Agilent Technologies

VESA DisplayPort Cable & Connector Compliance Test

Test Solution Overview Using the Agilent E5071C ENA Option TDR

Last Update 2013/2/18 (TH)

Purpose

• This slide will show how to make measurements of VESA DisplayPort Cable & Connector Compliance Tests by using the Agilent E5071C ENA Option TDR.

Agilent Digital Standards Program

Our solutions are driven and supported by Agilent experts involved in international standards committees:

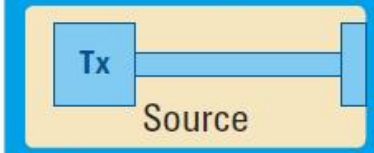
- Joint Electronic Devices Engineering Council (JEDEC)
- PCI Special Interest Group (PCI-SIG®)
- **Video Electronics Standards Association (VESA)**
- Serial ATA International Organization (SATA-IO)
- USB-Implementers Forum (USB-IF)
- Mobile Industry Processor Interface (MIPI) Alliance
- Optical Internetworking Forum (OIF)

We're active in standards meetings, workshops, plugfests, and seminars

Our customers test with highest confidence and achieve compliance faster

DisplayPort – Agilent Total Solution Coverage

Source Design & Test



√ DVD players √ ICs
√ Set top boxes √ Cameras

DSO90000A
Infiniium real time oscilloscope

W2212 Advanced Design System bundle

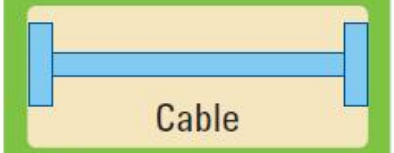
HDMI

- N5399B HDMI Compliance Test SW
- N1080A TPA fixture

DisplayPort

- W2642A Automation
- U7232A DisplayPort Compliance Test SW
- W2641A TPA fixture

Media Test



√ Cables √ Connectors
√ PC boards

86100C Infiniium DCA-J/TDR

E5071C ENA RF network analyzer

N5245A PNA-X 4-port 50GHz VNA

N1930B Physical Layer Test System (PLTS) version 5.2 software

W2212 Advanced Design System bundle

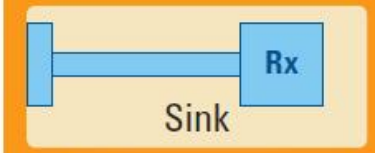
HDMI

- N1080A TPA fixture
- N1080B fixtures for HDI

DisplayPort

- Bit-DP-CBL-0001 fixture

Sink Test



√ HDTV monitors √ ICs
√ Repeators

ParBERT or N4903B JBERT

N5990A Compliance Automation

W2212 Advanced Design System bundle

HDMI

- E4887A TMDS Signal Generator
- N1080A TPA fixture

DisplayPort

- N4915A-006 DP ISI Generator
- W2642A Automation
- Bit-DP-RTF-0001 fixture
- W2641A TPA fixture

Protocol and HEC,ARC Test

√ Sources √ Sinks

HDMI

- N5998A HDMI protocol analyzer/generator
- Quantum Data 882EA
- 81150A HEAC Physical Layer and Audio Protocol

DisplayPort

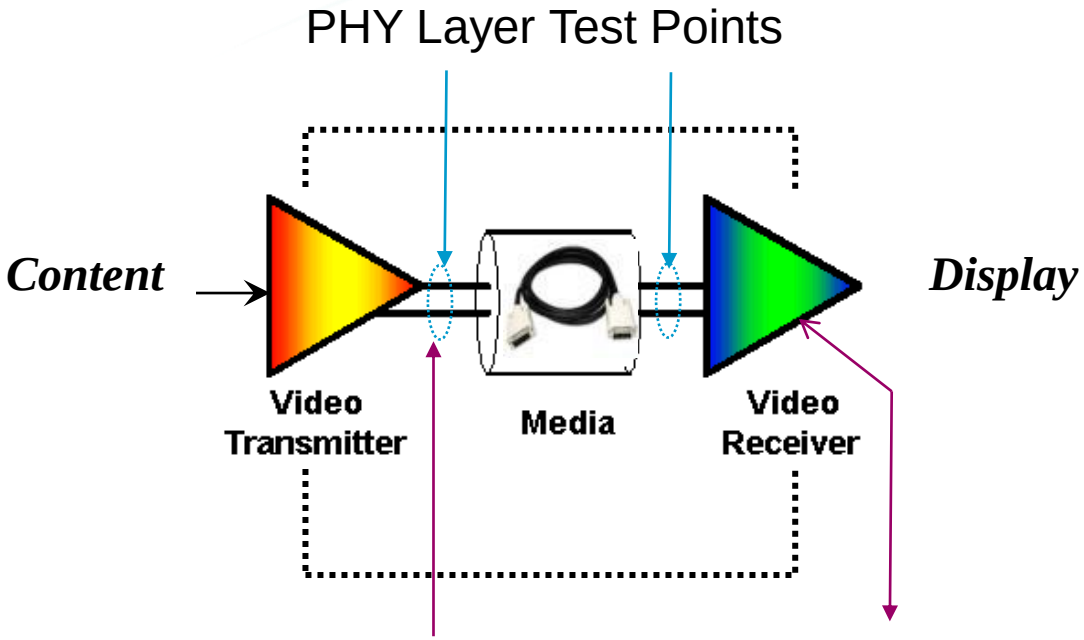
- W2642A AUX Channel Controller w/ Quantum Data

