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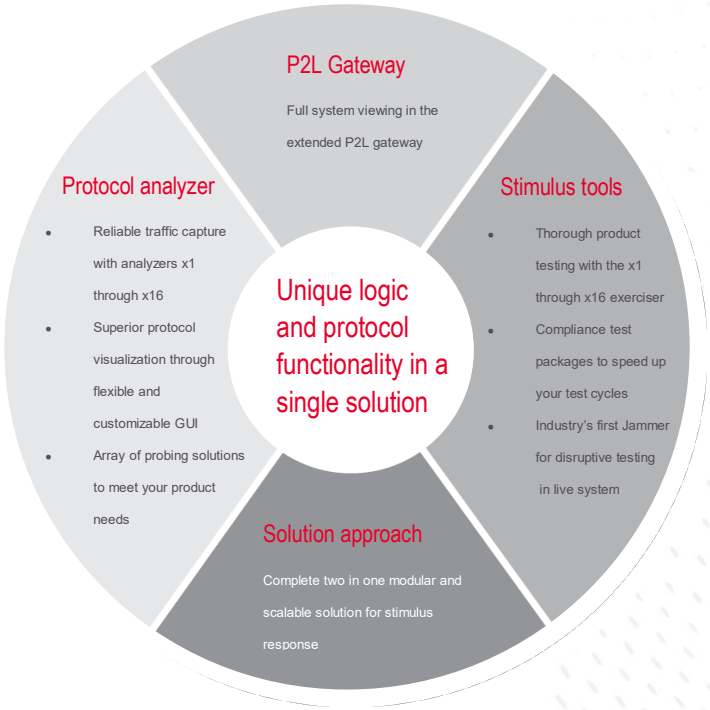
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DATA SHEET

E2960B Series for PCI Express® 2.0

Fastest Time to Insight

The most integrated and comprehensive PCI Express x1 through x16 test solution, with superior probing



KEYSIGHT TECHNOLOGIES

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Overview

The E2960B Series is the industry's most complete and integrated test system with x1 through x16 protocol analyzer, exerciser, compliance test packages and an array of probing solutions to meet test needs.

- The non-intrusive analyzer provides an authentic system view with genuine and unaltered signal characteristics.
- The exerciser provides thorough testing of the link from x1 to x16, with an automated LTSSM exerciser and predefined compliance test to expedite test cycles.
- The protocol to logic gateway (P2L gateway) for correlation with the Keysight Technologies, Inc. logic analyzers, enabling broad visibility into all parts of the system.
- Integrated solution for stimulus (exerciser) and response (analyzer) enables detailed observation and full understanding of the DUT's behavior.

These capabilities provide our customers with the fastest time to insight. Leaving more time for design debug, and bringing products to market quickly.

E2960B Key Features

- Reliable traffic capture and analysis.
- Fastest lock times in the industry, 3 to 4 FTS lock time typical, for effective active state power management (ASPM) testing.
- Easy flow and context sensitive display for clear protocol viewing.
- Full package of post processing capabilities including flow control tracking, traffic overview and real time statistics.
- Sophisticated triggering, search, and filtering capabilities.
- Includes unique logic capabilities such as lane view, fast ASPM sync time, and trigger on ordered set.
- Comprehensive probing capabilities, including Mid-bus 2.0, Flying Lead 2.0 and slot interposer probes.
- Unique LTSSM testing using pre-configured tests.
- Innovative jammer tool to simplify error injection and disruptive tests.
- PTC 2.0, compliance tests for PCI Express Gen1 and Gen2 on the same test card.
- Upgradable hardware model, can be used for PTC 2.0 or upgraded to the compliance assured test package with 170 PCI-SIG recommended additional tests, or to full exerciser capabilities.
- Cross triggering between logic analyzer and protocol analyzer.
- Ping-pong triggering with flags is supported.
- Strong integration between exerciser and analyzer allows the analyzer to capture only the key segments of the device behavior.
- Replay traffic in the exerciser recorded with the protocol analyzer.
- Consistent use model between both stimulus and response to minimize learning curve.

System Architecture Overview

1. Windows XP or Windows 7 PC host to manage and interact with the system. Multiple connection options for the controller:
   - 100 Mbps ethernet LAN directly from PC controller to chassis
   - USB to LAN dongle available for USB connectivity to PC
2. Chassis (2 slot or 4 slot available)
3. N5306A protocol analyzer module controlled via LAN or USB 2.0 link from the PC controller
4. N5316A test backplane, allows testing of end points without vendor system
5. N5309A exerciser module controlled via LAN or USB 2.0 link from the PC controller
6. N5315A slot interposer probe



Figure 2. E2960B protocol analyzer.

Platform continuity	The Keysight E2960B Series is based on the existing platform making the E2960A Chassis and probes usable again for PCIe™ 2.0.
	The complete software; including the GUI, is the same for both series of products, so customers can protect their investment and leverage their existing know-how to start PCIe 2.0 testing immediately.
	The E2960B Series APIs are compatible with existing E2960A (Gen 1) APIs, allowing scripts developed for Gen 1 to be reused in Gen2 testing.
Gen 2 Ready program	E2960B hardware used for PCI Express Gen 1 testing. Later, when your organization starts PCI Express Gen 2 testing, it is a simple license update to enable the same hardware for Gen 2 testing.
Unique logic and protocol functionality in a single solution	A fast and effective way to understand the data from the physical layer through to the transaction layer. This means instantaneous lane status information, both on the I/O module and in the GUI using the per lane LEDs.
	Per-lane view even prior to channel bonding completion—including 8b, 10b or K/D symbols.
	Two “Trigger-down-the-lane” patterns on selected lanes.
	Manual and automatic speed settings.
Test customization and automation with TCL or Windows DCOM	Automates tedious testing.
	Repeats tests for subsequent product builds.
	Creates and automates your specific test procedure.
	Performs regression tests.

From a lightweight portable system to large-scale validation environment

The E2960B Series is designed to be lightweight and portable, and take minimum space in your labs. However, if you need many analyzers or exercisers at once, the architecture is designed to support this. Multiple chassis can be connected together to form a large scale, time synchronized test system.



Figure 3.

Typical Configurations

The E2960B Series supports two main types applications, exerciser and protocol analyzer.

The main characteristic of the exerciser application is to create stimulus to the device under test (DUT). If you are testing an add-in card, the exerciser can be programed to emulate a root-complex. If you are doing root-complex testing, then the exerciser can be programmed to emulate an end device.

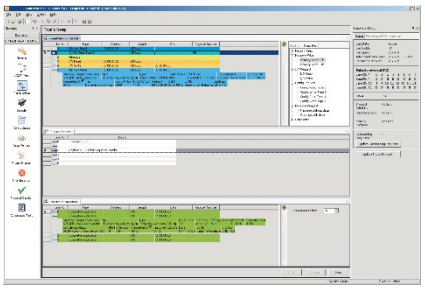
The exerciser application has programmable behaviors at the physical, data link and transaction layer, to allow you to comprehensively validate the behavior of your DUT before releasing the product. You can program the behavior of the exerciser yourself, or you can purchase the compliance assured test package from Keysight, which includes over 170 fully automated tests to validate the correct behavior of your device.

If problems are uncovered during the testing, then protocol analyzers are used to further debug and troubleshoot the issue at hand.

One of the key challenges of doing debugging in PCI Express Gen 2 is access to the signals. The E2960B Series analyzers address this challenge by providing a full array of probing solutions, mid-bus probes, slot interposer probes, and flying lead probes, to meet your test needs.

The E2960B Series protocol analyzers also include sophisticated features such as state-based triggering, easy-flow, context sensitive columns to help you gain insight faster.

Exerciser sample configuration	
Test card N5309A-E04	Exerciser and LTSSM Board x4 for PCIe 5 Gb/s
Test backplane N5316A	Test backplane
Software	
N5309A-EX2	Exerciser SW license exerciser and LTSSM at 5 Gb/s
N5309A-COM	Exerciser SW license compliance assured test package • Including over 170 additional PCI-SIG recommended compliance tests
N5309A-PTC	Exerciser SW license for PTC (free with exerciser purchase) • Includes the 13 PCI-SIG required compliance tests



Analyzer sample configuration	
Chassis N5302A	2 slot chassis
Test cards N5306A	Analyzer module for PCIe 5 Gb/s
Software N5306A-A04	Analyzer SW license x4 for PCIe 5 Gb/s
Probes N5315A-A04	Slot interposer x4 for PCIe 5 Gb/s

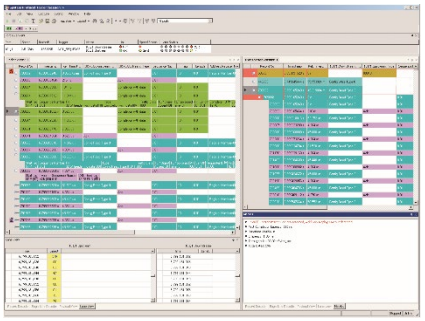


Figure 4. Analyzer and exerciser sample configurations.

