示波器實機量測研習營

Raymond Tseng, 品勛科技股份有限公司(Keysight優秀業績經銷商)
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(Pinsyun)品勛科技股份有限公司 ⊕
經銷商
PINSYUN

➢分別於台北、新竹、台南皆有據點
➢專業AE 團隊 / 設有開放實驗室
➢提供到府教育訓練
➢線上諮詢/即時服務

即時示波器的重要特性

當設計變得越來越複雜，專業的主流桌上型除錯和分析工具標準也隨之提高。 新的 Infiniium EXR 系列混合信號示波器（EXR 系列）是為專業工程師提供的通用型除錯工具。Infiniium EXR 採用先進的 ASIC，可支援 7 種整合式應用，包括示波器、數位電壓錶（DVM）、波形產生器、波特圖繪圖儀、計數器、協定分析儀和邏輯分析儀。EXR 系列提供多達 8 個類比通道，並以 16 個獨立的數位通道同時在 2.5 GHz 下運作。

本講座將深入介紹Infiniium EXR混合信示波器的功能與特色, 協助專業工程師快速的看見問題、解決問題, 完成量測結果。

Lab:

- 快速眼圖(Quick Eye Diagram)量測 (30 mins)

- 多通道電源時序(Multi-Channel Power Sequence) 量測 (30 mins)

- 除錯獵人(Fault Hunter)功能 (30 mins)

- 電源完整性與波德圖 (Power integrity & FRA) 測試 (40mins)

Agenda:

1:00 - 1:30 p.m.　報到

1:30 - 2:30 p.m.　即時示波器的重要特性

2:45 - 4:55 p.m.　實機操作體驗

- 快速眼圖(Quick Eye Diagram)量測

- 多通道電源時序(Multi-Channel Power Sequence) 量測

- 除錯獵人(Fault Hunter)功能

- 電源完整性與波德圖 (Power integrity & FRA) 測試

4:55 - 5:00 p.m.　問卷回填及幸運抽獎

Meet the Infiniium EXR-Series

Standard Performance

- 100 Mpts per channel memory
- 500 GB SSD
- 4 digit DVM, 10 digit counters
- Hardware accelerated plotting
- Segmented / history mode
- Fault Hunter
- Eye diagrams, clock recovery
- FFT, 50+ voltage/timing measurements
- *Training signals, auto demo modes*

Key Specifications				
Analog Channels	4 or 8, upgradeable			
Bandwidth	500 MHz → 2.5 GHz			
Sample rate	16 GSa/s			
Memory Depth	100 Mpts/ch → 400 Mpts/ch			
Update Rate	>200,000 wfm/s			
Resolution (high res)	10 bits (16 bits)			
	500 MHz	**1 GHz**	**2 GHz**	**2.5 GHz**
ENOB	8.2	8	7.6	7.5
Noise @ 1 mV/div	63 µV	73 µV	91 µV	100 µV
Logic Analysis	16 channels, separate connector			
DVM	4 digits			
Counter	2x 10 digit, 1x 8 digit			
AWG / FRA	50 MHz			
	4 Ch.		**8 Ch.**	
Max power draw	450 W		650 W	
Weight	13.8 kg		14.5 kg	
Dimensions	H: 33 cm // W: 44 cm // D: 22 cm			

# See an Accurate Representation of Your Signals
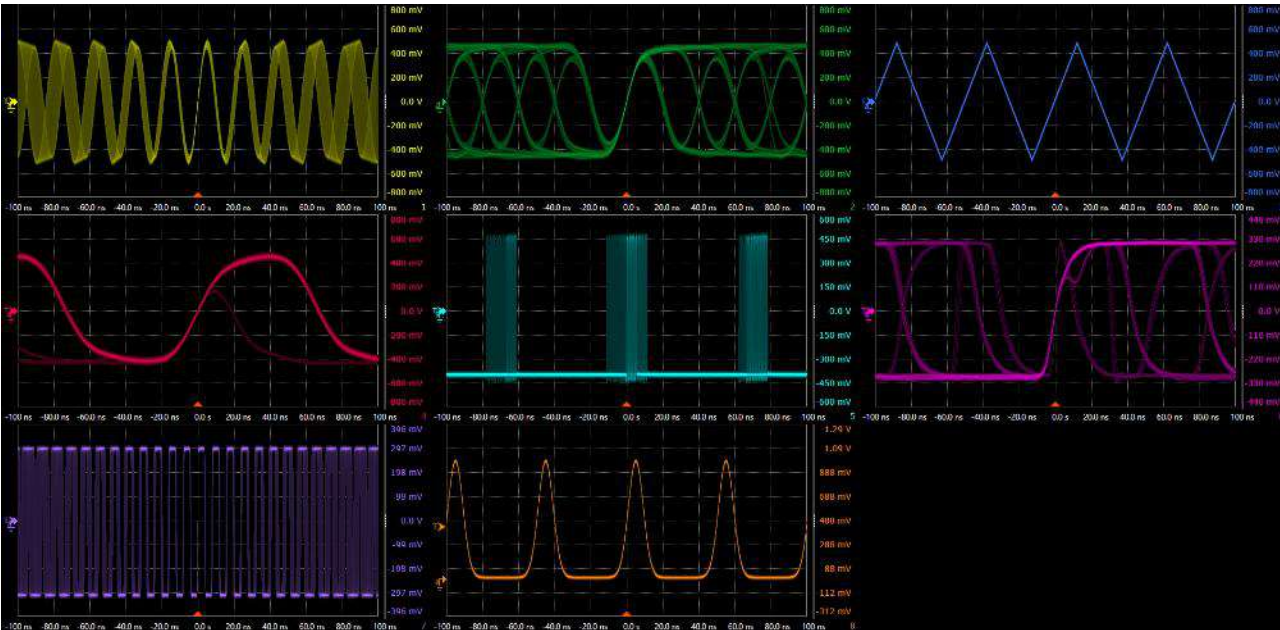
More Accurate

✓ High effective number of bits **(up to 9.0)**

✓ High resolution **(up to 16 bits)**

✓ Low noise **(down to 43 µV)**

✓ Accurate timebase **(8 parts per billion)**

More Capability

✓ 100 Mpts/ch standard memory *

✓ 2.5 GHz on 8 channels *

✓ 16 GSa/s on 8 channels *

✓ Full HD 1920x1080 resolution *

Better than key competitors!

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1024x768 XGA

1920x1080 Full HD
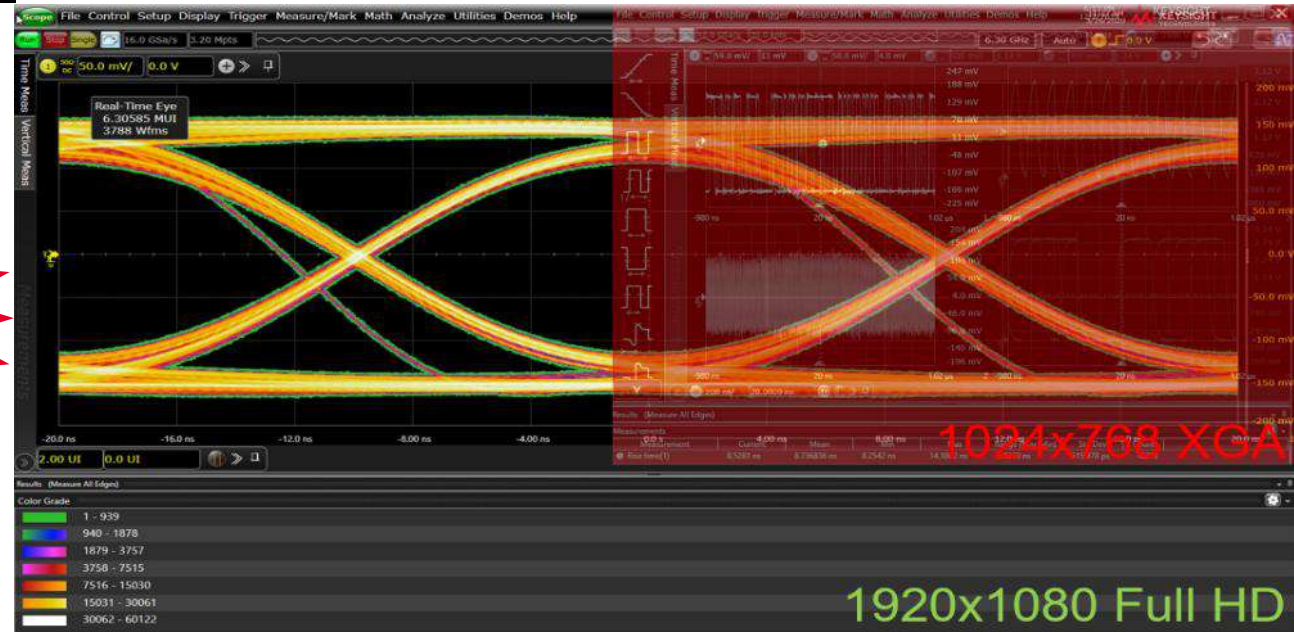
The Infiniium EXR-Series Is…

