

Webinar

# AVIONICS BUS INTERFACE TESTING

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Guido Schulze, Product Manager Oscilloscopes

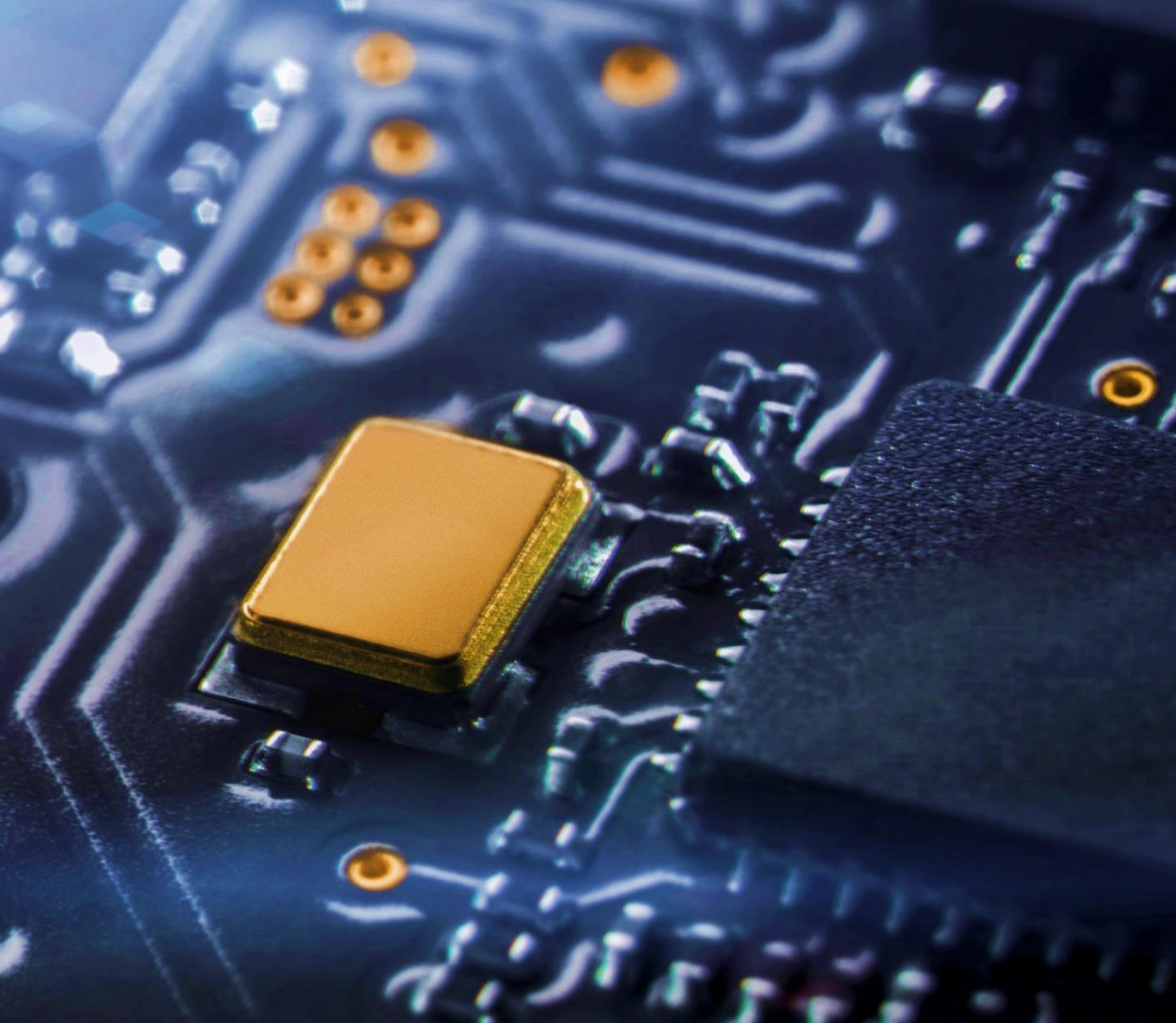
**ROHDE & SCHWARZ**

Make ideas real

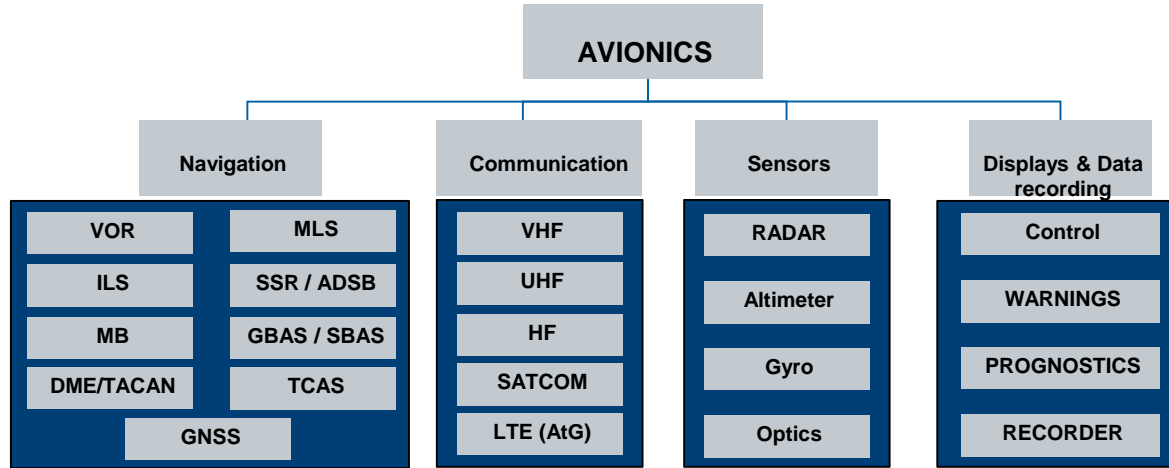


# TESTING YOUR AVIONIC DESIGNS

- ▶ **Avionic Test Trends & R&S Competencies**
- ▶ **Avionic bus testing**
  - High-speed digital interfaces, incl. PCBs & interconnects
  - Low-speed busses
  - Power integrity
- ▶ **Digital Test in Avionics**



# AVIONIC TEST TRENDS



- ▶ Unmanned Aerial Vehicles (UAV) and Unmanned Aerial Mobility (UAM) growth in expanding military & commercial applications including Air Navigation Service Providers (ANSP)
- ▶ New ICAO standards adopted for Communications, Navigation, and Surveillance/Air Traffic Management (CNS/ATM)
- ▶ Military avionics: increase in local/regional proprietary technology and increased demand for radar warning receiver testing
- ▶ **Increased digitalization including expanding and new industrial aircraft computer designs and integration across all platforms and systems**

