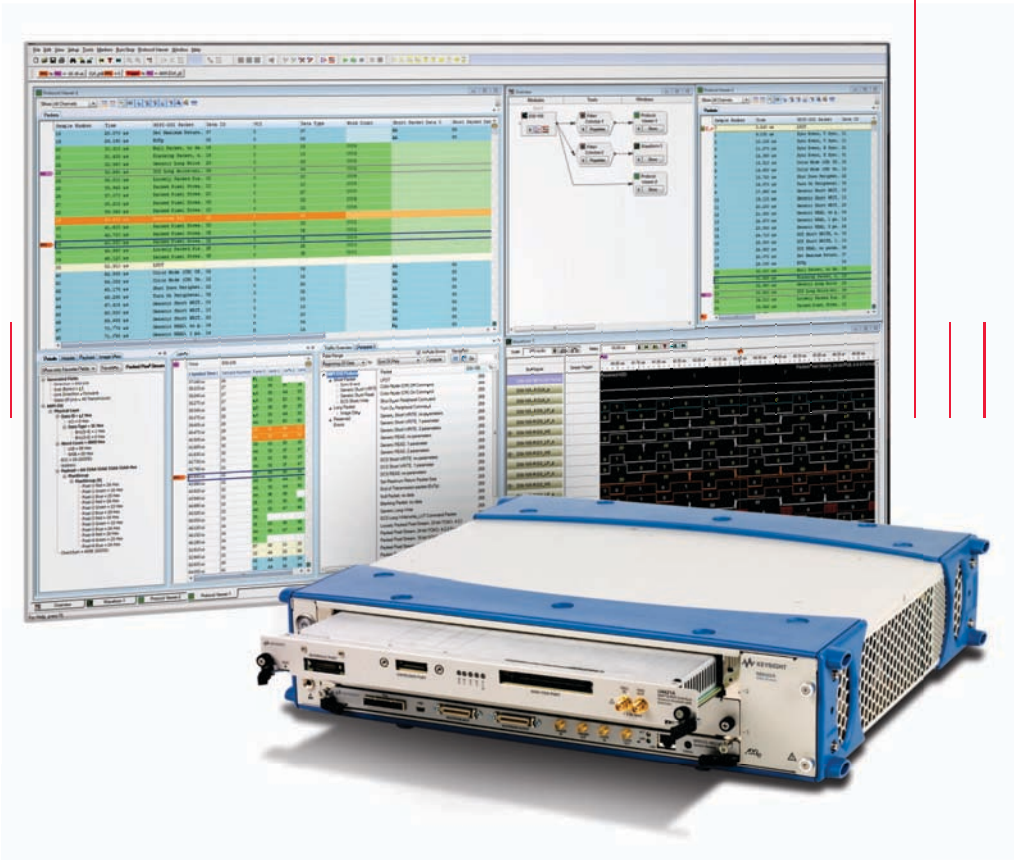
Keysight Technologies
U4421A MIPI® D-PHY™ Protocol Exerciser/Analyzer

Data Sheet



KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

The MIPI D-PHY Analyzer, Two Instruments in One

(Available with Option 601 or 603)

Link multiple windows together or track correlated events with markers

Isolate any packet's header

See data as a packet payload or as individual lanes

Any number of filters and views can be applied. Organize them easily in the overview GUI

Quickly customize simple drag-and-drop trigger macros

Get the "big picture" with the Overview tab

Use advanced if-then-else triggers to branch in any direction to up to eight different conditions. Add counters, timers, and flags for even more control

Raw Mode lets you see the "why" behind your protocol

The MIPI D-PHY Analyzer, Two Instruments in One
(Available with Option 601 or 603) (continued)

The U4421A MIPI D-PHY Analyzer option for CSI-2 and DSI gives you deep insight into your mobile computing designs

Time correlate multiple busses and views. Multiple modules (D-PHY, PCI, DDR, high-speed logic, and HDMI) can be installed in one mainframe, and multiple frames can be connected. Any number of filters and views can be applied. Organize them easily in the overview GUI. Link multiple windows together or track correlated events with markers.

