

# Falcon/Raptor Series - User Manual

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# Safety Information

Observe the following precautions to avoid fire or injury and prevent damage to this product or any products connected to it.

Use this product only for its intended purpose as specified.

Use only the power adaptor specified for this product and certified for the country of use.

Ensure that the power source provides the power level supported by the power adaptor.

To avoid fire or shock hazard, observe all ratings and markings on the product and power supply and ensure the product is properly grounded.

Do not connect or disconnect probes or test leads while they are connected to a voltage source. Connect the probe reference lead to earth ground only.

Do not block the power cord; it must remain accessible to the user at all times.

Do not operate this product with covers or panels removed.

If you suspect that there is damage to this product, have it inspected by qualified service personnel. Do not operate with suspected failures.

Do not operate in wet/damp conditions. Do not operate in an explosive atmosphere. Keep product surfaces clean and dry. Provide proper ventilation for operation of product.

Only qualified Protocol Insight personnel or representatives should perform service procedures

# Product Overview

**The Falcon series** are the established industry standard with powerful protocol analyzer and exerciser capabilities and unprecedented flexibility.

- The **Falcon G400B** is a protocol analyzer that can capture x2 bi-directional links as a "sniffer". It supports up to MIPI M-PHY v4.1 HS-G4B, UniPro v1.8 and UFS3.1.
- The **Falcon G450B** is identical to the G400B analyzer but is also a protocol exerciser that can generate link traffic on a x2 bi-directional link while simultaneously capturing the response traffic from the DUT. The Falcon G450B exerciser can execute the UniPro v1.61, UniPro v1.8, and JEDEC JESD224A Compliance/Conformance Test Suites (CTS), and has preliminary support for UFS 3.1 CTS testing.
- The Falcon G300B analyzer supports MIPI M-PHY v3.1 HS-G3, UniPro v1.61, and UFS2.1, and can be upgraded to support HS-G4B and UFS3.1.
- **The Falcon G350B** exerciser/analyzer is identical to the G300B analyzer but is also a protocol exerciser that can execute the UniPro v1.61 and JEDEC JESD224A Compliance/Conformance Test Suites (CTS), and can be upgraded to execute the UniPro v1.8 CTS with preliminary UFS3.1 CTS support.

**The Raptor series** are UFS and UniPro protocol analyzers with robust capabilities for debugging everyday issues. This series is only capable of protocol analysis.

- The **Raptor M400** is a protocol analyzer that can capture x2 bi-directional links as a "sniffer". It supports up to MIPI M-PHY v4.1 HS-G4B, UniPro v1.8, and UFS3.1
- The **Raptor M300** analyzer supports MIPI M-PHY v3.1 HS-G3, UniPro v1.61 and UFS2.1, and can be upgraded to support HS-G4B and UFS3.1.

# Key Features

## Smart Tune™ equalization

Capturing the signal from the DUT can be problematic when trace routing or the cabling to the test fixture causes poor signal integrity or probing issues. Smart Tune<sup>™</sup> equalization optimizes signal acquisition at the analyzer to ensure error-free MPHY symbol capture.

## Eye Monitor

Eye Monitor constructs an eye diagram of the link to determine link quality. Qualitative measurements can be done on the eye diagram for jitter, noise, and eye opening.

#### Streaming capture

Streaming capture uses the full 40Gbs bandwidth of Thunderbolt3 to store link traffic directly to disk in real time. This allows for virtually unlimited trace capture.

# Trace Validation<sup>™</sup> (TV) analysis

Trace Validation uses state machine logic to analyze captured traces algorithmically without user intervention. It analyzes bi-directional UniPro and UFS traffic, performing protocol sequence and timing analysis and packet header and payload inspection.

#### Events view

Displays events on the bus in a unique time-aligned display, and includes fillers, Prepare, SYNC, Hibern8, sleep, stall and other M-PHY level packets. Events view presents a complete picture of all events and allows drill-down to the lowest level bytes.

#### Compliance (CTS) Testing (Falcon G350B/G450B only)

Test executive performs compliance verification of UFS 3.1/2.1 and conformance verification of UniPro 1.8/1.61 with Compliance/Conformance Test Suites (CTS). It executes a range of CTS test cases, analyzing results using the Trace Validation engine and generating pass/fail and summary reports.

#### Stimulus for corner case and margin testing (Falcon G350B/G450B only)

Stimulus with full UniPro stack in HW allows creation of specific traffic on the link, offers extensive error injection and is capable of full protocol emulation.

#### Test executive stress testing (Falcon G350B/G450B only)

Test executive stress testing executes hundreds of thousands of tests automatically. Stop after any number of loops or No Result Test Cases.

#### Custom test case creation

Design custom tests to test corner cases or introduce errors for margin, stress, or error recovery testing. Editors allow complex test creation, error injection, device control, and protocol sequence and packet state machine construction for stimulus and Trace Validation.

# Instrument Description

The Falcon G300/G400 series and Raptor M Series consist of an instrument and a power brick. A controller PC with Thunderbolt 3 connectivity is required and is not included. Other components required for instrument operation that are not supplied include 50 ohm matched-length cables and power splitters, or a solder-down probe. See Accessories for more information.

**The Falcon G300/G400 and Raptor M Series** front panel connectors are used to probe links at the Tx, Rx, or the midpoint. The "Sublink 0 Analyzer" connectors are used to capture and analyze one direction of link traffic while the "Sublink 1 Analyzer" connectors capture the other direction of link traffic.

**The Falcon G350/G450** "Sublink 1 Tx Exerciser" front panel connectors generate traffic on the link and the "Sublink 0 Exerciser/Analyzer" connectors are used to capture and analyze the response traffic. When using the instrument as an exerciser the "Sublink 1 Analyzer" connectors are not used.

The connectors on the front panel are labeled from the instrument perspective, not the DUT perspective. So, the connectors labeled Rx are for capturing signals from the bus and connectors labeled Tx are for generating traffic on the bus.



## Analyzer front panel - Falcon G300B/G400B and Raptor M300/M400

## Analyzer front panel - Falcon G300/G400



Front panel connectors:

- A. Connect the TxDN and TxDP from device M-Tx lane 1 here.
- B. Connect the TxDN and TxDP from device M-Tx lane 0 here.
- C. Connect the RxDN and RxDP from device M-Rx lane 1 here.
- D. Connect the RxDN and RxDP from device M-Rx lane 0 here.
- G. Generates a UFS reference clock on 19.2, 26, 38.4 and 52 MHz at 1.2V.
- H. Generates a 1.2V reset signal.
- Trigger in to the analyzer. ١.
- J. Trigger out from the analyzer.
- K. Ground

Connectors are SMP male for Falcon G300B/G400B and Raptor M300/M400 and SMA female for Falcon G300/400.

NOTE: use of connector savers on the instument front panel SMP connectors is strongly recommended to avoid damage to the connectors. See THIRD PARTY ACCESSORIES for recomended connector saver accessories.



## Exerciser/Analyzer front panel - Falcon G350B/G450B



Front panel connectors:

- A. Connect the TxDN and TxDP from device M-Tx lane 1 here.
- B. Connect the TxDN and TxDP from device M-Tx lane 0 here.
- C. Connect the RxDN and RxDP from device M-Rx lane 1 here. This is used for the <u>analyzer</u> only, for the Exerciser these connectors are not used.
- D. Connect the RxDN and RxDP from device M-Rx lane 0 here. This is used for the <u>analyzer</u> only, for the Exerciser these connectors are not used.
- E. Connect to the RxDN and RxDP from device M-Rx lane 1 here. This is used for the <u>exerciser</u> only, for the analyzer these connectors are not used.
- F. Connect to the RxDN and RxDP from device M-Rx lane 0 here. This is used for the <u>exerciser</u> only, for the analyzer these connectors are not used.
- G. Generates a UFS reference clock on 19.2, 26, 38.4 and 52 MHz at 1.2V.
- H. Generates a 1.2V reset signal.
- I. Trigger in to the analyzer.
- J. Trigger out from the analyzer.
- K. Ground

Connectors are SMP male for Falcon G350B/G450B and SMA female for Falcon G350/450.

NOTE: use of connector savers on the instument front panel SMP connectors is strongly recommended to avoid damage to the connectors. See THIRD PARTY ACCESSORIES for recommended connector saver accessories.

## Side panels

#### Right - Falcon G300B/G400B and Raptor M300/M400



The Thunderbolt 3 connectors, which are USB Type-C connectors, do not support USB3.0.





The Thunderbolt 3 connectors, which are USB Type-C connectors, do not support USB3.0.

The power connector type is IEC, center pin is +12V.

#### Rear - Falcon G300B/G400B and Raptor M300/M40



The power connector type is IEC, center pin is +12V.

#### Licenses available

#### Full

<u>Instruments shipped after December 8, 2017</u> utilize an embedded HW key and no SW license is required. This key is configured at the factory, floats with the instrument and works with any PC.

<u>Instruments manufactured before December 8, 2017</u> require a SW license key to enable the appropriate capabilities, which is available from <u>support@protocolinsight.com</u>. SW license keys are node-locked to the controller PC and are not transferable.

#### Offline

If the application software is launched with no SW or HW key present, the application will enable Offline-only capabilities.

When Offline the user can open previously saved trace files to analyze the trace. The analysis windows available in Offline include the list, protocol decode and events windows. Offline-only does not enable the Trace Validation Results window or Trace Validation Editor.

#### Offline Viewer with Trace Validation and TV Editor

This license is a SW license available from <u>support@protocolinsight.com</u>. SW license keys are node-locked to a PC and are not transferable. *Offline with TV and TV Editor* operates like the standard Offline but enables the Trace Validation Results window and TV Editor to create custom TV tests.

#### Offline Viewer with Trace Validation and all Editors

This license is a SW license available from <a href="mailto:support@protocolinsight.com">support@protocolinsight.com</a>. SW license keys are node-locked to a PC and are not transferable. *Offline with TV and all Editors* operates like the standard Offline but enables the Trace Validation Results window plus all Editors, including the TV, advanced trigger and stimulus Editor.

## Options and Upgrades

Contact your local representative for list of available instrument SW/FW upgrades.

Ac	cessories	
	FG4PSD2B	x2 Bundle - 2 Pigtail cables with power connectors and probe tips
	FG4PSD3	Multi-Lead Pod option - Multi-Lead Pod, Carlisle cables, SSMP-to-SMP cable pairs
	FG4PSD2	x2 Bundle - Multi-Lead Pod, Carlisle cables, SSMP-to-SMA cable pairs, probe tips
	FSWOVTVE	Offline Viewer with Trace Validation and TV Editor
	FSWOVTVEDITORS	Offline Viewer with Trace Validation and all Editors
	EnhanceConn	Enhanced connectivity kit –TB3 6ft/2m 40Gbps active cable and retention device
	FAECase	Field carry bag

#### Third party accessories

The following accessories are available from third party suppliers:

- Connector savers: Adapter Coaxial Connector SMP Plug, Male Pin To SMP Jack, Female 50 Ohm Amphenol SV Microwave 1112-4012 CONN ADAPT PLUG-JACK SMP 50 OHM ADAPTER COAXIAL CONNECTOR or equivalent
- SMP-to-SMA cables: ≥18GHz, ≤225mm/9" length, phase-matched Centric RF C572-086-09B or equivalent
- SMA to SMA cables: ≥18GHz, ≤225mm/9" length, phase-matched Centric RF C581-086-09 or equivalent
- Power splitter, DC-18 GHz Mini-Circuits ZFRSC-183-S+ or equivalent

# Probing Configuration Options

Depending on the application, analyzer or exerciser/analyzer, there are several different recommended probing options for connecting to the DUT provided below.

Analyzer Solder-down x1 link shown



# Splitters

Off-the-shelf power splitters such as the Mini-Circuits DC-18 GHz ZFRSC-183-S+ can be used with standard SMP to SMA cables of ≥18GHz and maximum of 12 inches in length. Each link requires four power splitters and 12 cables as shown in this x1 link example:



## Breakout DUT

50% split = 16.7 ohms resistor



#### Interposer





#### Exerciser

Direct connection



# Setup and Operation

# General Instrument Configuration

All general instrument, device and user preference settings can be accessed from either the Settings menu

or by clicking from the toolbar. See SETTINGS WINDOW for information on how to change general settings.

### Analyzer Configuration

To configure for general debug analysis or for Trace Validation follow these steps:

#### Step 1: Connect the probes

Note: the labels on the analyzer front panel are from the instrument perspective.

- 1. Connect the Sublink 0 Rx\_1N to TxDN from the device M-Tx lane 1.
- 2. Connect the Sublink 0 Rx\_1P to TxDP from the device M-Tx lane 1.
- 3. Connect the Sublink 0 Rx\_0N to TxDN from the device M-Tx lane 0.
- 4. Connect the Sublink 0 Rx\_0P to TxDP from the device M-Tx lane 0.
- 5. Connect the Sublink 1 Rx\_1N to RxDN from the device M-Rx lane 1.
- 6. Connect the Sublink 1 Rx\_1P to RxDP from the device M-Rx lane 1.
- 7. Connect the Sublink 1 Rx\_ON to RxDN from the device M-Rx lane 0.
- 8. Connect the Sublink 1 Rx\_OP to RxDP from the device M-Rx lane 0.

See **PROBING CONFIGURATION OPTIONS** for more information on how to connect to the DUT.

#### Step 2: Configure the analyzer

- 1. Select Analyzer mode on the toolbar (G350B/G450B only)
- 2. Under Instrument Configuration select the desired memory Capture Options.
- 3. Under Instrument Configuration set the Connected Link Width for each direction to x1 or x2.
- 4. Under User Preferences determine if UFS packets are decoded when the trace capture is complete.

#### Step 3: Capture the trace

- 1. Configure the trigger from the Tools menu if desired.
- 2. Press Analyzer Connect, then Start, and capture the trace.

#### Step 4: Configure and run Trace Validation tests

- 1. Go to the TV Configuration window.
- 2. Select which Trace Validation Tests to run.
- 3. Press the Start button and watch the TV Results windows fill with Pass, Fail, Warning, or Info results.

#### Exerciser Configuration (G350B/G450B only)

To configure for compliance/conformance (CTS) testing, corner case, margin or automated stress testing follow these steps:

#### Step 1: Connect probes

Note: the labels on the analyzer front panel are from the instrument perspective.

- 1. Connect the Sublink 0 Rx\_1N to TxDN from the device M-Tx lane 1.
- 2. Connect the Sublink 0 Rx\_1P to TxDP from the device M-Tx lane 1.
- 3. Connect the Sublink 0 Rx\_0N to TxDN from the device M-Tx lane 0.
- 4. Connect the Sublink 0 Rx\_0P to TxDP from the device M-Tx lane 0.
- 5. Connect the Sublink 1 Tx\_1N to RxDN from the device M-Rx lane 1.
- 6. Connect the Sublink 1 Tx\_1P to RxDP from the device M-Rx lane 1.
- 7. Connect the Sublink 1 Tx\_0N to RxDN from the device M-Rx lane 0.
- 8. Connect the Sublink 1 Tx\_OP to RxDP from the device M-Rx lane 0.
- 9. Connect the UFS RST\_N to the DUT reset signal
- 10. If desired, connect the UFS REF CLK to the DUT ref clock input.

See **PROBING CONFIGURATION OPTIONS** for more information on how to connect to the DUT.

#### Step 2: Configure the exerciser/analyzer

- 1. Select Exerciser + Analyzer or CTS mode on the toolbar
- 2. Under Instrument Configuration select the desired memory Capture Options.
- 3. Under Instrument Configuration set the Connected Link Width for each direction to x1 or x2.
- 4. Under User Preferences determine if UFS packets are decoded when the trace capture is complete.

#### Step 3: Configure Device Under Test

- 1. Default device values are pre-set for the DUT in the Device Configuration tab of the Settings window. Update the Device Configuration values for any settings that are unique to your device, see APPENDIX D: DISCOVERING UFS DEVICE CONFIGURATION VALUES for more information.
- 2. A UniPro and/or UFS link connection between the exerciser and DUT is required for the exerciser to perform compliance/conformance (CTS) testing, corner case, margin or automated stress testing. Press the "Boot" button in the tool bar to boot the DUT. If UniPro is the Default Protocol in Settings->User Preferences->Display Preferences or is the selected Protocol in the Device Control section of the Configuration windows pressing "Boot" will initiate the Link Startup Sequence. If UFS is the selected protocol a boot will be completed including UniPro LSS and UFS.

#### Step 4: Configure tests

- 1. Go to the CTS Configuration or Exerciser & TV Configuration window.
- 2. Select which Speeds, Link Widths and other device configurations to test. If testing UFS the appropriate LUNs must be selected.
- 3. Select which test Categories and Tests to run.

#### Step 5: Configure stress testing

Test Run Order controls the order in which tests are executed.

1. **Loop Order:** loop order specifies the nested order of test execution. Tests will be run from the bottom up, with all tests in each loop executed before the next higher loop is begun. So, if the Loop Order is Speeds, Link Widths, Tests then all Tests will be completed for a Link Width before

being executed for the next Link Width, etc. The loop order can be adjusted by dragging categories up or down in the Loop Order box.

2. Ascending, Descending, Random Seed: this specifies which order the tests are executed within the Loop. If Random Seed is selected a value can be entered to generate a random but reproducible test order based on the seed value.

#### Step 6: Configure Run Control

Test Run Control specifies the number of iterations of the test configuration to run, dictated by Test Run Order. Test execution will stop after the specified Number of Loops (outer loops on Test Run Control) or No Result Test Cases have occurred.

The user can specify the number of test configuration loops to run OR the number of No Result Test Cases to allow before terminating the test run. When Number of No Result Test Cases field is blank or 0, tests are run for the given number of loops. If values are provided for both conditions, then tests are run until any ONE of the conditions is met.

#### Step 7: Run the configured tests

Press the Start or Start CTS button to run the configured tests, and watch the Results windows fill with Pass, Fail, Warning, or Info results.

# Running concurrent instances of the application software

Two instances of the application software can be used concurrently, however only one instance of the application can communicate with the analyzer hardware at a time. If you attempt to start more than two instances of the application software concurrently you will see a message box informing you that only two concurrent instances are supported.

When a second instance is started it will show "OFFLINE" in the title bar and its Connect button will be disabled. If you close the first instance, which has the Connect button enabled, the second instance remains an OFFLINE instance and to Connect to hardware you will need to start another instance to enable the Connect button.

You can also start the application software by double-clicking on an \*.pitx configuration file. If an application is already running, it will start a second instance which will load the configuration file.

You can load the same \*.pitx file in two instances and, for example, view different areas of the trace sideby-side in the two instances.

# Navigating the User Interface

## Tool Bar

1.	Mode select	2. Start/Stop TV/TE	3. Instrum status/set	nent tings	Trigge Filter	er r	3. Instrur contro	nent ol 4. DU1	status/co	ntrol	5. Applie	cation SI	tatus bar	Ар	olication	Status	Can	cel
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			Trace Validat	tion Results	Traffic Overv	view Stim	ulus Results							12	PAPor	verModeUserE	lata[2]	
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			B2		1150 Su	iblink1 6	5.169753300000	s	PACP_PWR_re	eq	PWM-G1 x1	NONE		0x0000	0010 ff	""""	H H H	
					1151 Su 1152 Su	blink1 6 blink0 6	5.170029006000	s Prepare	Filler (157X)	_	PWM-G1 x1	NONE		0×0000	0010 fe	43		
	✓ X1	X2			1153 Su	blink0 6	5.170038484000	s Burst			PWM-G1 x1	NONE		CAUGOO C				
	Validation Setting	s			1154 Su	blink0 6	5.170038484000	Start Of Burst/Desker	v		PWM-G1 x1	NONE						
	Debug Enabled				1155 Su 1156 Su	blink0 6 blink0 6	5.170040856000	s PACP PWR cnf			PWM-G1 x1 PWM-G1 x1	NONE						
	- beolg chabled				1157 Su	blink0 6	5.170083552000	s Filler (448x)			PWM-G1 x1	NONE						
	Tests All TV	Stim		_	1158 Su	blink1 6	5.170326298000	S	End Of Burst	GT	PWM-G1 x1	NONE	, ř					
					Product 1 tot		ure pure							Ln 0	0 KB (34 By	tes) 8 🔨	Bytes per lin	ne
		>	UniPro Pack	et List UFS	Packet List	UniPro Eve	ents OFS Event	s										

The tool bar allows selection of analysis view modes and run control for the test executive and the analyzer and status update information:

Modes (1) allow the user to select a set of three pre-defined windows based on the instrument configuration and type of analysis being conducted (see WINDOWS below).

