

Entwicklungen und Einsatz

moderner Laborgeräte am Beispiel von Oszilloskopen

10. Dezember 2015

Salzburg / Ö

Christian Bauer

x.test GmbH



Eckdaten

- ❖ Firmengründung 1. Mai 2010, als Partnerfirma von Agilent Technologies

Agilent Technologies ist nun Keysight Technologies



Unlocking Measurement Insights for 75 Years

- ❖ heute ca. 10 Mitarbeiter für Vertrieb, Schulung, Service, Support, ...

Unsere Partner

- ❖ Keysight Technologies (SA, NA, OSC, SG, PS, ...)
- ❖ Adlink, Ztec (modulare Messtechnik)
- ❖ EMSCAN, EMC, Haefely (EMV Messtechnik)
- ❖ FLIR (Thermographie)



Unlocking Measurement Insights for 75 Years



Agenda

- Debugging Oszilloskope
- Oszilloskope für Signalanalyse
- Fernsteuerung von Oszilloskopen

2 Haupt-Geräteklassen

Debugging – Geräte

- Hohe Updateraten
- „Schweizer Taschenmesser“
- Viele Funktionen fix vorgegeben

Signalanalyse-Geräte

- Höhere Bandbreiten
- Komfortable und flexible Bedienung
- Im Funktionsumfang selbst erweiterbar

Debugging – Oszilloskope

Der **Anwender**

ist der HW- oder embedded SW-Entwickler,
der seine Schaltung auf „Funktion“ überprüfen möchte

Seine **Herausforderungen**

Sind schnell und einfach
seltene Fehler und Anomalien finden

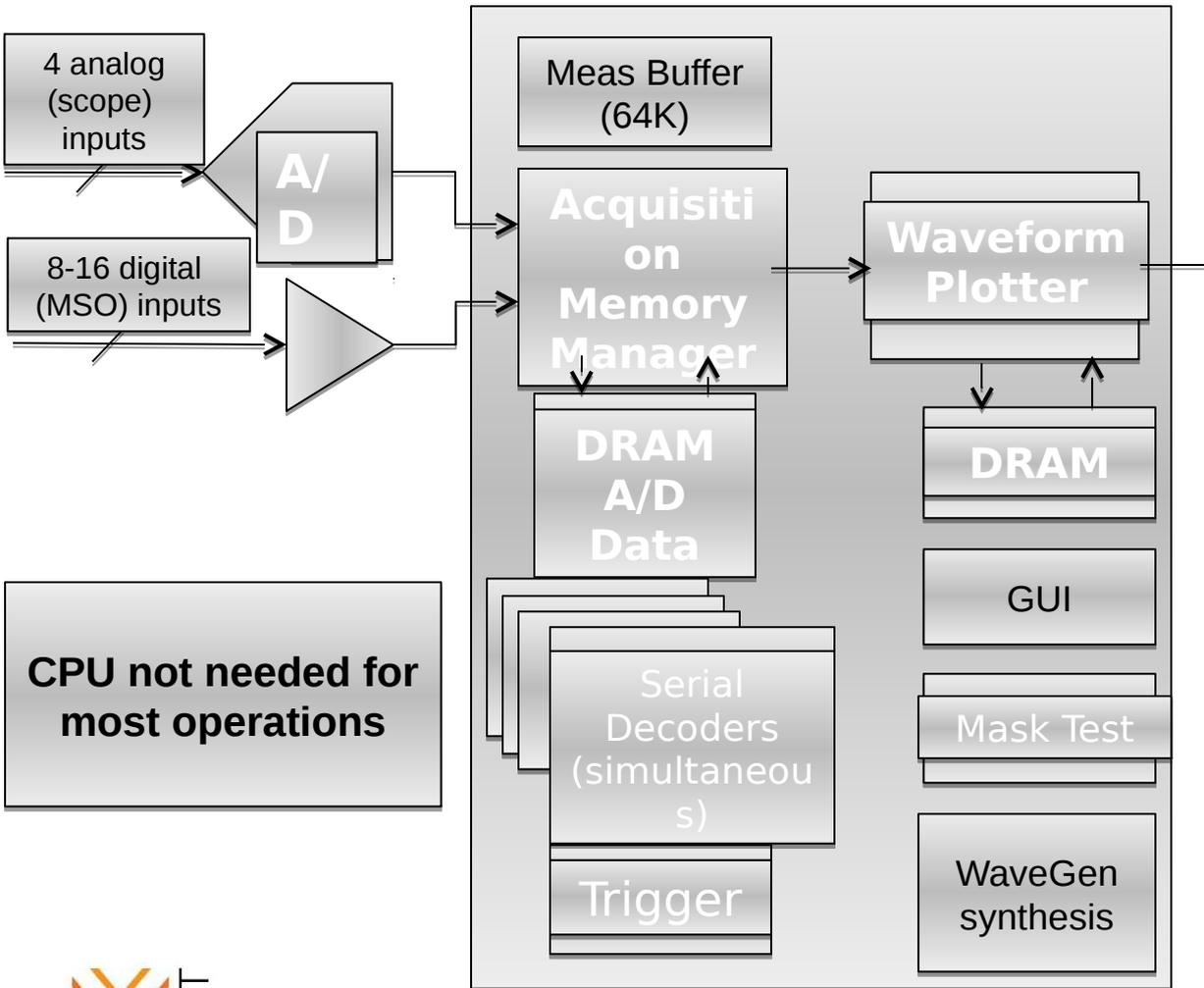
Die **Unterstützung**

Erhält er durch eine Vielzahl an Applikationen

Debugging – Oszilloskope



HW – Konzeption: InfiniiVision X-Series MegaZoom IV ASIC



- ### MegaZoom IV SOC ASIC
- **Fast:** up to 1,000,000 wfwm/sec
 - **Integrated:** MSO, acquisition memory, function generator, decode
 - **Affordable:** due to high integration



Debugging – Oszilloskope



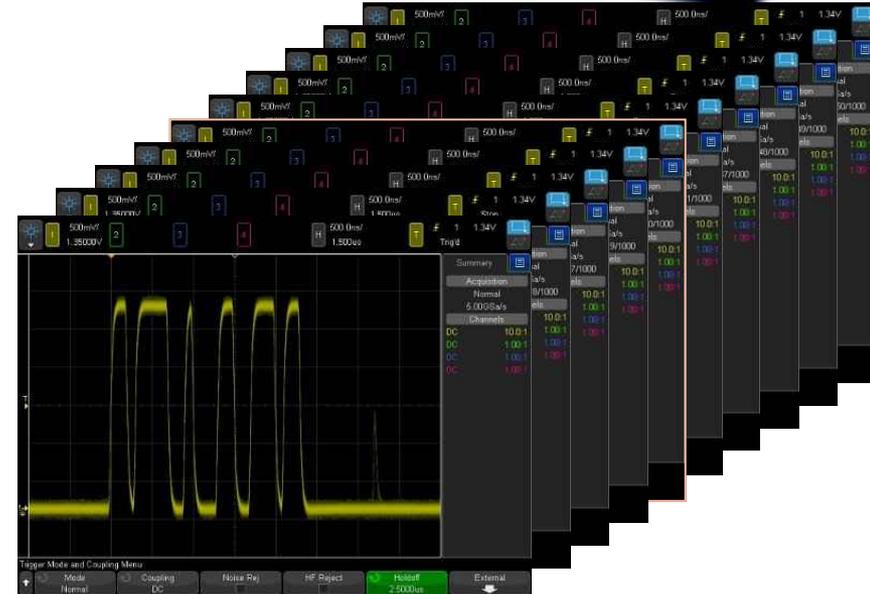
HW – Konzeption: InfiniiVision X-Series MegaZoom IV ASIC

Höchste Kurvenform-Update-Rate von bis zu **1,000,000**

Kurvenformen/Sekunde

– MegaZoom IV smart memory technology

- Responsive
- Uncompromised
- Segmented memory

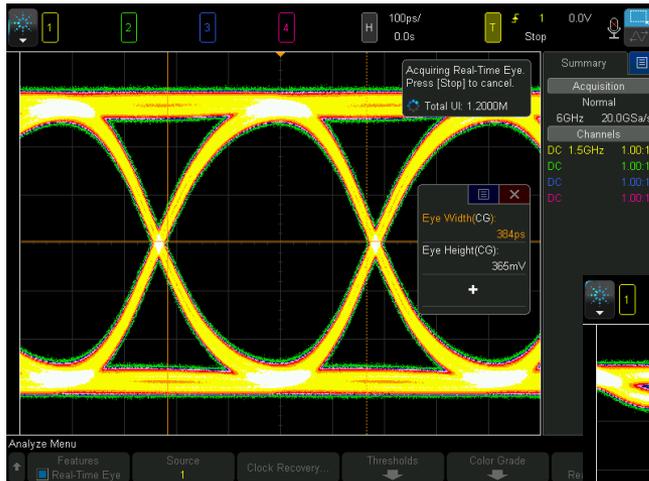


LIVEDEMO

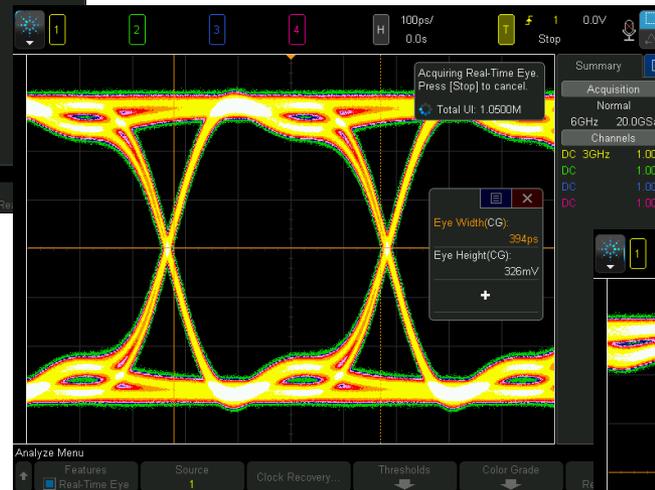


Debugging – Oszilloskope

Bandbreiten bis zu 6 GHz



- 1.5 GHz of bandwidth only sees the fundamental frequency of 2.4 Gbps PRBS NRZ signal (1.2 GHz fundamental frequency). The eye has the sine waveform shape.