Look deeply into packets with “peel off” tabs. Isolate any packet’s header, or data as a packet payload or individual lanes.

Raw Mode lets you see the “why” behind your protocol. Raw state data that is acquired by the analyzer can be displayed as a time-correlated waveform view.

Get the “big picture” with the Overview tab. Get a count of the various types of traffic in any period of time, including errors; then step through each occurrence with embedded navigation tools.

Isolate events with protocol-aware triggers. Simple drag-and-drop trigger macros can be quickly customized. Or use advanced if-then-else triggers to branch in any direction to up to eight different conditions. Trigger on packet types, errors or into payload data.

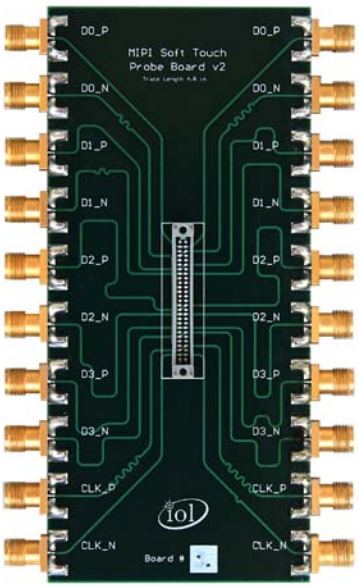
Probe any system with three flexible probing options (below). The E5381A differential flying leads let you connect to vias, headers, and traces. The E5404A Soft Touch Pro probe gives you a rugged in-board connection to a small footprint. In addition, UNH-IOL has created an SMA to Soft Touch break-out board that connects directly to their Reference Termination Board, or be used as a generic mid-bus adapter.

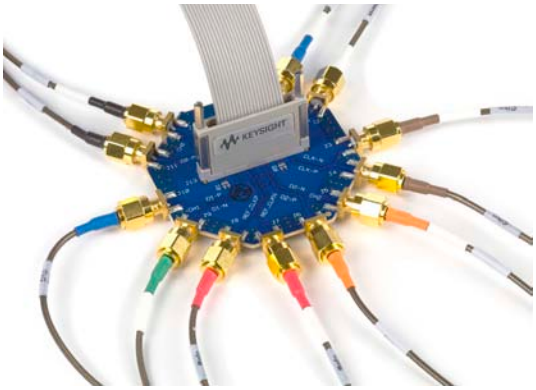
Key features:

- Protocol aware for DSI and CSI-2 traffic in all views, triggers, and filters
- Up to 1.5 Gb data rate
- Up to 16 GB Trace Depth
- Up to 4 data lanes + CLK
- 5-ns resolution raw mode data
- N-way trigger branching
- Integrated image extraction software

Target users: Designers and validators of

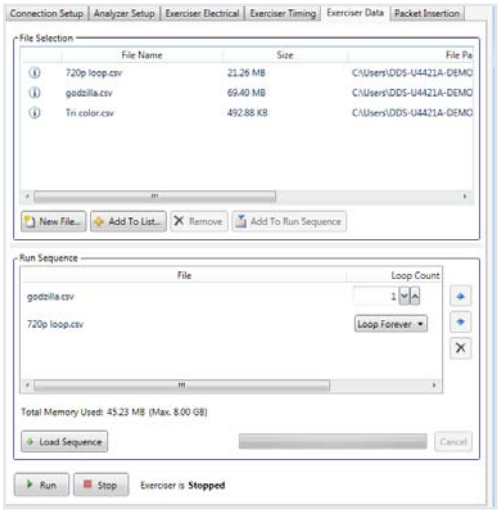
- Mobile devices
- Mobile embedded systems
- MIPI silicon/IP
- Cameras



