

Agilent Technologies

100BASE-TX Ethernet Cable Test






Test Solution Overview Using the Agilent E5071C ENA Option TDR

Last Update 2013/09/24 (TH)

Purpose

- This slide will show how to make measurements of **100BASE-TX Ethernet Cable Tests** by using the Agilent E5071C ENA Option TDR.

Ethernet Logo Certification Program

Standard	Standard Body
	USB-IF
	PCI-SIG
	SATA-IO
Ethernet	N/A

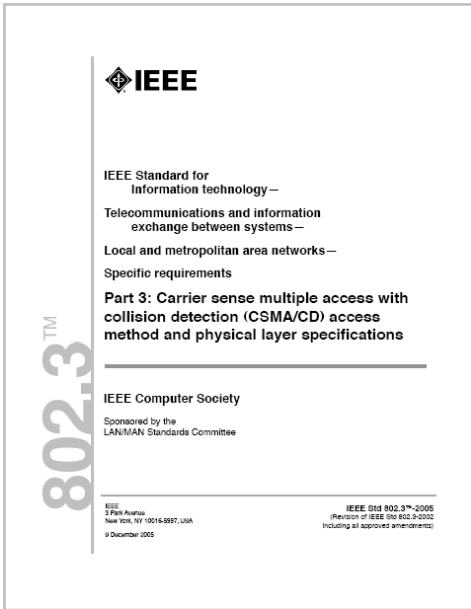
No logo certification program is available for Ethernet (100BASE-TX / 1000BASE-T).

- PHY tests performed in accordance to test procedure issued by University of New Hampshire InterOperability Laboratory (UNH-IOL).
- Self-compliance

Ethernet Specifications and Electrical Test Procedure

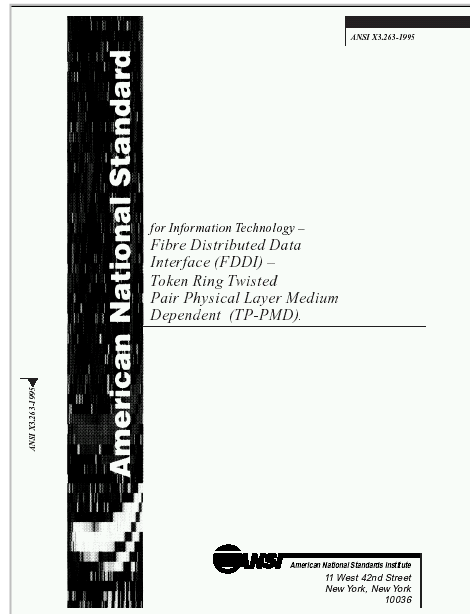
Specifications

IEEE Std 802.3™-2008



ANSI X3.263-1995

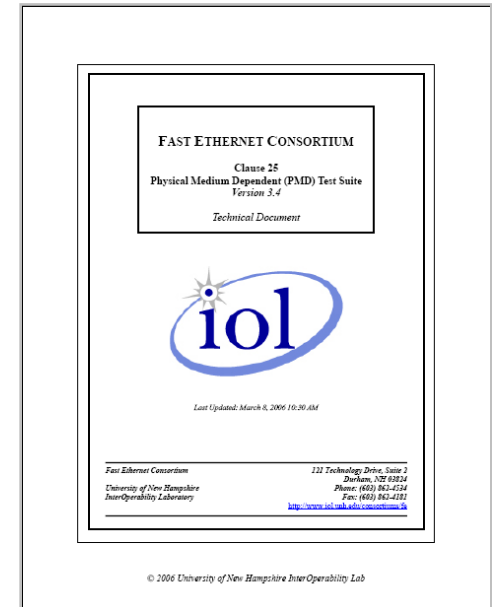
*Fiber Distributed Interface
-Token Ring Twisted Pair
Physical Layer Medium
Dependent*



