

### FEATURES & BENEFITS

- Accurate capture of 8.0 GT/s, 5.0 GT/s, and 2.5 GT/s
- Decode all PCI Express traffic including TLP, DLLP and ordered sets
- LTSSM state and sub-state diagrams to help identify and troubleshoot link-up issues
- Interposers supported: slot/AIC, U.2 (SFF-8639), M.2, SFF-8644 (coming soon)
- Complete and precise protocol capture and analysis of PCIe (up to Gen3) and Non-Volatile Memory Express (NVMe)
- Dedicated appliance; no swapping blades or modules
- Portable: Micro easily fits in a briefcase

### ADVANTAGES

- Zero Calibration.
- Trace is usable immediately.
- Breakthrough hardware can
  - Filter by BDF
  - Trigger on native NVMe
  - Immediately render NVMe without a boot trace
- Easily search for specific packets, primitives, ordered sets, addresses, or other events with the Quick Search and Advanced Search functions
- Field layouts matching the PCI Express specifications
- Buffer sizes up to 72 GB
- Lower TCO with standard cables and innovative interposers

SerialTek provides two market-leading PCI Express® (PCIe®) analysis solutions, the BusXpert PRO and the BusXpert Micro II (see figure 1), for PCIe (including Non-Volatile Memory Express® or NVMe) technology design and validation, including host bus storage adapters, computer systems, servers, and storage products. All SerialTek PCIe analysis products are compliant with the PCIe 1.x, 2.x and 3.0 specifications.

SerialTek analyzers “passively” capture all PCIe bus traffic without re-timing or re-transmitting bus signals—there is no masking or “cleaning up” of low-level link issues. In addition, SerialTek’s proprietary hardware natively captures, filters, triggers, and decodes BDFs and NVMe queues **without**

**the need to capture boot-up.** And development cycles are shortened because everything – including NVMe! – is ready to view in seconds (no need to save off the trace, first), and BusXpert’s intuitive software interface virtually eliminates the learning curve.


Several cost-effective and flexible PCIe interposers are available for BusXpert Analyzer users. High signal integrity on these industry-leading products means that users can capture PCIe and NVMe traffic via add-in card (AIC) (also known as “Slot” or “Card Edge”), U.2 (SFF-8639), and M.2 interposers at speeds of 8.0 GT/s (Gen3), 5.0 GT/s (Gen2), and 2.5 GT/s (Gen1) with **no configuration**. This contrasts greatly with competing solutions with a nearly impossible number of interposer and signal equalization options. The REFCLK is also brought out to oscilloscope connectors for CEM-level development and troubleshooting.


Low-cost SFF-8644 cables are used to connect the interposers to the SerialTek PCIe Analyzer. Unlike competing cables, which are bulky and can cost thousands, SFF-8644 cables are reliable, cost-effective, and easy to handle – an important factor in any PCIe® analyzer total cost of ownership (TCO) calculation.



**Figure 1: The BusXpert Micro 2 PCIe/NVMe Analyzer measures 7 inches x 10 inches x 2**

### Analyzer Specifications

x4 Micro II PCIe Analyzer		
	<b>Model Numbers</b>	PE-1MIA2-0403
	<b>Trace Buffer (Maximum)</b>	36GB
	<b>Data Rates Supported</b>	2.5, 5.0, and 8.0 GT/s
	<b>Widths Supported</b>	x1, x2, x4
	<b>Front Panel LEDs</b>	PCIe Status: Activity, TLP, ERR STS, CRC ERR Coding Err, Training; Speed: Gen1, Gen2, Gen3; Analyzer: Config, Ethernet, USB, Run, Trigger.
	<b>Impedance (Differential)</b>	95 Ohms (+/- 5%)
	<b>Power</b>	19.5V-9.23A; 180W Max Power (External Switching Power Adapter provided by SerialTek)
	<b>Dimensions</b>	7in (width) x 10in (depth) x 2in (height) / 178mm x 254mm x 51mm
	<b>Weight</b>	4.5 lbs / 2 kgs
	<b>Environmental</b>	Operating: 40 Degrees C Max Ambient Temperature