# AVIONIC TEST TRENDS & R&S COMPETENCIES



Flight Navigation

Radar

Satellite

Communication

Avionics Digital Bus Architecture

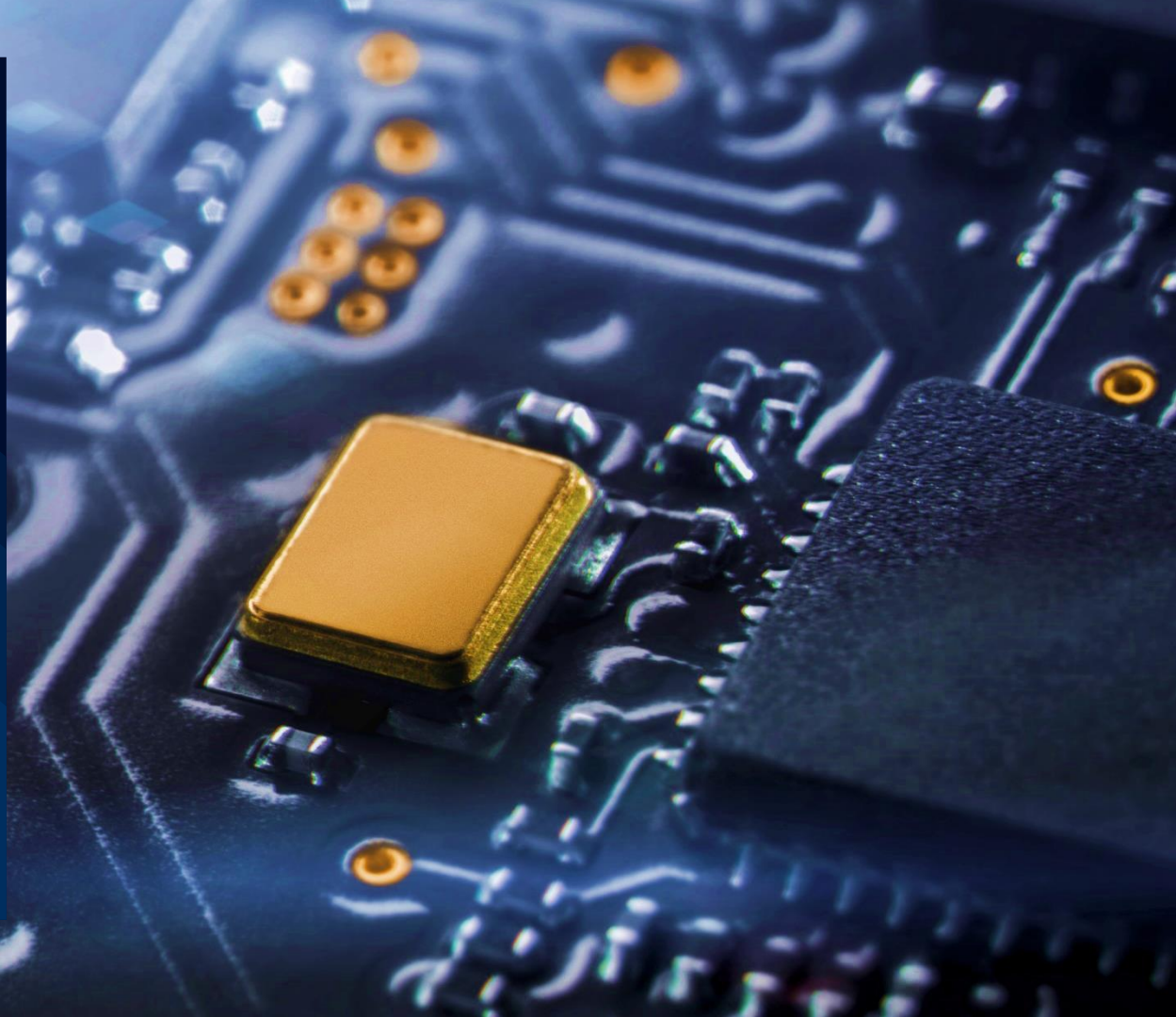
EMC/EMI

RF RE-D Risk Assessment

Professional Technology Training

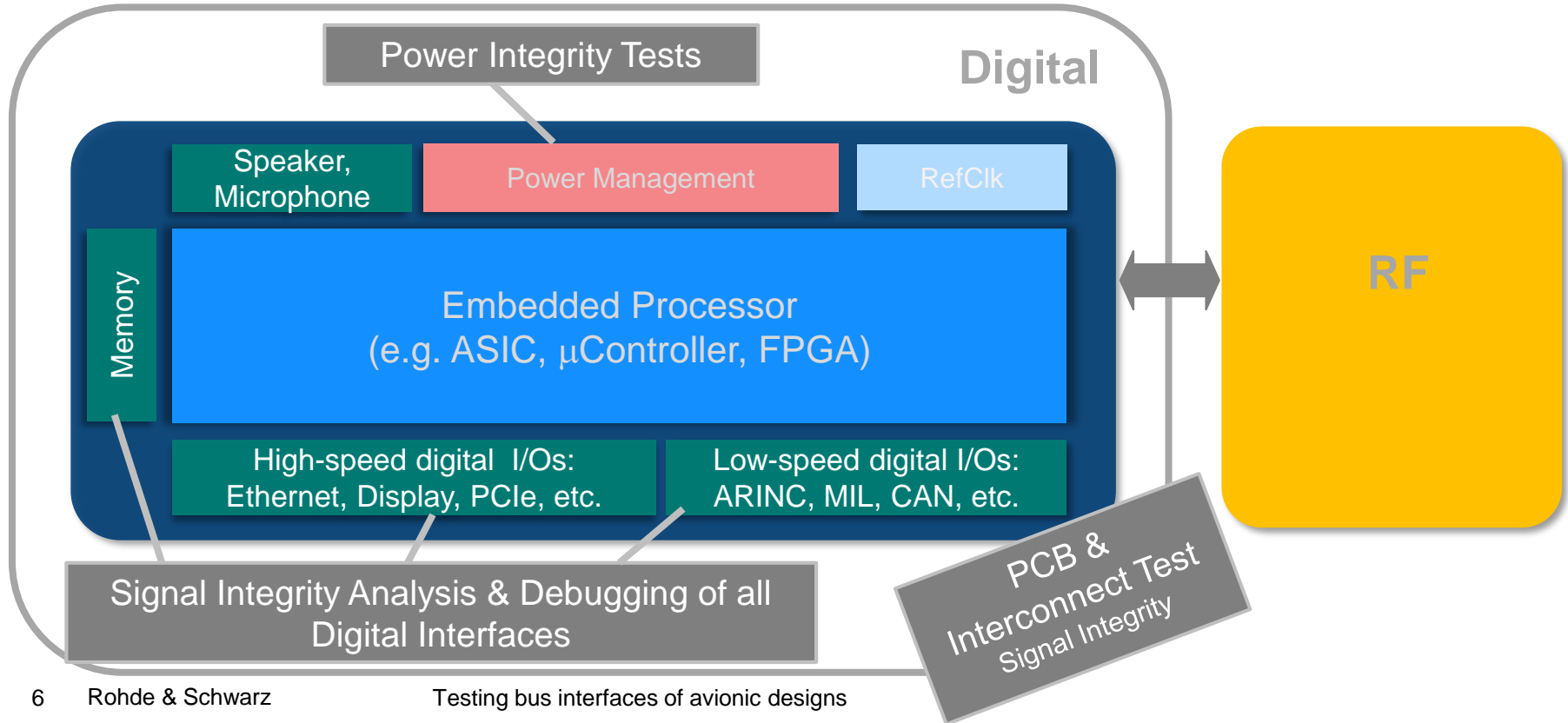
# TESTING YOUR AVIONIC DESIGNS

- ▶ Trends for Avionic busses
- ▶ Avionic bus testing
  - High-speed digital interfaces, incl. PCBs & interconnects
  - Low-speed busses
  - Power integrity
- ▶ Digital Test in Avionics

