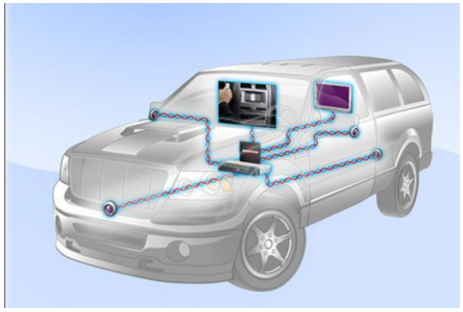
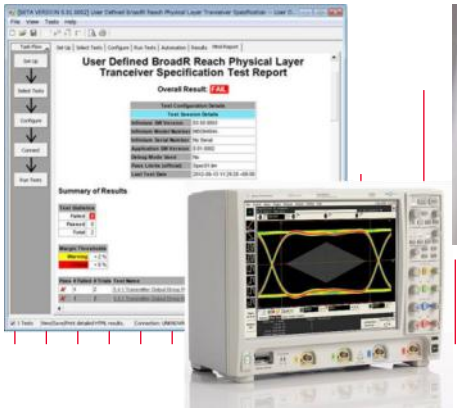
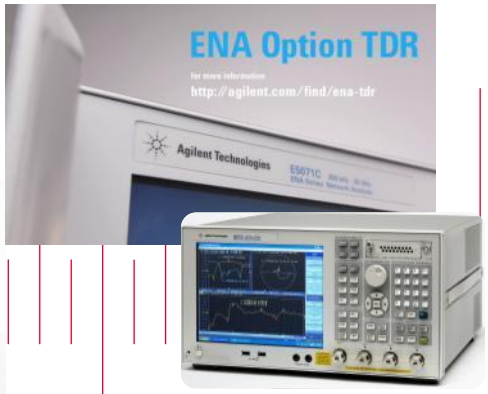


BroadR-Reach
PHY Compliance Solutions

Last Update: 2014/09/02 (YS)



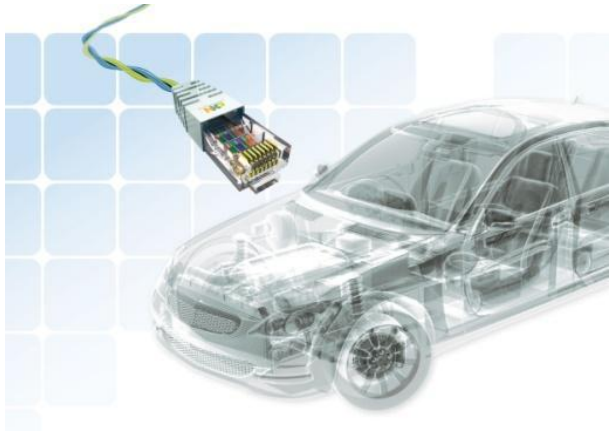


Oscilloscope and Protocol Division
Component Test Division

KEYSIGHT TECHNOLOGIES

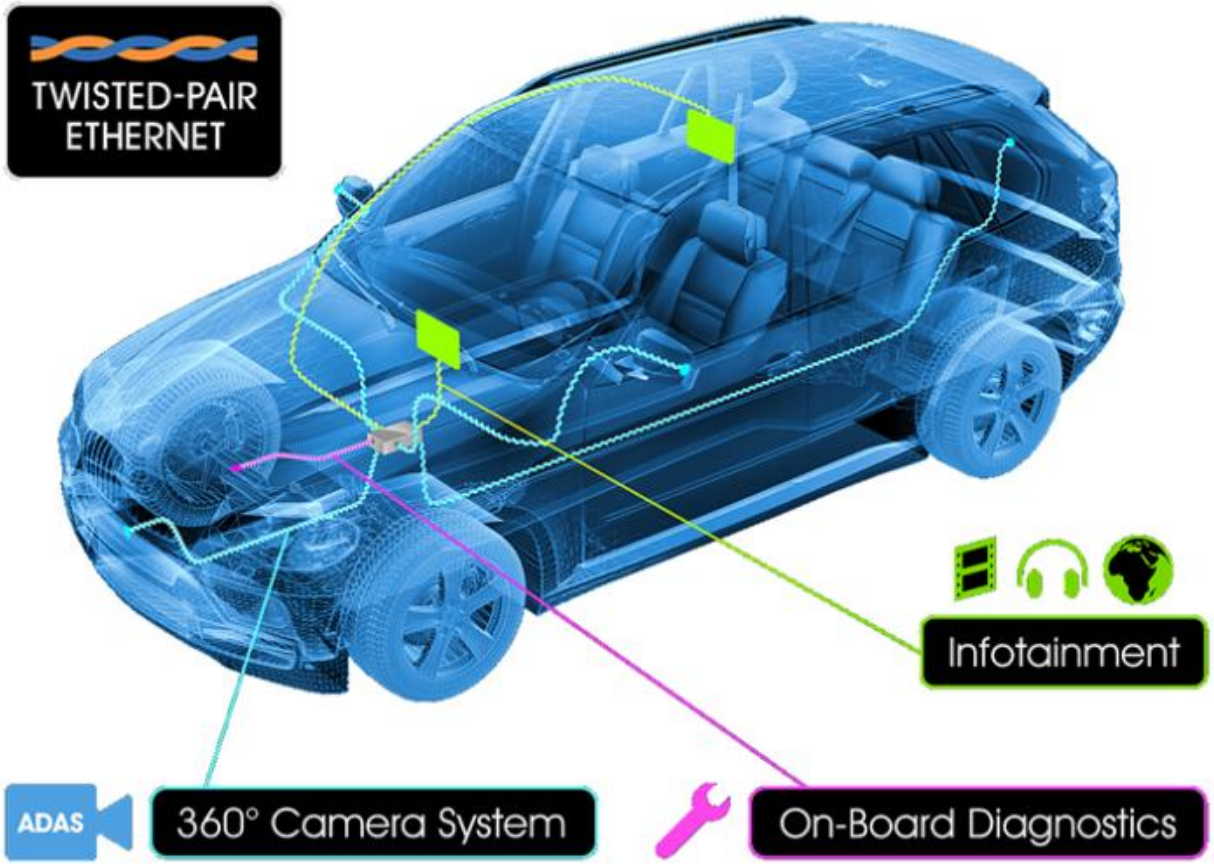
Agenda

- BroadR-Reach Overview
- Transmitter Testing
- Link Segment Testing

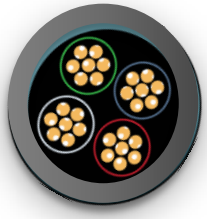
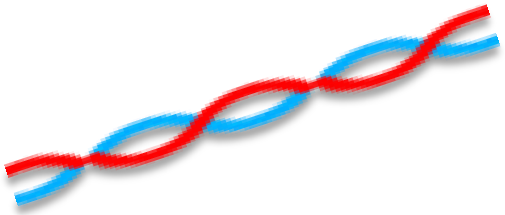
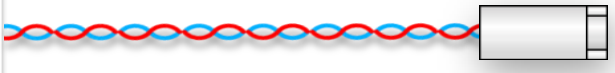