x8 PRO PCIe Analyzer		
	<b>Model Numbers</b>	PE-1PRA1-080318-000
	<b>Trace Buffer (Maximum)</b>	72GB
	<b>Data Rates Supported</b>	2.5, 5.0, and 8.0 GT/s
	<b>Widths Supported</b>	x1, x2, x4, x8
	<b>Front Panel LEDs</b>	PCIe Status: Activity, TLP, ERR STS, CRC ERR Coding Err, Training; Speed: Gen1, Gen2, Gen3; Analyzer: Config, Ethernet, USB, Run, Trigger.
	<b>Impedance (Differential)</b>	95 Ohms (+/- 5%)
	<b>Power</b>	100-240VAC 47-63Hz; 500W Max
	<b>Dimensions</b>	16 in(depth) x 14 in (width) x 3.5" (height) / 406mm x 356mm x 89mm
	<b>Weight</b>	14.5 lbs / 6.6 kgs
	<b>Environmental</b>	Operating: 40 Degrees C Max Ambient Temperature

### Interposers

x4, x8 AIC (Slot, Card Edge)	x4 U.2 (incl. dualport)	x4 M.2
		



### FEATURES & BENEFITS

- Interposers offered include: AIC (slot), M.2, and U.2. SFF-8644 coming soon
- Compliant with PCI Express 1.x, 2.x and 3.0 specifications
- Designed to capture PCIe® and NVMe® data at 8.0 GT/s, 5.0 GT/s and 2.5 GT/s
- Zero calibration required
- “Passive” tapping to avoid masking, hiding, or “cleaning up” electrical and/or link issues

### ADVANTAGES

- Adaptive slot interposers operate at various bus widths providing significant overall solution cost savings. The x8 slot interposer can operate at x1, x2, x4, and x8; the x4 can operate at x1, x2, and x4
- A single U.2 (SFF8639) interposer provides both dual-port (2x2) and single-port (x1, x2, or x4) analysis
- U.2 interposer comes in standard and extended lengths to accommodate all drive bays
- Low-cost, flexible, high-performance cabling for reliable analyzer-to-interposer connections provides real cost advantages over competing solutions that use cumbersome, bulky, and expensive iPass-type cabling
- Mini-SMP outputs for REFCLK# (varies by model)

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Several cost-effective and flexible PCIe® Interposer options are available. These interposer solutions are designed to provide maximum



Figure 1: PCIe Gen3 x4, x8 Slot/AIC Interposer.




performance with minimal configuration when capturing PCI Express communication data between hosts and devices. SerialTek’s latest generation of interposers delivers top performance with zero user-side calibration required.

The most commonly used interposer is the add-in card (AIC) form-factor (also known as “Slot” or “Card Edge”). High signal integrity on this industry-leading interposer makes it ideal not only for AIC PCIe analysis but also for M.2, U.2 (SFF-8639), and other PCIe connectors via adapters.

In addition to AIC, SerialTek provides native U.2 and M.2 interposers. The U.2 interposer combines single-port (1x4) and dual-port (2x2) functionality and is compatible with SSD cartridges, creating a perfect fit in any server. The U.2 interposer also comes in two depths to accommodate all drive bay geometries. The M.2 interposer has four Host/Socket adapters (HSAs) for all current M.2 form factors.

All BusXpert interposers provide header pins to select sideband signals for analysis and a REFCLK-oscilloscope SFL interface. Low-cost SFF-8644-based cabling connects the interposer to the Analyzer. All interposers are compatible with both the BusXpert PCIe/NVMe PRO (part number PE-1PRA1-080318-000) and BusXpert PCIe/NVMe Micro II (part number PE-1MIA2-0403) Analyzers.

