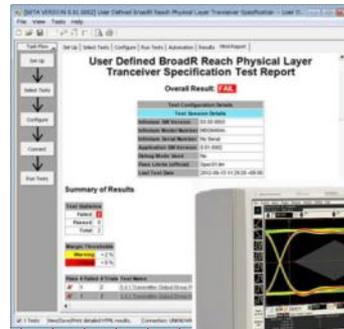


BroadR-Reach PHY Compliance Solutions

Last Update: 2014/12/10 (YS)



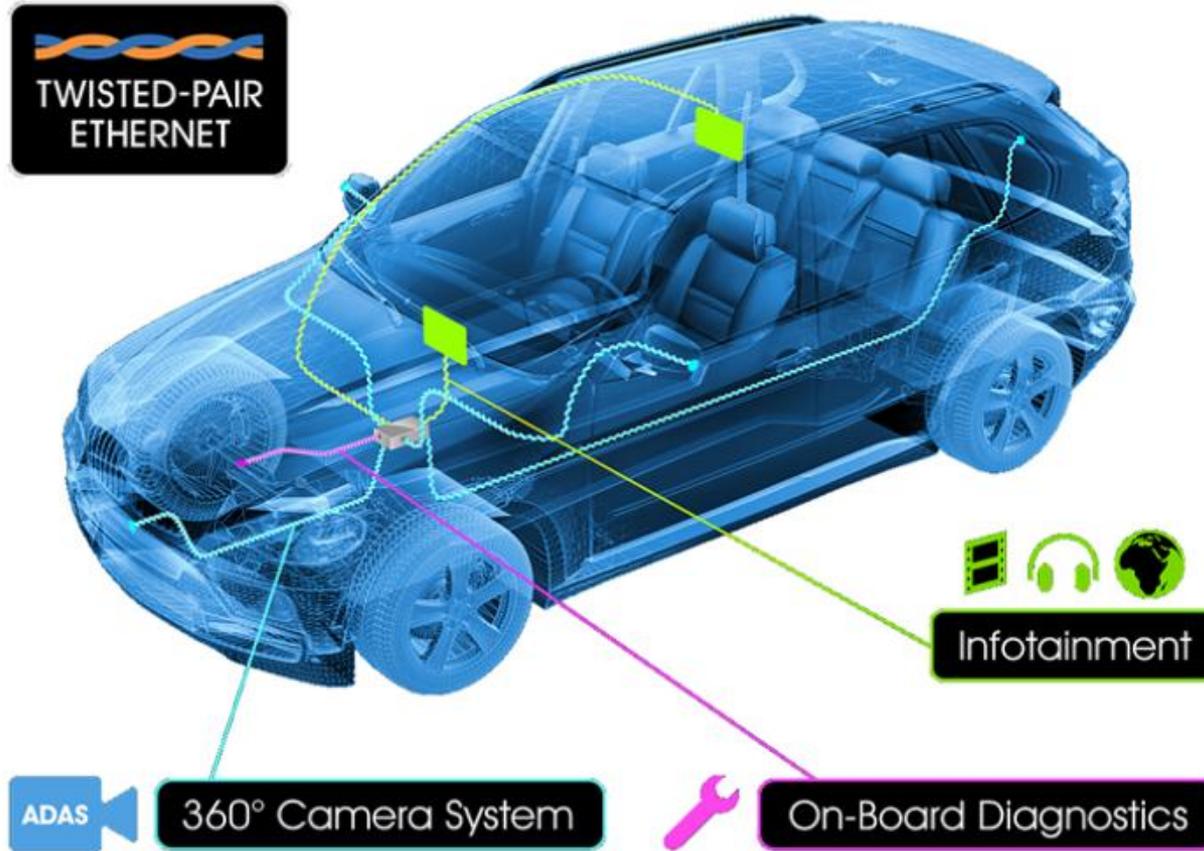
Oscilloscope and Protocol Division
Component Test Division

Agenda

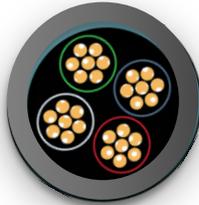
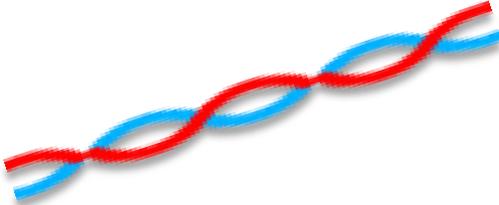
- BroadR-Reach Overview
- Transmitter Testing
- Link Segment Testing



BroadR-Reach Applications



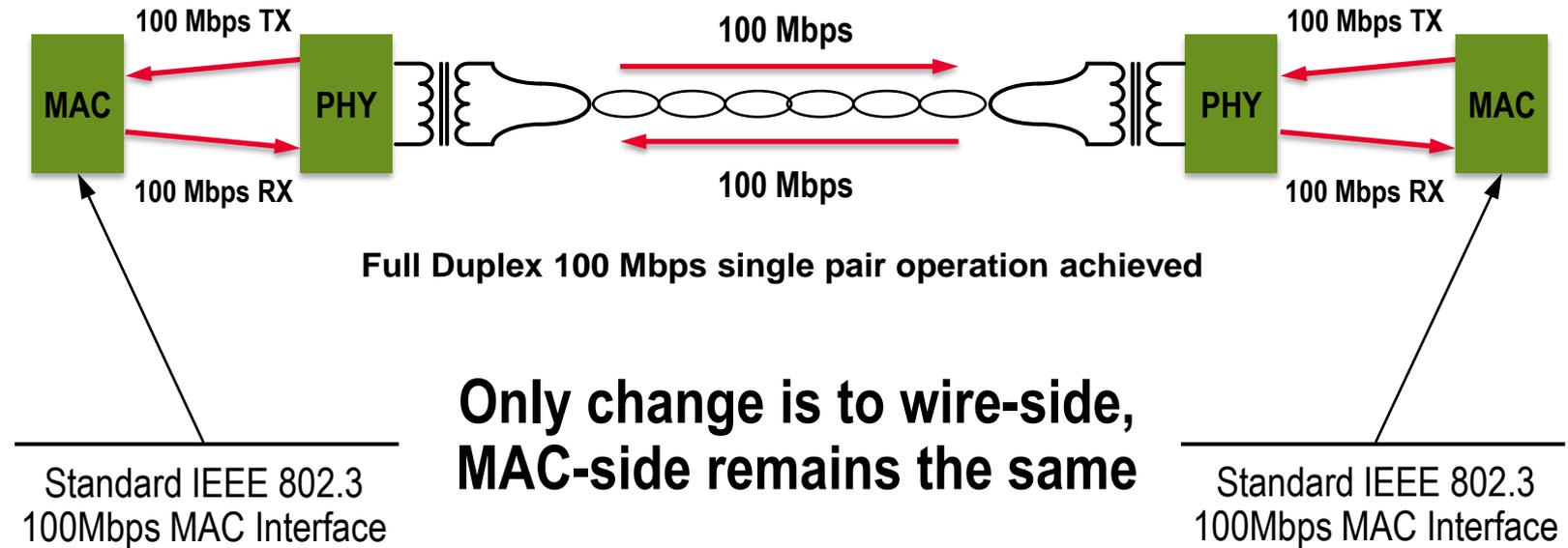
Connectivity Comparison

	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

100 Mbps symmetrical operation using standard Ethernet PHY components



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

OPEN (One Pair EtherNet) Alliance Members

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



Dr. Kirsten Matheus, 2ndEthernet&IP@Automotive Technology Day

Promoters 14, Adopters 66

19

Agenda

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



Keysight Automotive Applications

– InfiniiVision Oscilloscopes

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

– Infiniium Oscilloscopes

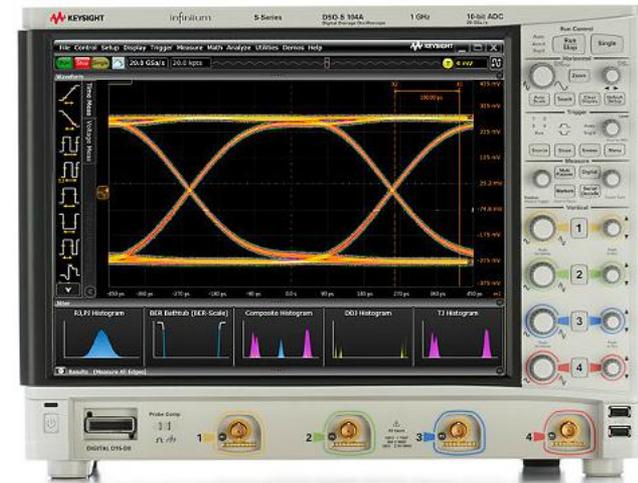
- CAN, LIN, FlexRay triggering and decode
- User-definable application (CAN signal quality testing)

