Automotive Ethernet

Bringing high speed data communication on the road
Dr. Ernst Flemming, Product Manager Oscilloscopes
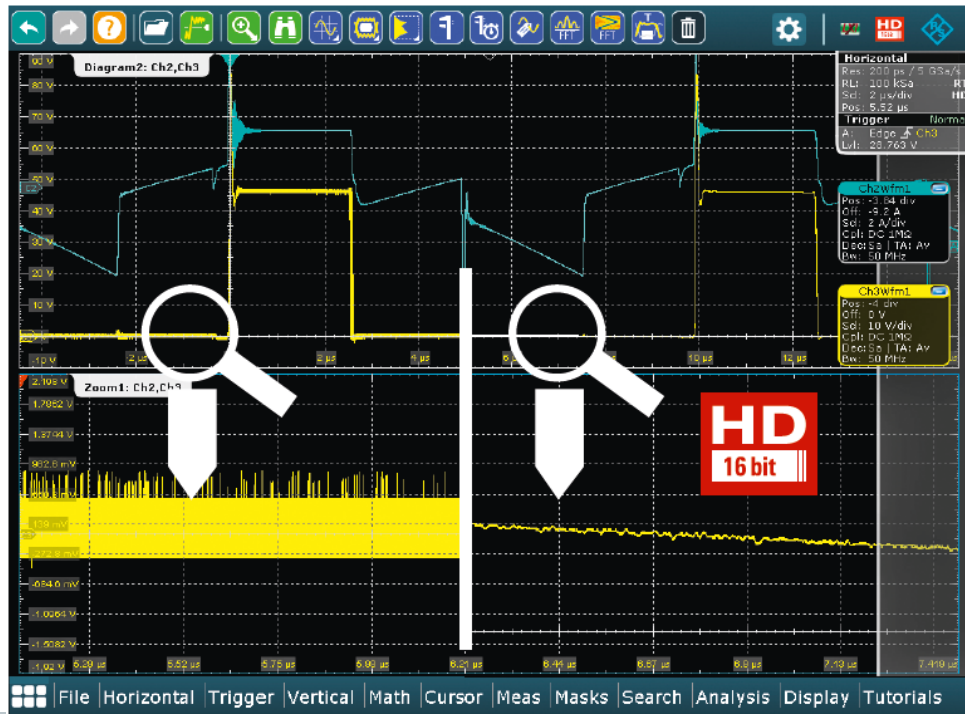
ROHDE&SCHWARZ
Automotive

Best Oscilloscope Performance
16-Bit High-Definition Mode

■ **Digital low pass filtering enables**

  ▪ Seamless increase of the vertical resolution from 8 bit to 16 bit

  ▪ Reduction of broadband noise

■ **… unveils all signal details**

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Best Oscilloscope Performance
16-Bit Digital Trigger