POWERFUL

EASY TO OWN

INTUITIVE TO USE

POWERFUL

EASY TO OWN

INTUITIVE TO USE

Power Testing

Protocol Layer Testing

Physical Layer Testing

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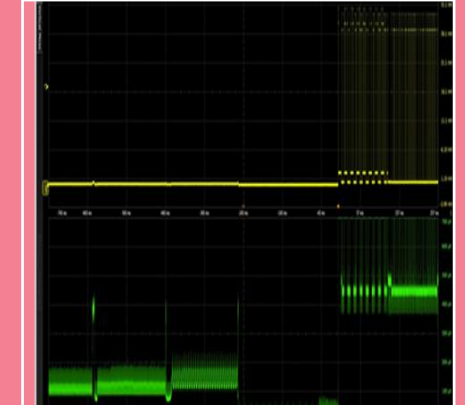# Testing Throughout the Power Ecosystem
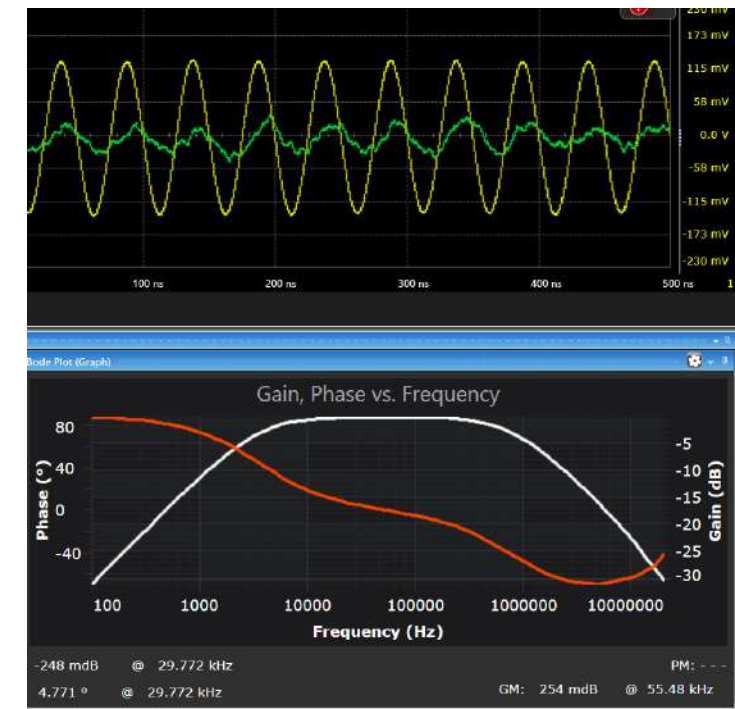

Power Conversion

Power Up/Down Sequencing
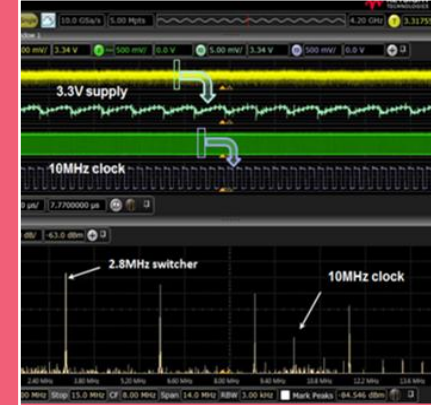
Power Rails / Distribution

Power Consumption

Power Conversion – D9010PWRA

- 20 different input, output, and switching device analysis

- PSRR, Control Loop Response to 50 MHz (using WaveGen)- i.e., Bode plots

- Setup Wizard to walk you through connection procedures

- Automatic Deskew

- High-accuracy voltage and current probes to select from

Power Up/Down Sequencing / PMIC Test – Standard

- Mask testing on every channel

- "One page report" with timing measurements and failures on screen

- Analyze control signals with protocol trigger/decoding
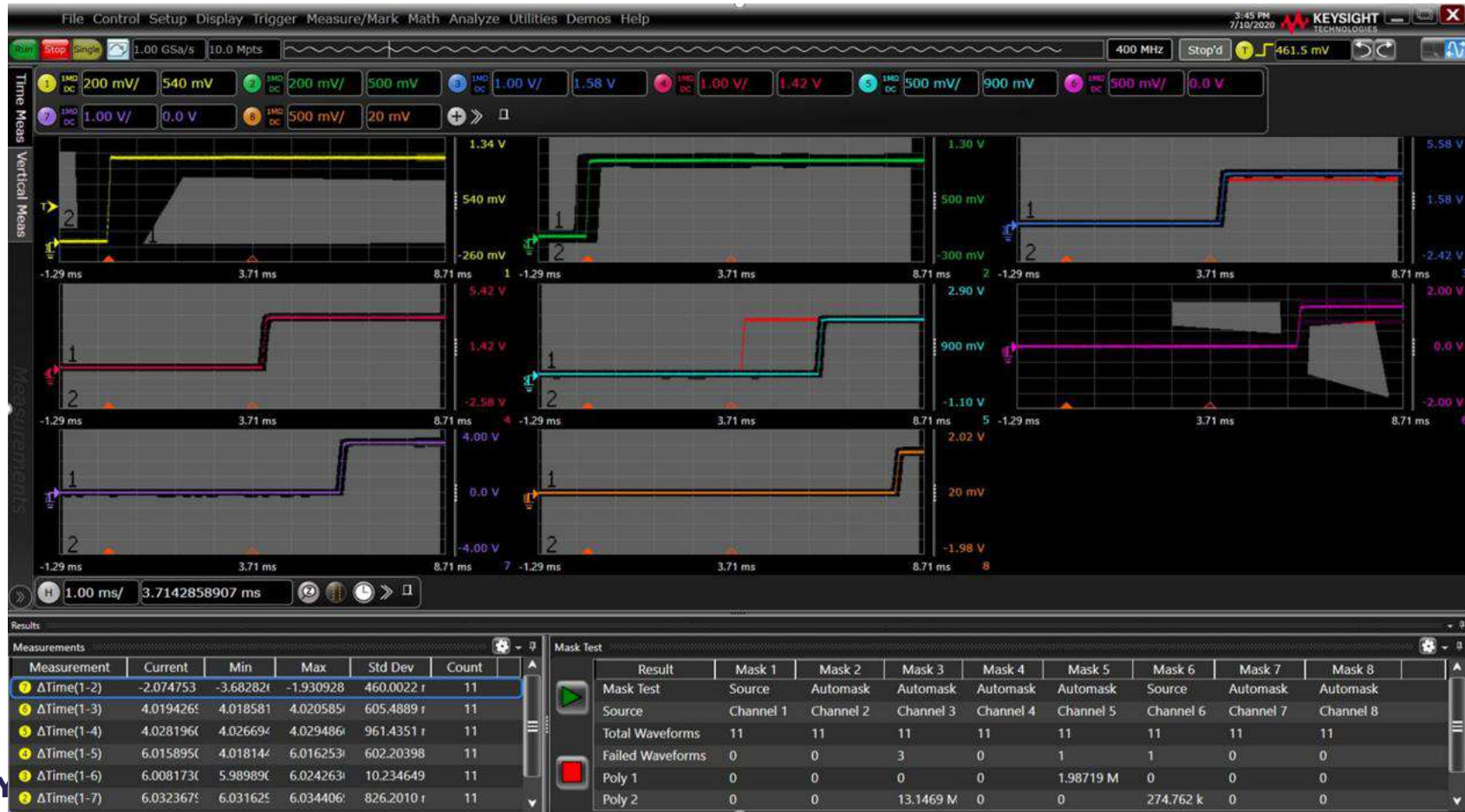
Power Distribution – D9010POWA

- Measure DC power rail quality with N7020A probe solution

- Perform "what if" analysis by simulating a cleaner power rail and seeing the net benefits to signal integrity
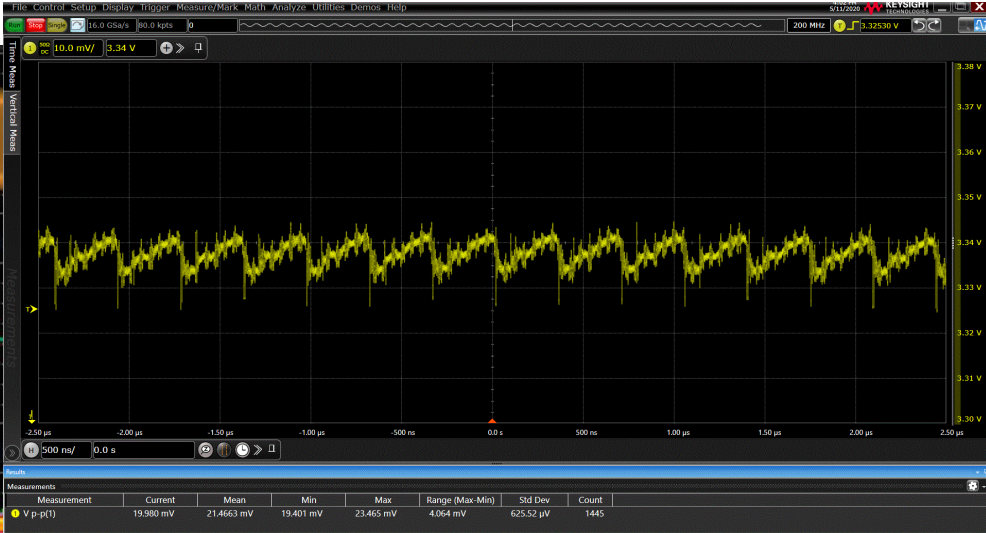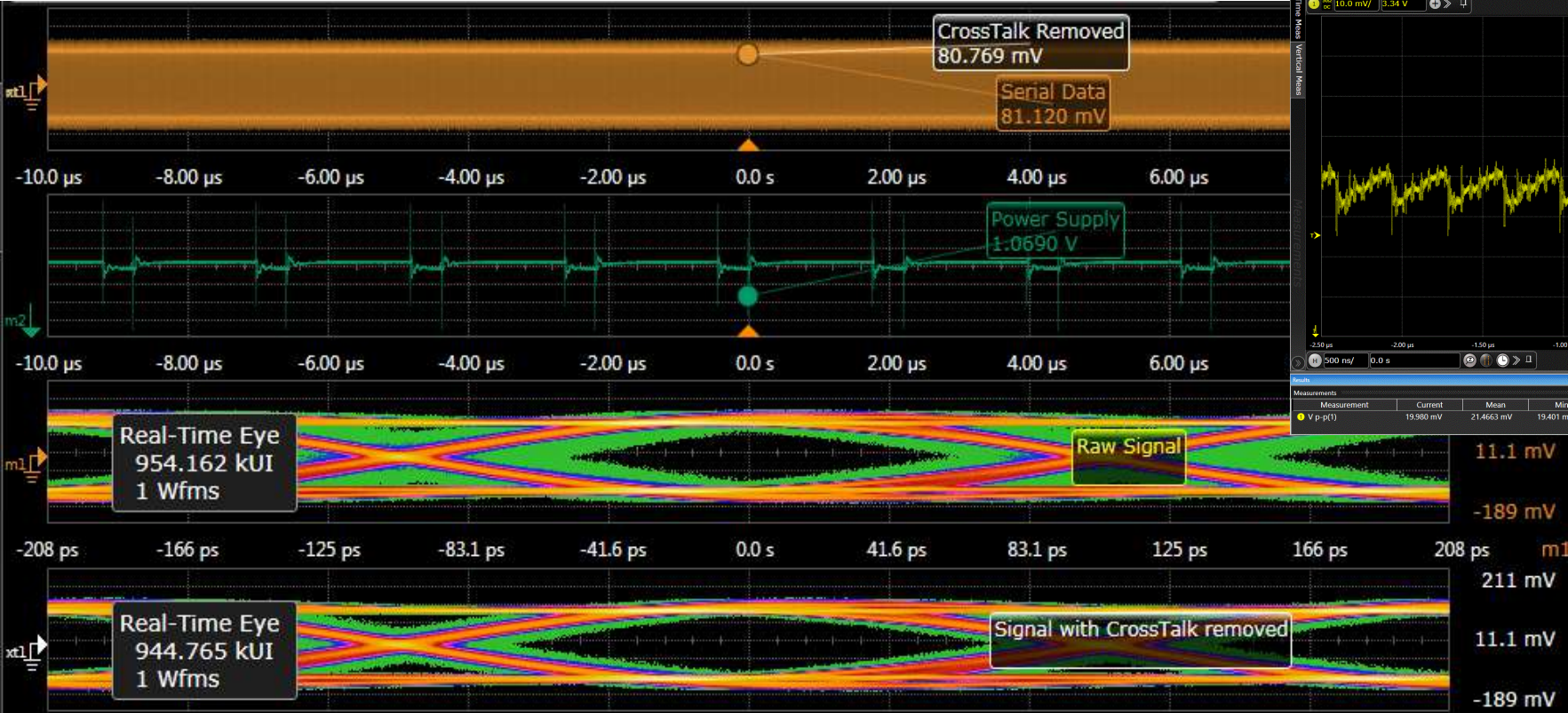
Power Consumption – N2820A/N2821A