KEYSIGHT TECHNOLOGIES

BroadR-Reach Applications

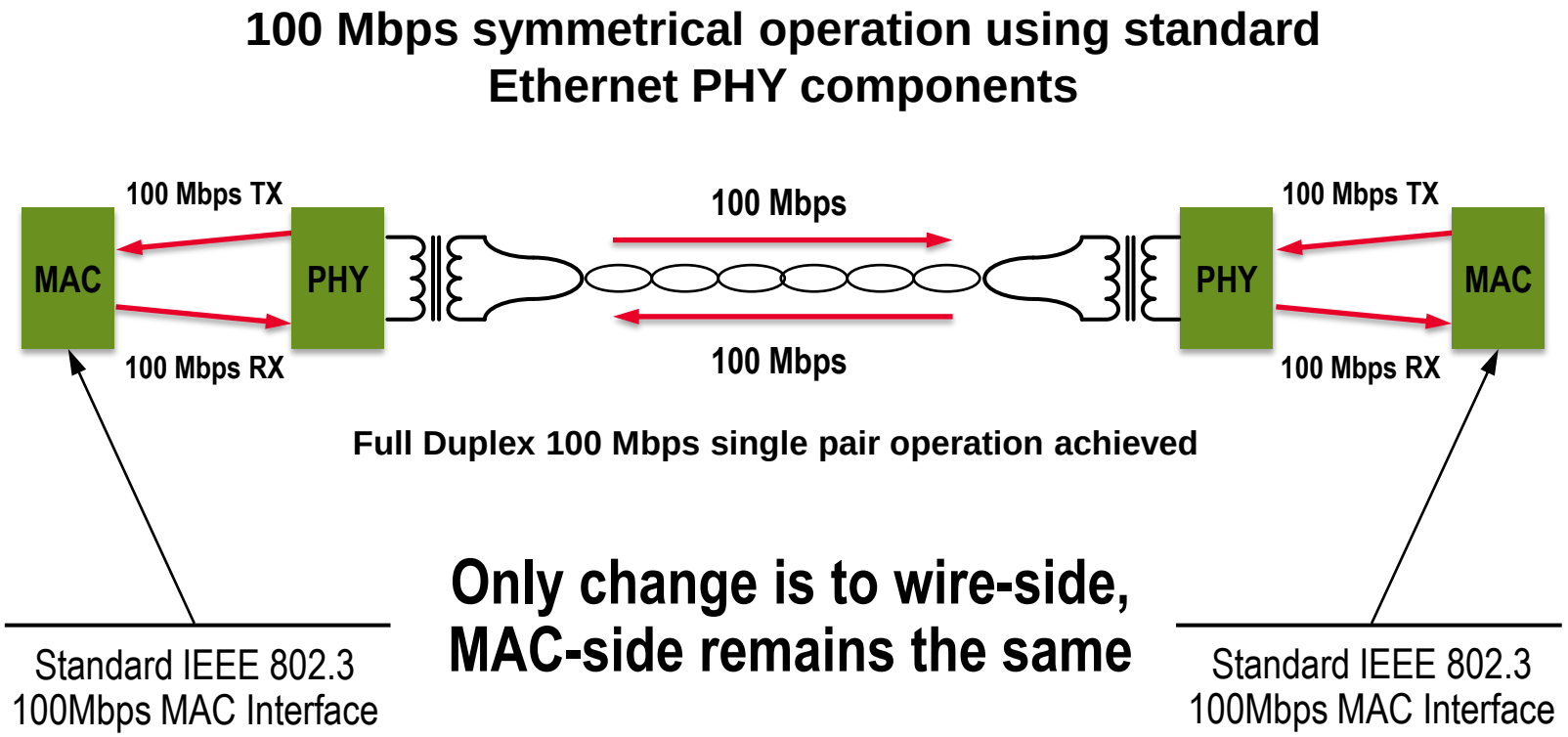


Connectivity Comparison

	Cable	Connector (2 ends, on-board and cable)
Standard Ethernet		
BroadR-Reach		

- Reduces connectivity costs up to 80%
- Reduces cabling weight up to 30%

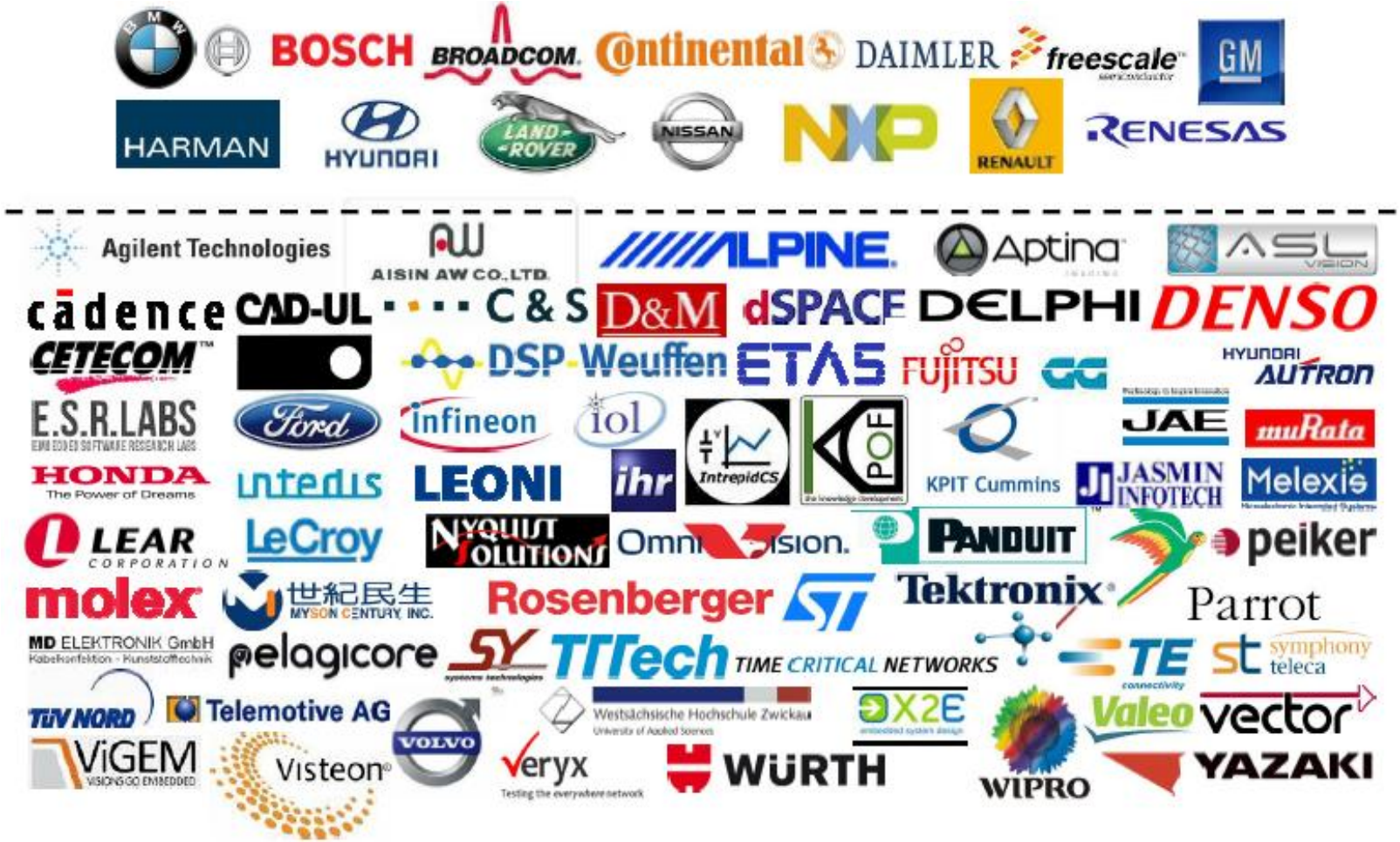
Cabling and Signal Communication



(Source : Automotive Update, Broadcom, 2012/2)

OPEN (One Pair EtherNet) Alliance Members

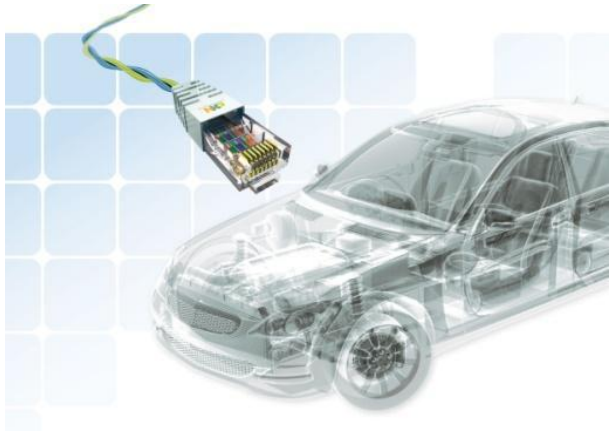
http://www.opensig.org/partners.php



Promoters 14, Adopters 66

Agenda

- BroadR-Reach Overview
- Transmitter Testing
- Link Segment Testing



Overview of PHY Transmitter Tests

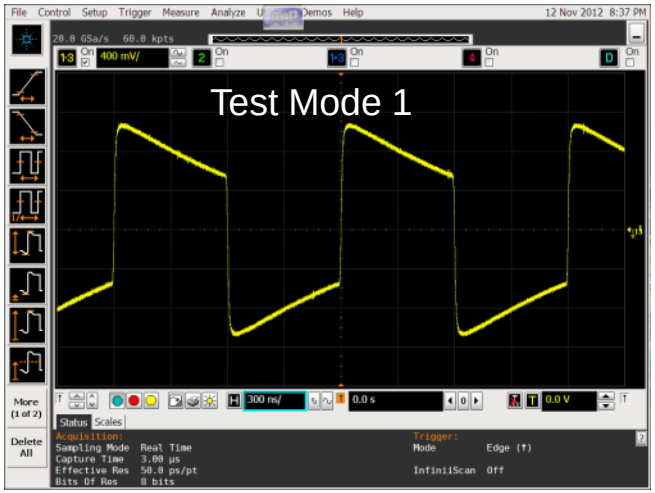
Category	Test Items	Measurement Equipment	Agilent Model
Transmitter	・5.4.1 Transmitter Output Droop ・5.4.2 Transmitter Distortion ・5.4.3 Transmitter Timing Jitter ・5.4.6 Transmit Clock Jitter	Oscilloscope (1GHz or better, 20Mpoints)	DSO9104A or better
	・5.4.4 PSD (Power Spectral Density) ・5.4.5 Minimum Power Spectral Density Mask	Spectrum Analyzer (1GHz)	N9010A (3.6GHz)

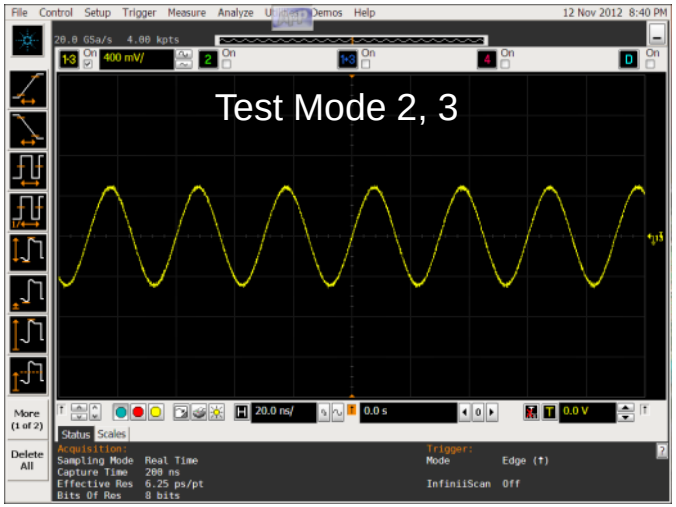
Test Patterns

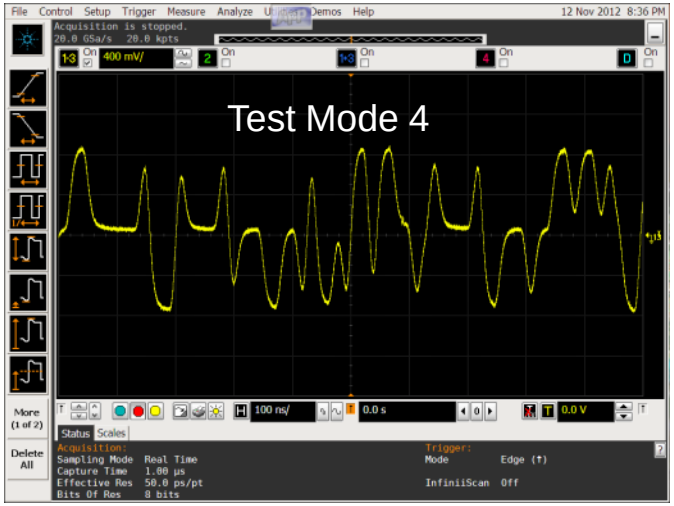
Table 5.1 Broad-R-Reach Test Modes

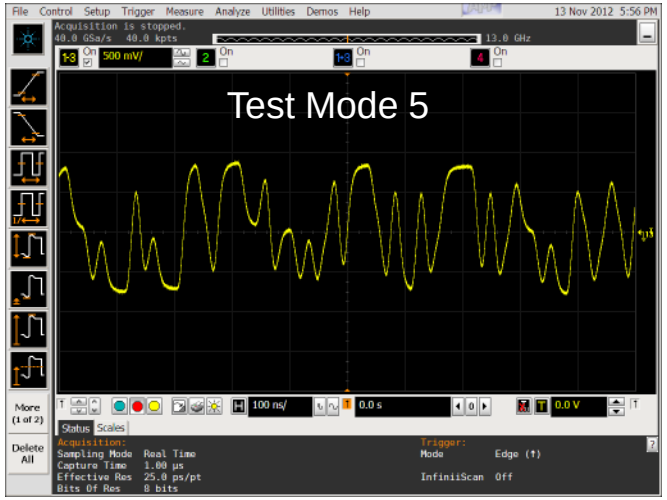
Register			Mode
0	0	0	Normal Operation
0	0	1	Test mode 1 – Transmit droop test mode
0	1	0	Test mode 2 – Transmit jitter test in MASTER mode
0	1	1	Test mode 3 – Transmit jitter test in SLAVE mode
1	0	0	Test mode 4 – Transmitter distortion test
1	0	1	Test mode 5 – Normal operation at full power. This is for the PSD mask and power level test
1	1	0	Reserved, operations not defined
1	1	1	Reserved, operations not defined

Test Patterns









5.4.1 Transmitter Output Droop

- Spec
  Vd / Vpk < 0.45

- Test Pattern
  Test Mode 1

- Test Procedure
- Measuring with Fixture shown in Figure 5.1
- Termination : 100Ω
- High Impedance Differential Probe with Scope

- Issue
- No definition of number of waveforms for measurement

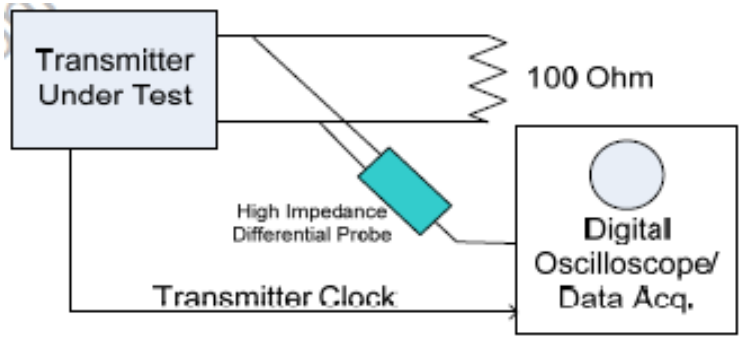


Figure 5.1 Transmitter Test Fixture 1: Droop, Jitter

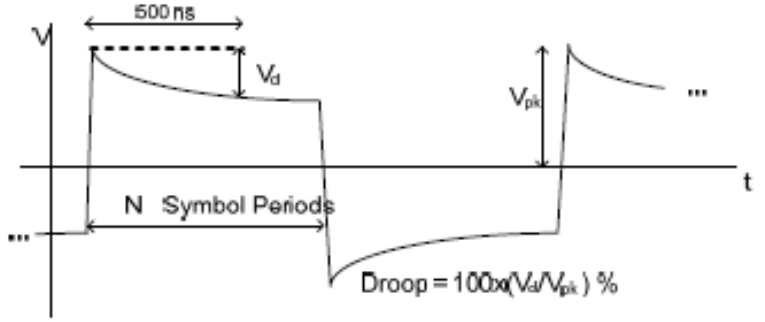


Figure 5.4 Test Mode 1 Output (not to scale)

5.4.2 Transmitter Distortion

- Spec
  Peak Distortion < 15mV

- Test Pattern
  Test Mode 4

- Test Procedure

- Calculating the maximum peak distortion of continuous 2,047 symbols using MATLAB script
- Measure transmitter distortion changing phase by 0.1UI step, and have to pass test over 6 times.
- Transmitter test

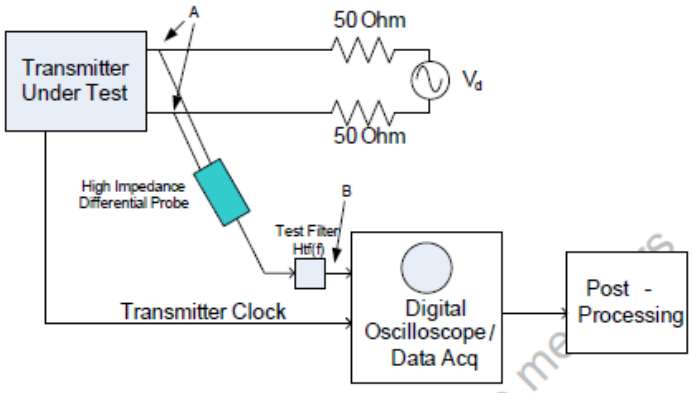


Figure 5.2 Transmitter Test Fixture 2: Distortion

5.4.3 Transmitter Timing Jitter

- Spec
  J_{TXOUT} < 50ps

- Test Pattern
  Test Mode 2

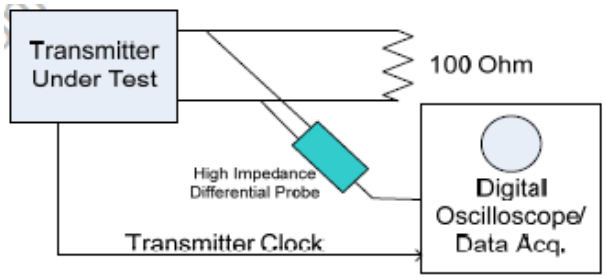


Figure 5-1 Transmitter Test Fixture 1: Droop, Jitter

- Test Procedure

- Measuring Jitter (RMS) between Test Mode 2 and unjittered reference.

