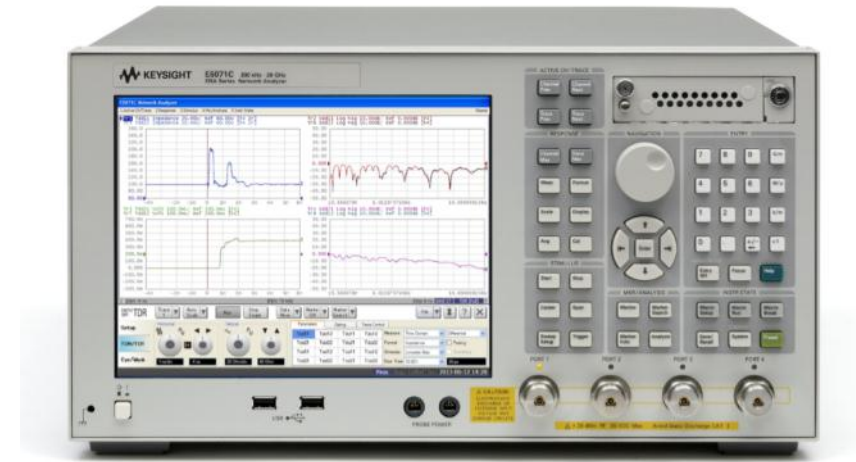


100BASE-TX Ethernet Cable Test Test Solution Overview Using the E5071C ENA Option TDR

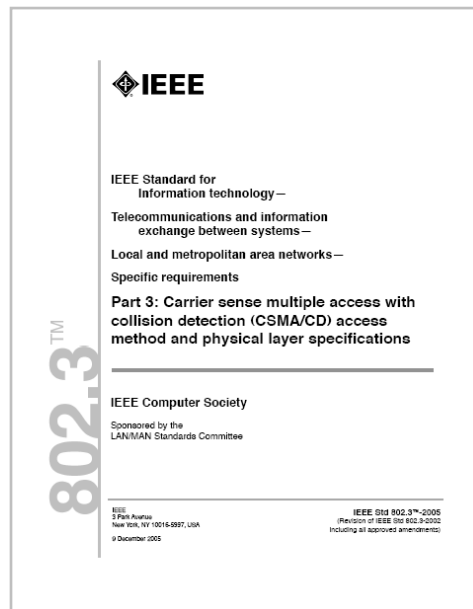


Last Update: 2015/04/08 (YS)

Reference Documents

Specifications

IEEE Std 802.3™-2008



ANSI X3.263-1995

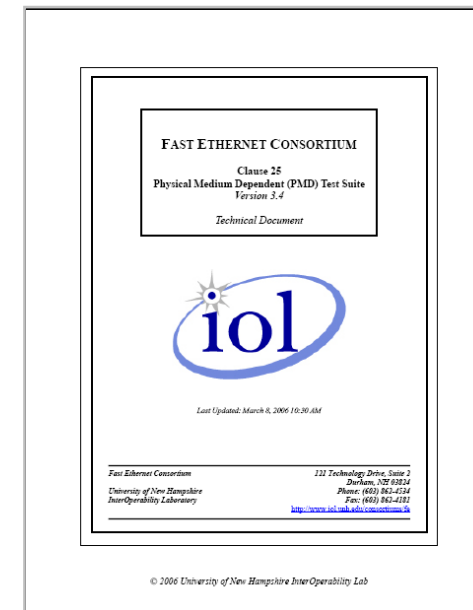
*Fiber Distributed Interface
-Token Ring Twisted Pair
Physical Layer Medium
Dependent*



Test Procedure

Test Suite for Ethernet

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



Ethernet Logo Certification Program

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

Logo certification program is not available for Ethernet (100BASE-TX / 1000BASE-T).