Industry's only shunt resistor current probe: N2820A-Series Current Probes

- ✓ High Sensitivity
- ✓ High Dynamic Range
- ✓ R_{SENSE}: 1mΩ to 1MΩ

Capture and analyze low level current flow in the device under test to characterize sub-circuits or measure current consumption of wireless battery-powered devices or integrated circuits

Minimum Current: 100nA

Maximum Current: >100A's

Dynamic range: 20,000:1

Zoom-out

Zoom-in
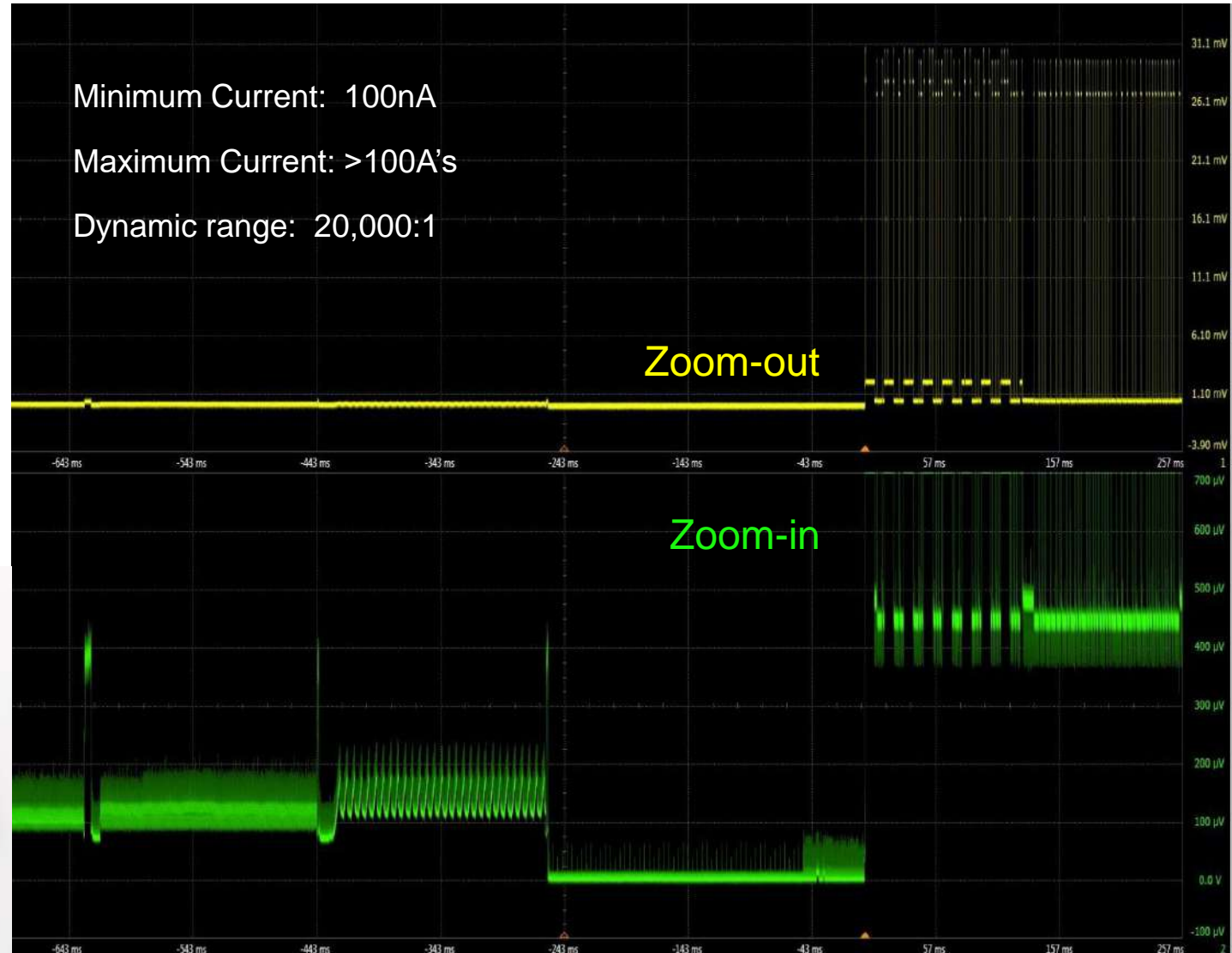
Protocol Layer Testing

- Hardware triggering lets you capture physical layer anomalies
- Powerful trigger and decode customization to drill down farther
- Test your signals against industry standards with compliance tests
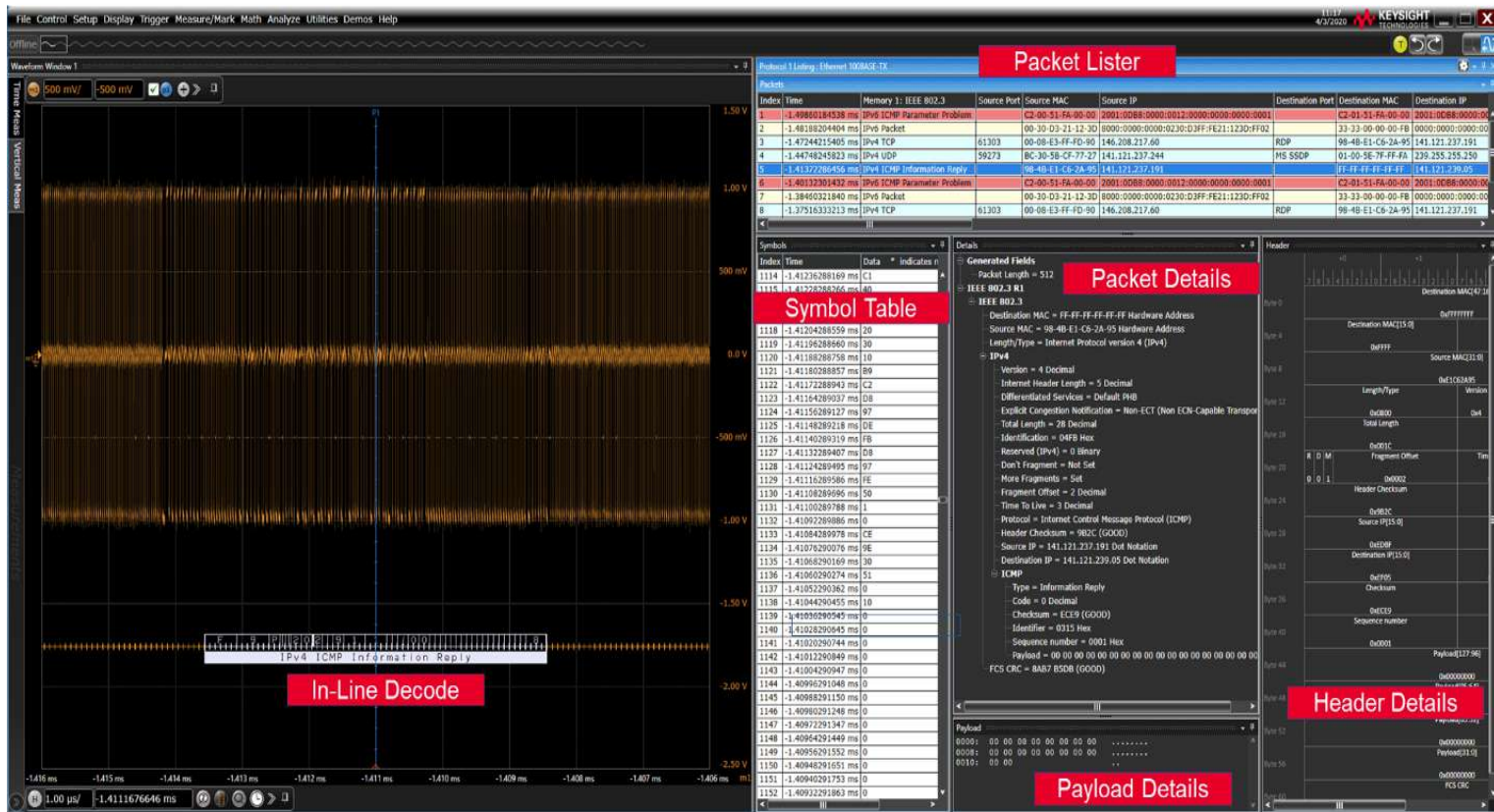
Low Speed Serial	Embedded
I^{2}C	USB 2.0 [1]
SPI	eUSB2
Quad SPI	USB-PD
eSPI	10/100 Ethernet [1]
Quad eSPI	
RS232/UART	
I^{2}S	
SVID	**MIPI**
JTAG [2]	RFEE [2]
Manchester	I3C
	SPMI
Automotive	
CAN / CAN FD	
LIN	**Military / Aero**
SENT	ARINC 429
FlexRay [2]	MIL STD 1553
100Base-T1 [1]	SpaceWire

1. Compliance Test Also Offered
2. Software trigger

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Physical Layer Testing

Trigger by Waveform Shape – D9010SCNA Event Identification Software

✓ InfiniiScan Zone Trigger: draw zones for a signal to hit or miss, or based on measured parameters.

