PCI Express Protocol Analysis
Summit T4 Gen4 PCI Express Analyzer
User Manual



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Teledyne LeCroy Protocol Solutions Group

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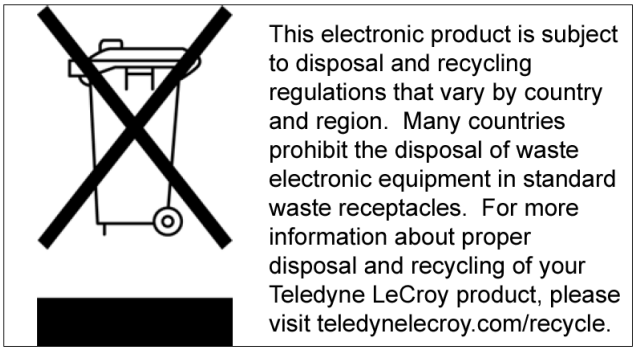
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WEEE Program



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Contents

Chapter 1: Overview 21

1.1 PCIe Protocol Analysis™ Analyzer Hardware and Software 21

1.1.1 CATC Trace Software 23
1.1.2 Summit T416 Analyzer 24
1.1.3 Summit T48 Analyzer 25
1.1.4 Features 26
1.1.5 Other Documents 26

Chapter 2: Hardware Description 27

2.1 System Components 27

2.2 Host Machine Requirements 27

2.3 Summit T416 Front Panel Description 28

2.4 Summit T48 Front Panel Description 30

2.5 Status and Config Display (Summit T4) 32

2.5.1 LCD Display and Button Functions for Analyzer Host Connection Setup 32
Set IP Configuration 32
Changing from Dynamic to Static IP Mode 33
Changing from Static to Dynamic IP Mode 33
Setting the Gateway and Subnet Mask 34

2.6 Summit T416 Rear Panel Description 36

2.7 Summit T48 Rear Panel Description 37

2.8 Gen4 CEM Interposer 38

2.8.1 Connecting the Gen4 CEM Interposer 38
2.8.2 Cabling Options for Tuning the Interposer 40
Installing the FTDI Serial Cable 40
Installing a USB Type-C Serial Cable 42
Using the Interposer Data Cable 43

2.9 Gen4 OCP NIC 3.0 Interposer Configuration 45
2.10 Gen5 Interposers 47
2.10.1 Gen5 x8 Interposer 47
2.10.2 Gen5 x16 Interposer 48
2.11 Multiport Mode Configuration 49
2.11.1 Summit T416 Configurations 50
Standard Mode using a cable-attached x16 interposer 51
Standard Mode Configuration using a MultiPort x16 interposer 52
Bifurcated (2 x8 Ports) Mode using cable-attached x16 interposer 54
Bifurcated (2 x8 Ports) Mode using MultiPort x16 interposer 55
Independent (2 x8 Ports) Mode using cabled-attached x8 interposer 57
Bifurcated (4 x4 Ports) Mode using cable-attached interposer 59
Bifurcated (4 x4 Ports) Mode using MultiPort x16 interposer 60
Independent (4 x4 Ports) Mode using MultiPort x4 interposer 62
Bifurcated (4 x2 Ports) Mode using two MultiPort x4 interposers 64
Connecting Midbus Probe 66
2.11.2 Summit T48 Configurations 67
Standard Mode Configuration using a cable-attached x8 interposer 68
Standard Mode Configuration using a MultiPort x8 interposer 69
Bifurcated (2 x4 Ports) Mode using a cable-attached x8 interposer 71
Bifurcated (2 x4 Ports) Mode using MultiPort x8 interposer 72
Independent (2 x4 Ports) Mode using Multiport x4 interposers 74
Bifurcated (2 x2 Ports) Mode using MultiPort x4 interposer 76
Connection with MidBus Probe 78
2.11.3 Gen4 x4 U.2/U.3 Single/Dual Port Interposer Configurations 79
U.2 x4 Single Port 79
Analyzing multiple x4 ports 80
U.2 x2 Dual Port Analysis 83
U.3 x4 Single Port Standard Mode 84

Chapter 3: Installation and Setup 87
3.1 Installing the PCIe Protocol Analysis software 87
3.1.1 Downloading the PCIe Protocol Analysis software 87
3.1.2 Windows Server 2016/2019 88
3.1.3 Launching the PCIe Protocol Analysis 97
3.2 Setting Up the Summit T416 or Summit T48 Analyzer using a USB Connection 98
3.3 Setting Up the Summit T416 or Summit T48 Analyzer using an Ethernet Connection .. 99
3.3.1 TCP Port Connections for Different Modes 99
3.4 Adding Devices Manually 103
3.4.1 Adding a Summit T416 or Summit T48 to an Ethernet Network 105

Chapter 4: Software Overview 111

4.1 The PCIe Protocol Analysis 111

4.2 Application Layout 112

4.3 Using the Toolbar 112

4.4 Toolbar Hide Buttons 116

4.4.1 Display Options: Level Hiding -> Direction 117

4.5 Using the Menus 118

4.5.1 File Menu 118

File Dialog 119

Clean Up Decoder Temp Files 120

4.5.2 Setup Menu 124

4.5.3 Record Menu 124

4.5.4 Report Menu 125

4.5.5 Search Menu 126

4.5.6 Quick Search Feature 129

4.5.7 View Menu 130

4.5.8 Tools Menu 131

4.5.9 Window Menu (helps display the loaded traces) 132

4.5.10 Help Menu 135

4.6 Dashboard View 135

4.6.1 Launching and Setting Recording Option from Dashboard View 137

4.7 Tool Tips 137

4.8 Keyboard Shortcuts 137

4.9 Status Bar 139

4.9.1 Recording Progress Bar 139

4.9.2 Recording Status 139

4.9.3 Recording Activity 141

4.9.4 Search Direction Indicator 141

4.10 Making a PCI Express Recording 141

4.10.1 Simple Mode Recording 141

4.10.2 Analyzer Calibration and Interposer Tuning 144

Connecting the Interposer 144

Interposer Tuning 144

4.10.3 Stopping a Recording 146

4.10.4 Saving a Recording 146

4.10.5 Multiport Mode 147

4.10.6 Multiport Mode Configuration: Summit T416 148

4.10.7 Multiport Mode Configuration: Summit T48 156

4.10.8 Recording Mode 162

4.10.9 Synchronized Recording 162

4.10.10 Multiport Analyzer Display (Synchronized vs. Non-Synchronized) 163
4.11 PCIe Protocol Analysis Files 165
4.11.1 CATC Trace Files 165
4.11.2 Recording Options Files 165
4.11.3 Display Options Files 165
4.12 Saving CATC Trace Files 165
4.12.1 Using the Save As Function 165
4.12.2 Saving a Portion of a CATC Trace 167
4.12.3 Save Copy As Function 167
4.12.4 Trace File Structure 169
4.13 Exporting a CATC Trace File 170
4.13.1 Export: To Text 171
4.13.2 Export: Packets to CSV Text 173
4.13.3 Export: To Generator File Format 175
Exporting a CATC Trace to a Traffic Generation File 175
4.13.4 Export From Data Flow View 178
Data Flow CSV File: Legacy Format 179
Data Flow CSV File: New Format 180
4.14 Printing Data Files 181
4.15 Analyzer Chat Window 181
4.15.1 CrossSync Control Panel 183
Launching the CrossSync Control Panel 183

Chapter 5: Recording Options 185
5.1 Recording Overview 185
5.2 General Tab 186
5.3 Recording Options: General Tab 187
5.4 Recording Type: Analyzer / Interposer / Mode 189
5.4.1 Selecting Multiport Mode before setting Recording Options 189
5.4.2 Recording Type: Interposer 192
5.4.3 Recording Type (trigger): Snapshot / Manual Trigger / Event Trigger 195
Snapshot 195
Manual Trigger 196
Event Trigger 196
5.5 Trigger Mode: Simple, Advanced or Script Mode 198
5.5.1 Simple Mode 198
5.5.2 Advanced Mode 198
Options in Advanced Mode: Disable Auto Channel Swap 199
Options in Advanced Mode: TC to VC mapping 200
5.5.3 Script Mode 202

5.6 Trace Filename and Path 204
5.7 Advanced Trace File Settings 205
5.8 Saving and Loading Previously Saved Recording Options 206
5.8.1 Saving Recording Options 206
Saving Recording Options: Buttons 206
Saving Recording Options: Steps 206
5.8.2 Loading Previously Saved Recording Options 207
Loading Recording Options: Buttons 207
Loading Recording Options: Steps 207
5.8.3 Loading Probe Settings in Recording Options 208
5.9 Filter Out 214
5.10 Trigger On 215
5.10.1 Triggering On (Simple Mode) 215
5.10.2 Triggering On (Advanced Mode) 216
5.11 Buffer Size 218
5.12 Recording Mode 219
5.12.1 Protocol Recording 219
SMBus Recording 219
Recording the CCIX Protocol 219
5.12.2 Bit Tracer Recording 221
5.12.3 NVMe Enhanced Recording 222
5.13 Trigger Position 223
5.14 Viewing Legacy Multi-Segmented CATC Traces 224
5.15 Link Settings 225
5.15.1 Speed 226
5.15.2 Link Width 227
5.15.3 Upstream and Downstream 229
5.15.4 Reference Clock 230
Internal 232
External 232
SMA 232
5.15.5 PCIe Specification Compatibility 232
5.15.6 Disable Descrambling 233
5.15.7 Auto-Configure Lane Polarity 233
5.15.8 Ignore EDS 233
5.15.9 Ignore Idle Errors 233
5.15.10 Swizzling Config... 233
Manual Configure Lane Swizzle 234
Example: Move Highest Source Lane First 237
Example: Move Lowest Source Lane First 237

Working with Less Than Sixteen Lanes 238
Auto-Configure Lane Swizzle 240
5.15.11 Decode Optimized Buffer Flush/Fill (OBFF) 241
5.16 Navigating Recording Rules 243
5.16.1 Toolbar 243
5.16.2 Available Events Area 243
5.16.3 Recording Rules: Main Display Area 243
5.16.4 Recording Rules Buttons 243
5.17 Recording Rules Overview 245
5.17.1 Defining Recording Rules 245
Steps to Create a Recording Rule 245
5.17.2 Resources 247
Basic Matcher (x8) 249
5.17.3 Ordered Set (OS) Matcher (x8) 250
Trigger on Control Skip 251
5.17.4 Data Link Layer Packets (DLLPs) Matcher (x8) 253
5.17.5 Transaction Layer Packets (TLPs) Matcher (x8) 254
5.17.6 Global State and Sequence States 255
Global State 256
Sequence State 257
5.17.7 Recording Rules Events 258
5.17.8 Properties Dialog Boxes for Events 261
Accessing the Properties Dialog 261
Event Properties Dialog Box Features 262
Link State Dialog 263
Ordered Sets 266
Framing Token 268
Compliance Set Properties Dialog 271
Error Properties Dialog 273
DLLP Packet Properties Dialog 275
TLP Header Properties Dialog 277
TLP Prefix Properties Dialog 277
AHCI Register Properties Dialog 281
NVME Register Properties Dialog 282
PQI Register Properties Dialog 284
SOP Unit Event Properties Dialog 285
Recording Rules: MCTP New Event 287
5.17.9 Actions Properties Dialog 296
Filter Out 298
Filter-Out In Simple Mode 298
Filter-Out in Advanced Mode 299
5.17.10 Filter In 300

5.17.11 Valid Configuration 301
5.17.12 Invalid Configuration 302
5.17.13 Filtering Events: (Electrical Idle, CLKREQ#, WAKE#, PERST#) 303
Example of CLKREQ# Filtering Enabled 303
5.17.14 Filtering Out NVMe CSTS, DLLP Ack and TLP Completions 304
5.17.15 Triggering Configuration on a per Lane Basis 315
DLLP/TLP Packets Category 316
Errors Category 317
Ordered Sets Category 317
5.17.16 Lane Trigger Configuration 318
Example 1: 318
Lane Trigger Configuration Example 2: 319
Lane Trigger Configuration Example 3: 319
5.17.17 Counter 322
How to Set a Counter 323
How to Increment or Reset a Counter 324
Changing the Value of the Counter 325
Deleting a Counter 326
5.17.18 Timer 326
How to Set a Timer 327
How to Start or Reset a Timer 329
Changing the Value of the Timer 330
Deleting a Timer 330
5.17.19 Channel 330
5.17.20 Lane Margining 331
5.18 Analyzer & Probe Settings 334
5.18.1 Library 334
5.18.2 Search Filter 335
Saving a Selected Preset 337
5.18.3 Library Operations 339
Buttons & Functions 340
5.19 General Guidelines for Calibration and AutoTuning 342
5.19.1 Interposer Host to DUT Path 342
Interposer Host to DUT CTLE and DCGain Settings 343
Interposer Host to DUT Autotune 348
Access to Configuration Space 349
Using Z516 or Z58 as a DUT 350
Auto-tuning algorithms 351
Host PC is running Window OS 354
Host is on Linux OS: 366
Write to Interposer 373
Write to RAM 373

Write to Flash + RAM 373
Write Default to Flash + RAM 373
Read from Interposer 373
Set All Lanes 373
Log 373
Save to File 373
Load from File or Predefined Values 373
5.19.2 Interposer to Analyzer Path 376
Calibration Dialog: Algorithms 377
5.19.3 Analyzer Calibration 378
Analyzer Calibration: Auto Option 379
Analyzer Calibration: Manual Option 381
Analyzer Calibration: Eye Scanner Option 383
5.19.4 Using the Autotune and Probe Calibration Wizard 389
Launch Auto Probe Calibration Wizard 391
Step 2: Interposer Verification 392
Setting Parameters 408
Setting Polarity 409
Precalibration 410
Setup Calibration: Host System and DUT Configuration 411
Connect to the Host System 412
Calibration Process 413
Calibration Results 414
5.20 Tools Options 416
5.20.1 Interposer Settings for Bifurcated Multiport Link 416
..... Saving Auto-Tune and Calibration Results 418
5.20.2 Autotune and Probe Calibration Wizard 418
5.21 Preparing to Record in NVMe Enhanced Mode 421
5.21.1 Snapshot – Simple Mode 421
Features 422
5.21.2 Snapshot – Advanced Mode 424
5.21.3 Event Trigger – Advanced Mode 425
5.21.4 SSD Device Configuration File 428
5.22 NVME Command Mode 430
5.22.1 NVME Command Mode - Simple verses Advanced Mode 430
5.22.2 Set Namespace IDs 433
5.22.3 NVME Command Mode Warnings 434

Chapter 6: Reading CATC Traces 435
6.1 Viewing PCI Express CATC Traces 435
6.2 Expand and Collapse Data Fields 435
6.3 Resizing Cells 436
6.4 Pop-up Menus 436
6.5 View Data Block 436
6.5.1 Save Data Block 437
6.6 Show Raw 10b Codes 438
6.7 Show Header Fields 439
6.8 Packet Cell Popup Menus 440
6.8.1 Show/Hide Link Tracker 441
6.8.2 Show Raw 10b Codes 442
6.8.3 Time From Trigger 443
6.8.4 Time From Marker 444
6.8.5 Copy for PETrainer 'packet' command 445
6.8.6 Set Start Quick Timing Marker 446
6.8.7 Set End Quick Timing Marker 446
6.8.8 Tag Pop Up Menu 447
Quick Timing Bar 449
6.8.9 Delete All Quick Timing Markers 449
6.8.10 Set Marker 449
6.8.11 Edit or Clear Marker 451
6.8.12 Format 452
6.8.13 Color 453
6.8.14 Other Packet Cell Popup Menus 454
Packet Header R-> Cell Popup Menu 454
Packet Header Speed Cell Popup Menu 454
6.9 Compressed CATC Trace View 455
6.10 Spreadsheet View 456
6.10.1 Columns 458
6.11 Detail View and Spreadsheet View 462
6.12 Decoding Traffic 463
6.12.1 Packet 463
6.12.2 Link 465
6.12.3 Split 465
6.12.4 Lane Margining Decoding 466
Typical Lane Margining Commands and Responses 466
Lane Margining Command: Step Margin to Timing Offset 468
Lane Margining Errors 469

6.12.5 NVMe Decoding 470
NVMe: Device ID and Model Name Decoded 472
NVMe: Data Field on Packets 473
NVMe: Trusted Computing Group Decode 475
The Opal Storage Specification 476
Opalite Version 0.1: Decoded 478
NVMe: Command IOPS and Doorbell Statistical Information 480
NVMe: Decode for Doorbells 484
Time Stamp from Implicit Start 486
NVMe Commands and Transactions: Data Throughput 487
NVMe Decoding vs. NVMe Specification 488
NVMe Controller Register 491
Decoding Multiple NVMe Commands for a Single MemRead or MemWrite 495
6.12.6 NVMe 1.2 Specification Decoding 498
6.12.7 Support for Physical Region Page (PRP) and Scatter Gather List (SGL) in Controller Memory Buffer (CMB) 502
6.12.8 NVMe Decoding for Host Memory Buffer FID 505
6.12.9 AHCI 506
6.12.10 ATA 506
ATA IO: Pending Transactions Statistical Report 507
6.12.11 PQI 510
6.12.12 SOP 510
6.12.13 SCSI 511
6.12.14 Decoding MCTP (Management Component Transport Protocol) 512
MCTP Levels in Floating Transactions Bar Window 512
Decoding MCTP Commands 513
Expanding MCTP Commands 517
Decoding MCTP Messages 518
MCTP Commands with SMBus Traffic 519
MCTP Commands: Request from Host, Response from Device 520
Decoding MCTP Messages and Transactions 521
MCTP Messages 522
MCTP Transactions 522
MCTP Errors Reported 523
MCTP Trace In Spreadsheet View 524
Decoding MCTP Messages with PLDM Message Types 525
Decoding MCTP Messages with NC-SI Message Types 526
MCTP Command with NVMe-MI Errors Decoded 527
MCTP Message Type and IC Cells 528
6.12.15 Decoding MCTP Messages with SMBus Traffic 530
Sideband Traffic: Displayed or Hidden 532
SMBus Errors 534

SMBus Error Tooltip 535
Traffic Summary Report: SMBus Errors 536
6.12.16 Decoding SMBus with Address Resolution Protocol (ARP) 538
6.12.17 Decoding MCTP Traffic with Vendor Defined Messages (VDM) 539
6.12.18 Decoding Side Band Signals 540
6.12.19 PMUX Channel ID Found and PMUX Packet Error Decoded in Trace 541
6.12.20 Decoding Traces with Different Class Codes 542
Example: Loading an NVMe Trace and Decoding for ATA 542
Example: Loading a PQI Trace and Decoding for NVMe 543
6.12.21 Data Link Features 544
6.12.22 Decoding PCI-SIG Vendor Defined Messages (VDMs) 545
6.12.23 Decode for NVMe 1.3c Specification 547
6.12.24 NVMe Warning Messages 551
Trace View 551
Traffic Summary View 553
Find NVMe Commands and Transactions 557
Hiding NVMe Warning Messages 559
6.12.25 Warning Messages in Split Traces 560
6.12.26 Decoding Lightweight Notification (LN) Protocol 562
Lightweight Notification Protocol Errors 563
Lightweight Notification Protocol in Trace Expert 564
Lightweight Notification Transaction Analysis Errors: Trace Expert 566
Find: Lightweight Notification Transactions 567
6.12.27 Decoding CCIX Protocol 568
6.12.28 Decoding TCG Support of Pyrite 569
6.12.29 MCTP: Simple Hiding 570
MCTP: Hide VDM Traffic 570
MCTP: Hide SMBus Traffic 572
6.12.30 Decoding NVME-MI Version 1.1 574
6.12.31 Decoding NVME-MI Version 1.1 with BMC 575
NVMe-MI BMC Errors 576
Errors Displayed in Traffic Summary 577
Decoding BMC Commands with Any Offset 578
SMBus Read Commands 579
6.12.32 Link Up/Link Down Direction 580
6.12.33 Swapping Direction of Recorded Traffic Data 581
6.12.34 Decoding Traces Exported from USB4 Traces with Tunneled PCIe Traffic 584

Chapter 7: Searching CATC Traces 587
7.1 CATC Trace Search Overview 587
7.2 Go to Trigger 588
7.3 Go to Selected Packet 588
7.4 Go to Packet 588
7.5 Go to Time 589
7.6 Go To Marker 589
7.6.1 Markers 590
Markers Overview 590
Functionality of Markers 591
Set New Marker 591
7.6.2 Attaching Markers 592
7.6.3 Adding an Attachment 593
7.6.4 Recording an Audio File 593
7.6.5 Video Files Supported 594
7.6.6 Attachment Types and Visualization 594
7.6.7 Embedded Attachments to a Marker 594
7.6.8 Viewing Attachments of a Marker 595
Text 595
Audio 596
Video 597
File Attachment 597
URL Link 597
YouTube Video 599
Images 599
Other Attachments 600
7.6.9 Edit Marker 601
7.6.10 All Markers Dialog 602
7.6.11 CATC Walk Playlist 604
7.6.12 Playlist Functionality 604
7.6.13 Playback Window 605
Playlist Playback Controls 606
7.7 Go to NVMe Transactions and Commands 607
7.7.1 NVMe Transaction 607
7.7.2 NVMe Command 608
7.8 Go To SCSI Menu 609
7.9 Go To Menu 610
7.9.1 Example: Search -> Go to -> Link Event -> Link Up/Link Down 611
7.9.2 Example: Search -> Go To -> Direction 612

7.10 Find 613
7.10.1 Event Groups for Packets 617
Example: TS1 and TS2 Event Groups 618
Example: Search for PMUX Channel ID 627
7.10.2 Event Groups for Link Transactions: 629
7.10.3 Event Groups for Split Transactions: 629
7.10.4 Event Groups for LM Commands 629
7.10.5 Event Groups for NVMe transactions: 630
7.10.6 Event Groups for PQI Transactions: 631
7.10.7 Event Groups for AHCI Transactions: 631
7.10.8 Event Groups for ATA transactions: 631
7.10.9 Event Groups for SOP Transactions: 631
7.10.10 Event Groups for SCSI Transactions: 631
7.10.11 Event Groups for NVMe Commands: 632
Example: Search for NVMe Command 632
Example: Search for NVMe Command: NVM Payload Portion 635
7.10.12 Event Groups for MCTP Messages: 636
Example: MCTP Messages to Search For 637
Example: Searching for PLDM Message Types within MCTP Messages 638
Example: Searching for NC-SI Message Types within MCTP Messages 639
7.10.13 Example: Search for DLLP Header -> Flow Control Feature 640
7.11 Find Next Packet Type 642
7.11.1 Quick Search Feature 642
7.11.2 Quick Search for MCTP Transactions 645
7.12 Toggle Search Direction 646

Chapter 8: Display Options 647
8.1 Setting Display Options 647
8.2 Specifying General Display Options 648
8.2.1 Collapsing Data Fields 649
8.2.2 Fonts 650
8.2.3 Configuration Name 651
8.2.4 Color, Format, and Hiding Options 652
8.2.5 Setting Field Colors 653
8.2.6 Changing Field Formats 655
8.2.7 Hiding Fields 657
8.2.8 Level Hiding 658
8.2.9 Error Hiding 662
Transaction Types 663
8.2.10 Warning Hiding 666
Transaction Types 667

8.3 Load a Previously Saved Display Options File 668
8.4 Saving Display Options 668

Chapter 9: BitTracer Recording 669
9.1 Enabling BitTracer Recording 669
9.2 Trigger Modes 670
9.3 Views Available for Captured Data 670
9.4 De-skewing Data 671
9.5 Data Display Formats 672
9.6 Color-Coding of BitTracer Contents 673
9.7 Report and Analysis Windows 673
9.8 Timing Measurements Bar 675
9.8.1 Markers/Speed Bar 675
9.8.2 Defining a Marker 676
9.9 Errors Bar 677
9.10 Symbols Bar 679
9.11 Events Bar 679
9.12 Packets Bar 680
9.13 Decoding Bar 681
9.14 Search 682
9.15 Link Configuration 683
9.16 Export of BitTracer Capture to CATC Trace Format 685
9.16.1 Exports Involving Multiple Logical Links on One Physical Link 685
9.16.2 Export To CSV Text 685
9.16.3 Exporting Data from Bit Tracer to a Trace File 687
9.17 Compressing and Expanding the Data View 692
9.18 Opening and Saving BitTracer Captures 693

Chapter 10: Reports and Tools 695
10.1 Trace Information 697
10.2 Error Summary 699
10.2.1 Error Summary for Storage Protocols 700
10.2.2 Error Summary for Storage Protocols -- NVMe 702
Types of NVMe Errors: 702
10.2.3 NVMe Queue Errors 703
Types of NVMe Queue Errors 703

10.2.4 NVMe CMD Errors....704
Types of NVMe CMD Errors....704
10.3 Traffic Summary....707
10.3.1 Traffic Summary for Storage Protocols....707
10.3.2 Using the Traffic Summary Window to Search the CATC Trace....708
10.3.3 NVMe Queue Time Metrics....708
NVMe Queue Time Metrics Defined (Commands/Transactions)....710
NVME Command Example....710
NVME Transaction Example....711
10.3.4 Traffic Summary Buttons....711
10.3.5 Traffic Summary for MCTP....712
10.3.6 Traffic Summary for Flow Control....715
10.4 Bus Utilization....716
10.4.1 Bus Utilization Pop-up Menu....717
10.4.2 Bus Utilization Buttons....718
Graph Area Options....720
Example: NVMe Queue Load Graph Feature....722
Graph Legend....723
Graph Properties....723
10.5 Link Tracker....724
10.5.1 Using the Link Tracker Window....724
10.5.2 Zooming In and Out....725
10.5.3 Collapsing Idle Time, Enabling Tool tips, and Resetting Column Widths....725
10.5.4 Docking and Undocking the Window....726
10.5.5 Setting Markers....726
10.5.6 Calculating Time between DWORDs....726
10.5.7 Hiding Traffic....727
10.5.8 Link Tracker Buttons....727
Exporting to CSV File....729
10.6 Data Flow Window....730
10.7 Flow Control Tracking....732
10.8 Using the CATC Trace Navigator....733
10.8.1 Displaying the Navigator....733
10.8.2 Navigator Toolbar....733
10.8.3 Navigator Ranges....734
10.8.4 To Determine Current Position....734
10.8.5 To Reset Navigator Range....735
10.8.6 Navigator Panes....735
10.8.7 To Show/Hide Nav55igator Panes....736
10.8.8 Navigator Slider....736
10.8.9 CATC Trace Navigator Legend....736
10.8.10 Using the Legend to Show/Hide Navigator Panes....737

10.8.11 Using the Legend to Set the Priority of Information Display 737
10.9 Detail View 738
10.10 LTSSM Flow Graph 739
10.10.1 LTSSM Dynamic Equalization 740
10.11 Lane Margining: Eye Diagram 743
10.12 Packet Header Bar 746
10.13 Packet Data Window 746
10.14 Configuration Space View 748
10.14.1 Save Configuration Space 751
10.14.2 Tools -> Import Configuration Space File 753
10.14.3 Configuration Space Editor 754
10.15 Using Unit Metrics 756
10.16 Metrics Defined for Link Transactions 756
10.16.1 Metrics Defined for Split Transactions 756
10.17 Show Metrics in the CATC Trace Display 757
10.17.1 Collapsed Metrics Header Display 757
10.17.2 Metrics Tool Tip Display 757
10.17.3 Expanded Metrics Header Display 757
10.18 Show Metrics in the Traffic Summary Window 758
10.18.1 Reports at Split Transaction Level 758
10.18.2 Reports at the Link Transaction Level 759
10.19 Show Metrics in the Bus Utilization Window 760
10.19.1 Unit-Based Averaging 761
10.19.2 Bus Utilization Window Features 761
10.19.3 Split Transaction Level Graphs 761
10.19.4 Link Transaction Level Graphs 762
10.20 Memory I/O Space Editor 763
10.21 TC to VC Mapping 763
10.22 Timing and Bus Usage Calculations 764
10.22.1 Timing Calculator 764
PCIe Timing Information: Entire Trace 765
Bus Utilization 765
Split Transaction Performance 766
Memory Writes Performance 766
Queue Utilization 766
Total Input/Output 768
Timing Calculator Display units 769
10.22.2 Details of Timing Calculations 770
Timing From Beginning of Event to Beginning of Event or to End of Event 770

Types of Events 770
Displaying Time 771
Markers 771
Timing To Beginning of NVMe Command 772
Timing To End of NVMe Command 773
Results from Timing Calculator 773
Timing to Beginning and End of Events: Effect on Queue Utilization 774
Timing to Beginning and End of Events: Effect on Total Input / Output 775
10.23 PCIe SSD Base Address Mapping 776
10.23.1 Base Address Not Record in Trace 776
10.23.2 Base Address Recorded in Trace 777
10.23.3 NVMe PCIe SSD Device Configuration 778
Interrupts 781
10.23.4 AHCI PCIe SSD Device Configuration 781
10.23.5 PQI PCIe SSD Device Configuration 783
10.23.6 SCSI PCIe SSD Device Configuration 785
10.24 Running Verification Scripts 787
10.24.1 NVMe Performance: Doorbell Timing 790
10.24.2 MCTP Transaction Verification Script Generation 791
10.25 Trace Expert 792
10.25.1 Performance Analysis 795
10.25.2 Trace Analysis Statistics 796
10.25.3 Error Reports 797
10.25.4 Trace Information 798

Chapter 11: Updates and Licensing 799
11.1 Updating the Analyzer 799
11.2 License Keys 799
11.3 License Information 799

Appendix A: How to Contact Teledyne LeCroy 801

Appendix B: China Restriction of Hazardous Substances Table 803

Appendix C: Quick Search Feature 805
C.1 Quick Search Feature: Pre-Defined Terms 805

Appendix D: Configuration Space Decoding 809
D.1 Mandatory Definitions 809
D.2 Mandatory Module Functions 809
D.2.1 DecodeRegister(offset) 810
D.2.2 GetSize() 810
D.3 Configuration Register Types 810
D.4 Primitives 811
D.4.1 GetRegisterField 811
D.4.2 AddField 811
D.4.3 AddSubField 812
D.5 Helper File 812

Appendix E: Example of XML File Format for SSD Decodes 813

Appendix F: Expandability 815
F.1 Expandability 815
F.1.1 Removal of Expansion Cards 816
F.1.2 Installation of Expansion Cards 820
F.1.3 Daisy-Chaining with CATC SYNC Expansion Cards 823
F.2 Link Width Expansion using Two Summit T48 Analyzers 825
F.2.1 Two Summit T48s Configured in Link Width Expansion Mode 825

Index: 829

Chapter 1

Overview

Designed for developers and validators, the Teledyne LeCroy Summit T416™ and Summit T48™ are Gen1/Gen2/Gen3/Gen4 PCI Express advanced verification systems.

By leveraging years of experience in protocol analysis tools for emerging markets, Summit T416 and Summit T48 blend sophisticated functionality with practical features to speed the development of PCI Express™ IP cores, semiconductors, bridges, switches, add-in boards, and systems.

1.1 PCIe Protocol Analysis™ Analyzer Hardware and Software

Features and Benefits

Summit T4 Analyzers have these features and benefits:

Features	Benefits
Powerful and Intuitive CATC Trace™ Analysis Software	Faster interpretation and debug of PCI Express traffic with color-coded, clearly labeled protocol elements in a graphical display.
Extensive Decoding	Complete, accurate and reliable decoding of TLPs (Transaction Layer Packets), DLLPs (Data Link Layer Packets), NVMe 1.4, PQI, AHCI, ATA, SOP and SCSI command transactions and all PCI Express Primitives.
Intelligent Reporting	Quickly identify and track error rates and abnormal link or timing conditions. Display configuration space and protocol specification details.
Sophisticated Viewing	View Packet, Link, Split, NVMe 1.4, PQI, AHCI ATA, SOP and SCSI command transaction levels of the PCI Express protocol. Collapsible/expandable headers with Tool tip explanations make it easy to navigate and interpret packet contents, headers, and commands. View packets, transactions of TLPs and DLLPs in classic CATC Trace™ format or in raw bit stream for deeper analysis.

Summit T416 128 GB Recording Capacity, 64 GB in each direction	Capture long recording sessions for analysis and problem solving.
Summit T48 64 GB Recording Capacity, 32 GB in each direction	Capture long recording sessions for analysis and problem solving.
Flexible Host Interface	USB and GIGE.
Downloadable CATC Trace Viewer	Share and annotate CATC Trace recordings within a development team. Freely distributable PCIe Protocol Analysis enables collaborative analysis across sites and time zones.
Summit T416 Bidirectional x1-x16, 2.5 GBps to 16.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.
Summit T48 Bidirectional x1-x8, 2.5 GBps to 16.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.
Field-upgradeable firmware and recording engine	Upgrades available for download direct from the Teledyne LeCroy website.
Flexible probing options	Supports variety of probing options including slot interposers, MidBus probes and specialty probes. Gen4 Slot Interposer Gen4 OCuLink Interposer Gen4 OCuLink Host Adapter Gen3 Interposer Gen3 MidBus probe Gen2 MidBus probe Gen2 multi-lead probe Gen2 active and passive interposers
External interface	Enables cross triggering between other test instruments.
Dword to Transaction Level Viewer	View Dwords, Packet, Link, Split, NVMe, PQI, AHCI ATA, SOP and SCSI command transaction levels of the PCI Express protocol.
Support for Gen1/Gen2/Gen3/ Gen4 Compliance Patterns	Gen1/Gen2/Gen3/Gen4 Compliance Patterns can be decoded as well as filtered out of the traffic stream.

1.1.1 CATC Trace Software

The Summit T4 utilize the CATC Trace™ to assist users in analyzing how PCI Express components work together, diagnose problems, and test for interoperability and standards compliance.

The CATC Trace is a powerful and intuitive expert software system embedding detailed knowledge of the protocol hierarchy and intricacies, as defined in the protocol specification. The software allows the user to control the Analyzer and set specific real-time triggering and filtering conditions. The CATC Trace utilizes a Windows-based graphical display that has been optimized for fast and easy navigation through a captured traffic session. Users are alerted as violations are detected at all levels of the protocol layering and can easily drill down on areas of interest or collapse and hide fields that are not relevant.

1.1.2 Summit T416 Analyzer

The Teledyne LeCroy Summit T416 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets.

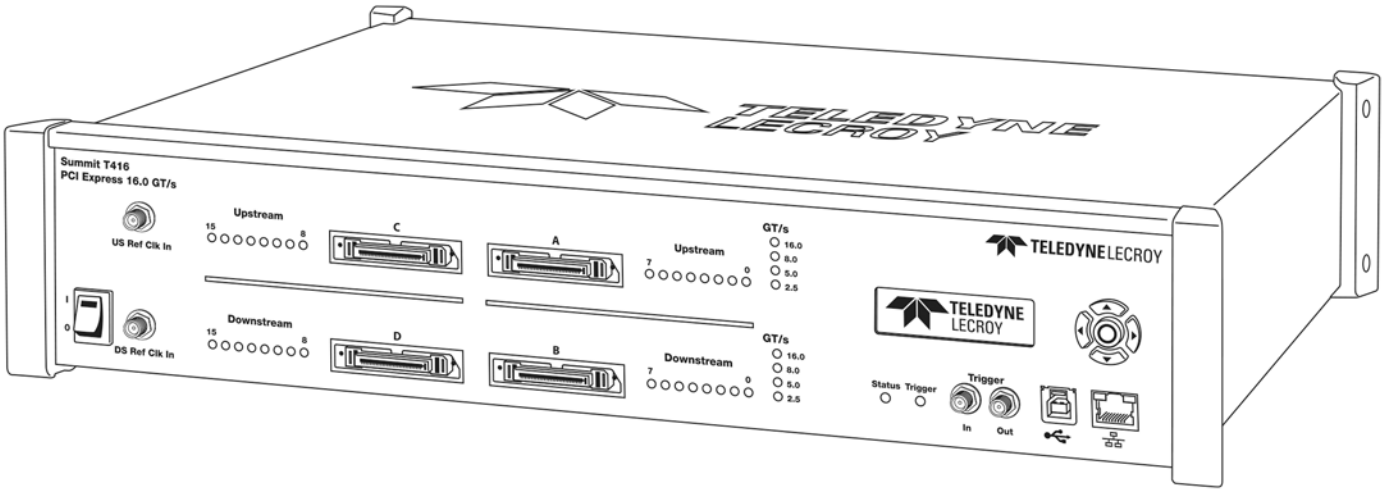


Figure 1.1: Summit T416 Analyzer

With advanced features such as support for PCI Express Spec 4.0, data rates from 2.5 to 16.0 GBps, lane widths from x1 to x16, and a full 128 GB of memory, the Summit T416 provides unmatched capability and flexibility for developers and users of advanced PCI Express products. The Summit T416 is the most advanced and sophisticated PCI Express Analyzer available in the market today.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T416 leverages the intuitive and powerful CATC Trace analysis software system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

In addition to a full suite of advanced hardware and software features, the Summit T416 has user-convenience and analysis features, such as support for "lane swizzling," which allows a board developer to lay out a mid-bus probe pad with lanes in non-standard order, simplifying the design of the board. Internally, the Summit T416 maps the lanes back into their correct order and accurately displays the embedded bus traffic. An optional Bit Tracer mode allows bytes to be recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

The Summit T416 supports USB and GIGE host interfaces. By connecting over GIGE, engineers can operate the system remotely (for example, install the client software on their desktop systems to control an analyzer operating in a remote lab). Also, multiple engineers working collaboratively can time-share use of a single analyzer, reducing the need for an additional analyzer for each engineer and increasing the cost effectiveness of the product.

1.1.3 Summit T48 Analyzer

The Teledyne LeCroy Summit T48 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets.

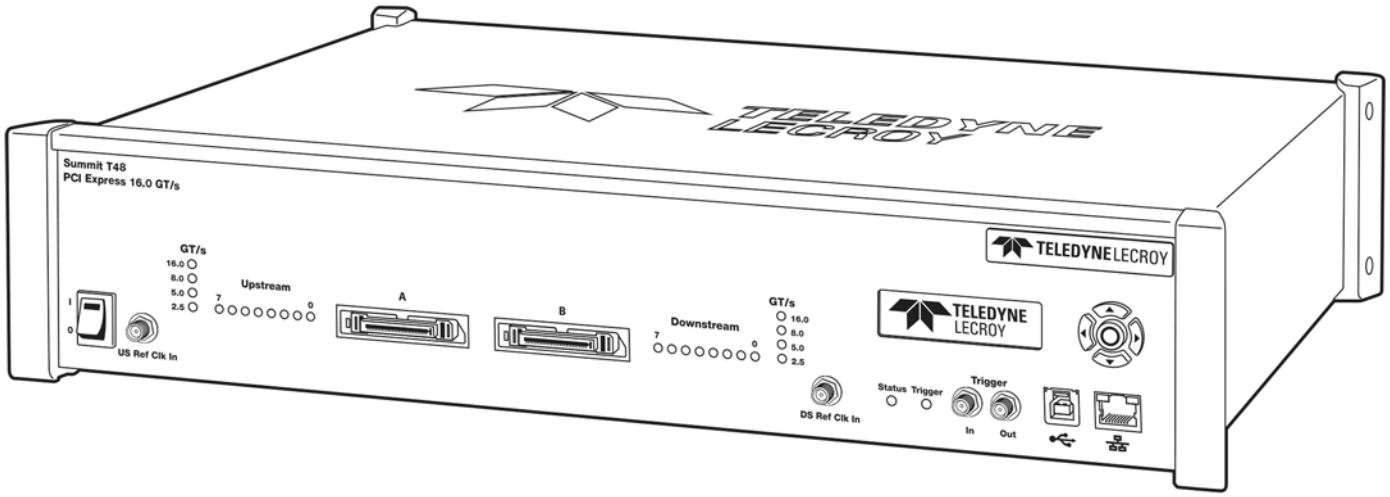


Figure 1.2: Summit T48 Analyzer

With advanced features such as support for PCI Express Spec 4.0, data rates from 2.5 to 16.0 GBps, lane widths from x1 to x8, and a full 64 GB of memory, the Summit T48 provides unmatched capability and flexibility for developers and users of advanced PCI Express products. The Summit T48 is the most advanced and sophisticated PCI Express Analyzer available in the market today.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T48 leverages the intuitive and powerful CATC Trace analysis software system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

In addition to a full suite of advanced hardware and software features, the Summit T48 has user-convenience and analysis features, such as support for "lane swizzling," which allows a board developer to lay out a mid-bus probe pad with lanes in non-standard order, simplifying the design of the board. Internally, the Summit T48 maps the lanes back into their correct order and accurately displays the embedded bus traffic. An optional Bit Tracer mode allows bytes to be recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

The Summit T48 supports USB and GIGE host interfaces. By connecting over GIGE, engineers can operate the system remotely (for example, install the client software on their desktop systems to control an analyzer operating in a remote lab). Also, multiple engineers working collaboratively can time-share use of a single analyzer, reducing the need for an additional analyzer for each engineer and increasing the cost effectiveness of the product.

1.1.4 Features

- **Powerful and Intuitive CATC Trace Analysis Software System**: The CATC Trace embeds deep understanding of the PCI Express protocol hierarchy and intricacies. This knowledge is presented in a colorful, intuitive and easy-to-use graphical display, allowing you to quickly capture and validate PCI Express product designs.
- **Protocol Hierarchical Viewing**: Displays Packet, Transaction, Split, NVMe 1.4, PQI, AHCI, ATA, SOP and SCSI command transactions levels of the PCI Express protocol, with increased drill-down detail for PCI Express primitives, errors, payloads or individual packets.
- **Multiport Mode:** T416 can analyze one link of up to x16 traffic, two links of up to x8 traffic (bifurcated or independent) or four links of up to x4 traffic (bifurcated or independent). The T48 can analyze one link of up to x8 traffic or two links of up to x4 traffic (bifurcated or independent).
- **Lane-Reversal Compatible**: Triggers, records, and displays PCI Express traffic logically, regardless of the physical configuration of the lanes.
- **Statistical and Error Reporting**: Provides a quick summary of the CATC Trace file to identify and track error rates and abnormal link or timing conditions.
- **Bit Tracer Recording Mode (optional)**: Records the bytes exactly as they come across the link, allowing debugging of PHY layer problems.
- **Auto Speed detection**: Follows link transitions through speed changes.
- **Lane Swizzling Support**: Allows board developers to lay out lanes in a non-standard order, simplifying board design.
- **Field-upgradeable Firmware and Engine**: Positions you to receive the latest PCIe Protocol Analysis enhancements and future additional capabilities. Allows field upgrades of all system types.
- **T416 has 128-GB Data Buffer**: Capture long time windows for in-depth analysis and identification of erratic problems.
- **T48 has 64-GB Data Buffer**: Capture long time windows for in-depth analysis and identification of erratic problems.
- **GIGE Ethernet Connectivity**: Allows connection to an Ethernet network and sharing of analyzer resources by multiple engineers.
- **USB connectivity**: Allows connection by USB cable.
- **CrossSync Application:** The CrossSync application allows you to select analyzers for synchronization and manage the recording process.

1.1.5 Other Documents

For more information, refer to the following documents:

- Teledyne LeCroy Analyzers File-based Decoding Manual
- PCIe Protocol Analysis/Trainer Automation Manual
- PCIe Protocol Analysis VSE Manual
- CrossSync Control Panel User Manual

Chapter 2

Hardware Description

The PCI Express™ system features Summit Analyzers.

2.1 System Components

Summit T416 system:

- Summit T416™ analyzer box
- One or two (for x8 or x16 recording) iPass Y probe data cables
- (optional) probes and interposers (see "Adding Devices Manually" on page 103)

Summit T48 system

- Summit T48™ analyzer box
- One (for x8 recording) iPass Y probe data cables
- (optional) probes and interposers (see "Adding Devices Manually" on page 103)

2.2 Host Machine Requirements

The Summit T416 and Summit T48 analyzers connect to a host machine. Please consult the **readme** file for the latest host machine requirements.

2.3 Summit T416 Front Panel Description

When powered on, the Summit T416 activates the user-accessible controls and LEDs on the front panel. See Figure 2.1.

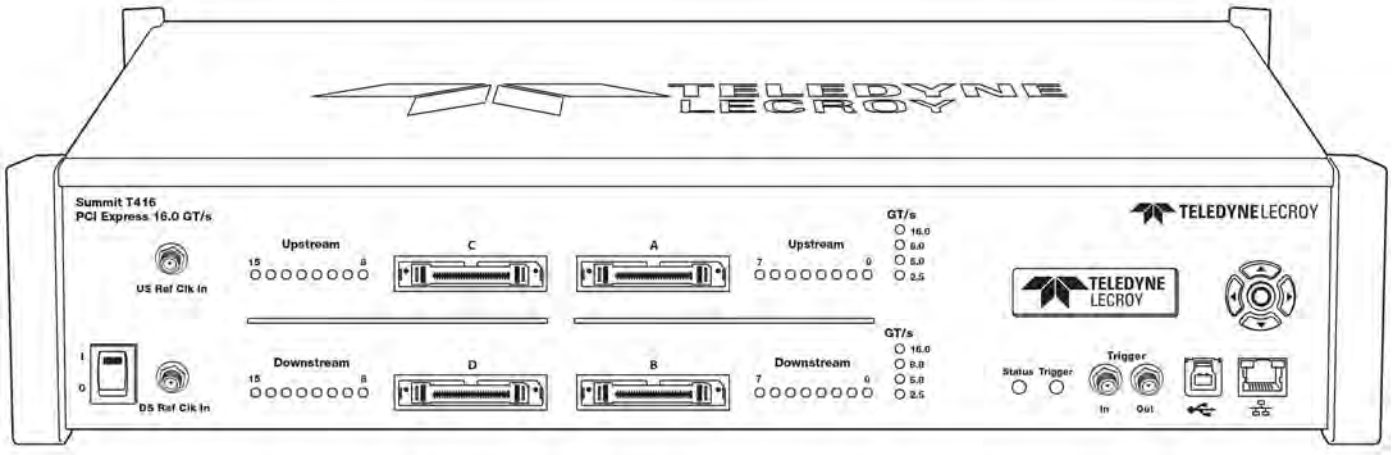


Figure 2.1: Summit T416: Front Panel

WARNING: Do not open the enclosure. There are no operator serviceable parts inside. Refer servicing to Teledyne LeCroy.

The controls and LEDs are:

- **Power Switch (black)**: 1 = On and 0 = Off. Once the analyzer is powered off you need to wait at least 10 seconds before you power it back on, otherwise the analyzer may not initialize properly.
- **LCD Menus**: Allow you to set up the Summit T416 and view status.
- **LCD Menu Navigation Buttons**: Allow you to navigate through the LCD menu.
- **Speed LEDs**: Indicate the current speed for the Upstream and Downstream link.
- **Upstream LED**: Indicates the activity of the Upstream lanes.
- **Downstream LED**: Indicates the activity of the Downstream lanes.
- **UPSTREAM [15:8] and UPSTREAM [7:0] connectors**: Connection to the probe for the capture of upstream direction of the link.
- **US Ref Clk In:** Upstream Reference Clock Input SMA.
- **DOWNSTREAM [15:8] and DOWNSTREAM [7:0] connectors**: Connection to the probe for the capture of downstream direction of the link.
- **DS Ref Clk In:** Downstream Reference Clock Input SMA.
- **Trigger**:
  - **In** for SMA external trigger input.
    - Trigger Input has a 1.5 kohm pullup resistor to 3.3 volts and a 50 ohm RC termination.
    - Threshold voltage for Trigger Input is 0.55 volts.
    - Voltages below 0.4 volts will be detected as low, voltages above 0.7 volts

will be detected as high.
- The minimal pulse width is 70ns for rising pulses and 20us for falling pulses.
- When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.

- **Out** for SMA external trigger output.
  - Output buffer is 3.3 volts. The buffer can drive up to 32 mA of current and meet VOH (2.5 V) and VOL (0.5 V) thresholds.
  - Output buffer can drive a 50 ohm DC load (such as scope input).

- **USB**: USB Type B connector for connection to host machine.
- **ETHERNET**: Gigabit Ethernet connector for connection to a host machine.

2.4 Summit T48 Front Panel Description

When powered on, the Summit T48 activates the user-accessible controls and LEDs on the front panel. See Figure 2.2.

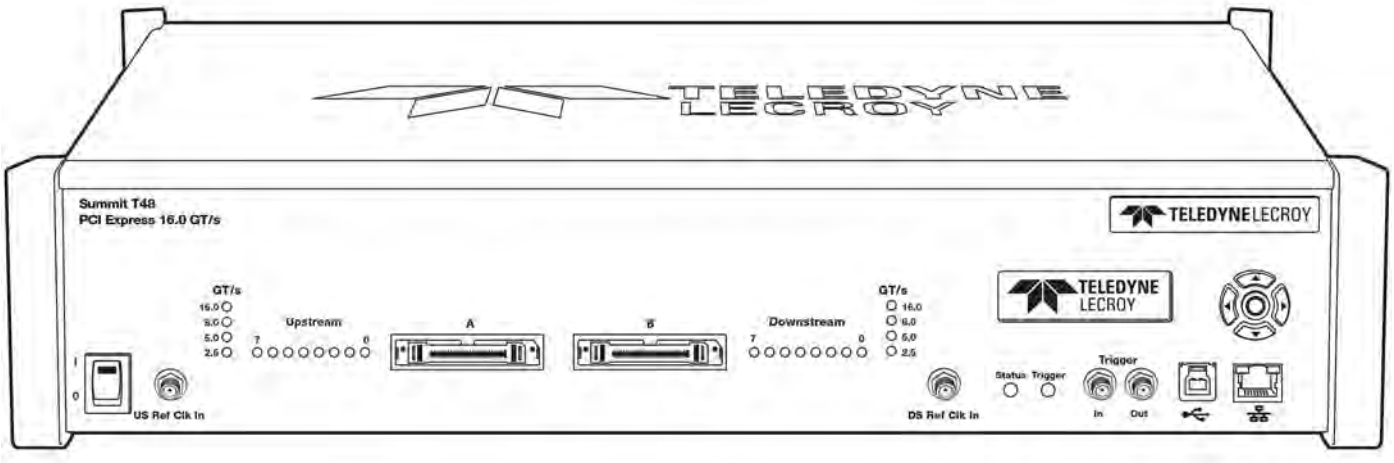


Figure 2.2: Summit T48: Front Panel

WARNING: Do not open the enclosure. There are no operator serviceable parts inside. Refer servicing to Teledyne LeCroy.

The controls and LEDs are:

- **Power Switch (black)**: 1 = On and 0 = Off. Once the analyzer is powered off you need to wait at least 10 seconds before you power it back on, otherwise the analyzer may not initialize properly.
- **LCD Menus**: Allow you to set up the Summit T48 and view status.
- **LCD Menu Navigation Buttons**: Allow you to navigate through the LCD menu.
- **Speed LEDs**: Indicate the current speed for the Upstream and Downstream link.
- **Upstream LED**: Indicates the activity of the Upstream lanes.
- **Downstream LED**: Indicates the activity of the Downstream lanes.
- **UPSTREAM [7:0] connectors**: Connection to the probe for the capture of upstream direction of the link.
- **US Ref Clk In:** Upstream Reference Clock Input SMA.
- **DOWNSTREAM [7:0] connectors**: Connection to the probe for the capture of downstream direction of the link.
- **DS Ref Clk In:** Downstream Reference Clock Input SMA.
- **Trigger**:
  - **In** for SMA external trigger input.
    - Trigger Input has a 1.5 kohm pullup resistor to 3.3 volts and a 50 ohm RC termination.
    - Threshold voltage for Trigger Input is 0.55 volts.
    - Voltages below 0.4 volts will be detected as low, voltages above 0.7 volts

will be detected as high.
- The minimal pulse width is 70ns for rising pulses and 20us for falling pulses.
- When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.

- **Out** for SMA external trigger output.
  - Output buffer is 3.3 volts. The buffer can drive up to 32 mA of current and meet VOH (2.5 V) and VOL (0.5 V) thresholds.
  - Output buffer can drive a 50 ohm DC load (such as scope input).

- **USB**: USB Type B connector for connection to host machine.
- **ETHERNET**: Gigabit Ethernet connector for connection to a host machine.

2.5 Status and Config Display (Summit T4)

The Summit T4 Analyzers have front panel LCD displays which indicate the configuration and status of the device. For example, during initialization, the LCD panel displays boot status messages. See Figure 2.3.

2.5.1 LCD Display and Button Functions for Analyzer Host Connection Setup

The host connection settings of the Summit T4 can be configured from the unit itself. Five buttons are provided to navigate menus and input settings presented on the LCD display. When you first turn on the Analyzer, after initialization, the LCD displays **Summit T416 or Summit T48 Available** with two arrows pointing up and down as shown in the illustration below.

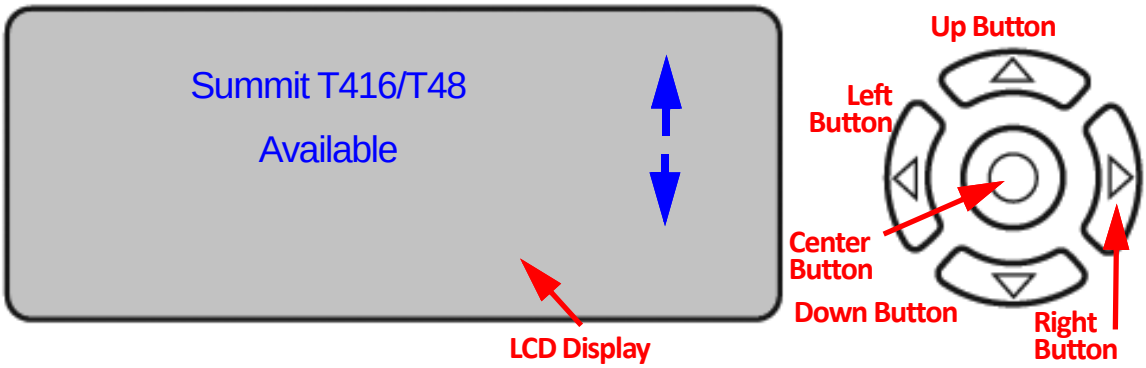


Figure 2.3: LCD Display and Button on the Front Panel

Press the **Up** ⇑ and **Down** ⇓ buttons to navigate through the following menu items:

- Displays current Static or Dynamic IP Address
- Summit T416 or Summit T48 SN (serial number)
- Connection
- Unit Name
- Set IP Configuration
- IP Mode Dynamic, or
- IP Mode Static

The **Left** ⇐ and **Right** ⇒ buttons are used to change the configuration properties.

The LCD will display **Button Inactive In This Menu Item** if the button does not serve any purpose for that selection.

Perform the following steps to set IP Configuration, Static on Dynamic IP using the buttons and the LCD display on the Analyzer:

2.5.1.1 Set IP Configuration

After powering on your unit (with the **TELEDYNE** LECROY logo being displayed (TELEDYNELECROY) and after waiting for it to initialize (**Initializing.....**), you can scroll through the LCD Menu display by pressing the **Down Button**:

- Main menu -> IP Address -> **Available** (Unit not in use by other user)

Scroll through the other menus by pressing the **Down Button:**

- Main Menu -> Product Name -> **Serial Number**
- Main Menu -> IP Mode -> **Dynamic**
  - The display will show you which IP Configuration mode your product is currently in: Dynamic or Static. In this case it is in Dynamic IP Address Mode
- Main Menu -> **Set IP Configuration**
  - From this menu you can change the IP Configuration from Dynamic to Static or from Static to Dynamic
- Main menu -> IP Address -> **Available** (Unit not in use by other user)

2.5.1.2 Changing from Dynamic to Static IP Mode

If your unit is in Dynamic IP Mode you can change it to Static IP Mode and manually set the IP Address by following the steps below:

To set a Static IP Address:

1. After initialization, press the **Down Button** to ensure your unit is in **Dynamic IP Mode**.
2. Press the **Down Button** until you see the **Set IP Configuration.**
3. Press the **Center Button** once to select **Set IP Configuration.**
   Set IP Mode -> Static is displayed in the LCD display.
4. Press the **Center Button** once to select **Set IP Mode Static.**
   The **Static IP** address (for example: 188.168.040.036) is displayed in the LCD display.
5. Press the **Center Button** once to set the **Static IP address.**
   The first numeral of the IP address will have a arrow below it pointing to it.
6. Use the **Up Button** or **Down Button** to change the IP Address.
7. Press the **Right Button** or **Left Button** to move to the right or left to change each component of the static or dynamic IP address and change it using step 6.
8. Once the IP Address is selected, press the **Center Button** to set the new **Static IP Address**.
9. The new **Static IP Address** will be displayed.
10. Press the **Up Button** once and "**Accept and Reboot"** will be displayed.
11. Press the **Center Button** and "**Center Button to Confirm Reboot"** will be displayed.
12. If you want the new **Static IP Address** to be stored and your unit to **Reboot** press the **Center Button: Rebooting ..... will be displayed.**
    a. Press any other button and your changes will be cancelled.
12. After **Rebooting** has completed, to check that you are in **Static IP Mode**, just scroll through the Main Menu using the **Down Button.**

2.5.1.3 Changing from Static to Dynamic IP Mode

If your unit is in Static IP Mode you can change it to Dynamic IP Mode, the IP Address will be set automatically by the network using DHCP.

To change from a Static IP address to a Dynamic IP address follow the steps below:

1. Ensure your unit is in Static IP Mode by scrolling through the Menus displayed on the LCD by pressing the down button. Main Menu -> IP Mode -> **Static.**
2. Press the **Down Button** one more time and **Set IP Configuration** should be displayed.
3. Press the **Center Button** once to select **Set IP Configuration.**
   Set IP Mode -> Dynamic should be displayed.
4. Press the **Center Button** once to select **Set IP Mode Dynamic.**
5. "**Accept and Reboot**" should be displayed. Press the **Center Button** once.
6. **"Center Button to Confirm Reboot"** should be displayed.
7. If you want the new Dynamic IP Address to be stored and your unit to Reboot press the **Center Button: Rebooting ..... will be displayed.**
   a. Press any other button and your changes will be cancelled.
8. To check that you are in Dynamic IP Mode, just scroll through the Main Menu using the **Down Button.**

Note: In case the device is often moved from one subnet to the other, it is recommended to set the IP Mode to Dynamic and to configure the DHCP server so that the device always receives the same (known) IP address. Many DHCP servers allow this type of static allocation based on the device's MAC address.

2.5.1.4 Setting the Gateway and Subnet Mask

Note: Setting the Gateway and Subnet Mask require a detailed knowledge of your network.

1. Ensure that you are in Static IP Mode by following the steps in "Set IP Configuration" on page 32 and "Changing from Dynamic to Static IP Mode" on page 33 if necessary.
2. Press the **Down Button** to get to the **Set IP Configuration** Menu.
3. Press the **Center Button** and then the **Down Button** to get to the **Set IP Mode Static** Menu.
4. Press the **Center Button** once and then press the **Down Button** to get to the **Subnet Mask** Menu.
5. To set the **Subnet Mask**: Press the **Center Button** and the first numeral of the **Subnet Mask** will have a arrow below it pointing to it.
6. Use the **Up Button** or **Down Button** to change the **Subnet Mask**.
7. Press the **Right Button** or **Left Button** to move to the right or left to change each component of the **Subnet Mask** and change it using step 6.
8. Once the **Subnet Mask** is selected, press the **Center Button** to set and display the new **Subnet Mask**.
9. The press the **Down Button** to get to the **Gateway Address** Menu.
10. To set the **Gateway Address**: Press the **Center Button** and the first numeral of the **Gateway Address** will have a arrow below it pointing to it.
11. Use the **Up Button** or **Down Button** to change the **Gateway Address**.

12. Press the **Right Button** or **Left Button** to move to the right or left to change each component of the **Gateway Address** and change it using step 11.
13. Once the **Gateway Address** is selected, press the **Center Button** to set and display the new **Gateway Address**.
14. Press the **Up Button** to confirm the **Subnet Mask** and then press the **Up Button** to confirm the **Static IP Address.**
15. Press the **Up Button** one more time to display **"Accept and Reboot".**
16. Press the **Center Button** once and the LCD display will read "**Center Button to Confirm Reboot".**
17. If you want the new **Subnet Mask, Gateway Address** and **Static IP Address** to be stored and your unit to Reboot press the **Center Button: Rebooting ..... will be displayed.**
    a. Press any other button and your changes will be canceled.

2.6 Summit T416 Rear Panel Description

The Summit T416 rear panel contains the following connectors:

- Wide-range **AC Connector** Module
  - Power socket
  - Enclosed 3.0 A, 250 V fuse
- **Sync In and Sync Out** connectors which are used to send synchronization and control messages to other Teledyne LeCroy Analyzers. See Figure 2.4.

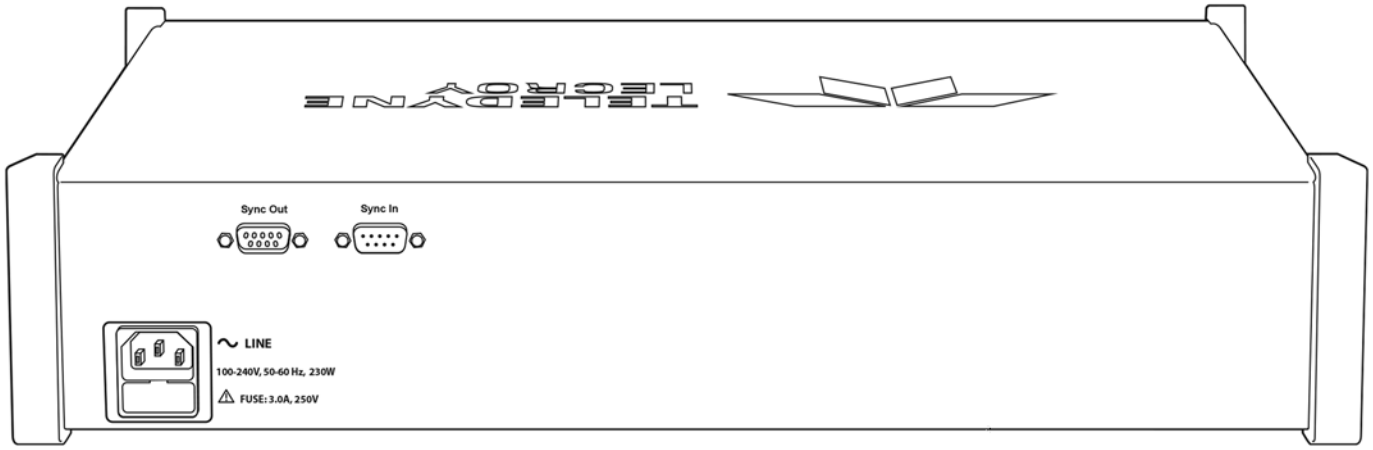


Figure 2.4: Summit T416: Rear Panel

2.7 Summit T48 Rear Panel Description

The Summit T48 rear panel contains the following connectors:

- Wide-range **AC Connector** Module
  - Power socket
  - Enclosed 3.0 A, 250 V fuse
- **Sync In and Sync Out** connectors which are used to send synchronization and control messages to other Teledyne LeCroy Analyzers. See Figure 2.5.

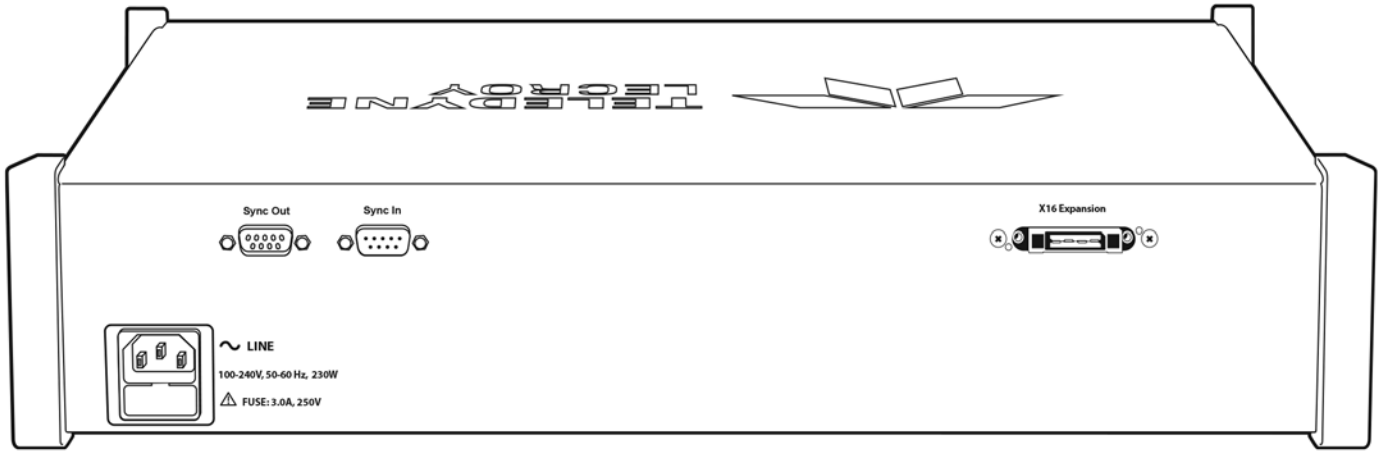


Figure 2.5: Summit T48: Rear Panel

2.8 Gen4 CEM Interposer

The Summit T416 or Summit T48 works with the PCI Express 4.0 Interposer.

- **Gen4 CEM Interposer**: The Teledyne LeCroy PCI Express 4.0 Interposer plugs in to a PCIe CEM Connector and allows you to probe PCI Express traffic between a host and a PCIe expansion card. The Gen4 Interposer supports data rates of 2.5 GT/s, 5.0 GT/s, 8.0 GT/s and 16.0 GT/s, and depending on the version purchased link widths up to x16.

2.8.1 Connecting the Gen4 CEM Interposer

The Gen4 Interposer and connecting to a Summit T416 or Summit T48 analyzer is discussed in more detail in the PCI Express 4.0 Interposer Quick Start Guide. See interconnect diagram below (see Figure 2.6).

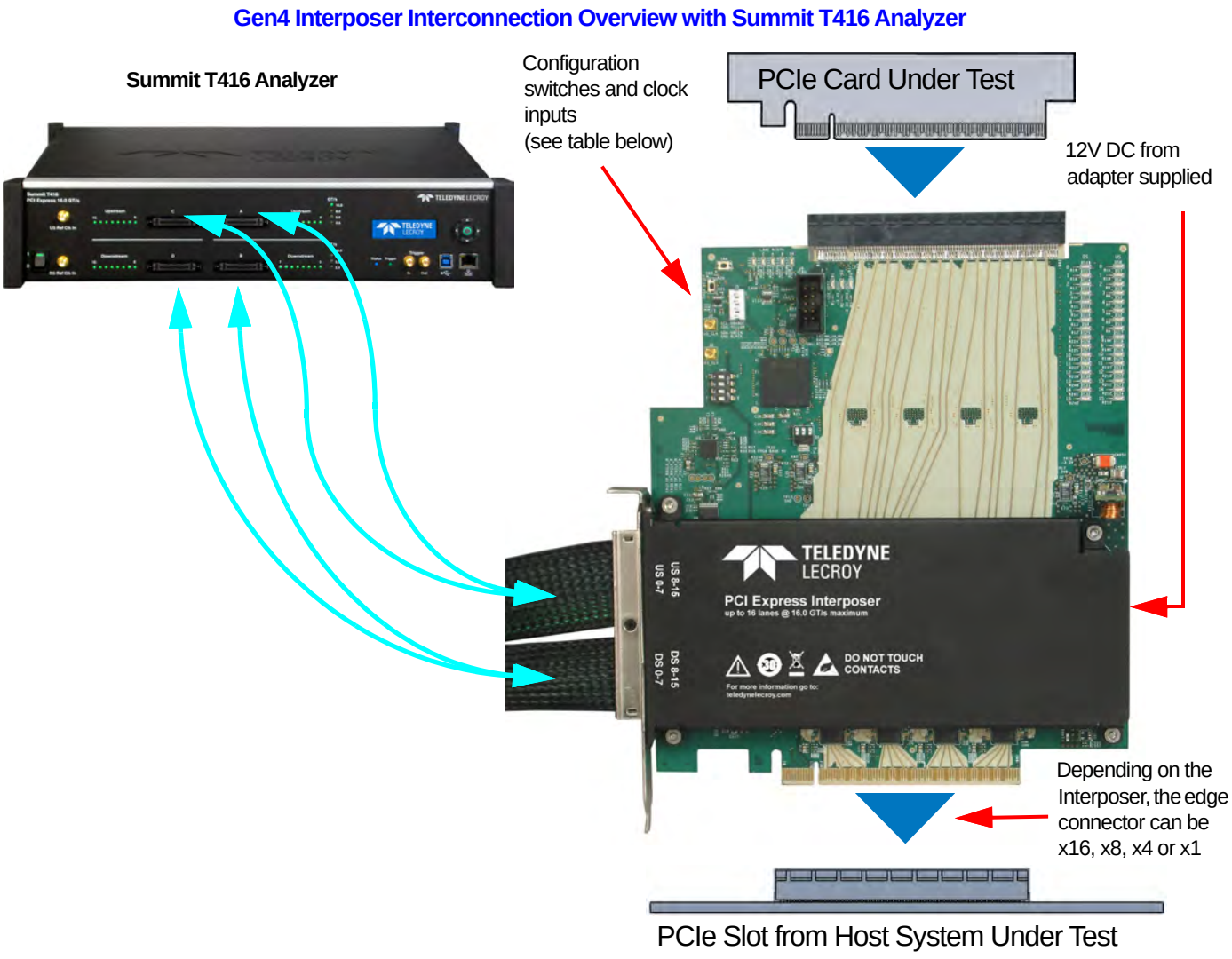


Figure 2.6: Summit T416 Connected to Gen4 Interposer

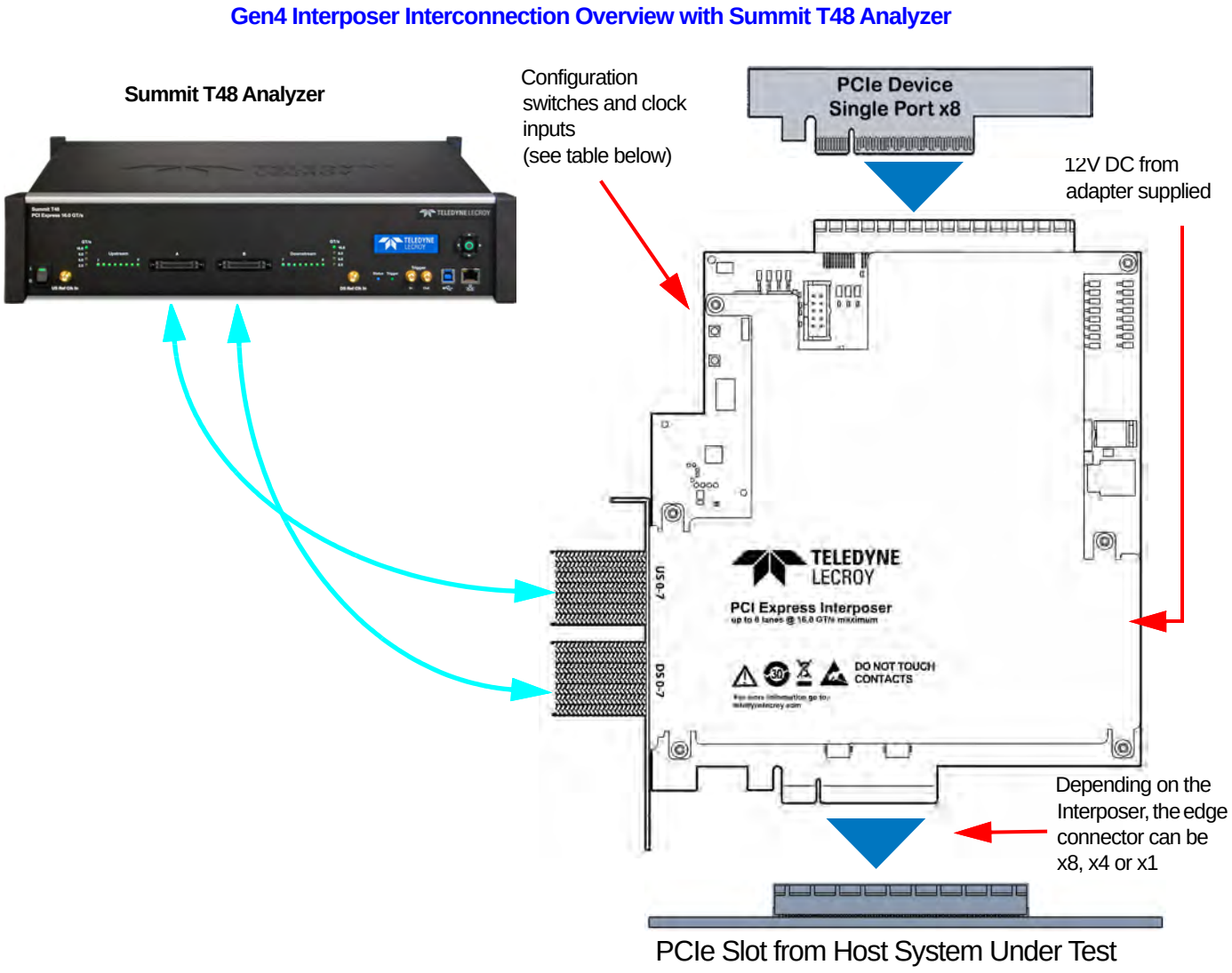


Figure 2.7: Summit T48 Connected to Gen4 Interposer

2.8.2 Cabling Options for Tuning the Interposer

There are three different cabling options to tune the interposer connected to the Summit T4:

- ❑ You can install an FTDI serial cable from the interposer to your host computer (see “Installing the FTDI Serial Cable” on page 40).
- ❑ You can install a USB Type-C cable from the interposer to your host computer (see “Installing a USB Type-C Serial Cable” on page 42).
- ❑ You can use the serial bus within the data cable from the interposer to the Summit T4 analyzer (see “Using the Interposer Data Cable” on page 43).

2.8.2.1 Installing the FTDI Serial Cable

Install the Interposer per instructions in the appropriate User Manual or Quick Start Guide.

To use the Utility you must connect a special FTDI cable (Teledyne LeCroy PN: 929278-00) attached from the interposer to your laptop. The steps to install the cable follow:

- ❑ Ensure the interposer is powered down.
- ❑ Locate the 3 pin connector for the Programming cable near the SW4 switch upper left section of the interposer (see Figure 2.8 on page 40).
- ❑ Align the cable so the SCL wire is located near the top pin, the SDA wire is located near the middle pin and the GND wire is located near the bottom pin (see Figure 2.8 on page 40).
- ❑ Push the FTDI connector onto the pins on the Interposer (see Figure 2.9 on page 41).

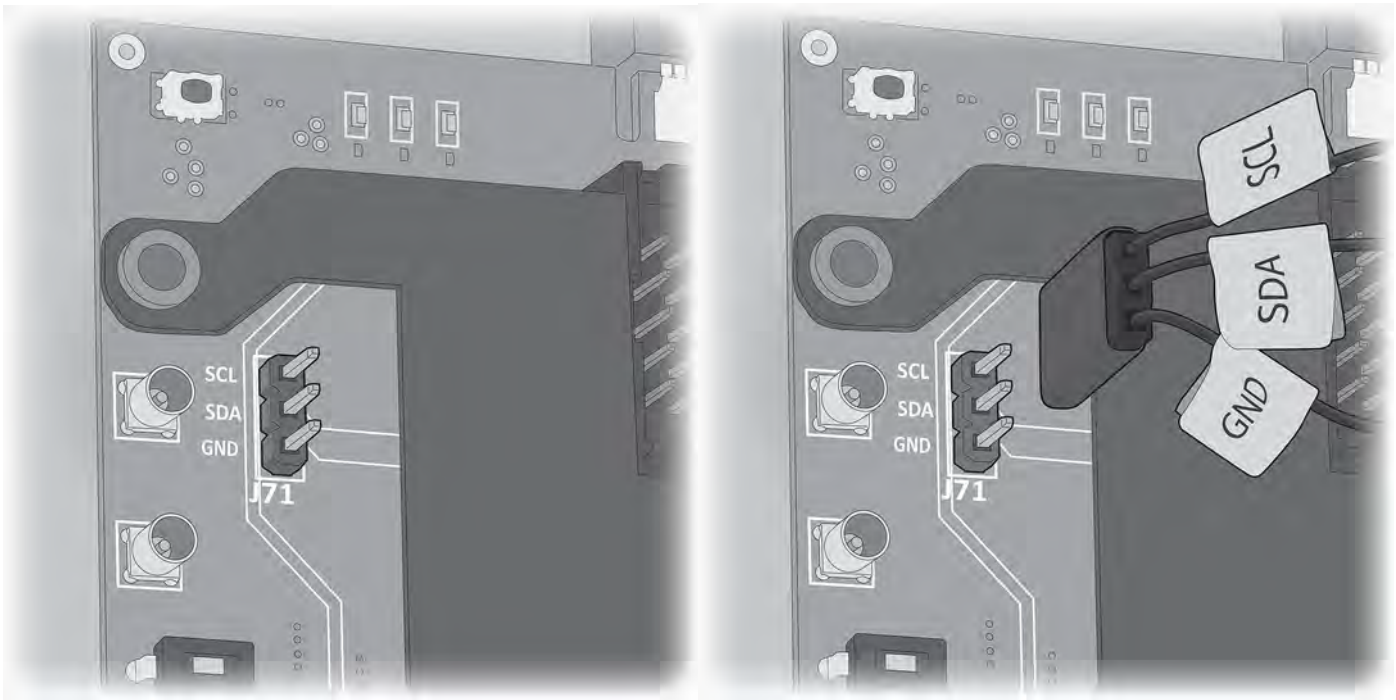


Figure 2.8: Typical Interposer: Programming Pins and Cable Ready to Attach

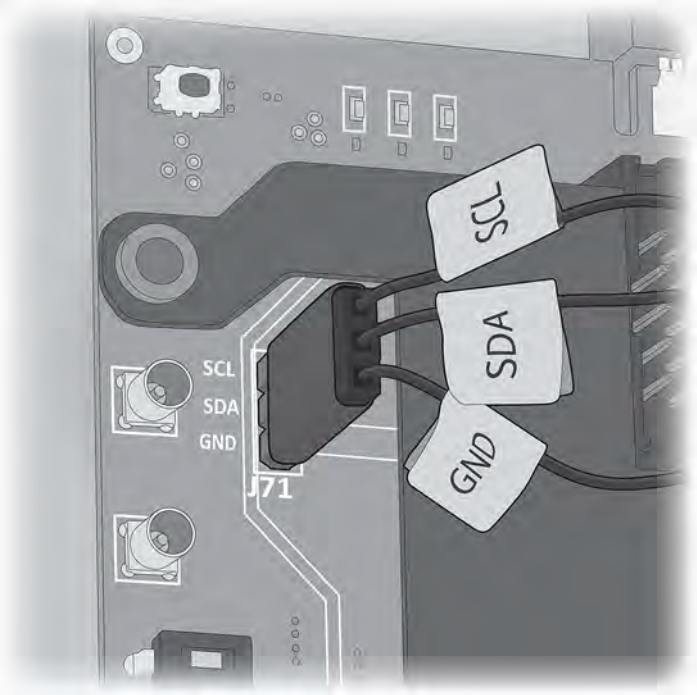


Figure 2.9: Typical Interposer: FTDI Serial Cable Attached to Interposer for Calibration

- After the cable has been attached to the Interposer, plug the other end of the cable into a USB connection on your laptop or computer.
- Power up the interposer.
- You can tune the interposer by adjusting the Continuous Time Linear Equalization (CTLE) values for each lane and the DC Gain (see “Analyzer Calibration and Interposer Tuning” on page 144) to obtain the best signal.

2.8.2.2 Installing a USB Type-C Serial Cable

- ❑ Ensure the interposer is powered down.
- ❑ Install the Type-C end of the USB cable into the corresponding USB Type-C connector on the interposer. See Figure 2.10.

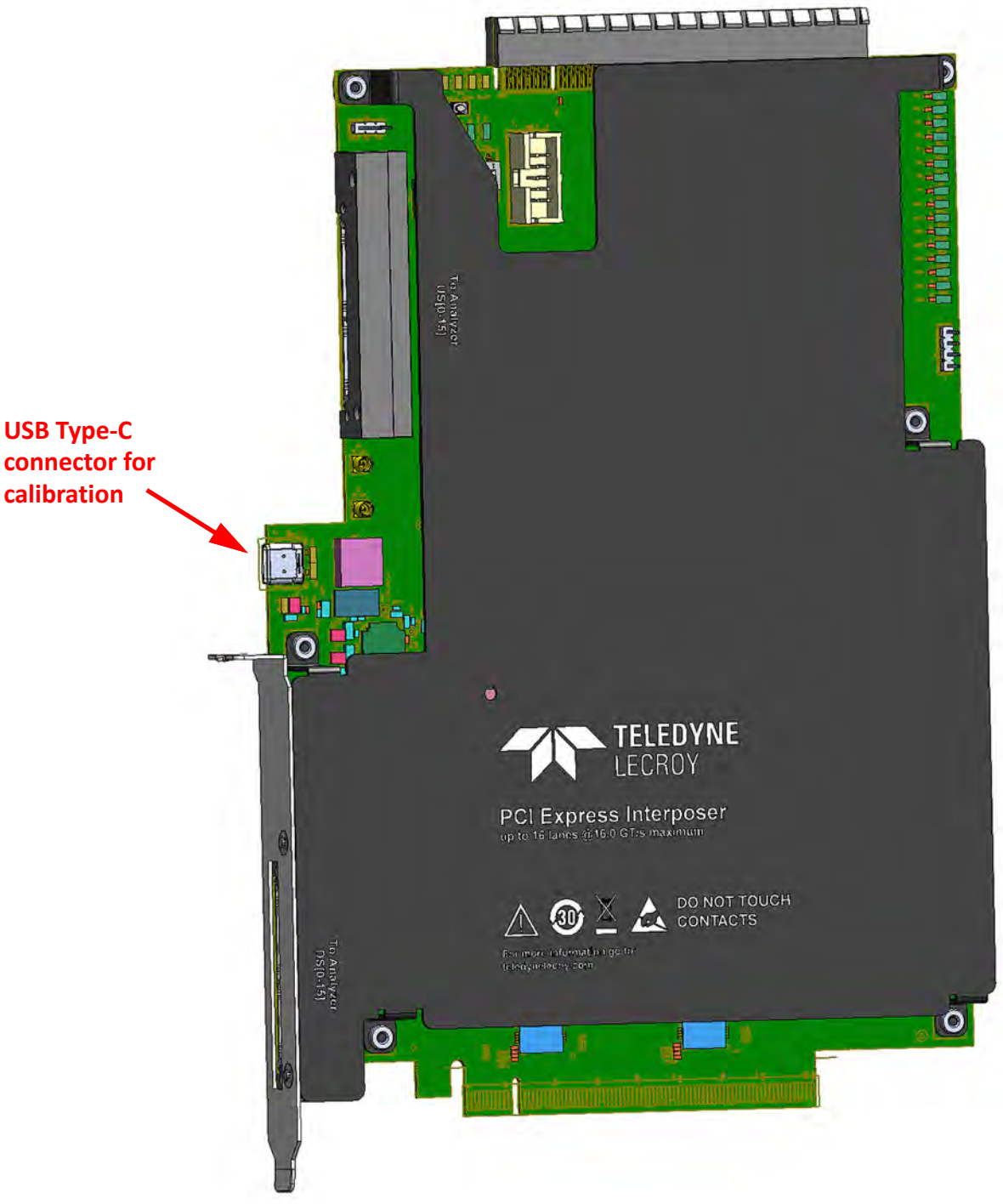


Figure 2.10: Gen4 Interposer with USB Type-C connector for calibration

- After the cable has been attached to the Interposer, plug the other end of the USB Type C cable into a USB connection on your host computer.
- Power up the interposer.
- You can tune the interposer by adjusting the Continuous Time Linear Equalization (CTLE) values for each lane and the DC Gain (see "Analyzer Calibration and Interposer Tuning" on page 144) to obtain the best signal.

2.8.2.3 Using the Interposer Data Cable

The same data cable that connect the interposer to the T4 system has the required serial interface to configure the interposer. Depending on interposer being used, the following cables can be used to program the interposer:

- Y Cable: Connects the interposer to the Summit T416 or T48 with both data signals and serial interface signals to program the interposer. See Figure 2.11.

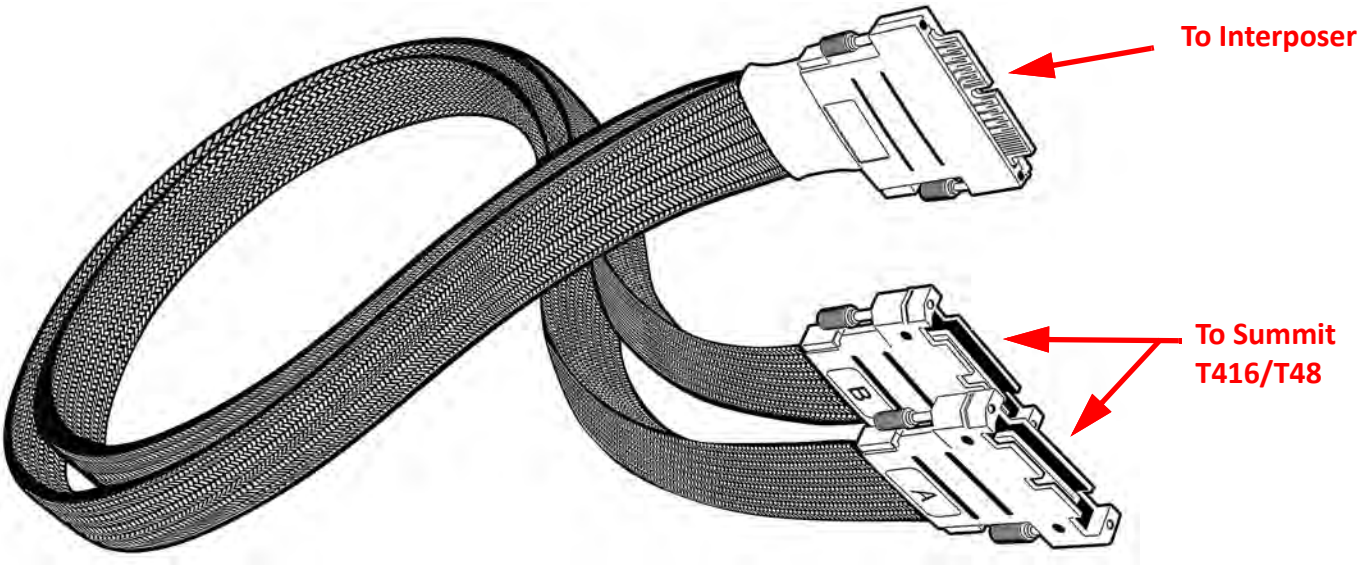


Figure 2.11: Y Cable

- Straight Cable: Connects the interposer to the Summit T416 or T48 with both data signals and serial interface signals to program the interposer. See Figure 2.12.

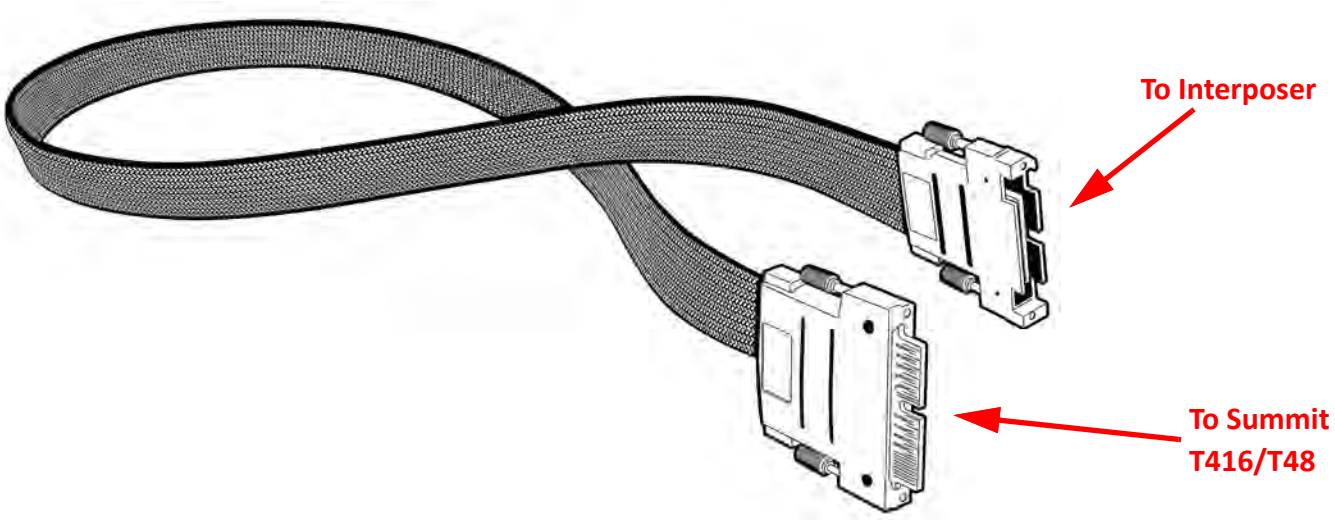


Figure 2.12: Straight Cable

- Attached Data Cables: Connects the interposer to the Summit T416 or T48 with both data signals and serial interface signals to program the interposer. See Figure 2.13.

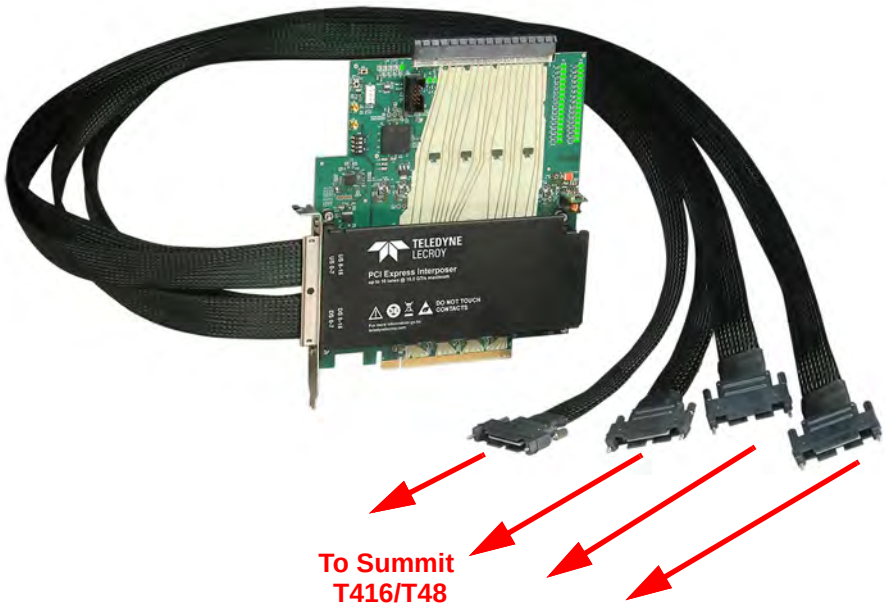


Figure 2.13: Interposer with Cables Attached

- After the data cables have been attached to both the interposer and the Summit T4, power up the interposer.
- You can tune the interposer by adjusting the Continuous Time Linear Equalization (CTLE) values for each lane and the DC Gain (see "Analyzer Calibration and Interposer Tuning" on page 144) to obtain the best signal.

2.9 Gen4 OCP NIC 3.0 Interposer Configuration

The Gen4 OCP NIC 3.0 Interposer is connected to the Summit T416 Analyzer using two (PE021UCX-A) cables. See Figure 2.14.

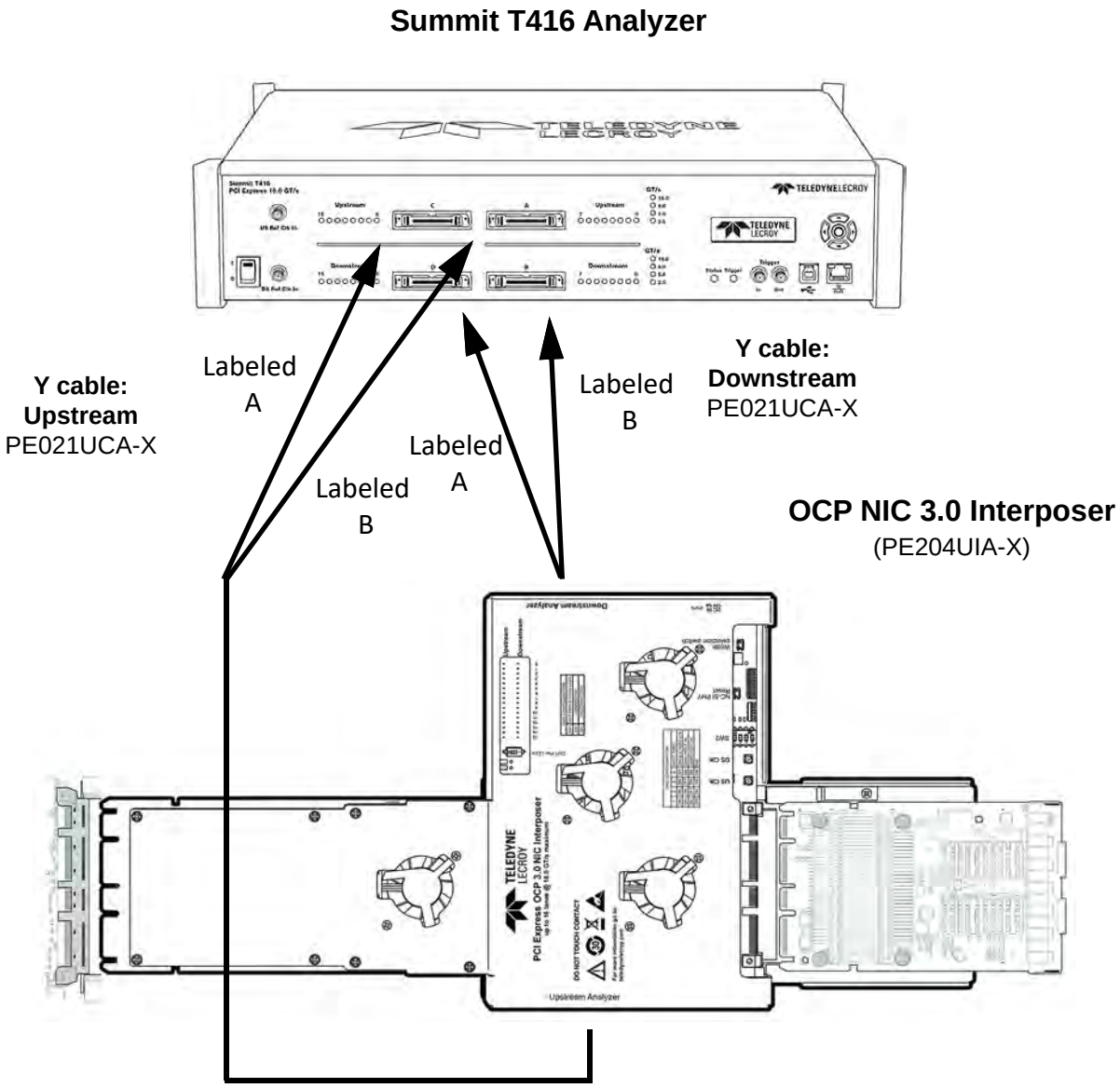


Figure 2.14: Gen4 OCP NIC 3.0 Interposer connected to the Summit T416 Analyzer

Note: MultiPort mode support works in two basic configurations:

- Bifurcated links
- Independent links.

For bifurcated links the use model is a single connector providing a clock and bus reset and shared among the split ports, a single interposer is used for this case.

For independent links, the use model is multiple connectors with separate clock and bus reset, separate interposers are used for each connector.

Hybrid cases of the two basic configurations described above are not supported.

For SRIS cases where two clocks are required per link, review the documentation to check on supported configurations.

2.10 Gen5 Interposers

2.10.1 Gen5 x8 Interposer

The diagram below shows the connection for a Gen5 x8 Interposer with a Summit T416 Analyzer. See Figure 2.15.

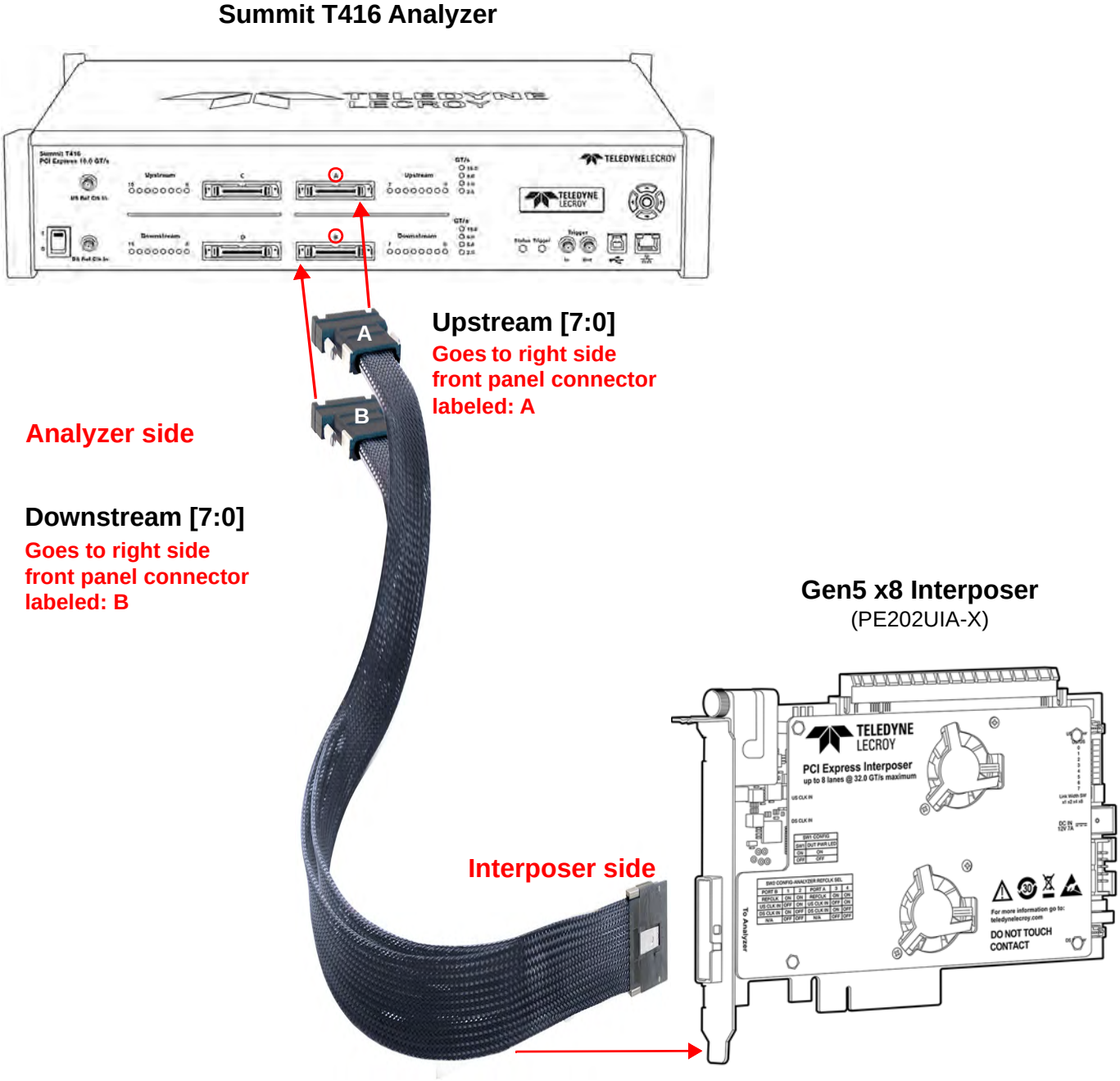


Figure 2.15: T416 Connected to Gen5 x4/x8 Interposer with Gen4 to Gen5 x8 Y Conversion Cable for Summit T416

2.10.2 Gen5 x16 Interposer

The diagram below shows the connection for a Gen5 x16 Interposer with a Summit T416 Analyzer. See Figure 2.16.

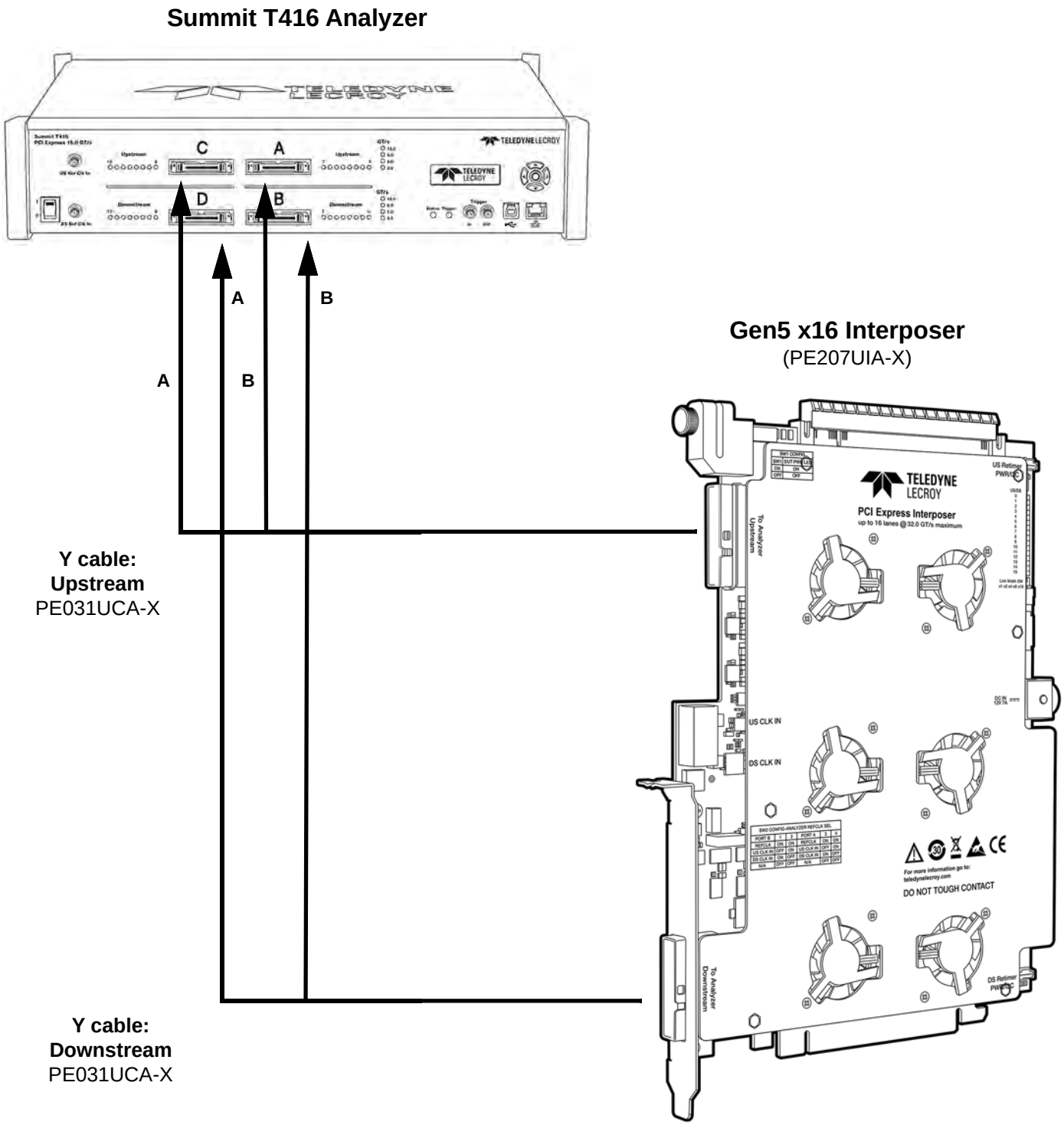


Figure 2.16: T416 Connected to Gen5 x16 Interposer with two Gen4 to Gen5 x8 Y Conversion Cable for Summit T416

2.11 Multiport Mode Configuration

MultiPort mode allows a single Summit T4 system to behave as multiple analyzer systems. This is achieved by connecting interposers as explained in this section. In the case of the Summit T416 you can analyze one x16 link from a single add-in card (standard mode), two x8 links from a single add-in card (bifurcated mode) or two x8 links from two separate devices (independent mode). You can also analyze four x4 links from a single add-in card (bifurcated mode) or four x4 links from four separate devices (independent mode).

In the case of the Summit T48 you can analyze one x8 link from a single add-in card (standard mode), two x4 links from a single add-in card (bifurcated mode) or two x4 links from two separate devices (independent mode).

Note: Multiport Mode requires a separate license.

Note: Cables A and B from the Interposer carry the bus signal REFCLK, needed by the Summit T416 analyzer when selecting the “External clock option”. The Summit T416 needs at least one clock (either an internal clock or an external clock) to be fed to one of the connectors in the pair A-C and B-D for multiport mode. If the particular configuration does not allow for that then the ports involved will not receive a clock and they can only record using the “Internal clock option”.

Supported multiport configurations that allow both “Internal and External clock options” are shown in Figure 2.17 on page 51, Figure 2.23 on page 57 and Figure 2.28 on page 62.

Supported multiport configurations that allow the use of the “Internal clock option” only are shown in Figure 2.20 on page 54 and Figure 2.26 on page 60.

To see how the PCIe Protocol Analysis Software handles each of these configurations see “Multiport Mode” on page 147.

2.11.1 Summit T416 Configurations

You can configure the Summit T416 as follows:

- Standard Mode: Single link width up to x16 (see Figure 2.17 on page 51 and Figure 2.18 on page 52)
  - Ref Clock GUI (see Figure 2.19 on page 53)
- MultiPort 2 x8 Bifurcated: 2 bifurcated ports, link width up to x8 for each port.
  - Single add-in card with two ports connected to the analyzer through a single interposer (see Figure 2.20 on page 54 and Figure 2.21 on page 55)
  - Ref Clock GUI (see Figure 2.22 on page 56)
- MultiPort 2 x8 Independent: 2 independent ports, link width up to x8 for each port
  - Two add-in cards connected to the analyzer through two interposers (see Figure 2.23 on page 57)
  - Ref Clock GUI (see Figure 2.24 on page 58)
- MultiPort 4 x4 Bifurcated: 4 bifurcated ports, link width up to x4 for each port.
  - Single add-in card with four ports connected to the analyzer through a single interposer (see Figure 2.25 on page 59 and Figure 2.26 on page 60)
  - Ref Clock GUI (see Figure 2.27 on page 61)
- MultiPort 4 x4 Independent: 4 independent ports, link width up to x4 for each port
  - Four add-in cards connected to the analyzer through four interposers (see Figure 2.28 on page 62
  - Ref Clock GUI (see Figure 2.29 on page 63)
- MultiPort 4 x2 Bifurcated: 4 bifurcated ports, link width up to x2 for each port.
  - Two add-in cards connected to the analyzer through two interposers (see Figure 2.30 on page 64
  - Ref Clock GUI (see Figure 2.31 on page 65)

Note: In MultiPort mode the labels in front of the analyzer do not necessarily correspond to the actual upstream/downstream and lane number connections.

2.11.1.1 Standard Mode using a cable-attached x16 interposer

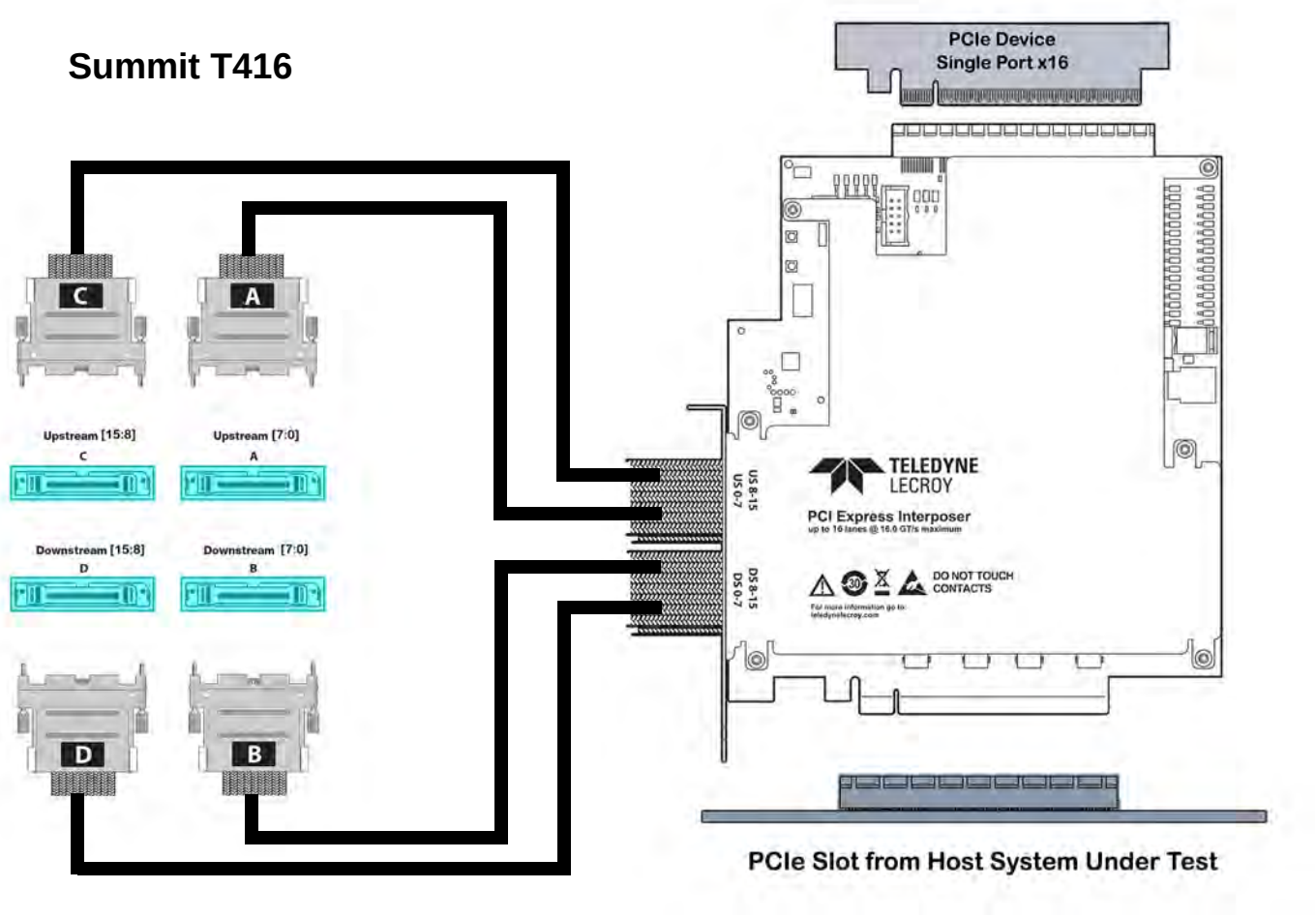


Figure 2.17: Standard Mode Configuration for Summit T416 using a cable-attached x16 interposer

2.11.1.2 Standard Mode Configuration using a MultiPort x16 interposer

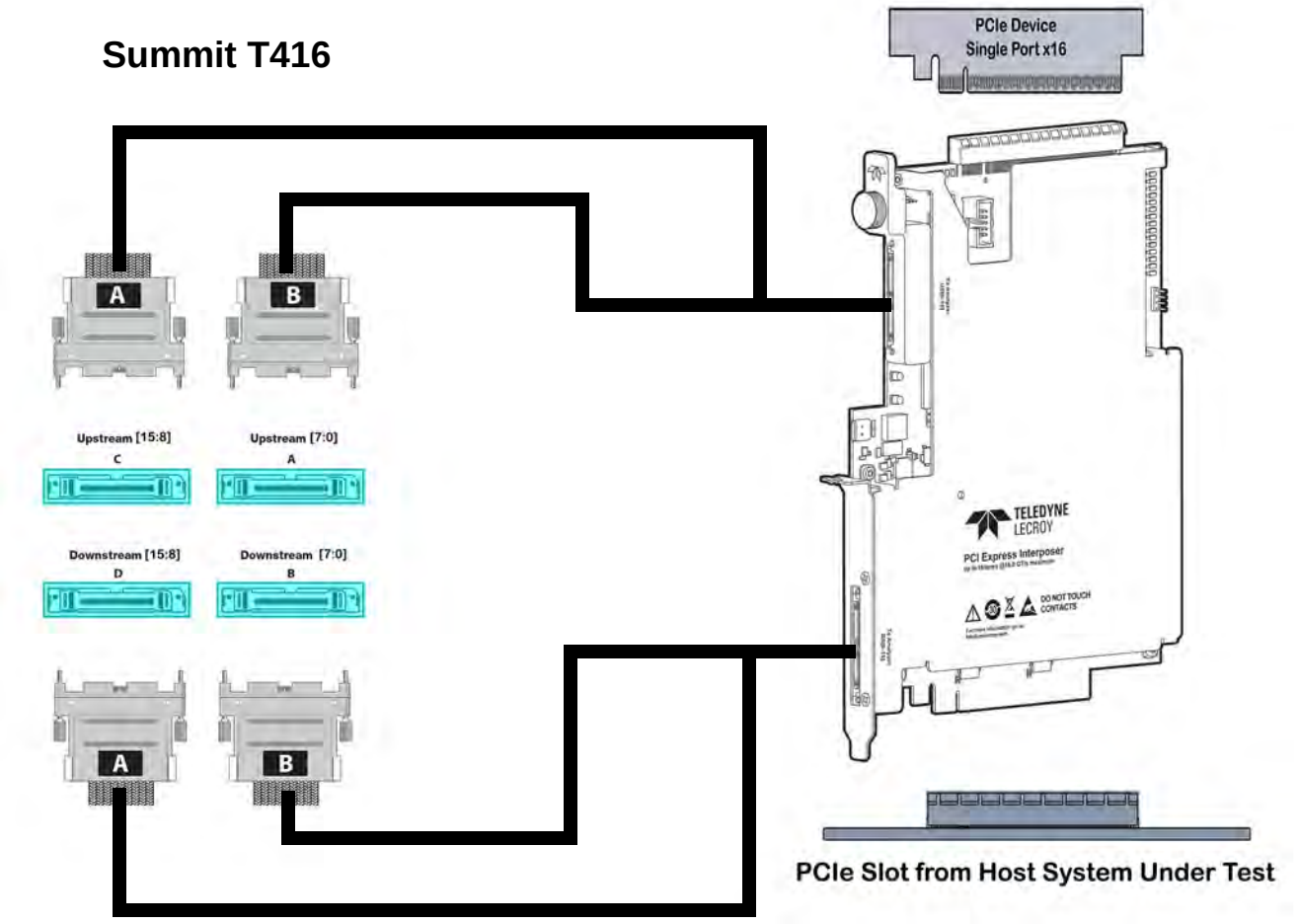


Figure 2.18: Standard Mode Configuration for Summit T416 using a MultiPort x16 interposer

- Uses Gen4 Y Cable: PE021UCA-X
- Reference Clock GUI for T416: Standard Mode (see Figure 2.19 on page 53)

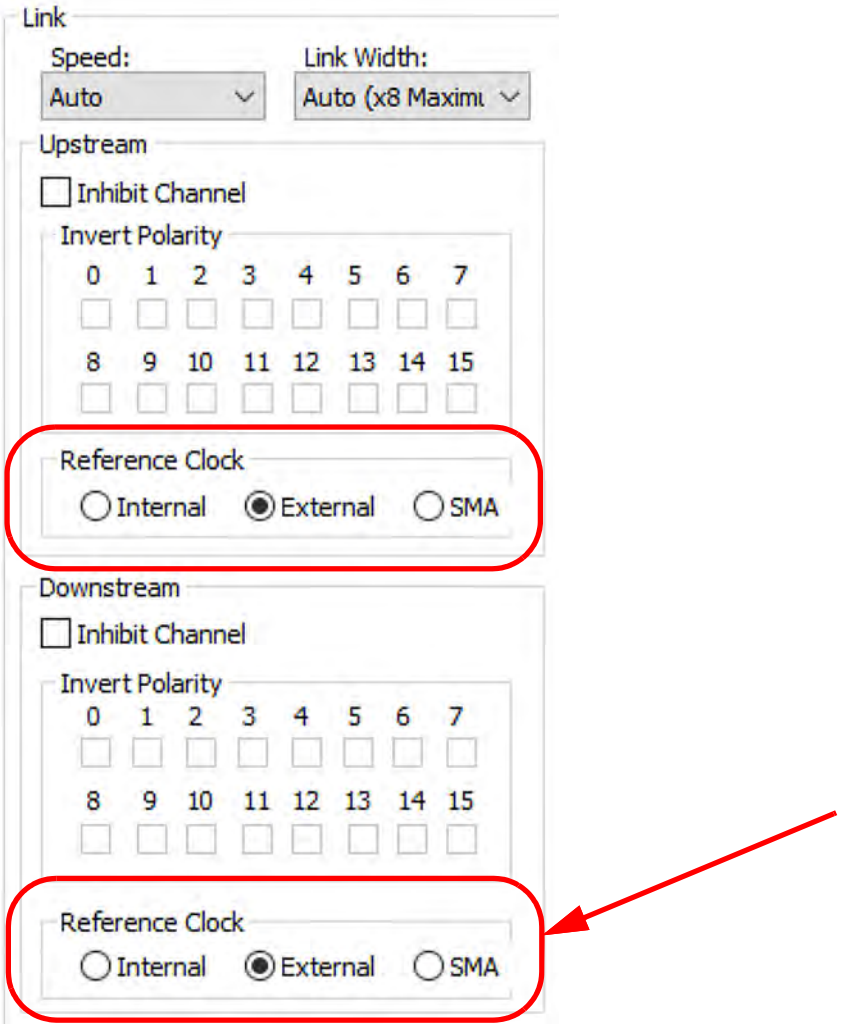


Figure 2.19: Reference Clock GUI for T416: Standard Mode

Other interposers and cables that can be used for MultiPort mode:

Gen3 x16 Interposer: PE104UIA-X with two (2) iPass Gen3 to Gen4 cables: PE016UCA-X

2.11.1.3 Bifurcated (2 x8 Ports) Mode using cable-attached x16 interposer

Summit T416

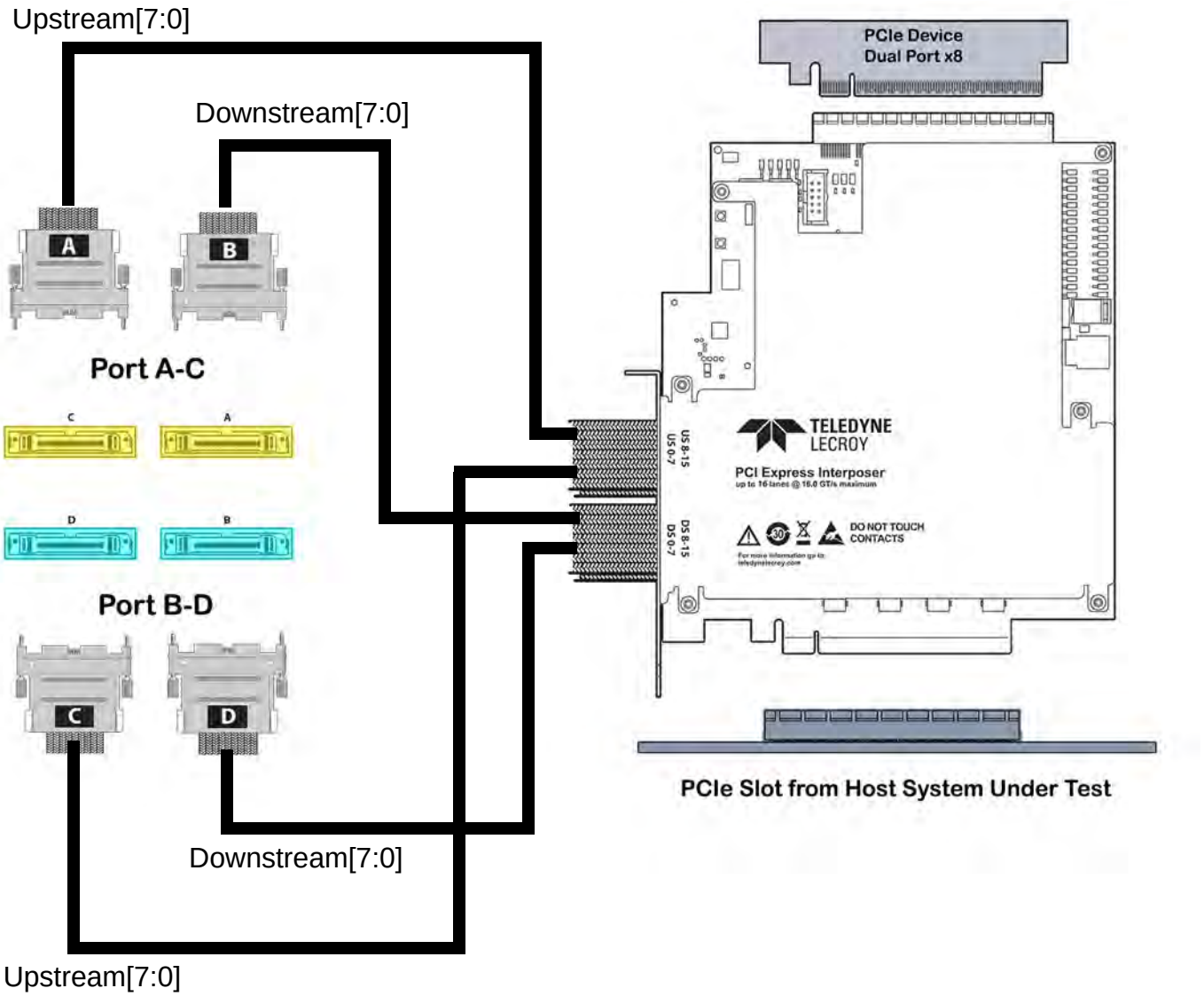


Figure 2.20: Bifurcated (2 x8 Ports) Mode for Summit T416 using cable-attached x16 interposer

2.11.1.4 Bifurcated (2 x8 Ports) Mode using MultiPort x16 interposer

Summit T416

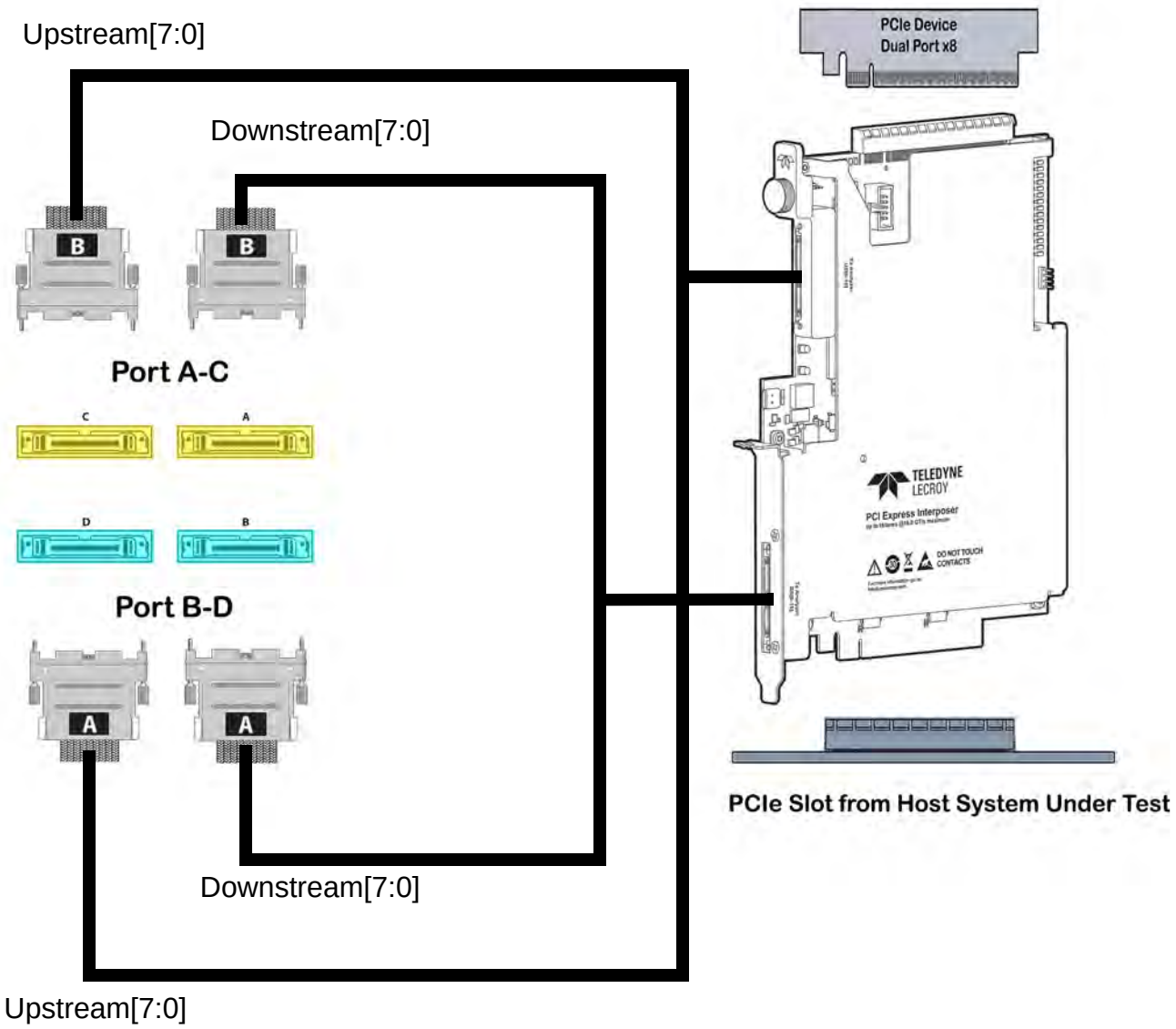


Figure 2.21: Bifurcated (2 x8 Ports) Mode for Summit T416 using MultiPort x16 interposer

- Uses Gen4 Y Cable: PE021UCA-X
- Reference Clock GUI for T416: Bifurcated Mode -> 2 x8 Ports (see Figure 2.22 on page 56)

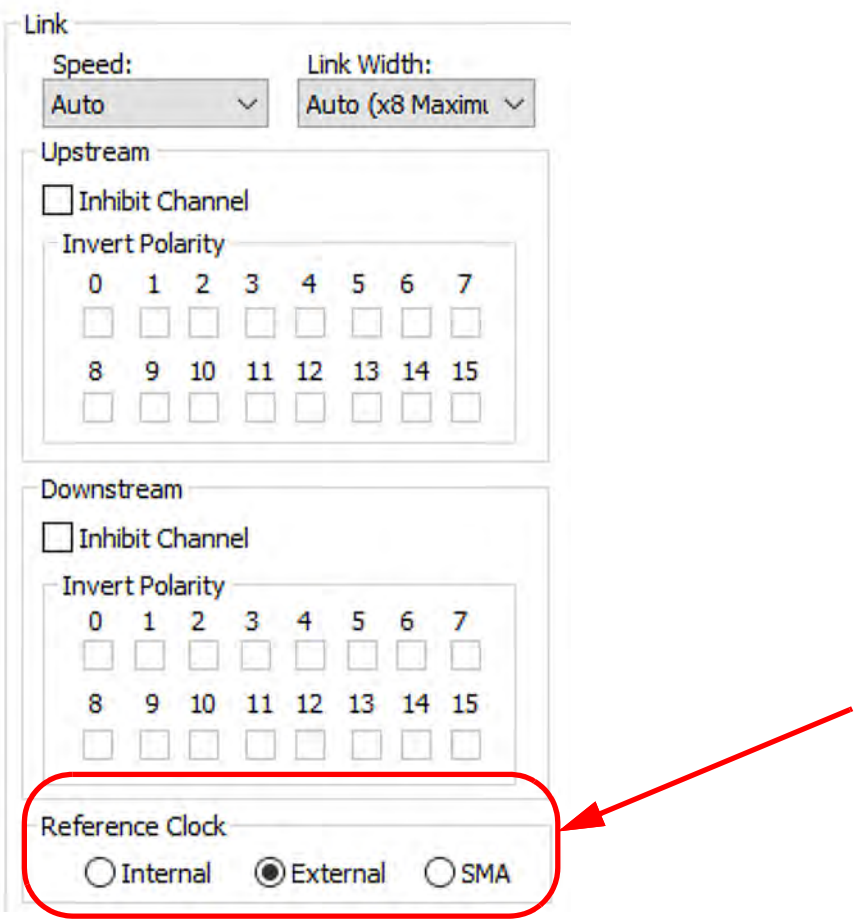


Figure 2.22: Reference Clock GUI for T416: Bifurcated Mode: Single Clock Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen3 x16 Interposer: PE104UIA-X with two (2) iPass Gen3 to Gen4 cables: PE016UCA-X

2.11.1.5 Independent (2 x8 Ports) Mode using cabled-attached x8 interposer

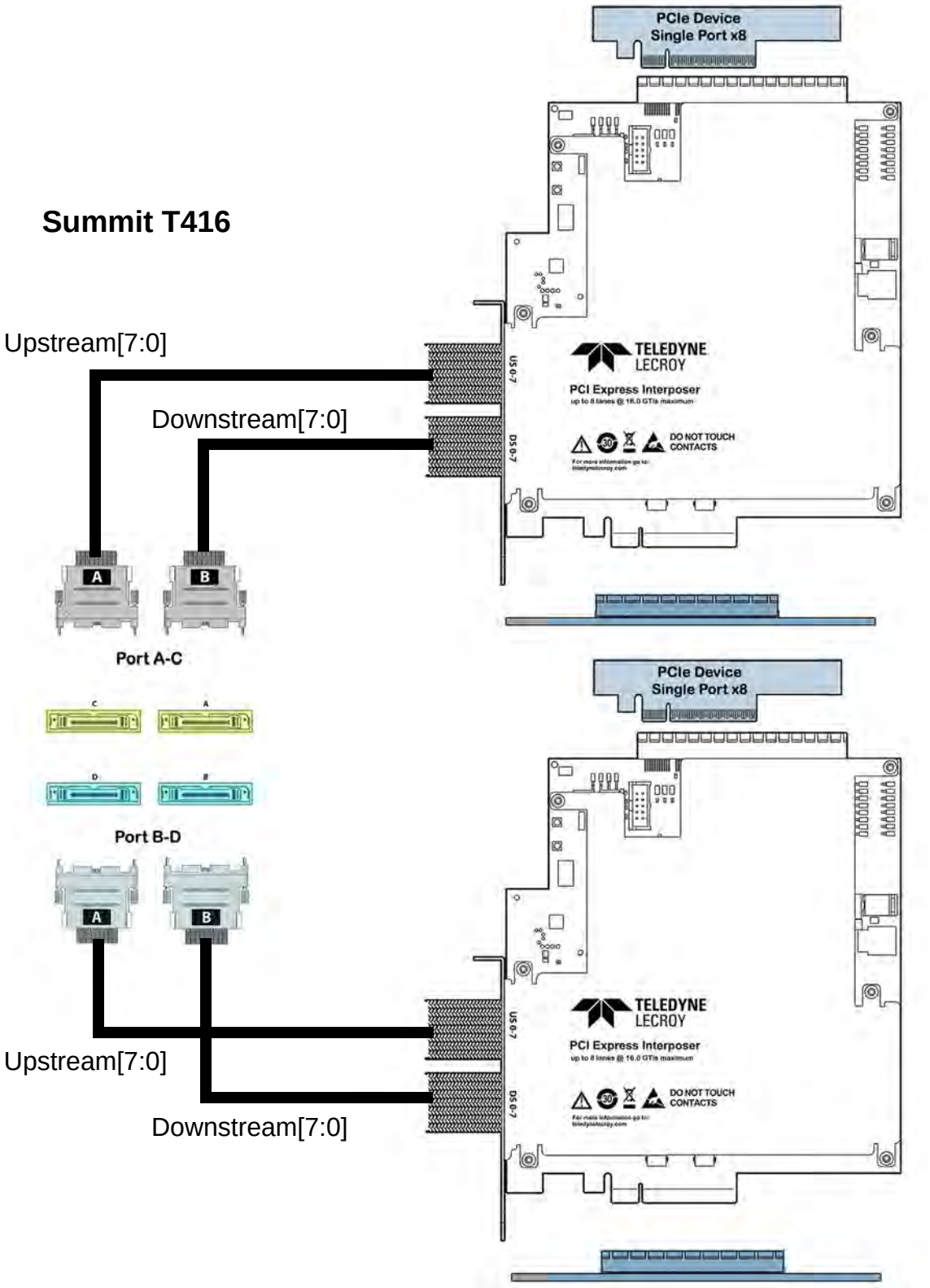


Figure 2.23: Independent (2 x8 Ports) Mode for Summit T416 using cabled-attached x8 interposer

- Reference Clock GUI for T416: Independent Mode -> 2x8 Ports (see Figure 2.24)

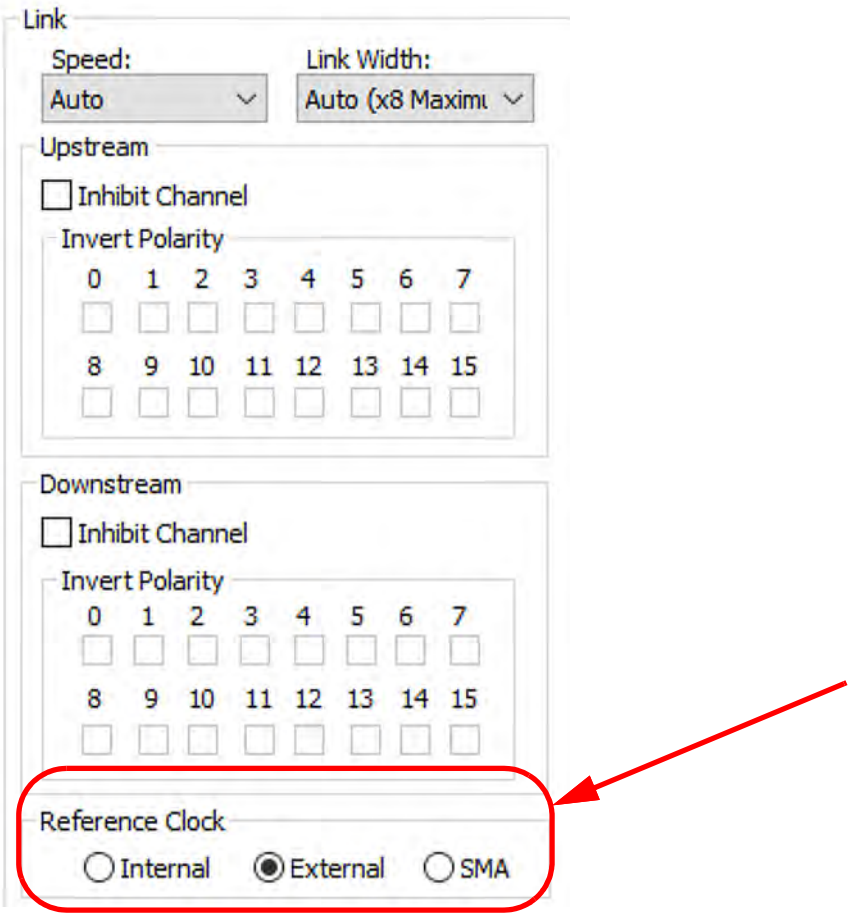


Figure 2.24: Reference Clock GUI for T416: Independent Mode -> 2x8 Ports Single Clock Upstream and Downstream

Other interposers and cables that can be used for similarly in this mode:

Gen3 x8 Interposer: PE130UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen4 x8 Oculink Interposer: PE163UIA-X (includes cables)

Gen3x8 Oculink Interposer: PE162UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 External Cable Interposer: PE120UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

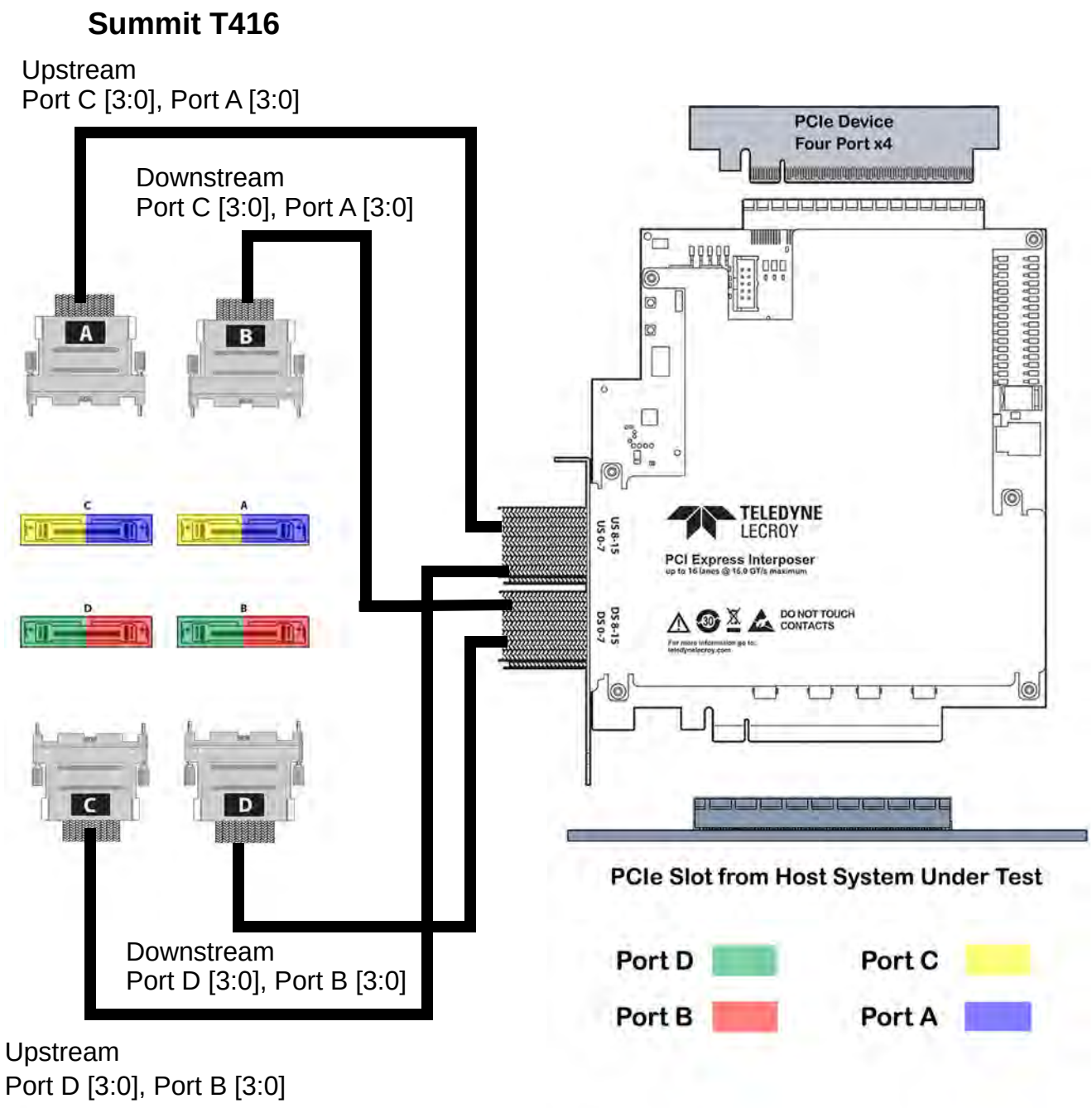
Gen3 x8 Express Module Interposer: PE062UIA=X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 90 Degree Right Angle Interposer: PE058UIA-x with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 90 Degree Left Angle Interposer: PE059UIA-x with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen4 x8 Multiport Slot Interposer: PE182UIA-X requires one (1) PCIe Y-Cable PE021UCA-X

2.11.1.6 Bifurcated (4 x4 Ports) Mode using cable-attached interposer



Note: The colors indicate how a link is formed across the analyzer connectors.
For instance: Port A is indicated with purple color, half of the lanes (Downstream [3:0])
are in connector A and the other half of the lanes (Upstream [3:0]) are in connector C on the analyzer.

Figure 2.25: Bifurcated (4 x4 Ports) Mode for Summit T416 using cable-attached interposer

- Reference Clock GUI for T416: Bifurcated Mode -> 4x4 Ports (see Figure 2.27 on page 61)

2.11.1.7 Bifurcated (4 x4 Ports) Mode using MultiPort x16 interposer

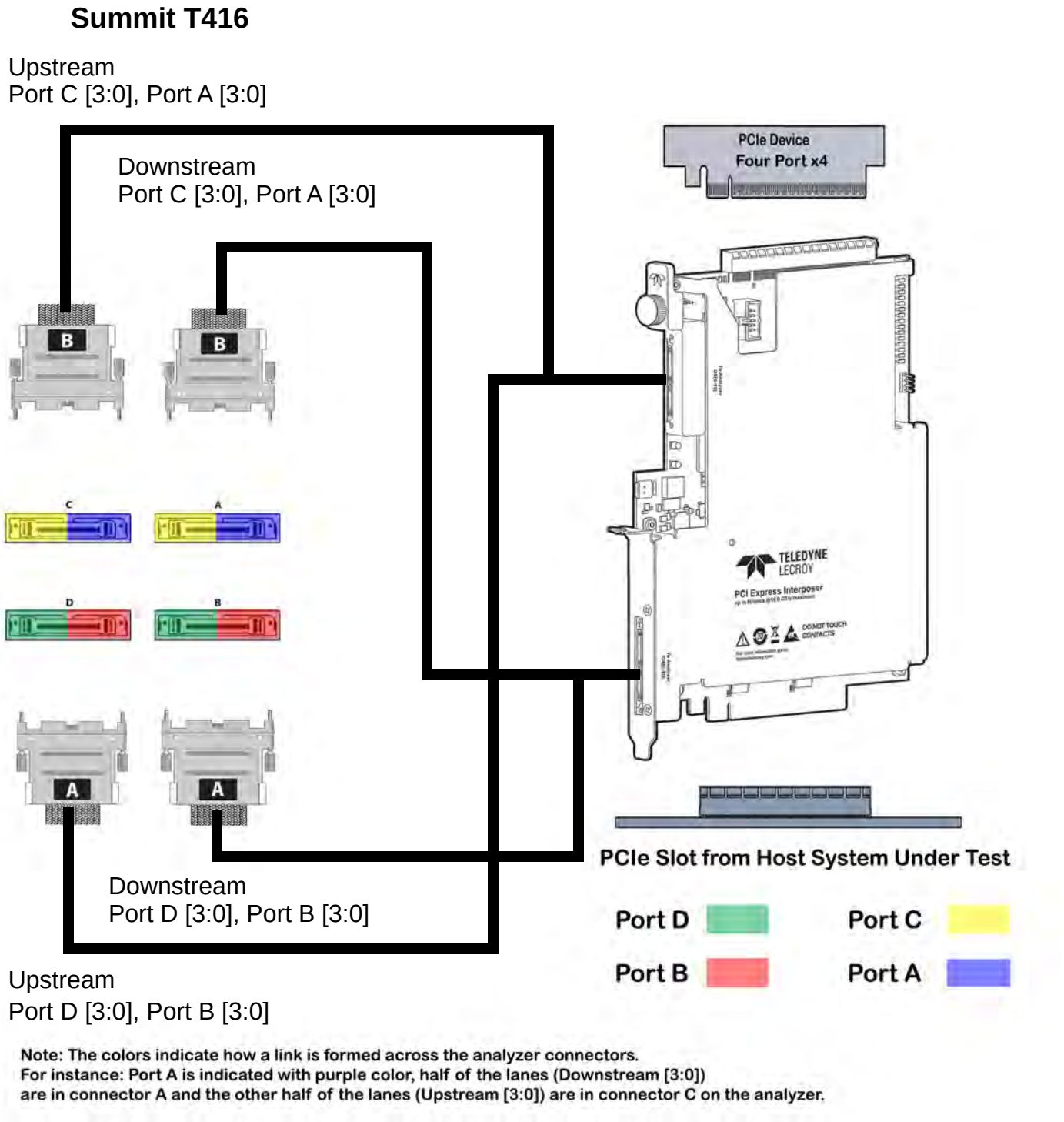


Figure 2.26: Bifurcated (4 x4 Ports) Mode for Summit T416 using MultiPort x16 interposer

- Uses Gen4 Y Cable: PE021UCA-X
- Reference Clock GUI for T416: Bifurcated Mode -> 4 x4 Ports using MultiPort interposer (see Figure 2.27 on page 61)

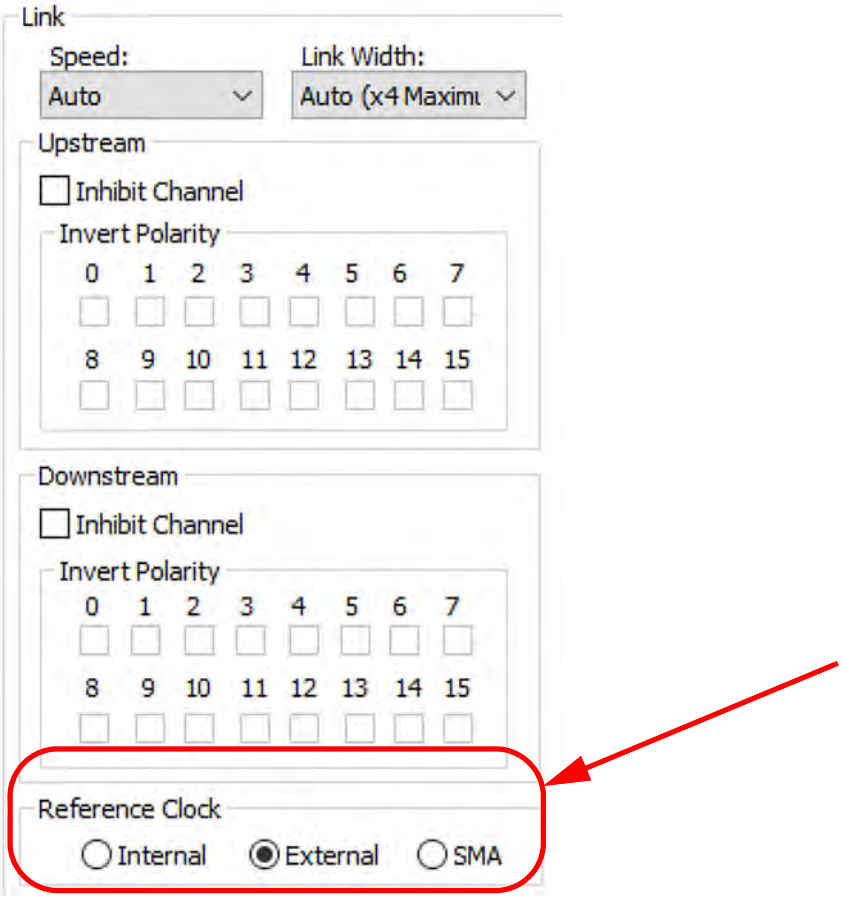


Figure 2.27: Reference Clock GUI for T416: Bifurcated Mode -> 4x4 Ports Single Clock Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen3 x16 Interposer: PE104UIA-X with two (2) iPass Gen3 to Gen4 cables: PE016UCA-X

2.11.1.8 Independent (4 x4 Ports) Mode using MultiPort x4 interposer

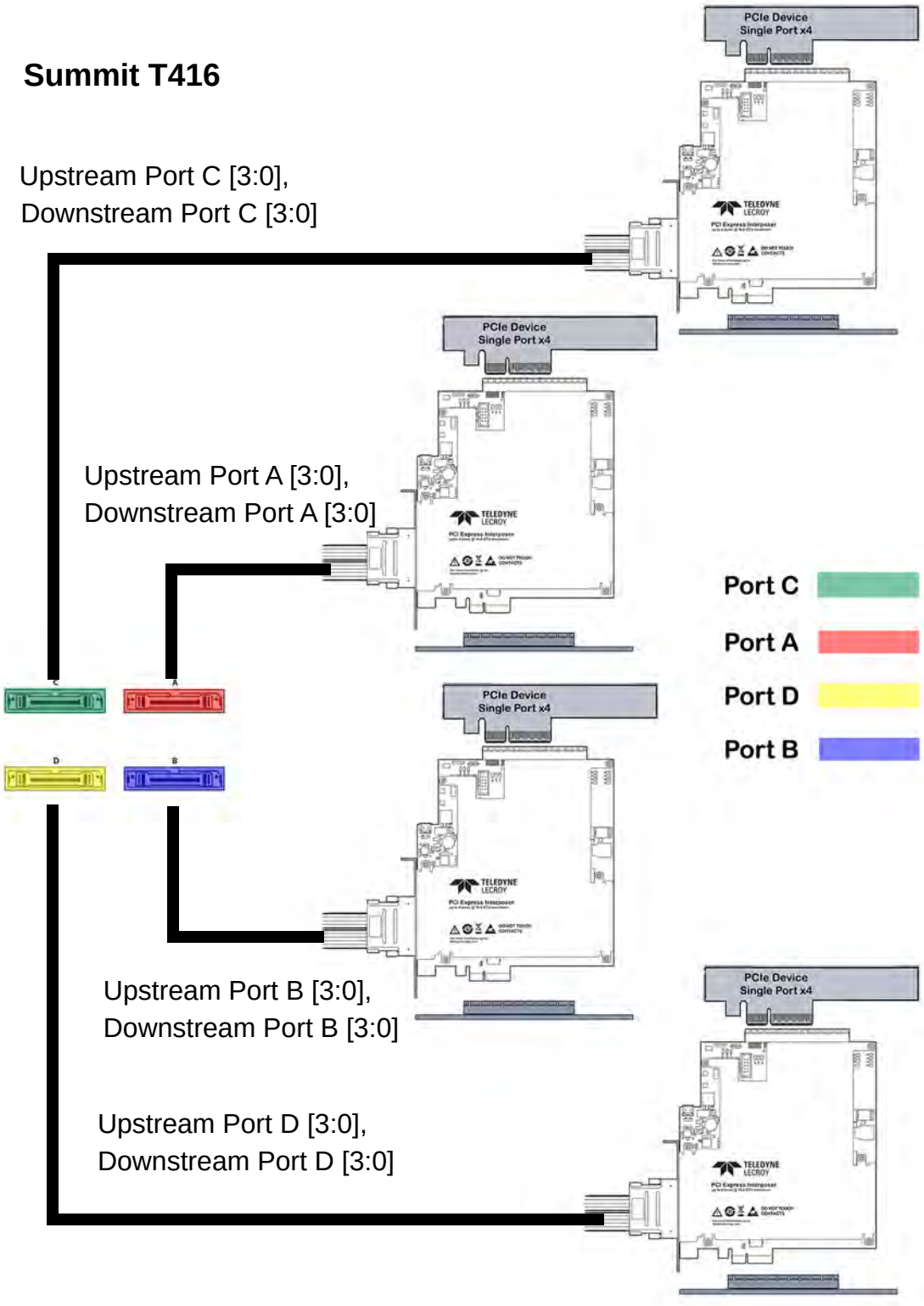


Figure 2.28: Independent (4 x4 Ports) Mode for Summit T416 using MultiPort x4 interposer

- Uses Gen4 Straight Cable: PE020UCA-X
- Reference Clock GUI for T416: Independent Mode -> 4 x4 Ports using MultiPort interposers (see Figure 2.29 on page 63)

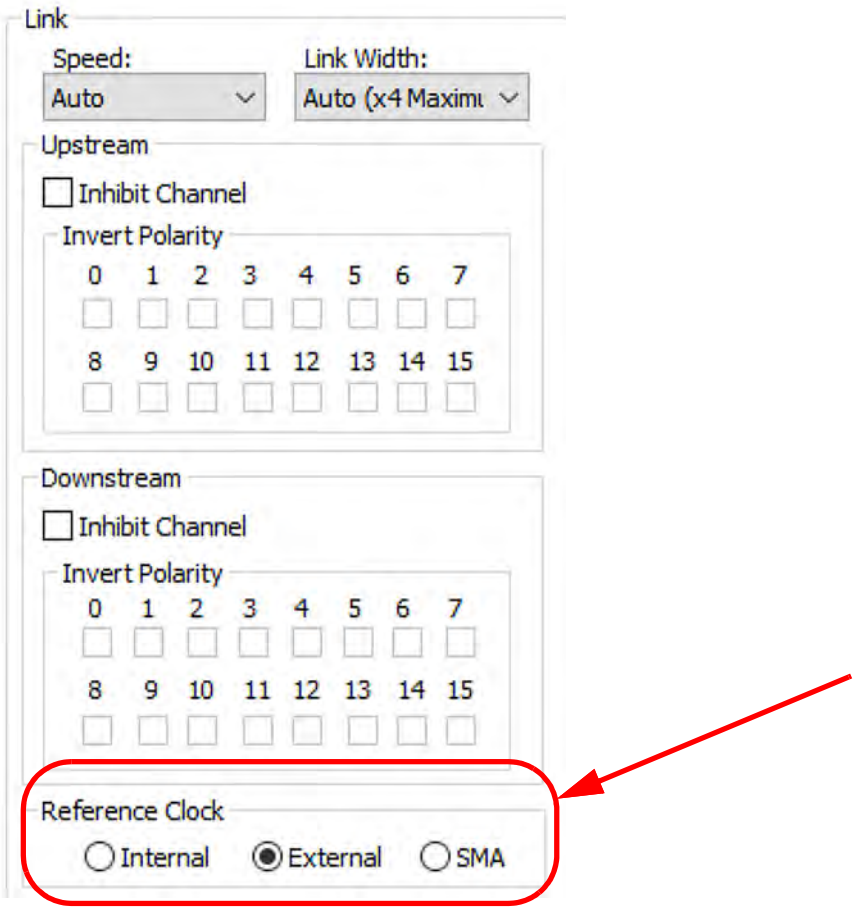


Figure 2.29: Reference Clock GUI for T416: Independent Mode -> 4x4 Ports Single Clock Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen4 x1 MultiPort Interposer: PE180UIA-X with one (1) Gen4 straight cable: PE020UCA-X

Gen3 x4 Slot Interposer: PE131UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x1 Slot Interposer: PE107UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

2.11.1.9 Bifurcated (4 x2 Ports) Mode using two MultiPort x4 interposers

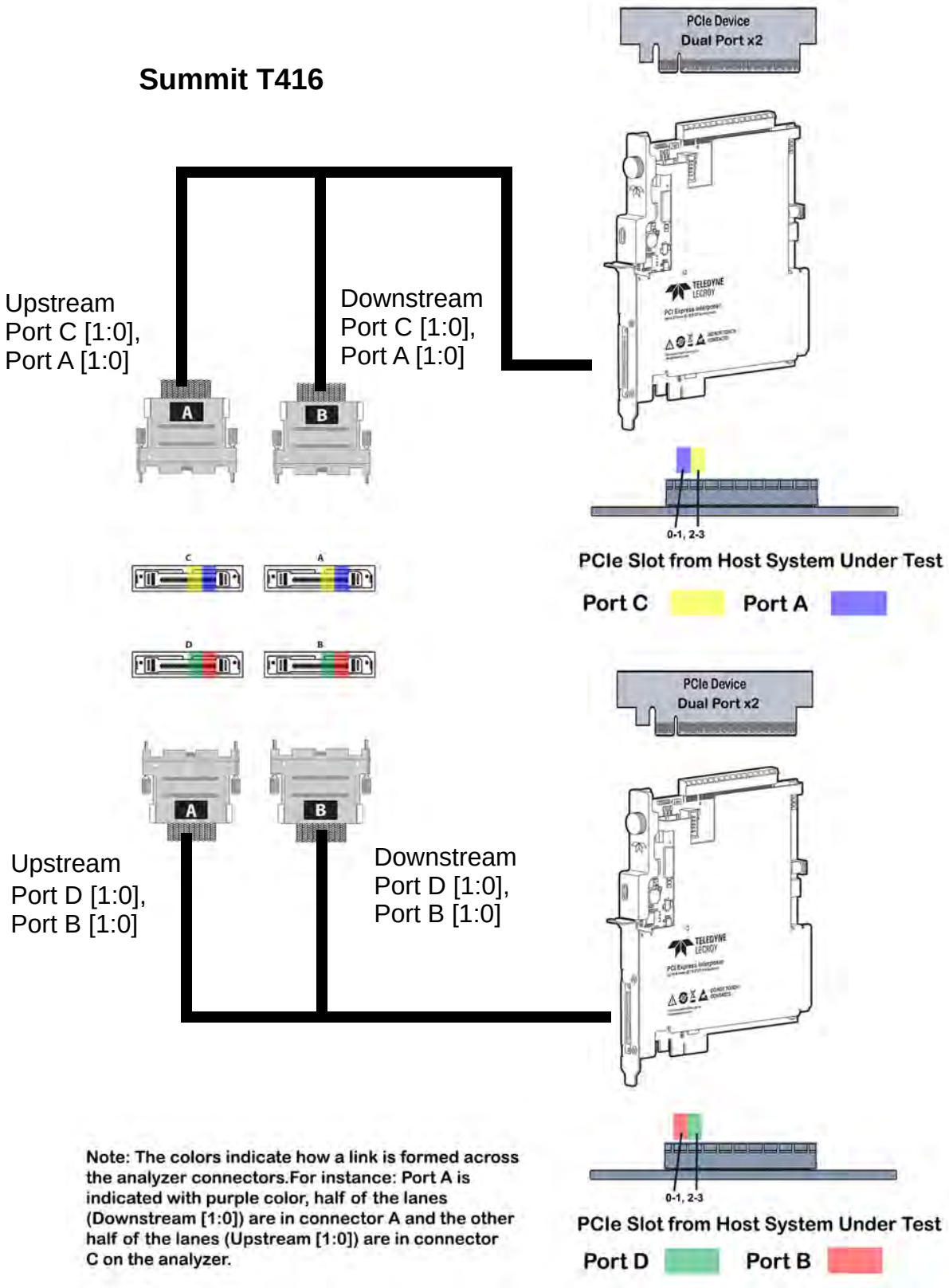


Figure 2.30: Bifurcated (4 x2 Ports) Mode for Summit T416 using MultiPort x4 interposer

- Uses Gen4 Y Cable: PE021UCA-X
- Reference Clock GUI for T416: Bifurcated Mode -> 4 x2 Ports using MultiPort interposer (see Figure 2.27 on page 61)

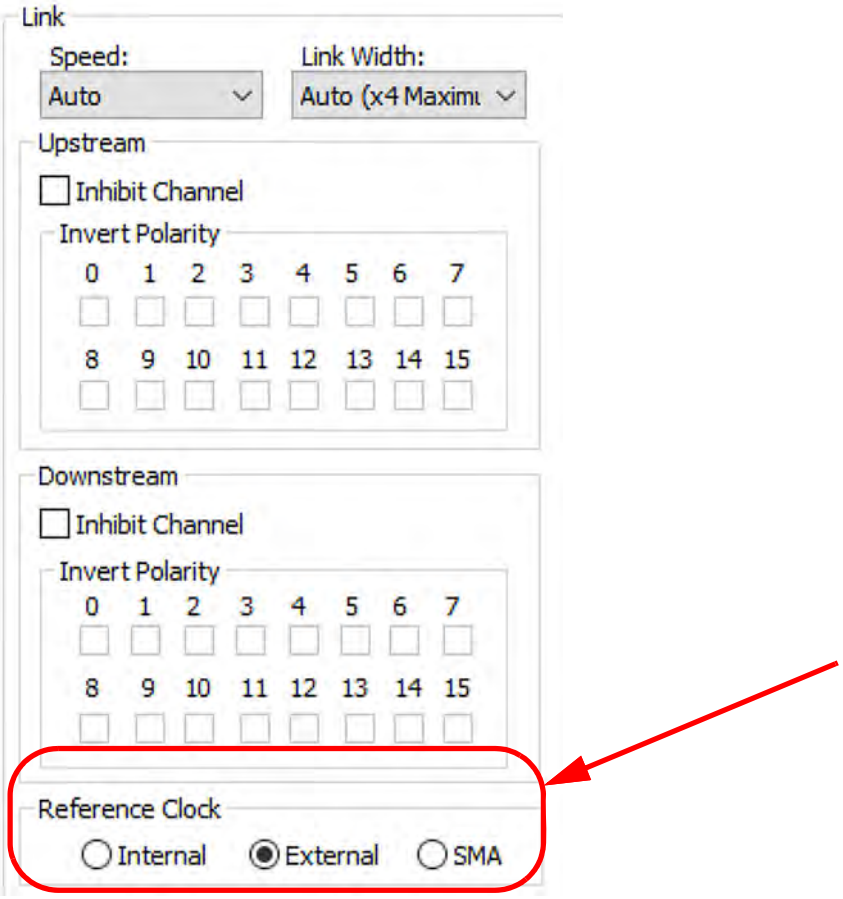


Figure 2.31: Reference Clock GUI for T416: Bifurcated Mode -> 4x4 Ports Single Clock Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen3 x16 Interposer: PE104UIA-X with two (2) iPass Gen3 to Gen4 cables: PE016UCA-X

2.11.1.10 Connecting Midbus Probe

The example shown below shows a MidBus Probe, which could be connected to as many as four x4 ports in either independent or bifurcated mode.

Connection diagram for Summit T416 Analyzer using separate clock supplied through the Summit T4 Sideband cables

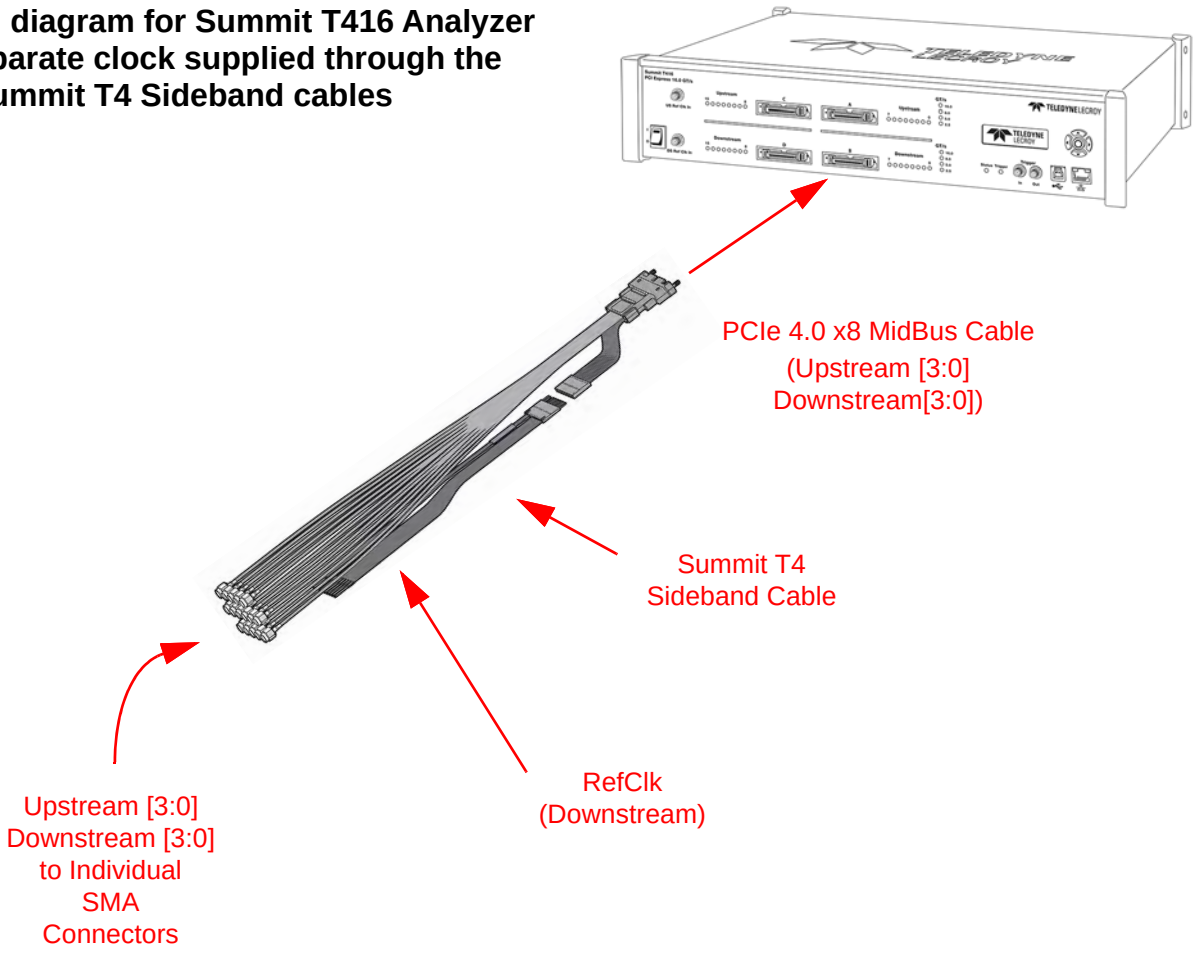


Figure 2.32: Summit T416 in Multiport Mode: Independent 4 x4 Ports (only one port shown)

2.11.2 Summit T48 Configurations

You can configure the Summit T48 as follows:

- Standard Mode: Single link width up to x8 (see Figure 2.33 on page 68 and Figure 2.34 on page 69)
  - Ref Clock GUI (see Figure 2.35 on page 70)
- MultiPort 2 x4 Bifurcated: 2 bifurcated ports, link width up to x4 for each port.
  - Single add-in card with two ports connected to the analyzer through a single interposer (see Figure 2.36 on page 71 and Figure 2.37 on page 72)
  - Ref Clock GUI (see Figure 2.38 on page 73)
- MultiPort 2 x4 Independent: 2 independent ports, link width up to x4 for each port
  - Two add-in cards connected to the analyzer through two interposers (see Figure 2.39 on page 74)
  - Ref Clock GUI (see Figure 2.40 on page 75)
- Multiport 2 x2 Bifurcated: 2 bifurcated ports, link width up to x2 for each port.
  - Single add-in card with two ports connected to the analyzer through a single interposer (see Figure 2.41 on page 76).
  - Ref Clock GUI (see Figure 2.42 on page 77).

Note: In MultiPort mode the labels in front of the analyzer do not necessarily correspond to the actual upstream/downstream and lane number connections.

2.11.2.1 Standard Mode Configuration using a cable-attached x8 interposer

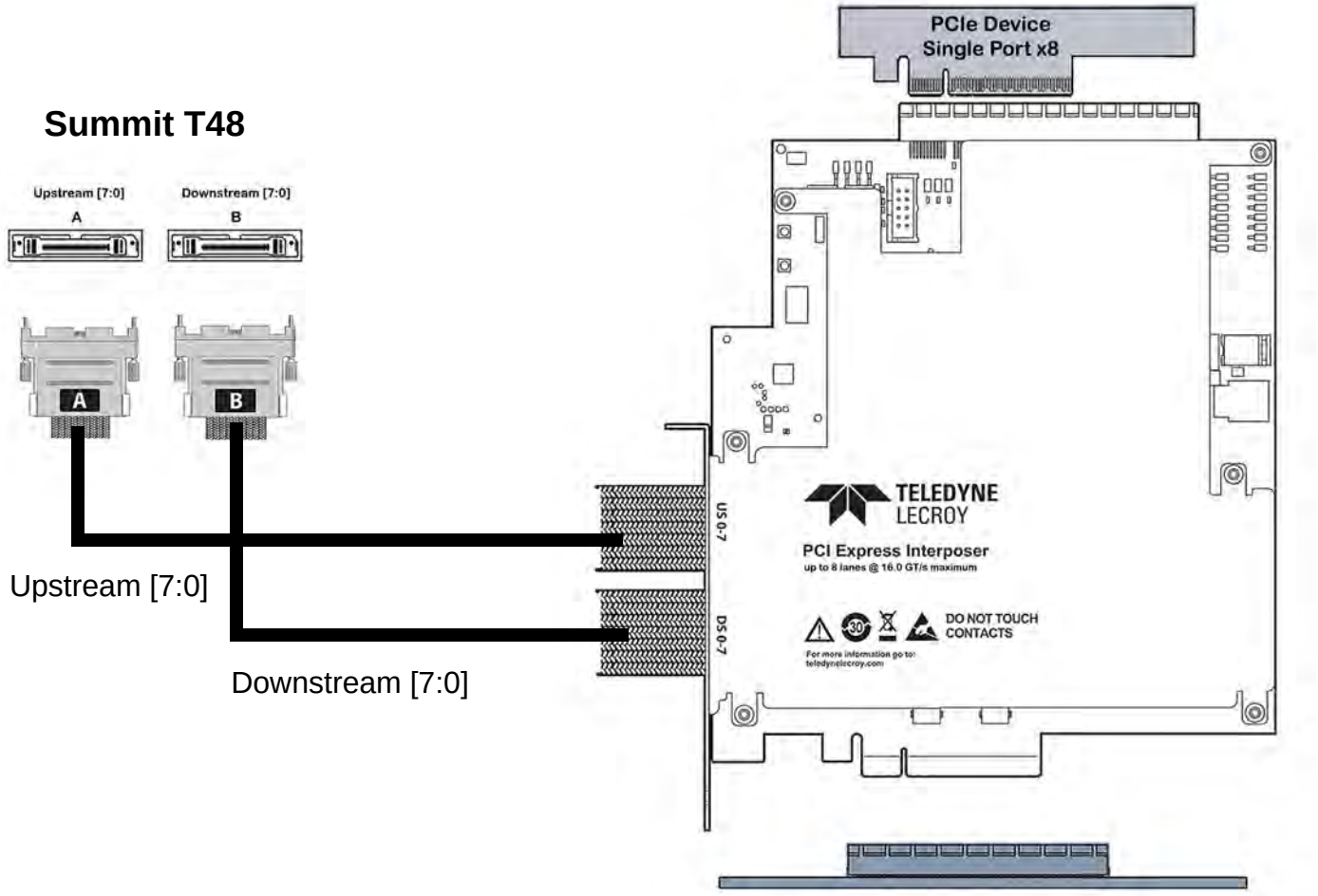


Figure 2.33: Standard Mode Configuration for Summit T48 using a cable-attached x8 interposer

2.11.2.2 Standard Mode Configuration using a MultiPort x8 interposer

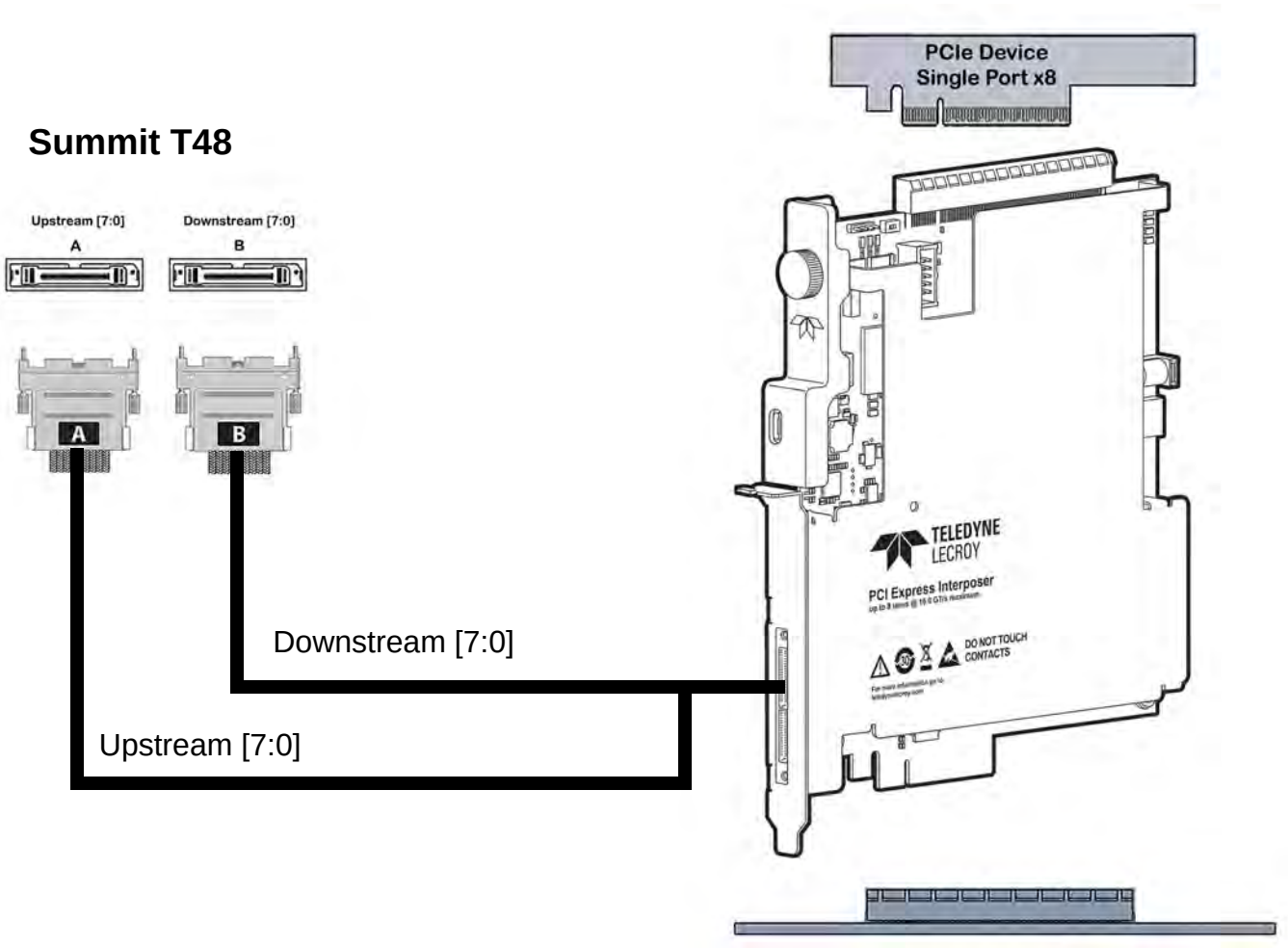


Figure 2.34: Standard Mode Configuration for Summit T48 using a MultiPort x8 interposer

- Uses Y cable: PE021UCA-X
- Reference Clock GUI for T48: Standard Mode (see Figure 2.35 on page 70)

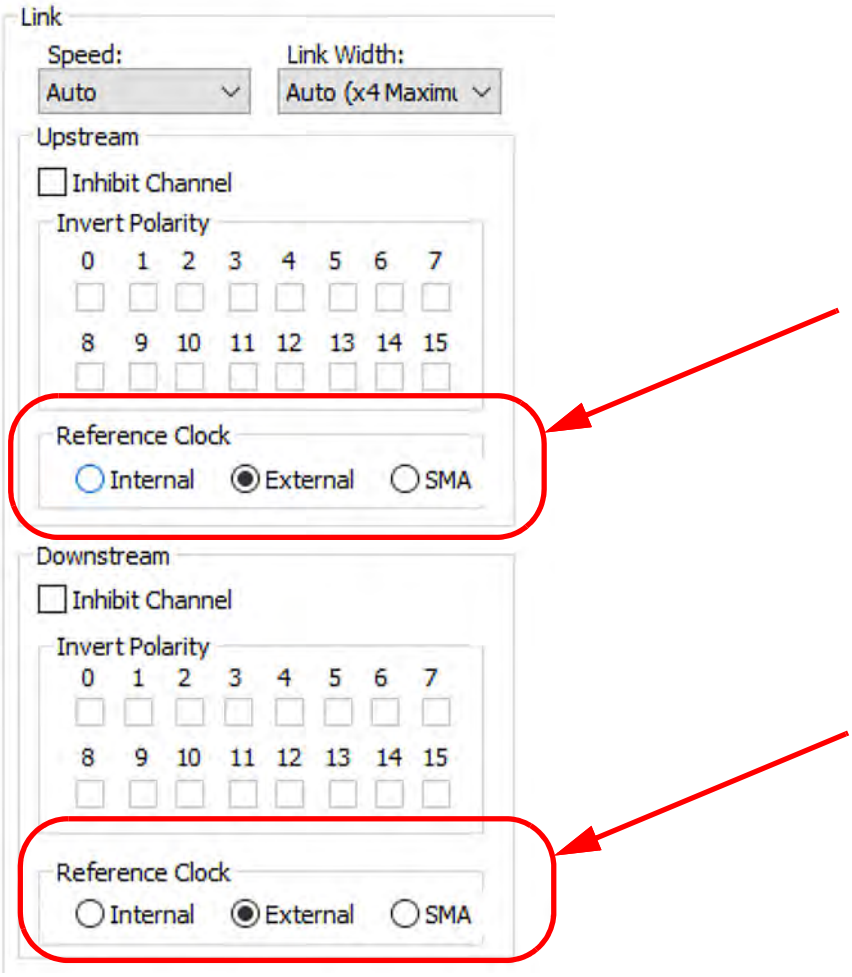


Figure 2.35: Reference Clock GUI for T48: Standard Mode -> Separate Ref Clock for Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen3 x8 Interposer: PE130UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen4 x8 Oculink Interposer: PE163UIA-X includes cables

Gen3x8 Oculink Interposer: PE 162UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 External Cable Interposer: PE120UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 Express Module Interposer: PE062UIA=X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 90 Degree Right Angle Interposer: PE058UIA-x with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 90 Degree Left Angle Interposer: PE059UIA-x with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

2.11.2.3 Bifurcated (2 x4 Ports) Mode using a cable-attached x8 interposer

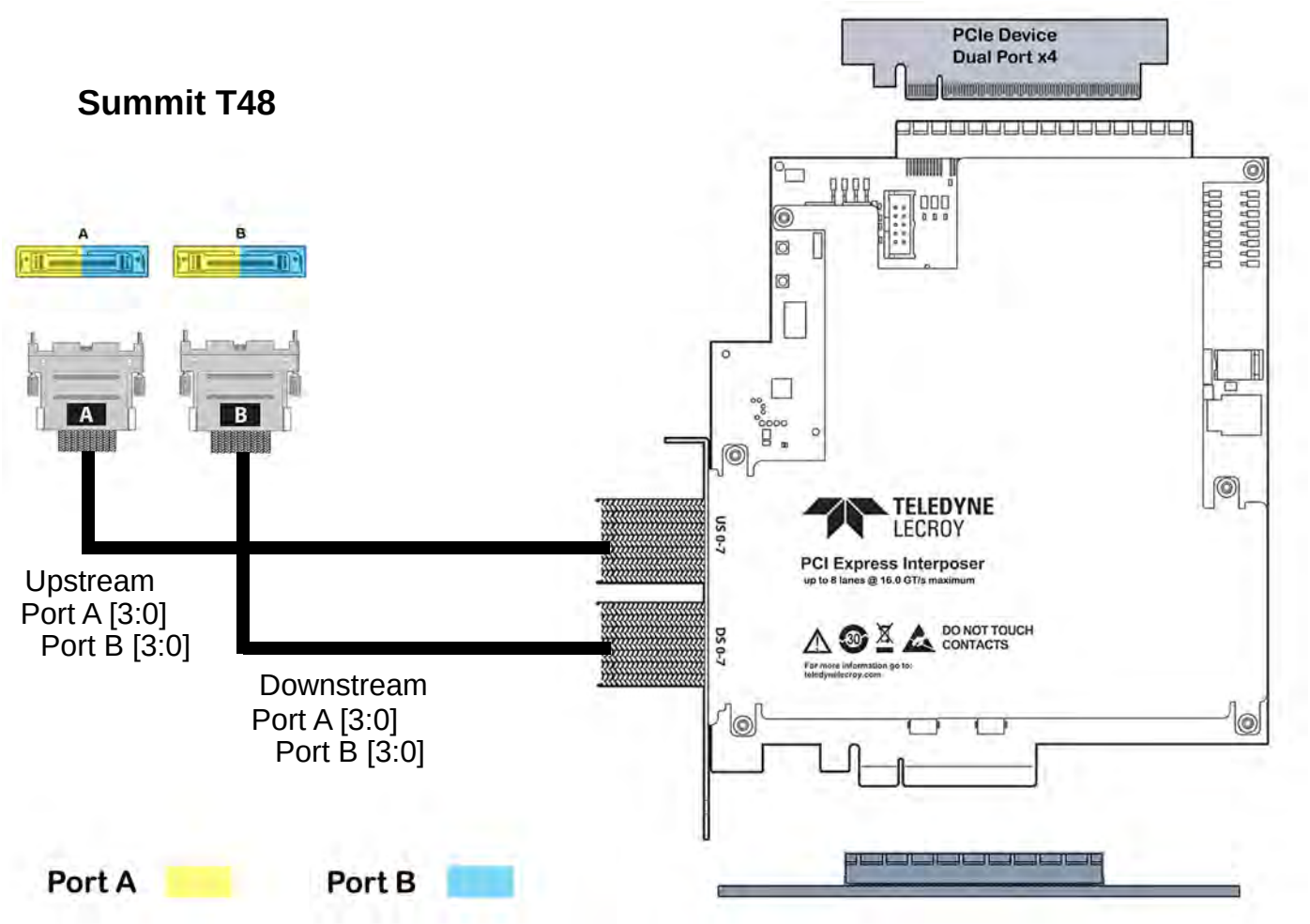


Figure 2.36: Bifurcated (2 x4 Ports) Mode with Summit T48 using a cable-attached x8 interposer

- Reference Clock GUI for T48: Bifurcated Mode using cable attached interposer (see Figure 2.38 on page 73)

2.11.2.4 Bifurcated (2 x4 Ports) Mode using MultiPort x8 interposer

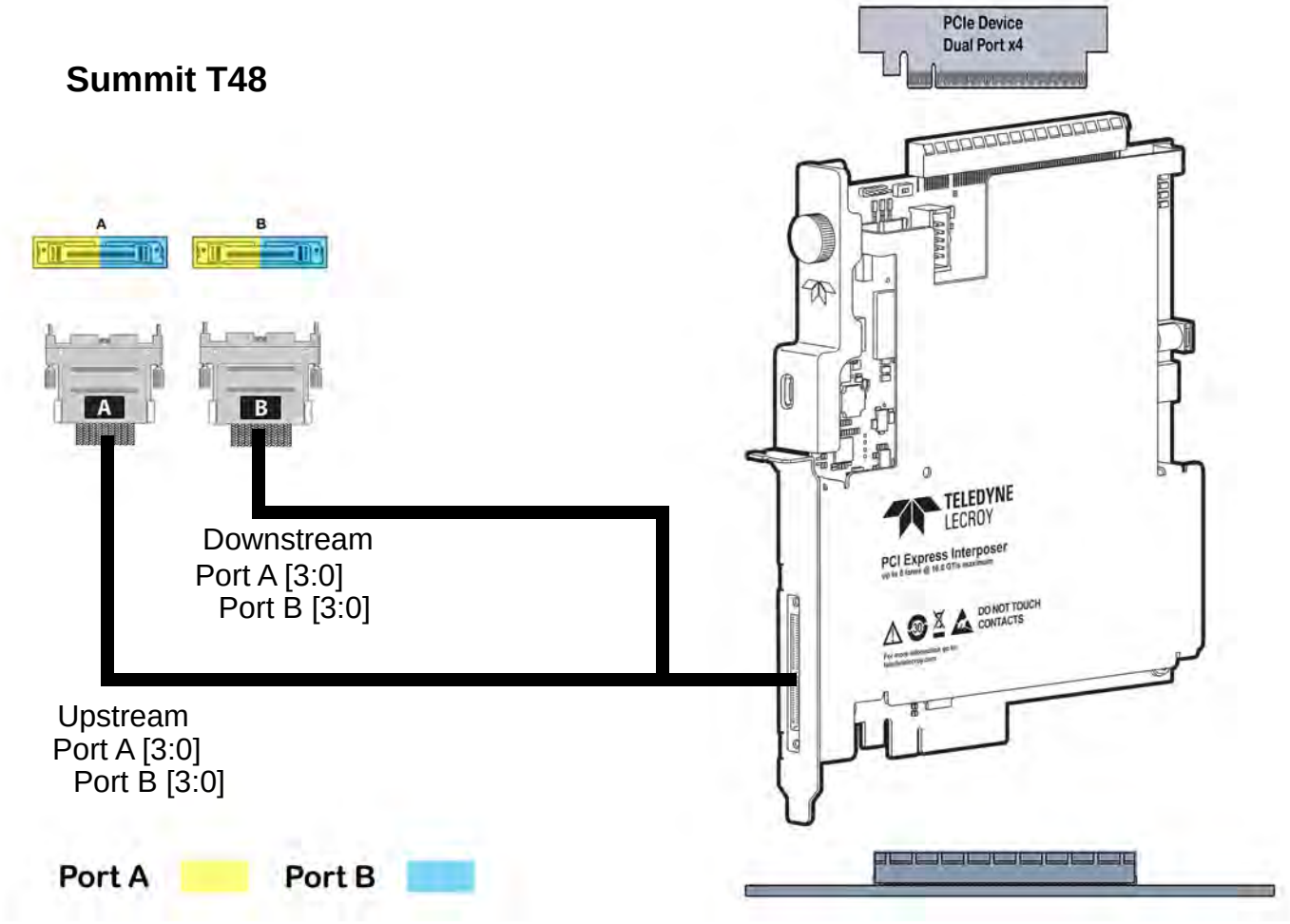


Figure 2.37: Bifurcated (2 x4 Ports) Mode for Summit T48 using MultiPort x8 interposer

- Uses Gen4 Y cable: PE021UCA-X
- Reference Clock GUI for T48: Bifurcated Mode (see Figure 2.38 on page 73)

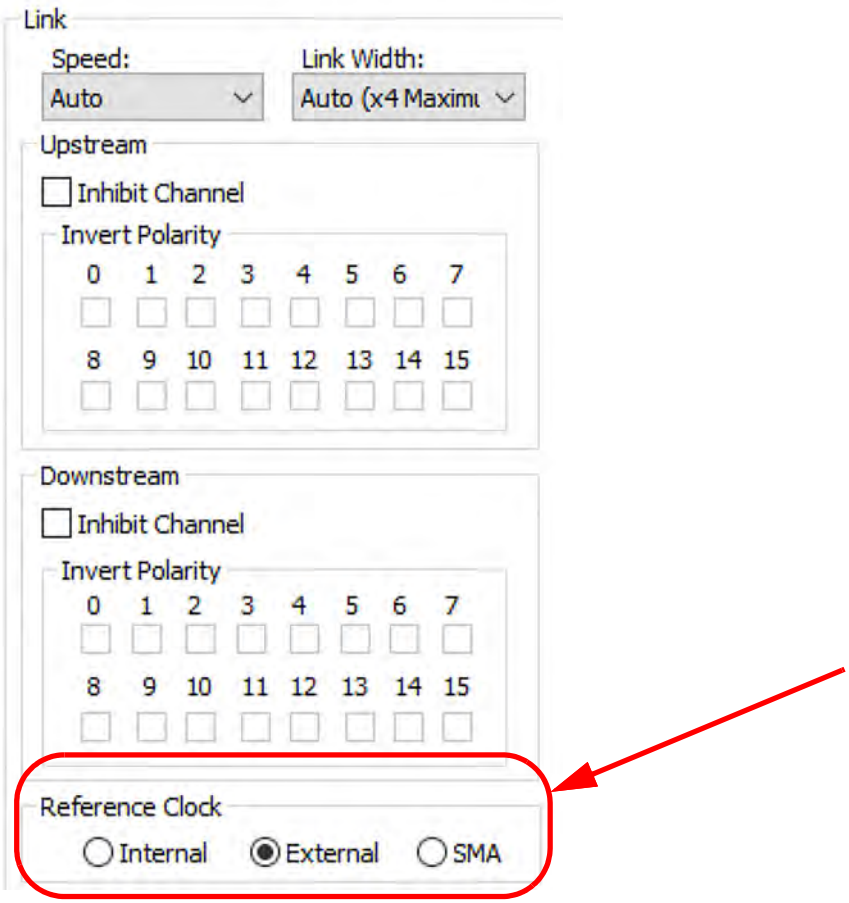


Figure 2.38: Reference Clock GUI for T48: Bifurcated Mode -> Single Clock Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen3 x8 Interposer: PE130UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen4 x8 Oculink Interposer: PE163UIA-X

Gen3x8 Oculink Interposer: PE 162UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 External Cable Interposer: PE120UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 Express Module Interposer: PE062UIA=X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 90 Degree Right Angle Interposer: PE058UIA-x with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x8 90 Degree Left Angle Interposer: PE059UIA-x with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

2.11.2.5 Independent (2 x4 Ports) Mode using Multiport x4 interposers

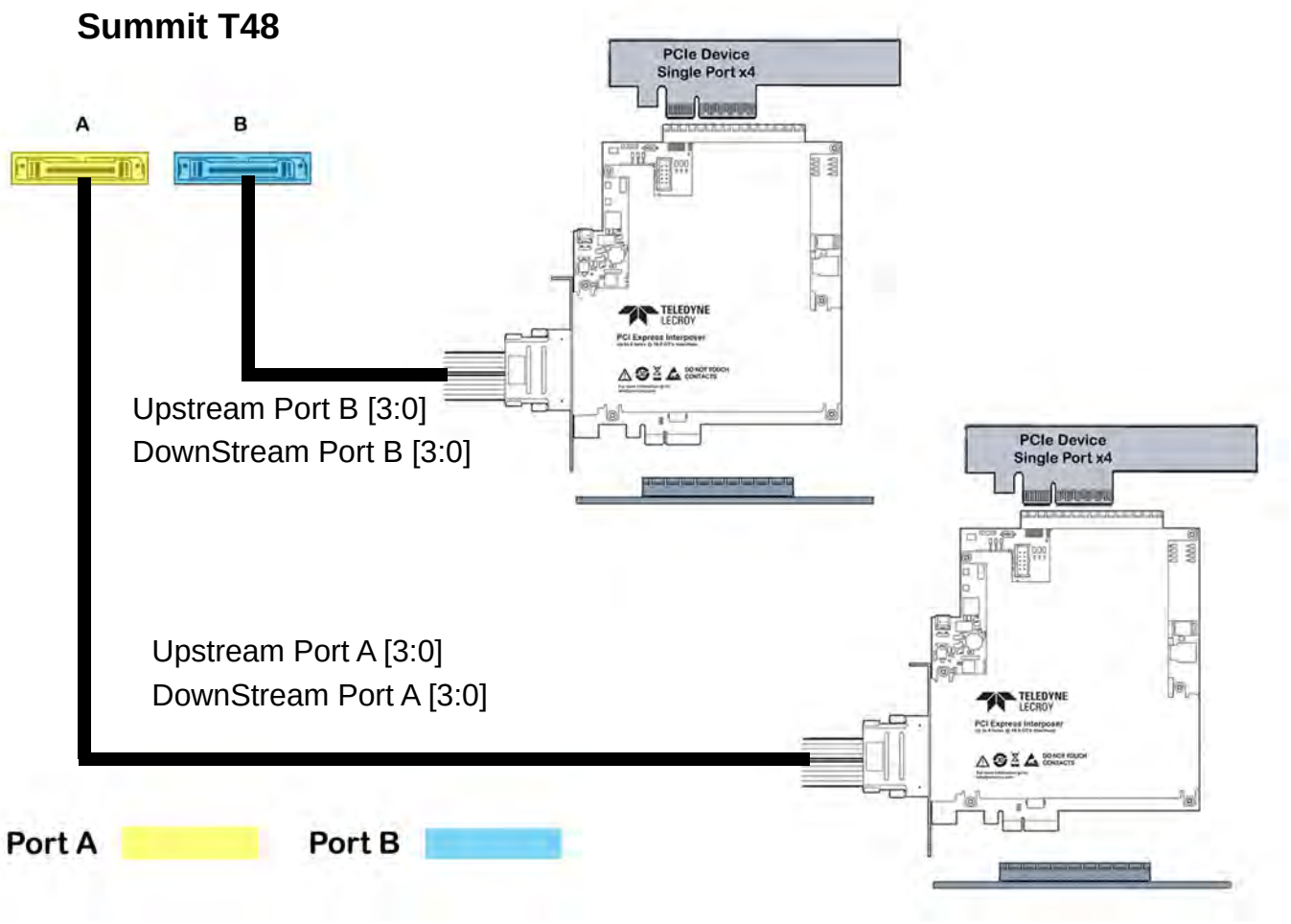


Figure 2.39: Independent (2 x4 Ports) Mode with Summit T48 using Multiport x4 interposers

- Uses Gen4 Straight Cable: PE020UCA-X
- Reference Clock GUI for T48: Independent Mode (see Figure 2.40 on page 75)

Other interposers and cables that can be used for MultiPort mode:

Gen4 x1 MultiPort Interposer: PE180UIA-X with one (1) Gen4 straight cable: PE020UCA-X

Gen3 x4 Slot Interposer: PE131UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x1 Slot Interposer: PE107UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

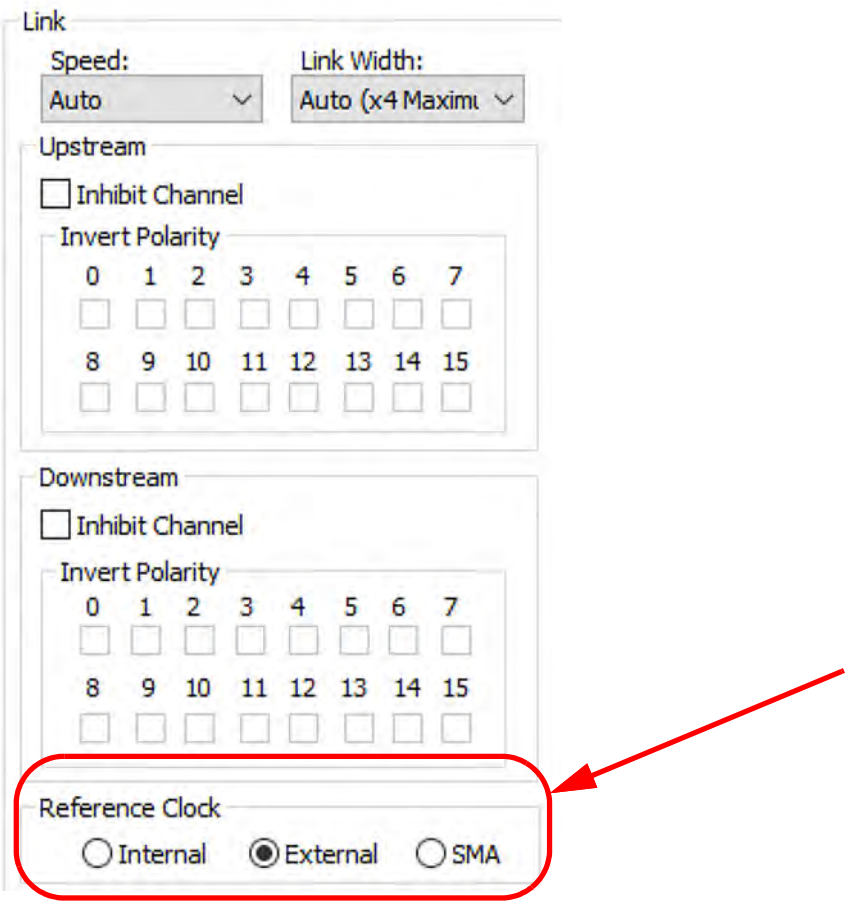


Figure 2.40: Reference Clock GUI for T48: Independent Mode -> Single Clock Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen4 x4 Interposer: PE181UIA-X with one (1) Gen4 straight cable: PE020UCA-X

Gen4 x1 Interposer: PE180UIA-X with one (1) Gen4 straight cable: PE020UCA-X

2.11.2.6 Bifurcated (2 x2 Ports) Mode using MultiPort x4 interposer

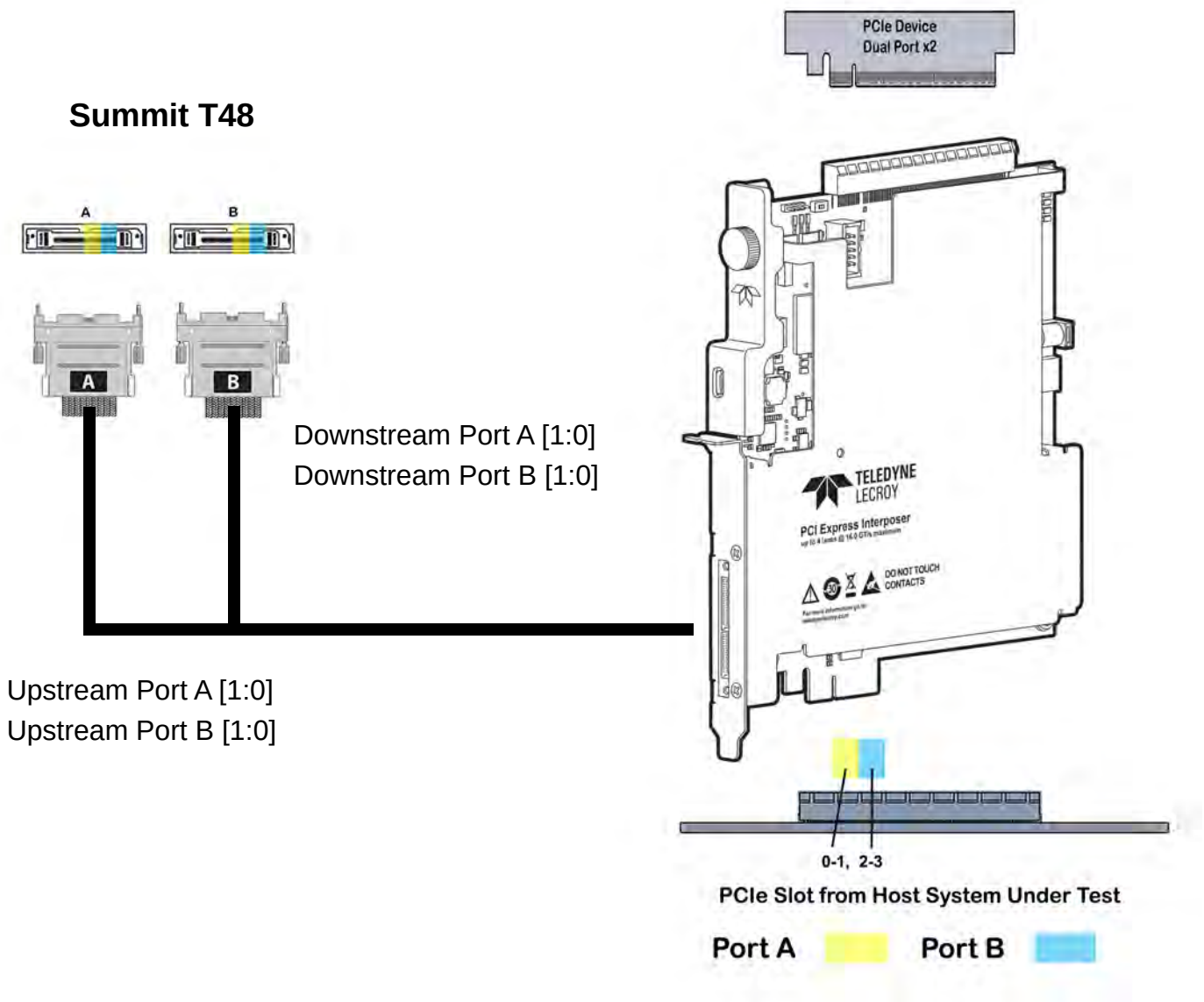


Figure 2.41: Bifurcated (2 x2 Ports) Mode for Summit T48 using MultiPort x4 interposer

- ❑ Uses Gen 4 Y cable: PE021UCA-X
- ❑ Reference Clock GUI for T48: Independent Mode (see Figure 2.40 on page 75)

Other interposers and cables that can be used for MultiPort mode:

Gen4 x1 MultiPort Interposer: PE180UIA-X with one (1) Gen4 straight cable: PE020UCA-X

Gen3 x4 Slot Interposer: PE131UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

Gen3 x1 Slot Interposer: PE107UIA-X with one (1) iPass Gen3 to Gen4 cable: PE016UCA-X

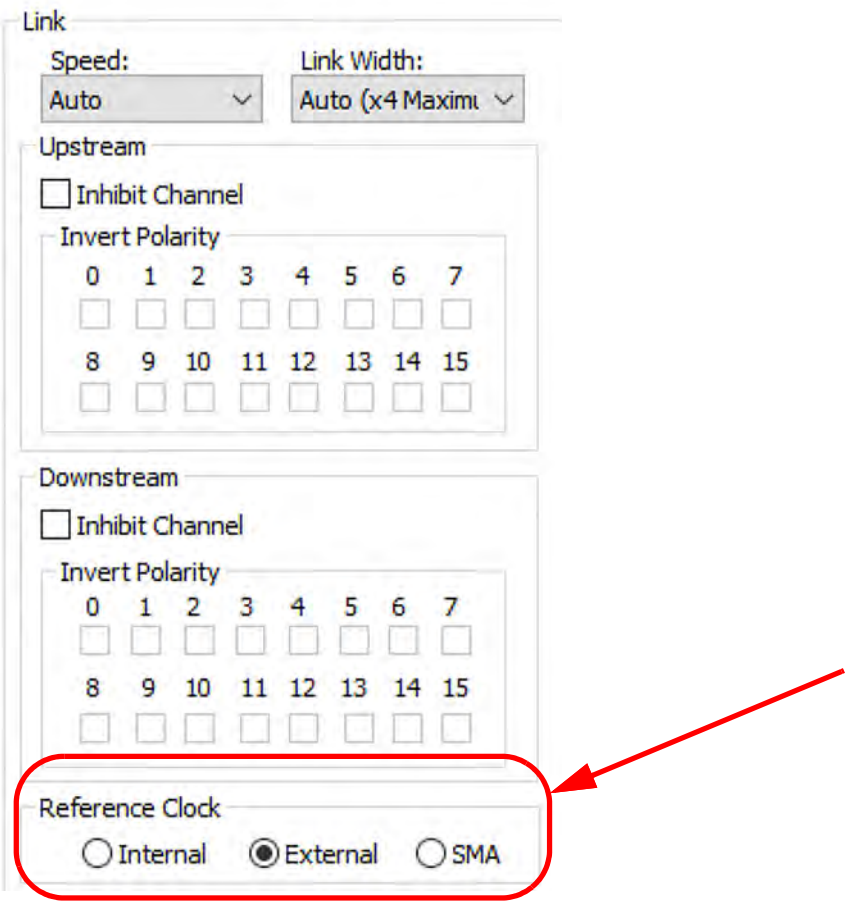


Figure 2.42: Reference Clock GUI for T48: Independent Mode -> Single Clock Upstream and Downstream

Other interposers and cables that can be used for MultiPort mode:

Gen4 x4 Interposer: PE181UIA-X with one (1) Gen4 straight cable: PE020UCA-X

Gen4 x1 Interposer: PE180UIA-X with one (1) Gen4 straight cable: PE020UCA-X

2.11.2.7 Connection with MidBus Probe

The example shown below shows a MidBus Probe, which could be connected to as many as two x4 ports in either independent or bifurcated mode.

Connection diagram for Summit T48 Analyzer using separate clock supplied through the Summit T4 Sideband cables

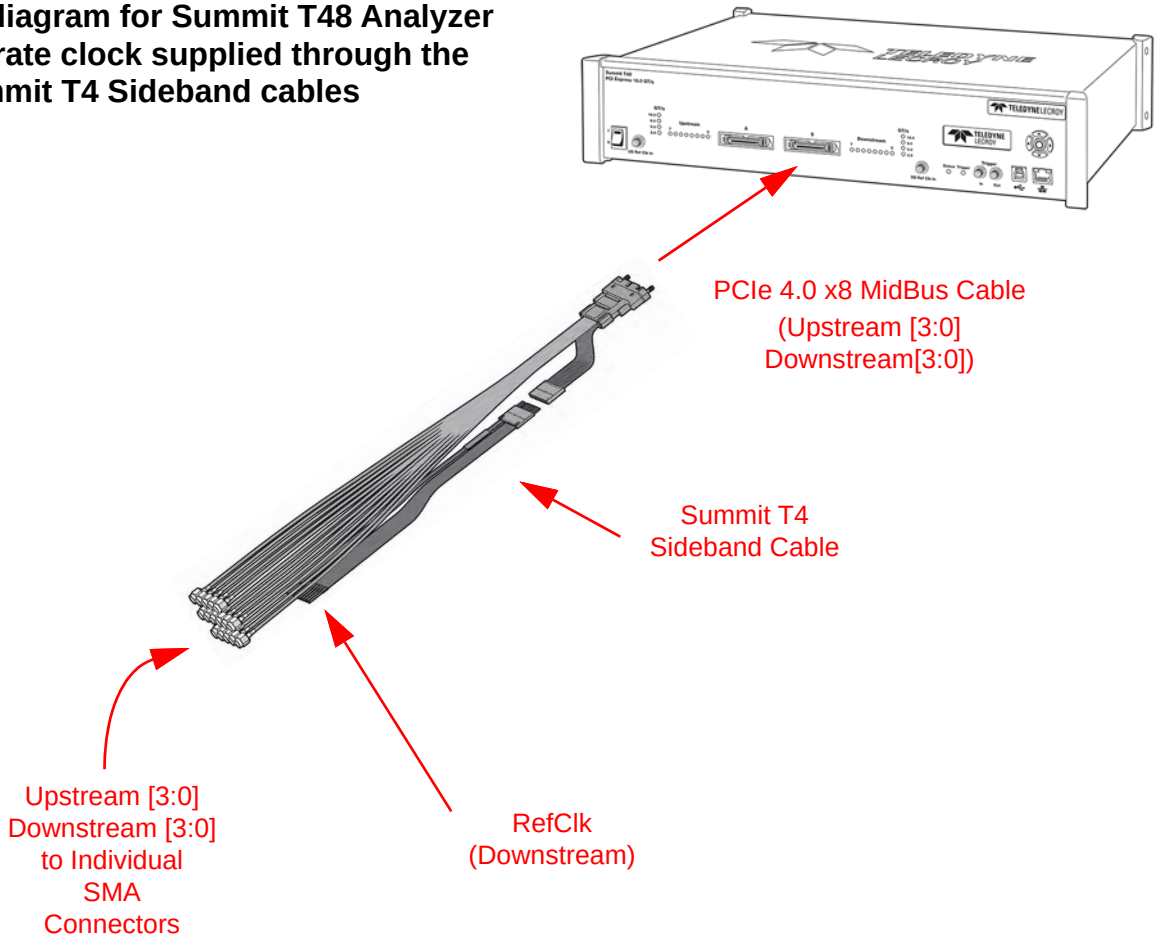


Figure 2.43: Summit T48 in Multiport Mode: Independent 2 x4 Ports (only one port shown)

2.11.3 Gen4 x4 U.2/U.3 Single/Dual Port Interposer Configurations

The Gen4 x4 U.2/U.3 Interposer can be used with Summit T416, Summit T48 and the PCIe Protocol Analysis software in the configurations described below.

- U.2 x4 Single Port
  - Standard Mode (see Figure 2.44 and Figure 2.45 on page 80)
  - Multiport Mode (see Figure 2.46 on page 80, Figure 2.47 on page 81 and Figure 2.48 on page 82)
- U.2 x2 Dual Port
  - Multiport Mode (see Figure 2.49 on page 83 and Figure 2.50 on page 83)
- U.3 x4 Single Port
  - Standard Mode See Figure 2.52 on page 84, Figure 2.53 on page 85 and Figure 2.54 on page 85)
- U.3 x2 Dual Port is currently not supported

2.11.3.1 U.2 x4 Single Port

When analyzing a U.2 x4 single port link the PCIe Protocol Analysis software should be used in Standard Mode and the interposer cables should be connected as shown in the diagrams below for Summit T416 and T48. See "Summit T416 Configurations" on page 50 and "Summit T48 Configurations" on page 67 for more details.

For the cases described below, the clock options available are Internal, External and SMA.

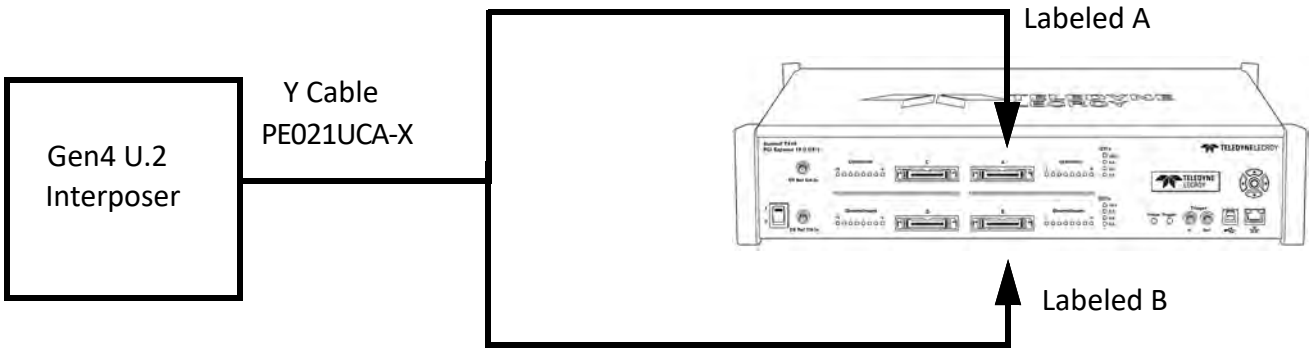


Figure 2.44: U.2 x4 Single Port with T416 in Standard Mode

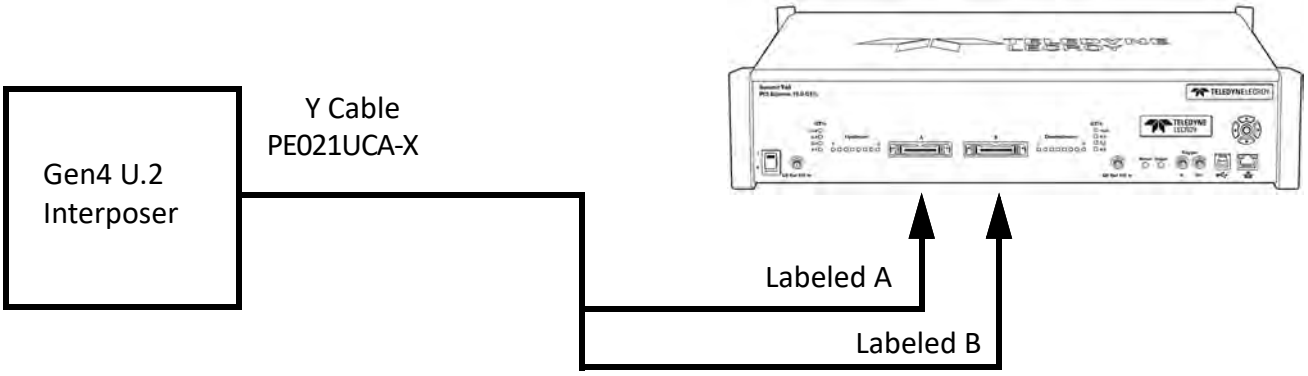


Figure 2.45: U.2 x4 Single Port with T48 in Standard Mode

2.11.3.2 Analyzing multiple x4 ports

When analyzing two independent U.2 x4 ports at the same time, two Gen4 U.2 interposers are required (see Figure 2.46). The PCIe Protocol Analysis software should be used in four ports independent option in MultiPort Mode for Summit T416 (see Figure 2.47 on page 81) or two ports independent option in Multiport Mode for Summit T48 (see Figure 2.48 on page 82) and the interposer cables should be connected as shown in the diagrams below for Summit T416 and T48. See "Summit T416 Configurations" on page 50 and "Summit T48 Configurations" on page 67 for more details.

Please observe clocking restrictions for these configurations. PCIe Protocol Analysis will provide warnings on configurations not supported.

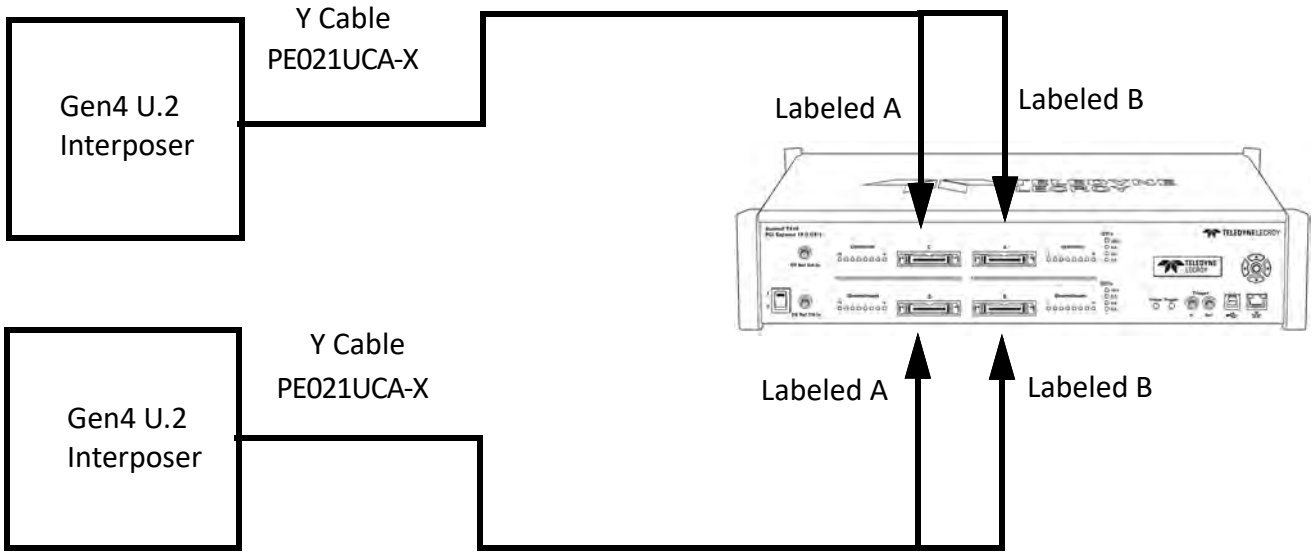


Figure 2.46: Analyzing up to two U.2 x4 independent ports with Summit T416 in MultiPort mode

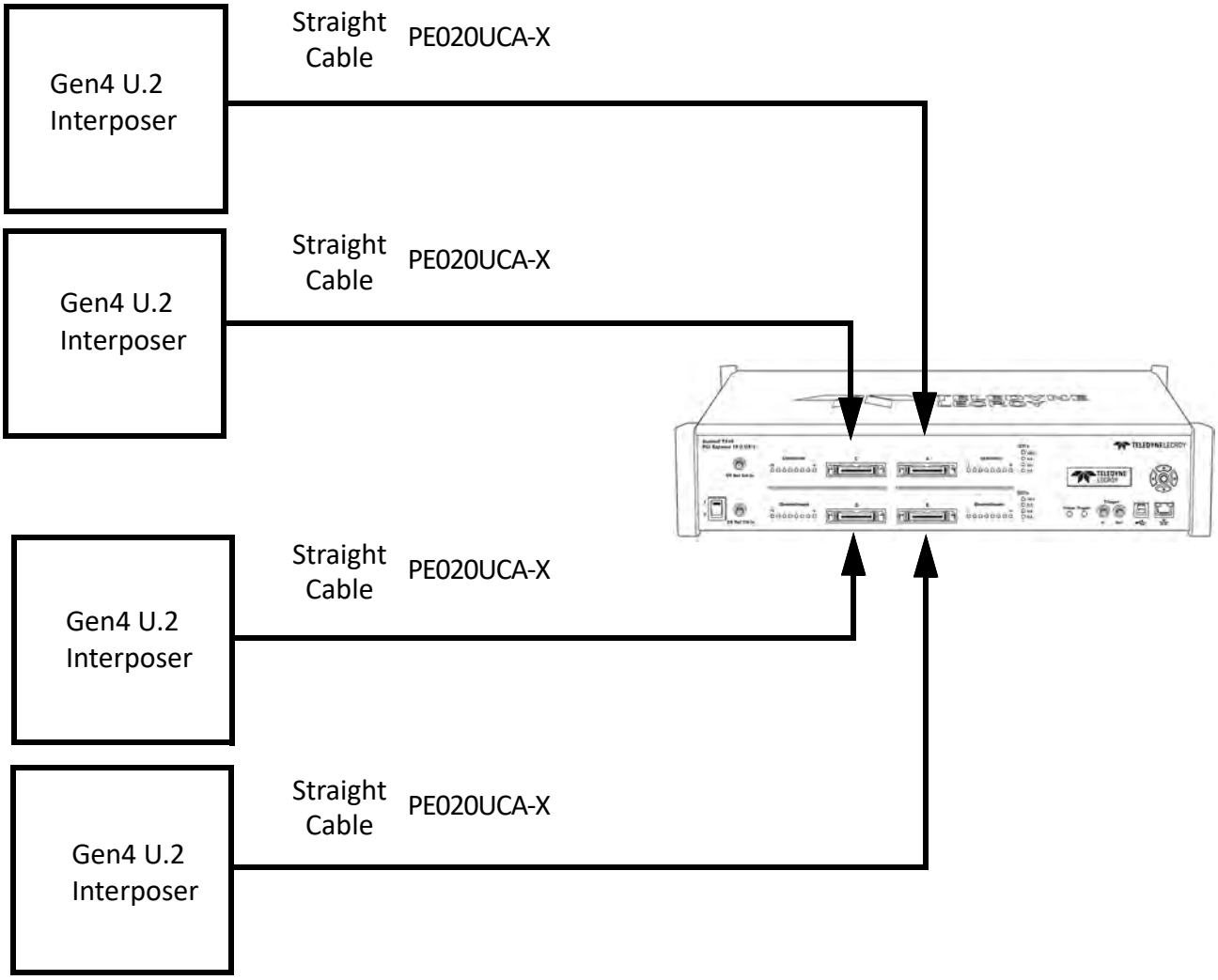


Figure 2.47: Analyzing up to four independent U.2 x4 ports with Summit T416 in Multiport mode

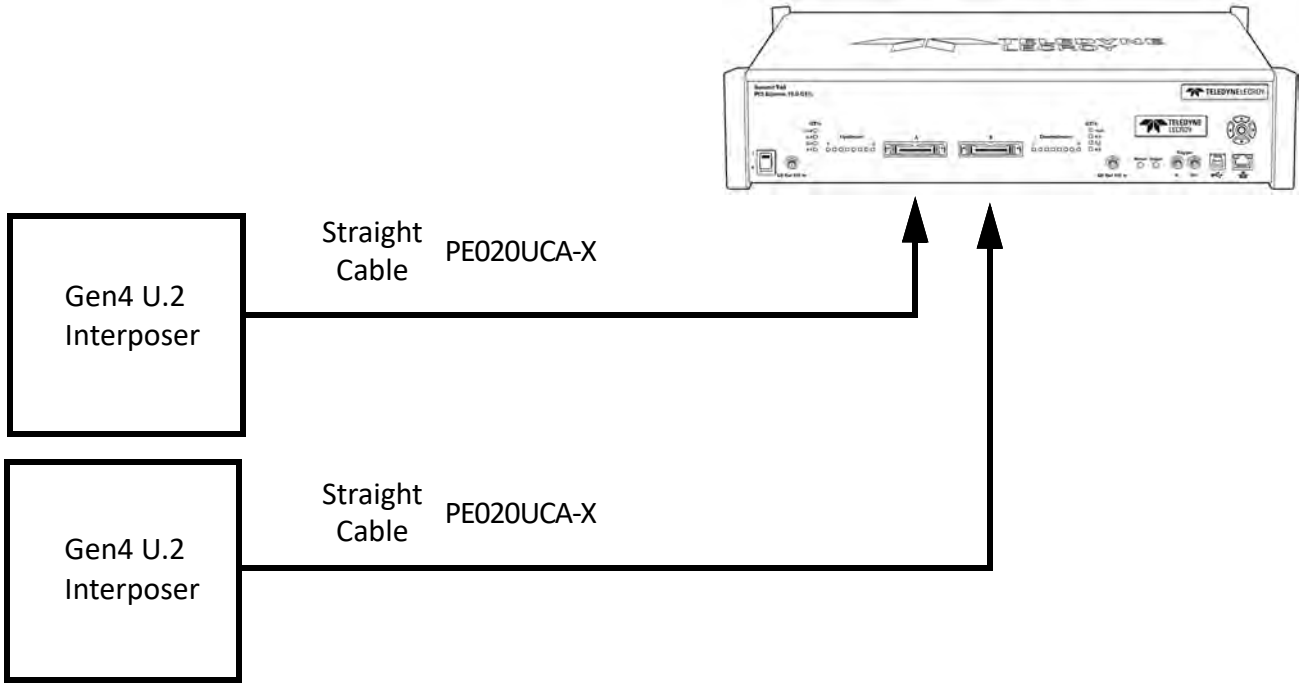


Figure 2.48: Analyzing up to two independent x4 ports with Summit T48

2.11.3.3 U.2 x2 Dual Port Analysis

When analyzing U.2 Dual Port (two x2 bifurcated ports) only one Gen4 U.2 interposer is needed. The PCIe Protocol Analysis software should be used in bifurcated x2 MultiPort Mode and the interposer cables should be connected as shown in the diagrams below for Summit T416 and T48. Up to four x2 ports can be analyzed this way using a Summit T416 and up to two x2 ports can be analyzed with Summit T48. See "Summit T416 Configurations" on page 50 and "Summit T48 Configurations" on page 67 for more details.

Please observe clocking restrictions for these configurations. PCIe Protocol Analysis will provide warnings on configurations not supported

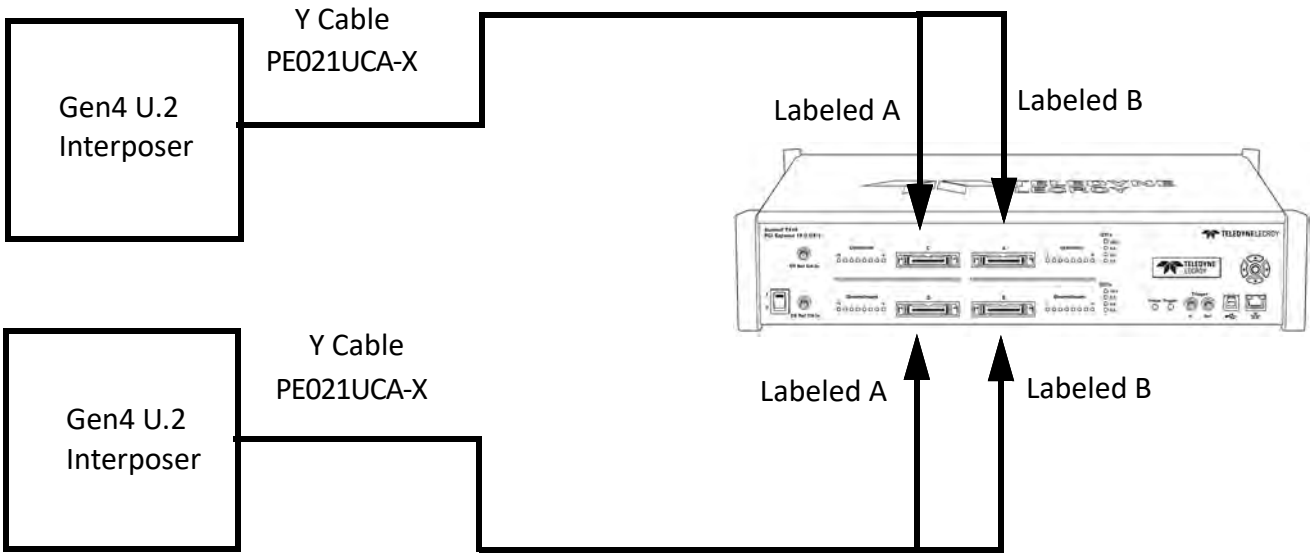


Figure 2.49: Analyzing two Dual x2 Ports with Summit T416 in MultiPort mode

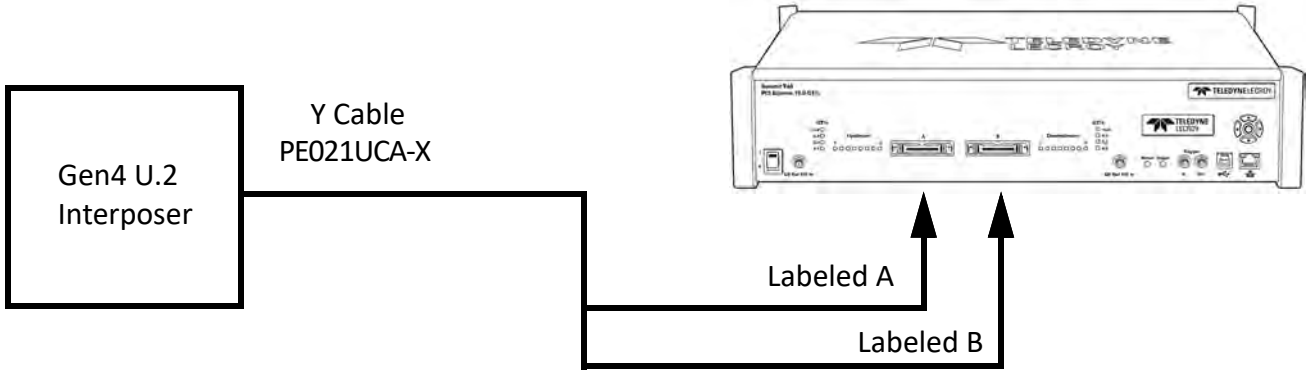


Figure 2.50: Analyzing Dual x2 Ports with Summit T48 in MultiPort mode

2.11.3.4 U.3 x4 Single Port Standard Mode

When analyzing a U.3 x4 single port link PCIe Protocol Analysis software should be used in Standard Mode and the interposer cables should be connected as shown in the diagrams for Summit T416 and T48. See "Summit T416 Configurations" on page 50 and "Summit T48 Configurations" on page 67 for more details.

Note: In the PCIe Protocol Analysis software you must use the Swizzle function and map physical lanes 4 and 5 use the logical lanes 0 and 1. Physical lanes 1 and 2 must be mapped to logical lanes 2 and 3. See "Swizzling Config..." on page 233. Map physical lanes according to Table 2.1 and Figure 2.51.

TABLE 2.1: Logical to Physical Lane Mapping

U.3 x4 Logical Lane	Analyzer Physical Lane
0	4
1	5
2	1
3	2

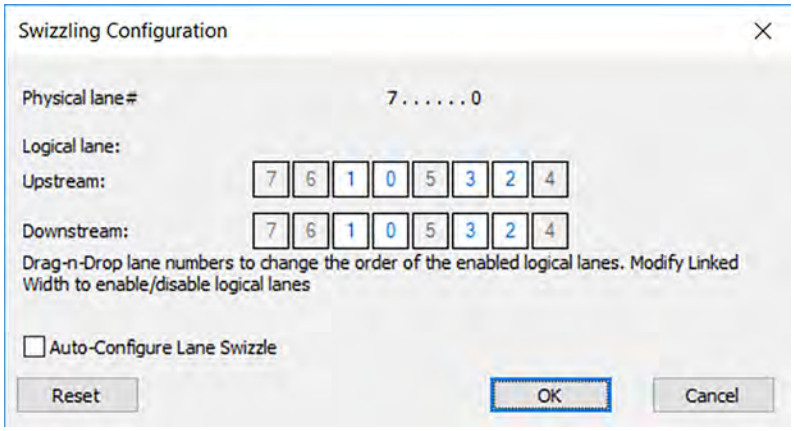


Figure 2.51: Logical to Physical Lane Mapping

Please observe clocking restrictions for these configurations. PCIe Protocol Analysis will provide warnings on configurations not supported.

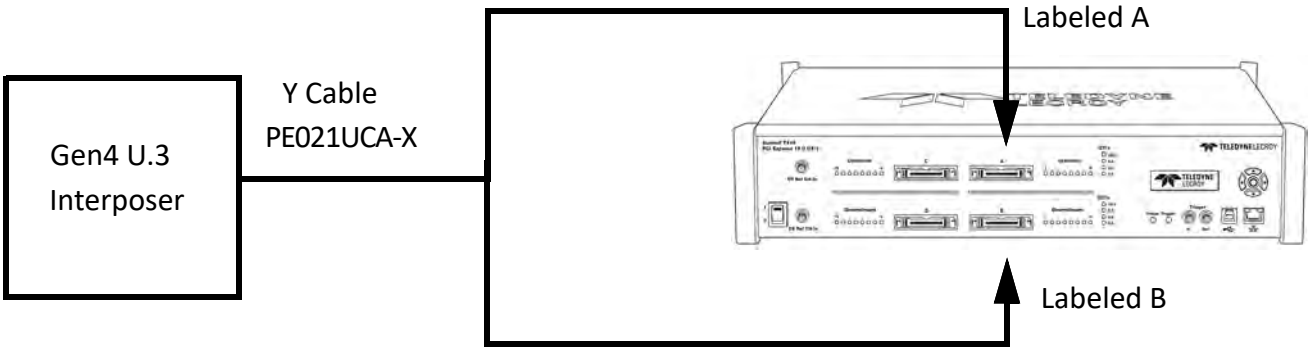


Figure 2.52: Analyzing a single U.3 x4 port with Summit T416 in Standard Mode

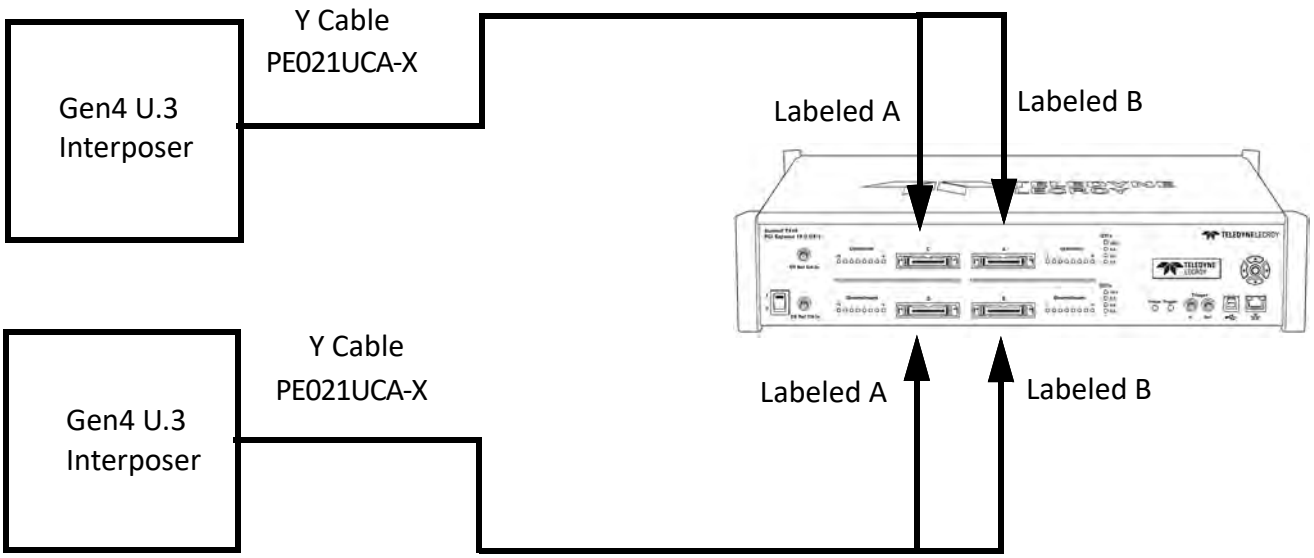


Figure 2.53: Analyzing up to two independent U.3 x4 ports with Summit T416 in MultiPort mode

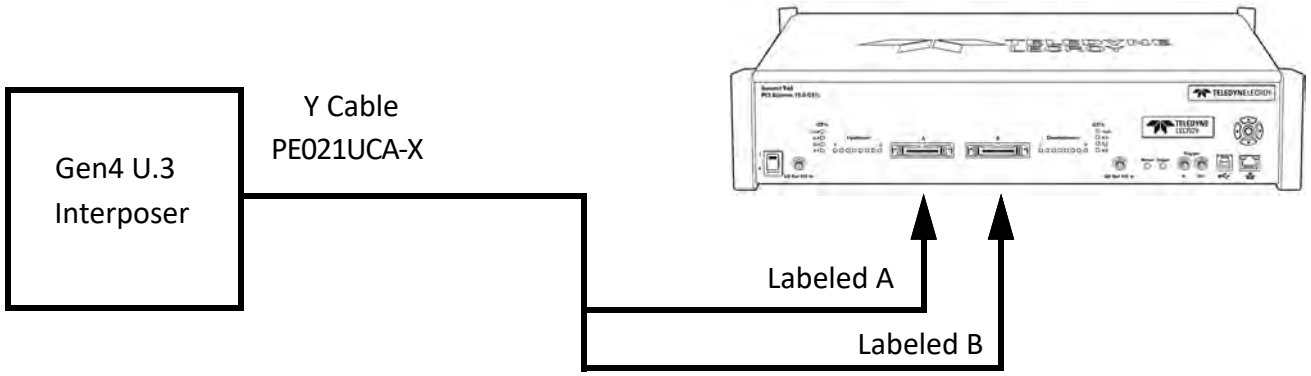


Figure 2.54: Analyzing single U.3 x4 port with Summit T48 in Standard Mode

Figure 2.55:

Chapter 3

Installation and Setup

The Summit T416™ and Summit T48™ are standalone systems.

You can begin PCI Express™ recordings after following the steps in this chapter.

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 on page 88.

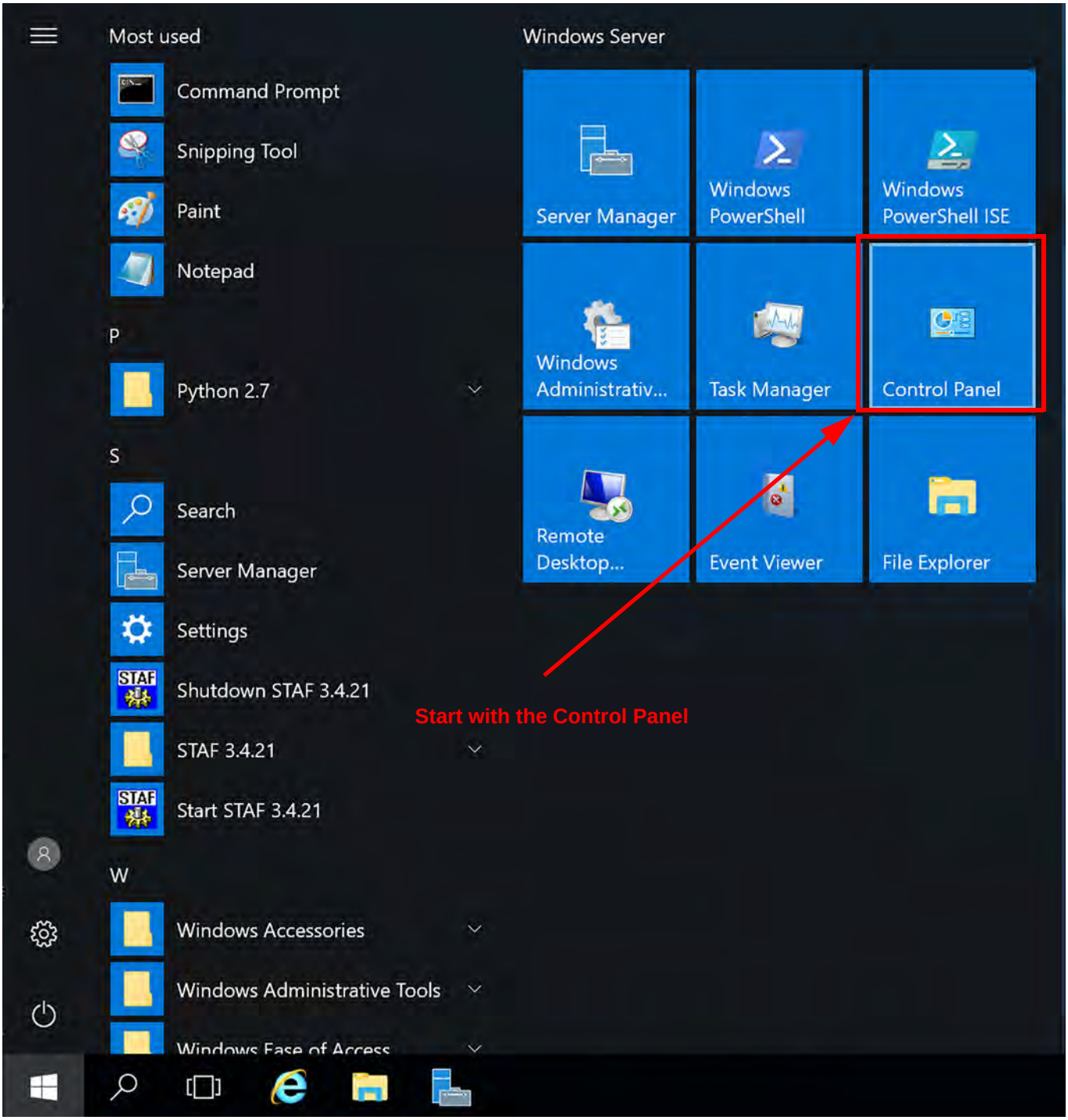


Figure 3.1: Windows Server 2016/2019: Start Menu -> Control Panel

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

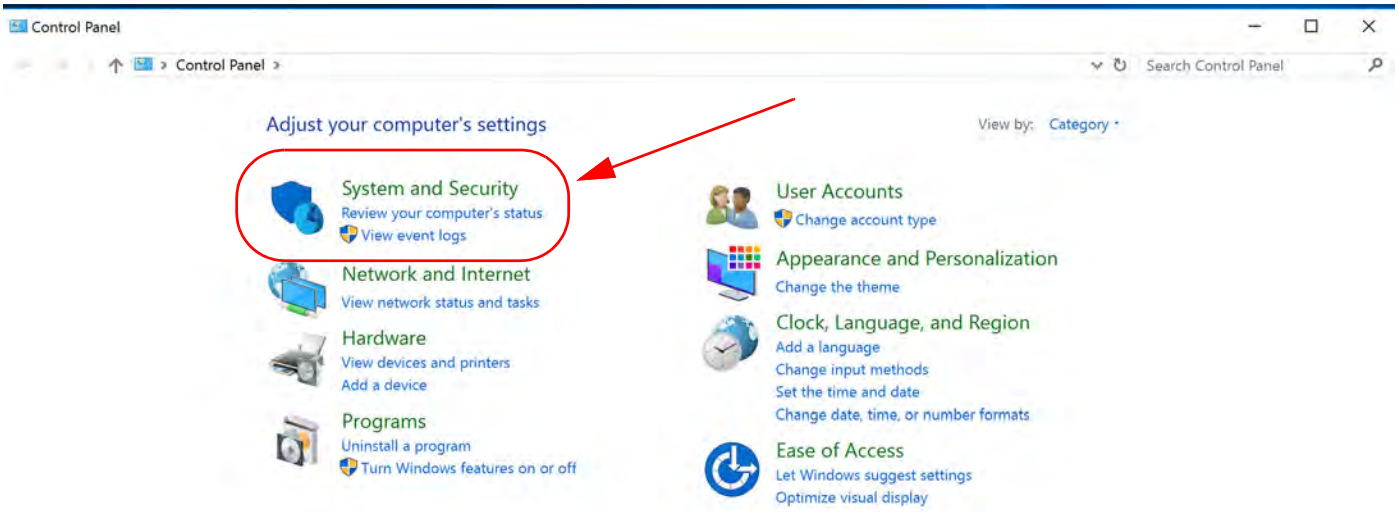


Figure 3.2: Windows Server 2016/2019: Control Panel -> System and Security Screen

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

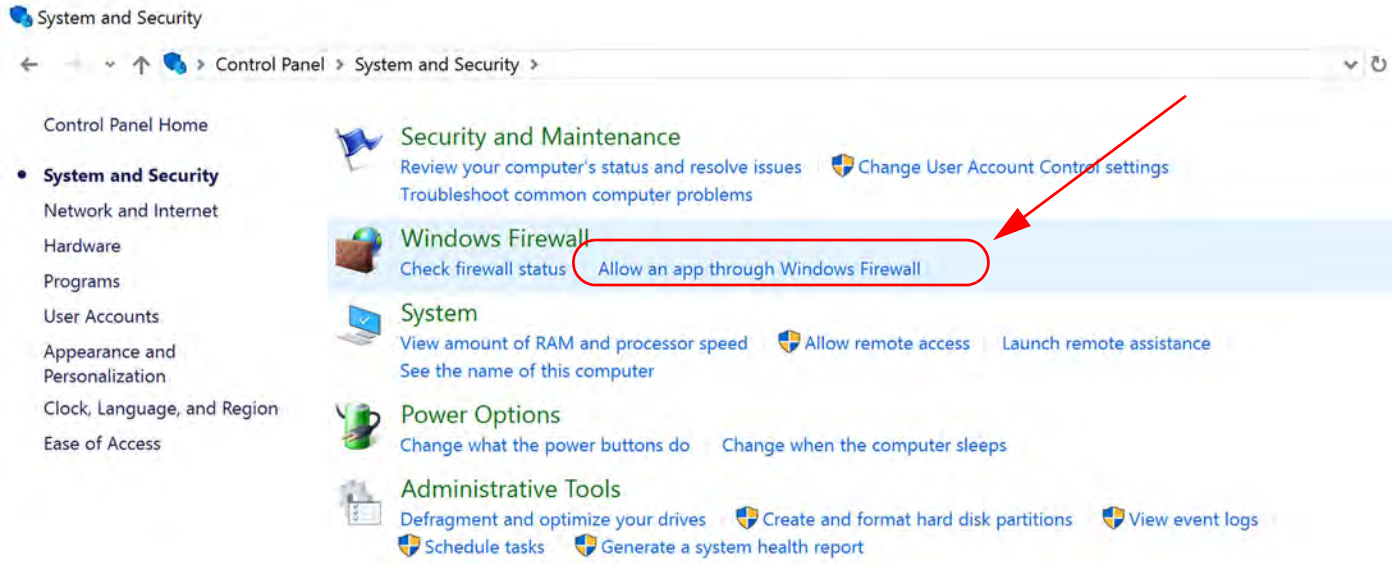


Figure 3.3: Windows Server 2016/2019: Allow an App Through Windows Firewall

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.

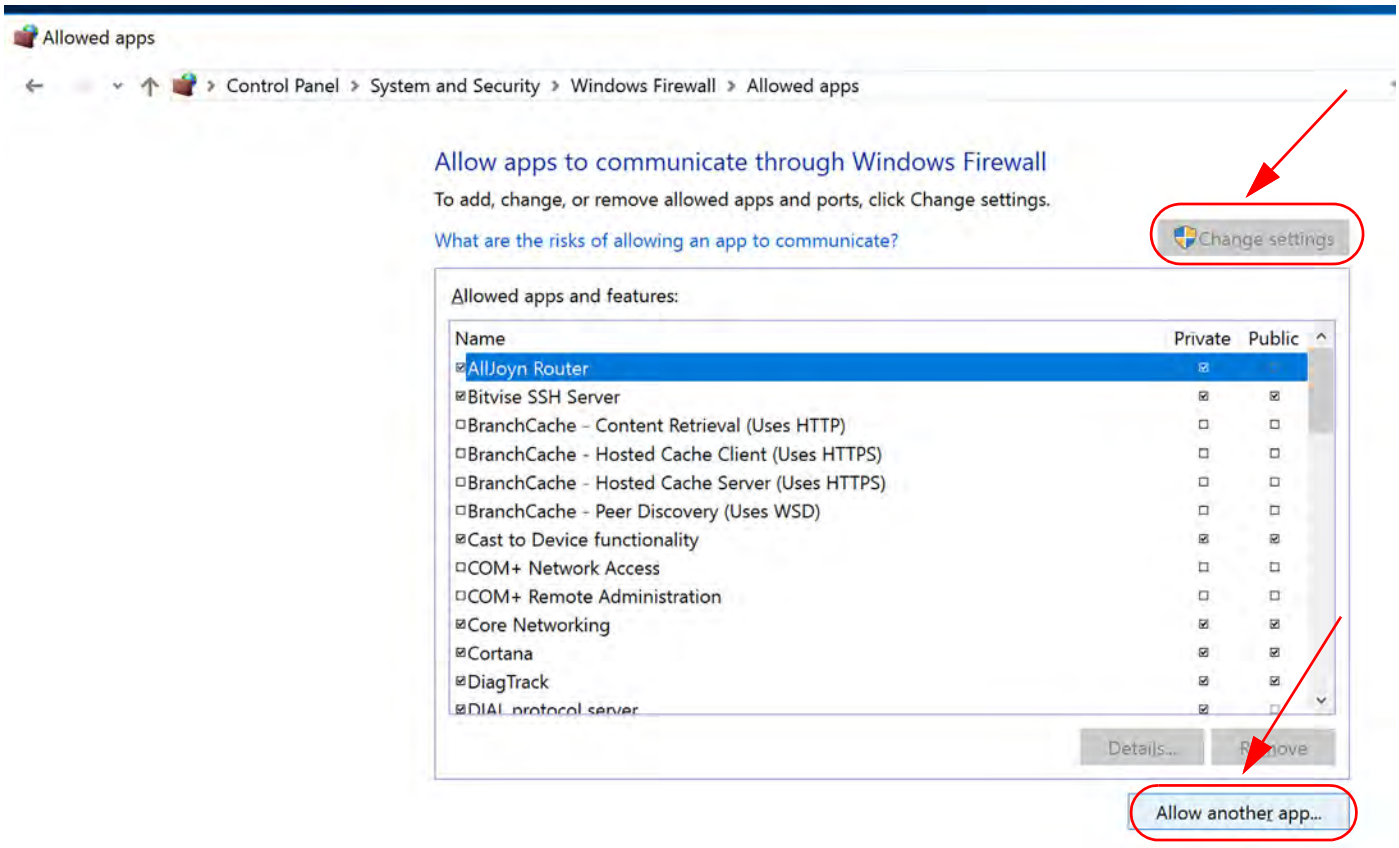


Figure 3.4: Windows Server 2016/2019: Change Settings -> Allowed Another app

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.

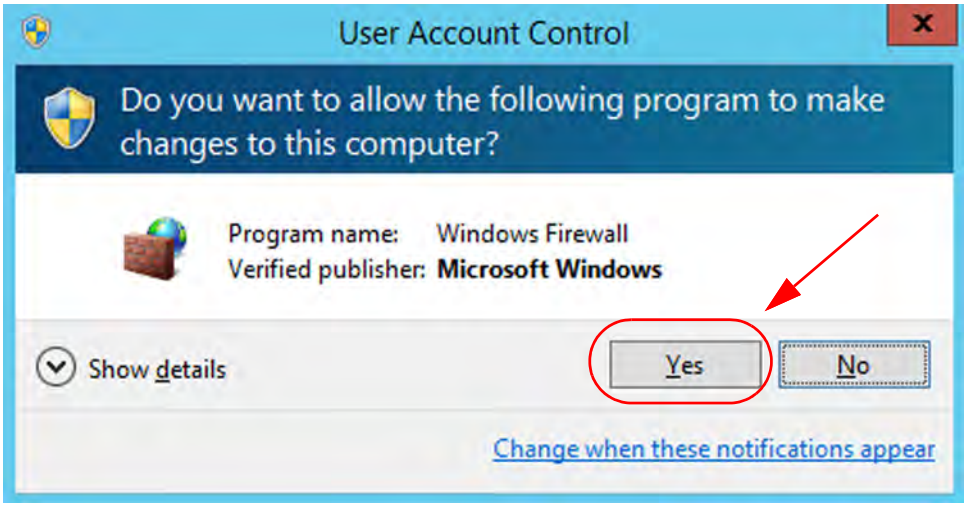


Figure 3.5: Windows Server 2016/2019: User Account Control

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

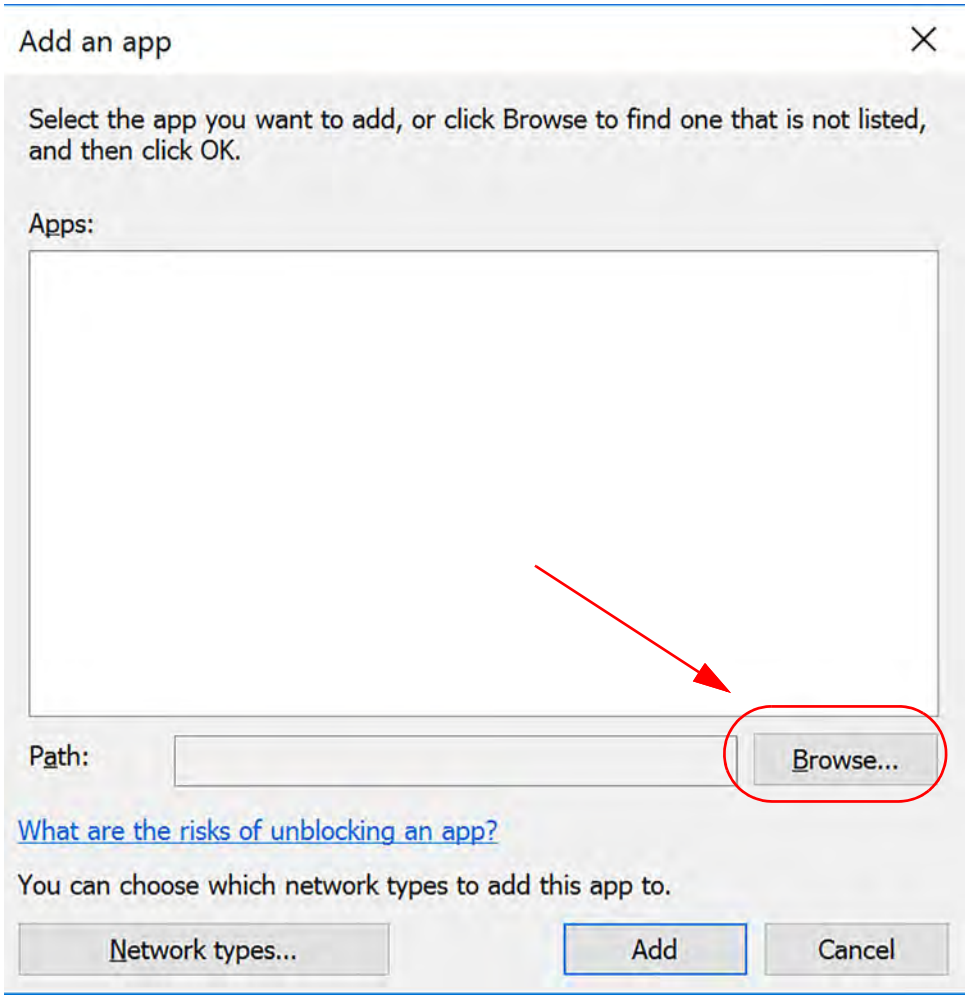


Figure 3.6: Windows Server 2016/2019: Add an App

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.

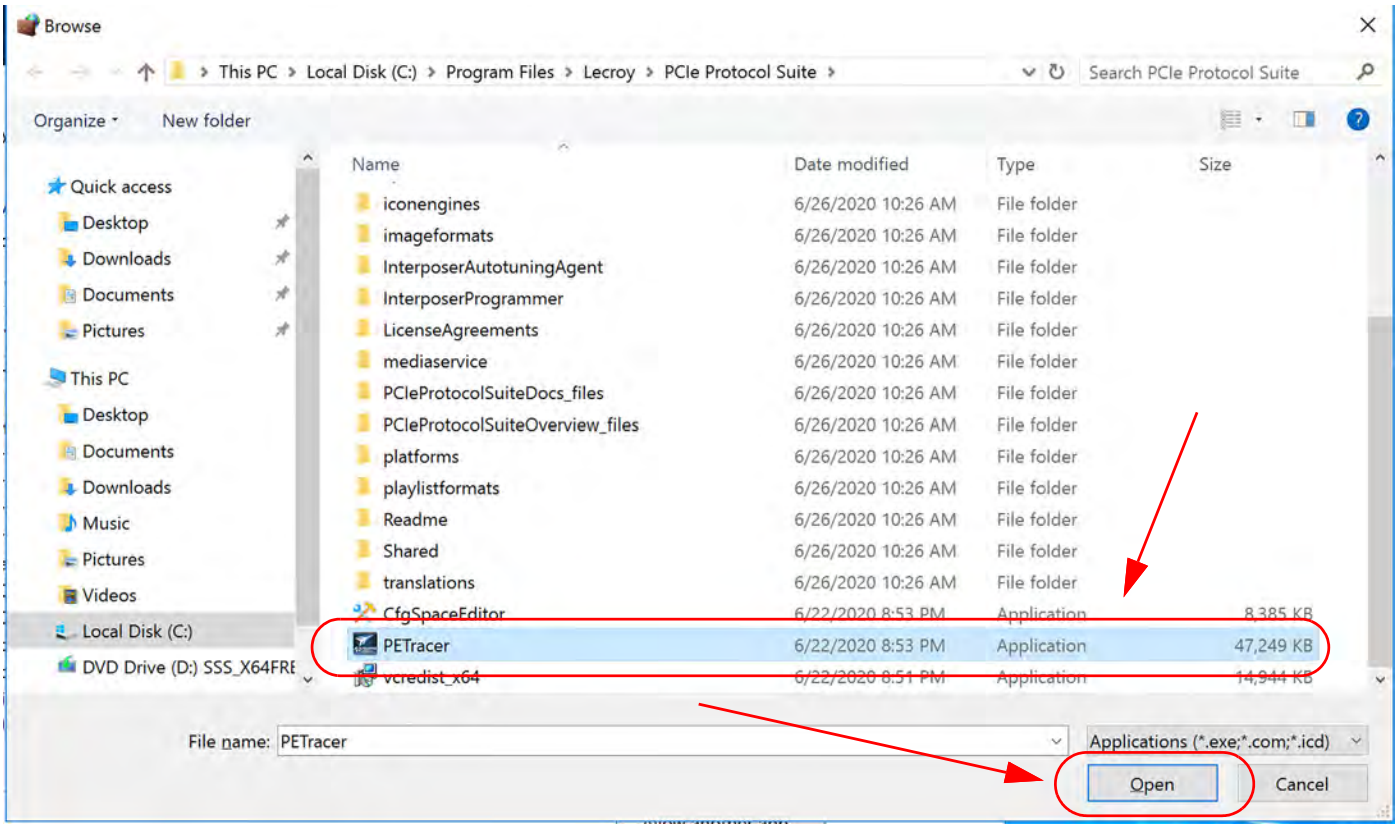


Figure 3.7: Windows Server 2016/2019: Browse to Find Application -> PCIe Protocol Analysis Application

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.

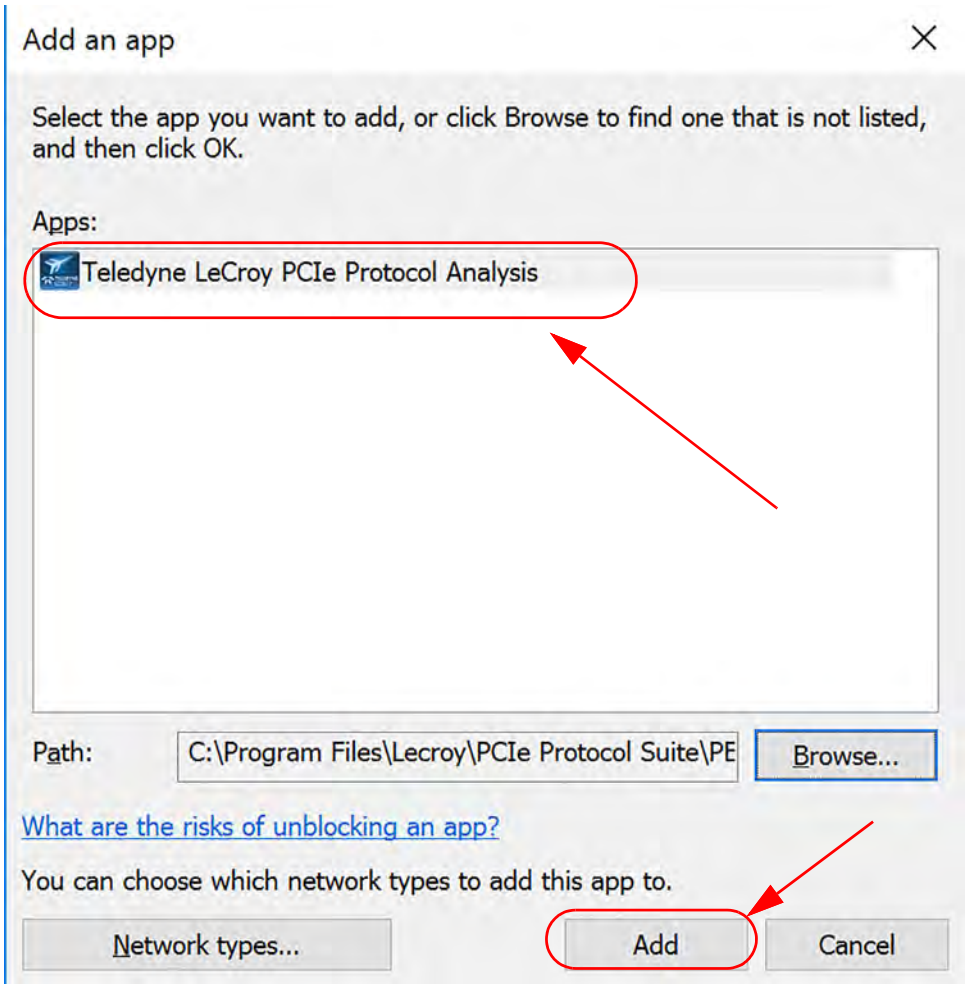


Figure 3.8: Windows Server 2016/2019: Add an Application to the Firewall Exceptions

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.

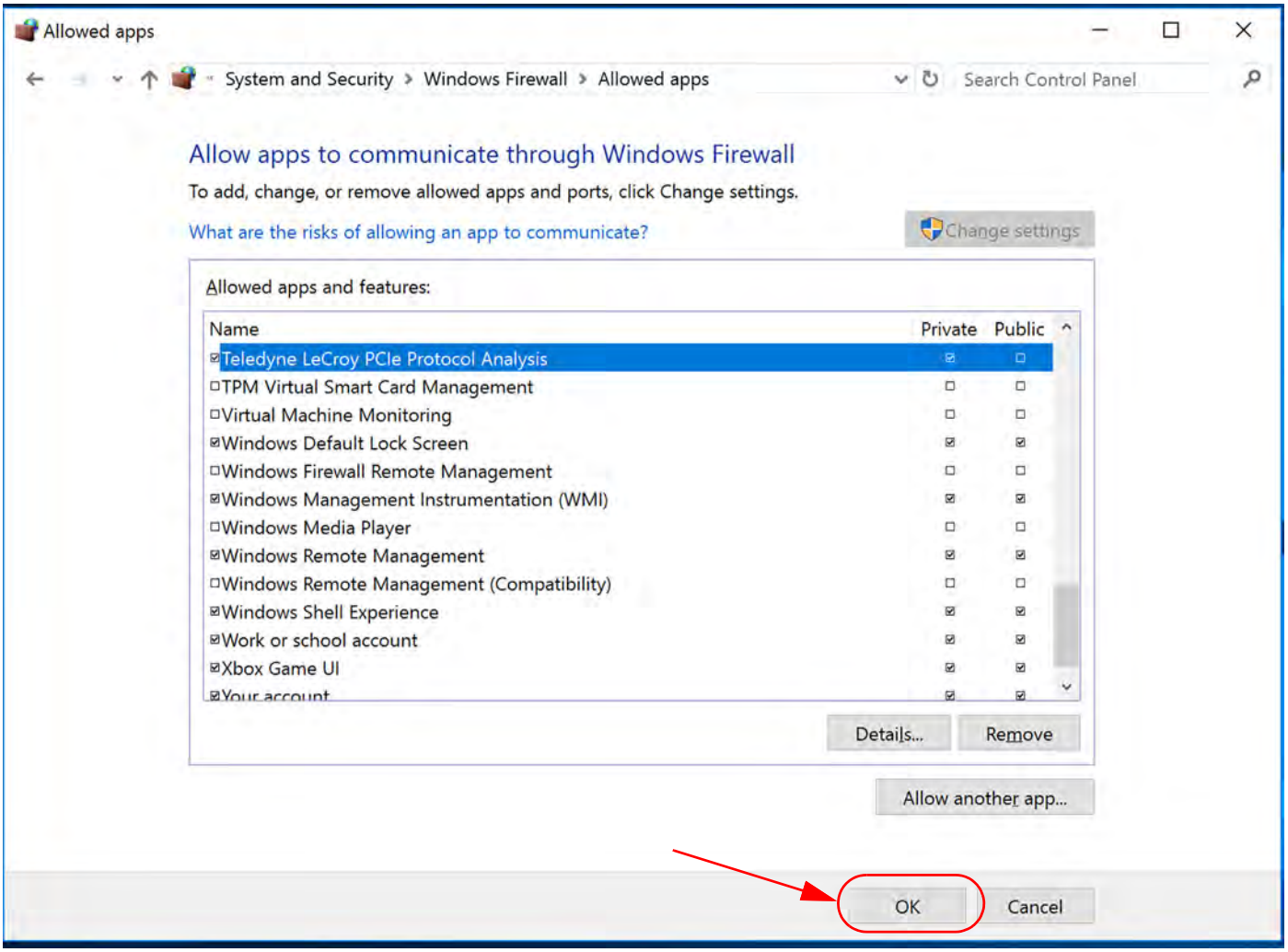


Figure 3.9: Windows Server 2016/2019: Add Teledyne LeCroy PCIe Protocol Suite to Allowed Applications

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 Wndows.

The PCIe Protocol Analysis program displays, as seen below. See Figure 3.10.

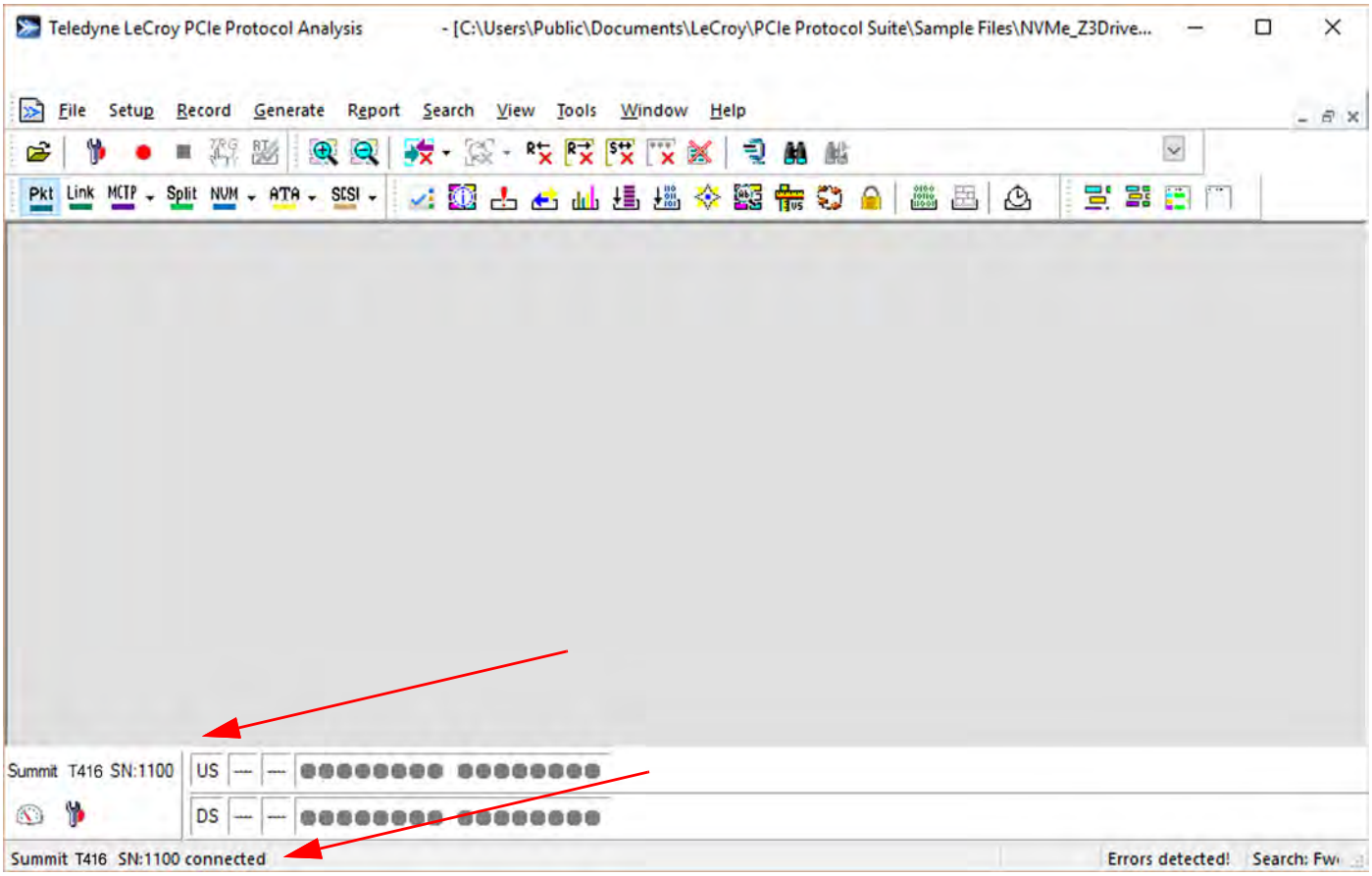


Figure 3.10: Teledyne LeCroy PCIe Protocol Analysis Application

Note: The image above shows the application with a T416 attached. If a T48 was attached instead the Summit T48 would be shown instead and there would be 8 lanes shown for both upstream and downstream traffic.

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

3.2 Setting Up the Summit T416 or Summit T48 Analyzer using a USB Connection

To set up the Analyzer using a USB connection:

1. Connect the Analyzer to a 100-volt to 240-volt, 50 Hz to 60 Hz, 120 W power outlet using the provided power cord.
2. Connect the USB port to a USB port on the host machine using a USB cable.

Note: To connect using Ethernet, see "Setting Up the Summit T416 or Summit T48 Analyzer using an Ethernet Connection" on page 99.

3. Turn on the front power switch.

Note: At power-on, the Analyzer initializes itself in approximately five seconds and performs an exhaustive self-diagnostic that lasts about forty seconds. The results are reflected by messages on the Summit T416 or Summit T48 LCD display. If the LCD display indicates failure, call Teledyne LeCroy Customer Support for assistance.

4. Follow the Microsoft® Windows® on-screen Plug-and-Play instructions for the automatic installation of the Analyzer as a USB device on your analyzing host machine. (The required USB drivers are installed on your system by the PCIe Protocol Analysis installation.)

   Click **Finish** when you see the message that says "Windows has finished installing the software that your new hardware requires" and the file has been installed in your host machine.

3.3 Setting Up the Summit T416 or Summit T48 Analyzer using an Ethernet Connection

3.3.1 TCP Port Connections for Different Modes

In MultiPort Mode the Summit T416 and Summit T48 use different TCP ports for different configurations. Typical port assignments are shown below.

TABLE 3.1: TCP Port Configurations

Logical Unit	T416: 4 Port	T416: 2 Ports	T416: 1 Port	T48: 2 Ports	T48: 1 Port
Unit 0	4000 – 4003	4000 – 4003	4000 – 4003	4000 – 4003	4000 – 4003
Unit 1	4010 – 4013	N/A	N/A	4010 – 4013	N/A
Unit 2	4020 – 4023	4020 – 4023	N/A	N/A	N/A
Unit 3	4030 – 4033	N/A	N/A	N/A	N/A

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 4012, 4013 and 4014 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.

1. Connect the Analyzer to a 100-volt to 240-volt, 50 Hz to 60 Hz, 120 W power outlet using the provided power cord.
2. Connect the Summit T416 or Summit T48 Analyzer to the network. The Ethernet port is on the front of the Analyzer.

Note: To connect using USB, see “Setting Up the Summit T416 or Summit T48 Analyzer using a USB Connection” on page 98.

3. Turn on the front power switch.

Note: At power-on, the Analyzer initializes itself in approximately five seconds and performs an exhaustive self-diagnostic that lasts about forty seconds. The results are reflected by messages on the Summit T416 or Summit T48 LCD display. If the LCD display indicates failure, call Teledyne LeCroy Customer Support for assistance.

4. After you have installed the PCIe Protocol Analysis application software, perform the following procedure to connect to a Summit T416 or the Summit T48 analyzer in the local network.

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

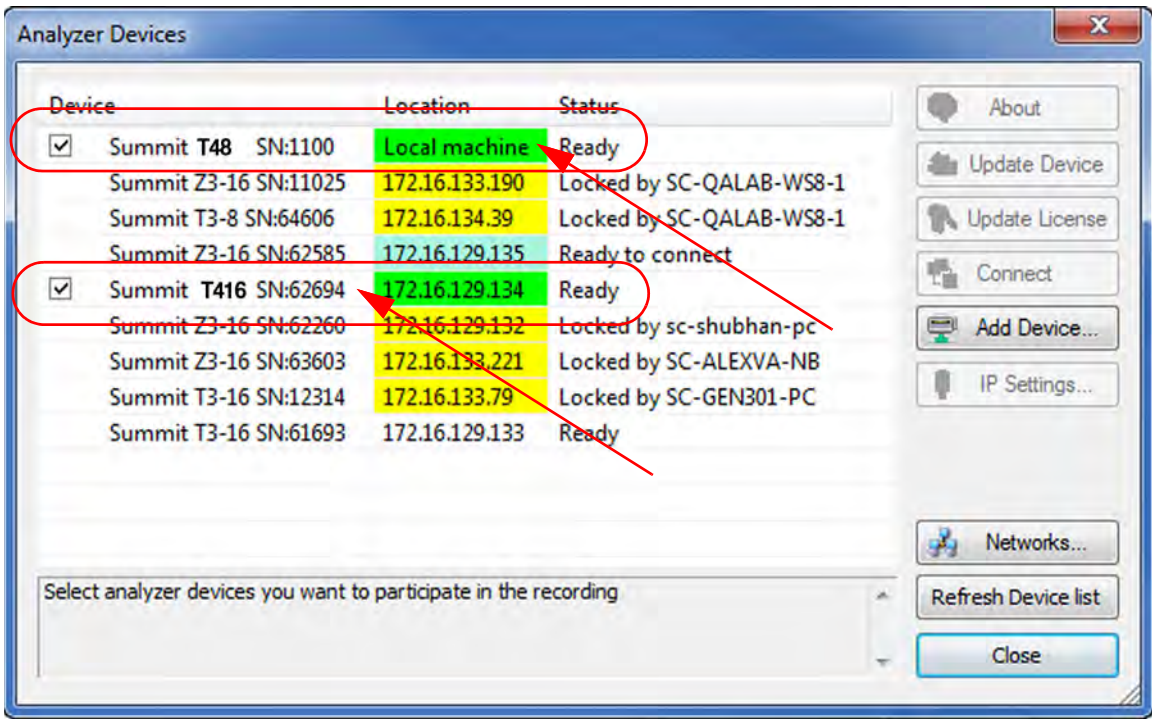


Figure 3.11: Analyzer Devices Dialog

The PCIe Protocol Analysis fills the list with devices that are connected over USB or discovered on the Ethernet network. The discovery mechanism works only within one network subnet. If a Summit is connected to the network on a different subnet, you can manually add the subnet to the list by clicking the **Add Device** button and specifying the IP address.

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

1. If a Summit device is marked Ready To Connect, you can select that device and press the **Connect** button to execute the connection procedure.

   After the connection is established, the application displays the Connection Properties dialog.

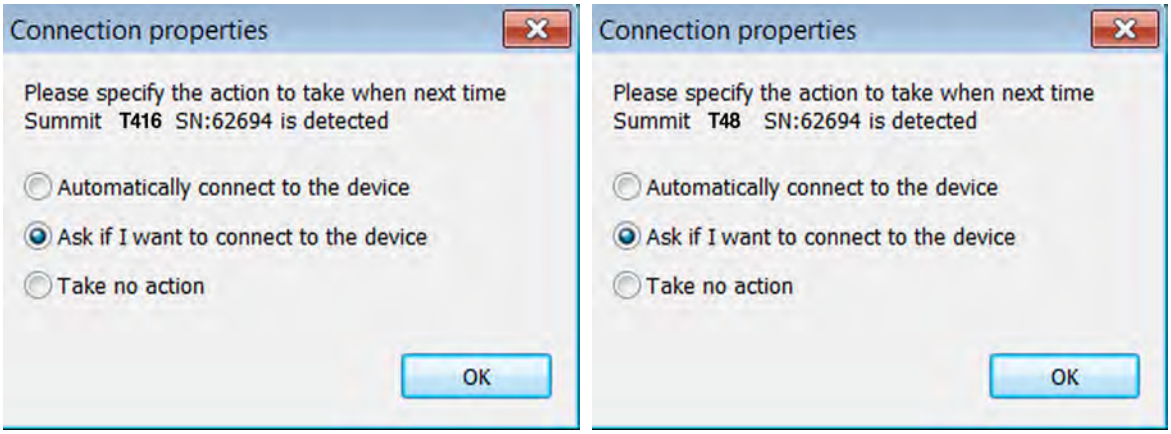


Figure 3.12: Connection Properties Dialog (T416 or T48)

Note: The Connection Properties dialog will show either the T416 or the T48 detected.

2. Select an option:
   - **Automatically connect to the device**: When the application is started or when the named device is added to 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 is added to 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 you want to add the named device to the network while the PCIe Protocol Analysis application is running on this computer, you must connect manually to use the named device.

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

3. Press **OK** in the Connection Properties dialog.

   After you finish the connect procedure, the Summit device to which you have connected is marked as **Ready** and you can use it for recording (see Figure 3.13 and Figure 3.14 on page 102).

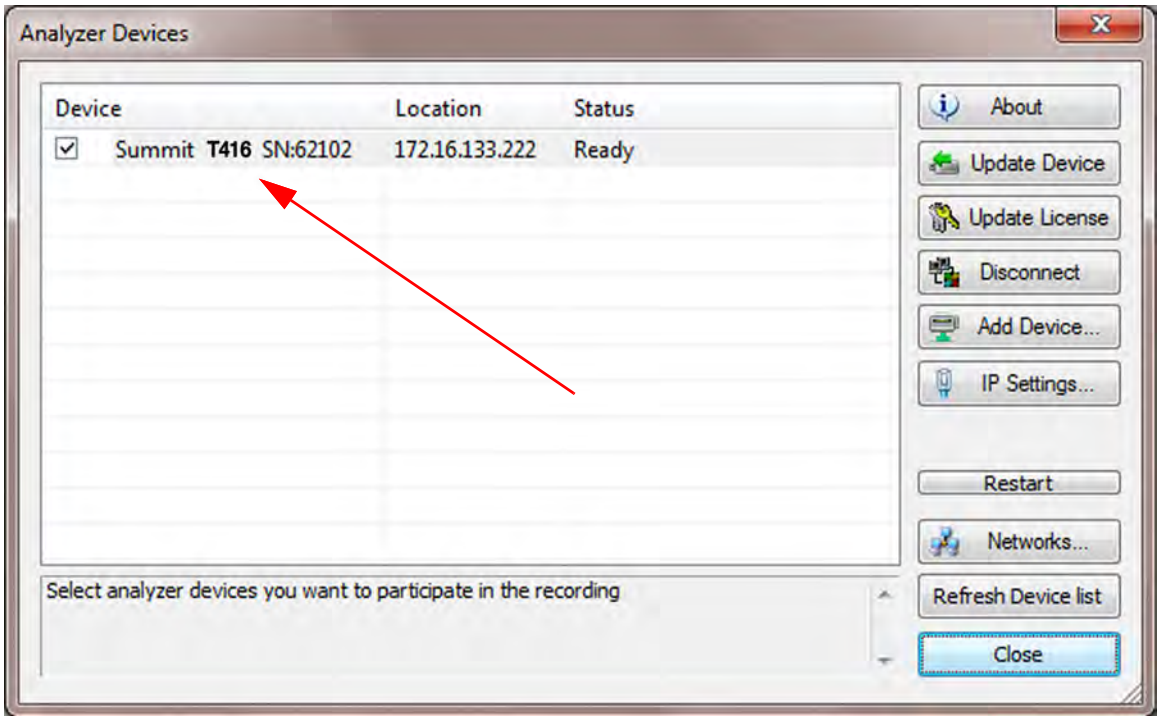


Figure 3.13: Analyzer Devices Dialog (T416)

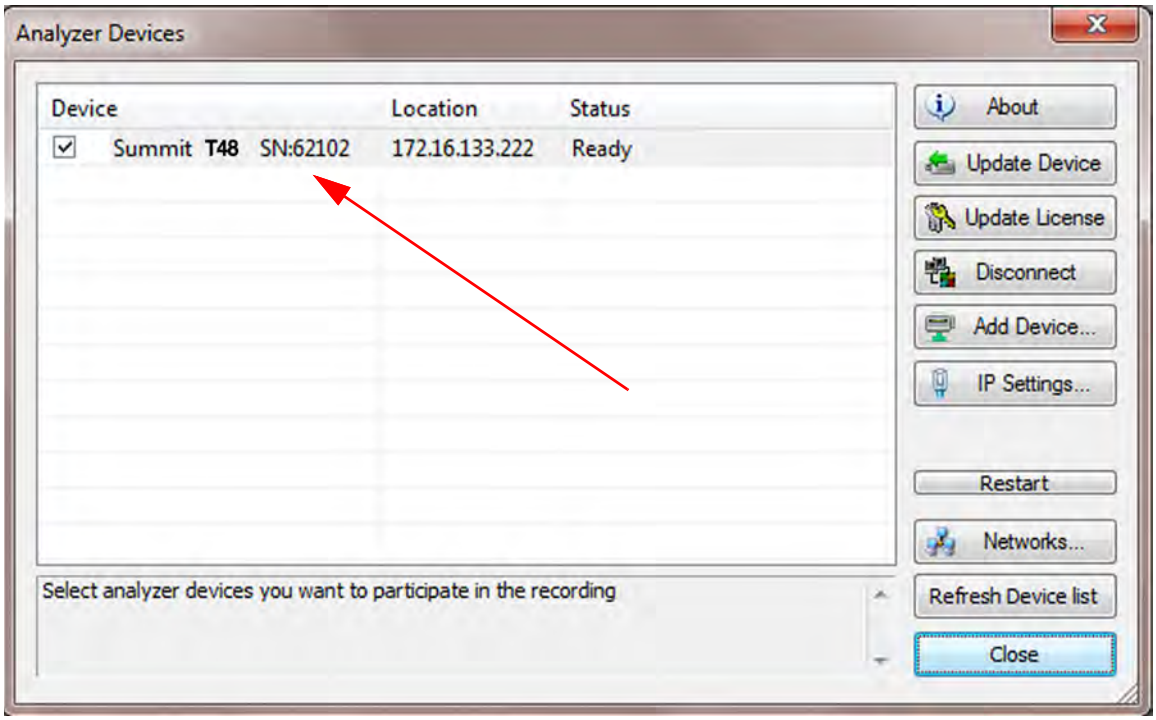


Figure 3.14: Analyzer Devices Dialog (T48)

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

Note: As of version PCIe Protocol Analysis version 7.34, the software is able to access a Summit analyzer via VPN solutions that require explicit bindings to PPP adapters that they create.

3.4 Adding Devices Manually

You can locate and add a Summit T416 or a Summit T48 analyzer 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.

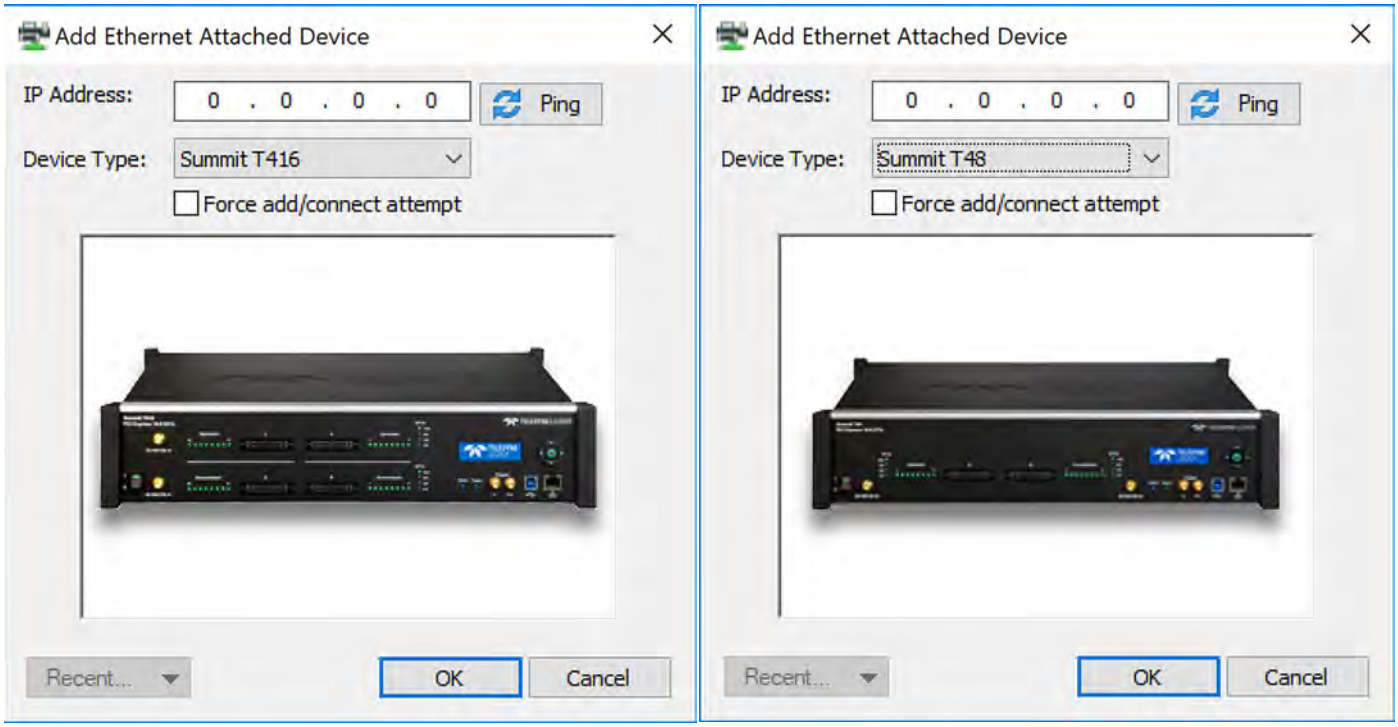


Figure 3.15: Add Ethernet Attached Devices Dialog (T416 or T48)

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 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 Analyzer Devices dialog.

If 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 PCIe Protocol Analysis displays a "Failed to connect" status message in gray.

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

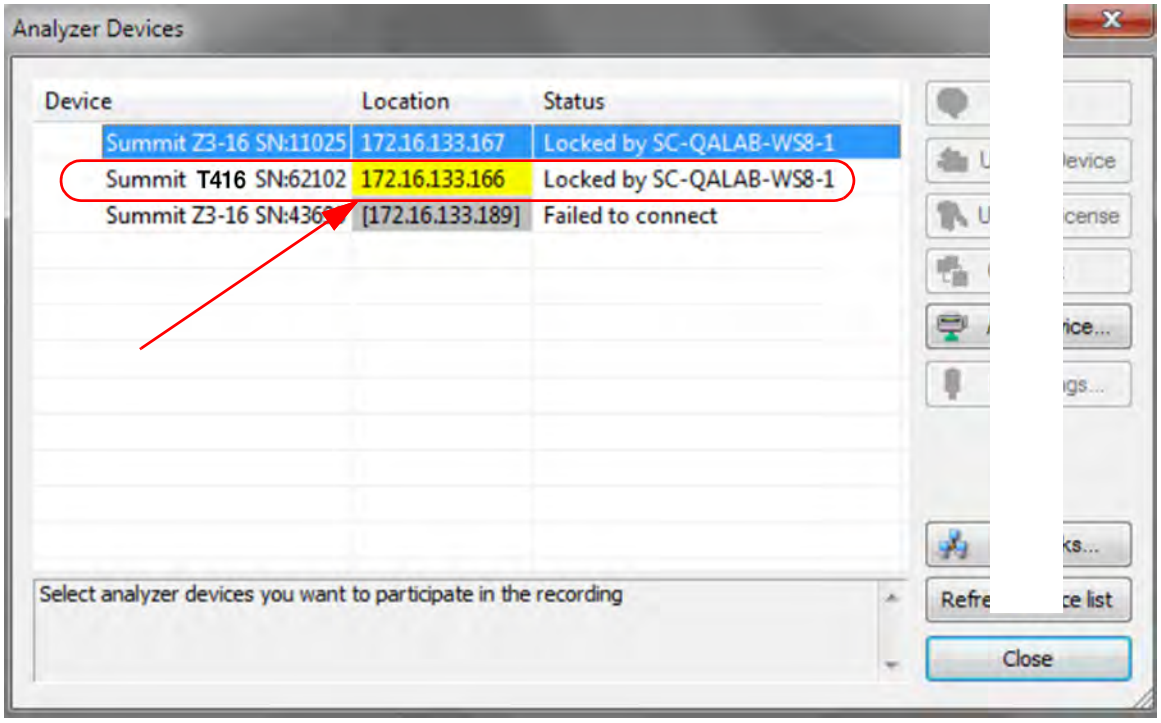


Figure 3.16: Add Ethernet Attached Devices Dialog (T416)

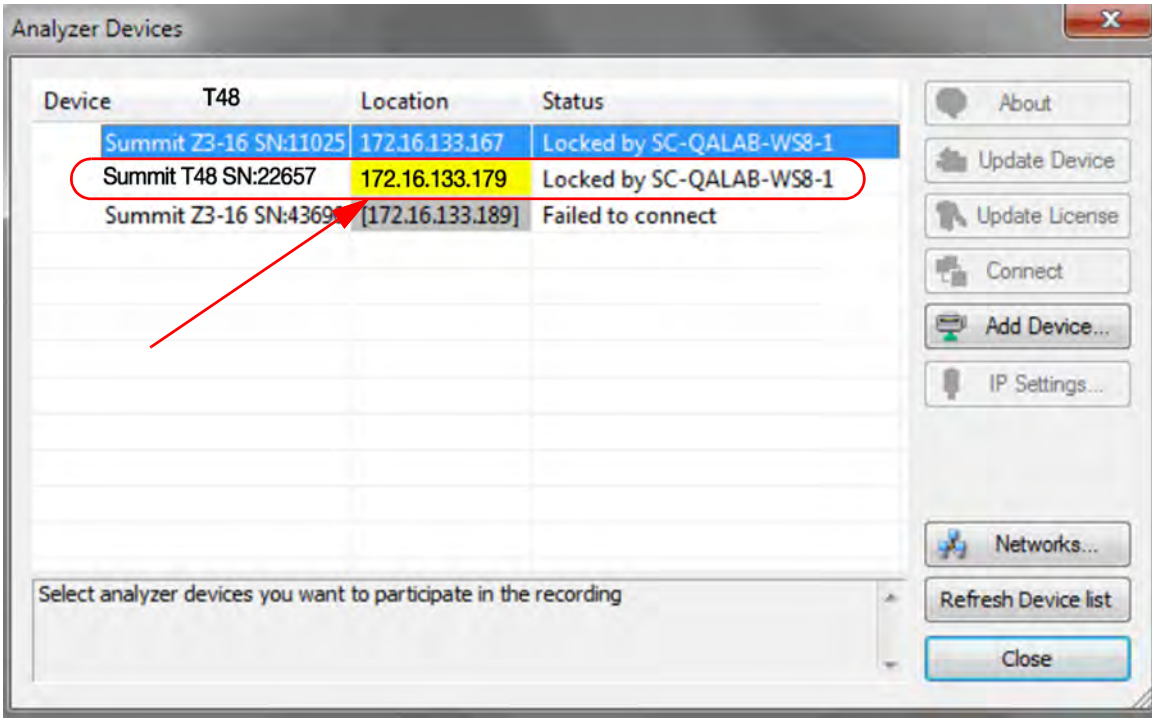


Figure 3.17: Add Ethernet Attached Devices Dialog (T48)

3.4.1 Adding a Summit T416 or Summit T48 to an Ethernet Network

If you have a Summit T416 or Summit T48 and want to add it to an Ethernet Network but don't know it's IP address you can find out the IP address and add it to the Ethernet Network using the USB connection.

With the USB cable installed, start up the PCIe Protocol Analysis and select **Setup > All connected Devices.**

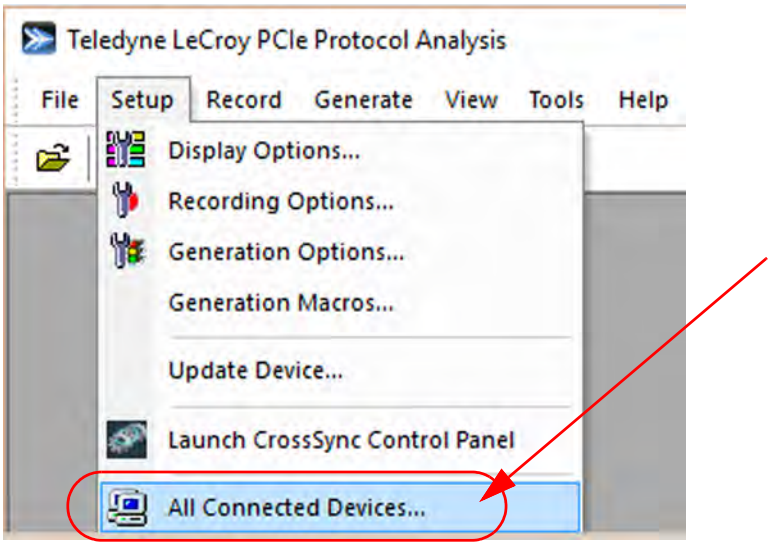


Figure 3.18: Setup > All Connected Devices

This will popup a dialog box showing all the connected devices on your network. See Figure 3.19.

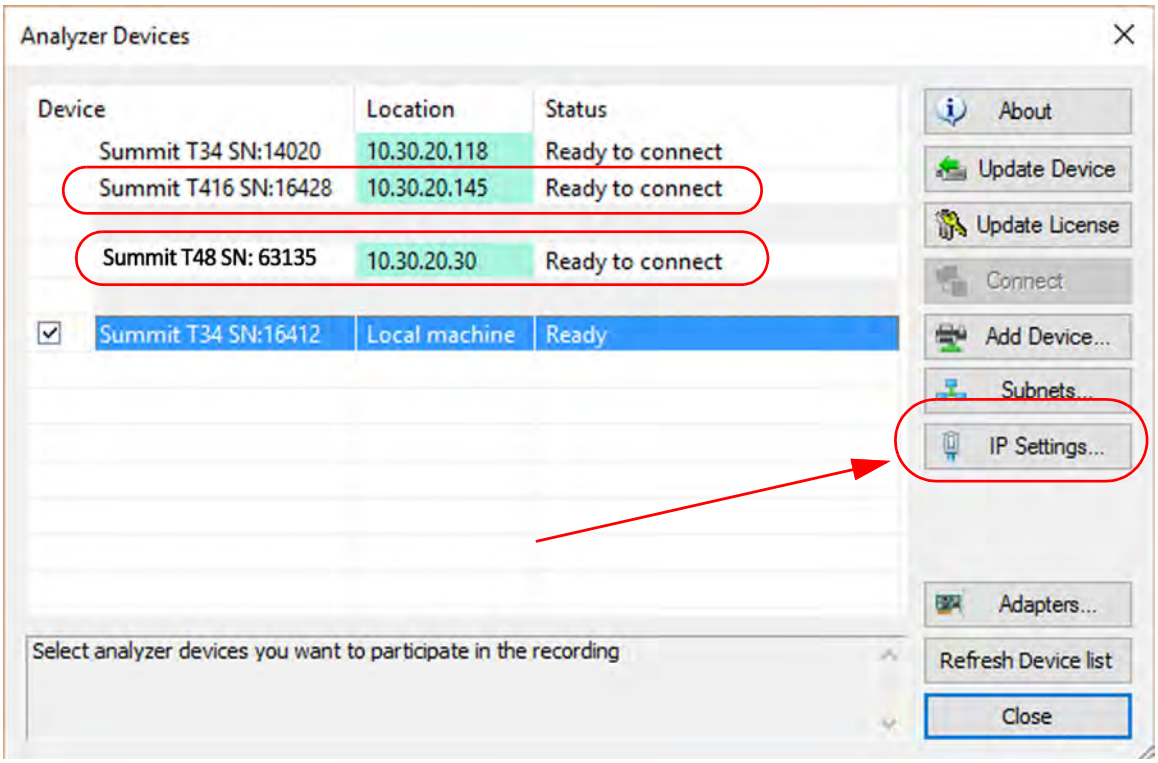


Figure 3.19: All Devices Connected on Your Network

To discover the IP address of the local T416 or T48 (attached via the USB cable to your Summit T416 or Summit T48), select the IP Settings tab. This will popup the Device Settings dialog box. See Figure 3.20.

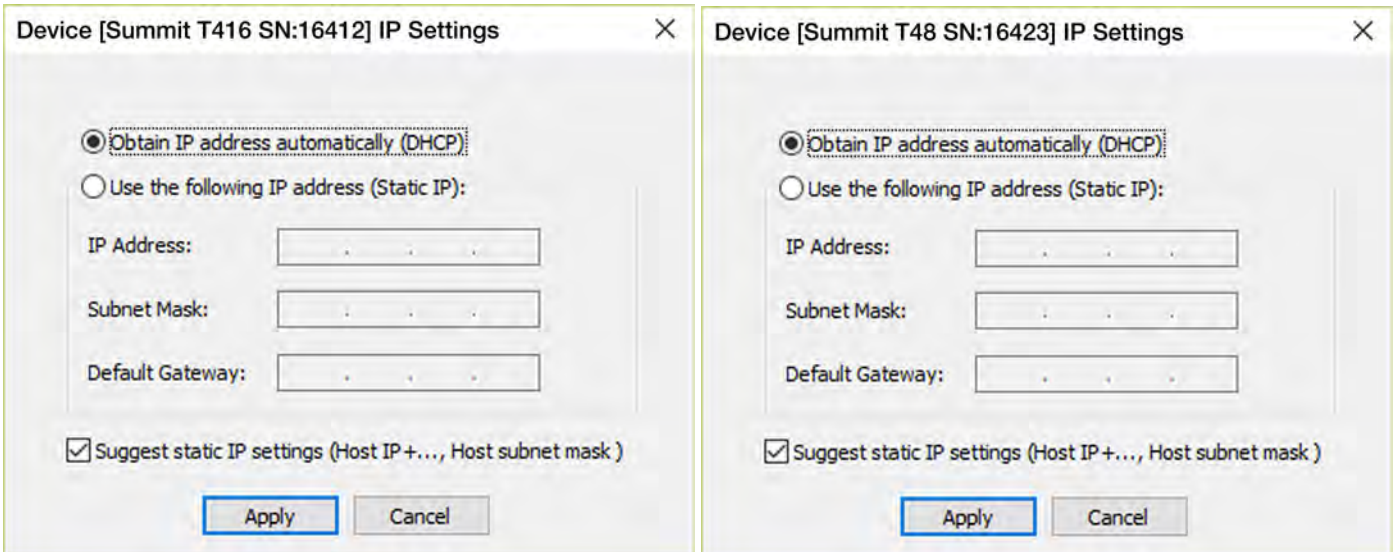


Figure 3.20: Device IP Settings (T416 or T48)

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 3.21).

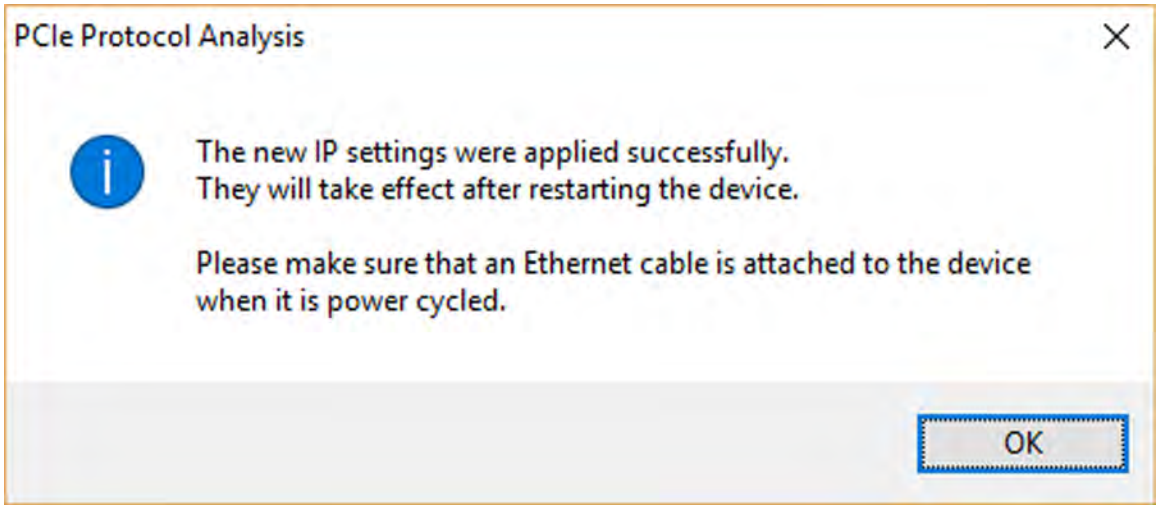


Figure 3.21: Use DCHP to Set IP Address

If you had chosen to use the Static IP address the following Dialog Box would popup (see Figure 3.22. You can either

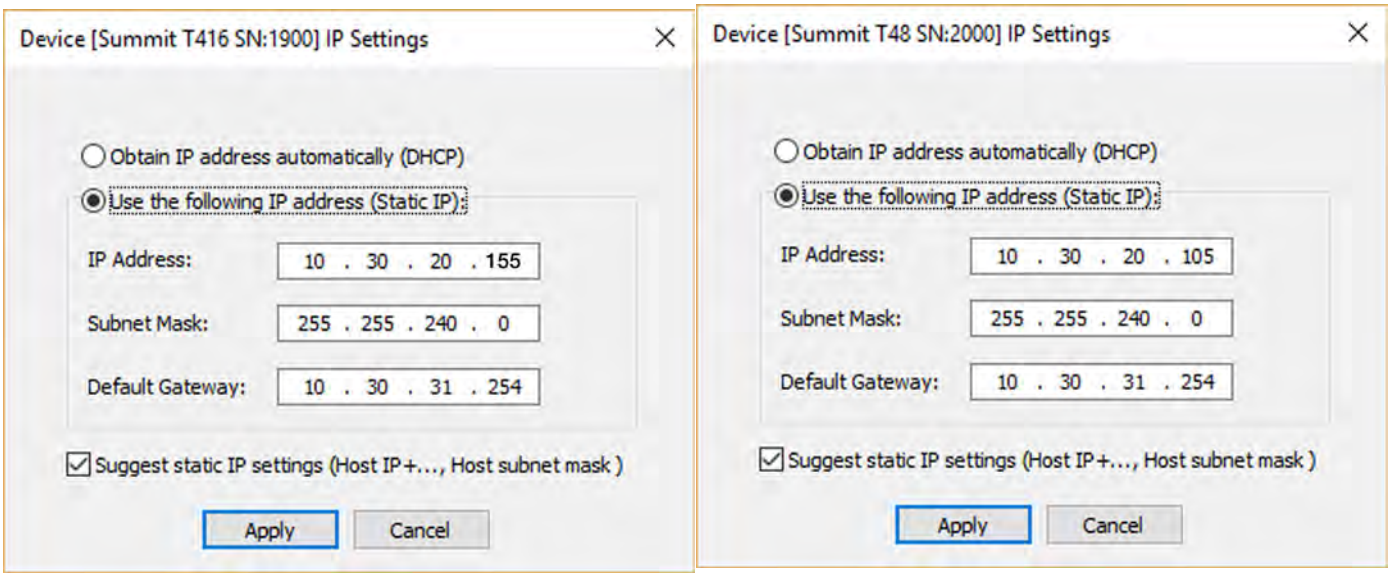


Figure 3.22: Use Static IP Address T416 or T48)

If you had chosen the Suggest static IP settings the following dialog box would popup (see Figure 3.23).

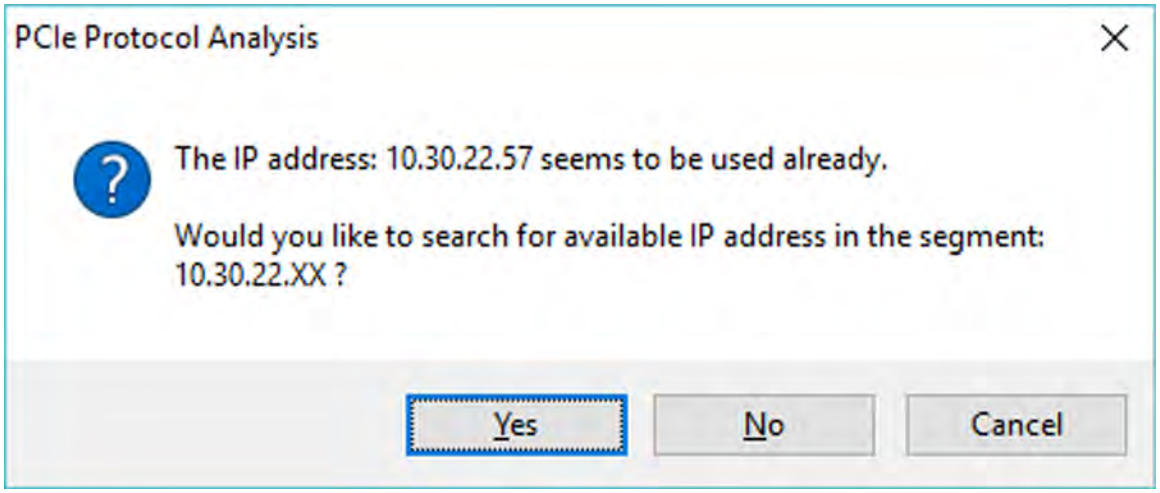


Figure 3.23: Suggest Static IP Settings

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

The the following dialog box will popup. See Figure 3.24.

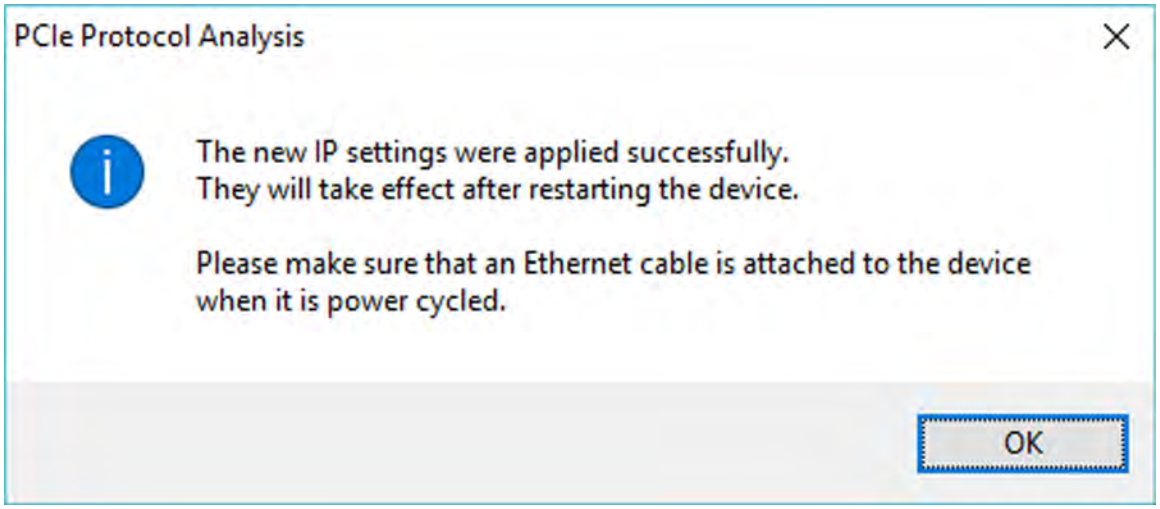


Figure 3.24: New IP Settings Applied

Now you should attach the Ethernet cable, disconnect the USB cable and cycle the power on the Summit T416 or Summit T48.

After the T416 or T48 re-initializes and the Status LED goes from OFF to Green to Blue, restart the PCIe Protocol Analysis and select **Setup > All Connected Devices.**

Now the Summit T416 or Summit T48 has an IP address and is Ready to Connect.

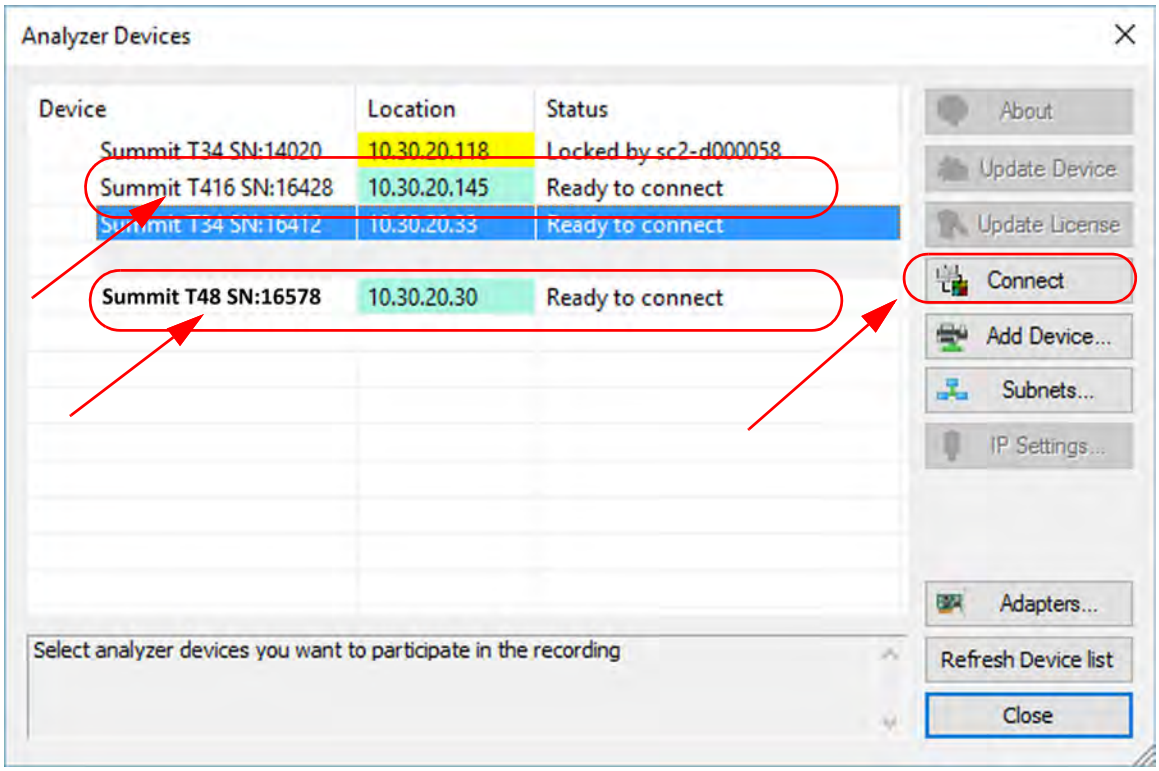


Figure 3.25: Analyzer Devices: T416 and T48 Showing IP Address

Select the Connect tab and you are ready to start capturing data traffic with the Summit T416 or the Summit T48.

Chapter 4

Software Overview

4.1 The PCIe Protocol Analysis

The PCIe Protocol Analysis™ software 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 Analyzer via an Ethernet or USB 2.0 connection (USB 1.0 is also supported). PCIe Protocol Analysis can be used without the Analyzer as a CATC Trace viewer for viewing, analyzing and printing traces.

The PCIe Protocol Analysis operates on systems using Windows Server 2019 (x64), Windows Server 2016 (x64) and Windows 10 64-bit. 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.

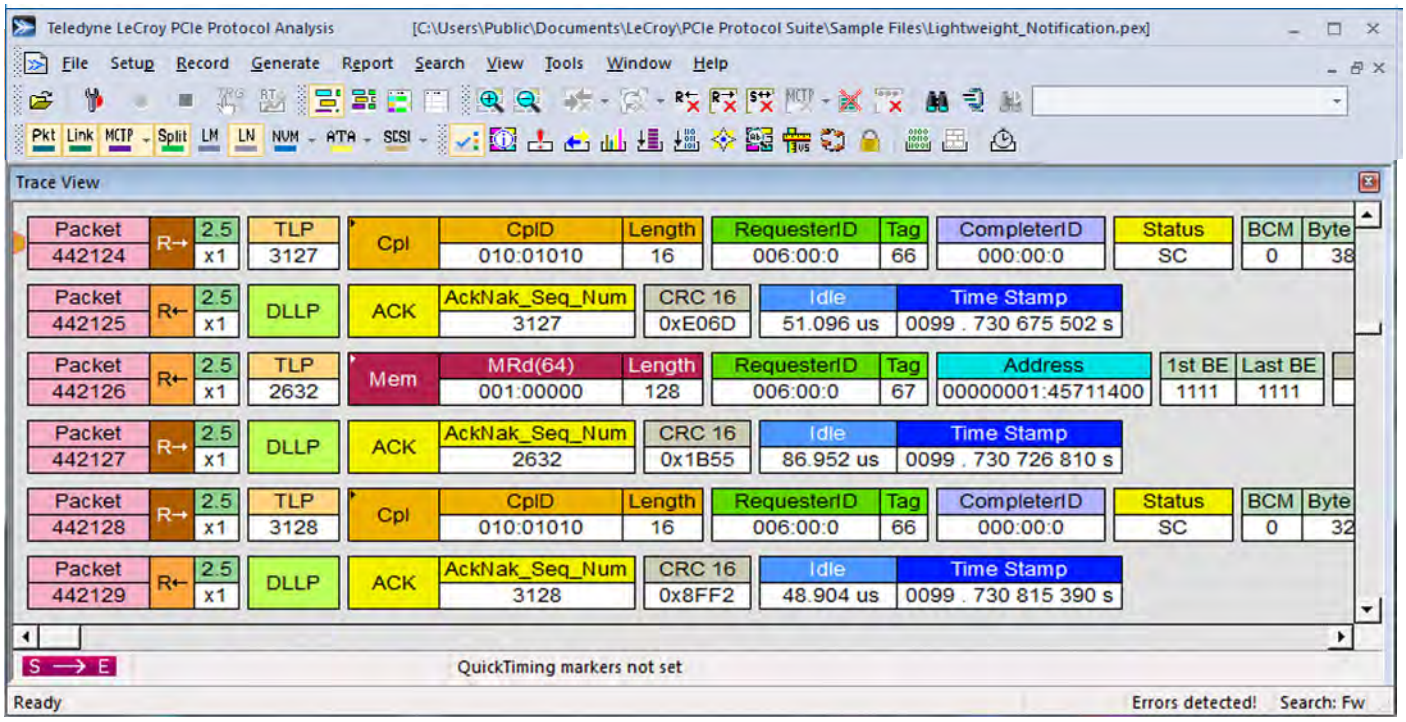


Figure 4.1: Sample of a CATC Trace

4.2 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.

4.3 Using the Toolbar

You can use the PCIe Protocol Analysis application Toolbar as a shortcut to most of the operations supplied by the menus.

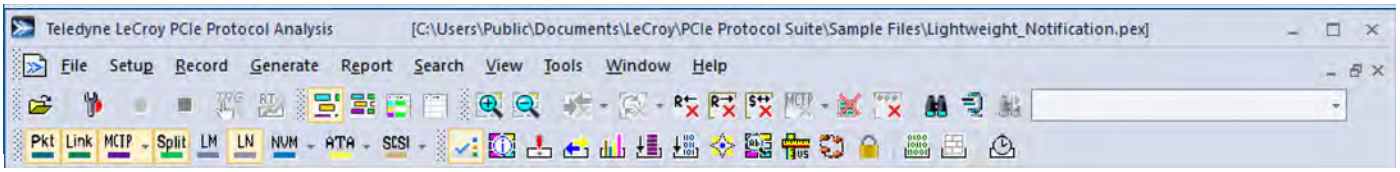


Figure 4.2: Summit T4 Toolbar

Table 4:

	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.		