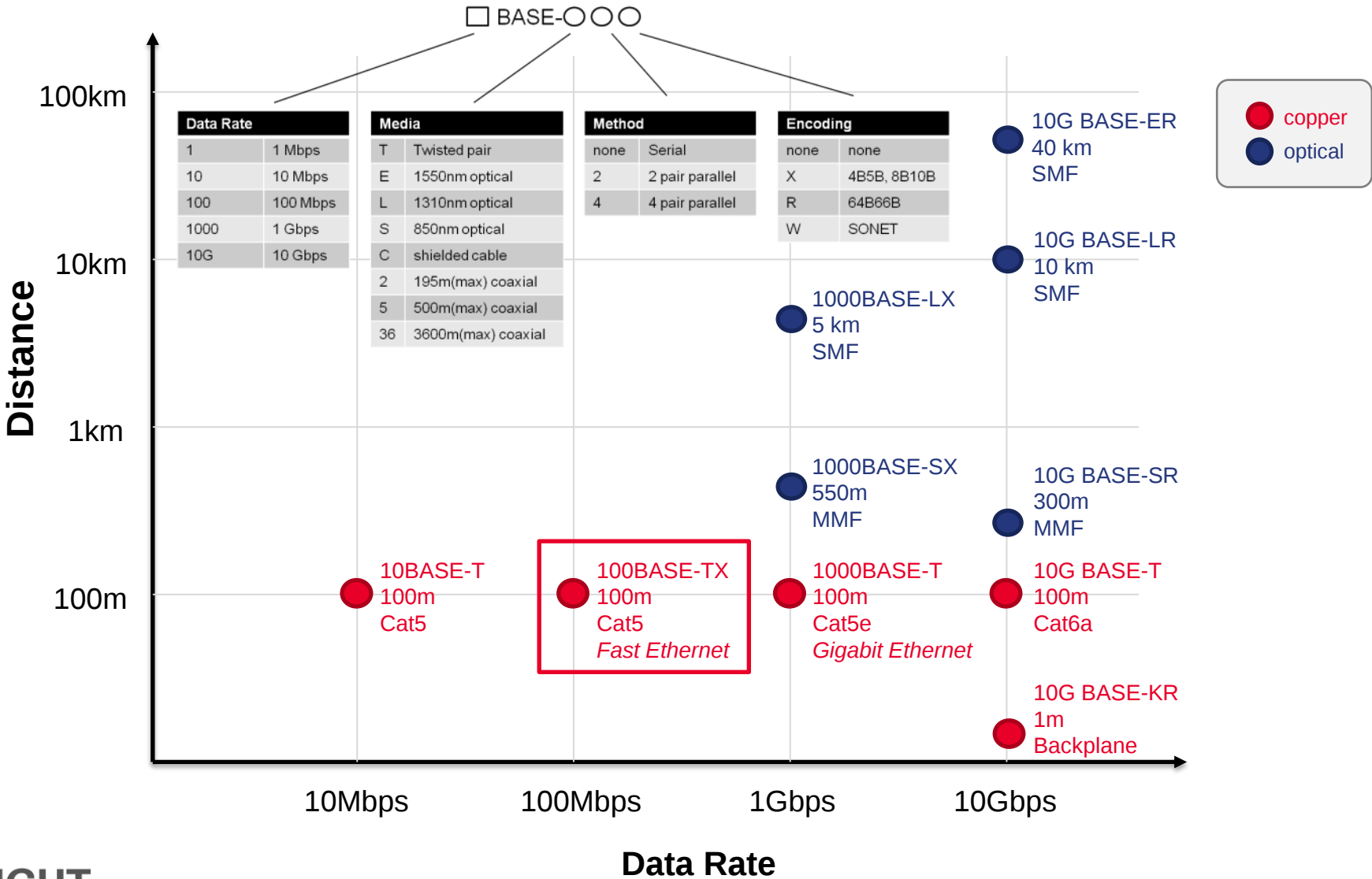
- PHY tests performed in accordance to test procedure issued by University of New Hampshire InterOperability Laboratory (UNH-IOL).
- Self-compliance

Keysight Digital Standards Program

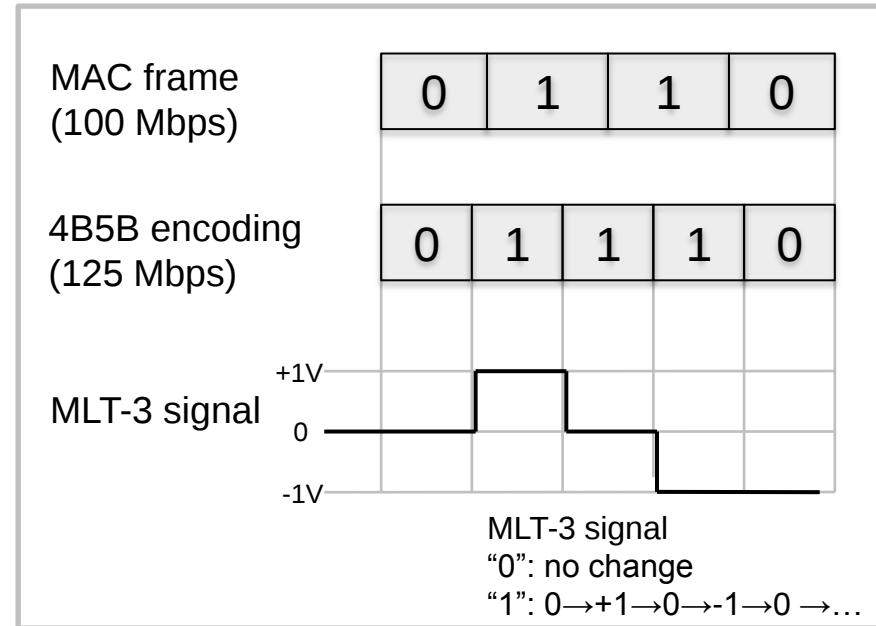
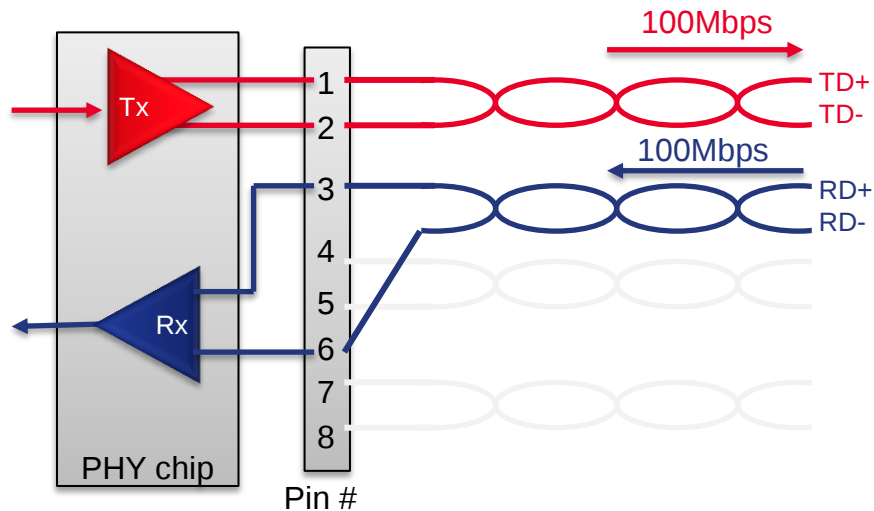
- Our solutions are driven and supported by Keysight experts involved in international standards committees:
 - Joint Electronic Devices Engineering Council (JEDEC)
 - PCI Special Interest Group (PCI-SIG®)
 - Video Electronics Standards Association (VESA)
 - Serial ATA International Organization (SATA-IO)
 - USB-Implementers Forum (USB-IF)
 - Mobile Industry Processor Interface (MIPI) Alliance
 - And many others...
- We're active in standards meetings, workshops, plugfests, and seminars.
- We get involved so you benefit with the right solutions when you need them.