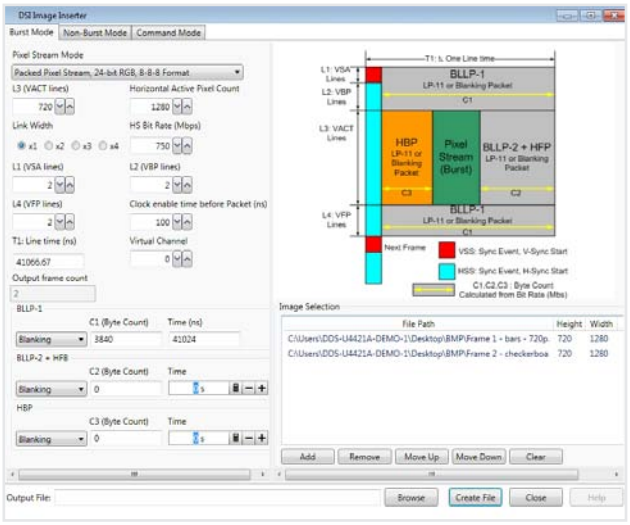


The MIPI D-PHY Analyzer, Two Instruments in One
(Available with Option 601 or 603) (continued)

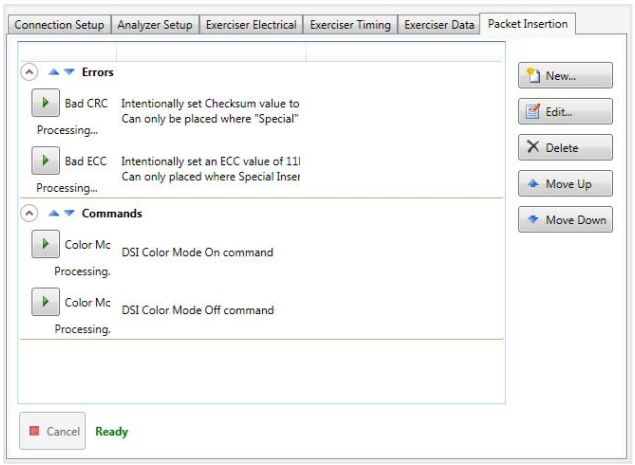
The U4421A MIPI D-PHY Analyzer option for CSI-2 and DSI gives you deep insight into your mobile computing designs (continued)



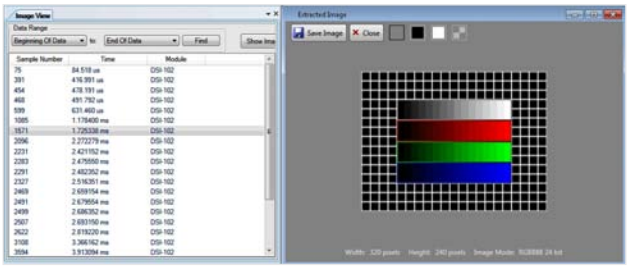
End-to-end data path analysis: Quickly create exerciser traffic ...



... based on images or commands ...



...or inserted packets...



... analyze and extract the transmitted images by physically probing or using the analyzer's internal loopback.

Adjust timing parameters, including data rate, output voltage, skew rate, signal timing, and lane skew.

The MIPI D-PHY Analyzer, Two Instruments in One
(Available with Option 601 or 603) (continued)

The U4421A MIPI D-PHY Analyzer option for CSI-2 and DSI gives you deep insight into your mobile computing designs (continued)

The U4421A MIPI D-PHY Exerciser option for CSI-2 and DSI provides the record depth necessary to stimulate designs with high-definition images and video. It also lets you simulate traffic from a wide variety of devices busses of varying signal performance.

Deep memory. With 1GB of standard memory, and with options for 4 GB and 16 GB, you can generate long sequences of high definition images and videos.

Internal loopback, available with the U4421A analyzer Options 601 and 603, lets you verify the exerciser's output. This gives you additional confidence in the data that you are sending to your target.

Change both HP and LP signal levels to understand how your system reacts to diminished signal voltages. A system that can tolerate lower signal swings will usually have a longer battery life.