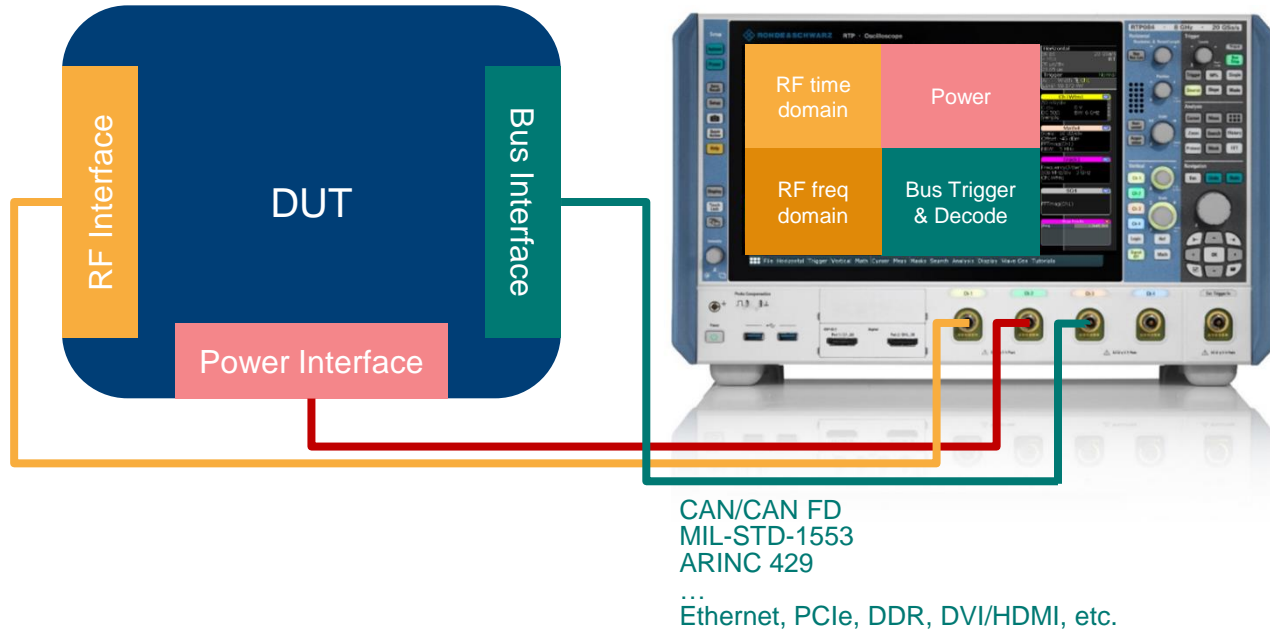


# BUS INTERFACES IN AVIONIC DESIGNS

The Digital Part: Typical Test Areas for Every New Designs



# MULTIDOMAIN ANALYSIS FOR SYSTEM-LEVEL DEBUGGING



## System-level Debugging

- Combine multiple measurements from different DUT interfaces on the same screen
- Look for possible correlations to determine causes of signal anomalies

# 1. HIGH SPEED DIGITAL INTERFACES

Why fast and reliable signal integrity solutions including PCB and interconnect tests are so important for integration of Highspeed Digital Interfaces?



# HIGHSPEED DIGITAL INTERFACES CHALLENGES

- ▶ Signal integrity challenges due to increasing data rates
- ▶ Interference issues due to increasing level of integration

**For optimal Signal Integrity analysis – T&M equipment needs to collect statistical data fast.**

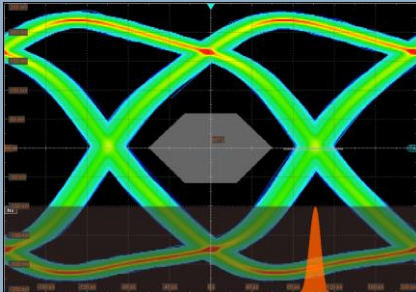


# HIGH SPEED DIGITAL INTERFACES

Require Dedicated Tests for Verification & Debugging

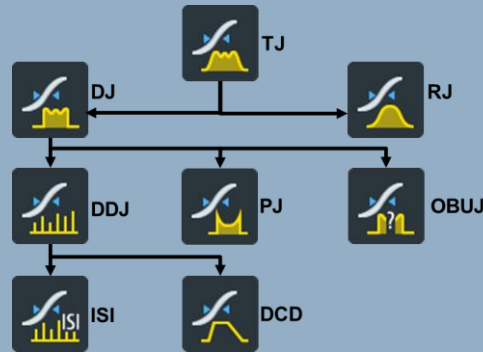
## Eye Diagram

- Fast update rate for statistical confidence
- Continuously operating Clock-Data-Recovery (CDR)
- Mask tests
- Deembedding function to compensate transmission loss



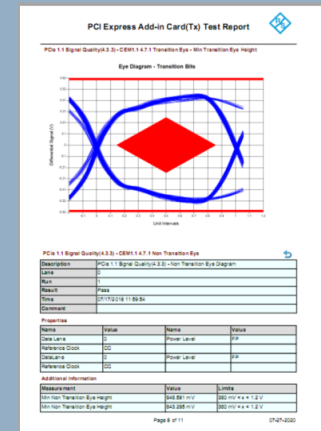
## Jitter & Noise Analysis

- Break-down of jitter and noise into individual components for characterization & debugging



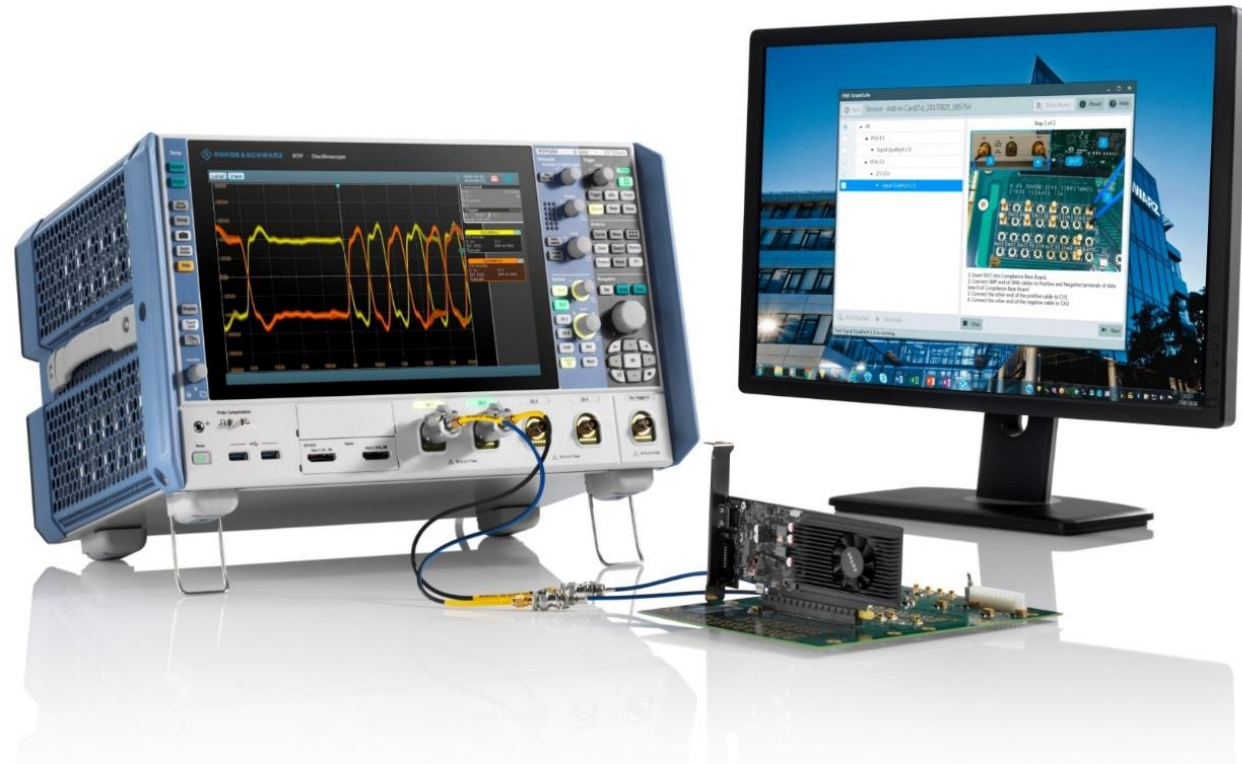
## Automated Compliance Tests

- Verify compliance of the physical layer to interface standards and report results