Ethernet Data Rate and Distance



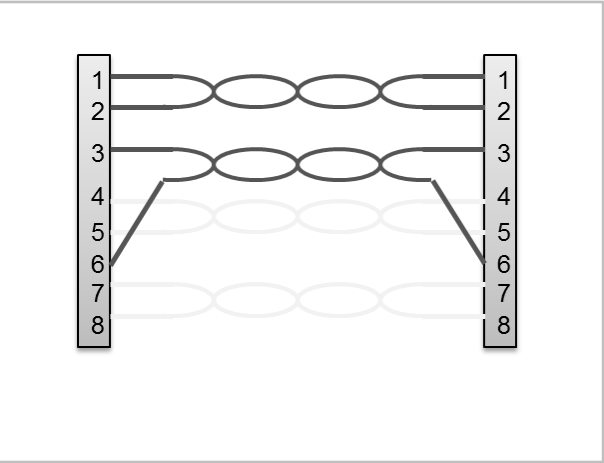
100BASE-TX Ethernet Overview



- 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

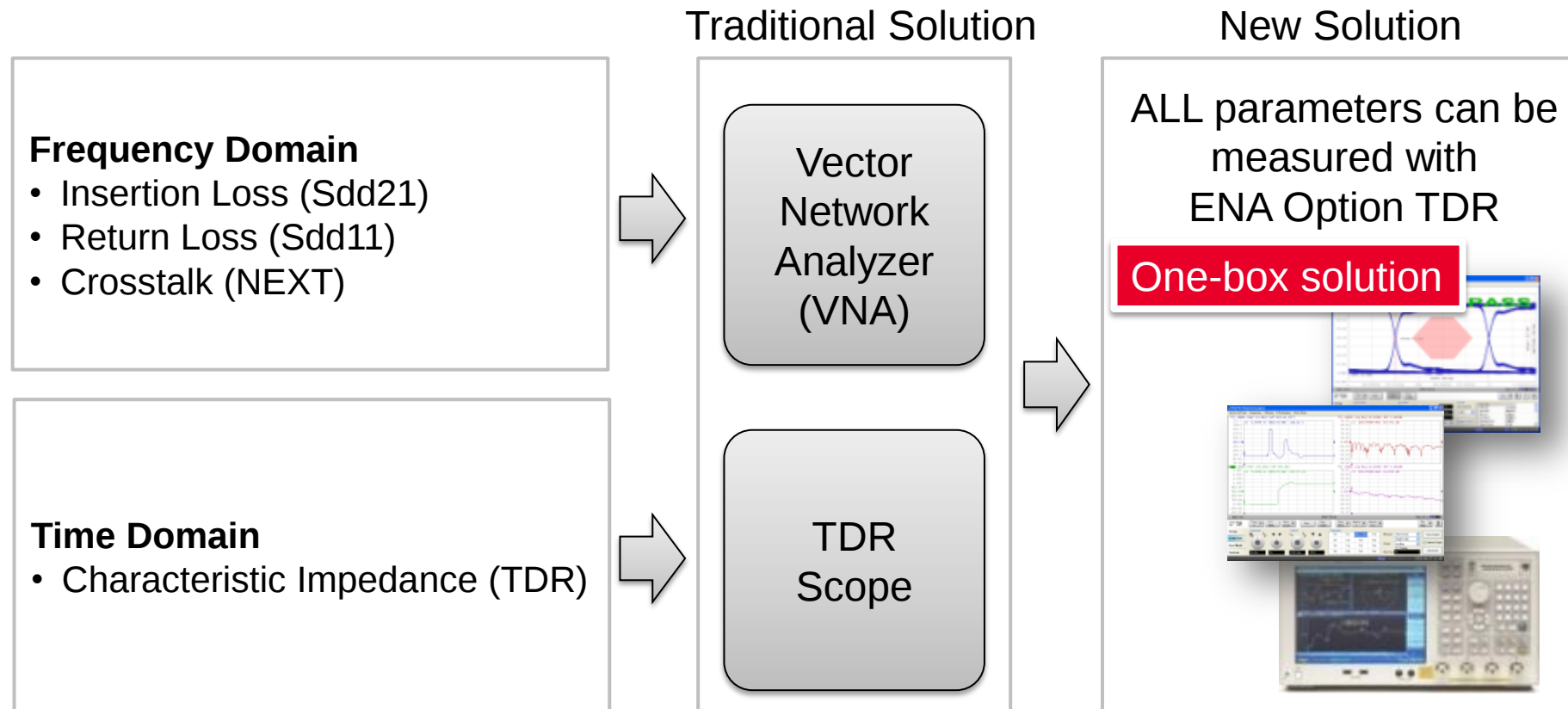
Measurement Parameters



Specification	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

Requirements for both time and frequency domain measurements



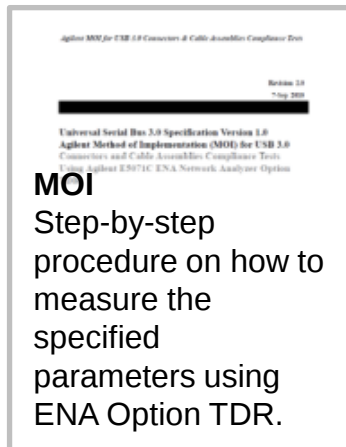
100BASE-TX Ethernet Cable Test Solution

Typical Configuration



- ENA Mainframe
 - 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)