Timing, Vertical, and Phase Noise – D9010JITA

✓ Analyze, measure, deconstruct and plot different components of jitter and noise
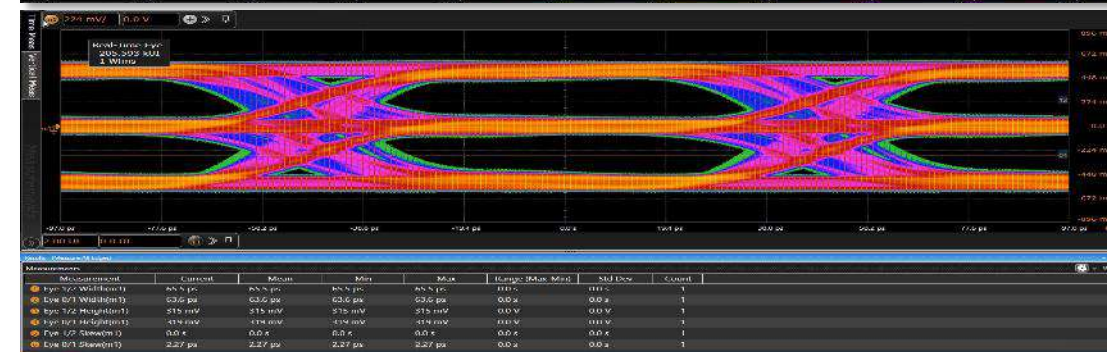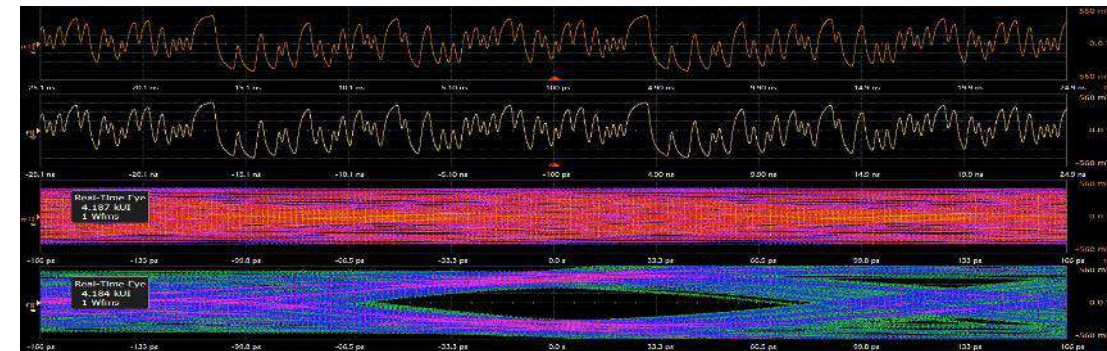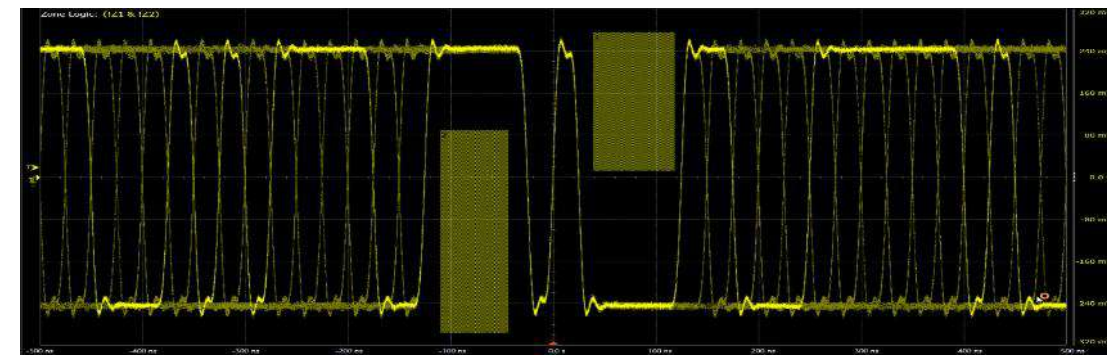
Cable and Fixture Removal – D9010DMBA

✓ Widen eyes by removing effects of cables or fixtures

Equalization and Crosstalk – D9020ASIA

✓ Widen eyes by removing effects of channel noise, ISI

✓ Simulate and remove effects of aggressors on signals

PAM-3 – D9010PAMA

✓ Measurements, clock recovery, and eye diagrams

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	POWERFUL	Reduce Bench Clutter – 7 Instruments in 1
	EASY TO OWN	▶ Optimize Your Lab Time – Infiniium Offline
	INTUITIVE TO USE	Plan for the Future – Full Upgradeability

Reduce Bench Clutter – 7 Instruments in 1

Integrated Instruments	
Digital Oscilloscope	Digital Voltmeter
Logic Analyzer (MSO)	Counter
Protocol Analyzer	Function Generator
	Frequency Response Analyzer

Product sizes to scale!

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Logic Analysis (MSO)

## Correlate analog and digital domains synchronously using MSO capability!

- ✓ Use symbols to **quickly interpret waveforms**
- ✓ Use digital channels for **protocol trigger and decode** (I²C, SPI, RS-232, JTAG, USB etc)
- ✓ Combine with oscilloscope channels to trigger across up to **24 channels simultaneously**

| Logic Channel Specifications	
Channels	16
Sample Rate	8 GSa/s
Memory Depth	31.25 Mpts/ch
Minimum Detectable Pulse	2 ns
Maximum Toggle Rate	>200 MHz

DVM / Counter
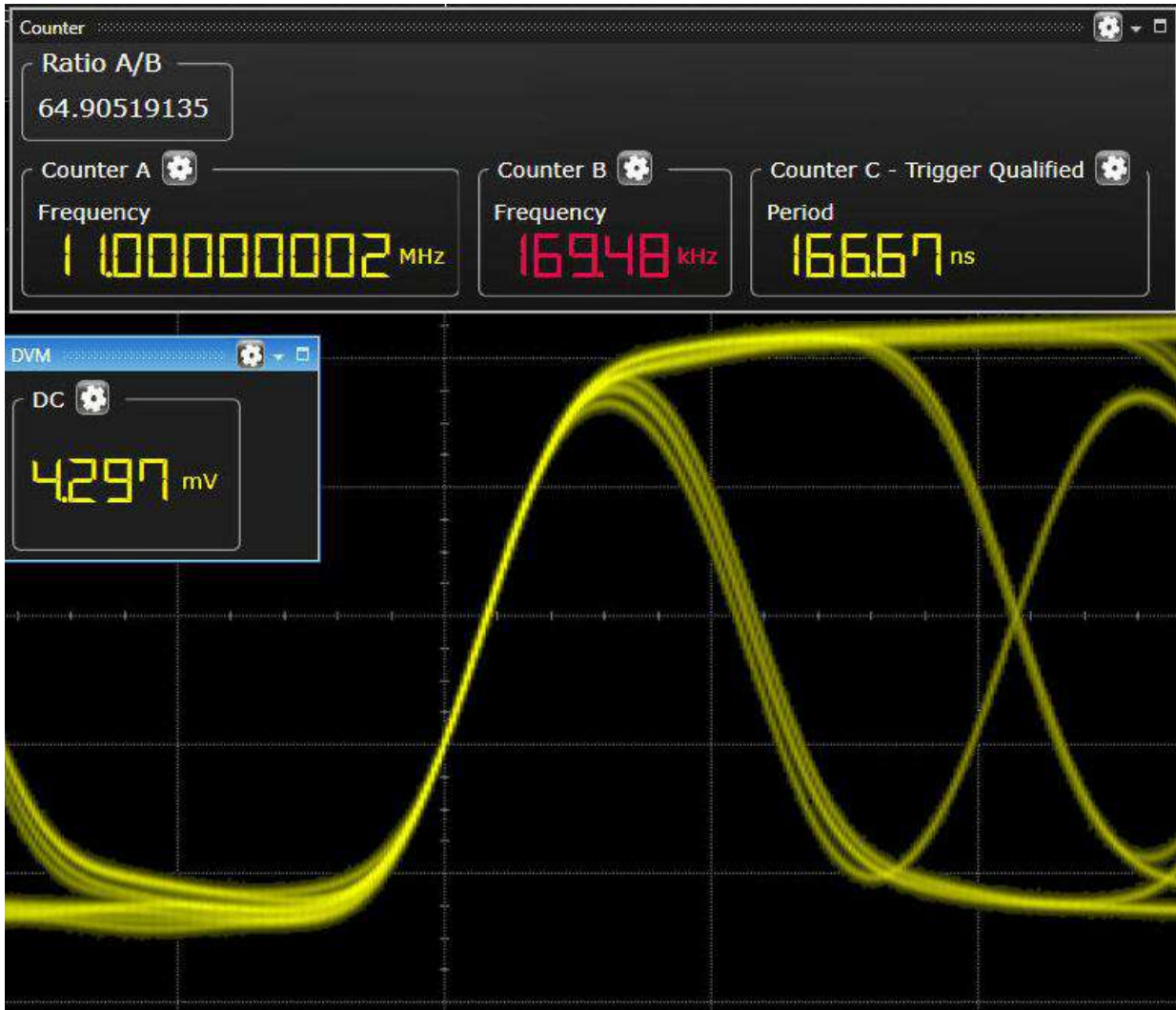
- Avoid turning on a channel, scaling, and optimizing the display for simple voltage and frequency measurements
- **Separate signal path behind the input BNC**
- More accurate than a traditional measurement

DVM Specifications	
Digits	4
Sources	Analog Channels 1 thru 8
Modes	AC_{RMS}, DC, DC_{RMS}