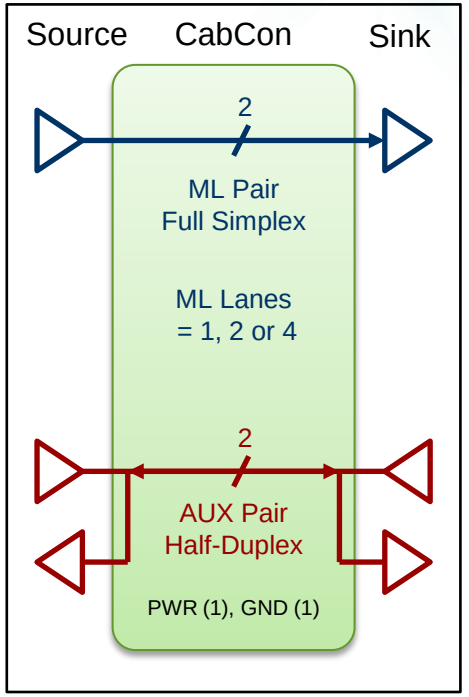
HDMI and DisplayPort Design and Test - A Better Way (http://cp.literature.agilent.com/litweb/pdf/5990-8001EN.pdf)

Reference Document

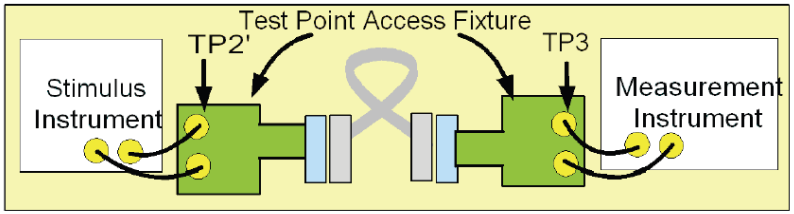
- VESA DisplayPort Standard Version 1, Revision 2a
- VESA Display Port PHY Compliance Test Specification Version 1.2b

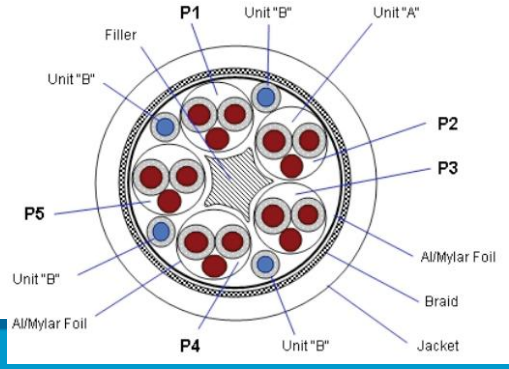
DisplayPort Cable and Connector Compliance Test Solution