# R&S RTP HIGH-PERFORMANCE OSCILLOSCOPE

- ▶ 4-16 GHz bandwidth
- ▶ Dedicated hardware for real-time Signal-Integrity
- ▶ Most compact & silent for everyday use in the lab



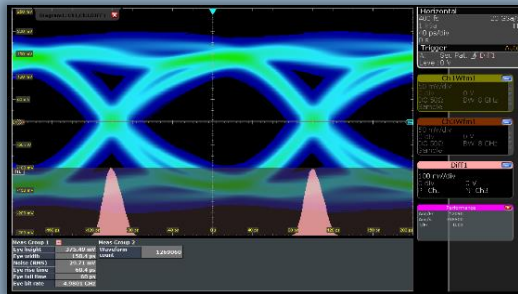
Providing Unique Signal Integrity Analysis Functions

# R&S RTP HIGH-PERFORMANCE OSCILLOSCOPE

Providing Unique Signal Integrity Analysis Functions

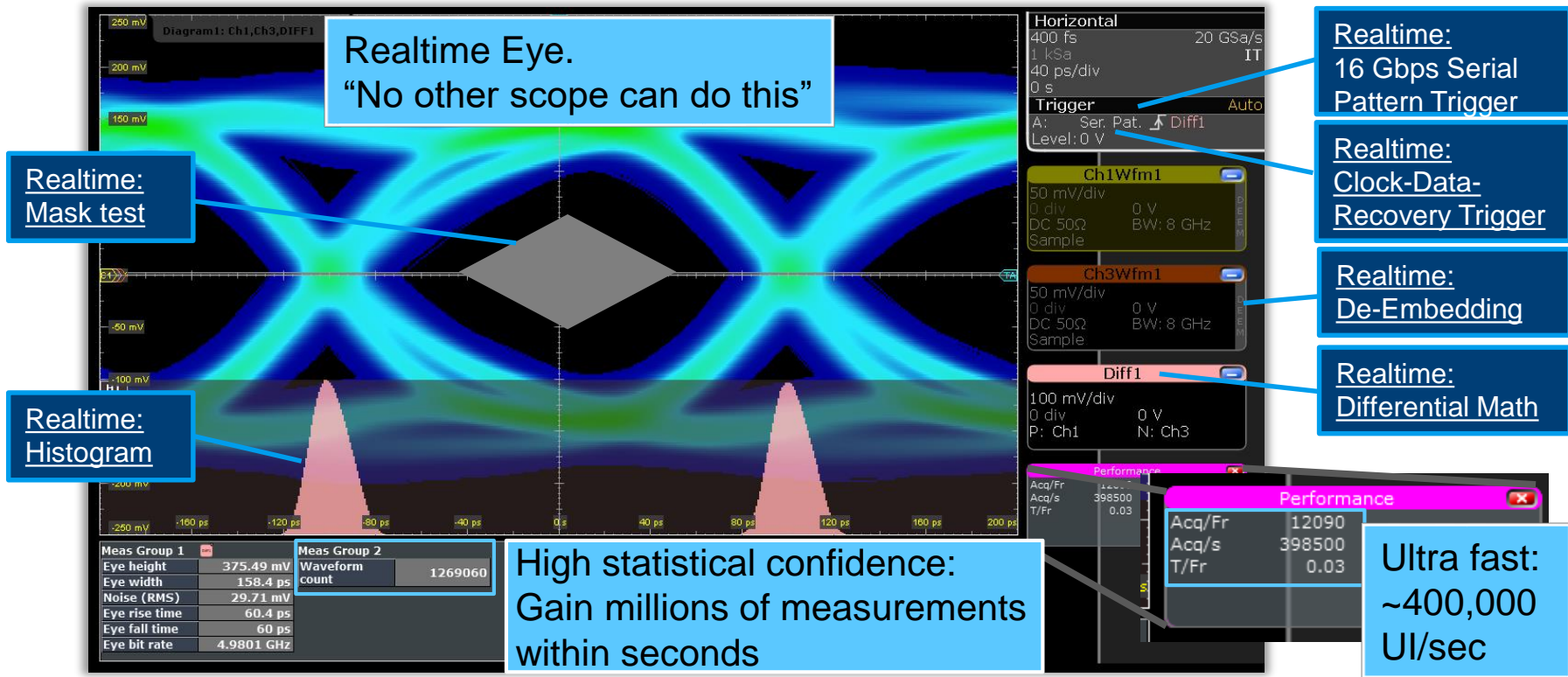
## Fastest Eye Diagram Analysis

- CDR based triggering
- Real-time deembedding
- Real-time differential math
- Real-time analysis (histogram, mask)



# R&S RTP HIGH PERFORMANCE OSCILLOSCOPES

## Making It Fast – Realtime Analysis

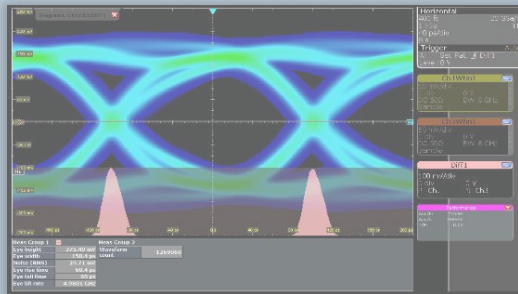


# R&S RTP HIGH-PERFORMANCE OSCILLOSCOPE

## Providing Unique Signal Integrity Analysis Functions

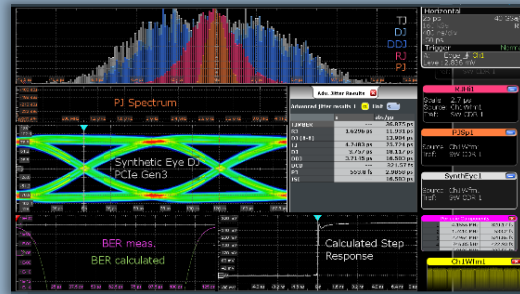
### Fastest Eye Diagram Analysis

- CDR based triggering
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### Most detailed Jitter Decomposition

- Histograms for all components
- Track and Spectrum views
- Eye diagram, BER bathtub
- Step/Frequency response



# R&S ADVANCED JITTER & NOISE ANALYSIS

## ► Options

- RTO/P-K133 - Advanced Jitter Analysis (*incl. K12*)
- RTO/P-K134 - Advanced Jitter and Noise Analysis (*incl. K12 / K133*)