- 3 GHz sees the fundamental and some of the 3rd harmonics of 2.4 Gbps PRBS NRZ signal.



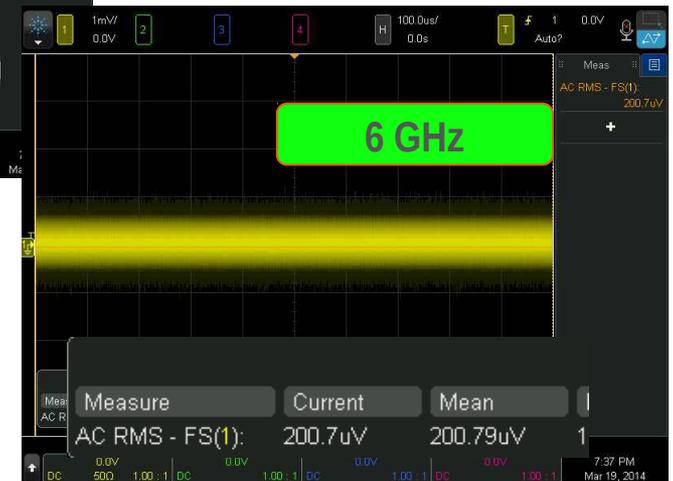
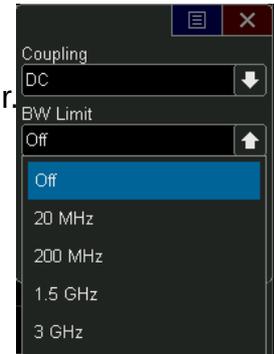
- 6 GHz sees up to 5th harmonics of 2.4 Gbps PRBS NRZ signal, giving you the most details

Debugging – Oszilloskope

Bandbreiten bis zu 6 GHz => geringeres Rauschen



- Hardware bandwidth filter



- Features:

- One of the lowest noise floors of all embedded OS scopes
- Hardware bandwidth filter

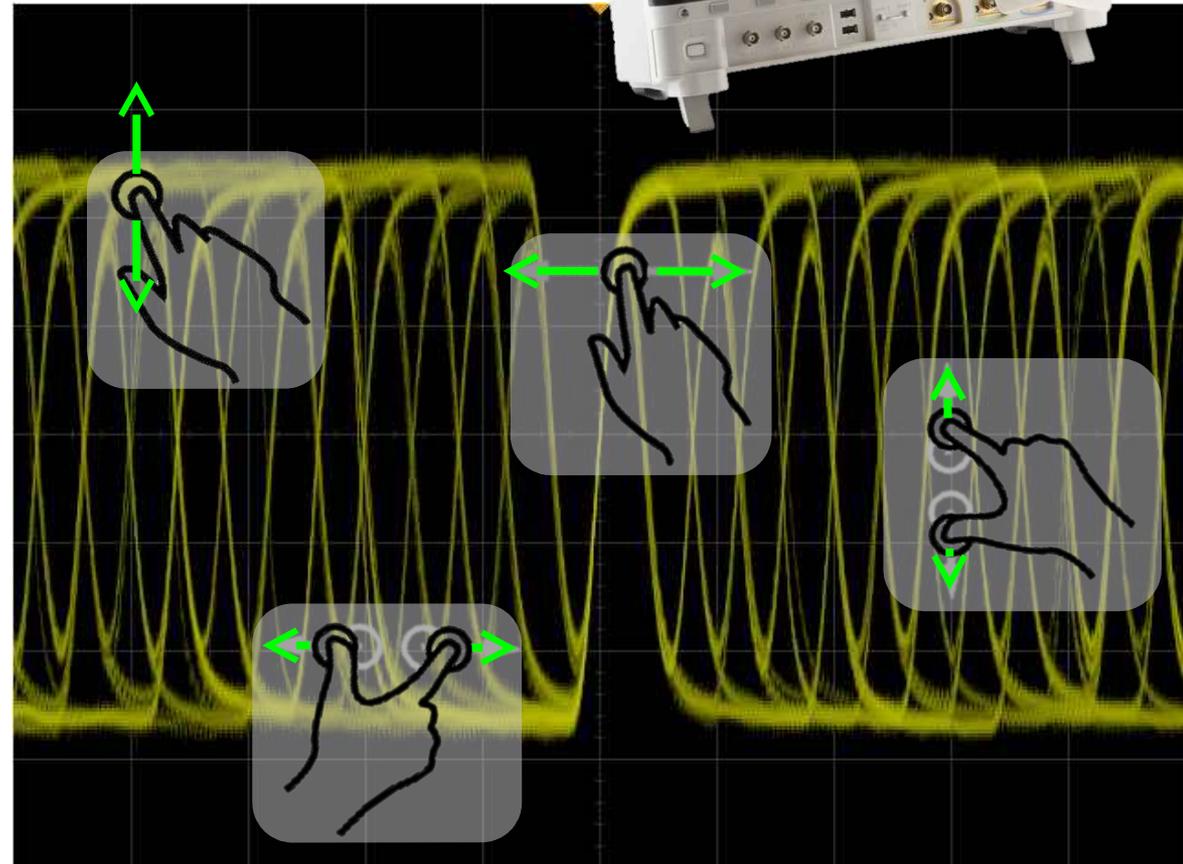
- Advantages & Benefits:

- The low noise floor is critical especially making low amplitude signals such as power ripple measurements. The low noise floor improves the measurement repeatability and consistency as well.
- Hardware bandwidth filter helps to make your application measurement at the optimized bandwidth. An extra bandwidth adds unwanted noise to your measurements.

Debugging – Oszilloskope

Visualisierung und Bedienung

- Problems/Challenges Addressing:
 - Multi-touch and gesture operations are expected on a capacitive touch screen today
- Features:
 - The first multi-touch capacitive touch screen with gesture support
- Advantages & Benefits
 - Operates intuitively like your favorite tablets and smartphones
 - Minimum learning curve required