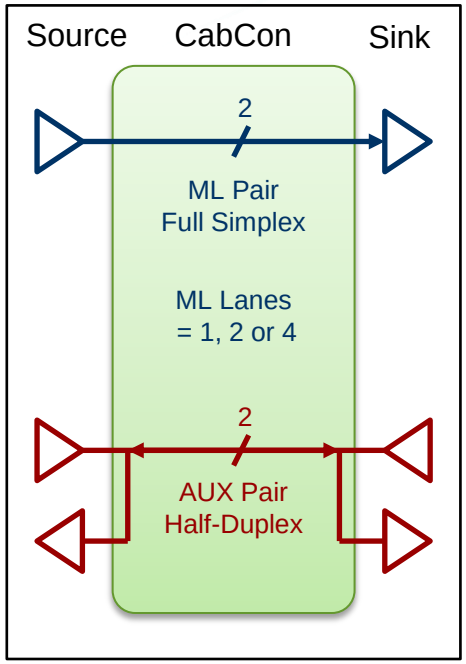
Link Layer/Protocol Test and Control Points





DisplayPort PHY Compliance Test Solution

Measurement Parameters



Time Domain Measurements

Bulk Cable and Connector Impedance (Normative)
Intra-Pair Skew (Normative)
Inter-Pair Skew (Normative)

Frequency Domain Measurements

Insertion Loss (Normative)
Return Loss (Normative)
Near End Noise (*)
Far End Noise (Normative)

* Near End Noise (NEN): Normative for AUX Channel, Main Link(0) and Main Link(3) and Informative for the rest of the Main Link Channels.

DisplayPort PHY Compliance Test Solution

Solution Overview

•DisplayPort cable & connector compliance testing requires parametric measurements in both time and frequency domains

Traditional Solution

Frequency Domain
- Insertion Loss
- Return Loss
- Near End Noise
- Far End Noise

→ Vector Network Analyzer (VNA)

Time Domain
- Bulk Cable and Connector Impedance
- Intra Pair Skew
- Inter Pair Skew

→ TDR Scope

New Solution

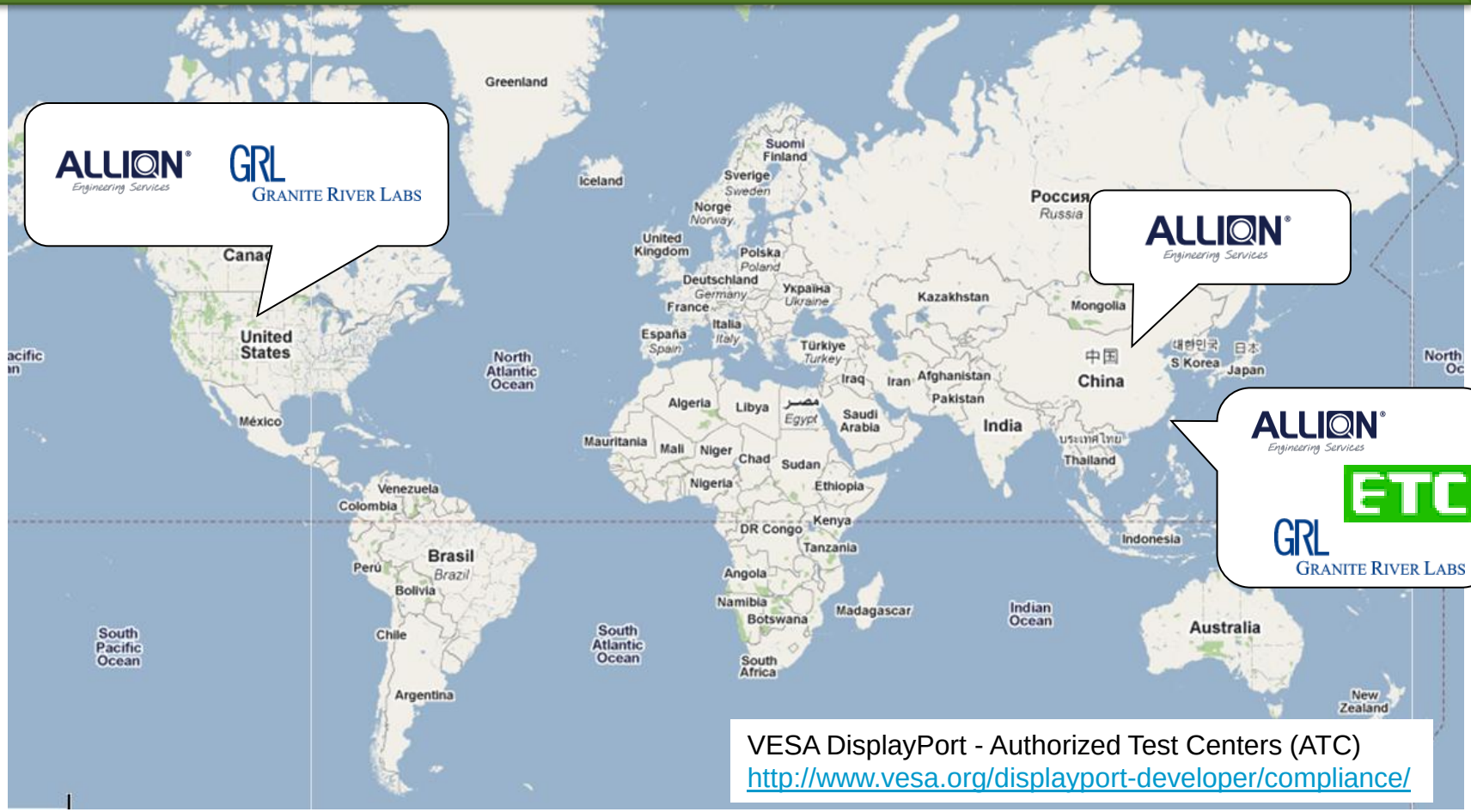
•**ALL** parameters can be measured with **ENA Option TDR**