Table 5:

	Displays CATC Trace view.		Displays color spreadsheet view.
	Displays compressed CATC Trace view.		Displays black and white spreadsheet view.

Table 6:

	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.

Table 7:

	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 Sideband traffic.
	Hide MCTP VDM and Hide SMBus MCTP		

Table 7:

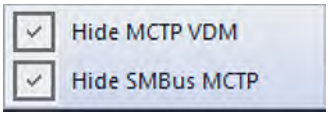
			
	Quick Search window: Allows user to search for pre-defined terms or type in their own term to search for. See “Quick Search Feature” on page 129.		
			

Table 8:

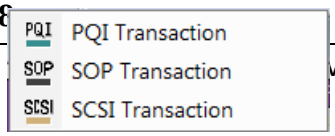
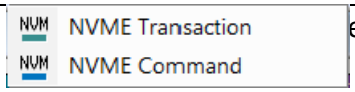
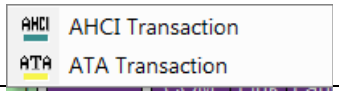
	View Packet Level data.		 vel data.
	 el		View PQI, SOP and SCSI Transaction Level data pull down menus.
	View NVME Transaction Level and Command data pull down menus		
			View MCTP Transaction Level data
	View AHCI and ATA Transaction Level data pull down menus		Lane Margining Commands/Respones
			Lightweight Notification Transaction Level data

Table 9:

	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

Table 9:

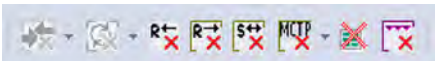
	Error Report Opens a window that lists all errors identified in the recording.		Detail View Shows the Detail view of the selected packet.
	Traffic Summary Opens a window that lists all events that occurred during the recording		Running Verification Scripts Runs selected Verification Scripts
	Bus Utilization 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.

Table 10:

	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.		

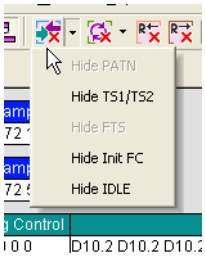
4.4 Toolbar Hide Buttons

The PCIe Protocol Analysis application toolbar has seven buttons related to show/hide of CATC Trace file contents. The buttons allow you to quickly adjust the display to your needs.



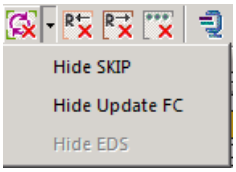


Hide Training: Brings up a drop-down menu that lets you to hide all or a portion of the packets in the training portion of the CATC Trace.





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.



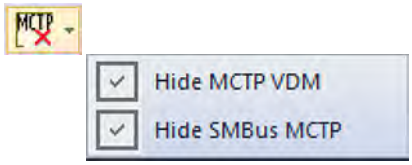
Hide Downstream: Hide all traffic from the root complex to endpoint devices.



Hide Sideband: Hide all sideband traffic (includes SMBus traffic).



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.



4.4.1 Display Options: Level Hiding -> Direction

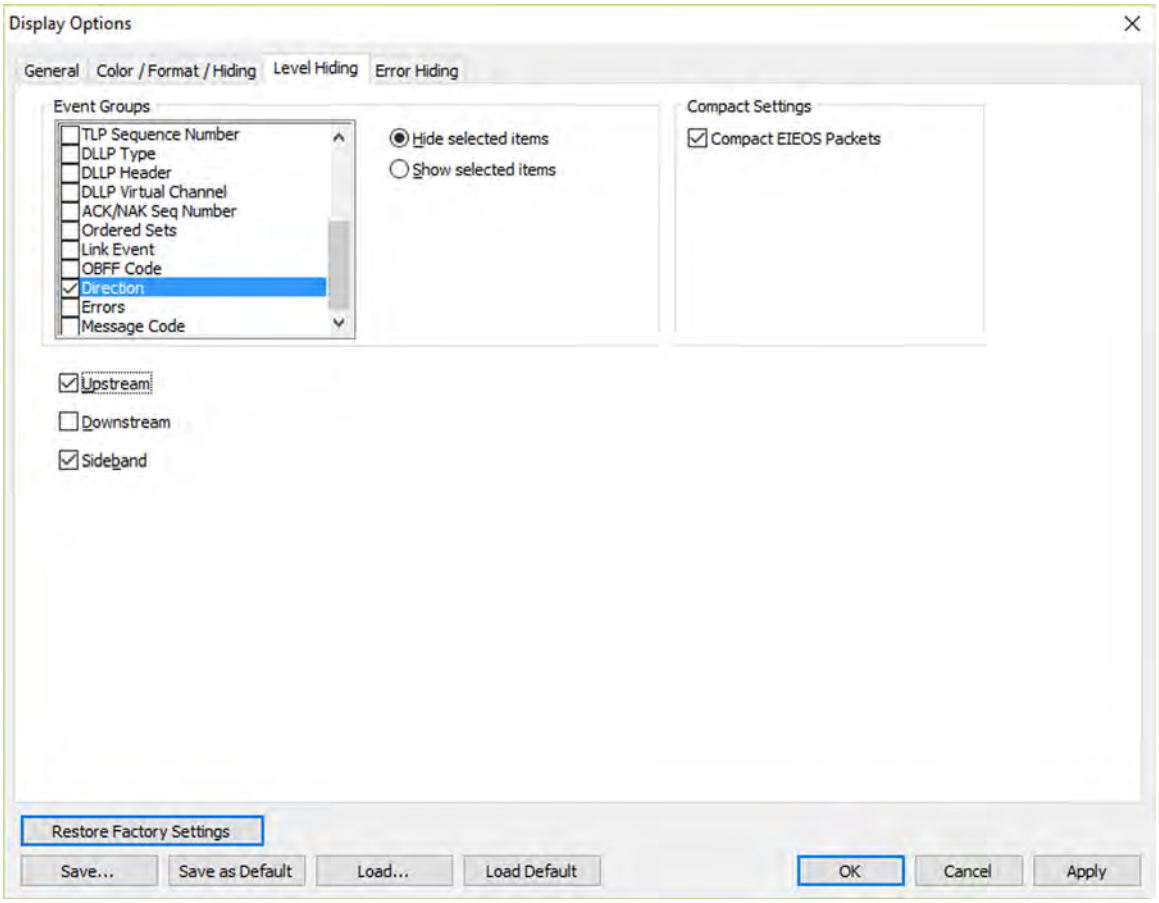


Figure 4.3: Display Options: Level Hiding -> Direction

You can select the Direction of traffic to Hide:

- Upstream
- Downstream
- Sideband (includes SMBus traffic)

Hide Unassociated Traffic: Hides the lower-level transaction packets. Example: Link Transactions and Packets are considered "unassociated" when using Split Transaction Level view.



4.5 Using the Menus

The PCIe Protocol Analysis application main display includes the following set of pull-down menus:



4.5.1 File Menu

Table 11:

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 165.
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 “Save Copy As Function” on page 167.
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 120).
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 (Z3-16).
Exit	Exit the PCIe Protocol Analysis application.

4.5.1.1 File Dialog

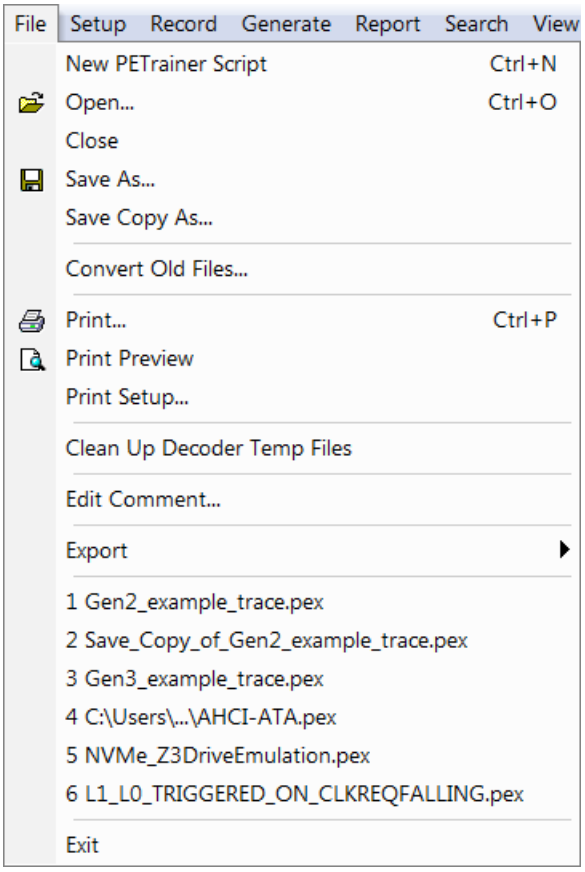


Figure 4.4: File Dialog

4.5.1.2 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 4.5.

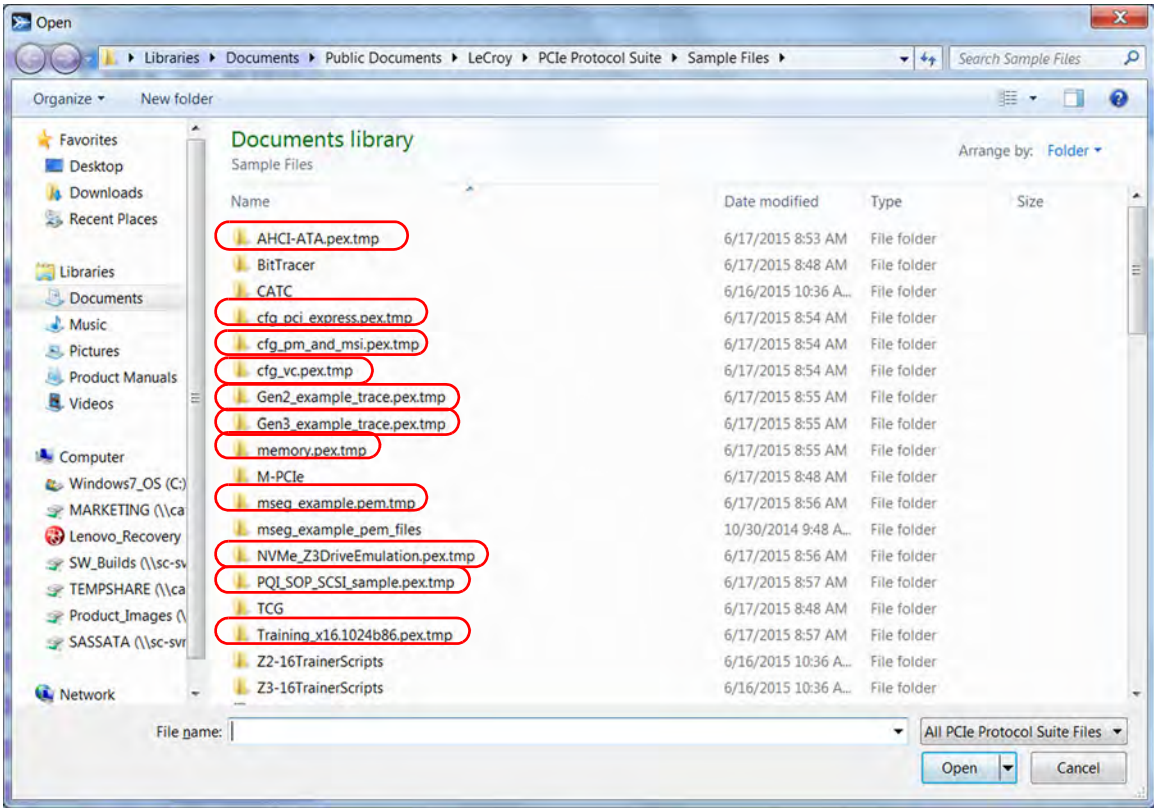


Figure 4.5: Sample Files Folder After Opening a Variety of Traces

2. Now select the File -> Clean Up Decoder Temp Files (see Figure 4.4 on page 119).
3. The following Dialog will pop up: See Figure 4.6 on page 121.

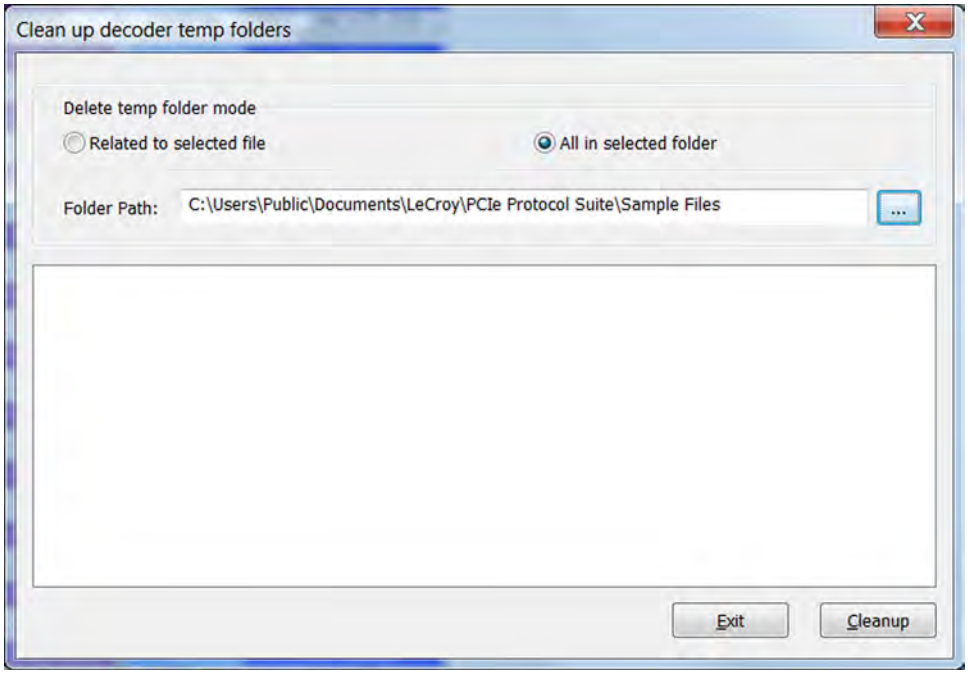


Figure 4.6: Clean Up Decoder Temp Files Dialog

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 4.7.

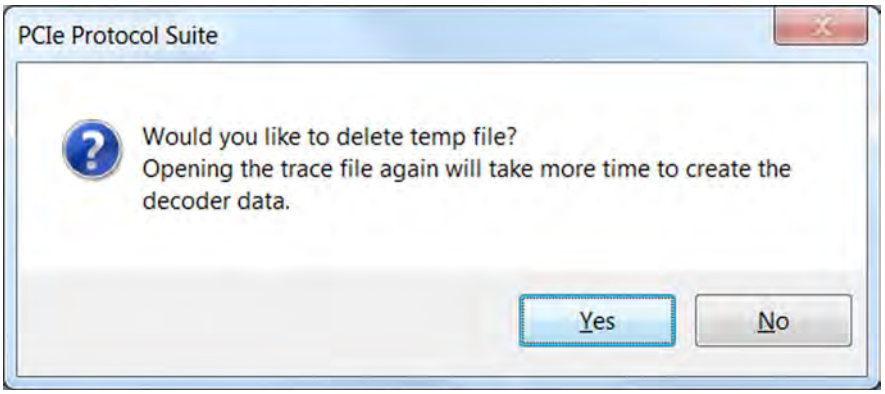


Figure 4.7: Clean Up Decoder Temp Files Warning Dialog

6. Click on Yes, (if files are still in use the Clean Up will Fail, see Figure 4.8 on page 122).

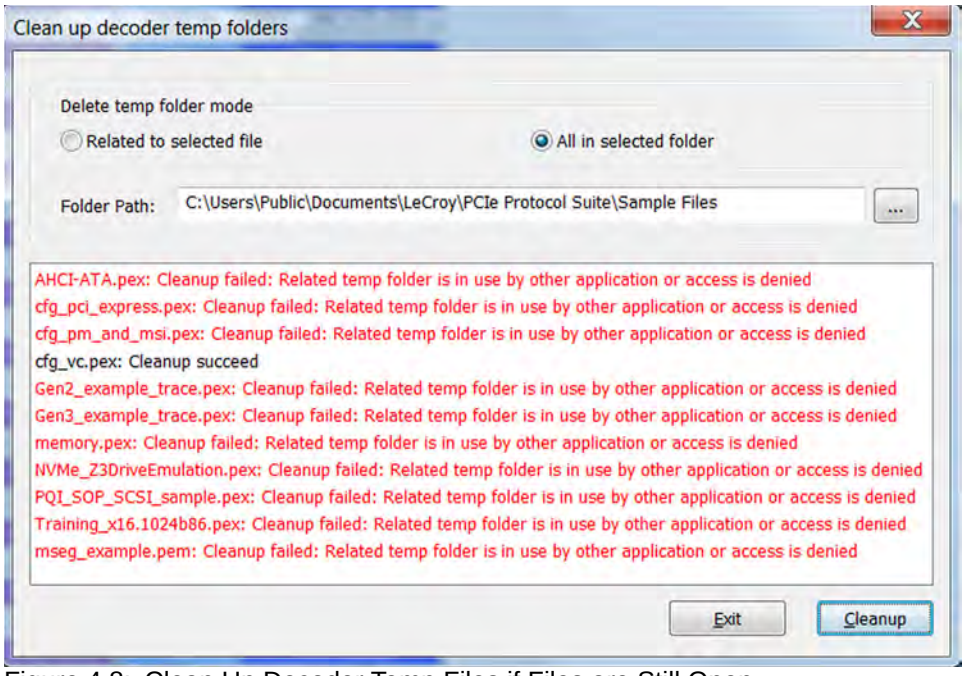


Figure 4.8: Clean Up Decoder Temp Files if Files are Still Open

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 4.9).

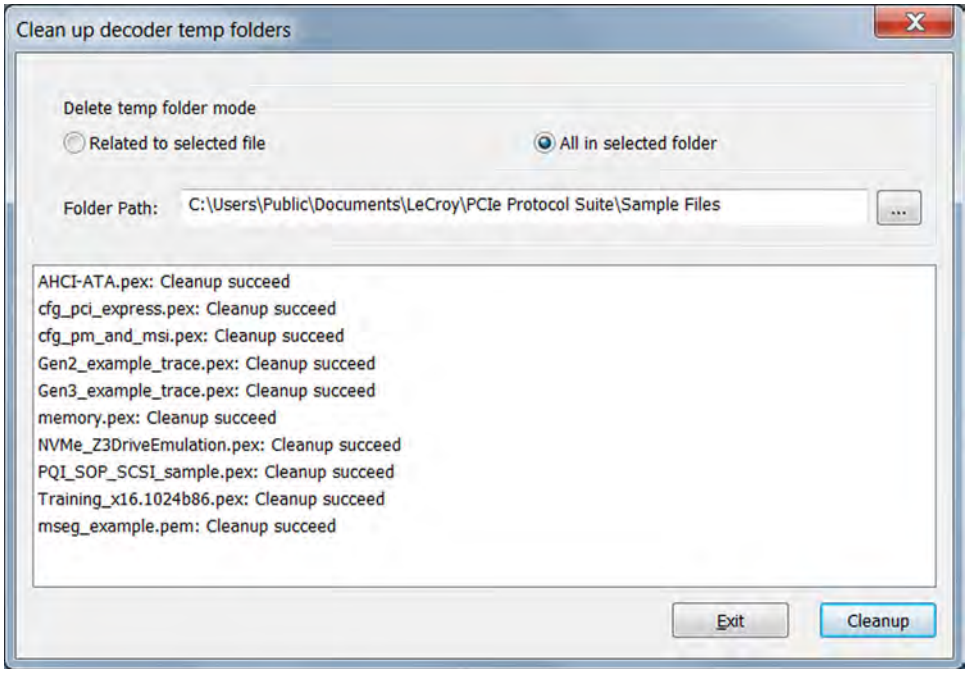


Figure 4.9: Results of Running Clean Up Command

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 4.10).

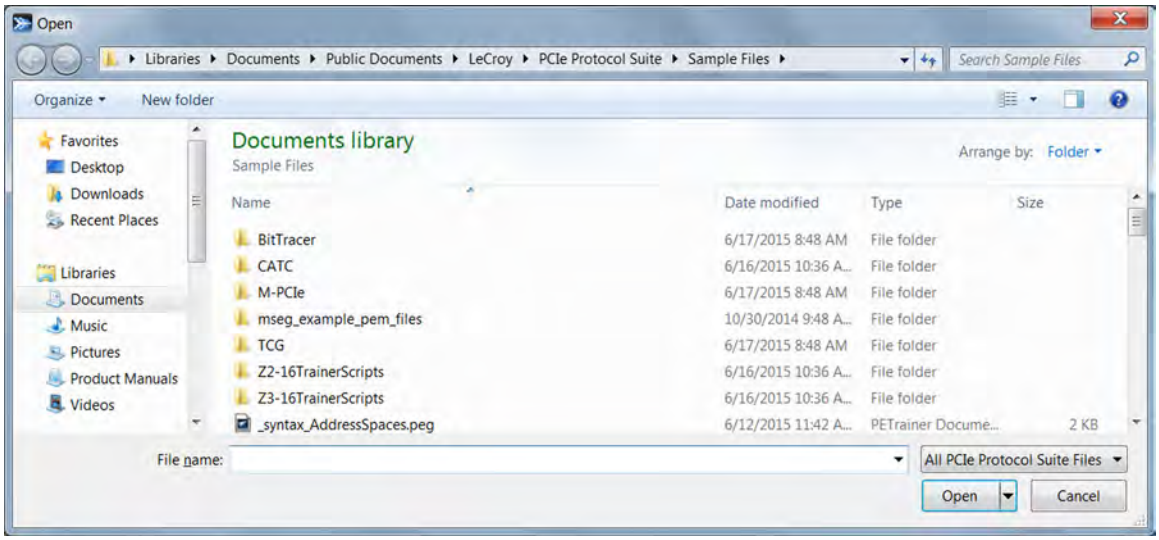


Figure 4.10: Sample File Folder After Temp File Clean Up

12. Compare Figure 4.5 on page 120 with Figure 4.10 to ensure that the .tmp files have been deleted.

4.5.2 Setup Menu

Table 12:

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 183.
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.

4.5.3 Record Menu

Table 13:

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.

4.5.4 Report Menu

Report Menu operations are only available when you are working with a CATC Trace file.

Table 14:

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.

4.5.5 Search Menu

Search Menu operations are only available when you are working with a CATC Trace file.

Table 15:

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 Segment/ 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, Traffic Class, DLLP Virtual Channel, TLP Virtual Channel, Direction, Speed, Link Width, Requester ID, Completer ID, Data Lengths, Errors.

Table 15:

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, Link Margining Commands 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 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.

Table 15:

	You can search 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 and RPMB. You can search for the MCTP transactions: MCTP Packets, MCTP Source Endpoint ID, MCTP Destination Endpoint ID or MCTP Control Messages. You can search SCSI transactions by Event Group: SCSI Operation, Command Status, Task Management, Task Management Response, Errors, SCSI Logical Unit Numbers. 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.

4.5.6 Quick Search Feature

The Quick Search feature allows you to either search for a pre-defined term (see Figure 4.11) 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 636.

For a list of all possible terms, refer to "Quick Search Feature" on page 799.

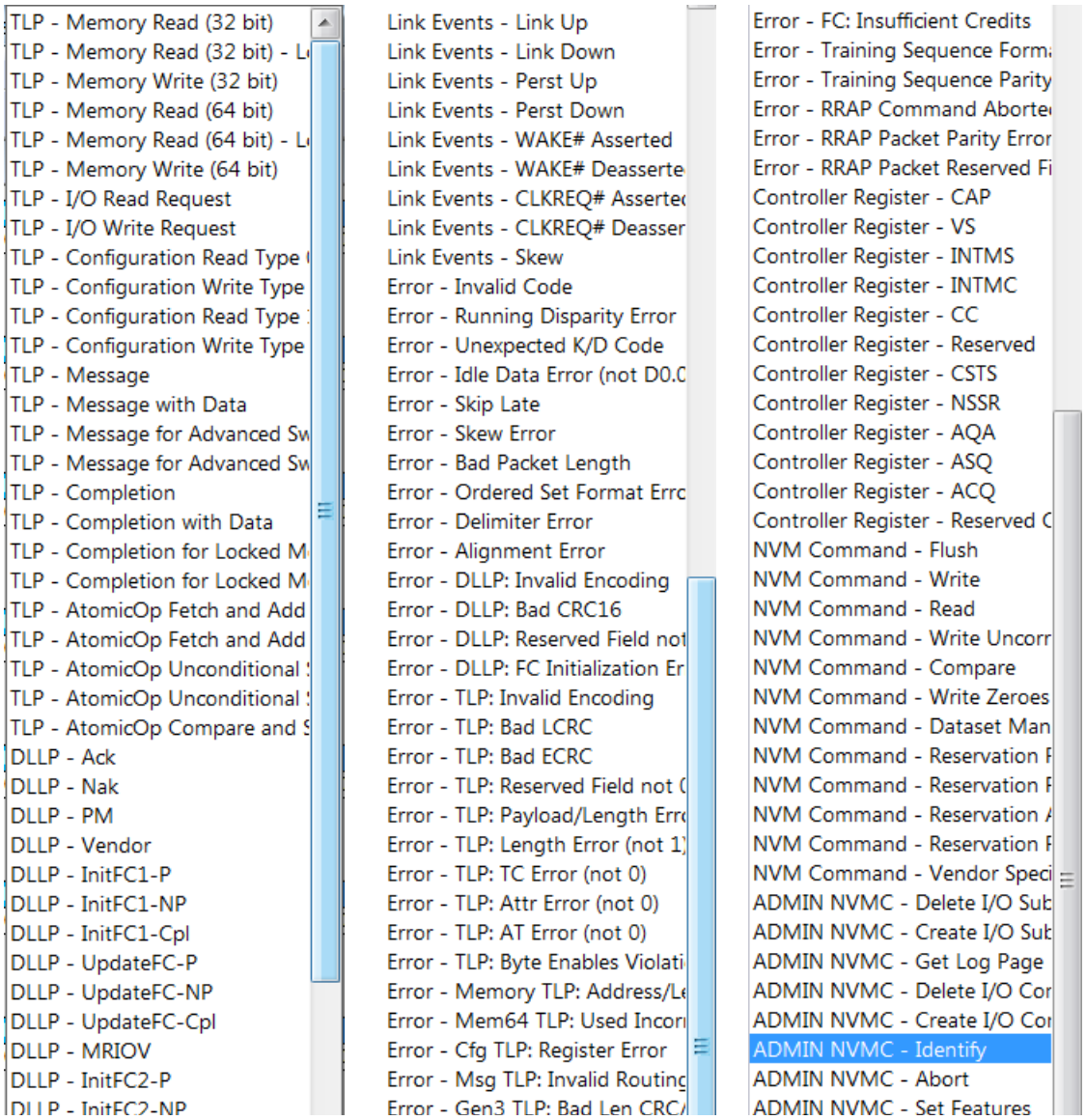


Figure 4.11: Quick Search: Pre-Defined Terms

4.5.7 View Menu

Table 16:

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 598).
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.

Table 16:

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.
NVMe Transaction Level	View the current recording at the NVMe Transaction Level.
PQI Transaction Level	View the current recording at the PQI Transaction Level.
ACHI Transaction Level	View the current recording at the ACHI Transaction Level.
ATA Transaction Level	View the current recording at the ATA 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.
Restore views to default positions	Restores views to the default positions after you click **Yes** on the prompt.

4.5.8 Tools Menu

Table 17:

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.

Table 17:

Interposer Programmer	This utility allows you to program the Continuous Time Linear Equalizer (CTLE) and DCGain on the interposer connected to your analyzer to achieve optimum link performance.
Probe Calibration	This utility will bring up the Autotune and Probe Calibration Wizard.
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.

4.5.9 Window Menu (helps display the loaded traces)

Table 18:

New Window	Opens a copy of the current CATC Trace window.
Cascade	Displays all open CATC Trace windows in an overlapping arrangement.
Tile	Displays all open CATC Trace windows as a series of strips across the display.
Arrange Icons	Arranges minimized CATC Trace windows at the bottom of the display.
Synchronize Traces	Synchronizes a BitTracer trace and a Protocol trace exported from it such that their views scroll together based on timestamps.
Windows	Displays all open windows. Select to display. See Figure 4.12 on page 133 and Figure 4.13 on page 133 as well as “Trace Display Options” on page 133.

For a more detailed explanation of the Window Menu options see Figure 4.12 and Figure 4.13 as well as “Trace Display Options” on page 133.

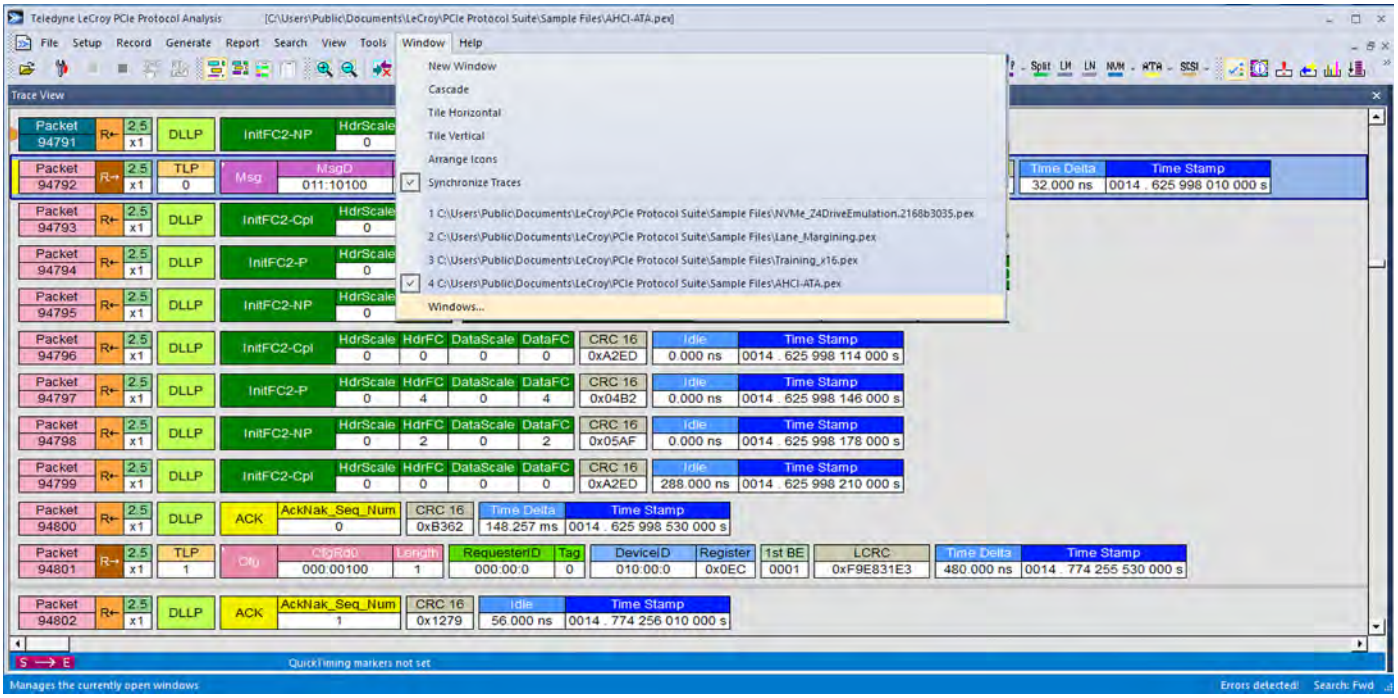


Figure 4.12: Window: Windows Menu with four traces loaded

If you select Windows from the options above a new menu will popup with the list of loaded traces. See Figure 4.13.

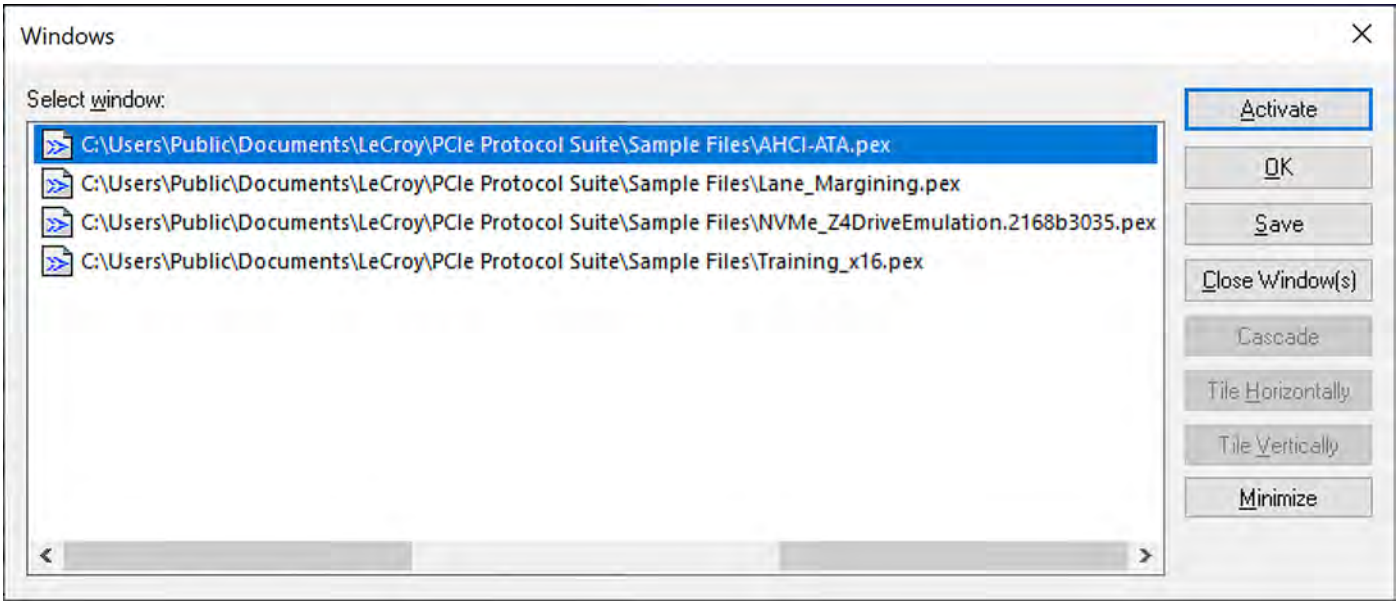


Figure 4.13: Window: Windows menu with four traces loaded

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.

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

4.6 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.

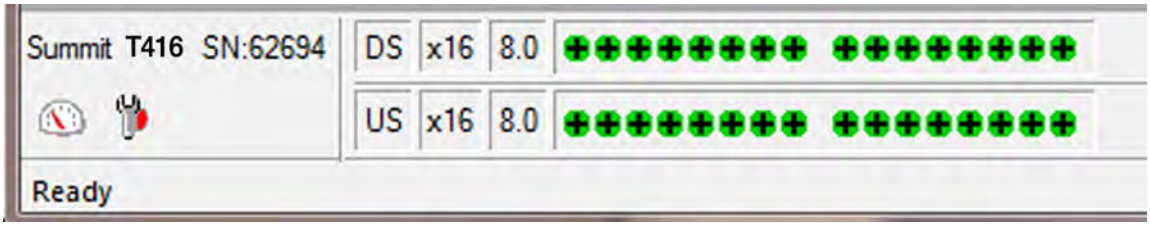


Figure 4.14: Dashboard View Icon Displaying Device

Dashboard (see Figure 4.15 on page 136) 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

Note: The dashboard display depends on the Recording Options configuration and may not match the current actual link state. For example, if the analyzer is configured to track 2.5 GT/s speed only, the Dashboard View will display 2.5GT/s speed as a current tracking speed regardless of the actual speed of the link.

Note: The update to the status bar requires reading the current state of the analyzer. This happens at the end of the recording. In case the analyzer is power cycled, perform at-least one recording to have the updated status bar with current analyzer link information.

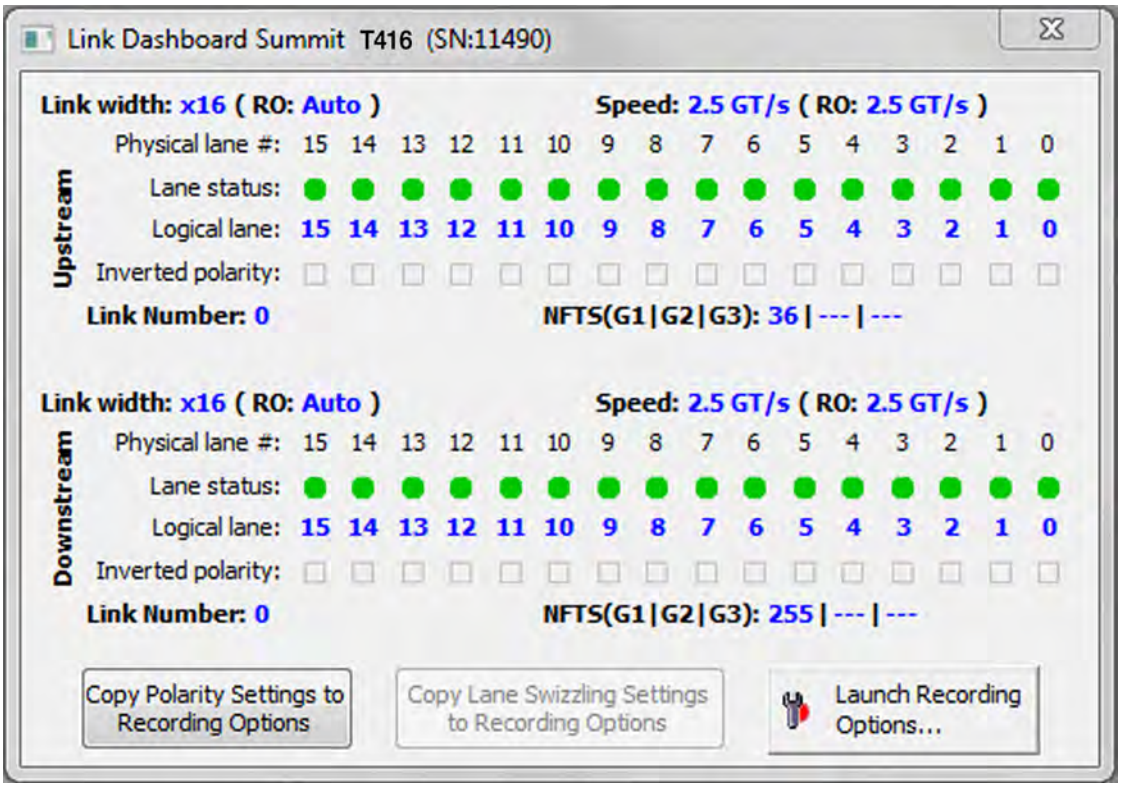


Figure 4.15: Dashboard View Dialog

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.

4.6.1 Launching and Setting Recording Option from Dashboard View

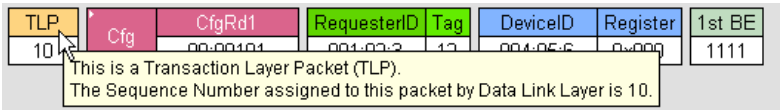
You can select a device and click the **Launch Recording Options as shown in** Figure 4.15 button to go to **Recording Options**. In the Recording Options window the Upstream and Downstream channels can be set manually by unchecking the **Auto-Configure Lane Polarity** checkbox, refer to Figure 5.1 on page 187 (3G). Click on the **Port Polarity Settings to Recording Options** to save the settings.

Note: The lane polarity values are dynamic so this feature allows the user to make the settings and save them for future use.

In the default setting the **Auto-Configure Lane Polarity** checkbox is selected, refer to Figure 5.1 on page 187 (3G).

4.7 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.

4.8 Keyboard Shortcuts

Table 19:

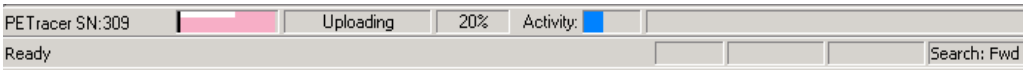
Keystrokes	Operation
Ctrl+N	New PCIe Protocol Analysis script
Ctrl+O	Open file
Ctrl+P	Print
Ctrl+S	Save file
Ctrl+R	Start Analyzer recording
Ctrl+T	Stop Analyzer recording
Ctrl+Home	Jump to first packet
Ctrl+End	Jump to last packet
Ctrl+G	Go to packet...
Ctrl+F	Open Find dialog

Table 19:

Ctrl+1	Access documentation
F3	Find next
F6	Next pane
Shift+F6	Previous pane
Ctrl+B	Search backward

4.9 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 139. 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 139 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 **Toggle Search Direction** from the Search menu.

4.9.1 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.

4.9.2 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 4.16: Status Bar - Waiting For Trigger

The status bar displays **Uploading** when recording is complete and is being uploaded (see Figure 4.17 on page 140).



Figure 4.17: Status Bar - Uploading

The status bar displays **Triggered** when the trigger condition has occurred, but uploading has not commenced yet.

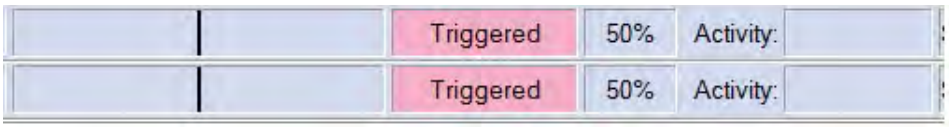


Figure 4.18: Status Bar - Triggered

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.

4.9.3 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.

4.9.4 Search Direction Indicator

The fourth segment in the status bar indicates search direction. The direction can be changed by selecting Toggle Search Direction from the Search menu.

4.10 Making a PCI Express Recording

4.10.1 Simple Mode Recording

After connecting the Analyzer to the device(s), you must select Standard Mode or Multiport Mode (see "Multiport Mode" on page 147). The default mode is usually Standard Mode.

After selecting the number of ports to analyze you need to configure Recording Options for each one. 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 (see Figure 4.19 on page 142 and Figure 4.20 on page 143).

   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.

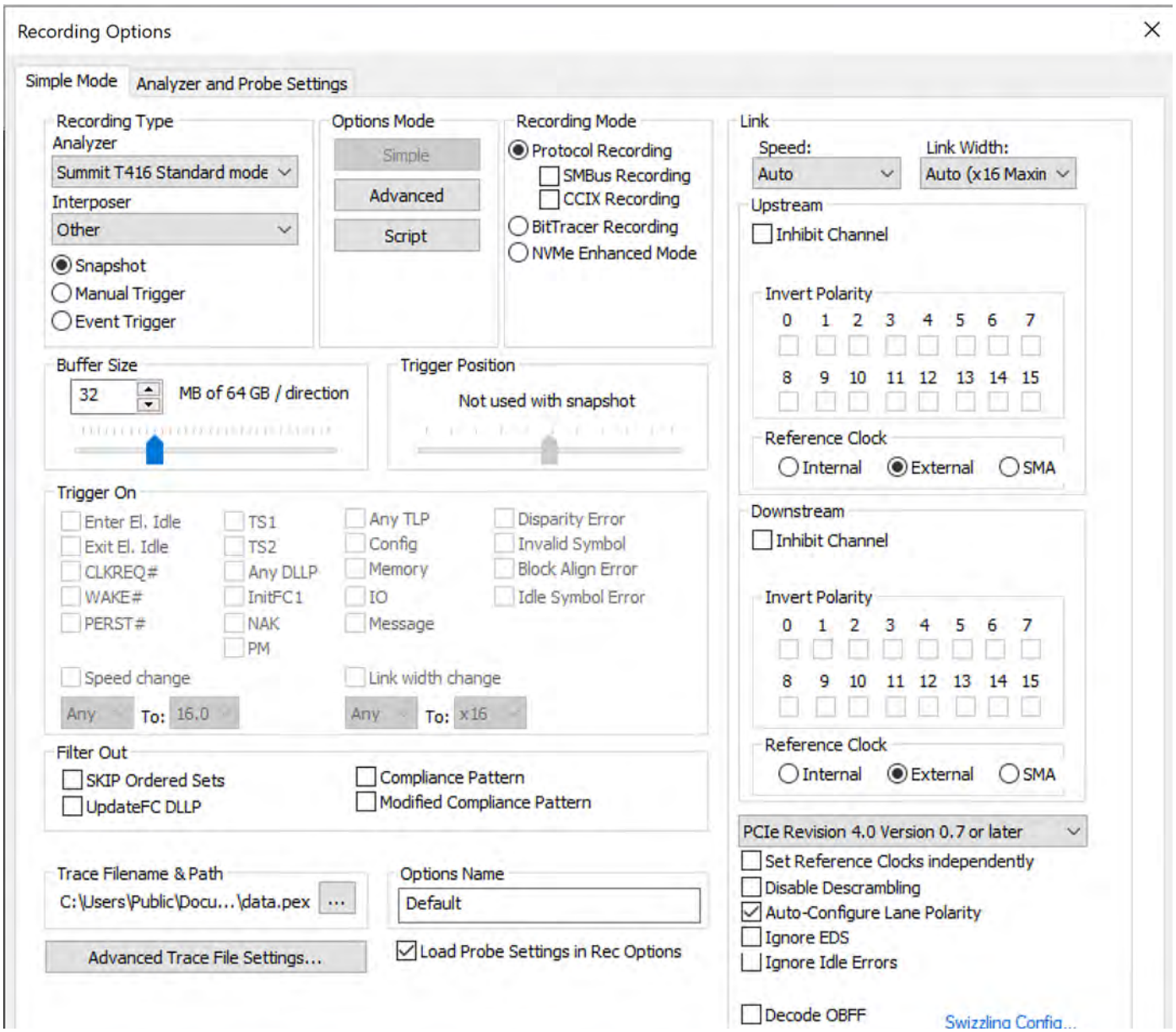


Figure 4.19: Summit T416 in Simple Recording Mode

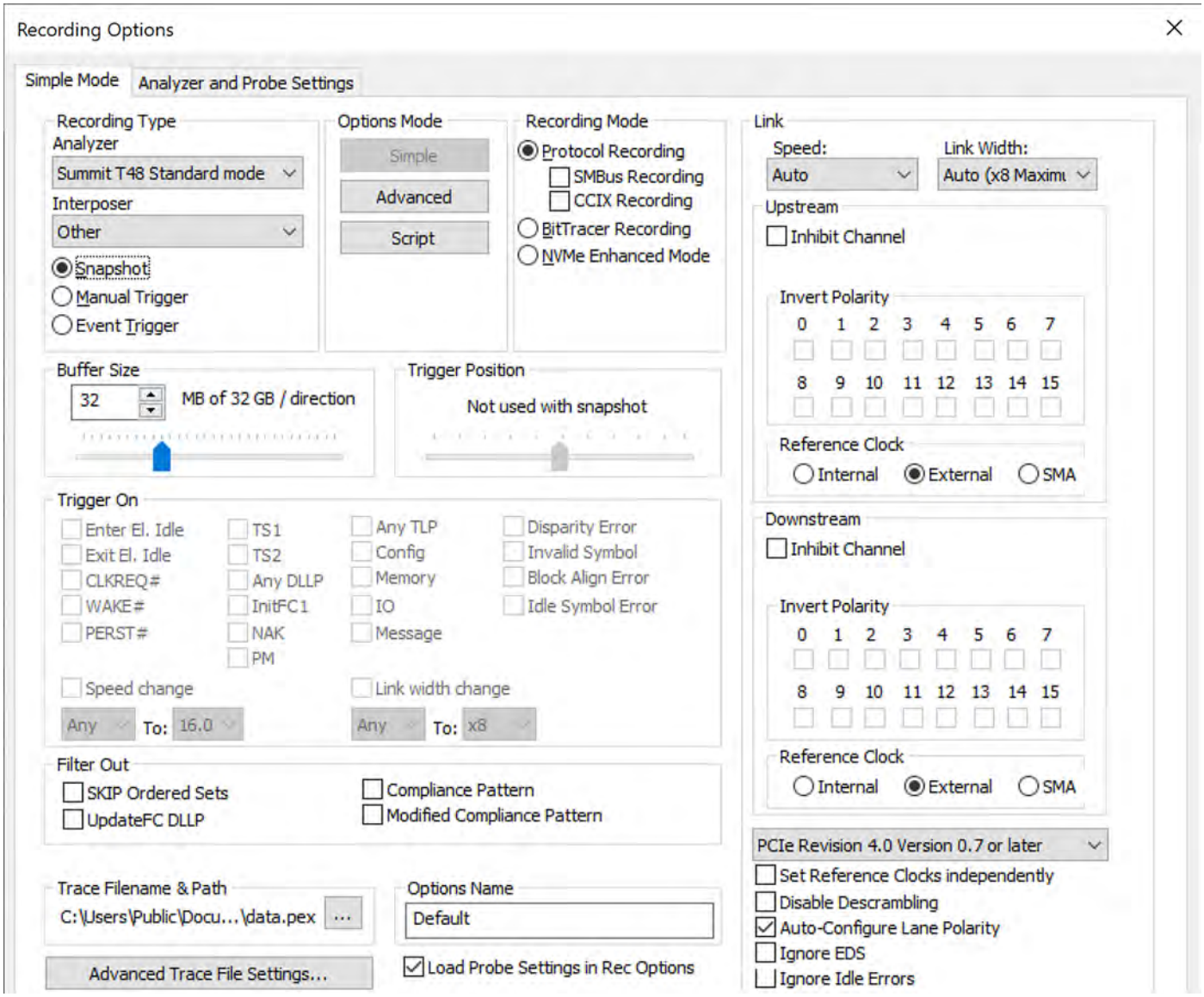


Figure 4.20: Summit T48 in Simple Recording Mode

3. In the **Link** section, specify the lane 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. For multi-lane PCI Express links when using Auto options, the Analyzer needs to observe link training in order to record link traffic correctly.
5. Click **OK** at the bottom of the Recording Options dialog to apply the Analyzer recording settings specified.
6. Click the **Record** button.

4.10.2 Analyzer Calibration and Interposer Tuning

4.10.2.1 Connecting the Interposer

Refer to “Cabling Options for Tuning the Interposer” on page 40 for the different options to connect the interposer for calibration or tuning purposes. After the interposer is connected and powered ON, you can use the Interposer Programmer tool to perform calibration or tuning. Selecting Interposer Programmer will pop up the PCIe Interposer Programmer Utility. See Figure 5.226 on page 417.

4.10.2.2 Interposer Tuning

In order to get the best recordings possible and allow the PCIe link through an interposer run error free, the PCIe Analysis software allows the user to adjust different settings before the recording takes place. There are two paths that need to be considered:

- Analyzer Path (TAP4 Settings): Monitoring signals from the PCIe link on the interposer to the Summit analyzer.
  - The process of adjusting and optimizing the analyzer path is referred to as "calibration". See “Interposer to Analyzer Path” on page 376 for details.
- Device path (Host to DUT Settings): PCIe link between the host and the device card through the interposer.
  - The process of adjusting and optimizing the device path is referred here as "auto-tuning" the Host to Device path. See “Interposer Host to DUT Auto-tune” on page 348 for details.

For Summit T4 system there are three areas where calibration can take place: The Host to DUT path on the interposer, the Interposer Analyzer path and the front end of the analyzer (Equalizer Settings). See Figure 4.21 on page 145.

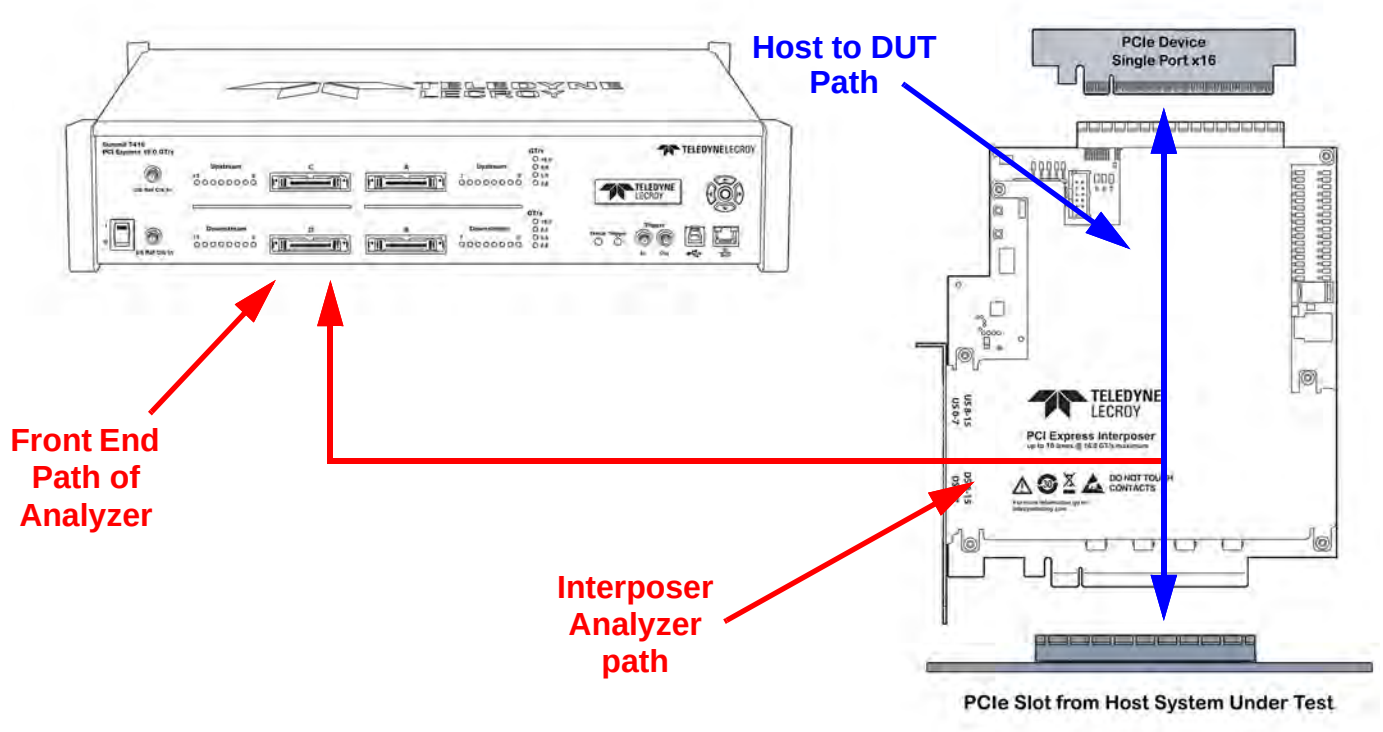


Figure 4.21: Analyzer Path for Calibration vs. DUT Path for Tuning

4.10.3 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.

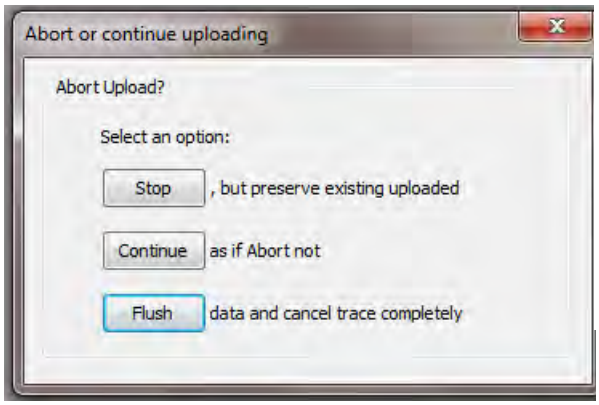


Figure 4.22: Abort Upload

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.

4.10.4 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.

4.10.5 Multiport Mode

MultiPort mode allows a Summit T4 system to behave as multiple analyzer systems. The first thing to configure in the Software is to decide how many ports will be analyzed.

Summit T4 analyzers can be run in Standard Mode or Multiport Mode.

Note: If the link width of the analyzer you are using is set to a larger value than the link width being used in Mutliport Mode a warning message will pop up asking you if you want to link width set to be compatible with the options selected in Mulitport mode. See "Trace Filename and Path" on page 204.

To configure the Summit T4 Analyzer in MultiPort mode select the Gear icon. See Figure 4.23.

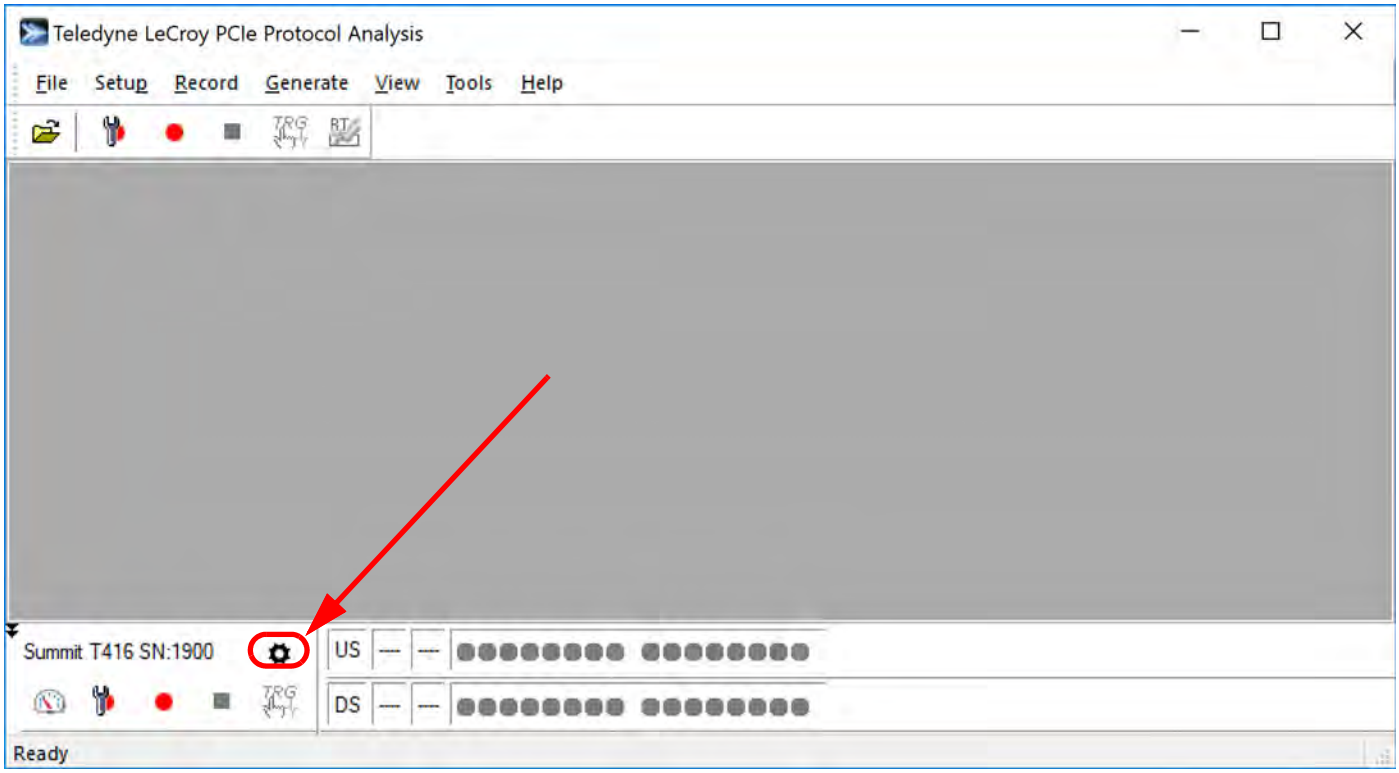


Figure 4.23: Summit T416 Multiport Gear Button shown

Select the gear icon and the Multiport Analyzer Settings dialog box will pop up. See Figure 4.24 on page 148.

4.10.6 Multiport Mode Configuration: Summit T416

If you select Standard Mode the Multiport Analyzer Settings dialog box will show a single x16 port. See Figure 4.24.

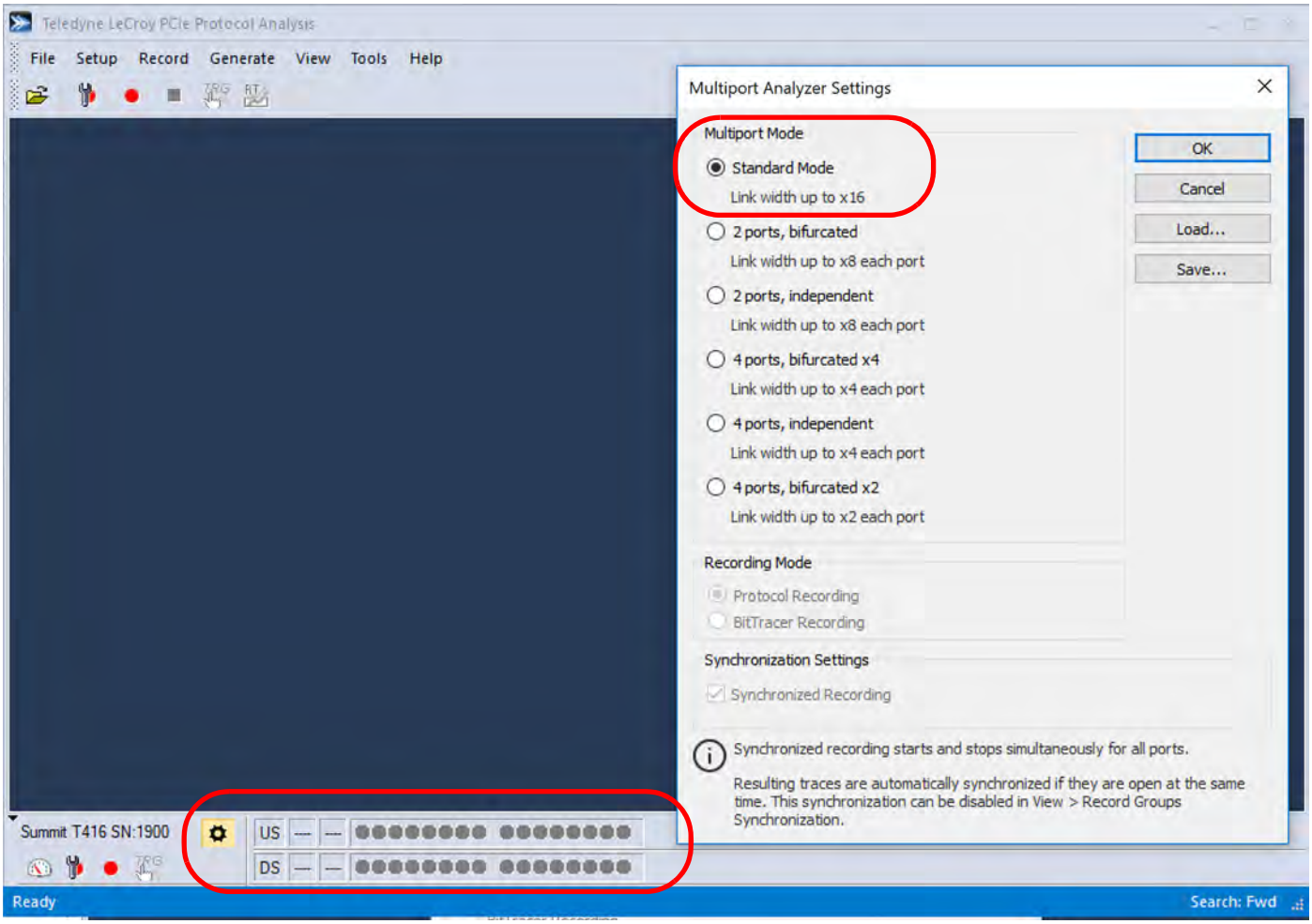


Figure 4.24: Multiport Mode Analyzer Settings: Summit T416 -> Standard Mode, single port x16

This configuration for Multiport Mode is discussed in more detail for the Summit T416 in "Standard Mode using a cable-attached x16 interposer" on page 51 and "Standard Mode Configuration using a MultiPort x16 interposer" on page 52.

If you select 2 ports, bifurcated the Multiport Analyzer Settings dialog box will show two x8 ports. See Figure 4.25.

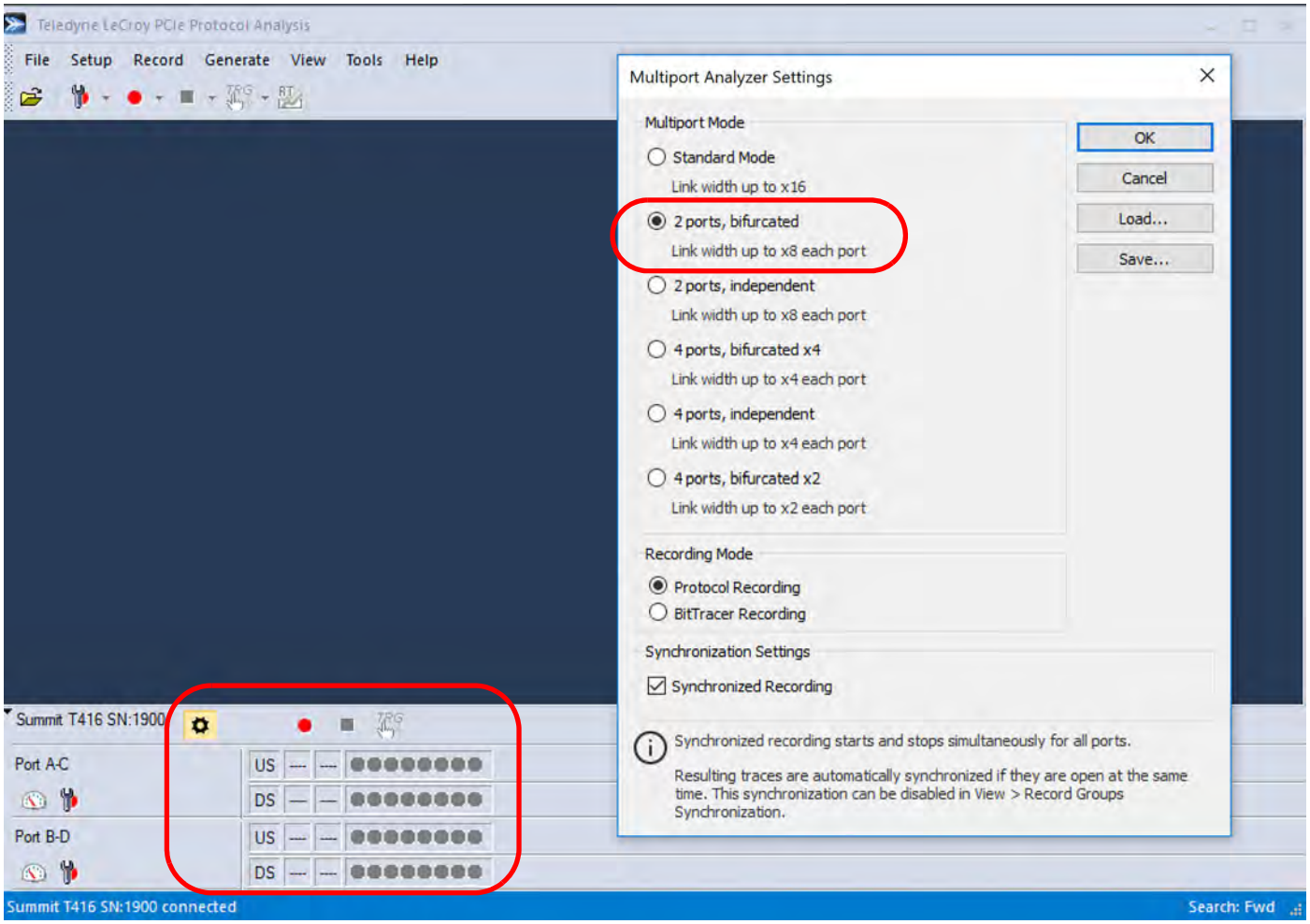


Figure 4.25: Multiport Mode Analyzer Settings: Summit T416 -> 2 ports x8, bifurcated

This configuration for Multiport Mode is discussed in more detail for the Summit T416 in “Bifurcated (2 x8 Ports) Mode using cable-attached x16 interposer” on page 54 and “Bifurcated (2 x8 Ports) Mode using MultiPort x16 interposer” on page 55.

If you select 2 ports, independent the Multiport Analyzer Settings dialog box will show two x8 ports. See Figure 4.26.

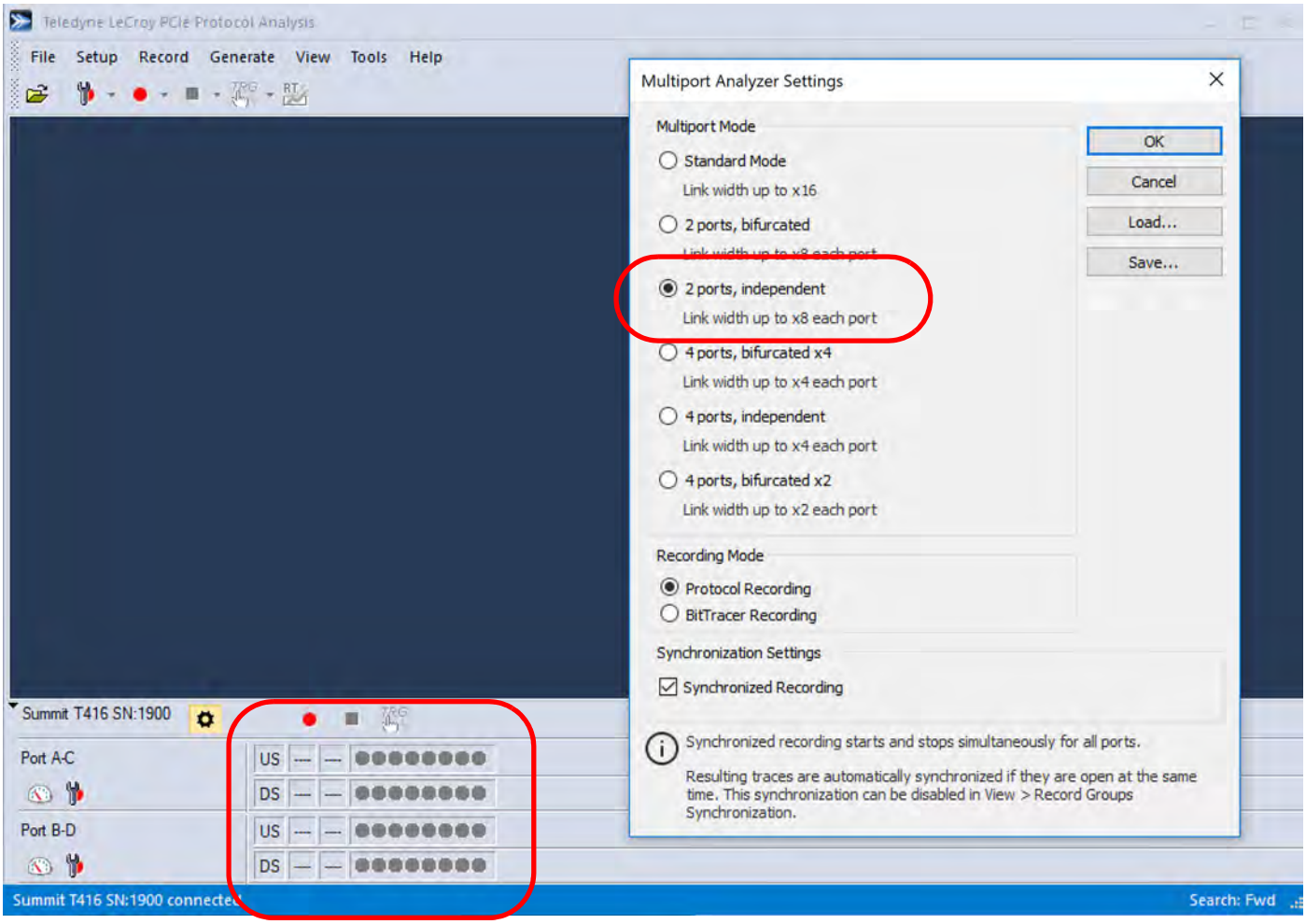


Figure 4.26: Multiport Mode Analyzer Settings: Summit T416 -> 2 ports x8, independent

This configuration for Multiport Mode is discussed in more detail for the Summit T416 in “Independent (2 x8 Ports) Mode using cabled-attached x8 interposer” on page 57.

If you select 4 ports, bifurcated the Multiport Analyzer Settings dialog box will show four x4 ports. See Figure 4.27.

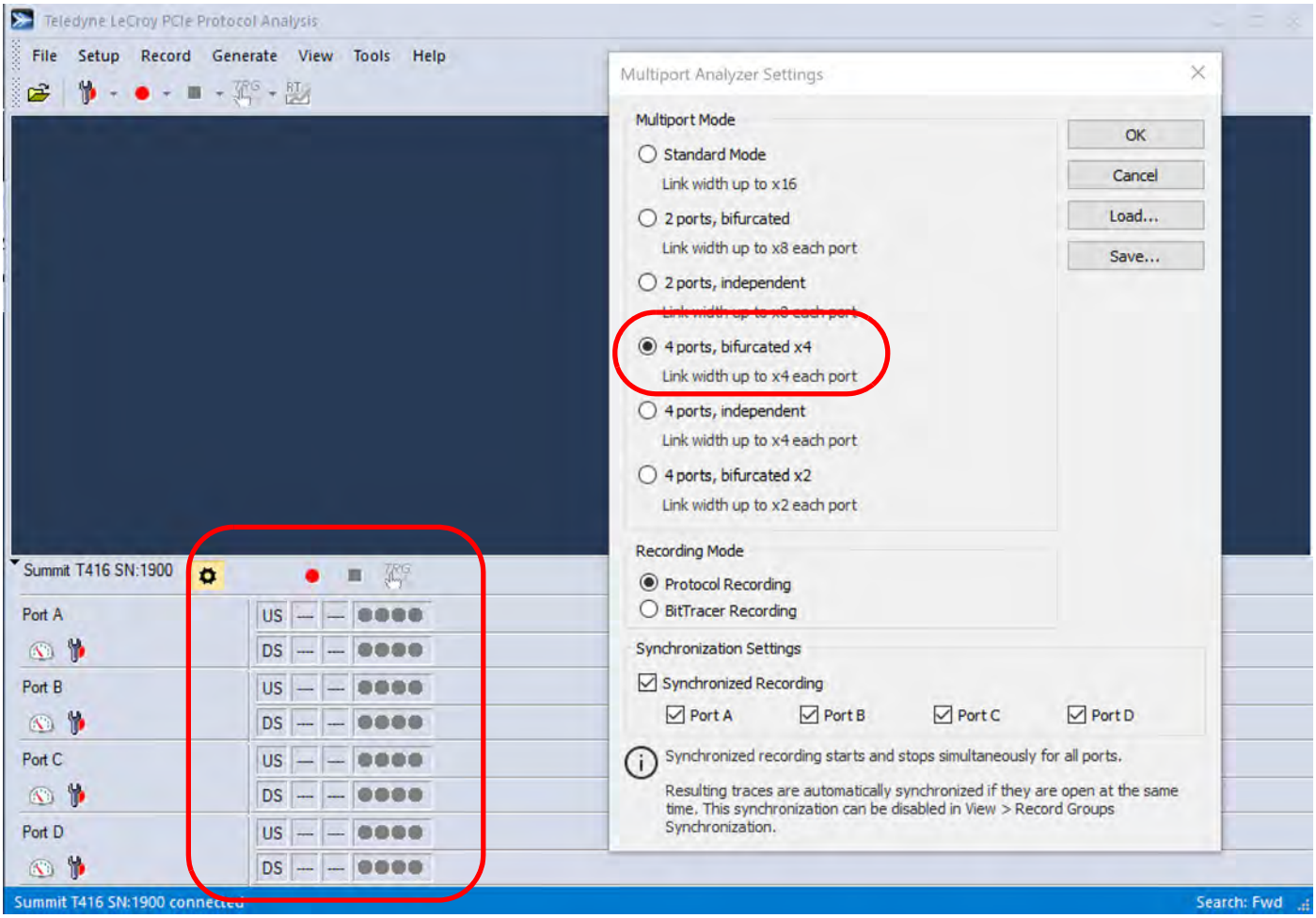


Figure 4.27: Multiport Mode Analyzer Settings: Summit T416 -> 4 ports x4, bifurcated

This configuration for Multiport Mode is discussed in more detail for the Summit T416 in “Bifurcated (4 x4 Ports) Mode using cable-attached interposer” on page 59 and “Bifurcated (4 x4 Ports) Mode using MultiPort x16 interposer” on page 60.

If you select 4 ports, independent the Multiport Analyzer Settings dialog box will show four x4 ports. See Figure 4.28.

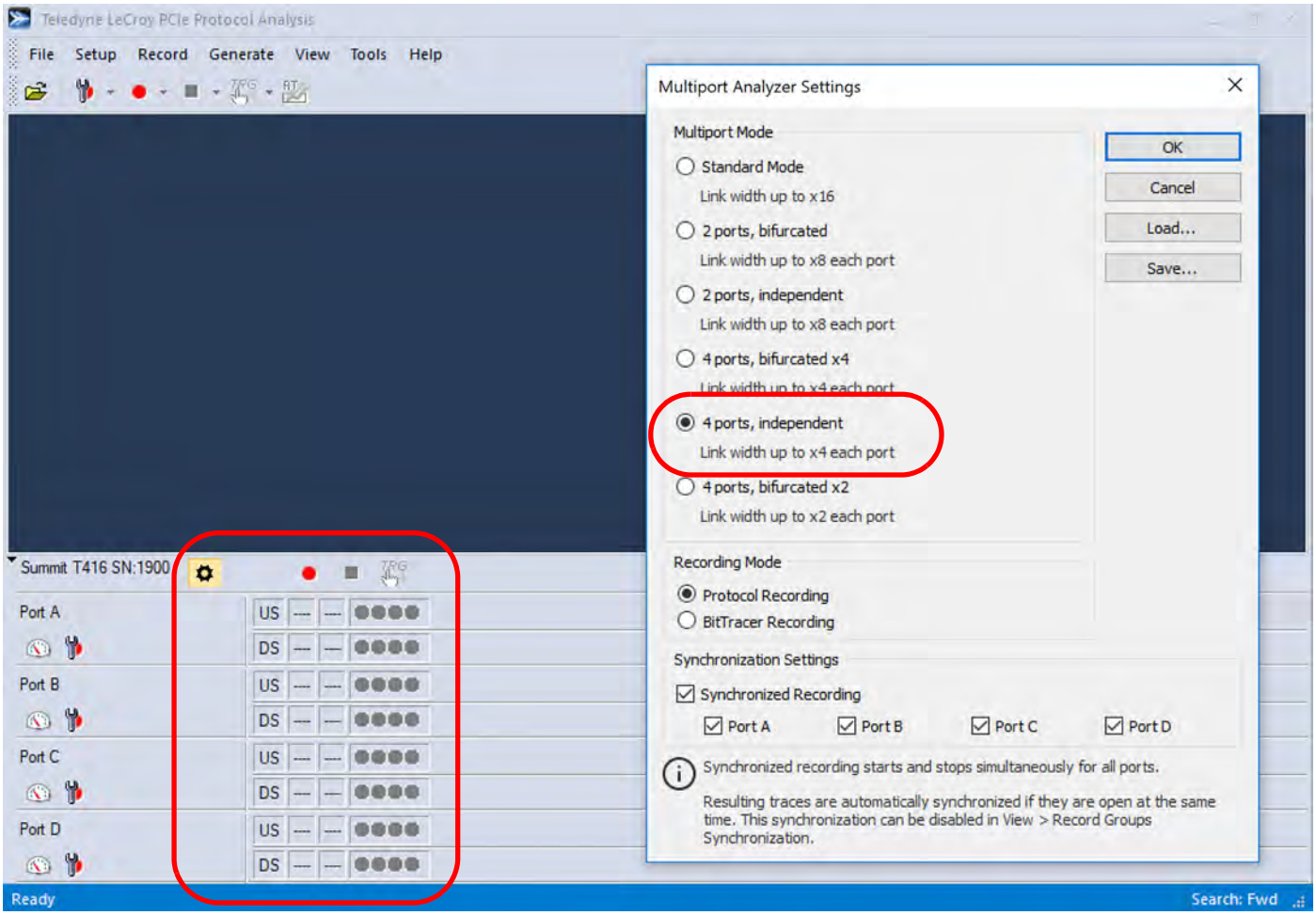


Figure 4.28: Multiport Mode Analyzer Settings: Summit T416 -> 4 ports x4, independent

This configuration for Multiport Mode is discussed in more detail for the Summit T416 in “Independent (4 x4 Ports) Mode using MultiPort x4 interposer” on page 62.

If you select 4 ports, bifurcated x2 the Multiport Analyzer Settings dialog box will show four x2 ports. See Figure 4.29.

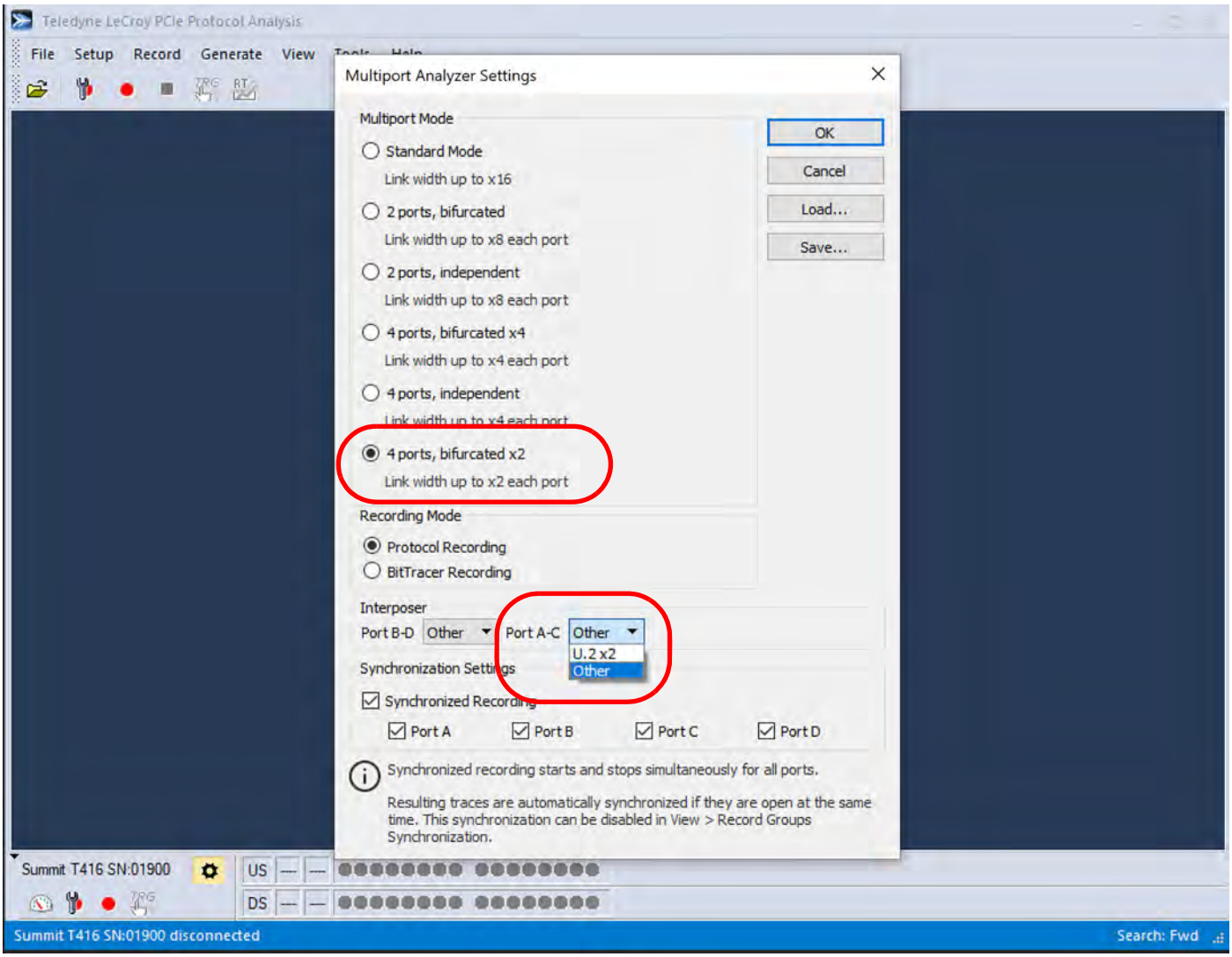


Figure 4.29: Multiport Mode Analyzer Settings: Summit T416 -> 4 ports x2, bifurcated

You must also select the type of Interposer to be used with the Summit T416 analyzer. There are two options for the Port B-D and two options for Port A-C:

- U.2 x2
- Other

You can choose U.2 x2 for Port B-D and Other for Port A-C depending on your hardware configuration. As an example, if U.2 x2 was selected for Port B-D and Other was selected for Port A-C you would get the following recording configuration after click the “OK” button.

The following information message will popup. See Figure 4.30 on page 154.

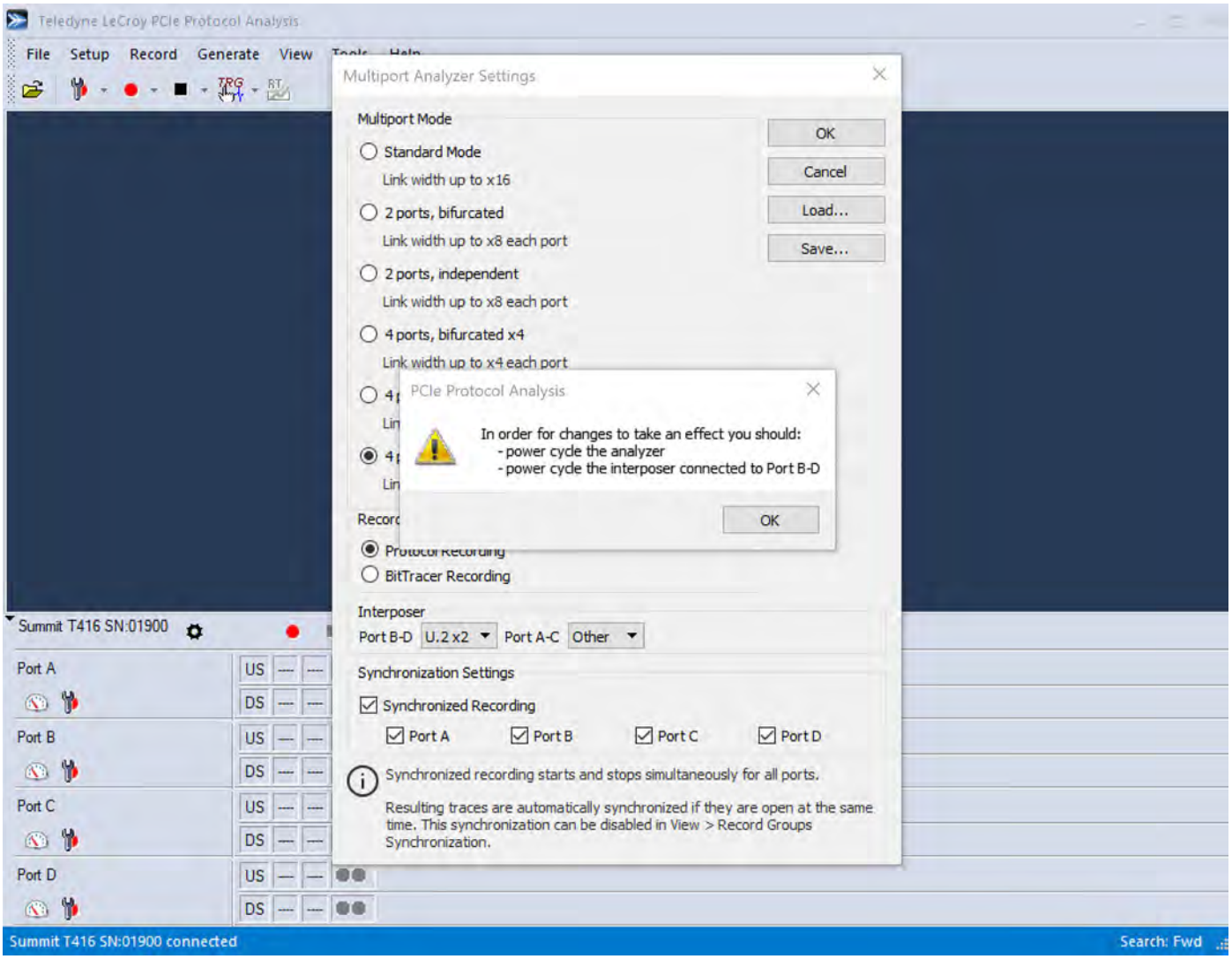


Figure 4.30: Summit T416 Power Cycle Message

After the appropriate power cycling the Summit T416 will be configured for four ports x2. See Figure 4.31 on page 155.

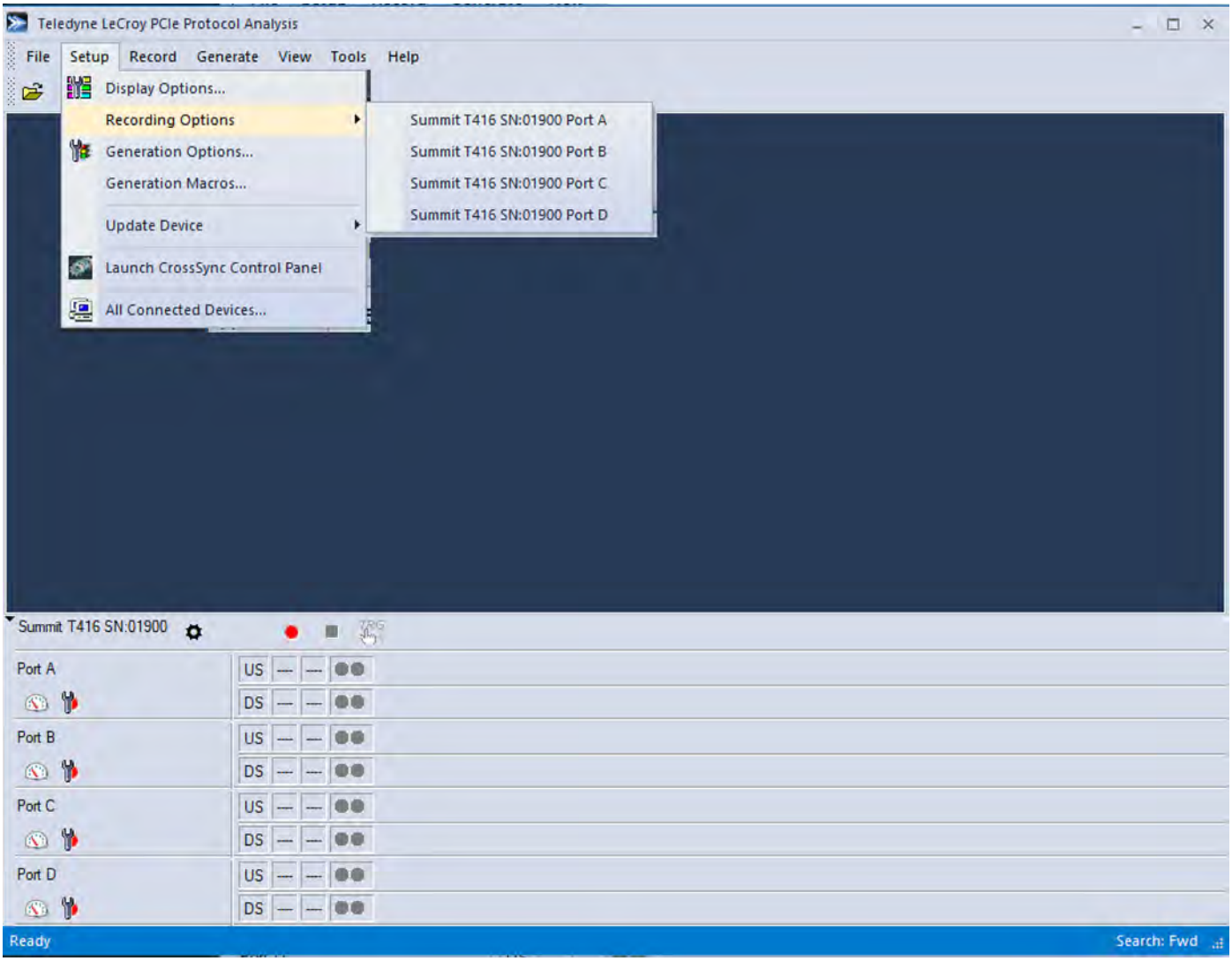


Figure 4.31: Summit T416 Configured for Four Ports x2

This configuration for Multiport Mode is discussed in more detail for the Summit T416 in “Bifurcated (4 x2 Ports) Mode using two MultiPort x4 interposers” on page 64 and “Bifurcated (4 x2 Ports) Mode using two MultiPort x4 interposers” on page 64.

4.10.7 Multiport Mode Configuration: Summit T48

If you select Standard Mode the PCIe Protocol Analysis dashboard will show a single x8 port. See Figure 4.32.

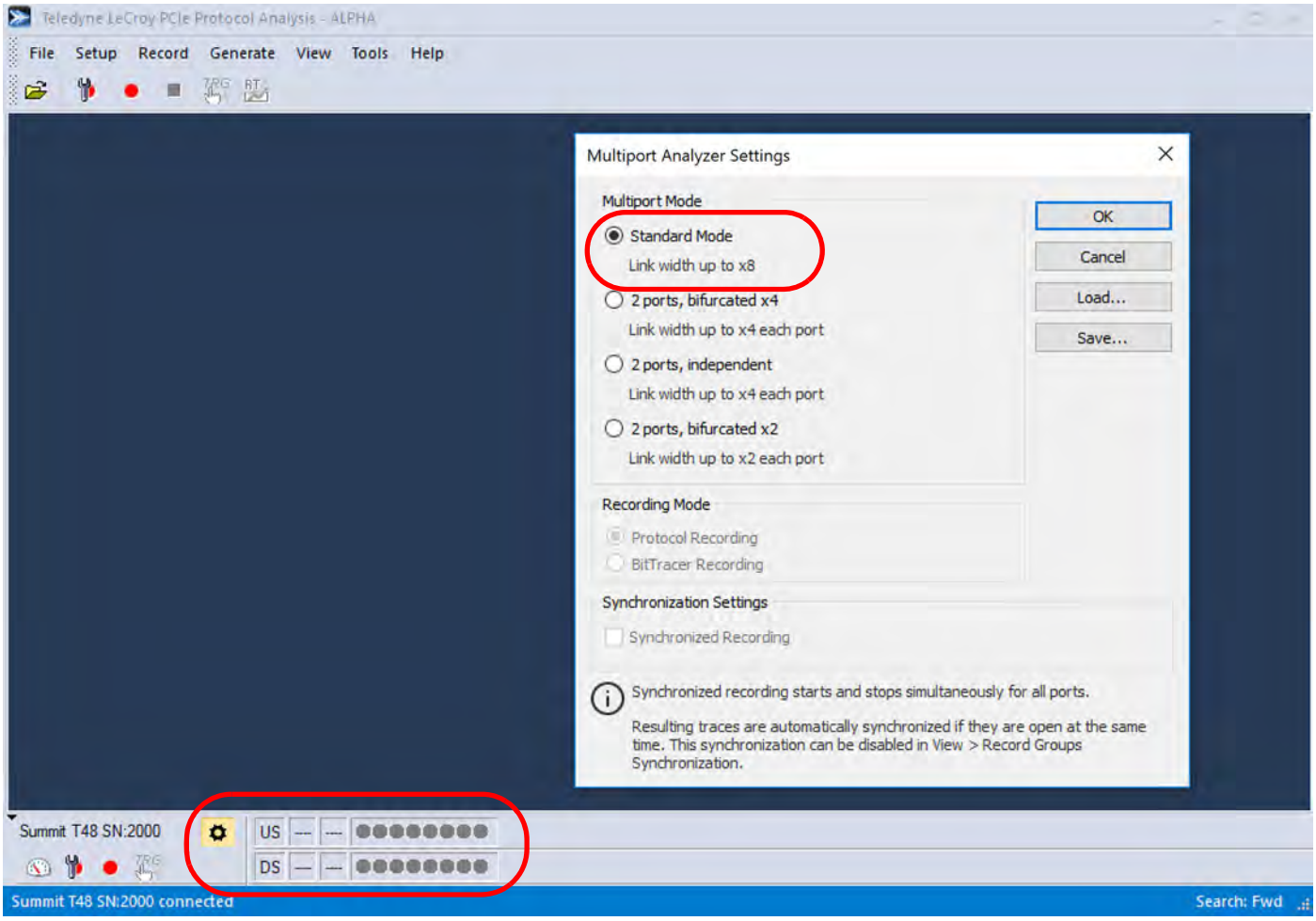


Figure 4.32: Multiport Mode Analyzer Settings: Summit T48 -> Standard Mode, single port x8

This configuration for Multiport Mode is discussed in more detail for the Summit T48 in “Standard Mode Configuration using a cable-attached x8 interposer” on page 68 and “Standard Mode Configuration using a MultiPort x8 interposer” on page 69.

If you select 2 ports, bifurcated the PCIe Protocol Analysis dashboard will show two x4 ports. See Figure 4.33.

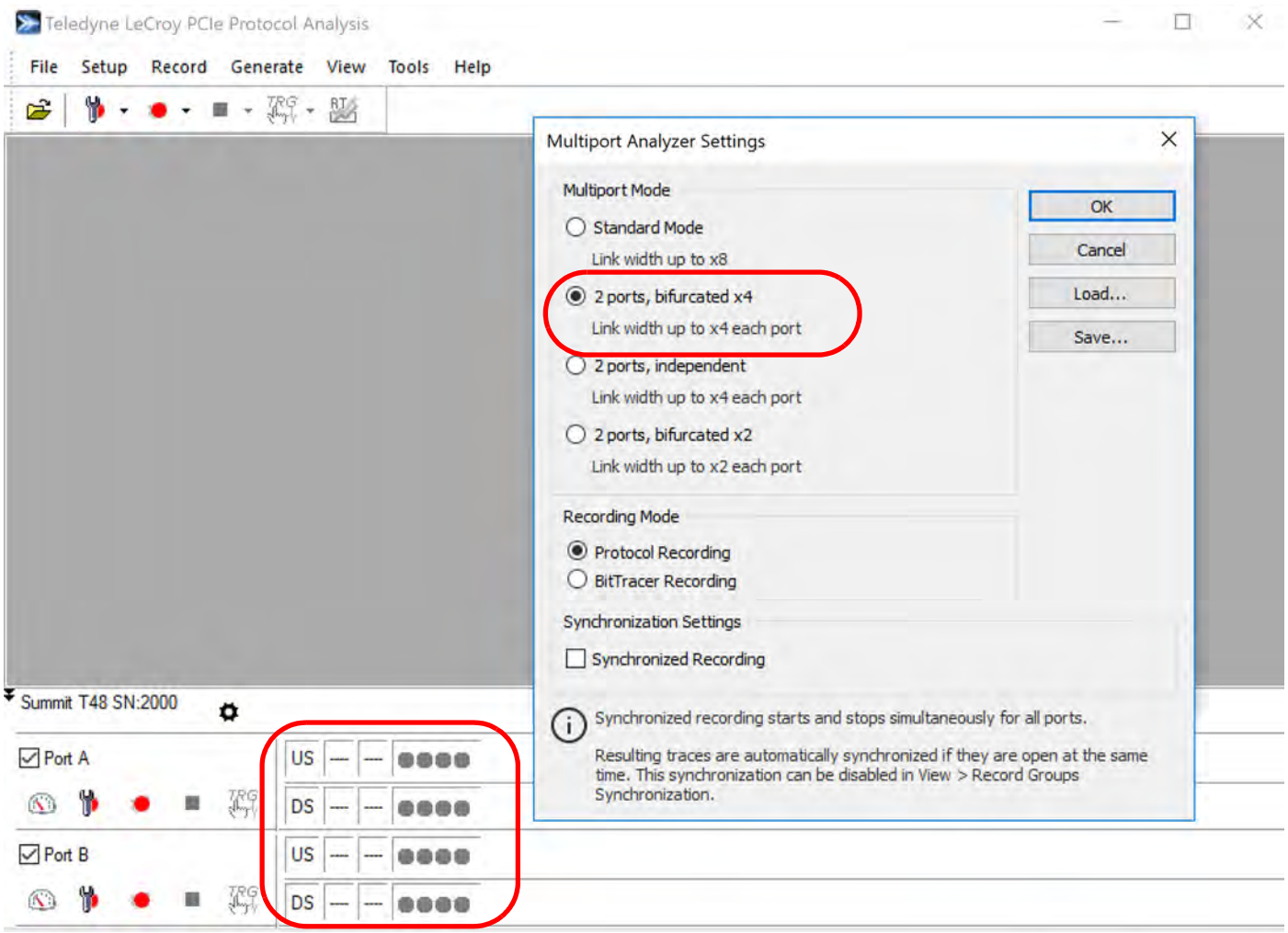


Figure 4.33: Multiport Mode Analyzer Settings: Summit T48 -> 2 ports x4, bifurcated

This configuration for Multiport Mode is discussed in more detail for the Summit T48 in “Bifurcated (2 x4 Ports) Mode using a cable-attached x8 interposer” on page 71 and “Bifurcated (2 x4 Ports) Mode using MultiPort x8 interposer” on page 72.

If you select 2 ports, independent the PCIe Protocol Analysis dashboard will show two x4 ports. See Figure 4.34.

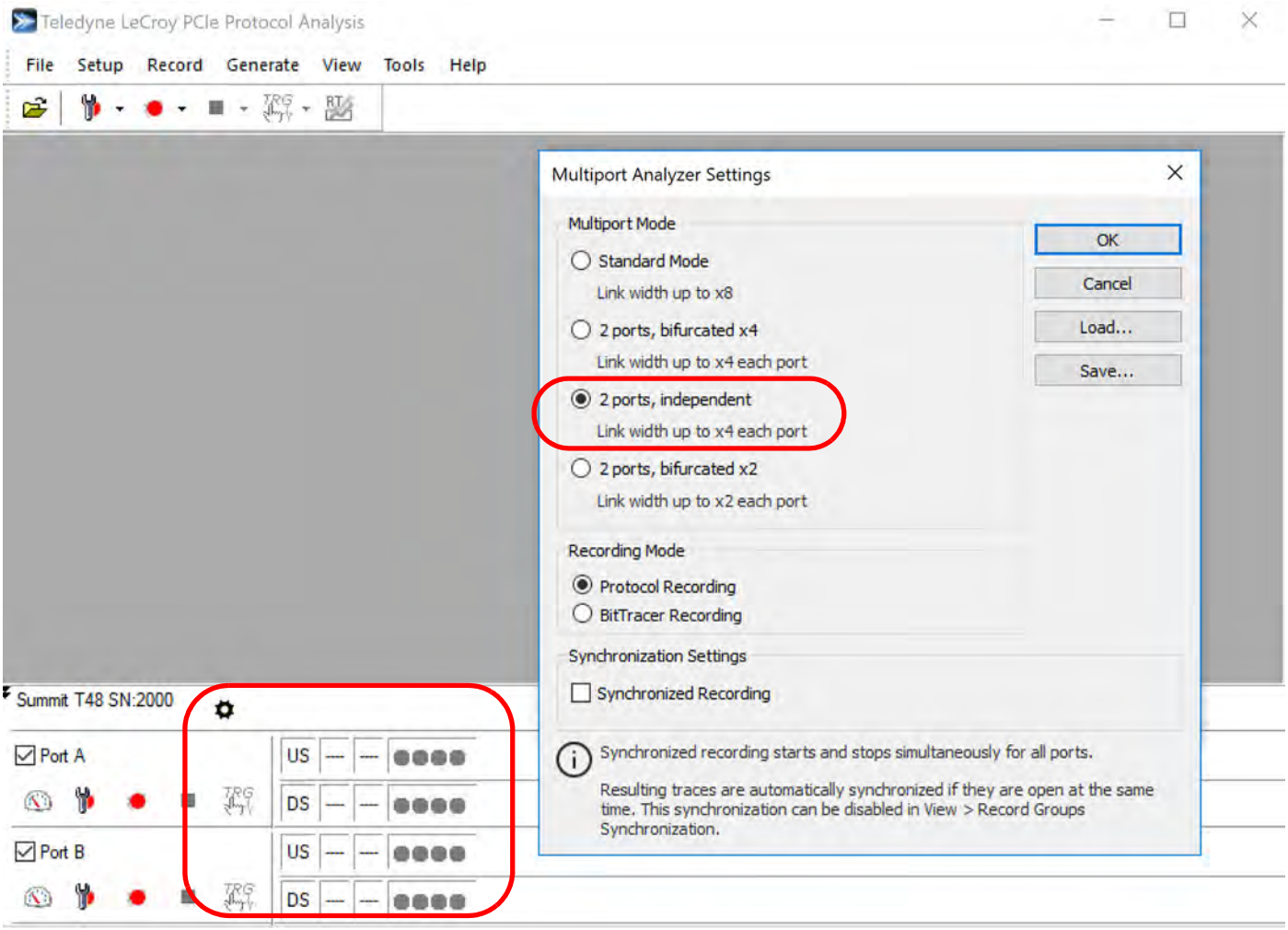


Figure 4.34: Multiport Mode Analyzer Settings: Summit T48 -> 2 ports x4, independent

This configuration for Multiport Mode is discussed in more detail for the Summit T48 in “Independent (2 x4 Ports) Mode using Multiport x4 interposers” on page 74.

If you select 42ports, bifurcated x2 the Multiport Analyzer Settings dialog box will show two x2 ports. See Figure 4.35.

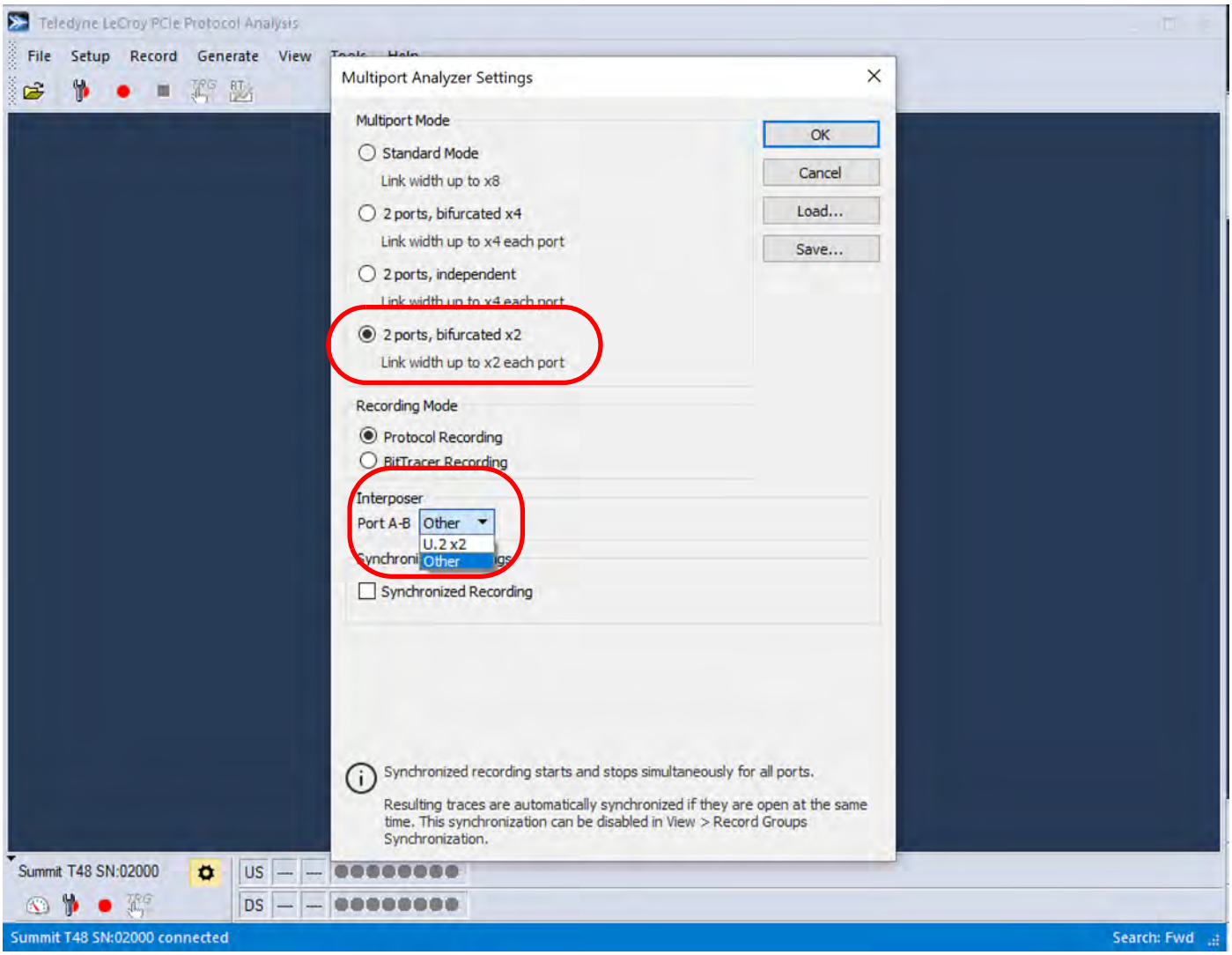


Figure 4.35: Multiport Mode Analyzer Settings: Summit T48 -> 2ports x2, bifurcated

You must also select the type of Interposer to be used with the Summit T48 analyzer. There are two options for the Port B-D and two options for Port A-C:

- U.2 x2
- Other

You can choose U.2 x2 for Port A-B depending on your hardware configuration. As an example, if U.2 x2 was selected for Port A-B you would get the following recording configuration after click the "OK" button.

The following information message will popup. See Figure 4.36 on page 160.

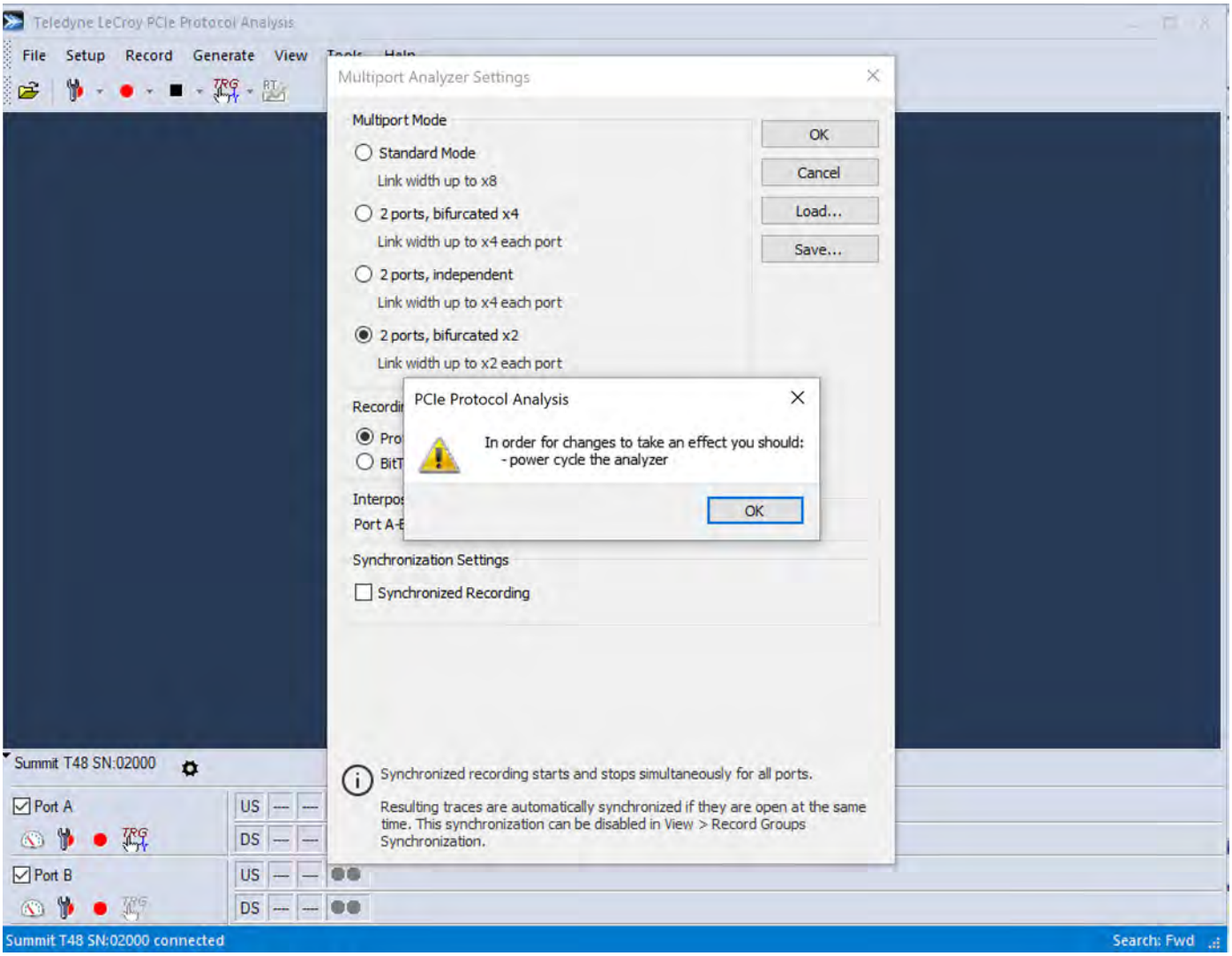


Figure 4.36: Summit T48 Power Cycle Message

After the appropriate power cycling the Summit T48 will be configured for two ports x2. See Figure 4.37 on page 161.

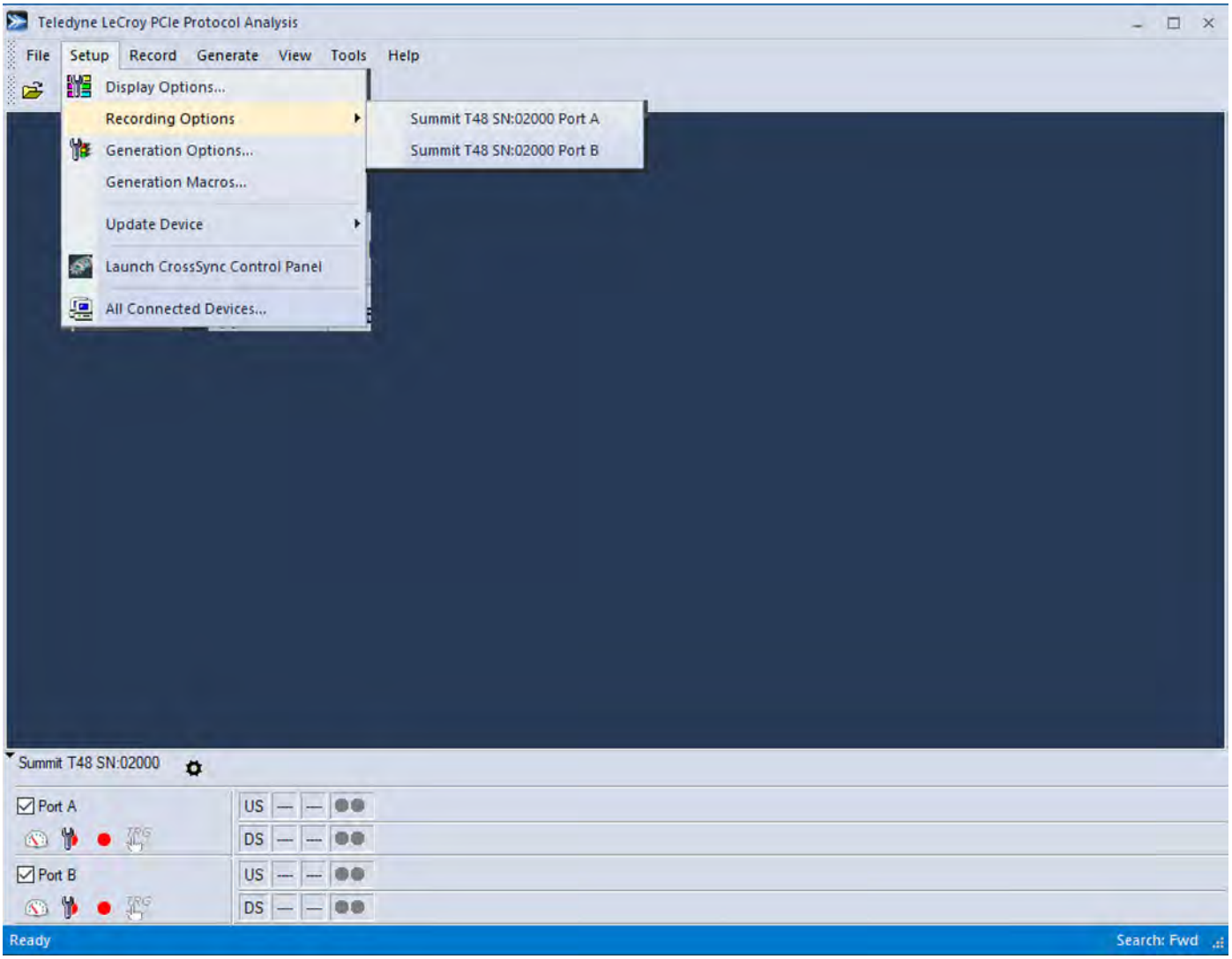


Figure 4.37: Summit T48 Configured for Two Ports x2

This configuration for Multiport Mode is discussed in more detail for the Summit T48 in “Bifurcated (2 x2 Ports) Mode using MultiPort x4 interposer” on page 76 .

4.10.8 Recording Mode

- Protocol Recording see “Protocol Recording” on page 219
- BitTracer Recording see “Bit Tracer Recording” on page 221

4.10.9 Synchronized Recording

- You can also choose to have the traces recorded to be synchronized or not. See Figure 4.38.

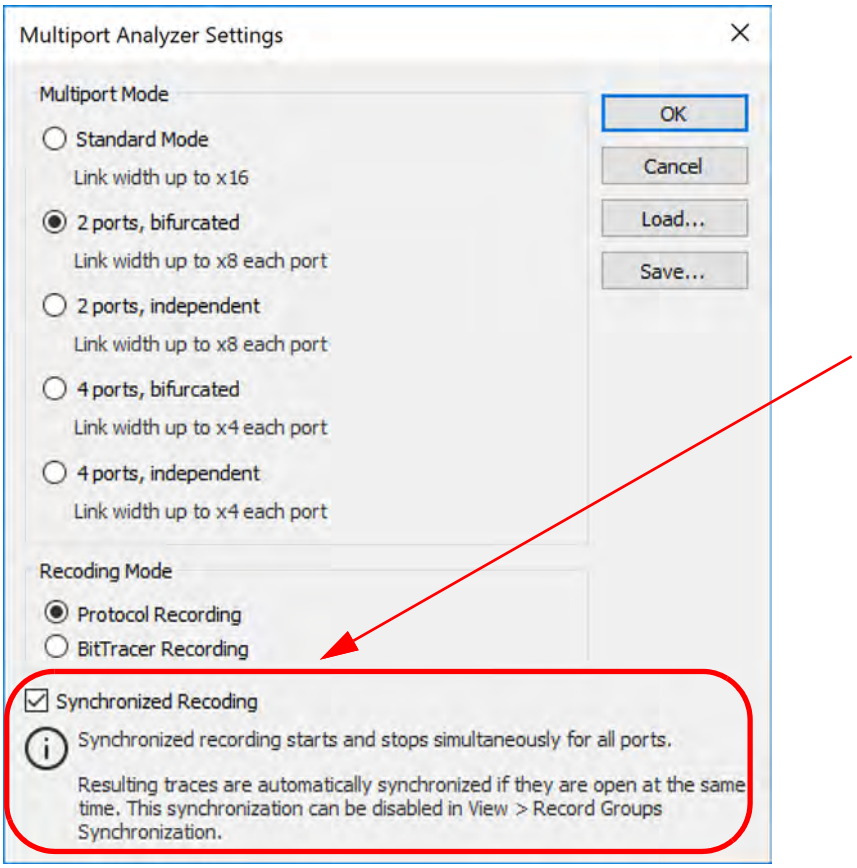


Figure 4.38: Multiport Mode Selected, Options Available: Summit T416

The Summit T48 has the same Synchronized Recording capability.

4.10.10 Multiport Analyzer Display (Synchronized vs. Non-Synchronized)

Once you have selected a configuration for the analyzer other than Standard Mode, you'll see the analyzer displayed with the configuration you have chosen. Since the ports are synchronized there is only a single button for Start Recording, Stop Recording and Manual Trigger. See Figure 4.39.

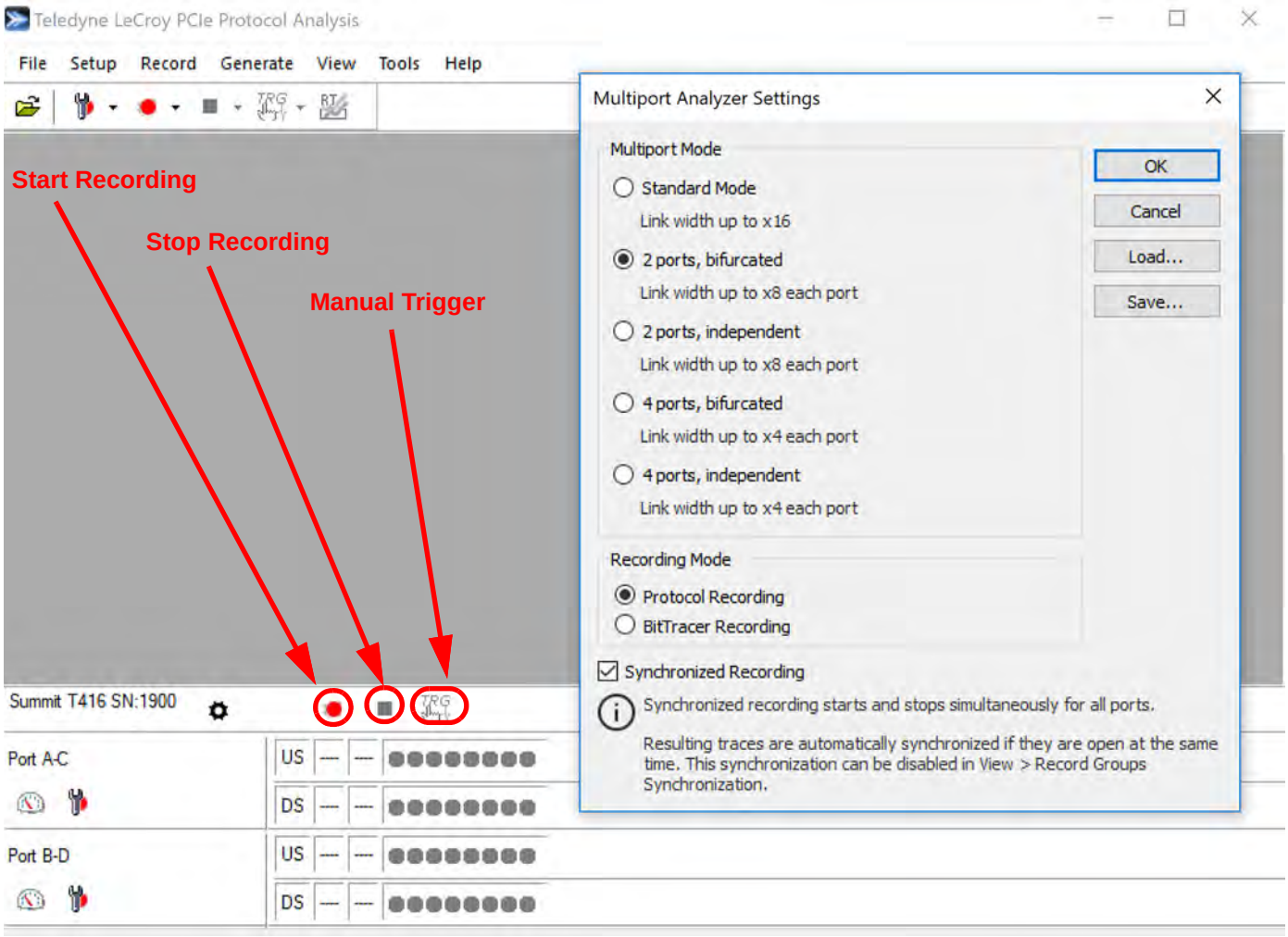


Figure 4.39: Summit T416: Configuration Selected -> Two Ports x8, Bifurcated, Synchronized

If you had not selected Synchronized the PCI Protocol Analysis dashboard would show the each port has its own Start Recording, Stop Recording and Manual Trigger buttons. See Figure 4.40.

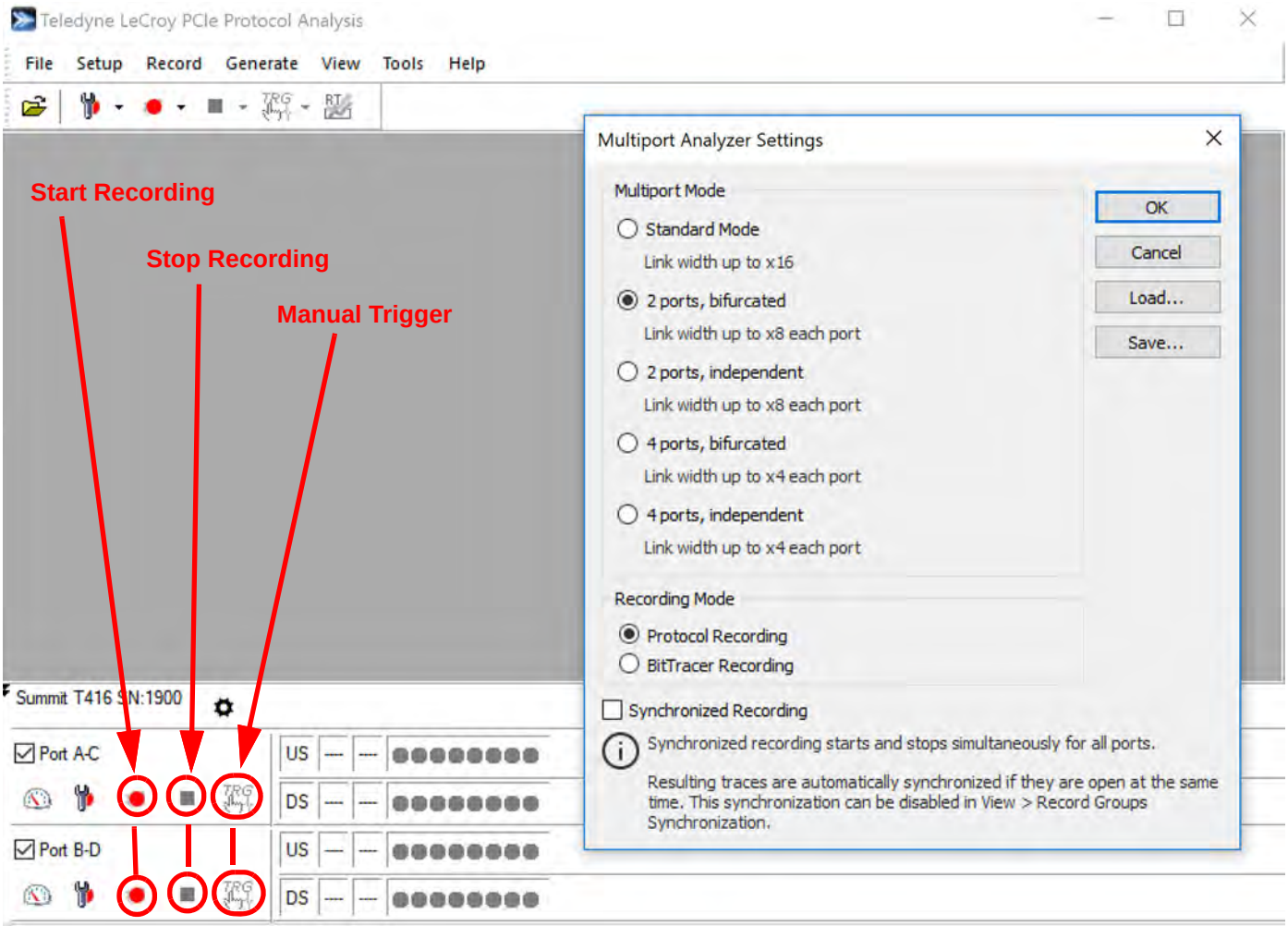


Figure 4.40: Summit T416 Configuration Selected -> Two x8 Ports, Bifurcated, Not Synchronized

The Summit T48 has the same capabilities in Multiport Mode.

Other details of recording in Multiport mode are addressed in “Recording Options” on page 185.

4.11 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.

4.11.1 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.

4.11.2 Recording Options Files

Recording Options files are created when you set recording options. These files use the **.rec** or the **.crec** extension and contain recording option information. For more information, see Chapter 5, “Saving and Loading Previously Saved Recording Options,” on page 206.

4.11.3 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.

4.12 Saving CATC Trace Files

4.12.1 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 4.41 on page 166).

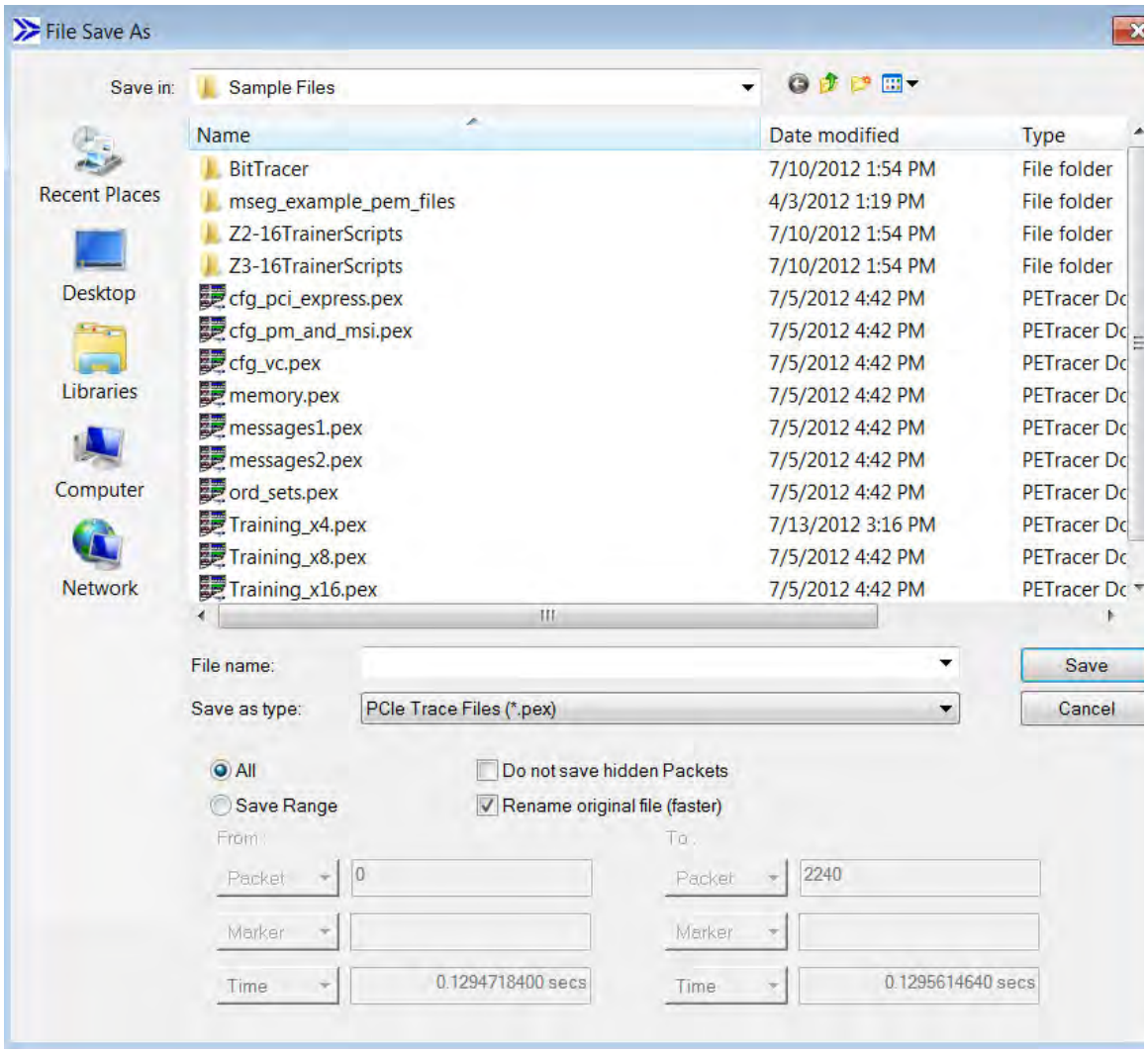


Figure 4.41: File Save As Dialog

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.

4.12.2 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.

4.12.3 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 4.42.

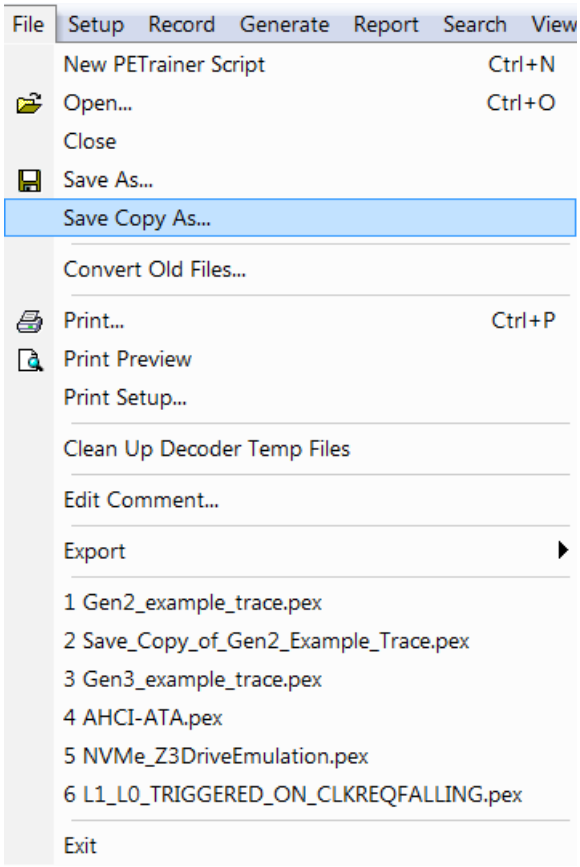


Figure 4.42: File -> Save Copy As Function

Select Save Copy As and the following dialog will pop up and you can enter a unique file name (see Figure 4.43 on page 168).

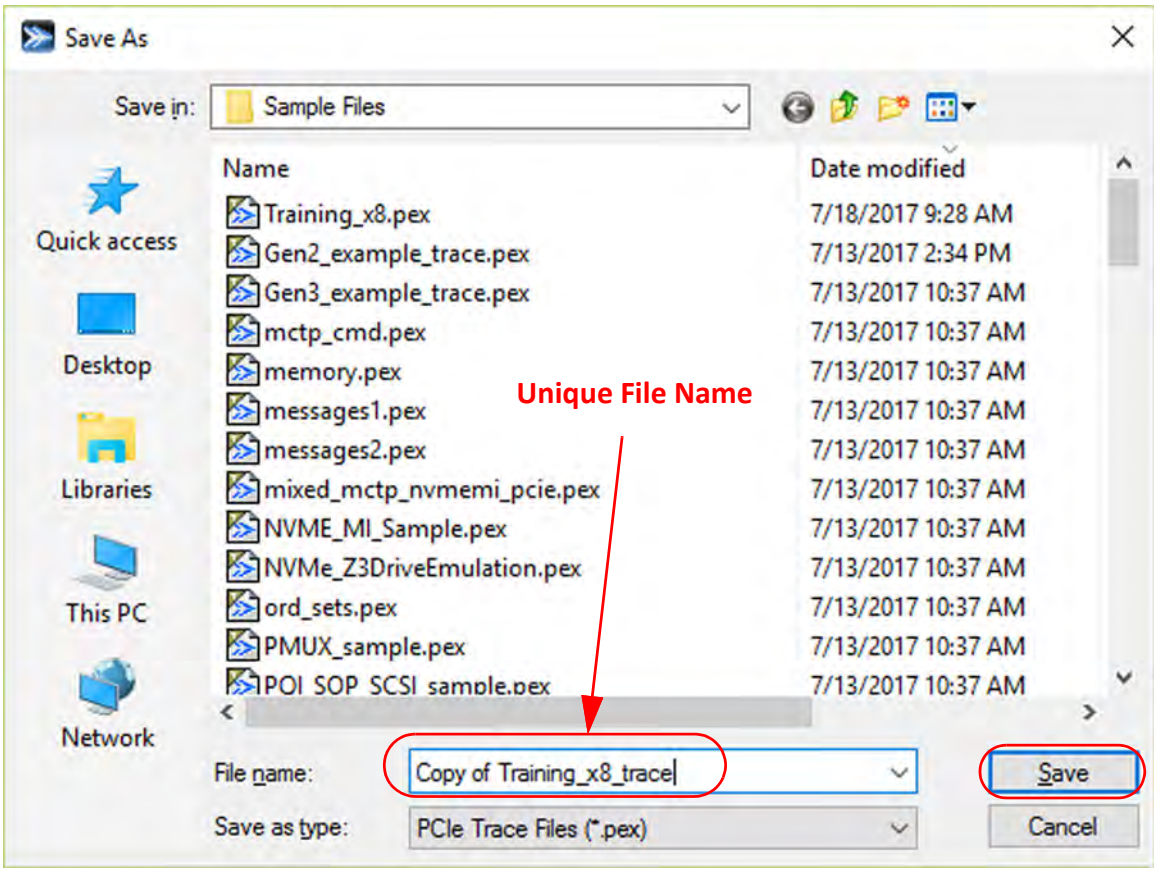


Figure 4.43: Save As Copy Dialog (Sample File Directory Before Save)

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 4.44.

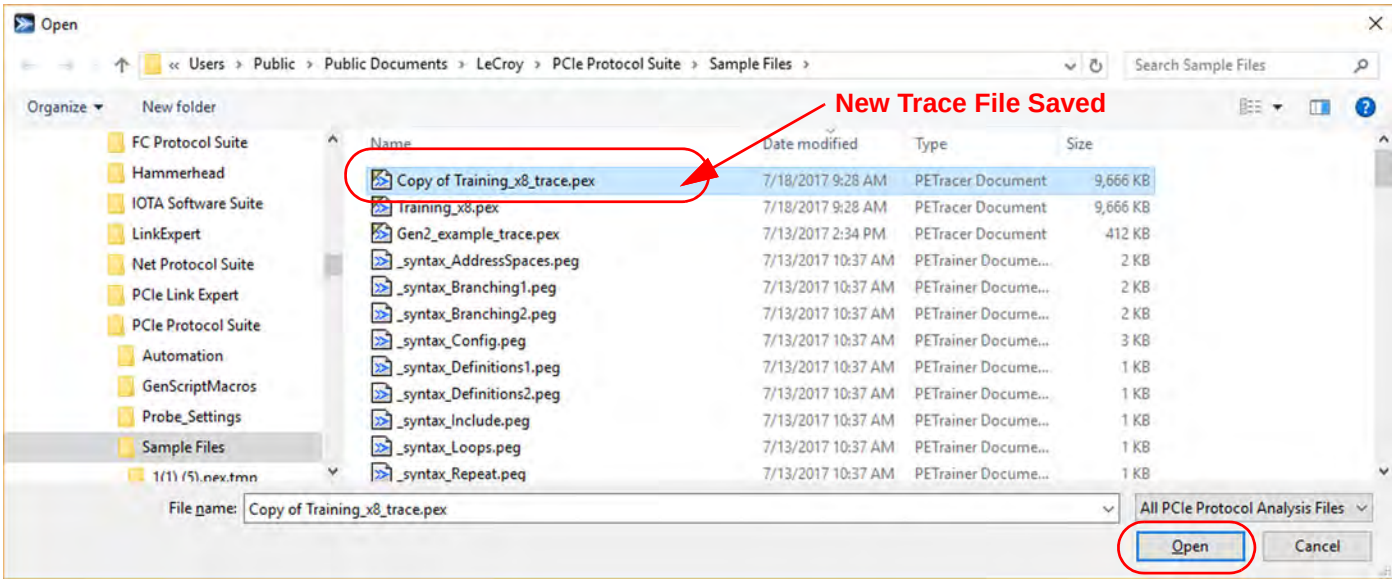


Figure 4.44: File -> Open: New Trace File Available

4.12.4 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.

4.13 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**.

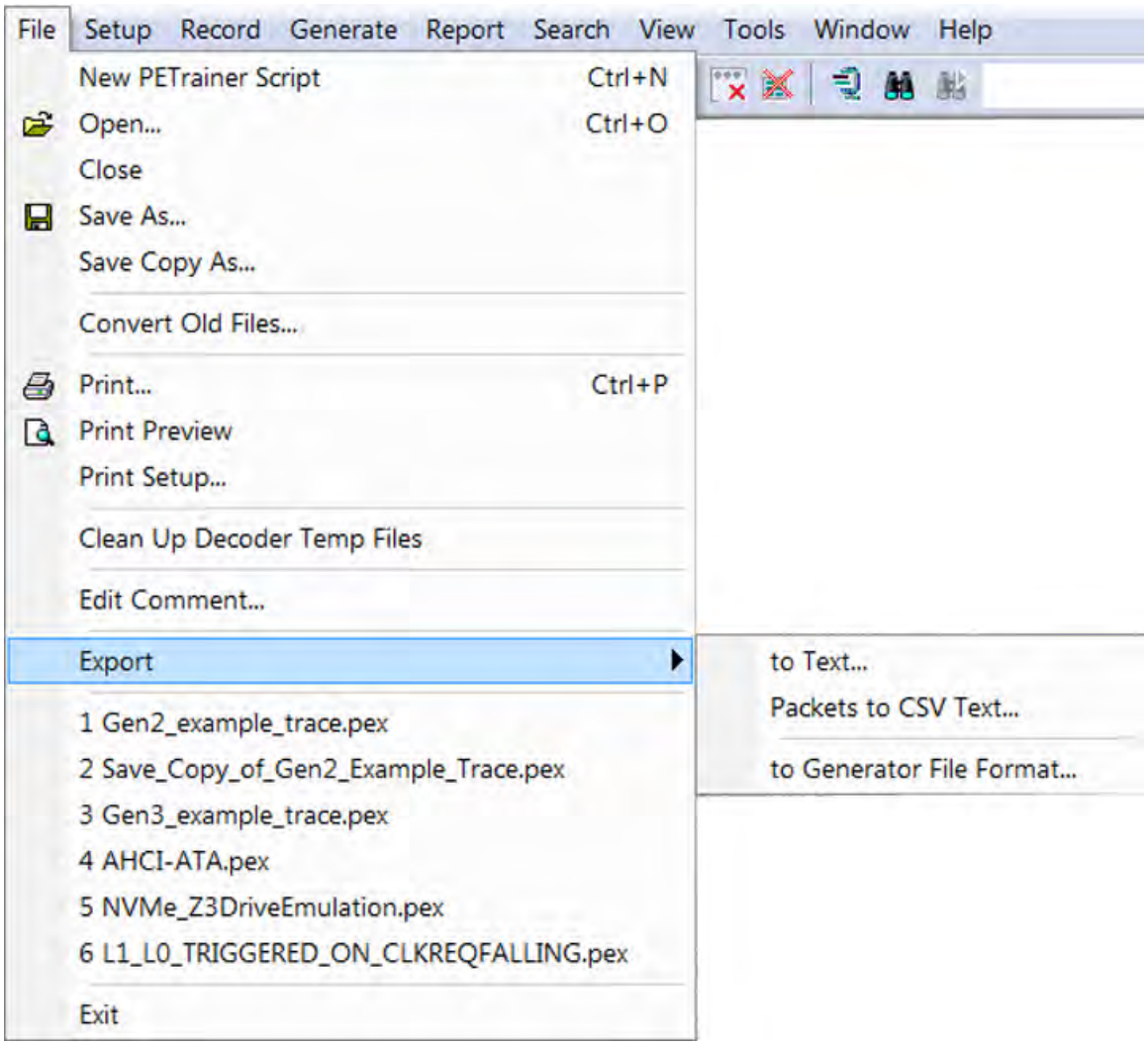


Figure 4.45: Exporting a File

4.13.1 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 4.46) or to use the newer default format. See Figure 4.48 on page 172.

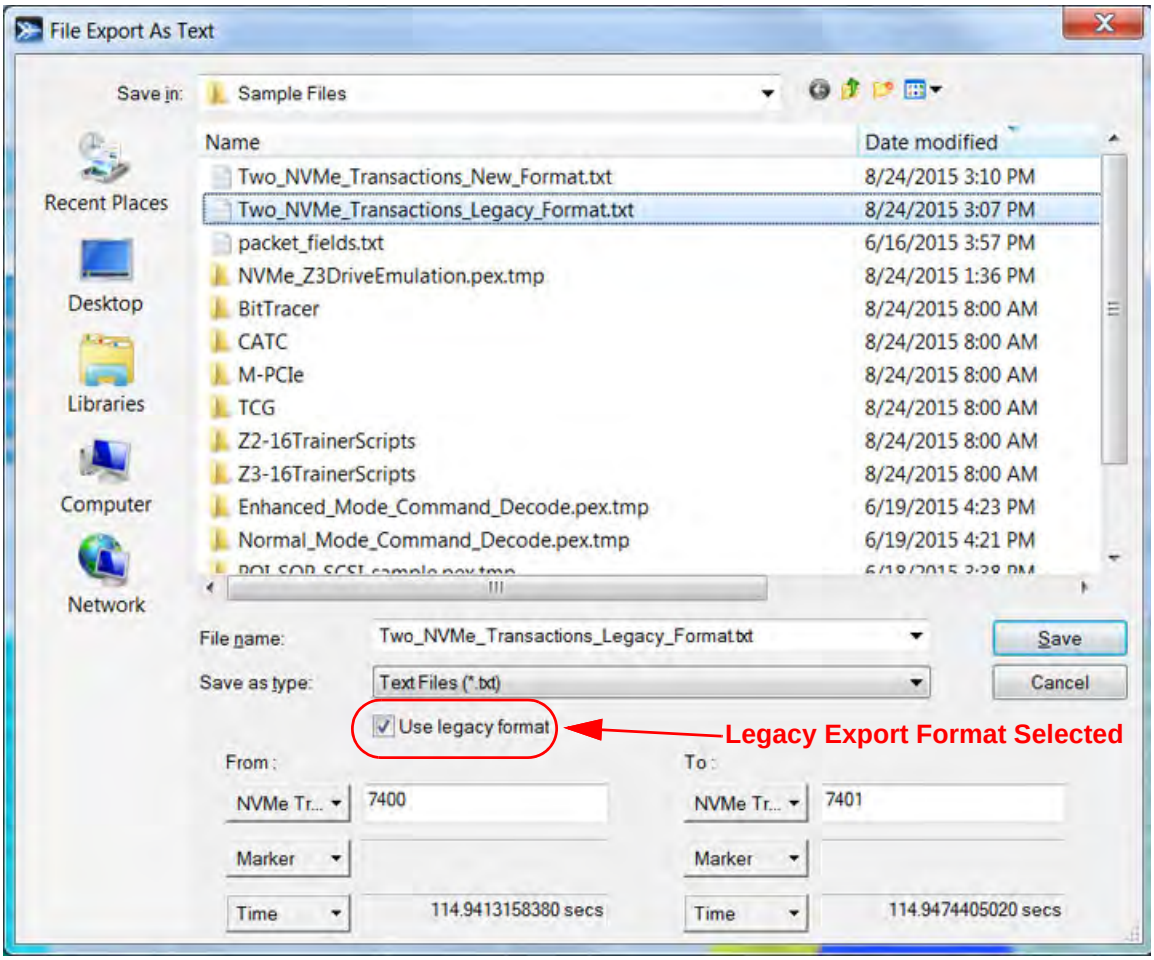


Figure 4.46: Export Two NVMe Transactions to Text File, Legacy Format

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 4.47) , Markers or Time see Figure 4.48 on page 172.

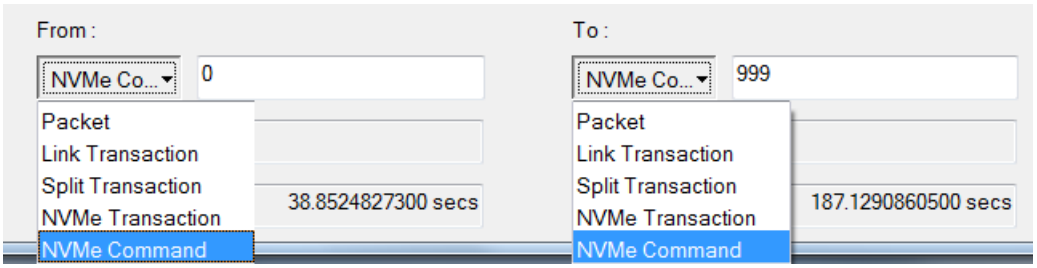


Figure 4.47: From and To Delimiters

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

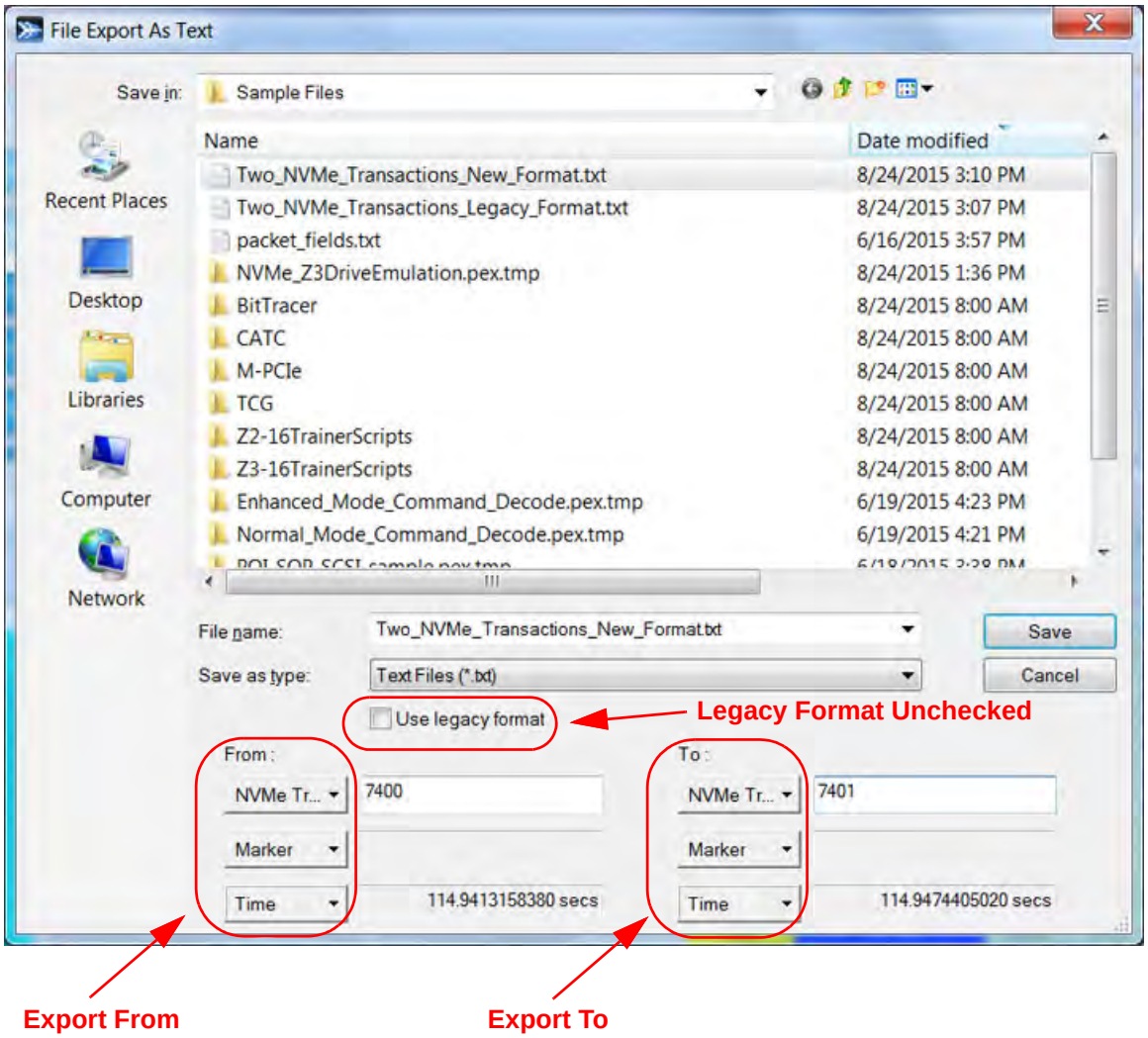


Figure 4.48: Export Two NVMe Transactions to Text File, New Format

You can see the differences in the two file formats below:

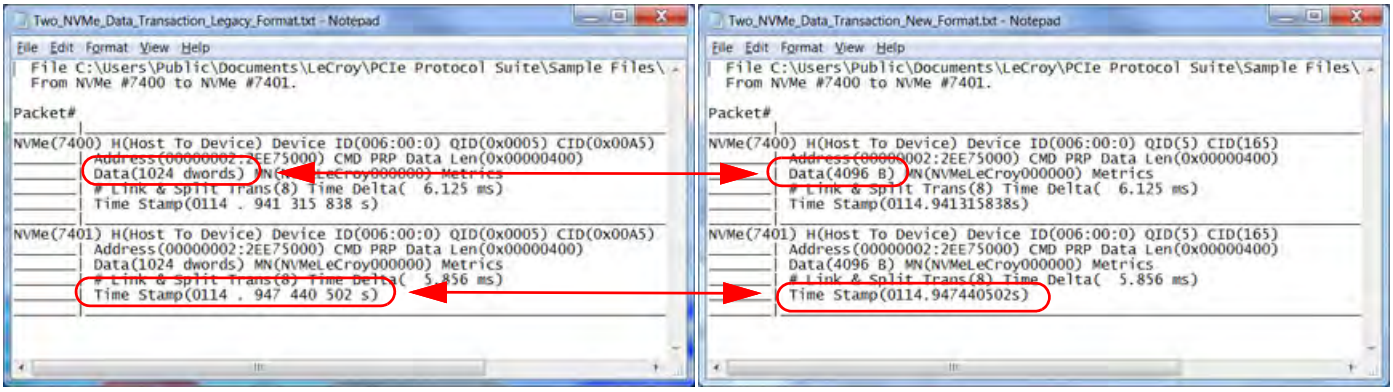


Figure 4.49: Export Trace Data to Text: Legacy vs New Format

4.13.2 Export: Packets to CSV Text

Now we'll Export Packets to CSV text using the legacy format, see Figure 4.50.

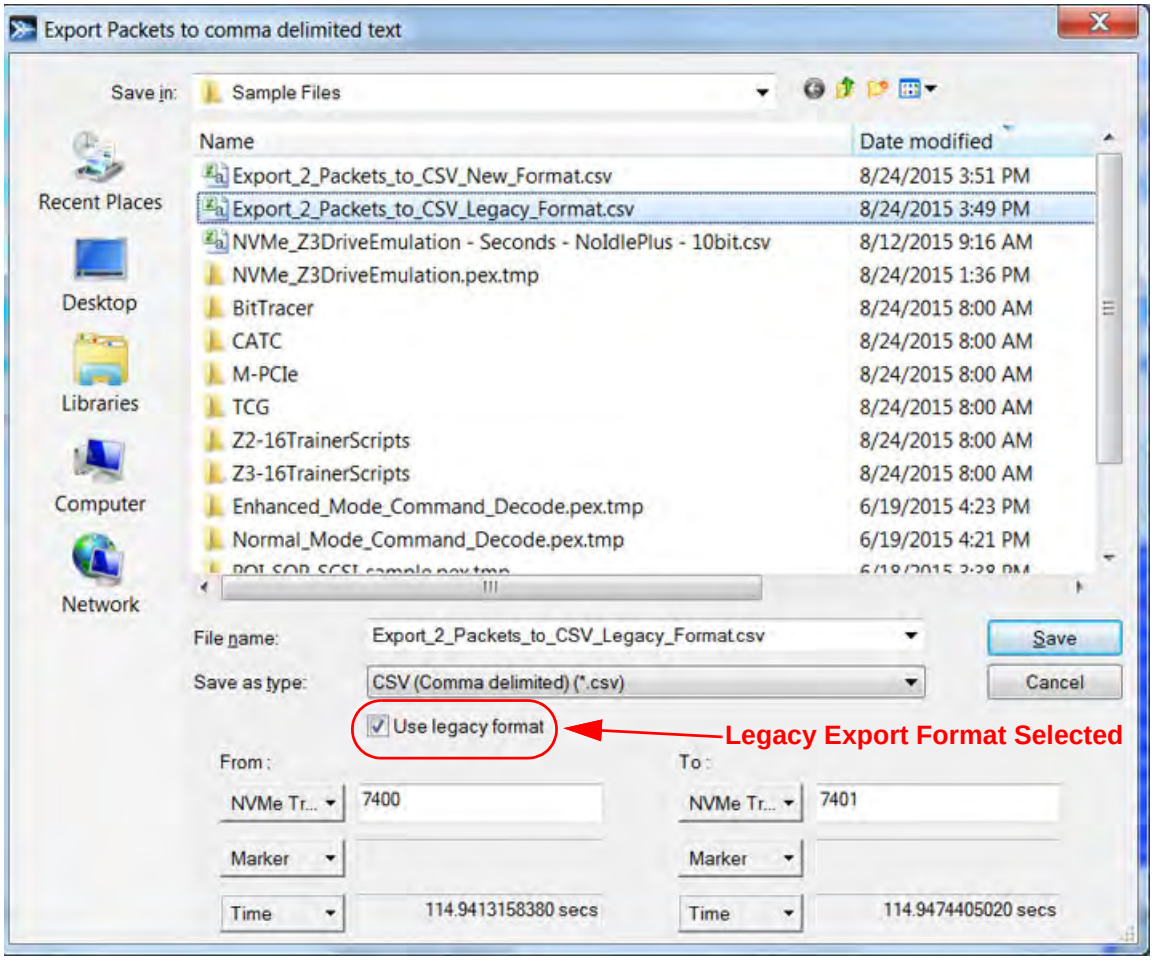


Figure 4.50: Export Packets to Comma Delimited Text: Legacy Format

Or we can export Packets to CSV text using the new format, see Figure 4.51.

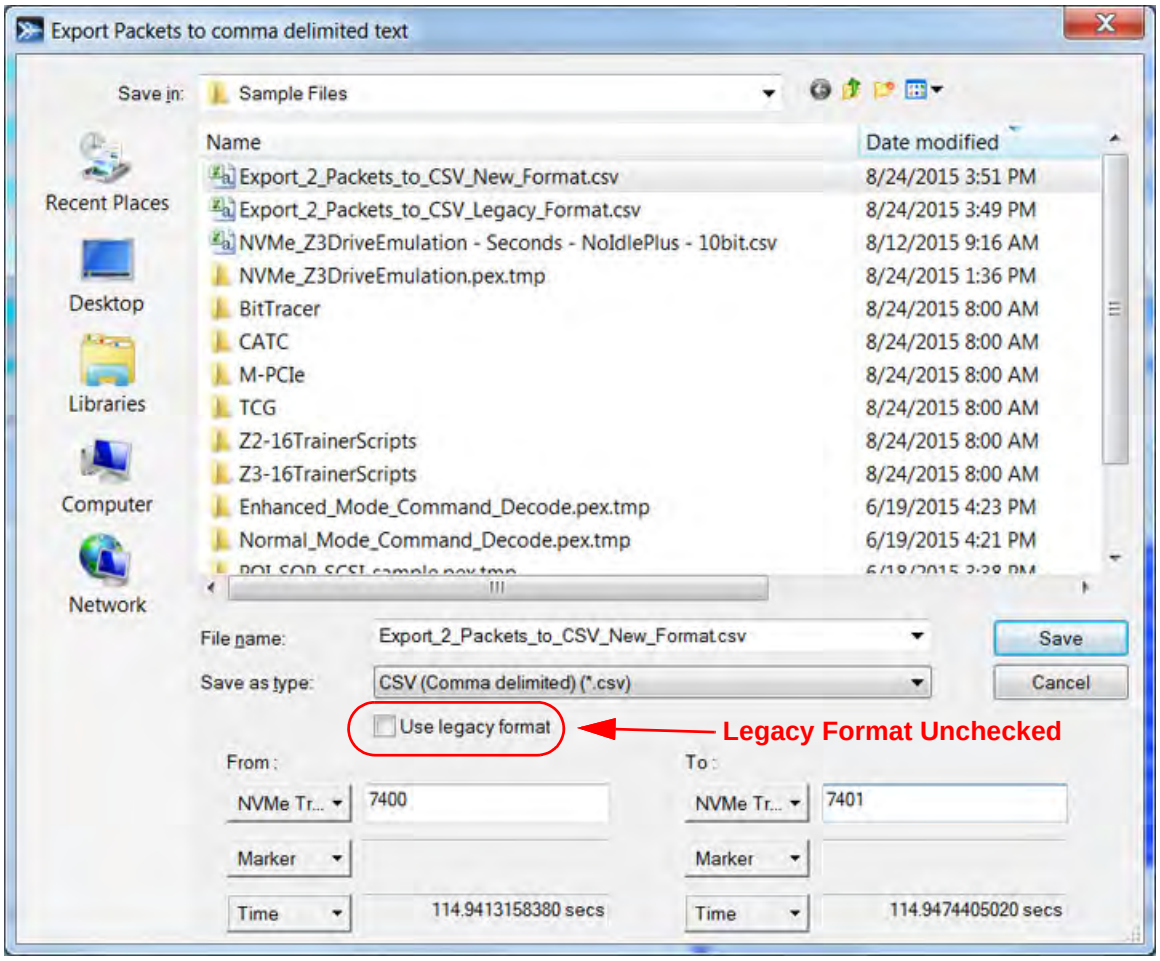


Figure 4.51: Export Packets to Comma Delimited Text: New Format

The differences in the two files can be seen in Figure 4.52.

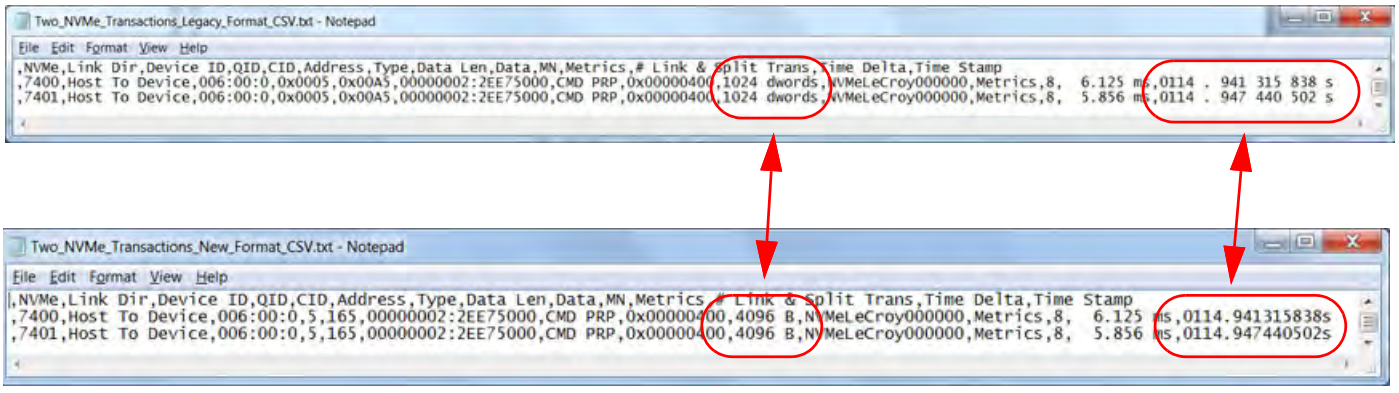


Figure 4.52: Export Packets to CSV Text: Legacy vs New Format

4.13.3 Export: To Generator File Format

To export a Trace File to Generator File format, choose that option. See Figure 4.53

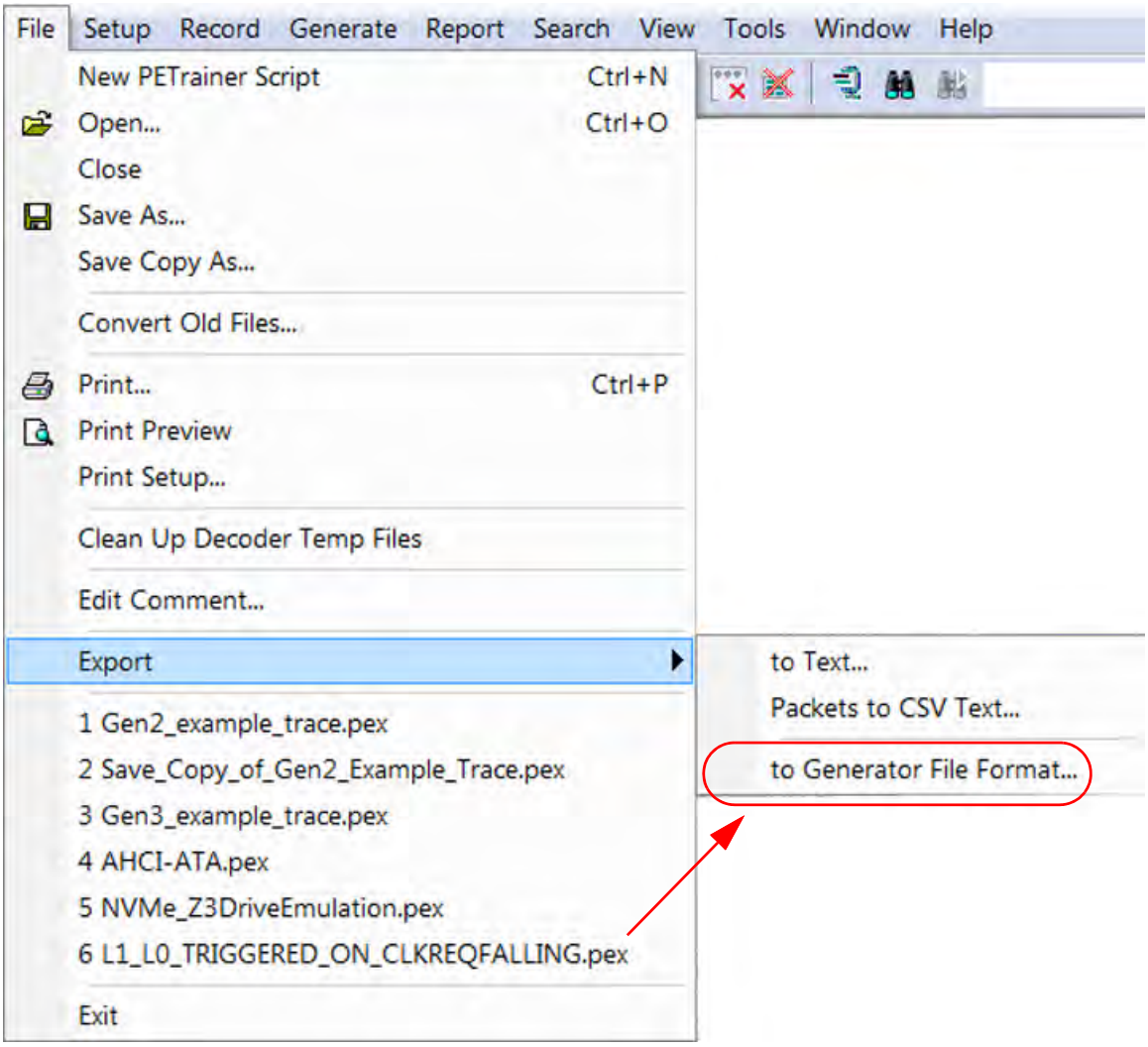


Figure 4.53: Export to Generator File Format

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. Z3-16) to generate data traffic to test a device.

4.13.3.1 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 4.54 on page 176.

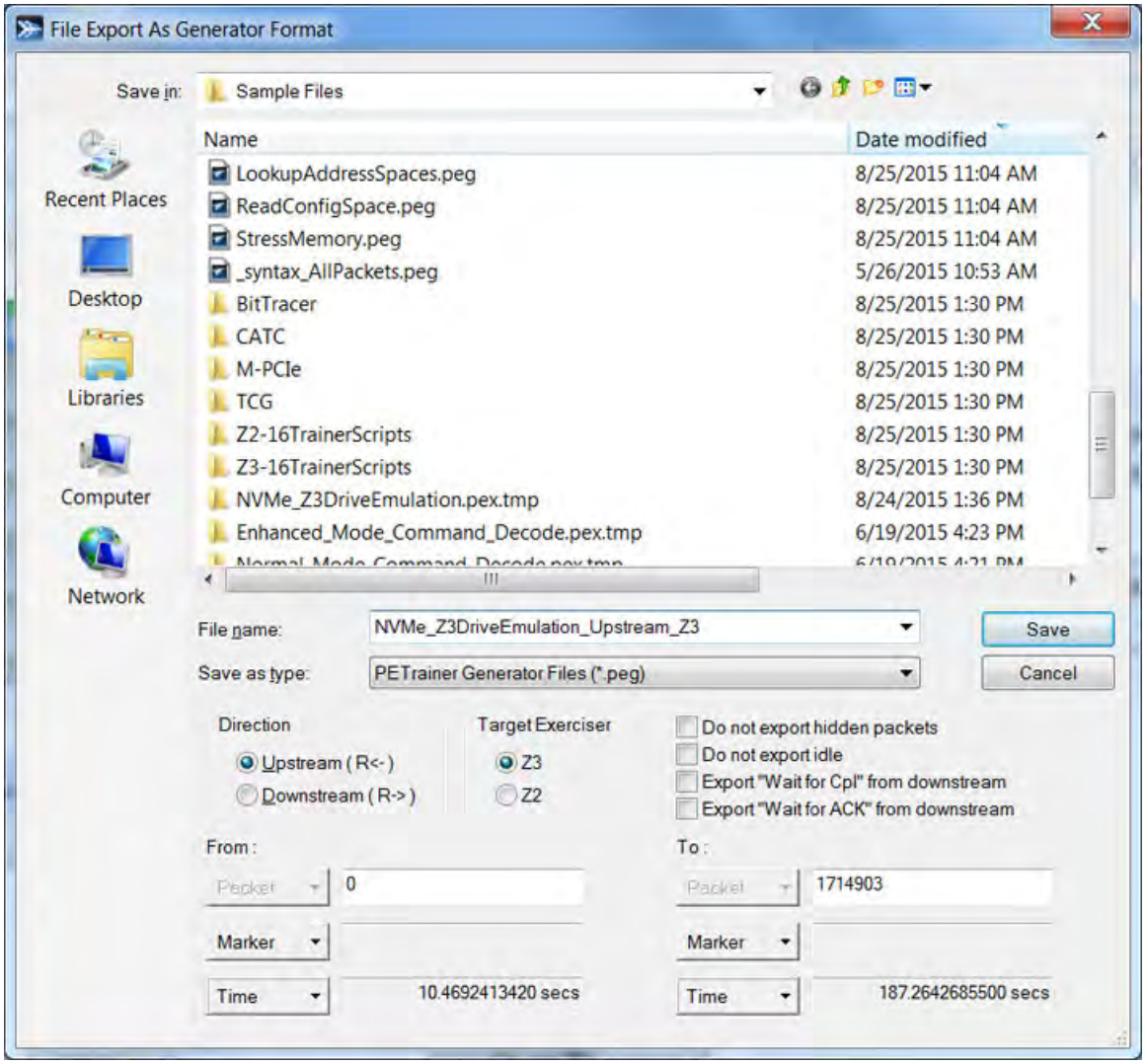


Figure 4.54: File Export As Generator Format Dialog.

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 (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.

4.13.4 Export From Data Flow View

You can also Export Trace Data from the Data Flow view (see Figure 4.55, Figure 4.56 on page 179 and Figure 4.57 on page 180) in either the Legacy or New data format.

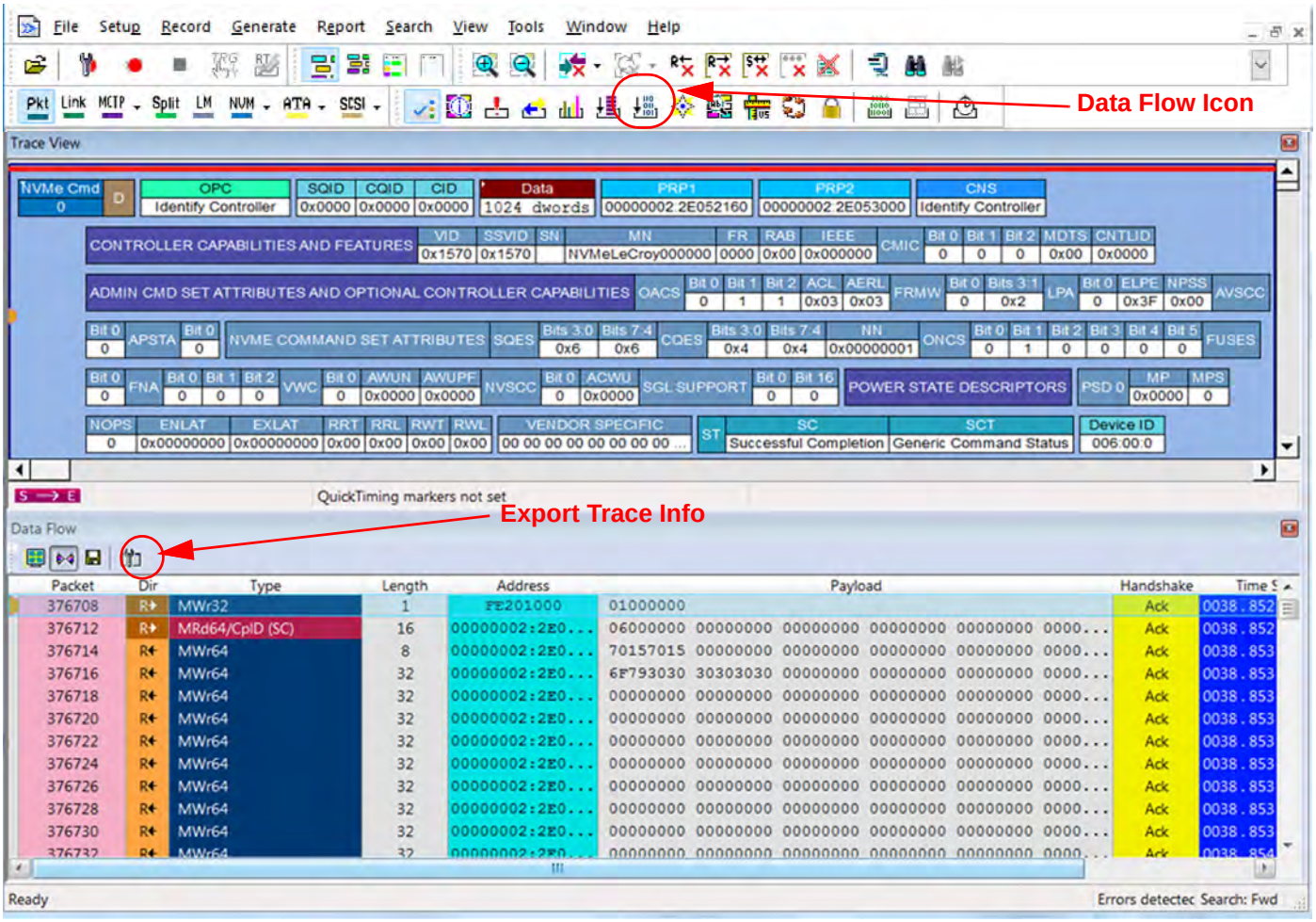


Figure 4.55: Data Flow View: Export by Selecting Save Icon

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 4.56.

4.13.4.1 Data Flow CSV File: Legacy Format

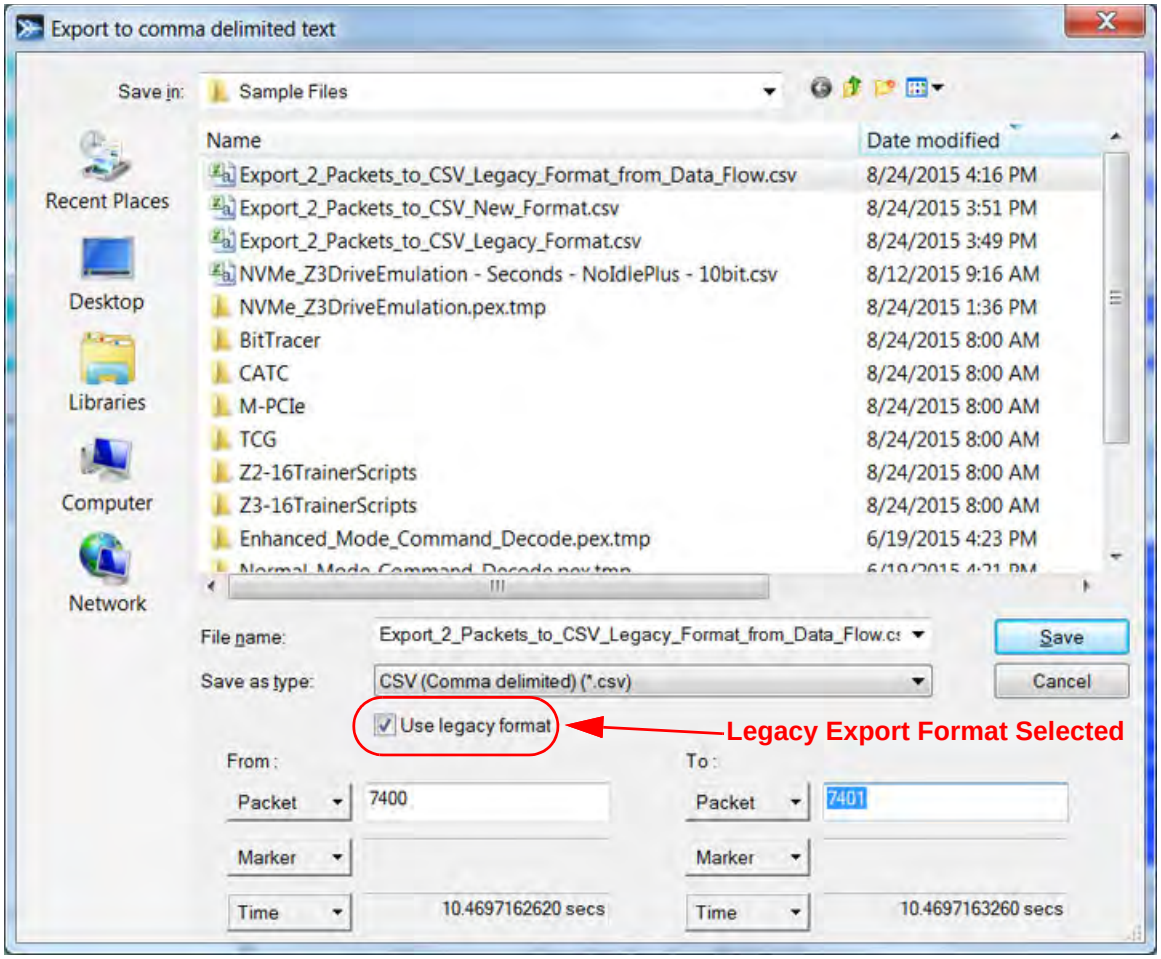


Figure 4.56: Data Flow View: Export Packets to Comma Delimited Text: Legacy Format

4.13.4.2 Data Flow CSV File: New Format

Next we'll chose the New Data format for the CSV file. See Figure 4.57.

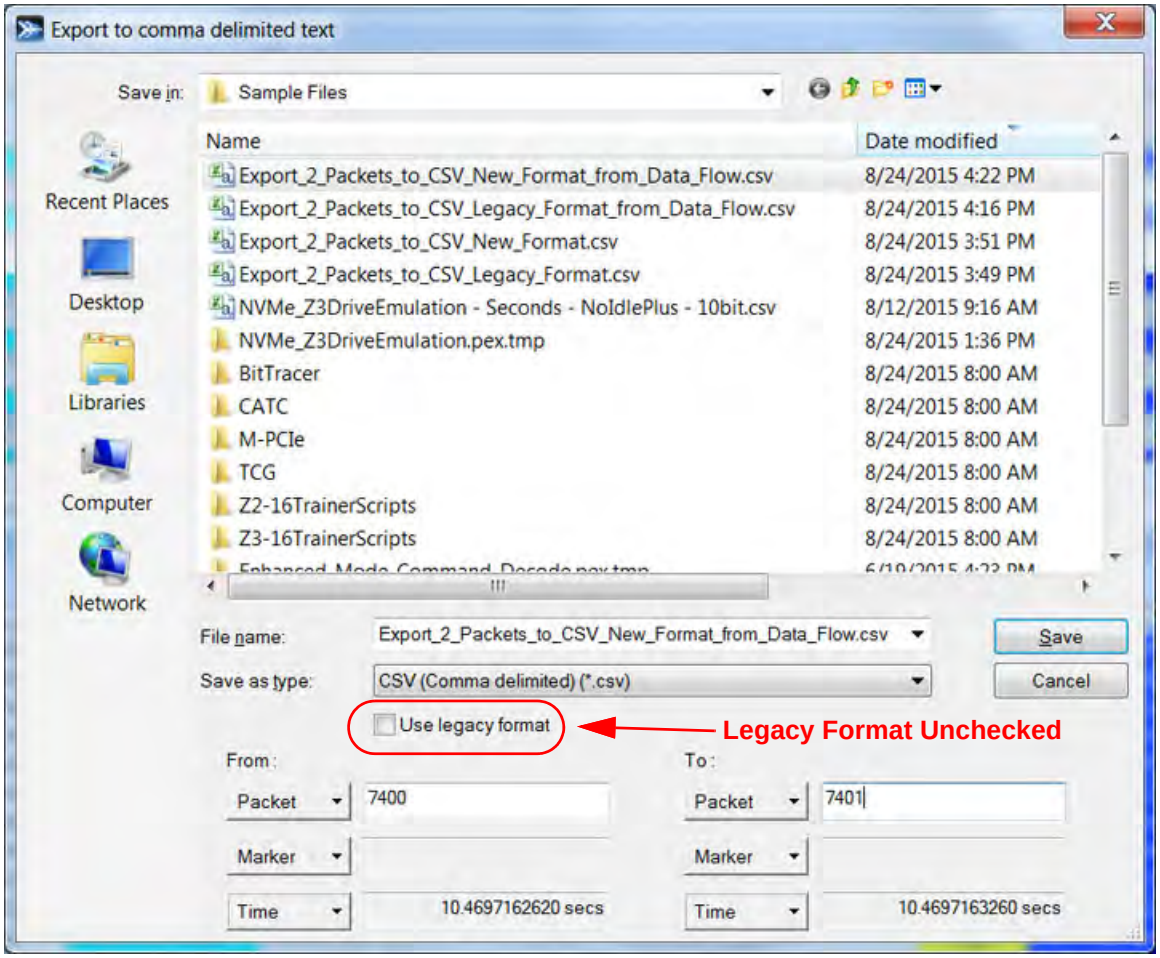


Figure 4.57: Data Flow View: Export Packets to Comma Delimited Text: New Format

4.14 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 4.58 on page 181).

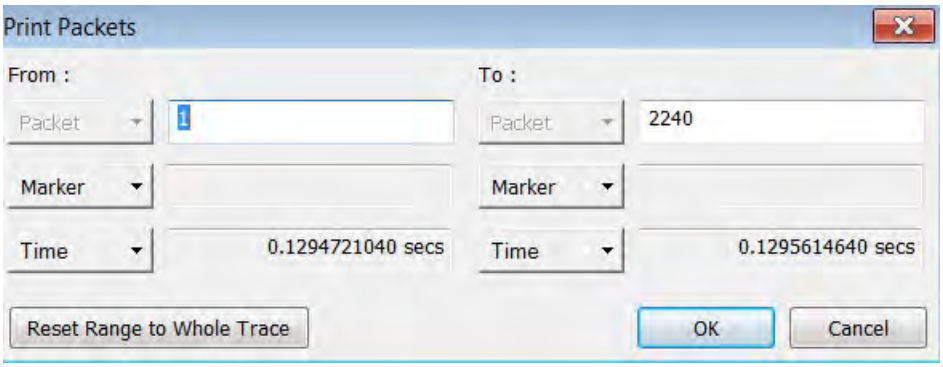


Figure 4.58: Print Packets Dialog

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.

4.15 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 4.59 on page 182.

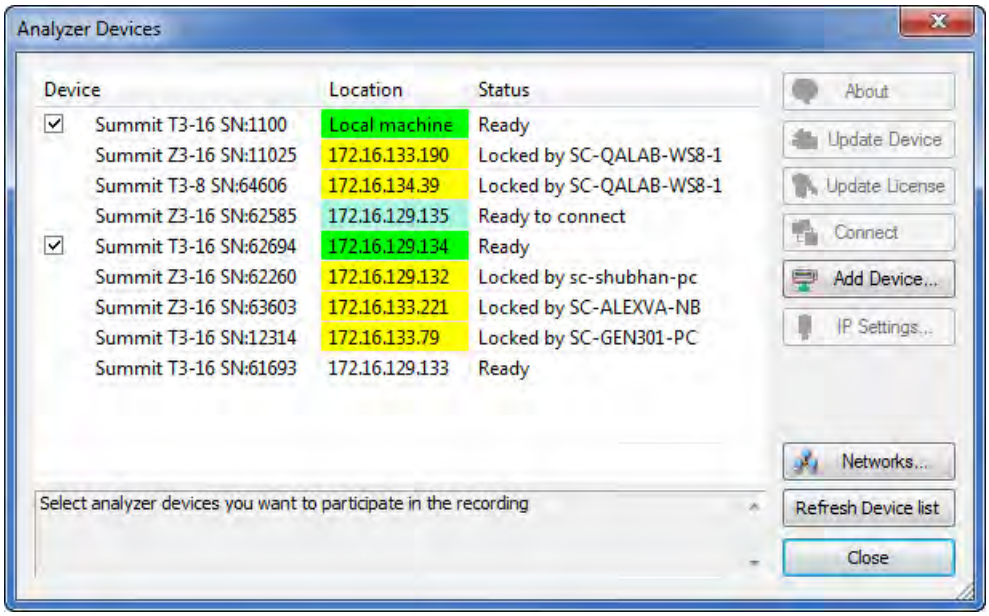


Figure 4.59: Analyzer Network Dialog

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.

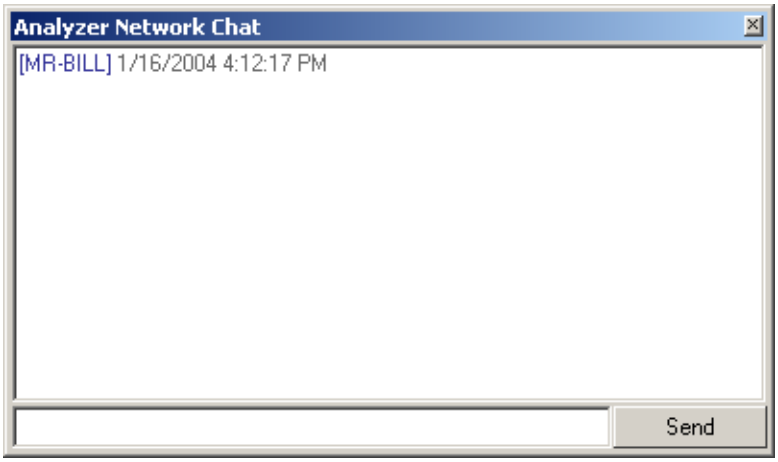


Figure 4.60: Analyzer Network Chat Dialog

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.

4.15.1 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.

4.15.1.1 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.

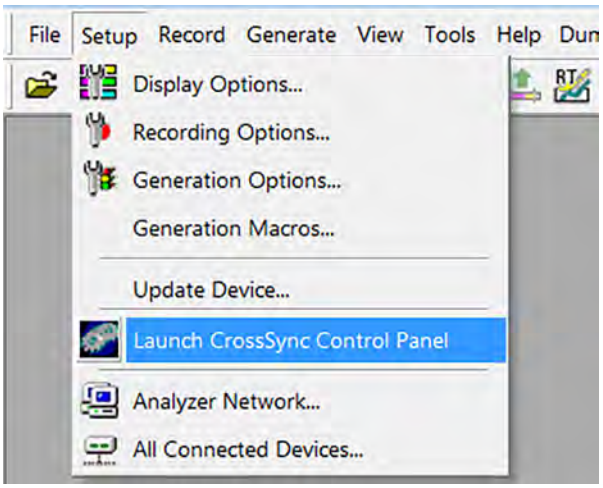


Figure 4.61: Launching CrossSync from the PCIe Protocol Analysis Application

Please refer to the *CrossSync Control Panel User Manual* for more information.

Chapter 5

Recording Options

5.1 Recording Overview

After installing the software, recording options should be set prior to recording. The recording options define the behavior of the Summit T416 during recording. You can create, save and load previously saved recordings. This section explains how to define recording options on the Summit T416 or Summit T48 Analyzer.

5.2 General Tab

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 tab of the Recording Options.

The General tab displays options that affect all recordings (Figure 5.1 on page 187).

5.3 Recording Options: General Tab

This section describes the General Tab recording options.

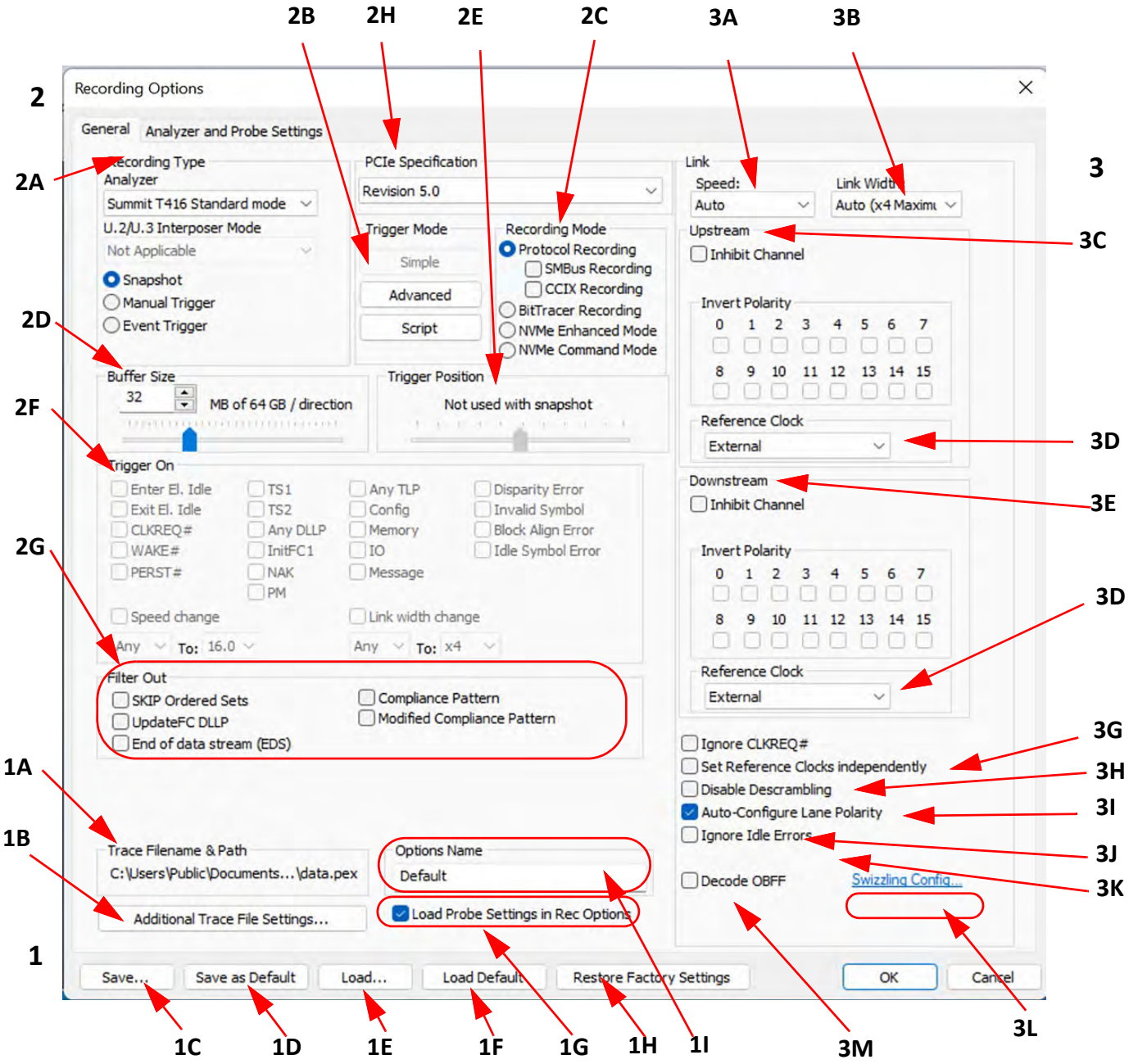


Figure 5.1: Summit T416 in Simple Recording Options

Note: Please refer to the figure callout numbers in each of the sections below to co-relate to Figure 5.1 shown above. For instance, for Simple and Advanced Mode, see Figure 5.1: 2B.

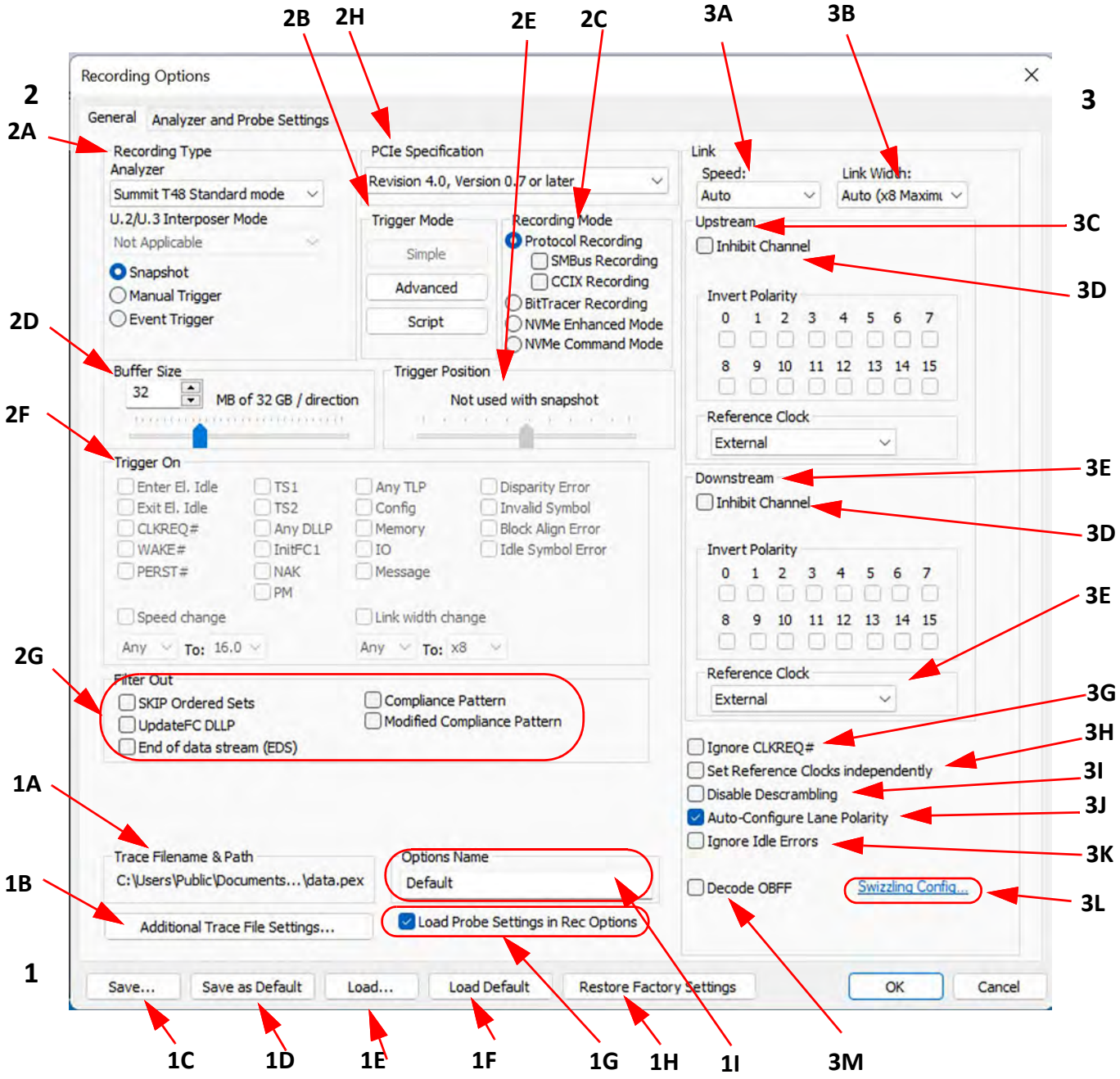


Figure 5.2: Summit T48 in Simple Recording Options

Note: For the T416 Recording Options refer to Figure 5.1 on page 187. For the T48 Recording Options refer to Figure 5.2 on page 188. In the following section with detailed explanations always refer to Figure 5.1 on page 187 for the T416 and refer to Figure 5.2 on page 188 for the T48.

5.4 Recording Type: Analyzer / Interposer / Mode

The recording type options available on each analyzer are different. As shown in Figure 5.1 on page 187 the Summit T416 Analyzer is detected and the recording options available for it are displayed (See Figure 5.1 on page 187: 2A).

When the analyzer is not yet detected, you can choose the analyzer from the drop-down menu which displays the following:

- **Summit T416:** Displays the options for the Summit T416 Analyzer.
- **Summit T48** (2 Units): Displays the same options as Summit T48 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. See "Link Width Expansion using Two Summit T48 Analyzers" on page 825.
- **Summit T48:** Displays the options for the Summit T48 Analyzer.
- **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 Z416:** Displays the options for the analyzer portion of the Z416.
- **Summit T28**: Displays the options for the Summit T28 Analyzer.
- **Summit T24**: Displays the options for the Summit T24 Analyzer.

5.4.1 Selecting Multiport Mode before setting Recording Options

If you have selected Multiport Mode before you select the Recording Options, when you select the Recording Options tab the Multiport mode you selected will be displayed. See Figure 5.3 on page 190.

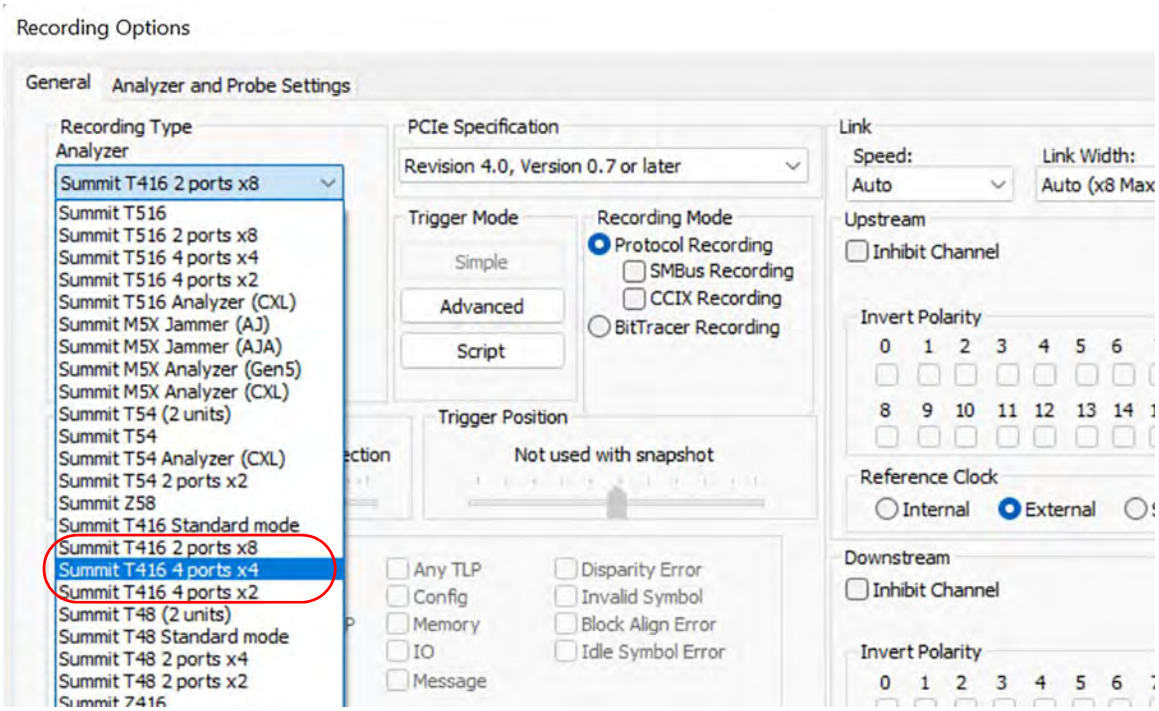


Figure 5.3: Recording Options in Multiport Recording

If you select the Summit T416 in 2 port mode each port will automatically update the Recording Option to a maximum of Link Width x8. The Link Width for the Summit T416 in 2 port mode has been automatically updated. See Figure 5.4 on page 191.

If you select the Summit T416 in 4 port mode you can chose the Link Width x4 or x2.

Similar options are available with the Summit T48.

In Multiport Mode, you are limited to a single clock mode for both Upstream and Downstream. The definitions for Internal, External and SMA are described in more detail in section “Reference Clock” on page 230.

Note: In MultiPort mode, SMA trigger out is disabled.

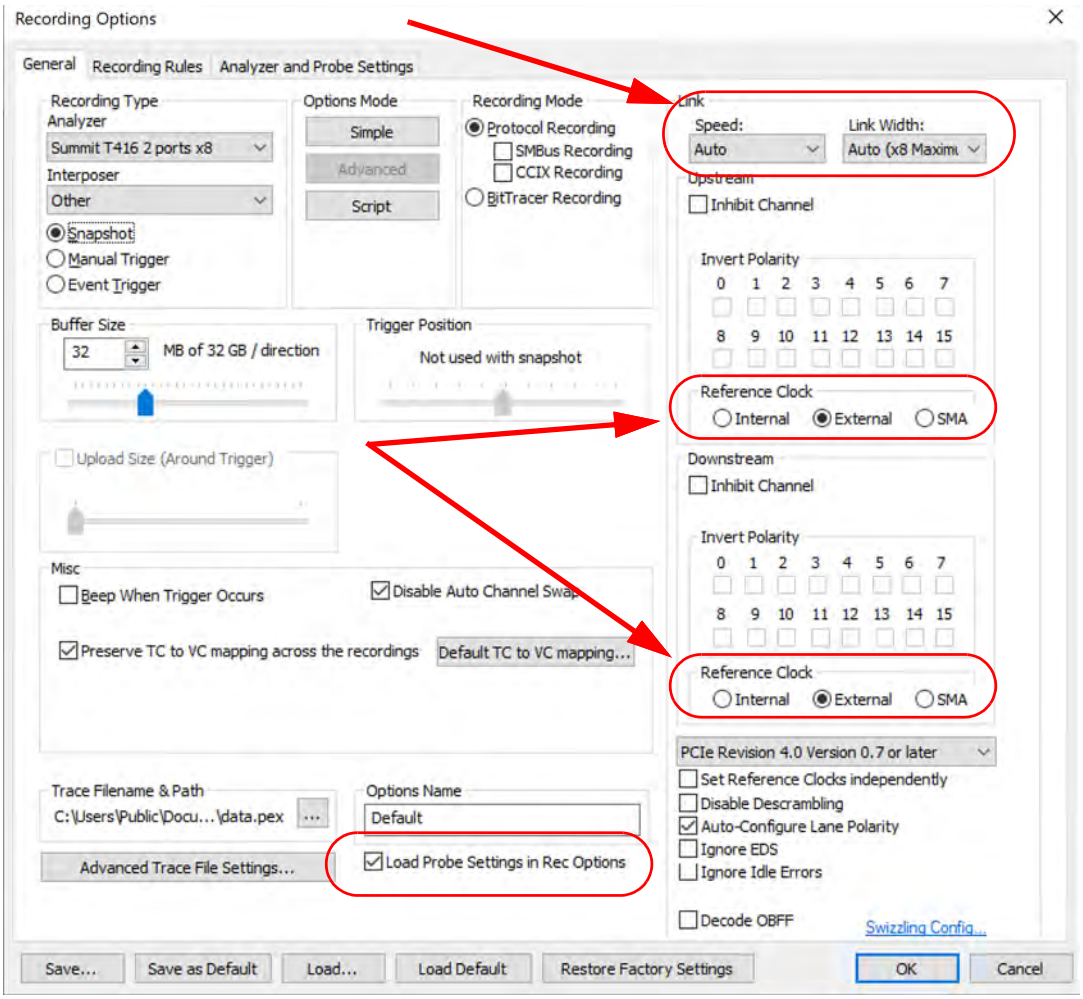


Figure 5.4: Recording Options: Link Width set to maximum of x8

The T48 responds in a similar fashion only the Link Width is different.

5.4.2 Recording Type: Interposer

You must select the type of Interposer in the system you are analyzing see Figure 5.5.

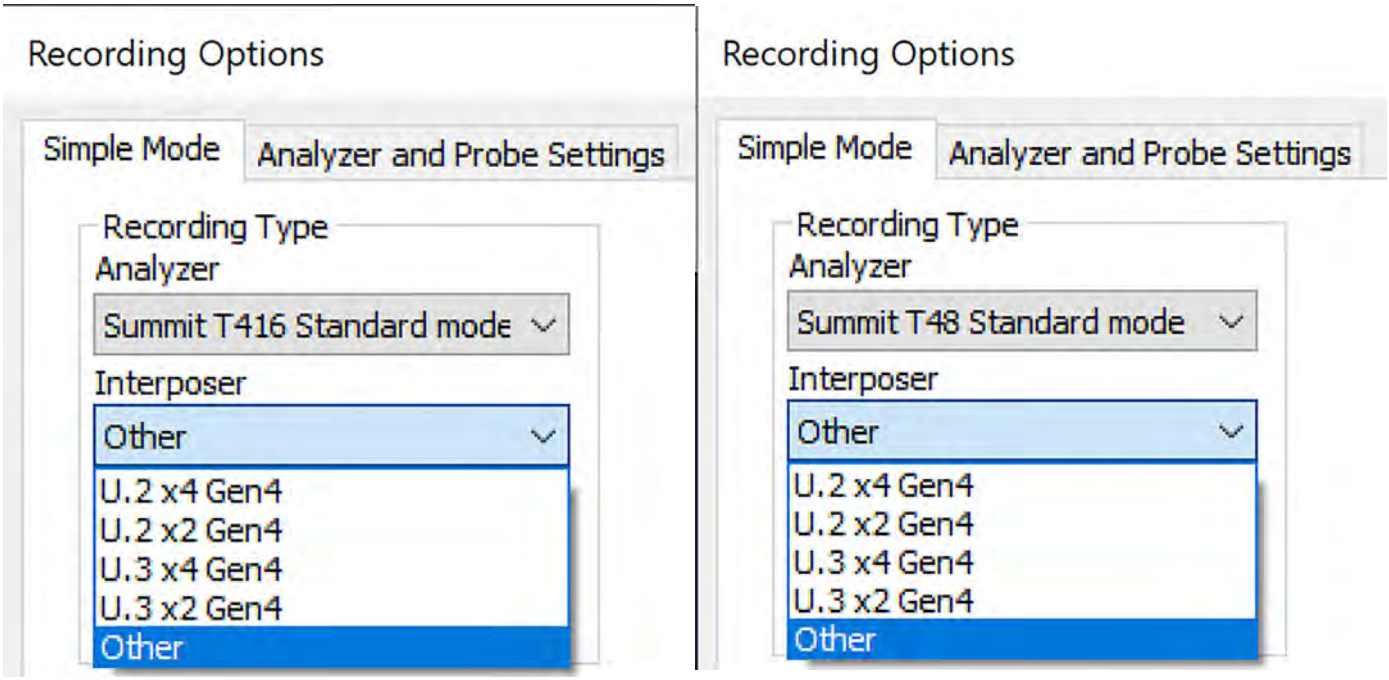


Figure 5.5: Select Interposer Type: T416/T48 -> U.2/U.3 or Other

If you select a U.2 or U.3 Interposer the following message will pop up about Saving Settings to Flash before Power Cycling (see Figure 5.6).

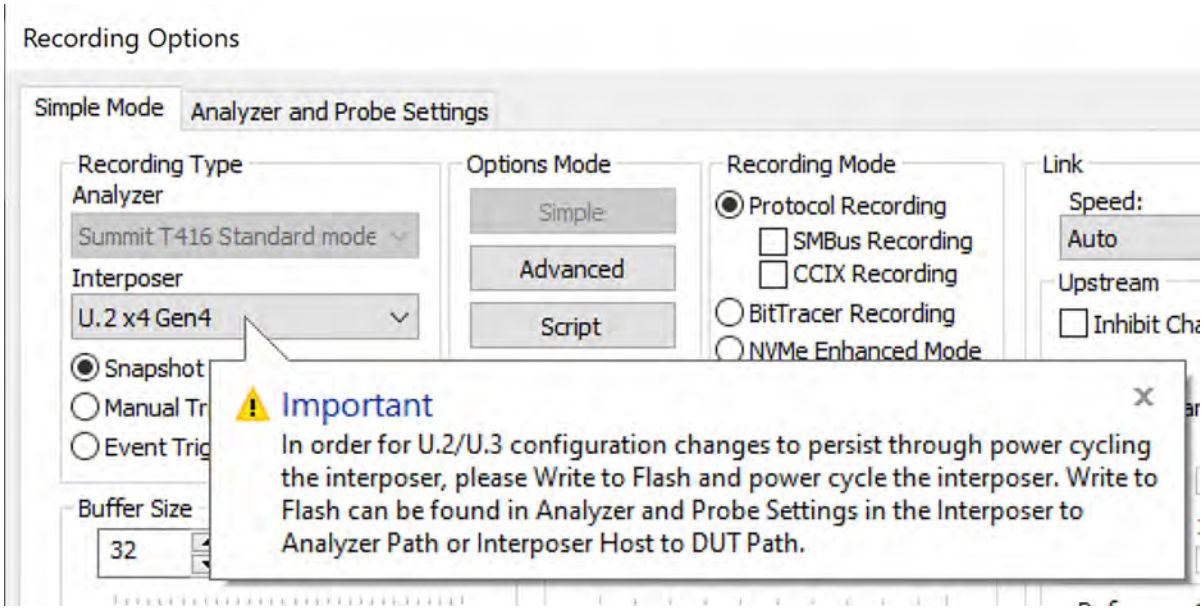


Figure 5.6: Information Message after selecting U.2 or U.3 Interposers

The Write to Flash option can be found in the “Interposer Host to DUT Path” on page 342 section or in the “Interposer to Analyzer Path” on page 376 section.

Swizzling Configuration

If you had previously chosen an interposer that did not need the physical lanes and logical lanes to be swizzled, you would get the following screen when you select the “Swizzling Config...” link. See Figure 5.7.

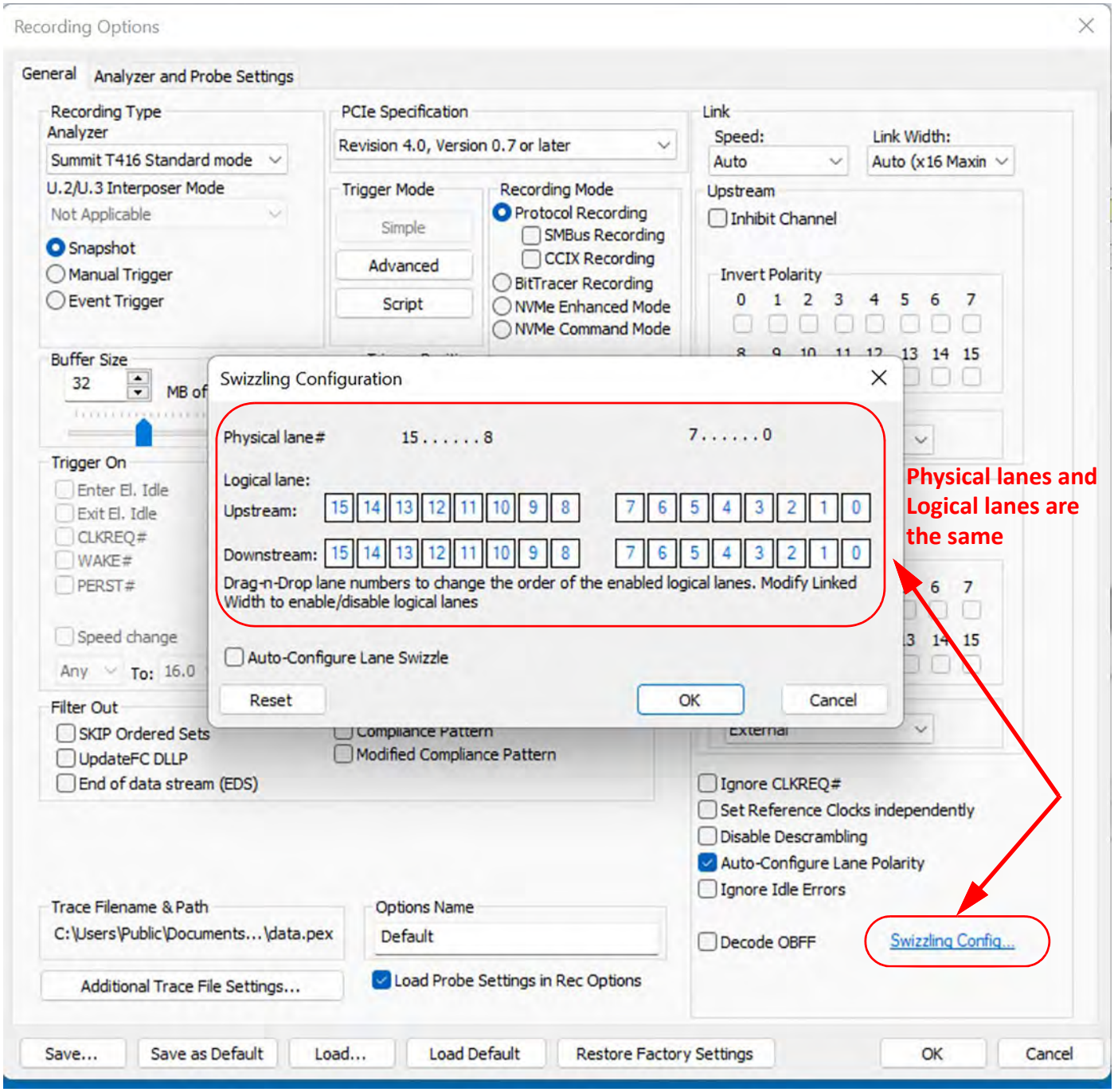


Figure 5.7: Physical Lanes and Logical Lanes are the same

But if the physical lanes and the logical lanes are different, the analyzer needs to be told that. For example, if you selected the U.3 Dual Port Gen4, the following warning messages will appear.

See Figure 5.8, Figure 5.9 and Figure 5.10 on page 195.

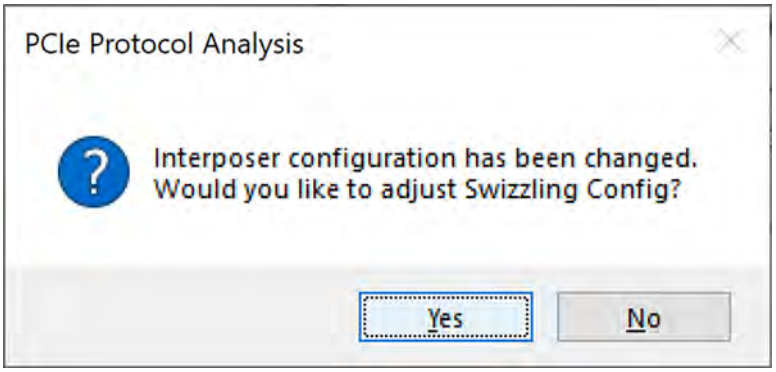


Figure 5.8: Interposer configuration changed, need to adjust logical and physical lanes

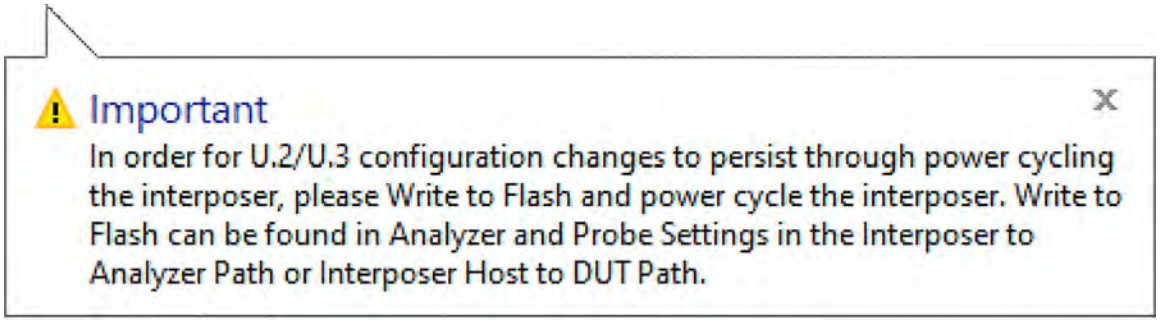


Figure 5.9: Warning Message: Keep Configuration Changes through Power Cycle

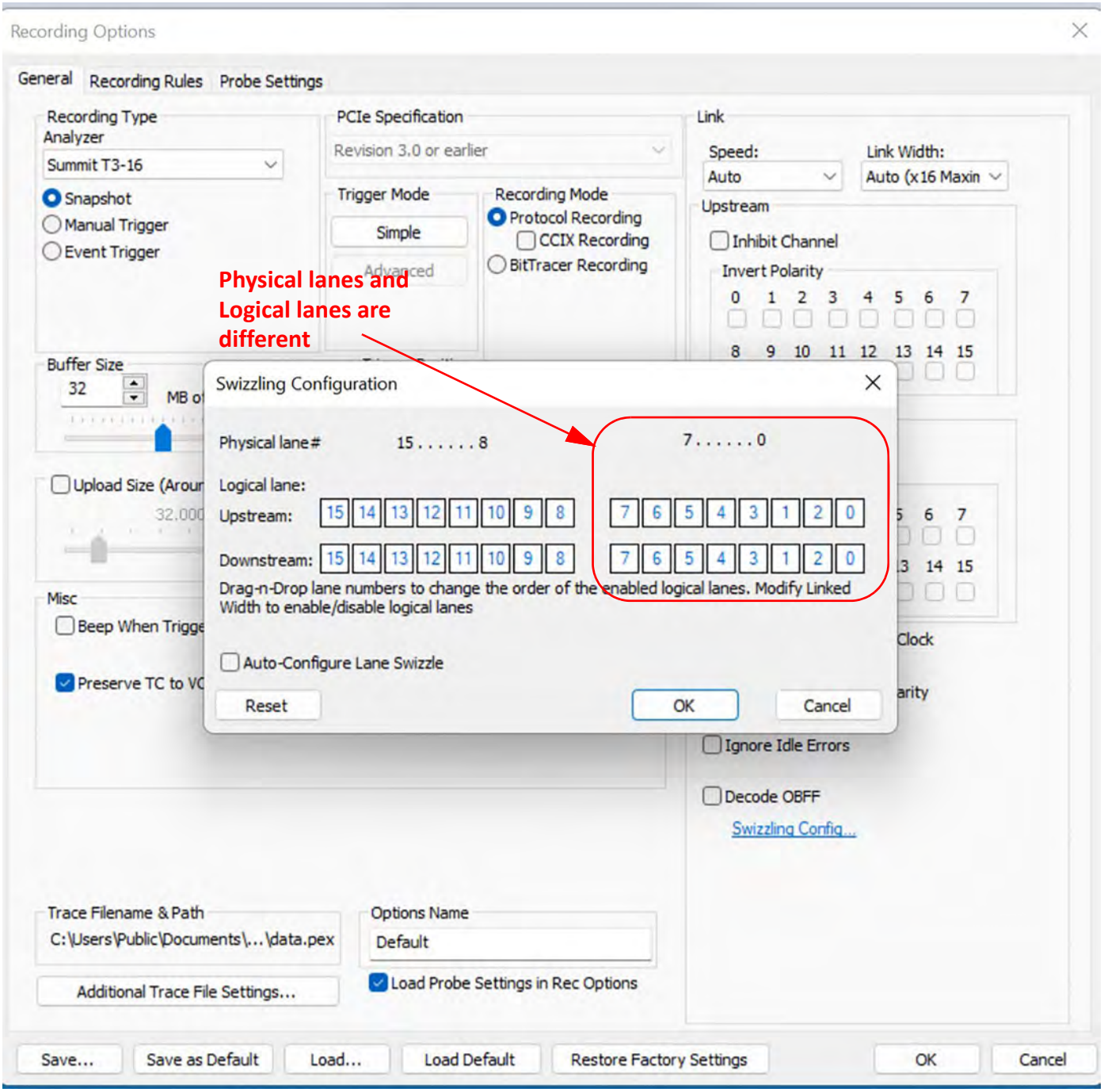


Figure 5.10: Physical and Logical Lanes are Different

For more on “Swizzling” Lanes see “Swizzling Config...” on page 233.

5.4.3 Recording Type (trigger): Snapshot / Manual Trigger / Event Trigger

5.4.3.1 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.

5.4.3.2 Manual Trigger

Recording begins when you select **Start** in the application. Pressing the **Trigger** button allows the Analyzer to finish recording by switching between the pre-trigger buffer and the post-trigger buffer. Recording continues until the post-trigger buffer has been filled. You can also end the recording immediately by pressing the **Stop** button in the application. See Figure 5.11 on page 196.

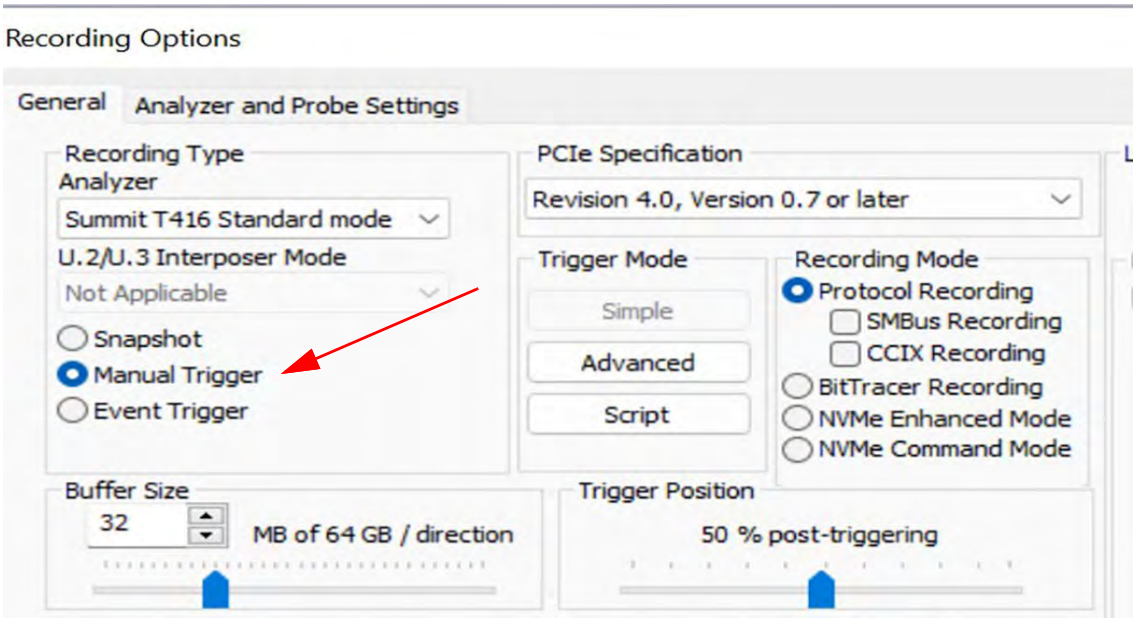


Figure 5.11: Manual Trigger

Note: Consider that when filtering is enabled, pressing the Trigger button will not necessarily cause the post-trigger buffer to fill automatically, due to packets being filtered and not stored. In this case you will have to use the Stop button to immediately end the recording.

5.4.3.3 Event Trigger

Event Trigger is a recording that switches between the pre-trigger buffer and the post-trigger buffer when it is triggered by an event in the CATC Trace. An Event Trigger begins when you select **Start** in the application and ends when the specified triggering event occurs in the CATC Trace or you press **Stop**. If an event triggers the end of the recording, the Analyzer records a predefined amount of post-trigger data (specified by Trigger Position and Buffer Size.)

To terminate an Event Trigger recording, press the Manual Trigger button on the front of the Analyzer. When the Manual Trigger button is pressed, the Analyzer continues to record until the specified post-trigger buffer has been filled.

See Figure 5.12 on page 197.

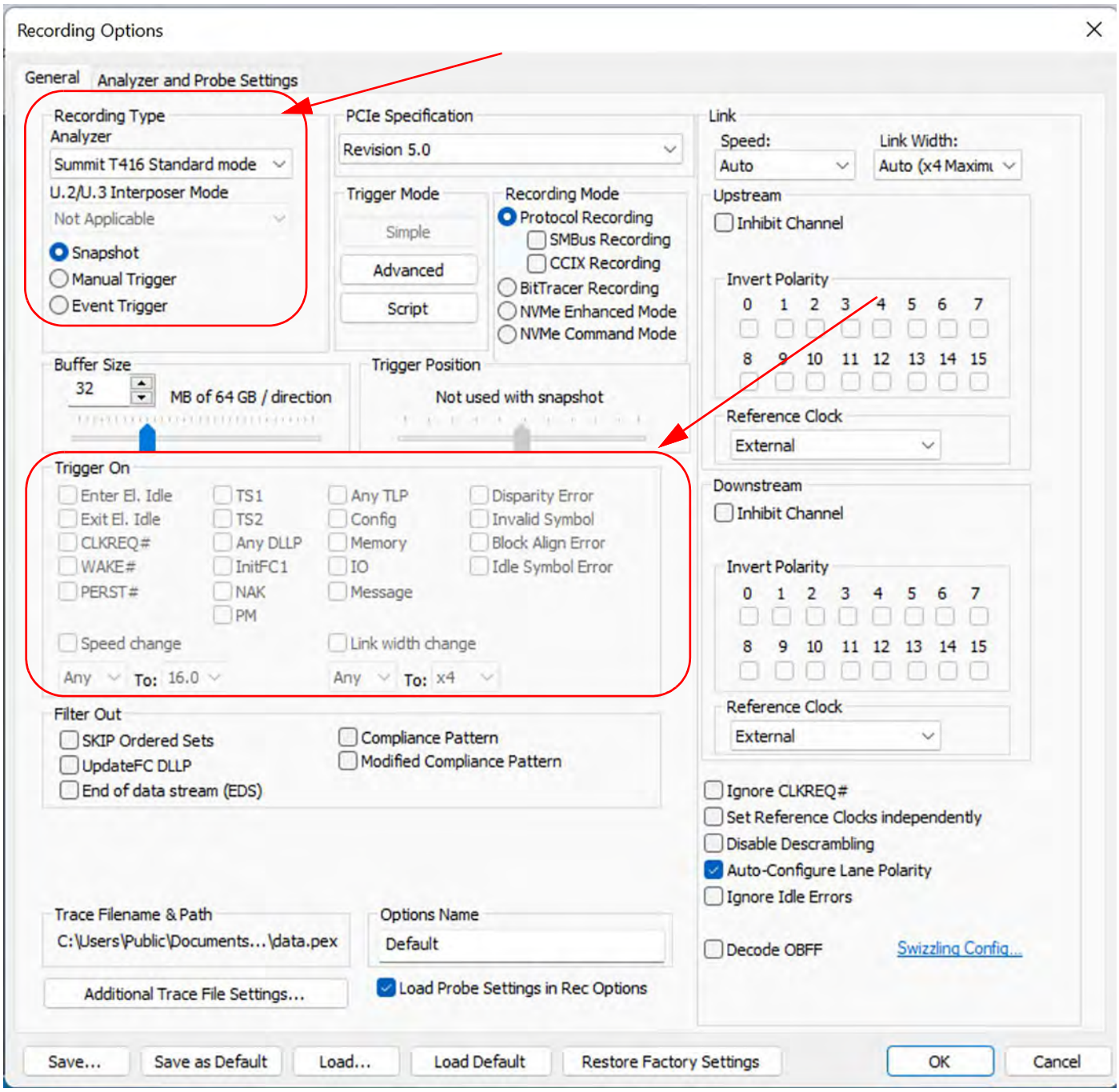


Figure 5.12: Simple Recording Options: Triggered Events

Note: All the options are the same for the T48 analyzer.

5.5 Trigger Mode: Simple, Advanced or Script Mode

The recording options are Simple, Advanced or Script modes. The Simple Recording and Advanced Recording options are the same in functionality, only the interface displayed is different.

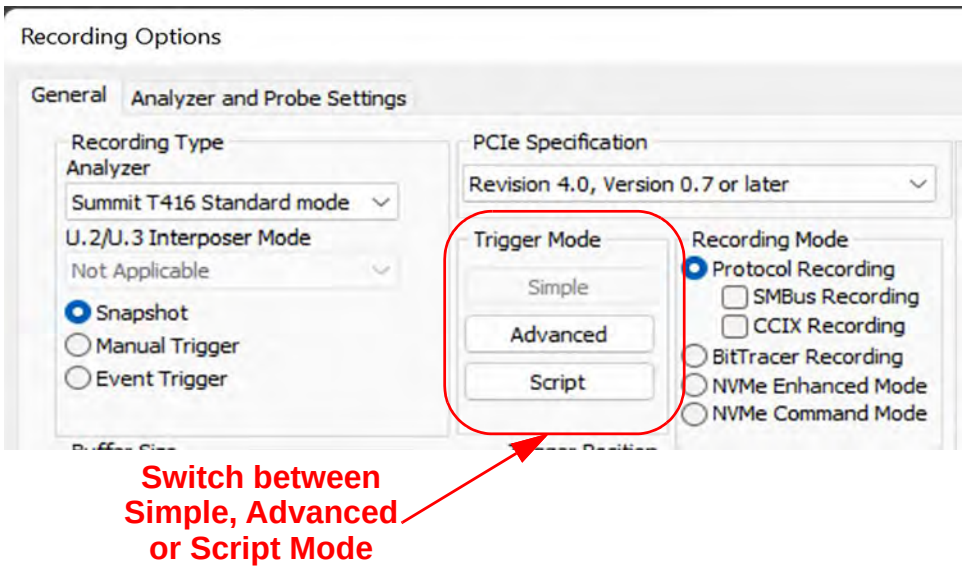


Figure 5.13: Switch to Simple Mode Button (T416 and T48)

5.5.1 Simple Mode

The Simple Mode allows quick access to commonly used options. The recording options are the same in both modes (See Figure 5.1 on page 187: 2B).

In Simple Mode, if you change the radio button from **Snapshot** to **Event Trigger**, the available triggering will be highlighted. See "Event Trigger" on page 196.

5.5.2 Advanced Mode

The Advanced Mode defines event triggers for the Recording Rules.

In Advanced Mode, the Recording Rules tab displays a GUI to set up recording rules for Triggered Events. see Figure 5.14 on page 199.

If you have defined some Recording Rules in Advanced Mode using the GUI, you can see the equivalent script if you select **General -> Script -> Recording Script**. See Figure 5.5.2.1 on page 199.

Note: The Summit T416 and T48 behave similarly.

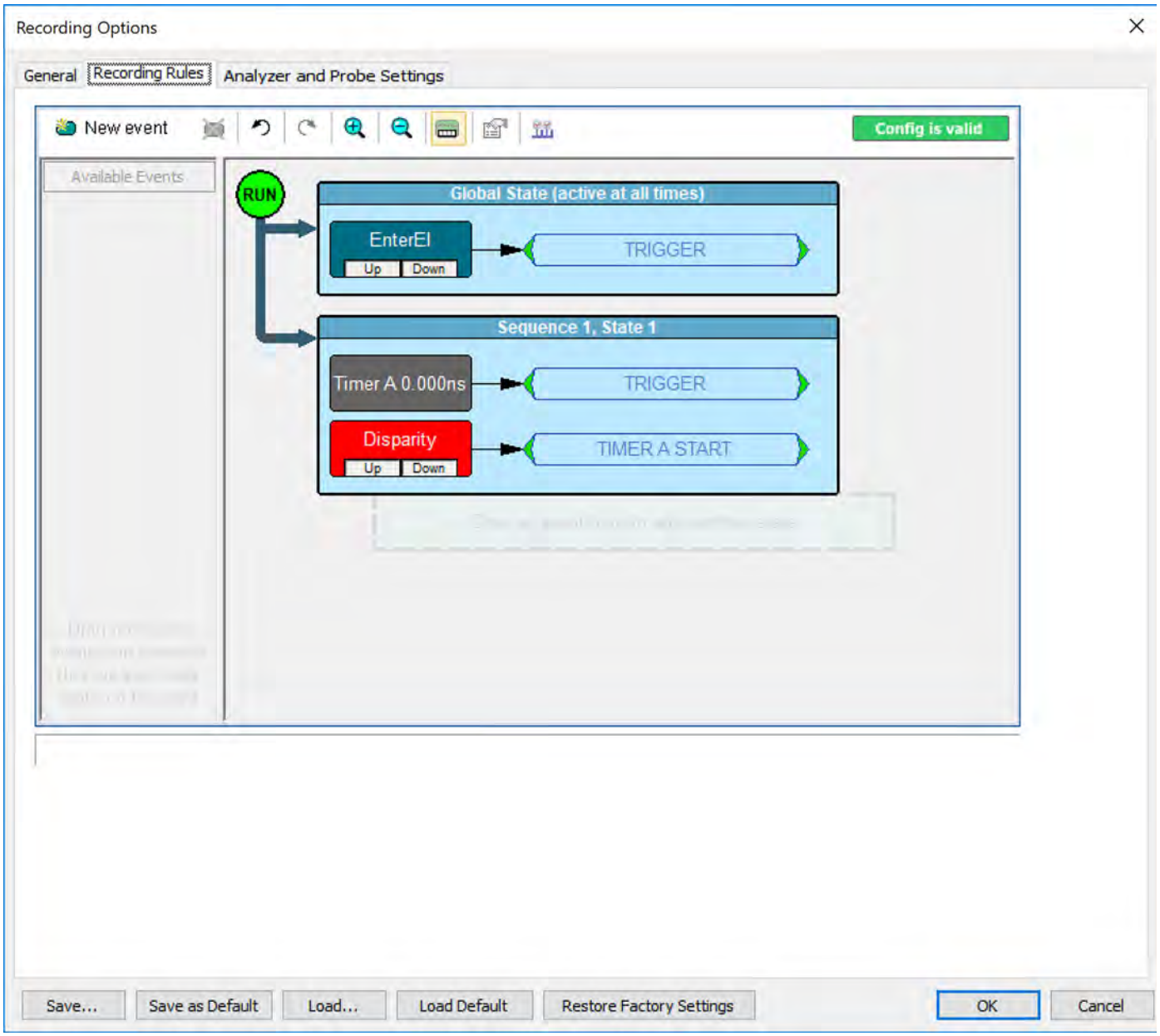


Figure 5.14: Advanced Mode: Recording Rules GUI

5.5.2.1 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.

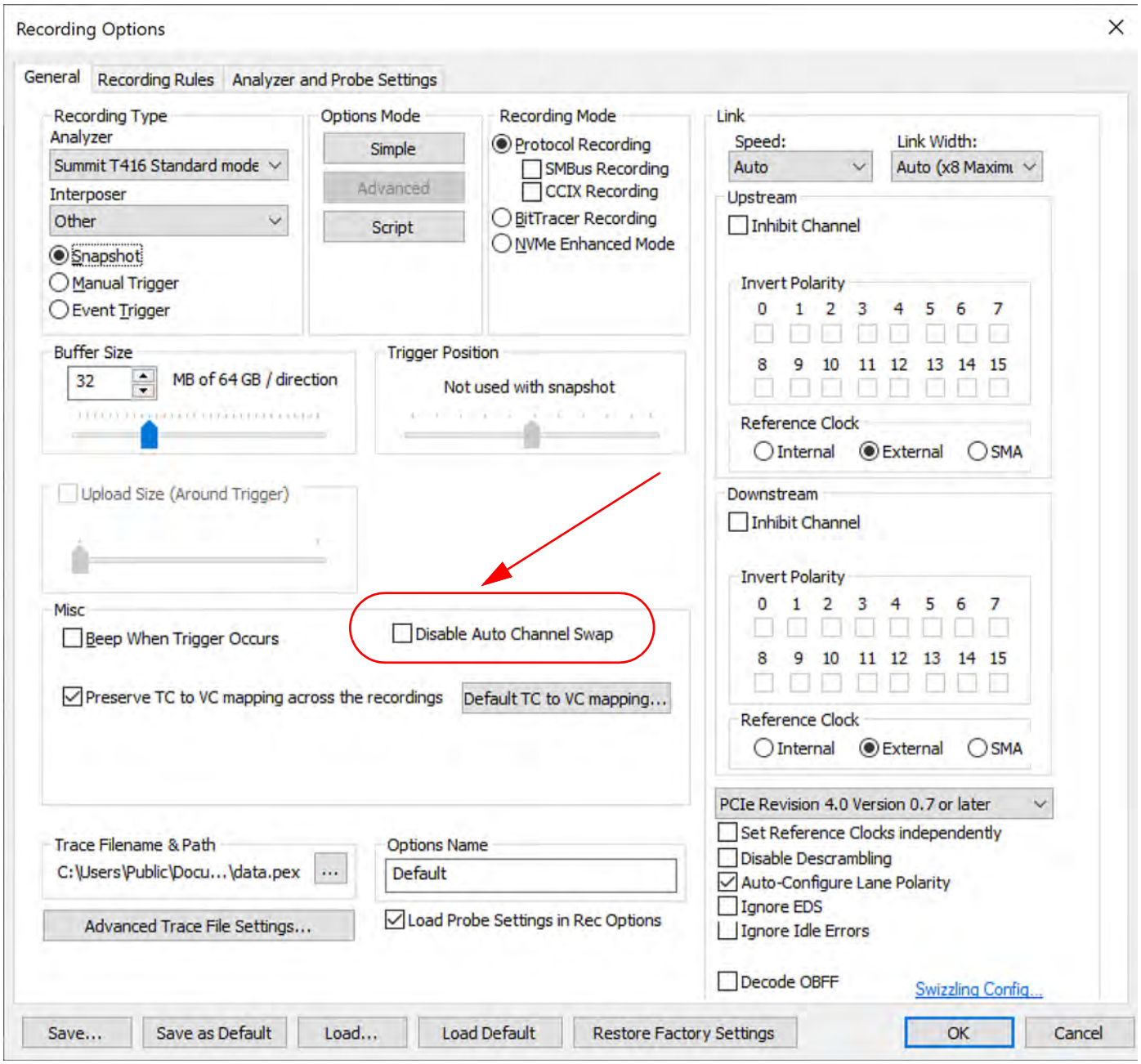


Figure 5.15: Recording Options: Advance -> Disable Auto Channel Swap

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).

5.5.2.2 Options in Advanced Mode: TC to VC mapping

One Recording Option that becomes available in Advanced Mode is TC to VC mapping. See Figure 5.16.

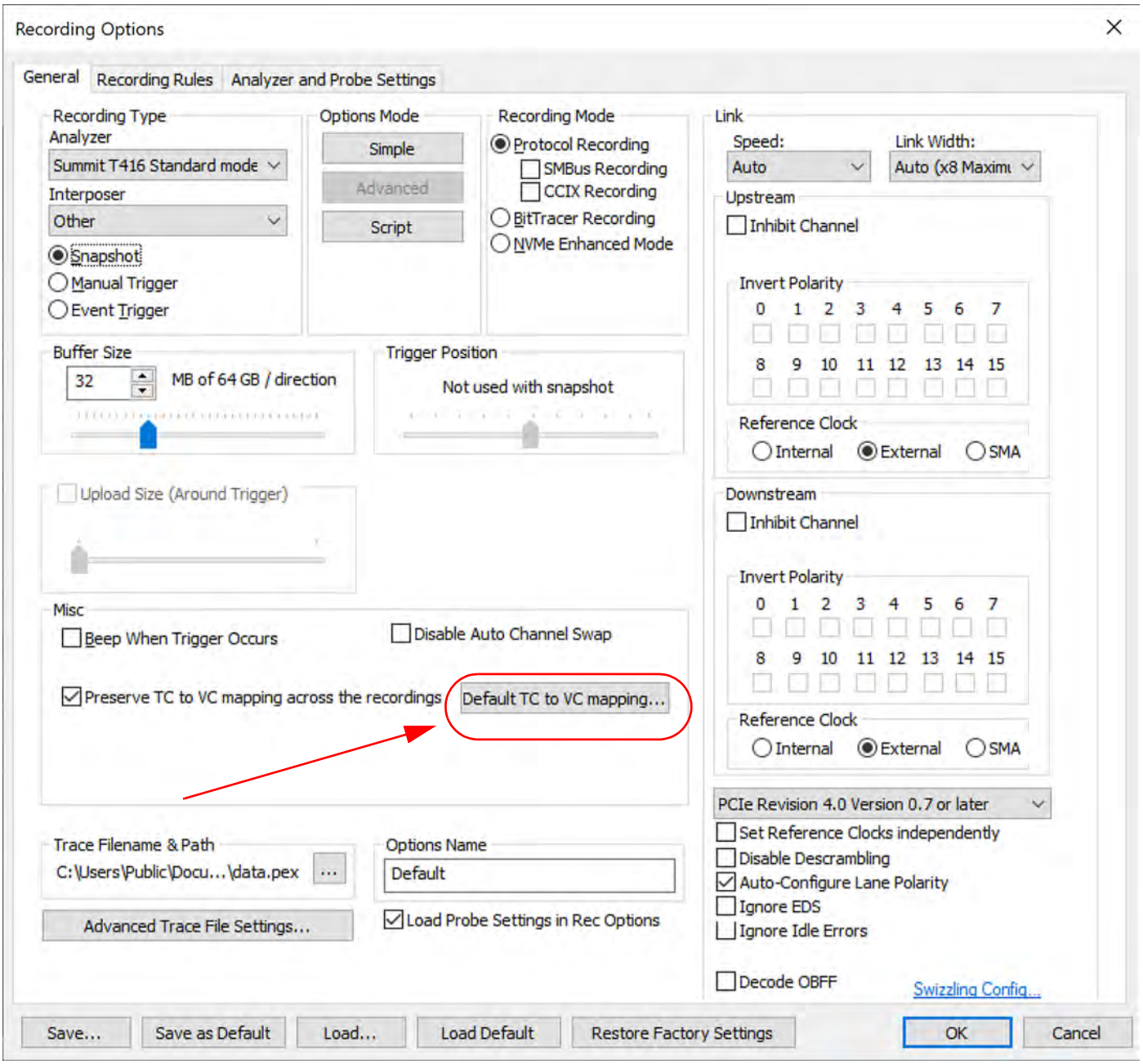


Figure 5.16: T416 Advanced Recording Mode: Default TC to VC mapping

If you select Default TC to VC mapping, the following dialog box pops up and you can manipulate the TC to VC mapping. See Figure 5.17 on page 202.

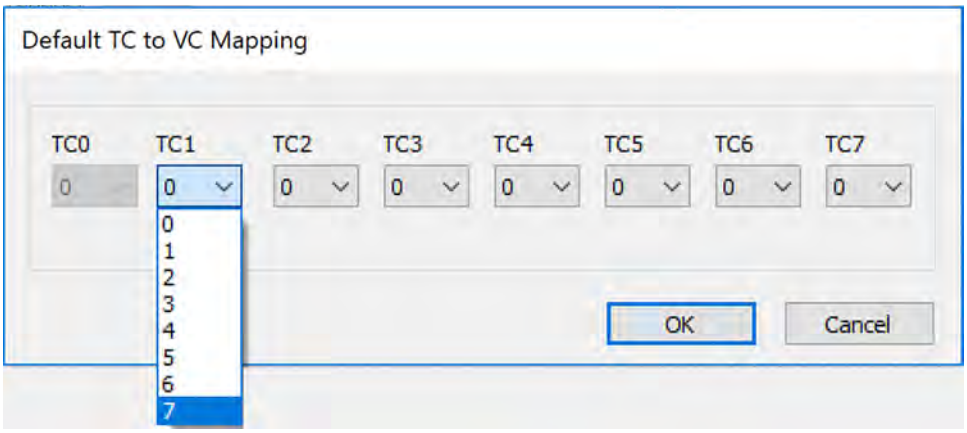


Figure 5.17: TC to VC Mapping

5.5.3 Script Mode

In Script Mode, the Recording Rules tab changes to the Recording Script tab. This is a text editor with a Script Commands pane to allow you to create a Recording Options script. See Figure 5.18 on page 203.

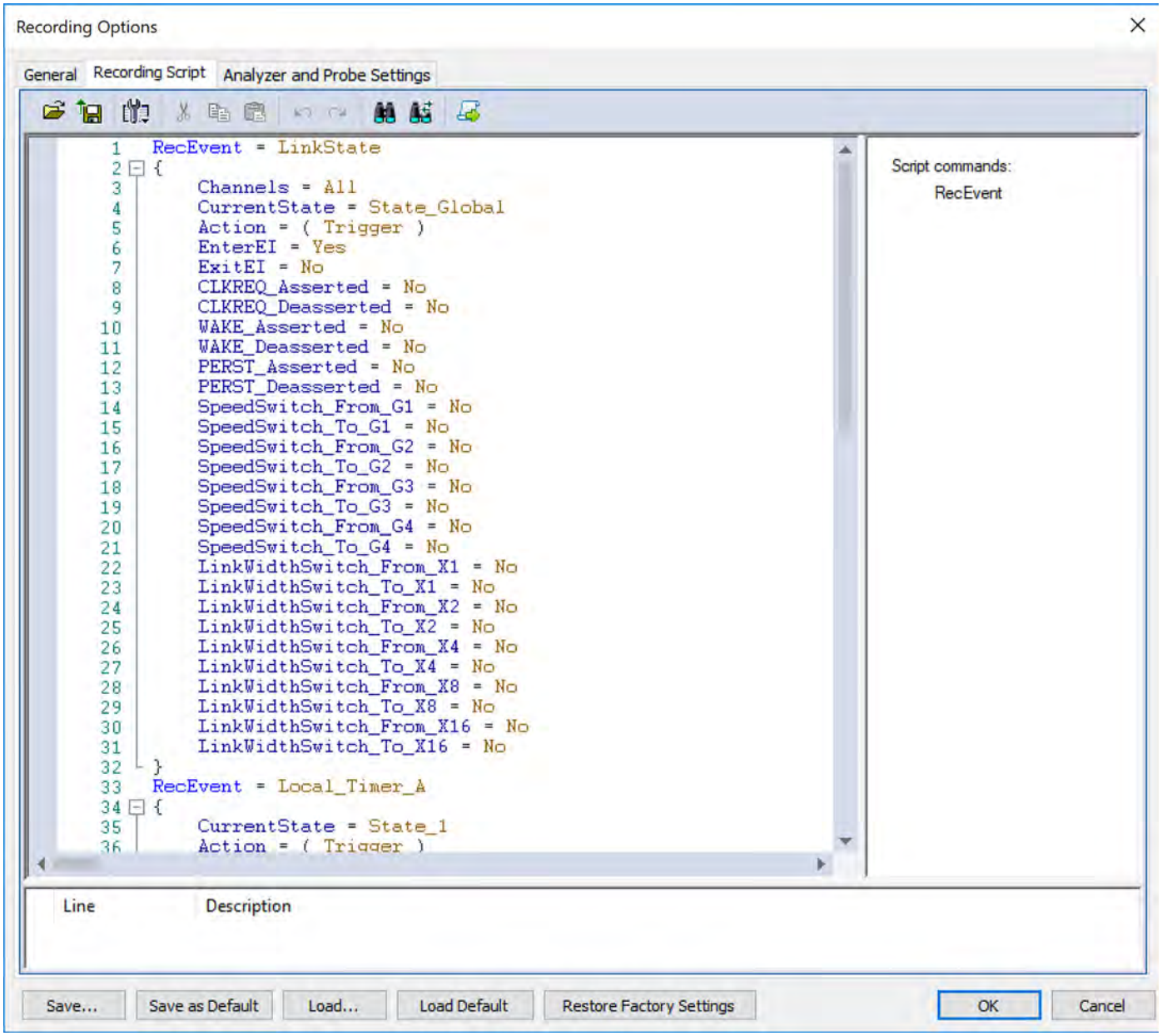


Figure 5.18: Script Mode Example -> Equivalent to GUI

5.6 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 5.1 on page 187: 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.

5.7 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 5.1 on page 187: 1B or Figure 5.19 and Figure 5.20 on page 205.

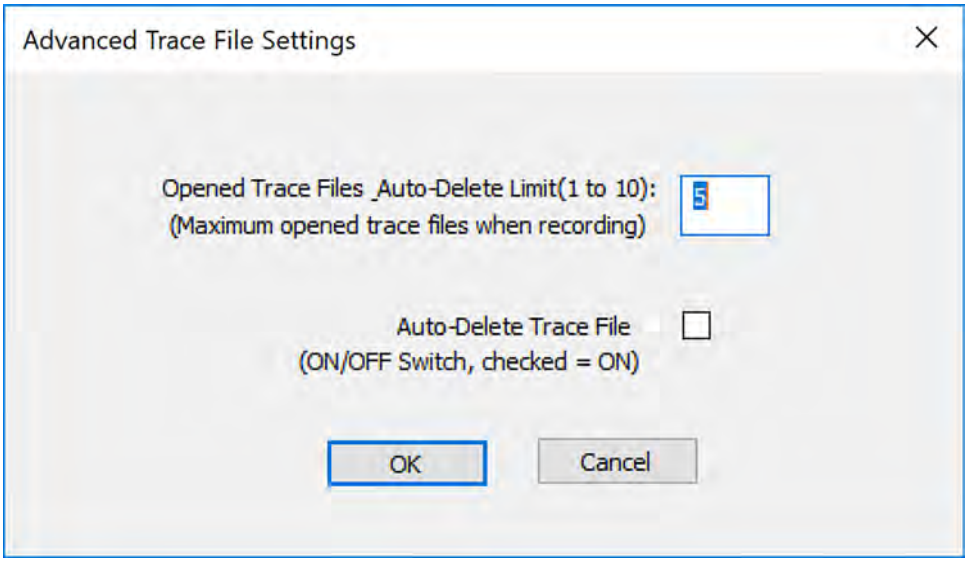


Figure 5.19: Advanced Trace File Settings: 5 Open Traces at a time

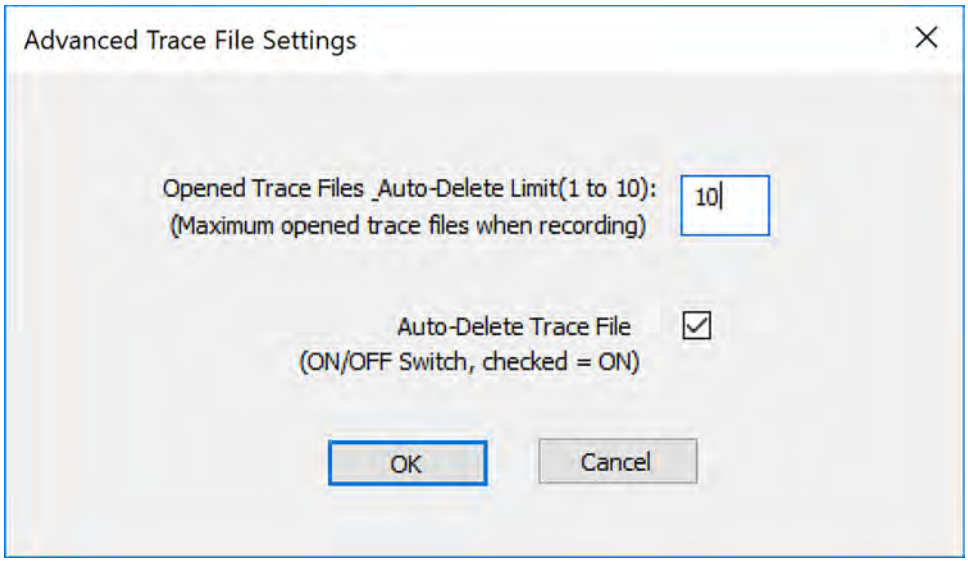


Figure 5.20: Advanced Trace File Settings: 10 Open Traces at a time, Auto-Delete when maximum number reached (10)

5.8 Saving and Loading Previously Saved Recording Options

You can save a recording or load previously saved recordings. In the Recording Options dialog the following Save options are available (see Figure 5.1 on page 187: 1C and 1D).

Recording Options settings can be saved and later reused by loading previously saved files. File options are:

- General Recording (**.rec** extension): A general recording options file which contains settings from the 'General(Tab)', 'Recording Rules' and 'Analyzer Calibration' tabs
- Recording Rules (**.rr** extension): See Chapter 5, "Recording Rules Overview," on page 245.
- PCIe Trace Files (**.pex** extension). See Chapter 4, "Saving CATC Trace Files," on page 165.
- Probe Settings Files (**.ps** extension) See Chapter 5, "Loading Probe Settings in Recording Options," on page 208.

5.8.1 Saving Recording Options

5.8.1.1 Saving Recording Options: Buttons

Table 5.1: Saving Recording Options Buttons

Button	Description
Save	Saves the current options to whatever file name you provide.
Save As Default	Save the current recording options into the default Recording Options file. 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	A descriptive, supplemental label that you can assign to a Recording Options file so you can easily recall what settings are in the 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.**

5.8.1.2 Saving Recording Options: Steps

Recording Options settings can be saved and later reused.

1. Open the Recording Options dialog by selecting **Setup > Recording Options.**
2. Set your options.
3. (Optional) To add a descriptive label to this file to help you remember what options were set, use the **Options Name** box.
4. Click **Save**. The **Save As** dialog box displays.
5. Enter a unique file name.

6. Choose the type of file you want to save from **Save as type**. See Figure 5.21. The **.rec** extension is added by default.

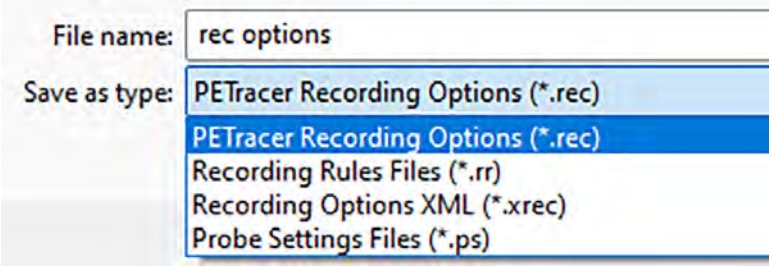


Figure 5.21: Save as type Extension Choices

7. Click **Save**.

5.8.2 Loading Previously Saved Recording Options

5.8.2.1 Loading Recording Options: Buttons

Table 5.2: Loading Recording Options Buttons

Button	Description
Load	Loads a previously saved set of recording options.
Load Default	Loads the default set of recording options.
Restore Factory Settings	Restores the Factory Settings for Recording Options.
OK	Applies changes and closes the Recording Options dialog.
Cancel	Cancels changes and closes the Recording Options dialog.

5.8.2.2 Loading Recording Options: Steps

To load Recording Options:

1. Select **Setup > Recording Options** from the menu. **Recording Options** displays.
2. Select **Load** from the Recording Options dialog. The Load dialog opens and lists previously saved options files ().
3. Select a file and the file format (see Figure 5.22).

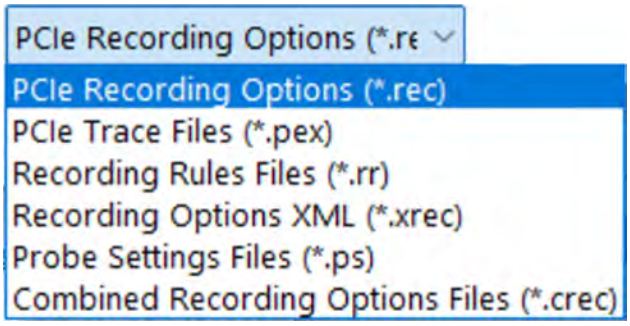


Figure 5.22: Load Extension Choices

4. Click **OK**. The options file loads.

5.8.3 Loading Probe Settings in Recording Options

By default, this checkbox is selected (see Figure 5.1 on page 187: 1G), which will load a probe settings file that you have generated.

If the “Load Probe Settings In Rec Options” checkbox is not selected the default probe settings are used. See Figure 5.23.

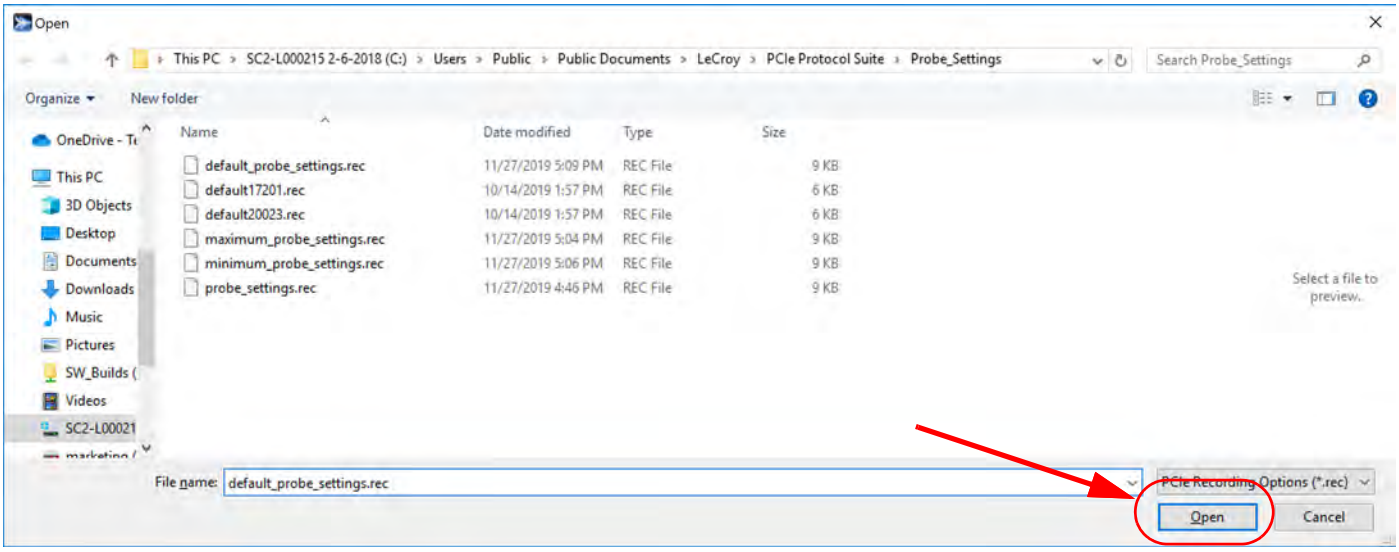


Figure 5.23: Default Probe Settings

Probe Settings are shown in Figure 5.24 on page 209.

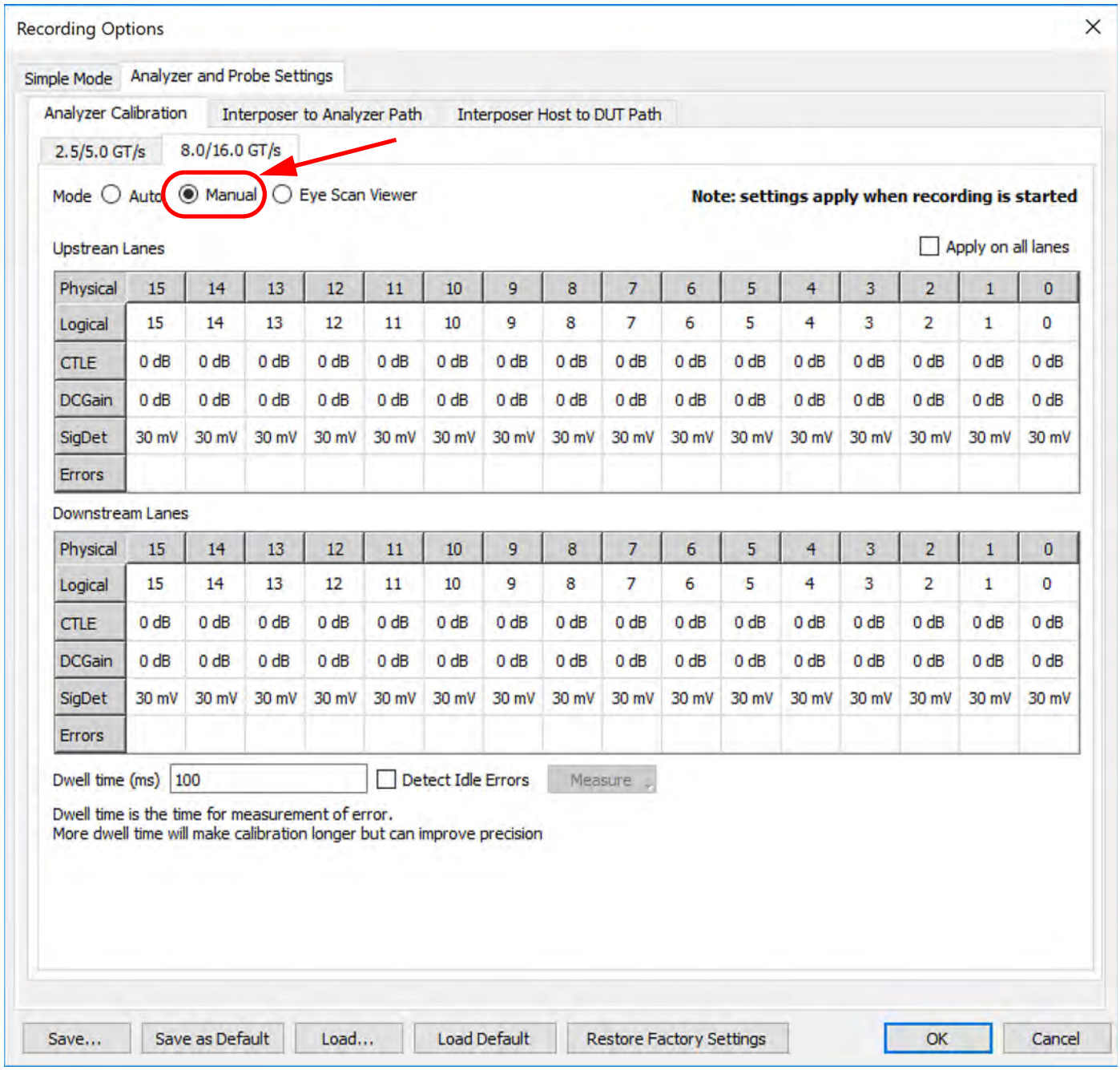


Figure 5.24: User Defined Probe Settings: Manual Mode

Note: For the Summit T48 only 8 lanes will be displayed.

Figure 5.25 on page 210 shows saving your probe settings values that will be used the next time you set up the Recording Options (with the “Load Probe Settings in Rec Option” checkbox selected) instead of the default values.

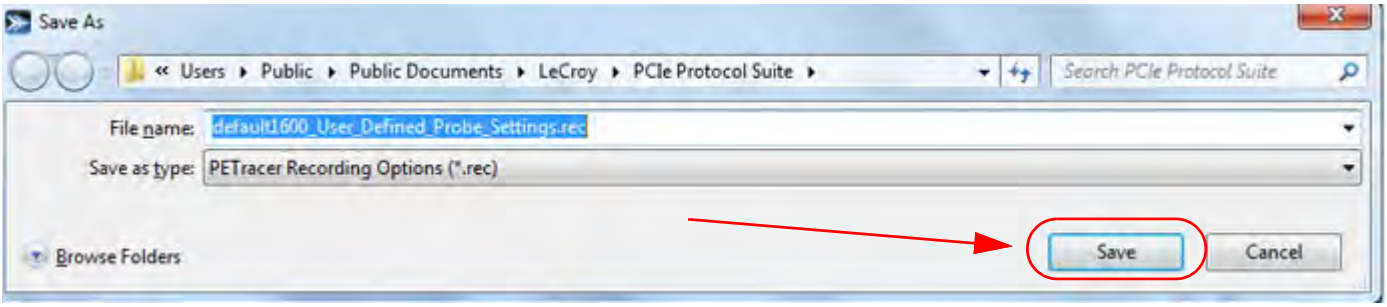


Figure 5.25: User Defined Probe Settings File: Saved

When you set up the Recording Options at a later date and have the “Load Probe Settings In Rec Options” checkbox selected, select the Load button and you can select which set of Probe Settings you want to use. See Figure 5.26 on page 211 and Figure 5.27 on page 212. For the T48 the image will show the T48 in the Recording Type box and 8 lanes will be loaded.

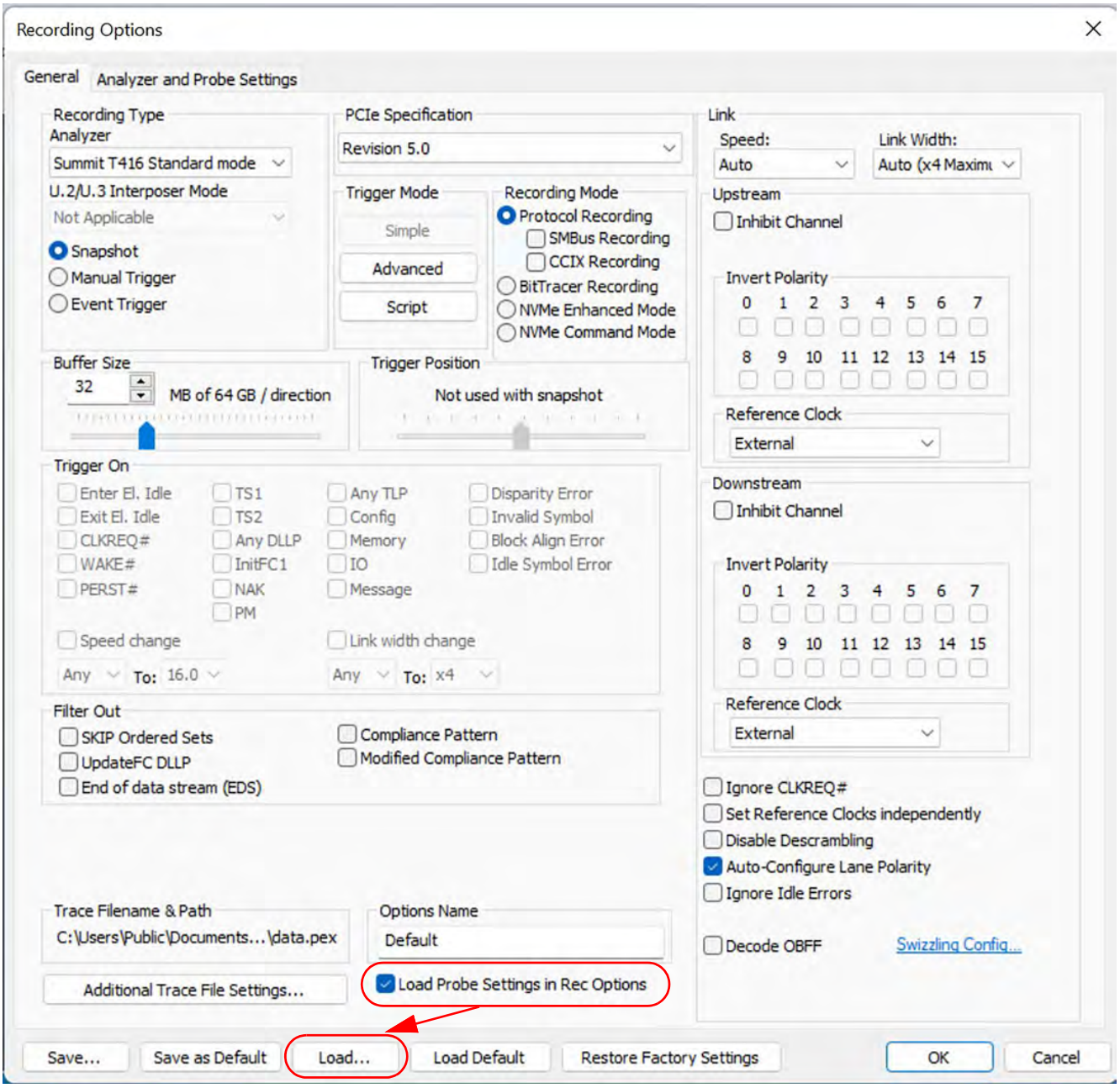


Figure 5.26: Load Probe Settings from User File

Select the file of Probe Settings you want to use and click Open. See Figure 5.27 on page 212.

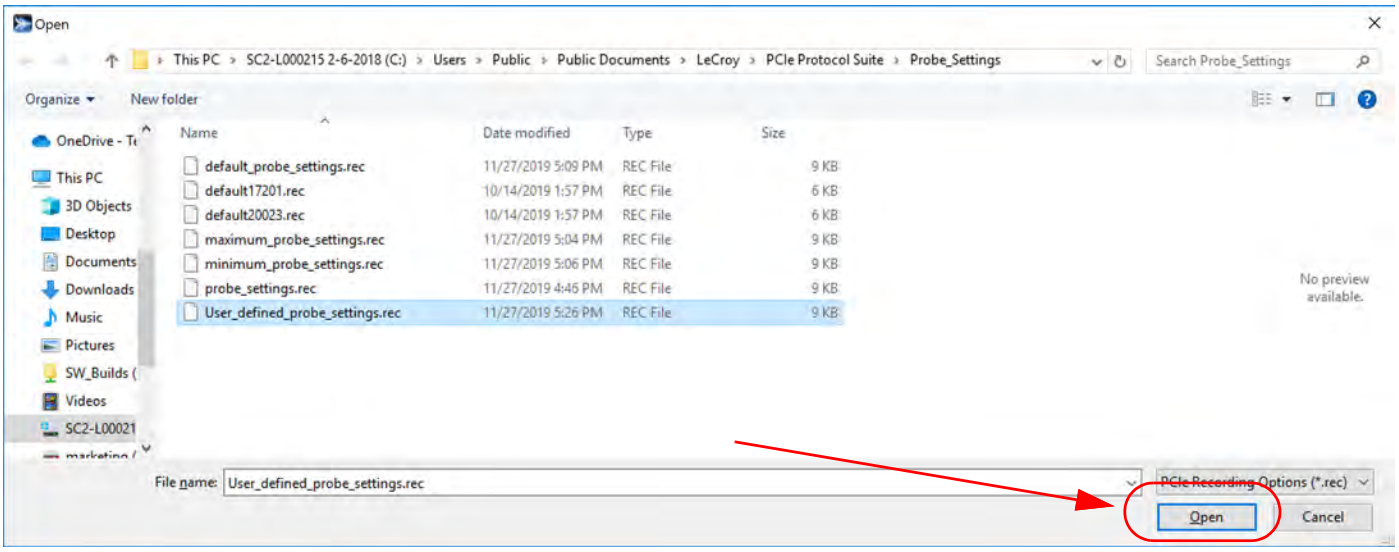


Figure 5.27: User Defined Probe Settings File

If you then select the Probe Settings tab, you'll see that the Probe Settings from the file you selected have been applied. See Figure 5.28 on page 213.

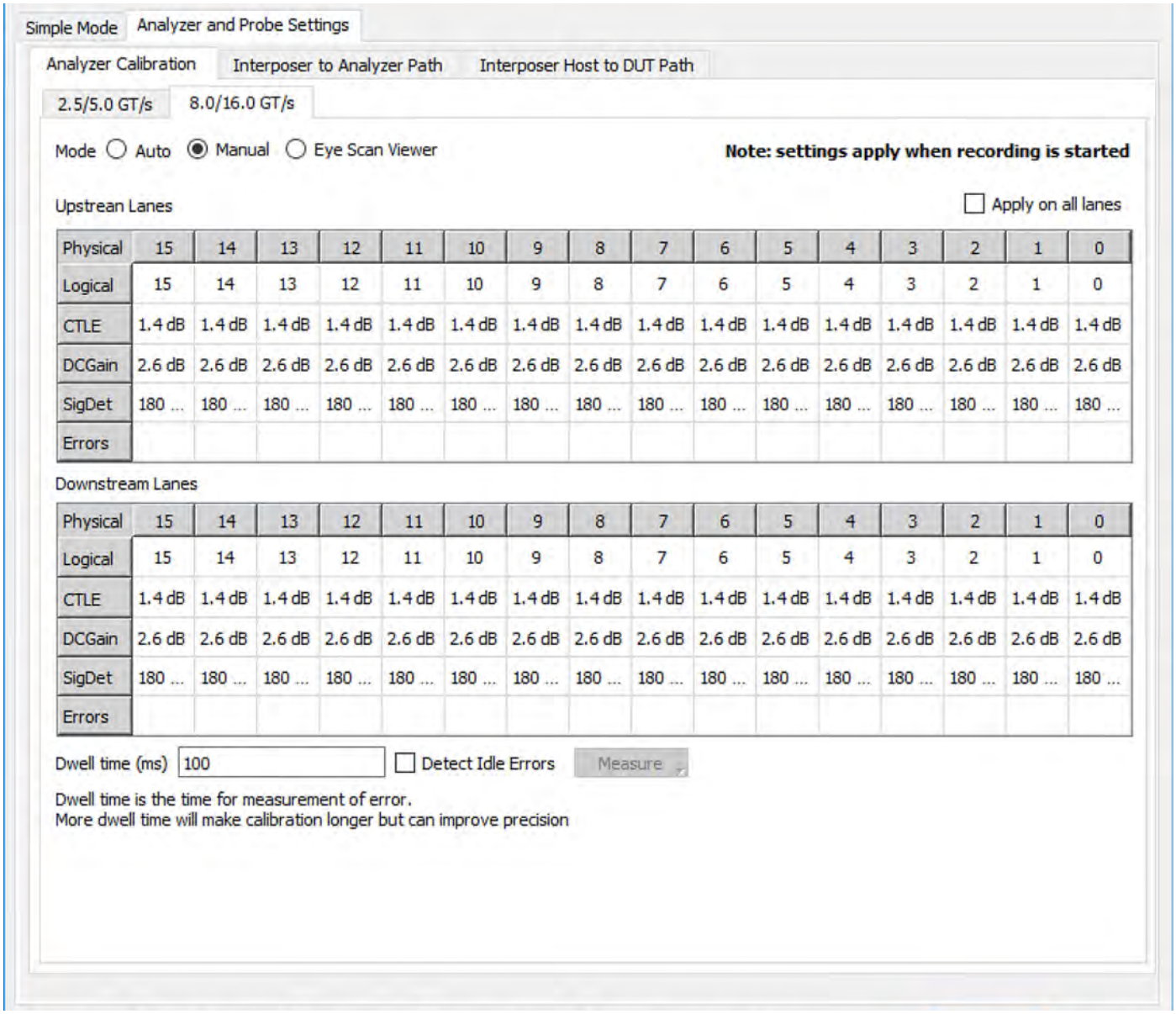


Figure 5.28: User Define Probe Settings Applied

Note: For the T48 the image will show 8 lanes will be loaded.

If you load a set of Probe Settings but you've de-selected the "Load Probe Settings In Rec Options" checkbox the probe settings **will not** be applied. The "Load Probe Settings In Rec Options" checkbox on the General Options Tab must be set to apply Probe Settings.

5.9 Filter Out

Filter Out allows you to filter out the following types of events (see Figure 5.1 on page 187: 2H):

- SKIP Ordered Sets
  - Training Sequence 1 (TS1)
  - Training Sequence 2 (TS2)
  - Electrical Idle (EI)
  - Fast Training Sequence (FTS)
  - SKIP
- Update Flow Control (FC) Data Link Layer Packets (DLLP): UpdateFC DLLP
  - Posted Requests
  - Non-Posted Requests
  - Completion
- Compliance Pattern
- Modified Compliance Pattern

5.10 Trigger On

Triggering Options can be set in both Simple and Advanced Modes. The options in the Simple Mode for easy access (see Figure 5.29 on page 216).

In the Advanced Mode triggering is set up via the Recording Rules (see "Triggering On (Advanced Mode)" on page 216. The Simple Mode allows you to simply define triggering by checking the boxes shown below (see Table 5.1 on page 215).

Note: Ensure that the correct analyzer is selected for the right options.

5.10.1 Triggering On (Simple Mode)

You can check any of the boxes shown in Table 5.1 for Trigger On in Simple Mode (see Figure 5.29 on page 216).

TABLE 5.1: Simple Mode Trigger On Events (Upstream or Downstream)

Enter Elec Idle	TS1	Any TLP	Disparity Error
Exit Elec Idle	TS2	Config	Invalid Symbol
CLKREQ#	Any DLLP	Memory	Block Align Error
WAKE#	InitFC1	IO	Idle Symbol Error
PERST#	NAK	Message	
	PM		
	Speed Change: Any, 2.5, 5.0. 8.0, 16.0 To: Any, 2.5, 5.0, 8.0, 16.0	Link Width Change: Any, x1, x2, x4 or x8 To: Any, x1, x2, x4 or x8	

Note: Trigger Position slider becomes enabled only when Recording Type is set to Manual Trigger or Event Trigger.

Note: If you check 2 or more boxes the triggering will occur based on an OR condition, not AND condition.

Note: External Input Trigger is not configurable, it will always cause the analyzer to trigger on a toggle when using manual trigger or triggering on any event.

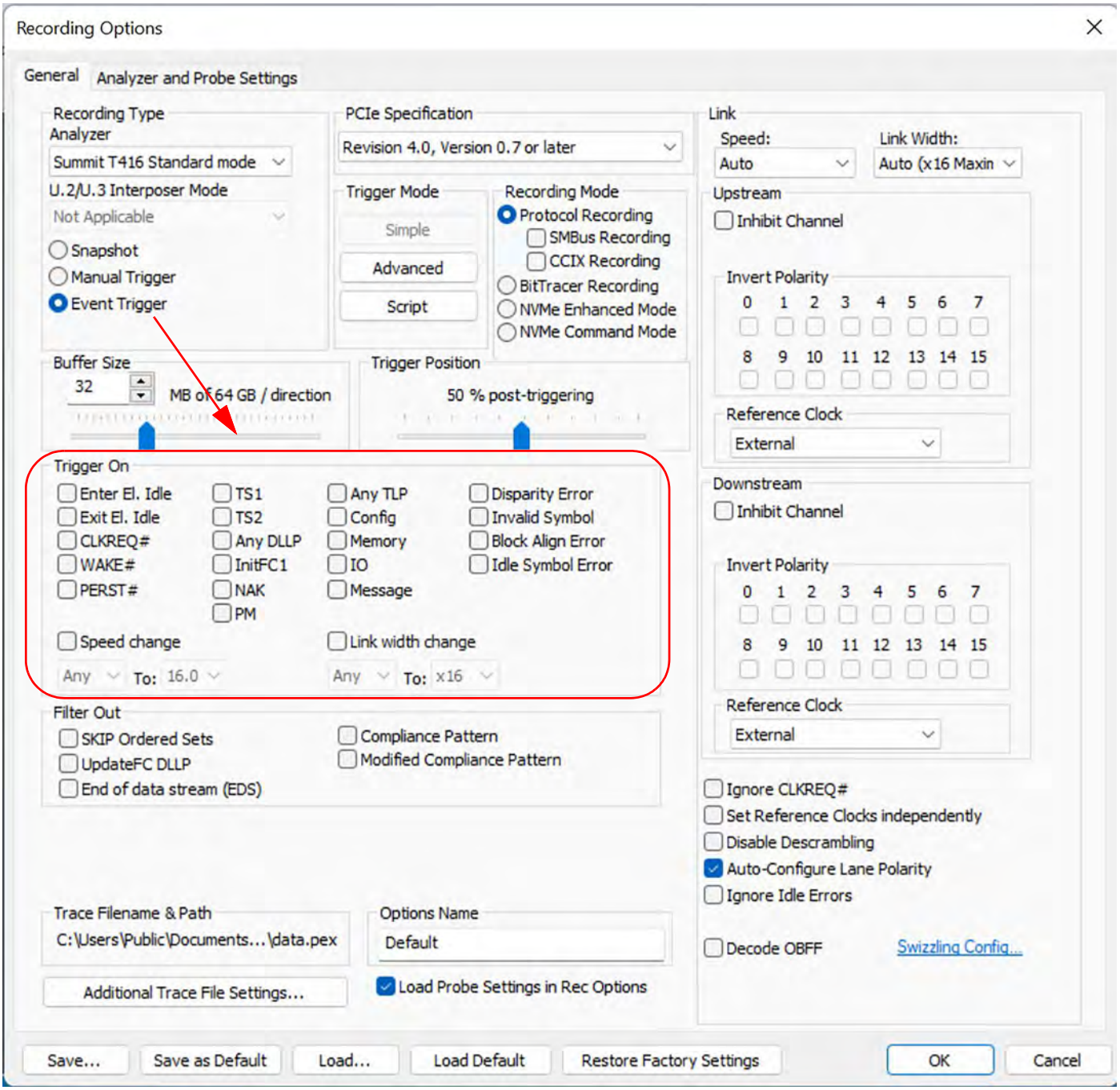


Figure 5.29: Simple Mode Triggering Options

5.10.2 Triggering On (Advanced Mode)

The Advanced Mode gives you additional flexibility to drill down and configure these options in greater detail via the Recording Rules dialog.

In the Advanced mode click on the Recording Rules tab to configure the settings. As shown in Figure 5.30, the Recording Rules tab allows you to create New Events. For each event you can create Actions. The Recording Rules are explained in greater detail in “Navigating Recording Rules” on page 243.

Note: In MultiPort mode, SMA trigger out is disabled.

Note: The External Input Trigger is combined with any other trigger defined in the sequencer.

Note: External Input Trigger is not configurable, it will **always** cause the analyzer to trigger on a toggle (change in level: Low to High or High to Low) when using “Manual Trigger” (see “Manual Trigger” on page 196) or triggering on any “Event Trigger” (see “Event Trigger” on page 196).

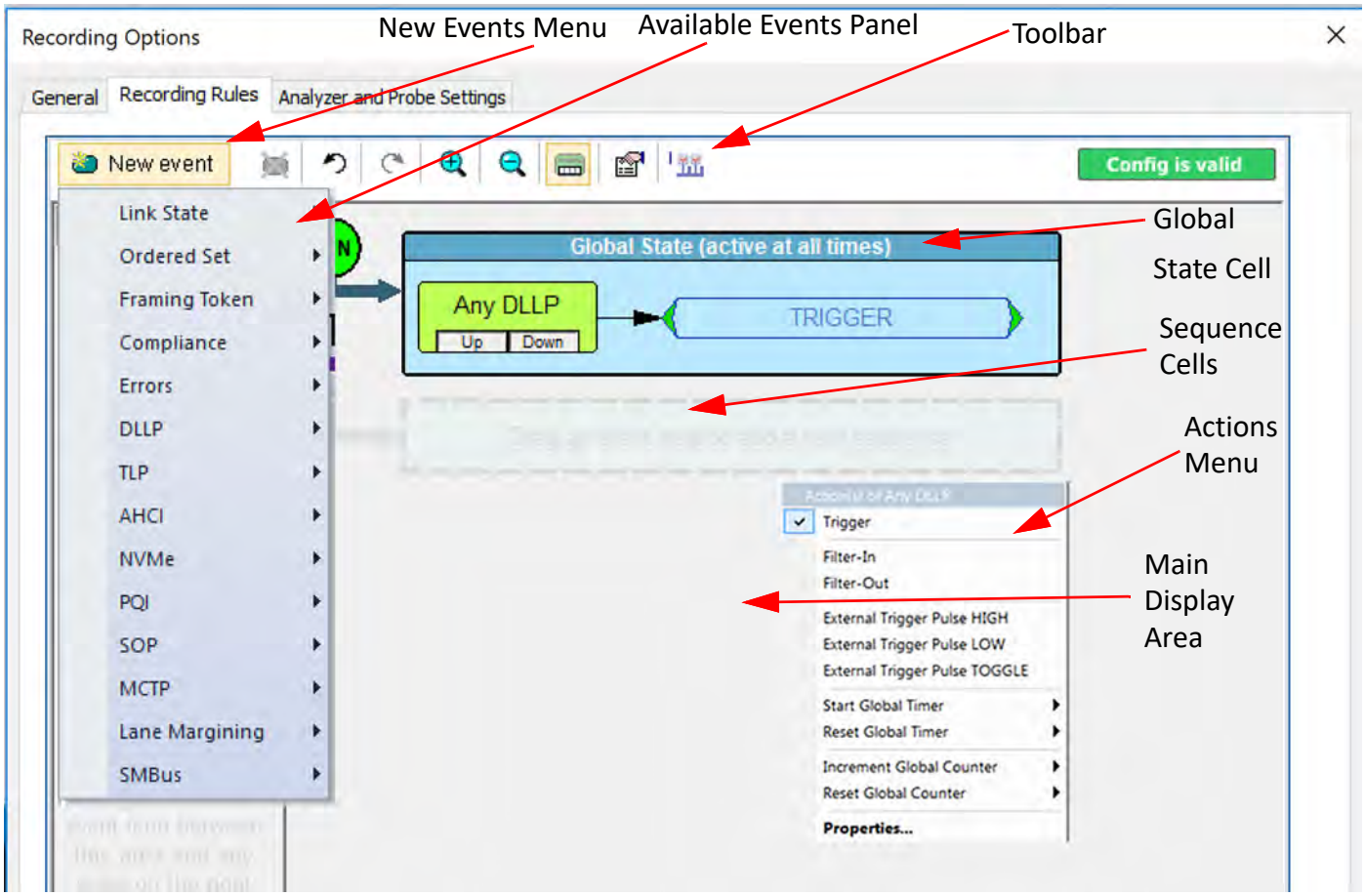


Figure 5.30: Recording Rules Tab

5.11 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 5.1 on page 187: 2D (64 GB per direction for the T416, 32 GB per direction for the T48 Upstream and Downstream). The Buffer Size slide-bar allows you to set the size of the recording buffer (see Figure 5.31).



Figure 5.31: Buffer Size Slide Bar (T416 and T48)

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.

Note: In MultiPort mode, the total analyzer buffer is split equally among the selected number of ports regardless of the port being used or not.

5.12 Recording Mode

There are five recording options for Recording Mode with the T416 and T48 (see Figure 5.1 on page 187: 2D and Figure 5.2 on page 188: 2D as well as Figure 5.32 below):

- Protocol Recording
  - SMBus Recording
  - CCIX Recording
- BitTracer Recording
- NVMe Enhanced Mode

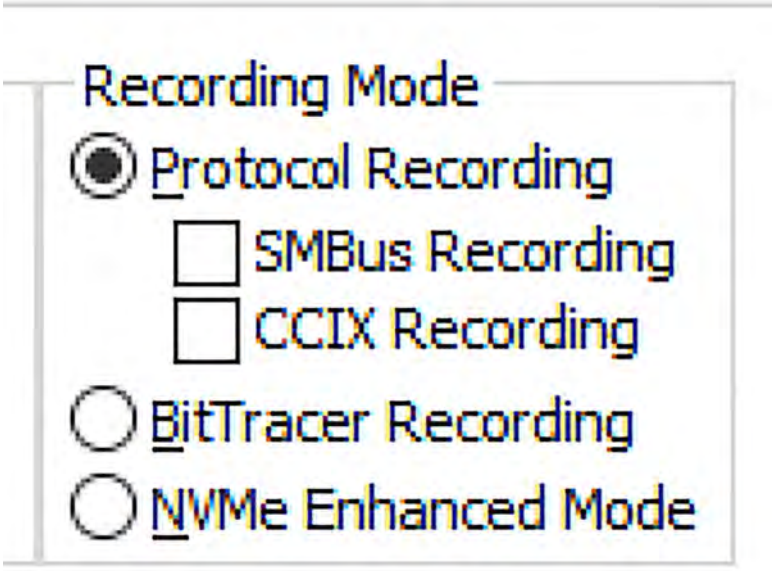


Figure 5.32: Recording Mode Options

5.12.1 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.

5.12.1.1 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 “Decoding MCTP Messages with SMBus Traffic” on page 530.

5.12.1.2 Recording the CCIX Protocol

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. See Figure 5.33 on page 220.

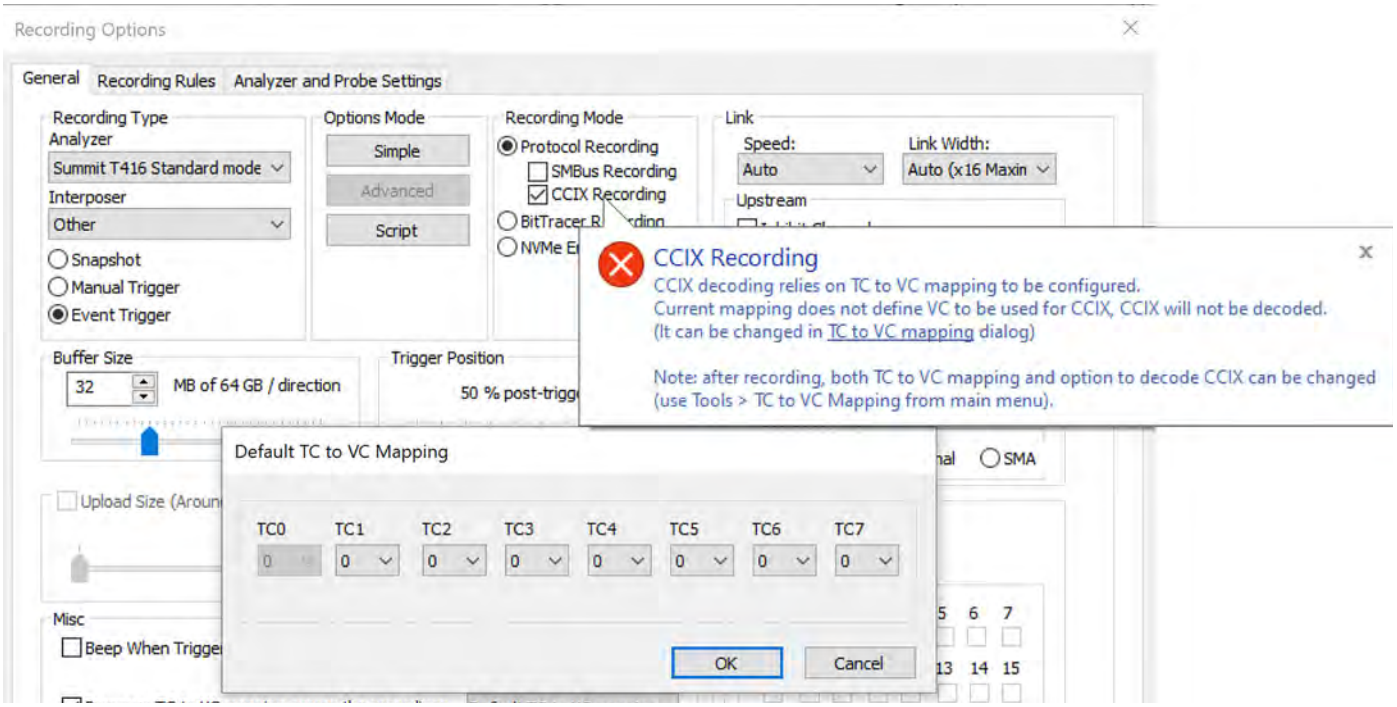


Figure 5.33: Selecting CCIX Recording Before Mapping from TC to VC

After mapping TC to VC the warning message goes away, as shown in Figure 5.34

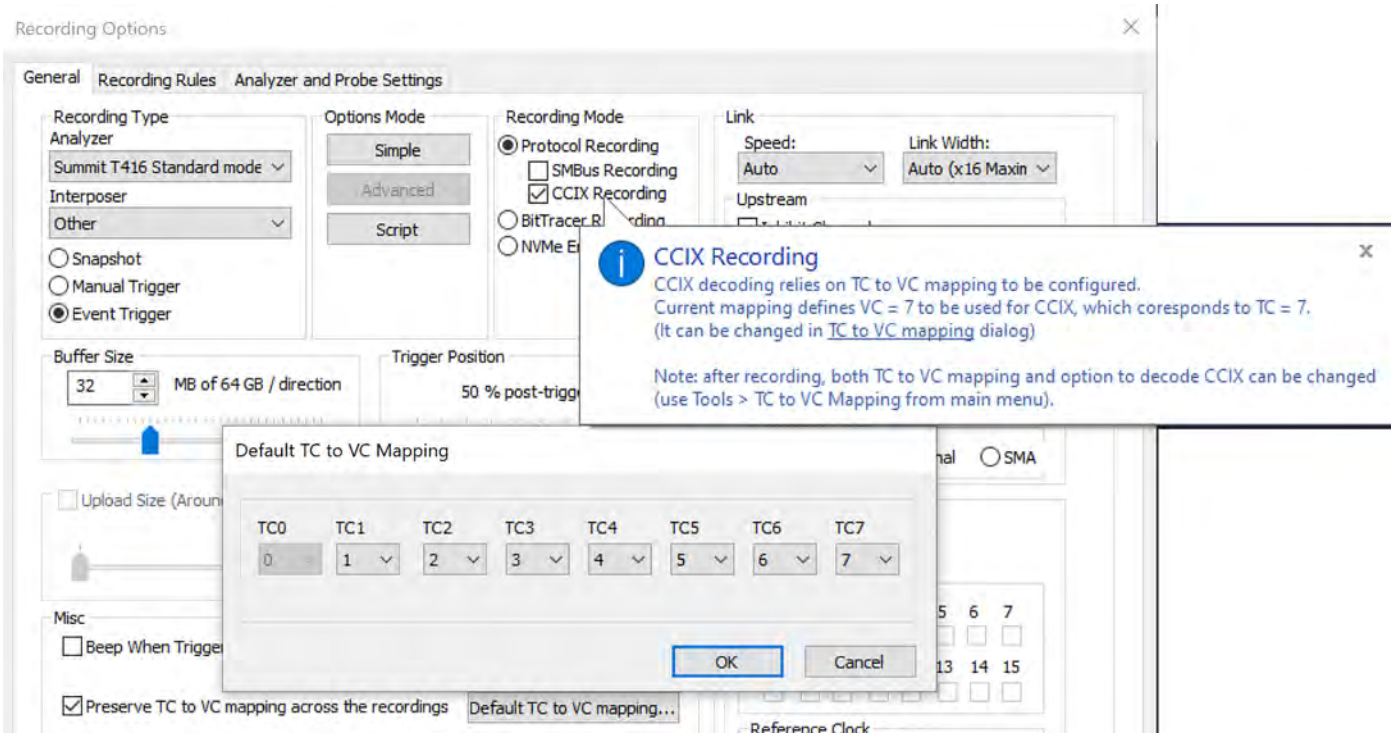


Figure 5.34: Selecting CCIX Recording After Mapping from TC to VC

See “Decoding CCIX Protocol” on page 568 for more details.

5.12.2 Bit Tracer Recording

When the Bit Tracer Recording box is checked, the recording behaves as a regular serial logic analyzer. The data is displayed in Bit Tracer view which displays the symbols being transmitted on each PCI Express lane. In this mode, you can trigger on the same events and use the sequencer as with Protocol Recording Mode but filtering is not allowed. The Bit Tracer mode will record all the traffic.

The option "Lane Deskew Bypass" is provided as a debug feature and limits the triggers to be used to only the basic resources and Packet Match using ordered sets. You can still use triggering for DLLPs and TLPs but since the data is not deskewed, it will trigger on a pattern that matches your selection but may not necessarily be a valid packet. See Figure 5.35.

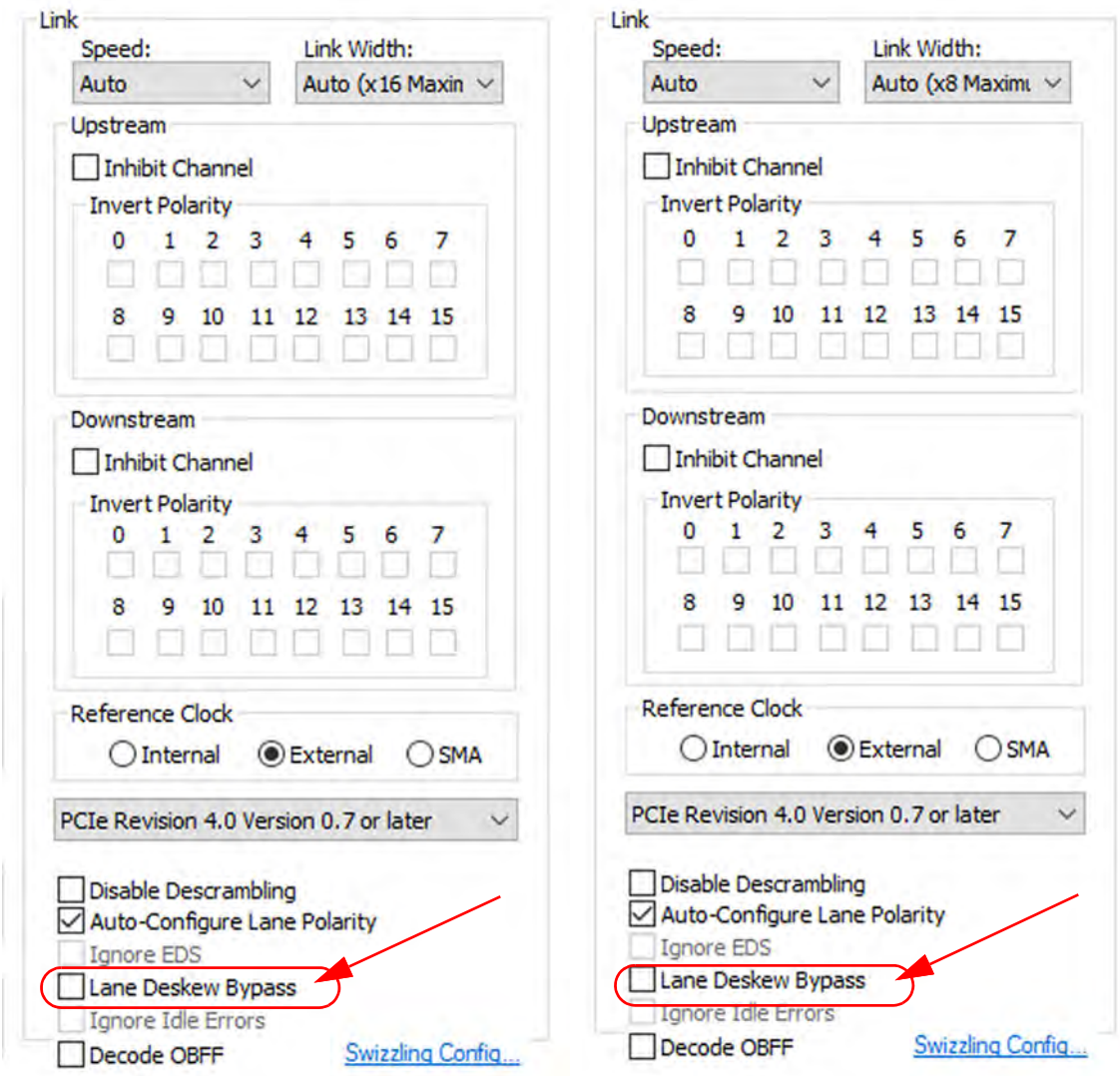


Figure 5.35: Bit Tracer Recording: Lane Deskew Bypass Mode (T416 and T48)

Note: Leaving all the boxes unchecked results in no trigger in that direction. For more information, see "BitTracer Recording" on page 669.

5.12.3 NVMe Enhanced Recording

When this mode is selected and Simple Mode is used, the GUI will be configured optimally to allow recording of very long captures of PCIe traffic that will be decoded as NVMe.

Before using this mode, make sure all the PCIe Link parameters are selected properly. You can achieve this by recording a trace in Protocol Recording mode during L0 and confirm the trace looks clean. Once you have found the correct Link parameters they will be used in NVMe Enhanced Recording mode.

For more details see "Preparing to Record in NVMe Enhanced Mode" on page 421.

5.13 Trigger Position

This Trigger Position slide-bar lets you adjust the amount of recording buffer allocated to recording pre-trigger and post-trigger traffic (See Figure 5.1 on page 187: 2E).

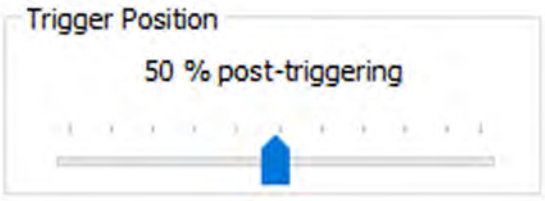


Figure 5.36: Trigger Position Slide Bar

For example, if you set the Trigger Position to 90% Post-Triggering Traffic, the Analyzer records 10% pre-trigger traffic and 90% post-trigger traffic.

Trigger Position is only available when Manual Trigger or Event Trigger is selected.

5.14 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.

5.15 Link Settings

The Link options panel allows you to manage links (see Figure 5.37 on page 225 for the T416 and Figure 5.38 on page 226). You can define the basic link parameters or leave it on Auto detect. The various link settings are described in this section (See Figure 5.1 on page 187: 3).

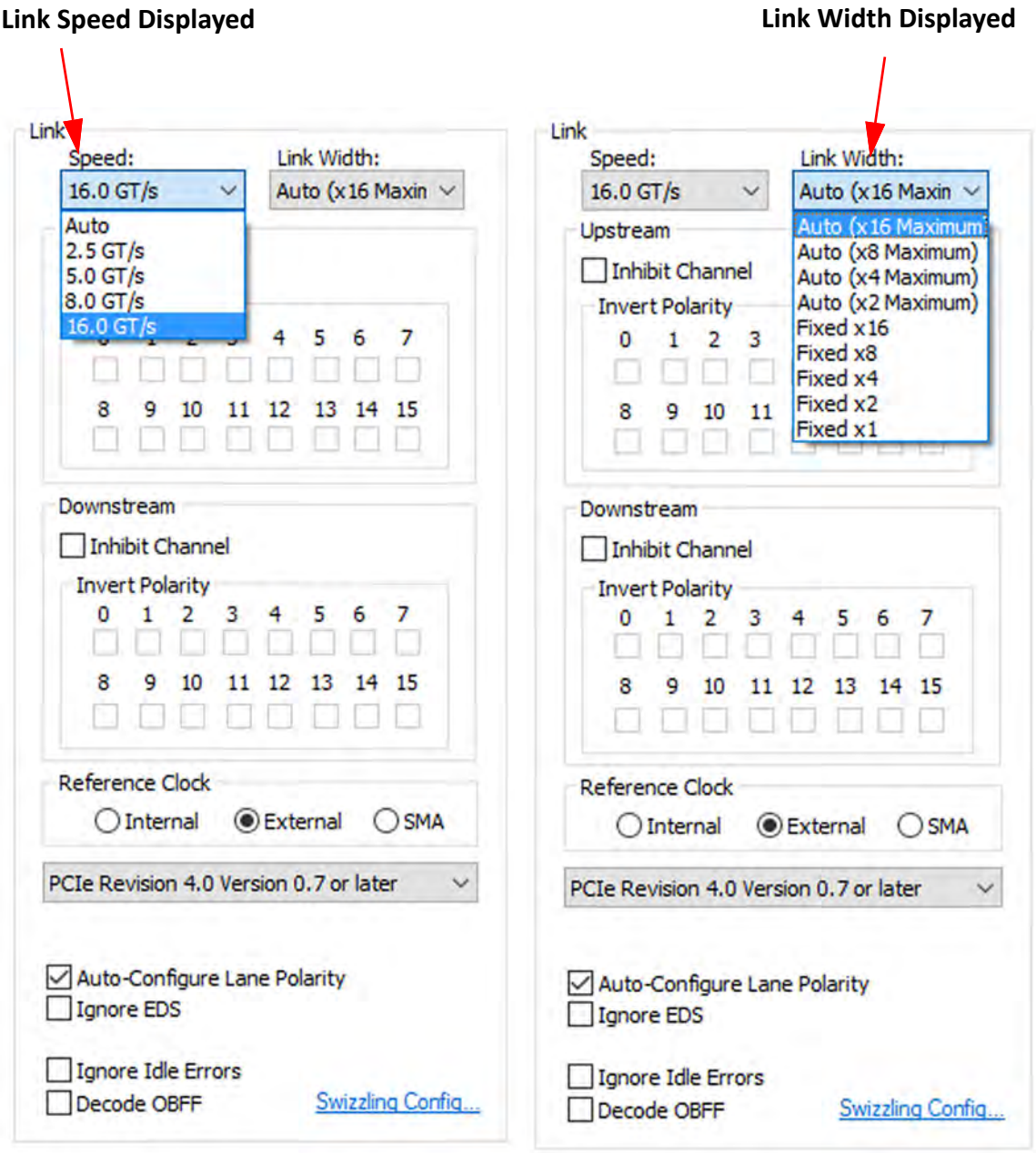


Figure 5.37: Link Options for Summit T416

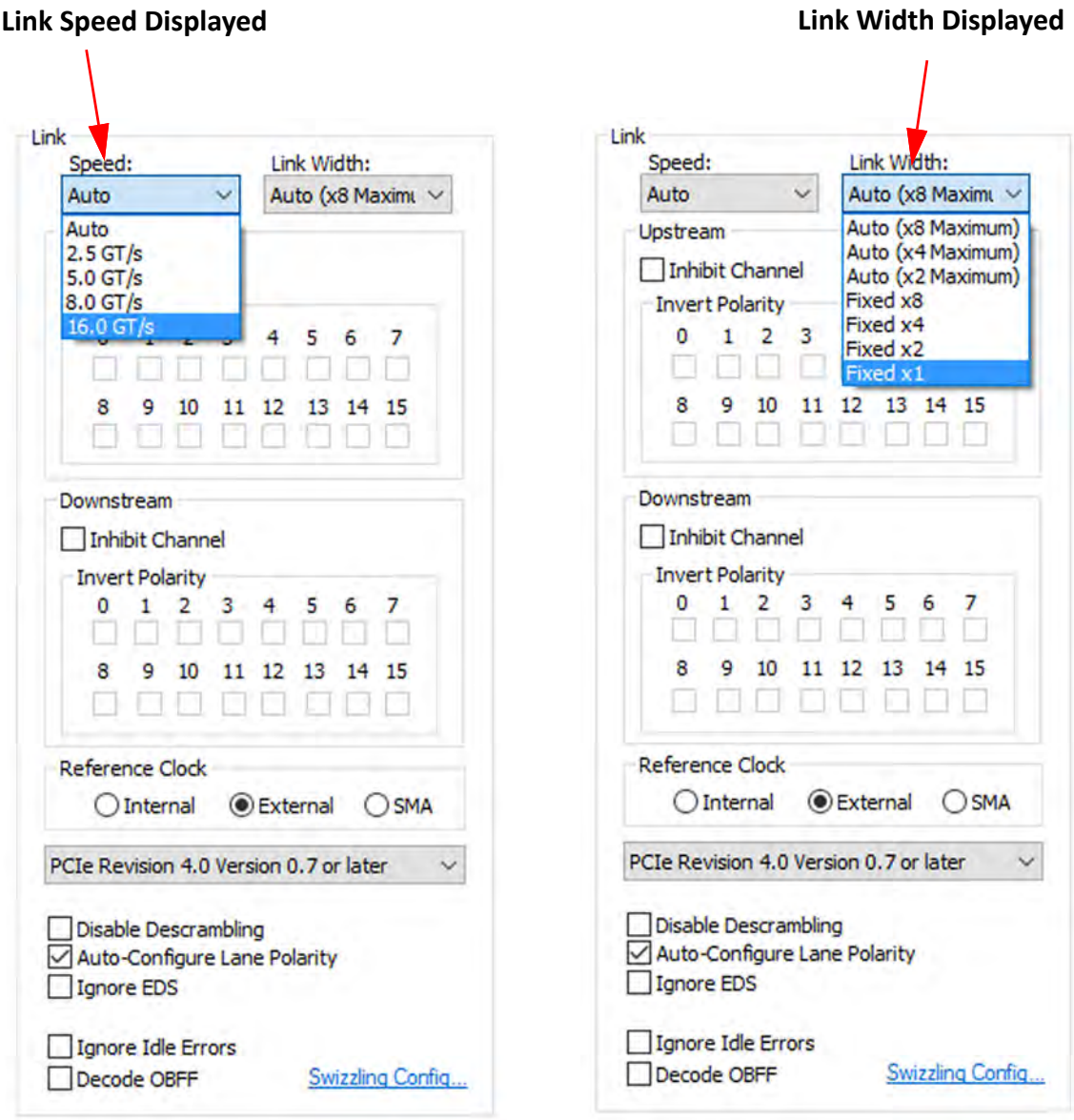


Figure 5.38: Link Options for Summit T48

5.15.1 Speed

The Speed can be set at Auto, 16.0 GT/s, 8.0 GT/s, 5.0 GT/s, or 2.5 GT/s for the T416 and the T48 from the drop-down menu. The default is Auto (see Figure 5.1 on page 187: 3A or Figure 5.37 on page 225 and Figure 5.38 left side).

Note: Auto: When set to Auto, Teledyne LeCroy's embedded software auto-determines the speed. This also turns on **Disable Descrambling**.

When set to a specific speed (16.0 GT/s, 8.0 GT/s, 5.0 GT/s, or 2.5 GT/s) Teledyne LeCroy's software forces the hardware to record at that speed.

Note: When set to a specific speed, (End of Data Stream) EDS detection is disabled.

For Auto speed setting to work the polarity setting of lane 0 has to be correct. The polarity can be set manually if the link is already in L0 state, or, for automatic polarity detection, the bus has to go through a training sequence so the analyzer can track the polarity.

Note: When selecting Auto in the Speed drop-down list the embedded software is able to find the correct speed even if the link does not go through a training sequence.

5.15.2 Link Width

The Link Width sets the physical width of the link. Select the Link Width from the drop-down menu (see Figure 5.1 on page 187: 3B or Figure 5.37 on page 225 right side for the T416 or Figure 5.38 on page 226 for the T48). The available options (and the default) will be shown according to the detected product.

Auto Max X16Calculates link width automatically up X16 (T416)

Auto Max X8 Calculates link width automatically up X8 (T48)

Auto Max X4 Calculates link width automatically up X4

Auto Max X2 Calculates link width automatically up X2

Fixed X1 Link is assumed to be always X1

Fixed X2 Link is assumed to be always X2

Fixed X4 Link is assumed to be always X4

Fixed X8 Link is assumed to be always X8

Fixed X16 Link is assumed to be always X16

Note: If the bus goes to a link width is different from the one selected as a fixed option, the trace will be full of errors. In this case, select the Auto option.

Note: When selecting Auto in the Link Width drop-down list, the embedded software is able to find the correct link width even if the link does not go through a training sequence.