• 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



New S-Series Oscilloscope

BroadR-Reach Transmitter Tests

- • Transmitter Output Droop Test
 - Positive Droop Test
 - Negative Droop Test

- • Transmitter Timing Jitter
 - Slave Jitter Test
 - Master Jitter Test

- Transient Clock Frequency
 - Slave Transient Clock Frequency
 - Master Transient Clock Frequency

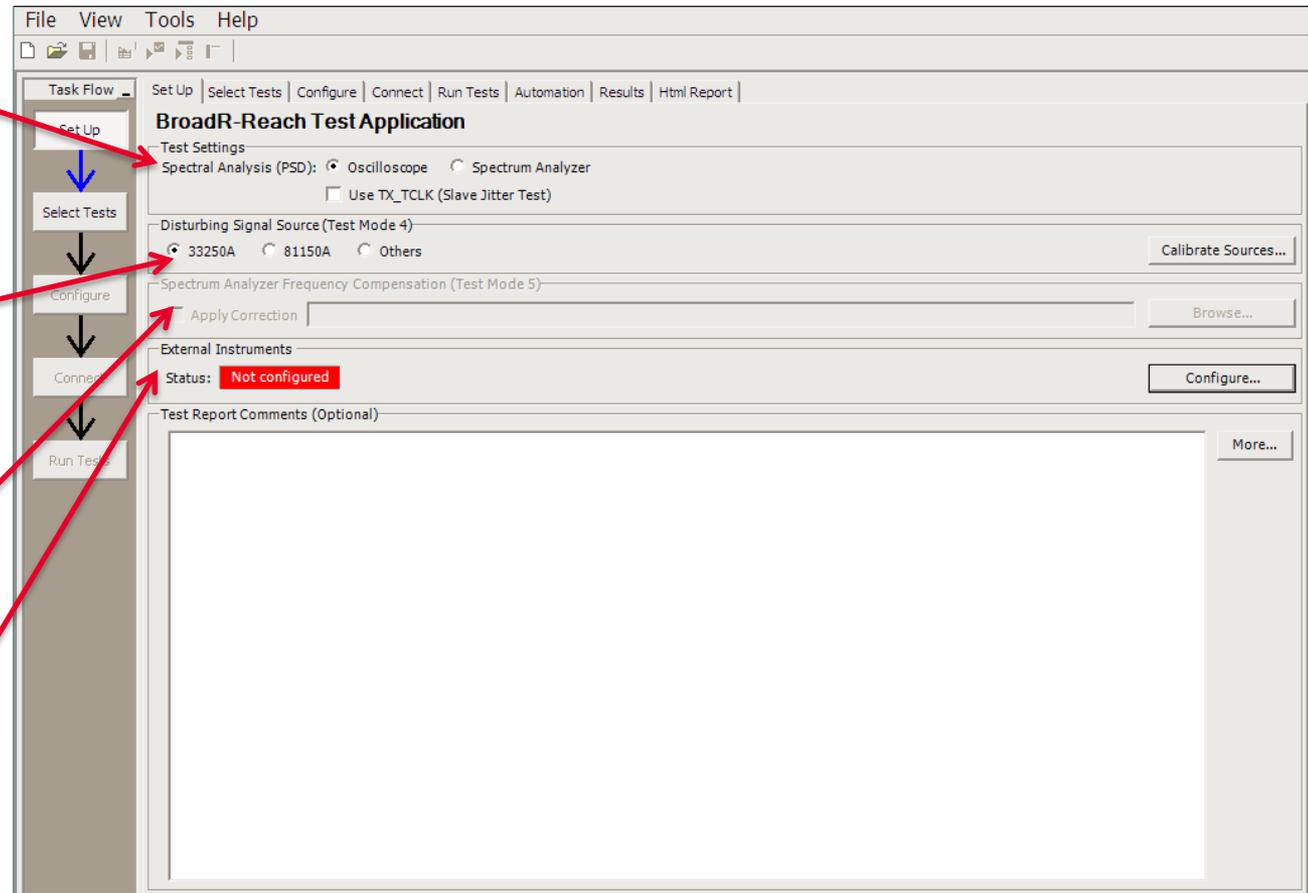
- • Transmitter Distortion Test (along with MATLAB)

- Power Spectral Density
 - Scope FFT
 - Spectral Analyzer

- Offline Waveform analysis

BroadR-Reach Compliance Application

- For power spectrum density measurement use either Keysight Spectrum analyzer or oscilloscope. We setup the Keysight spectrum analyzer for you.
- We setup the Keysight signal source for you and calibrate it automatically.
- Fixture correction file can be used for the spectrum analyzer to get the most accurate measurement possible.
- Used to setup external instruments such as signal sources and spectrum analyzers.



BroadR-Reach Compliance Application

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

- Easy to use interface with 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.

File View Tools Help

Task Flow

Set Up

Select Tests

Configure

Connect

Run Tests

Set Up Select Tests Configure Connect Run Tests Automation Results Html Report

Broad-R Reach Tests

Test Mode 1 Tests

+Vout Droop

-Vout Droop

Test Mode 2 Tests

TX_TCLK Frequency (Master)

MDI Output Jitter, JTXOUT (Master)

Test Mode 3 Tests

TX_TCLK Frequency (Slave)

TX_TCLK Jitter (Slave)

Test Mode 4 Tests

Transmitter Distortion

Test: Transmitter +Vout Droop

Pass Limits: Transmitter +Vout Droop < 45.00 %

Description: The positive droop measured with respect to an initial peak value after the zero crossing and the value 500ns after the initial peak, shall be less than 45%.

Reference: BroadR-Reach Physical Layer Transceiver Specification v1.2, Section 5.4.1

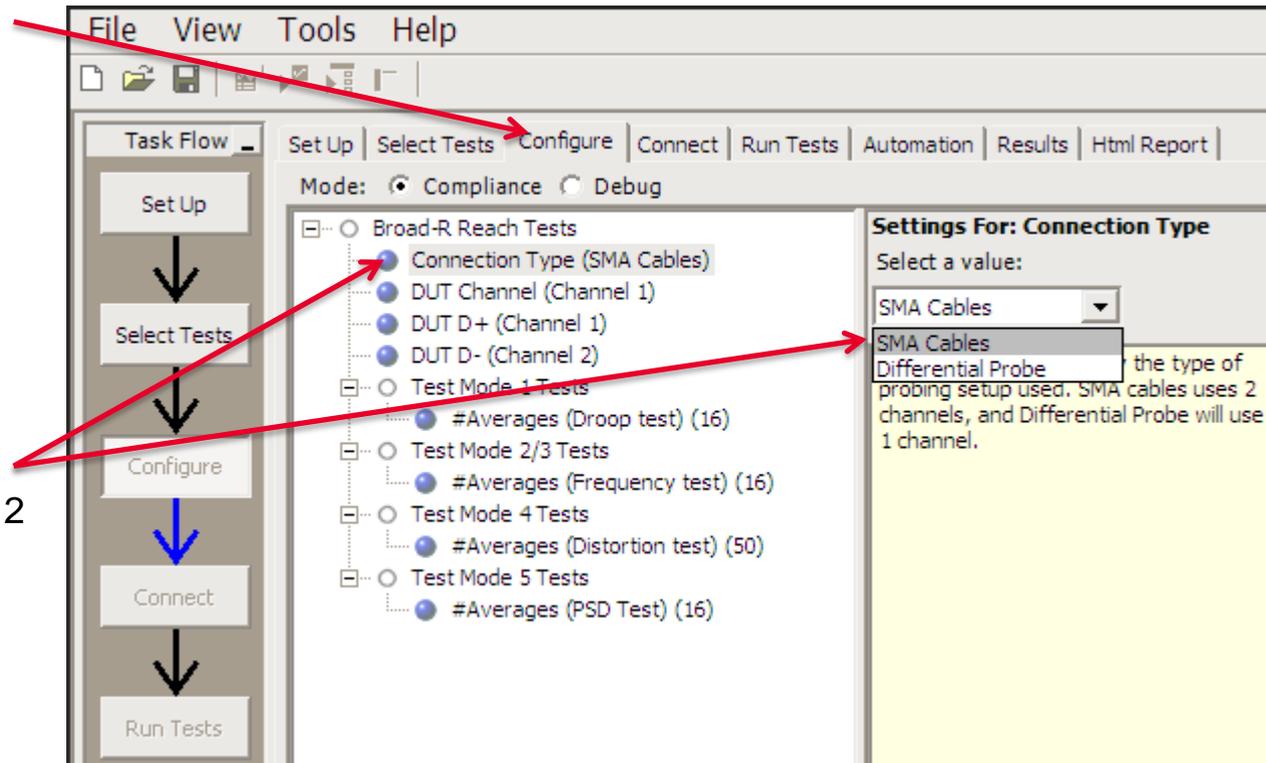
=== Margin Formula: ===

Margin = ((Max - Actual) / |Max|) * 100%

The Keysight 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.

