Entwicklungen und Einsatz

moderner Laborgeräte am Beispiel von Oszilloskopen

Christian Bauer

x.test GmbH

10. Dezember 2015

Salzburg / Ö

Eckdaten

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

  Agilent Technologies ist nun Keysight Technologies

- 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)

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

4 analog (scope) inputs

8-16 digital (MSO) inputs

A/D

Meas Buffer (64K)

Acquisition Memory Manager

Waveform Plotter

DRAM A/D Data

DRAM

GUI

Serial Decoders (simultaneous)

Mask Test

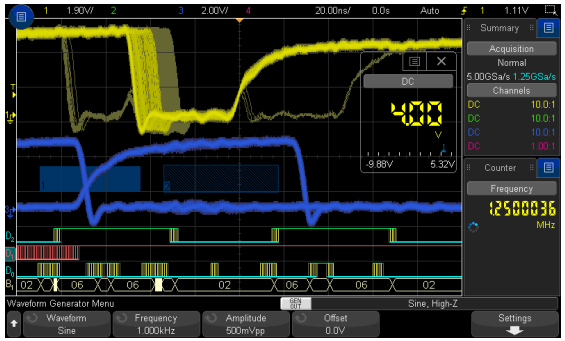
Trigger

WaveGen synthesis

CPU not needed for most operations

MegaZoom IV SOC ASIC

- **Fast:** up to 1,000,000 wvfm/sec
- **Integrated:** MSO, acquisition memory, function generator, decode
- **Affordable:** due to high integration



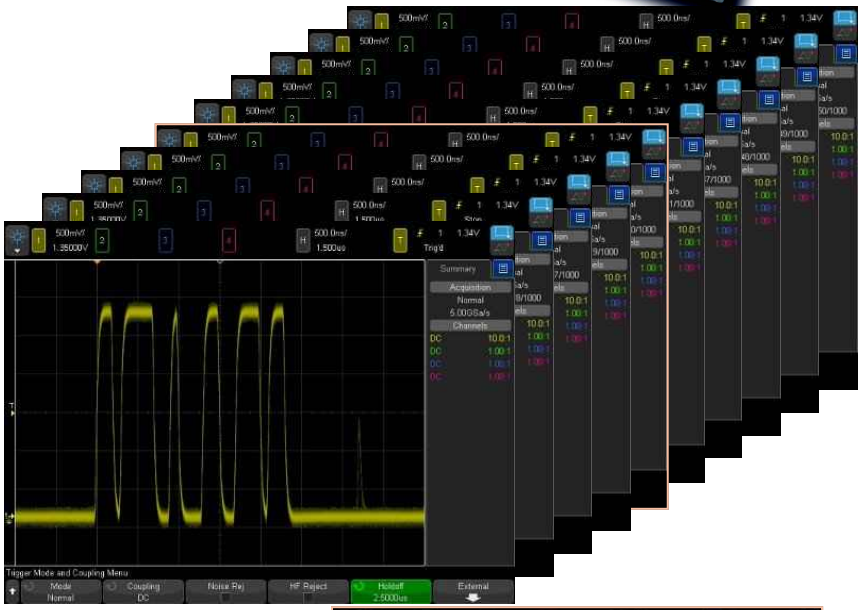
Debugging – Oszilloskope

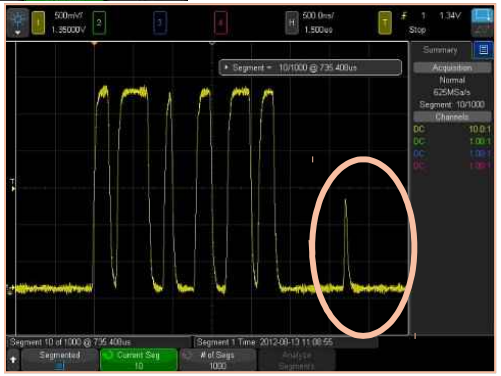
HW – Konzeption: InfiniiVision X-Series MegaZoom IV ASIC

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

Kurvenformen/Sekunde

- MegaZoom IV smart memory technology
  - Responsive
  - Uncompromised
  - Segmented memory

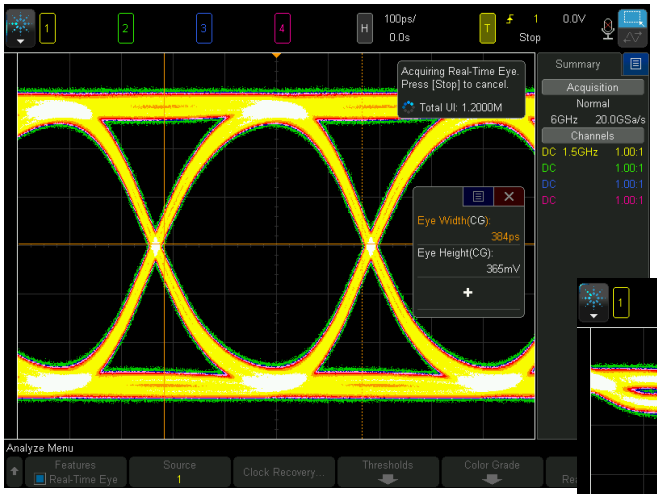




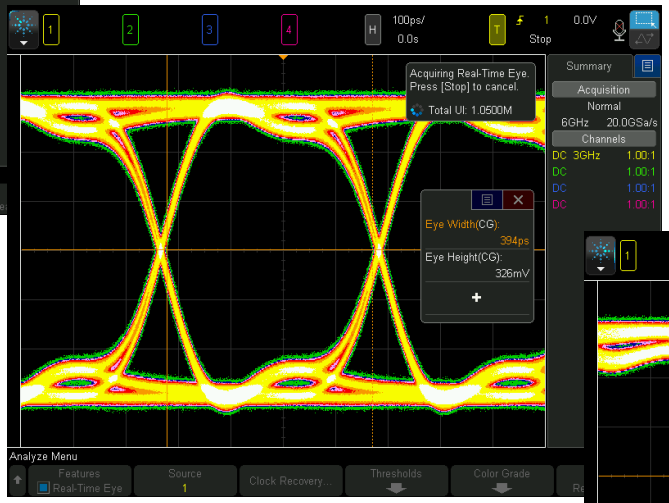
LIVEDEMO

Debugging – Oszilloskope

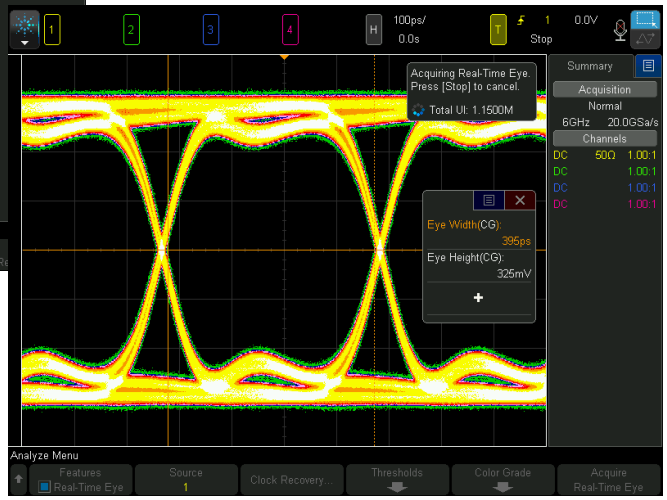
Bandbreiten bis zu 6 GHz



- 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.



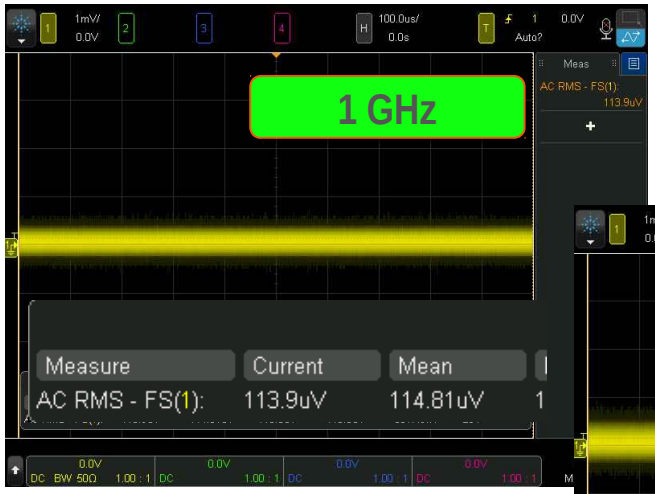
- 3 GHz sees the fundamental and some of the 3rd harmonics of 2.4 Gbps PRBS NRZ signal.