Note: If an Auto Link Width is selected, there is no Lane Reversal. If a Fixed Link Width is selected, the Reverse Lanes checkbox is enabled. See Figure 5.39 on page 228 for the T416 and Figure 5.40 on page 229 for the T48

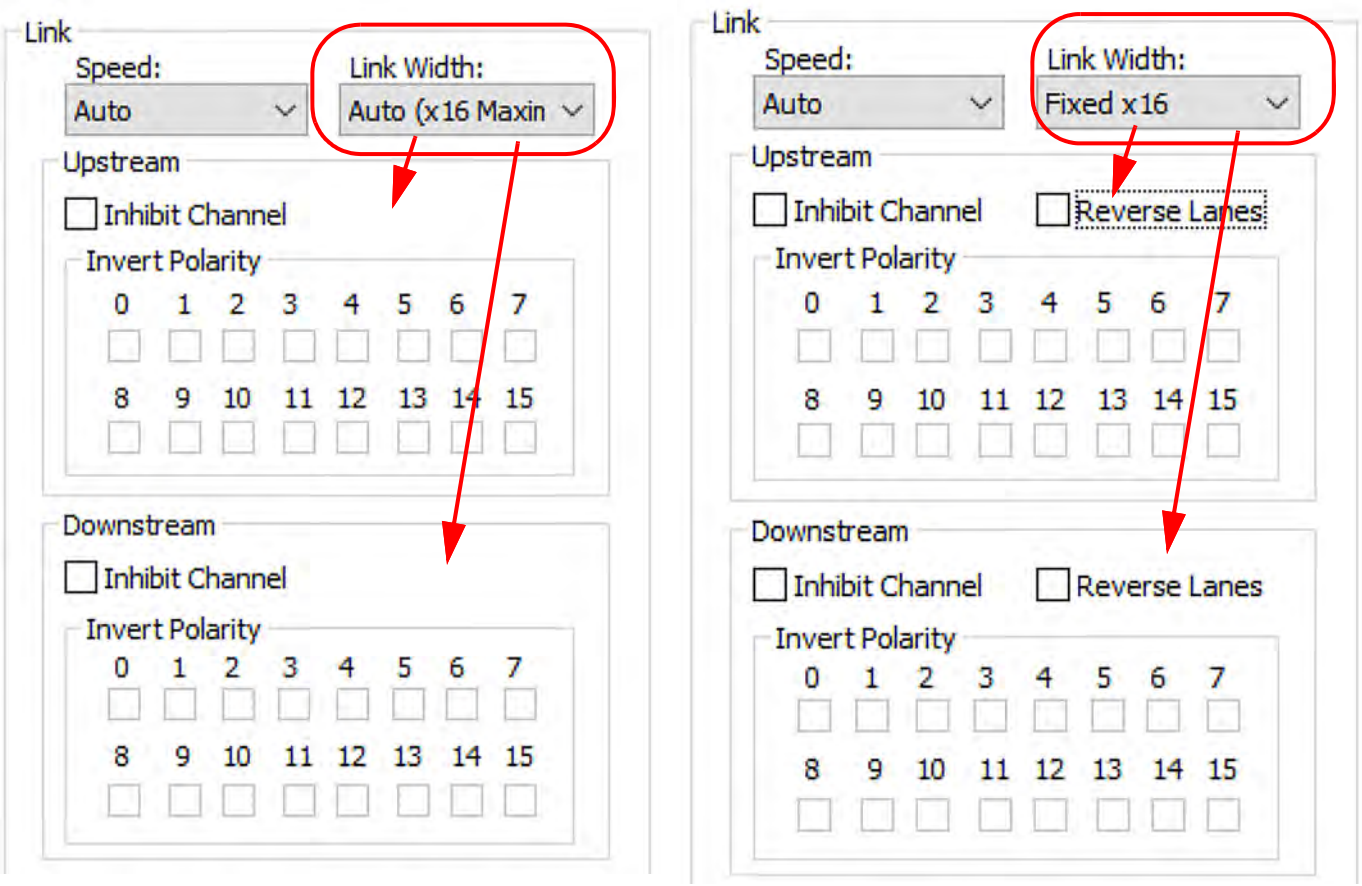


Figure 5.39: T416 Link Width: Auto -> No Lane Reversal,
Fixed Lane Width -> Lane Reversal Check Box is Enabled

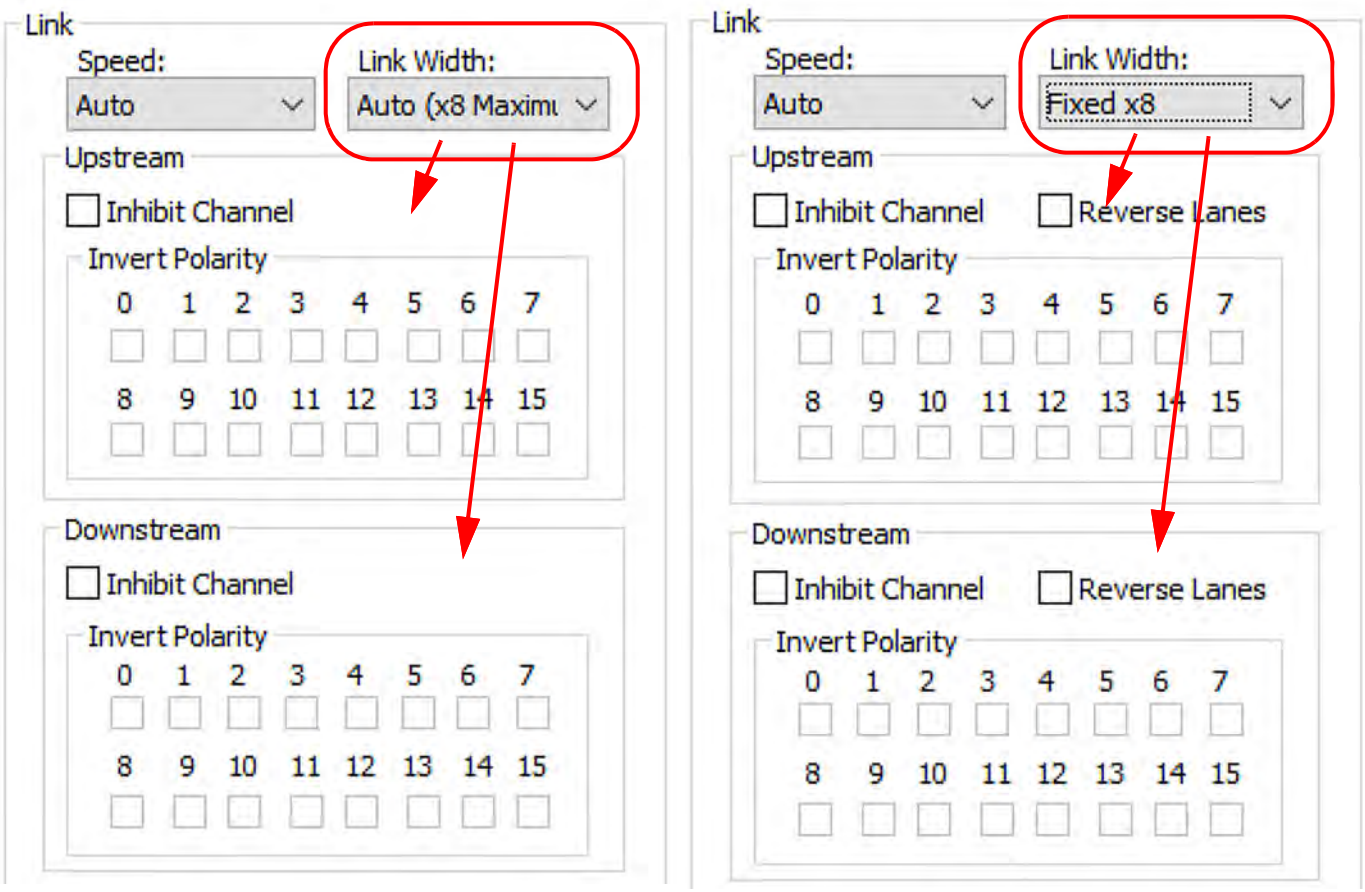


Figure 5.40: T48 Link Width: Auto -> No Lane Reversal,
Fixed Lane Width -> Lane Reversal Check Box is Enabled

5.15.3 Upstream and Downstream

Gives you low-level control over each link direction. The heading for these boxes indicates the port and/or unit to which the following options are applied based on the current Analyzer configuration (see Figure 5.1 on page 187: 3C and 3E for the T416, see Figure 5.2 on page 188: 3C and 3E for the T48).

- Inhibit Channel: Do not record/upload this channel
- Reverse Lanes: Manual lane reversal. If Auto-Configure Lane Swizzle is set, the Reverse Lanes option will be ignored.
- Invert Polarity

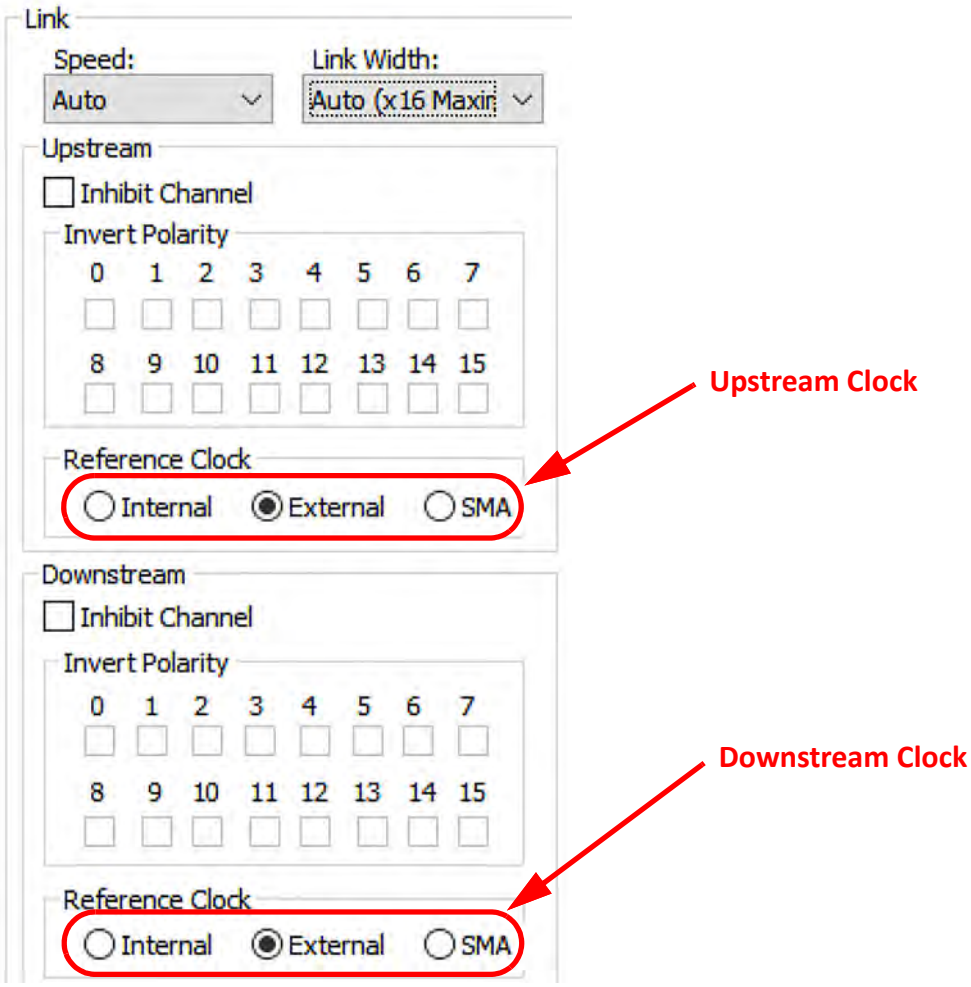


Figure 5.41: Link Settings: Upstream and Downstream

The clock source is the same for both Upstream and Downstream unless you select the Set Reference Clocks Independently checkbox (see “Reference Clock” on page 230).

5.15.4 Reference Clock

See Figure 5.1 on page 187: 3D for the T416, see Figure 5.2 on page 188: 3D for the T48 or refer to the figure above (Figure 5.41 on page 230).

Usually, both Upstream and Downstream directions use the same clock option this is why the recording option Reference Clock Independently is set by default.

In cases when you have to use different clocks for the different traffic directions you must select the “Set Reference Clock Independently” option (see Figure 5.1 on page 187: 3G) and set the upstream and downstream clock to come from different sources. See Figure 5.42.

You can chose the Reference Clock to be one of three sources: the Internal Clock (100MHz +/-300ppm No SSC clock generated in the analyzer), an External Source

(Reference clock from the PCIe bus routed through the interposer cable) or SMA connector on the front panel.

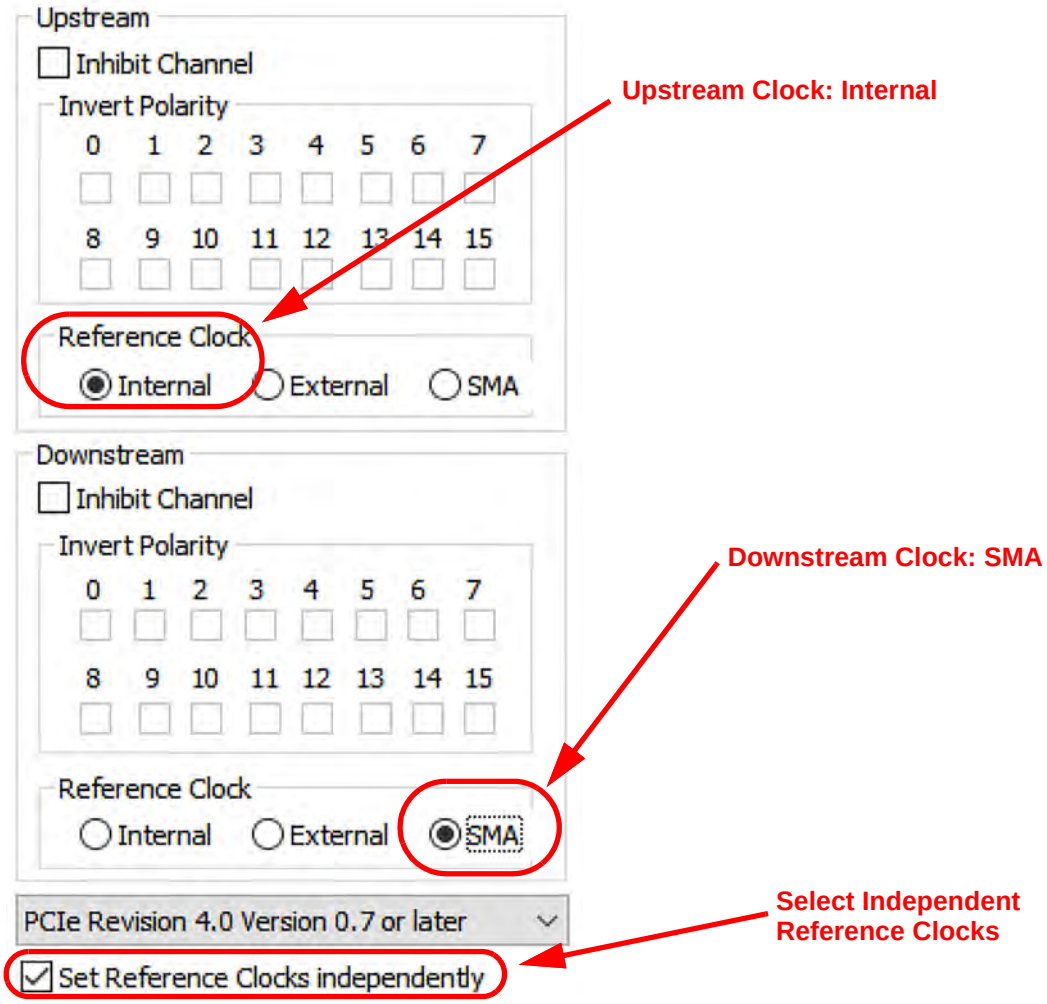


Figure 5.42: Setting Clocks to Come from Different Sources

5.15.4.1 Internal

The analyzer has an internal clock generator that can be used for recording when the Device Under Test does not supply a reference clock. In this case, you de-select the External Reference Clock checkbox.

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.

5.15.4.2 External

For the T416 or T48, External Clock means to use the clock that is supplied through the Y iPass cable. The iPass cable gets its clock from the specific interposer being used with the analyzer, which in turn may have up to two different clock sources: RefClk from the PCIe edge connector (all interposers have this option) or the SMA connectors. You also need to select the External Reference Clock checkbox.

Teledyne LeCroy's latest interposers (Gen3) usually support separate clocks for SRIS applications.

Note: If the PCI Express link under analysis uses spread-spectrum clocking, then the Analyzer must use an external reference clock from the system. Select the External Reference Clock checkbox.

5.15.4.3 SMA

The SMA clock recording option refers to the **Ref Clk In** SMA input connectors on the front panel of the analyzer. This recording option in the user interface controls both Upstream and Downstream clock selection. When using the SMA option both clock cables must be connected and the clock must be supplied by the system in order for the recording to happen correctly. The standard PCI Express compliant reference clock is supported. You also need to select the SMA Reference Clock checkbox.

Note: For Summit T416 in MultiPort mode 4 x4, SMA selection is not available for ports A and B.

Note: In MultiPort mode, SMA trigger out is disabled.

5.15.5 PCIe Specification Compatibility

You can select which version of the PCIe Specification (see Figure 5.1 on page 187: 2H for the T416, see Figure 5.2 on page 188: 2H for the T48) you want to apply:

- ❑ PCIe Revision 4.0 Before Version 0.7
- ❑ PCIe Revision 4.0 Version 0.7 or later
- ❑ PCIe Revision 5.0

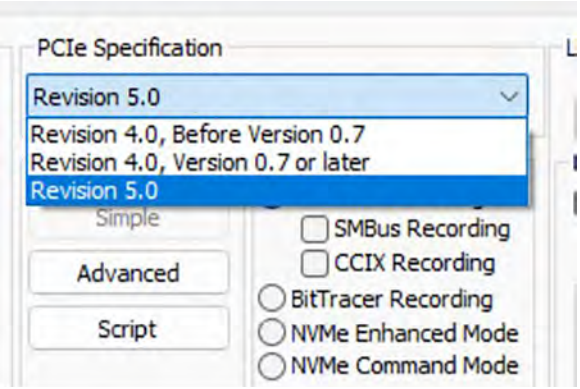


Figure 5.43: Recording Options: PCIe Specification Compatibility

5.15.6 Disable Descrambling

If checked, causes the Analyzer to assume that none of the PCI Express traffic is scrambled. By default, the Analyzer determines the scrambling state of the devices under test (see Figure 5.1 on page 187: 3H for the T416, see Figure 5.2 on page 188: 3H for the T48).

Note: When selecting Gen3 speed the disable scrambling option is not available. This option can be used only for Gen1 or Gen2 speeds. It will show as well for Auto speed but it affects only Gen1 or Gen2 traffic.

5.15.7 Auto-Configure Lane Polarity

Lets the Analyzer determine lane polarity (see Figure 5.1 on page 187: 3I for the T416, see Figure 5.2 on page 188: 3I for the T48). Auto functions such as Auto Configure polarity rely on Gen1 or Gen2 training sequences to properly discover their values. If the speed option is set to fixed Gen3, the analyzer will never see these sequences and the polarity discovery will not be reported properly in the dashboard dialog.

5.15.8 Ignore EDS

Lets the Analyzer ignore End of Stream (EDS) token. See Figure 5.1 on page 187: 3J for the T416, see Figure 5.2 on page 188: 3J for the T48.

5.15.9 Ignore Idle Errors

When set, the analyzer will not store errors in between packets into memory. This option helps to preserve analyzer memory to store more packets in cases where memory efficiency is critical. This option filters out Compliance Pattern as well. See Figure 5.1 on page 187: 3K for the T416, see Figure 5.2 on page 188: 3K for the T48.

5.15.10 Swizzling Config...

The Swizzling Config dialog allows you to reconfigure the logical order of the lanes in a link separately for Upstream and Downstream PCIe directions. You can perform the logical

to physical assignment manually or let the analyzer detect this on its own (Auto-Configure Lane Swizzle option checked). See Figure 5.1 on page 187: 3L for the T416 or Figure 5.2 on page 188: 3L for the T48 and Figure 5.44 on page 235).

Note: Autoswizzle works only when the analyzer sees the LTSSM Configuration state link training sequence.

5.15.10.1 Manual Configure Lane Swizzle

If you know how your physical link is connected and the lane numbers advertised for each lane, then you can use the manual swizzle option (Auto-Configure Lane Swizzle option unchecked). On the Swizzling Configuration dialog, drag the number of the logical lane (in blue) to the desired lane physical position.

In the case shown below the Link Width is set to Auto (x16 Maximum) for the T416 , so all 16 lanes are available to be manually configured. See Figure 5.44 on page 235 for the T416.

Note: If you are using the Summit T48 the maximum Link Width will be x8 but the concepts of Lane Swizzling are the same.

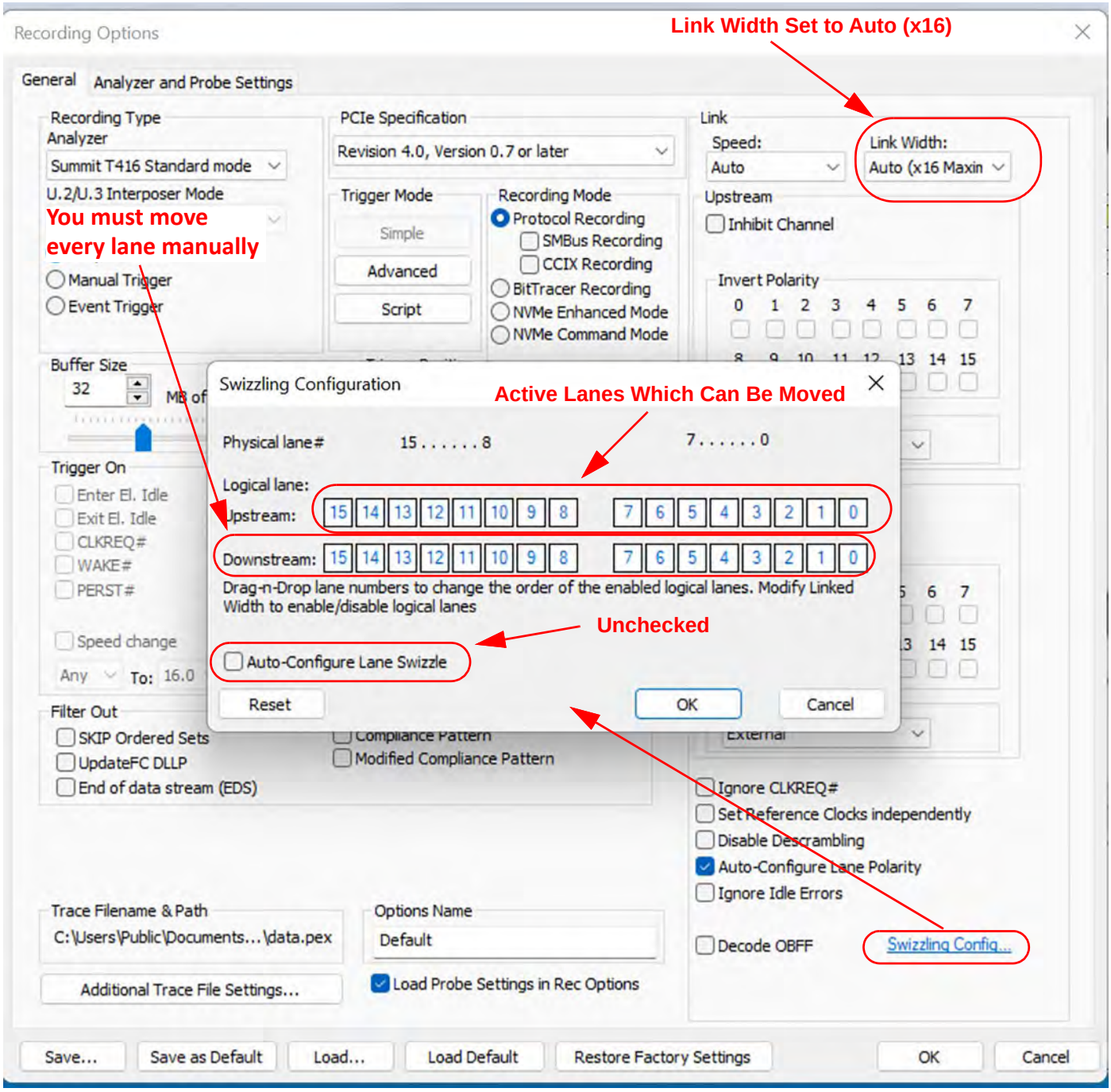


Figure 5.44: Manual Swizzle: Link Width Set to Auto (x16)

In the example shown below, we re-assigned the Upstream Physical lanes as follows:

- Lane 7 to Lane 15
- Lane 6 to Lane 14
- Lane 5 to Lane 13
- Lane 4 to Lane 12
- Lane 3 to Lane 11
- Lane 2 to Lane 10
- Lane 1 to Lane 9

- Lane 0 to Lane 8

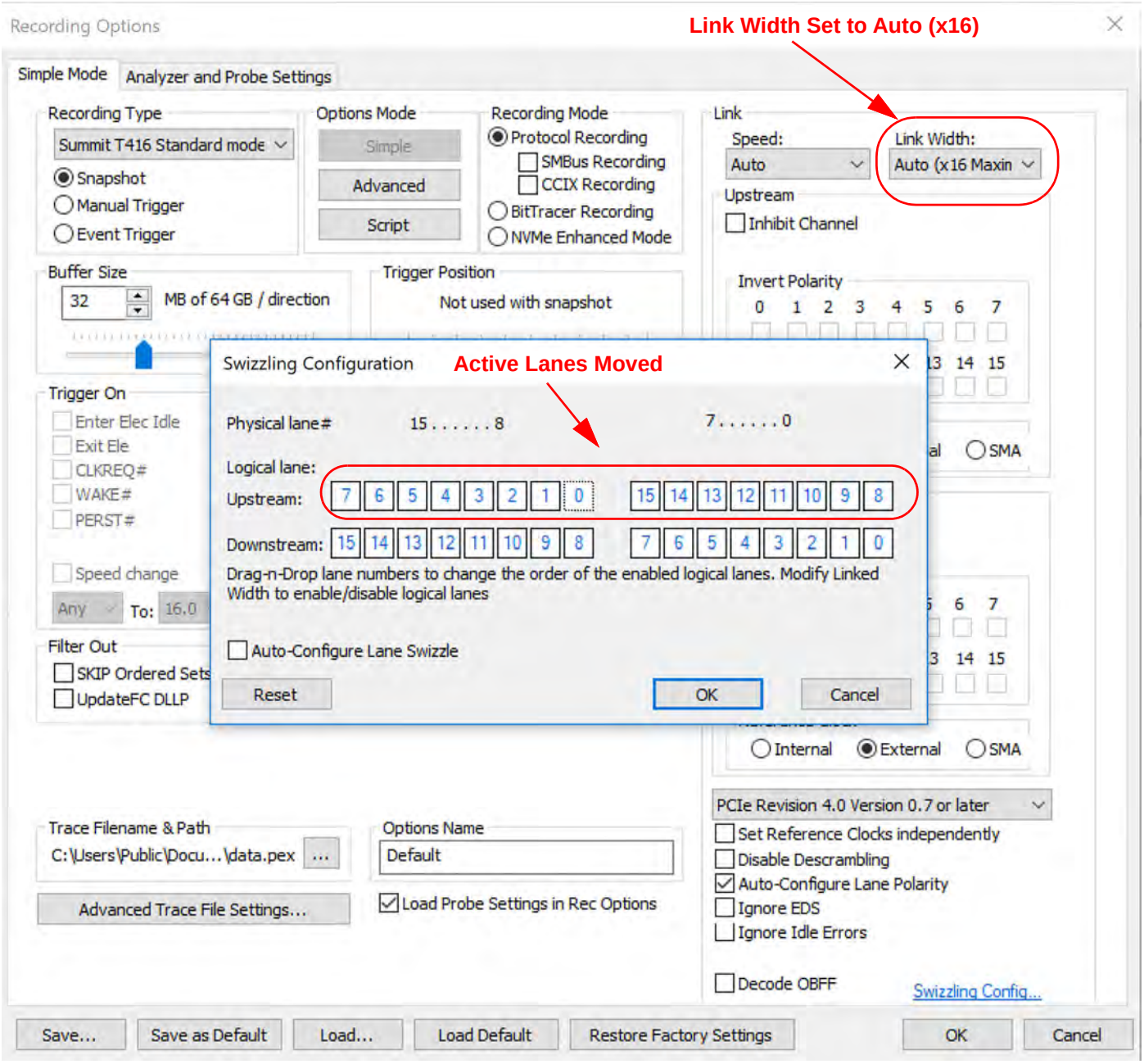


Figure 5.45: Manual Swizzle Configuration

Note: The simplest way to make new lane assignments is to always move the highest source lane number to the highest destination lane number.

Note: If the source lane has a lower number than the lane it is replacing, then the software performs a right shift to the higher numbered replaced lane. If the source lane has a higher number than the lane it is replacing the software performs a left shift to the lower numbered replaced lane.

5.15.10.2 Example: Move Highest Source Lane First

In the example below we replaced Lane 7 with Lane 3 and Lanes 7 through 4 were shifted to the right. Then Lane 7 was replaced with Lane 2 and Lanes 7 through 4 were shifted to the right. Then Lane 7 was replaced with Lane 1 and Lanes 7 through 4 were shifted to the right. Finally Lane 7 was replaced with Lane 0 and Lanes 7 through 4 were shifted to the right.

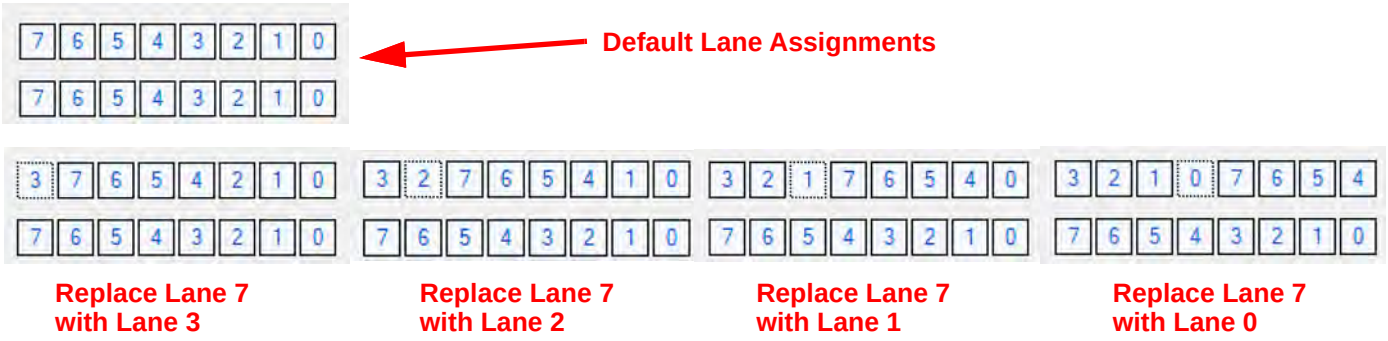


Figure 5.46: Manually Moving Lane Assignments: Highest Numbered Lane First

5.15.10.3 Example: Move Lowest Source Lane First

If you start with the lowest numbered lane you will get completely different results.

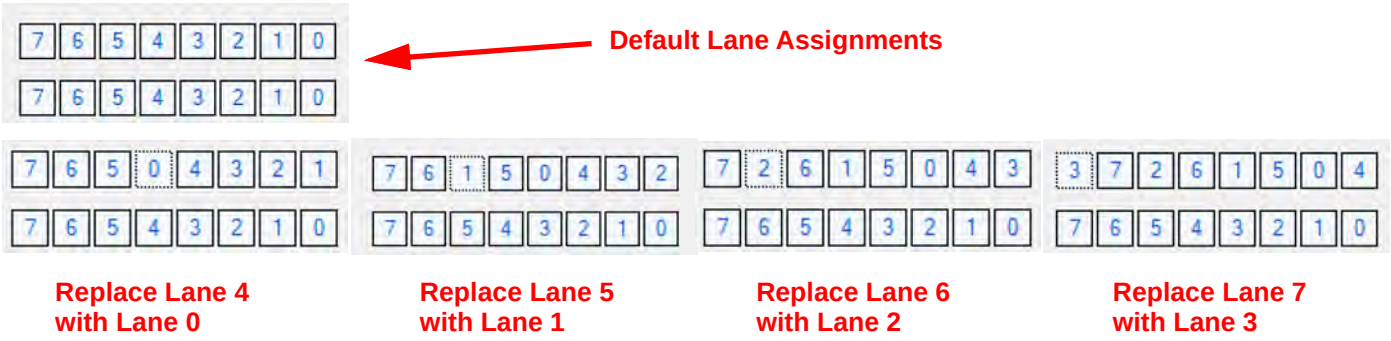


Figure 5.47: Manually Moving Lane Assignments: Lowest Numbered Lane First

5.15.10.4 Working with Less Than Sixteen Lanes

If the lane number in the box is not in blue this means that the lane is not participating in the link from the Summit analyzer's point of view. This may happen because the Link Width selected is less than x16. See Figure 5.48.

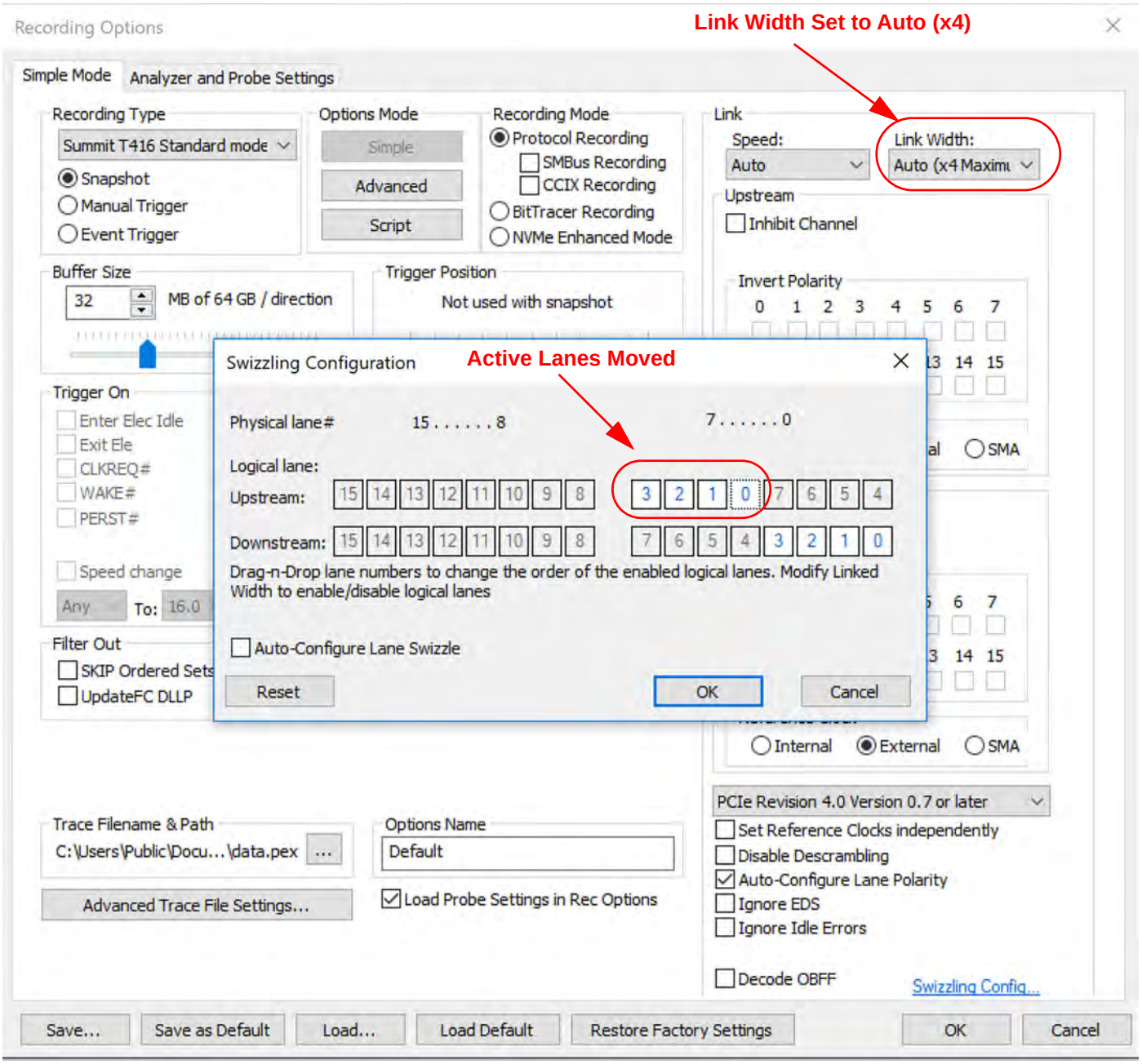


Figure 5.48: Manual Lane Swizzle Configuration: Moving Four Lanes

Note: In the example above Lane 0 through Lane 3 are the only active lanes. They can be moved to any lane that the analyzer supports. The analyzer in this case is the Summit T416, which can support 16 lanes.

If you need the logical lane to be assigned to a position that has a number in gray color, you need to make sure the Link Width can support that lane by increasing the Link Width option. In the case shown below, we wanted to move Lane 7 to Lane 15. To make Lane 7 an active lane we had to increase the Link Width to x8. See Figure 5.49

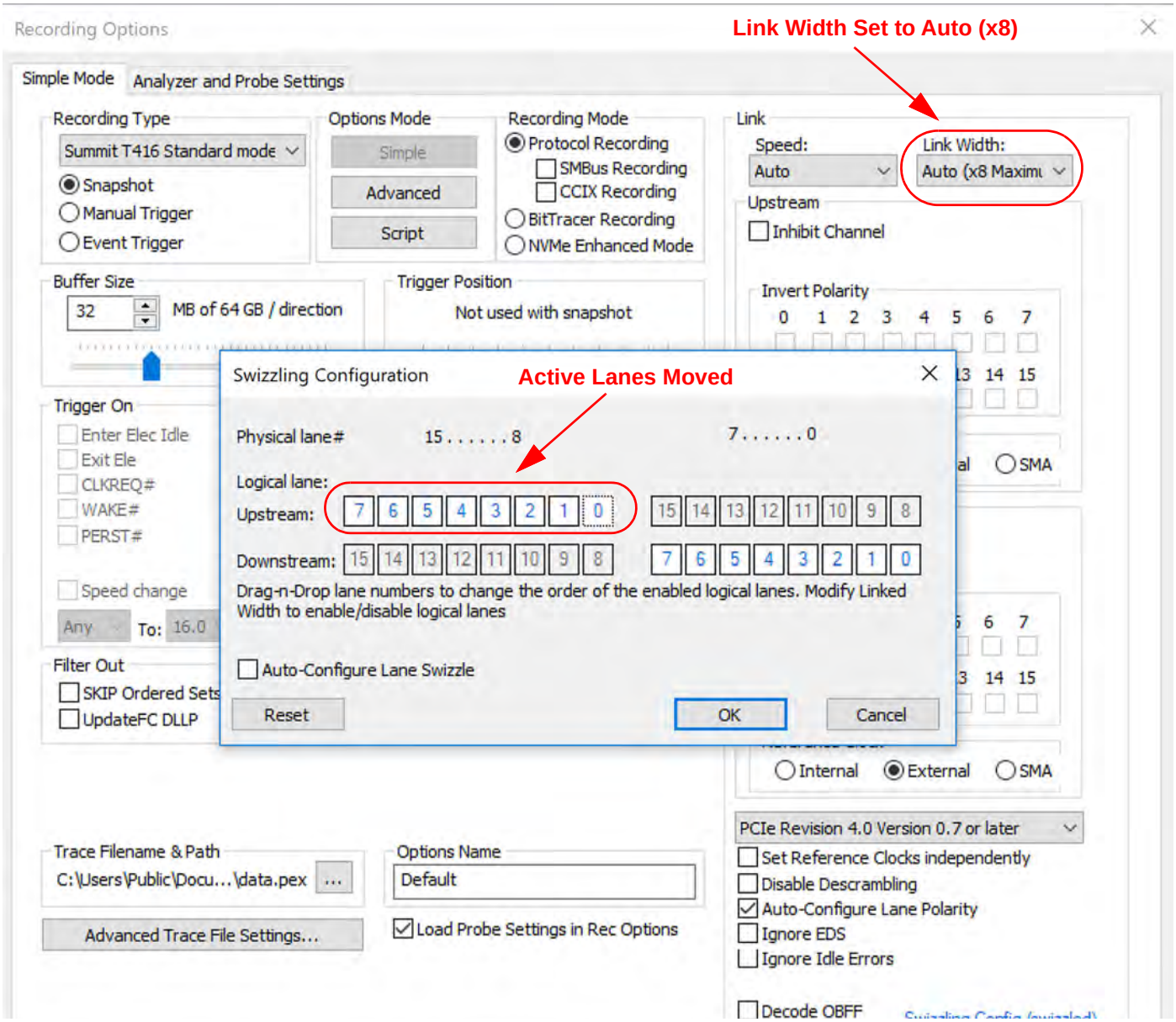


Figure 5.49: Manual Lane Swizzle Configuration: Moving Eight Lanes

Note: If the link you are trying to analyze is lower than x16 and the lane resides in a grayed position you need to select the Auto Link Width option that will include the physical lane to use.

5.15.10.5 Auto-Configure Lane Swizzle

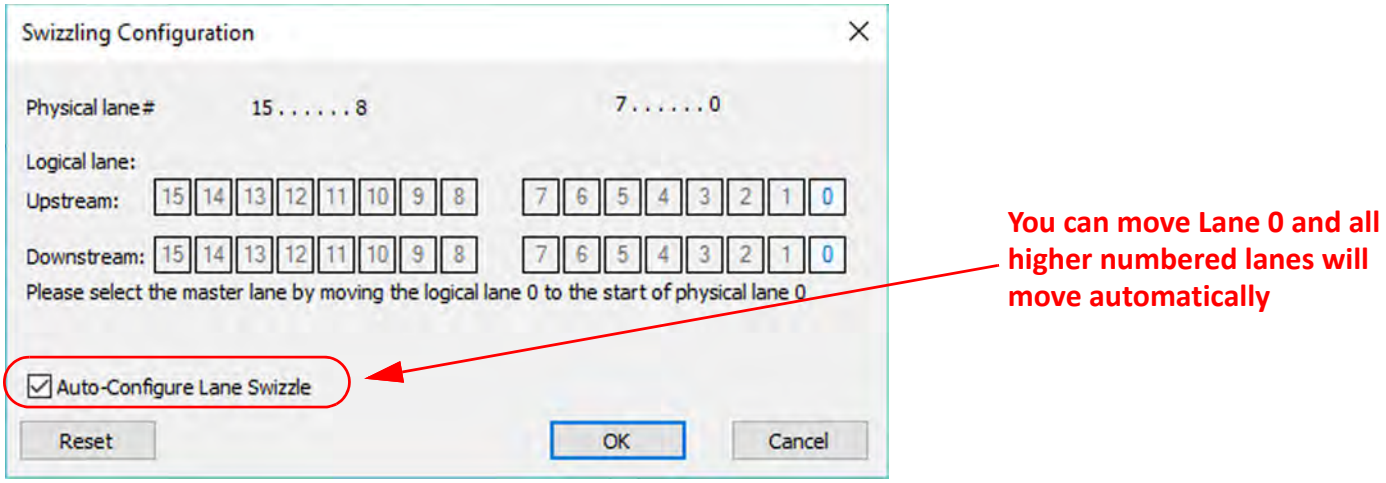


Figure 5.50: Swizzling Config Dialog

When the Auto-Configure Lane Swizzle option is checked the Summit Analyzer requires you to provide the physical location for at least one lane with active traffic. You can specify this by moving the enabled lane L0 to the physical location where either lane 0 is or any other active lane for the link. See Figure 5.51 on page 241.

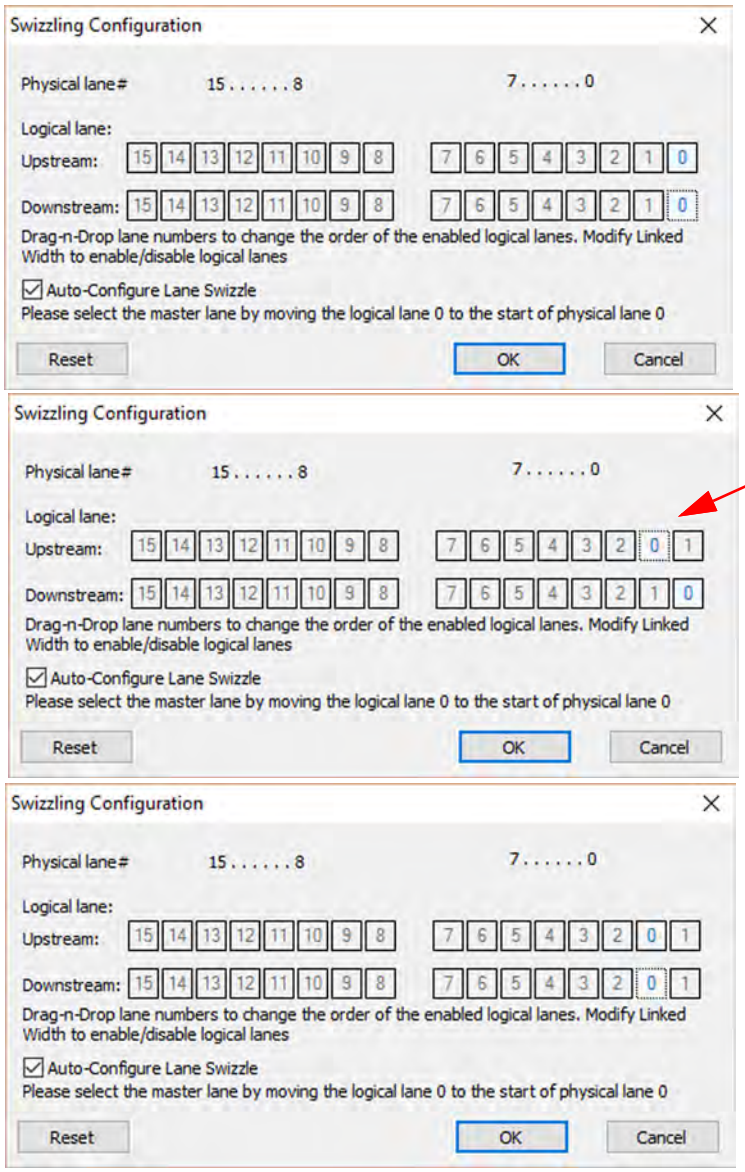


Figure 5.51: Manually Configuring Lane 0 when Auto-Configure Lane Swizzle is Checked

Note: Auto-Configure Lane Swizzle will not work properly if the link is bifurcating. Use manual swizzle instead.

5.15.11 Decode Optimized Buffer Flush/Fill (OBFF)

Select this checkbox to decode Optimized Buffer Flush/Fill (OBFF) events. See Figure 5.1 on page 187: 3M for the T416 or Figure 5.2 on page 188: 3M for the T48). As a system operates, each of its devices does not know the power state of each of the resources in the system. Without coordination, each of the devices will go in and out of their low-power states as necessary to execute the tasks they are assigned to do. This "asynchronous" behavior prevents the optimal power management of the CPU, host

memory sub-system and other devices, because the intermittent traffic keeps the system permanently awake and unable to optimize power management across the system.

As part of an implementation of a system-level power strategy, the idle time and low-power states of the devices must be optimized to enable them to stay in their low-power states longer. Basically, a host can provide information to all devices by broadcasting a message about the system power state. The devices can utilize this information to group a load of requests, wait until the system wakes up, and burst out all of the requests at the same time. By doing this, the device does not wake up a sleeping CPU and/or the system memory sub-system. Waiting creates extended periods of system inactivity which saves overall system power. The host utilizes the OBFF to give devices a "hint" so they can optimize their behavior, which improves power management at the system level.

5.16 Navigating Recording Rules

The Recording Rules window has three main areas, the Toolbar, Available Events panel and the Main Display panel (see Figure 5.30 on page 217).

5.16.1 Toolbar

The toolbar contains buttons such as the New Events button for issuing commands, Delete Current Event, Undo, Redo, Zoom in and out, Show/Hide Channels, Properties, and Lane Trigger Configuration.

5.16.2 Available Events Area

The Available Events area is in the left repository panel where you can park buttons that you intend to use in the Main display area. The events in this panel do not affect the recording. You can drag and drop events in the Main Display panel.

5.16.3 Recording Rules: Main Display Area

The Main Display area is the right panel where you create trigger and filter conditions. You create conditions by dragging buttons onto the Main display area from the Available Events area. You then create additional conditions by right-clicking a button and selecting options from a pop-up menu. See Creating Recording Rules.

5.16.4 Recording Rules Buttons

The Recording Rules toolbar allows you to create and edit recording rules:



TABLE 5.2: Recording Rules Toolbar Buttons

New event	New Event. Opens a drop-down menu with a list of events.		Zoom in
	Delete. Delete selected event.		Zoom out
	Undo. Undoes last action.		Show/Hide Channels. Shows/hides the channel buttons.
	Redo. Undoes last Undo command.		Show properties. Opens the Properties dialog for the selected item.
	Lane Trigger Configuration: Sets lane pre-conditions for event categories.		

5.17 Recording Rules Overview

The Recording Rules allows you to specify complex triggering and filtering options. The Summit T416 and Summit T48 monitor incoming traffic and looks for specified events. It performs actions like triggering and filtering. Complex options can be created by putting Events in a sequence.

Events are based on Resources (see “Resources” on page 247).

5.17.1 Defining Recording Rules

The Recording Rules page is used to set triggers and filters. To access this page, select **Setup > Recording Options > Recording Rules**.

You can also access the New Event menu by right-clicking in the blue space in the Global State or in the Sequence State (see Figure 5.52).

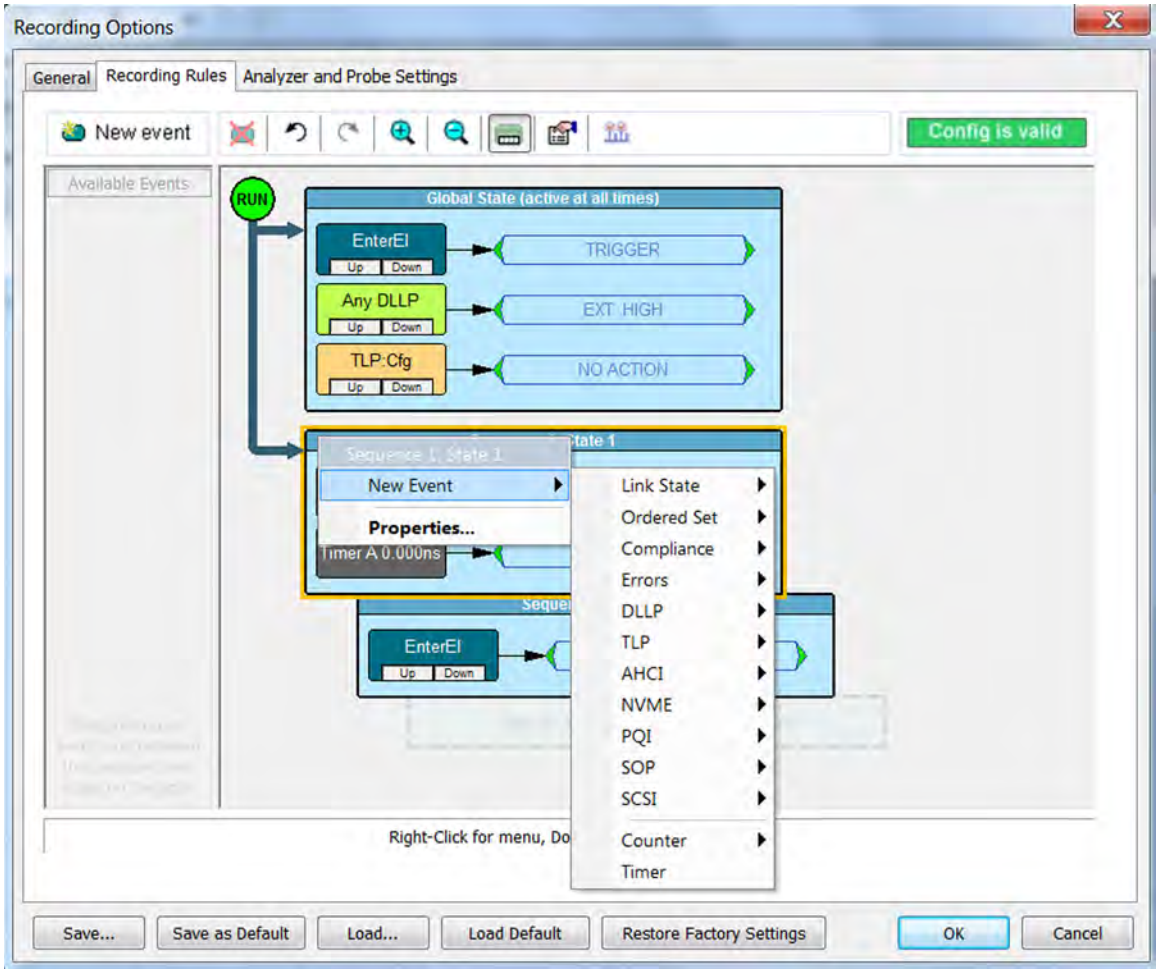


Figure 5.52: Defining New Events

5.17.1.1 Steps to Create a Recording Rule

There are three steps to creating a recording rule:

1. Select events.

2. Place the events in the Global State or Sequence cells.
3. Assign actions to the events.

Note: There are limits to the types of rules that can be created.

1. Click New event and select one or more events from the menu (see Figure 5.53). Selecting an event automatically places it in the Available Events area. This repository area serves as a parking lot where you can place event buttons without them having any effect on the Analyzer.

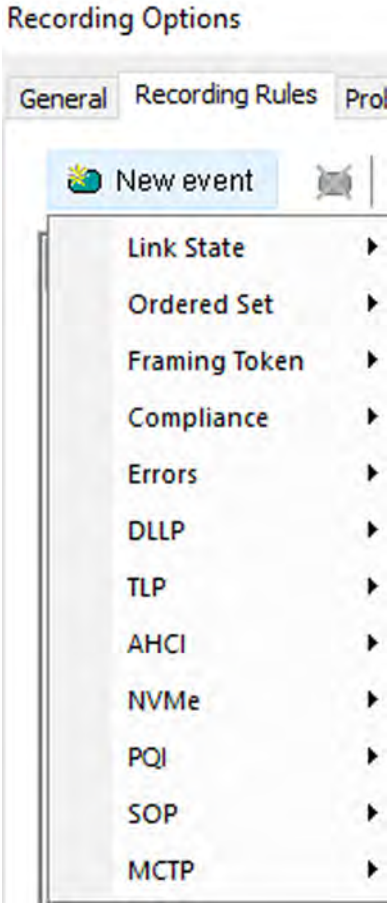
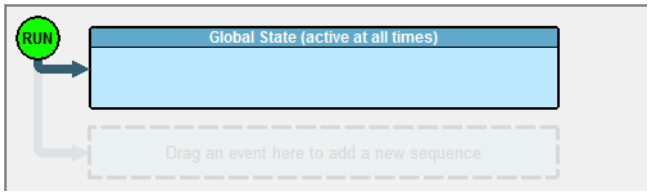


Figure 5.53: New Event Menu

2. Drag the selected events from the Available Events area into either the Global State Cell or the Sequence Cell (see “Recording Rules Overview” on page 245).



Global State Cell

If you want the Analyzer to always search for the event, place it in the cell marked **Global State**.

Sequence Cell

To create an event sequence, place two or more events in the faintly marked cell that reads **Drag an event here to add a new sequence**. At this point, the selected events have no effect because an action has not been assigned.

3. To select a sub-set of your selected event, right-click it and choose **Properties**. A Properties dialog opens that presents additional options. For example, if you open the Properties dialog for Errors, you can set the specific types of errors the Analyzer should look for.
4. Assign an action to the selected events by right-clicking each of the events, selecting **Specify Action** from the pop-up menu, and assigning an action such as **Trigger, Filter**, or **Count**. Be sure to click the event itself and not the **State** cell that it is sitting in (which produces a different pop-up menu).

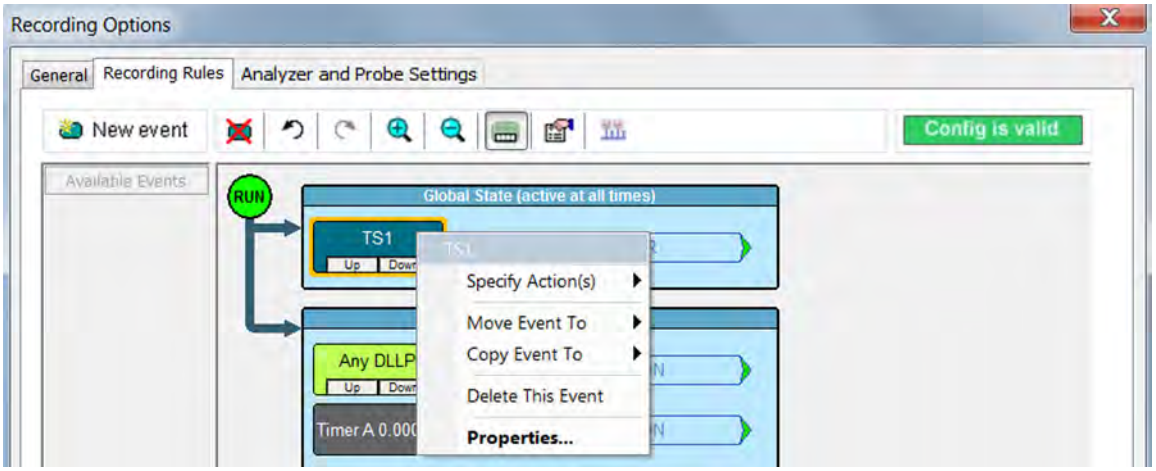


Figure 5.54: Assigning an Action

Note: You can also assign actions to events by double-clicking the event or action and selecting the Actions page when the Properties dialog opens (see "Event Properties Dialog Box Features" on page 262).

Click **OK** to close the dialog. At this point, assuming that the other options in the Recording Options dialog have been set (such as the General page), you can begin the recording by pressing the Start **Recording** button.

5.17.2 Resources

Events in Recording Rules are captured based on the Matching Resources available. There are four types of Matching Resources as follows:

- Basic Matchers (8 each)
- Ordered Set (OS) Matchers (8 each)
- Data Link Layer Packet (DLLP) Matchers (8 each)
- Transaction Layer Packet (TLP) Matchers (8 each)

These Matchers are hardware specific resources that are programmed internally to capture specified events and are not available to the user. Although they can be programmed to capture a wide variety of events you can define a very complex set of events which would need more resources than are available. It that case the Configuration button at the top right of the Recording Options dialog box will show Config is invalid .

If you click on the “Config is Invalid” box a detailed Warning message will pop up. See Figure 5.55 on page 248. In this case, too many basic resource events were defined in the Global State.

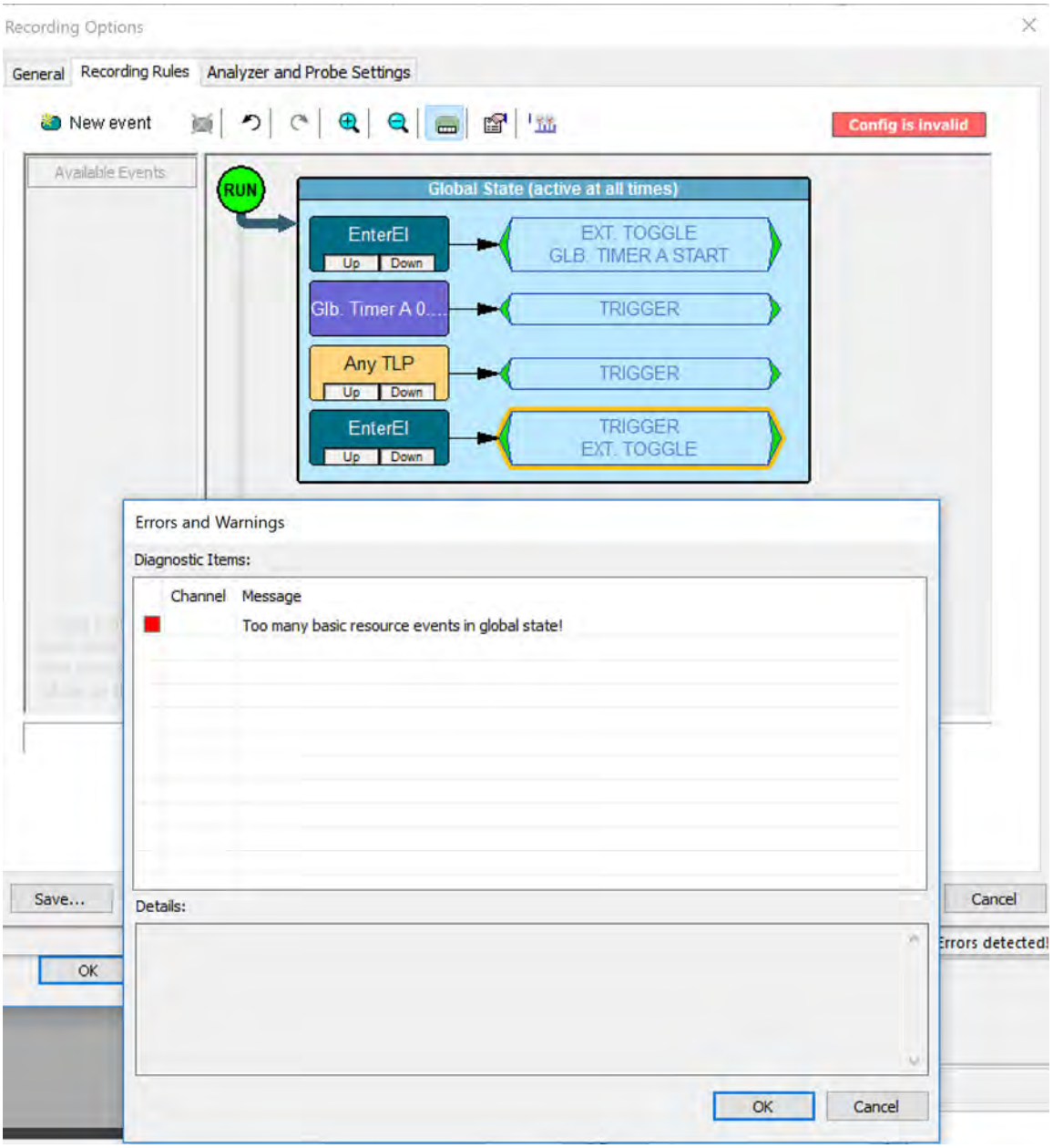


Figure 5.55: Config: Invalid -> Shows Warning Message

If you define a set of events that are missing actions or have inherent contradictions

you'll see the Configuration button show Config warnings . If you click on the Configuration button it will produce a list of issues that will need to be corrected before you get the Config is valid .

5.17.2.1 Basic Matcher (x8)

The Basic Matcher generally are used internally to detect the Link State set of Events. See Figure 5.56.

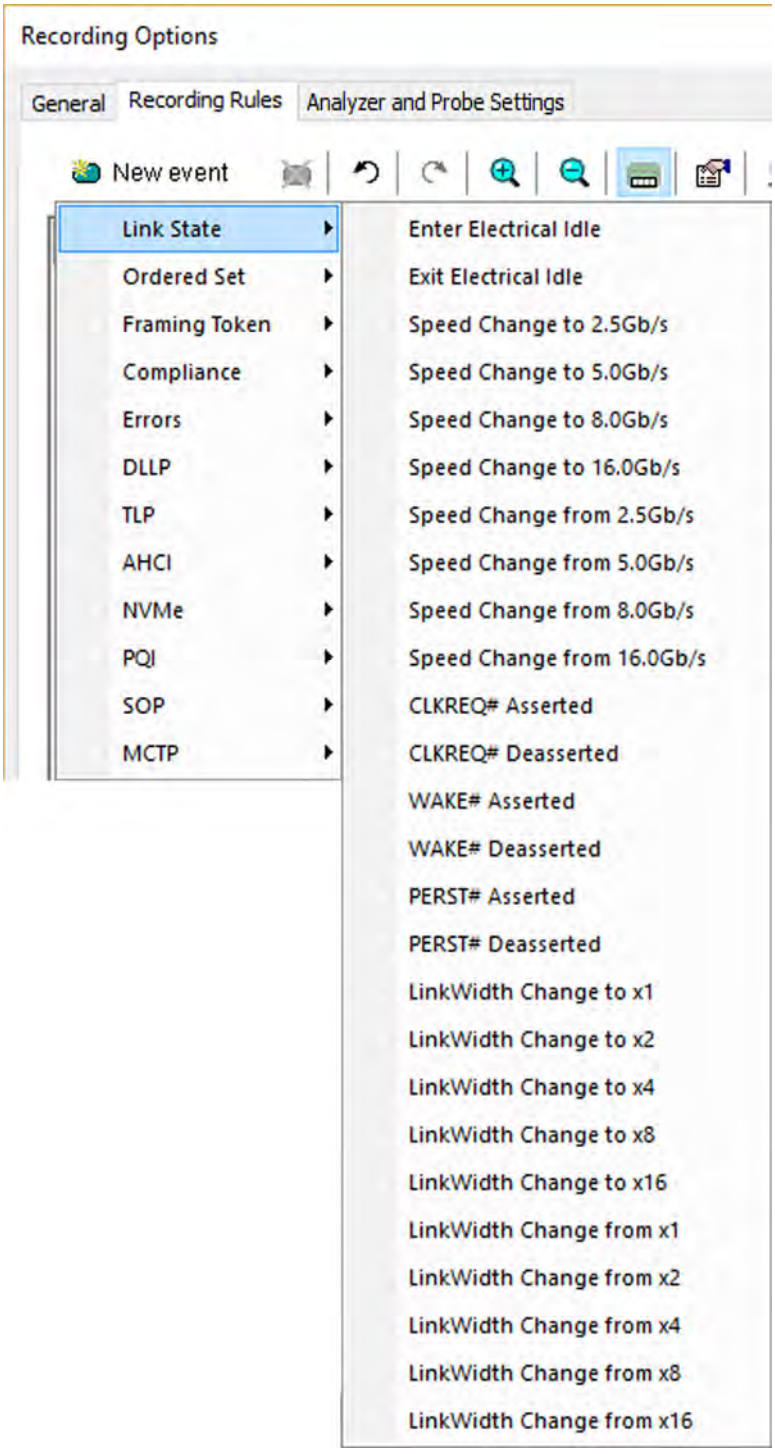


Figure 5.56: Setting Up a Packet Match Resource - Link State

5.17.3 Ordered Set (OS) Matcher (x8)

The Ordered Set Matcher is used internally to detect all of the Ordered Sets (OS). See Figure 5.57.

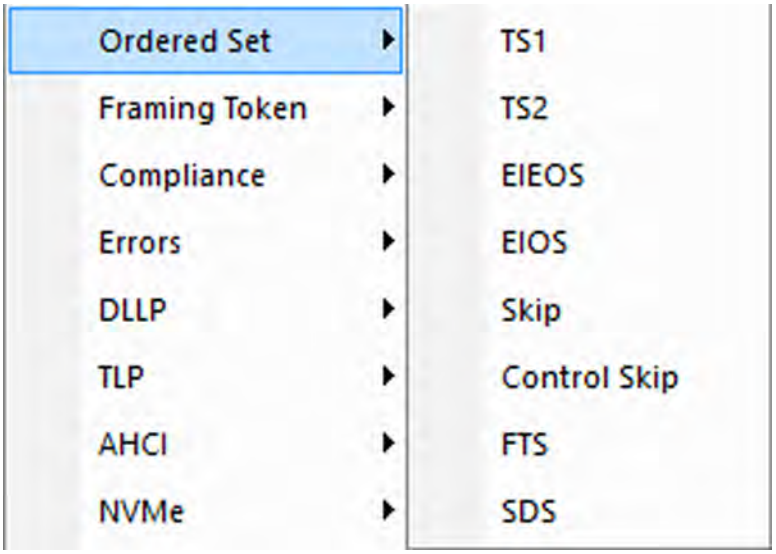


Figure 5.57: List of Ordered Sets (OS)

5.17.3.1 Trigger on Control Skip

You can trigger on Control Skips. See Figure 5.58 through Figure 5.62 on page 253.

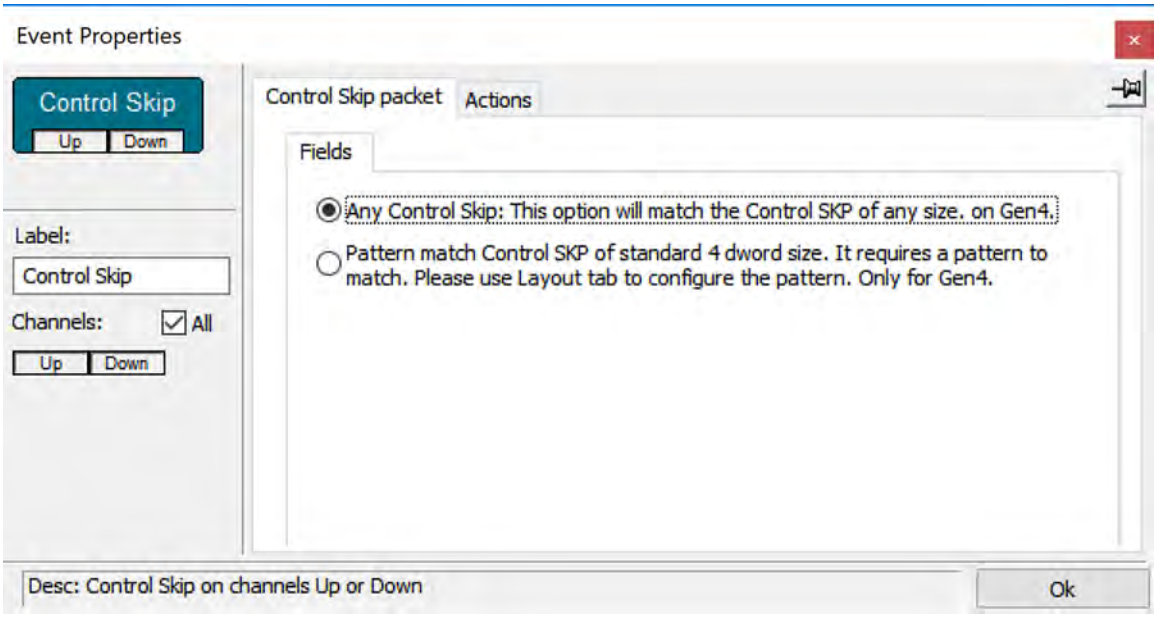


Figure 5.58: Trigger on Control Skips

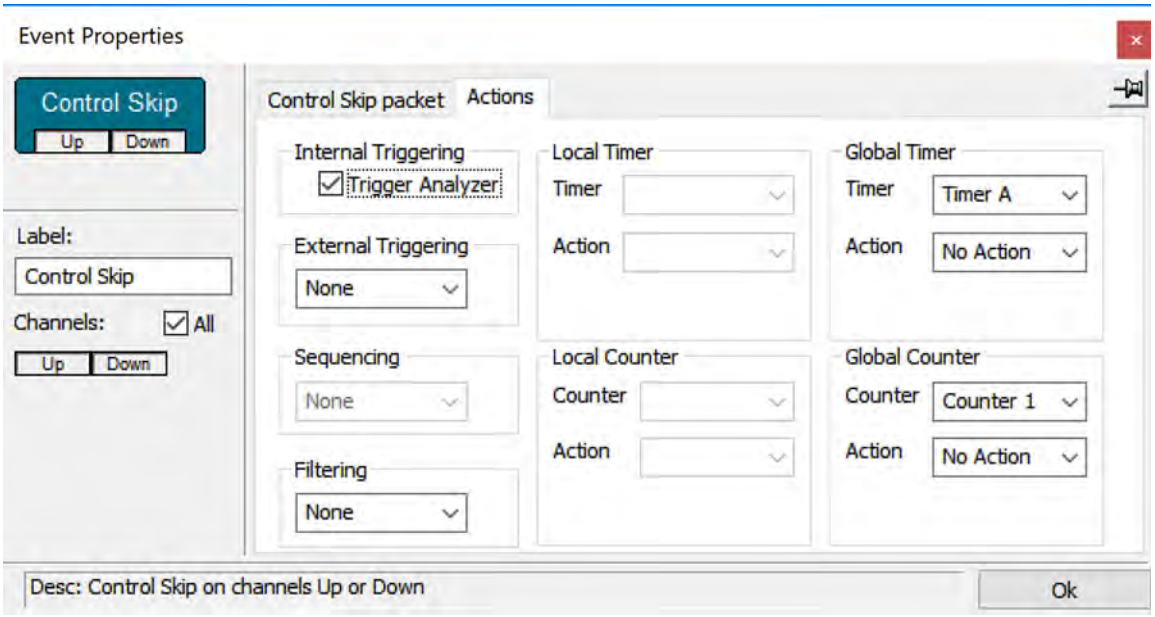


Figure 5.59: Trigger on Control Skip: Action -> Trigger Analyzer

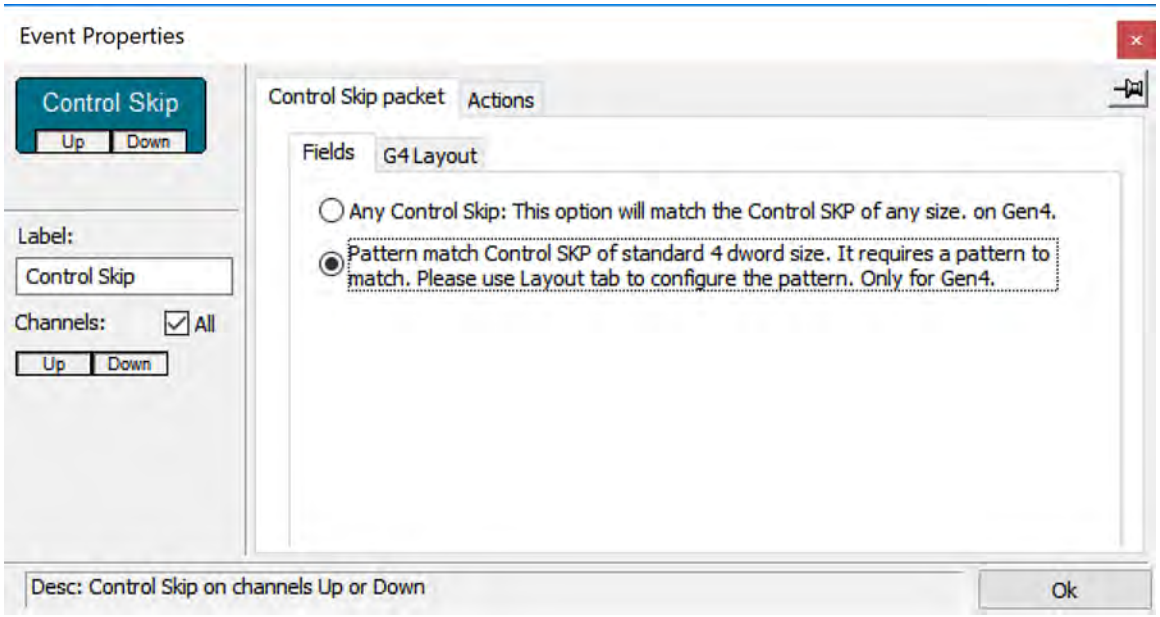


Figure 5.60: Trigger on Control Skip: Pattern Match

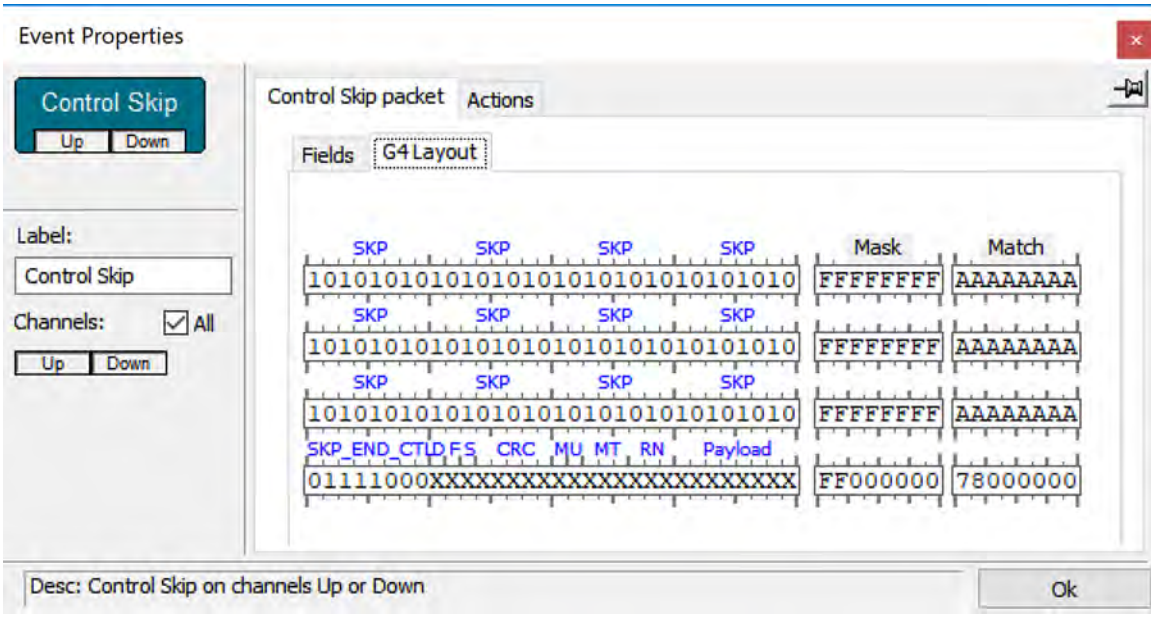


Figure 5.61: Trigger on Control Skip: Pattern Match -> G4 Layout

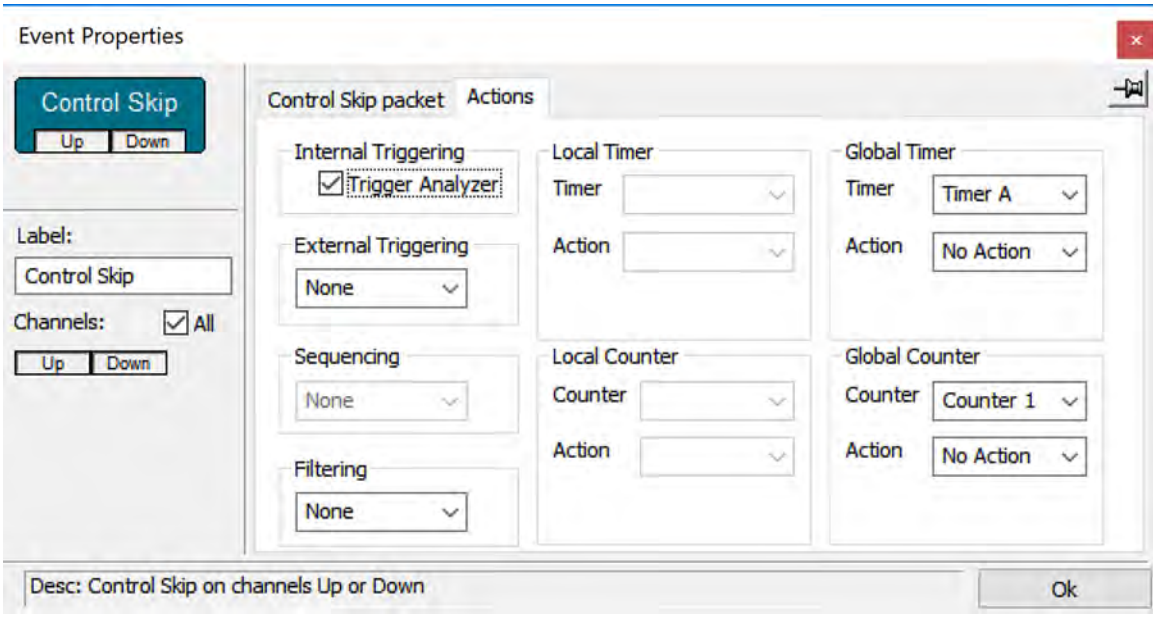


Figure 5.62: Trigger on Control Skip: Trigger Analyzer

5.17.4 Data Link Layer Packets (DLLPs) Matcher (x8)

The Data Link Layer Packets (DLLPs) Resource Matcher is used internally to detect DLLPs. See Figure 5.63.

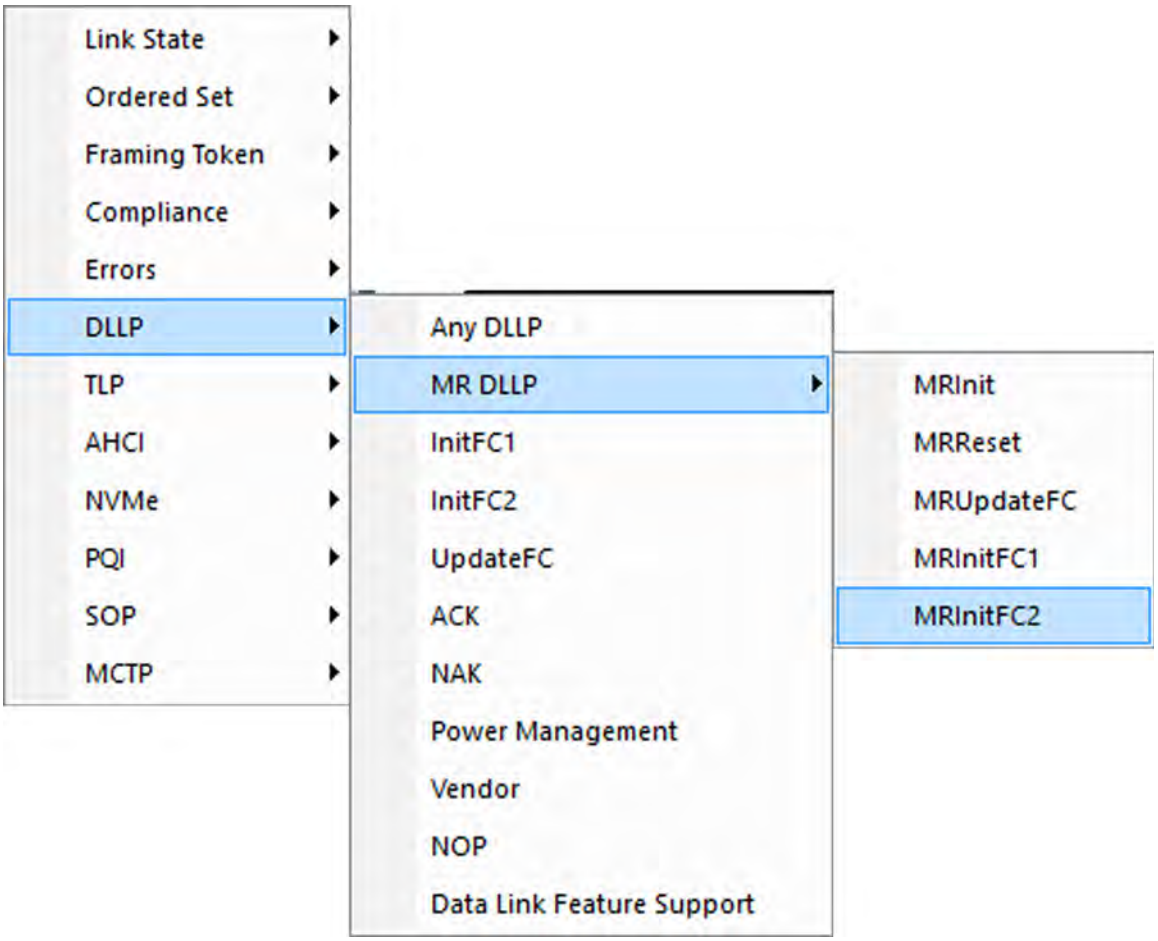


Figure 5.63: List of DLLPs

5.17.5 Transaction Layer Packets (TLPs) Matcher (x8)

The Transaction Layer Packets (TLPs) Resource Matchers are used internally to detect TLPs. See Figure 5.64.

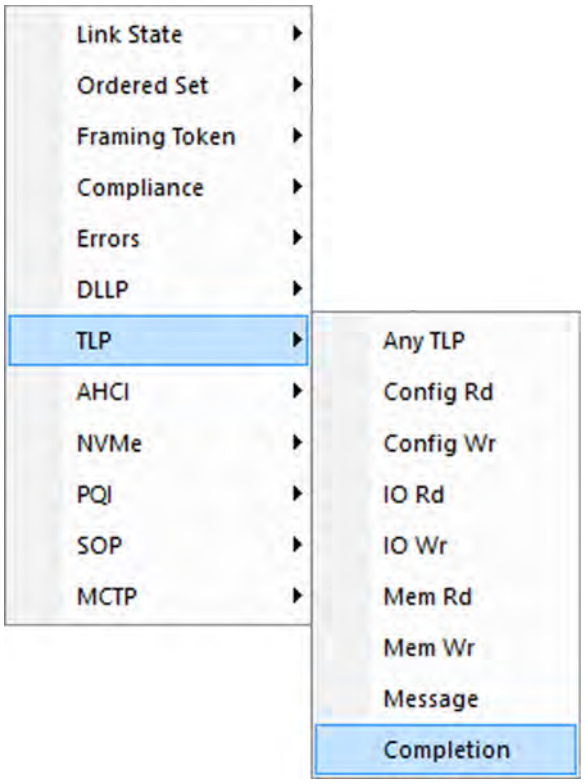


Figure 5.64: Transaction Layer Packets

5.17.6 Global State and Sequence States

The Main Display area in the center of the Recording Rules window has two cells that affect events differently, they are the Global State and Sequence State.



Figure 5.65: Global State Cell and Sequence State Cell

In the Global and Sequence State you can add events by clicking on the New Event button and after the event is in the State you can right-click to Specify Actions, Move, Copy or Delete the event. You can view the Properties dialog to make additional changes to the Property of the event (see Figure 5.65 on page 255). The description of these actions are given in Table 5.4 on page 296.

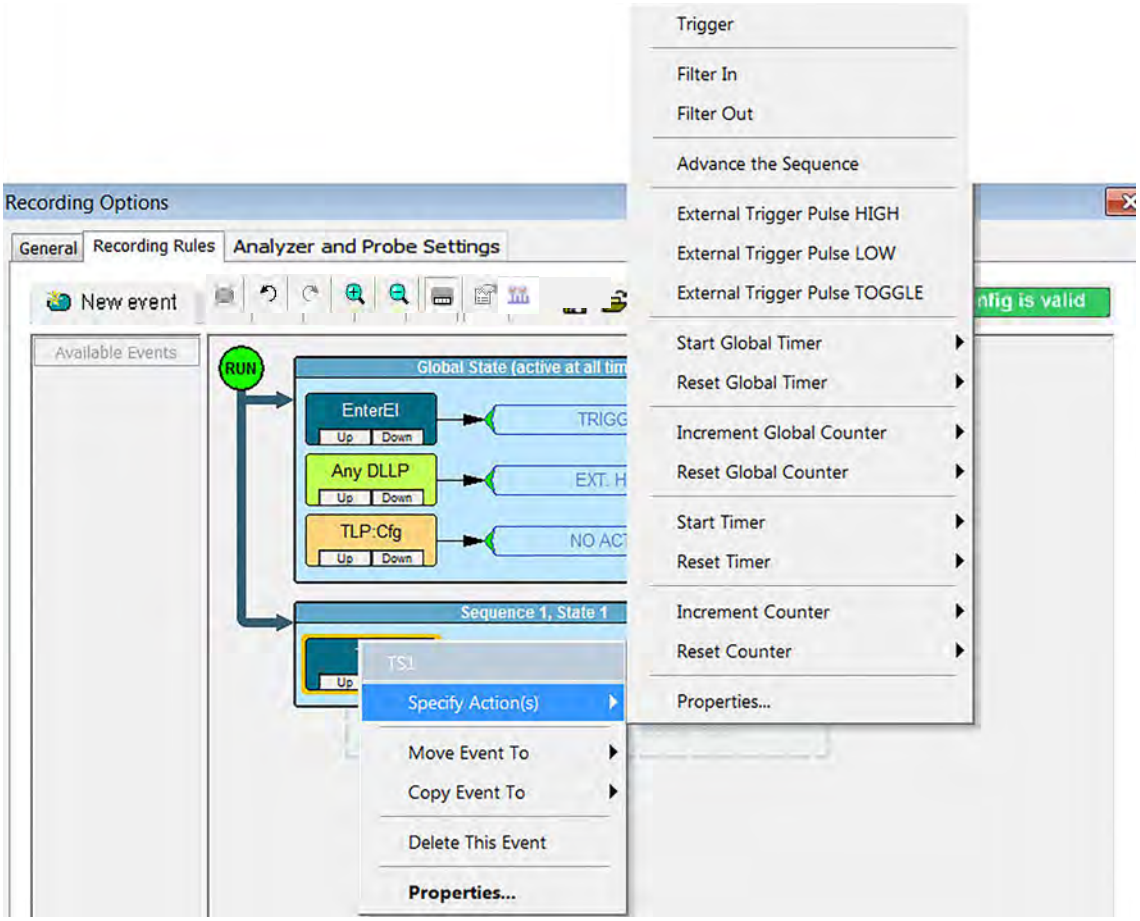


Figure 5.66: Global State Menu

5.17.6.1 Global State

The Global State is active all the time. The Summit T4 analyzers track all the Events and Actions defined in the Global State throughout the recording. In the Global State the Link State, Ordered Set (except TS1 and TS2), Errors, Counter and the Timer use Basic Resources while TLP, DLLP, TS1 and TS2 use Packet Match Resources. The Global State has two Timers and two Counters.

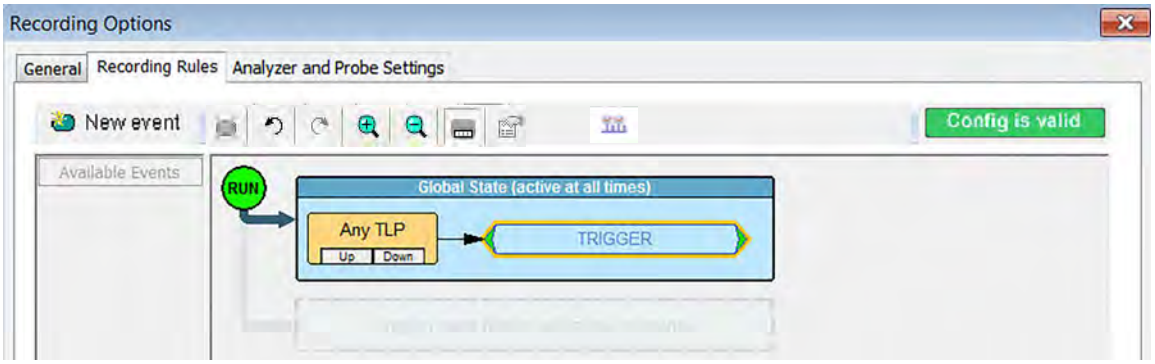


Figure 5.67: Global State

For the Global State there are only 2 Basic Resources for each Channel. Some optimization is done internally to accommodate additional resources. You can keep

adding resources to the Global state so long as the **Config is valid** button stays green. If you add a new event which is not valid a window appears with a message prompting **Invalid Recording Rules Configuration** and the **Config is valid** button will turn red (see Figure 5.68 on page 257).

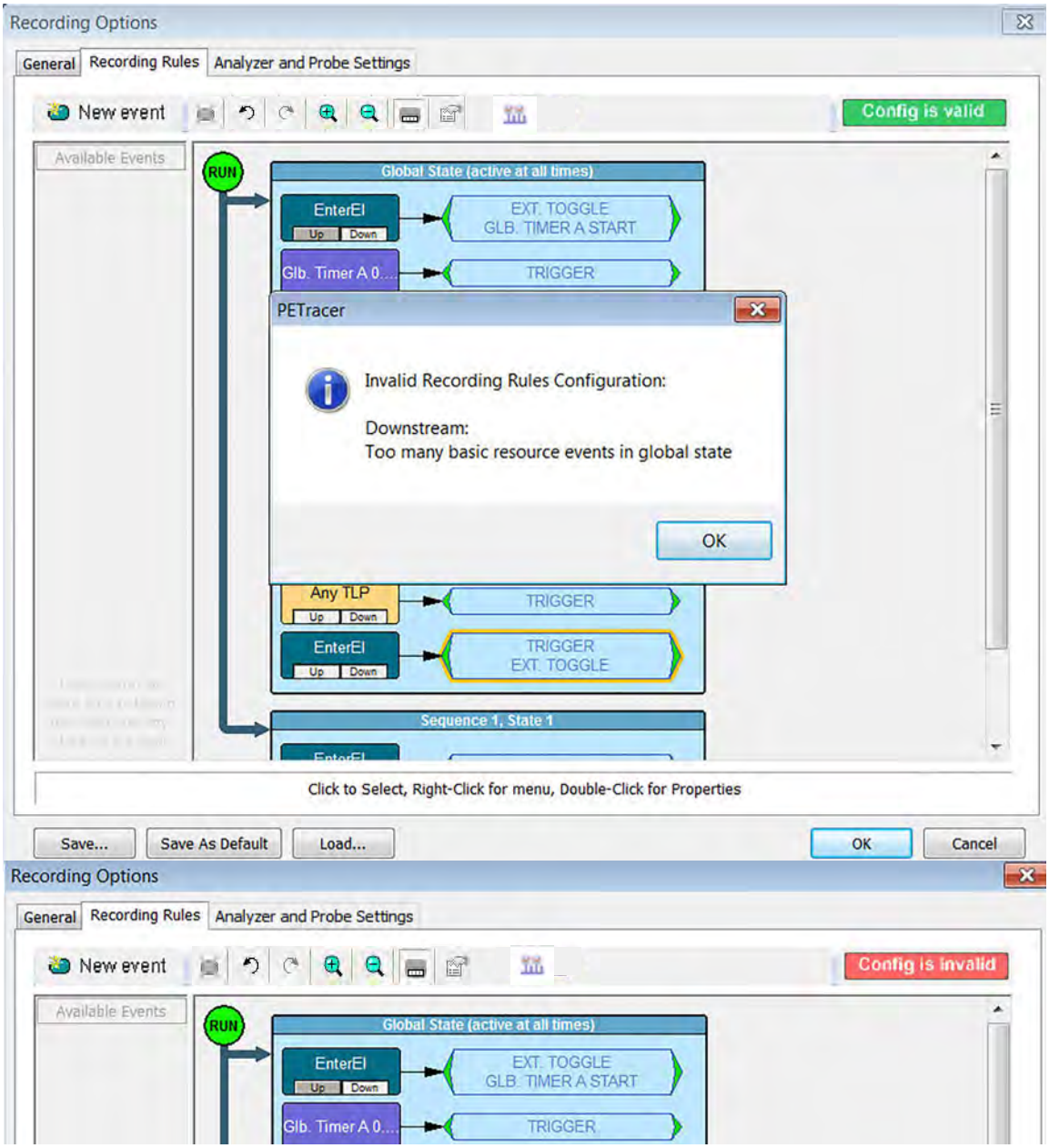


Figure 5.68: Valid and Invalid Recording Rules Configuration Dialogs

5.17.6.2 Sequence State

The cell marked **Drag an event here to add another sequence** is the Sequence State (see Figure 5.69). In the Sequence State you can define a sequence of Events and Actions which the Summit T3-16 Analyzer looks for at pre-determined times. Sequences are chains of events culminating in a trigger or any other action. A sequence which is a separate chain of events can be created with up to 16 states. A state is an event condition

with an action within a sequence. Once a Sequence State is added the cell marked will read **Drag an event here to add another state.**

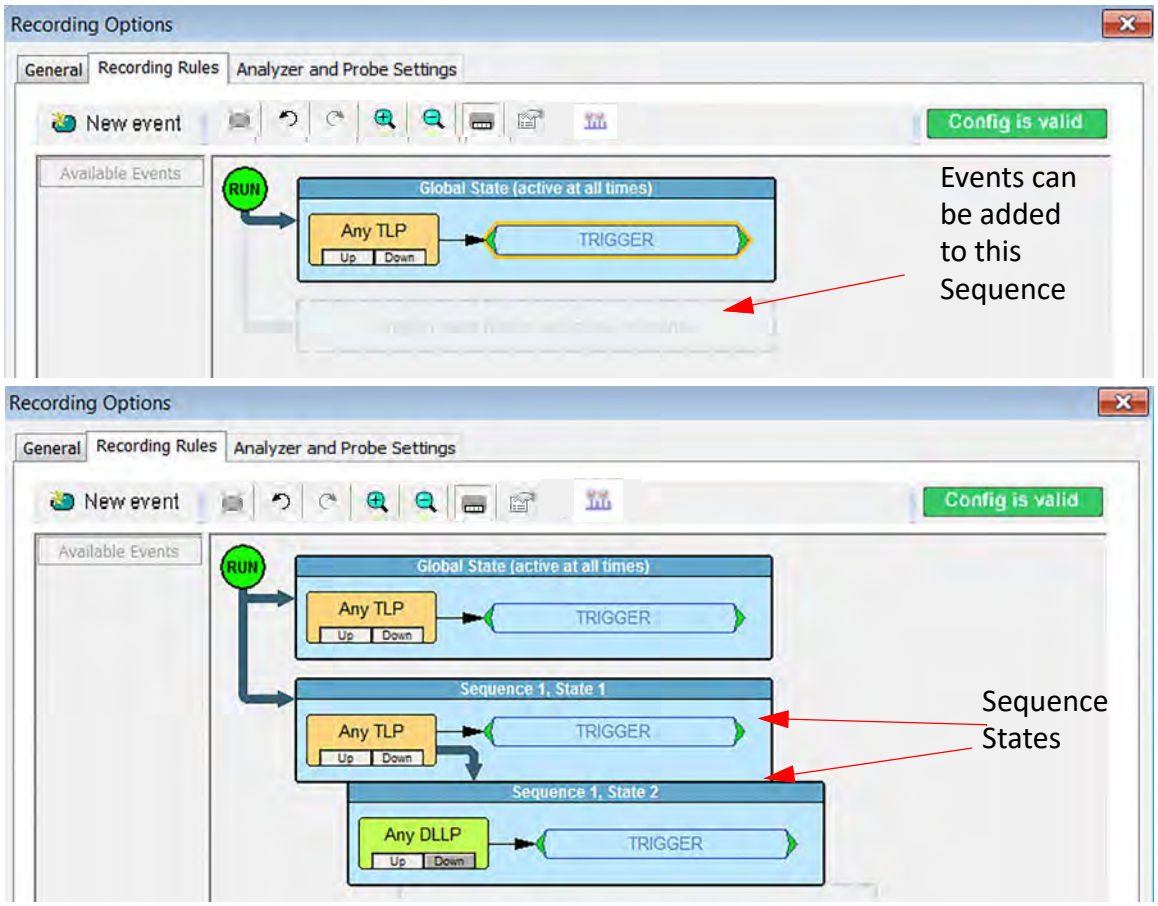


Figure 5.69: Sequence State Events

In the Sequence State the Link State, Ordered Set, Errors, Counter and the Timer use Basic Resources while DLLP and TLP use Packet Match Resources. There are four Timers and four Counters in the Sequence State.

Note: In each Sequence State up to eight Basic Resources and eight Packet Match Resources can be defined.

5.17.7 Recording Rules Events

There are eleven sets of Events that can configured and actions can be set for every Event.

TABLE 5.3: Events and Event Actions

Event	Pre-Defined Event Actions
Link State	
	Enter Electrical Idle

TABLE 5.3: Events and Event Actions (Continued)

	Exit Electrical Idle
	Speed Change to 2.5Gb/s
	Speed Change to 5.0Gb/s
	Speed Change to 8.0Gb/s
	Speed Change to 16.0Gb/s
	Speed Change from 2.5Gb/s
	Speed Change from 5.0Gb/s
	Speed Change from 8.0Gb/s
	Speed Change from16.0Gb/s
	CLKREQ# Asserted
	CLKREQ# Deasserted
	WAKE# Asserted
	WAKE# Deasserted
	PERST# Asserted
	PERST# Deasserted
	LinkWidth Change to x1
	LinkWidth Change to x2
	LinkWidth Change to x4
	LinkWidth Change to x8
	LinkWidth Change to x16
	LinkWidth Change from x1
	LinkWidth Change from x2
	LinkWidth Change from x4
	LinkWidth Change from x8
	LinkWidth Change from x16
Ordered Set	
	TS1
	TS2
	EIEOS
	EIOS
	Skip
	Control Skip
	FTS
	SDS
Framing Token	
	EDS

TABLE 5.3: Events and Event Actions (Continued)

	EDB
Compliance	
	Gen1 / Gen2
	Gen3 / Gen4
Errors	
	Disparity Error
	Symbol Error
	Block Align Error
DLLP	
	Any DLLP
	MR DLLP (MRInit, MRReset, MRUPdatFC, MRInitFC1, MRInitFC2
	InitFC1
	InitFC2
	UpdateFC
	ACK
	NAK
	Power Management
	Vendor
	NOP
	Data Link Feature Support
TLP	
	Any TLP
	Config Rd
	Config Wr
	IO Rd
	IO Wr
	Mem Rd
	Mem Wr
	Message
	Completion
AHCI	
	AHCI Register
NVME	
	NVME Register

TABLE 5.3: Events and Event Actions (Continued)

	ACQ
	AQA
	ASQ
	CAP
	CC
	CQyHDBL
	CSTS
	INTMC
	INTMS
	NSSR
	Reserved (0x18...0x1B)
	Reserved (0x40...0xEFF)
	Reserved Command Set Specific
	SQyTDBL
	VS
	CMBLOC
	CMBSZ
PQI	
	PQI Register
SOP	
	SOP IU Type
MCTP	
	MCTP Packets

Note: NVME Command, PQI Command and SCSI command sets are available for selection when Link Width option is set to X4 or lower in the Recording Options.

5.17.8 Properties Dialog Boxes for Events

Properties dialog boxes provide additional settings for Events, States, and Actions in the Recording Rules page. You can access a Properties dialog by double-clicking an **Event, State, Action** or any other object. It allows you to set triggers and filters. For example, to set a trigger on a specific type of error, you open the Properties dialog.

5.17.8.1 Accessing the Properties Dialog

To see the Properties dialog, first create an event button by clicking the **New Event** button and choosing an event from the menu. Open the Event Properties dialog by doing one of the following:

- Double-click an event.

- Right-click an event and select **Properties** from the pop-up menu.
- Click the **Properties** button on the toolbar.

5.17.8.2 Event Properties Dialog Box Features

The following features are displayed in the any Event Properties dialog box (see Figure 5.70 on page 263).

Event Icon Preview

This icon shows you which event properties you are editing. The Icon Preview looks exactly like the icon in the Main Display area.

Icon Label

A text box for labeling the button. Whatever you type here appears on the button.

Channels

These controls allow you to select the channel(s) that the Analyzer should search when it is looking for the event.

Pin Button

The Pin Button on the top right corner of the dialog allows you to **pin** the Properties dialog to the application so that it does not go away when another object appears such as an event, state or action.

Description String

This area contains a textual description of the event.

Event-specific Settings

The largest part of the Event Properties dialog. The settings in this area vary for different events. Some events do not have any additional settings. After selecting the options you want click on the “OK” button.

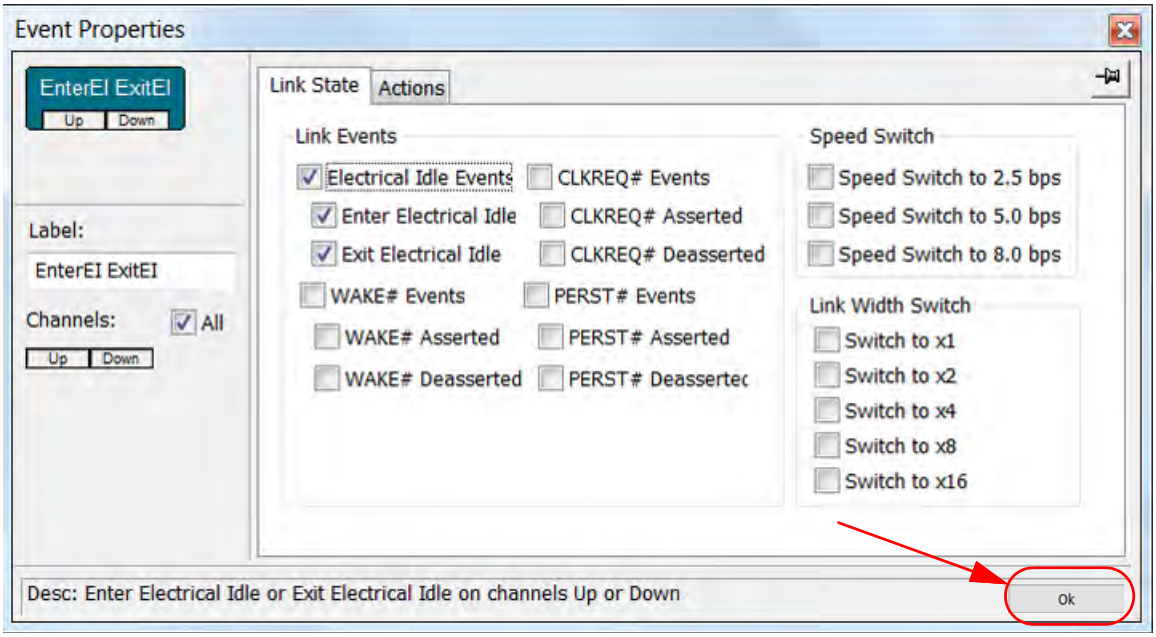


Figure 5.70: Properties Dialog Box

5.17.8.3 Link State Dialog

The Link Properties dialog lets you select the link state. In the case shown below, PERST# events are the Link States selected. See Figure 5.71. After selecting the options you want click on the “OK” button.

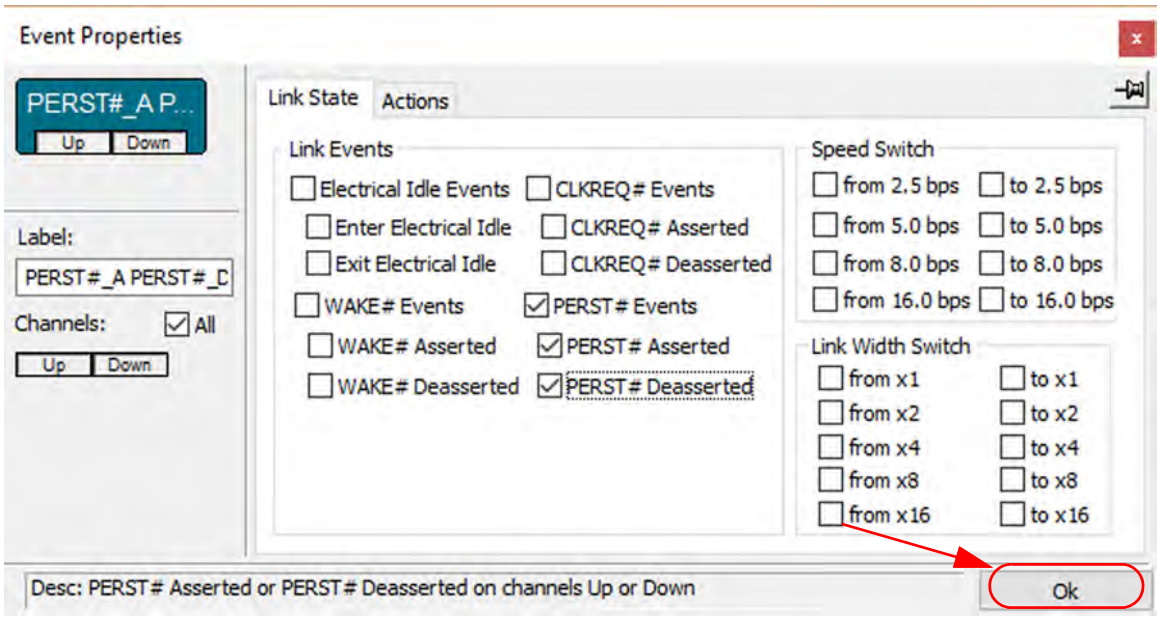


Figure 5.71: Link State Properties Dialog: PERST#.

Link State Actions

In this case, the Link State Action to be taken would be to trigger the analyzer. See Figure 5.72. After selecting the options you want click on the “OK” button.

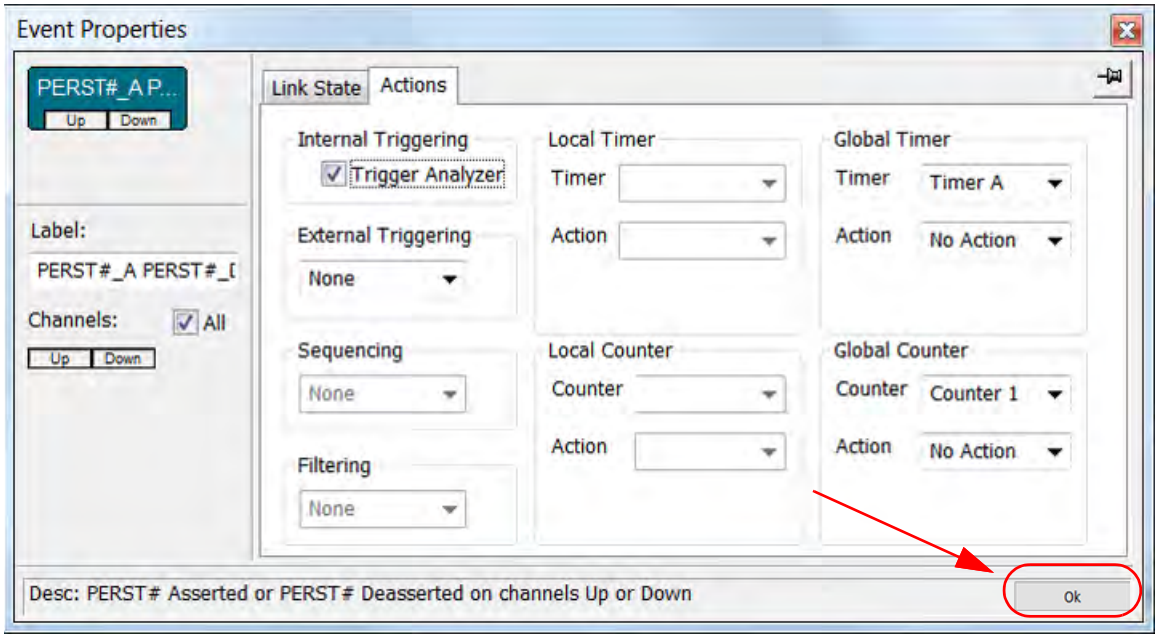


Figure 5.72: Event Properties: Link State Actions: Trigger Analyzer

Global State: CLKREQ# or PERST# Triggers

You could have either a PERST# or CLKREQ# event trigger the analyzer by applying those two conditions to the Global Settings. See Figure 5.73.

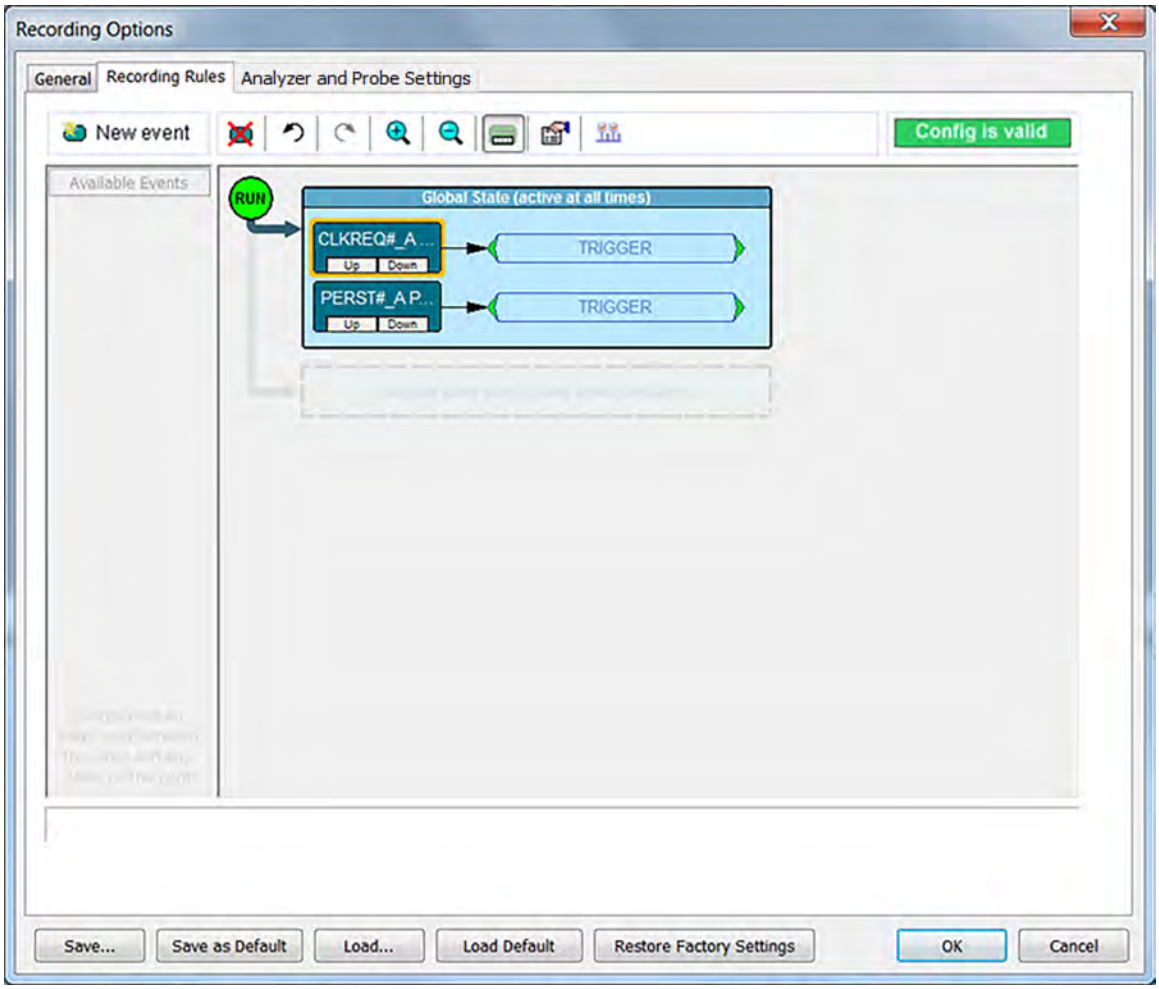


Figure 5.73: Global State: CLKREQ# or PERST# Triggers Analyzer

5.17.8.4 Ordered Sets

A typical Ordered Set Event would be a TS1 packet with the following fields:

- Link Number: Any or PAD
- Lane Number: Any, PAD or Use Lane Trigger
- N_FTS: Any
- Data Rate: Any, G1, G2, G3 or G4
- Atnms Change: Any, Set or Cleared
- Speed Change: Any, Set or Cleared
- Hot Reset: Any, Assert or De-Assert
- Disable Link: Any, Assert or De-Assert
- Loopback: Any, Assert or De-Assert
- Disable Scramble: Any, Assert or De-Assert
- Completion Received: Any, Assert or De-Assert
- Identifiers (6-15): Any, TS1(4Ah) or Custom

See Figure 5.74.

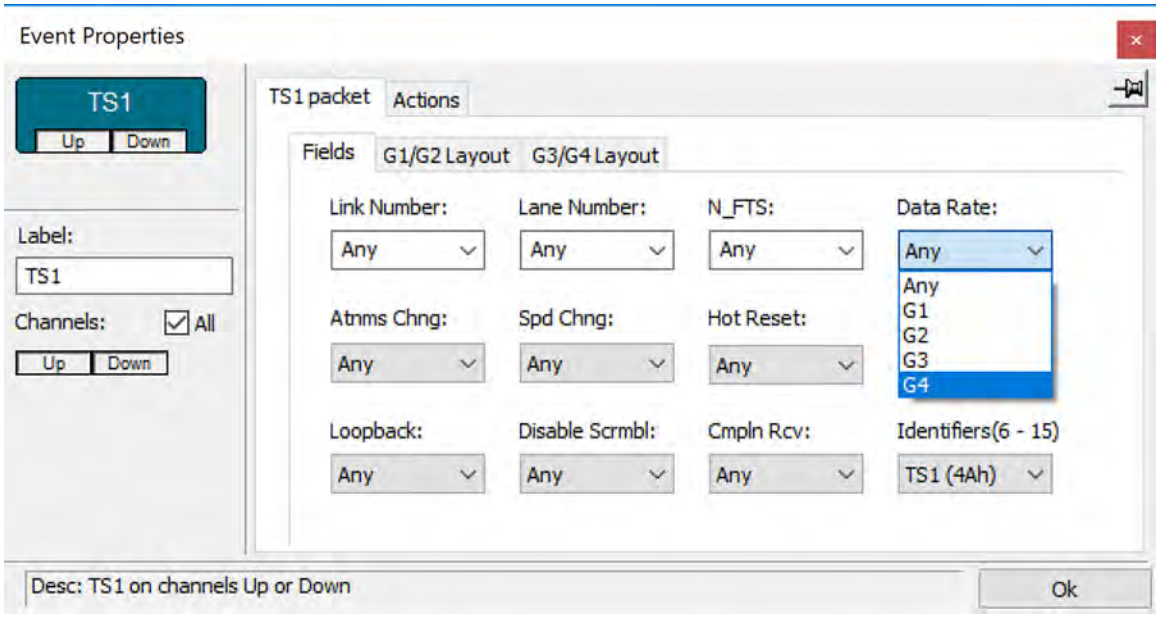


Figure 5.74: Typical Ordered Set: TS1 Event Fields

For G1/G2 Layout the options are shown in Figure 5.75 on page 267.

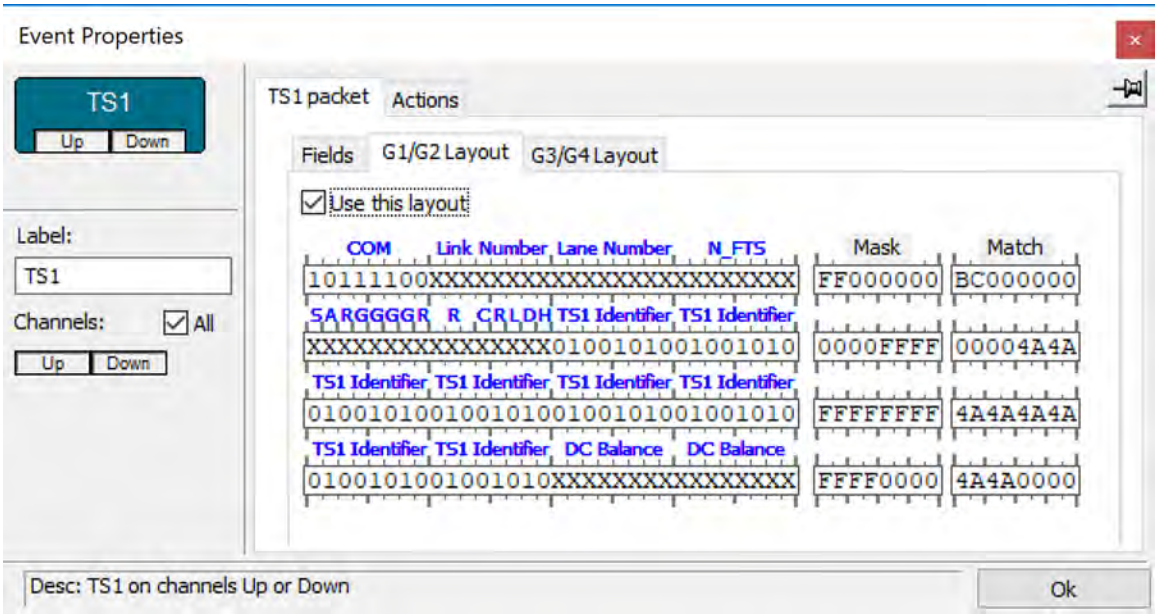


Figure 5.75: Ordered Set: TS1 -> G1/G2 Layout Options

For G3/G4 Layout the options are shown in Figure 5.76.

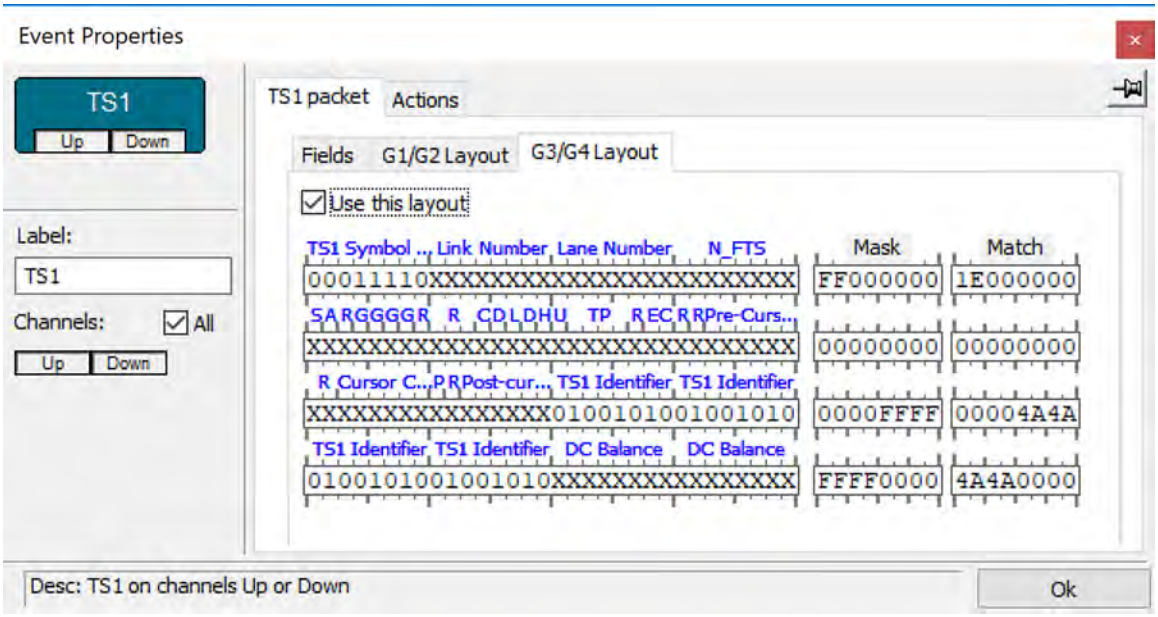


Figure 5.76: Ordered Set: TS1 -> G3/G4 Layout Options

TS1 Actions are shown in Figure 5.77 on page 268.

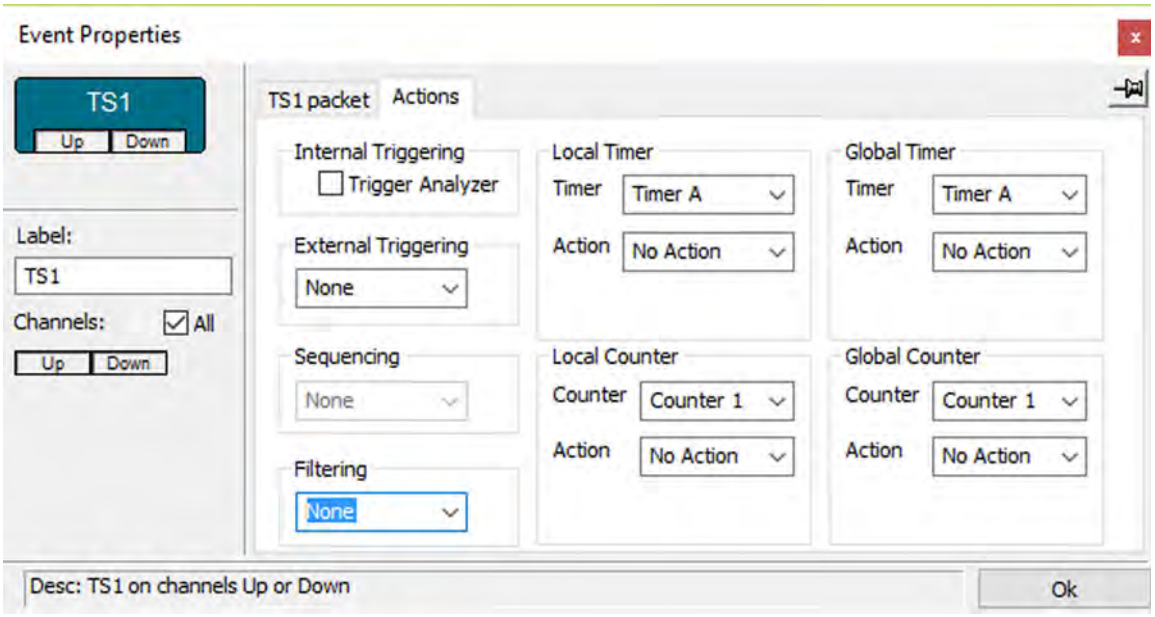


Figure 5.77: Ordered Sets: TS1 -> Actions

5.17.8.5 Framing Token

A Framing Token can be selected as shown in Figure 5.78.

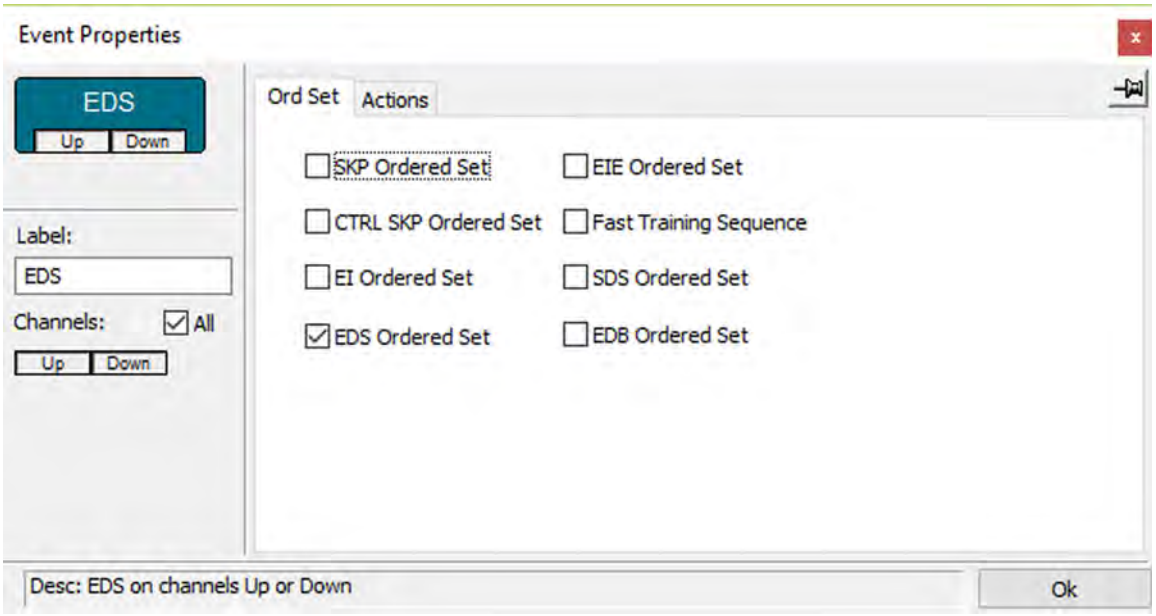


Figure 5.78: Framing Token: Event

The Framing Token Actions are shown below. See Figure 5.79 on page 269.

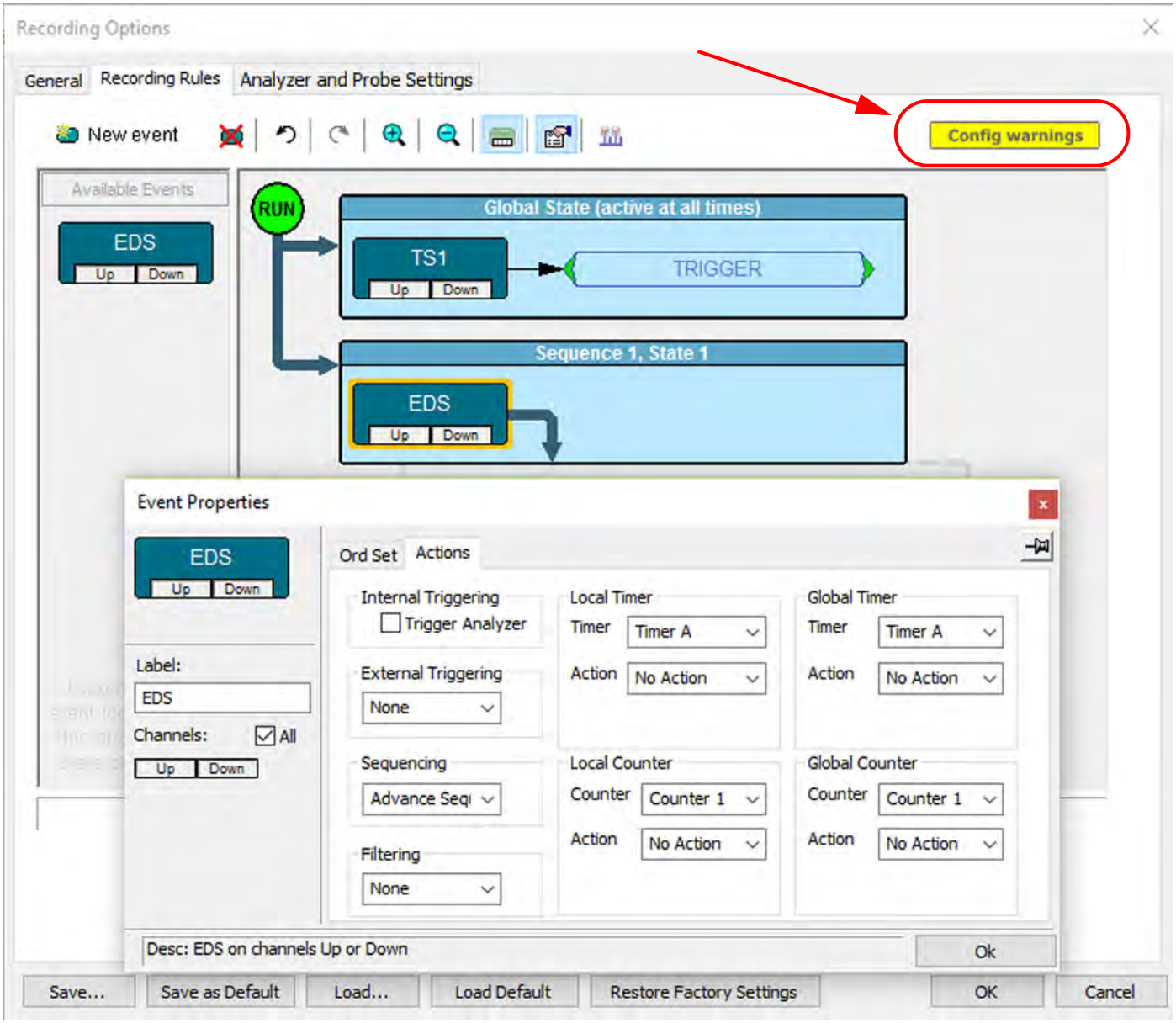


Figure 5.79: Framing Token: Actions

In this example the Advance Sequence was selected but no subsequent state was defined, so the Configuration button is showing: Config Warning. If you click on the Config Warning button a message dialog pops up, telling you what the problem is. See Figure 5.80 on page 270.

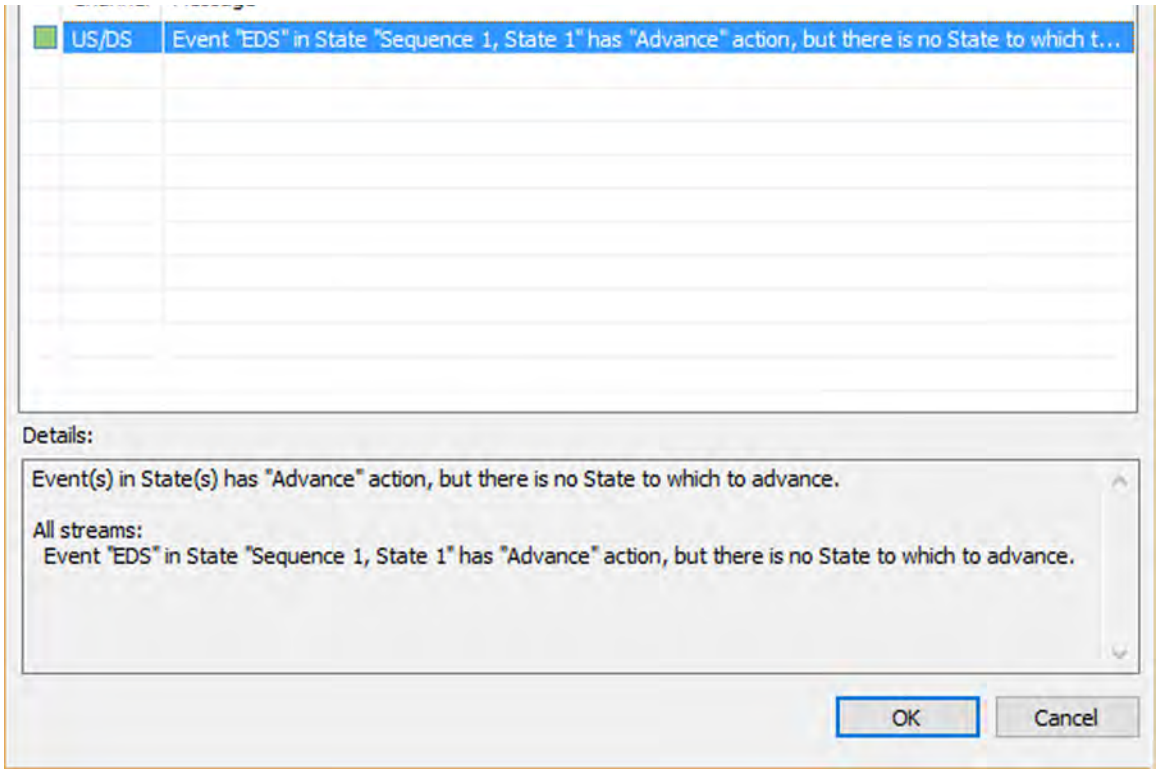


Figure 5.80: Configuration Warning Dialog

If you add another state, the Configuration will be valid. See Figure 5.81 on page 271.

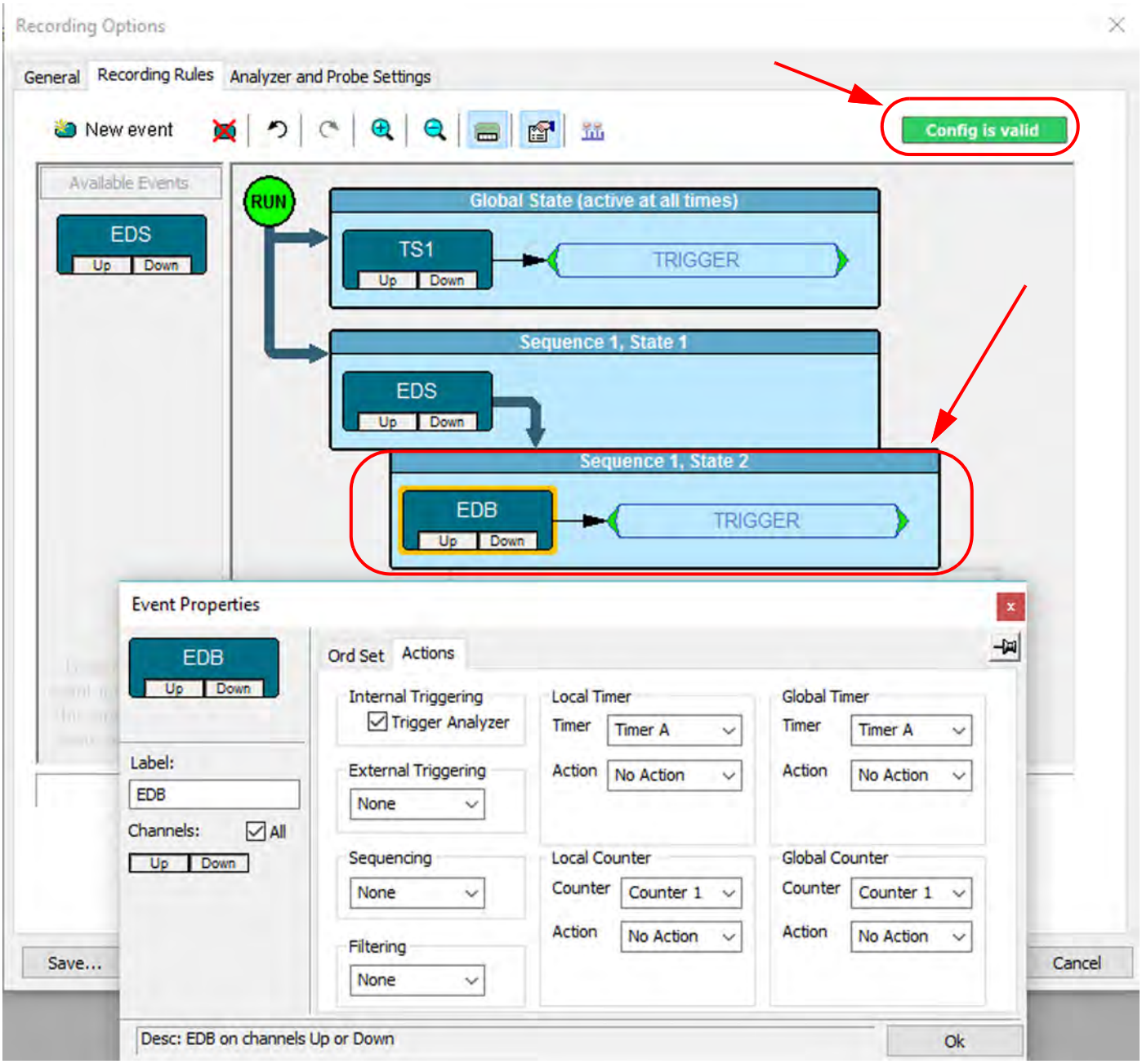


Figure 5.81: Add a State to get Valid Configuration

5.17.8.6 Compliance Set Properties Dialog

After selecting the options you want click on the “OK” button.

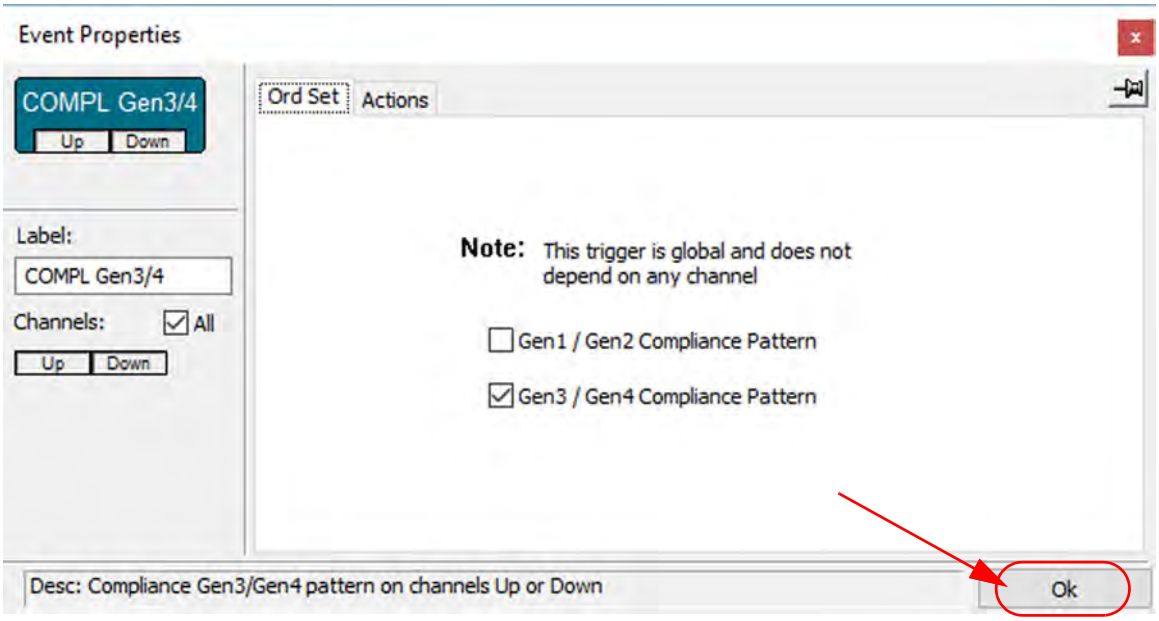

Event Properties
COMPL Gen3/4
Up
Down
Label:
COMPL Gen3/4
Channels:
All
Up
Down
Ord Set
Actions
Note: This trigger is global and does not depend on any channel
Gen1 / Gen2 Compliance Pattern
Gen3 / Gen4 Compliance Pattern
Desc: Compliance Gen3/Gen4 pattern on channels Up or Down
Ok

Figure 5.82:

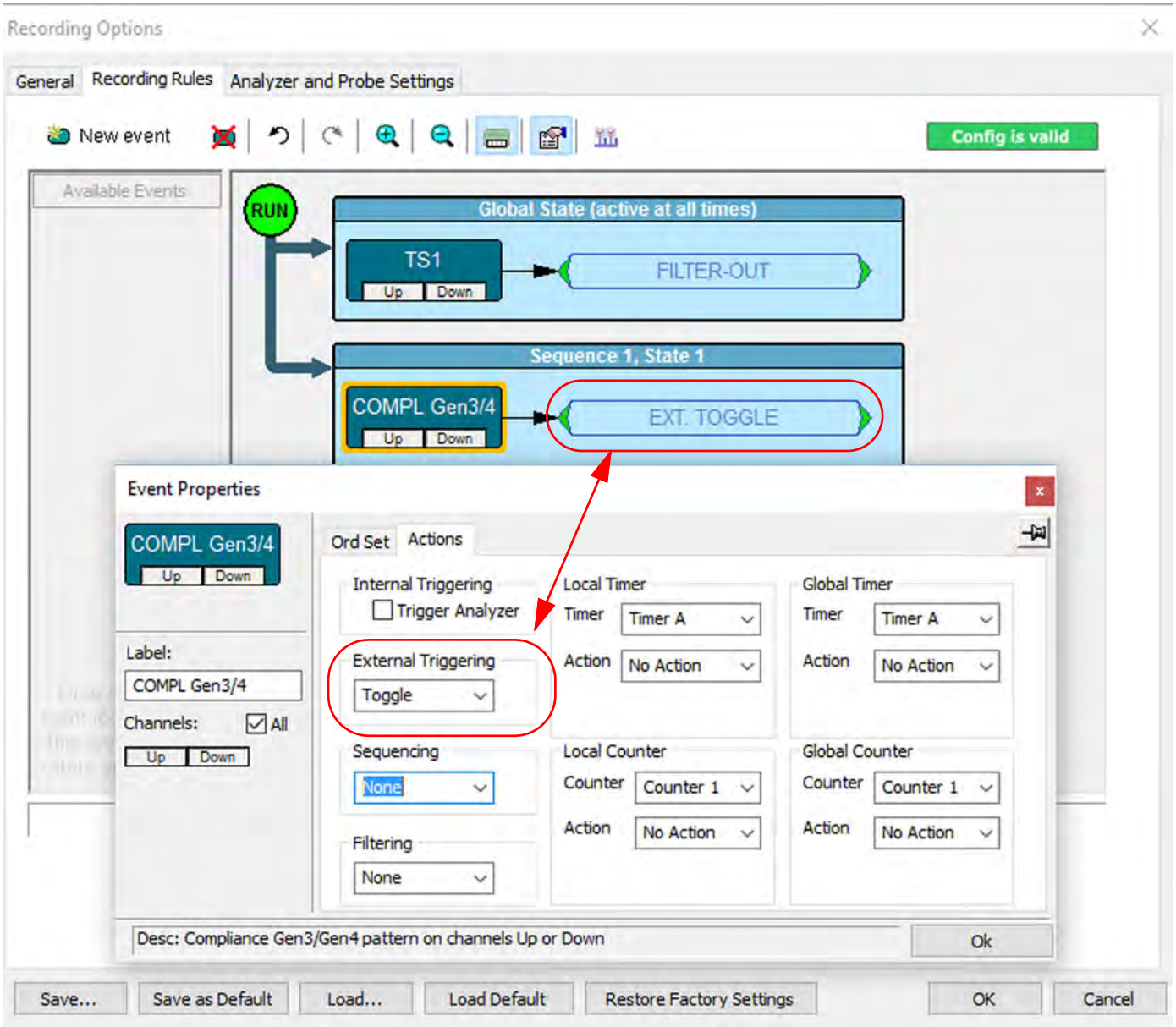


Figure 5.83: Compliance Event: Action -> Toggle Trigger

The select the Compliance Actions you want to occur. See Figure 5.83 on page 273.

5.17.8.7 Error Properties Dialog

The Error Properties dialog lets you select specific error types for performing an action. There are three types of Errors:

- Disparity
- Symbol
- Block Align

Each Error type has it's own Event block and similar Actions that can be taken. See Figure 5.84.

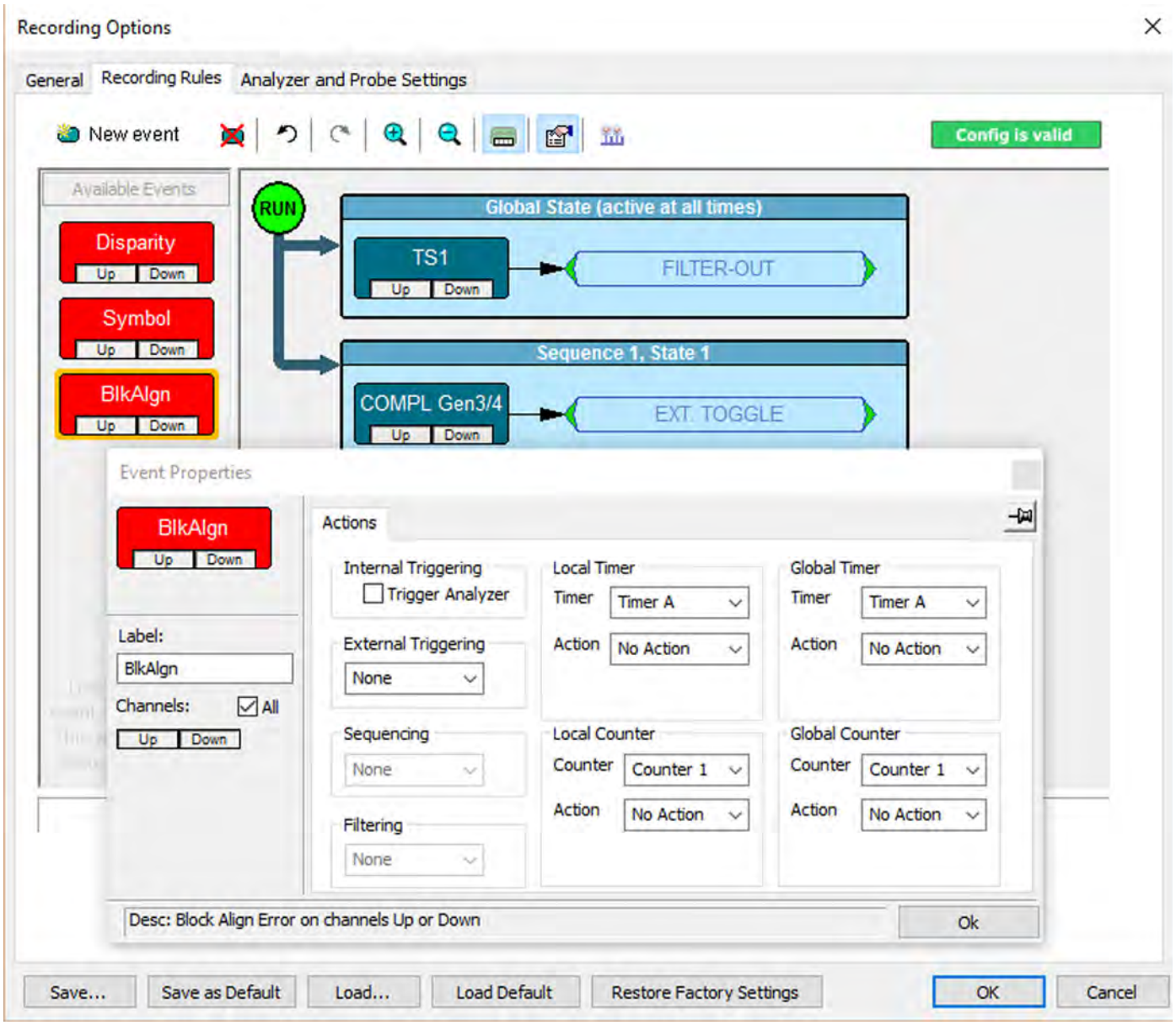


Figure 5.84: Error Events: Actions Dialog

5.17.8.8 DLLP Packet Properties Dialog

The DLLP Packet Properties dialog allows you to specify any DLLP field as shown below. After selecting the options you want click on the “OK” button. See Figure 5.85.

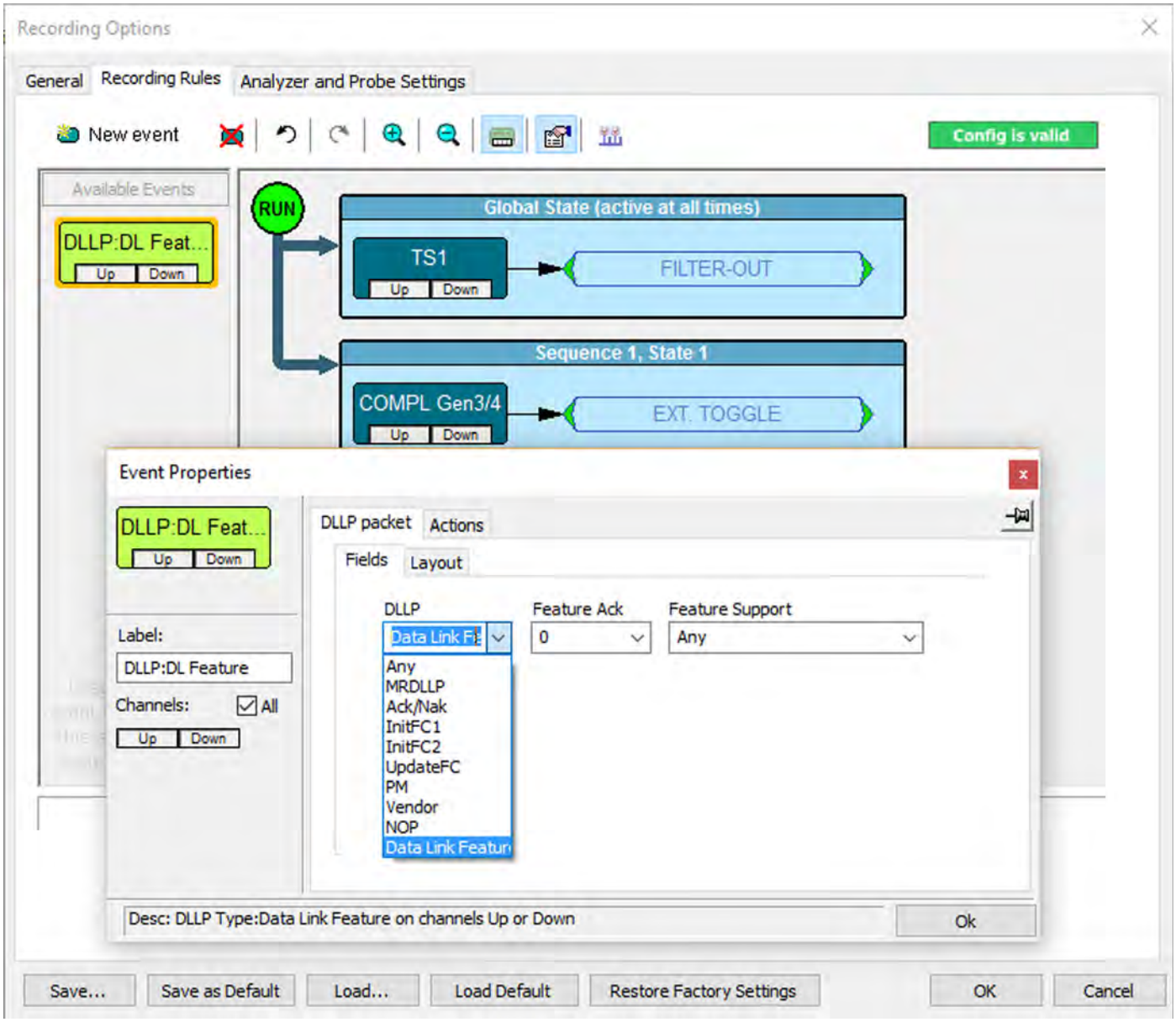


Figure 5.85: DLLP Packet Properties Dialog.

The Layout tab of the DLLP Packet Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below. After selecting the options you want click on the “OK” button.

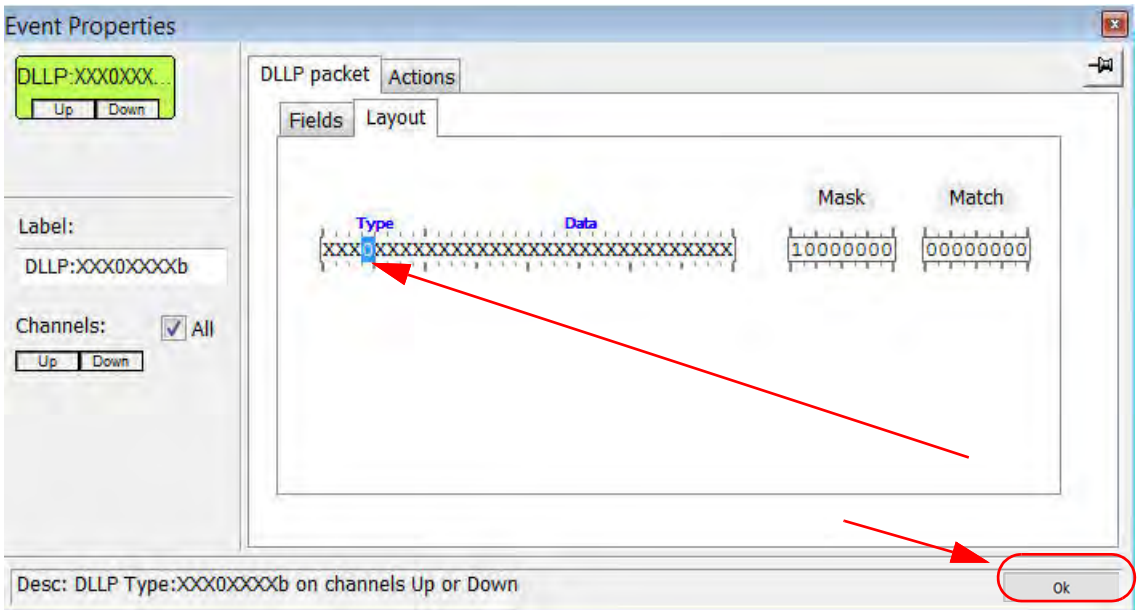


Figure 5.86: DLLP Packet Properties Dialog

Then you can choose the Action you want to occur after the Event is captured. See

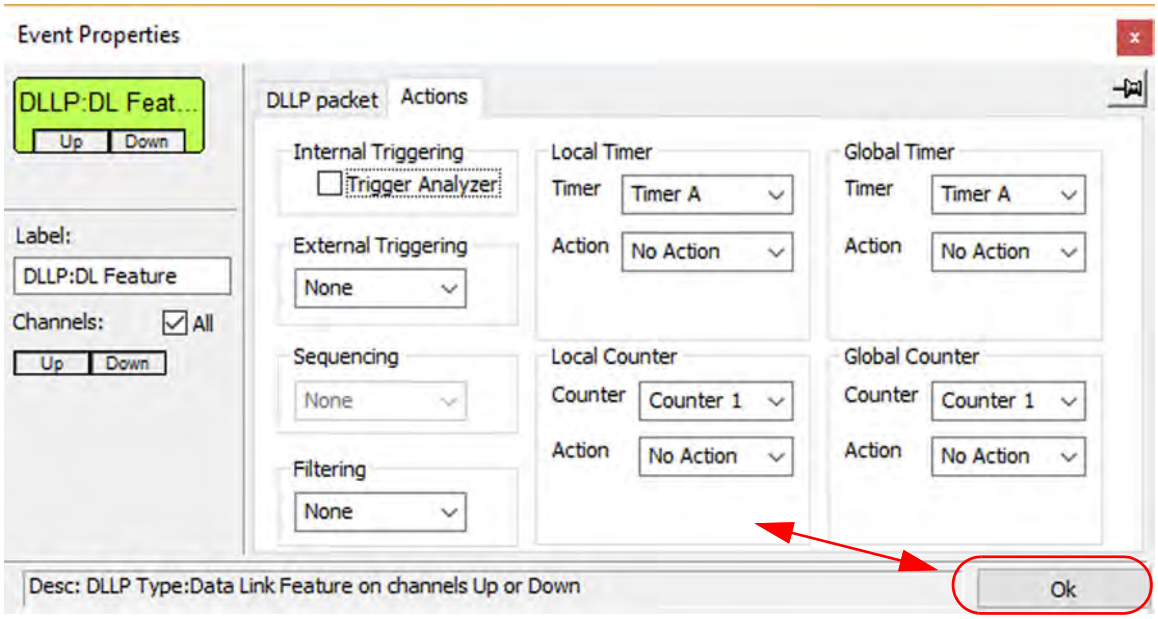


Figure 5.87: DLP Packet: Actions Available

5.17.8.9 TLP Header Properties Dialog

The TLP Header Properties dialog enables you to set the TLP Header Fields and Layout, TLP Prefixes and Actions. You can manually change the Requester/Completer ID. After selecting the options you want click on the “OK” button.

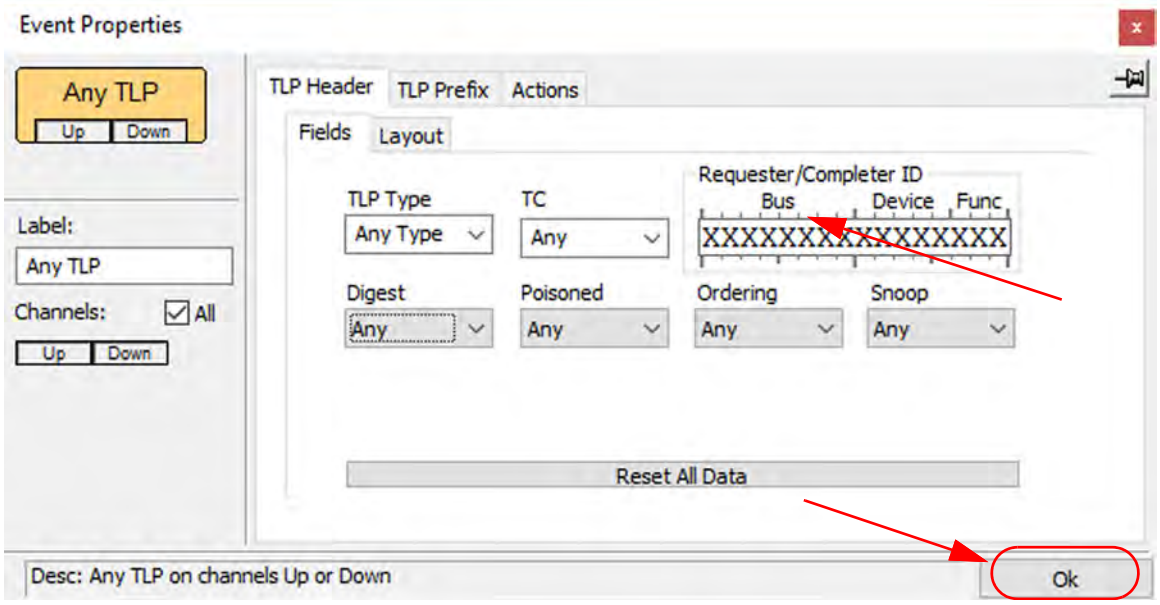


Figure 5.88: TLP Header Properties Dialog.

5.17.8.10 TLP Prefix Properties Dialog

The Layout tab of the TLP Prefix Packet Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below. After selecting the options you want click on the “OK” button.

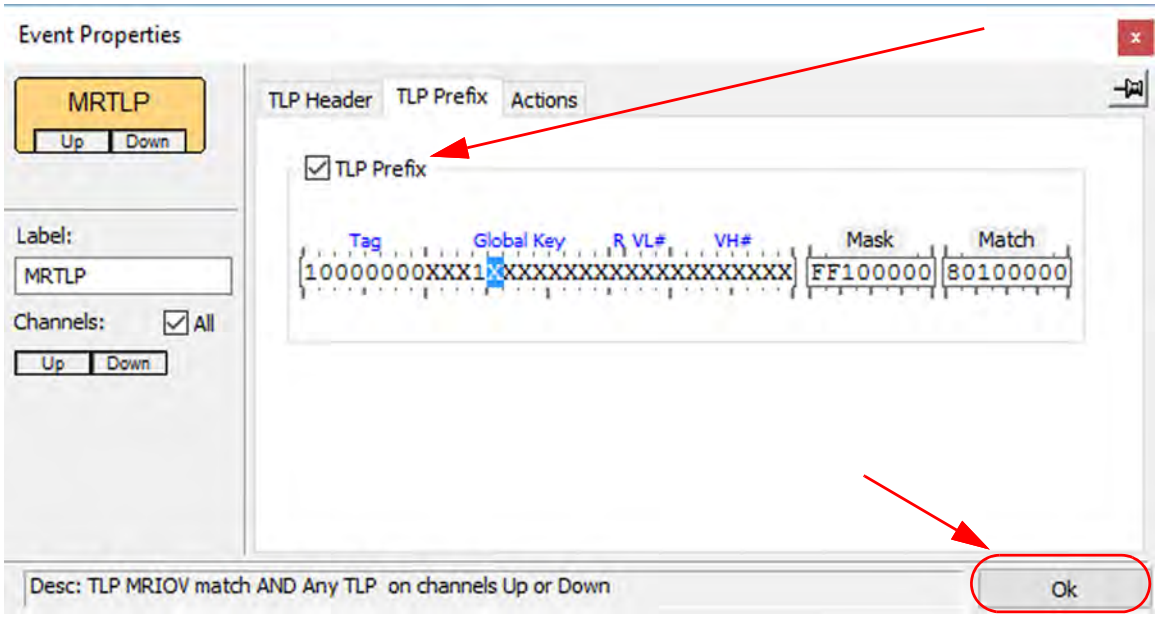


Figure 5.89: TLP Prefix Properties Dialog: (TLP MRIOV Match AND Any TLP)

TLP Actions are shown below in Figure 5.90.

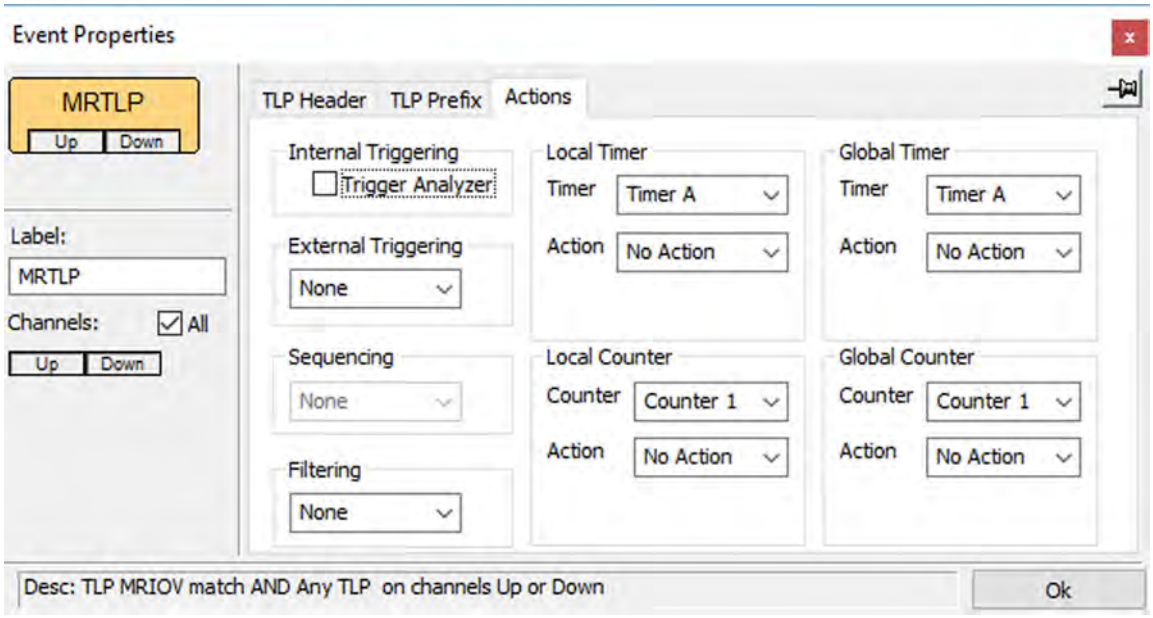


Figure 5.90: TLP MRIOV and Any TLP Event: Actions

TLP: Lightweight Notification -> Message Properties Example

You can set the analyzer to trigger on a TLP Lightweight Notification Protocol Message by selecting TLP -> Message and then setting the “L” bit to 1 in the TLP Header Layout field. See Figure 5.91.

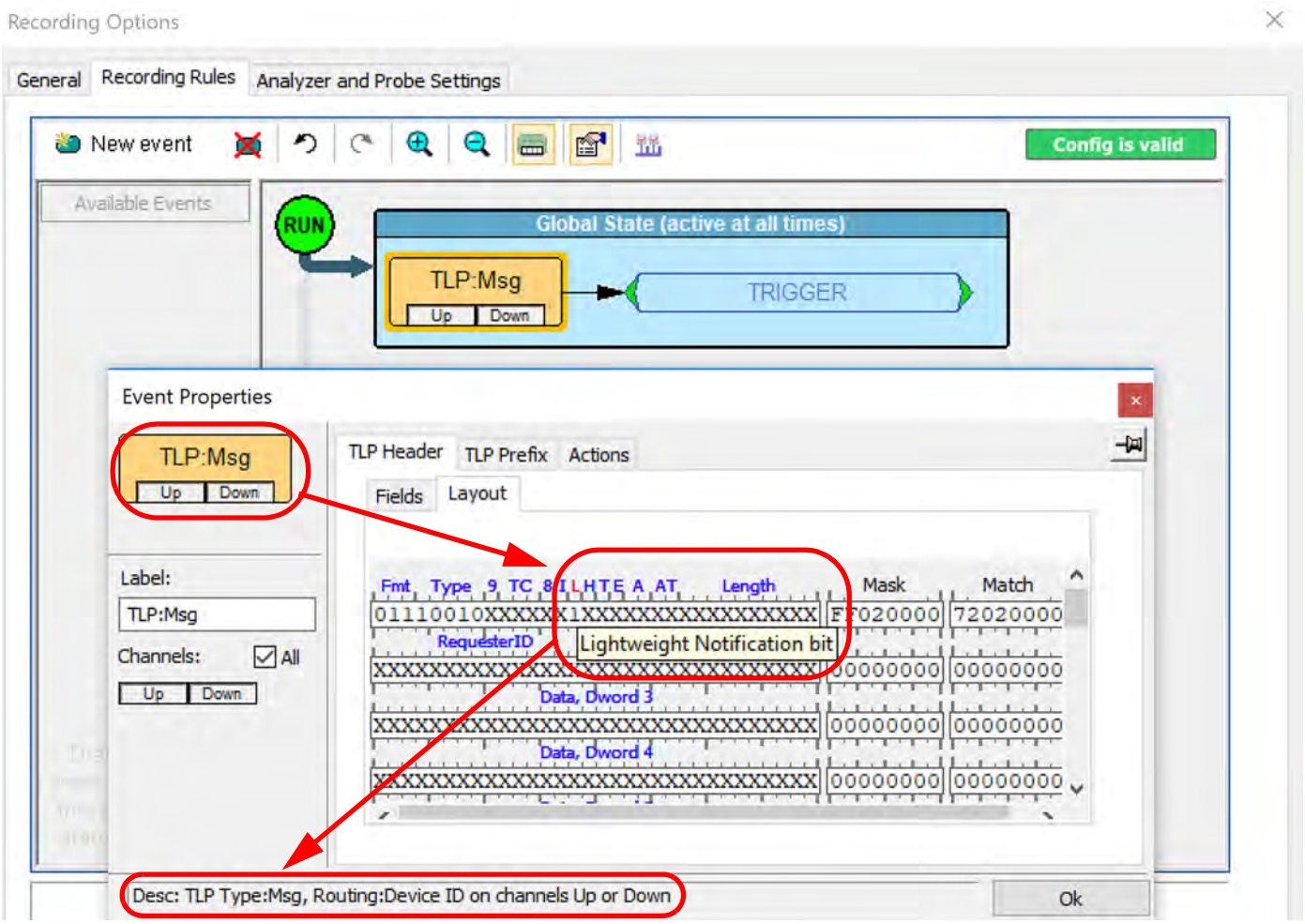


Figure 5.91: TLP: Lightweight Notification Protocol Message

TLP: Lightweight Notification -> Memory Read Example

You can set the analyzer to trigger on a TLP Lightweight Notification Protocol Memory Read by selecting TLP -> Memory Read and setting the “L” bit to 1 in the TLP Header Layout field. See Figure 5.92 on page 280.

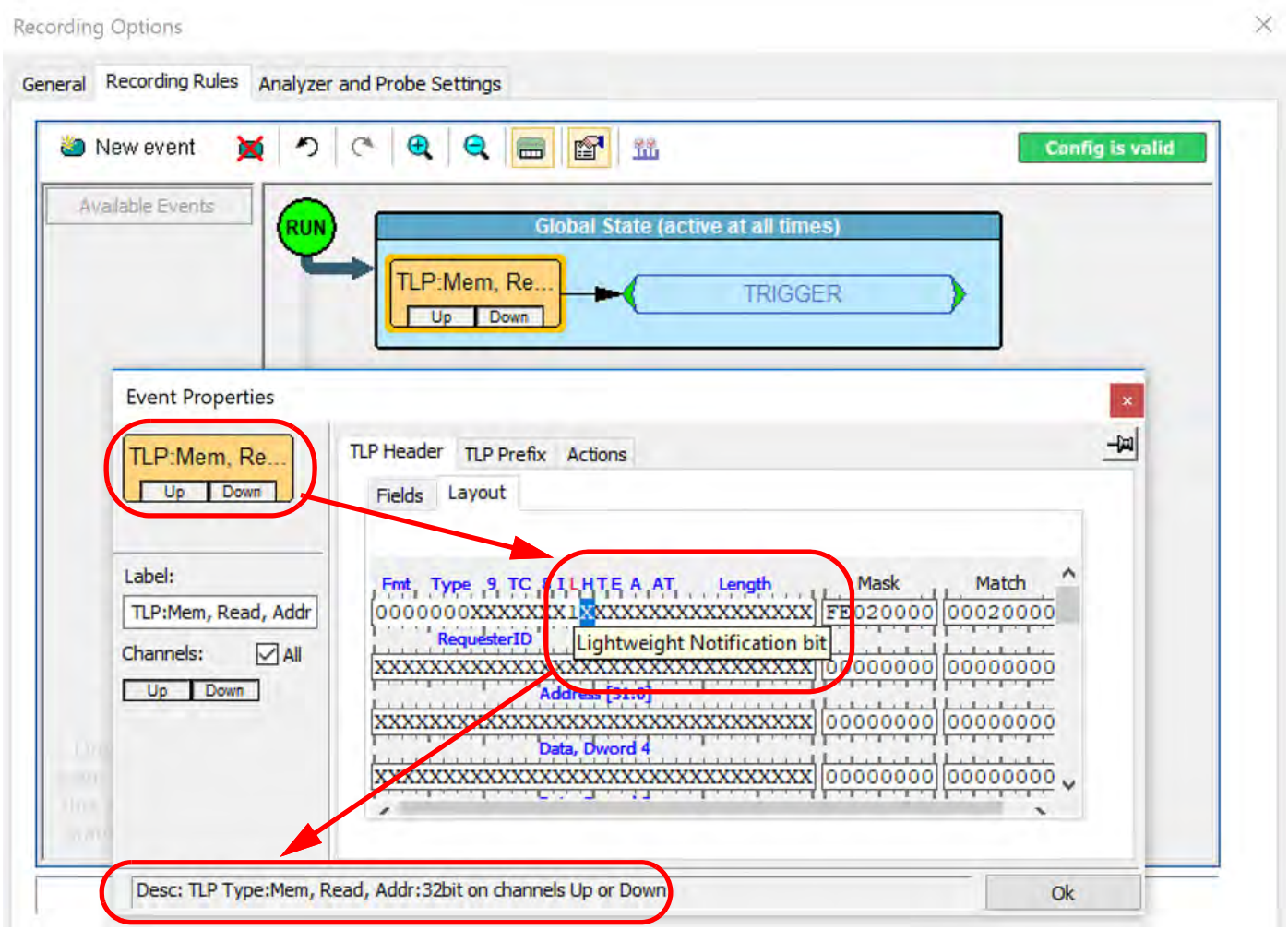


Figure 5.92: TLP: Lightweight Notification Protocol Memory Read

5.17.8.11 AHCI Register Properties Dialog

The AHCI Register Properties dialog allows you to enter the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset. After selecting the options and Actions you want click on the “OK” button. See Figure 5.93 and Figure 5.94 on page 281.

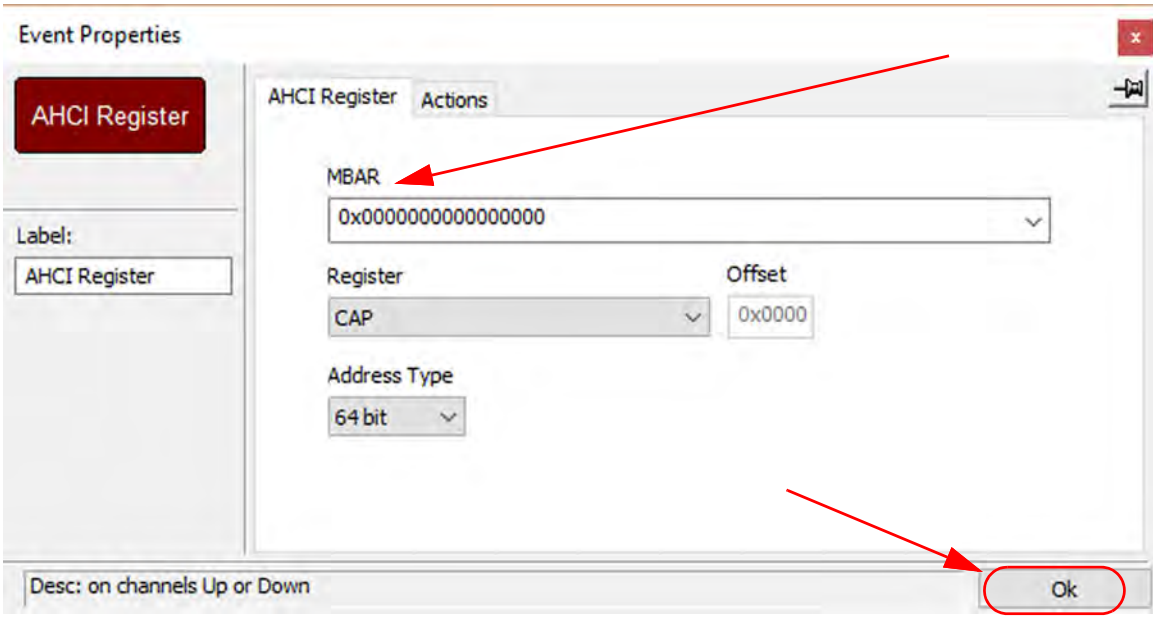


Figure 5.93: AHCI Register Properties Dialog.

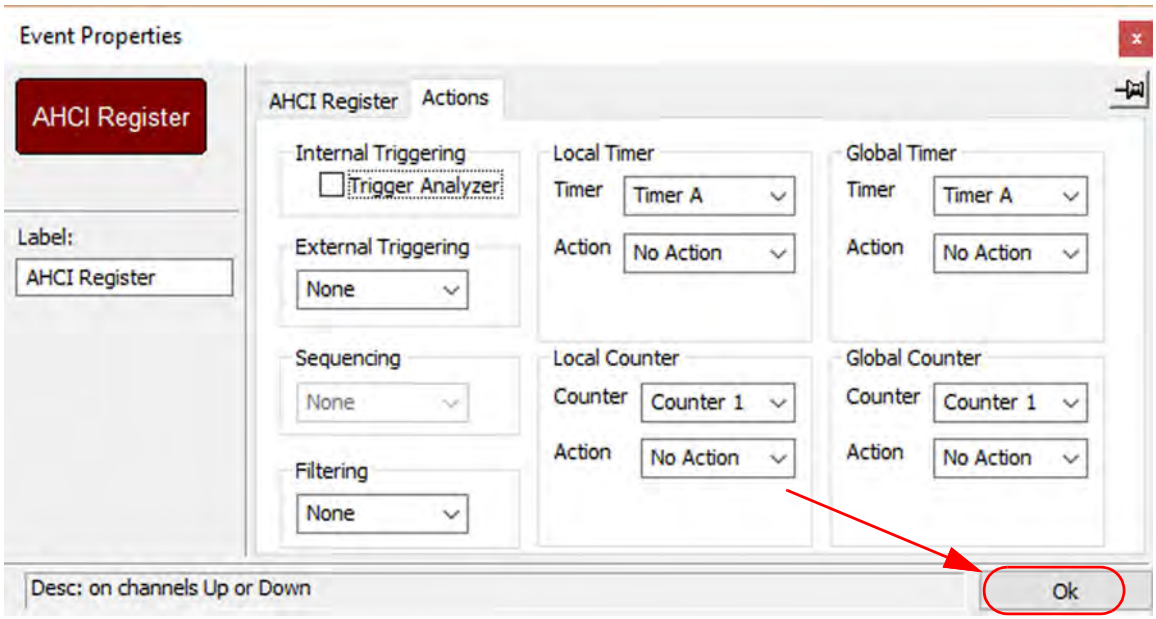


Figure 5.94: AHCI Register Actions Dialog

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only.

5.17.8.12 NVME Register Properties Dialog

Any of the NVMe Register options can be selected from the New Event list. The NVME Register options are shown in Figure 5.95 on page 282.

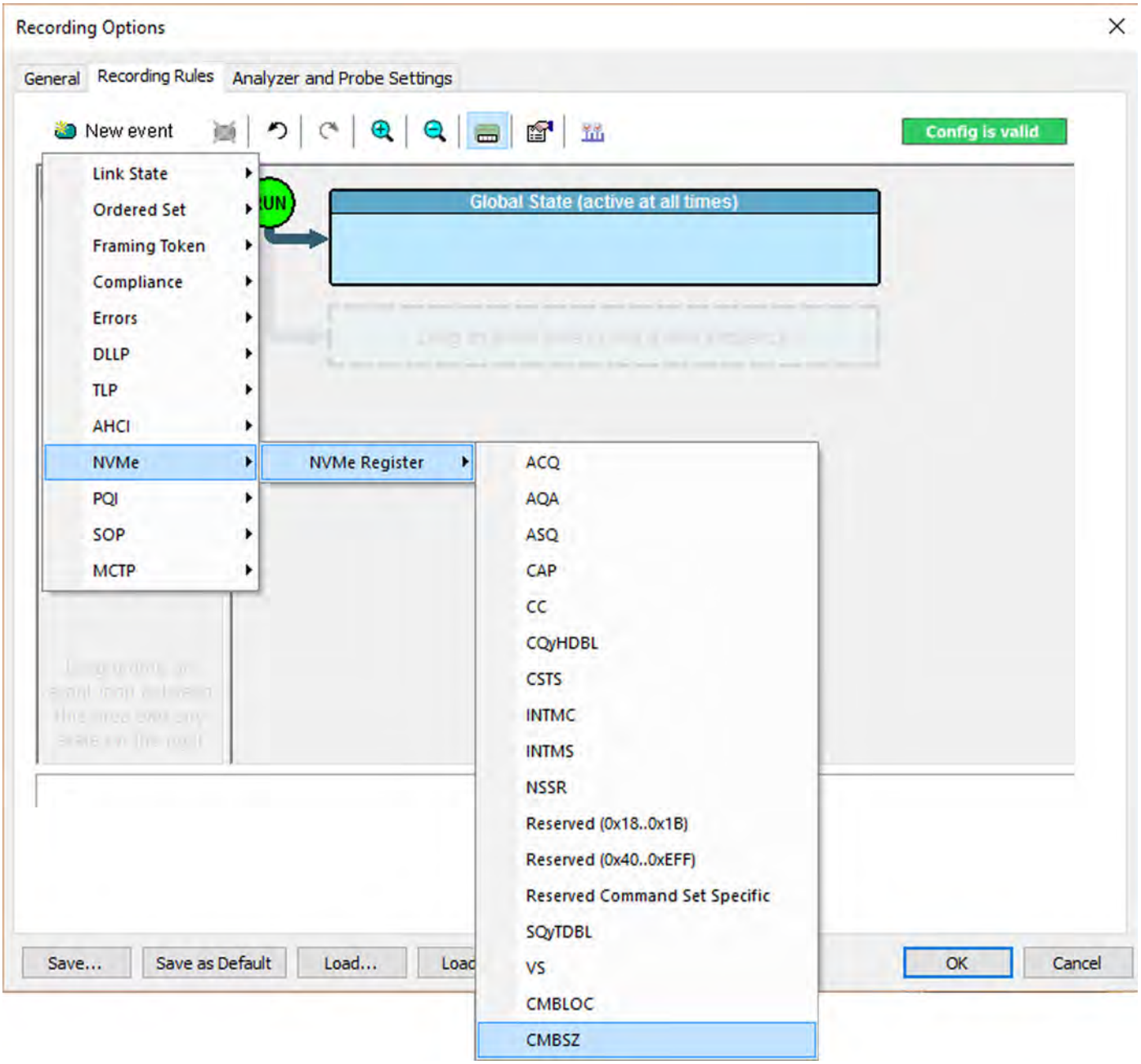


Figure 5.95: NVME Register Options Dialog

The NVME Register Properties dialog allows you to select the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset. See Figure 5.96 on page 283.

The data pattern can be entered directly into the field, but some fields can be selected from the drop-down list. Click on the field name for a list of available registers as illustrated in and Figure 5.97 on page 283.

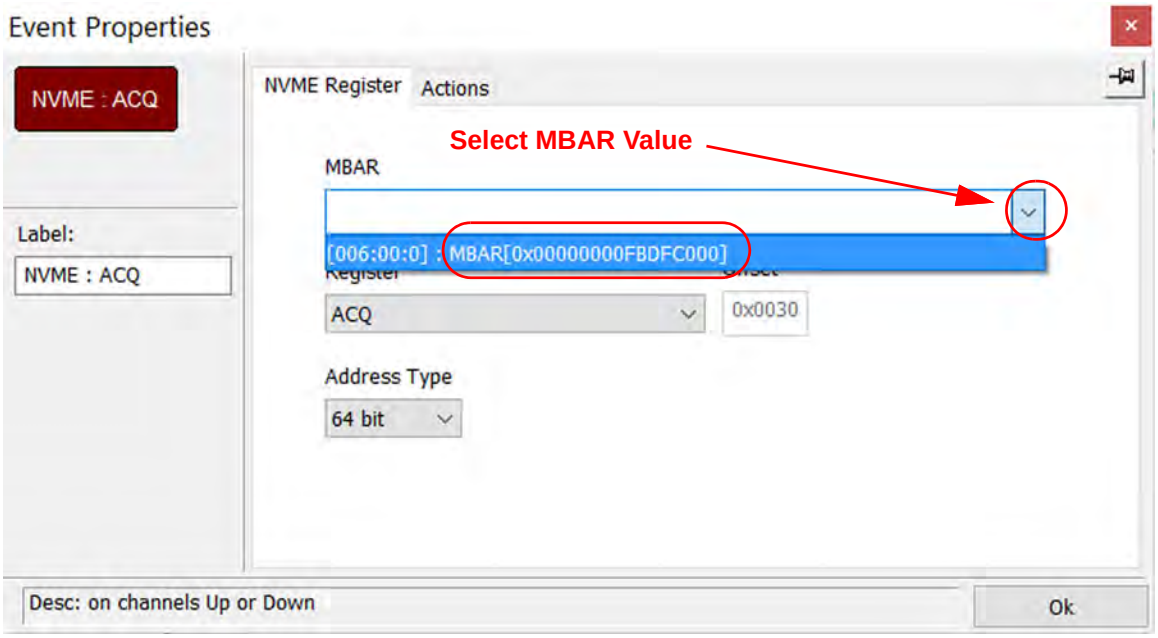


Figure 5.96: NVME Register Properties Dialog with MBAR Value Shown

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only. After selecting the options you want click on the "OK" button.

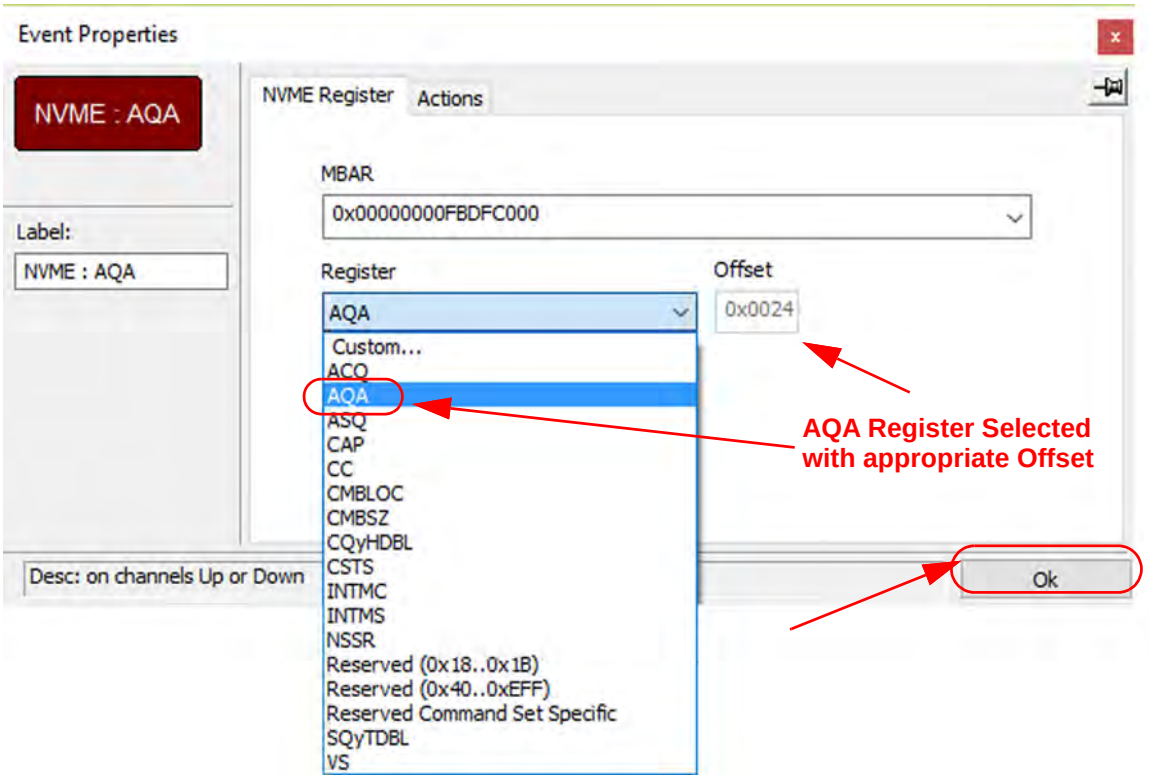


Figure 5.97: NVME Registers from Drop Down List

NVME Register Options: AQA Actions

Select an Action from the NVMe : AQA Actions dialog. See Figure 5.98 and click “OK”.

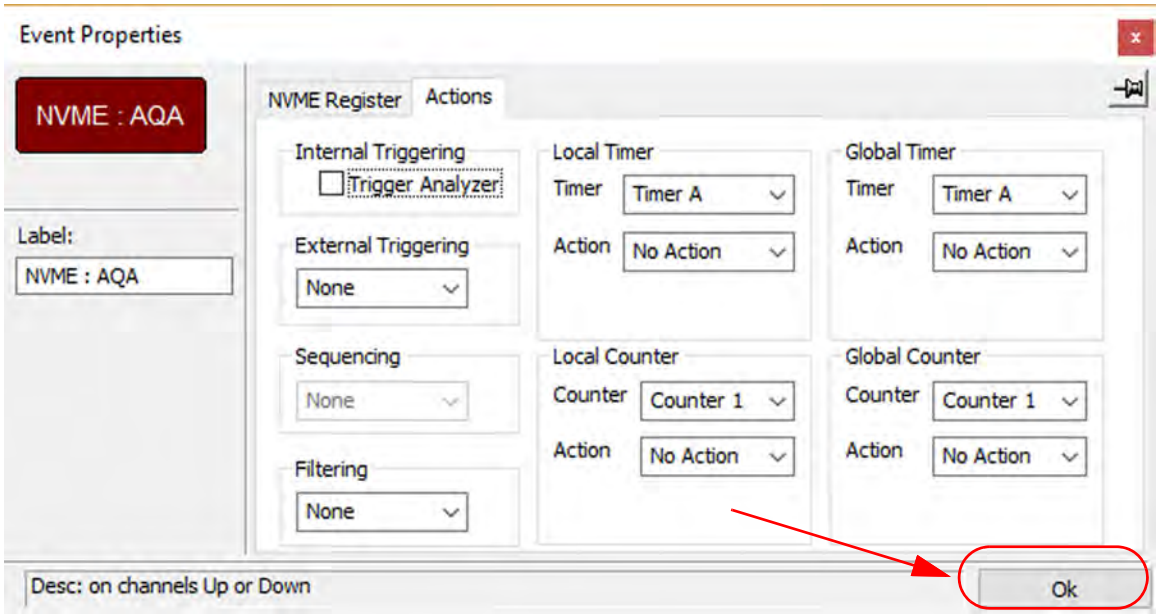


Figure 5.98: NVME Register Options: AQA Actions

5.17.8.13 PQI Register Properties Dialog

The PQI Register Properties dialog allows you to enter the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset. After selecting the options you want click on the “OK” button.

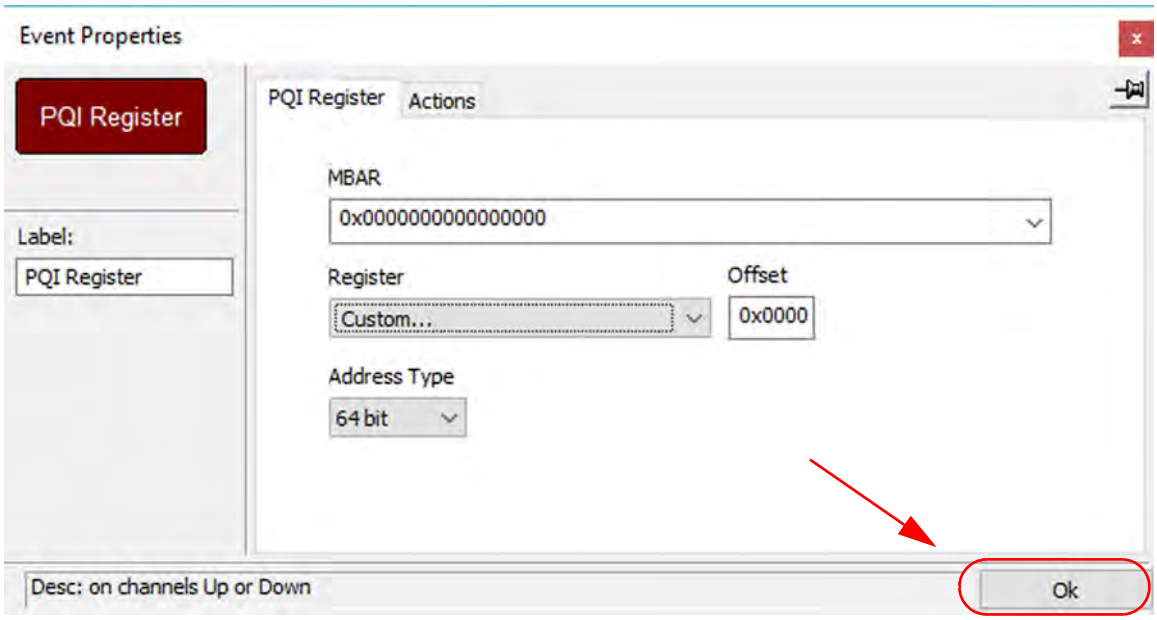


Figure 5.99: PQI Register Properties Dialog.

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only.

The select an Action from the PQI register Actions dialog. See Figure 5.100 and click “OK”.

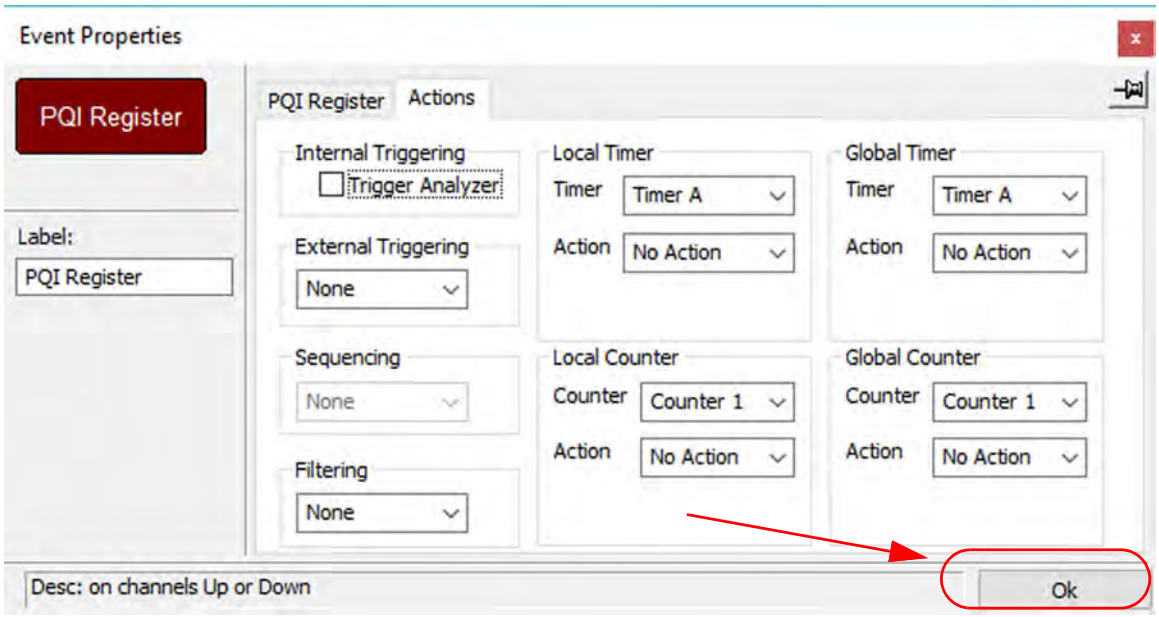


Figure 5.100: PQI Register: Actions Dialog

5.17.8.14 SOP Unit Event Properties Dialog

The SOP Unit Event Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in Figure 5.101. After selecting the options you want click on the “OK” button.

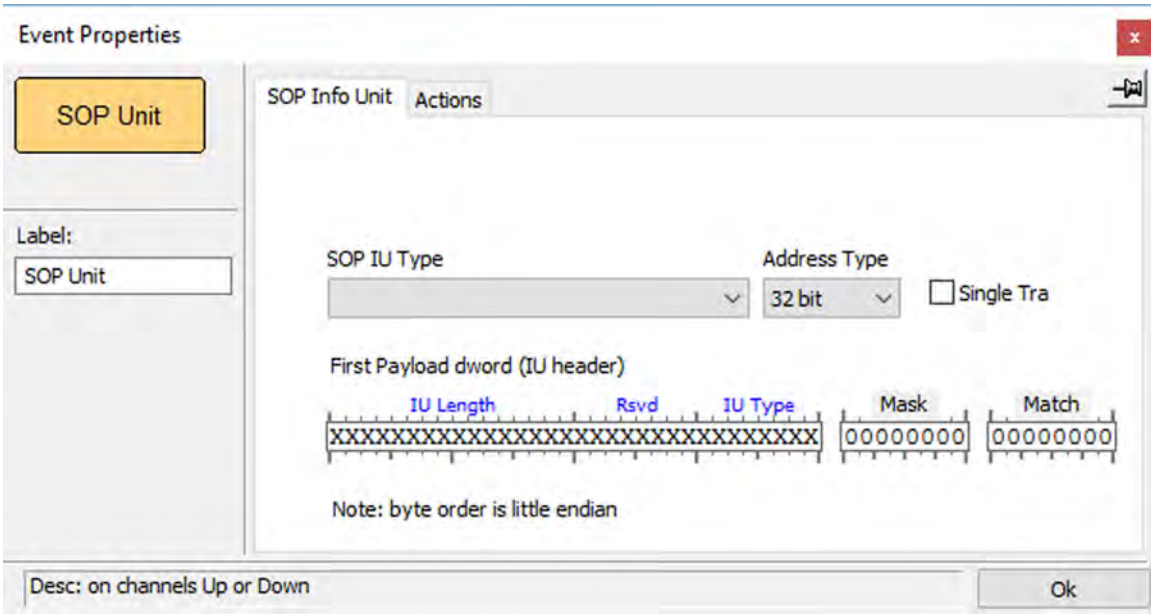


Figure 5.101: SOP Unit Event Properties Dialog.

The SOP IU Types are shown in Figure 5.102. Select the Type you want and then click on "OK".

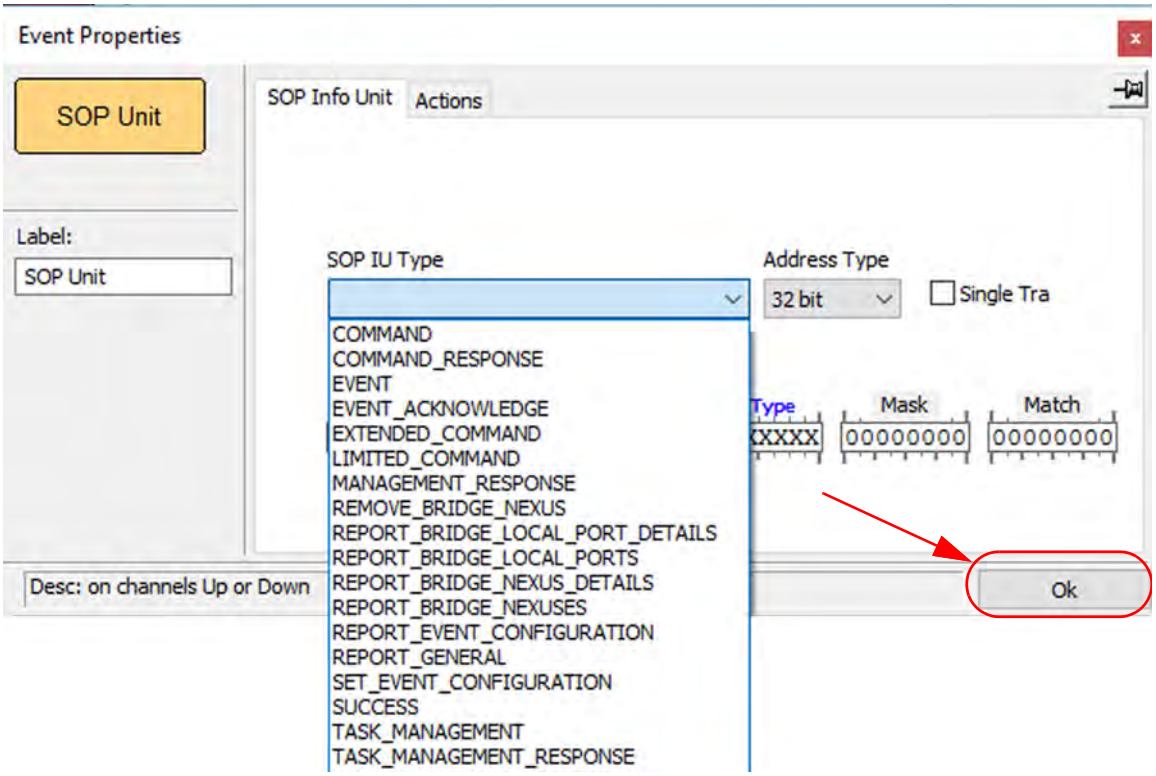


Figure 5.102: SOP Register: SOP IU Type

The SOP Register Actions are shown in Figure 5.93.

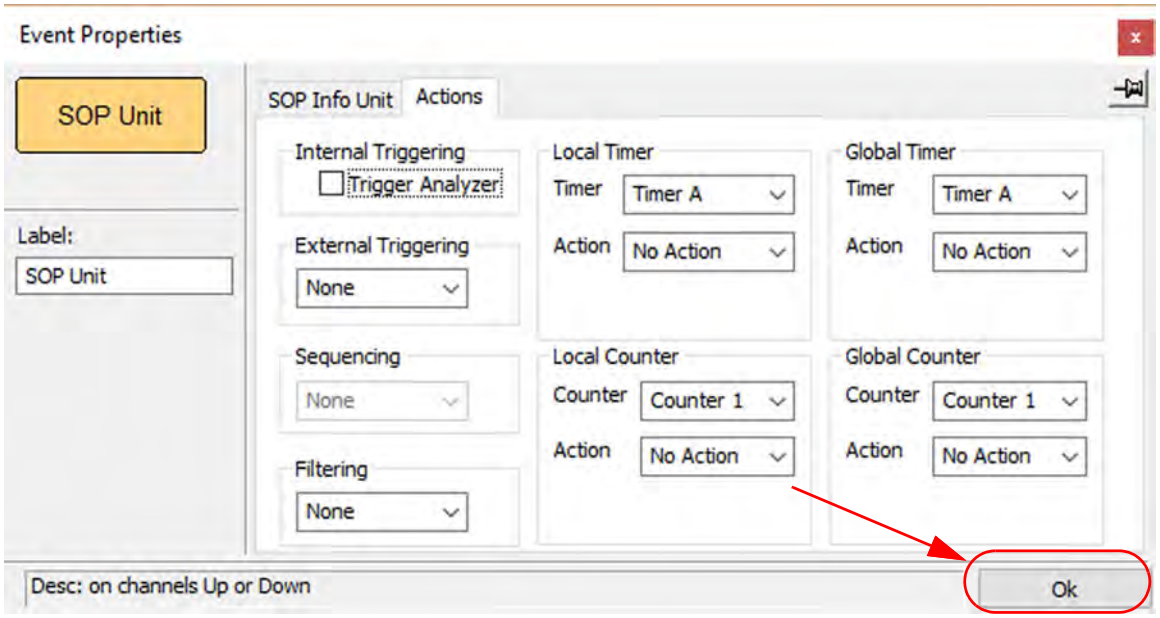


Figure 5.103: SOP Register: Actions

5.17.8.15 Recording Rules: MCTP New Event

You can select MCTP Packets to trigger a recording (see Figure 5.104 and Figure 5.105).

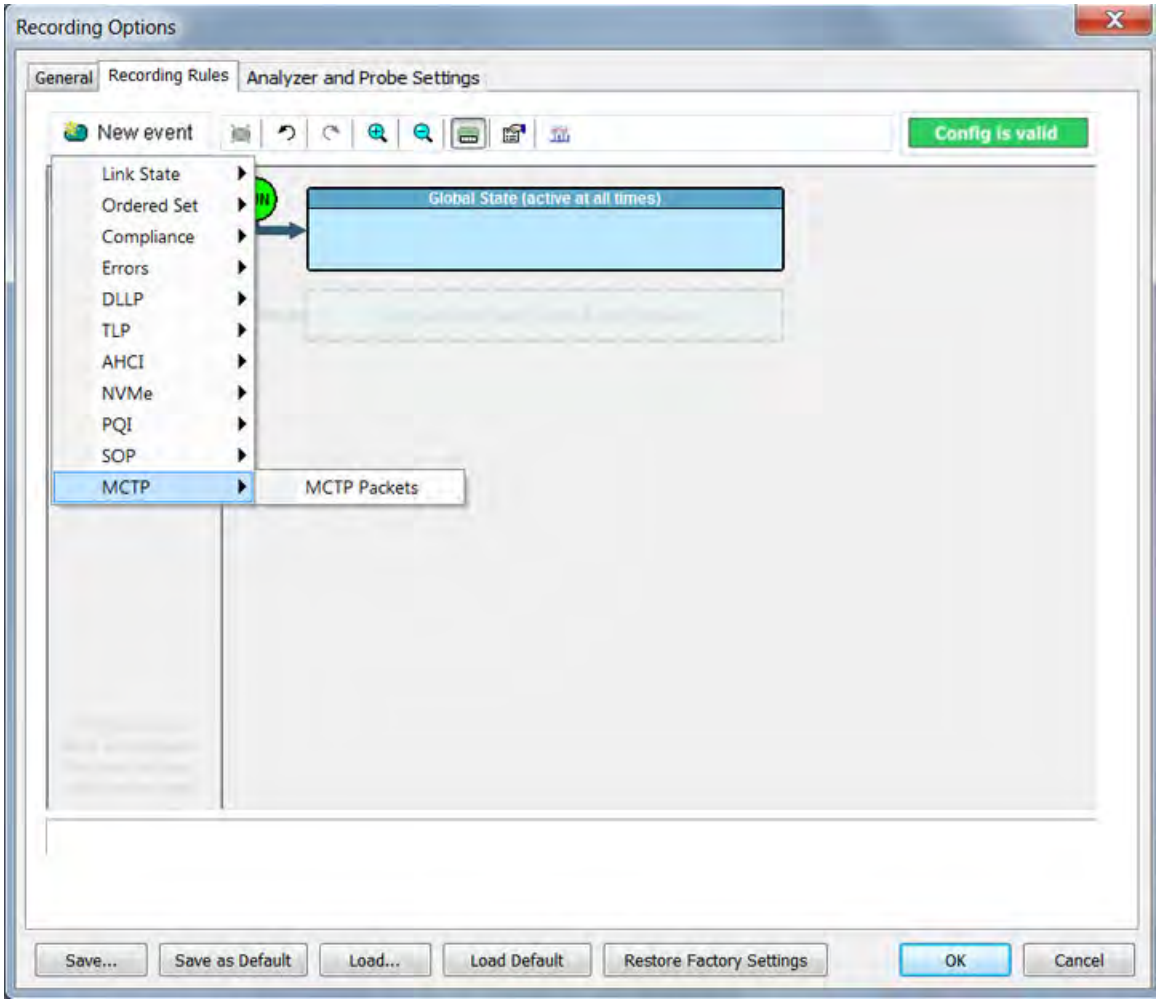


Figure 5.104: Recording Rules: MCTP New Event -> MCTP Packets

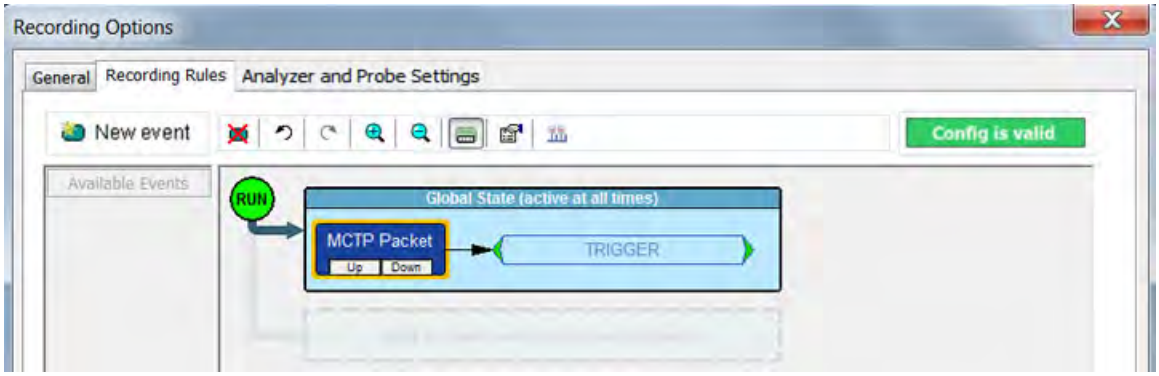


Figure 5.105: Recording Rules: MCTP Packet -> Trigger Recording

Event Properties: MCTP Packet -> Fields

The MCTP Packet Fields you can trigger on are shown in Figure 5.106. The options include Transport -> TLP VDM (Vendor Defined Message) and SMBus. After selecting the options you want click on the “OK” button.

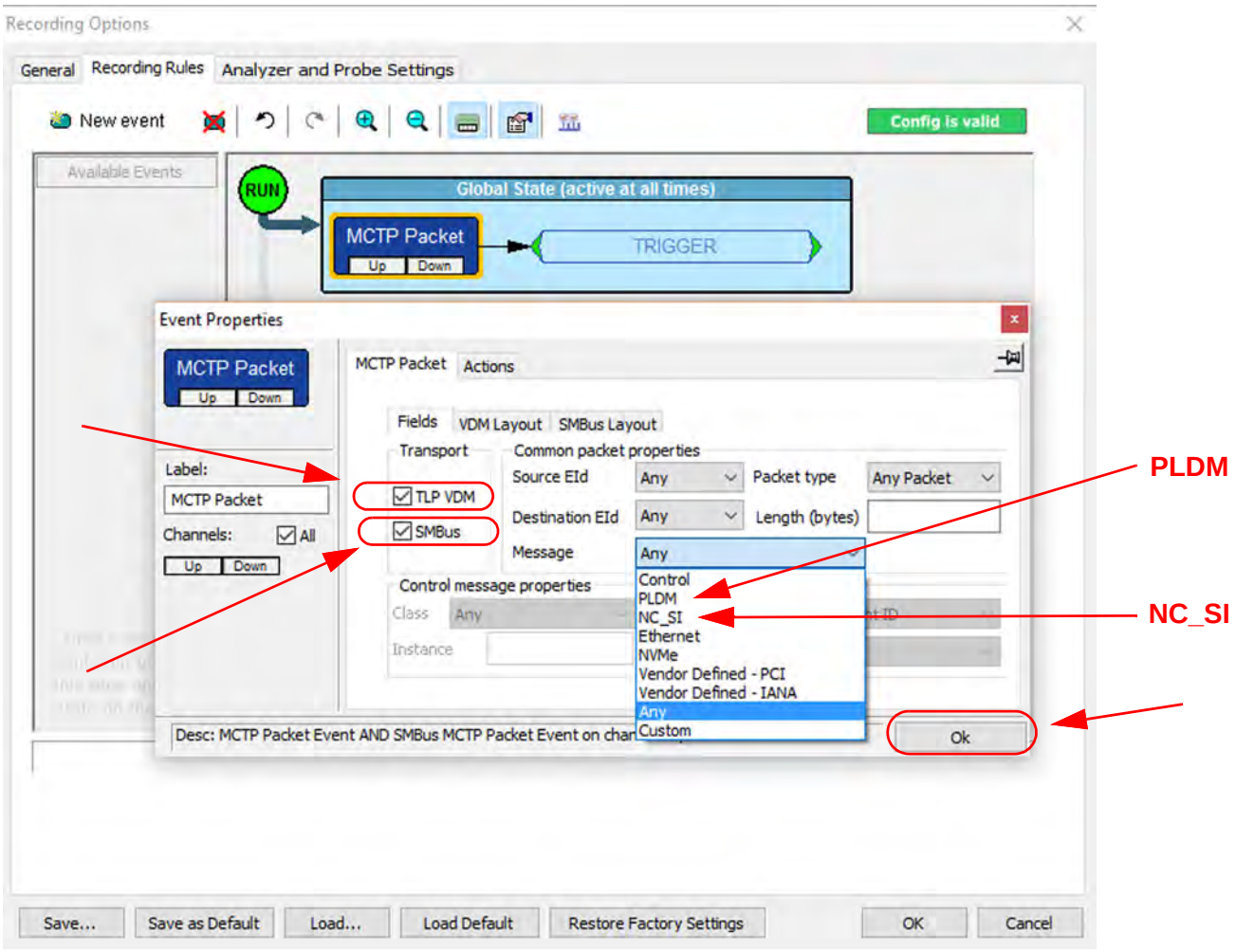


Figure 5.106: Event Properties: MCTP Packet -> Fields -> Messages

You can trigger on the following Transport types:

- TLP VDM
- SMBus

You can also trigger on the following Message Types

- Control
- PLDM
- NC_SI
- Ethernet
- NVME
- Vendor Defined - PCI
- Vendor Defined - IANA
- Any

- Custom

You can trigger on the following Packet types:

- Any Packet
- Start Packet
- Middle Packet
- End Packet
- Single Packet

Event Properties: MCTP Packet: VDM Layout

You can also trigger on MCTP Packet VDM Layout. After selecting the options you want click on the “OK” button.

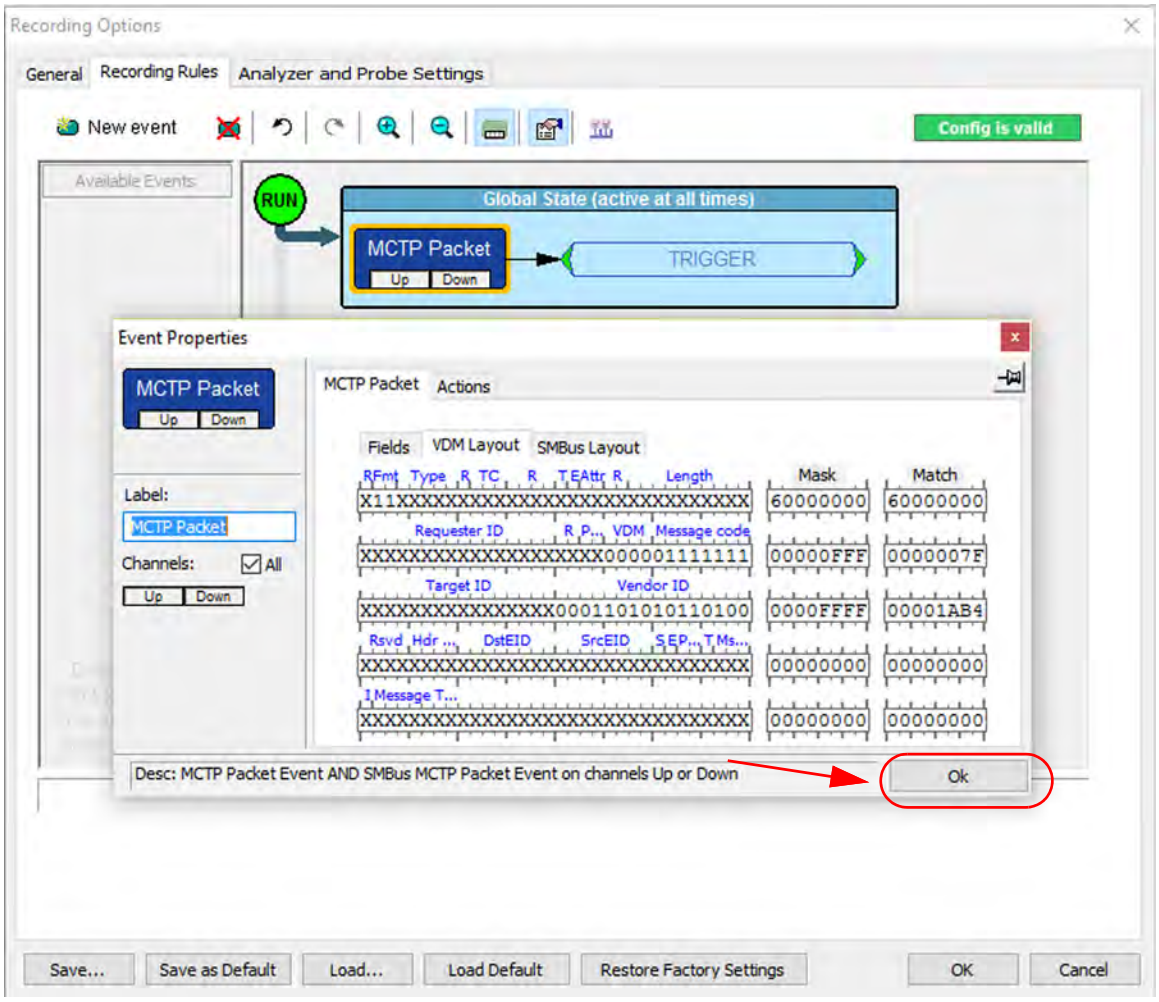


Figure 5.107: MCTP Packet: Layout Options for Trigger -> VDM Layout with Default Mask

Event Properties: MCTP Packet: SMBus Layout

You can also trigger on MCTP Packet SMBus Layout. After selecting the options you want click on the “OK” button.

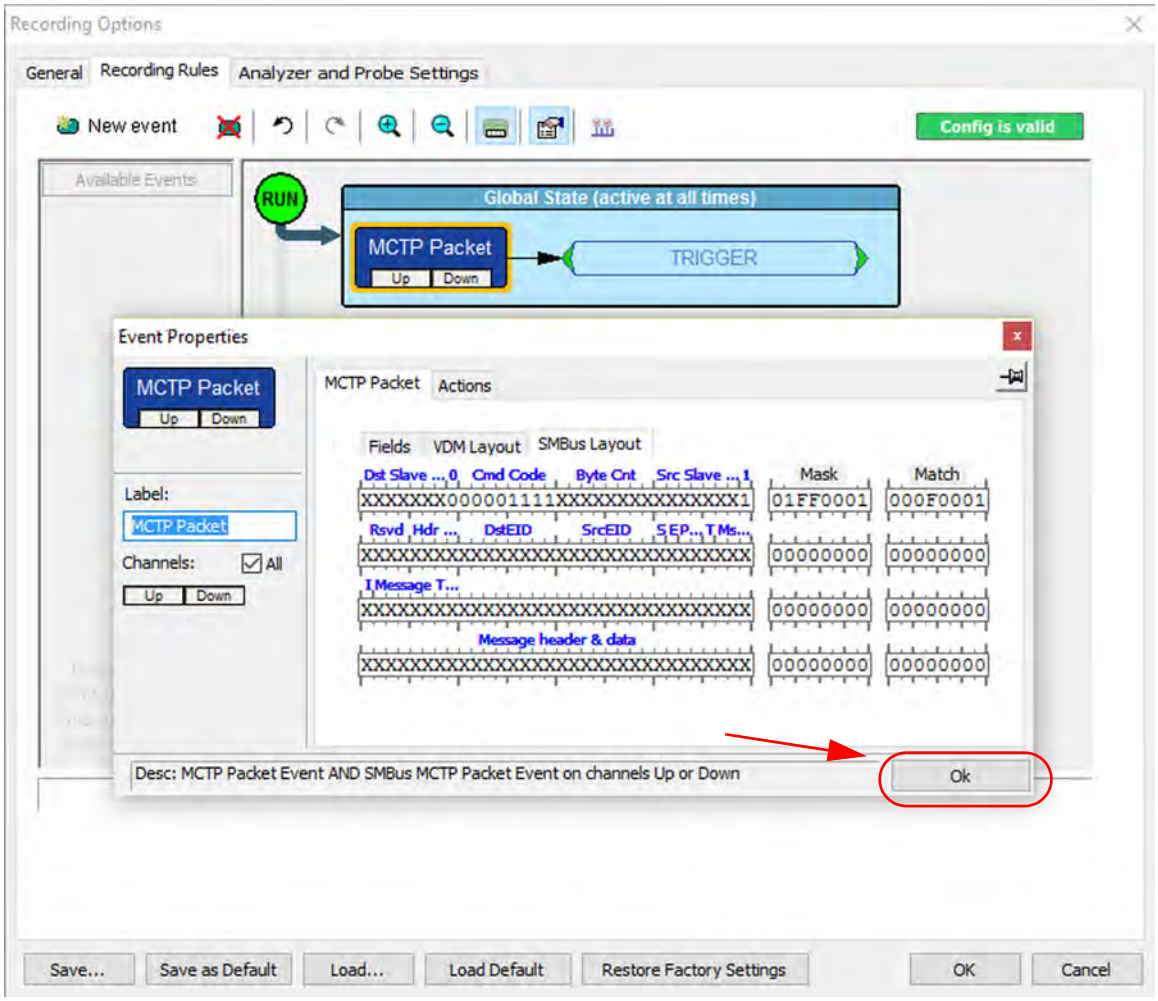


Figure 5.108: MCTP Packet: Layout Options for Trigger -> SMBus Layout with Default Mask

Event Properties: MCTP Packet -> Message: Control

If you choose MCTP Packet -> Message: Control, the Control message properties section of the GUI is enabled. See Figure 5.109.

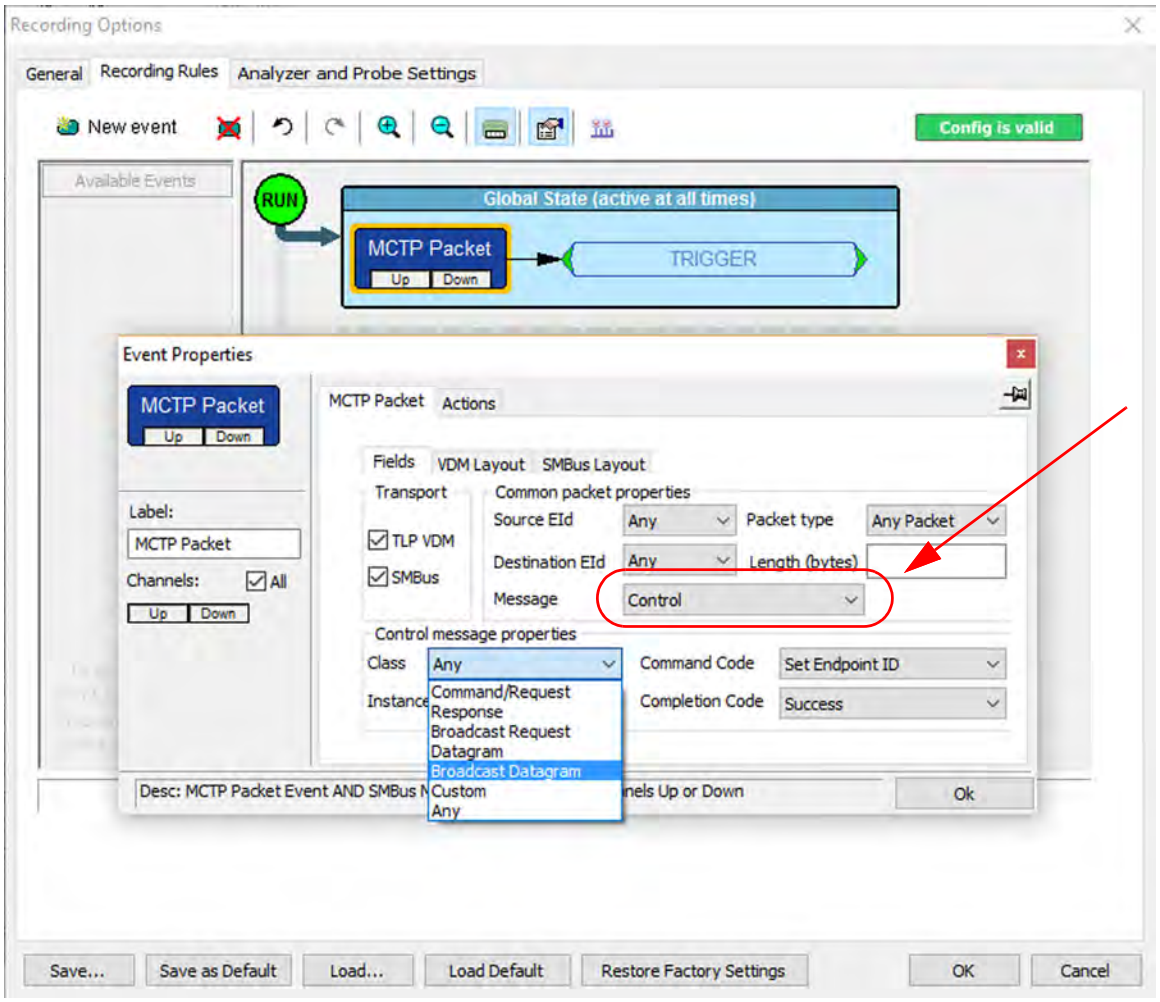


Figure 5.109: MCTP Packet -> Message: Control

MCTP Packet -> Control message properties

From this drop down dialog you can choose any of the following options to trigger on:

- Class
  - Command/Request
  - Response
  - Broadcast Request
  - Datagram
  - Broadcast Datagram
  - Custom
  - Any

There is a window for an Instance number:

- Instance (User Input)

There is also a drop down dialog for Command Codes:

- Command Codes (see Figure 5.110)

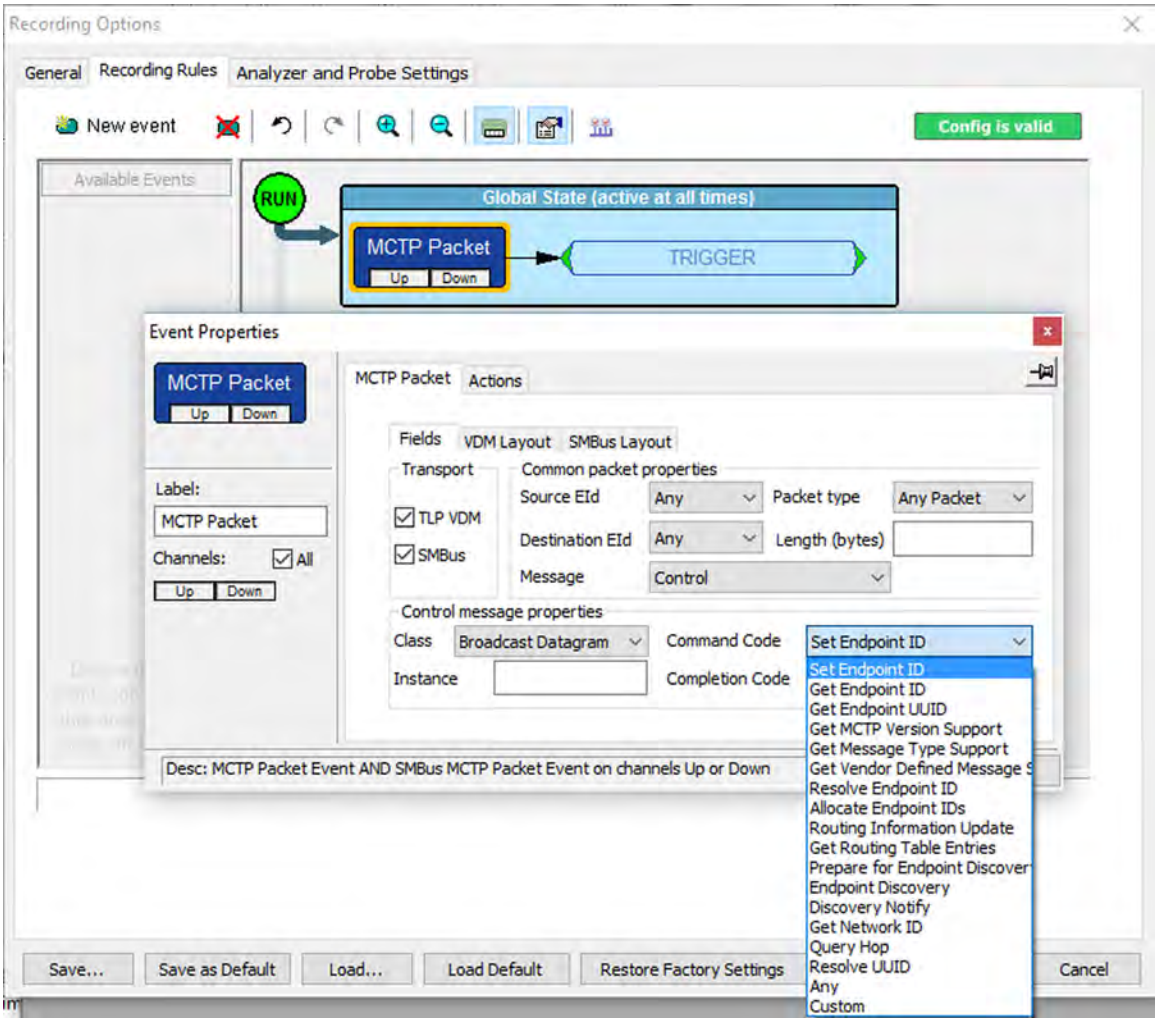


Figure 5.110: MCTP Packet -> Message: Control: Command Codes

- Set Endpoint ID
- Get Endpoint ID
- Get Endpoint UUID
- Get MCTP Version Support
- Get Message Type Support
- Get Vendor Defined Message Support
- Resolve Endpoint ID
- Allocate Endpoint IDs
- Routing Information Update
- Get Routing Table Entries
- Prepare for Endpoint Discovery
- Endpoint Discovery
- Discovery Notify
- Get Network ID
- Query Hop
- Resolve UUID
- Any
- Custom

There is also a drop down dialog for Completion Codes:

- Completion Codes (see Figure 5.111)

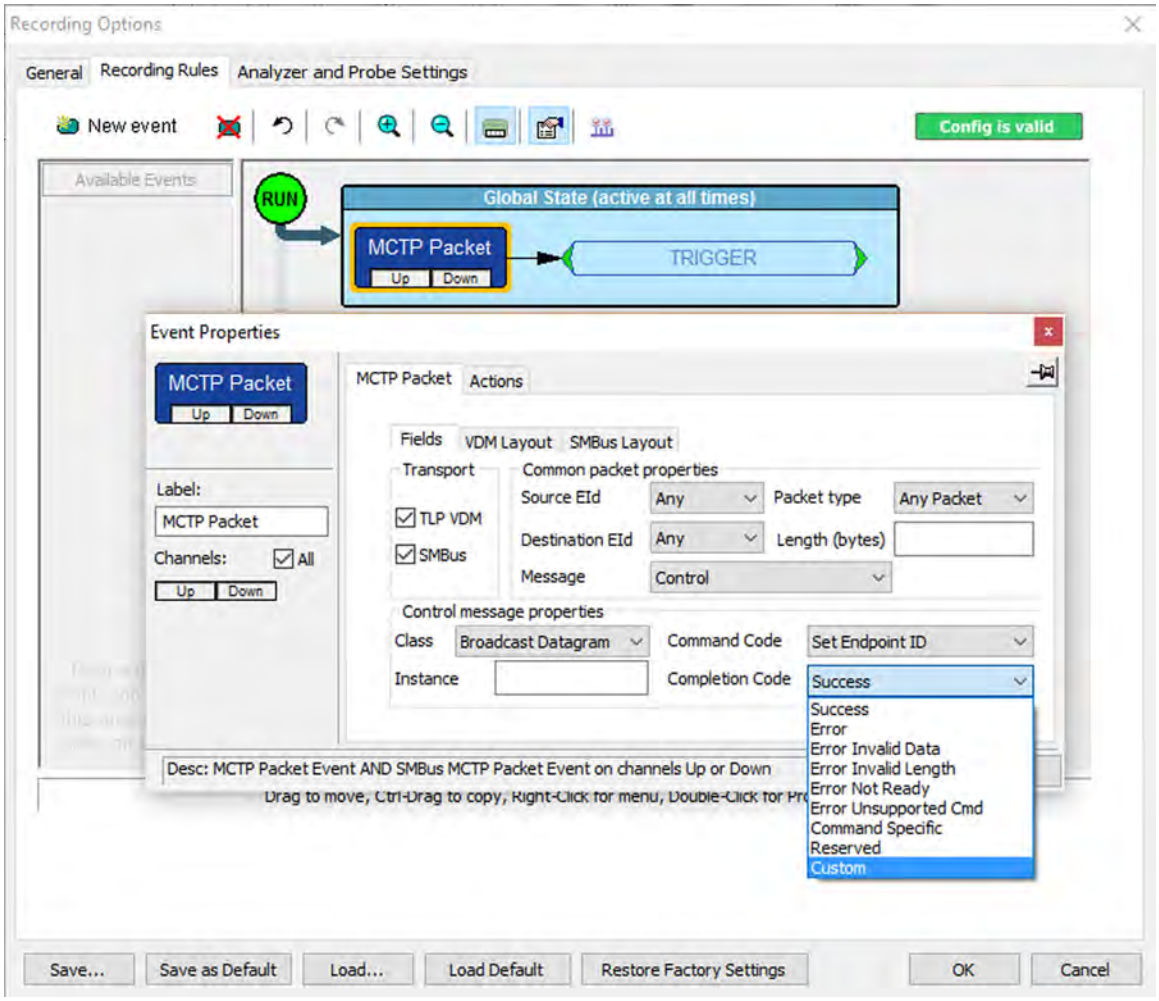


Figure 5.111: MCTP Packet -> Message: Control: Completion Codes

- Success
- Error
- Error Invalid Data
- Error Invalid Length
- Error Not Ready
- Error Unsupported Cmd
- Command Specific
- Reserved
- Custom

Event Properties: MCTP Packet -> Actions

The Actions available after triggering on an MCTP Packet are shown in Figure 5.112. After selecting the options you want click on the “OK” button.

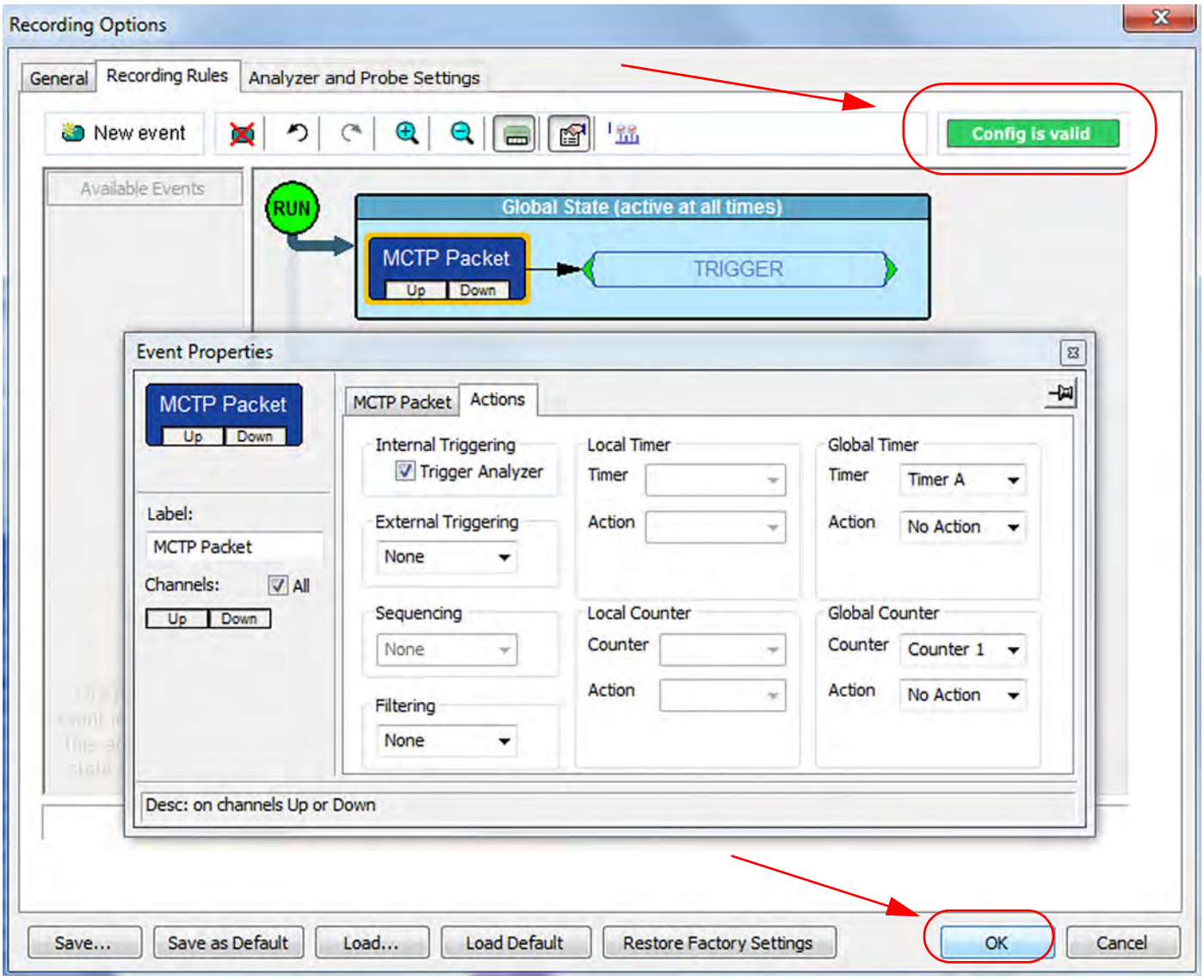


Figure 5.112: Recording Rules: MCTP Packet -> Internal Trigger: Valid

If you had attempted to choose both triggering and filtering the s/w tells you that is an Invalid triggering configuration. See Figure 5.113 on page 296.

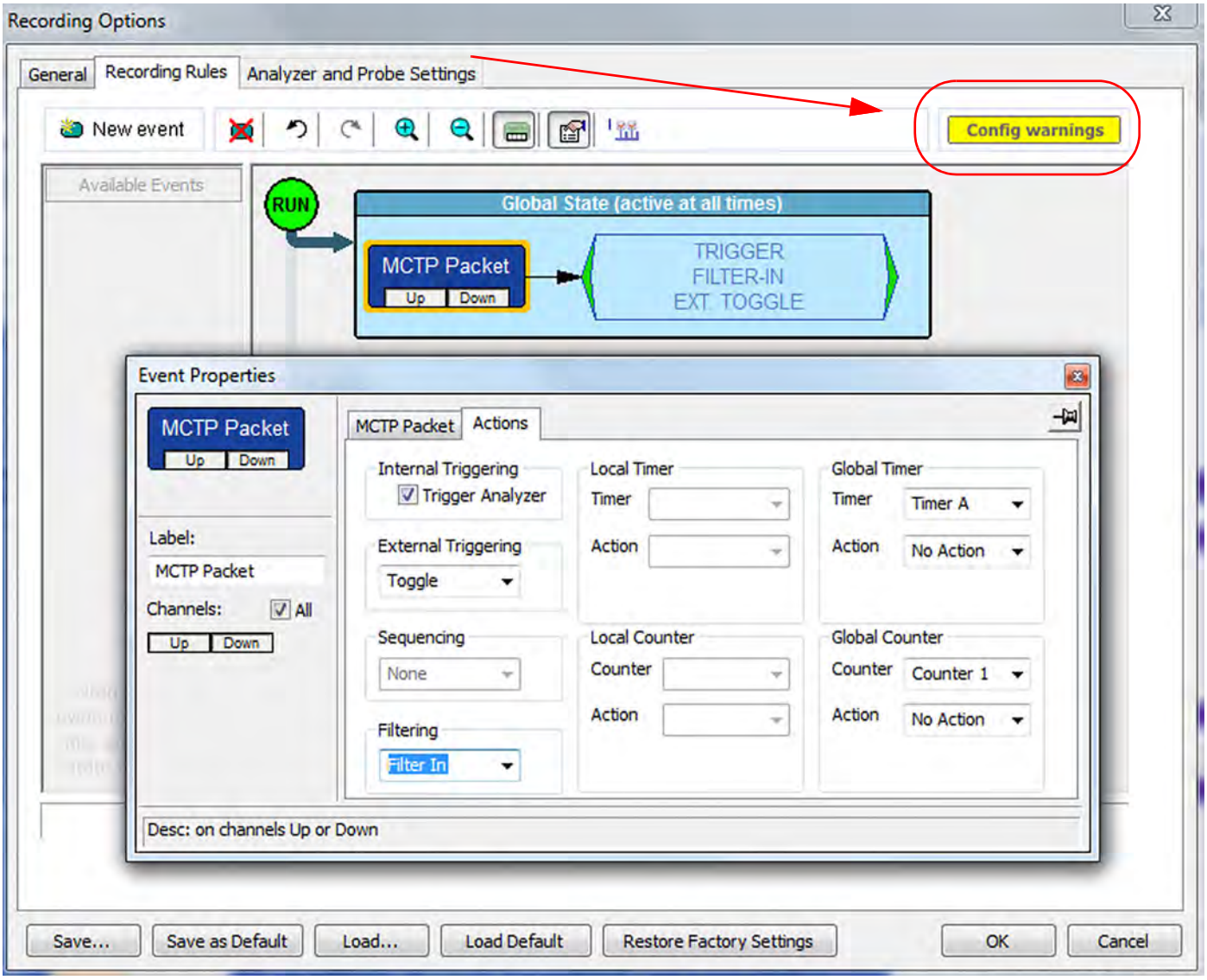


Figure 5.113: Recording Rules: MCTP Packet -> Internal Trigger and Filtering: Invalid

5.17.9 Actions Properties Dialog

Every Event has an Action tab as shown in Figure 5.114 on page 297.

The following tables describes the Actions for each Event.

TABLE 5.4: Event Actions

Action	Description
Label	Label the action.
Channels	Select Channels to go upstream or downstream.
Internal Triggering	Check the box to enable Internal Triggering from the Trigger In input. Any edge of the supplied signal will cause the analyzer to trigger.

TABLE 5.4: Event Actions

External Triggering	Set the External Triggering to Low, High or Toggle. The default is None. Note: The trigger latency for the Summit T416/T48 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 T416/T48 Trigger Out connector.
Sequencing	Set the Sequence to Advance. The default is None.
Filtering	Set the Filtering to Filter Out. You cannot Filter In in the Summit Z3-16. The default is None.
Local Timer	Set the Local Timer, there are four options available.
Action	You can set the Action of the timer to Start or Reset. When you reset the timer it resets to it's initial value. The default is No Action.
Local Counter	Set the Local Counter, there are four options available.
Local Counter Action	You can set the Action of the Counter to Increment or Reset. The Counter increments by one and resets to its initial value. The default is No Action.
Global Timer	Set the Global Timer, there are two options available.
Global Timer Action	You can set the Action of the timer to Start or Reset. When you reset the timer it resets to it's initial value. The default is No Action.
Global Counter	Set the Global Counter, there are two options available.
Global Counter Action	You can set the Action of the Counter to Increment or Reset. The Counter increments by one and resets to its initial value. The default is No Action.

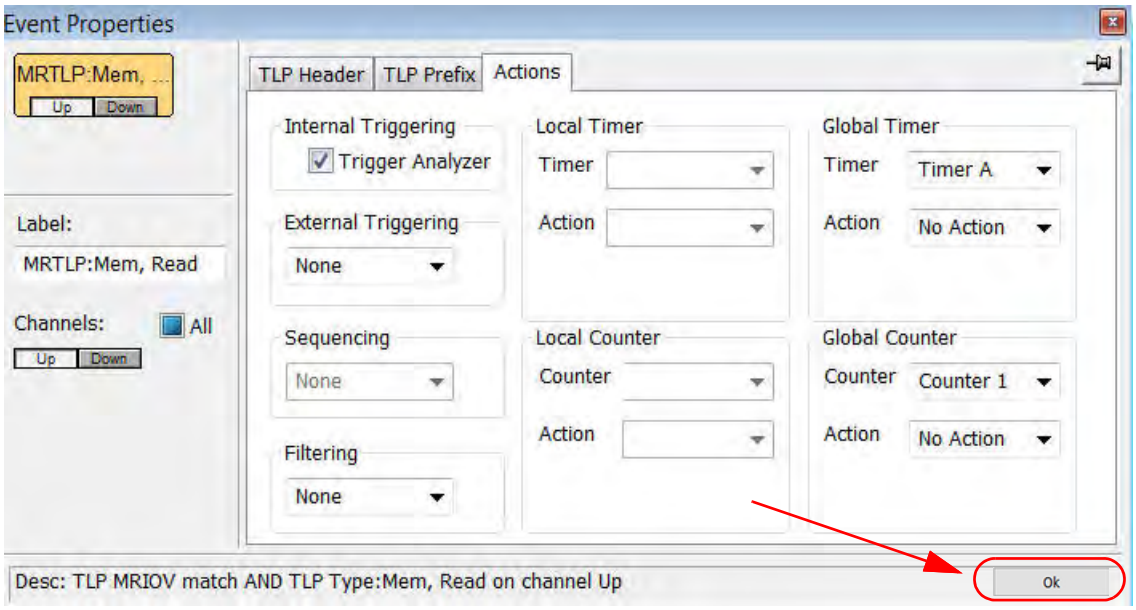


Figure 5.114: Actions Properties Dialog

5.17.9.1 Filter Out

A filter causes the Analyzer to filter out specified events from the recording. If events are filtered out of the recording, they are excluded from the Analyzer's buffer and not simply hidden from the CATC Trace. The purpose of “filtering out” is to preserve recording memory so you conduct longer recording sessions and exclude events that do not interest you.

5.17.9.2 Filter-Out In Simple Mode

In Simple Mode you can filter out:

- SKIP Ordered Sets
- UpdateFC DLLP
- End of Data Stream (EDS)
- Gen1 / Gen2 Compliance Pattern
- Modified Compliance Pattern
- Link Events (Link Up and Link Down)
- CLKREQ#
- WAKE#
- PERST#
- Idle Errors

See Figure 5.115.

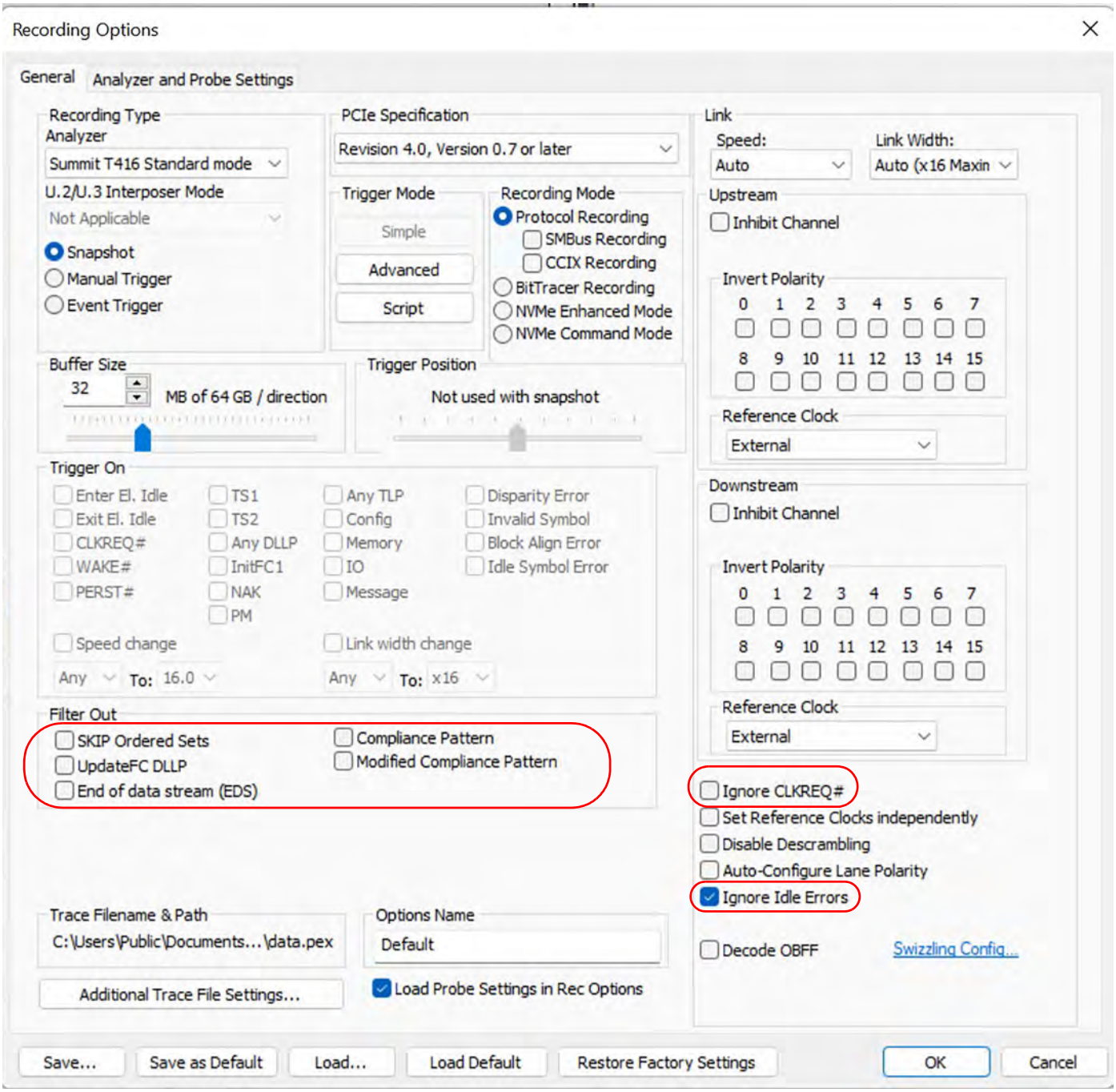


Figure 5.115: Simple Mode: Filter Out -> T416

Note: If you did Filter-Out all the events shown above, you'd create an empty trace and get a warning message (see "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." on page 648.)

5.17.9.3 Filter-Out in Advanced Mode

To enable "filter-out" in Advanced Mode, place an event button into either the **Global State** cell or the **Sequence** cell, then right-click the button and choose an **Action** (see

previous topic).

From the sub-menu, select **Filter-Out.** See Figure 5.116.

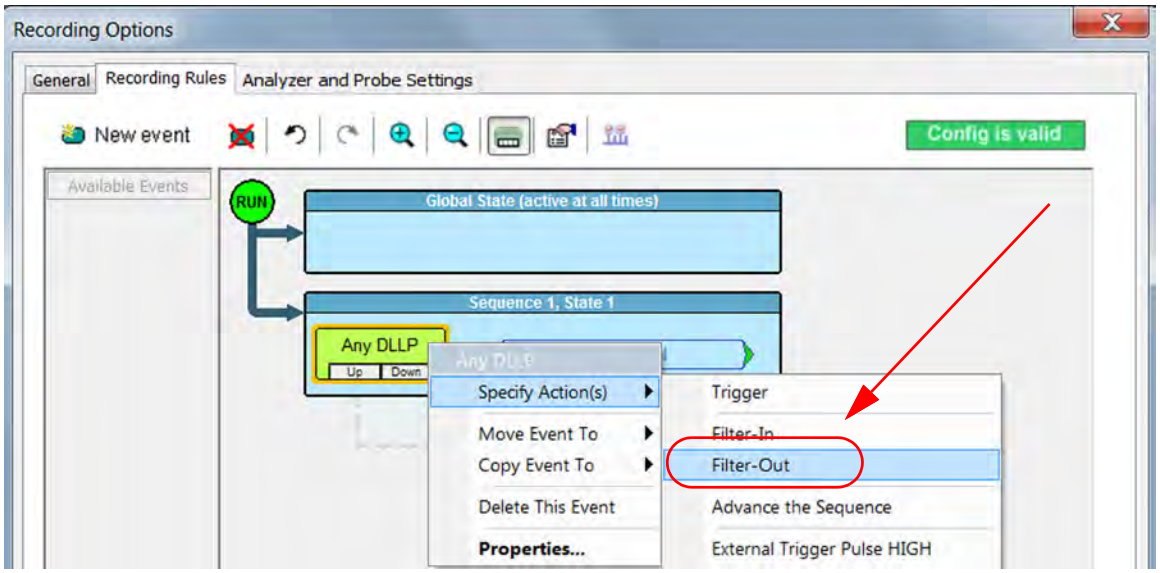


Figure 5.116: Filter Out Option

Note: The Filter-Out option is only available in the DLLP, TLP, TS1 and TS2 Ordered Sets, for Link Events Enter/Exit Electrical Idle, WAKE# Asserted/Deasserted, CLKREQ# Asserted/Deasserted or PERST# Asserted/Deasserted.

Note: If you did Filter-Out all events (by mistake), you'd create an empty trace and get a warning message (see "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." on page 648.)

5.17.10 Filter In

"Filter in" is the logical opposite of "Filter Out". In this case, you are specifically interested in capturing specific events or traffic and ignoring everything else. If events are filtered in to the recording, they are included in the Analyzer's buffer. The purpose of "filtering in" is to preserve recording memory so you conduct longer recording sessions and include only events that interest you. Filter -n is only available in Advanced Mode.

As an example, let's say you want to capture **Any DLLP** and **Any NVMe:ACQ** Commands.

First switch to **Advanced Mode**.

To enable "Filter-In" place an event button (DLLP -> Any DLLP) into the **Global State** cell, then right-click the button and choose an **Action**. From the sub-menu select **Filter-In.**

Then select NVMe under New Event and NVMe Register:ACQ and place that event into the **Sequence 1, State 1** cell. Then right-click the button and choose an **Action**. From the sub-menu select **Filter-In.** See Figure 5.117.

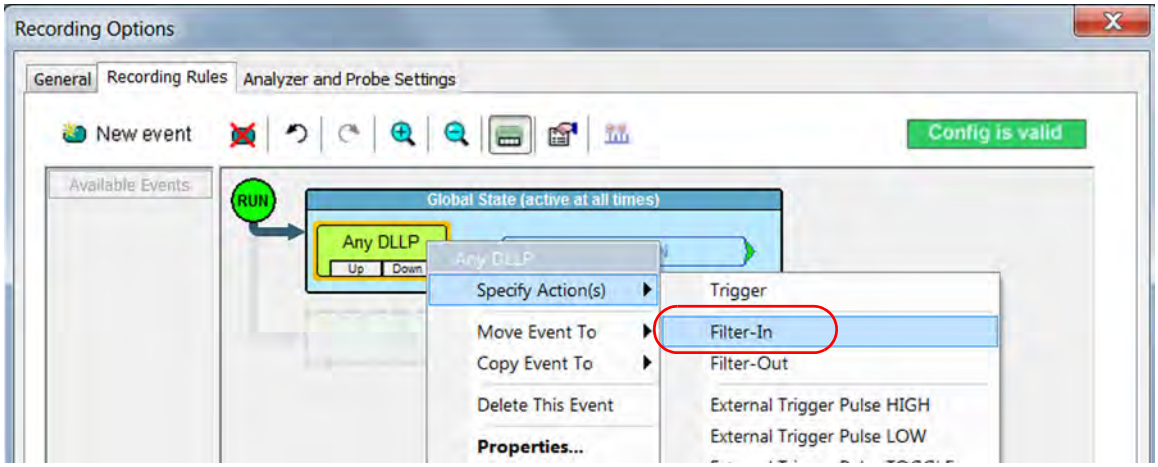


Figure 5.117: Filter In Option

Note: When a **Filter-In** is selected the analyzer filters out everything else by default.

5.17.11 Valid Configuration

In this case, you have chosen a Global State Filter-In on any DLLP and Sequence 1, State 1 to have an NVMe Command:ACQ Filter-In. This is a valid configuration as shown in Figure 5.118.

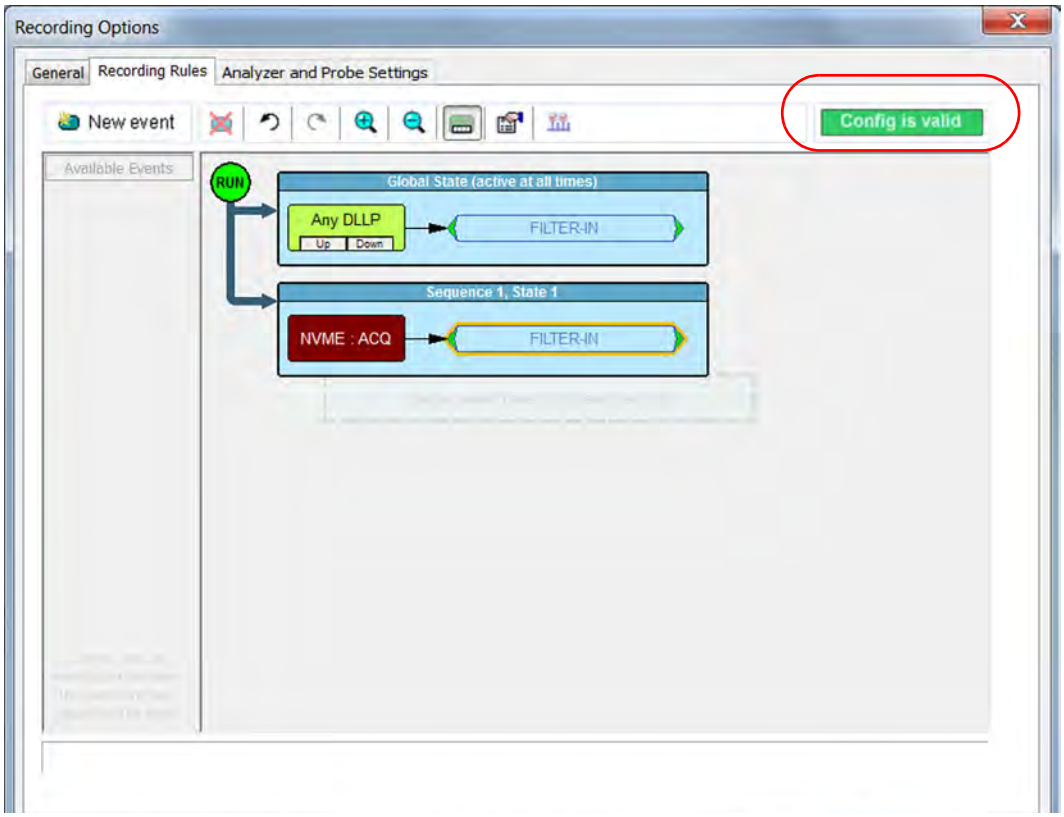


Figure 5.118: Filter In: Advanced Mode: Filter In Any DLLP and Any NVMe ACQ Command

Note: If you change the Global State to Any DLLP but switch to FILTER-OUT you'll get the following warning message: See Figure 5.119 on page 302.

5.17.12 Invalid Configuration

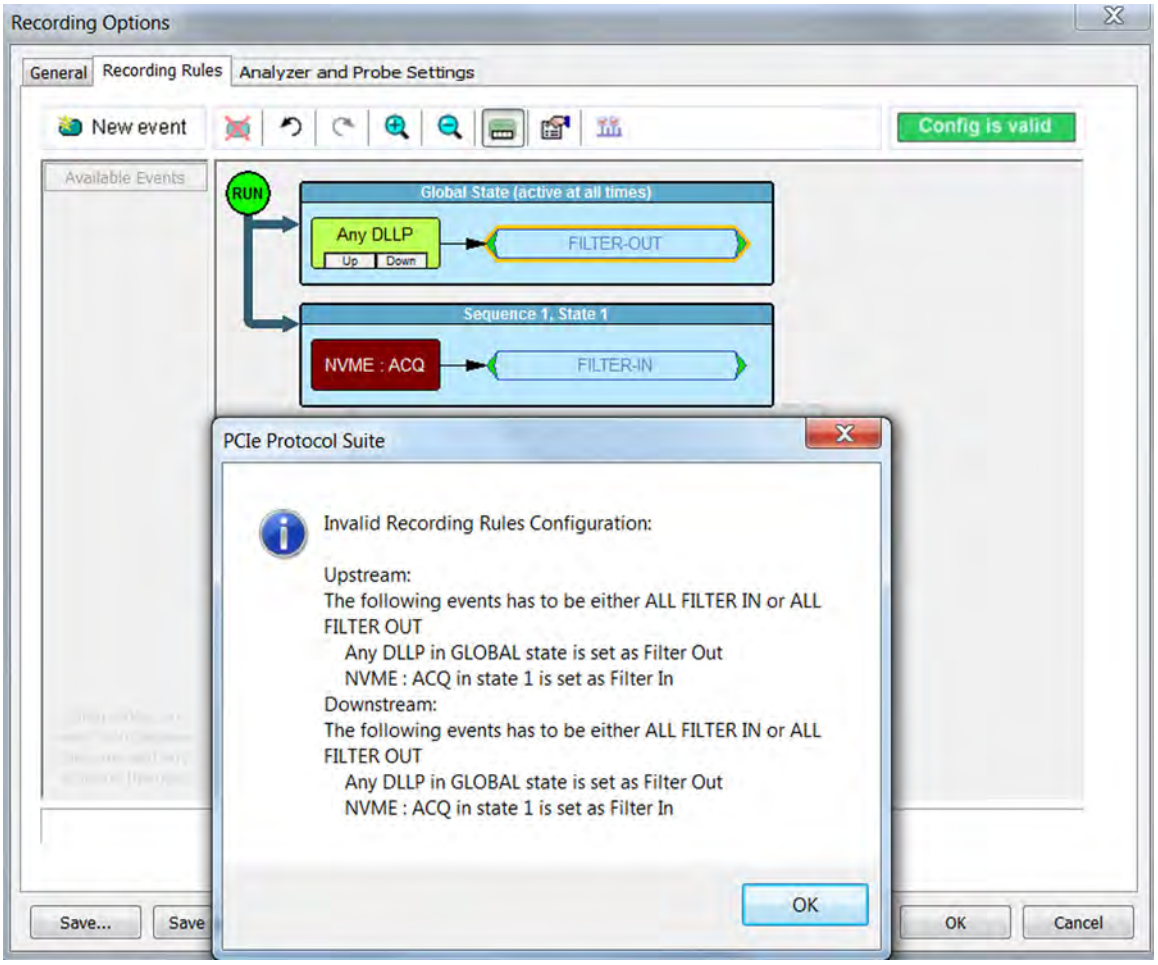


Figure 5.119: Warning Message for Invalid Configuration

The analyzer is warning you that you've set a Global Rule to Filter-Out Any DLLP and that condition will filter out the NVMe:ACQ Command you're looking for. So the recording rules have to be consistent. You'd get the same message if you set Any DLLP to Filter-In but set the NVMe:ACQ Command to Filter-Out. The warning message would pop up and if you hit OK, the **Config is Invalid** message will light up. See Figure 5.120 on page 303.

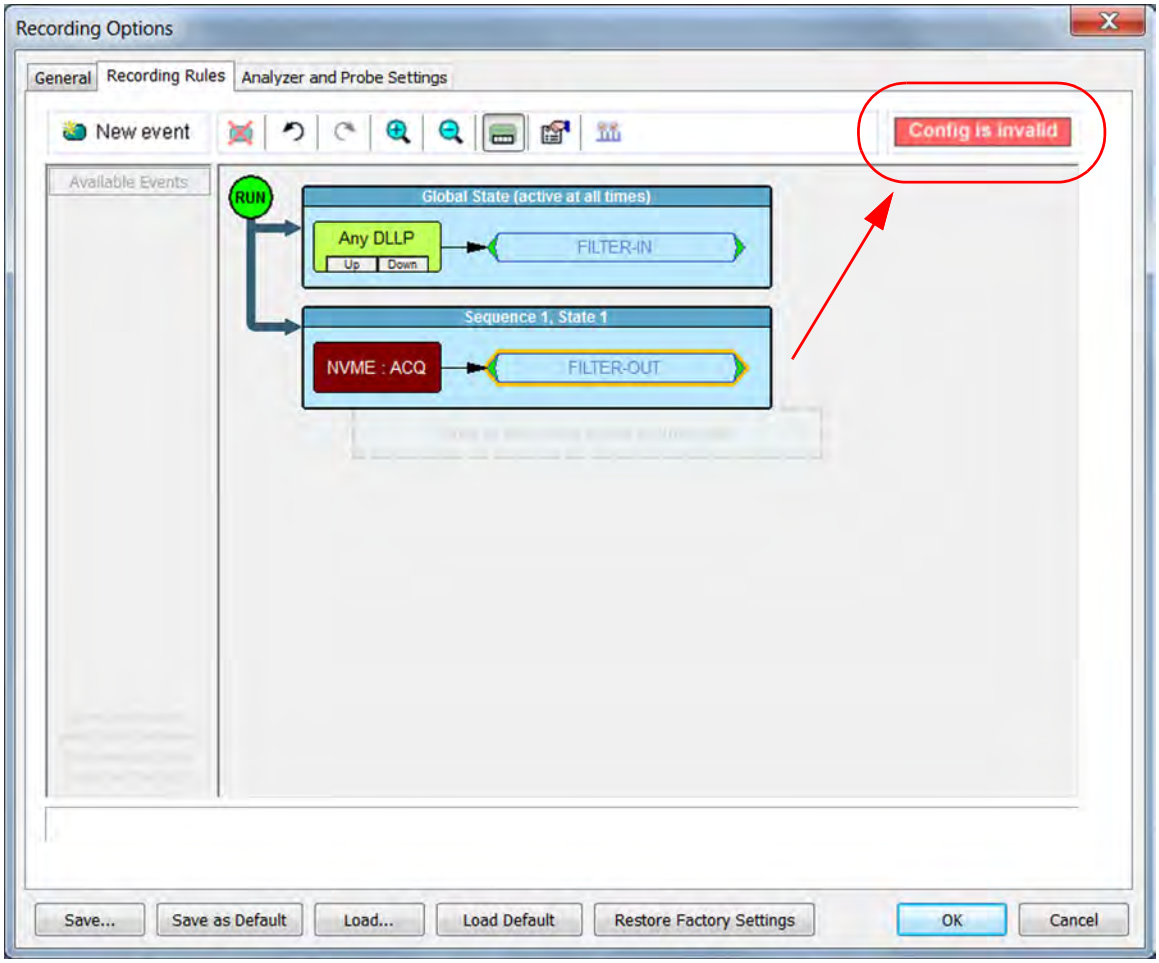


Figure 5.120: Filter In: Any DLLP, Filter Out Any NVMe:ACQ Command -> Invalid Config

So the tool won't let you try to set recording options that are logically inconsistent.

5.17.13 Filtering Events: (Electrical Idle, CLKREQ#, WAKE#, PERST#)

To be able to Filter-out the following events (Electrical Idle, CLKREQ# and WAKE# and PERST#), the event must be in a global state.

5.17.13.1 Example of CLKREQ# Filtering Enabled

See Figure 5.121 on page 304 for an example of CLKREQ# events in the global state. The event may be both asserted and deasserted or only asserted/ deasserted. Then you'll see that filtering of those events is enabled. After selecting the options you want click on the "OK" button.

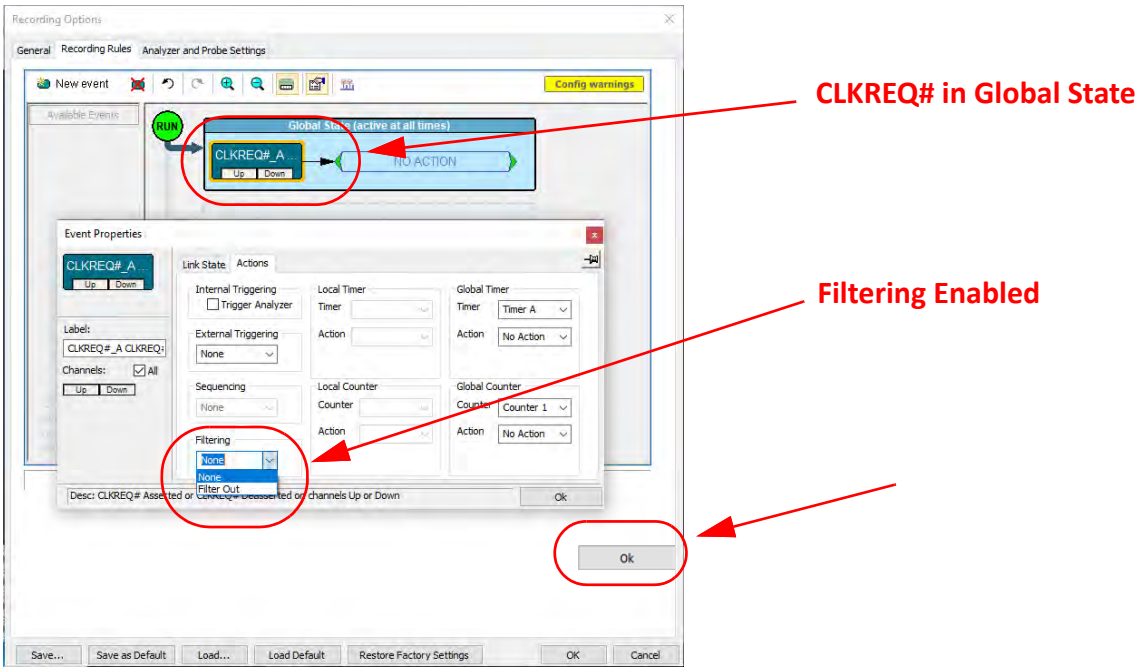


Figure 5.121: Link Event: CLKREQ# => Event in global state => Filtering Enabled

5.17.14 Filtering Out NVMe CSTS, DLLP Ack and TLP Completions

To enable longer recordings, you can filter out NVMe CSTS, DLLP Acks and TLP Completions in Global Options by using the Advanced Recording Options. See Figure 5.122.

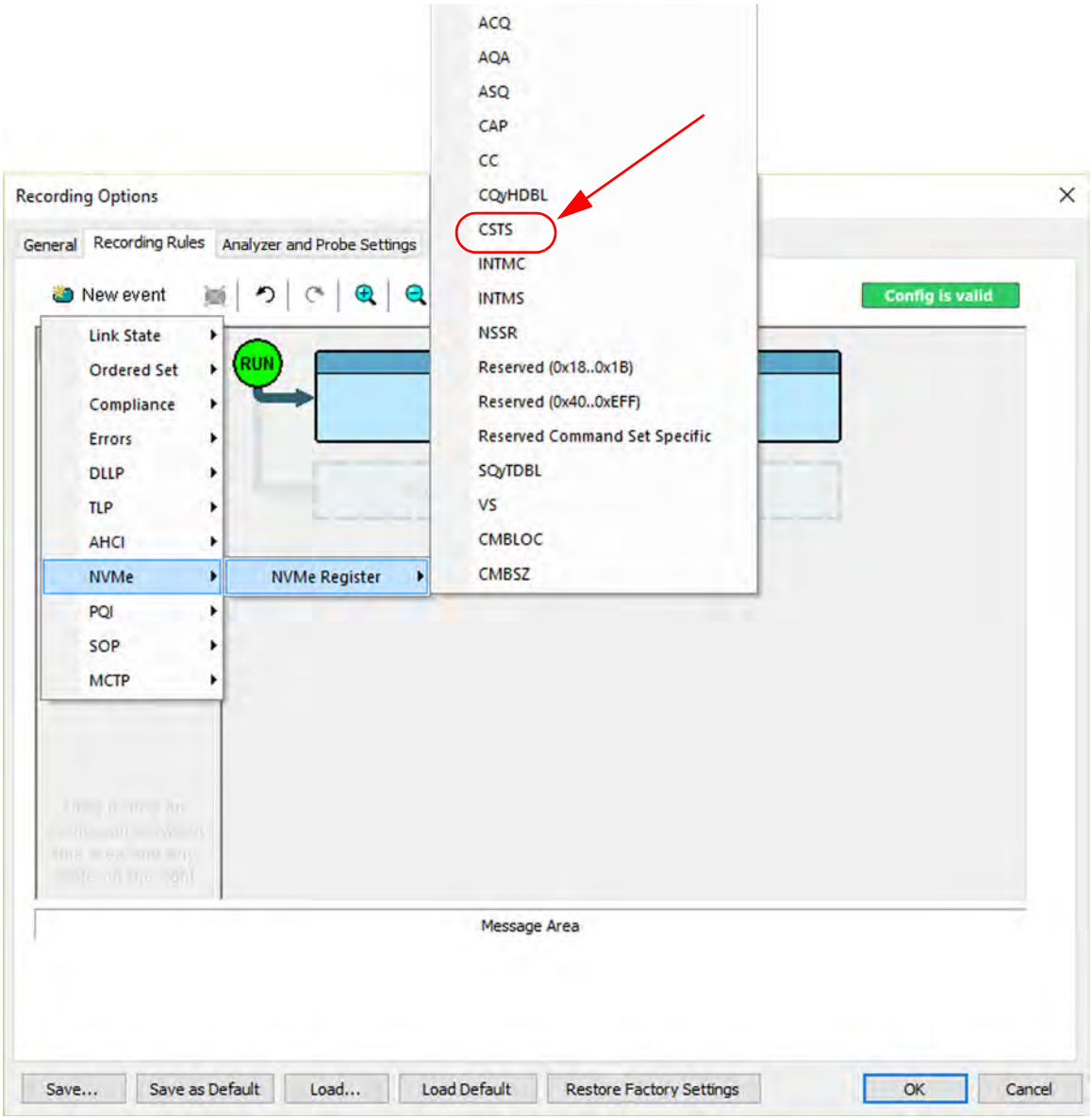


Figure 5.122: Filtering Out NVMe CSTS

If you select **New Event -> NVMe -> NVMe Register -> CSTS -> Actions** you'll have the option to filter out the CSTS events. See Figure 5.123 on page 306.

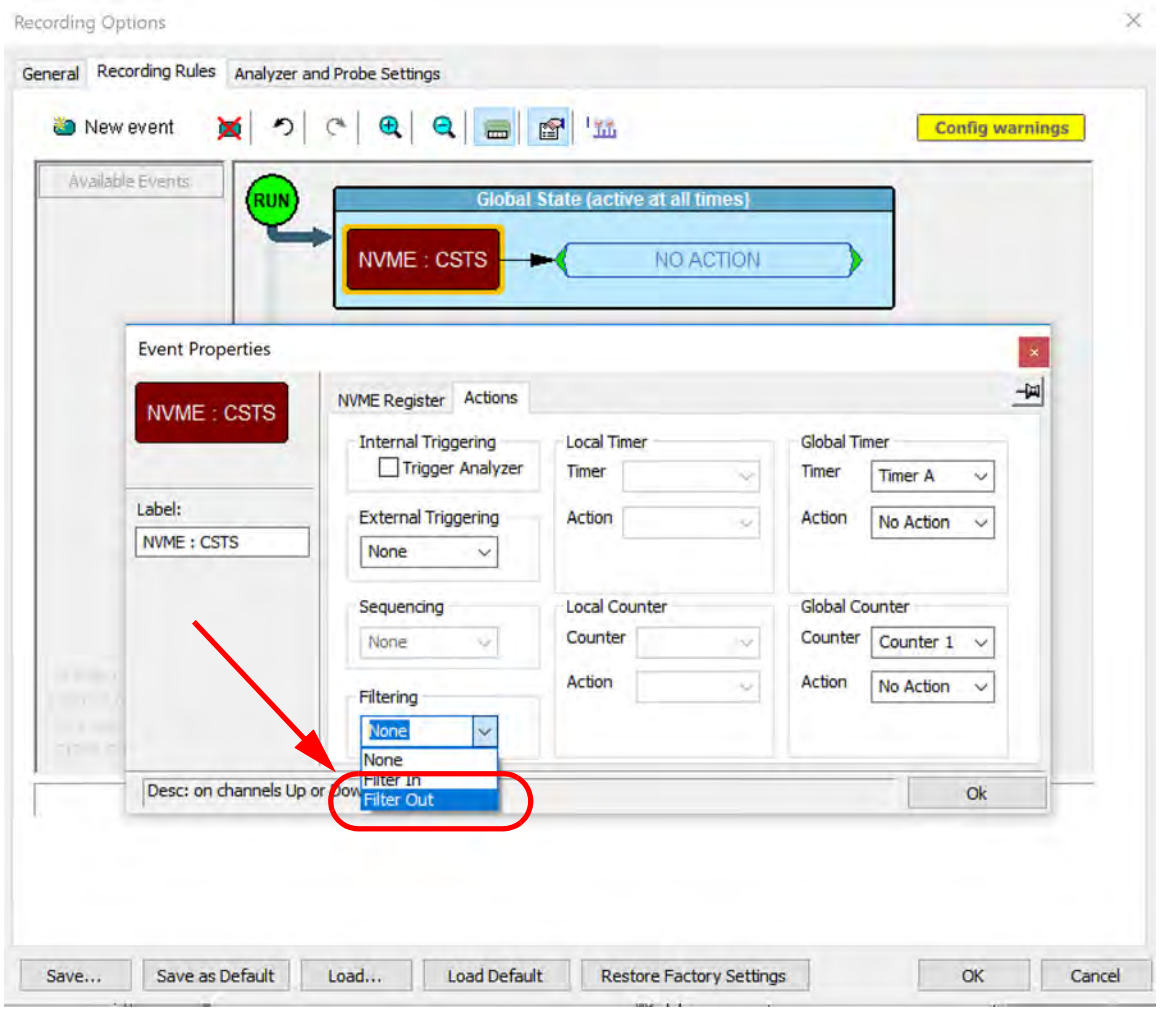


Figure 5.123: Selecting Recording Options: NVMe -> CSTS Event

Set the Action to Filter Out. Then click on “OK”. See Figure 5.124 on page 307.

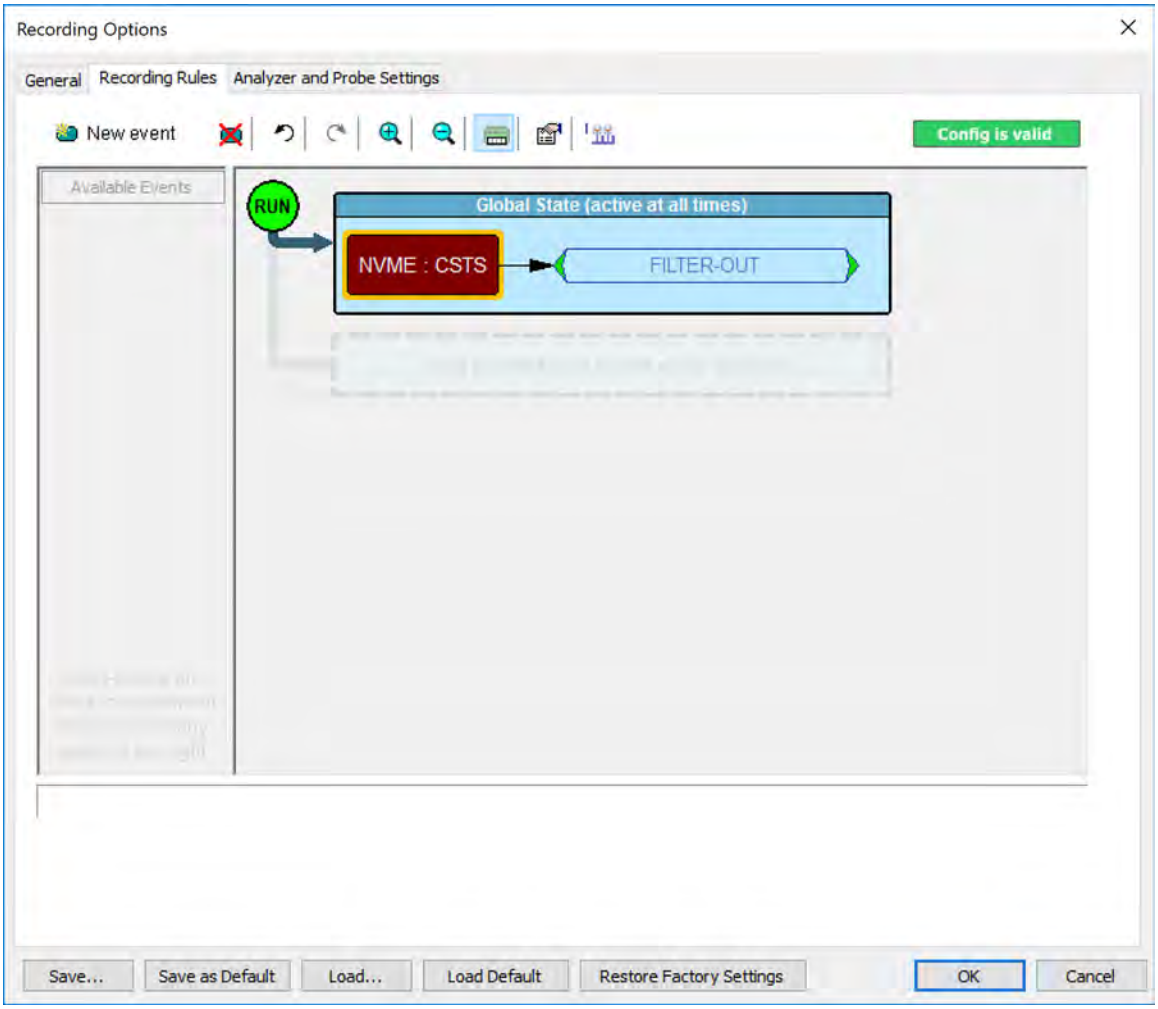


Figure 5.124: Recording Options: Filter Out NVME CSTS

Next add DLLP Acks to also be Filtered Out. See Figure 5.125 on page 308.

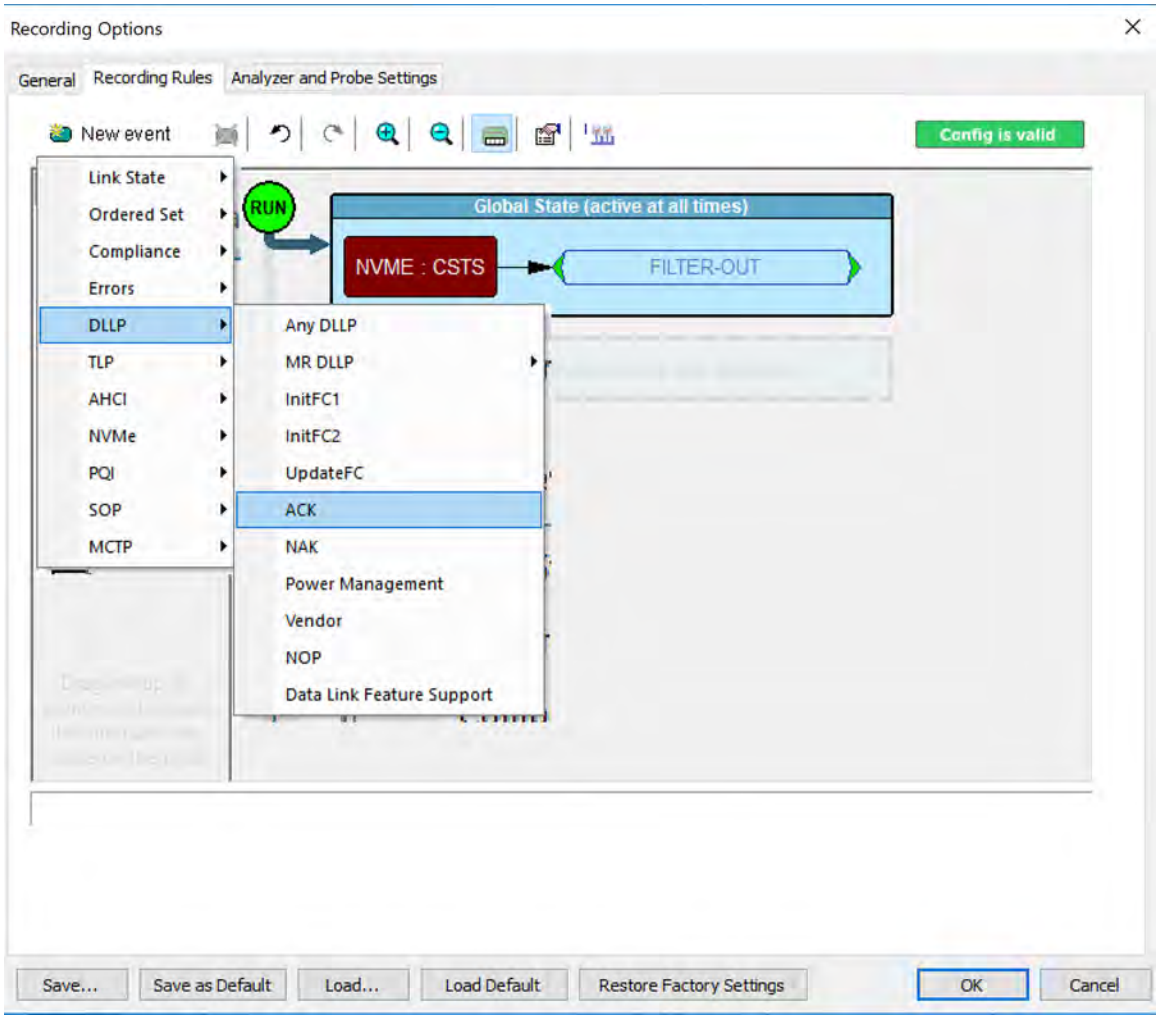


Figure 5.125: Recording Options: DLLP -> ACK

Click on “OK”, then add the Action -> Filter Out and place the DLLP in the Global State. See Figure 5.126 on page 309.

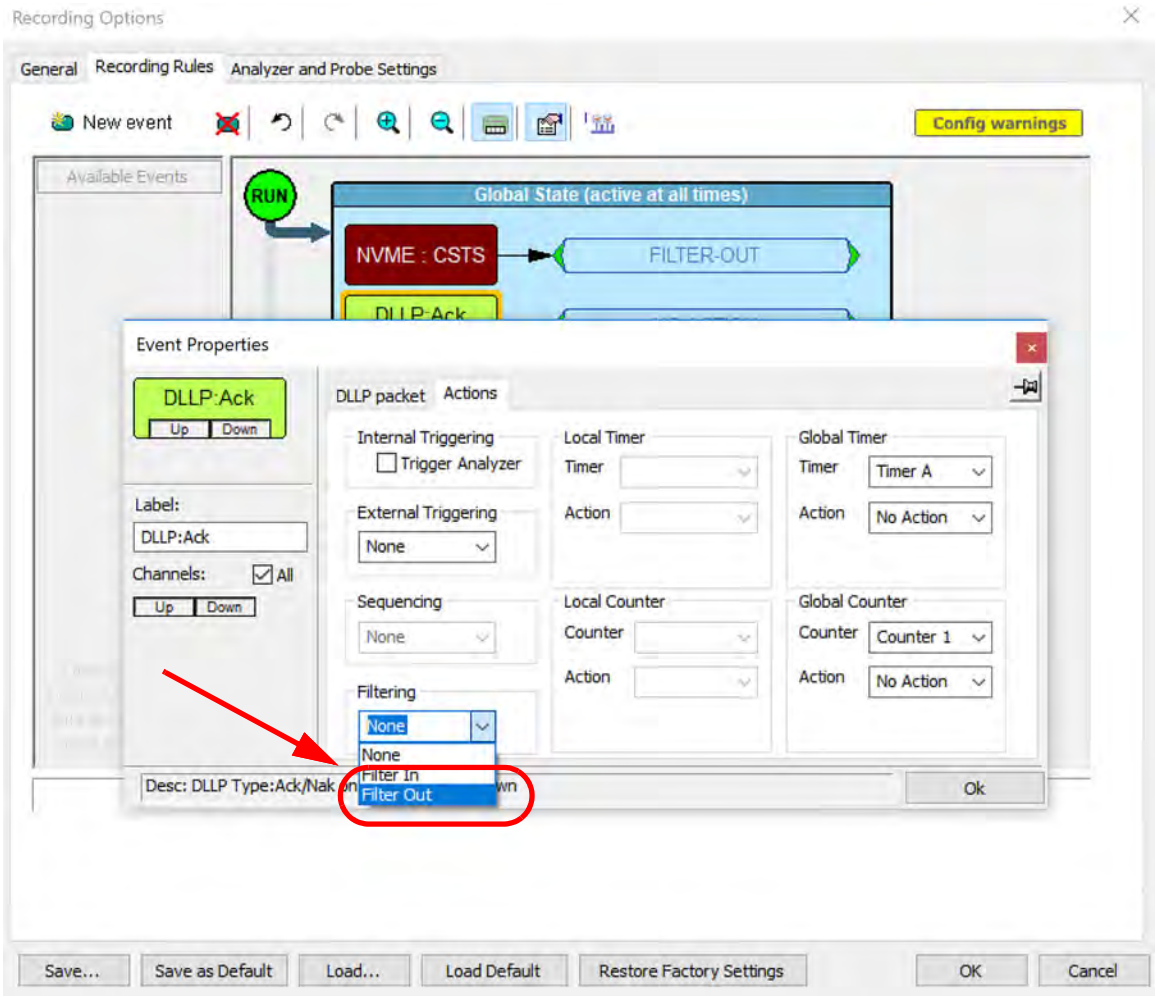


Figure 5.126: Select Action: Filter Out

Select Actions -> Filtered Out.

Click on “OK” and the DLLP:Ack with Action “Filter-Out” will be placed in the Global Options state. See Figure 5.127 on page 310.

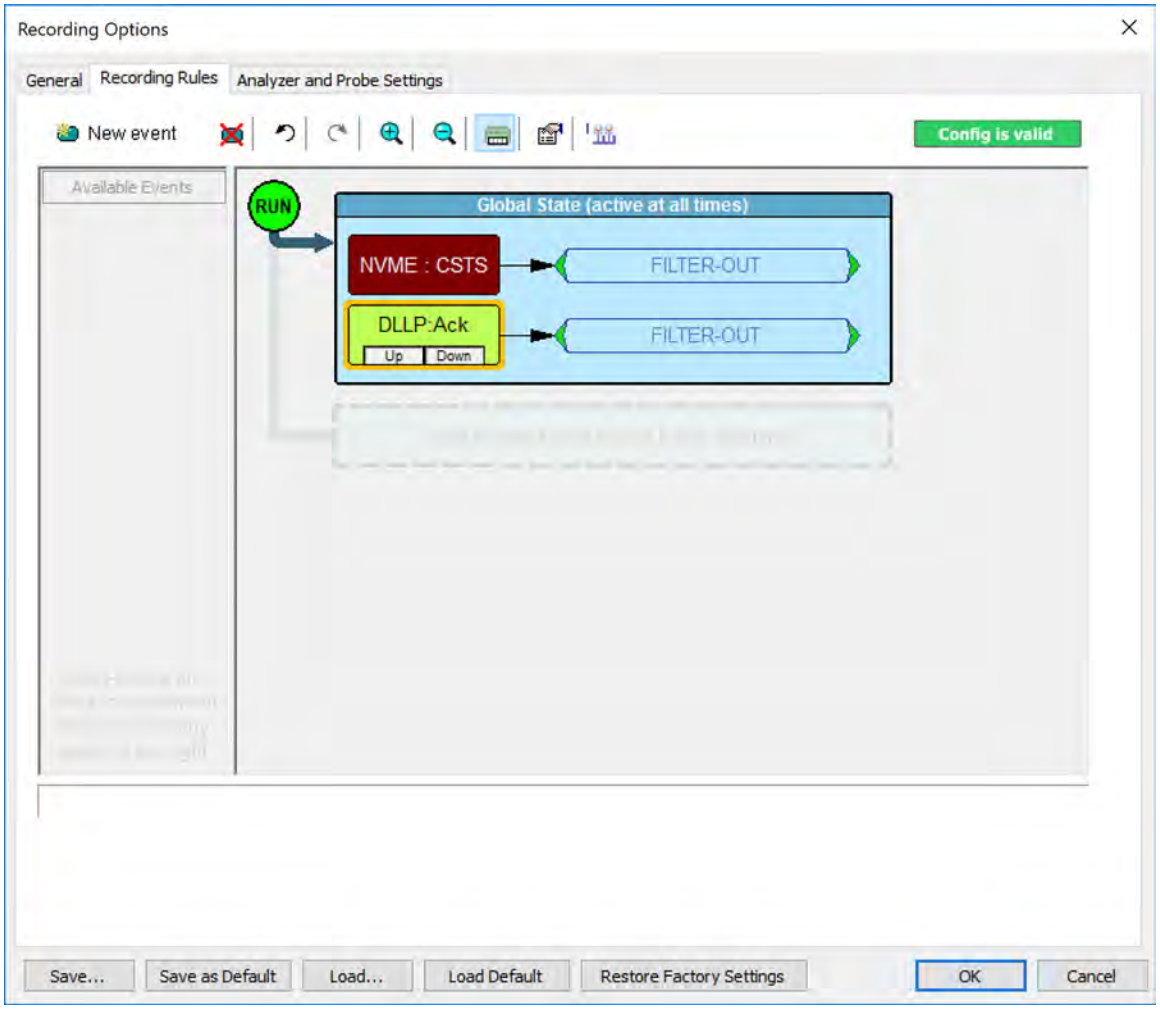


Figure 5.127: Place Recording Option: DLLP:Ack -> Filter-Out in the Global State

To these Recording Options you can add TLP Completions. See Figure 5.128 on page 311.

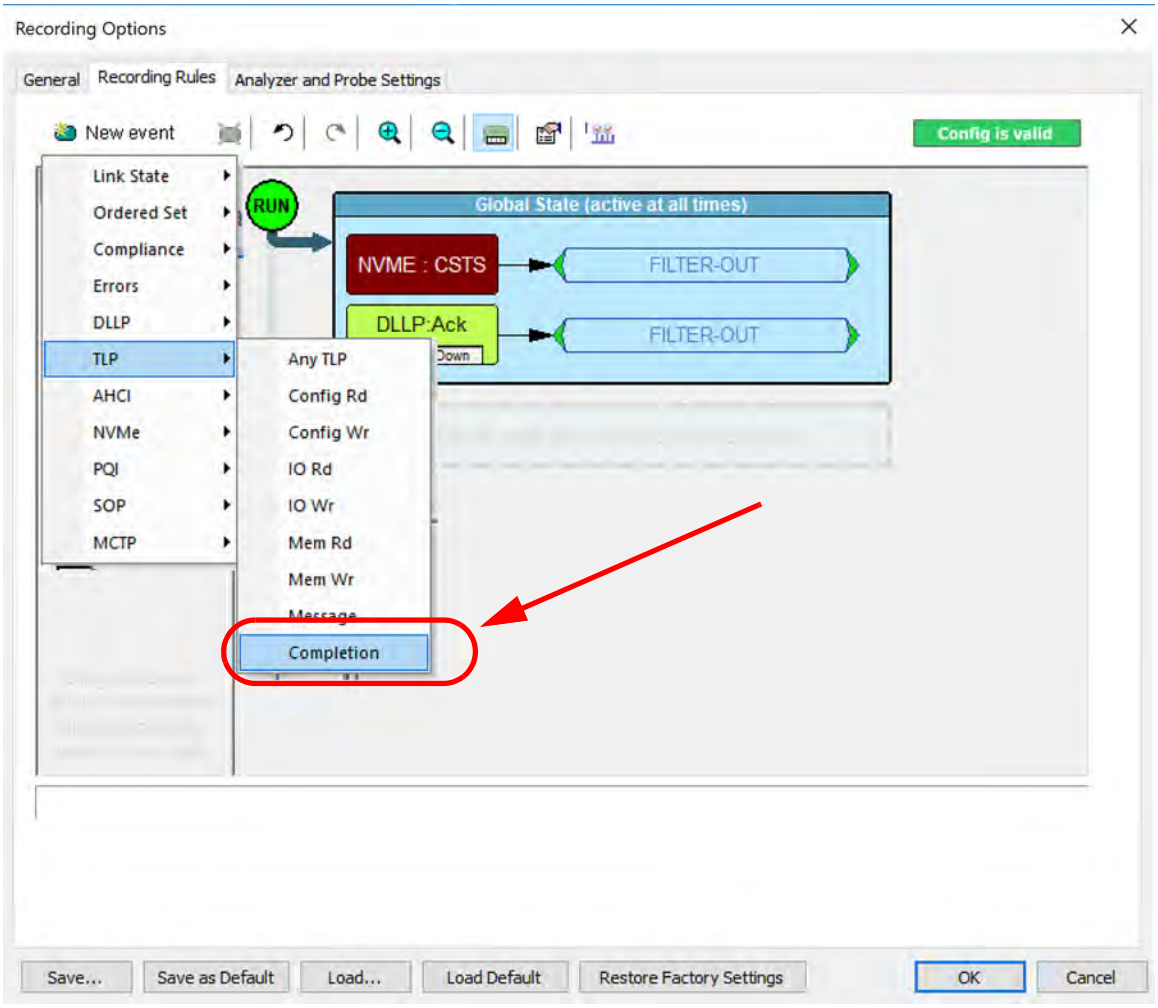


Figure 5.128: Recording Options: NVME, DLLP -> Filtered Out, Add TLP Completion

Then add the TLP Completion Layout Options. Set the Type to Cpl/CplD. See Figure 5.129 on page 312.

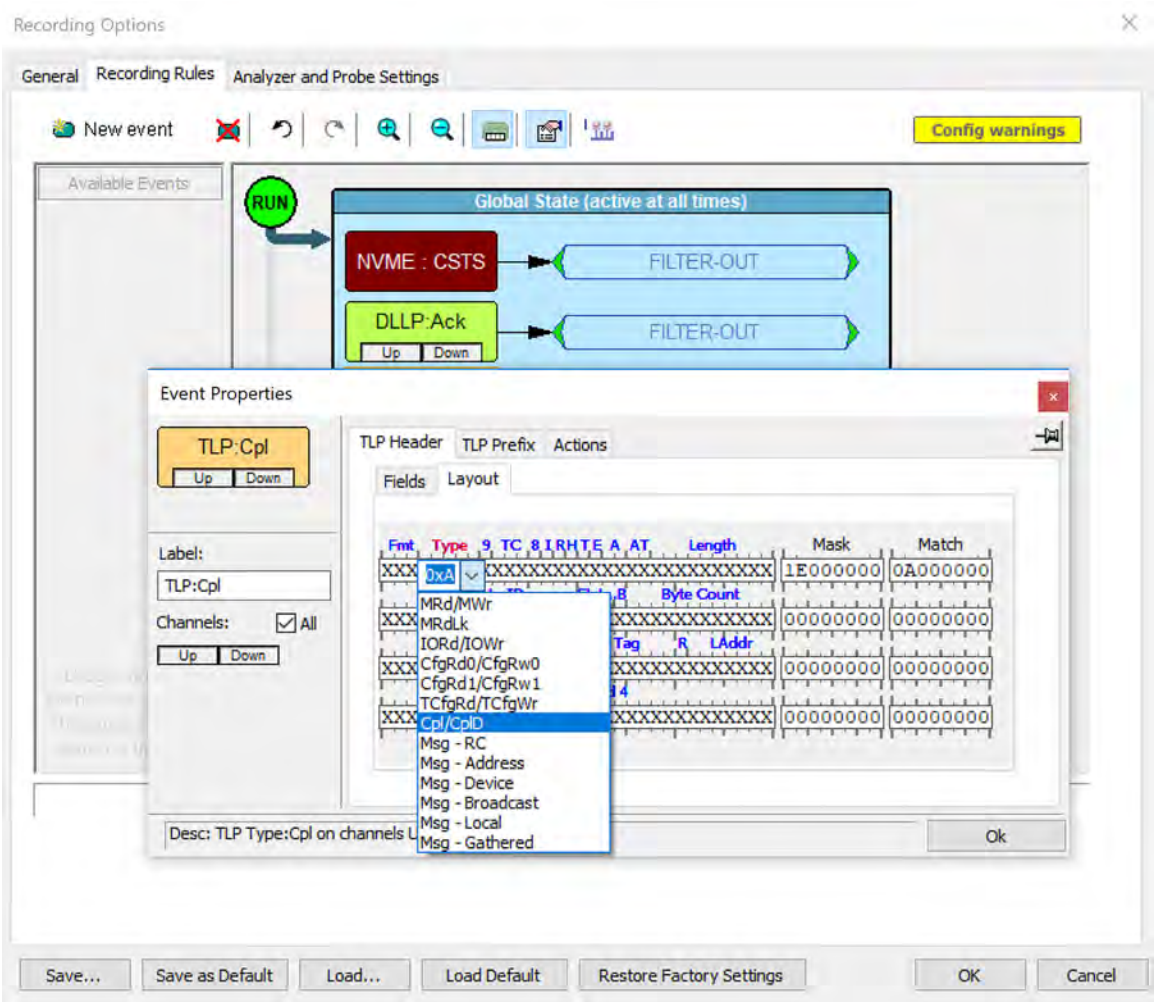


Figure 5.129: Recording Options: TLP:Cpl -> Select CPl/CplD

Next set the LAddr Layout Option to 0x1C. See Figure 5.130 on page 313

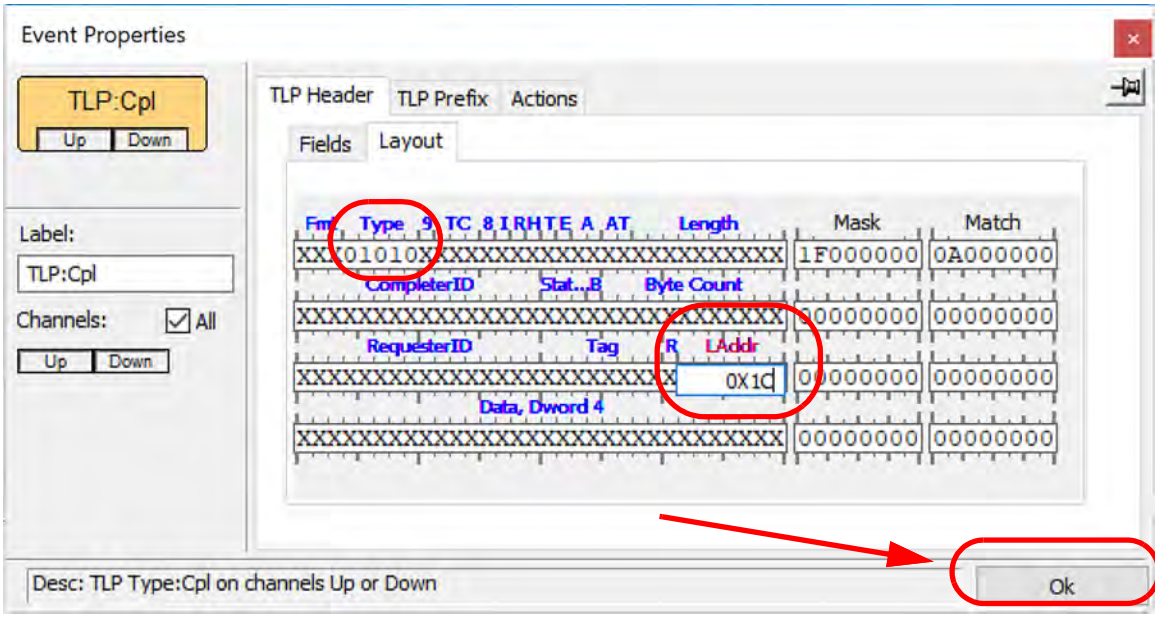
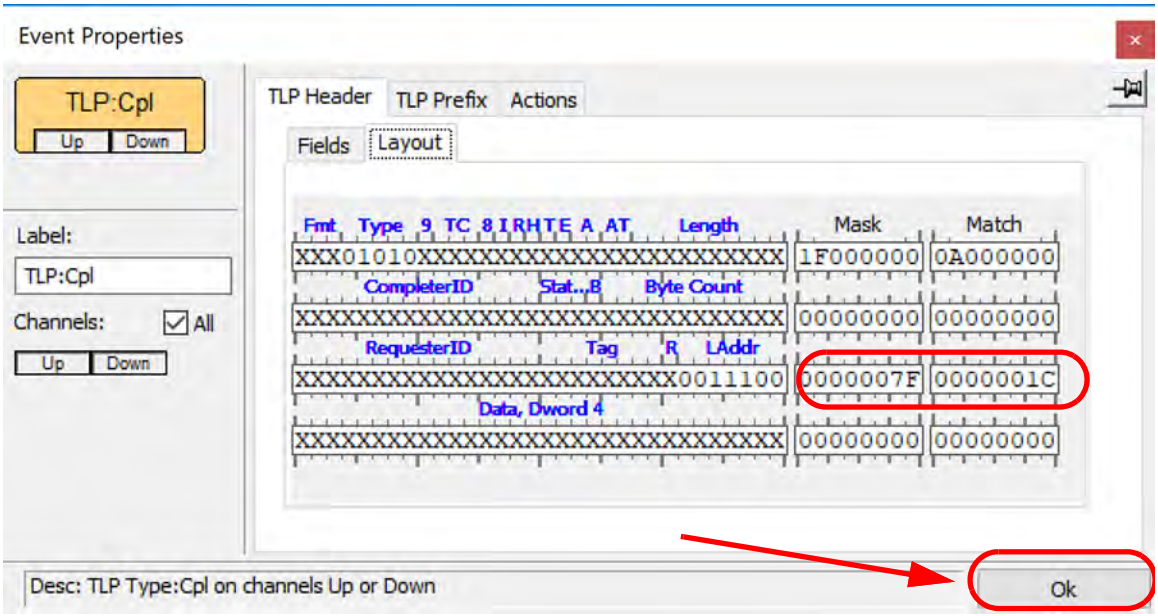


Figure 5.130: Recording Options: TLP:Cpl -> Layout Type: 01010, LAddr: 0x1C

This will set the Mask to 7F and the Match to 1C. See Figure 5.131.



Click on “OK” and then set the Action to Filter-Out. See Figure 5.131 on page 314.

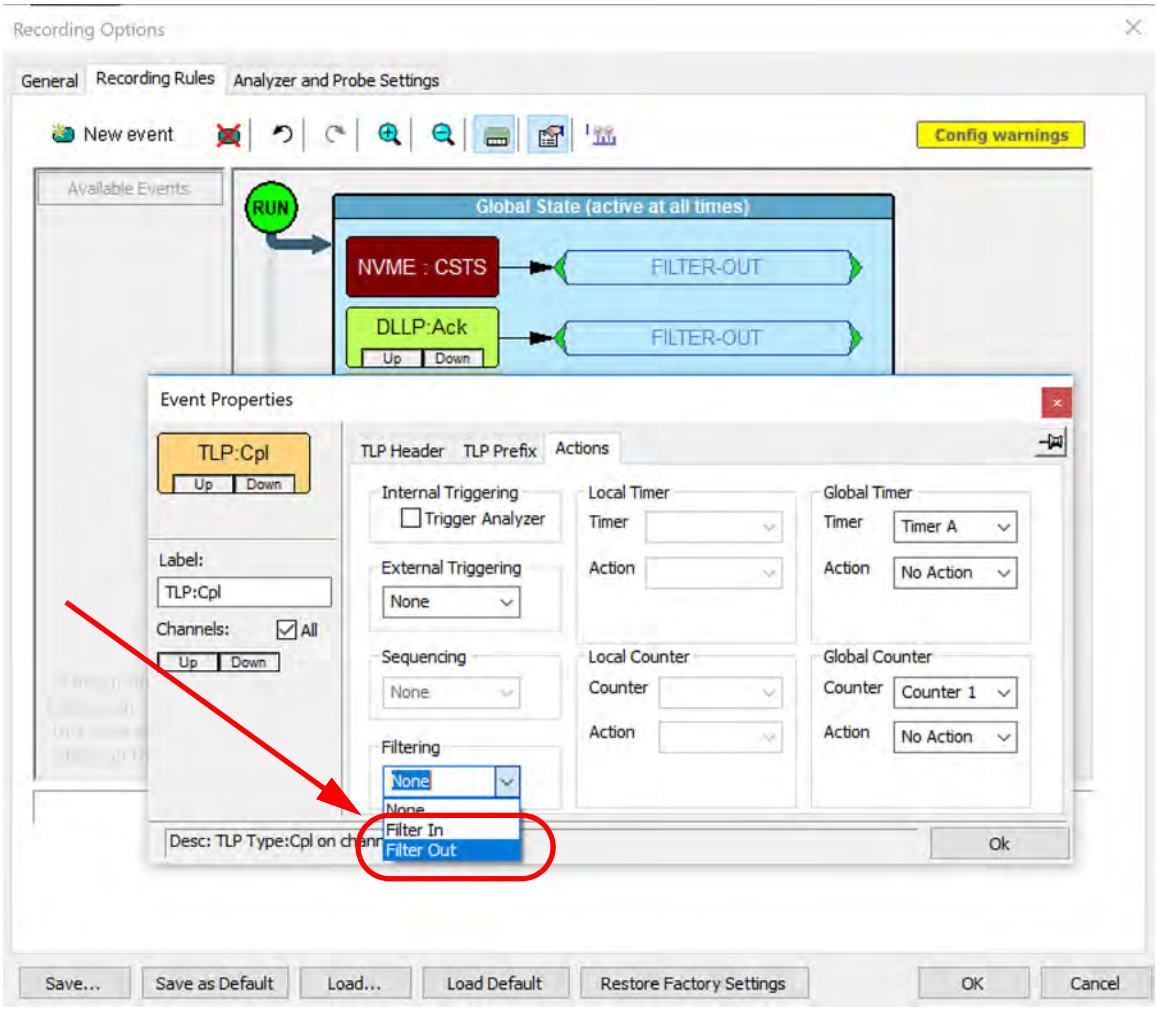


Figure 5.131: TLP:Cpl -> Actions: Filter-Out

Add this property to the Global State. See Figure 5.132 on page 315.

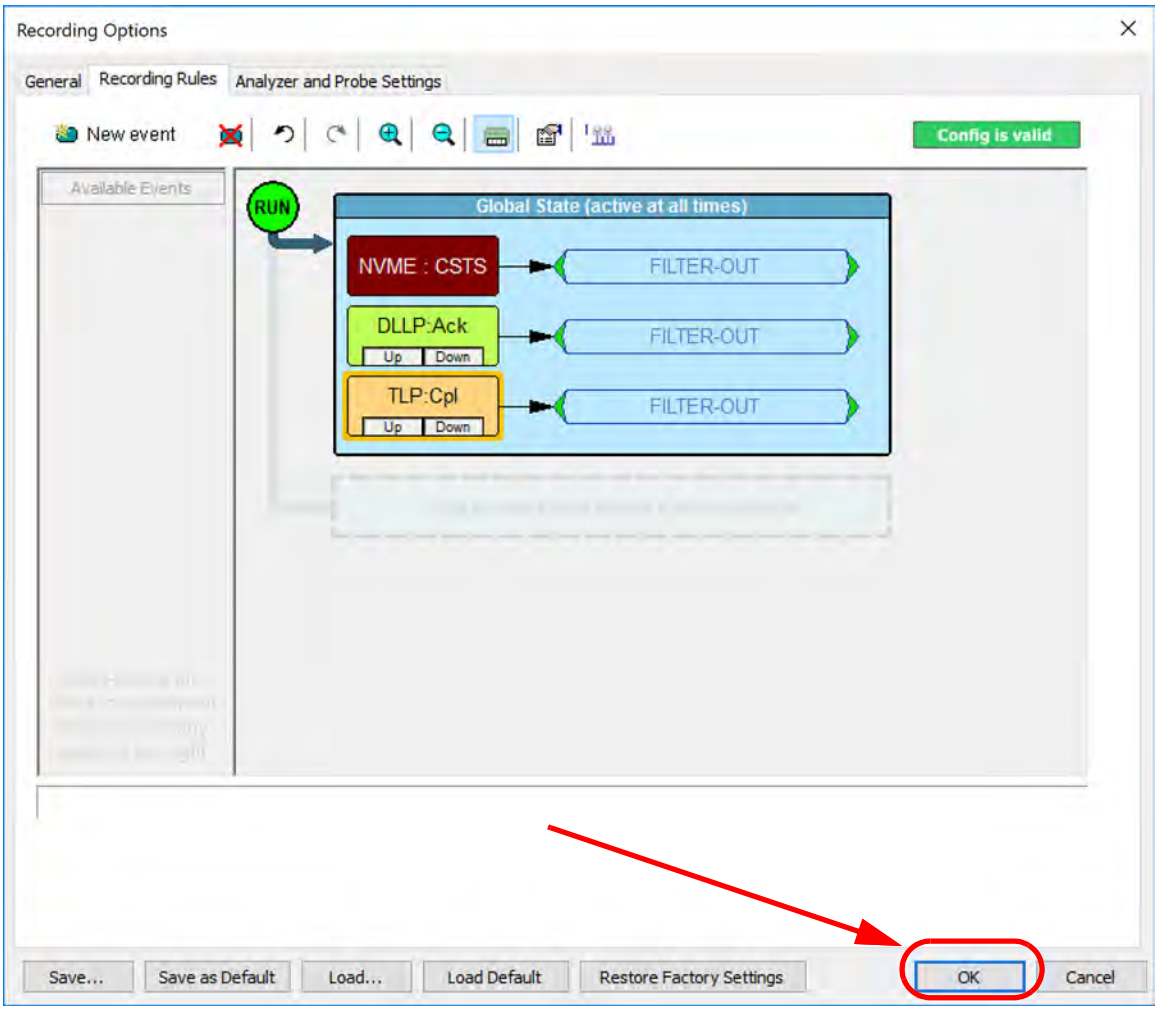


Figure 5.132: Recording Options: NVME, DLLP and TLP all Filtered-Out

Click on “OK” and these Properties will all be Filtered Out of the recording.