One-box Solution !!

DisplayPort PHY Compliance Test Solution

Authorized Test Centers (ATC) Supporting ENA Option TDR

ENA option TDR is used by authorized test centers (ATC) to perform DisplayPort cable assemblies compliance tests.



VESA DisplayPort - Authorized Test Centers (ATC)
http://www.vesa.org/displayport-developer/compliance/

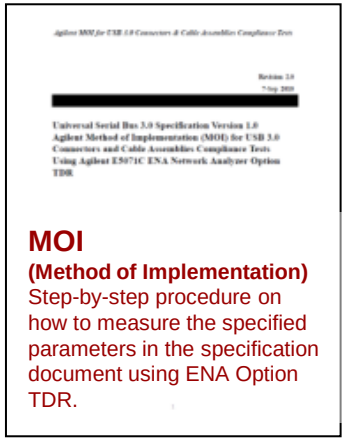
DisplayPort PHY Compliance Test Solution

ENA Option TDR Solution

- ENA Mainframe
  - E5071C-4D5: 4-port, 300kHz to 14GHz
  - E5071C-4K5: 4-port, 300kHz 20GHz
- Enhanced Time Domain Analysis Option (E5071C-TDR)
- ECal Module
  - N4433A for E5071C-4D5/4K5

ENA Option TDR is a certified solution for cable PHY.
http://www.vesa.org/displayport-developer/certified-components/

- Method of Implementation (MOI) document available for download on Agilent.com
- State files (4D5, 4K5) and cal kit definition file for official cal fixtures are also available


Universal Serial Bus 3.0 Specification Version 1.0
Agilent Method of Implementation (MOI) for USB 3.0 Connectors and Cable Assemblies Compliance Tests Using Agilent E5071C ENA Network Analyzer Option TDR

MOI
(Method of Implementation)
Step-by-step procedure on how to measure the specified parameters in the specification document using ENA Option TDR.

DisplayPort Test Fixture
Fixtures for testing DisplayPort cable assemblies and connectors are available for purchase through BitifEye.
http://bitifeye.com/