Debugging - Oszilloskope

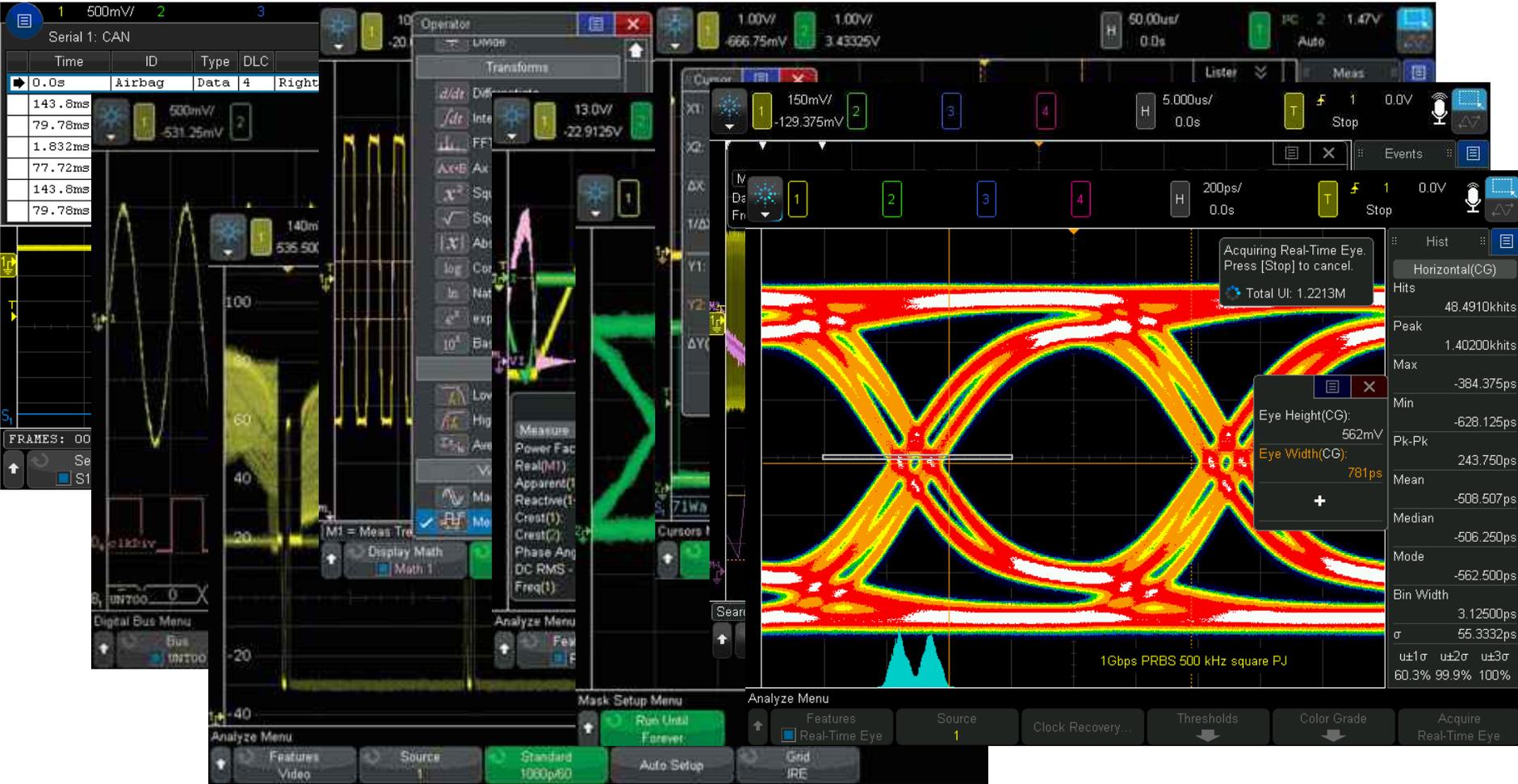
Neue Hilfsmittel – Zone Trigger

- Problems/Challenges Addressing:
 - Triggering is a challenge to most engineers.
 - Graphical and intuitive trigger, yet keeping fast waveform update rate is in demand
- Features:
 - Find the signal of your interest. Draw the box, and you are there
 - Hardware InfiniiScan Zone maintains >160,000 scan's per second
- Advantages & Benefits
 - It's so intuitive, "if you can see it, you can trigger on it"!
 - Trigger and isolates even rare anomalies due to the ultra-fast scan rate not possible with other software solutions.



Debugging - Oszilloskope

Das „Schweizer Taschenmesser“



Debugging – Oszilloskope

Das „Schweizer Taschenmesser“

- Logikanalysator
- Trigger-Möglichkeiten
- Dekodierung und Triggerung von seriellen Bussen
- Eingebauter Funktionsgenerator
- Digitales Voltmeter
- Mathematik-Funktionen
- Power-Analyzer
- Jitter-Analyzer
- Maskentests
- Segmented Memory
- uvm.

16 digital
channels

Serial
protocol
decodes



3-digit
digital
voltmeter

10-digit
counter /
totalizer

Dual channel
arbitrary/function generator

Signalanalyse – Oszilloskope

Der **Anwender**

ist der HW- oder Chip-Designer,
der sicherstellen muss, dass die Kommunikation zwischen Chips und
Baugruppen mit geringer Bitfehlerrate funktioniert

Seine **Herausforderungen**

sind immer höhere Datenraten, genaueste Signalabbildung und
komplexe, aber seltene Messaufgaben

Die **Unterstützung**

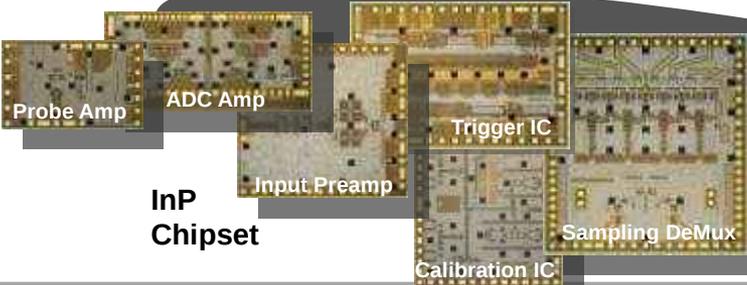
erhält er durch ein neuartiges, offenes Bedienkonzept, das die
Qualifizierung von bestehenden Bussen erleichtert und spezielle
Messaufgaben ermöglicht

HW-Herausforderungen:

- Extrem hohe Bandbreiten bis 63 GHz
- Geringes Eingangsrauschen
- Präzise, jitterfrei Clock-Erzeugung
- Höhere Auflösung bei A/D-Wandler
- Amplituden- und Phasengangkompensation

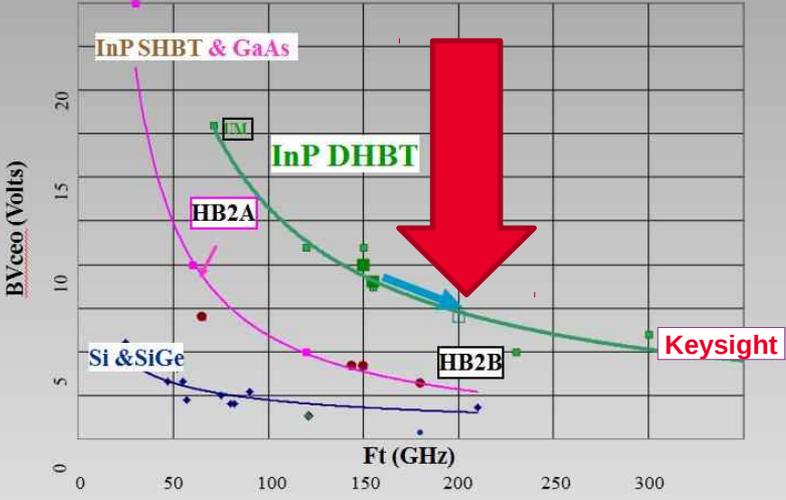
Signalanalyse – Oszilloskope

HW-Herausforderungen:



Proprietary Indium Phosphide Technology

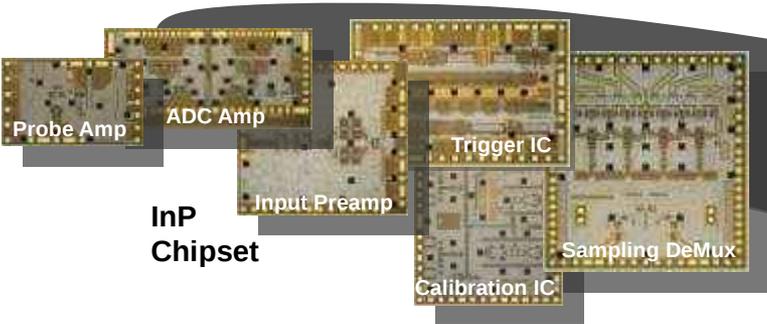
IC Process Performance



InP Benefits

- Captive process
- High-speed & high-voltage
- Flat response
- Extensible

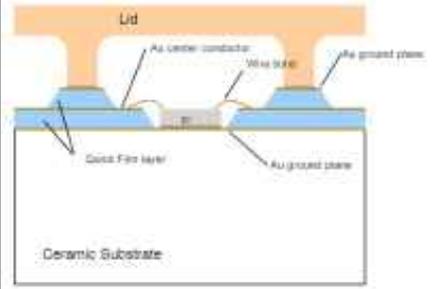
Signalanalyse – Oszilloskope



Custom IC Packaging



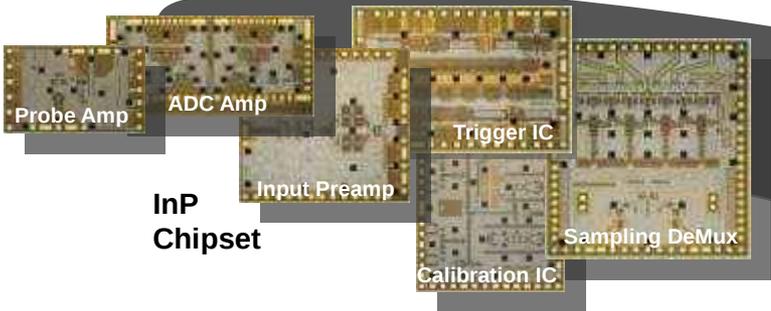
Quick Film 3D Packaging



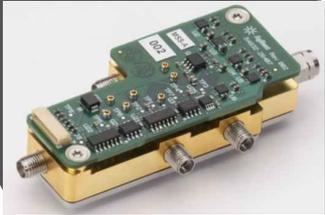
Quick Film 3D Packaging

- Custom Keysight technology
- Exceptional signal integrity
- Substrate keeps chipset cool and reliable

Signalanalyse – Oszilloskope



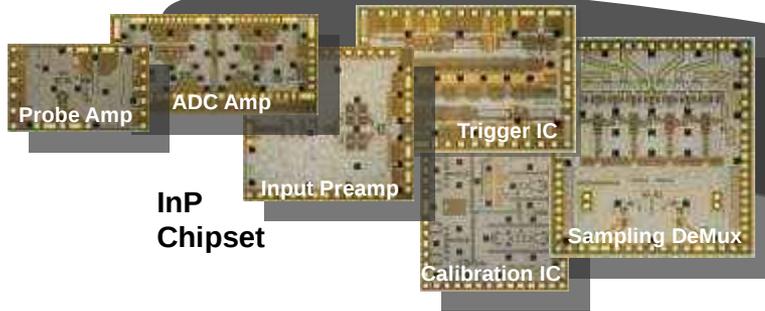
RealEdge technology enables signal acquisition at 160 GSa/s and 63 GHz of real time bandwidth.



Unlike our competitors, Keysight achieves high bandwidth and sample rate through interleaving, **without a signal integrity penalty**.

Our expertise in **microwave technology** enables a higher performance, lower noise, and highly integrated system architecture.

Signalanalyse – Oszilloskope



The World's Most Accurate Oscilloscopes

Quick Film 3D Packaging



Differentiating Technology...