- Scope Setting
  Sampling Rate : 20GSa/s, Memory : 20M points

- Acquisition time is over 1ms. Repeat test many times.

5.4.4 Transmitter Power Spectral Density (PSD)
5.4.5 Minimum Power Spectral Density Mask

- Spec

- Test Pattern
  Test Mode 5

- Test Procedure
- Spectrum Analyzer or oscilloscope
- Balun
- RBW : 10kHz
- VBW : 30kHz
- Avg : 16
- RMS Detector

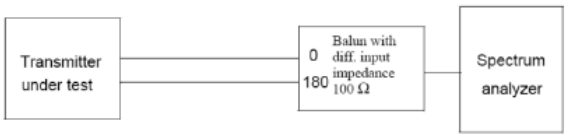


Figure 5.3 Transmitter Test Fixture 3: PSD Mask

Table 5.3 Power Spectral Density Min & Max Mask Definition

Frequency	PSD Upper Bound (dBm)*	PSD Lower Bound (dBm)*
@1MHz	-23.3	-30.7
@20MHz	-24.8	-35.6
@40MHz	-28.5	-49.0
57MHz – 200MHz	-36.5	-

* Settings: RBW=10 KHz, VBW=30KHz, Avg: 16X, RMS detector, sweep time 3.275 seconds.

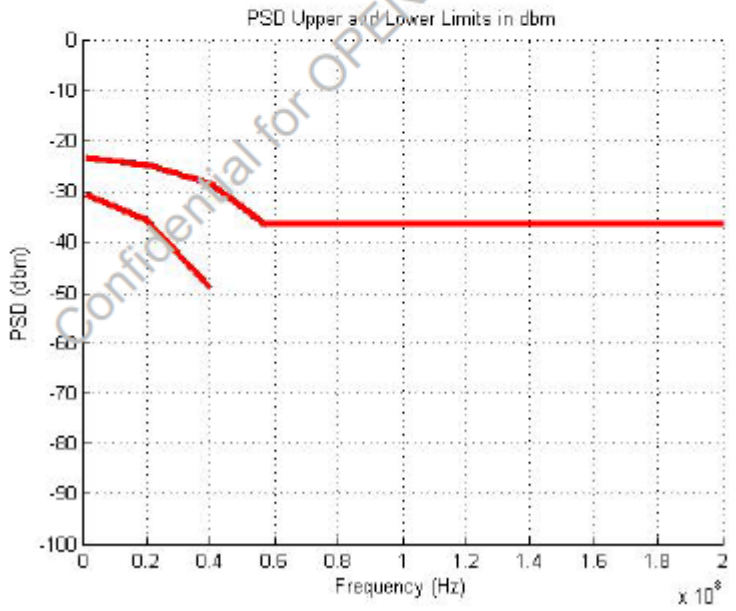
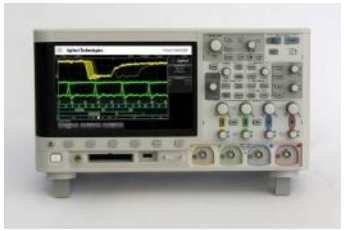


Figure 5.5 PSD Upper and Lower Limits

Agilent Automotive Applications

– **InfiniiVision Oscilloscopes**



- CAN, LIN, FlexRay triggering and decode
- CAN Eye-diagram mask testing

– **Infiniium Oscilloscopes**

- CAN, LIN, FlexRay triggering and decode
- User-definable application (CAN signal quality testing)
- New compliance apps
  - BroadR-Reach (N6467A)
  - MOST150 and MOST50 (N6466A)

– **Probing**

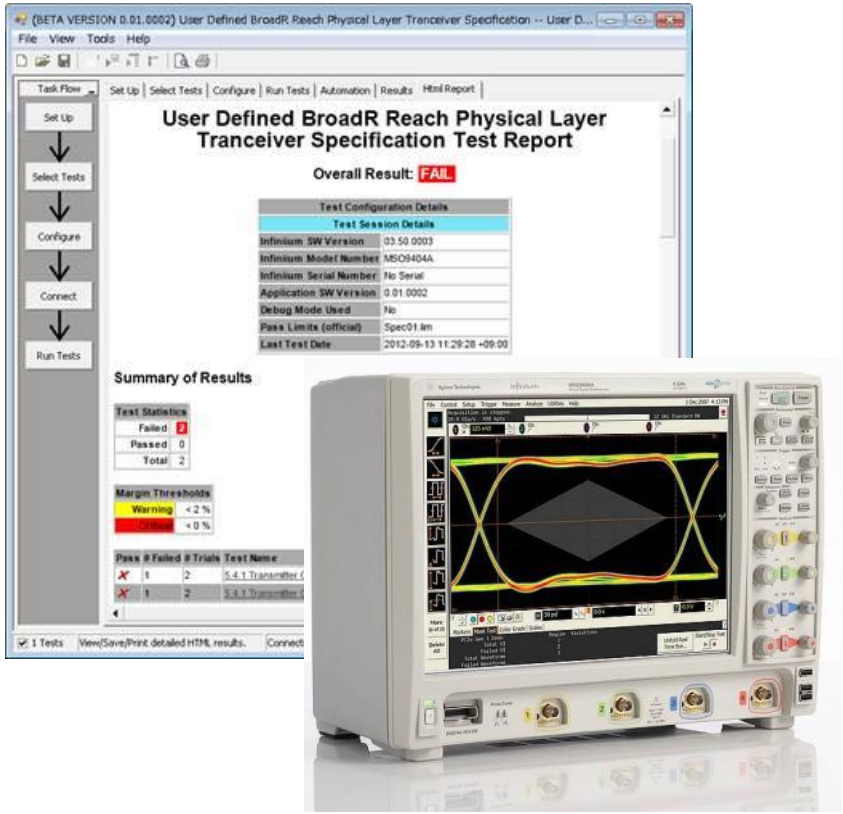
- N2783L 100 MHz current probe (5m cable)
- N5450A high-temperature extension cables for InfiniiMax probes
- N2820/N2821A high-sensitivity current probes

Agilent BroadR-Reach Oscilloscope Application

Compliance application for Infiniium Oscilloscopes

•Product Number: N6467A
•Price: $2,500 (USD)
•Orderable and shipping: March 1, 2013
•Compatible with Infiniium: (1 GHz or more BW requirement)

- 9000 A Series
- 9000 H Series
- 90000 A Series
- 90000 X Series
- 90000 Q Series



Scope Configuration: DSO9104A example

Model Number	Product Description	Qty
Oscilloscope		
DSO9104A or better	1GHz Oscilloscope	1
Application SW		
DSO9104A option 002	EZJIT Plus	1
DSO9104A option 003	SDA	1
DSO9104A option 040	UDA	1
N6467A	BroadR Reach PHY Compliance application	1
Probing & Connection to DUT*		
1130A (*)	InfiniiMax I 1.5GHz	1
E2678A (*)	Socket Probe Head	1
N5395C (*)	Ethernet Test Fixture	1
	SMA(m)-SMA(m) Cable *	2

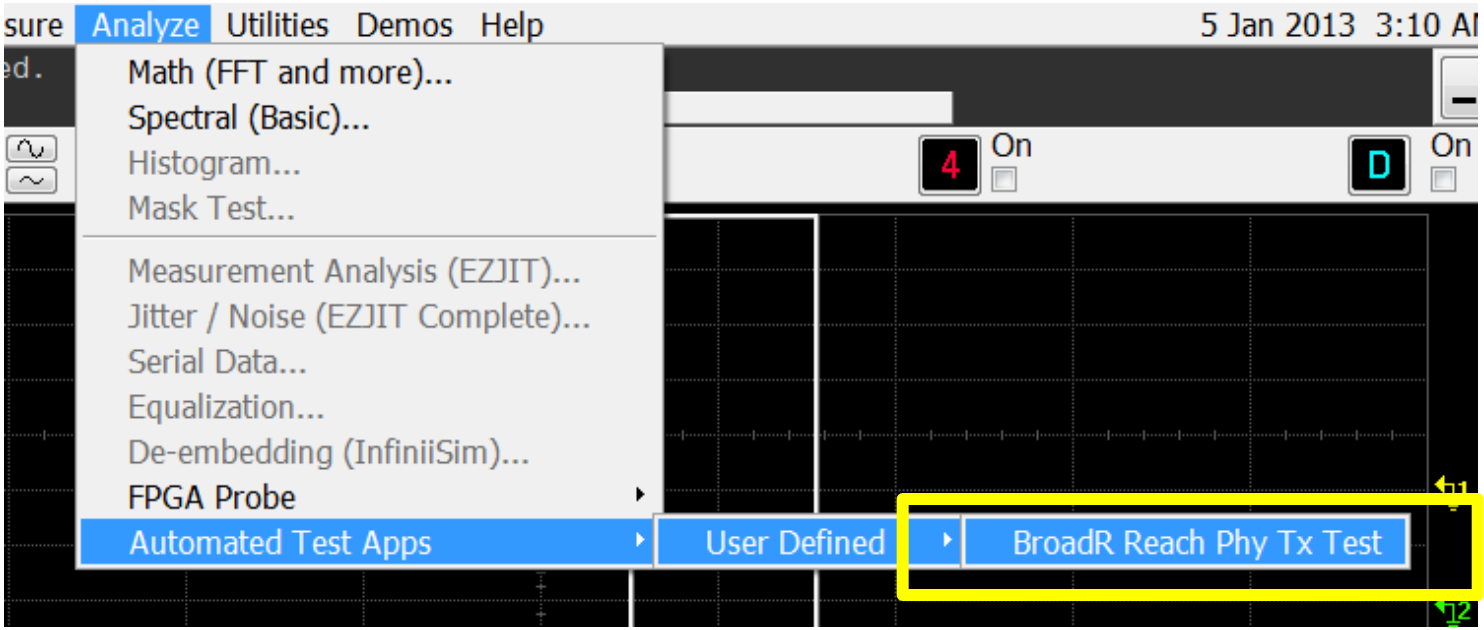
* BroadR Reach specification does NOT define connector spec so probing will vary from user to user. Agilent scope needs D+ and D- . This can be done with SMA or BNC cabling, with a differential probe, or using a test fixture..

Spectrum Analyzer Configuration: N9010A Example

Model Number	Product Description	Qty
N9010A	EXA series spectrum analyzer or oscilloscope	1
N9010A option 503	9kHz - 3.6GHz	1
N9010A option FSA	Fine Step Attenuator	1
1250-1250	N(m)-SMA(f) adapter	1
	Balun	1
82357B **	USB-GPIB Interface	1

** Needed to control spectrum analyzer from oscilloscope if spectrum analyzer is used.

Starting the Oscilloscope Compliance App

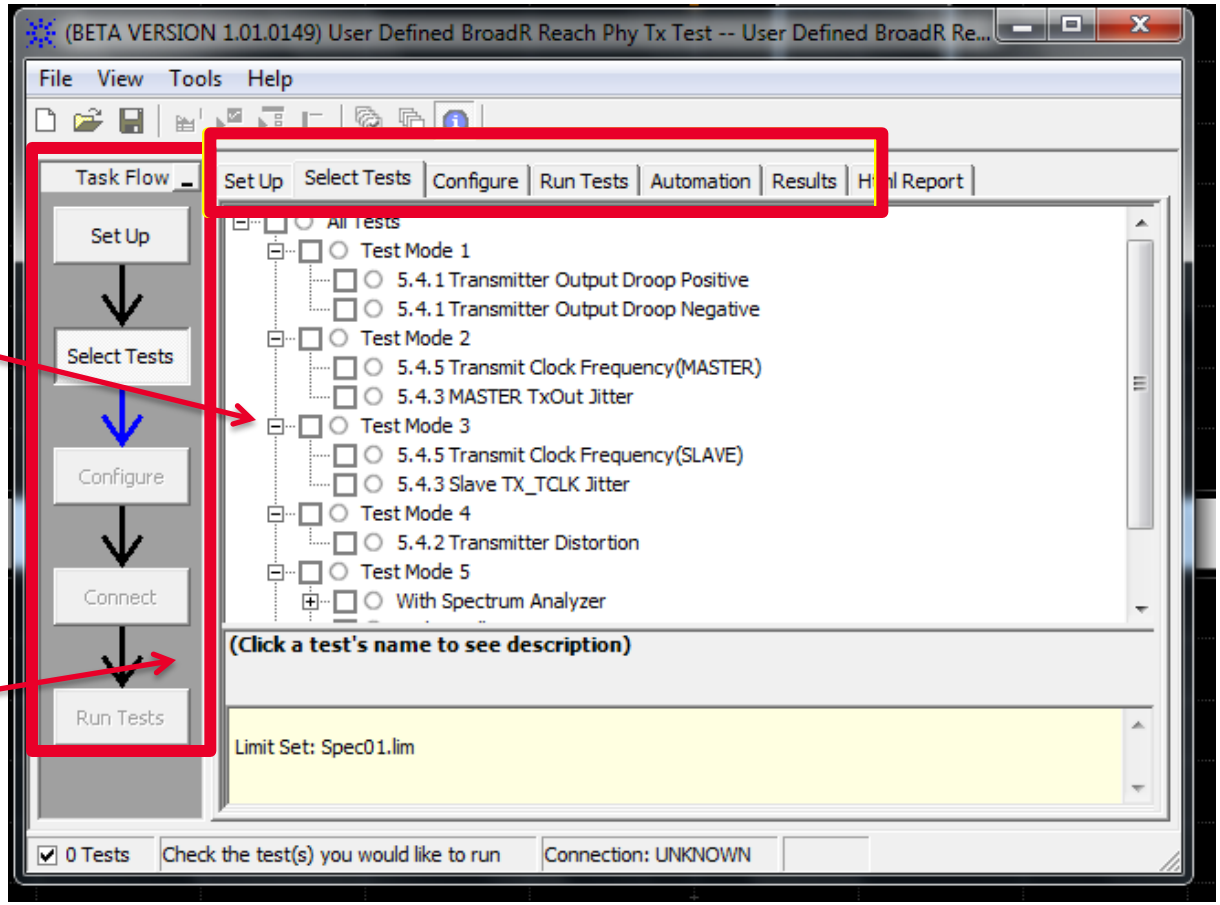


Navigating within the Oscilloscope App

Tabs along the side and top guide the user to the next logical step.