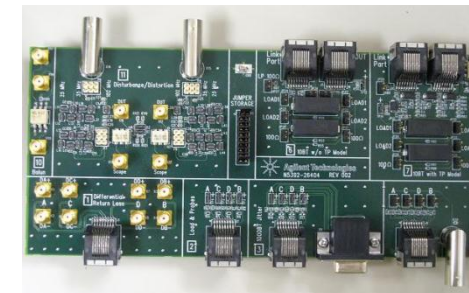
(*) The list above includes the major equipment required. Please contact our sales representative for configuration details.



- Method of Implementation (MOI) document and instrument setup files available for free download on Keysight.com

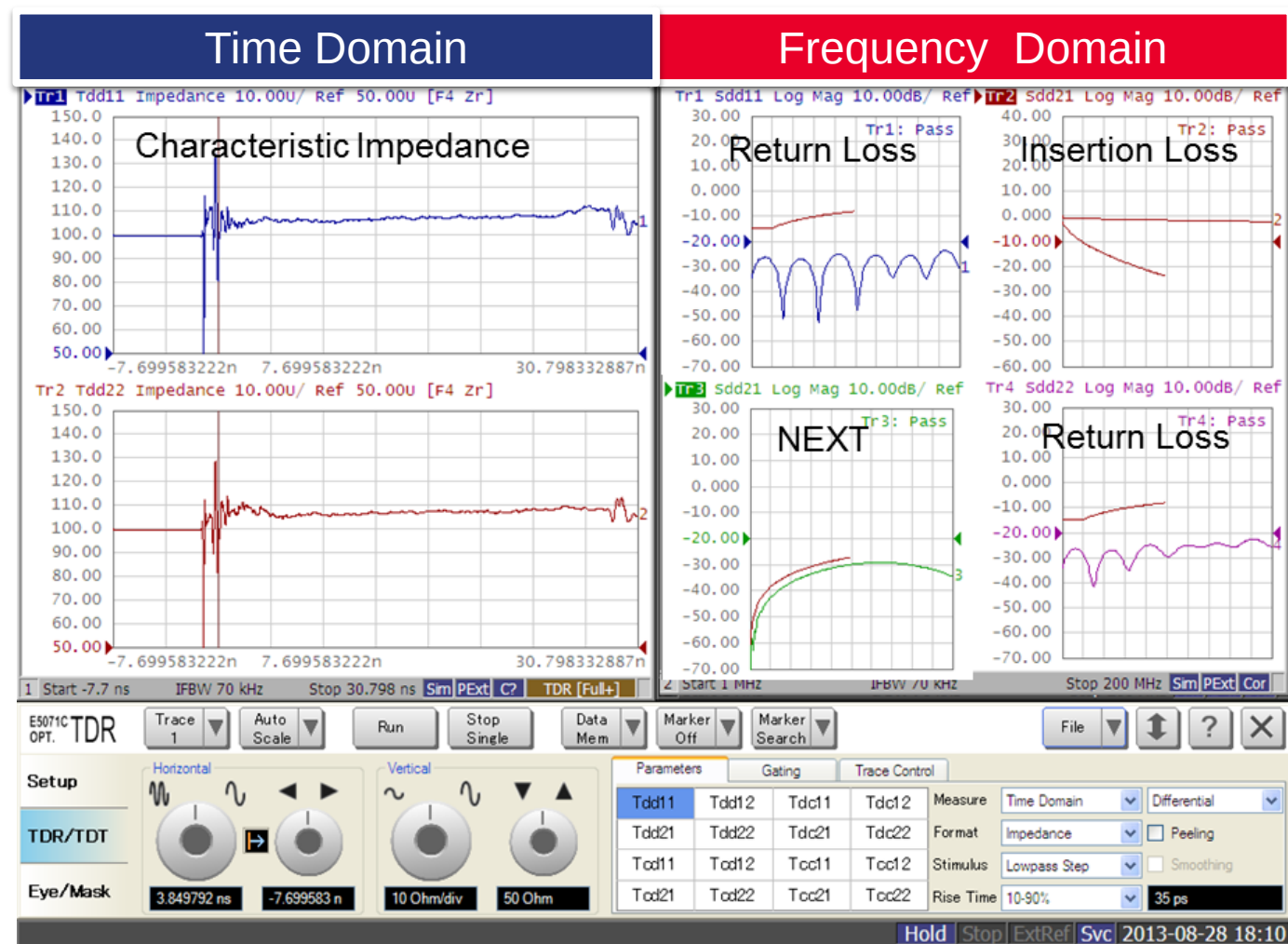
Test Fixtures

Keysight P/N: N5392-66402 (2/ea)
Test Fixture for Ethernet Application.