PCI Express Gen 2 Ready Program

As the industry starts validating PCI Express Gen 2 designs, many discussions are underway to decide whether to continue investment in test equipment for PCI Express Gen 1 or to shift the investment to Gen 2. The Gen 2 Ready program has been created to make this decision easier. The Gen 2 Ready program is investment protection of your current test tool investments. Independent of the required lane width, x1 to x16, the Keysight E2960B Series for the PCI Express 2.0 analyzer and exerciser is now available either at 2.5 Gb/s or 5 Gb/s. You can use the E2960B today just for Gen 1 applications, and migrate to Gen 2 testing over time. The upgrade to Gen 2 functionality is fast and easy, with a software only update—no need for exchange, or swapping out hardware.

Analyzer link	Gen2 Ready configuration	Description	Upgrade to Gen2
x1	N5306A	Analyzer module for PCIe 5 Gb/s (requires 2 for x 16)	N5310U-U21
	N5306A-G01	Analyzer SW license x4 for PCIe 2.5 Gb/s	Upgrade x1 from Gen2 Ready to Gen2
	N5315A-A01	Slot interposer x1 for PCIe 5 Gb/s	
	N5302A	2-slot portable chassis	
x4	N5306A	Analyzer module for PCIe 5 Gb/s (requires 2 for x 16)	N5310U-U24
	N5306A-G04	Analyzer SW license x4 for PCIe 2.5 Gb/s	Upgrade x4 from Gen2 Ready to Gen2
	N5315A-A04	Slot interposer x4 for PCIe 5 Gb/s	
	N5302A	2-slot portable chassis	
x8	N5306A	Analyzer module for PCIe 5 Gb/s (requires 2 for x 16)	N5310U-U28
	N5306A-G08	Analyzer SW license x8 for PCIe 2.5 Gb/s	Upgrade x8 from Gen2 Ready to Gen2
	N5315A-A08	Slot interposer x8 for PCIe 5 Gb/s	
	N5302A	2-slot portable chassis	
x16	N5306A	Analyzer module for PCIe 5 Gb/s (requires 2 for x 16)	N5310U-U26
	N5306A	Analyzer module for PCIe 5 Gb/s (requires 2 for x 16)	Upgrade x16 from Gen2 Ready to Gen2
	N5306A-G16	Analyzer SW license x16 for PCIe 2.5 Gb/s	
	N5306A-G16	Analyzer SW license x16 for PCIe 2.5 Gb/s	
	N5315A-A16	Slot interposer x16 for PCIe 5 Gb/s	
	N5302A	2-slot portable chassis	
Exerciser link	**Gen2 Ready configuration**	**Description**	**Upgrade to Gen2**
x1	N5309A-E01	Half sized exerciser and LTSSM board x1 for PCIe 5 Gb/s	N5310U-E12
	N5309A-EX1	Exerciser SW license and LTSSM for PCIe 2.5 Gb/s	Upgrade from Gen2 Ready to Gen2
x4	N5309A-E04	Half sized exerciser and LTSSM board x4 for PCIe 5 Gb/s	N5310U-E12

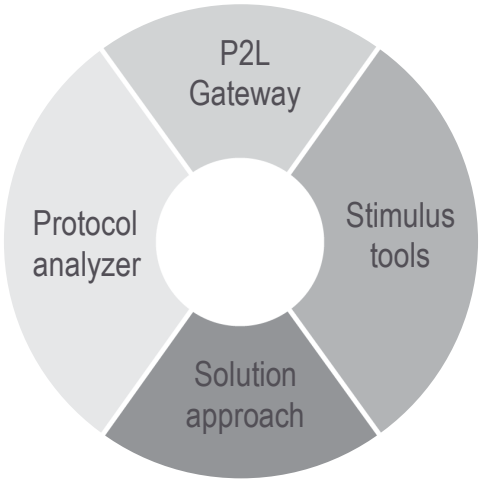
	N5309A-EX1	Exerciser SW license and LTSSM for PCIe 2.5 Gb/s	Upgrade from Gen2 Ready to Gen2
x8	N5309A-E08	Half sized exerciser and LTSSM board x8 for PCIe 5 Gb/s	N5310U-E12
	N5309A-EX1	Exerciser SW license and LTSSM for PCIe 2.5 Gb/s	Upgrade from Gen2 Ready to Gen2
x16	N5309A-E16	Half sized exerciser and LTSSM board x16 for PCIe 5 Gb/s	N5310U-E12
	N5309A-EX1	Exerciser SW license and LTSSM for PCIe 2.5 Gb/s	Upgrade from Gen2 Ready to Gen2
Jammer link	**Gen2 Ready configuration**	**Description**	**Upgrade to Gen2**
x1	N5323A-J01	Jammer module x1 for PCIe 5 Gb/s	N5310U-J12
	N5323A-JM1	Jammer SW license: Jammer at 2.5 Gb/s	Upgrade from Gen2 Ready to Gen2
x4	N5323A-J04	Jammer module x4 for PCIe 5 Gb/s	N5310U-J12
	N5323A-JM1	Jammer SW license: Jammer at 2.5 Gb/s	Upgrade from Gen2 Ready to Gen2
x8	N5323A-J08	Jammer module x8 for PCIe 5 Gb/s	N5310U-J12
	N5323A-JM1	Jammer SW license: Jammer at 2.5 Gb/s	Upgrade from Gen2 Ready to Gen2

Overview

Protocol analyzer	Reliable traffic capture and analysis	System traffic is easy to understand with the x1 to x16 analyzer. • 2.5 Gb/s and 5 Gb/s PCI Express traffic is reliably captured. • Advanced triggering capabilities reduce the time needed to detect difficult-to-find errors. • Reliable data capture even exiting L0s, with the industry's fastest lock time of 3 to 5 fast training sequences (typical). • It is fast and easy to understand the data through context-sensitive column analysis with easy flow views. • SR-IOV and MR-IOV decodes to support debug and analysis even for the latest specifications from PCI-SIG.
		Full package of post processing features including: • Flow control credit counting and graphing. • Transaction viewer and transaction metrics. • Real time statistics graphing and post processed performance statistics. • Traffic overview.

	Family of superior probing solutions to meet your application needs	The protocol analyzer has a full array of probing solutions, including mid-bus, slot interposer, and flying lead probes, from x1 to x16. • Mid-bus and flying lead probes are designed with low capacitive loading to minimize signal distortion. • The slot interposer probe combines outstanding analog repeating technology with mechanical robustness, to allow probing where signal integrity is marginal. • Low profile mid-bus probe for access in blade server environments.
P2L Gateway	Full system viewing	Cross bus analysis is made possible using the P2L gateway. • Multiple protocols can be monitored at the same time (e.g., PCI Express to DDR). • It provides time-correlated views between the logic analyzer view and the protocol analyzer view. • Cross triggering provided between the logic analyzer and protocol analyzer • Ping-pong triggering between the logic analyzer and protocol analyzer through flags support.
Stimulus	Fully validate the DUT (device under test)	The exerciser • Emulates both root complex and endpoint to allow testing of any type of DUT for PCI Express 2.0. • Uses the exerciser and test backplane to test the end point without a system. • Automates testing with the built-in API interface.
		The Jammer • Validate the DUT and software under extreme conditions by creating corner cases and injecting inline errors. • Inject errors into a real system with any OS and any driver and any application. • Easy to setup, the Jammer is transparent to the PCI express hierarchy. Just insert it into a working system, and start testing.
	Thorough link testing	Pre-defined LTSSM tests can help validate complex and hard to test state transition of the DUT's LTSSM.
		Easily validate new additions to the 2.0 specifications, including dynamic lane width changes, and link negotiations.
	Compliance testing	Over 170 compliance test scripts (as defined by the PCI-SIG) quickly test for compliance to the PCI Express 2.0 specifications at the transaction, data link layers, as well as in the configuration space.
		The exerciser has an easy-to-use GUI; a single click to run all tests, or sub-section of test cases.
		Precise reports to clearly identify pass, fail, and warning results.
Solution approach		A single solution for stimulus (exerciser) and response (analyzer) enables a fully integrated overview, a detailed observation of the

	Two in one solution for stimulus and response	DUT's behavior, and a consistent look and feel across both the exerciser and analyzer.
		Integrated exerciser and analyzer allows easy record and replay; save a packet from the analyzer, and replay in the exerciser.