Specific tests categorized by test mode. In this case test modes 1-5.

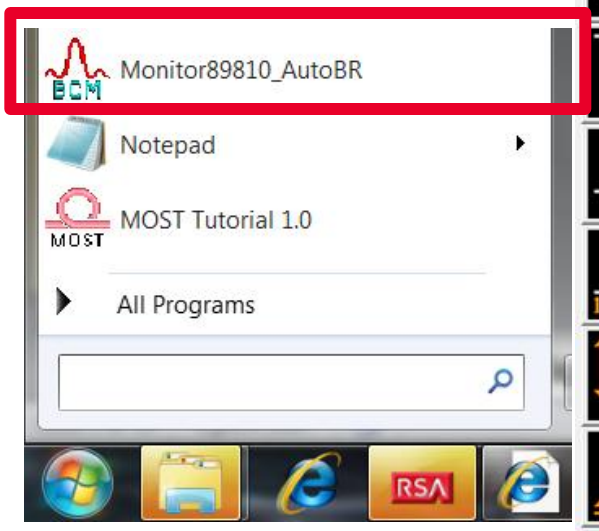
Click on the test to get a clear description and location of spec.

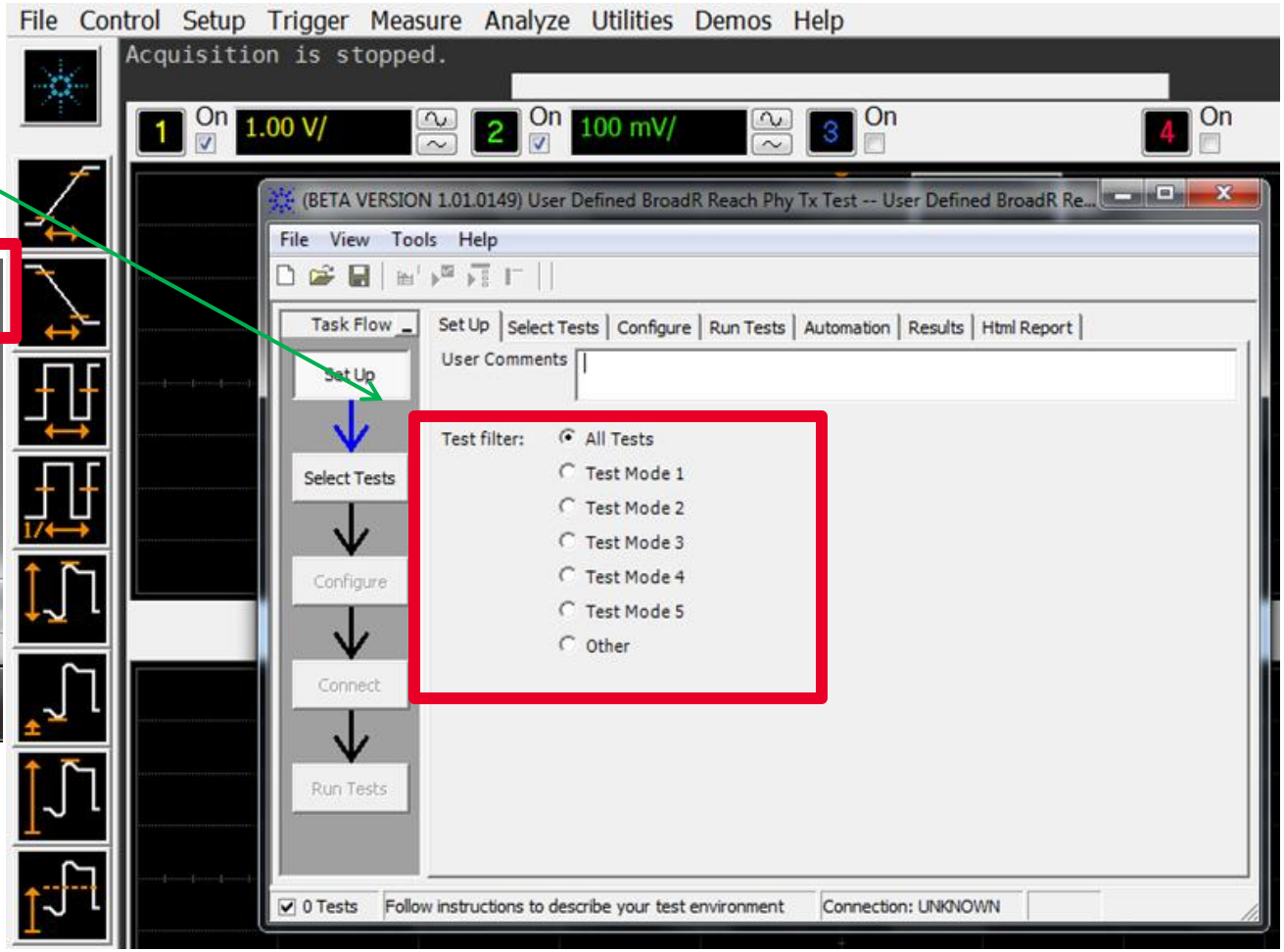


The Agilent automated test engine guides you quickly through selecting and configuring tests, setting up the connection, running the tests, and viewing the results. You can easily select individual tests or groups of tests with a mouse-click.

Setting Test Modes for Stress Patterns

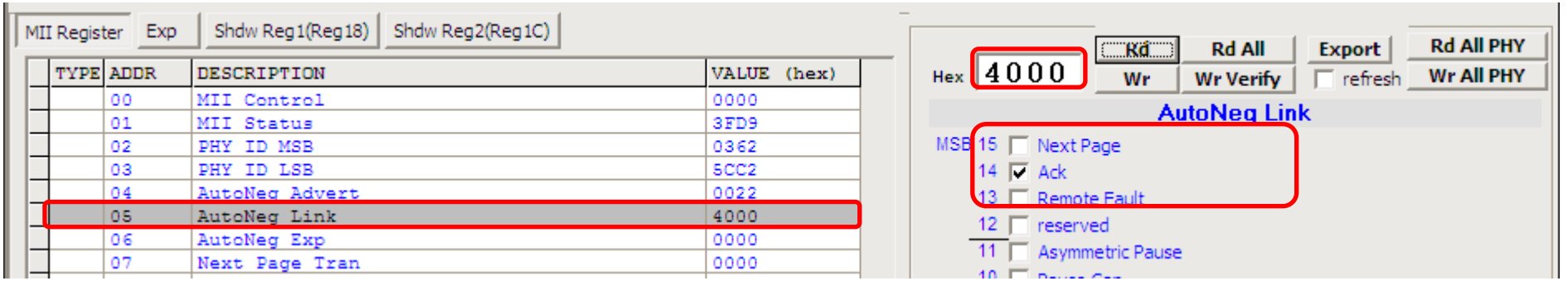
Using Broadcom's Monitor program to select specified test mode as indicated.



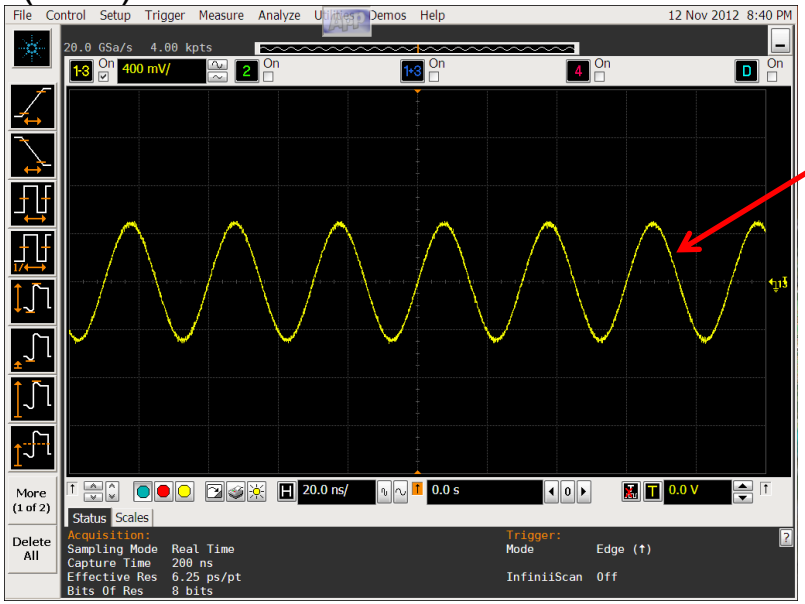


Broadcom Monitor Program – Test Mode 2/3

Select “Ack” to put the DUT into Test mode 2 or “Ack and “Remote Fault” for test mode 3



After you select “Ack” make sure that you click the “Wr” (write) button…then “Rd” (read) the value back to make sure the write took…you should see the 4000 hex

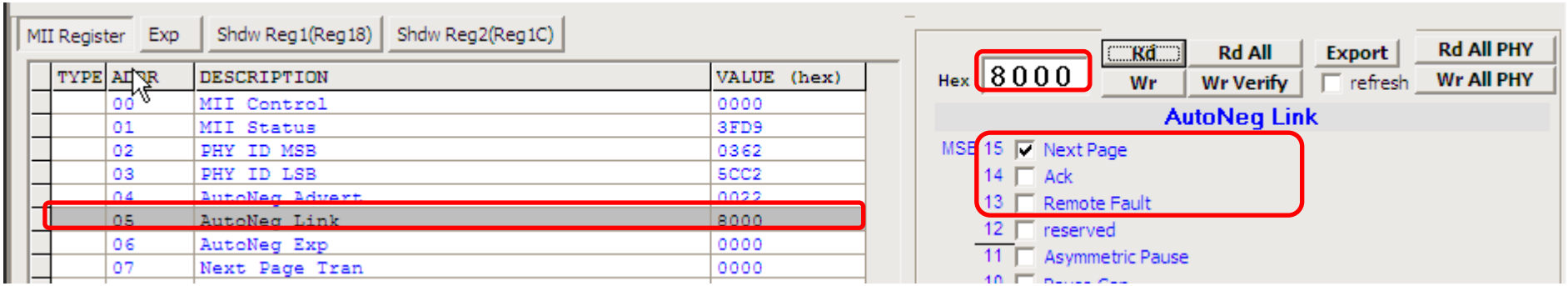


You should see the waveform on the left if you did it right…

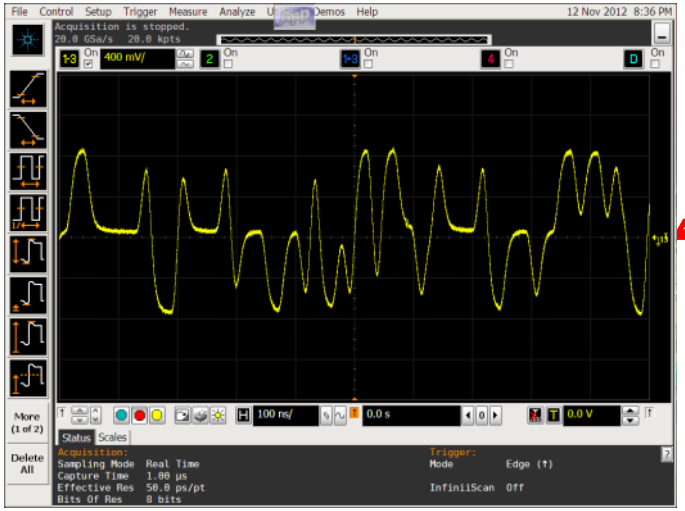
Note: Test mode 2 and 3 are the same.