BroadR-Reach Compliance Application

- The configure tab allows the user to select different channels and other measurement attributes.
- For example the signal input can be changed from a differential probe to 2 SMA cables.



BroadR-Reach Compliance Application

File View Tools Help

When you make multiple tests where the connections must be changed, the software prompts you with connection diagrams.

The screenshot displays a software interface for configuring test connections. On the left, a sidebar contains the text "Follow these instructions to start testing" and a "View Wfm" button. The main area features a connection diagram with the following components and connections:

- Oscilloscope**: A box at the top right with two SMA connectors labeled "+Chan" and "-Chan".
- 33250A Slave** and **33250A Master**: Two function generator boxes on the left. They are connected to the Ethernet Test Fixture via SMA cables.
- DUT**: A Device Under Test box on the left, connected to the Ethernet Test Fixture via two SMA cables (one blue, one red).
- Ethernet Test Fixture Section 11**: A central box with four SMA connectors. It is connected to the Oscilloscope via two SMA cables (one blue, one red).
- GIPIB connection via USB-GPIB adapter**: A line connects the Slave/Master area to the Oscilloscope.

Below the diagram is a table with the following content:

Step	Notes
1. Connect the DUT to the Ethernet Test Fixture, Section 11 using a pair of SMA cables.	Connect the DUT to the SMA connectors labeled "DUT"
2. Connect the Function Generators to the Ethernet Test Fixture, Section 11 using a pair of SMA cables.	Please calibrate the Function Generators before running the test.
3. Connect the Oscilloscope to the output of the Ethernet Test Fixture, Section 11	Connect the oscilloscope to the SMA connectors labeled "C"

At the bottom of the interface, there are three buttons: a checked checkbox "I have completed these instructions", a "Run Tests" button, and an unchecked checkbox "Suppress all connection prompt".

Each connection is clearly identified for the user including additional hardware and cables

BroadR-Reach Compliance Application

File View Tools Help

Set Up | Select Tests | Configure | Connect | Run Tests | Automation | Results | Html Report

BroadR-Reach Test Report

Overall Result: **FAIL**

Test Configuration Details	
Device Description	
Disturbing Signal Source	33250A
Connection Type	Spectrum Analyzer
Test Session Details	
Infiniium SW Version	04.20.0001
Infiniium Model Number	DSO9404A
Infiniium Serial Number	No Serial
Application SW Version	0.99.9032
Debug Mode Used	No
Last Test Date	2013-04-11 04:28:00 UTC -06:00

Summary of Results

Test Statistics	
Failed	3
Passed	5
Total	8

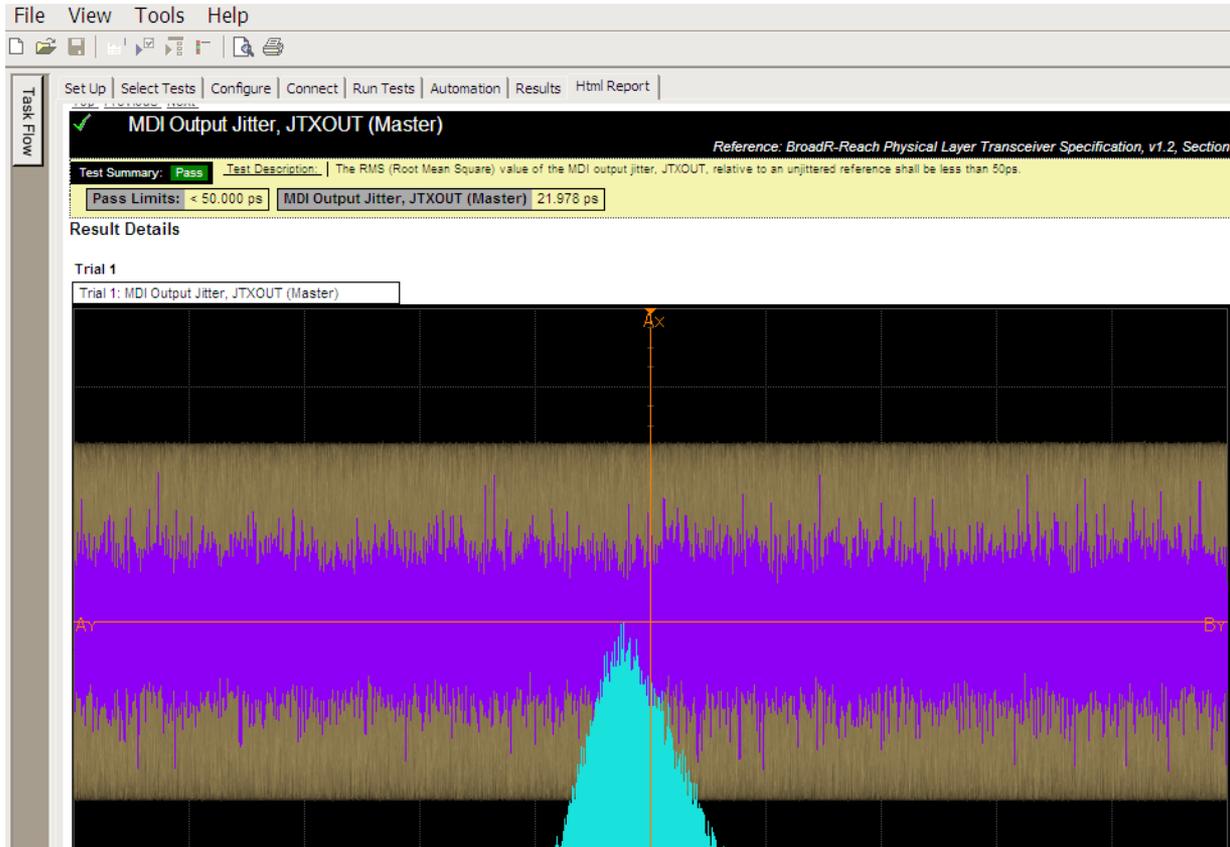
Margin Threshold	
Warning	< 2 %
Critical	< 0 %

Pass	# Failed	# Trials	Test Name	Worst Actual	Worst Margin	Pass Limits
X	1	1	Transmitter +Vout Droop	55.11 %	-22.5 %	VALUE < 45.00 %
X	1	1	Transmitter -Vout Droop	55.22 %	-22.7 %	VALUE < 45.00 %
✓	0	1	TX_TCLK Frequency	66.668990	66.668990	66.660000 MHz <= VALUE <=

- Margins and thresholds can be changed to reflect current design model testing. Yellow is marginal while red indicates the spec threshold has been broken.
- In this case the test has failed because the signal was over the threshold.