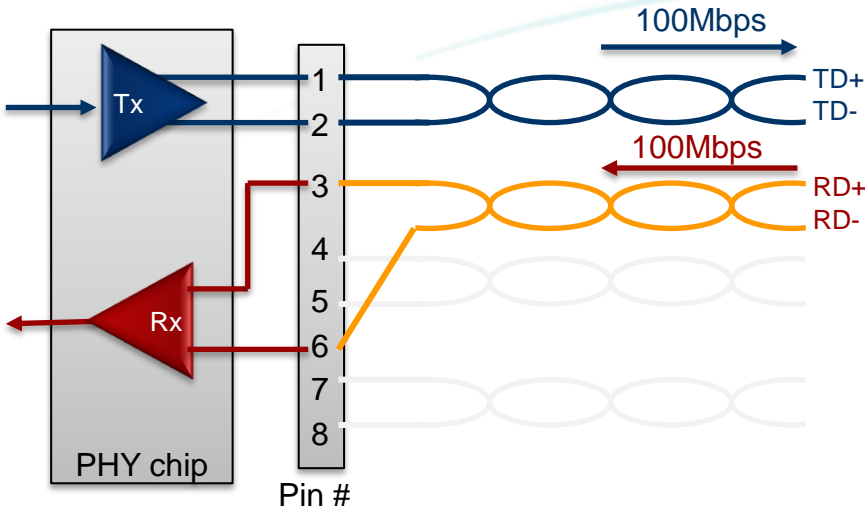
Test Procedure

Test Suite for Ethernet

*University of New Hampshire
InterOperability Laboratory (UNH-IOL)*



100BASE-TX Overview



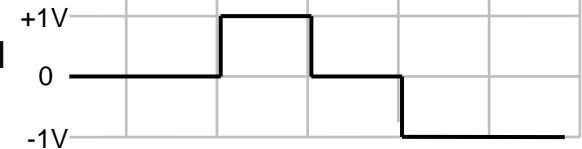
MAC frame
(100 Mbps)

0	1	1	0
---	---	---	---

4B5B encoding
(125 Mbps)

0	1	1	1	0
---	---	---	---	---

MLT-3 signal



MLT-3 signal

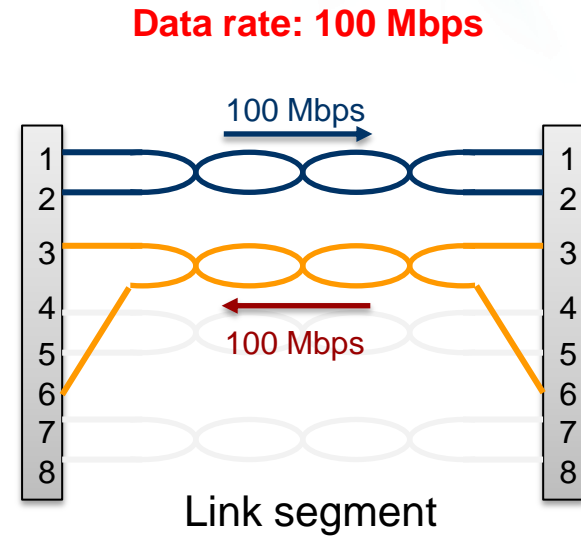
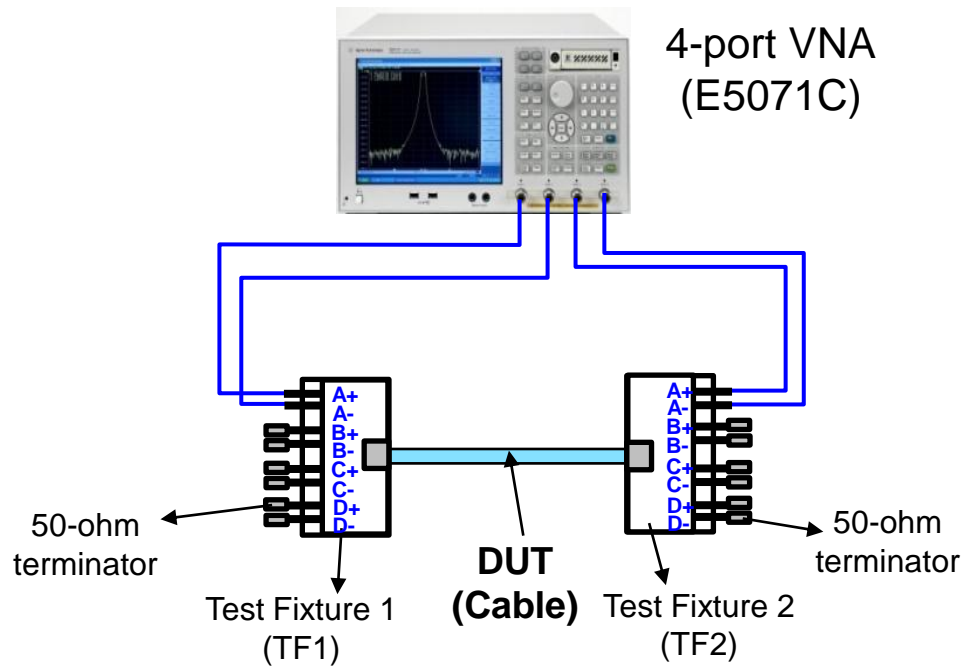
"0": no change

"1": 0 → +1 → 0 → -1 → 0 → ...

- Data rate: 100 Mbps
- Tx and Rx are independent and use 1 twisted pair each. The remaining 2 pairs are not used.
- **4B5B** MAC frame encoding... convert 4 bit pattern into 5 bit pattern to limit length of consecutive 1s, or 0s to within 4 bits (x1.25)
- **MLT-3** (Multi Level Transmission - 3) modulation used to reduce the signal frequency... No change for a "0", change level sequentially for a "1"
- Highest frequency component is 31.25MHz. **Cat 5** (max 100MHz) cable or better is required.