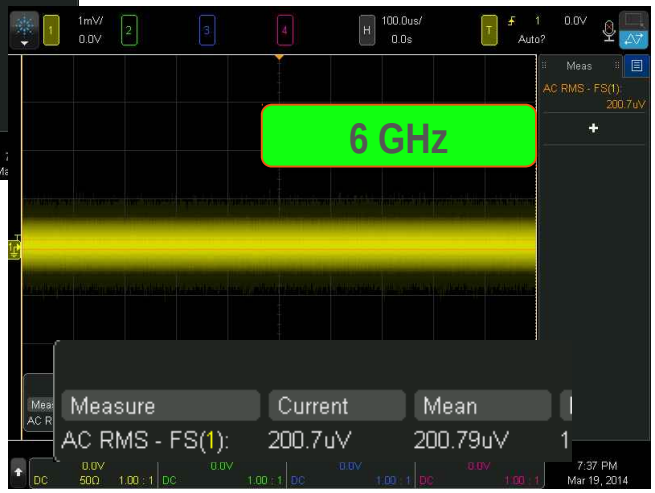


- 6 GHz sees up to 5th harmonics of 2.4 Gbps PRBS NRZ signal, giving you the most details

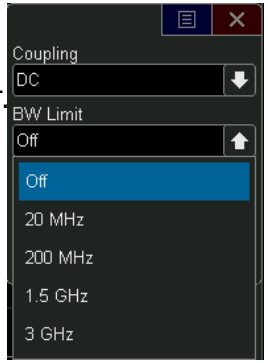
Debugging – Oszilloskope

Bandbreiten bis zu 6 GHz => geringeres Rauschen





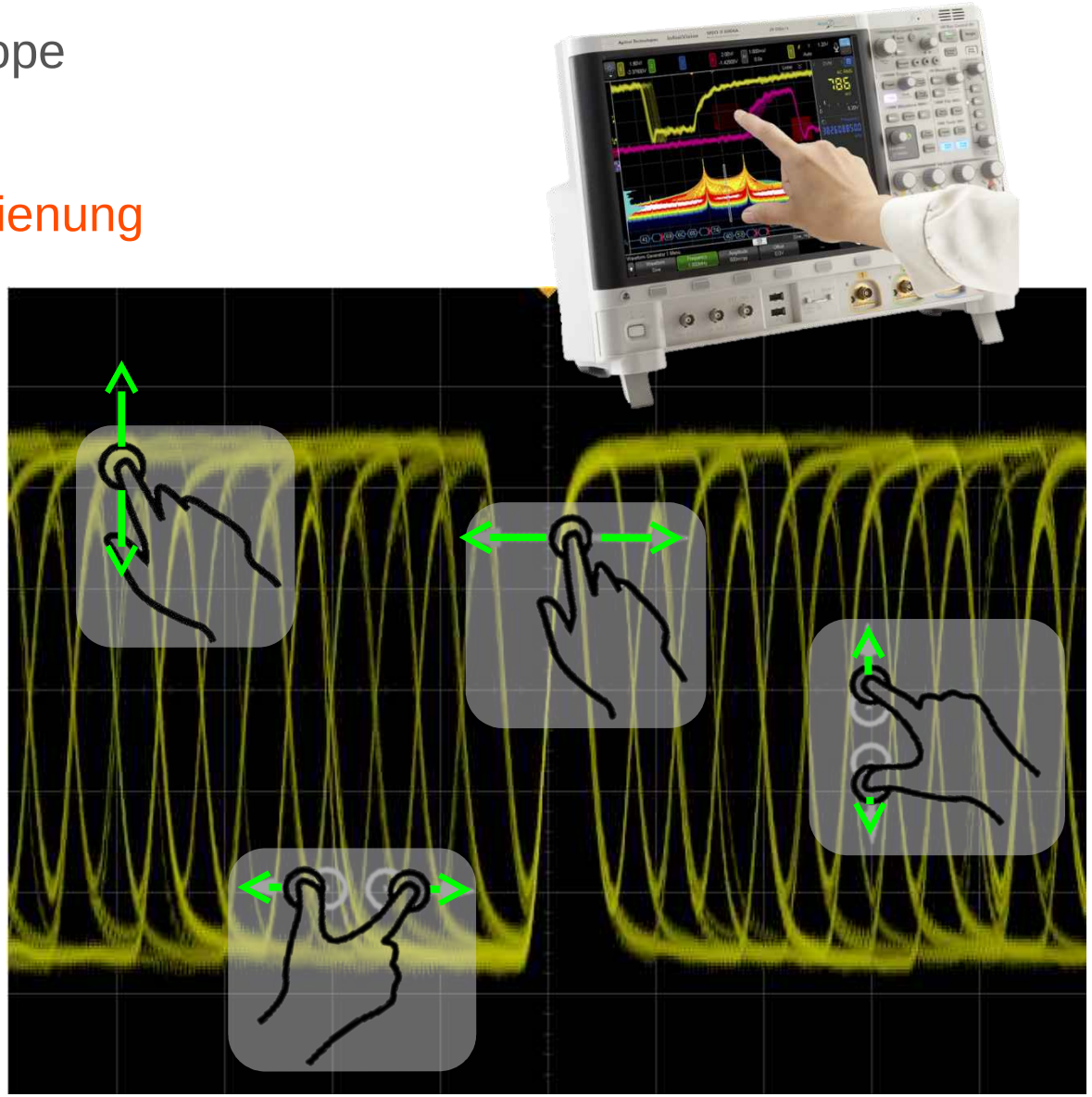
- Hardware bandwidth filter.



- 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.

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



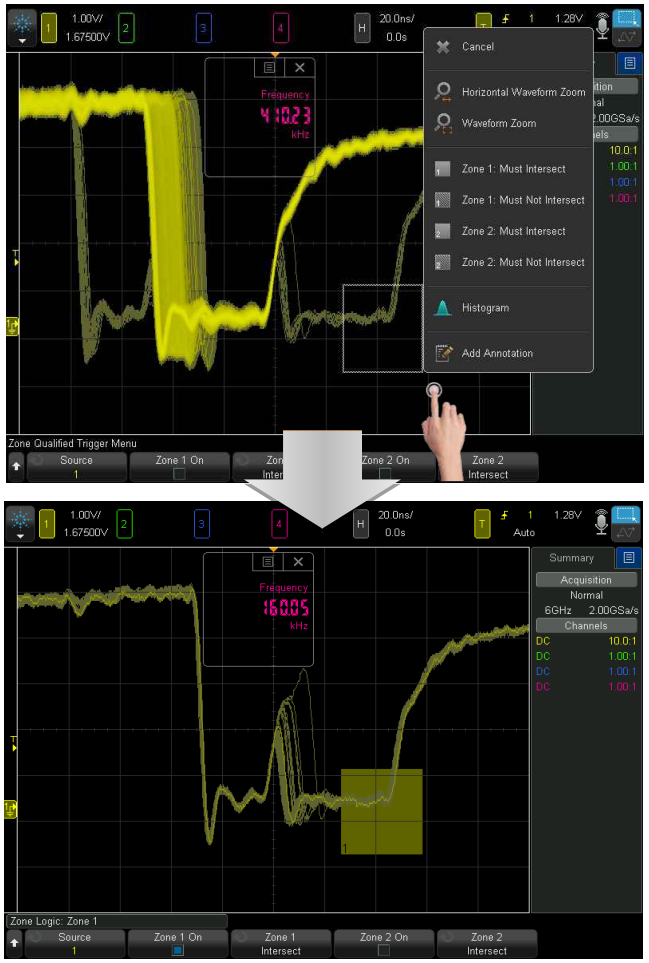
Debugging - Oszilloskope

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

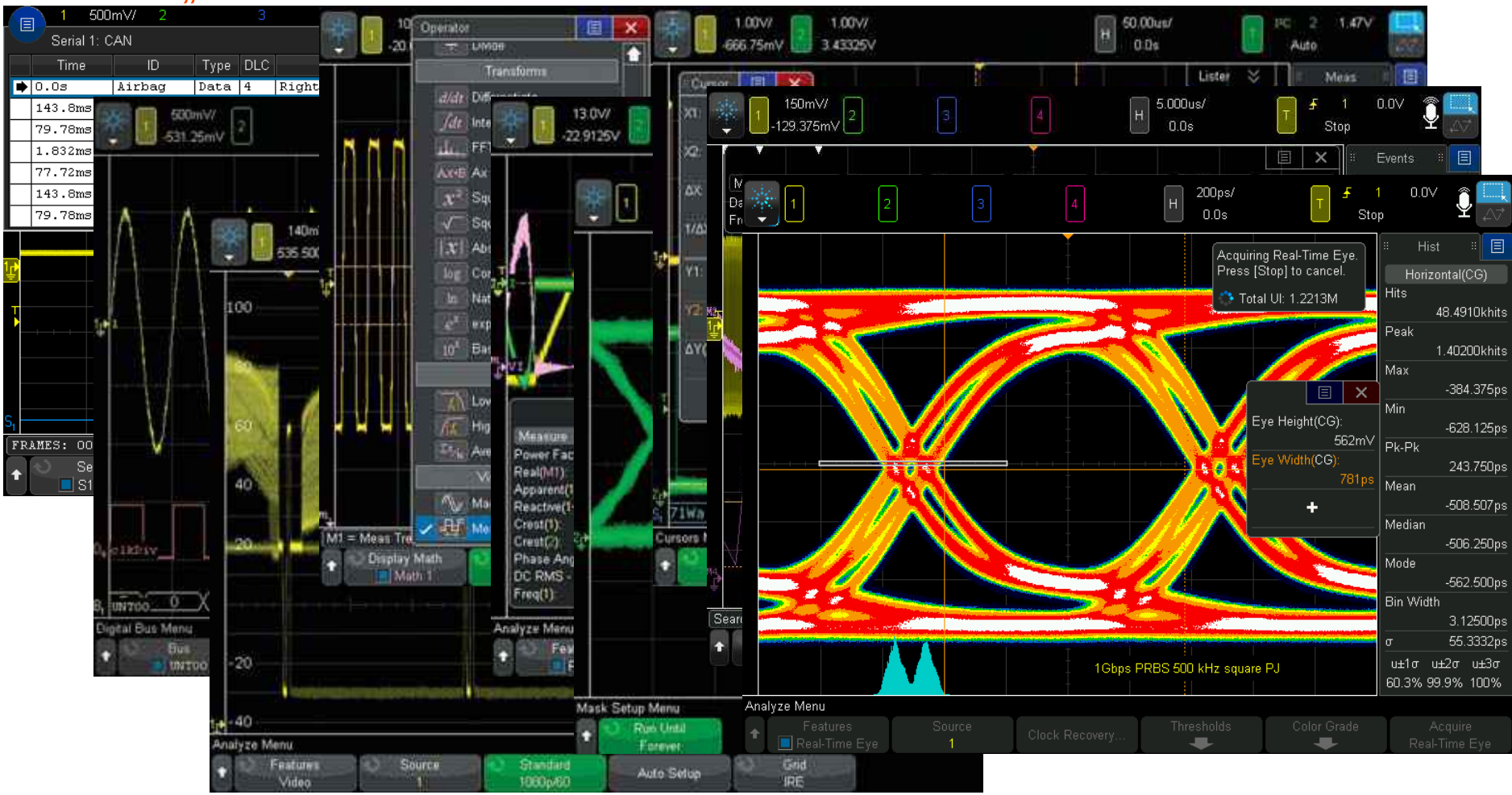
- Features:
  - Find the signal of your interest. Draw the box, and you are there
  - Hardware InfiniiScan Zone maintains >160,000 scan's per second