Start (2) initiates Trace Validation or test case execution for the selected tests.

Instrument status/settings and control (3) displays the status of the instrument hardware and software connection, various settings and starts and stops trace capture.

Instrument status:

Red = software application is not connected to instrument hardware and the software is offline.

Yellow = software application is connected to the instrument hardware and the software is online.

Green = the instrument is connected and capturing traces.

Clicking on the Trigger or Filter buttons will open the Trigger Setup and Filter windows.

By clicking Connect the software will initiate connection with the hardware and go online.

Clicking Start or Stop will begin or end a trace capture.

Settings (3) configures user preferences, the instrument hardware, and the device under test (G350B/G450B only). Settings can also be accessed from the menu.

The DUT status/control (4) indicators show the status of the DUT. One indicator is used for each direction of a link, so a x1 link will show two indicators and a x2 link will have four indicators. Indicator colors are as follows: grey = not connected, yellow = device operating at PWM speeds, green = device operating at HS speeds. Clicking Boot will initiate a UniPro or UFS boot of the DUT.

The application status bar (5) indicates progress during common activities such as file open/save and test case execution.

Clicking the blue info icon on the right side will open the APPLICATION STATUS window.

User Preferences	Instrument Configuration	Device Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings	
Analyzer – License: 8	GB Memory and x	2 Link Width					Reset Ana	alyzer
Host Sublink Connect Lane 0 r Lane 1 r	0 Label: ted Link Width: naps to Analyzer C naps to Analyzer C	Host hannel: hannel:	x1   * 0   * 1   *	Device – Sublink 1 Connecto Lane 0 m Lane 1 m	l Label: ed Link Width naps to Analy: naps to Analy:	Device 22 Channel: 22 Channel:	x1 0 1	× ×
Capture Capture Instrum Disk Bul When D	Options Type: ent Memory Depth ffer Limit (300 GB N iisk Buffer Full:	(8 GB Max): 1 (ax): 1 S	treaming MB 024 MB top Capture	<b>•</b>		Streamin	ng Performance	Test
Initial Powe Host Speed: Link Wid Initial Scra Initial Rate	r Mode dth: mbling: e Series: B   ~	PWM-C	i1   *   *	Device – Speed: Link Wid	th:	F	PWM-G1 1	► ►
Other Settin Output Cl	ngs ————————————————————————————————————	19.2 MHz	Apply Initial I	Power Mode Exerciser H	ISG4 ADAPT 1	Type: No AD	DAPT V	
Rate Serie Restore Fa	s: actory Settings in T	Auto 🛛 🍸	Save Save	Sync Lengt as Default	h Filter: Load	min Load Defa	¥	
Restore Fa	actory Settings in A	ll Tabs			[	ОК	Apply	Cancel

Pressing cancel will stop any background

processes being performed, such as calculating Traffic Overview or Events, and can cancel test executive and trace validation execution.

**Custom toolbars** can be added to the main application, see **USER TOOLBAR TAB** for more information. Custom toolbars are added to the row below the factory default toolbar:



#### Windows

Selection of one of three display modes (1 above), Analyzer, CTS, or Exerciser + Analyzer, will activate a set of pre-defined windows:

**Analyzer mode** will open the Trace Validation Results and Traffic Overview windows, UniPro and UFS Packet List and Events windows, TV Configuration, Packet Decode and Data View. Instrument Status is positioned on the right side as a tab, and Simple Packet Search is a tab on the left side.

**CTS mode** opens the TV Results and Traffic Overview windows, the Packet List and Events windows, and Packet Decode and Data View. It also opens the CTS Configuration window to set up and run CTS test cases. Available for the G350B/G450B only.

**Exerciser + Analyzer mode** opens the TV Results and Traffic Overview windows, and the UniPro and UFS Packet List and Events windows, Packet Decode and Data View. It also opens the Stimulus Results and Exerciser & TV Configuration windows. The Exerciser & TV Configuration window provides access to all configuration settings and the permits the running all tests, including differing stimulus and Trace Validation tests, in one single test run. This can result in the creation of one test result trace file with many types of link traffic. Available for the G350B/G450B only.

File Test	Results Reports View Analyzer Control To	ools Help										
Mode: E	Exerciser + Ana 👻 📄 Start	Analyzer 😑 🔅	Conn	ect Sta	rt	Host Core Boot	n File Finished!					
A	Inalyzer				× 1	v						
Exert C	TS on 🗘 🗘 🗴	Trace Validation Resu	ilts					# ×	Packet De	code	- 4	- A Str
- B	xerciser + Analyzer	Test Name *	Test ID					Î	Packet: 32,	Host, READ (10) DA	A (D 8 16 32	Iner
cket	Initiate Reboot Device Up Every Run		lest ID						Byte			A state
Se Pre	otocol	Status T	est ID	Test Name		Rule		Inde		Transaction	Elage (Received)	atus
r G	UniPro UFS	<ul> <li>A Test Name:</li> </ul>	AFC Sequ	ence Numb	er Order (14	48 items)				)) 0x22	0x00	
		👻 🗹 Test Name:	AFC with	CReq Set (8	items)			11		LUN	Task Tag	
🔪 Те	est Run Order	<ul> <li>Test Name:</li> </ul>	Check for	Packet Erro	ors (1 items)					0x00 Received (bute 4)	Ox1F	
~	Test Run Control	<ul> <li>A Test Name:</li> <li>A Test Name:</li> </ul>	Data Fran	aits (16234: ne TCO Sequ	s items) ience Numb	pers (5 items)				0x00	0x00	
	lest Kun control	<ul> <li>X Test Name:</li> </ul>	Link Start	up Sequenc	e (9187 iten	ns)				Reserved (byte 6)	Reserved (byte 7)	
- C	Transmission Mode	Test Name:	NAC Tran	smission Di	sabled (2 ite	ems)				0x00	0x00	
	Conception and the second se	Test Name:	PACP_GE	req (1 iten	ns)					0x00	0x00	
	Scrambling	<ul> <li>X Test Name:</li> </ul>	PowerMo	_req (550 li deChange (	594 items)					Data Segm	ent Length	
· C	Rate Series	<ul> <li>✓ Test ID:</li> </ul>	25 (6 item	s)						0x4	000	
			5	PowerModeC	Change	Found a PACP_PWR_req		115		Ox0	000	
L	Traffic Class		- -	PowerModec	.nange 	PAPC_PWR exchange success		116 *		Data Buffer	Offset [15:0]	
<b>√</b> 1	TC0 TC1									Ox0	000	
	- General	Test Cases Complete	:d: 434	Passed: 1	75 Fa	ailed: 259 Timeout: 0				Data Iransfer 0x0	000	
î L	Speed	Trace Validation Resu	Its Traffic	Overview St	imulus Result	5			18	Data Transfer	Count [15:0]	i 🕶
✓ P	PWM G1 PWM G2	UPP Product Upp							Detection			
P	PWM G3 PWM G4	UPS Packet List	anuanza M	umber Order	14				Data view	,		-
	HS G1 HS G2	Test case. The Arc 3	equence is	under order,		1				00 01 02	03 04 05 06	07
	45 G3	B1 B2 In test	Index	Direction	Time	Host	Device	Ê	0x00000			00
			55	Sublink1	14.13229	READY TO TRANSFED	WRITE (10)		0x00000			00
~ C	Link Width		57	Sublink0	14.50534	READT TO TRANSFER	WRITE (10) DATA (DATA OUT)		0x00000	0010 00 00 40	00 00 00 00	00
Z X	(1 <b>x</b> 2		58	Sublink0	14.52061	RESPONSE			0x00000	018 00 00 00	00 00 00 00	00
			59	Sublink1	14.91565		READ (10)		0x00000	1020 46 d9 8d	a2 52 3d 5a	77
<u>^</u> ∨a	alidation Settings		60	Sublink0	14.91625	READ (10) DATA (DATA IN) RESPONSE		_	0x00000	0028 89 0a f6	cc fd 16 26	ed
De	ebug Enabled		62	Sublink1	18.82749	TEST STIDE	READ CAPACITY (10)		0x00000	0030 5f ad 05	3b 87 d4 ad	41
			63	Sublink0	18.82800	READ CAPACITY (10) RESPONSE (DATA I			0x00000	1038 E0 bb 3d	bb 49 73 67	ec
<b>Λ</b> Τ	Tests All TV Stim		64	Sublink0	18.82800	RESPONSE	READ (10)		0×00000	040 C9 46 SI	05 80 20 45	91
	Filter Linked Tests		05	Sublink I	19.20033	DEAD (AD) DATA (DATA IN)	READ (TO)	, ř		1040 10 6a 05	u, 21 00 01	
	11.76 AVA.W. 1.A							<u> </u>	Ln 0	16 KB (16,416 Byte:	s) 8 👶 Bytes	per
	>	UniPro Packet List	JFS Packet	List UniPro E	vents   UFS E	events						

Figure 1: Exerciser + Analyzer window layout

All windows are dock-able inside or outside of the application framework, using standard docking paradigms. Windows can be restored to the default mode configurations by selecting View->Restore Default Layout from the main menu.

#### Configuration window – Analyzer mode

#### Device Control

**Protocol:** Selecting either UniPro or UFS Protocol determines which tests are listed in the Tests section below. This also dictates the action of the Boot button on the toolbar.

#### Validation Settings

**Debug Enabled:** turns on Trace Validation test debugging. Messages that are generated by the Trace Validation test are output to the Trace Validation Results window to help users track progress in the Trace Validation analysis. See Debug under INTERPRETING TRACE VALIDATION RESULTS for more information.

#### Tests

Select the test cases to be executed. The following test categories are available for execution in Analyzer mode:

**UFS CTS Test Cases:** The Test Cases in this category verify compliance to the UFS CTS. A Trace Validation result of "Pass" indicates the DUT meets the CTS Test Case criteria. In Analyzer mode these tests are run as Trace Validation tests against existing traces.

**UFS Debug:** This category contains general UFS debug tests.

**UniPro CTS Test Cases:** The Test Cases in this category test the DUT for compliance to the UniPro CTS. A Trace Validation result of "Pass" indicates the DUT meets the CTS Test Case criteria. In Analyzer mode these tests are run as Trace Validation tests against existing traces.

**UniPro Debug:** This category contains debug test cases to check UniPro behavior. For example, to verify that the Link Startup Sequence ran correctly.

**Search TVs:** These Trace Validation tests can be used to search a trace for specific conditions. The application software library includes three search TVs, "Find UniPro Error Packets", "Find UFS Error Packets" and "Find Protocol Insight CTS Markers".

**Advanced Trigger Offline TVs**: Advanced Triggers that have been defined with Test Editor can be run against any previously captured trace to find trigger events in existing traces, or to test newly constructed advanced triggers. If no Advanced Triggers have been defined this category won't appear.

*Custom Tests*: Custom test directories are displayed in *italics* at the bottom of the list; with Trace Validation custom tests shown in Analyzer mode. If no custom test cases exist in a directory the directory will not be displayed. The tests listed can be refreshed from the File menu as new custom test case are created.

#### Configuration window – CTS mode

Available for the G350B/G450B only.

#### Device Control

**Initiate Reboot Device Up Every Run:** If this box is checked, the reset line (see line 9 of **STEP 1: CONNECT PROBES**) is asserted and a UFS boot and/or UniPro Link Startup Sequence is executed before every test case. This should be used for early testing to verify the tests work with a known device state, once this has been verified it is recommended to deselect this option.

**Protocol:** Depending on this selection, the test list in the Tests section of the Configuration windows is filtered for UniPro or UFS tests and the Configured LUNs section is hidden or displayed for device and run control choices.

This selection also controls the action of the Boot button in the tool bar. The Boot button will either boot the device through LSS if UniPro is selected, or to UFS if UFS is selected.

The primary (default) protocol for this selection can be set in Settings->User Preferences->Display Preferences

#### Test Run Order

Control the order in which tests are executed. Run order is specified by Loop Order in Ascending, Descending, or Random Seed order. See STEP 5: CONFIGURE STRESS TESTING for more information.

#### Test Run Control

Specify the number of test cycles of the test configuration to run. Test execution will stop after the specified number of full test loops (outer loops on Test Run Control) or No Result Test Cases have occurred. See **STEP 6: CONFIGURE RUN CONTROL** for more information.

#### Transmission Mode

Controls Auto/NonAuto power modes during Test Run operation.

#### Scrambling

Enable or disable data scrambling during Test Run operation.

#### Rate Series

Enable or disable Rate Series A and/or B.

#### Traffic Class

Only TCO is supported during Test Run operation.

#### Configured LUN

If UFS Protocol is selected under Device Control in the Configuration windows or as the Primary (default) Protocol in Settings->User Preferences->Display Preferences, this section will be visible and is used to choose the Configured LUNs to control and test with test executive Run Control.

All UFS tests in the Configuration windows are associated with a LUN. The tests that have a LUN value of 255 correspond to the NONE (LU agnostic) selection in the Configured LUN selector. For requests that do not target a specific LUN (e.g. a Query Request with the Read Descriptor Opcode) the NONE LUN is used.

The NONE (LU Agnostic) LU is specific to the Protocol Insight test Configuration windows, they aren't mentioned in the UFS spec. Since every test is associated with a LU this is how to define a test that is LU agnostic.

#### Speed

Configure the speeds to be tested.

#### Link Width

Configure the link widths to be tested. UniPro and UFS widths up to x2 are supported.



#### Validation Settings

**Debug Enabled:** turns on Trace Validation test debugging. Messages that are generated by the Trace Validation test are output to the Trace Validation Results window to help users track progress in the Trace Validation analysis. See Debug under INTERPRETING TRACE VALIDATION RESULTS for more information.

#### Tests

Select the CTS test cases to be executed.

#### Configuration window - Exerciser + Analyzer mode

Available for the G350B/G450B only.

This configuration window replicates all the functionality of the **CONFIGURATION WINDOW – CTS MODE**, with the following additions to the Tests section:

#### Tests

The list of available tests can be filtered:

Selecting "All" will display all tests in the list, including Stim, TV and CTS tests. The type of test is identified by an icon as either a legacy Stimulus Builder test with a red  $^{S}$ , a Stimulus Test Editor test with an orange  $^{S}$ , a Trace Validation test  $^{TV}$ , or a test containing both Stimulus and Trace Validation  $^{TS}$ .

Selecting All permits the running of all tests, including differing Stimulus and Trace Validation tests, in one single test run, resulting in the creation of one trace result file with many types of link traffic and analysis.

Selecting "TV" will display only Trace Validation tests.

Selecting "Stim" displays only stimulus tests.

**Filter Linked Tests:** Checking the "Filter Linked Tests" box when All is selected will filter the list and only display those tests that include both a Stim and associated TV test. Tooltips identify the Stim test linked to each TV test listed.

Depending on the display mode selected the following test categories and tests may be available for execution in the Tests section:

**UFS CTS Test Cases:** The Test Cases in this category test the DUT for compliance to the UFS CTS. Execution of the linked Stimulus with a Trace Validation result of "Pass" indicates the DUT meets the CTS Test Case criteria.

UFS Debug: This category contains general UFS debug tests.

**UniPro CTS Test Cases:** The Test Cases in this category test the DUT for compliance to the UniPro CTS. Execution of the linked Stimulus with a Trace Validation result of "Pass" indicates the DUT meets the CTS Test Case criteria.

**UniPro Debug:** This category contains general UniPro debug test cases to check UniPro behavior. For example, to verify that the Link Startup Sequence ran correctly.

**Search TVs:** These Trace Validation tests can be used to search a trace for specific conditions. The application software library includes three search TVs, "Find UniPro Error Packets", "Find UFS Error Packets" and "Find Protocol Insight CTS Markers".

**Advanced Trigger Offline TVs**: Advanced Triggers that have been defined with Test Editor can be run against any previously captured trace to find trigger events in existing traces, or to test newly constructed advanced triggers. If no Advanced Triggers have been defined this category won't appear.

*Custom Tests*: Custom test directories are displayed in *italics* at the bottom of the list; if no custom test cases exist in a directory the directory will not be displayed. Depending on the display mode selected, Stimulus and/or Trace Validation custom tests will be shown. The tests listed can be refreshed from the File menu as new custom test case are created.

#### UniPro and UFS Packet List windows

The Packet List windows display all packets in a trace. If Trace Validation is used, clicking on a result in the Trace Validation Results window will position the cursor in the Packet List window on the packet of interest in the test sequence.

The information displayed in the Packet List can be changed by right-clicking in the column header bar and selecting different columns from the list available.

	In test	Packet	Index	Time	Time Relative Previous	Packet Name	Device	Host	Direction	Power Mode	Preempting	Gear	Link Width	Speed	MIBAttribute		COLT CDC 10
		32268	128034	909.140255053 s	698.133 us	End Of Burst		End Of Burst	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			CCIT CRC-16
		95766	128035	909.140922084 s	667.031 us	Start Of Burst/Deskew	Start Of Burst/Deskew		UP	PWM-G1 x1	NO	0x1	0x1	PWM			ConfigResultCode
		95767	128036	909.140924444 s	2.360 us	AFC TC1	AFC TC1		UP	PWM-G1 x1	NO	0x1	0x1	PWM			comgressiteoue
		95768	128037	909.140931524 s	7.080 us	AFC TC0	AFC TC0		UP	PWM-G1 x1	NO	0x1	0x1	PWM			Credit Value
		95769	128038	909.140990516 s	58.992 us	End Of Burst	End Of Burst		UP	PWM-G1 x1	NO	0x1	0x1	PWM			
		32269	128039	909.141134583 s	144.067 us	Start Of Burst/Deskew		Start Of Burst/Deskew	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			CReq
		32270	128040	909.141167511 s	32.928 us	AFC TC1		AFC TC1	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			Dect/CRectID For
		32271	128041	909.141200442 s	32.931 us	AFC TC0		AFC TC0	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			DesicFoltiD_Enc
81		32272	128042	909.141898576 s	698.134 us	End Of Burst		End Of Burst	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			DestDeviceID Enc
		32273	128043	909.325826308 s	183.927732 ms	Start Of Burst/Deskew		Start Of Burst/Deskew	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			bestberteelb_ene
82		32274	128044	909.325846068 s	19.760 us	PACP_SET_req		PACP_SET_req	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM	PA_TxTrailingClocks (		DevID
B2 = 909.32	5846068 s	70	128045	909.326163536 s	317.468 us	Start Of Burst/Deskew	Start Of Burst/Deskew		UP	PWM-G1 x1	NO	0x1	0x1	PWM			<b>D</b> I 4
B2 to B1 = 1	83.947492	2 ms /1	128046	909.326165892 s	2.356 us	PACP_SET_cnf	PACP_SET_cnf		UP	PWM G1 x1	NO	0x1	0x1	PWM		~	Direction
		95772	128047	909.326227121 s	61.229 US	End Of Burst	End Of Burst	Faul Of Puret	DOMIN	PWM-G1 x1	NO	0x1	0x1	PWM			FOM
		32275	128048	909.326544201 s	317.080 Us	End Of Burst		End Of Burst	DOWN	PWM-GTXT	NO	0x1	UXI	PWW			EOW
		22277	120049	909.3409824495	19,760.00	DACD SET rea		DACD SET and	DOWN	PWMPG1x1	NO	0x1	0x1	PININ	TV HE EVIC LENGT	~	Error
		95773	128051	909.341002205 s	201 786 ur	Start Of Buret/Dockow	Start Of Burrt/Dackow	rwor_aci_req	LID	PWM-G1 x1	NO	0x1	0x1	PIA/M	TX_H3_3TNC_CENGIN	1000	
		95774	128052	909 341296355 s	2 360 us	PACE SET onf	PACE SET onf		UP	PWM-G1 x1	NO	0x1	0x1	PWM			FCT
		95775	128052	909 341357662 s	61 307 us	End Of Burst	End Of Burst		UP	PWM-G1 x1	NO	0x1	0x1	PWM			<b>F</b> 1
		32278	128054	909.341700342 s	342.680 us	End Of Burst	and or barr	End Of Burst	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			Flags
		32279	128055	909.357781755 s	16.081413 ms	Start Of Burst/Deskew		Start Of Burst/Deskew	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			Frame Seg Number
		32280	128056	909.357801515 s	19.760 us	PACP_SET_reg		PACP_SET_reg	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM	PA_TxHsG1SyncLength		riane seq. Number
		95776	128057	909.358093224 s	291.709 us	Start Of Burst/Deskew	Start Of Burst/Deskew		UP	PWM-G1 x1	NO	0x1	0x1	PWM	- , ,	~	Gear
		95777	128058	909.358095584 s	2.360 us	PACP_SET_cnf	PACP_SET_cnf		UP	PWM-G1 x1	NO	0x1	0x1	PWM		-	
		95778	128059	909.358156887 s	61.303 us	End Of Burst	End Of Burst		UP	PWM-G1 x1	NO	0x1	0x1	PWM			GenSelectorIndex
		32281	128060	909.358499648 s	342.761 us	End Of Burst		End Of Burst	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			In And
		32282	128061	909.372845150 s	14.345502 ms	Start Of Burst/Deskew		Start Of Burst/Deskew	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM		~	In test
		32283	128062	909.372864910 s	19.760 us	PACP_SET_req		PACP_SET_req	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM	PA_TxHsG2SyncLength	1	Link Width
		95779	128063	909.373156534 s	291.624 us	Start Of Burst/Deskew	Start Of Burst/Deskew		UP	PWM-G1 x1	NO	0x1	0x1	PWM		188	
		95780	128064	909.373158894 s	2.360 us	PACP_SET_cnf	PACP_SET_cnf		UP	PWM-G1 x1	NO	0x1	0x1	PWM			MIBAttribute
		95781	128065	909.373220239 s	61.345 us	End Of Burst	End Of Burst		UP	PWM-G1 x1	NO	0x1	0x1	PWM			
		32284	128066	909.373563043 s	342.804 us	End Of Burst		End Of Burst	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			Mibvalue
		32285	128067	909.387912222 s	14.349179 ms	Start Of Burst/Deskew		Start Of Burst/Deskew	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM			Dealast
		32286	128068	909.387931978 s	19.756 us	PACP_SET_req	Sec. 012	PACP_SET_req	DOWN	PWM-G1 x1	NO	0x1	0x1	PWM	PA_IXHsG3SyncLength		racket
		95782	128069	909.588223648 s	291.670 us	Start Of Burst/Deskew	Start Of Burst/Deskew		UP	PWM-G1 x1	NO	0x1	UX1	PWWM		~	Packet Name
		95785	128070	909.388226005 5	2.337 US	End Of Runt	End Of Runt		UP	PWW-G1 x1	NO	0x1	0x1	PWM			
	<	30701	12007	505:300207334 S	01.529 US	End Of Burst	End Of Burst		UP	FWW-GTX1	NU	UXI	UXI	PWWW		~	Packet Type
																	PACP_FunctionId
																1	Power Mode
																1	PACP_Functionia

**Correlated views:** The Packet List views can be locked so that the active cursor correlates to the same packet in each view. Clicking the Lock icon in the upper right corner of a List view will lock all windows, and a "Correlated" bookmark will identify the active cursor in each window view.