▎ Unique digital trigger allows to trigger on smallest signal details

Trigger on overshoot

ROHDE&SCHWARZ
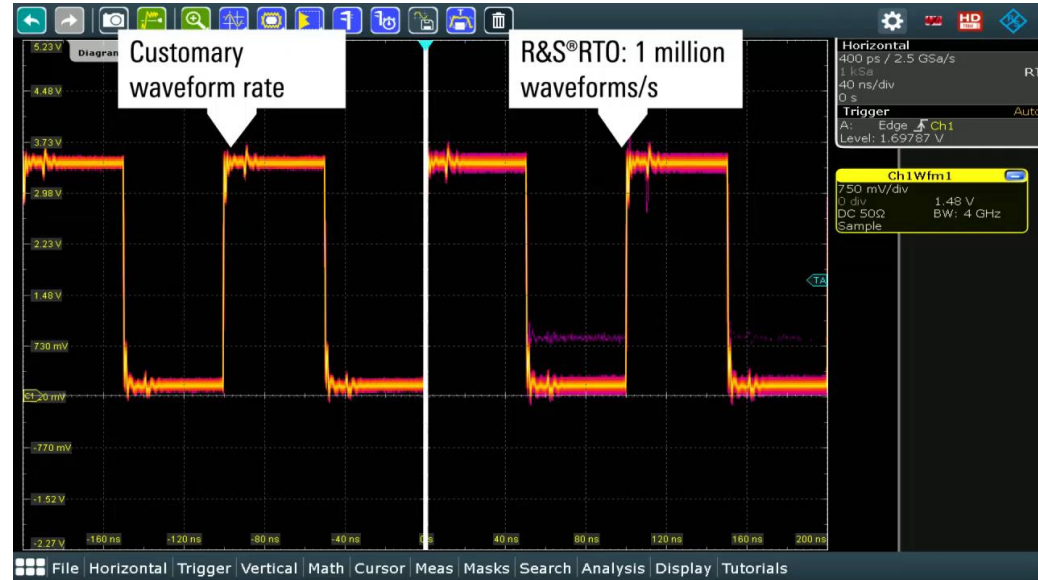**Automotive**

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Best Oscilloscope Performance
Quickly find signal faults

Hardware accelerated signal processing
→1 Mio waveforms/s update rate

**Quickly find signal faults with
1 Million waveforms/s**

Fast, reliable detection of sporadic signal faults.

Why Automotive Ethernet ?

❚ Main Motivation:

- Higher data throughput e.g. head unit connection (100 → 1000Mbit/s)

- Low latency for ADAS (<250µs)
  Future latency autonomous driving (50µs?)

- Clean network architecture, e.g. firmware download

- Benefit of Ethernet standards, e.g. AVB, TSN, EEE

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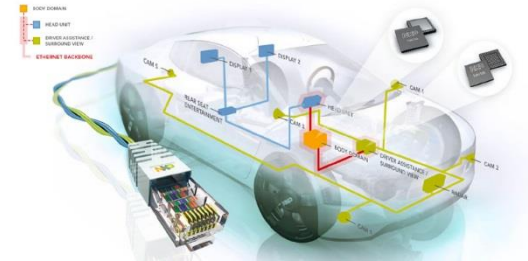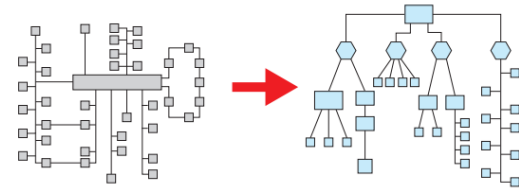
Ethernet Compliance Test: BroadR-Reach®

Technical Background

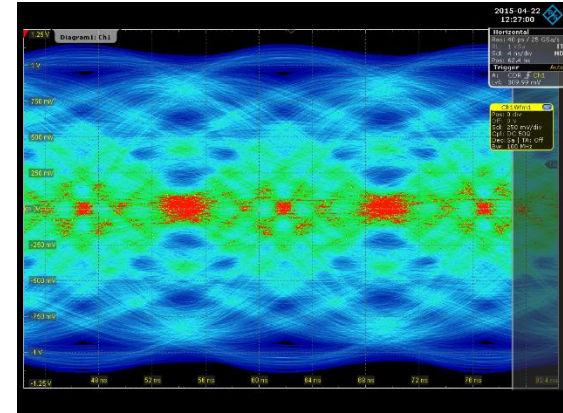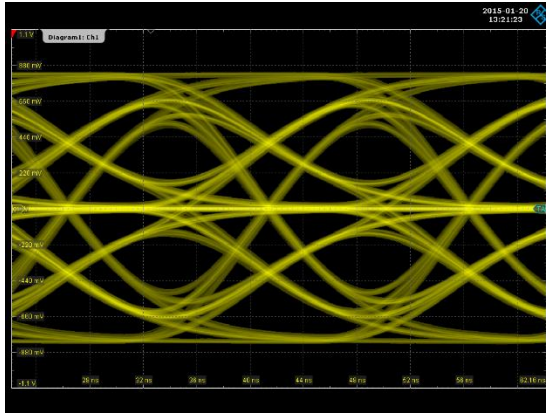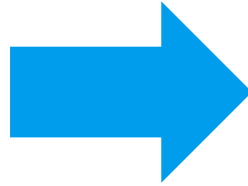| OSI		TCP/P
7	Application	Applications: FTP, HTTP, SMTP…)
6	Presentation	
5	Session	
4	Transport	TCP
3	Network	IP
2	Data Link	**100BASE-T1**
1	Physical	