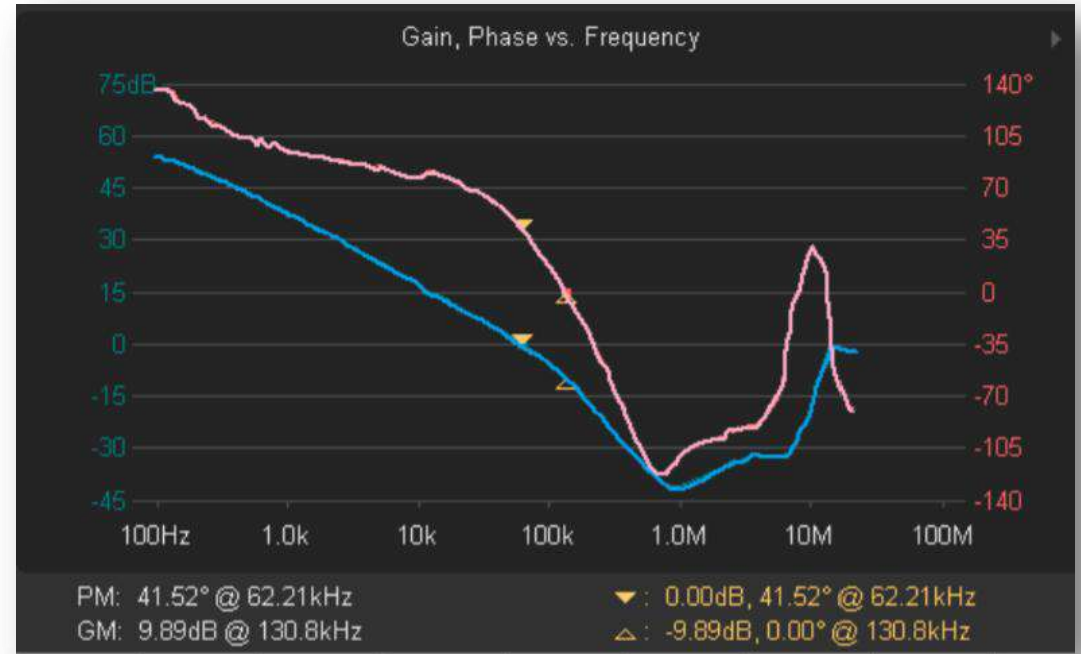| Counter Specifications	
Digits	2x 10 digit, 1x 8 digit
Sources	Analog Channels 1 thru 4
Modes	10 digit counters: frequency, period, totalize 8 digit counter: trigger qualified A/B ratio of 10 digit counters
Maximum Frequency	Bandwidth of Scope

WaveGen / Bode Plotter

Use the WaveGen to send command signals, simulate added channel noise, see frequency response, and stress test your designs with ease!
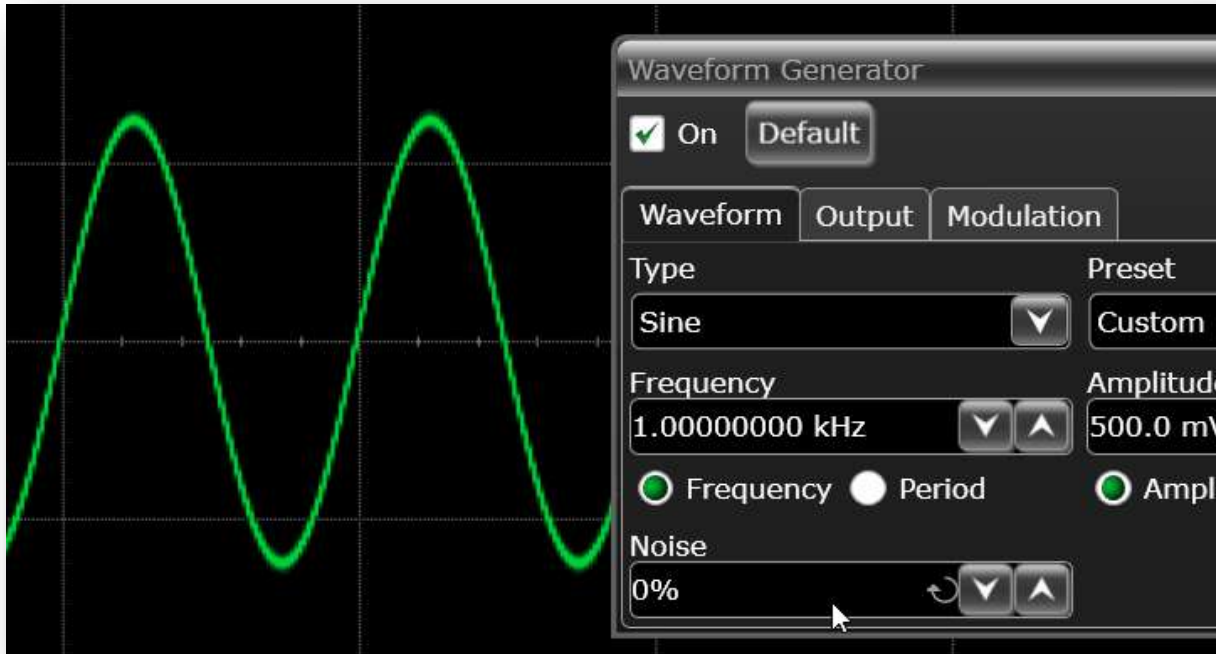
WaveGen Specifications

Output (Amplitude+Offset)	± 10 V_{PP} (1 MΩ), ± 5 V_{PP} (50 Ω)
Frequency (sine)	50 MHz sine, 20 MHz square
Preconfigured Waveforms	Sine, Square, Pulse, Triangle, Ramp, Noise, DC, Cardiac, Sinc, Exponential Rise/Fall, Arbitrary
Arbitrary Waveform Memory	128 Kpts
Modulation	AM, FM, FSK

Bode Plot Specifications

Frequency Mode	Single or Swept
Frequency Range	10 Hz to 50 MHz
Number of Test Points	1 to 1,000 points across test range
Test Results	Gain and phase plots, automatic gain/phase margin

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Optimize Your Lab Time - Infiniium Offline

D9010BSEO – Analyze Data Anywhere

- Expand the use of one scope amongst several users:

- Record deep data from the actual scope to analyze waveforms in-depth at your desk, including changing parameters for deeper inspection using an identical 2D scope on your PC. (No learning curve required for a laptop-based scope interface).

- Save set-up parameters for your next session.

- Share data with remote experts to analyze in-depth. Others can fully adjust waveforms from a laptop to find what they need.

- Save waveforms to **compare and document iterative designs.**

- Present in-depth **design review** evidence by demonstrating changes via captured waveforms, zooming in or changing settings as needed during the meeting.

|	**POWERFUL**	Always Fast – No Special Modes
	EASY TO OWN	One Click Debug – Fault Hunter
	INTUITIVE TO USE ▶	Save Time – Quick Analysis, Wizards, Help

Always Fast – No Special Modes

Metric	Why You Should Care	EXR-Series	Comparable Oscilloscope
Triggering (wfm/s)	See more of your signal	>200,000 (>200x faster)	1,000
Averaging (wfm/s)	Noise reduction on repetitive signals	>12,000 (>120x faster)	100
Measurements (meas/s)	Reach 6σ quicker	>300,000 (20% faster)	250,000
Eye plotting (UI/s)	Identify transients and jitter	>750,000 (>50x faster)	15,000

The Infiniium EXR-Series builds **eye diagrams over 50 times faster** than most oscilloscopes in its class. In the same amount of time, the EXR-Series captures 5.7 million UI while a comparable oscilloscope captures only 0.12 million UI.
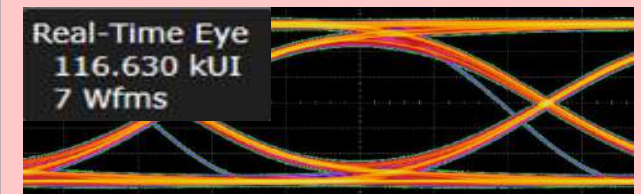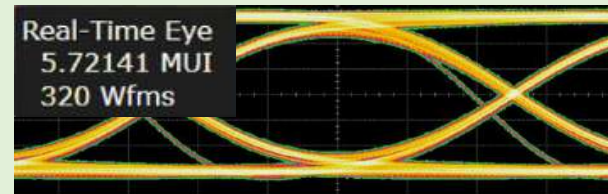
The Infiniium EXR-Series **displays your waveform over 200 times faster** than most oscilloscopes in its class. On this signal, the EXR-Series triggers 170,000 times per second, while a comparable oscilloscope triggers only 500 times per second. You can easily see the difference in quality.

Real-Time Eye
5.72141 MUI
320 Wfms

Real-Time Eye
116.630 kUI
7 Wfms

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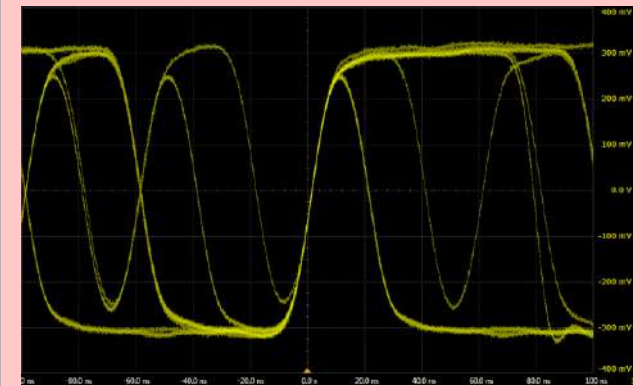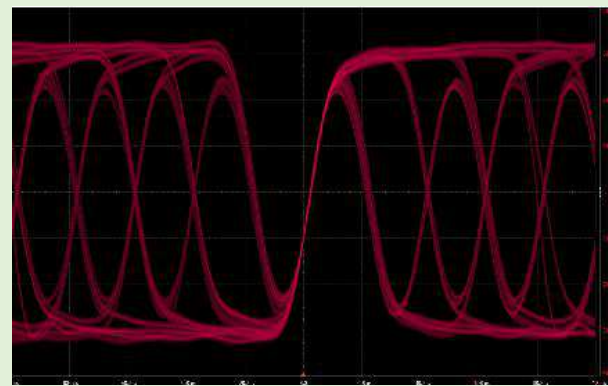
One-Click Debug - Fault Hunter

- **ALL NEW Fault Hunter** automatically finds signal anomalies
- View button to **see waveform issues**
- **Analyze glitches**, slow edges, runts

Never miss an intermittent signal fault again

*Debug faster and with confidence*

Save Time – Quick Setups

Execute tests with one click using our exclusive "Quick" features!