- 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

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**

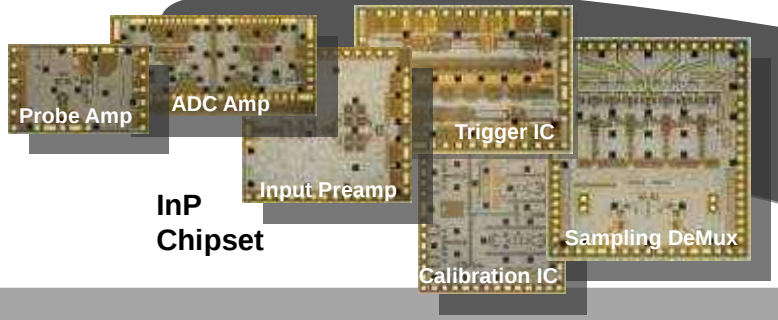
erhält er durch ein neuartiges, offenes Bedienkonzept, dass die Qualifizierung von bestehenden Bussen erleichtert und spezielle Messaufgaben ermöglicht

HW-Herausforderungen:

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

Signalanalyse – Oszilloskope

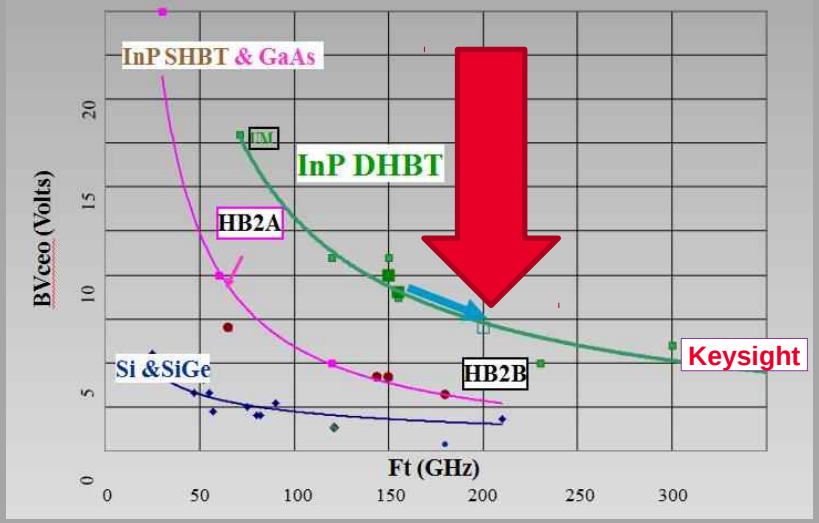
HW-Herausforderungen:



InP Chipset

Proprietary Indium Phosphide Technology

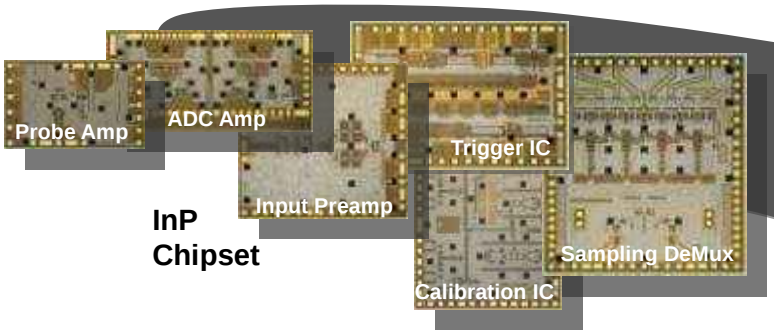
IC Process Performance



InP Benefits

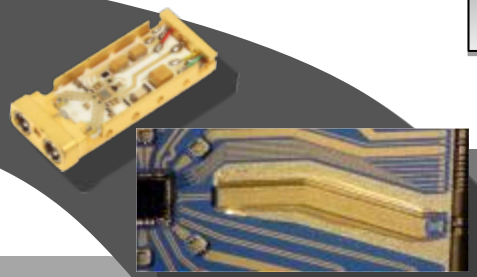
- *Captive process*
- *High-speed & high-voltage*
- *Flat response*
- *Extensible*

Signalanalyse – Oszilloskope

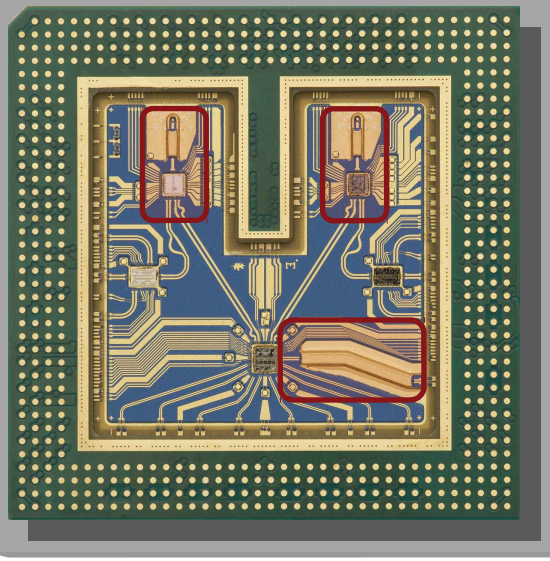


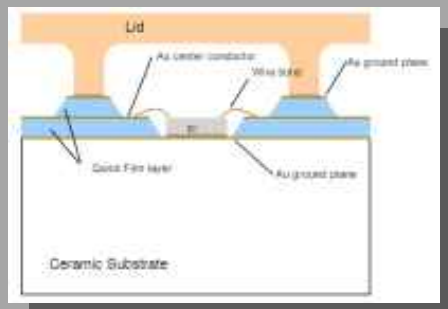
InP Chipset

Custom IC Packaging



Quick Film 3D Packaging



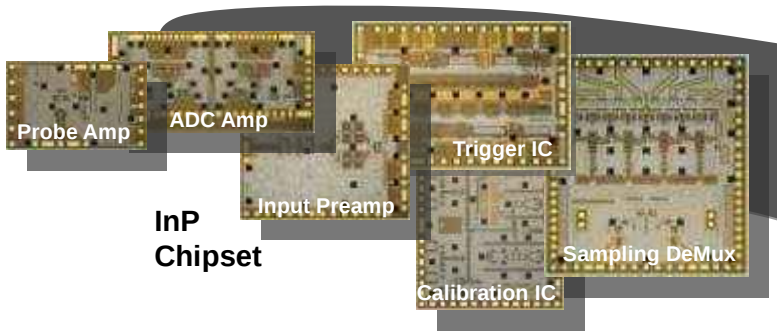


Quick Film 3D Packaging

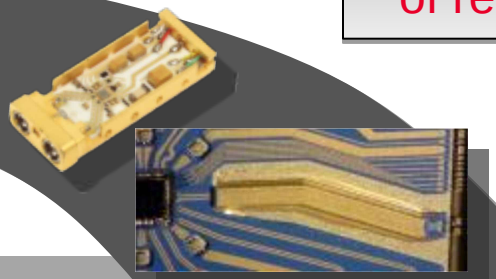
- *Custom Keysight technology*
- *Exceptional signal integrity*
- *Substrate keeps chipset cool and reliable*

Signalanalyse – Oszilloskope

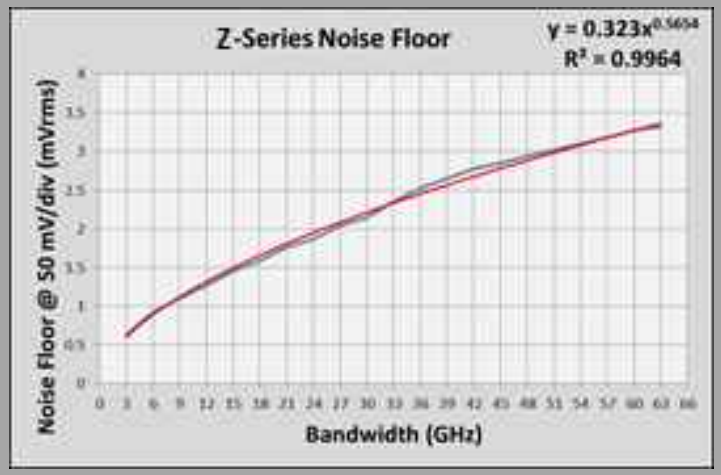
RealEdge technology enables signal acquisition at 160 GSa/s and 63 GHz of real time bandwidth.