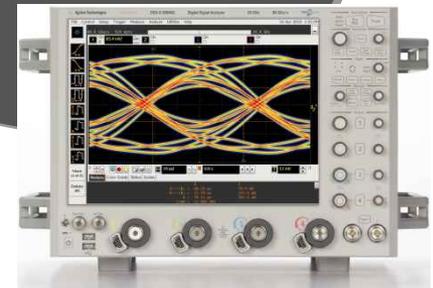
- High bandwidth InP chipset in Keysight's proprietary "HB2B Process"
- Packaged in Keysight's proprietary "QuickFilm" modules
- Proprietary epitaxial material
- RealEdge microwave technology

Enables Differentiating Performance...

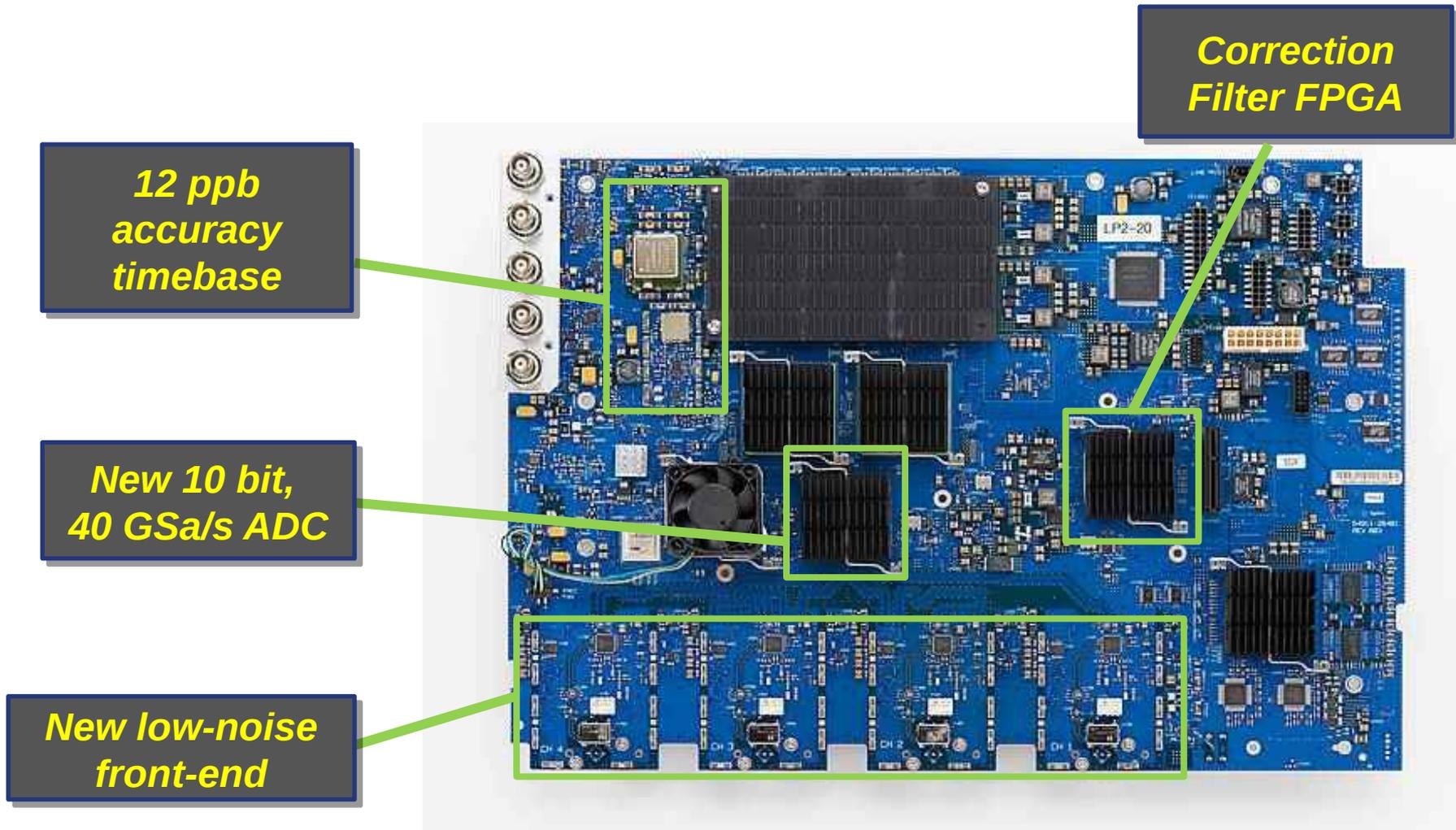
- Analog bandwidth to 63 GHz
- Industry leading low-noise and superior signal integrity
- Highest effective number of bits (ENOB)

In The World's Most Accurate Scopes

RealEdge Technology



Signalanalyse – Oszilloskope



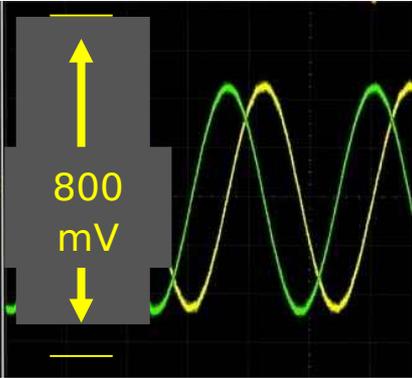
Signalanalyse – Oszilloskope

10 bit A/D Wandler

- 40 GSa/s sample rate (fastest 10-bit ADC in the world)
- ADC ENOB up to 8.7



65 nm CMOS ADC with 130 nm Bi-CMOS buffer IC



Traditional Scope

- 8 bits of vertical resolution
- $2^8 = 256$ Q levels

3.125 mV

A diagram showing two yellow dots representing the minimum and maximum values of a signal. A red bracket spans the distance between them, with the text "3.125 mV" written in red to the left of the bracket.

S Series ADC

- 10 bits of vertical resolution
- $2^{10} = 1024$ Q levels

0.781 mV

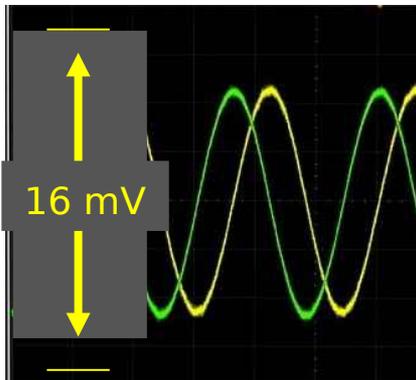
A diagram showing four yellow dots representing the minimum and maximum values of a signal. A red bracket spans the distance between them, with the text "0.781 mV" written in red to the right of the bracket.

Minimum resolution
@ 800 mV full screen

Signalanalyse – Oszilloskope

2 mV/div Vertical Scaling in Hardware at Full BW

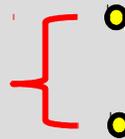
More resolution at 5mV/div and below vs traditional 8-bit scopes



Traditional Scope

- 8 bits of vertical resolution
- SW magnification at < 56 mV

218 μV^*



S Series ADC

- 10 bits of vertical resolution
- $2^{10} = 1024$ Q levels



16.6 μV

Minimum resolution
@ 16 mV full screen

*Assume SW magnification at 7 mV/div = full screen of 56 mV. $56 \text{ mV} / 256 = 218 \text{ uV}$.

Signalanalyse – Oszilloskope

Frequency Response Impact on Scope

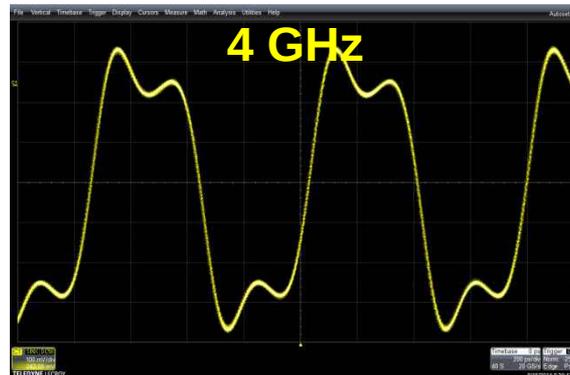
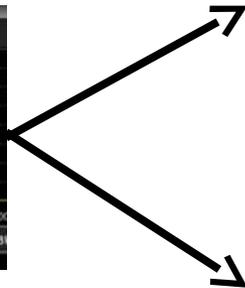
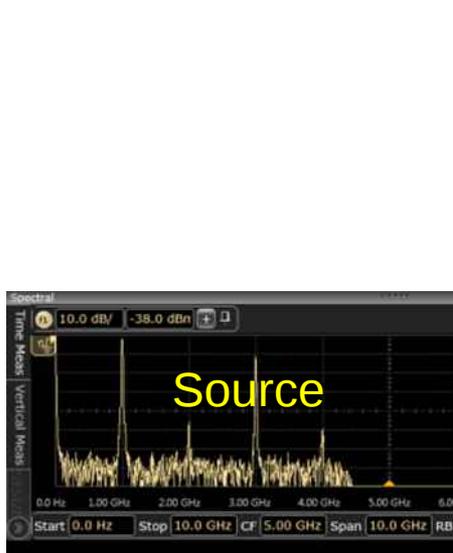
MUST List for Correct Signal Shape

1. All signal components (fundamental + all harmonics) must be in BW of scope
2. Scope must have flat magnitude response
3. Scope must have flat phase response

Signalanalyse – Oszilloskope

Why do Scopes of Equal Bandwidths Show Different Waveshapes?