- ✓ Quick Measurements
- ✓ Quick Trigger/Decode
- ✓ Quick Fault Hunter
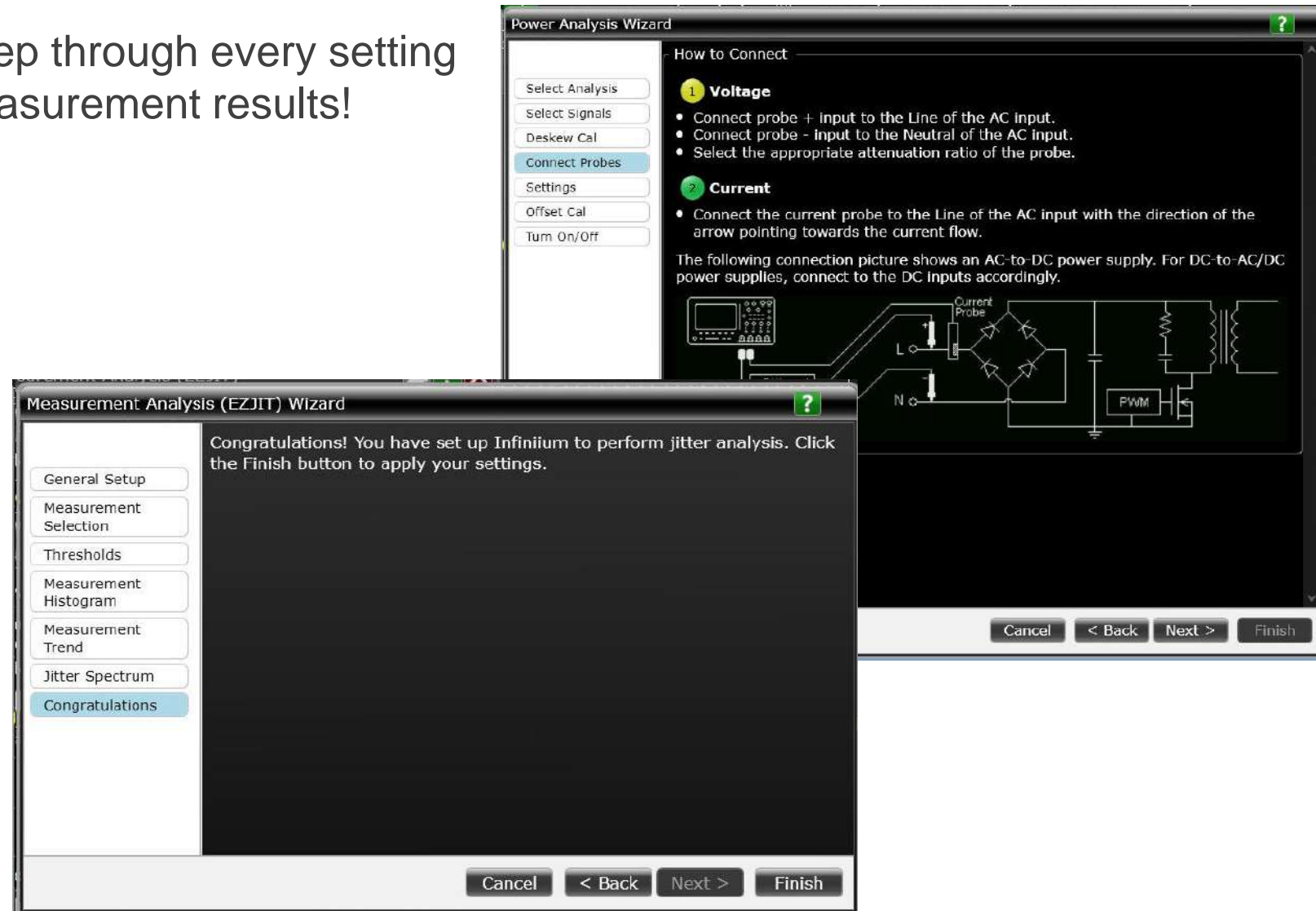- ✓ Quick Eye Diagrams
- ✓ Quick Jitter Decomposition

Measurements

	Measurement	Current	Mean	Min	Max	Range (Max-Min)	Std Dev	Count
1	V p-p(1)	904 mV	889 mV	806 mV	932 mV	125 mV	36.5 mV	46598
2	Period(1)	59.8 ns	70.2 ns	39.6 ns	140 ns	101 ns	31.2 ns	28000
3	Frequency(1)	16.7 MHz	16.8 MHz	7.12 MHz	25.3 MHz	18.2 MHz	6.30 MHz	28000
4	Rise time(1)	15.0 ns	14.9 ns	10.8 ns	20.1 ns	9.31 ns	1.31 ns	41122
5	Fall time(1)	16.4 ns	14.7 ns	9.18 ns	19.1 ns	9.89 ns	1.70 ns	42865
6	V max(1)	469 mV	434 mV	334 mV	474 mV	140 mV	41.3 mV	46598
7	V min(1)	-435 mV	-455 mV	-485 mV	-356 mV	130 mV	24.1 mV	46598
8	+ width(1)	40.0 ns	41.1 ns	18.6 ns	101 ns	82.8 ns	21.7 ns	31131
9	- width(1)	19.9 ns	35.7 ns	18.4 ns	80.3 ns	62.0 ns	19.1 ns	34259
10	Duty cycle(1)	66.8 %	53.3 %	24.6 %	76.9 %	52.4 %	14.2 %	28000
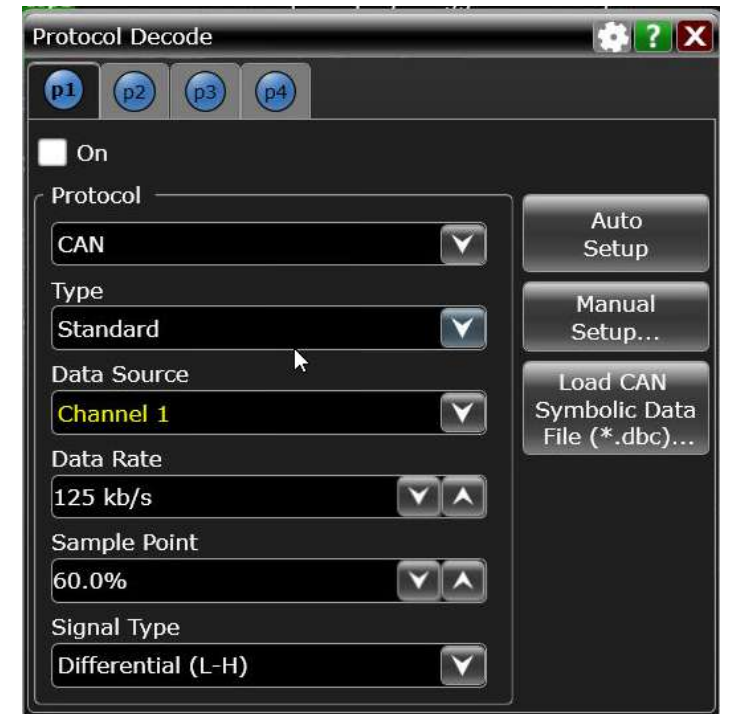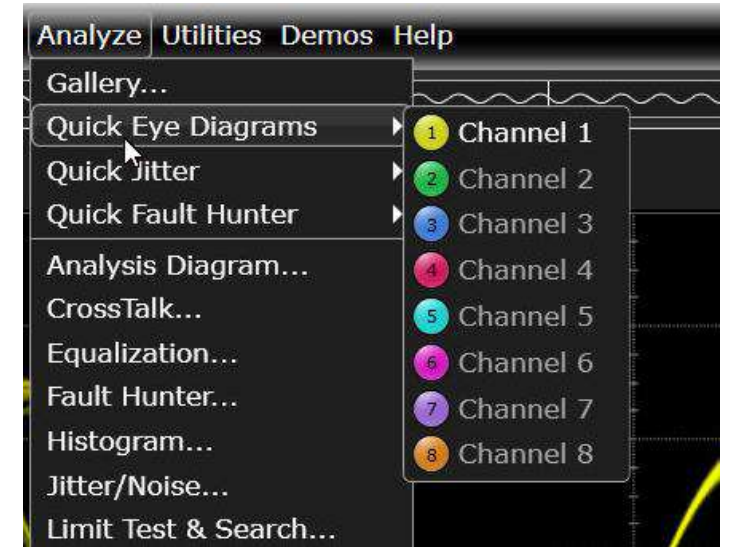
Save Time – Automatic Setup Wizards

Setup wizards walk you step by step through every setting you need to adjust for the best measurement results!

- ✓ Switch Mode Power
- ✓ Power Integrity
- ✓ Real-Time Eyes
- ✓ Measurement Analysis
- ✓ Crosstalk
- ✓ Jitter Decomposition
- ✓ …And More!

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Save Time – One Click Help

Access built-in help for any menu with a single click!