**Interposer and Analyzer Specifications**

<b>x4, x8 AIC/Slot Interposer</b>		
	<b>Model Numbers</b>	PE-1SLI1-0304-000, PE-1SLI1-0308-000
	<b>Specification Compliancy</b>	PCIe 1.x, 2.x, 3.0
	<b>Data Rates Supported</b>	2.5, 5.0, and 8.0 GT/s
	<b>Widths Supported</b>	x1, x2, x4
	<b>Analyzer Connector</b>	SFF8644 (SerialTek proprietary)
	<b>Impedance (Differential)</b>	95 Ohms (+/- 5%)
	<b>Power</b>	12V DC External
	<b>Dimensions</b>	9.9 in (length) x 3.6 in (height) / 251mm x 91mm
	<b>Weight</b>	5.4 oz / 153 grams
<b>x4 U.2/SFF8639 Interposer</b>		
	<b>Model Numbers</b>	PE-2U2I1-0304-000
	<b>Specification Compliancy</b>	PCIe 1.x, 2.x, 3.0
	<b>Data Rates Supported</b>	2.5, 5.0, and 8.0 GT/s
	<b>Widths Supported</b>	x1, x2, x4
	<b>Analyzer Connector</b>	SFF8644 (SerialTek proprietary)
	<b>Impedance (Differential)</b>	95 Ohms (+/- 5%)
	<b>Power</b>	12V DC External
	<b>Dimensions (Length x Width (nose length))</b>	Standard: 13.25in x 6.50in (5.375in) 337mm x 165mm (136mm) Extended: 17.50in x 6.50in (9.376in) 445mm x 165mm (238mm)
	<b>Weight</b>	13.10 oz / 371 grams
<b>x4 M.2 Interposer</b>		
	<b>Model Numbers</b>	PE-1M2I1-0304-000
	<b>Specification Compliancy</b>	PCIe 1.x, 2.x, 3.0
	<b>Data Rates Supported</b>	2.5, 5.0, and 8.0 GT/s
	<b>Widths Supported</b>	x1, x2, x4
	<b>Analyzer Connector</b>	SFF8644 (SerialTek proprietary)
	<b>Impedance (Differential)</b>	95 Ohms (+/- 5%)
	<b>Power</b>	12V DC External
	<b>Dimensions</b>	9.9 in (length) x 3.6 in (height) / 251mm x 91mm
	<b>Weight</b>	5.4 oz / 153 grams



### FEATURES & BENEFITS

- Fast: traces come up in seconds – even NVMe
- Optimized: see PCIe and NVMe configuration and transactions without capturing bootup (incl. hotswap)
- Configurable: drag, drop, dock, and resize views. Customize colors to highlight key events. Hide or rearrange columns
- Clean: debug faster using only the views you choose
- Free: software support is free and always will be. Colleagues download the full software at no additional cost

SerialTek provides two market-leading PCI Express® (PCIe®) analysis solutions, the BusXpert PRO and the BusXpert Micro II, for PCIe (including Non-Volatile Memory Express® or NVMe) technology design and validation, including host bus storage adapters, computer systems, servers, and storage products. All SerialTek PCIe analysis products are compliant with the PCIe 1.x, 2.x and 3.0 specifications.

For all of the PCIe BusXpert’s hardware innovations, it’s in working with the captured trace that the BusXpert truly shines. Multiple views at various layers of abstraction give a customizable display of the trace. One-click Quick Show, Hide, and Search; Advanced Search, Show, and Hide; one-click toggling between PCIe, NVMe, LTSSM, Upstream, and Downstream—and much more—all work to expedite trace analysis.

**Figure 1 (right): Transaction View aggregates all events in a transaction and expands to show individual events. Configurable columns give additional information.**