5.17.15 Triggering Configuration on a per Lane Basis

The Lane Trigger Configuration Icon (available on the Recording Options => Recording Rules toolbar see Figure 5.133) provides the user with the ability to add pre-conditions on specific lanes that the analyzer will use as an additional restriction on a defined triggering event.

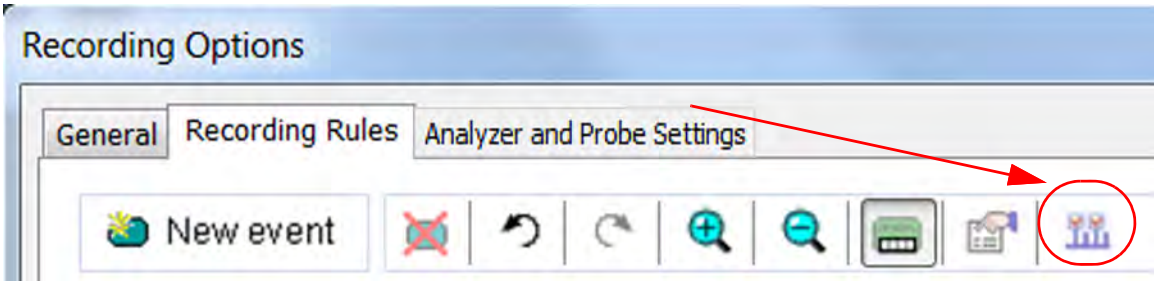


Figure 5.133: Lane Trigger Configuration

This option has three categories of events which can be made lane-based:

- DLLP/TLP Packets
- Errors
- Ordered Sets

Each of these events has restrictions on the lanes available, as spelled out in the GUI.

- These selections will be applied globally
- Lane selections will be applied to logical lane(s) and NOT physical lane(s)
- Default is “all Lanes”, but you can select one or more lanes as targets
- Filter-in/out will not function is you are using per lane triggering

5.17.15.1 DLLP/TLP Packets Category

For DLLP/TLP packets starting in selected lanes, the packet must start in lanes 0, 4, 8 or 12. One or more of these four lanes can be selected to look for the start of DLLP/TLP packets and the selection can be made for each direction by checking boxes.

See Figure 5.134 on page 316.

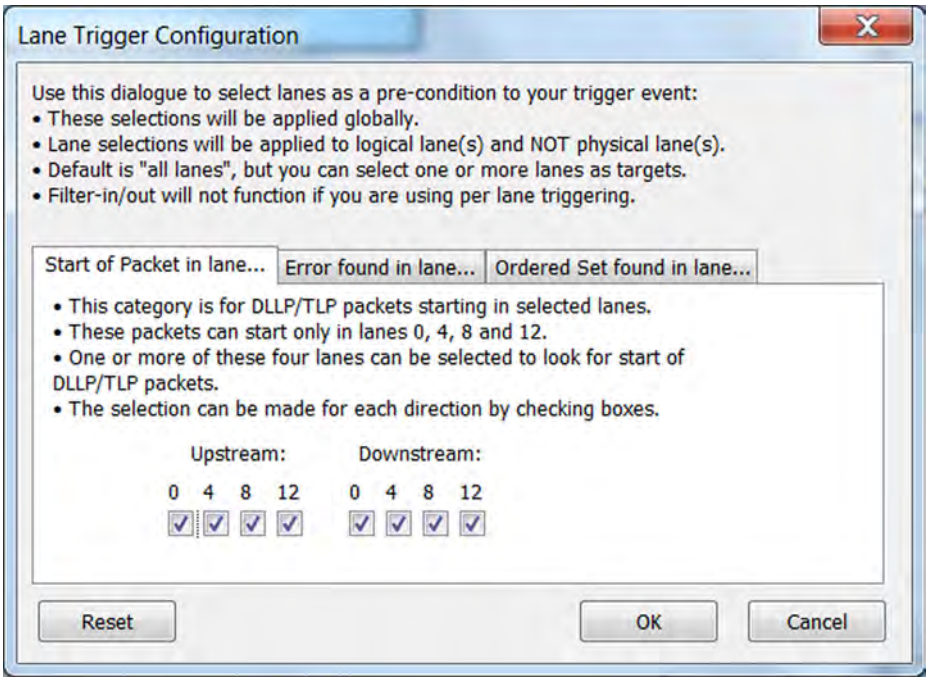


Figure 5.134: Start of Packet in lane GUI

5.17.15.2 Errors Category

Errors category can be used as a pre-condition to trigger on an event in selected Upstream or Downstream lanes. The types of errors that will be detected are limited to:

- Symbol errors
- Disparity errors
- Block errors

See Figure 5.135 on page 317.

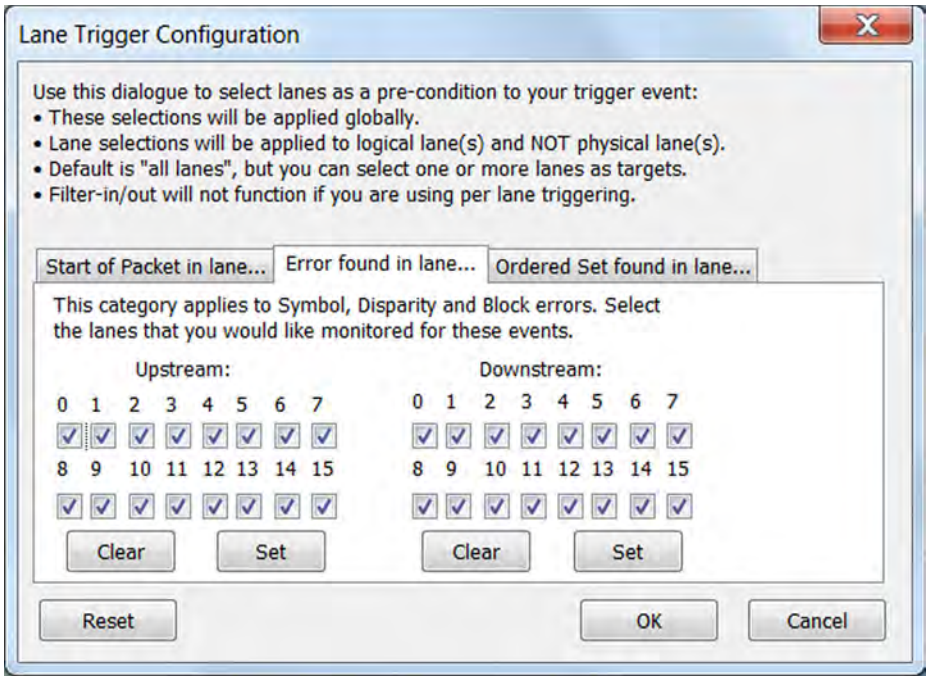


Figure 5.135: Error Found In Selected Lanes

5.17.15.3 Ordered Sets Category

This category includes all types of ordered sets (TS1, TS2, EIEOS, EIOS, Skip, FTS, and SDS).

If a specific lane is selected in the Event Properties dialog of a TS ordered set the same specific lane must be selected here or no triggering event will occur.

See Figure 5.136.

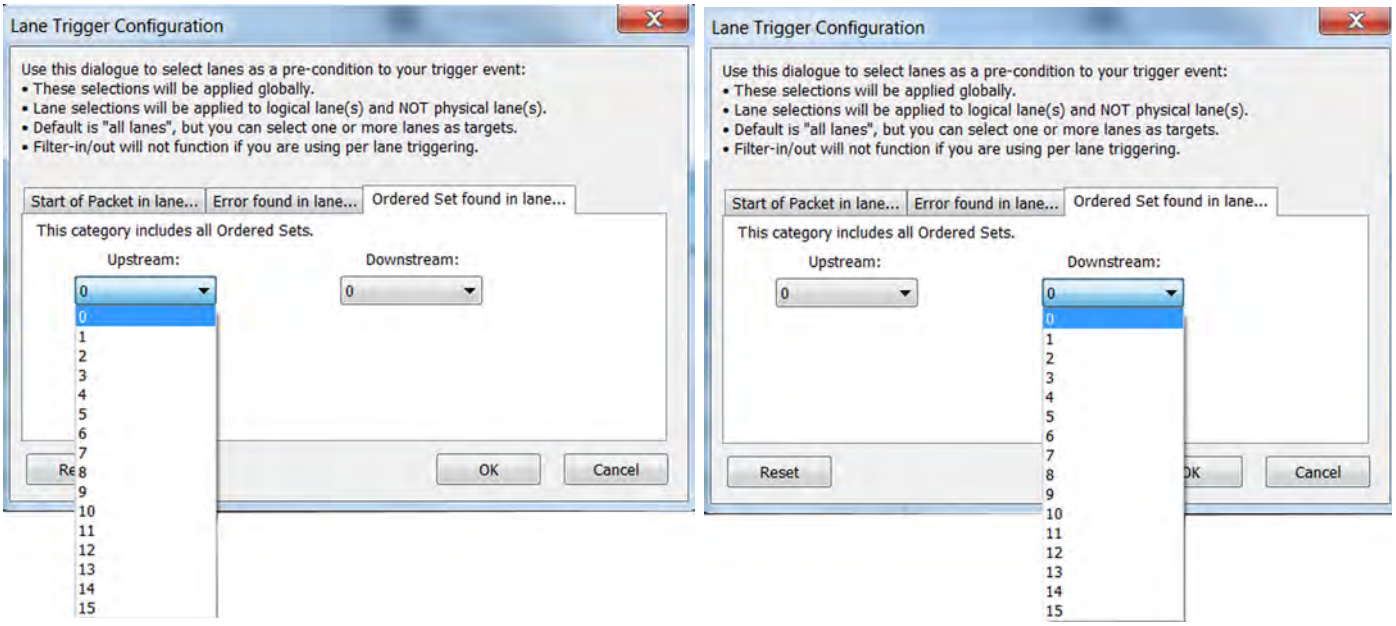


Figure 5.136: Ordered Sets Found in Upstream and Downstream Lanes

5.17.16 Lane Trigger Configuration

5.17.16.1 Example 1:

If you need to trigger on TLPs that start on lane 4 in the upstream direction perform the following selection (see Figure 5.137):

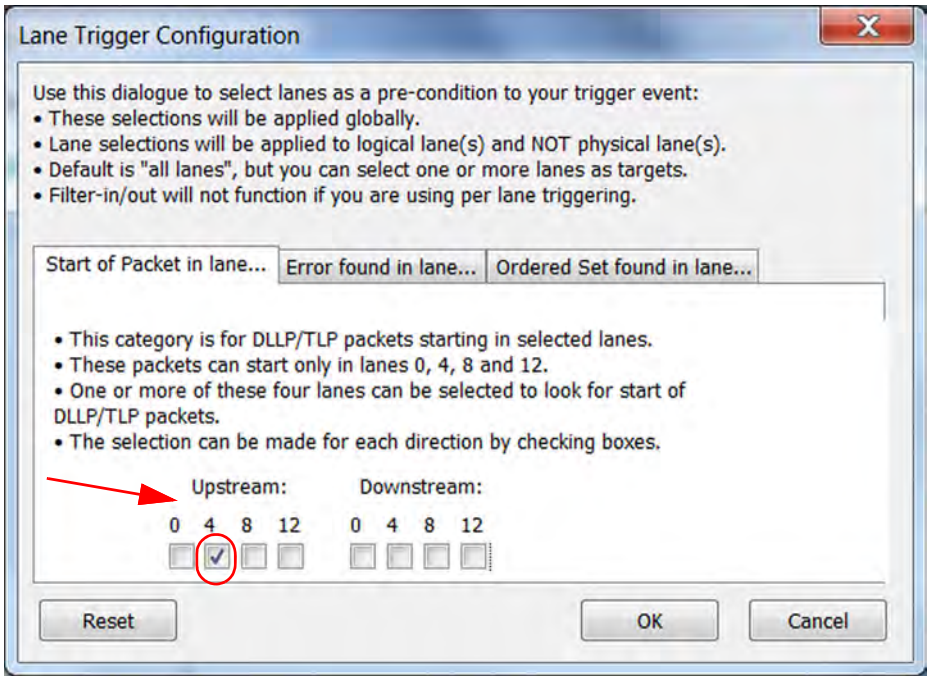


Figure 5.137: Lane Trigger Configuration: Example 1

Then select the appropriate event to trigger the analyzer.

5.17.16.2 Lane Trigger Configuration Example 2:

If you need to trigger the analyzer on errors happening on lanes 4 and 6 in the upstream direction, perform the following selections:

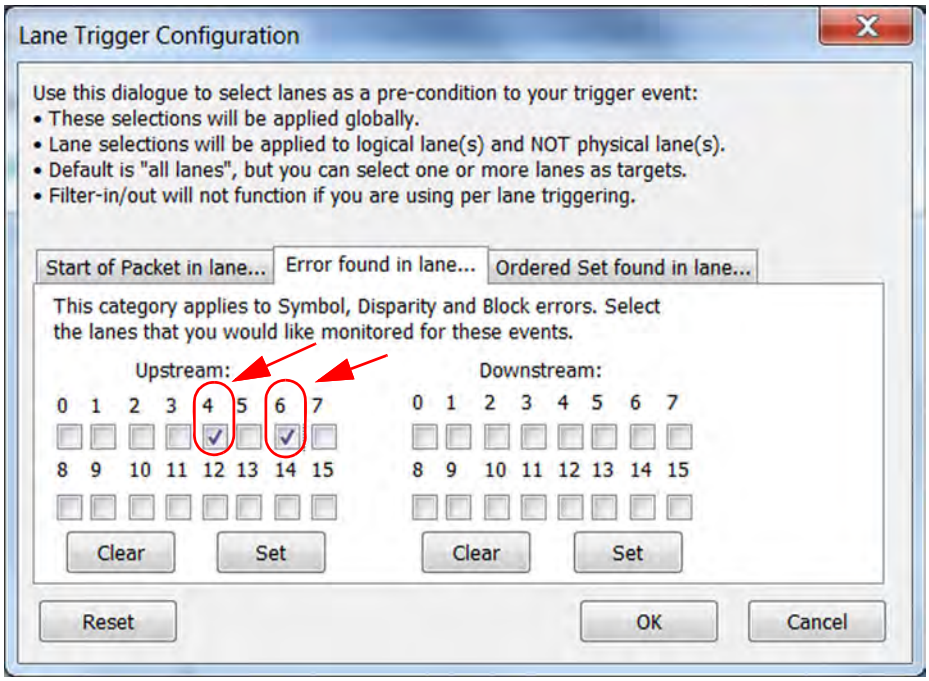


Figure 5.138: Lane Trigger Configuration: Upstream Errors on Lanes 4 and 6

Then select the appropriate event to trigger the analyzer.

5.17.16.3 Lane Trigger Configuration Example 3:

If you need to trigger on a TS1 Event with Link Number = 00 and Lane Number = PAD that happens on Lane 3 only in the Downstream direction, perform the following selections for Lane Triggering (see Figure 5.139):

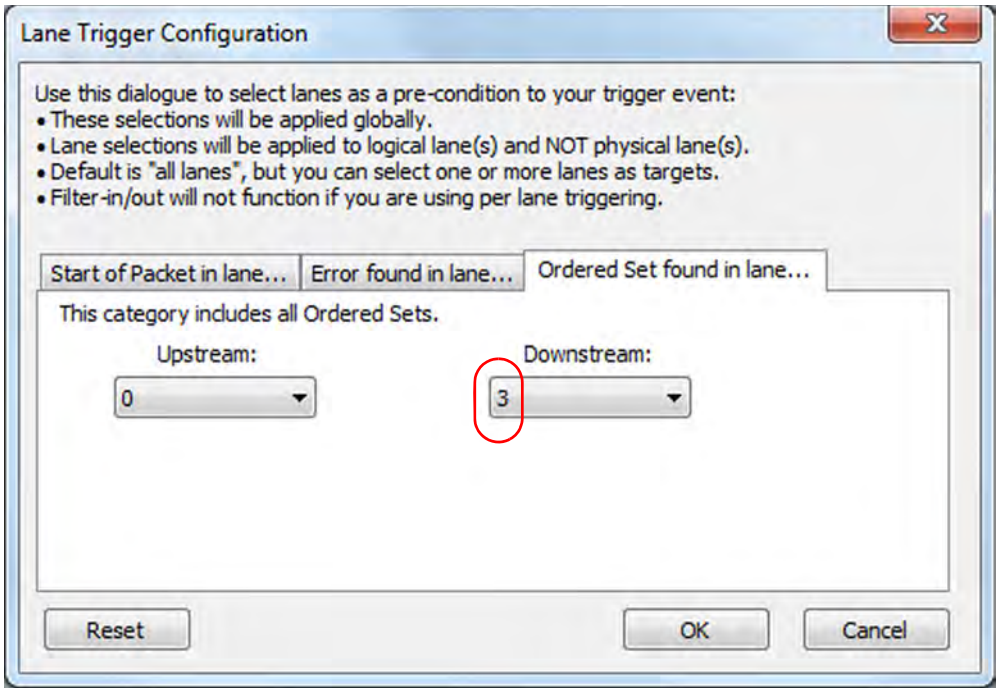


Figure 5.139: Lane Trigger Configuration: Downstream TS1, Downstream, Lane 3

Then select a TS1 Event and select only the Downstream direction, set Link Number = 00 and Lane number = PAD fields (see Figure 5.140). After selecting the options you want click on the “OK” button.

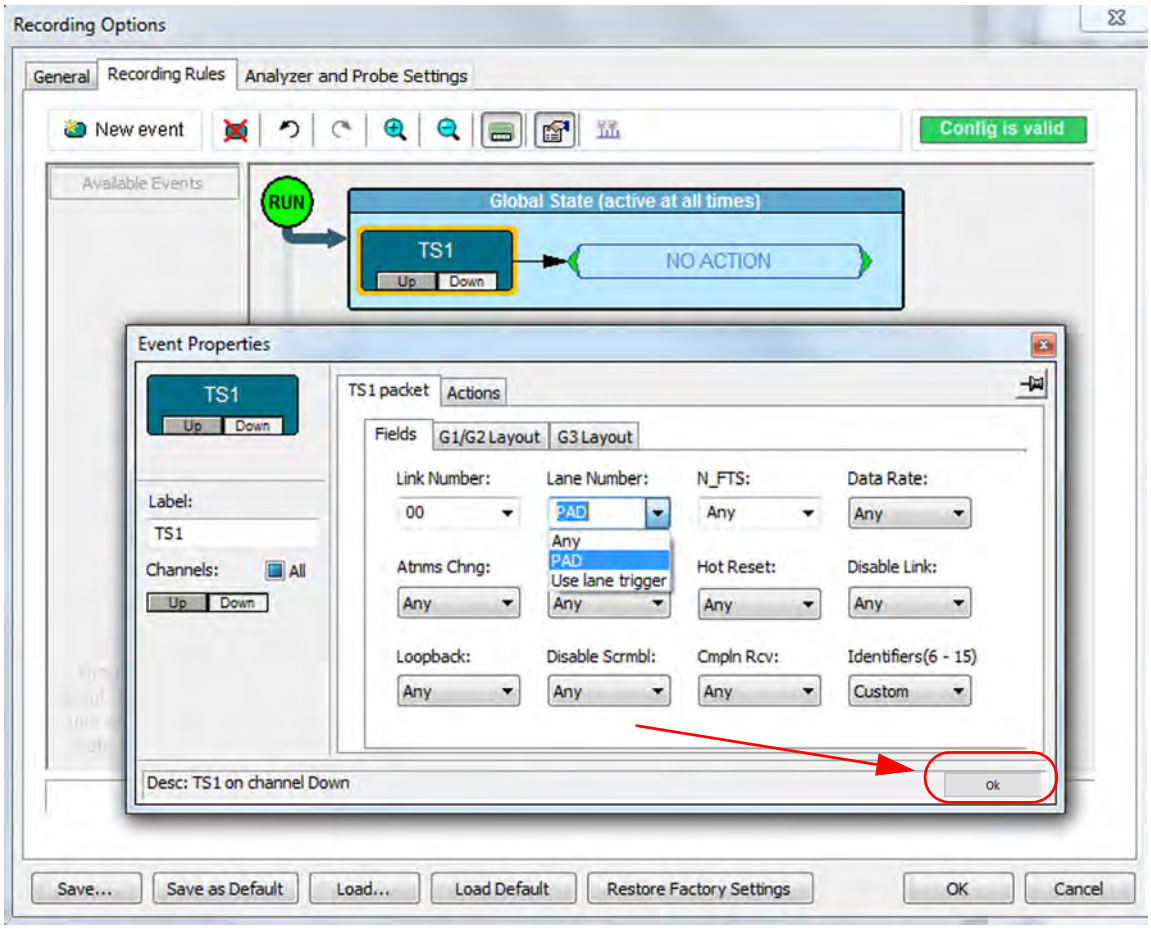


Figure 5.140: Setting the Event Properties for TS1 Downstream

Finally, set the Action Tab to trigger the analyzer (see Figure 5.141 on page 322). After selecting the options you want click on the “OK” button.

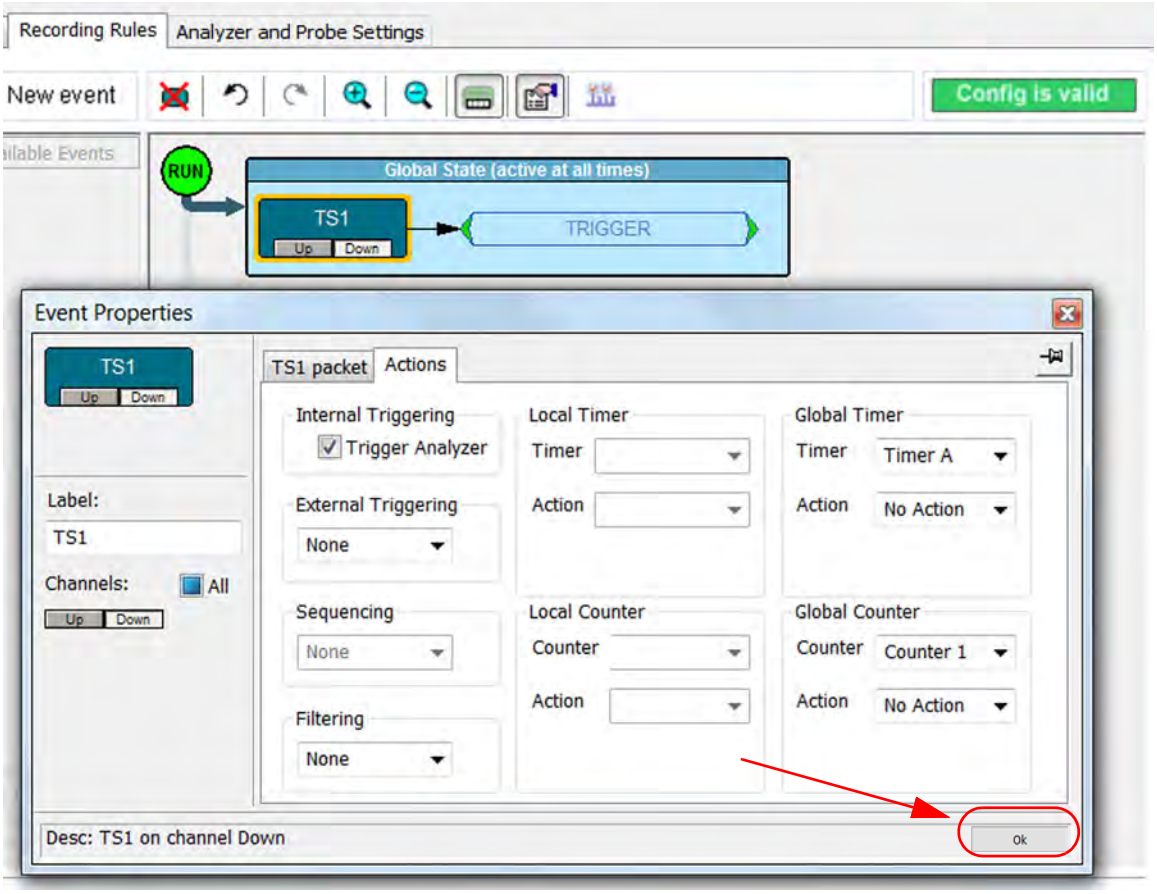


Figure 5.141: Event Properties: Actions = Trigger Analyzer

Now the analyzer will be triggered on a TS1 Event with Link Number = 00 and Lane Number = PAD that happens on Lane 3 only in the Downstream direction.

5.17.17 Counter

Counters can be created for any specific event or for multiple events (see Figure 5.142 on page 323). Counters function similar to an event and are independent of the event, thus allowing greater flexibility. You can select a counter for any event and if both channels are selected you can set the counter to count upstream and downstream. Counters can be reset providing further flexibility. The counter once set lives in the State. In an Advance to Sequence state once the action proceeds from one sequence state to the next, the counter in the preceding state will stop and the counter in the current state will start.

There are two Counters for the Global State and four Counters for the Sequence State.

The counters have different colors for the Global State and Sequence State. Each color signifies a different meaning in the Global and Sequence states.

Note: Counters can be controlled only from one direction not both, meaning starting, reset and incrementing must be done from events occurring in the same channel (upstream or downstream) of the selected counter.

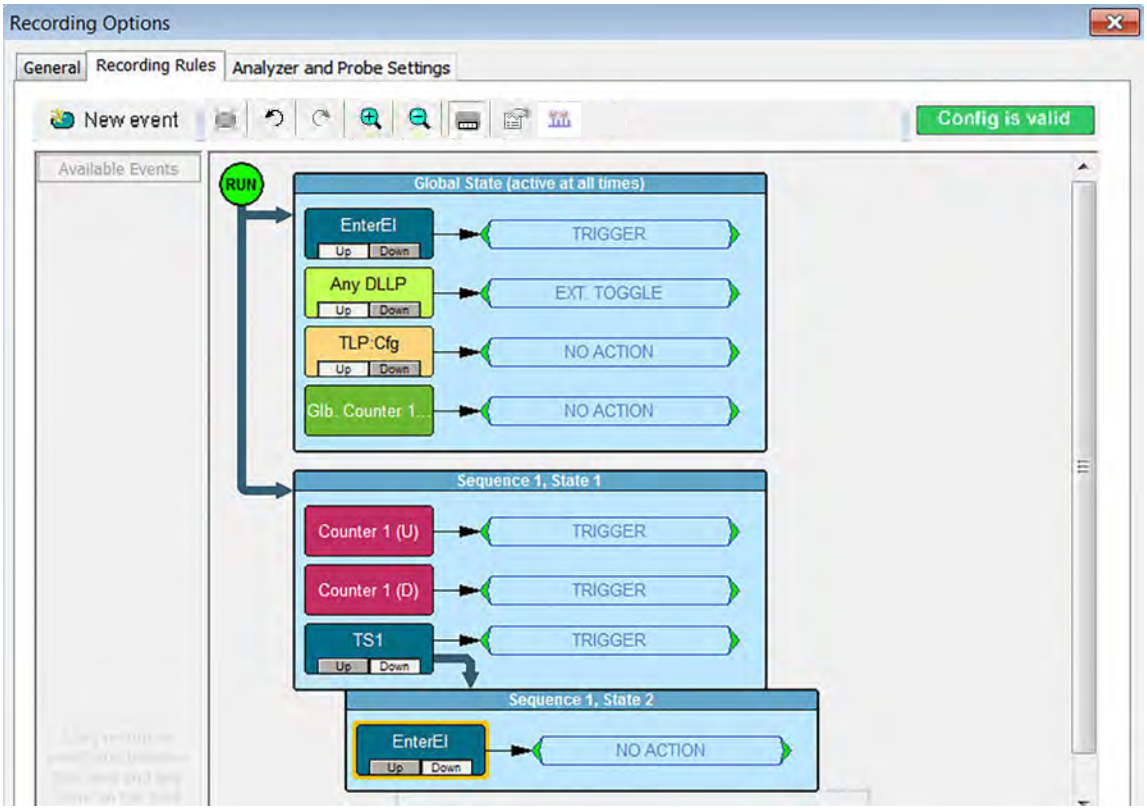


Figure 5.142: Global and Sequence State Counters

As shown in Figure 5.142 there is a Global Counter 1, set to the value of 2 on channel up displayed in green in the Global State and there are two counter 1s, set to the value of 2, one counting upstream and the other counting downstream displayed in pink in the Sequence State.

5.17.17.1 How to Set a Counter

Counters are events and you can add a counter to the Global State or the Sequence State as an event by doing the following:

Right-click in the blue space in the Global or Sequence State and **New Event > Counter > UpStream or DownStream**. See Figure 5.143 on page 324.

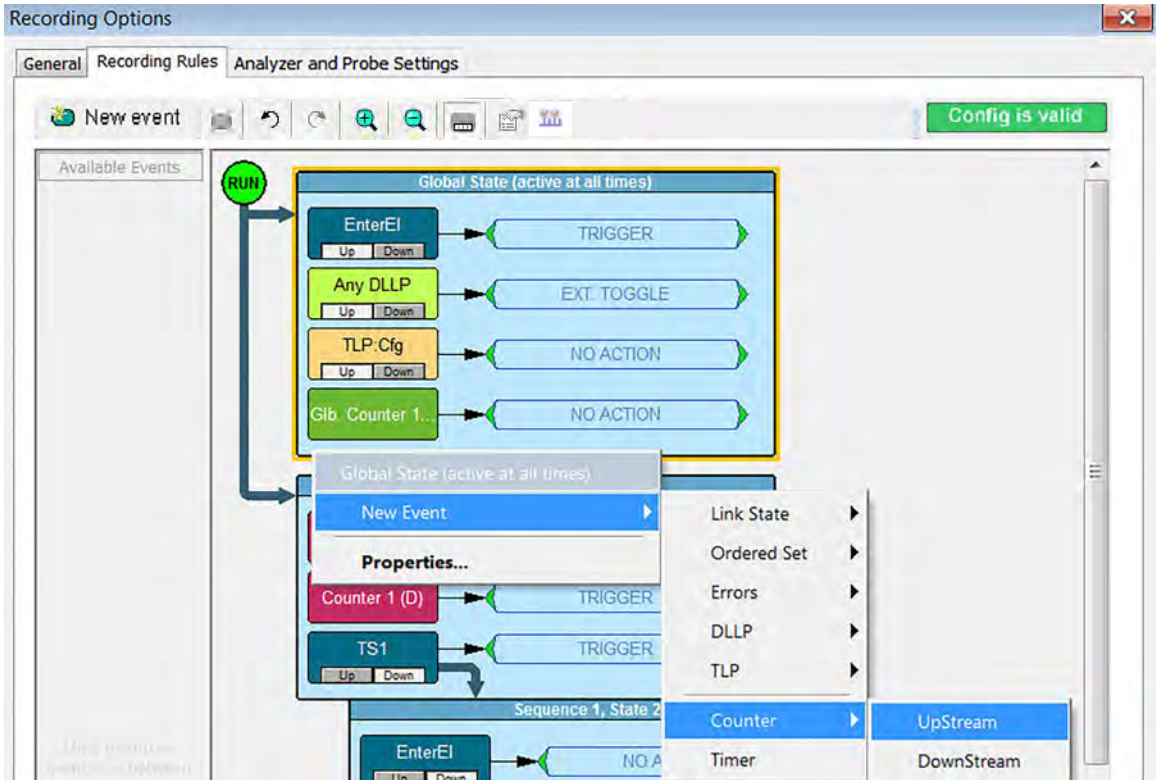


Figure 5.143: Setting Global and Sequence State Counter Events

5.17.17.2 How to Increment or Reset a Counter

You can Increment or Reset counters in the Global State and in the Sequence State by performing the following steps:

1. Open the Recording Rules page, select an event, and drag it to the **Global State** or **Sequence** cells. For details on these steps (see "Events with Channels" on page 331).
2. Right-click on an event and select **Specify Actions > Increment Global Counter > Global Counter 1** from the menu (see Figure 5.144 on page 325).

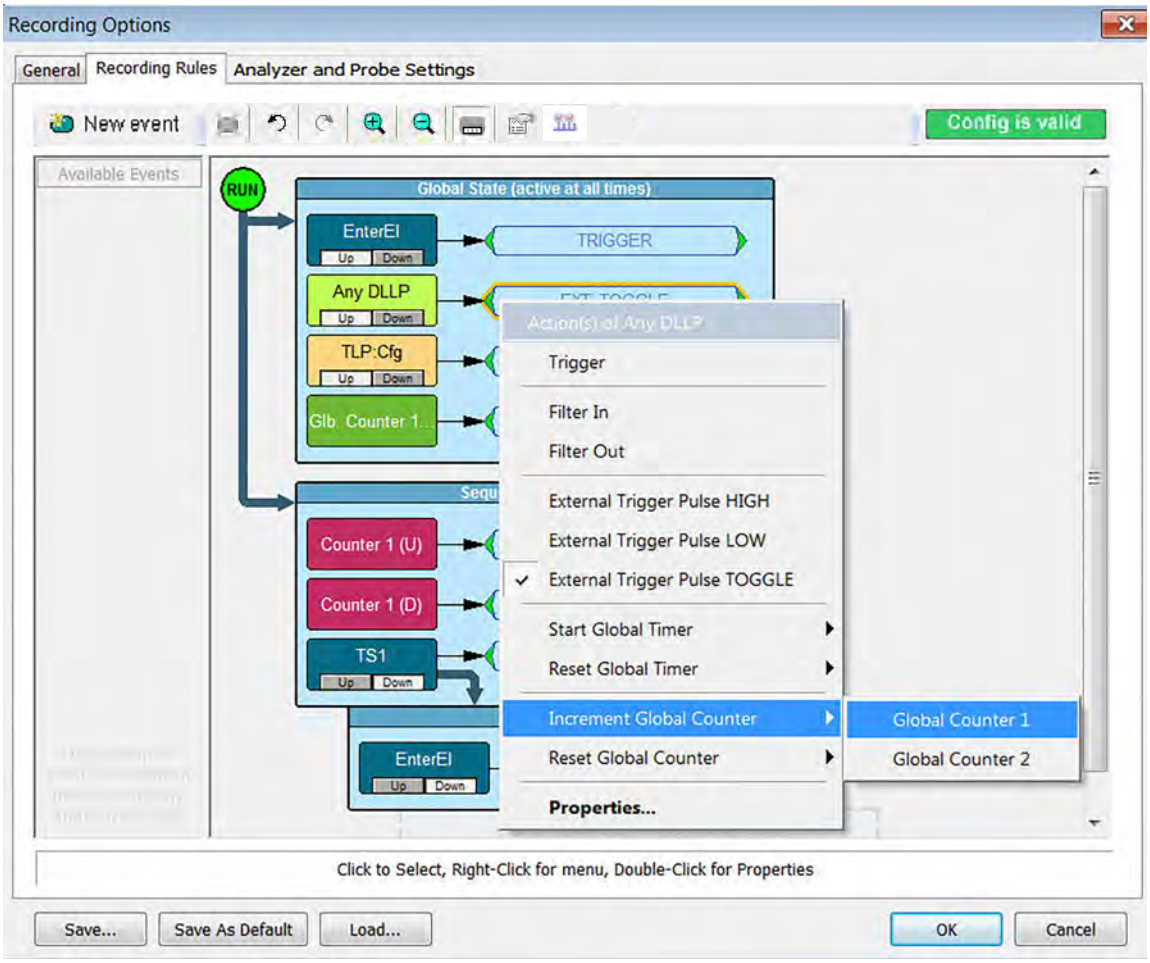


Figure 5.144: Incrementing and Resetting Global and Sequence State Counters

Note: Listed below are some of the considerations to note about the counter functionality.

1. If a counter is reset, it will restore to it's original value, in this case the value defined by the user.
2. Resetting a counter will stop it and set it to it's original value.
3. Local counters for a particular state will automatically reset if the sequencer advances to another state. Example: "Counter A" in State 1 and "Counter A" in State 2 are different timers not related to each other.
4. Local counters are controlled by events defined in the same state where the counters are defined.
5. In case of competing actions to control global counters using the same event from global and local states, the control from local states takes priority.

5.17.17.3 Changing the Value of the Counter

To change the value of the counter:

1. Double-click on the Counter.

2. Enter a new value in the pop-up dialog. This causes the new value to appear in the counter button.

5.17.17.4 Deleting a Counter

To delete a counter

1. Right-click on the Counter.
2. Select **Delete This Event.** The counter will disappear from the event.

5.17.18 Timer

The Timer has two options which are Start and Reset. When set to Start it starts the timer and when set to Reset it resets the timer to its initial value. When the timer count is down to 0 the action is triggered.

The Global State timer can trigger, start an action. It can also affect some other timers and counters.

The timers have different colors for the Global State and Sequence State. Each color signifies a different meaning in the Global and Sequence states.

There are two Timers for the Global State and four Timers for the Sequence State.

Note: Timers can be controlled (Start/Reset) deterministically from events happening in any channel (upstream or downstream direction) as long as these events are more than 380 ns apart. For timers controlled by events happening on a single direction the control happens at the line rate.

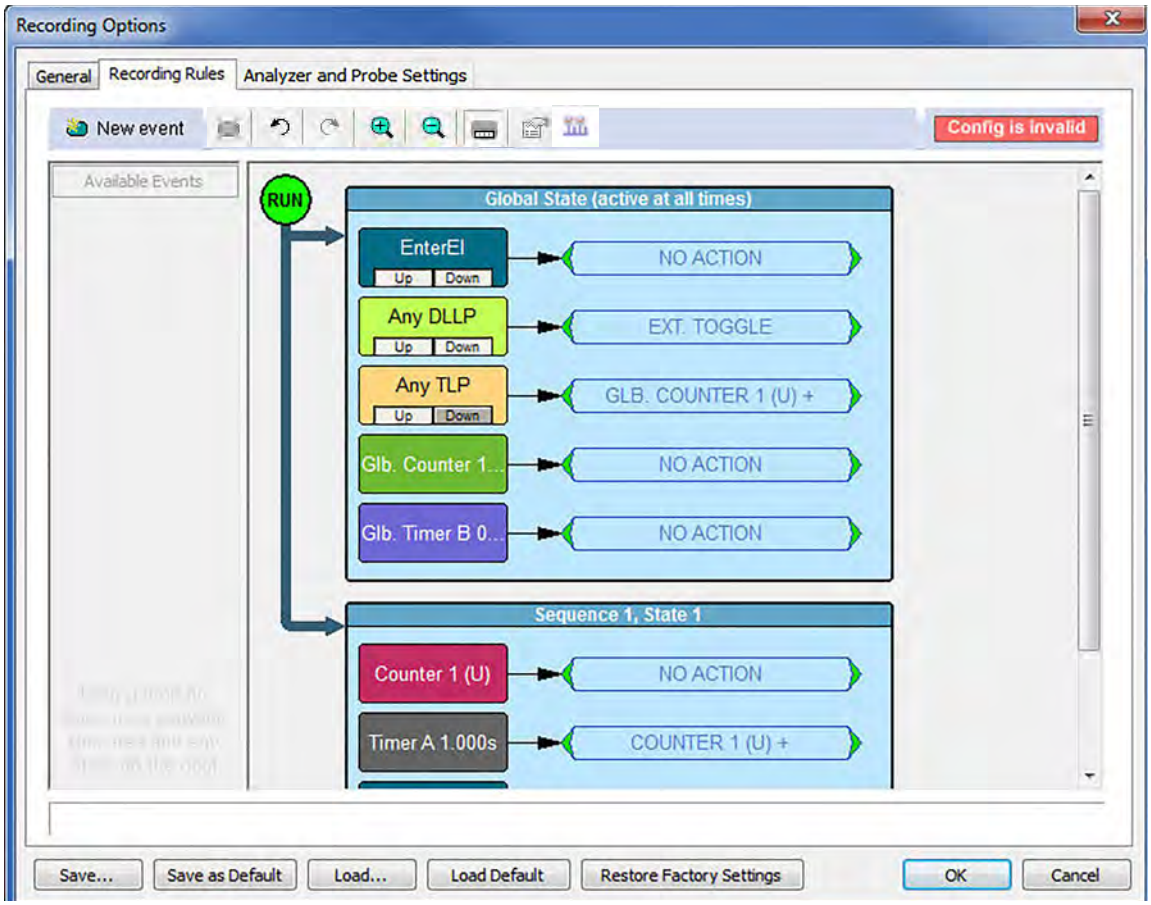


Figure 5.145: Global and Sequence State Timers

As shown in Figure 5.145 on page 327 there is a Global Timer A, set to the value of 1.000s on channel Up displayed in blue in the Global State and there is one timer A, set to the value of 1.000s on channel Down displayed in brown in the Sequence State.

5.17.18.1 How to Set a Timer

Timers are events and you can add a timer to the Global State or the Sequence State as an event by doing the following:

Right-click in the blue space in the Global or Sequence State and **New Event > Timer**.

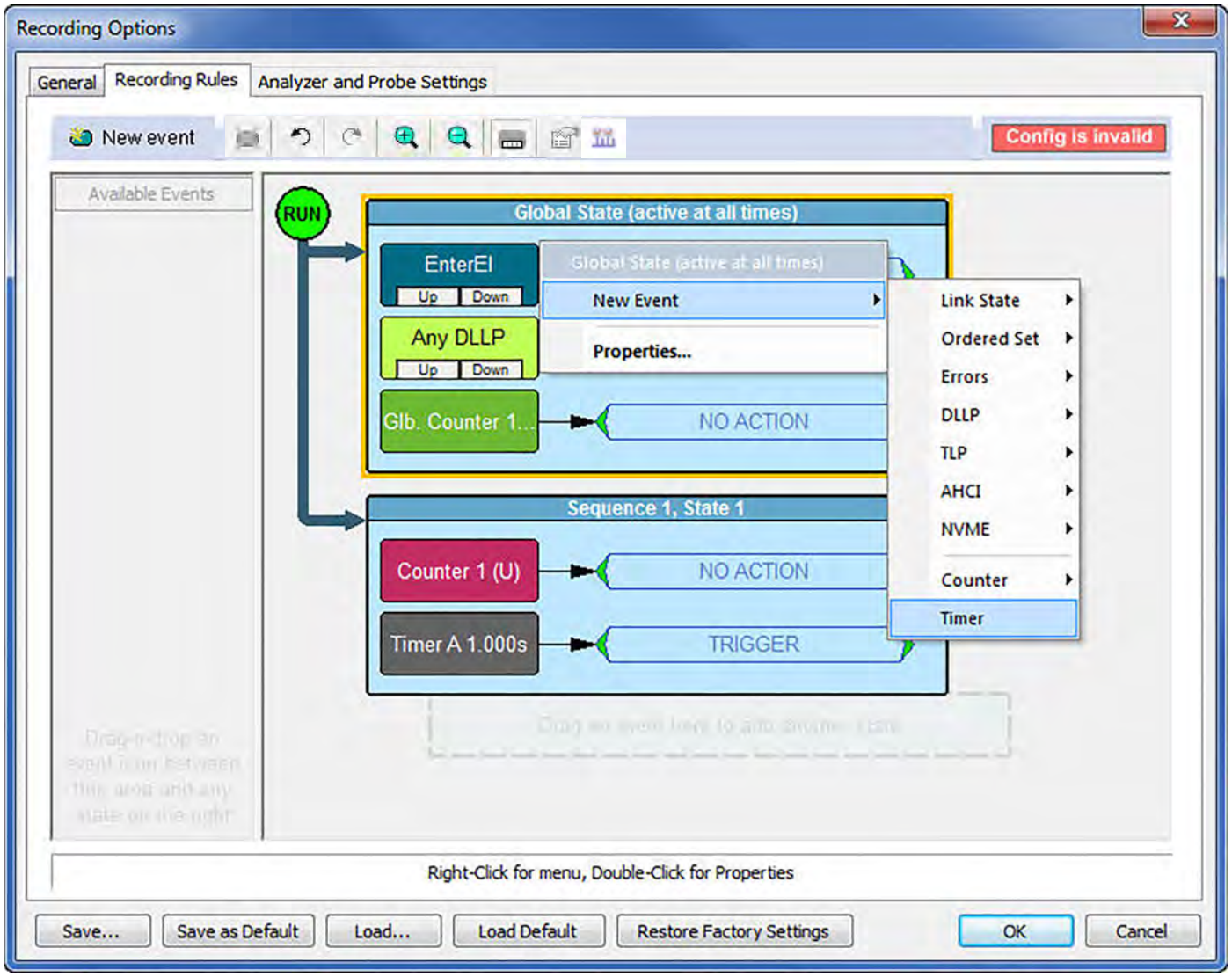


Figure 5.146: Setting Global and Sequence State Timer Events

5.17.18.2 How to Start or Reset a Timer

You can Start or Reset the Timer in the Global State and in the Sequence State by performing the following steps:

1. Open the Recording Rules page, select an event, and drag it to the **Global State** or **Sequence** cells. For details on these steps (see "Events with Channels" on page 331).
2. Right-click on an event and select **Specify Actions > Start Global Timer > Global Timer A** or **Timer B** from the menu (see Figure 5.147 on page 329).

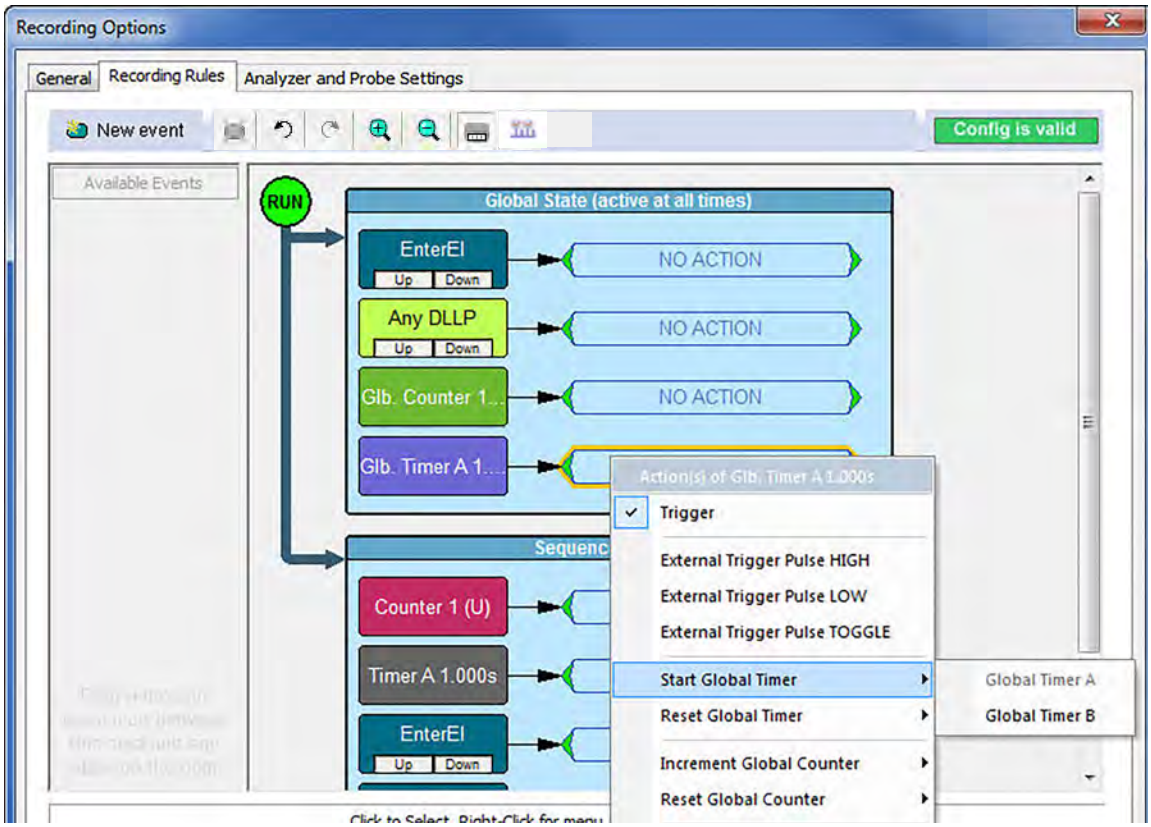


Figure 5.147: Starting and Resetting Global and Sequence State Timers

Note: Listed below are some of the considerations to note about timer functionality

1. If a timer is reset, it will restore to it's original value, in this case the value defined by the user.
2. Resetting a timer will stop it and set it to it's original value.
3. Local timers for a particular state will automatically reset if the sequencer advances to another state. Example: "Timer A" in State 1 and "Timer A" in State 2 are different timers not related to each other.
4. Local timers are controlled by events defined in the same state where the timers are defined.
5. In case of competing actions to control global timers using the same event from global and local states, the control from local states takes priority.

5.17.18.3 Changing the Value of the Timer

To change the value of the timer (see Figure 5.148 on page 330):

1. Right-click on the Timer.
2. Select **Properties**
3. Enter in values for the Timer in the fields provides in Secs, Millisecs, Microsecs and Nanosecs on the Timer tab. After selecting the options you want click on the “OK” button.

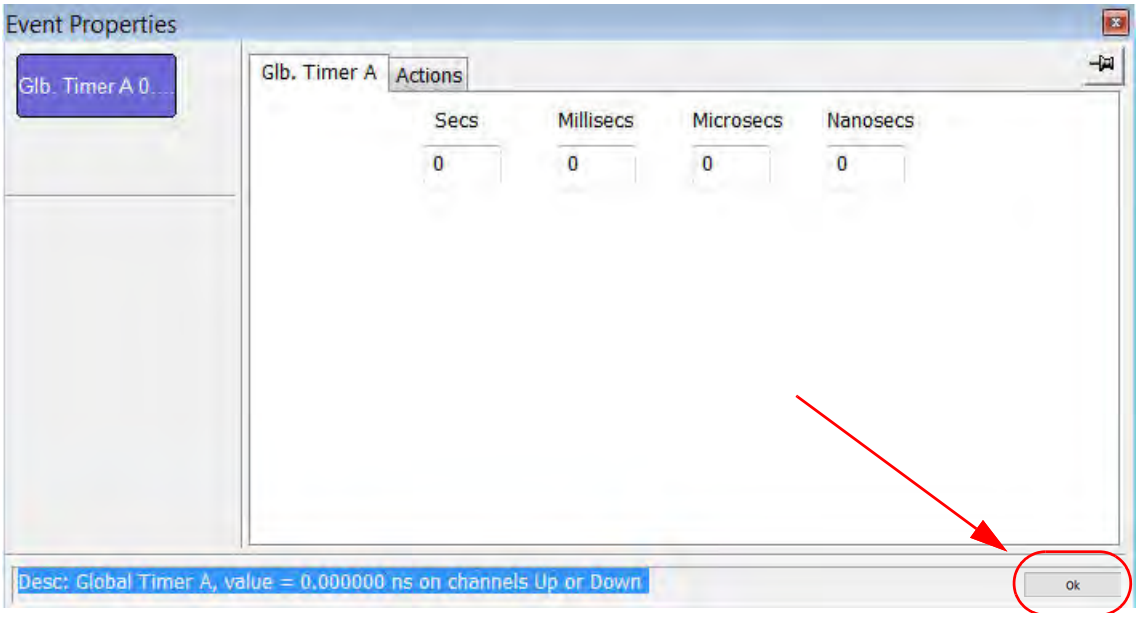


Figure 5.148: Setting the Timer Values

4. Click on the Actions tab and set the External and Internal Triggering, Sequencing and Filtering options. You can label the timer.

5.17.18.4 Deleting a Timer

To delete a Timer

1. Right-click on the Timer.
2. Select **Delete This Event.** The Timer will disappear from the event.

5.17.19 Channel

Every event has two channels, one upstream and the other downstream. You can use both channels with any event. The channels are independent of each other. If both channels are selected it is valid but no action occurs, and thus no timer and counter is created. Figure 5.149 shows three events in the Global State, the first event is on Channel Up and the 3rd event is on Channel Down.

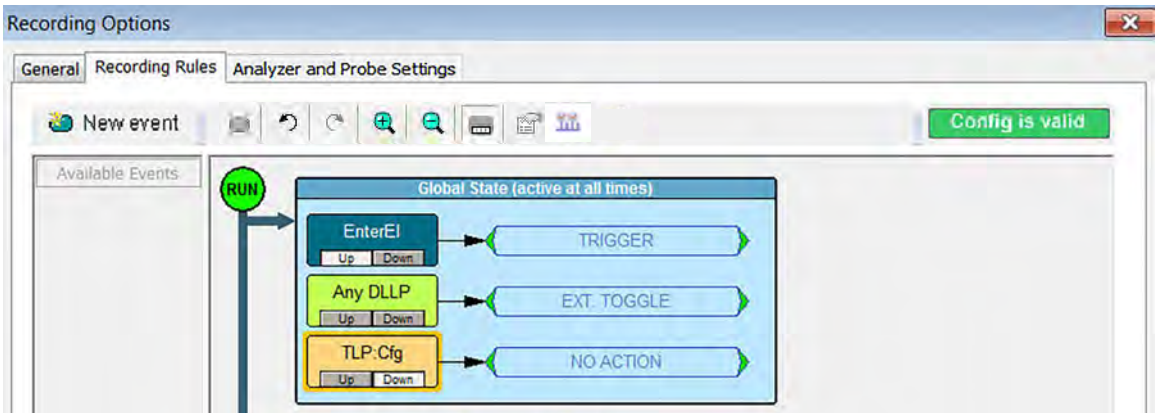


Figure 5.149: Events with Channels

5.17.20 Lane Margining

You can use Lane Margining as an Advanced Recording Rule. You need to define the following Fields:

- Margin Command
- Margin Type
- Receiver Name
- Margin Payload

See Figure 5.150 on page 332

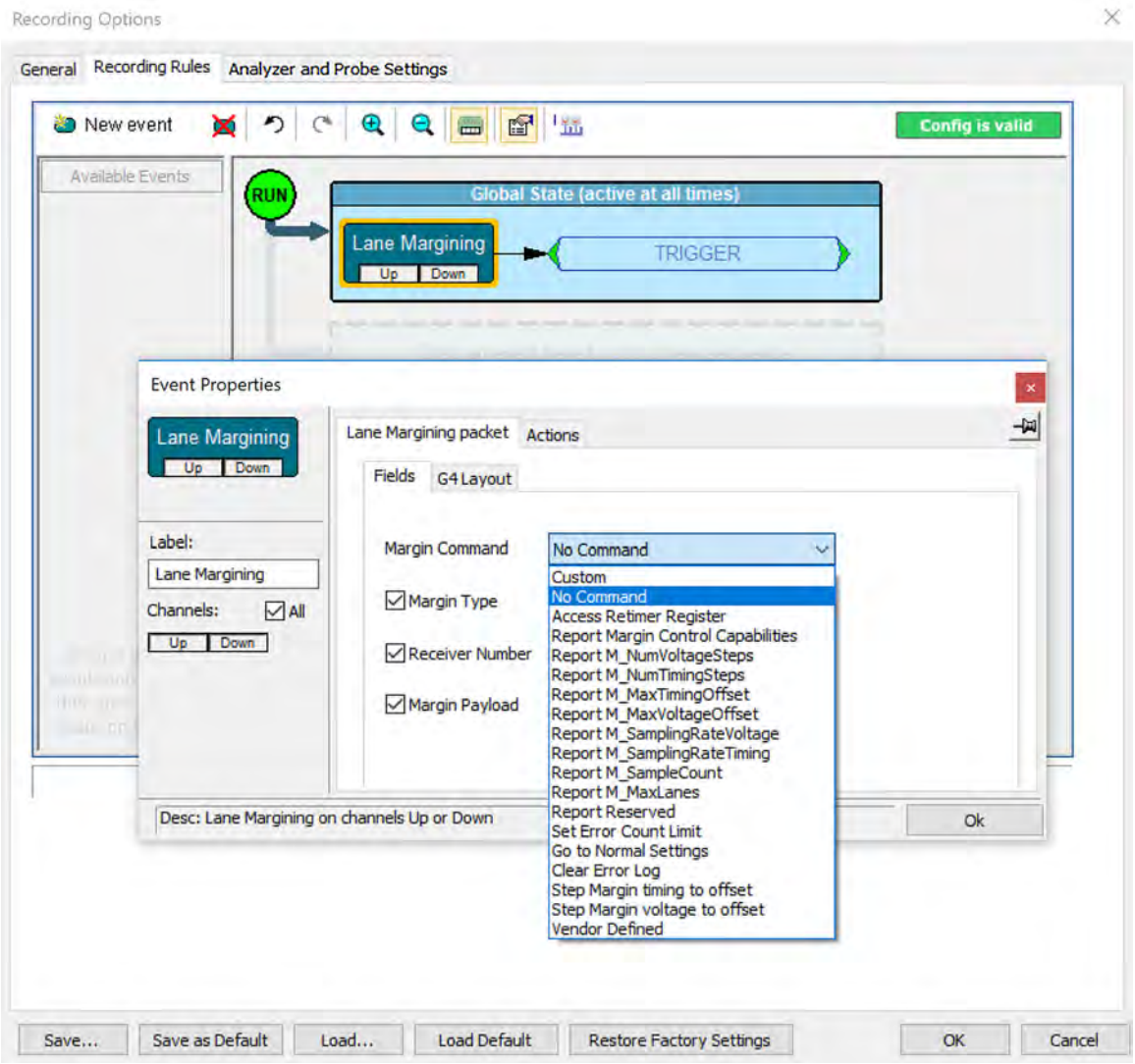


Figure 5.150: Lane Margining: Fields -> Margin Commands

You can also update the four DWORDS in the G4 Layout dialog box.See Figure 5.151 on page 333.

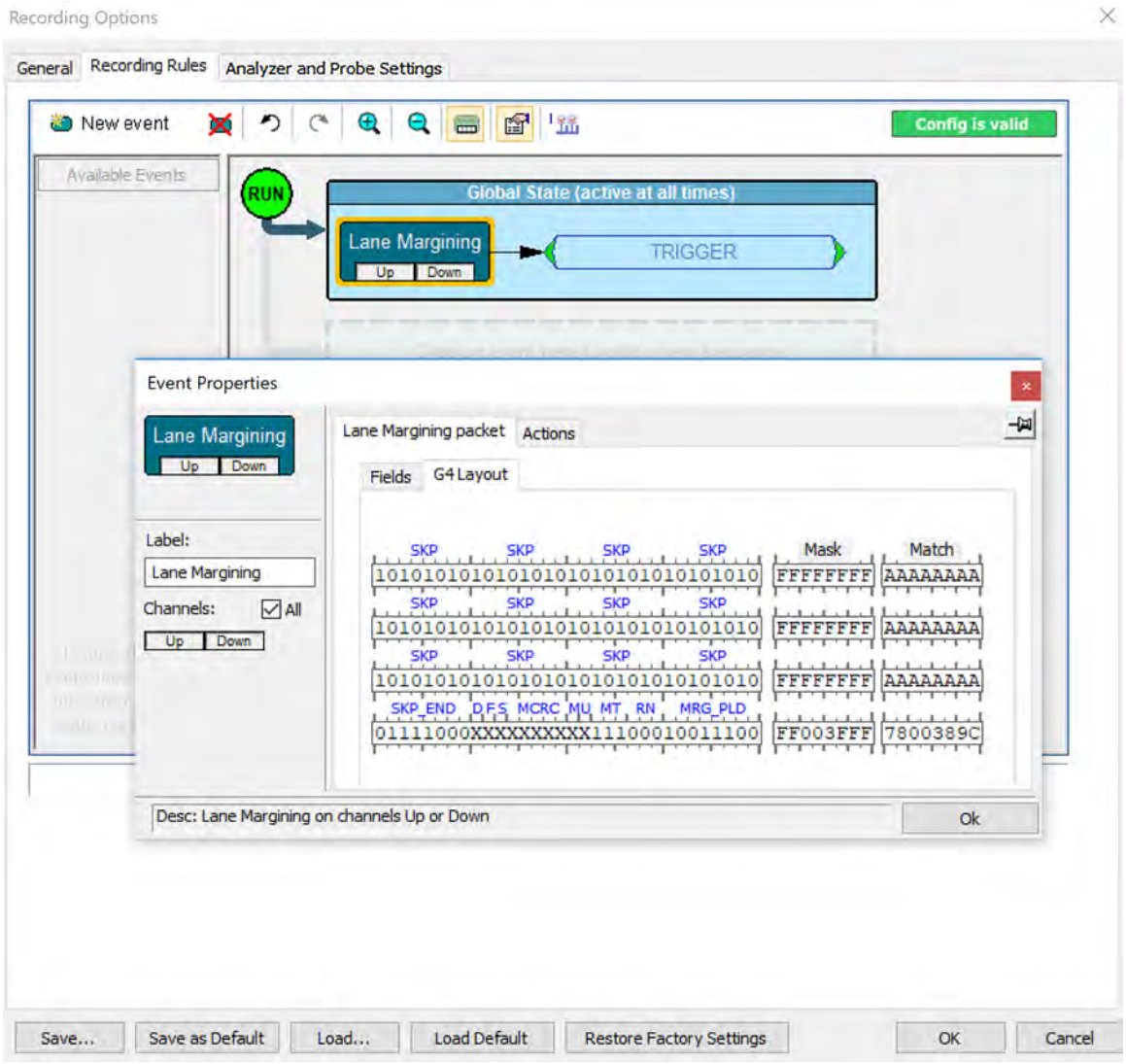


Figure 5.151: Four DWORDS Need to Define G4 Layout

5.18 Analyzer & Probe Settings

This tab allows you to access a list of presets, which can be selected from the library and immediately applied, and to view your connected Analyzer (Figure 5.152).

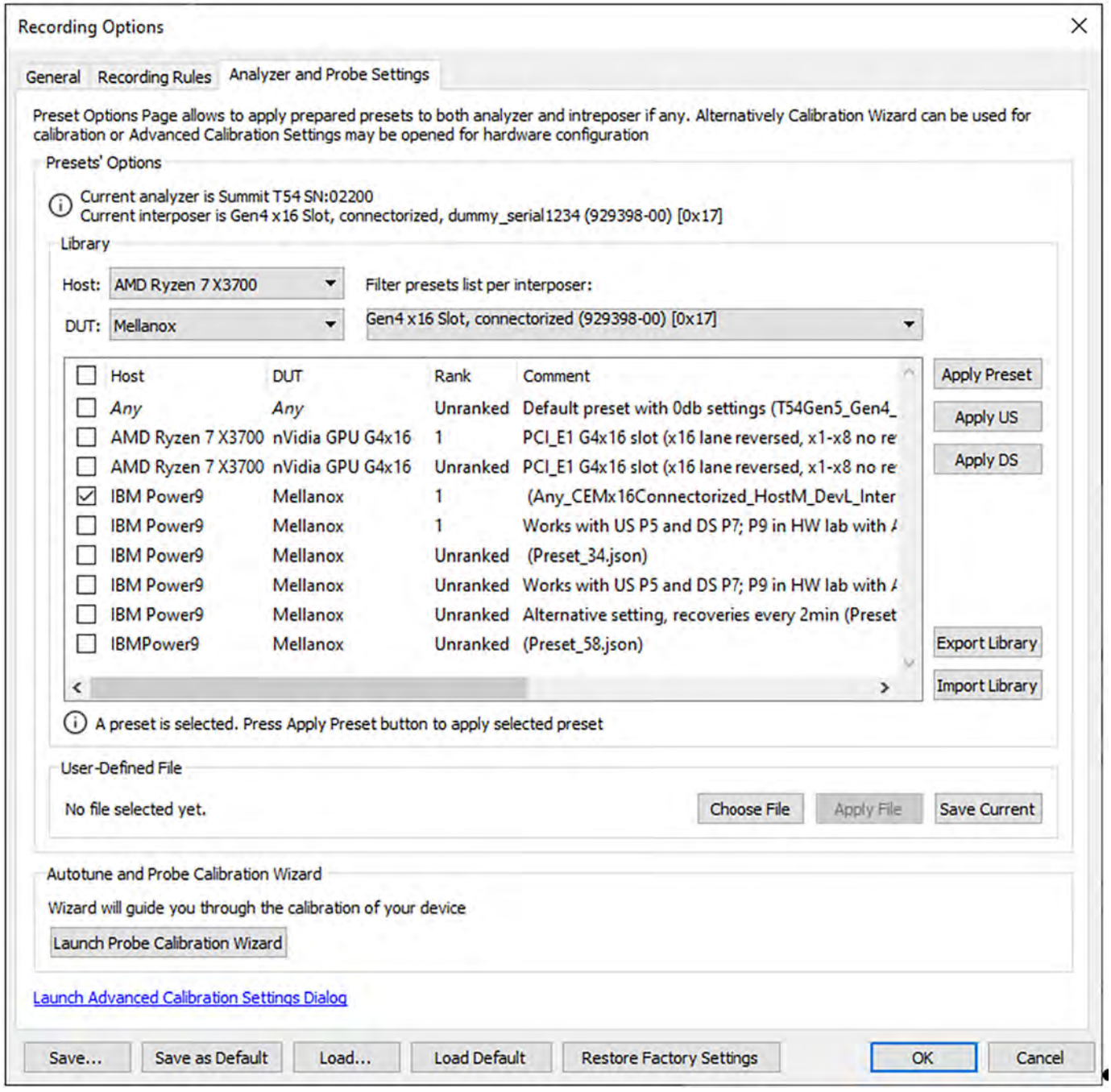


Figure 5.152: Recording Options Presets' Options

5.18.1 Library

The Library contains the presets you can apply and includes the following combo-boxes (Figure 5.153):

- Host – Lists all available Hosts
- DUT – Lists all available DUTs
- Interposer – Lists all available Interposers

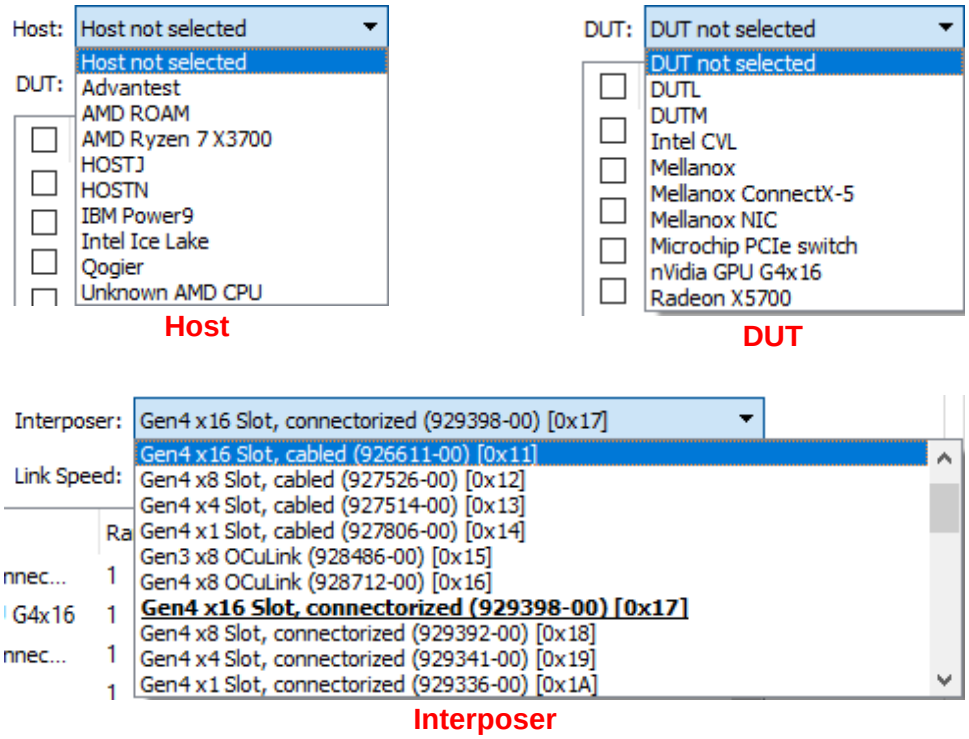


Figure 5.153: Combo-Boxes of Presets' Options

The Interposer connected to the setup is shown in bold and underlined.

When the Analyzer and Probe Settings tab is opened, the connected interposer is automatically displayed in Interposer combo-box. In this example, the list of available Hosts and DUTs is limited to those presets that support current Interposer.

5.18.2 Search Filter

When you select a Host and DUT for the connected Interposer, the presets are shown in the following order:

1. Presets with full match of Host and DUT (displayed in bold)
2. Presets with match in Host
3. Presets with Match in DUT

Note: Currently, only one preset can be selected.

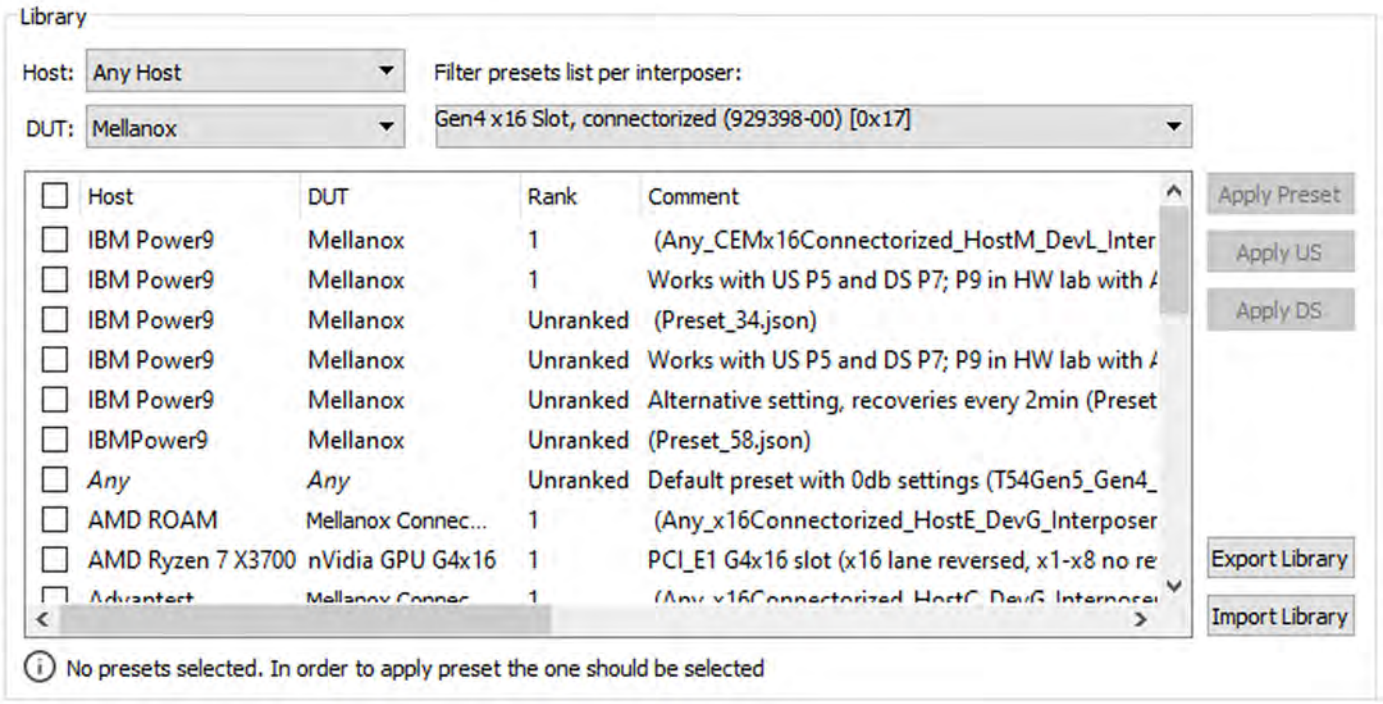


Figure 5.154: Presets' Match in DUT

Selected preset can be applied either on both channels using **Apply Preset** or separately, using **Apply US** or **Apply DS**. Applied presets are applied in Rec Options and written to the Interposer to all Calibration tables.

Note: The Host may need to be rebooted to ensure the DUT is able to reach the necessary speed.

Note: **Column Rank** shows the rate of errors on the link on the scale from 1 to 10, where 1 indicates that there are few or zero errors (Figure 5.137). The larger Rank number indicates that the Preset will contain more errors. It is not recommended to use a Preset with rank higher than 6, because the number of errors on the link will be high.

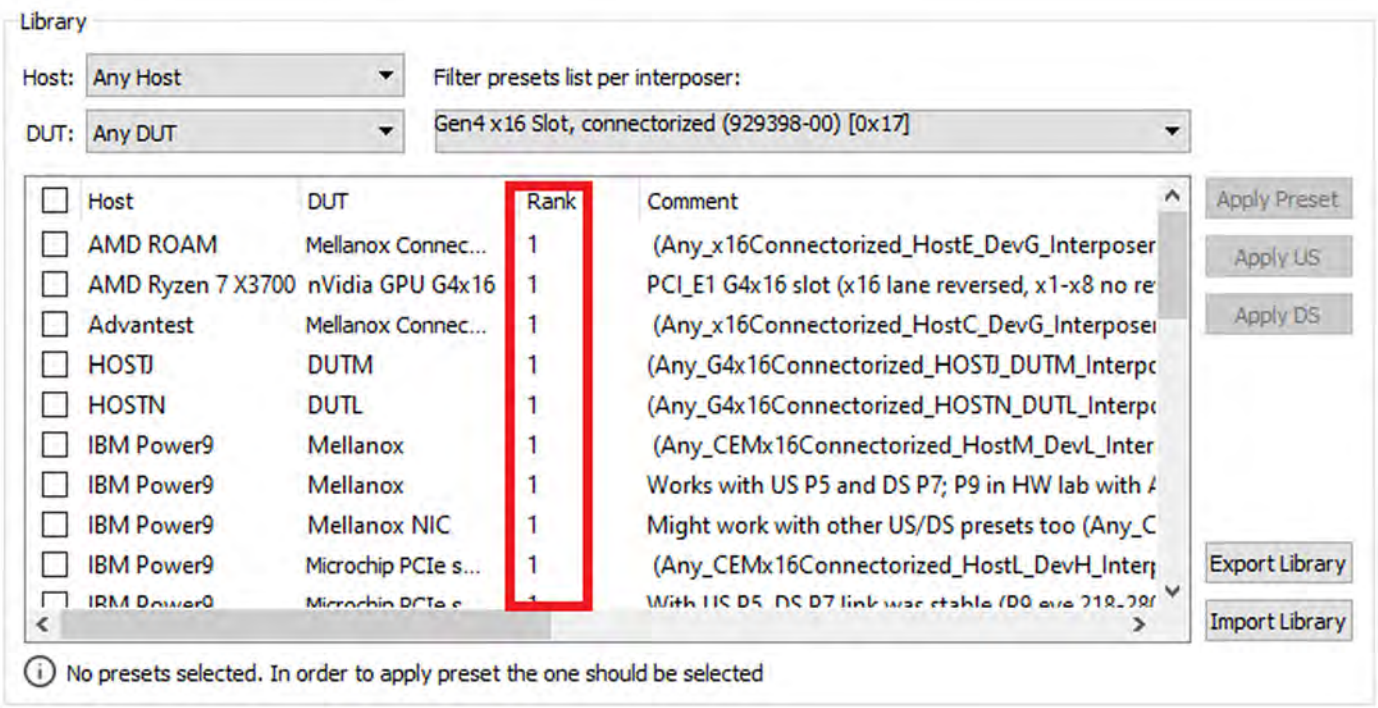


Figure 5.155: Preset with Low Rank Number

Note: It is not recommended that you apply a Preset with a different board ID as it will not be accurate.

5.18.2.1 Saving a Selected Preset

To save the selected Preset file:

1. Click the **Save Current** button (Figure 5.156) to save the selected Preset file. The Add Configuration File Info dialog box opens, where you can add more configuration details (Figure 5.157).

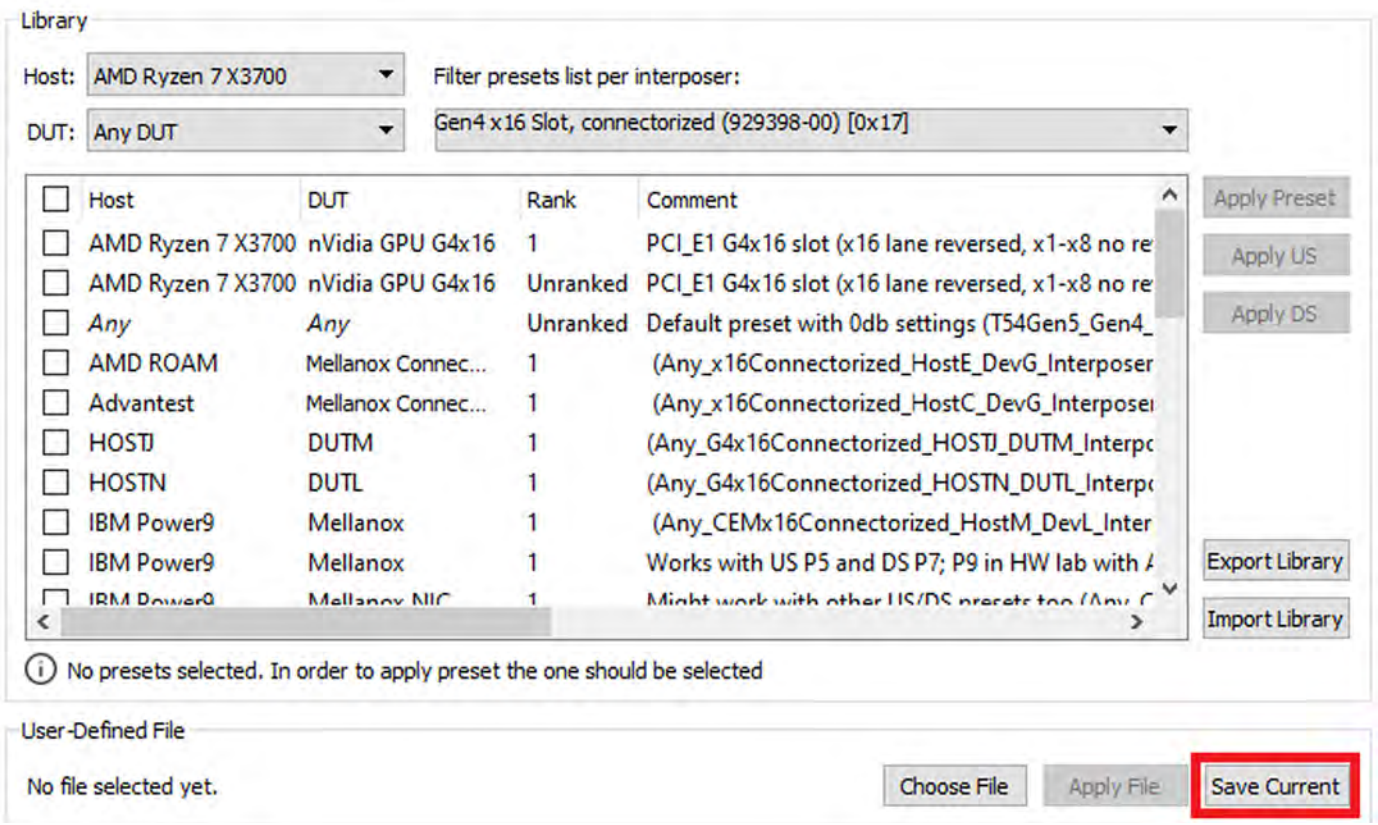


Figure 5.156: Save the Currently Selected Preset

2. Provide a Platform Name and all other details to ensure future searches find the saved values (Figure 5.157).

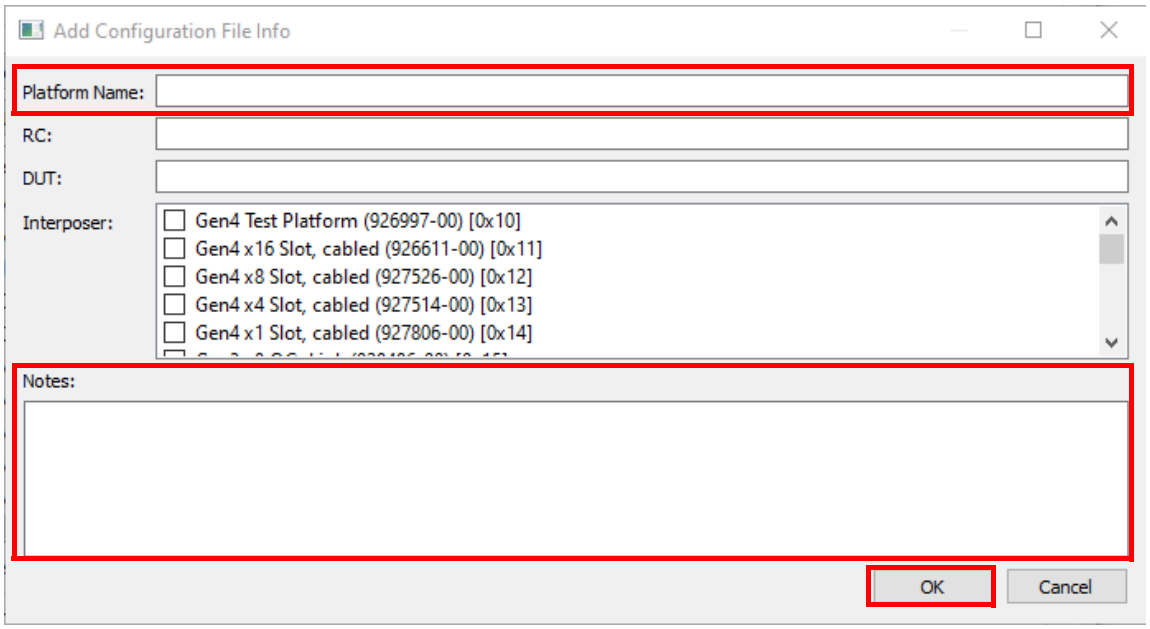


Figure 5.157: Add Configuration File Info Dialog Box

3. If desired, enter additional comments and information into the **Notes** field.

4. Click **OK**. The *Save settings file* window opens (Figure 5.158).

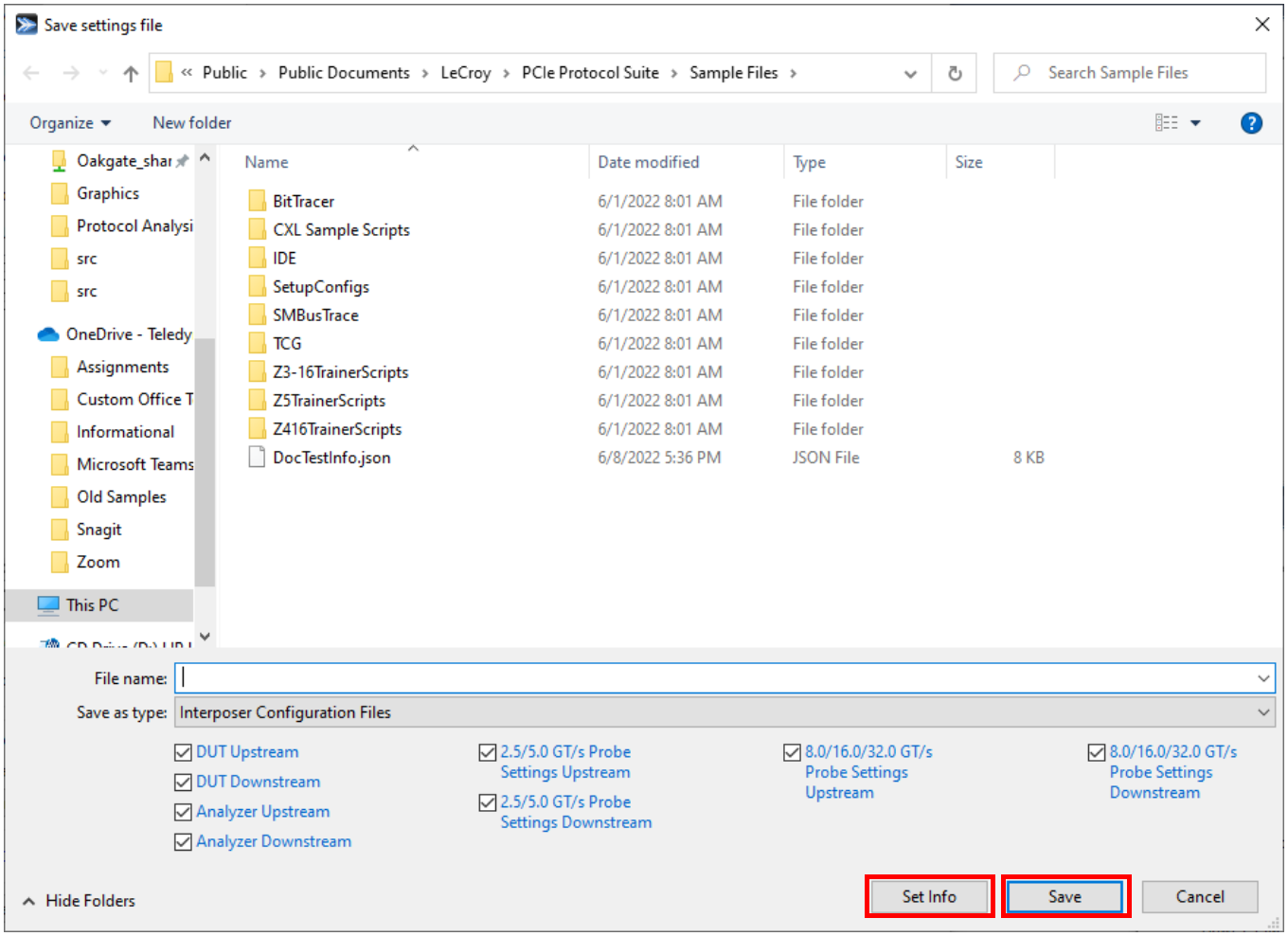


Figure 5.158: Save Settings File Window

5. Enter a file name and click **Save**.

Note: You can skip Step 5 to allow the software to automatically define the interposer.

6. If you wish to specify additional details to the Configuration File, click **Set Info** and follow the prompts.

Note: If you are saving the preset to C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\InterposerCfgPresets, it will appear in the library and will be exported along with other presets in the folder.

5.18.3 Library Operations

Teledyne LeCroy maintains an online database of presets.

If you are connected to the Internet when you launch the PCIe Protocol Analysis software, your local presets will be automatically updated with the latest information from the

online database. If you have no Internet connection, you can easily import the exported library file into the application.

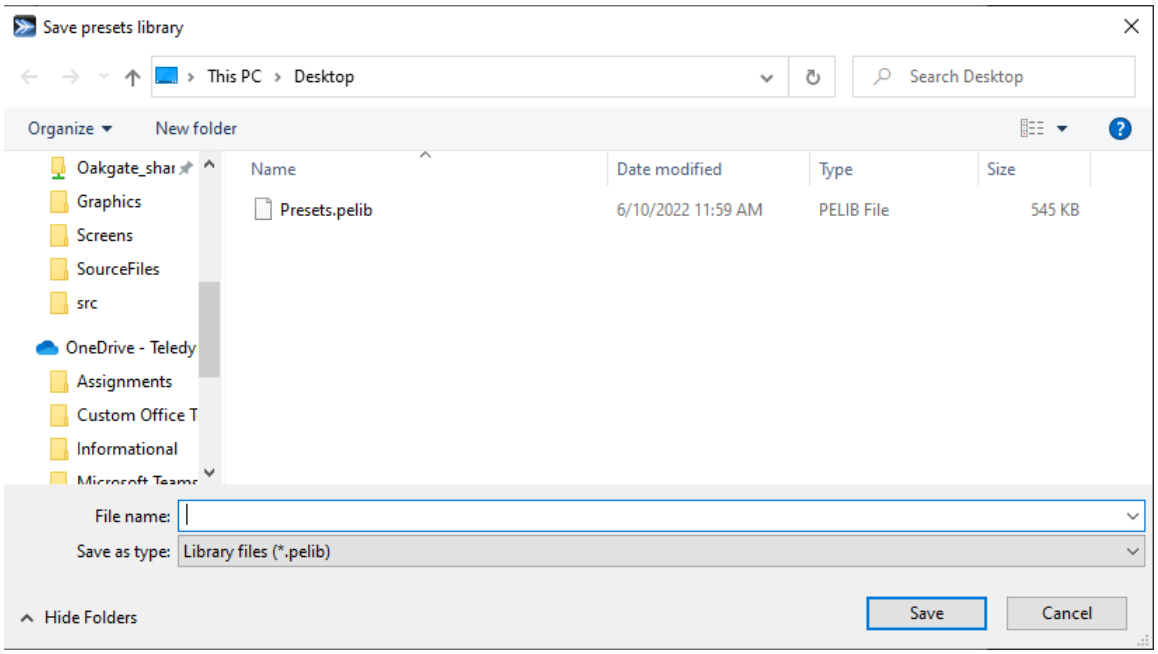


Figure 5.159: Export Library to Computer – User Defined File

5.18.3.1 Buttons & Functions

TABLE 5.1: Buttons – Analyzer & Probe Settings

Button	Function/Description
Apply Preset	Applies settings to both upstream and downstream channels for the selected Preset.
Apply US	Applies settings to upstream channels only for the selected Preset.
Apply DS	Applies settings to downstream channels only for the selected Preset[1].
Export Library	Creates a file in which all of the presets in the Library can be exported into one file in *.pelib format.
Import Library	Opens the Library with all of the presets without an Internet connection. It automatically rewrites the folder C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\InterposerCfgPresets
Choose File	Loads the preset. You can choose to load presets with all of the tables or only your selected presets.
Apply File	Saves Rec Options and writes the values to the Interposer from Presets on the selected tables. **Note:** If the Preset was created for a different Interposer board ID, the warning prompt shown in Figure 5.160 appears.

TABLE 5.1: Buttons – Analyzer & Probe Settings (Continued)

Button	Function/Description
Save Current	Saves the manually selected values and writes to the interposer in all three tabs: • Interposer Host to DUT Path • Interposer to Analyzer Path • Analyzer Calibration both 2.5/5.0 GT/s and 8.0/16.0/32.0 GT/s
Launch Probe Calibration Wizard	Opens the Autotune and Calibration Wizard. This will lead you through the steps for both Autotuning the Analyzer and Calibrating the Probe. 5.19.4, *"Using the Autotune and Probe Calibration Wizard"*.
Launch Advanced Calibration Settings Dialog — Link that opens the Advanced Calibration Setting dialog window. Use this option to manually adjust the probes. See 5.19.3, *"Analyzer Calibration"*.	
Save...	Saves the Rec Options.
Save as Default	Saves the current Recording Options as default 1.
Load...	Opens File Explorer with a path to the PCIe Protocol Suite. Select a folder and click **Open** to apply the Rec Options.
Load Default	Loads the default Recording Options
Restore Factory Settings	Restores all Recording Options (including defaults) back to the original factory settings
OK	Applies the settings.
Cancel	Discards any changes that were made in Rec Options and closes Rec Options window

1. Once you click **Apply**, you will be prompted to reboot the Host to correctly apply the selected Preset.

Note: If you select a Preset, which was not developed for the current interposer, the interposer will try to map the values.

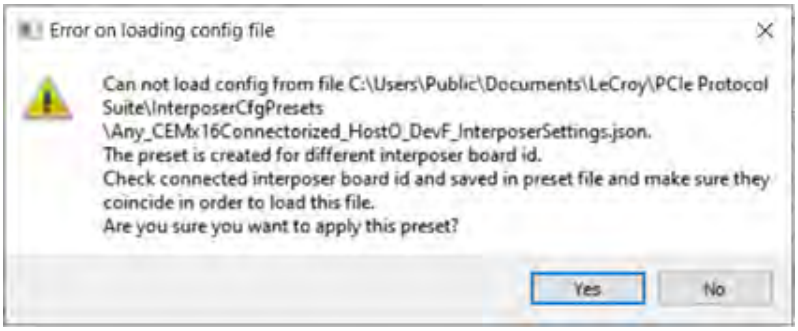


Figure 5.160: Warning Prompt – Error Loading Config File

5.19 General Guidelines for Calibration and AutoTuning

Note: Examples shown below are for Gen4 Interposers. The process for Gen5 Interposers is similar but the specific examples may not be identical.

Following are some general guide lines to help stream line this process.

1. First make sure that the device is getting link up with underlying host, if needed set the BIOS parameters.
2. The device should be visible to the host OS, in order to do the auto-tuning and calibration, if it is not present, please try the presets manually and reboot the Host OS, check again, if device is getting detected then the auto-tuning / calibration routine can work on it. Note: it is not necessary to have the stable or clean link, just a link, may be a Gen1 x1 is good enough to start the calibration / tuning process. The process will bring the device to the max level possible in terms of Speed and Linkwidth.
3. Once the device is detected by Host OS, first start the Host to DUT path auto-tuning. (“Interposer Host to DUT Path” on page 342).
4. Once that is done, then start the "Interposer to Analyzer Path autotuning (“Interposer to Analyzer Path” on page 376).
5. In the end if there are still errors, then try to do Analyzer Calibration (“Analyzer Calibration” on page 378).
6. Another approach to Auto Tuning and Probe Calibration is to use the Auto Tune and Probe Calibration wizard, which automates the process for you (“Using the Autotune and Probe Calibration Wizard” on page 389).

5.19.1 Interposer Host to DUT Path

This dialog box allows you to Autotune the Interposer Host to DUT path settings.

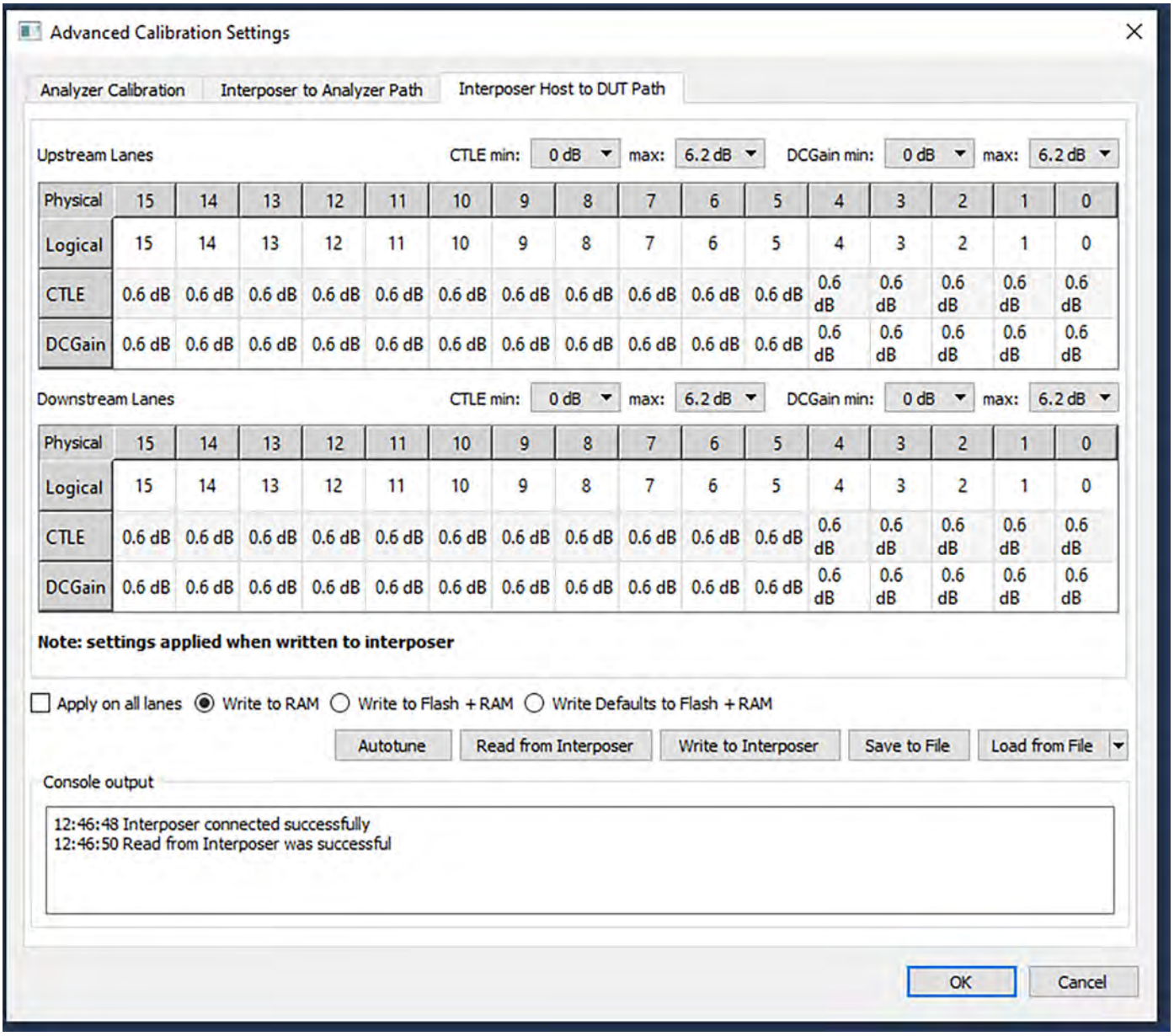


Figure 5.161: Interposer Host to DUT Path

5.19.1.1 Interposer Host to DUT CTLE and DCGain Settings

Combo-boxes are provided above the Upstream and Downstream lanes allowing you to specify CTLE and DCGain minimum and maximum value ranges.

If no custom ranges were saved in the RAM of the interposer, the system displays the full range that the current model supports.

To set a custom range, select the values from the CTLE and DCGain drop down menus, as shown in Figure 5.162.

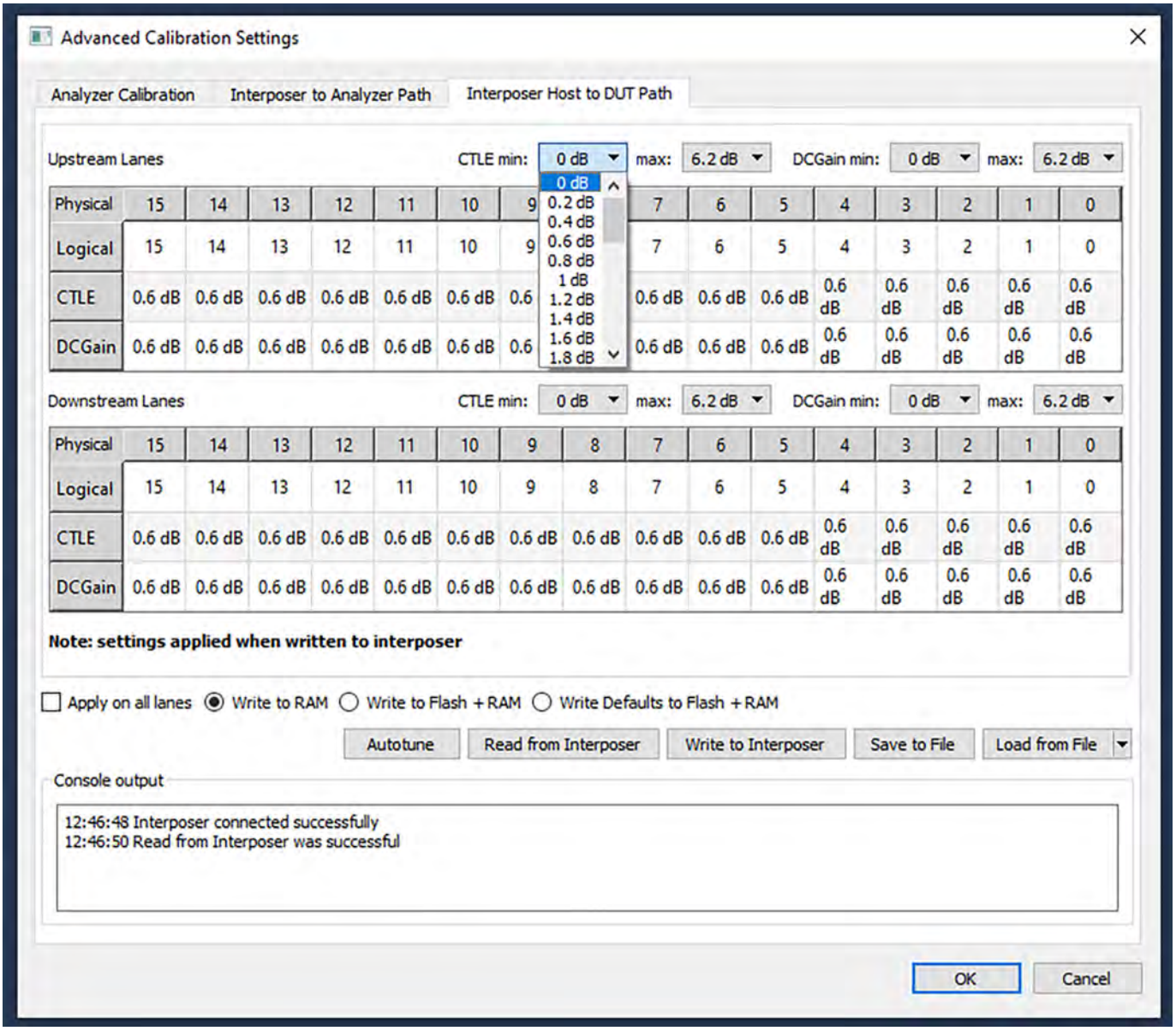


Figure 5.162: Advanced Calibration Settings: Selecting CTLE Range

You can only select numbers within the range available in the lane table. Selecting a the minimum or maximum range outside of the specified ranges causes the lanes to turn red (Figure 5.162).

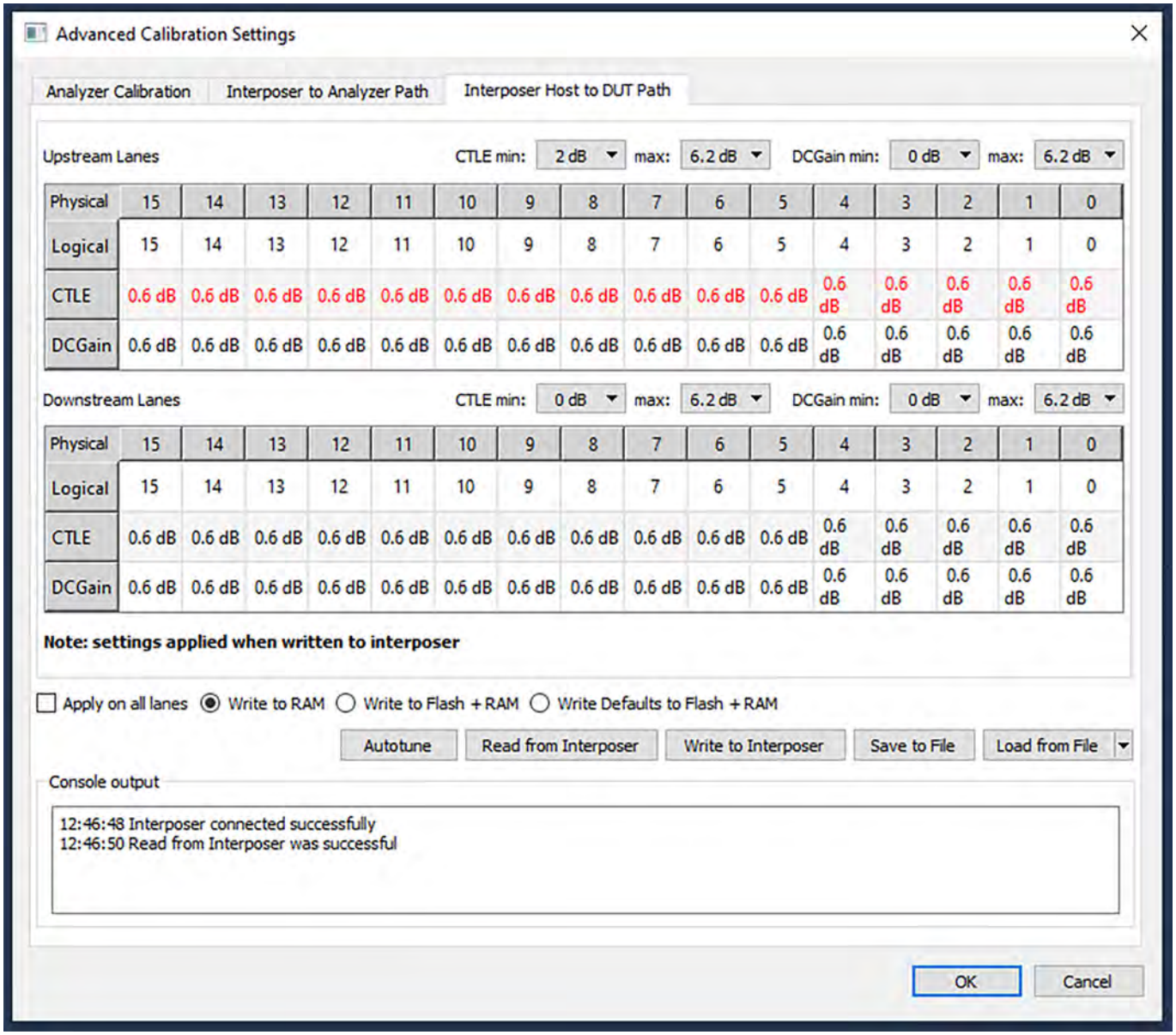


Figure 5.163: Advanced Calibration Settings: CTLE Outside of Range

A warning also displays, as shown in Figure 5.164.

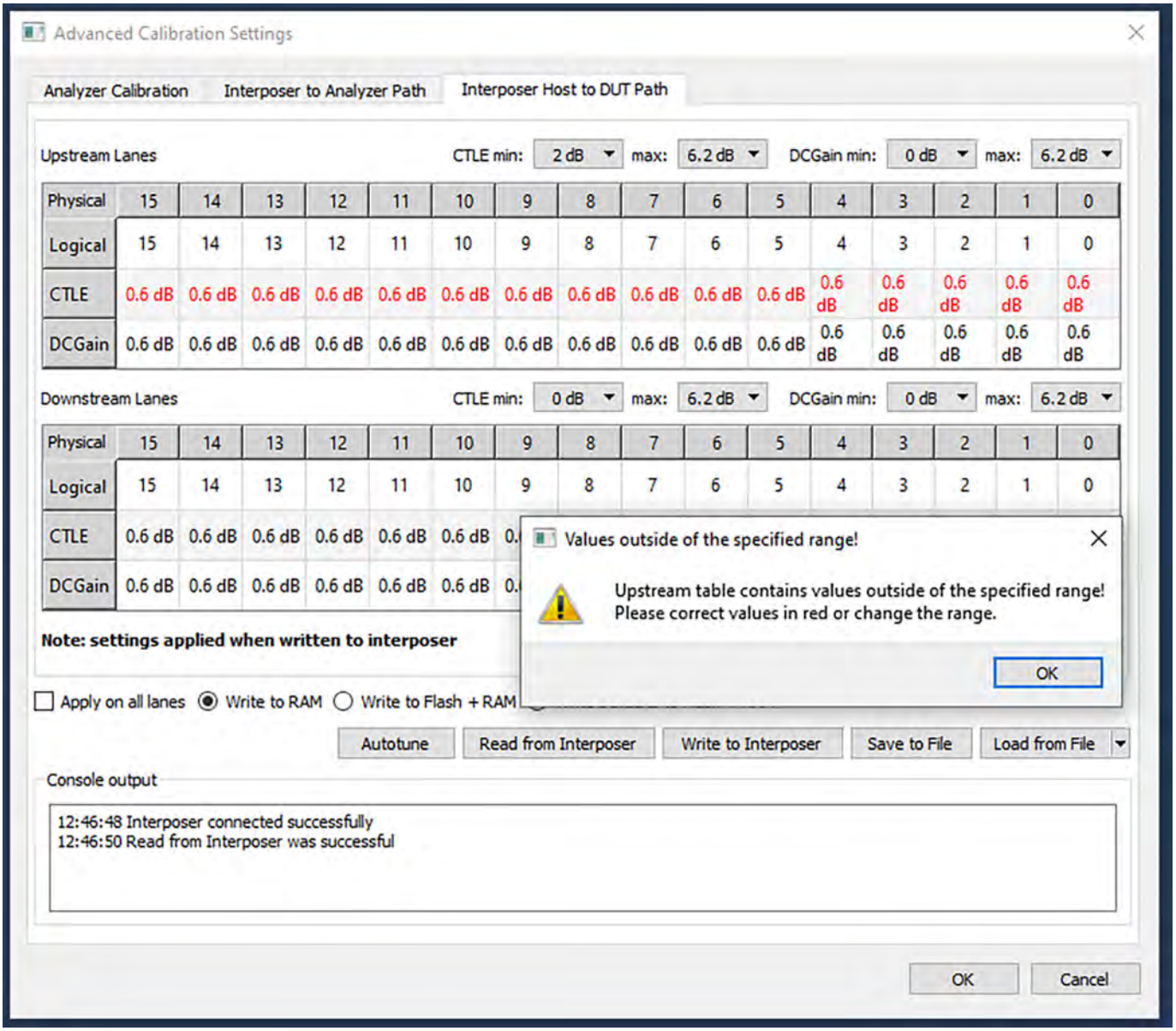


Figure 5.164: Advanced Calibration Settings: Values Outside Specified Range

You must fix the values before you can **Save to File**, **Write to Interposer**, **Read from Interposer**, or start the **Autotune** process.

To fix all the red values in the row to the minimum specified value within the range:

1. First, click the column of the values that need to change.
2. Change the values. Use the <tab> button to navigate between values.

Once the values are in range, you can select **Write to Interposer** or **Read from Interposer**. Clicking **Write to interposer** or **Read from Interposer** also writes /reads the selected ranges to the RAM / Flash.

Note: When selecting **Write to Interposer**, the selected Ranges will be reset to those supported by the current interposer.

5.19.1.2 Interposer Host to DUT Autotune

The goal of DUT auto-tuning is to get the device to the target link speed and width with minimal error rate, by adjusting CTLE and DCGain values. Target link speed and width can be selected in the dialog before starting the auto-tuning.

The auto-tuning routine automatically sets and writes to the interposer CTLE and DCGain values, measures error rate and if necessary resets the DUT or reboots the host.

Typical Setup

Typical setup for this feature consists of two PCs as described below:

- Target Host PC where the interposer is connected
- Client PC running the PCIe Protocol Analysis software application which can perform the following tasks:
  - adjust analyzer settings
  - adjust interposer settings
  - perform recording/analysis of a captured trace
  - manage the Target Host PC via client software:
    - queries list of installed hardware
    - queries of the DUT/Root complex settings
    - OS reboot

The Target Host PC may be managed either through Windows or Linux OS (Operating System). Depending on the host OS there are two possible solutions.

- SSH (Secure Shell -> Linux OS)
- SSL (Secure Sockets Layer -> Windows OS)
- SSH (TDY Provided -> Linux OS)

The choice of SSH vs. SSL depends on which method is easier for setting up the Target Host PC.

The choice of SSH vs. SSL depends on which method is easier for setting up the Target Host PC.

Secure Shell (SSH)

SSH (Secure Shell) uses public-key cryptography to authenticate the remote computer and allow it to authenticate the user, if necessary. There are several ways to use SSH; one is to use automatically generated public-private key pairs to simply encrypt a network connection, and then use password authentication to log on. Another is to use a manually generated public-private key pair to perform the authentication, allowing users or programs to log in without having to specify a password. In this scenario, anyone can produce a matching pair of different keys (public and private). The public key is placed on all computers that must allow access to the owner of the matching private key (the owner keeps the private key secret). While authentication is based on the private key, the key itself is never transferred through the network during authentication. SSH only verifies whether the same person offering the public key also owns the matching private key. In all versions of SSH it is important to verify unknown public keys, i.e. associate the public keys with identities, before accepting them as valid. Accepting an attacker's public key without validation will authorize an unauthorized attacker as a valid user.

Secure Sockets Layer (SSL)

SSL (Secure Sockets Layer) is the standard security technology for establishing an encrypted link between a web server and a browser. This link ensures that all data passed between the web server and browsers remain private and integral. SSL is an industry standard and is used by millions of websites in the protection of their online transactions with their customers.

To be able to create an SSL connection a web server requires an SSL Certificate. When you choose to activate SSL on your web server you will be prompted to complete a number of questions about the identity of your website and your company. Your web server then creates two cryptographic keys - a Private Key and a Public Key.

The Public Key does not need to be secret and is placed into a Certificate Signing Request (CSR) – a data file also containing your details. You should then submit the CSR. During the SSL Certificate application process, the Certification Authority will validate your details and issue an SSL Certificate containing your details and allowing you to use SSL. Your web server will match your issued SSL Certificate to your Private Key. Your web server will then be able to establish an encrypted link between the website and your customer's web browser.

The complexities of the SSL protocol remain invisible to your customers. Instead their browsers provide them with a key indicator to let them know they are currently protected by an SSL encrypted session - the lock icon in the lower right-hand corner, clicking on the lock icon displays your SSL Certificate and the details about it. All SSL Certificates are issued to either companies or legally accountable individuals.

Typically an SSL Certificate will contain your domain name, your company name, your address, your city, your state and your country. It will also contain the expiration date of the Certificate and details of the Certification Authority responsible for the issuance of the Certificate. When a browser connects to a secure site it will retrieve the site's SSL Certificate and check that it has not expired, it has been issued by a Certification Authority the browser trusts, and that it is being used by the website for which it has been issued. If it fails on any one of these checks the browser will display a warning to the end user letting them know that the site is not secured by SSL.

5.19.1.3 Access to Configuration Space

The Target Host PC with installed Interposer, the DUT and the client software (Auto-tuning process) **REQUIRES** access to device configuration space, which is achieved by using a software program that runs on the Target Host PC:

- InterposerAutotuningAgent.exe if the Target Host PC OS is Windows.
- Bash scripts, if the Target Host PC OS is Linux.

5.19.1.4 Using Z516 or Z58 as a DUT

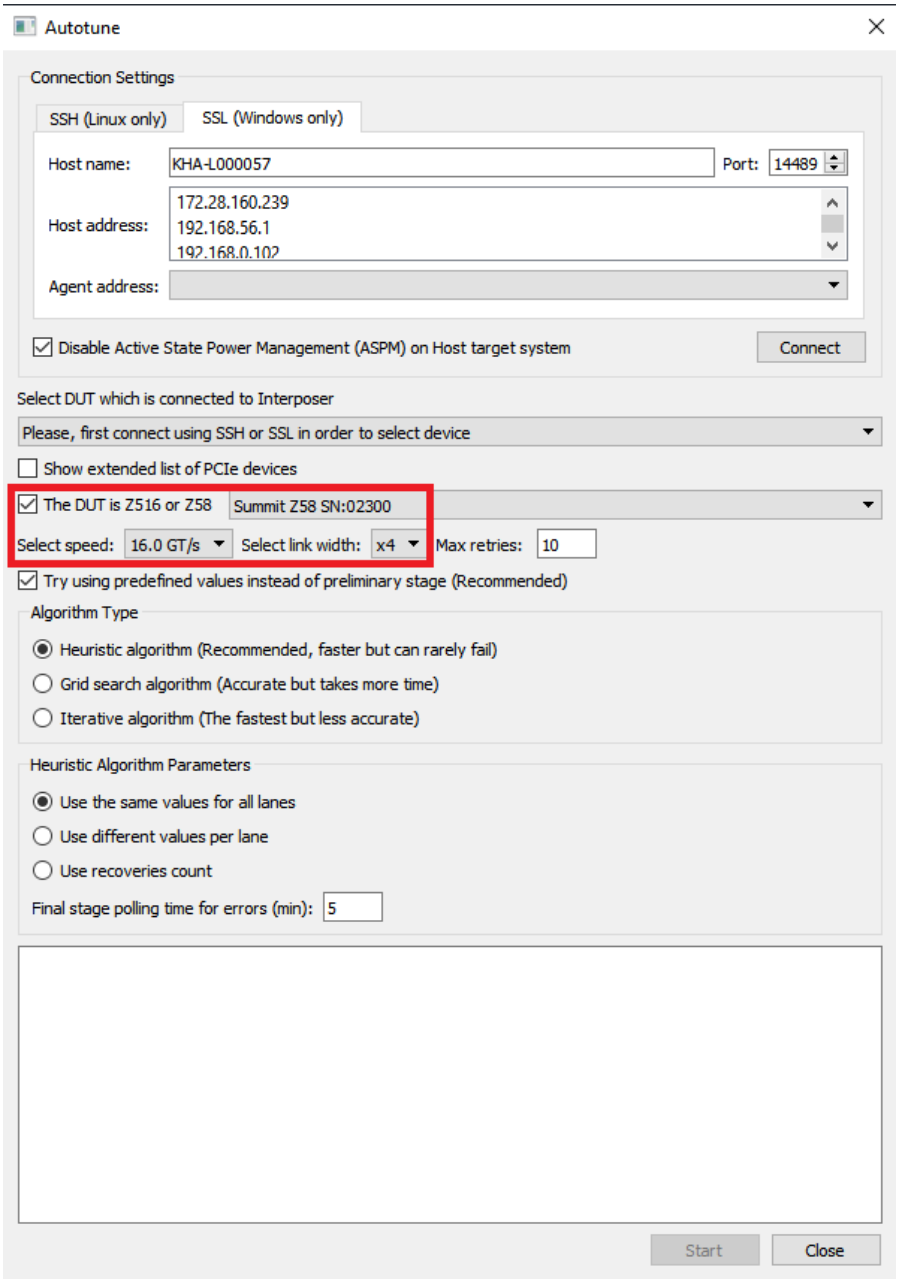


Figure 5.165: The DUT is Z516 or Z58 option

If the DUT is Z516 or Z58 exerciser, then **The DUT is Z516 or Z58** must be selected and the connected host device must be chosen from the list. See Figure 5.165.

If this option is enabled, then during the auto-tuning:

- Link state (current link width and link speed) is read from the register in the configuration space of the port of the selected DUT instead of the configuration space of the DUT.
- Connect macros is executed for the chosen Exerciser instead of performing software link reset.

5.19.1.5 Auto-tuning algorithms

The Autotune dialog allows selecting one of several algorithms. The selected algorithm determines the steps that are performed during the process to find optimal CTLE and DCGain settings.

For most algorithms the auto-tuning routine uses the number of correctable and non-fatal errors read from the device and port as a link quality metric (the read values are reported in the log after each measurement). Consult the PCI Express® Base Specification for the definition of correctable and non-fatal errors. Since this error number is a link-wide metric, all algorithms except Predictive with enabled **Use different values per lane** option use equal values of CTLE and DCGain for all lanes.

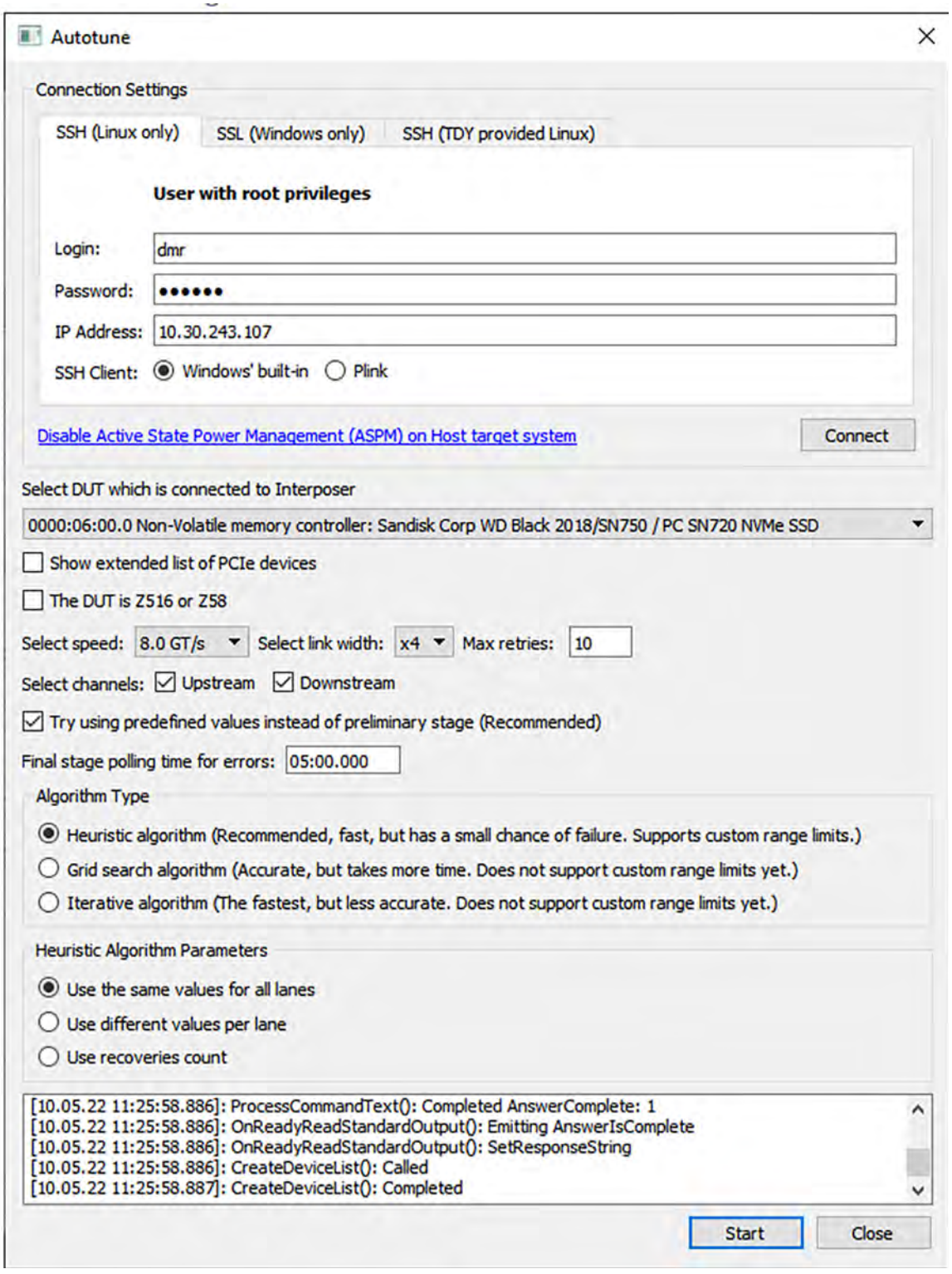


Figure 5.166: Auto-Tune: Algorithm Selection Options

Below is the list of the available algorithms with their descriptions:

Heuristic Algorithm

The heuristic search method utilizes information from the previous measurements to determine the direction of the settings with the lower number of errors.

Auto-tuning is performed separately for upstream and downstream. For each direction there are several stages. Each subsequent stage has a larger error polling interval. The advance to the next stage occurs when zero error rate is archived on the current stage. The found settings are used as the starting point for the algorithm in the next stage. If the routine cannot find settings with a zero error rate, then the auto-tuning stops.

First the routine performs an exhaustive search with large steps (which is described below) with duration stage time 500 millisecond. As a result, it saves some best points (by error rates) to start the next algorithm from.

The durations of all stages but the last are predefined. The first stage is 500 milliseconds. Then error polling time gradually increases: 2, 5, 10, 20, 40 seconds and 1, 2, 5, 10, 20, 30 minutes. For the final stage the errors polling time may be configured using **Final stage polling time for errors (min)** option in the Autotune dialog. It may be from 1 to 60 minutes. Note that if, for example, 5 minutes is specified, then the stages with longer error polling time (10, 20 and 30 minutes stages) are not performed.

Note that this algorithm starts from the CTLE and DCGain produced by first Grid search run. In case the algorithm fails to find good values from first point then procedure starts again (without additional Grid search run) selecting the next point until good values are found or all saved points are tested.

This algorithm also supports custom range limits. The only values within the appropriate range will be tested by the algorithm and during the checking for presets.

Note: For custom ranges to apply, the "Try using predefined Values …" option must be selected. Otherwise, the algorithm ignores the custom range.

In addition, after any write to interposer in scope of this algorithm DUT is reset to adopt to new line characteristics.

Also for this algorithm it is possible to configure how errors are measured. The following options are available in **Heuristic Algorithm Parameters** in the Autotune dialog:

- **Use the same values for all lanes**
  The same values for parameters (CTLE and DCGain) are set for all lanes on one channel. The number of correctable and non-fatal errors read from the device and port will be used to determine the link quality.
- **Use different values per lane**
  Parameters for each lane are tuned separately. In this case to determine number of errors on each lane an analyzer is used.
- **Use recoveries count**
  The same values for parameters are set for all lanes on one channel. The number of recoveries counted on the analyzer are used to determine the link quality. This number is applied for entire link so the same values should be used for each lane. This is main algorithm which often produces accurate results and does not

take as much time as Grid search.

Grid Search Algorithm

If this option is selected, then the auto-tuning routine performs an exhaustive search through the predefined subset of settings for both channels at the same time.

There are three stages. During the first stage the routine uses large steps to find spots with settings, with which the device is able to work at the target link width and speed (as specified in the Autotune dialog). Then the same process but with smaller steps is repeated in the found spots. Then on the final stage each value inside the found on the second stage good spots is checked to find zero error rate.

Note that since a lot of different combinations of CTLE and DCGain values are checked, this algorithm may take more time to complete than other algorithms but is more accurate because more values are tested.

Iterative Algorithm

In this algorithm, there are several calibration stages where the auto-tuning routine tries adjacent value combinations to minimize error rate. It is done separately for upstream and downstream.

For the first stage the step is 0.6 dB, and for all subsequent stages the step is 0.2 dB. Each stage beginning from the second stage uses a larger error-collection interval, which allows the algorithm to detect less frequent errors but also slows the tuning process. If at any stage except the first stage (that is, every stage with minimal steps) the algorithm cannot achieve zero error rates for its interval, tuning stops.

During this process DUT reset is done (without rebooting host), after that, error rate is re-checked, and the tuning stage is repeated if needed. This algorithm is the fastest of all but may not produce accurate results.

Note: The Autotune dialog allows selecting the target speed and width of the link. If the current speed or link width reported by the DUT does not match the target values and the selected Algorithm Type is **Predictive algorithm** or **Coordinate descent,** then an additional step is performed before starting the selected algorithm. On this step the software routine is trying to walk with large steps through the CTLE/DCGain space to find spots where the link is good enough for the device to switch to the target speed and link width. If the link width is less than required, then the host is rebooted. If the speed is less than required, then the DUT reset is performed without reboot. The software routine is careful not to disrupt the link so much that the device becomes unavailable, making a host reboot needed, but it can happen sometimes. At this stage, the software routine is checking very few CTLE/DCGain combinations in predefined patterns. The error rate is not checked on this stage.

5.19.1.6 Host PC is running Window OS

Prerequisites

1. On the client PC (where PCIe Software Suite is installed), go to the folder "C:\Program Files\LeCroy\PCIe Protocol Suite\" and copy InterposerAutotuningAgentLauncher.exe to the removable media.

2. Run the PCIe Protocol Analysis software.
3. Go to 'Recording Options' -> Interposer 'Autotuning' tab.
4. Push the 'Autotune button'.
7. Open 'SSL (Windows only)' tab. Write down the values of 'Host address'/'Port' fields (see Figure 5.167 on page 355).

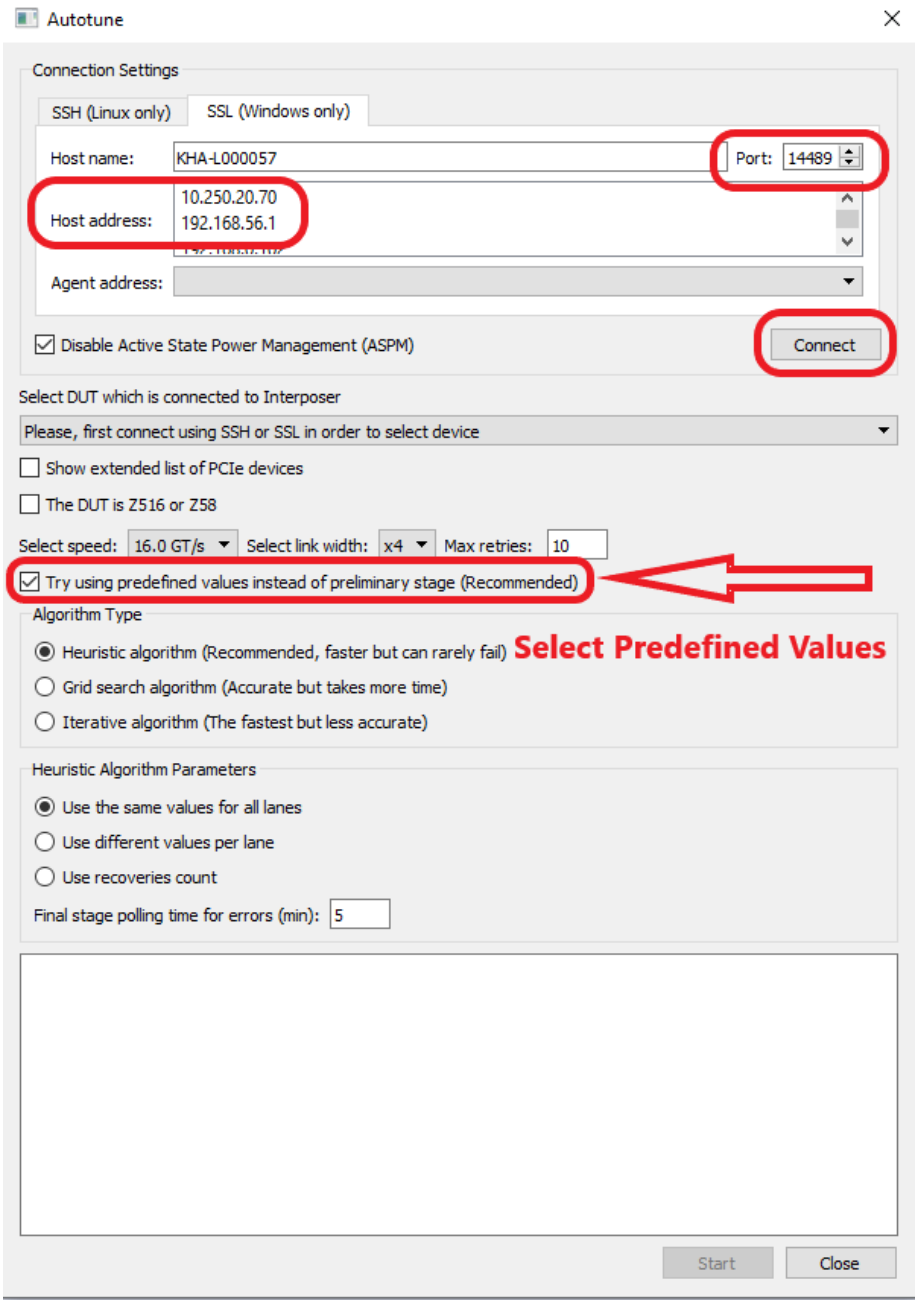


Figure 5.167: Auto-Tune: Select Predefined Values

If you select the Predefined Values for Auto-Tune and return to the Host to DUT Settings dialog box, click on the Load from File tab (see Figure 5.168 on page 356) and you'll see a list of devices (see Figure 5.169 on page 357).

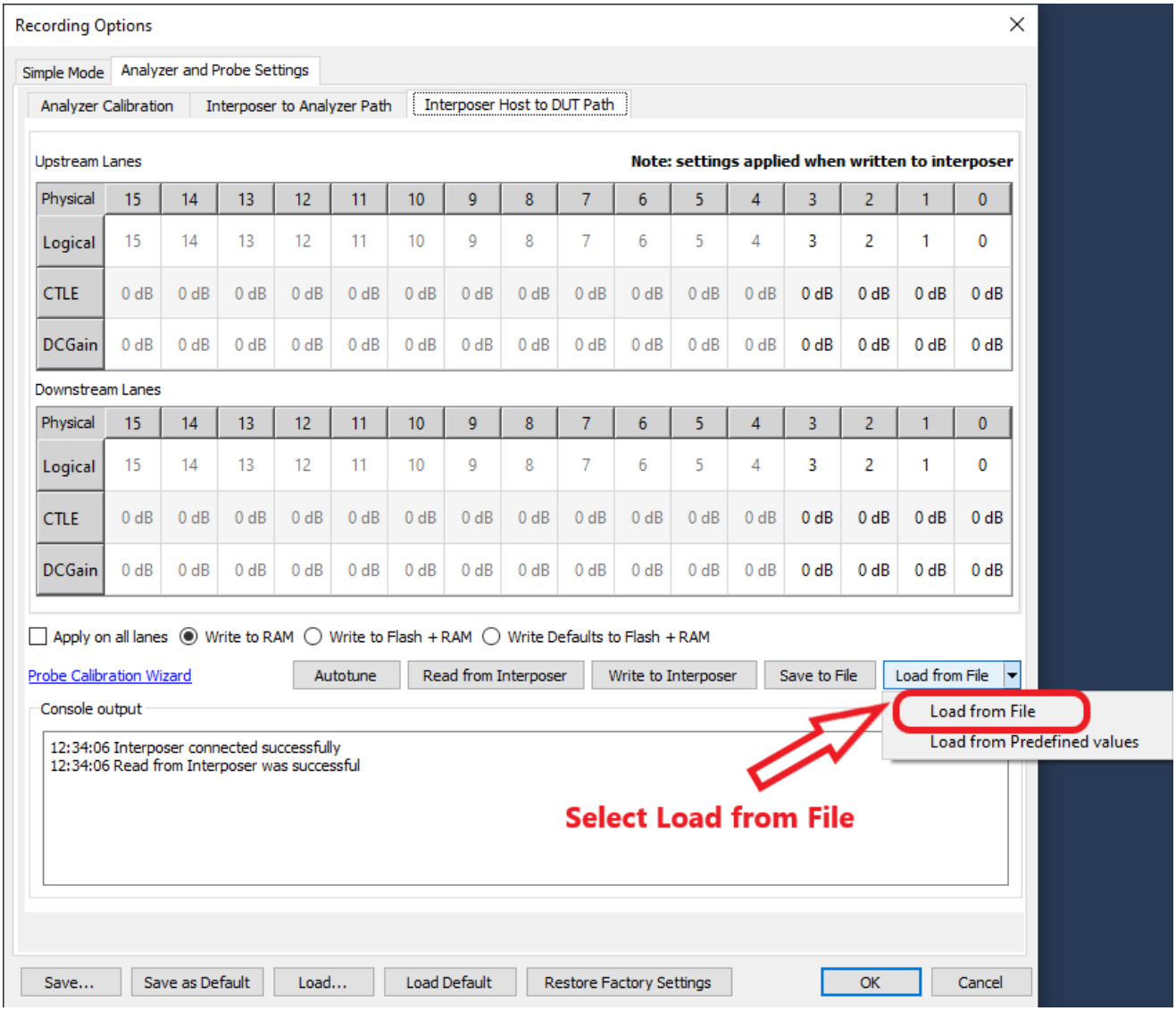


Figure 5.168: Host To DUT Settings: Load From File

If you select Load from File a List of DUT Settings will pop up. See Figure 5.169 on page 357.

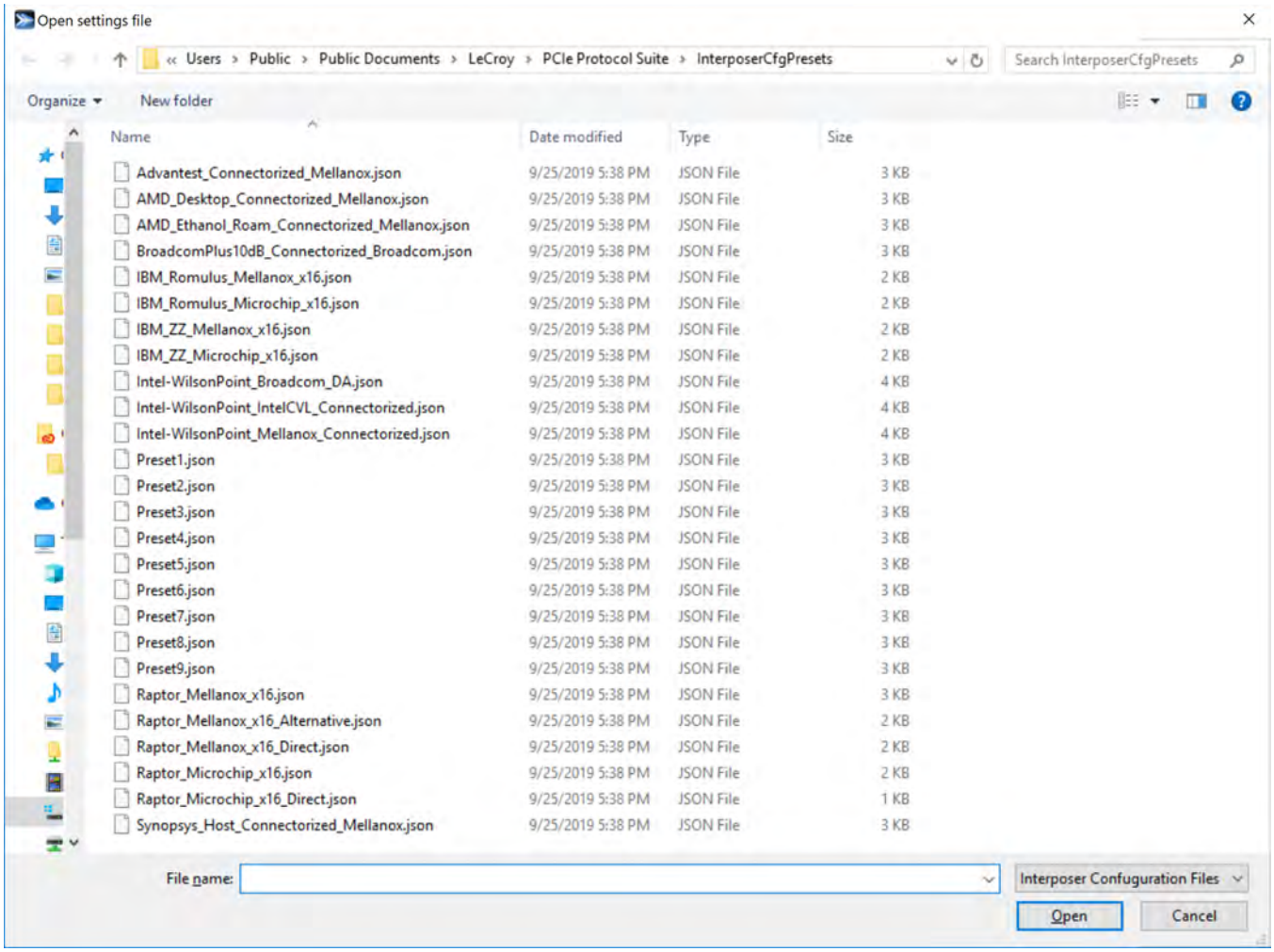


Figure 5.169: Load from File: List of Files

Another way to view the Predefined Values is to select Load from Predefined Values tab and the Choose Predefined values dialog box will pop up. See Figure 5.170 on page 358.

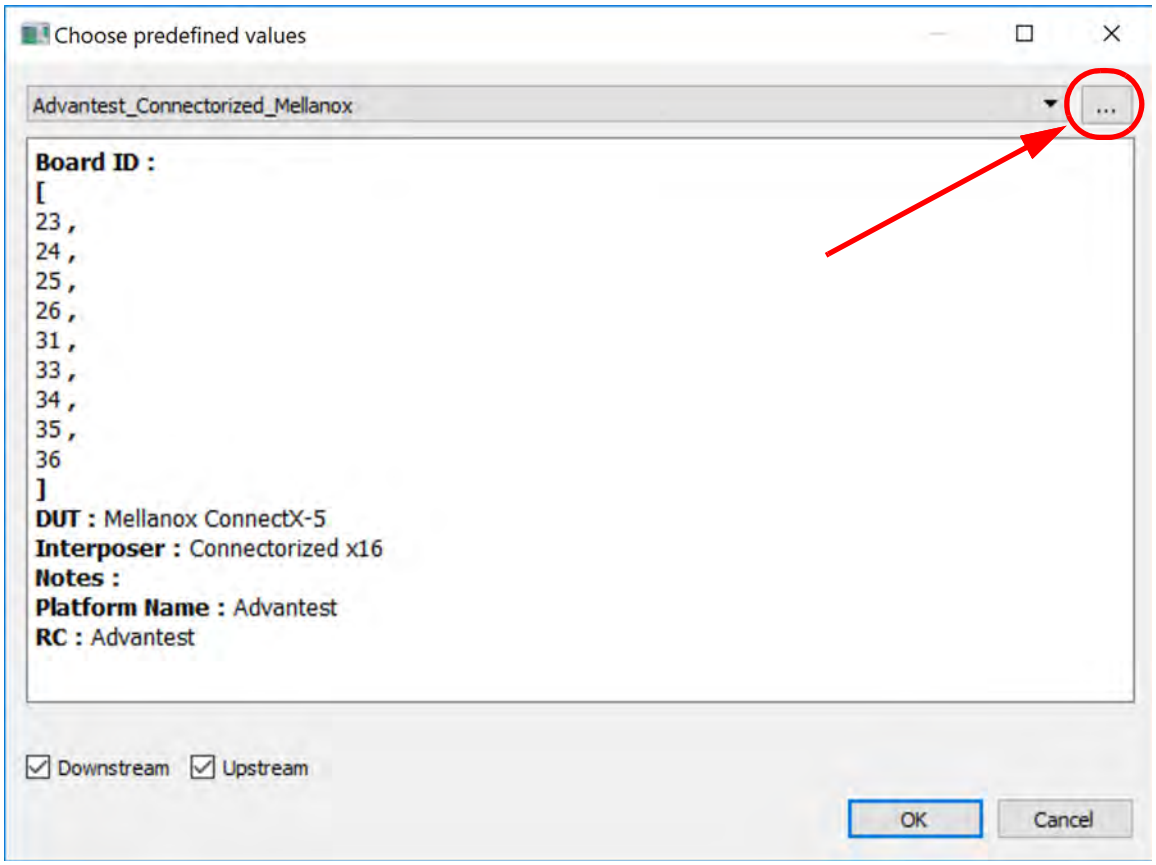


Figure 5.170: Choose predefined values

If you select the ... tab you'll see a list of all the predefined DUT Settings. See Figure 5.171 on page 359.

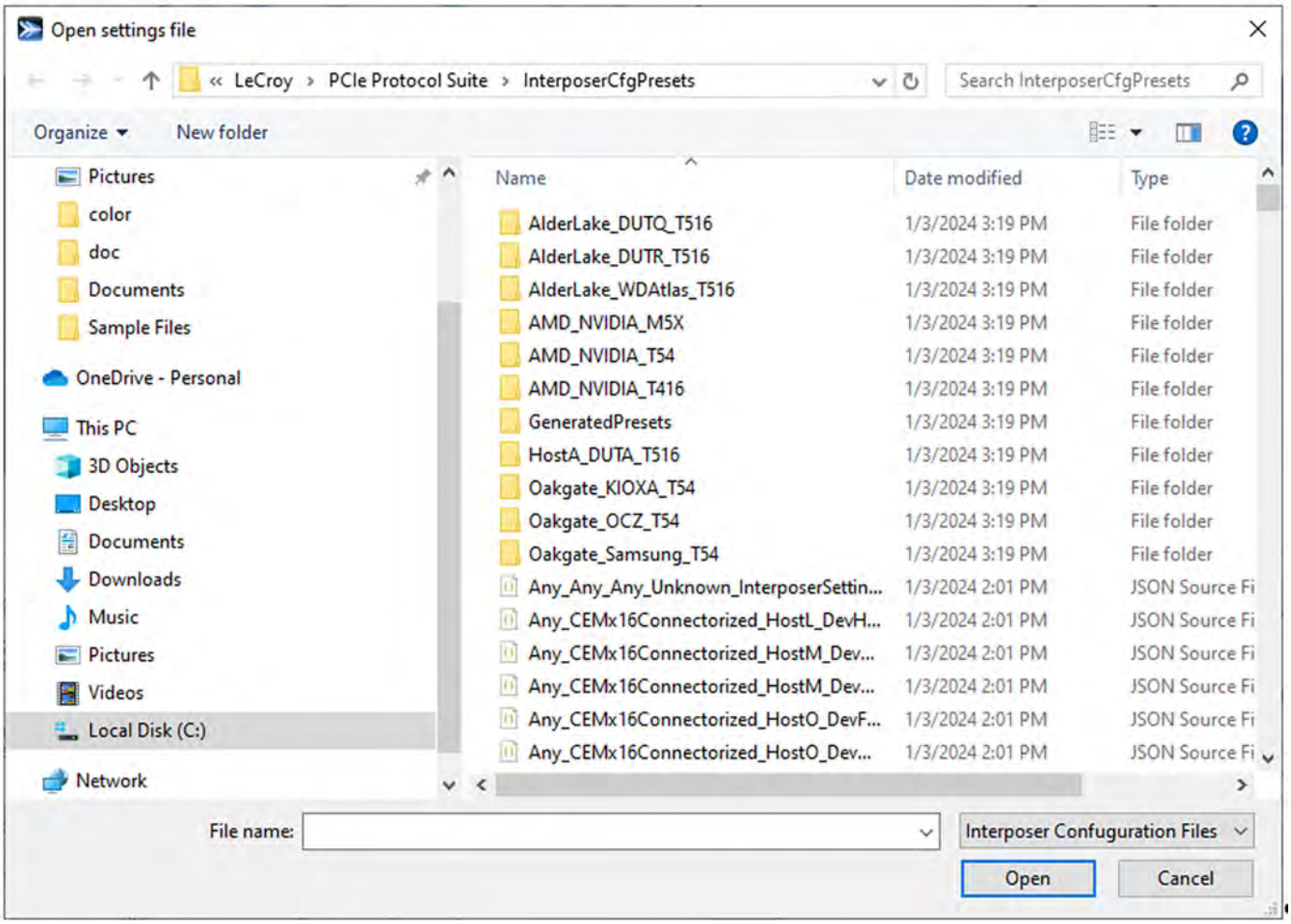


Figure 5.171: Set of Predefined DUT Settings

Another way to select a set of Predefined Values is to select the small black down pointing arrow and the list of predefined DUTs will appear. See Figure 5.172.

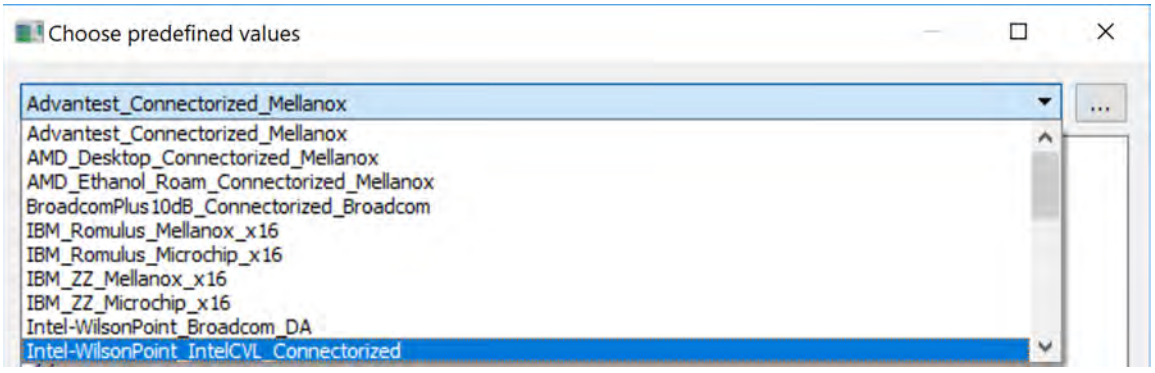


Figure 5.172: Choose predefined Values: Arrow

After you select a device (in this case the Intel-WilsonPoint_IntelCVL_Connectorized) the data for that device will pop up in the Choose predefined values dialog box. SeeFigure 5.173.

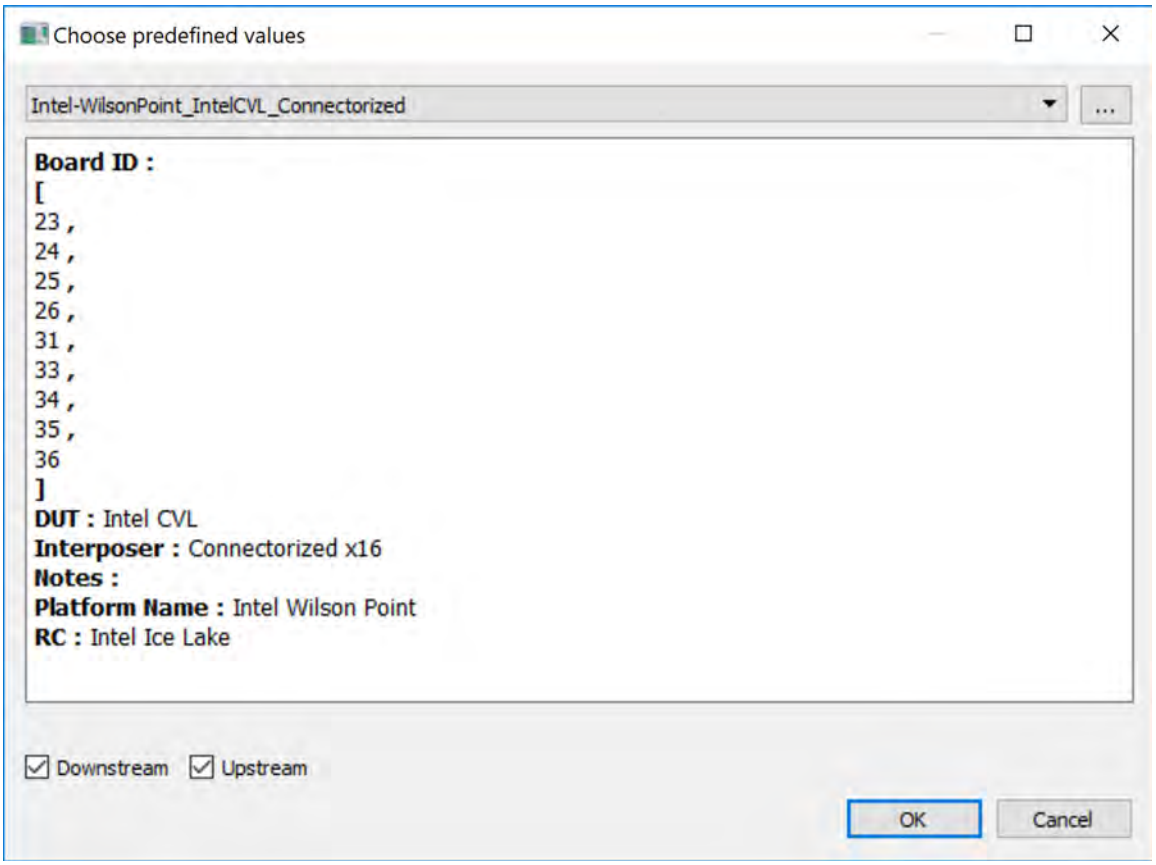


Figure 5.173: Choose predefined values: Intel-WilsonPoint...

InterposerAutotuningAgent installation on target host

1. Copy **InterposerAutotuningAgentLauncher.exe** to the target host PC
2. Run
3. **cmd.exe** with administrative credentials.
4. Run
5. InterposerAutotuningAgentLauncher.exe
6. Make sure that PMA driver installed successfully
7. Enter IP Main host and port address (see step 2 from prerequisites)
8. Press Enter. Make sure there are no warning and error messages. See Figure 5.174.
9. Close command prompt.

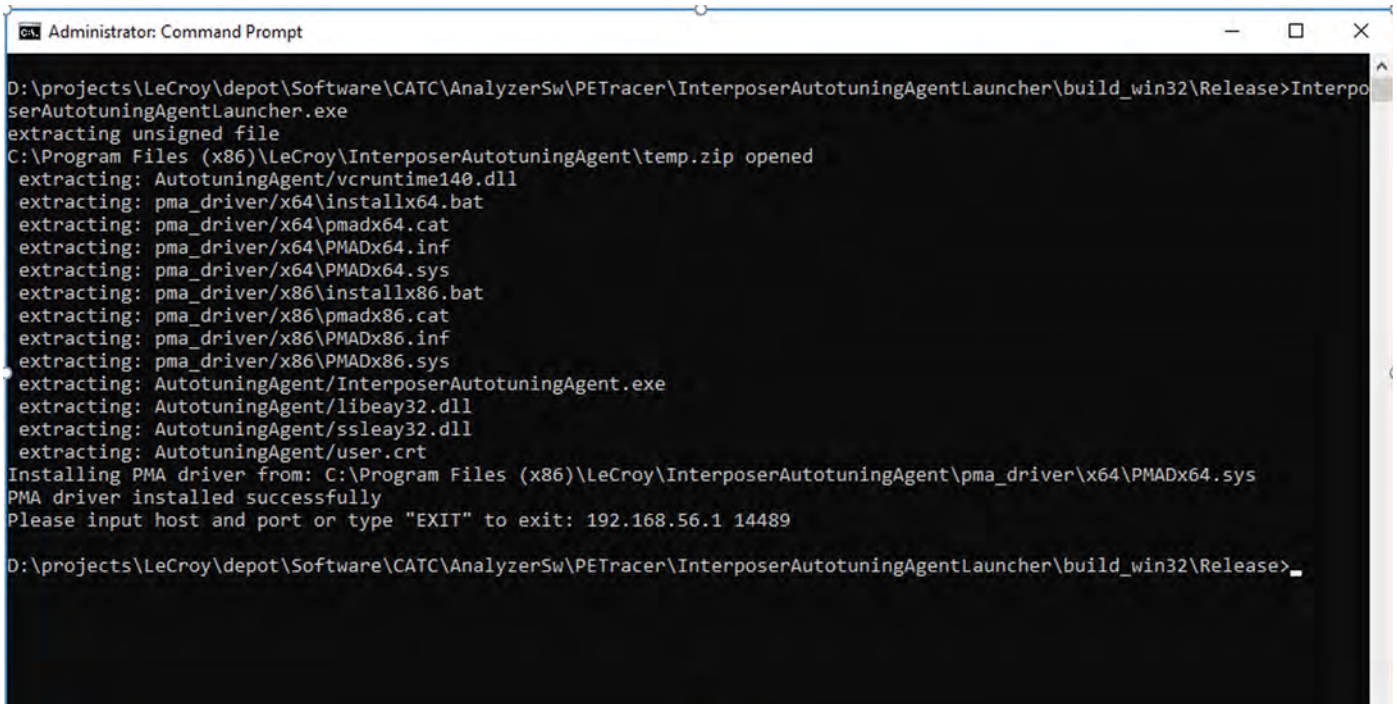


Figure 5.174: Administrator: Command Prompt

If something went wrong uninstall launcher using "Add/Remove Programs" and repeat again.

Uninstalling InterposerAutotuningAgent

1. Go to Windows settings -> 'Add or remove programs'
2. Remove 'Interposer Autotuning Agent'

Verify the service is correctly installed and running on target Host PC.

After successful InterposeAutotuningAgent installation new windows service must appear and be “Running”. See Figure 5.175.

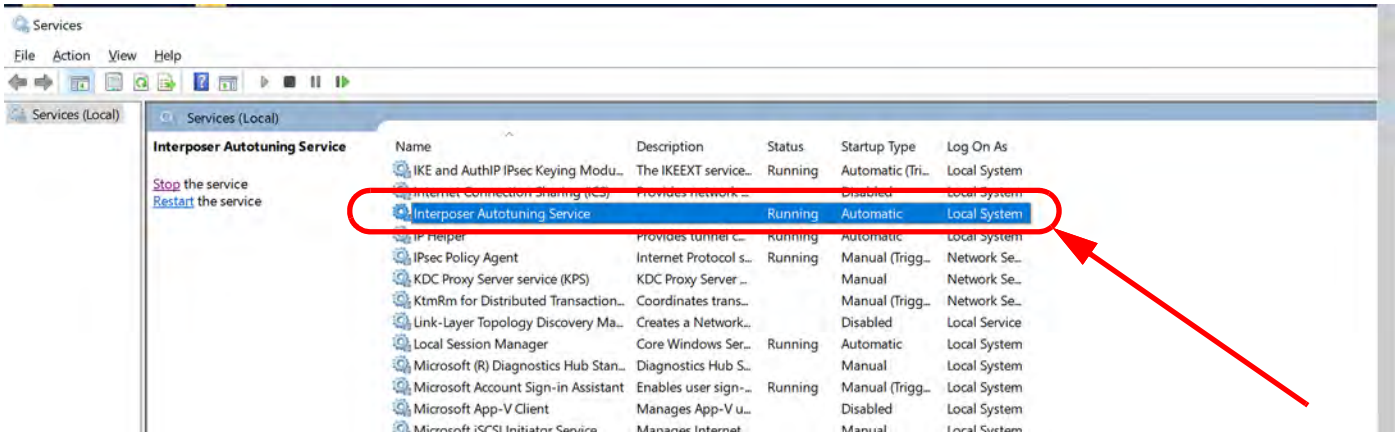


Figure 5.175: Services: Interposer Autotuning Service

After Agent startup, it immediately attempts to connect the client PC for every 5s. Such behavior may cause false positive warning of antivirus software or IDS (intrusion detection systems). It is recommended to uninstall/disable agent as soon as it is no longer needed.

User has option to stop Agent remotely from Auto-tuning dialogue. In such cases Agent stops service and tries to uninstall itself.

Start auto-tuning process:

1. From the PC where analyzer is connected, 0pen PCIe Protocol Analysis software.
2. Connect to the Analyzer.
3. Open the "Recording Options" dialog.
4. Switch to "Host-to-DUT settings" tab.

See Figure 5.176 on page 362.

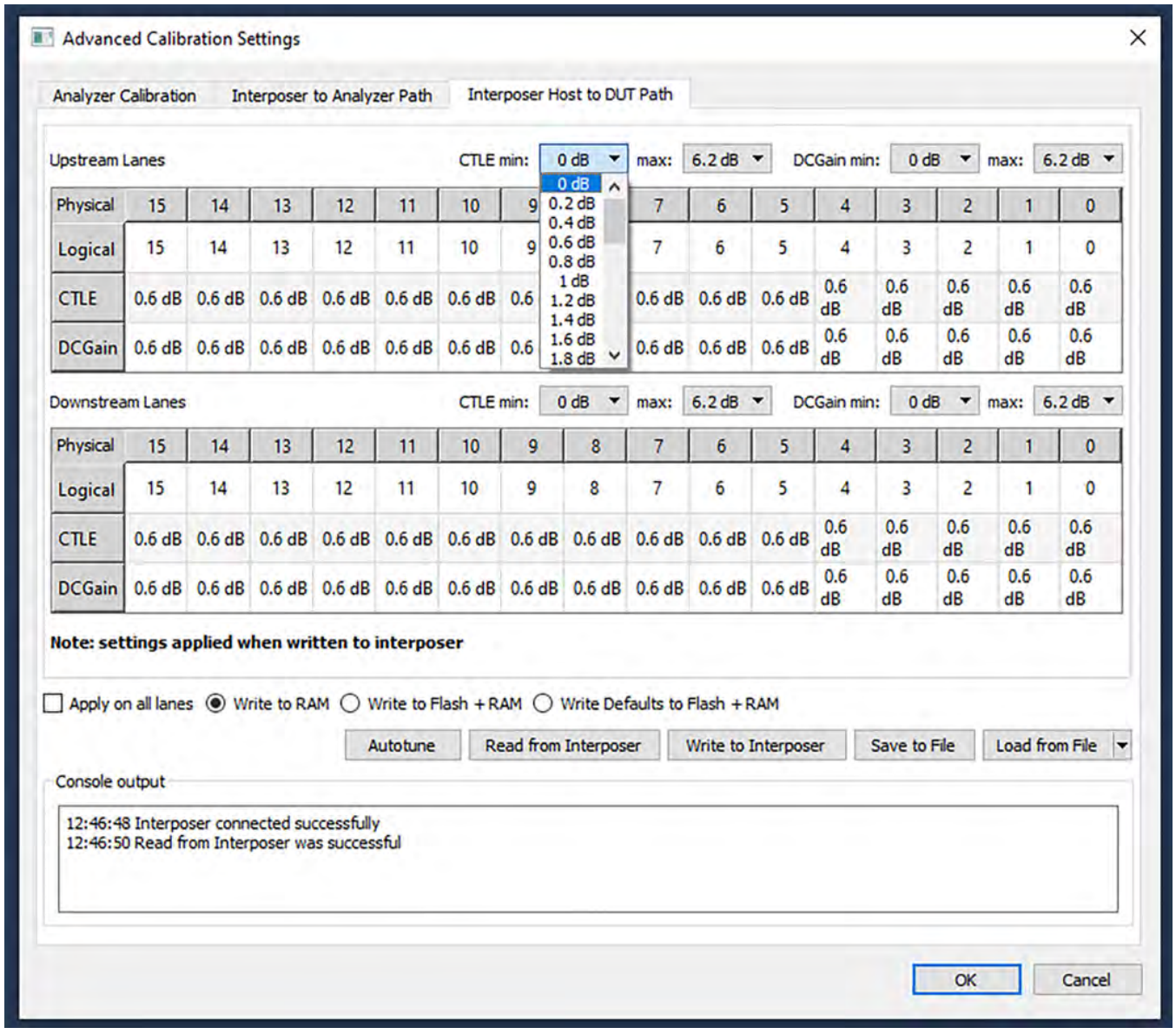


Figure 5.176: Recording Options: Interposer Host to DUT Path -> Autotune

5. Click **Autotune** (see Figure 5.176) to bring up the Autotune dialog.See Figure 5.177 on page 363.

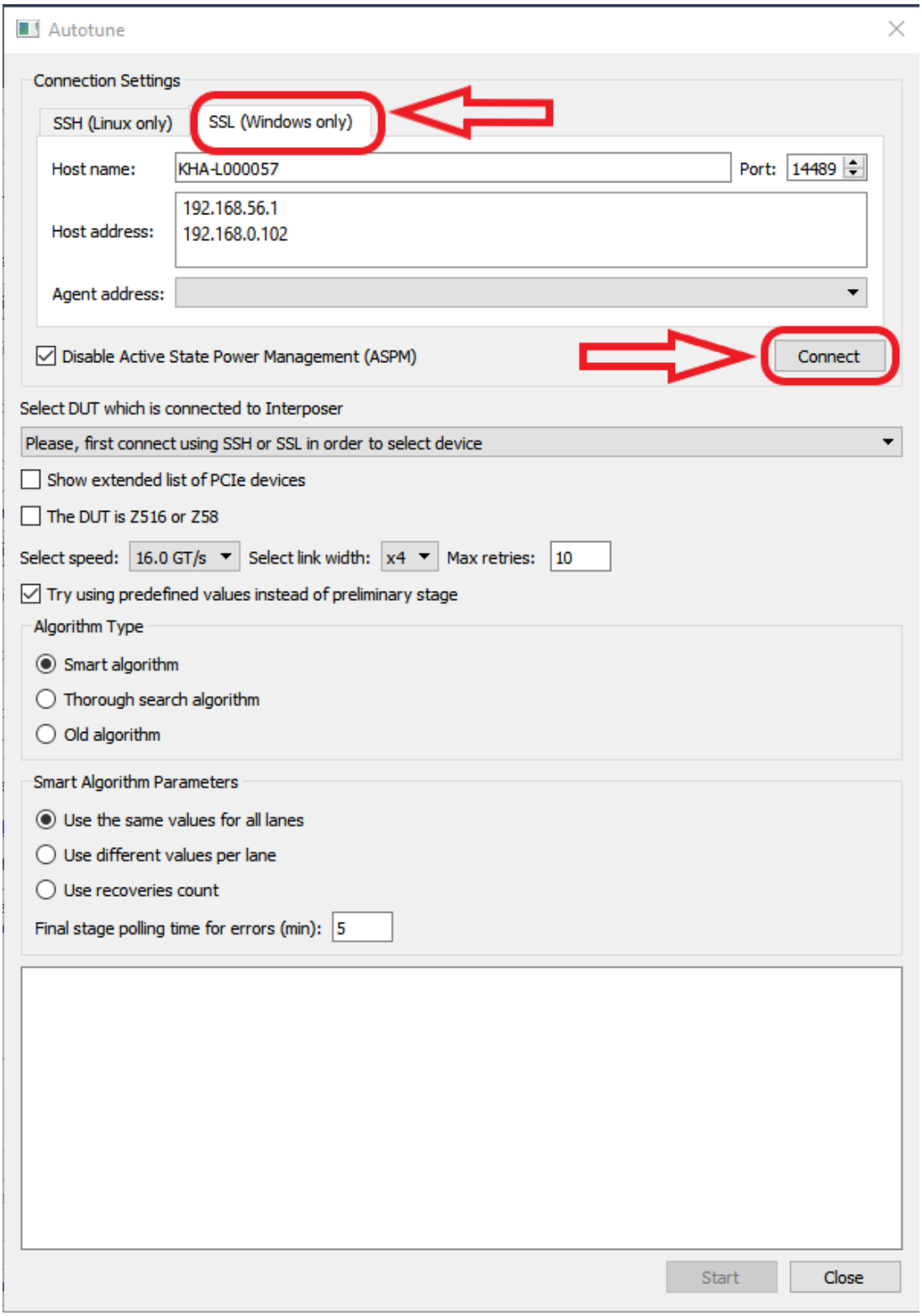


Figure 5.177: Auto-Tune Dialog

6. Select SSL (Windows only), complete the agent install process as describe above (put ref. mark here), before the next step.
7. Dialog window will open, with options to do DUT path.

8. Click "Connect" button. Connection to target host will be established (it may take several seconds) and then list of devices on host will appear. See Figure 5.178.

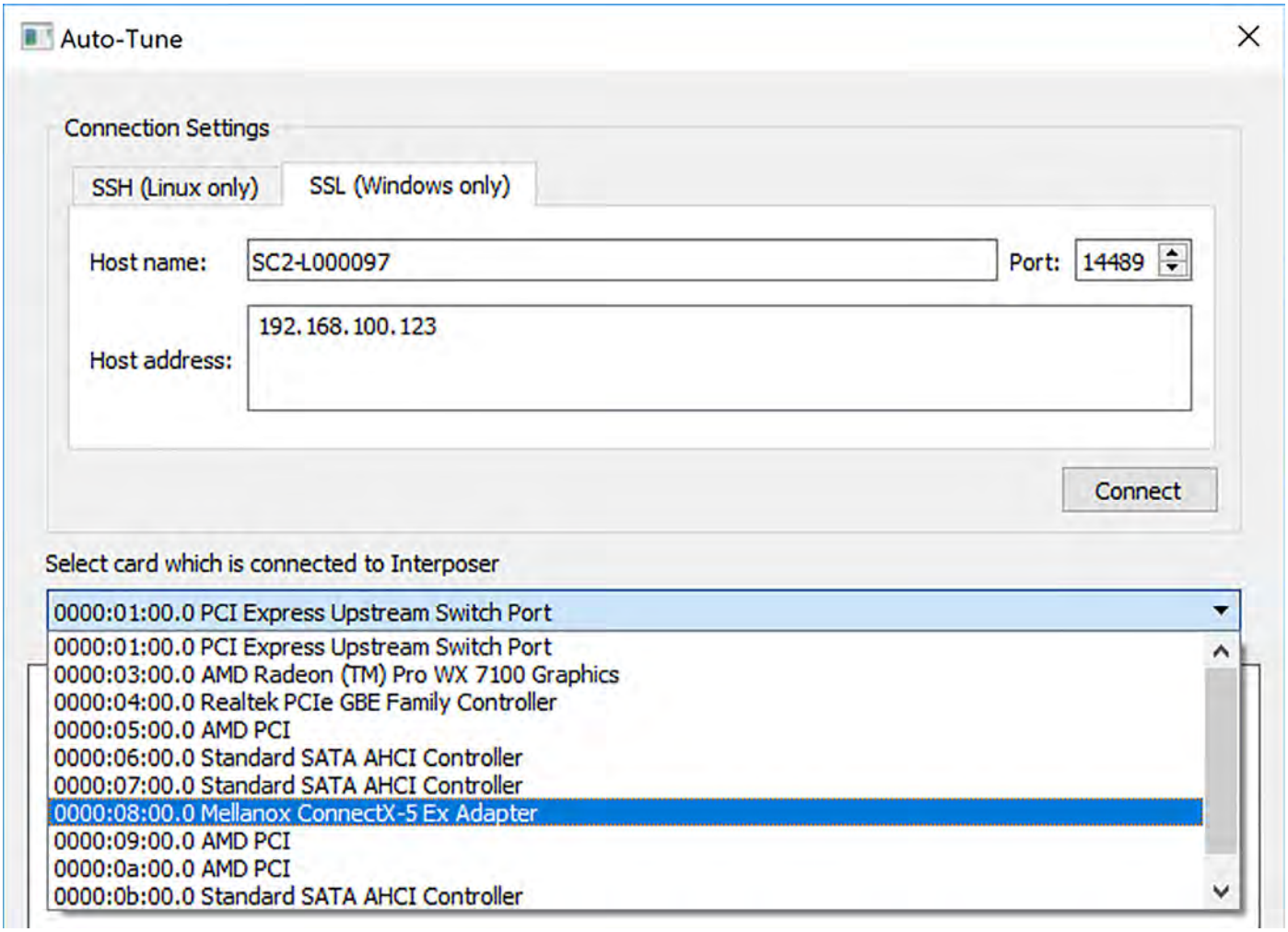


Figure 5.178: List of PCIe Devices

If the list of devices on the host does not appear and the error as shown on Figure 5.146 is reported in the log, then the InterposerAutotuningAgent should be reinstalled on the target host using the steps described in “Uninstalling InterposerAutotuningAgent” and “InterposerAutotuningAgent installation on target host” sections above.

This error may occur if the InterposerAutotuningAgent from one of the previous PCIe Protocol Analysis versions is installed on the target host.

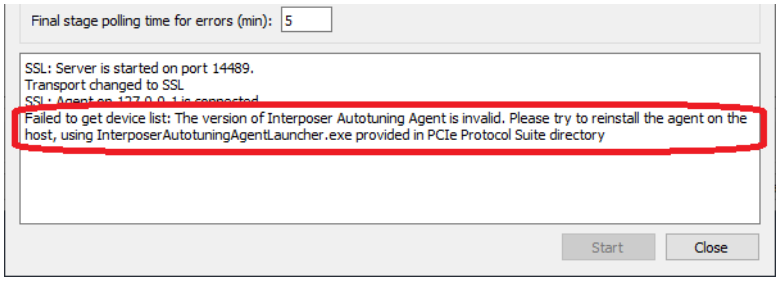


Figure 5.179: Incorrect Agent Version Error

9. Select desired link width, speed and algorithm parameters.
10. Select DUT in this list. There is no way for software to detect if selected device is a correct one or not. If wrong device was selected calibration will still start but of course will not do anything useful. In most cases it will stop after about two minutes and then user can re-run it selecting correct device this time. In this case we chose the Mellanox PCIe card to Auto-Tune.

Note: This is a critical step, please select a correct device not the bridge, otherwise the tuning will not work.

11. After clicking "OK" tuning will begin, detailed progress report will be shown in the log area. User can press the "Stop" button which will abort tuning process, but this may leave link unstable or absent in which case setting some reasonable interposer parameters and rebooting of target host may be needed.

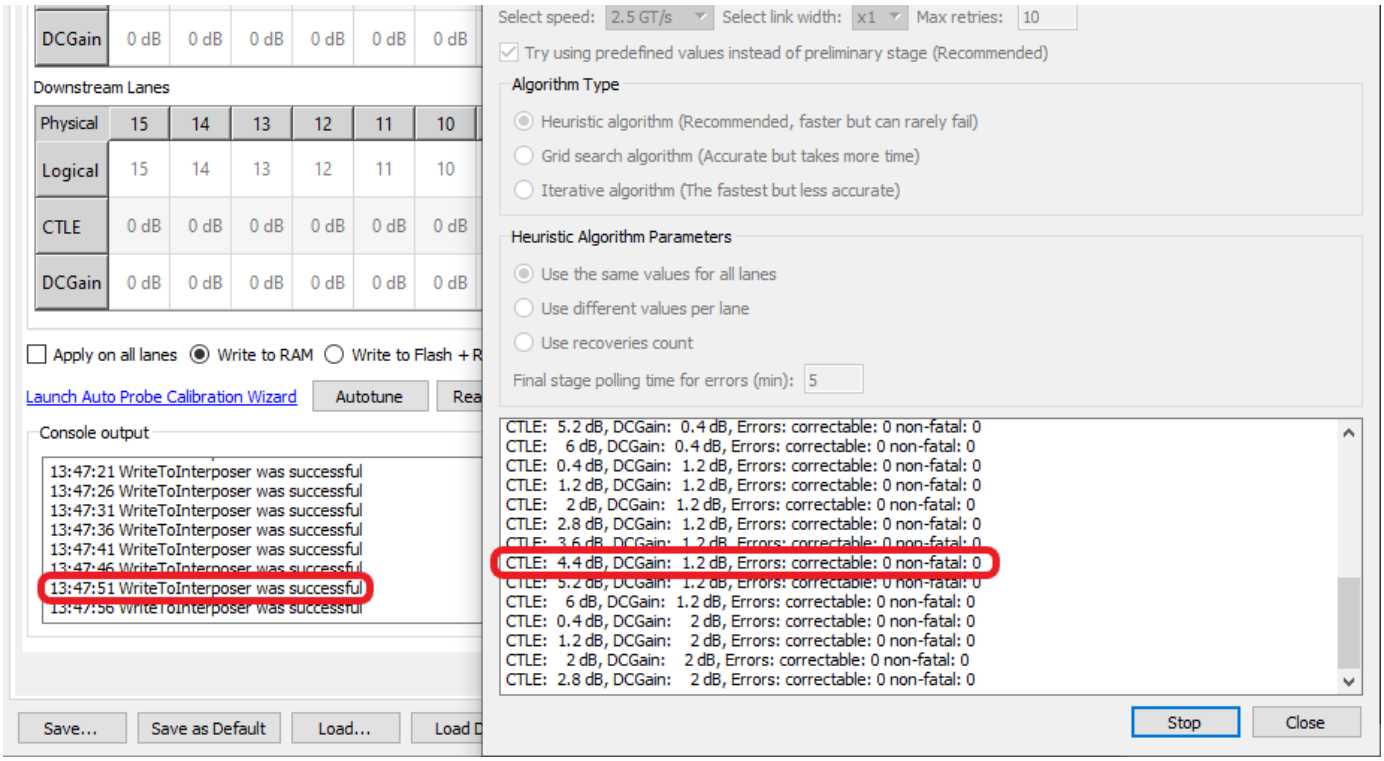


Figure 5.180: PCIe Card Selected: Auto-Tune Started

As you can see from Figure 5.180 as Auto-Tuning proceeds new CTLE and DC Gain values are written to the Interposer.

12. If any error occurs, it will be reported in dialog window as well as in the log area. It is meant as unattended process. There is no specific estimate of time it will take, but on most setups, it will be in the range from 3 to 30 minutes. On some setups it may take a lot longer (as long as several hours)
13. Depending upon the host, it is possible that the host reboot process hangs, in this case, if it cannot come back up even after 10 minutes, timeout popup will be shown with request to reboot host manually, but overall process is automatic.
14. When tuning is finished, a dialog is shown which allows users to keep newly-found settings or return to previous settings.
15. If SSL agent is used user will be prompted to stop auto-tuning agent on closing auto-tuning dialog. If agent is stopped user will need to reinstall it to do DUT path tuning again.

5.19.1.7 Host is on Linux OS:

For Linux hosts SSH connection is used, meaning network connectivity to target host and SSH credentials are required. These credentials should either directly give root privileges on host or be enough to get root access using 'sudo' command. Required tools will be transferred to target host automatically. The target host PC may be rebooted several times during calibration it should be connectible by SSH after reboots without manual intervention (i.e. SSH server should be started on boot, port should be opened in firewall and so on).

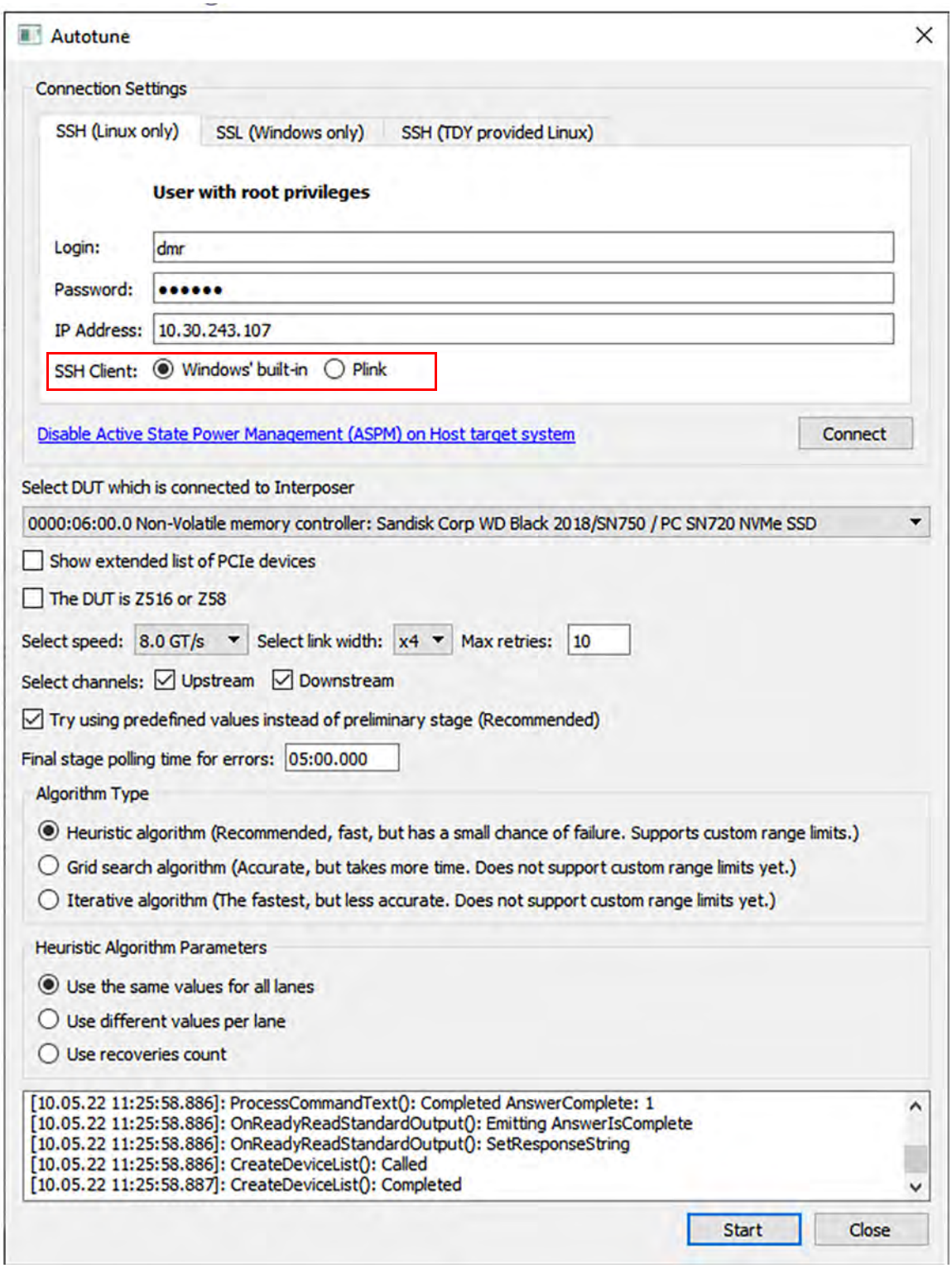


Figure 5.181: Autotuning Options

Autotuning can use one of two methods for communication with the Host:

- “Windows' built-in” - Autotuning uses an ssh.exe and scp.exe which are provided as part of the Windows installation.

- "Plink" - Autotuning uses a separate Plink utility. It is installed automatically together with PCIe Protocol Analysis software. This option may cause issues with connection to the Host if it uses ANSI escape sequences during SSH communication.

Commands to Validate the Setup:

Connecting to Linux host from Windows cmd.exe: (see Figure 5.182)

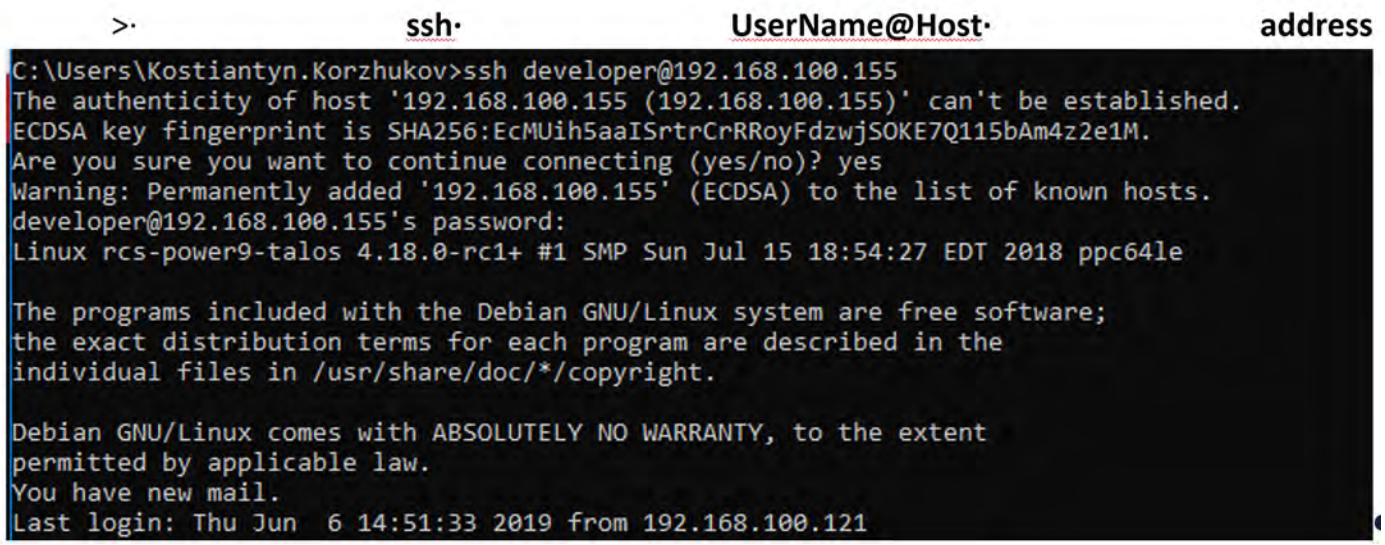


Figure 5.182: Connecting to Linux host from Windows cmd.exe

Get list all installed PCIe devices: # lspci (see Figure 5.183).

```
developer@rcs-power9-talos:~$ lspci
0000:00:00.0 PCI bridge: IBM Device 04c1
0001:00:00.0 PCI bridge: IBM Device 04c1
0001:01:00.0 SATA controller: Marvell Technology Group Ltd. 88SE9235 PCIe 2.0 x2 4-port SATA 6 Gb/s Controller (rev 11)
0002:00:00.0 PCI bridge: IBM Device 04c1
0003:00:00.0 PCI bridge: IBM Device 04c1
0003:01:00.0 USB controller: Texas Instruments TUSB73x0 SuperSpeed USB 3.0 xHCI Host Controller (rev 02)
0004:00:00.0 PCI bridge: IBM Device 04c1
0004:01:00.0 Ethernet controller: Broadcom Limited NetXtreme BCM5719 Gigabit Ethernet PCIe (rev 01)
0004:01:00.1 Ethernet controller: Broadcom Limited NetXtreme BCM5719 Gigabit Ethernet PCIe (rev 01)
0005:00:00.0 PCI bridge: IBM Device 04c1
0005:01:00.0 PCI bridge: ASPEED Technology, Inc. AST1150 PCI-to-PCI Bridge (rev 04)
0005:02:00.0 Multimedia video controller: ASPEED Technology, Inc. ASPEED Graphics Family (rev 41)
0030:00:00.0 PCI bridge: IBM Device 04c1
0030:01:00.0 VGA compatible controller: Advanced Micro Devices, Inc. [AMD/ATI] Ellesmere [Radeon Pro WX 7100]
0030:01:00.1 Audio device: Advanced Micro Devices, Inc. [AMD/ATI] Ellesmere [Radeon RX 580]
0031:00:00.0 PCI bridge: IBM Device 04c1
0031:01:00.0 Non-Volatile memory controller: Samsung Electronics Co Ltd NVMe SSD Controller SM961/PM961
0032:00:00.0 PCI bridge: IBM Device 04c1
0033:00:00.0 PCI bridge: IBM Device 04c1
```

Figure 5.183: Get List of all Installed PCIe Devices

Note: The device under test (DUT) should be present in this list, otherwise the auto-tuning will not work.

Reboot target host from command line

In some cases installed PCI hardware doesn't detect correctly, usually reboot attempts will help.

sudo reboot (see Figure 5.184).

```
developer@rcs-power9-talos:~$ sudo reboot
[sudo] password for developer:
Connection to 192.168.100.155 closed by remote host.
Connection to 192.168.100.155 closed.
```

Figure 5.184: Reboot Command

Start auto-tuning process

1. From the PC where analyzer is connected, open the Teledyne Lecroy PCIe Protocol Analysis software.
2. Connect to the Analyzer.
3. Open the “Recording Options” window.
4. Select the “Analyzer and Probe Settings” tab.
5. Click the “Launch Advanced Calibration Settings Dialog” text, located at the bottom.
6. The Advanced Calibration Settings dialog displays. Select the “Interposer Host to DUT Path” tab (see Figure 5.185)

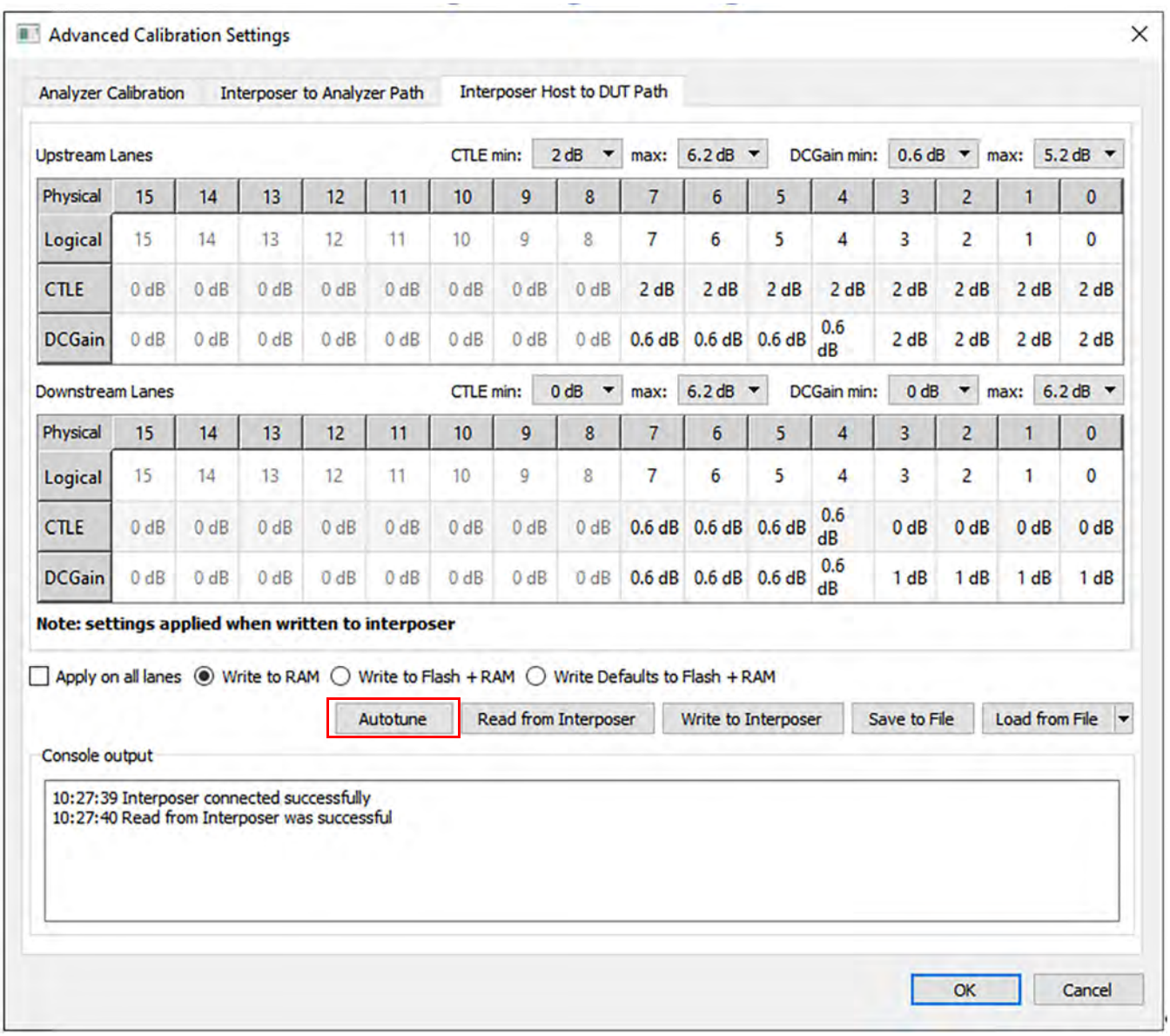


Figure 5.185: Host to DUT Settings

7. Click the **Autotune** button. The Autotune dialog box for the Host to DUT Settings appears, with options to do the DUT path (see Figure 5.185 on page 370).

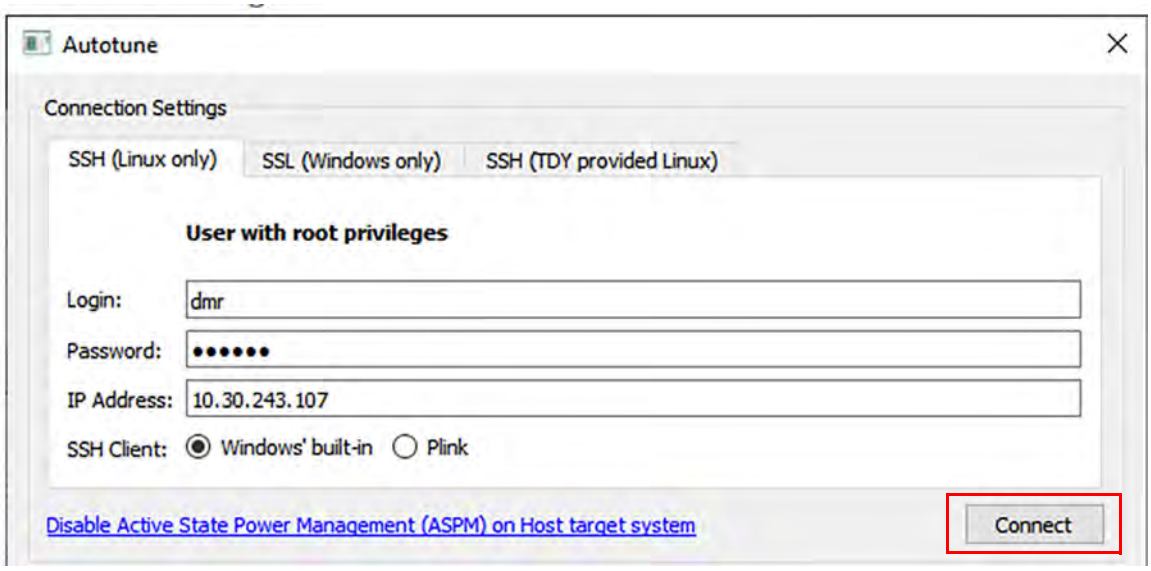


Figure 5.186: Options for Tuning the DUT Path

8. Enter target host settings:
   - ❑ Select what kind of connection to remote host should be used from settings configured in the upper section:
   - ❑ To auto-tune device connected to Linux host: Enter user, password and IP address of the target host and click **Connect**. (see Figure 5.186).
9. The connection to target host will be established (it may take several seconds), then list of devices on host will appear. Select the DUT from this list. There is no way for the software to detect if the selected device is the correct one. If the wrong device was selected, calibration will still start but will not do anything useful. In most cases, it will stop after about two minutes. Then, re-run it selecting the correct device
10. Select desired link width, speed and algorithm parameters.
11. Click OK to begin the calibration.
    - ■ A detailed progress report will be shown in the log area.
    - ■ You can press the **Stop** button to abort the tuning, but this may leave the link unstable or absent. In this case, setting some reasonable interposer parameters and rebooting of target host may be needed.
12. If any error occurs, it will be reported in dialog window and duplicated in log area. It is meant as unattended process. There are no specific estimates time it takes to complete, but on most setups, it will be in the range from 3 to 30 minutes. On some setups it may take a lot longer (as long as several hours).
13. Under some conditions target host may reboot one or several times. As a last-resort option if it cannot come back up after 10 minutes timeout popup will be shown with request to reboot host manually, but overall process is automatic.
14. When calibration is finished dialog window will be shown which allows users to keep newly-found settings or return to previous settings.
15. If SSL agent is used user will be prompted to stop auto-tuning agent on closing auto-tuning dialog. IF agent is stopped user will need to reinstall it to do DUT path calibration again.

16. Perform Analyzer path calibration:
    a. Go to TAP4Settings -> Interposer Analyzer Path
    b. Press button "Calibrate"
16. After clicking "OK" calibration will begin, detailed progress report will be shown in the log area. User can press the "Stop" button which will abort tuning, but this may leave link unstable or absent.

Auto-tuning cannot break host/DUT link. If error rate is high enough, small estimate is used which goes in 1dB intervals through CTLE/DC Gain, and search for a point with minimal error rate. This is done independently for upstream and downstream. Then final stage walks around this point finding per-lane error-free combination of CTLE/DC Gain. If zero error rate was achieved this stage will be repeated with increased error measurement interval, up to 60 seconds.

5.19.1.8 Write to Interposer

Press this button to write equalization settings to the interposer.

The result of this operation depends on selected radio button above

Note: While writing is in progress, the Application title bar may show “Not Responding”. This is normal and will go away after writing is complete.

5.19.1.9 Write to RAM

If “Write to RAM” radio button is selected then equalization settings will be written to interposer but would not remain on the interposer after power-cycling it.

5.19.1.10 Write to Flash + RAM

If “Write to Flash + RAM” radio button is selected then settings will be written and saved into Flash Memory on the interposer. These setting would remain on the interposer even after power-cycling it.

5.19.1.11 Write Default to Flash + RAM

If “Write Default to Flash + RAM” radio button is selected then write will restore the interposer to its default settings

Note: Writing to Flash takes several minutes to complete. While writing is in progress, the Application title bar may show “Not Responding”. This is normal and will go away after writing is complete.

5.19.1.12 Read from Interposer

Press this button to read the equalization settings from the interposer.

Note: While reading is in progress, the Application title bar may show “Not Responding”. This is normal and will go away after reading is complete.

5.19.1.13 Set All Lanes

Check this box and change the values in Lane 0 to change all the values in the corresponding column.

5.19.1.14 Log

This log would also be saved in the same location as the “.exe” file. The log should provide some preliminary information about connection and display values read /written.

5.19.1.15 Save to File

You can save your settings to a file.

5.19.1.16 Load from File or Predefined Values

You can load predefined CTLE and DC Gain values from a file or load CTLE and DC Gain values from a set of Predefined values for a specific configuration of hardware. See Figure 5.187

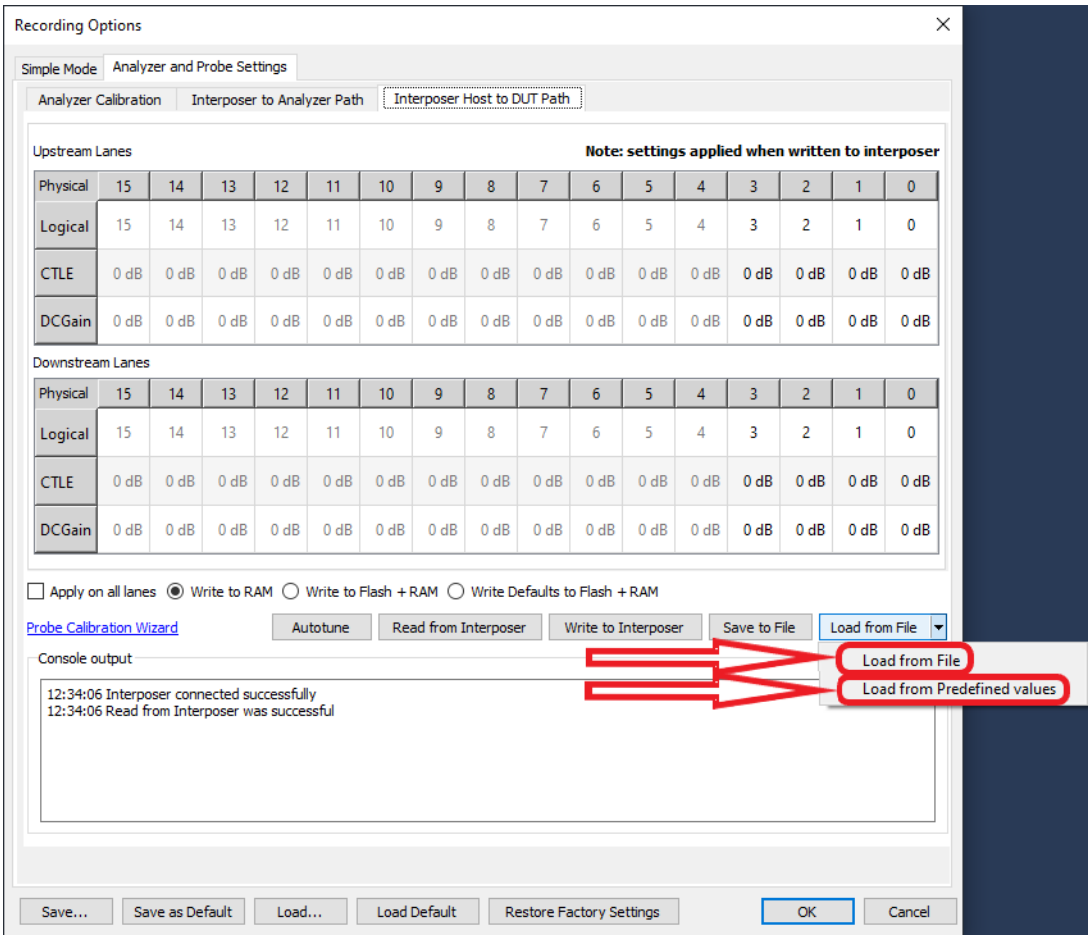


Figure 5.187: Load from File

You can chose from either:

- Load from File: Opens a dialog box to choose a file from where the application was loaded (see Figure 5.188 on page 375)
- Load from Predefined values: Opens a dialog box with a specific configuration of hardware (see Figure 5.189 on page 375)

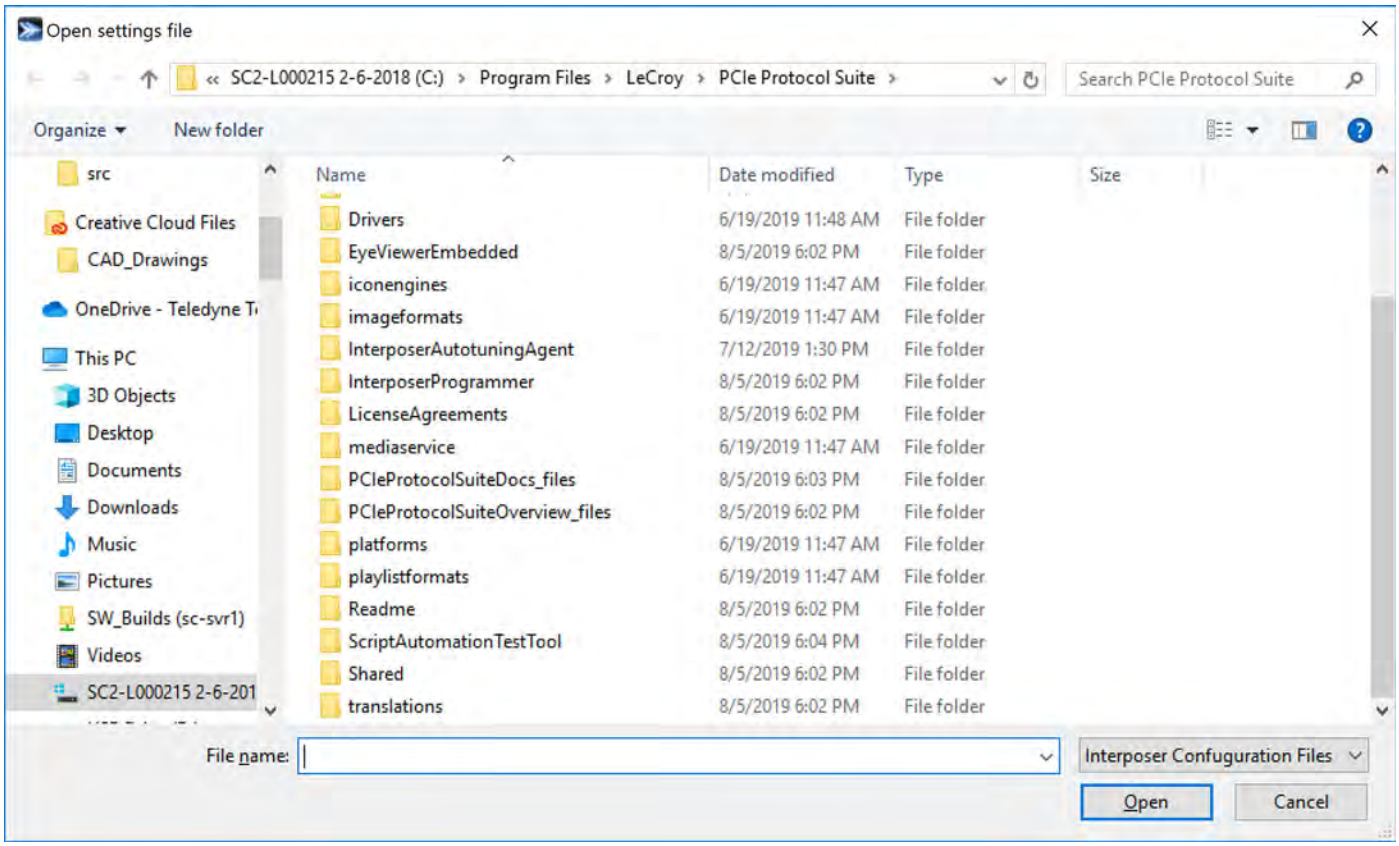


Figure 5.188: Load from File

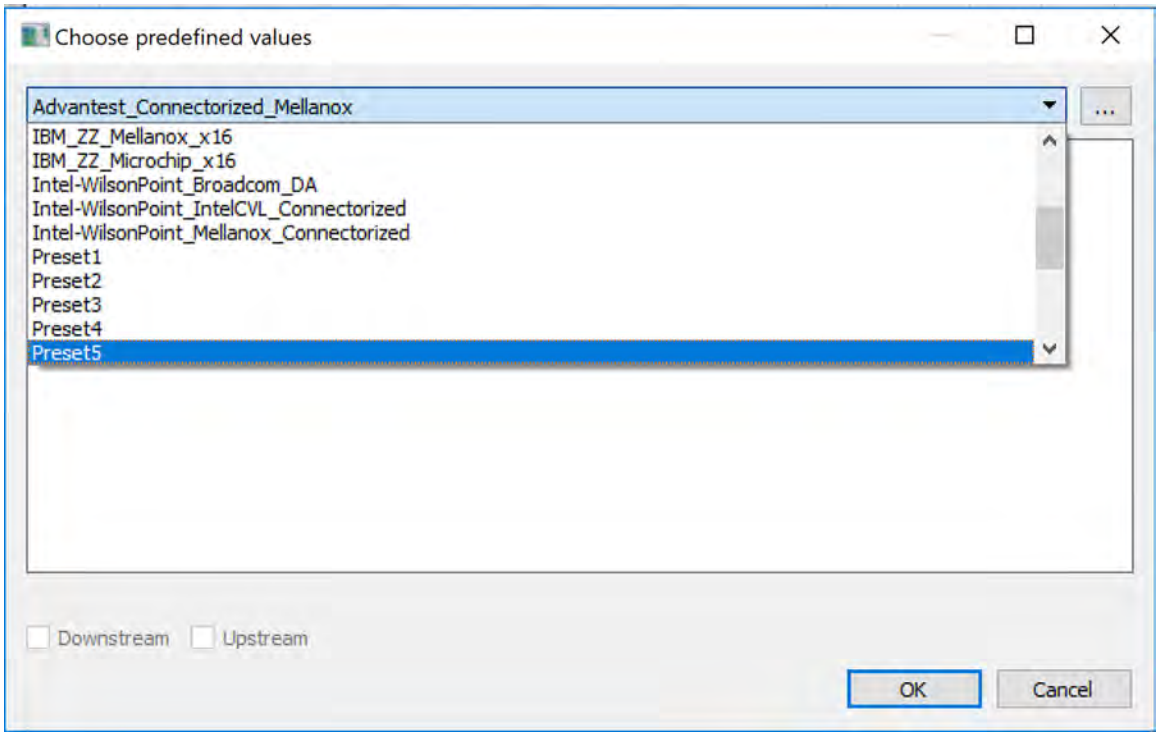


Figure 5.189: Load from Predefined values: Specific configurations or 1 of 9 Presets

5.19.2 Interposer to Analyzer Path

At this stage all the interposer related tuning is complete, now user can calibrate the "Front-End" of the analyzer by automatically finding the best presets for "Equalizer Settings" (see Figure 5.190).

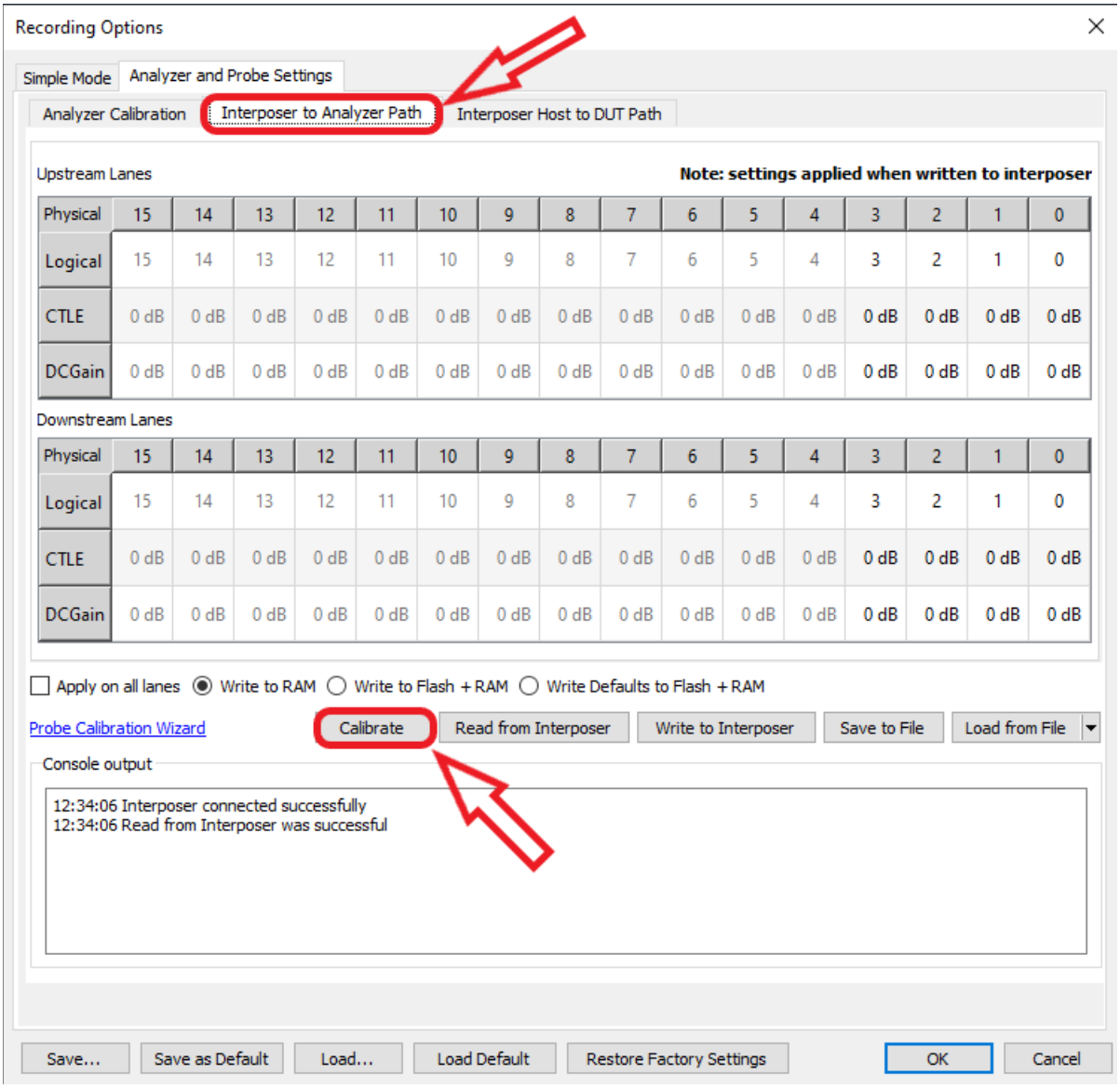


Figure 5.190: Interposer to Analyzer Path

5.19.2.1 Calibration Dialog: Algorithms

The dialog for calibration of Interposer to Analyzer Path allows selecting one of several algorithms. The selected algorithm determines the steps that will be performed during the process to find optimal CTLE and DCGain settings.

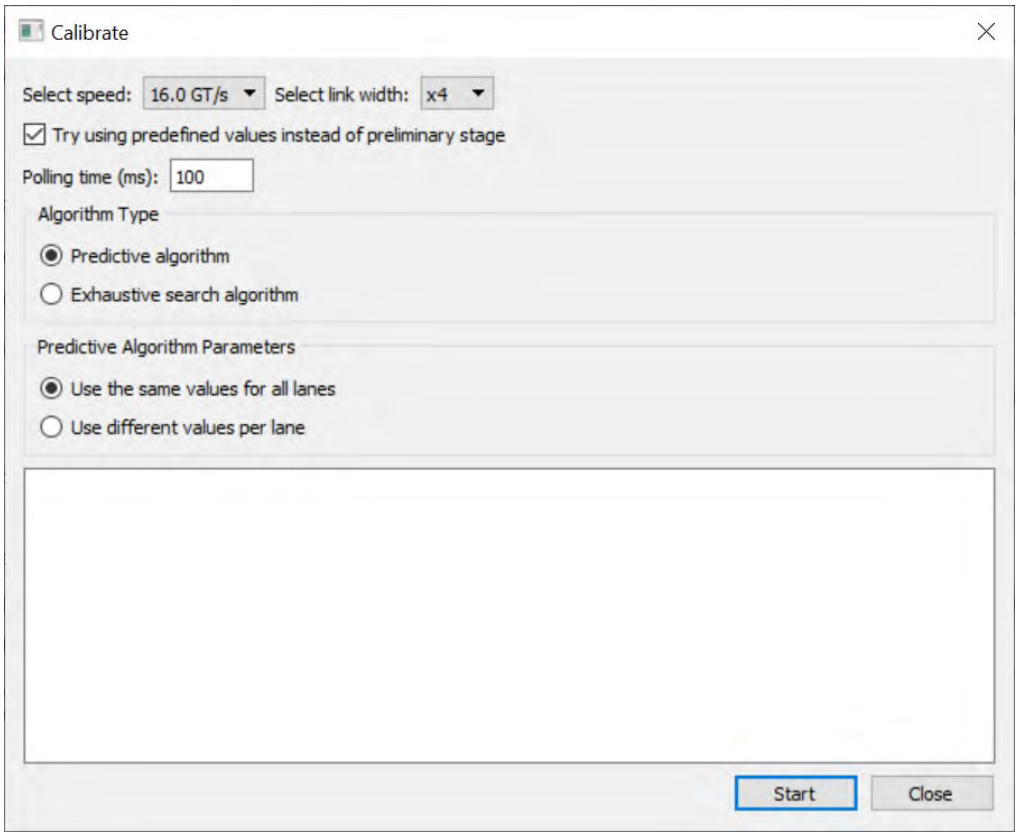


Figure 5.191: Interposer to Analyzer Path Calibration dialog

Below is a list of the available algorithms for calibration with descriptions:

Predictive algorithm

This option is similar to Heuristic algorithm for auto-tuning. It also uses the same heuristic search method and performs the calibration in several stages. Please see the algorithm details in the “Auto-tuning algorithms” on page 351 section.

The maximal error polling time is shorter for calibration and only four stages are performed: first 500 milliseconds and then 2, 5, 10 seconds stages. Final stage polling time can be configured in milliseconds in appropriate option.

Exhaustive search algorithm

The calibration routine checks all possible combinations of CTLE and DCGain settings (the same value is used for all lanes).

There are two stages:

1. On the first stage errors are measured for combinations of each CTLE value and DCGain values with step 1dB.
2. On the second stage errors are measured for combinations of each CTLE value and each DCGain value.

Firstly, all values are checked with polling time 1 ms and then some best values are retested with selected polling time.

If the settings are found with which error rate is zero for each lane on both channels, then the calibration finishes without checking all combinations.

5.19.3 Analyzer Calibration

The Summit T416 and Summit T48 can be calibrated to work with specific links. The T.A.P.4 is a proprietary Teledyne LeCroy technology that allows DUT signaling to be optimized for the purposes of recording a clean trace. The T.A.P.4 tab allows for this optimization to be performed on each lane of the link by modifying different settings such as CTLE, DC Gain and Signal Detection threshold.

Select **Recording Options > Analyzer and Probe Settings -> Analyzer Calibration** from the **Setup** menu to display the available modes that can be used for Analyzer Calibration:

- Auto (See Figure 5.192): Calibrating at 16.0 GT/s: CTLE and DC Gain are selected
- Manual
- Eye Scanner View

5.19.3.1 Analyzer Calibration: Auto Option

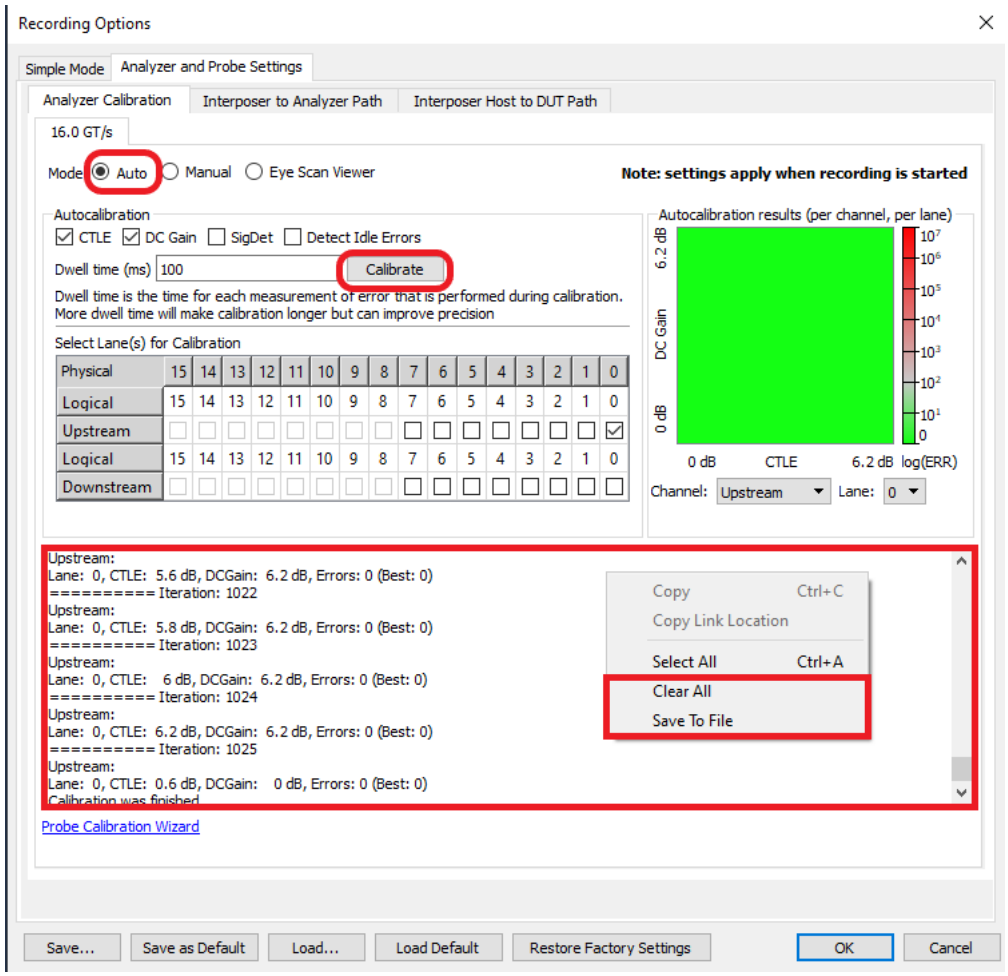


Figure 5.192: T416 or T48: Analyzer Calibration Auto Mode

Note: For the Summit T48 only 8 lanes are available.

There is a log area where all checked values with current and best number of errors are listed during calibration process. On right mouse button click context menu is opened where log can be cleared or saved to .txt file.

The Calibration is done in this sequence:

1. Correctly set the lane polarity manually, auto lane polarity is not supported.
2. Calibration requires a fixed speed, so, if the speed selection is “Auto”, then user is required to select the speed at the time of starting the calibration.
3. In “Auto-calibration” area check lanes that need calibration. Usually all lanes will need calibration. All lanes in some direction (upstream or downstream) can be checked by clicking on accordingly named button in front of row of lane checkboxes.

4. Select some of checkboxes for CTLE, DC Gain and SigDet. It is recommended to check both CTLE and DC Gain to produce better results, but it will increase time needed for calibration because more values will be checked.

Note: SigDet option is not available for all devices and this option may absent

5. Decide if analysis of packets should be used to check their correctness instead of simpler checks. If so check “Detect Idle errors” checkbox. Usually is recommended to check it.
6. Select interval during which errors will be counted on each calibration step. Longer interval will give more precise results, but calibration time will be increased linearly. Usually default value (100 ms) is good enough for quick check and to estimate how long calibration will take, but longer intervals would be preferable.

Note: Firstly all values will be tested with interval equal to 1 ms and then best found values will be re-checked with selected time.

7. Press “Calibrate” button. Calibration process will start with progress bar shown.
8. After calibration finish per-lane error data are presented, separately for upstream and downstream.
9. Calibration results can be saved by clicking “OK”.

5.19.3.2 Analyzer Calibration: Manual Option

In **Recording Options > Analyzer and Probe Settings -> Analyzer Calibration -> Manual Mode** each lane selected has the following options to achieve the best signal for detection and recording:

- CTLE (Continuous Time Linear Equalization): 0 to 6.2 dB in 0.2 dB steps
- DC Gain: 0 to 6.2 dB in 0.2 dB steps
- SigDetect (Signal detection threshold): 30 mV to 410 mV in 7 steps

The default is for SigDet 60 mV but you can vary the threshold from 30 mV to 410 mV depending on the amplitude of the signals being generated and correctly detected in your system. You can also set the CTLE value and the DC Gain in conjunction with the threshold SigDet level to get a high quality signal for recording and analysis. See Figure 5.193 on page 382.

- Measure: You can also set the Measure value to be 16.0 GT/s or 8.0 GT/s.

Note: When using the MidBus Probe, SigDet is recommended to be set at 40 mV for each lane.

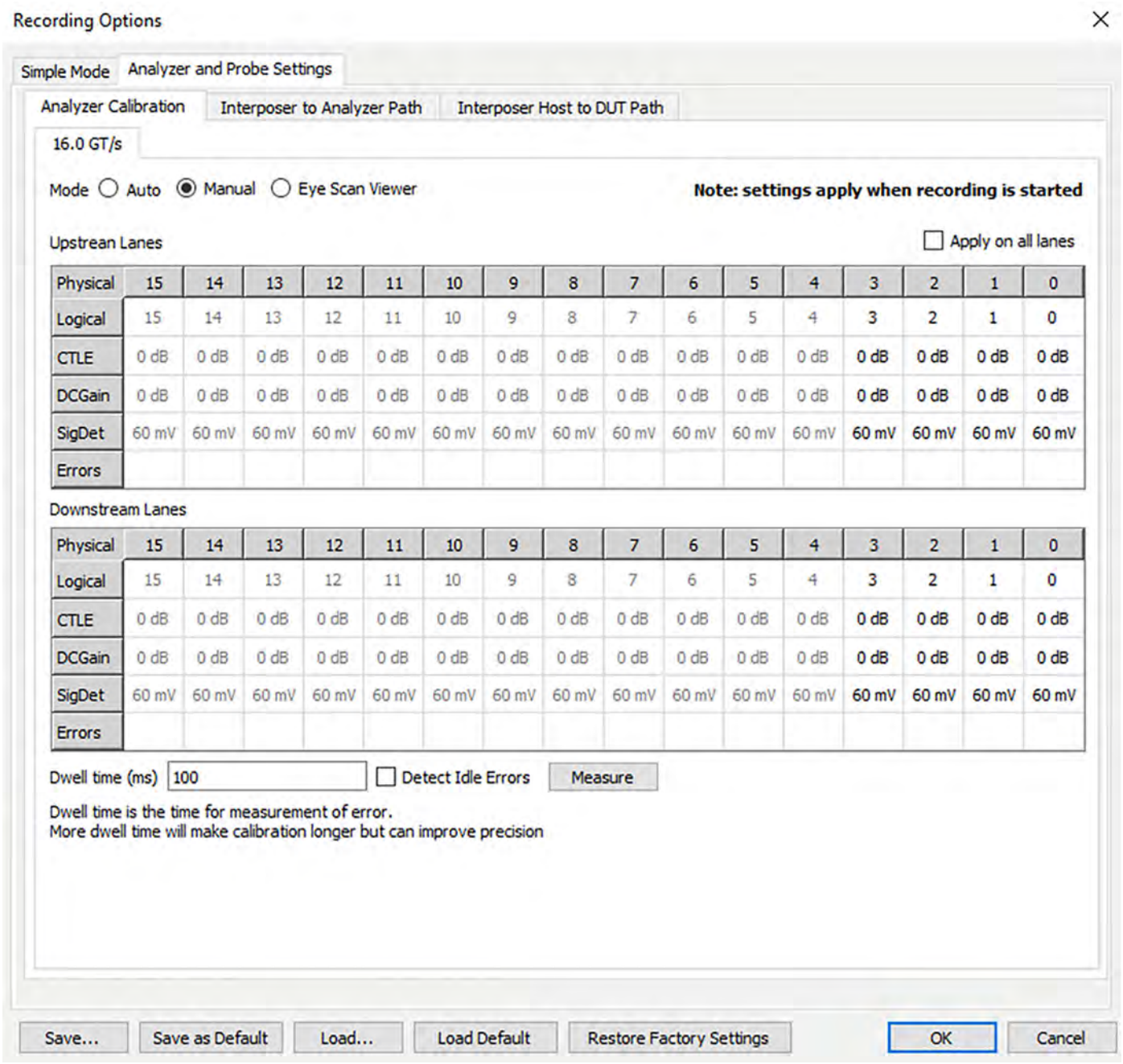


Figure 5.193: T416 or T48: Analyzer Calibration Manual Mode

5.19.3.3 Analyzer Calibration: Eye Scanner Option

In **Recording Options > Analyzer and Probe Settings -> Analyzer Calibration -> Eye Scanner View** you can take measurements of the “Eye” of the signal. See Figure 5.194.

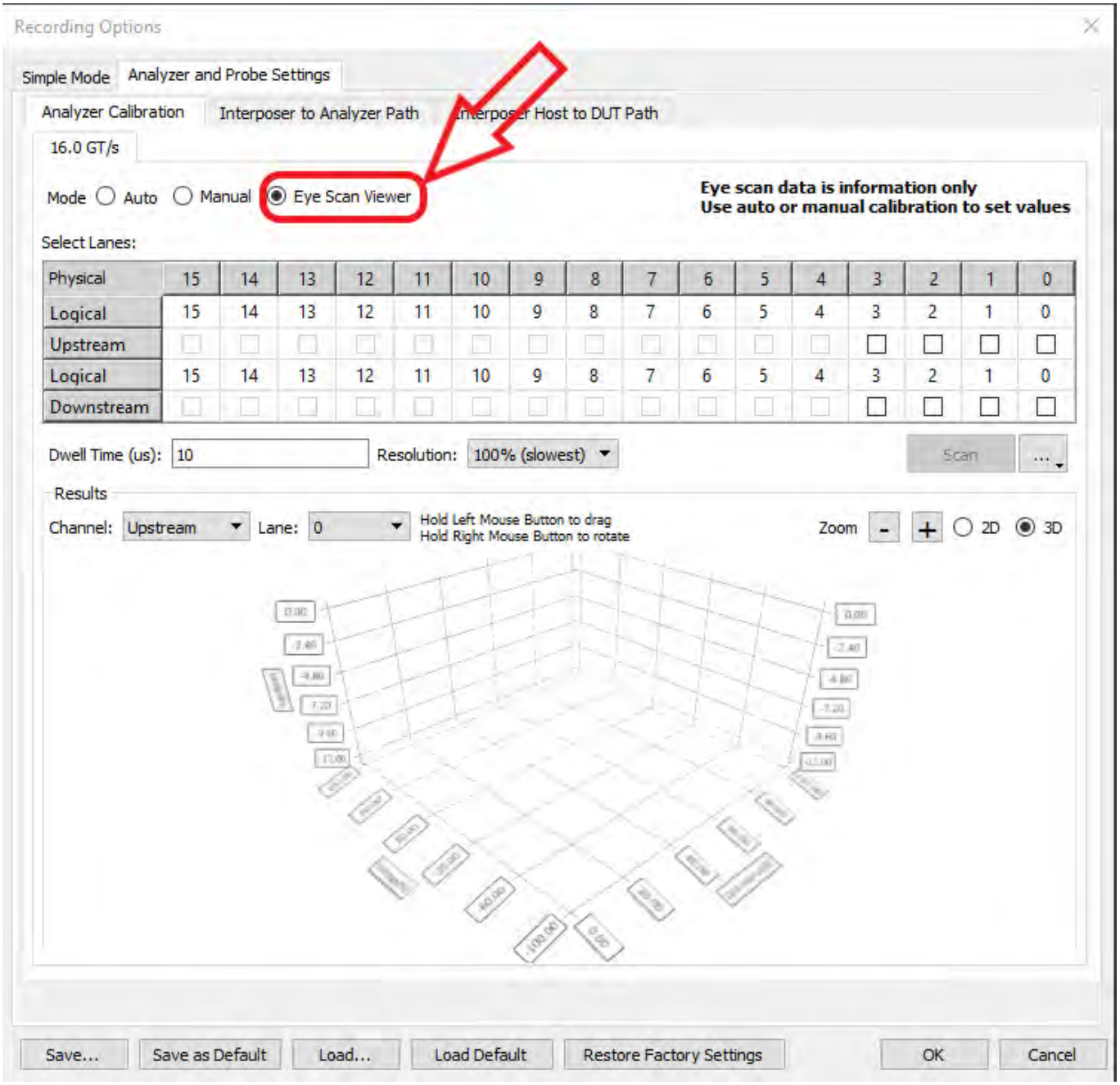


Figure 5.194: T416 or T48: Analyzer Calibration -> Eye Scanner View

Eye Scanner

Eye Scanner allows you to generate a diagram of the relative signal quality of received signals at the receiver of the analyzer being used.

Using the Eye Scanner Feature

To use the Eye Scanner feature the user's host system must be connected to an analyzer in the "ready" state and the link under test must be operational, but does not have to be generating data traffic.

Select **Recording Options > Analyzer and Probe Settings -> Eye Scanner** from the **Recording Options** menu (see Figure 5.1 on page 187 for the T416 or Figure 5.2 on page 188 for the T48) to display Eye Scanner Settings (see Figure 5.195 on page 385).

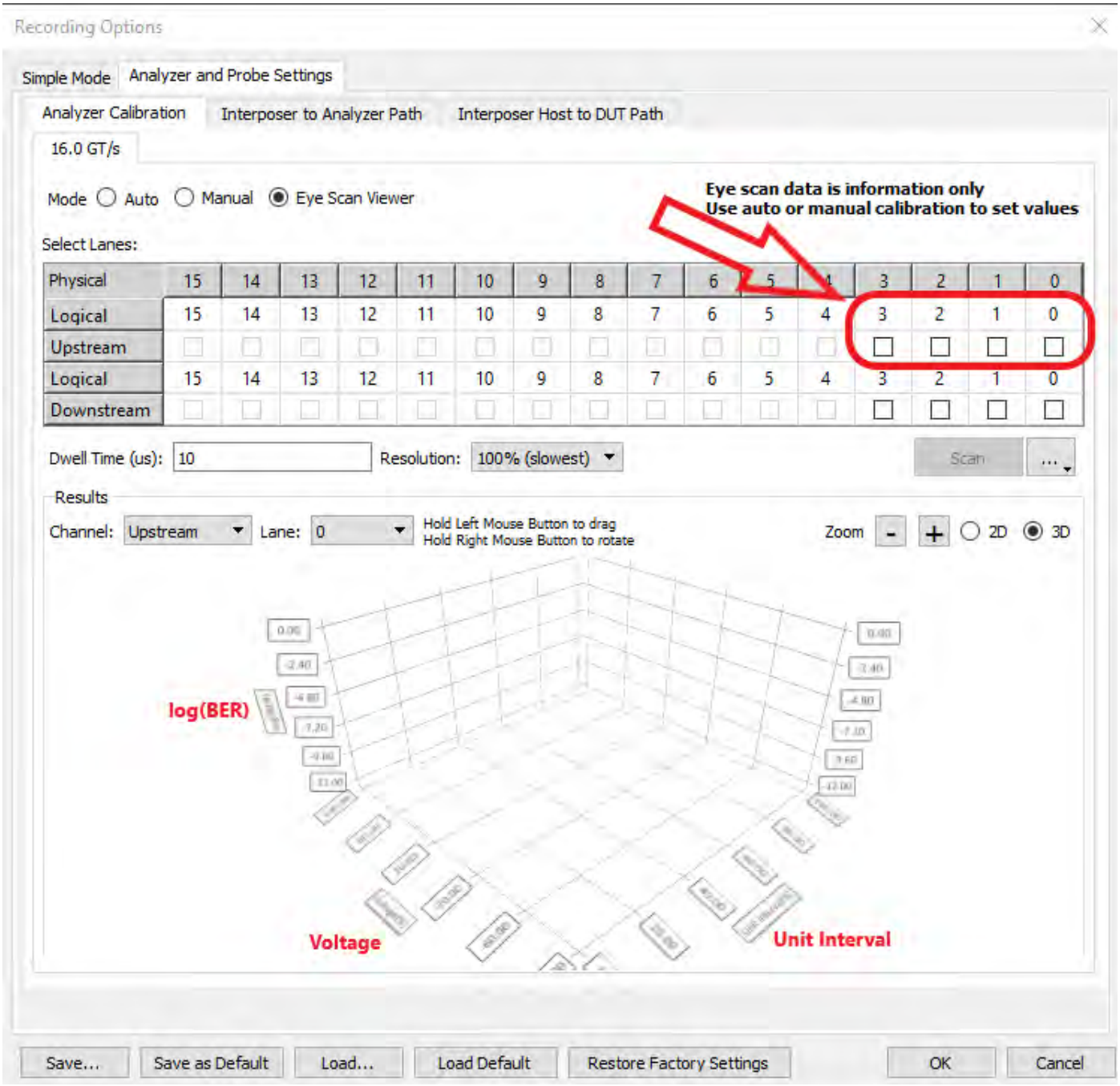


Figure 5.195: Eye Scanner Settings

Set up the options you want:

- Channels: Number of active lanes
- Dwell Time: Time spent at each data point
- Resolution: 100%, 50%, 25%, 12% (slowest to fastest)
- Dimensions: 2D or 3D

For our example we used a Summit T48 with a single channel operating, 10 usec dwell time, 100% Resolution (slowest) and 3D capture.

Click on the Scan button and the analyzer starts the process. See Figure 5.196.

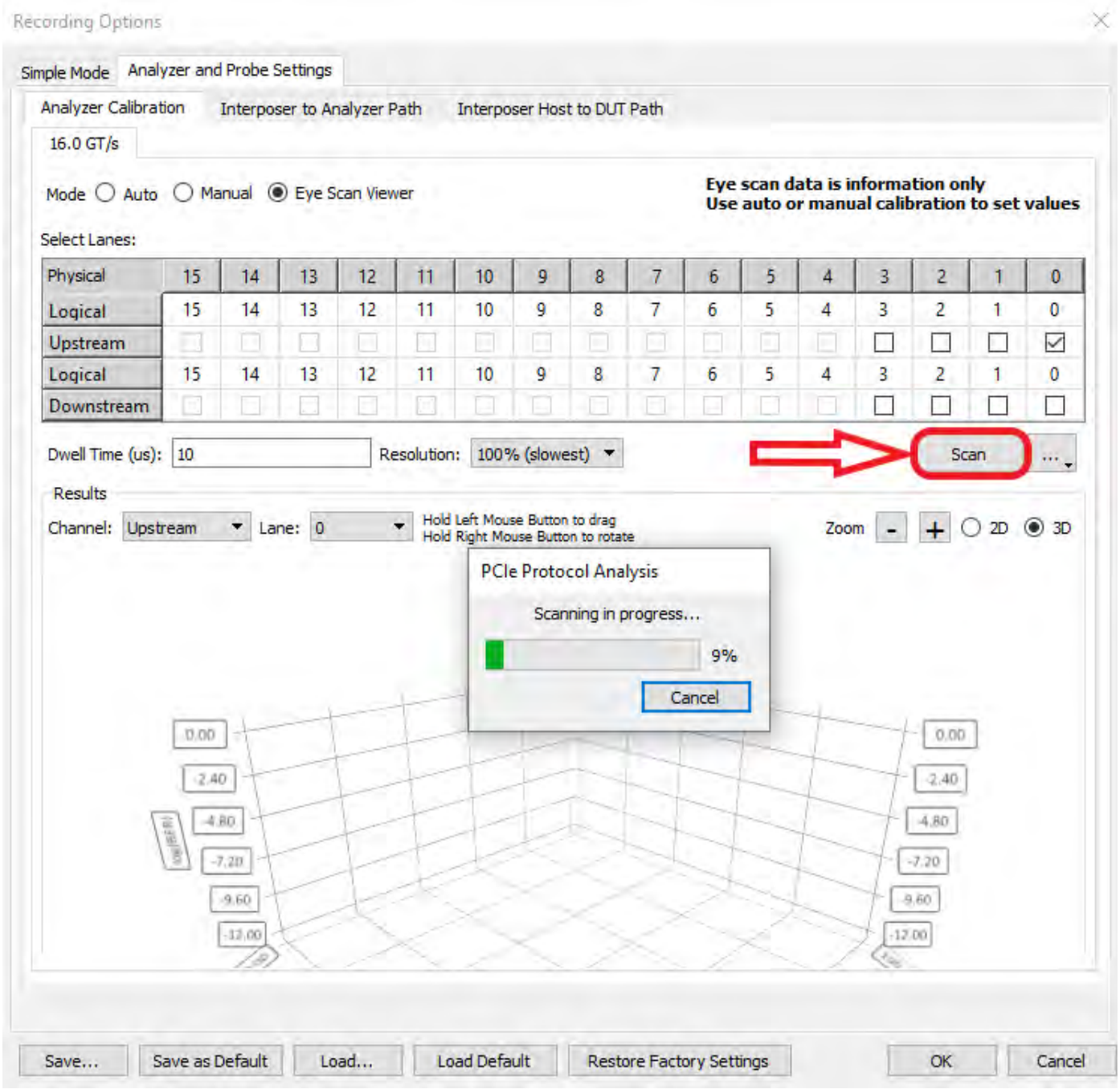


Figure 5.196: Eye Scanner in Process

The results can be seen in Figure 5.197 on page 387.

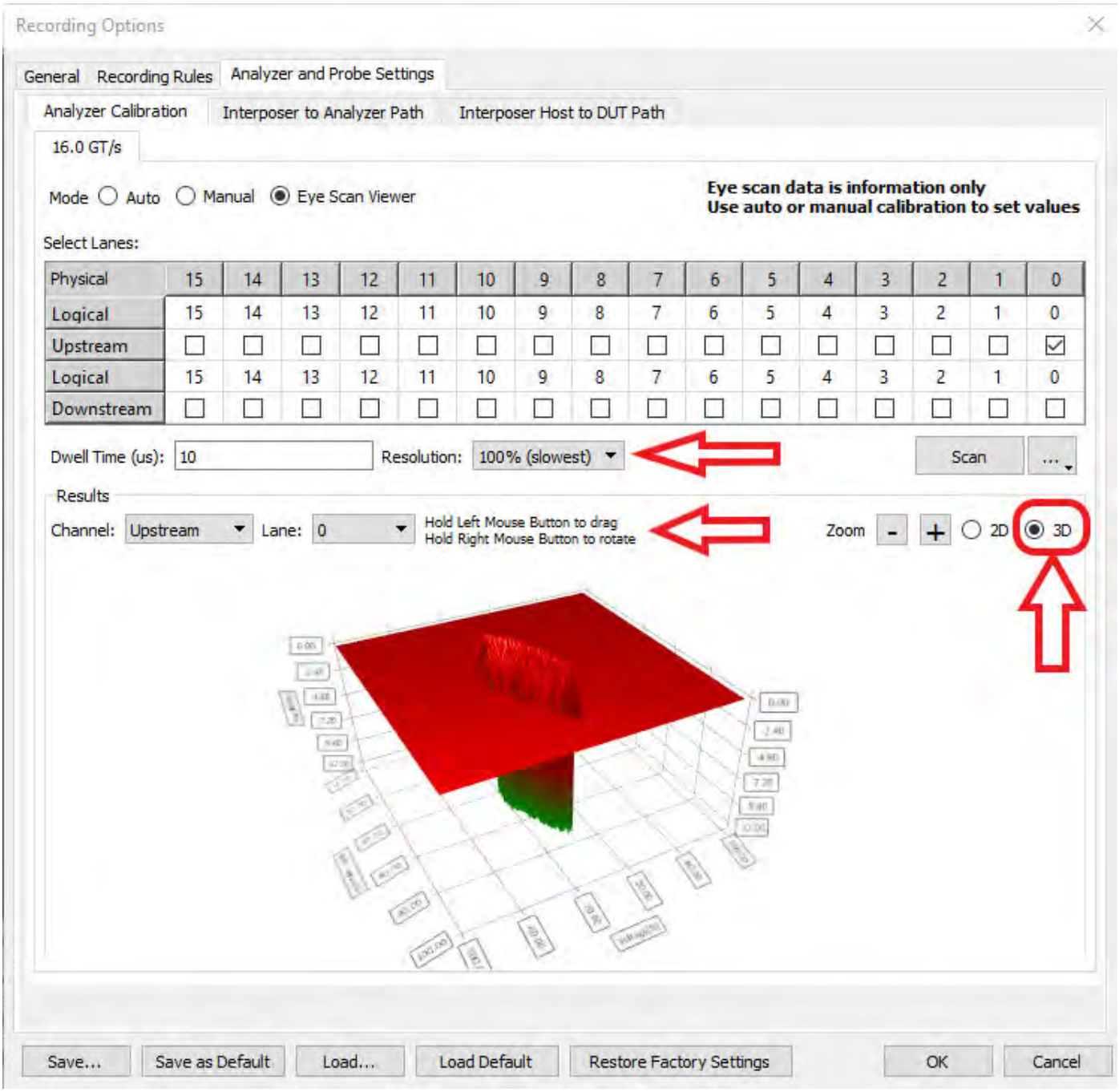


Figure 5.197: Results of Eye Scanner

You manipulate the resulting diagram in the following ways:

- Zoom In/Out
- Rotate the diagram
- Move the diagram

If you want a two dimensional view of the “eye”, select 2D and you’ll get a 2 dimensional representation. See Figure 5.198.

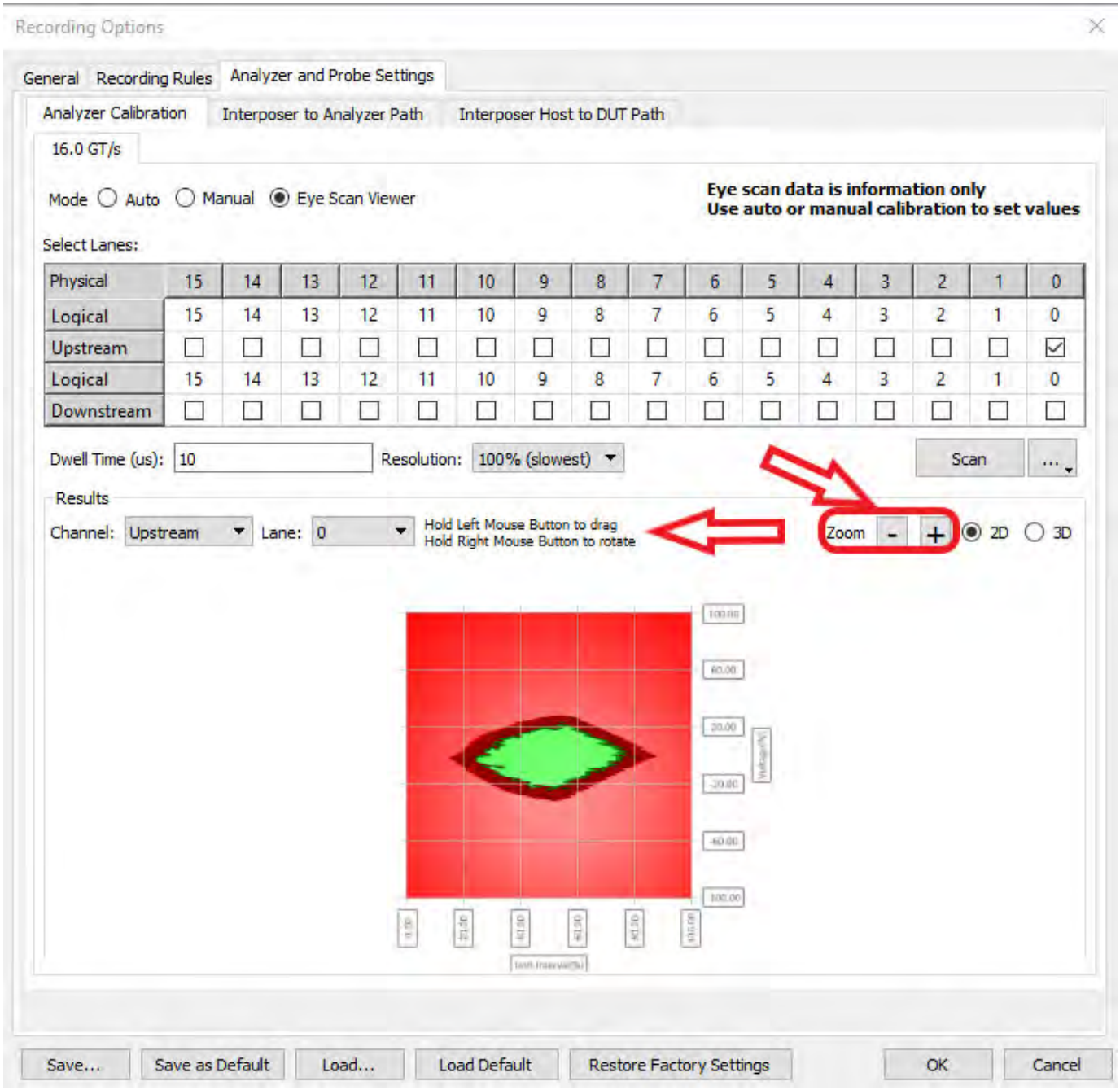


Figure 5.198: Two Dimensional View of “Eye”

Interpreting the Eye Diagram

The X-Axis is the relative phase of the Eye and the Y-Axis is the relative height of the Eye based on the number of steps taken. If the dwell time is increased or decreased the accuracy is increased or decreased. A longer dwell time interval will result in additional data samples being captured and longer rendering times for the eye diagram display.

Probe Settings and the Eye Diagram

The probe settings can be manipulated for better signal quality per "Interposer to Analyzer Path" on page 376. The Eye Diagram will show the results of the updated probe settings.

5.19.4 Using the Autotune and Probe Calibration Wizard

The Autotune and Probe Calibration wizard guides you through both the Autotune and Probe Calibration process steps as outlined below:

- Analyzer Verification
- Interposer Verification
- Setting Parameters
- Setting Polarity
- Precalibration
- Calibration Finished

To start the Autotune and Calibration Wizard select **Recording Options -> Analyzer and Probe Settings** (see Figure 5.199)

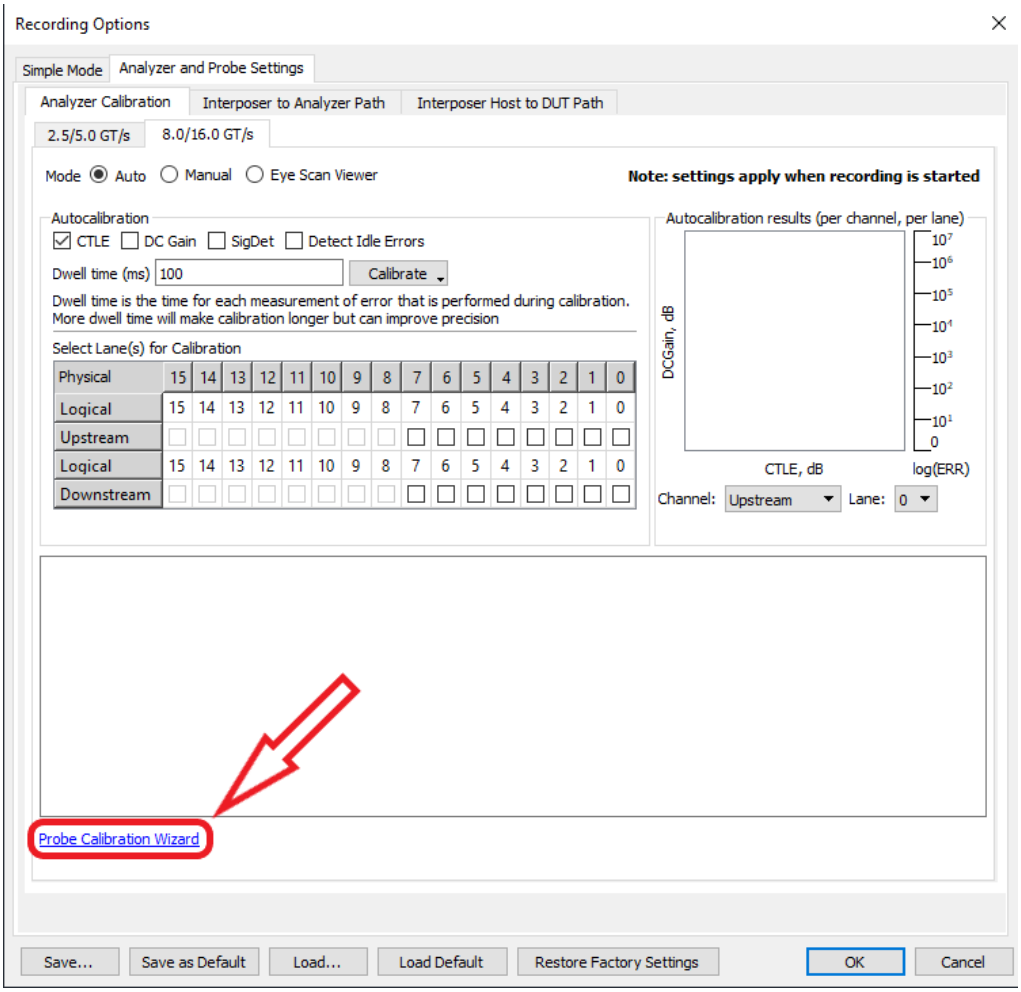


Figure 5.199: Select Recording Options -> Analyzer and Probe Settings

5.19.4.1 Launch Auto Probe Calibration Wizard

Select the Probe Calibration Wizard link. The following dialog box will pop up and lead you through the steps for both Autotuning the analyzer and Calibrating the Probe. See Figure 5.200.

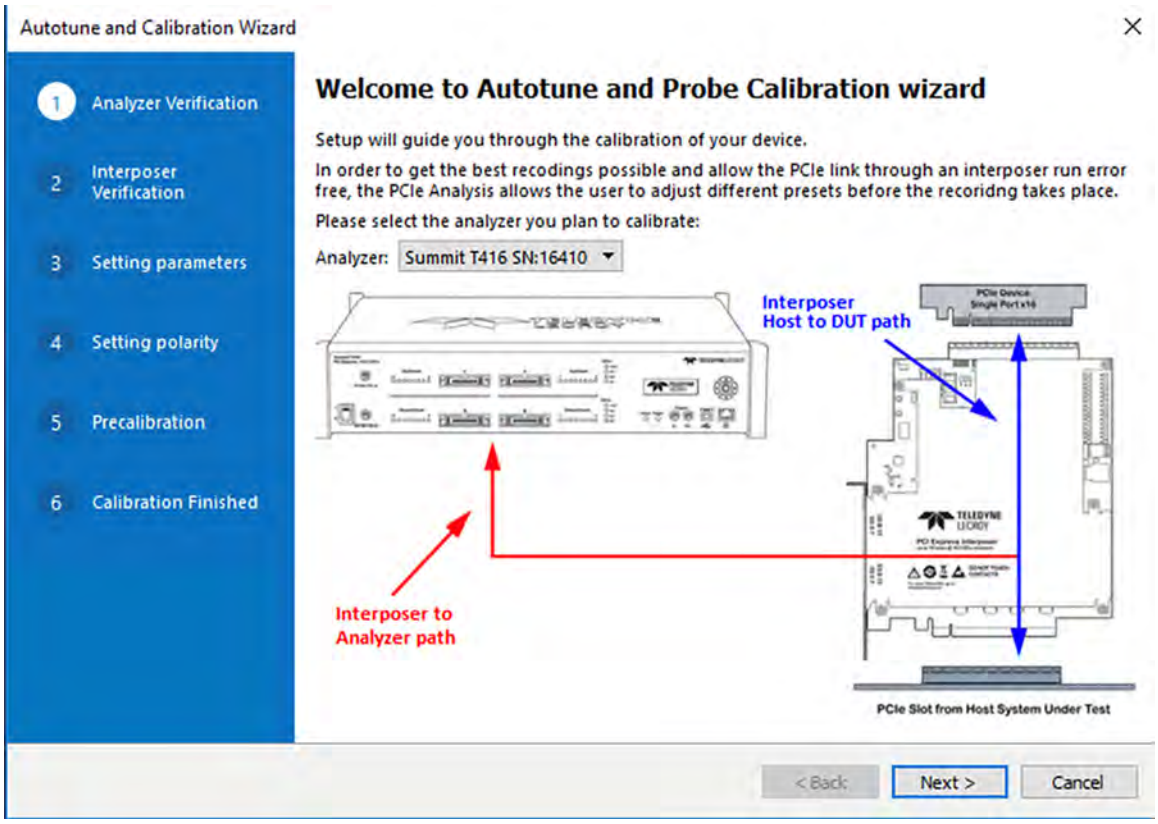


Figure 5.200: Autotune and Probe Calibration Wizard: Step 1 -> Analyzer Verification

First you choose the Analyzer you plan to calibrate.

Then click on next to go to Step 2: Interposer Verification (see Figure 5.201 on page 392).

5.19.4.2 Step 2: Interposer Verification

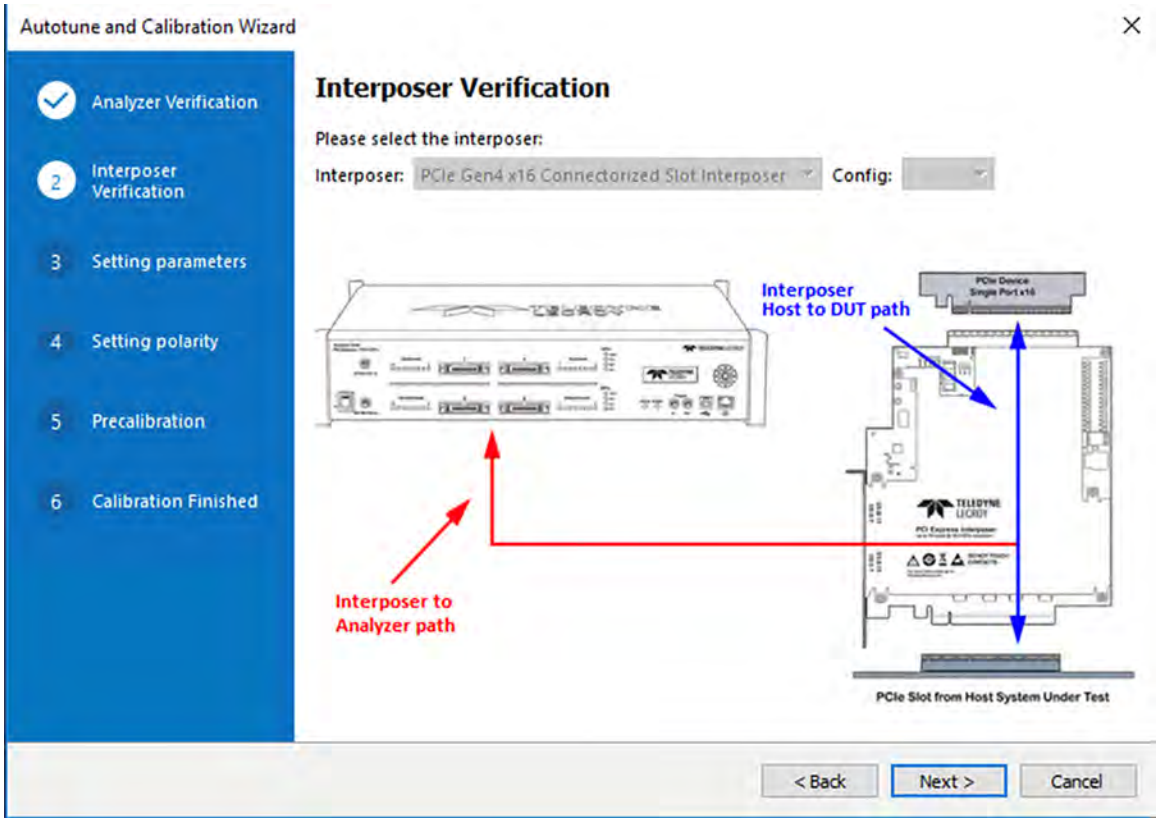


Figure 5.201: Autotune and Probe Calibration Wizard: Step 2 -> Interposer Verification

Depending on the interposer and analyzer you are using you'll see the following images pop up for Step 2: see Figure 5.202 on page 393 to Figure 5.216 on page 407.

Summit T416 in Single Port x16 Mode with Gen4 x16 Cable-Attached Slot Interposer

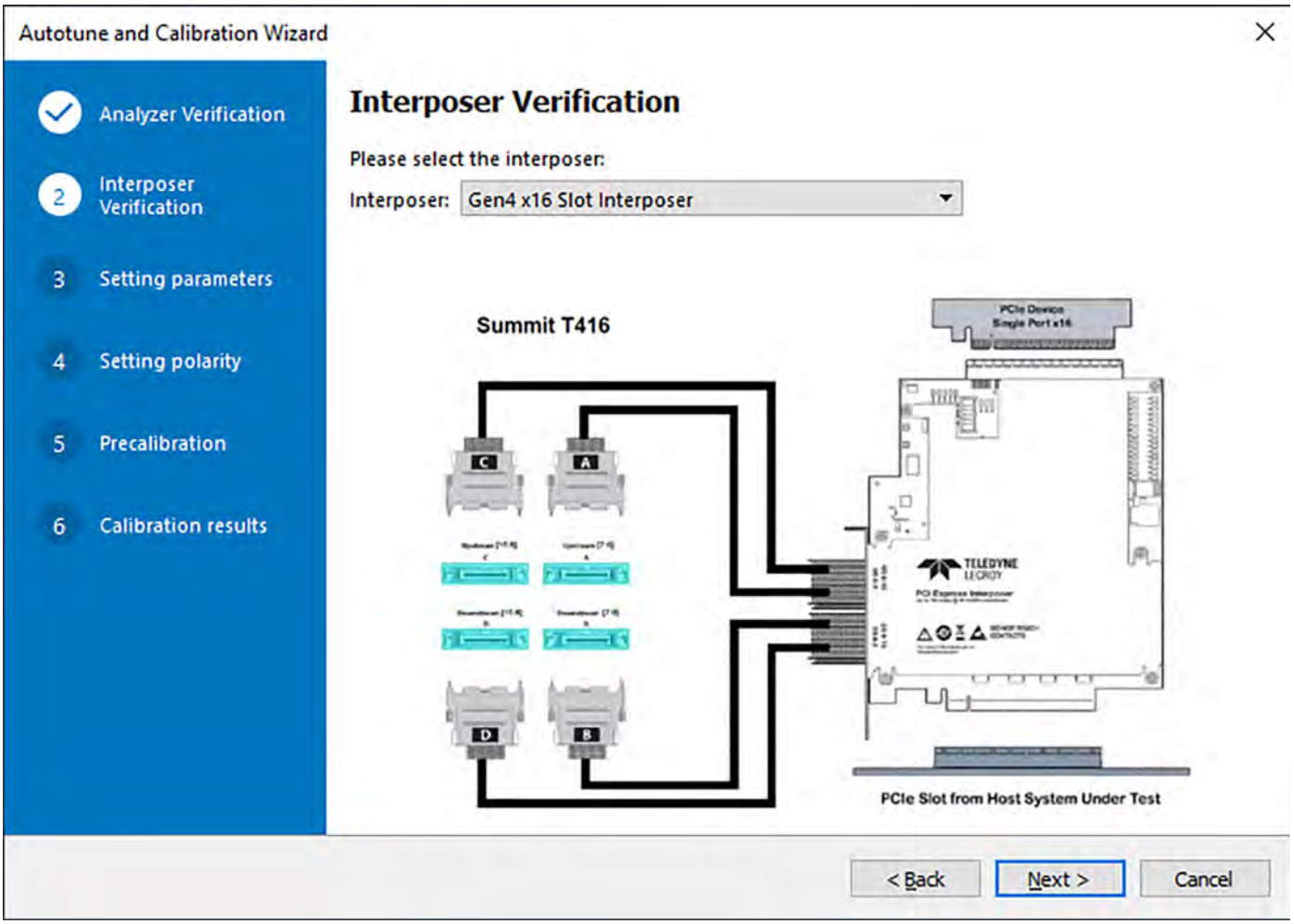


Figure 5.202: Summit T416 in Single Port x16 Mode with Gen4 x16 Cable-Attached Slot Interposer

Summit T416 in Two Port x8 Bifurcated Mode with Gen4 x16 Cable-Attached Slot interposer

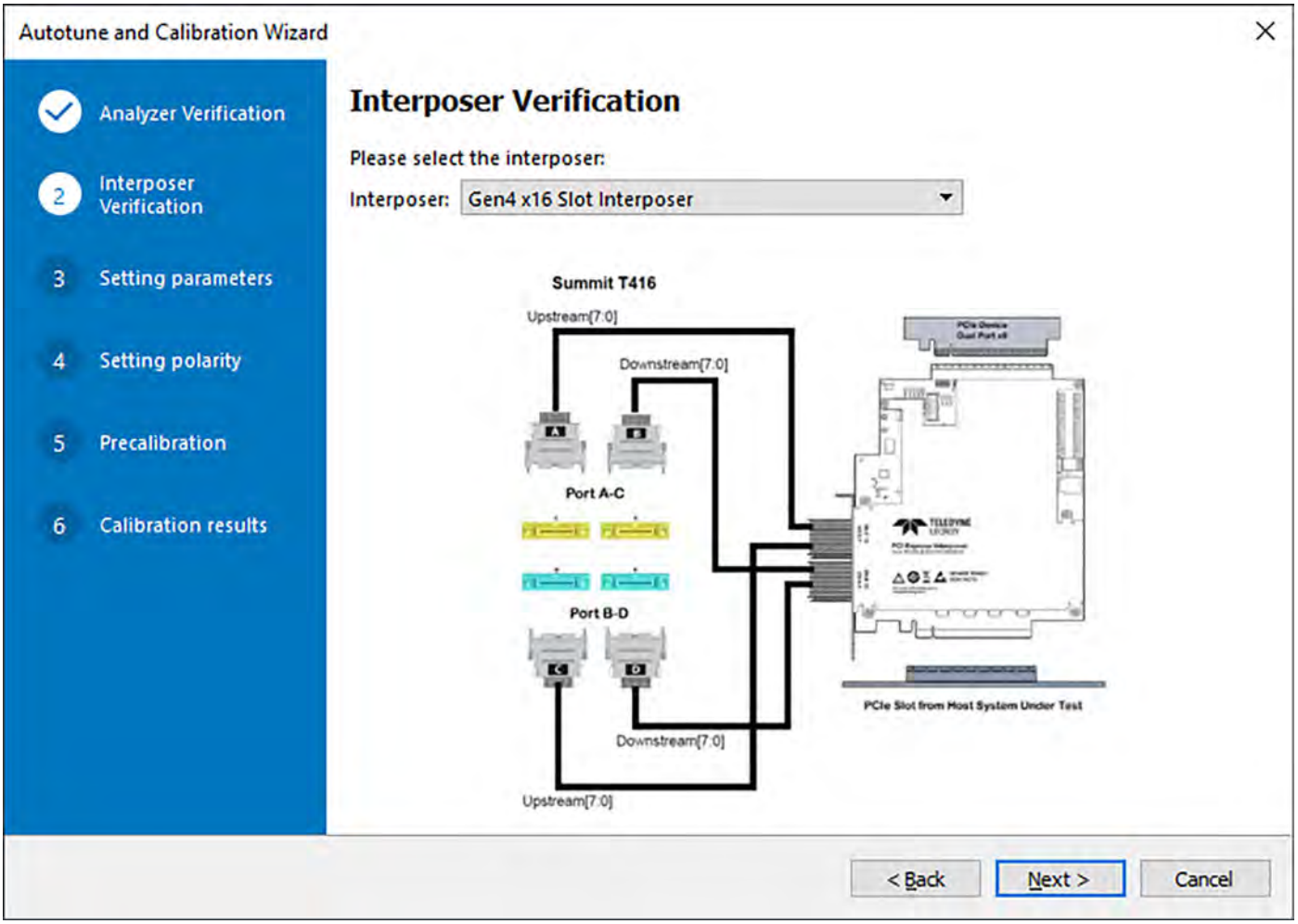


Figure 5.203: Summit T416 in Two Port x8 Bifurcated Mode with Gen4 x16 Cable-Attached Slot Interposer

Summit T416 in Two Port x8 Independent Mode with Gen4 x8 Cable-Attached Slot Interposers

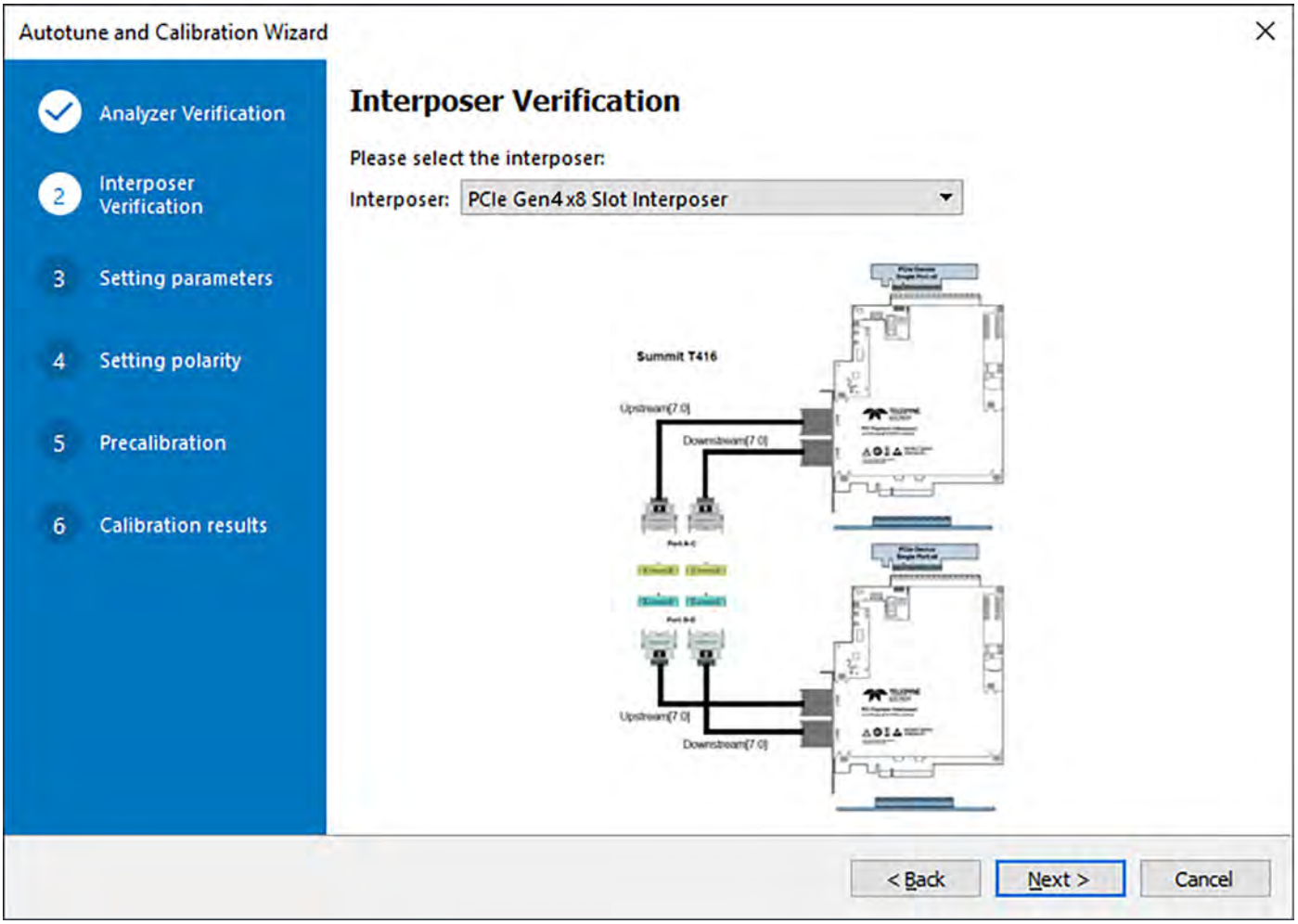


Figure 5.204: Summit T416 in Two Port x8 Independent Mode with Gen4 x8 Cable-Attached Slot Interposers

Summit T416 in Four Port x4 Bifurcated Mode with Gen4 x16 Interposer

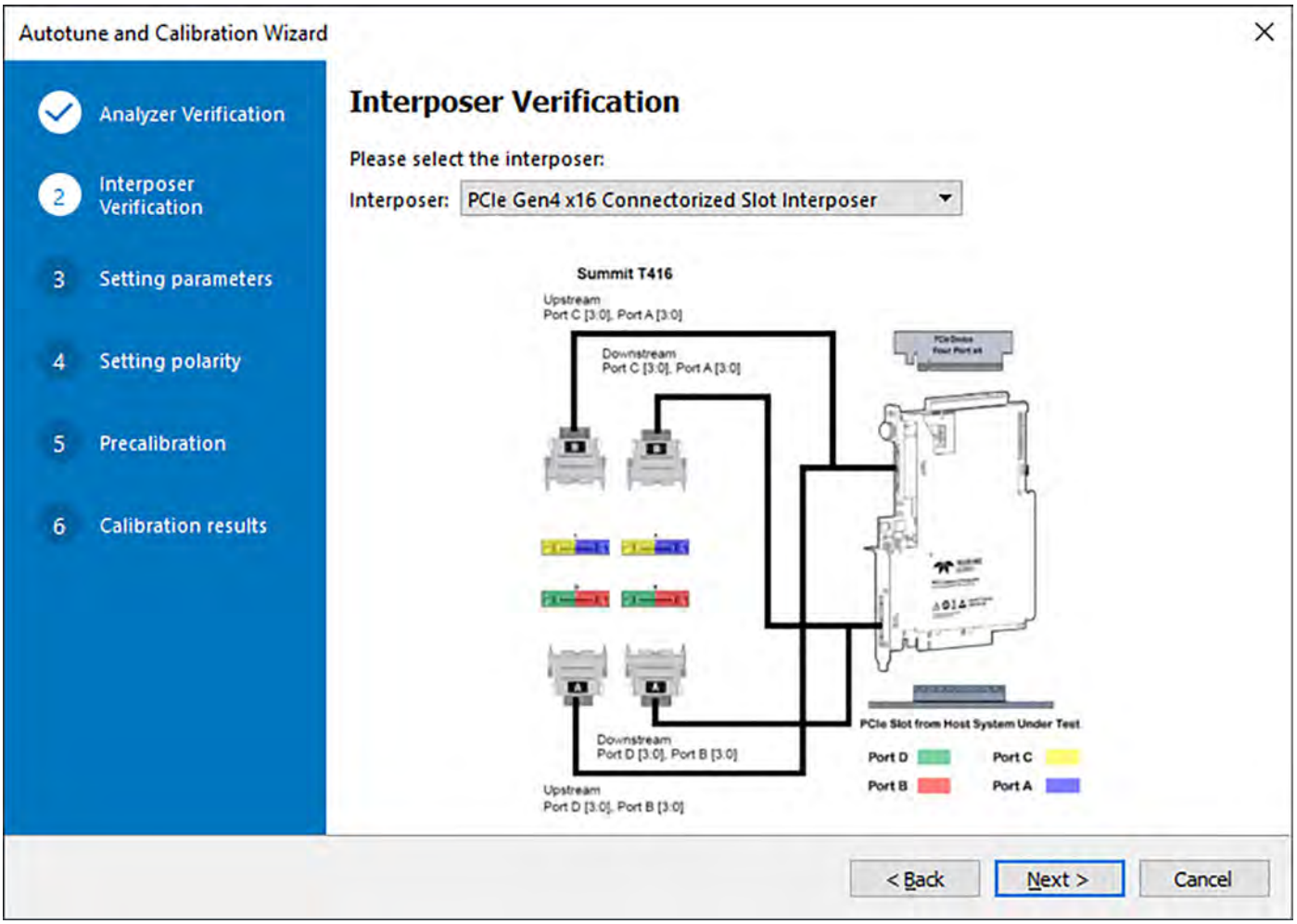


Figure 5.205: Summit T416 in Four Port x4 Bifurcated Mode with Gen4 x16 Interposer

Summit T416 in Four Port x4 Independent Mode with Gen4 x4 Interposers

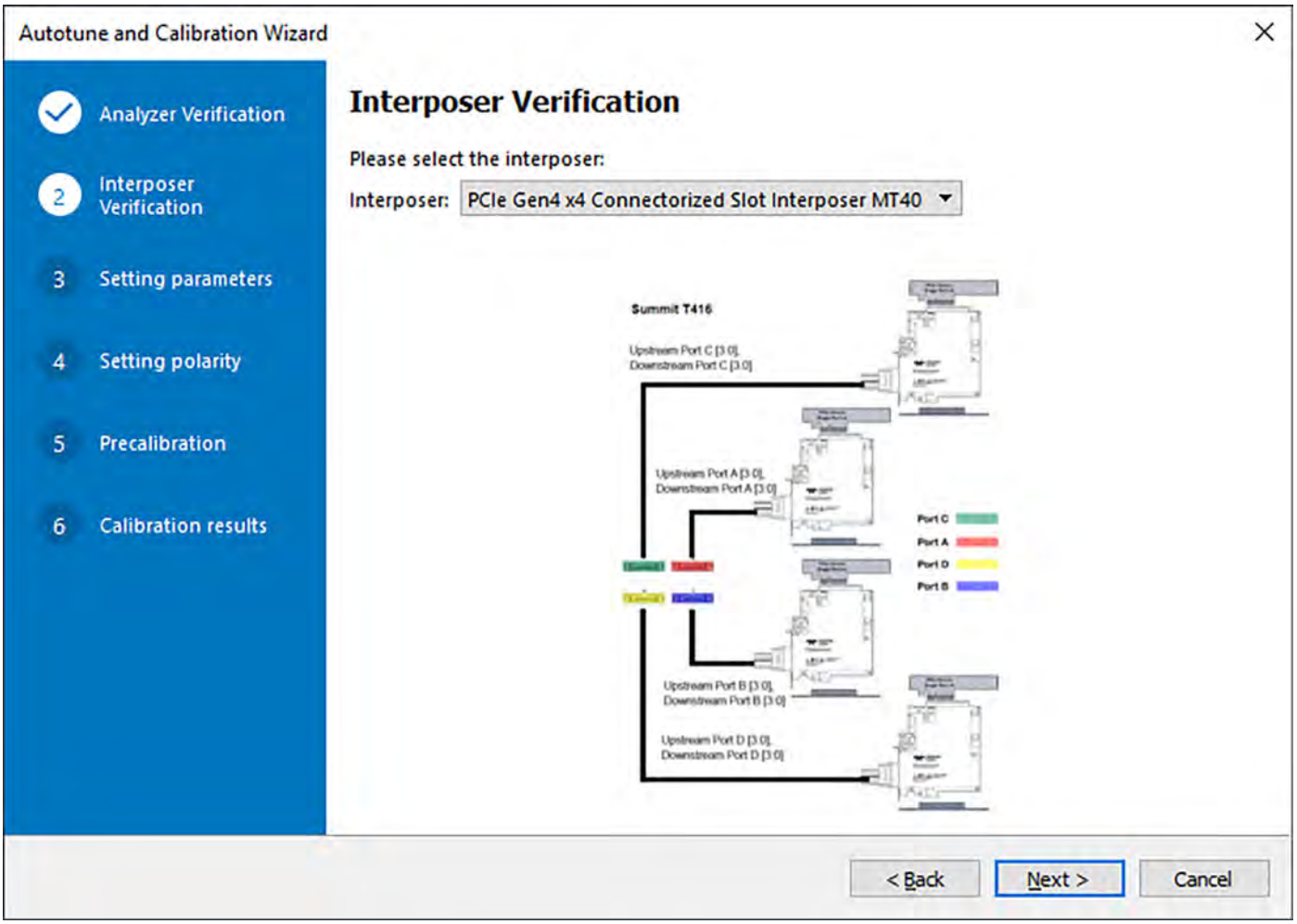


Figure 5.206: Summit T416 in Four Port x4 Independent Mode with Gen4 x4 Interposers

Summit T416 in Four Port x2 Bifurcated Mode with U.2/U.3 Interposers

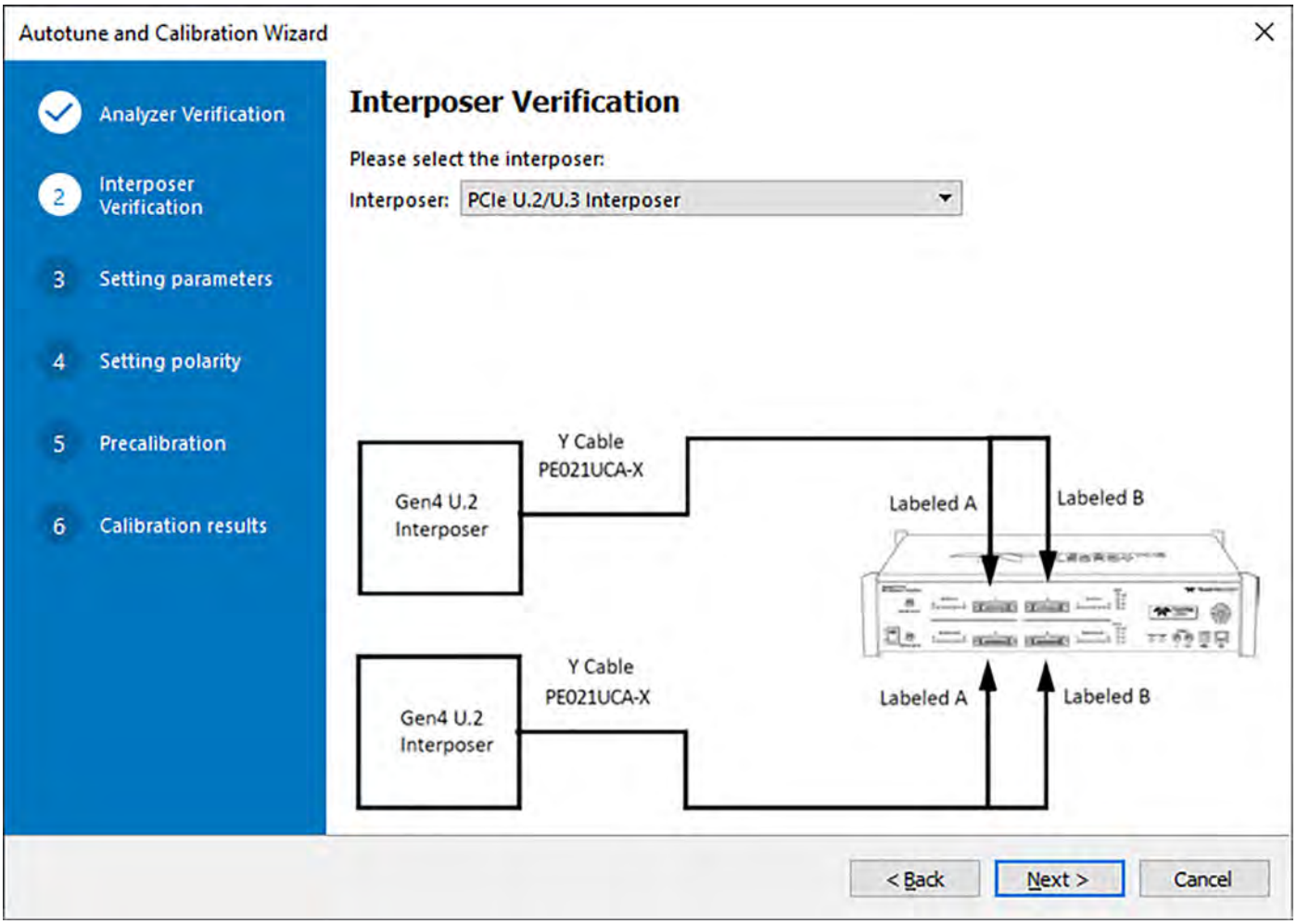


Figure 5.207: Summit in T416 Four Port x2 Bifurcated Mode with U.2/U.3 Interposers

Summit T48 in Single Port x8 Mode with Gen4 x8 Interposer

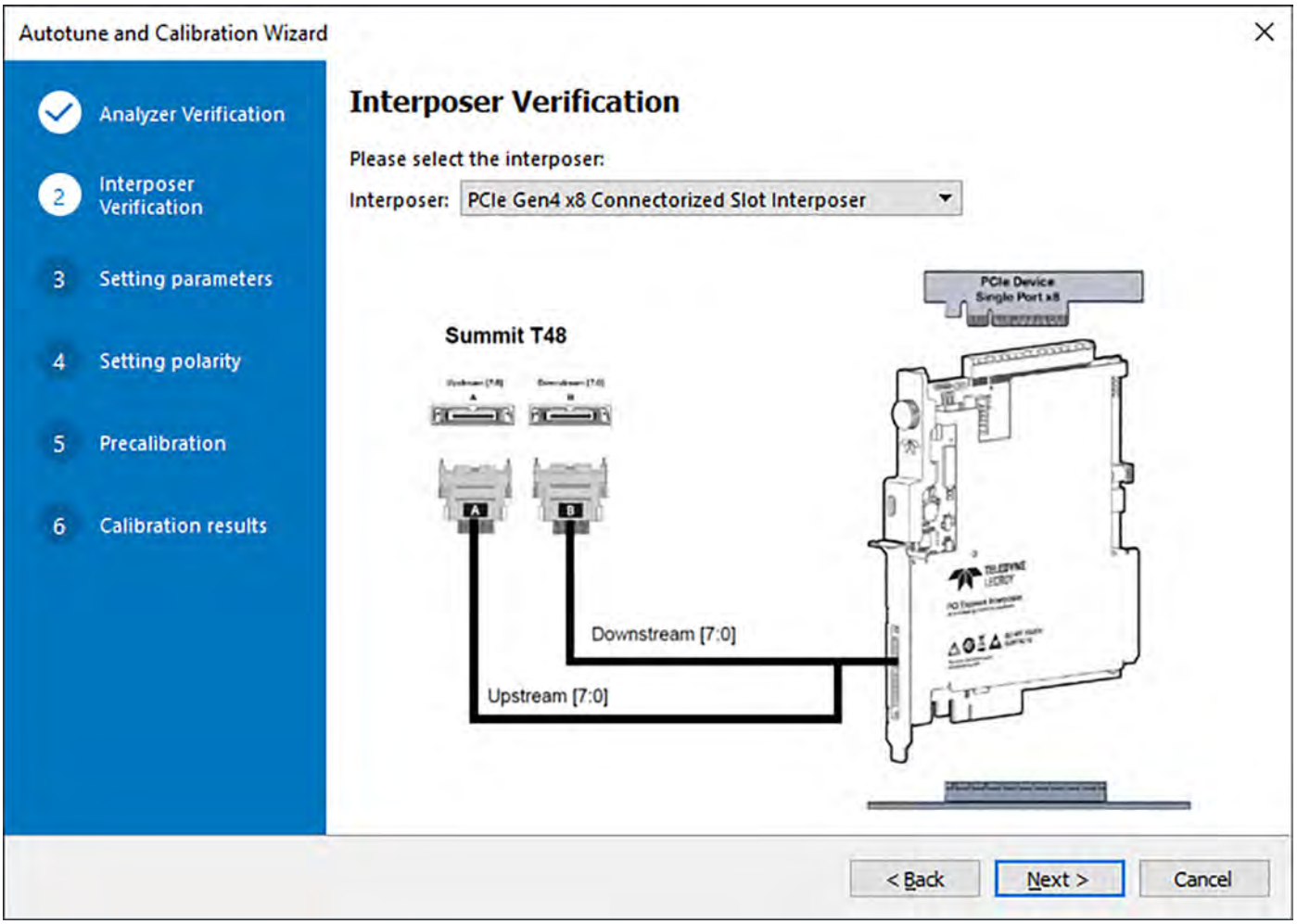


Figure 5.208: Summit T48 in Single Port x8 Mode with Gen4 x8 Interposer

Summit T48 in Single Port x8 Mode with Gen4 x8 Cable-Attached Interposer

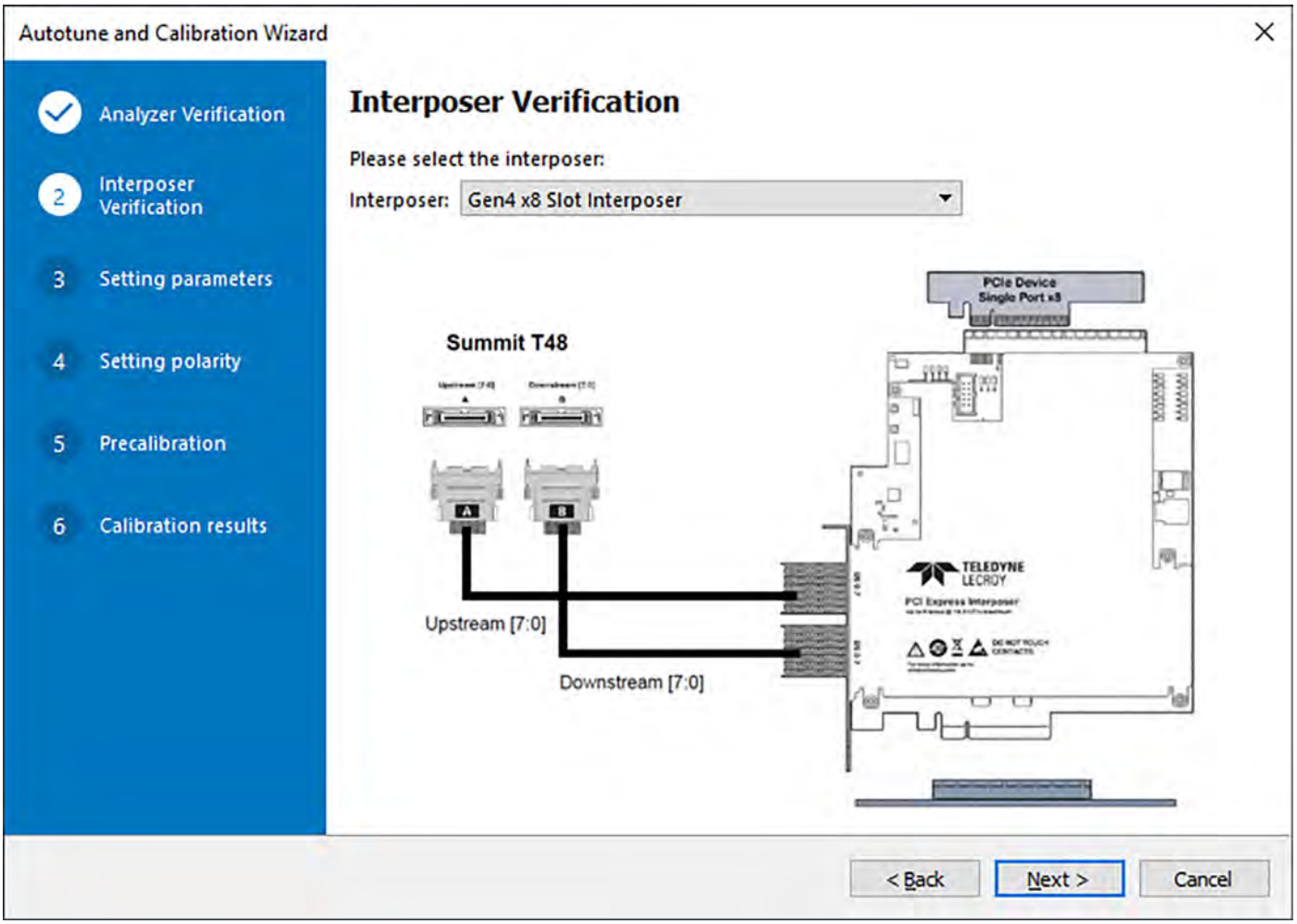


Figure 5.209: Summit T48 in Single Port x8 Mode with Gen4 x8 Cable-Attached Interposer

Summit T48 in Two Port x4 Bifurcated Mode with Gen4 x8 Interposer

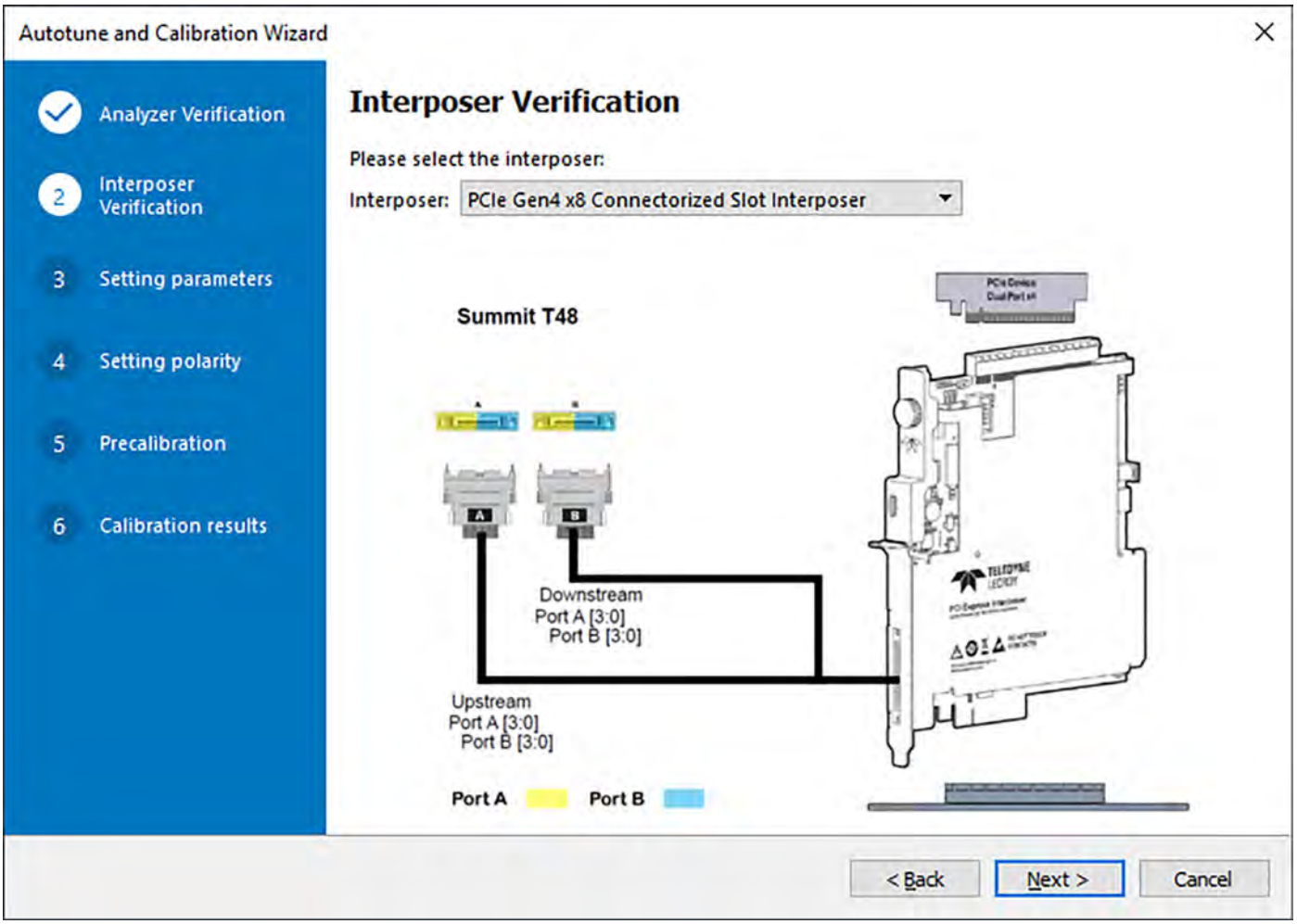


Figure 5.210: Summit T48 in Two Port x4 Bifurcated Mode with Gen4 x8 Interposer

Summit T48 in Two Port x4 Independent Mode with Gen4 x4 Interposers

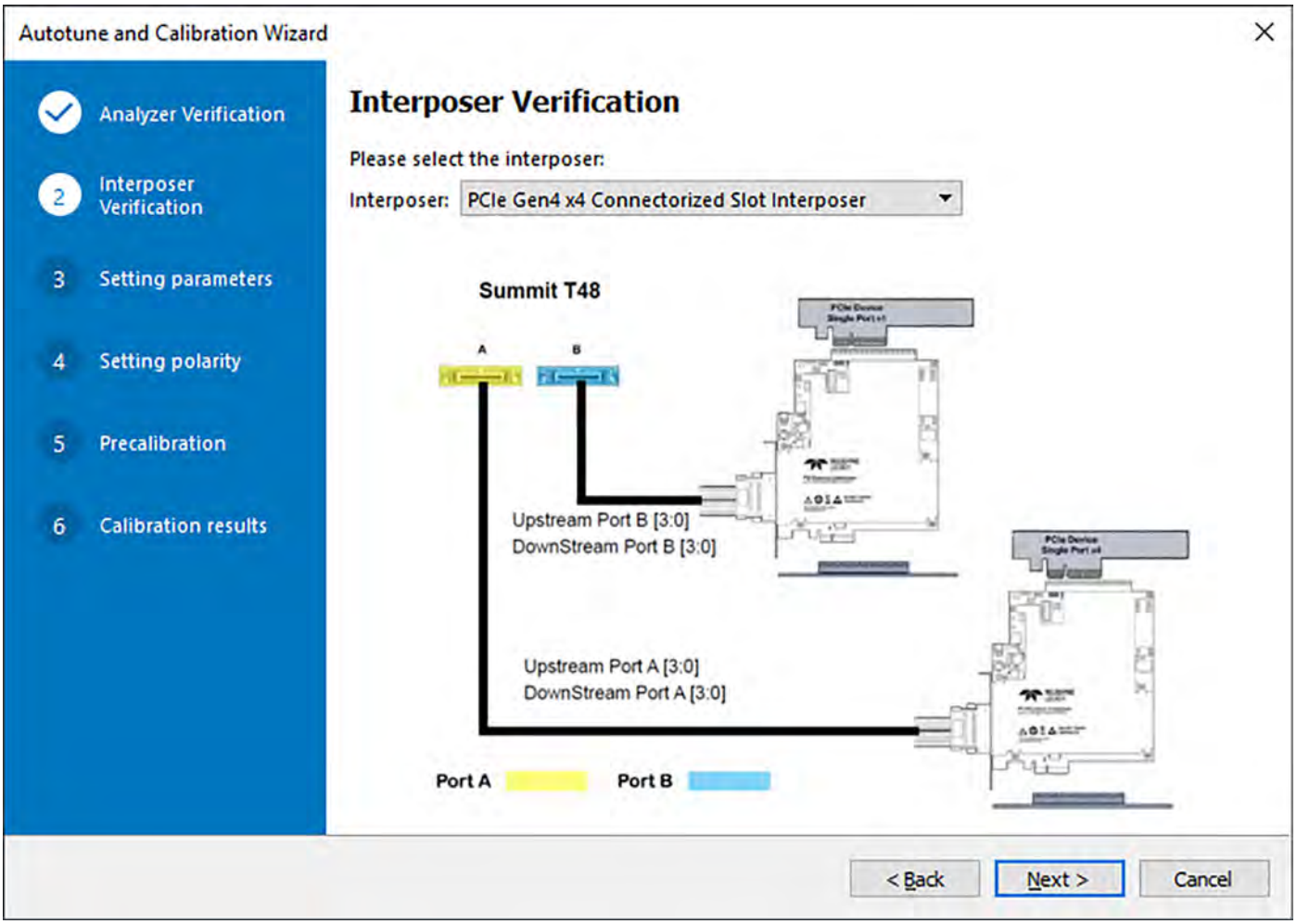


Figure 5.211: Summit T48 in Two Port x4 Independent Mode with Gen4 x4 Interposers

Summit T48 in Two Port x2 Bifurcated Mode with U.2/U.3 interposer

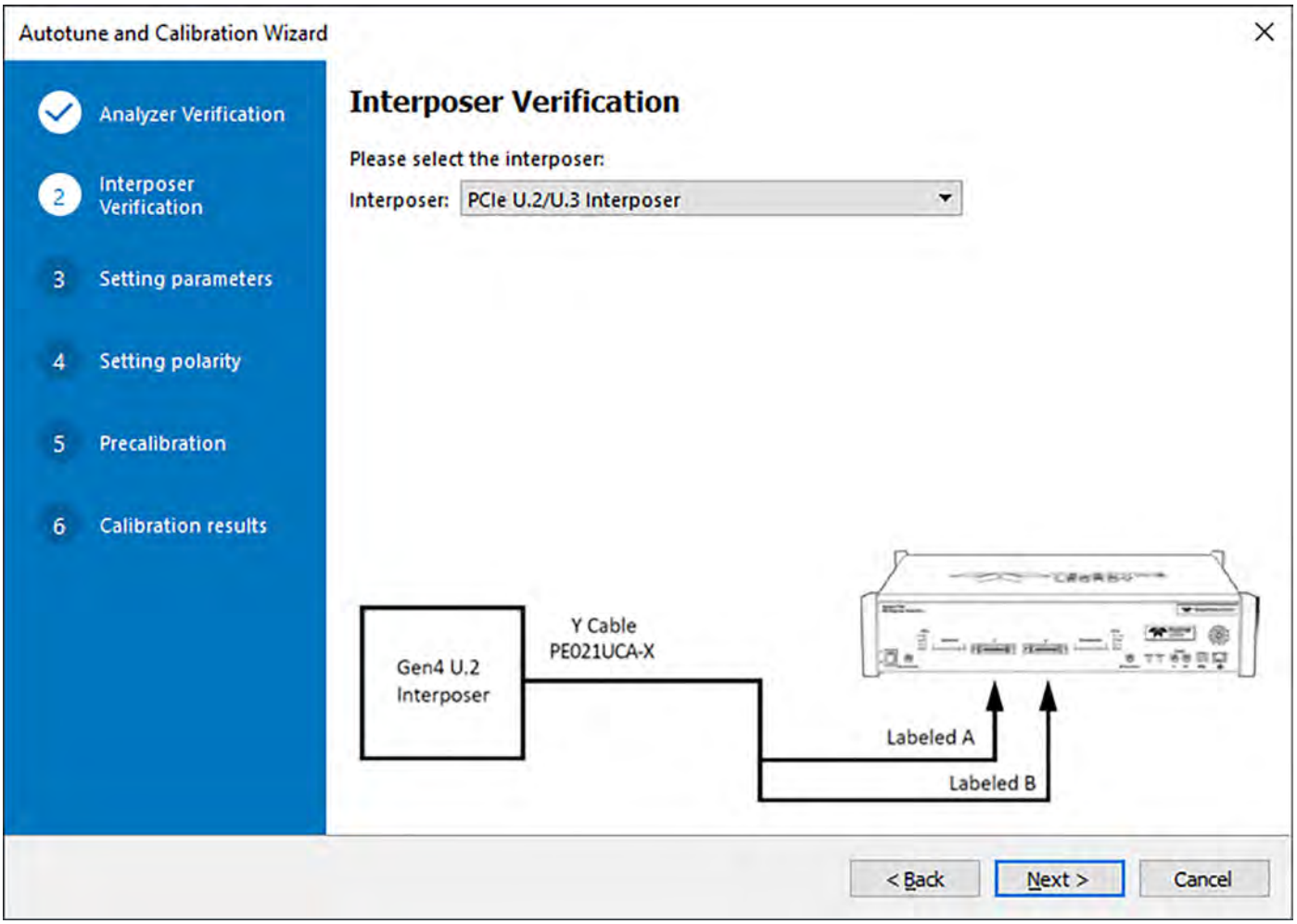


Figure 5.212: Summit T48 in Two Port x2 Bifurcated Mode with U.2/U.3 interposer

Summit T48 in Single Port x16 Expanded Mode with Gen4 x16 interposer

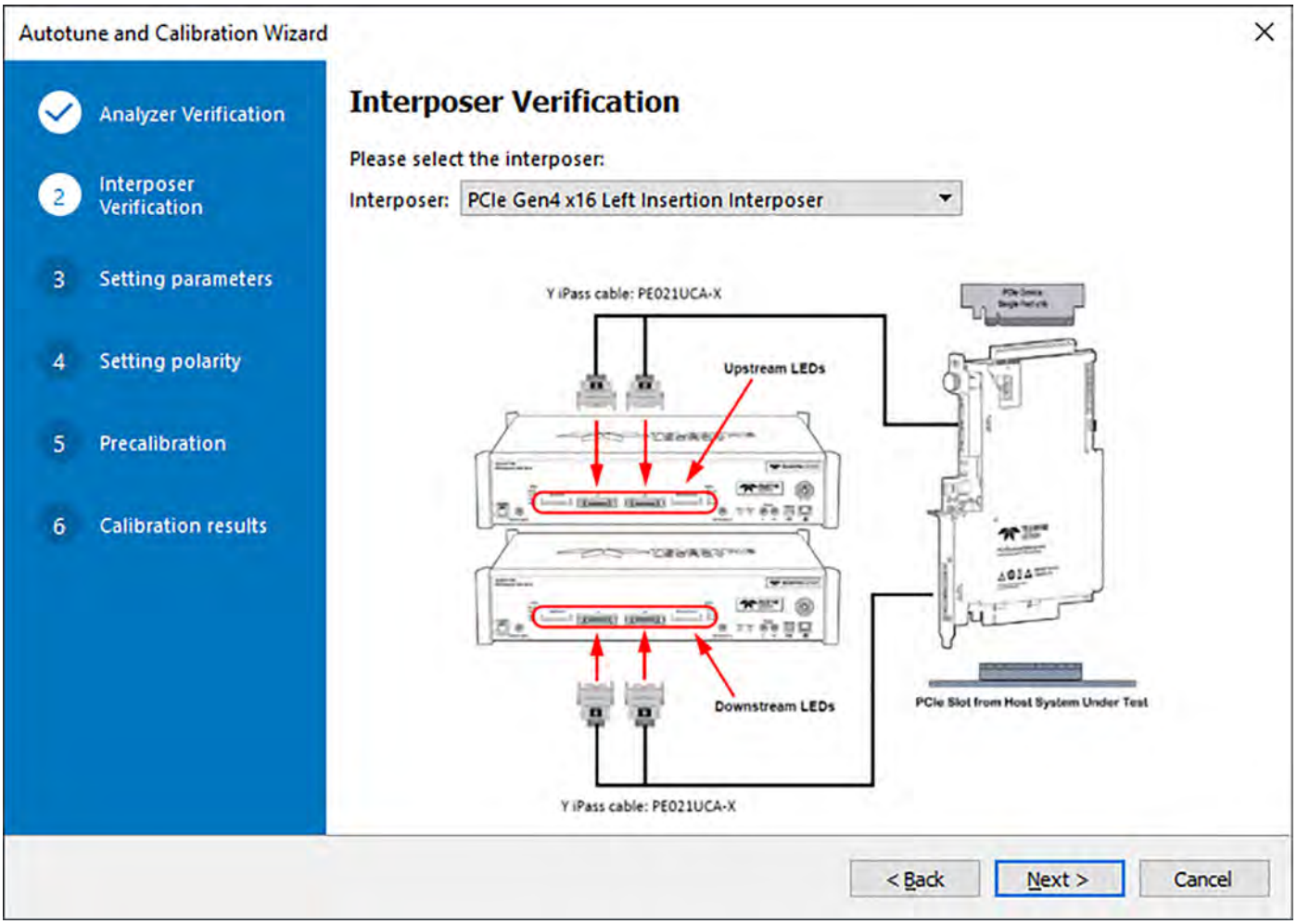


Figure 5.213: Summit T48 in Single Port x16 Expanded Mode with Gen4 x16 interposer

Summit T48 in Single Port x4 Mode with Gen4 M.2 x4 Interposer

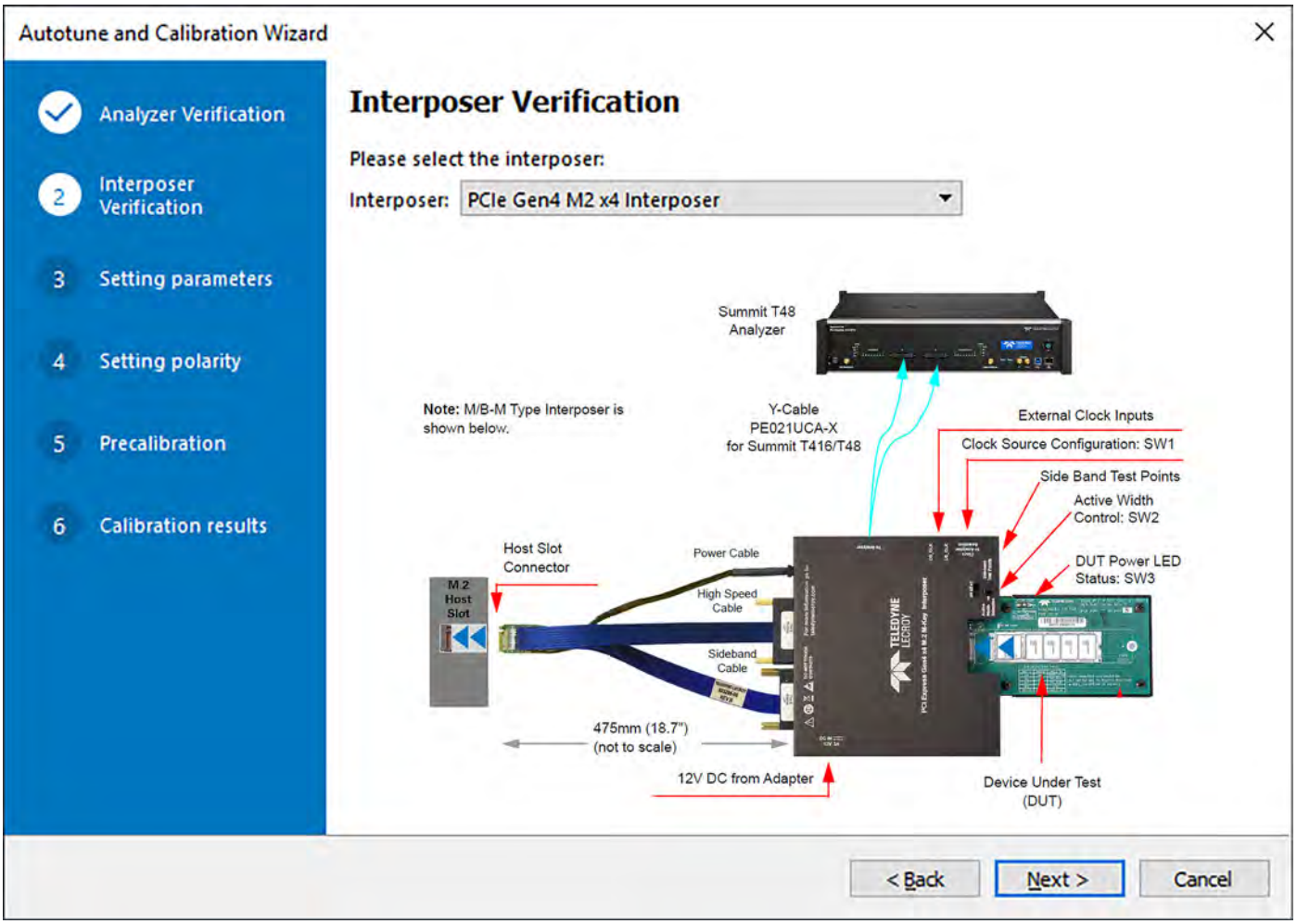


Figure 5.214: Summit T48 in Single Port x4 Mode with Gen4 M.2 x4 interposer

Summit T48 in Single Port x4 Mode with Gen4 x4 RSSD Interposer

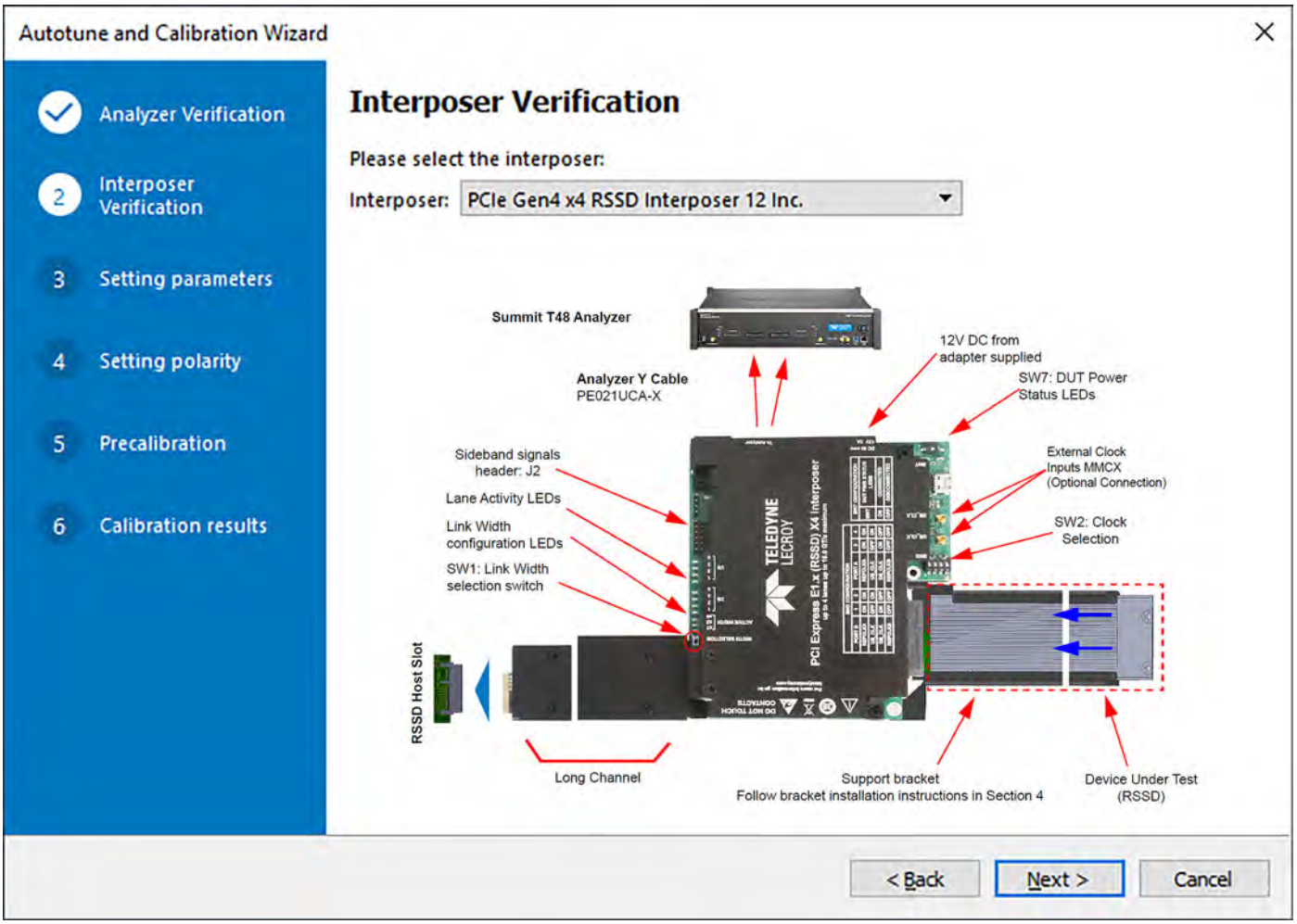


Figure 5.215: Summit T48 in Single Port x4 Mode with Gen4 x4 RSSD interposer

All Other Interposer Types

If the interposer doesn't match one of the modes outlined above a blank interconnect section will be shown.