N5306A Analyzer

Features

Display	Highly configurable GUI, based on a configurable tabular view
	Color customization
	Condensed data view using context sensitive columns
	"Ping-pong" view of upstream/downstream data with easy flow
	Easy navigation within captured trace
	Traffic overview (post capture)
	Per lane display, to show individual lane data
	Multiple views of the packet decode for faster debugging; record decode view, singe line decode view, payload view, lane view
	Expand and collapse packets in order to view/hide full packet, with errors that are highlighted
	Color-coded transaction types allow easy recognition of various types of traffic
	Multiple markers with comment functionality

	Display with time stamps, absolute timestamps, relative time stamps, and ability to configure any location as time zero
	Multiple listings with independent layout
	Transaction view with associated transaction metrics
	Ability to dynamically track link width changes
	Real time statistics
	Post processed performance statistics
	Flow control credit tracking counters and graphs
Trigger	Graphical trigger setup
	Multi-state, multi-level trigger sequencer • Eight states • Two counters/timers • Four pattern terms • Internal, cross module arm in/out for including in trigger sequencer from another analyzer
	External trigger in and out
	Protocol error trigger
	Multi-directional branching
	Filtering (real time) • Idles • On a per-packet basis controlled by the trigger sequencer • Storage qualification
	Filter conditions can be defined individually for each trigger sequencer state
	Trigger on payload (up to 128 bits)
	Trigger on a per-bit user specified training sequence ordered set
Search/filter	Fast hardware based searching and filtering
	Graphical search/filter setup with easy to configure drag and drop interface
	Search/filter on protocol errors
	Multiple parallel search/filter conditions • Up to 6 patterns at the same time
	Extensive list of predefined patterns (TLP, DLLP, ordered sets, training sequences, protocol errors)
	User definable data patterns
Traffic capture	Supports capturing in x1, x2, x4, x8, x16 link width with 2.5 GT/s and 5 GT/s
	Non-intrusive traffic capturing
	Captures training sequences, ordered sets, data-link-layer packets and transaction-layer packets in both directions simultaneously

	Supports data rates 2.5 GT/s and 5 GT/s (± 300 ppm)
	Error detection
	Disparity errors and invalid 10b symbols in hardware
	LCRC, symbol, disparity, EDB, framing, idle data malformed packet check (CRC error, invalid field contents, length mismatch) in software
Programming languages	Windows DCOM API
	Full API documentation
Other	Record and replay analyzer to exerciser traffic
	Timestamps with 8 ns resolution (absolute and relative)
	Automatic lane polarity detection
	2 GB trace memory for x1 to x 8 analyzers; 4 GB trace memory for x16 analyzers
	Latency measurements (using markers)

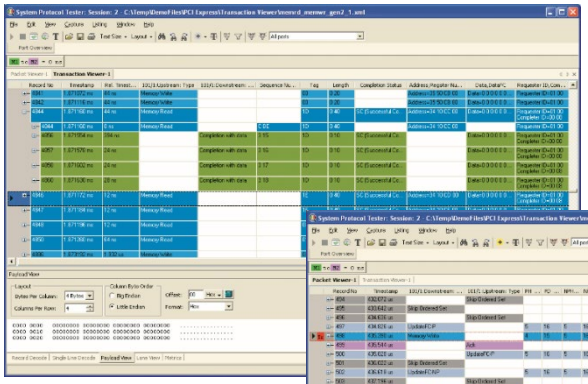


Figure 5. Transaction View.

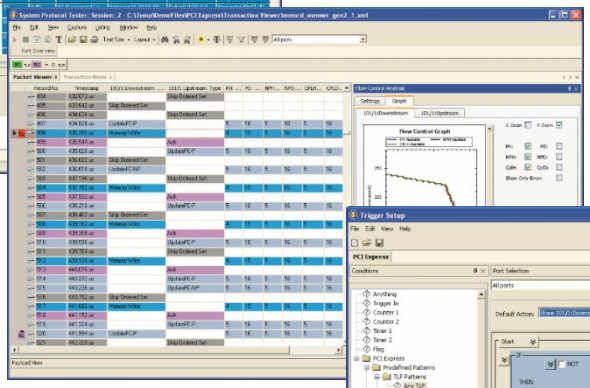


Figure 6. Flow Control tracking.

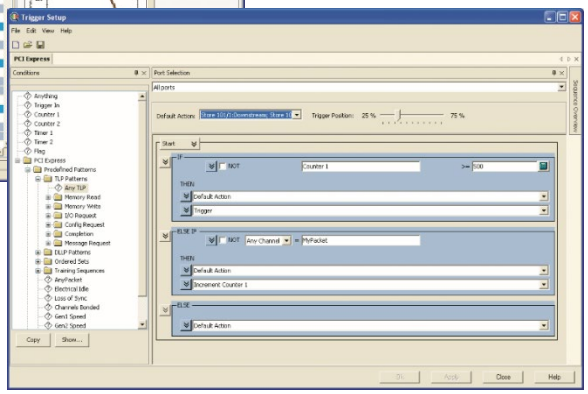


Figure 7. Trigger Setup.

Specifications

System	
The N5306A analysis module is an I/O blade that fits into a 2-slot portable chassis (N5302A) or 4-slot rackmountable chassis (N5304A).	
The software application that controls the N5306A module runs on a Windows XP or Windows 7 PC host.	
For more details regarding the chassis or PC controller, see the related products section of the data sheet.	
Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +55 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
General characteristics	
Memory	2 GB
Display	4-character LEDs display on the I/O module for status information
Status LED	16 per lane LEDs to indicate status of the individual lanes
	Two status LEDs to indicate module global status • Grey: System is not configured • Red: Speed is not detected or system is not configured • Yellow: System configured to speed of 2.5 Gb/s • Green: System configured to speed of 5 Gb/s
Connectors	Analyzer probe connector
	Intermodule connector (used to connect to the logic analyzer via the N5319A P2L gateway with flags support)
	Self test connector
	REF clock out
	10 MHz clock out
	Sync port for P2L support

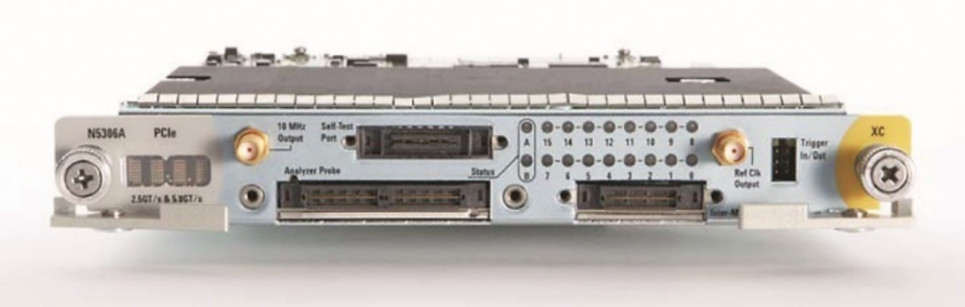


Figure 5. N5306A analyzer.

N5322A Extended Interface Module

Features and specifications

System	
The N5322A extended interface module should be used in conjunction with the N5306A analyzer I/O module for extended analysis capabilities.	
Features	
Status LED	16 per lane LEDs to indicate status of the individual lanes
	Two status LEDs to indicate module global status • Grey: System is not configured • Red: Speed is not detected or system is not configured • Yellow: System configured to speed of 2.5 Gb/s • Green: System configured to speed of 5 Gb/s
Connectors	Analyzer probe connector
	Intermodule connector
	REF clock input
Active state power management (ASPM) capabilities	Bit lock after L0s with typical 3 to 5 fast training sequences
Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +55 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)

Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
Electrical characteristics Jitter tolerance	Eye width: 0.55 UI (minimum)



Figure 6. Extended interface module.