Time	Channel	Command	Status	Transfer Size	Data Preview	Speed
13.802.420.053.000	[Down 1, Up 1]	Memory Read Request	Successful Completion	4 0000000h		8.0
13.803.430.555.000	[Down 1, Up 1]	Memory Read Request	Successful Completion	4 0000000h		8.0
13.804.441.963.000	[Down 1, Up 1]	Memory Read Request	Successful Completion	4 0000000h		8.0
13.804.442.047.000	Up 1	TLP Memory Read Request (0x822)				
13.804.614.400.000	Up 1	DLLP Ack (0x822)				
13.804.614.442.000	Down 1	TLP Completion With Data (0x819)				
13.804.615.078.000	[Down 1, Up 1]	Memory Write Request	Transaction Complete	4 0000000h		8.0
13.804.615.078.000	Down 1	TLP Memory Write Request (0x823)				
13.804.615.164.500	Up 1	DLLP Ack (0x823)				
13.804.615.129.000	[Down 1, Up 1]	Memory Read Request	Successful Completion	4 0000000h		8.0
13.804.615.654.000	[Up 1, Down 1]	Memory Read Request	Successful Completion	64 00000009h 00000000h 0...		8.0
13.804.653.788.500	[Up 1, Down 1]	Memory Write Request	Transaction Complete	16 007f007fh 00000000h 00...		8.0
13.804.654.826.500	[Up 1, Down 1]	Message Request Local - Terminate at Receiver	Transaction Complete	0		8.0
13.805.626.487.500	[Down 1, Up 1]	Memory Write Request	Transaction Complete	4 0000000h		8.0
13.805.628.392.500	[Up 1, Down 1]	Message Request Local - Terminate at Receiver	Transaction Complete	0		8.0
13.805.628.392.500	Up 1	TLP Message Request Local - Terminate at Receiver (0x81e)				
13.805.628.434.500	Down 1	DLLP Ack (0x81e)				
13.805.629.259.500	[Down 1, Up 1]	Memory Write Request	Transaction Complete	4 00000002h		8.0

Bit	Field	Value
7	Fmt	0 (3 DW header, no data)
6	Type	00 (MRd)
5	Reserved	0
4	TC	0 (Best Effort)
3	Reserved	0
2	Attr[2]	0 (Default)
1	LN	0
0	TH	0 (Default)
0-3	TD	0 (Default)
4-5	EP	0 (Default)
6-7	Attr[1]	0 (Default)
8-9	Attr[0]	0 (Default)
10-11	AT	0 (Default/Untranslated)
0-11	Length	001
0-11	Requester ID	0000
0-11	Tag	00
0-3	Last DW BE	0
4-7	1st DW BE	F
0-11	Address	DFC3001C

**Figure 2 (left): Details View displays the fields in an event as they appear in the specification. Display values in binary, decimal, or hex; change the bit width; define your own events complete with custom field names.**

**Figure 3 (right): Data View displays individual bits in an event as binary, decimal, or hex. Control the endianness, display bits as Bytes, Words, or DWORDs, and ASCII. See only the payload or the entire packet. Compare data from different transfers. Search for specific string of values within the packet.**

Packet	Hex	Bin	Dec	BYTES	WORDS	DWORDs	Big Endian	Little Endian	Bytes per row	Search data
00000000	005F	2468	0000	0100	.._sh....				8	
00000008	0000	0F00	C3DF	1C00	.....				8	
00000010	1899	FDD1			....				8	



### FEATURES & BENEFITS

- Fast: traces come up in seconds – even NVMe
- Optimized: see PCIe and NVMe configuration and transactions without capturing bootup (incl. hotswap)
- Intelligent: trigger and filter on actual NVMe events without false-positives
- Free: software support is free and always will be. Colleagues download the full software at no additional cost

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The SerialTek BusXpert PCIe/NVMe Analyzer is the first and only protocol analyzer designed from the ground up to analyze NVMe. It should come as no surprise, then, that BusXpert for NVMe is the best NVMe analyzer in the world, bar none. Only the BusXpert can

- Detect and decode NVMe *on the fly*, including hotswap
- Pre-capture filter selected Bus Device Functions (BDFs)
- Trigger on packets to/from specific BDF(s), incl. NVMe devices and queue(s)
- Display decoded NVMe (and PCIe) seconds after capture completes