UniPro Packe	et List								-	⊐ ×
Test Case:	() AFC	Sequence N	umber Order	; 14				(   T   🔊 🔤	All Test	â
Т	In test	Index	Direction	Time	Host	Device	Power Mode	Error	MIBAttrib	ite 个
		4028	Sublink1	20 17251		Filler (129v)	HS-G1B v1	NONE		
UniPro Packe	et List								-	⊐ ×
Test Case:	(i) AFC	Sequence N	umber Order	, 14				(  T   🔊 🗖	All Test	
Т	In test	Index	Direction	Time	Host	Device	Power Mode	Error	MIBAttrib	ite î
		4014	Sublink1	20.17148		Prepare	HS-G1B x1	NONE		
		4015	Sublink0	20.17148	Data Frame TC0		HS-G1B x1	NONE		
		4016	Sublink0	20.17148	Data Frame TC0		HS-G1B x1	NONE		
Correl		4017	Sublink0	20.17148	Data Frame TC0		HS-G1B x1	NONE		
		4018	Sublink0	20.17148	Filler (150x)		HS-G1B x1	NONE		
		1010		20.474.40	E LOCE I			NIGNE		

**Color Coded packets:** Common packet types in the list window are color-coded the same, for example, all End\_of\_Burst, PACP\_SET\_cnf or PACP\_GET\_cnf packets are of the same color. Color selections can be changed from the menu from Setting->Packet Display or by clicking the Settings icon on the toolbar.

All error packets are highlighted in red. For more info about error packets see "What is the difference between Symbol Errors in the Instrument Status window and red error packets in the UniPro and UFS Packet listing windows?" in the app note PDF "*App Note Tech Support FAQs*".

**Bookmarks** can be added to any packet in a Packet List or Event view window by right-clicking and selecting Add Bookmark. By right-clicking and selecting Edit Bookmark an existing bookmark can be renamed or given a different color.

Bookmarks can be used to add comments to traces in the Comments field. Comment are tied to a bookmark, which can be locked to a specific packet so it can't be moved. All comments in a trace can be viewed in the BOOKMARK LIST WINDOW; if the comment has multiple lines the full comment is displayed in the tooltip when hovering over the comment:

Create Marker	-		$\times$
Marker Text:			
Marker Color:			
User Lock:			
Comment:			
		С	ancel

Bookmarks       UniPro Time       UFS Time       Comment <ul> <li>Test UniPro</li> <li>S.10049477 s</li> <li>invalid</li> <li>This is a test UniPro comment</li> </ul> <ul> <li>B1</li> <li>S.38342754 s</li> <li>S.38342754 s</li> </ul> <ul> <li>Test UFS</li> <li>S.744387343 s</li> <li>S.744387343 s</li> <li>Test UFS comment</li> </ul> <ul> <li>B2</li> <li>6.100207912 s</li> <li>6.100207912 s</li> </ul> Name       UniPro Time Relative       UFS Time Relative       Comment	UniPro Time         UFS Time         Comment           Pro         5.10049477 s         invalid         This is a test UniPro comment           5.38342754 s         5.38342754 s         5.38342754 s           5.744387343 s         5.744387343 s         Test UFS comment           6.100207912 s         6.100207912 s         6.100207912 s
Name     UniPro Time     UFS Time     Comment       Image: Test UniPro     5.10049477 s     invalid     This is a test UniPro comment       Image: Test UFS     5.38342754 s     5.38342754 s       Image: Test UFS     5.744387343 s     5.744387343 s       Image: Test UFS     6.100207912 s       Image: Test UFS     6.100207912 s       Image: Test UFS     0.100207912 s	UniPro Time         UFS Time         Comment           Pro         5.10049477 s         invalid         This is a test UniPro comment           5.38342754 s         5.38342754 s         5.38342754 s           5.744387343 s         5.744387343 s         Test UFS comment           6.100207912 s         6.100207912 s         6.100207912 s
Test UniPro       5.10049477 s       invalid       This is a test UniPro comment         B1       5.38342754 s       5.38342754 s         Test UFS       5.744387343 s       5.744387343 s         Test UFS       6.100207912 s         B2       6.100207912 s         Name       UniPro Time Relative       UFS Time Relative	Pro       5.10049477 s       invalid       This is a test UniPro comment         5.38342754 s       5.38342754 s       5.38342754 s         5.744387343 s       5.744387343 s       Test UFS comment         6.100207912 s       6.100207912 s
B1       5.38342754 s       5.38342754 s         Image: Test UFS       5.744387343 s       5.744387343 s         Test UFS       6.100207912 s         B2       6.100207912 s         Name       UniPro Time Relative       UFS Time Relative	5.38342754 s       5.38342754 s         5.744387343 s       5.744387343 s         6.100207912 s       6.100207912 s
Test UFS         5.744387343 s         5.744387343 s         Test UFS comment           B2         6.100207912 s         6.100207912 s         6.100207912 s           Name         UniPro Time Relative         UFS Time Relative         Comment	5.744387343 s         5.744387343 s         Test UFS comment           6.100207912 s         6.100207912 s
B2 6.100207912 s 6.100207912 s Name UniPro Time Relative UFS Time Relative Comment	6.100207912 s 6.100207912 s
Name UniPro Time Relative UFS Time Relative Comment	
	UniPro Time Relative UFS Time Relative Comment
Test UniPro -999.713142 ms invalid This is a test UniPro comment	-999.713142 ms invalid This is a test UniPro comment
B1 -716.780372 ms -716.780372 ms	-716.780372 ms -716.780372 ms
Test UFS - 355.820569 ms - 355.820569 ms Test UFS comment	-355.820569 ms -355.820569 ms Test UFS comment

Hovering over a bookmark will display a tooltip indicating timestamp and delta time to other bookmarks. If **Zero Time Stamp Here** is selected, all timestamps are recalculated from the selected packet, with negative timestamps before and positive timestamps

B1 = 909.141898576 s B1 to B2 = 183.947492 ms

after that packet. Selecting Restore Original Time Stamp will reset the timestamps to the original values.

**Navigating a Packet List window** can be accomplished in several ways activated by rightclicking anywhere in a Packet List or Event window:

**Go To** permits navigation to Start of Trace, End of Trace, last packet or bookmarks.

	Add Bookmark	
Start of Trace	Go To	+
B1	Place Bookmark	•
B2	Goto Packet Index	
Correlated	Goto Packet Time	
Last Host Packet	Zero Time Stamp Here	
Last Device Packet		
End of Trace		

#### UniPro Events window

The UniPro Events window contains five panes, the Overview, Detail, Link, Lane and Sample panes, that allow drill-down from the full trace to the lowest level packet information:



#### Overview pane

The Overview pane, in the blue box, consist of two scatter charts (one for each direction) that represent each packet in the trace with its time position as a dot. Since there are usually more packets in a trace than horizontal pixels in the view, each dot in the view will usually represent multiple packets.



The numbers along the X-axis represent time since the beginning of the trace and each row along the Y-axis represents a set of packet types.

The top row is the Speed row and is always present when any packet is present. It is the only multi-color row, changing color when the speed changes. The speed colors are:

PWM-G0 x1

PWM-G0 x1, PWM-G0 x2, PWM-G1 x1, PWM-G1 x2

PWM-G2 x1

PWM-G2 x1, PWM-G2 x2

PWM-G3 x1

PWM-G3 x1, PWM-G3 x2

PWM-G4 x1

PWM-G4 x1, PWM-G4 x2

PWM-G5 x1

PWM-G5 x1, PWM-G5 x2

PWM-G6 x1

PWM-G6 x1, PWM-G6 x2

PWM-G7 x1

PWM-G7 x1, PWM-G7 x2

HS-G1A x1

HS-G1A x1, HS-G1A x2, HS-G1B x1, HS-G1B x2

HS-G2A x1

HS-G2A x1, HS-G2A x2, HS-G2B x1, HS-G2B x2

HS-G3A x1

HS-G3A x1, HS-G3A x2, HS-G3B x1, HS-G3B x2

HS-G4A x1

HS-G4A x1, HS-G4A x2, HS-G4B x1, HS-G4B x2

UNKNOWN

Unknown speed

The remaining rows are presented in this order:

BAD

DataFrame\_BadTC, AFCBadTC

NAC

NAC

DATA

DataFrame\_TC0, DataFrame\_TC1

PACP

PACP\_PWR\_req, PACP\_PWR\_cnf, PACP\_CAP\_ind, PACP\_CAP\_EXT1\_ind, PACP\_EPR\_ind, PACP\_TEST\_MODE\_req, PACP\_GET\_req, PACP\_GET\_cnf, PACP\_SET\_req, PACP\_SET\_cnf, PACP\_TEST\_DATA\_0, PACP\_TEST\_DATA\_1, PACP\_TEST\_DATA\_2, PACP\_TEST\_DATA\_3

AFC

AFC\_TC0, AFC\_TC1

TRG

TRG\_UPR0, TRG\_UPR1. TRG\_UPR2

Event

SOB, EOB, FLR, SKIP, PREPARE, SYNC, HIBERN8, BURST, SLEEP, STALL, LINE\_RESET, LINE\_CFG

End\_Of\_Trace

End of trace is marked with a white dot with a red border. There can be multiple End\_Of\_Trace events.

In the Overview pane there are 3 special markers, B, E, and C, which are drawn above each direction chart. The orange color of the B and E markers correspond to the range in the orange Detail pane (see red arrows below) while the C marker is always light blue. Hover over a marker to see its long name and time:

- B Begin Where the Detail pane Begins in the Overview pane
- E End Where the Detail pane Ends in the Overview pane
- C Center The location of the packet that is at the Center in all Event views

Bookmarks (e.g. B1 and B2) are drawn below each direction and tie to the same bookmarked packets in the other display windows. If additional bookmarks are added by the user, they will also be displayed in all Events panes. If you hover over a bookmark it will display its time and the time to other markers.

By clicking/dragging in the Overview pane or by moving the B/E markers or by selecting a button in the Zoom Tool Bar on the left the range that is displayed in the Detail pane below can be changed. The C marker moves to the center of the B/E range when you change the B/E range with any method:

UniPro Eve	ents								- ⊡ ×
*******	- Overview								^
Zoom	но	9.33184174919 s		10 B	2				250.0 s
S	s o Speed								
	t r								
<u> </u>									
Ð,		9.33184174919 s		100.0 :					250.0 s
Θ	DO			10 B	E F				250.0 s
	v e								
9	i r c v	<b>SS 1 = 1</b>							
*	e i				and the second se				
Zoom		B2	50.0 s				200.0 s		250.0 s
Mode	- Detail								
A	A-		102.0 s			105.0 s			108.0 s
ОL		•• •••	•••••						••
*	t a	1	*****	: :		• • • • • • • • • • • • • • • • • • • •	:	: :	•
Lanes			•••••						
Nav									108.0 s
	DD		102.0 s			105.0 s			108.0 s
		•• •••	•••••			•••••			• •
	c i	3• :::	••••••	: :		• • • • • • • • • • • • • • • • • • • •	:	: :	
1		•••••	•••••			•••••			• •
1									108.0 s
		101.0 s	102.0 s	103.0 s	104.0 s	105.0 s	106.0 s	107.0 s	108.0 s

#### Detail pane

The Detail pane is similar in appearance to the Overview pane, but it displays only the range currently selected in the Overview pane. It uses the same colors and row arrangement as the Overview pane. A dot typically indicates multiple packets of the type for the row, but you can zoom in to a point where a dot represents a single packet.



You can change the range that is displayed in the Link and Lanes panes, which are the panes below the Detail pane, by clicking/dragging in the Detail pane.

In the Detail pane there are 3 special markers, LB, LE and C. The LB/LE/C markers are not moveable. The yellow color of the LB and LE markers correspond to the range in the yellow Link pane below, while the C marker is always light blue. Hover over a marker to see its long name and time:

- LB Link Begin Where the Link pane Begins in the Detail pane
- LE Link End Where the Link pane Ends in the Detail pane
- C Center The location of the packet that is at the Center in all Event views

The range of packets that are displayed in the Link pane below is indicated by the yellow LB and LE markers and with an area of shading in the Detail pane.

mode	Detail								
A (	H D		102.0 s			105.0 s			108.0 s
$\bigcirc$	o e								
<u> </u>	t a								
*********		••••	- <b>•</b>	•		•••••			· · · ·
Lanes		•••••	•• •	•		•••••	•	• •	••
Nav									108.0 s
	D D		102.0 s			105.0 s			108.0 s
	e e v t =			•			•	• •	• •
	i a			•			•	• •	
	c i			: :		•••••	•	: :	
	e		<u> </u>						- T-\\
		01.0 s							108.0 s
S.	1.1								<u>k</u> =
	LINK			10					
<u> </u>	Packet Index	15798 (102 (15881 (102 79097	15919 (102 47670	161	169216161616991 (104 91616	16161717171717007 (105 62142	7190 (106 16960	17212 (106 817247 (107 15082	
¥	s N Speed	HS-G1B x1	15510 (105.47070	PWN	4-G1 x1	HS-G18 x1	11100 (100.10300	17213 (100.0117247 (107.15055	
	Packet Time								
Zoom	Event Time								
Mode	Markers			tC					
A	DL			LB	LĘ				
ÓL.	Packet Index	15807 (102.4 15889 (102.79199	15927 (103.47772	16 1	168111611616883 (104.816116	16 16 17 17 17 17 106 (105.62245	7188 (106.17062	17222 (106.8 17256 (107.15196	
· ·	i K Speed	HS-G1B x1		PWM-G1 x1		HS-G1B x1			PWM-G1 x1
********	<ul> <li>Packet Time</li> <li>Event Time</li> </ul>			Line Devel					Line Deept
Lanes	Markers			une-kesét					une-keset
Nav	indiker3								

#### Link pane

The Link pane creates an intermediate view between the Overview and Detail scatter charts and the bytedetailed raw Lane and Sample panes.



In the Link pane the X-axis is a modified time scale. A packet time may be so small in comparison to a Sleep that a true time scale for the packet would be less than a pixel in width, and the packet "rectangles" appear as a line with a minimum width. Events are shown on a separate row from Packets. Where possible, packets are grouped together to make a single rectangle. The tool tip for the rectangle shows the packets and time that the rectangle represents.

In the Link pane there are 3 special markers, LB, LE and C. The LB/LE/C markers are not moveable. The green color of the LB and LE markers correspond to the green Lane pane below, while the C marker is always light blue. Hover over a marker to see its long name and time:

- LB Link Begin Where the Lane pane Begins in the Link pane
- LE Link End Where the Lane pane Ends in the Link pane
- C Center The location of the packet that is at the Center in all Event views

The range of packets that are displayed in the Lane pane are indicated by the green LB and LE markers.

#### Lane pane

The Lane pane shows byte level detail for about 200 packets around the Center marker (fewer packets are displayed when the packets contain a lot of data). The X-axis is based only on the width of the displayed bytes, it is not time-based and the only time component is the displayed time.

The higher level panes in Events (Overview, Detail, and Link) display decoded packet data from the UniPro Packet List window. In contrast the Lane pane is built from the raw trace data.

The default Lane display interleaves the packets from the two lanes to show their time order. The X-axis is based only on the width of the displayed bytes, it is not time-based, and the only time component is the displayed time:

UniPro Ever	its		<b>▼</b> □	×
UniPro Ever Zoom	Lane - H L o A s N t E S U D L e A v N i E c S e	Packet Index Speed Packet Name Event Name State 0 Lane 0 Host State 1 Lane 1 Host Markers Interleave Packet Index Speed Packet Name Event Name State 0 Lane 0 Device State 1 Lane 1	437 (80.3)       1143911440 (80.3)       1144111456114601146111462 (80.7)       11463 (         -G1B x1       HS-GHS-G1B x1       HS-GHS-GHS-GHS-GHS-GHS-GHS-GHS-GHS-GHS-G	×
Lanes Nav		State 1 Lane 1 Device Markers	Hiber(Hiber)	×

Selecting the "Compress" button causes the display to redraw with no interleaving, and the "Compress" button becomes "Interleave":

UniPro Ever	nts					<b>-</b> □ ×
Zoom C C C C	Lane H L o A s N t E	Packet Index Speed Packet Name Event Name State 0 Lane 0 Host State 1 Lane 1 Host Markers	00 0x00 0x00 0x00 0x0 00 0x00 0x00 0x00	00 0x00 0x00 0x00 0x00 0 00 0x00 0x00 0	6189 (45.55         HS-G1B x1         Filler         0x00 MK0 0x0F FLR FLR 0x4A         0x00 0x21 0x8C FLR FLR 0x00	6191 HS-G1 End O FLR MK2 FLR FLR
Zoom Mode A L Lanes Nav	DL eA v A i E c S e	Packet Index Speed Packet Name Event Name State 0 Lane 0 Device State 1 Lane 1 Device Markers	4       6198 (45.55)         1       HS-G1B x1         Filler         Filler         6       0x41 FLR       FLR       0x6         0       0x5B       FLR       FLR       0x0	6199 6200 (45.55 HS-G HS-G1B x1 H End C Filler S 8 MK2 FLR FLR 0x40 0 MK2 FLR FLR 0x00 H	5201 6202 6203 6204 6205 (45.92 HS-G HS-G HS-G HS-G HS-G HS-G IB x1 Sleep Prepa Burst Sleep Prepa Burst MK0 FLR FLR 0 MK1 FLR FLR 0 Hiber Hiber	<ul> <li>6206 (4</li> <li>HS-G11</li> <li>Data Fr</li> <li>0x25 MK0 0</li> <li>0x00 0x07 0</li> </ul>

An analyzer sample is 64 bits and may contain a time stamp and status info or a delta time stamp, status info and 4 data bytes. Each delta time is added to the previous time to get the present time. The "State 0" and "State 1" rows indicate where full time stamps are in the trace. Hovering the cursor over a packet of interest could therefore provide the following information on that packet:

Γ <sup>Lan</sup>	ie –																
Н	L	Packet Index		6191 619	2 (45.55			6193 (	45.55								
0	A N	Speed		HS-G <sup>1</sup> HS-	G1B x1			HS-G1	B x1								
ť	E	Packet Name															
	S	Event Name		End O <mark>Fille</mark>	r			Sleep									
		State 0						Sleep/									
		Host	FLR	MK2 FLR	0x1F	FLR	0x00										
		State 1	FLR	FLR FLR	0x00	FLR	0x00	L Die eine									
		Lane 1						Hiberi									
		Host															
		Compress															
D e	L A	Packet Index	90 (45 55						6194	6195	6196	(45 59	5	6197	(45 55		6198 (
v	Ν	Speed	-G1B x1						HS-G1	HS-G	HS-G	1B x1		HS-G	1B x1		HS-G1
i	E	Packet Name												AFC T	C0		
e c	2	Event Name	epare						Burst	Start	Filler						Filler
		State U	epai						Burst								
		Device								MK0	FLR	FLR	0x04	MK0	0x0F	0x41	FLR
		State 1			One I	lot: C	)x01			К1	FLR	FLR	0x00	0xC3	0xD0	Ox5B	FLR
		Lane 1	ben		Hex:	0	xBC										
		Device			Samp	le: 14	1590 2105										
		Markers			_ Absol _ Valid:	1	5195										
			*		Packe	tTim	e[0]: <u>4</u>	5.55177	7624	s							>
					– Packe	tTim	e[1]: 4	5.55177	7632	s —							
B	1	B2 <			Samp	leTin	ne: 45.5	551777	624 s								

**One Hot** is present for K-Code bytes. It is the One Hot equivalent for the K-Code as defined in the spec.

Hex is the Hex value of the byte. K-Codes have both a One Hot and Hex encoding.