N5309A Exerciser, Protocol Test Card 2.0 and Compliance Tests

Compliance testing

General	Compliance tests run on existing N5309A exerciser hardware
	PCI Express Gen 1 and Gen 2 both supported
	Easy to use GUI • Integrated into N5309A exerciser GUI • Run single tests, or select multiple tests for sequential execution • Test tagging at start and end of every test. Allowing easy capture and analysis with Keysight's protocol analyzer
Test support	Two test packages available
	E2969B PTC2 • Supports all 13 PCI-SIG mandatory test cases

	N5309A-COM compliance assured test package with over 170 recommended tests • 70 transaction layer tests • 40 link layer test • 66 config space tests • 1 electrical test

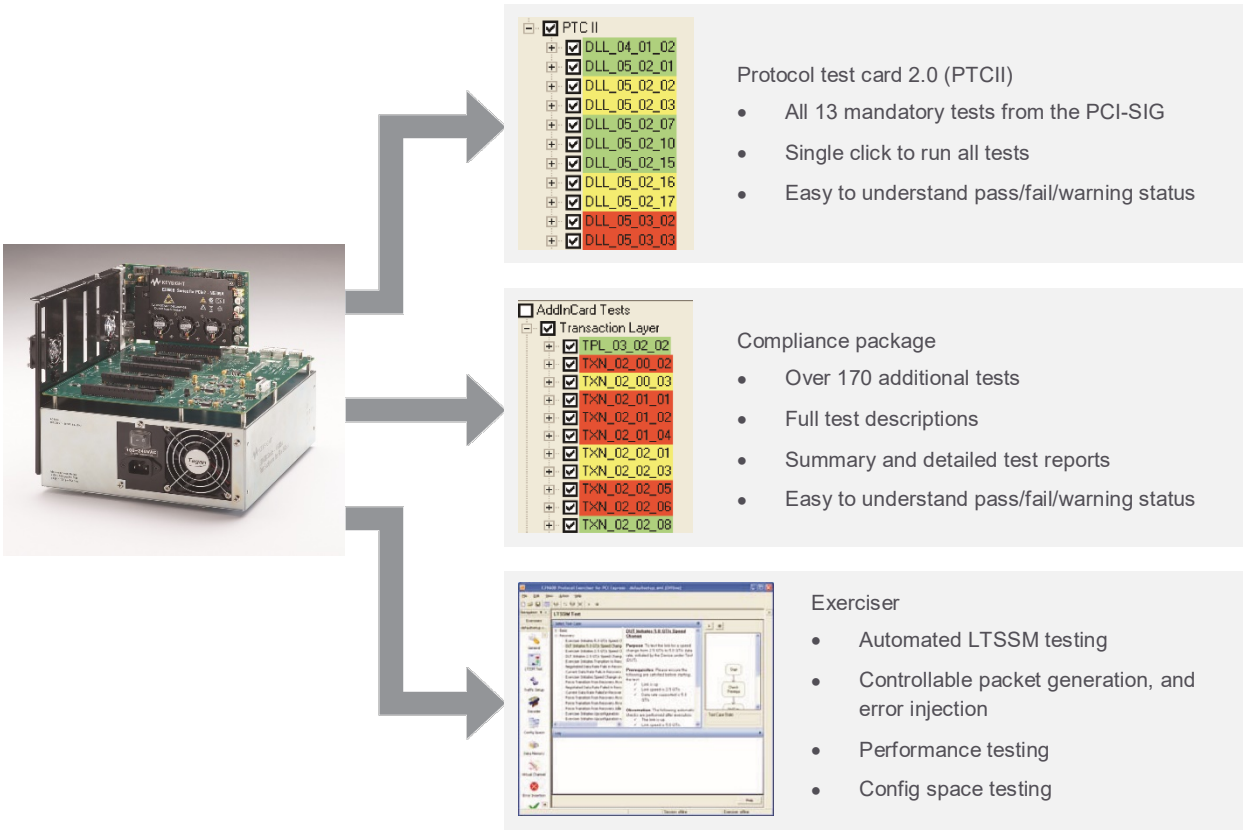


Figure 7. Exerciser and Compliance Test: One hardware, multiple applications.

Exerciser features

Physical layer	Fully automated symbol encoding/decoding, generation, and validation of packet framing; ability to report framing errors to user
	Scrambling can be turned on or off by user
	Configurable, automatic link initialization and training • Automatic Lane Polarity Detection (RX), separate for each lane • Programmable Lane Polarity Inversion (TX), separate for each lane • Automatic link width negotiation; link widths x1, x4, x8, x16 supported; user can configure which widths will be negotiated during link training

	• Programmable Tx Lane Reversal (Rx is automatic) • Programmable Lane Skew: (± 7 symbols, resolution: 1 symbol time)
	Link Training and Status State Machine (LTSSM): Full support for states: detect, polling, configuration, recovery, L1, L0s, L0
	Programmable skip rate and number of SKPs per skip OS
	Note concerning power management: When exiting from L0s or L1 the exerciser's receiver may not be able to receive data until the second SKP ordered set. Packets might get lost, causing a retraining of the PCI Express link.
Data link layer	Fully implemented data link control and management state machine
	Automatic flow control initialization; programmable credits and flow control update rate
	Automated generation of data link layer packets (DLLPs): ACK/NAK, Init/Update-FC
	Automatic generation and checking of LCRC and sequence numbers; allows the insertion of incorrect LCRCs into TLPs for testing purposes; automatic retry function management
Transaction layer	User software can define arbitrary sequences of transactions
	"Send single packet" for simple packet transmission one memory for block transactions per virtual channel
	Conditional start on RX pattern matcher, external trigger in and completion status
	Generation and receipt of packets at maximum bandwidth (stress testing); up link width x8 at 5 GT/s
	Infinite loop
	One completer queue defines the way completion packets are sent out (e.g. lengths, errors inserted, partitions, etc) • Completions can be split into individual packets
	Up to 32 outstanding requests can be "pending" (256 in extended mode) (request without completion)
	Decoders (6 BARS + Expansion ROM decoder)
	Payload generation and reception from/into data memory



Figure 8. N5309A exerciser and LTSSM exerciser.

Packet generation	Transmit modes • Send single packet • Block transfer • Import packet from captured analyzer trace
	Sent single packet • Send any type of TLP, with control of all the fields • Create errors on the transmitted packet
	Block transfer • Create large transfers (read or write), with configurable request size • Automatic data comparator to ensure no data corruption • Performance testing to ensure maximum data rates
	Completion queues • Program any type of completion status
Error generation and analysis	Error insertion capabilities on the physical layer, data link layer and transaction layer
	Physical layer • Transmitter polarity inversion • Transmitter lane reversal • Determinant lane skew of up to 7 symbols • Link width and lane sequence negotiation emulating a x1, x4, x8, x16 device • Sending packets with incorrect “running disparity” • TX framing errors on TLPs

	Data link layer • Sending packets with incorrect LCRC • Systematically answers NAK instead of ACK, for retry buffer test • Wrong sequence numbers • Generate a free form DLLP with any bit changed
	Transaction layer • Arbitrary header field contents • Sending “nullified TLPs” • Sending “poisoned TLPs” • Advertised packet length (in TLP header) is different from actual packet length (by one word) • The transmitter ignores flow control credits • Completion loss/delay
Configuration space	Can emulate the configuration of different types of PCI Express devices
	Supports up to 6 base address registers and expansion ROM decoder
	Full support for PCI Header type 0 configuration space
	Supported capability structures • PCI power management capability structure • MSI capability structure • PCI Express capability structure • Virtual Channel capability structure • Advanced error reporting structure
Display	Explorer like tree structure to select test
	Display of test log in GUI
	Feedback of state transitions performed
	Timestamp in [ns] for all states
	Link status indications
	Link width x1, x4, x8, x16
Debug support	External trigger on exit from L0
	Log file output of LTSSM exerciser state transitions and timestamps
	Automatic flow control initialization with infinite credits
Supported states	Detect
	Polling
	Configuration
	L0, L0s, L1
	Recovery
Easy software upgrade	Ability to upgrade from PTC II license to Compliance Assured Test Package licence to full exerciser and LTSSM software licence

Specifications

System requirements	
The N5309A is a standalone PCIe card that can be used for the PTCII, compliance assured test package and exerciser application. The software application that controls the N5309A card runs on a Windows XP or Windows 7 PC host connected via a USB 2.0 link. For more details regarding the PC controller, see related products section of the data sheet.	
Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +55 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard

General characteristics	
Power requirements	100 to 240 Vac
	130 to 160 VA 1.5 A maximum
	47 to 63 Hz
Form factor	PCI Express standard height, half size card
	Length: 168 mm (6.6 inch)
	Height: 111 mm (4.37 inch)
	Component height on top side including heat sink: 19 mm (0.75 inch)
Connectors	Front bracket: • USB type B • Vin 18 V DC, 3.5 A • PCIe analysis output, proprietary
	Top connector: • PCIe, connector x16, only x1 lane connection
	Bottom connector: • PCIe, x1, x4, x8 or x16 (version dependent)