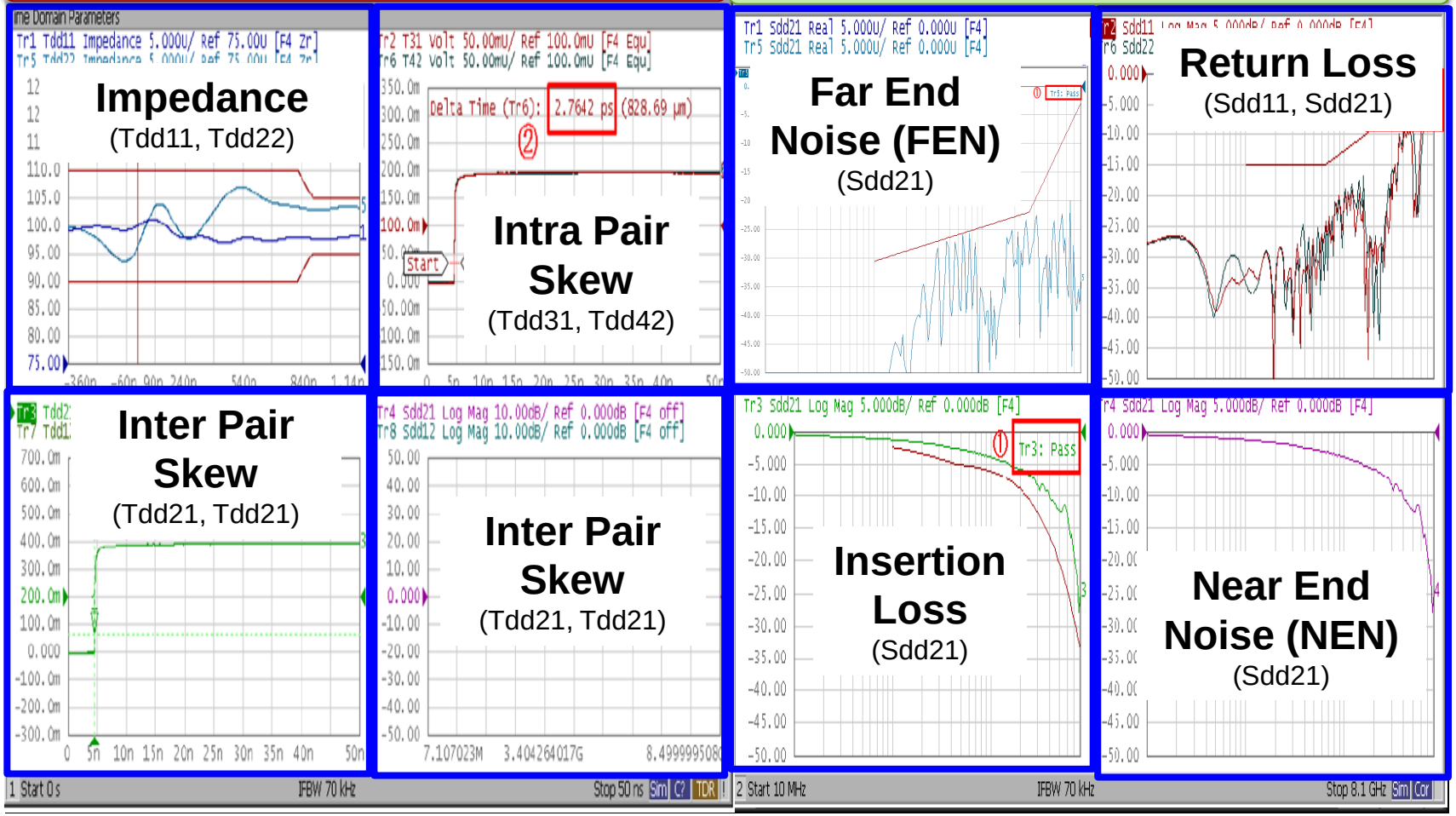
www.agilent.com/find/ena-tdr_compliance
www.agilent.com/find/ena-tdr_dp-cabcon