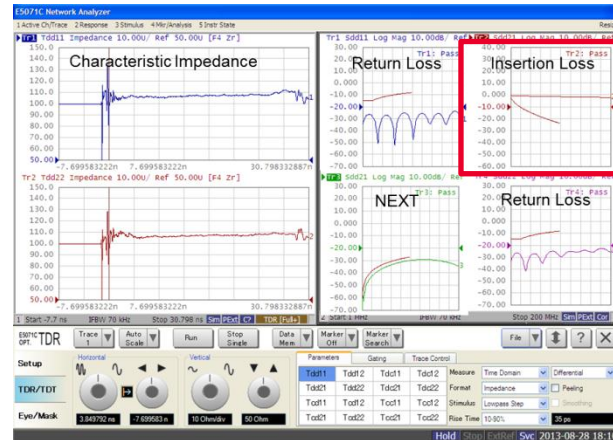
100BASE-TX Ethernet Cable Test

Measurement Parameters

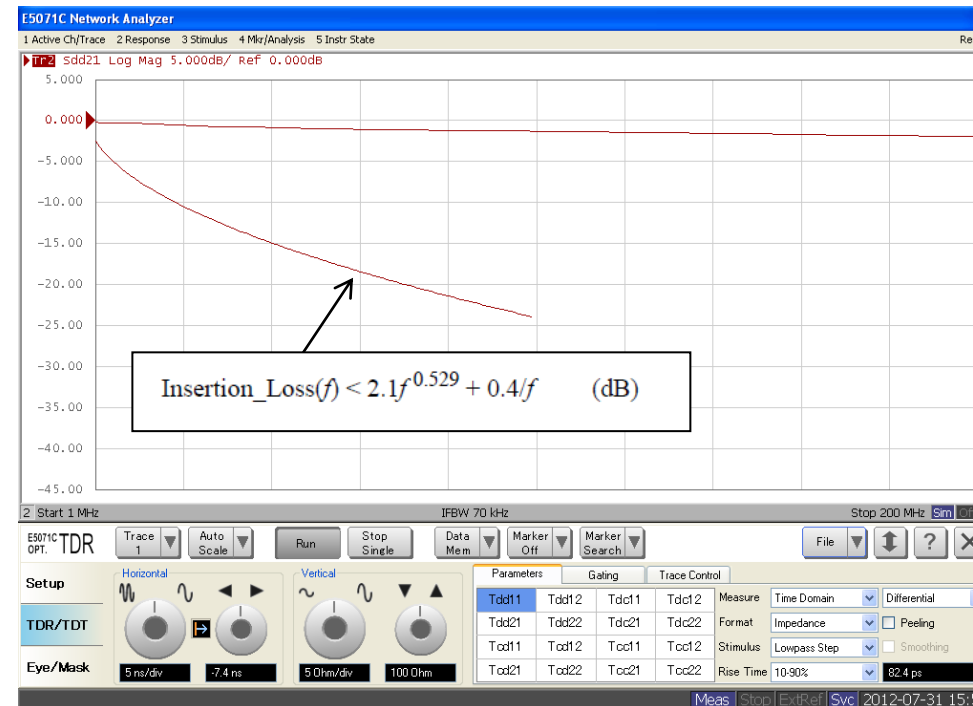
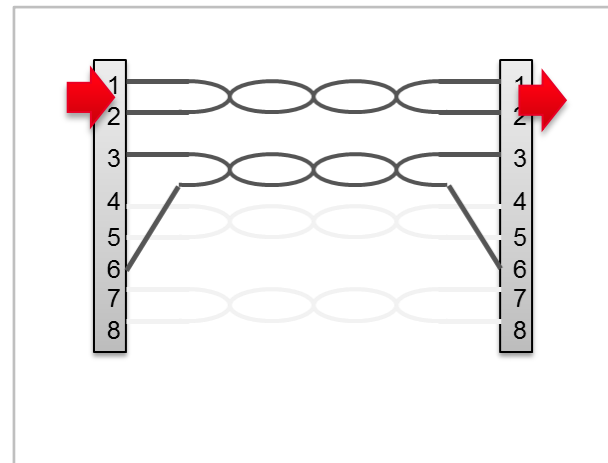