100BASE-TX Ethernet Cable Test

Test Setup Example



- 100BASE-TX runs over two wire-pairs inside a Category 5 or better cable.
- Uses one pair of twisted wires in each direction, providing 100 Mbps in each direction (full duplex).

100BASE-TX Electrical Test Item List

Specifications	Test Items
IEEE Std 802.3™-2008	[25.4.7.2.1] Insertion loss
	[25.4.7.2.2] Differential characteristic impedance
	[25.4.7.2.3] Return loss
	[25.4.7.2.4] Differential near-end crosstalk (NEXT)

100BASE-TX Ethernet Cable Test

Solution Overview

- 100BASE-TX Ethernet cable evaluation requires measurements in both the time and frequency domains.

Traditional Solution

Frequency Domain

- Insertion Loss (Sdd21)
- Return Loss (Sdd11)
- Crosstalk (NEXT)



Vector Network Analyzer (VNA)

Time Domain

- Differential Characteristic Impedance (TDR)



TDR Scope



New Solution

- ALL** parameters can be measured with **ENA Option TDR**



100BASE-TX Ethernet Cable Test Configuration

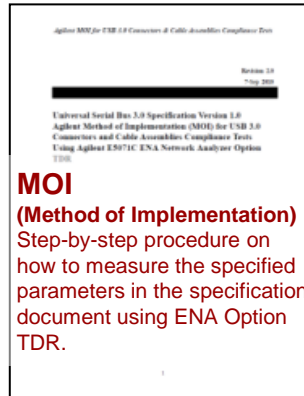


- ENA Mainframe (*1)
 - E5071C-440/445: 4-port, 9 kHz/100 kHz to 4.5 GHz
 - E5071C-460/465: 4-port, 9 kHz/100 kHz to 6.5 GHz
 - E5071C-480/485: 4-port, 9 kHz/100 kHz to 8.5 GHz
 - E5071C-4D5: 4-port, 300 kHz to 14 GHz
 - E5071C-4K5: 4-port, 300 kHz to 20 GHz
- Enhanced Time Domain Analysis Option (E5071C-TDR)
- ECal Module (N4431B / N4433A)

*1: Select one of frequency options. Note 100BASE-TX Ethernet cable tests require frequency up to 100 MHz.

*2: The list above includes the major equipment required. Please contact our sales representative for configuration details.

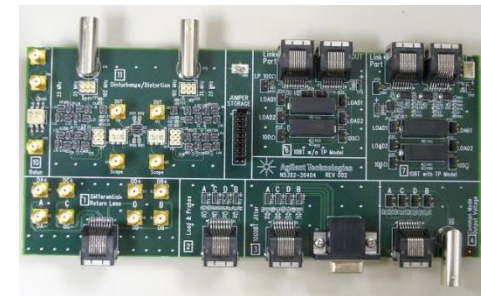
•Method of Implementation (MOI) document and state files (44x/46x/48x or 4D5/4K5) available for download on Agilent.com



www.agilent.com/find/ena-tdr_compliance-cabcon
www.agilent.com/find/ena-tdr_ethernet-cabcon

Test Fixtures

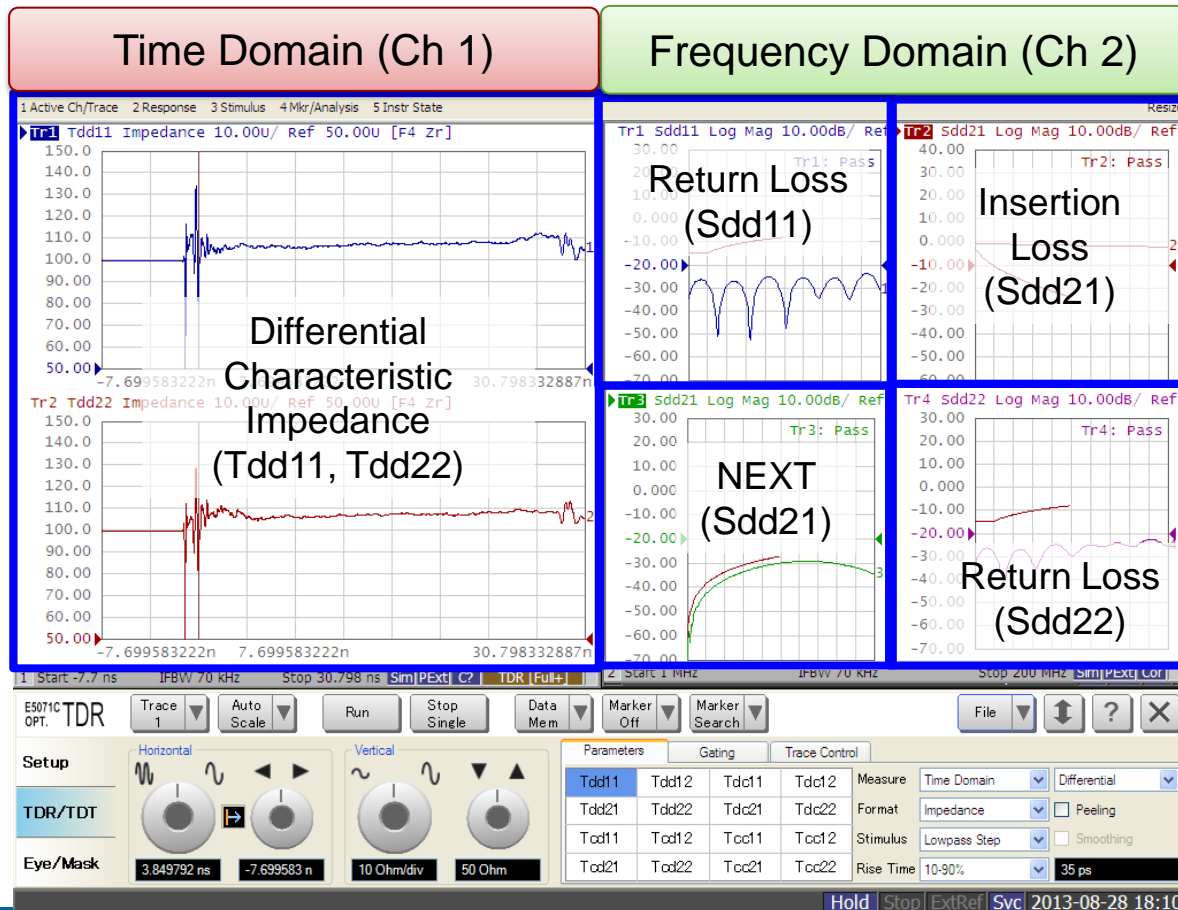
Agilent P/N: N5392-66404 (2/ea)
Test Fixture for Ethernet Application.