Change signal data rate, slew rate, and lane timing to get insight into how your systems and peripherals react to a wide variety of CSI and DSI signals. Bring the "plug-fest" experience to your bench.

Generate traffic quickly with your own CSV files, the integrated packet inserter or the optional image inserter software. Recall your favorite patterns with user-defined "hot" (shortcut) keys.

Each module can simultaneously be an exerciser and an analyzer. Combine multiple modules in a 2 (M9502A) or 5 (M9505A) slot AXIe mainframe to analyze and simulate cross-system behavior.

Key features:

- Generate user-defined D-PHY traffic
- Up to 1.5 GB data rate
- Up to 16 GB trace depth
- Change speed, slew rate, voltage levels and lane skew
- Flexible pattern creation
  - GUI
  - Packet inserter
  - Image inserter

Target users: Designers and validators of

- Mobile devices
- Mobile embedded systems
- MIPI silicon/IP
- Displays

Keysight U4421A – Analyzer Option (601) Performance Characteristics

Electrical	
HSV minimum differential	100 mV
LPV threshold range	0 to 1.5 V
Lane width	Up to 4 with Option 004. Analyze 1-, 2-, 3-, or 4-lane systems
Performance	
Maximum bit rate (high-speed mode)	1.5 Gbps
Minimum bit rate (high-speed mode)	80 Mbps
Maximum bit rate (low-power mode)	10 Mbps
Minimum bit rate (low-power mode)	N/A
Raw mode LP sample resolution	5 ns, typical for LP traffic; 1 ÷ bit rate for HS traffic
Maximum data rate of probes	
E5381A	1.5 Gbps with 82 Ω coaxial resistor adapter, 1.0 Gbs with damped wire and 3-pin header adapters.
E5405A	1.5 Gbps
Memory	**User allocated (shared among exerciser, analyzer and raw mode)**
Standard	1 GB
Option M04 (recommended for images)	4 GB
Option M16 (recommended for video)	16 GB
Protocol	
Protocol version support	
Display	Display Serial Interface (DSI) v1.1 Display Serial Interface (DSI) v1.02.00 Display Serial Interface Version 1.01.00 Display Command Set (DCS) v1.1 Display Command Set (DCS) v1.02.00 Display Command Set v1.01.00 Stereoscopic Display Formats (SDF) v1.0
Camera (CSI-2)	Camera Serial Interface 2 v1.01.00 Camera Serial Interface 2 v1.00 (CSI-2)
Protocol viewer	Hierarchical packet-level display
Protocol views	Packets, header, lanes, payload, and traffic overview
Protocol decoder	
Simultaneous HS and LP data support	Yes
Short and long packet decode	Yes
CSI-2 and DSI-1 decode	Yes, user selectable
Waveform view (Raw Mode)	Packets and lanes
Error display	
SOT error display	Yes
EOT error display	Yes
Escape error display	Yes
Sequence error display	Yes
Turnaround error display	Yes
ECC, CRC error display	Yes
Contention detection	No
Track changes in speed (HS/LP) mode	Yes
Correlation markers	> 1,000 user-defined
Marker measurements	Yes, user-defined time and count measurements
Window correlation lock	Yes, user-defined

Keysight U4421A – Analyzer Option (601) Performance Characteristics (Continued)