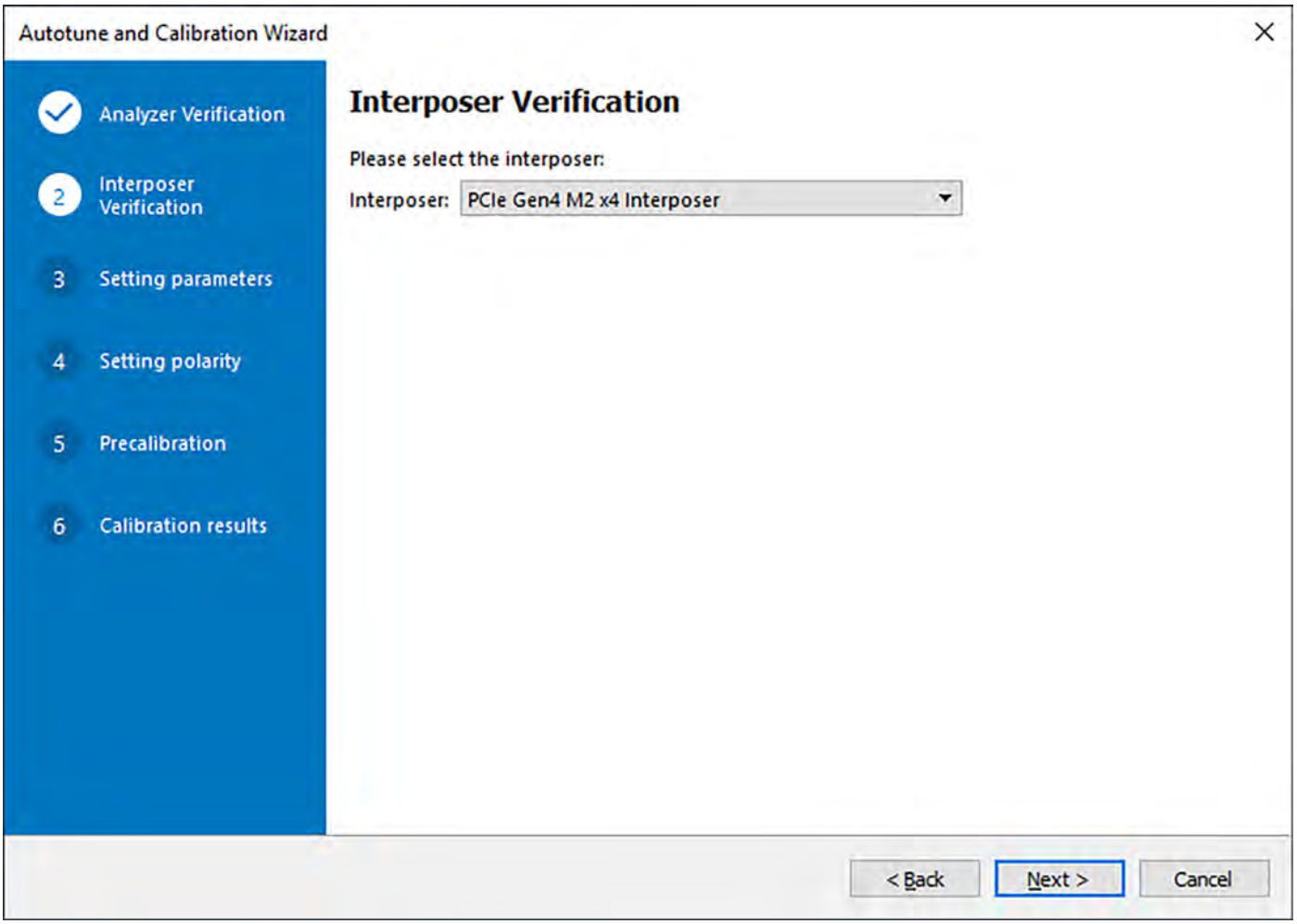


Figure 5.216: All Other Interposer Types

Then click on the next step: Set the Parameters (see "Setting Parameters" on page 408).

5.19.4.3 Setting Parameters

In this case we are working with the Gen4 x16 Slot Interposer.

Click on Next to go to Step 3: Setting parameters (see Figure 5.217).

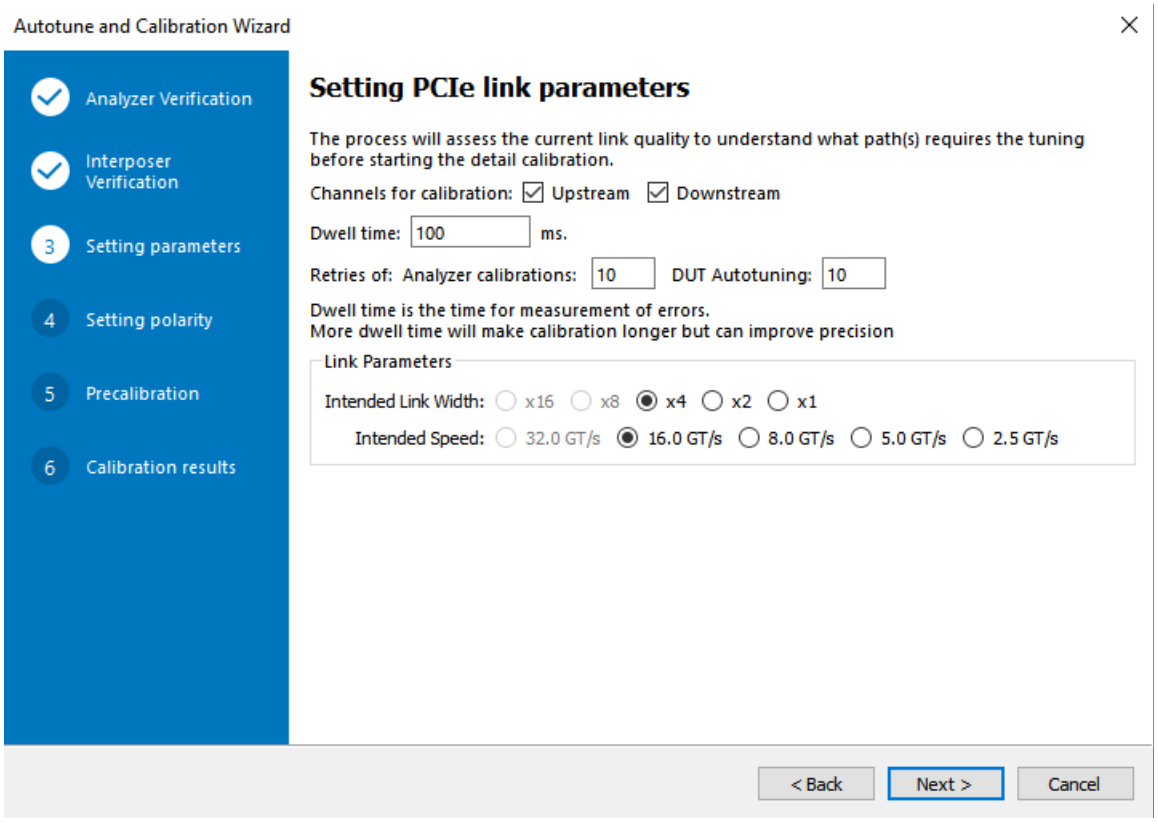


Figure 5.217: Autotune and Probe Calibration Wizard: Step 3 -> Setting Parameters

In this step you can set Channels for calibration, the Dwell time for measurement errors, select maximum number of retries of Analyzer calibration and DUT Autotuning and set up the link parameters.

Then click on Next to Set polarity (see “Setting Polarity” on page 409).

5.19.4.4 Setting Polarity

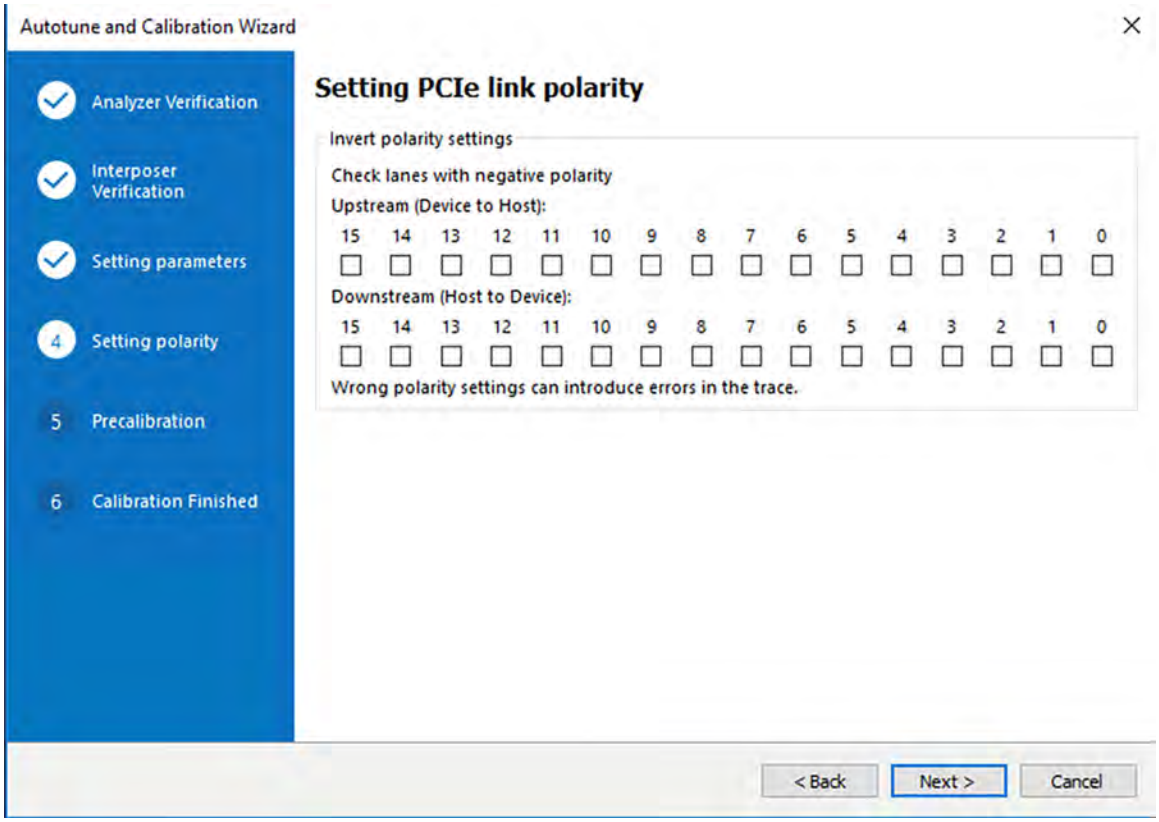


Figure 5.218: Autotune and Probe Calibration Wizard: Step 4 -> Setting Link Polarity

Here you can invert the polarity of Upstream or Downstream lanes.

Then click on Next to go to the Precalibration step (see “Precalibration” on page 410).

5.19.4.5 Precalibration

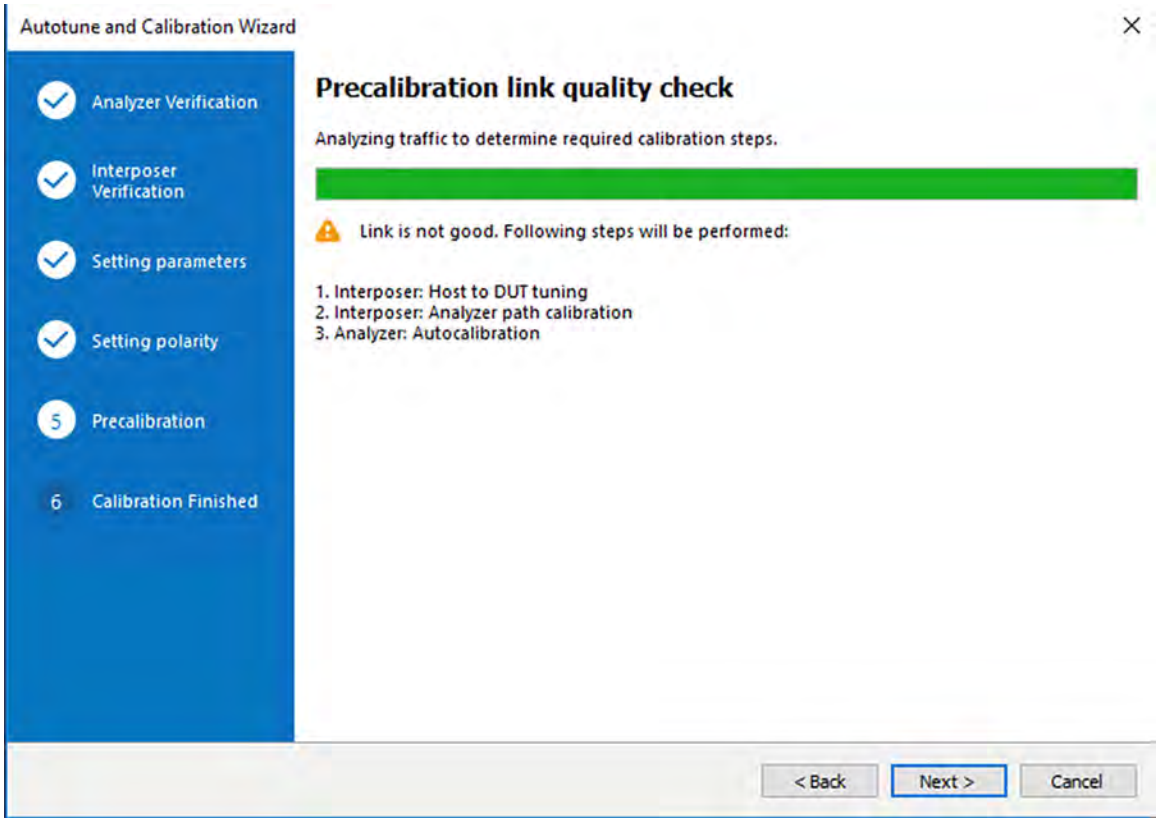


Figure 5.219: Autotune and Probe Calibration Wizard: Step 5 -> Precalibration Link Quality Check

This step check the quality of the link before calibration.

In this case the Link Quality was not good, so the following steps were taken:

- Interposer: Host to DUT Tuning
- Interposer: Analyzer path calibration
- Analyzer: AutoCalibration

To perform the steps outlined above the DUT, Host and operating system must be selected (see “Setup Calibration: Host System and DUT Configuration” on page 411).

5.19.4.6 Setup Calibration: Host System and DUT Configuration

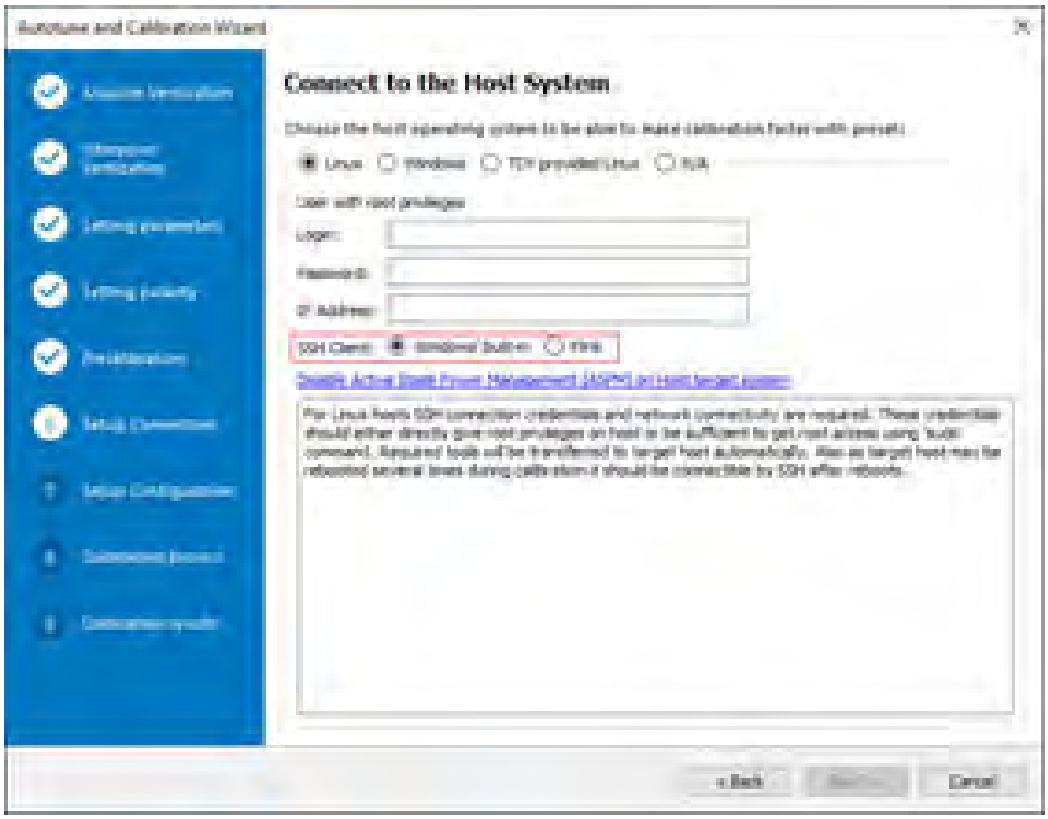


Figure 5.220: Autotune and Probe Calibration Wizard: Step 6 -> Setup Connection

Select the Host operating system and enter the Host system information. Different Host system information must be specified depending on the selected Host operating system:

- For Windows: Agent address must be selected;
- For Linux: Login, Password and IP Address must be entered;
- For N/A: no additional system information is required.

Once you have selected the DUT, the Host and the Host operating system, click on Next and proceed to the step, which involved connecting to the Host system. See “Connect to the Host System” on page 412).

5.19.4.7 Connect to the Host System

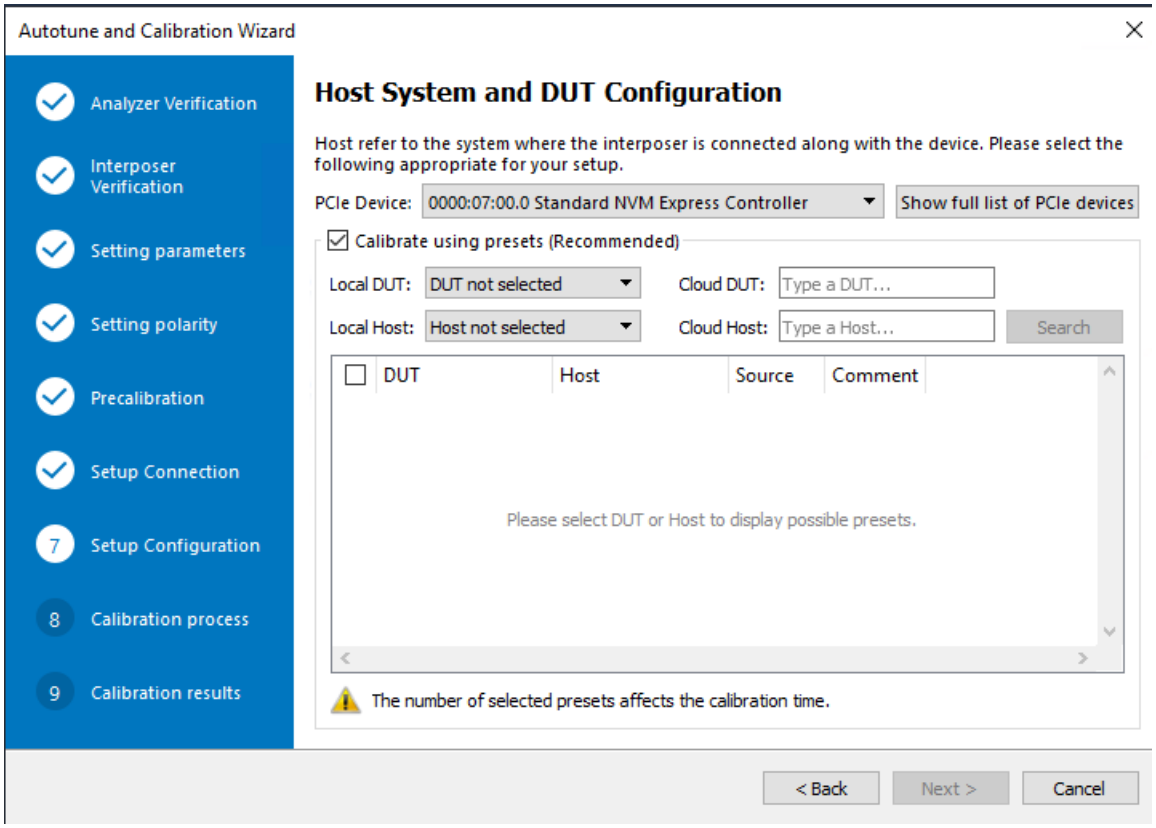


Figure 5.221: Autotune and Probe Calibration Wizard: Step 7 -> Host System and DUT configuration

If Windows or Linux operating system was chosen on the previous step, then you must select the DUT you are using. In this case the DUT is a Standard NVM Express Controller.

Some PCIe devices, for example Root Complex Root Ports, Event Collectors, etc., will not be shown in the list. Click Show Full List of PCIe Devices to view all connected PCIe devices that are detected.

Also in this step you can select the presets which will be used during the Calibration process. Presets may be:

- Local – presets which are stored on the local computer in C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\InterposerCfgPresets folder;
- Cloud – presets which are stored in the cloud in the Internet.

Select names in Local DUT and/or Local Host to add local presets to the list. Enter names in Cloud DUT and/or Cloud Host fields and click on Search to add cloud presets to the list. Then check one or more presets in the list. The checked presets will be used during the Calibration process.

By default, the option Calibrate using presets is enabled, so you must check at least one preset. Uncheck Calibrate using presets option to be able to start the Calibration process without selecting presets.

Click on Next and the Calibration process will begin. See “Calibration Process” on

page 413.

5.19.4.8 Calibration Process

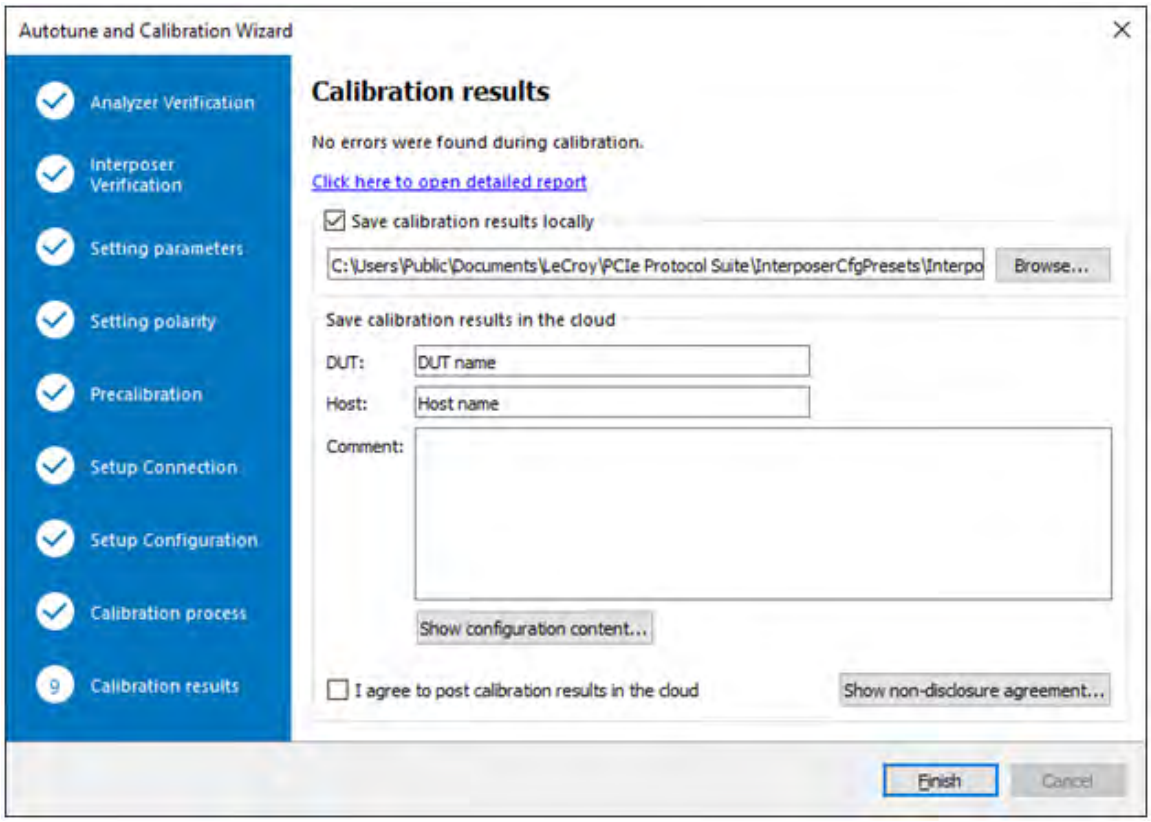


Figure 5.222: Autotune and Probe Calibration Wizard: Step 8 -> Calibration Process

In this step you can see from the log window the Autotuning and Calibration steps being taken by the PCIe Analysis software. After the Calibration process has completed (and this make take awhile), select Next and a dialog box will pop up that shows a link to the Calibration results. See “Calibration Results” on page 414.

In case of successful calibration (no errors were found during the Calibration process) the Calibration results may be saved locally to the specified file and/or in the cloud with the specified DUT and Host names and optional Comment.

The Calibration results will be saved as a preset after clicking Finish:

- Locally, if Save calibration results locally is checked. The locally saved preset can be accessed on this PC or copied to another;
- In the cloud, if I agree to post calibration results in the cloud is checked. The pre-set saved in the cloud can be accessed from any PC connected to the Internet and will be shown in the list on the Step 7 (“Setup Connection”) when searching for cloud presets.

5.19.4.9 Calibration Results

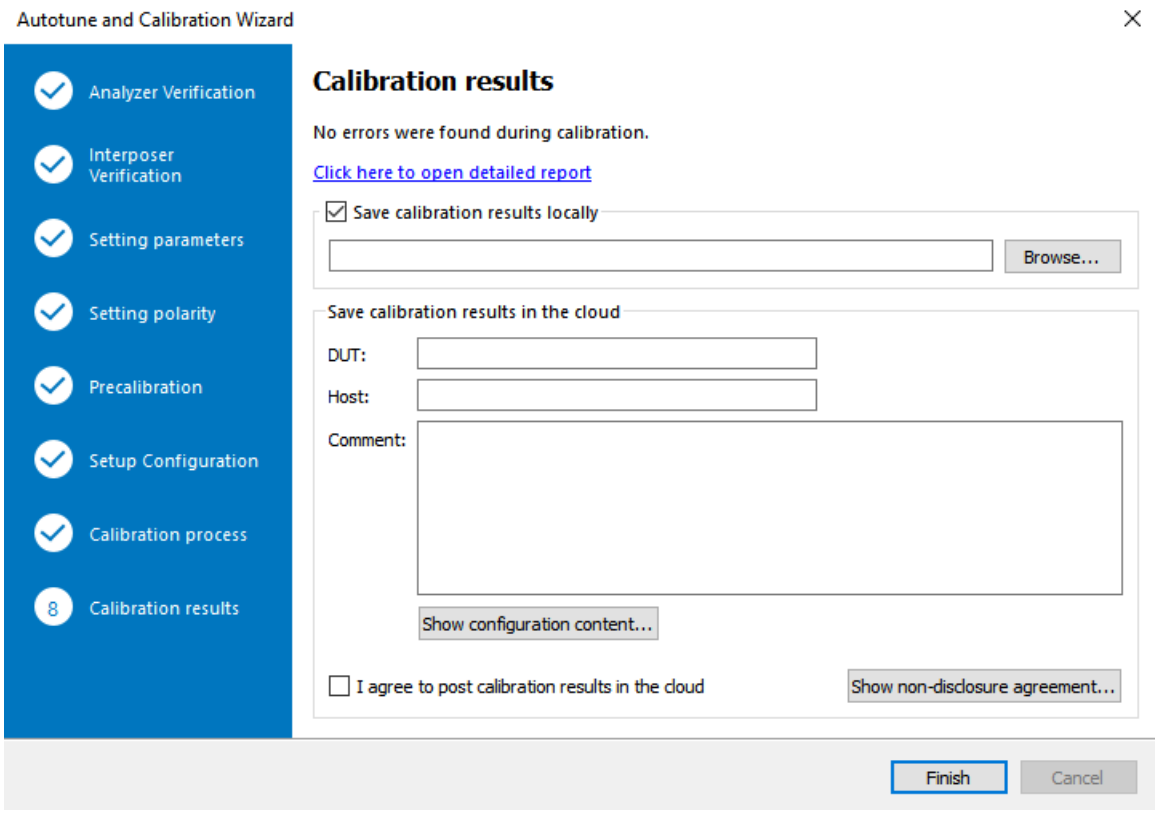
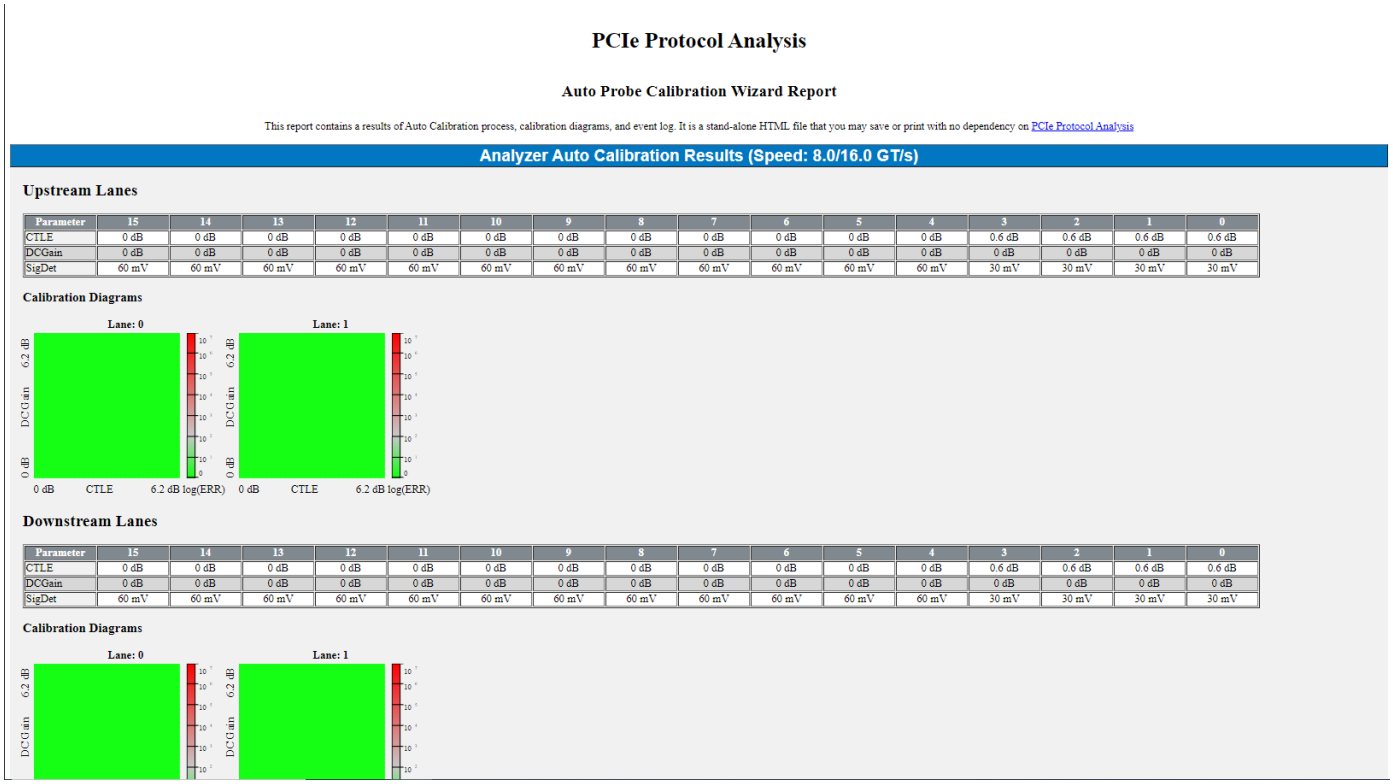


Figure 5.223: Autotune and Probe Calibration Wizard: Step 9 -> Calibration Results

Click on the link to view the Calibration results. See Figure 5.224 on page 415.



PCIe Protocol Analysis

Auto Probe Calibration Wizard Report

This report contains a results of Auto Calibration process, calibration diagrams, and event log. It is a stand-alone HTML file that you may save or print with no dependency on PCIe Protocol Analysis

Analyzer Auto Calibration Results (Speed: 8.0/16.0 GT/s)

Upstream Lanes

Parameter	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CTLE	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0.6 dB	0.6 dB	0.6 dB	0.6 dB
DCGain	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
SigDet	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	30 mV	30 mV	30 mV	30 mV

Calibration Diagrams

Downstream Lanes

Parameter	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CTLE	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0.6 dB	0.6 dB	0.6 dB	0.6 dB
DCGain	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
SigDet	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	60 mV	30 mV	30 mV	30 mV	30 mV

Calibration Diagrams

Figure 5.224: Autotune and Probe Calibration Wizard: Step 10 -> Calibration Results

From the Calibration Report you can see the values used for each lane (Upstream and Downstream):

- CTLE
- DCGain
- SigDet

5.20 Tools Options

5.20.1 Interposer Settings for Bifurcated Multiport Link

Currently the only possible option to change the presets of a Bifurcated multiport link is to use the USB connection, user can bring the dialog by selecting **"Tools -> Interposer Programmer"** (see Figure 5.225).

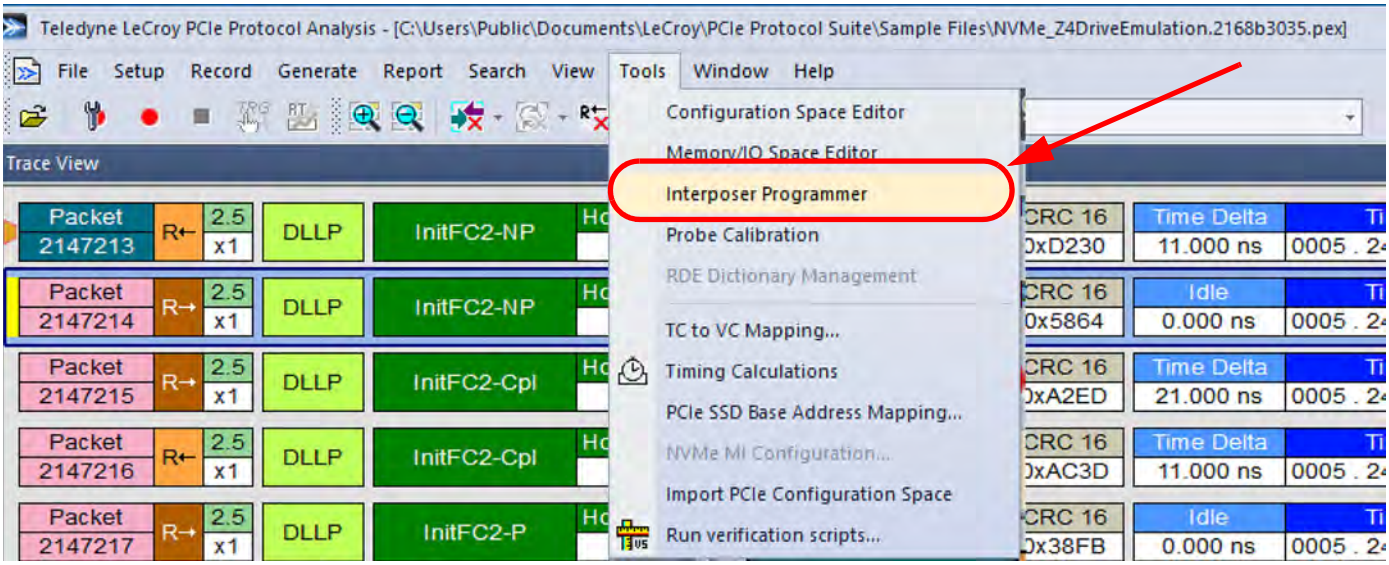


Figure 5.225: Tools: Interposer Programmer

This will bring the dialog with an option to connect the interposer via FTDI/USB-C. See Figure 5.226 on page 417.

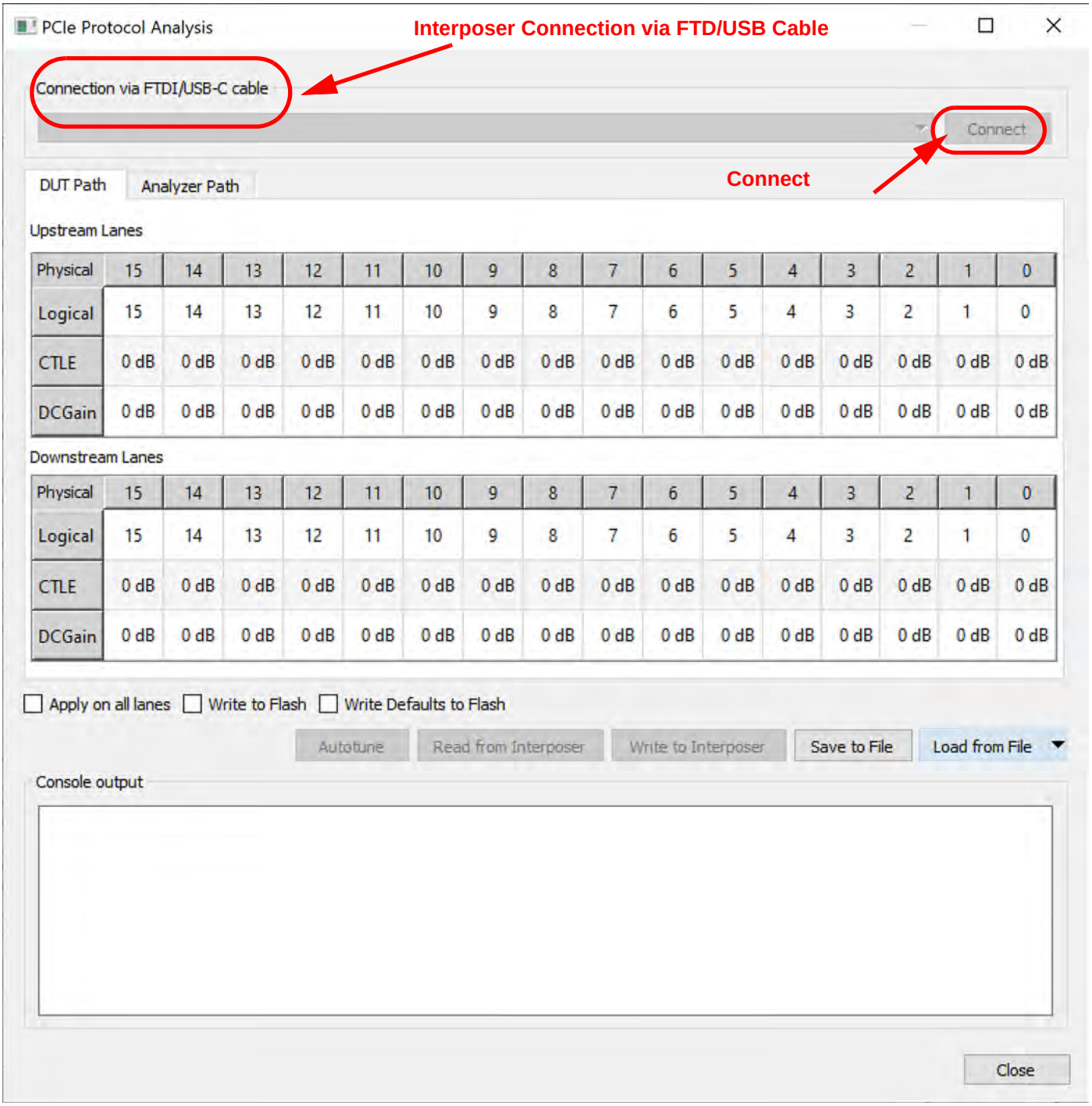


Figure 5.226: PCIe Interposer Programmer Utility

1. Power on the Interposer (if not already powered up).
2. Select the Connect button on the right side of the dialog box. See Figure 5.226 on page 417.

Again, this is only needed for bifurcated link setups and if there is an error on the recoding option dialog i.e. on "Host-To-DUT" tab. The dialog control will work the same as described earlier in the section (“Start auto-tuning process:” on page 362).

5.20.1.1 Saving Auto-Tune and Calibration Results

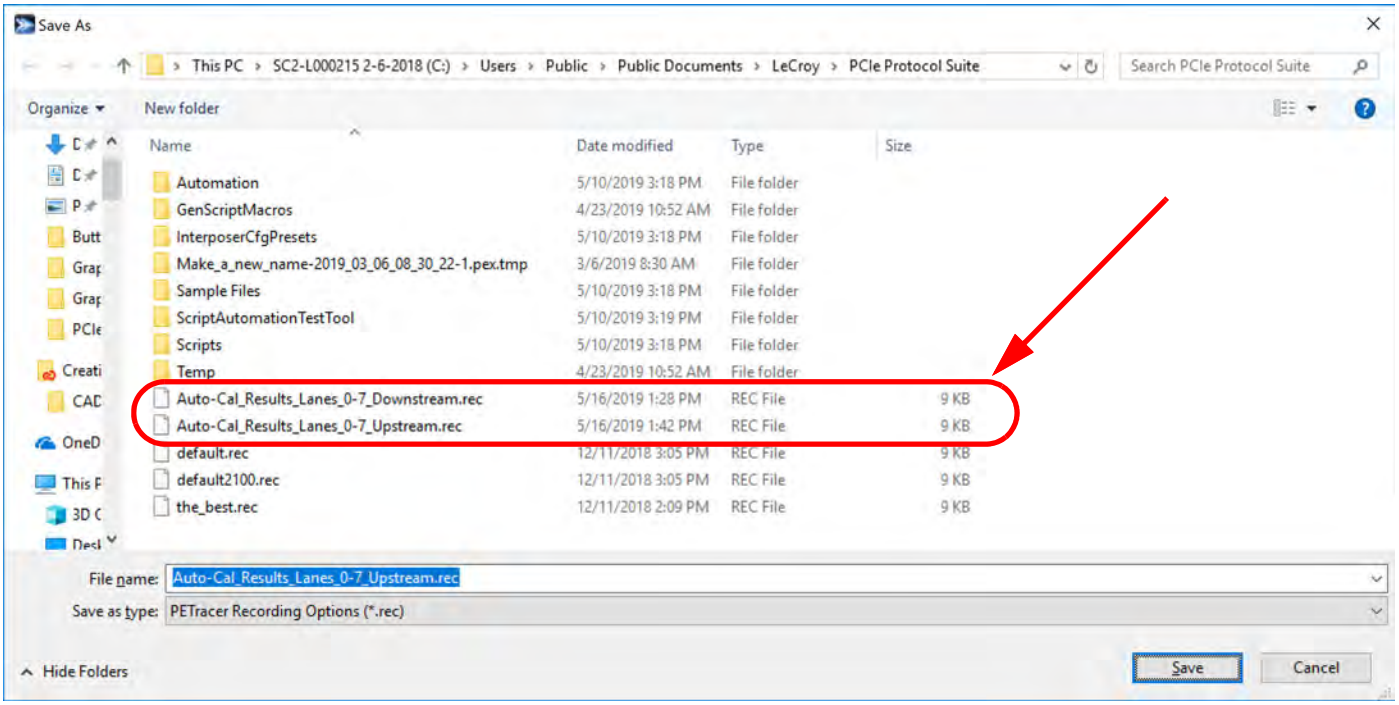


Figure 5.227: Directory ot Saved Auto-calibration Results

You can also Save, Save as Default, Load, Load Default or Restore Factory Settings. See Figure 5.228.

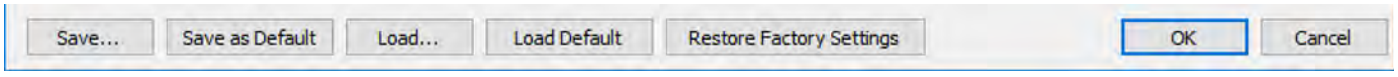


Figure 5.228: Save, Save as Default, Load, Load Default or Restore Factory Settings

5.20.2 Autotune and Probe Calibration Wizard

You can bring up the Autotune and Probe Calibration Wizard, which will guide you through the calibration of your device. See Figure 5.229.

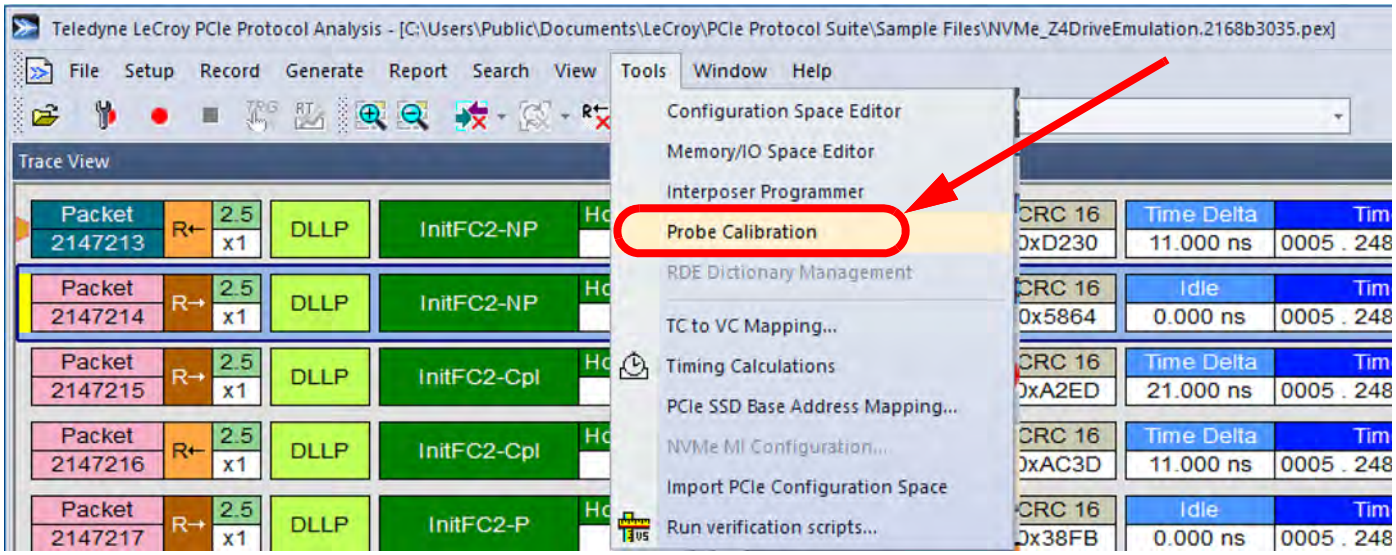


Figure 5.229: Tools -> Probe Calibration

Selecting Probe Calibration will bring up the Autotune Wizard. See Figure 5.230 on page 420.

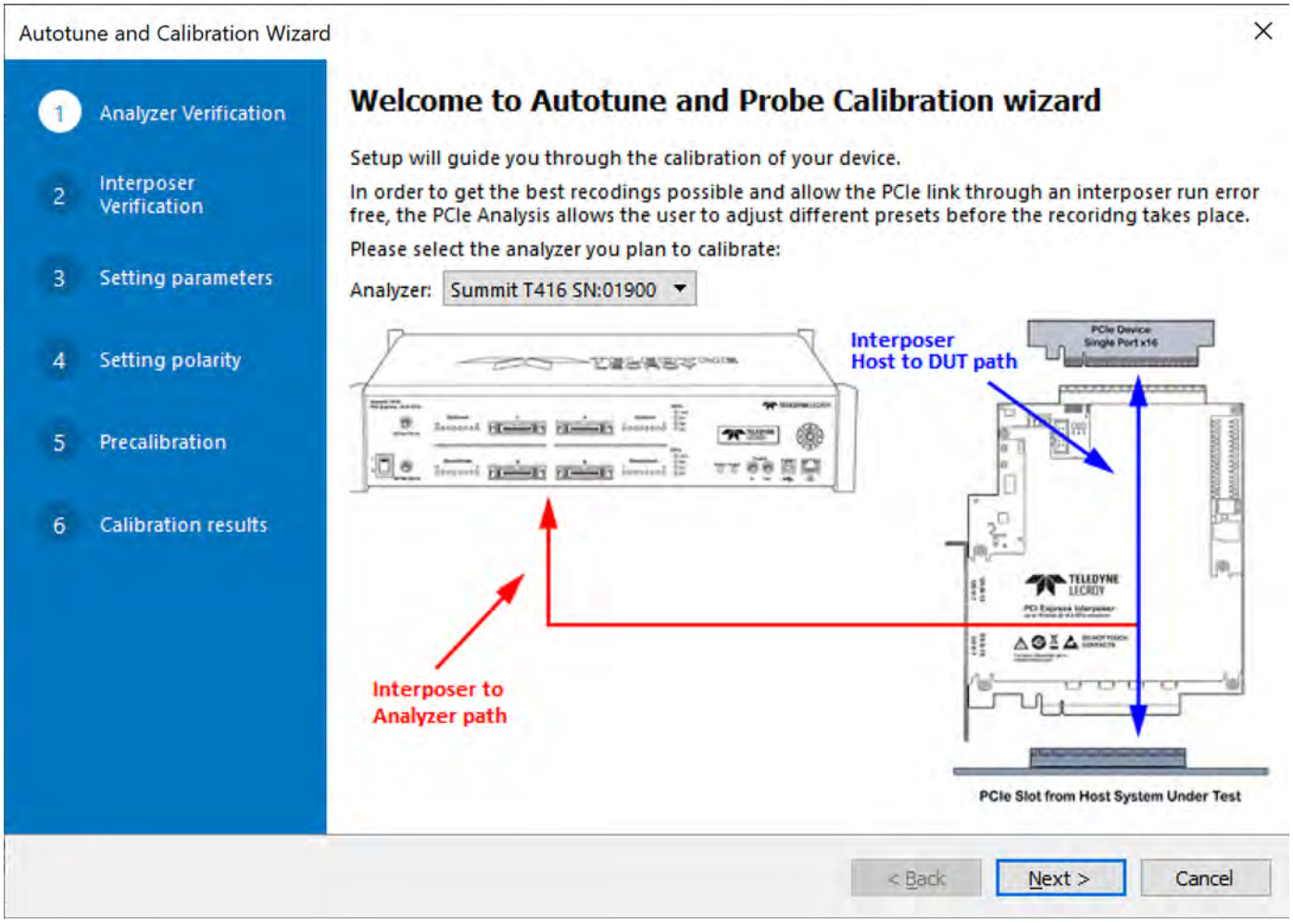


Figure 5.230: Autotune and Probe Calibration Wizard

The Autotune and Probe Calibration Wizard will guide your through the following steps:

- Analyzer Verification
- Interposer Verification
- Setting Parameters
- Setting Polarity
- Precalibration
- Calibration Results

Note: The Autotune Wizard does not support lane reversal.

5.21 Preparing to Record in NVMe Enhanced Mode

Several prerequisite steps are required to ensure the system is configured properly for recording in NVMe enhanced mode. A PCI Protocol recording should be taken in L0 to determine that all the PCIe link parameters are selected correctly to record without errors. Once that is done the link parameters should not be changed for later recordings.

Secondly, a PCIe protocol recording should be taken of the complete power up and connection sequence between the NVMe device and host. This boot recording is required to map all of the configuration registers, devices, submission and completion command queues and other resources to the correct address spaces. These mappings will be used automatically by NVMe Enhanced Mode to create a set of filters to only filter in and record traffic from the correct set of devices and resources.

A boot recording will be automatically recognized by the software and saved for later sessions. It is recommended to capture a new boot recording for each session because resources can be created and deleted in the gap between a boot recording and an NVMe Enhanced Mode recording and those resources created in the interim will not be recognized correctly.

There are three separate methods to use the NVMe Enhanced Recording Mode.

- Snapshot – Simple Mode
- Snapshot – Advanced Mode
- Event Trigger – Advanced Mode

The simplest is the Snapshot in Simple mode as described below.

Note: The screen shots for NVMe Enhanced Mode are for the T34 but the T416 and T48 have similar options.

5.21.1 Snapshot – Simple Mode

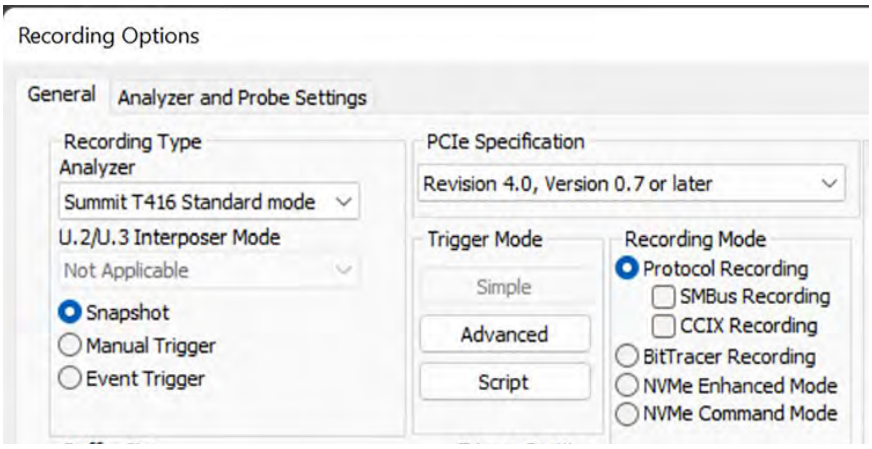


Figure 5.231: NVMe Enhanced Recording Mode

When the NVMe Enhanced Mode button is selected the following warning will popup in the Recording Panel (under NVMe Device ID#) if an SSD Device Configuration File has not been stored. To generate and store an SSD Device Configuration File is a two step process:

- First record a boot trace
  (see http://teledynelecroy.com/doc/capture-of-an-nvme-boot-up-trace-appnote)
- Second, Export the SSD Device Configuration File

5.21.1.1 Features

NVMe Enhanced Recording Mode allows filtering of all traffic except the exact traffic desired by the user. This will extend the potential recording depth to millions of commands and allow recording over time intervals that were previously impossible.

Simple recording mode is shown below (Figure 5.232) and shows the available resources to filter in: NVMe Commands, Doorbells, Controller Registers, MSI interrupts, ACKs and Device Config, along with all the available devices detected in the boot recording. Selecting a check box will include that type of traffic in the recording.

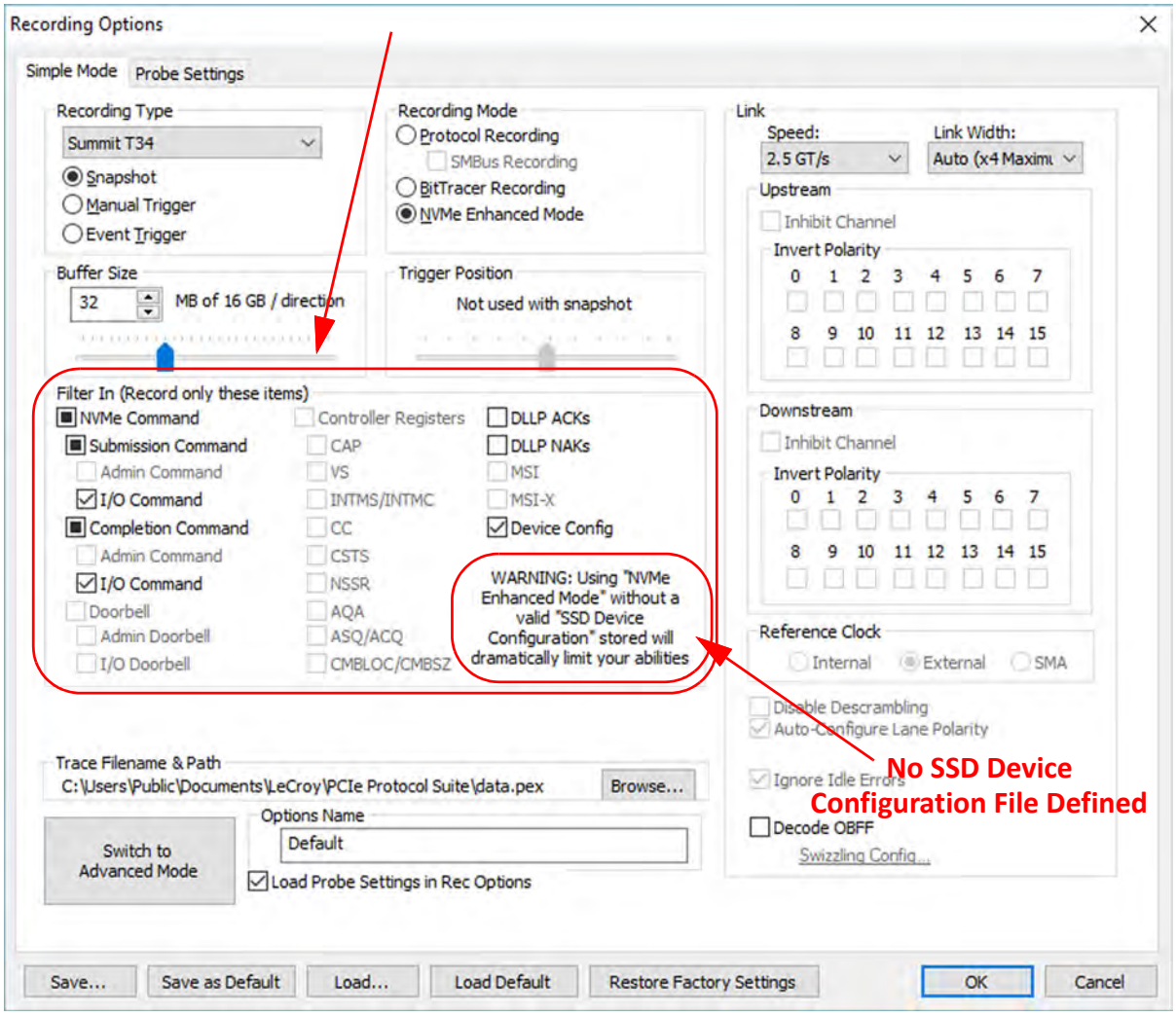


Figure 5.232: NVMe Enhanced Recording Mode: Snapshot - Simple Mode, Device not Defined

If you had defined a valid SSD Device Configuration the Recording Menu would display the device under test. See Figure 5.233 on page 423. A sample SSD Device Configuration file is shown in "SSD Device Configuration File" on page 428.

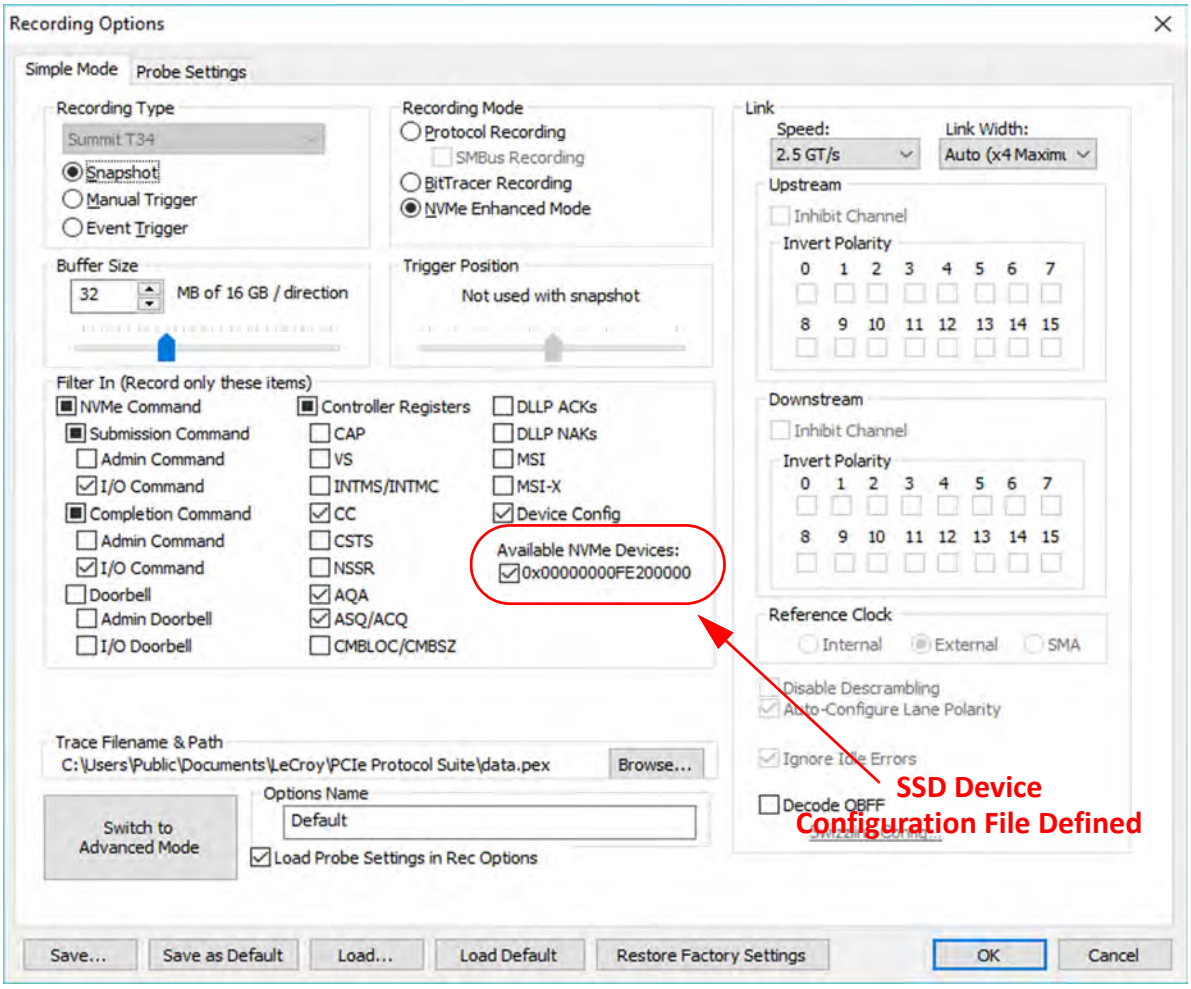


Figure 5.233: NVMe Enhanced Recording Mode: Snapshot - Simple Mode, Device Defined

Note: If you try and go to Event Trigger - Simple mode the following warning message pops up:

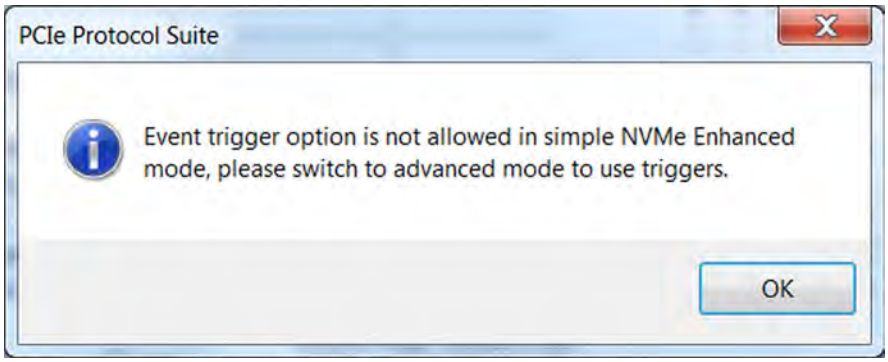


Figure 5.234: NVMe Enhanced Mode: Event Trigger - Simple Mode

5.21.2 Snapshot – Advanced Mode

The General options in Snapshot - Advanced Mode are shown below:

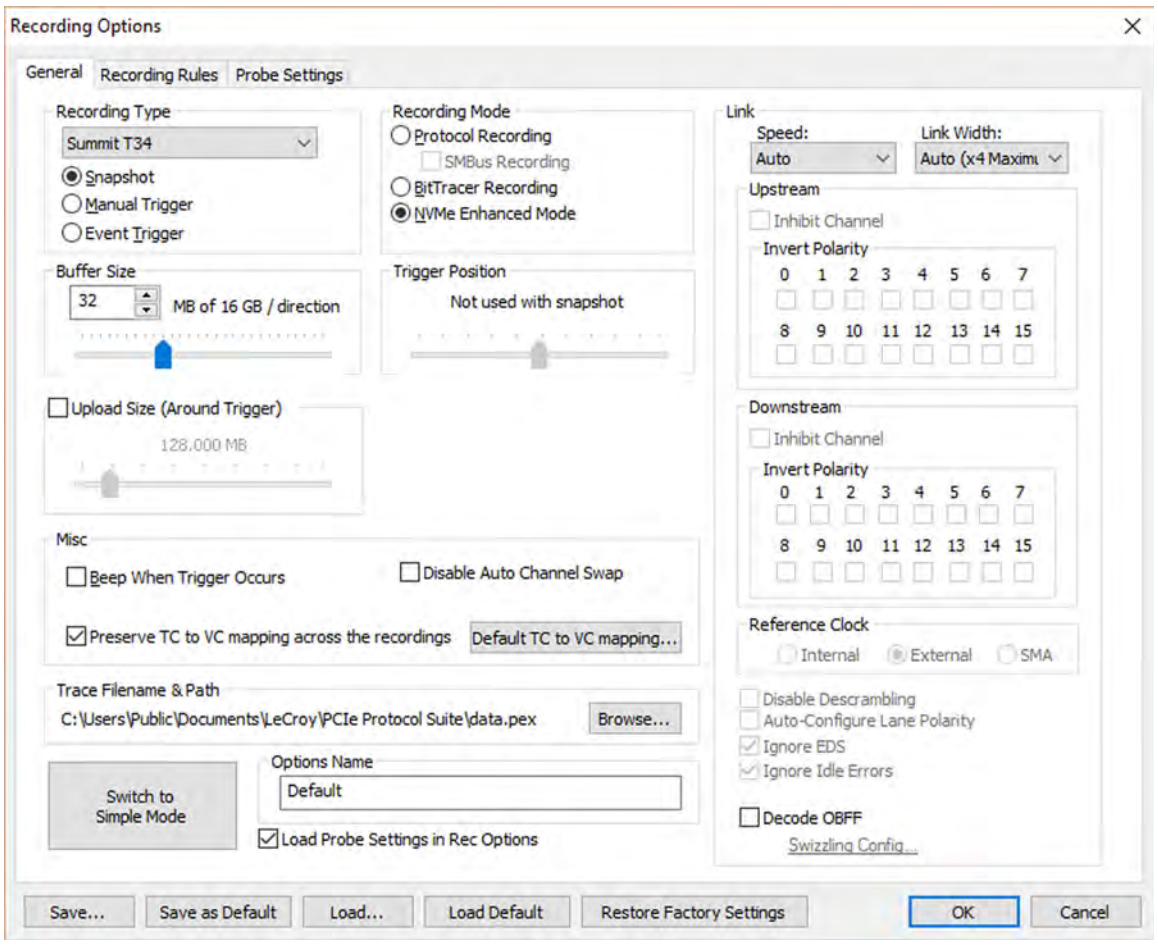


Figure 5.235: NVMe Enhanced Mode: Snapshot-Advanced Mode

Open the Recording Rules to see that an NVMe Enhanced Mode Event has been automatically added to the Recording Rules (see Figure 5.236 on page 424).

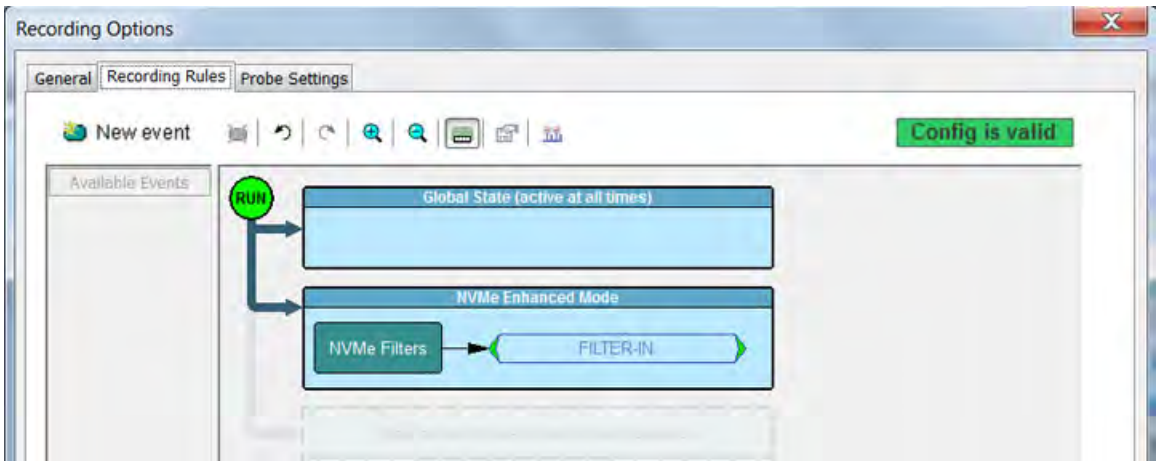


Figure 5.236: NVMe Enhanced Mode: NVMe Filters Event Added

Select the NVMe Filters box to bring up the following dialog. After selecting the options you want click on the “OK” button.

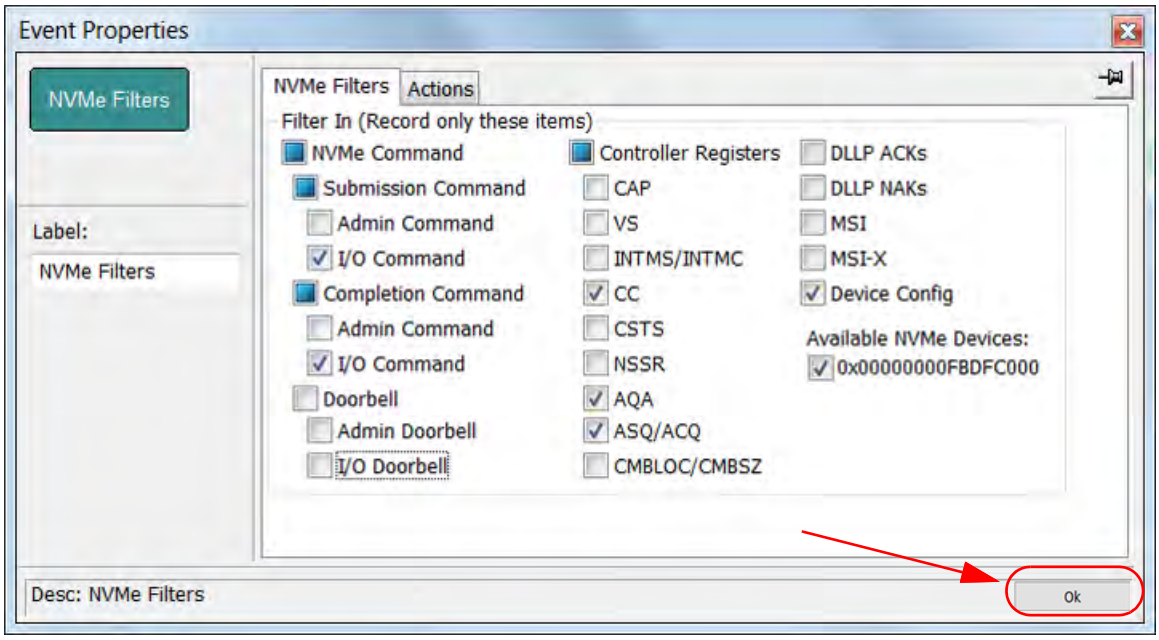


Figure 5.237: NVMe Enhanced Mode: NVMe Filters

Note: No Actions are available at this time.

5.21.3 Event Trigger – Advanced Mode

Changing to Event Trigger -> Advanced Mode will pop up the following dialog. See Figure 5.238.

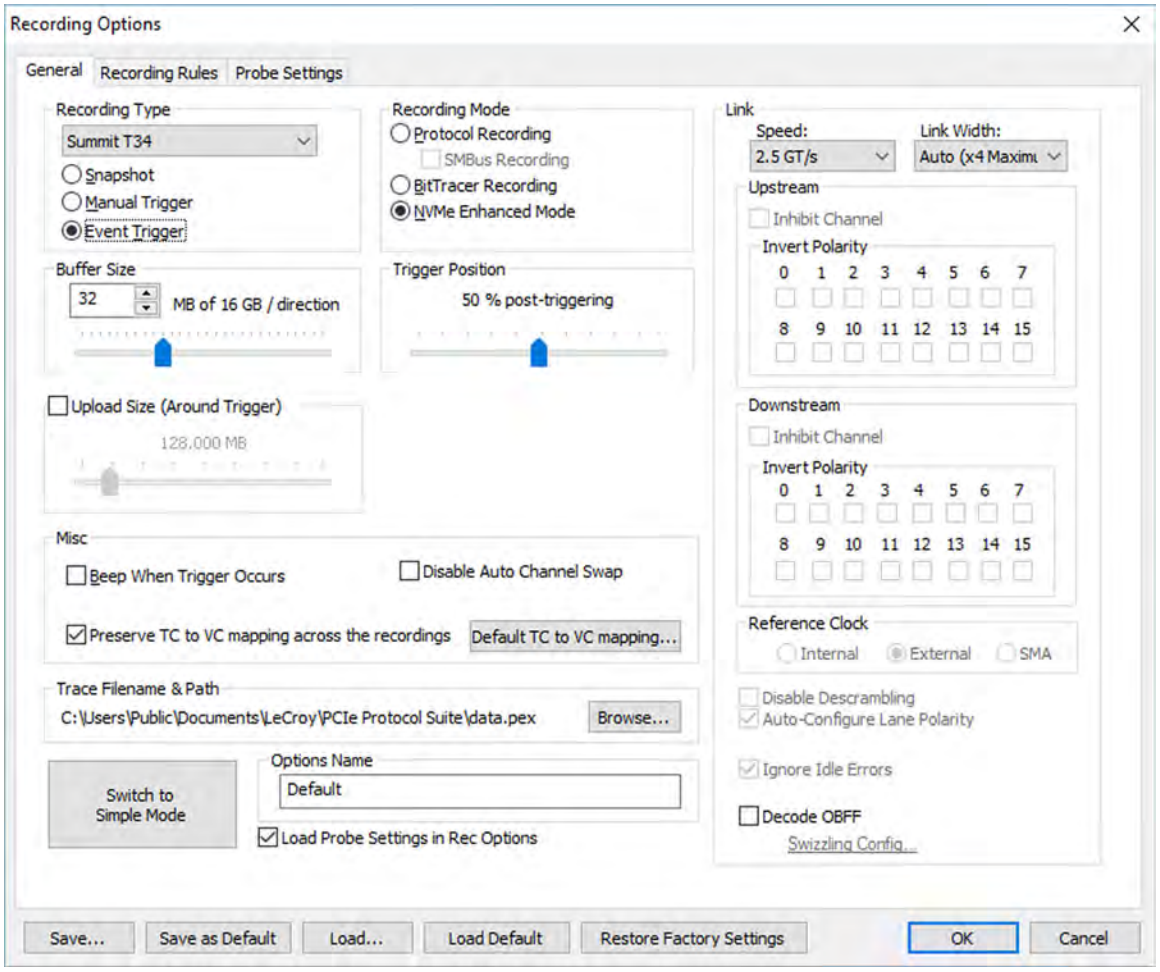


Figure 5.238: NVMe Enhanced Recording: Event Triggered - Advanced Mode

Selecting Recording Rules will pop up the same warning message if a boot trace and SSD Device Configuration File have not been generated (see Figure 5.232 on page 422).

The next step is to continue defining your Recording Rules:

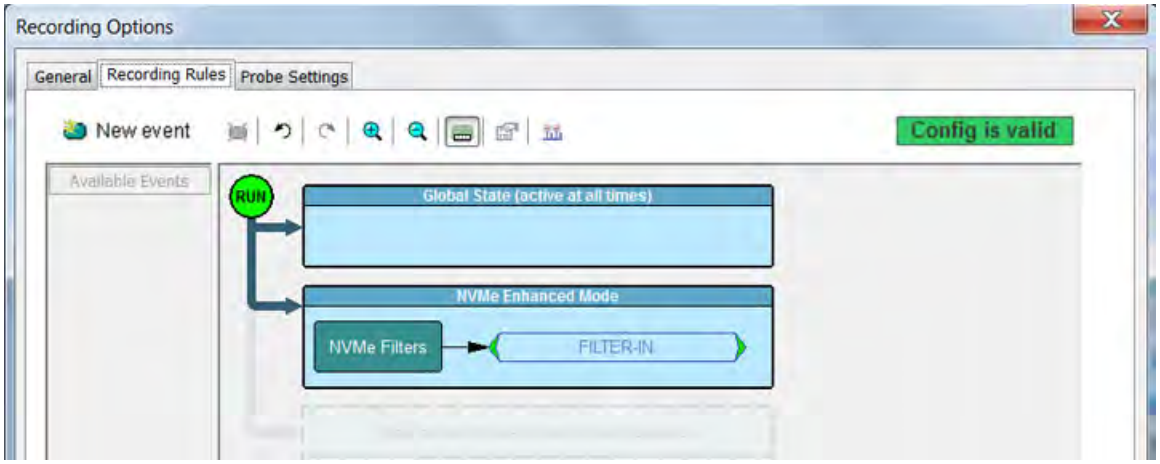


Figure 5.239: NVMe Enhanced Recording Mode: Defining Recording Rules

The NVMe Filters in Enhanced Mode are the same in both Snapshot - Advanced Mode and Triggered Event - Advanced Mode: See Figure 5.240 on page 427. After selecting the options you want click on the “OK” button.

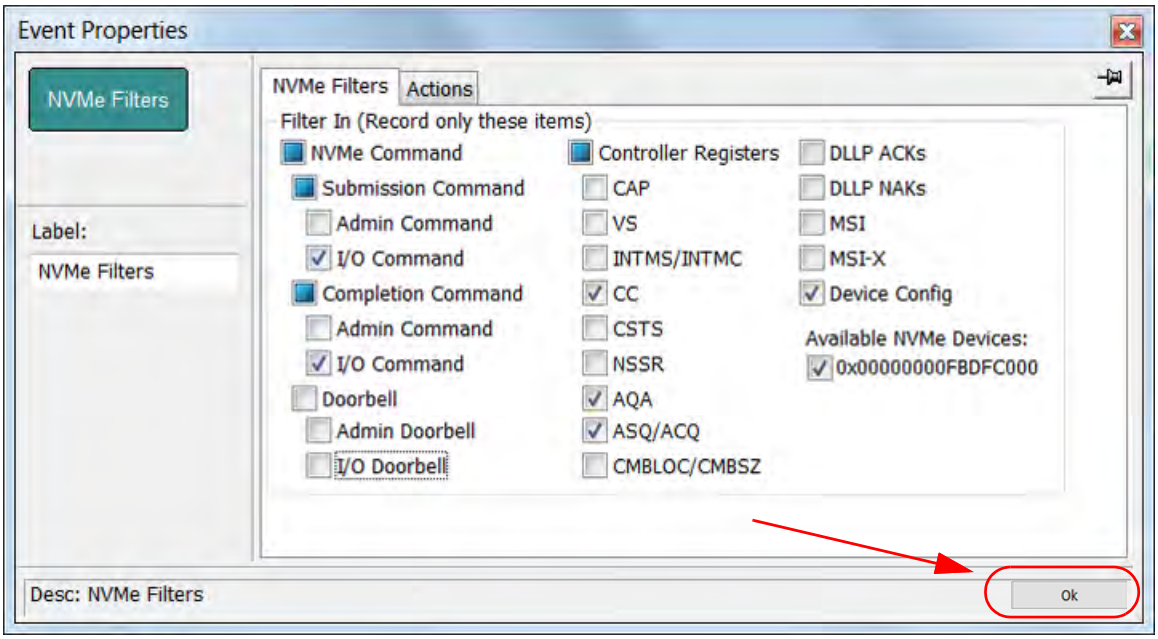


Figure 5.240: Triggered Event - Advanced Mode: Filter Options

Note: No Actions are available at this time.

Now that you have the NVMe Enhanced Mode/NVMe Filters in place, you can continue refining your triggering criteria and then start recording data.

Note: If you try and return to Event Trigger - Simple mode, the GUI automatically changes to Simple Mode - Snapshot, see Figure 5.241 on page 428.

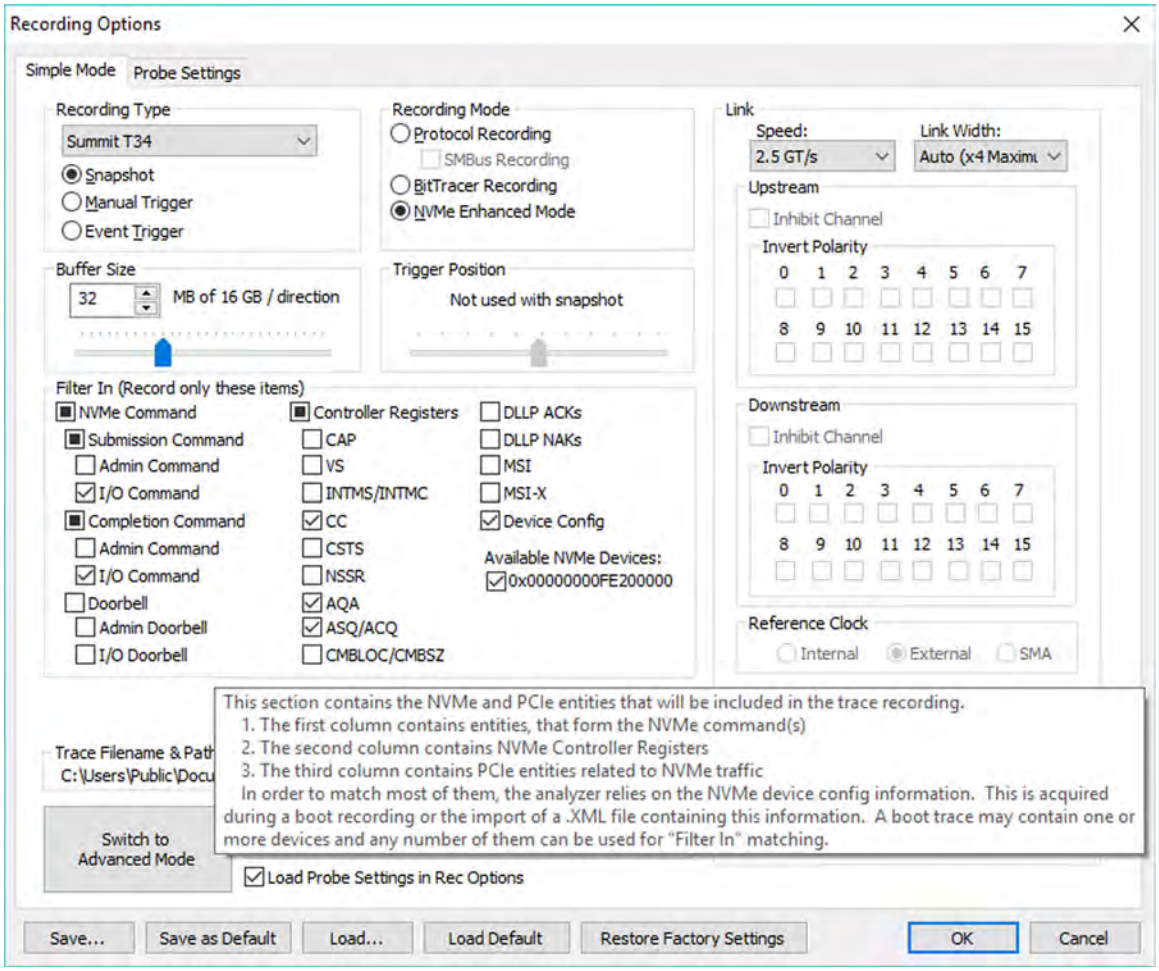


Figure 5.241: NVMe Enhanced Mode: Simple Mode - Snapshot

5.21.4 SSD Device Configuration File

As explained earlier in "Preparing to Record in NVMe Enhanced Mode" on page 421 an XML file is one way to enable the analyzer to run in NVMe Enhanced Mode. A typical XML file, which works in both Simple and Advanced Mode is shown below:

This XML file would be located in the C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Temp directory.

<?xml version="1.0"?>

<DEVICES XML_FORMAT_VERSION="1.0"><DEVICE GUID="{1B105360-2808-4A07-AFE4-AF49F1D61CC6}" ENABLE="0x1" DEVICEID="006:00:0" VENDORID="0" CLASSCODE="67586" DEVICENAME="" TRANSACTION_LIFETIME_NS="0">

<BARS><MBAR ID="0" VALUE="0xFBDFC000"/><BAR ID="2" VALUE="0x00000000"/><BAR ID="3" VALUE="0x00000000"/><BAR ID="4" VALUE="0x00000000"/><BAR ID="5" VALUE="0x00000000"/></BARS>

<PROTOCOL IOSQES="6" MQES="64" ASQS="127" PROTOCOL="NVME" ACQS="127" DSTRD="4" IOCQES="4" LBASIZE="512" MPS="4096"/><Queues><Queue IR_VECTOR="0" ADDRESS="0x23F3BC000" SIZE="64" QID="0" IR_ENABLED="0" TYPE="ASQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E641000" SIZE="1024" QID="8" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E76D000" SIZE="1024" QID="11" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E7D1000" SIZE="1024" QID="12" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F143000" SIZE="1024" QID="4" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E6A5000" SIZE="1024" QID="9" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"

ADDRESS="0x23E709000" SIZE="1024" QID="10" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F07B000" SIZE="1024" QID="2" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F1A7000" SIZE="1024" QID="5" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23EFCB000" SIZE="1024" QID="7" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F1CA000" SIZE="1024" QID="6" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F0DF000" SIZE="1024" QID="3" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F3DD000" SIZE="1024" QID="1" IR_ENABLED="0" TYPE="IOSQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F3BE000" SIZE="16" QID="0" IR_ENABLED="0" TYPE="ACQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E651000"
SIZE="1024" QID="8" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E6B5000" SIZE="1024" QID="9"
IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23F3ED000" SIZE="1024" QID="1" IR_ENABLED="0"
TYPE="IOCQ"/><Queue IR_VECTOR="0" ADDRESS="0x23E77D000" SIZE="1024" QID="11" IR_ENABLED="0" TYPE="IOCQ"/
><Queue IR_VECTOR="0" ADDRESS="0x23E7E1000" SIZE="1024" QID="12" IR_ENABLED="0" TYPE="IOCQ"/><Queue
IR_VECTOR="0" ADDRESS="0x23F153000" SIZE="1024" QID="4" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23E719000" SIZE="1024" QID="10" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F08B000" SIZE="1024" QID="2" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F1B7000" SIZE="1024" QID="5" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23EFDB000" SIZE="1024" QID="7" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F1DA000" SIZE="1024" QID="6" IR_ENABLED="0" TYPE="IOCQ"/><Queue IR_VECTOR="0"
ADDRESS="0x23F0EF000" SIZE="1024" QID="3" IR_ENABLED="0" TYPE="IOCQ"/></Queues><Namespaces/><Interrupts/></
DEVICE></DEVICES>

5.22 NVME Command Mode

Note: NVME Command Mode is available only for the following Summit T4 modes:

- T416 Standard Mode
- T48 Standard Mode
- T48 (2 units)

NVME Command mode is a Recording Option and is similar to NVMe Enhanced mode. However, NVME Command Mode allows you to filter in specific NVMe commands and registers. It also supports some PCIe filtration, such as DLLPs and interrupts. NVME Command Mode supports commands according to NVMe 2.0 specification.

NVME Command Mode has options for Simple Mode and Advanced Mode.

5.22.1 NVME Command Mode - Simple verses Advanced Mode

When you select Simple mode while in NVME Command Mode then commands, warnings, and the **Set Namespace ID** button display in the General tab in Recording Options. See Figure 5.242.

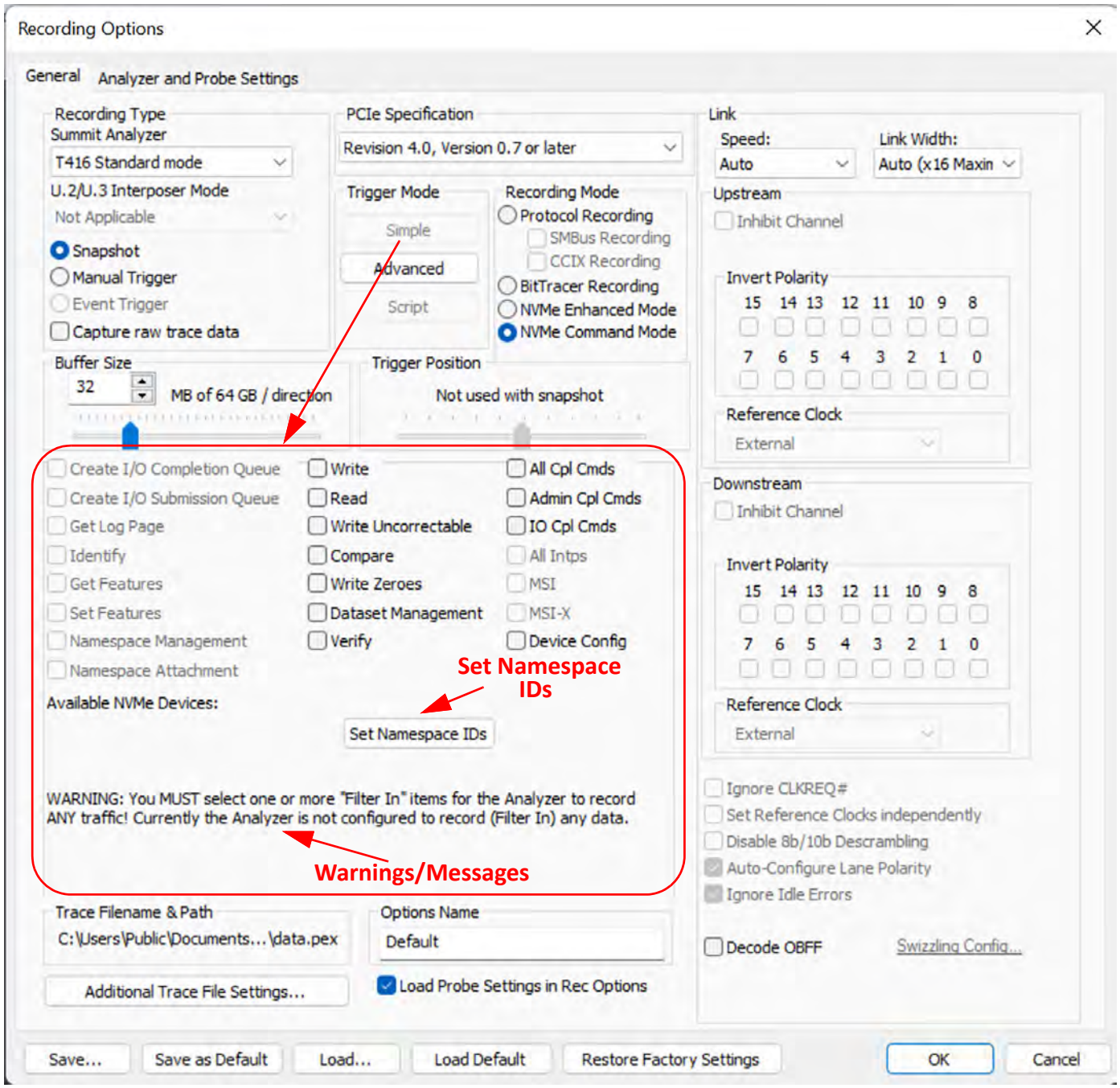


Figure 5.242: NVME Command Mode: Simple Mode

When selecting Advanced Mode in NVME Command Mode, the Recording Rules tab appears. Commands, warnings, and the **Set Namespace IDs** button are on the Recording Rules tab. See Figure 5.243 and Figure 5.244.

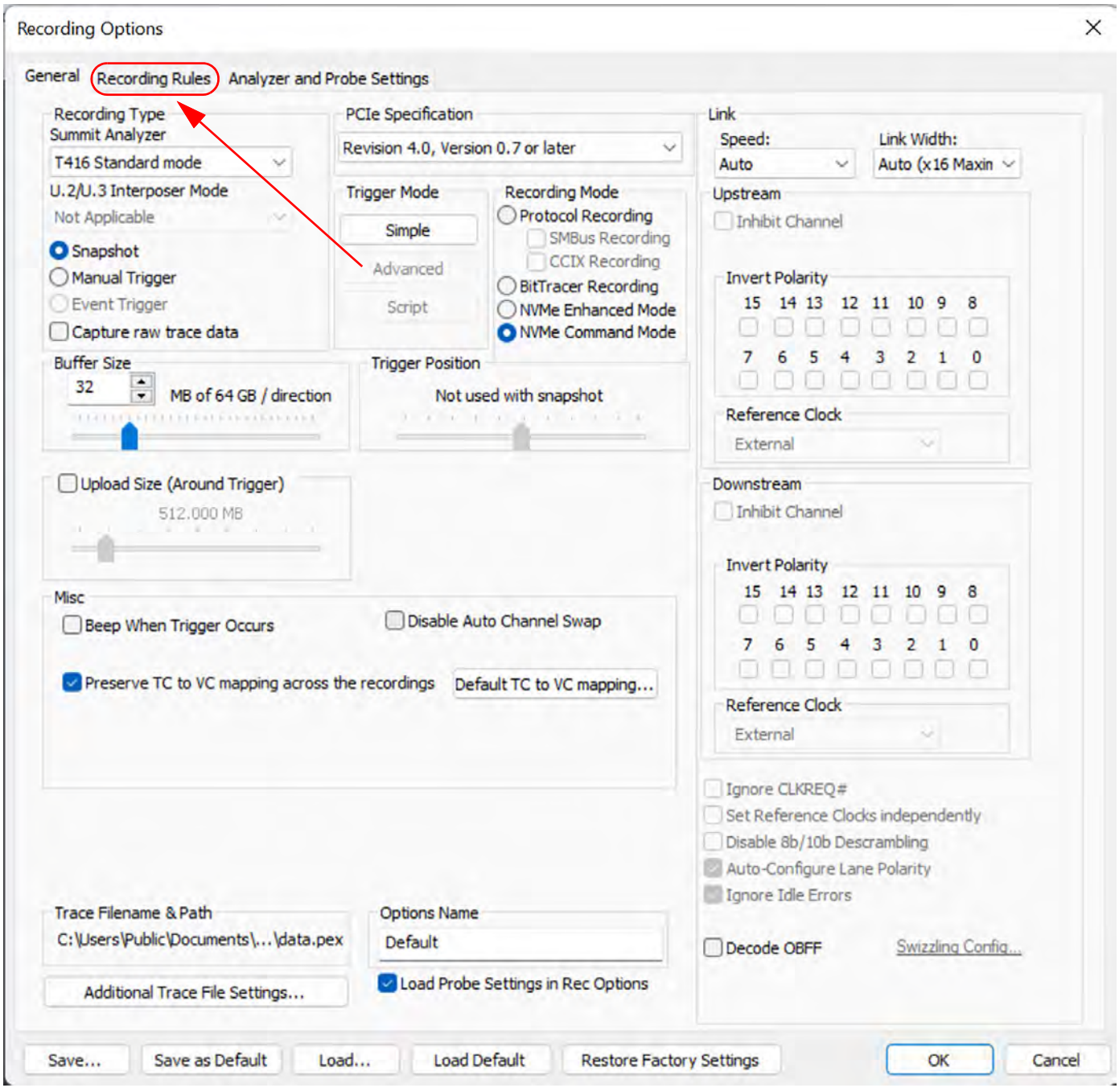


Figure 5.243: NVME Command Mode: Advanced Mode

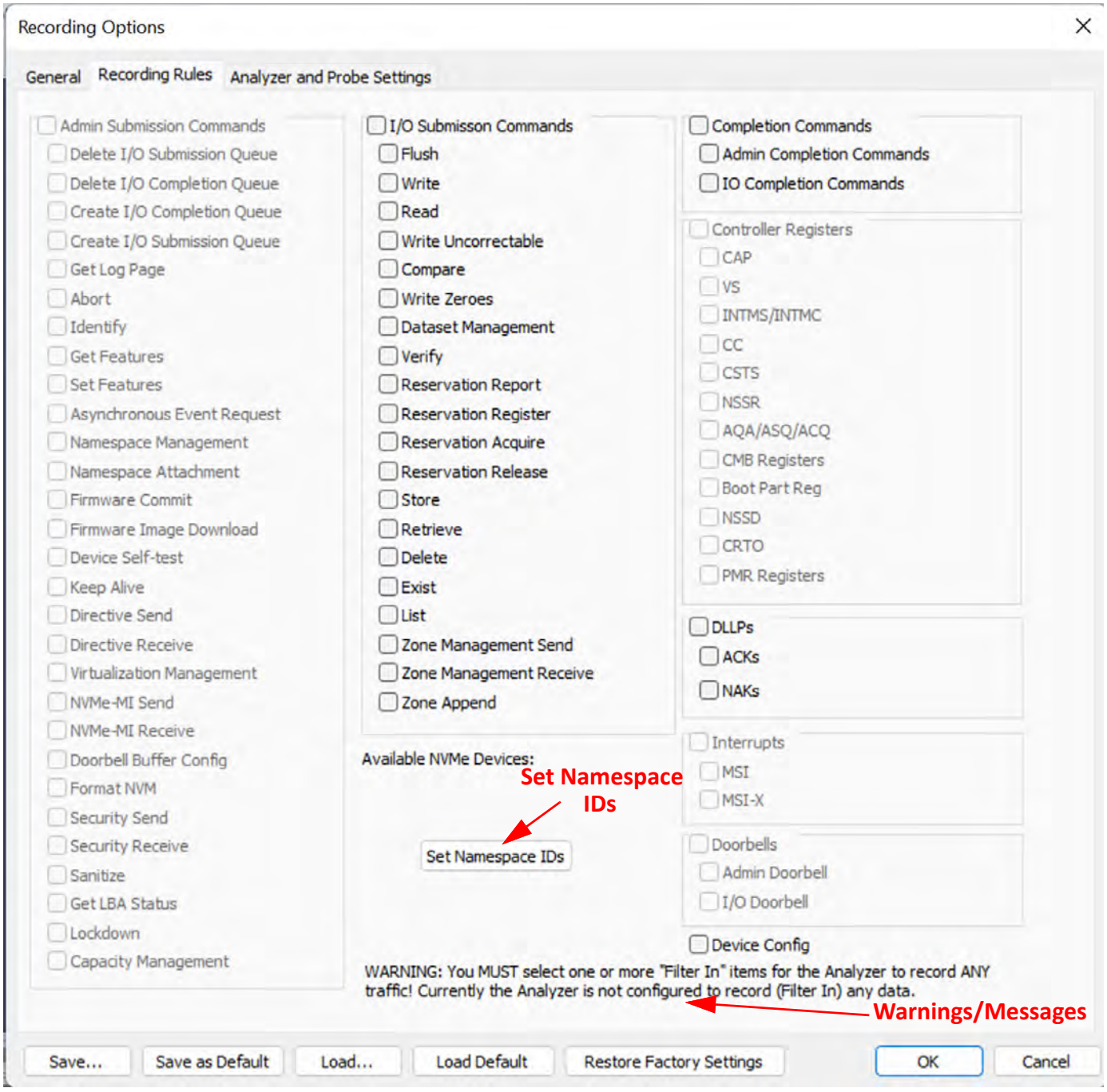


Figure 5.244: NMVE Command Mode: Advanced Mode Recording Rules

5.22.2 Set Namespace IDs

With NVME Command Mode, you can set namespace identifications using the **Set Namespace IDs** button. See Figure 5.245.



Figure 5.245: NVME Command Mode: Set Namespace IDs

5.22.3 NVME Command Mode Warnings

Warnings exist within NVME Command Mode to help you create the best recordings for your devices.

When you first click on NVME Command Mode and do not have a valid SSD Device Configuration, a warning displays. See Figure 5.246.

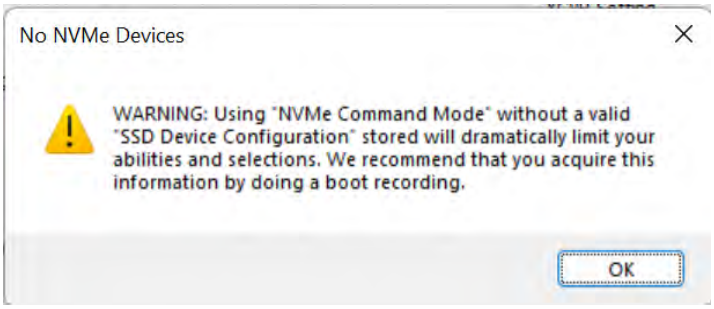


Figure 5.246: Warning: No valid SSD Device Configuration

If you do not select any NVME Command Space filters, then the following message displays:

Warning: You MUST select one or more “Filter In” items for the Analyzer to record ANY traffic! Currently the Analyzer is not configured to record (Filter In) any data.

If you select too many filters, then the following message displays:

Not enough bus engine resources to fit this item. Precision can decrease.

Chapter 6

Reading CATC Traces

6.1 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.

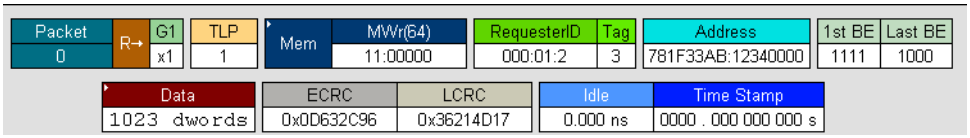


Figure 6.1: Typical CATC Trace

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.

6.2 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.

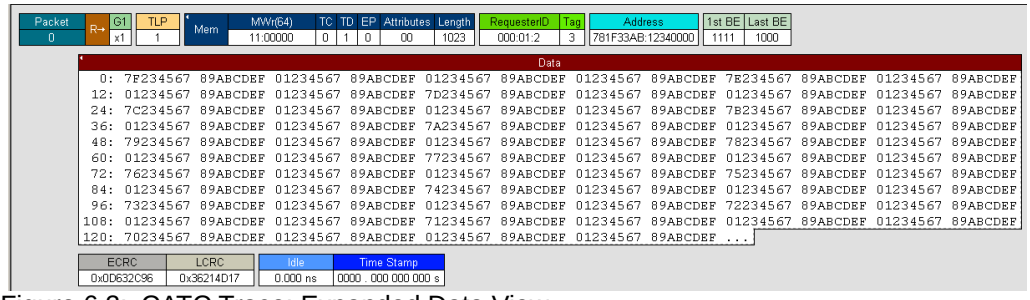


Figure 6.2: CATC Trace: Expanded Data View

A repeat of any above methods causes the display to return to a Short Data format.

6.3 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.

6.4 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.

6.5 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

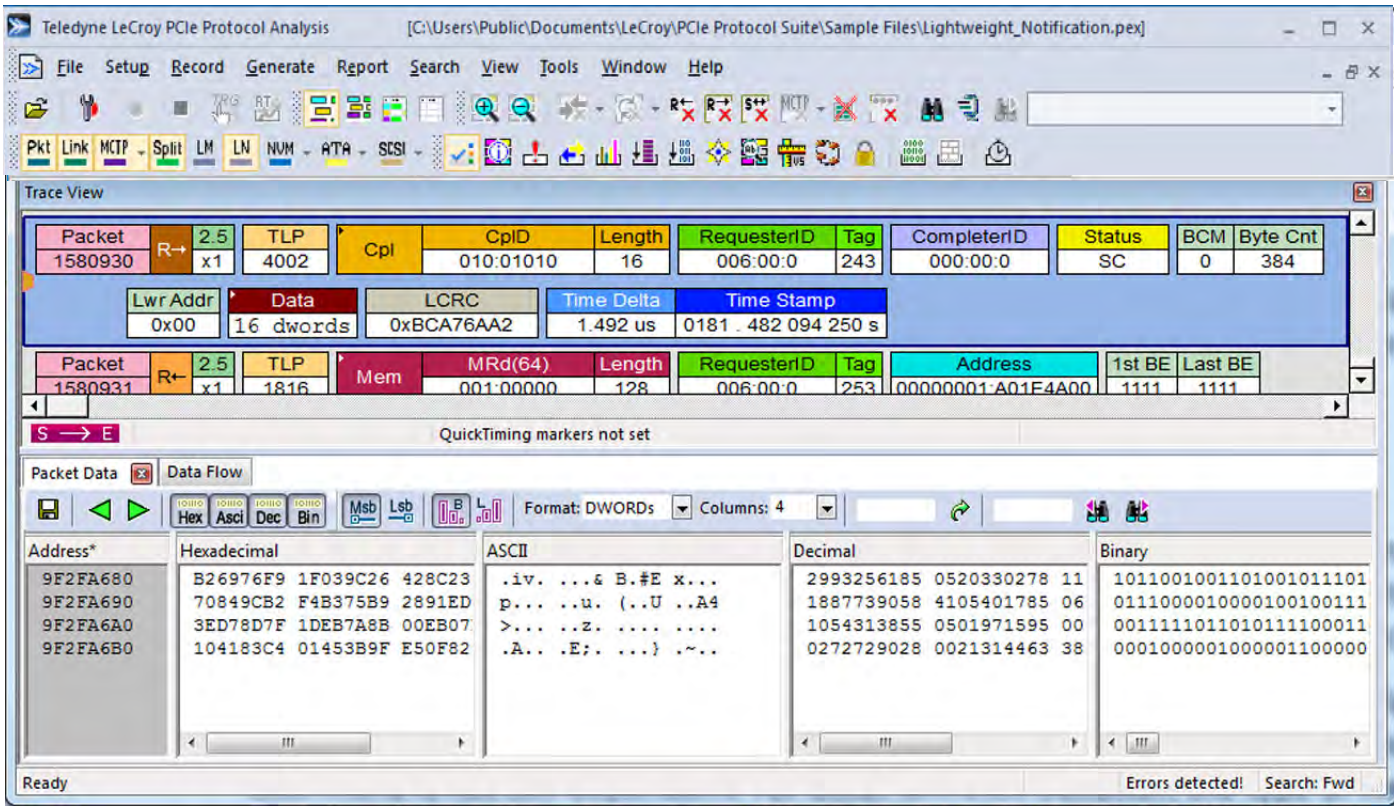


Figure 6.3: Viewing a Data Block

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.

6.5.1 Save Data Block

You can also **Save** the data in Hexadecimal, ASCII, Decimal, or Binary formats. See Figure 6.4.

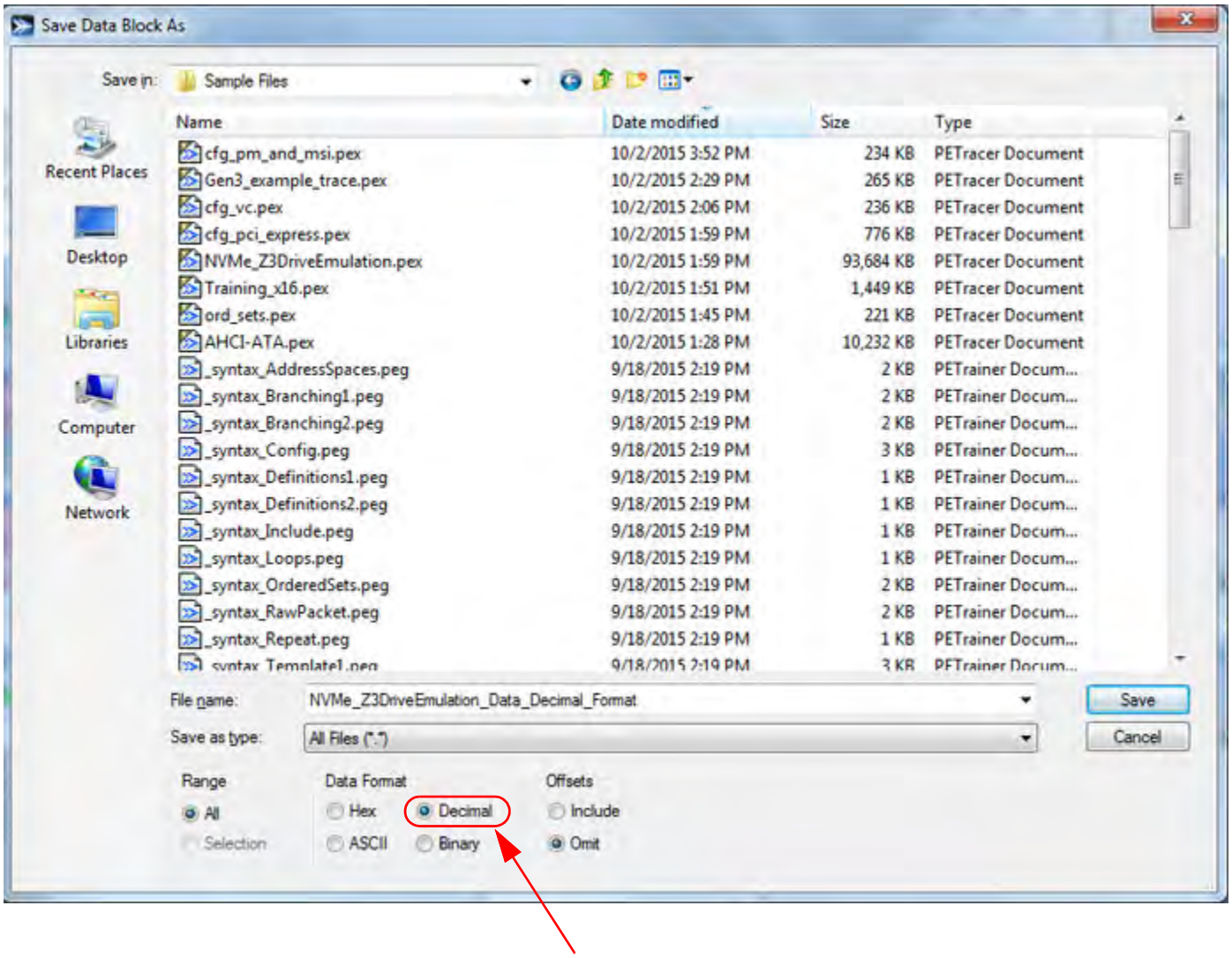


Figure 6.4: Save Data Block In Hex, Decimal, ASCII or Binary

The Saved file is shown in Figure 6.5 on page 424.

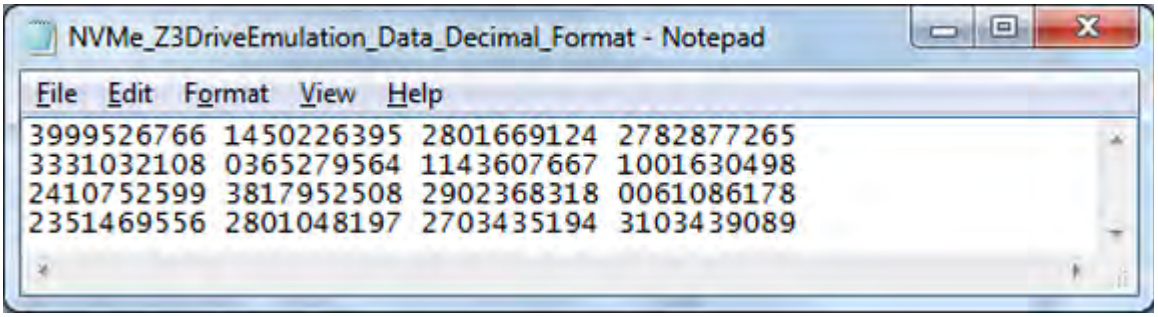


Figure 6.5: Saved Data File in Decimal Format

6.6 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.

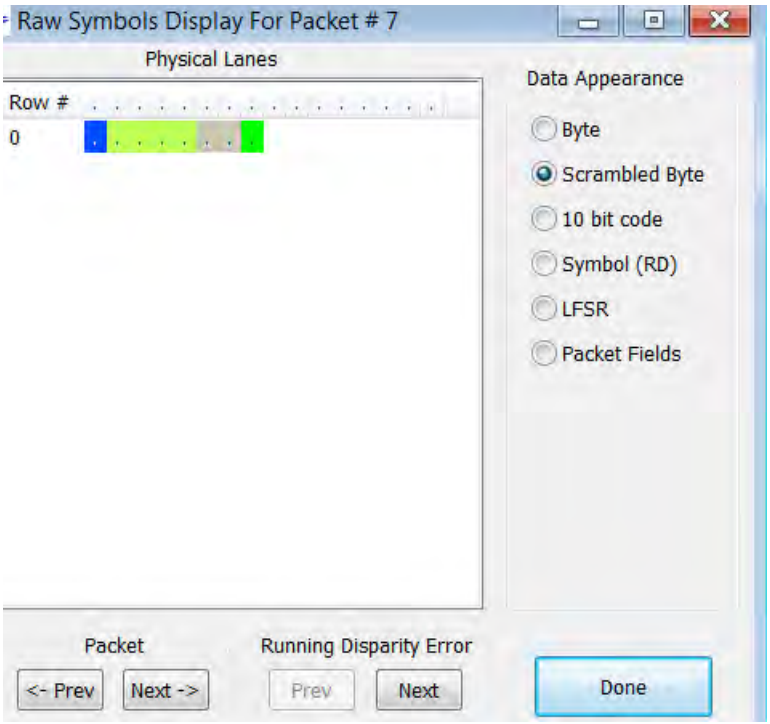


Figure 6.6: Show Raw 10b Codes Dialog

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.

6.7 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).

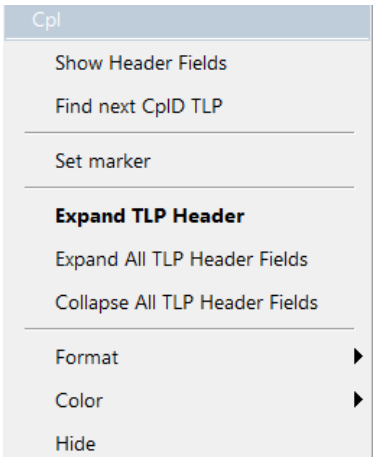


Figure 6.7: CATC Trace View: Header Popup Menu

2. Select **Show Header Fields**. The following dialog opens.

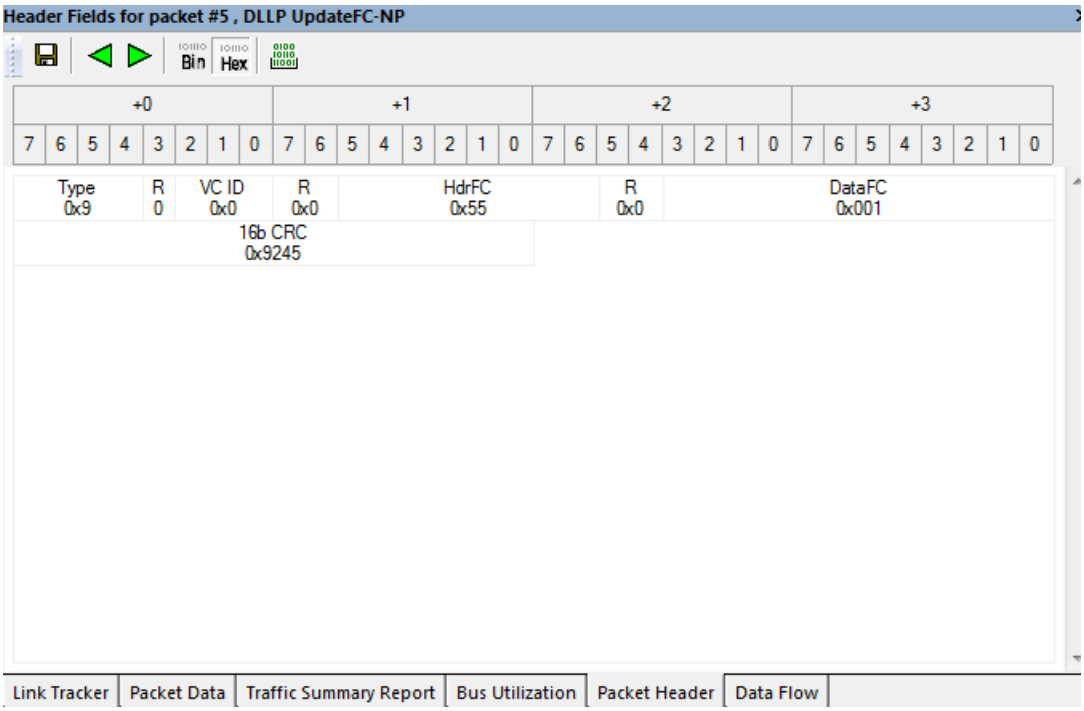


Figure 6.8: Viewing Packet Fields

3. Use the **Prev** and **Next** buttons to navigate to other headers.

6.8 Packet Cell Popup Menus

The Packet cell has a right-click pop-up menu that includes the following topics. See Figure 6.9.

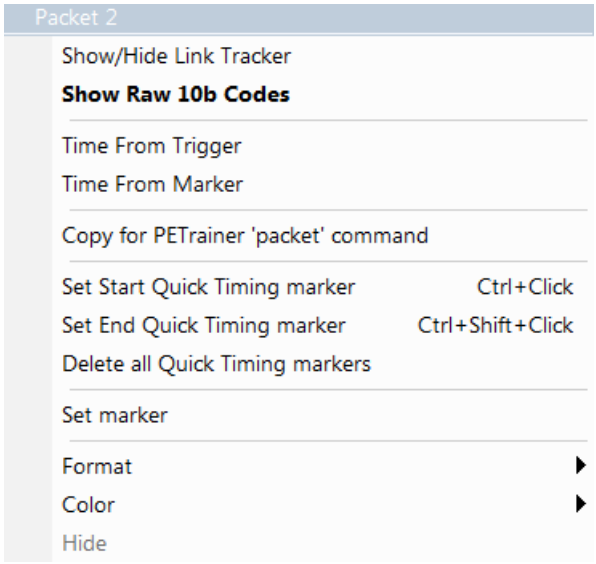


Figure 6.9: Packet Cell Popup Menu

Each topic can be selected and generate more information about the topic. The following sections describe each of the topics in the menu.

6.8.1 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 6.10.

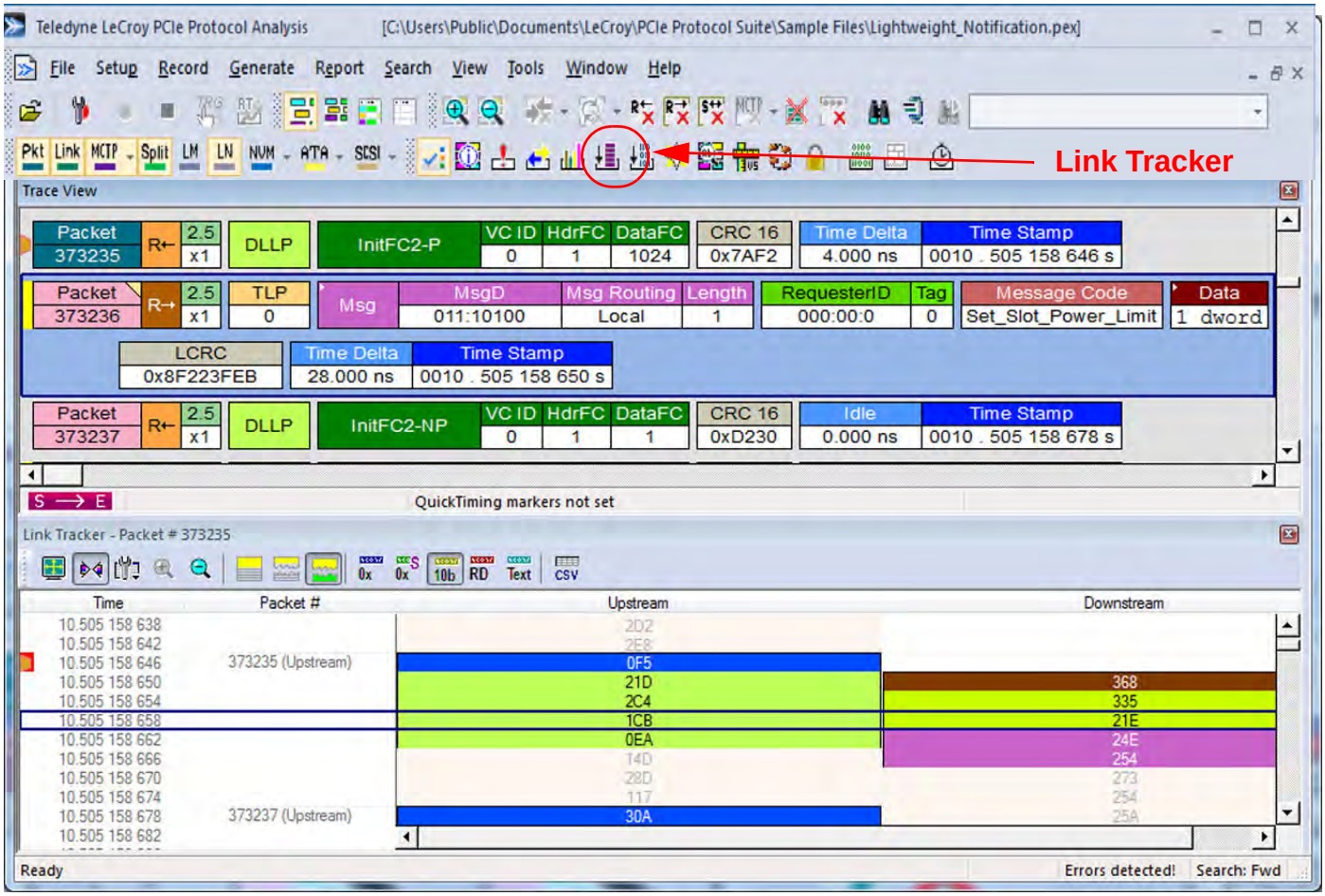


Figure 6.10: Packet Cell Popup Menus: Trace View and Link Tracker View

Link Tracker is discussed in more detail in “Link Tracker” on page 704.

6.8.2 Show Raw 10b Codes

Click on Show Raw 10b Codes and the Raw Symbols Display for the selected Packet pops up. See Figure 6.11.

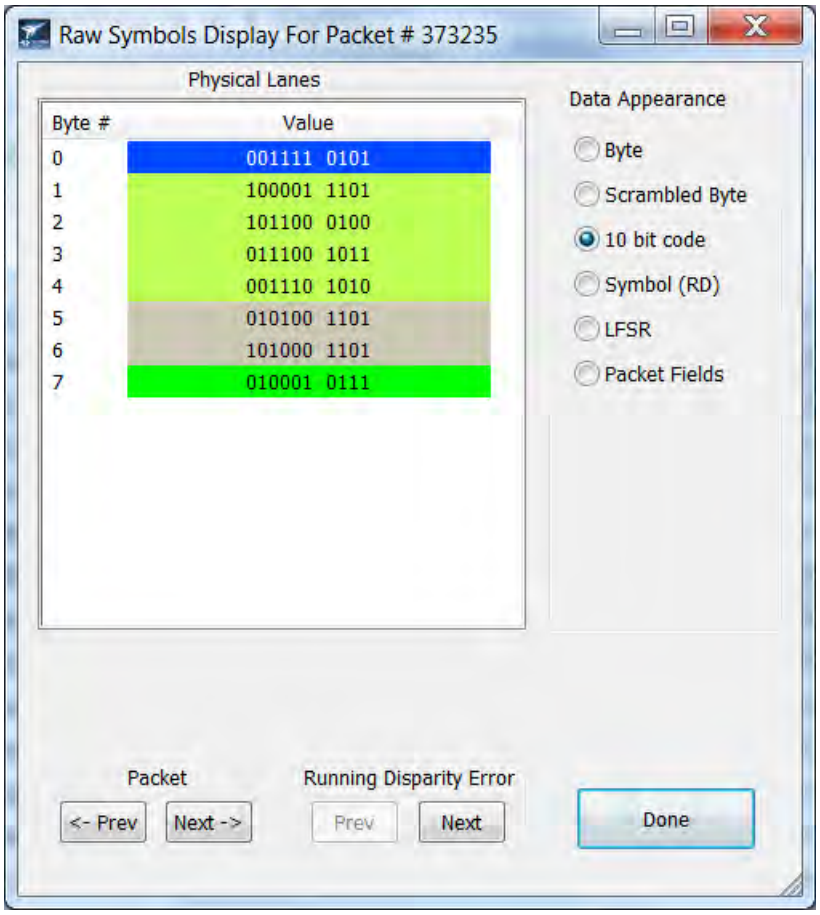


Figure 6.11: Packet Cell Popup Menus: Show Raw 10b Codes

Raw 10b Codes is discussed in more detail in “Show Raw 10b Codes” on page 424.

6.8.3 Time From Trigger

Select Time From Trigger and the Timing Calculator pops up. See Figure 6.12.

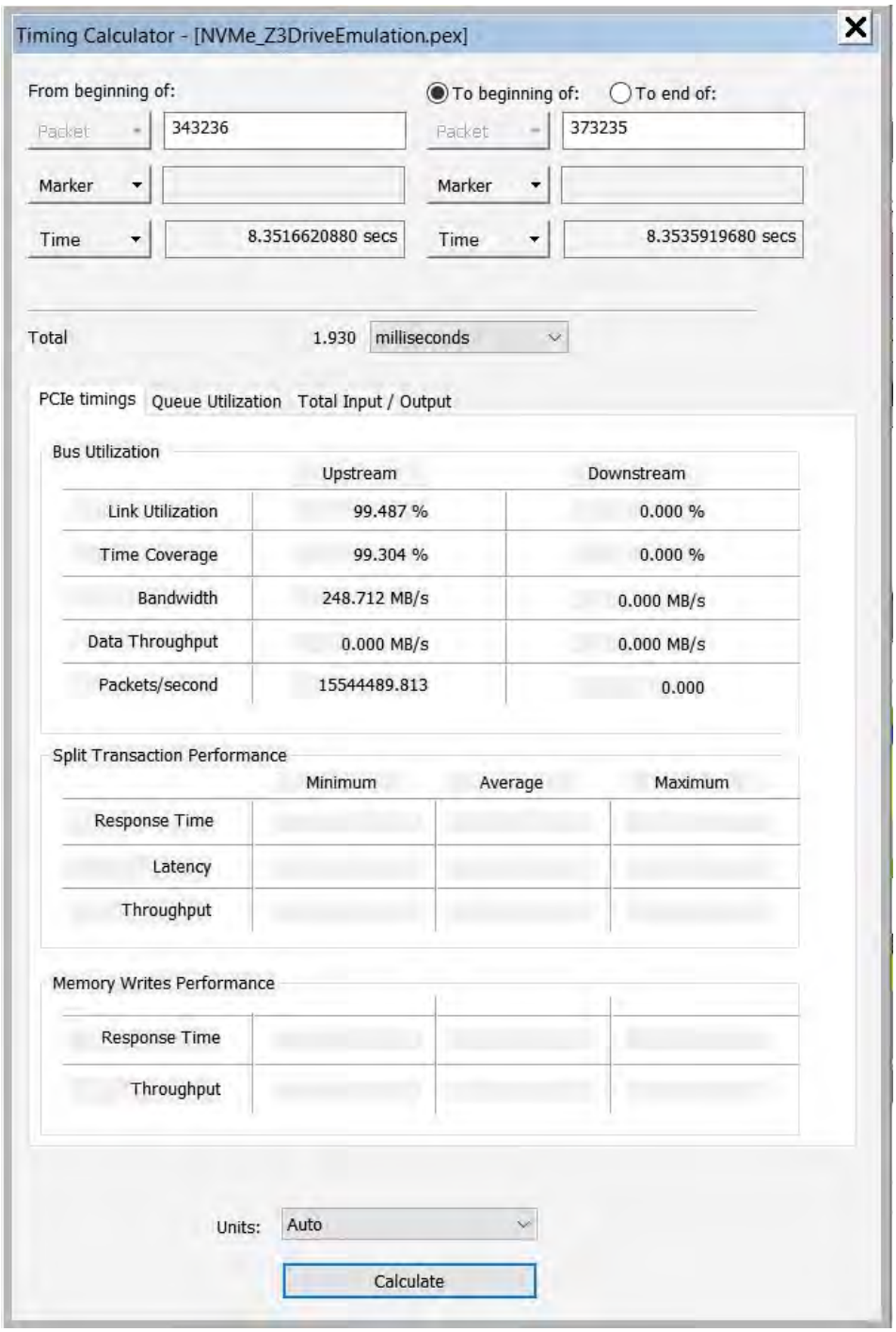


Figure 6.12: Packet Cell Popup Menus: Timing Calculator

The Timing Calculator is discussed in more detail in “Timing Calculator” on page 744.

6.8.4 Time From Marker

Click on Time From Marker and the following menu pops up along with the Timing Calculator. See Figure 6.13.

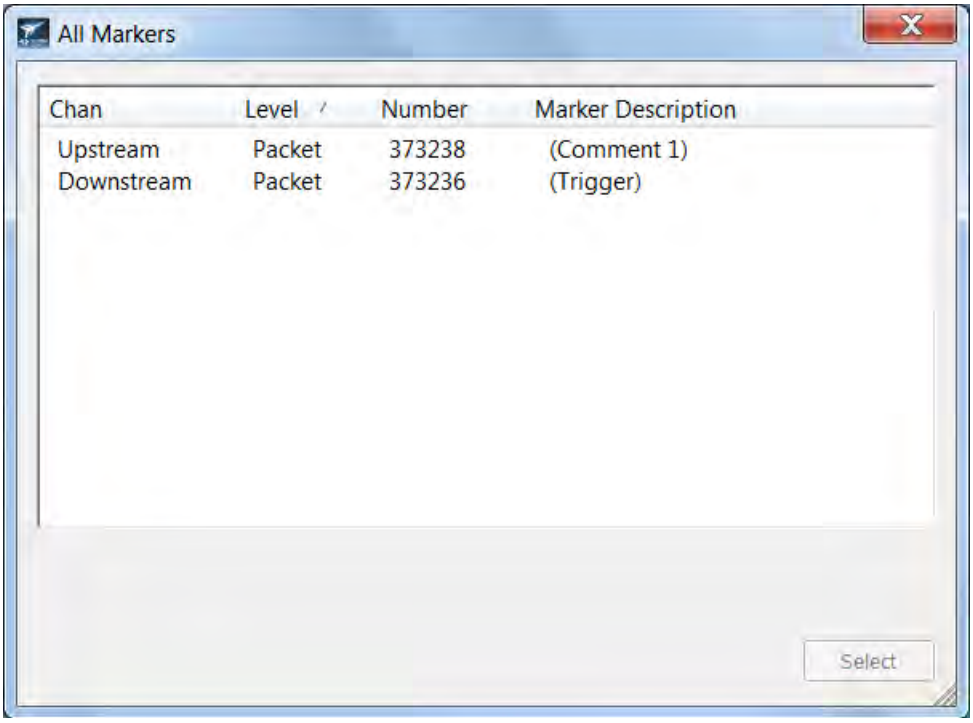


Figure 6.13: Packet Cell Popup Menus

Markers are discussed in more detail in “Set Marker” on page 435 and the Timing Calculator is discussed in more detail in “Timing Calculator” on page 744.

6.8.5 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 (Z3-16 etc.).

An example is shown below of a typical Packet and the PETrainer commands generated:

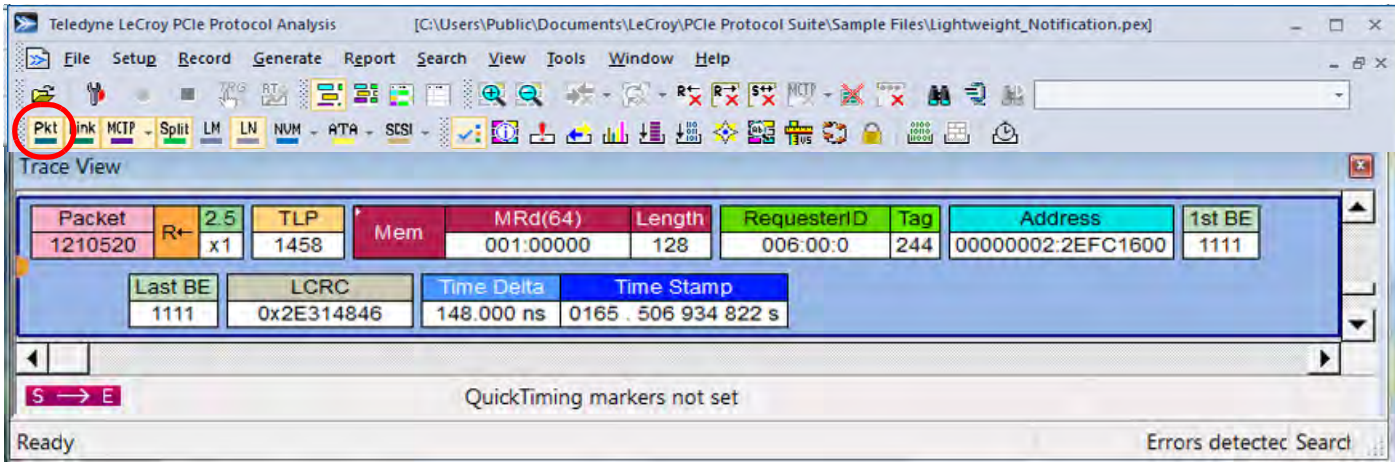


Figure 6.14: Packet Cell Popup Menus: Copy for PETrainer ‘packet’ Command

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
}
```

6.8.6 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 6.15: Packet Cell Popup Menus: Set Start Quick Timer Marker

6.8.7 Set End Quick Timing Marker

Sets the end packet for the Quick Timing marker. An E symbol is displayed at the packet.

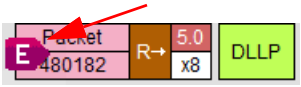


Figure 6.16: Packet Cell Popup Menus: Set End Quick Timer Marker

6.8.8 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 6.17). The Summit T416 or Summit T48 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

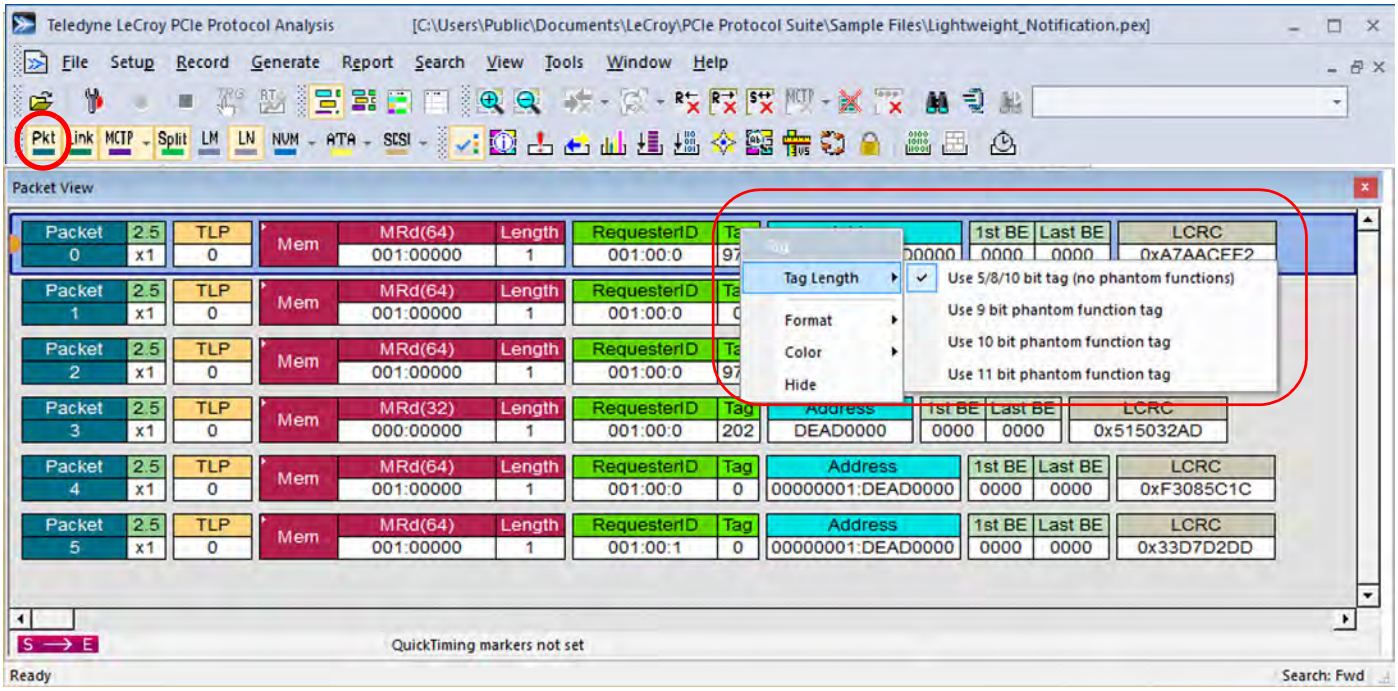


Figure 6.17: Packet Cell Popup Menus: Tag Length Pop Up Menu selections

The tag also has a tooltip associated with it to give you more information about the Packet's RequesterID Tag. See Figure 6.18 on page 434 and Figure 6.19 on page 434.

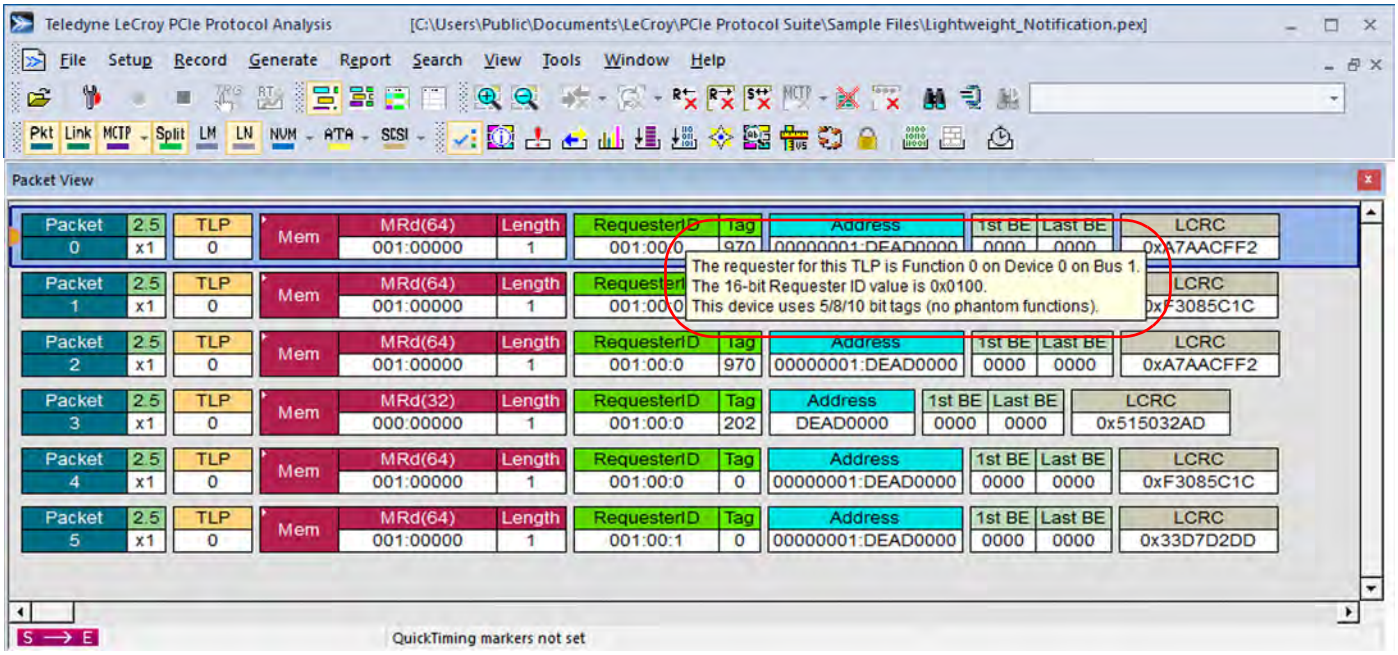


Figure 6.18: Packet Cell: Tag Tooltip

The Summit T416 or Summit T48 can also decode RegisterID blocks that use phantom function tags. As shown in the figure below. See Figure 6.19.

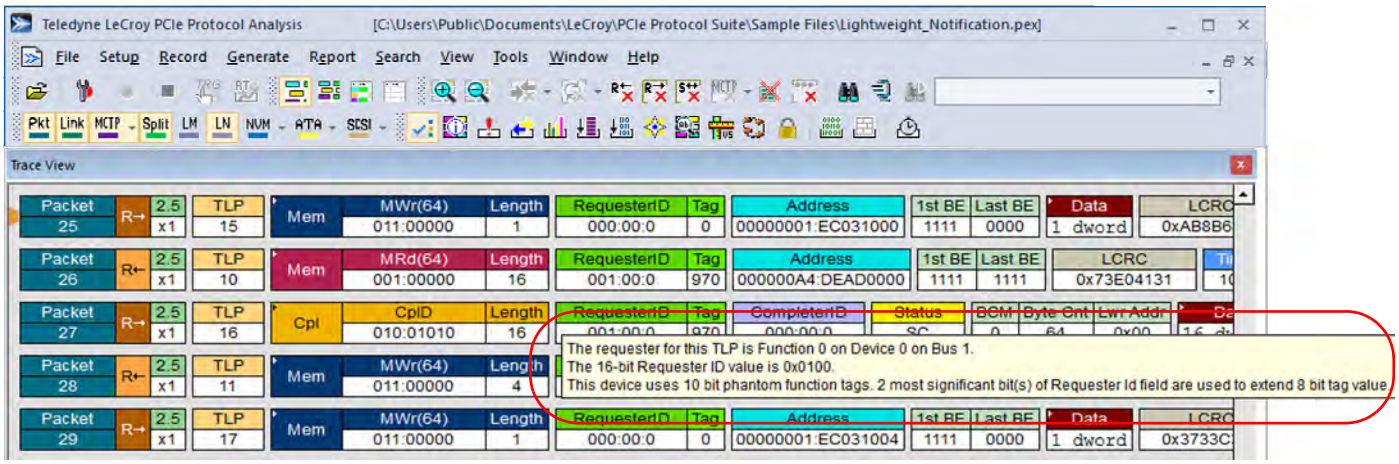


Figure 6.19: Packet Cell: Phantom Function Tag Tooltip

6.8.8.1 Quick Timing Bar

The Quick Timing Bar (see Figure 6.20 on page 435) 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 ed in any available selection units Each value is described in bytes or bits value, to be comparable. Auto mode will select MB or GB automatically depending on result value so that values are more readable. The same units can be selected in the Timing Calculator dialog.

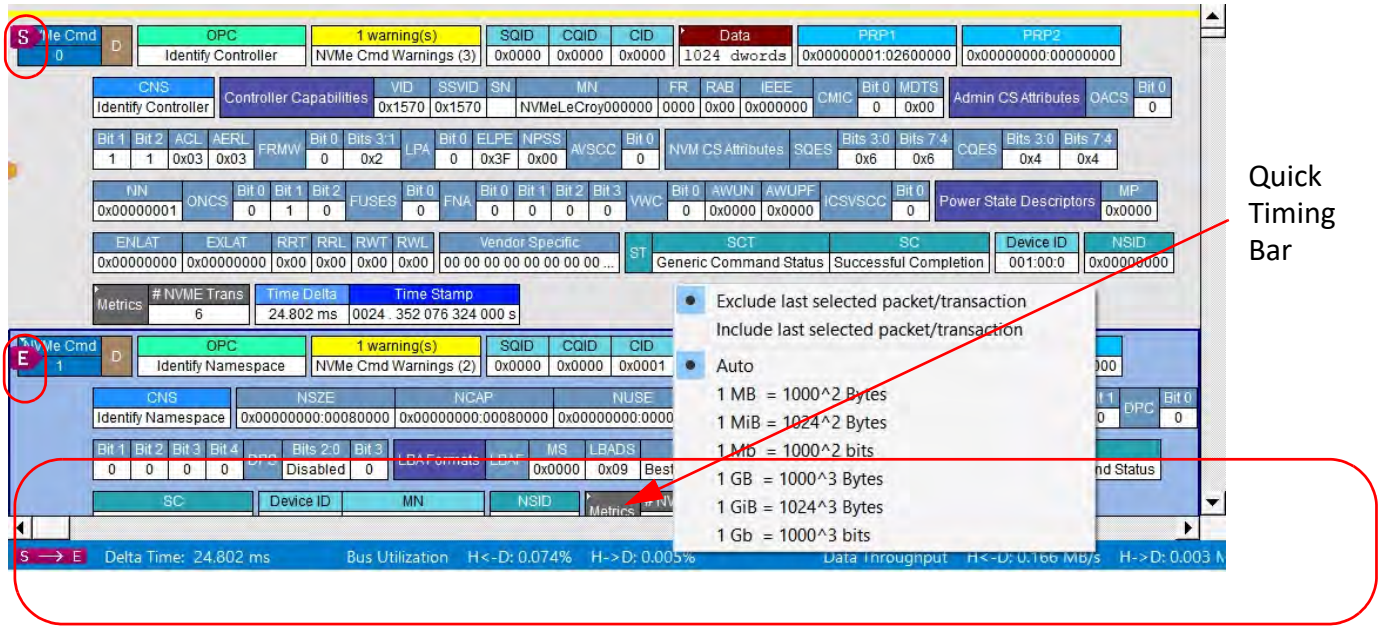


Figure 6.20: Quick Time Bar

6.8.9 Delete All Quick Timing Markers

Deletes all Quick Timing markers.

6.8.10 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 6.21 on page 436) or hover over the packet and click **Ctrl+K,** or select the packet and click **Ctrl+L**.

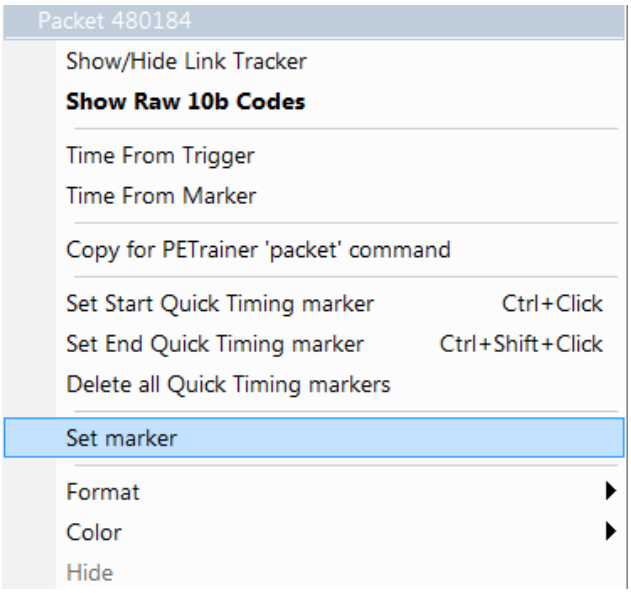


Figure 6.21: CATC Trace: Set Marker

2. Click **Set Marker**.
3. When the Create Marker for Packet # pop-up displays (see Figure 6.22), enter a unique identifier for the packet in the Comment field.

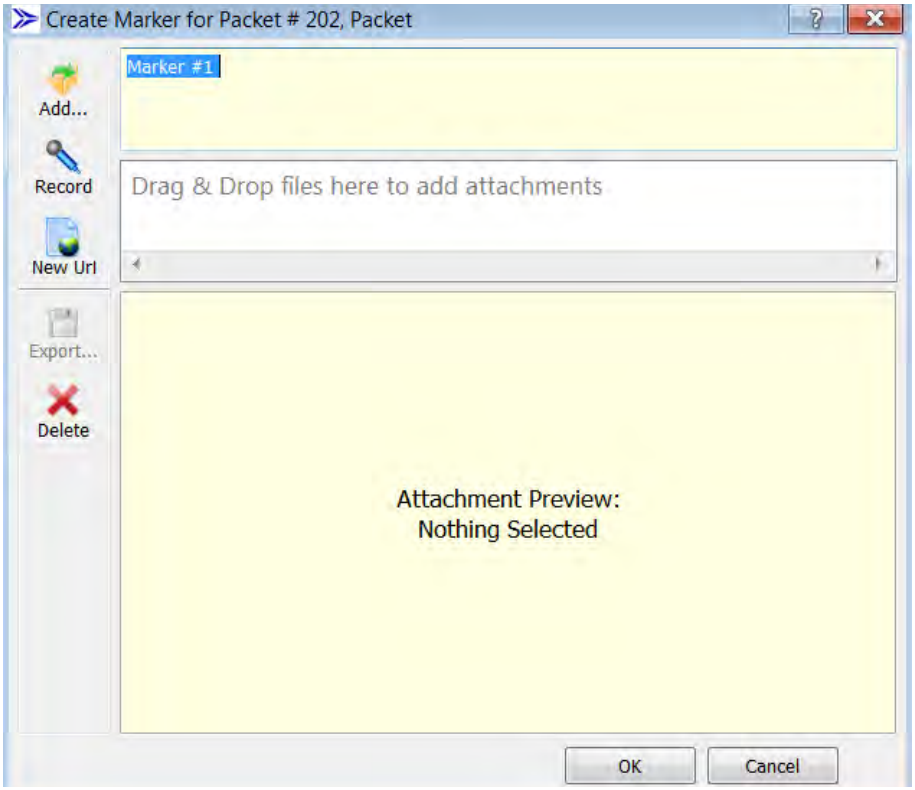


Figure 6.22: Create Marker for Packet Dialog

Later, you can go directly to this packet using the Go To Marker operation in the Search Menu.

6.8.11 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 6.23).

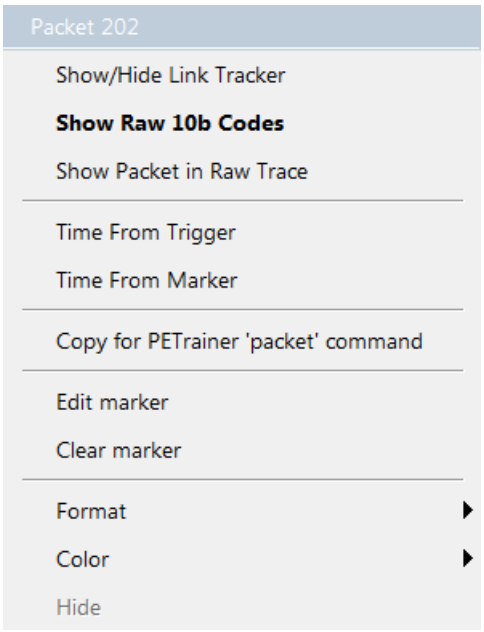


Figure 6.23: Edit Marker Pop-up Menu

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.

6.8.12 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 6.24.

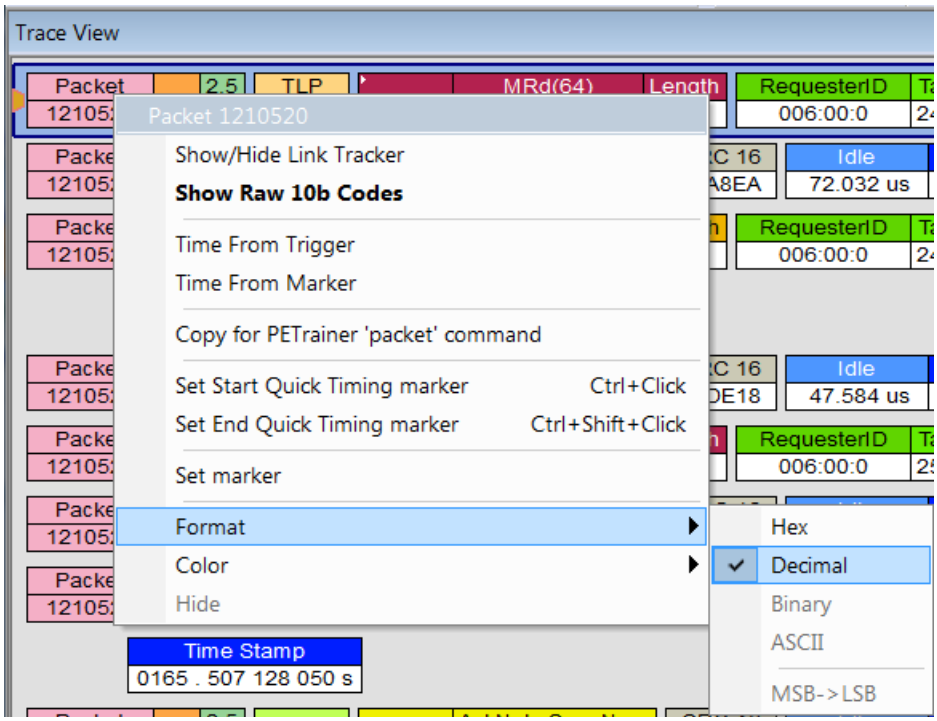


Figure 6.24: Packet Cell Popup Menus: Format

6.8.13 Color

Selecting the Packet Cell Popup Menu Color allows you to change the color of the Packet Cell. See Figure 6.25. Choose one of the twenty standard colors or pick Other for more choices.

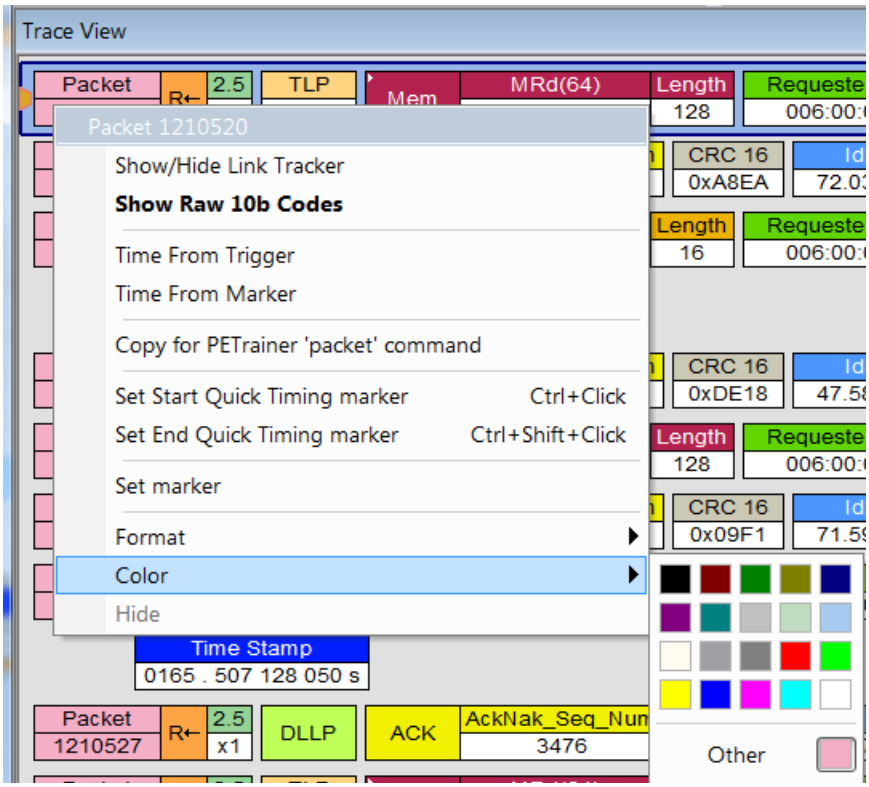


Figure 6.25: Packet Cell Popup Menus: Color

6.8.14 Other Packet Cell Popup Menus

6.8.14.1 Packet Header R-> Cell Popup Menu

The Packet Header R-> cell has a pop-up menu (see Figure 6.26) with the Swap Upstream/ Downstream command, which changes the directionality of the packets in the CATC Trace.

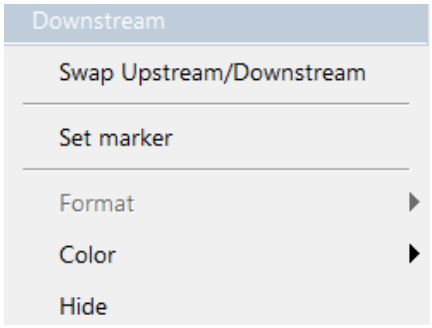


Figure 6.26: CATC Trace View: Packet Header Direction Popup Menu

6.8.14.2 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 425), which exposes a detailed view of the selected Header field (see the following figure).

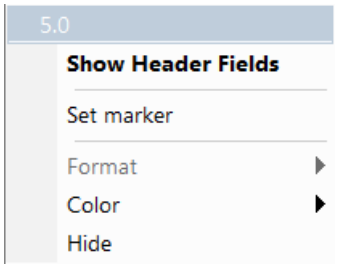


Figure 6.27: CATC Trace View: Packet Header Speed Popup Menu

6.9 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 6.28 on page 441).

To compress the CATC Trace:

- Click  on the toolbar.

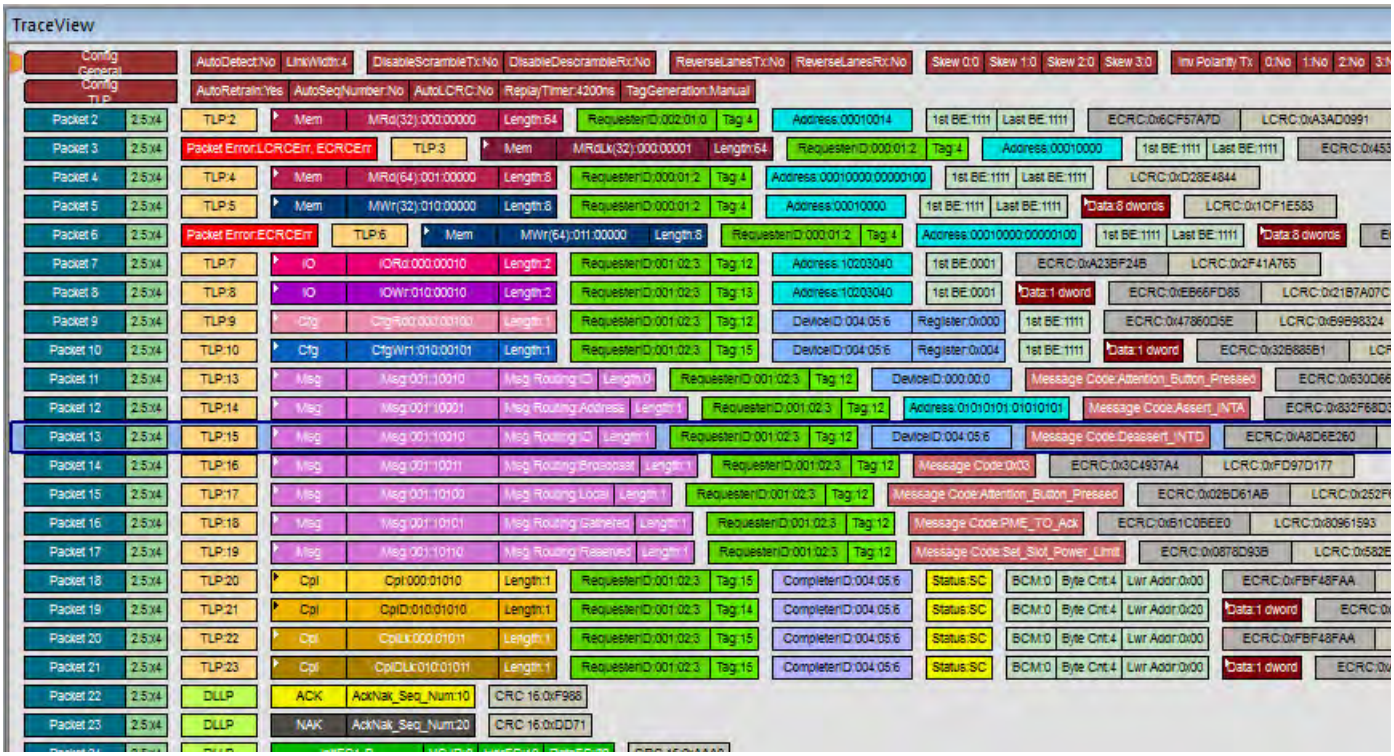


Figure 6.28: Compressed CATC Trace

- Click  on the toolbar to return to the normal CATC Trace View, or Select **View > Trace Views > CATC Trace.**

6.10 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 6.29 and Figure 6.30).

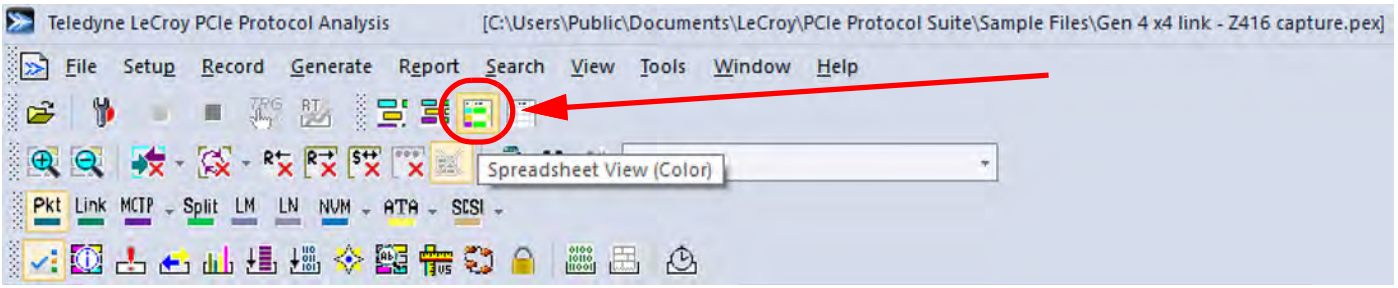


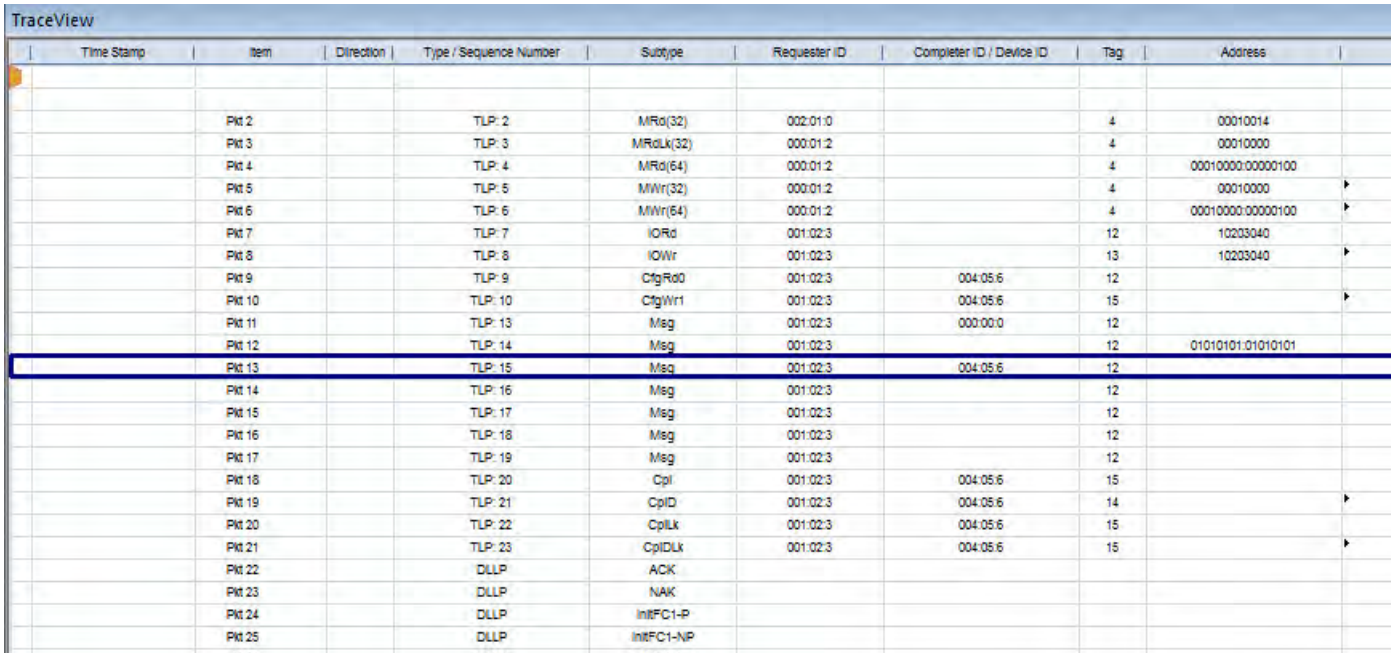
Figure 6.29: Spreadsheet View Icon in Toolbar

You can see the resulting Spreadsheet View of the trace below.



Figure 6.30: Spreadsheet View (Color)

- Click  on the toolbar to display the Spreadsheet View B/W.



TraceView

Time Stamp	Item	Direction	Type / Sequence Number	Subtype	Requester ID	Completer ID / Device ID	Tag	Address
	Pkt 2		TLP: 2	MRd(32)	002:01:0		4	00010014
	Pkt 3		TLP: 3	MRdLk(32)	000:01:2		4	00010000
	Pkt 4		TLP: 4	MRd(64)	000:01:2		4	00010000:00000100
	Pkt 5		TLP: 5	MWr(32)	000:01:2		4	00010000
	Pkt 6		TLP: 6	MWr(64)	000:01:2		4	00010000:00000100
	Pkt 7		TLP: 7	IORd	001:02:3		12	10203040
	Pkt 8		TLP: 8	IOWr	001:02:3		13	10203040
	Pkt 9		TLP: 9	CfgRd0	001:02:3	004:05:6	12	
	Pkt 10		TLP: 10	CfgWr1	001:02:3	004:05:6	15	
	Pkt 11		TLP: 13	Msg	001:02:3	000:00:0	12	
	Pkt 12		TLP: 14	Msg	001:02:3		12	01010101:01010101
	Pkt 13		TLP: 15	Msg	001:02:3	004:05:6	12	
	Pkt 14		TLP: 16	Msg	001:02:3		12	
	Pkt 15		TLP: 17	Msg	001:02:3		12	
	Pkt 16		TLP: 18	Msg	001:02:3		12	
	Pkt 17		TLP: 19	Msg	001:02:3		12	
	Pkt 18		TLP: 20	Cpl	001:02:3	004:05:6	15	
	Pkt 19		TLP: 21	CplD	001:02:3	004:05:6	14	
	Pkt 20		TLP: 22	CplLk	001:02:3	004:05:6	15	
	Pkt 21		TLP: 23	CplDLk	001:02:3	004:05:6	15	
	Pkt 22		DLLP	ACK				
	Pkt 23		DLLP	NAK				
	Pkt 24		DLLP	InitFC1-P				
	Pkt 25		DLLP	InitFC1-NP				

Figure 6.31: Spreadsheet View (Black And White)

6.10.1 Columns

Right click on any column and the following options pop up. See Figure 6.32.

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

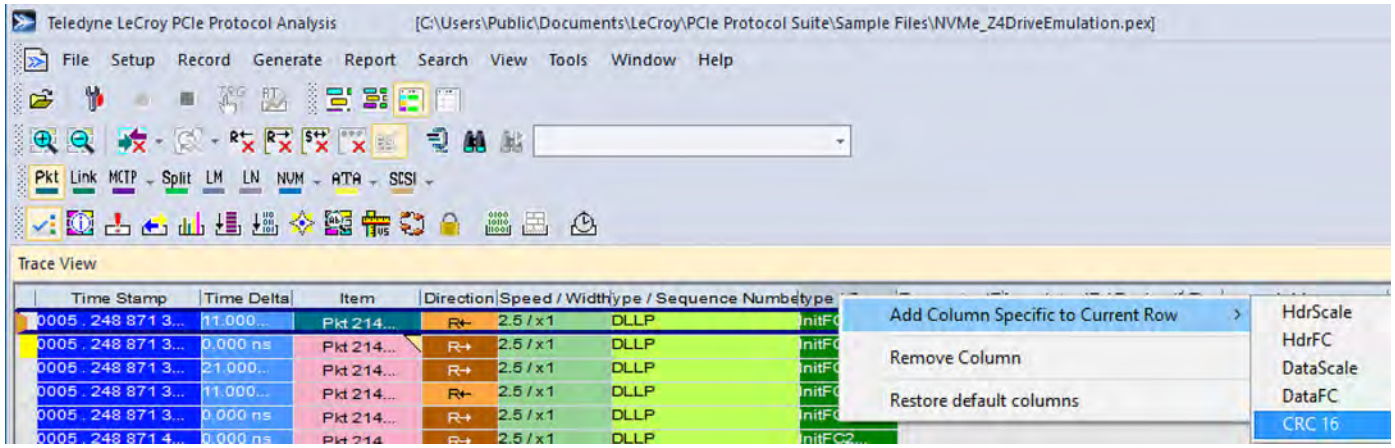


Figure 6.32: Add Columns Specific to Current Row

You can add a column with the CRC 16 values. See Figure 6.33

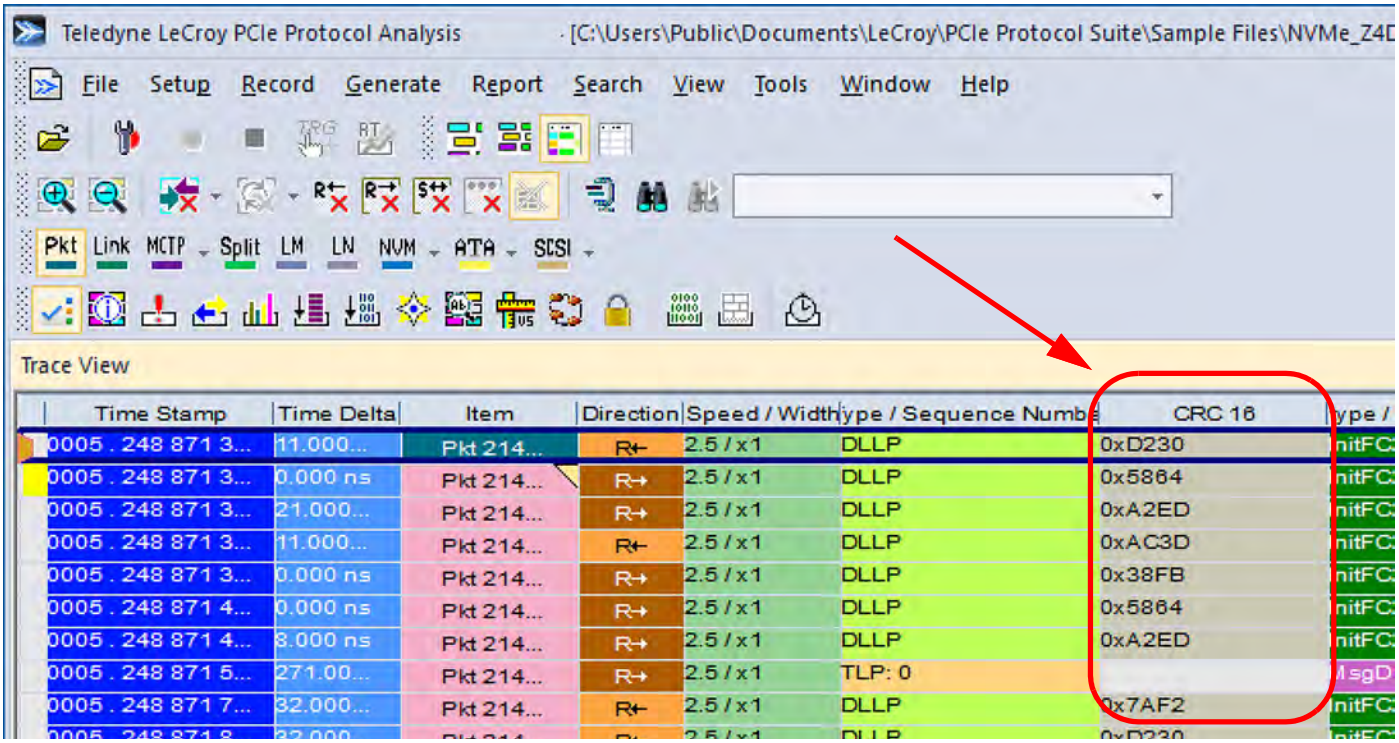


Figure 6.33: Added Column with CRC 16

You can delete the column that you right clicked on. See Figure 6.34.

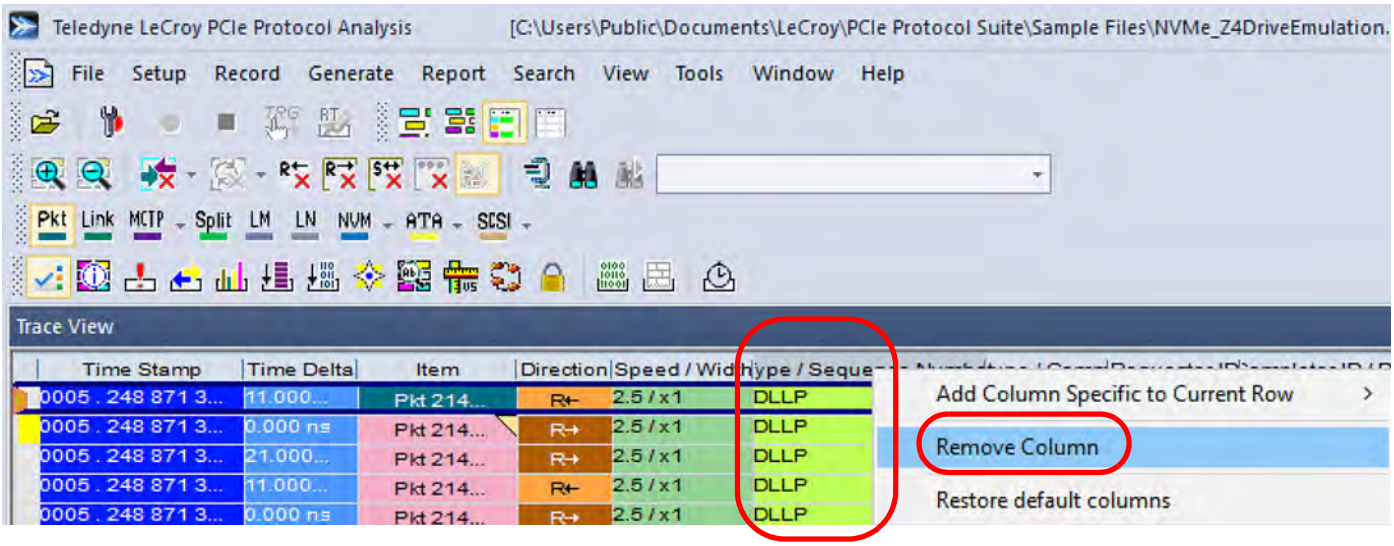


Figure 6.34: Right Click on Type/Sequence Number Column

Click on Remove Column and it's deleted from Spreadsheet View. See Figure 6.35.

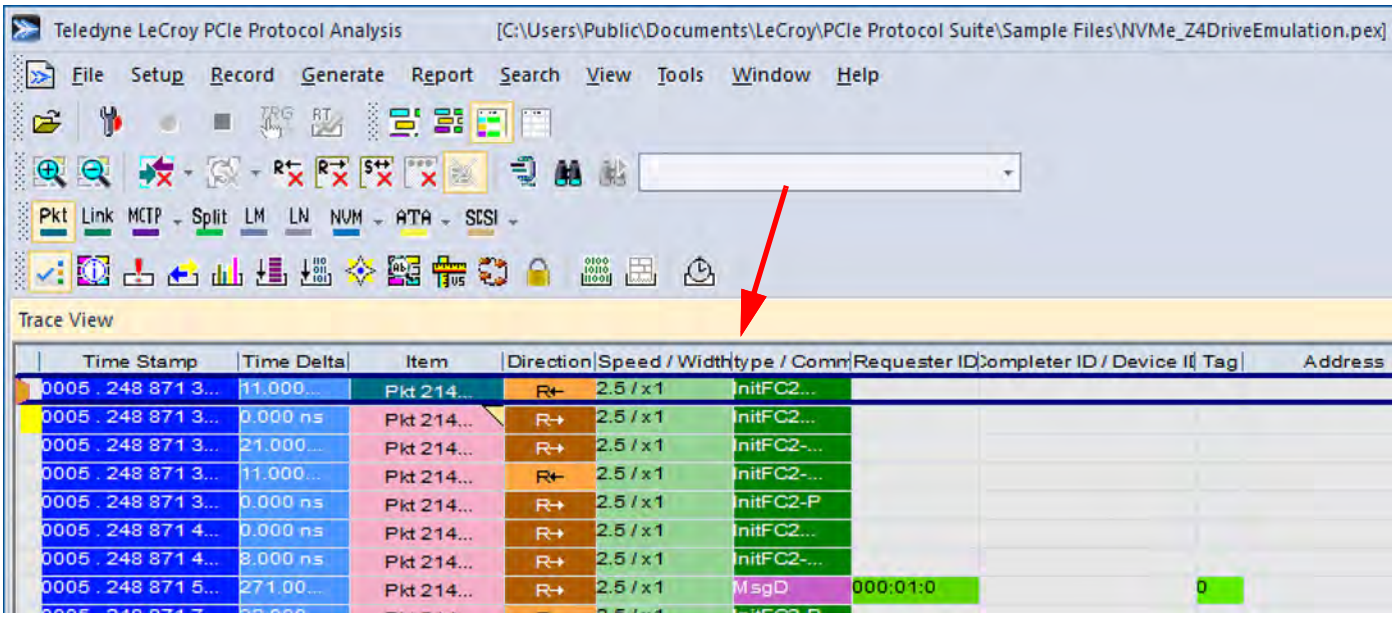


Figure 6.35: Selected Column Removed

You can also Restore the set of system Default columns. See Figure 6.36 on page 446.

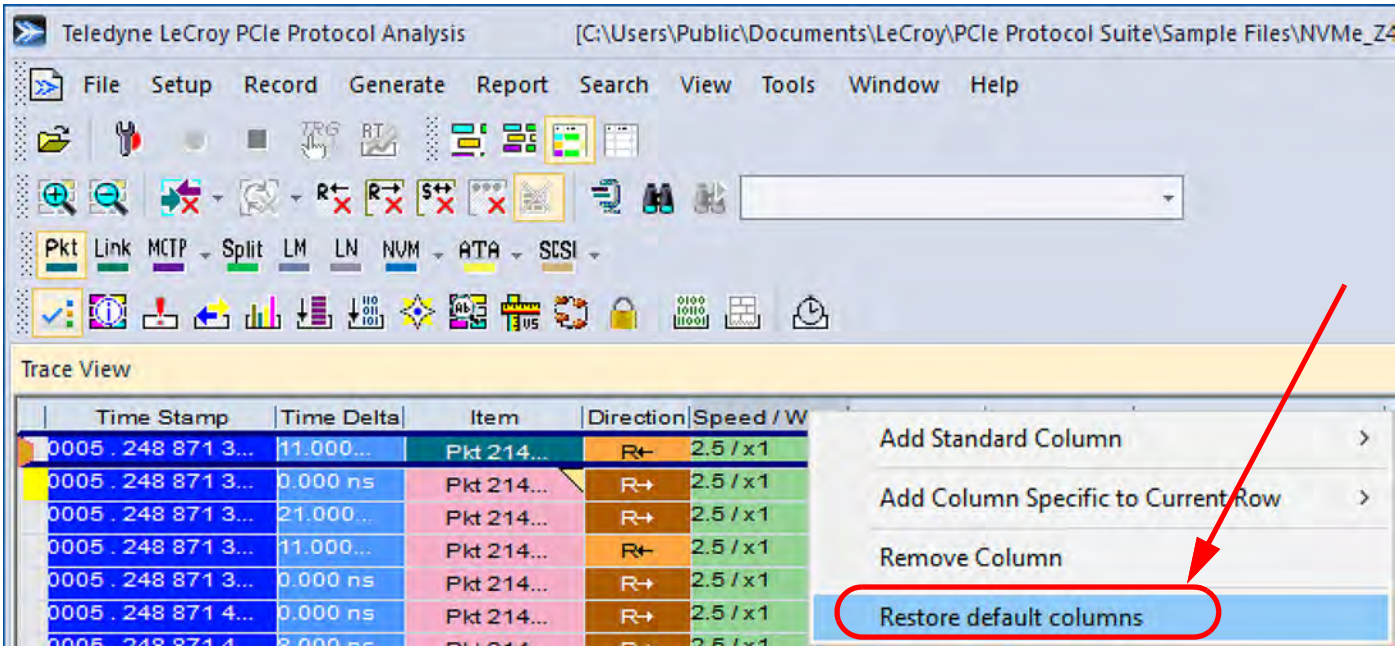


Figure 6.36: Restore Default Columns

If you select Restore default columns you'll get a Warning message. See Figure 6.37.

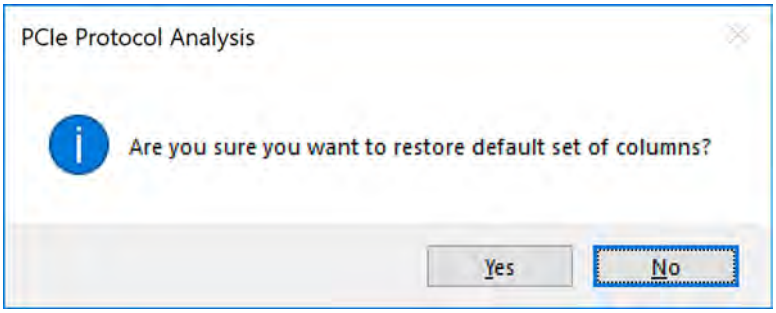


Figure 6.37: Warning Message about Restoring Default Set of Columns

Click on Yes and you'll get the default set of columns. See Figure 6.38 on page 447.

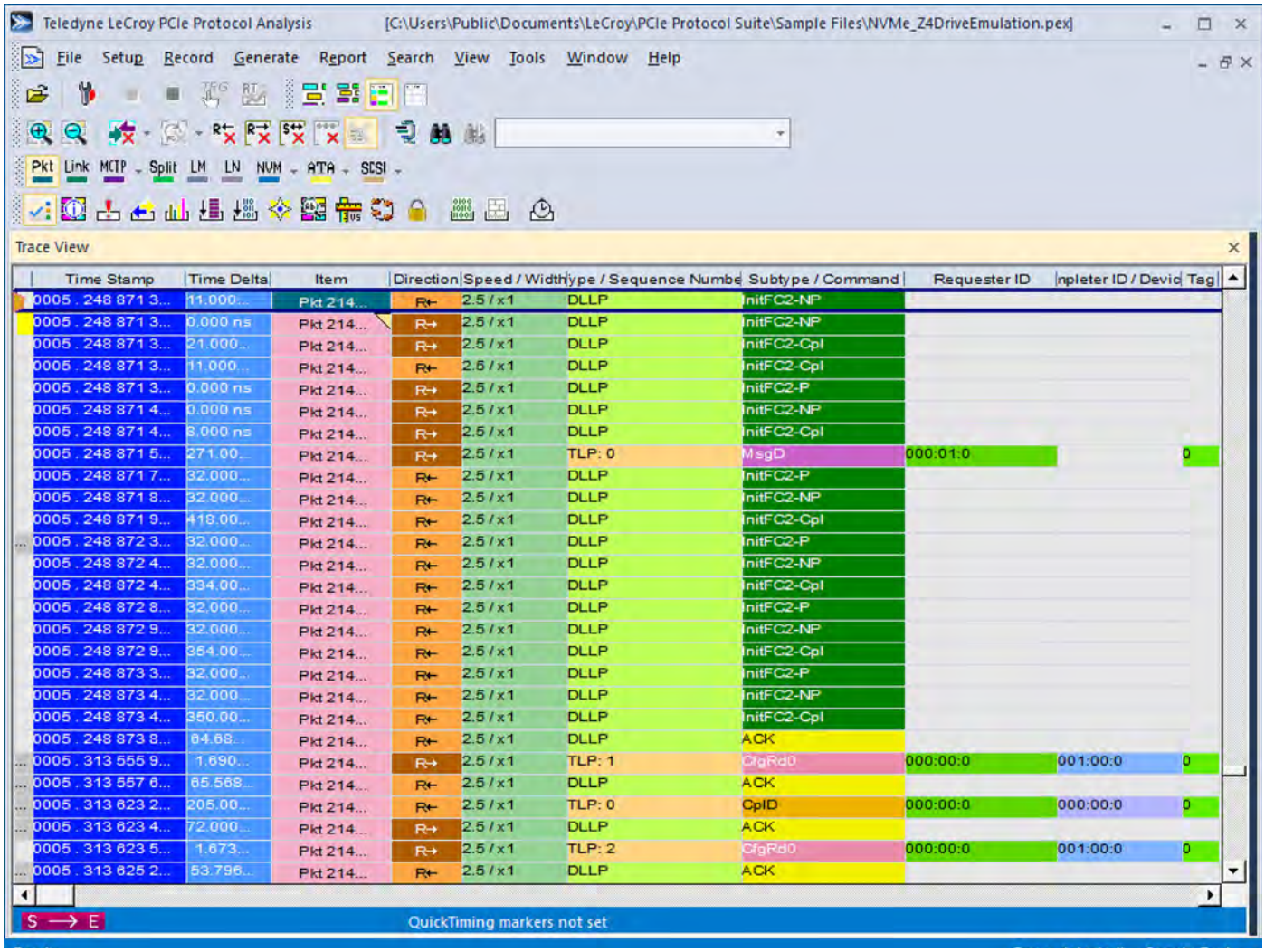


Figure 6.38: Default Set of Columns

6.11 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 6.39).

To put a Detail View header as a column in the Spreadsheet View, drag the header to a column divider in the Spreadsheet View.

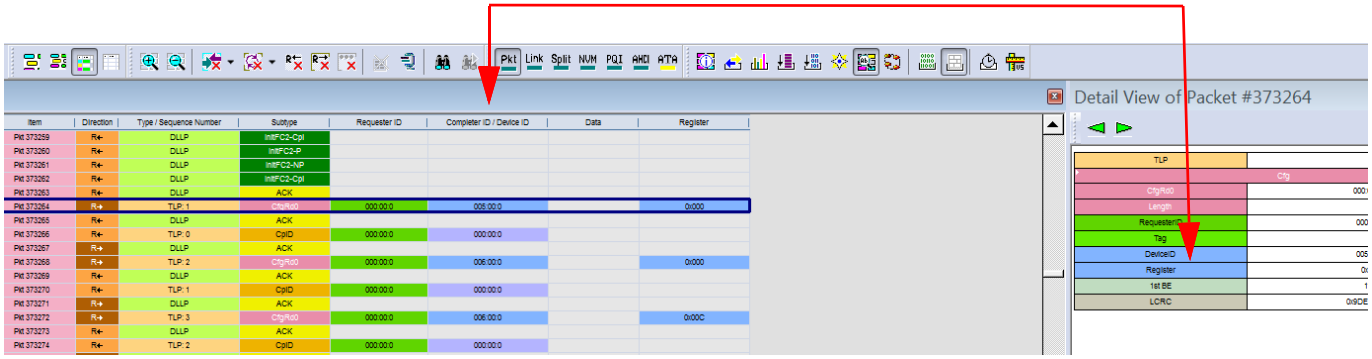


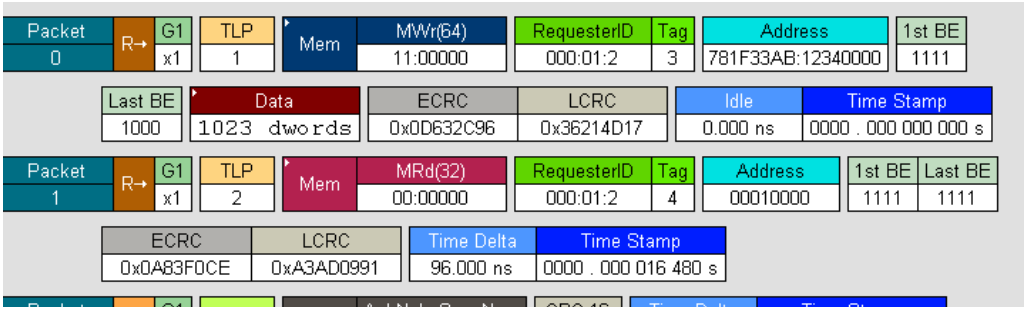
Figure 6.39: Detail View in Spreadsheet View

6.12 Decoding Traffic

The PCIe Protocol Analysis has several decode levels:

6.12.1 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 6.40 on page 450.

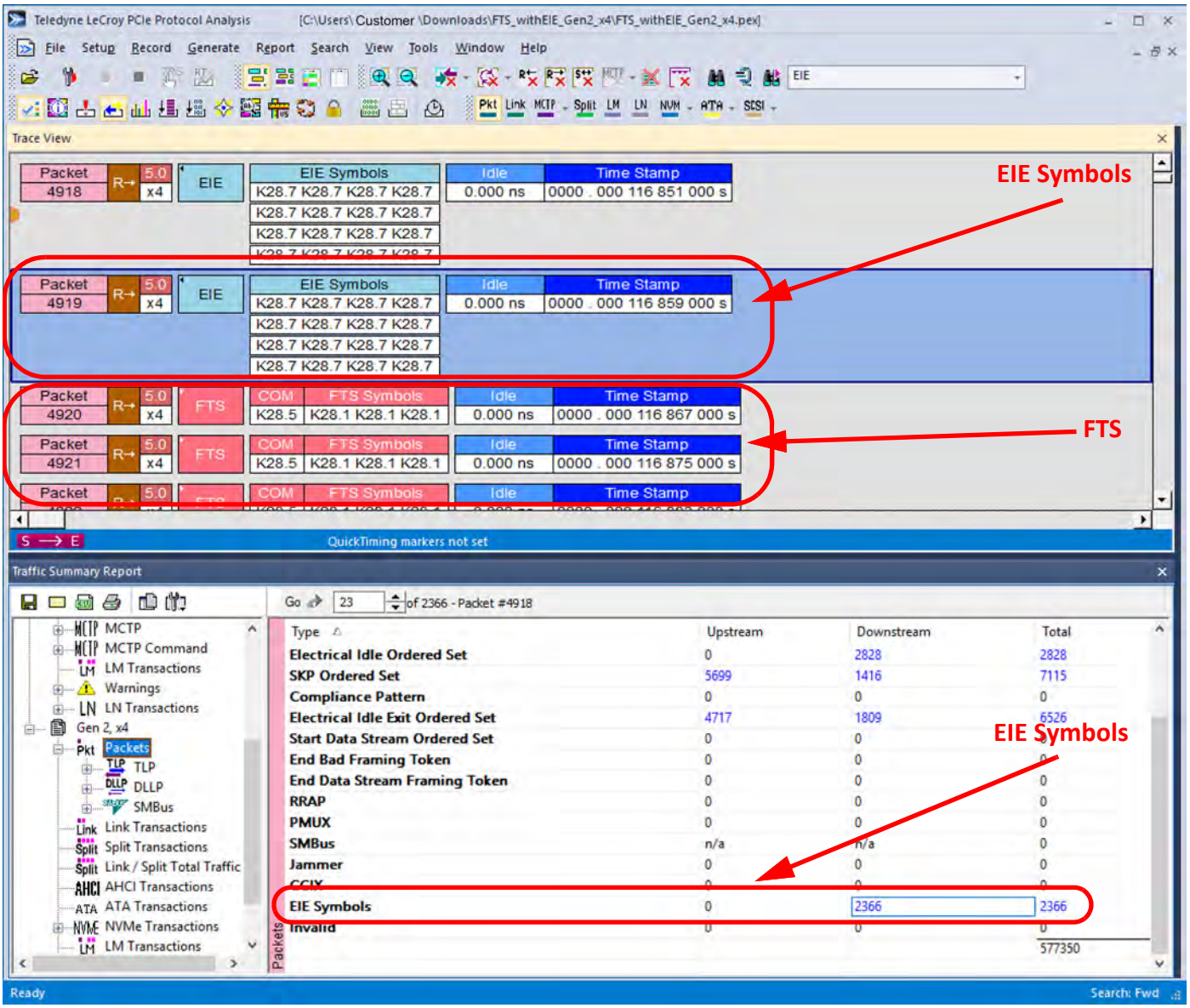
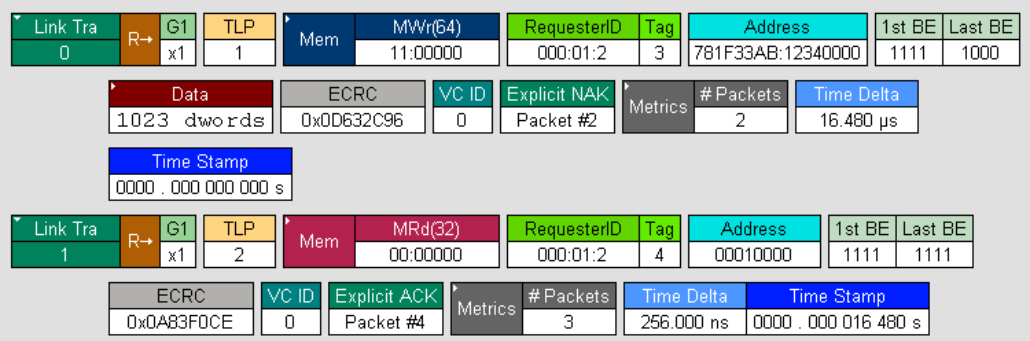


Figure 6.40: EIE Symbols Decoded before FTS

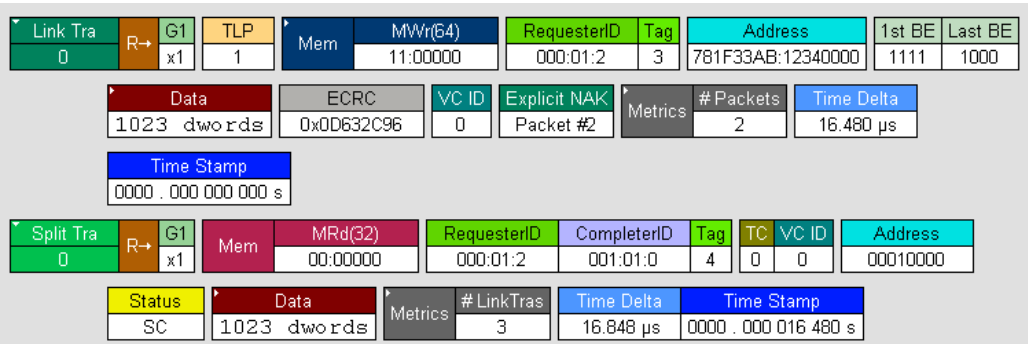
6.12.2 Link

Link level decode Link is composed of TLP packets matched with a corresponding ACK or NAK coming from the opposite direction.



6.12.3 Split

Split level decode Split is composed of two Link transactions, the Request TLP and the Completion TLP from the other direction.



6.12.4 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 6.41.

6.12.4.1 Typical Lane Margining Commands and Responses

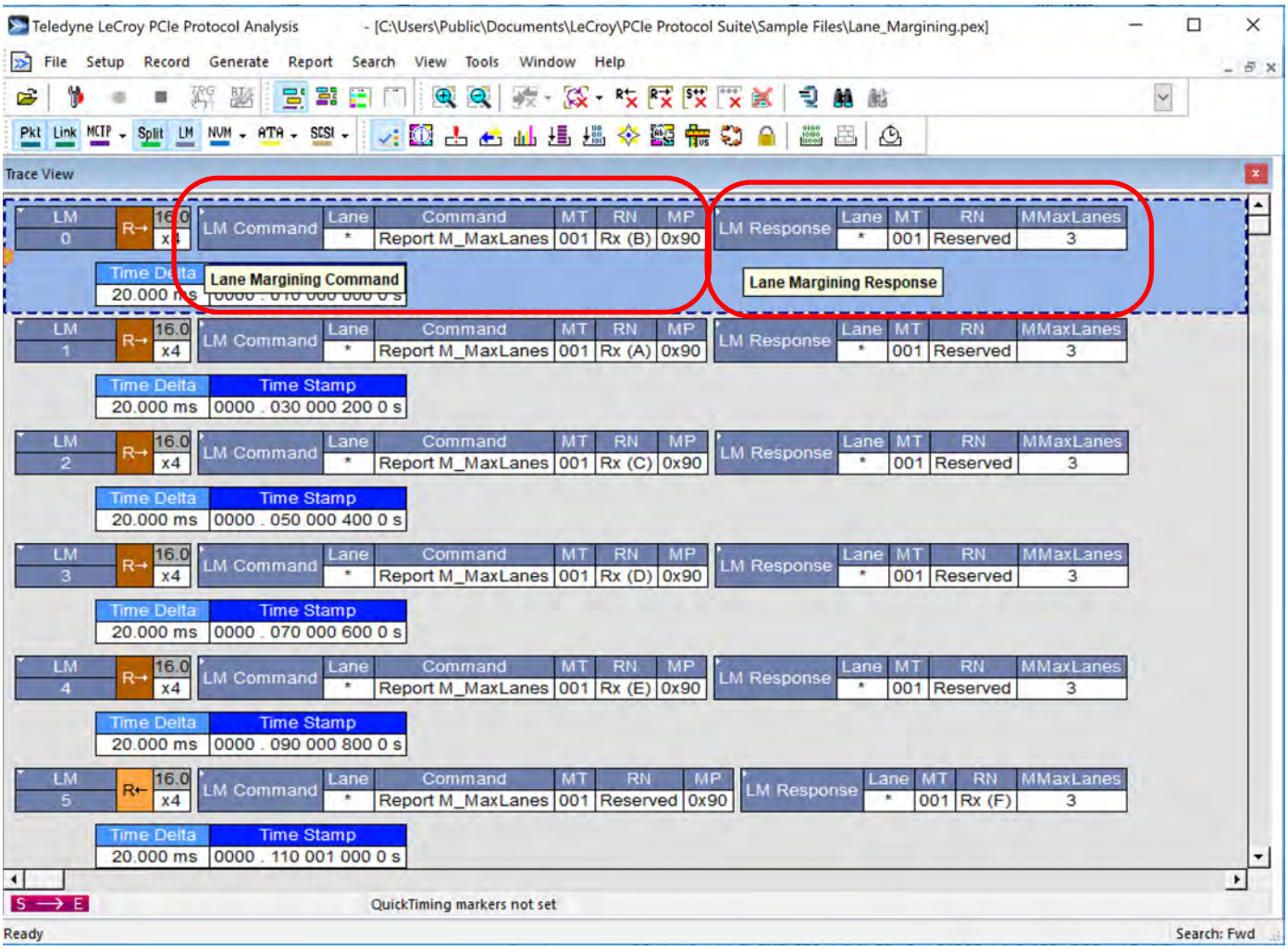


Figure 6.41: Lane Margining Decoding: Command and Response

More Lane Margining Commands and Responses are shown in Figure 6.42 on page 453.

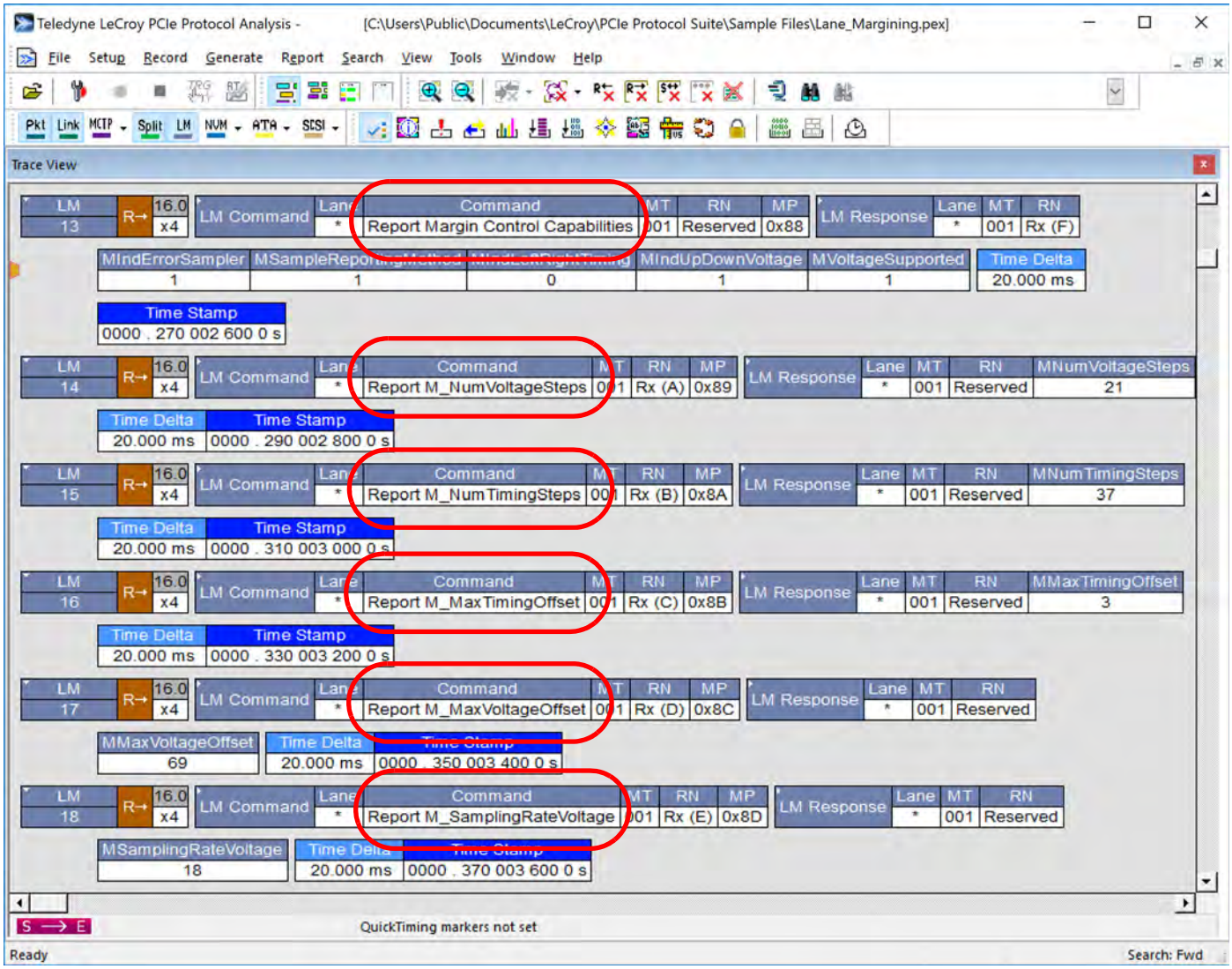


Figure 6.42: More Lane Margining Commands and Responses

6.12.4.2 Lane Margining Command: Step Margin to Timing Offset

The Lane Margining Command: Step Margin to Timing Offset in shown in Figure 6.43.

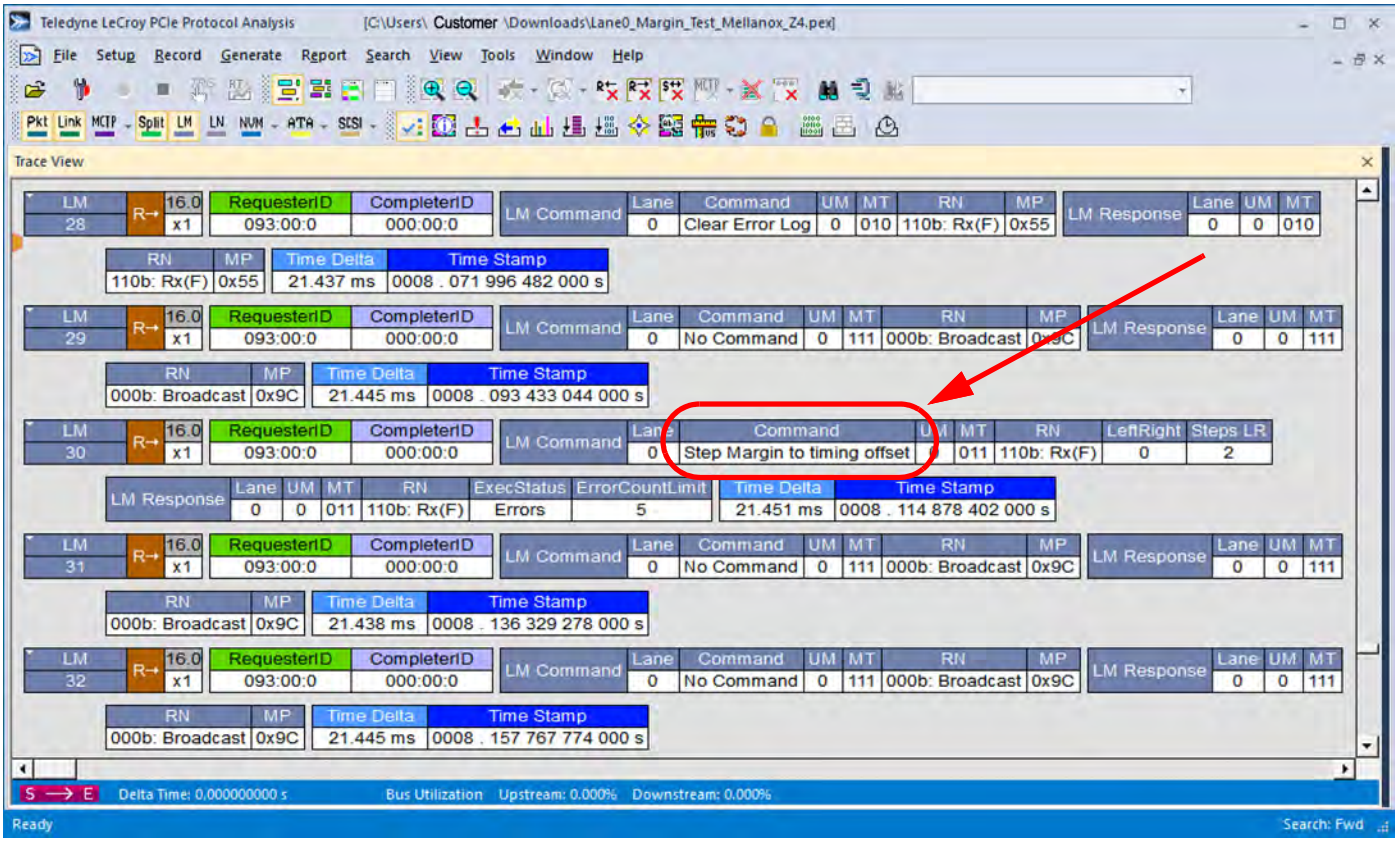


Figure 6.43: Lane Margining Command: Step Margin to Timing Offset

6.12.4.3 Lane Margining Errors

Lane Margining errors can also be decoded. As shown in the sample below (see Figure 6.44).

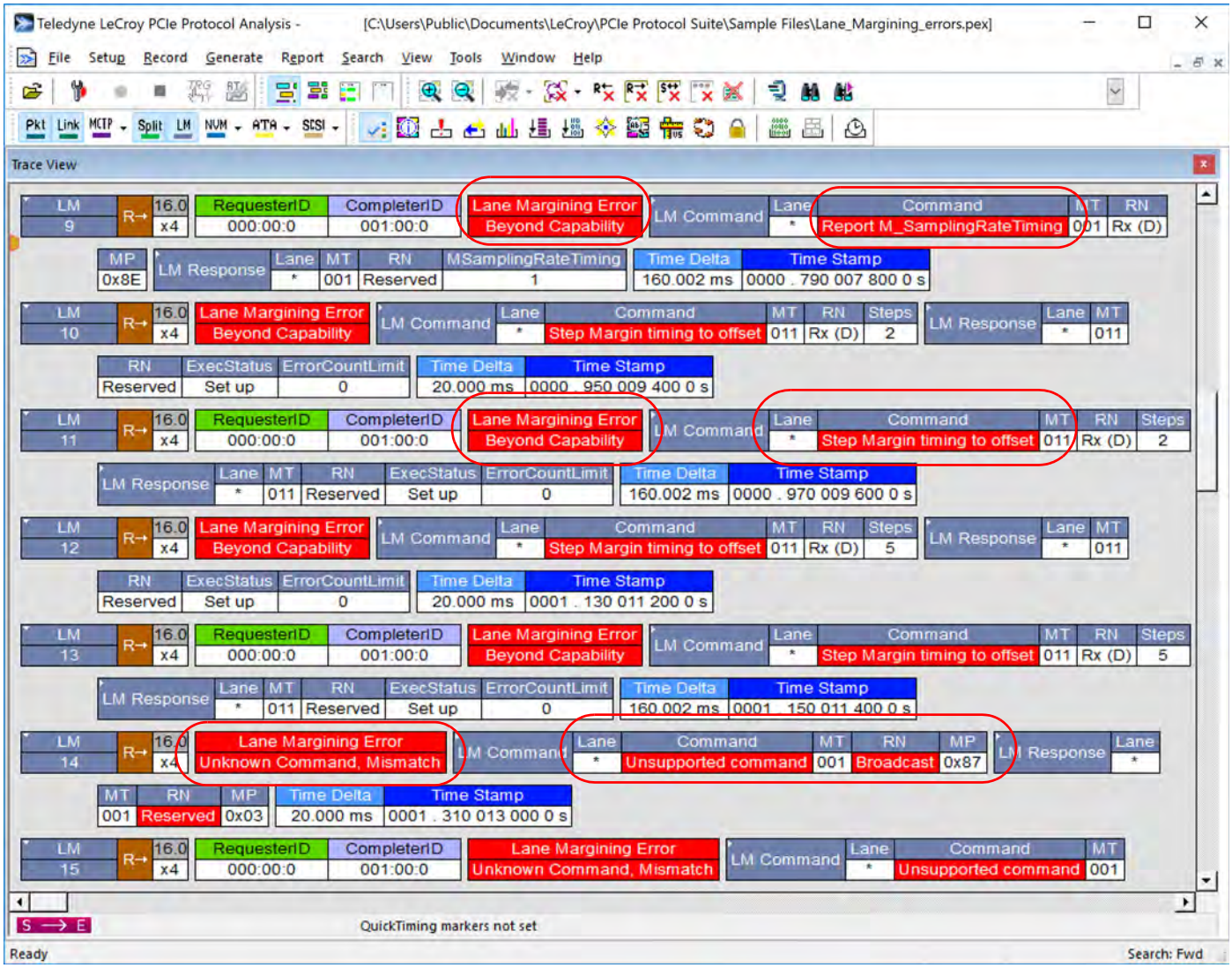


Figure 6.44: Lane Margining Errors: Decoded

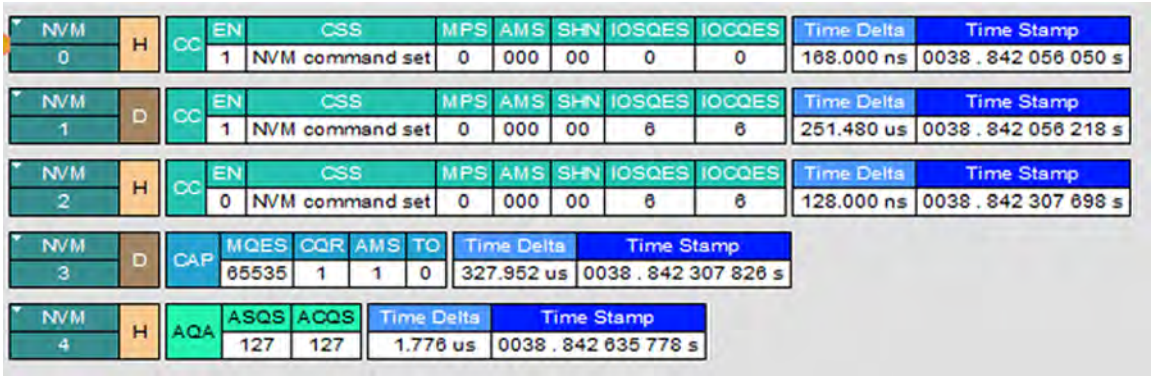
6.12.5 NVMe Decoding

The PCIe Protocol Analysis software supports decoding of NVMe 1.4.

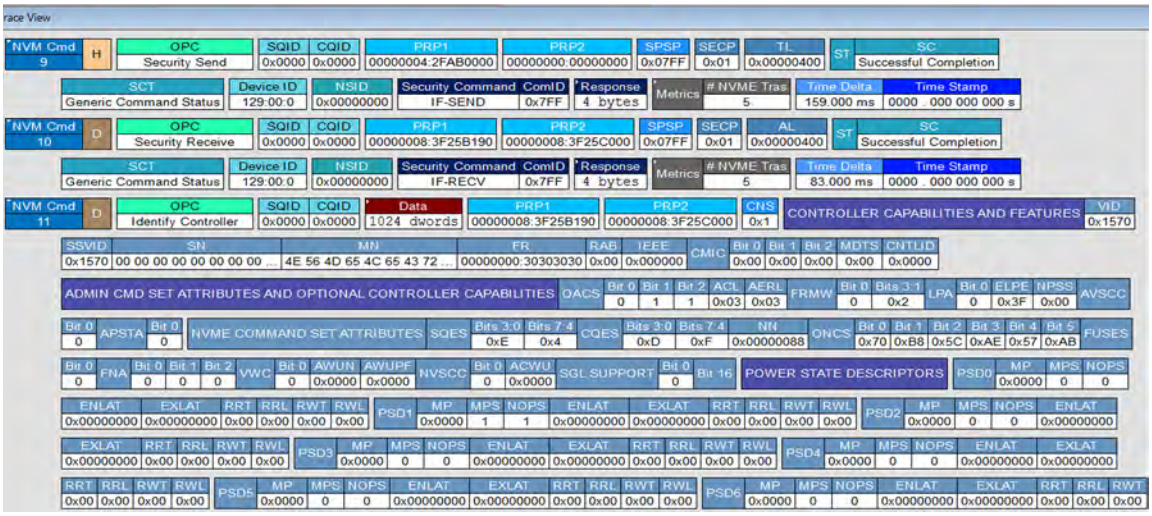
To decode the NVMe protocol there are two levels available: NVMe Transaction level, which decodes the individual NVMe transactions from the PCI Express protocol and NVMe Command level, which gathers NVMe transactions into a single command. If the top level button 

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 169). 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.

6.12.5.1 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 6.45 and Figure 6.46 on page 458).

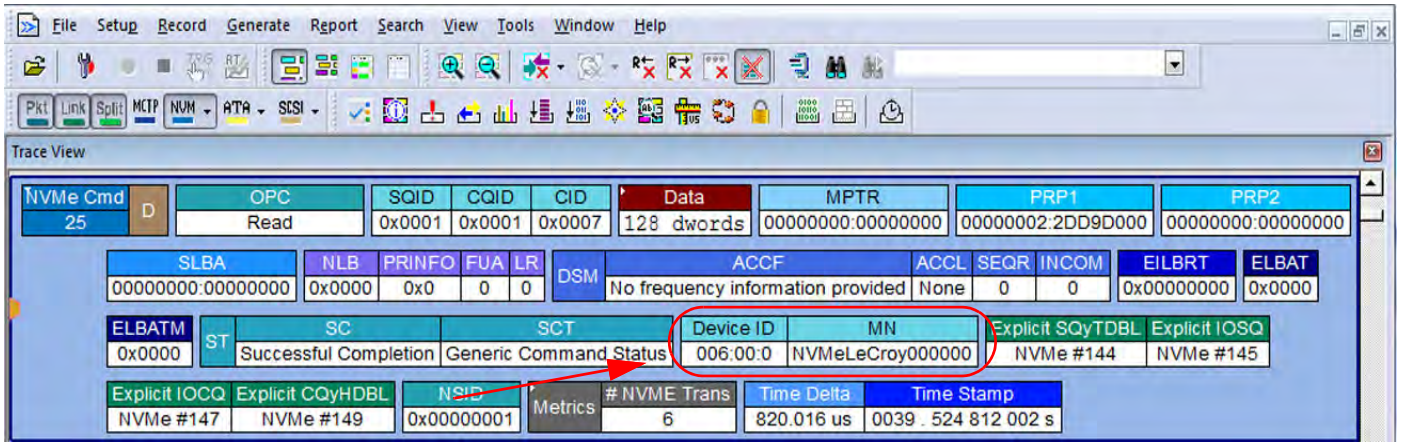


Figure 6.45: Device ID and Model Number Decoded from NVMe Trace

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 6.46 on page 458.

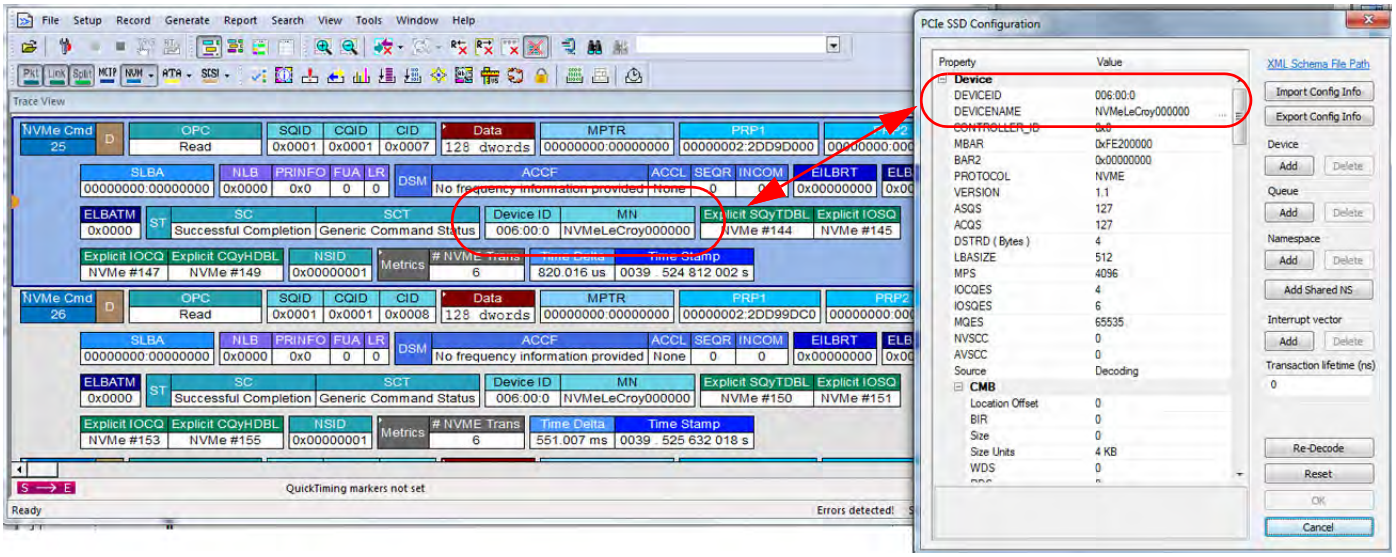
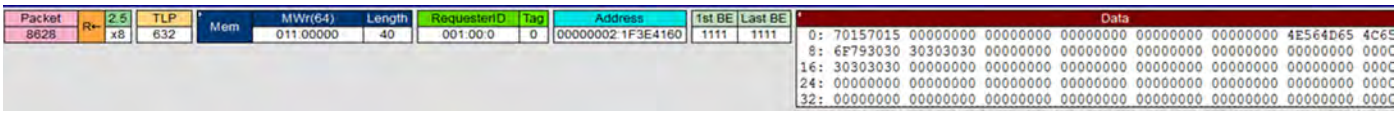


Figure 6.46: Device ID and Device Model Name Shown in SSD Configuration Dialog

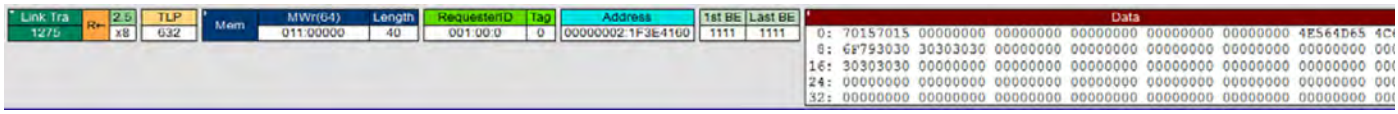
6.12.5.2 NVMe: Data Field on Packets

While the data field section displayed for a PCIe packet shows the actual payload for that PCIe packet (as shown below):

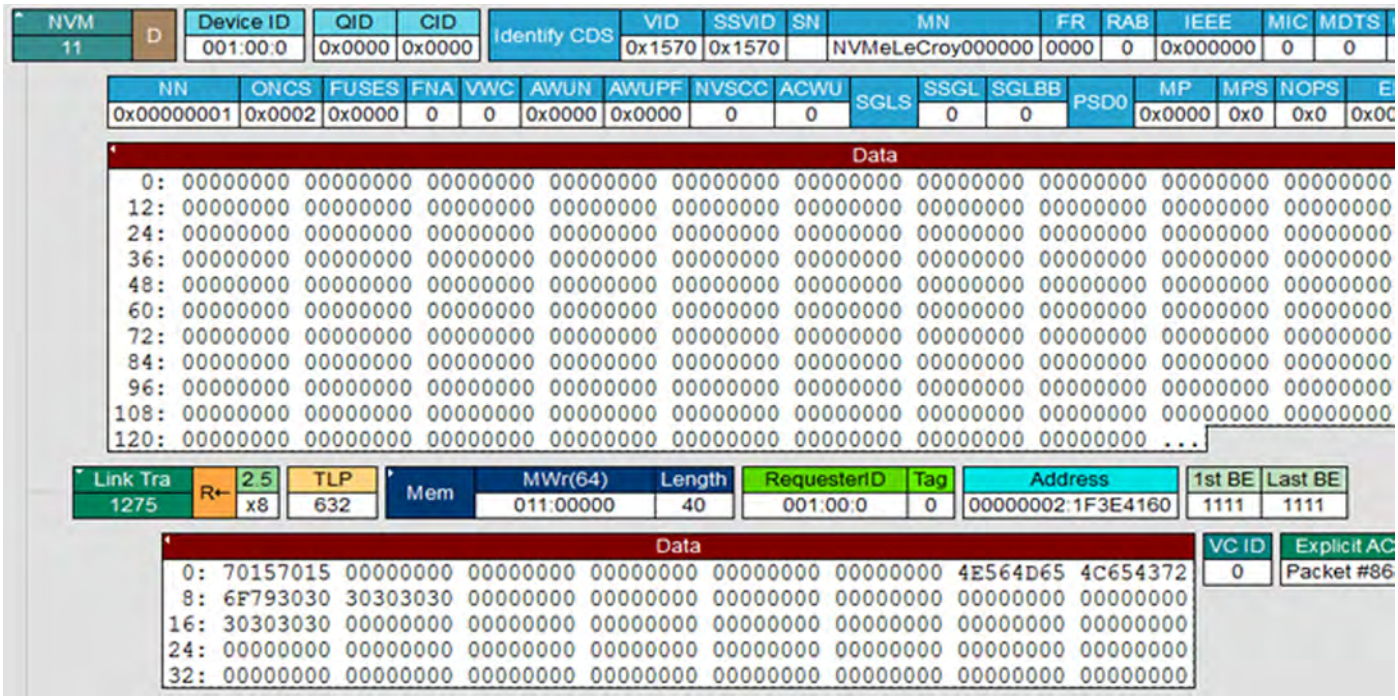


The content for this field changes depending on the decode level selected and the particular command decoded.

For example, at the PCIe transaction level, this field still reflects the PCIe payload field involved in the PCIe transaction (as shown below):

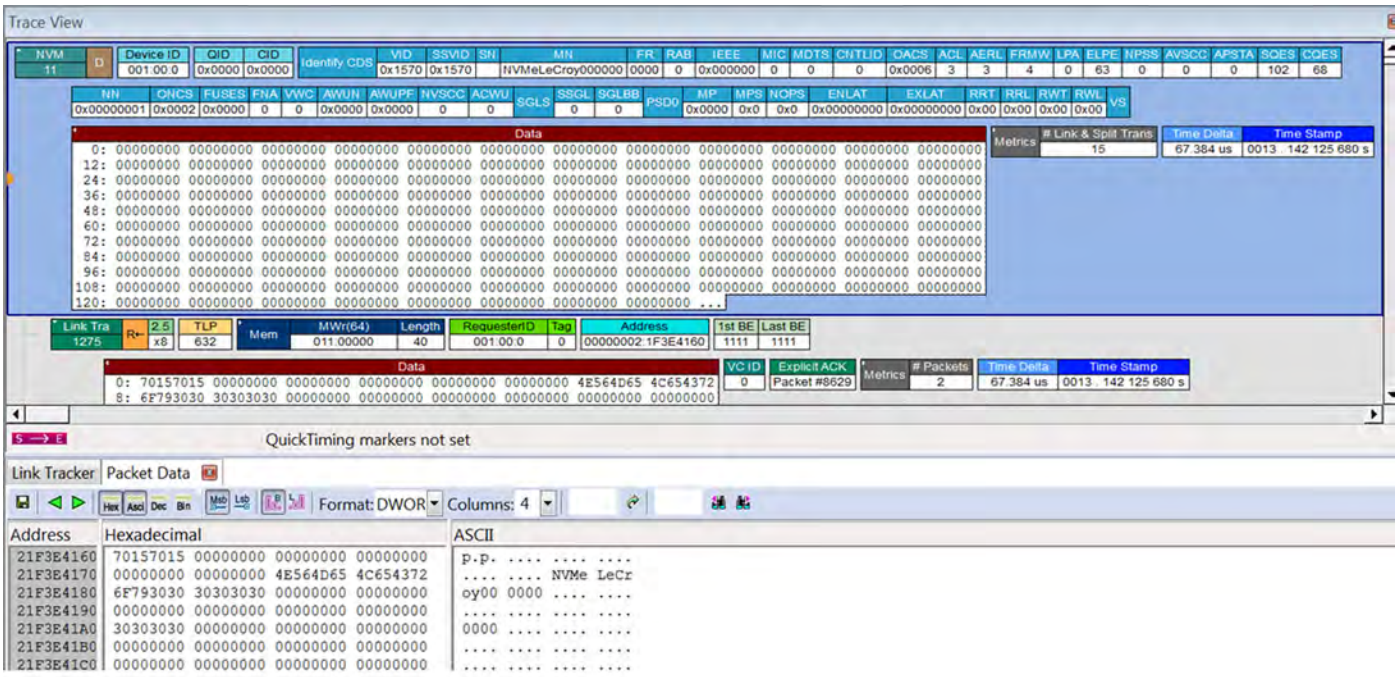


At the NVMe transaction level for identify command is shown below:



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):


Trace View
Data
Metrics
Time Delta
Time Stamp
Link Tracker
Packet Data
Format: DWOR
Columns: 4
Address
Hexadecimal
ASCII
21F3E4160 70157015 00000000 00000000 00000000 p.p. ....
21F3E4170 00000000 00000000 4E564D65 4C654372 .... NVMe LeCr
21F3E4180 6F793030 30303030 00000000 00000000 oy00 0000 ....
21F3E4190 00000000 00000000 00000000 00000000 ....
21F3E41A0 30303030 00000000 00000000 00000000 0000 ....
21F3E41B0 00000000 00000000 00000000 00000000 ....
21F3E41C0 00000000 00000000 00000000 00000000 ....

6.12.5.3 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 6.47.

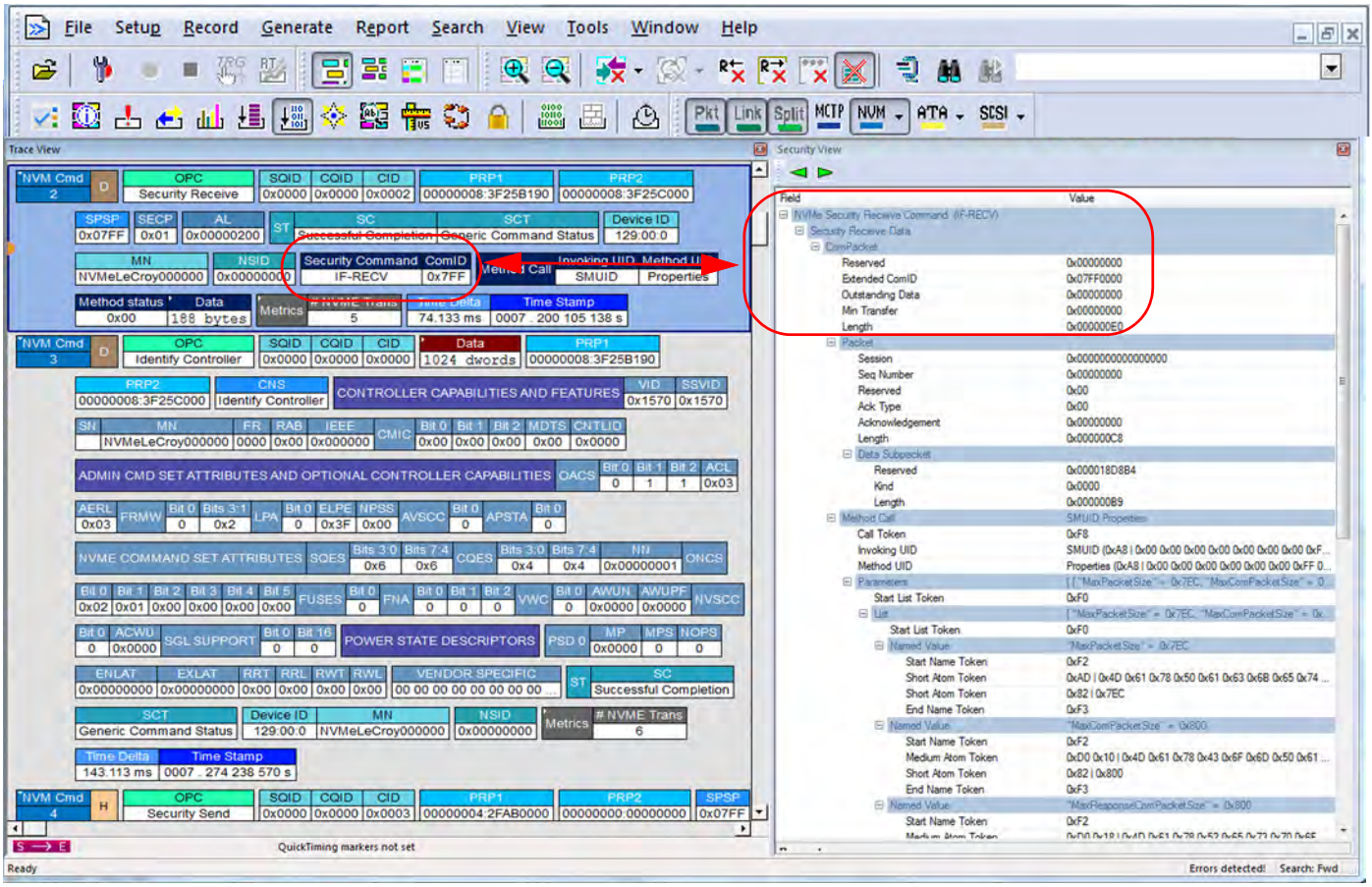


Figure 6.47: NVMe Command with TCG Details

6.12.5.4 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 deauthentication).
- Enable interoperability between multiple SD vendors.

NVMe: TCG Opal Decoded

The PCIe Protocol Software can decode and display Opal TCG fields. See Figure 6.48.

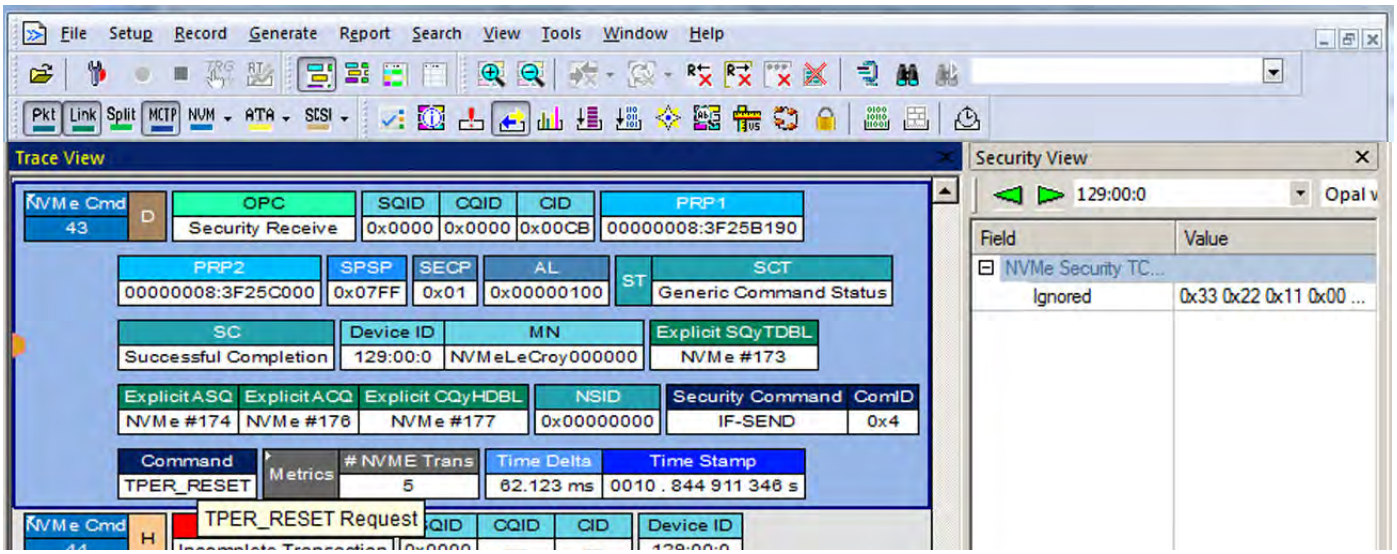


Figure 6.48: NVMe Trace: Opal TCG Security Fields Decoded

A more detailed view of the security field is shown in Figure 6.49 on page 463.

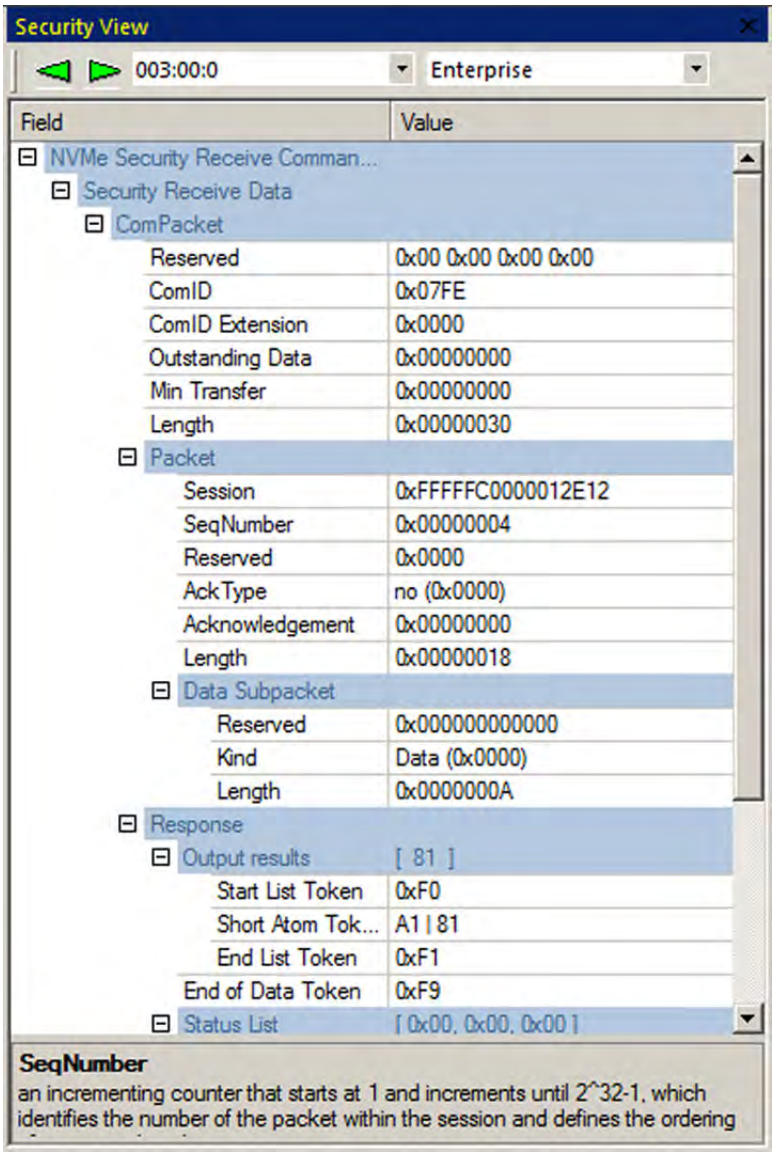


Figure 6.49: NVMe Trace: Opal TCG Security Fields Decoded in Detail

6.12.5.5 Opalite Version 0.1: Decoded

The PCIe Protocol Analysis software can decode the TCG transaction: Opalite Security Version 0.1 (as shown in Figure 6.50 and Figure 6.51 on page 465 below):

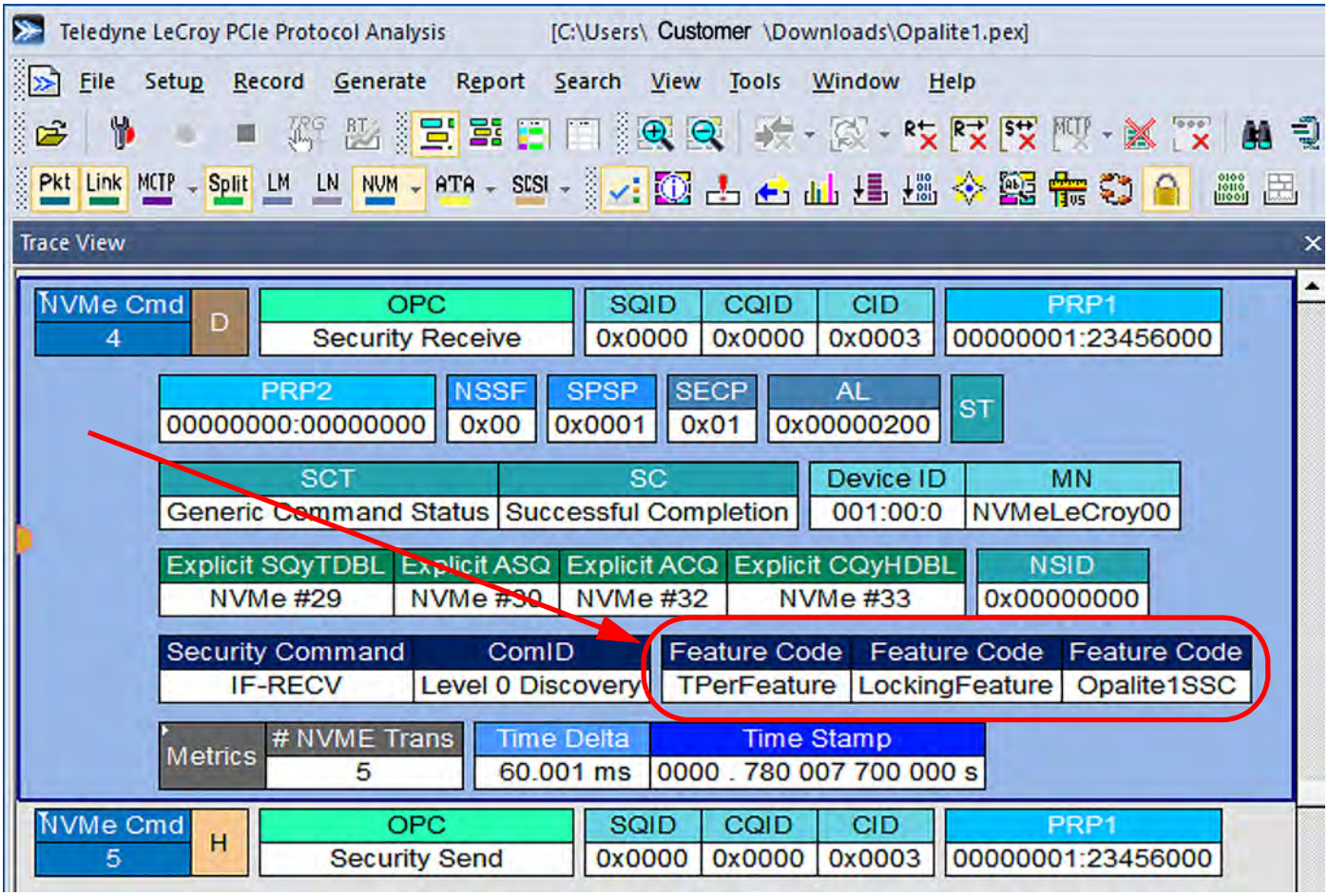


Figure 6.50: NVMe Trace: Opalite v0.1 TCG Security Fields Decoded

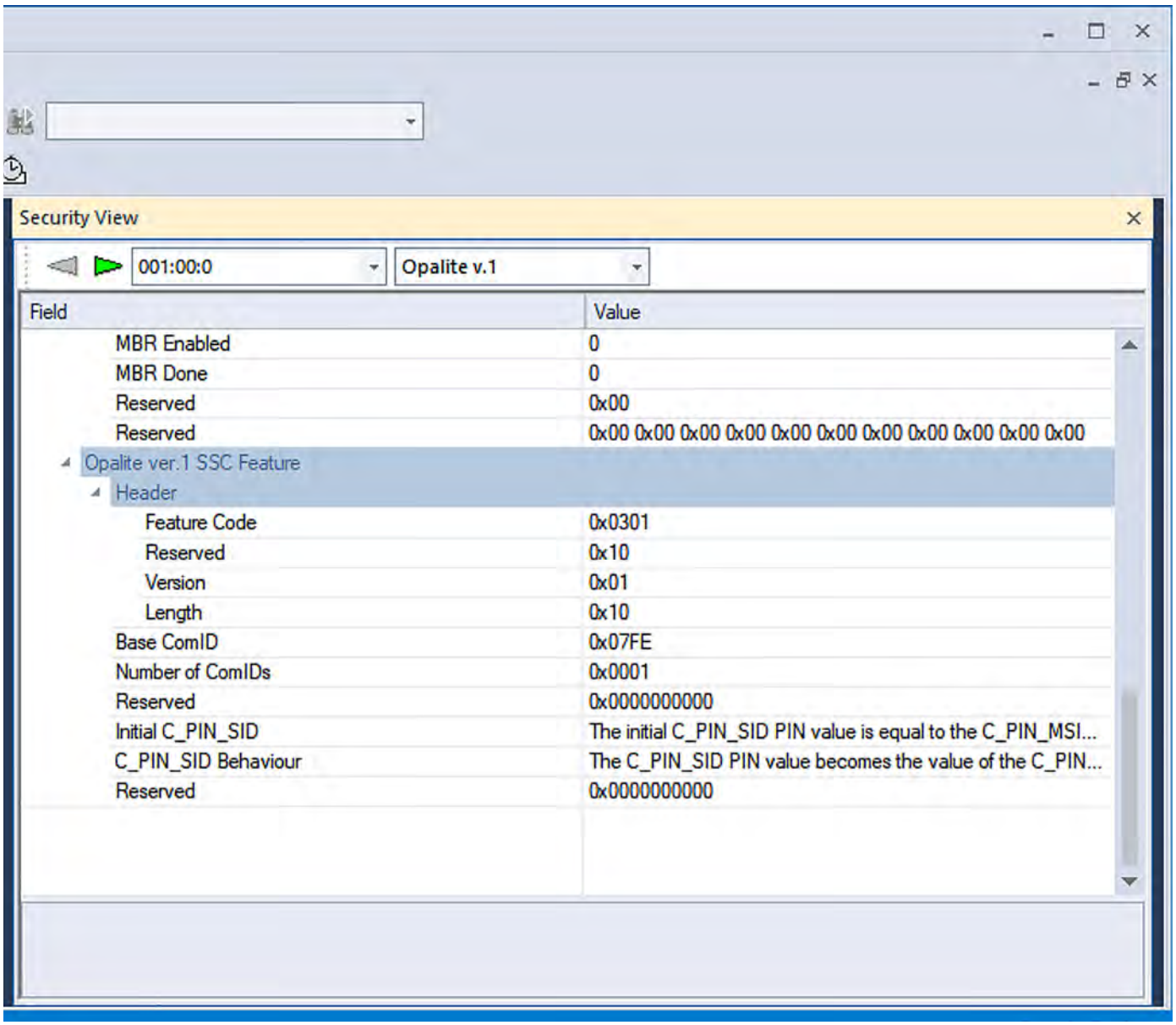


Figure 6.51: NVMe Trace: Opalite v0.1 TCG Security Fields Decoded -> Details

6.12.5.6 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 6.52 and Figure 6.53 on page 466.

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

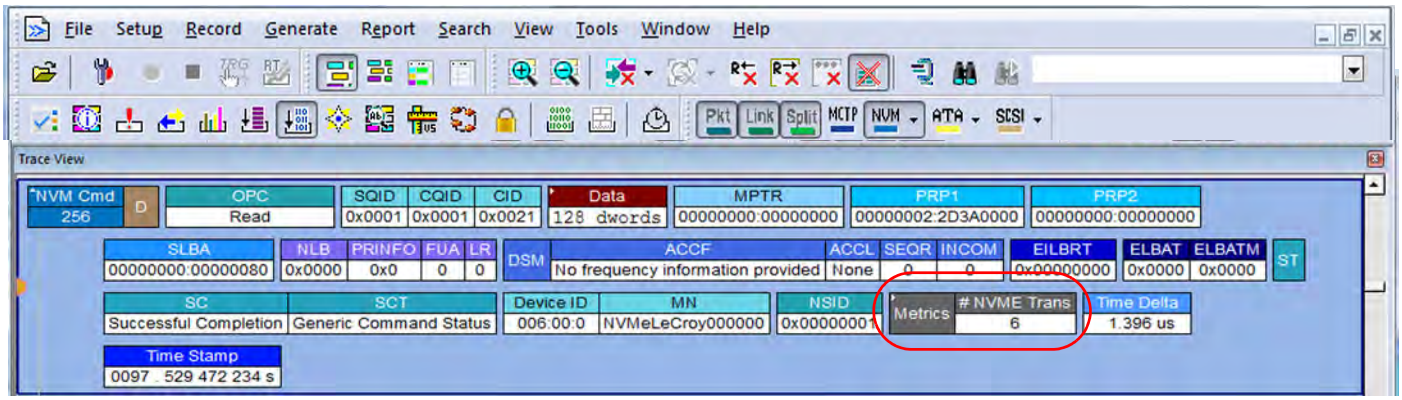


Figure 6.52: NVMe Read Command Packet with Metrics Box

Move the cursor over the Metrics box to display the information about the NVMe Command. See Figure 6.53.

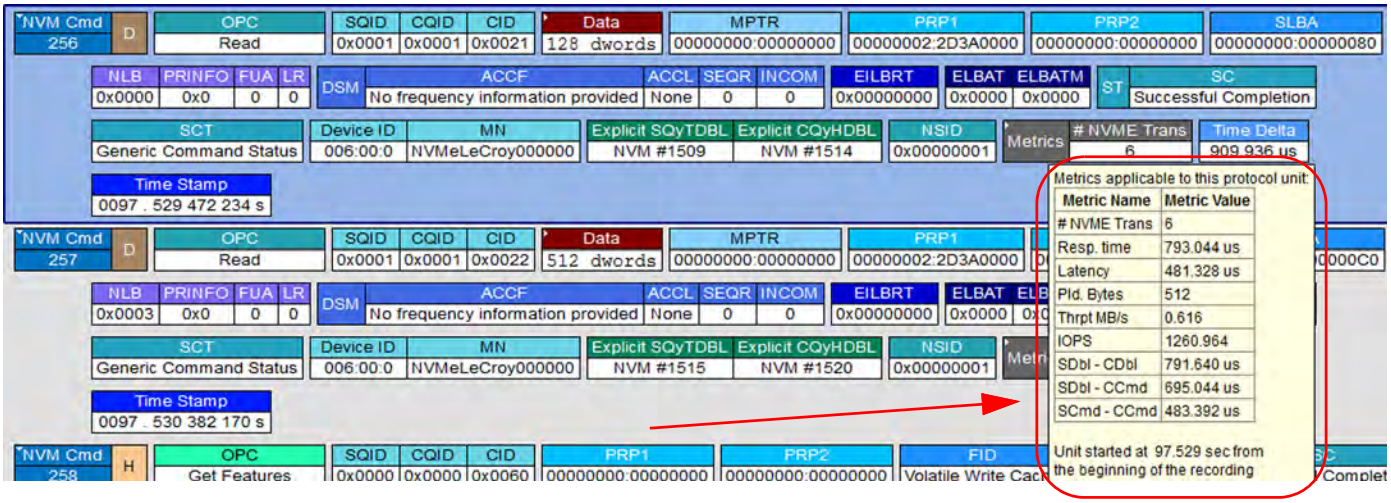


Figure 6.53: NVMe Read Command Packet with Metrics Displayed

If you click on the white arrow in the Metrics box, the information about the packet will be displayed in the Trace. See Figure 6.54.

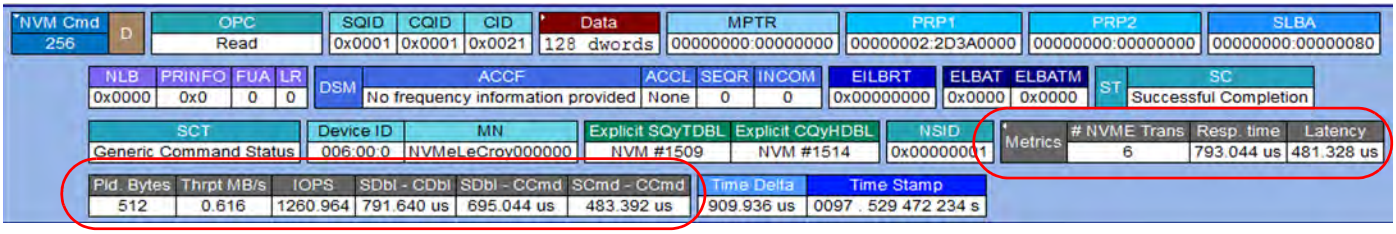


Figure 6.54: NVMe Read Command Packet with Metrics Displayed in Trace

The IOPS value is defined when you move the cursor over the IOPS box. See Figure 6.55.

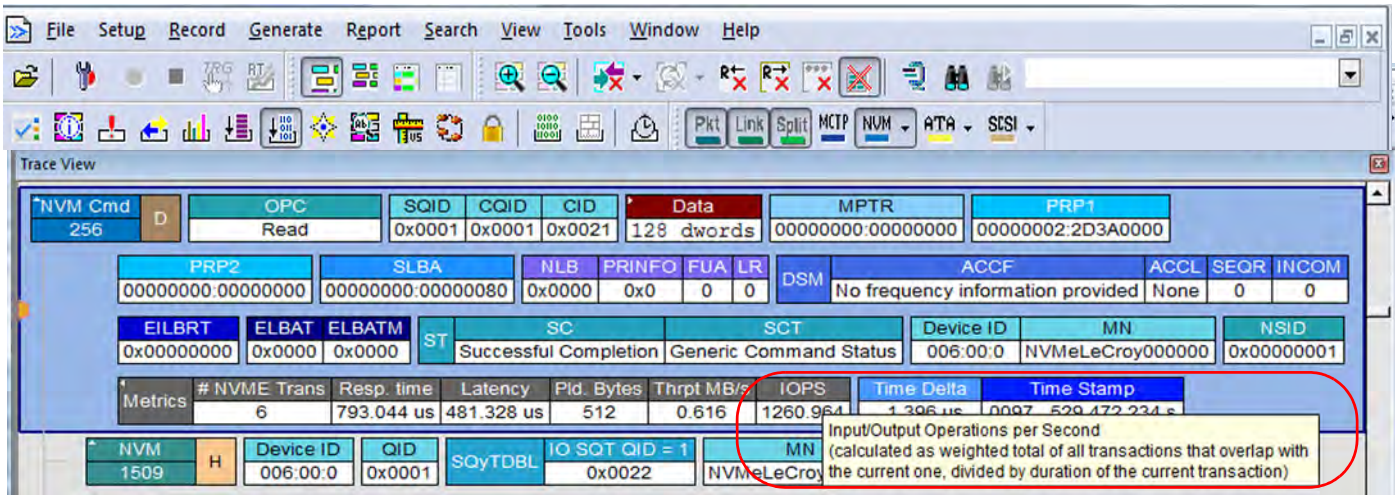


Figure 6.55: NVMe READ Command: IOPS Defined

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 6.56.

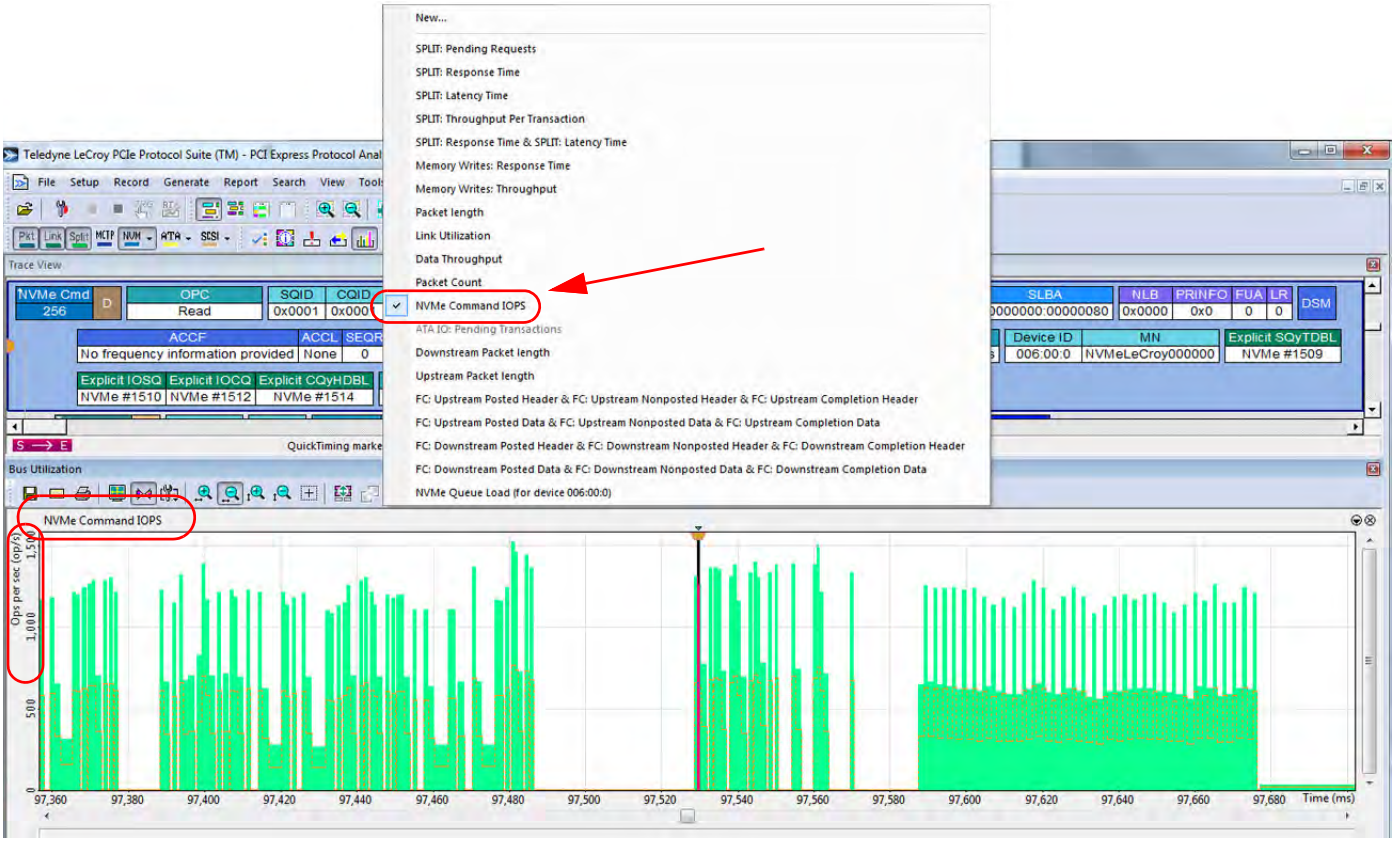


Figure 6.56: NVMe READ Command: Bus Utilization -- IOPS

NVMe Command IOPS is also displayed in the Spreadsheet and Detailed Views. See Figure 6.57.

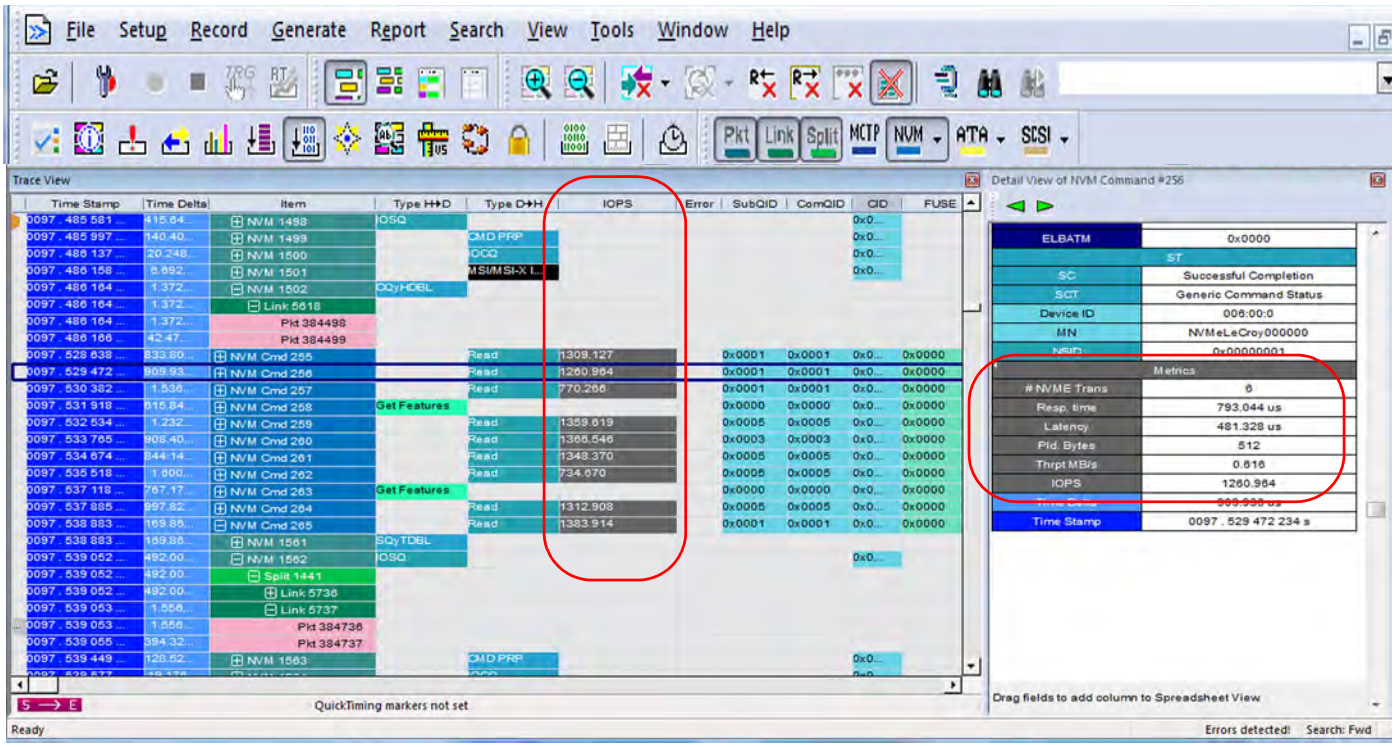


Figure 6.57: NVMe READ Command: IOPS Statistics

6.12.5.7 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 6.58 on page 471.
- 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 6.58 on page 471)
- For CQyHDBL: Command was explicitly/implicitly finished by CQyHDBL in NVMe #number
- For Missing Doorbells: Doorbell is missing
- For Filtered: Doorbells are filtered out

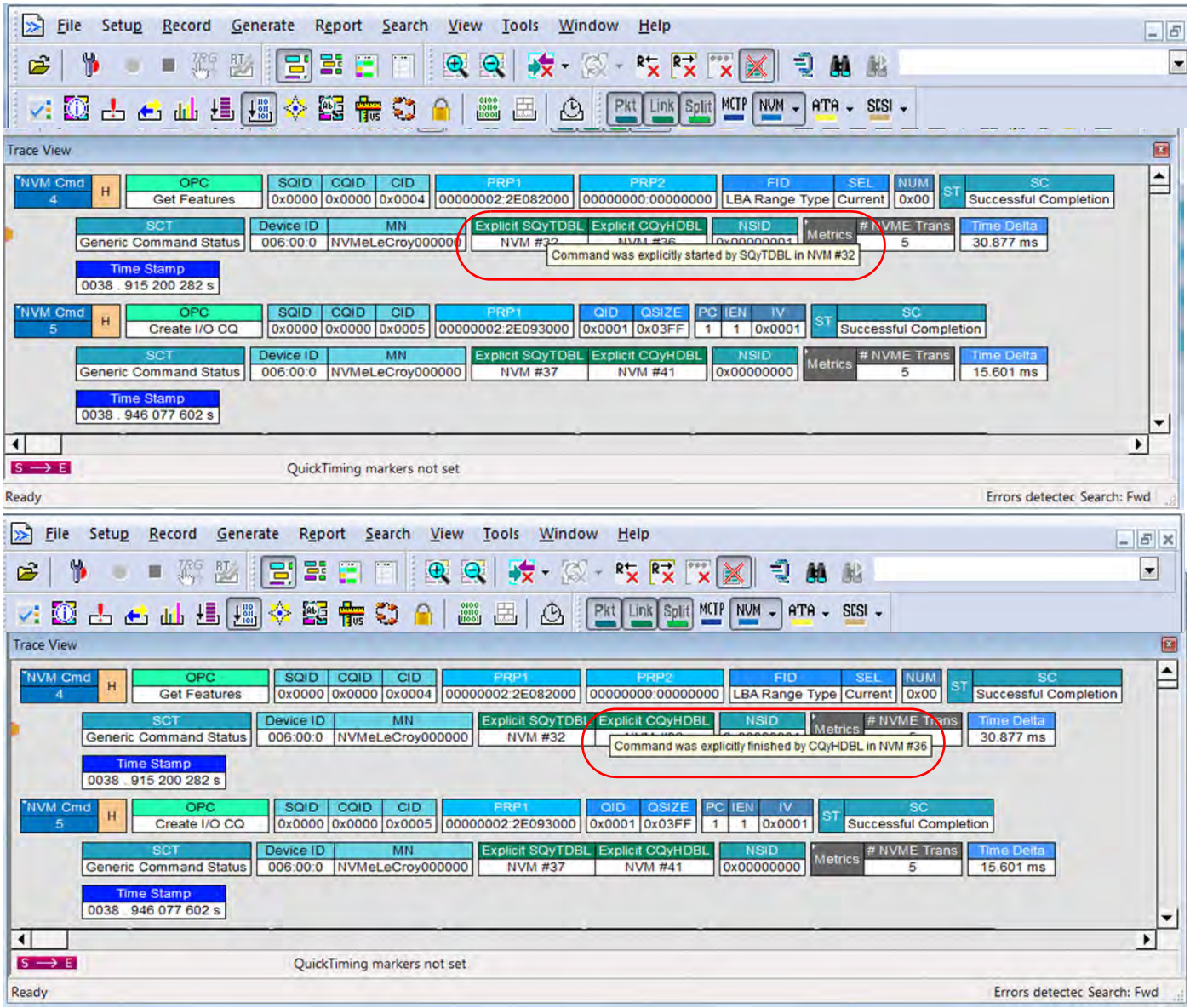


Figure 6.58: NVMe Decoding: Example of Explicit Doorbell in Trace with Tool Tips

6.12.5.8 Time Stamp from Implicit Start

The time stamp for an NVMe command can either be referenced from the recorded trace start time (see Figure 6.59) or from the implicit start of the command (see Figure 6.60). If you right click on the Time Stamp, the Time Stamp Context Menu will pop up. This allows you to Check or Uncheck the "Calculate Timestamp from implicit start if present" box.

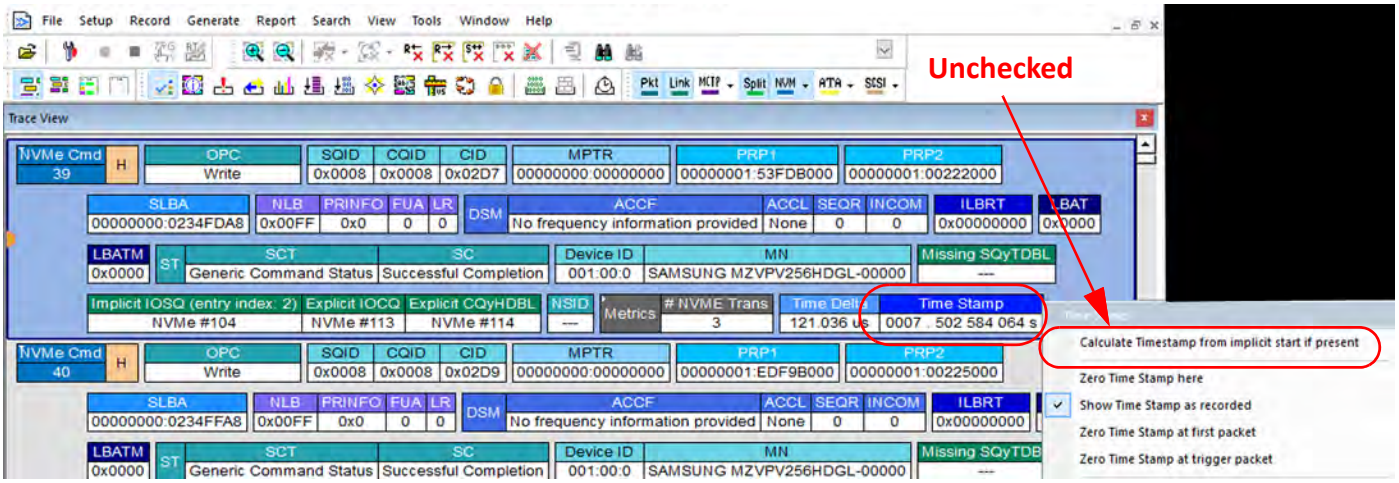


Figure 6.59: Timestamp Referenced from Start of Trace = 7.502584064 seconds

If you select "Calculate Timestamp from implicit start if present" you'll get the following results. In this case, the Implicit Start was earlier in the trace than the NVMe command so the timestamp for the NVMe command is earlier (see Figure 6.60).

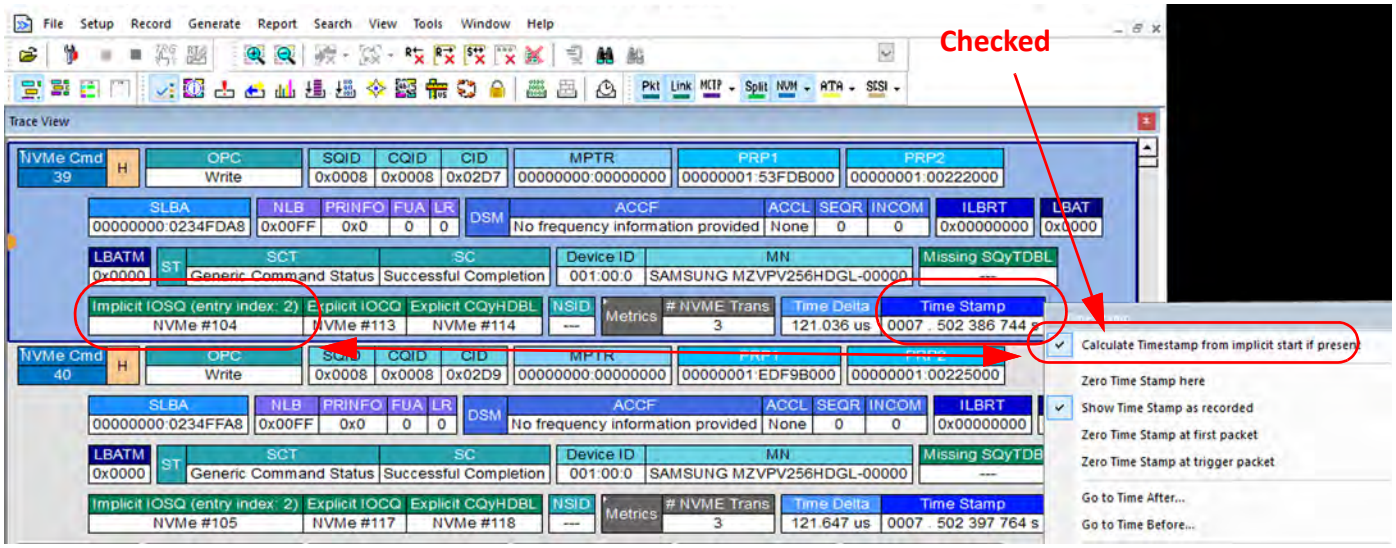


Figure 6.60: Timestamp Referenced from the Implicit Start = 7.502386744 seconds

6.12.5.9 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 6.61 and Figure 6.62.

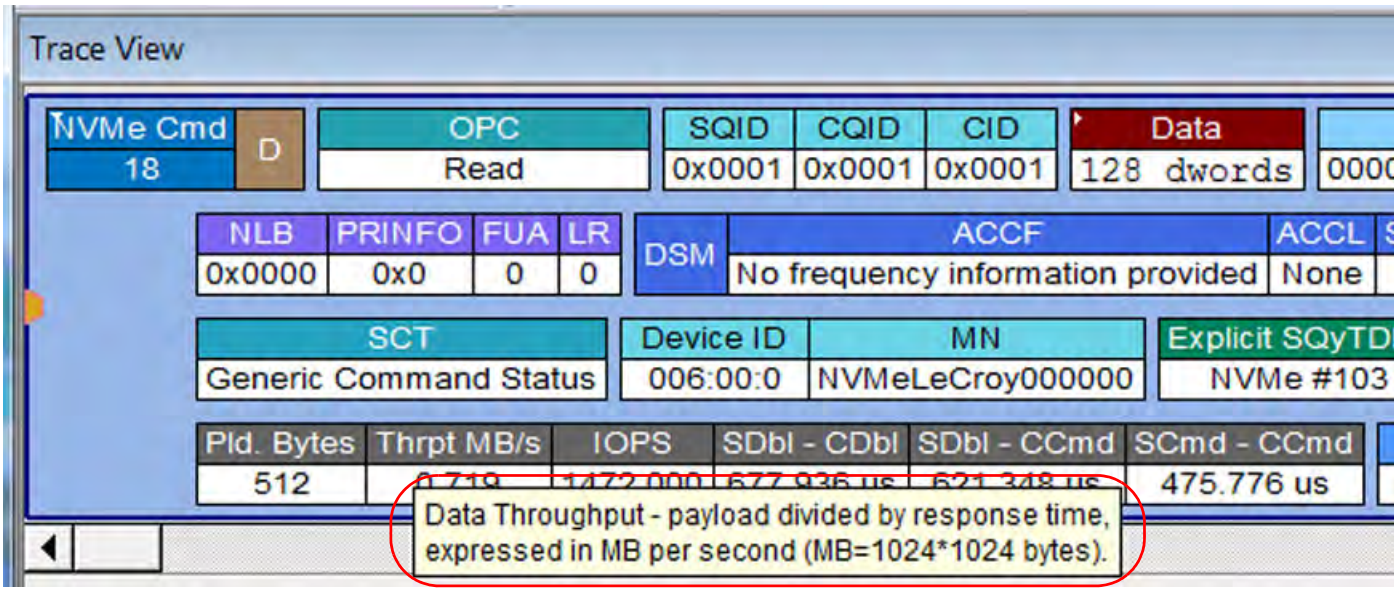


Figure 6.61: NVMe Command: Data Throughput

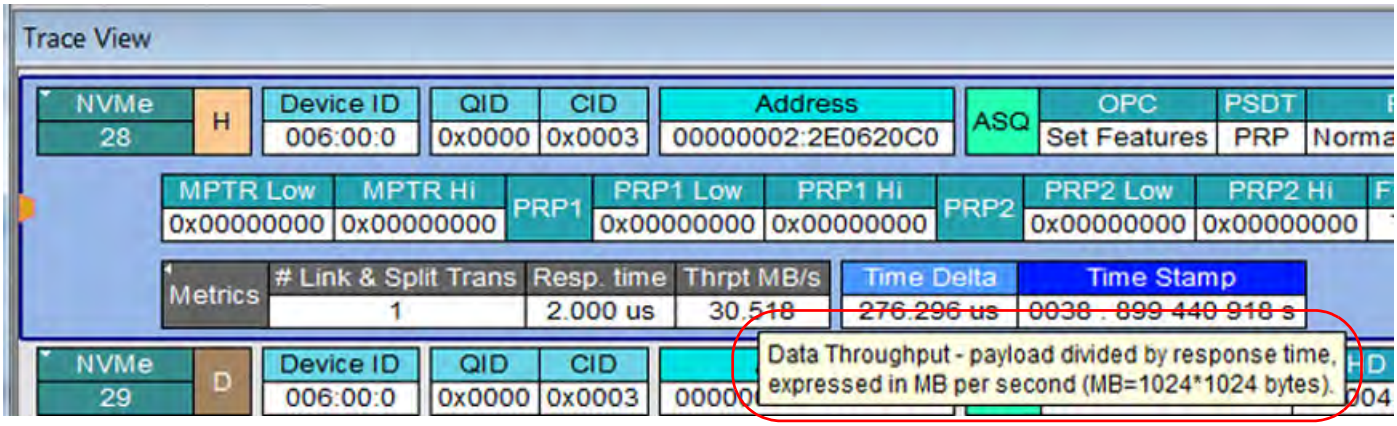


Figure 6.62: NVMe Transaction: Data Throughput

6.12.5.10 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 6.63).

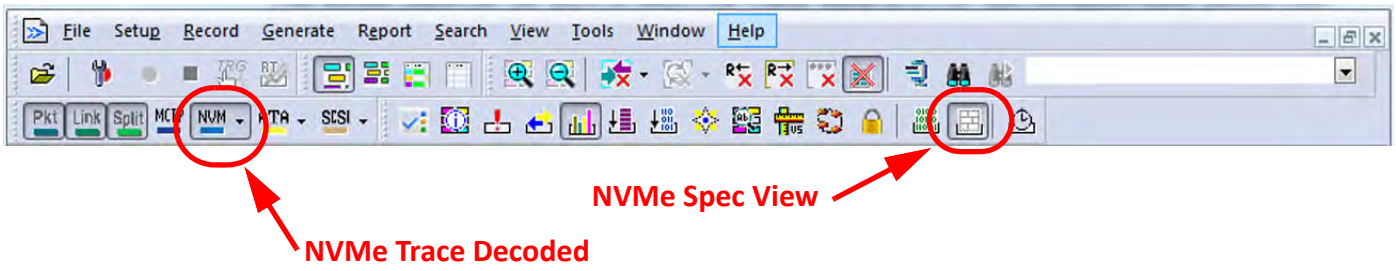


Figure 6.63: PCIe Protocol Analysis Toolbar -> NVMe Specification View

The NVMe data can be seen in both the Trace View and the Specification view below (see Figure 6.64 and Figure 6.65 on page 475).

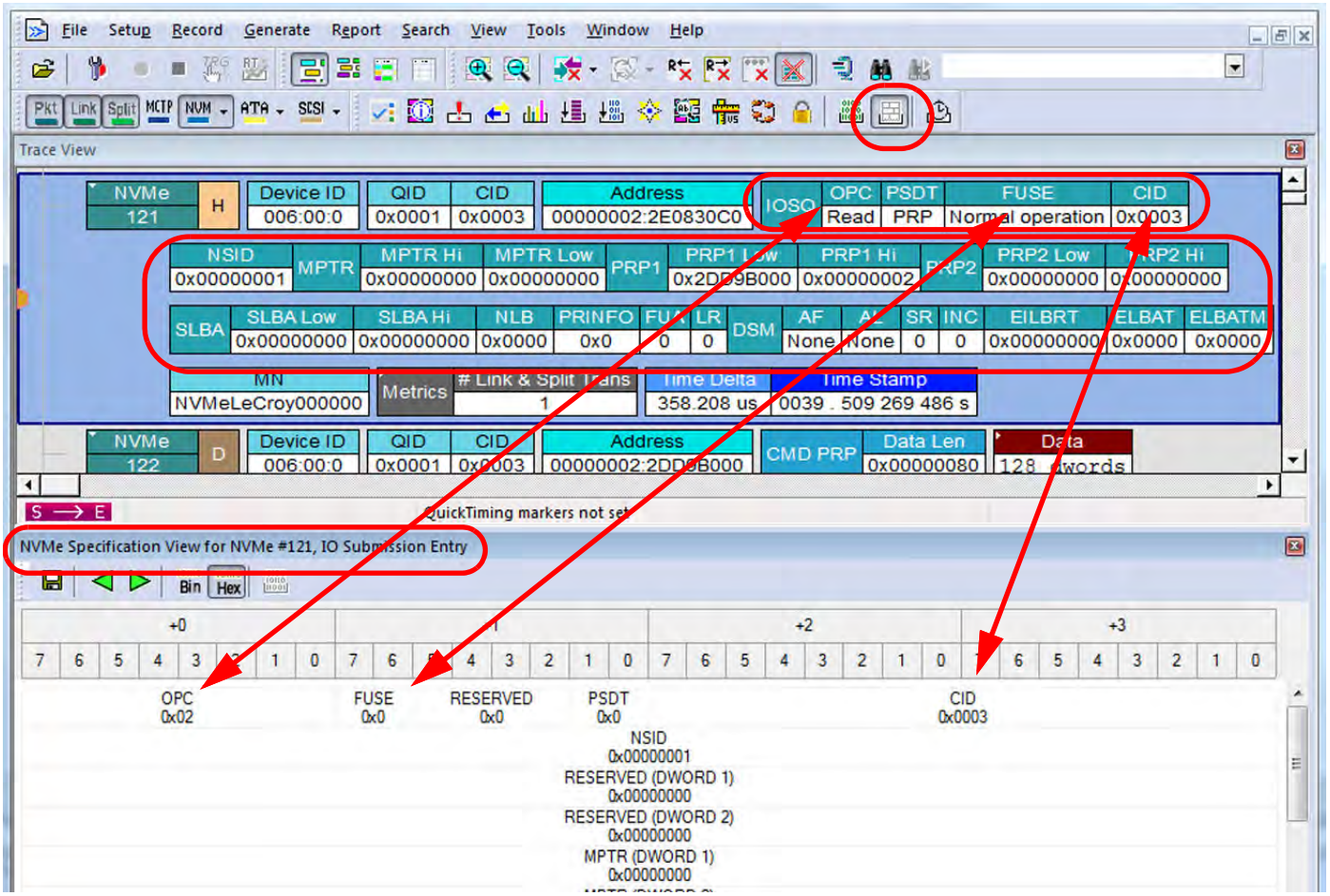


Figure 6.64: Decoding NVMe Trace -> Trace View vs. Spec View (Part 1)

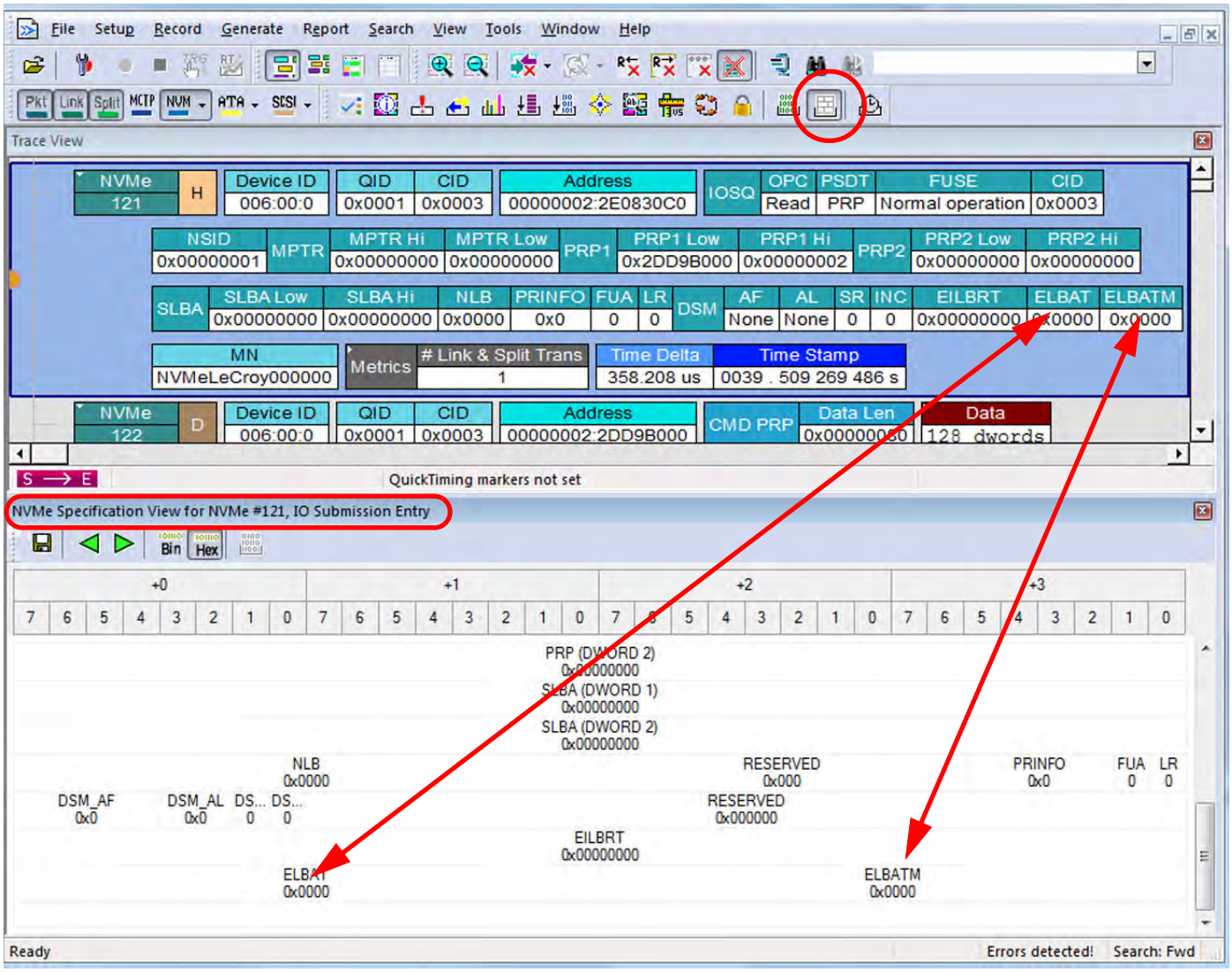


Figure 6.65: Decoding NVMe Trace -> Trace View vs. Spec View (Part 2)

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 6.66

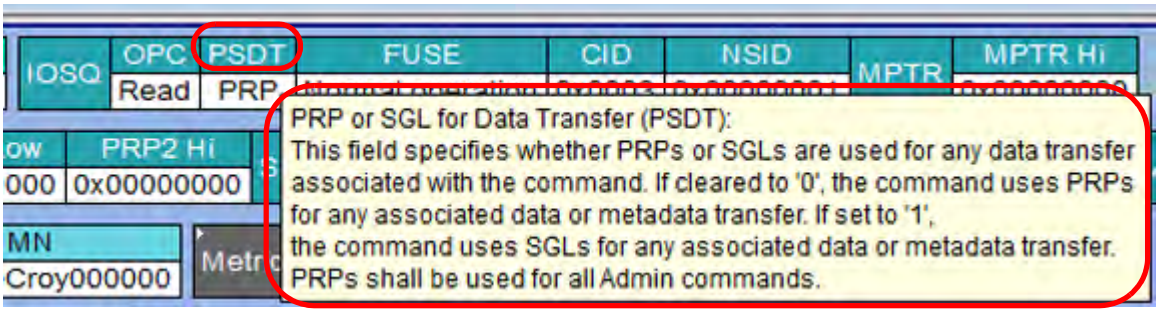


Figure 6.66: NVMe Specification: Trace View Tool Tip

Similar Tool Tips are available in the NVMe Specification View. See Figure 6.67 on page 476.

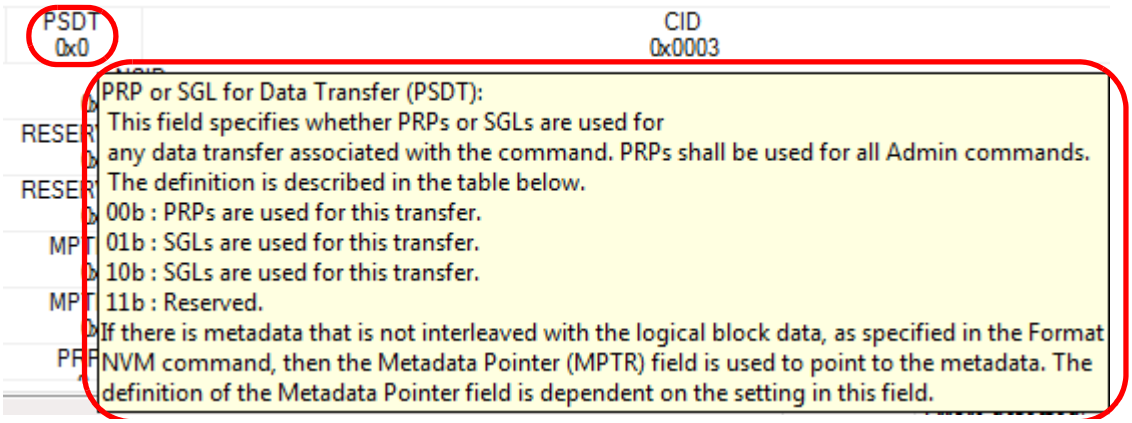


Figure 6.67: NVMe Specification View: Tool Tip

The NVMe Specification View is also available from the Main Toolbar under Report -> NVMe Specification. See Figure 6.68.

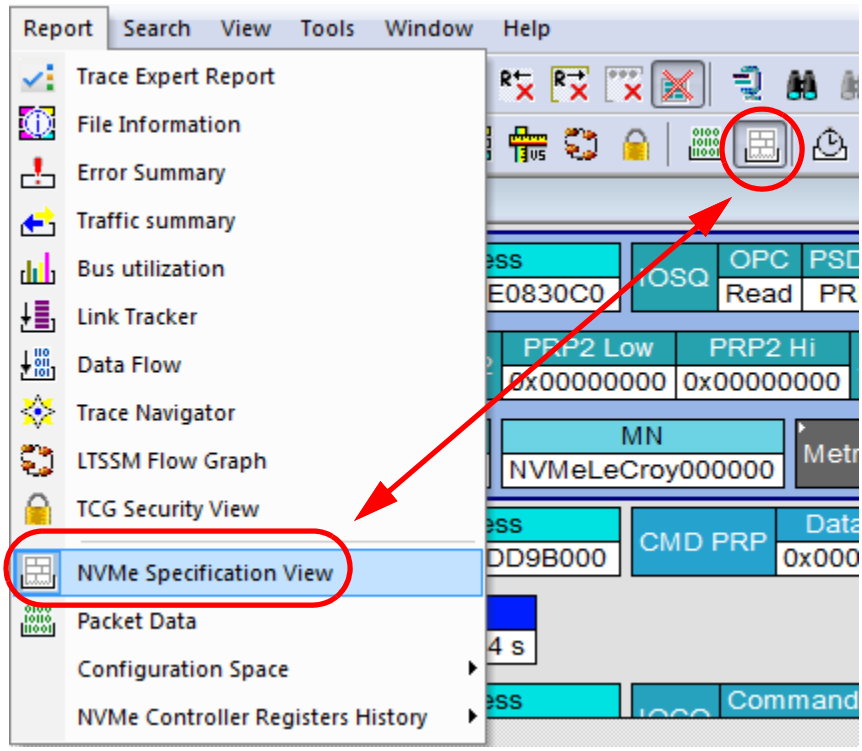


Figure 6.68: Report: NVMe Specification

6.12.5.11 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 6.69).

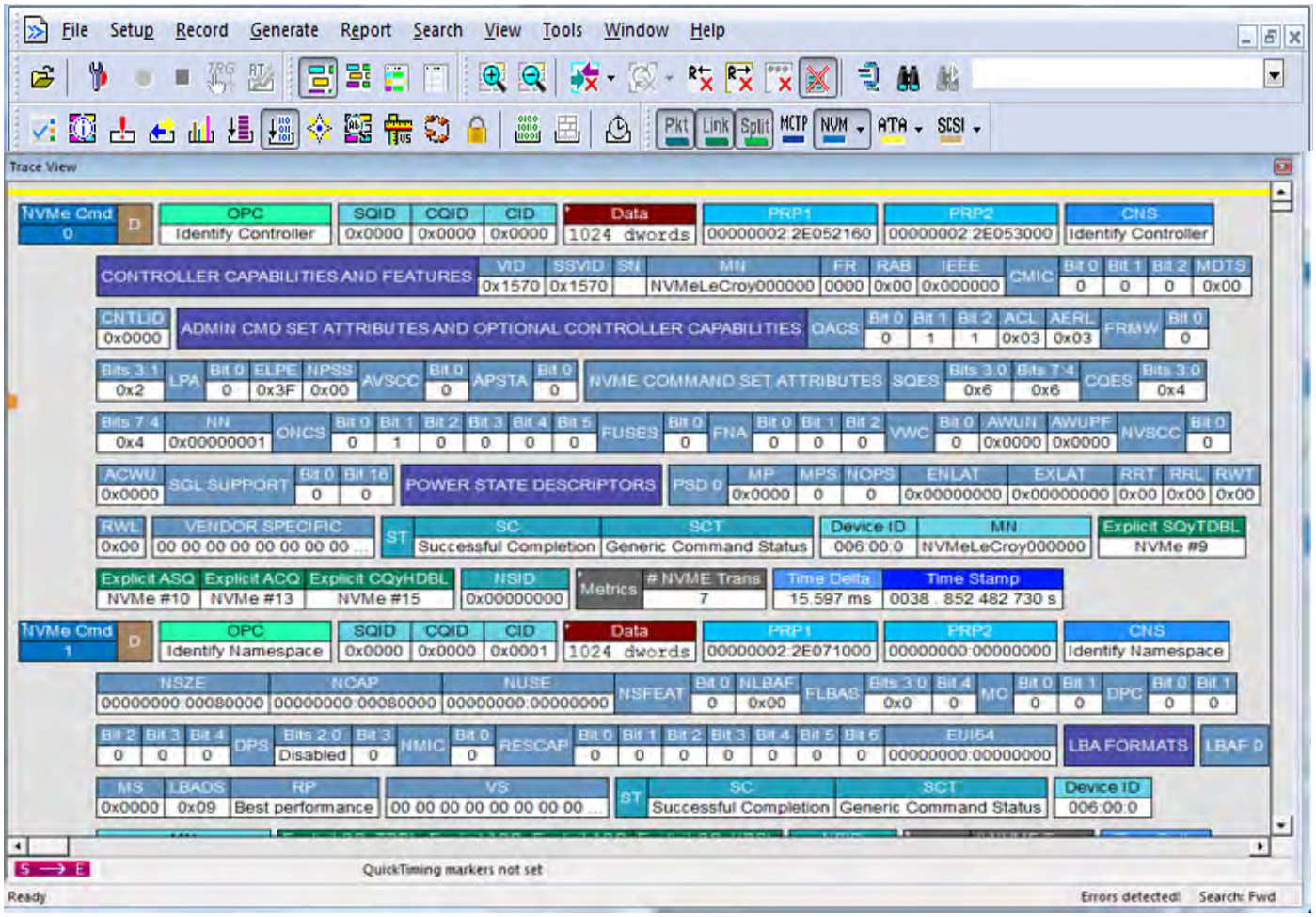


Figure 6.69: NVMe Trace Loaded

3. Select Reports -> NVMe Controller Registers History (see Figure 6.70 on page 478).

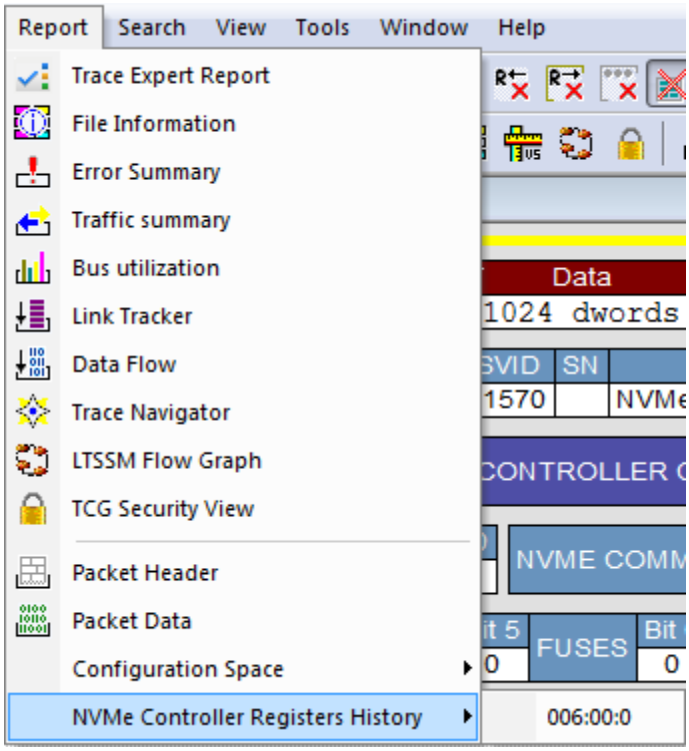


Figure 6.70: Reports -> NVMe Controller Registers History

4. Select the time shown (006:00:0) and the following display will pop up. See Figure 6.71 on page 479.

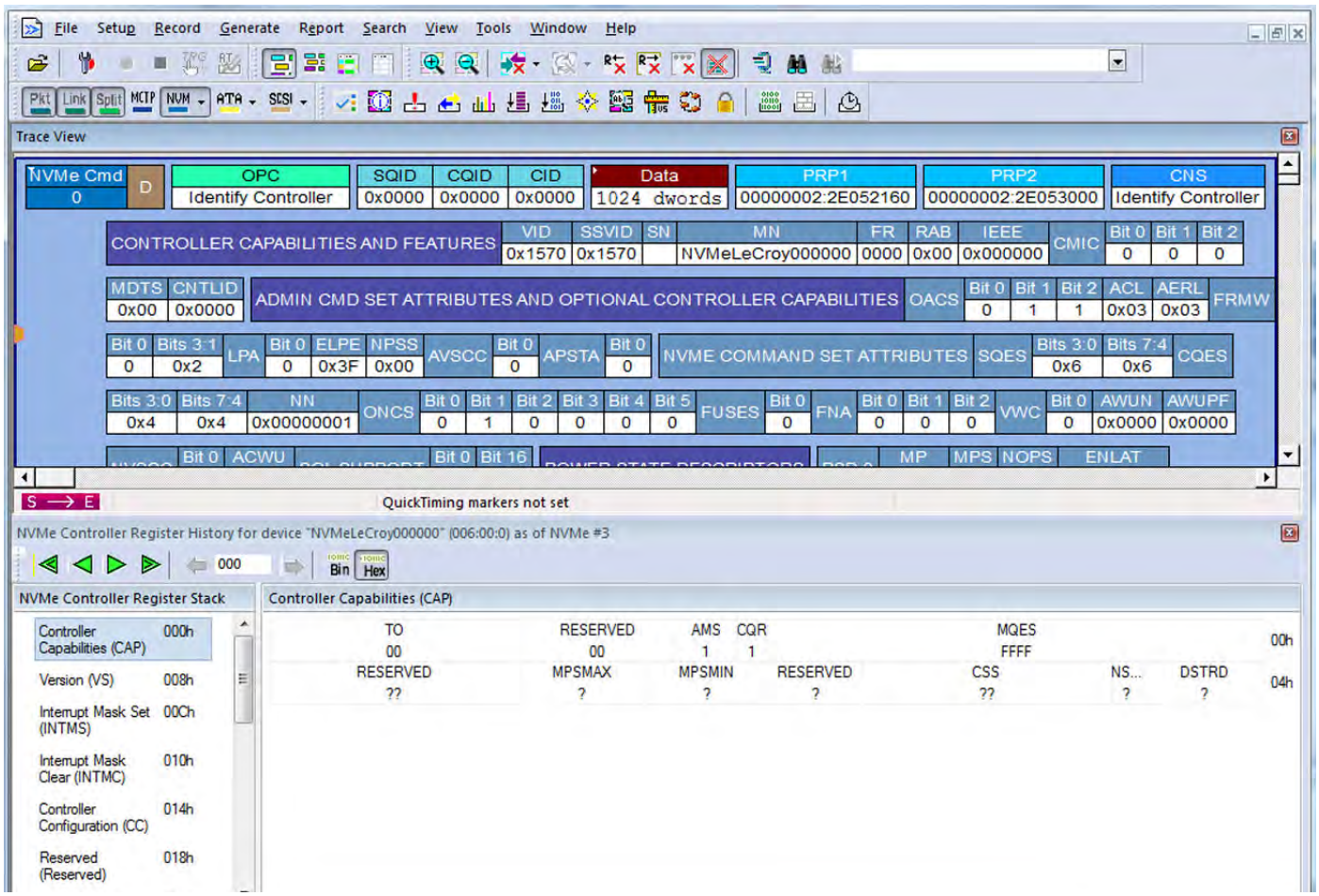


Figure 6.71: Reports -> NVMe Controller Registers History Displayed

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

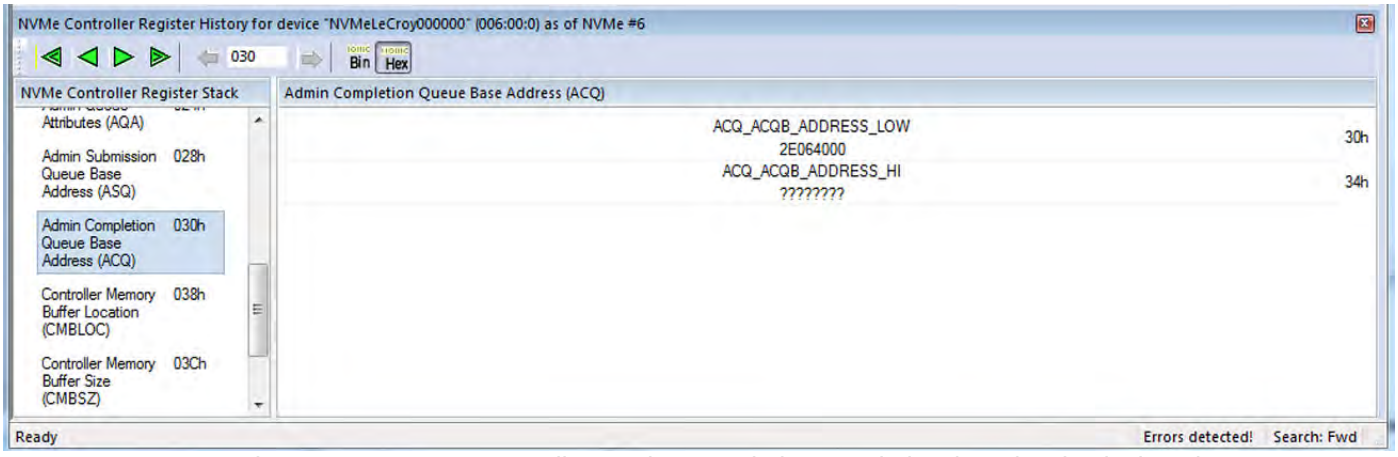


Figure 6.72: NVMe Controller Registers: Admin Completion (ACQ) 30h Displayed

6. As an example you could click on the Next NVMe arrow and the Admin Queue Attributes would be displayed (see Figure 6.73).

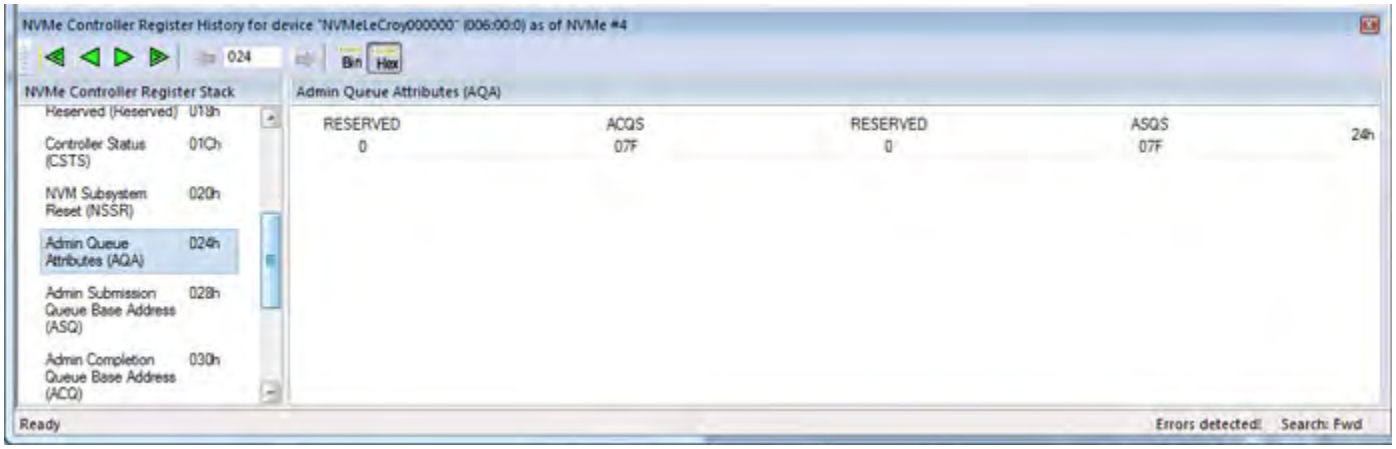


Figure 6.73: NVMe Controller Registers: Admin Queue Attributes (AQA) 024h Displayed

7. You can continue clicking the Green arrow to see more of the NVMe Controller Register Stack. See Figure 6.74 on page 480.

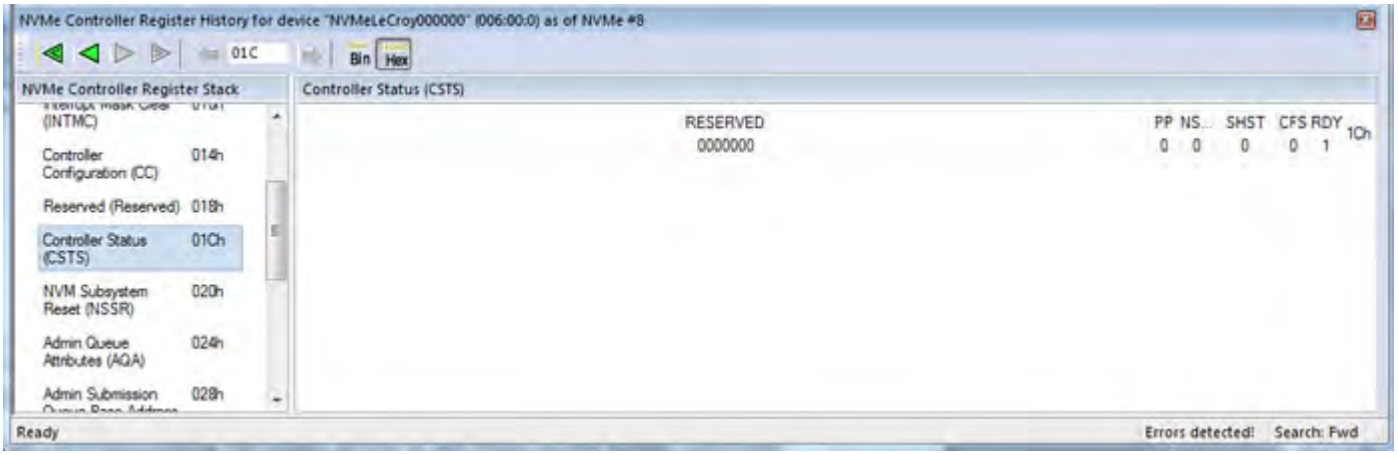


Figure 6.74: NVMe Controller Registers: Controller Status (CSTS) 01Ch

6.12.5.12 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 6.75. 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 6.75).

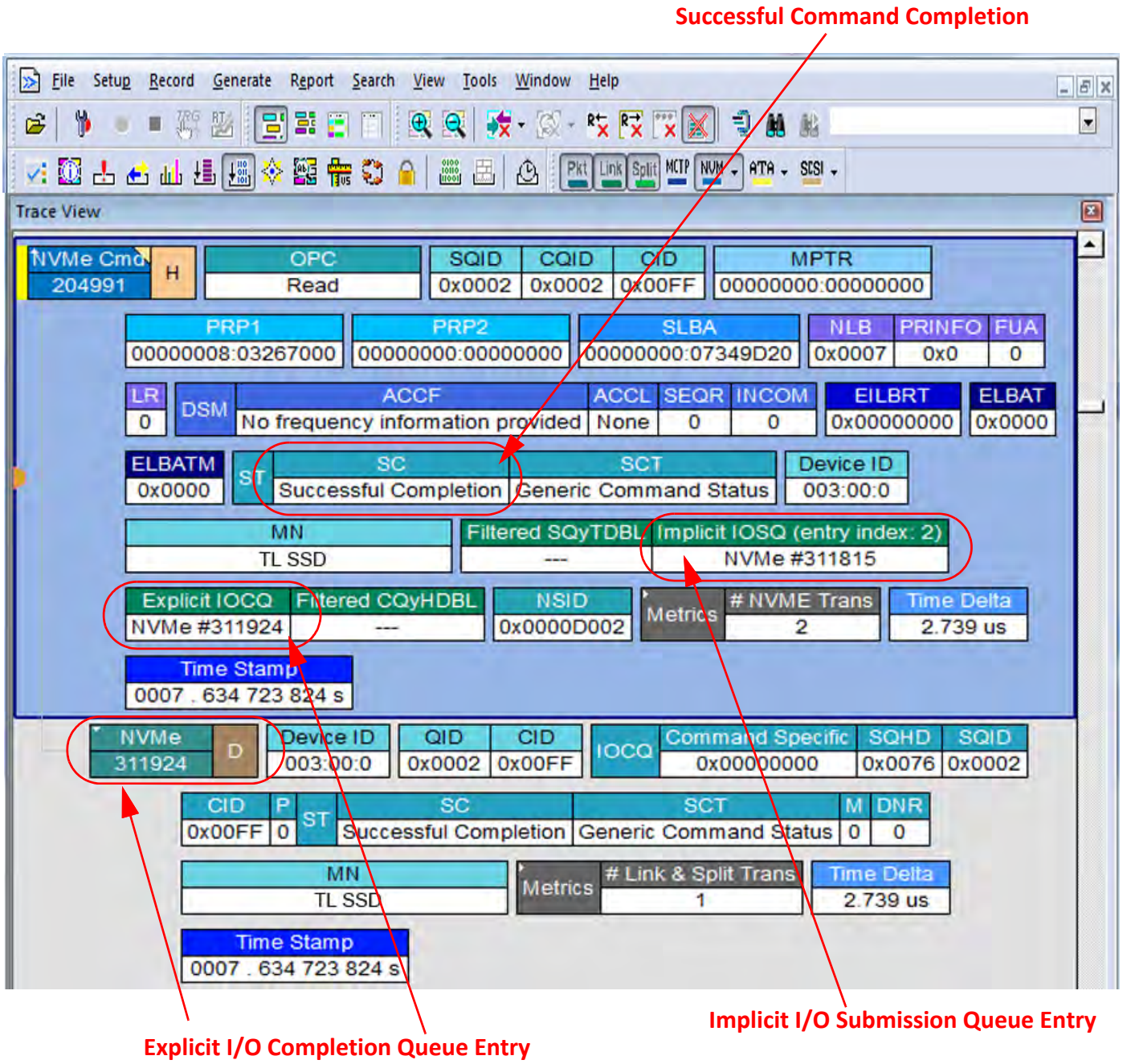


Figure 6.75: Implicit I/O Submission Queue Entry (IOSQ) and Explicit I/O Completion Queue Entry (IOCQ)

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 6.76).

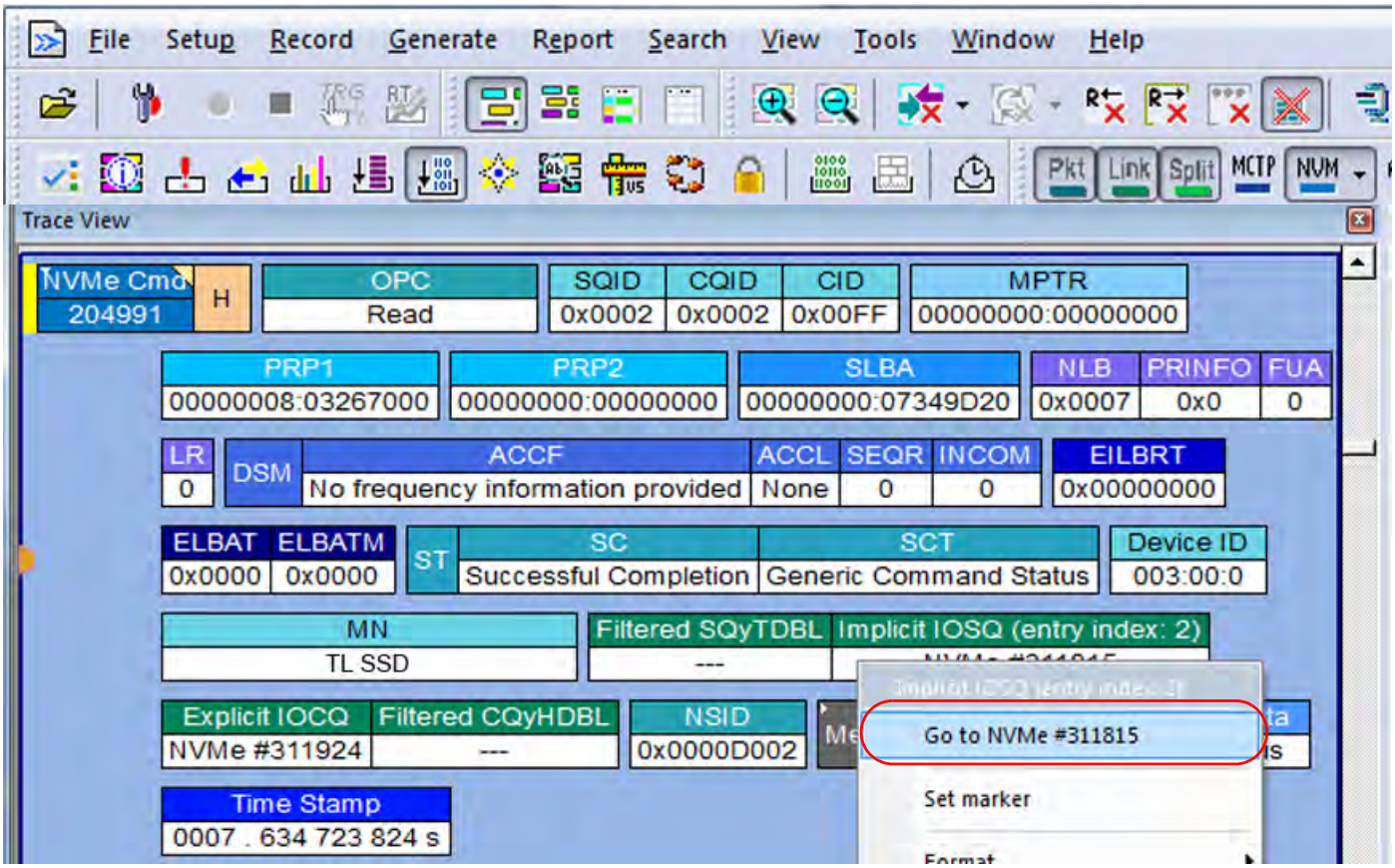


Figure 6.76: Implicit IOSQ Command

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 6.77 on page 483)

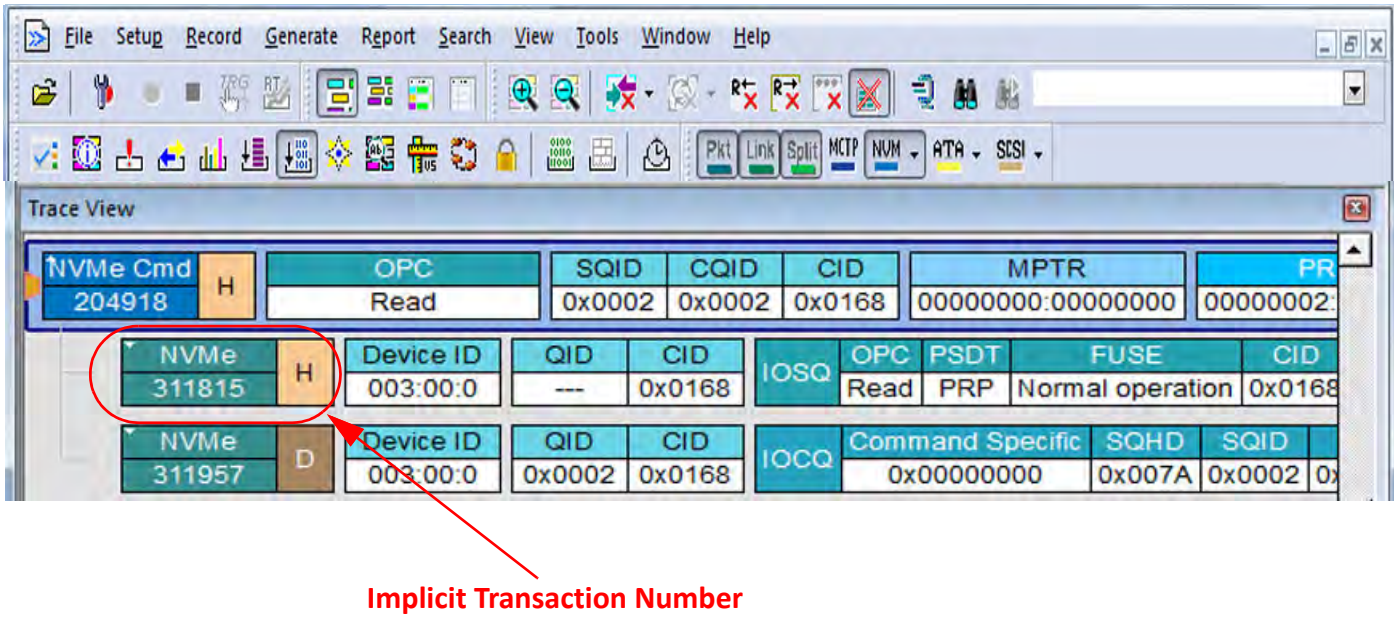


Figure 6.77: NVMe Transaction #318815: Part of NVMe Command 204918

If you expand the NVMe Transaction 311815 down to the Packet level (312224), you'll see two commands (32 DWORDS). See Figure 6.78.

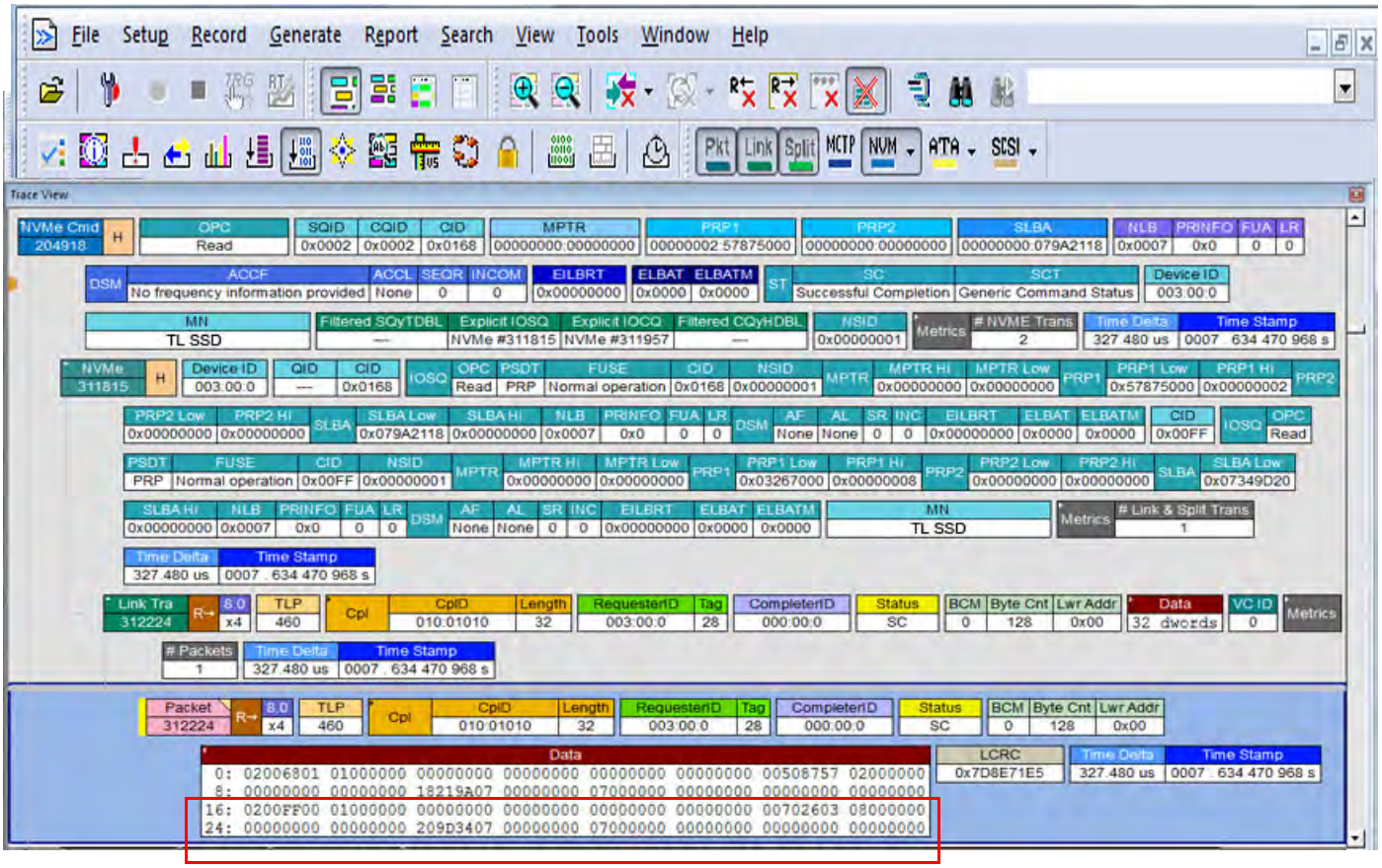


Figure 6.78: Implicit NVMe Transaction Decoded to Packet Level with Two Commands

6.12.6 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 6.79, Figure 6.80, Figure 6.81 on page 486 and Figure 6.82 on page 487).

- Name Space Management
- Replay Protected Memory Blocks
- SSD Dialog Shared NameSpace
- SSD Dialog Version and CMB Configurations

The figure below (Figure 6.79) shows the support added for decoding of the namespace management commands in NVMe data traffic.

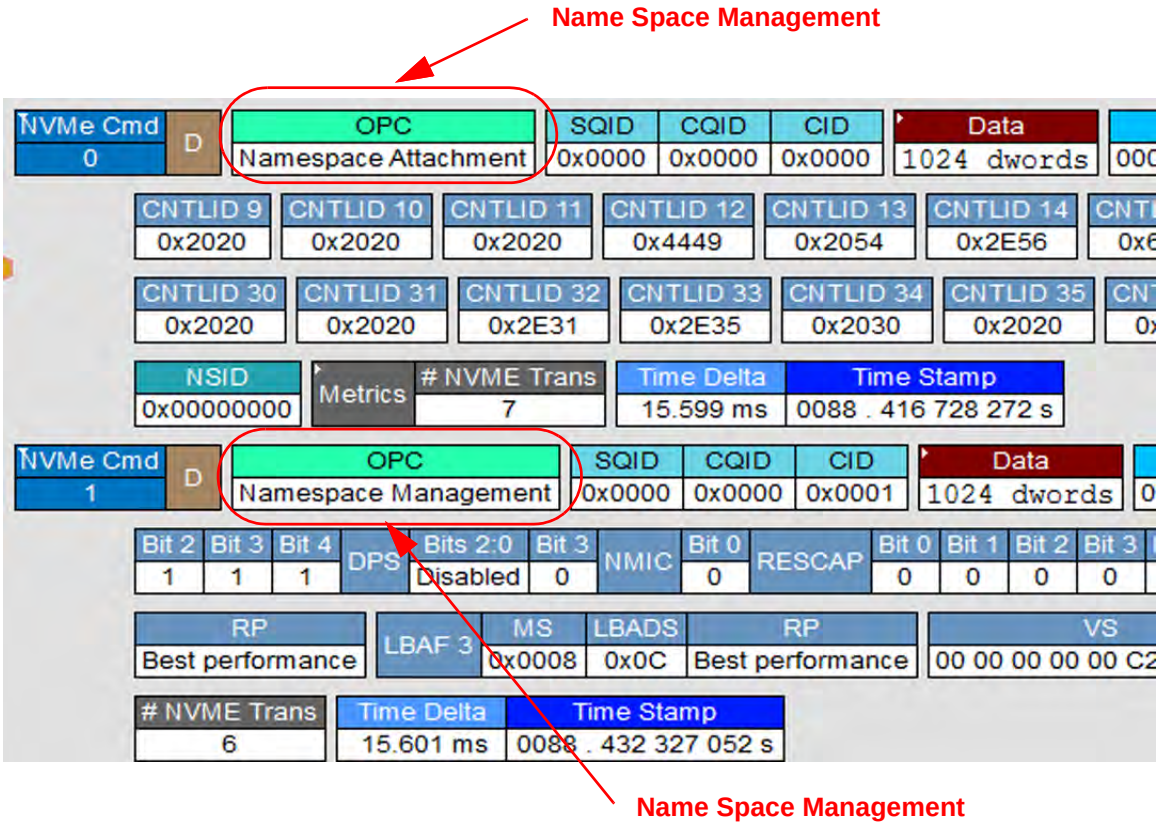


Figure 6.79: NVMe 1.2 Specification: Name Space Management

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 6.80) shows the support added for the Replay Protected Memory Block (RPMB) command in NVMe data traffic.

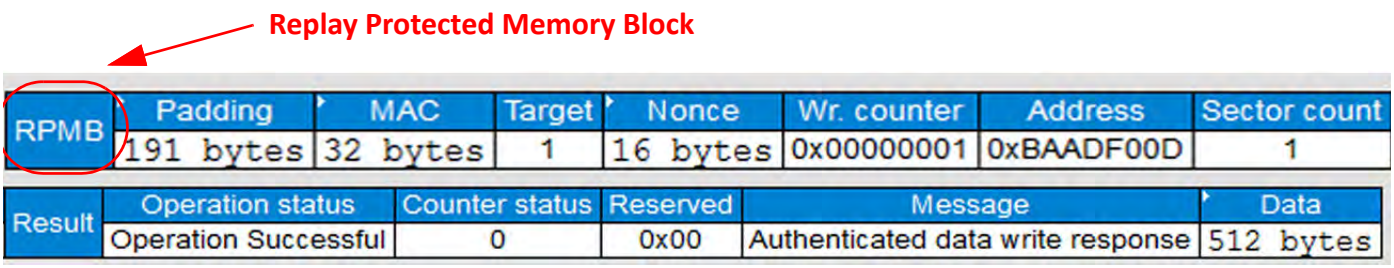


Figure 6.80: NVMe 1.2 Specification: Replay Protected Memory Block

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 6.81) shows the support added for the Shared Namespace command in NVMe data traffic.

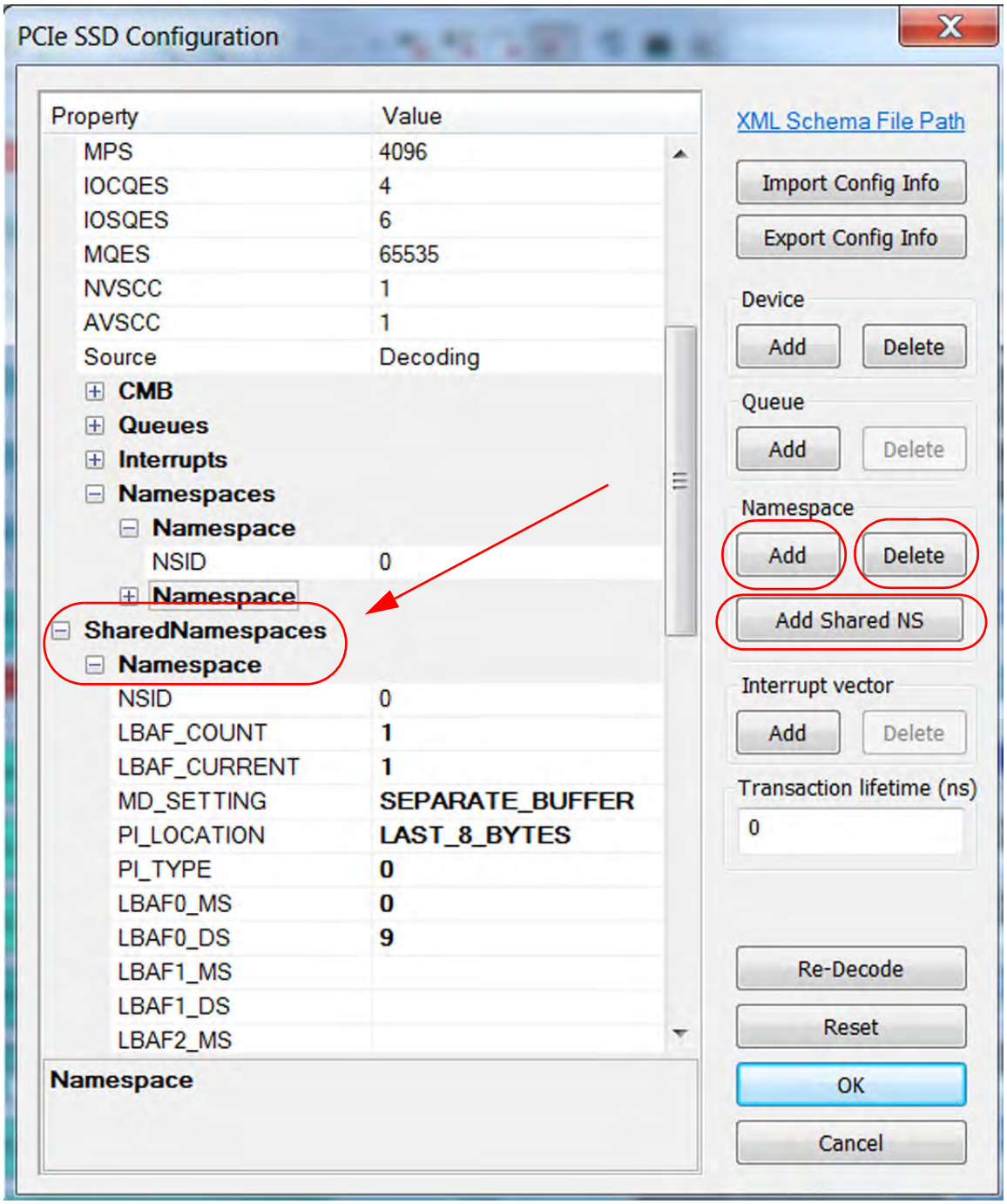


Figure 6.81: NVMe 1.2 Specification: Shared Namespaces

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 6.82) shows the added support for the Controller Memory Buffer (CMB) as defined in the NVMe 1.2 Spec.

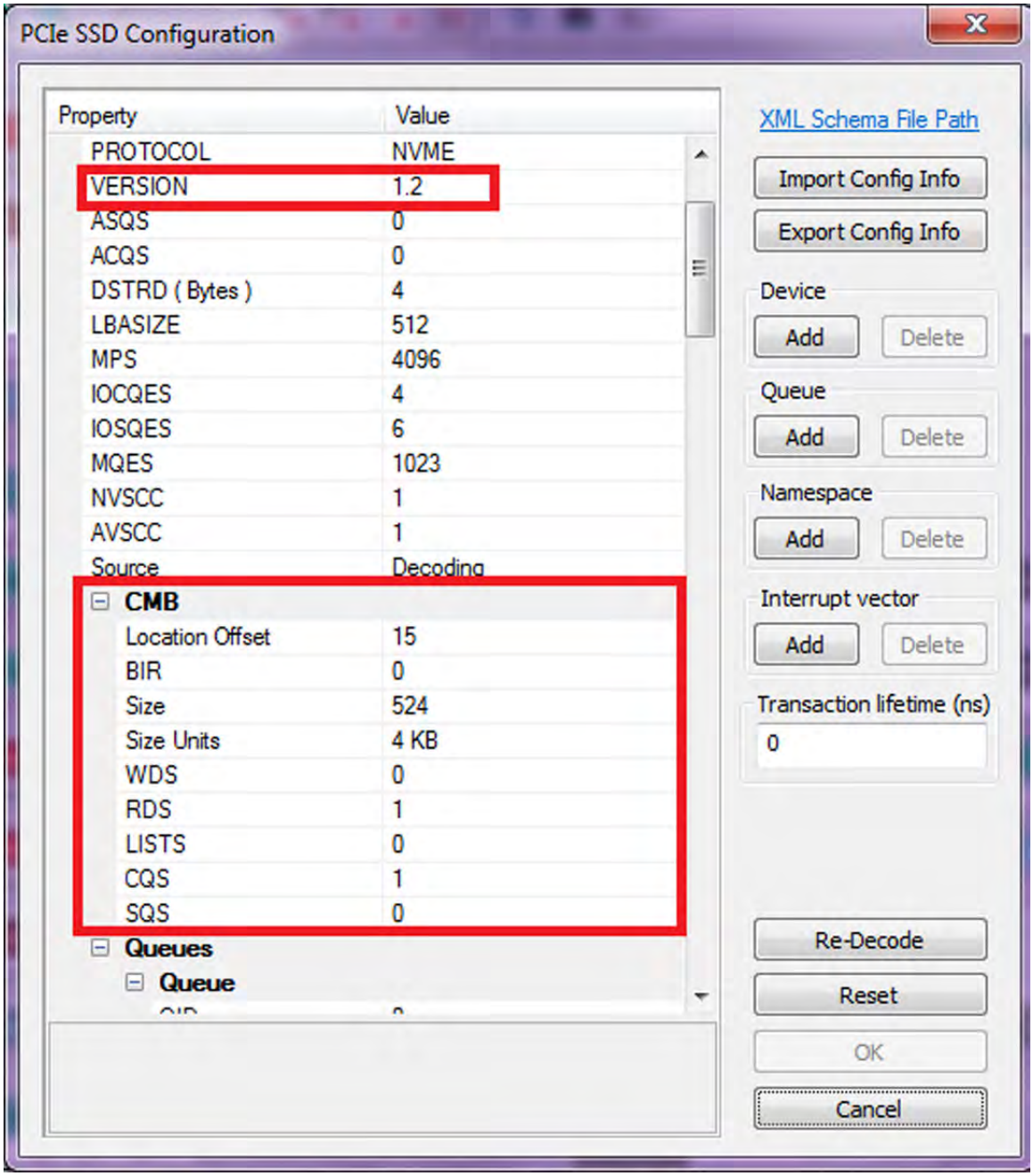


Figure 6.82: NVMe 1.2 Specification: SSD Dialog Version and CMB Configuration

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.

6.12.7 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 6.83 through Figure 6.85 on page 490.

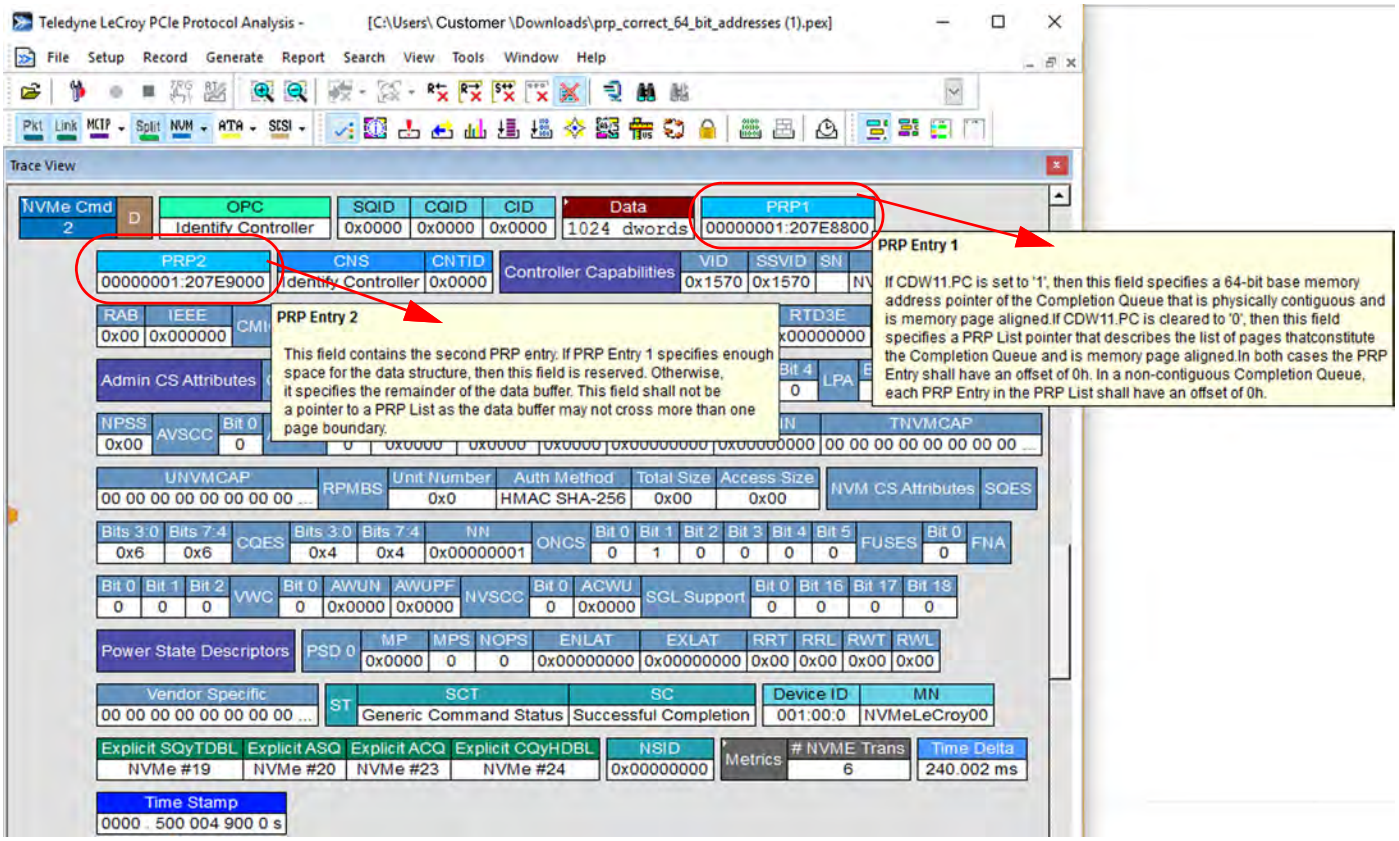


Figure 6.83: PRP1 and PRP2 in CMB Supported in PCIe Protocol Analysis Software

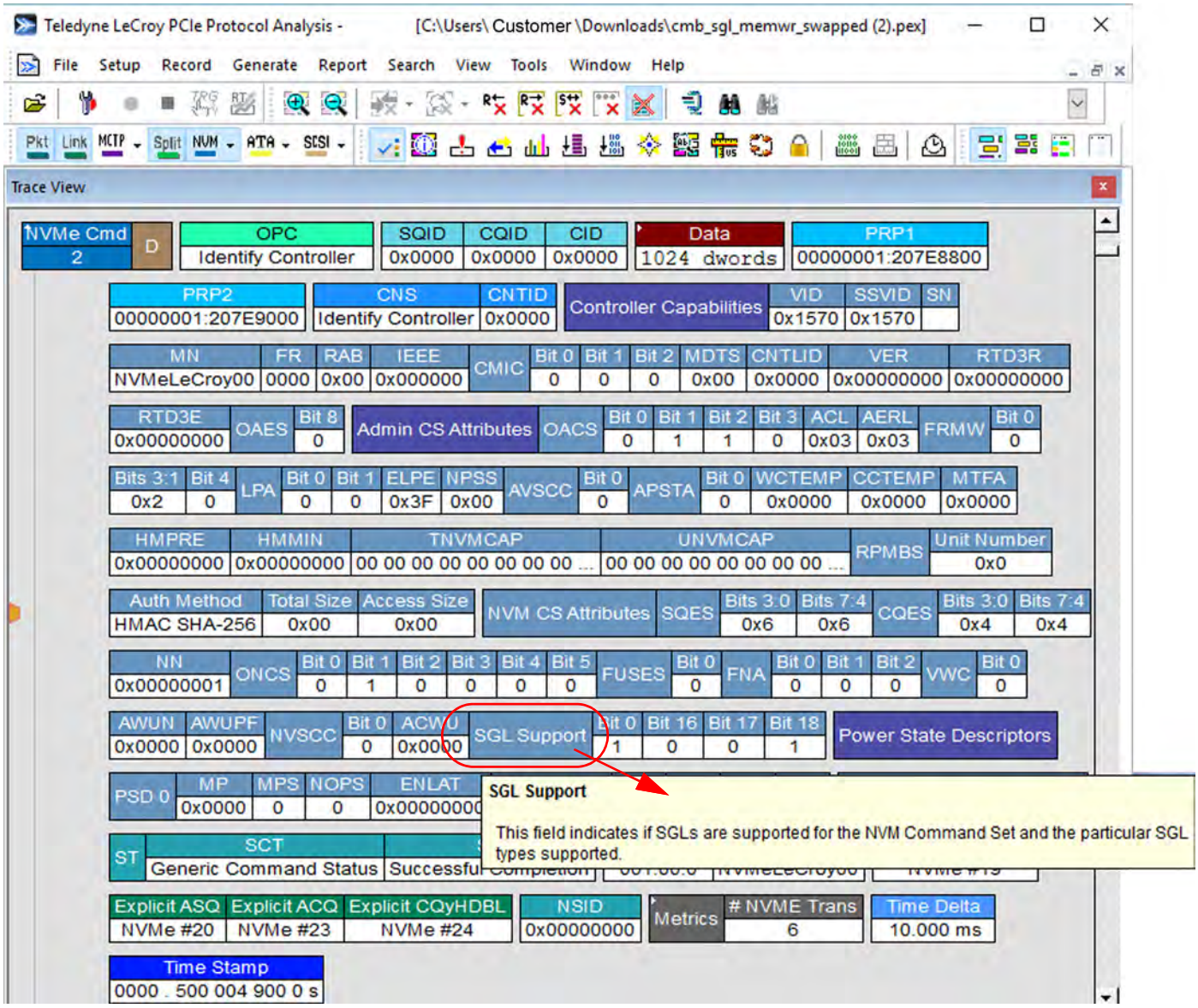


Figure 6.84: SGL Descriptor Supported in PCIe Protocol Analysis Software

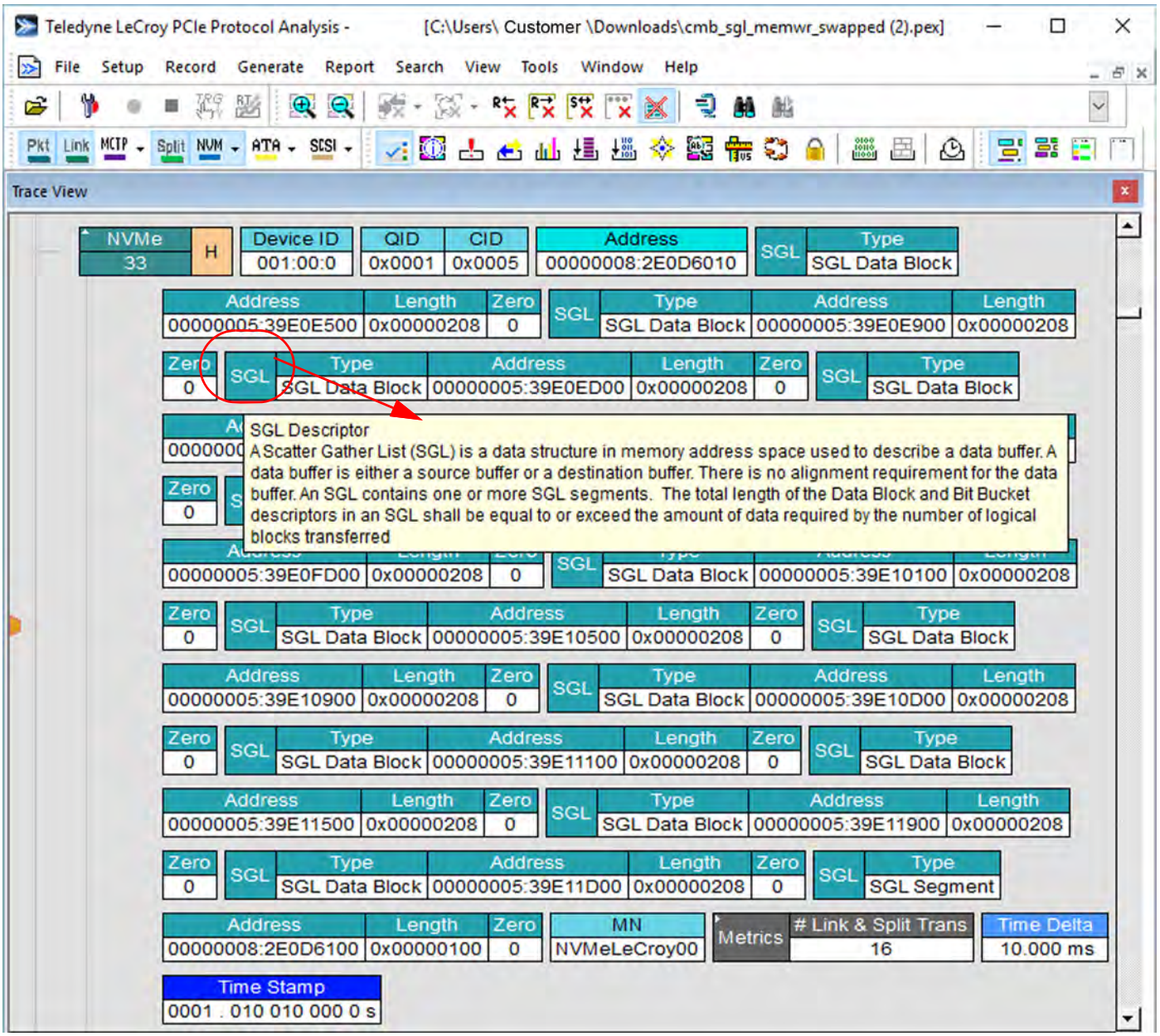


Figure 6.85: SGL Descriptor Tooltip

6.12.8 NVMe Decoding for Host Memory Buffer FID

The PCIe Protocol Analysis software can decode NVMe Host Memory Buffer FID as shown in Figure 6.86.

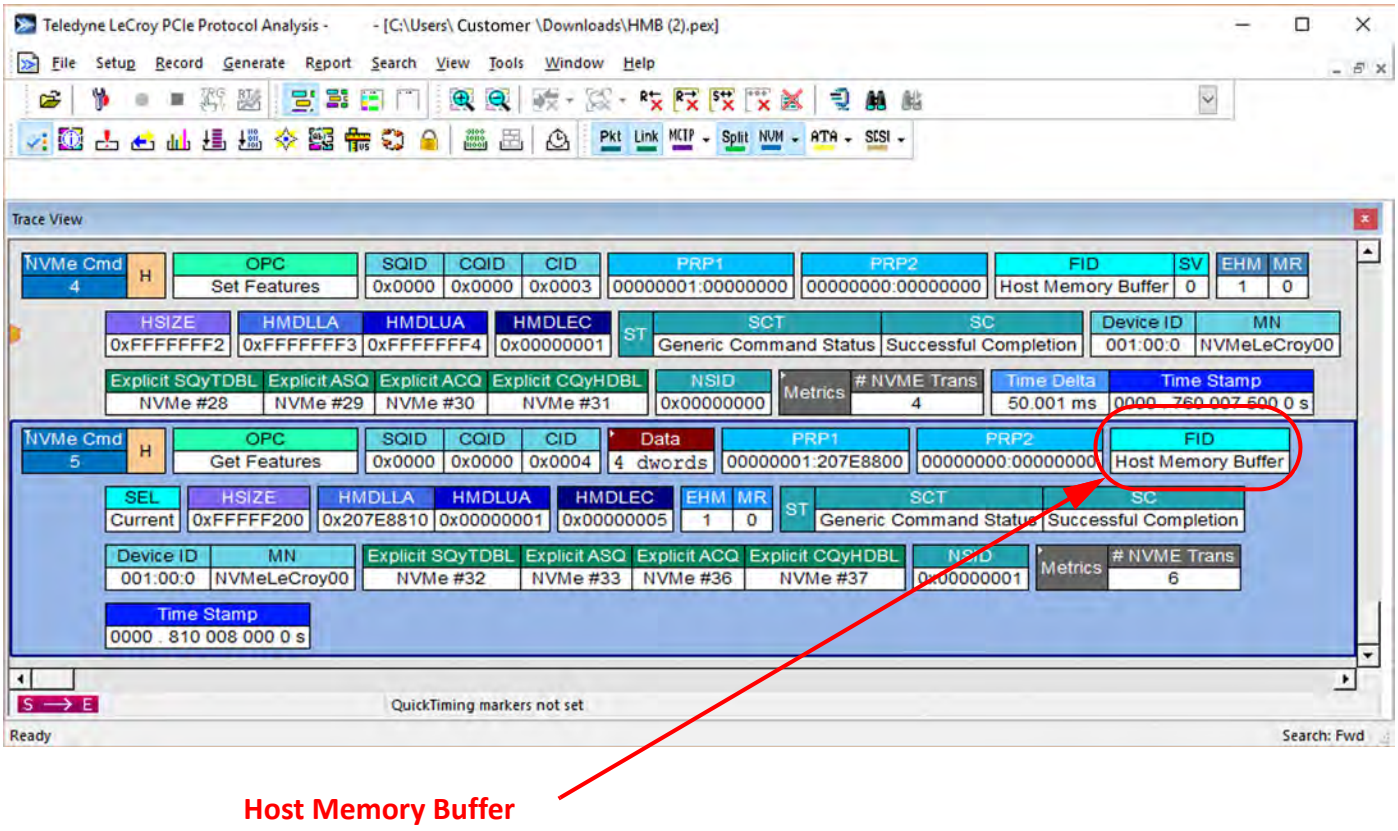
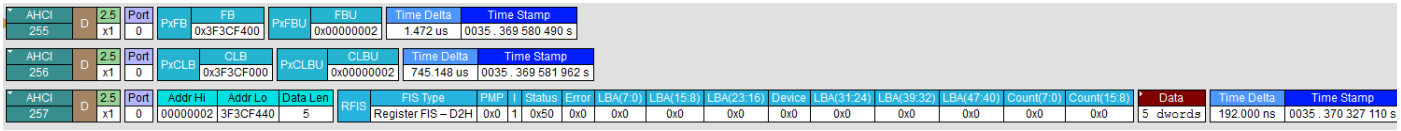


Figure 6.86: NVMe Trace with Host Memory Buffer FID Properly Decoded

6.12.9 AHCI

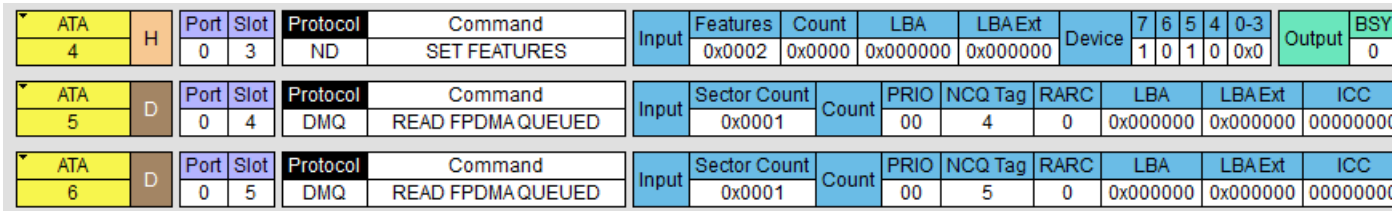
AHCI level decode displays AHCI transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of AHCI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the AHCI decode level.



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.

6.12.10 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.

6.12.10.1 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 6.87.

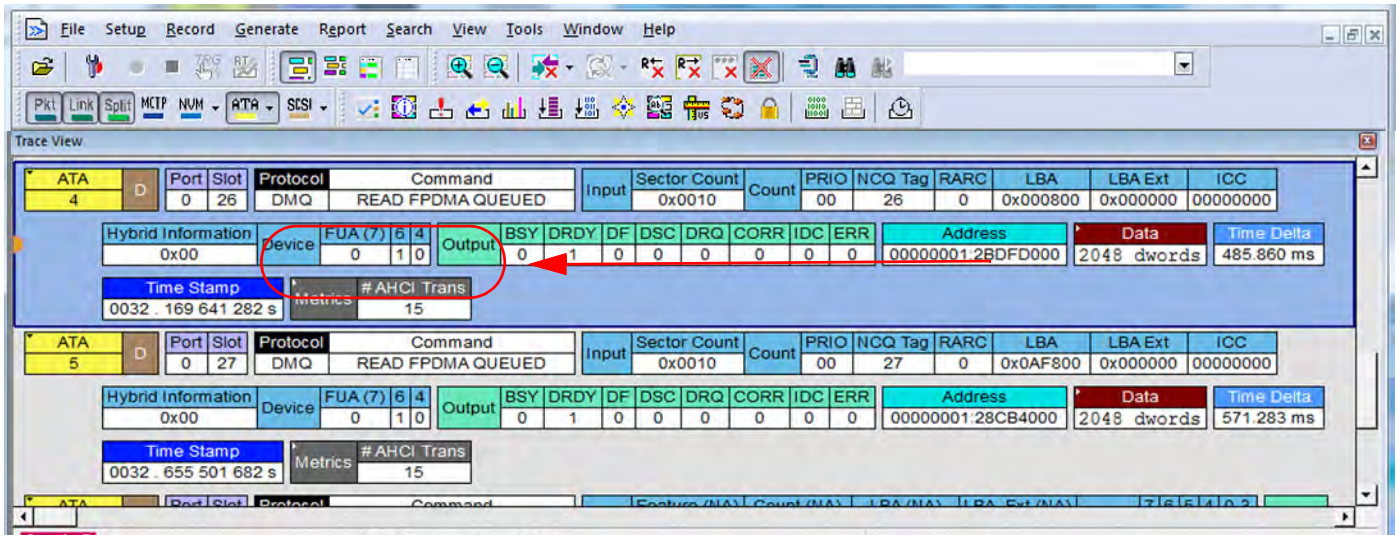


Figure 6.87: ATA IO Pending Transactions: Metrics Box

Move the cursor over the Metrics box to display the information about the ATA Packet. See Figure 6.88 on page 493.

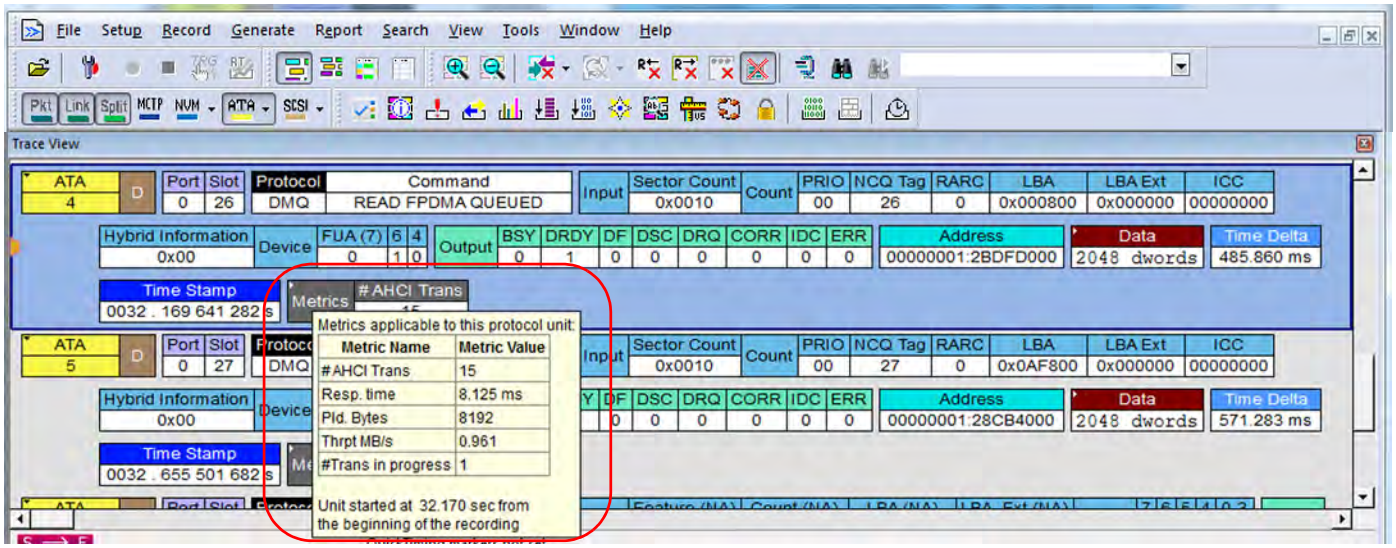


Figure 6.88: ATA IO Pending Transactions: Metrics Box -- Information Displayed

You can click on the small white arrow in the Metrics box to display the information in the Trace. See Figure 6.89 on page 494.

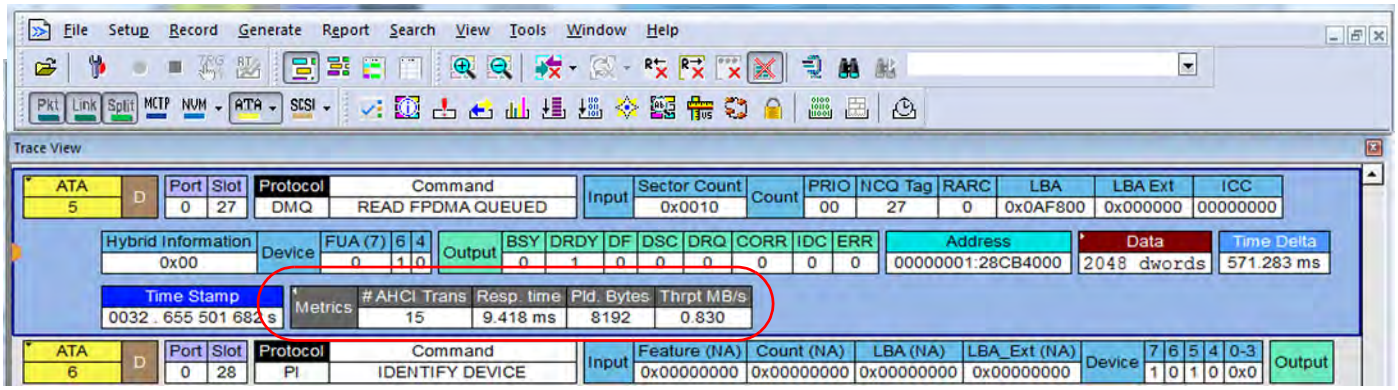


Figure 6.89: ATA IO Pending Transactions: Metrics Displayed in Trace

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 6.90 on page 495.

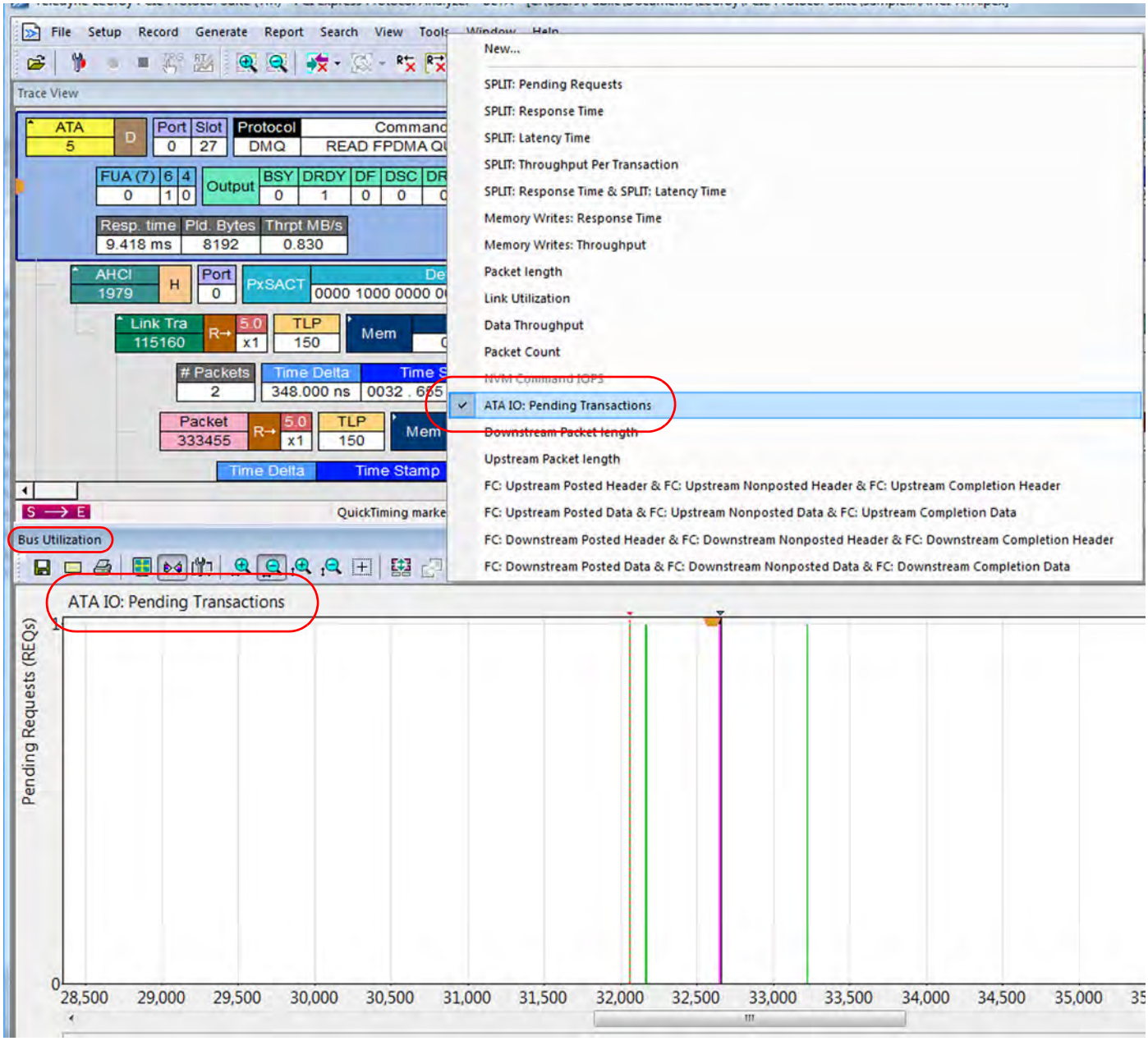
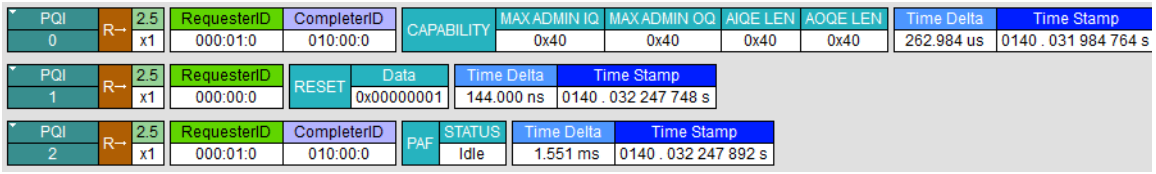


Figure 6.90: ATA IO Pending Transactions: Bus Utilization View

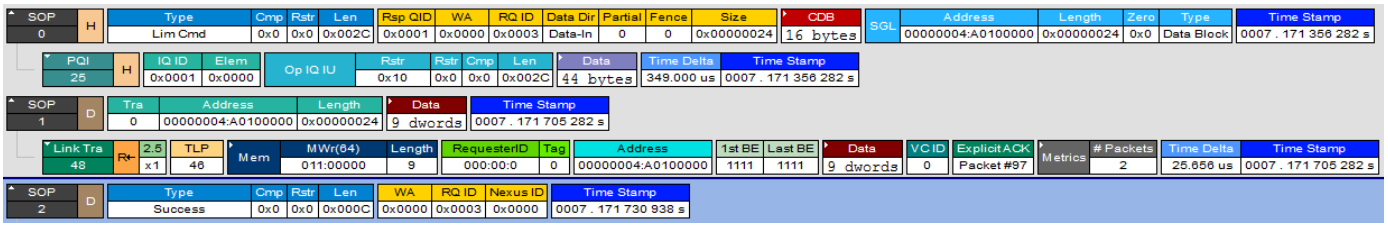
6.12.11 PQI

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.



6.12.12 SOP

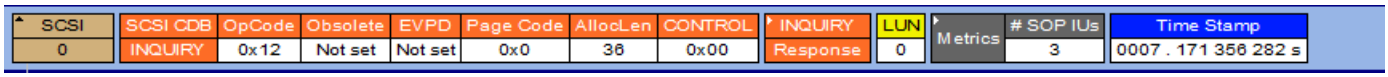
SOP level decode SOP displays SOP transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of SOP, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then PQI level and finally the 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.

6.12.13 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.



SCSI	SCSI CDB	OpCode	Obsolete	EVPD	Page Code	AllocLen	CONTROL	INQUIRY	LUN	Metrics	# SOP IUs	Time Stamp
0	INQUIRY	0x12	Not set	Not set	0x0	36	0x00	Response	0		3	0007 . 171 356 282 s

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.

6.12.14 Decoding MCTP (Management Component Transport Protocol)

Note: The Summit T416 and Summit T48 can decode MCTP traffic per specifications outlined in the *Readme* file.

6.12.14.1 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 6.91) down into the trace and the Floating Transaction Level Bar Window will be shown (see Figure 6.92). 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 6.91: Transaction Level Toolbar

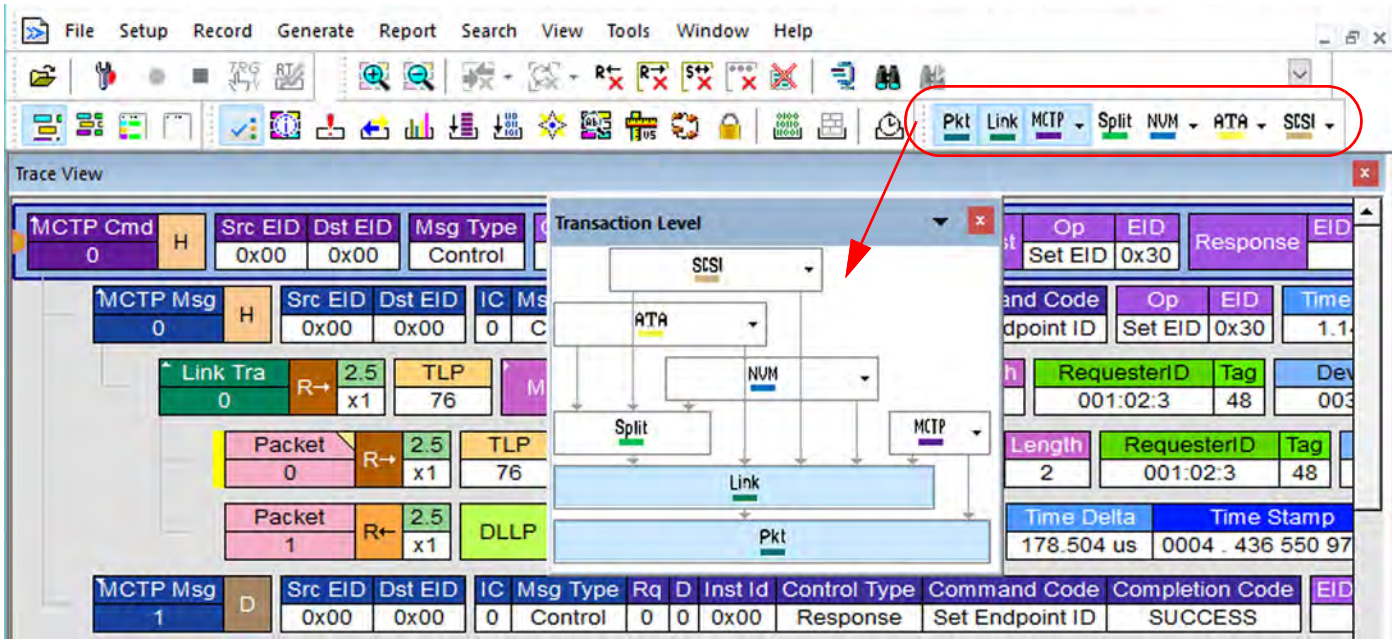


Figure 6.92: MCTP Levels in Floating Transaction Bar Window

6.12.14.2 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 6.93.

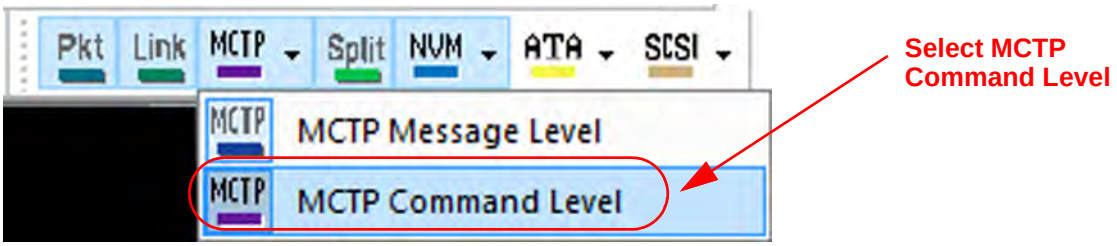


Figure 6.93: MCTP Decoding Icon on Toolbar

This will decode MCTP Commands in the trace. The following types of MCTP Message Types can be decoded:

- MCTP Control: See Figure 6.94 on page 500
- NC-SI: See Figure 6.94 on page 500
- PLDM: See Figure 6.95 on page 501
- PLDM: Firmware Commands Decoded -> See Figure 6.96 on page 501 and Figure 6.97 on page 502.

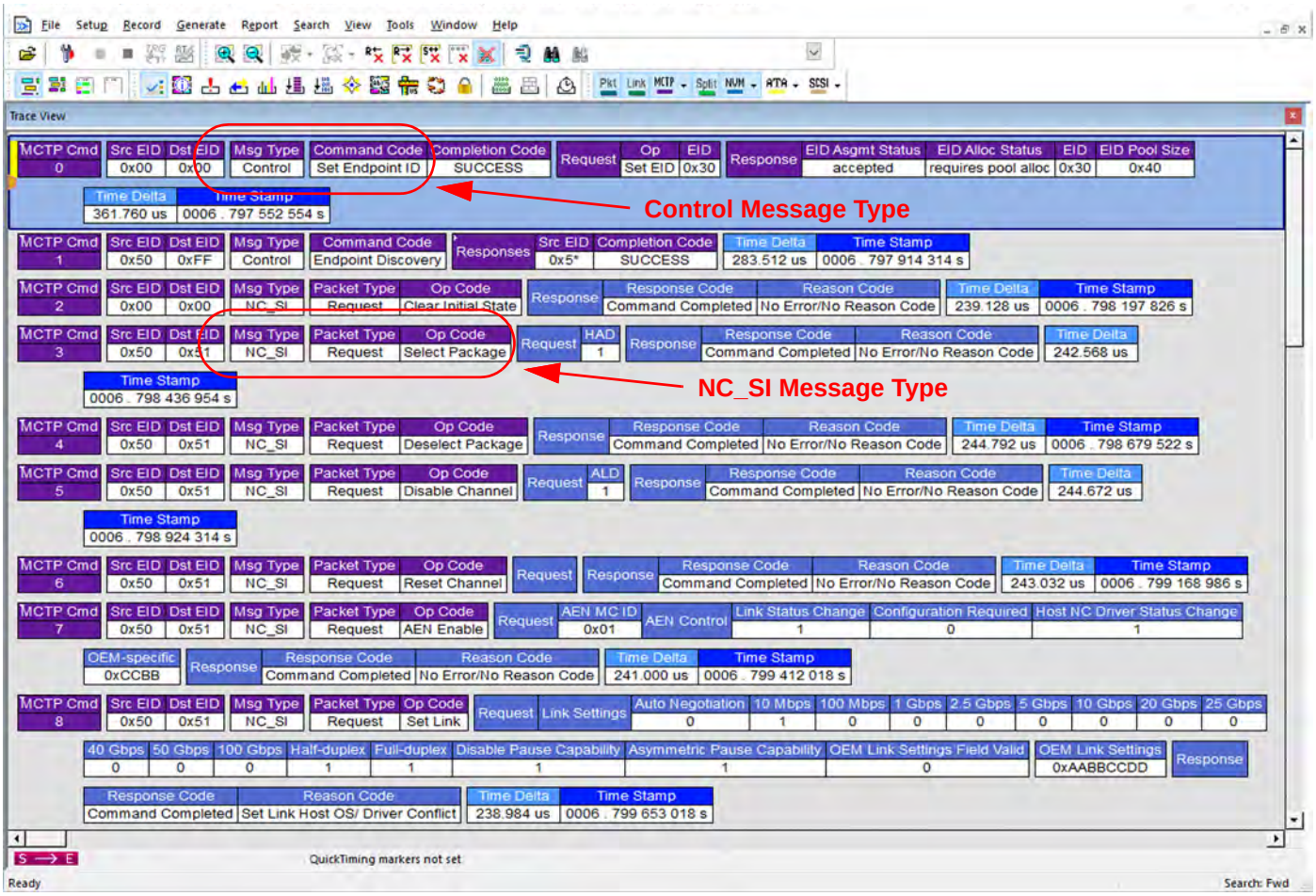


Figure 6.94: MCTP Commands Decoded: Control and NC_SI Types

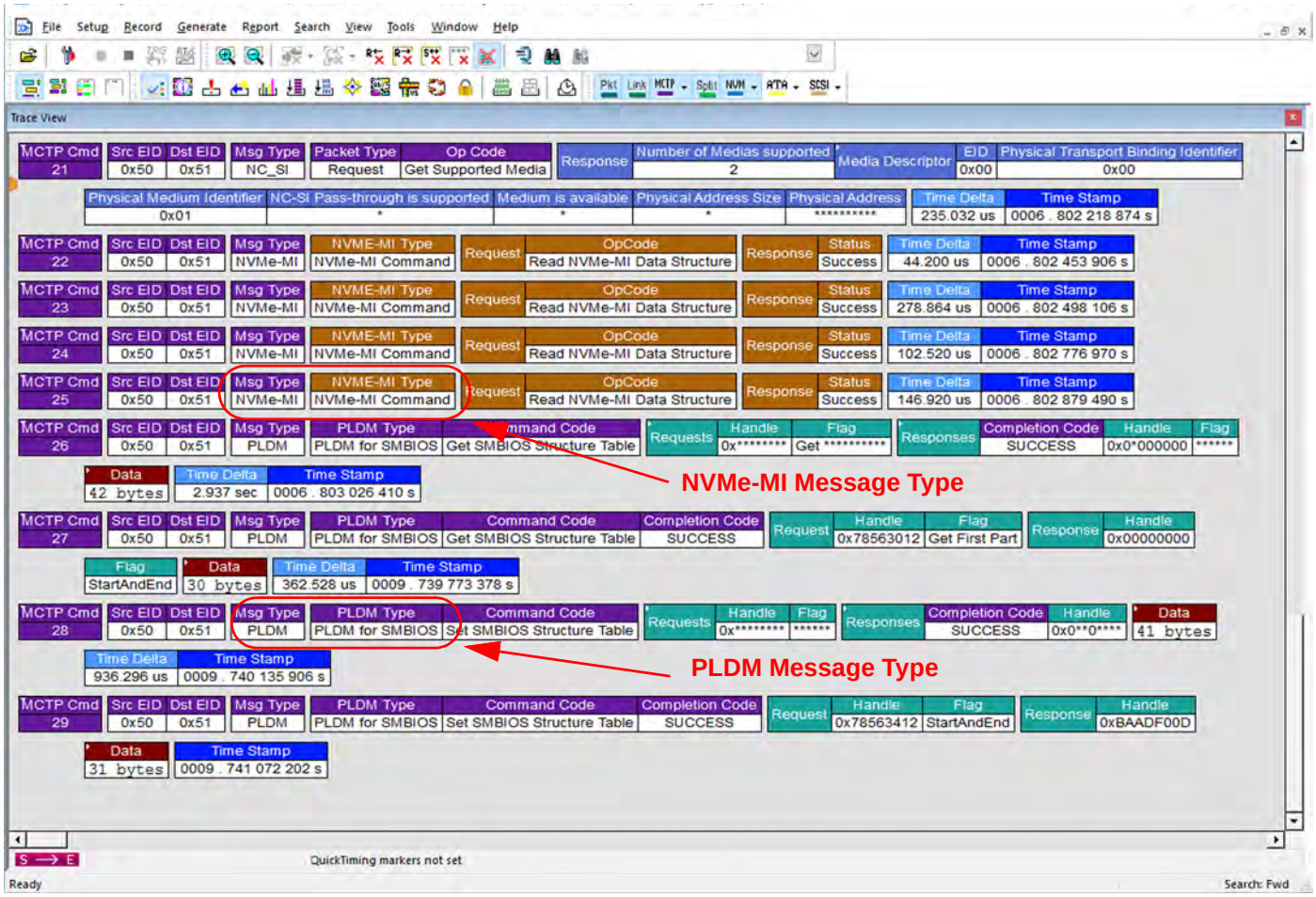


Figure 6.95: MCTP Commands Decoded: NVMe-MI and PLDM Types

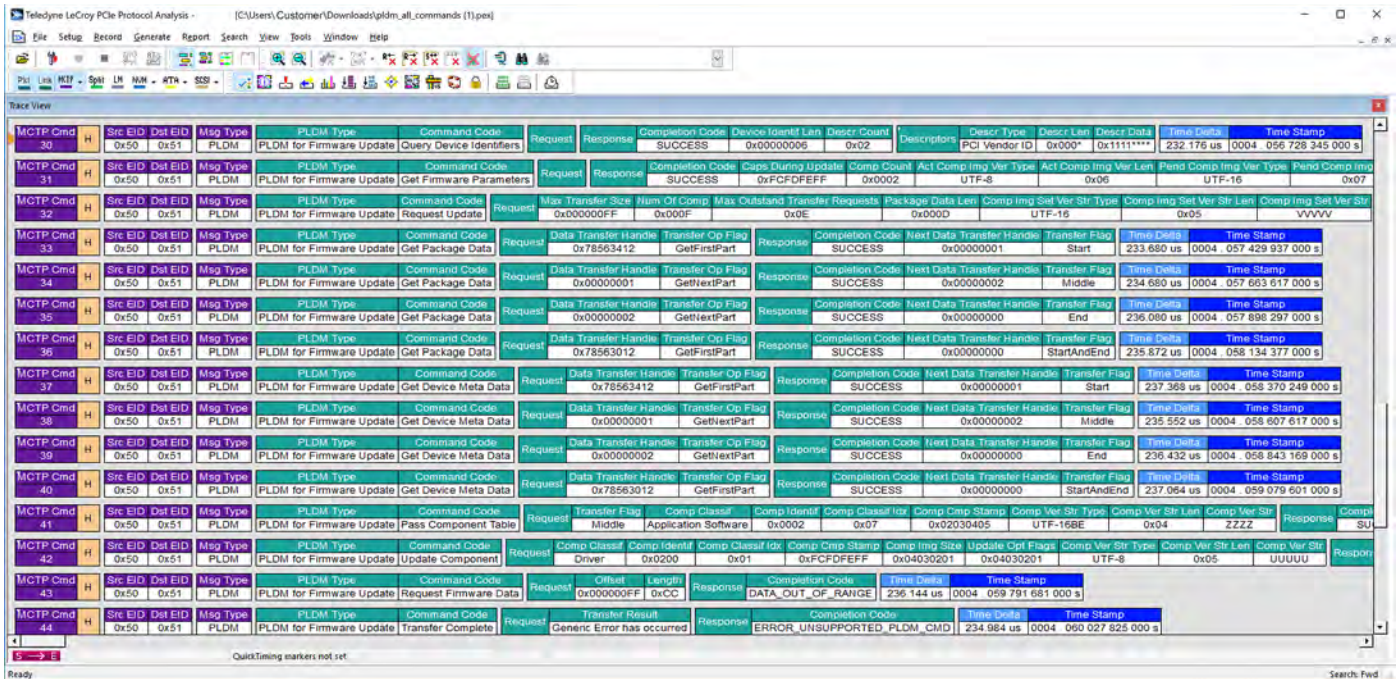


Figure 6.96: PLDM Firmware Update Commands Decoded

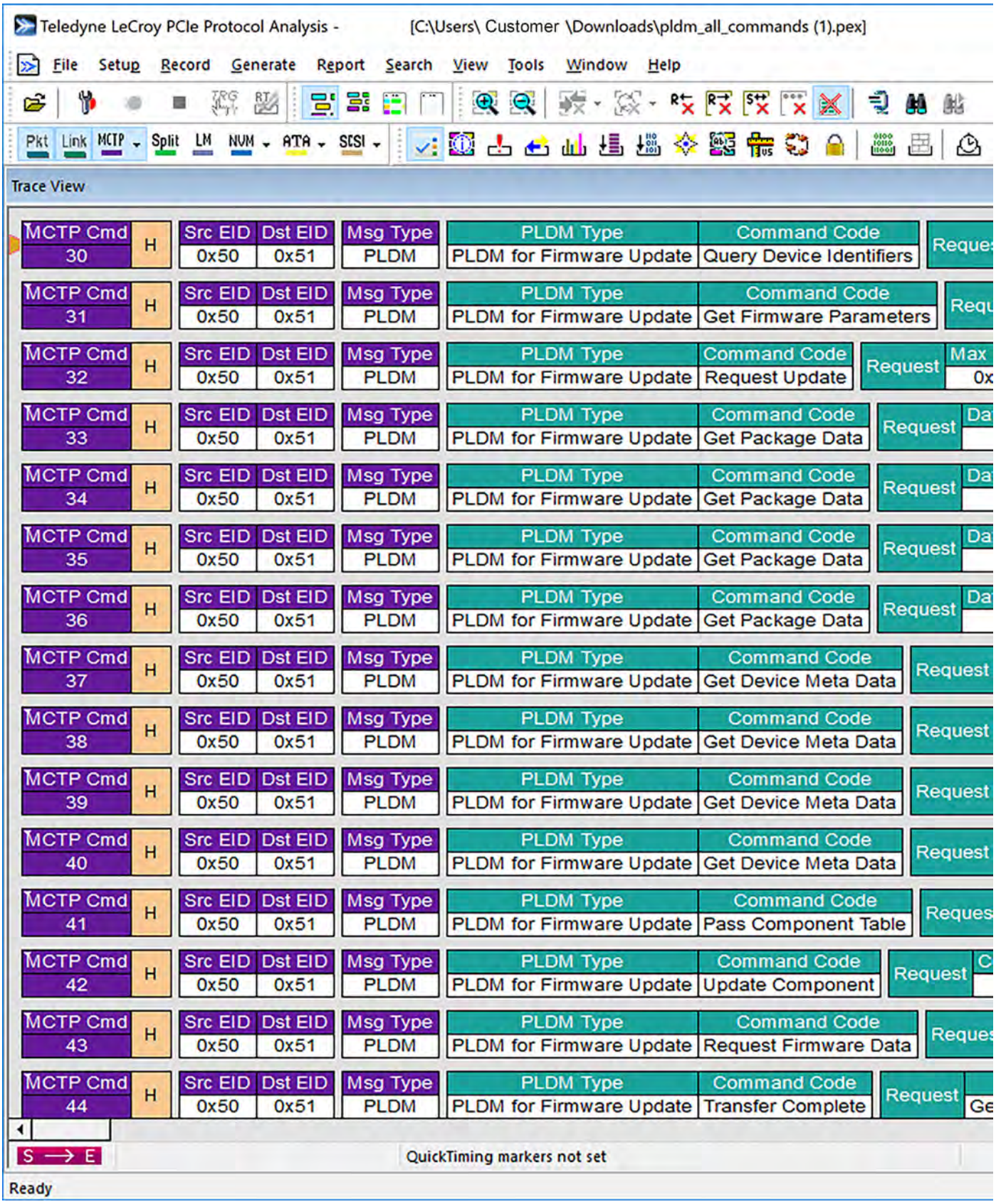


Figure 6.97: PLDM Firmware Update Commands Decoded (Details shown)

6.12.14.3 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 6.98 on page 503.

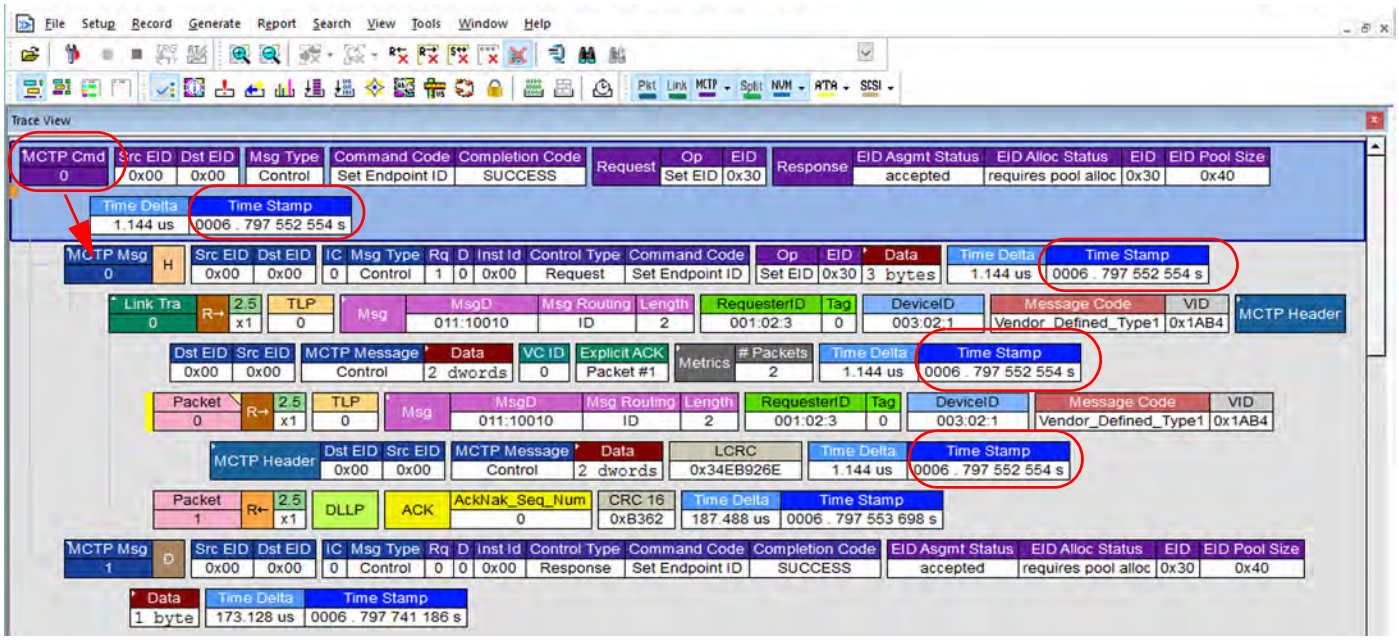


Figure 6.98: MCTP Command 0 Expanded

6.12.14.4 Decoding MCTP Messages

If you had selected MCTP Messages to be decoded instead of Commands, only the MCTP Messages would be displayed. See Figure 6.99.

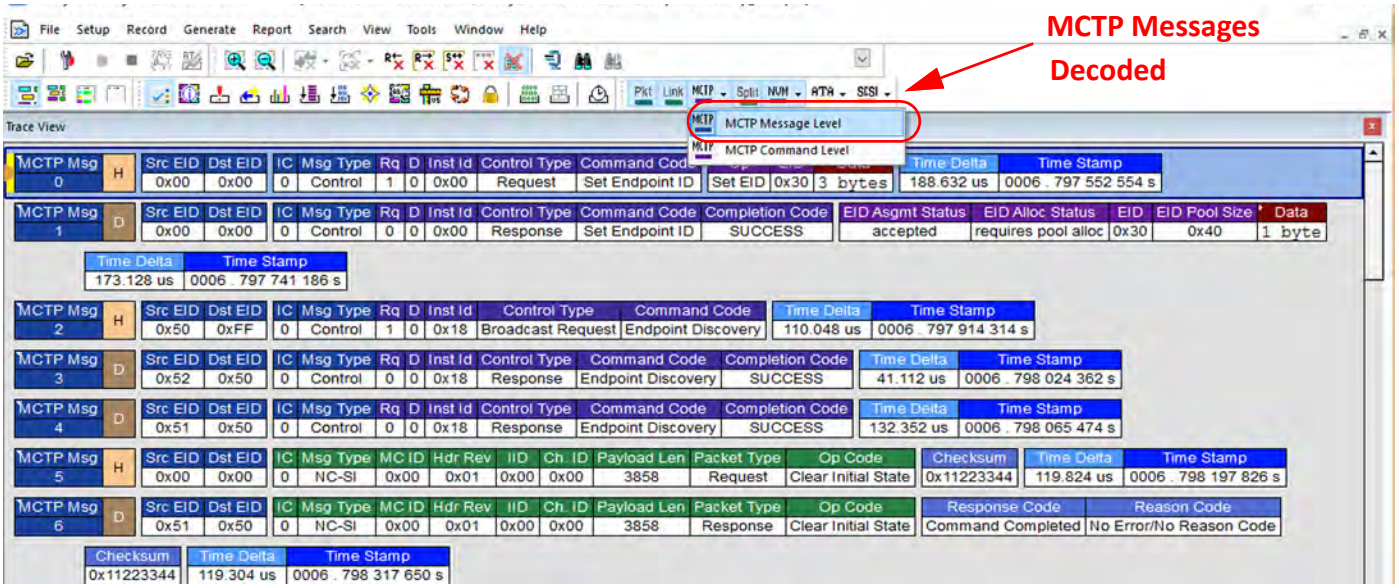


Figure 6.99: MCTP Messages Decoded

If you expand the MCTP Message you'll see the same information you saw by expanding the MCTP Command. See Figure 6.100 on page 504.

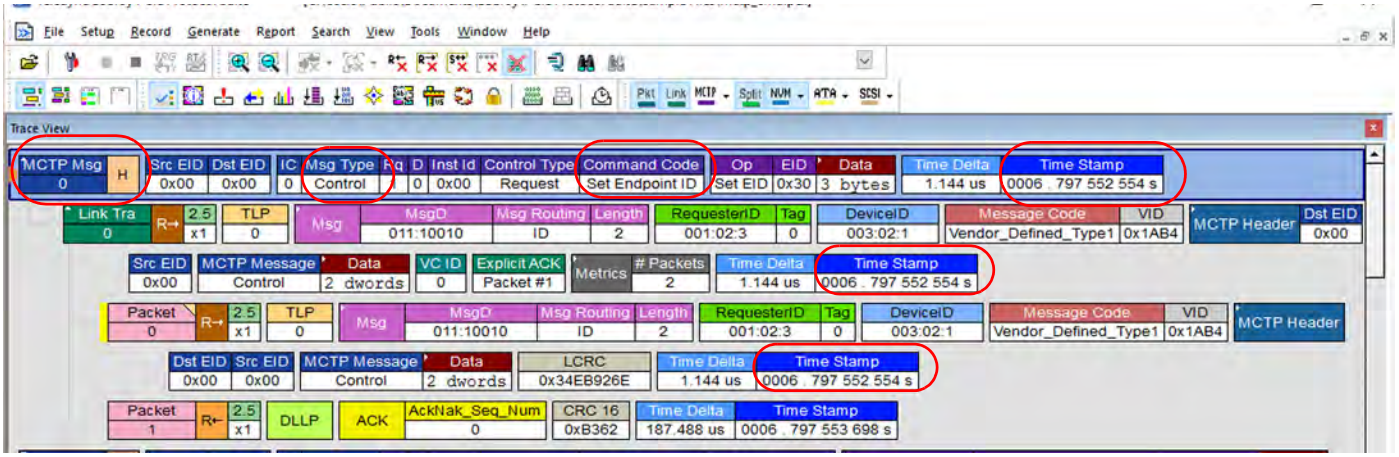


Figure 6.100: Expanding MCTP Message

6.12.14.5 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 6.101.

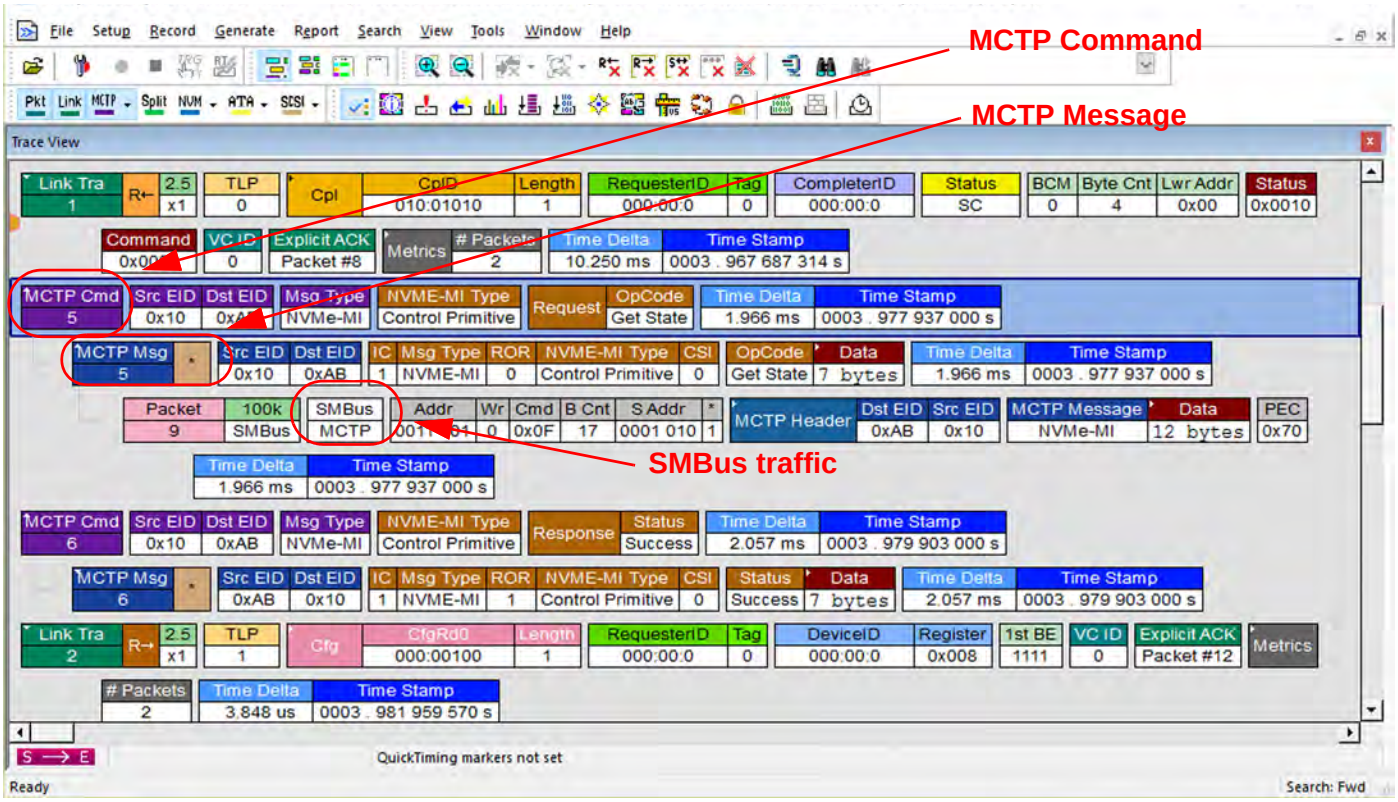


Figure 6.101: MCTP Command with SMBus Traffic

6.12.14.6 MCTP Commands: Request from Host, Response from Device

MCTP commands can be decoded as shown below (see Figure 6.102). As you can see the MCTP Command is made up of MCTP messages. One is from the Host the response is from the Device.

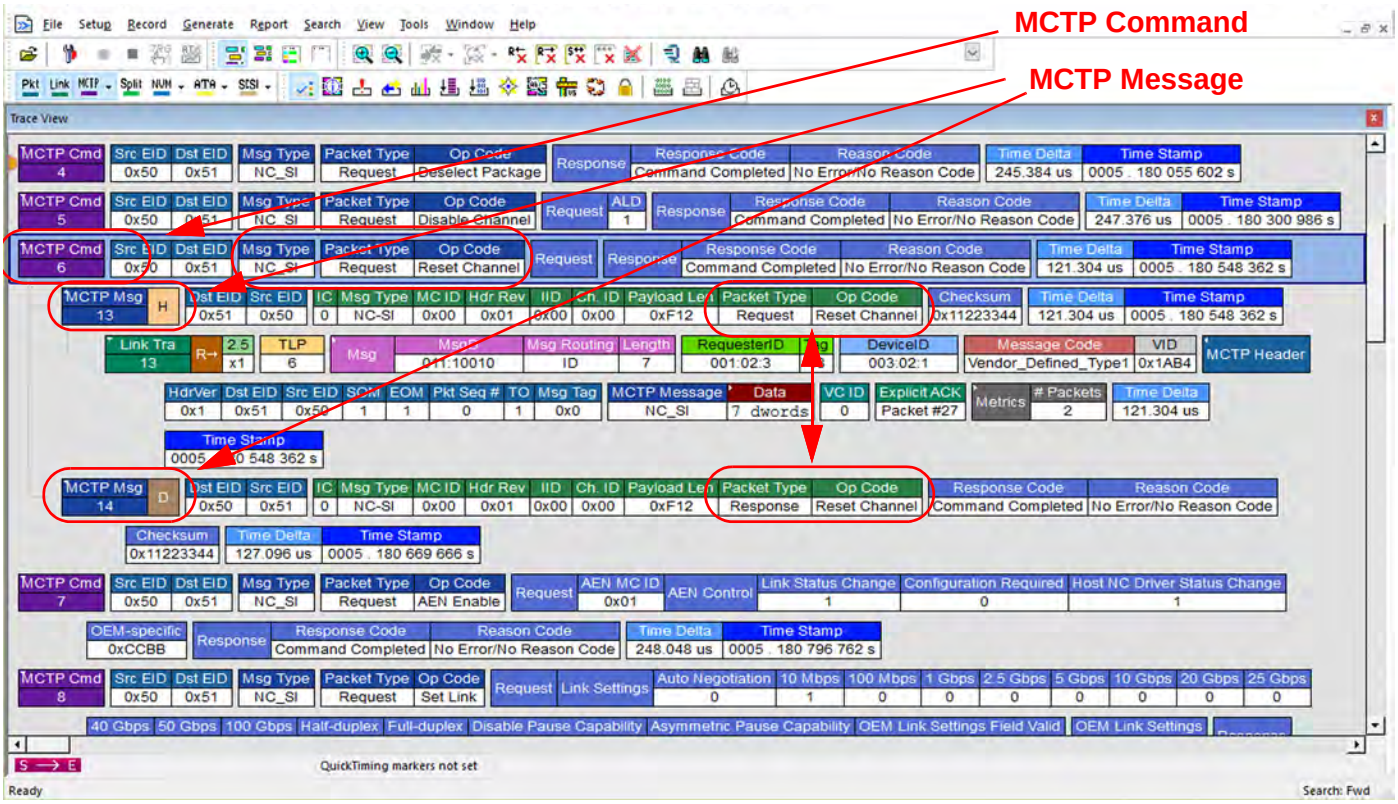


Figure 6.102: Decoding MCTP Commands

6.12.14.7 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 6.103.

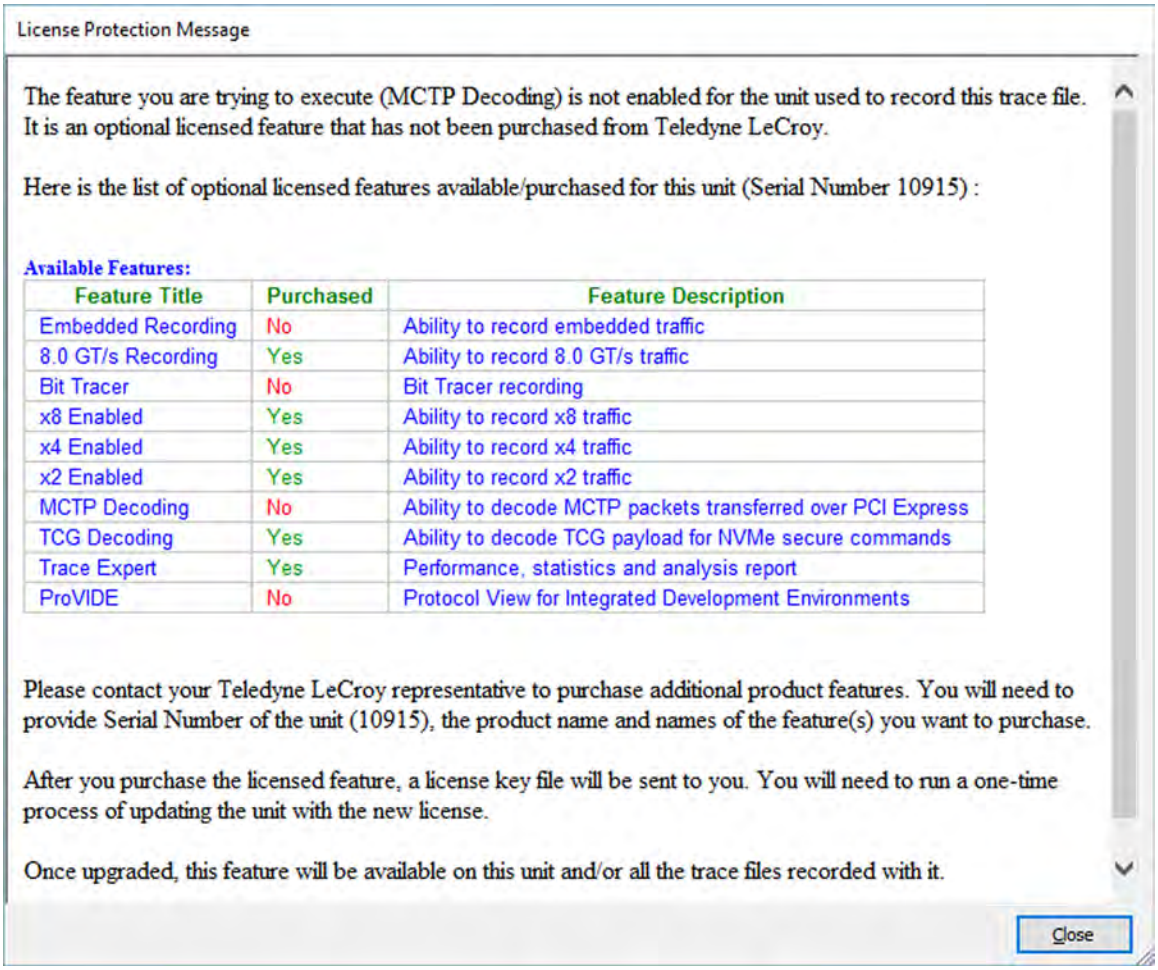


Figure 6.103: Warning Message: No MCTP License

You can decode both MCTP messages and transactions within traces by selecting CATC Trace View, Decoding Packets, Links and MCTP 

. You'll see that the transaction contains an MCTP Header and an MCTP Message. See Figure 6.104 on page 508.

6.12.14.8 MCTP Messages

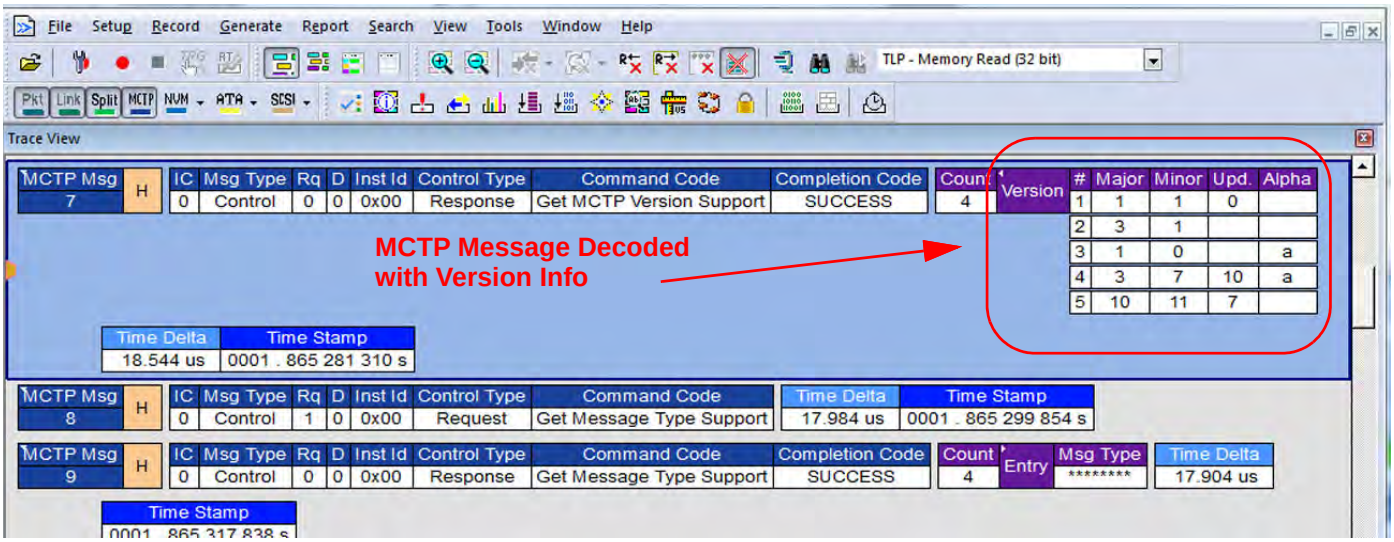


Figure 6.104: MCTP Message Decoded

6.12.14.9 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 6.105.

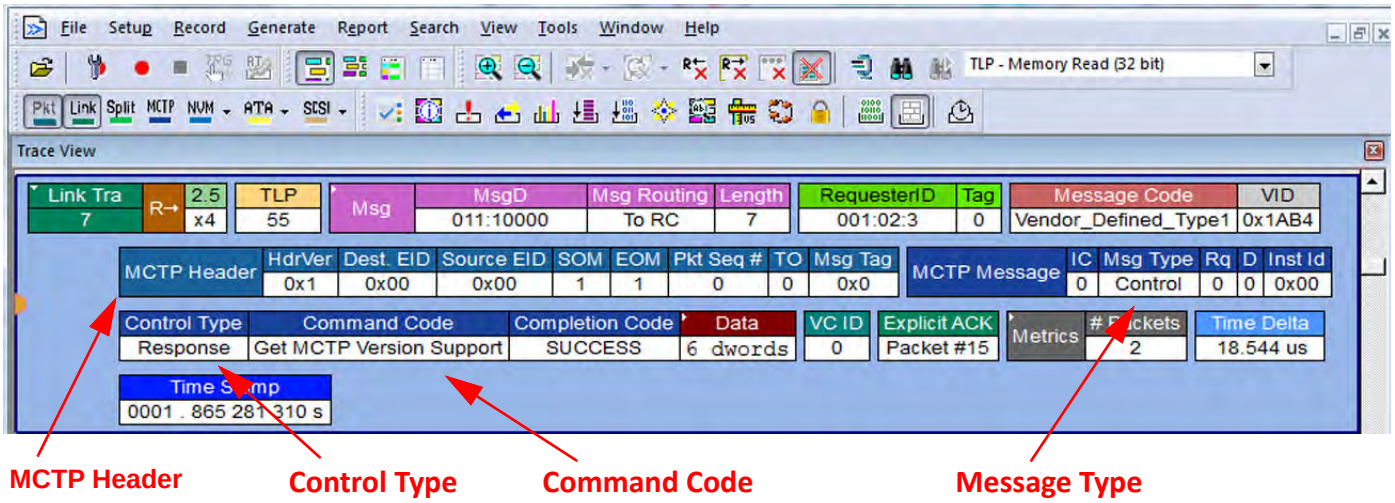


Figure 6.105: Decoding MCTP Transactions

6.12.14.10 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 6.106 on page 509.

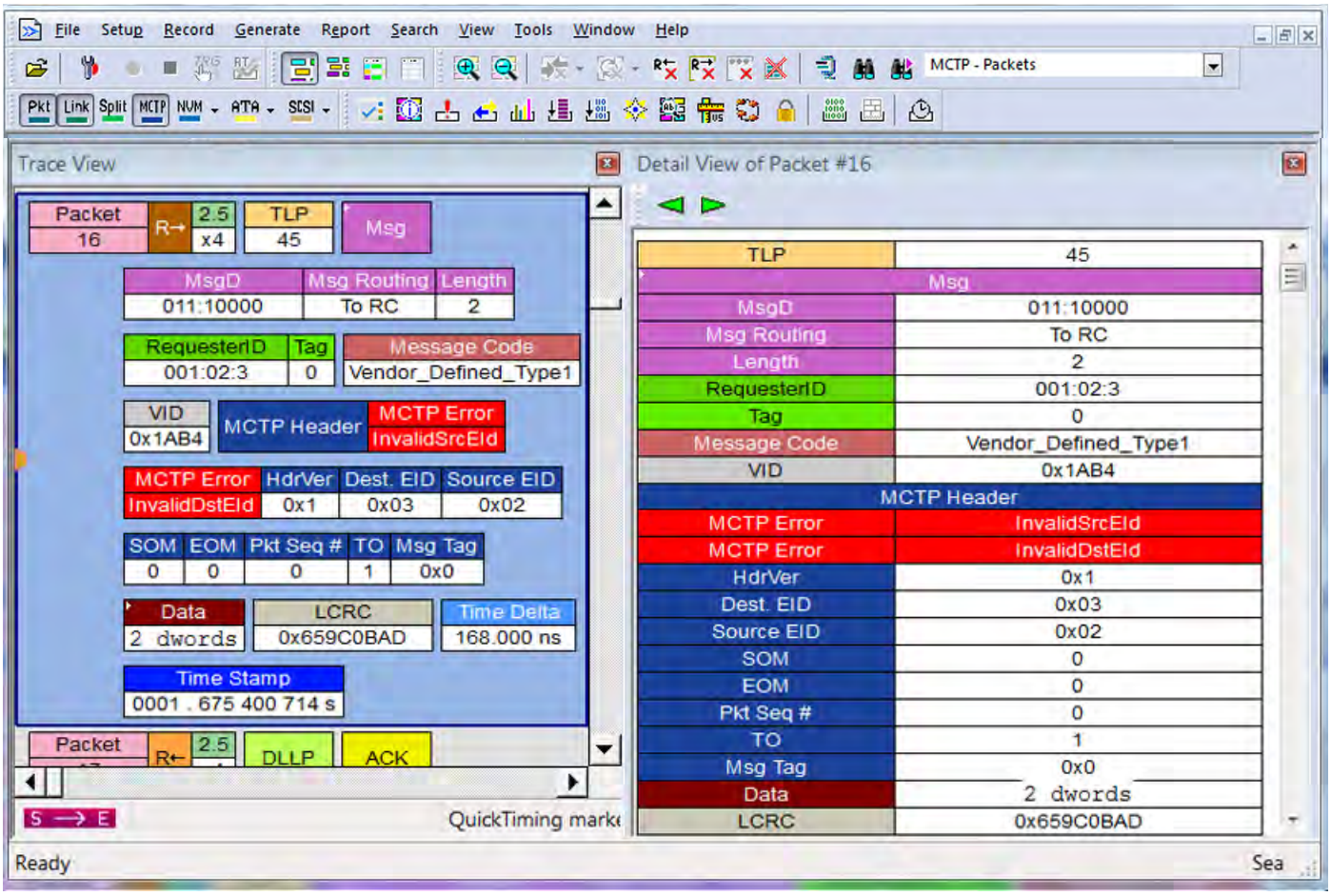


Figure 6.106: MCTP Transaction Errors Reported

6.12.14.11 MCTP Trace In Spreadsheet View

MCTP Traces can be displayed in Spreadsheet View. See Figure 6.107.

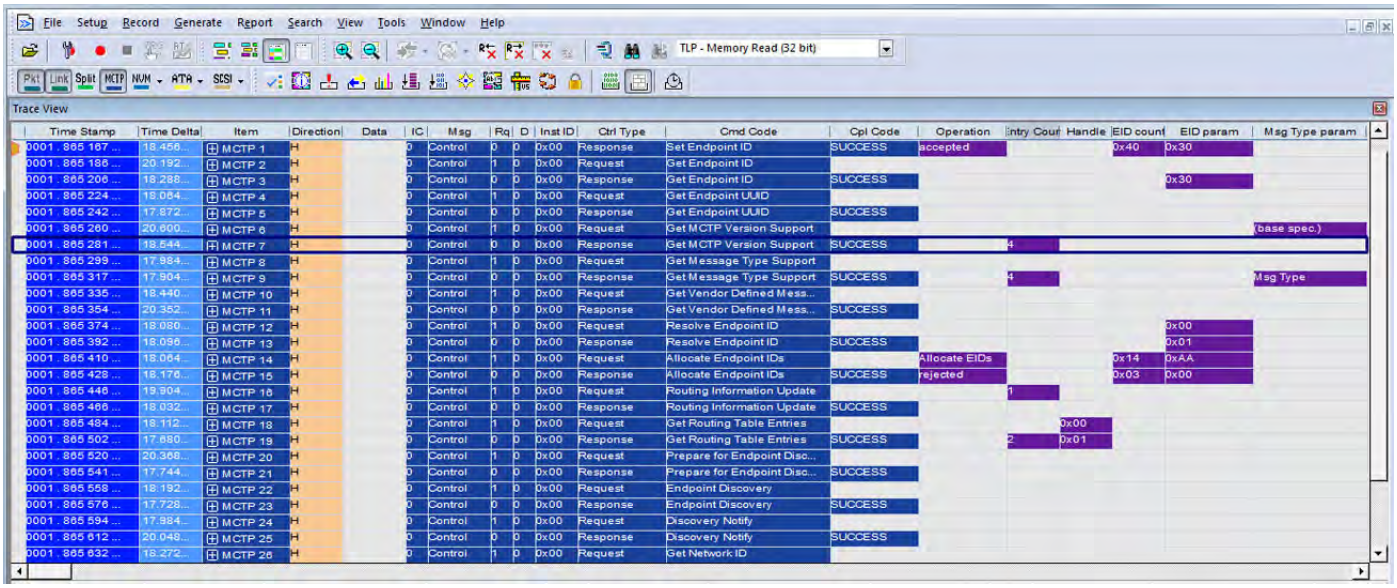


Figure 6.107: MCTP Trace in Spreadsheet View

6.12.14.12 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 6.108. In the example shown below there are both PLDM Requests and PLDM Responses.

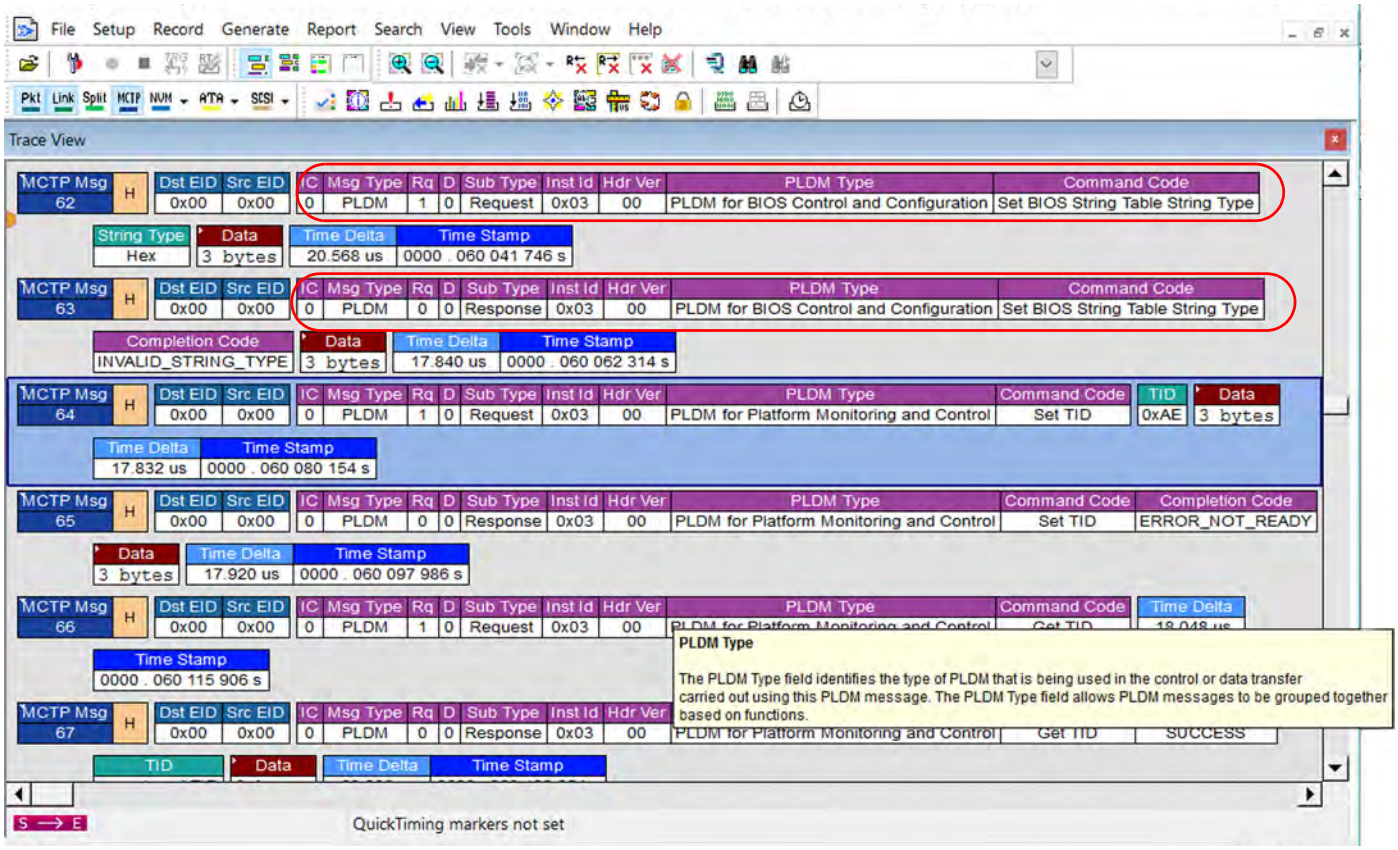


Figure 6.108: MCTP Message with PLDM Message Type

6.12.14.13 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 6.109. In the example shown below, there is an NC-SI Request packet type followed by the NC-SI packet Response.

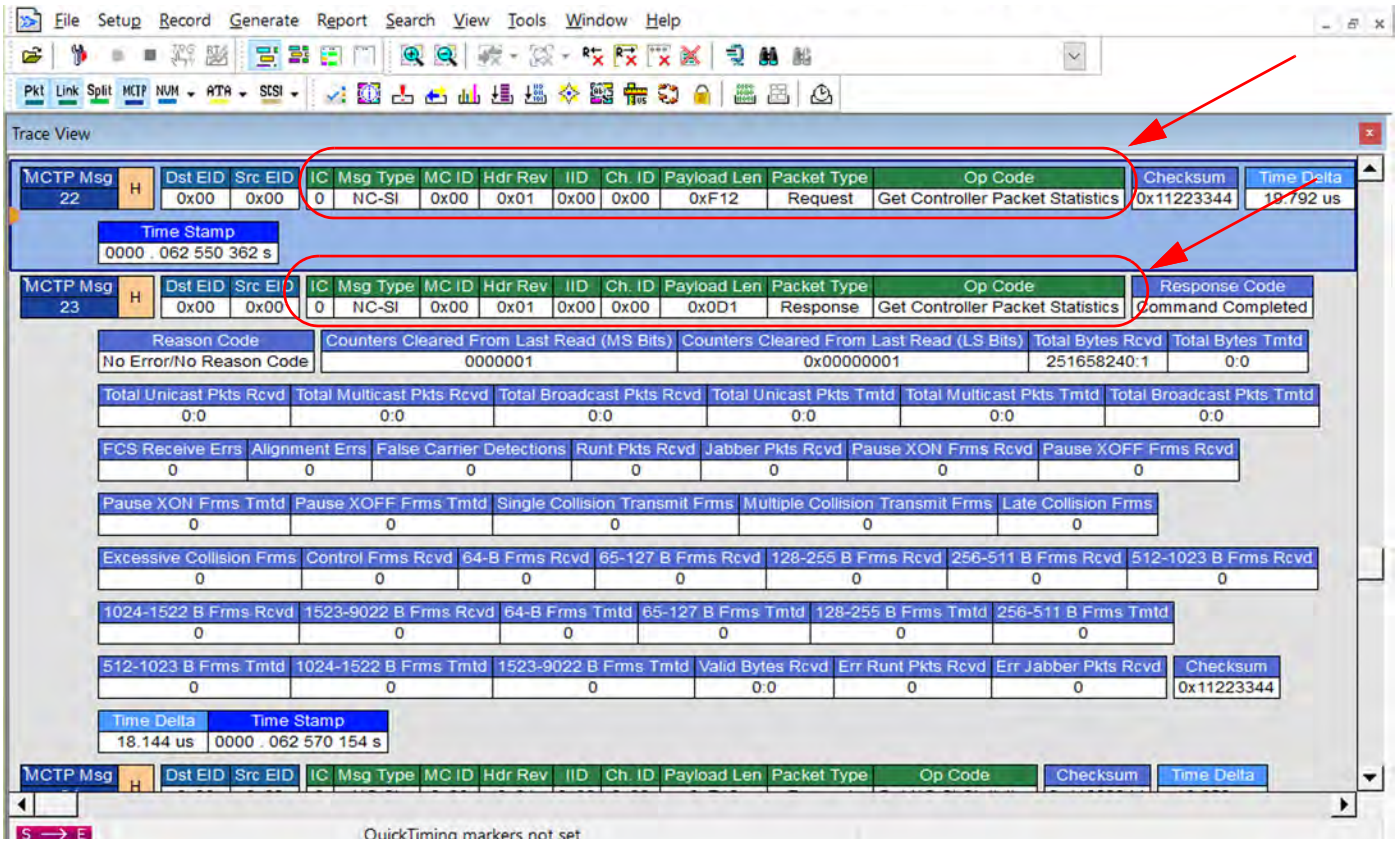


Figure 6.109: MCTP Message with NC-SI Message Type

6.12.14.14 MCTP Command with NVMe-MI Errors Decoded

The PCIe Protocol Analysis can detect, decode and display NVMe-MI errors in MCTP traffic, as shown below in Figure 6.110.

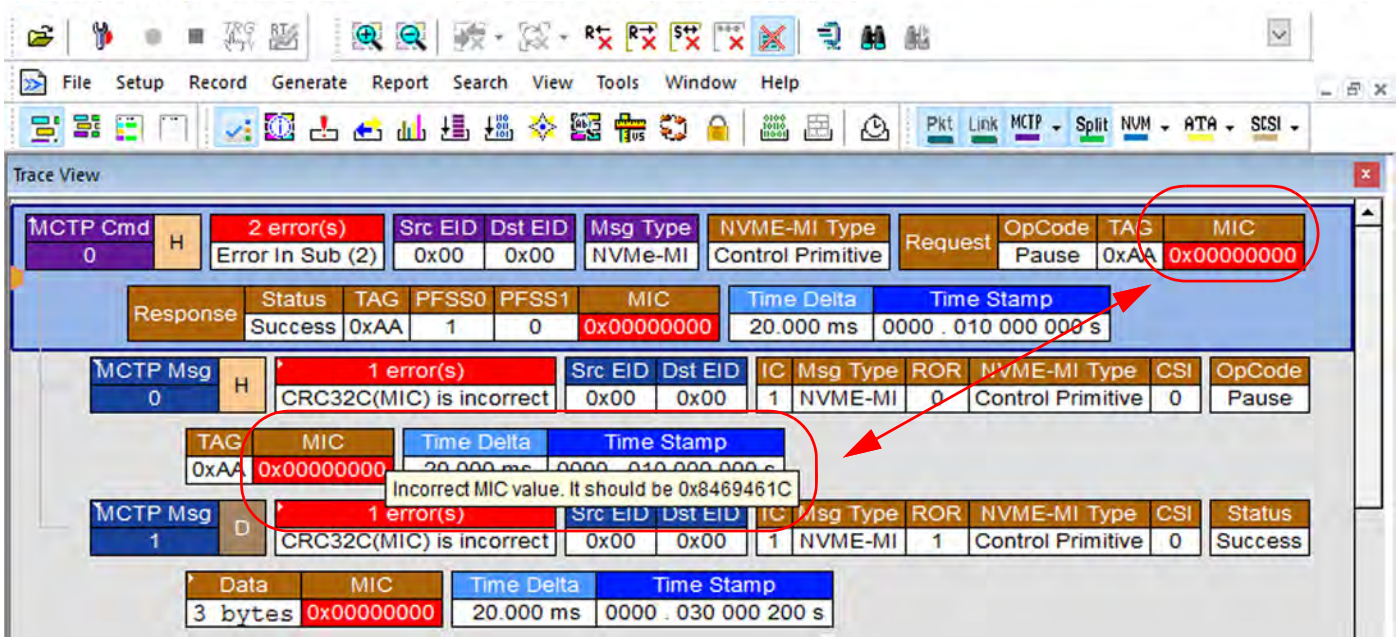


Figure 6.110: Errors Decoded In MCTP/NVMe-MI Traffic

6.12.14.15 MCTP Message Type and IC Cells

You can decode MCTP Messages and IC cells. See Figure 6.111.

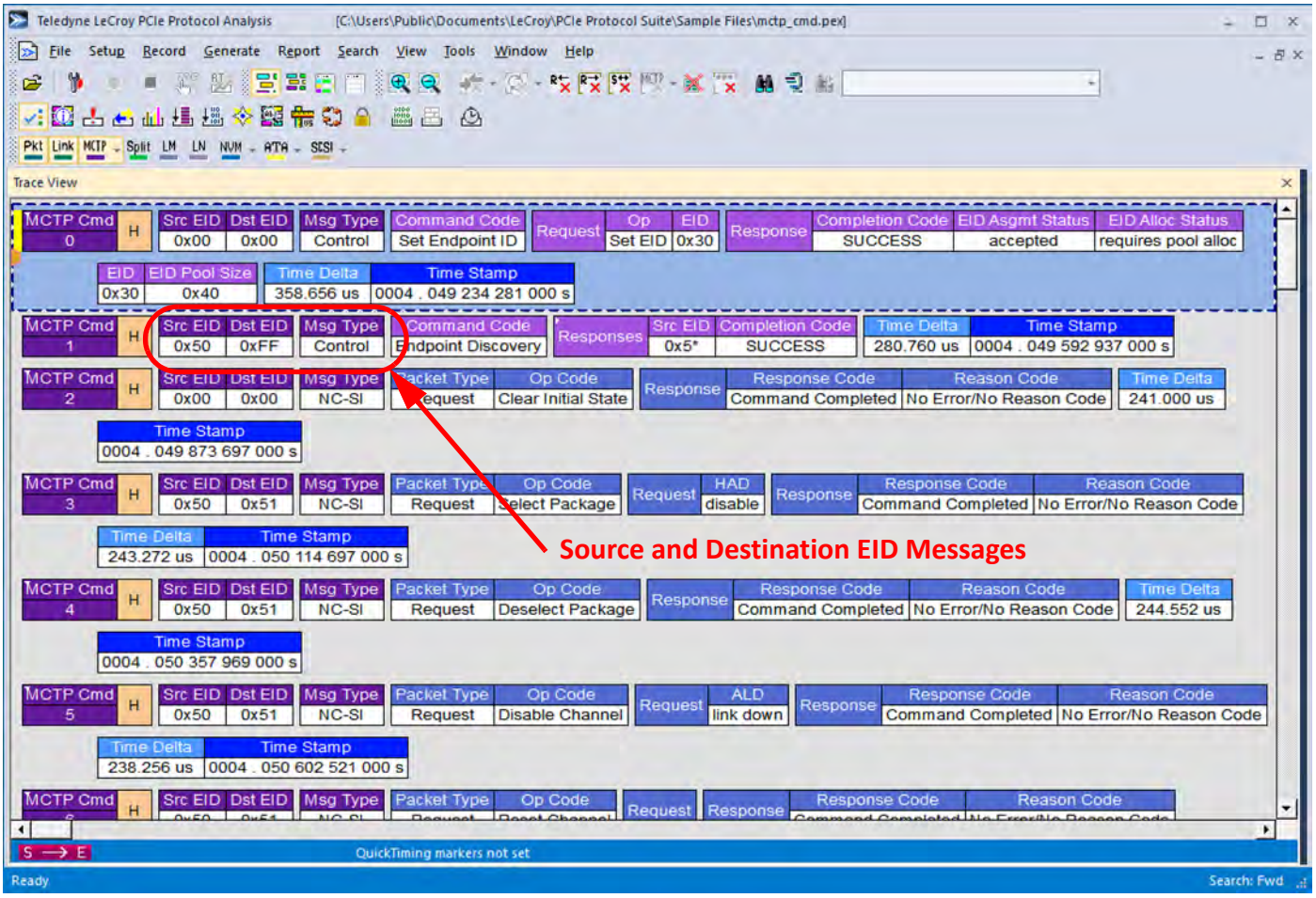


Figure 6.111: MCTP Messages Types and IC Cells Decoded

The colors of the MCTP Messages can be seen in the Display Options. See Figure 6.112 on page 515

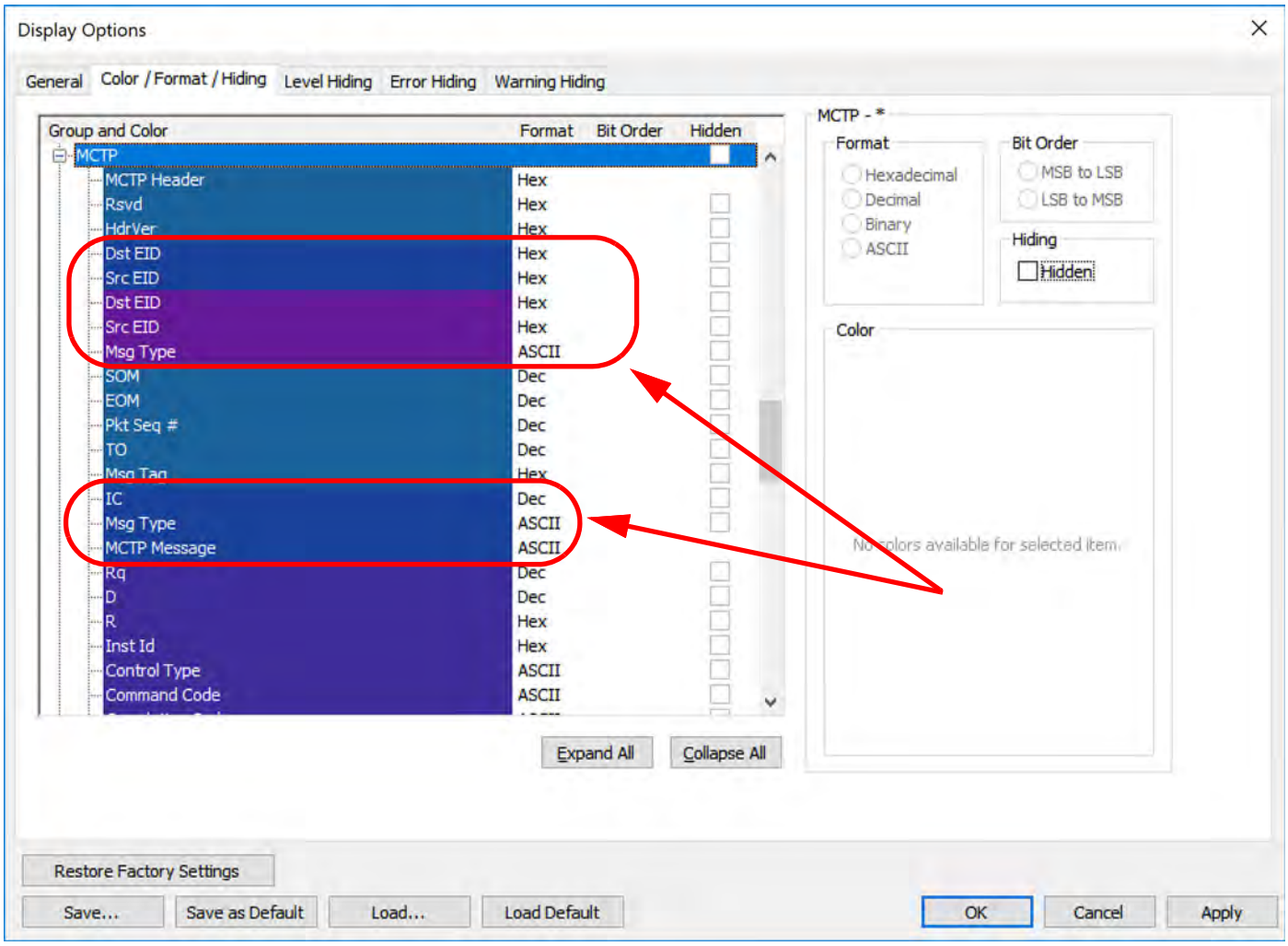


Figure 6.112: MCTP Commands and Transaction Colors from Display Options

6.12.15 Decoding MCTP Messages 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 I²C 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 T416 or Summit T48 can capture SMBus traffic and display it as part of an MCTP message along with normal PCIe Data traffic, as shown in Figure 6.113 and Figure 6.114 on page 517.

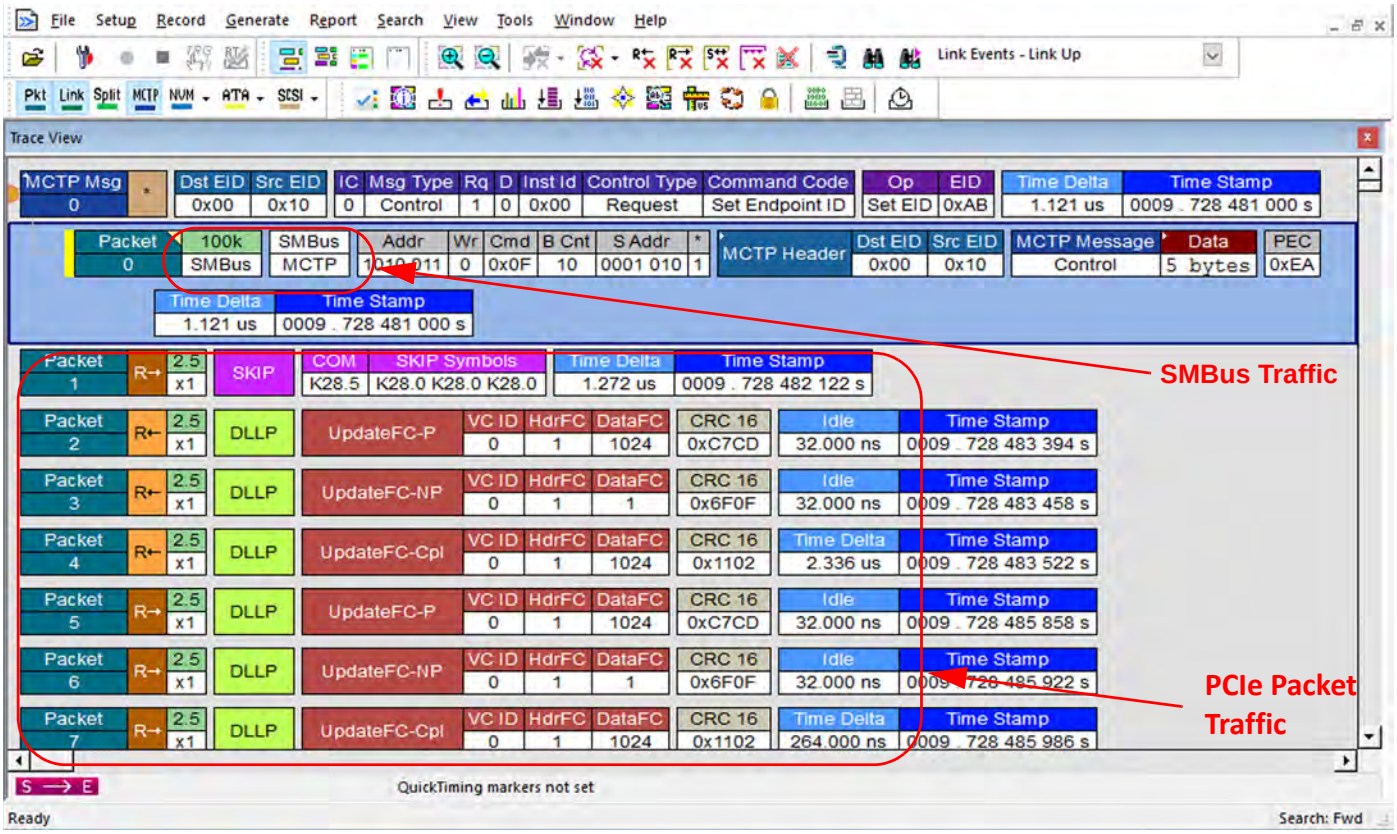


Figure 6.113: MCTP Message with SMBus Sideband Traffic and PCIe Packet Traffic

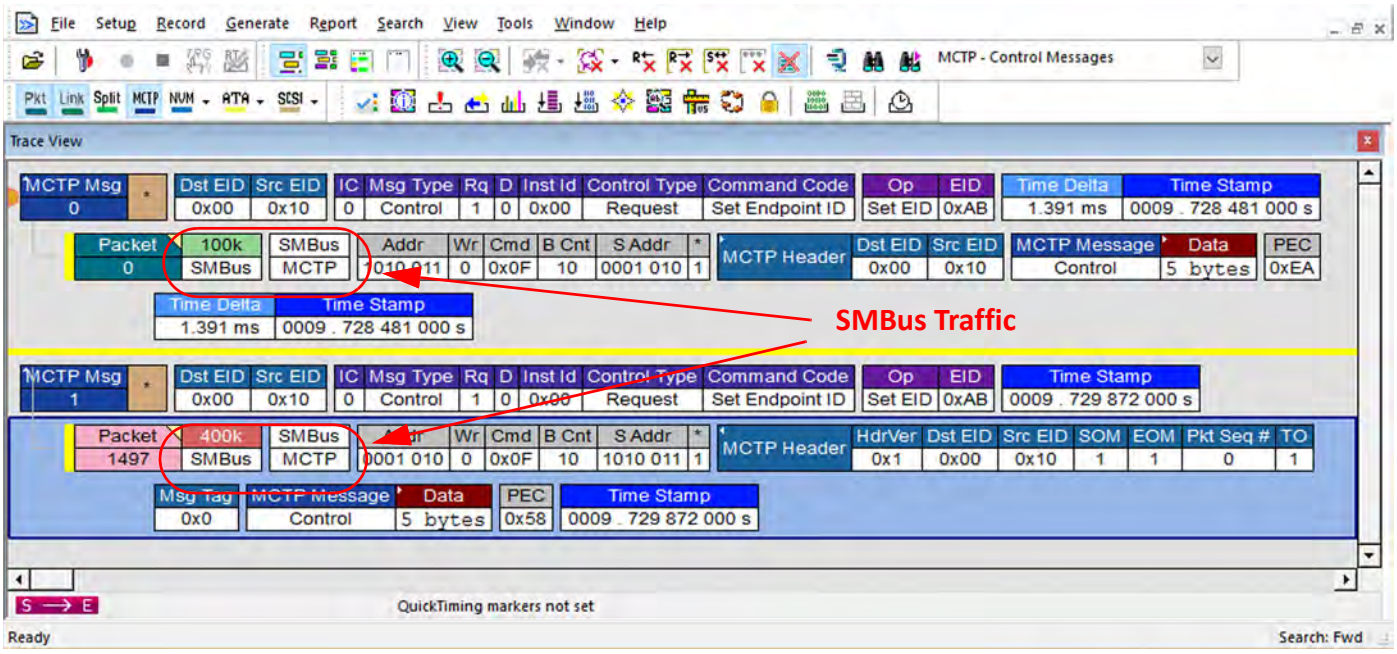


Figure 6.114: SMBus Traffic within two MCTP Messages

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 6.115 shows Sideband traffic displayed. Figure 6.116 on page 519 shows the SMBus traffic Hidden.

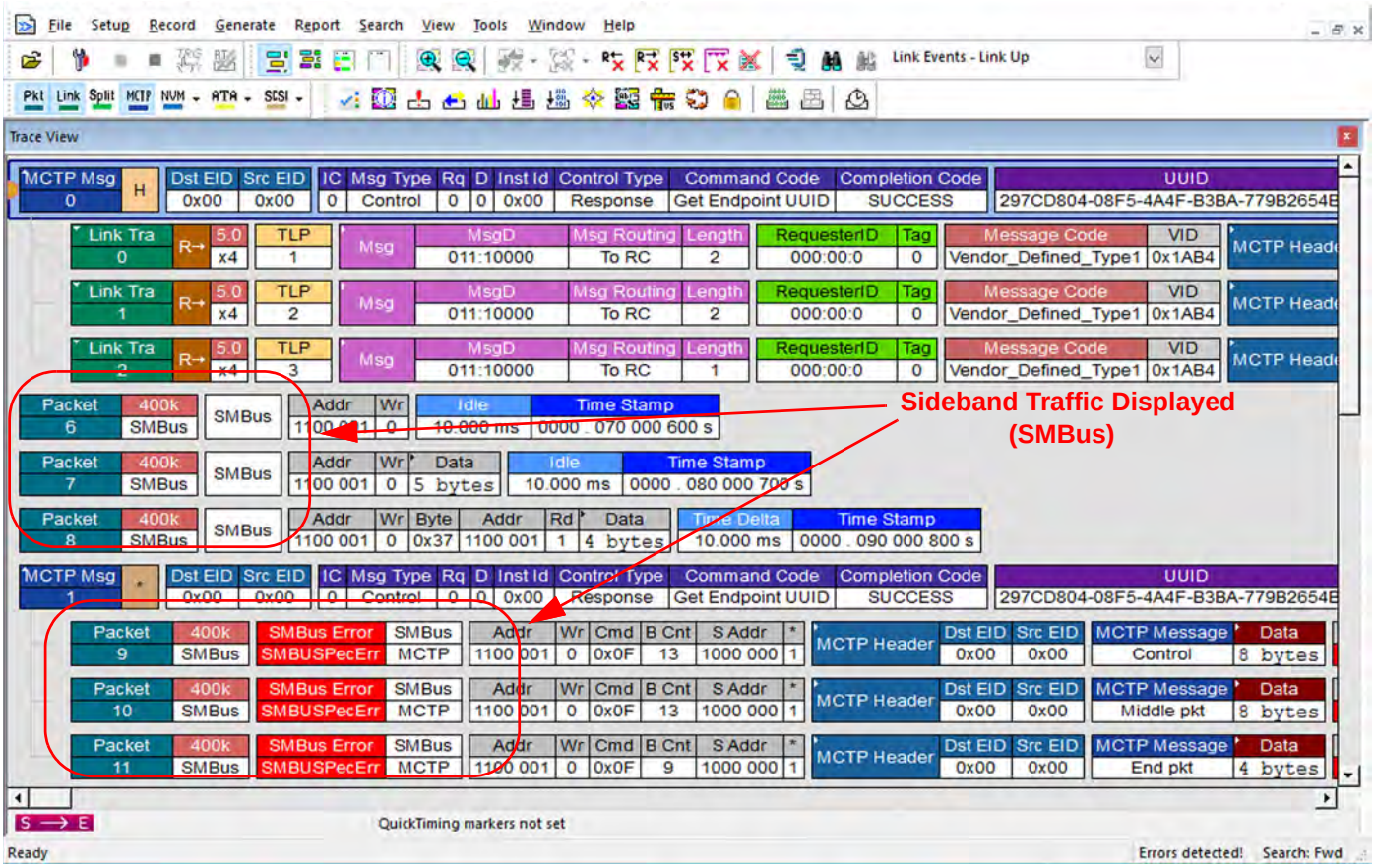


Figure 6.115: Displaying Sideband Traffic (SMBus)

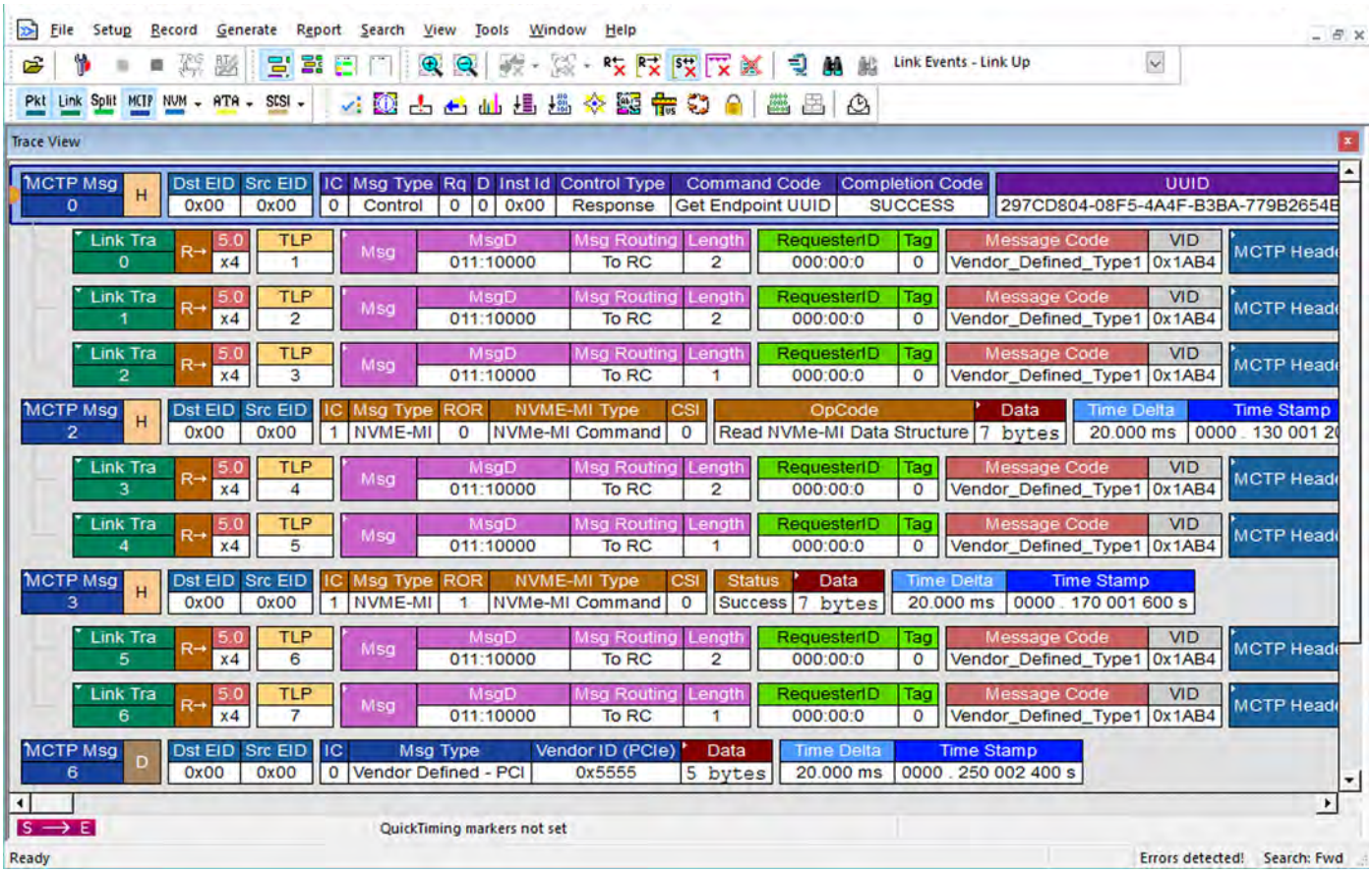


Figure 6.116: Hiding Sideband Traffic (SMBus)

If you compare Figure 6.115 on page 518 and Figure 6.116 you'll see that all the SMBus traffic has been hidden in Figure 6.116. 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 T416 or Summit T48 analyzer can detect a wide variety of SMBus errors (as shown in Figure 6.117 and Figure 6.118 on page 521).

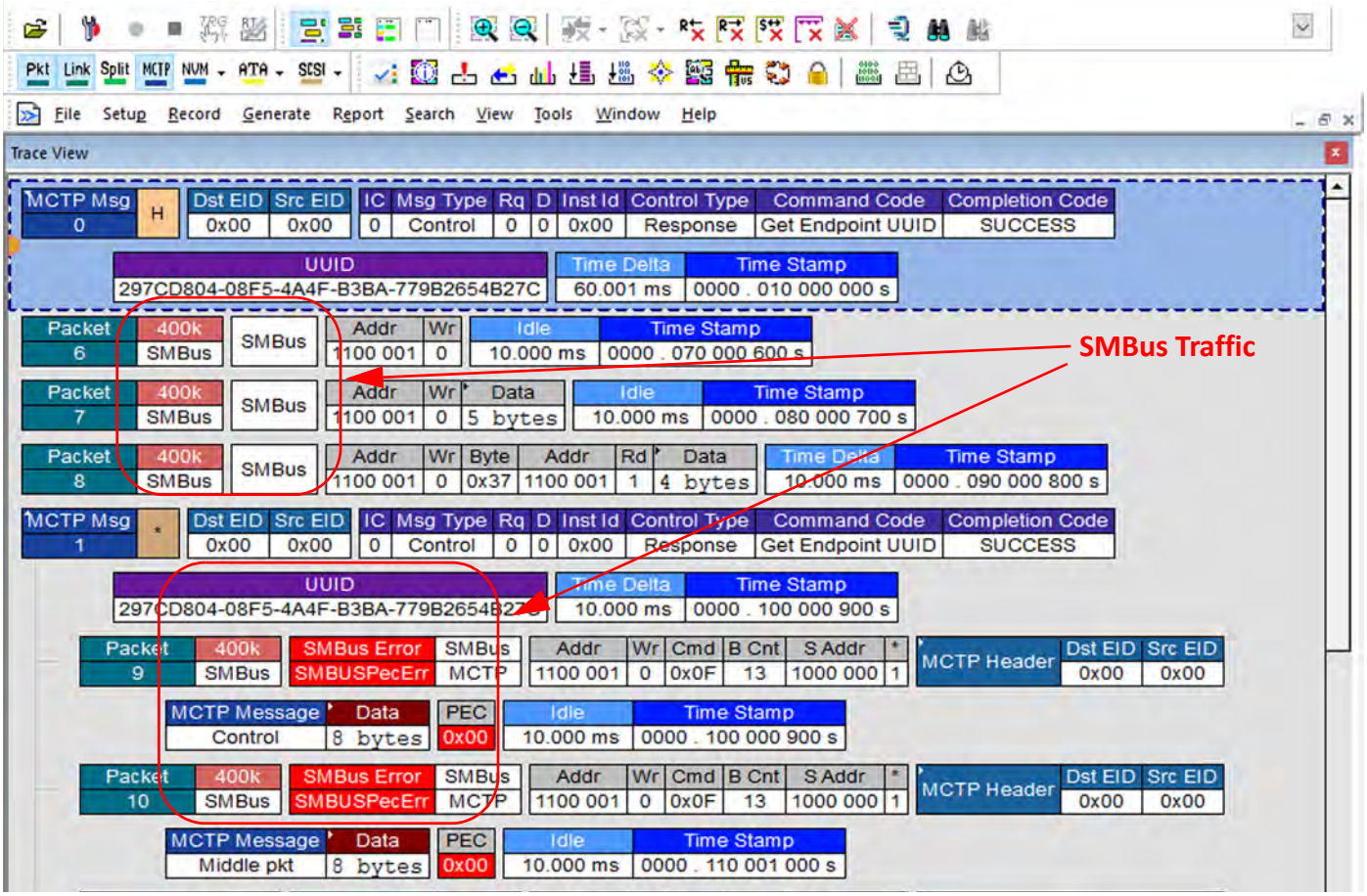


Figure 6.117: SMBus Traffic within two MCTP Messages with Errors

SMBus Error Tooltip

If you scroll over each SMBus Error a tooltip with a detailed explanation of the error will popup. See Figure 6.118.

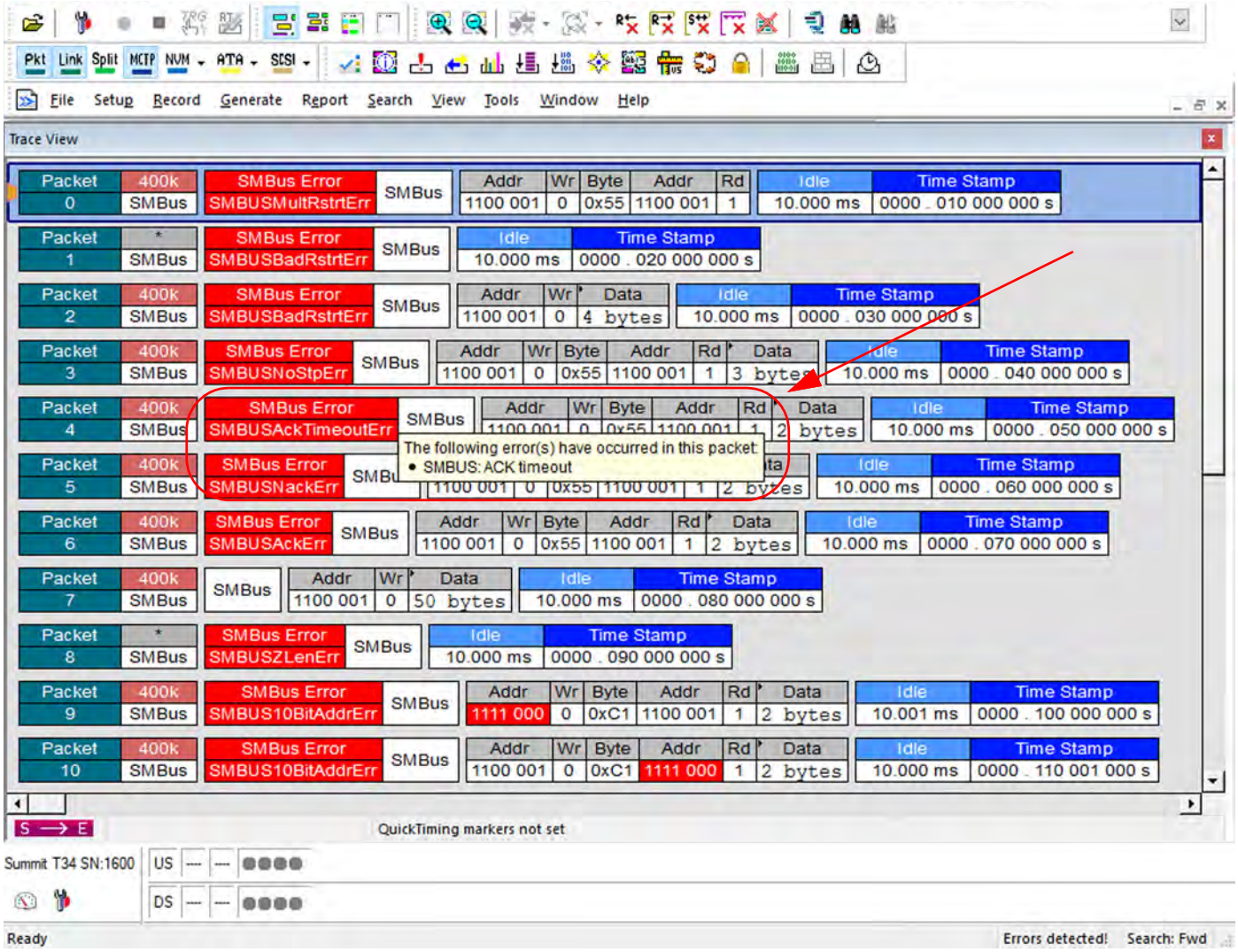


Figure 6.118: Decoding SMBus with Errors

Traffic Summary Report: SMBus Errors

Another way of displaying the SMBus errors is to select the Traffic Summary Report (as shown in Figure 6.119).

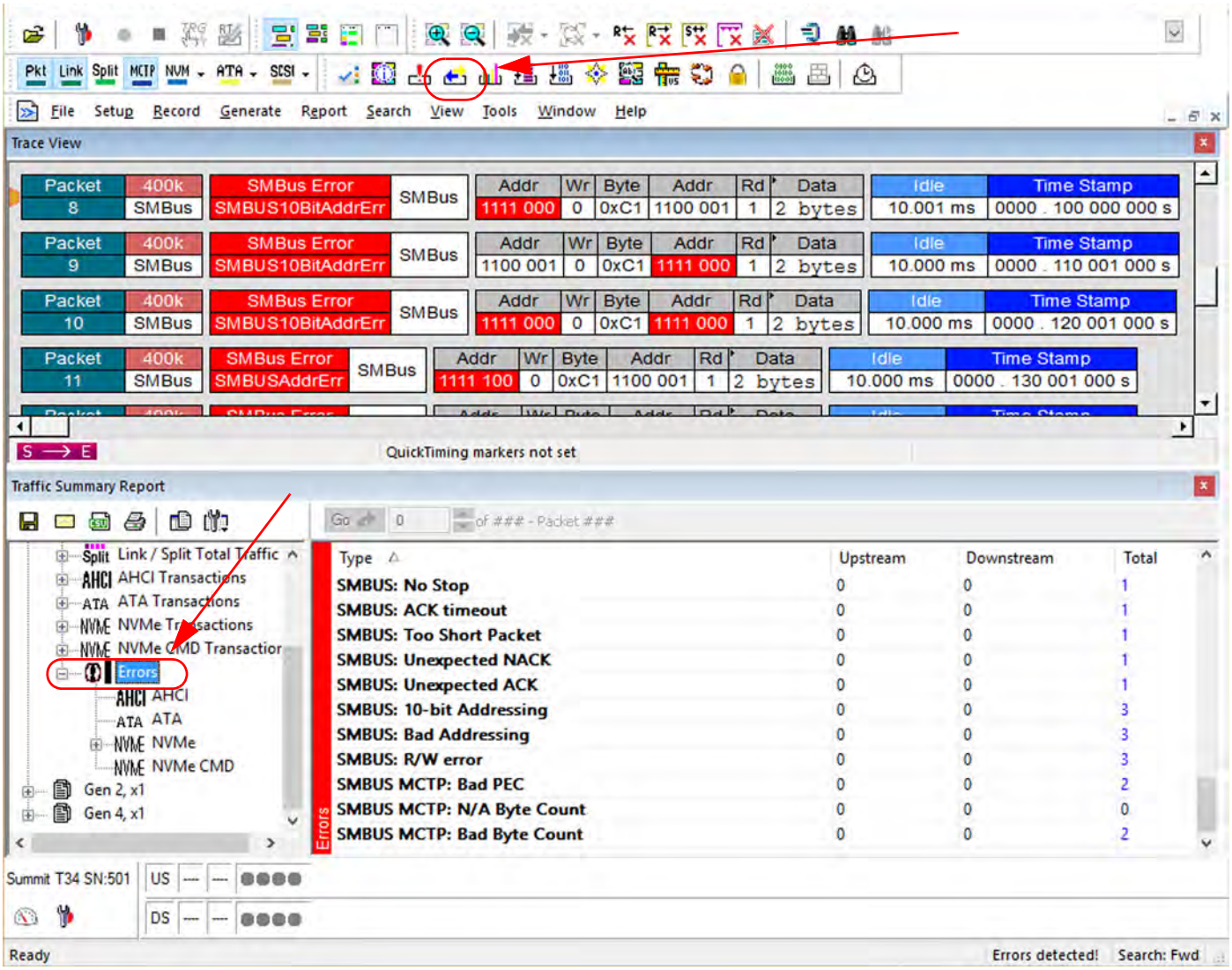


Figure 6.119: Traffic Summary Report: SMBus Errors

The complete set of SMBus errors that the Summit T416 or Summit T48 can detect is contained in the table below: Table 6.5.

TABLE 6.5: 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

6.12.16 Decoding SMBus with Address Resolution Protocol (ARP)

The PCIe Protocol Analysis can decode SMBus traffic with Address Resolution Protocol as shown below in Figure 6.120.

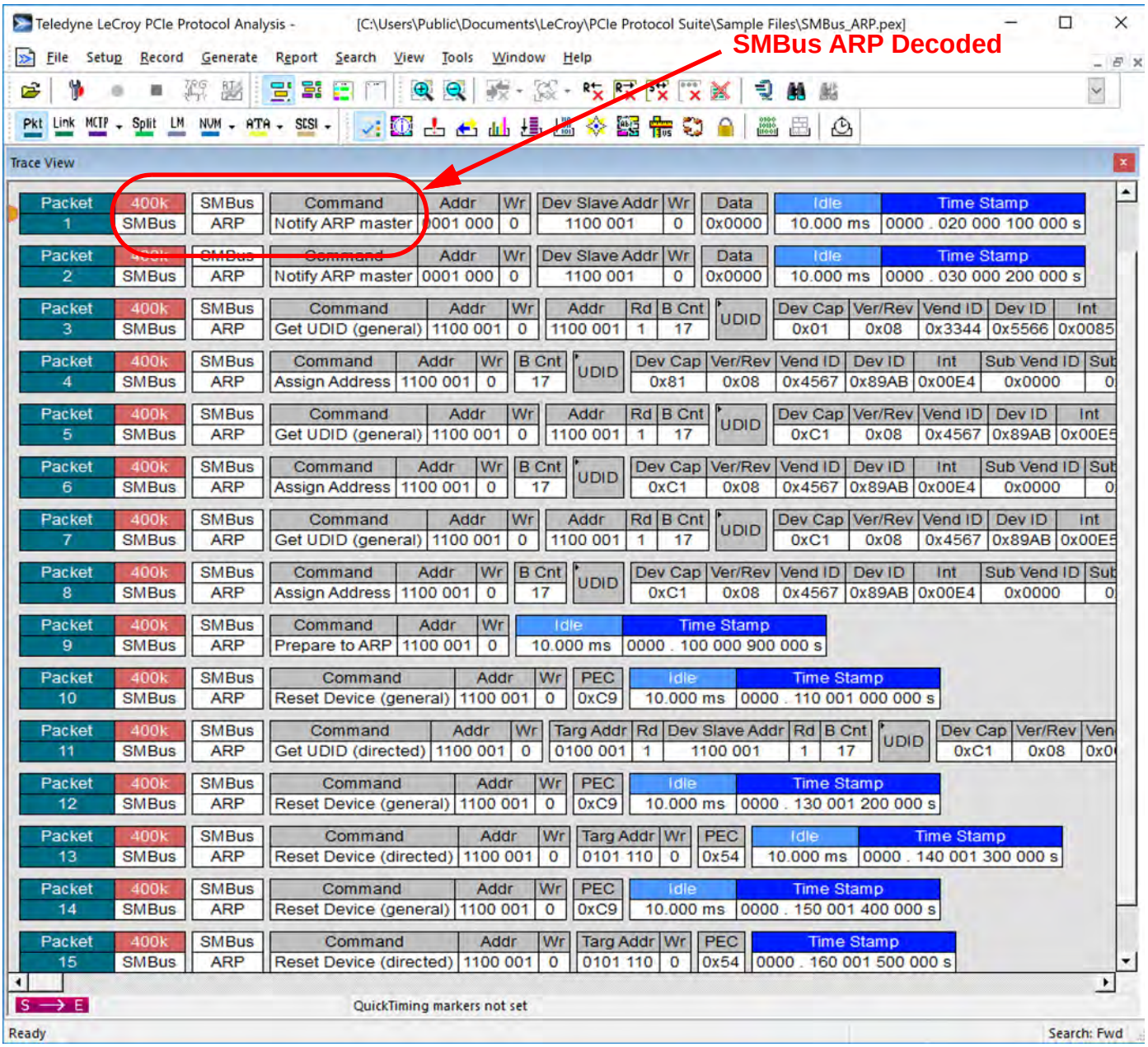


Figure 6.120: SMBus Address Resolution Protocol Decoded

6.12.17 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 6.121.

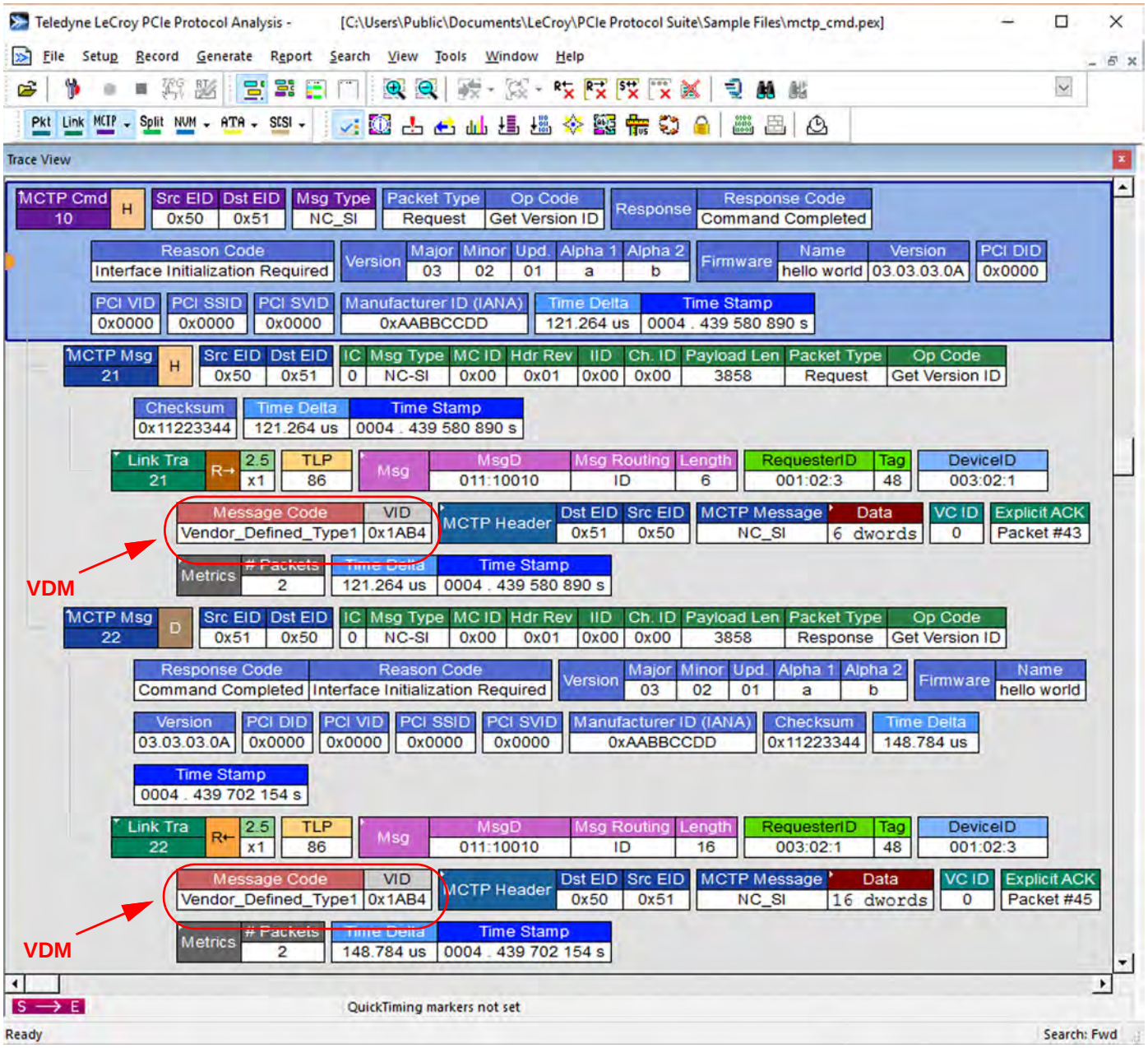


Figure 6.121: MCTP Traffic: Decoding Vendor Defined Messages (VDM)

6.12.18 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.

6.12.19 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 6.122.

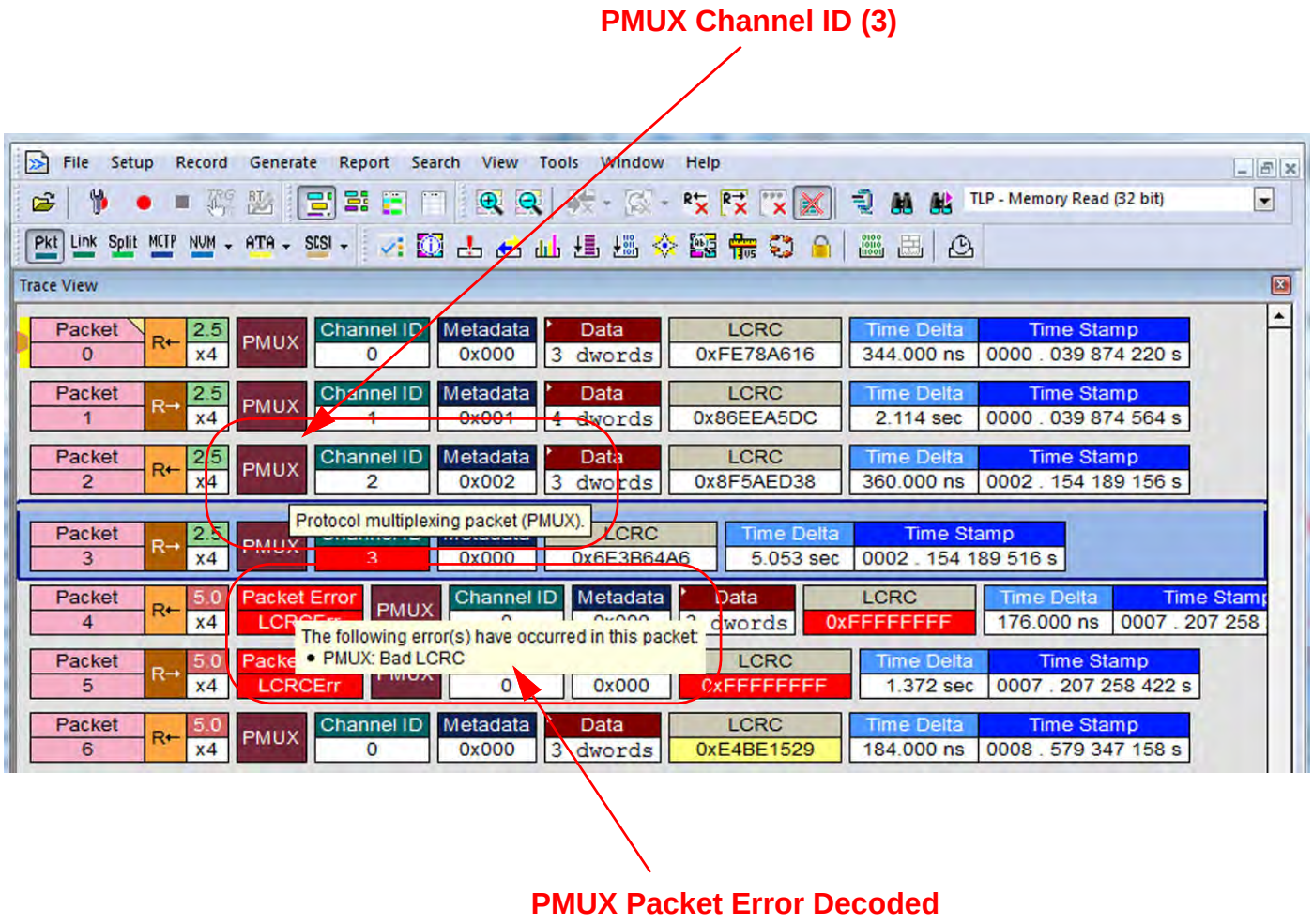


Figure 6.122: PMUX Channel ID (3) Found in Trace and Packet Error Decoded

6.12.20 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.

6.12.20.1 Example: Loading an NVMe Trace and Decoding for ATA

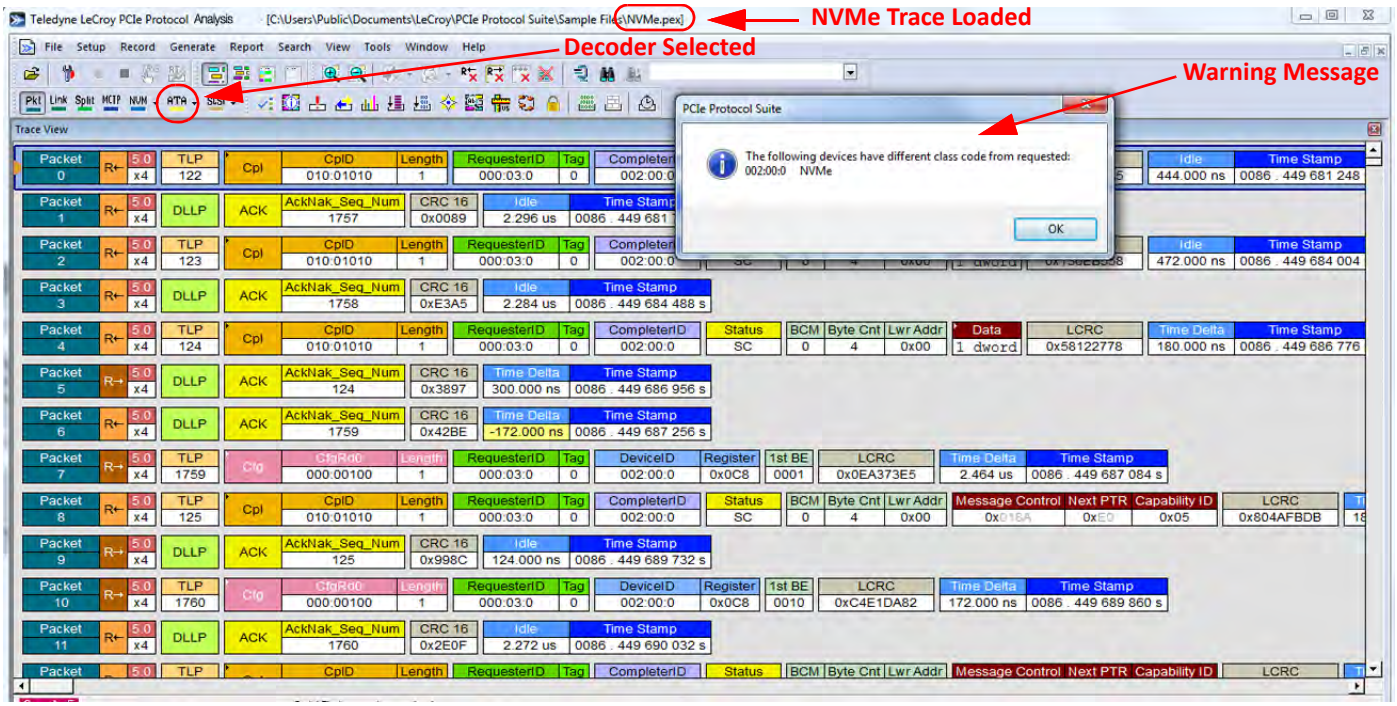


Figure 6.123: NVMe Trace Loaded Different Than ATA Decoder Selected

6.12.20.2 Example: Loading a PQI Trace and Decoding for NVMe

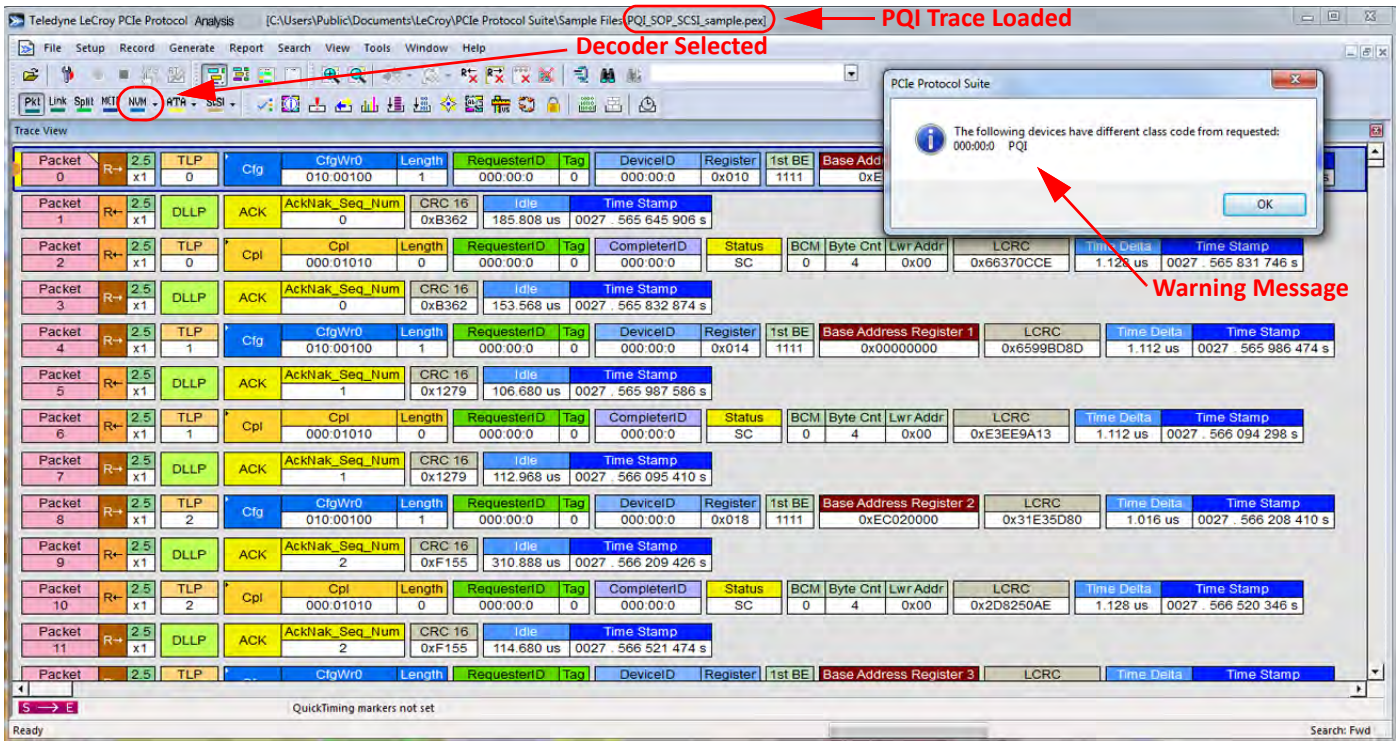


Figure 6.124: PQI Trace Loaded Different Than NVMe Decoder Selected

6.12.21 Data Link Features

The Summit T416 or Summit T48 can decode Data Link Features as shown in Figure 6.121.

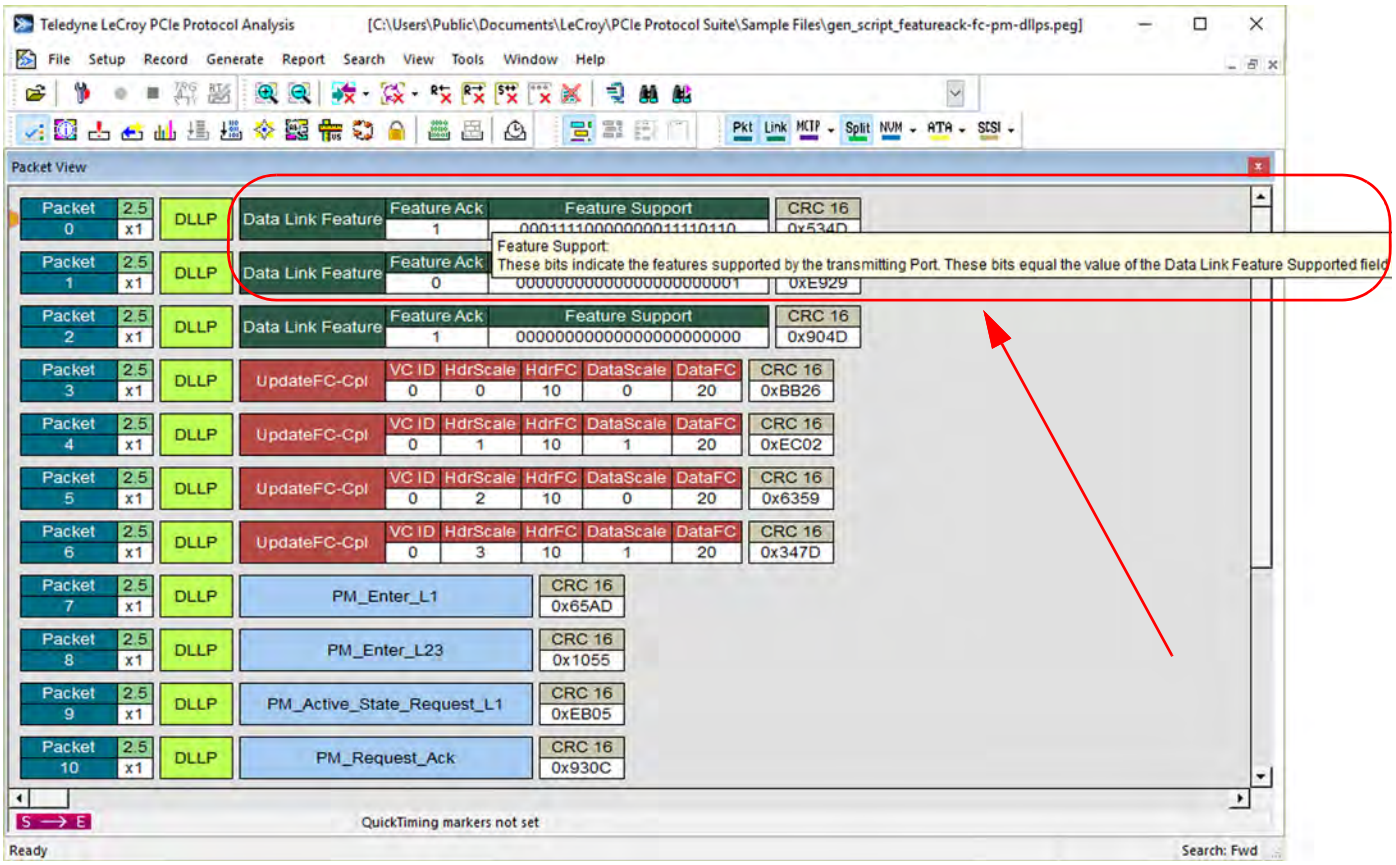


Figure 6.125: Decoding Data Link Features

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:

TABLE 6.6: Data Link Feature Supported Bit Definition

Bit Location	Description
0	**Scaled Flow Control** – indicates support for Scaled Flow Control. Scaled Flow Control must be supported in Ports that support 16.0 GT/s or higher operation.
Others	Reserved

6.12.22 Decoding PCI-SIG Vendor Defined Messages (VDMs)

PCI-SIG VDMs can be decoded as shown below in Figure 6.126.

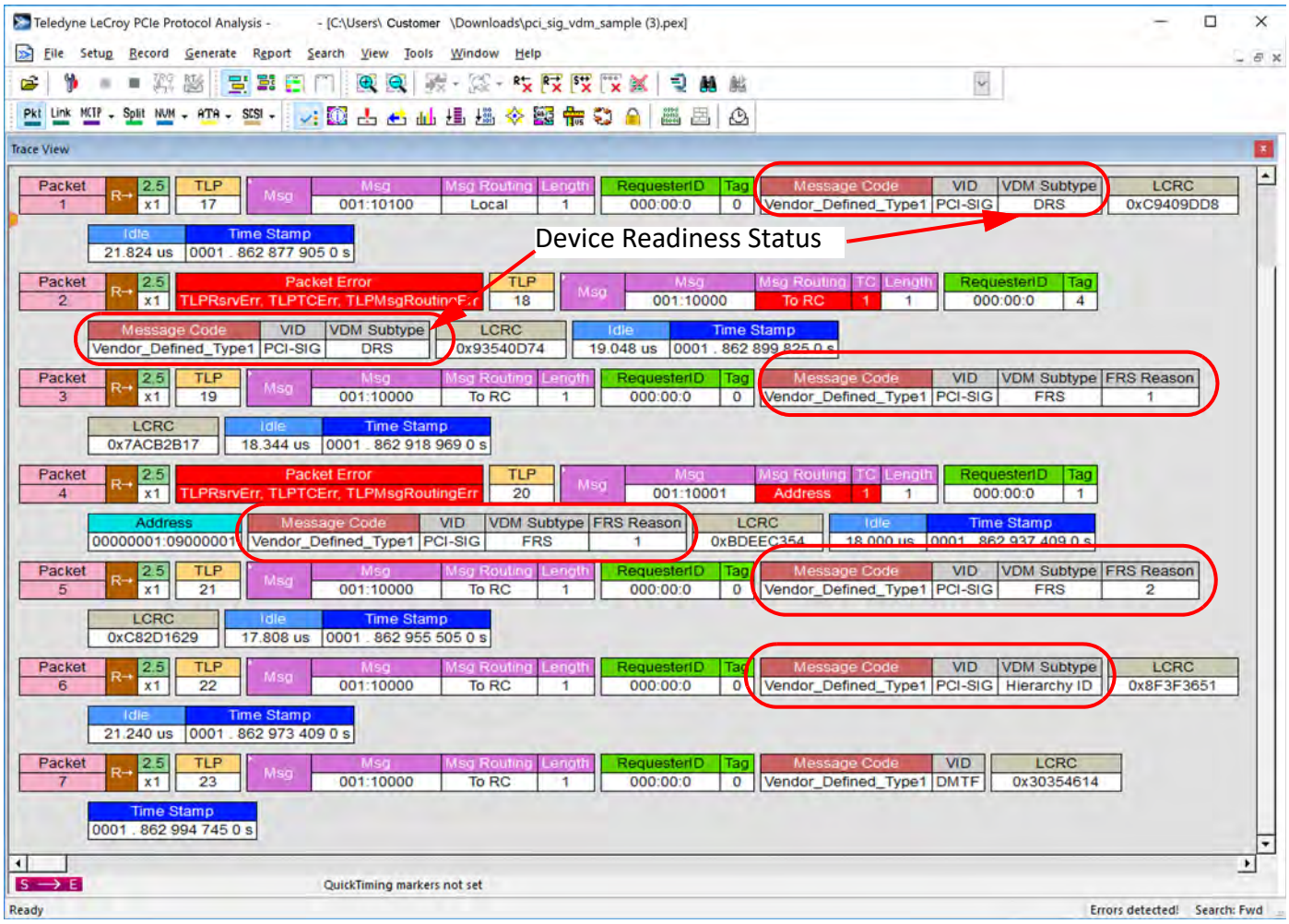


Figure 6.126: Decoding PCI-SIG VDMs

You can roll the cursor over each VDM to display it's tooltip. The one for Device Readiness Status is shown below (see Figure 6.127).

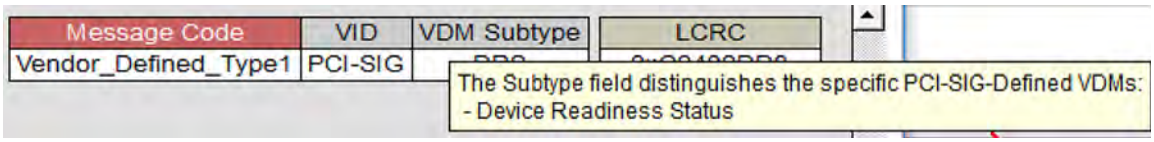


Figure 6.127: Device Readiness Status Tooltip

You can also bring up the decoded trace in Detailed mode (see Figure 6.128 on page 532).

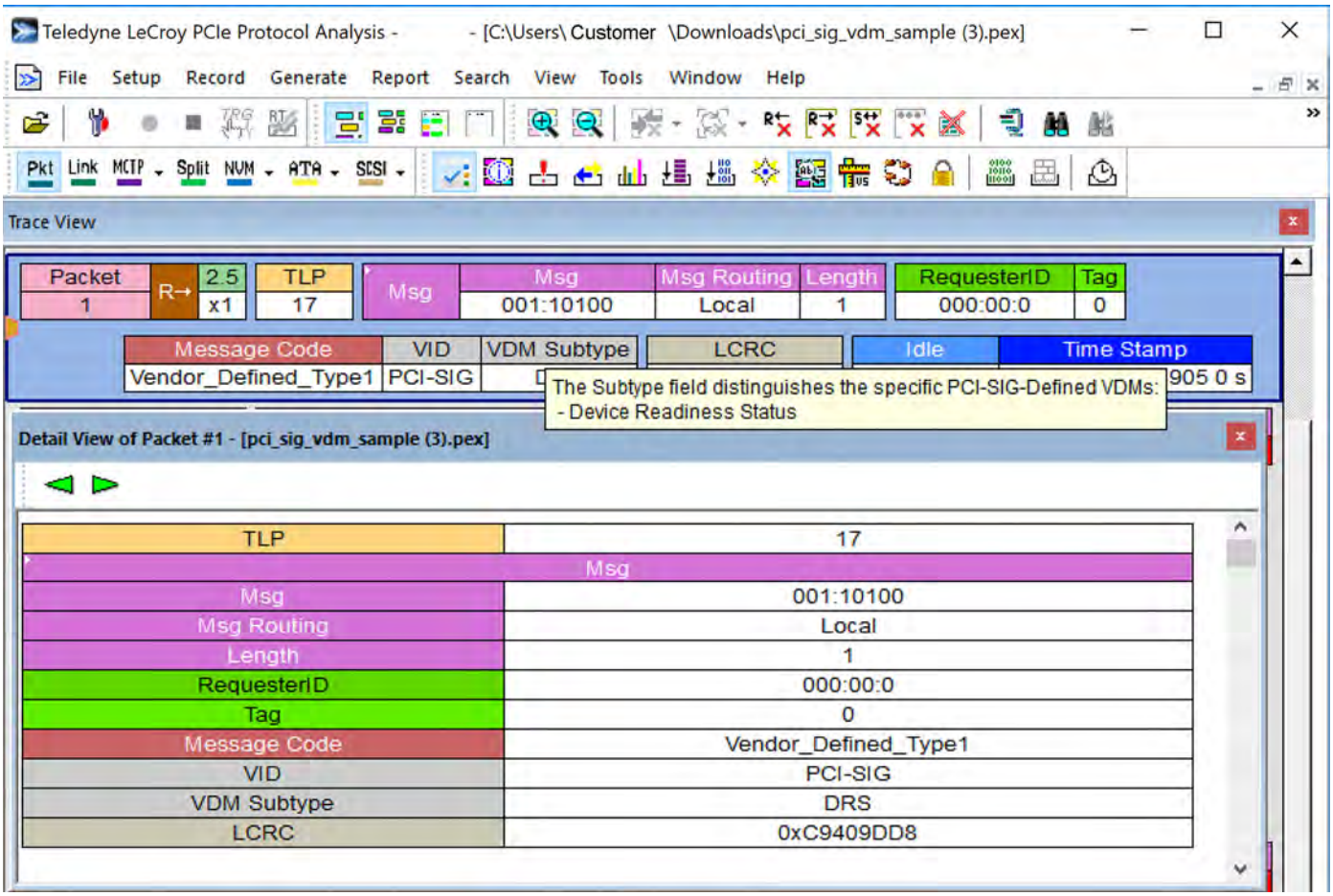


Figure 6.128: Decoding PCI-SIG VDM: Displayed in Detailed Mode

Other VDM Messages include:

- LN
- FRS
  - Reason 1: DRS Message Received
  - Reason 2: D3 Hot to D0 Transition Completed
- Hierarchy ID
- DMTF

6.12.23 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 6.129 through Figure 6.132 on page 536).

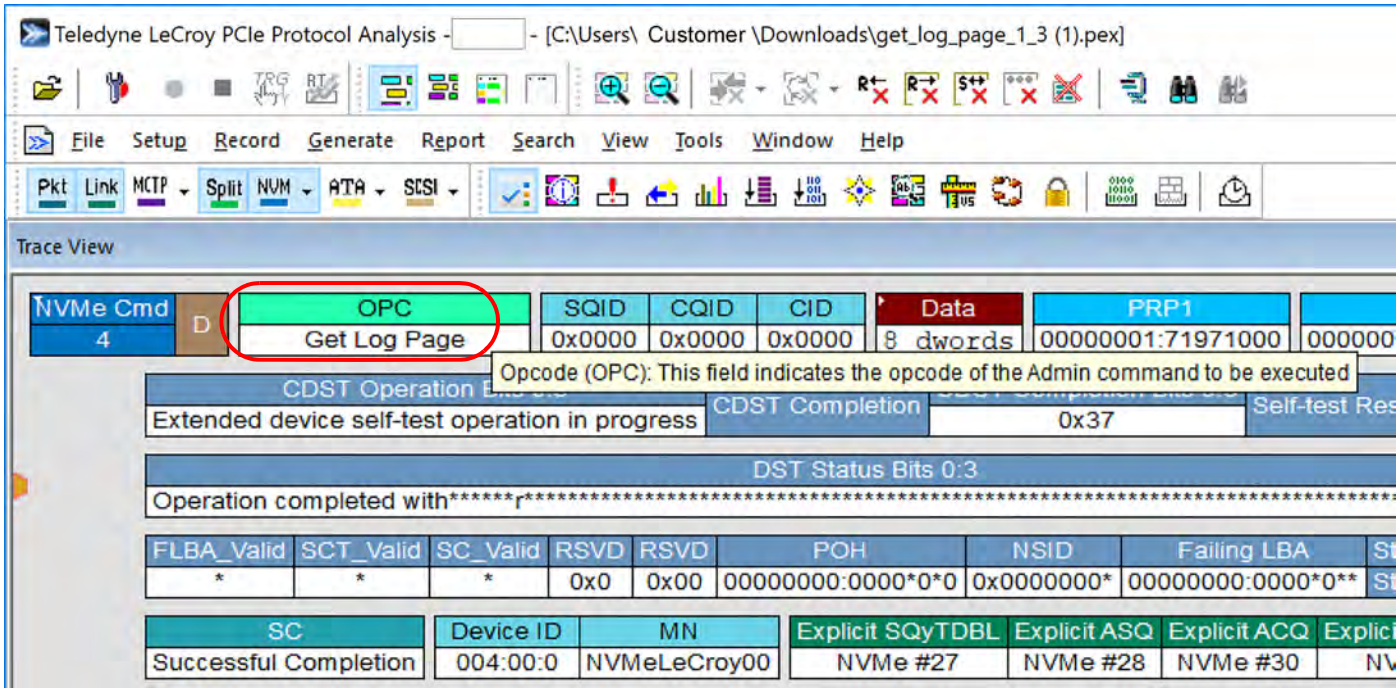


Figure 6.129: NVMe 1.3c Spec: Decodes --> Get Log Page

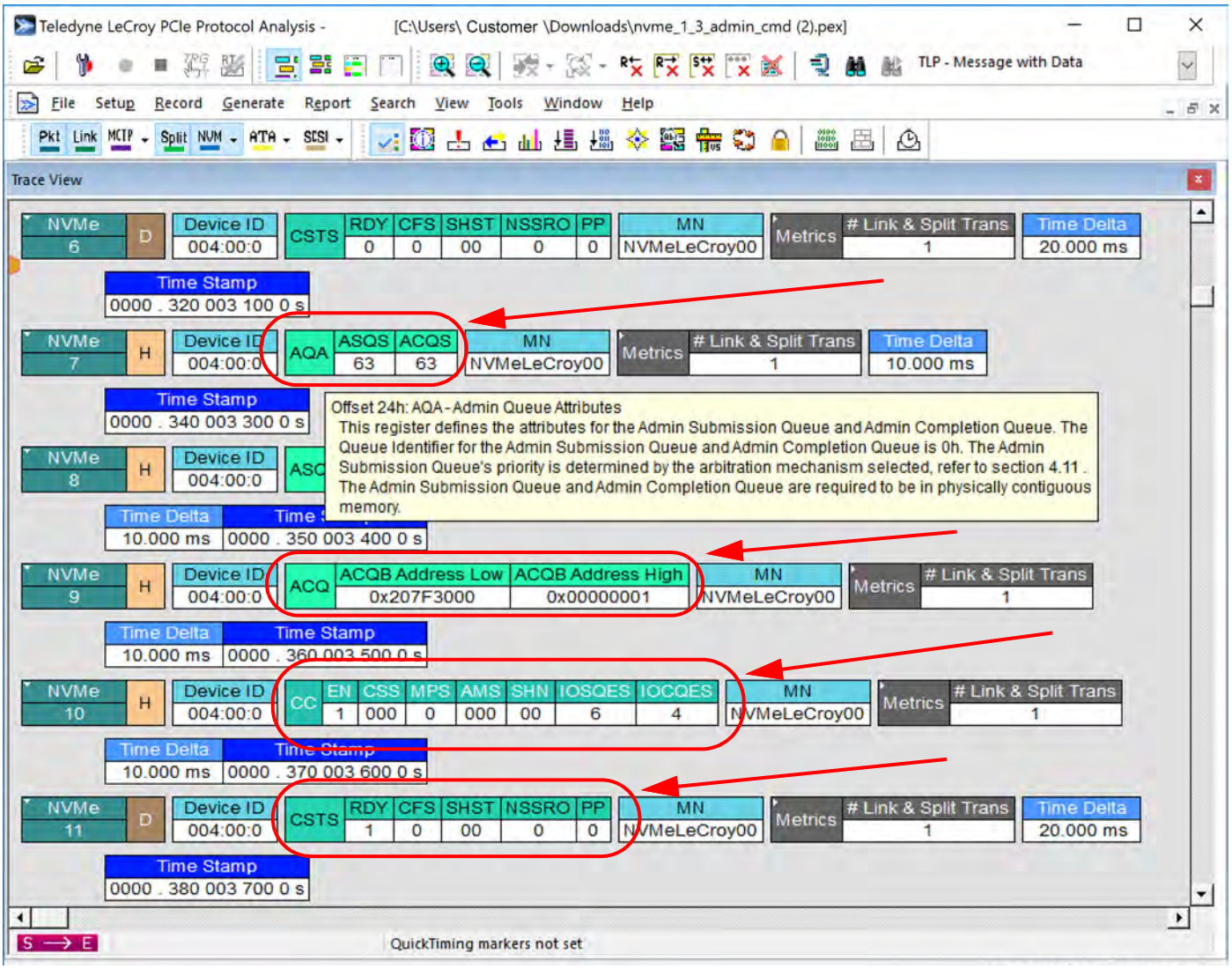


Figure 6.130: NVMe 1.3c Spec: Decodes --> Admin Commands

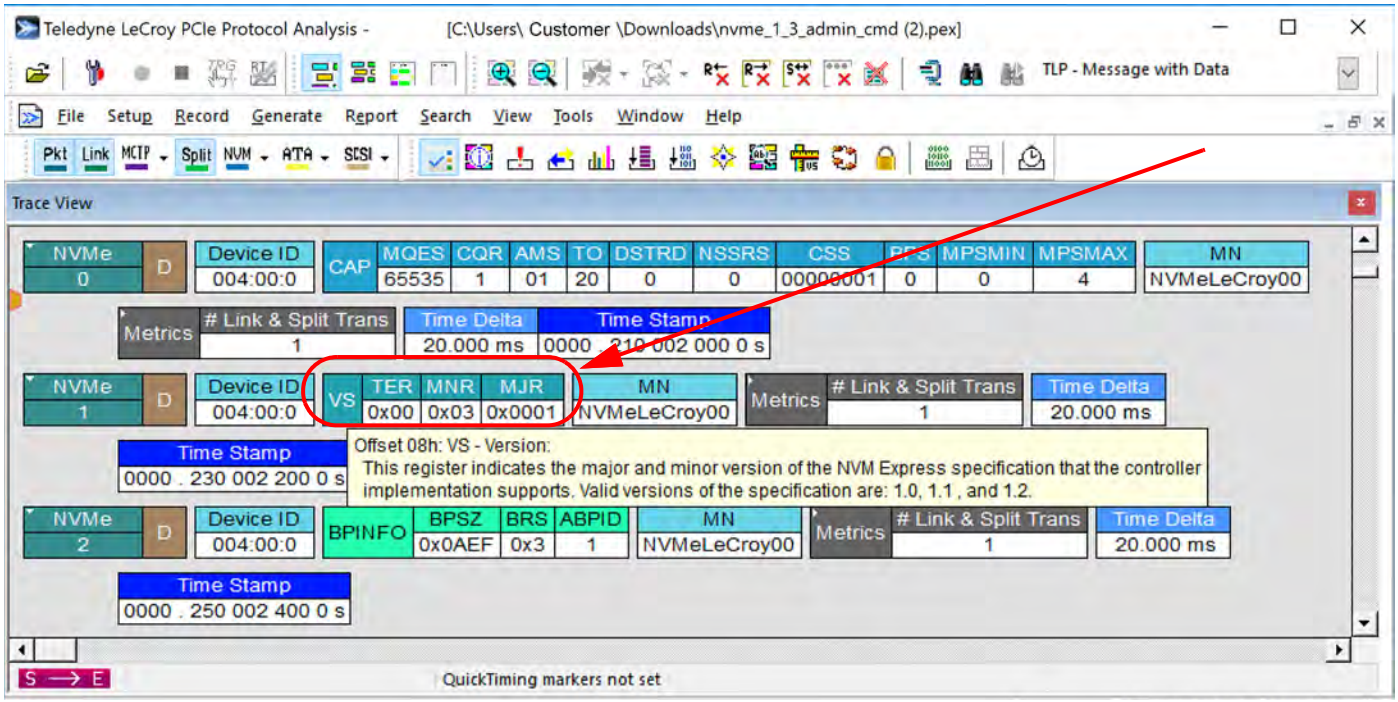


Figure 6.131: NVMe 1.3c Spec: Decodes --> Spec Version 1.3c

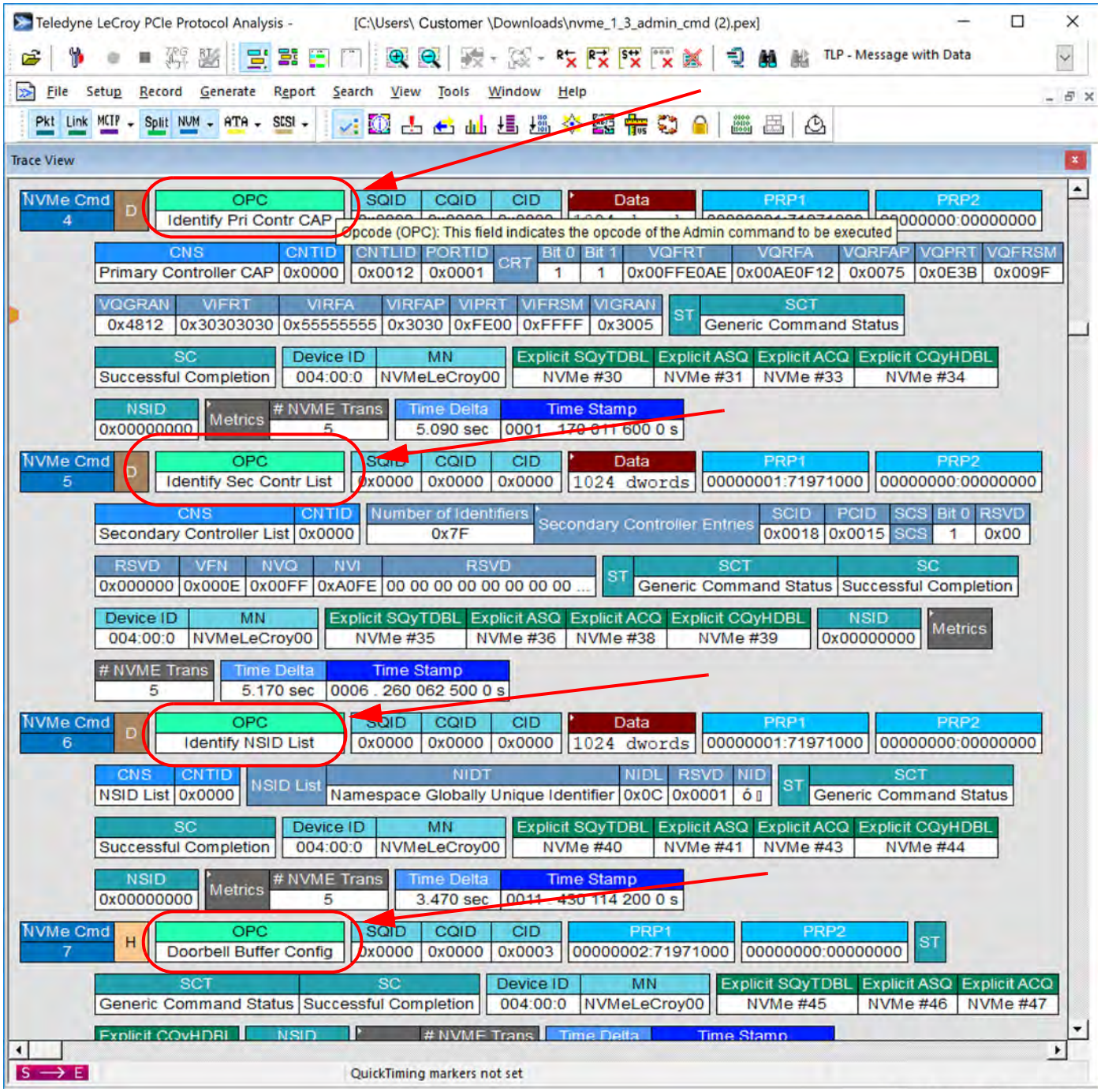


Figure 6.132: NVMe 1.3c Spec: Decodes --> Opcodes

6.12.24 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

6.12.24.1 Trace View

If you decode for NVMe Commands and Transactions you'll see the following types of warning messages: See Figure 6.133, Figure 6.134 on page 538, Figure 6.135 on page 538 and Figure 6.136 on page 538.

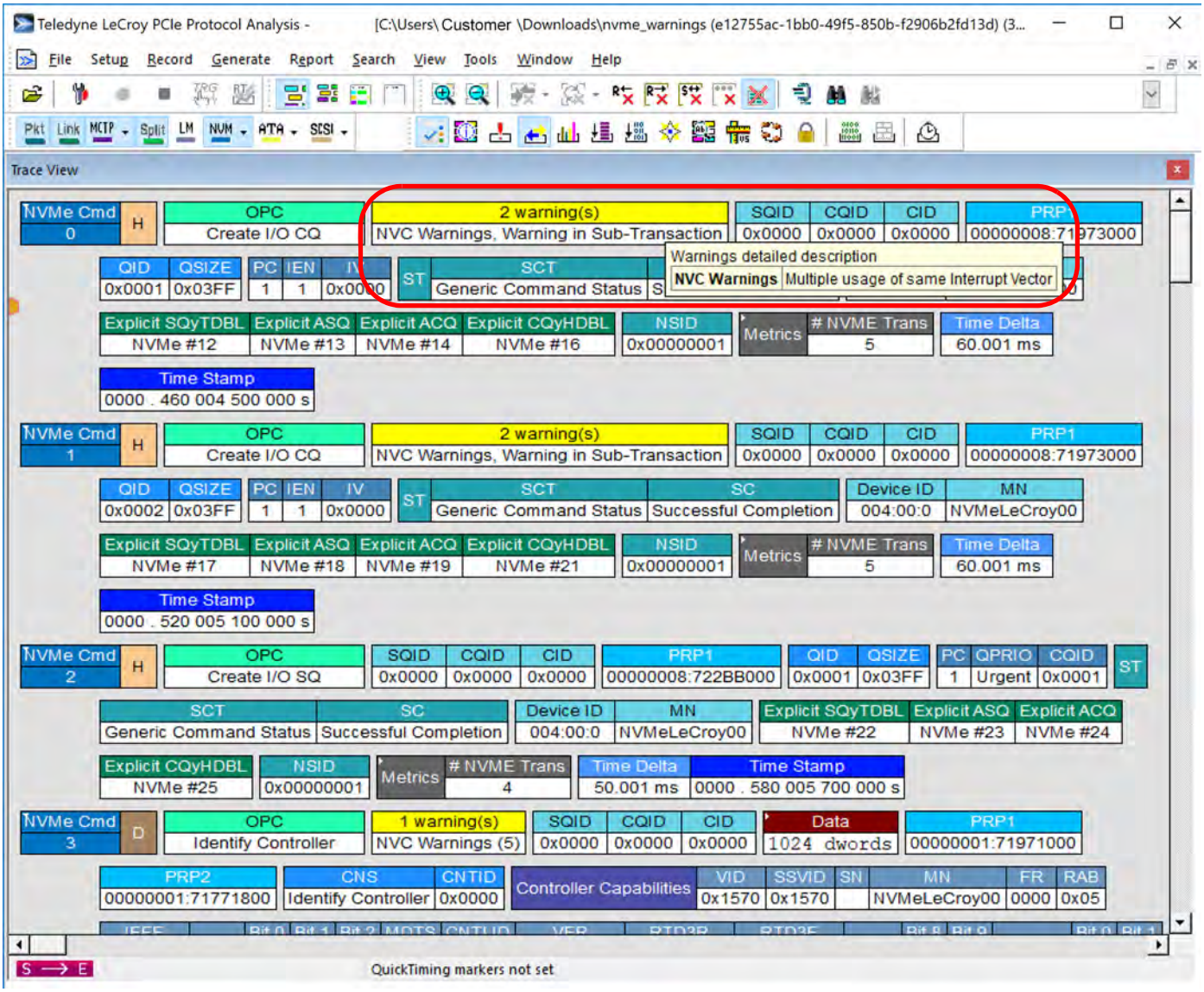


Figure 6.133: NVMe Command: Warning Message 1

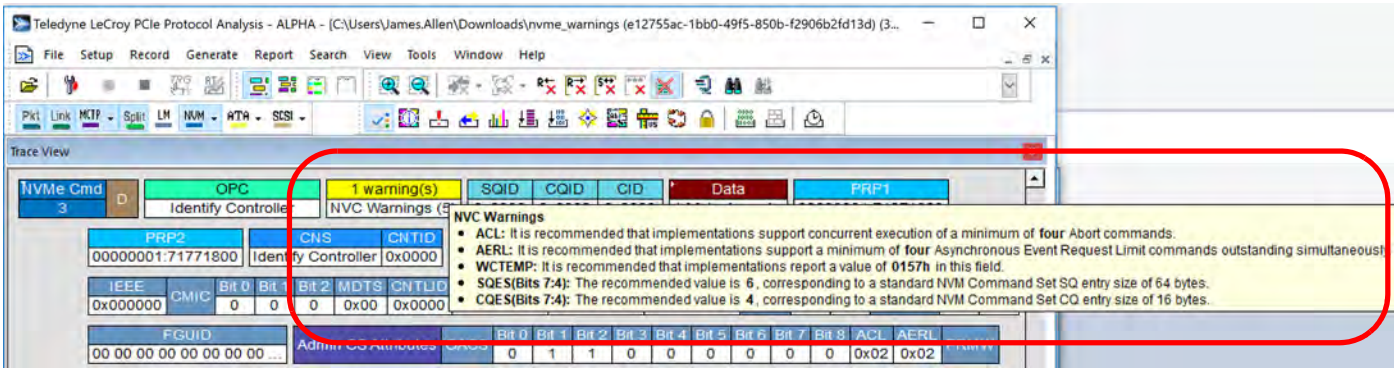


Figure 6.134: NVMe Command: Warning Message 2

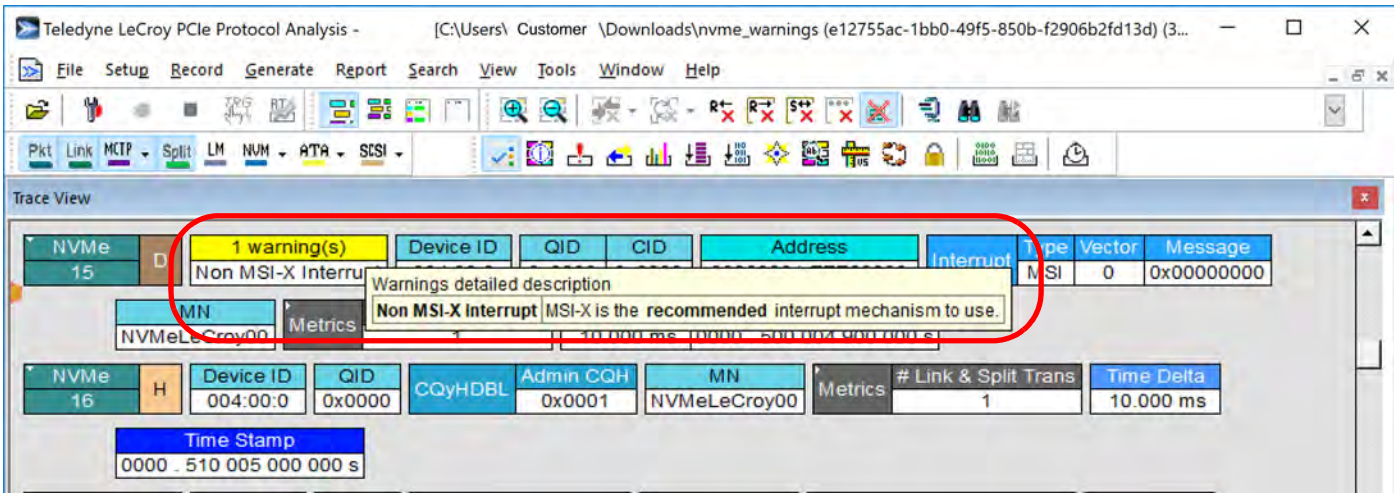


Figure 6.135: NVMe Transaction: Warning Message

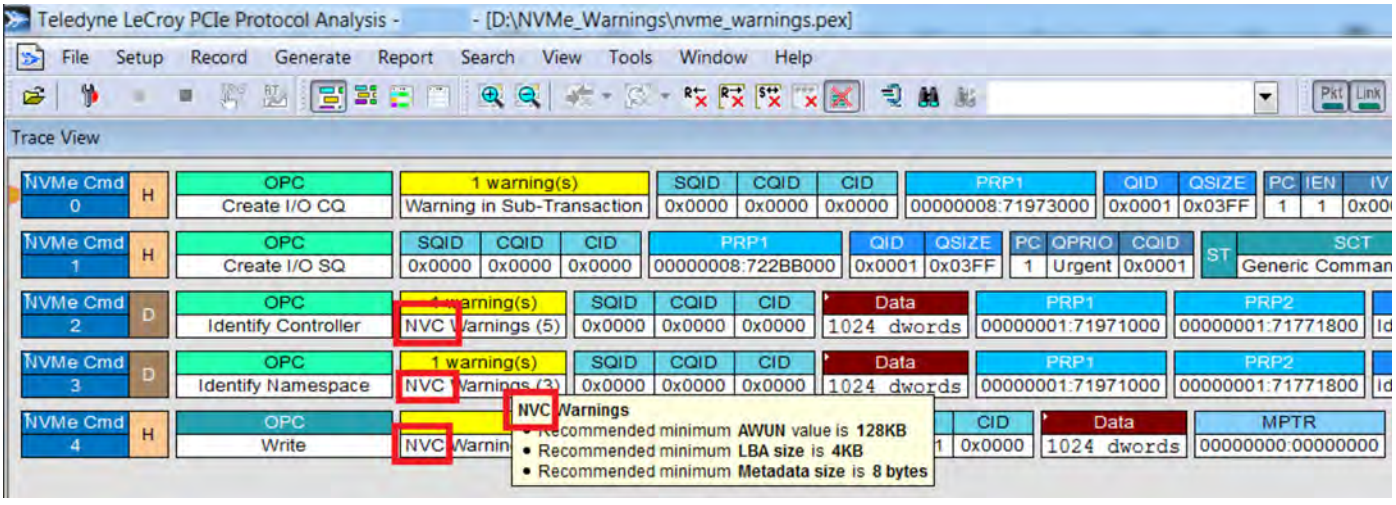


Figure 6.136: NVME Command: NVC Warning Messages

6.12.24.2 Traffic Summary View

The NVMe Warning Messages can be seen in the Traffic Summary Reports (see Figure 6.137, Figure 6.138 on page 540, Figure 6.139 on page 541 and Figure 6.140 on page 542) below:

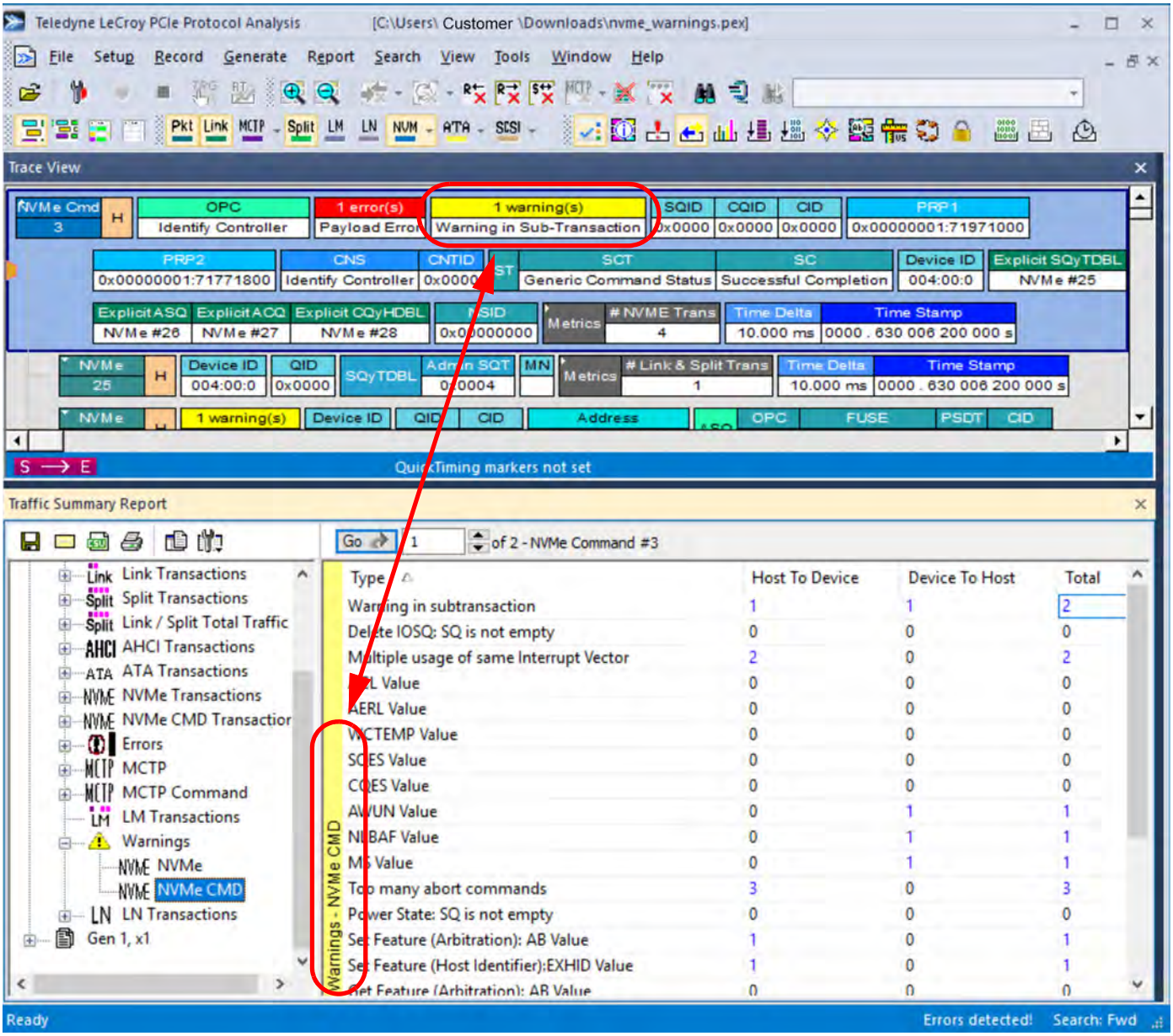


Figure 6.137: Warnings: NVMe CMD

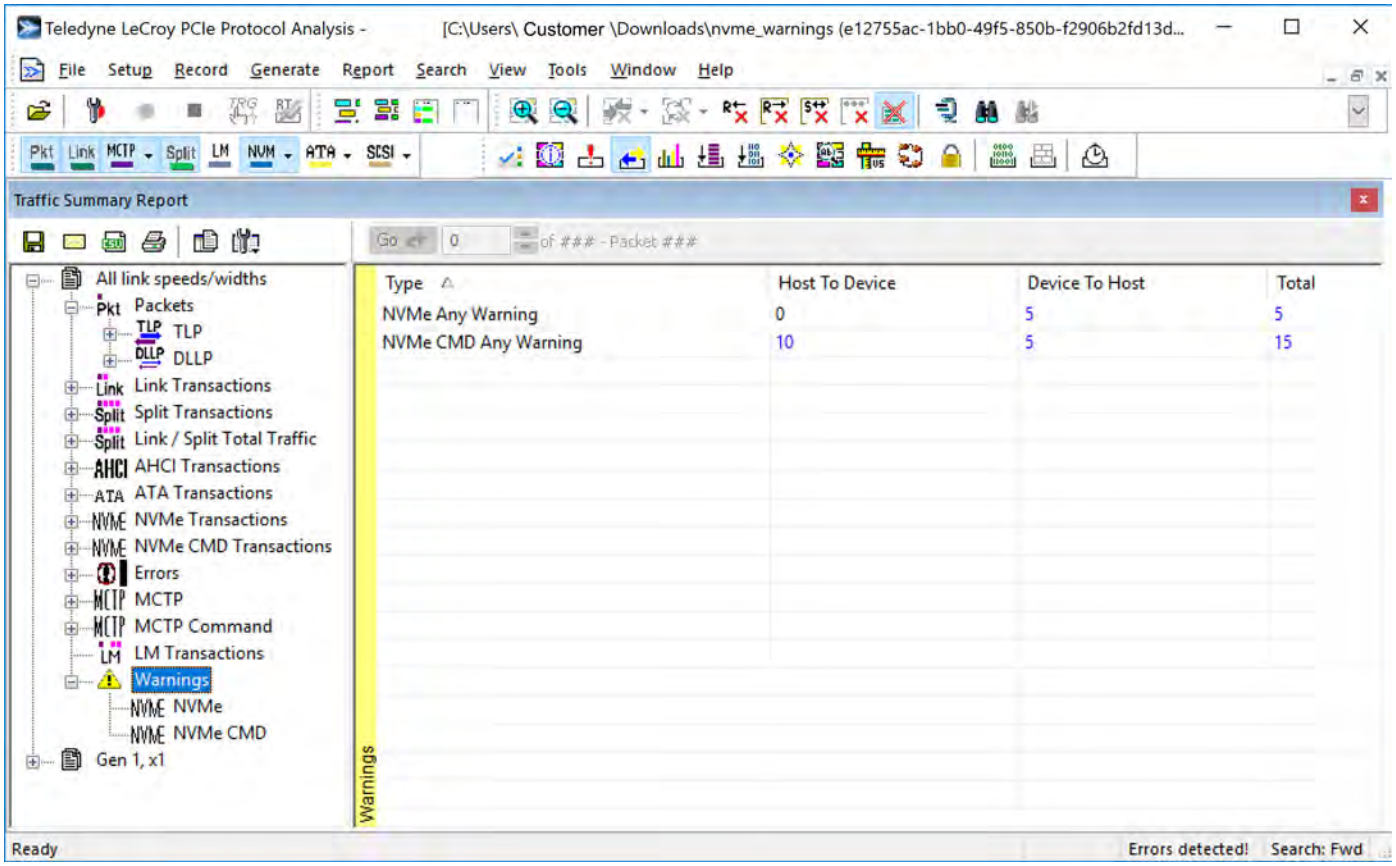


Figure 6.138: NVMe Warning Messages: Traffic Summary

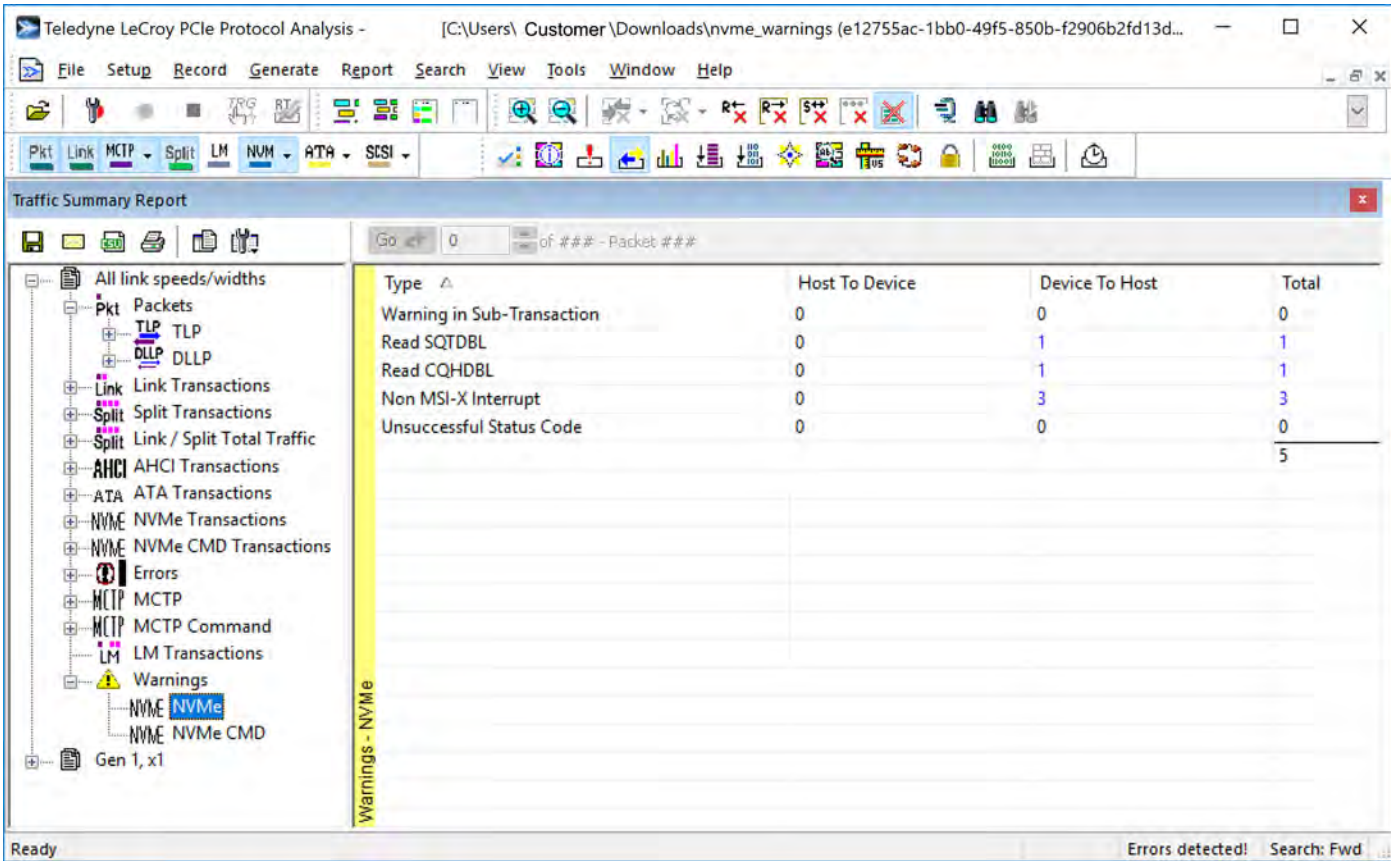


Figure 6.139: NVMe Warning Messages: Traffic Summary NVMe

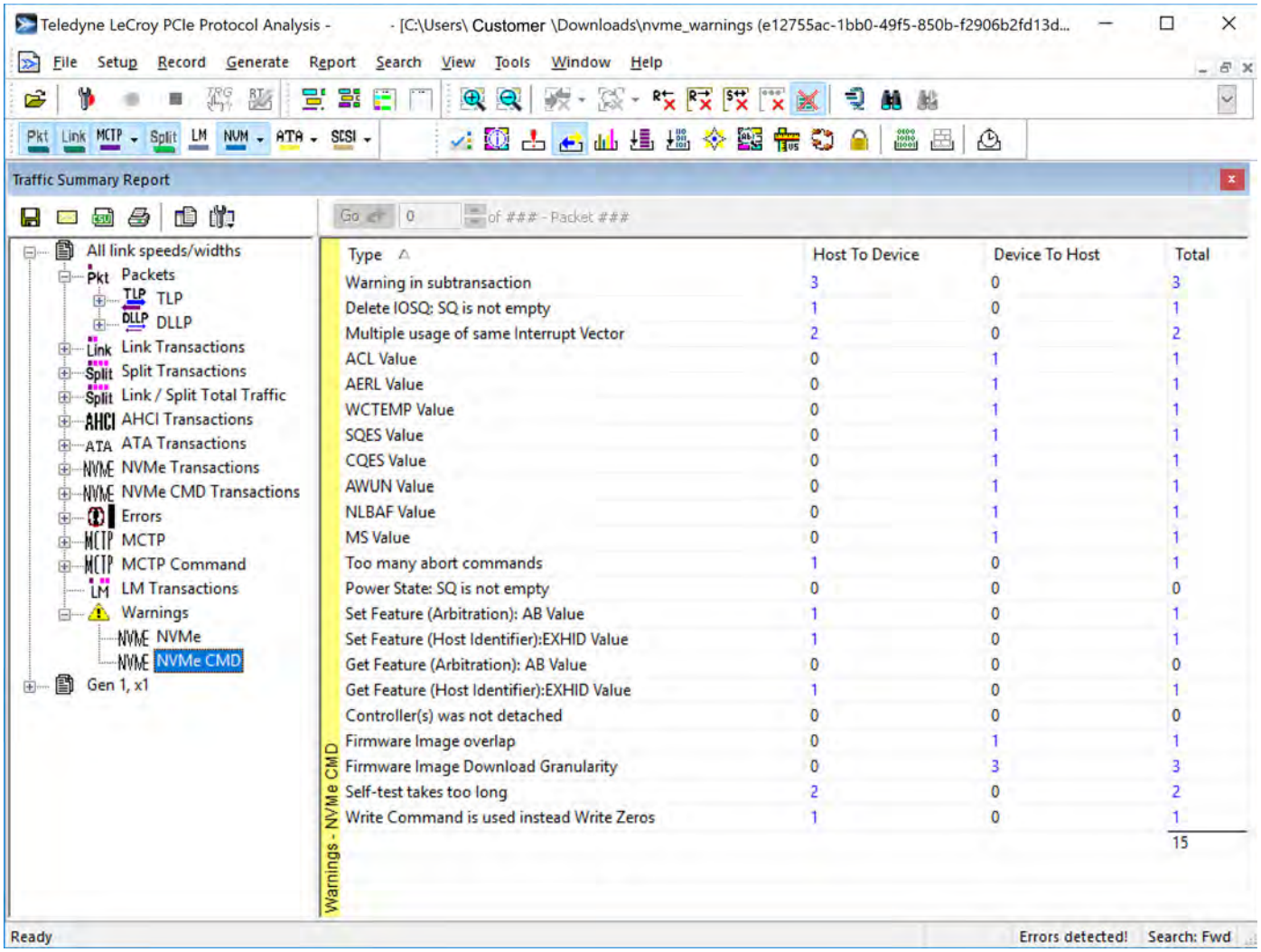


Figure 6.140: NVMe Warning Messages: Traffic Summary NVMe CMD

6.12.24.3 Find NVMe Commands and Transactions

You can use the "Find" function to display the NVMe Commands and Transactions Warning Messages. See Figure 6.141 on page 543 and Figure 6.142 on page 544.

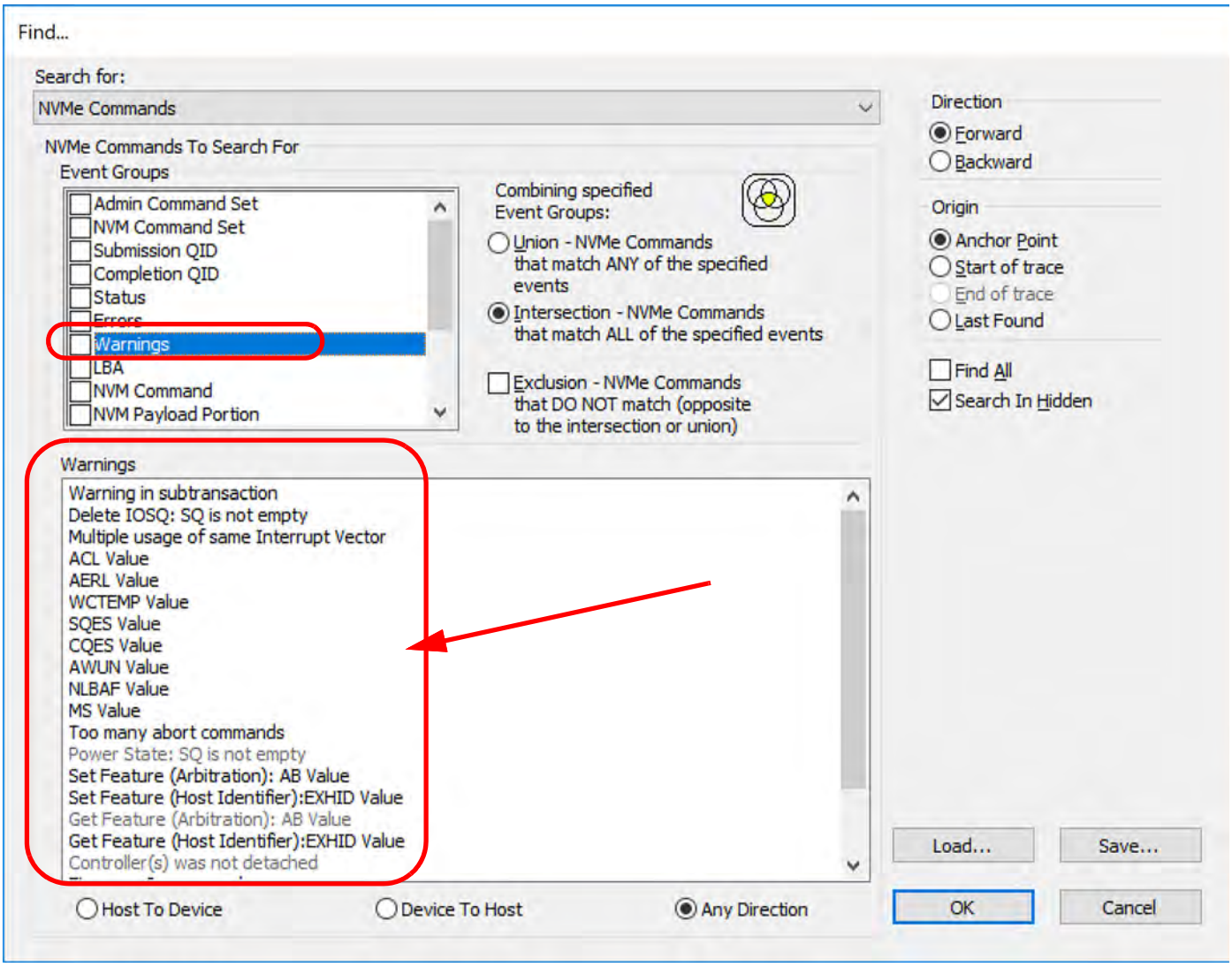


Figure 6.141: Find: NVMe Commands -> Warning Messages

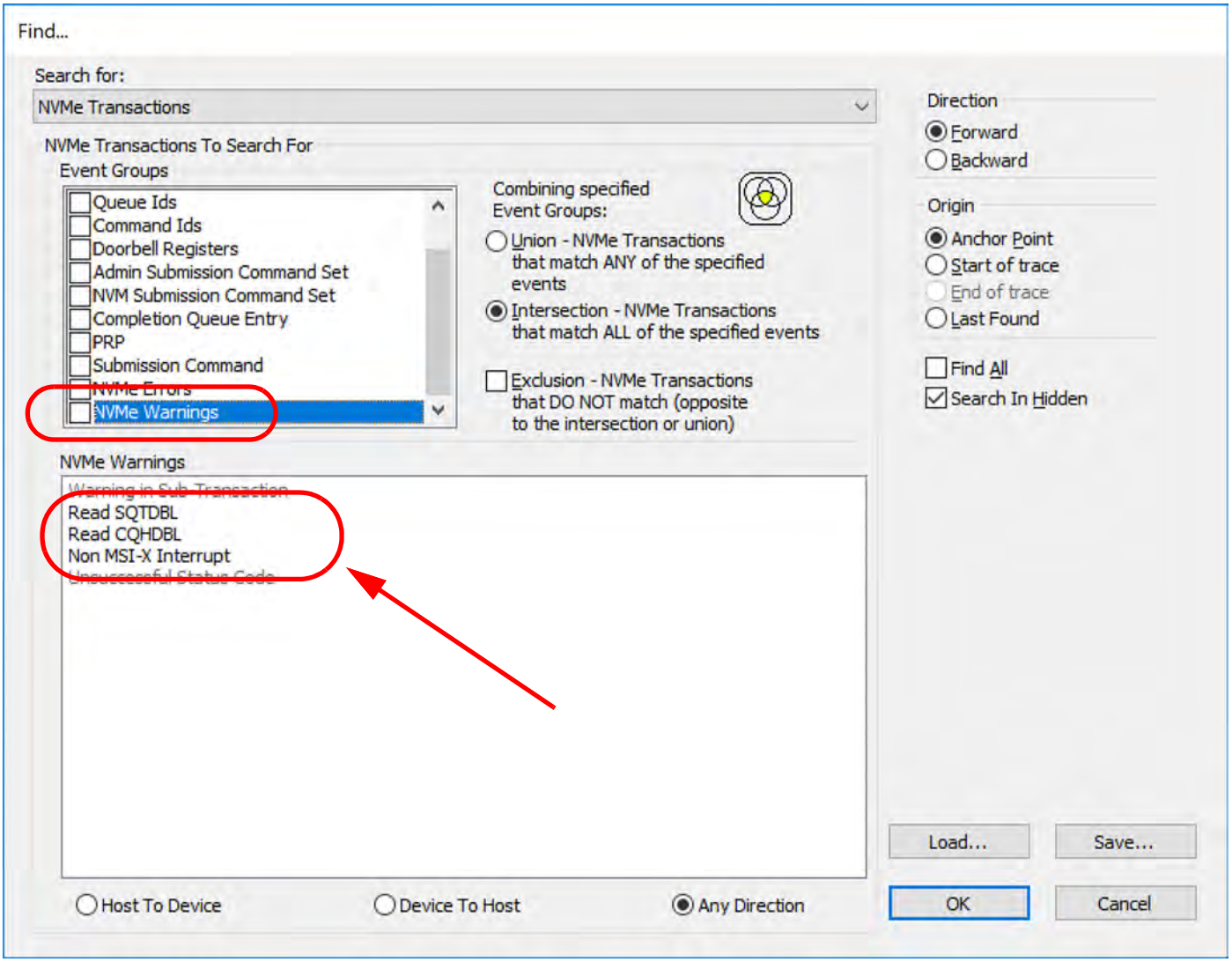


Figure 6.142: Find: NVMe Transactions -> Warning Messages

6.12.24.4 Hiding NVMe Warning Messages

You can also Hide  NVMe Warning Messages to remove them from the traffic. See Figure 6.143 on page 545.

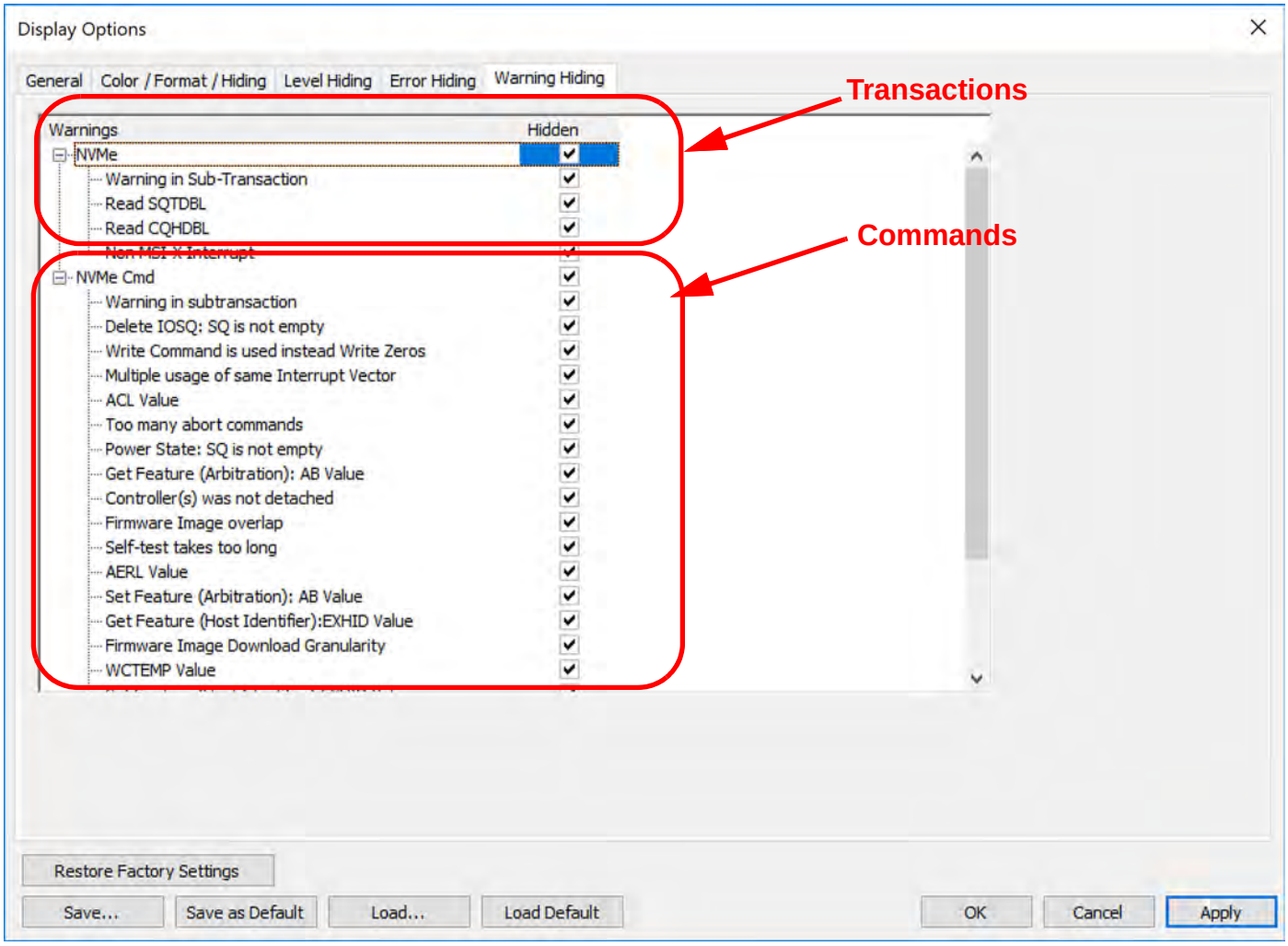


Figure 6.143: Hide -> NVMe Warning Messages

6.12.25 Warning Messages in Split Traces

The PCIe Protocol Analysis software can decode errors in Split transactions as shown in Figure 6.144.

You can see the following types of Errors:

- Completer Data Inconsistency
- Attributes Mismatch
- Error in sub-transaction

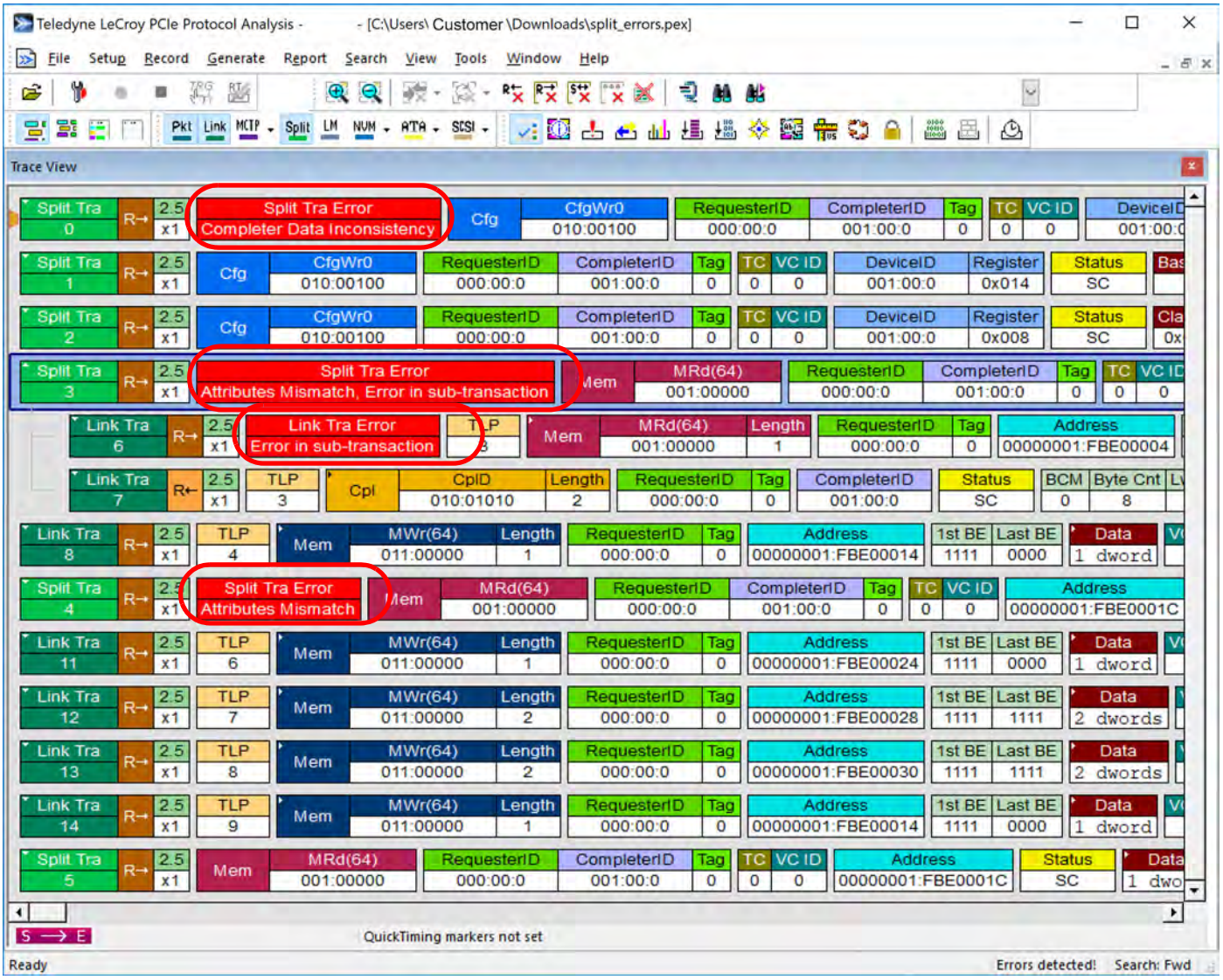


Figure 6.144: Warning Messages in Split Transactions

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 6.145 on page 547.

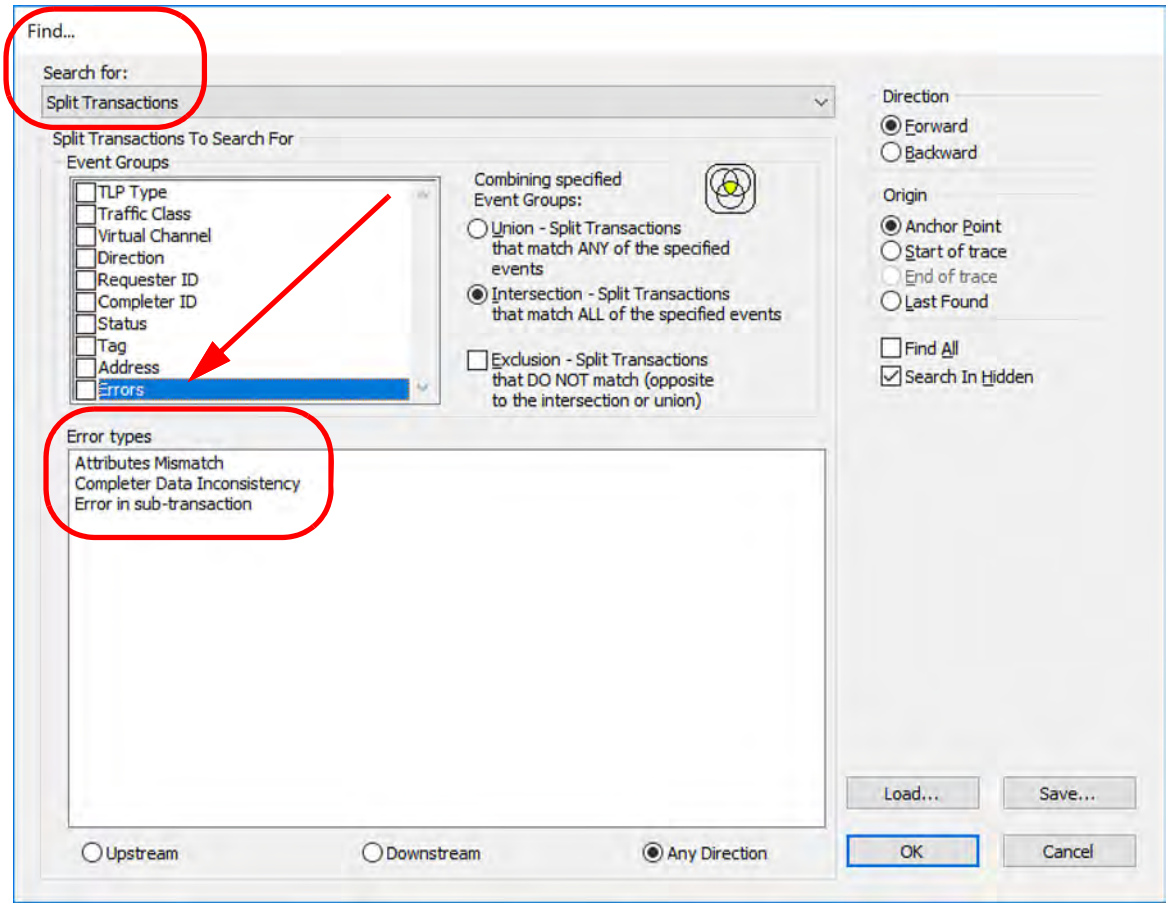


Figure 6.145: Search for Split Transaction Errors

6.12.26 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 6.146 as well as the Traffic Summary Report.

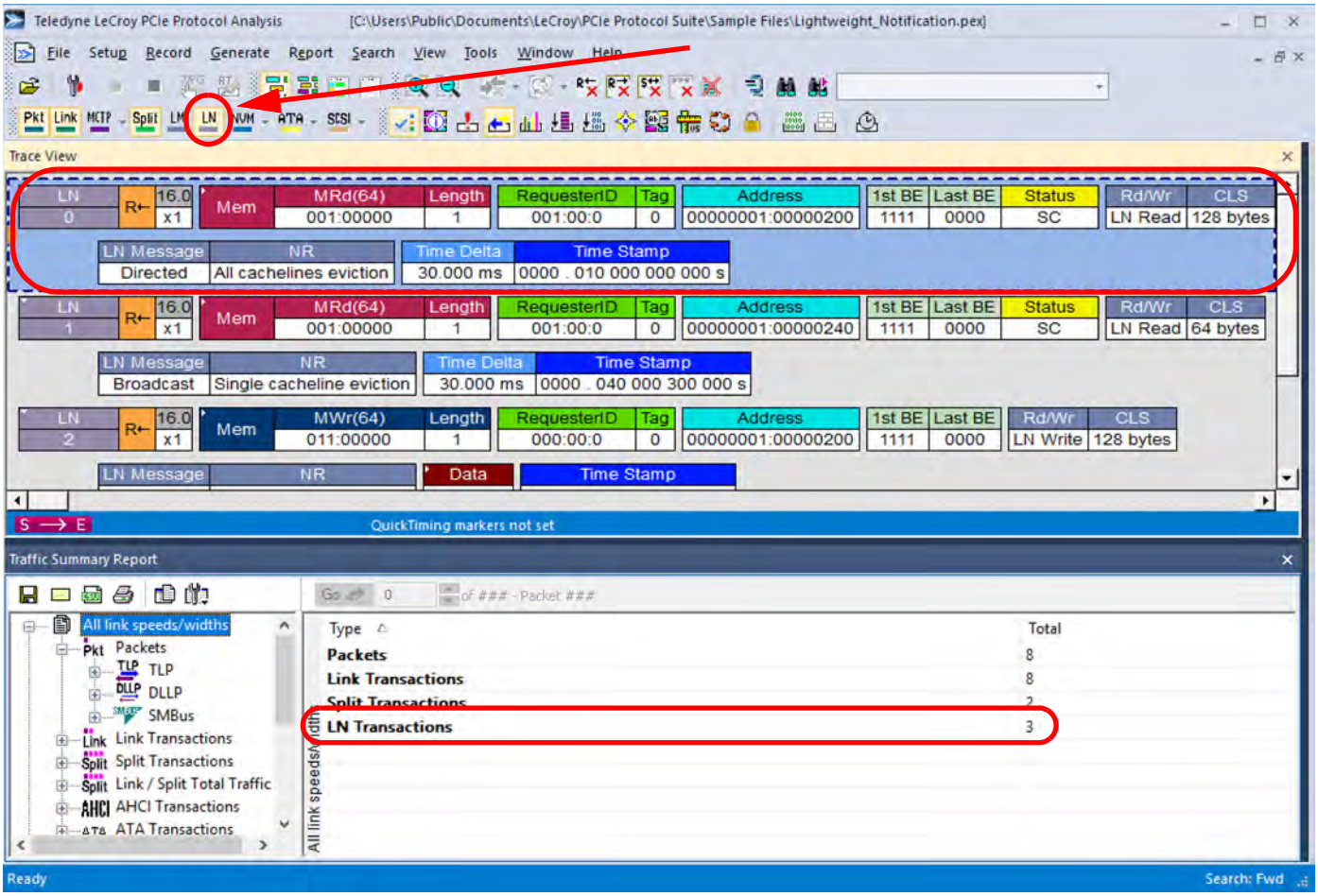


Figure 6.146: Decoding Lightweight Notification (LN) Protocol

6.12.26.1 Lightweight Notification Protocol Errors

The PCIe Protocol Analysis software also decodes any errors in the LN protocol. See Figure 6.147

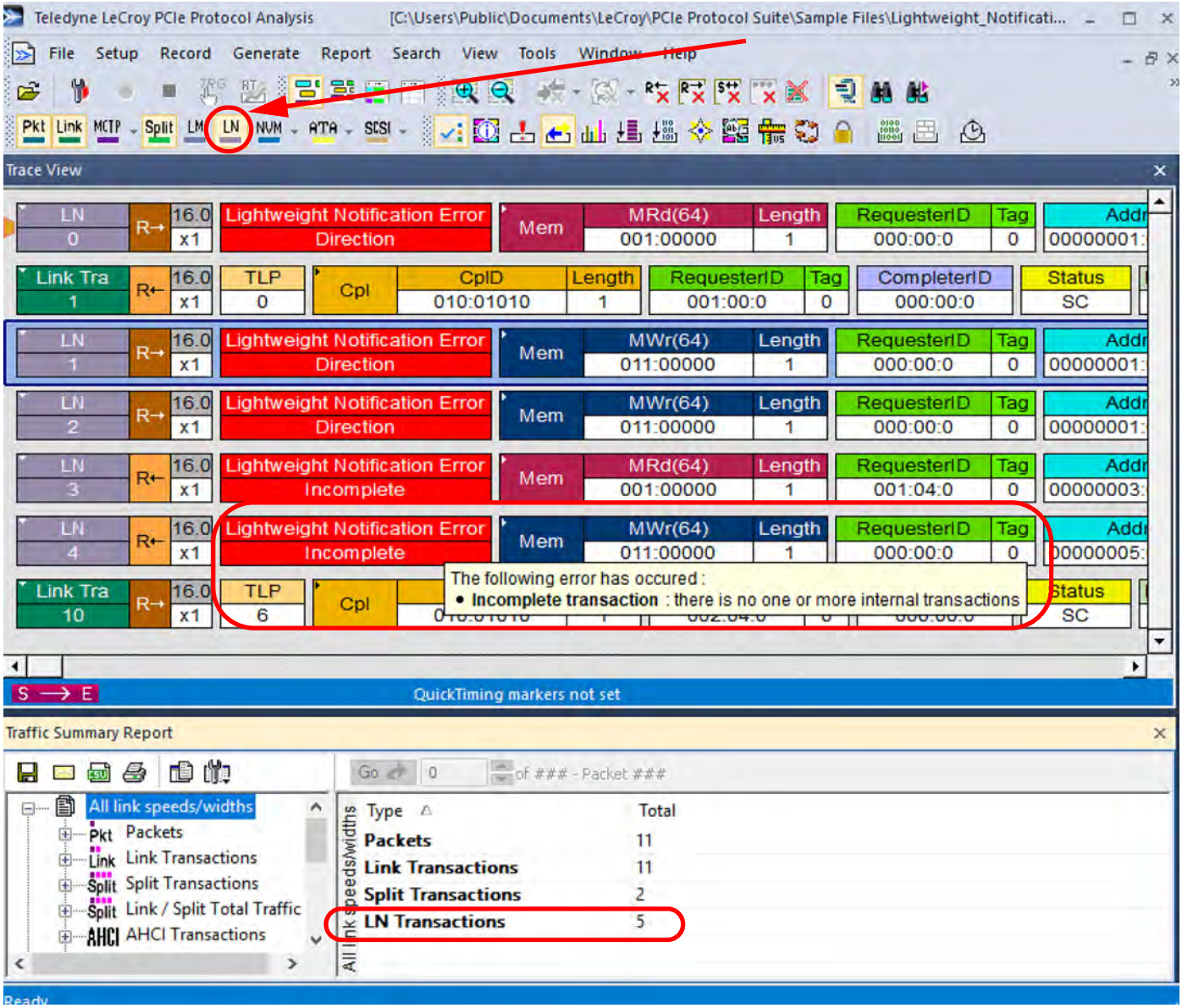


Figure 6.147: Decoding Errors in Lightweight Notification Protocol

6.12.26.2 Lightweight Notification Protocol in Trace Expert

The LN Protocol is also shown in the Trace Expert View (see Figure 6.148).

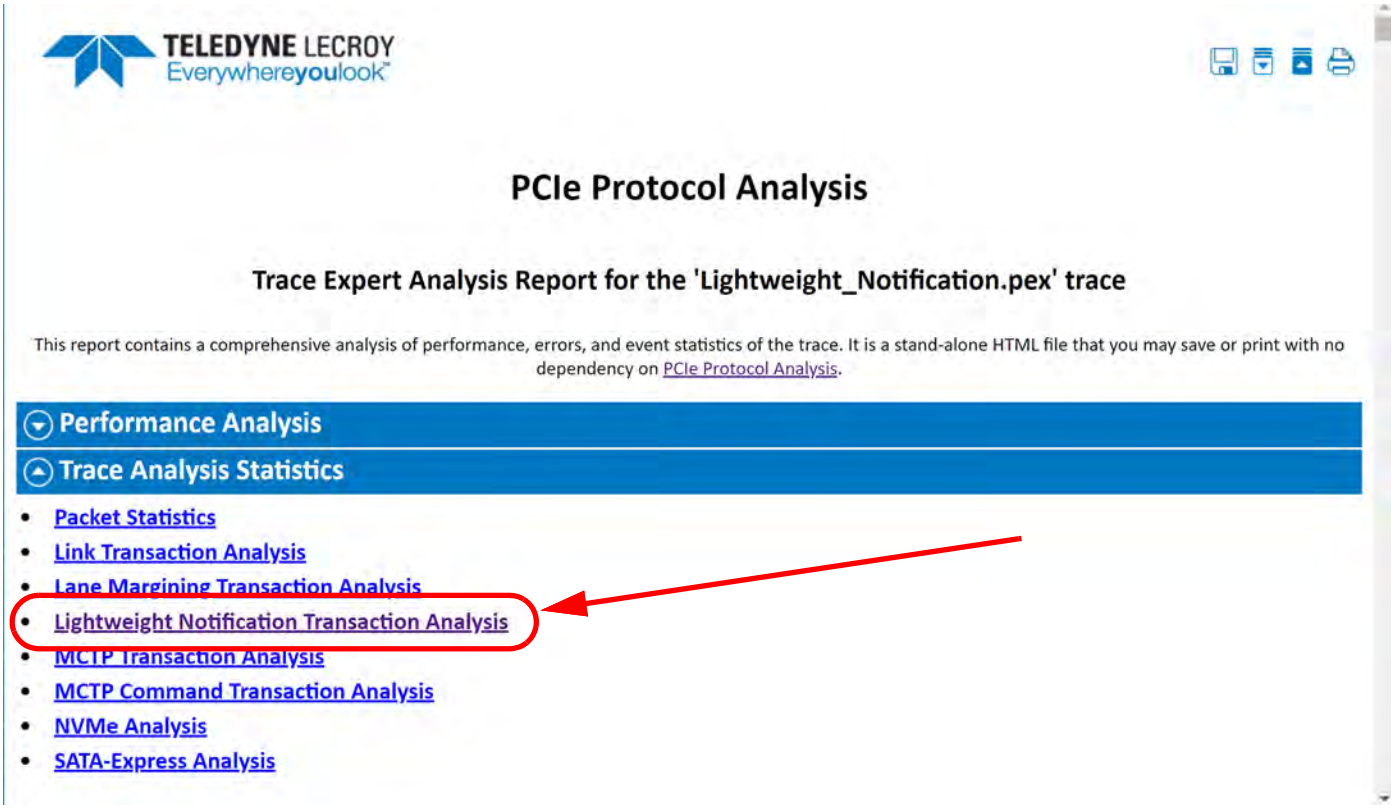
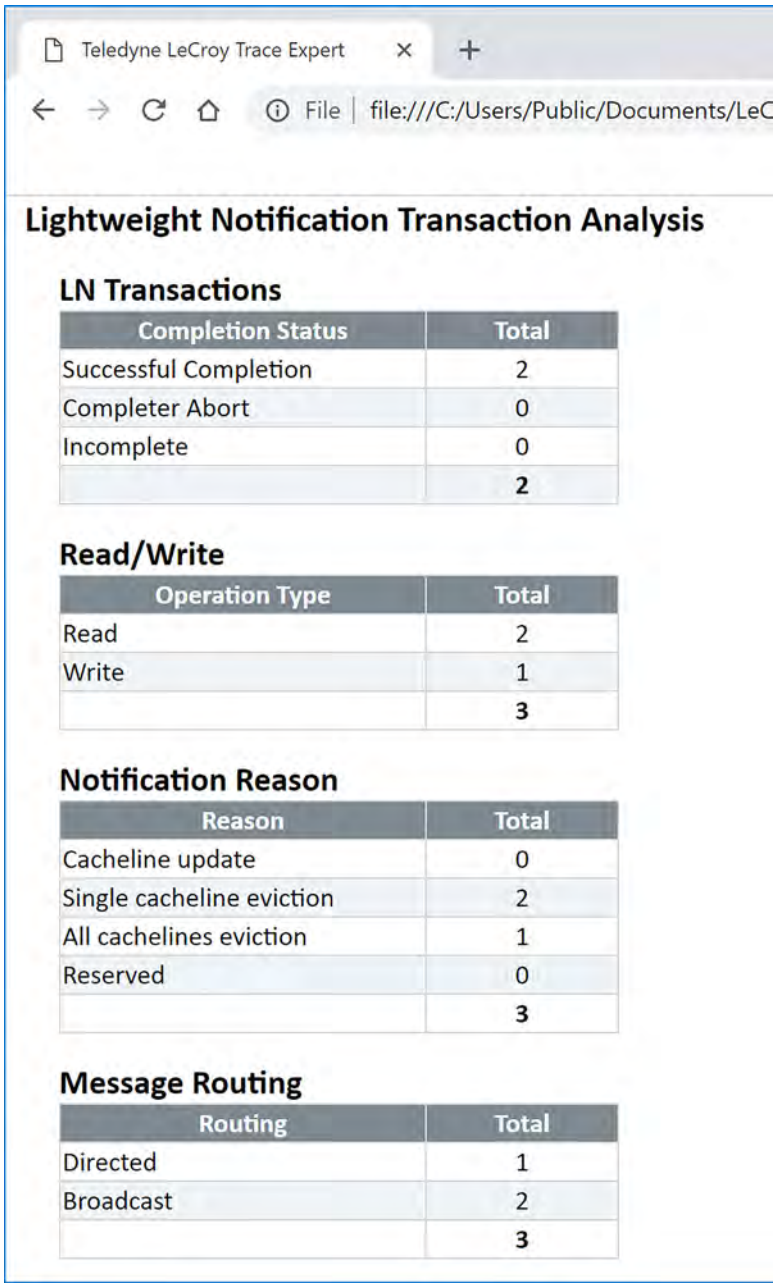


Figure 6.148: Lightweight Notification Transaction Analysis

The details of that LN Transaction Analysis can be seen in Figure 6.149 on page 551.



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 6.149: LN Transaction Analysis

6.12.26.3 Lightweight Notification Transaction Analysis Errors: Trace Expert

Lightweight Notification Transaction Analysis Errors can also be seen in Trace Expert. See Figure 6.150.

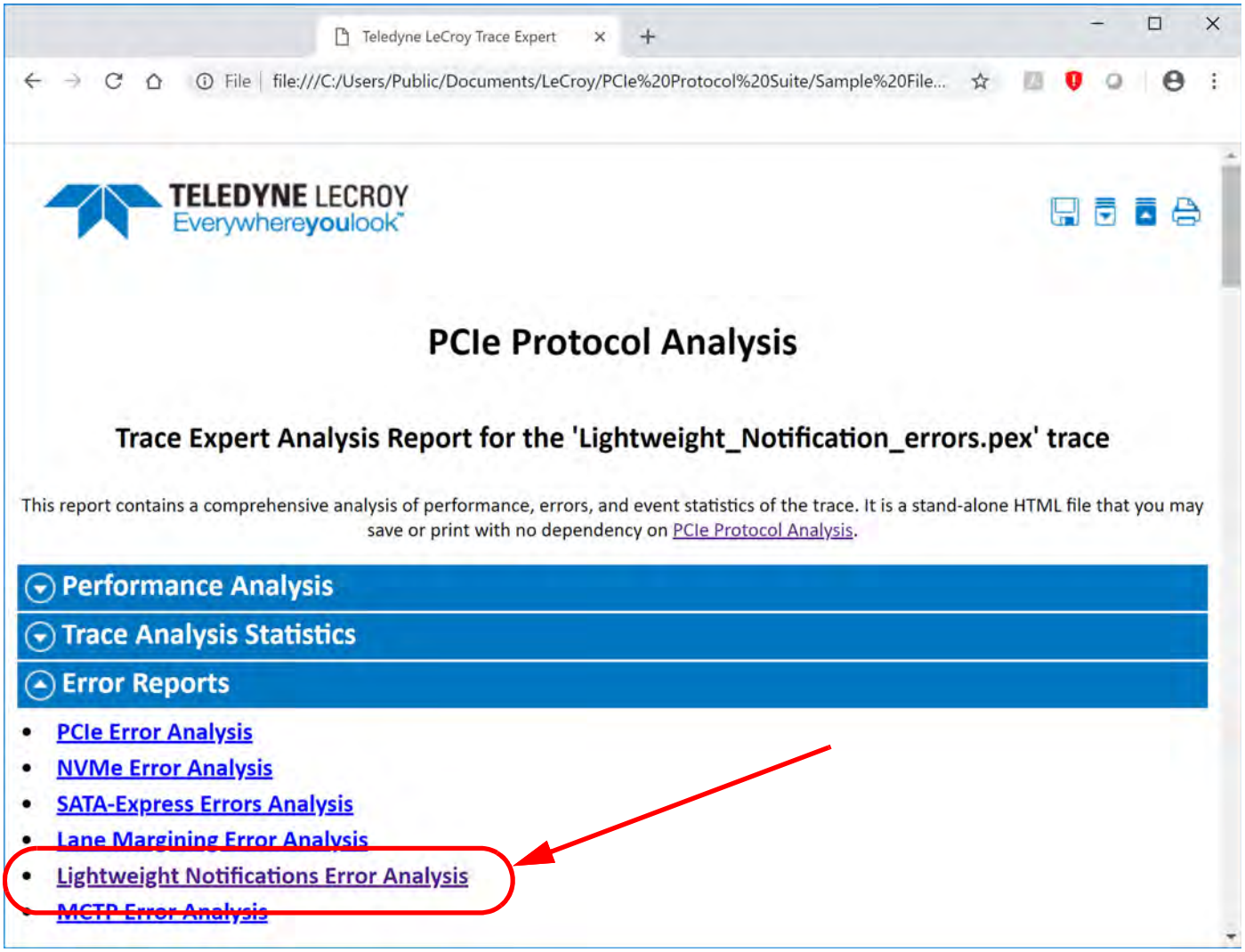


Figure 6.150: Trace Expert: Lightweight Notification Transaction Analysis Errors

Those errors can be seen in detail in Trace Expert (see Figure 6.151 on page 553).

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 6.151: Lightweight Notification Errors from Trace Expert

6.12.26.4 Find: Lightweight Notification Transactions

You can use the Find tool to locate Lightweight Notification transactions. See Figure 6.152.

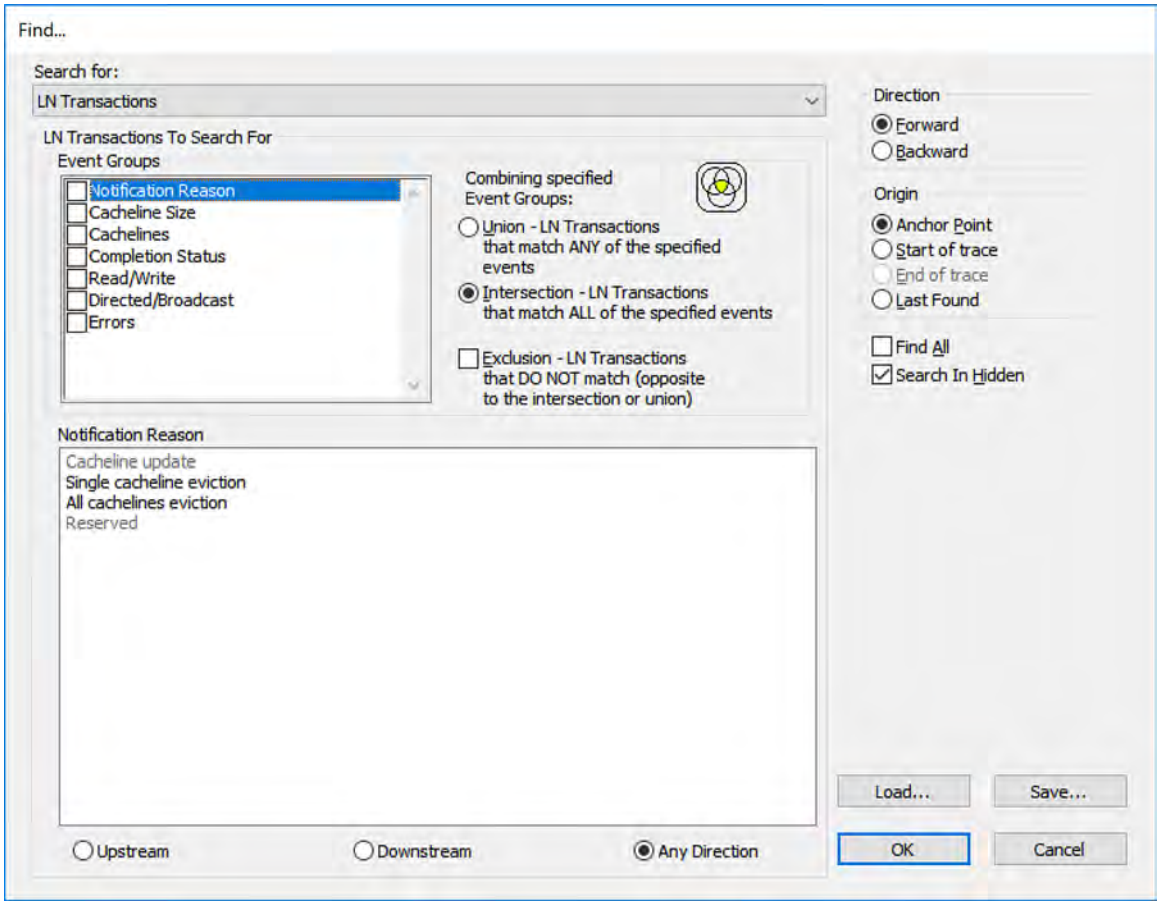


Figure 6.152: Lightweight Notification transactions

6.12.27 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.

6.12.28 Decoding TCG Support of Pyrite

The PCIe Protocol Analysis software is capable of decoding Trusted Computing Group (TCG) Pyrite transactions. See Figure 6.153.

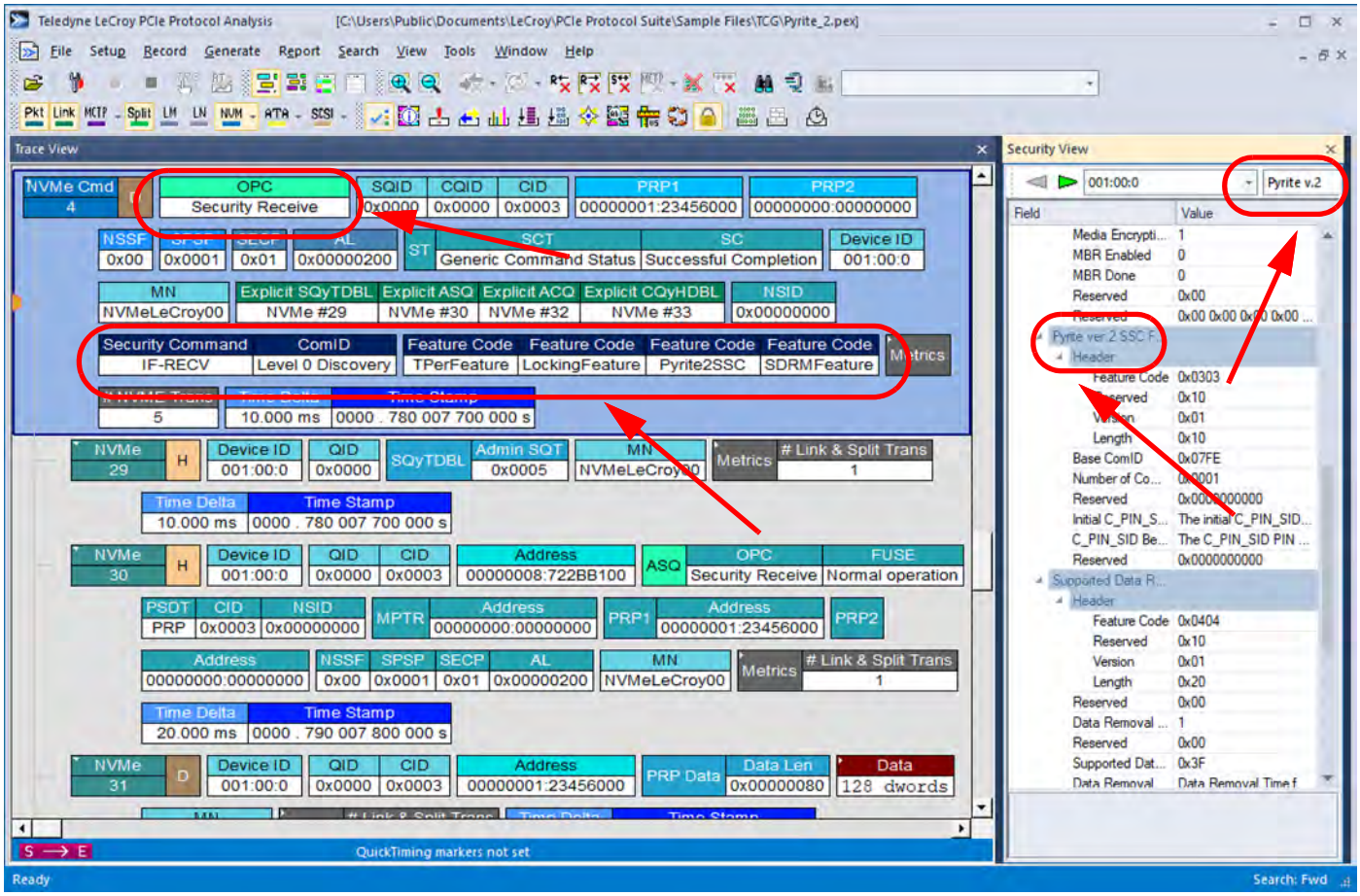


Figure 6.153: TCG Transactions: Decoded -> Pyrite

6.12.29 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 6.154.

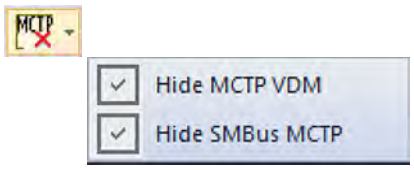


Figure 6.154: MCTP: Simple Hiding Icon

6.12.29.1 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 6.155) and with VDM traffic hidden (see Figure 6.156 on page 557).

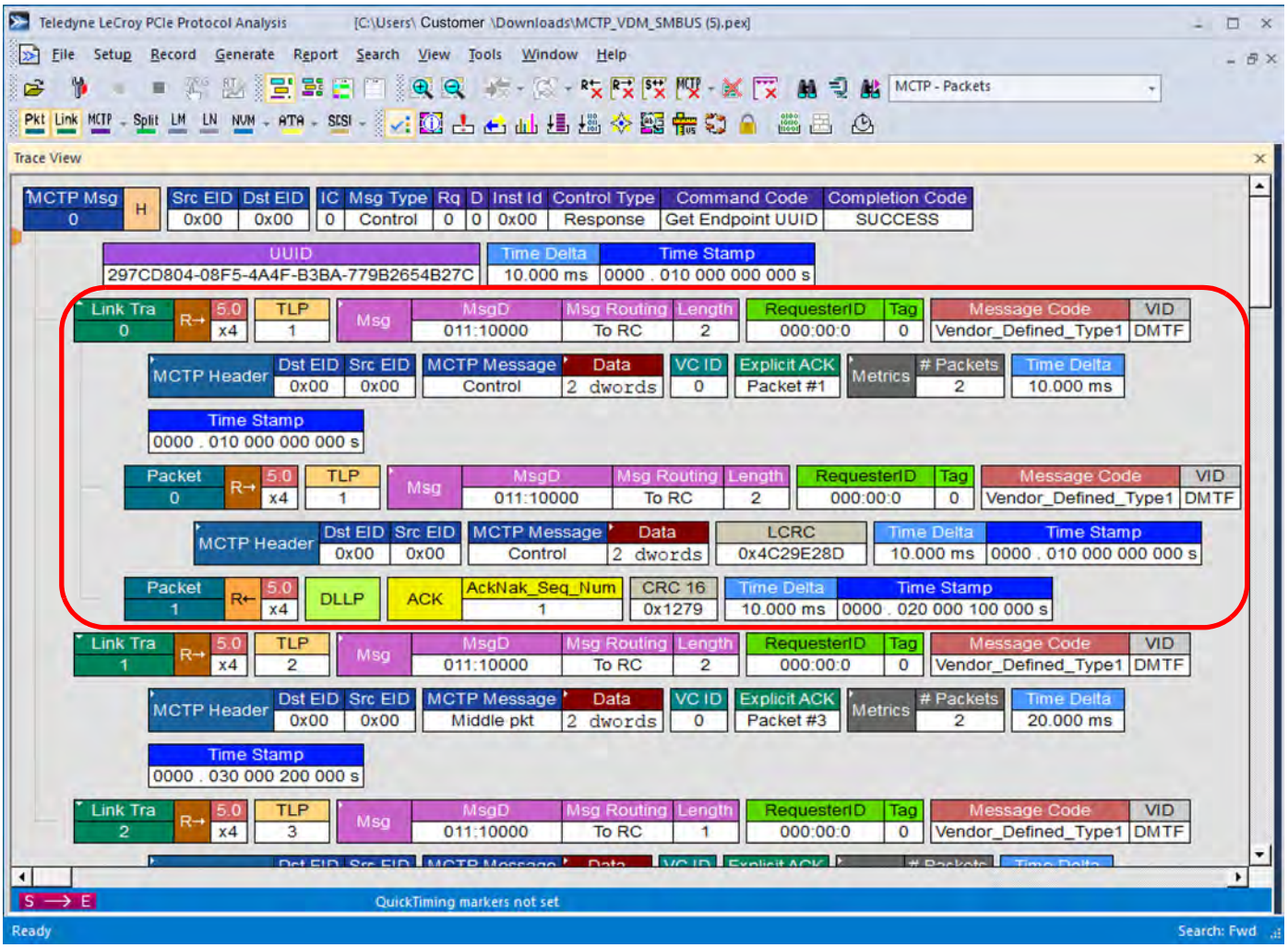


Figure 6.155: MCTP VDN Traffic: Link 0, Packet 0 -> Shown

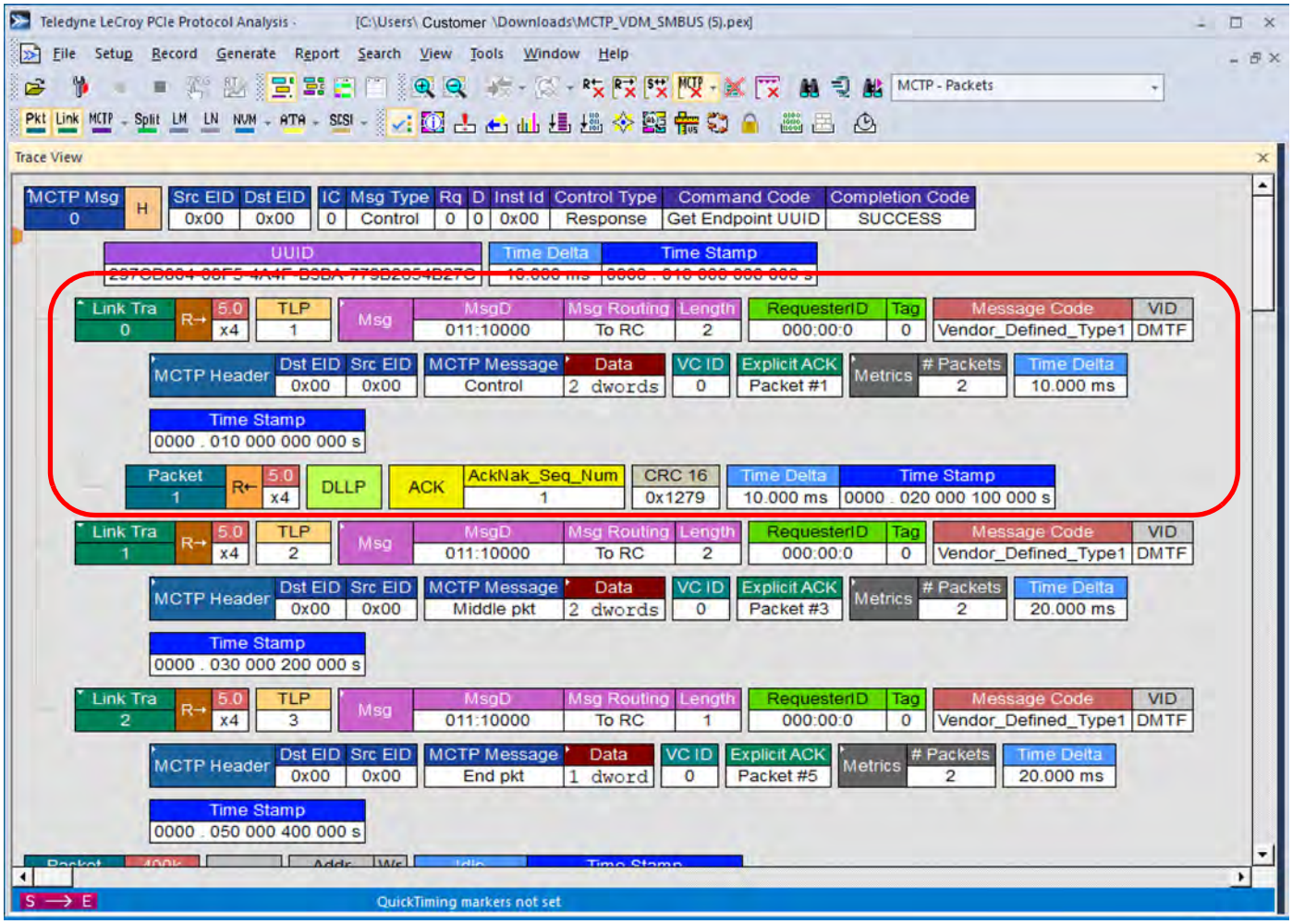


Figure 6.156: MCTP VDN Traffic: Link 0, Packet 0 -> Hidden

6.12.29.2 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 6.157) and with SMBus MCTP traffic hidden (see Figure 6.158 on page 559).

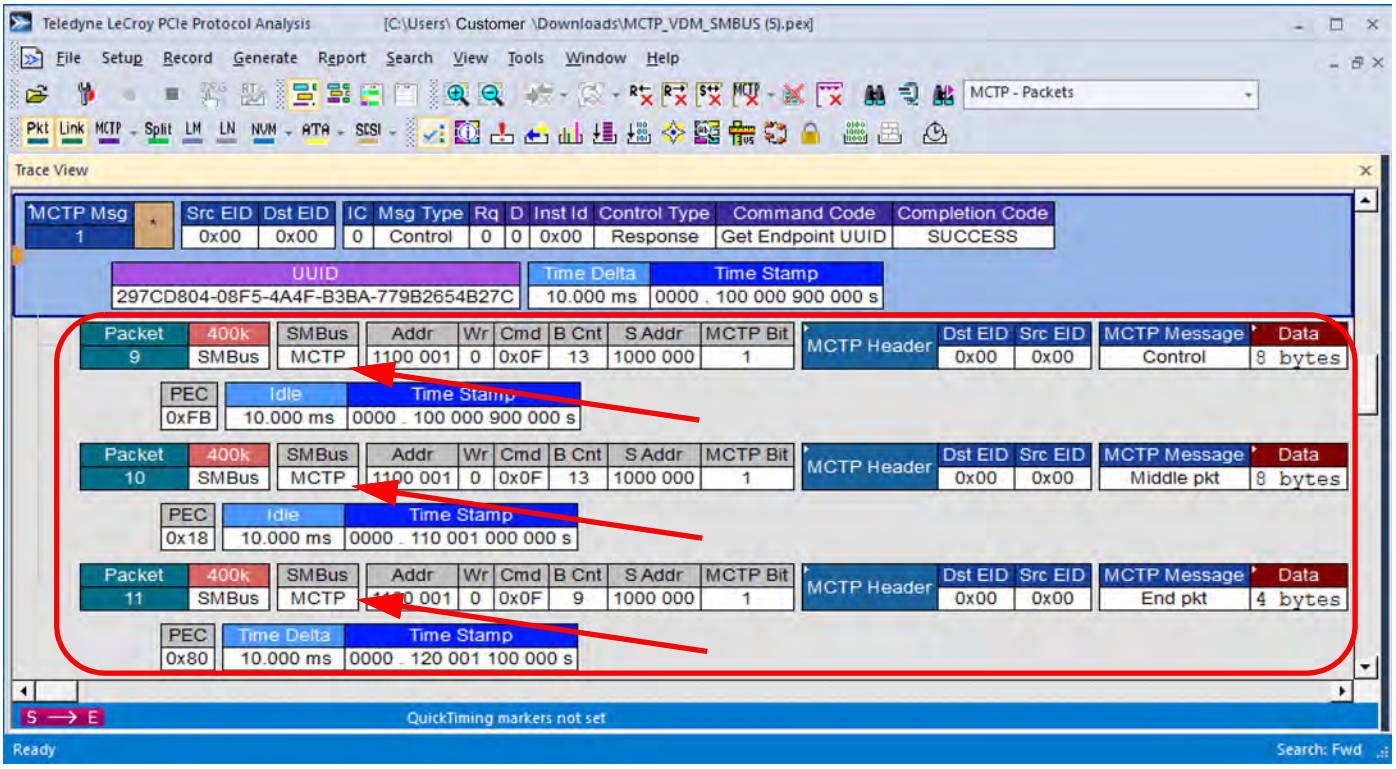


Figure 6.157: MCTP SMBus Traffic: Shown

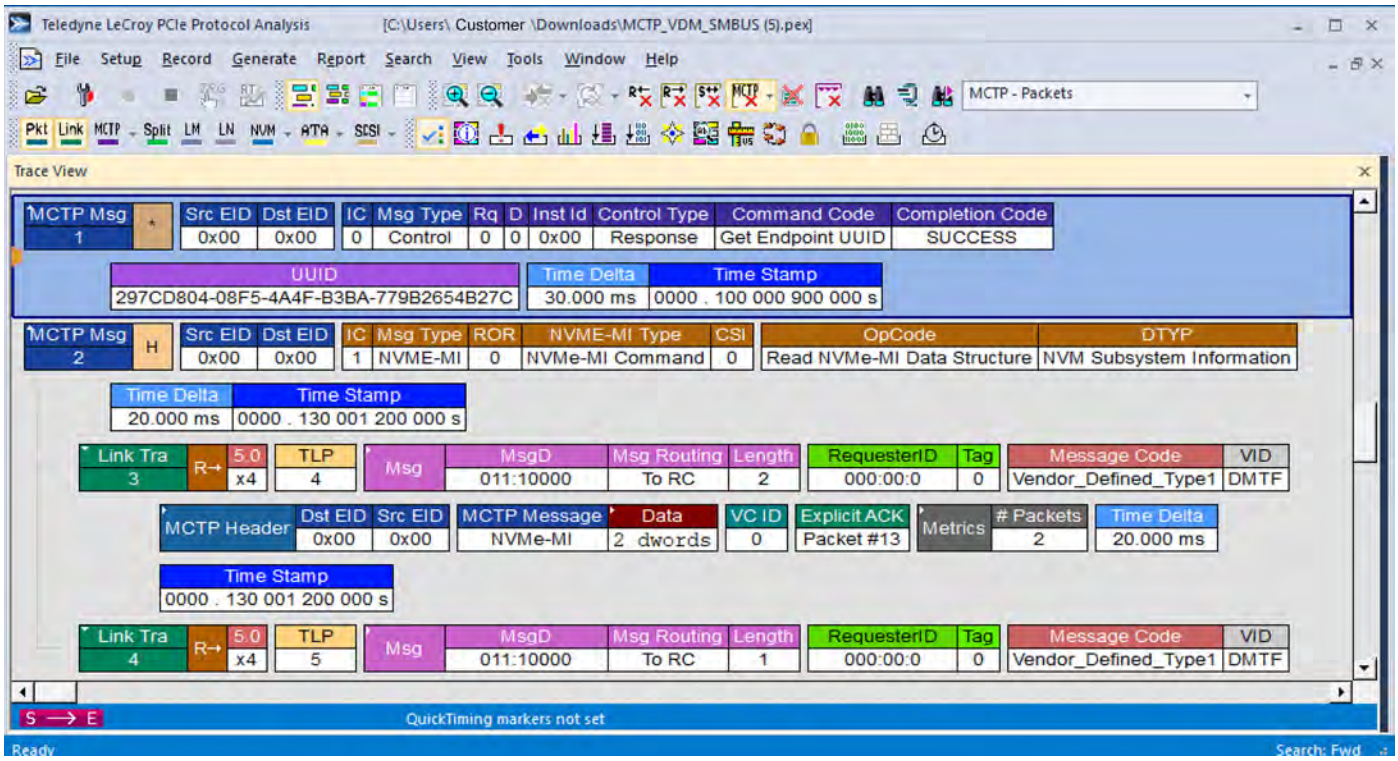


Figure 6.158: MCTP SMBus Traffic: Hidden

6.12.30 Decoding NVME-MI Version 1.1

The PCIe Protocol Analysis software can decode NVME-MI Version 1.1 traffic. See Figure 6.159.

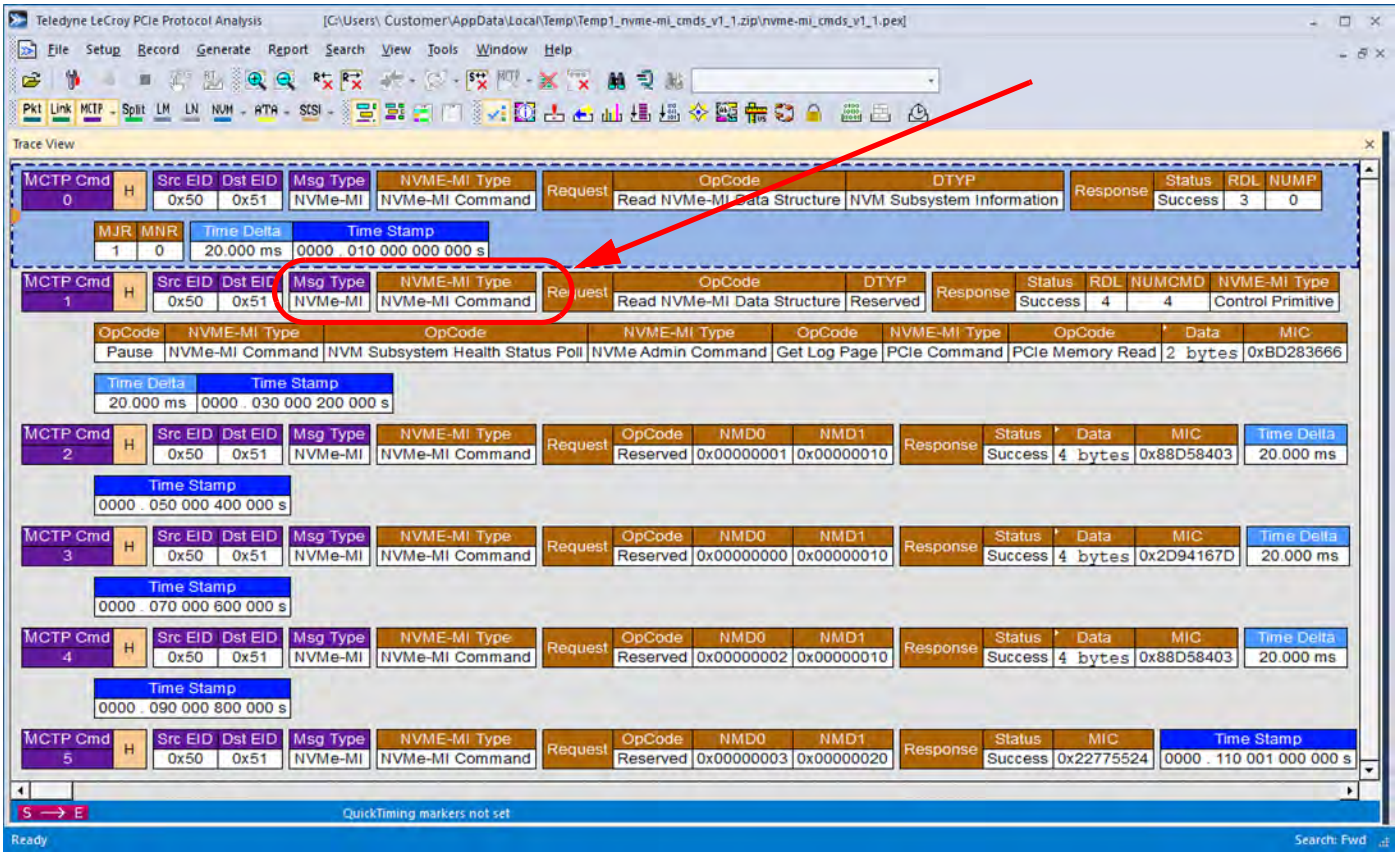


Figure 6.159: Decoding NVME-MI Version 1.1

6.12.31 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 6.160.

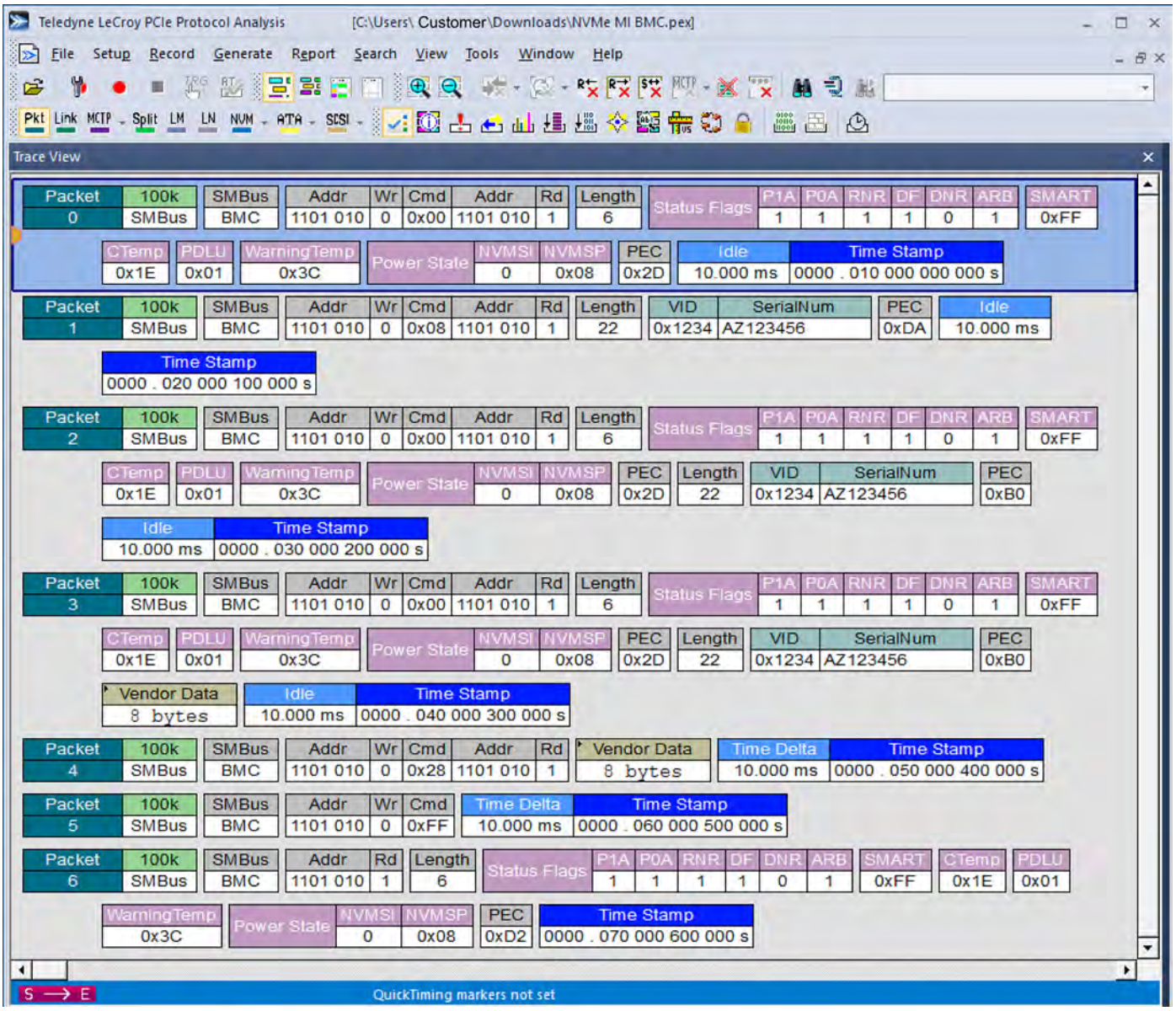


Figure 6.160: Decoding NVMe-MI BMC Traffic

6.12.31.1 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 6.161.

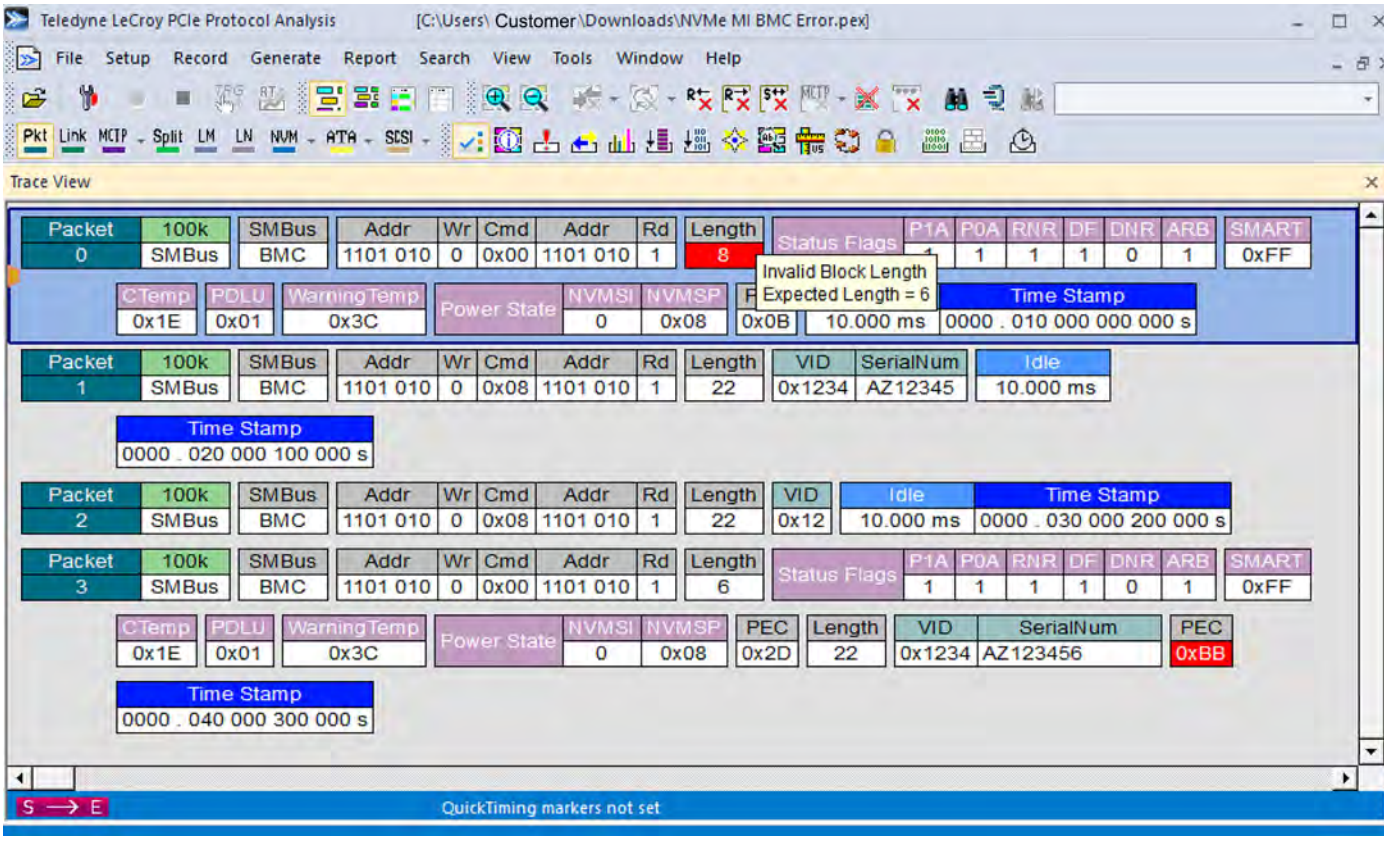


Figure 6.161: Decoding NVMe-MI BMC Errors

6.12.31.2 Errors Displayed in Traffic Summary

SMBus BMC errors also show up in the Traffic Summary View. See Figure 6.162.

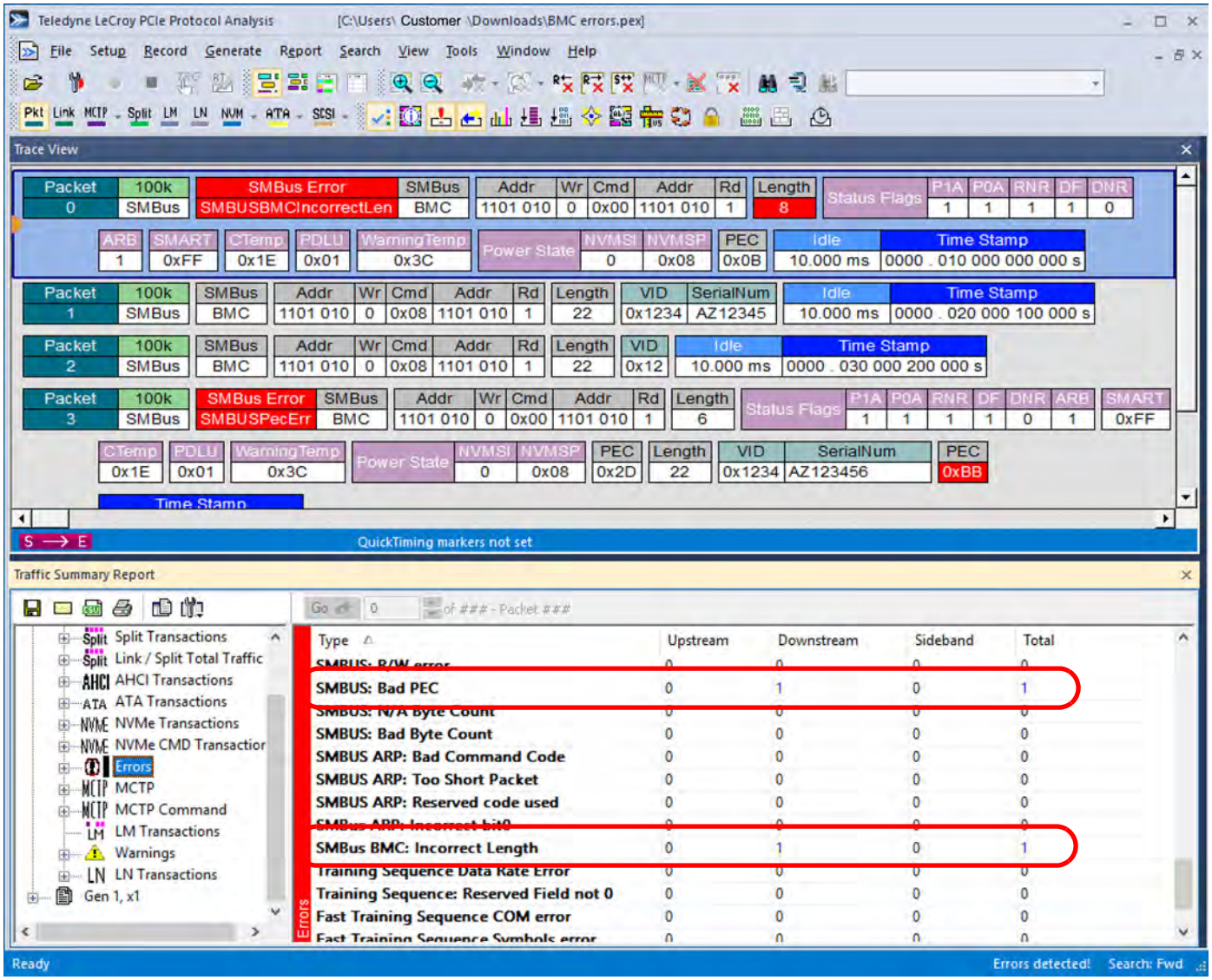


Figure 6.162: SMBus BMC Errors in Traffic Summary

6.12.31.3 Decoding BMC Commands with Any Offset

The PCIe Protocol Analysis can decode BMC Commands with any offset as shown below in Figure 6.163.

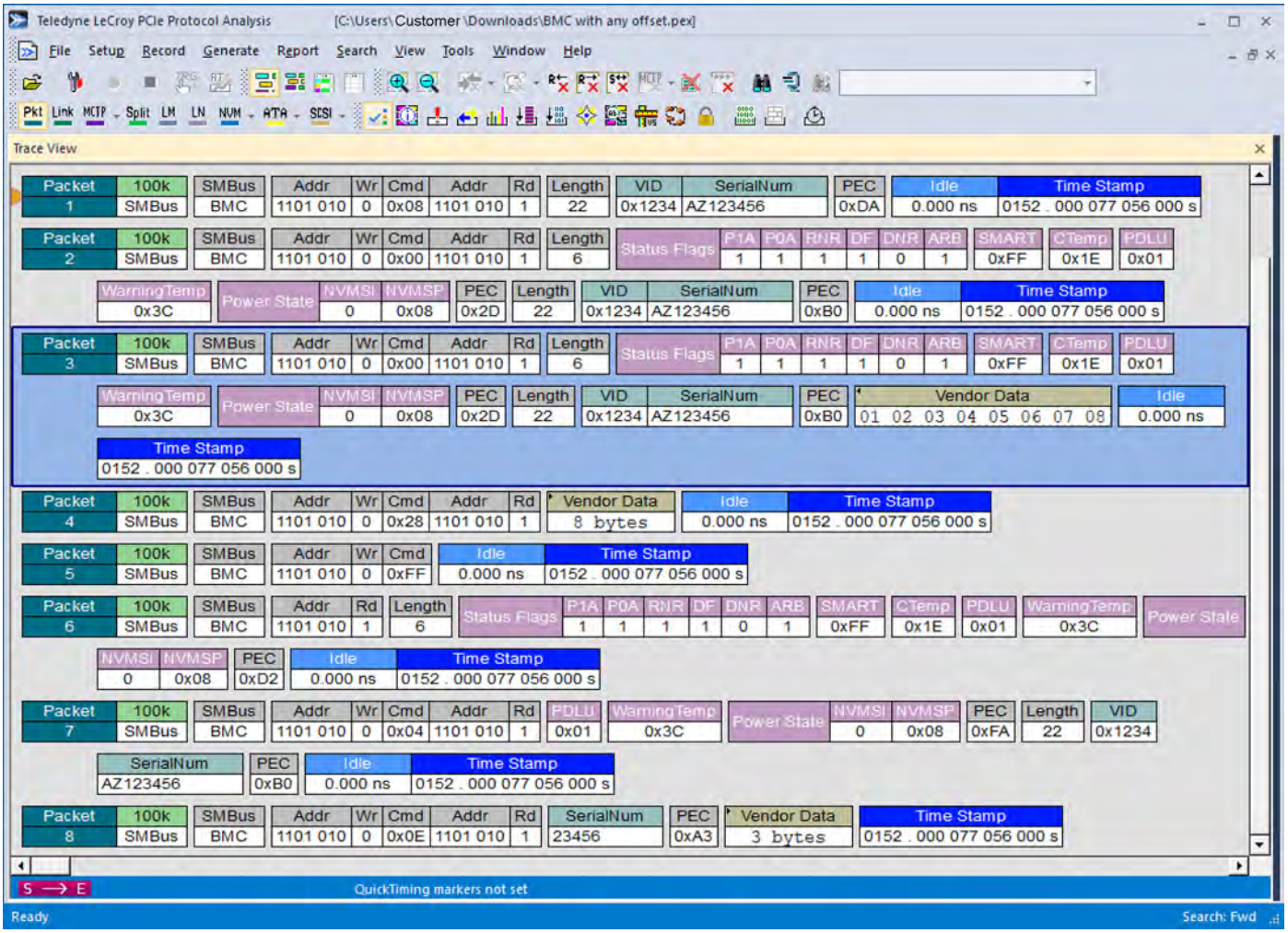


Figure 6.163: Decoding BMC Commands with Any Offset

6.12.31.4 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 6.164.

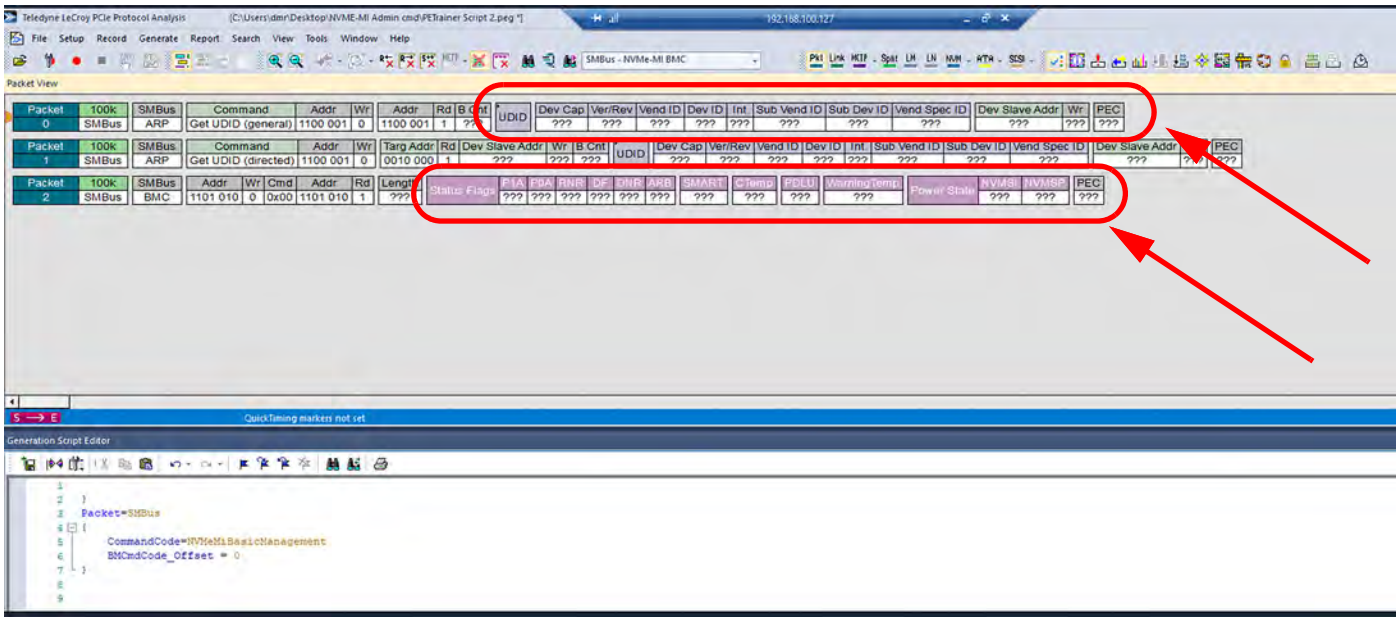


Figure 6.164: Reading BMC transactions from DUT

6.12.32 Link Up/Link Down Direction

Link Up and Link Down Events show the direction the traffic is traveling, either from the host or from the device. See Figure 6.165.

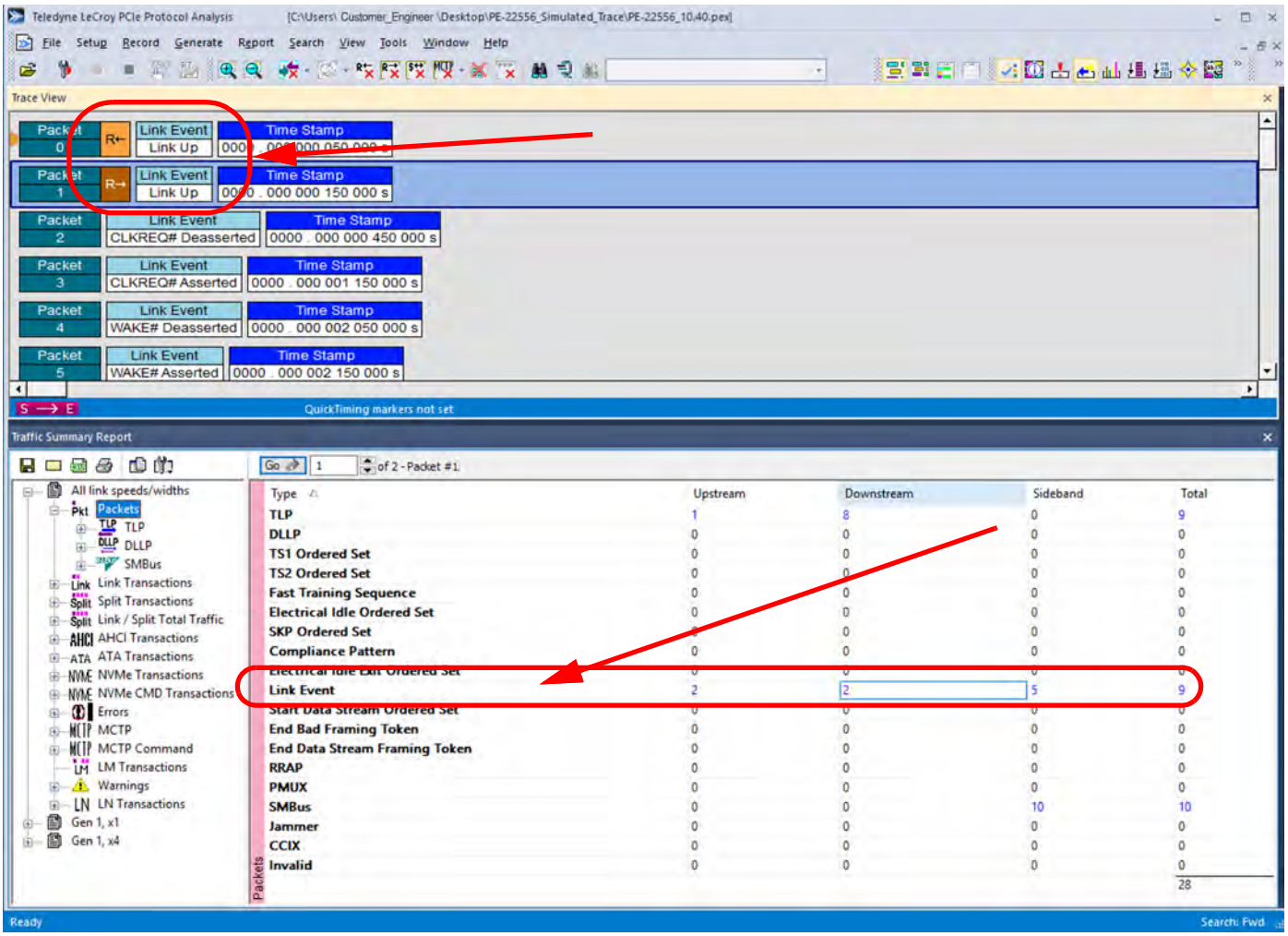


Figure 6.165: Link Up and Link Down Event Show Direction of Traffic

6.12.33 Swapping Direction of Recorded Traffic Data

Swapping Upstream/Downstream direction of traffic gives you the ability (in a recorded trace) to reverse the direction of the traffic which was recorded. See Figure 6.166.

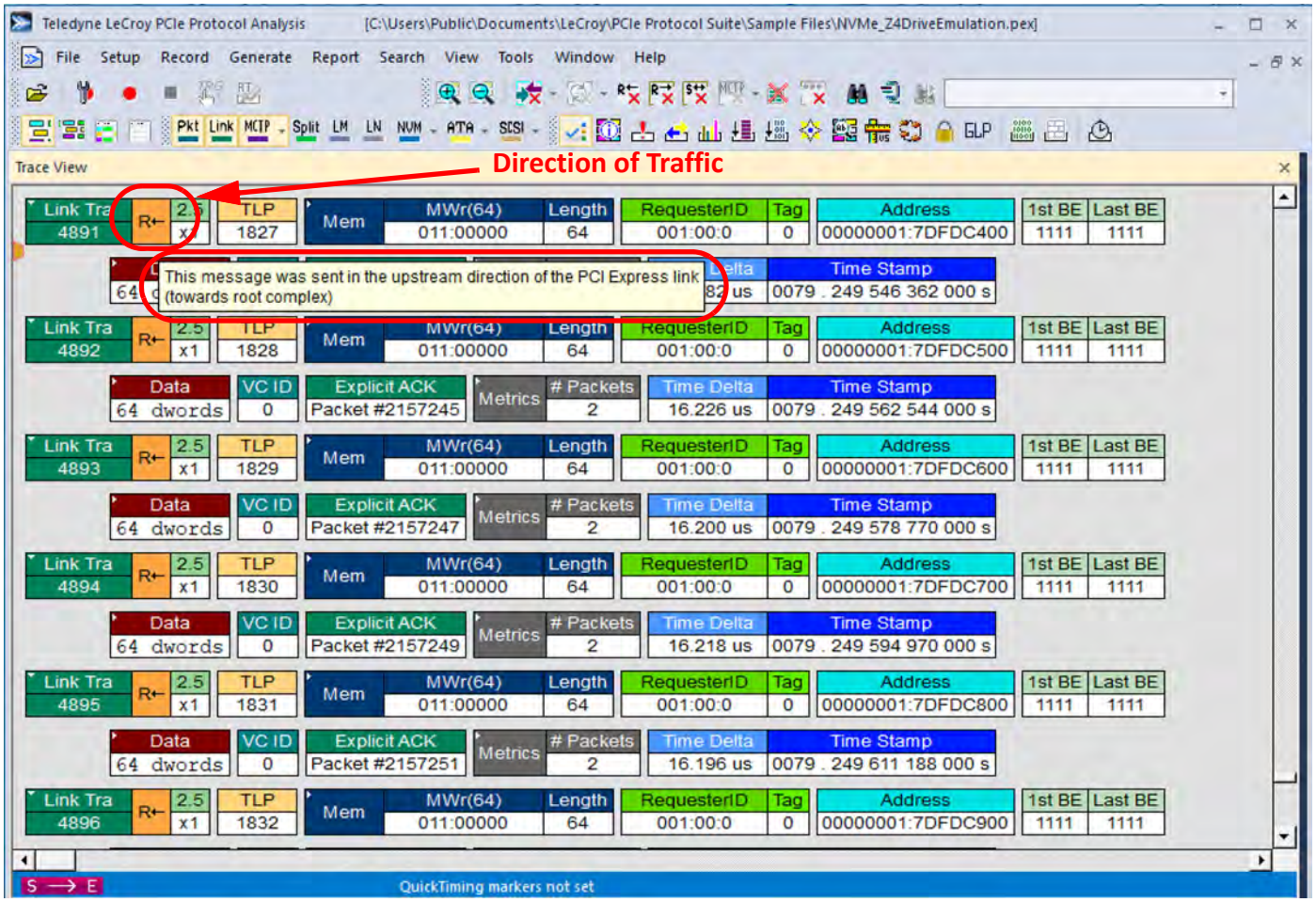


Figure 6.166: Recorded Trace: Traffic Flows in Direction it was Recorded

If you hover over the direction box (just to the right of the Link Transaction number) and perform a right click a context menu will pop up. See Figure 6.167 on page 568.

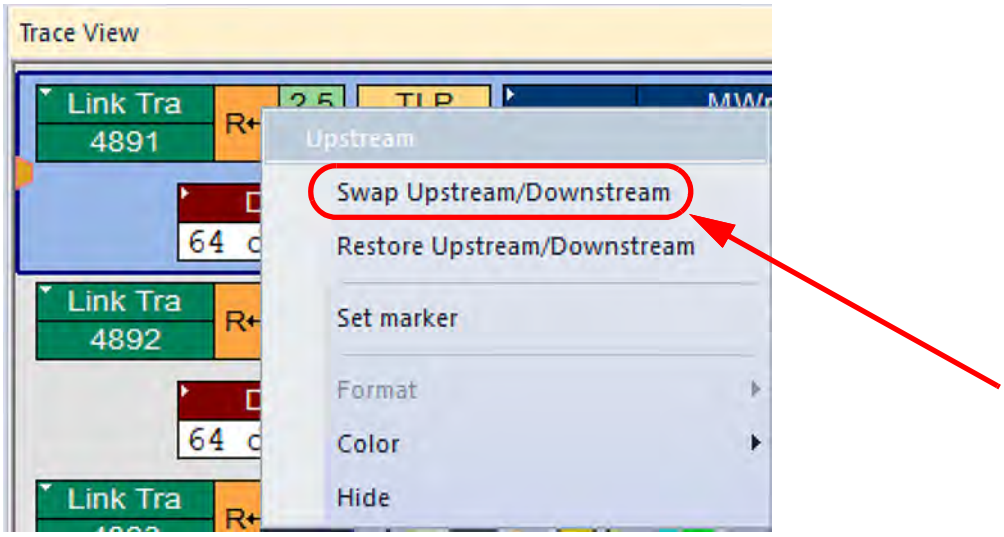


Figure 6.167: Context Menu Showing Traffic Direction

If you select Swap Upstream/Downstream the direction of the traffic will change and the tooltip will reflect that change. The color of the direction block will also change. See Figure 6.168 on page 569.

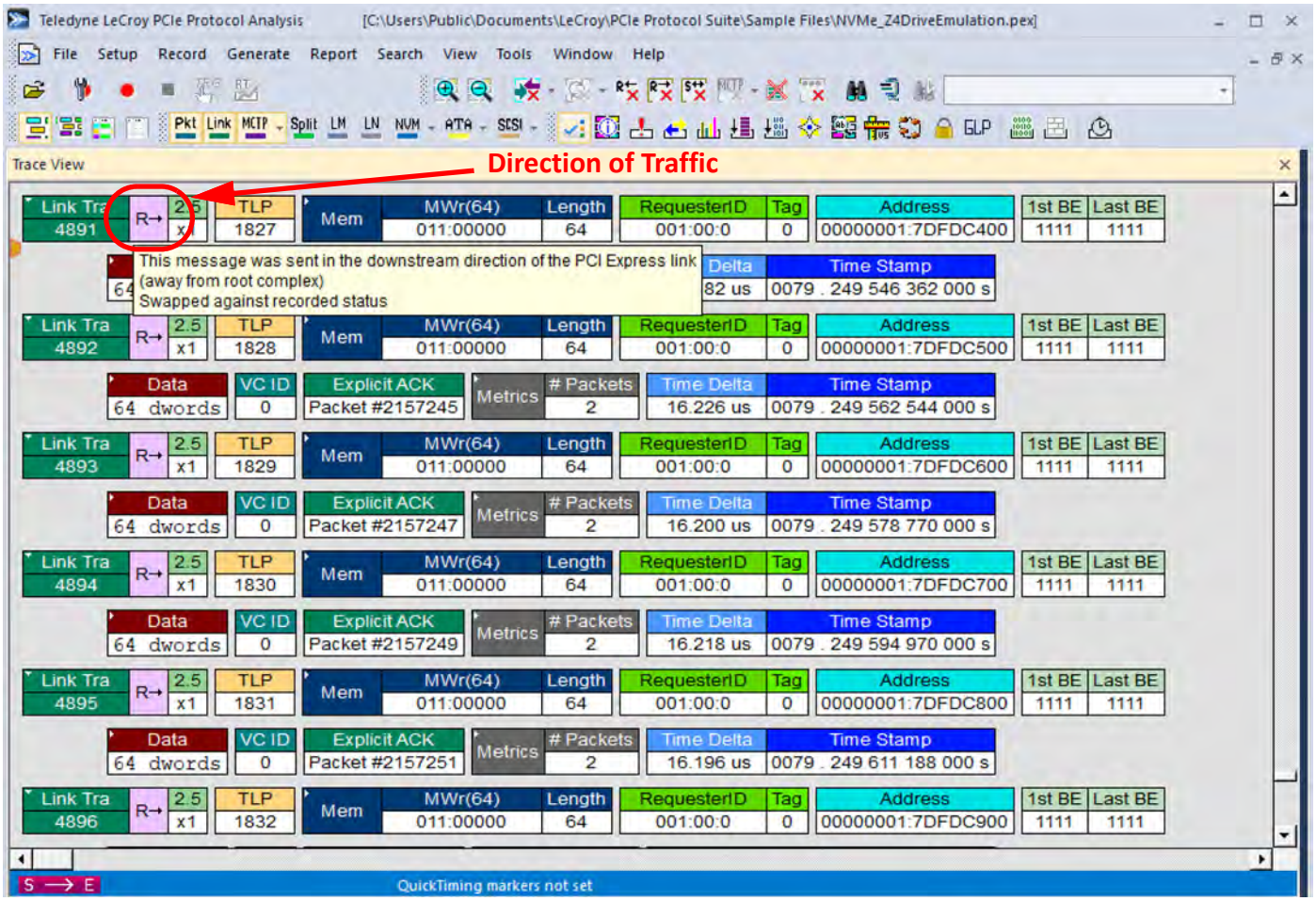


Figure 6.168: Direction of Traffic has been Swapped

If you want to swap the traffic direction back to the way it was originally recorded simply bring up the context menu (left click in the direction block) and select “Restore Upstream/ Downstream”. See Figure 6.169.

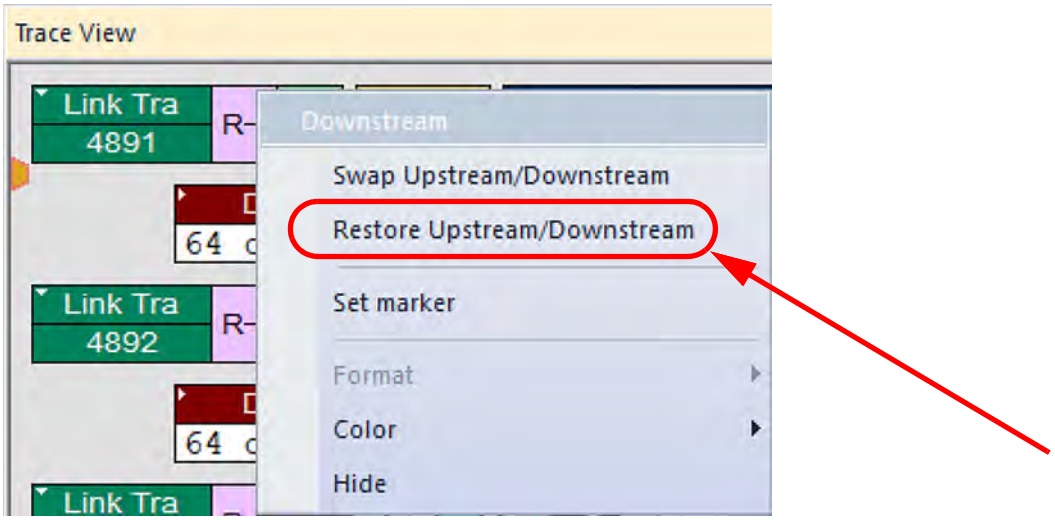


Figure 6.169: Context Menu Showing Traffic Direction: Downstream with Restore Option

6.12.34 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 6.170. 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.

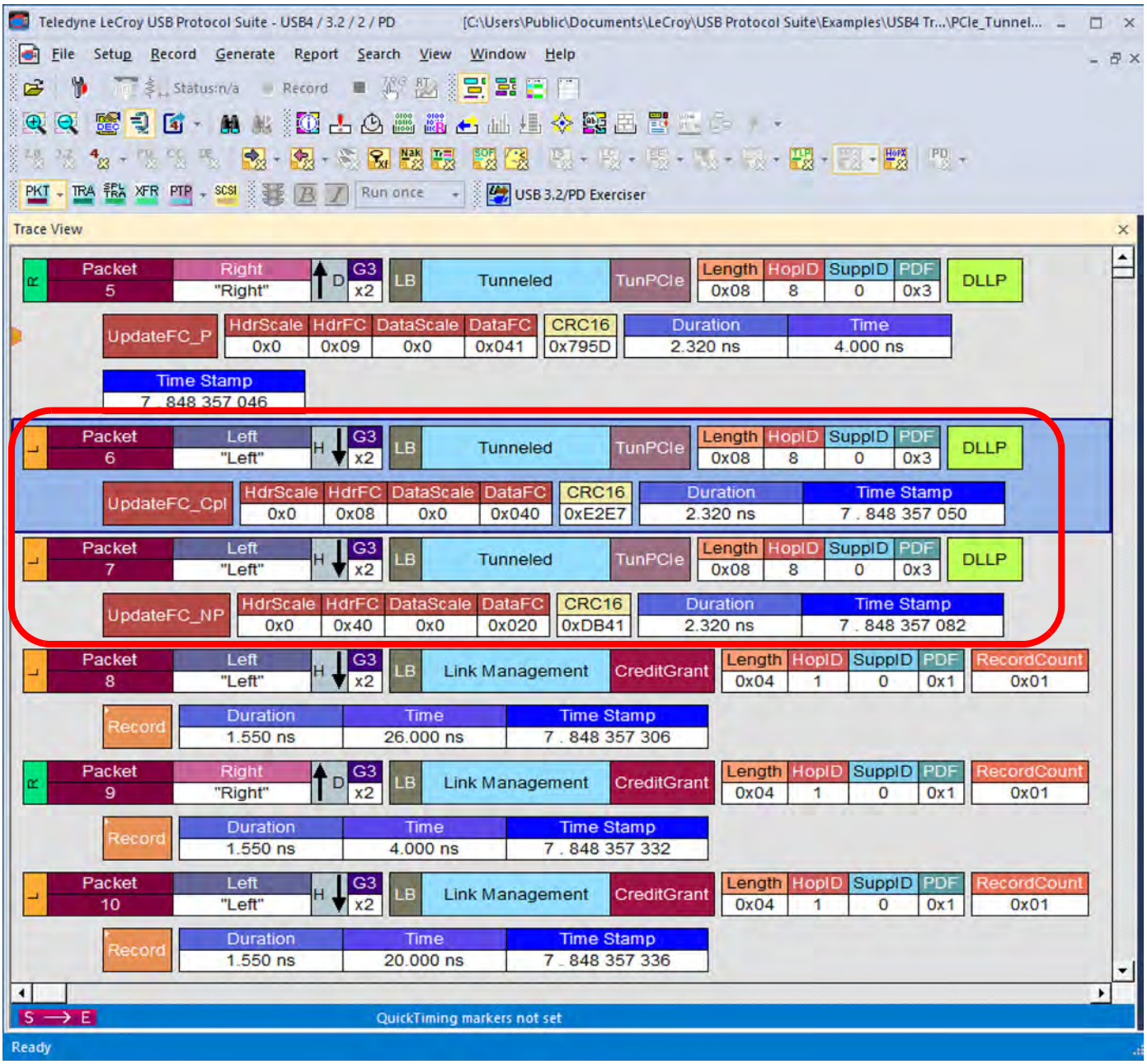


Figure 6.170: USB4 Trace with PCIe Tunneled Traffic

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 6.171 on page 571.

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.

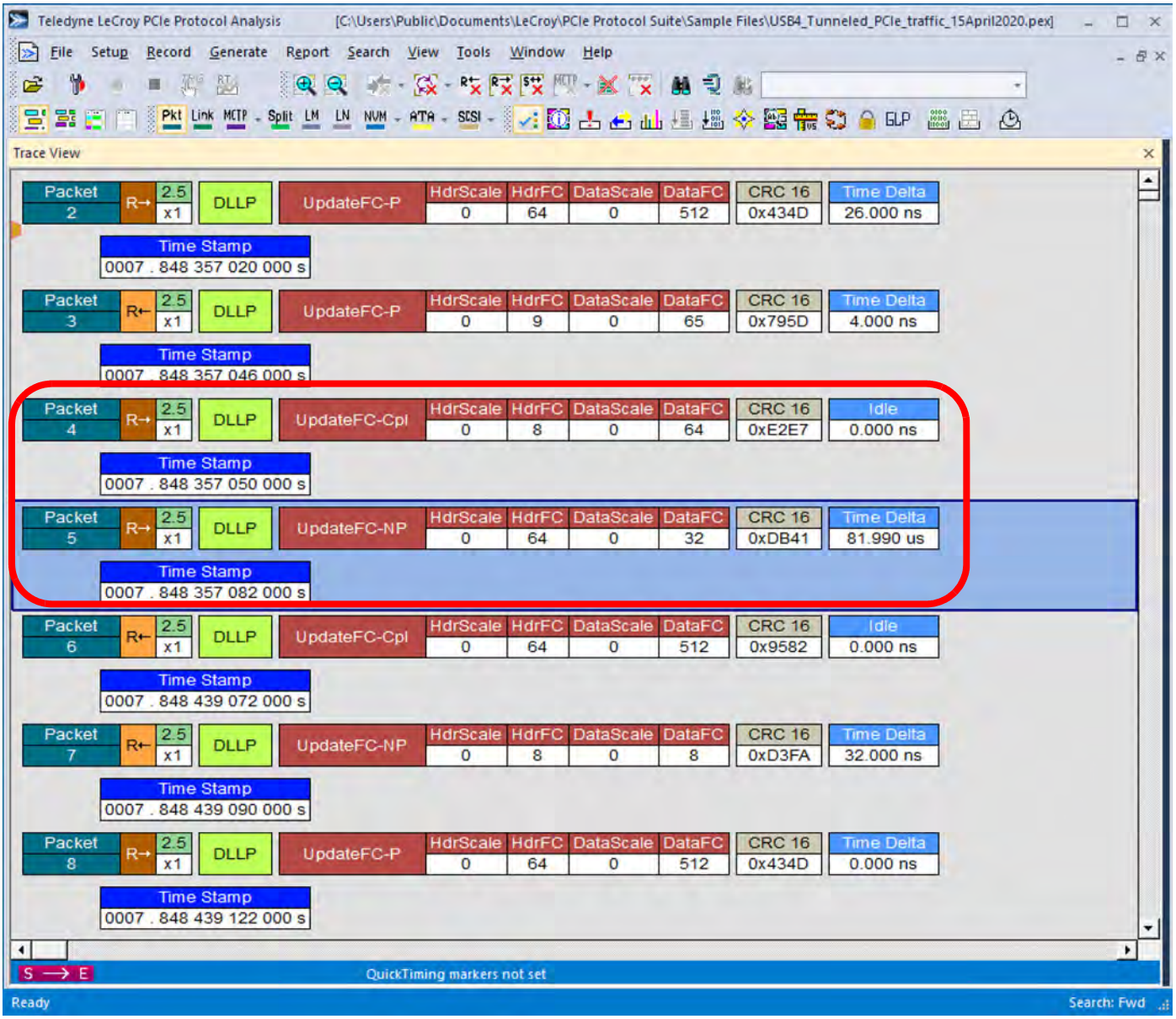


Figure 6.171: PCIe Tunneled Traffic from USB4 Trace Decoded and Analyzed by the PCIe Protocol Analysis software

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.

Chapter 7

Searching CATC Traces

This chapter describes how to search for CATC Trace events.

7.1 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. See Figure 7.1 on page 574.

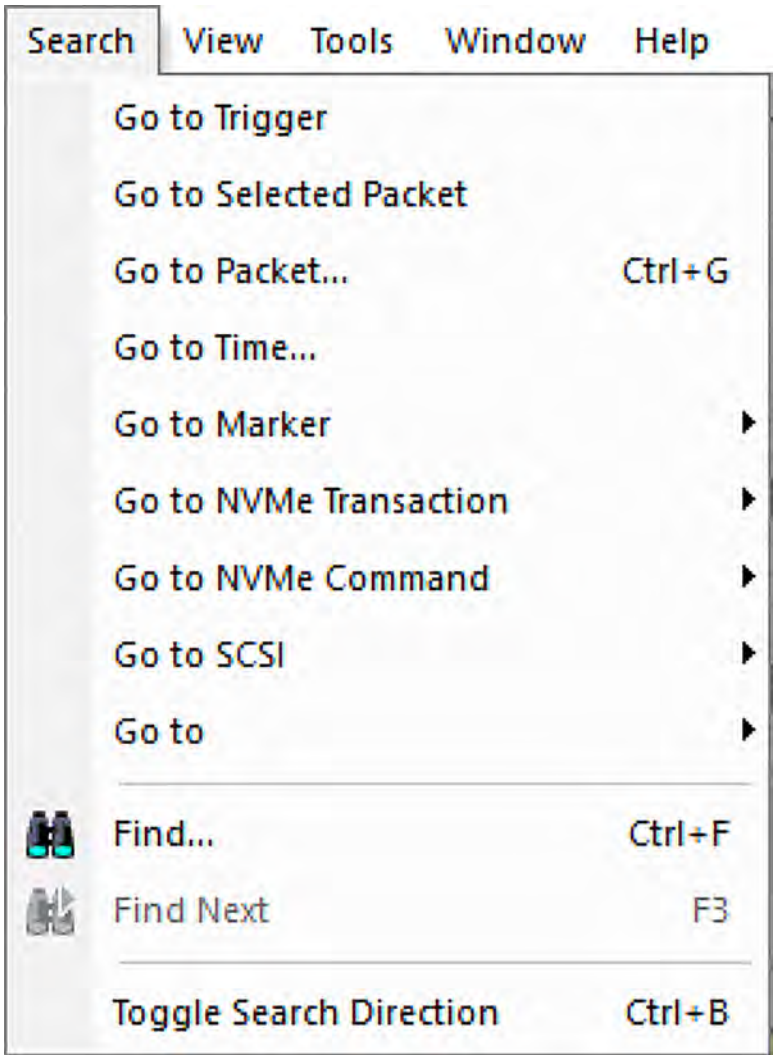


Figure 7.1: Search Menu Options

7.2 Go to Trigger

To position a trigger packet at the top of the screen:

Select **Search > Go to Trigger**.

7.3 Go to Selected Packet

To position a selected packet at the top of the screen:

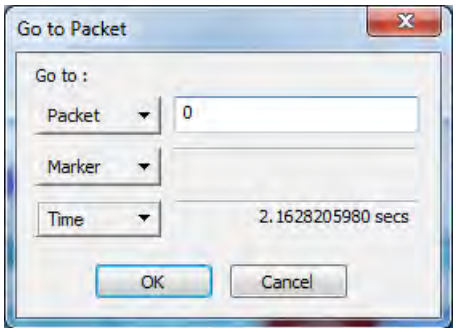
Select the packet and Select **Search > Go to Selected Packet**.

7.4 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).

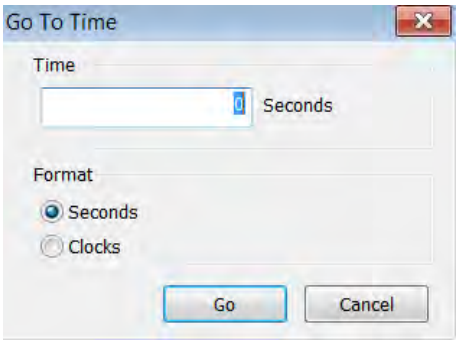
2. Choose the needed transaction level from the Packet drop-down list and enter the transaction number. Please note that transaction levels is added to list if corresponding level is decoded for current trace file.
3. Click **OK**.



7.5 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**.

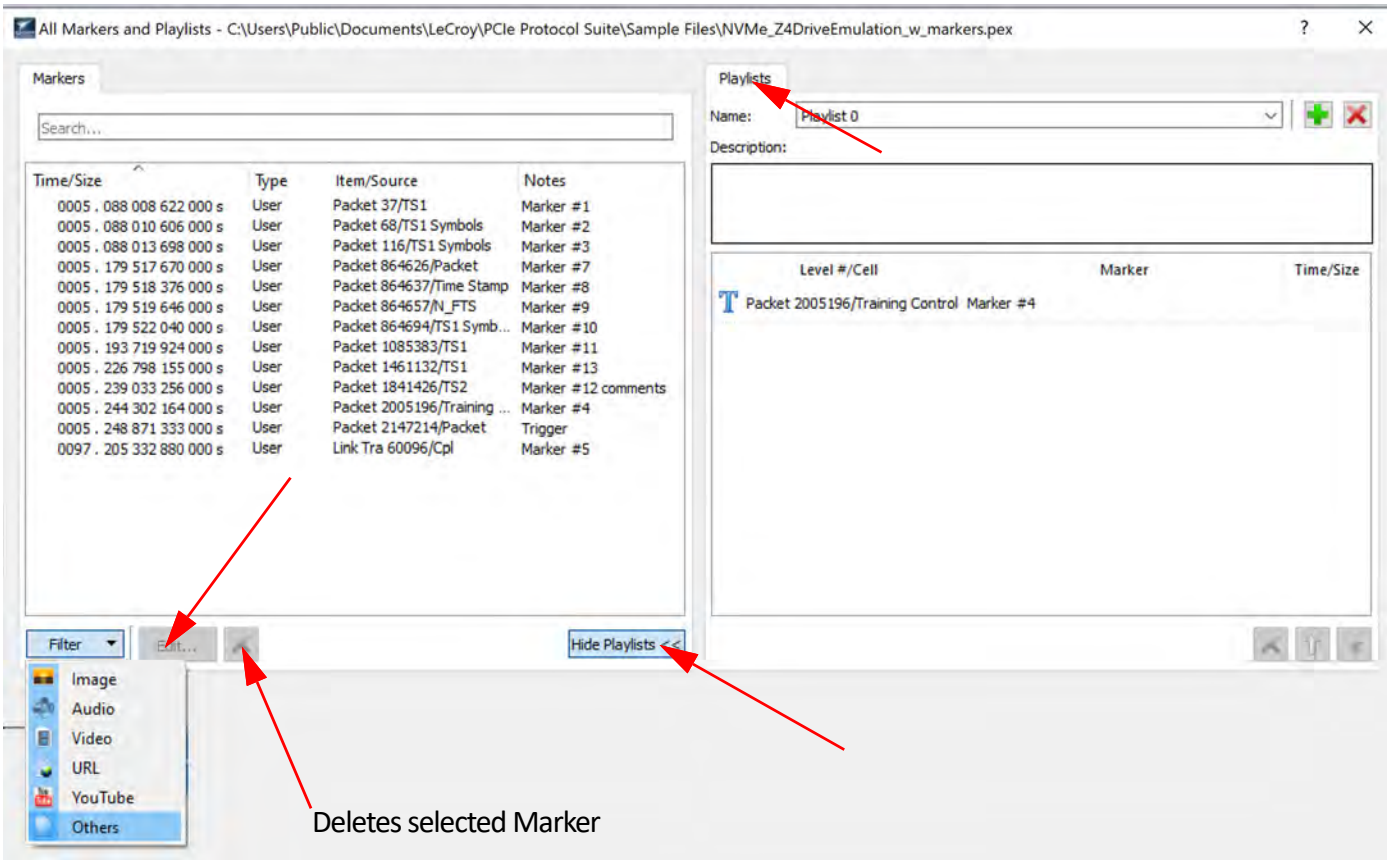
7.6 Go To Marker

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).



7.6.1 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.

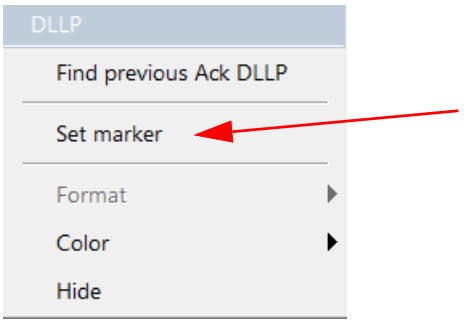
Functionality of Markers

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 7.2 on page 578).

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 7.2 on page 578):

- 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.

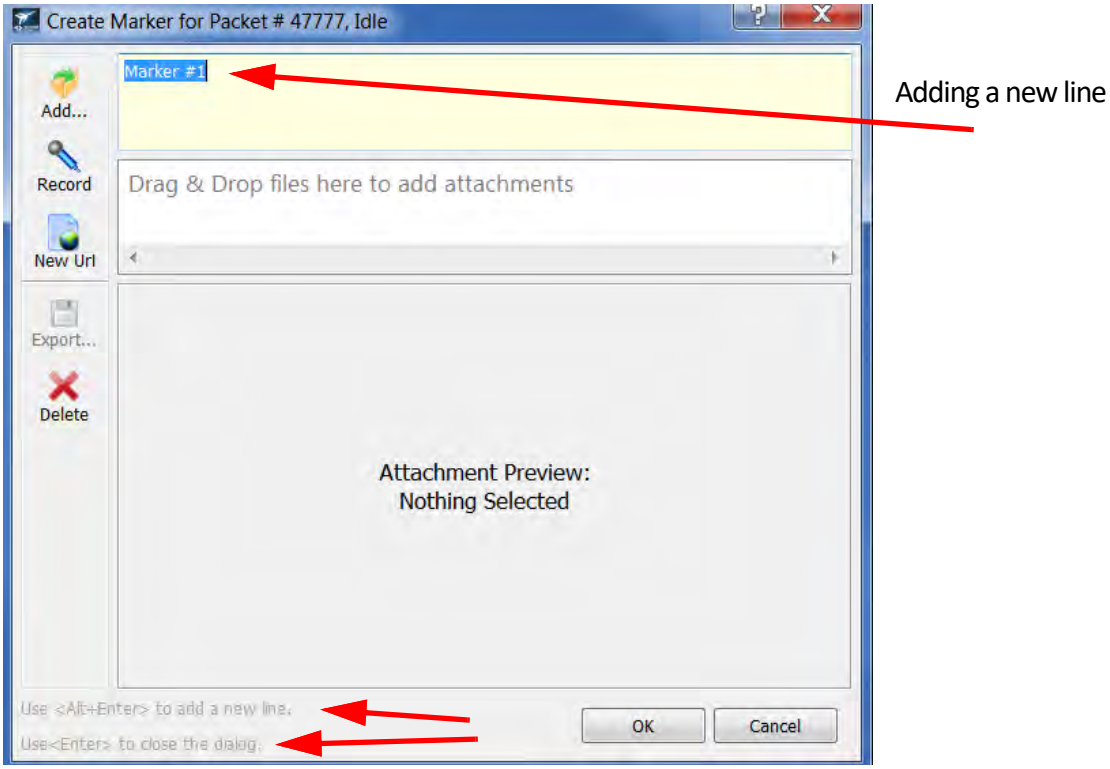


Figure 7.2: Create Marker for Packet Dialog

Click **Enter** to close the Marker dialog.

Click **ALT > Enter** to add a new line.

As shown above you can:

Add...	Add icon. Click on this icon to add any file. See "Adding an Attachment" on page 579.	Export...	Export icon. Click on this icon to export an attachment.
Record	Record icon. Click on this icon to record audio. See "Recording an Audio File" on page 579.	Delete	Delete icon. Click on this icon to delete an attachment
New Url	New URL icon. Click on this icon to add any URL.		

7.6.2 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.

7.6.3 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 7.3 on page 579).
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.

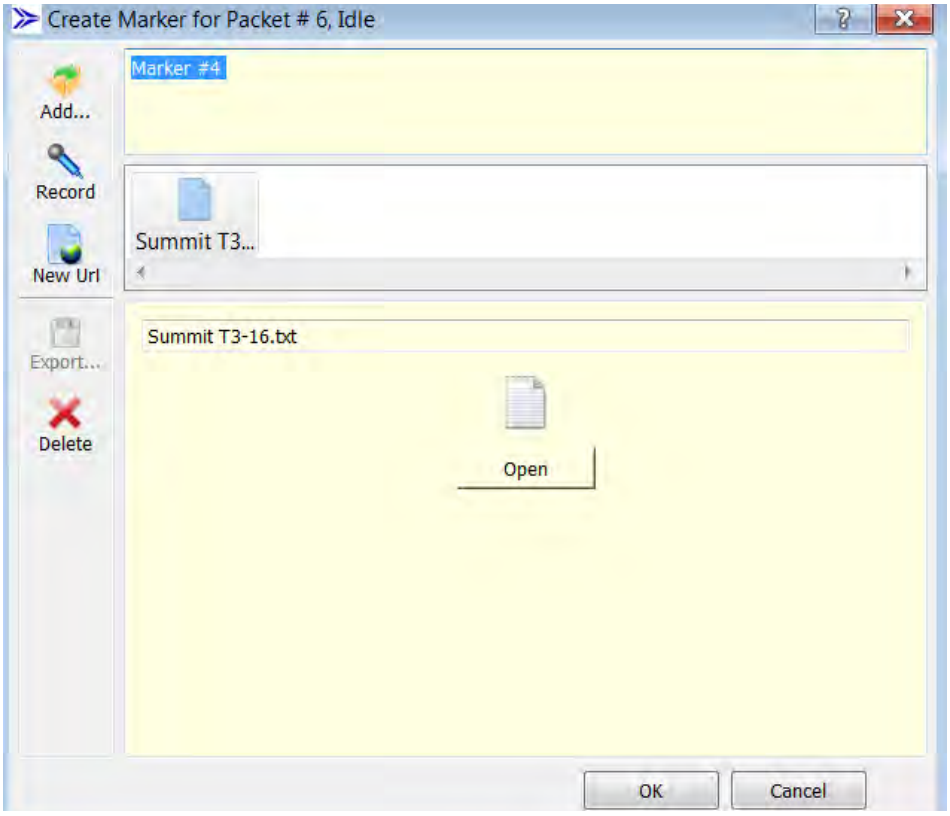


Figure 7.3: Create Marker for Packet Dialog

7.6.4 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.

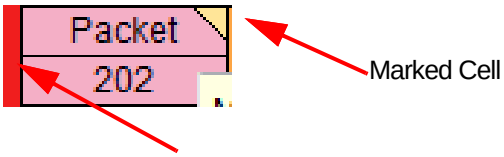
Note: This functionality is disabled if a microphone is not installed.

7.6.5 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.

7.6.6 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.



A marker may comprise any number of attachments of any types.

7.6.7 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.

7.6.8 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 580, a window pops up displaying the contents of the marked cell (see Figure 7.4 on page 581).

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.

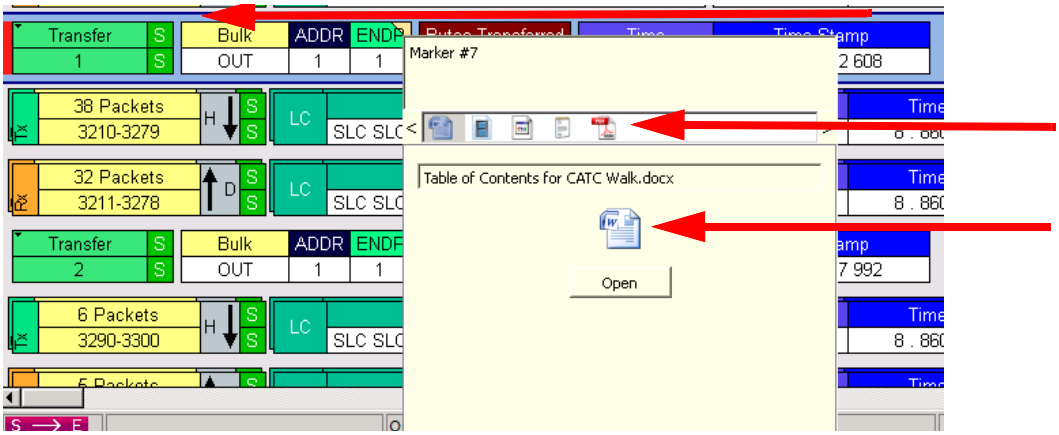


Figure 7.4: Pop-up Displaying Marker Contents

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.

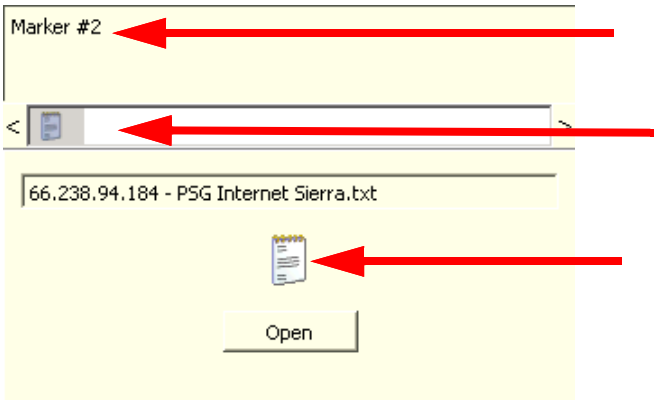


Figure 7.5: Text Attachment Pop-up Window

If there is no attachment, **No Attachments** displays in the status bar at the bottom.

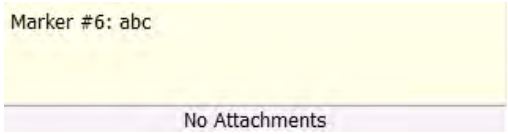


Figure 7.6: No Attachments Pop-up Window

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 7.7 on page 582).

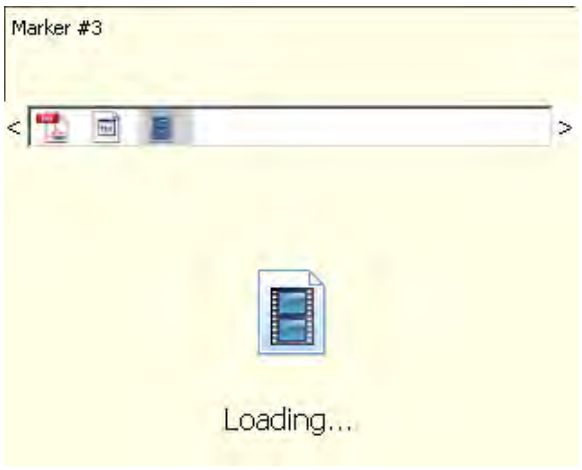


Figure 7.7: Preview Attachments Pop-up Window

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.

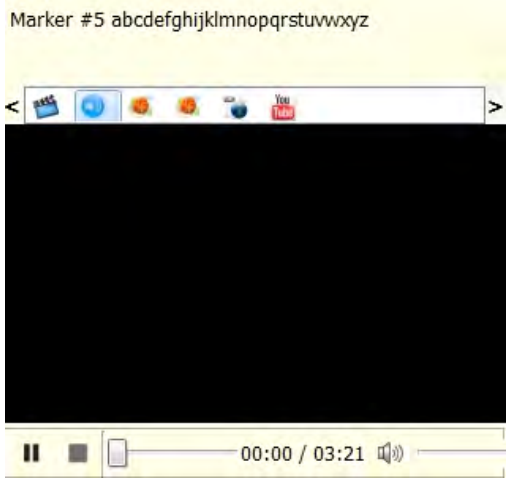


Figure 7.8: Adding a Marker that is an Audio Snippet

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 7.9: Adding a Marker that is a Video Clip

File Attachment

You can attach any kind of file, including images, PDFs, documents, media files, etc.

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 7.10.

Web Link

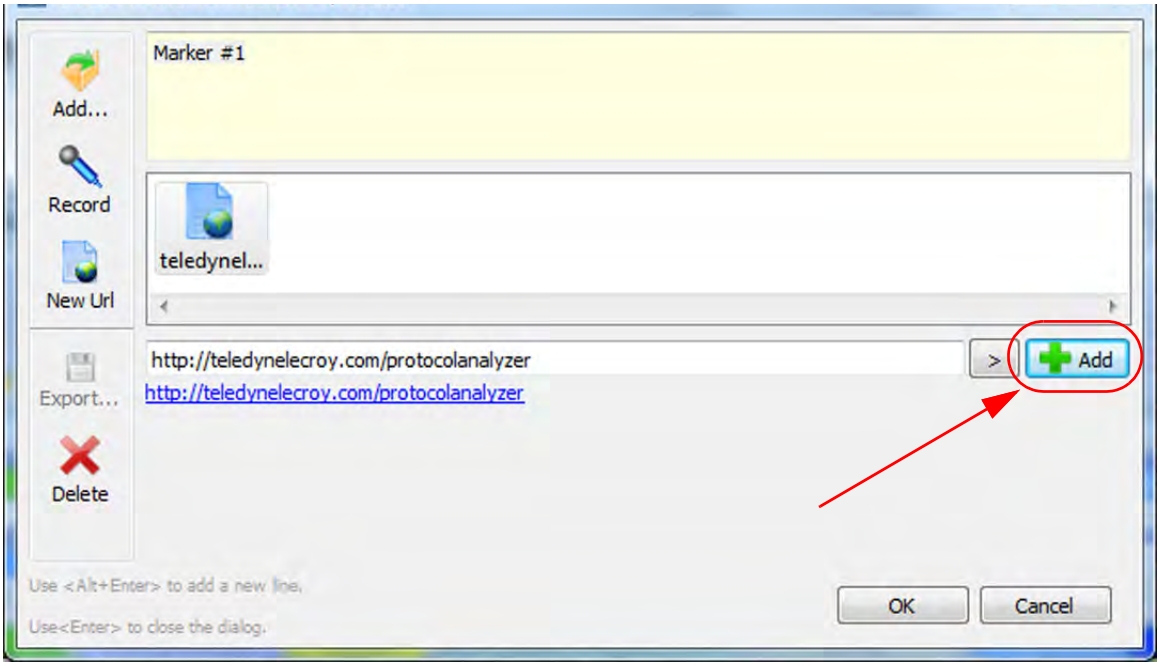


Figure 7.10: Marker: URL Link

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 7.11.

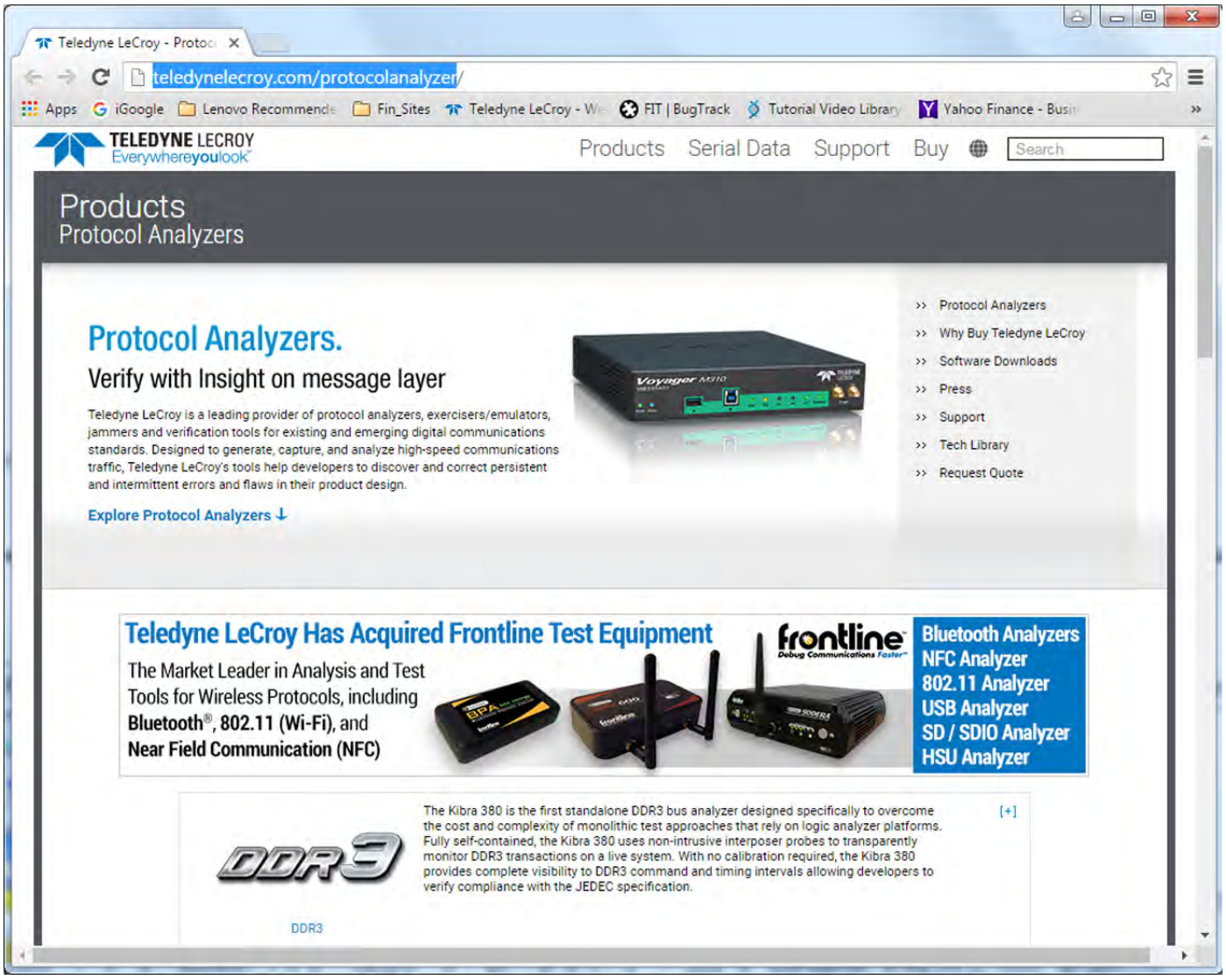


Figure 7.11: Opening a URL Marker in a Separate Window

YouTube Video

YouTube's video player is embedded for YouTube Video playback. See Figure 7.12.



Figure 7.12: Adding a Marker that is a YouTube Video

Images

The image is embedded in the trace. See Figure 7.13.



Figure 7.13: 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 7.14

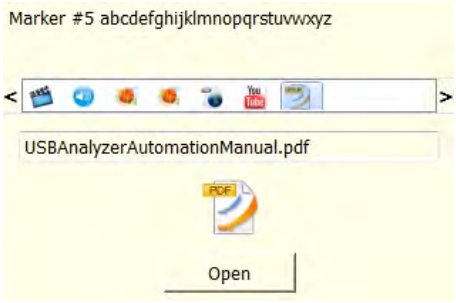


Figure 7.14: Adding a Marker: System Default

7.6.9 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 7.15: EDIT Marker for Packet Dialog

7.6.10 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 7.16 on page 588). 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 7.17 on page 589.

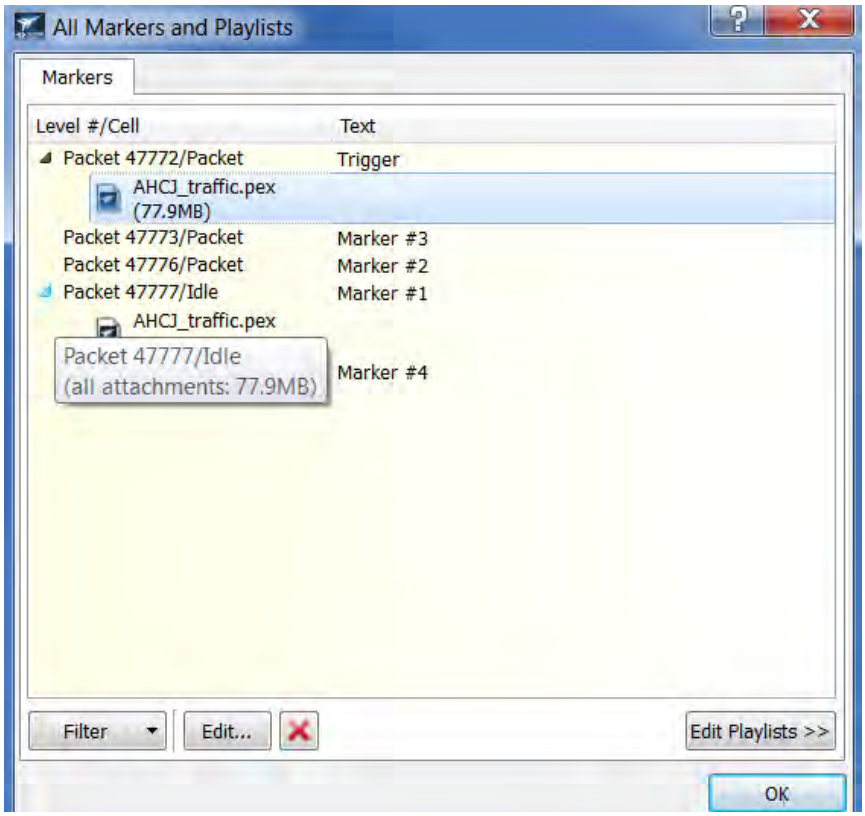


Figure 7.16: All Markers and Playlists Dialog

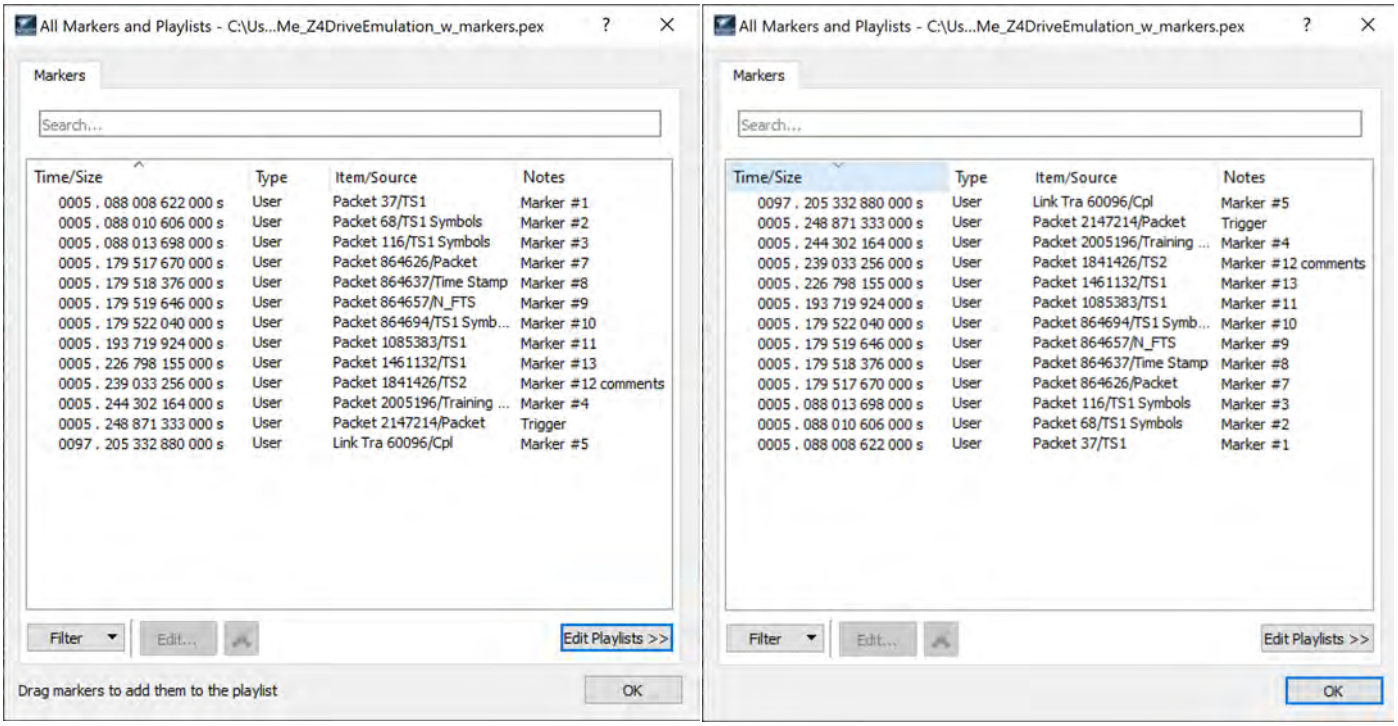


Figure 7.17: Markers Sorted by Timestamps in Ascending and Descending Order

You can filter to show or hide text, image, audio, video, URL, YouTube videos and other files.

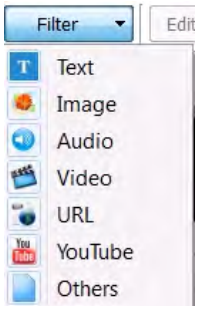


Figure 7.18: Filter Dialog

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.

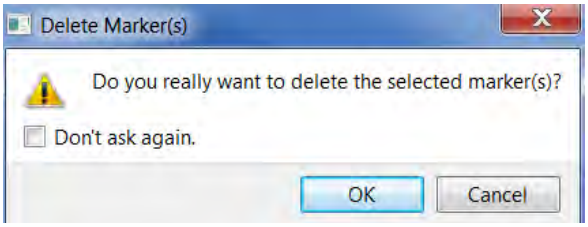


Figure 7.19: Confirmation Dialog

7.6.11 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.

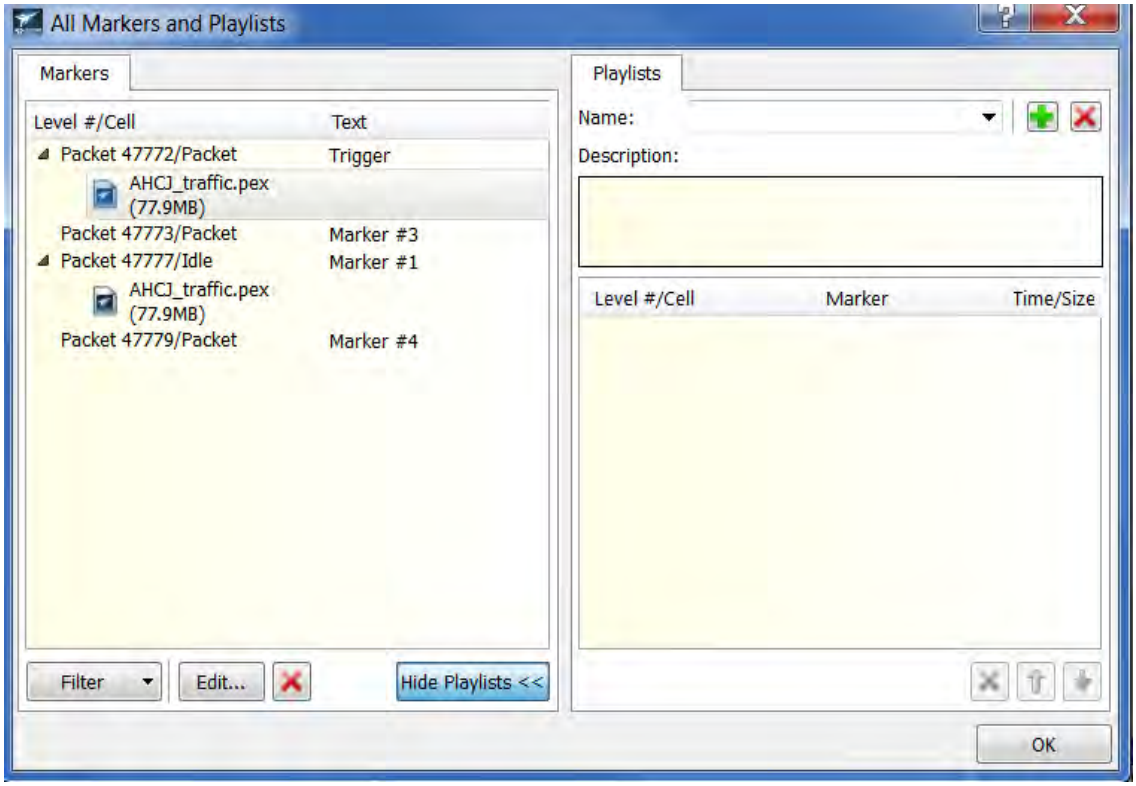


Figure 7.20: Edit CATC Walk Playlists Dialog

7.6.12 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.