	Trigger in/out: • LVCMOS 2.5 V, see user guide • Vin maximum 3.0 V
	Power in: • ATX power connector to supply the top connector
SSC	Support for SSC
Data memory	160 kB
Electrical characteristics	
Data in	Input levels • Minimum: 100 mV • Maximum: 1.2 V
	Jitter tolerance • Compliant to PCIe specification 2.0 Rev 0.9
	Frequency • Minimum: 2.5 GHz –300 ppm; 5 GHz –300 ppm • Maximum: 2.5 GHz +300 ppm; 5 GHz +300 ppm
	SSC support • None
Data out	Output level • Minimum: 800 mV (full swing) • Typical: 1000 mV • Maximum: 1.2 V
	De-emphasis 3.5 dB • Typical: 3.5 dB
	De-emphasis 6 dB • Typical: 6.0 dB
	UI interval • Minimum: –300 ppm • Maximum: +300 ppm
	Total jitter • Typical: 0.3 UI
	Electrical idle • Typical: 20 mV
External clock in	Level • Minimum: 800 mVdiff Maximum: 1200 mVdiff
	AC coupled
	Frequency: 100 MHz
Reference clock in	Compliant to PCIe specification 2.0

N5323A Jammer

Features

General features	
Ability to configure the physical layer characteristics of the device, including skew, lane polarity, and lane ordering	
Protocol checker included, ability to flag any protocol violations during test	
Statistics tables and graphs, to show when errors were inserted during test	
External trigger In/Out, with the ability to trigger the analyzer and vice versa	
Jamming options	
Jamming actions can occur on the physical layer, data link layer and also transaction layer. The list of actions that the jammer can perform are:	
Physical layer	Disparity error on symbols, lanes or packets
	Drop STP/END characters
	Link retrain / recovery
Data link layer	Drop specified DLLP
	Insert arbitrary DLLP
	Corrupt CRC values
	NAK incoming TLP
	Offset sequence number
Transaction layer	Delay TLP
	Drop/Insert TLP
	Replace TLP payload
	Modify TLP header
Automation test	
The jammer similar to other PCI Express products from Keysight provides a complete API that allows all aspects of the jammer to be automated. This is key for implementing a regression test environment. In addition, to help you get started, there is a suite of pre-defined test cases available. • TCL API with full online documentation • Five example test scenarios scripts, part of the QuickTest framework • Additional 25 test scripts available for purchase, part of the QuickTest framework	

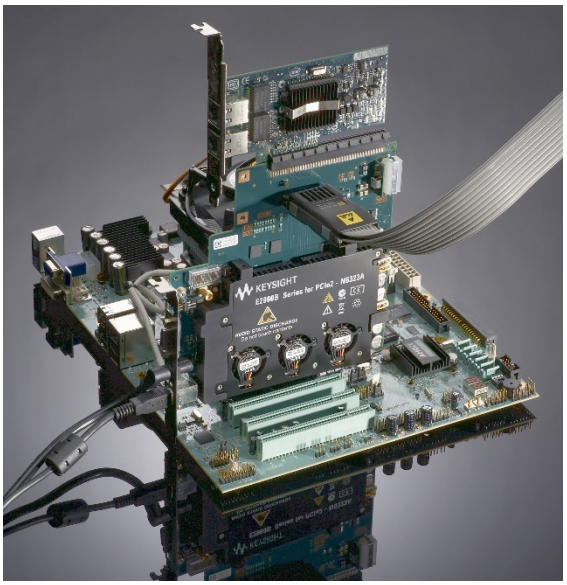


Figure 9. Jammer inserted between motherboard and add-in card.

Specifications

System requirements	
The N5323A is a standalone PCI Express card form factor. The software application that controls the N5323A card runs on a Windows XP or Windows 7 PC host connected via a USB 2.0 link.	
Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +55 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
General characteristics	
Power requirements	100 to 240 Vac
	130 to 160 VA 1.5 A maximum
	47 to 63 Hz

Form factor	PCI Express half size card Length: 168 mm (6.6 inch) Height: 181 mm (7.1 inch)				
	Component height on top side including heat sink: 19 mm (0.75 inch)				
Connectors	Front bracket • USB type B • Vin 18 V DC, 3.5 A • PCIe analysis output, proprietary	Top connector • PCIe, connector x16, maximum x8 lane connection	Bottom connector • PCIe x1, x4 or x8 (version dependent)	Trigger in/out • LVCMOS 3.3 V, see user guide • Vin maximum 4.6 V	Power in • ATX power connector to supply the top connector
SSC	Supported				
Data memory	128 kB				

Electrical characteristics

Data in	Input levels • Minimum: 100 mV • Maximum: 1.2 V	Jitter tolerance • Compliant to PCIe Specification 2.0 Rev 0.9	Frequency • Minimum: 2.5 GHz ± 300 ppm 5 GHz ± 300 ppm • Maximum: 2.5 GHz +300 ppm; 5 GHz +300 ppm	SSC support • None
Data out	Output level • Minimum: 800 mV (full swing) • Typical: 1000 mV • Maximum: 1.2 V UI interval • Minimum: –300 ppm • Maximum: +300 ppm	De-emphasis 3.5 dB • Typical: 3.5 dB Total jitter Typical: 0.3 UI	De-emphasis 6 dB • Typical: 6.0 dB Electrical idle • Typical: 20 mV	
External clock in	Minimum level: 800 mVdiff			
	Maximum level: 1200 mVdiff			
	AC coupled			
	Frequency: 100 MHz			
Reference clock in	Compliant to PCIe specification 2.0			

N4241A/2A/3A Full Size Mid-Bus Probe

Features

The Keysight mid-bus 2.0 Series of probes using soft touch technology, are specially designed to provide support for up to 16-channel probing and give insight to the system without influencing it.	
General	Three types of mid-bus probes; straight (N4241A), swizzled x16 (N4242A), split x4 (N4243A)
	Mid-bus interposers available for all link width and link types
	5 ft cable length for flexible setup between analyzer and test system
	Each mid-bus probe ships with five retention modules, and extras can be ordered with E2960B-RET-05



Figure 10. N4241A/2A/3A mid-bus probe.



Figure 11. Mid-bus probe head.

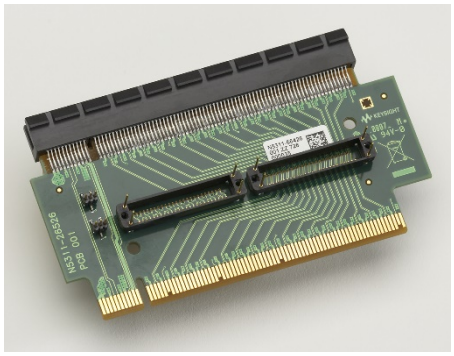


Figure 12. Mid-bus interposer.

Specifications

See mid-bus probe manual for a more detailed description.

Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +40 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
Airflow	140 linear feet per minute for a single probe with no heat source within 1 inch distance
	200 linear feet per minute for 2 probes placed side to side with minimum spacing
General characteristics	
Probe tip	Width: 3.6 cm (1.40 inch)
	Depth: 1.5 cm (0.60 inch)
	Height: 6.7 cm (2.62 inch)
	Weight: 0.75 kg (1.65 lbs)
Probe cable	Length: 1.5 m (59.06 inch)
	Weight: 0.75 kg (1.65 lbs)
Electrical characteristics	
Absolute maximum ratings	Amplitude data signal: 2 V_{ppdiff}
	Amplitude ref. CLK: 5 V_{ppdiff}
Jitter tolerance	Eye width: 0.6 UI (minimum)
	Trace length transmitter: 9 inch (maximum for worst case scenario)
Capacitive loading	150 fF
Data signals	Frequency • Minimum: 2.5 GHz –300 ppm 5 GHz –300 ppm • Maximum: 2.5 GHz +300 ppm 5 GHz +300 ppm
	Eye opening minimum: 60 mV (eye width of 0.6 UI)
	Maximum input amplitude: 1600 mV_{ppdiff} (eye width of 0.85 UI)

Ref. CLK	Amplitude • Minimum: 800 mV_{ppdiff} • Maximum: 2000 mV_{ppdiff}
	DC offset • Minimum: 0 mV • Maximum: 500 mV
	Frequency • Minimum: 100 MHz –300 ppm • Maximum: 100 MHz +300 ppm
	SSC • Minimum: –0.5% • Maximum: 0%