## ► New analytic approach

- Jitter & Noise separation based on Step Response

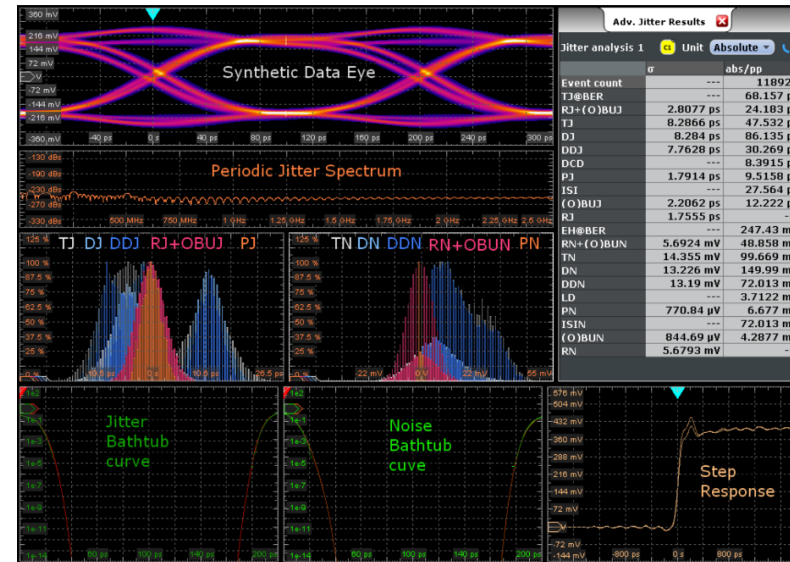
## ► Deep insights

- All relevant jitter & noise components (DDJ/N, ISI, PJ/N, RJ/N, BUJ/N, TJ/N)
- Step Response & Frequency Response display
- DDJ/N or DJ/N Eye diagram
- Histograms, Bathtub curve, etc.

## ► Future proof: PAM support

## ► *Introduced at DesignCon Jan. 2020*

R&S@RTP-K134 option			
R&S@RTP-K133 option			
R&S@RTP-K12 option			
Standard functions			
Period	cycle-to-cycle	TJ (meas.)	TN (meas.)
Frequency	jitter N-cycle	TJ (@ BER)	EH (@ BER)
Setup	jitter cycle-to-	RJ	RN
Setup/hold	cycle width	RJ+OBUJ	RN+OBUN
time	cycle-cycle	DJ	DN
Setup/hold	duty cycle	DJ (δδ)	
ratio	time interval	DDJ	DDN
	error data rate	ISI	ISIN
	unit interval	DCD	LD
	skew delay	PJ	PN
	skew phase	DDJ+PJ	DDN+PN
		OBUJ	OBUN
		OBUJ (δδ)	OBUN (δδ)

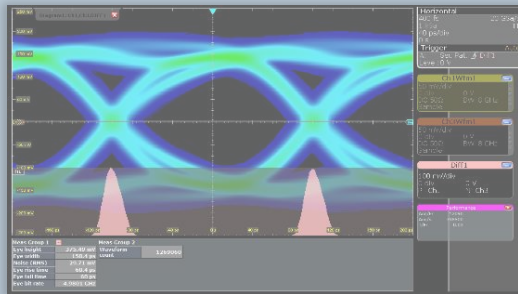


# R&S RTP HIGH-PERFORMANCE OSCILLOSCOPE

## Providing Unique Signal Integrity Analysis Functions

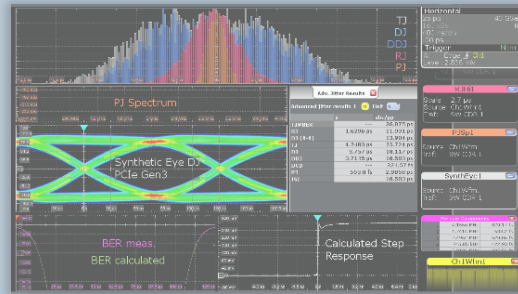
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### Automated Compliance Tests

- Dedicated compliance test options
- Guided user steps
- Automated configuration and test execution
- Detailed reporting





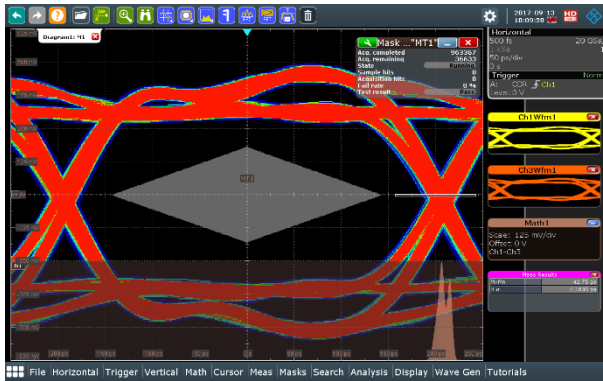
# R&S RTP HIGH-PERFORMANCE OSCILLOSCOPE

## Ethernet Debugging and Compliance

# R&S RTP HIGH-PERFORMANCE OSCILLOSCOPE

## PCI Express Debugging and Compliance

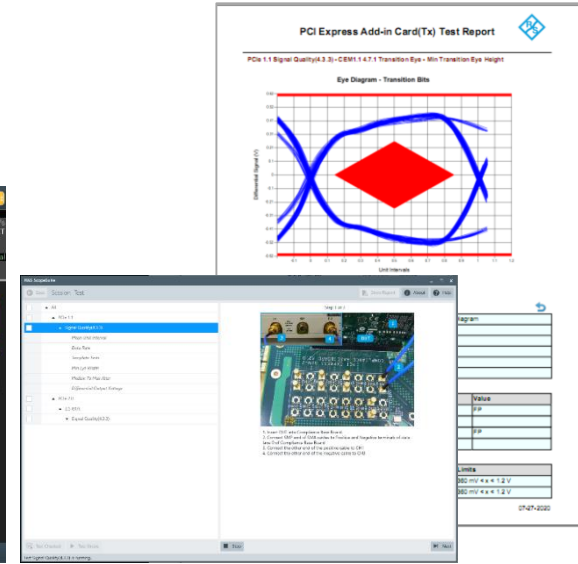
- Solution for PCIe 1.1/2.0/3.0
  - Signal Integrity debugging (Serial pattern trigger / CDR)
  - Protocol triggering and decoding
  - Compliance testing with R&S ScopeSuite



Data eye and mask testing



Decoding of 5 Gbps PCIe 2.0



Automated Compliance testing

# R&S RTP HIGH-PERFORMANCE OSCILLOSCOPE

## DDR Debugging and Compliance

- ▶ Solutions for DDR3 and DDR4
- ▶ Powerful debugging capabilities
  - Read/Write Decoding
  - Data Eye – mask test, eye measurements
  - Combine with Realtime Deembedding
- ▶ Compliance test according JEDEC standards
  - DDR3/4, LPDDR3/4
- ▶ Interposer from partners such as Nexus Technologies or EyeKnowHow

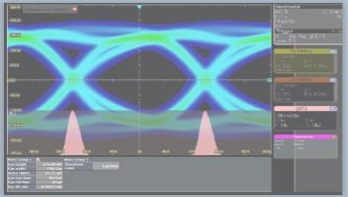


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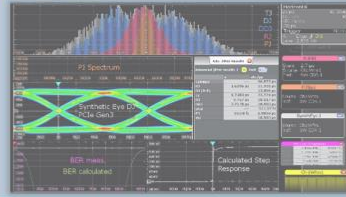
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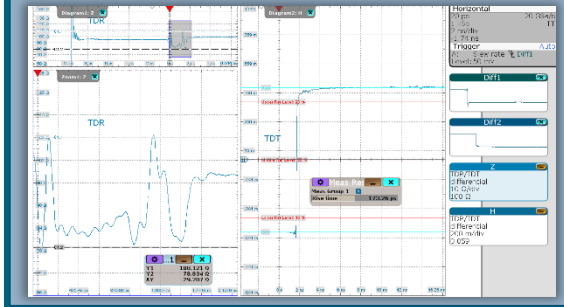
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- Detailed reporting



### Most versatile TDR/TDT Analysis

- 16 GHz differential Pulse Source
- TDR / TDT Analysis SW
- Guided calibration & measurement
- PacketMicro Probe



# TDR/TDT ANALYSIS

- ▶ Options
  - TDR/TDT analysis option (RTP-K130)
  - 16 GHz differential pulse source (RTP-B7)
- ▶ Powerful capabilities
  - Integrated pulse source
  - Guided calibration
  - Fast results
  - Browser accessories (PacketMicro)
- ▶ Typical application
  - PCB debugging



## **2. LOW SPEED DIGITAL INTERFACES**

Why trigger and decoding solutions are so important for integration of Low-speed Digital Interfaces?