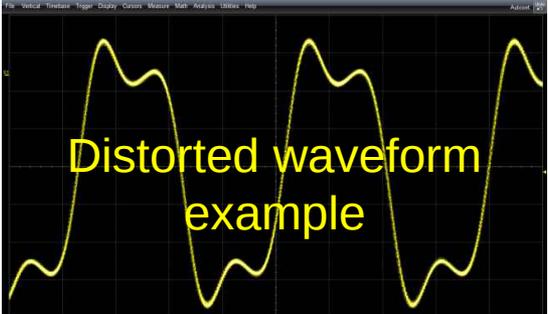
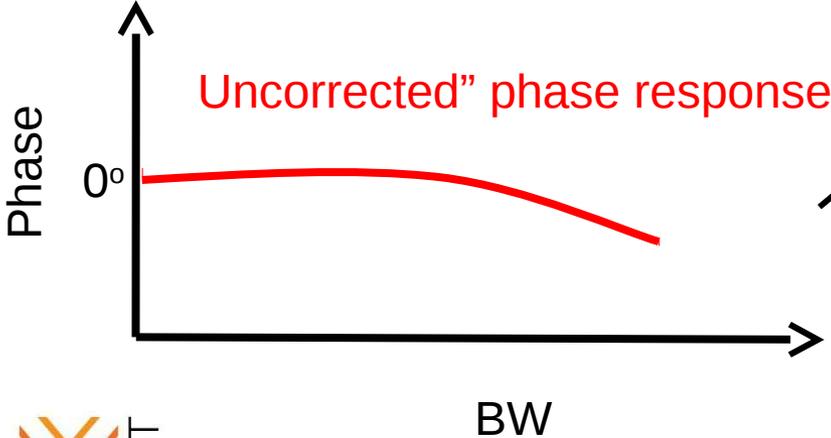
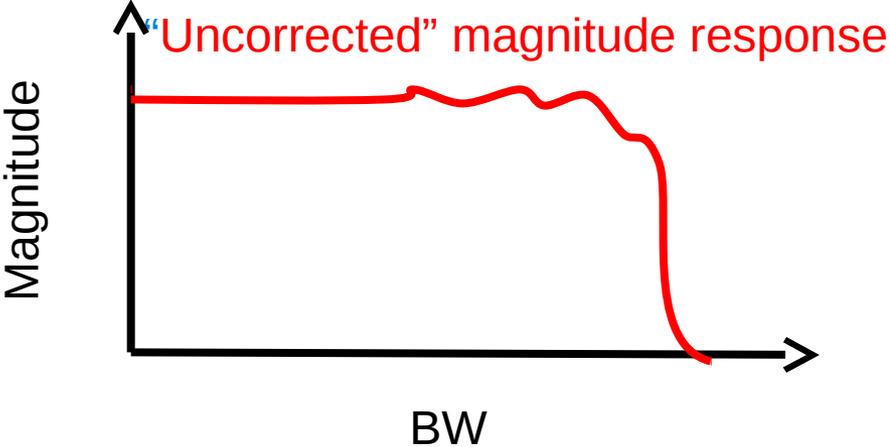
All scope settings are identical



The two scopes will report different V_{pp} and risetime values

Signalanalyse – Oszilloskope

Natural Analog Filter are Imperfect



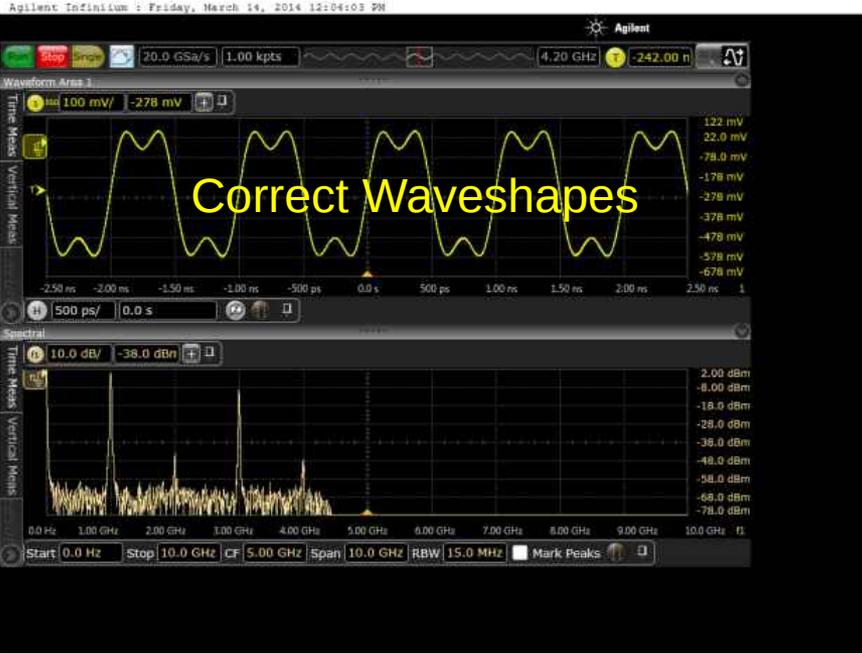
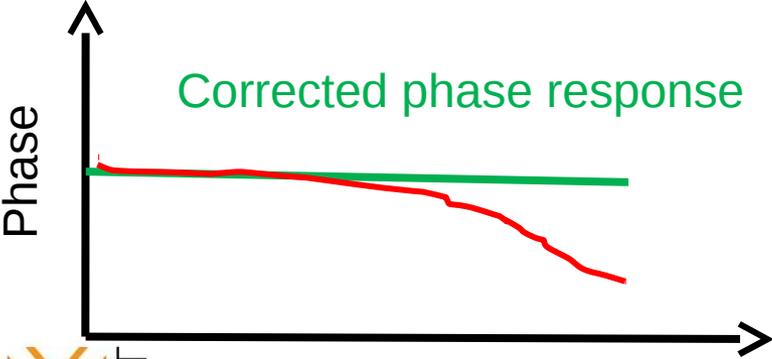
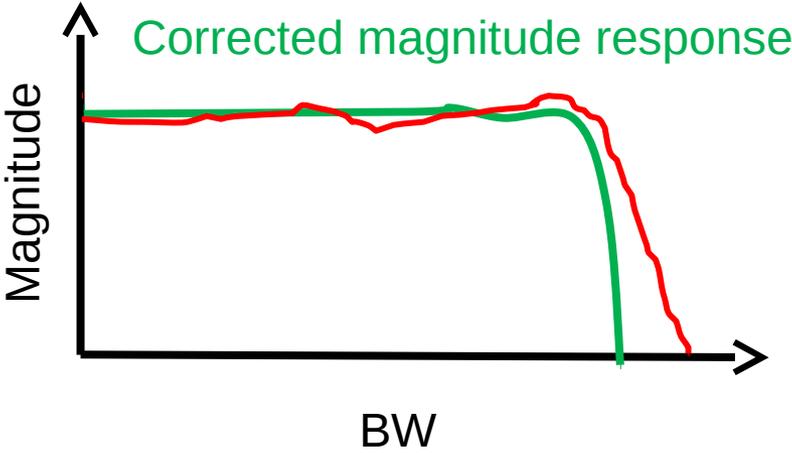
Phase Linearity

Oscilloscope phase impacts waveform shape. The less linear the phase the less square a square wave will look.