**Sample** The Sample Number is calculated in the Packet List View from binary trace data.

**Absolute** Is the Index in the UniPro Packet List that corresponds to the first two bytes in the sample. Most bytes do not correspond to the first two bytes of a packet, for example the data bytes in a data packet. These bytes have an Absolute of -1.

**Valid** Is the Valid status bits in the sample. They indicate the lanes where the 4 data bytes occurred. 4 in lane 0, 4 in lane 1, two in each lane, two in one lane and a repeat count. The lanes the bytes are in can be seen by the row where they are drawn. Repeat counts are drawn with a gray background.

**Packet Time** This is the time the packet starts in the UniPro Packet List and is equal to the time from full time stamps and delta times.

**Packet Time[0] Packet Time[1]** Sometimes a packet begins in the second two bytes in a sample. Then the time of the second packet is computed based on link speed.

**Sample Time** Is displayed when there are two Packet Times and is the time from the time stamps and delta times in the samples.

If you hover across a row of data bytes you will see the Sample number increment. You may see a case where a Sample number has been skipped between adjacent samples. This occurs when a time stamp carries the same status info as the previous sample. There is no change in the lane state so nothing appears in the Packet List for this sample.

#### Sample pane

The Sample pane shows byte level detail for the first 2 billion samples. The X-axis is based only on the width of the displayed bytes, it is not time-based, and the only time component is the displayed time. The packets in the two lanes are interleaved to show their Packet Index order.

The higher level panes in Events (Overview, Detail, and Link) display decoded packet data from the UniPro Packet List window. In contrast the Sample pane is built from the raw trace data.



#### UFS Events window

The UFS Events panes are very similar to the UniPro Events panes. See UNIPRO EVENTS WINDOW for more information. An important difference is that in UFS Events, each row represents a <u>single packet type</u>.

There are many possible packet types in UFS but in practice a trace tends to contain a subset of all the possible packets that could be displayed. By dragging the blue bar at the bottom of the Detail pane the scatter chart height can be increased to display more packet types.



The Detail pane is a zoomed view of the Overview chart that works just like the UniPro Events pane:


This chart is sized larger because packet level details will be more important to users in this view.

In both the Overview and Detail panes the packet colors are the same as in the UFS Packet List window and can be changed from the Settings menu:

User Preferences	Instrument Configuration	Device Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings
<ul> <li>UFS</li> <li>U</li> <li>U</li></ul>	Packets JFS SCSI JFS Protocol QUERY REQUEST QUERY RESPONSE ASK MANAGEMENT TO Packets 2 1.5 PHY TO Overview Colors AD JAC OATA ACP ACP AFC RG Vent Ind_Of_Trace TO Speed Colors actory Settings in T	r his Tab	Save Save a	s Default	Load	Load Defa	ult
Restore F	actory Settings in A	ll Tabs				ОК	Apply Cancel

The Link panes are similar to the Link panes in UniPro Events. The important difference is that rather than having an Events time row, they have either a Request or Response packet row, depending on direction:

Link				
н	L	Packet Index		111
0	1	Speed		HHF
5 +	K	Packet Time		
L.		Resp. Time		
		Markers	TETB2	
D	L	Packet Index		1-11
e	I	Speed		HHF
v i	K	Packet Time		
c		<b>Request Time</b>		
е		Markers	1C 1E1B2	

#### Packet Decode window

To display the protocol decode of a packet of interest in the Packet Decode window, click on the packet in the appropriate Results window or in a Packet List window. Hovering over a bit displays additional decode information. Selecting 8, 16, or 32 defines the bit width of the display.

### Data View window

The Data View window displays the entire packet, including header and payload for a selected packet. While the first 160 bytes of data are fully decoded in the Packet Decode window, the remainder of the packet payload is displayed in the Data View window only. Up to 16 bytes can be displayed per line.

By right-clicking anywhere in the Data View window the user can choose from several options to copy the data for pasting into other applications.

### Trace Validation Results window

Since CTS test cases use the Trace Validation engine for protocol sequence and packet inspection, the Trace Validation Results window is used in the Analyzer, CTS and Exerciser + Analyzer modes to display test or analysis results.

The TV Results window allows extensive quantitative analysis of results data. Results can be grouped and summarized, sorted, and filtered by any header column. To turn on or off a column, right click in the column header area.

Key words can be searched from the Search bar.

To group and summarize, click on any column header and drag into the Test Results field. This will summarize the results with an item count of occurrences.

Clicking on a TV Results message in the Results window will center that packet in the Packet List and Packet Decode windows for further analysis.



have Vali	dation P	Resulta									
Search (	(irht)										
Test Na	me	Test ID									
		_									
	S2a *	Last ID	Lest Name	Rule				Index	Speed	Gear	Link Wi
	lest Nar	we Are Sequ	ence Number Order (4 its	nine)		~	Siatus				
÷ 🛈 1	fest Nar	ne: AFC with (	CReq Set (1 items)			~					
- × 1	fest Nar	ne: Check for	Packet Errors (8 items)			~	Test Name				
÷ 🗊 1	fest Nar	ne: CheckGree	ats (1 items)			1					
- × 1	fest Ner	ne: CountMes	sages (2 items)			5	Index				
- × 1	fest Nar	ne: Data Fram	e TCO Sequence Number	is (6 items)		1	Sec.				
- ~ 1	tol Ner	ne.10 Throug	hput (1861 Rems)				apres -				
	✓ 1987	107 26 (1851 1	terns)	D			Gtar	10170			
	à	20	10 Throughput	Den	in Three dead Test	~	Link Width	65010	ME IN		
	- ă	20	10 Throughout	Date	Frank IR		Scrambling	65012	102		
	ě	25	IO Throughout	Inc	antaneous 944.444 Add Butes / ser		Transmission Mode	65812	HS.		
	- m	26	ID Throughout	600 800	KANK 1 BAR STR SAR Date / car		Protocol	65812	MC.		
	6		K) (houghout	Data	Frame UP			65814			
	- õ		ID Ihmughout	101	antzoeous 94444444 Relat / sec			05814			
	0		IO Throughout	ki.	erage: 1,416.666.666 Bytes / sec		Hate Series	65814			
	÷.		IO Throughput	Data	Frame UP:						
			10 Throughput		lantaneous: 937,931,034 Bytes / sec			65817			
	۲		IO Throughput		rage: 1,256,351,039 Bytes / sec						
			10 Throughput	Data				65819			
	0		IO Throughput		lantarreous: 944,444,444 Bytes / sec						
			IO Throughput		erage: 1,178,519,532 Bytes / sec						
			IO Throughput	Data	Frame UP:						
			ID Ihmughput		fantaneous 944,444,444 Bytes / sec						
	- Q		ID Throughput	AV	erage: 1,131.761,442 Bytes / sec			05821			
	<u> </u>		IO Throughput	Data	France UP:			65823			
	- Q		ID Throughput	las	antannous 1944,444,444 Bytas / snr			05874	214		
	-X-	20	to motghput	ku but	Stage: -1, 100,570,034 bytes / sec			65823	112		
	- 2	20	10 Throughput	Data	Manie OF: 027.031.024 Bits (			65034	MC N		
		20	10 Threadend	115	anter 1077 237 722 Bobs (1991			65034	110		
	- 0	25	IO Throughput	Data	France I IP			55356	HS		
	- m	25	IO Throughout	Data	antaneous 944 444 444 Evtes / sec			65056	HC		
	- Õ	25	ID Throughout	RV.	Prage: 1.060/658/578 Bytes / sec			65856	HS		
	0		ID Throughout	Data	Frame UP:			65853			
	•		ID Ihmughout	115	fantanaous 944,444,444 Bytes / sec			65866			
	(i)		ID throughout	RV	erage: 1,047,785,794 Wytes / sec						
			10 Throughput	Data	Frame UR:			65856			
			IO Throughput		tantanzous: 944,444,444 Bytos / soc						
			IO Throughput		erage: 1,037,447,988 Bytes / sec			65856			
	(D)		IO Throughput	Data				65059			
			IO Throughput		lantaneous. 937,931,034 Bytes / sec			65859			
	۰¢		IO Throughput		rege: 1,028,355,387 Bytes / sec			65859			
Test Cas	et Com	eleted: 74	Passed: 74	Faled: D	Timorut ()						

# Traffic Overview window

Traffic Overview offers a summary of all packets found in the trace. Any packet can be found by selecting that packet type in the Traffic Overview window, clicking on either Host, Device or Total, and clicking the up or down buttons to go to the next or previous packets, or <| and |> to go to the first or last packets.

### Stimulus Results window

The Stimulus Results window provides success/fail information on the stimulus test cases executed. This window does not display analysis results but only whether the stimulus test ran successfully. Information in this window is not saved with File->Save Configuration or File->Save Configuration/Analyzer Capture.

raffic Overview		Next	Instance: A				
LiniPro Packet Name		Hort	Total	1 LIEC Parket Name	Davica	Hort	Total
Data Frame TCO	1382	1229	2611	NOPOLIT	63	0	63
AFC TCO	911	1454	2365	TEST UNIT READY	272		272
AFC TC1	126	126	252	REGUEST SENSE	18		18
NAC	8			FORMAT UNIT	3		
Start Of Burst/Deskew	2134	1716	3850	READ (6)	10		10
TRG UPRO	441		756	INCURY	10		
TRG UPR1	630	40574	41204	START STOP UNIT	9		
TRG UPR2	6930	624	7554	SEND DIAGNOSTIC	3		
End Of Burst	441	1716	2157	READ CAPACITY (10)	10		10
End Of Burst GT	1683		1683	READ (10)	18		
PACP PWR reg	55		55	WRITE (10)	12	0	
PACP PWR onf	0			VERIFY (10)	4		
PACP CAP ind	63	63	126	PRE-FETCH (10)	5		
PACP CAP EXT1 ind	63			SYNCHRONIZE CACHE (10)	5		
PACP SET reg	126		126	MODE SELECT (10)	10		10
PACP SET onf	0			MODE SENSE (10)	31		
Filer	6683	3758	10441	REPORT LUNS	14		
Prepare	2130		3846	COMMAND UNKNOWN	2		
Hibern8	0			DATA OUT	1		
Burst	2134		3850	WRITE (10) DATA (DATA OUT)	9		
Sleep	2162	1796	3958	MODE SELECT 10 DATA (DATA OUT)	9		
Line-Reset	84			TASK MANAGEMENT REQUEST UNKNOWN	1		
End Of Trace	1			TASK MANAGEMENT REQUEST (Abort Task)	1		
				TASK MANAGEMENT REQUEST (Abort Task Set)	1		
				TASK MANAGEMENT REQUEST (Clear Task Set)	1		
				TASK MANAGEMENT REQUEST (Logical Unit Reset)	4		
				TASK MANAGEMENT REQUEST (Query Task)	1		
				TASK MANAGEMENT REQUEST (Query Task Set)	1		
				QUERY REQUEST (READ DESCRIPTOR)	15		
				QUERY REQUEST (WRITE DESCRIPTOR)	2		
				QUERY REQUEST (READ ATTRIBUTE)	5		
				QUERY REQUEST (WRITE ATTRIBUTE)	19		
				QUERY REQUEST (READ FLAG)	71		
				OUERY REQUEST (SET FLAG)	73		

#### Message Console

Messages generated by the NLog debug logging tool are automatically sent to the Message Console. These are the same messages that are stored to the NLog default log file at C:\Users\[user name]\AppData\ Local\Protocol\_Insight\Falcon\Temp\logs\ logfile.txt.

Messages output from Stimulus Editor can also display in the Message Console if implemented by the user.

The NLog messages can be disabled by unchecking "Show Log Messages".

# Simple Packet Search window

Simple Packet Search will search forwards or backwards on any sublink for any packet type, packet header or payload value. A gated search range can be created by positioning bookmarks in the trace and using the **From** dropdown under Search Options.

Select any active packet from the list in "Select Event for Search from this List" and use the Search Options

to navigate to packets that meet the search criteria. <u>Note:</u> until Traffic Summary calculation is completed Simple Packet Search cannot be used since the available packets will not be populated in the search list.

Double-clicking on the packet type of interest will bring up the Packet Editor (the same used for Simple Trigger) to edit the header or payload values to search for. These packet values can be saved as Favorite Packets for later re-use with either Simple Packet Search or Simple Trigger.

#### Bookmark List window

The Bookmark List window will display all bookmarks in the trace, with the timestamp, delta time to every other bookmark, and comments. Right clicking

Clear All	Sno	w Log Wessages			
earch		2	Show all messages writ	ten to the log file	
est Results	- drag a c	column here to gro	up results		
D	Status	Time	Source	Source Detail	Message
1	1	1/14/2020 9:48 A	M NLog	App.Main	Open Config and Trace C:\Us
	1	1/14/2020 9:48 A	M NLog	App.Main	Opening PITX file
3	1	1/14/2020 9:49 A	M NLog	UniProEventP	Index UniPro Events Device
4	1	1/14/2020 9:49 A	M NLog	UniProEventP	Index UniPro Events Host
		1/14/2020 9:49 A	M NLog	UniProEventP	Finish Index UniPro Events De
	1	1/14/2020 9:49 A	M NLog	UniProEventP	Finish Index UniPro Events Ho
7		1/14/2020 9:49 A	M NLog	PacketIndexer	Calculate UFS Traffic Overviev
	1	1/14/2020 9:49 A	M NLog	PacketIndexer	Finish Calculate UFS Traffic O
)		1/14/2020 9:49 A	M NLog	UniProEventP	Index UFS Events Device
<	-				>
Messages:	14	Info: 14	Warning: 0	Error: 0	
ace Valida	tion Result	ts Traffic Overview	Message Console	Bookmark List	



within the list will enable navigation to any bookmark in the trace. The Bookmark List window can only be accessed from Menu->View->Bookmark List.

### Trigger Setup window

The Trigger Setup window is accessed from the Tools menu. The Choose Trigger dropdown allows selection of different trigger actions.

**No Trigger** will cause the analyzer to continue to run until the Stop button is clicked.

Choose Trigger:	Use Advanced Trigger	Trigger Position: 50%				
Advanced Trigger	Trigger Immediate Use Simple Trigger —					
Refresh New	Use Advanced Trigger	Adva	nced Trigger L			
Reverse Pack	et Directions	Sta	ite 0: Advance			
Double-click or Dra	g Event to Trigger	If	Sublink			

**Trigger Immediate** will cause the analyzer to immediately start filling the capture memory and acquisition will stop when memory is full.

**Simple** and **Advanced Triggers** will monitor all sublinks for any packet type, packet header or payload value and trigger the analyzer to stop capturing when the trigger criteria are met.

The **Trigger Position** is used to set how much acquisition memory is reserved to save trace data prior to the trigger event vs. after the trigger event. If a 20% trigger position is set the analyzer will reserve 80% of the memory for post-trigger fill. This means that if the trigger occurs deep in the trace then 100% of the buffer will fill, 20% before and 80% after. But if the trigger event occurs very early in the trace, say after only filling 5% of the total memory, the capture will total less than 100% because 5% will be before the trigger and 80% after the trigger for 85% total.

#### Simple Trigger

To set a Simple Trigger select Use Simple Trigger from the Choose Trigger dropdown. Double click on the packet of interest from the left-side packet list and it will appear in the right-side "Trigger on any of these Events" area. Alternatively, the packets can be dragged/dropped. If multiple packets are chosen, the trigger machine will use OR logic.



Double-clicking on a packet in the "Trigger on any of these Events" area will bring up the Packet Editor (the same used for Simple Packet Search) to edit the header or payload values to trigger on. These packet values can be saved as Favorite Packets for later re-use with either Simple Trigger or Simple Packet Search.

Simple Triggers can also be saved as Favorite Simple Triggers for future use.

## Advanced Trigger

Advanced Triggers are created and edited using the Test Editor, which can be accessed from the Tools menu or by selecting Advanced Trigger from the Choose Trigger dropdown in the Trigger Setup window and clicking New or Load.

Once created Advanced Triggers are automatically added to the list of available triggers in the left pane of the Advanced Trigger tab. Clicking Refresh will update the list of available Advanced Triggers.

Advanced Triggers that were saved with and then loaded from a \*.pitx trace do not include the full \*.piat Advanced Trigger information



and thus are not editable; these are listed in yellow with a ToolTip "This trigger is not editable". To modify a non-editable Advanced Trigger the user must open the \*.piat file in the \AdvancedTriggers directory.

**To set an Advanced Trigger**, double click or drag the trigger of interest from the left pane into "Drag Advanced Trigger Here" in the right pane.

See the Advanced Trigger Editor User Manual for details on how to construct an advanced trigger.

The TRG IN connector on the instrument front panel (see ANALYZER FRONT PANEL - FALCON G300B/G400B AND RAPTOR M300/M400) can be selected as an Analyzer Resource in the Simple Trigger window or in the Advanced Trigger Editor and can be used with other packet events. When a trigger event has occurred a TRG OUT is always asserted to the front-panel TRG OUT connector as a 1.8V ±0.3V signal.

# Filter window

The Filter window, accessed from the Tools -> Filter menu, permits the filtering of specific packet types either before or after the trace has been stored and saved.

**The pre-capture Hardware Filter** can eliminate Fillers, Skips, Start of Bursts, End of Bursts and AFC\_TCO packets. The L2 Message Payload filter keeps the first 272 bytes of the Message (a Message is the UniPro packet containing a UFS packet) and removes the remaining contents of the packet.

Since these are filtered out prior to trace capture they are not stored or saved with the pitx trace.

Packets can still be used as a trigger resource even if that packet is filtered out with the HW filter. This is because the trigger engine is before the filter block.

**Post-Capture Software Filter** will capture and store all packets, but it will suppress the selected packet types from the UniPro List window. The Traffic Summary window will still display all packets but highlights and deactivates those that have been filtered.

If Traffic Overview, Simple Packet Search or Bookmark navigation is used to go to a software filtered packet the active packet displayed will be the packet just before the filtered packet. In TV Results the "In Test" markers will disappear with the filtered packet and the user won't be able to go to those filtered packets. Simple Triggers can still be constructed with Filter enabled; if the trigger packet is filtered out the Trigger bookmark will mark the closest unfiltered packet prior to the trigger event.