100BASE-TX Ethernet Cable Test

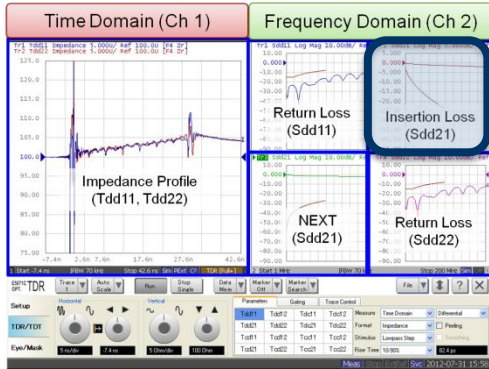
Measurement Parameters

ENA Option TDR is one-box solution which provides complete characterization of interconnects (time domain, frequency domain.)

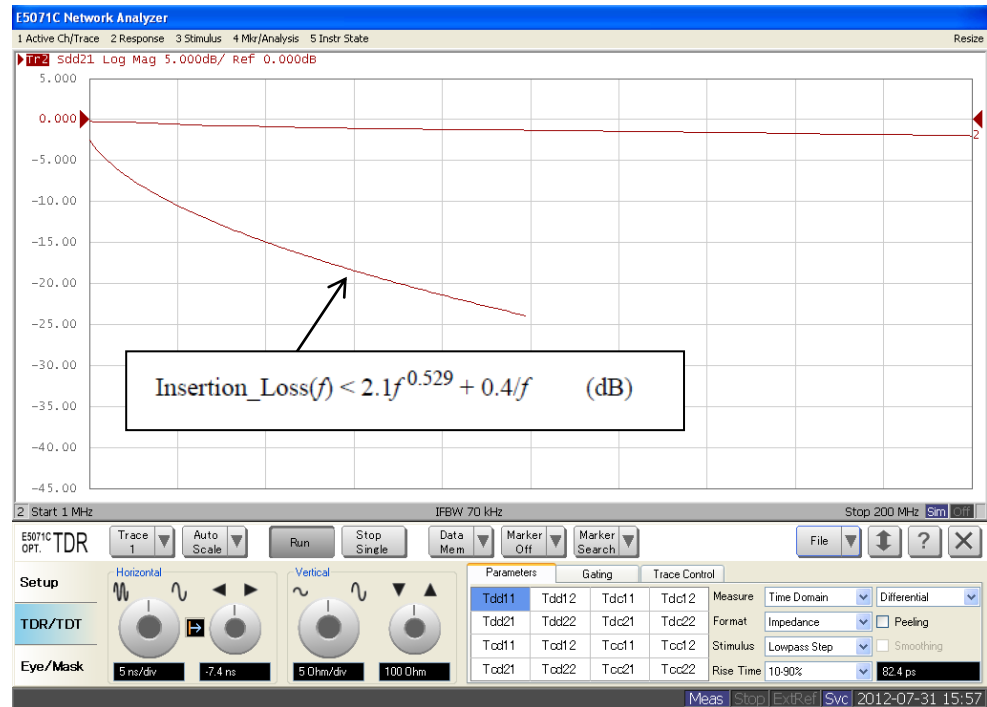
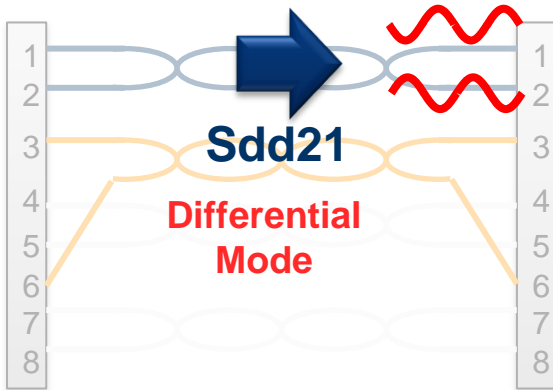