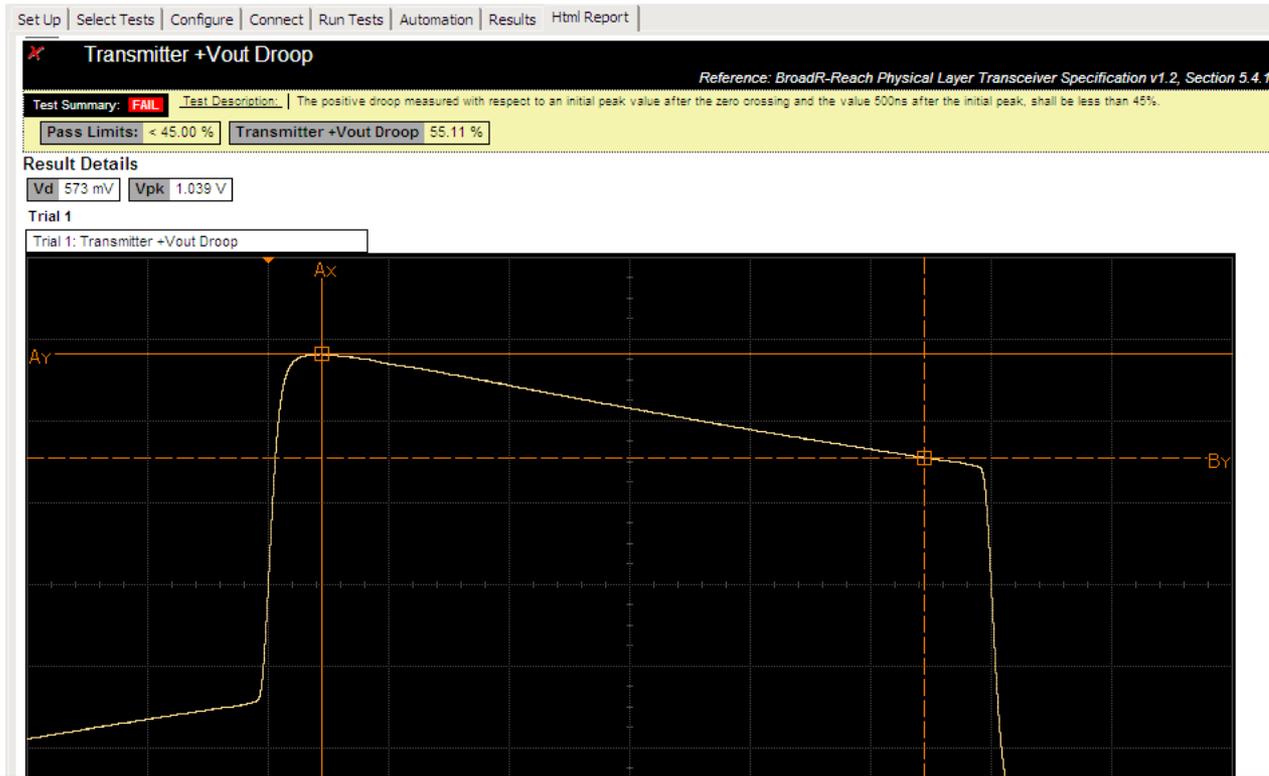
The Ethernet electrical test software results screen shows a summary of the tests performed, pass/fail status, and margin. Clicking on a specific test also shows the test specification and a measurement waveform, if appropriate.

BroadR-Reach Compliance Application



Additional details are available for each test, including the test limits, test description, and test results, including waveforms, if appropriate.

BroadR-Reach Compliance Application

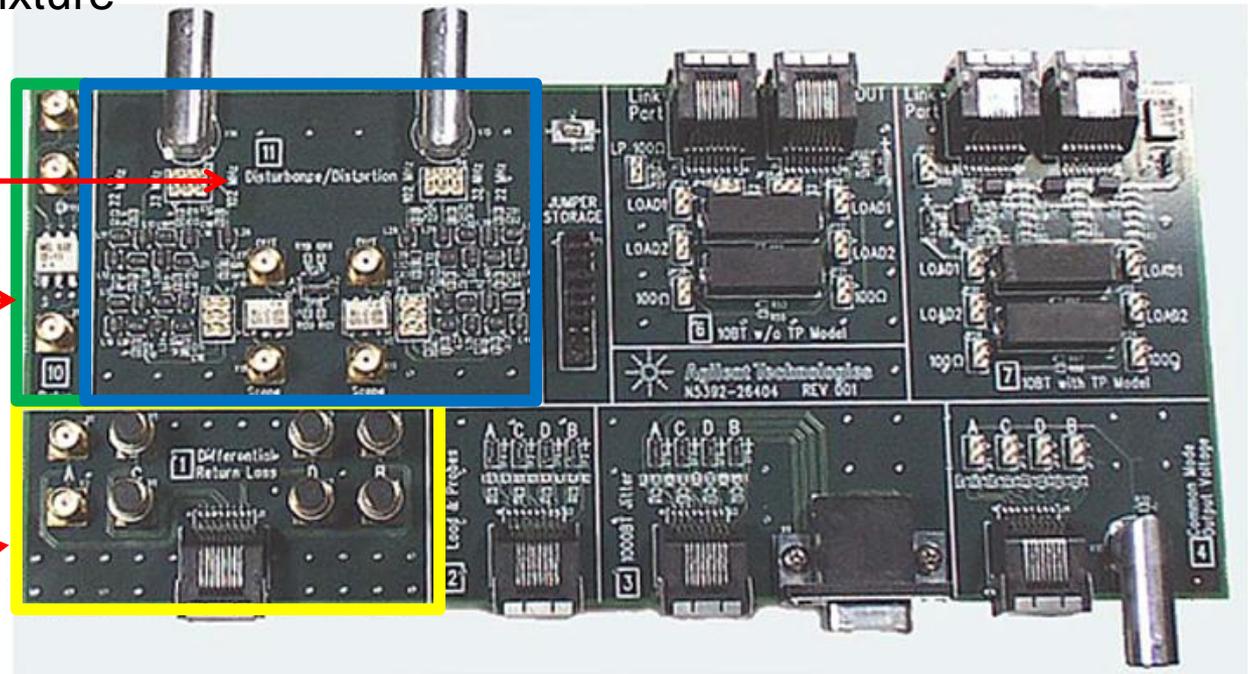


In the report we can display screen shots of the device under test to show how the signal passed or failed. In this case we are showing the Droop test measurement.

Keysight Ethernet Fixture

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

- Disturbing signal test section (Blue) →
- Balun used for Power spectrum density test (Green) →
- Break out board used for RJ45 connections (Yellow) →



Keysight Advantages

N6467A BroadR-Reach Compliance application does it all...

Saves you money...on analysis software

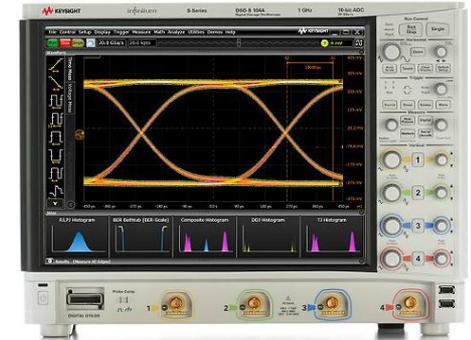
- ✓ No extra cost for software analysis tools such as EZJIT+ and SDA a savings of \$18K USD.
- ✓ HTML results can be displayed in any computer that has Internet explorer, no need to have a scope to see reports.

Saves you time...you don't need to be an expert on every instrument

- ✓ Full automated control of the oscilloscope
- ✓ Full automated control of the vector network analyzer
- ✓ Full automated control of spectrum analyzer
- ✓ Full automated control of signal source

No need for a live signals...

- ✓ Full offline analysis, just import waveforms even from other scopes.



The N6467A Compliance application will calibrate, setup and run the hardware for you so you don't have to be an expert, saves you time and money!!!

Scope Configuration: DSOS104A example

Model Number	Product Description	Qty
Oscilloscope		
• DSOS104A or better	1GHz, 10 bit ADC, 20GSa/s, 50 Mpts/Ch Oscilloscope	1
Application SW		
• 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. Keysight scope needs D+ and D- . This can be done with SMA or BNC cabling, with a differential probe, or using a test fixture..

Configuration – Transmitter test

Model Number	Product Description	Qty
DSOS104A	1GHz, 10 bit ADC, 20GSa/s, 50 Mpts/Ch Oscilloscope	1
N6467A	BroadR Reach PHY Conformance Test Software	1
1130A (*)	InfiniiMax I 1.5GHz	1
E2678A (*)	Socket Probe Head	1
N5395C (*)	Ethernet Test Fixture	1
82357B (**)	USB-GPIB Interface	1
33SMA-Q50-0-4 (***)	Fairview Microwave SMA(f) to QuickMate SMA(m) push-on adapter (Optional)	2

(*) These products are shown as example.

BroadR Reach specification does NOT define connector spec, so please discuss with customer about the way of probing.

(**) Needed to control spectrum analyzer from oscilloscope

(***) Optional productivity saver, used for quick connection from fixture to scope to DUT. 4 can be added for even further productivity enhancements.

Configuration – Transmitter test – PSD Test

Model Number	Product Description	Qty
N9010A	EXA series spectrum analyzer (*)	1
N9010A option 503	9kHz - 3.6GHz	1
N9010A option FSA	Fine Step Attenuator	1
1250-1250	N(m)-SMA(f) adapter	1
	Balun (Built into the Ethernet Fixture)	1
	SMA(m)-SMA(m) Cable (*)	2

(*) Power Spectral density test is done by default by the scope through an FFT function, however customers can also use the spectrum analyzer for PSD test as well.

(**) These products are shown as example.

BroadR Reach specification does NOT define connector spec, so please discuss with customer about the way of probing.