InP Chipset



Quick Film 3D Packaging

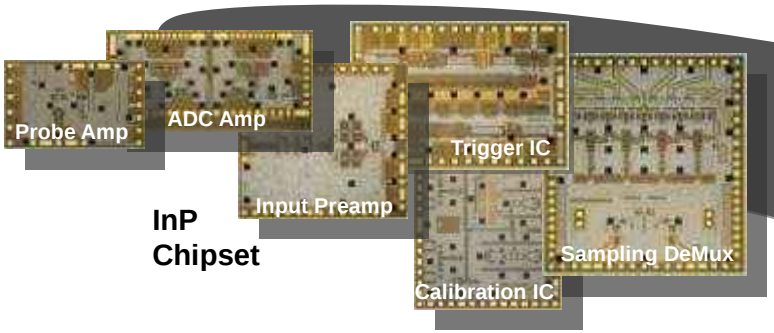


RealEdge Technology

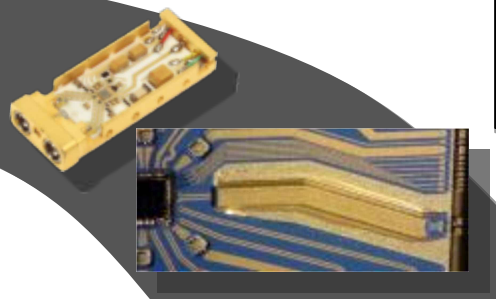
Unlike our competitors, Keysight achieves high bandwidth and sample rate through interleaving, **without a signal integrity penalty**.

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

Signalanalyse – Oszilloskope



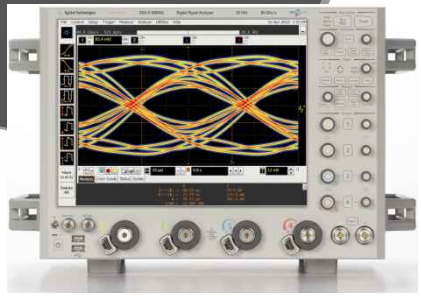
InP Chipset



Quick Film 3D Packaging

The World's Most Accurate Oscilloscopes

RealEdge Technology



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

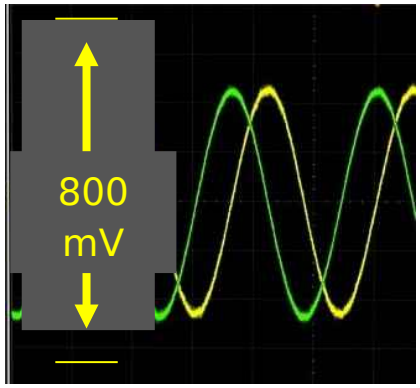
Signalanalyse – Oszilloskope

Signalanalyse – Oszilloskope

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

10 bit A/D Wandler

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



Traditional Scope

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

3.125 mV

S Series ADC

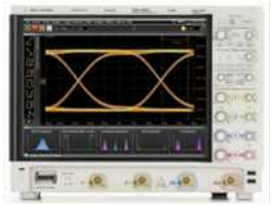
- 10 bits of vertical resolution
- 2^{10} =1024 Q levels

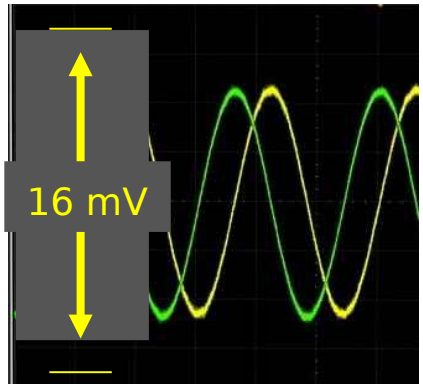
0.781 mV

Minimum resolution
@ 800 mV full screen

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 uV*

S Series ADC

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

16.6 uV

Minimum resolution
@ 16 mV full screen

*Assume SW magnification at 7 mV/div = full screen of 56 mV. 56 mV/256 = 218 uV.

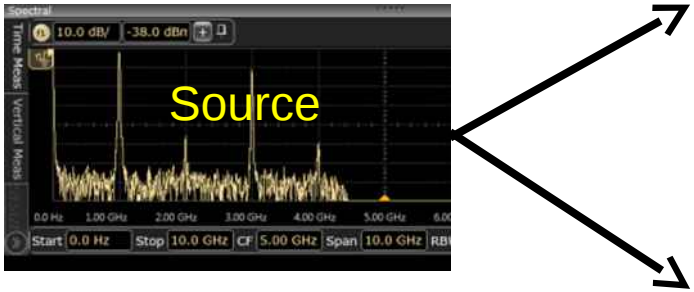
Frequency Response Impact on Scope

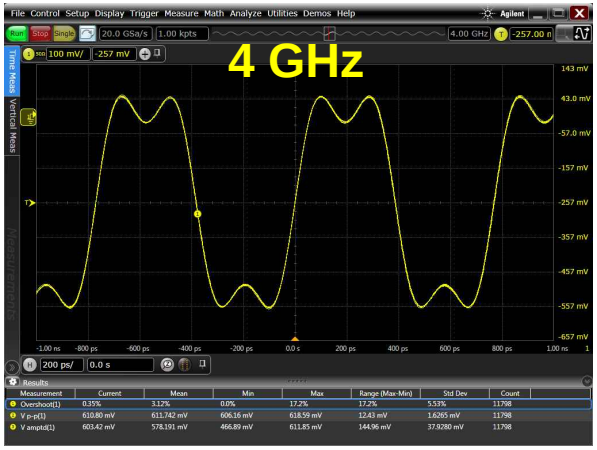
MUST List for Correct Signal Shape

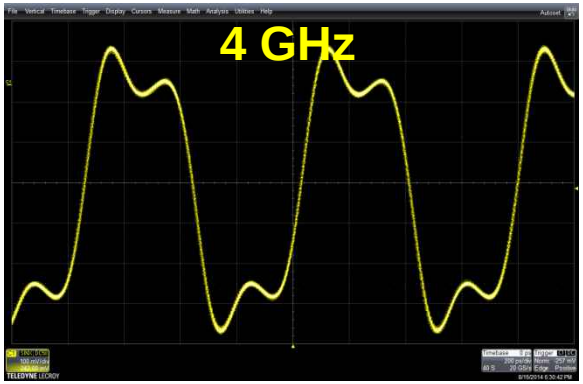
1. All signal components (fundamental + all harmonics) must be in BW of scope
2. Scope must have flat magnitude response
3. Scope must have flat phase response

Why do Scopes of Equal Bandwidths Show Different Waveshapes?