Signalanalyse – Oszilloskope

S-Series Correction Filters

Always-on – run in a big, fast FPGA

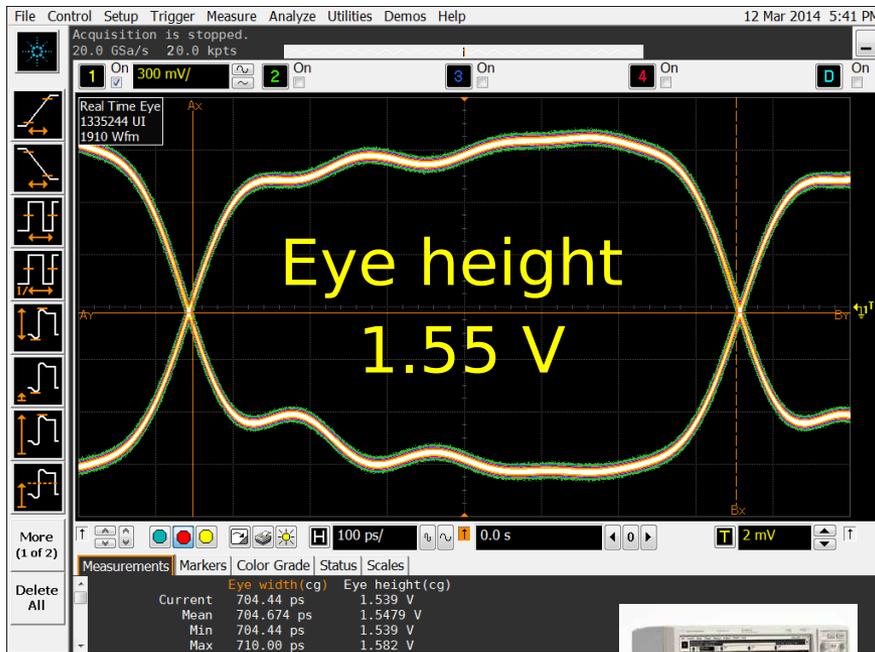


Signalanalyse – Oszilloskope

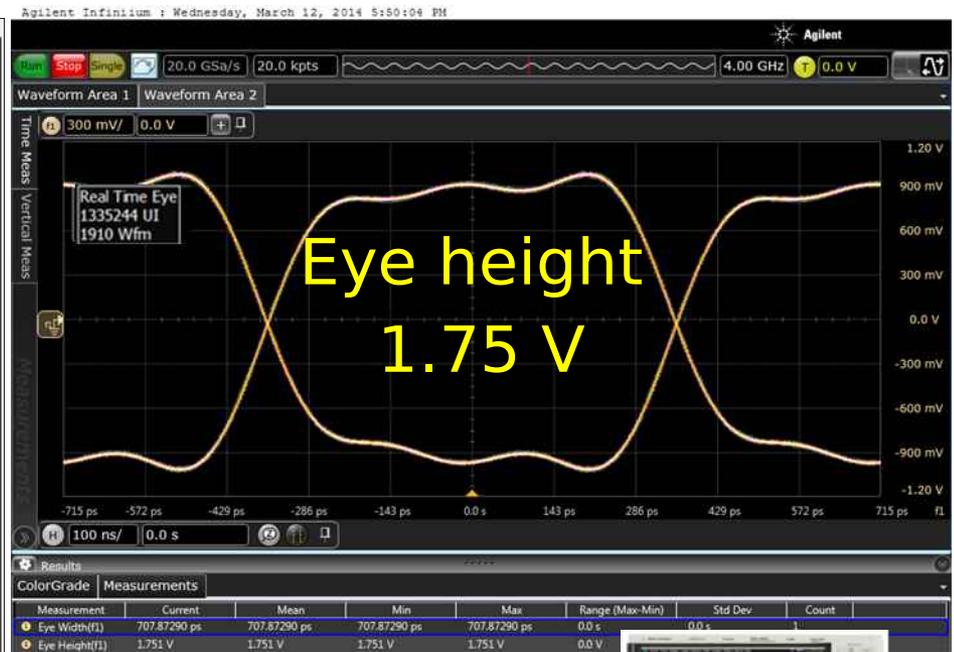
What different does Low Noise AND Flat Responses make?

Measurement Example with Identical settings

200 mV bigger eye height



Infiniium DSO9404A (4GHz)



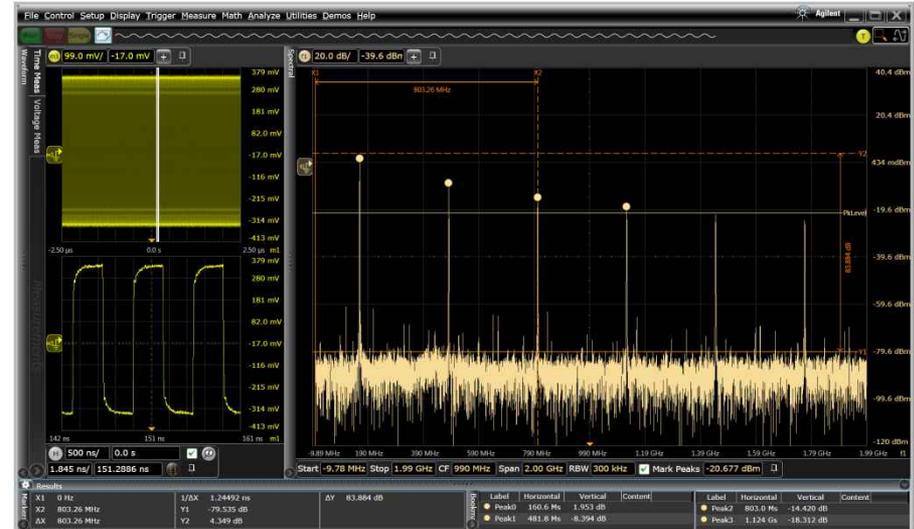
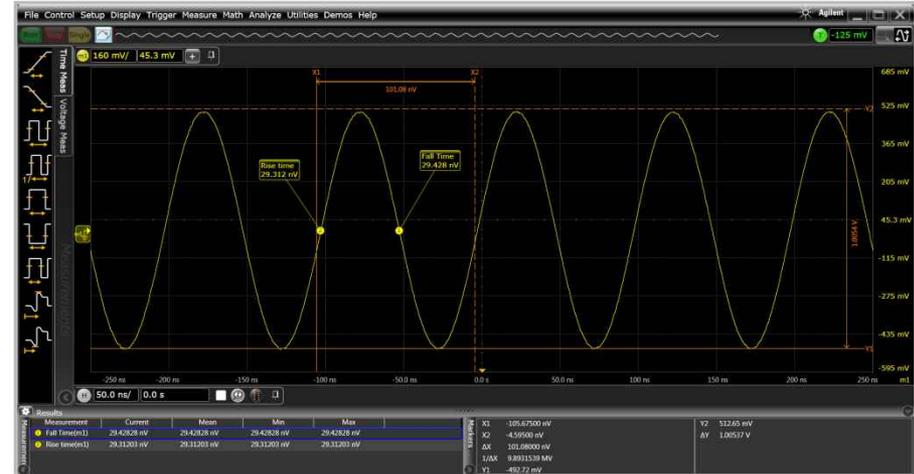
Infiniium DSOS404A (4GHz)



Signalanalyse – Oszilloskope

Next Generation Infiniium UI

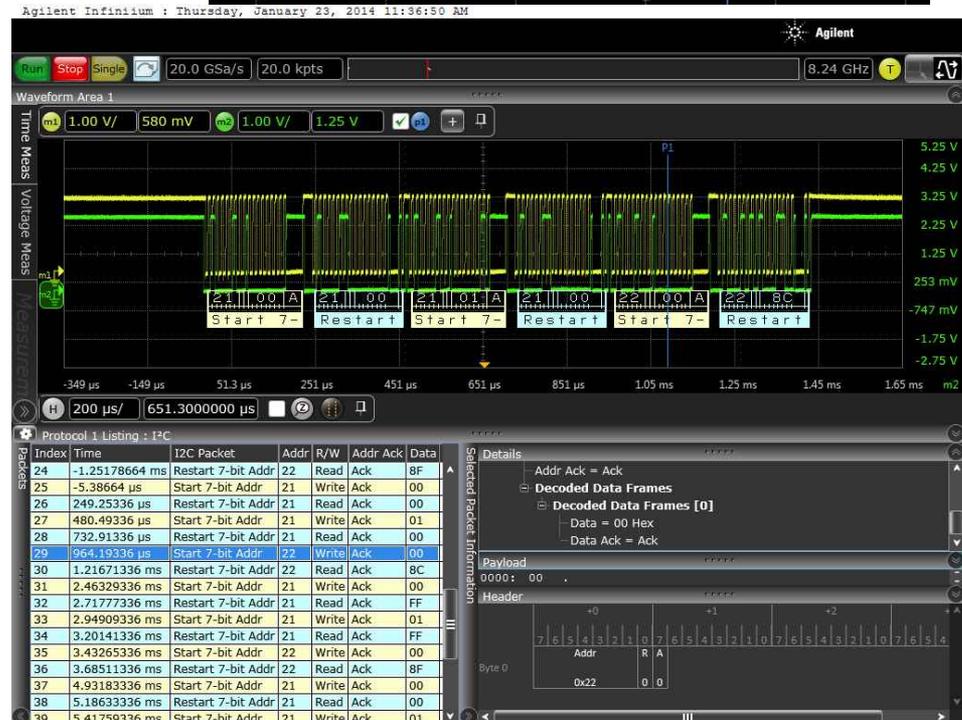
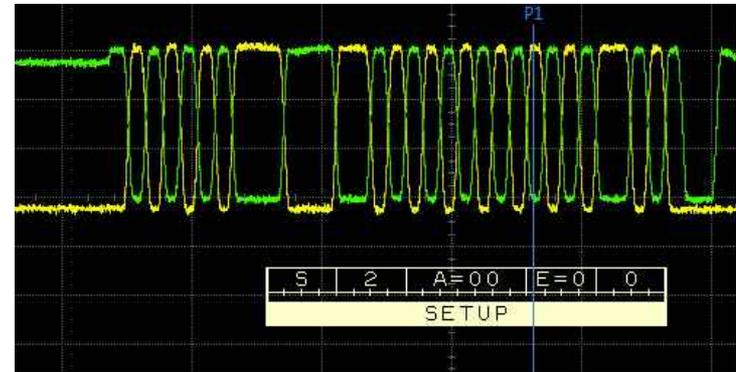
- Standard feature rich software
- Annotated axis values
- Results window (adjustable size)
- 16 grids per window, up to 8 windows
- > 50 automated measurements
- 16 math functions
- Up to 20 simultaneous measurements
- Analysis/measurements on gated regions
- Waveform viewer
- Spectral viewer
- Multi-tab with support for external monitor



Protocol Options

Fixed, server, and transportable licenses

- 8B/10B
- CAN and CAN .dbc
- DigRF v4
- DVI
- HDMI
- FlexRay
- I2C/SPI
- JESD204B (contact factory)
- JTAG LIN
- MIPI CSI-3 (M-PHY)
- MIPI D-PHY MIPI LLI
- MIPI RFFE
- MIPI UniPro
- PCI e Gen1 and Gen2
- RS-232/UART
- SATA/SAS
- SPI
- SVID
- USB 2.0
- USB 3.0
- USB 3.0 SuperSpeed Inter-Chip (SSIC)