# LOWSPEED DIGITAL INTERFACES CHALLENGES

- ▶ Protocol coding data complicate debugging
- ▶ Interference issues due to increasing level of integration

**For optimal data debugging – T&M equipment needs protocol-specific triggering and data analysis.**



# LOW SPEED DIGITAL INTERFACES

## Require Dedicated Tools for Protocol-specific Debugging

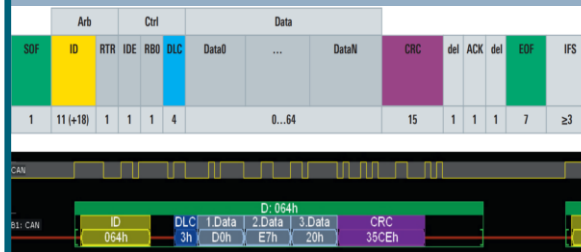
### Protocol Decoding

- Decoding of various control and programming protocol standards
- User definable decoding based on NRZ, 8B/10B or Manchester coding



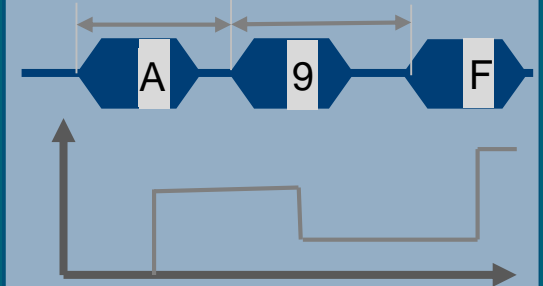
### Protocol Triggering

- For debugging – trigger on Protocol events and errors



### Bus Measurements

- Measurement of protocol timing
- Measurement and analysis of protocol data





# R&S PROTOCOL TRIGGERING AND DECODING SOLUTIONS

- ▶ Dedicated protocol options
- ▶ Flexible decode option for certain coding schemes
- ▶ HW processing support for fast results



Trigger & decode



Software options

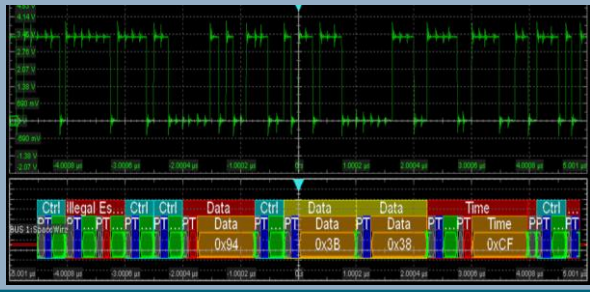
Providing Unique Protocol-Specific Analysis Functions

# R&S OSCILLOSCOPE

## Providing Unique Protocol-Specific Analysis Functions

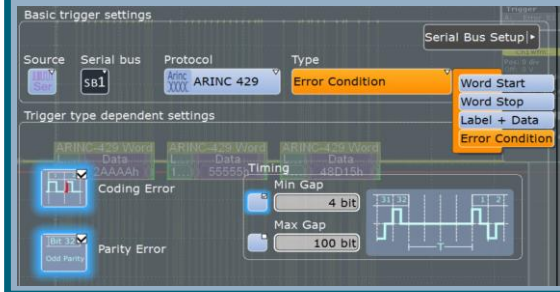
### Gain protocol inside with decoding options

- Comprehensive portfolio of decoding options
- Time-correlation of waveform and protocol data
- View data in waveform or table
- Powerful search and navigation



### Powerful protocol-based trigger functions

- Reliable isolate protocol events (e.g. address or data) and errors with protocol specific trigger
- HW support



### Analyze protocol data with bus measurement option

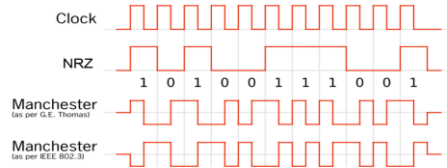
- supports I2C, SPI, UART, RS232, CAN, CAN-FD, LIN, Ethernet
- Display protocol data as waveform
- Measure frame spacing, frame error rate, or bus idle time, etc.



# CUSTOM TRIGGERING AND DECODING NRZ / MANCHESTER

## ► Define your own proprietary protocol structure

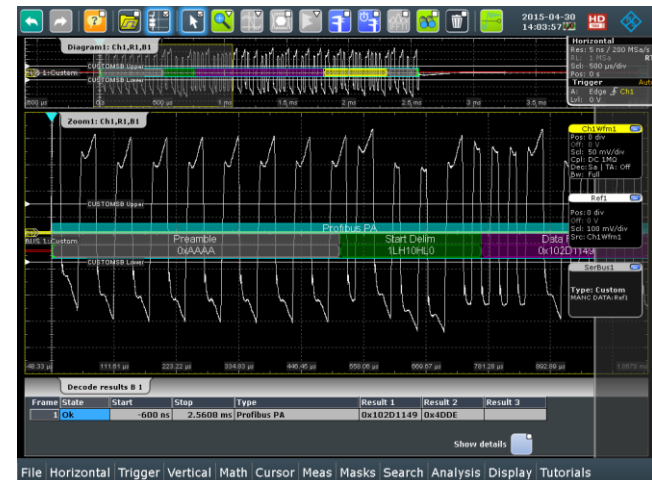
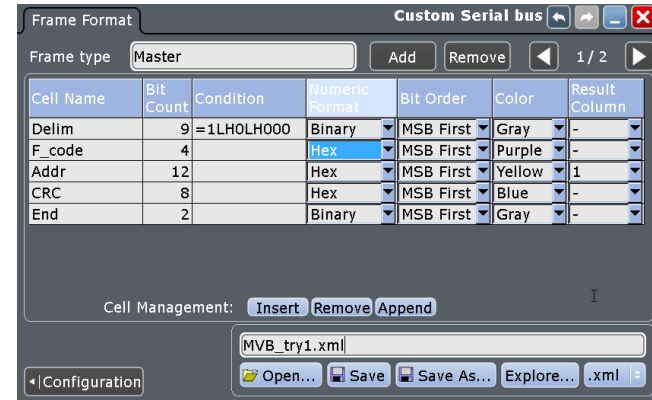
- Bit encodings:
  - Manchester, Manchester II, NRZ clocked / unclocked
- Frame format:
  - Define multiple different frame types
  - Define multiple cells within one frame
  - Define frame ids and content conditions
  - Select color, bit order and result display column



## ► Comprehensive functions:

- Protocol-based triggering
- Search function

## ► Option: RTE/ RTO/ RTP-K50



## **3. POWER INTEGRITY**

What are the right tools and analyzing functions for appropriate characterizing & debugging?