All scope settings are identical

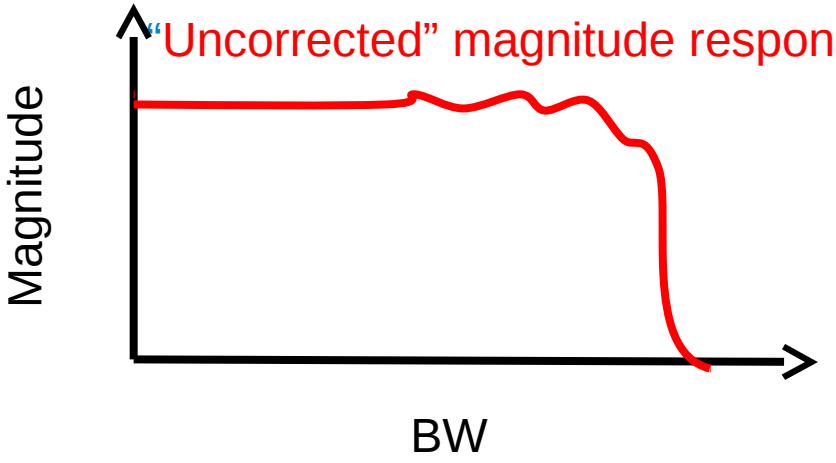


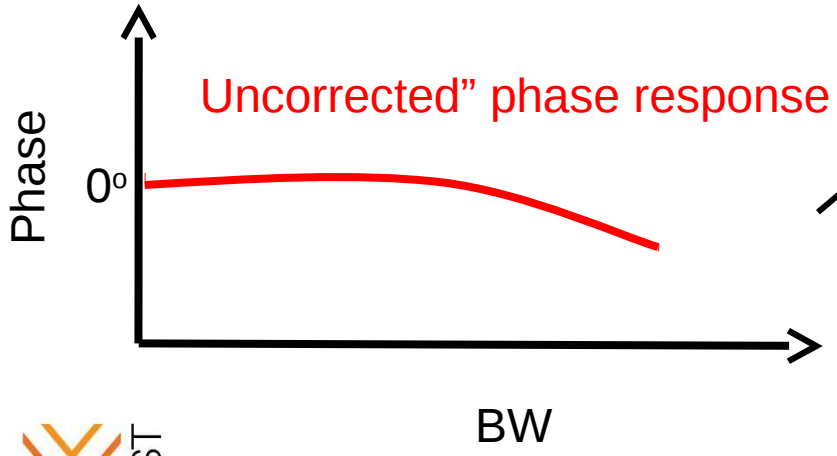


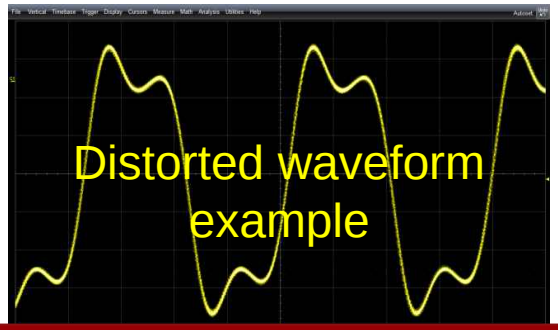


The two scopes will report different Vpp and risetime values

Natural Analog Filter are Imperfect





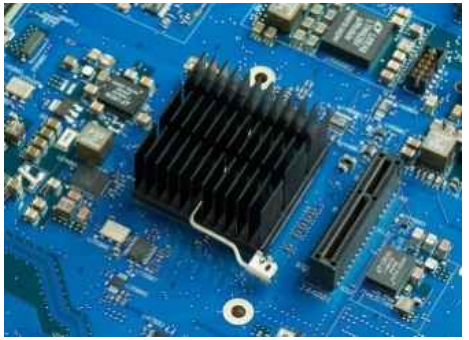


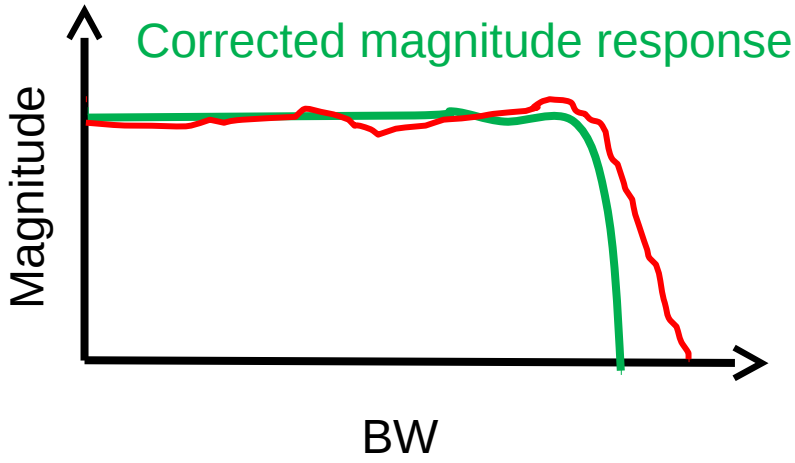
Phase Linearity

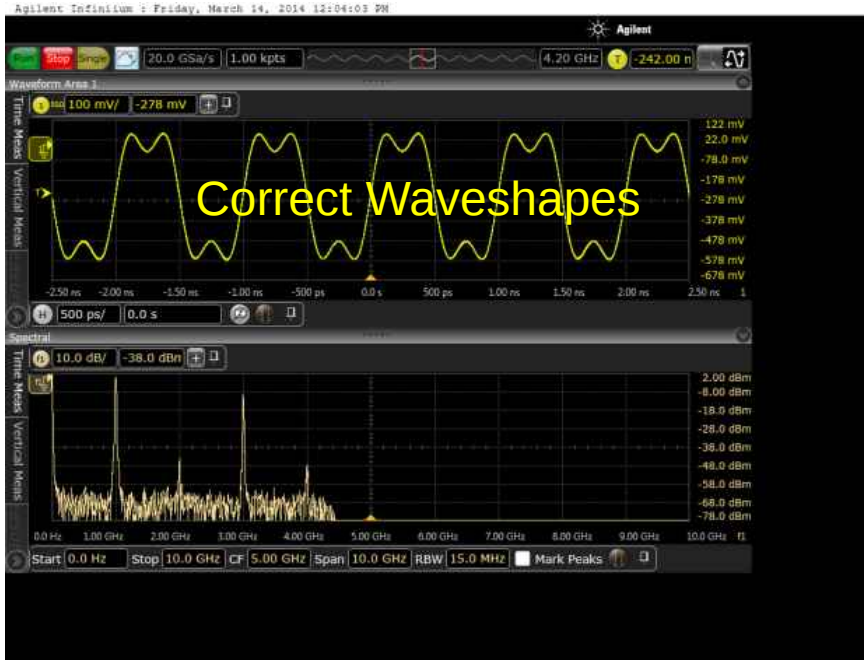
Oscilloscope phase impacts waveform shape. The less linear the phase the less square a square wave will look.

S-Series Correction Filters

Always-on – run in a big, fast FPGA





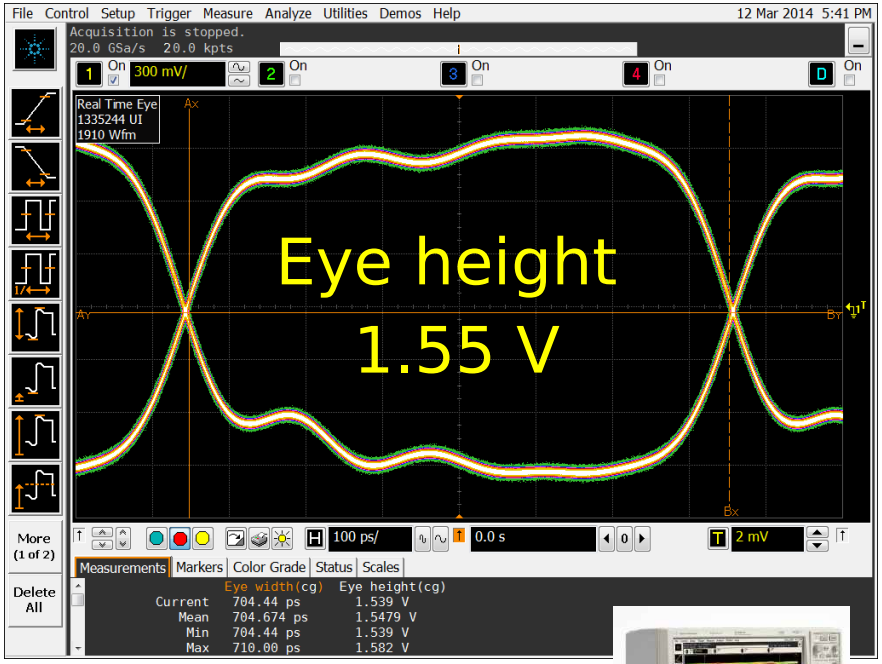


Signalanalyse – Oszilloskope

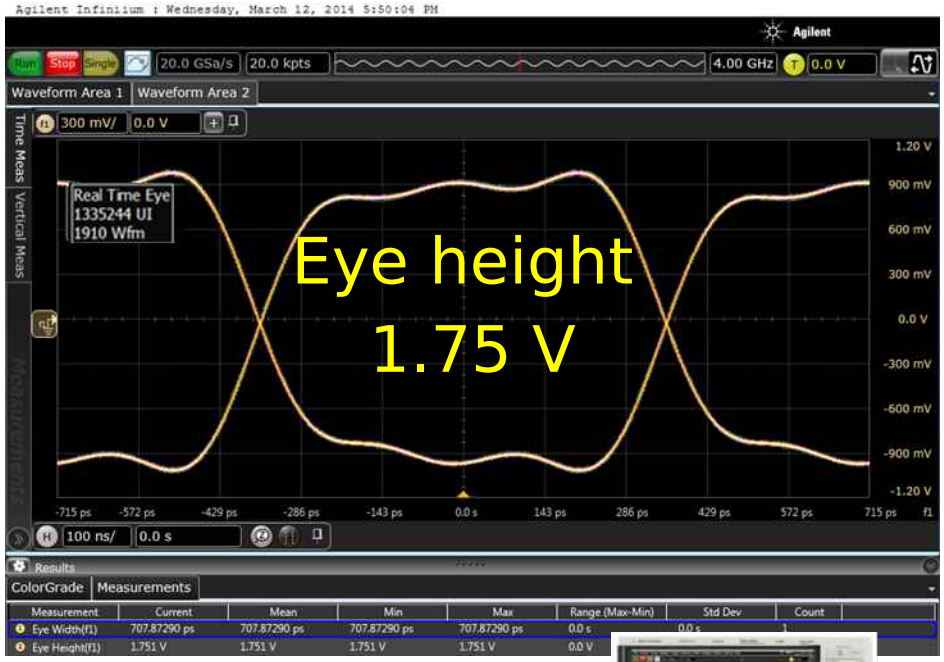
What different does Low Noise AND Flat Responses make?