IEEE Standard 802.3™-2008

25.4.7.2.1 Insertion Loss



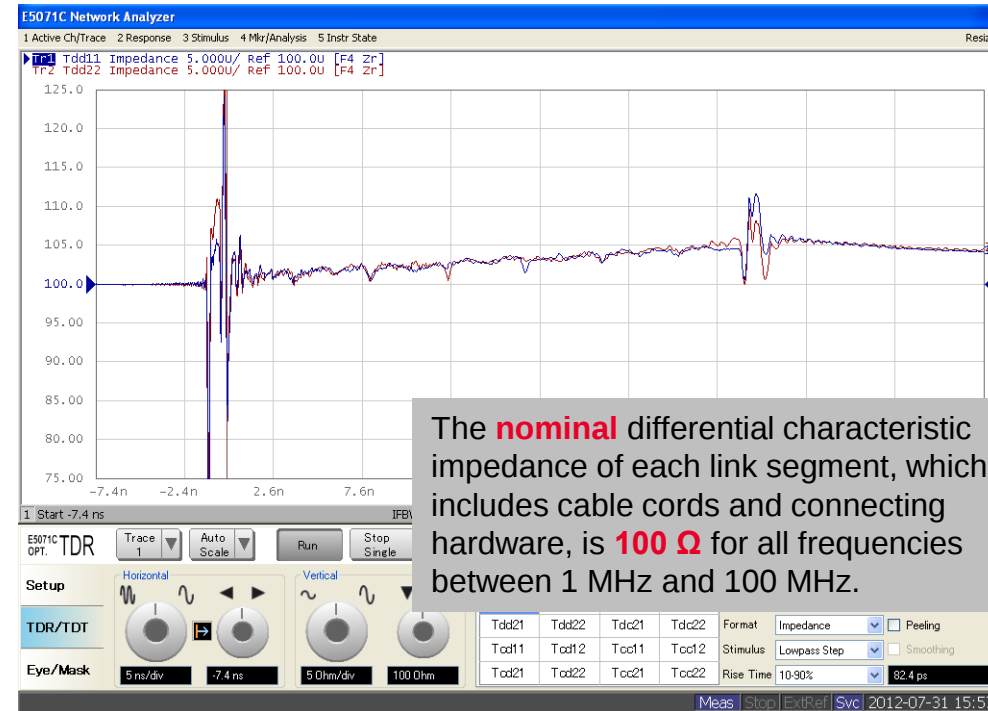
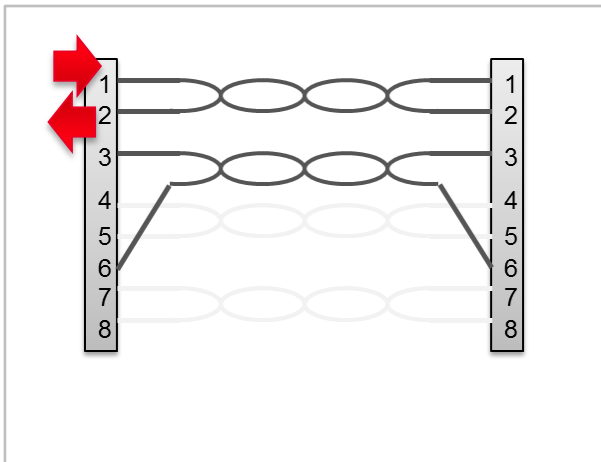
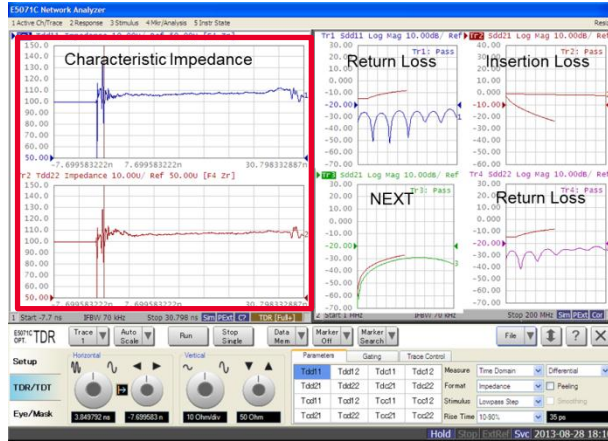
- Frequency response of the differential signal that propagates through the cable.
- Direct measure of the signal reaching the receiver.
- Provides a measure for the highest useable bandwidth.



IEEE Standard 802.3™-2008

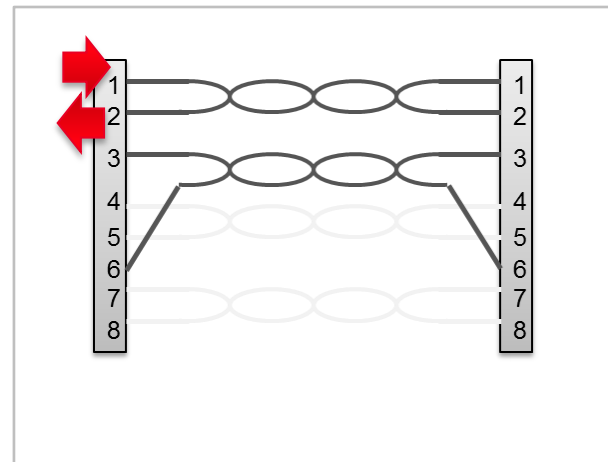
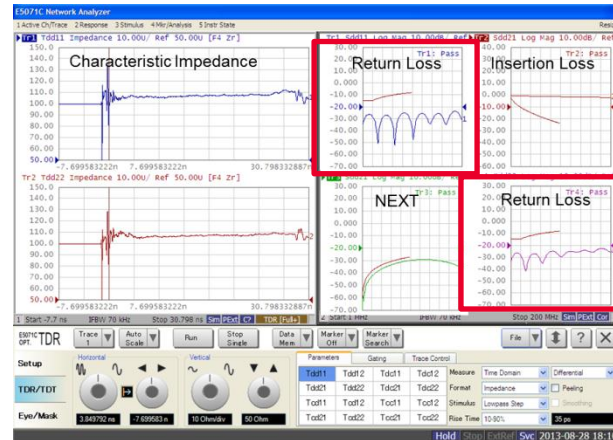
25.4.7.2.2 Differential characteristic impedance

- 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.