- One twisted pair, unshielded
- Full duplex
- PAM 3 coding
- 66 MHz transmission frequency
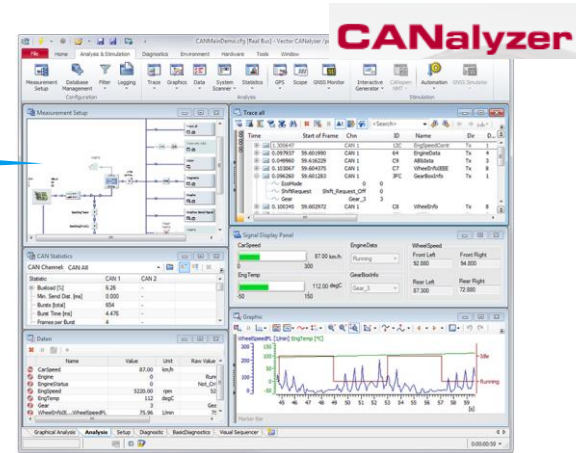- runs on standard Flexray cabling

ROHDE & SCHWARZ Automotive
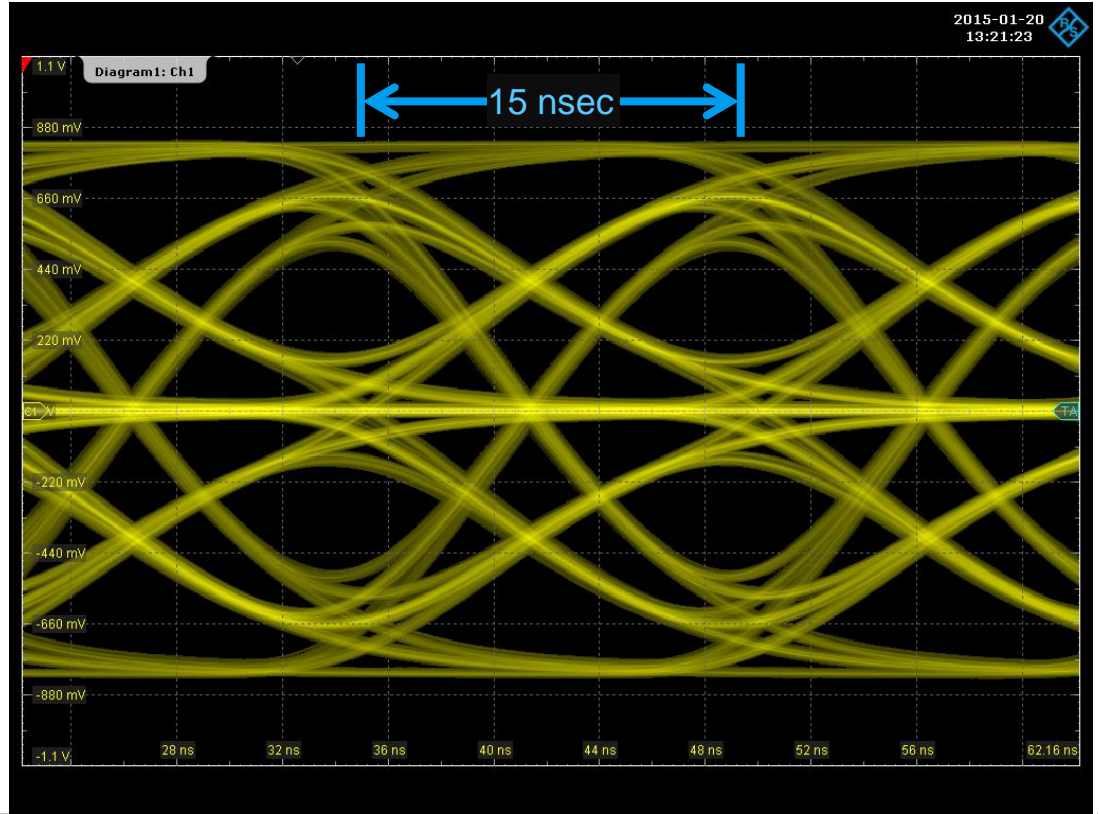
From the Lab to the Road