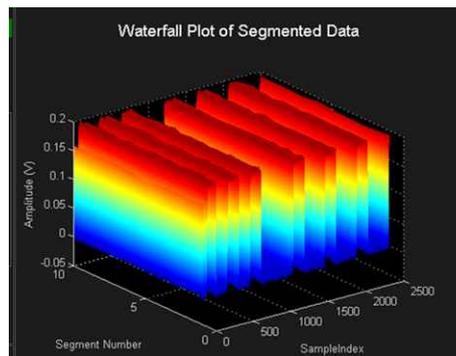
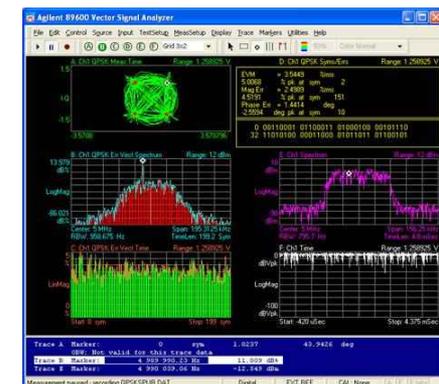
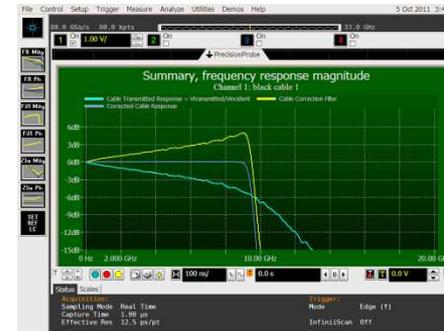
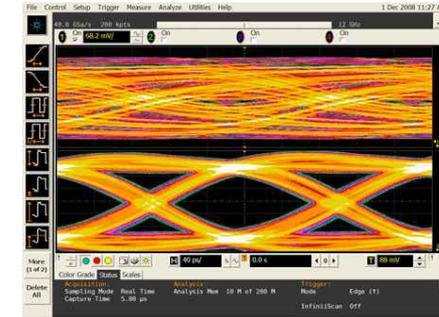


Signalanalyse – Oszilloskope

Analysis Options

Fixed, server, and transportable licenses

- DSA (EZJIT complete + SDA)
- Equalization
- EZJIT
- EZJIT+
- EZJIT Complete vertical noise analysis
- FPGA Dynamic Probe for Xilinx FPGAs
- InfiniiScan
- InfiniiSim Basic
- InfiniiSim Advanced
- Matlab integration
- OSA (Oscilloscope Signal Analyzer)
- Power
- Precision Probe
- Serial Data Analysis
- UDA (User-defined application)
- UDF (User-Defined Function)
- VSA (Vector Signal Analysis)

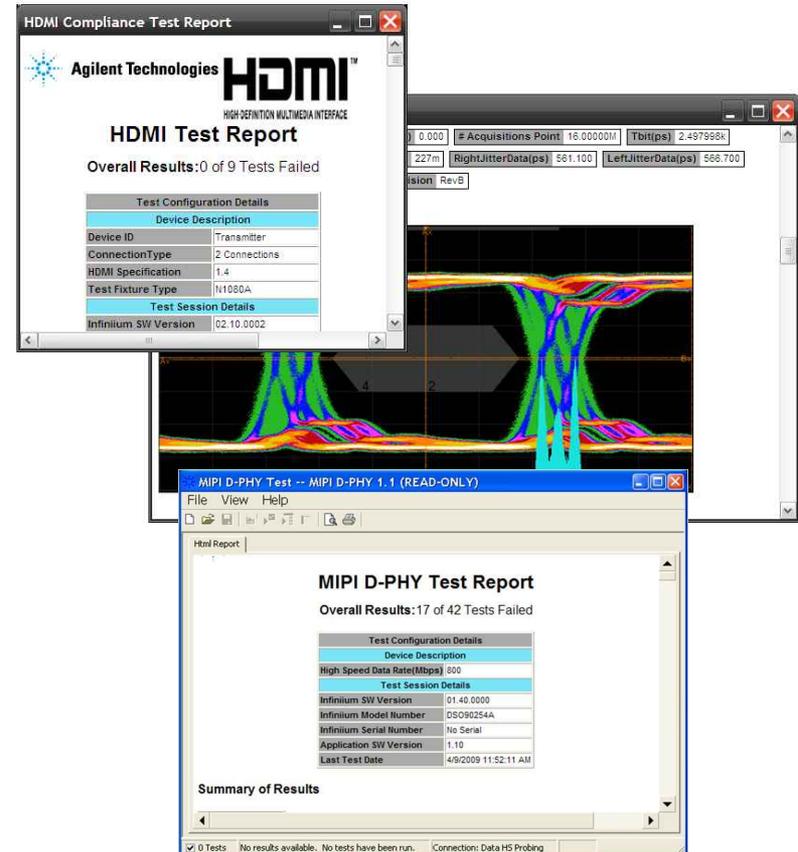


Signalanalyse – Oszilloskope

Compliance Options

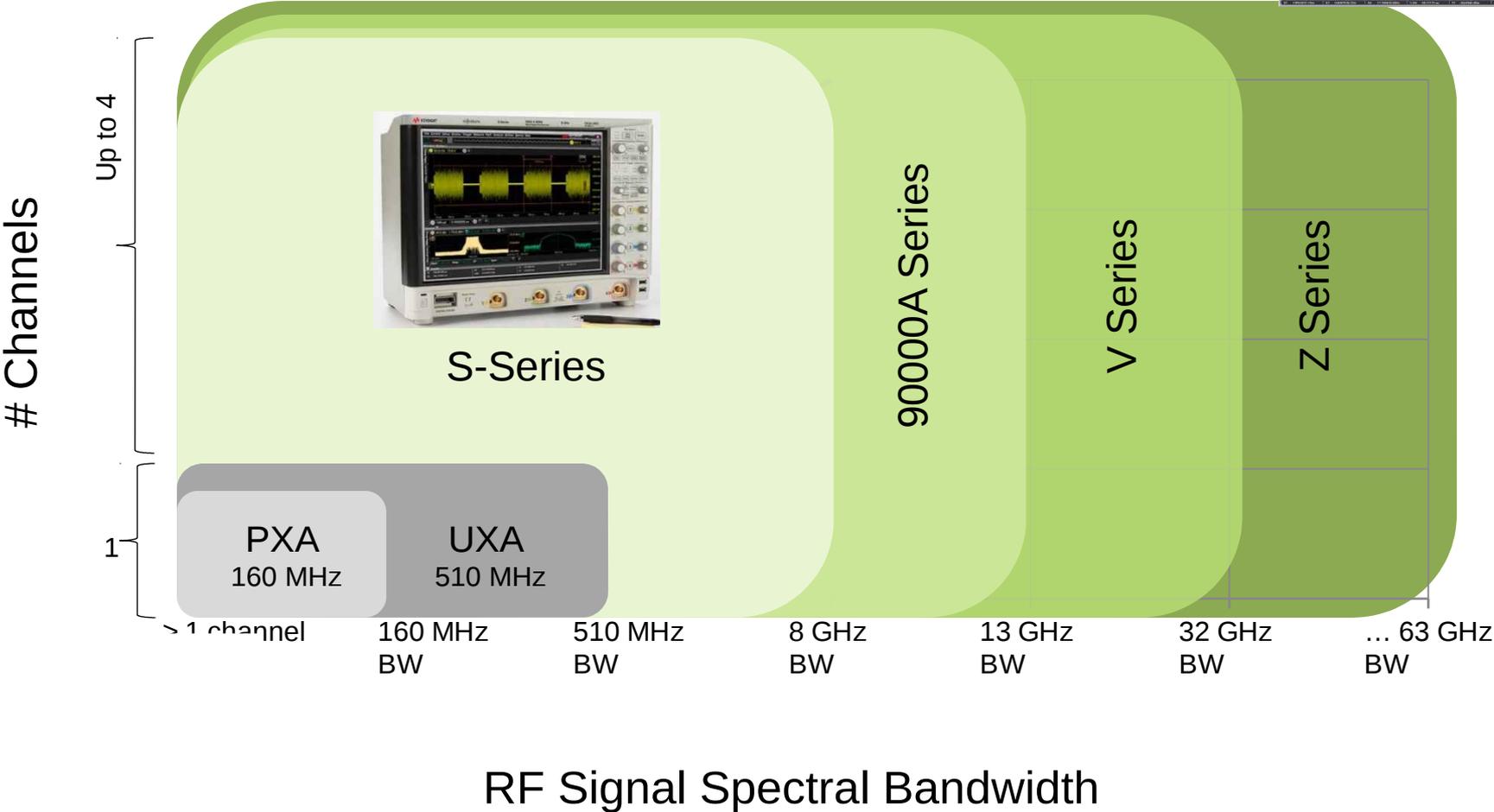
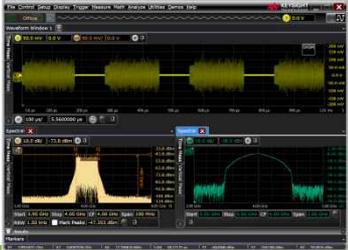
Fixed, server and transportable licenses

	Min BW (GHz)
BroadR-Reach	1
DDR1 (200 MT/s to 1067 MHz)	1GHz to 4 GHz
DDR2 + LPDDR2 (400 MT/s to 1067 MT/s)	2 GHz to 4GHz
DDR3 + LPDDR3 (800 MT/s to 1067 MT/s)	4 GHz
eMMC	1
Ethernet	1
Ethernet + EEE	1
10GBase-T	2.5
HDMI 1.4	8
MHL 2.0	8
MIPI D-PHY	4
MIPI M-PHY	6
MOST	1.5
PCIe Gen 1	6
UDA software	1
UHS-I	1
UHS-II	6
USB 2.0	1.5
HSIC	1.5
XAUI	6