#### UniPro Packets Post-Capture Software Filter PACP CAP EXT1 ind AFC BAD TC PACP\_CAP\_EXT2\_ind AFC TC0 AFC TC1 Data Frame BAD TC Data Frame TC0 Data Frame TC1 NAC Mag End Of Burst End Of Burst GT Filler PACP CAP ind PACP\_CAP\_EXT1\_ind PACP\_CAP\_EXT2\_ind PACP\_GET\_cnf PACP\_GET\_req PACP PWR cnf PACP SET cnt Hardware Filter Only AFC\_TC0, Filler, Skip, EOB, SOB, and Massane Payload supported PACP\_SET\_req Scrambled Filler (2 byte) Filler crambled Filler (2 lane) Start Of Burst/Deskew Start Of Burst/Deskey End Of Burst TRG\_UPR0 TRG\_UPR1 Message Payload AFC TC0 TRG UPR2 Adapt Lane 0 (2x) Burs EOB MPHY Hibern8 Line-Cfg Stall SYNC When software filter is applied: 🔵 Show Only Selected Packets 💿 Hide Selected Packets Save as Default Load... Load Default Clear Filters ок Apply

Select Packets for Filters Double-click or Drag Packet to Add

# Settings window

The Settings window is accessed from the Settings menu or the settings icon icon the toolbar. The Settings window has separate tabs for User Preferences, Instrument Configuration, Device Configuration, Database Configuration, Packet Display, User Toolbar, Smart Tune Equalization and Advanced Settings.

Settings can be customized for each tab and saved and loaded from files located at C:\Users\[user name]\Documents\Protocol Insight\Falcon\Settings. Customized User Preferences are saved to a .prf file, Instrument Configurations are saved to a .ins file, Device Configurations are saved to a .dev file, and Packet Display settings can be saved to a .pcl file. User Toolbar settings can be saved to a .utb file, and Smart Tune Equalization settings can be saved to a .equ file. These files can be copied so that users can carry their own personal configuration setting with them from PC to PC.

Note that Instrument and Device settings are saved with the trace when File->Save Configuration/Analyzer Capture... is used, and when a trace is opened the settings saved with the trace will override the settings in the Settings window. This allows the user to preserve the exact settings used when the trace was captured.

#### User Preferences tab

User Preferences allows the user to tailor their experience and optimize application software performance based on their typical application and most common use models. For example, a user who is primarily interested in using the listing window to debug UniPro may choose to set the default mode to Analyzer, turn off automatic decode and calculation of UFS packets, and set the default Packet Listing Window and calculation settings exclusively for UniPro.

Settings		<u>_</u>					_		×
User Preferences	Instrument Configuration	Device Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings		
e Display Pref	erences								
Initial Mode	2	Analy	/zer 🛛 👻	Correlate	Scrolling in	Packet Lists:			
Primary Pro	tocol	UFS	~	- Number Defaul	r Display — t: 🔽	1234.567890	0x1234567	8	
Active Pack	et Listing Window	UFS	~	Forma	tted:	1,234.567 89	0x1234 567	'8	
Calculation Decode UFS	Calculation Preferences          Calculation Preferences         Decode UFS         V         When the Primary Protocol is UFS, Decode UFS must be selected         Calculate UES Traffic Overview								
Index UniPr	o Events	•							
Index UFS E Calculate Sa	events Somple List								
Show Warni Save When Save When	ng Dialog On Thes Starting the Analy Clearing TV Result	e Events	Sav	e When Starti e When Starti	ng All Tests ng CTS Test	s s			
Save When	Clearing All Result	s/Data	Sav	e When Starti	ng TV Tests	$\checkmark$			
Temporary ( This director Default: Current: New Path	Temporary Directory Path This directory is used for the temporary files that are created when you unload the analyzer or load a .pitx file Default: C:\Users\[UserName]\AppData\Local\Protocol_Insight\Falcon\Temp Current: C:\Users\[UserName]\AppData\Local\Protocol_Insight\Falcon\Temp New Path Use Default								
Restore Fa	ctory Settings in Th	nis Tab	Save Save a	as Default	Load	Load Defa	ult		
Restore Fa	ctory Settings in A	ll Tabs				ОК	Apply	Can	cel

#### **Display Preferences**

Setting the **Initial Mode** controls which display mode is active when the software application is launched (see **WINDOWS** for more information). The **Primary Protocol** controls whether UFS packets are decoded (if selected in Calculation Preferences), what the default protocol is for the device Boot/Reboot button in the toolbar, and the selected test list under Device Control in the Configuration window. The **Active Packet** 

**Listing Window** sets the default Packet List window, for example selecting UniPro will cause the UniPro Packet List window upon completion of a trace capture.

**Correlate Scrolling in Packet Lists** locks the UniPro and UFS List windows by default when scrolling.

**Number Display** makes large numbers more readable if the Formatted box is checked. It adds comma separators before the decimal place and spaces after every three digits or every four hex values. This applies only within the GUI and does not affect exported data.

#### **Calculation Preferences**

After the instrument has captured a trace it is off-loaded to the application software and the UniPro Packet List, Packet Decode and Data View windows are immediately populated with decoded trace data.

The UFS Packet List, Packet Decode and Data View windows are also populated with decoded UFS data if the Decode UFS box is checked under Calculation Preferences.

Background calculations then are initiated to update the UFS Traffic Overview, Events windows and Sample List if those boxes are checked in Calculation Preferences.

The background calculations can take time and during background calculation you cannot save the trace file unless you cancel calculations from the toolbar. To disable automatic background calculation of some or all of the automatic calculations deselect those under "Calculation Preferences".

If a trace has been saved without completing some or all calculations, when the file is re-opened it will automatically start calculating in the background if a box is checked under "Calculation Preferences".

You can force a calculation of an uncalculated trace by selecting Calculate Options from the Results menu.

The application software will still be highly responsive while it is doing background calculation, and Packet List, Packet Decode and Data View windows are fully functional. However, until Traffic Overview is calculated the Simple Packet Search functionality will not be available.

#### Show Warning Dialog On These Events

This section can be used to change warning dialog preferences if the "Do not show this message again" box has been checked in any warning dialog.



For example, the Save Configuration and Data warning dialog will appear anytime the following actions are performed: opening a new trace file, exiting the application, starting the analyzer, clearing results and data, clearing Trace Validation results, or running tests.

#### **Temporary Directory Path**

When unloading trace data from the instrument to the application software, large files are temporarily created that can grow to be 5-10x larger than the actual \*.pitx file. This can affect the performance of the application if the target directory is located on a drive that has slower write speeds and/or insufficient disk space.

The path where these temporary files are stored can be changed to point to another location, typically a faster larger drive.

#### Instrument Configuration tab

This tab is used to configure the Falcon or Raptor instrument. To display status information about the analyzer and exerciser instrument and UniPro link see the **INSTRUMENT STATUS WINDOW**. To configure analyzer and exerciser tests see the **CONFIGURATION WINDOW**.

User Instrument Preferences Configuratio	Device Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings
Analyzer – License: 8 GB Memory ar	nd x2 Link Width					Reset Analyzer
Host Sublink 0 Label: Sublink 0 Sync Length Connected Link Width: Lane 0 maps to Analyz Lane 1 maps to Analyz	Host Filter: min er Channel: er Channel:	* x1  * 0  * 1  *	Device – Sublink 1 Sublink 1 Connecte Lane 0 m Lane 1 m	Label: Sync Lengtl ed Link Widt haps to Analy haps to Analy	Device n Filter: mir h: rzer Channel: rzer Channel:	□
Capture Options Capture Type: Instrument Memory De Disk Buffer Limit (3072 When Disk Buffer Full:	pth (8192 MB Max): 00 MB Max):	Standard 1 1024 Stop Capture	¥ MB MB		Streamin	g Performance Test
Host Speed: Link Width: Initial Scrambling: Initial Rate Series:	PWM-G x1	1 I V I V Apply Initial R	Device – Speed: Link Wid	th:	P	WM-G1   *   1   *
Other Settings         Output Clock:       19.2 MHz         Rate Series:       Auto         Auto       ✓         Restore Factory Settings in This Tab       Save         Save as Default       Load						
Restore Factory Settings	in All Tabs				ОК	Apply Cancel

In the **Host** and **Device** sections the sublinks can be renamed and mapped and the channels can be defined.

# **Capture Options**

Capture Options are used to define where traces are stored during capture. Choosing *Standard* will store the trace in instrument memory, up to the maximum amount specified in the Instrument Memory Depth field. Once the specified amount of memory has been filled, the oldest data will be discarded, and capture will continue with a circular buffer until the analyzer is stopped or a trigger event occurs.

Choosing *Streaming* will immediately output the trace via the Thunderbolt3 interface and store the data on the controller PC hard drive. The size of the capture can be defined. Once the *Disk Buffer Limit* has been reached, the oldest data will be discarded and capture will continue with a circular buffer if *Wrap Buffer* is selected, otherwise the capture will stop. Note that streaming capture requires HW filtering of fillers, skips and UFS TC0 message payload to ensure optimum bandwidth.

With streaming capture the entire trace is stored to disk before any processing, so if there is an error during processing the trace is still on disk and the "Save debug File" will save the whole trace. If there is an error during capture the trace will be lost.

*Streaming Performance Test* evaluates the Thunderbolt3 and host PC performance for the two fundamental functions required for streaming: interface Bandwidth from instrument to the PC and Disk Write bandwidth. 1000MB/s is considered the minimum so any test not achieving 1000MB/s is evaluated as failing.

See APPENDIX F: STEAMING CAPTURE for more details on how streaming capture works, or APPENDIX 2: SYSTEM REQUIREMENTS for a description of the minimum PC requirements for streaming capture.

#### **Initial Power Mode**

The Initial Power Mode settings are used to tell the analyzer the initial power mode to assume for sync to the link, if the analyzer is capturing a link in mid-transmission. The analyzer can capture a trace from an existing UniPro link, but the analyzer needs to be told what power mode the UniPro link is operating at.

Once the initial power mode is configurated in the Instrument Configuration window and the analyzer syncs to the current power mode, the analyzer will continue to track the link power mode.

#### **Other Settings**

Selecting a UFS clock with the Output Clock selection is only necessary if you are using the UFS external reference clock signal on the front panel of the instrument.

# Device Configuration tab (G350B/G450B only)

The Device Configuration tab allows configuration of specific device parameters for UniPro, UFS Device and UFS LUN Configuration.

To change values in the **UFS LUN Configuration** section, select all LUNs to be configured by using the keyboard Shift and Control keys while selecting the LUNs of interest. Then enter the appropriate variables to configure the LUNs for test execution. See **AppENDIX D: DISCOVERING UFS DEVICE CONFIGURATION VALUES** for more information on how to obtain the values necessary to properly configure the UFS device.

Note: when a trace file is saved as a PITX file, the device configuration information is saved with the file. After opening a PITX file if changes are made to the device configuration using the Device Configuration window these changes will overwrite the settings in the trace file.

User Preferences	Instrument Configuration	Device Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings	
Server N	Name:	localhost\Pro	tocolInsight					
Databas	se Name:	ProtocolInsig	ht					
Authent	tication Type:	Windows Aut	hentication					<b> </b> ~
Test	Connection	Repair Datab	ase					
For more in	nformation see the	SQL Server Config	uration App Note:		SQL Server	Configuratio	n App Note	
Restore Fa	actory Settings in T	his Tab	Save	as Default		Load De	fault	
Restore Fa	actory Settings in A	II Tabs				ок	Apply	Cancel

The Database Configuration tab is used to update and save settings to repair the SQL database. See APPENDIX A: RESETTING YOUR SQL DATABASE thru APPENDIX C: MANUALLY INSTALLING MICROSOFT SQL SERVER for more information on how to configure the SQL database using this tab.

Jser Preferences	Instrument Configuration	Device Configuratio	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings
Att	ribute Name	Va	lue				
Device.T	C0TxMaxSDUSize	27					
Device.T	COTxMaxSDUSize	x 13 35					
Device.T	C0TxMaxSDUSize	x 37 10					
Device.T	COTxMaxSDUSize	x 128 34					
Device.T	COTxMaxSDUSize	x 240 65					
Device I	stFeatureCPortR	0-0	0				
Davice Fi	estTectEesture("D						
Device S	acondTactFeature	CPort 0					
Device T	hirdTortEasturaCl	ort 0					
Device.F	ourthTestFeature	Port 0					
UFS Device	•						
Device Desi	criptor Values -		Geometry Des	riptor Values			
	bNumbe	rLU: 0x08			bMaxin	BufferSize: 0x08	
	bNumber	VLU: 0x04			bMaxOut	BufferSize: 0x08	
bNumbe			Miscellaneous				
	iManufacturerN.	ame: 0x01			bConfigDe:	scrLock=0: 🔽	
	iProductN	me: 0x02	bBootEnable	1 and BOOT	LU A/B assig	ned to LU:	
	iOe	nID: 0x03	D.	bMaxDi	ataOutSize (J	Attributes): 0.00	
	iSerialNum	ber: 0x04		bRefCli	Freq has be	en written: 🔽	
	ProductRevisionL	evel: 0x05		bConfigDescr	Lock has be	en written: 🔽	
	Unique v			H-MEN A-	binitPowe	rMode=1: ✓	
	bInitActiveICCL	evel: 0x00	Ena	ble write On	IMMED -	upported:	
	bDeviceRTT	Cap: 0x00					
0 1				R	ead-Write E	Control:	
			Contr	ol Extension M	Node subpa	ge supported:	
3		Read-Write	e Recovery Mode Pa	ge		T about the	
5				WRITE F	RETRY COUN	T changeable:	
6				RECOVER	RY TIME LIM	IT changeable:	1
		Mode Sav	able				
Boot						Control Page:	
RPMB					Read-W	/rite Recovery:	
UFS Device					Cacl	hing Recovery:	
REPORT LL	INS	Value in U	NIT Descriptor		_		
NONE (LU	Agnostic)		q	bl opicalBlockC	ount:		-
				bLUWritePr	otect:		
		MAX Add	essable -				
		- Motor Addr				LBA:	
						LBA:	
						16:	
				LBA les	s than (2^16	1-0.9	
		Miscellane	ous -		C-1-107		
			M	DDE SELECT o	ommand sur	opported:	-
				bProvisioning	Type set to t	0x2 or 0x3:	
			IMMED s	upported by	SYNCHRONI	ZE CACHE	
					MaxCo	ntextiD=0:	
Restore Fact	tory Settings in Th	nis Tab	Save_ Sav	e as Default	Load	Load Def	iault
		-					
Restore Fact	tory Settings in Al	l Tabs				OK	Apply Cance

# Packet Display tab

This tab allows the user to customize most packet colors used in the List and Event views.

User Preferences	Instrument Configuration	Device Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings
UFS I UFS I UFS I UT UT UT UT UT UT UT UT UT UT	Packets IFS SCSI IFS Protocol QUERY REQUEST QUERY RESPONSE ASK MANAGEMENT TO Packets 2 1.5 HY TO Overview Colors AD IAC ACP FC RG Vent Ind_Of_Trace To Speed Colors actory Settings in Th	nis Tab	Save Save a	s Default	Load	Load Defa	ult
Restore Fa	actory Settings in A	ll Tabs				ОК	Apply Cancel



To restore the original toolbars choose View $\rightarrow$ Restore Default Layout.

reports	Packet Decode
▶ View	
► Tools	
Settings	
User Preferences	
Instrument Configuration	
Device Configuration	
Database Settings	
Packet Display	
User Toolbar	
Equalization Settings	
Advanced Settings	
Restore Factory Settings in This Tab Save Save	e as Default Load Load
Restore Factory Settings in All Tabs	OK

### Smart Tune Equalization tab

Default ATT (Attenuation), VGA (variable-gain amplification), CTLE (continuous time linear equalization), and DFE (decision feedback equalization) settings are loaded into instrument hardware when the application software initially connects to the Falcon and Raptor instrument.

In some instances acquiring the signal from the DUT can be problematic when test fixture trace routing or the cabling required to connect to the test fixture causes poor signal integrity or probing issues. To optimize signal acquisition in the case of poor signal integrity or probing issues the Falcon and Raptor Series offer Smart Tune<sup>™</sup> equalization capability.

Smart Tune allows the user to choose between setting fixed equalization values manually for the frontend PHY, auto equalizing using the M-PHY4.1 ADAPT capability or running auto equalization continuously each time a Burst is opened on the link.

To **set equalization values manually** individual values can be entered in the Sublink 0 and Sublink 1 *Initial/Fixed Equalization Values* section or saved values can be loaded from a file. Since the mapping of each of the PHY equalization settings to a physical parameter is complex, manual entry of values should only be done on the advice and recommendation of Protocol Insight Support.

To run Auto Equalization using the MPHY ADAPT **sequence** check the box *Enable Auto Equalization using* the MPHY ADAPT sequence, then execute a Link Startup Sequence on the DUT and run the ADAPT sequence between the Host and Device. Return to the Equalization tab and click "Get Results". Verify that a successful Smart Tune was achieved, see Verifying Smart Tune Results section. If successful, Smart Tune can safely be left with Enable Auto Equalization using the MPHY ADAPT sequence checked, in this mode it will equalize every time ADAPT is ran. Optionally, the results can be saved and used as fixed values, see the Saving and Applying Results section. If the Smart Tune was unsuccessful, see Verifying Smart Tune Results section, try repeating the entire process by running the ADAPT sequence again. If the Smart Tune results continue to be unsuccessful refer to the

User Instrument Preferences Configuration	Device Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings	
Smart Tune Equalization	on						Î
Sublink 0 Equalization							- I
Initial / Fixed Equalization	on Values ————						n
ATT	VGA	CTLE DI	FE1 DFI	E2			
Sublink 0 Lane 0: 0x0	0x4   ~	0x7   ¥ 0x	:00 0x0	0			
Sublink 0 Lane 1: 0x0	▼ 0x4   ▼	0x7   ¥ 0x	:00 0x0	0			
		24.07					╵┃┃
Enable Auto Equalizatio	on using the MPHY Al	DAPT sequence					
Enable Auto Equalizatio		nhals hafara data	cting TOP				
Enable fob linter, igno			cung ros				
Equalization Results		177 1/01	cau c	0.554	150		וור
FOM	Done Abort	ATT VGA	CTLE	DFE1 DI	-E2		
Sublink 0 Lane 0: 0x00	0 0x00 0x00	0x00 0x00	0x00	0x00 0	×00		
Sublink 0 Lane 1: 0x00	0 0x00 0x00	0x00 0x00	0x00	0x00	x00		
Get Results Cop	by Results to Fixed Eq	ualization Values					
							-
- Sublink 1 Equalization							
- Juitial / Eved Equalization	Values -						
ATT	VGA	CTLE DI	FE1 DFI	E2			11
Sublink 1 Lane 0: 0x0	~ 0x4 ~	Oxa 👻 Ox	:00 0x0	0			
Sublink 1 Jano 1:							н.
Subilitik T Laffe 1. 0x0	• 0x4 •	0xa   * 0x	:00 Ox0	0			J∣∎
Enable Auto Equalization	on using the MPHY A	DAPT sequence					
Enable Auto Equalization	on continuously						
Enable TOB filter, ignore 0x100000 symbols before detecting TOB							
Equalization Results							n
FOM	Done Abort	ATT VGA	CTLE	DFE1 DI	E2		
Sublink 1 Lane 0: 0x00	0 0x00 0x00	0x00 0x00	0x00	0x00	x00		
Sublink 1 Lane 1: 0x00	0 0x00 0x00	0x00 0x00	0x00	0x00	x00		
Get Results Cop	by Results to Fixed Eq	ualization Values					
							<u> </u>
Restore Factory Settings in This Tab Save Save as Default Load Load Default							
Restore Factory Settings in	n All Tabs				ок	Apply	Cancel

<u>Troubleshooting Auto Equalization using the MPHY ADAPT sequence</u> section. Note that because ADAPT is only supported in M-HY 4.1 for HS-G4 this capability does not support lower HS speeds.

**Troubleshooting Auto Equalization using the MPHY ADAPT sequence:** These troubleshooting instructions are intended for Analyzer mode.

- If the results show Abort > 0 and Done == 0: This indicates that PHY is not seeing enough symbols to complete a Smart Tune. Verify that the Host and Device ADAPT sequence length is long enough, Falcon/Raptor has a RX\_HS\_ADAPT\_LENGTH\_COARSE\_Capability value of 0x91 (course,17), thus the Host and Device must both use an ADAPT\_length of 0x91. If either Host or Device is does not use an ADAPT\_length of 0x91 you can change the value after Link Startup but before the power mode change. Set the attribute PA\_PeerRxHsAdaptInitial (0x15D3) to 0x91 in both the local and peer DME's.
- If the host and device ADAPT sequences length is long enough but still Abort > 0, it could be caused but the PHY falsely detecting a Tail of Burst to soon. Select the *Enable TOB Filter*, start with the default value of 0x100000 for symbols to ignore. You can increase or decrease the symbols to ignore based on the ADAPT length. If you continue to have issues you can try *Auto Equalization continuously* or contact Protocol Insight Support with traces that show link startup, power mode change and the ADAPT sequence. Also take screen captures of the Equalization Results after each attempt.