Source: BMW

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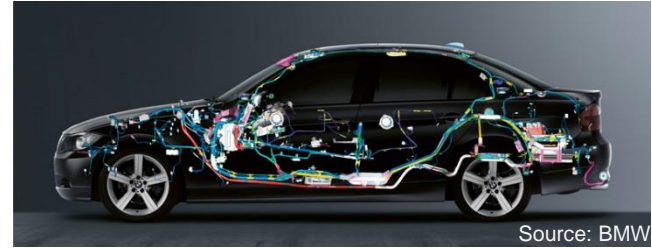
Quality Testing – Traditional Networks

OSI		CAN
7	Application	Application
6	Presentation	
5	Session	
4	Transport	
3	Network	
2	Data Link	DLL
1	Physical	PHY

Protocol Test

Eye Test

CANalyzer

Source: Vector

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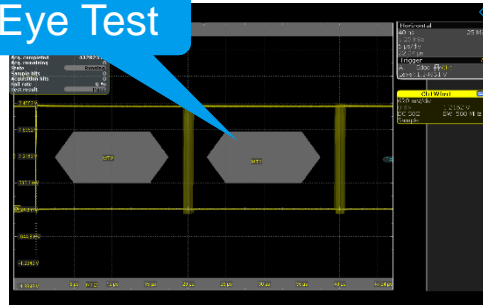
Quality Testing – Automotive Ethernet

OSI		100BASE-T1
7	Application	Applications: FTP, HTTP, SMTP…)
6	Presentation	
5	Session	
4	Transport	TCP, UDP
3	Network	IP
2	Data Link	100BASE-T1
1	Physical	

Protocol Test

Compliance Test

Source: Vector

CANalyzer.Ethernet

Transmitter Timing Jitter Mastermode (5.4.3)
Transmitter Timing Jitter Slavemode (5.4.3)
Transmitter Power Spectral Density (5.4.4)
Transmitter Clock Frequency (5.4.5)
MDI Return Loss (8.2.2)
MDI Mode Conversion Loss (96.8.2.2)
MDI Mode Conversion Loss Adaptor Verification (96.8
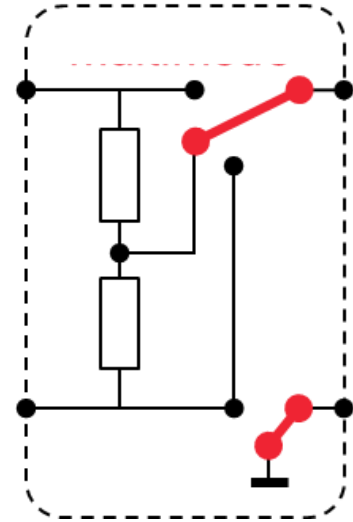MDI Common Mode Emission (96.5.1.2)

Compliance Test Example I: Transmitter Droop

❚ Test mode 1 (40 transmits of +1 followed by 40 transmits of -1)