# POWER INTEGRITY CHALLENGES

- ▶ Increasing number of power rails
- ▶ Lower margins due to lower supply voltages
- ▶ Interferences due to dense designs of mixed technologies

**An optimal solution for characterizing and debugging DC power rails demands suitable probes & oscilloscopes.**



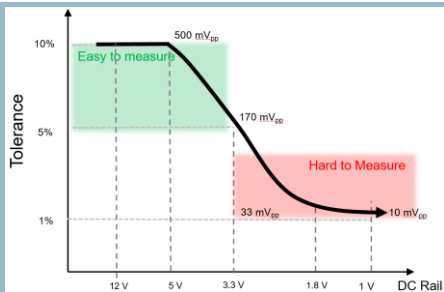
Providing Solutions for Power Integrity

# POWER INTEGRITY

## Requires Dedicated Tools for Verification & Debugging

### The Right Scope

- Fast update rate
- Min. vertical scale: 1..2 mV/div in HW at full bandwidth
- Low noise
- Support of specialized probes also on high-performance class instruments

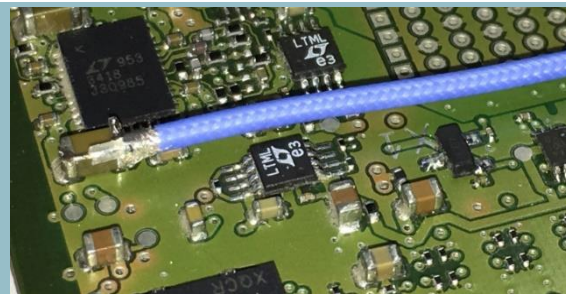


### Specialized Probes

#### Power Integrity Probe

- Bandwidth >2 GHz
- Low noise with 1:1 attenuation
- Extended offset range
- Connectivity

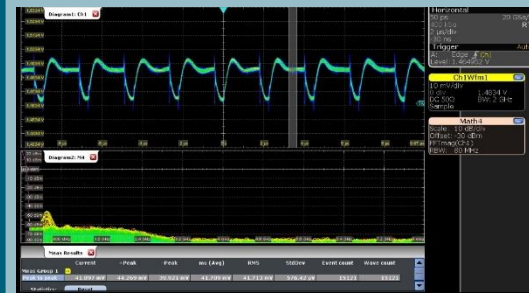
Current probes, etc.



### Dedicated Analysis Functions

#### Typical measurements

- Ripple, Load step response
- Power-up/down, Sequencing
- Drift over temperature and input voltage
- EMI debugging / harmonic analysis



# R&S POWER INTEGRITY SOLUTION

- ▶ Low Noise
- ▶ Fast FFT
- ▶ Fast Update Rate
  
- ▶ Low-Price Alternatives  
-RTM / RTA Oscilloscopes
  
- ▶ Superior Power Rail Probes



Providing Unique Power Integrity Analysis Functions

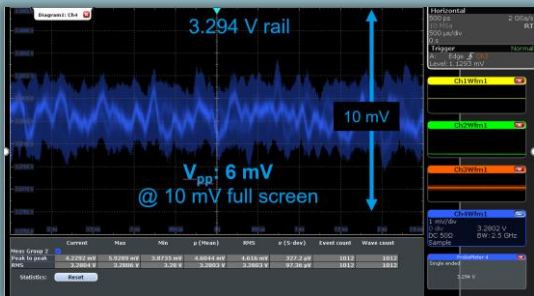


# R&S RTO & RTP HIGH-PERFORMANCE OSCILLOSCOPE

## Providing Unique Power Integrity Analysis Functions

### Fast Scopes: RTE, RTO, RTP

- Up to 1,000,000 wfms/s to find worst case tolerances quickly
- 1 mV/div in HW, full bandwidth
- Lowest noise w/ 16 bit HD mode
- Most sensitive trigger to capture very small amplitude droops



### Best Power Rail Probes

- RT-ZPR20/40 Power Rail Probes
  - 1:1, 2/4 GHz bandwidth
  - Highest offset: +/-60 V
  - Browser and solder-in tips
  - Unique R&S Probe Meter (high accuracy DC voltmeter)
- Portfolio of current probes
- Multi-channel 18 bit power probes



### Unique Analysis Functions in one instrument

- Fast and responsive FFT to detect interferer
- R&S ProbeMeter for precise DC measurements (0.05%)
- Fast measurements for statistics analysis



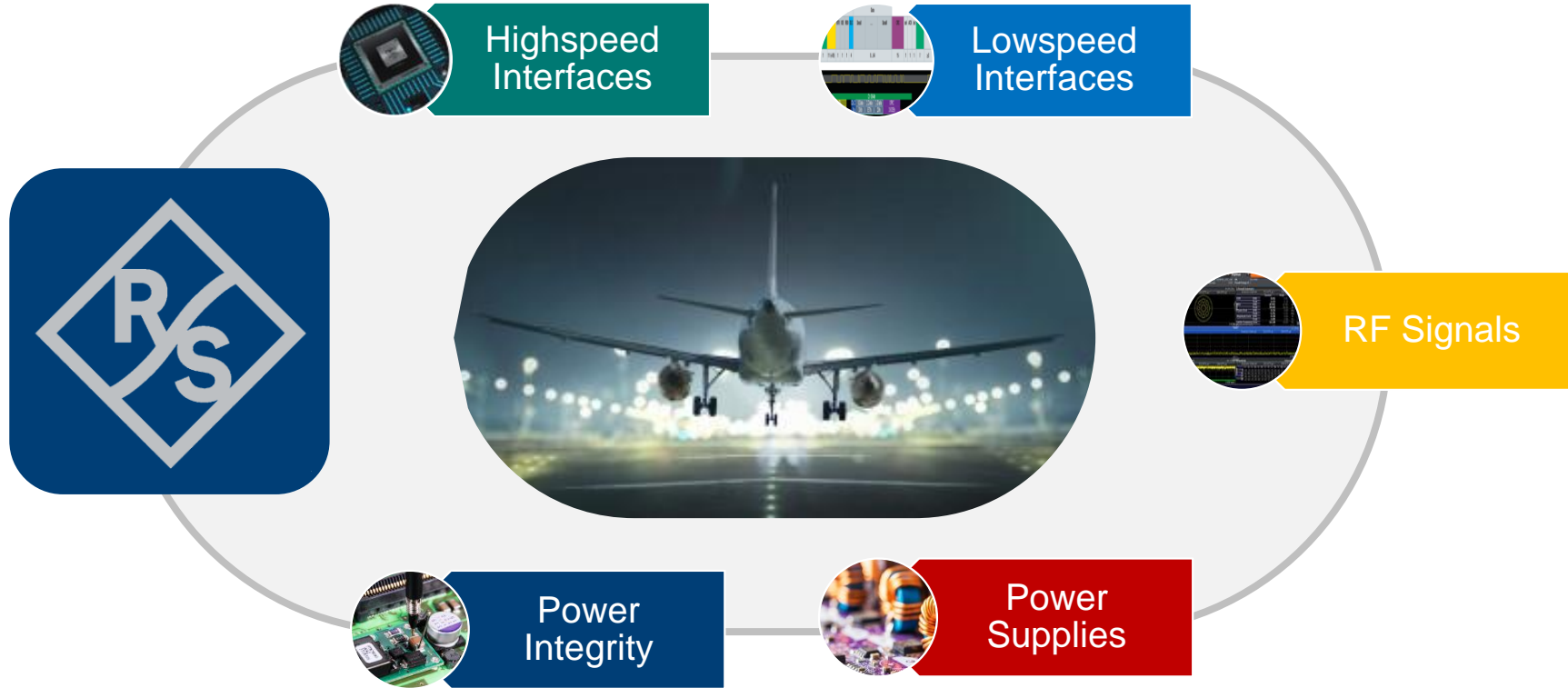


# SUMMARY

R&S addresses T&M needs for RF, highspeed digital and power design.