Measurement Example with Identical settings

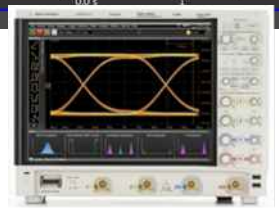
200 mV bigger eye height



Infiniium DSO9404A (4GHz)



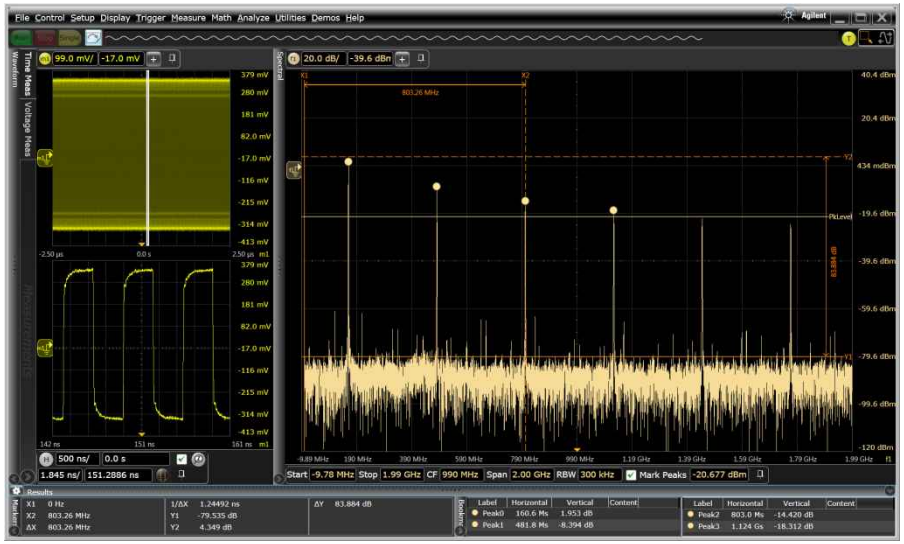
Infiniium DSOS404A (4GHz)



Signalanalyse – Oszilloskope

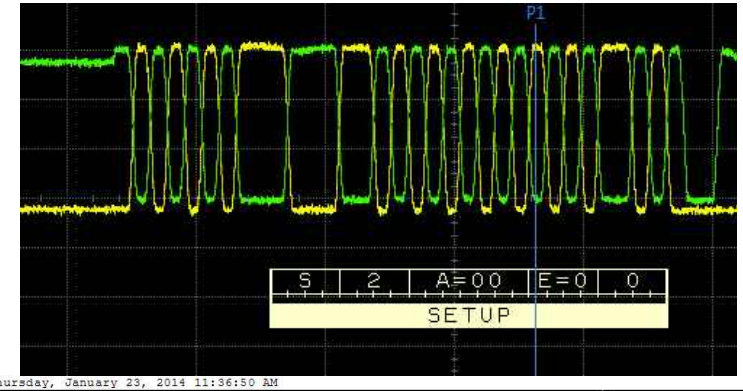
Next Generation Infiniium UI

- 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

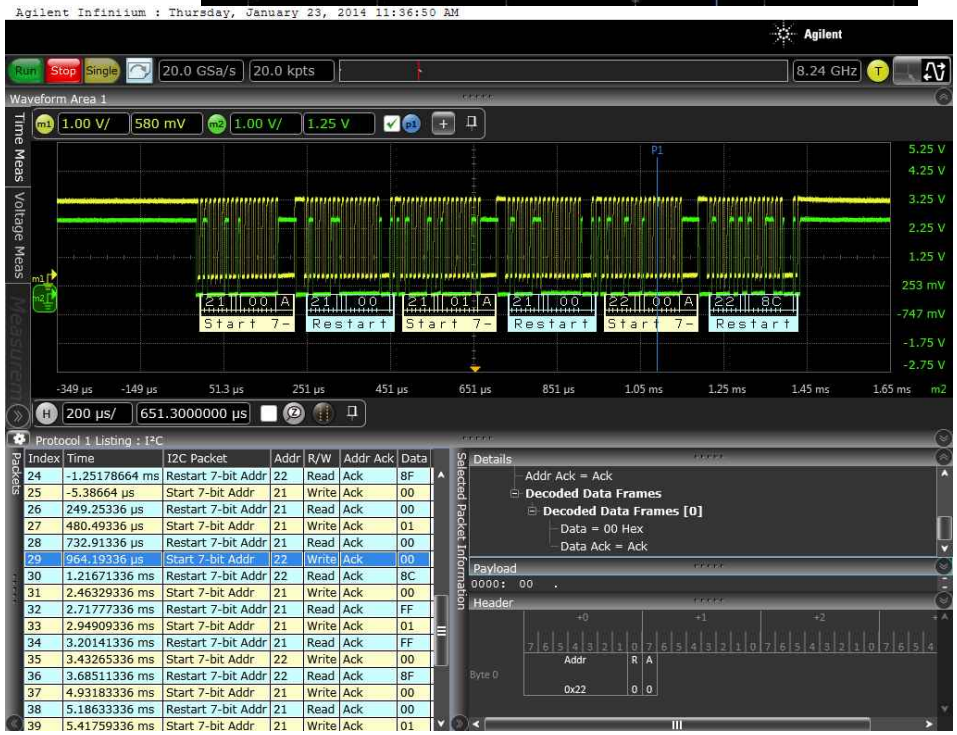


Protocol Options

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

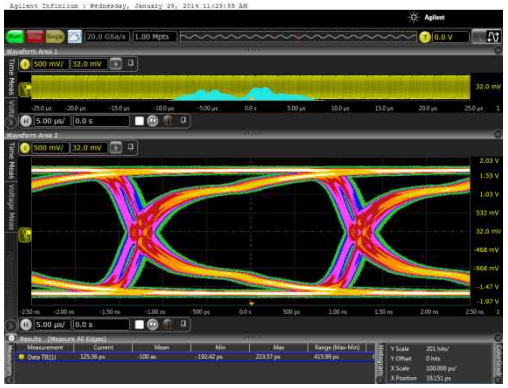


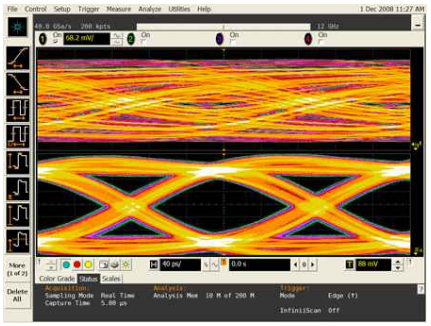
Signalanalyse – Oszilloskope

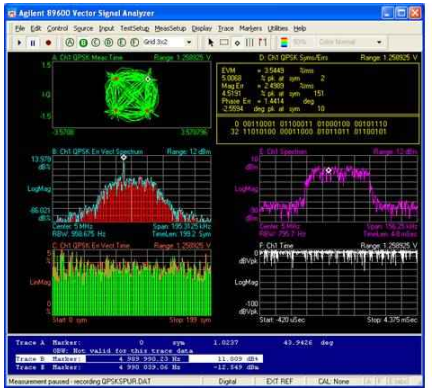
Analysis Options

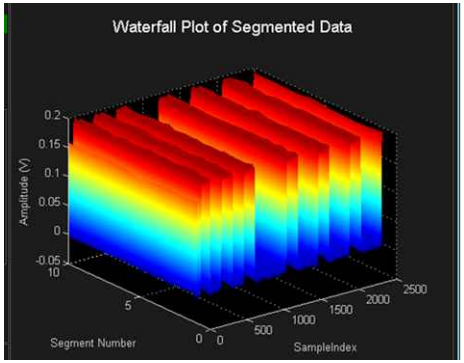
Fixed, server, and transportable licenses

- 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)







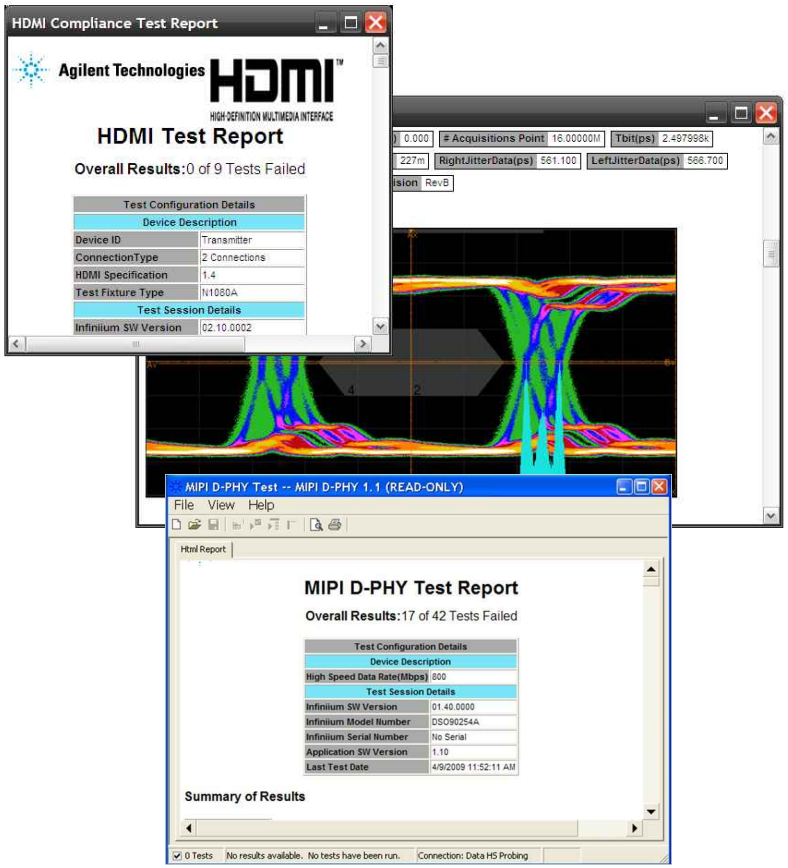


Signalanalyse – Oszilloskope

Compliance Options

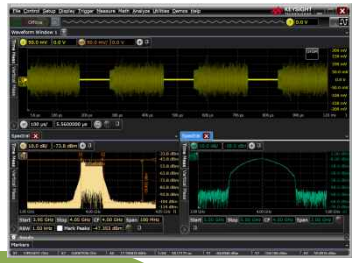
Fixed, server, and transportable licenses