To run **Auto equalization continuously** select *Enable Auto Equalization continuously*. Then execute a Link Startup Sequence on the DUT and change power mode to the fastest mode supported and begin sending a good equalization data pattern. To achieve the best results Smart Tune typically requires ~10MB of random data to be sent in a single burst. The recommended way to send random data for Smart Tune is in fast mode with scrambling enabled, because scrambled fillers are a pseudorandom data pattern. Verify that the analyzer is seeing data by observing the Hardware Counters increasing in the Instrument Status window. Return to the Equalization tab and click "Get Best EQ Values". This will determine the maximum FOM value by observing equalization results for 5 seconds, then it will save the equalization values with the best FOM Quality. Once completed you should observe successful results, see <u>Verifying Smart Tune</u> <u>Results</u> section. If successful, the results should be saved and used as fixed values, see the <u>Saving and</u> <u>Applying Results</u> section. Auto Equalization continuously mode should only be used to get equalization results and it is not recommended to leave Smart Tune in the Auto Equalization continuously mode. This capability supports all HS speeds, including HS-G1 to HS-G4B.

The **Equalization Results** section shows the value of the equalization settings that are currently being applied in the PHY. When running Smart Tune equalization, the PHY will try to find the ideal equalization values (ATT, VGA, CTLE, DFE). The status information (FOM (Figure of Merit), Abort, Done) will indicate the quality of the Smart Tune equalization. The **Done** counter indicates how many times equalization tuning successfully completes. When running Smart Tune this counter should increment every time a new Smart Tune is ran. The **Abort** counter indicates how many times equalization tuning fails, failures typically occur because the PHY did not see enough bytes of data in a single burst, typically ~10MB are required to be sent in 1 burst for the PHY to correctly equalize. The **FOM** value indicates how good the equalization values are. The larger FOM value the better the equalization is, see Table 1 below for FOM Value to FOM Quality mapping. *Poor* FOM Quality typically indicates poor signal integrity which results in errors being captured. The FOM value is the perceived quality of the equalization, the only definitive test is if the RX can capture error free. There are instances where the FOM is a false large value, meaning the FOM Quality is a *Good* value but errors are still captured. This typically happens when the data pattern that was used for tuning is not random data, FILLERS that are NOT scrambled is the worst data for Smart Tuning.

**Verifying Smart Tune Results**: A successfully Smart Tune is indicated by the Done counter value >= 1, values for all the PHY values should have changed from the previous value and the Figure of Merit value (FOM) should be Good quality, see **Error! Reference source not found.**.

- Successful Smart Tune is indicated by (Done >= 1 and FOM Quality = Good)
- Failed Smart Tune is indicated by (Done == 0 and Abort >= 1).
- **Poor** quality Smart Tune is indicated by (Done >= 1 and FOM Quality = Poor).
- Smart Tune did not run if Done == 0 and Abort == 0.

FOM Quality	FOM Value
Good	>=0x60
Poor	<0x60 & >= 0x50
Bad	<0x50

Table 1 FOM Value to FOM Quality Mapping

**Saving and Applying Results**: To save the values select "Copy Results to Fixed Equalization Values" to load the values into the PHY and switch to Fixed Equalization mode by unchecking the *Enable Auto Equalization using the MPHY ADAPT sequence* and *Enable Auto Equalization continuously*.

#### Advanced Settings tab

**CAUTION:** the Advanced Settings tab requires expert knowledge of the instrument and the Device Under Test and test fixture configurations. The Advanced Settings tab should only be used on the advice and

recommendation of Protocol Insight Support. Before beginning the user must acknowledge this by checking the box that "I understand how to use Advanced Settings".

User Instrument Preferences Configurat	t Device ion Configuration	Database Configuration	Packet Display	User Toolbar	Smart Tune Equalization	Advanced Settings	
I understand how to	use Advanced Settings						
PHY Settings			<b>f</b> Streamir	ng Settings <del>–</del>			
Other Settings			Total B	uffer Size:		١	ИB
Force LS Termination	ons:		Memo	ry Buffer Cou	nt (2-512):		
Force RX Termination	ons		Memo	ry Buffer Size:		not connected	
Time after EOB igno	ore data: Off	~	4 MB	provides ~80	% of full perfor	mance, 8 MB	
Filter Squelch Exit [	us]: Off	· ·	provid		mance.		
PACP PWR tracking	cnf/req per	sublink	Admir	jing these val nistrator perm	lues requires Winission. The An	ındows alyzer must be	
Reset PHY			conne this co	ected to the o omputer for t	omputer. You v he change to ta	vill need to reb ke effect	poot
PWM Settings			Ļ				
PWM Pulse Filter Set	ttings For Sublink 0 <del>—</del>			se Filter Settir	ngs For Sublink	1 ———	
PWM-G1: 12 ns			PWM-G1	: 12 ns   ▼			
PWM-G2: 6 ns			PWM-G2	: 6 ns   ▼			
PWM-G3: 3 ns			PWM-G3	: 3 ns 🔻			
PWM-G4: 0 ns	*		PWM-G4	: 0 ns 🔻	7		
ByPass PWM Filter:							
Apphy DW/M							
							j
5 🛛 💌 Value of VersionI	nfo advertised during	LSS (PA <u>L</u> ocalVerInfo)					
Disable TX Error	Insertion At Boot						
Exerciser automa	ntically responds to LSS						
Stop capturing d	ata in DIFF-Z						
Enable terminatio	ons in PWM exerciser	mode					
Restore Factory Setting	js in This Tab	Save Save a	as Default	Load	Load Def	ault	
Restore Factory Setting	gs in All Tabs				ОК	Apply	Cancel

For information on how to use the Advanced Settings tab contact your local Protocol Insight representative or <a href="mailto:support@protocolinsight.com">support@protocolinsight.com</a>.

#### Instrument Status window

This window is used to display status information about the analyzer and exerciser instrument and UniPro link operation. To configure the instrument see the INSTRUMENT CONFIGURATION TAB under Setting on the menu. To configure analyzer and exerciser tests see the CONFIGURATION WINDOW.

The **Analyzer section** of Instrument Status is used to display analyzer and trigger status, and the analyzer memory Capture Options configured.

Analyzer Memory is displayed if Standard is selected as the Capture Type in Capture Options in the Instrument Configuration tab of the Settings window. The amount of embedded Instrument Memory Depth selected is displayed along with a percentage representing the amount of memory filled relative to the amount of memory allocated.

The analyzer always reserves the amount of memory after the trigger that is set with the Trigger Position; if a 20% trigger position is set the analyzer will reserve 80% of the memory for post-trigger fill. What this means is that if the trigger occurs deep in the trace then 100% of the memory buffer will fill, 20% before and 80% after. But if the trigger event occurs very early in the trace, say after only filling 5% of the total memory, the capture will total less than 100% because 5% will be before the trigger and 80% after the trigger for 85% total. See TRIGGER SETUP WINDOW for more information.

Streaming File Usage is displayed if Streaming is selected as the Capture Type in Capture Options in the Instrument Configuration tab. Streaming File Usage shows the amount of Disk Buffer Limit allocated and the percentage of that buffer that has been filled by the capture. Streaming Buffer Usage displays a graphical representation of the amount of the instrument's embedded memory and the controller PC's RAM that is being used as a buffer as the trace is being written to the Streaming File on disk. See APPENDIX F: STEAMING CAPTURE for more information.

The **Link Power Mode section** provides real-time link status and power mode information.

The **Hardware Counters section** provides insight into the realtime traffic on the link by counting the number of M-PHY symbols and symbol errors observed on each sublink/lane. Symbol errors in the Instrument Status window are KCode raw bit capture



errors, typically caused by signal integrity problems, probing issues or M-PHY issues. The Hardware Counters will increment independently of if the analyzer Run button is selected.

### **Application Status**

The Application Status window can be accessed from the toolbar by clicking on the blue info icon to the right of the application status bar in the Tool Bar.

The Application Status window will display progress on any computationally intensive functions being performed by the application, such as file opens, Traffic Overview and Events indexing, zooms, searches, and Trace Validation runs.

If the Application Status window is opened before a Configuration/Analyzer Capture file is opened the status window will display all computations while the trace file is being opened.

Application Status messages will be automatically cleared when a new trace is captured or loaded from a file.



#### Eye Monitor

The Eye Monitor window, accessed from **Menu** $\rightarrow$ **Tools** $\rightarrow$ **Eye Monitor**, constructs an eye diagram of the link to determine the link quality.

To develop useful eye diagram measurements Eye Monitor must be run against high speed traffic with lots of transitions, preferably HS-G4B in NonAuto mode with Scrambling enabled.

To perform an eye diagram measurement:

- 1. Click Connect on the toolbar. The application will connect to the instrument hardware and begin tracking symbols on the link.
- 2. Initiate suitable traffic across the link and verify that the analyzer is seeing that traffic by observing the counters increasing under Hardware Counters in the Instrument Status window.
- 3. Open the Eye Monitor tool and choose which Lanes to measure, choose what Eye Diagram Resolution to run the measurement at, and which Sample Points to measure the eye at.
- 4. Click Start Eye Measurement.

After the measurement is complete the results can be saved and shared by clicking the Save... button. Qualitative measurements can be done for jitter, noise, and eye opening by dragging the X and Y cursors in each eye measurement panel, delta values will be displayed in the cursor tooltip.



# Menu Functions

Many menu functions are duplicated on the easy to access **TOOL BAR**. This section provides additional detail for the more complex functions.

# File Menu

All trace data, including trace indexing for Traffic Overview and Events window, Trace Validation results, and any settings from the Configuration windows are saved in a file with file extension of .pitx (Protocol Insight Test).

#### →Open Configuration...

This function is used to open a previously saved \*.pitx file to restore the Configuration Window and all instrument and device configuration settings.

### File→Open Configuration/Analyzer Capture...

This function is used to open a previously saved \*.pitx file including the instrument and device configuration, the trace capture, trace indexing for Traffic Overview and Events views, and Trace Validation results.

#### File→Open Recent Configuration/Analyzer Capture...

This function is used to open recently used traces and/or configuration files.

### File→Save Configuration...

This function is used to save the instrument and device configuration. The file extension of .pitx is used for these files.

### File→Save Configuration/Analyzer Capture...

This function is used to save instrument and device configuration plus the trace capture, trace indexing for Traffic Overview, Trace Validation results and Events view indexing. The file extension of .pitx is used for these files.

#### File→Refresh Advanced Trigger Tests

Updates the list of advanced triggers in the Advanced Trigger window with the advanced triggers in <User>\Documents\Protocol Insight\Falcon\ AdvancedTrigger.

### File→Refresh Trace Validation Test List

Updates the list of Trace Validator test categories and custom Trace Validator test cases in the Configuration windows from the categories and test cases in <User>\Documents\Protocol Insight\Falcon\CustomTests.

Directories in <User>\Documents\Protocol Insight\Falcon\CustomTests are displayed in *italics* as categories in the Configuration window test lists, appended to the bottom. For example, the directory <User>\Documents\Protocol Insight\Falcon\CustomTests\ProjectX would appear in the test lists as the category *ProjectX*. Custom tests must be saved in categories (sub-directories). New categories can be created by adding new sub-directories in <User>\Documents\Protocol Insight\Falcon\CustomTests\Protocol Insight\Falcon\CustomTests with File Explorer.

#### File→Refresh Stimulus Test List

Updates the list of custom stimulus test categories and custom stimulus test cases in the Configuration windows from the categories and test cases in <User>\Documents\Protocol Insight\Falcon\CustomTests.

Directories in <User>\Documents\Protocol Insight\Falcon\CustomTests are displayed in *italics* as categories in the Configuration window test lists, appended to the bottom. For example, the directory <User>\Documents\Protocol Insight\Falcon\CustomTests\ProjectX would appear in the test lists as the category *ProjectX*. Custom tests must be saved in categories (sub-directories). New categories can be created by adding new sub-directories in <User>\Documents\Protocol Insight\Falcon\CustomTests with File Explorer.

#### File→Export Decoded Packets as CSV

CSV export can be performed for a defined section of a trace or the entire trace:

Export Decoded Packets as CSV			
Protocol:	✓ UniPro 🔲 UFS		
SubLink:	🗸 Device 🖌 Host		
Packet Data:	Append to Each Row		
From:	Begin		
То:	End		
Export			

The data columns exported to .csv are same as the columns that are defined in UniPro/UFS Packet List window. Enabling the Packet Data: Append to Each Raw can export all raw data to .csv with the columns selected. The export .csv data will separate by commas.

#### File→Export Analyzer Capture Range

A pitx file can be saved that only includes trace data between two selected bookmarks. Any existing bookmarks in the file can be used for to define export boundaries:

Export a Range of Packets to a Configuration File				
SubLink:	✓ Device ✓ Host			
From:	Begin 🛛 💌			
То:	End 🛛			
	Exp	ort		

This export file will also include the configuration settings.

#### File extensions:

Some file extensions have changed with v1.8.0. Legacy file extensions are still supported for backward compatibility. Here is a complete list of all file extensions:

Traces (including the configuration & analyzer captures) \*.pitx Settings User Preferences \*.prf Instrument Configuration \*.ins Device Configuration \*.dev Database Configuration \*.dec Packet Display \*.pcl User Toolbar \*.utb Smart Tune Equalization \*.equ Advanced Settings \*.ads Triggers Advanced Trigger File \*.piat Simple Trigger File \*.smp Packet File \*.pkt Simple Search Packet File \*.pkt Trace Validation Validation, state machine and diagram files \*.pitv (v1.8.0 and later) Validation files \*.piv (legacy files prior to v1.8.0) State machine files \*.sm (legacy files prior to v1.8.0) Diagram files \*.sm.diagram (legacy files prior to v1.8.0) Stimulus Editor/Builder files Stimulus Editor Files \*.pie (Stimulus files for v1.8.0 and later) Stimulus Builder Files \*.pis (legacy Stimulus files prior to v1.8.0, deprecated)

# Test Menu

# Test→Run

Starts the Stim and Trace Validation tests selected and configured in the Configuration windows.

### Test→Stop

Stops the tests that are currently running.

#### Results Menu

Results→Clear Stimulus Results

**Results**→**Clear Trace Validation Results** 

#### Results→Clear All Results and Data

Selecting these menu options will clear the respective Results window or windows of all test results.

#### **Results**→**Calculate** Options

This forces a calculation of any uncalculated trace data. Only valid options that have not been calculated will be active.

#### Reports Menu

### Reports→Trace Validation Results Reports→Stimulus Results

Summary reports can be created by configuring the TV Results and Stimulus Results windows (grouping, summarizing, sorting, filtering and expanding levels) and then printing them from this menu. This menu will reproduce exactly what is reflected in the Results window to a PDF file. Stimulus Results can also be exported to a CSV or XML file.

Reports→UniPro Packet List Reports→UFS Packet List A Packet List report can be generated from a Packet List window.

This menu will reproduce exactly what is reflected in the Packet List window to a PDF file.

#### View Menu

Any windows that have been closed will be opened by selecting these options. Restore Default Layout will restore the default window and toolbar layout.

#### Analyzer Control Menu

Analyzer Control→Connect Analyzer Control→Start Analyzer Control→Stop

These menu items provide the same functionality as the Analyzer status/control tool bar. Clicking Connect will establish a connection between the analyzer application and the instrument hardware if it is available. Clicking Start or Stop will begin or end a trace capture.

### Tools Menu

#### Tools→ Trigger

The Trigger dialog is used to create, modify and set triggers.

#### Tools→ Filter

Selecting this menu option will open the Filter window. See **FILTER WINDOW** for more information.

#### Tools $\rightarrow$ Eye Monitor

Selecting this menu option will open the Eye Monitor dialog to perform eye measurements on the link. See Eye MONITOR for more information.

#### $Tools \rightarrow Editor$

#### Editor → Open Editor

This launches Protocol Insight's Visual Studio Editor tool as a separate application for editing existing or creating new Advanced Triggers, Trace Validation or Stimulus tests.

#### Editor→New Advanced Trigger

This launches Protocol Insight's Visual Studio Editor tool as a separate application and opens a new Advanced Trigger file.

#### Editor→New Trace Validator

This launches Protocol Insight's Visual Studio Editor tool as a separate application and opens a new Trace Validator project.

#### Editor→New UniPro Stimulus

This launches Protocol Insight's Visual Studio Editor tool as a separate application and opens a new UniPro Stimulus test project.

#### Editor→New UFS Stimulus

This launches Protocol Insight's Visual Studio Editor tool as a separate application and opens a new UFS Stimulus test project.

#### Tools→ Streaming Statistics

The Streaming Statistics dialog displays information on the streaming performance (bandwidth and bottlenecks) of the Thunderbolt3 connection between the instrument and the controller PC. This streaming data is collected continuously any time Streaming Capture is used.

#### Tools→ Save Debug File

#### Settings Menu

Settings → User Preferences

See **USER PREFERENCES** for more information.

#### Settings → Instrument Configuration

See **INSTRUMENT CONFIGURATION TAB** for more information.

#### Settings $\rightarrow$ Device Configuration

See **DEVICE CONFIGURATION TAB (G350B/G450B ONLY)** for more information. This will be greyed out and inactive if Analyzer mode is selected.

#### Settings → Database Configuration

See **DATABASE CONFIGURATION TAB** for more information.

The Microsoft SQL Server and instrument-specific database settings are configured automatically with the initial software installation. However, in some instances it may be necessary to reset your database settings, reconfigure your database or re-install it manually from scratch. The Database Configuration dialog is used to update and save settings to repair the database. See APPENDIX A: RESETTING YOUR SQL DATABASE thru APPENDIX C: MANUALLY INSTALLING MICROSOFT SQL SERVER for more information.

#### Settings $\rightarrow$ Packet Display

See **PACKET DISPLAY TAB** for more information.

#### Settings → User Toolbar

See USER TOOLBAR TAB for more information.

#### Settings → Smart Tune Equalization

See **SMART TUNE EQUALIZATION TAB** for more information.

MB Read From DDR (Last Transfer):	0
MB Read From DDR (Current Run):	0
MB Read From DDR (Total):	0
MB Written To Disk (Current Run):	0
MB Written To Disk (Total):	0
DMA Bandwidth (Current):	0
DMA Bandwidth (Cumulative):	0
Disk Bandwidth (Current):	0
Disk Bandwidth (Cumulative):	0
DDR Bandwidth (Current):	0
DDR Bandwidth (Max):	0
DDR Bandwidth (Average):	0
Reset Stats	

Instrument Configuration D	Database Configura	onfiguration Packet Display			
Server Name:	localhost\ProtocolInsight				
Database Name:	ProtocolInsight				
Authentication Type:	Windows Authent	ication			
User Name:					
Test Connection	Repair Database		Apply	Cancel	
For more information see Appendix A: Reconfiguring the SQL Database in the User Manual User Manual					
	0	<			

### Settings → Advanced Settings

See **ADVANCED SETTINGS TAB** for more information.

#### Help Menu

#### Help $\rightarrow$ User Manuals

User Manuals are provided for the instrument, Advanced Trigger, Trace Validation Editor, and Stimulus Editor.

#### Help $\rightarrow$ Compatibility-> Test Case Revisions and Interpretations...

Selecting **Test Case Revisions and Interpretations...** will launch a web browser and navigate to a web page which provides regularly updated information on test cases that have been revised or required interpretation to develop.

Protocol Insight may revise certain test cases from the strict interpretation of the UniPro or UFS CTS to facilitate effective and accurate test execution. Any revisions are described here.

Interpretation of some test cases may have been required to account for ambiguities in the UFS spec, the UniPro spec, and/or the CTS specs. To complete the development of the CTS tests Protocol Insight may have made certain interpretations which could alter the results of the test cases; those interpretations are described here.

#### Help $\rightarrow$ Compatibility->Known Issues...

Selecting **Known Issues...** will launch a web browser and navigate to a web page which provides regularly updated information on any known issues with the application software or firmware.

# Post-Capture Analysis

# Trace Validation

Trace Validation (TV) is a state machine analysis tool that analyzes captured traces using specific and or logic and states to find problems and events. TV tests can be run against any captured trace as a complete post-capture analysis tool for search, pass/fail testing, stress test analysis or for general debug.