N5328A Half Size Mid-Bus Probe

Features

The half size mid-bus probe 2.0 supports up to 8 channels (x4 bi-directional), and is especially designed for mobile or embedded applications where space is constrained. With a smaller footprint, this probe allows for easier routing and board layout compared to the full size mid-bus probe.	
General	5 ft cable length for flexible setup between analyzer and test system
	Each mid-bus ships with five retention modules, extras can be ordered N5328A-RET-05

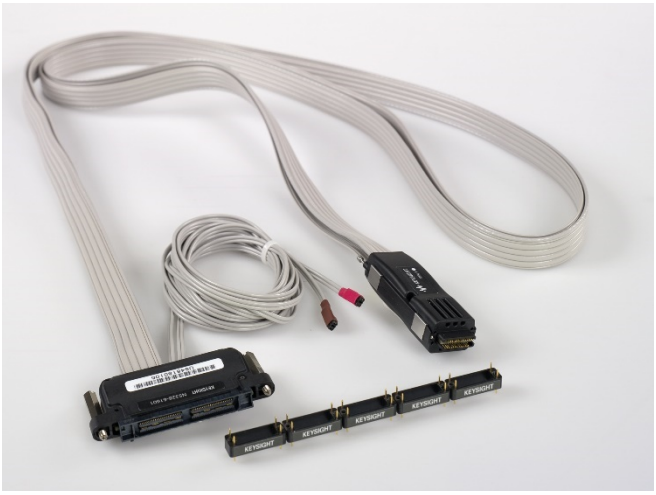


Figure 13. N5328A half size mid-bus probe.



Figure 14. Half size mid-bus probe head.

Specifications

See probe manual for a more detailed description.

Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +40 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
Airflow	140 linear feet per minute for a single probe with no heat source within 1 inch distance
	200 linear feet per minute for 2 probes placed side to side with minimum spacing
General characteristics	
Probe tip	Width: 2.3 cm (0.91 inch)
	Depth: 1.5 cm (0.60 inch)
	Height: 6.4 cm (2.53 inch)
Probe cable	Length: 1.5 m (59.06 inch)
	Weight: 0.75 kg (1.65 lbs)
Electrical characteristics	
Absolute maximum ratings	Amplitude data signal: 2 V_{ppdiff}
	Amplitude ref. CLK: 5 V_{ppdiff}
Jitter tolerance	Eye width: 0.6 UI (minimum)
	Trace length transmitter: 9 inch (maximum for worst case scenario)
Capacitive loading	150 fF
Data signals	Frequency • Minimum: 2.5 GHz –300 ppm • Maximum: 2.5 GHz +300 ppm
	Eye opening minimum: 60 mV (eye width of 0.6 UI)
	Maximum input amplitude: 1600 mV_{ppdiff} (eye width of 0.85 UI)

Ref. CLK	Amplitude • Minimum: 800 mV_{ppdiff} • Maximum: 2000 mV_{ppdiff}	5 GHz –300 ppm 5 GHz +300 ppm
	DC offset • Minimum: 0 mV • Maximum: 500 mV	
	Frequency • Minimum: 100 MHz –300 ppm • Maximum: 100 MHz +300 ppm	
	SSC • Minimum: –0.5% • Maximum: 0%	

N4241F Flying Lead Probe

Features

The Keysight flying lead probe 2.0 is designed to expose hard-to-reach signals for mobile and embedded systems, allowing access to the PCIe link at 5 Gb/s speeds without a designed-in connector.	
General	Each probe can monitor up to a x8 PCI Express link, and two probes can be combined for x16 links
	5 ft cable length for flexible setup between analyzer and test system
Probe tip	Socketed probe tip allows easy and reliable connection to resistors
	Amplification done outside of probe tip to ensure minimum size, and minimize thermal concerns

Specifications

See flying lead probe manual for a more detailed description.

Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +40 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)

Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
Airflow	140 linear feet per minute for a single probe with no heat source within 1 inch distance
	200 linear feet per minute for 2 probes placed side to side with minimum spacing



Figure 15. Flying lead probe.

General characteristics	
Probe cable	Length: 1.5 m (59.06 inch)
	Weight: 0.75 kg (1.65 lbs)
Probe tip characteristics	Socketed differential tip
	Dimensions
	Flying leads length: 15 cm (5.91 inch)
	Tip width: 4.71 mm
	Tip length: 3.33 mm

Electrical characteristics	
Absolute maximum ratings	Amplitude data signal: 2 V_{ppdiff}
	Amplitude ref. CLK: 5 V_{ppdiff}
Jitter tolerance	Eye width: 0.65 UI (minimum)
	Trace length transmitter: 9 inch (maximum for worst case scenario)
Capacitive loading	200 fF
Data signals Note: These measurements are only valid when using Keysight-supplied resistors (E5381-82101).	Frequency • Minimum: 2.5 GHz –300 ppm • Maximum: 2.5 GHz +300 ppm
	Eye opening minimum: 75 mV (eye width of 0.65 UI)
	Maximum input amplitude: 1600 mV_{ppdiff} (eye width of 0.85 UI)
Ref. CLK	Amplitude • Minimum: 800 mV_{ppdiff} 5 GHz –300 ppm • Maximum: 2000 mV_{ppdiff} 5 GHz +300 ppm
	DC offset • Minimum: 0 mV • Maximum: 500 mV
	Frequency • Minimum: 100 MHz –300 ppm • Maximum: 100 MHz +300 ppm
	SSC • Minimum: –0.5% • Maximum: 0%

Features

General	The Keysight ZIF flying leads probe is designed with reliable signals and ease of probing access in mind, allowing access to the PCIe link at 5 Gb/s speeds without a designed in connector.
	Also, by leveraging the Keysight infiniimax ZIF probe tip, it allows designers to use the same probe points for both physical layer Oscilloscope measurements well as logical/protocol measurements.
	Over 6 ft cable length for flexible setup between analyzer and test system
Probe tip	Easy to connect and disconnect zero insertion force (ZIF) differential tip, to protect probe head and ensure many reuses
	Both N5426A and N5451A ZIF tips supported, to ensure maximum flexibility

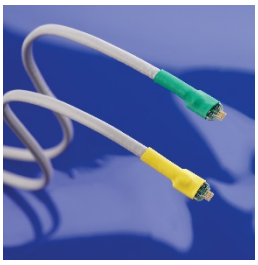
	Amplification done outside of probe tip to ensure minimum size, and minimize thermal concerns

Specifications

See flying lead probe manual for a more detailed description.

Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +40 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
Airflow	140 linear feet per minute for a single probe with no heat source within 1 inch distance
	200 linear feet per minute for 2 probes placed side to side with minimum spacing





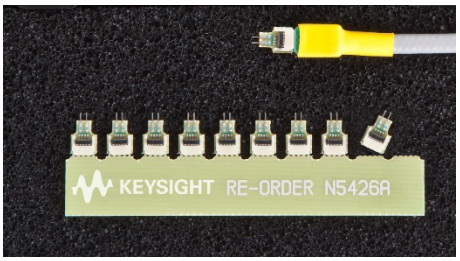


Figure 16. ZIF flying leads probe.

N4241Z ZIF Flying Leads Probe

Specifications

General characteristics	
Probe cable	Analyzer cable length: 1.5 m (59.06 inch)
	Weight: 0.75 kg (1.65 lbs)
Probe tip characteristics	Zero Insertion Force (ZIF) differential tip
	Dimensions
	Flying leads length: 21 cm (8.27 inch)
	Tip width: 5.54 mm (0.218 inch)
	Tip length: 10.5 mm (0.413 inch)
Electrical characteristics	
Absolute maximum ratings	Amplitude data signal: 2 V_{ppdiff}
	Amplitude ref. CLK: 5 V_{ppdiff}
Jitter tolerance	Eye width: 0.65 UI (minimum)
	Trace length transmitter: 9 inch (maximum for worst case scenario)
Capacitive loading	≤ 250 fF
Data signals Note: These measurements are only valid when using Keysight-supplied ZIF tip N5426A or N5451A.	Frequency • Minimum: 2.5 GHz –300 ppm 5 GHz –300 ppm • Maximum: 2.5 GHz +300 ppm 5 GHz +300 ppm
	Eye opening minimum: 75 mV (eye width of 0.65 UI)
	Maximum input amplitude: 1600 mV_{ppdiff} (eye width of 0.85 UI)
Ref. CLK	Amplitude • Minimum: 800 mV_{ppdiff} • Maximum: 2000 mV_{ppdiff}
	DC offset • Minimum: 0 mV • Maximum: 500 mV
	Frequency • Minimum: 100 MHz –300 ppm • Maximum: 100 MHz +300 ppm
	SSC • Minimum: –0.5% • Maximum: 0%