Broadcom Monitor Program – Test Mode 4

Select “Next Page” to put the DUT into Test mode 4…



After you select “Next Page” make sure that you click the “Wr” (write) button…then “Rd” (read) the value back to make sure the write took…you should see the 8000 hex

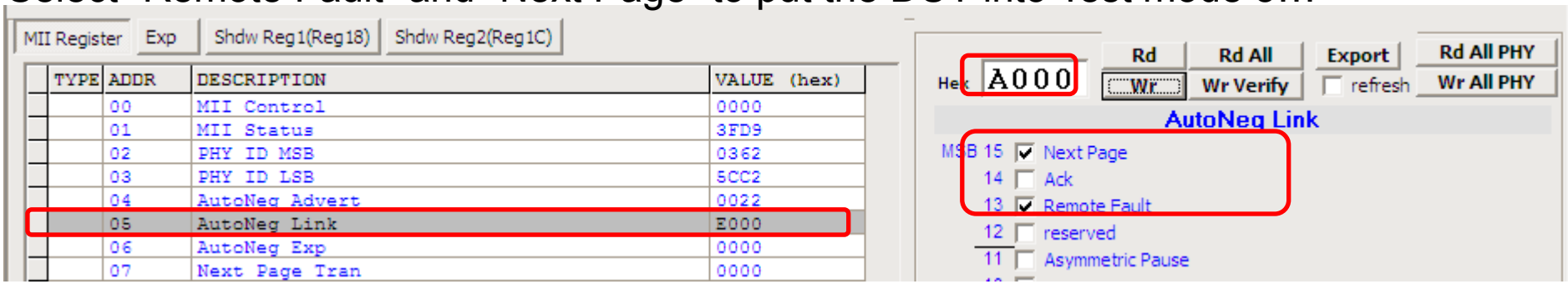


Test Mode 4

You should see the waveform on the left if you did it right…

Broadcom Monitor Program – Test Mode 5

Select “Remote Fault” and “Next Page” to put the DUT into Test mode 5…



After you select “Remote Fault” and “Next Page” make sure that you click the “Wr” (write) button…then “Rd”(read) the value back to make sure the write took… you will see the A000 hex

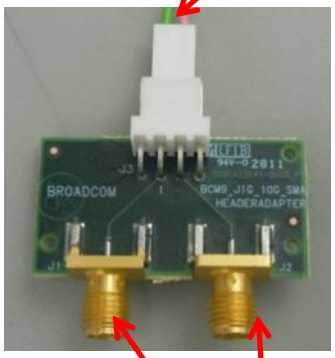
Test Mode 5

You should see the waveform on the left if you did it right…

BroadR-Reach Cabling & Breakout

Twisted pair cable

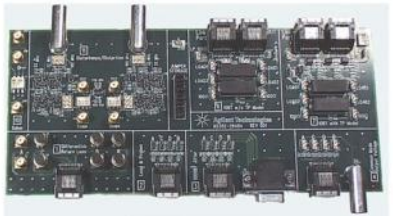
Twisted pair cable connection



User will need to supply D+ and D- to oscilloscope.

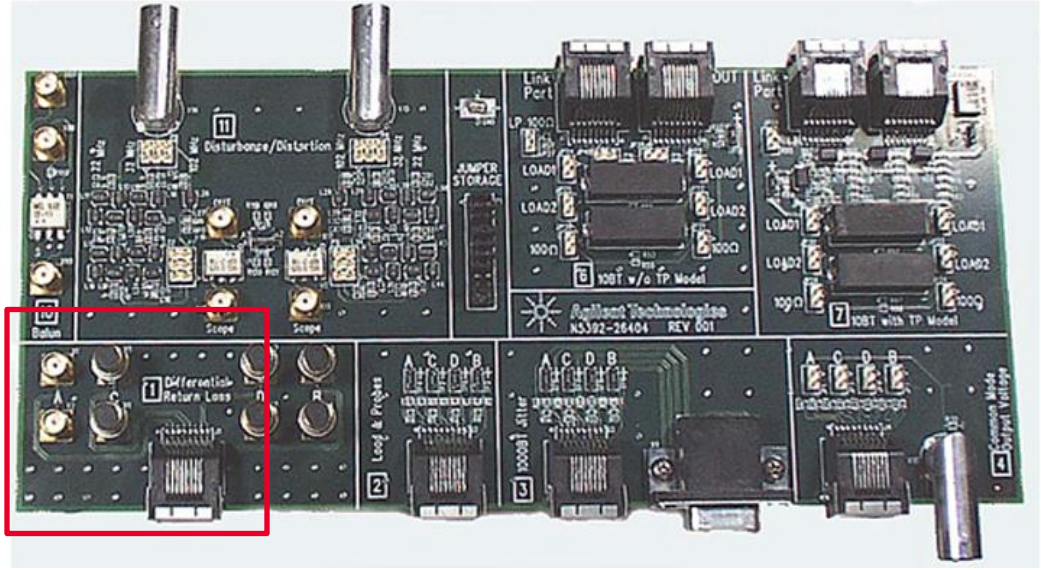
- If using their own connector, they can build their own break-out board.
- If using standard RJ45 connector, they can use Agilent's Ethernet compliance fixture.

SMA Differential output



Agilent Ethernet Fixture if used for Breakout

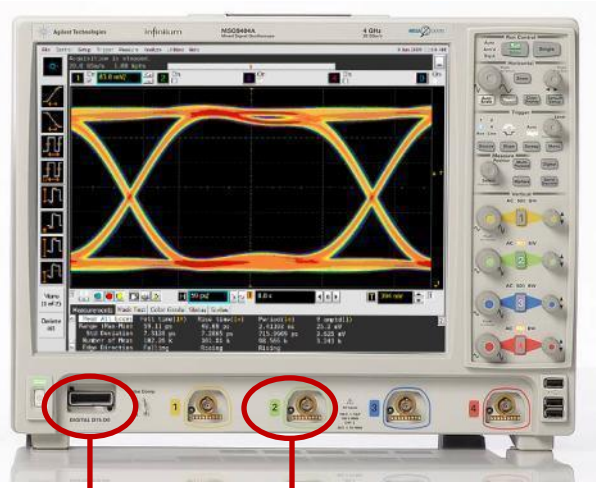
- Supports
  - Automotive BroadR-Reach spec
  - 10/100/1000 Ethernet compliance spec
- Includes:
  - Fixture
  - 2 Ethernet Cables
  - Calibration fixture

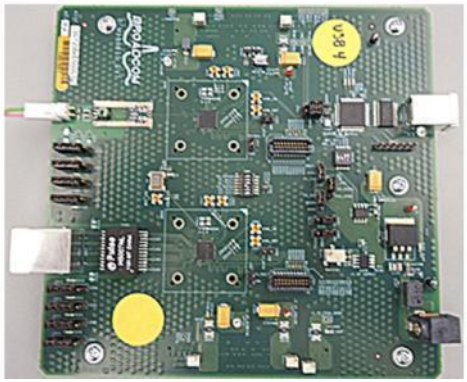


Example Setup

USB Cable from DUT to scope

DSO9104A 1 GHz or better



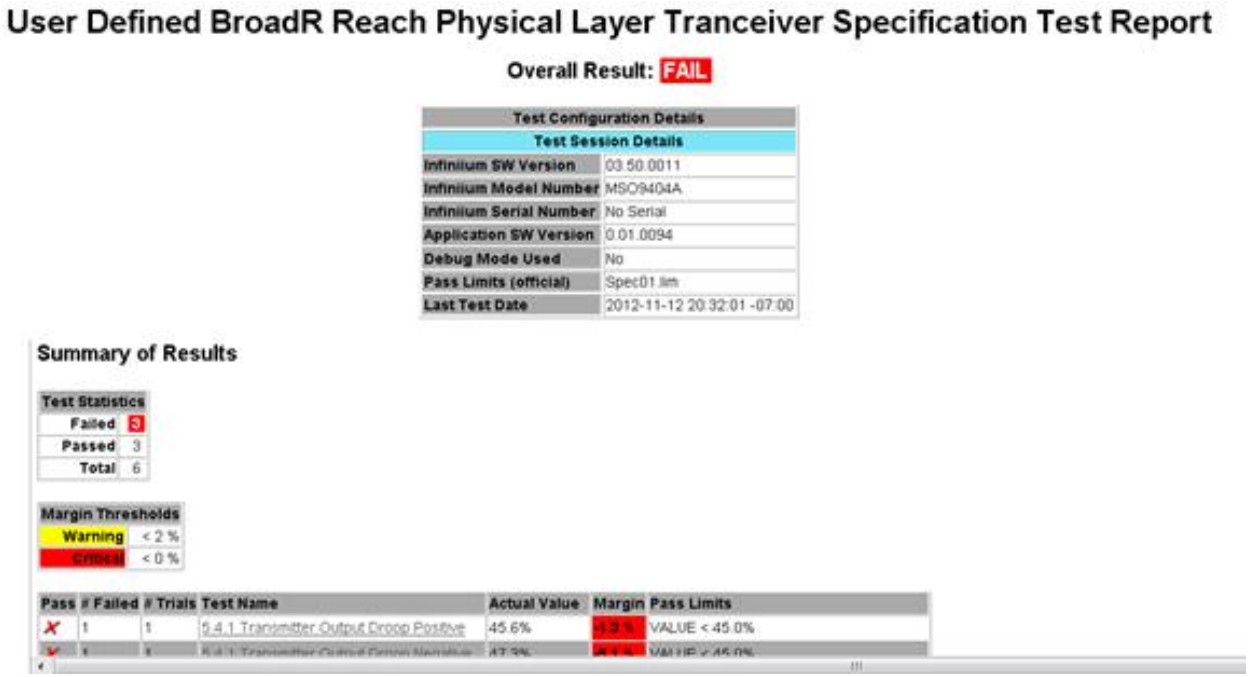


Broadcom DUT

Twisted pair cable from DUT to connector board

BNC Cables from connector board to scope

BroadR-Reach Compliance Report (.html)



User Defined BroadR Reach Physical Layer Tranceiver Specification Test Report

Overall Result: FAIL

Test Configuration Details	
Test Session Details	
Infiniium SW Version	03.50.0011
Infiniium Model Number	MSO9404A
Infiniium Serial Number	No Serial
Application SW Version	0.01.0094
Debug Mode Used	No
Pass Limits (official)	Spec01.lim
Last Test Date	2012-11-12 20:32:01 -07:00

Summary of Results

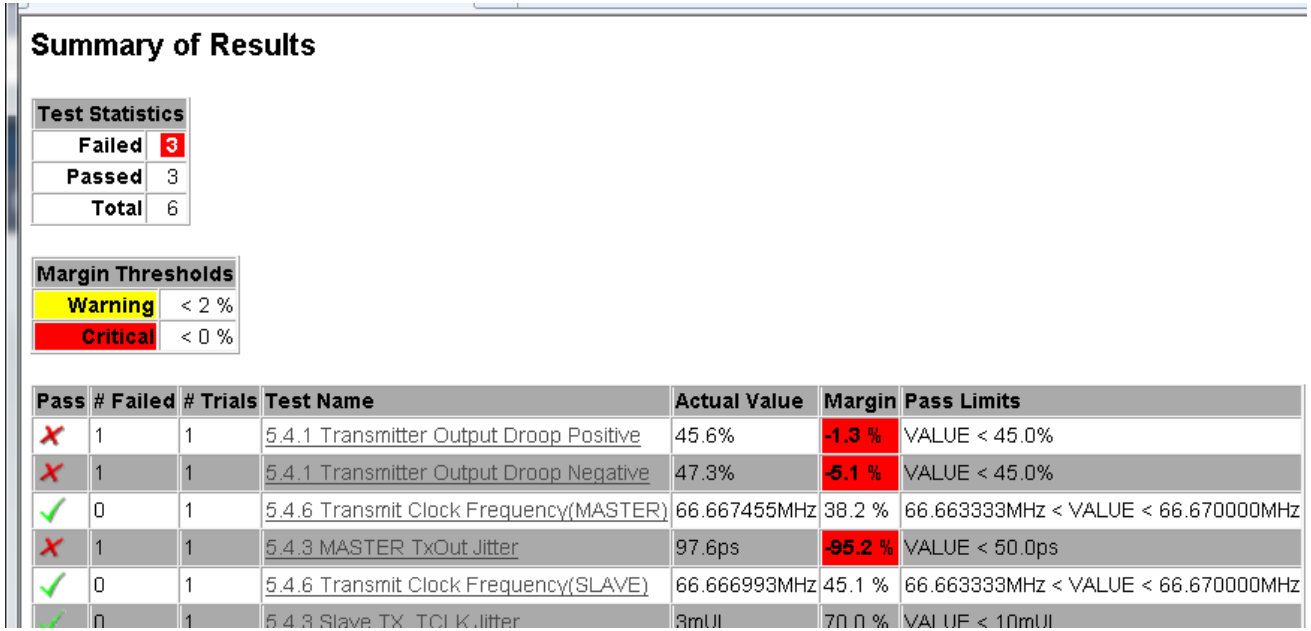
Test Statistics	
Failed	3
Passed	3
Total	6

Margin Thresholds	
Warning	< 2 %
Critical	< 0 %

Pass	# Failed	# Trials	Test Name	Actual Value	Margin	Pass Limits
✗	1	1	9.4.1 Transmitter Output Droop Positive	45.6%	-1.3 %	VALUE < 45.0%

- Summary of the tests performed
- Pass/fail status, and margin.
- Clicking on a specific test also shows the test specification and a measurement waveform, if appropriate.