There are generally four types of TV tests that can be run: pre-defined CTS tests, debug tests, SearchTVs and custom tests. The application software library includes hundreds of pre-defined CTS, debug and search TVs that can be used as-is or modified and saved as their own unique analysis test cases. And the user can use Trace Validation Editor to create their own custom TV tests.

**Pre-defined CTS tests** are supplied with the application software library for most UniPro and UFS CTS tests defined by the respective standards organizations.

When these CTS tests are executed the Exerciser inserts a specific Protocol Insight marker packet into the trace to indicate the beginning of each CTS test in the trace (see **TEST EXECUTION AND TRACE VALIDATION** 

ANALYSIS FOR FALCON EXERCISER for more information). If TV does not find the marker packet TV will not complete and will instead generate the message "State machine did not run".

For this reason, the TV CTS tests supplied with the application software library should only be used to analyze traces generated with the Exerciser with the matching CTS Stim test case containing a marker packet.

The pre-defined CTS tests are designed to follow the exact packet sequence defined in each CTS. For example, in JESD224A, the CTS test 8.1.3 "UFS\_ContextManagement\_03" requires the following specific packet sequence:

- 1. Issue Query Request Write Attribute command to set wContextConf for read and write operation
- 2. Issue READ (10) command
- 3. Issue WRITE (10) command
- 4. Issue Query Request Write Attribute command to clear wContextConf (INDEX = N).

Therefore, the TV test for UFS CTS 8.1.3 specifically requires a Query Request Write Attribute command followed by a Read (10) followed by a Write (10) followed by another Query Request Write Attribute command. If these packets are not found in this sequence the test will fail.

**Debug tests** are designed to analyze any trace, not just ones generated by the Exerciser for CTS, to find issues that are commonly associated with UniPro or UFS turn-on problems. Examples include Link Startup problems and Powermode Change failures. Debug tests are intended to be used with traces captured in either exerciser or analyzer mode. If no states in the captured trace match the criteria of the debug TV, the message "State machine did not run" will be generated. See APPENDIX E: DEBUG TEST DESCRIPTIONS for a list and explanation of these tests.

**SearchTVs** are tests created by Protocol Insight to search a trace for specific conditions. The application software library includes three search TVs, "Find UniPro Error Packets", "Find UFS Error Packets" and "Find Protocol Insight CTS Markers".

**Custom TV tests** can be created by the user, either from scratch or from a pre-defined test in the application software library. See the separate Trace Validation Editor User Manual for more information.

# Trace Validation Results - Group and Summarize

Analysis of results in the TV Results window can be done with grouping. To group click on any column header and drag into the Test Results field. This will summarize the results with an item count of occurrences. Multiple column headers can be dragged into the Test Results field (1) to create tiered groupings for analysis:



Figure 2: Grouping and Summarizing

**The item count** represents the number of items in the grouping below, so in this example (2) "Test Name: UniPro: Power Mode Change" counted 4 items, representing 4 different test results. This item count summing function can be manipulated with a high degree of flexibility by reordering the groupings to count different items in addition to tests, such as number of Failures (Status) or Rules.

**Summary Status flag:** for any grouping of results the summary status flag represents the worst-case result of the grouping (**3**). In this example, 4 results were determined for "Test Name: UniPro: Power Mode Change", and the worst result was a Failure so "Test Name: UniPro: Power Mode Change" is marked as Failure.

# Trace Validation Results - Sort and Filter

In the TV Results window any column header can be clicked to filter out results or to sort results by that column:



Figure 3: Sorting and Filtering

# UniPro and UFS Packet List windows

The Packet List windows display all packets. See UNIPRO AND UFS PACKET LIST WINDOW for more details.

# UniPro and UFS Events windows

The Events windows display all events in a trace, with separate rows for significant events such as speed changes, UniPro packets and UFS READs and WRITEs. Zooming is can be accomplished by dragging a zoom box in the Events window, and the controls on the left side of the Events window can undo zoom or otherwise control display zooming. See UNIPRO EVENTS WINDOW for more details.

# Packet Decode and Data View windows

To display the protocol decode of a packet of interest in the Packet Decode window click on the packet in the TV Results window or in the appropriate Packet List window. Hovering over a bit in the Packet Decode window displays additional decode information Selecting 8, 16, or 32 defines the bit width of the display. Full payload is displayed in the Data View window. See PACKET DECODE WINDOW and DATA VIEW WINDOW for more details.

# Analysis Reports

TV Results and Packet List reports can be created by configuring the appropriate window and then printing it. See **REPORTS MENU** for more information.

# Operational Overview and Theory of Operation

Trace Validation is the analysis engine for compliance/conformance testing (CTS), corner case, margin and automated stress testing, and sniffer-style trace capture, analysis and debug.

Trace Validation is a complex state machine system that processes analyzer traces algorithmically and applies state machine logic to packet sequences to verify conformance or compliance to the specifications.



Figure 4: Example UniPro Power Mode Change Trace Validation State Machine

# Interpreting Trace Validation Results

The Trace Validation engine performs protocol sequence and packet inspection with five possible status results for each rule check displayed in the Trace Validation Results window:

# Failure X

Any protocol sequence or packet that does not meet a rule specified in MIPI UniPro v1.1 CTS, the JEDEC JESD224 or JESD224A CTS, or as defined in a custom test case

#### Warning 🥂

Any protocol sequence or packet that does not conform to a "shall" specified in MIPI UniPro v1.61 spec, JEDEC JESD220x spec, or as defined in a custom test case

Pass

Any protocol sequence or packet that conforms to the UniPro spec and CTS and JEDEC spec and CTS.

#### Info

a

Info messages communicate the progress during the test or information about the packets, and are typically followed by a status result such as Pass or Failure. See example to the right, where there are several Info messages followed by a Success message and Pass status.

#### Test Name Test ID Rule Test ID Test Name Test Name: AFC Sequence Number Order (148 items) Test Name: AFC with CReq Set (8 items) Test Name: Check for Packet Errors (1 items) Test Name: CheckCredits (162343 items) Test Name: Data Frame TC0 Sequence Numbers (5 items) fest Name: Link Startup Sequence (9187 items) Test Name: NAC Transmission Disabled (2 items) Test Name: PACP\_GET\_req (1 items) Test Name: PACP\_SET\_req (356 items) Test Name: PowerModeChange (594 items) Test Name: Verify Control Frames (4 items) Test Name: Verify Data Frames (4 items) est Name: Verify NAC Transmission (12 items) est Name: Verify Outstanding Frames (400 items) Test Cases Completed: 434 Passed: 175 Failed Timeout

#### Debug **Q** (TV mode only)

Provides information on state machine execution of an inspection rule in Trace Validation if debug hooks were placed in the TV test case:



M Indicates an Action was executed. This could be a Log Message Action, Counter Action, or a Set or Modify Variable Action run by either a State or an Event.



🔘 Indicates that the Trace Validation engine transitioned into a new State.

Indicates that a Validator was tested and the result was true.

Indicates that a Validator was tested and the result was false.

The results can be grouped, summed, sorted and filtered by various test parameters or packet characteristics. See TRACE VALIDATION RESULTS - GROUP AND SUMMARIZE and TRACE VALIDATION RESULTS - SORT AND FILTER for more information.

# Test execution and Trace Validation analysis for Falcon exerciser

To execute compliance/conformance testing (CTS), corner case, margin and automated stress testing in "CTS and Exerciser + Analyzer" mode the test cases are initiated by the exerciser and the Trace Validation engine is used to verify the results. Trace Validation examines the trace to verify that the protocol sequences and packets conform to the UniPro or UFS CTS, specifications or custom tests. This flowchart shows the operation:



Figure 5: Test executive exerciser operation

**For UniPro CTS testing**, to locate the beginning of each test case in the trace a PACP\_SET\_req marker packet is inserted followed by the packet(s) necessary to commence the test. The marker packet contains a value that uniquely identifies the test case:

- The PACP\_SET\_req **MIBattribute** value identifies the author of the test case. The predefined ranges are listed below.
  - **OxFFFF** Test case authored by Protocol Insight
  - **0xFF00-0xFFFE** This range reserved
  - **0xF000-0xFEFF** Range available range for customer defined test cases.
- The **MIBvalue** identifies the specific test being executed:
  - **Domain (8 bits)** Used to define a category of test case for the given owner. Existing Protocol Insight domains are:
    - 01 CTS specific test cases
    - **02** Power mode tests

• **Case ID** (24 bits) – Identifies a specific test case within a given domain. Protocol Insight test cases follow a major, minor, revision style using 8 bits for each.

For example, the CTS test case 1.1.4 Invalid Configuration Request written by Protocol Insight would have a complete ID of 0x01010104.

**For UFS CTS testing**, to locate the beginning of each test case in the trace a NOP OUT packet is inserted with the follow reserved bits set:

- Reserved Bytes 12 & 13 Place the Protocol Insight Flag 0xFFFF
  - **OxFFFF** Test case authored by Protocol Insight
  - **0xFF00-0xFFFE** This range reserved
  - **0xF000-0xFEFF** Range available range for customer defined test cases.
- Reserved Bytes 14 17 The four parts of the test case ID
  - **Domain (8 bits)** Used to define a category of test case for the given owner. Existing Protocol Insight domains are:
    - **01** CTS specific test cases
    - 02 Power mode tests
  - **Case ID (24 bits)** Identifies a specific test case within a given domain. Protocol Insight test cases follow a major, minor, revision style using 8 bits for each.

# Test execution and Trace Validation analysis for analyzer

This flow charts shows the operation of the test executive for "sniffer" style Trace Validation analysis:



Figure 6: Trace Validation operation

# Warranty

For Product(s):

Protocol Insight warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Protocol Insight, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Protocol Insight for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Protocol Insight.

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# Appendix A: Resetting Your SQL Database

Follow these steps to reset your SQL database:

- 1. Launch Protocol Insight application software
- 2. Select Settings  $\rightarrow$  Database Settings
- 3. Enter the following
  - a. Server Name: "localhost\ProtocolInsight"
  - b. Database Name: "ProtocolInsight"
  - c. Authentication Type: "Windows Authentication"
- 4. Click **Repair Database**.

User Preferences	Instrument Config	Device Config	Database Config	Packet Display	Advanced Settings	
Server Name:		localhosť	\ProtocolInsight			
Database Nan	ne:	Protocoll	nsight			
Authentication Type:		Windows	Authentication			×
Test	Connection	Repair D	atabase			
For more inform	ation see the SQL Ser	rver Configuration	App Note	SQL Server (	Configuration App No	ote
Restore Factory	Settings			ОК	Apply	ancel

- 5. Click **Yes** on the warning message box
- 6. You should get a dialog box saying "Database was restored successfully"
- 7. You can now use the software normally

# Appendix B: Reconfiguring your SQL Database

Follow these steps to reconfigure your SQL database:

- 1. Launch Protocol Insight application software
- 2. Select Settings → Database Settings
- 3. Enter the following

**Server name:** Enter the SQL Server instance to connect to. By default this should be localhost\Protocolinsight.

**Database Name:** The name of the database on the server. By default this is Protocolinsight.

Server Name:	localhost\Protocolli	nsight		
Database Name:	ProtocolInsight			
Authentication Type:	Windows Authentic	ation		×
Test Connection	Repair Database		ОК	Cancel

**Authentication Type:** Two authentication modes are available when connecting to an instance of the Database Engine:

**Windows Authentication** - Microsoft Windows Authentication mode allows a user to connect through a Windows user account.

**SQL Server Authentication** - When a user connects with a specified login name and password from a non-trusted connection, SQL Server performs the authentication itself by checking to see if a SQL Server login account has been set up and if the specified password matches the one previously recorded. If the Authentication Type selected is SQL Server Authentication:

**User Name:** The SQL Server login id to connect to SQL Server should be "sa" if you are using the Default Password (see below).

**Password:** The Password to connect to SQL Server with.

**Use Default Password:** This will override the password with the default password for the sa account. User Name must be "sa" and the SQL Server install must be the default from installing the software.

When you have entered all the data, click Test Connection to make sure the server, database, and security are valid.

# Appendix C: Manually Installing Microsoft SQL Server

Follow these steps to manually install and configure your SQL database:

NOTE: If you are manually installing during setup, start with Step 3.

- 1. Obtain the SQL Server 2017 Express edition installation media from Microsoft
  - a. https://www.microsoft.com/en-us/download/details.aspx?id=55994
  - b. Click Download
- 2. Run SQLServer2017-SSEI-Expr.exe from your download location.
- 3. On the "Select an installation type" screen, choose Custom

<u>B</u> asic	<u>C</u> ustom	<u>D</u> ownload Media
Select Basic installation type to install the SQL Server Database Engine feature with default configuration.	Select Custom installation type to step through the SQL Server installation wizard and choose what you want to install. This installation type is detailed and takes longer than running the Basic install.	Download SQL Server setup files now and install them later on a machine of your choice.

- 4. Select a download media location and Click Install At this point the installation files will be downloaded from Microsoft. Once complete, the installation should start.
- 5. SQL Server Installation Center Click Installation on the list of options in the left pane
- 6. Click " New SQL Server stand-alone installation or add features to an existing installation"



- 7. Install Rules Verify that you don't have any required updates and click Next
- 8. Installation Type Choose Perform a new installation of SQL Server 2017 and click Next
- 9. License Terms Check I accept the license terms and click Next
- Features Selection Click the Unselect All button and then choose only the "Database Engine Services" feature. Click Next (You can optionally change the installation drive if you need to install to a drive other than C:\)

Feature Selection Select the Express features to i	nstall.		
Global Rules Product Updates Install Setup Files Installation Type License Terms Feature Selection Feature Rules Instance Configuration Server Configuration Database Engine Configuration Feature Configuration Rules Installation Progress Complete	Cooking for Reporting Servi Eestures:     Instance Features     Oatabase Engine Services     Ostabase Engine Services     A    Machine Learning Ser     R     Python     Full-Text and Semant     PolyBase Query Servi Shared Features     Client Tools Connectivity     Client Tools Connectivity     Select ∆II    Unselect AII	vices (In-Database) in vices (In-Database) ic Extractions for See	Includes the Database Engine, the core service for storing, processing and securing data. The Prerequisites for selected features:         Already installed:         Microsoft Visual C++ 2015 Redistributable         Windows PowerShell 3.0 or higher         Disk Space Requirements         Drive C: 1001 MB required, 121025 MB
	Instance goot directory: Shared feature directory: Shared feature directory ( <u>x</u> 86):	C:\Program Files\Mi C:\Program Files\Mi C:\Program Files (x8	icrosoft SQL Server\ icrosoft SQL Server\ 6)\Microsoft SQL Server\

11. Instance Configuration – Choose **Named Instance** and Enter "ProtocolInsight" as the instance name. The Instance ID should automatically update to "PROTOCOLINSIGHT". Click Next.

instance configuratio	on					
Specify the name and instan	ce ID for the instance of S0	QL Server. Instance ID	becomes part of the ir	stallation path.		
Global Rules	O <u>D</u> efault instance					
Product Updates Install Setup Files Install Rules Installation Type	Named instance:	Protocollnsight				
	Instance <u>I</u> D:	PROTOCOLINSIGHT				
icense Terms						
License Terms Feature Selection Feature Rules	SQL Server directory:	C:\Program Files\Mic	rosoft SQL Server\MS	SQL14.PROTOCOLI	NSIGHT	
License Terms Feature Selection Feature Rules I <b>nstance Configuration</b> Server Configuration	SQL Server directory: Installed instances:	C:\Program Files\Mic	rosoft SQL Server\MS	SQL14.PROTOCOLI	NSIGHT	
icense Terms eature Selection eature Rules <b>nstance Configuration</b> Server Configuration Jatabase Engine Configuration	SQL Server directory: Installed instances: Instance Name	C:\Program Files\Mic	rosoft SQL Server\MS Features	GQL14.PROTOCOLI	NSIGHT	sion
License Terms Feature Selection Feature Rules Instance Configuration Server Configuration Database Engine Configuration Feature Configuration Rules	SQL Server directory: Installed instances: Instance Name PPG	C:\Program Files\Mic	rosoft SQL Server\MSS Features SQLEngine	GQL14.PROTOCOLI Edition Developer	NSIGHT Ver 14.0	sion .1000.169
icense Terms Feature Selection Feature Rules Instance Configuration Server Configuration Database Engine Configuration Feature Configuration Rules	SQL Server directory: Installed instances: Instance Name PPG PROTOCOLINSIGHT	C:\Program Files\Mic Instance ID MSSQL14.PPG MSSQL14.PROTOC	rosoft SQL Server\MSS Features SQLEngine SQLEngine	Edition Eveloper Express	NSIGHT Ver 14.0 14.0	sion .1000.169 .1000.169
icense Terms Feature Selection iceature Rules Instance <b>Configuration</b> Database Engine Configuration reature Configuration Rules Installation Progress	SQL Server directory: Installed instances: Instance Name PPG PROTOCOLINSIGHT <shared compone<="" td=""><td>C\Program Files\Mic Instance ID MSSQL14.PPG MSSQL14.PROTOC</td><td>rosoft SQL Server\MSS Features SQLEngine SQLEngine Conn, BC, SDK</td><td>Edition Developer Express</td><td>Ver 14.0 14.0 14.0</td><td>sion .1000.169 .1000.169 .1000.169</td></shared>	C\Program Files\Mic Instance ID MSSQL14.PPG MSSQL14.PROTOC	rosoft SQL Server\MSS Features SQLEngine SQLEngine Conn, BC, SDK	Edition Developer Express	Ver 14.0 14.0 14.0	sion .1000.169 .1000.169 .1000.169
License Terms Feature Selection Feature Rules Instance Configuration Server Configuration Database Engine Configuration Database Engine Configuration Rules Installation Progress Complete	SQL Server directory: Installed instances: Instance Name PPG PROTOCOLINSIGHT <shared compone<br=""><shared compone<="" td=""><td>C:\Program Files\Mic Instance ID MSSQL14.PPG MSSQL14.PROTOC</td><td>Features SQLEngine SQLEngine Conn, BC, SDK SSMS, Adv_SSMS</td><td>Edition Developer Express</td><td>Ver 14.0 14.0 14.0 13.0</td><td>sion .1000.169 .1000.169 .1000.169 .15700.28</td></shared></shared>	C:\Program Files\Mic Instance ID MSSQL14.PPG MSSQL14.PROTOC	Features SQLEngine SQLEngine Conn, BC, SDK SSMS, Adv_SSMS	Edition Developer Express	Ver 14.0 14.0 14.0 13.0	sion .1000.169 .1000.169 .1000.169 .15700.28
License Terms Feature Selection Feature Rules Instance Configuration Server Configuration Database Engine Configuration Feature Configuration Rules Installation Progress Complete	SQL Server directory: Instajled instances: Instance Name PPG PROTOCOLINSIGHT <shared compone<br=""><shared compone<="" td=""><td>C:\Program Files\Mic Instance ID MSSQL14.PPG MSSQL14.PROTOC</td><td>Features SQLEngine SQLEngine Conn, BC, SDK SSMS, Adv_SSMS,</td><td>Edition Developer Express</td><td>NSIGHT 14.0 14.0 14.0 13.0 12.0</td><td>sion .1000.169 .1000.169 .1000.169 .15700.28 .2569.0</td></shared></shared>	C:\Program Files\Mic Instance ID MSSQL14.PPG MSSQL14.PROTOC	Features SQLEngine SQLEngine Conn, BC, SDK SSMS, Adv_SSMS,	Edition Developer Express	NSIGHT 14.0 14.0 14.0 13.0 12.0	sion .1000.169 .1000.169 .1000.169 .15700.28 .2569.0

- 12. Server Configuration Leave the default options, click Next.
- 13. Database Engine Configuration Click the **Add Current User** button if the current windows user is not listed in the **Specify SQL Server administrators** box. Click Next.
- 14. Wait for the installation to complete and click Finish.