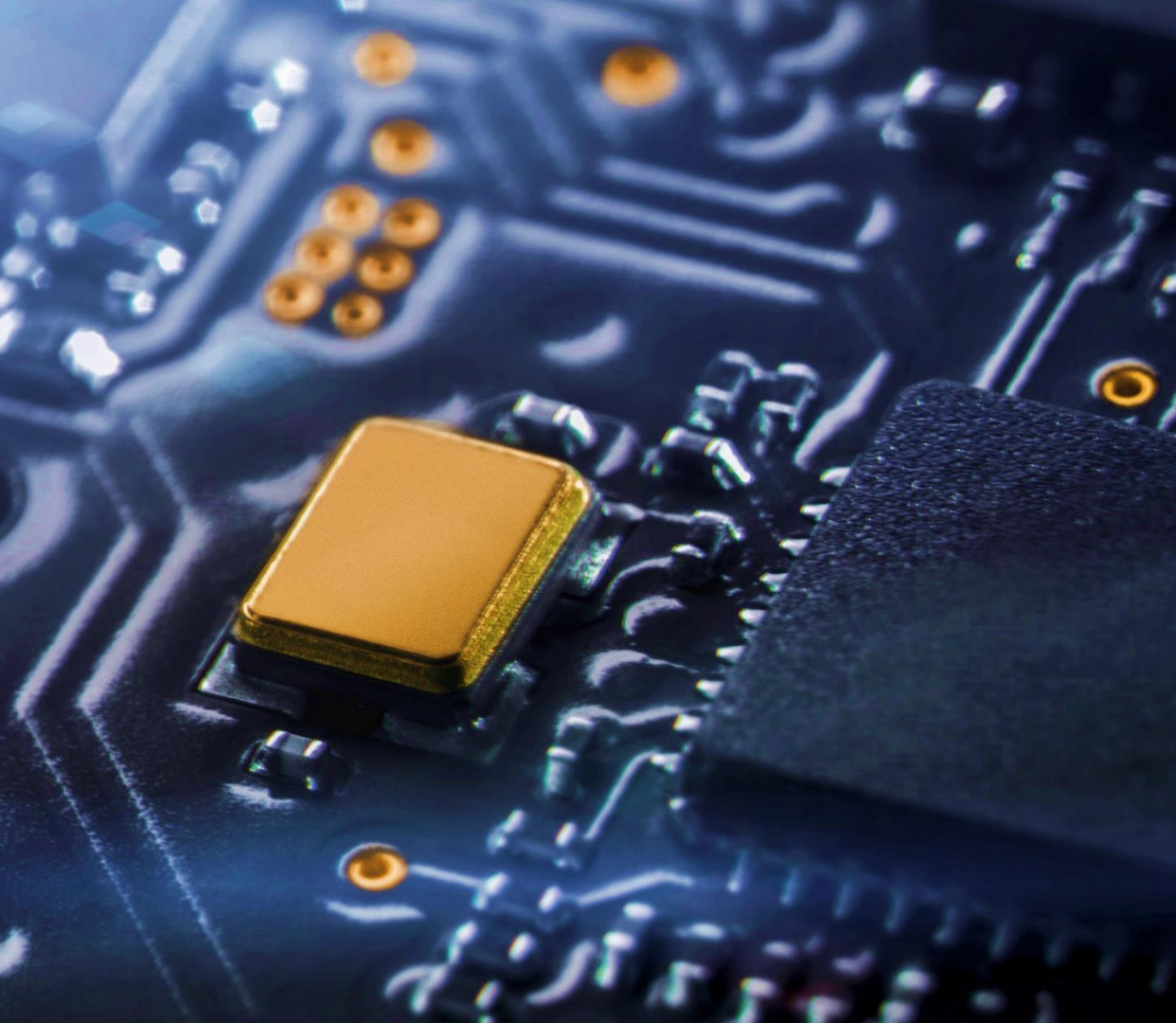
# VERIFY YOUR AVIONIC DESIGNS AND COMPONENTS

R&S a reliable partner – providing overall T&M solutions



# TESTING YOUR AVIONIC DESIGNS

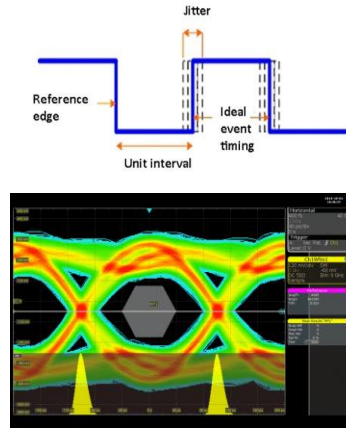
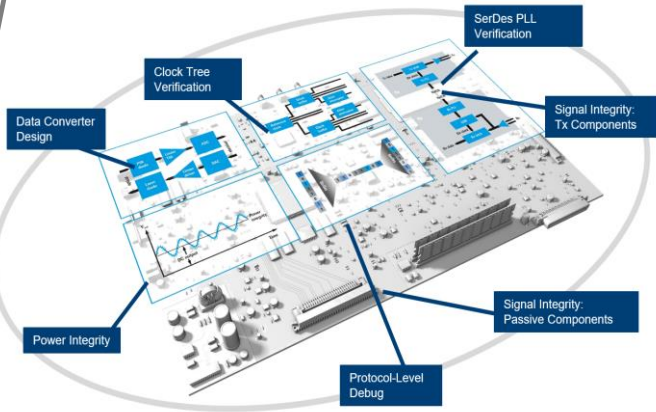
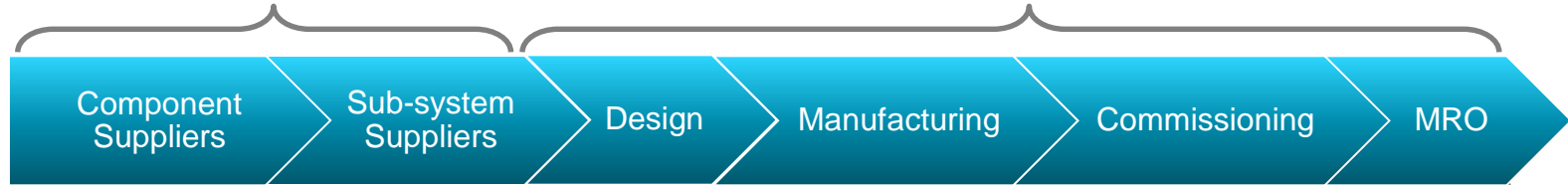
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  - Low-speed busses
  - Power integrity
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# DIGITAL TEST IN AVIONICS

Digital Design component manufacturing

Avionics Computer Integration



# ANALYSIS VOICE COMMUNICATIONS

Broad portfolio of T&M  
equipment to ensure safe  
flight operation

- ▶ Radio testing and calibration with R&S®CMA180
- ▶ Cable/antenna testing using R&S®ZPH
- ▶ Interference hunting with R&S®PR200
- ▶ Passive voice quality assurance with R&S®AVQA



# CERTIUM

Find out more

[www.rohde-schwarz.com/avionics-testing](http://www.rohde-schwarz.com/avionics-testing)



**ROHDE & SCHWARZ**

Make ideas real