BroadR-Reach Compliance Summary



Summary of Results

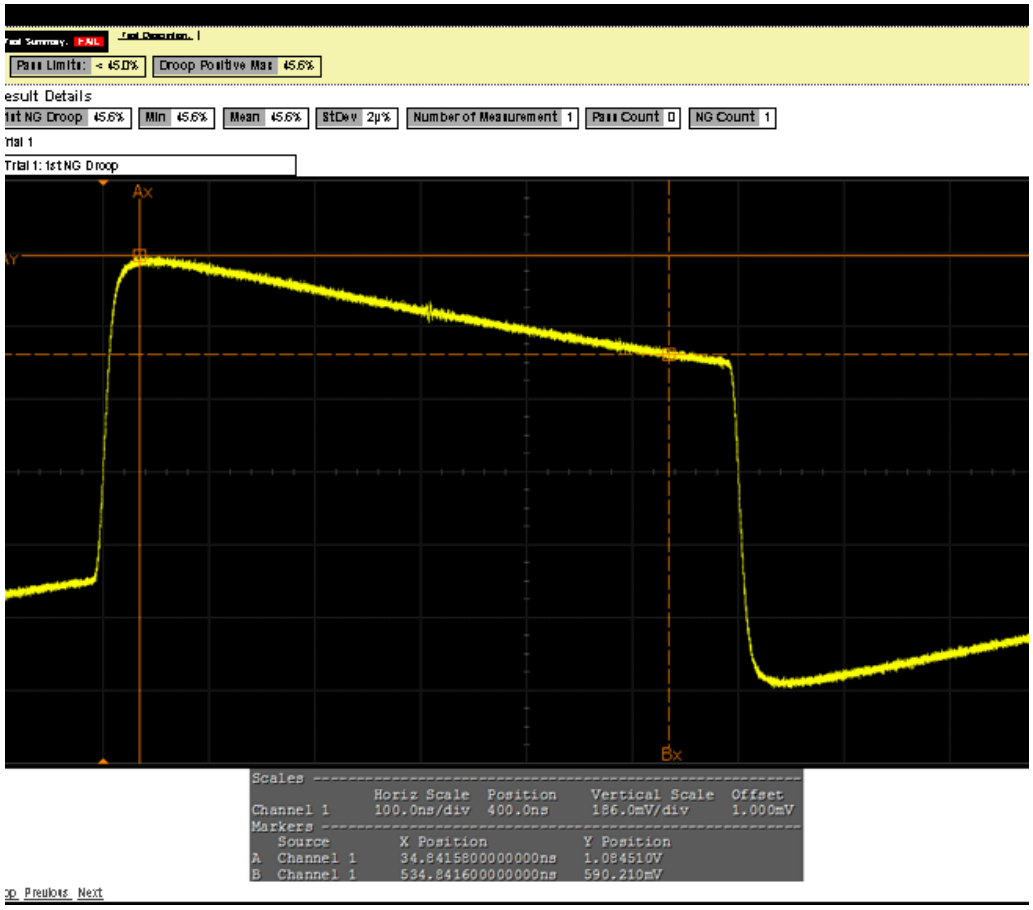
Test Statistics	
Failed	3
Passed	3
Total	6

Margin Thresholds	
Warning	< 2 %
Critical	< 0 %

Pass	# Failed	# Trials	Test Name	Actual Value	Margin	Pass Limits
✗	1	1	5.4.1 Transmitter Output Droop Positive	45.6%	-1.3 %	VALUE < 45.0%
✗	1	1	5.4.1 Transmitter Output Droop Negative	47.3%	-5.1 %	VALUE < 45.0%
✓	0	1	5.4.6 Transmit Clock Frequency(MASTER)	66.667455MHz	38.2 %	66.663333MHz < VALUE < 66.670000MHz
✗	1	1	5.4.3 MASTER TxOut Jitter	97.6ps	-95.2 %	VALUE < 50.0ps
✓	0	1	5.4.6 Transmit Clock Frequency(SLAVE)	66.666993MHz	45.1 %	66.663333MHz < VALUE < 66.670000MHz
✓	0	1	5.4.3 Slave TX_TCLK Jitter	3mUI	70.0 %	VALUE < 10mUI

Summary of all tests with hyperlink to additional detail

BroadR-Reach Compliance Detail



- Additional details are available for each test, including the test limits, test description, and test results, Including waveforms, if appropriate.
- In this case we are showing the Droop test measurement.

Programmatic Control

- Infiniium remote programming interface (RPI) software for programmatic control of all compliance applications
- Order
  - Option 011 for new scope purchases
  - N5452A Compliance Application Remote Programming Toolkit for existing Infiniium scopes

Testing Over an Extended Period of Time

For example: environmental chamber over a week of time

- Application support “multi-trial” tests
- Application generates a single .html report that covers the results of all single run tests combined into a multi-trial report.

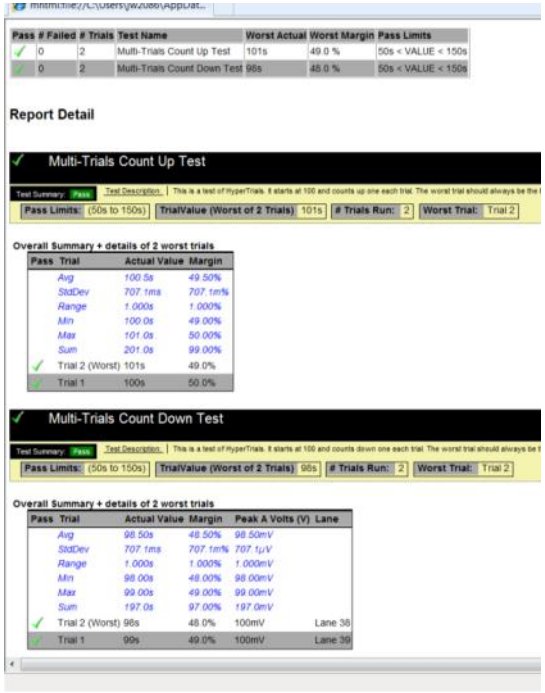
PersistentOptionSet	Multi-Trial Tests
POS_346	Option1
Infiniium SW Version	04.10.0001
Infiniium Model Number	DSO90804A

Test Statistics	
Failed	0
Passed	2
Total	2

Margin Thresholds	
Warning	< 2 %
Critical	< 0 %

Pass	# Failed	# Trials	Test Name	Worst Actual	Worst Margin	Pass Limits
✓	0	2	Multi-Trials Count Up Test	101s	49.0 %	50s < VALUE < 150s
✓	0	2	Multi-Trials Count Down Test	98s	48.0 %	50s < VALUE < 150s

Report Detail



Adding User-Defined Tests to the Compliance App

- Initial oscilloscope compliance app release does not support Add-Ins
  - End user can’t add tests to a generated app without the source code as initial version is a productized UDA
  - Plan to release a native compliance application version in late 2013

Other Oscilloscope Compliance Apps for Ethernet

- Agilent 10/100/1000bT Compliance Package
- 10G Base-T Compliance app
- XAUI Electrical Validation with 10GBASE-CX4, CPRI, OBSAI, and Serial RapidIO Support
- 10/100/1000Base-Te Energy Efficient Ethernet Compliance app
- BroadR-Reach Compliance application

Agenda

- BroadR-Reach Overview
- Transmitter Testing
- Link Segment Testing

Link Segment Test Overview

Test Items
7.1.1 Characteristic Impedance
7.1.2 Insertion Loss
7.1.3 Return Loss
7.1.4 Mode Conversion
7.2 Power Sum Alien Near End Crosstalk (PSANEXT)
7.2 Power Sum Alien Attenuation to Crosstalk Ratio Far End (PSAACRF)

•Reference: Open Alliance BroadR-Reach™ (OABR) Physical Layer Transceiver Specification For Automotive Applications, V3.2, June 24, 2014, Broadcom Corporation

Link Segment Test Solution

BroadR-Reach link segment testing requires parametric measurements in both time and frequency domains.

Frequency Domain
- Insertion Loss (Sdd21)
- Return Loss (Sdd11)
- Mode Conversion (TCT, TCTL)
- Alien Crosstalk (PSANEXT, PSAACRF)

Time Domain
- Characteristic Impedance (TDR)

Traditional Solution

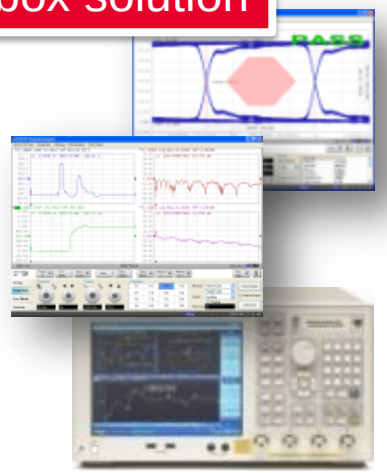
Vector Network Analyzer (VNA)