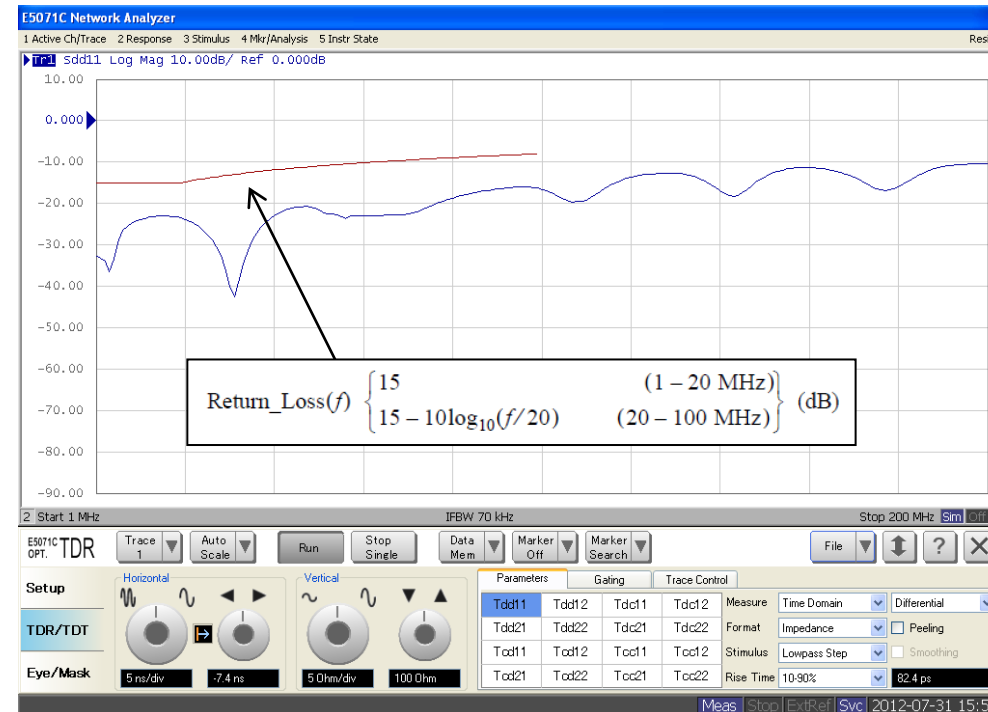


IEEE Standard 802.3™-2008

25.4.7.2.3 Return loss



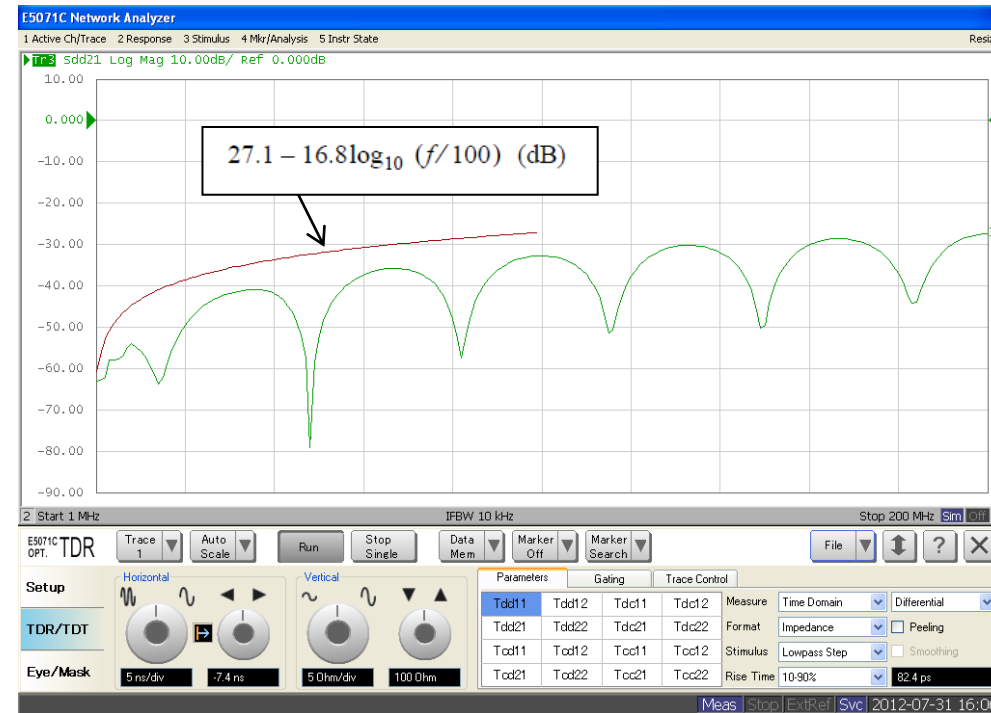
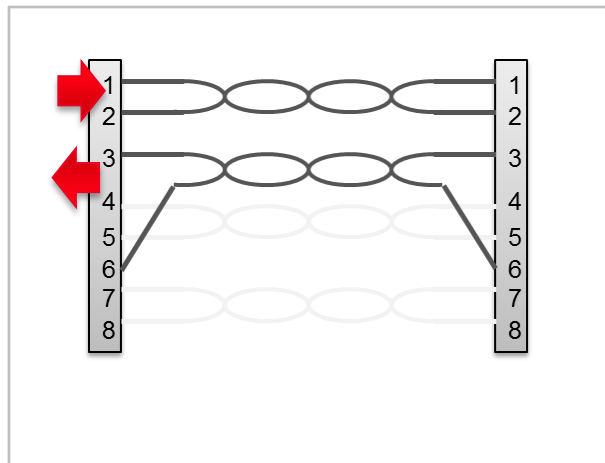
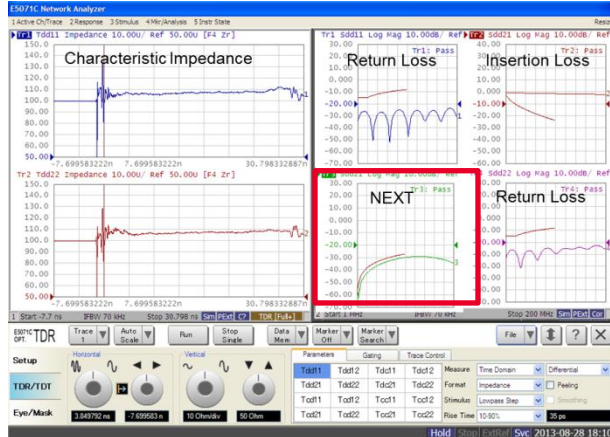
- Ratio of reflected voltage to incident voltage. Key parameter when evaluating impedance mismatch.
- When impedance match is poor, transmission signal quality is degraded due to multiple-reflection effects, leading to increase in bit error rate.