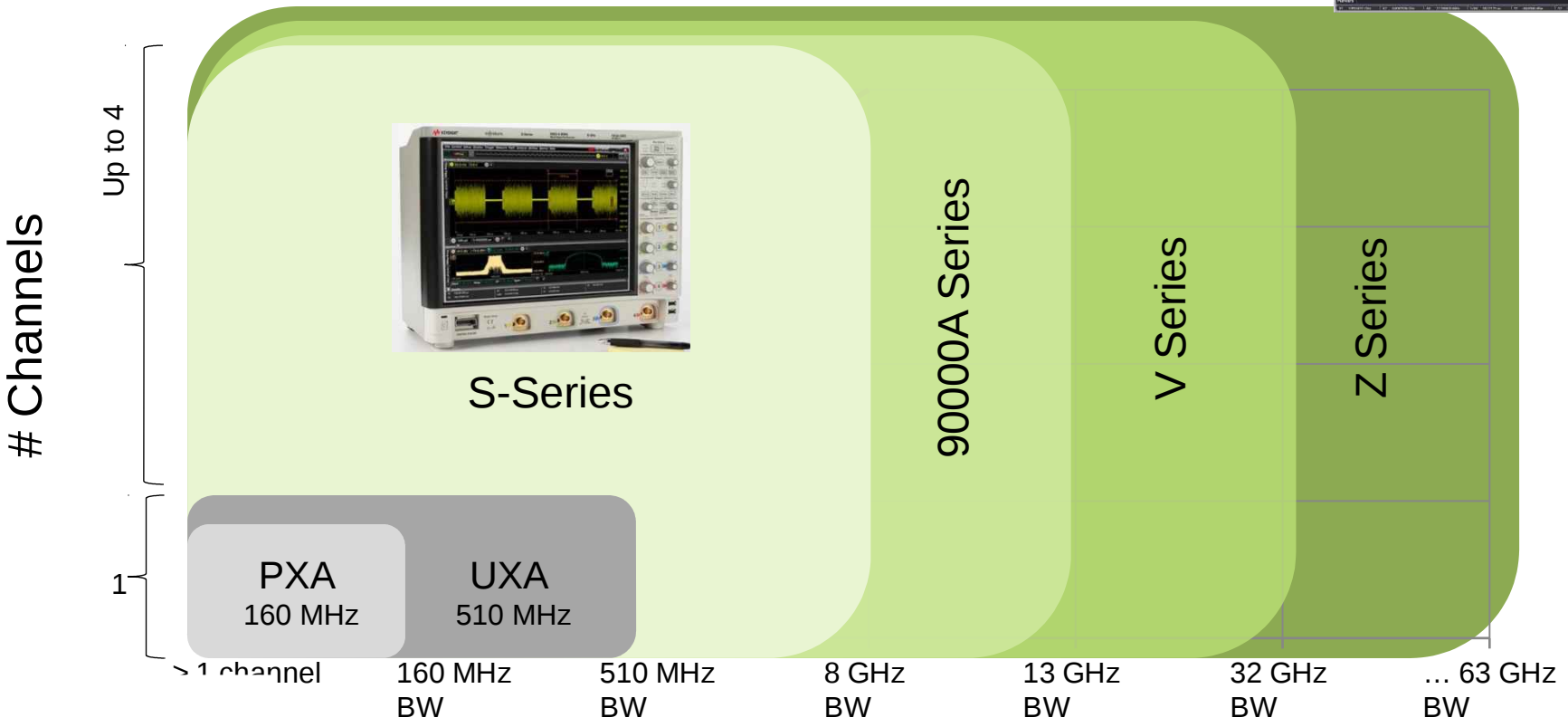
	Min BW (GHz)
BroadR-Reach	1
DDR1 (200 MT/s to 1067 MHz)	1GHz to 4 GHz
DDR2 + LPDDR2 (400 MT/s to 1067 MT/s	2 GHz to 4GHz
DDR3 + LPDDR3 (800 MT/s to 1067 MT/s)	4 GHz
eMMC	1
Ethernet	1
Ethernet + EEE	1
10GBase-T	2.5
HDMI 1.4	8
MHL 2.0	8
MIPI D-PHY	4
MIPI M-PHY	6
MOST	1.5
PCIe Gen 1	6
UDA software	1
UHS-I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



Signalanalyse – Oszilloskope

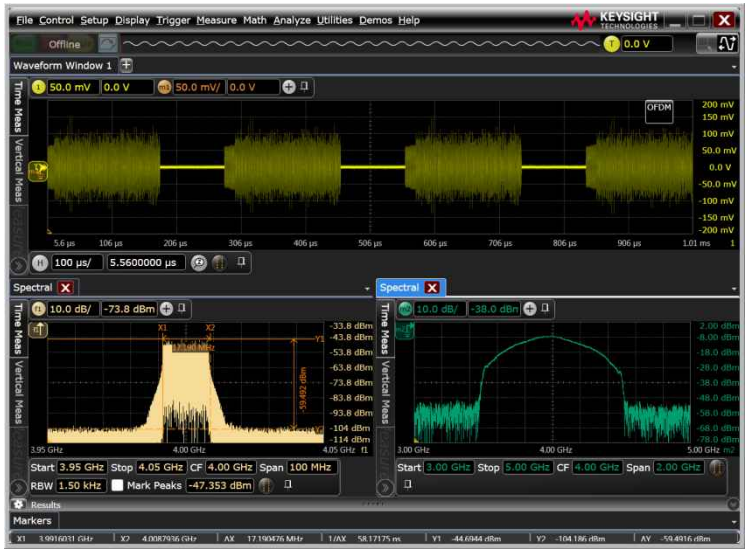
RF Measurements?