❚ Specification: Max droop after 500 ns of 26.9%
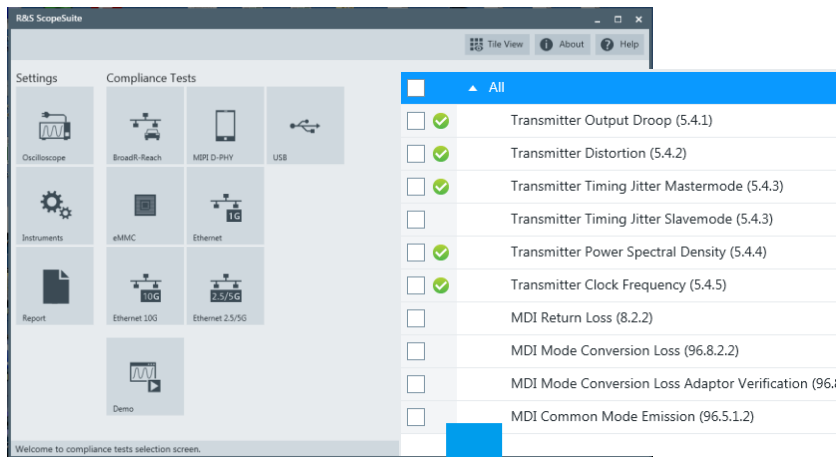
❚ Test Setup
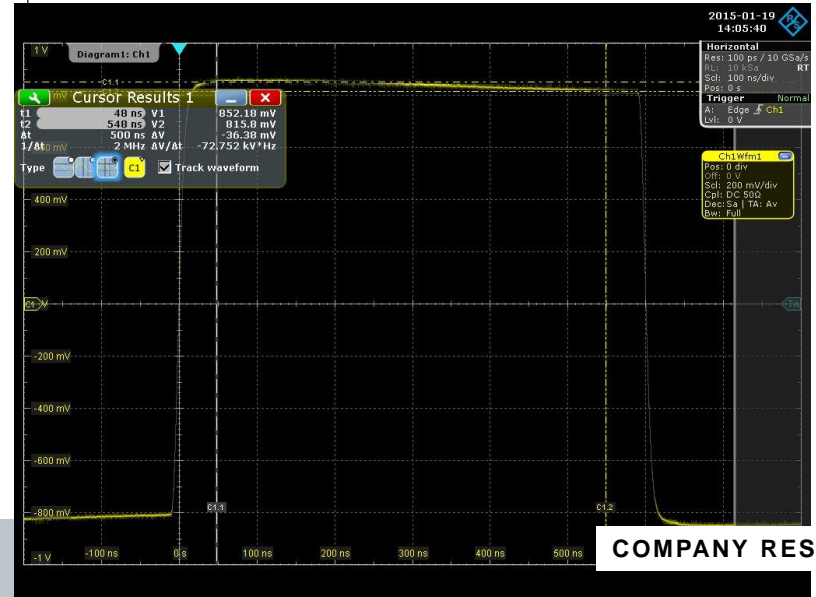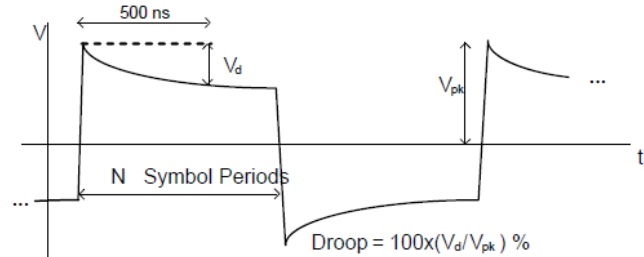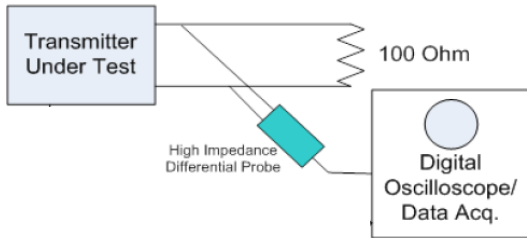
Compliance Test Example II: MDI Common Mode Emmission

■ Requirement that the common mode of the differential signal does not emit more than
  ▪ **MDI Common Mode Emmission**
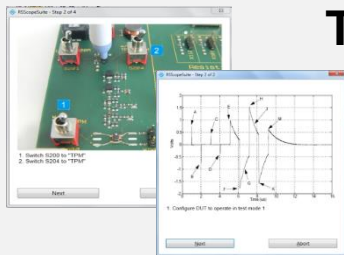 ▪ to be < 27 dBμV from 1 to 200 MHz at 10 kHz RBW

MDI Common Mode Emmission
Test Fixture

R&S Compliance Solution
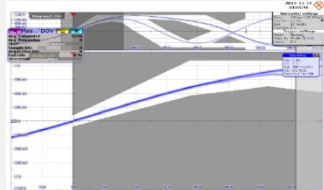
Pass-Fail results