IEEE Std 802.3™-2008

25.4.7.2.1 Insertion Loss



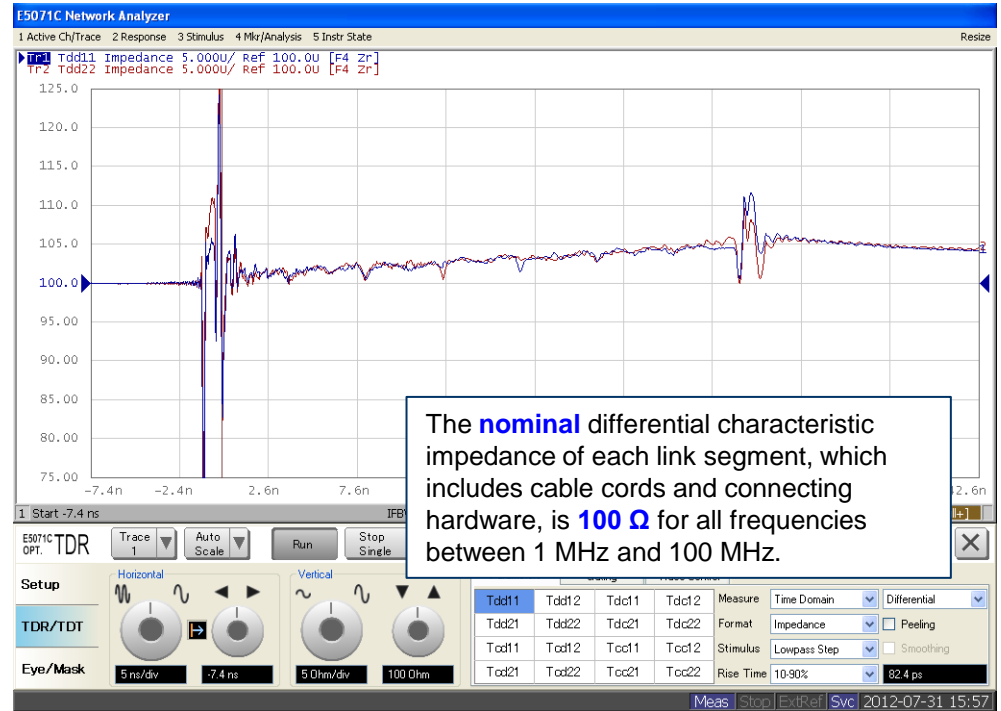
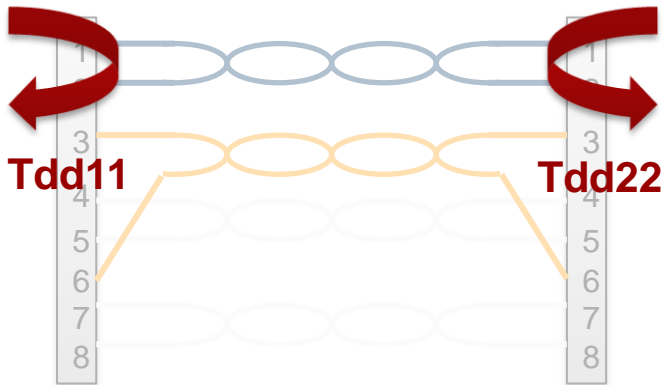
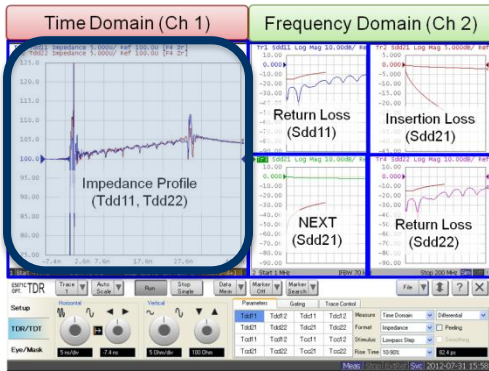
- Frequency response of the differential signal that propagates through the cable.
- Direct measure of the signal reaching the receiver.
- Provides a measure for the highest useable bandwidth.