N5315A Slot Interposer Probe

Features

Interposer	Analog repeating slot interposer
	Physical link width x1 x4 x8 x16
	Electrical Idle conditions are propagated by the slot interposer
	Mechanical stabilization for the device under test
	Cable holders to prevent them from laying on top of DUT or backplane
	Mechanical Stabilization with backplane to ensure firm PCIe slot connection
	Power management capabilities (15-35 FTS)

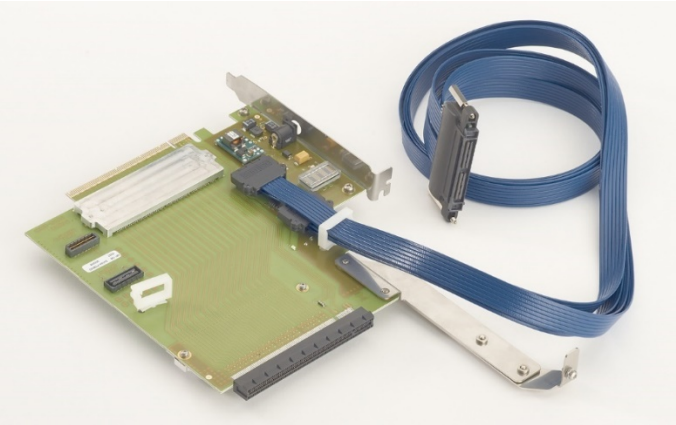


Figure 17. N5315A slot interposer probe.

Specifications

Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +55 °C
	Storage: 40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard

General characteristics	
Display	4-character LED display status
LED	Two status LEDs
Power requirements	100 to 240 Vac
	130 to 160 VA 1.5 A maximum
	47 to 63 Hz
Form factor	Length: 195.8 mm (7.71 inch)
	Height: 169.5 mm (6.67 inch)
Probe cable length	1.0 m (39.37 inch)
Connector	Front bracket: Vin 18 V DC, 3 A
	Top connector: PCIe, connector x16
	Bottom connector: PCIe, x1, x4, x8 or x16 (version dependent)
Electrical characteristics	
Absolute maximum ratings	Amplitude data signal: 2 V_{ppdiff}
	Amplitude ref. CLK: 5 V_{ppdiff}
Jitter tolerance	Eye width: 0.6 UI (minimum)
	Trace length transmitter: 9 inch (maximum for worst case scenario)
DUT path	Added jitter: Below 0.1U
	Output voltage level: 100 to 110% of the input signal
	Delay: 1200 psec
	Lane-to-lane skew: Below 30 psec
External clock level	Minimum: 800 mVdiff
	Maximum: 2000 mVdiff
	AC coupled frequency: 100 MHz

N5316A Passive Backplane

Features

General	Provides power and clock to DUT
	Test fixture for add-in card testing with exerciser

Power	Separate power on/off for fast reset in tests
	Power reset
	AUX (stand by) power for add-in card available if required
	Per bus power switch
Link width	All link widths are supported
Clocks	Clock generation with/without SSC
	Input for external clock
	Clock output (e.g. for scope measurements)
	Supports different mid-bus probes N4241A/2A/3A
	Reset/power button
Connectors	Bus 1 • One pair of x16 PCIe connectors • Two x8 mid-bus probe retention modules with bidirectional footprint supporting N4242A (x16), N4241A (x1, x4, x8), N4243A (dual x4)
	Bus 2 • One x16 PCIe connector with loop back
	Bus 3 • One pair of x16 PCIe connectors • Two x8 mid-bus probe retention modules with unidirectional footprint supporting two N4241A (x1, x4, x8, x16)



Figure 18. Passive backplane.

Specifications

Environment	
Temperature (AT-ETM757)	Operating: +5 °C to +40 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
	Main supply voltage fluctuations are not to exceed 10% of the nominal supply voltage
General characteristics	
Power requirements	100 to 240 Vac
	10/6A
	47 to 63 Hz
Connectors	5x PCI Express x16 physical connector
	Five mid-bus probe retainers to hold N4241A/2A/3A mid-bus probes
	DUT power connector
Dimensions	Length: 30.5 cm
	Width: 24.5 cm
	Height: 13.5 cm excluding rear cover
	Weight: Approximately 5 kg
Electrical characteristics	
Slot supply voltages	Maximum power rating • +12 V/5.5 A per PCI slot • +3.3 V/3.0 A per PCI slot
Connectors	Power out connector
	Disk drive power connector • 12 V 5.5 A maximum • 5 V 3 A maximum
Clocks	SMA external clock input • 800 mVpp AC coupled onboard

	SMA clock output • Terminate into 50 Ω • Level: typically 800 mVpp)
	Reference clock at PCI connectors • According PCI Express Specification 2.0 Rev 0.9 • Frequency 100 MHz ± 300 ppm
	SSC supported • 30 kHz triangle waveform is used with 0.5% down-spread

N5313A P2L Gateway Cable

Specifications

General	Make the Keysight logic analyzer and E2960B PCI Express protocol analyzer one complete tool
	Full view of interaction between busses monitored by the logic analyzer and the PCI Express bus
GUI	Time correlated views between the logic analyzer and protocol analyzer
	Shared markers between both instruments
Triggering	Cross triggering between the logic analyzer and protocol analyzer
Connectors	Connects to the PCI Express module
	3 BNC connects to the 16900 logic analyzer module

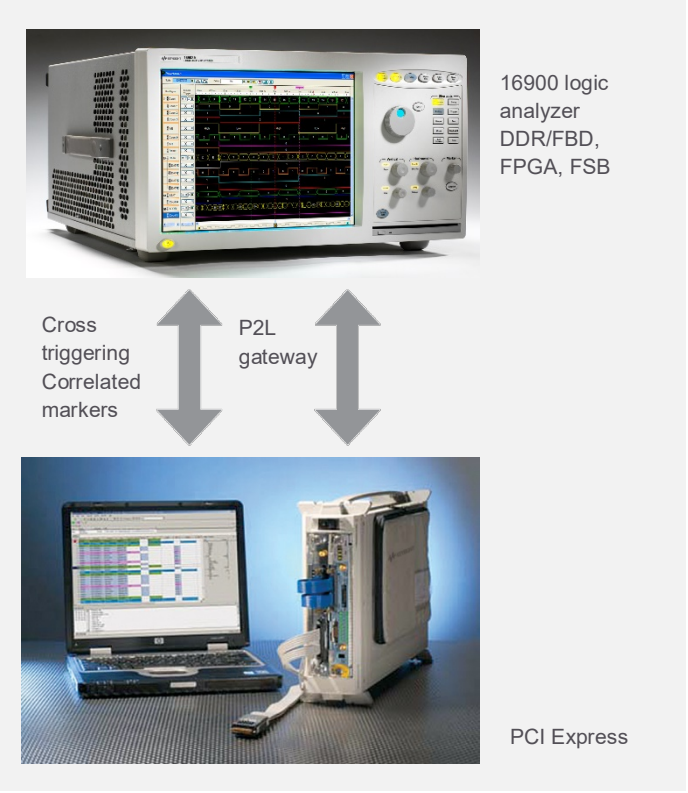


Figure 19. PCI Express to logic correlated system.



Figure 20. N5313 P2L gateway cable.



Figure 21. P2L system viewing.