	Test	Description	Run	Result	Detail
☐	Output Droop		1	✅	2/2
☐	Transmitter Distortion No TX_TCLK No Disturber		1	✅	11/11
☐	Transmitter Timing Jitter Mastermode		1	✅	1/1
☐	Power Spectral Density		1	❌	0/1
☐	Power Spectral Density		2	✅	1/1
☐	Transmitter Clock Frequency		1	✅	1/1

Test

Guided steps   Auto measurements

Report

- Screenshot
- Measurement result
- Pass-Fail result
- Test summary

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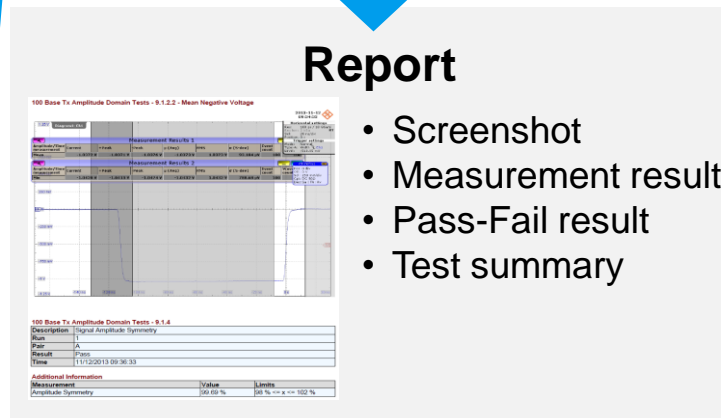
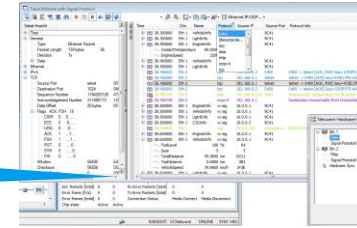# RTO-K24 – BroadR-Reach® Compliance Test
At a Glance

Key Features
▮ Complete test solution from R&S
▮ Includes OEM required test cases
▮ Test is approved by IOL of the UNH

Complete Test Solution including VNA, function generator and test fixture

100BASE-T1 Quality Testing – What is missing ?

OSI		100BASE-T1
7	Application	Applications: FTP, HTTP, SMTP…)
6	Presentation	
5	Session	
4	Transport	TCP, UDP
3	Network	IP
2	Data Link	100BASE-T1
1	Physical	

Protocol Test

Protocol Errors, EMI Debug, Latency, Timing

Compliance Test

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100BASE-T1 Triggering and Decoding

Idle frames are marked as gray

Ethernet decoding of source, destination, type and data

100BASE-T1 Triggering and Decoding

Decoding can be shown as final, edges, descrambled, reversed bits or ternary signals

100BASE-T1 Triggering and Decoding

100BASE-T1 Triggering and Decoding

▌ Recommended Equipment:
- RTO2002 or RTE1052 or higher (min. bandwidth 500MHz)
- RTO-K57 or RTE-K57 100BASE-T1 T&D option
- RT-ZF5 Ethernet Probing fixture (to separate the duplex communication via directional couplers)
- SMA cables with RT-ZA10 SMA-BNC adapters

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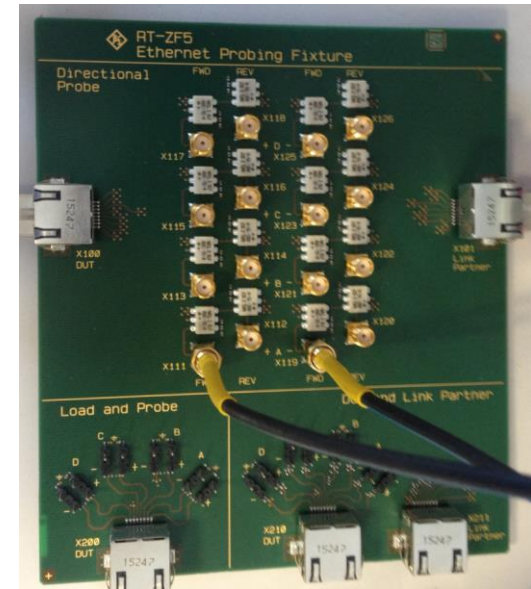
1000BASE-T1 Ethernet Compliance Test

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What is the difference between 100BASE-T1 and 1000BASE-T1 ?