Triggering capabilities	
Trigger on protocol commands	Yes, with > 130 macros
Simple trigger	Drag and drop
Advanced trigger	
Sequence levels	Up to 8
Logical branching	N-way
Trigger on protocol patterns	Yes, on both DSI and CSI long and short packet headers
Protocol pattern customization	Yes, with bit-level editing
Payload pattern matcher	First 4 bytes
Event counter	Yes
Time counter	Yes, 100 ns accuracy
Real-time error detection	5 ns resolution ± 5 ns of accuracy
SOT error trigger	Yes, on a per lane basis
EOT error trigger	Yes, on a per lane basis
Escape error trigger	Yes, on a per lane basis
Sequence error trigger	Yes, on a per lane basis
Turnaround error trigger	Yes, on a per lane basis
ECC	Yes
CRC	Yes
Display	
Low power state of data transmission	All escape mode actions, except ultra-low power
Stopped	No
Image extractor / Image inserter	
DSI	
Burst mode	Packed pixel stream, 16-bit RGB, 5-6-5 format Packed pixel stream, 18-bit RGB, 6-6-6 format Loosely packed pixel stream, 18-bit RGB, 6-6-6 format Packed pixel stream, 24-bit RGB, 8-8-8 format Packed pixel stream, 30-bit RGB, 10-10-10 format Packed pixel stream, 36-bit RGB, 12-12-12 format Packed pixel stream, 12-bit YCbCr, 4:2:0 format Packed pixel stream, 16-bit YCbCr, 4:2:2 format Loosely packed pixel stream, 20-bit YCbCr, 4:2:2 format Packed pixel stream, 24-bit YCbCr, 4:2:2 Format
Non-burst mode	Packed pixel stream, 16-bit RGB, 5-6-5 format Packed pixel stream, 18-bit RGB, 6-6-6 format Loosely packed pixel stream, 18-bit RGB, 6-6-6 format Packed pixel stream, 24-bit RGB, 8-8-8 format Packed pixel stream, 30-bit RGB, 10-10-10 format Packed pixel stream, 36-bit RGB, 12-12-12 format Packed pixel stream, 12-bit YCbCr, 4:2:0 format Packed pixel stream, 16-bit YCbCr, 4:2:2 format Loosely packed pixel stream, 20-bit YCbCr, 4:2:2 format Packed pixel stream, 24-bit YCbCr, 4:2:2 format
Command mode	3 bits per pixel 8 bits per pixel 12 bits per pixel 16 bits per pixel 18 bits per pixel 24 bits per pixel

Keysight U4421A – Analyzer Option (601) Performance Characteristics (Continued)

Image extractor / Image inserter (Continued)	
CSI	
	RGB444
	RGB555
	RGB565
	RGB666
	RGB888
	YUV420 8-bit
	YUV420 8-bit (Chroma shifted pixel sampling) legacy YUV420 8-bit
	YUV420 10-bit
	YUV420 10-bit (Chroma shifted pixel sampling) YUV422 8-bit
	YUV422 10-bit
	RAW6
	RAW7
	RAW8
	RAW10
	RAW12
	RAW14