### AUTODETECT NVMe

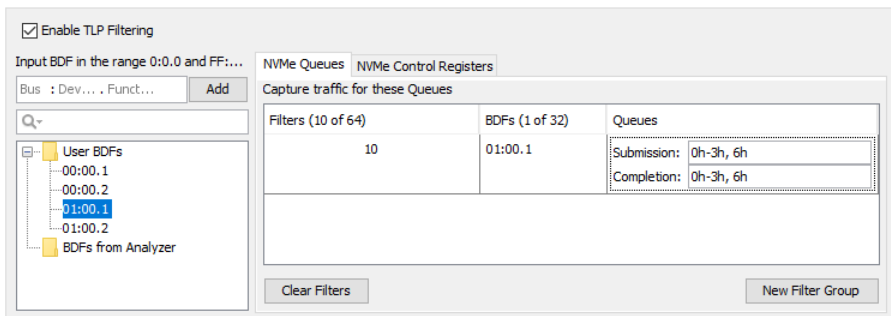
Patent-pending technology exclusive to the BusXpert automatically identifies each Bus Device Function – including devices removed from or added to the bus – prior to, during, and after capture. This information is then used to determine the BDF source or destination for all PCIe bus traffic, *on the fly*. This gives BusXpert a level of precision unmatched by any other PCIe or NVMe protocol analyzer.

**Figure 1. Without capturing boot-up, the following information is automatically captured by BusXpert: Config Space (below left), NVMe Queues (below center), Controller Registers (below right)**

Queue Type	Queue ID	Queue Size (# of Entries)	Base Address	Valid From	Valid To
I/O Completion	0x01	0xff	8cd23000	17.300.843.388.000	End of Recording
I/O Submission	0x01	0xff	8cd1e000	17.301.848.099.500	End of Recording
Admin Submission	0x00	0xff	8cd2b000	17.296.820.271.000	End of Recording
Admin Completion	0x00	0xff	8cd26000	17.296.820.271.000	End of Recording

### FILTER BY BDFS

The ability to determine the BDF source or destination of every Transaction Layer Packet (TLP) on the bus allows BusXpert PCIe to pre-capture filter by BDF and/or NVMe queue – a capability unmatched in the industry. Users can select from auto-detected BDFs and queues, or manually enter their own.



**Figure 2. TLP Filtering allows users to select which BDFs and/or NVMe queues are included in the trace. This interface is also used to refine TLP trigger events to specific BDFs and queues, eliminating false-positive triggers commonly associated with NVMe triggering.**

### TRIGGER ON PACKETS TO/FROM SELECTED BDFS AND NVMe QUEUES

The same interface used in the pre-capture filter (figure 2, above) is also used in the creation of triggers based on NVMe queues and PCIe BDFs. By specifying a BDF and queue, random TLP payload data no longer results in a false trigger. No other PCIe analyzer can do this.

### INSTANT NVMe. NO NEED TO WAIT.

SerialTek’s breakthrough BusXpert hardware allows the decode and display of NVMe within seconds of trace capture. There is no need to wait hours for a trace to save and post-process – only to discover that a new trace is needed.

**Figure 3. NVMe Transactions are decoded and displayed in moments in BusXpert Transaction View. Expand transactions in one click to display the underlying PCIe side-by-side with the corresponding NVMe.**