Configuration – Transmitter - Return Loss Test

Model Number	Product Description	Qty
E5071C	ENA Series Network Analyzer	1
E5071C option 440	9kHz-4.5GHz 4port S parameter Test set	1
1250-1250	N(m)-SMA(f) adapter	2
N4431B	4 ports Ecal 9kHz-13.5GHz	1
N4431B option 010	4 x 3.5mm (f) connectors	1
	Fixture (***)	1
	Cables (***)	

(***) BroadR Reach specification does NOT define connector spec, so please discuss with customer about the way to acquire signal to ENA.

Ethernet Compliance Applications

- N6468A SFP+ Ethernet Compliance Application
www.keysight.com/find/SFP
- N8814B 10GBASE-KR Ethernet Backplane Compliance Application Software
www.keysight.com/find/10G-KR
- N8815A 10GBASE-KR 64B/66B Ethernet Backplane Decoder
www.keysight.com/find/10GBASE-KR
- N5392B 10/100/1000BASE-T Standard and Energy Efficient Ethernet Compliance application
www.keysight.com/find/EEE
- U7236A 10GBASE-T Ethernet Electrical Conformance Application
www.keysight.com/find/10gbase-t
- N5431A XAUI Electrical Validation with 10GBase-CX4, CPRI, OBSAI, and Serial RapidIO Support
www.keysight.com/find/N5431A
- N6467A BroadR-Reach Compliance Application
www.keysight.com/find/BroadR-Reach
- N8828A 40GBASE-CR4 and 100GBASE-CR10 Compliance Application
www.keysight.com/find/100G-CR10
- N8829A 100GBASE-KR4 Compliance Application
www.keysight.com/find/100G-KR4
- N8830A 100GBASE-CR4 Compliance Application
www.keysight.com/find/100G-CR4

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

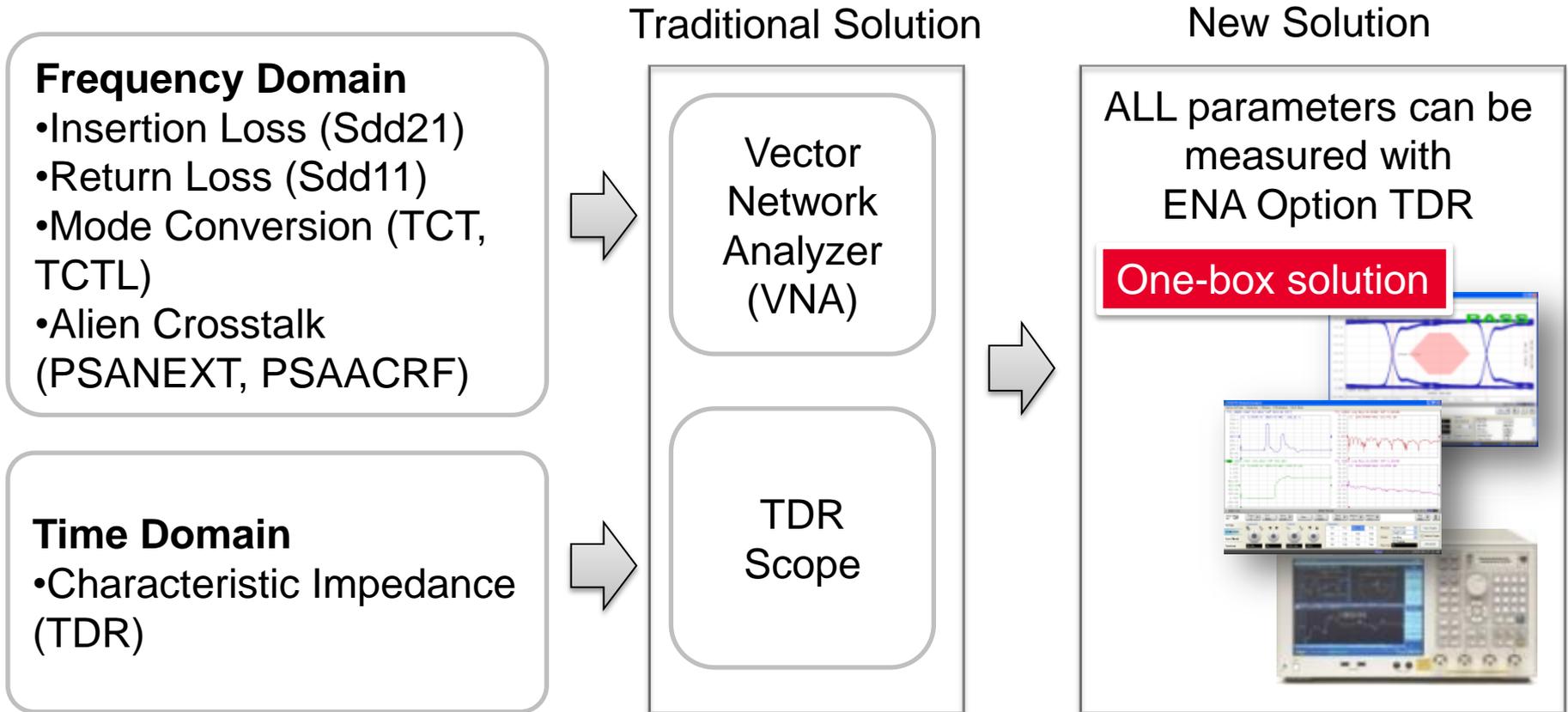
7.2 Power Sum Alien Near End Crosstalk (PSANEXT)

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

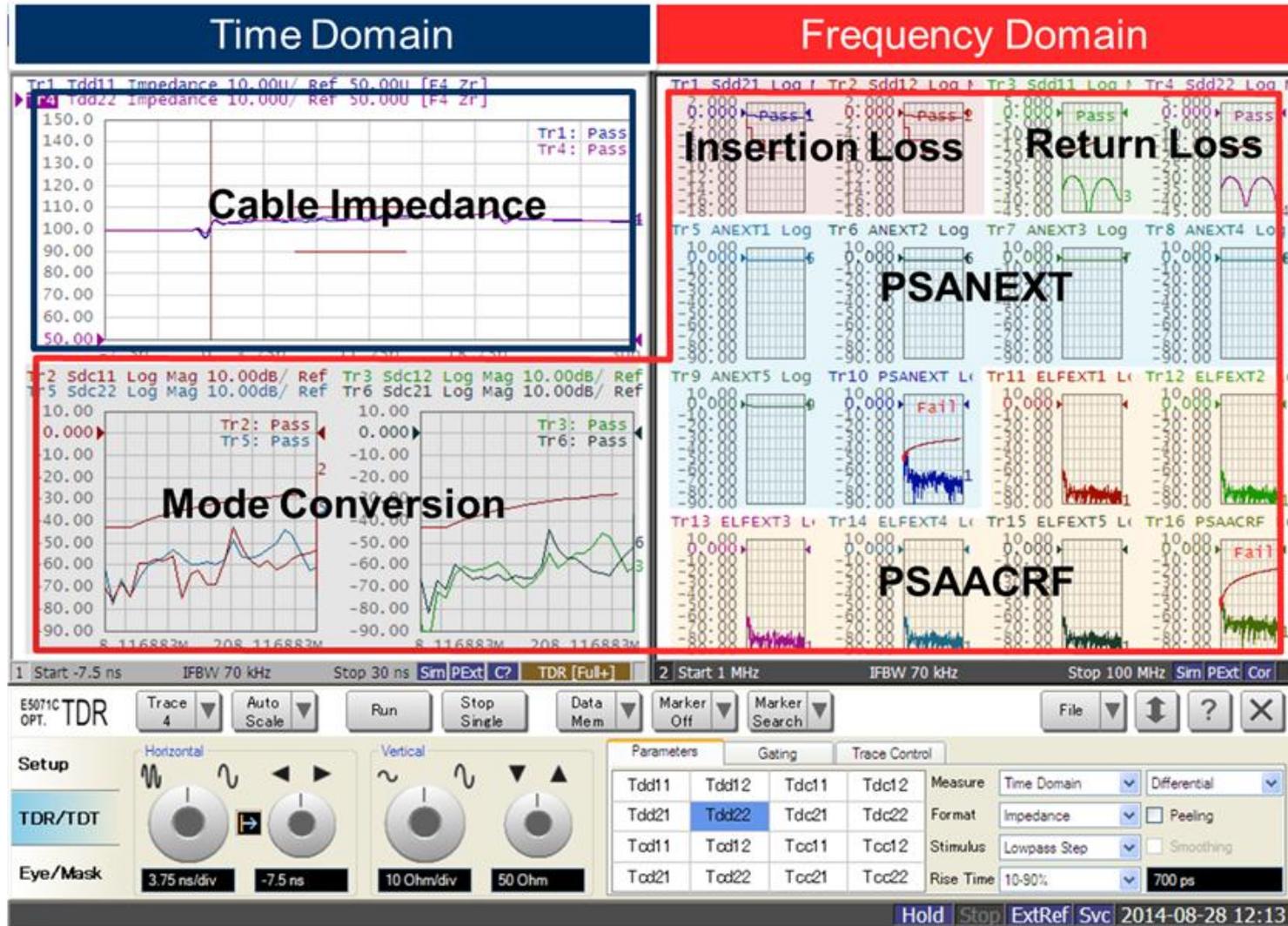
•Reference: Open Alliance BroadR-Reach™ (OABR) Physical Layer Transceiver Specification For Automotive Applications, V3.2, June 24, 2014, Broadcom Corporation