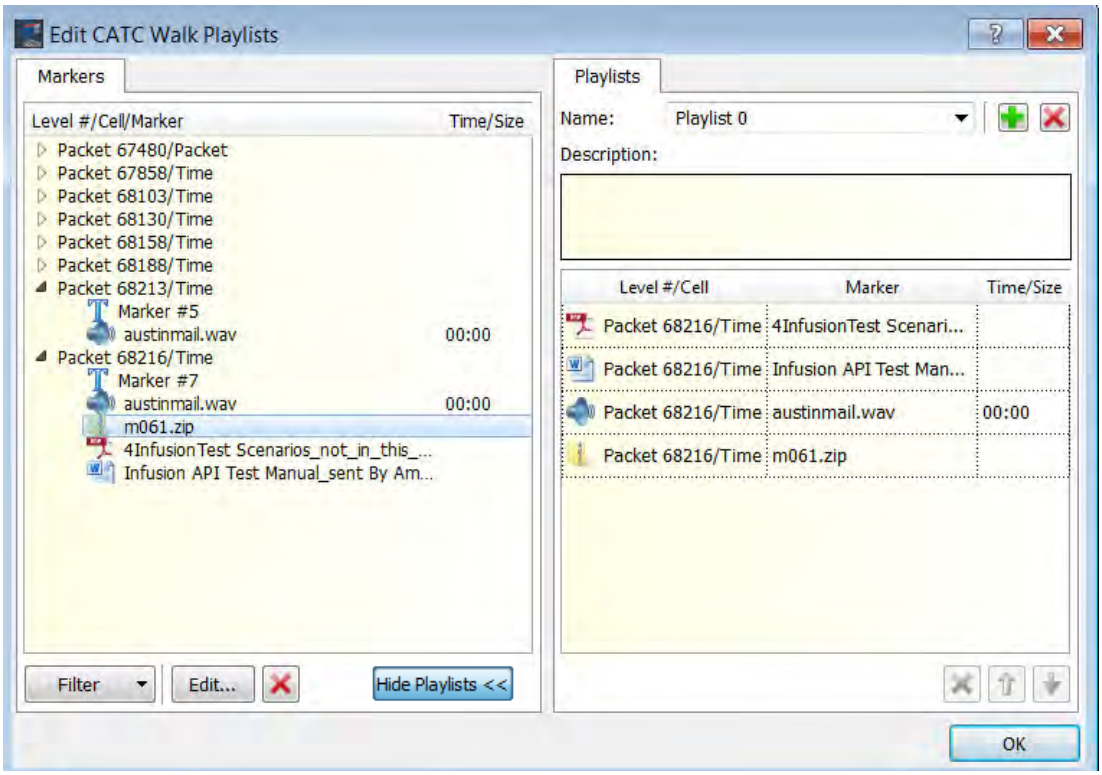


Figure 7.21: Edit CATC Walk Playlists Dialog

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

7.6.13 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.

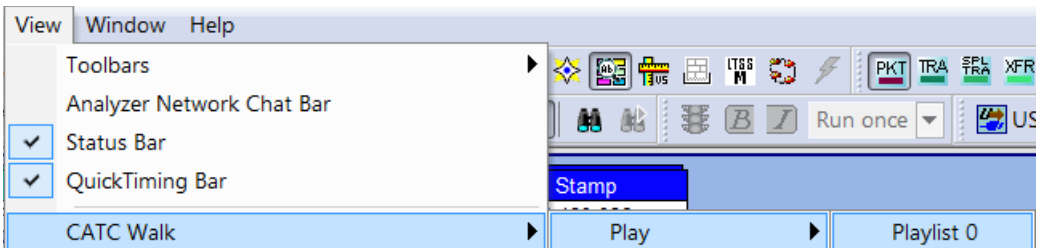


Figure 7.22: View Dialog

The attachment item starts to play in the Playback window (see Figure 7.23).



Figure 7.23: 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.

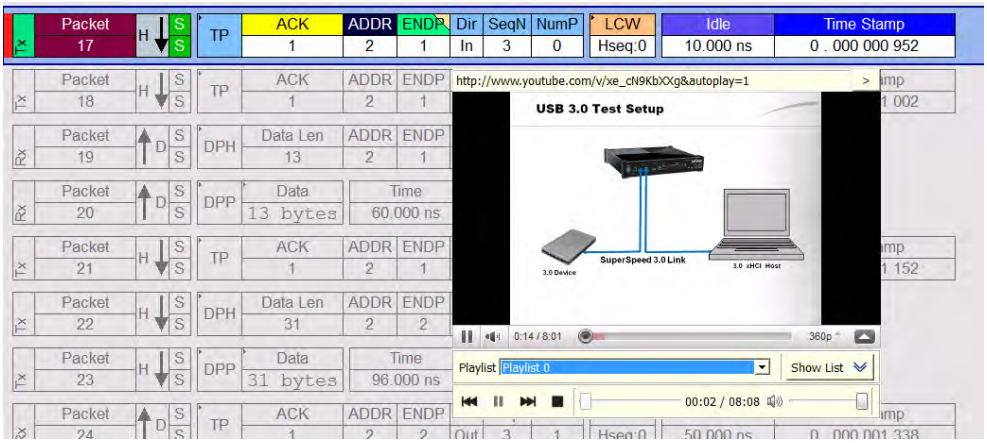
Playlist Playback Controls

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

7.7 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.

7.7.1 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 7.24 on page 594

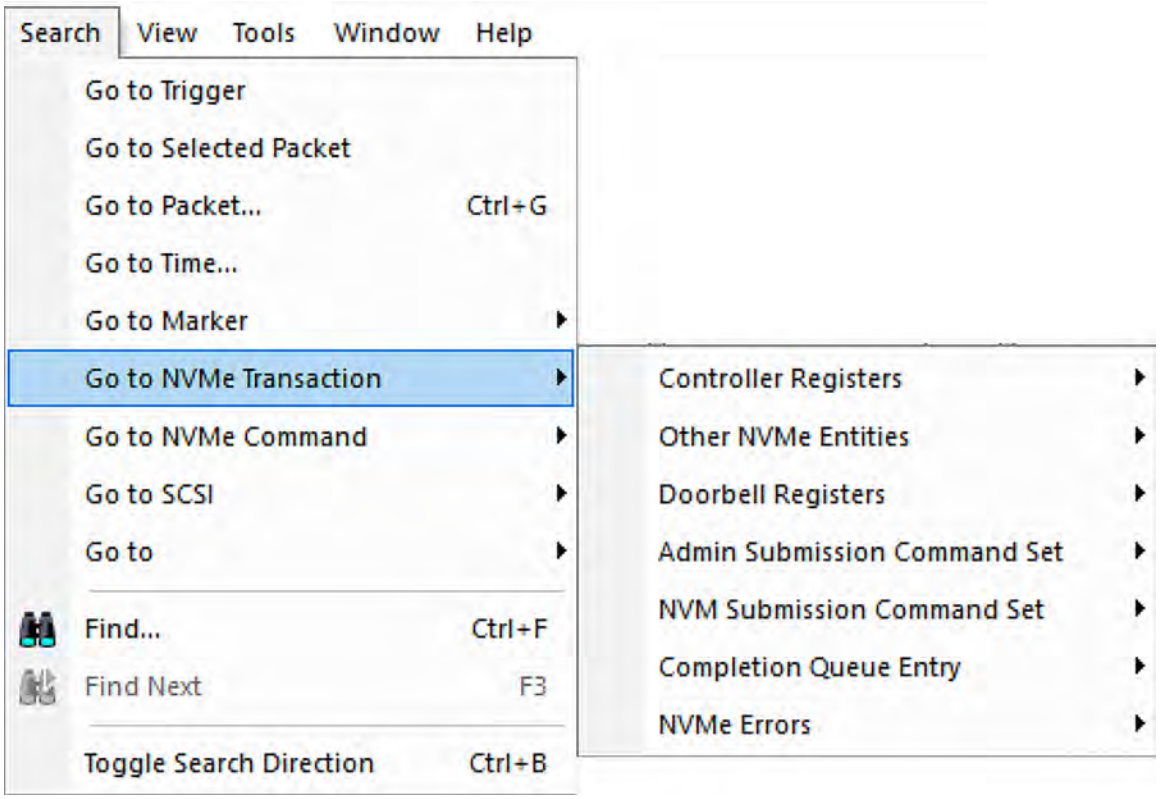


Figure 7.24: Search: NVMe Transaction Types

7.7.2 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 7.25 on page 595.

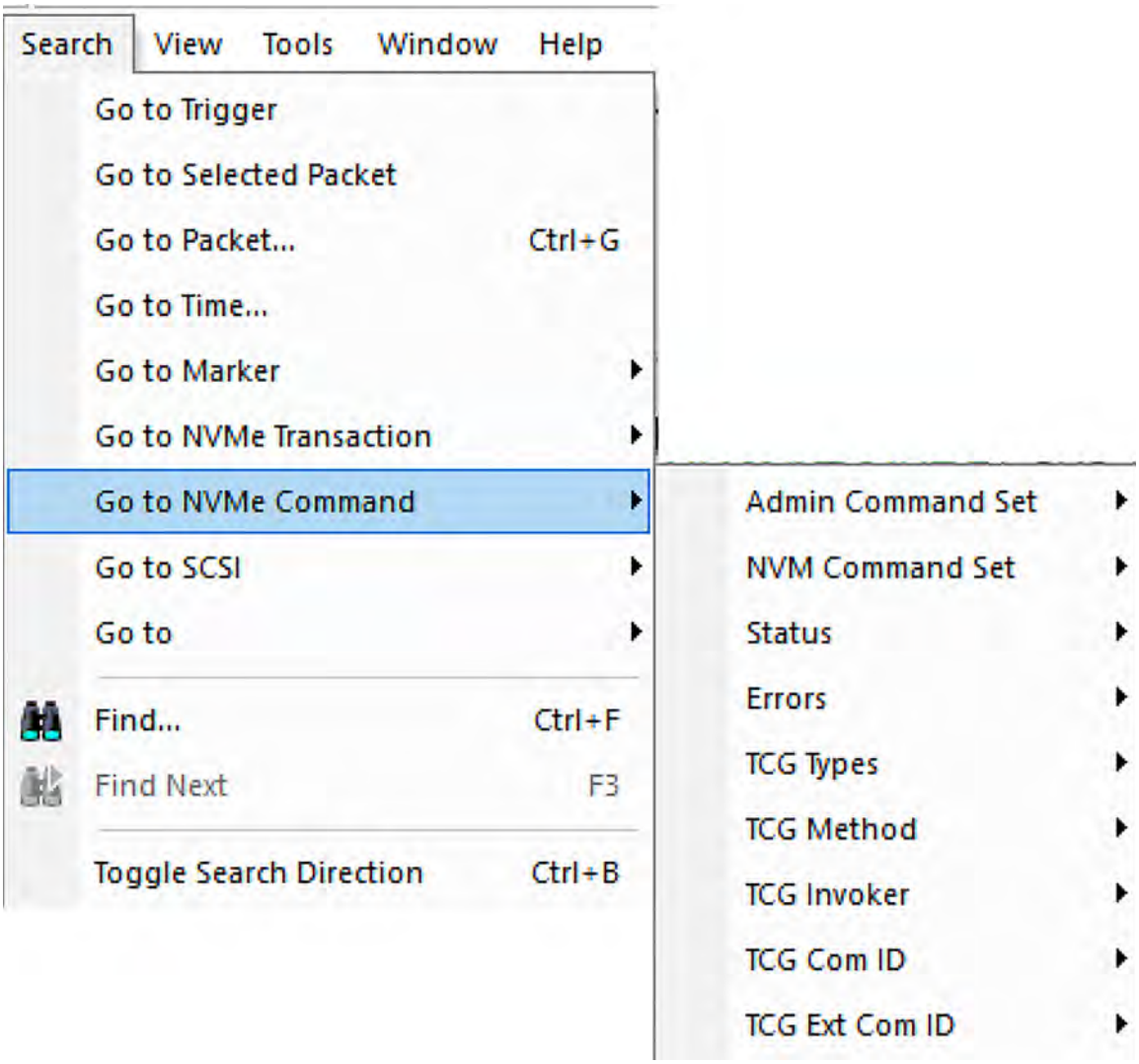


Figure 7.25: Search: NVMe Command Types

7.8 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

7.9 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

7.9.1 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.

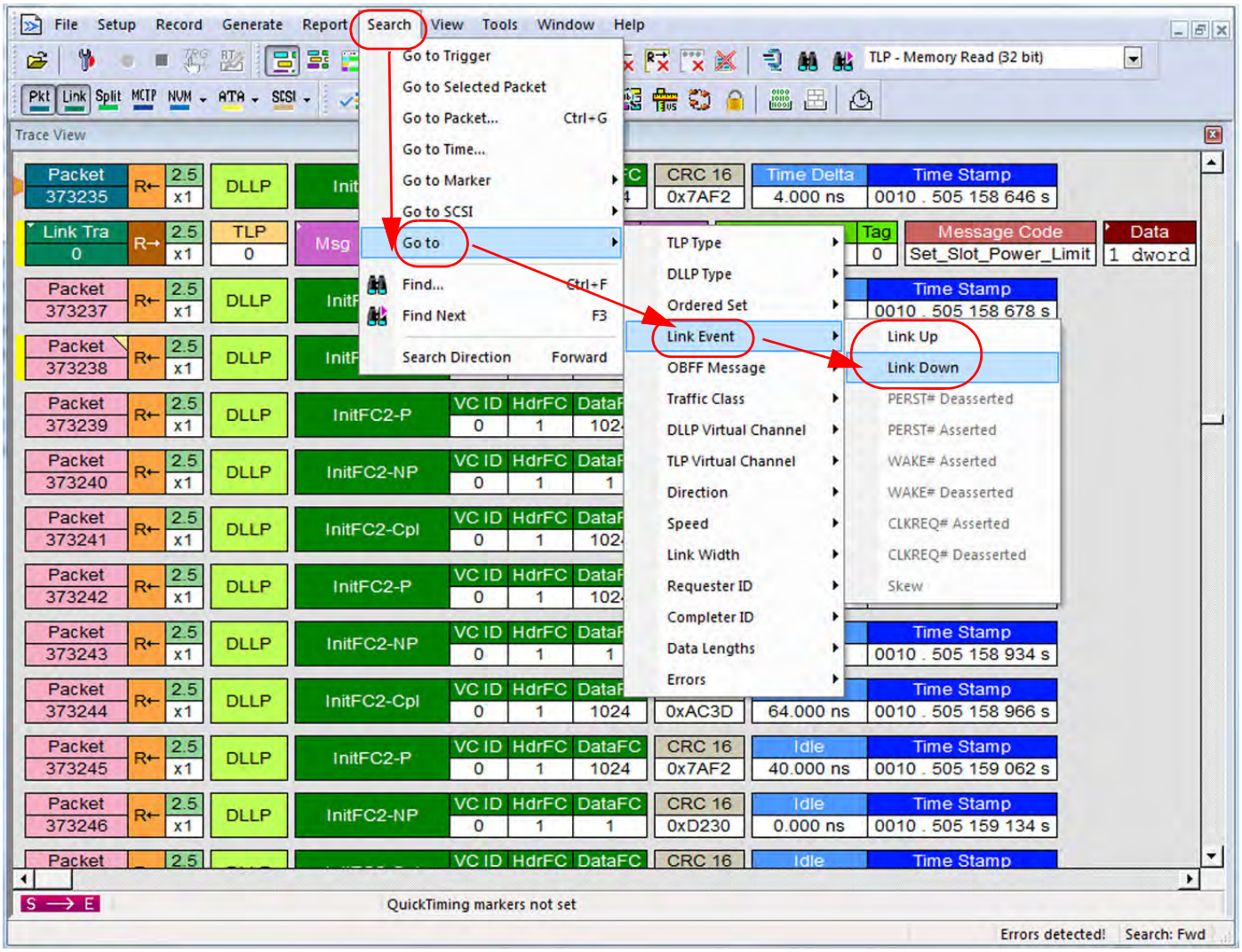


Figure 7.26: Search -> Go to -> Link Event -> Link Up / Link Down: Set Up Search

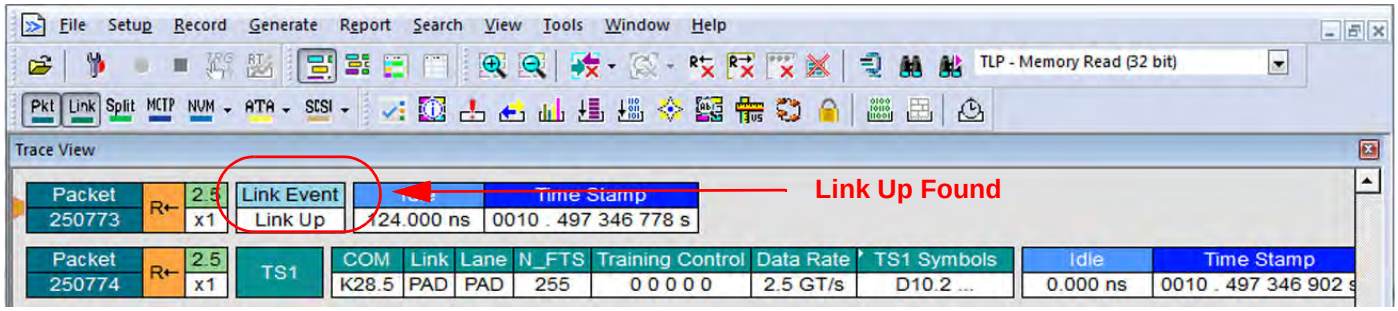


Figure 7.27: Search -> Go to -> Link Event -> Link Up: Found

7.9.2 Example: Search -> Go To -> Direction

The Search -> Go To -> Direction option will show you Upstream, Downstream and Sideband.

See Figure 7.28.

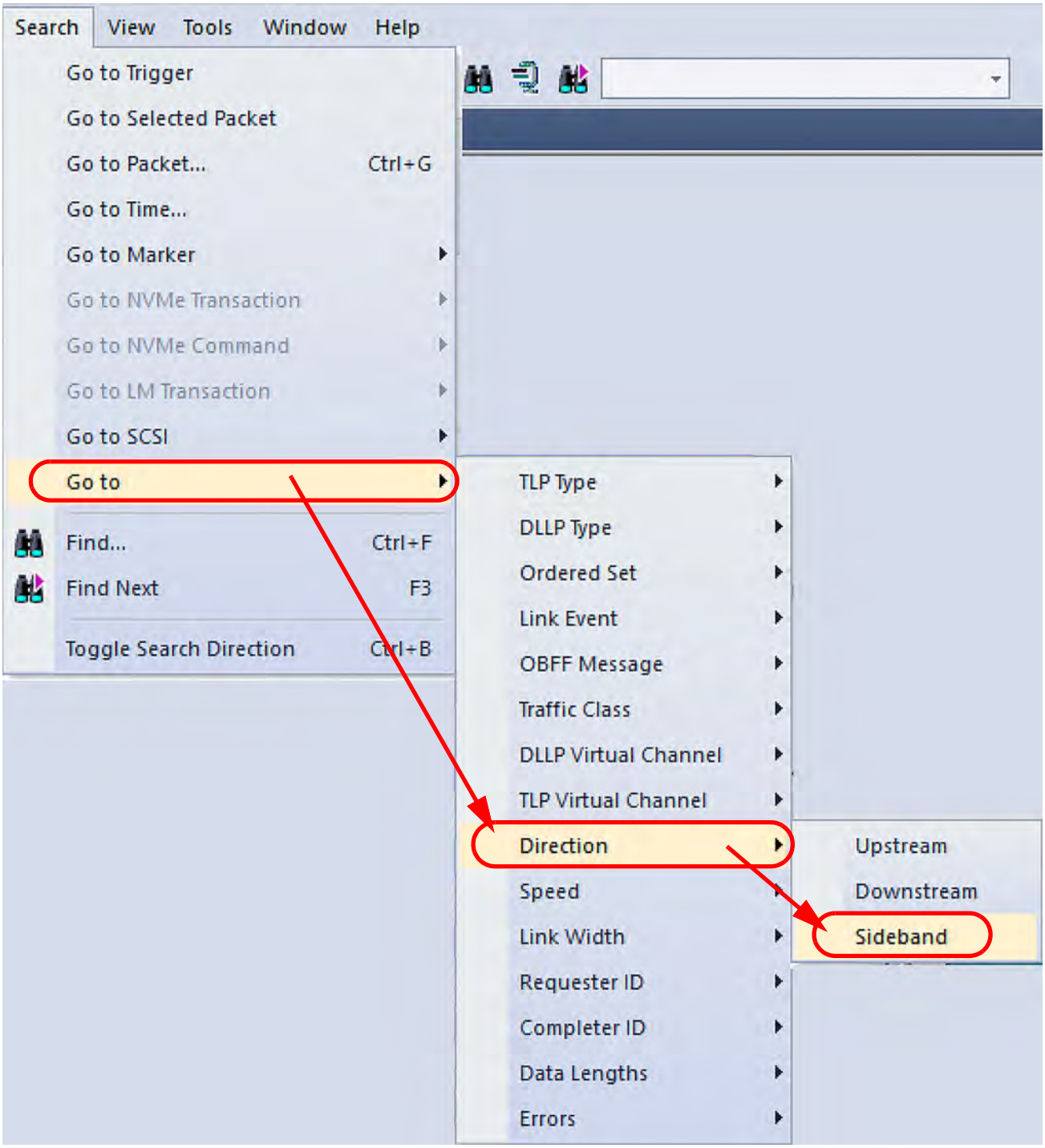


Figure 7.28: Search -> Go To -> Direction -> Sideband

7.10 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) as shown in Figure 7.29.

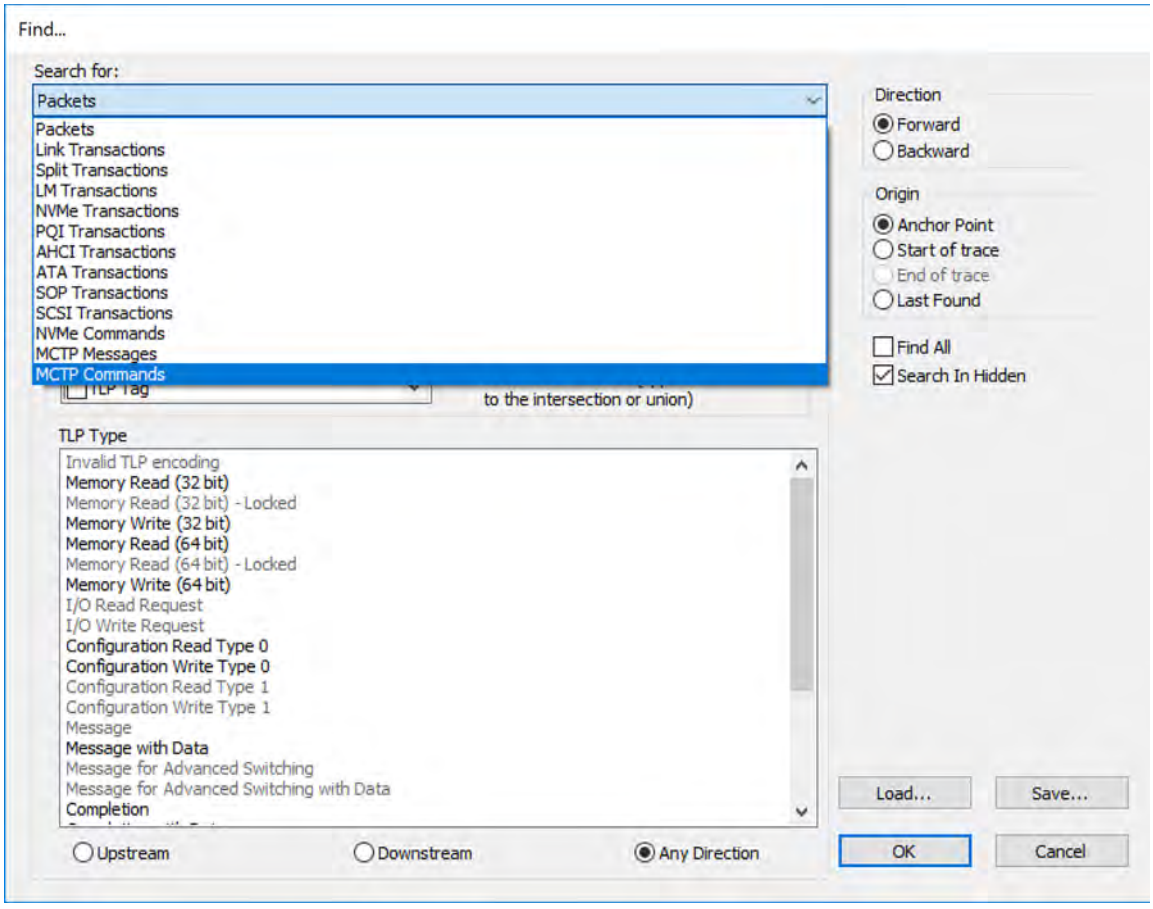


Figure 7.29: Find: Search for

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, PMUX Channel ID, 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 7.48 on page 616.

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” on page 618.

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 “Example: MCTP Messages to Search For” on page 623. 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 624 and “Example: Searching for NC-SI Message Types within MCTP Messages” on page 625.

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).

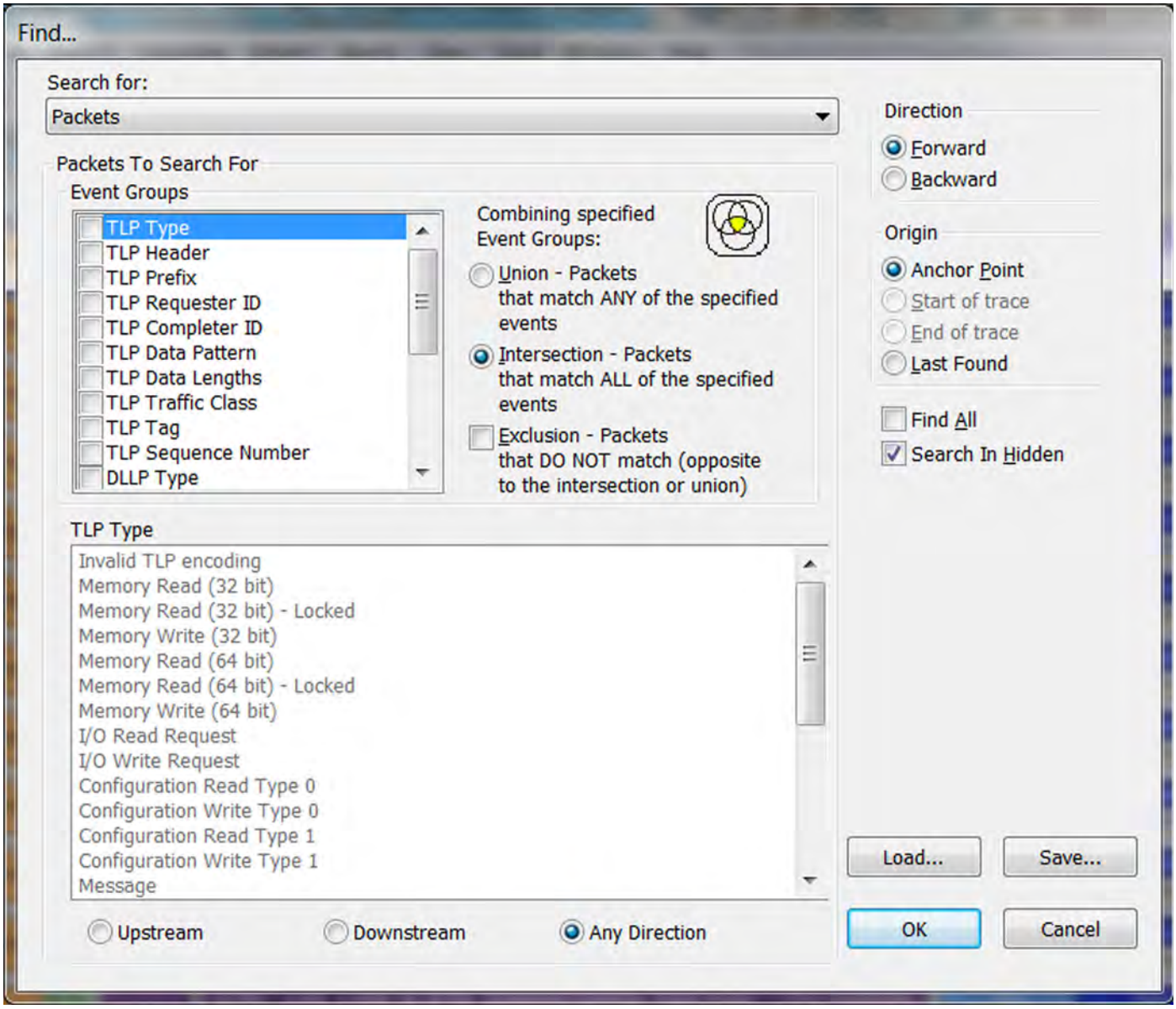
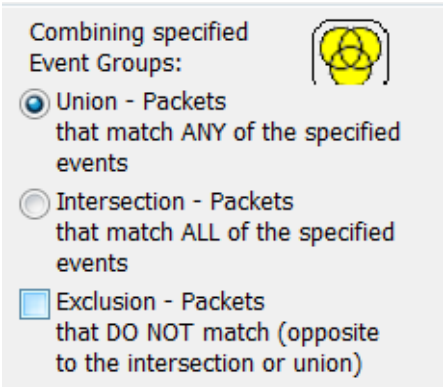


Figure 7.30: Find Dialog

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**.

7.10.1 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
- PMUX Channel ID
- DLLP Type
- DLLP Header
- DLLP Virtual Channel
- ACK/NAK Seq Number
- Ordered Sets
- Link Event
- OBFF Code
- Direction
- Errors
- TS1 Data (see “Example: TS1 and TS2 Event Groups” on page 604)
- TS2 Data (see “Example: TS1 and TS2 Event Groups” on page 604)
- Message Code

Example: 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.

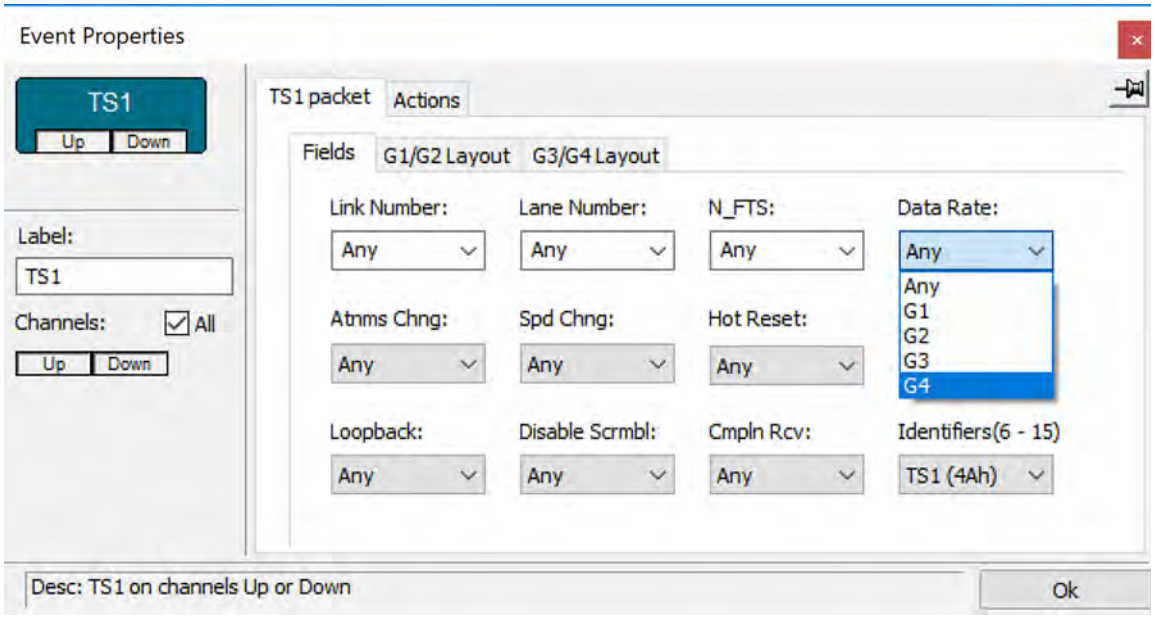


Figure 7.31: TS Data Fields Tab

Select parameters from the drop-down lists to use.

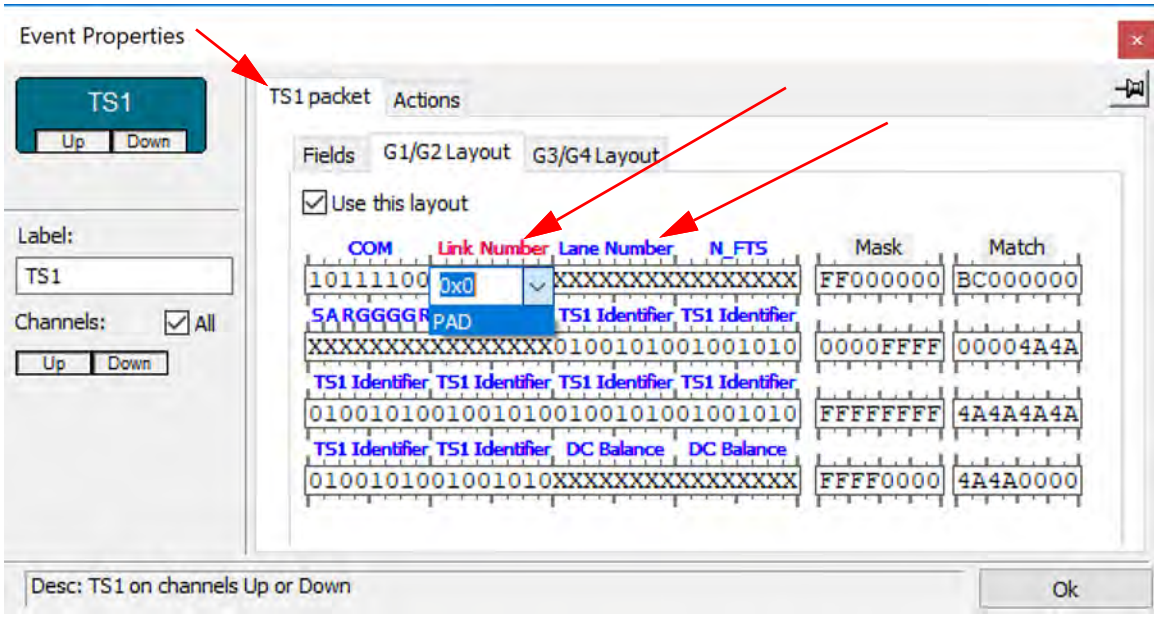


Figure 7.32: TS G1/G2 Layout Tab

Select parameters from the links to use and enter the mask and match values.

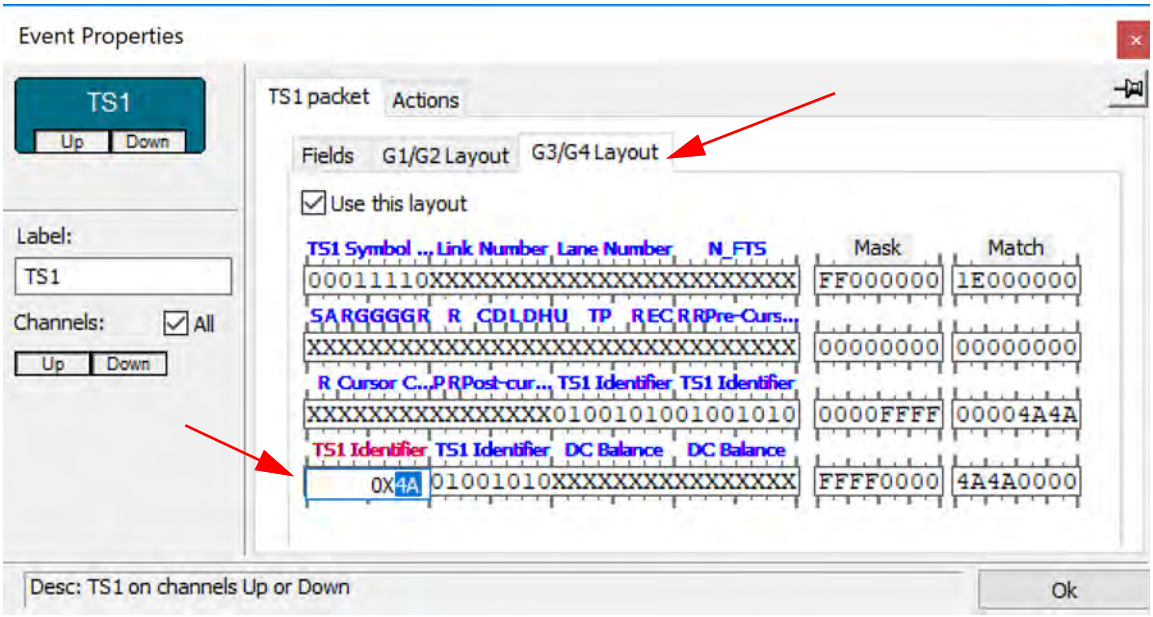


Figure 7.33: TS G3/G4 Layout Tab

Select parameters from the links to use and enter the mask and match values.

Example: TS1 Packet with G3 Speed and G3 Data Rate

In order to select TS1/TS2 packets for search/triggering on G3/G4 speed you need to set data for search/triggering to G3 (see Figure 7.34).

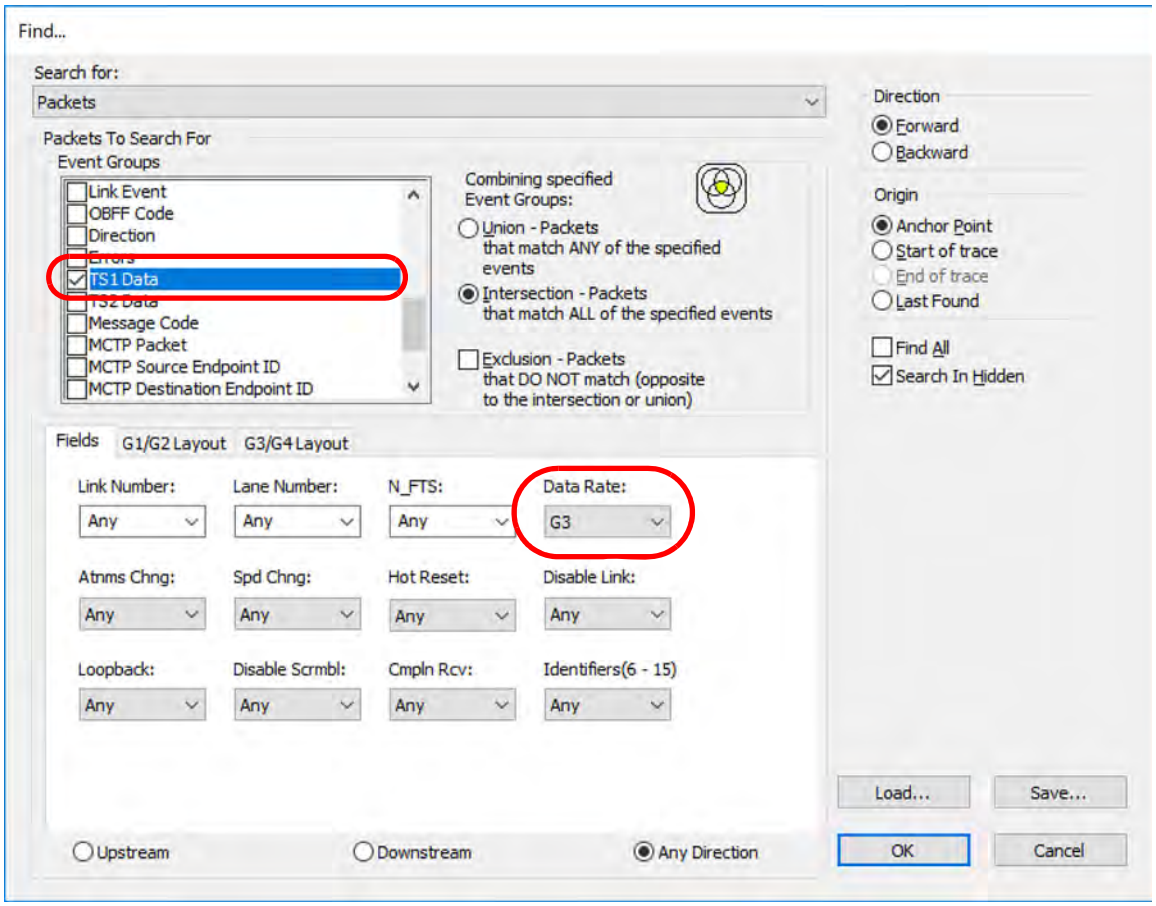


Figure 7.34: Set Search for: Packets -> TS1 Data and Data Rate G3

Set the Recording Options -> TS1 -> Event Properties with the same options. See Figure 7.35 on page 607.

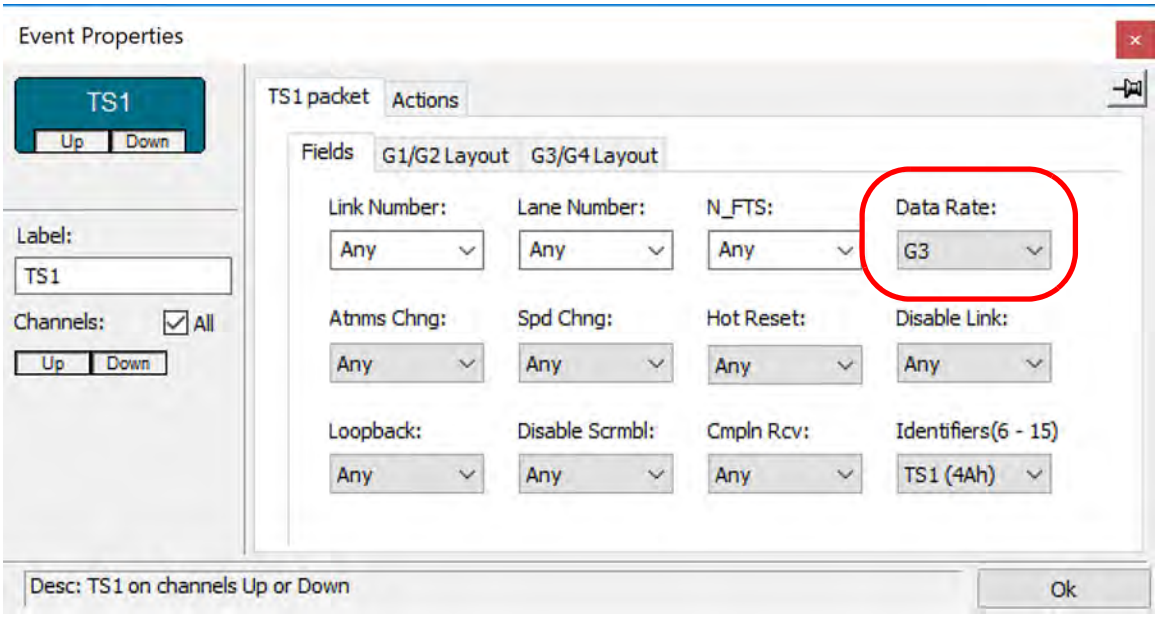


Figure 7.35: Recording Options: Event Properties -> TS1 Data Rate = G3

Uncheck the checkbox “Use this layout” in G1/G2 Layout tab (see Figure 7.36 on page 607).

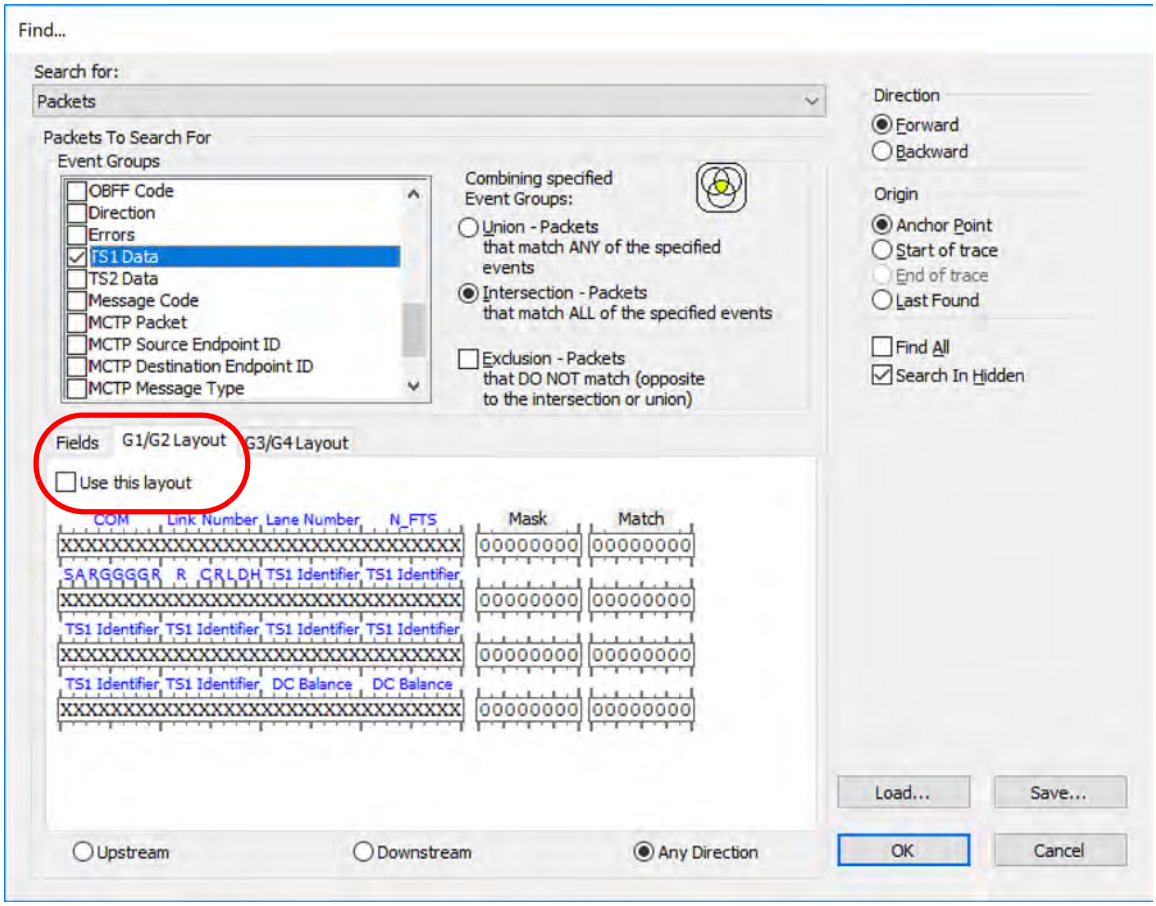


Figure 7.36: Find: Search for Packets -> TS1 G1/G2 Layout

Set the Recording Options -> TS1 packet -> Event Properties with the same options (see Figure 7.37).

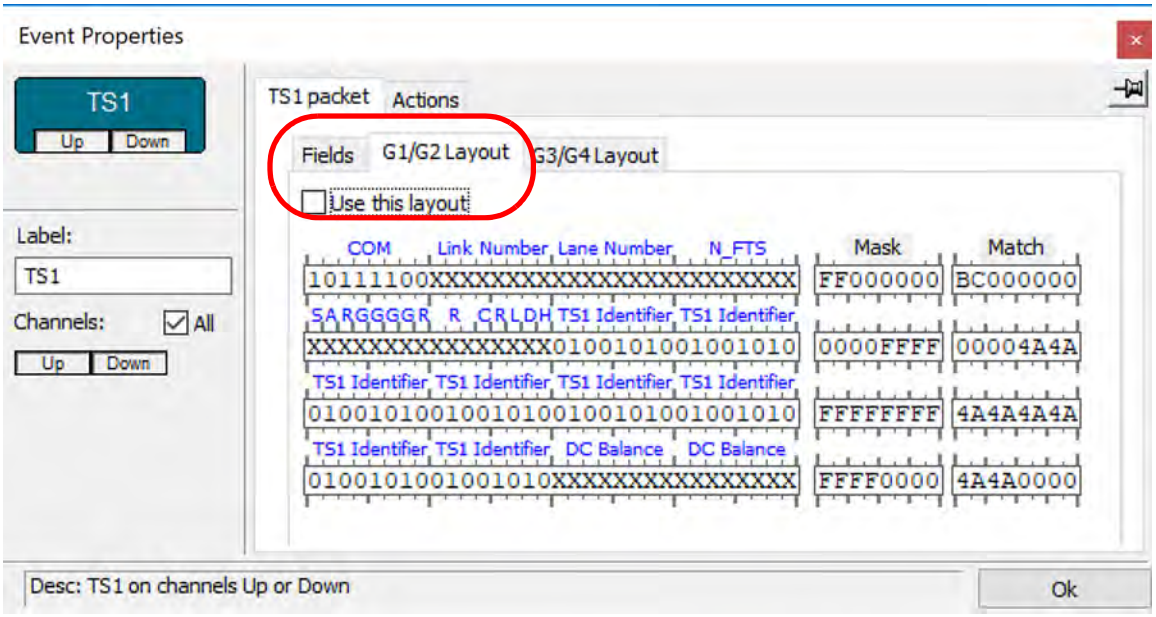


Figure 7.37: Set Recording Options: TS1 Event Properties

Keep the checkbox "Use this layout" in G3/G4 Layout tab checked. See Figure 7.38.

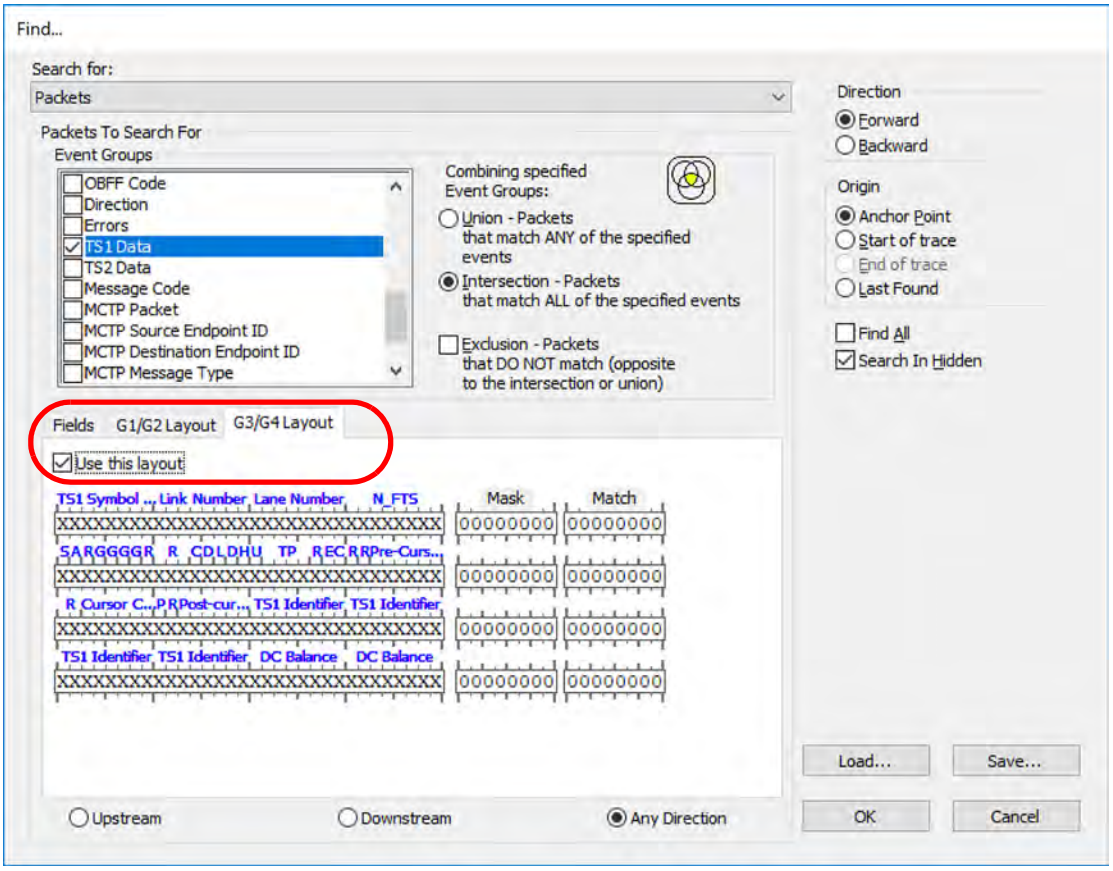


Figure 7.38: Find: TS1 Data -> G3/G4 Layout

Set the Recording Options, TS1 Event Properties with the same options. See Figure 7.39.

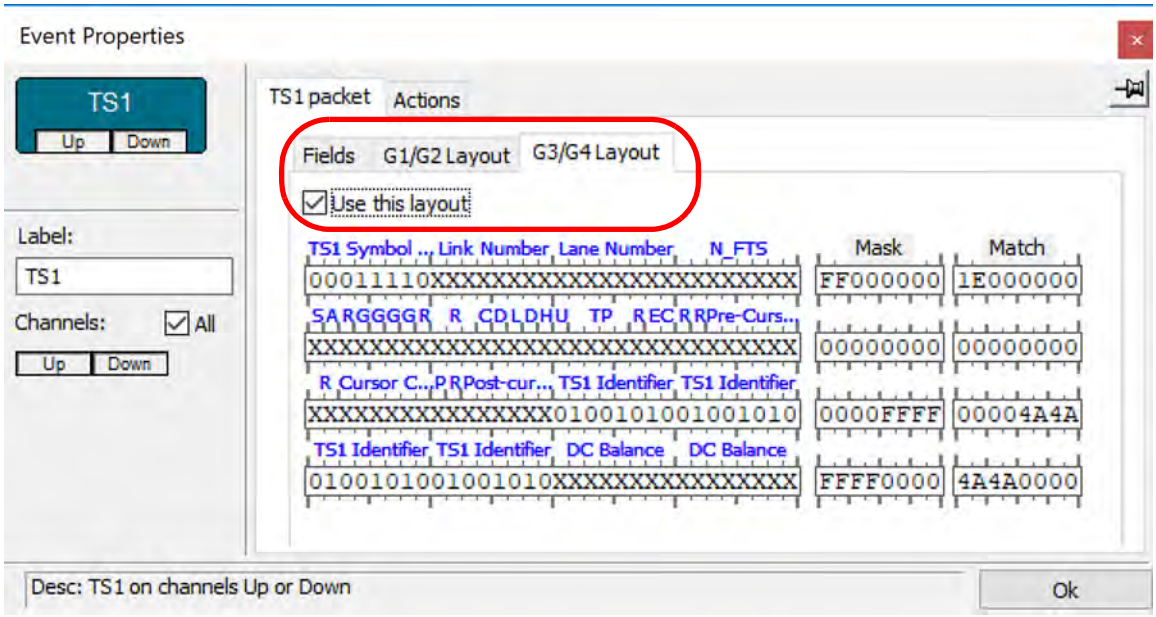


Figure 7.39: Recording Options; TS1 -> Event Properties

Search results example is shown in Figure 7.40.

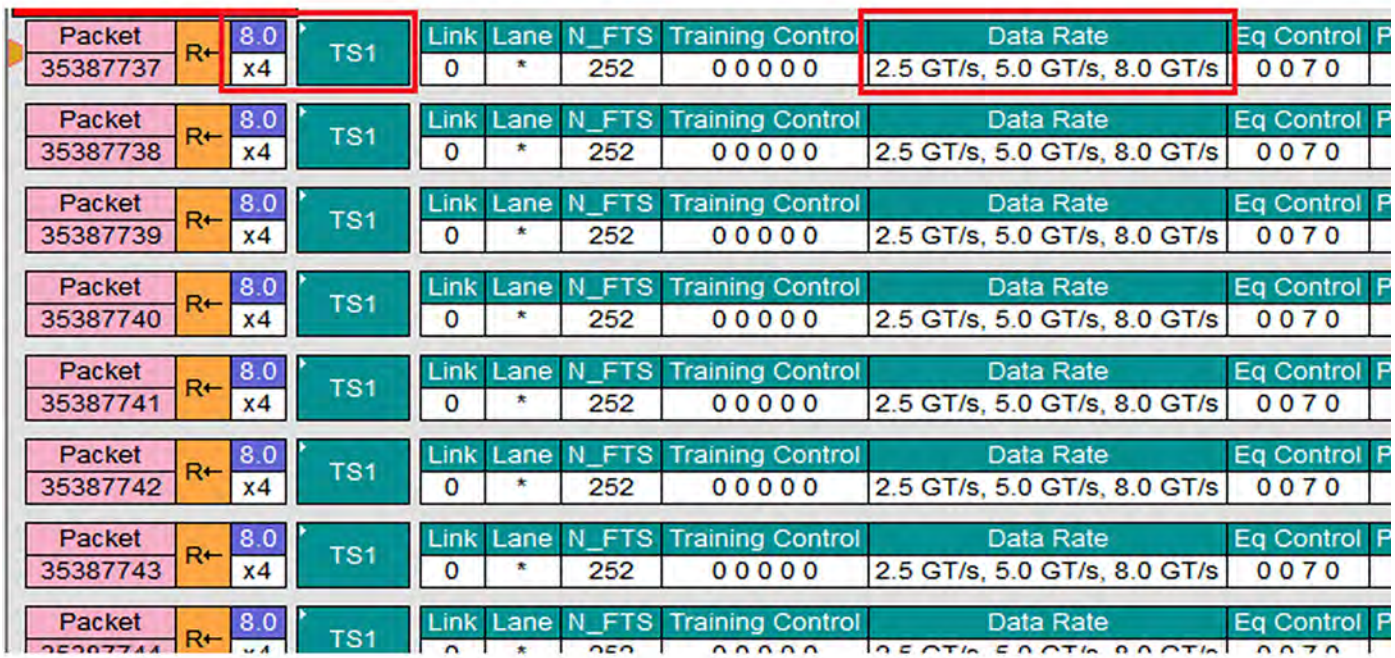


Figure 7.40: Example of Finding TS1 Packet with G3 Speed and G3 Data Rate

Example: TS1 Packet with G1 Speed and G3 Data Rate

In order to select TS1/TS2 packets for search/triggering on G1/G2 speed you need to set the data rate for searching/triggering to G3. See Figure 7.41.

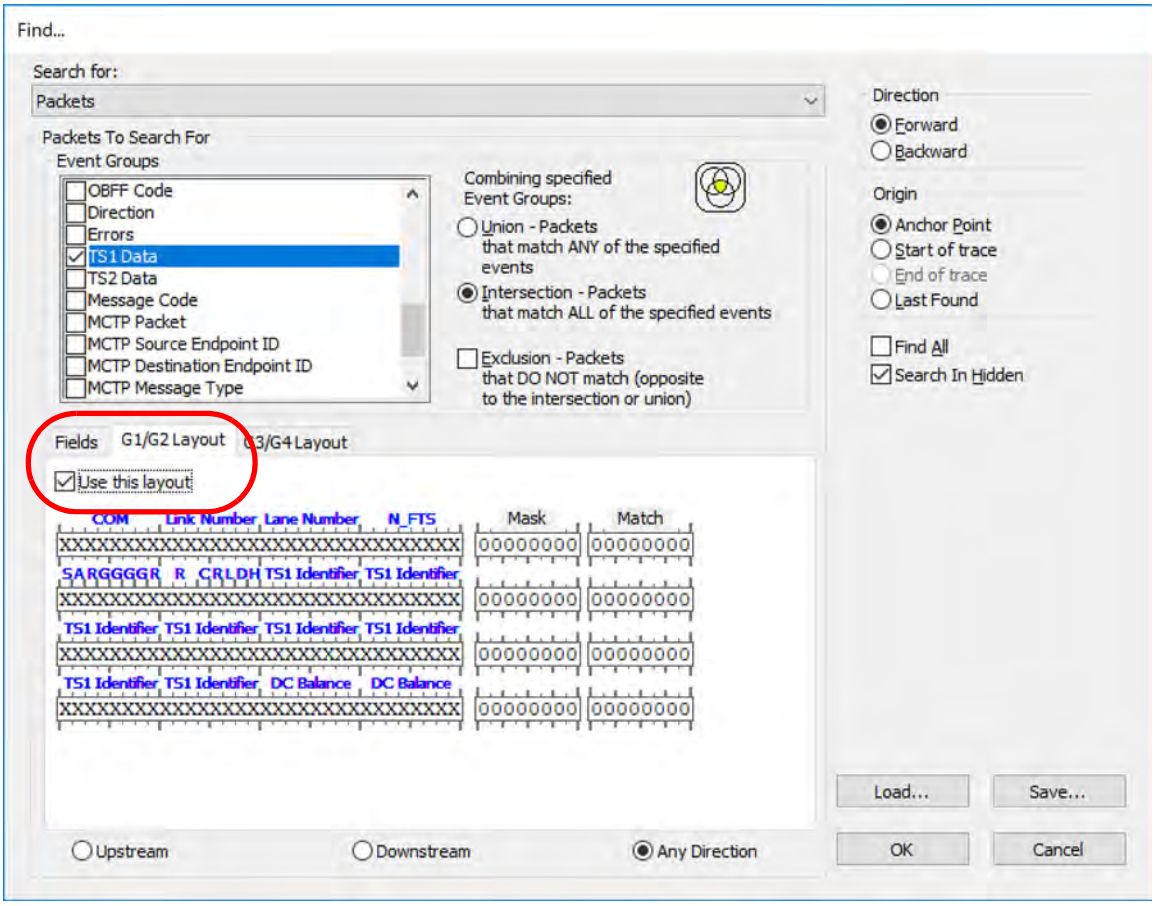


Figure 7.41: Find: TS1 Data -> G1/G2 Layout

Set the Recording Options with the same options. See Figure 7.42 on page 611.

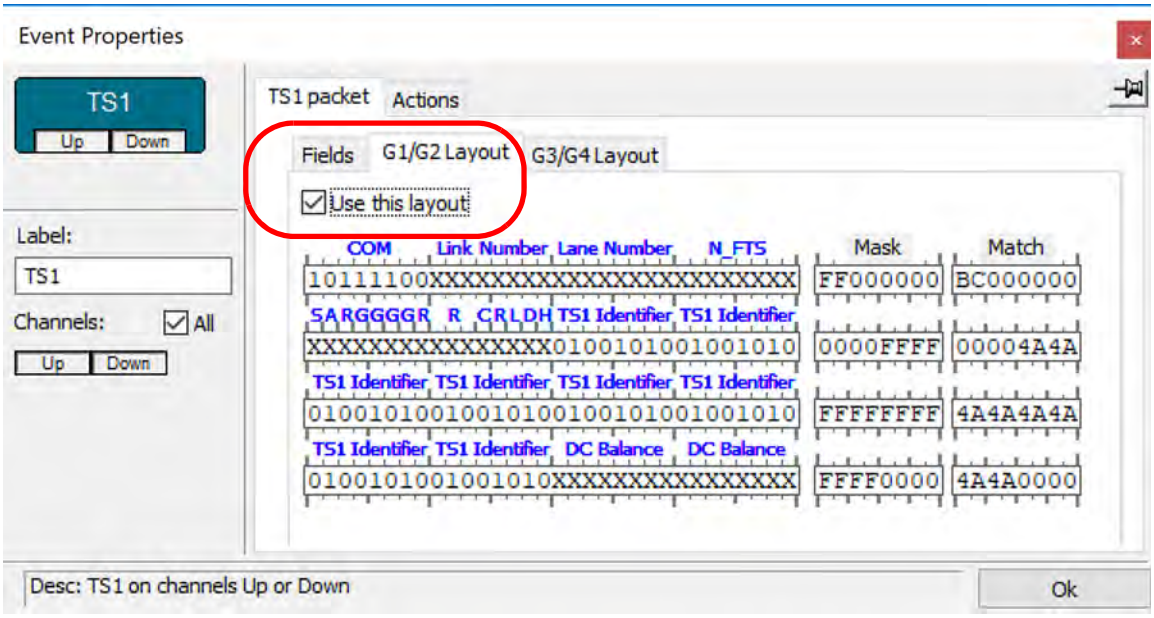


Figure 7.42: Recording Options: TS1 -> Event Properties

Uncheck the checkbox “Use this Layout” in the G3/G4 tab in the Find -> Search for dialog box. See Figure 7.43.

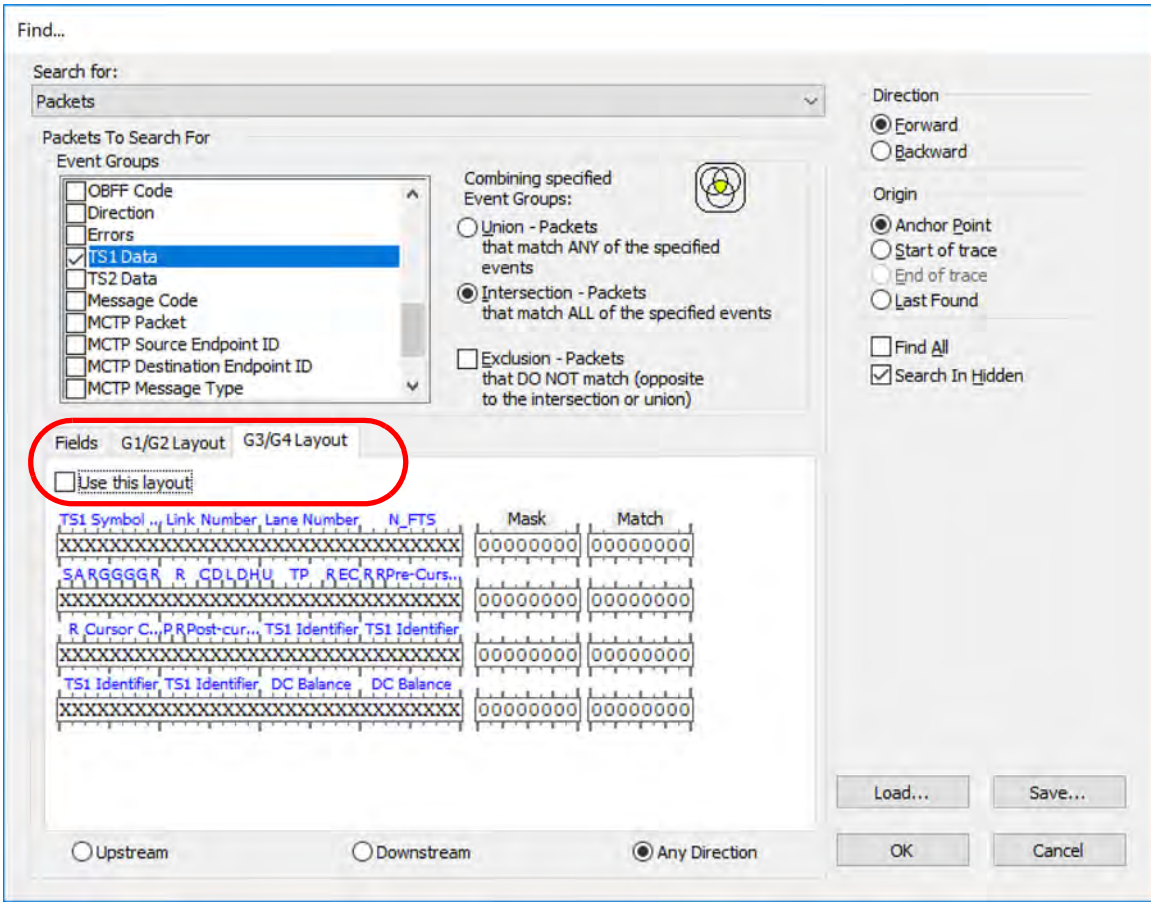


Figure 7.43: Find: TS1 Data -> G3/G4 Layout

In a similar fashion uncheck the checkbox in Recording Options, TS1, Event Properties. See Figure 7.44.

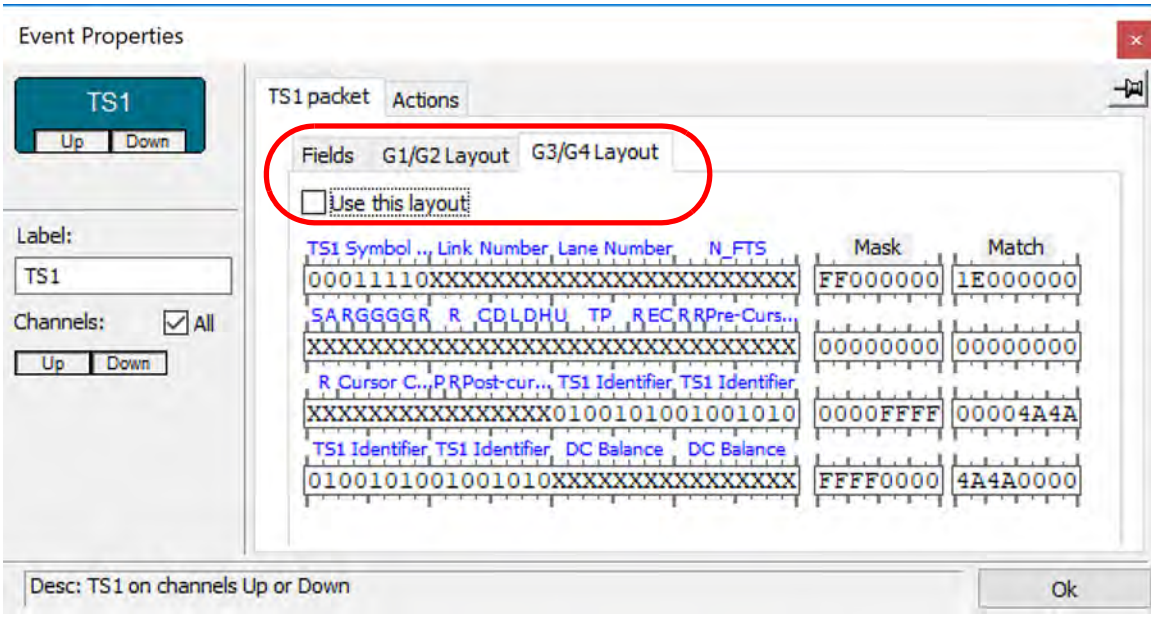


Figure 7.44: Recording Options: TS1 -> Event Properties

An example of a captured trace with TS1 at G1 speed and Data at Gen3 Data Rate is shown below. See Figure 7.45.

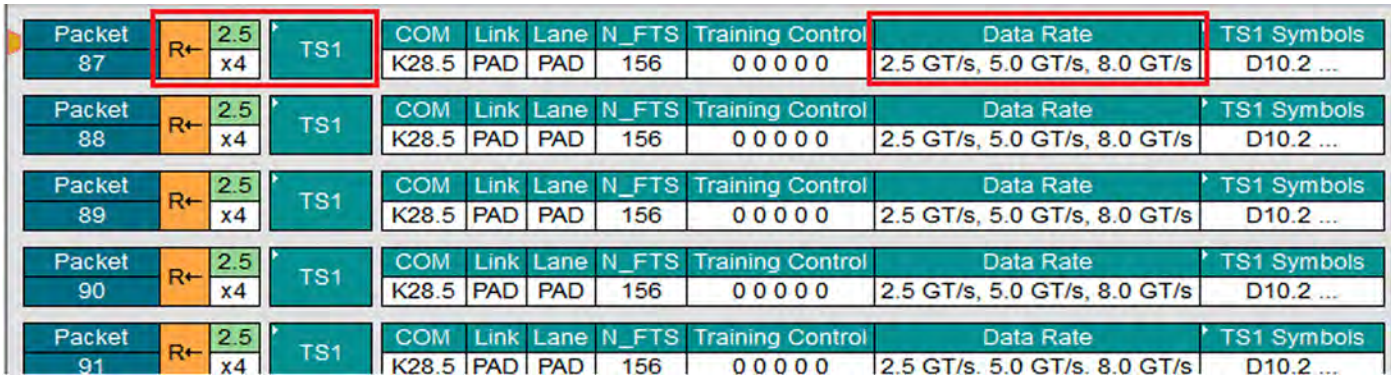


Figure 7.45: TS1 Packet with G1 Speed and G3 Data Rate

Example: Search for PMUX Channel ID

In this case, we are searching for the following event:

- PMUX Channel ID (see Figure 7.46)

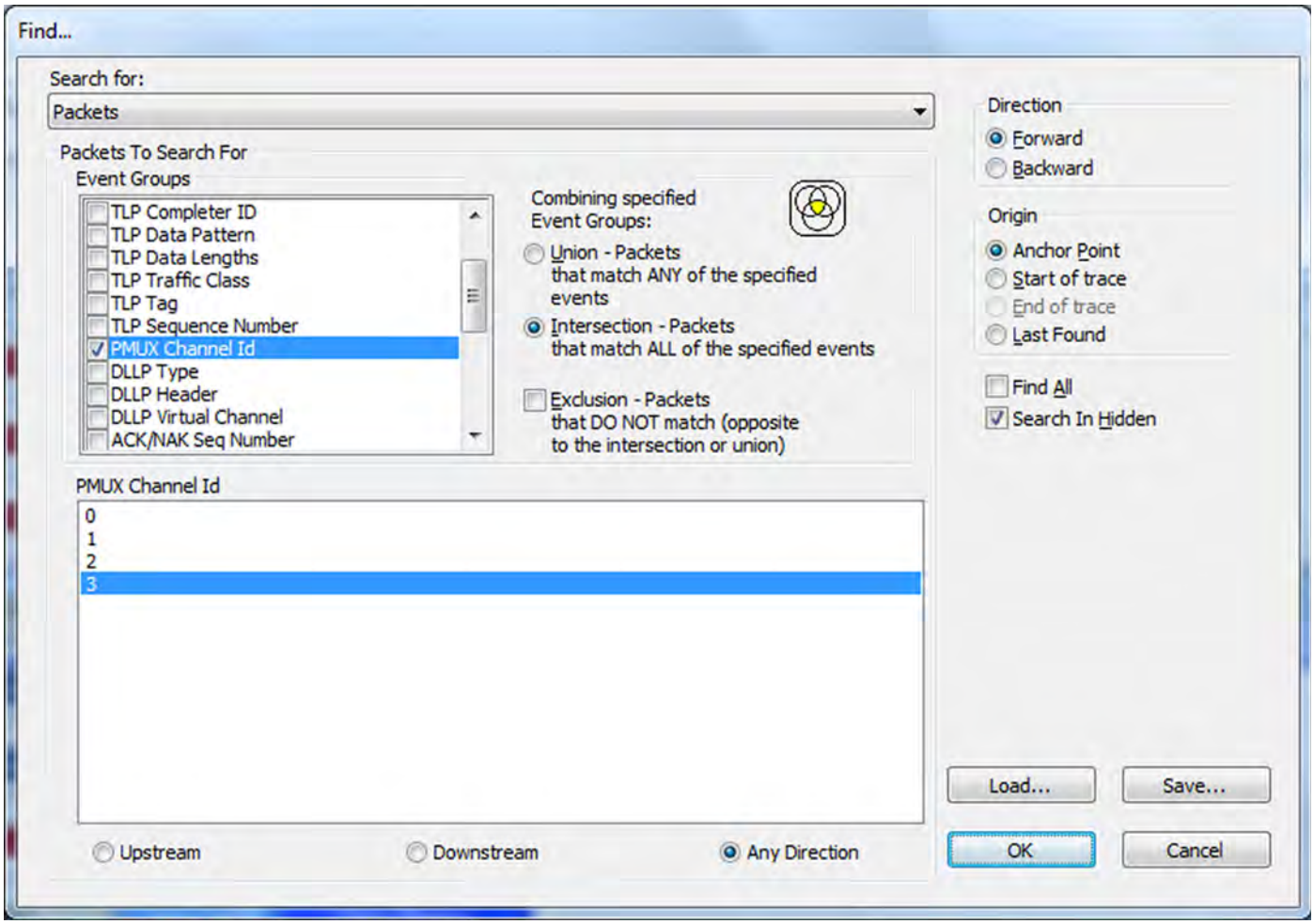


Figure 7.46: Search for: PMUX Channel ID (3)

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 7.47.

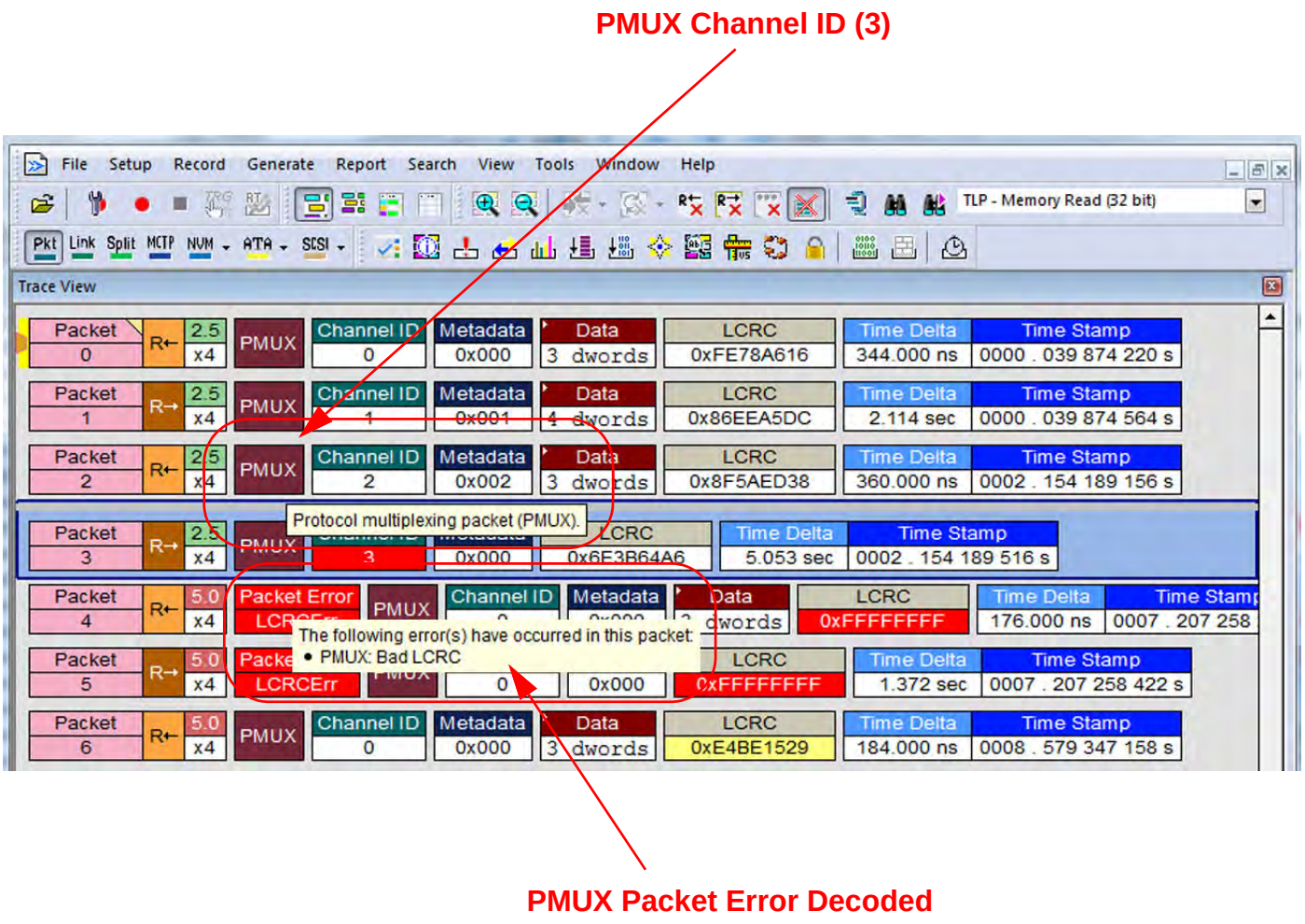


Figure 7.47: PMUX Channel ID (3) Found in Trace and Packet Error Decoded

7.10.2 Event Groups for Link Transactions:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID
- CompleterID
- Status
- Tag

7.10.3 Event Groups for Split Transactions:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- Requester ID
- Completer ID
- Status
- Tag
- Address

7.10.4 Event Groups for LM Commands

- Margin Command
- Margin Type
- Receiver Number
- Errors

Example: Search for Lane Margining Command: ReportLM_SamplingRateVoltage (see Figure 7.48 on page 616).

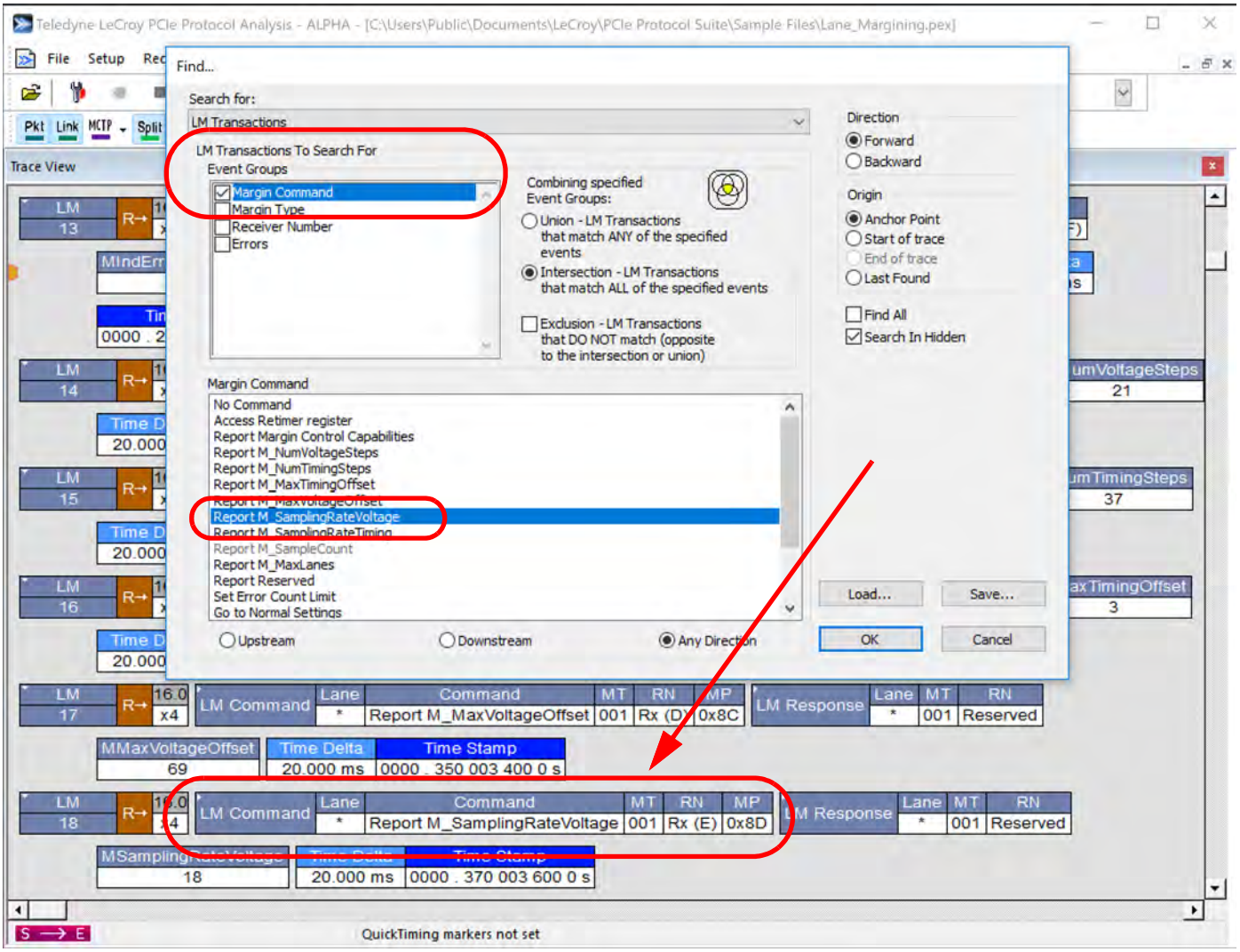


Figure 7.48: Find: Lane Margining Transaction -> Margin Command -> ReportLM_SamplingRateVoltage

7.10.5 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

7.10.6 Event Groups for PQI Transactions:

- PQI Register ID
- PQI Admin Functions
- PQI Errors

7.10.7 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

7.10.8 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

7.10.9 Event Groups for SOP Transactions:

- SOP Information Unit ID
- SOP Errors

7.10.10 Event Groups for SCSI Transactions:

- SCSI Commands
- Command Status
- Task Managements
- Task Management Responses
- Errors
- SCSI Logical Unit Numbers

7.10.11 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.

Example: Search for NVMe Command

In this case, we are searching for the following event (see Figure 7.49 on page 619):

- NVMe Command
- Event Group NVM command
- Command = 0x02, Read
- Value = 1
- Fields = SQID [SELECTED: 1]

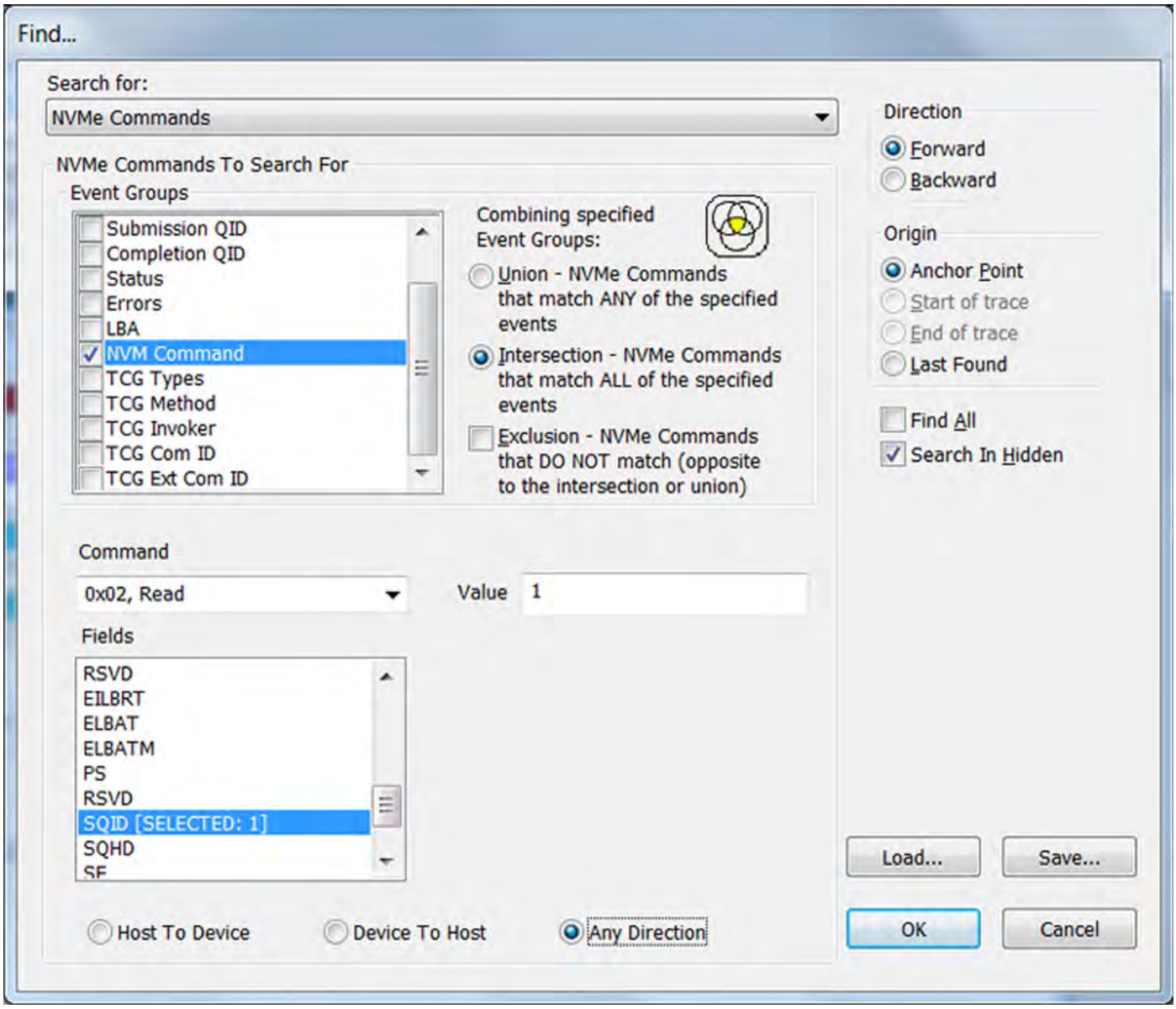


Figure 7.49: Find: Search for NVMe Command

Select OK.

Figure 7.50 on page 620 shows that NVMe Command #67 is a Read Command that has an SQID value of 1.

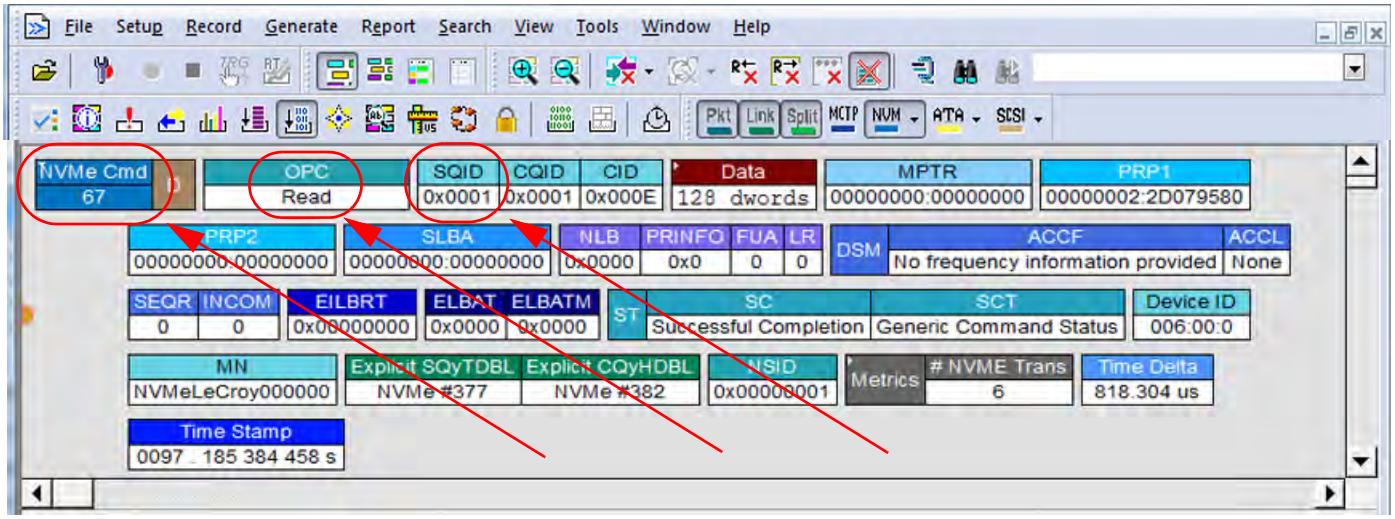


Figure 7.50: Find => Search for NVMe Command => Found

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 7.51.

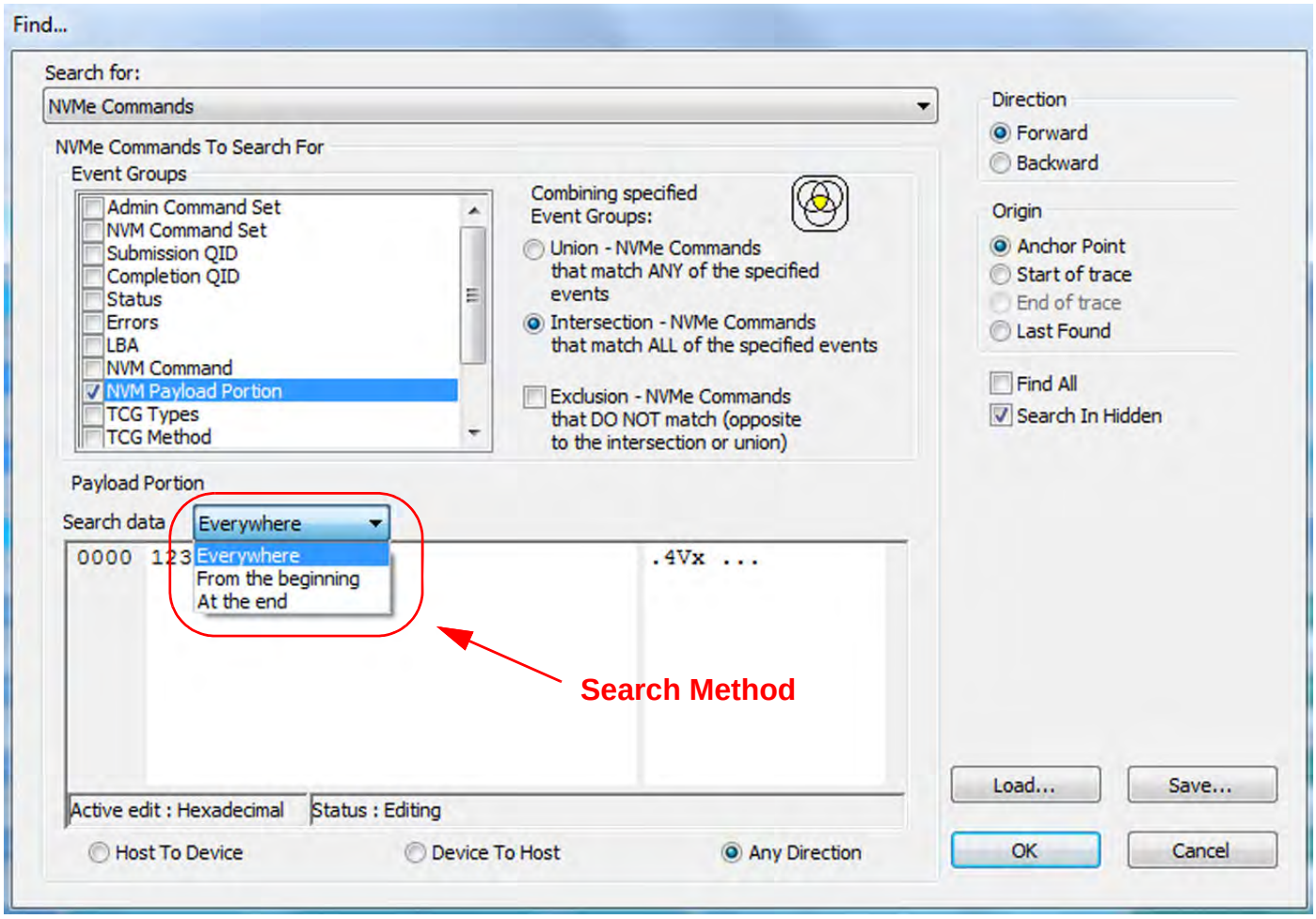


Figure 7.51: Find: Search for NVMe Commands -> NVM Payload Portion

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 7.52 on page 622.

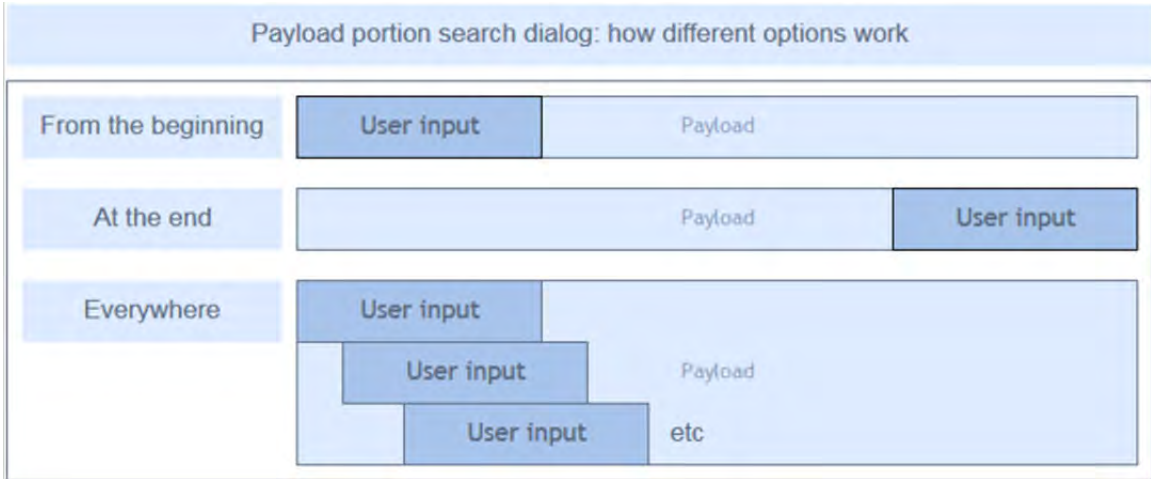


Figure 7.52: Search NVM Payload: Different Methods

7.10.12 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

Example: 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 7.53.

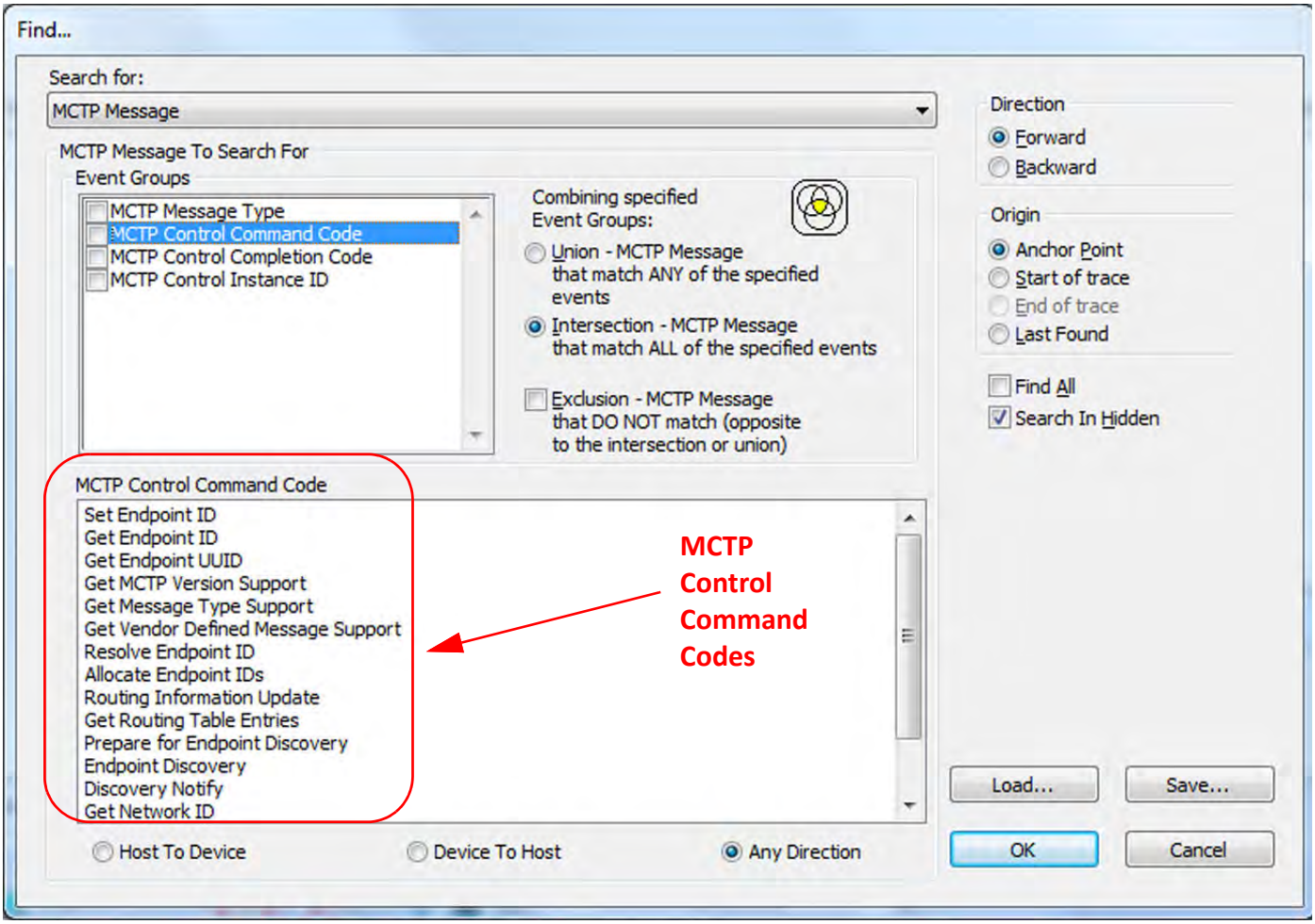


Figure 7.53: Search for MCTP Messages

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 7.54.

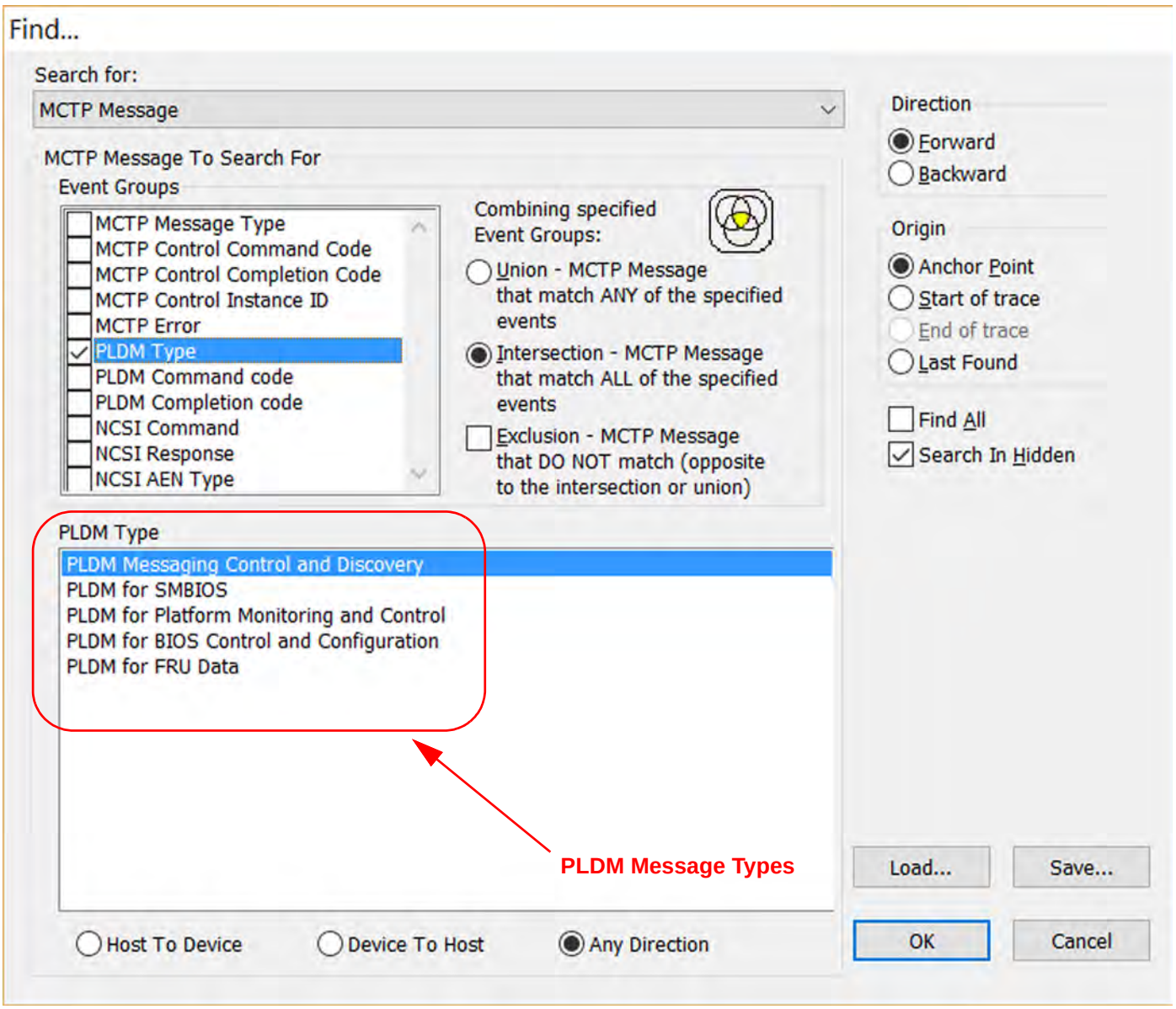


Figure 7.54: Search for PLDM Message Types with MCTP Message

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 7.55.

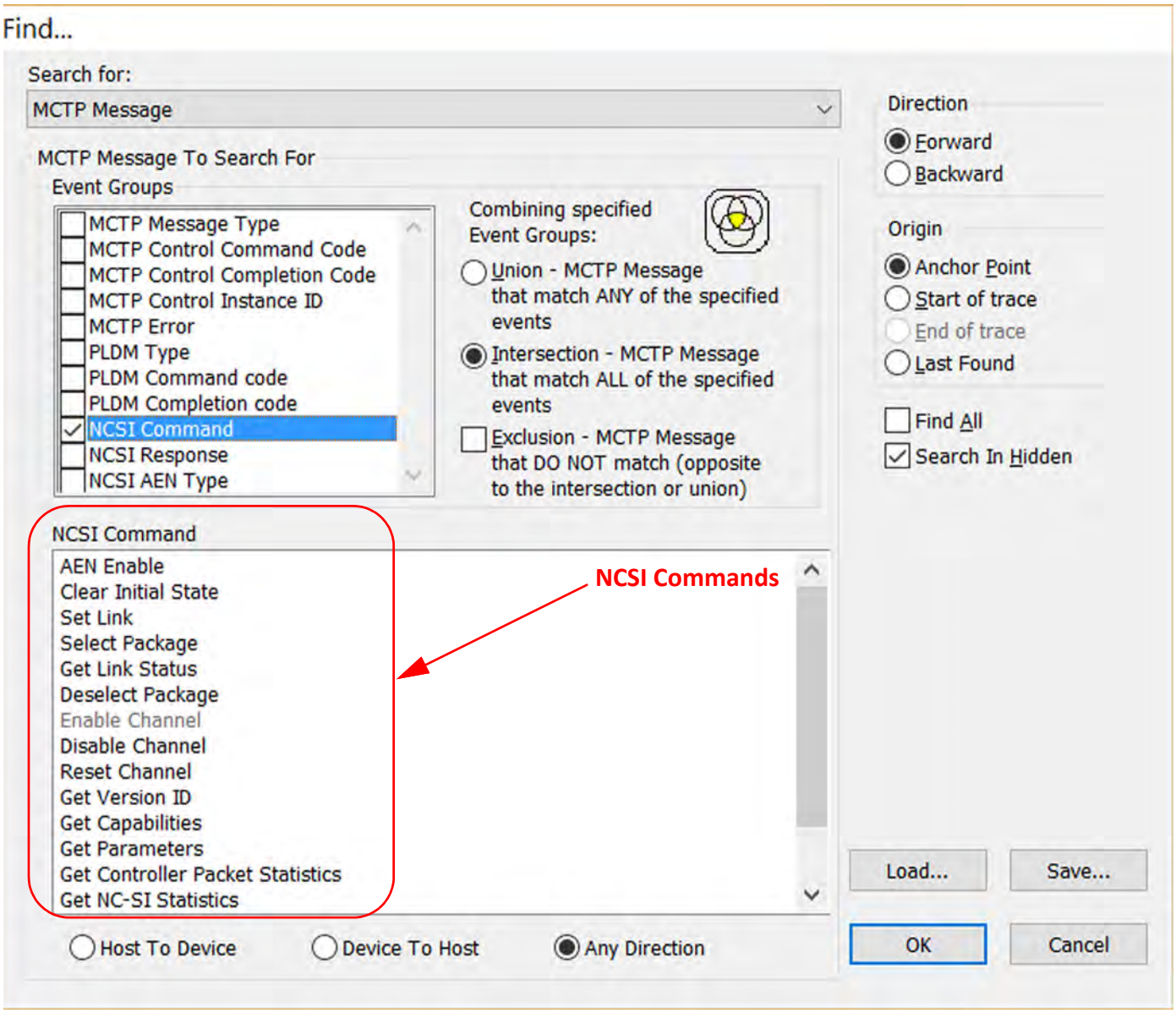


Figure 7.55: Searching for NC-SI Message Types within an MCTP Message

7.10.13 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 7.56 and Figure 7.57 on page 627)

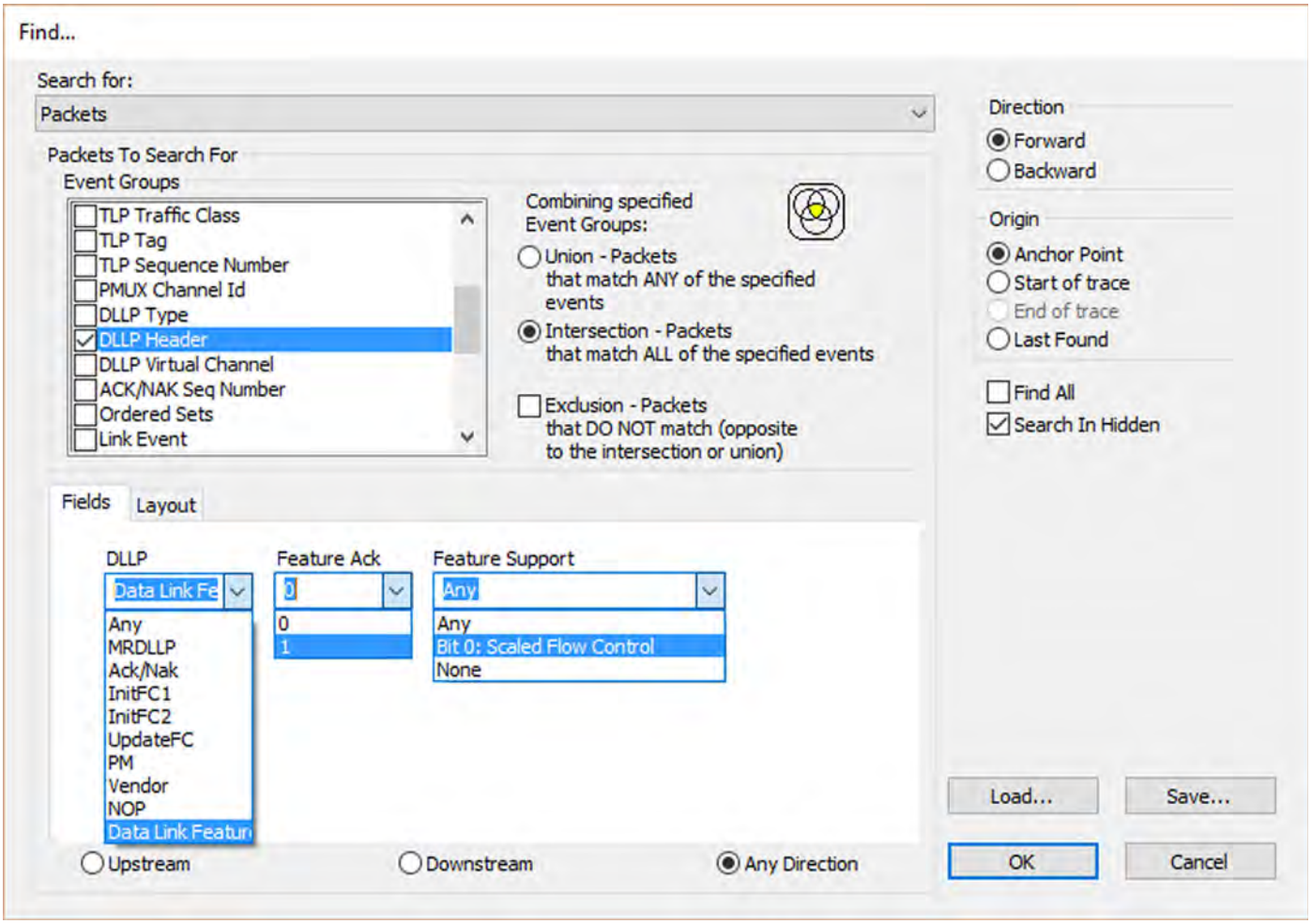


Figure 7.56: Search for: Flow Control Packet -> Fields

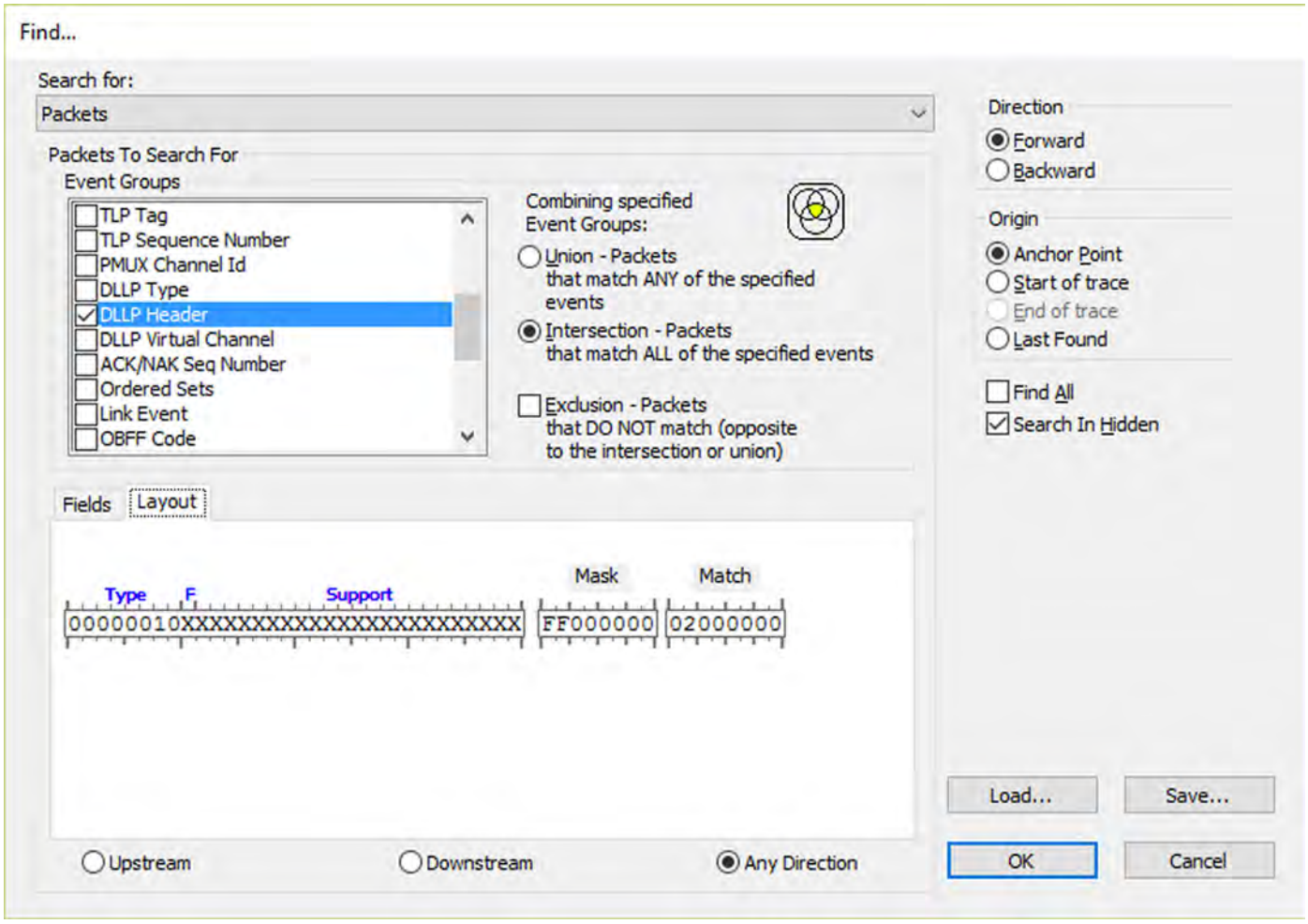


Figure 7.57: Search for: Search for: Flow Control Packet -> Layout

7.11 Find Next Packet Type

Use Find Next or click  to search for the next packet meeting the search criteria.

7.11.1 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 7.58).

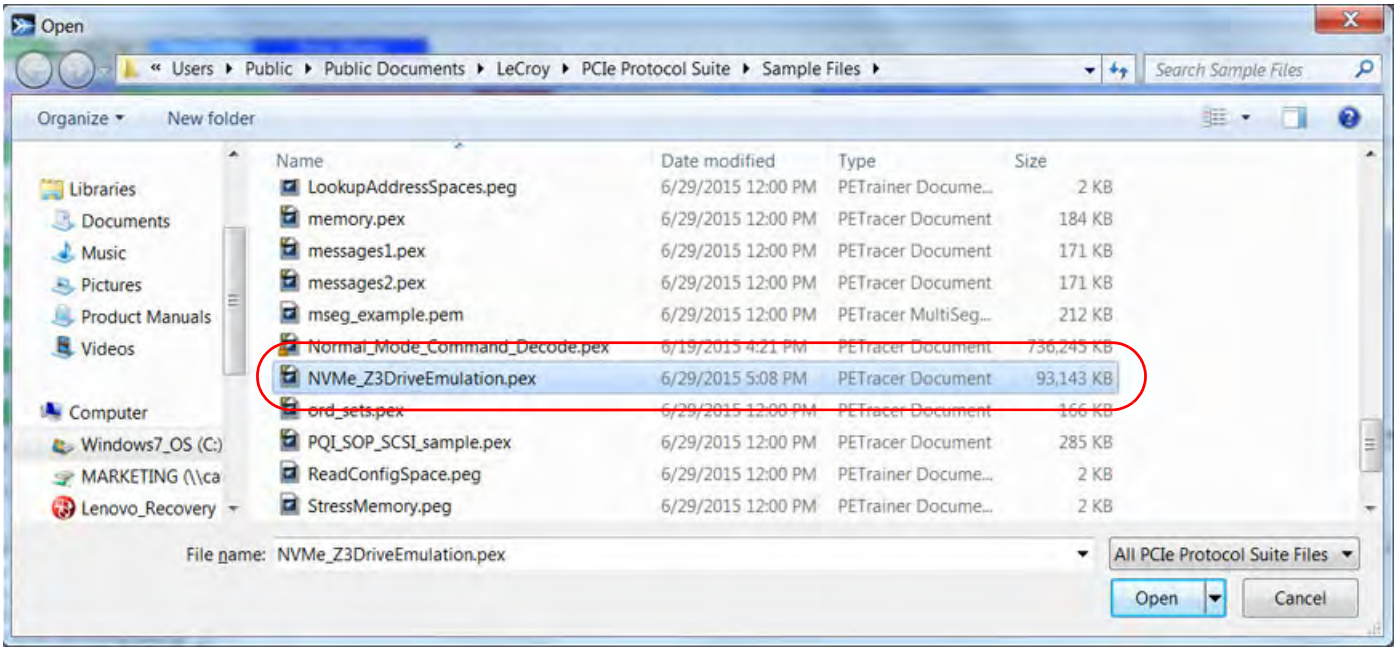


Figure 7.58: Location of Trace File to be Loaded

Select the NVMe_Z3DriveEmulation.pex file and click on Open.

The Main Menu will look like Figure 7.59 after you chosen to look for NVMe commands and removed unrelated traffic.

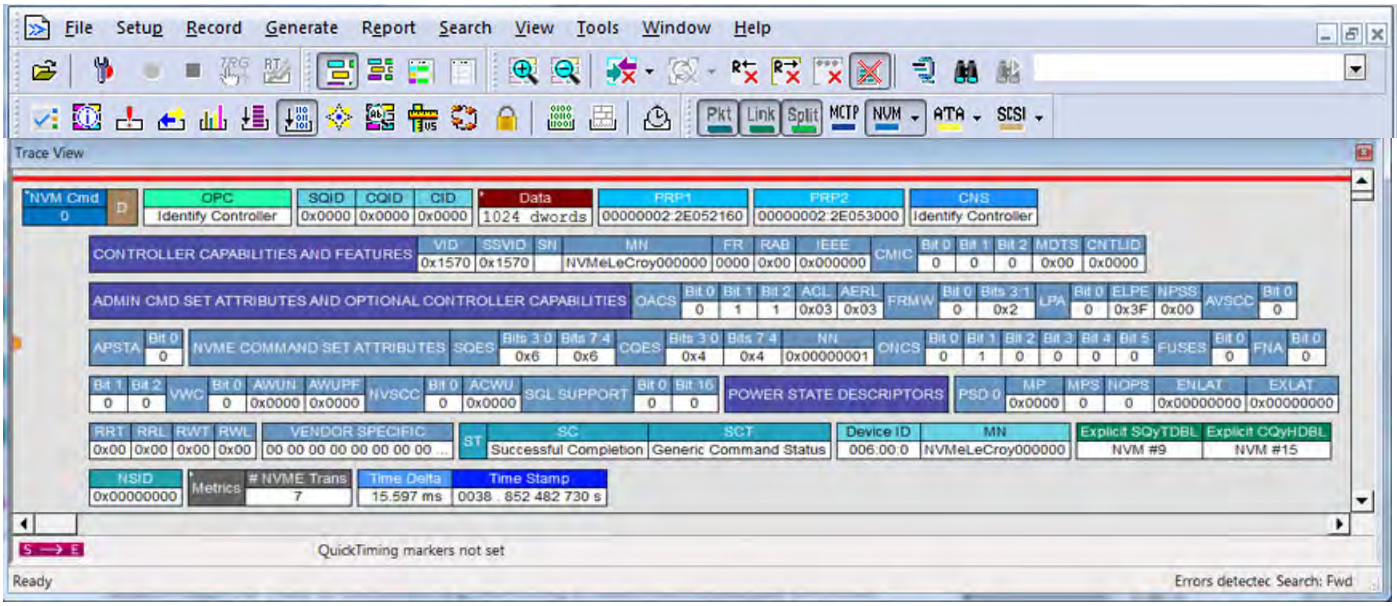


Figure 7.59: Main Menu with NVMe_Z3DriveEmulation Trace Loaded

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 7.60).

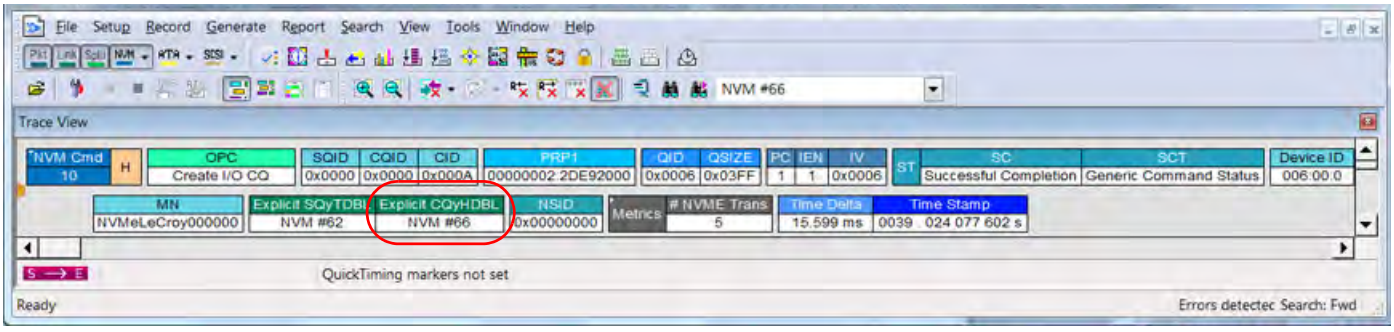


Figure 7.60: Search for NVM #66

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 4.11 on page 129) 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 7.61: Search Progress Window

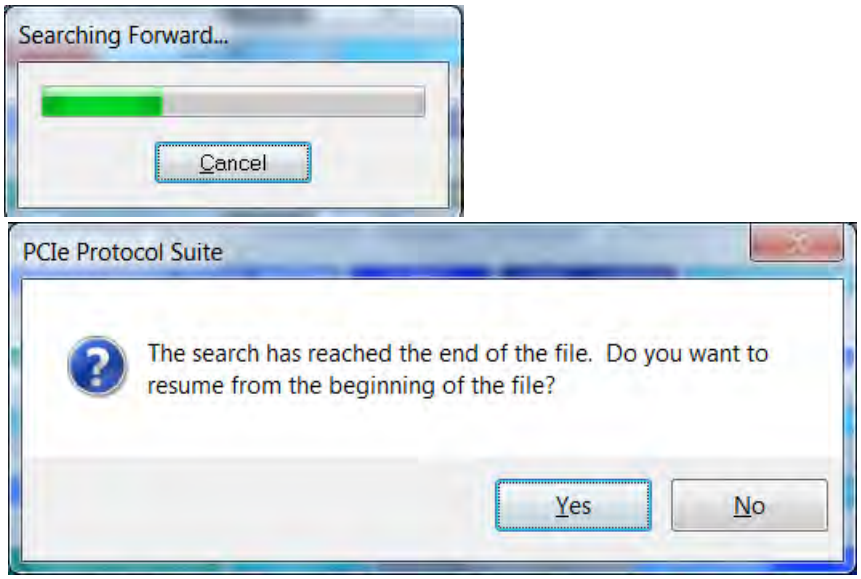


Figure 7.62: Resume Searching From Beginning of Trace

If you select Yes, the tool will continue searching from the start of the Trace, then the following window will pop up:

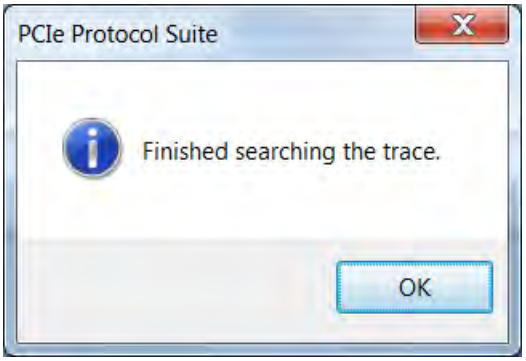


Figure 7.63: Finished Searching Trace

If the tool hasn't moved to a new Packet, the term being Searched for was not found.

7.11.2 Quick Search for MCTP Transactions

MCTP traces can use the Quick Search feature to look for MCTP Packets and Control Messages. See Figure 7.64.

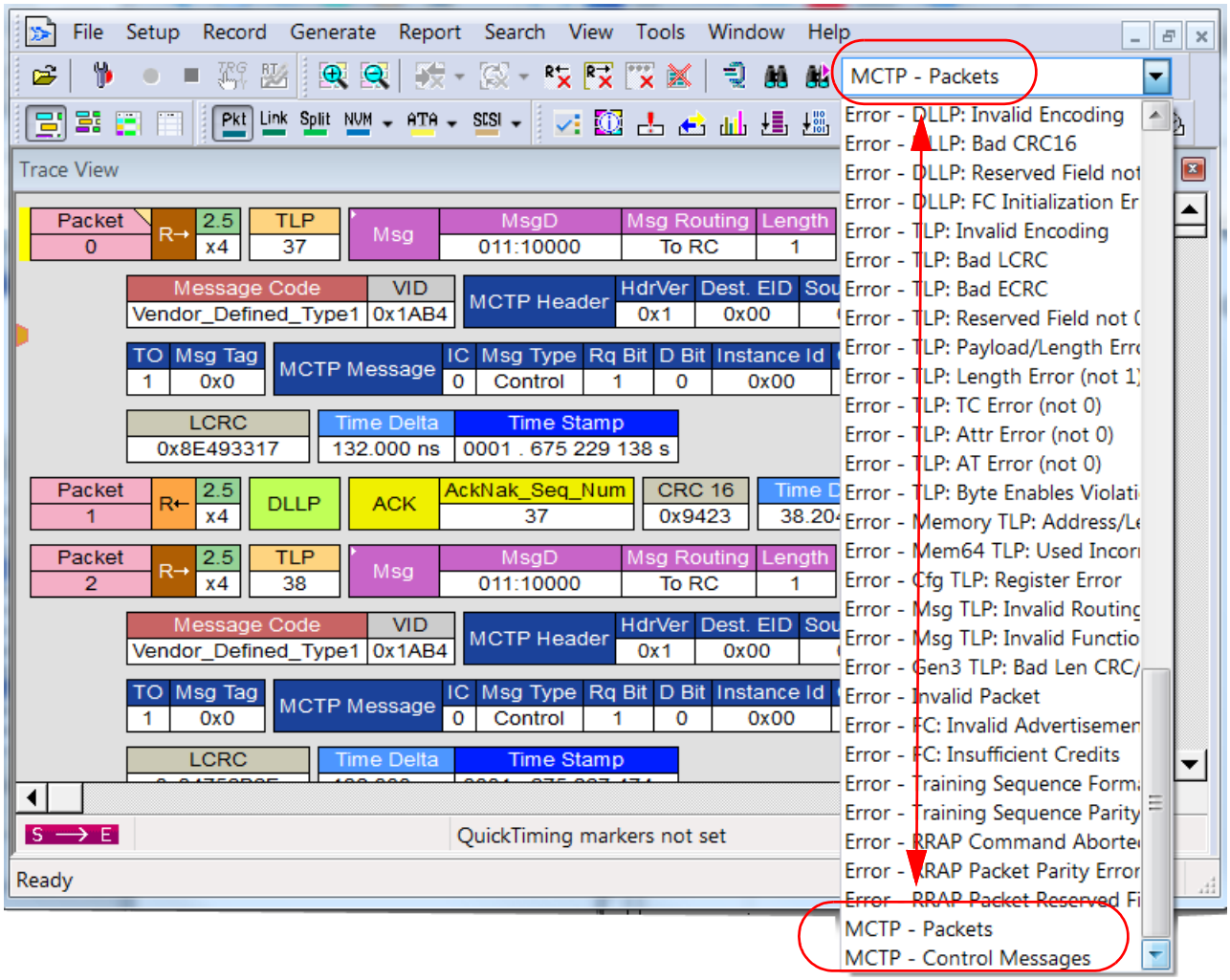


Figure 7.64: Quick Search Feature: MCTP Transactions

7.12 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.

Chapter 8

Display Options

8.1 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 8.1.

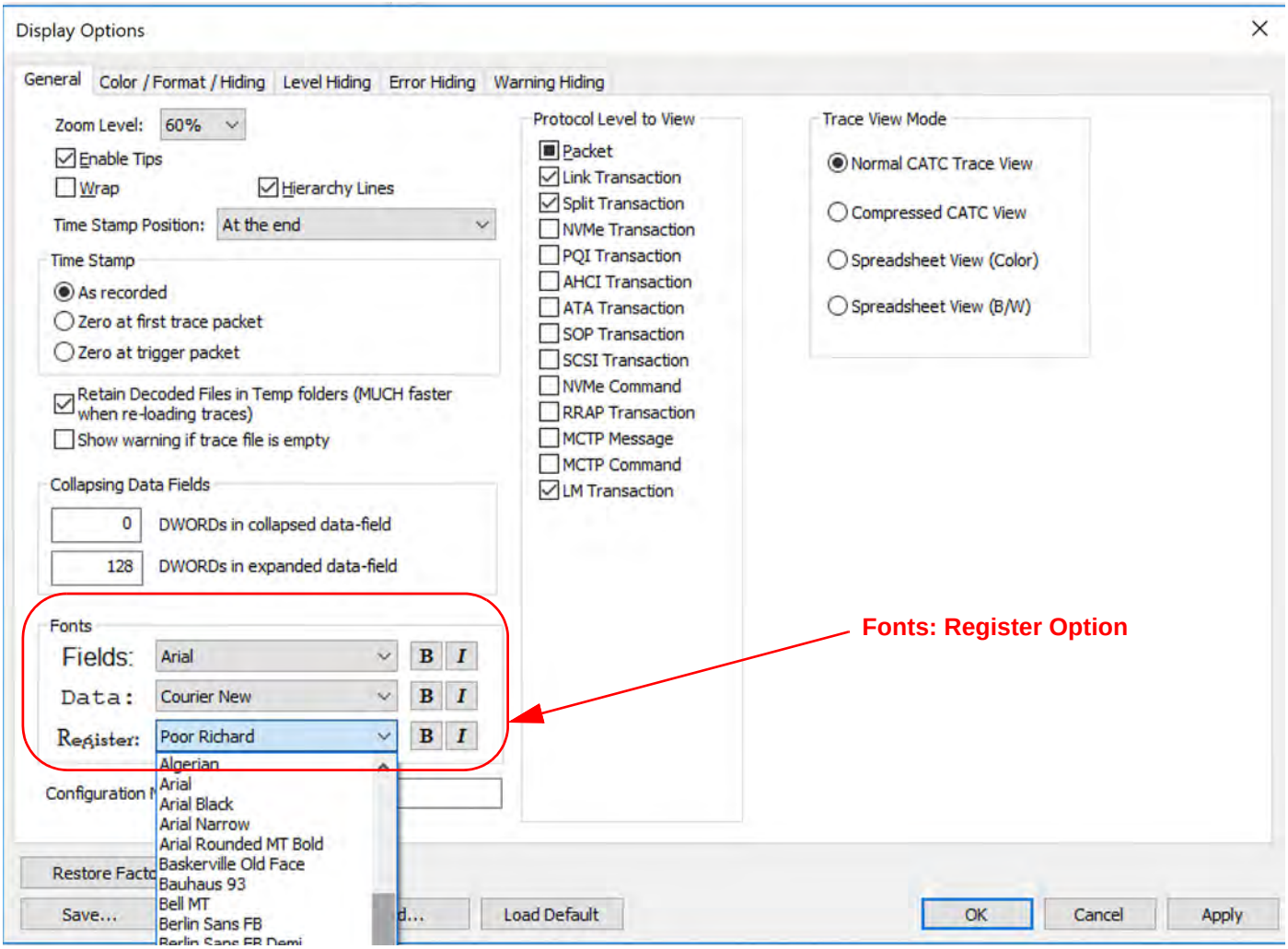


Figure 8.1: Display Options Dialog - General Tab

8.2 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, PQI, AHCI, ATA, SOP, SCSI command, NVMe 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).

8.2.1 Collapsing Data Fields

This affects the "Data" field in the TLP packets when using the collapse feature (see Figure 8.2 on page 651).

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.

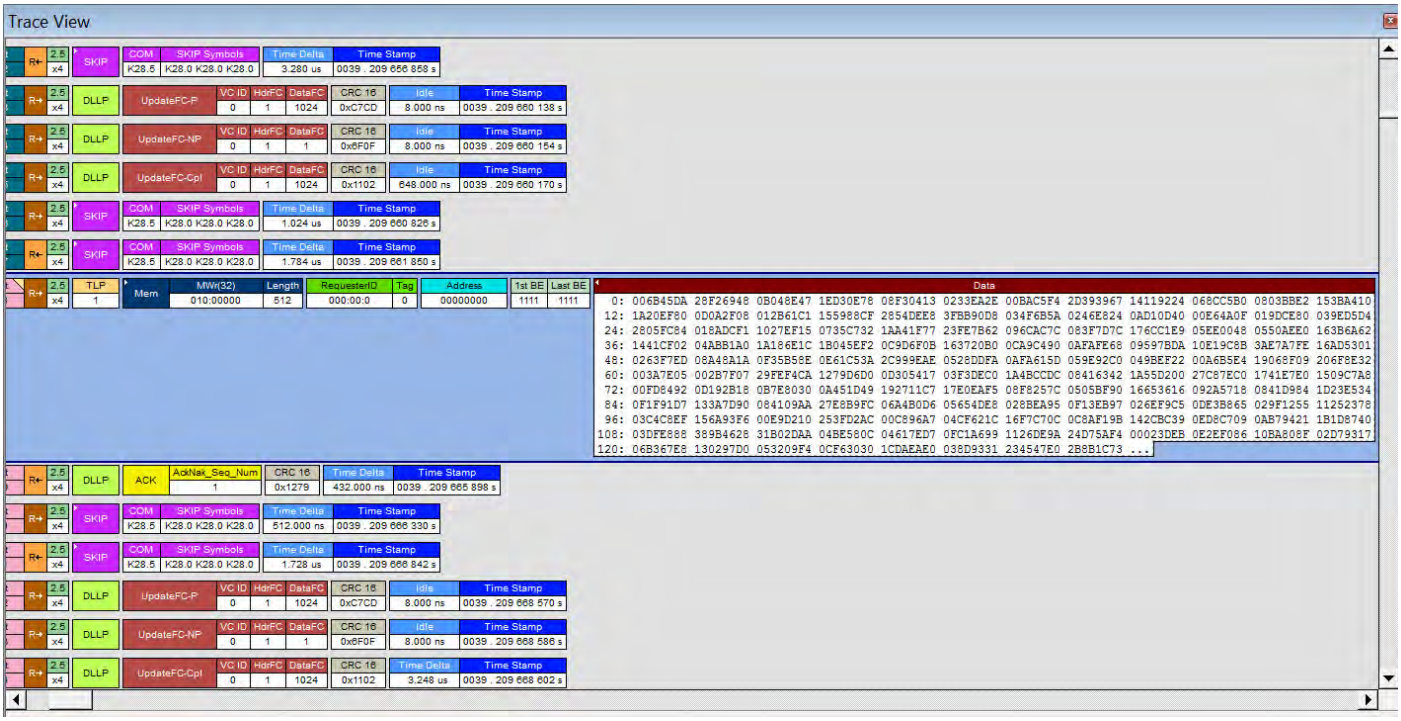


Figure 8.2: Expanded Data Field

8.2.2 Fonts

Fonts: Allows the appearance of field text and/or data text as well as Registers to be defined.

8.2.3 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.

8.2.4 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 8.3 on page 654).

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.

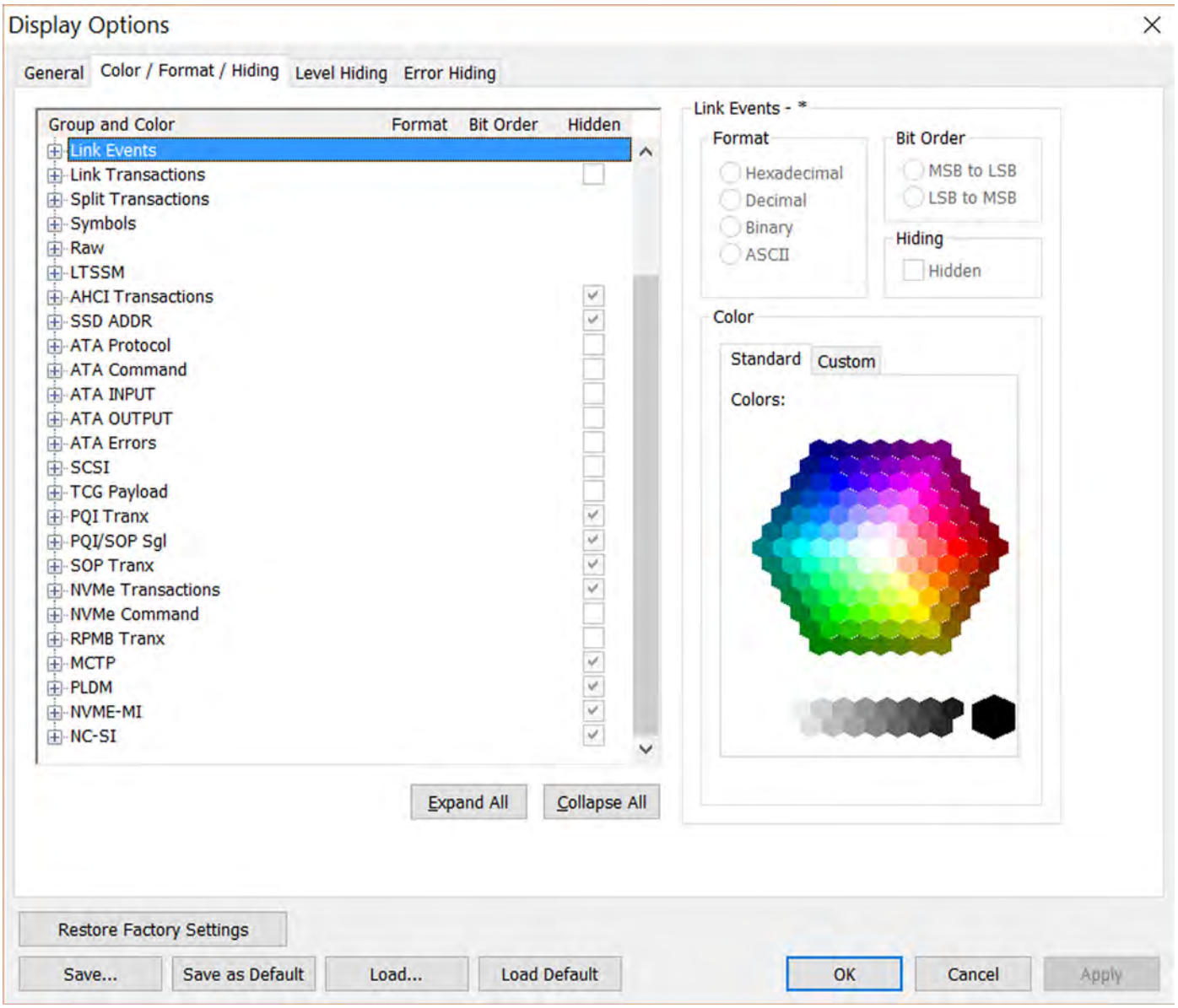


Figure 8.3: Display Options Dialog - Color/Format/Hiding Tab

8.2.5 Setting Field Colors

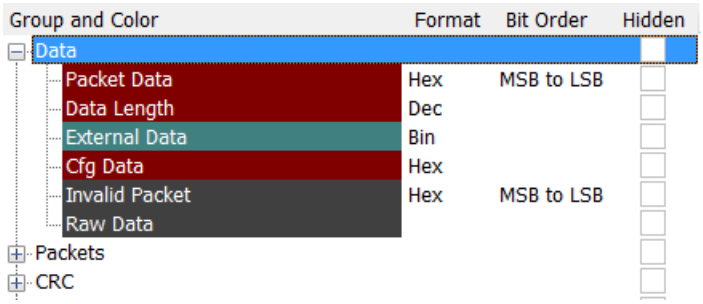
The Field Colors tab allows you to customize the colors associated with each field used in the packet view.

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 8.4 on page 656).

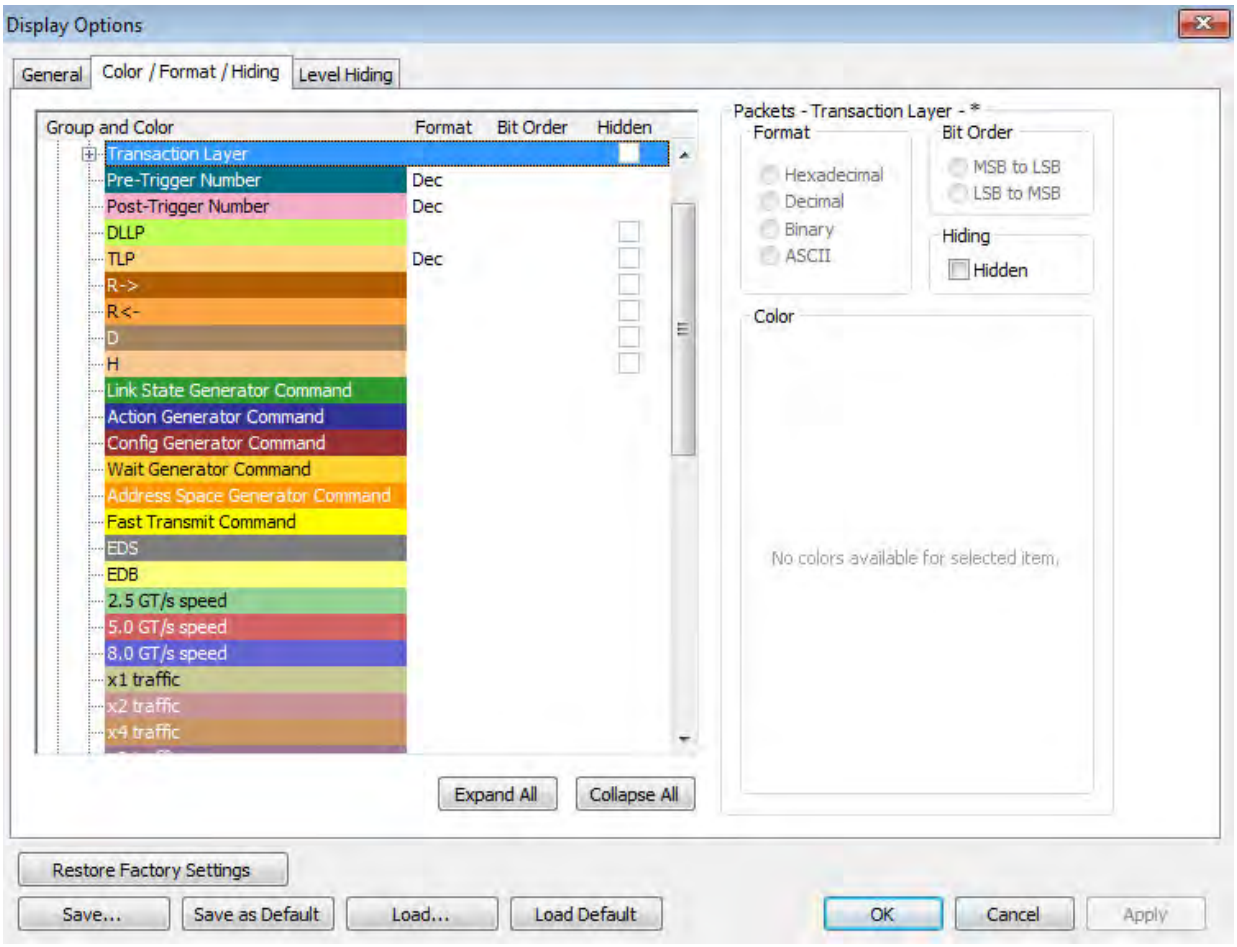


Figure 8.4: Display Options Dialog Color/Format/Hiding Tab

8.2.6 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 8.5 on page 657).

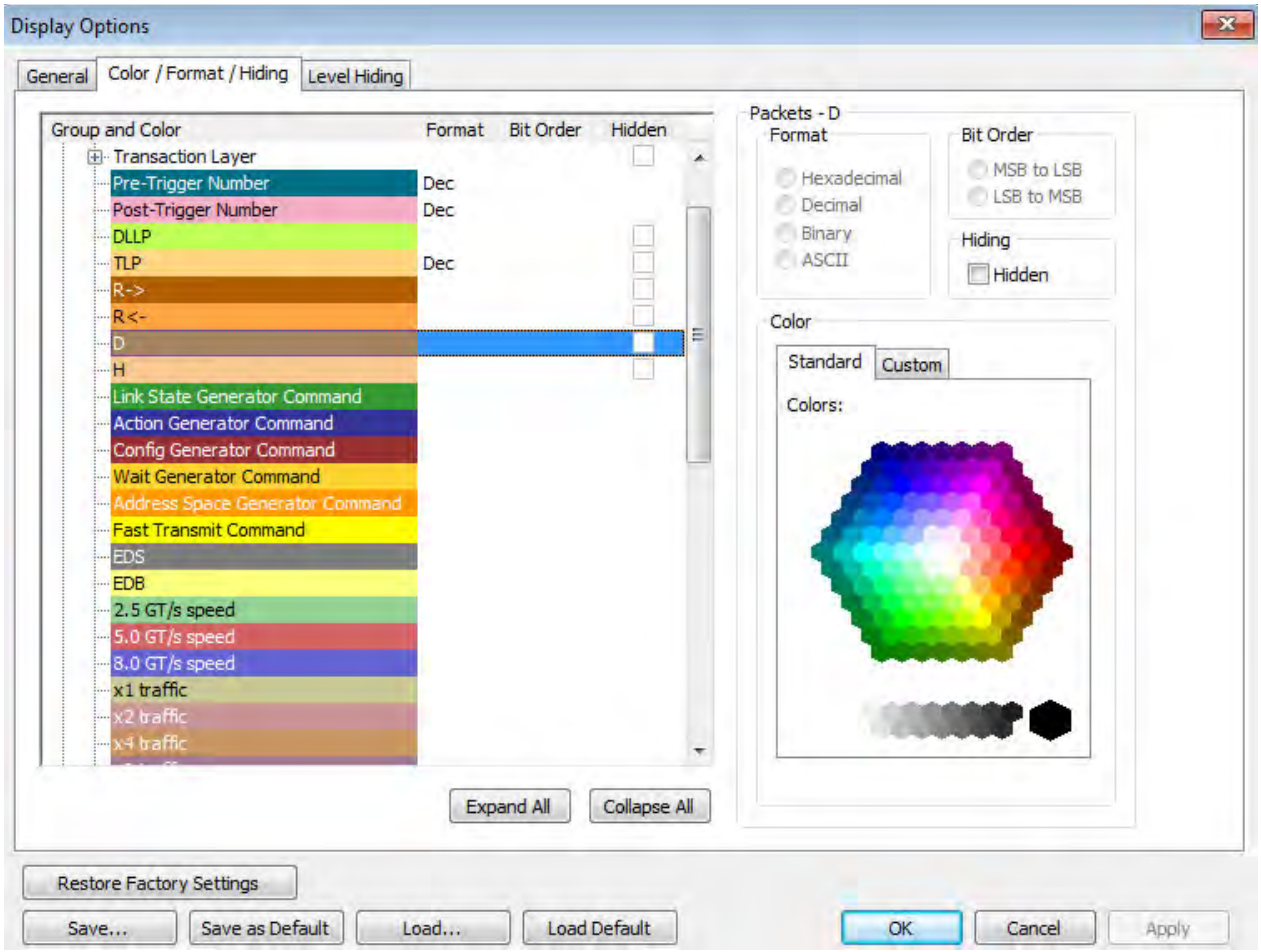
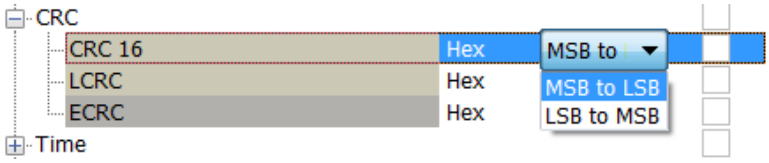


Figure 8.5: Display Options Dialog Color/Format/Hiding Tab

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**.

8.2.7 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.

8.2.8 Level Hiding

The Level Hiding tab lets you hide traffic by Event Group (see Figure 8.6). If you select one or more event types from the Event Group list, the selected types are hidden from the CATC Trace.

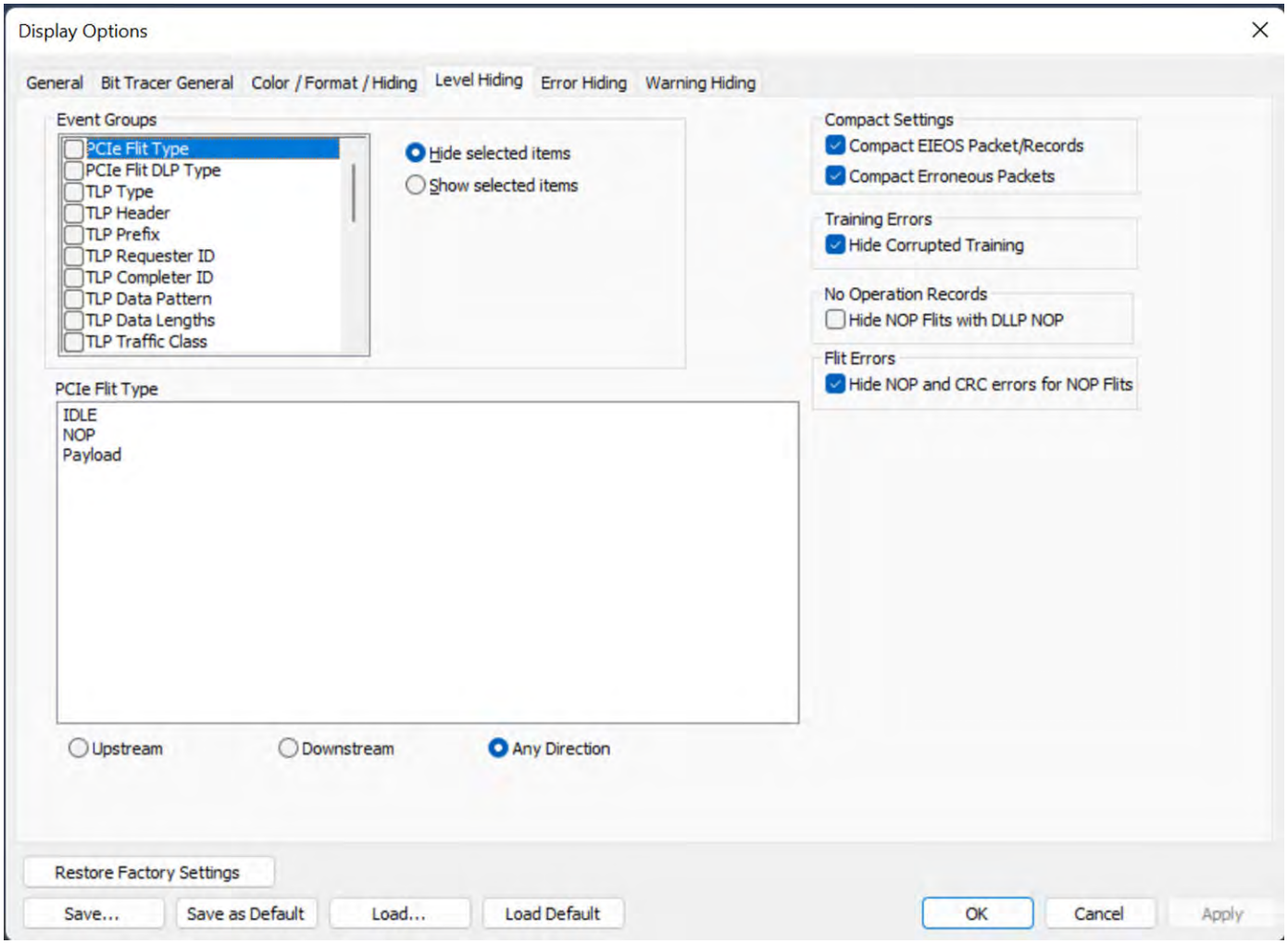


Figure 8.6: Display Options Dialog - Level Hiding Tab

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 **Sideband** signals. (These include SMBus signals).
5. (Optional) Select **Compact EIEOS packets** and/or **Compact Erroneous Packets**.
6. (Optional) Select **Hide Corrupted Training**.
7. (Optional) Select **Hide NOP Flits with DLLP NOP.**
8. (Optional) Select **Hide NOP and CRC Errors for NOP Flits.**
9. 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

8.2.9 Error Hiding

The Error Hiding page lets you hide errors by Transaction Types (see Figure 8.7). If you select one or more transaction types from the list, the selected types are hidden from the CATC Trace.

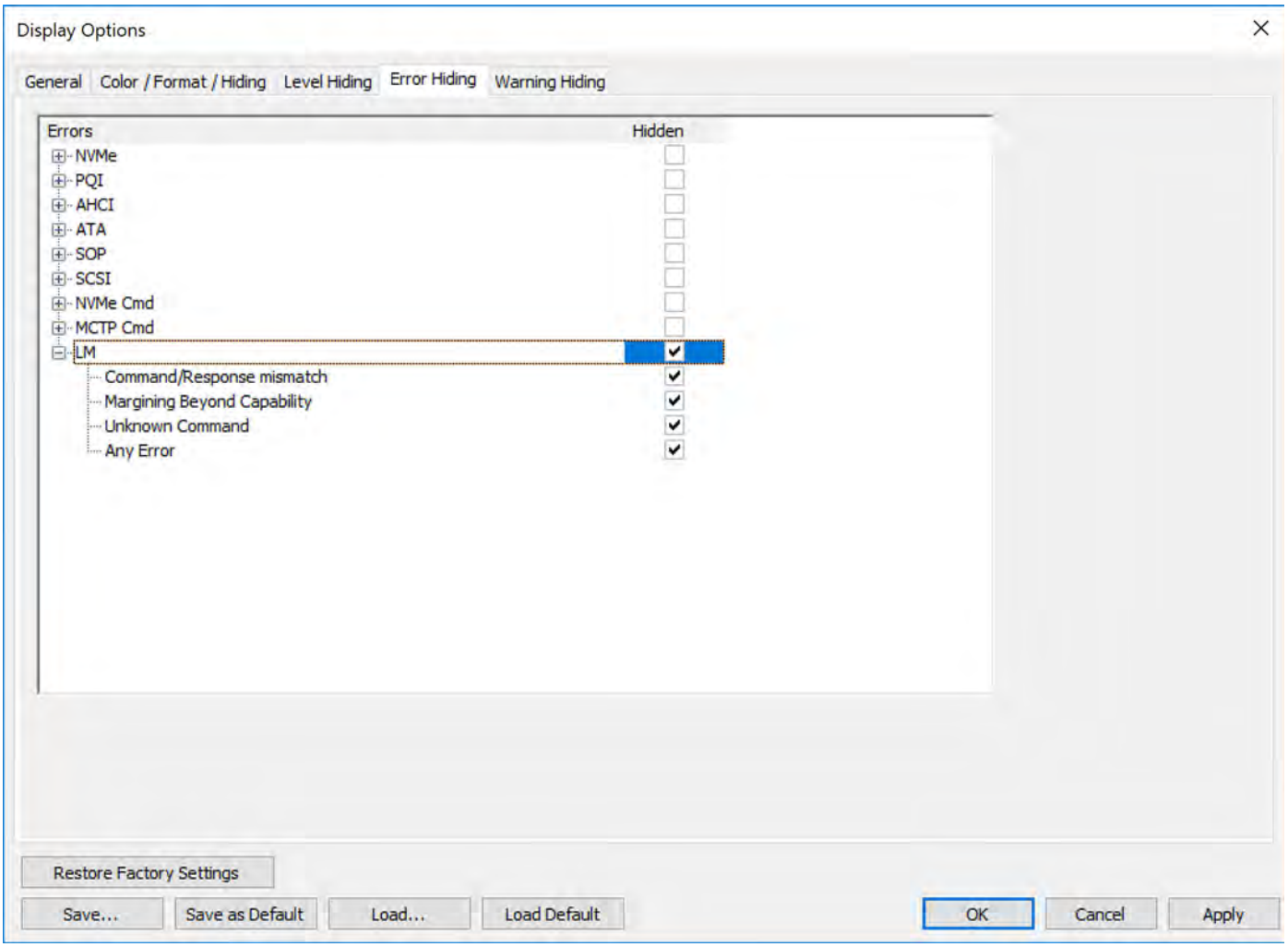


Figure 8.7: Display Options: Error Hiding -> Lane Margining Error Hiding shown

8.2.9.1 Transaction Types

The Transaction Types which can have their errors hidden include:

- NVMe
- PQI
- AHCI
- ATA
- SOP
- SCSI
- NVMe Cmds
- LM

Each Transaction Type has a large selection of errors that can be selectively hidden. See Figure 8.8, Figure 8.9 on page 666 and Figure 8.10 on page 667.

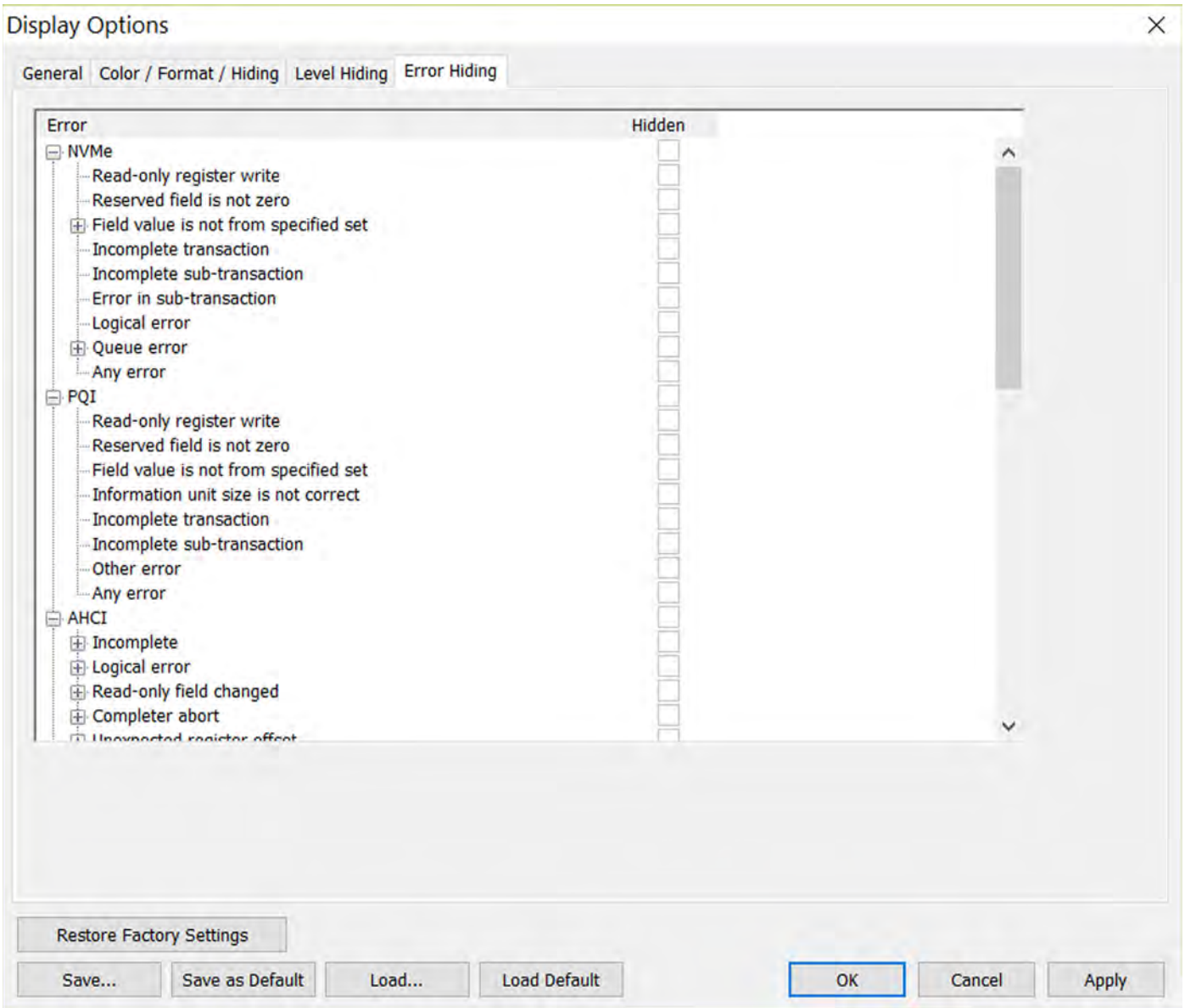


Figure 8.8: Display Options: Error Hiding -> Transaction Types: NVMe/PQI/AHCI

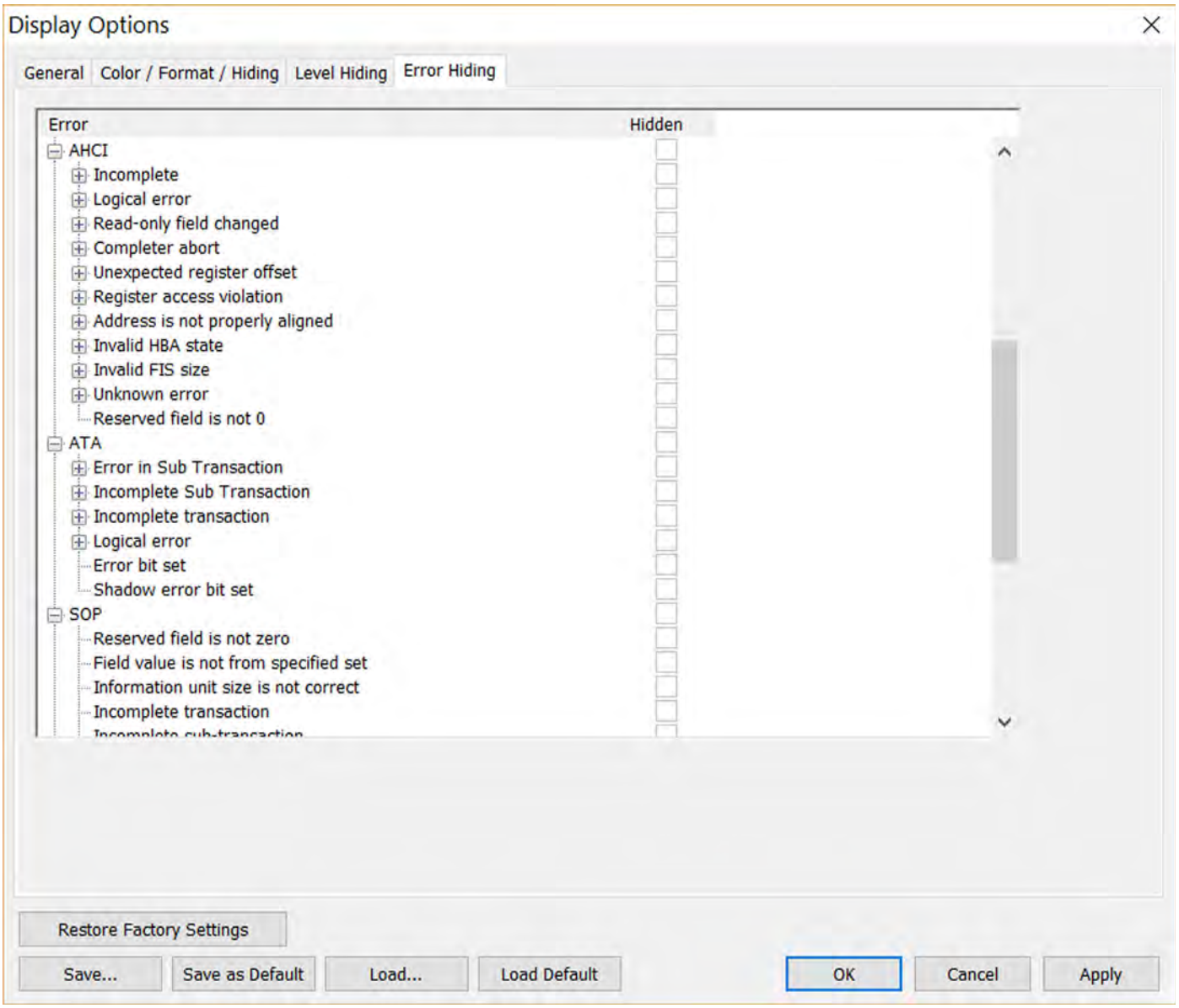


Figure 8.9: Display Options: Error Hiding -> Transaction Types: AHCI/ATA/SOP

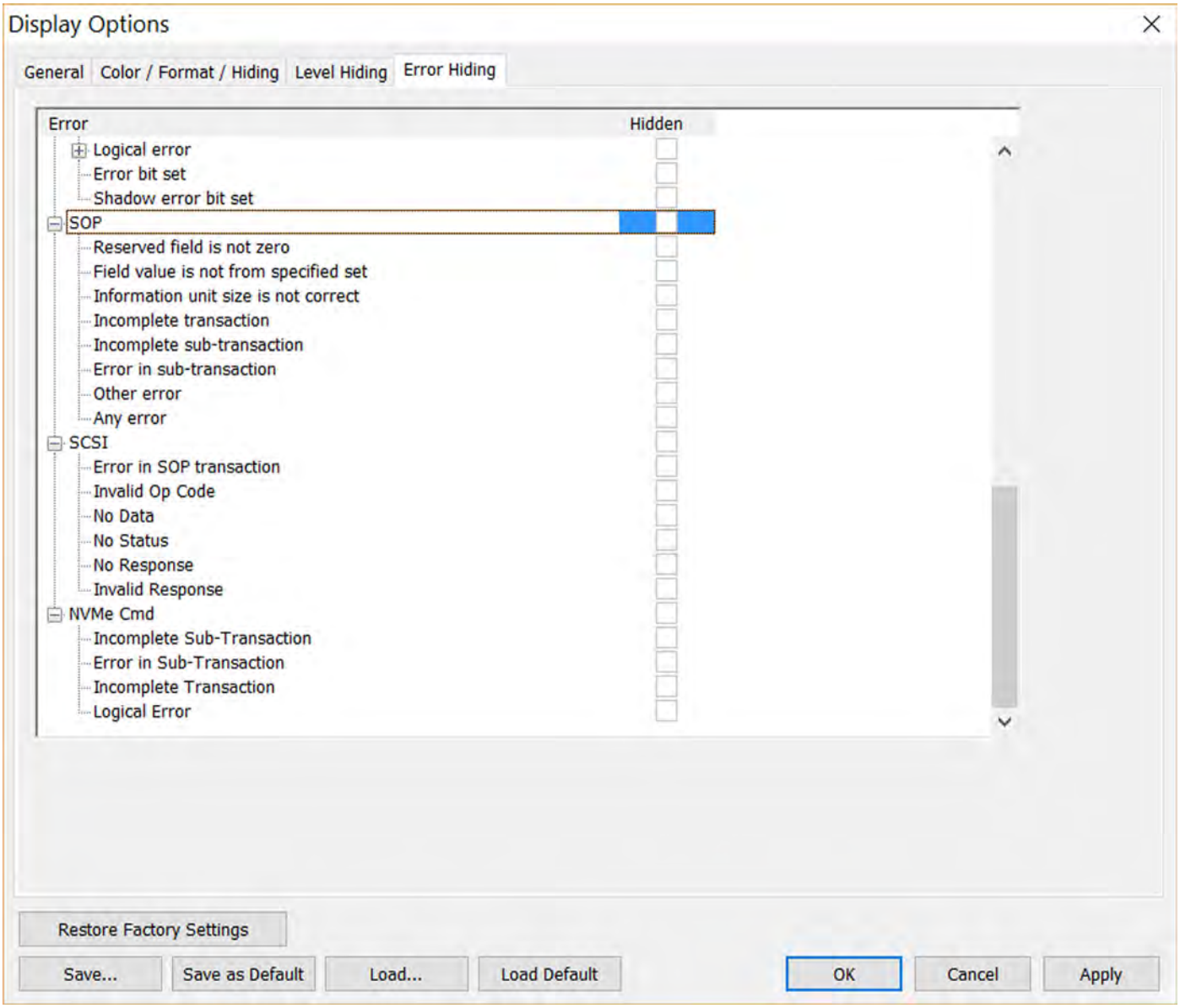


Figure 8.10: Display Options: Error Hiding -> Transaction Types: SOP/SCSI/NVMe Cmd

8.2.10 Warning Hiding

The Warning Hiding page lets you hide warnings by Transaction Types (see Figure 8.11). If you select one or more transaction types from the list, the selected warnings are hidden from the CATC Trace.

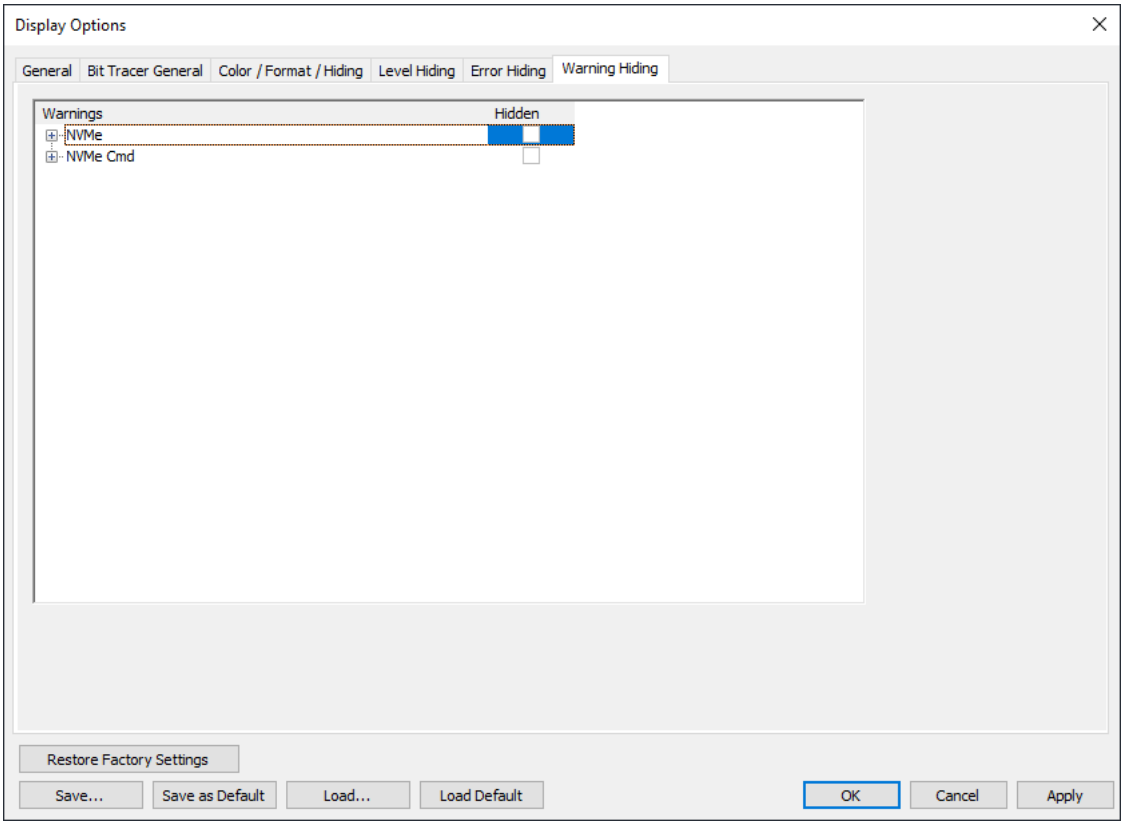


Figure 8.11: Display Options: Warnings Hiding

8.2.10.1 Transaction Types

The Transaction Types which can have their warnings hidden include:

- NVMe
- NVMe Cmds

8.3 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.

8.4 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.

Chapter 9

BitTracer Recording

Note: BitTracer Recording is an optional feature.

The Summit T416 or Summit T48 analyzer has an optional **BitTracer** data capture mode, which captures bi-directional link traffic in raw format. The BitTracer recording mode captures and displays traffic before lane-to-lane de-skew operations and before descrambling of 10b bytes. The BitTracer mode includes support for multiple logical links (bifurcations) on a single physical link.

The BitTracer recording mode has its own user interface, which provides characterizations of link traffic that are not available in the standard protocol analyzer mode. You can export BitTracer recordings for viewing in CATC Trace format.

Note: This feature can be included at initial purchase or added in the field with a software upgrade license. To obtain a software license key to add this feature, contact Teledyne LeCroy.

Lane Deskew Bypass in recording options prevents lanes from being bonded by the analyzer, allowing you to troubleshoot problems with physical layer.

9.1 Enabling BitTracer Recording

To enable the BitTracer recording mode, open the **Recording Options**.

In the Target Analyzer section of the General tab, select **Summit T416 or Summit T48.**

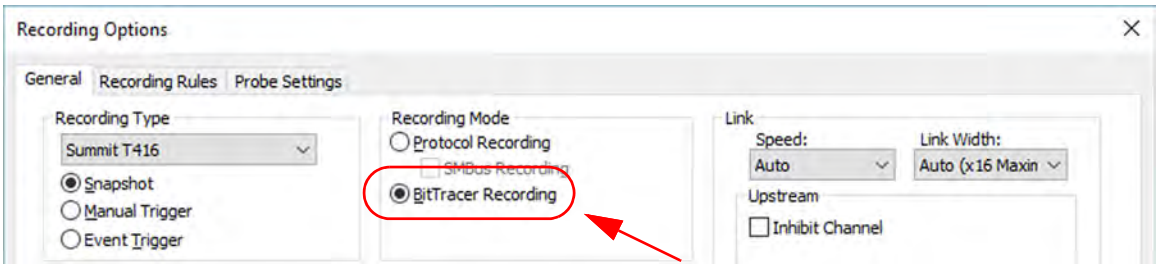


Figure 9.1: Recording Mode

In the Recording Mode section, select **Bit Tracer Recording.**

.

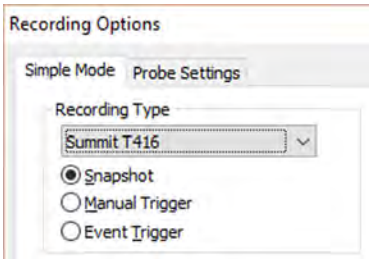


Figure 9.2: Recording Type

In Bit Tracer Recording, you can use the Snapshot, Manual Trigger, and Event Trigger recording types.

Note: You can also use other standard Recording Options, such as Link Width, Buffer Size, and Lane Polarity Settings, to characterize the link.

9.2 Trigger Modes

If you select Event Trigger, you may select basic trigger settings in the Trigger On dialog.

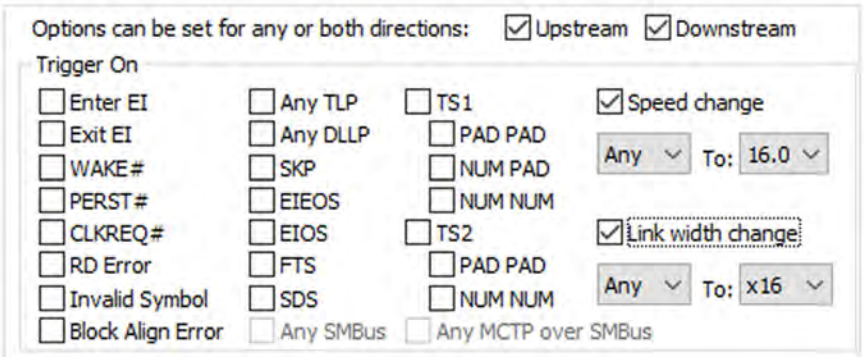


Figure 9.3: Trigger On Dialog

9.3 Views Available for Captured Data

BitTracer mode displays captured data lane-by-lane and byte-by-byte in each direction (upstream and downstream), with the time scale progressing left to right.

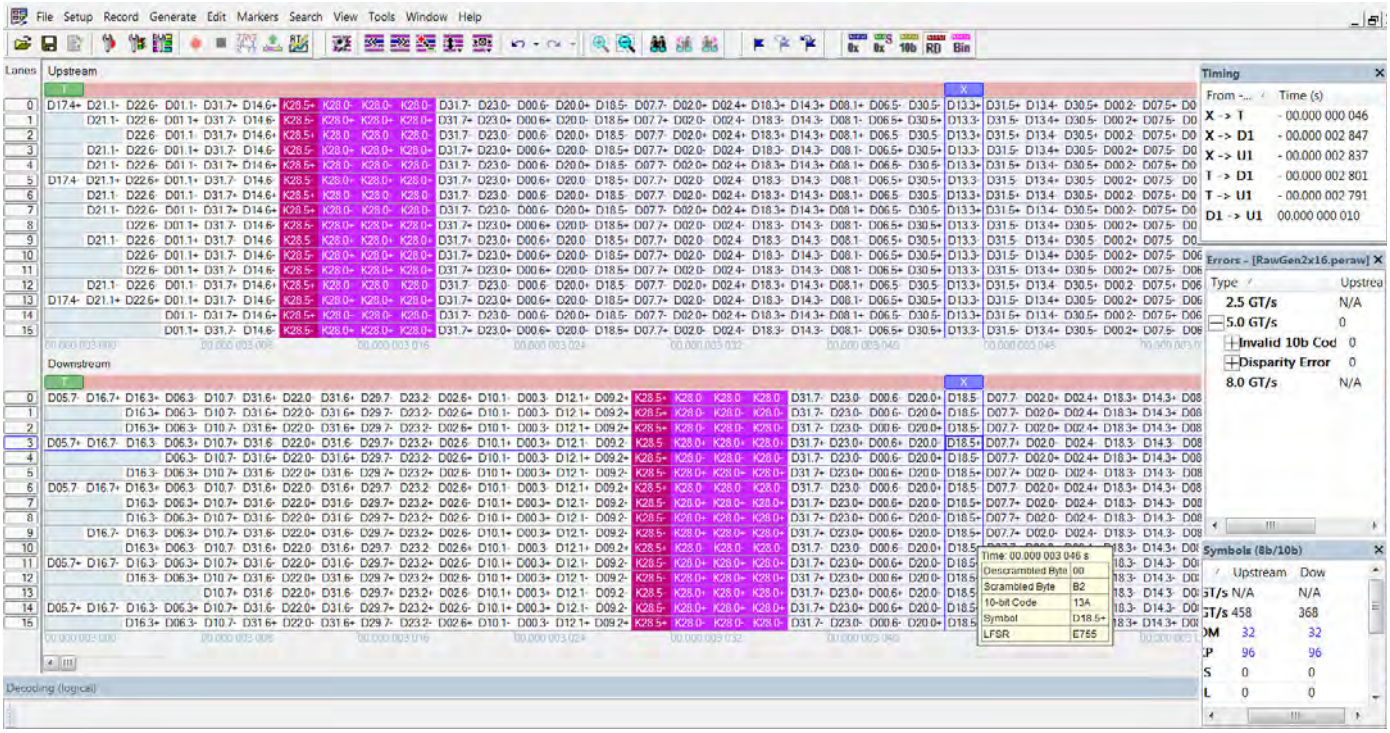


Figure 9.4: Captured Data

Other views are provided for timing measurements, marker placement, physical layer errors, captured symbol types, packets, events, and decoding of ordered sets and packets. You can view any or all displays simultaneously, using the **Windows** selection in the View menu.

9.4 De-skewing Data

By default, BitTracer recordings display captured data in time de-skewed format, across all lanes for both directions. But it is possible, for debug purposes, to bypass this de-skew using the **Lane De-skew Bypass** check box in **Recording Options**.

When lanes are not de-skewed, individual bytes are as they were captured on the recorded link, before the receiver device on the link (or the receiver logic on the PCIe Protocol Analysis analyzer) has performed lane-to-lane de-skew operations. You can manually skew the captured data, left or right, in increments of one symbol time (for Gen2 this is one byte) using the associated toolbar buttons. See Figure 9.5 on page 652.

Note: For Gen3 you can manually skew the captured data, left or right, in increments of 1 bit using the associated toolbar buttons.

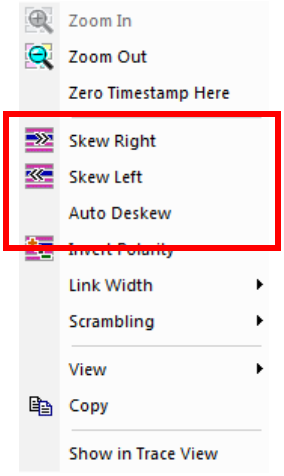


Figure 9.5: Skewing Data

You can automatically de-skew an entire lane direction. First, left-click on the direction in the data window. Then right-click to display a popup menu. Then select **Auto De-Skew.**



Figure 9.6: De-Skew Data

You can de-skew only one direction for each right-click operation. To automatically de-skew the opposite direction, first left-click on that direction in the data window.

Note: The skew observed in the bit tracer is the actual skew of the lanes in the link plus the skew introduced by the analyzer interface. The De-skew Bypass option is not intended for skew measurements or estimations.

9.5 Data Display Formats

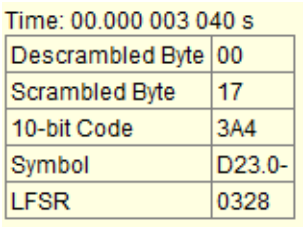
To display traffic in K/D symbol (with Running Disparity indicated), scrambled, descrambled, 10-bit, and Binary code formats:

- Use the toolbar.



Figure 9.7: Data Formats

- Right-click to display a menu.
- Place the cursor over any given byte to display all byte formats (including an LFSR value) in pop-up list.



Time: 00.000 003 040 s

Descrambled Byte	00
Scrambled Byte	17
10-bit Code	3A4
Symbol	D23.0-
LFSR	0328

Figure 9.8: Pop-up List

Note: Descrambled values can only be displayed after the first recorded skip ordered set. Data prior to the skip is displayed in scrambled values, due to the unknown LFSR.

Note: For Binary Data Display Format, bits are shown in order of transmission on the bus.

9.6 Color-Coding of BitTracer Contents

To increase visual understanding of BitTracer displays, different symbol types have color-coding:

- Presence or non-presence of a lane's byte-lock
- Idle data characters (D0.0)
- K codes
- Invalid 10b symbols
- Signal presence
- Background of the Markers Bar (see "Markers/Speed Bar" on page 655). (color coded according to traffic speed).
- All symbols of a TS1/TS2 ordered set

By default, these color selections match the standard color selections used in the CATC Trace format. You can modify them in the Display Options menu, accessible from the Main toolbar or the Setup menu.

9.7 Report and Analysis Windows

In the report windows, BitTracer mode provides several functions to analyze traffic:

- Statistical information
- Timing measurements
- Packet decoding

To activate/deactivate a report window, use **Views > Windows,** see Figure 9.9 on page 654.

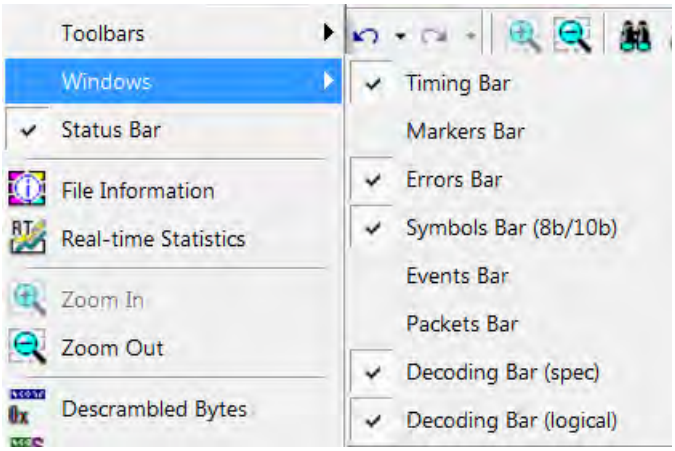


Figure 9.9: Activate/Deactivate Reports

You can rearrange the report windows.

All report windows are dockable.

9.8 Timing Measurements Bar

BitTracer mode provides timing measurements on captured data:

- Measurements from the Trigger position relative to user-selected X and Y markers
- X-Y measurements
- Measurements between user-defined markers

9.8.1 Markers/Speed Bar

Markers are displayed in the speed bar above the data. Place your cursor in the speed bar and the Current speed will be displayed. In this case, the traffic was running at 5.0 GT/s when the trace was taken. See Figure 9.10.

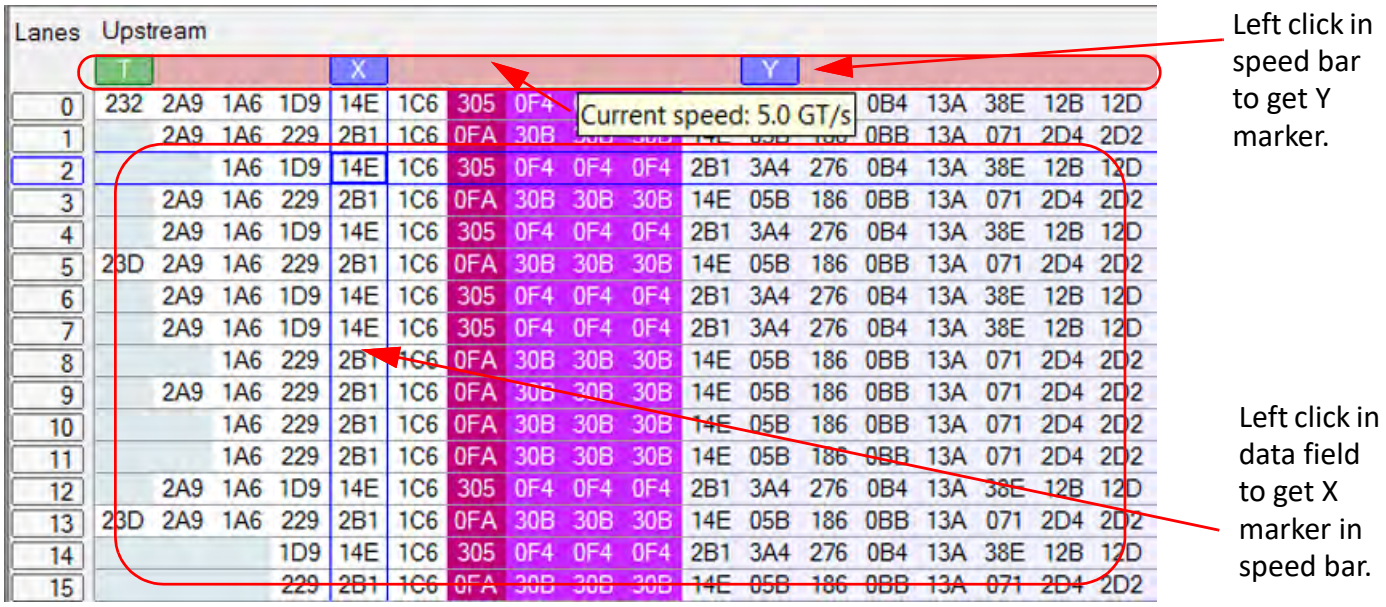


Figure 9.10: Marker/Speed Bar Example

The Trigger marker T is at the point where BitTracer recognized the user-defined trigger condition.

To set an X marker X, left-click anywhere in the data display, see Figure 9.10.

To set a Y marker Y, left-click in the narrow speed bar where the T and X markers are displayed. See Figure 9.10.

9.8.2 Defining a Marker

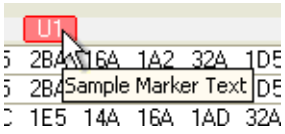
To define a marker, select the **Set Marker** command in the Markers menu or use the **Toggle Marker** icons in the toolbar. You can also use the Jump to Next or Previous marker icons in the toolbar.



User-defined markers are numbered in the order they were placed:

- U1 U1, U2, and so on in the upstream direction
- D1, D2 D2, and so on in downstream direction.

You can set a marker with text using the **Set Marker with Text...** command in the Markers menu. After setting the marker, when the mouse pointer is on the marker symbol, the marker text displays as a tooltip.



You can also display the Markers window, which lists all markers and their locations, including a hyperlink for each.

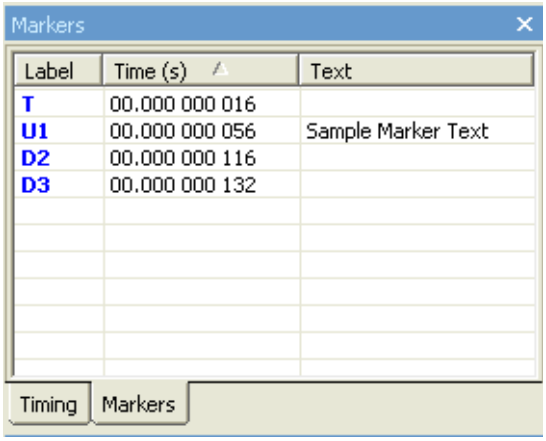


Figure 9.11: Markers Window

Timing measurements between all combinations of X, Y, U, and Trigger cursors are in the Timing window.

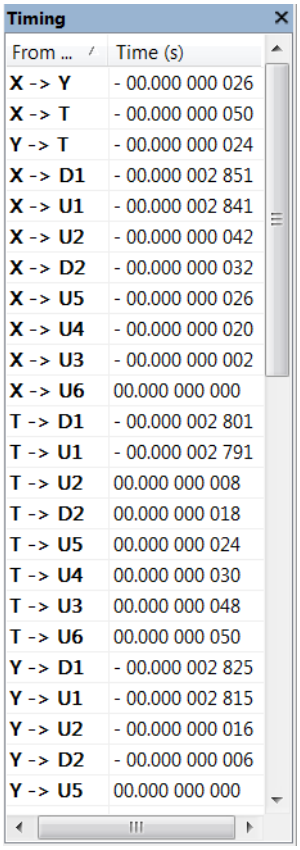


Figure 9.12: Timing Window

9.9 Errors Bar

BitTracer mode provides a summary of 10b errors (invalid symbols) and disparity errors in the Errors window. The window shows the total error count and errors per-lane for each error type. Hyperlinks allow jumps to selected errors.

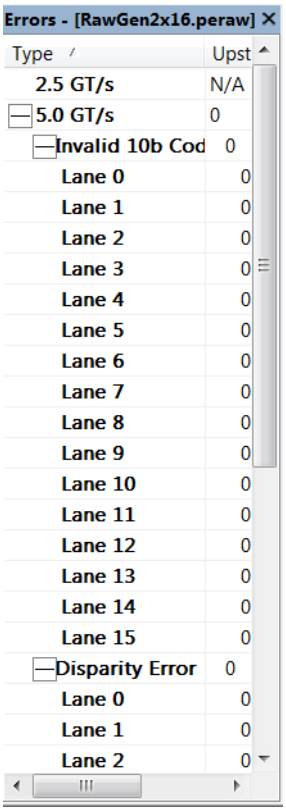


Figure 9.13: Errors Window

BitTracer mode also highlights errors:

- Invalid symbols have a black background.
- Bytes with incorrect running disparity have red borders.

9.10 Symbols Bar

The Symbols window provides a summary of the different symbol types captured, by quantity and direction, and includes hyperlinks for jumps to selected symbols.
Expanding the **+** sign at the left of each symbol provides a summary of symbols by lane.

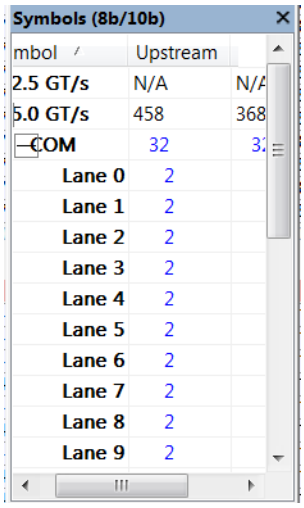


Figure 9.14: Symbols Window

9.11 Events Bar

The Events report window summarizes Link Up, Link Down, and Speed Switch events for Upstream and Downstream.

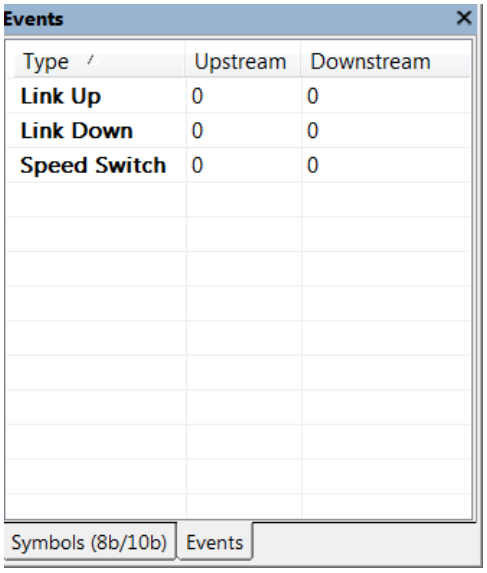


Figure 9.15: Events Window

Note: The table entries are hyperlinks.

9.12 Packets Bar

The Packets report window summarizes packet types detected in the file.

Note: To obtain packet types, you must perform a post-capture "Analyze" step. After capture, when you open the Packets Bar for the first time, items can display the command "Analyze". To start the analysis, click the word **Analyze**. After analysis finishes, the results are saved with the file. Therefore, you do not need to click **Analyze** the next time.
The table entries are hyperlinks.

Note: If you edit anything, the results are no longer valid, and the system requires you to click **Analyze** again.

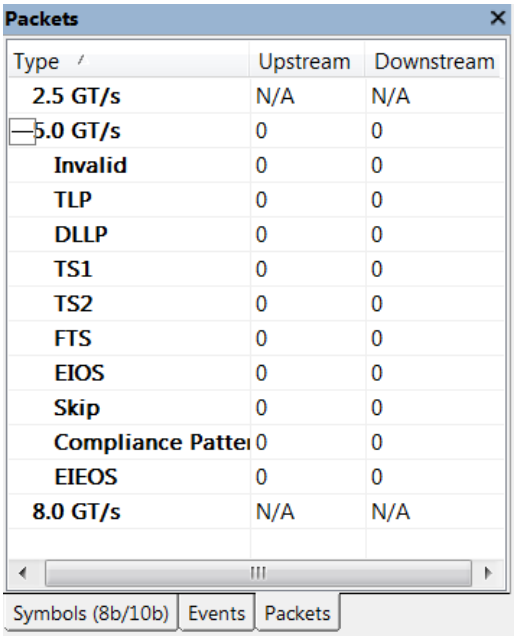
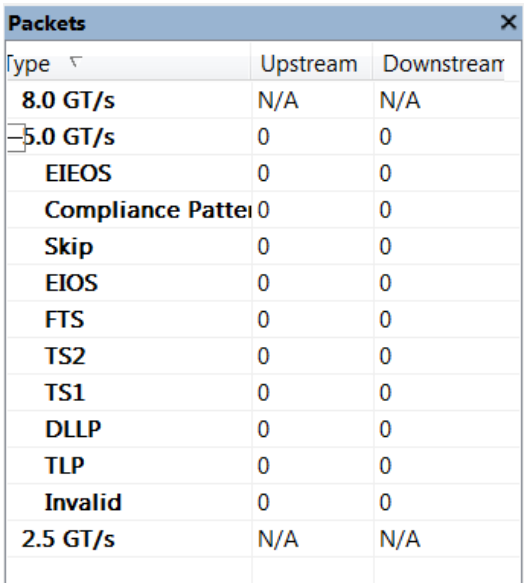


Figure 9.16: Packets Window

After analysis, the Packets Bar looks like the following (see the following figure):



9.13 Decoding Bar

If you select them in the data view, or search or jump locates a feature, BitTracer mode displays ordered sets and packets in the Decoding dialog (see Figure 9.17 on page 662).

- **Logical view** is identical to CATC Trace format.
- **Specification view** provides a more elementary display. The Specification view includes an option to display data in hex or binary format.

Note: Packets and ordered sets translate directly to this view from data capture and use any post-capture skew manipulations you add, or use natural lane-to-lane skew present on the link if you have not added post-capture skew manipulations. Typically, you would perform an Auto De-Skew before viewing ordered sets and packets in this view.

Use the left and right arrows to search for the next or previous symbol type.

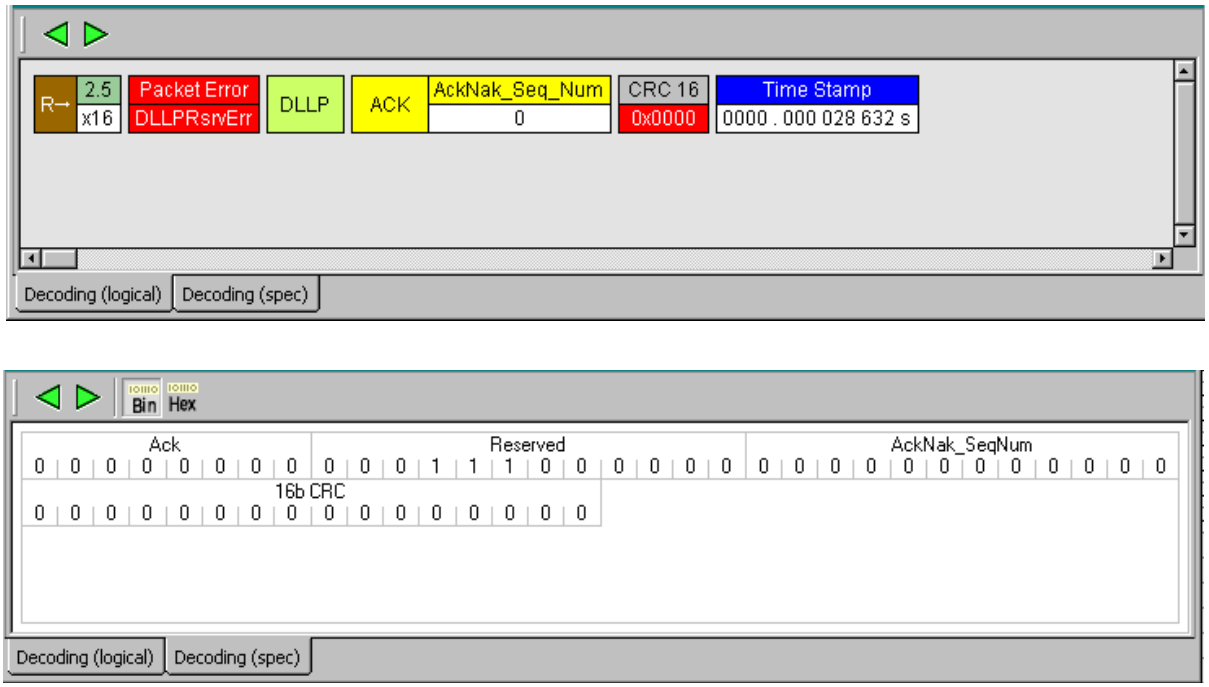


Figure 9.17: Decoding Dialog

9.14 Search

To search, use the Search toolbar.



Clicking the **Search** icon displays the Search dialog (see Figure 9.18 on page 663).

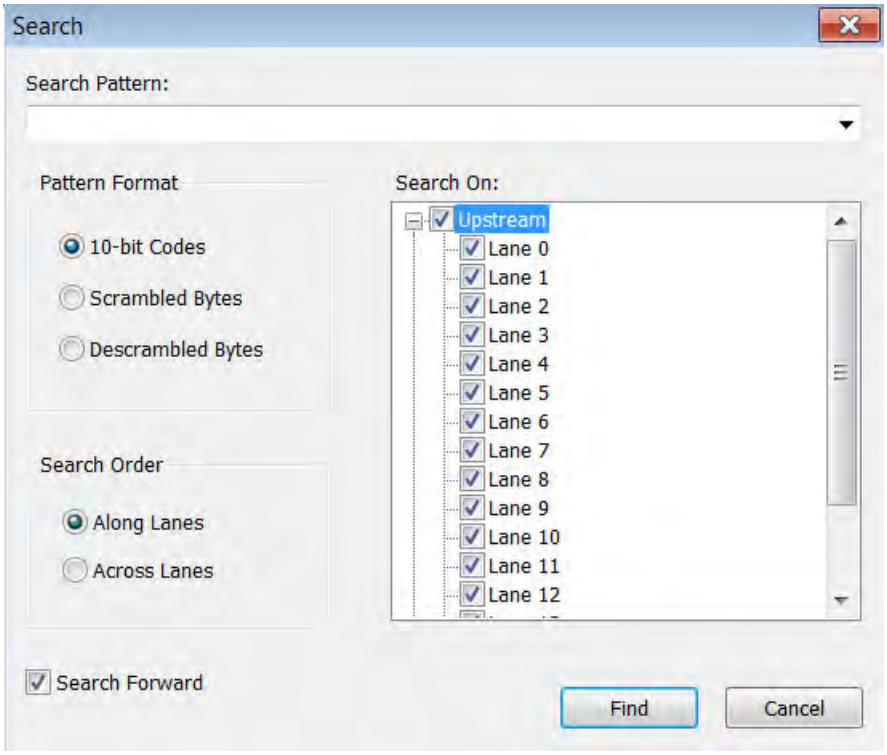


Figure 9.18: Search Dialog

You can copy data shown in the BitTracer display across a lane (horizontally) or across multiple lanes (vertically), and then paste it into the Search Pattern window.

The Search Pattern window stores previous search values, which you can recall by selecting the Search Pattern drop-down button.

In the Pattern Format section, select to search in 10-bit Codes, Scrambled Bytes, or Descrambled Bytes format.

In the Search Order section, select to search Across Lanes (multiple lanes, vertically) or Along Lanes (individual lanes, horizontally).

To define the direction (upstream or downstream) and the lanes on which to search, use the Search On section.

9.15 Link Configuration

Use the toolbar icon or right-click in the data views to display the Link Configuration dialog (see the following figure). This dialog allows you to associate logical lanes with physical lanes, thereby providing support for lane bifurcation (multiple logical links on the same physical link).

After logical lanes map to physical lanes, BitTracer mode reconfigures the display to show the selected logical link (and the logical link width, as the link width selected in the dialog).

Use the arrows to force symbol time skew on any lane.

Use the polarity checkbox to invert lane polarity on the selected lane or use the **+/-** toolbar icon.



Use the scrambling option to select a scrambling algorithm, as per specification 1.0a or legacy specification 1.0.

Select **Edit > Edit Link** or click the  icon to display the Link Configuration for Upstream dialog (see Figure 9.19).

Note: This dialog applies to one direction at a time (upstream or downstream). Left-click in the direction in the data display to edit the configuration for that direction.

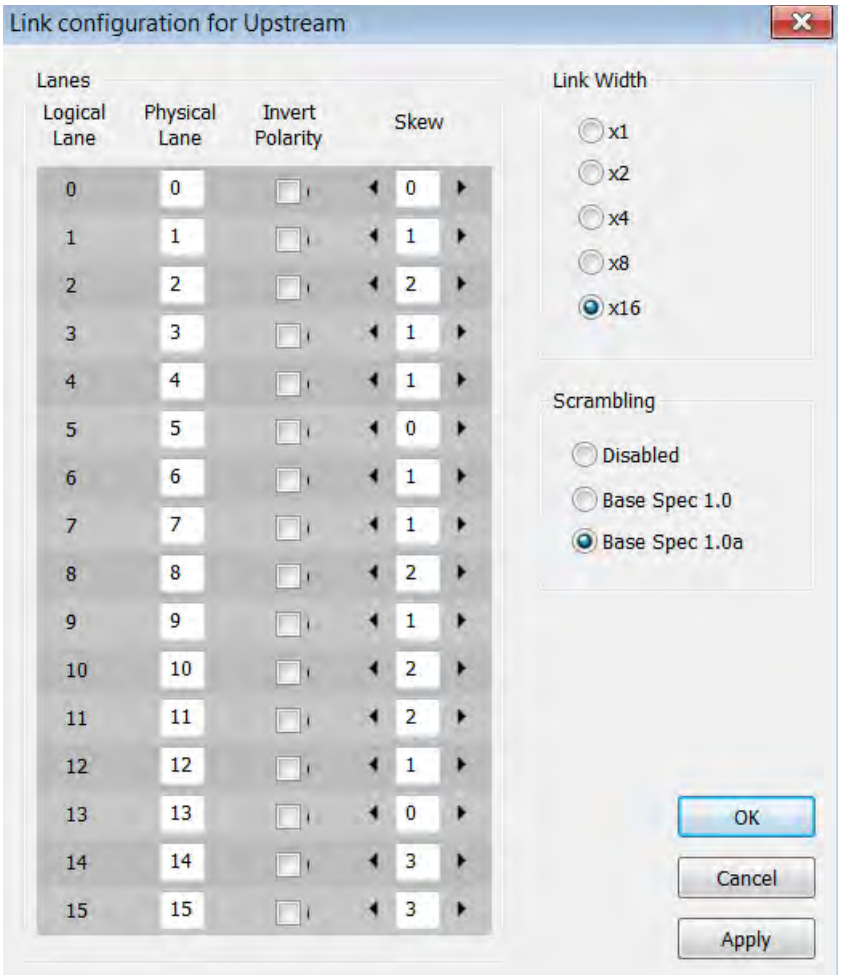


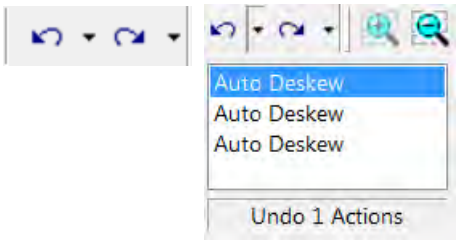
Figure 9.19: Link Configuration for Upstream Dialog

As you perform operations that affect display configurations, the application records them. To undo or redo operations, use the Undo and Re-do icons on the toolbar.

9.16 Export of BitTracer Capture to CATC Trace Format

You can export BitTracer captures to standard CATC Trace file formats, selecting the **Export** option from the File menu.

Note: If the bit trace is not deskewed, you should use the Auto De-skew feature before using the export feature.



The exported CATC Trace keeps association information with the original BitTracer file. Such traces scroll synchronously when you select the **Synchronize Traces** option in the Windows menu.

You can navigate between BitTrace and CATC Trace using the **Show in Trace View/ Show Packet in Raw Trace** context menu.

9.16.1 Exports Involving Multiple Logical Links on One Physical Link

If a single BitTrace capture contains more than one logical link, you can export each logical link to CATC Trace format. You may then cascade or tile the various BitTracer exports, which then scroll together in linked fashion, along with the original BitTracer file. The Export dialog provides options to export a limited range within the BitTrace capture and to automatically open the exported capture in CATC Trace format.

9.16.2 Export To CSV Text

Select **File > Export > Packets to CSV Text** to display the Export Packets to comma delimited text dialog. Select desired options from the From and To Segment, Marker and Time drop-down lists (see Figure 9.20 on page 666).

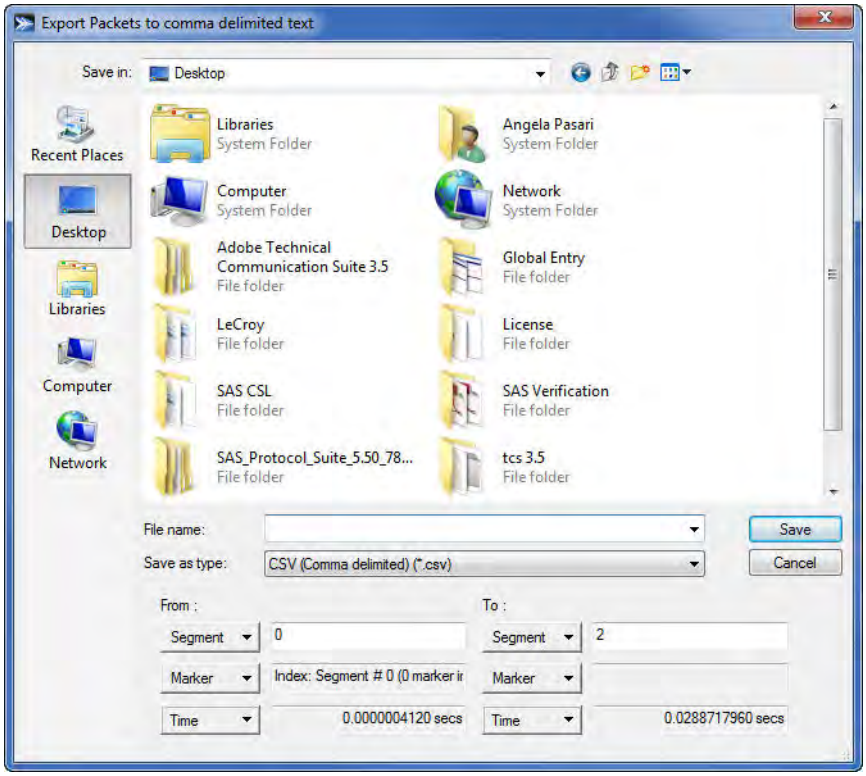


Figure 9.20: Export Packets to Comma Delimited Text Dialog

9.16.3 Exporting Data from Bit Tracer to a Trace File

Matching Link Width

Note: To export data correctly from Bit Tracer to a Trace file the Link Width of the recorded data traffic must match the Link Width of the Trace. If the Link Width is altered the result will be a Trace with errors in it.

In the example below, a raw data file is loaded with a recorded Link Width of x16 (see Figure 9.21).

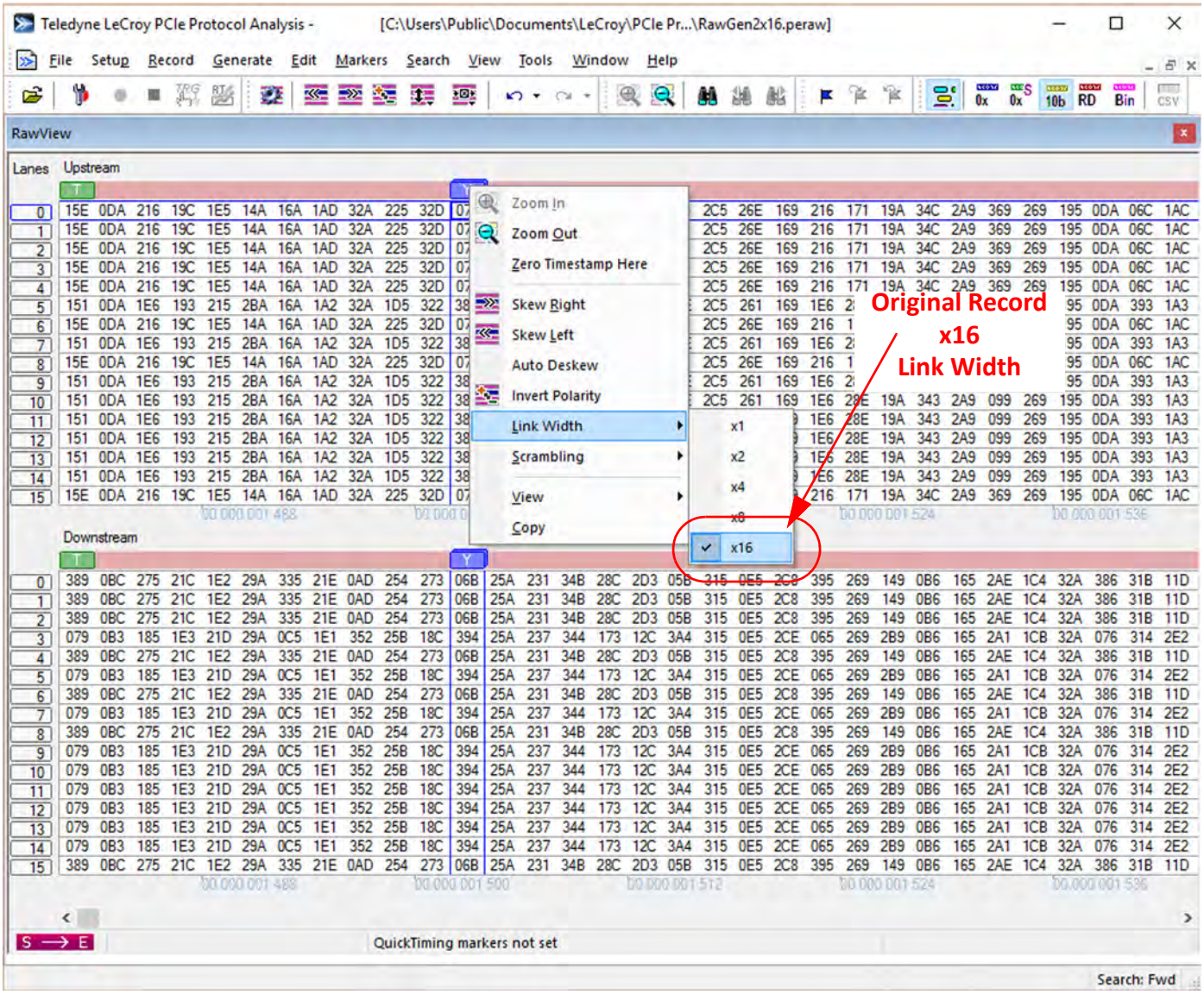


Figure 9.21: Raw Data File Loaded with x16 Link Width

Then the Raw Data File is Exported to Trace (see Figure 9.22 on page 668).

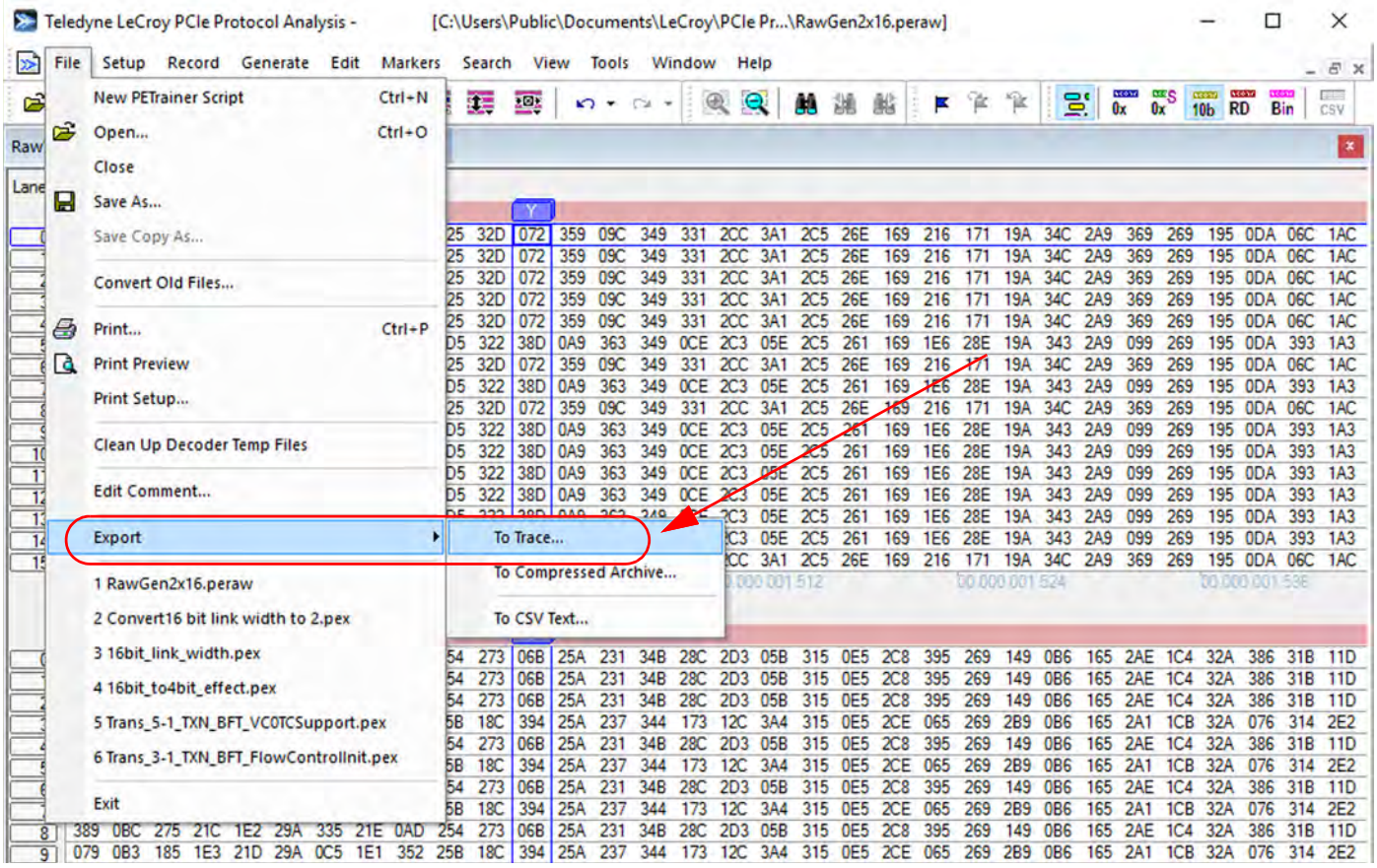


Figure 9.22: Raw Data File Exported from Bit Tracer to Trace File

The resulting trace file shown in CATC View (see Figure 9.23 on page 669).

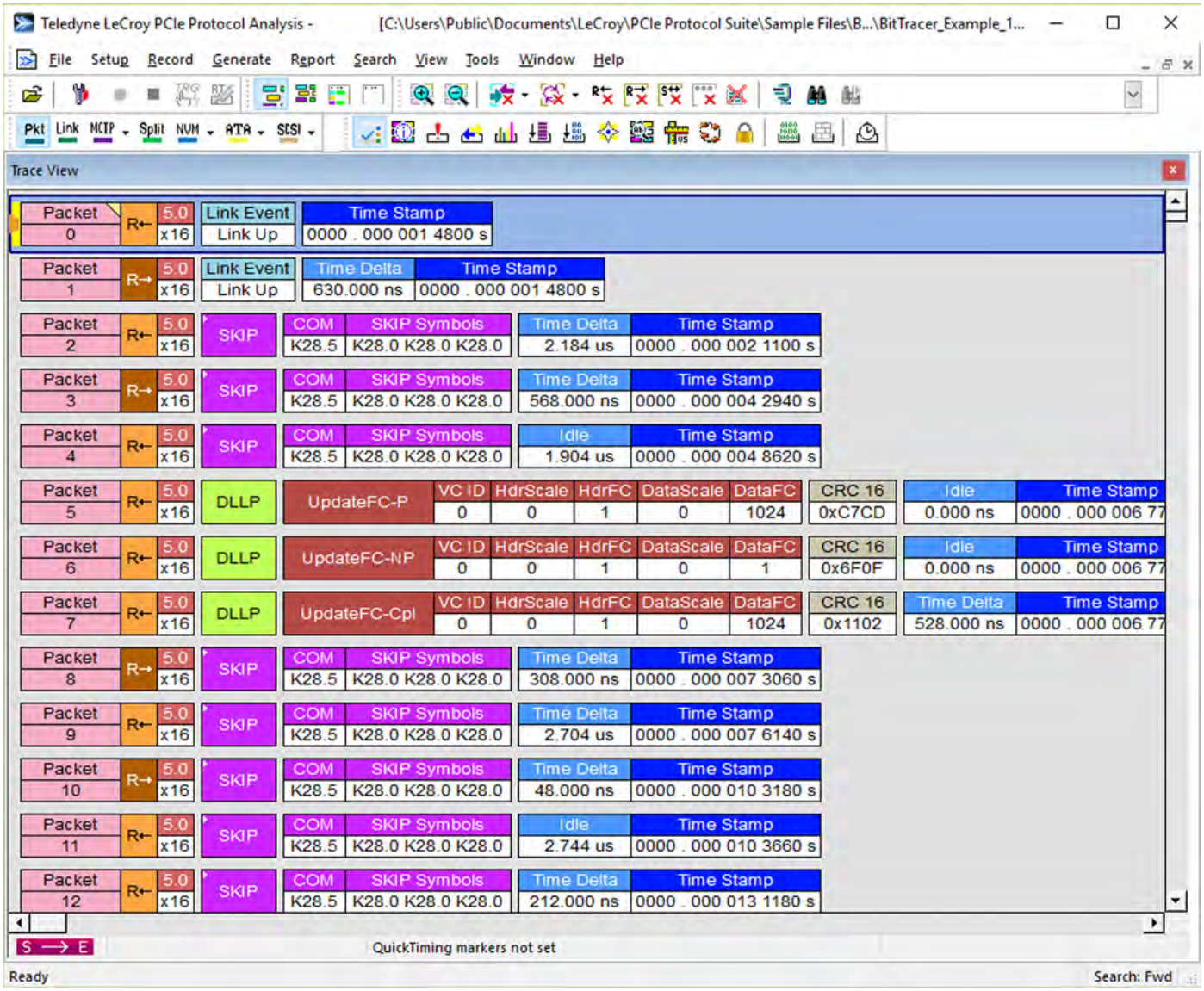


Figure 9.23: Exported Trace File from Bit Tracer

Changing Link Width from Original Recording

If you change the Link Width of the data traffic from the original recording and Export that data traffic to a Trace, the Trace will be decoded with errors. See Figure 9.24 and Figure 9.25 on page 671.

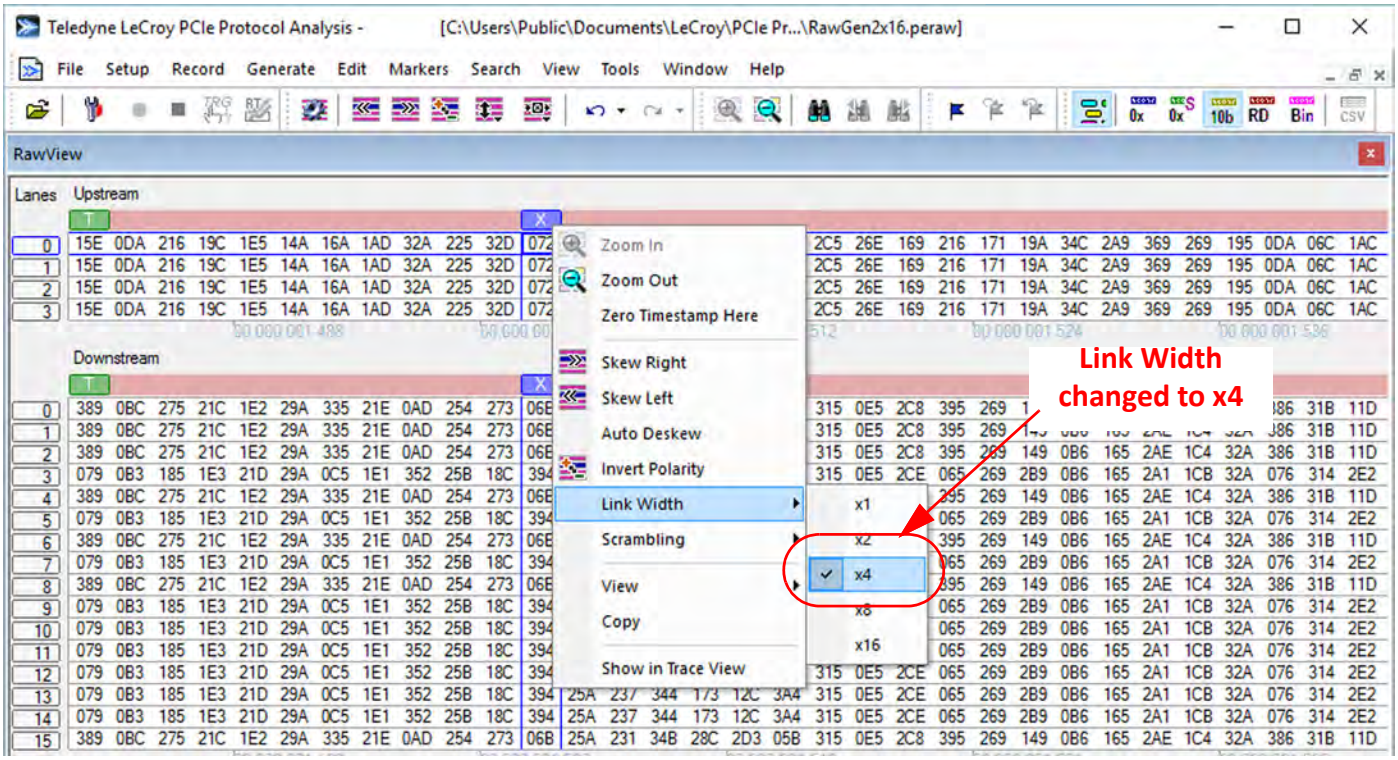


Figure 9.24: Link Width Changed From x16 to x4

Exporting the Data Traffic to a Trace will result in decoding errors (see Figure 9.25 on page 671.

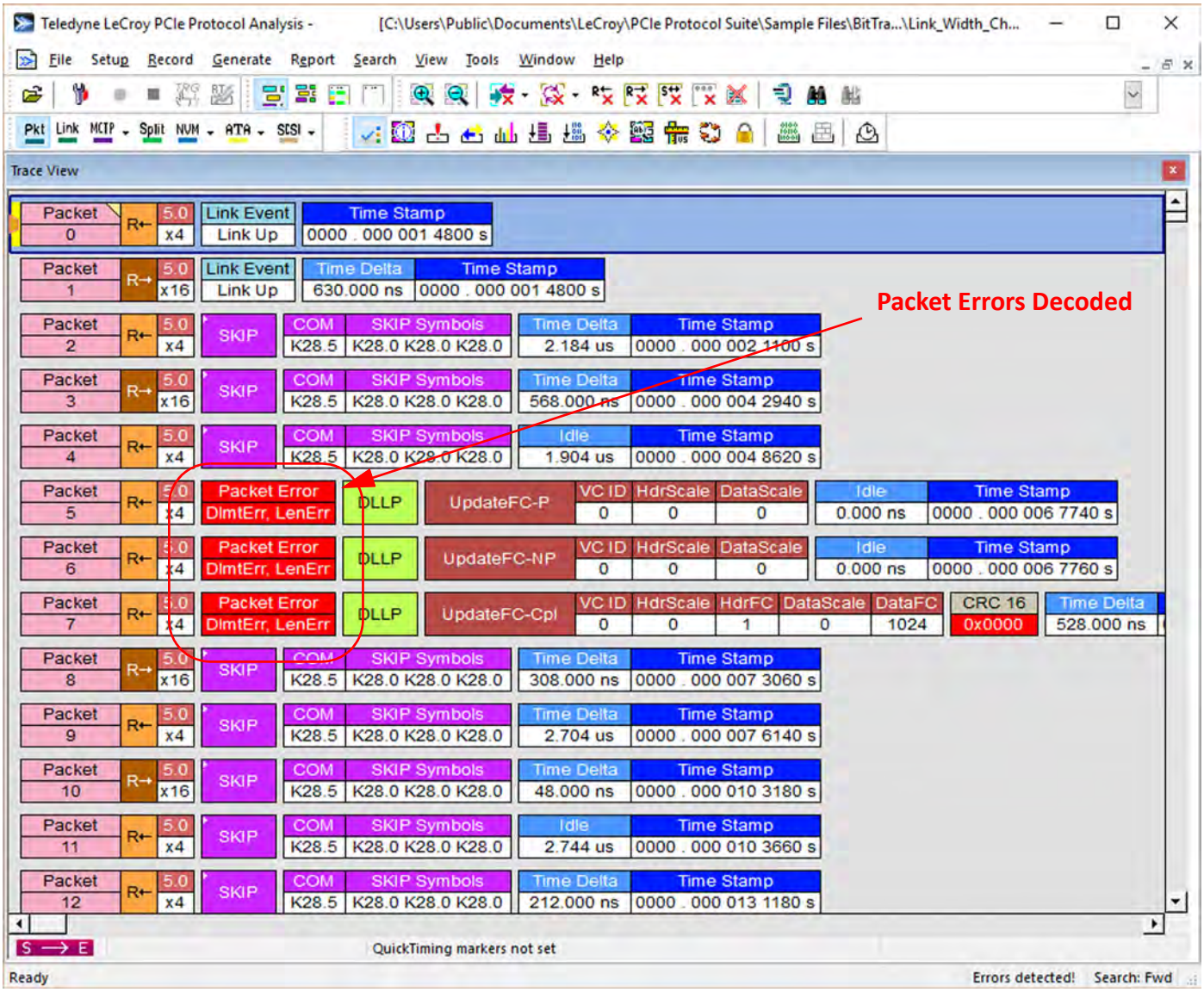


Figure 9.25: Export Data File with Changed Link Width (from x16 to x4)

9.17 Compressing and Expanding the Data View

You can compress (zoom out) the horizontal timing of the displayed data to view higher-order link behaviors. You can expand (zoom in) to examine higher-resolution views.

To zoom in or zoom out, right-click the data view, then select a command or select a zoom icon on the toolbar.



Alternatively, to zoom in, left-click and drag across a desired range of data.

9.18 Opening and Saving BitTracer Captures

You can save BitTracer captures in various file types.

You can collate and archive these files for transport, using the **Export to Compressed Archive** feature in the File menu.

The main BitTracer files have a ***.peraw** extension.

You can open these files in the PCIe Protocol Analysis application using the **File > Open** command.

Chapter 10

Reports and Tools

Reports assist you in analyzing traffic recorded by the Analyzer. See Figure 10.1.

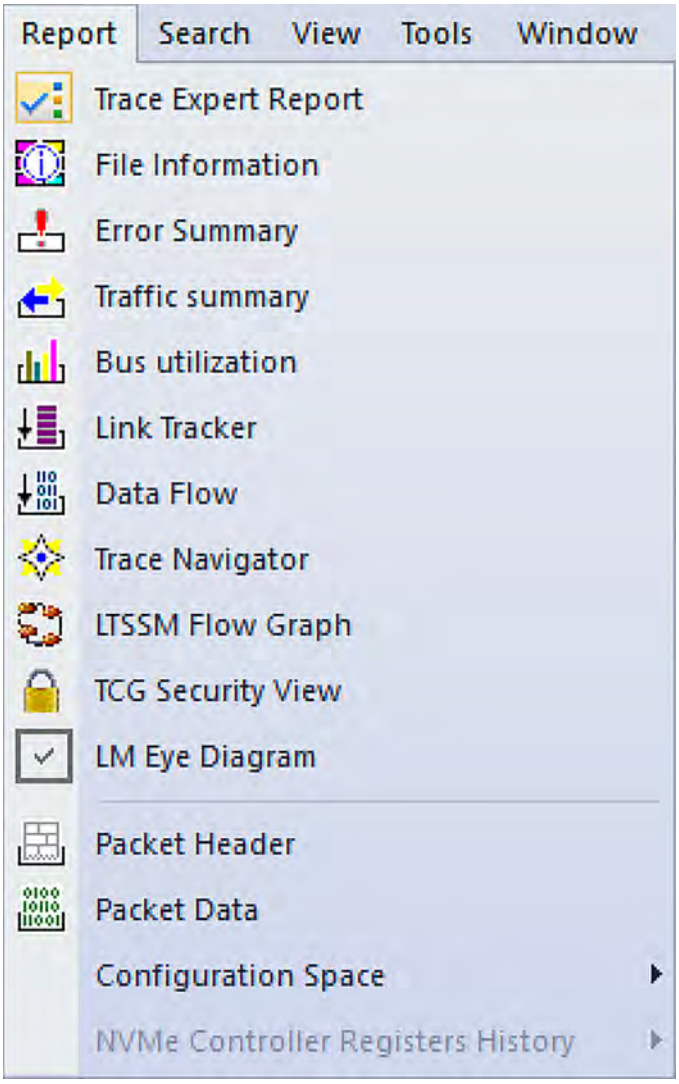


Figure 10.1: Reports Pull Down Menu

The available reports are:

- **Trace Information**: To view general information about the CATC Trace file. See “Trace Information” on page 677.
- **Error Summary**: To view a count of errors in a CATC Trace file. See “Error Summary” on page 679.
- **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 687.
- **Bus Utilization**: To display information on bandwidth usage for the transmit and receive channels. See “Bus Utilization” on page 696.
- **Link Tracker**: Displays a detailed chronological view of events. See “Link Tracker” on page 704.
- **Data Flow**: Shows marker, packet, direction, type, length, address, payload, handshake, and timestamp information. See “Data Flow Window” on page 710 and “Flow Control Tracking” on page 712.
- **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 713.
- **Detail View**: Shows the detail view of the selected packet. See“Detail View” on page 718.
- **LTSSM Flow Graph**: Shows a state diagram of bus activity. See “LTSSM Flow Graph” on page 719
- **LM Eye Diagram:** Displays the samples taken during Lane Margining. See “Lane Margining: Eye Diagram” on page 723
- **Packet Header**: Shows packet header information. See “Packet Header Bar” on page 726
- **Packet Data**: Shows packet or transaction payload. See “Packet Data Window” on page 726.
- **Configuration Space**: Displays a Configuration Space. See “Configuration Space View” on page 728.
- **Metrics**: Measures key operating parameters. See “Using Unit Metrics” on page 736 through “Show Metrics in the Bus Utilization Window” on page 740.
- **Real Time Statistics**: To display statistical information for the channels. See “Memory I/O Space Editor” on page 743.
- **Memory I/O Space Editor**: Displays the Memory I/O Space Editor dialog. See “Memory I/O Space Editor” on page 743.
- **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 743.
- **Timing Calculations**: To view timing measured between two events set within the CATC Trace file. See “Timing and Bus Usage Calculations” on page 744.
- **PCIe SSD Base Mapping**: Displays the PCIe SSD Base Address dialog. See “PCIe SSD Base Address Mapping” on page 756.
- **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 767.

- **Trace Expert**: Generates reports on Performance Analysis, Trace Analysis Statistics, Error Reports and Trace Information. See "Trace Expert" on page 772.

Reports are available from the Report menu and buttons on the Tool bar. Tools are available from the Tools menu.

10.1 Trace Information

The Trace Information window provides a summary on the currently displayed file.

Select **Reports > Trace Information**  to display the Trace Information window.

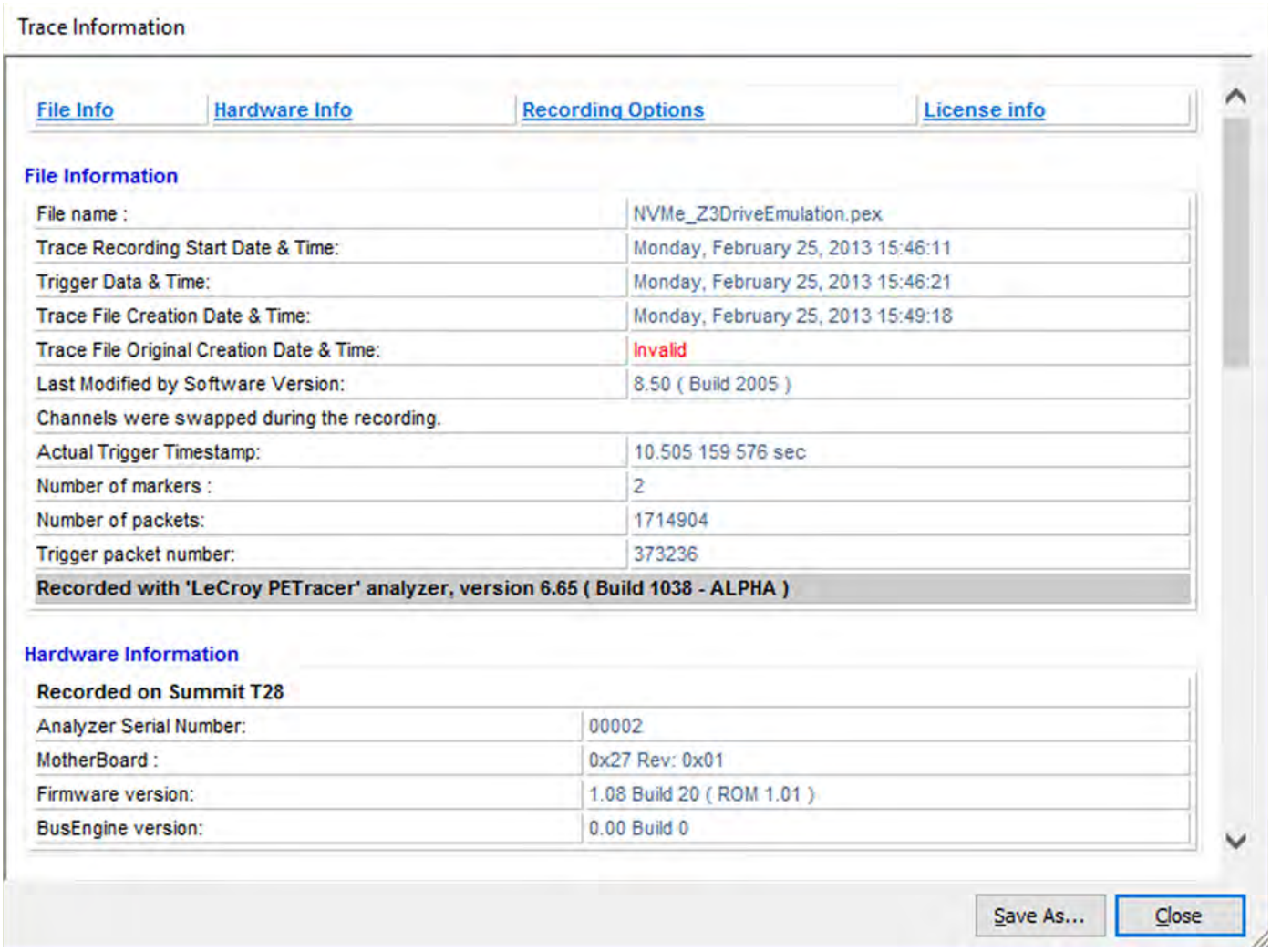


Figure 10.2: Trace Information Part 1

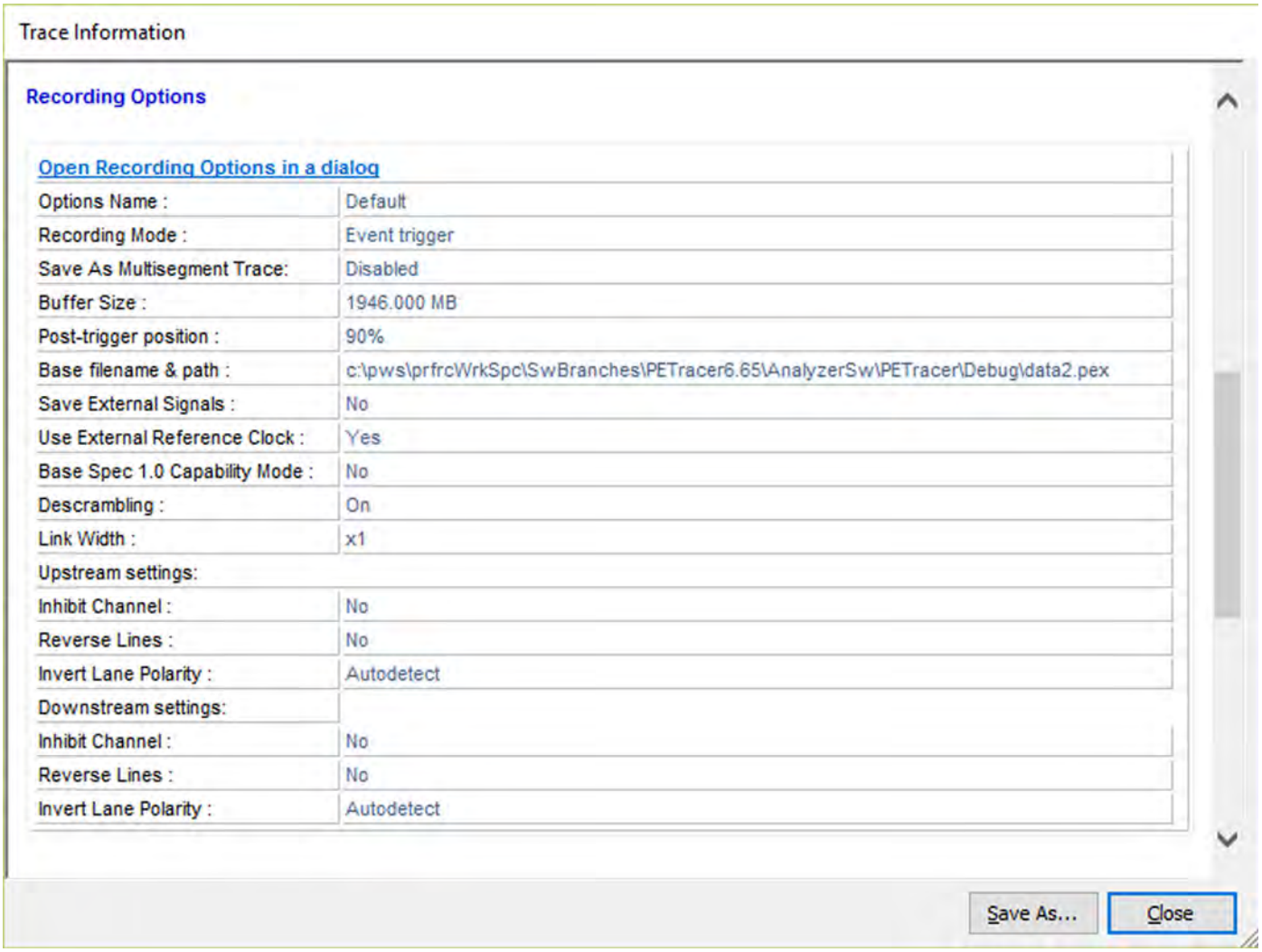


Figure 10.3: Trace Information Part 2

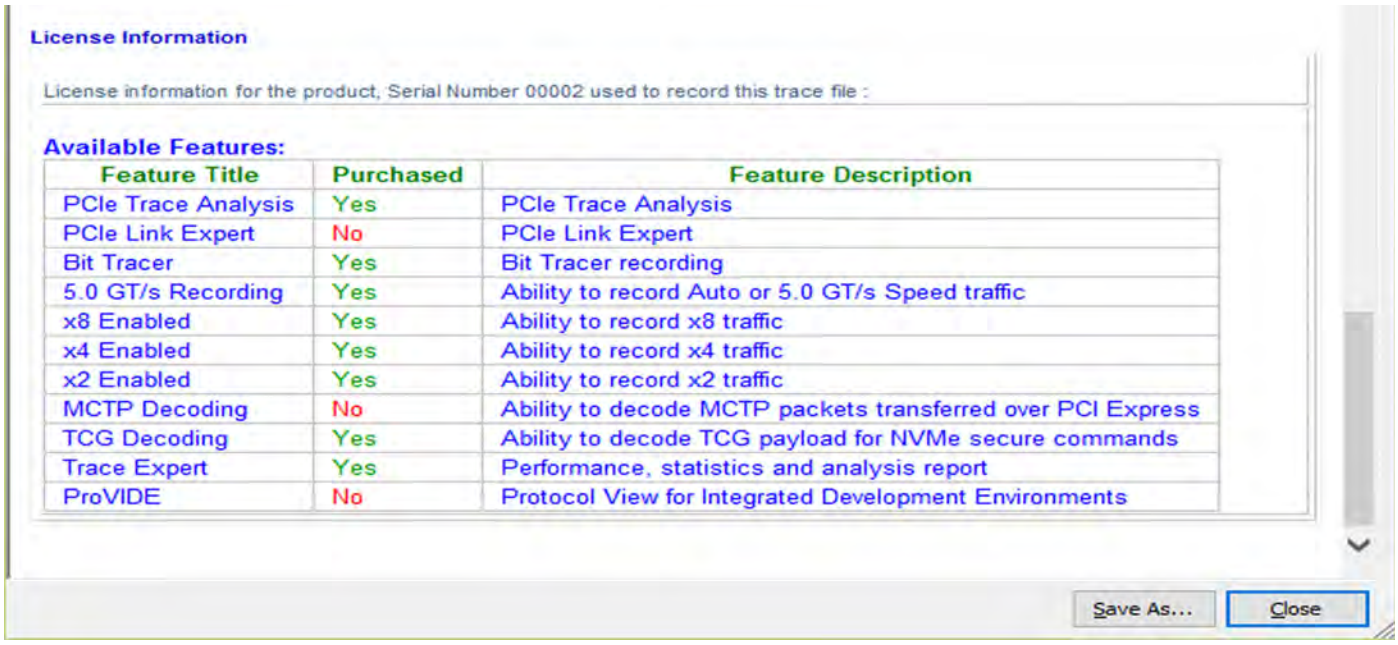


Figure 10.4: Trace Information Part 3

10.2 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 10.5 on page 679).

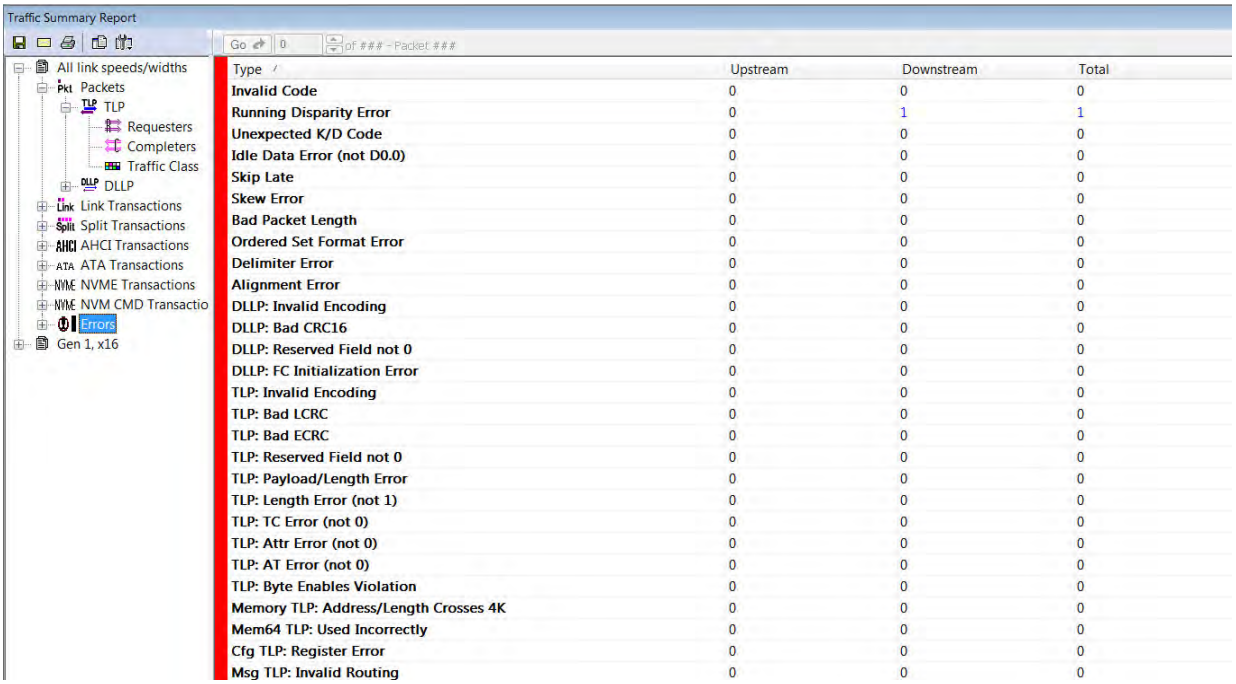


Figure 10.5: Error Summary Dialog.

10.2.1 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.

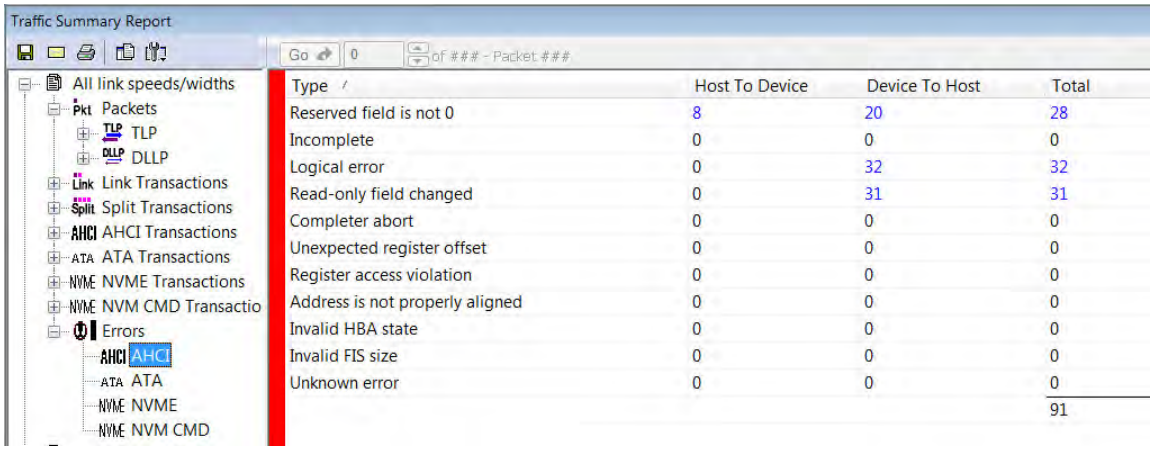


Figure 10.6: AHCI Error Summary Dialog.

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.

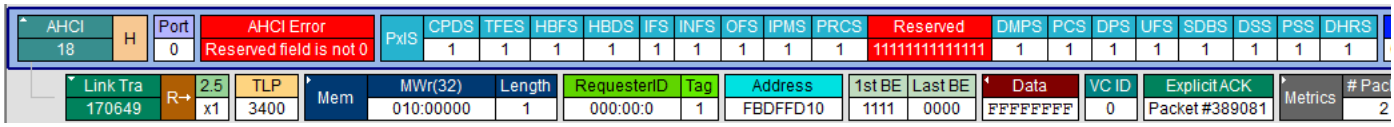


Figure 10.7: Reserved Field Not Filled With Zeroes

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.

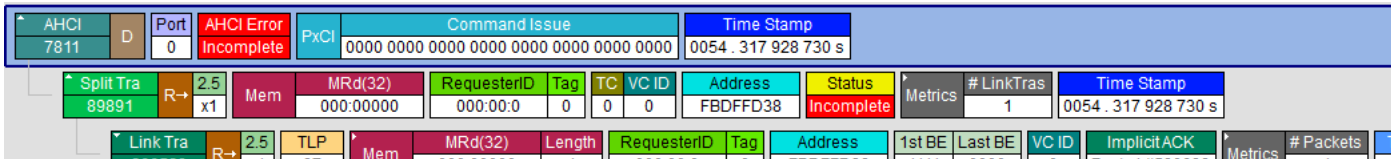


Figure 10.8: Incomplete

Logical Error

One or more fields are in an inconsistent state relative to the other fields in the same or other registers.

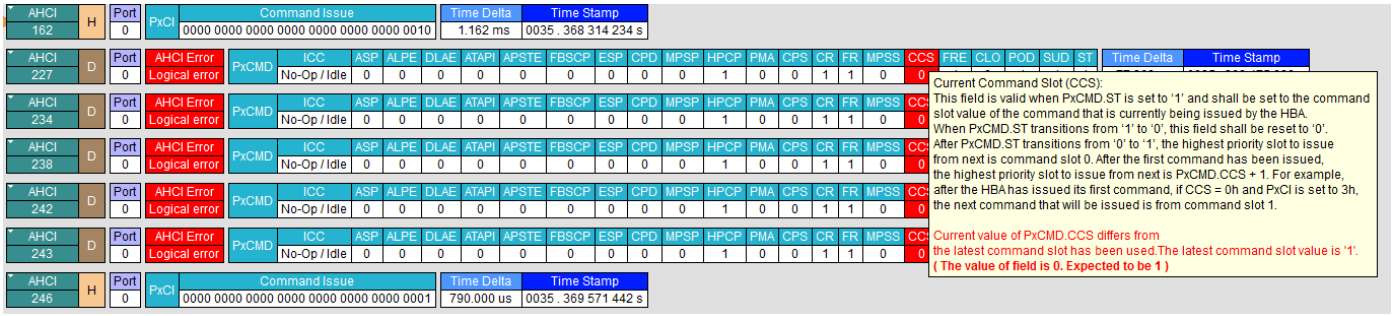


Figure 10.9: Logical Error

Read-only Field Changed

The value of the read-only field differs from the previous one.

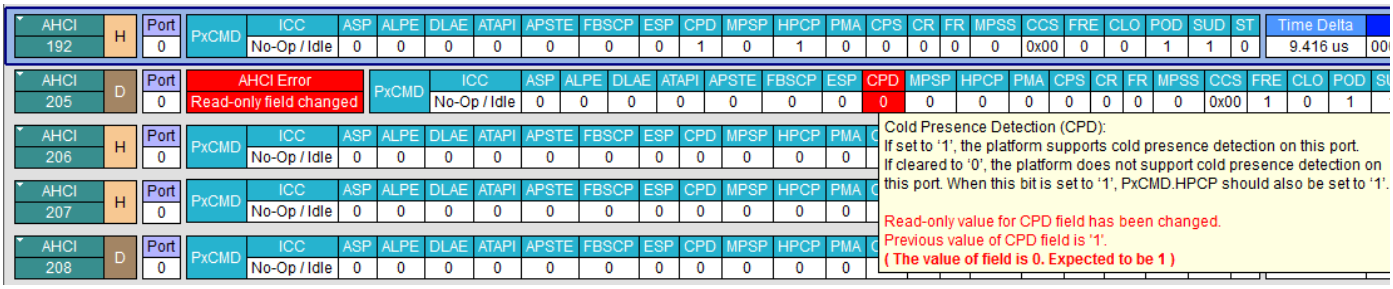


Figure 10.10: Read-only Field Changed

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**.

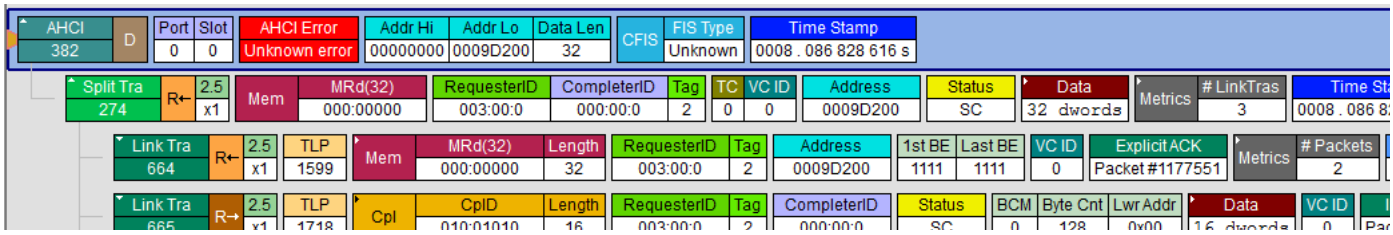


Figure 10.11: Unknown

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.

10.2.2 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 10.12, Figure 10.13 and Figure 10.14.

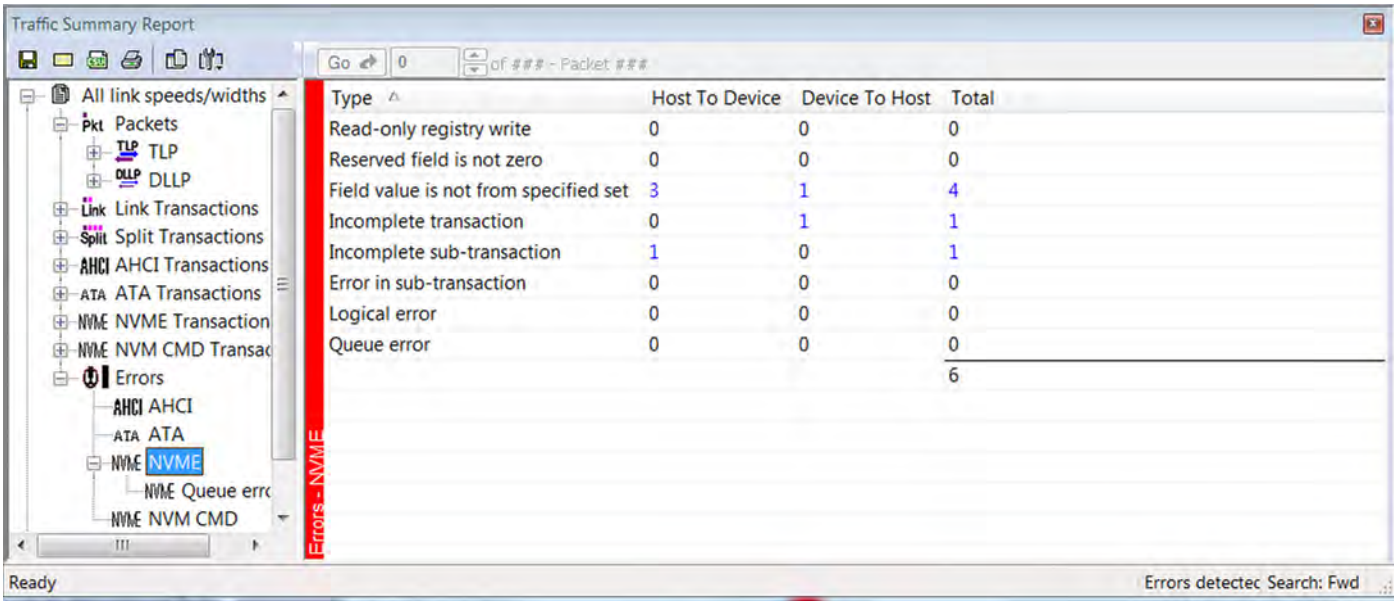


Figure 10.12: NVMe Errors After Decoding the Trace

10.2.2.1 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.

10.2.3 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.

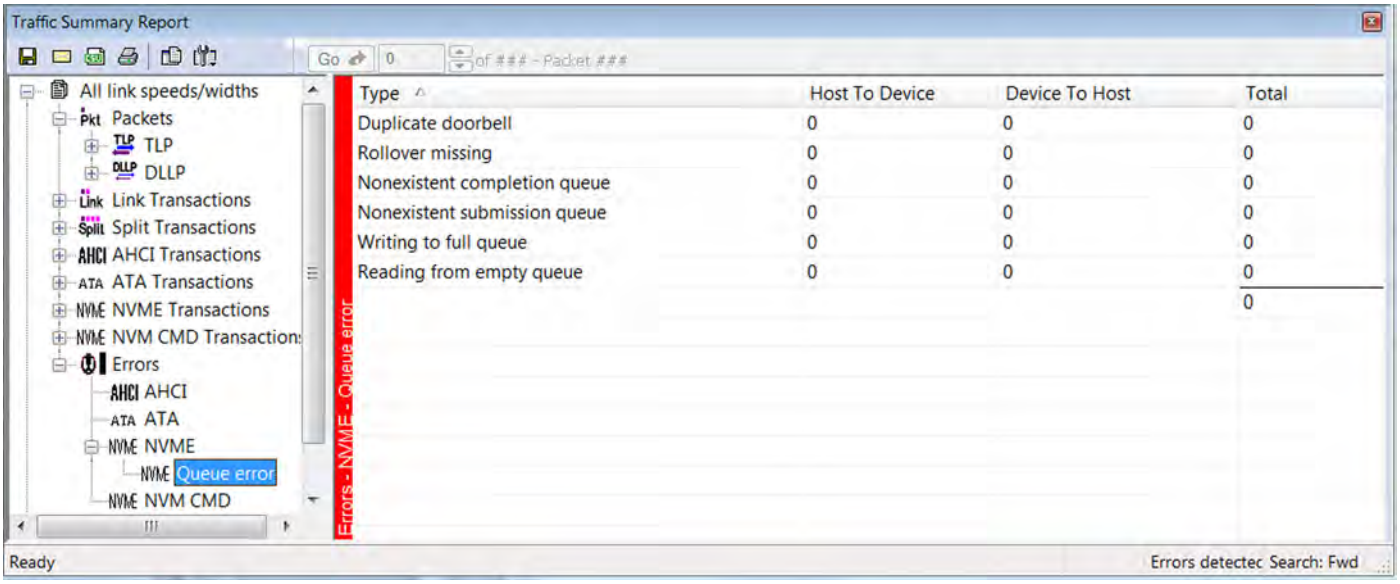


Figure 10.13: NVMe Errors Specific to NVMe Queues

10.2.3.1 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.

10.2.4 NVMe CMD Errors

The NVMe CMD sub-entry of the Error Summary dialog lists errors which are specific to NVMe command decoding. See Figure 10.14

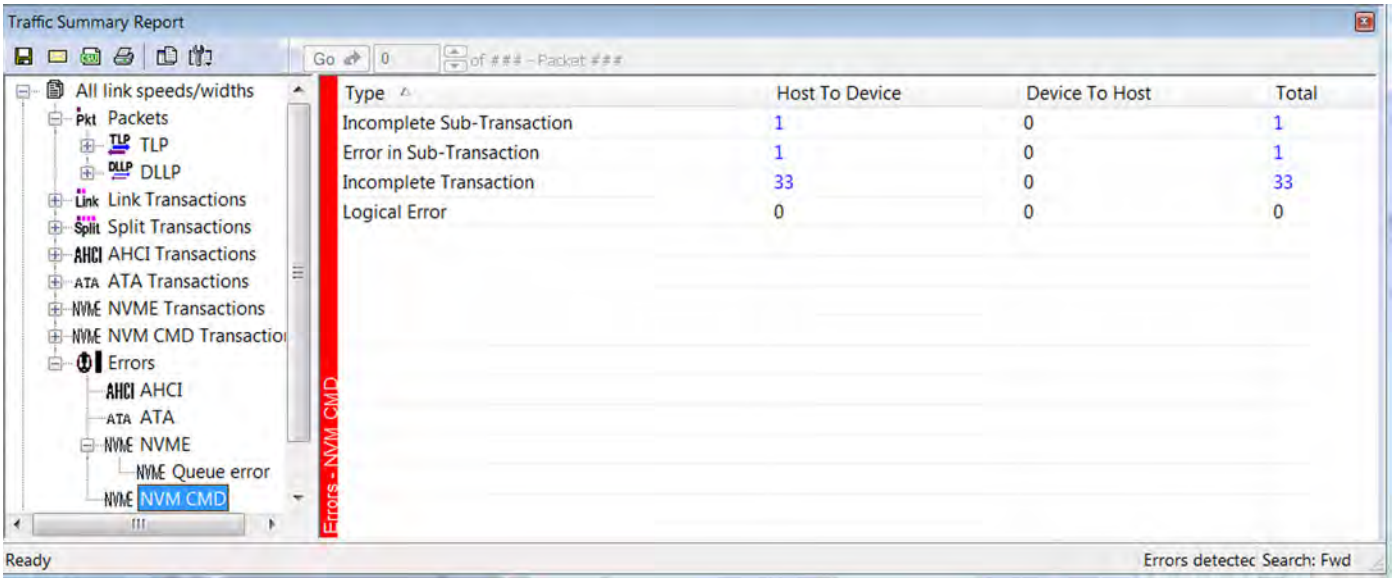


Figure 10.14: NVMe Errors Specific to NVMe Commands

10.2.4.1 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 10.15.

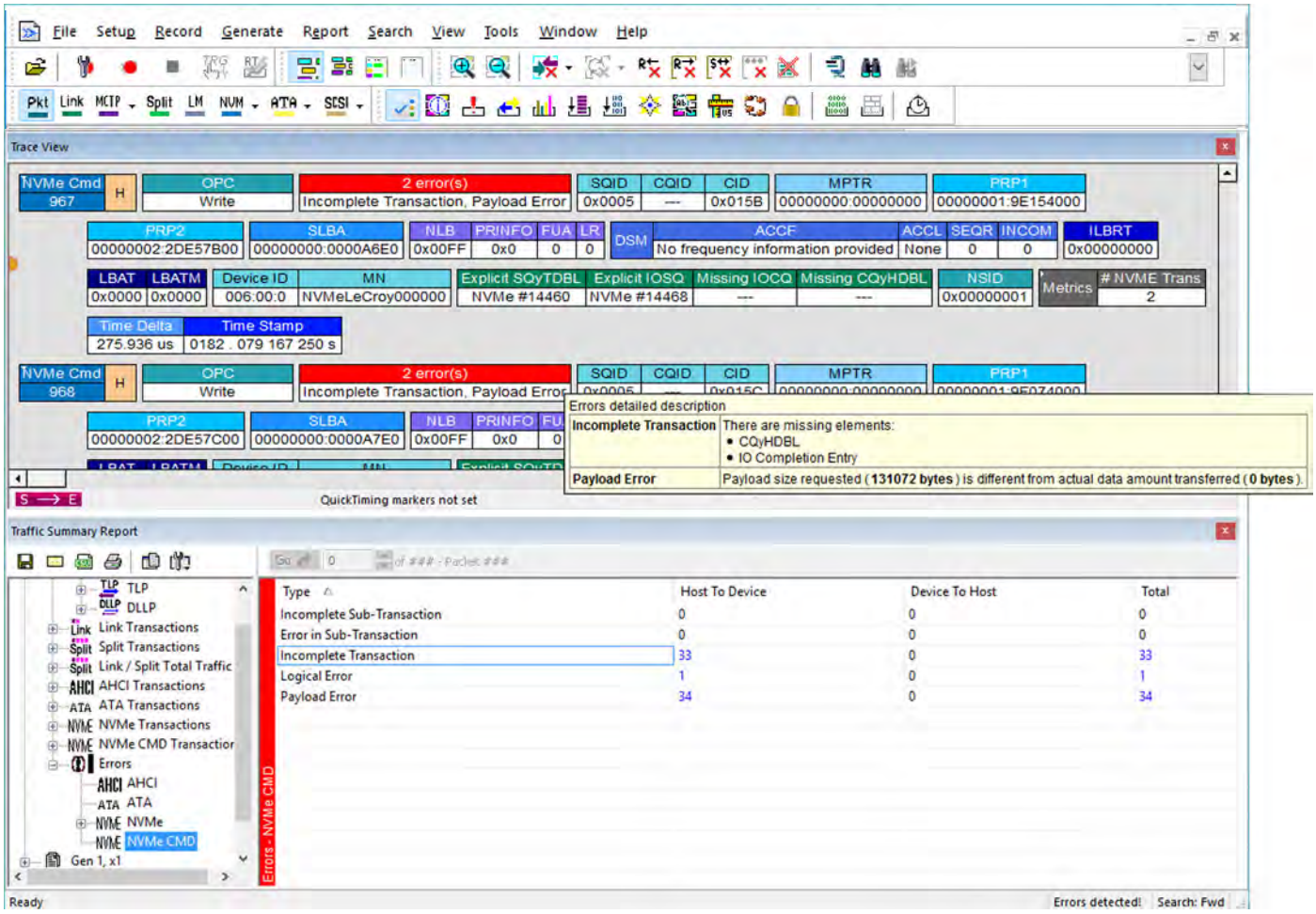


Figure 10.15: NVMe CMD Error -> Incomplete Transaction with Tooltip

4. Logical Error: Groups any potential logic errors, such as declaring a payload of 64 bytes (0) but sending 0 bytes. See Figure 10.16.

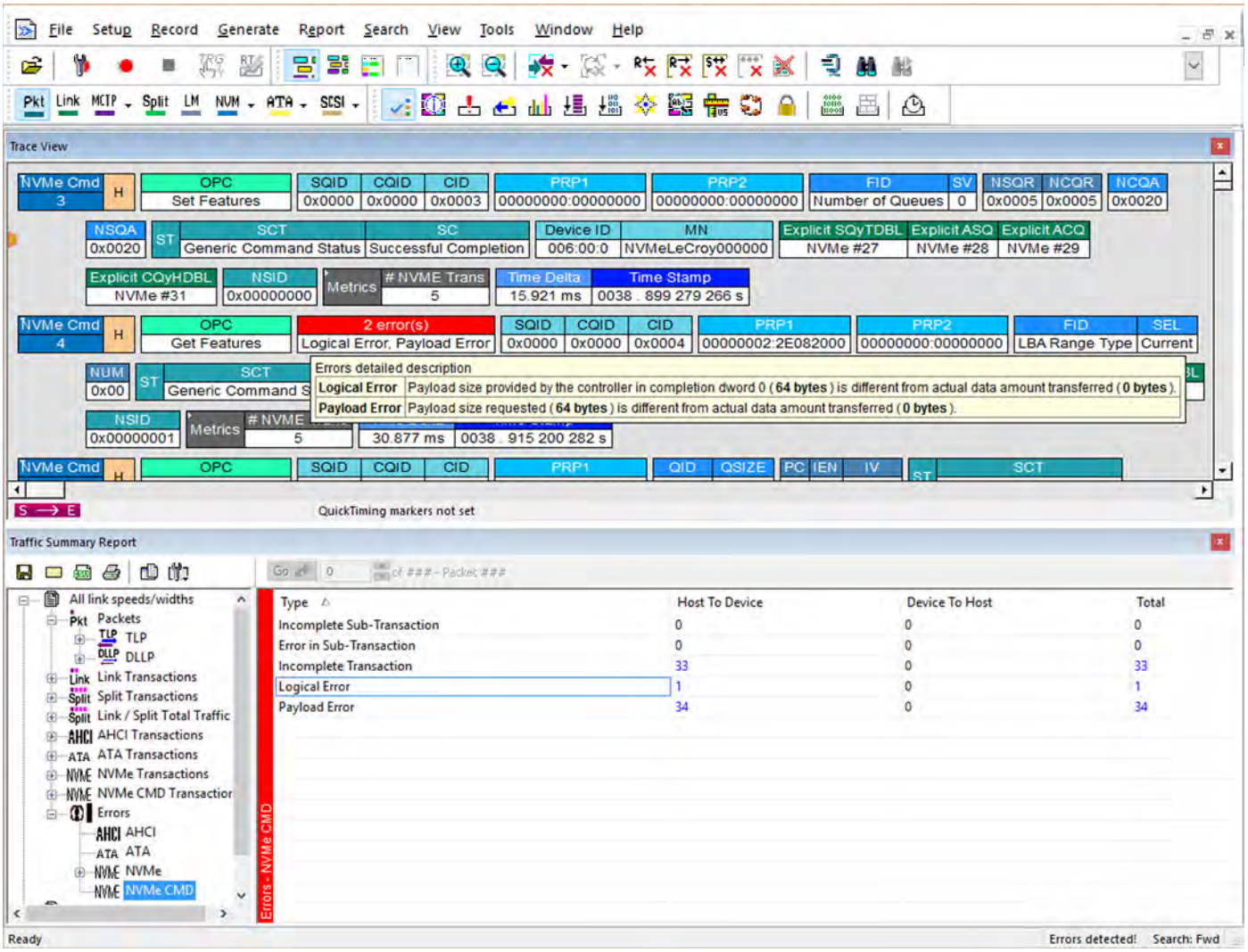
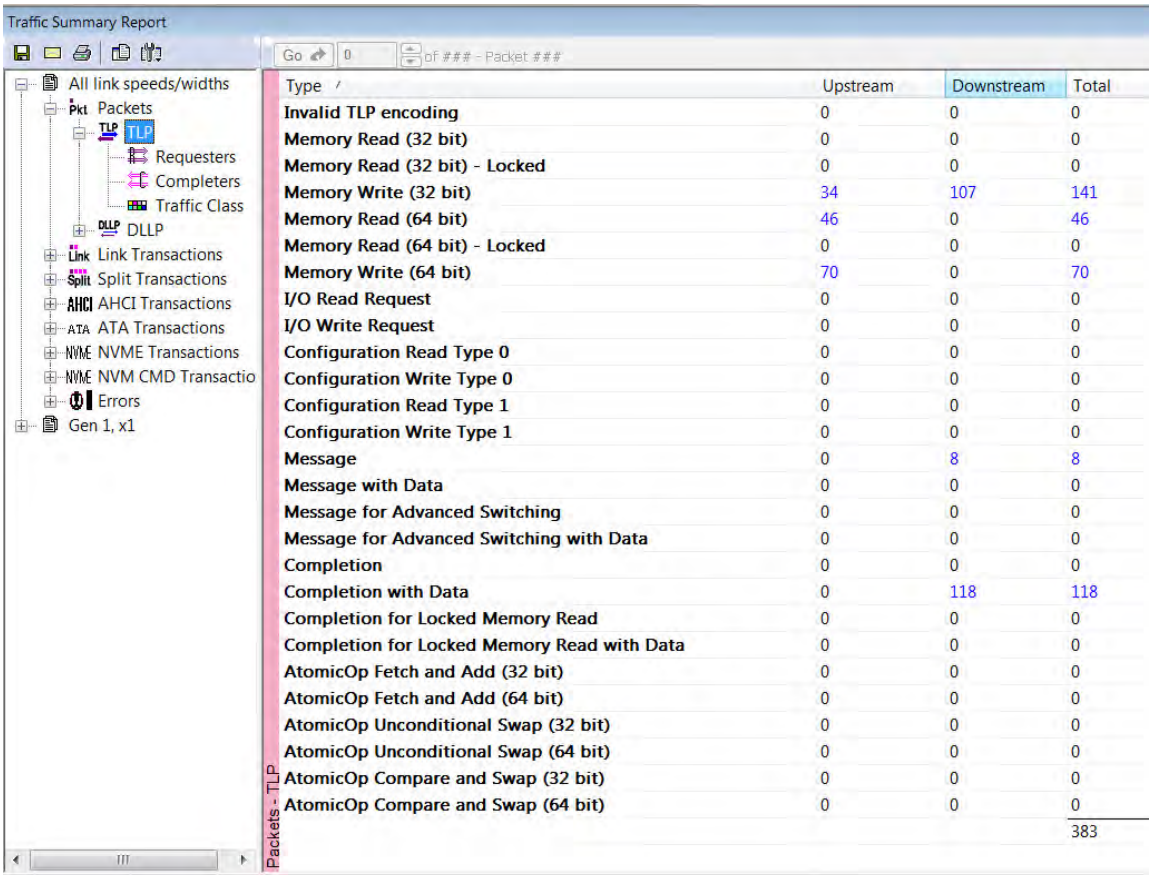


Figure 10.16: NVMe CMD Error -> Logical Error with Tooltip

10.3 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.



Type	Upstream	Downstream	Total
Invalid TLP encoding	0	0	0
Memory Read (32 bit)	0	0	0
Memory Read (32 bit) - Locked	0	0	0
Memory Write (32 bit)	34	107	141
Memory Read (64 bit)	46	0	46
Memory Read (64 bit) - Locked	0	0	0
Memory Write (64 bit)	70	0	70
I/O Read Request	0	0	0
I/O Write Request	0	0	0
Configuration Read Type 0	0	0	0
Configuration Write Type 0	0	0	0
Configuration Read Type 1	0	0	0
Configuration Write Type 1	0	0	0
Message	0	8	8
Message with Data	0	0	0
Message for Advanced Switching	0	0	0
Message for Advanced Switching with Data	0	0	0
Completion	0	0	0
Completion with Data	0	118	118
Completion for Locked Memory Read	0	0	0
Completion for Locked Memory Read with Data	0	0	0
AtomicOp Fetch and Add (32 bit)	0	0	0
AtomicOp Fetch and Add (64 bit)	0	0	0
AtomicOp Unconditional Swap (32 bit)	0	0	0
AtomicOp Unconditional Swap (64 bit)	0	0	0
AtomicOp Compare and Swap (32 bit)	0	0	0
AtomicOp Compare and Swap (64 bit)	0	0	0
			383

Figure 10.17: 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.

10.3.1 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.

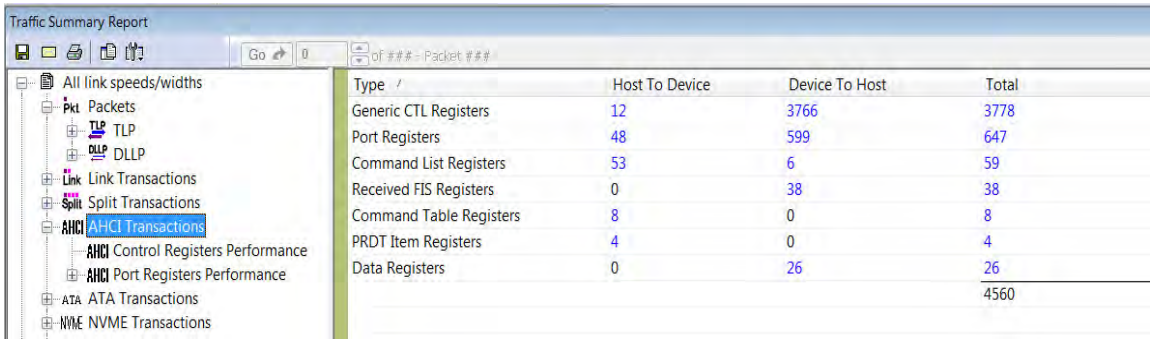


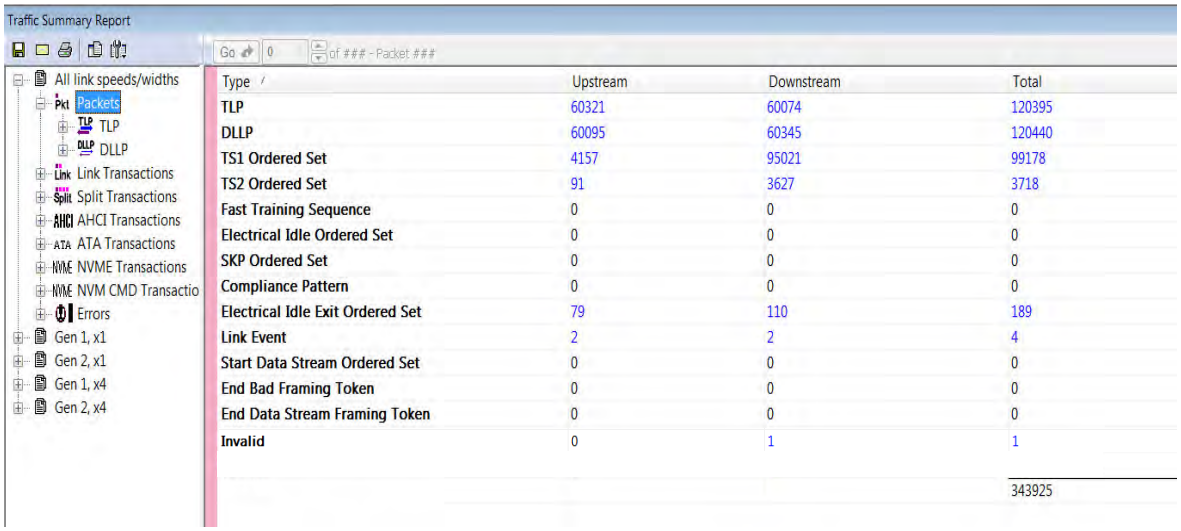
Figure 10.18: AHCI Traffic Summary Dialog

10.3.2 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.

10.3.3 NVMe Queue Time Metrics

NVMe Queue Time Metrics can be seen in the Traffic Summary, which includes all of the Doorbell Metrics (see Figure 10.19).

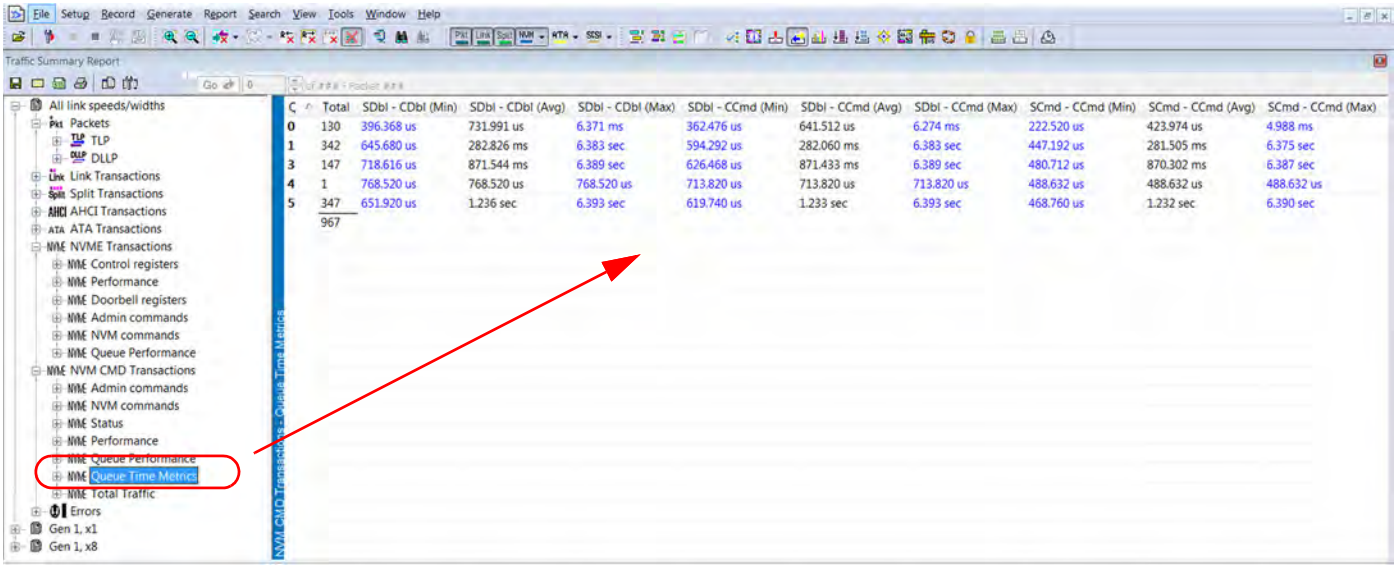


Figure 10.19: NVMe Queue Time Metrics for Doorbell Operations

NVMe Queue Time Metrics Defined (Commands/Transactions)

TABLE 10.7: 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 10.20.

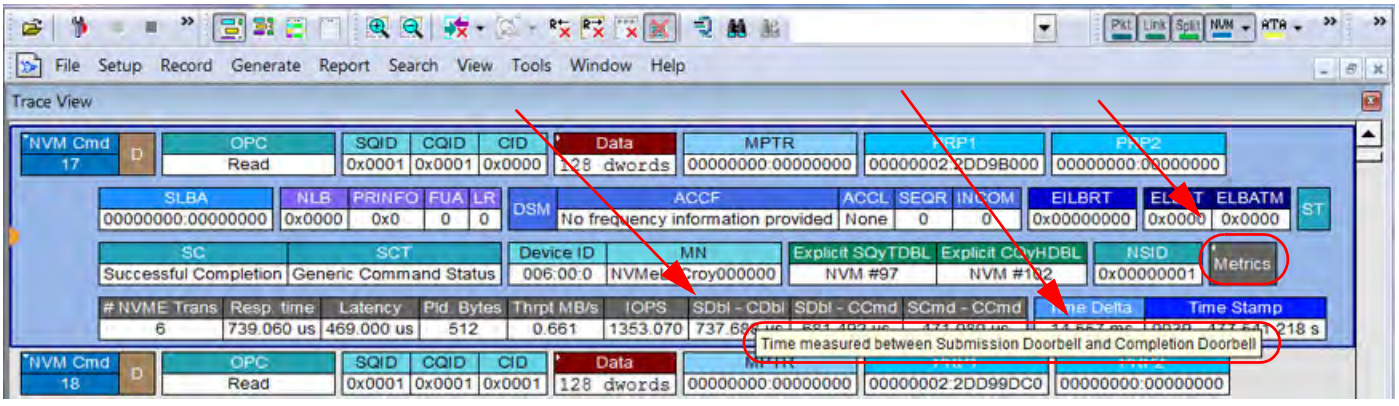


Figure 10.20: NVMe Queue Time Metrics Defined: SDbl - CDbl

NVME Transaction Example

As an example for NVMe Transactions: For Resp time: see Figure 10.21.

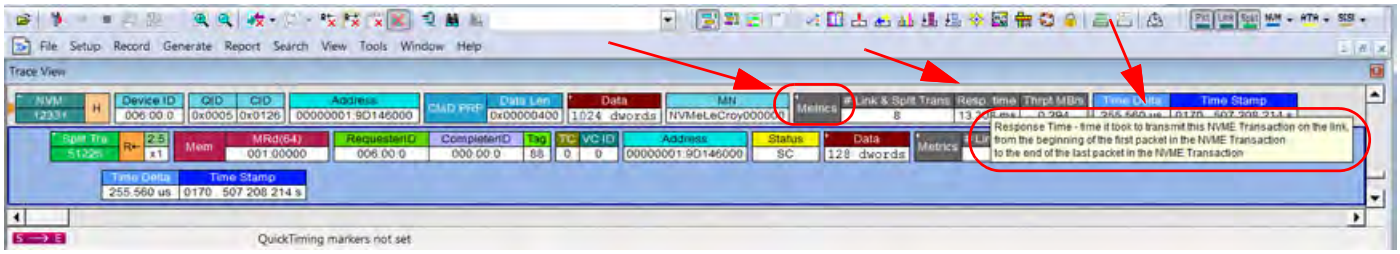


Figure 10.21: NVMe Transactions Metrics: Response Time

10.3.4 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

10.3.5 Traffic Summary for MCTP

After loading an MCTP trace, you can generate a traffic summary report for MCTP Messages (see Figure 10.22), Control Command Code (see Figure 10.23 on page 693) and Control Completion Codes (see Figure 10.24 on page 694).

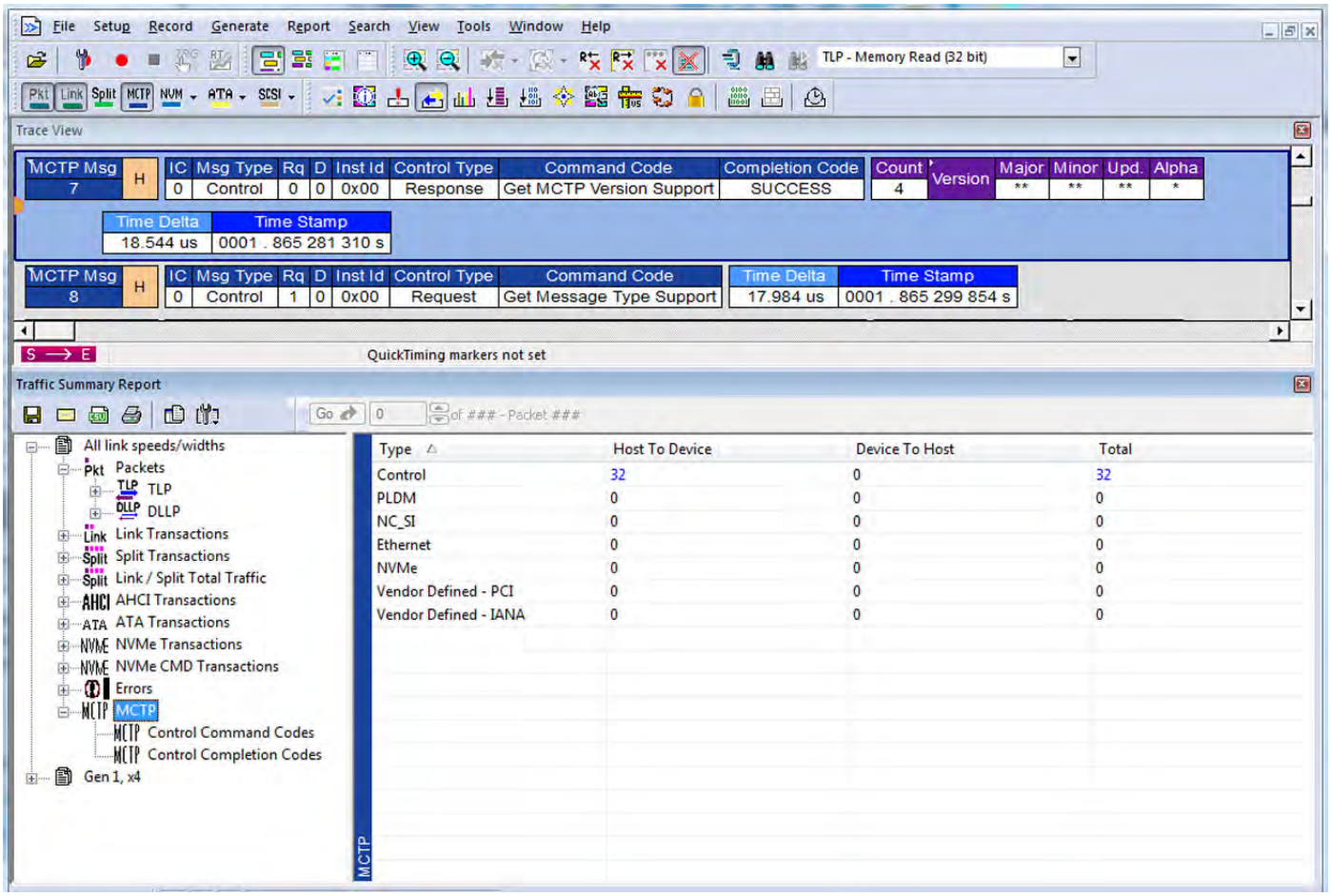


Figure 10.22: MCTP Message Traffic Report Summary -> All

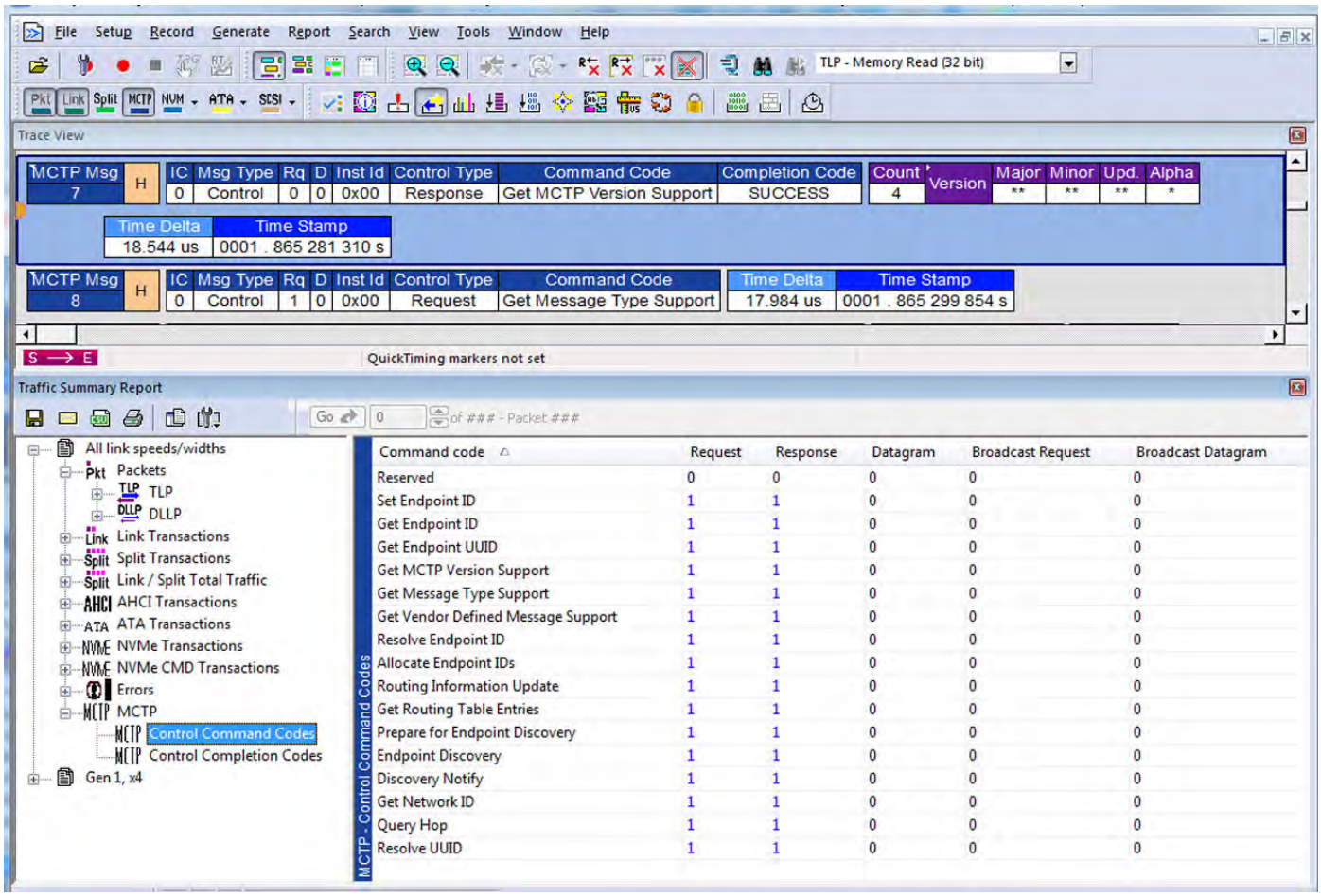


Figure 10.23: MCTP Message Traffic -> Control Command Codes Report

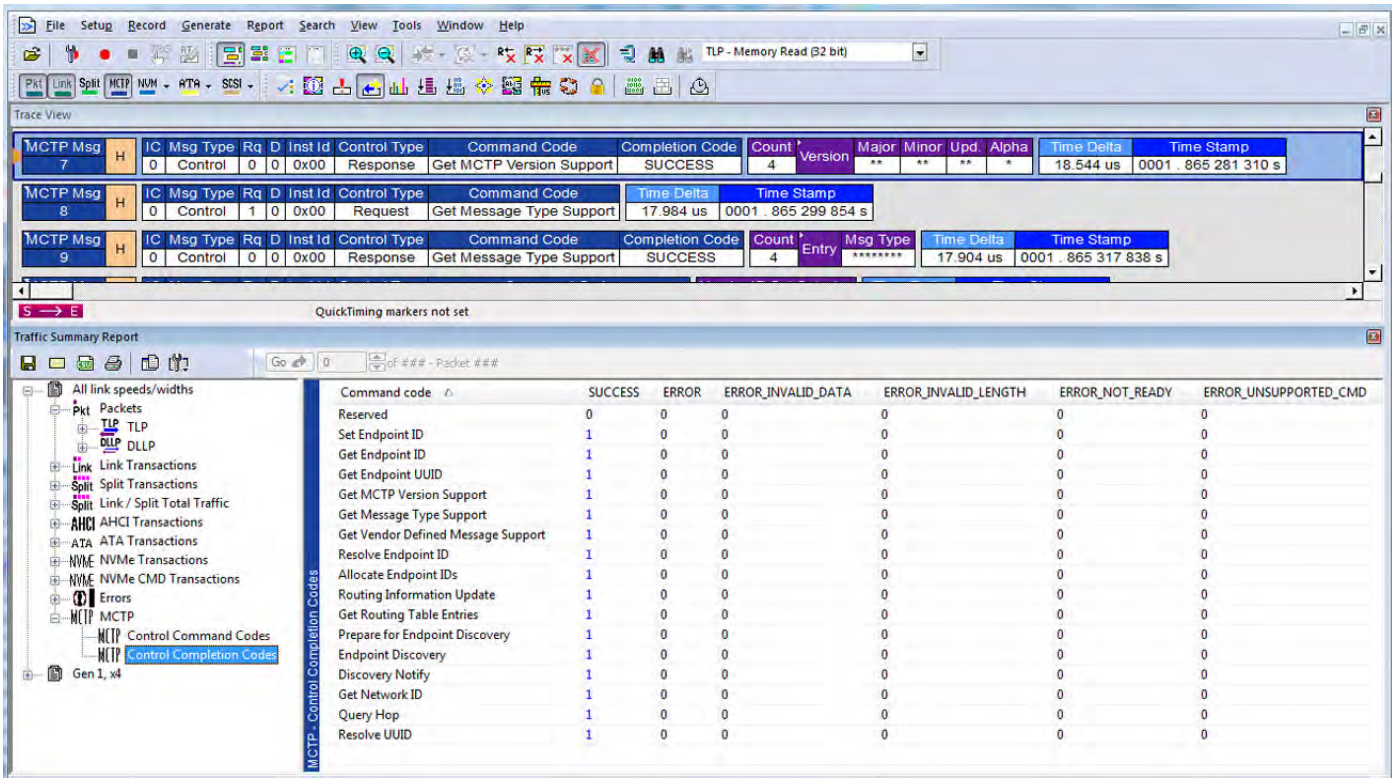


Figure 10.24: MCTP Message Traffic -> Control Completion Codes Report

10.3.6 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 10.25).

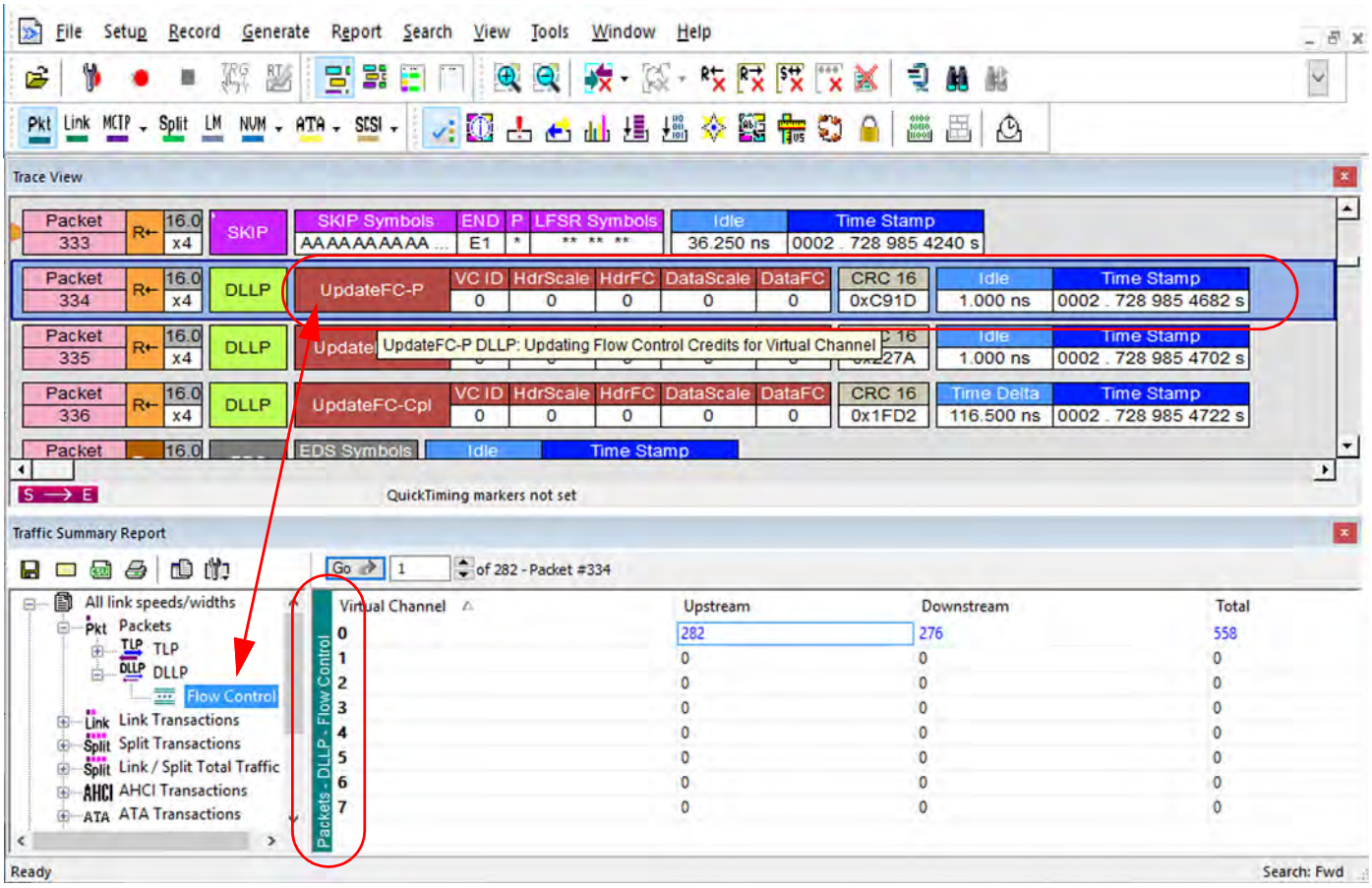


Figure 10.25: Flow Control Trace Showing Traffic Summary

10.4 Bus Utilization

Select **Report > Bus Utilization** from the menu or press  to open the Bus Utilization dialog.

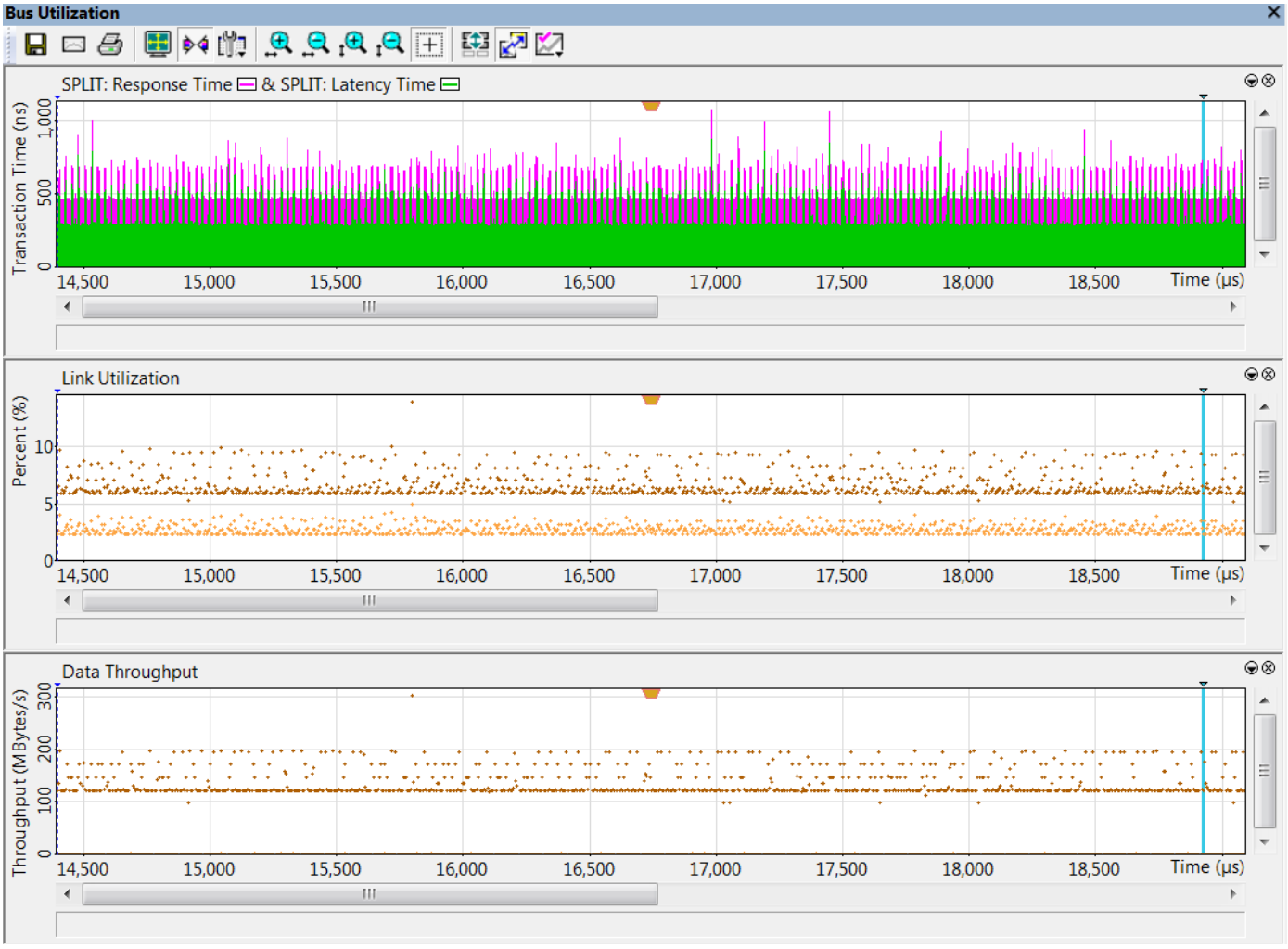


Figure 10.26: Bus Utilization Dialog

The Bus Utilization window displays information on bandwidth use for the transmit and receive channels.

10.4.1 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.

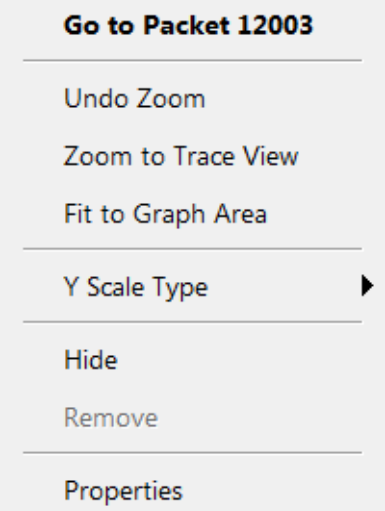


Figure 10.27: Bus Utilization Menu

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 10.28 on page 698).

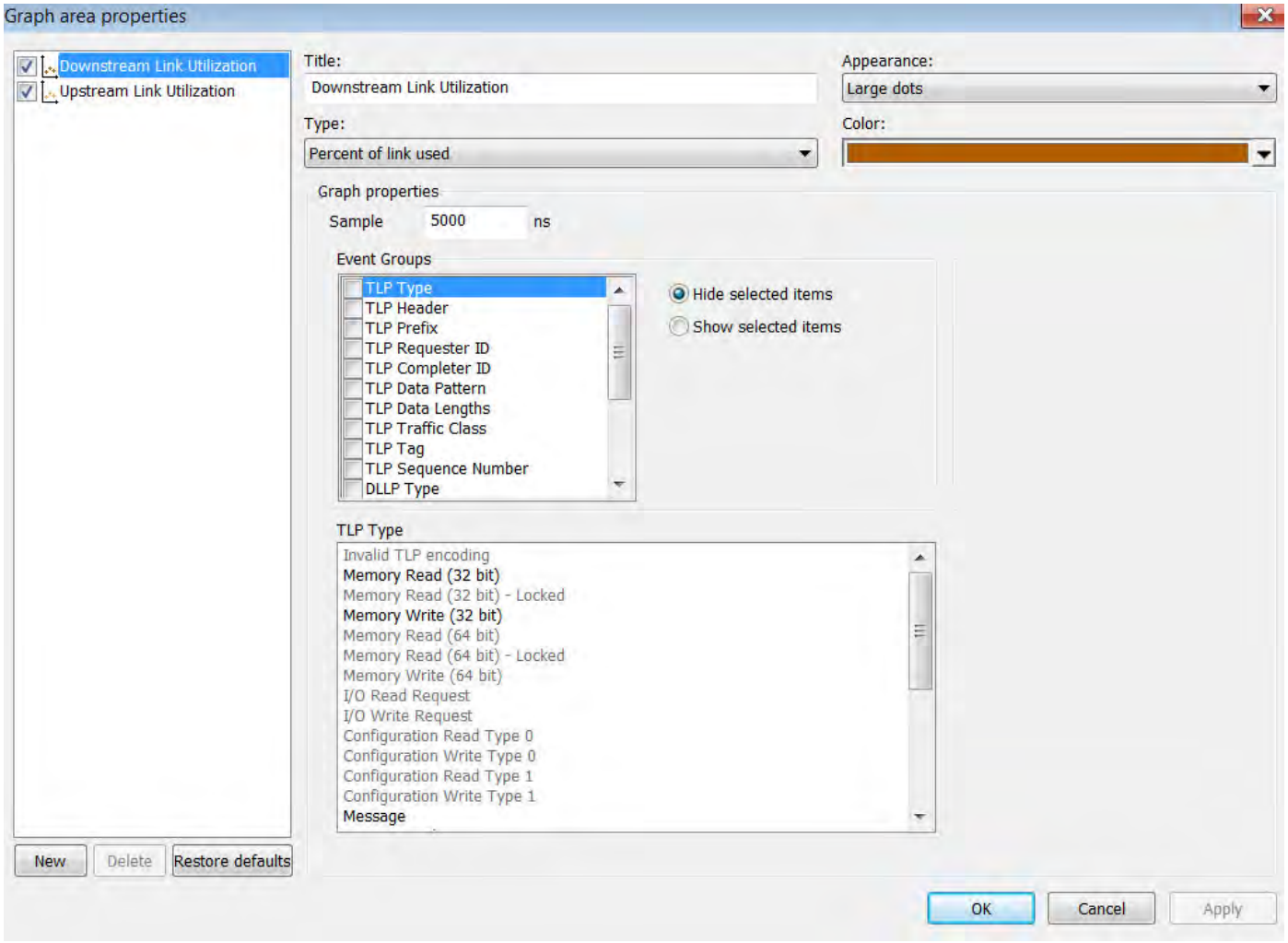


Figure 10.28: Graph Area Properties Dialog

10.4.2 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 10.29:

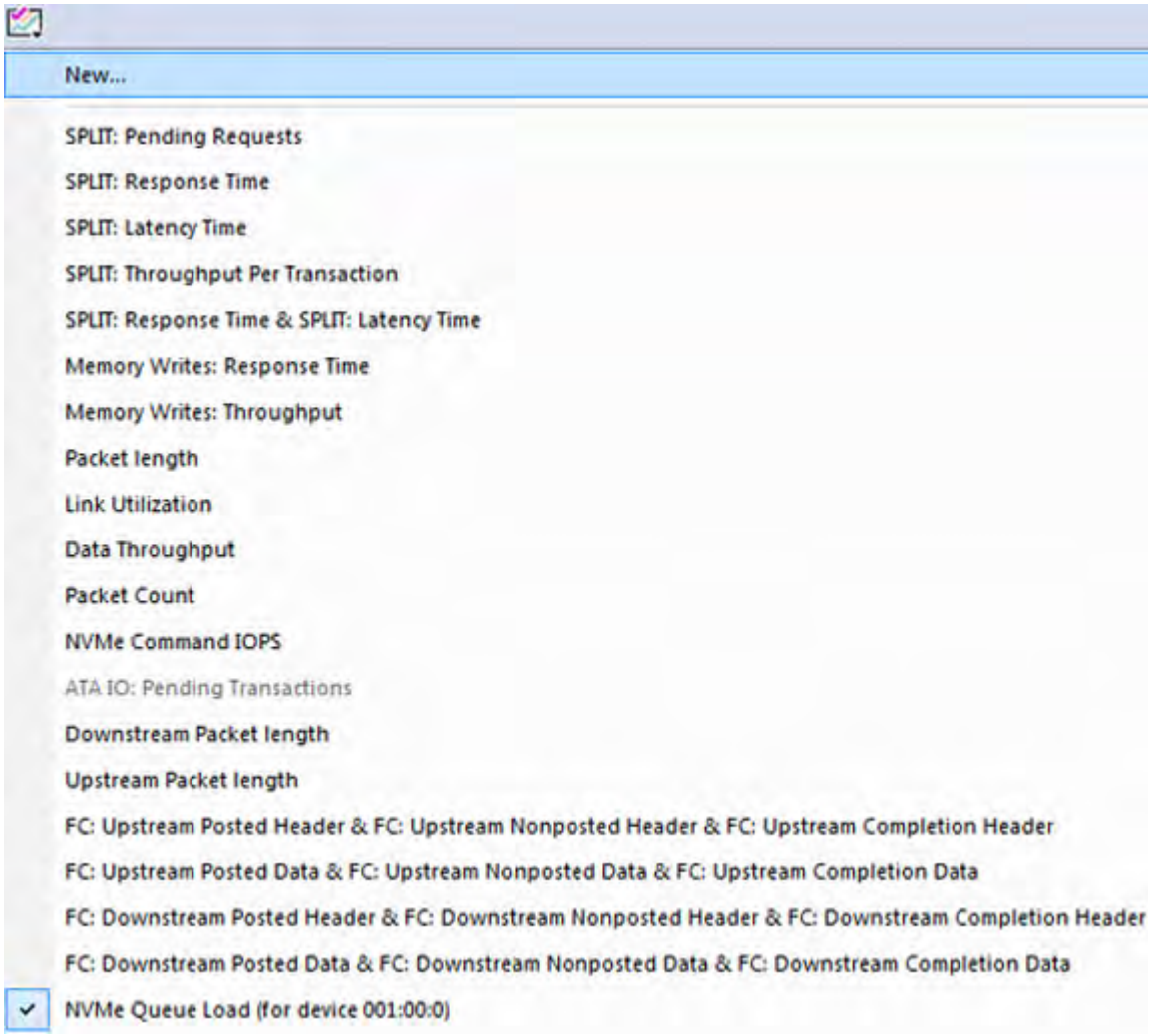


Figure 10.29: Graph Area Options Dialog

- 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 10.30.

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 10.30: Bus Utilization: NVMe Queue Load

Graph Legend

Graph legend can be viewed by moving mouse pointer over graph title. See Figure 10.31 on page 703.

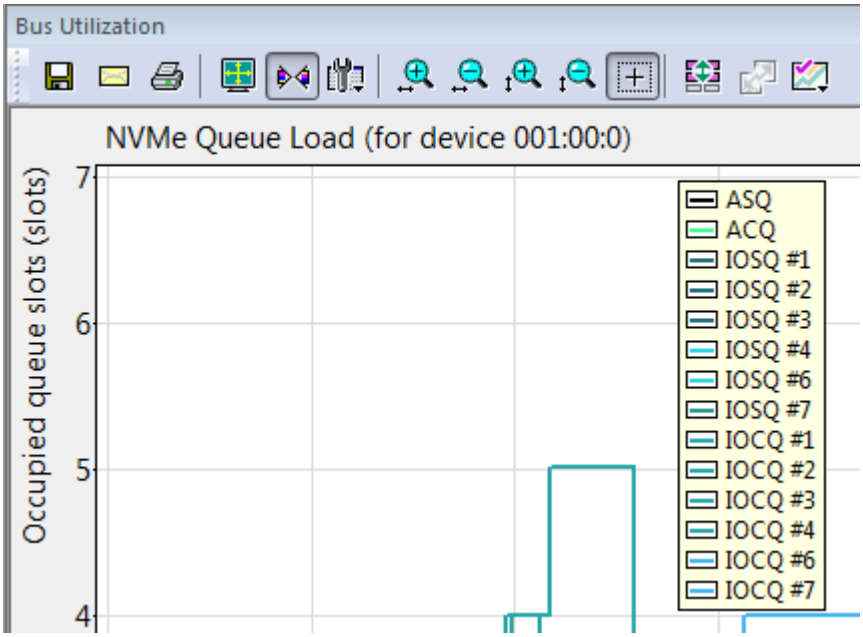


Figure 10.31: Bus Utilization: Graph Legend Details

Graph Properties

Queues to show can be selected in Graph Properties (as well as line colors). See Figure 10.32.

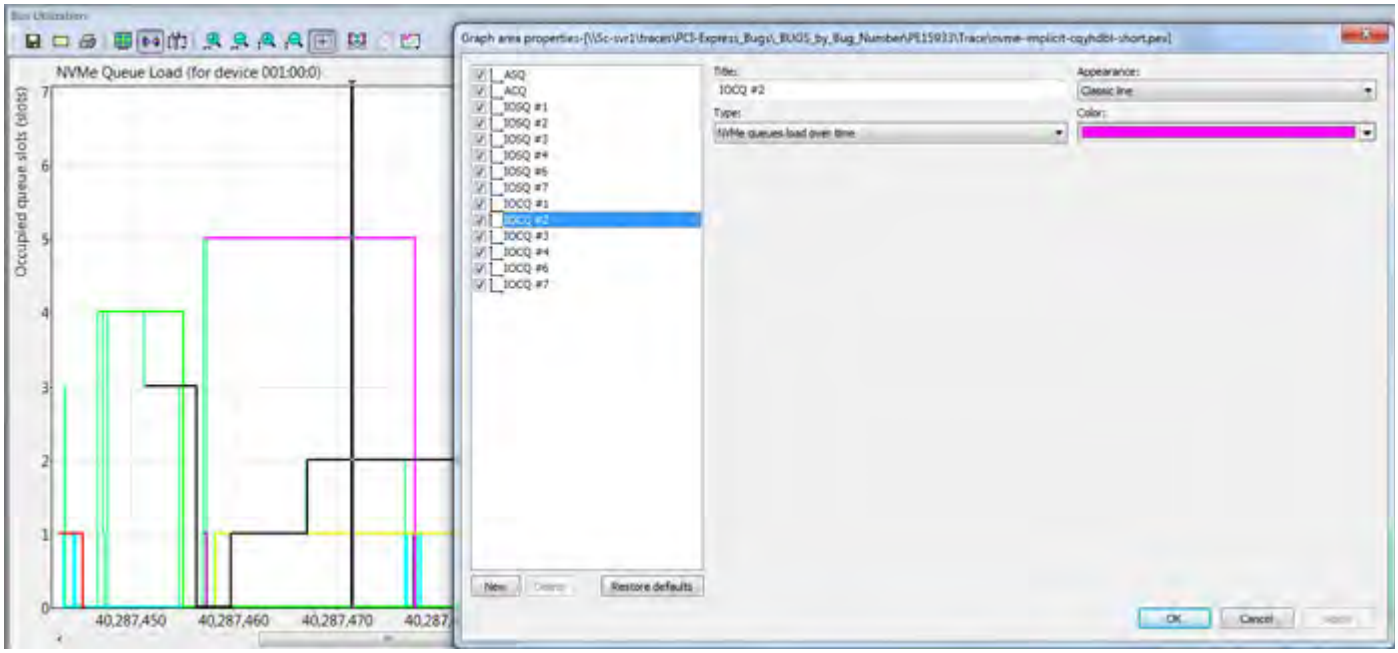


Figure 10.32: Bus Utilization: NVMe Queues => Selected in Graph Properties

10.5 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.

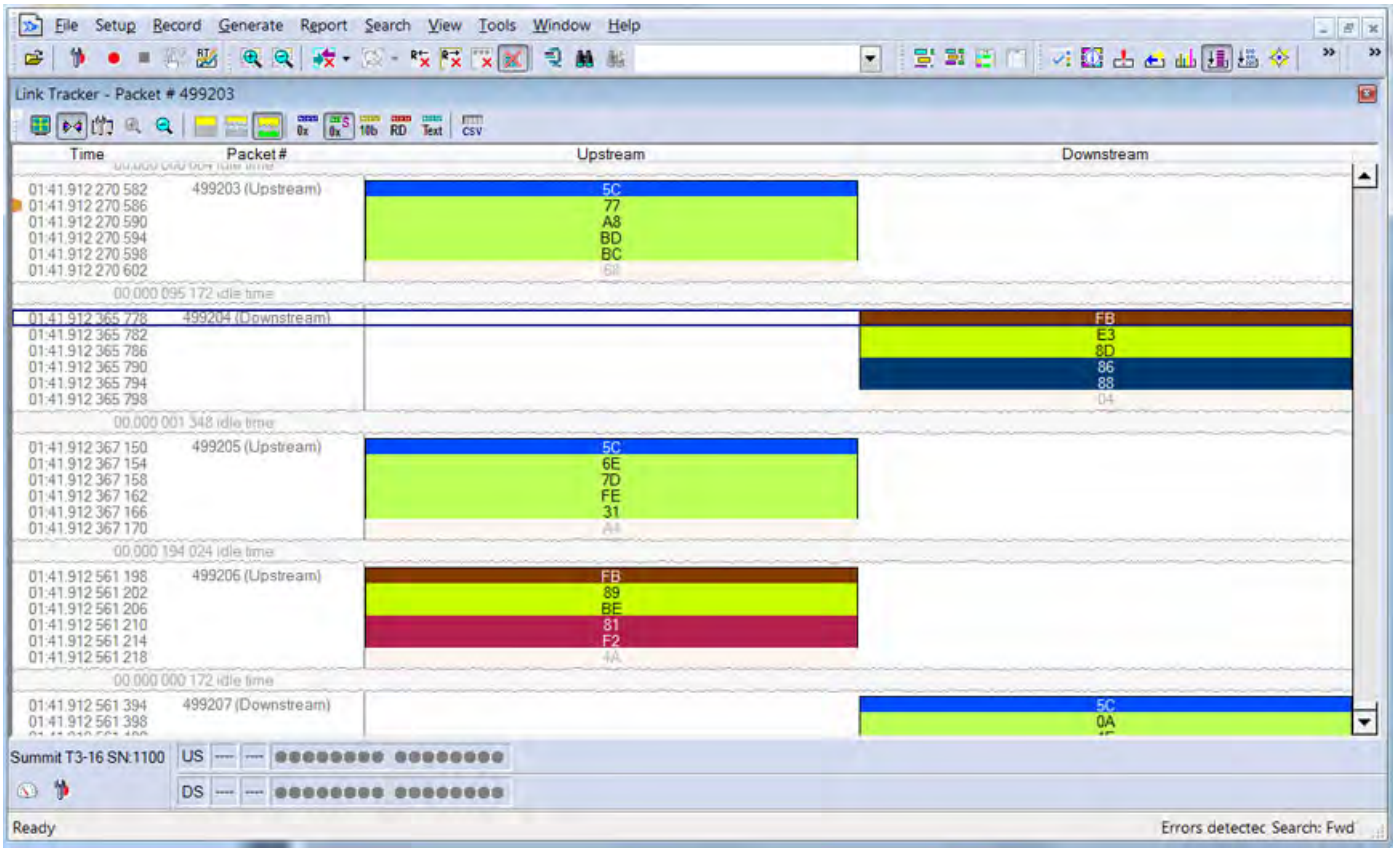


Figure 10.33: Link Tracker Window

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.

10.5.1 Using the Link Tracker Window

The Link Tracker window can be reformatted in several ways.

10.5.2 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.

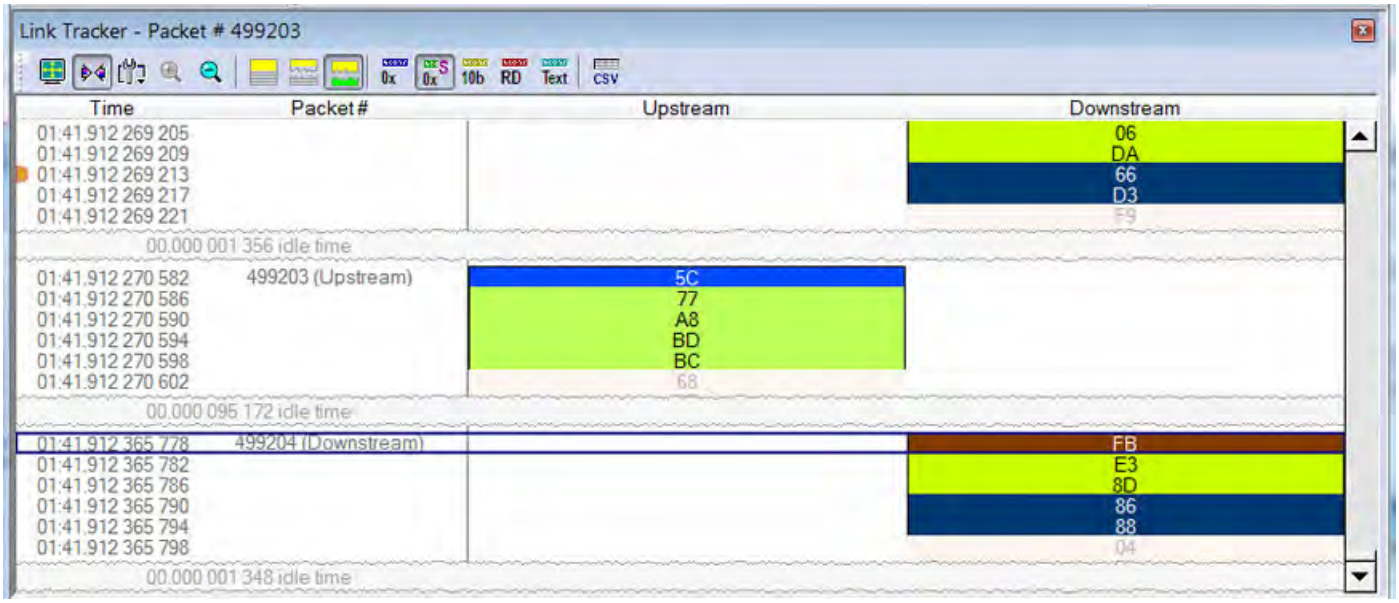


Figure 10.34: Link Tracker: Zoomed Out

10.5.3 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.

10.5.4 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.

10.5.5 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.

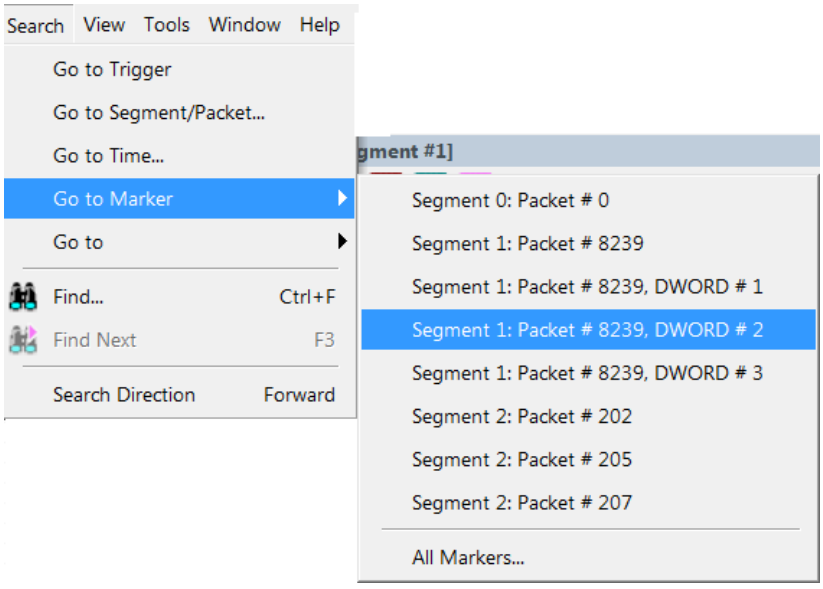


Figure 10.35: Selecting the Go to Marker Option

10.5.6 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.

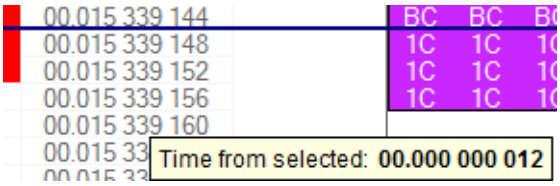


Figure 10.36: Viewing Time Values

10.5.7 Hiding Traffic

You can hide Idles and other data from the Link Tracker window by clicking the **Hide** buttons on the toolbar.

10.5.8 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 704 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.
	Show Descrambled Bytes
	Show Scrambled Bytes
	Show 10b Codes
	Show Symbols
	Show Text
	Show Binary values
	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 10.37.

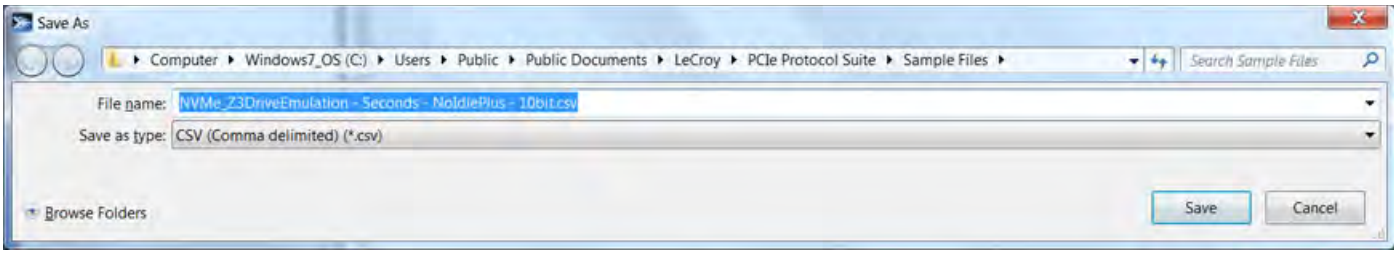


Figure 10.37: Link Tracker: CSV File to be Saved and Location

Select Save and the tool will start. See Figure 10.38.

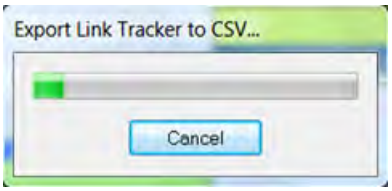


Figure 10.38: Tool Exporting Link Tracker Data to CSV File

The generated CSV file can be viewed in Excel.

10.6 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.

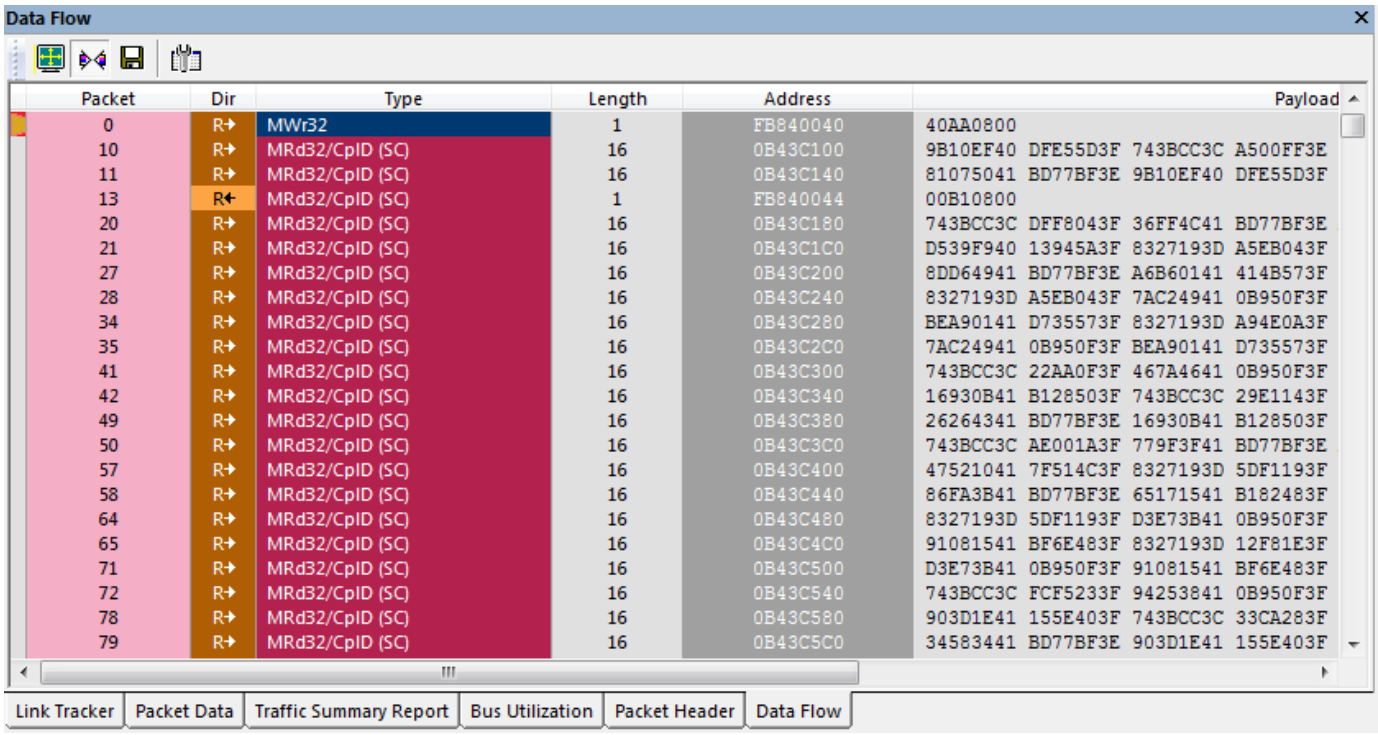
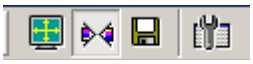


Figure 10.39: Data Flow Window



The toolbar allows you to (see Figure 10.40 on page 711):

- 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

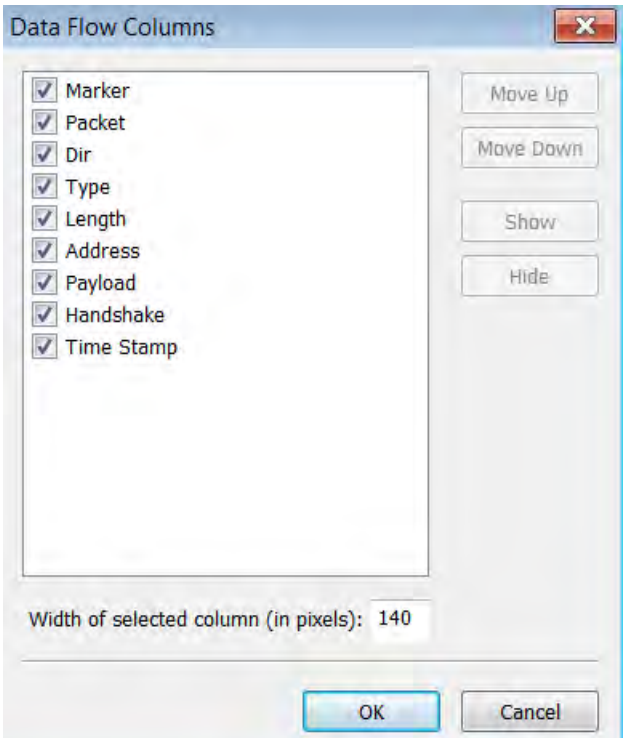


Figure 10.40: Data Flow Columns Dialog

10.7 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.

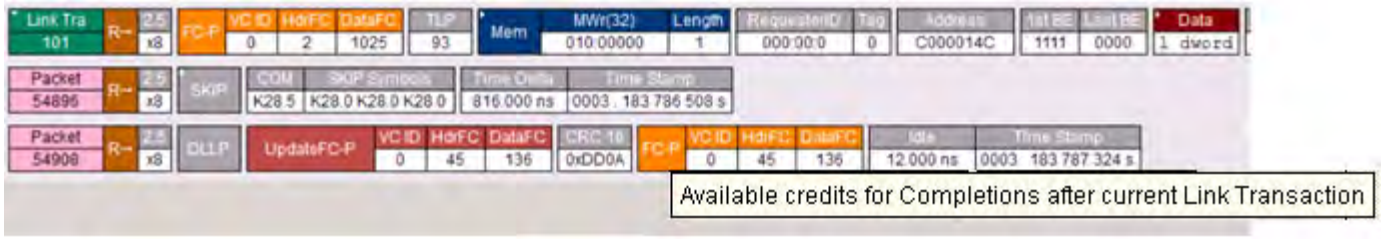


Figure 10.41: Flow Control Display

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.

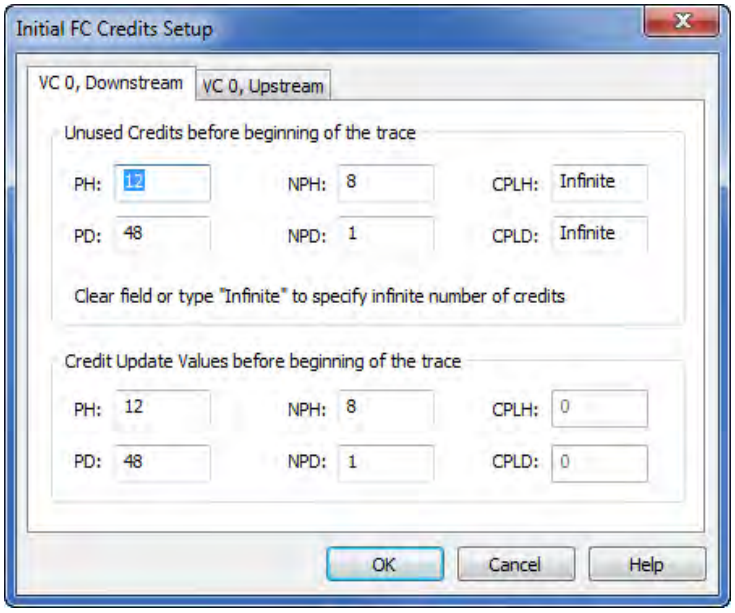


Figure 10.42: Flow Control Setup Dialog

10.8 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.

10.8.1 Displaying the Navigator

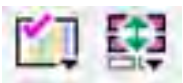
Click  in the toolbar to display the Navigator. The Navigator appears on the right side of the Main window. It has a two-button toolbar and a vertical slider bar. It also has colored panes for navigating the CATC Trace in different ways. You set which panes are displayed through Navigator pop-up menus (see Figure 10.43 on page 713).



Figure 10.43: Navigator Dialog

10.8.2 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.

10.8.3 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.

.



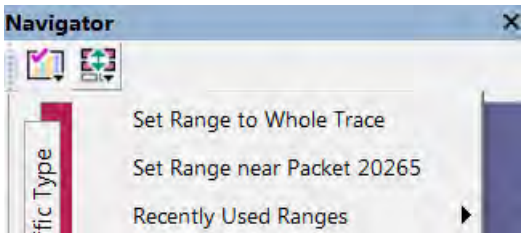
10.8.4 To Determine Current Position

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.

10.8.5 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.

10.8.6 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.

10.8.7 To Show/Hide Nav55igator 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.

10.8.8 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.

10.8.9 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 10.43 on page 713).

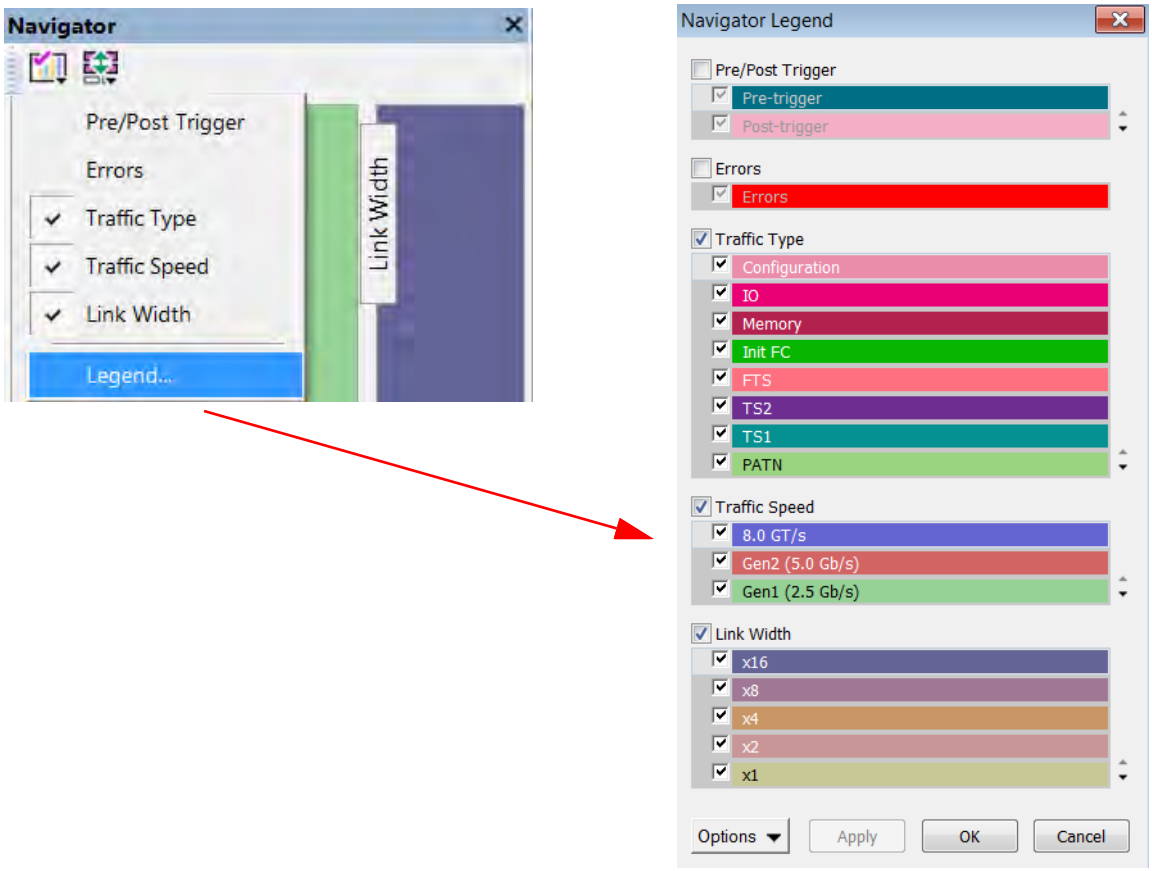


Figure 10.44: Navigator Pane and Navigator Legend Dialog

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.

10.8.10 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.

10.8.11 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.

10.9 Detail View

Click  to show the Detail View of the selected packet.

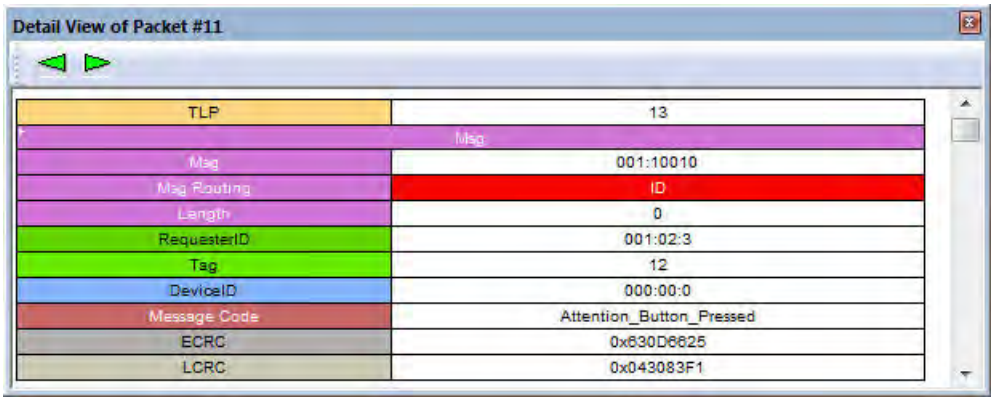


Figure 10.45: Detail View

10.10 LTSSM Flow Graph

The Link Training and Status State Machine (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 10.46 on page 719), select **Report > LTSSM Flow Graph.**

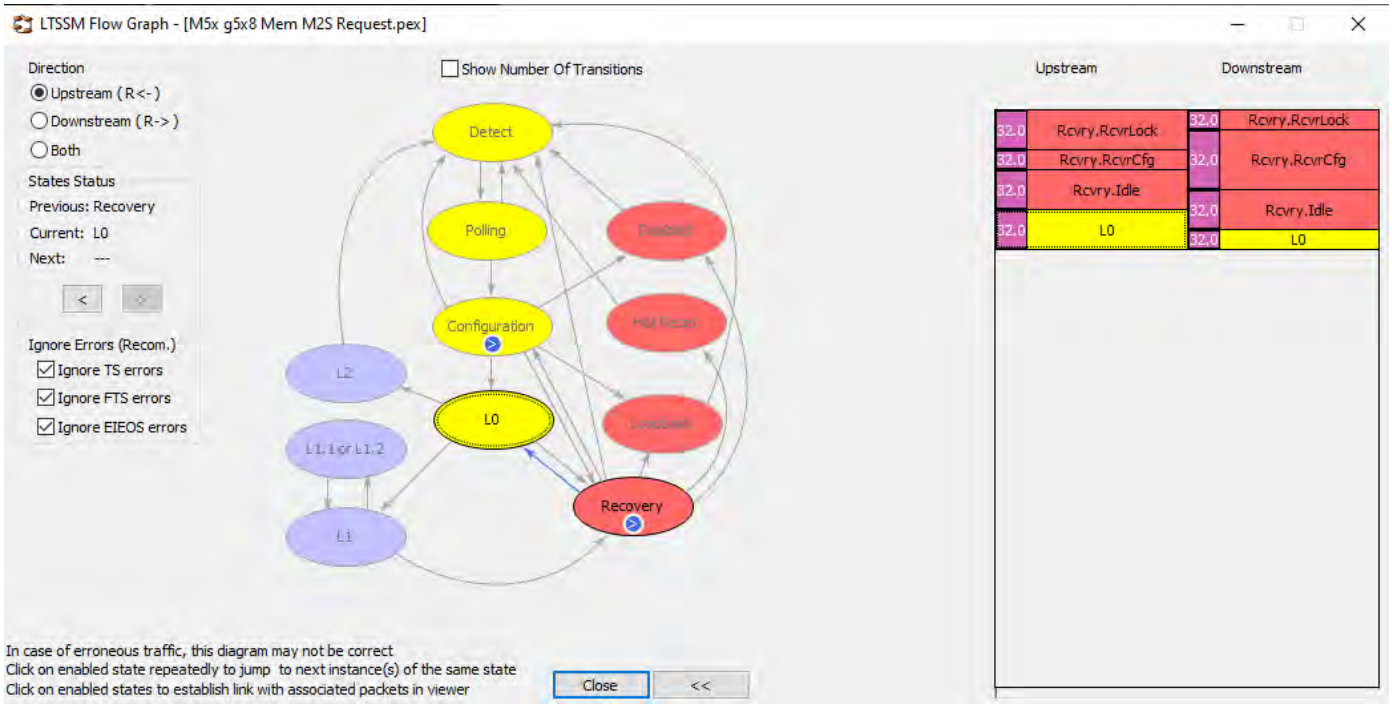


Figure 10.46: LTSSM Flow Graph Dialog

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**.

10.10.1 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 10.47.

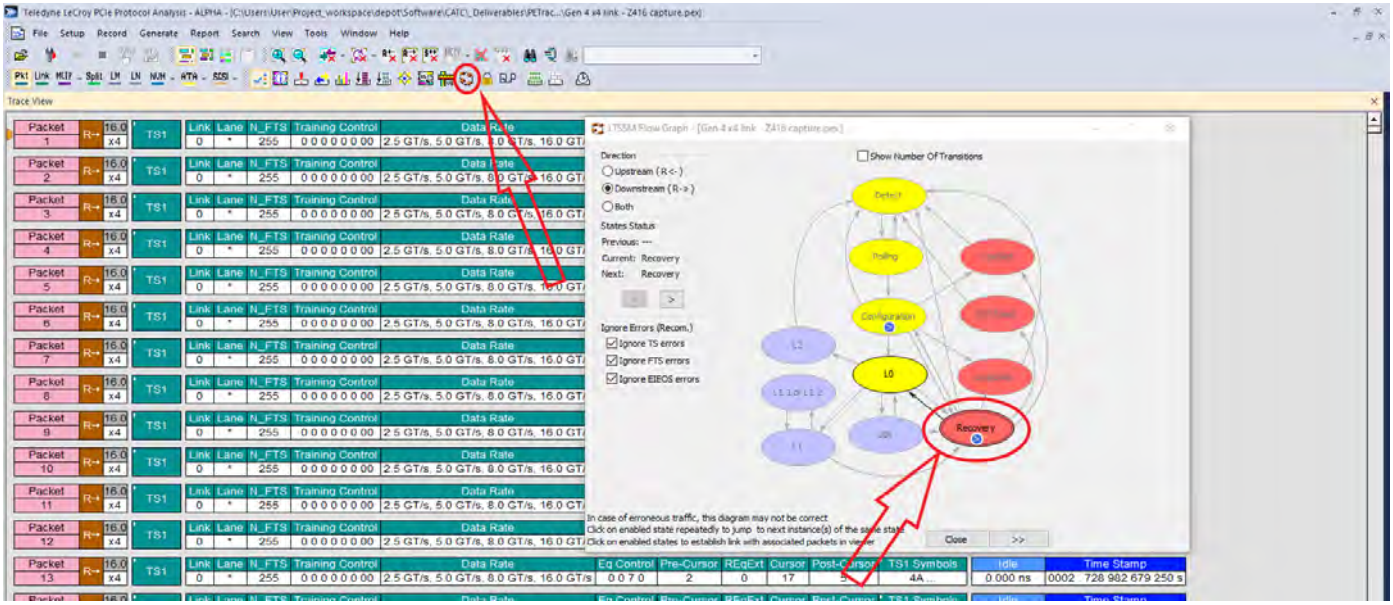


Figure 10.47: Recovery Phase of LTSSM

Click on the arrow in the blue circle in the Recovery state to see more detail. See Figure 10.48 on page 721.

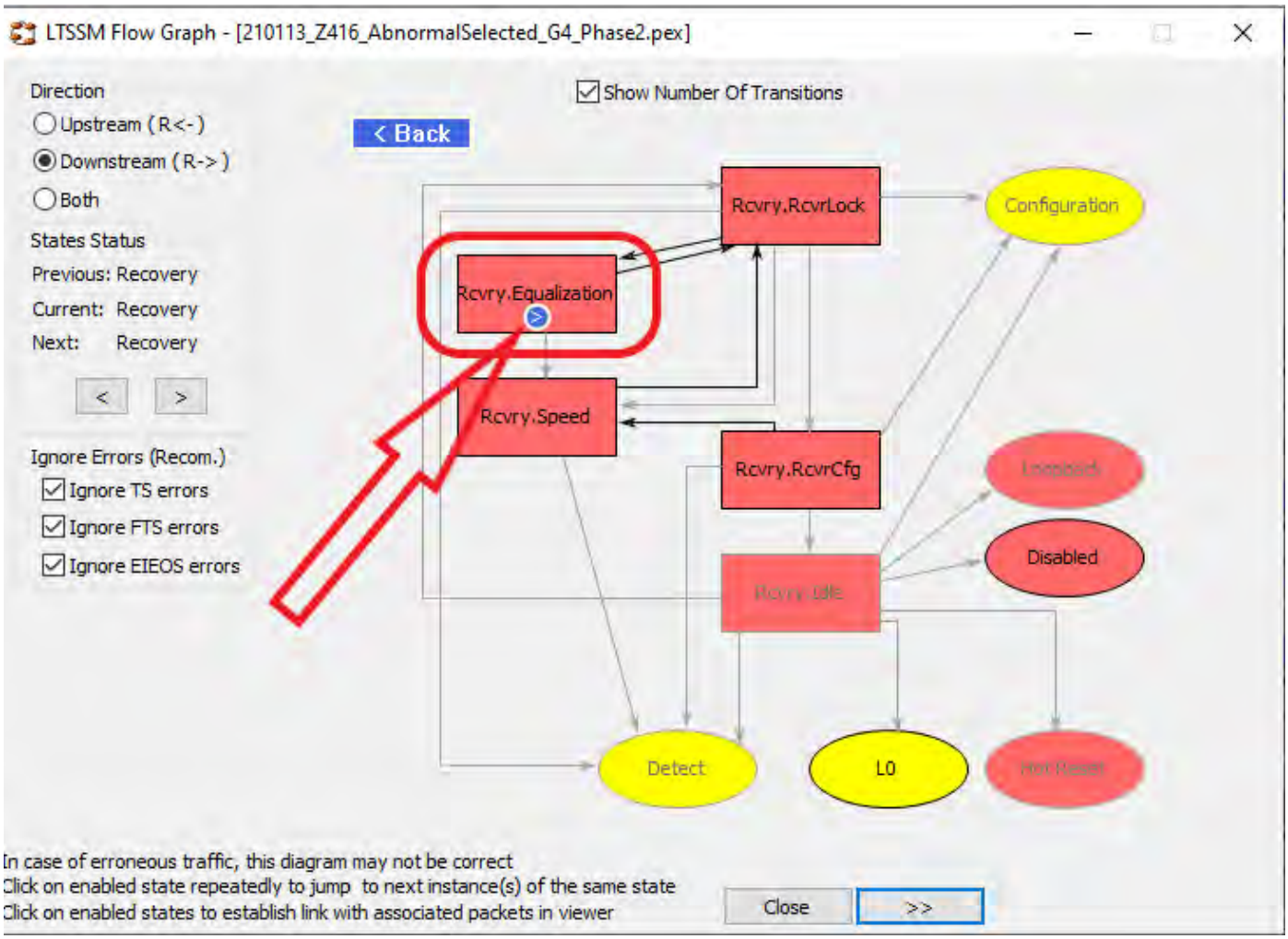


Figure 10.48: Recovery Equalization State

Click on the blue circle with the white arrow in the Recovery.Equalization state to review the PreCursor, Cursor and PostCursor values. See Figure 10.49 on page 722.

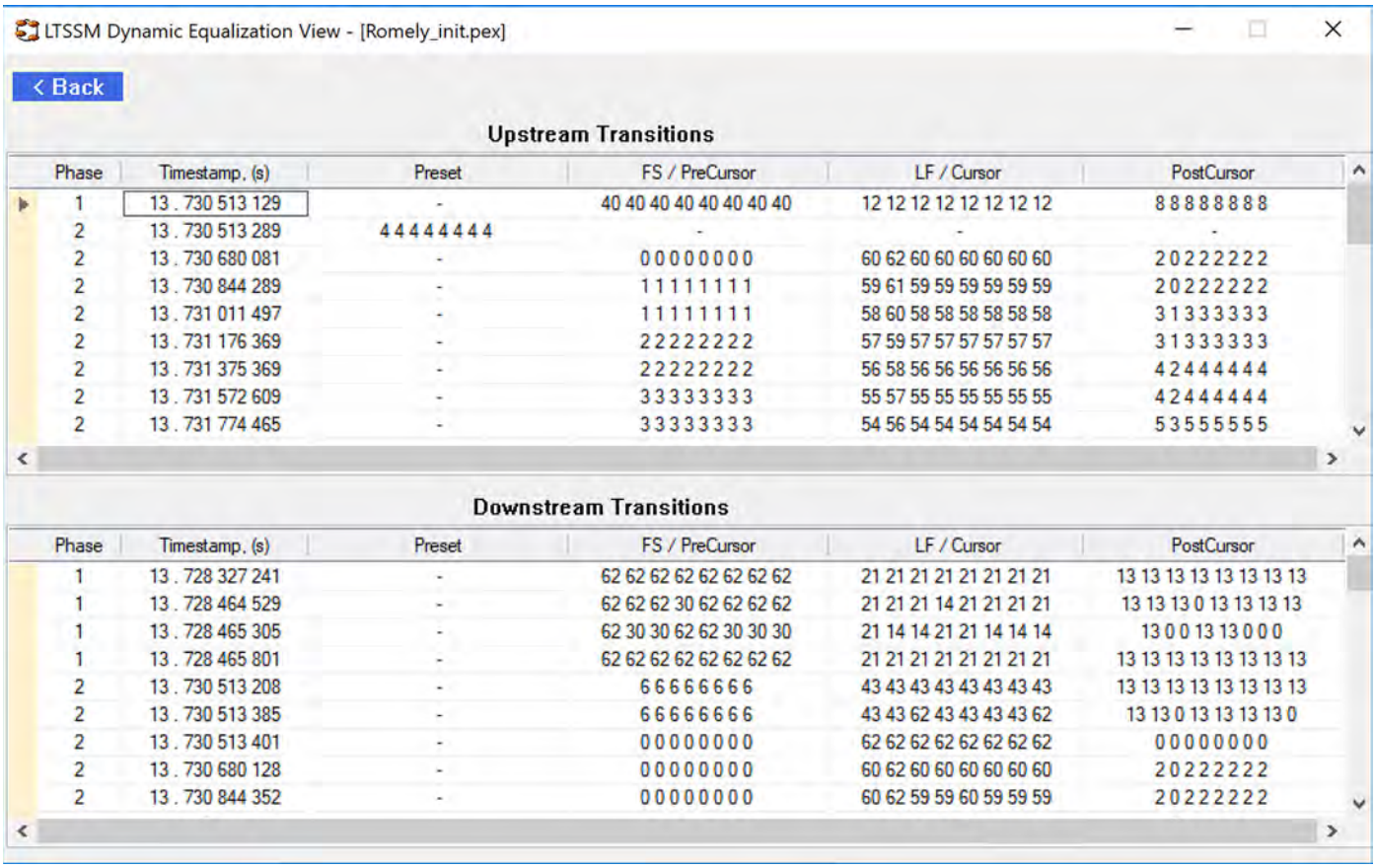


Figure 10.49: LTSSM Dynamic Equalization: PreCursor, Cursor and PostCursor Values

10.11 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 10.50.