IEEE Std 802.3™-2008

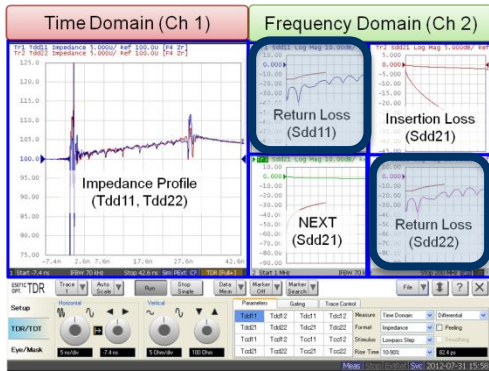
25.4.7.2.2 Differential characteristic impedance

- Noise is generated at the receiver due to impedance mismatch and multiple reflections. The impedance profile provides an indication of the multiple reflection noise.
- Most commonly measured parameter, but is an indirect measure of the signal reaching the receiver.

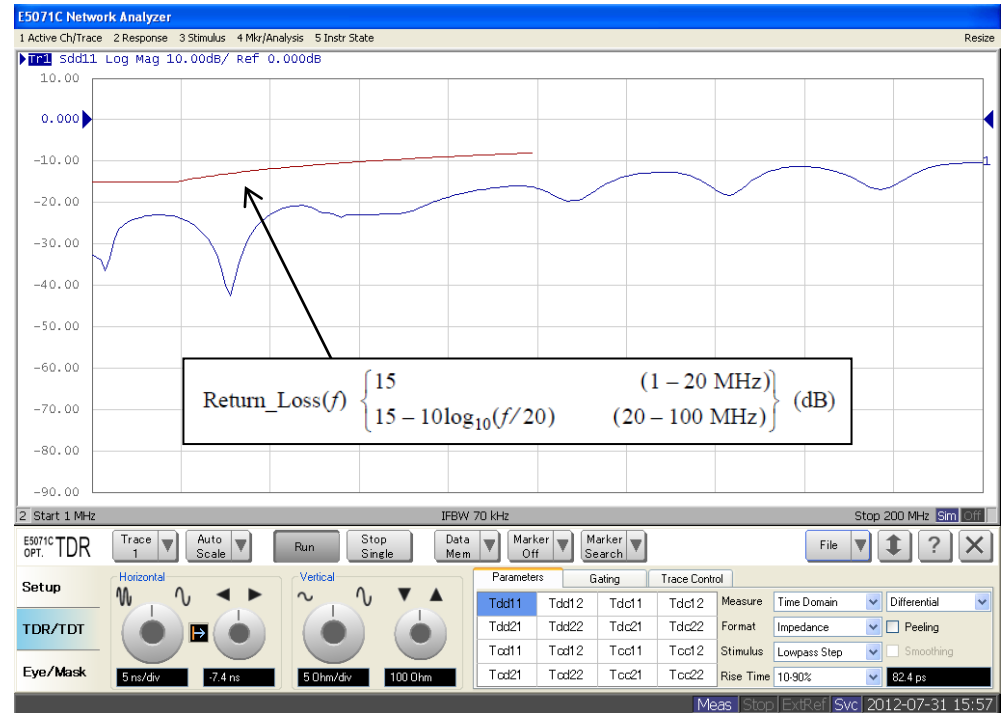
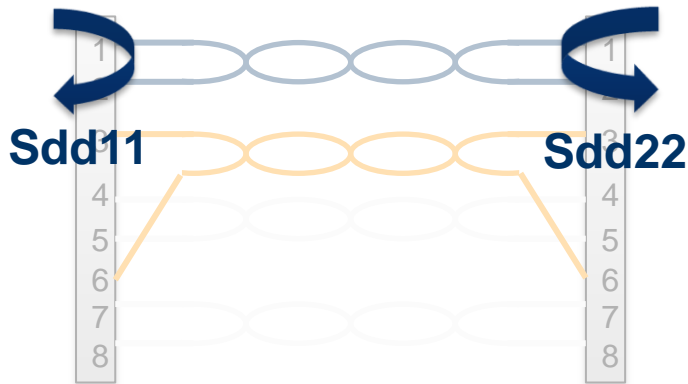