Time	Channel	Command	Status	Transfer Size	Data Preview	Speed	Tag	Address/Reg	Re
17.296.812.551.500	[Down 1, Up 1]	NVMe: Read Controller Capabilities	Successful Completion	4 28010ffh	8.0	0000h	DF010000h	00	
17.296.813.135.500	[Down 1, Up 1]	NVMe: Read Controller Configuration	Not Enabled	4 00000000h	8.0	0000h	DF010014h	00	
17.296.813.717.500	[Down 1]	NVMe: Write Controller Configuration	Not Enabled	4 00460000h	8.0	0000h	DF010014h	00	
17.296.819.423.000	[Down 1]	NVMe: Write Admin Queue Attributes	Transaction Complete	4 00ff00ffh	8.0	0000h	DF010024h	00	
17.296.819.492.000	[Down 1]	NVMe: Write Admin Submission Queue Base Address	Transaction Complete	4 8cd2b000h	8.0	0000h	DF010028h	00	
17.296.819.545.500	[Down 1]	NVMe: Write Admin Submission Queue Base Address	Transaction Complete	4 00000000h	8.0	0000h	DF01003Ch	00	
17.296.819.594.500	[Down 1]	NVMe: Write Admin Completion Queue Base Address	Transaction Complete	4 8cd26000h	8.0	0000h	DF010030h	00	
17.296.819.668.000	[Down 1]	NVMe: Write Admin Completion Queue Base Address	Transaction Complete	4 00000000h	8.0	0000h	DF010034h	00	
17.296.819.716.500	[Down 1, Up 1]	NVMe: Read Controller Configuration	Not Enabled	4 00460000h	8.0	0000h	DF010014h	00	
17.296.820.314.000	[Down 1]	NVMe: Write Controller Configuration	Enabled	4 00460000h	8.0	0000h	DF010014h	00	
17.296.820.363.000	[Down 1, Up 1]	NVMe: Read Controller Status	Not Ready	4 00000000h	8.0	0000h	DF01001Ch	00	
17.297.821.792.500	[Down 1, Up 1]	NVMe: Read Controller Status	Ready	4 00000000h	8.0	0000h	DF01001Ch	00	
17.297.822.640.500	[Down 1, Up 1]	NVMe: Set Features	Successful Completion	0	8.0	0000h	8CD2B000h	03	
17.297.822.648.500	[Down 1, Up 1]	NVMe: Read Controller Status	Ready	4 00000000h	8.0	0000h	DF01001Ch	00	
17.298.831.087.500	[Down 1, Up 1]	NVMe: Identify	Successful Completion	4,096 80868086h 444d5643h 3...	8.0	0000h	8CD2B040h	03	
17.298.831.140.000	[Down 1, Up 1]	NVMe: Read Controller Status	Ready	4 00000000h	8.0	0000h	DF01001Ch	00	
17.299.837.980.000	[Down 1, Up 1]	NVMe: Identify	Successful Completion	4,096 ba4d4b00h 00000000h b...	8.0	0000h	8CD2B080h	03	
17.299.838.020.500	[Down 1, Up 1]	NVMe: Read Controller Status	Ready	4 00000000h	8.0	0000h	DF01001Ch	00	
17.300.842.759.500	[Down 1, Up 1]	NVMe: Create I/O Completion Queue	Successful Completion	0	8.0	0000h	8CD2B0C0h	03	
17.300.842.810.500	[Down 1, Up 1]	NVMe: Read Controller Status	Ready	4 00000000h	8.0	0000h	DF01001Ch	00	
17.301.847.501.500	[Down 1, Up 1]	NVMe: Create I/O Submission Queue	Successful Completion	0	8.0	0000h	8CD2B100h	03	
17.301.847.544.000	[Down 1, Up 1]	NVMe: Read Controller Status	Ready	4 00000000h	8.0	0000h	DF01001Ch	00	
17.302.863.308.500	[Down 1, Up 1]	NVMe: Read	Successful Completion	512 23232323h 23232323h 2...	8.0	0000h	8CD1E000h	03	
17.302.863.308.500	Down 1	Submission Queue Doorbell Ring; TLP Memory Write Request (0xcfb);							
17.302.863.496.000	Up 1	Command Fetch; TLP Memory Read Request (0xd37);							
17.302.863.923.500	Down 1	Read; TLP Completion With Data (0xcfa);							
17.302.936.311.500	Up 1	Data; TLP Memory Write Request (0xd39); 128 bytes							
17.302.936.354.500	Up 1	Data; TLP Memory Write Request (0xd3a); 128 bytes							
17.302.936.397.000	Up 1	Data; TLP Memory Write Request (0xd3b); 128 bytes							
17.302.936.438.000	Up 1	Data; TLP Memory Write Request (0xd3c); 128 bytes							
17.302.936.579.000	Up 1	Command Completion; TLP Memory Write Request (0xd3d);							
17.303.865.287.000	Down 1	Completion Queue Doorbell Ring; TLP Memory Write Request (0xcfb);							
17.307.863.358.000	[Down 1, Up 1]	NVMe: Read Controller Status	Ready	4 00000000h	8.0	0000h	DF01001Ch	00	