Hardware Configuration

EXR258A

Bandwidth (x100 MHz)
Channel Count

Instrument Upgrades	Model
Add memory, 200/400 Mpts/ch	EXR2MEM
Add AWG, 50 MHz	EXR2WAV
Add MSO, 16 channels	EXR2MSO

Model Numbers by Bandwidth and Channels		
Bandwidth	**4 Channels**	**8 Channels**
500 MHz	EXR054A	EXR058A
1 GHz	EXR104A	EXR108A
2 GHz	EXR204A	EXR208A
2.5 GHz	EXR254A	EXR258A

Additional Equipment	Model
Extra SSD, 500 GB / 1 TB (removable)	EXR2SSD
Rackmount kit, 8U	EXR2RACK
Transit case (Case Cruzer)	3F2002-1910C [3]
BNC(m) - SMA(f) Adapters	54855-67604
GPIB adapter (ICS Electronics)	4865B [3]

Calibration Options	Model
ISO 17025 Cal. (Not Accredited)	EXR000-1A7
ISO 17025 Cal. (Accredited)	EXR000-AMG

Future Upgrades	Model
Add bandwidth, up to 2.5 GHz	EXR2BW
Add analog channels, 4 to 8	EXR28CH

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Software Configuration

Protocol Decode/Trigger Applications	Model
I²C, SPI, Quad SPI, RS232/UART, I²S, SVID, Manchester, eSPI [1], JTAG [1]	D9010LSSP
USB 2.0, USB-PD, 10/100 Ethernet	D9010EMBP
CAN/CAN-FD/CAN-dbc, LIN, SENT	D9010AUTP
I³C, SPMI, RFFE	D9010MPLP
ARINC 429, MIL-1553, SpaceWire	D9010MILP
Infiniium Basic Protocol Trigger/Decode Bundle: Includes all of the above	D9011BDLP
Automotive Ethernet	D9020AUTP

Offline Applications (PC Based)	Model
Infiniium Offline (full Infiniium UI)	D9010BSEO
EZJit Complete Offline	D9010JITO
DMBA + ASIA + PAMA Offline	D9010ASIO
Protocol Decode Offline (Protocols are split up in two packages, see datasheet)	D9010LSPO D9010HSPO

Power Applications	Model
Power Integrity (Rails, Distribution)	D9010POWA
Switch Mode Power (w/ FRA)	D9010PWRA

Signal Integrity Applications	Model
EZJit Complete: Jitter Analysis	D9010JITA
InfiniiScan Zone Triggering	D9010SCNA
De-Embedding	D9010DMBA
Equalization and Crosstalk	D9020ASIA

Advanced Applications	Model
PAM-3 and PAM-4 Analysis	D9010PAMA
User-Defined Application	D9010UDAA

Compliance Applications	Model
USB 2.0	D9010USBC
10/100 Ethernet	D9010ETHC
Automotive Ethernet	AE6900T

A Range of Keysight Oscilloscopes

|	InfiniiVision Class Scopes			Infiniium Class Scopes	
	3000T X-Series	**4000 X-Series**	**6000 X-Series**	**S-Series**	**EXR-Series**
Channels	2, 4	2, 4	2, 4	4	4, 8
Max Bandwidth	100 MHz → 1 GHz	100 MHz → 1.5 GHz [1]	1 GHz → 6 GHz [2]	500 MHz → 8 GHz [2]	500 MHz → 2.5 GHz
Sample Rate [3]	2.5 GSa/s	2.5 GSa/s	10 GSa/s	10 GSa/s	16 GSa/s
Max Memory [3]	2 Mpts	2 Mpts	2 Mpts	400 Mpts	400 Mpts
ADC	8 bits	8 bits	8 bits	10 bits	10 bits
WaveGen	1x 20 MHz	2x 20 MHz	2x 20 MHz	N/A	1x 50 MHz
MSO	16 channels	16 channels	16 channels	16 channels	16 channels
Operating System	Embedded	Embedded	Embedded	Windows 10	Windows 10

1. Max bandwidth is 1 GHz with four channels on
2. Max bandwidth is 4 GHz with four channels
3. Specified with all analog channels on

All-New Hi-Z+
Passive Probing System

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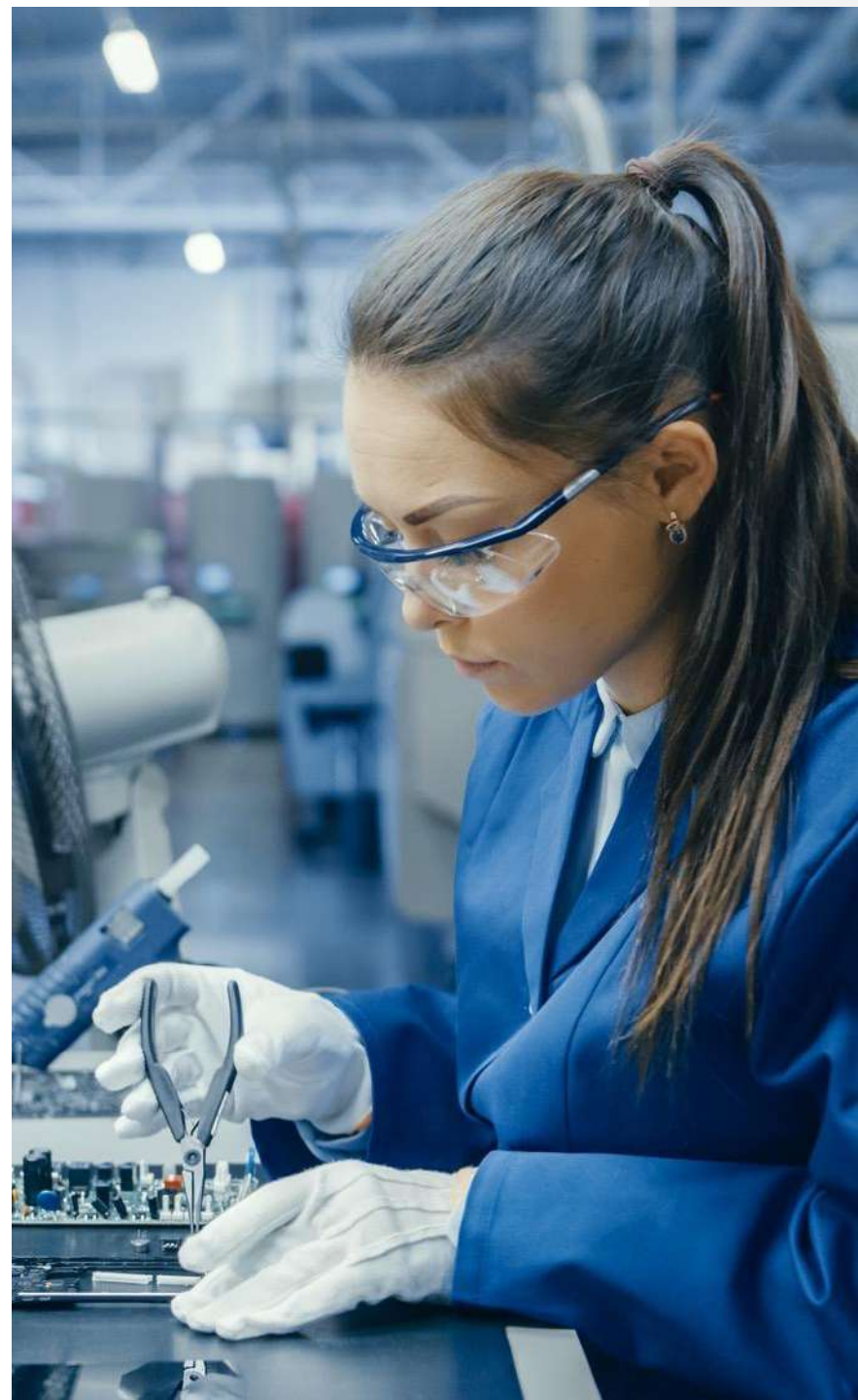
Hi-Z+ Passive Probing System

Perfect for demanding high-voltage, fast signals, Keysight's new Hi-Z+ passive probing system delivers never before seen performance in a compact, rugged design.

PP0001A…

✓ 1 GHz of bandwidth and 300 V_{RMS} of input voltage

PP0002A…

✓ 800 MHz bandwidth and 1.2 kV_{RMS} input voltage

PP0003A…

✓ MMCX probing with 1 GHz bandwidth and 30 V_{RMS} input voltage

All three offer…

✓ A broad selection of connection accessories available

✓ Compact, rugged 5 mm tip for probing the tightest spaces

	PP0001A	PP0002A	PP0003A
Bandwidth	1 GHz	800 MHz	1 GHz
Voltage (rms)	300	1200	30
Voltage (peak)*	1500	3000	42.4
Input to scope	Via PP0004A	Via PP0004A	Via PP0004A
Tip style	Cartridge tip	Cartridge tip	MMCX

*peak overvoltage is allowed for a duration of a few milliseconds or less.

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Hi-Z+ Passive Probing System

| Part Kit	Description	Notes	Standard?
PP0011A	PP0001A / PP0002A accessory kit	Channel ID rings, grabber hook, BNC adapter, ground springs, ground clip	Yes
PP0013A	PP0003A accessory kit	Channel ID rings, redblack mini grabbers, MMCX to square adapter	Yes
PP0014A	PP0001A fixed cartridge accessory kit	Probe tip cartridge, protective tip covers	Yes
PP0017A	PP0001A adapter kit	Square socket probe tip adapters, PCB to probe tip adapters	**No**
PP0018A	PP0002A fixed cartridge accessory kit	Probe tip cartridge, protective tip covers	Yes
PP0019A	PP0002A adapter kit	Square socket probe tip adapters, PCB to probe tip adapters	**No**
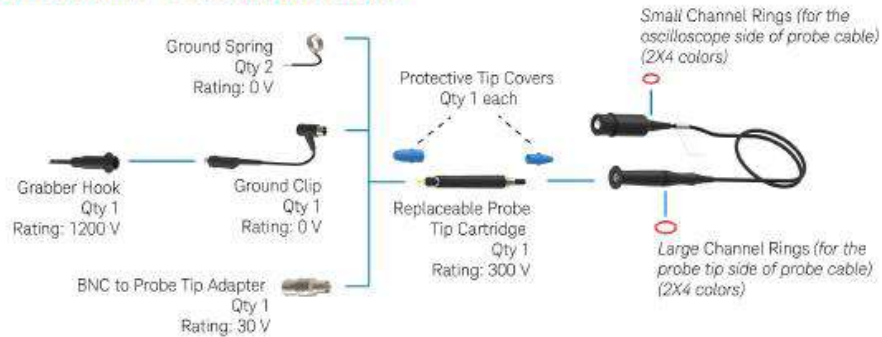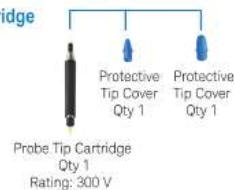
Target Markets, Applications

Target Customers

- R&D Design
- R&D Validation
- Installation and Maintenance

+

Applications

- High Power Converters
- High Power Semiconductors
- Large Motor Drive Design
- Gallium Nitride (GaN) devices

| Infineon | GaN Systems Inc. | Qorvo | NXP Semiconduc... | Wolfspeed |
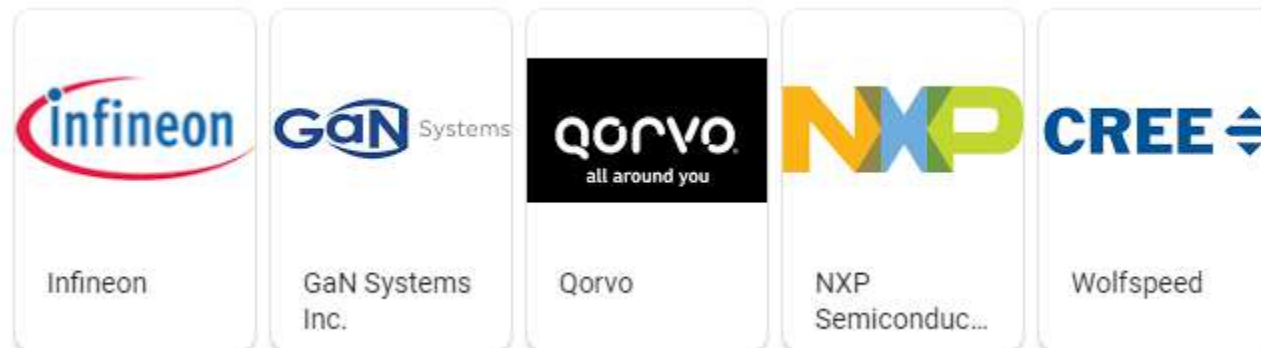
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Labs

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Demo 1: Quick Eye Diagram (30 mins)

1. Select **Setup > Factory Default**. This resets the scope.

2. Select **Setup > Waveform Generator**. Under the Type dropdown, switch it from **Sine to Demo**. In the Demo dropdown that appears below that, select **Real-Time Eye**. Then click the On checkbox in the top left of the dialog to enable the signal. Close the dialog.