Link Segment Test Solution

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



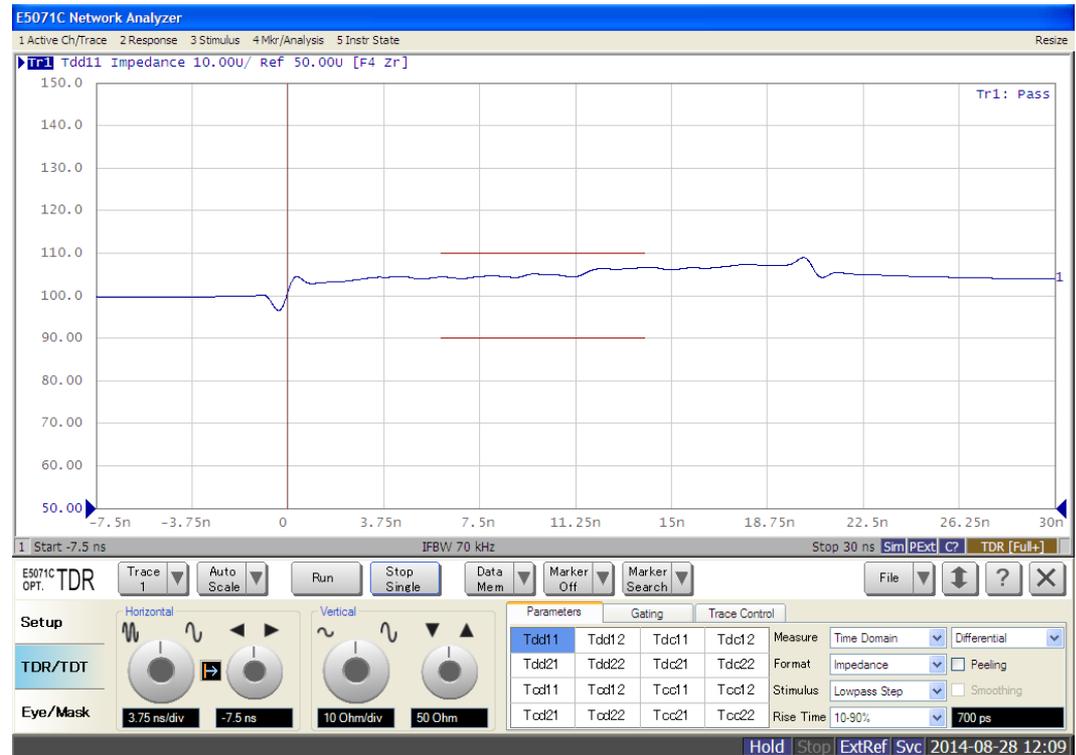
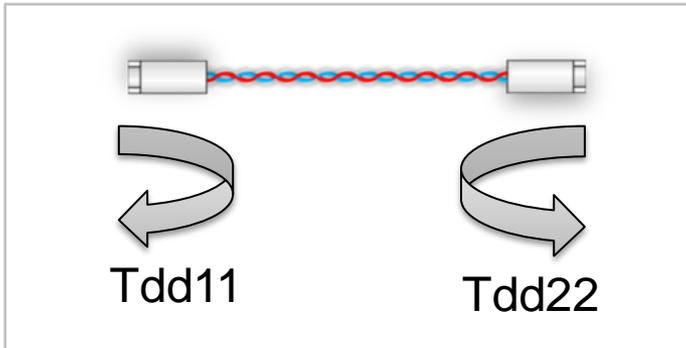
Link Segment Test Measurement Example



7.1.1 Characteristic Impedance

Specification

$$Z = 100\Omega \pm 10\% @ tr < 700ps$$

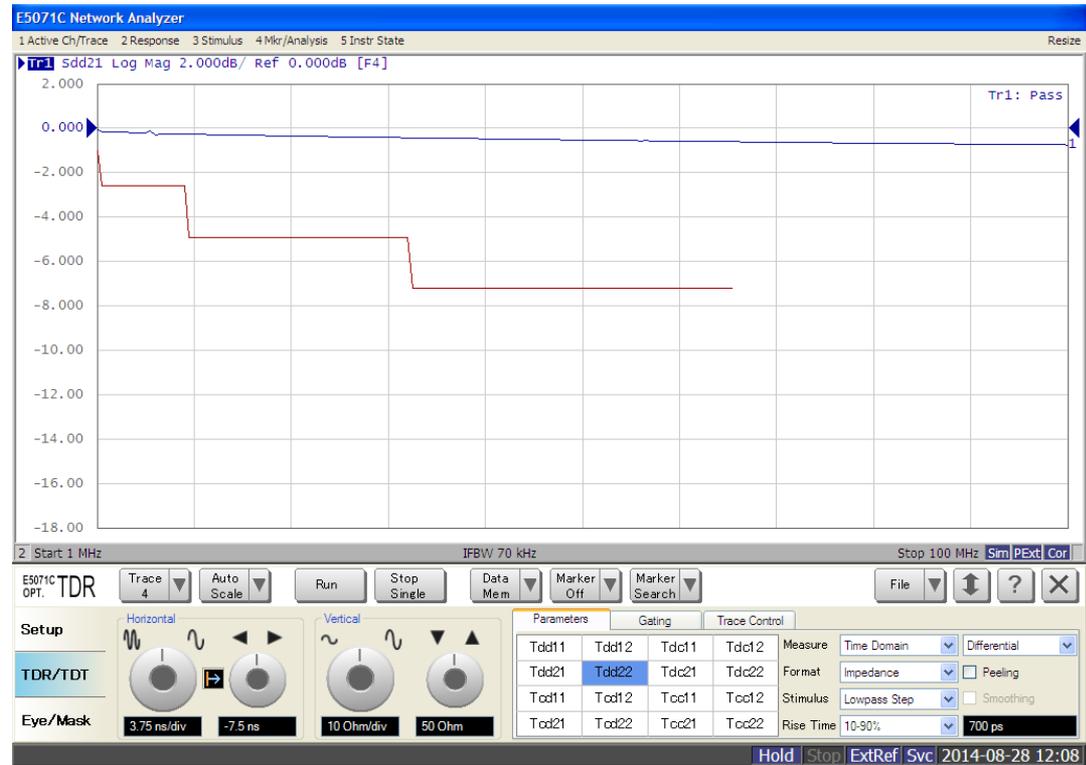
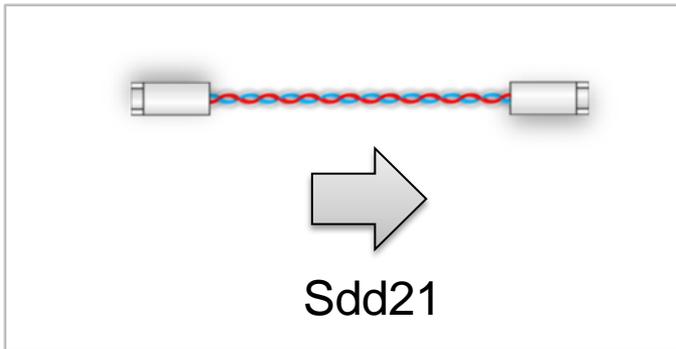