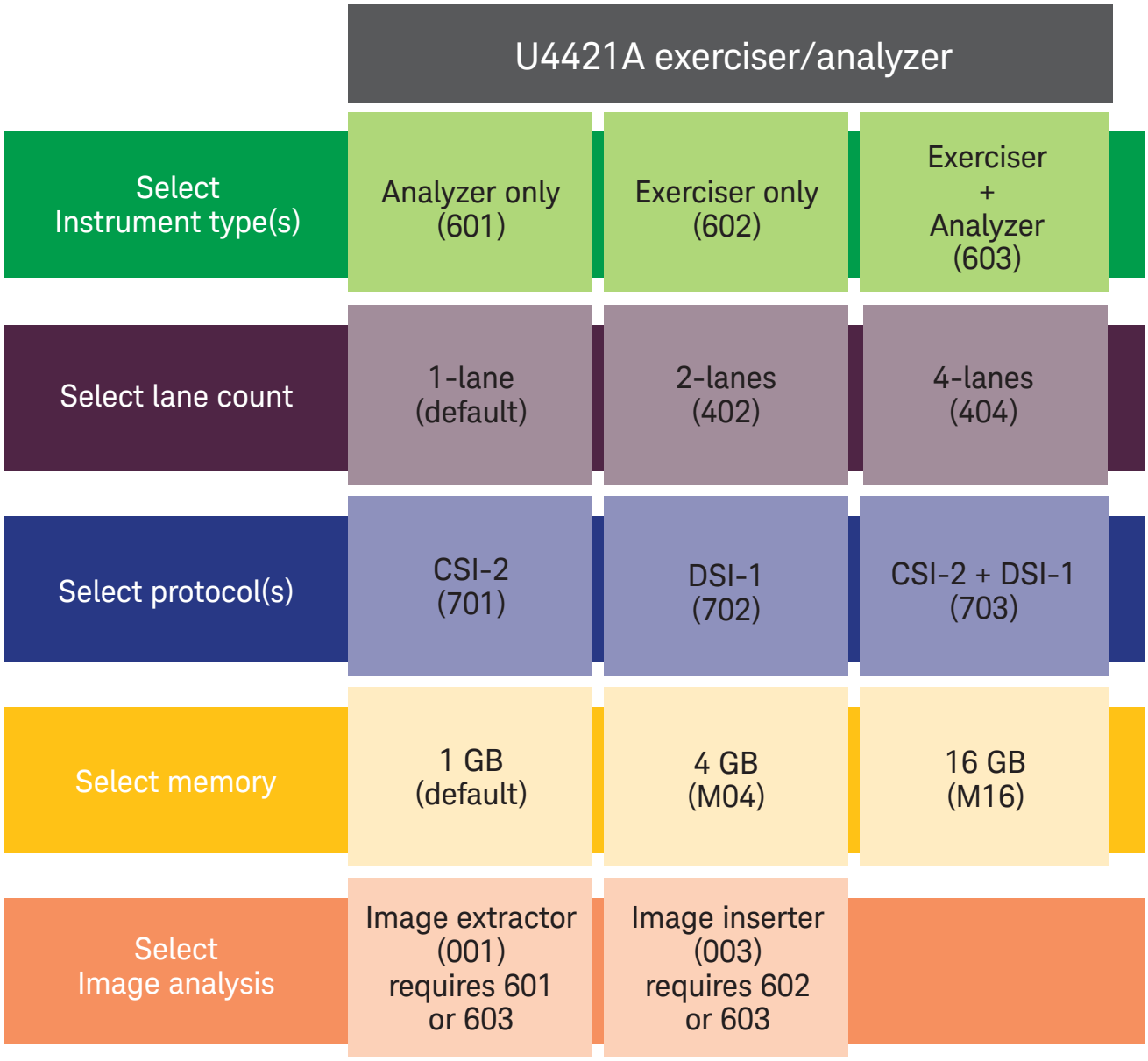
Keysight U4421A – Analyzer Option (602) Performance Characteristics

Electrical	**Features**
Lane width	Up to 4 with Option 404. Exercise 1-, 2-, 3-, or 4-lane systems
Low-power voltage high adjustment	500 mV to 1.5 V
Low-power voltage low adjustment	± 100 mV
High-speed output differential voltage	60 mV to 320 mV
High-speed common mode voltage	60 mV to 380 mV
Output driving impedance	High-speed: 50 Ω; Low-power: 82.4 Ω
Bus termination modes	Open, dynamic, static 100 Ω differential
Waveform timing control	Yes, automatic or manual settings
CLK-POST timing control	Yes, automatic or manual settings
CLK-PRE timing control	Yes, automatic or manual settings
CLK-PREPARE timing control	Yes, automatic or manual settings
CLK-TRAIL timing control	Yes, automatic or manual settings
CLK-ZERO timing control	Yes, automatic or manual settings
HS-EXIT timing control	Yes, automatic or manual settings
HS-PREPARE	Yes, automatic or manual settings
HS-ZERO	Yes, automatic or manual settings
HS-TRAIL	Yes, automatic or manual settings
LPX	Yes, automatic or manual settings
TA_Get	Yes, automatic or manual settings
TA_GO	Yes, automatic or manual settings
CLK lane and data lane skew adjust	5 ps, resolution typical; ± 0.5 UI @ 1 GB and above
Reference clock input	Required, Clock input = 1/10 bit rate to 700 Mbs, 1/20 above 700 MB
Performance	
Maximum bit rate (high-speed mode)	1.5 Gbps
Minimum bit rate (high-speed mode)	80 Mbps
Maximum bit rate (low-power mode)	10 Mbps
Minimum bit rate (low-power mode)	800 Kbps
Memory	**User allocated (shared among Exerciser, Analyzer and Raw Mode)**
Standard	1 GB
Option M04 (recommended for images)	4 GB
Option M16 (recommended for video)	16 GB
Packet insertion	
HSDT request error generation	Yes, with timing control to violate specs
SOT synch error generation	No
Endof HSDT error generation	Yes, with timing control to violate specs
LPD transmission error generation	Yes, with waveform timing control and direct control of data transmitted on the link
Protocol errors	Yes
Turnaround error generation	No (does not operate in slave mode)
ECC, CRC error generation	Manual