3. Change the time scale to **50us/scale, 200mV/scale**

4. Navigate to **Analyze > Quick Eye Diagrams > Channel 1**

5. Navigate to **Analyze > Quick Jitter > Channel 1**

6. In Graphs > **Select all graphs**
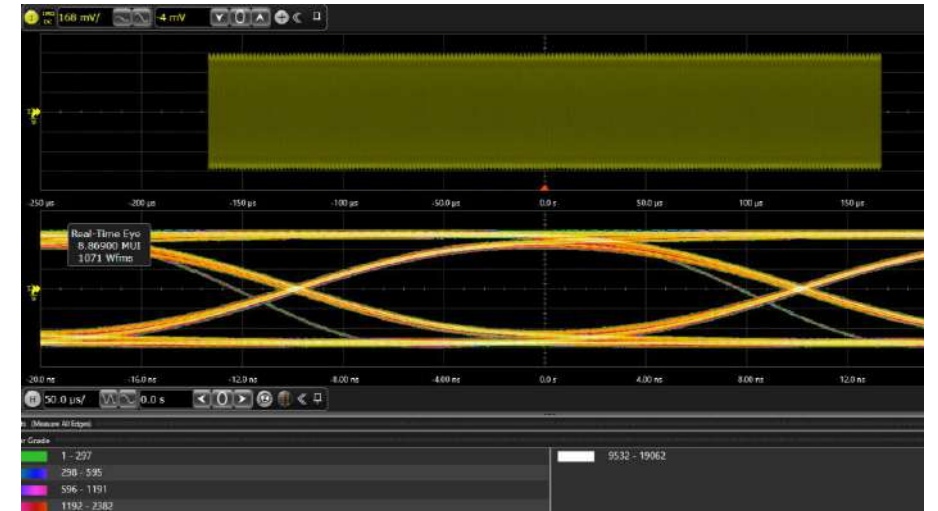
Demo 2: Multi-Channel Power Sequence (30 mins)

1. Select **Setup > Factory** Default. This resets the scope.

2. Select **all 8 channels** and see the difference between **Separate/Tile/Overlay**

3. Select **Analyze > Mask Test > Select Channel > Auto Mask.**

4. You can create mask for every channel for power sequence testing.
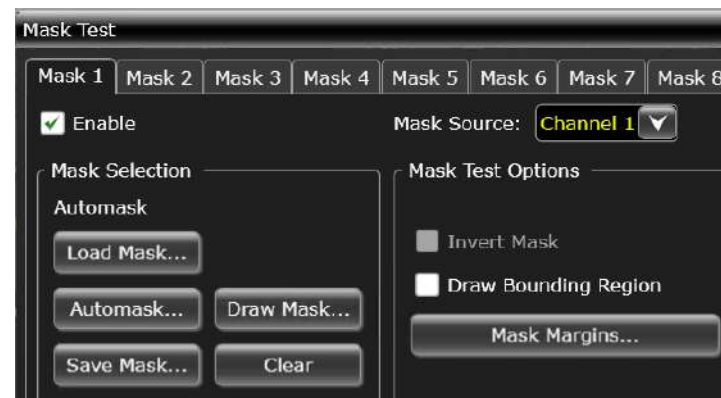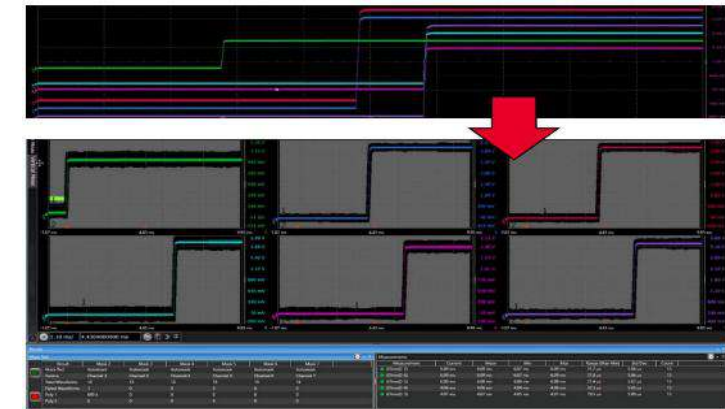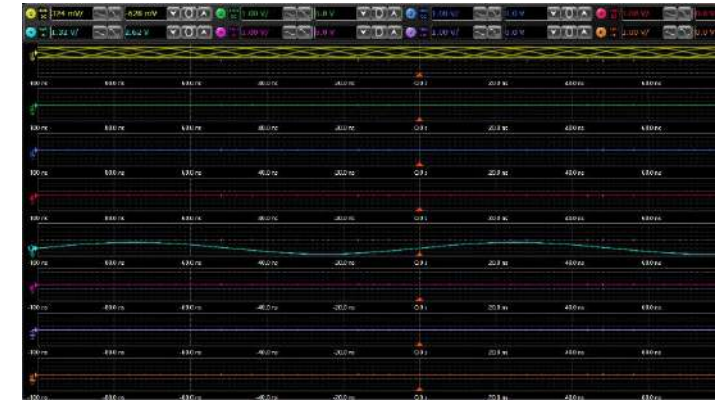
Demo 3: Fault Hunter (30 mins)

1. Call out the signal issues on screen. This would be perfect to use with Fault Hunter.

2. Navigate to **Analyze > Quick Fault Hunter > Channel 1.**

3. When all tests are complete, click View for one of the test failures.

4. Then click **Copy to Trig**. Click the trigger shortcut to show how Fault Hunter copies the failure condition to a trigger for additional captures!

5. Go to **Measure/Mark > COUNTER**; Turn on the Counter C to period to see how often the error condition happens.
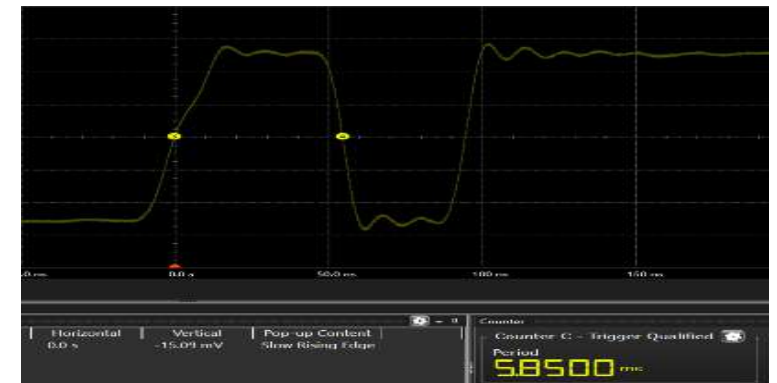
Demo 4: Bode Plot (20 mins)

1. Connect the **DSOXBODE** training board directly to the oscilloscope's **Gen Out BNC**.

2. Connect a passive probe between the **channel-1** input BNC of your scope to the training board's **VIN CH1** test pin. Connect the probe's ground lead to one the test pins labeled GND.

3. Connect a passive probe between the **channel-2** input BNC of your scope to the training board's **BPF OUT CH2** test pin. Connect this probe's ground lead to the other test pin labeled GND.

4. Navigate to **Analysis > Power Analysis**.

5. One the Analysis Menu, click on **Frequency Response Measurements** and click **Control Loop Response(Bode)** at sub menu.

6. Change the Stop Freq setting to **10 MHz**.

7. Change the Points setting (number of different frequencies to test) from **60 to 300**.

8. Change the Amplitude from **200 mVpp to 500 mVpp**.

9. Click **ON**

Channel-1 probe

Channel-2 probe
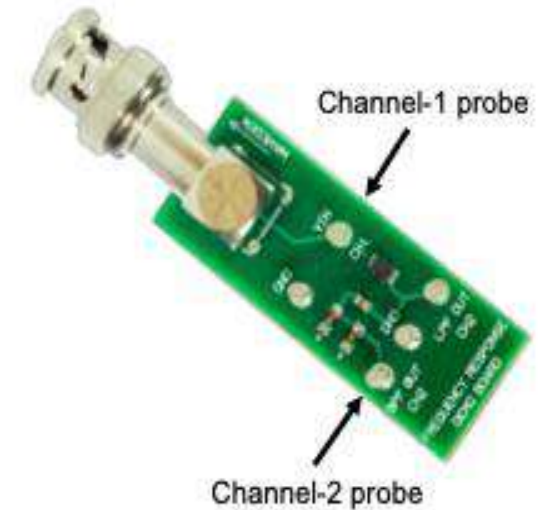
Demo 4: Power Integrity (20 mins)

1. Navigate to **Analyze > CrossTalk**
   - Crosstalk: Data & Data
   - Power Integrity: Power & Data

2. Navigate to **Demos > Tutorials & Demos**

3. Naviate to **Analysis > Power Integrity**

4. **Click Load Demo**

5. Change the Points setting (number of different frequencies to test) from **60 to 300**.

6. While not related to History/Segmented, I usually find this a nice time to show the ADC Resolution dropdown. Watch my demo video for more details if desired.

KEYSIGHT