7.1.2 Insertion Loss

Specification

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

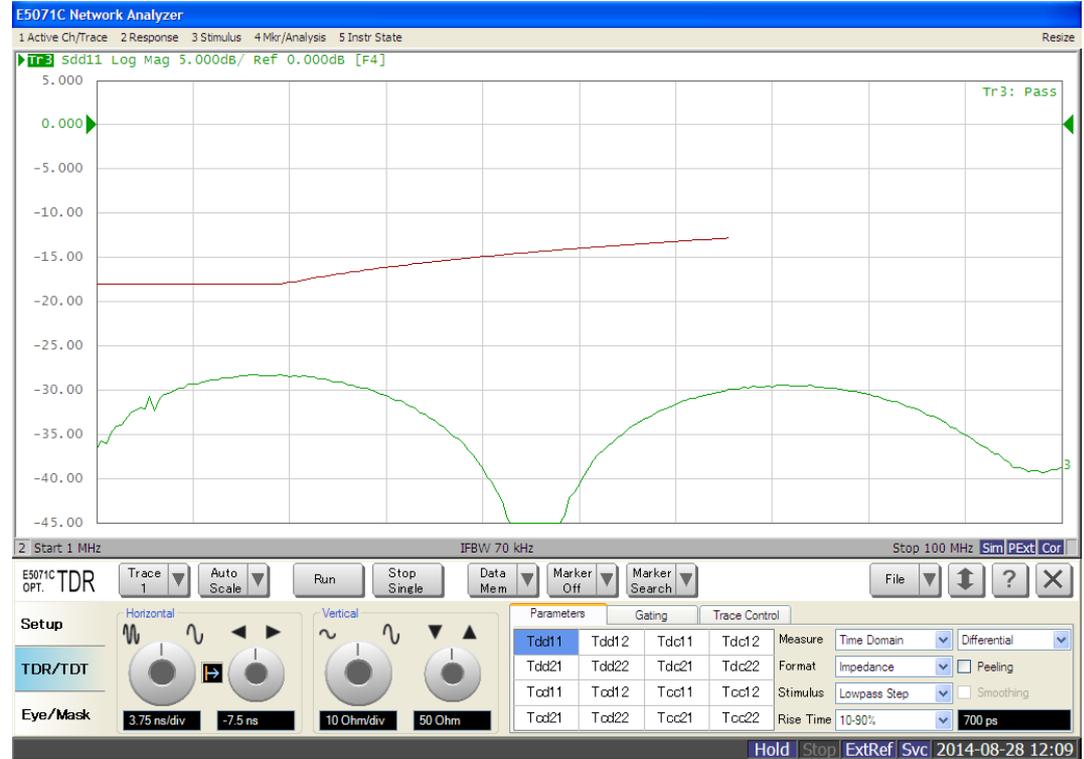
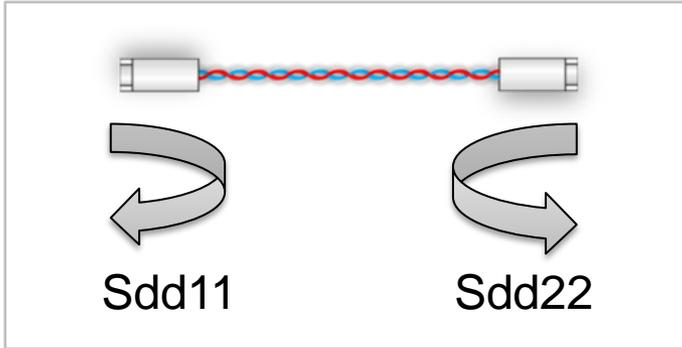
(*) Insertion loss includes the attenuation of the DUT, equipment cables, and connector losses



7.1.3 Return Loss

Specification

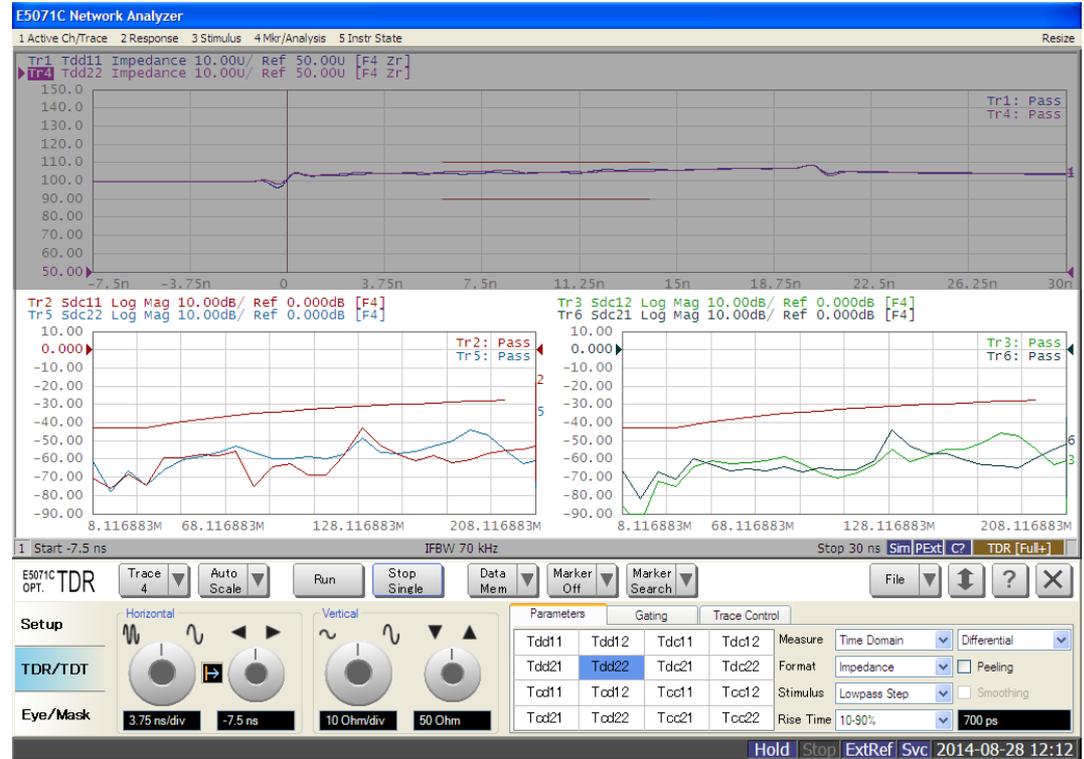
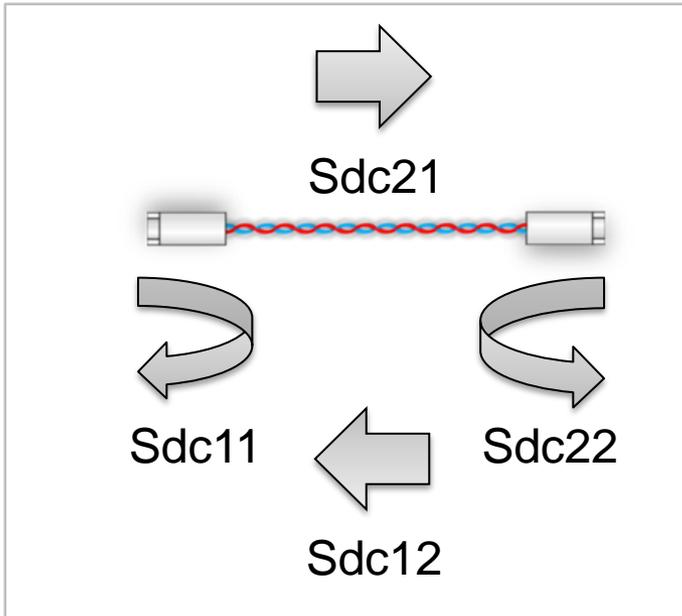
Freq	7.1.3 Return Loss
1-20 MHz	< -18 dB
20-66 MHz	< $-18 + 10 \log_{10}(f/20)$ [dB]



7.1.3 Mode Conversion

Specification

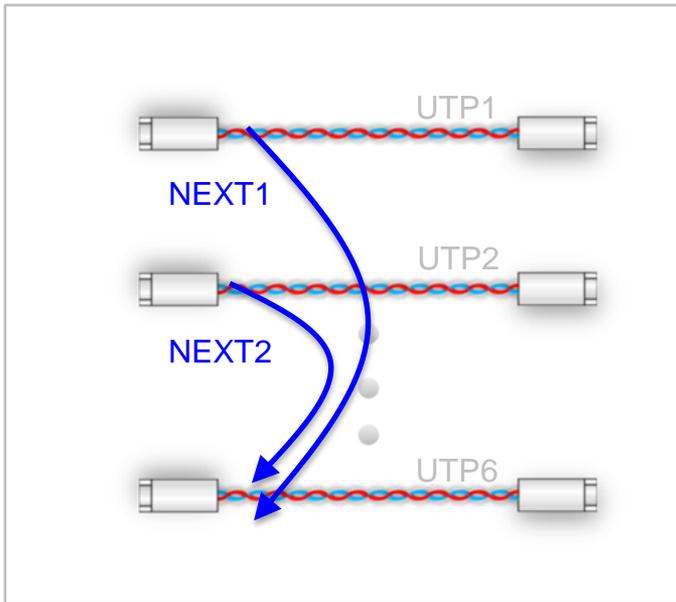
Freq	7.1.3 Return Loss
1-33 MHz	< -43 dB
33-200 MHz	< $-43 + 20 \log_{10}(f/33)$ [dB]