IEEE Std 802.3™-2008

25.4.7.2.3 Return loss



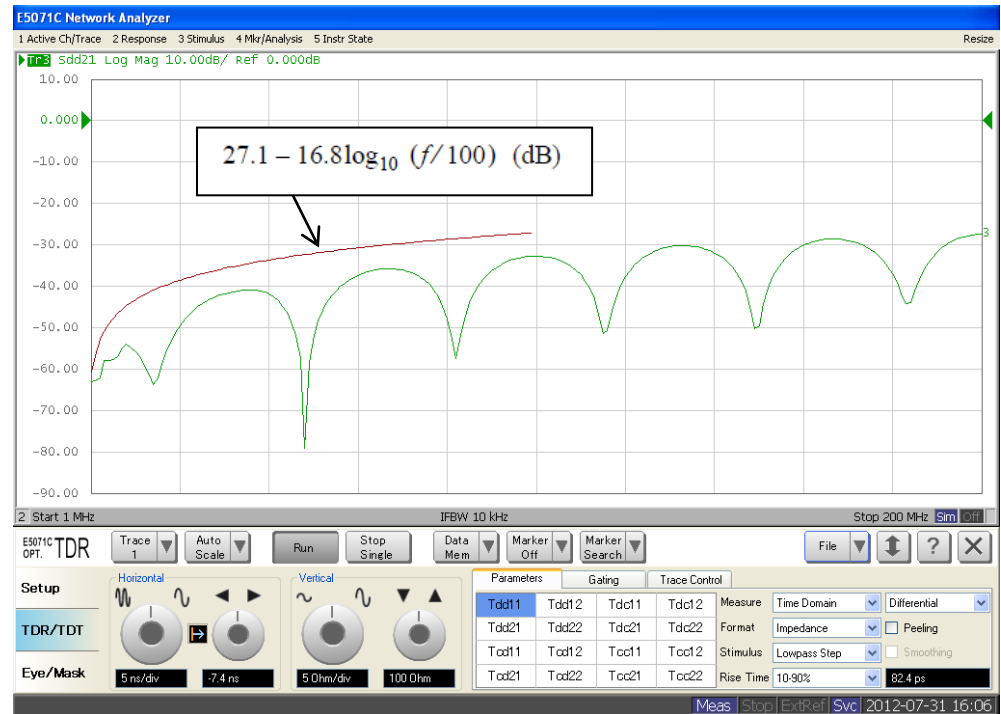
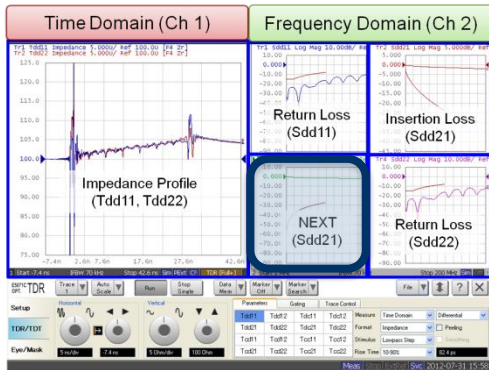
- Ratio of reflected voltage to incident voltage. Key parameter when evaluating impedance mismatch.
- When impedance match is poor, transmission signal quality is degraded due to multiple-reflection effects, leading to increase in bit error rate.



IEEE Std 802.3™-2008

25.4.7.2.4 Differential near-end crosstalk (NEXT)

- Measure of the coupling between the differential pairs.

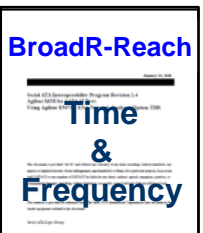
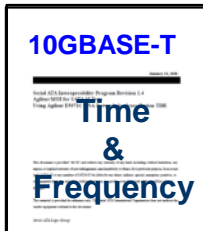
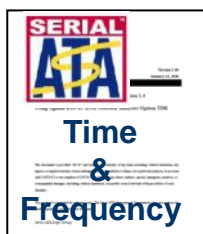
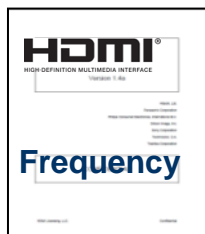
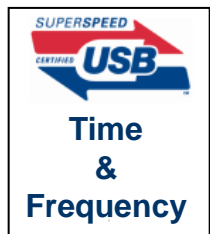


ENA Option TDR Compliance Test Solution

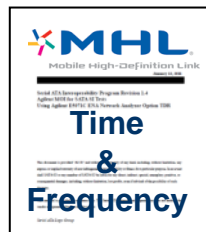
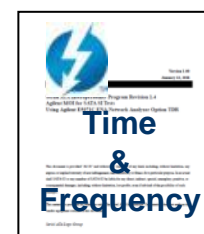
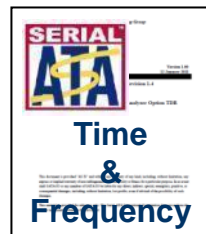
Certified MOIs

Compliance test solutions (i.e. Certified MOIs) with the ENA Option TDR are available at:
www.agilent.com/find/ena-tdr_compliance

Cable / Connector



Transmitter/Receiver (Hot TDR)



* For more detail about Thunderbolt and BroadR-Reach compliance test solution using the ENA Option TDR, contact Agilent sales representative.

ENA Option TDR Compliance Test Solution

Certified Test Centers using ENA Option TDR

Test Centers Support ENA Option TDR

ENA Option TDR is used world wide by certified test centers of USB, HDMI, DisplayPort, MHL, Thunderbolt and SATA.