IEEE Standard 802.3™-2008

25.4.7.2.4 Differential near-end crosstalk (NEXT)

- Measure of the coupling between the differential pairs.



ENA Option TDR Certified Method of Implementation (MOI)

Available for free download at www.keysight.com/find/ena-tdr_compliance

Cable / Connector

- USB
- HDMI
- SATA
- DisplayPort
- 100BASE-TX
- 10GBASE-T
- 10GBASE-KR/40GBASE-KR
- MHL
- PCIe
- BroadR-Reach



Tx/Rx Impedance (Hot TDR)

- HDMI
- SATA
- MIPI
- 10GBASE-KR/40GBASE-KR
- MHL
- Thunderbolt
- SD Card (UHS-II)
- Cfast



Certified Test Centers using ENA Option TDR

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

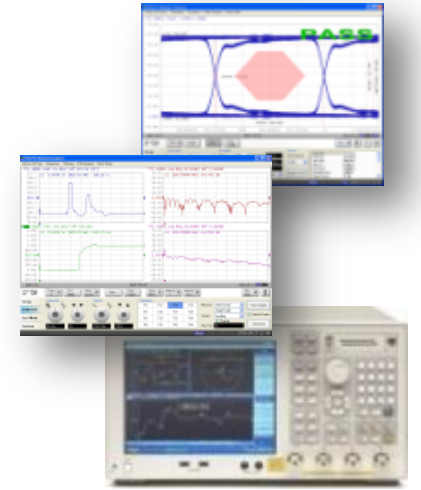


100BASE-TX Ethernet Cable Test Solution

Summary

ENA Option TDR Cable Test Solution

- **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

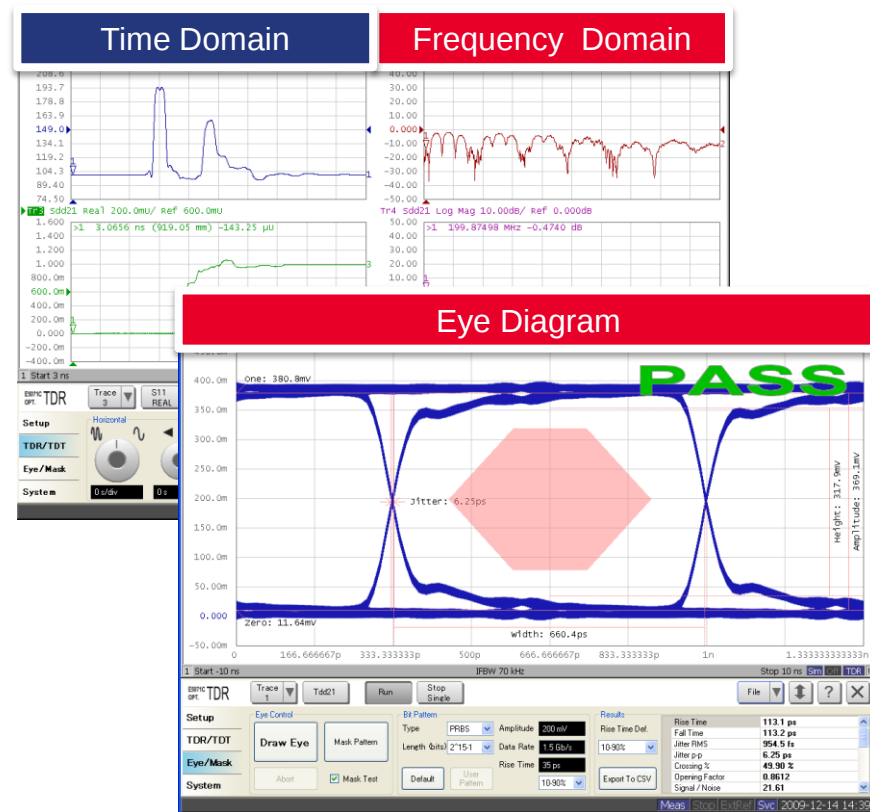




What is ENA Option TDR?

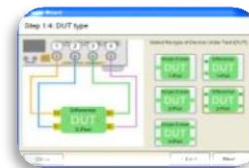


The ENA Option TDR is an application software embedded on the ENA, which provides an one-box solution for high speed serial interconnect analysis.

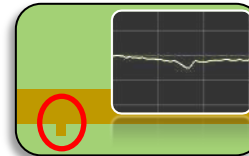


3 Breakthroughs

for Signal Integrity Design and Verification



Simple and Intuitive Operation



Fast and Accurate Measurements



High ESD Robustness

What is ENA Option TDR?

[Video] Changing the world of Time Domain Reflectometry (TDR) Measurements



<https://www.youtube.com/watch?v=uBHXkzk4Izk>

Additional Resources

ENA Option TDR Reference Material www.keysight.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.keysight.com/find/ena-tdr_compliance