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

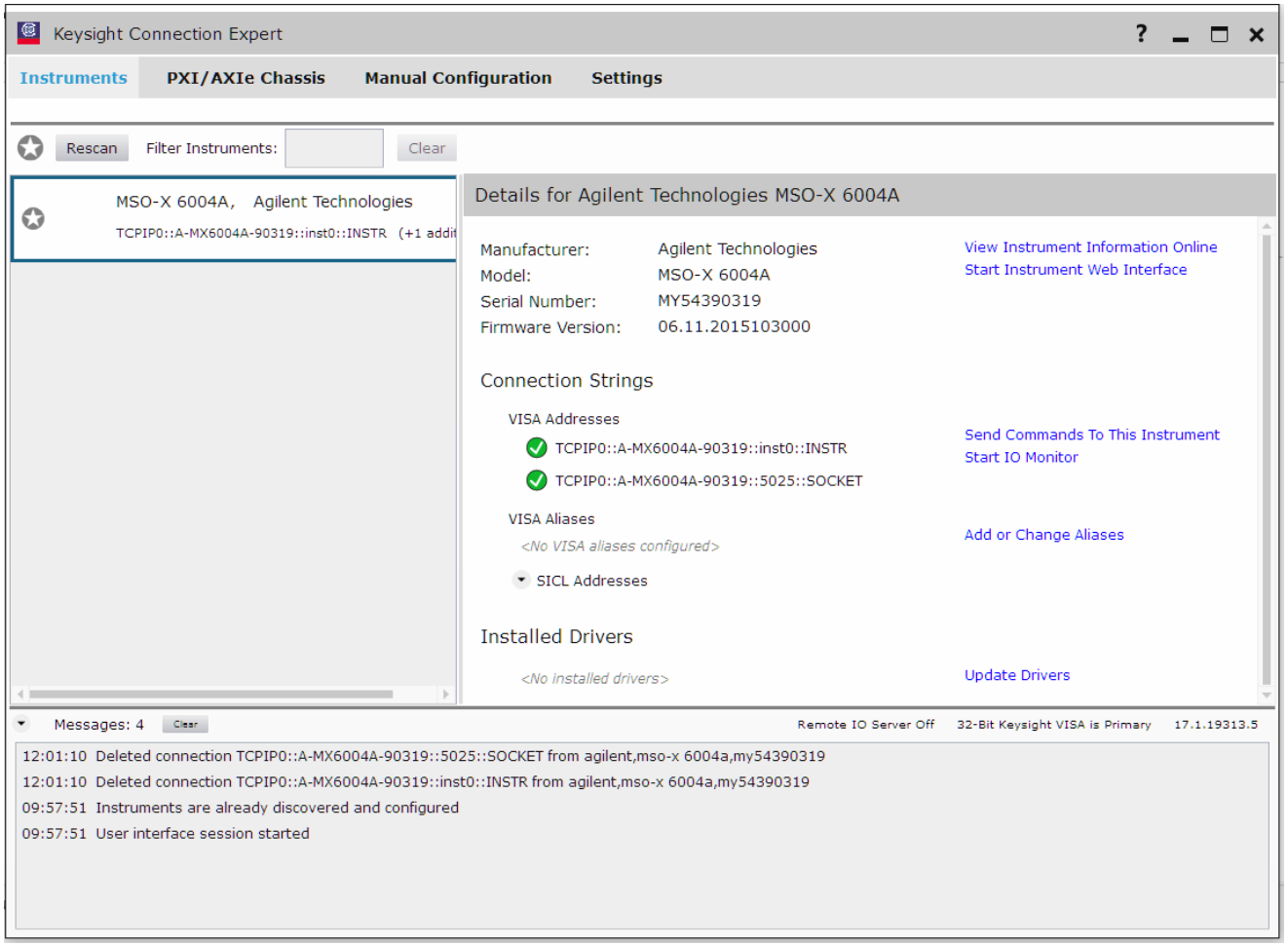
Tastköpfe

Fernbedienung von modernen Oszilloskopen

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

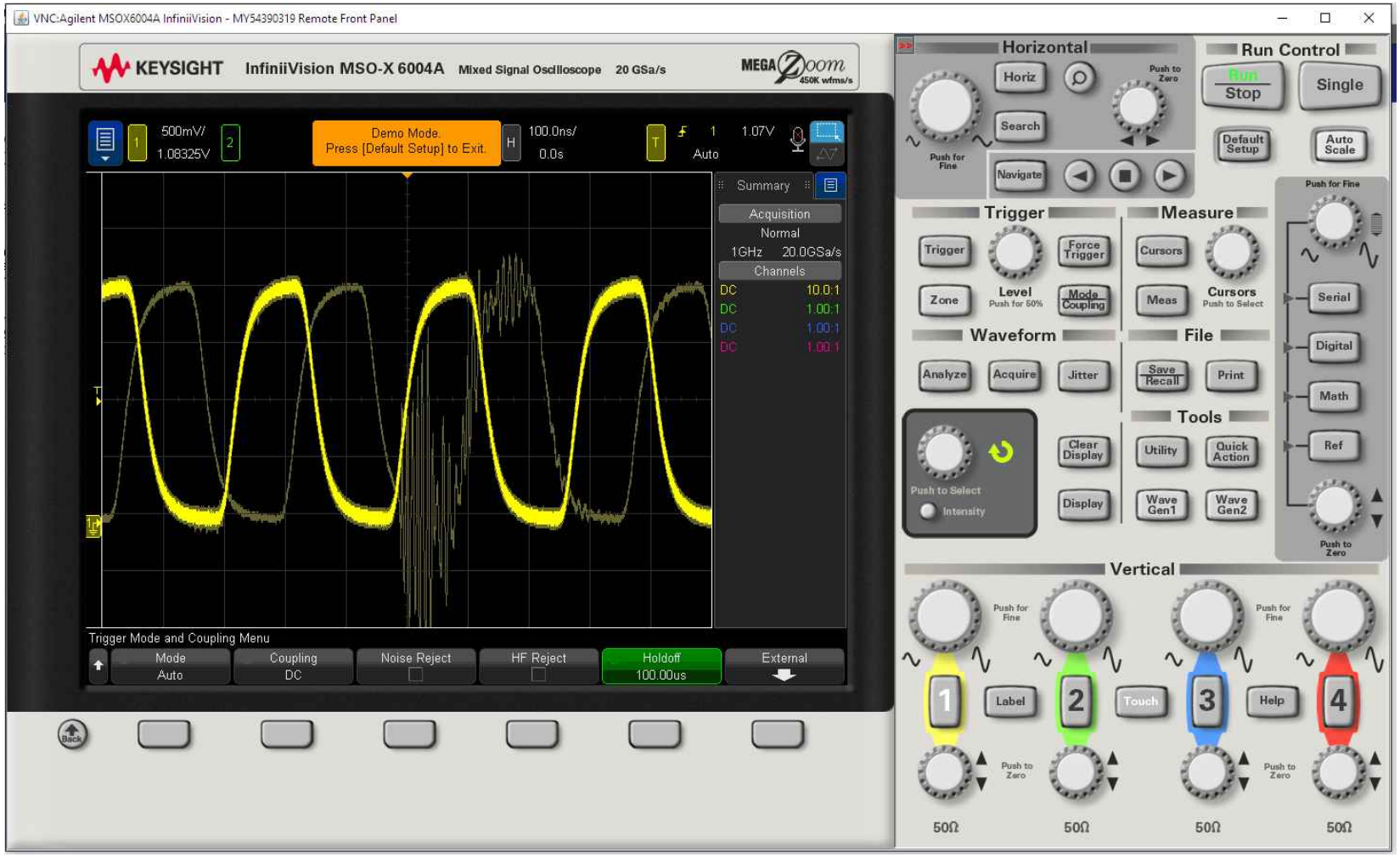
Signalanalyse – Oszilloskope

Connection Expert



Fernbedienung von modernen Oszilloskopen

Web – Server

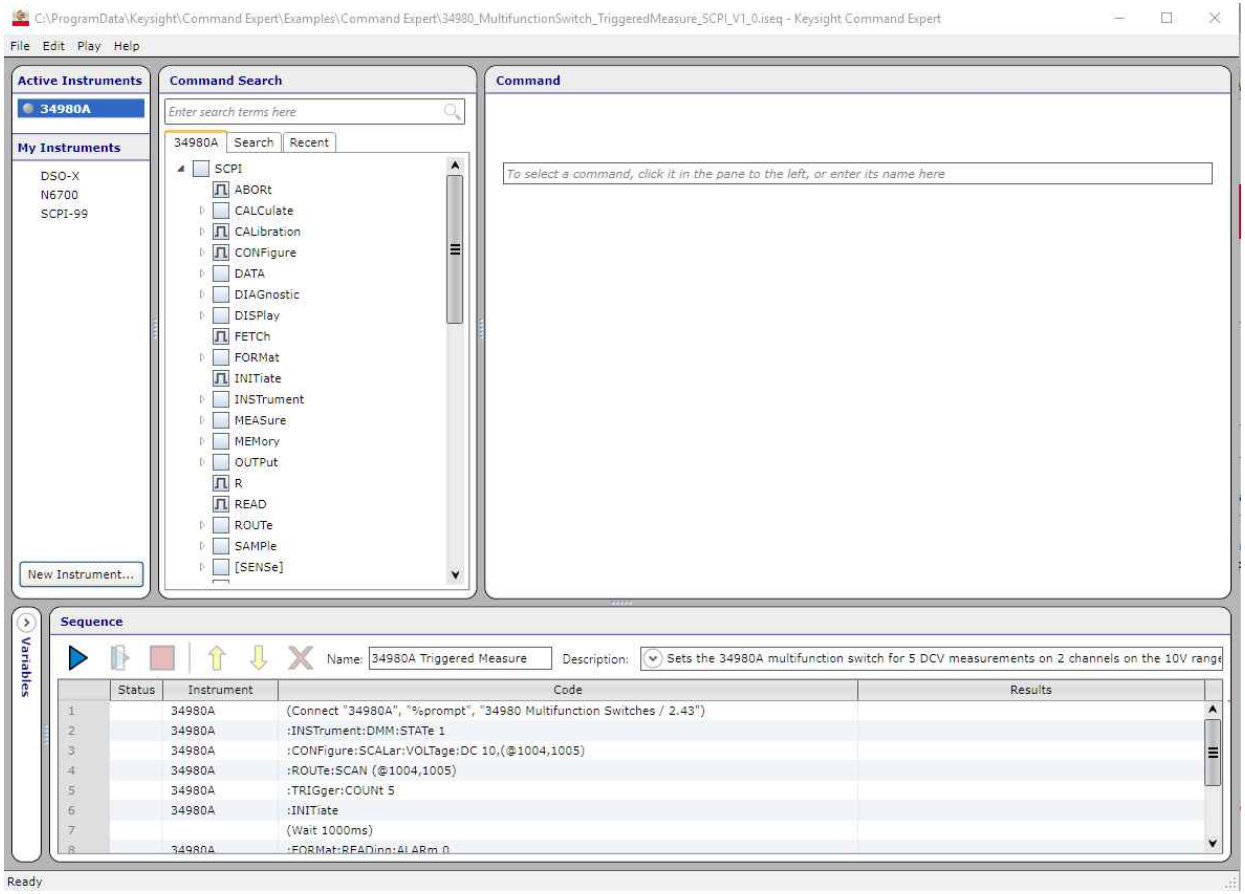


Signalanalyse – Oszilloskope

Makro-Scripts

Signalanalyse – Oszilloskope

Command Expert



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.

Auch **2016** freuen wir uns wieder auf zahlreiche Bewerbungen **engagierter** und **motivierter Masterminds!**

DANKE SCHÖN!

christian.bauer@xtest.at

0676 / 889766 733