TDR Scope

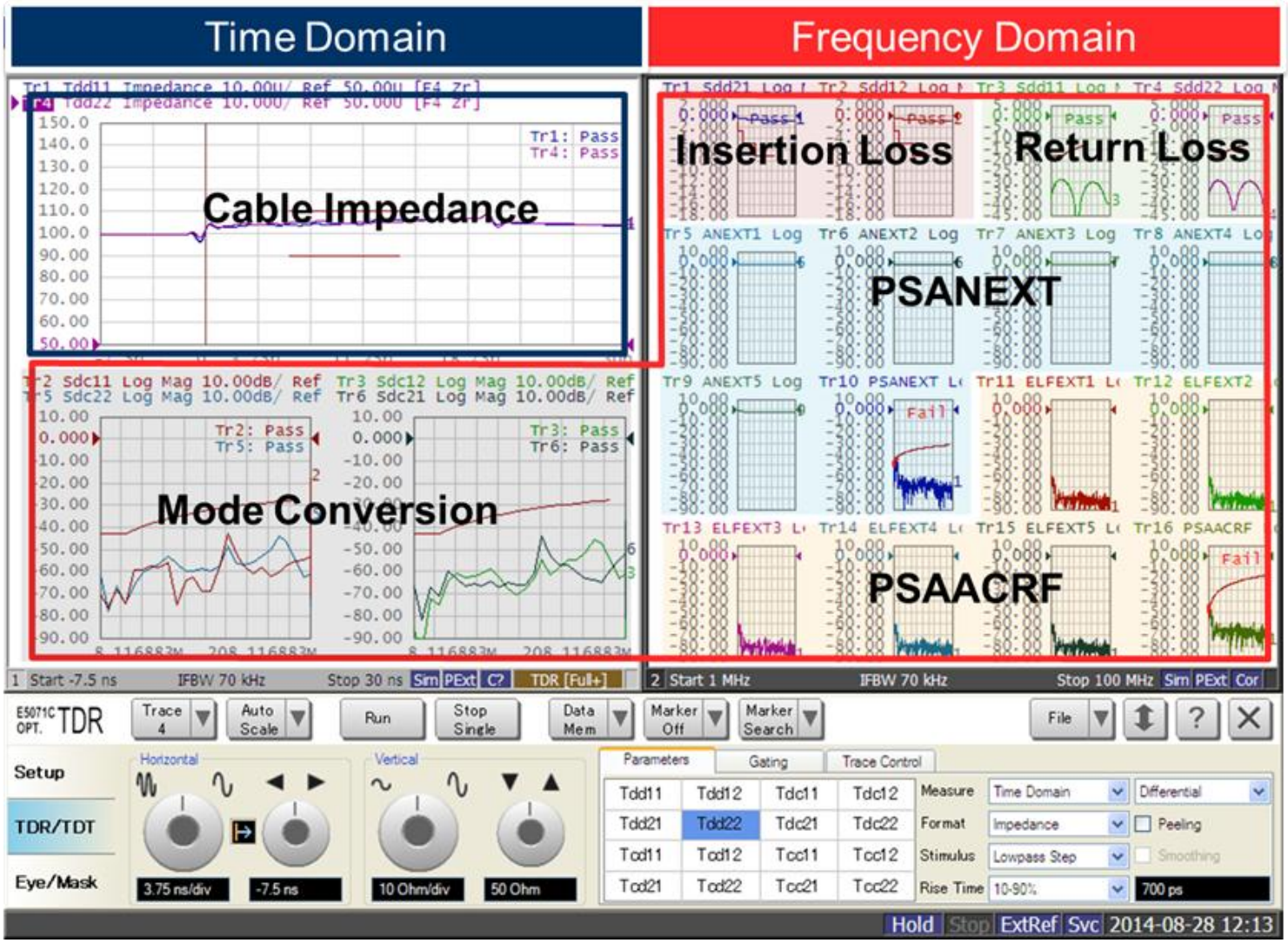
New Solution

ALL parameters can be measured with ENA Option TDR

One-box solution



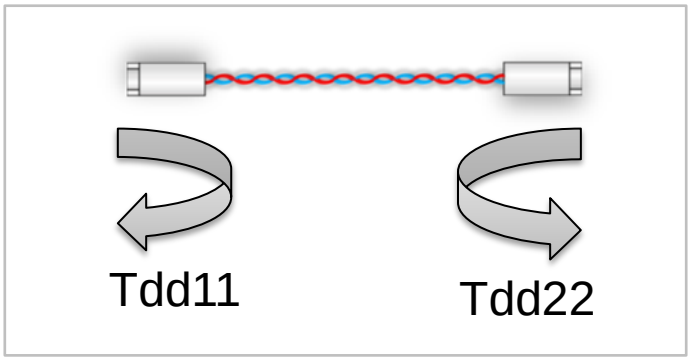
Link Segment Test Measurement Example

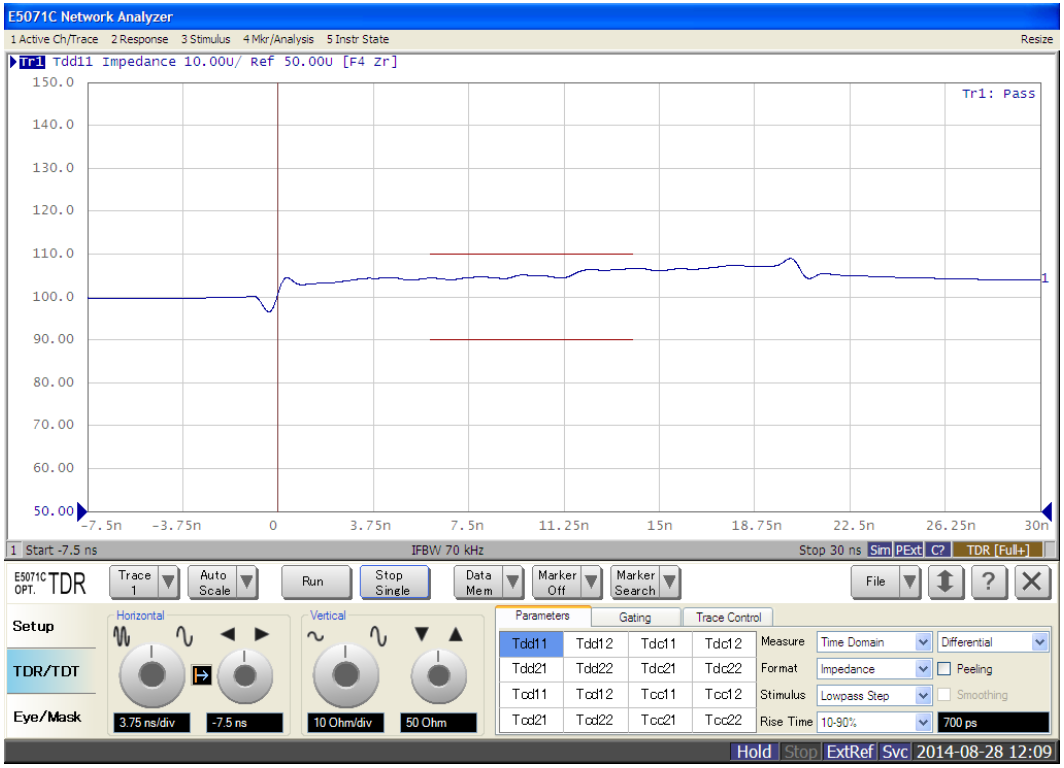


7.1.1 Characteristic Impedance

Specification

Z = 100Ω +/- 10% @ tr<700ps



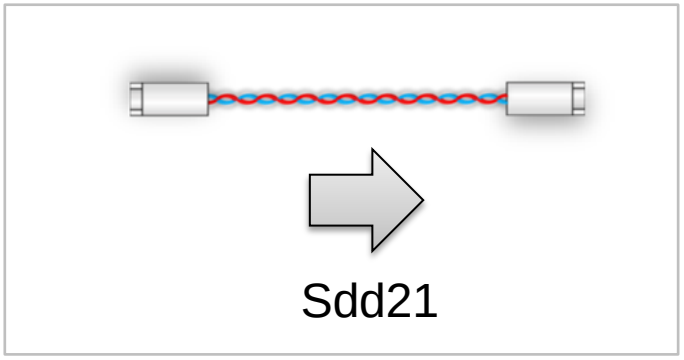


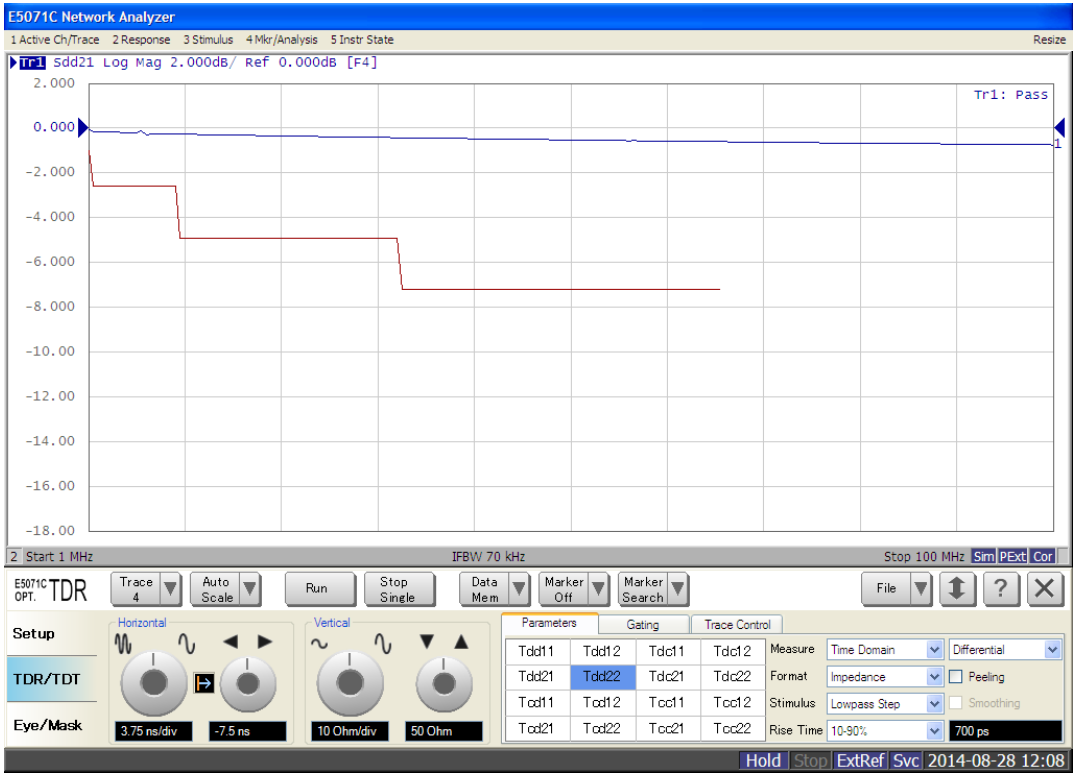
7.1.2 Insertion Loss

Specification

Freq	Loss (*)
1 MHz	< -1.0 dB
10 MHz	< -2.6 dB
33 MHz	< -4.9 dB
66 MHz	< -7.2 dB

(*) Insertion loss includes the attenuation of the DUT, equipment cables, and connector losses

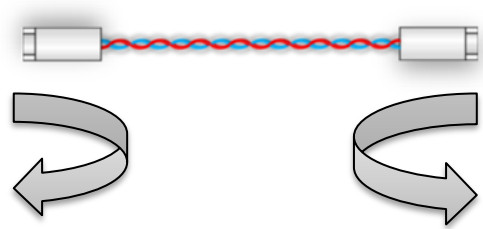


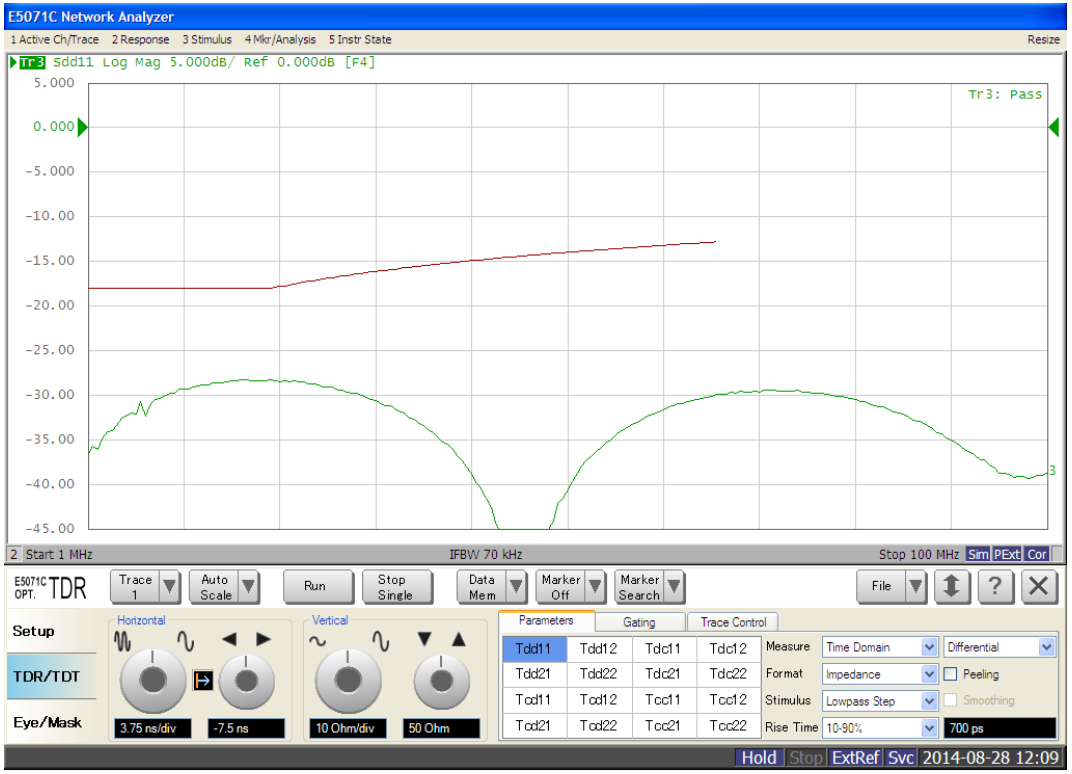


7.1.3 Return Loss

Specification

Freq	7.1.3 Return Loss
1-20 MHz	< -18 dB
20-66 MHz	< -18+10log10(f/20) [dB]

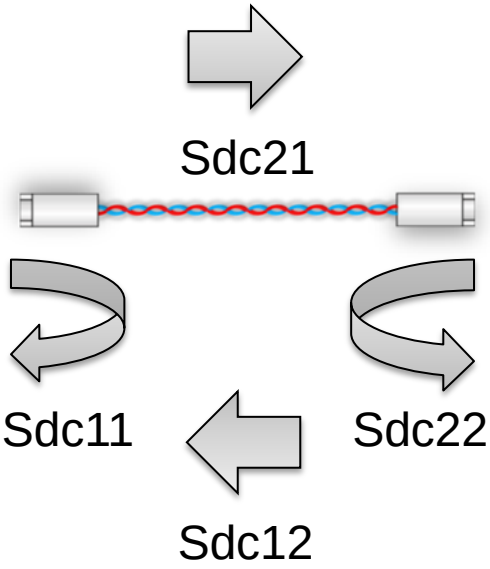


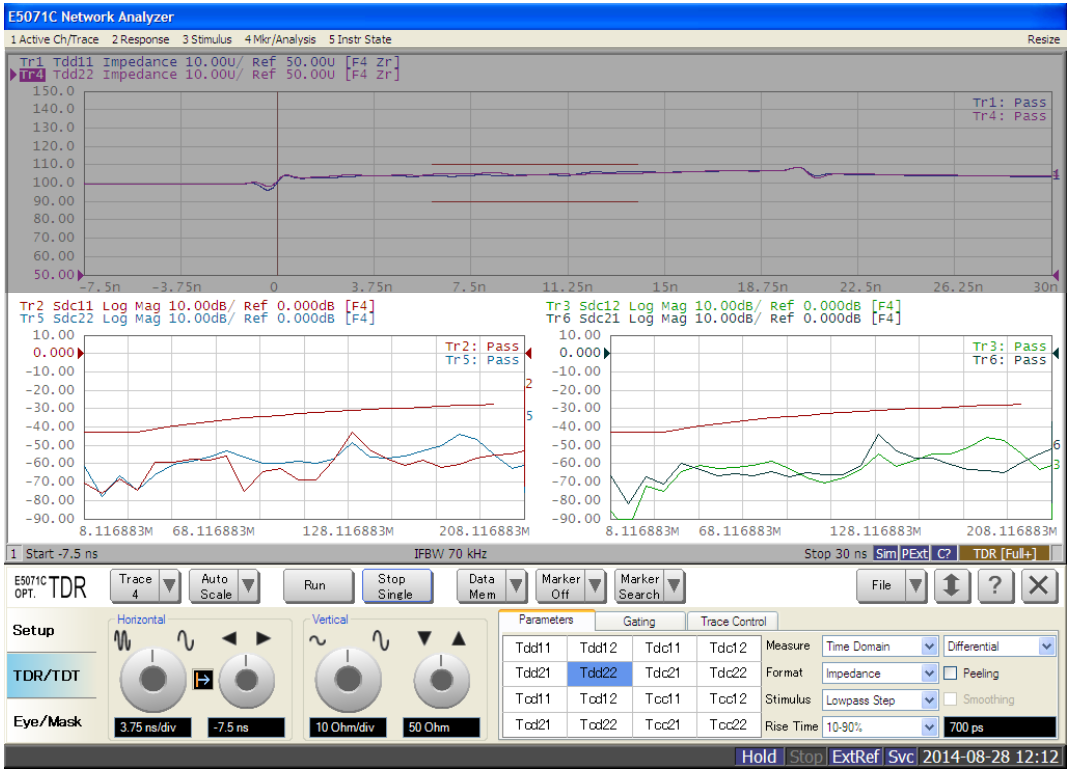


7.1.3 Mode Conversion

Specification

Freq	7.1.3 Return Loss
1-33 MHz	< -43 dB
33-200 MHz	< -43+20log10(f/33) [dB]