# Appendix D: Discovering UFS Device Configuration Values

Select LUN 0, Boot LUN, UFS Device LUN, Report LUNs, and NONE LUN and then run the following tests to obtain the necessary device information to configurate the Device:

- Device Configuration: "Device Descriptor Values"
  - All values for this can be found by looking at the response of test case 8.4.1 ReadDescriptor\_01
- Device Configuration: "Geometry Descriptor Values"
  - All values for this can be found by looking at the response of test case 8.4.9 ReadDescriptor\_09
- UFS LUN Configuration: "Read-Write recovery mode page"
  - These values are vendor specific, default to unselected. The standard does not define which Read-Write Error Recovery mode page fields are changeable.
- UFS LUN Configuration:
  - Some values for this can be found by looking at the response of test case 8.4.3 ReadDescriptor\_03
  - Select all configured LUNs in the Configuration window
    - Set the correct values for the following:
    - bProvisioning set to 0x2 or 0x3
    - MaxContextID=0 can be found from wContextCapabilities, bits [3:0] is MaxContextID
- Run test case 7.7.2 ReadCapacity\_10. In the LUN Configuration pane set the MAX addressable LBA from the RETURNED LOGICAL BLOCK ADDRESS response field in the READ CAPACITY 10 response packet. Also set the qLogicalBlockCount and bLogicalBlockSize.
- Min Page code should be fine at 0x02 (Vendor Specific)
- IMMD (Vendor Specific)
- "Mode Page PS Values" and "Mode Saveable"
  - All values for this can be found by looking at the response of test cases 7.3.2 ModeSense\_02, 7.3.6 ModeSense\_06 and 7.3.10 ModeSense\_10.

# Appendix E: Debug Test Descriptions

## UFS Debug Tests

#### UFS Stimulus

The following stimulus tests perform as the test name implies. For example, the "Read BusyRTC Flag" reads the BusyRTC flag.

Read BackgroundOpsEn Flag Read BusyRTC Flag *Read Configuration Descriptor* Read Device Descriptor *Read Device Health Descriptor* Read Device Init Flag Read DeviceLifeSpanModeEn Flag Read Geometry Descriptor Read Interconnect Descriptor Read Manufacturer Name String Descriptor Read OEM ID String Descriptor Read PermanentWPEn Flag Read PermanentlyDisableFwUpdate Flag Read PhyResourceRemoval Flag *Read Power Parameters Descriptor* Read PowerOnWPEn Flag *Read Product Name String Descriptor Read Product Rev Level String Descriptor* Read PurgeEnable Flag Read RPMB Unit Descriptor Read RefreshEnable Flag Read Serial Number String Descriptor *Read Unit Descriptor* Read bActiveICCLevel Attribute Read bBackgroundOpStatus Attribute

Read bBootLunEn Attribute Read bConfigDescrLock Attribute Read bCurrentPowerMode Attribute Read bDeviceCaseRoughTemperature Attribute Read bDeviceFFUStatus Attribute Read bDeviceTooHighTempBoundary Attribute Read bDeviceTooLowTempBoundary Attribute Read bMaxDataInSize Attribute Read bMaxDataOutSize Attribute Read bOutOfOrderDataEn Attribute *Read bPSAState Attribute* Read bPurgeStatus Attribute Read bRefClkFreq Attribute Read bRefClkGatingWaitTime Attribute Read bRefreshFreq Attribute Read bRefreshMethod Attribute Read bRefreshUnit Attribute Read dDynCapNeeded Attribute Read dPSADataSize Attribute Read dSecondsPassed Attribute Read wContextConf Attribute Read wExceptionEventControl Attribute Read wExceptionEventStatus Attribute

#### **UFS Trace Validation**

#### Command Response

This test checks that every Command sent by the tester receives a Response from the DUT.

#### Latency

This Trace Validation test is a generic framework which can be customized to measure latency response between packets. It will measure and compute the min, max, and average latency between packets of interest. In addition, it has a threshold value, vLatencyThreshold, defined in the Idle state that can be used to set a Pass/Fail criteria on the measured latency. It looks for packets in either direction but can be modified to look only in one direction by using Metadata Validators. This framework was used to create the **Command Response** and **DataIn Packet** latency tests.

#### Latency Command Response

This test measures the latency between a Command transaction code and a Response transaction code. It looks for packets in both directions. The vLatencyThreshold variable in the Idle state can be modified to set a Pass/Fail criteria. The resulting measurement value is in pSec.

#### Latency DataIn Packet

This test measures the latency between a Read Command and the DATAIN response. It looks for packets in both directions. The vLatencyThreshold variable in the Idle state can be modified to set a Pass / Fail criteria. The resulting measurement value is in pSec.

#### *READ(10)*

This test will check for the correct response to READ(10) / WRITE(10) commands from the tester to the DUT. It looks for errors and verifies the correct number of DATA IN / DATA OUT packets.

#### Transaction Response

This test verifies all UFS commands sent by the tester have an appropriate response. It returns the number of commands it finds.

#### WRITE)10)

This test will check for the correct response to READ(10) / WRITE(10) commands from the tester to the DUT. It looks for errors and verifies the correct number of DATA IN / DATA OUT packets.

## UniPro Debug Tests

#### UniPro Stimulus

#### FrameSeqNumNAC

This stimulus test generates data frames with an invalid Frame Sequence Number. It tests the DUTs ability to respond correctly to invalid Frame Sequence Numbers.

#### Generate Eye Monitor Traffic

This stimulus test can be used to generate suitable traffic for building eye patterns using the Eye Monitor under Tools  $\rightarrow$  Eye Monitor

HS-Gx-RateX\_Terminated (multiple tests) HS-Gx-RateX\_Unterminated (multiple tests)

#### *PWM-Gx (multiple tests)*

The above three stimulus test groups test the ability to send and receive one data packet at the specified settings.

TTCErr Type4Err Type7Err TypeAFCErr TypeEOFEvenErr TypeEOFOddErr

## TypeNACErr

The above seven Err stimulus tests generate the type of error implied in their name. They are useful for verifying the DUT response to error conditions.

#### UniPro Trace Validation

#### AFC Sequence Number Order

This test case verifies that AFC sequence numbers are in order. It accounts for Hibernate and AFC frames with errors.

#### AFC with CReq Set

This test verifies that an AFC with CReq set to 0 is sent in response to an AFC with the CReq bit set.

#### Check for Packet Errors

Checks entire trace for any UniPro packet errors.

#### CheckCredits

This test tracks the number of credits sent between the tester and DUT and reports errors if there are too many credits available or too many bad data frames

#### CountMessages

This trace validation counts the number of data frames seen both up and down and reports that number.

#### Data Frame TCO Sequence Numbers

This test tracks the sequence numbers of the data frames and checks for proper replay of NAC'd data frames.

#### *IO Throughput*

This trace validation calculates the instantaneous and average Data Frame throughput from and to the DUT. Clicking on an IO Throughput message (Rule) in the TV Results window will move the cursor to the Data Frame packet that is the subject of that throughput measurement.

#### Link Startup Sequence

This test verifies proper progression through the seven phases of link startup, in both directions.

#### NAC Transmission Disabled

This test verifies that NAC transmission is disabled until the DL Layer receives one Data or Control frame without any error.

#### PACP\_GET\_req

This test verifies that all get requests are acknowledged with a PACP\_GET\_cnf.

## PACP\_SET\_req

This test verifies that all set requests with the cnf bit set are acknowledged with a PACP\_SET\_cnf.

#### PowerModeChange

This test verifies that a PACP\_PWR\_req power mode change request is properly handled.

#### Verify Control Frames

This test verifies all of the fields in a control frame and checks for any error.

#### Verify Data Frames

This test verifies all of the fields in a data frame and checks for any error.

#### Verify NAC Transmission

This test looks for bad packets and checks for a corresponding NAC. It also looks for unexpected NACs.

#### Verify Outstanding Frames

This test verifies that there is no more than 16 outstanding data frames that are unacknowledged.

## Appendix F: Steaming Capture

If Streaming is selected as the Capture Type in Capture Options in the Instrument Configuration tab from Menu $\rightarrow$ Settings the instrument will write the captured trace to the controller PC's SSD drive.

As a trace is captured it is buffered through the instrument memory (8GB) to the controller PC's system RAM (configurable, with default value of 4x1GB=4GB) and then saved to the SSD disk. The application software will DMA data from the instrument memory to System RAM over the thunderbolt cable; with a x4 Thunderbolt connection and compliant cable the transfer speeds should be ~2.4GB/s. In parallel the application moves data from the System RAM to disk. The transfer rate from System Ram to disk is dependent on system and the disk performance; with the best NVMe disks speeds of ~2.5GB/s are typical.

Streaming Buffer Usage in the Instrument Status window displays a graphical representation of the amount of the instrument's embedded memory and the controller PC's system RAM that is being used as a buffer as the trace is being written to the Streaming File on disk. On a controller PC with a slower SSD write speed, the system RAM will fill up first, then the instrument's buffer. Once the analyzer capture has stopped the Streaming Buffer Usage will gradually decrease down to zero as all data is written from the buffers to the disk, and Streaming File Usage will stop incrementing and show the final trace size.

Instrument Configuration  $\rightarrow$  Streaming Performance Test can be used to characterize the system. This reports the achievable DMA bandwidth instrument to System RAM and from System RAM to disk. If the system does not meet the needed performance the System RAM buffer can be increased in Streaming Settings in the Settings  $\rightarrow$  Advanced Settings tab. The max size of the System RAM buffer is only limited by the amount of RAM on the system; we recommend leaving at least 16GB of RAM for the application SW and other programs to use, so on 16GB we recommend using the default values of 4GB, on a 32GB system you can use up to 16GB.

## Appendix 1: Hardware Specifications

Product specifications are subject to change without notice.

## Falcon G300B/G400B series, Raptor M series

## Falcon G400 series, Falcon G300 series (shipped after 1/22/2018)

#### Analyzer

M-PHY Type-I Speeds:

High-Speed (HS) Gear1, Gear2, Gear3 A/B, and Gear 4 A/B modes

Low-speed Pulse-width Modulation (PWM) Gear1 to Gear4 in Type-I LS implementation

Link Width: x1 and x2

Trace capture memory depth: 8 GB

Probing:

Falcon G300B/G350B/G400B/G450B, Raptor M300/M400: SMP, solder-down Falcon G300/G350/G400/G450: SMA, solder-down

#### Exerciser

M-PHY Type-I

Speeds:

High-Speed (HS) Gear1, Gear2, Gear3 A/B, and Gear 4 A/B modes

Low-speed Pulse-width Modulation (PWM) Gear1 to Gear4 in Type-I LS implementation Link Width: x1 and x2

Trace capture memory depth: 8 GB, shared between exerciser and analyzer Probing:

Falcon G300B/G350B/G400B/G450B, Raptor M300/M400: SMP Falcon G300/G350/G400/G450: SMA

## **Advanced Trigger**

States: 4 N way branching, Trigger In, Trigger Out, Go To State
Packet Matchers: 5 per direction (8 Symbol Matchers each).
Additional State/FLR/SKP matcher: 2 per direction
Counters: 2
Compare Actions: < (Less Than), == (Equal), > (Greater Than), >= (Greater Than OR Equal)
Modify Actions: Hold (No Change), Count + 1 (Increment), Count - 1 (Decrement)

Only one Compare Action per Counter can be defined in a trigger. That one Compare Action is available in all states. You can't program "Counter1 < 5" in one state and then "Counter1 > 5" in another state. If you program "Counter1 < 5" in one state then that is the only Compare Action available for Counter1 in any state of the trigger. Either or both counters can be incremented or decremented in each state.

#### DUT Requirements to sync analyzer to a UniPro link

Spec	Typical
256 Symbols, 0x48 Capability value	64 Symbols, 0x46 Capability value
256 Symbols, 0x48 Capability value	64 Symbols, 0x46 Capability value
256 Symbols, 0x48 Capability value	64 Symbols, 0x46 Capability value
256 Symbols, 0x48 Capability value	64 Symbols, 0x46 Capability value
	<b>Spec</b> 256 Symbols, 0x48 Capability value 256 Symbols, 0x48 Capability value 256 Symbols, 0x48 Capability value 256 Symbols, 0x48 Capability value

TxHsG1PrepareLength(0x1553)	0xA Capability value	0x3 Capability value
TxHsG2PrepareLength(0x1554)	0xA Capability value	0x3 Capability value
TxHsG3PrepareLength(0x1557)	0xA Capability value	0x3 Capability value
TxHsG4PrepareLength(0x15D1)	0xA Capability value	0x3 Capability value
RxLsPrepareLength	0xA Capability value	0x1 Capability value
RxPwmBurstClosureLength	0x1F Capability value	0x1 Capability value
To sync to existing link	one Start of Burst	one Start of Burst

The typical settings assume configuration with 50/50 splitter and recommended cables. Actual performance may vary depending on the probing and the signal integrity of the DUT.

## DUT Requirements to establish a UniPro link with the Falcon exerciser

The device must execute a UniPro 1.61 or 1.8 compliant Link Startup Sequence.

## Falcon G300 series (shipped before 1/22/2018)

#### Analyzer

M-PHY Type-I Speeds:

High-Speed (HS) Gear1, Gear2, and Gear3 A/B modes

Low-speed Pulse-width Modulation (PWM) Gear1 to Gear4 in Type-I LS implementation

Link Width: x1 and x2

Trace capture memory depth: 8 GB

Probing: SMA and solder-down available

#### Exerciser

M-PHY Type-I Speeds: High-Speed (HS) Gear1, Gear2, and Gear3 A/B modes Low-speed Pulse-width Modulation (PWM) Gear1 to Gear4 in Type-I LS implementation Link Width: x1 and x2 Trace capture memory depth: 8 GB, shared between exerciser and analyzer Probing: SMA required for exerciser functionality

#### **Advanced Trigger**

States: 4 N way branching, Trigger In, Trigger Out, Go To State
Packet Matchers: 5 per direction (8 Symbol Matchers each).
Additional State/FLR/SKP matcher: 2 per direction
Counters: 2
Compare Actions: < (Less Than), == (Equal), > (Greater Than), >= (Greater Than OR Equal)
Modify Actions: Hold (No Change), Count + 1 (Increment), Count - 1 (Decrement)

Only one Compare Action per Counter can be defined in a trigger. That one Compare Action is available in all states. You can't program "Counter1 < 5" in one state and then "Counter1 > 5" in another state. If you program "Counter1 < 5" in one state then that is the only Compare Action available for Counter1 in any state of the trigger. Either or both counters can be incremented or decremented in each state.

#### DUT Requirements to sync analyzer to a UniPro link

Attribute	Typical
TxHsG1SyncLength (0x1552)	16 symbols, 0x44 Capability value
TxHsG2SyncLength (0x1555)	16 symbols, 0x44 Capability value
TxHsG3SyncLength (0x1556)	16 symbols, 0x44 Capability value
TxHsG1PrepareLength(0x1553)	Oxb capability value
TxHsG2PrepareLength(0x1554)	0xb capability value
TxHsG3PrepareLength(0x1557)	0xb Capability value
RxLsPrepareLength	0x8 Capability value
RxPwmBurstClosureLength	0x1f Capability value
To sync to existing link	one Start of Burst

Typical settings assume configuration with 50/50 splitter and recommended cables. Actual performance may vary depending on the probing and the signal integrity of the DUT.

#### DUT Requirements to establish a UniPro link with the Falcon exerciser

The device must execute a UniPro 1.61 compliant Link Startup Sequence.

#### I/O Signals and Voltage Outputs - Falcon G300B/400B series, Raptor M series

UFS reference clock output: 19.2, 26, 38.4 and 52 MHz at 1.2V  $\,$ 

UFS\_Reset\_N or RST: 1.2V output ± 0.3V

JESD220x requires CLK and RST voltage of 0.65\*VCCQ - VCCQ+1.3. This is 0.715-1.6V min and max VCCQ and 0.78-1.5V typical VCCQ. The output voltage changes depending on the load impedance of the DUT; open circuit voltage is 1.3V and at  $50\Omega$  a voltage of 0.90V is supported.

Trigger in to the analyzer:  $1.8V \pm 0.3V$  required. Trigger out from the analyzer:  $1.8V \pm 0.3V$  generated.

Front panel probe power ±4V

#### I/O Signals and Voltage Outputs - Falcon G300/400 series

The UFS reference clock output:19.2, 26, 38.4 and 52 MHz at 1.8V. The UFS\_Reset\_N or RST: 1.8V output. Trigger in to the analyzer:  $1.8V \pm 0.3V$  required. Trigger out from the analyzer:  $1.8V \pm 0.3V$  generated.

## **Physical Characteristics**

#### Falcon G300B/400B series, Raptor M series

Dimensions	12.7" x 2.7" x 9.9", 32.4cm x 6.9cm x 25.0cm
	Bumper adds 0.21", or 5mm to the height and 0.28" or 7mm to the width.
Weight	5.9lbs, 2.7kg
Package Dimen	sions 18" x 18" x 11", 45.72cm x 45.72cm x 27.94 cm
Package Weigh	t 12.0lbs, 5.4kg
Falcon G300/G400 se	ries

Dimensions	13.6" x 3.0" x 12.12", 34.54cm x 7.62cm x30.78cm
Weight	10.2lbs, 4.6kg
Package Dimensions	18" x 18" x 11", 45.72cm x 45.72cm x 27.94cm
Package Weight	16.3lbs, 7.4kg

## **Operating Conditions**

Falcon, Falcon B and Raptor are suitable for use in dry indoor lab locations not exceeding 35°C, and are to be installed in accordance with the all local and national codes. They are not intended for use in hazardous locations.

## Safety, Compliance and Environmental Information



Conforms to UL STD 60950-1 Certified to CSA STD C22.2 # 60950-1 ETL Control Number: 5009155

CE

Complies with IEC 60950-1:2005 (Second Edition) + Am 1:2009 + Am 2:2013 Manufacturer's Declaration of Conformity to European Directive 2014/35/EU (Low Voltage Directive)

#### Compliant with

CISPR 24:2015 Issue:2015 Ed:2.1 Information technology equipment - Immunity characteristics - Limits and methods of measurement

CISPR 32 2015 COR 1 2016 Electromagnetic compatibility of multimedia equipment - Emission requirements

EN 55024:2010 Information technology equipment - Immunity characteristics - Limits and methods of measurement

EN 55032:2012 Electromagnetic compatibility of multimedia equipment - Emission requirements

EN 61000-3-2:2014 Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current  $\leq$  16 A per phase)

EN 61000-3-3:2017 Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to Conditional Connection

IEC 61000-3-2(Ed:4.0): 2014-05, EN 61000-3-2: 2014-08 Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits For Harmonic Current Emissions (Equipment Input Current <= 16 A Per Phase)

IEC 61000-3-3 Ed. 3.1 b:2017 Electromagnetic compatibility (EMC) - Part 3-3: Limits -Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to Conditional Connection

FCC 47CFR 15: 2016 Telecommunication, Radio Frequency Devices

ICES-003: 2016 Issue 6, Information Technology Equipment (Including Digital Apparatus) — Limits and Methods of Measurement

Compliant with the European Union directive 2002/95/EC and 2011/65/EU on the Restriction of the use of certain hazardous substances in electrical and electronic equipment and components (RoHS).

# Export Control Classification Number (ECCN) and Schedule-B Harmonization Code

No. 3B992 b.4.b.1, No License Required

US Export Schedule-B harmonization code: 9030.89.0100

Country of Manufacture: USA

# Appendix 2: System Requirements

Power requirements – external power supply

- EDAC Power Electronics Co., Ltd model EA1068
- Universal AC input 100 to 240V AC
- Output: DC +12V/6A
- Frequency: 50 to 60Hz
- Safety: UL/CUL, TUV, CB, FCC, CCC, CE, PSE, KC Mark
- Meets RoHS and WEEE

#### Host PC requirements

Basic configuration:

- Intel<sup>®</sup> Core<sup>™</sup> i7 or i9 processor or equivalent.
- 32 GB RAM recommended, 16 GB minimum.
- NVMe solid state drive with 500GB free space recommended, 256GB minimum free space.
- <u>Thunderbolt 3</u> enabled type-c connector required.

To take full advantage of streaming capture with v2.0.0 and later FW/SW we recommend:

- The fastest processor available, e.g. Intel i9-8950HK Processor (4.8GHz turbo)
- 64GB of RAM recommended, 32GB minimum
- 1TB NMVe SSD with Sustained Write Bandwidth of 2.5GB/s recommended, 2.1GB/s minimum
- <u>Thunderbolt 3</u> enabled type-c connector required.

Software requirements

- Windows 10 64-bit operating system
- Microsoft SQL Server 2014 or later
- Microsoft Visual Studio 2015 Community or Professional editions or

Microsoft Visual Studio 2015 Isolated Shell

• Protocol Insight application software and firmware version 1.0.4872 or later. Note: v1.4.4.6327 or later software and firmware is required to support the Falcon G400 series.

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