	100BASE-T1	1000BASE-T1
Symbol rate	66.66 MHz	750 MHz
DUT clock	66.66 MHz	125 MHz
Coding	PAM 3	PAM 3

1000BASE-T1 Compliance Test Solution

Pass-Fail results

Test

Guided steps   **Auto measurements**

Report

- Screenshot
- Measurement result
- Pass-Fail result
- Test summary

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First 1000BASE-T1 Compliance Test Solution !

Key Features

▮ Complete test solution from R&S
▮ Covers latest standards incl. IEEE 1000BASE-T1
▮ Includes testing with and without DUT clock access
▮ Close cooperation with UNH-IOL
▮ Ease-of-use with guided test
▮ Strong reporting functionality
 (pdf, docx, HTML)
▮ Runs on oscilloscope or PC
▮ Optional measurements on single ended signals

Test Solution

- R&S®RTO with min. 2 GHz
- R&S®RTO-K87 option and R&S®ScopeSuite Software
- R&S®RT-ZF2 Test Fixture
- R&S®RT-ZF6 Frequency Converter
- R&S®RT-ZD30 Active Differential Probe
- R&S®RTO-B6 Waveform Generator
- R&S®ZND vector network analyzer with R&S®ZND-K5 or R&S®ZNB

ROHDE & SCHWARZ
Automotive

100BASE-T1 Test Requirements
R&S offers a complete solution

	R&S Test Solution
Latest IEEE standard 100BASE-T1 supported	+
Support of addl. test cases (ECU), OEM requirements	Common mode emission Mode conversion
DUT clock support	• with DUT clock incl. converter • without DUT clock (clock recovery)
Test Equipment	RTO2000, RT-ZD10, ZND, RT-ZF2, RT-ZF3
100BASE-T1 Triggering & Decoding (Q3/17)	+
1000BASE-T1 Compliance	+
Complete and future proof Automotive Ethernet solution	+
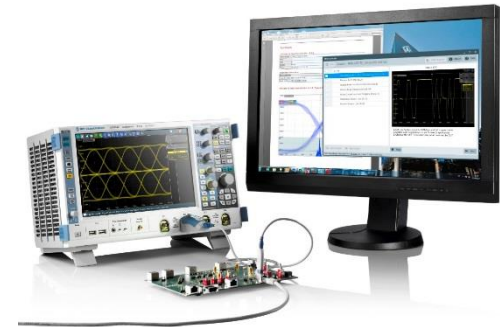
Rohde & Schwarz Offering

- Oscilloscopes from 50 MHz to 6 GHz
- Handheld scope for lab and field testing incl. bus decode
- 1 Mio wfms/s update rate, 16 bit vertical resolution
- All relevant automotive bus interfaces can be tested
- Automotive Ethernet supported
- EMI Debug with strong FFT capability
- Complete portfolio incl. spectrum and network analyzers etc.

	R&S®Scope Rider	R&S®HMO1000	R&S®RTB	R&S®HMO3000	R&S®RTM	R&S®RTE	R&S®RTO
Power Integrity	X	X	X	X	X	X	X
I2C/UART/SPI T&D	X	X	X	X	X	X	X
LIN T&D	X	X	X	X	X	X	X
CXPI T&D						X	X
CAN T&D	X	X	X	X	X	X	X
CAN-FD T&D	X					X	X
SENT T&D	X					X	X
FlexRay T&D						X	X
Ethernet Decode						X	X
MIPI D-PHY							X
100BASE-T1 Compl.							X
100BASE-T1 T&D							X
1000BASE-T1 Compl.							X
EMI Debug						X	X

New

Probes for every application

Multi Domain | HD 16bit

HD 16bit | Multi Domain

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Thank You

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