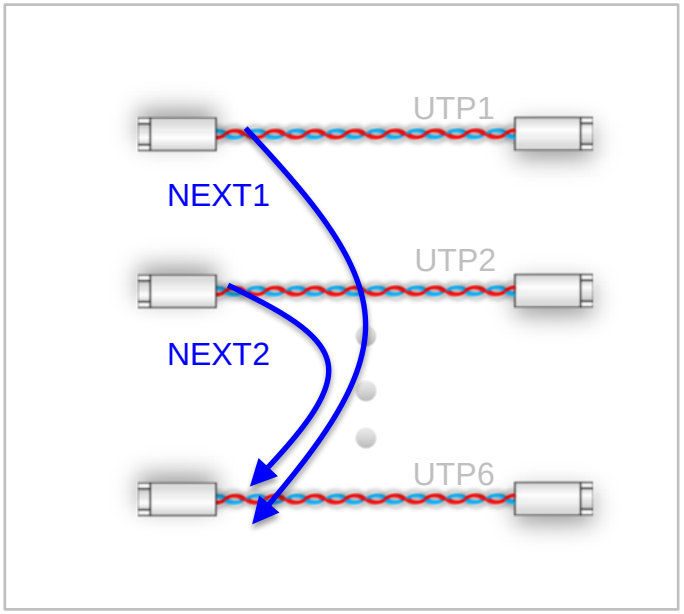


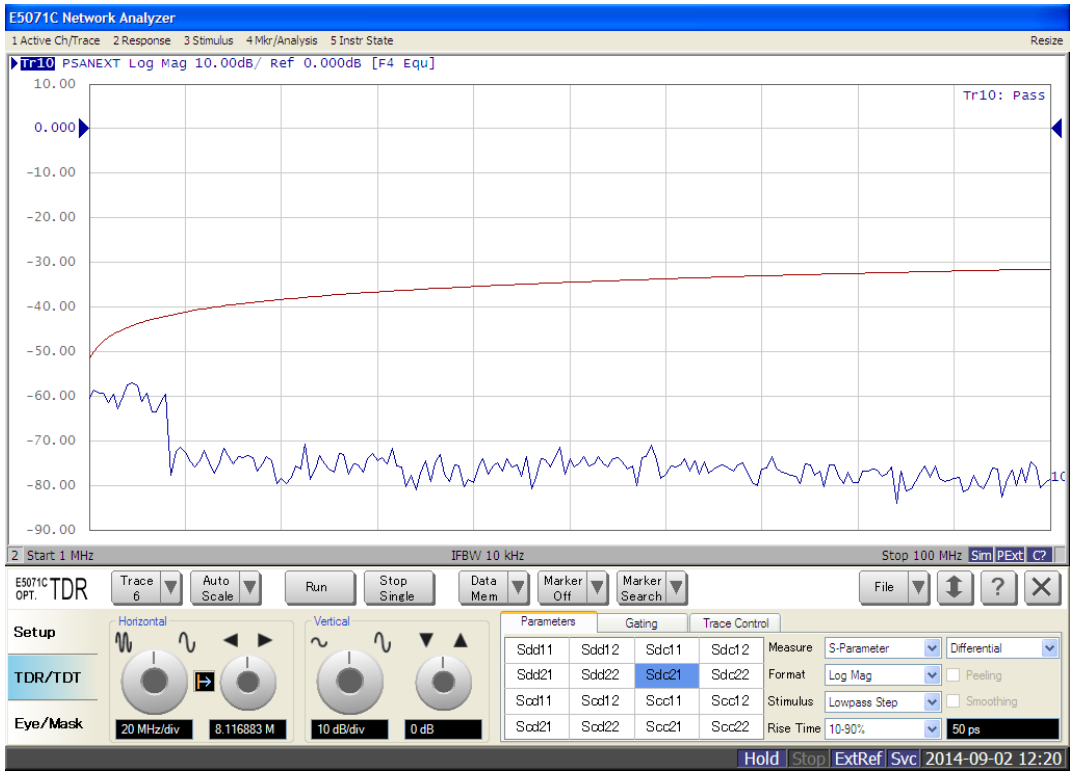


7.2 Power Sum Alien Near End Crosstalk (PSANEXT)

Specification

PSANEXT > 31.5 – 10log10(f/100) [dB], where f = 1-100MHz



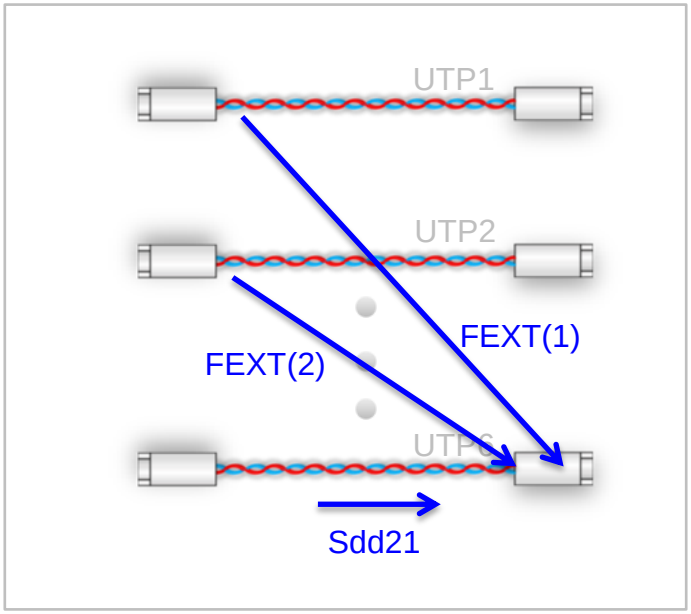


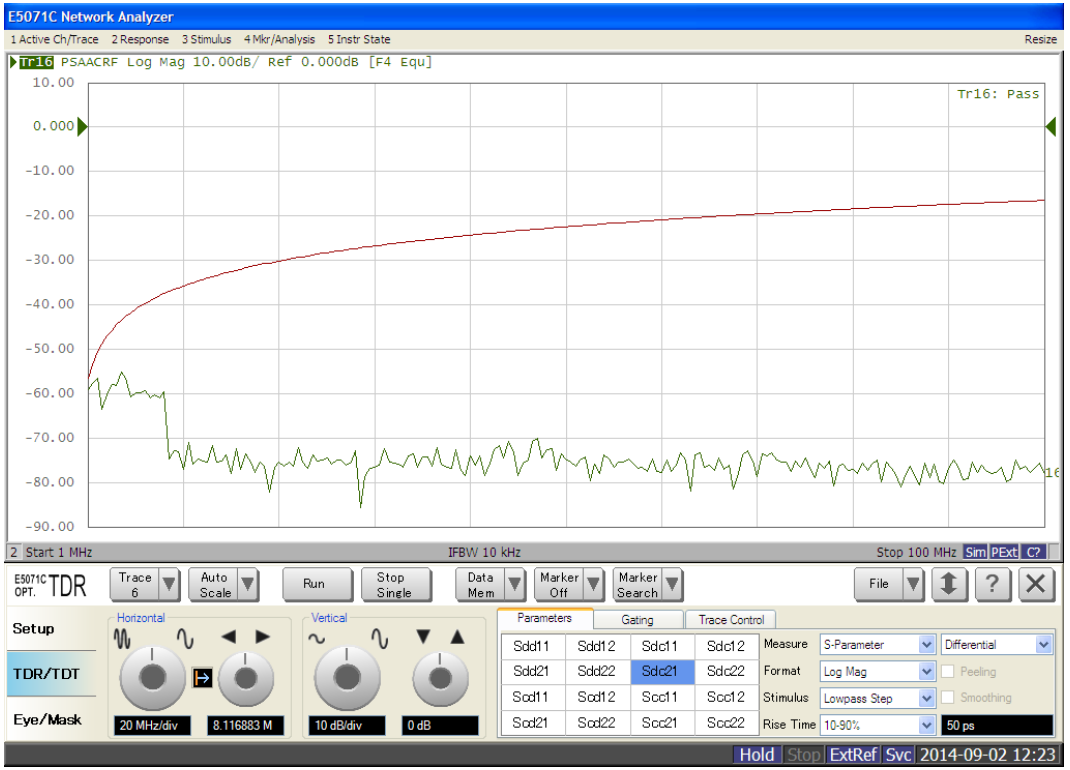
PSANEXT = NEXT (1+2+…+5)

7.2 Power Sum Alien Attenuation to Crosstalk Ratio Far End (PSAACRF)

Specification

PSAACRF > 16.5 – 20log10(f/100) [dB], where f = 1-100MHz





PSAACRF = ELFEXT(1+2+…+5)

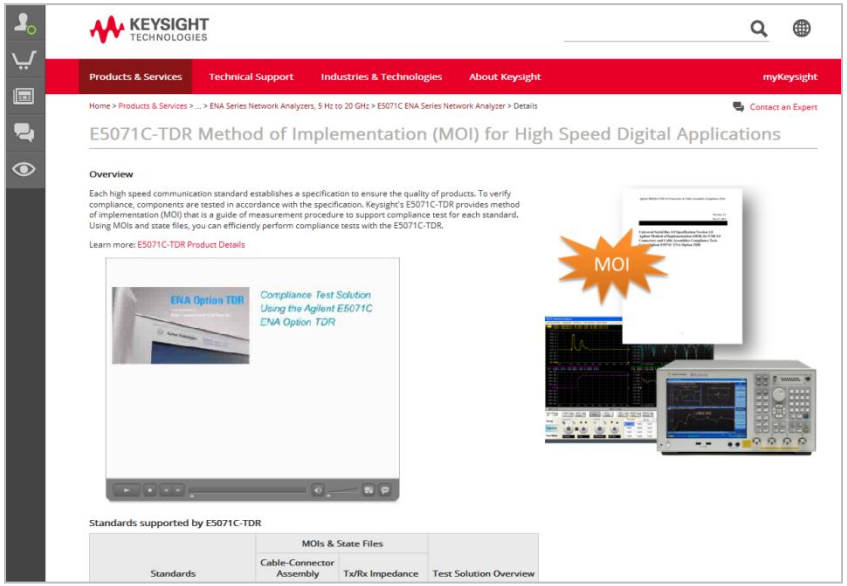
- ELFEXT(1) = FEXT(1) - Sdd21
- ELFEXT(2) = FEXT(2) - Sdd21
- …
- ELFEXT(5) = FEXT(5) - Sdd21

KEYSIGHT TECHNOLOGIES

Agilent BroadR-Reach Link Segment Test Solution

- ENA Mainframe
  - E5071C-440: 4-port, 9kHz to 4.5GHz
  - E5071C-445: 4-port, 100kHz to 4.5GHz
- Enhanced Time Domain Analysis Option (E5071C-TDR)
- ECal Module (N4431B)

- Instrument setup files available for download on Keysight.com



BroadR-Reach Cable Test Fixtures

- When using the standard RJ45 connector, Agilent's Ethernet compliance fixture is available.

- When using a custom connector, the user needs to build own break-out board to connect to the instrument.

Summary

ENA Option TDR BroadR-Reach Testing Solution is ….

•**One-box solution** which provides complete characterization (time domain and frequency domain) of the link segment.

•Similar look-and-feel to traditional TDR scopes, providing **simple and intuitive operation** even for users unfamiliar to VNAs and S-parameters.