Ethernet Cable Compliance Test Solution

Summary



ENA Option TDR Cable/Connector Compliance Testing Solution is

- **One-box solution** which provides complete characterization of high speed digital interconnects (time domain, frequency domain, eye diagram)
- Similar look-and-feel to traditional TDR scopes, providing **simple and intuitive operation** even for users unfamiliar to VNAs and S-parameters
- Adopted by test labs worldwide



Questions?

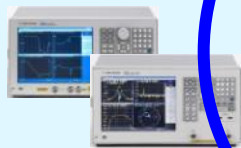


Agilent VNA Solutions

Performance



FieldFox
Handheld RF Analyzer
5 Hz to 4/6 GHz



E5061B
NA + ZA in one-box
5 Hz to 3 GHz
Low cost RF VNA
100 k to 1.5/3.0 GHz



E5071C
World's most popular economy VNA
9 kHz to 4.5, 8.5 GHz
300 kHz to 20.0 GHz



E5072A
Best performance ENA
30 kHz to 4.5, 8.5 GHz

ENA Series



PNA
Performance VNA
10 M to 20, 40, 50, 67, 110 GHz
Banded mm-wave to 2 THz



PNA-L
World's most capable value VNA
300 kHz to 6, 13.5, 20 GHz
10 MHz to 40, 50 GHz



PNA-X, NVNA
Industry-leading performance
10 M to 13.5/26.5/43.5/50/67 GHz
Banded mm-wave to 2 THz



PNA-X receiver
8530A replacement

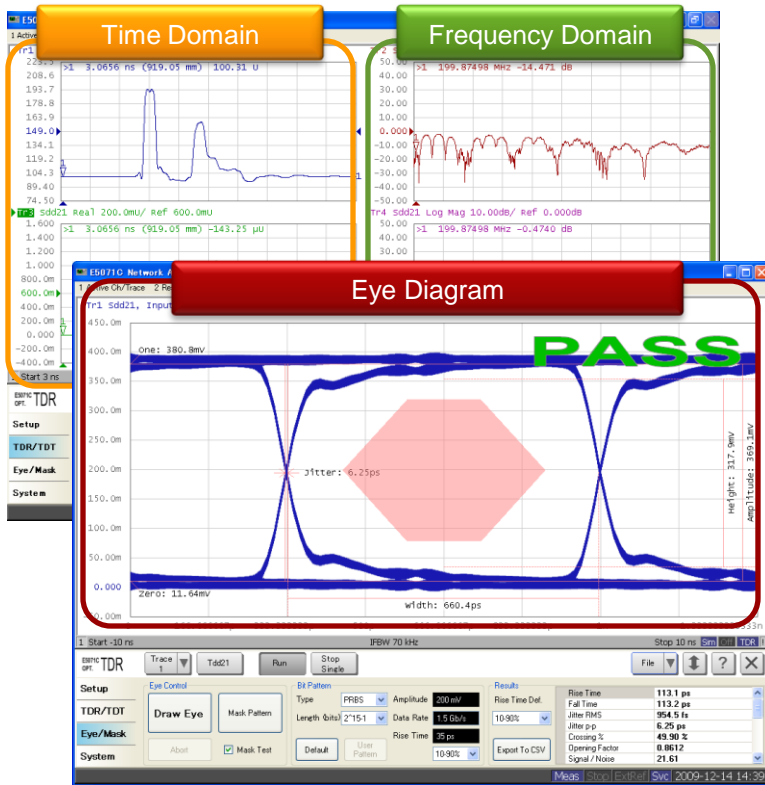


Mm-wave solutions
Up to 2 THz

PNA Series

What is ENA Option TDR?

The ENA Option TDR is an application software embedded on the ENA, which provides an **one-box solution** for high speed serial interconnect analysis.



3 Breakthroughs

for Signal Integrity Design and Verification



Simple and Intuitive Operation



Fast and Accurate Measurements



ESD Robustness

What is ENA Option TDR?

[Video]

Agilent ENA Option TDR

Changing the world of Time Domain Reflectometry (TDR) Measurements

- www.youtube.com/watch?v=hwQNllyJ5hI&list=UUAJAJd97CfnCehC4jZAFkxQ&index=20&feature=plcp
- www.agilent.com/find/ena-tdr



Additional Resources



•ENA Option TDR Reference Material

www.agilent.com/find/ena-tdr

•Technical Overview (5990-5237EN)

•Application Notes

- Correlation between TDR oscilloscope and VNA generated time domain waveform (5990-5238EN)
- Comparison of Measurement Performance between Vector Network Analyzer and TDR Oscilloscope (5990-5446EN)
- Effective Hot TDR Measurements of Active Devices Using ENA Option TDR (5990-9676EN)
- Measurement Uncertainty of VNA Based TDR/TDT Measurement (5990-8406EN)
- Accuracy Verification of Agilent's ENA Option TDR Time Domain Measurement using a NIST Traceable Standard (5990-5728EN)

•Method of Implementation (MOI) for High Speed Digital Standards

www.agilent.com/find/ena-tdr_compliance