Signalanalyse – Oszilloskope

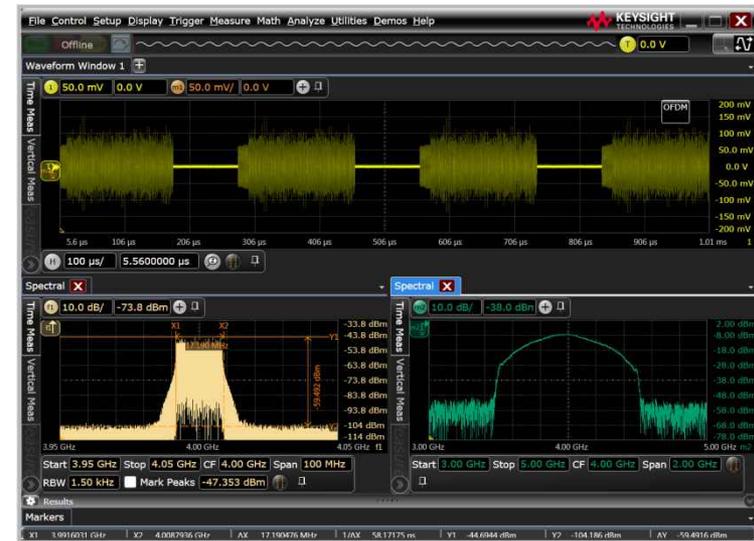
RF Measurements?



Signalanalyse – Oszilloskope

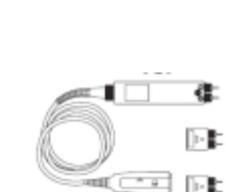
Considering S-Series for RF Measurements?

Typical RF Characteristic values from measured results on an 8 GHz S-Series Oscilloscope	
Sensitivity / Noise Density (1 mV/div; -38 dBm range) Power Spectral Density measurement at 1.0001 GHz, 1.0001 GHz center frequency, 500 kHz span, and 3 kHz RBW	-160 dBm/Hz
Noise Figure (derived from measurement above)	14 dB
Signal to Noise Ratio / Dynamic Range (0 dBm 1 GHz input carrier, 0 dBm scope input range) 1 GHz center frequency, 100 MHz span, 1 kHz RBW, measurement at +20 MHz from center	108 dB
Absolute amplitude accuracy (0 to 7.5 GHz)	+/- 1 dB
Deviation from linear phase (0 to 7.5 GHz)	+/- 7 deg
Phase noise (@ 1 GHz) 10 kHz offset 100 kHz offset	-121 dBc/Hz -122 dBc/Hz
EVM (802.121 2.4 GHz carrier, 20 MHz wide, 64 QAM)	-47 dB (0.47%)
Spurious responses (0 dBm signal, 0 dBm input range) Spur Free Dynamic Range (SFDR) 1 GHz, 0dBm signal present at input, FFT =5 GHz span, 3 GHz center, 100 kHz RBW	72 dB
2nd Harmonic distortion 1 GHz input, 0 dBm, 5 GHz span, 3 GHz center, 100 KHz RBW	-64 dBc
3rd Harmonic distortion 1 GHz input, 0 dBm, 5 GHz span, 3 GHz center, 100 KHz RBW	-46 dBc
Two-Tone Third-Order Intermodulation distortion (TOI) 0 dBm input tones, 2.435 GHz and 2.439 GHz, 2 MHz separation, 2.437 GHz center frequency, 10 MHz span, 100 kHz RBW, 6 dBm input range	21.5 dBm
Input Match (< 50 mV/div, 0-7 GHz) (≥ 50 mV/div, 0-7 GHz)	-15 dB; 1.4 VSWR -19 dB; 1.25 VSWR



Signalanalyse – Oszilloskope

Tastköpfe



Fernbedienung von modernen Oszilloskopen

- Web-Server
- Makro-Scripts
- Connection Expert
- Command Expert
- BenchVue

Signalanalyse – Oszilloskope

Connection Expert

The screenshot displays the Keysight Connection Expert application window. The title bar reads "Keysight Connection Expert". The main menu includes "Instruments", "PXI/AXIe Chassis", "Manual Configuration", and "Settings".

Under the "Instruments" tab, there is a "Rescan" button, a "Filter Instruments:" text box, and a "Clear" button. A list of instruments is shown, with the selected instrument being "MSO-X 6004A, Agilent Technologies" with the address "TCPIP0::A-MX6004A-90319::inst0::INSTR (+1 addi)".

The "Details for Agilent Technologies MSO-X 6004A" panel shows the following information:

- Manufacturer: Agilent Technologies (with a link to "View Instrument Information Online")
- Model: MSO-X 6004A (with a link to "Start Instrument Web Interface")
- Serial Number: MY54390319
- Firmware Version: 06.11.2015103000

The "Connection Strings" section includes:

- VISA Addresses:
 - TCPIP0::A-MX6004A-90319::inst0::INSTR (checked)
 - TCPIP0::A-MX6004A-90319::5025::SOCKET (checked)
- VISA Aliases: <No VISA aliases configured> (with a link to "Add or Change Aliases")
- SICL Addresses: (collapsed)

The "Installed Drivers" section shows <No installed drivers> (with a link to "Update Drivers").

At the bottom, the "Messages" pane shows a list of log entries:

- 12:01:10 Deleted connection TCPIP0::A-MX6004A-90319::5025::SOCKET from agilent,mso-x 6004a,my54390319
- 12:01:10 Deleted connection TCPIP0::A-MX6004A-90319::inst0::INSTR from agilent,mso-x 6004a,my54390319
- 09:57:51 Instruments are already discovered and configured
- 09:57:51 User interface session started

System status at the bottom right: Remote IO Server Off, 32-Bit Keysight VISA is Primary, 17.1.19313.5

Fernbedienung von modernen Oszilloskopen

Web – Server

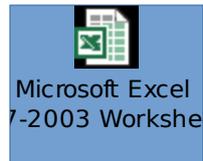
The image displays a remote front panel for a Keysight InfiniiVision MSO-X 6004A Mixed Signal Oscilloscope. The main display shows a yellow waveform with a 'Demo Mode' warning. The control panel on the right is divided into several sections:

- Horizontal:** Includes knobs for 'Push for Fine' and 'Push to Zero', and buttons for 'Horiz', 'Search', and 'Navigate'.
- Run Control:** Features 'Run/Stop', 'Single', 'Default Setup', and 'Auto Scale' buttons.
- Trigger:** Contains 'Trigger', 'Zone', 'Level' (with 'Push for 50%' label), and 'Force Trigger' buttons.
- Measure:** Includes 'Cursors' and 'Meas' buttons.
- Waveform:** Has 'Analyze', 'Acquire', and 'Jitter' buttons.
- File:** Includes 'Save Recall' and 'Print' buttons.
- Tools:** Features 'Clear Display', 'Display', 'Utility', 'Quick Action', 'Wave Gen1', and 'Wave Gen2' buttons.
- Vertical:** Includes four knobs labeled '1', '2', '3', and '4' with '50Ω' labels below them, and 'Push for Fine' and 'Push to Zero' buttons.

The bottom of the interface shows a 'Trigger Mode and Coupling Menu' with options like 'Mode Auto', 'Coupling DC', 'Noise Reject', 'HF Reject', 'Holdoff 100.00us', and 'External'.

Signalanalyse – Oszilloskope

Makro-Scripts



Signalanalyse – Oszilloskope

Command Expert

File Edit Play Help

Active Instruments
34980A

My Instruments
DSO-X
N6700
SCPI-99

Command Search
Enter search terms here

34980A Search Recent

- SCPI
 - ABORT
 - CALCulate
 - CALibration
 - CONFigure
 - DATA
 - DIAGnostic
 - DISPlay
 - FETCh
 - FORMat
 - INITiate
 - INSTrument
 - MEASure
 - MEMory
 - OUTPut
 - R
 - READ
 - ROUTE
 - SAMPle
 - [SENSe]

Command
To select a command, click it in the pane to the left, or enter its name here

Sequence
Name: 34980A Triggered Measure Description: Sets the 34980A multifunction switch for 5 DCV measurements on 2 channels on the 10V range

	Status	Instrument	Code	Results
1		34980A	(Connect "34980A", "%prompt", "34980 Multifunction Switches / 2.43")	
2		34980A	:INSTrument:DMM:STATe 1	
3		34980A	:CONFigure:SCALar:VOLTage:DC 10,(@1004,1005)	
4		34980A	:ROUTE:SCAN (@1004,1005)	
5		34980A	:TRIGger:COUNt 5	
6		34980A	:INITiate	
7			(Wait 1000ms)	
8		34980A	:FORMat:READing:AI ARm 0	

Ready

Signalanalyse – Oszilloskope

BenchVue



AXAWARD 2016

Der **AUSTRIAN X.TEST AWARD** kurz AXAWARD,

als österreichischer **Technik-Nachwuchswettbewerb** bekannt, findet heuer zum fünften Mal statt.

Über 200 Teilnehmerinnen und Teilnehmer hatten sich 2015 um den AXAWARD beworben.

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DANKE SCHÖN!

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