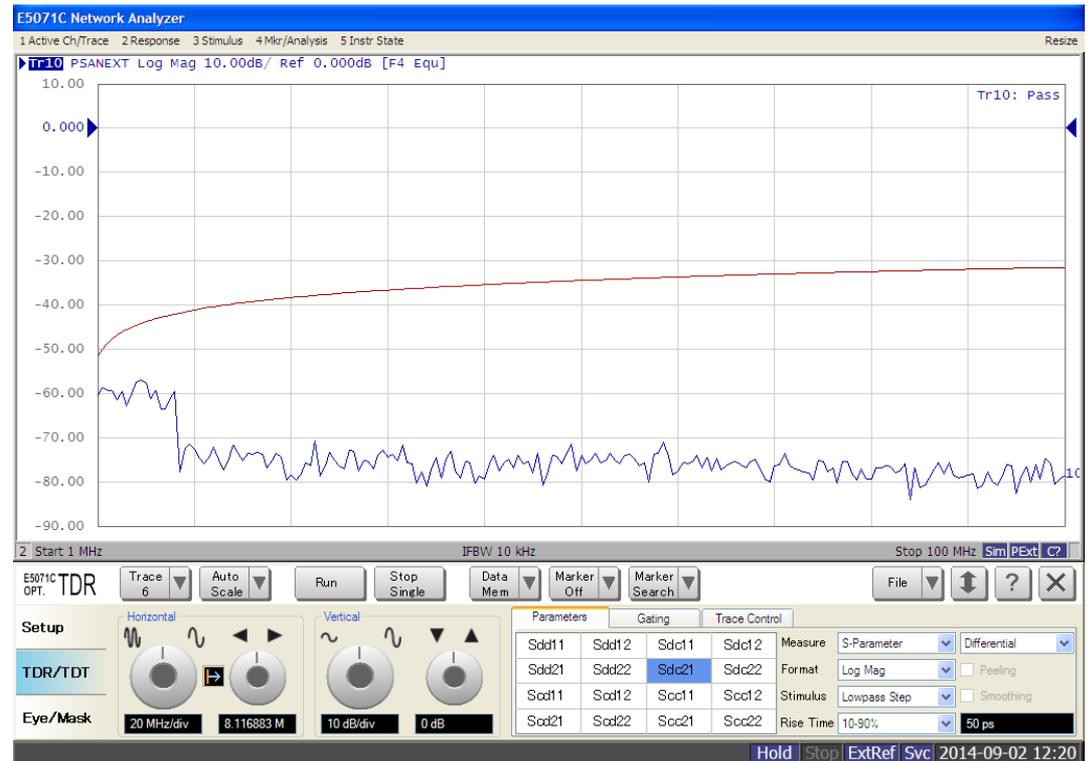
7.2 Power Sum Alien Near End Crosstalk (PSANEXT)

Specification

$PSANEXT > 31.5 - 10\log_{10}(f/100)$ [dB], where $f = 1-100\text{MHz}$



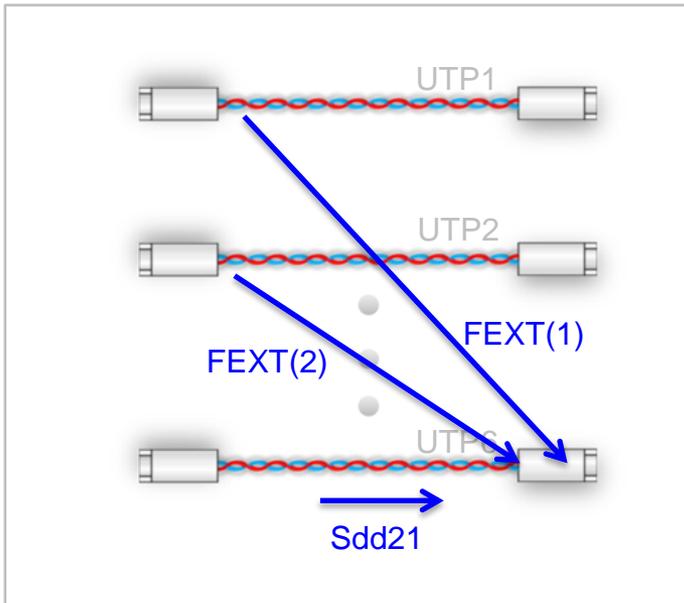
$$PSANEXT = NEXT (1+2+\dots+5)$$



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

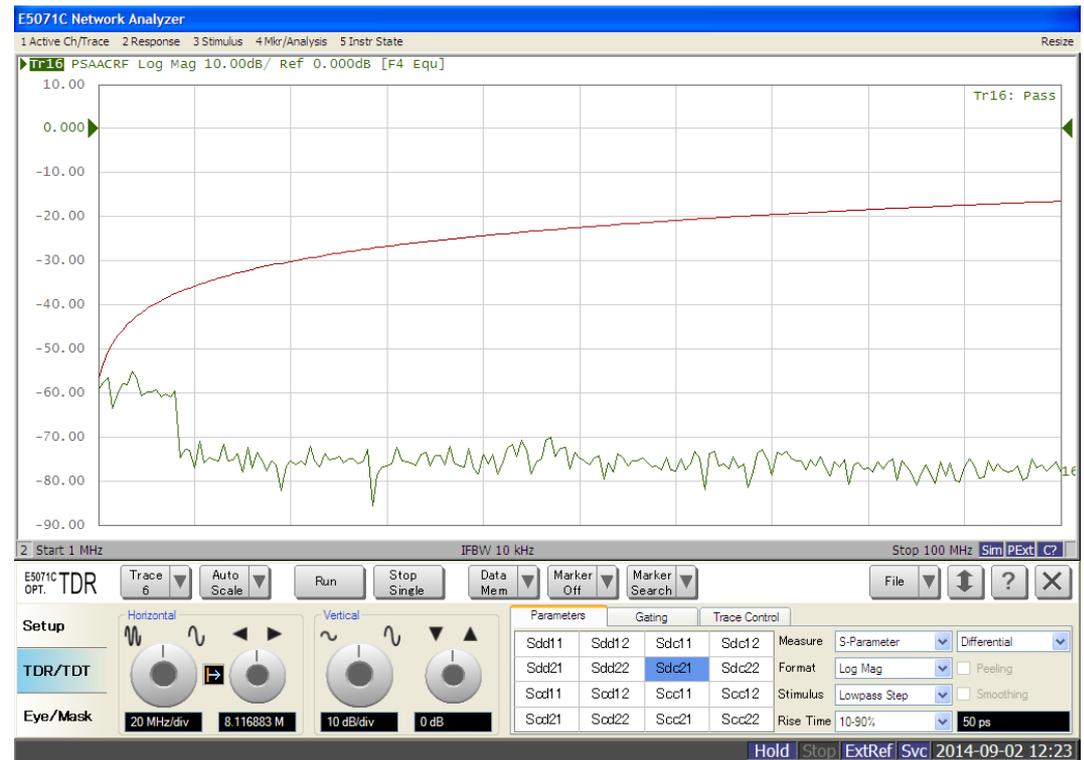
Specification

PSAACRF > $16.5 - 20\log_{10}(f/100)$ [dB], where $f = 1-100\text{MHz}$



$$\text{PSAACRF} = \text{ELFEXT}(1+2+\dots+5)$$

- $\text{ELFEXT}(1) = \text{FEXT}(1) - \text{Sdd21}$
- $\text{ELFEXT}(2) = \text{FEXT}(2) - \text{Sdd21}$
- ...
- $\text{ELFEXT}(5) = \text{FEXT}(5) - \text{Sdd21}$



Keysight 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

The screenshot shows the Keysight website page for the E5071C-TDR Method of Implementation (MOI) for High Speed Digital Applications. The page includes a navigation bar, a search bar, and a main content area with an overview section. A video player is visible, showing a compliance test solution using the Agilent E5071C ENA Option TDR. A table at the bottom lists standards supported by E5071C-TDR, including Standards, Cable-Connector Assembly, Tx/Rx Impedance, and Test Solution Overview.

BroadR-Reach Cable Test Fixtures

• When using the standard RJ45 connector, Keysight'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.