N5319A P2L Gateway Cable with Flag Support

Specifications

General	Make the Keysight logic analyzer and E2960B PCI Express protocol analyzer one complete tool
	Full view of interaction between busses monitored by the logic analyzer and the PCI Express bus
GUI	Time correlated views between the logic analyzer and protocol analyzer
	Shared markers between both instruments
Triggering	Cross triggering between the logic analyzer and protocol analyzer
	Ping pong triggering between logic analyzer and protocol analyzer through flag support. Four flags supported
Connectors	Connects to the PCI Express protocol analyzer
	3 BNC connects to the 16900 logic analyzer module

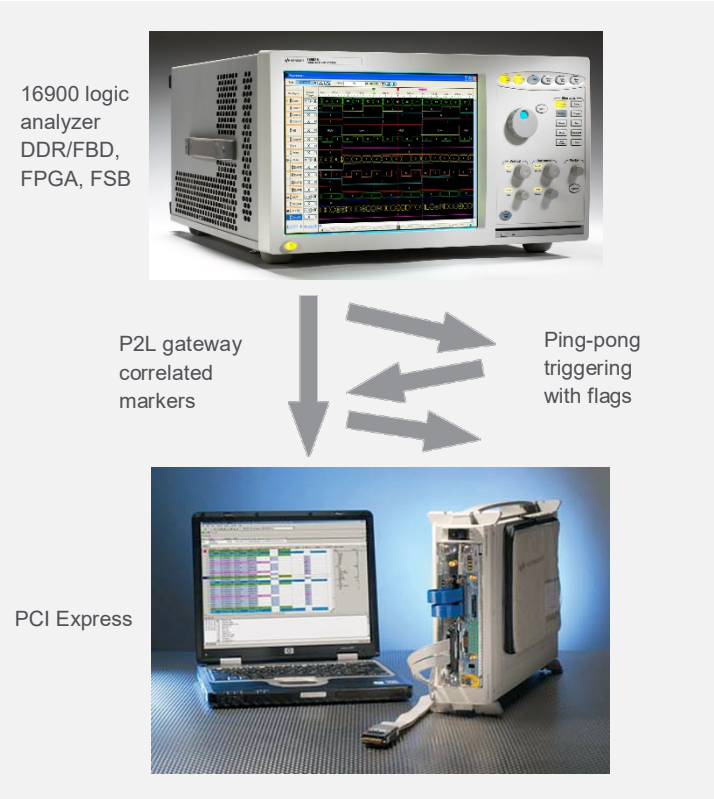


Figure 22. PCI Express.



Figure 23. N5319A P2L gateway cable with flag support.



Figure 24. P2L system viewing.

Related Products

N5302A (2 Slot) or N5304A (4 Slot) Chassis

Environment	
Temperature (AT-ETM757)	Operating: 0 °C to +55 °C
	Storage: –40 °C to +70 °C
Humidity (AT-ETM758)	Operating: 15 to 95%
	Operating soak: 90% (24 h)
Safety standards	Installation category: EN ISO/IEC 17025, IEC 61010-1/EN61010-1, II
	Pollution degree: 2
	Environmental rating: Standard
	Main supply voltage fluctuations are not to exceed 10% of the nominal supply voltage

General characteristics	
Power requirements	100 to 120 Vac
	200 to 250 Vac
	550 VA maximum
	47 to 63 Hz
Physical characteristics	
2-slot chassis	Width: 30 cm (11.81 in)
	Depth: 49.0 cm (19.29 in)
	Height: 11 cm (4.33 in)
	Weight (empty): 5.1 kg (112 lbs)
4-slot chassis	Width: 45.4 cm (17.87 in); mounts in EIA-standard 48.3 cm (19 in) rack
	Depth: 49.0 cm (19.29 in)
	Height: 2U - 8.89 cm (3.5 in)
	Weight (empty): 5.1 kg (112 lbs)
Connectors	
MDI	RJ-45; 100 Mb/s ethernet (to PC controller)
MDI-X	RJ-45; 100 Mb/s ethernet (to next chassis)
AT hard drive power	Connector on probe board (uses 12 V only)
External trigger in	Female BNC; trigger input from external device
External trigger out	Female BNC; trigger output from external device

Related Keysight Literature

Publication title	Publication number
Agilent PCI Express Gen 2 - Flyer	5989-6395EN
Agilent E2969B Protocol Test Card II for PCI Express 2.0 - Flyer	5989-7594EN
PCI Express® Jammer - Brochure	5990-3222EN
PCI Express Probes for E2960B PCI Express Analysis Systems - Brochure	5990-4123EN
U4301A PCI Express® 3.0 Analyzer Module - Data Sheet	5990-5018EN

Ordering Information

Protocol analyzer

Hardware		Description
	N5306A	Analyzer module for PCIe 5 Gb/s
	N5322A	Extended interface module for PCIe 5 Gb/s
Software		
Gen2 analyzer software	N5306A-A01	Analyzer SW license x1 for PCIe 5 Gb/s
	N5306A-A04	Analyzer SW license x4 for PCIe 5 Gb/s
	N5306A-A08	Analyzer SW license x8 for PCIe 5 Gb/s
	N5306A-A16	Analyzer SW license x16 for PCIe 5 Gb/s
Gen2 Ready analyzer software	N5306A-G01	Gen2 Ready analyzer SW license x1 for PCIe 2.5 Gb/s
	N5306A-G04	Gen2 Ready analyzer SW license x4 for PCIe 2.5 Gb/s
	N5306A-G08	Gen2 Ready analyzer SW license x8 for PCIe 2.5 Gb/s
	N5306A-G16	Gen2 Ready analyzer SW license x16 for PCIe 2.5 Gb/s
Probes		**Description**
Gen2 probes	N4241A	Mid-bus probe 2.0 bi-directional x8 for PCIe 5 Gb/s
	N4242A	Mid-bus probe 2.0 swizzled x16 for PCIe 5 Gb/s
	N4243A	Mid-bus probe 2.0 kit split x4 for PCIe 5 Gb/s
	N4241F	Flying lead set 2.0 Bi-directional x8 for PCIe 5 Gb/s
	N5315A-A01	Slot interposer for PCIe 5 Gb/s link width x1
	N5315A-A04	Slot interposer for PCIe 5 Gb/s link width x4
	N5315A-A08	Slot interposer for PCIe 5 Gb/s link width x8
	N5315A-A16	Slot interposer for PCIe 5 Gb/s link width x16

Gen1 probes	E2960B-MEC	Express card adapter for PCIe 2.5 Gb/s for N4241A
	E2945A	PCI Express x1 passive probe board
	E2946A	PCI Express x4 passive probe board
	E2947A	PCI Express x8 passive probe board
	E2941B	EXCH AVAIL soft touch mid-bus probe for PCI-Express
	N4221A	Mid-bus probe 1.0 bi-directional x8 for PCIe 2.5 Gb/s
	N4221F	Flying lead set 1.0 bi-directional x8 for PCIe 2.5 Gb/s
	N4228A	1/2 sized compression cable set for PCI Express 2.5 Gb/s
	N5317A	PCIe probe connection cable (connect Gen1 probes to Gen2 systems)
Accessories		**Description**
	N5302A	2-slot portable chassis
	N5304A	4-slot chassis
	E2960B-LAN	USB to LAN adapter for chassis to controller connectivity
	E2960B-RET-05	Retention modules for mid-bus probe 2.0 - 5 pcs
	E2960B-RET-50	Retention modules for mid-bus probe 2.0 - 50 pcs
Logic analyzer to protocol analyzer correlation accessories	N5313A	P2L gateway cable to connect 16900A to E2960B analyzer
	N5319A	P2L gateway cable with flags to connect 16900A to E2960B analyzer

Exerciser

Hardware		Description
	N5309A-E01	Half size exerciser and LTSSM module x1 for PCIe 5 Gb/s
	N5309A-E04	Half size exerciser and LTSSM module x4 for PCIe 5 Gb/s
	N5309A-E08	Half size exerciser and LTSSM module x8 for PCIe 5 Gb/s
	N5309A-E16	Half size exerciser and LTSSM module x16 for PCIe 5 Gb/s
Software		
Gen2 exerciser software	N5309A-EX2	Exerciser SW license: exerciser and LTSSM at 5 Gb/s
Gen2 Ready exerciser software	N5309A-EX1	Gen2 Ready exerciser SW license: exerciser and LTSSM at 2.5 Gb/s
Compliance tests	N5309A-PTC	Exerciser SW license: protocol test cards software (included with exerciser purchase)
	N5309A-COM	Exerciser SW license: compliance assured test package (over 170 pre-defined tests)
Accessories		**Description**
	N5316A	Test backplane for PCIe2
Protocol Test Cards		**Description**
PTC1	E2969A	Protocol test card for PCI Express Gen 1 (includes software and hardware)
PTC2	E2969B	Protocol test card for PCI Express Gen 2 (includes software and hardware)

Jammer

Hardware		Description
	N5323A-J01	Jammer module x1 for PCIe 5 Gb/s
	N5323A-J04	Jammer module x4 for PCIe 5 Gb/s
	N5323A-J08	Jammer module x8 for PCIe 5 Gb/s
Software		
	N5323A-JM1	Gen2 Ready Jammer SW license: Jammer at 2.5 Gb/s
	N5323A-JM2	Jammer SW license: Jammer at 5 Gb/s
	N5323A-SCR	Jammer SW license: Jammer scripts

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