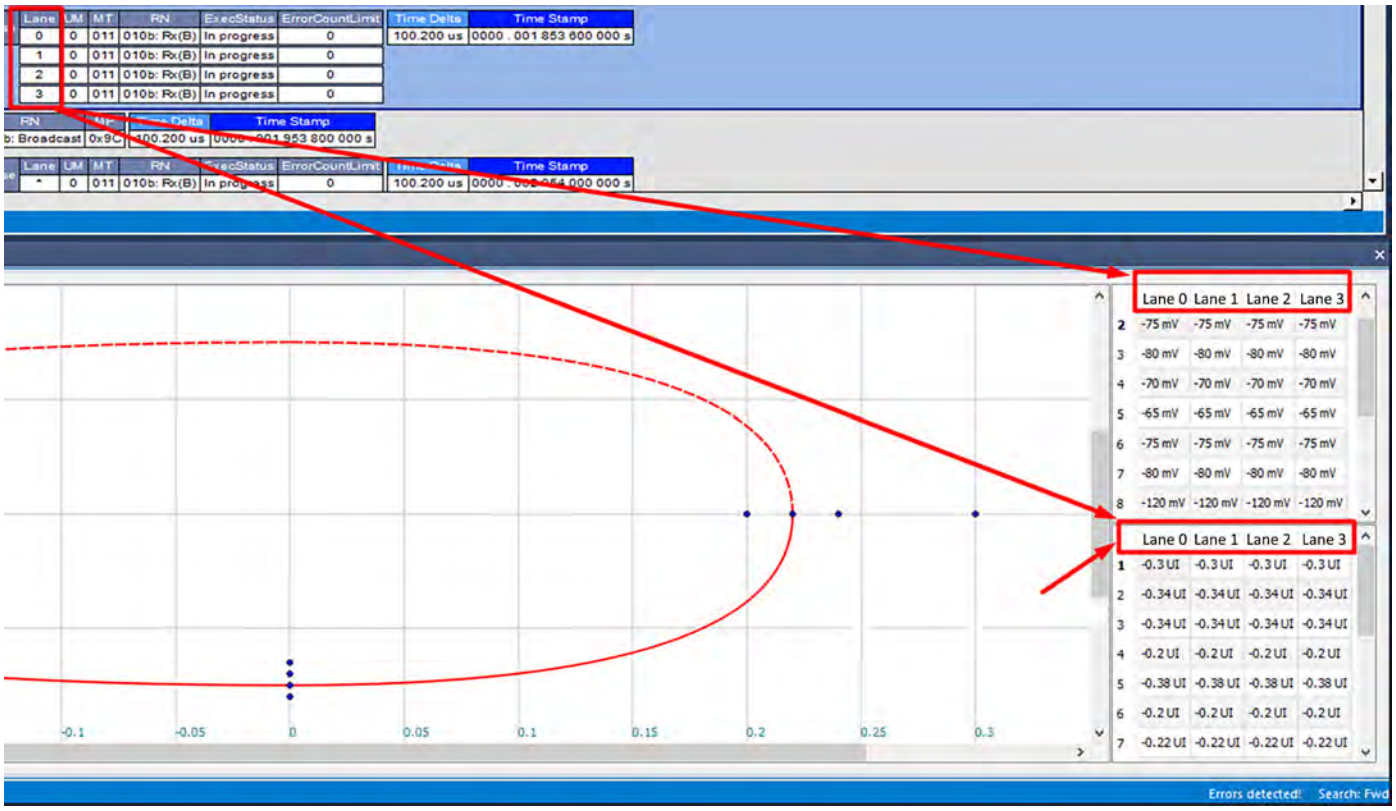


Figure 10.50: Decoded Lane Margining Trace: Eye Diagram

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 10.51 on page 724.

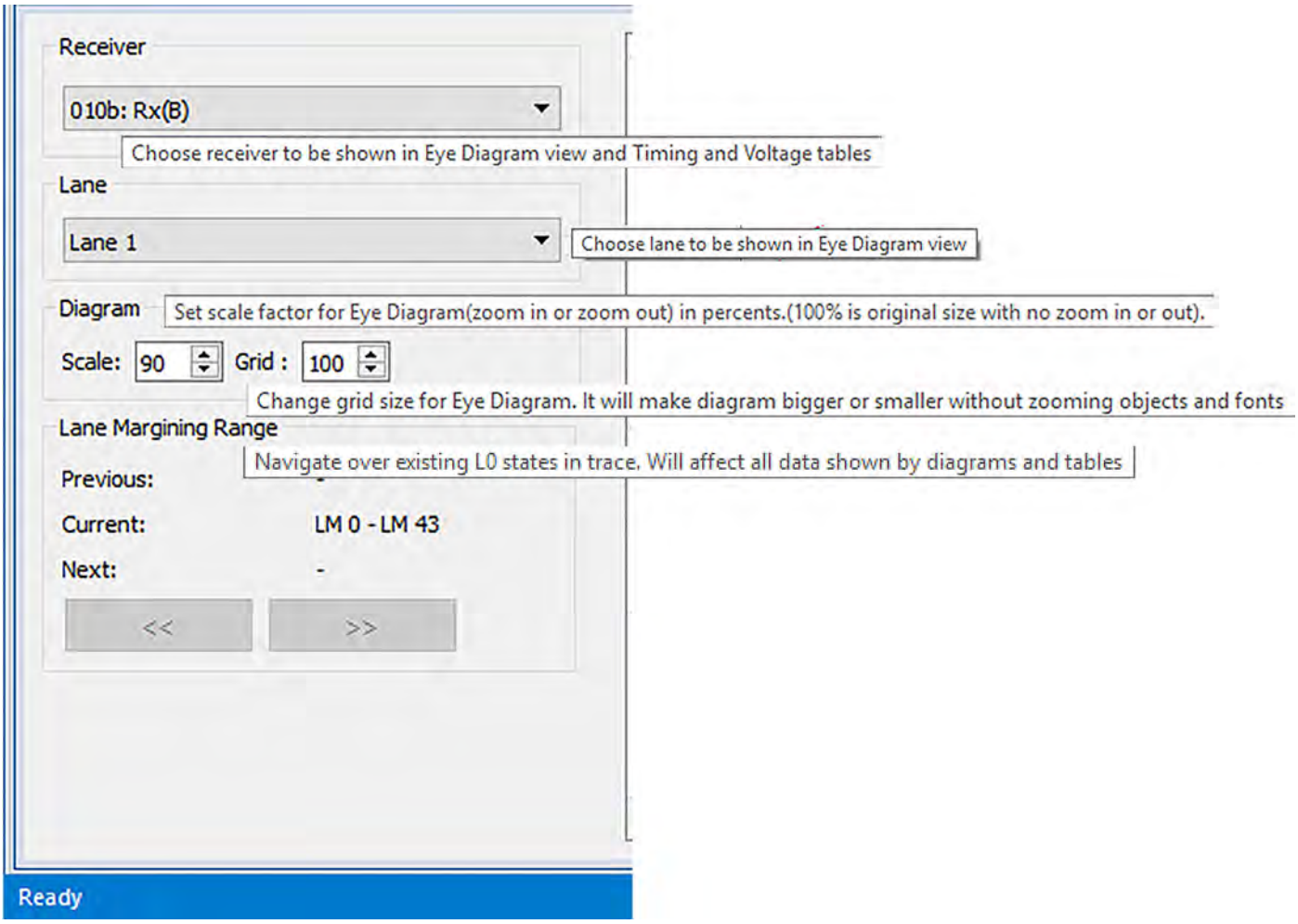


Figure 10.51: Options and Tooltips: Left side of Eye Diagram

On the right side of the Eye Diagram there are the following options:

- Lane 0 - Lane 3: Shows voltage transactions for given receiver
- Lane 0 - Lane 3: Shows timing transactions for given receiver

See Figure 10.52 on page 725.

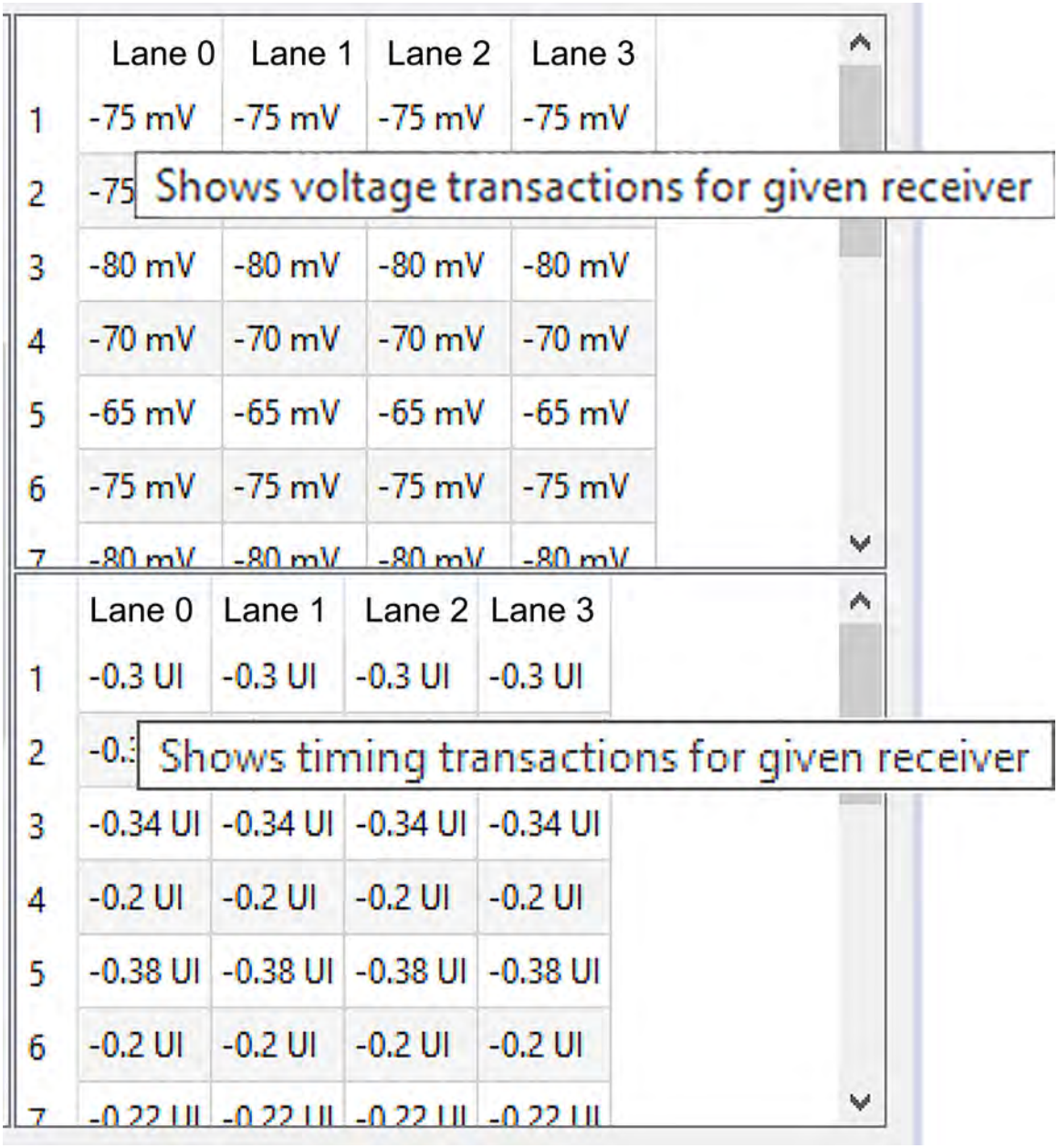


Figure 10.52: Options and Tooltips: Right side of Eye Diagram

10.12 Packet Header Bar

The Packet Header bar shows packet header information.

To display the Packet Header bar (see Figure 10.53 on page 726), select **Report > Packet Header** or click the  toolbar icon.

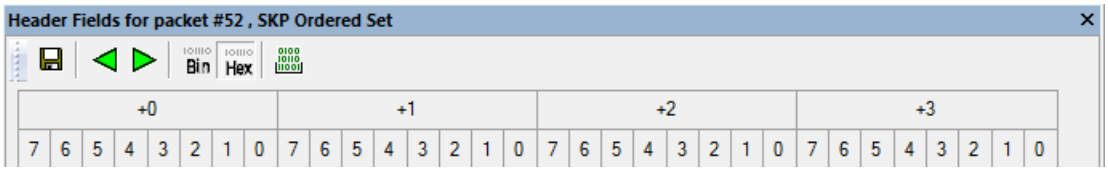


Figure 10.53: Packet Header Bar

The toolbar allows you to Save, go to Previous or Next, display Hexadecimal or Binary, and show the Packet Data window.



10.13 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.

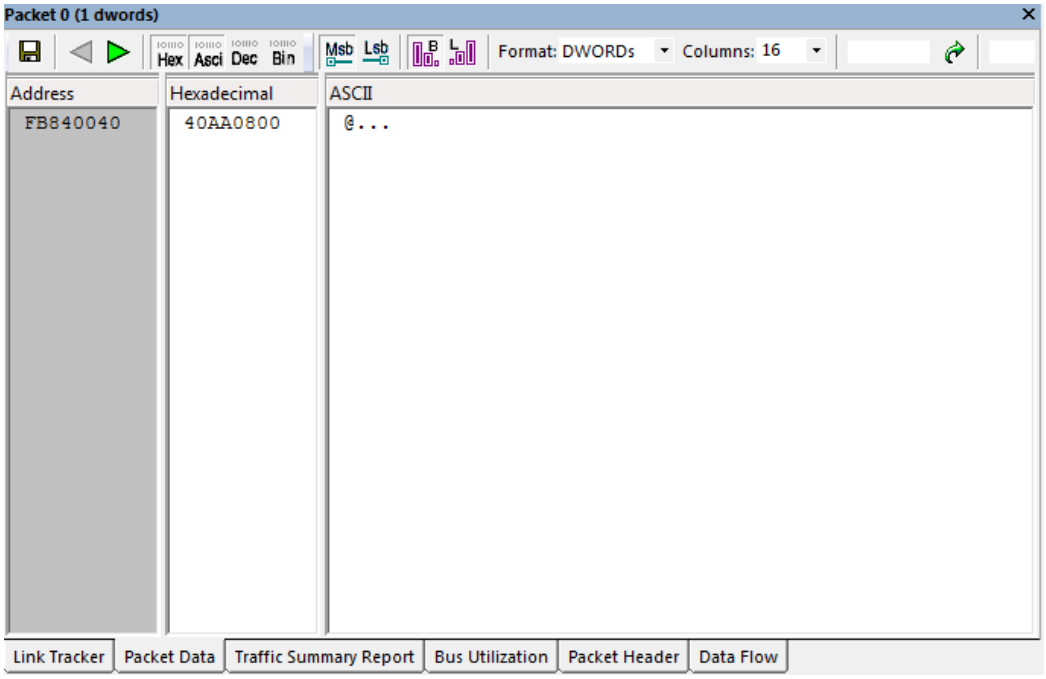
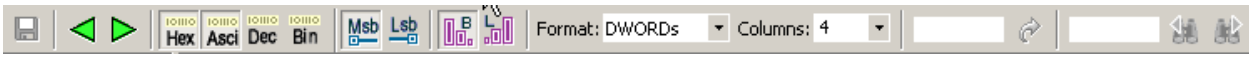


Figure 10.54: Packet Data Window

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.

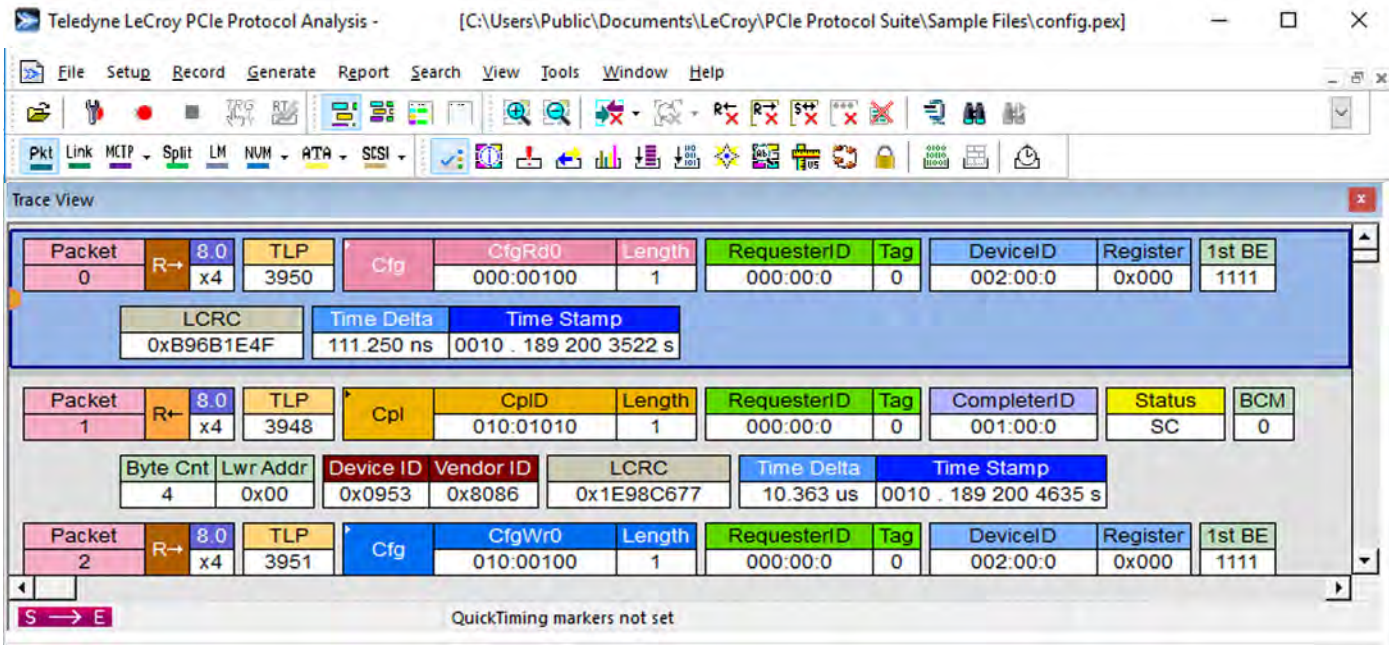
You can enter text and Search Previous or Search Next.

10.14 Configuration Space View

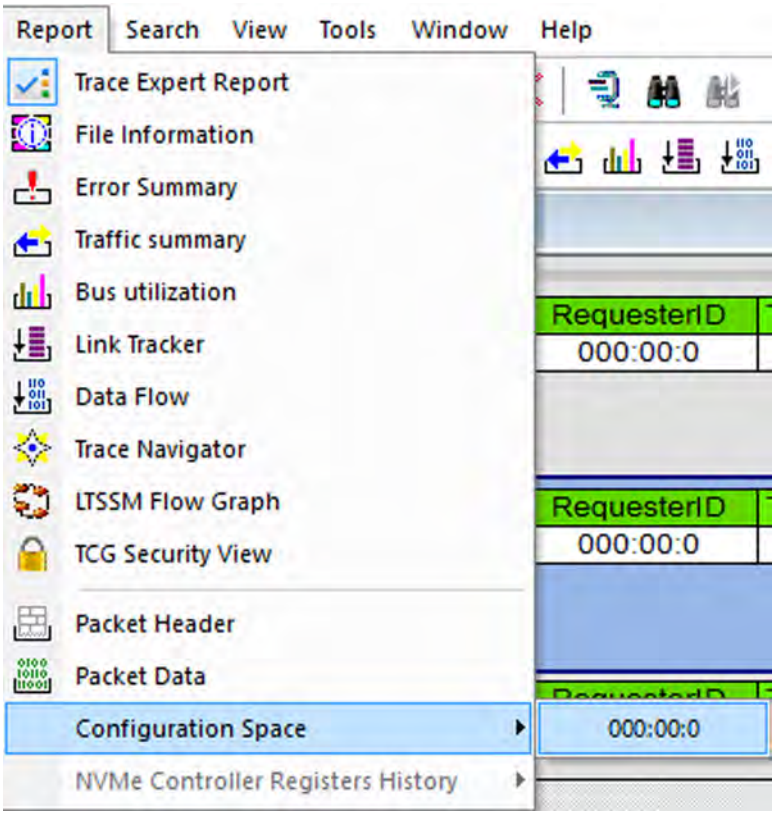
The Configuration Space View displays information about the Configuration Space state as of the current packet of the currently selected device. The view shows the Configuration Space Header and the PCI-compatible or PCI Express Capability Structures.

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 10.55 on page 730).

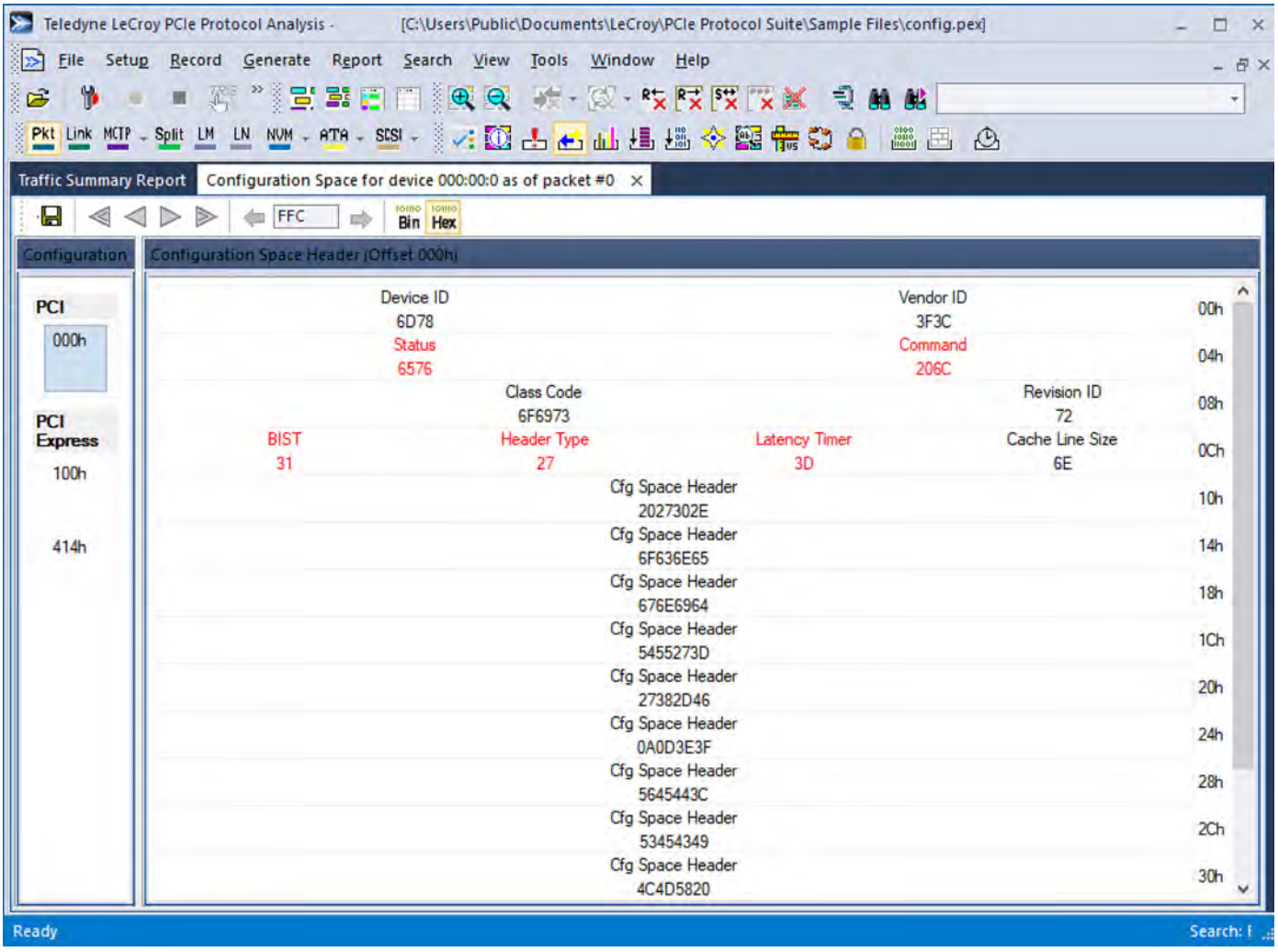


Figure 10.55: Configuration Space View

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.)

10.14.1 Save Configuration Space

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 10.56.

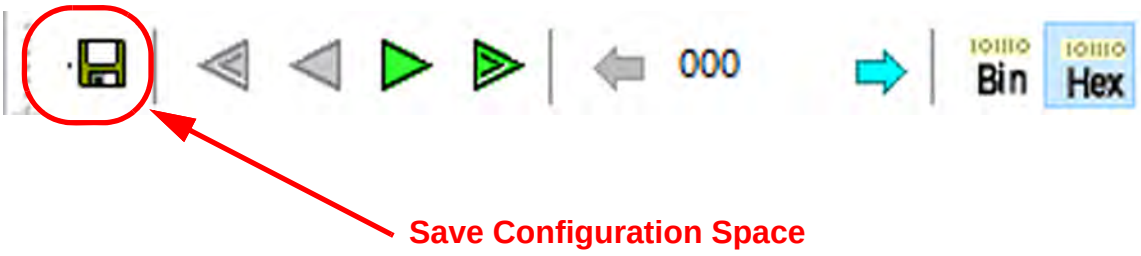


Figure 10.56: Saving Configuration Space File

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 10.57.

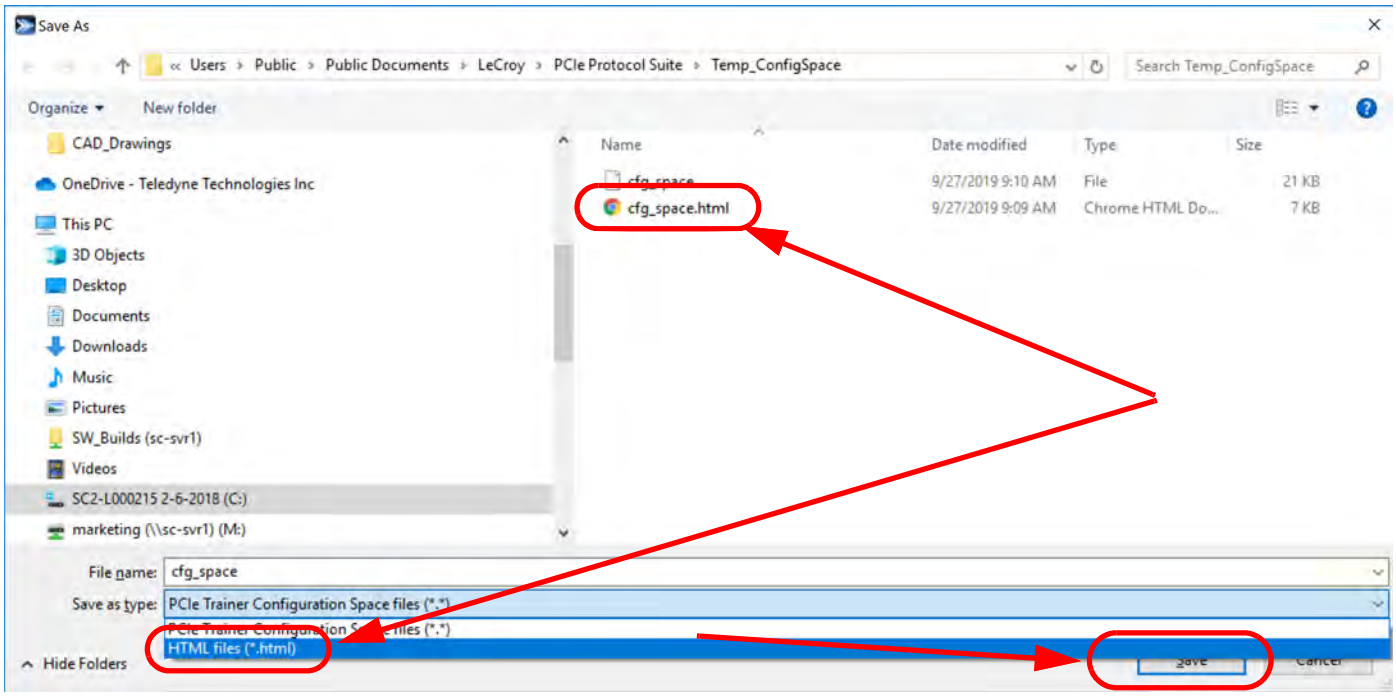


Figure 10.57: Location of Configuration Space File: PCIe Protocol Suite/Temp

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 10.58 on page 732.

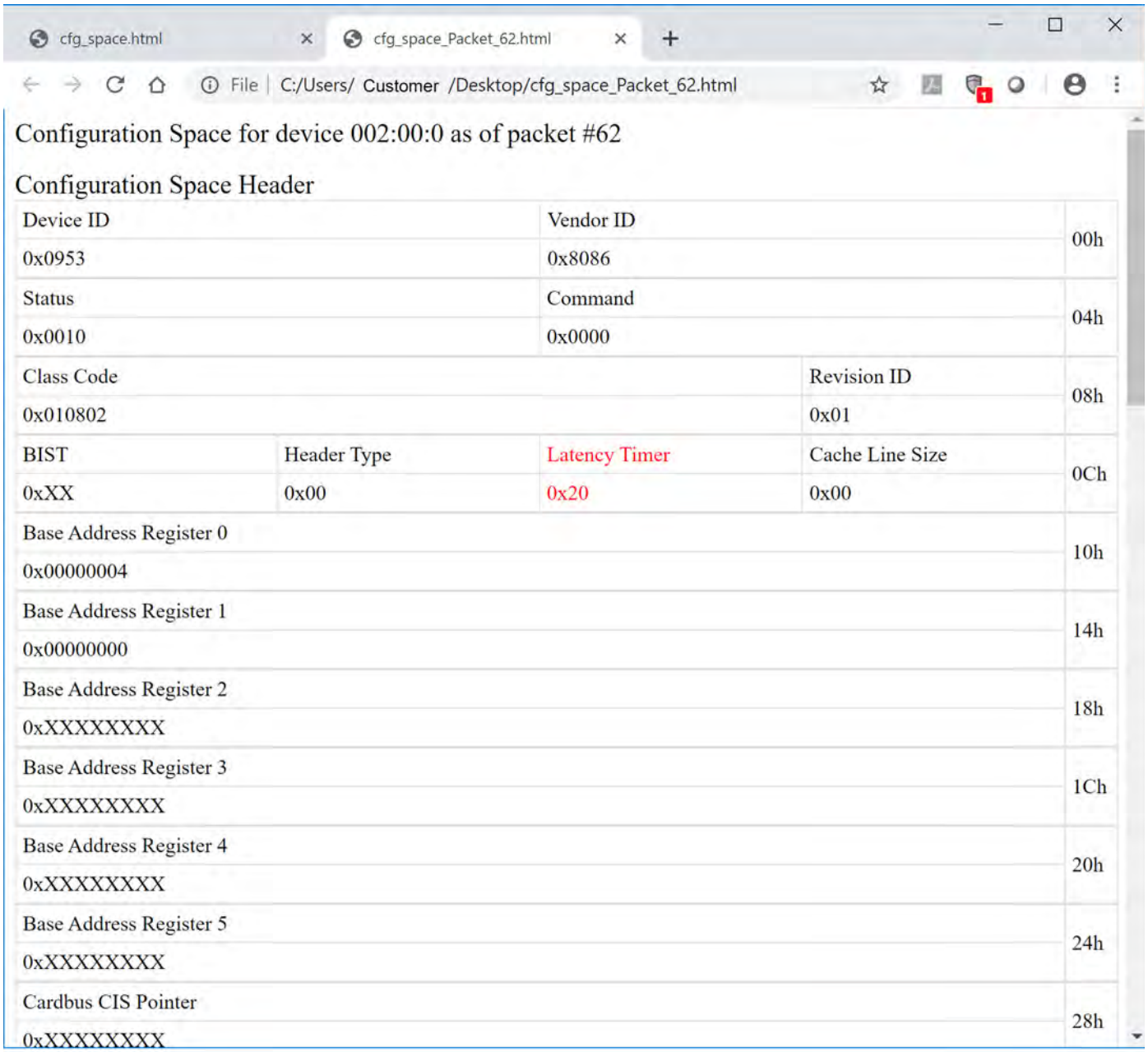


Figure 10.58: Saving Configuration Space File As: HTML

10.14.2 Tools -> Import Configuration Space File

Import Configuration Space dialog can be launched from Tools menu after PCIe trace file is opened. See Figure 10.59.

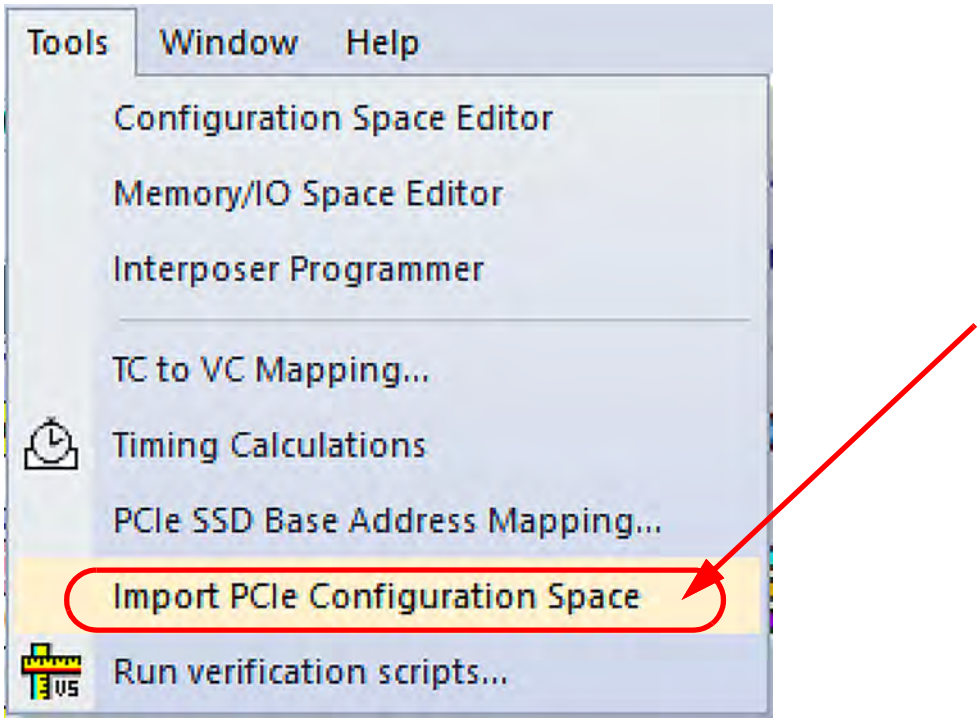


Figure 10.59: **Tools -> Import PCIe Configuration Space**

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 10.60.

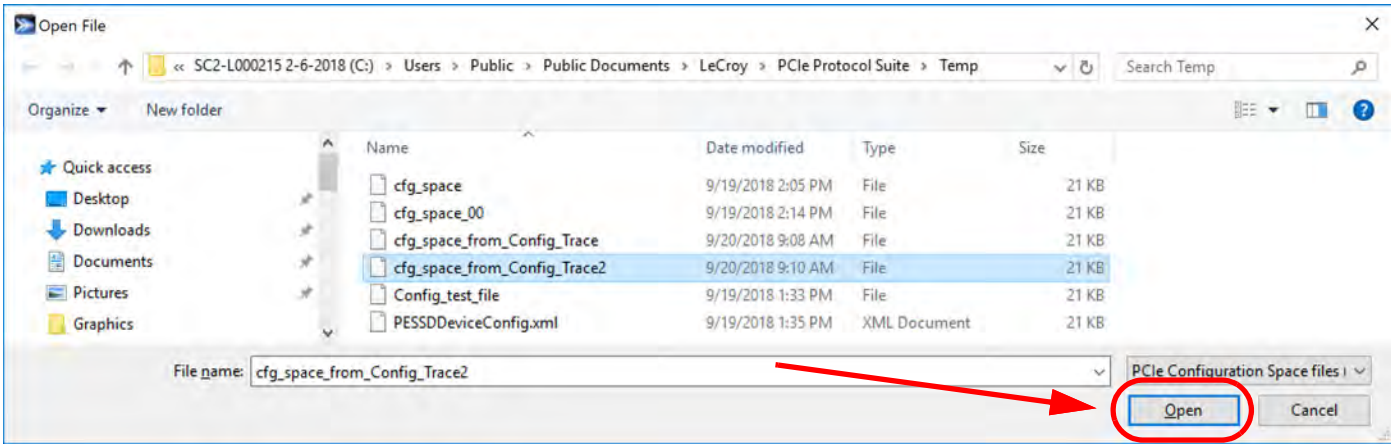


Figure 10.60: Saved Configuration Space files

Select **Open** and the Import PCIe Configuration Space dialog pops up. See Figure 10.61.

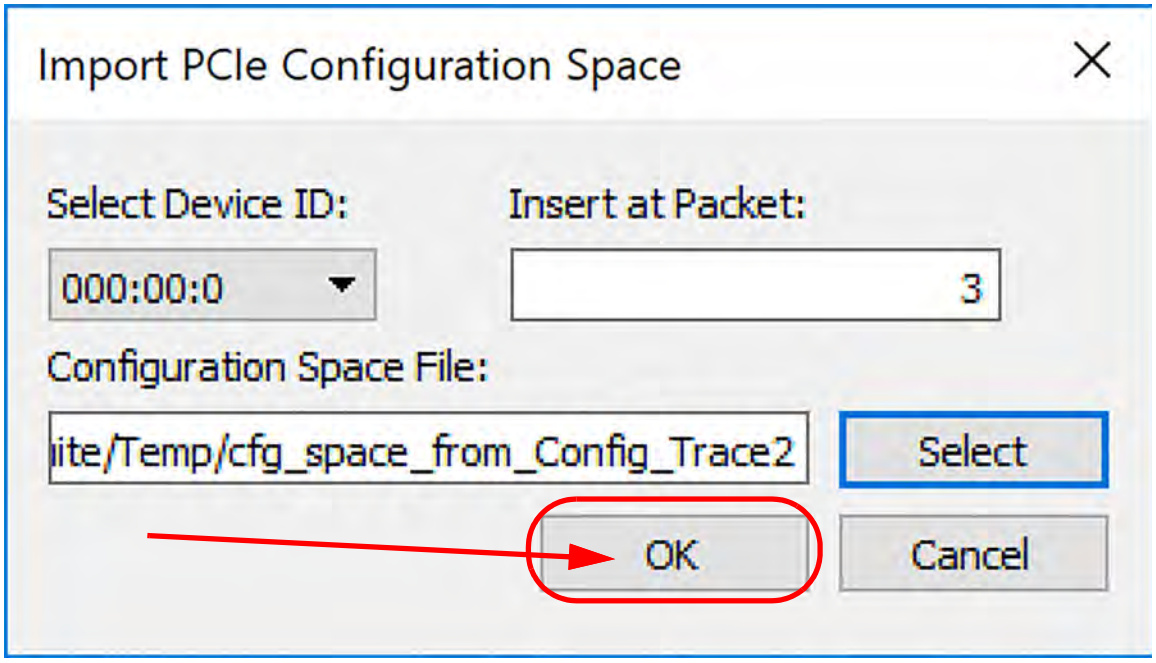


Figure 10.61: Import PCIe Configuration Space Dialog

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

10.14.3 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 10.62 on page 735).

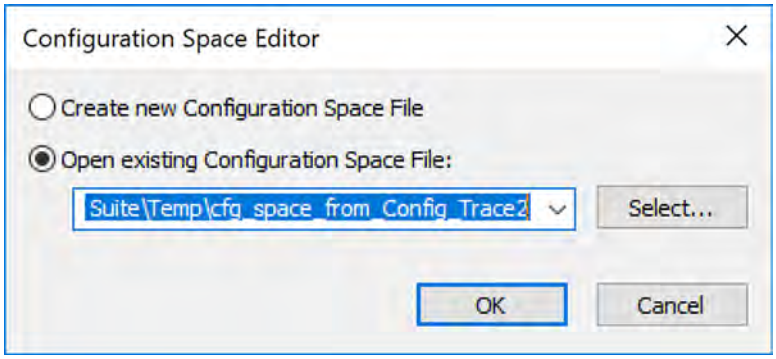


Figure 10.62: Configuration Space Editor Dialog

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 10.63.

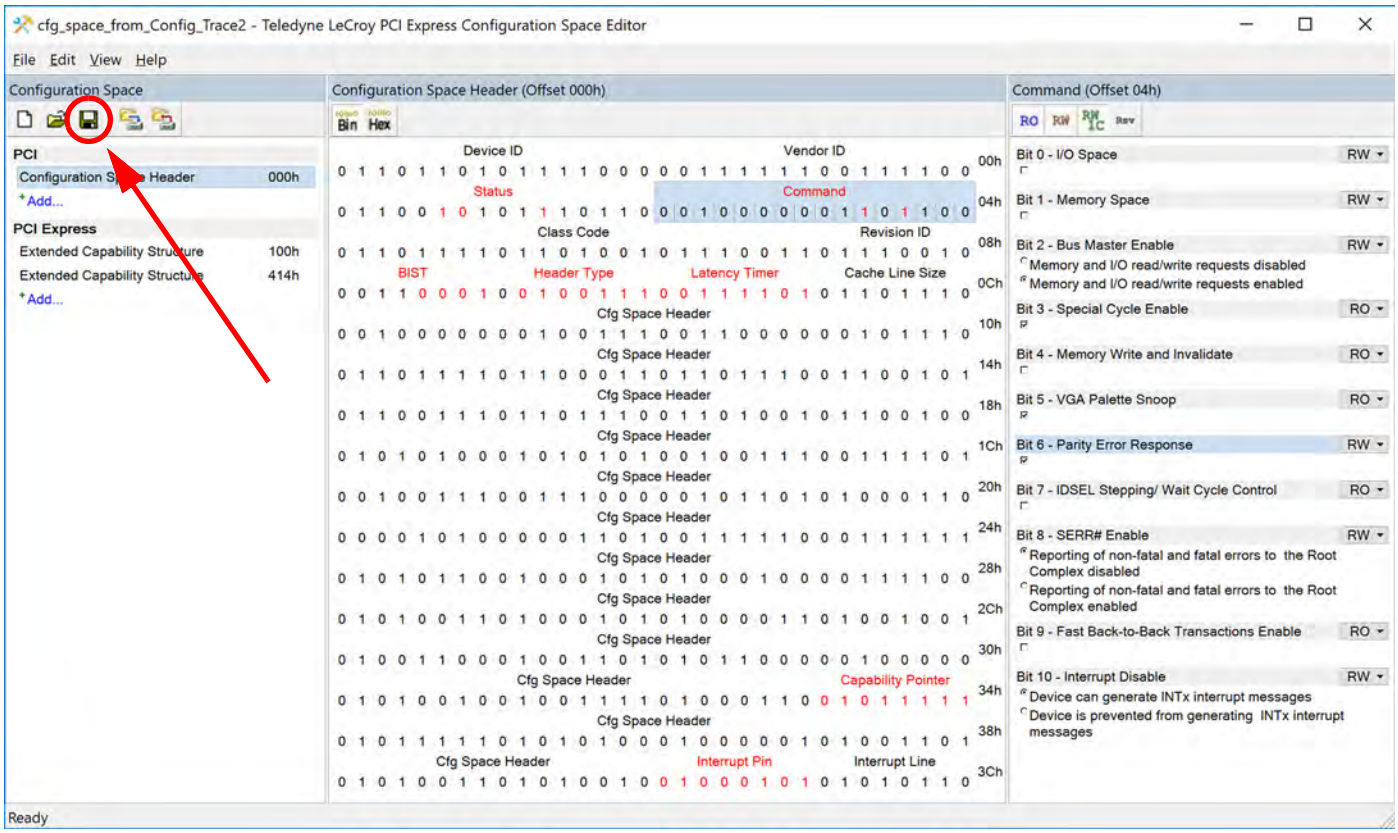


Figure 10.63: Configuration Space File: Example

Note: See "Configuration Space Decoding" on page 795 for details of the Configuration Space file.

10.15 Using Unit Metrics

For every protocol unit at the Link or Split transaction level, PCIe Protocol Analysis™ calculates and displays a set of metrics. Metrics are measurements of key operating parameters. You can use metrics to evaluate performance of traffic in the CATC Trace stream.

You can view metrics information in the CATC Trace display, the Traffic Summary window, and the Bus Utilization window.

PCIe Protocol Analysis defines different metrics for Link and Split transactions.

10.16 Metrics Defined for Link Transactions

- **Number of Packets**: The total number of packets that compose this Link transaction.
- **Payload**: The number of data payload bytes this Link transaction transferred.
- **Response Time**: The time it took to transmit this Link transaction on the PE link, from the beginning of the first packet in the transaction to the end of the last packet in the transaction.
- **Data Throughput**: The payload divided by response time, expressed in megabytes (MB) per second (MB = 1024*1024 bytes).

Note: Usually, the Number of Packets metric for a link transaction is two (in case of explicit acknowledge) or one (in case of implicit acknowledge). However if Naks/link level retries are involved, this metric might be higher. As a result, the Number of Packets metric is useful in highlighting unusual link transactions.

10.16.1 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.

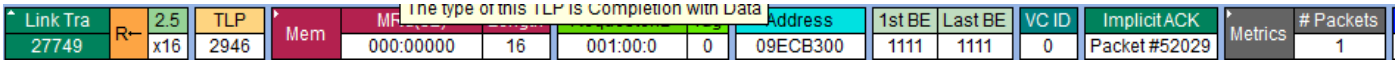
Note: The Number Of Link Transactions metric for a Split Transaction usually is two for a Configuration or IO request. It can be bigger then two for a Memory Read request.

10.17 Show Metrics in the CATC Trace Display

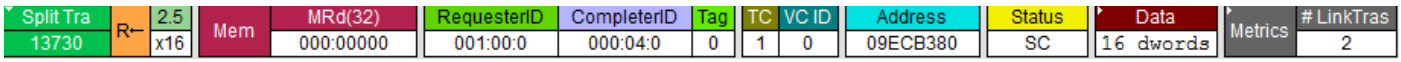
In the CATC Trace view display of Link Transaction or Split Transaction levels, all metrics information applicable to a specific protocol unit is displayed in a Metrics header. The header is located close to the end of the unit, in front of the Time cell. You can expand and collapse the header to show or hide the metrics information.

10.17.1 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.

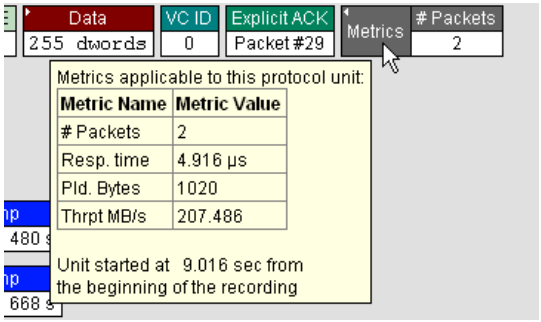


Following is a collapsed metrics display for a unit of Split Transaction. The collapsed header display shows only the metrics cell representing Number of Link Transactions.



10.17.2 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.

10.17.3 Expanded Metrics Header Display

When you expand the Metrics header, the display creates a separate cell for each applicable metric:

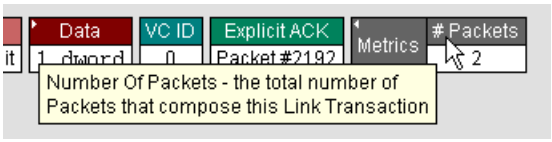
The following is the expanded Metric header for a unit in the Split Transaction view.

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.

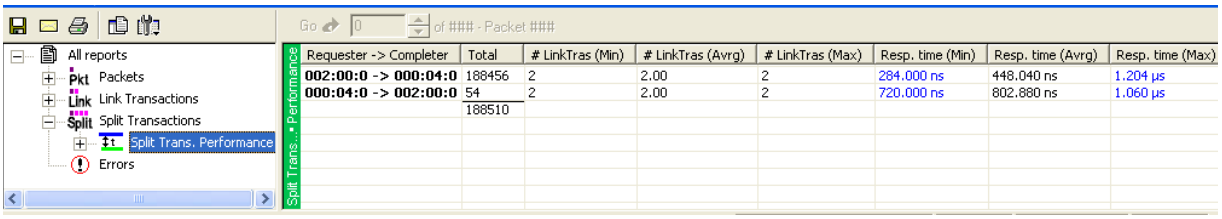


10.18 Show Metrics in the Traffic Summary Window

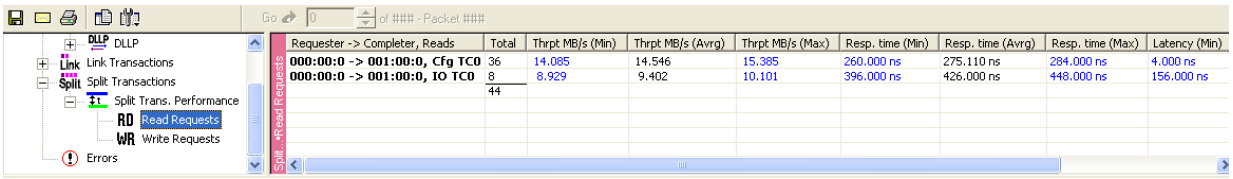
Some of the Traffic Summary reports at the Link and Split Transaction levels are based on metrics collected for the corresponding protocol units in the CATC Trace.

10.18.1 Reports at Split Transaction Level

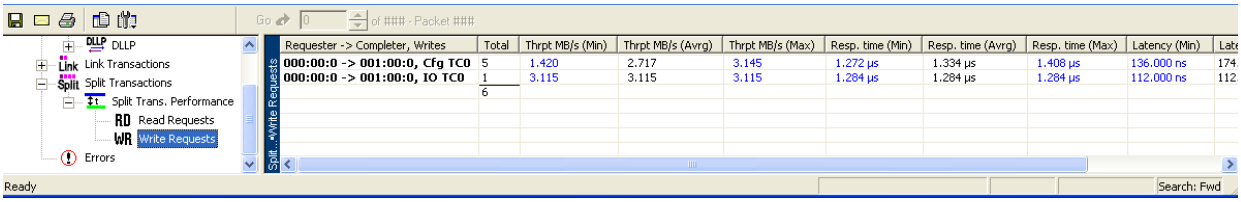
Split Transaction Performance: This report table groups the Split Transactions by Requester-Completer pair and displays Minimum/Average/Maximum data for Number Of Link Transactions and Response Time metrics.



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).



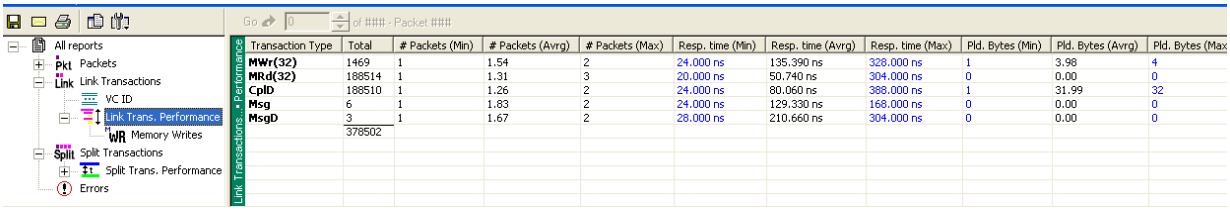
Write Requests Performance: This report table includes only the Split Transactions that present Write Requests (Configuration and IO). It groups them by the combination of Requester-Completer pair, request type, and Traffic Class and displays Minimum/Average/Maximum data for Throughput, Response Time, and Latency metrics.



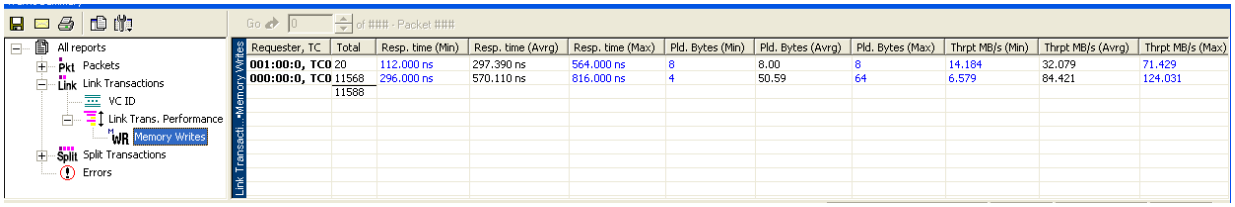
10.18.2 Reports at the Link Transaction Level

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.

10.19 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):



10.19.1 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.

10.19.2 Bus Utilization Window Features

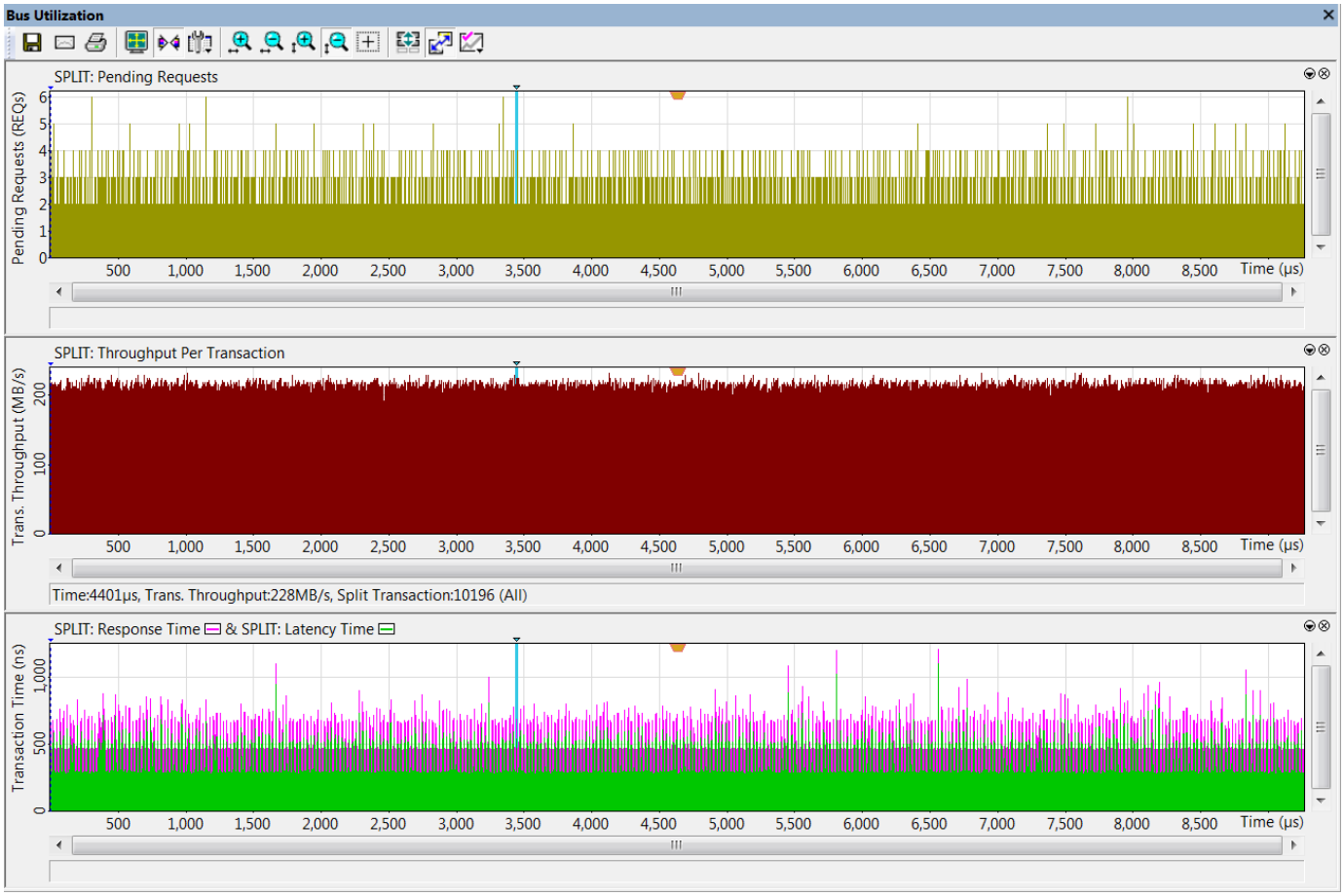
For the seven Split- and Transaction-level graphs listed, all Bus Utilization window features are available, such as zooming in/out, changing scale type, scrolling, context-sensitive status, and graph synchronization. See Bus Utilization and Bus Utilization Buttons for more on these features.

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.

10.19.3 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.

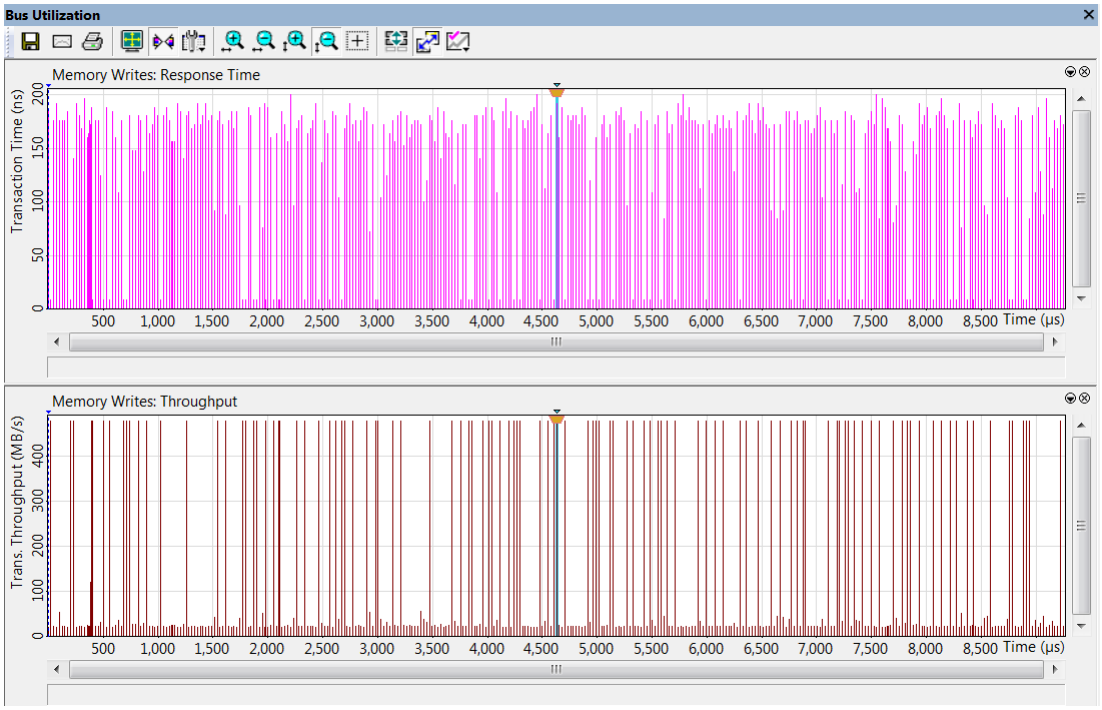
The following shows the graphs for the Split level:



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.

10.19.4 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).



10.20 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.

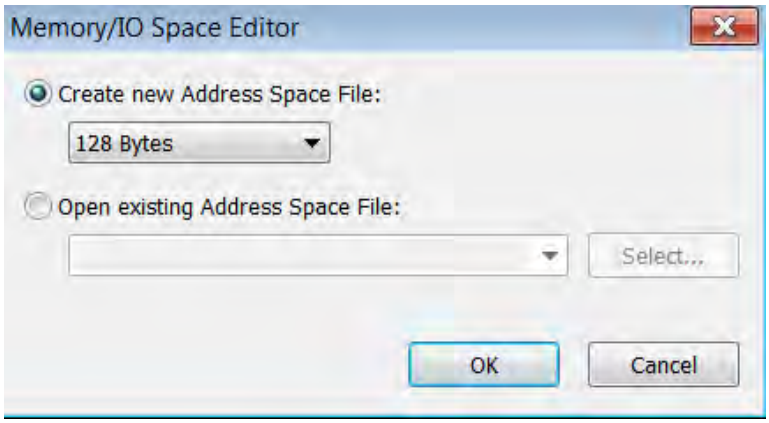


Figure 10.64: Memory I/O Space Editor Dialog

10.21 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).

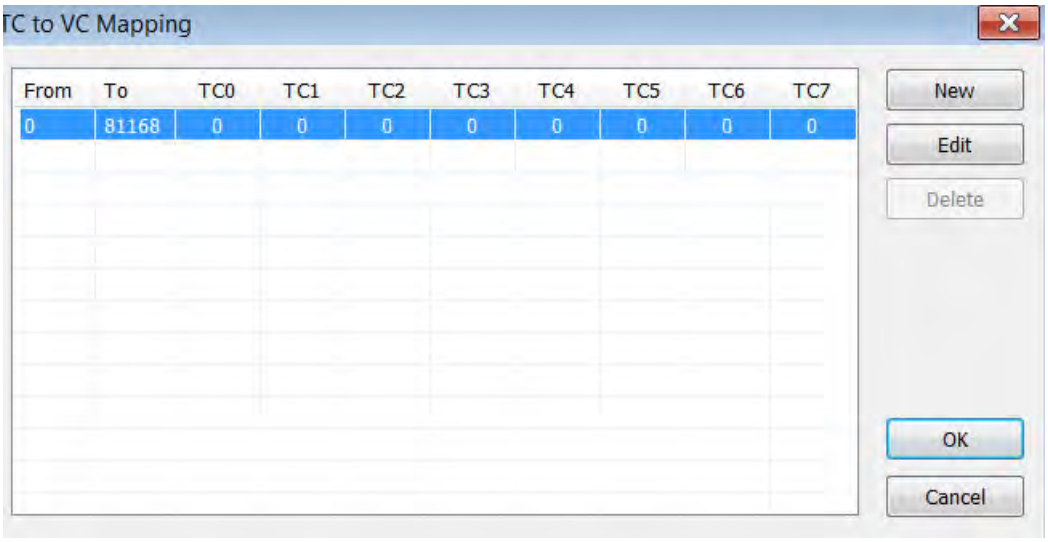


Figure 10.65: TC to VC Mapping Dialog

10.22 Timing and Bus Usage Calculations

10.22.1 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 10.66.

PCIe Timing Information: Entire Trace



Figure 10.66: 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.

Formula (Gen1/Gen2): (packet_symbols * byte_bits) / total_time in seconds. byte_bits is 10 when 1 MB or 1 GB unit is selected and 8 otherwise.

Formula (Gen3/Gen4/Gen5): (packet_symbols * 8) / total_time in seconds.

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 10.67) below.

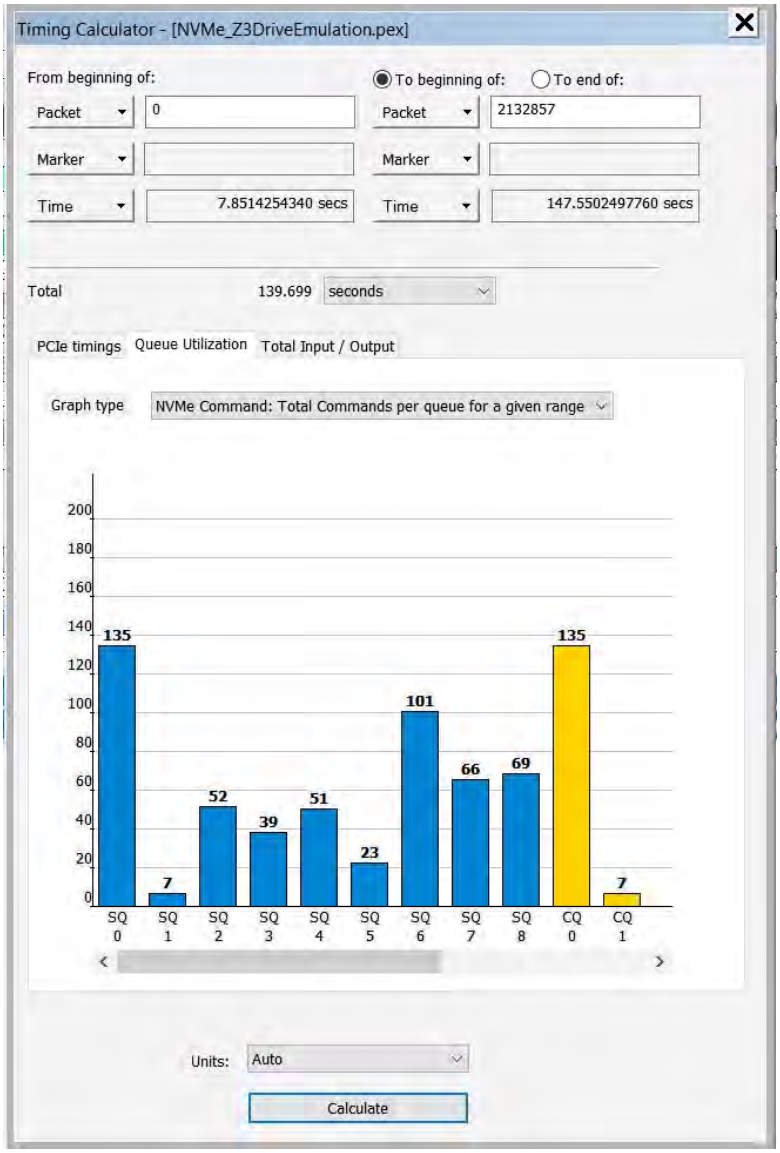


Figure 10.67: Timing Calculator: Queue Utilization

Total Input/Output

The Total Input / Output has two sections:

- Link/Split Total Traffic
- NVMe Command Total Traffic

See Figure 10.68

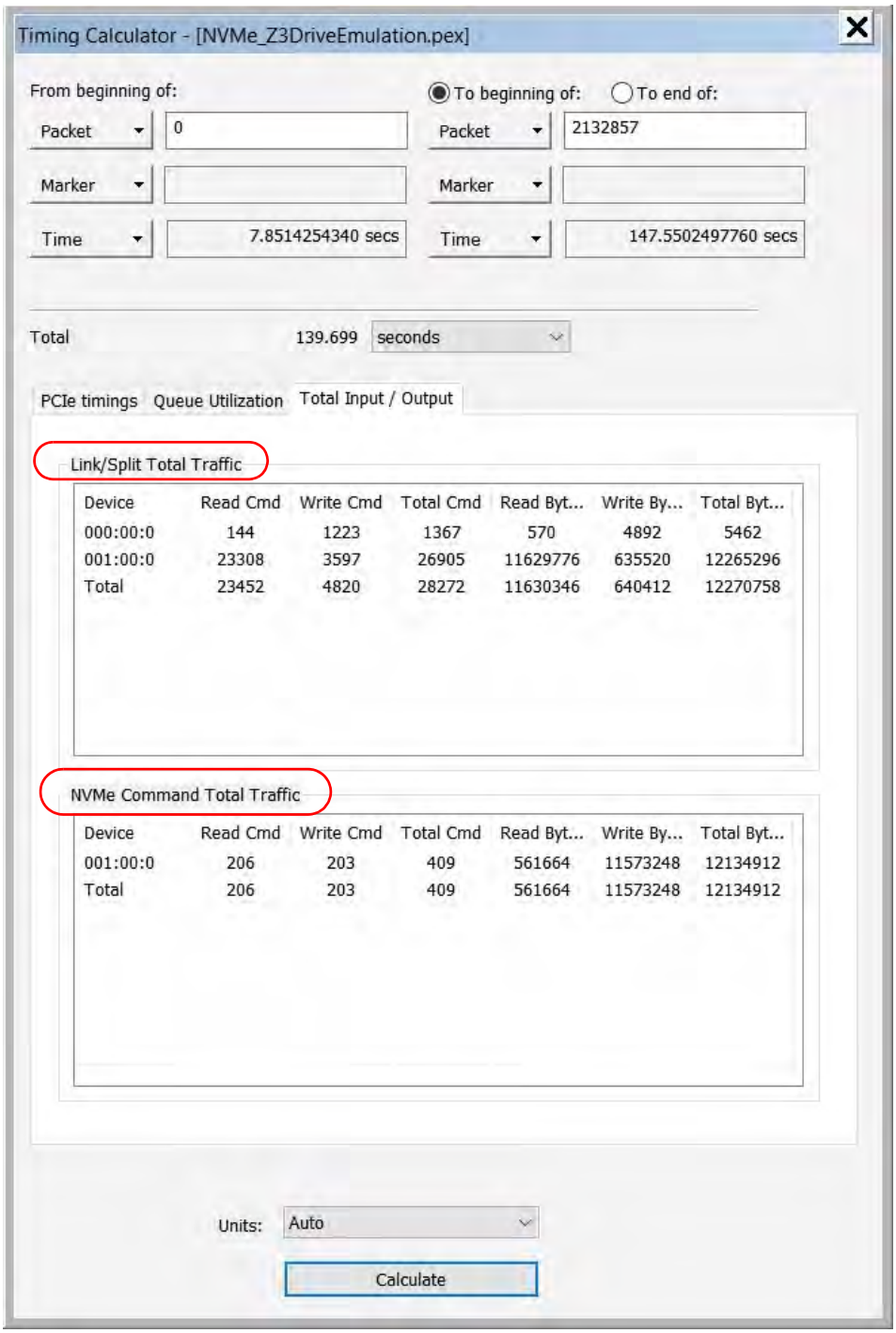


Figure 10.68: Timing Calculator: Total Input / Output

Timing Calculator Display units

The Timing Calculator can display data in several different units by selecting the appropriate combo box value and hitting the Calculate button (see Figure 10.69).

Each unit type is described in bytes or bits value, to be comparable. Auto mode will select MB or GB automatically depending on result value so that values are more readable.

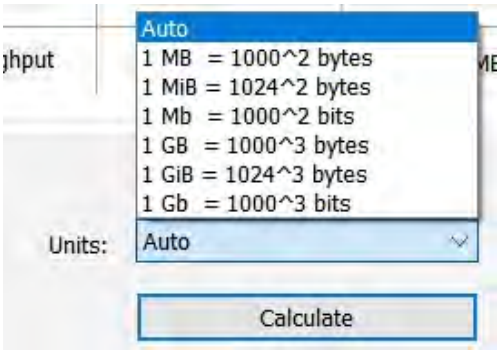


Figure 10.69: Unit Selection

The results are displayed as shown below in Figure 10.70.

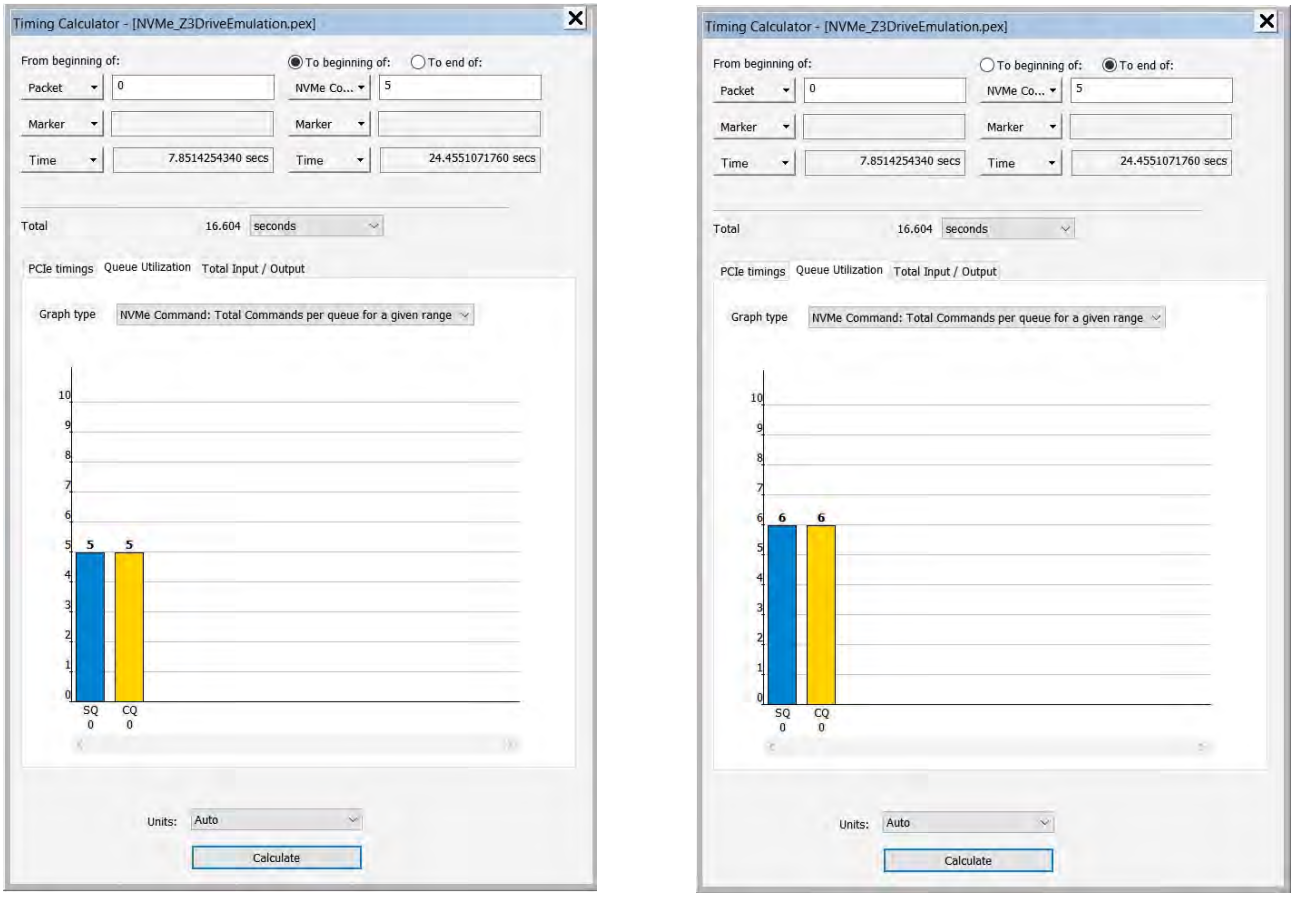


Figure 10.70: Timing Calculator: PCIe Timing Displayed in MB and Mb

10.22.2 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 10.71.

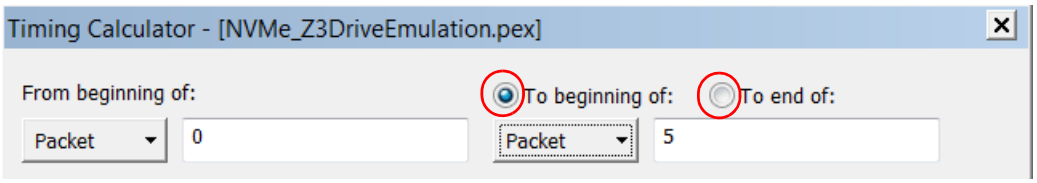


Figure 10.71: Timing Calculator: Beginning of Event to Beginning of Event or to End of Event

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 10.72.

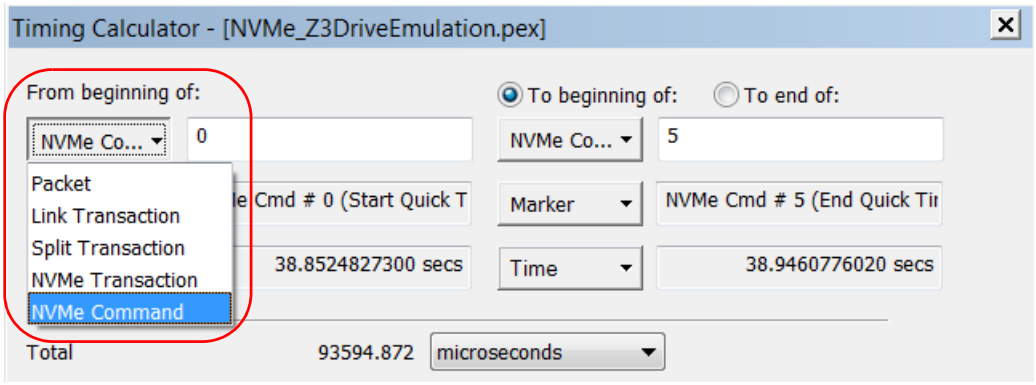


Figure 10.72: Timing Calculator: Types of Events

Displaying Time

The time can be displayed in nanoseconds, microseconds, milliseconds and seconds. See Figure 10.73.

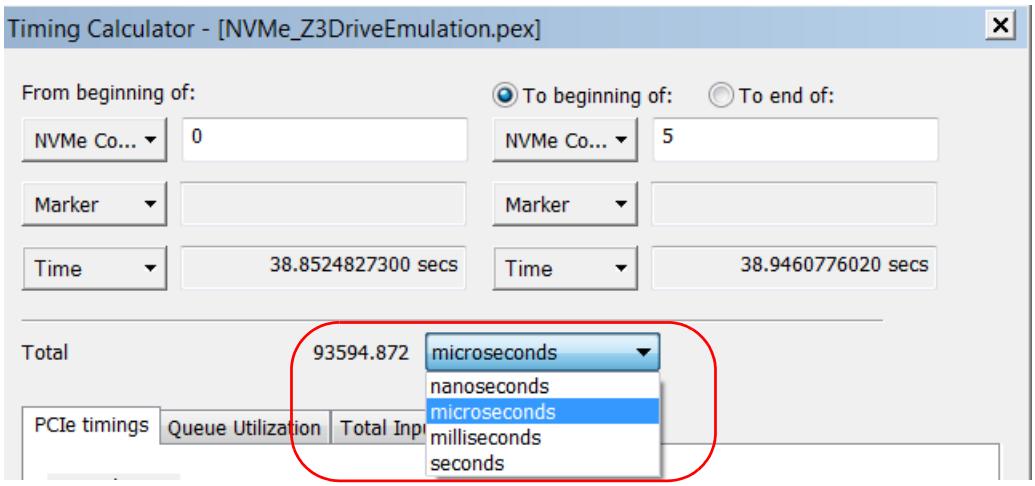


Figure 10.73: Timing Calculator: Timing Units

Markers

If Markers were set, they would be visible in the Marker pull-down (see Figure 10.74).

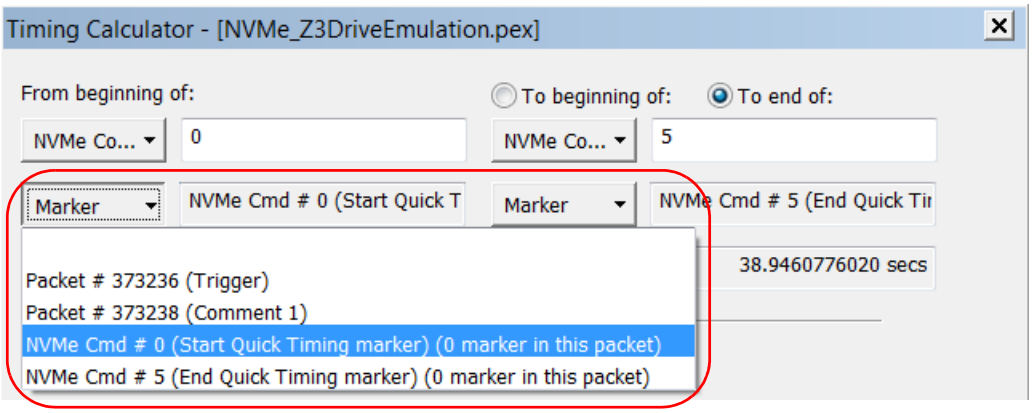


Figure 10.74: Timing Calculator: Markers Set

If the Trigger and Comment 1 Markers were chosen, the Timing Calculator would come up with the following results: see Figure 10.75 on page 752. As you can see from the results, the markers were only two packets apart.

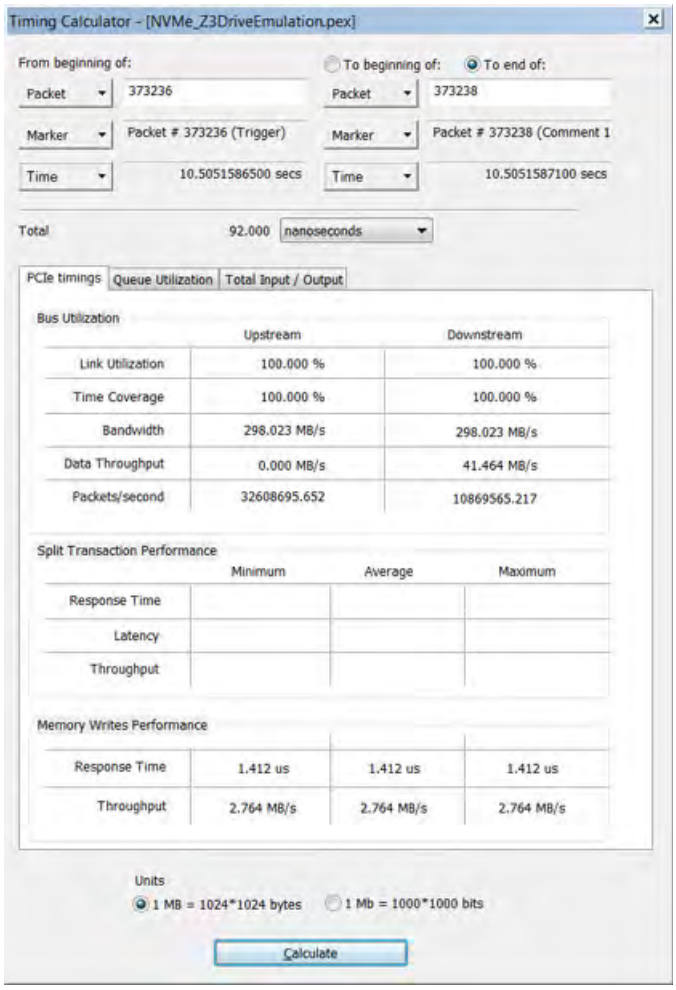


Figure 10.75: Timing Calculator: Results Between Markers

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 10.76.

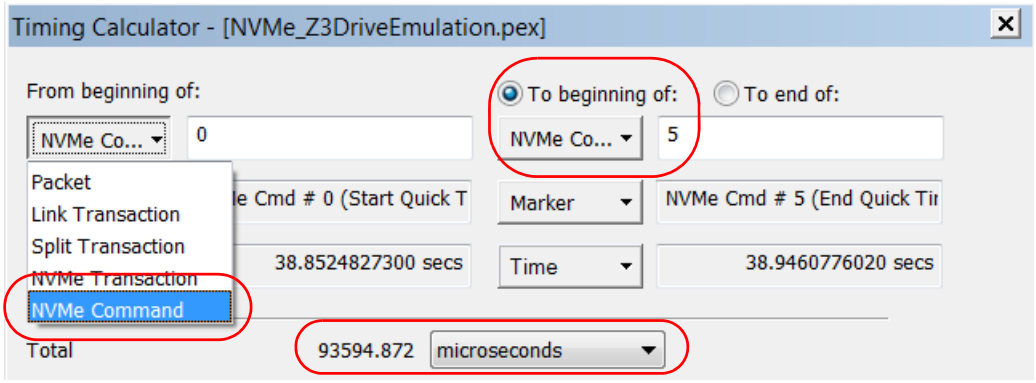


Figure 10.76: Timing Calculator: Selections for Timing Calculations

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 10.77 on page 753.

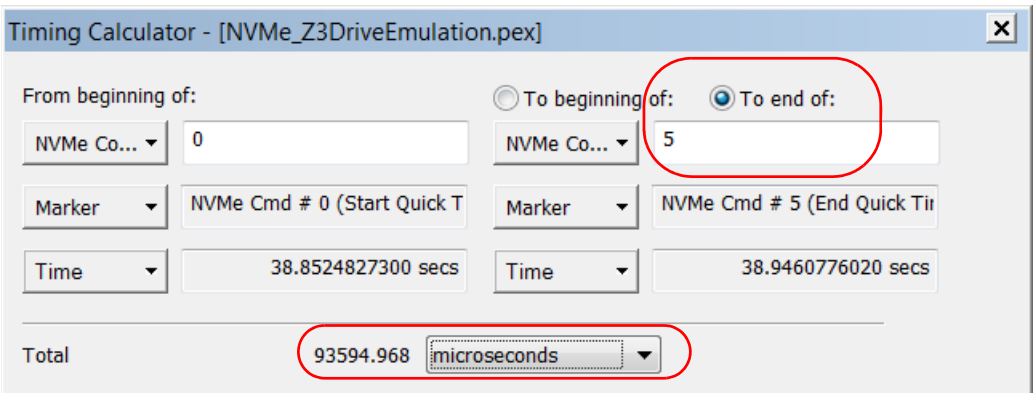


Figure 10.77: Timing Calculator: To end of NVMe Command 5

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 10.78.

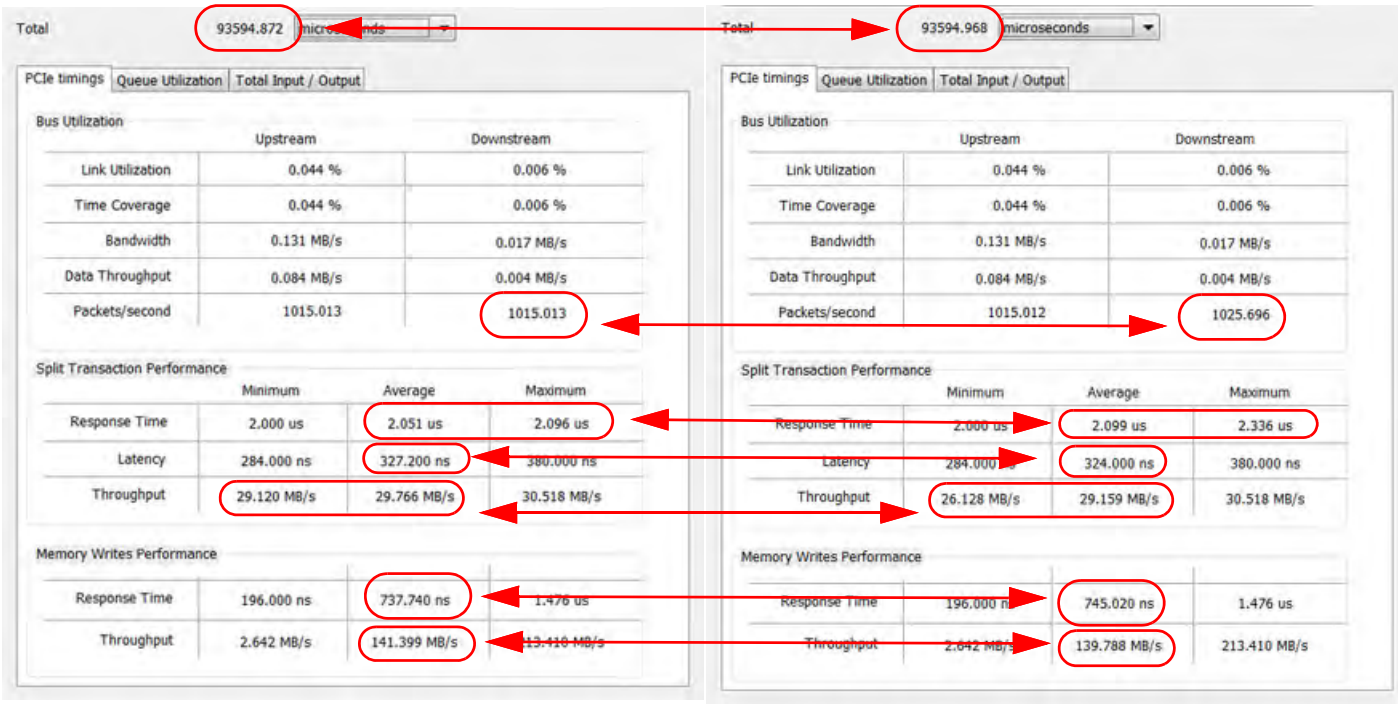


Figure 10.78: Timing Calculator: Beginning of NVMe Cmd 5 and Ending of NVMe Cmd 5 (MB)

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 10.79.

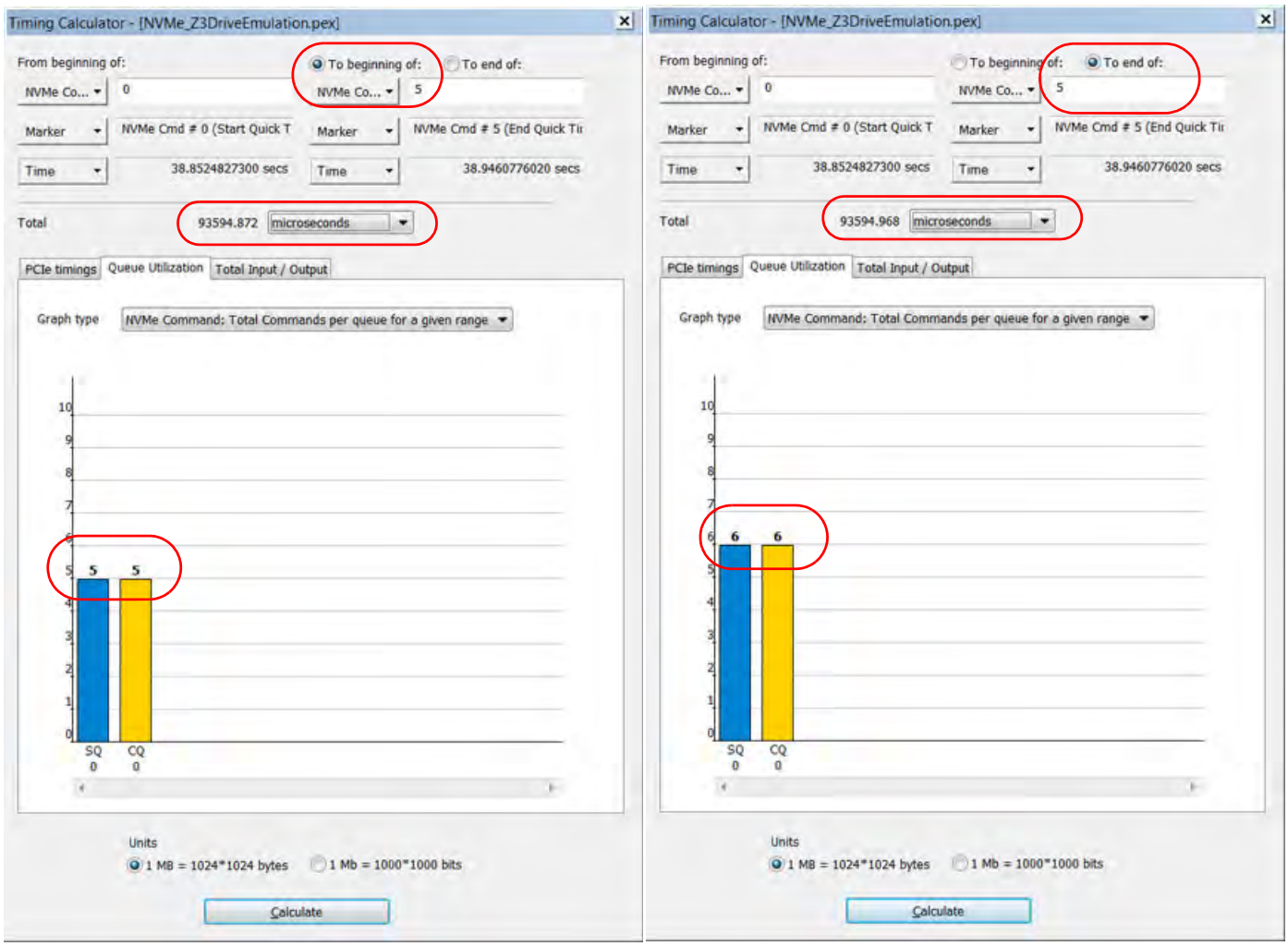


Figure 10.79: Timing Calculator: Queue Utilization

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 10.80.

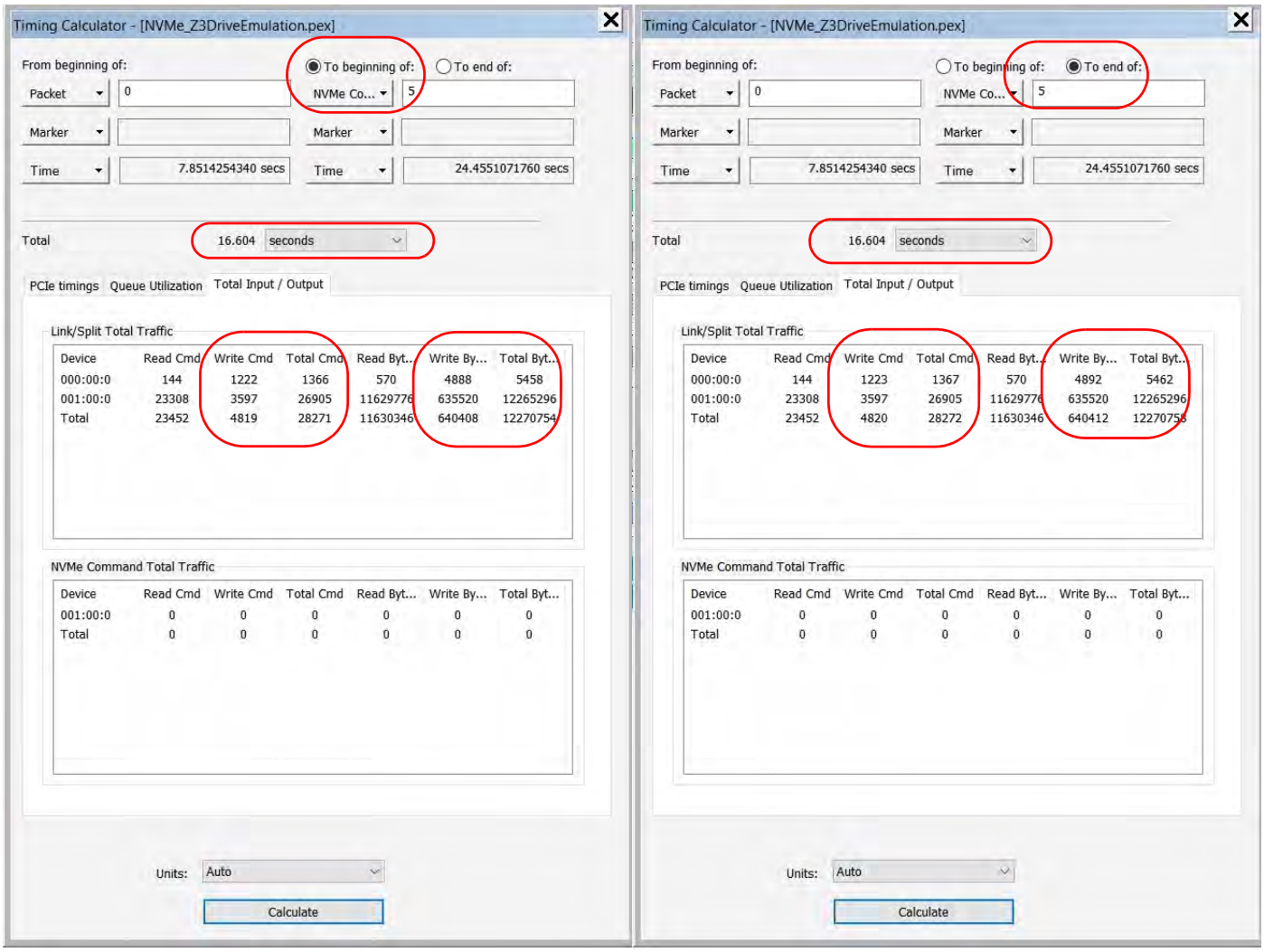


Figure 10.80: Timing Calculator: Differences in Total Input / Output

The two displays show that including NVMe Command 5 adds one more Write Command and it's associated number of bytes.

10.23 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 10.81.

10.23.1 Base Address Not Record in Trace

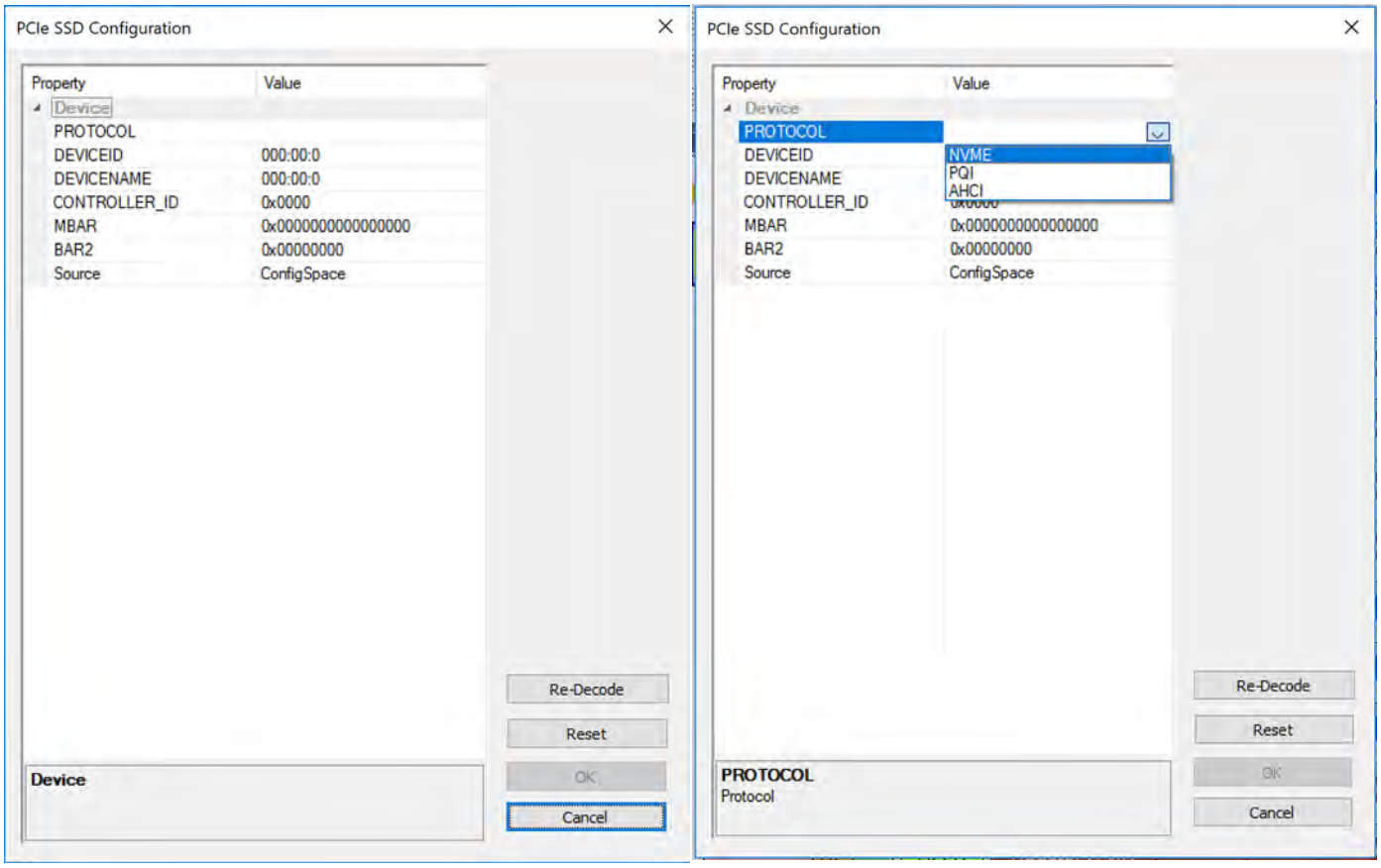


Figure 10.81: Trace without Protocol Type Specified

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 10.82 on page 757.

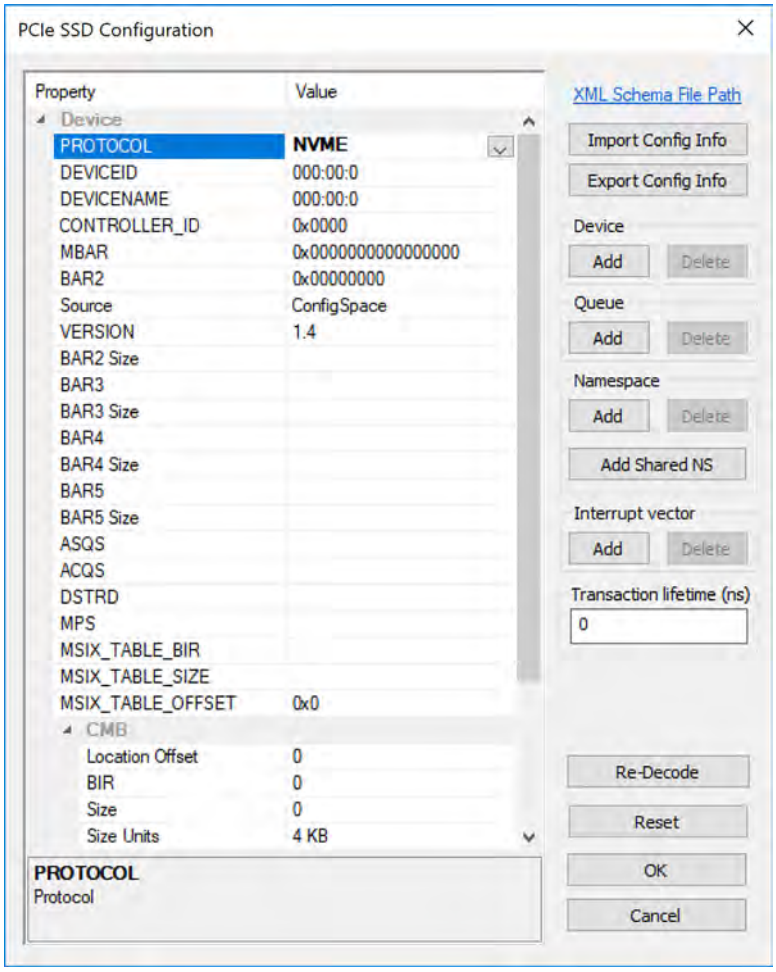


Figure 10.82: PCIe SSD Configuration dialog box populated with NVME options

10.23.2 Base Address Recorded in Trace

In cases when Base Address assignment is recorded in the trace, the software will determine all the values automatically. The PCIe SSD Configuration dialog displays (see Figure 10.83 on page 760).

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.

10.23.3 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 10.83 on page 760 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 10.83 on page 760). 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 path).
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 761).
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.

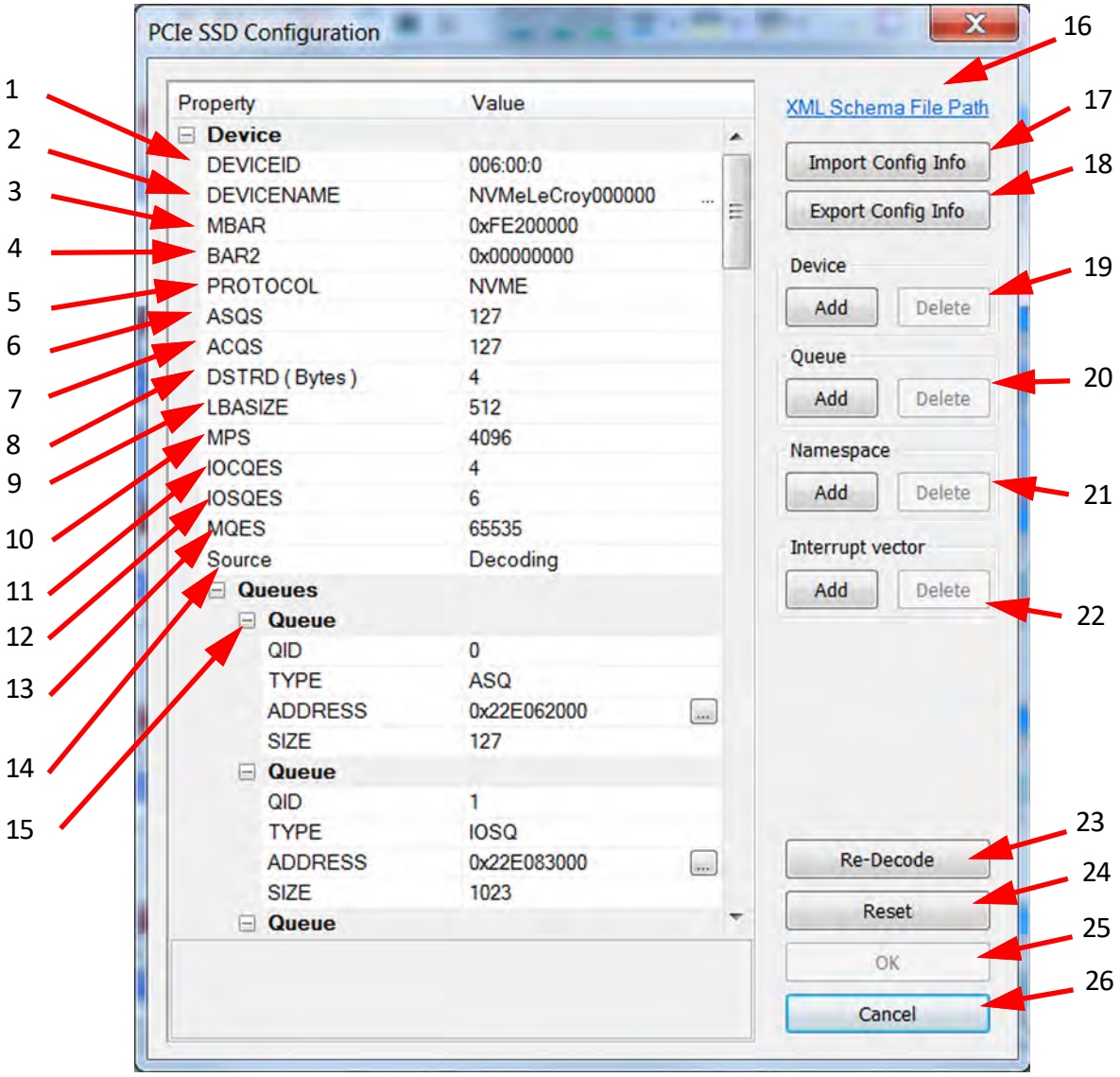


Figure 10.83: PCIe SSD Configuration Dialog Pre-decoding

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 10.85).

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.

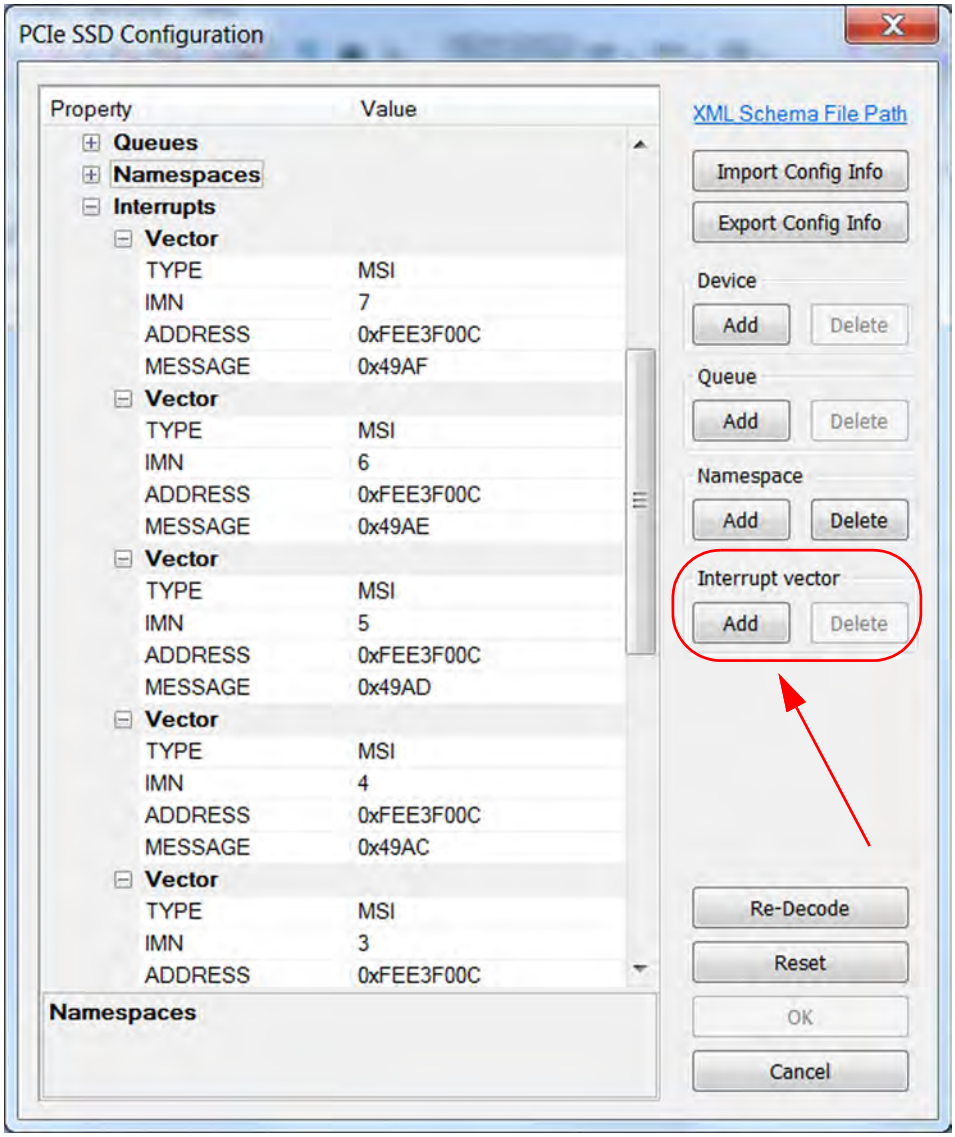


Figure 10.84: MSI and MSI-x Interrupts

10.23.4 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 10.85 for AHCI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.85).

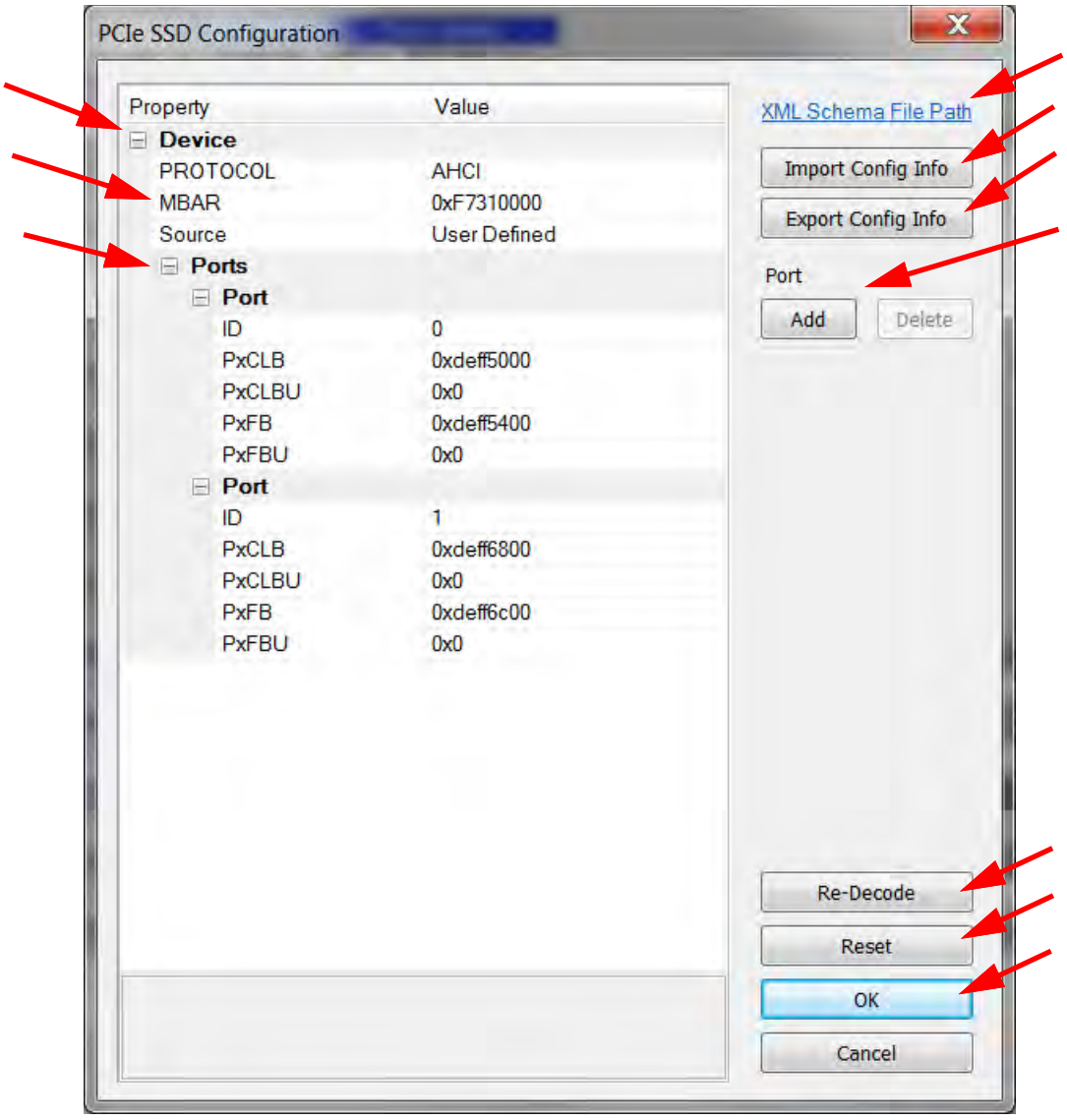


Figure 10.85: AHCI PCIe SSD Configuration Dialog

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 10.87 on page 765). 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 decoding 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.

10.23.5 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 10.86 for PQI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.86).

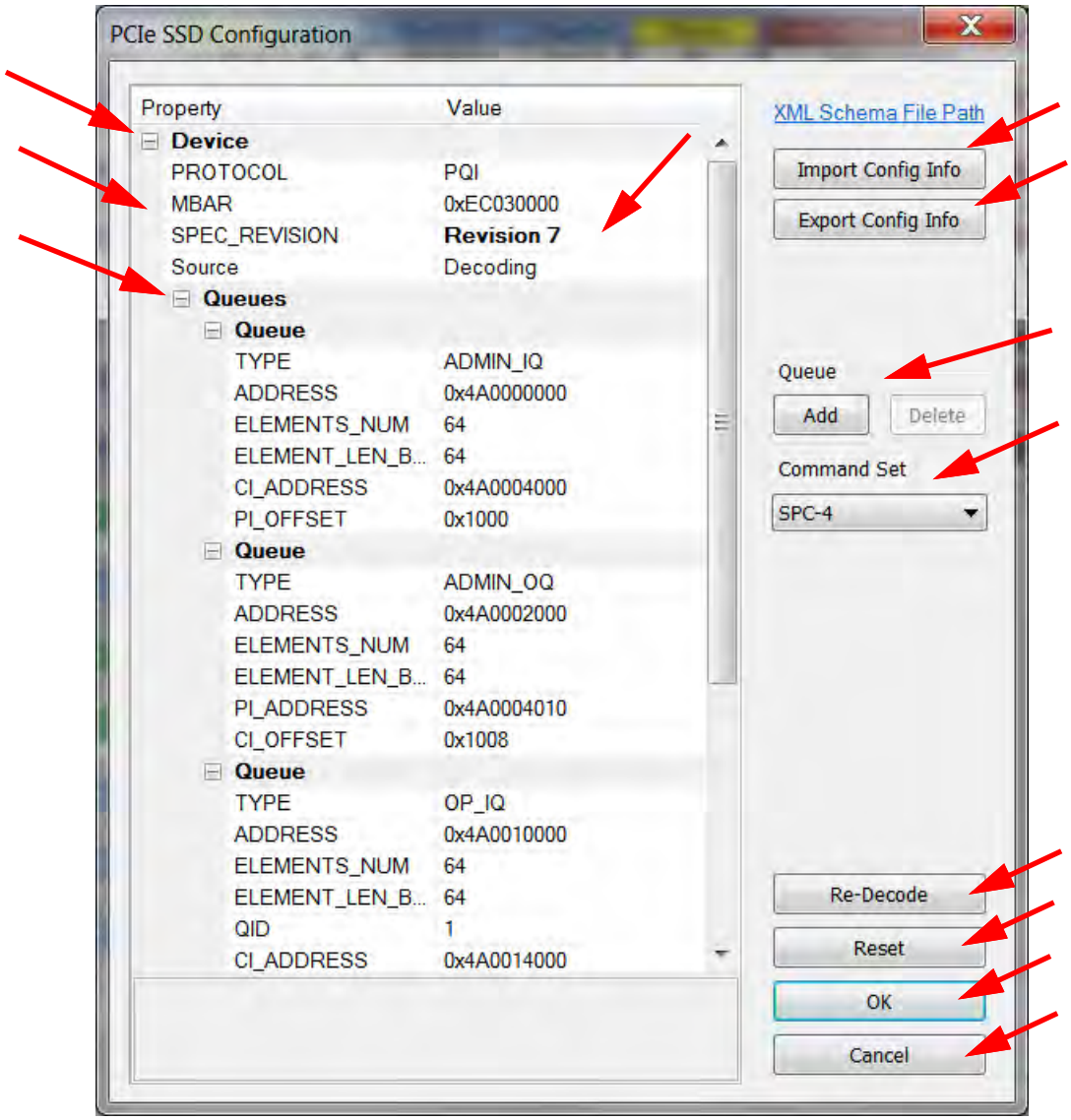


Figure 10.86: PQI PCIe SSD Configuration Dialog Pre-decoding

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 10.87). 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.

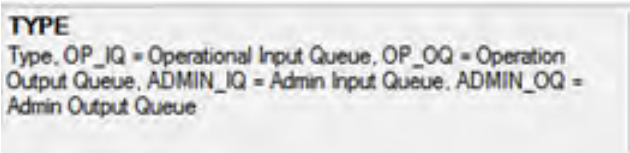


Figure 10.87: Node Types

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 10.86 on page 764).

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.

10.23.6 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 10.88 on page 766 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 10.88 on page 766).

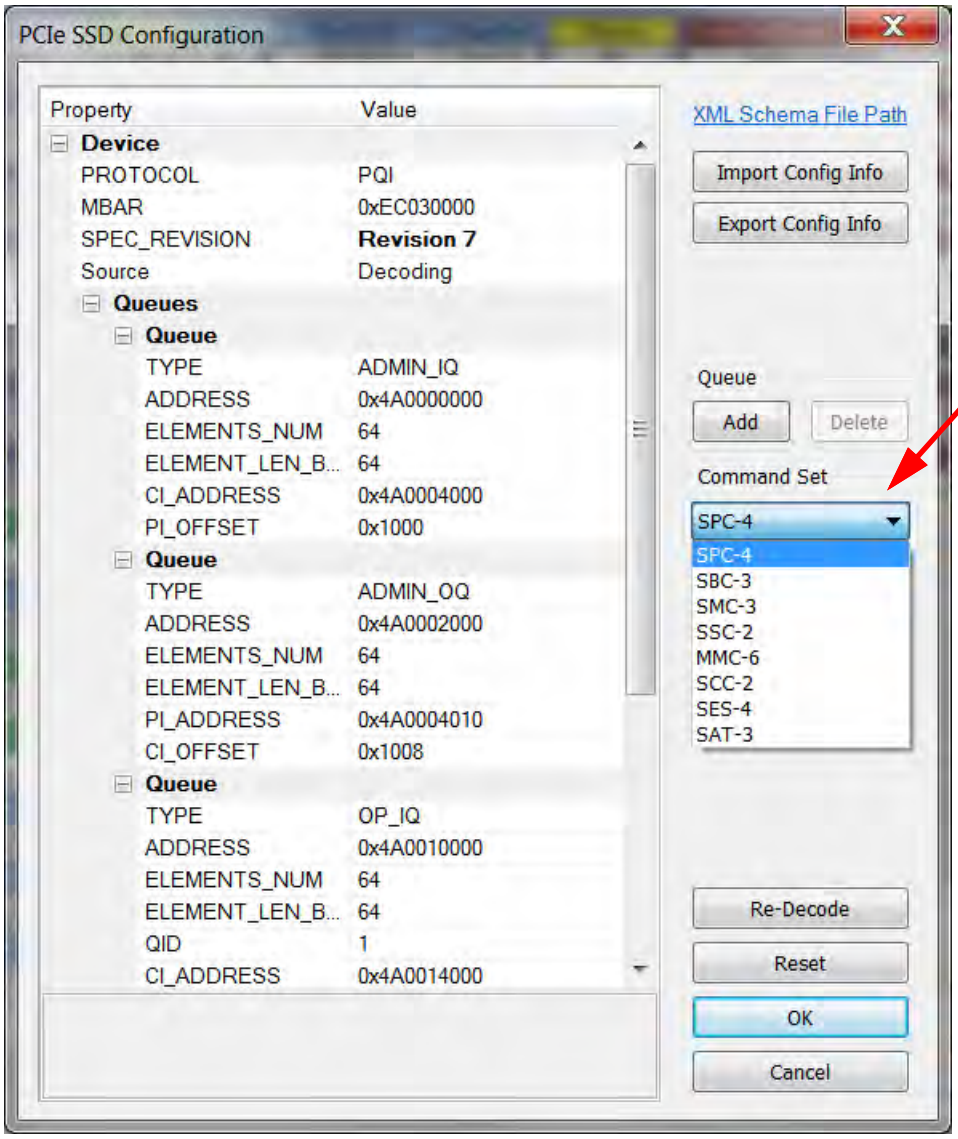


Figure 10.88: PCIe SSD Configuration Dialog - SCSI

See “Example of XML File Format for SSD Decodes” on page 799 for a template of the XML files.

10.24 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 10.89 on page 767), select **Tools > Run verification scripts**

or click the  icon.

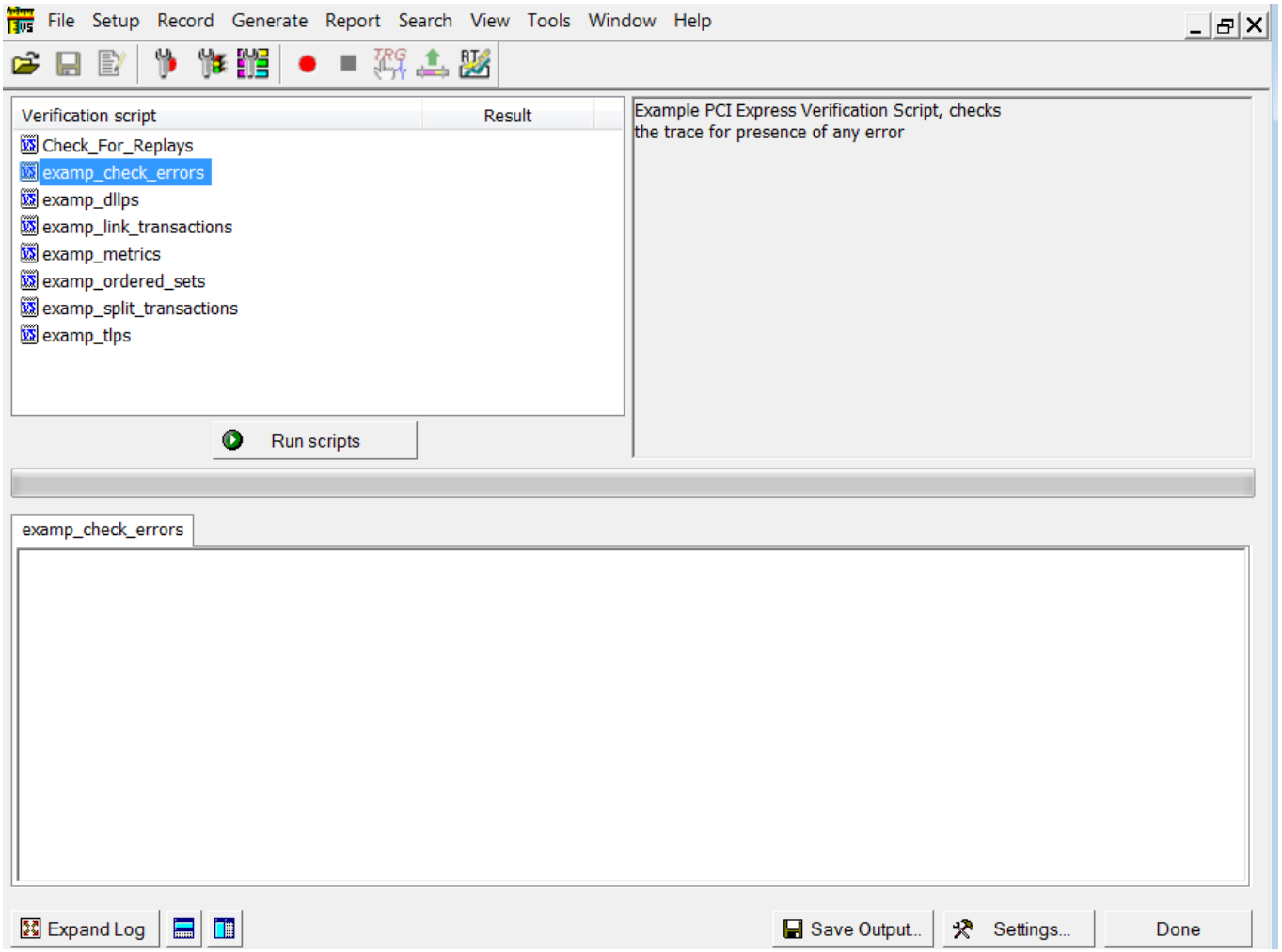


Figure 10.89: Verification Scripts Dialog

If you select examp_ltssm you'll get the following output. See Figure 10.90.

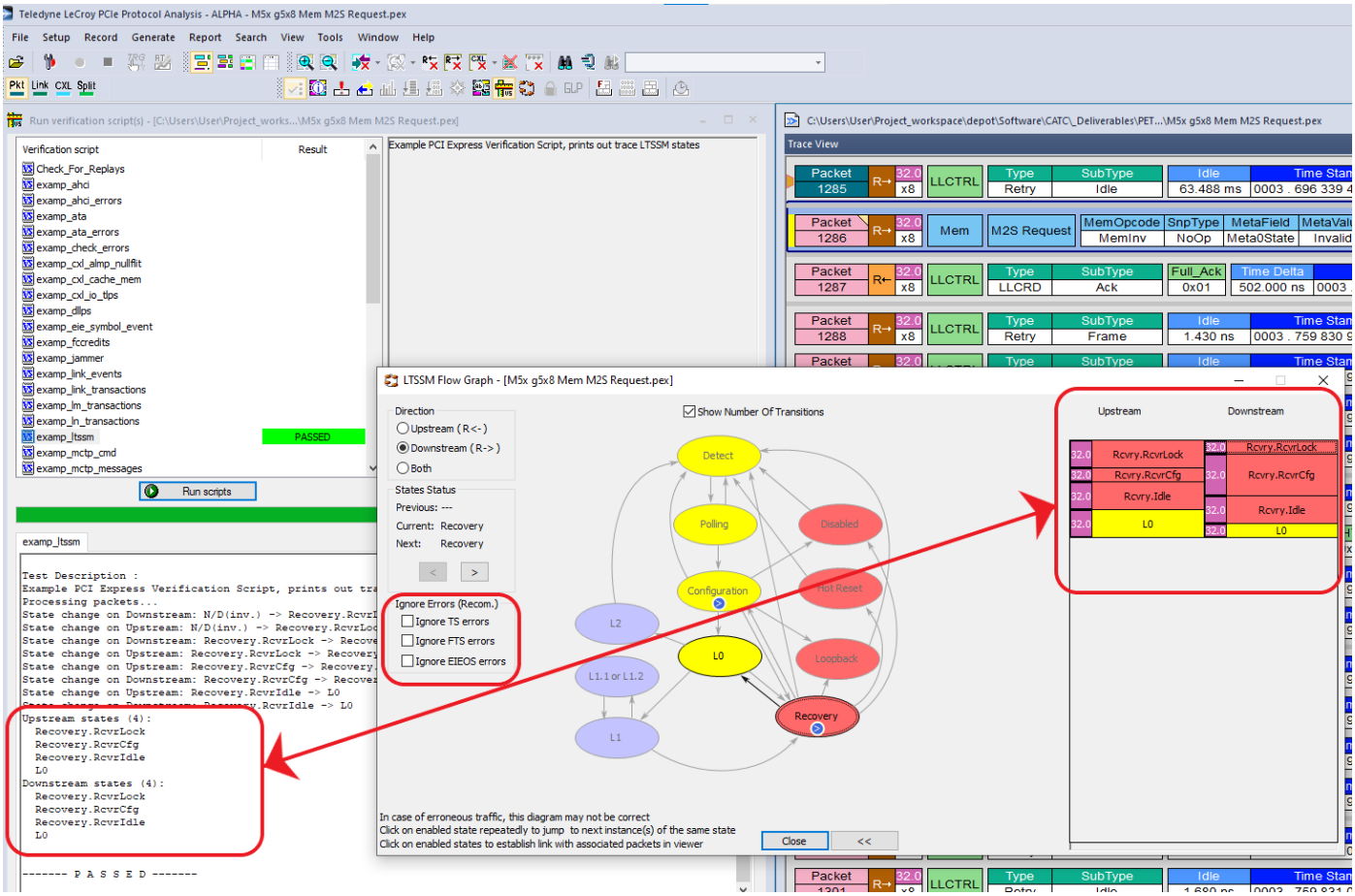
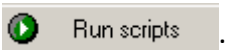


Figure 10.90: Run Verification Script: examp_ltssm

The available verification scripts are in the Verification script section.

Note: Verification scripts are not ignoring TS/FTS/EIEOS errors, so values may be different if some of the ignore options are enabled.

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 10.91 on page 769).

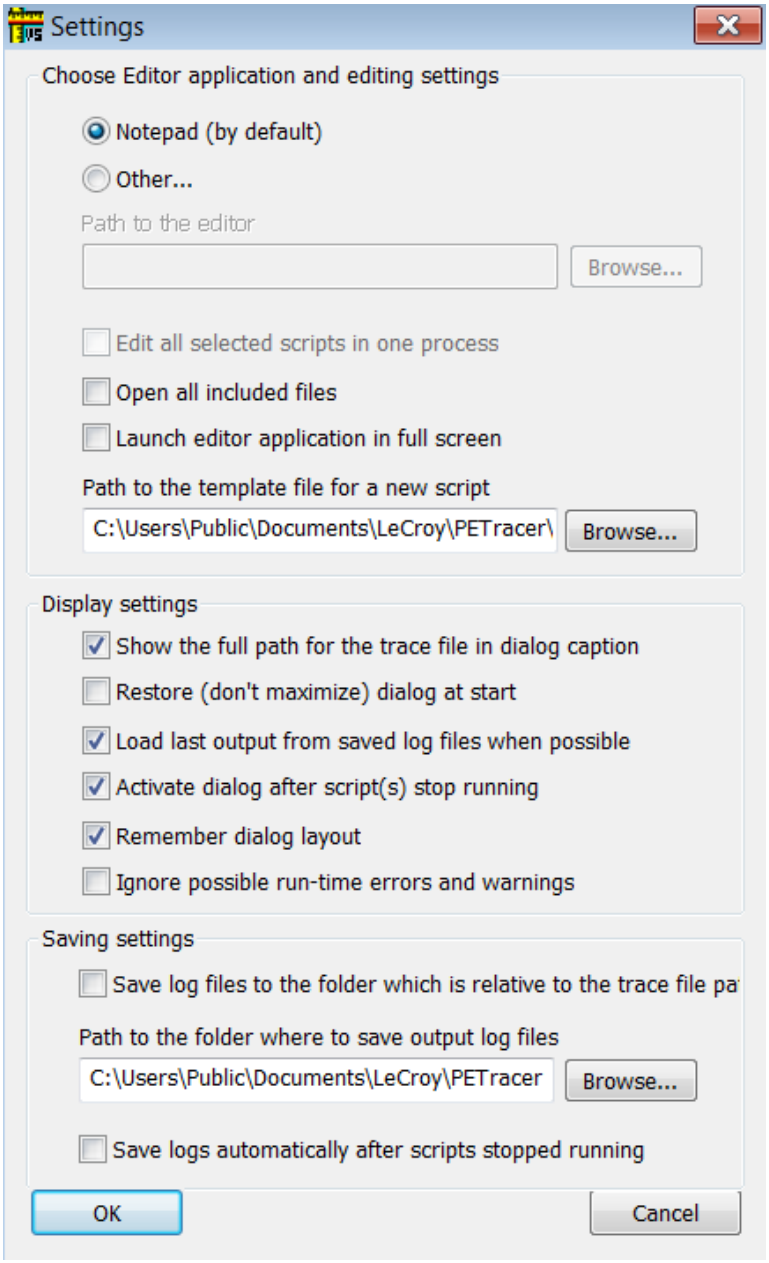


Figure 10.91: Settings Dialog

You can choose the editor, display settings, and saving settings.

10.24.1 NVMe Performance: Doorbell Timing

You can run verification scripts to determine Doorbell performance, see Figure 10.92.

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

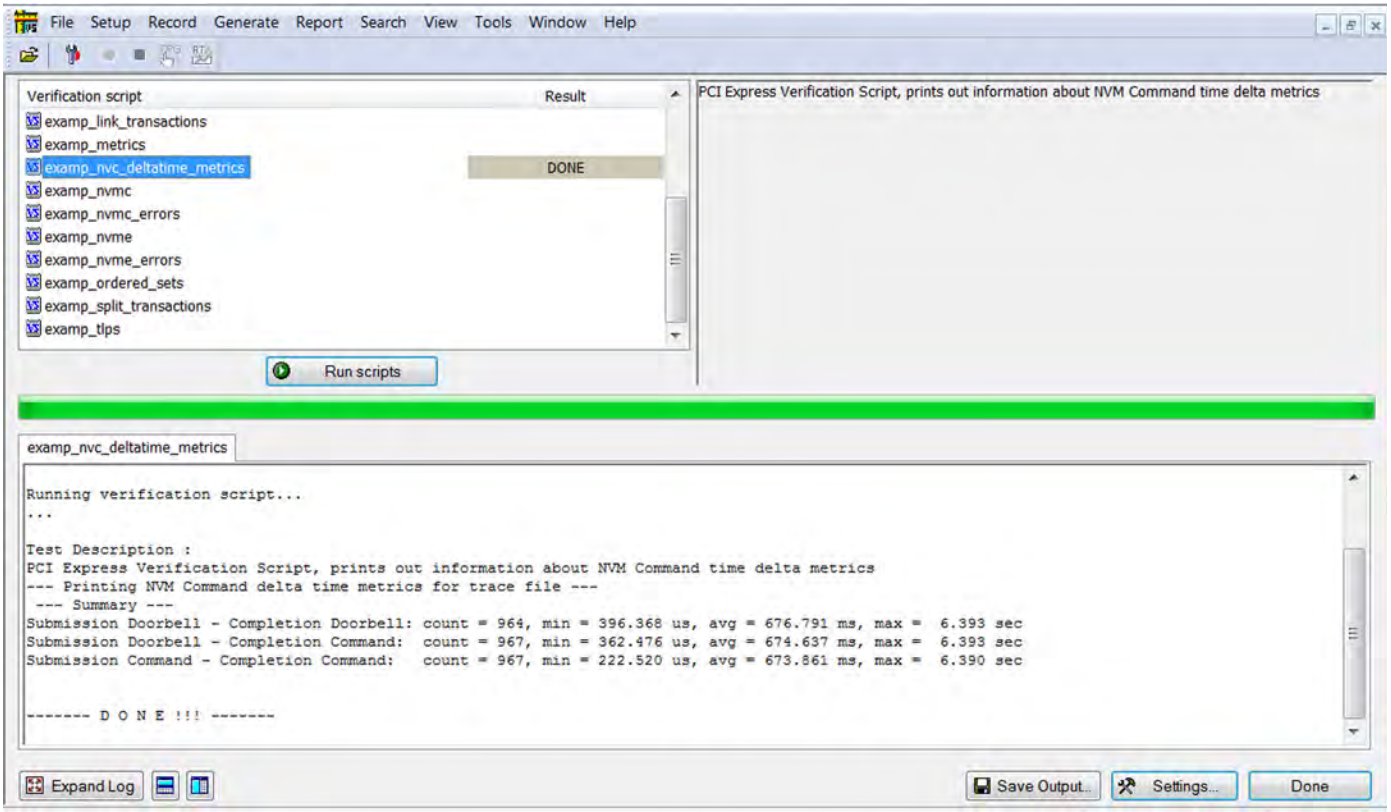


Figure 10.92: NVMe Performance Script Verification

10.24.2 MCTP Transaction Verification Script Generation

You can run the Verification Script Engine on MCTP Transactions. See Figure 10.93

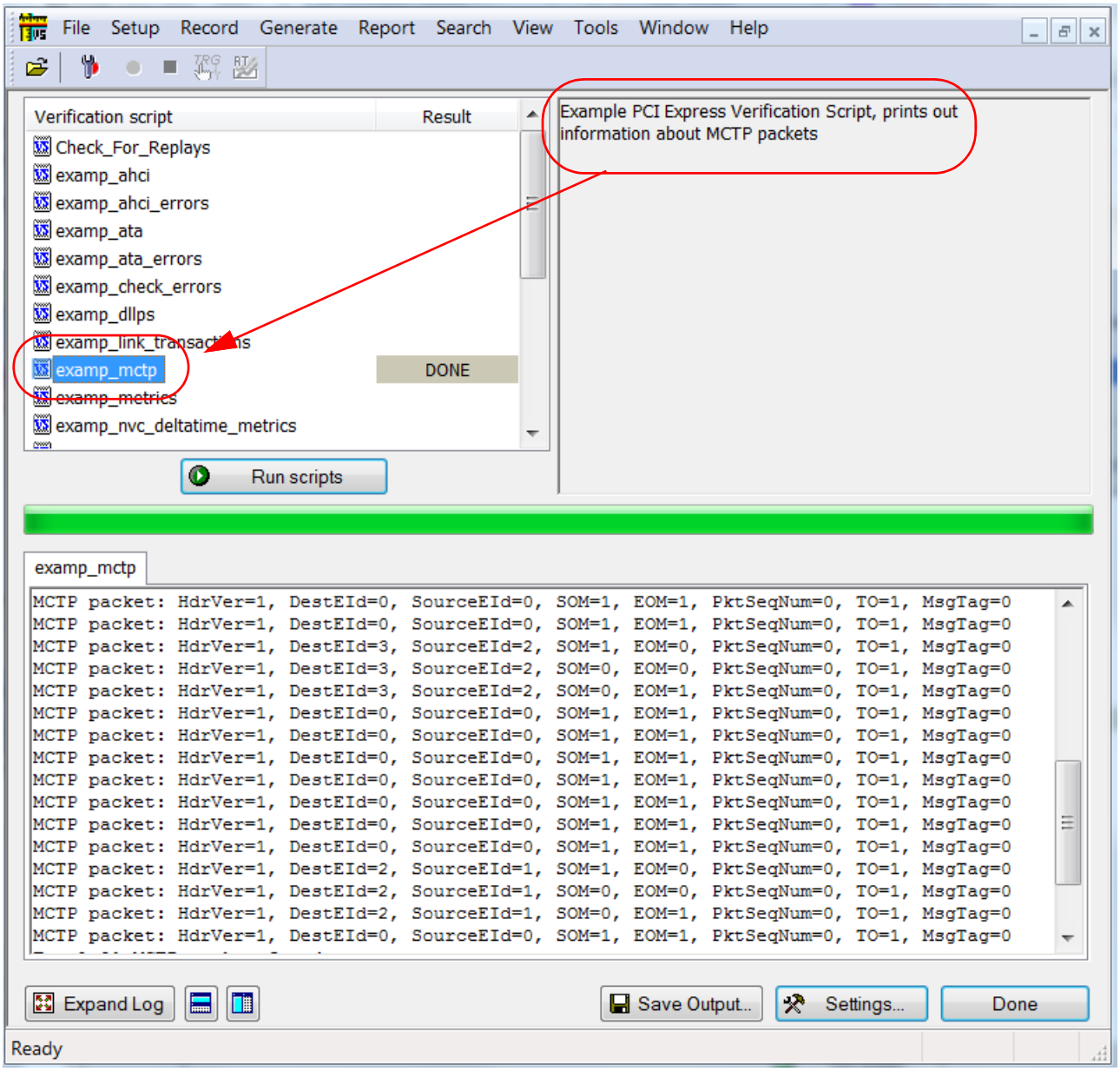


Figure 10.93: Running VSE on MCTP Transactions

10.25 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 10.94.

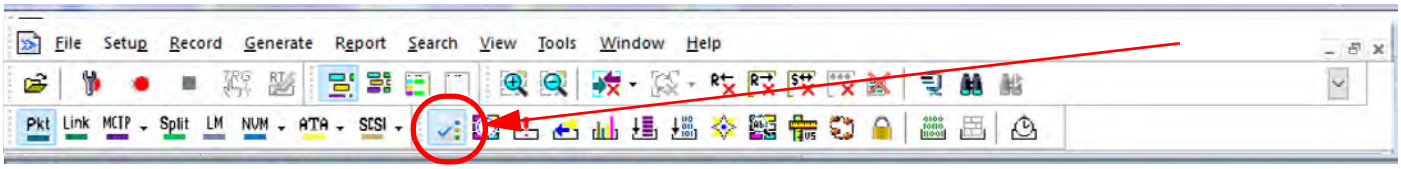


Figure 10.94: Main Toolbar: Trace Expert

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 10.95 on page 773). Any additional decoding required to generate the report will be done automatically.

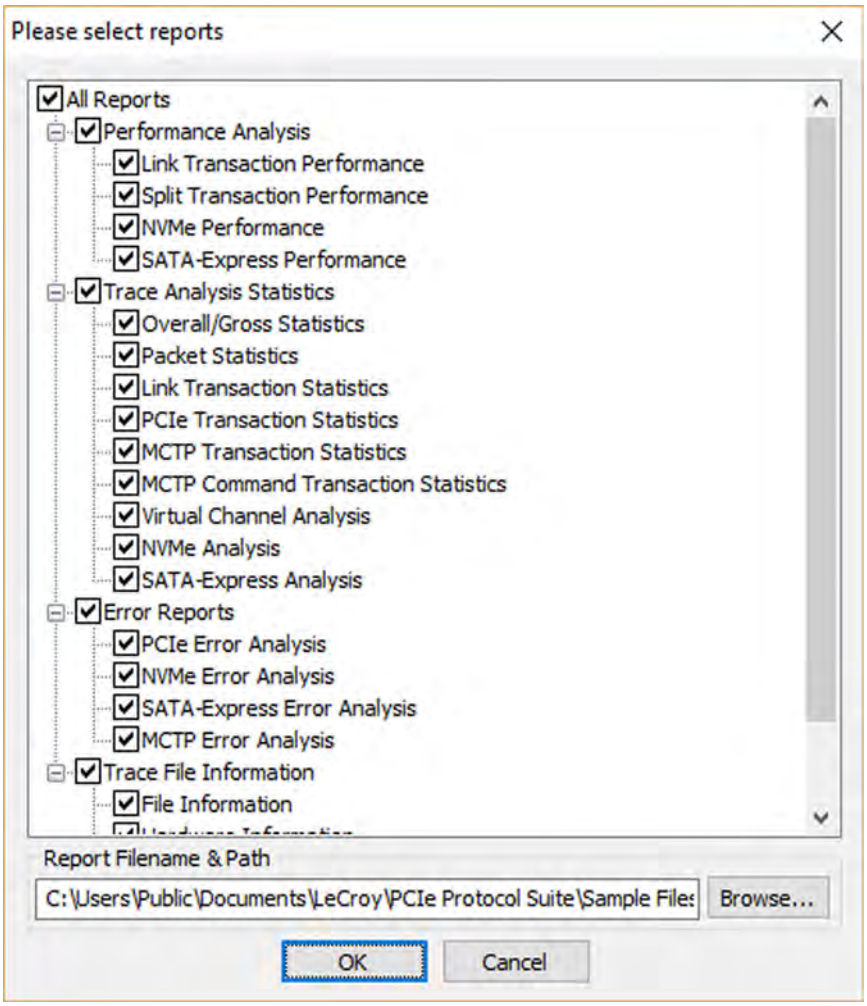


Figure 10.95: Trace Expert Report Types and Path

The generated report (see Figure 10.96 on page 774) 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.

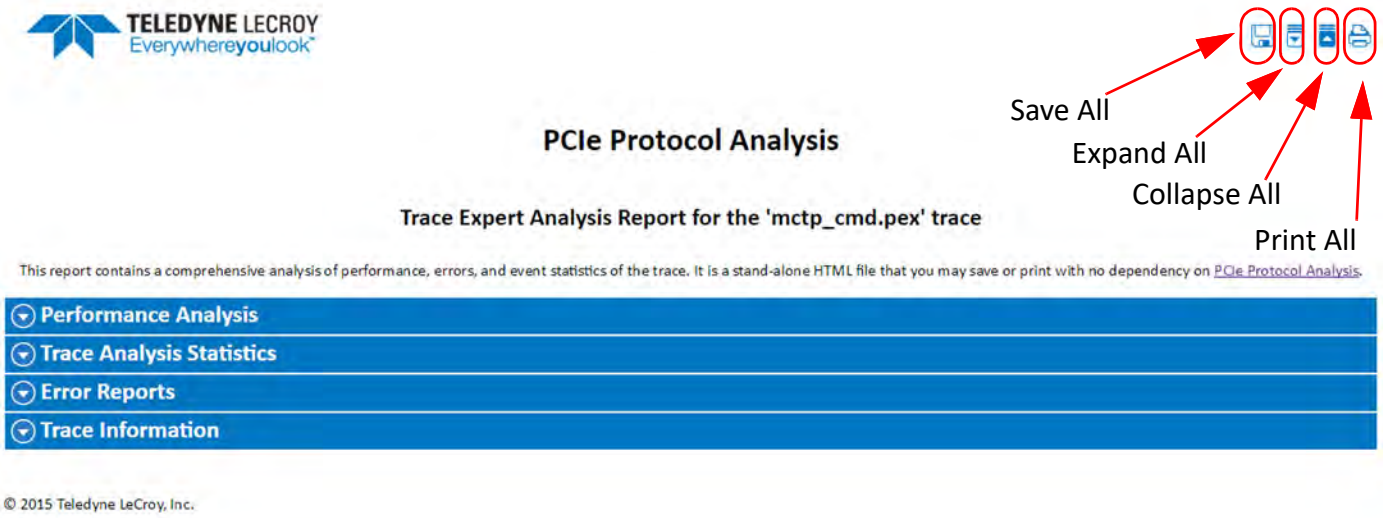


Figure 10.96: Trace Expert Main Menu

Select “Performance Analysis” on page 775 to bring up the respective dialog.

Select “Trace Analysis Statistics” on page 776 to bring up the respective dialog.

Select “Error Reports” on page 777 to bring up the respective dialog.

Select “Trace Information” on page 778 to bring up the respective dialog.

10.25.1 Performance Analysis

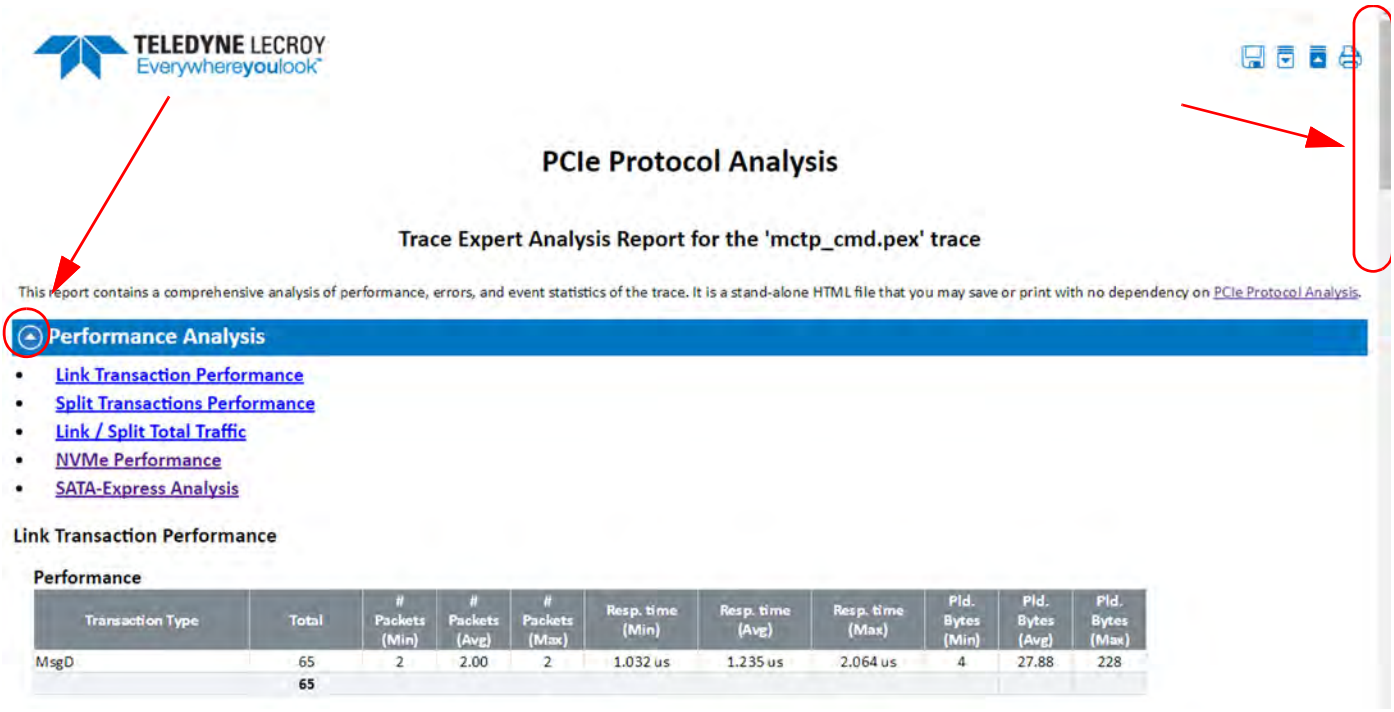


Figure 10.97: Trace Expert - Performance Analysis

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.

10.25.2 Trace Analysis Statistics

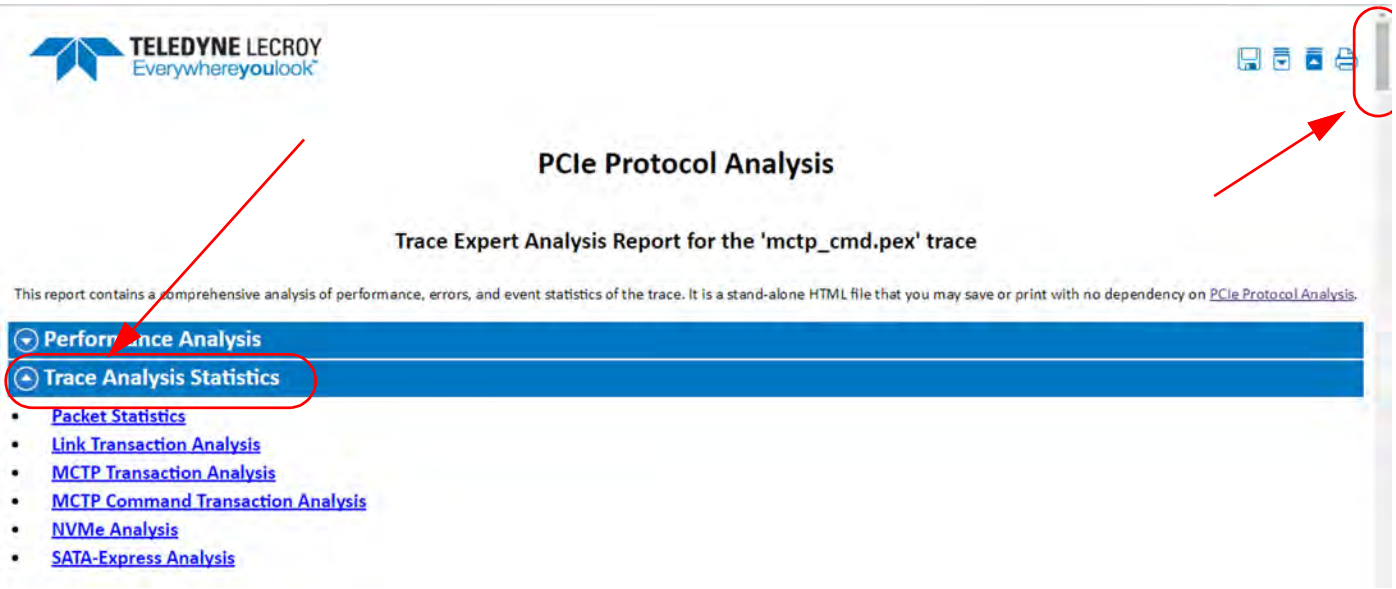


Figure 10.98: Trace Analysis Statistics

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.

10.25.3 Error Reports

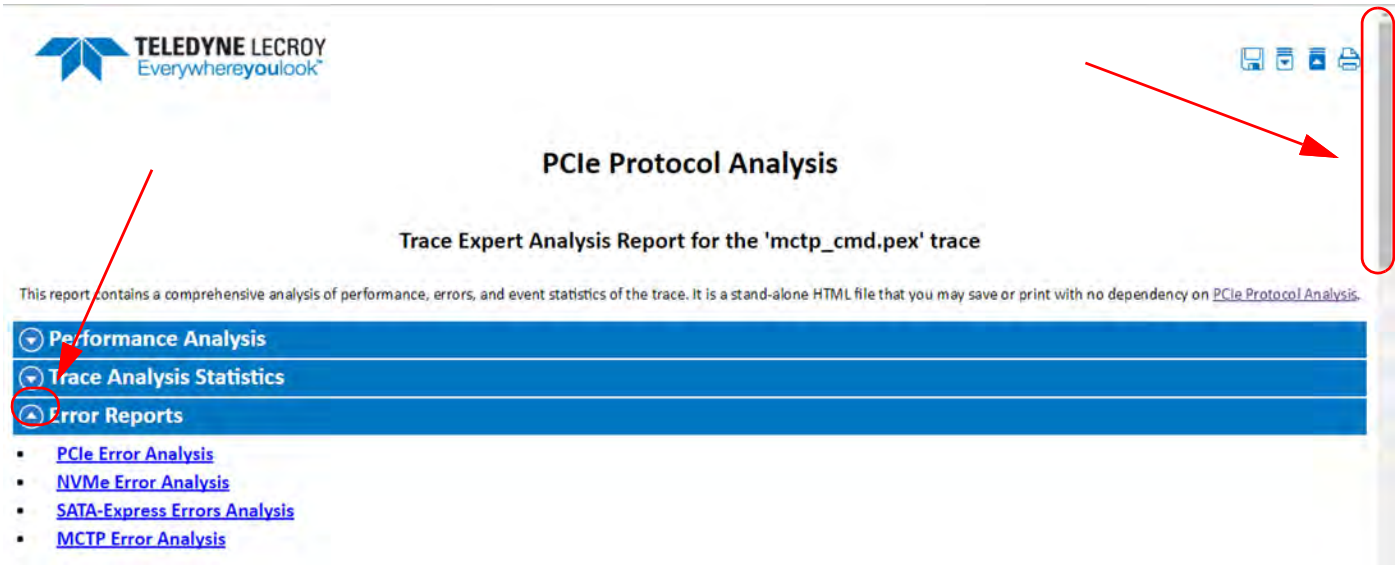


Figure 10.99: Error Reports

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.

10.25.4 Trace Information

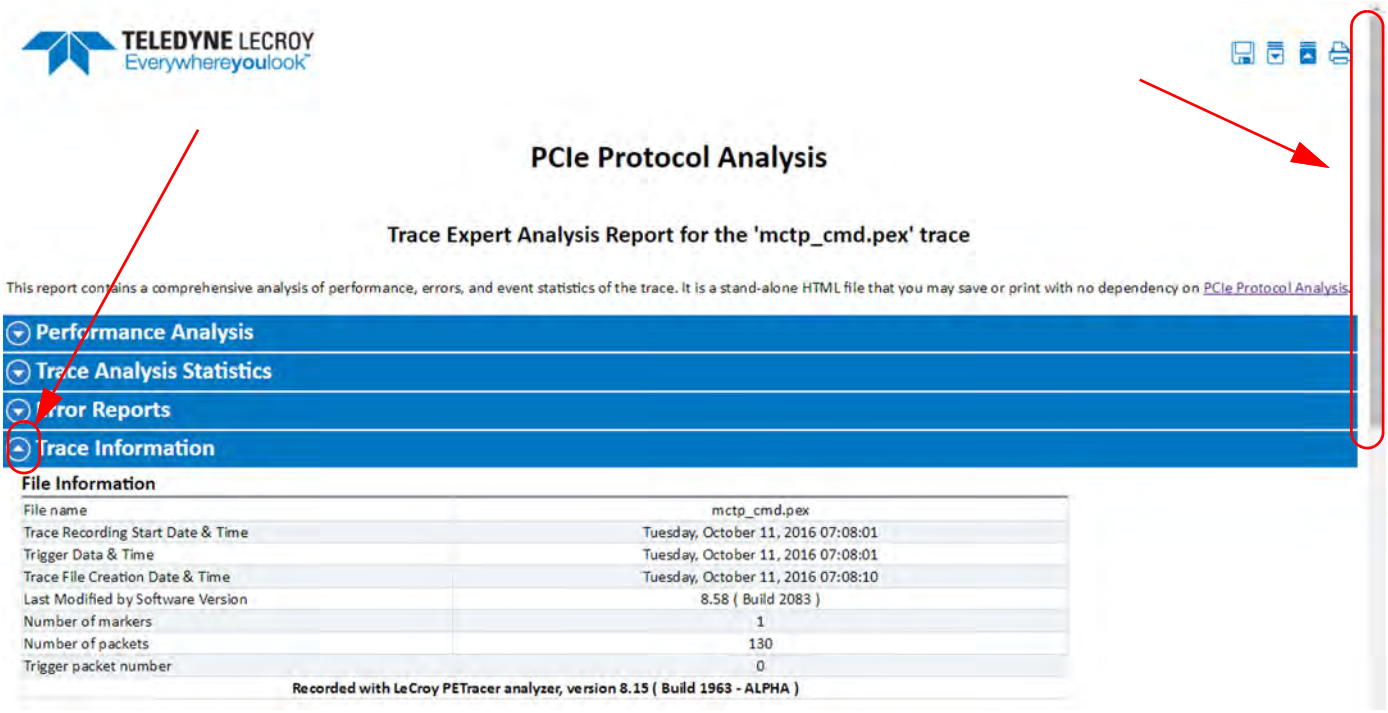


Figure 10.100: Trace Information

Selecting Trace Information generates the following reports:

- File Information
- Hardware Information
- Recording Options
- License Information

Scroll down to see the other reports and information.

Chapter 11

Updates and Licensing

11.1 Updating the Analyzer

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 box for **Summit T416™** or **Summit T48™.**
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** to initiate the updating of the Analyzer.

11.2 License Keys

A License Key is necessary to enable software maintenance. If you attempt to record with the Analyzer 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 Analyzer.

After you obtain the License Key, follow these steps to install it:

1. Select **Setup > All Connected Devices > Update License** from the menu bar. to display the Select License Key File dialog box.
2. Enter the **path** and **filename** for the License Key or use the Browse button to navigate to the directory that contains the License Key.
3. Select the **.lic** file, and then click **Update Device**.

11.3 License Information

You can view Licensing information for your Analyzer by selecting **Help > Display License Information**… from the menu bar. The License Information window displays data about the maintenance expiration and purchased features.

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:

部件名称	有毒有害物质和元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{6+})	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

Part Name	Toxic or Hazardous Substances and Elements					
	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  and then moving the cursor into the window and hitting the Enter key.

A complete list of pre-defined terms is shown in Table 1.

TABLE C.1: Pre-Defined Searchable Terms

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

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
DLLP - Ack	Controller Register - Reserved
DLLP - Nak	Controller Register - CSTS
DLLP - PM	Controller Register - NSSR
DLLP - Vendor	Controller Register - AQA
DLLP - InitFC1-P	Controller Register - ASQ
DLLP - InitFC1-NP	Controller Register - ACQ
DLLP - InitFC1-Cpl	Controller Register - CMBLOC
DLLP - UpdateFC-P	Controller Register - CMBSZ
DLLP - UpdateFC-NP	Controller Register - Reserved
DLLP - UpdateFC-Cpl	Controller Register - Reserved Command Set Specific
DLLP - MRIOV	NVMe I/O Cmd - Flush
DLLP - InitFC2-P	NVMe I/O Cmd - Write
DLLP - InitFC2-NP	NVMe I/O Cmd - Read
DLLP - InitFC2-Cpl	NVMe I/O Cmd - Write Uncorrectable
DLLP - NOP	NVMe I/O Cmd - Compare
Link Events - Link Up	NVMe I/O Cmd - Write Zeroes
Link Events - Link Down	NVMe I/O Cmd - Dataset Management
Link Events - PERST# Deasserted	NVMe I/O Cmd - Reservation Register
Link Events - PERST# Asserted	NVMe I/O Cmd - Reservation Report
Link Events - WAKE# Asserted	NVMe I/O Cmd - Reservation Acquire
Link Events - WAKE# Deasserted	NVMe I/O Cmd - Reservation Release
Link Events - CLKREQ# Asserted	NVMe I/O Cmd - Vendor Specific
Link Events - CLKREQ# Deasserted	NVMe ADMIN Cmd - Delete I/O Submission Queue
Link Events - Skew	NVMe ADMIN Cmd - Create I/O Submission Queue
Error - Invalid Code	NVMe ADMIN Cmd - Get Log Page
Error - Running Disparity Error	NVMe ADMIN Cmd - Delete I/O Completion Queue

Error - Unexpected K/D Code	NVMe ADMIN Cmd - Create I/O Completion Queue
Error - Idle Data Error (not D0.0)	NVMe ADMIN Cmd - Identify
Error - Skip Late	NVMe ADMIN Cmd - Abort
Error - Skew Error	NVMe ADMIN Cmd - Set Features
Error - Bad Packet Length	NVMe ADMIN Cmd - Get Features
Error - Ordered Set Format Error	NVMe ADMIN Cmd - Asynchronous Event Request
Error - Delimiter Error	NVMe ADMIN Cmd - Firmware Activate
Error - Alignment Error	NVMe ADMIN Cmd - Firmware Image Download
Error - DLLP: Invalid Encoding	NVMe ADMIN Cmd - Format NVM
Error - DLLP: Bad CRC16	NVMe ADMIN Cmd - Security Send
Error - DLLP: Reserved Field not 0	NVMe ADMIN Cmd - Security Receive
Error - DLLP: FC Initialization Error	NVMe ADMIN Cmd - I/O Command Set specific
Error - TLP: Invalid Encoding	NVMe ADMIN Cmd - Vendor specific
Error - TLP: Bad LCRC	MCTP - Packets
Error - TLP: Bad ECRC	MCTP - Control Messages
Error - TLP: Reserved Field not 0	

Appendix D

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**.

D.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.

D.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.

D.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.

D.2.2 GetSize()

This function returns the size of the capability structure specified by CapabilityID.

D.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.

D.4 Primitives

Decoding uses the following primitives.

D.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.

D.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.

D.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.

D.5 Helper File

ConfigSpaceCommon.inc include file contains useful functions for script decoding.

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

Expandability

F.1 Expandability

- Summit T416: CATC SYNC Expansion Card functionality is built-in
- Summit T48: CATC SYNC Expansion Card functionality is built-in
- Summit T34: CATC SYNC Expansion Card functionality is built-in
- Summit T316: CATC SYNC Expansion Card is separate
- Summit T38: CATC SYNC Expansion Card is separate

You can time correlate different analyzers by daisy-chaining multiple Summit T416, Summit T48 and Summit T316 analyzers or connect to other Teledyne LeCroy protocol analyzers with the CATC SYNC Expansion Cards (ACC-EXP-002-X).

Note: More combinations of analyzers are possible, contact psgsupport@teledynelecroy.com for more details.

Note: The following steps only apply to the Summit T316, T3-8, T28 and T24.

When purchased with the analyzer, this card is typically installed in the analyzer at the factory but it can be purchased separately. There are both extraction and insertion instructions below depending on which operation you need to perform.

The expansion slot can be located on either the front panel or the rear panel, so the first step is to find the expansion slot.

If you are inserting an expansion card see “Installation of Expansion Cards” on page 806. If you are removing an expansion card continue with the steps below.

You can remove expansion cards with two simple tools.

F.1.1 Removal of Expansion Cards

You can remove expansion cards using two tools:

- Standard (flat blade) 3/16” screwdriver
- Teledyne LeCroy Extraction Tool (part number 230-0160-00)

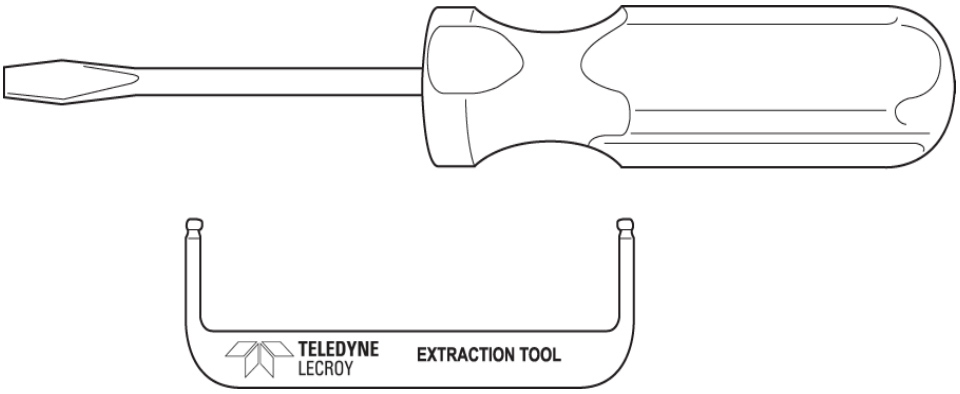


Figure F.1: Tools needed to Remove the Expansion Cards

To remove an expansion card, follow these steps:

1. Unplug the system from AC power and turn the system so the expansion port is facing you.

Note: There are two retaining screws and the holes for the extraction tool that are located on the panel of the expansion card. See Figure F.2.

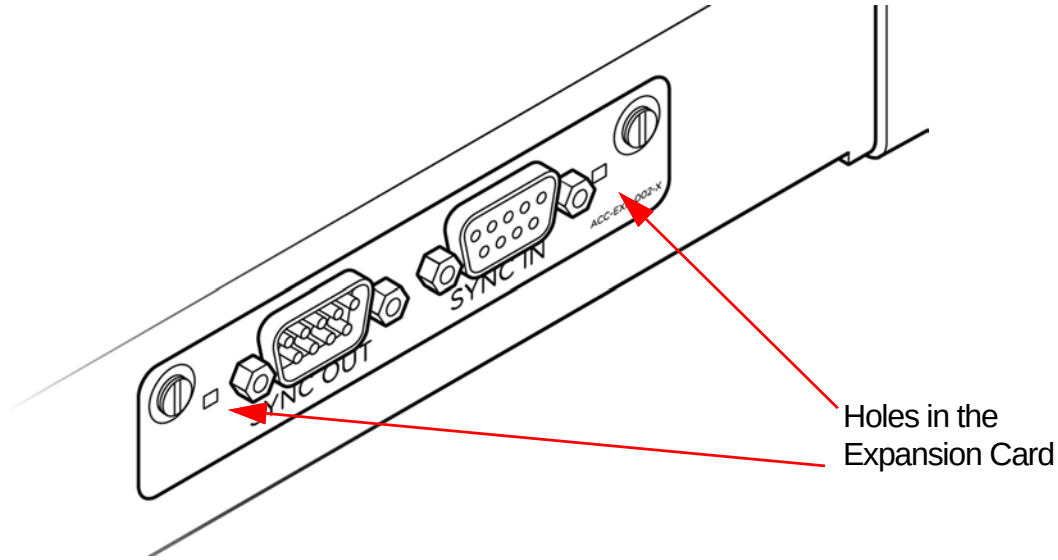


Figure F.2: Holes in the Expansion Card Panel

2. Using the screwdriver, loosen both retaining screws by rotating them counter-clockwise approximately two full turns, until feeling slight resistance. **Do not force the retaining screws** after two turns.

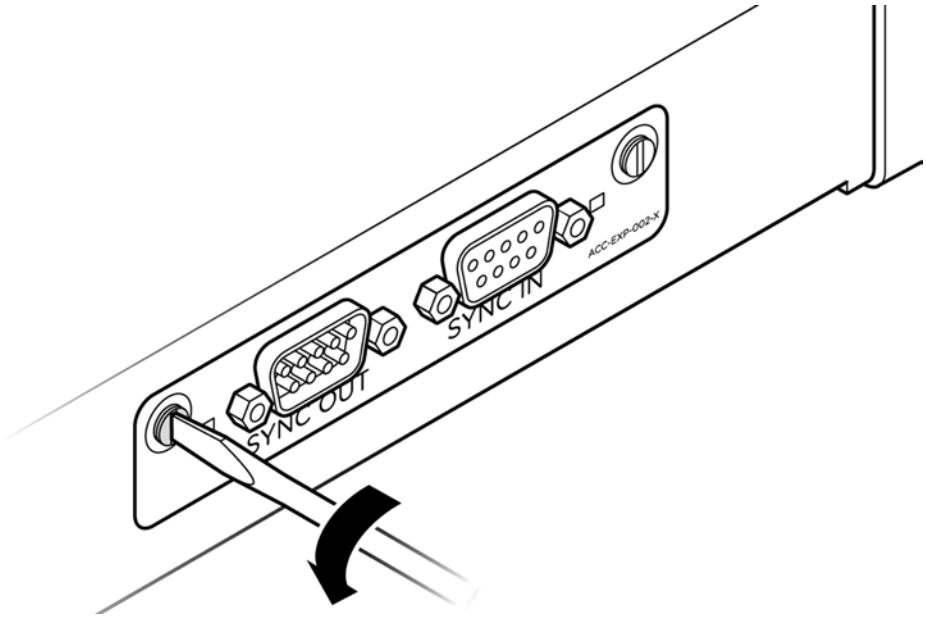


Figure F.3: Loosen Retaining Screws on CATC Card

3. Insert the extraction-tool prongs into the holes in the expansion card panel.

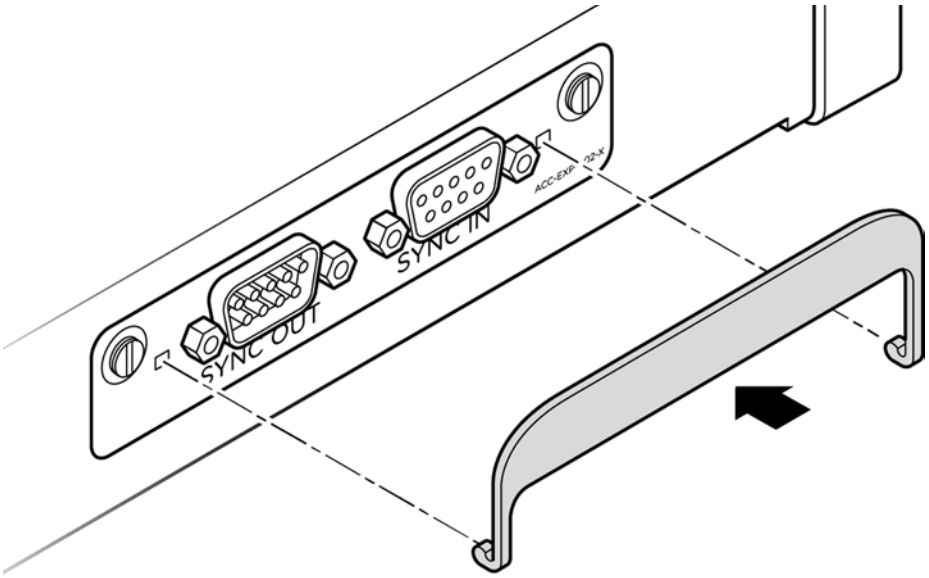


Figure F.4: Insert Extraction Tool

Note: If the prongs do not slip easily into the holes, use a small nail file or similar device to remove paint from the prongs

4. Rotate the extraction tool to a horizontal position to lock the prongs into place and make a handle.

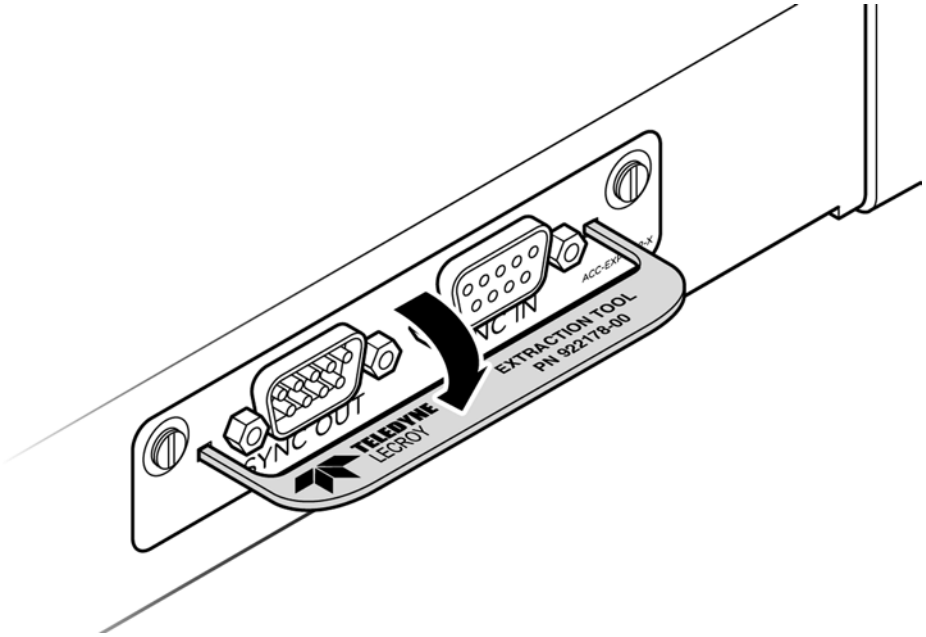
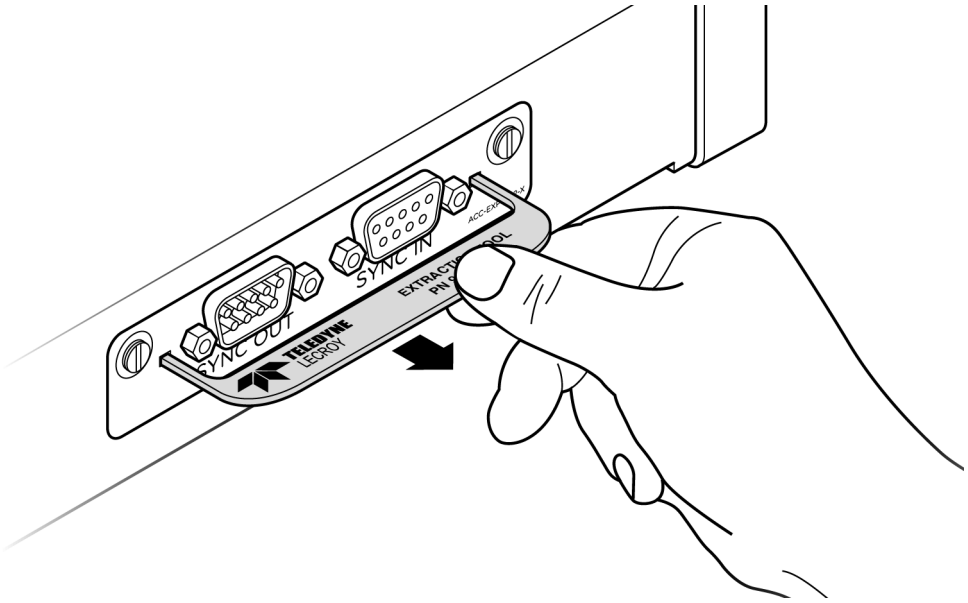


Figure F.5: Insertion of Handle/Tool into Expansion Card Panel

5. Using the extraction tool as a handle, gently wriggle the expansion card forward about 1/8”.



6. Repeat step 5 approximately three times, until the card is free from the retaining screws and you can remove the card from the system.
7. Replace the CATC Expansion Card with a blank panel and tighten the retaining screws. See Figure F.6.

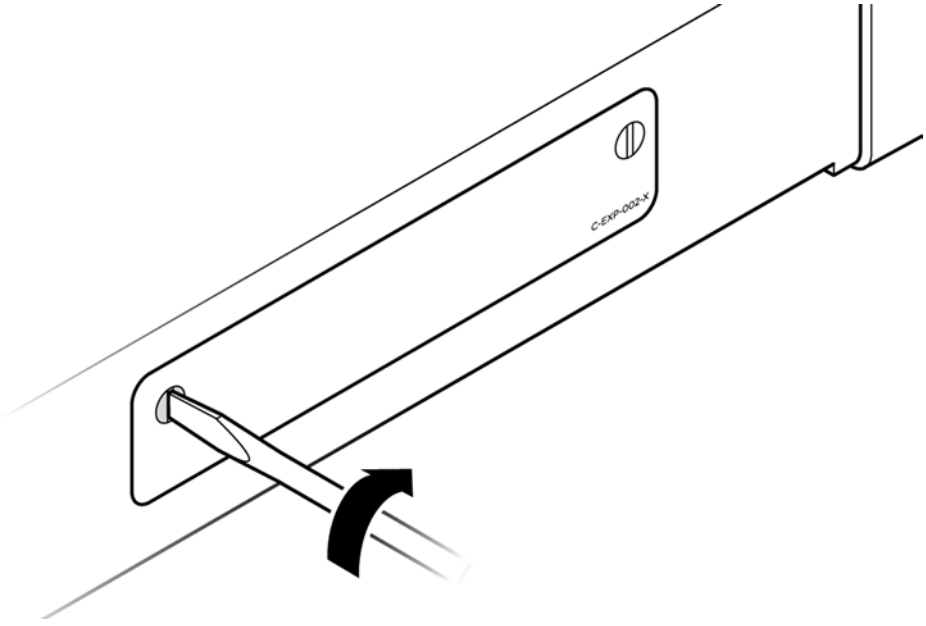


Figure F.6: Replace Retaining Screws in Blank Panel and Tighten

F.1.2 Installation of Expansion Cards

1. Locate the blank expansion panel on either the front or the rear of the analyzer and then continue with the steps below.

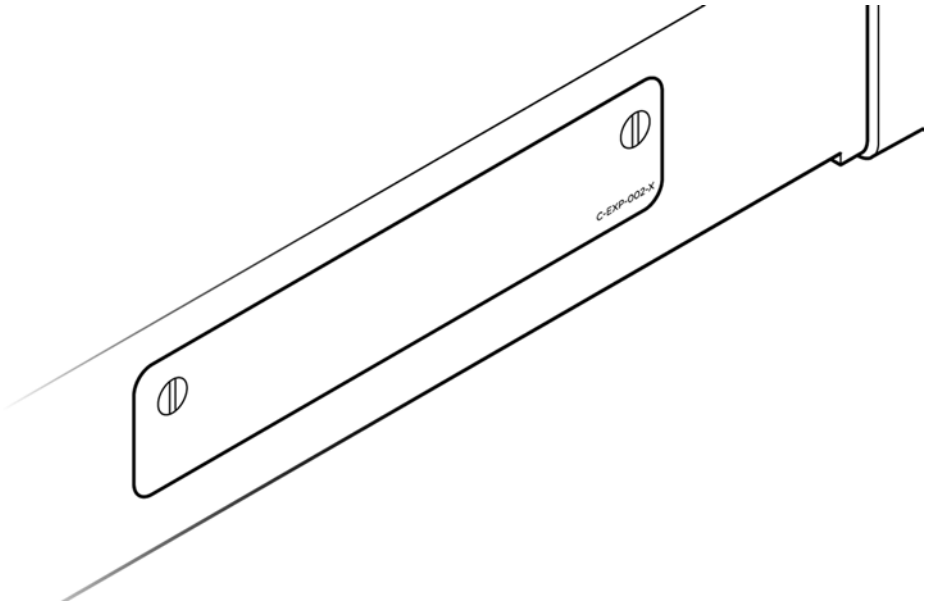


Figure F.7: Front or Rear of Analyzer: Blank Panel

2. Using a flat bladed screw driver, loosen the two retaining screws.

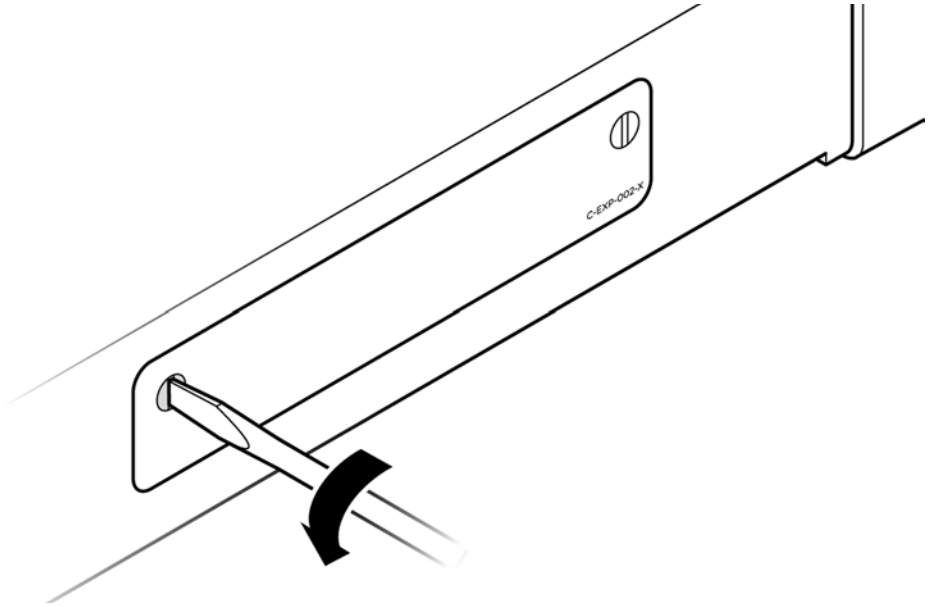


Figure F.8: Loosen Retaining Screws from Blank Panel

3. Remove the retaining screws and blank panel, exposing the inside of the analyzer.

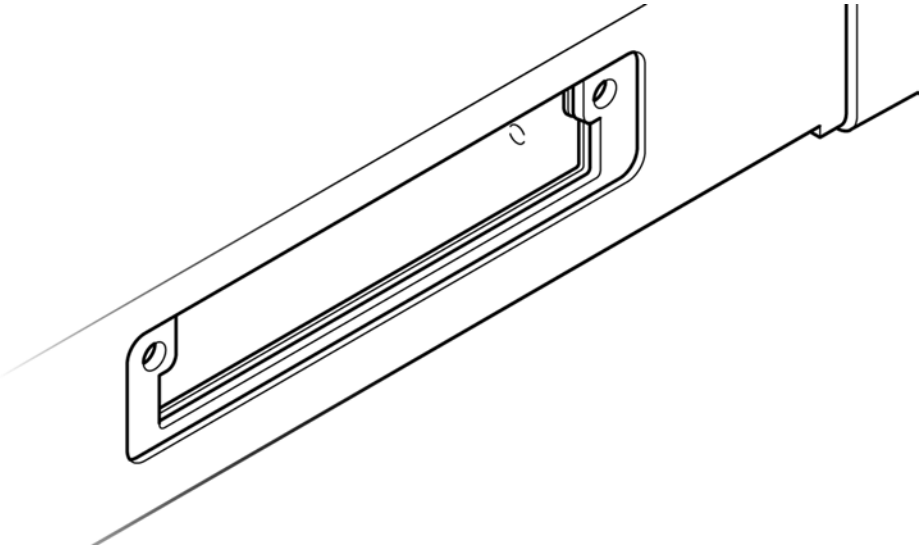


Figure F.9: Rear of Analyzer with Blank Plate Removed

4. Insert the CATC card into the rear of the Analyzer. Gently push on the back panel of the card until you feel the card seat with the internal connector.

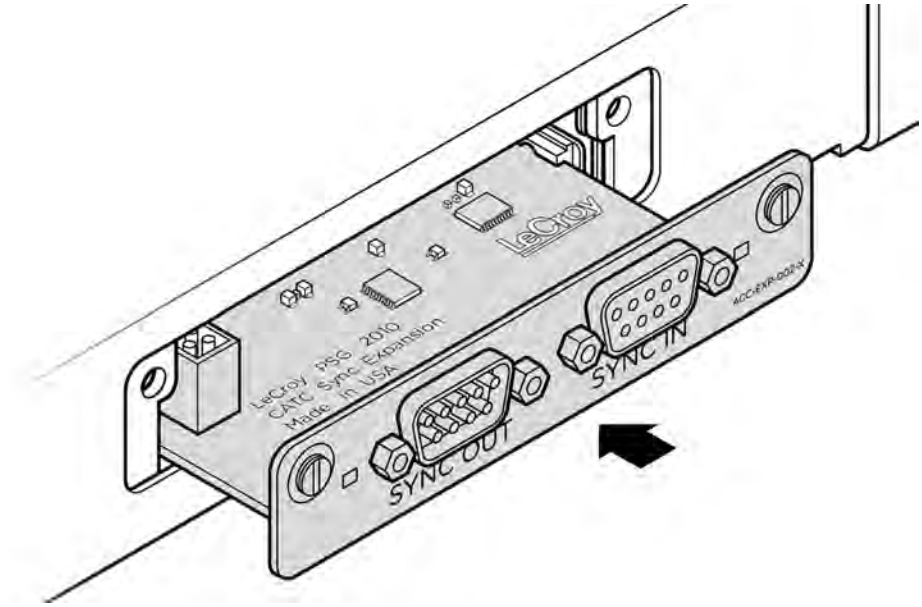


Figure F.10: CATC Card Being Inserted into Rear of Analyzer

5. After the card is seated, tighten the retaining screws.

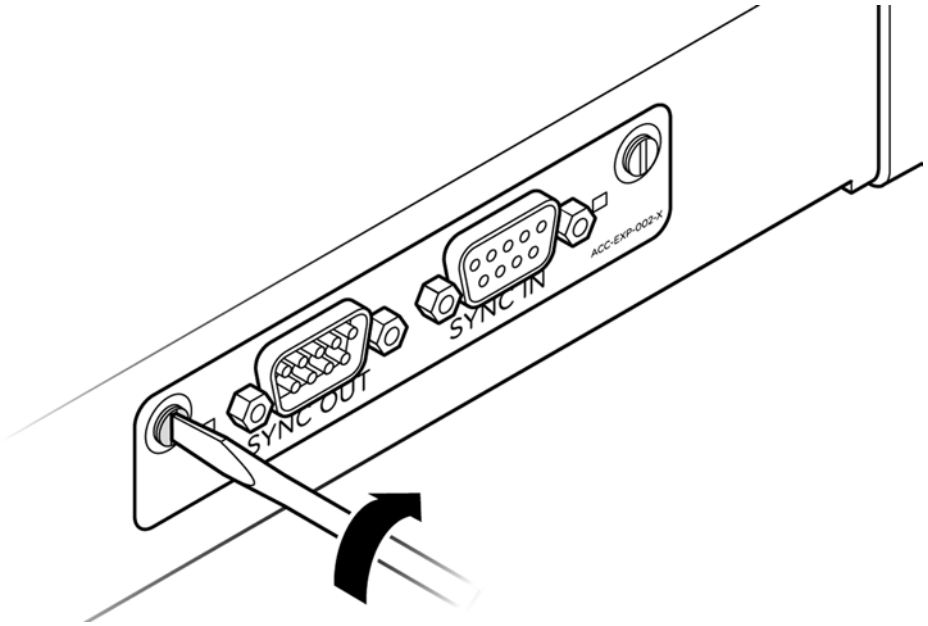


Figure F.11: Tighten the Retaining Screws on the CATC Card

6. The CATC card can now be connected to other CATC cards in other analyzers. As described in the next section (“Daisy-Chaining with CATC SYNC Expansion Cards” on page 809).

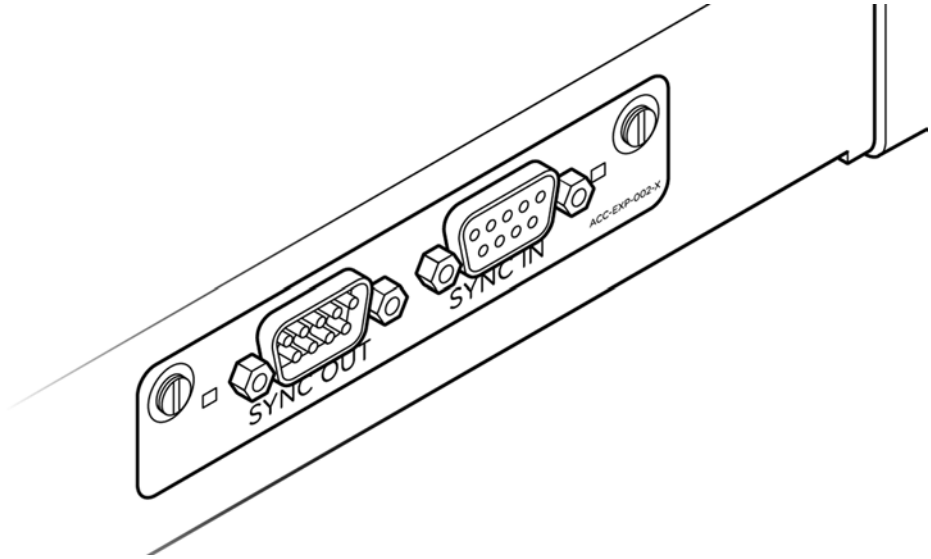


Figure F.12: Analyzer with CATC Card Installed

F.1.3 Daisy-Chaining with CATC SYNC Expansion Cards

You may daisy-chain up to eight analyzer units by connecting the units through the optional CATC SYNC Expansion Card on the analyzer back.

Daisy-chained analyzer units will have their timestamping, recording, and triggering functions synchronized to +/- 100ns. In this example, we daisy-chain the following analyzers:

- Summit T416
- Summit T48
- Summit T3-8

Note: More combinations of analyzers are possible, contact psgsupport@teledynelecroy.com for more details.

Perform the following steps to connect the CATC Sync ports between two or more analyzers:

1. Make sure to stop any recordings in progress.

Note: You may plug/unplug the sync cable while the analyzer unit is powered on.

2. Connect the female end of the sync cable to the SYNC OUT port of one Analyzer.
3. Connect the male end of the sync cable to the SYNC IN port of the other Analyzer (see Figure F.13 on page 810.)
4. Repeat steps 2-3 to connect additional units (up to eight total) as needed.
5. DO NOT create a closed loop from the last unit back to the first unit.

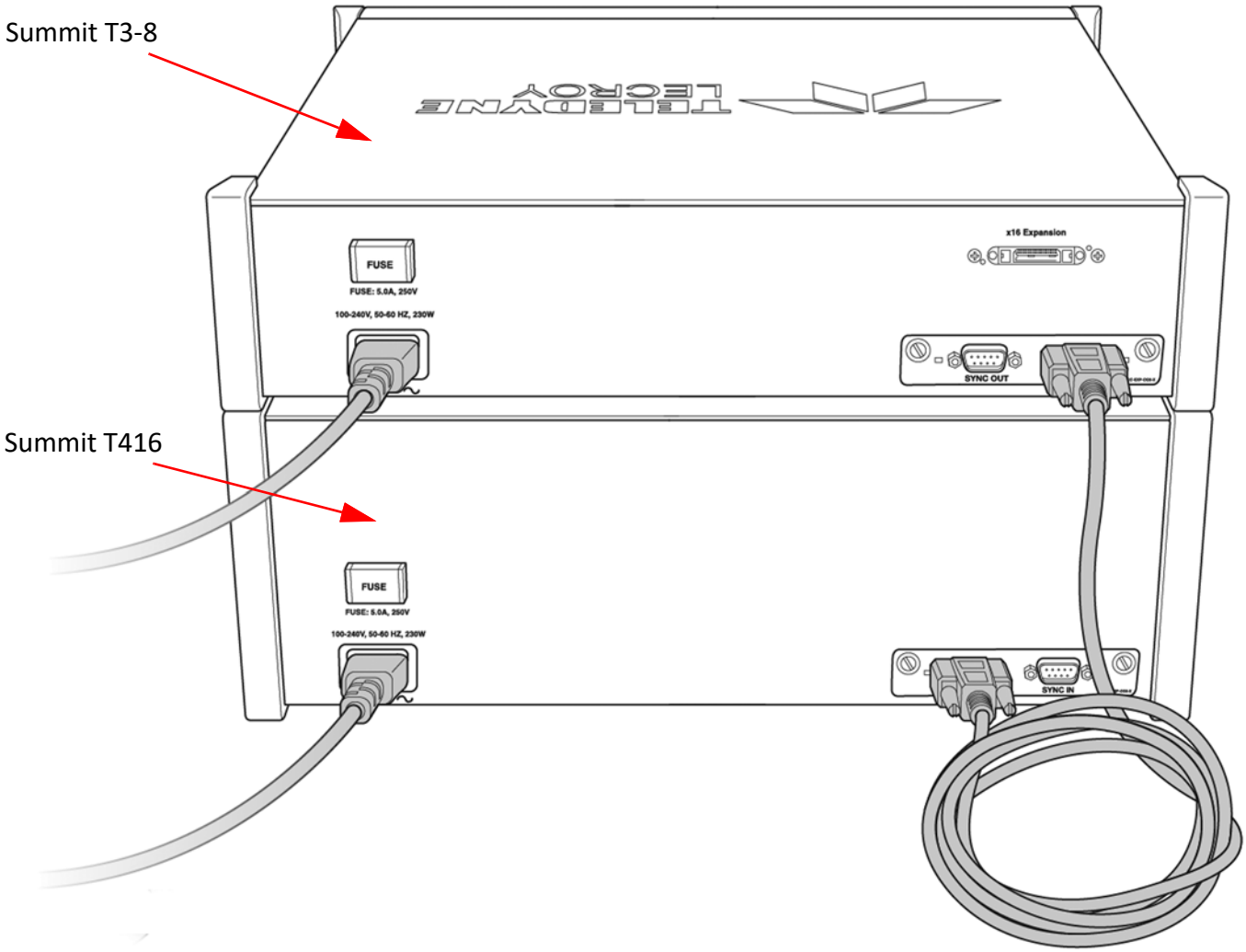


Figure F.13: An Example of Connecting a Summit T3-8 to a Summit T416 Analyzer

F.2 Link Width Expansion using Two Summit T48 Analyzers

Another type of expansion, which can be implemented with two Summit T48 Analyzers, can double the link width of the combined analyzers.

Two Summit T48 Analyzers can be combined to form a single device with a link width of 16 lanes.

F.2.1 Two Summit T48s Configured in Link Width Expansion Mode

You can set up two Summit T48 analyzers to work together as one analyzer, in Expansion Mode, to support x16 recording capability.

To set up the hardware configuration, perform the following steps:

1. Before setting up the hardware configuration, turn power off on both analyzers.
2. Locate the PE106ACA-X Expansion Kit for two Summit T48 Analyzers.
3. Using a DB9 to DB9 CATC-Sync Cable, connect the Sync/Data port from one Summit T48 analyzer to the Sync/Data port connector of the second Summit T48 analyzer. See Figure F.14.
4. Using a x16 Expansion Ribbon Cable, connect the Expansion connector on the back of one Summit T48 analyzer to the Expansion connector on the back of the other Summit T48 analyzer. See Figure F.14.

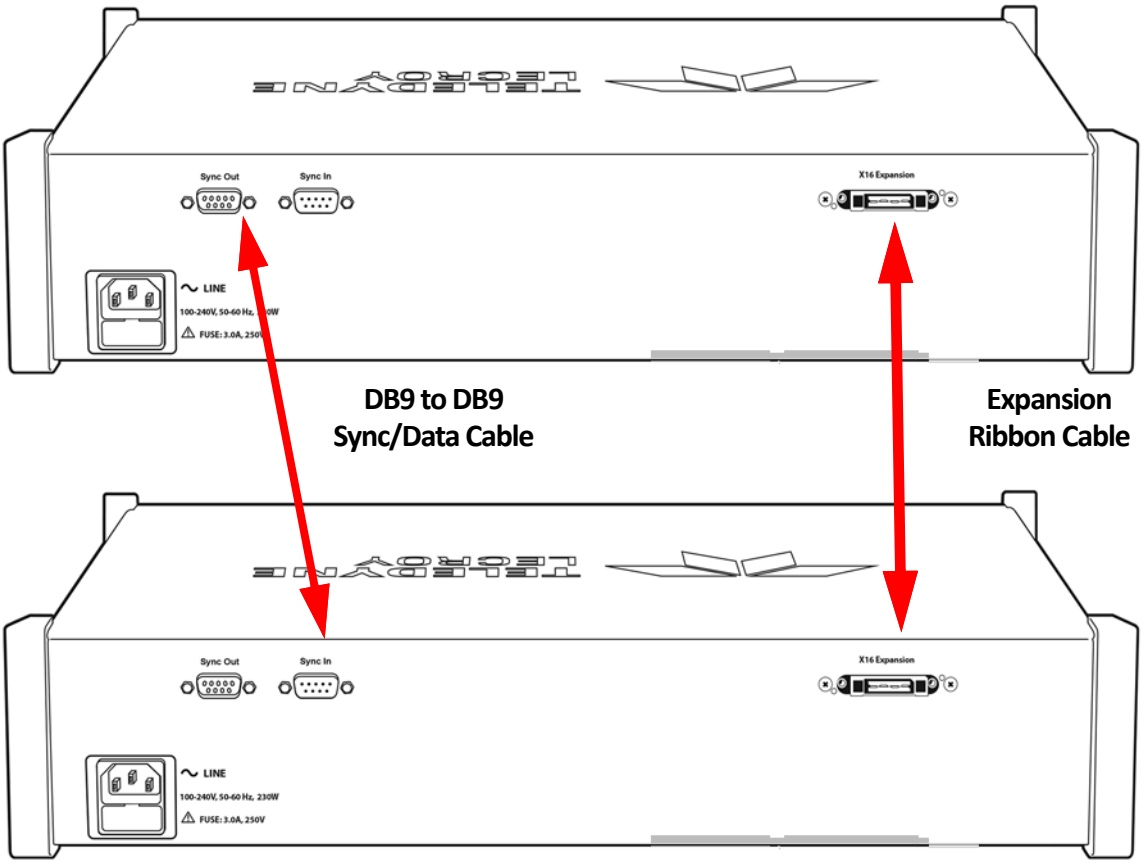


Figure F.14: Connecting x16 Expansion Connectors and Sync/Data connectors on T48

5. Connect the cable (PE021UCA-X) from the Interposer Upstream [0:15] (labeled A and B) to the left and right connectors on the top T48 (marked A and B) on the front panel. See Figure F.15.
6. Connect the cable (PE021UCA-X) from the Interposer Downstream [0:15] (labeled A and B) to the left and right connectors on the bottom T48 (marked A and B) on the front panel. See Figure F.15.

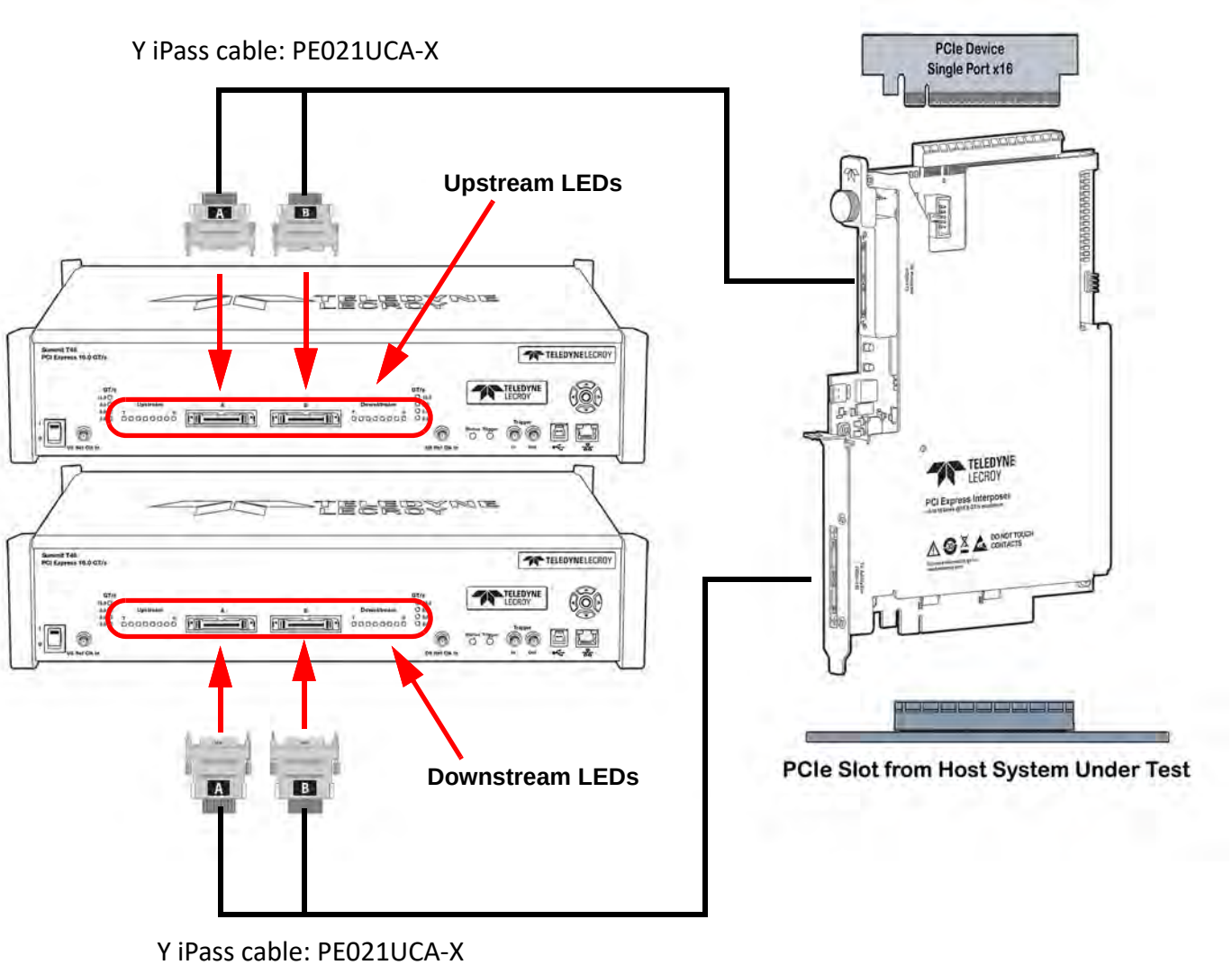


Figure F.15: Gen4 x16 Interposer connected to two T48s in expanded mode

7. Connect both analyzers to the host machine that has the PCIe Protocol Analysis application.
8. After completing the hardware configuration, apply power to both Summit T48 analyzers.
9. Apply power to the Gen4 Xx16 Interposer
10. Open the PCIe Protocol Analysis application on the host machine.
    - ❑ The software automatically detects and configures the analyzers to work as one x16 - capable analyzer. See Figure F.16 on page 813.

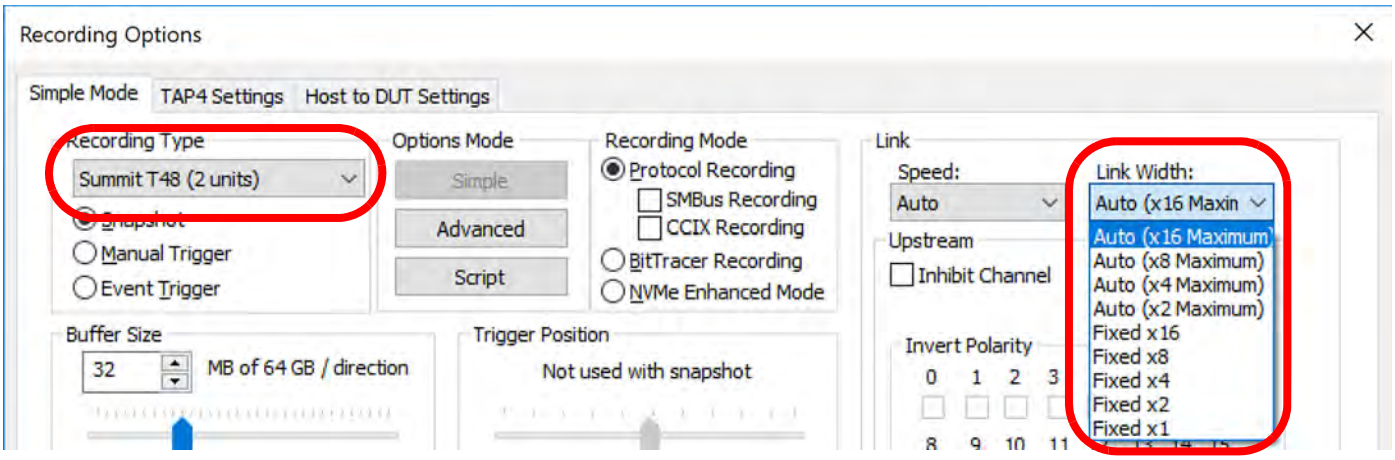


Figure F.16: Summit 48 (2 Units) Recording Options: Link Width up to x16

- One Summit T48 analyzer is assigned the Upstream direction, and the other analyzer is assigned the Downstream direction.
- The Speed LEDs will illuminate on the appropriate side of each analyzer to indicate the direction in which each Summit T48 is recording. The Speed LED in one of the Summit T48 analyzers will illuminate only on the left side, to indicate the PCIe lanes are being recorded from the Upstream direction. The other T48 analyzer will have the Speed LED illuminating only on the right side, to indicate the PCIe lanes are recorded from the Downstream direction.

11. Once the PCI Protocol Analysis software has been enabled, the Expanded T48 dashboard will look something like the figure below (see Figure F.17). In this example the Summit Z3-16 Exerciser is running at 2.5 GT/s.

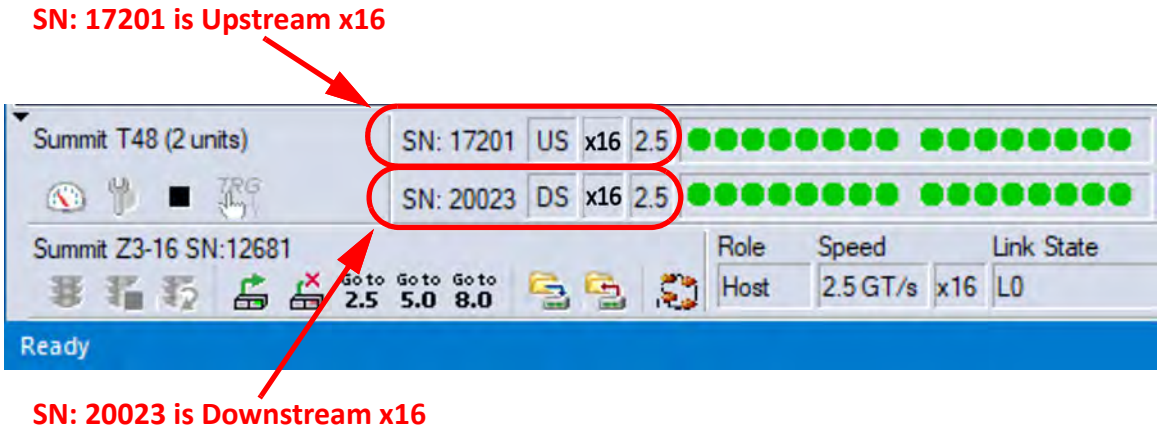


Figure F.17: Expanded T48: Dashboard

Note: The serial numbers of the respective T48s can be found from the **Toolbar -> Setup -> All Connected Devices**.

Index

Symbols

.lic files 799
.opt files 668
.peraw file extension 693
.pex files 165
.ps files 206
.rec files 165
.rr files 206
*.pem 224
+ Packet # button 653
+ sign 679

Numerics

10b errors 677
10-bit code format 672

A

Accessing the Properties Dialog 261
Actions Properties Dialog 296
Activity 139
Adding an Attachment 593
Advanced Hiding Options 117
AHCI level decode 506
All Connected Devices 181
All Markers Window 602
Analyzer
  license 799
  update 799
analyzer
  testing 141
Analyzer Devices 181
Analyzer Network Chat Bar command 182
application 87
ATA level decode 506
Attaching Markers 592
Auto De-Skew command 672
Auto-Configure Lane Polarity 233
Available Events area 246
  243
averaging 761

B

Bandwidth 766
Base Spec 1.0 Rev Compatibility Mode 226
Binary code format 672
Bit Tracer mode 24, 25
BitTracer
  color-coding 673
  compressing data view 692
  data capture mode 669
  data display 672
  Data Display toolbar. 672
  decoding 681
  de-skewing 671
  enabling 669
  Errors window 677
  expanding data view 692
  exporting 685
  link configuration 683
  logical links 685
  markers 675
  recording mode 669
  report windows 673
  saving 693
  search 682
  Symbol window 679
  timing 675
  Timing window 676
  trigger 670
  views 670
  zooming 692
blue current-position indicator 736
Both directions 739
Buffer Size 218
Bus Utilization 716, 765, 776
  buttons 718
  features 761

metrics 760
pop-up menu 717
BusEngine update 799

C

calculating time between DWORDs 726
CATC Trace 23
CATC Trace View 455
CATC Walk Playlist 604
cells 436
resizing 436
states 255
Change Counter Value command 330
changing
markers 451
Changing the Value of the Counter 325
Changing the Value of the Timer 330
Channel 330
Channels 262
Chat session 182
Chat window 181
Clear Marker command 451
Clocks radio button 589
Collapse Idle 728
Collapse Idle Plus. 728
Collapsible Idle Time 725
collapsing 435
Color Format Hiding tab 652
Color pop-up menu 653
colors 653
Combining Specified Event Groups 616
Combo box 751
Comma Separated Value files 170
Comment field 450
comment string 449
components 27
Compressed CATC Trace 455
Configuration Space 748
Configuration Space dialog box 748
Configuration Space Header 750
Configuration Space View 748, 749
configuring
Recording Options 141
Connecting the Analyzer to Power 99
Contact Support 801
Contact Teledyne LeCroy 801
Continue option 146
Continuous Time Scale 728
Control-b command 646
controls
Analyzer T3-16 28, 30
Count action 247
Counters 322
CrossSync Control Panel 26, 124
CSV files 170
current-position indicator 736

D

daisy-chain 823
Data Block window 436
data cells 436
Data Field 435
Data Flow command 730
Data Flow window 730
Data Throughput 756, 766
data.pex file 146, 165
decode levels 463
decoding 463
Decoding window 681
default.opt file 668
Defining Recording Rules 245
Deleting a Counter 326
Deleting a Timer 330
delimiters 736
descrambled format 672
Description String 262
descriptive label 206
Detail View and Spreadsheet View 462
Direction 176
Direction field 616
Disable Descrambling 233
disparity errors 677
Display area 112
Display Configuration Name 651
Display License Information command 799
Display Options 647
command 647
dialog box 647
fFiles 165
loading 668
saving 668
Display Options button 647
DLLP Packet Properties dialog 275, 276
Do not export hidden packets 176
Do not export Idle packets 177
Do not save hidden packets option 167
Downstream 229
DOWNSTREAM 1 connector 28, 30
DOWNSTREAM 2 connector 28
Downstream direction 739
Downstream LED 28, 30
Drag an event here to create a new sequence 257

DS Ref Clk In 28, 30
DWORDs
  timing 726

E
Edit Comment command 181
Edit Marker 601
Edit Marker command 451
Edit Marker for Packet # pop-up 450
e-mail 801
Empty Trace Warning Message 648
Enable Tool tips 648
Error Hiding tab 662
Error Properties dialog box 273
Error Summary dialog box 699
errors
  10b 677
  disparity 677
Errors pane 735
Errors window 677
ETHERNET 29, 31
Event Groups menu 615
Event Icon Preview 262
Event Navigation 711
Event Trigger recording type 196
events
  searching 587
Events report window 679
Event-specific Settings 262
Exclude option 616
Expand Data command 435
Expansion Slot 36
Export command
  BitTracer 685
Export to Compressed Archive command 693
Export Wait for ACK from upstream 177
Export Wait for Cpl from upstream 177
exporting 170

F
field
  hiding 657
Field Colors tab 653
Field Formats tab 655
File Export dialog box 175
file formats 170
File Menu 118
filter 298
Filter action 247
Filter In button 300
Filter Out 214
Filter Out button 300
Find command 613
Find dialog box 615
Find Next command 642
finding 615
Firmware update 799
First, Prev, Next, and Last buttons 751
Fit to Graph Area 717
Flush option 146
Fonts 650
format
  field 655
From 176
From packet # field 181
From Packet field 167
front panel 28, 30
Functionality of Markers 591

G
Gen2 PCI Express 16-lane advanced verification system 21
General tab 186, 647
Generator file format 170
Global State 256
Global State and Sequence States 255
Global State Cell 246
Go To Marker command 589
Go to Marker command 726
Go To menu 609, 610
Go to Packet # 717
Go to Packet command 588, 589
Go to Trigger command 588
Grid Lines 711
Group and Colors column 653, 655

H
header fields 439
Help Menu 135
Hexadecimal vs. Binary tabs 751
Hide 717
Hide buttons 116, 727
Hide Downstream button 116
Hide Sideband button 116, 117
Hide SKIP and Update FC button 116
Hide Training button 116
Hide Upstream button 116
hiding 657, 658
  Idles 727
Hiding tab 658
Hierarchy Lines 648
host machine requirements 27

How to Increment or Reset a Counter 324
How to Set a Counter 323
How to Set a Timer 327
How to Start or Reset a Timer 329

I
Icon Label 262
information
  priority 737
interface 87
Intersection option 616

K
K/D symbol format 672
Key
  License 799
keyboard shortcuts 137
keystrokes 137

L
label 206
lane swizzling 24, 25
Latency 766
Latency Time 756
Launching the CrossSync Control Panel 183
layout 112
LCD display 32
LCD Display and Button Functions 32
LCD Display and Button Functions for Configuring the Analyzer 32
LCD Menu Navigation Buttons 28, 30
LCD Menus 28, 30
LEDs
  Analyzer T3-16 28, 30
Legend option 736
level hiding 658
Level Hiding tab 658
levels 463
LFSR value 672
license files 799
License Information window 799
License Key 799
licensing information 799
Linear 717
Link 225
Link Configuration dialog 683
Link level decode 465
Link section 143
Link Settings 225
Link State Dialog 263
Link Tracker
  buttons 727
  toolbar 724
Link Tracker window 724
  docking 726
  markers 726
  reformat 724
link training 143
Link Transaction
  metrics 759
Link Transaction Level graphs 762
Link Transaction Performance 759
Link Utilization 765
Link Width 226, 227
Link Width pane 735
Load button 207, 668
Load command 207, 668
loading 207, 668
Loading Recording Options 214
Logarithmic 717
logical links
  BitTracer 685
Logical view 681
long format 435
LTSSM Flow Graph 739
LTSSM Flow Graph command 739

M
Main Display Area 724
Main display area 243
Manual Trigger
  recording type 196
Markers 590
  Adding an Attachment 593
  Attachment Types and Visualization 594
  Embedded Attachments to a Marker 594
  Recording an Audio File 593
  Video Files supported 594
markers 449
  BitTracer 675
  deleting 451
  editing 451
  setting 449, 726
  user-defined 676
Markers Overview 590
Markers window 676
Memory Writes 759
Memory Writes Performance 766
Menu bar 112
menus 118
  pop-up 436
metrics 756

Bus Utilization 760
Link Transaction 759
Link Transactions 756
Split Transaction 758
Split Transactions 756
trace 757
Traffic Summary 758
unit-base averaging 761
Metrics Header 757
Metrics Tooltip 757
Microsoft® Windows®-based host machine 87
Msb -> Lsb checkboxes 656
Multi-Segment Toolbar 116, 118

N

navigating 733
Navigating Recording Rules 258
Navigator 733
displaying 733
legend 736
panes 734, 735
range 734, 735
ranges 734
slider 736
toolbar 733
Navigator Legend dialog box 737
Navigator Panes button 736
Navigator Range button 735
New Event button 246
New Events button 261
Number of Link Transactions 756
Number of Packets 756
NVMe level decode 470
NVMe PCIe SSD Device Configuration 778

O

opening
program 97
operating system 87
Options Name box 206
Ordered Set Properties Dialog 271
Origin field 616

P

Packet # 653
Packet # field 450
Packet Data command 746
Packet Data window 746
Packet Directionality Cell 454
Packet Header bar 746
Packet Header Cell 454
Packet Header command 746
Packet Heading Cell 440
Packet level decode 463
Packet Match Resource 249
Packets report window 680
Packets/second 766
pane checkbox 737
Pattern Format section 683
Payload 756
PCI Express 16-lane advanced verification system 21
PCI Express Spec 2.0 24, 25
PCIe Protocol Analysis Files 165
PCIe Protocol Analysis SN message 139
PCIe Protocol Analysis T3-16
opening 97
pem 224
PHY layer problems 24, 25
Pin Button 262
Playback Window 605
Playlist Functionality 604
Playlist Playback Control 606, 607
plus symbol 653, 655
polarity checkbox 683
pop-up menus 436
Power Switch 28, 30
PQI level decode 510
PQI PCIe SSD Device Configuration 781, 783
Pre/Post Trigger pane 735
Print command 181
Printer button 181
printing 181
Probe Settings 376
Properties 717
Properties button 262
Properties command 247
Properties dialog 261
Properties dialog box 247, 261
Protocol Level to View 648
protocol unit 756

R

range delimiters 736
Raw 10b Codes 438
Read Requests Performance 758
reading 435
Ready message 139
Recently Used Ranges 735
Record button 143
Record Menu 124, 125
recorded activity 141
recording 141, 186

stopping 146
Recording button 247
Recording Options
command 186
dialog box 186
files 165
saving 206
settings 206
Recording Options command 141
Recording Options-General Tab 187
recording progress 139
Recording Progress Bar 139
Recording Rules
buttons 243
toolbar 243
Recording Rules Events 258
recording status 139
Recording Type 215
Remove 717
Report Menu 125
Report menu 697
reports 696
Reset Column Widths 726
resizing 436
Resources 247
Response Time 756, 766
Retain Decoded Files 648
Row Selection 711
Run verification scripts command 787
Running Disparity 672

S

Save As command 165
Save As Default 207, 668
Save button 668
Save packet range command 167
saving 165, 668
BitTracer 693
scrambled format 672
SCSI level decode 511
Search 139
command 587
Search Bwd message 646
search direction 141
Search For menu 615
Search Fwd message 646
Search Menu 126
Search On section 683
Search Order section 683
Search Pattern window 683
Search window
BitTracer 682
searching 587
Seconds radio button 589
Send command 182
Sequence Cell 247
Sequence State 250, 256, 257
Set Display Options command 653
set IP Configuration 33
Set IP Mode Static 33
Set Marker command 450, 726
Set Marker with Text command 676
Set Range Near Packet xxx 735
Set Range to Whole Trace 735
Setting Default Recording Options 206
setting markers 449
Settings button 788
Settings window 788
Setup Menu 124
short format 435
shortcuts 137
Show Configuration Space for xxxx 749
Show Header Fields command 439
Show Header Fields dialog box 439
Show Number of Transitions checkbox 739
Show Packet in Raw Trace 685
Show Raw 10b Codes command 438
Simple and Advanced Mode 198
small triangle 435
Snapshot recording type 195
software 111
installation 87
update 799
SOP and SCSI PCIe SSD Device Configuration 785
SOP level decode 510
Specification view 681
Specify Action command 247
Speed LEDs
28, 30
Split level decode 465
Split Transaction
metrics 758
Split Transaction Level graphs 761
Split Transaction Performance 758, 766
Spreadsheet View 456
Start menu 97
Status Bar 139
Status bar 112
Stop button 146
Stop option 146
stopping recording 146
Summit T3-16 21, 24, 25, 27

Summit T3-16 front panel 28, 30
Swap Recording Channels 226
Swizzling Config... 243
Symbol window 679

T
T416 rear panel 36
T48 rear panel 37
testing 141
text files 170
Throughput 766
Tight Columns 711
time between DWORDs 726
Time Coverage 766
Time Stamp 648
time value 727
time-based averaging 761
Timer 326
Timestamp at the beginning 648
Timing and Bus Usage Calculator 764
Timing Calculations command 763, 764
Timing Calculator dialog box 764
Timing measurement
  BitTracer 675
Timing window 676
Title bar 112
TLP Header Properties dialog box 277
TLP Prefix Packet Properties dialog 277
To 176
to Generator File Format 175
To packet # field 181
To Packet field 167
Toggle Search Direction command 646
Tool tip Display 725
Toolbar 112, 243
  112
Tools Menu 131
Tools menu 697
Tooltips 137
trace
  cells 436
  exporting 170
  files 165
  metrics 757
  saving 165
Trace Filename and Path 204
Trace View Mode 648
Trace Viewer 97
traces
  searching 587
traffic 435
  analyzing 695
Traffic Speed pane 735
Traffic Summary
  buttons 711
  metrics 758
Traffic Summary window 707
  moving to packets 708
Traffic Type pane 735
triangle 435
Trigger 28, 30
Trigger action 247
Trigger marker 675
Trigger Position 219, 223
Triggering 243
Triggering On (Advanced Mode) 421
Triggering On (Simple Mode) 215

U
Undo Zoom 717
Union option 616
unit 756
unit-based averaging 761
Update Analyzer dialog 799
Update command 799
Update Device command 799
Update License command 799
Update License dialog box 799
updates 799
Uploading 139
Upstream 229
UPSTREAM 1 connector 28, 30
UPSTREAM 2 connector 28
Upstream direction 739
Upstream LED 28, 30
US Ref Clk In 28, 30
USB 29, 31
Use External Reference Clock 230
user-defined markers 676

V
Verification Script dialog box 787
View Data Block command 436, 438
View Menu 129
View Options 728
View Options button 725
View Settings 719
Viewer 97
Viewing Attachments of a Marker 595

W
web site 801

Window Menu 132
Windows® based host machine 111
Wrap 648
Write Requests Performance 759
Writes Response Time 762
Writes Throughput 762

X
X marker 675

Y
Y marker 675
Y Scale Type 717
yellow range delimiters 736

Z
zoom 725
Zoom Level 648
Zoom to Trace View 717