Keysight U4421A – Analyzer Option (602) Performance Characteristics (Continued)

Environmental specifications		
Radiated emissions (RE)	CISPR 11/EN55001	Group 1 Class A
Radiated immunity (RI)	EN/IEC 61000-4-3 frequency range @ V/m	80 MHz to 2 GHz @ 3 V/m; 2 GHz to 2.7 GHz @1 V/m
Electrostatic discharge	(EN/IEC 61000-4-2)+ discharge air/contact (kV)	15/8
Operating temperature	Operating range: Min-max (°C)	+5 ±40
Storage temperature	Storage range: Non-operating min-max (°C)	–40 ±70
Operating humidity	max % RH @ temperature °C	80 @ 40
Storage humidity	max % RH @ temperature °C	90 @ 65
Random vibration, Operating	5 to 500 Hz random, Grms	0.21
Random vibration, Survival	5 to 500 Hz random, Grms	2.09
Half sine shock	2 mS half sine delta velocity m/sec (in/sec)	1.6 (63)
Trapezoidal shock	24 mS trapezoidal delta velocity m/sec (in/sec)	8.00 (315)
Operating altitude	(kilo feet/kilo meters)	10/3.1
Storage altitude	Non-operating (kilo feet/kilo meters)	15/4.6
Operating magnetic field immunity	A/m rms	30
Safety	IEC 61010-1	Single fault condition

Module Configuration



Chassis and Probing Configuration

Chassis option

M9502A	2-slots
M9505A	5-slots

PC control options

M9536A	Embedded PC module (no cables or adapters needed)
Connecting via PCIe® to a Desktop PC	
M9048A	PCIe desktop adapter
Y1202A	PCIe cable (x8 to x8)
Connecting via PCIe to a Laptop PC	
M9045B	ExpressCard adapter
Y1200B	PCIe cable (x1 to x8)

Analyzer probes (with Options 601 or 603)

N2815A	REQUIRED (Logic cable)
Pick one or more of the following	
E5381A	Flying lead adapter
E5405A	Soft touch adapter
SMA breakout to soft touch adapter (available from UNH-IOL)	

Exerciser probe (with Options 602 or 603)

U4422A	SMA cable, MIPI D-PHY, 13 leads/1.5 Gbps

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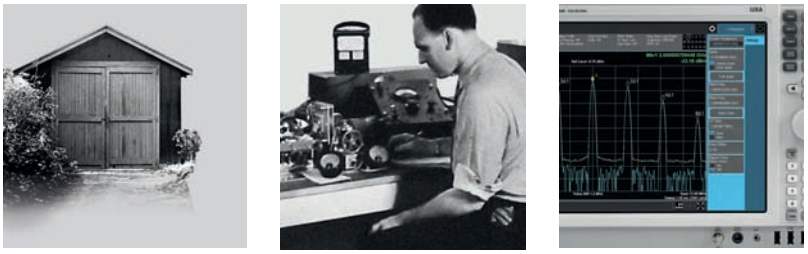

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