DisplayPort PHY Compliance Test Solution

Measurement Parameters

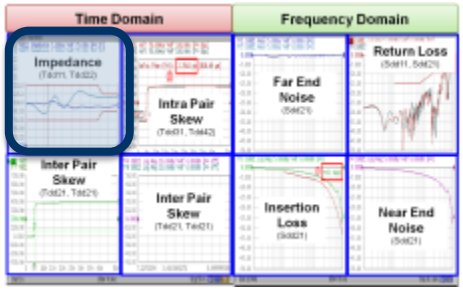
Time Domain

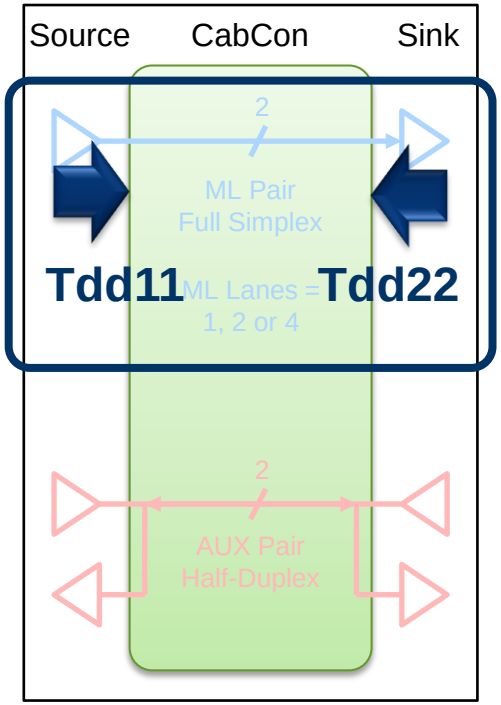
Frequency Domain



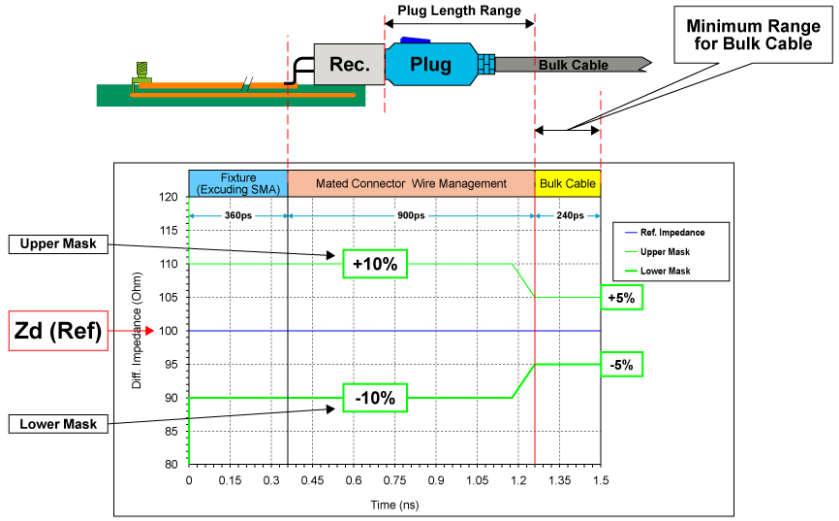
DisplayPort PHY Compliance Test Solution

Bulk Cable and Connector Impedance





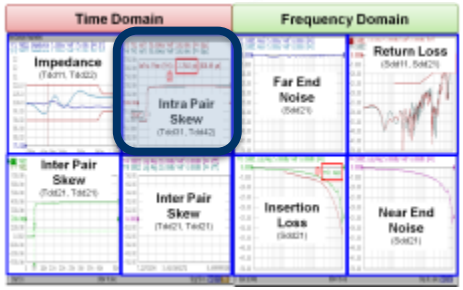
- Multiple reflections from impedance mismatches cause noise at the receiver. Therefore, the impedance profile provides an indication of multiple reflection induced noise
- Impedance is the most used parameter, but is an indirect measure of the signal arriving at the receiver

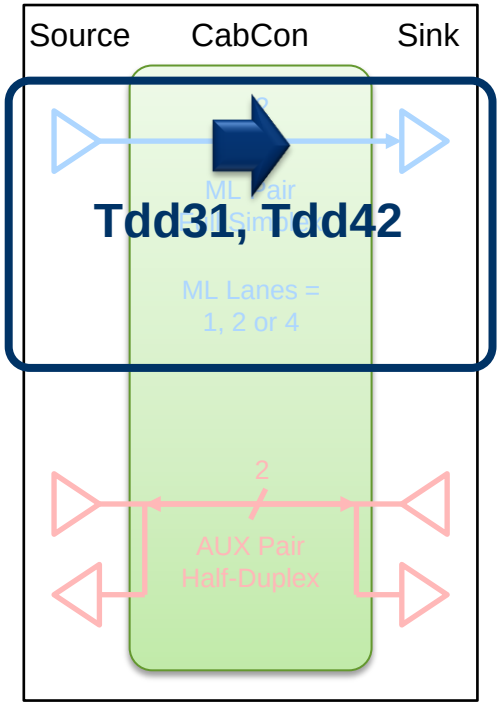


Impedance Profile Measurement Impedance Limit Example (for Standard DP cable)

DisplayPort PHY Compliance Test Solution

Intra-Pair Skew



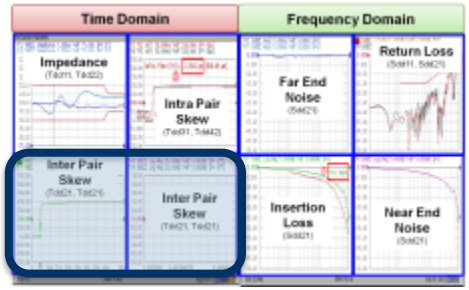


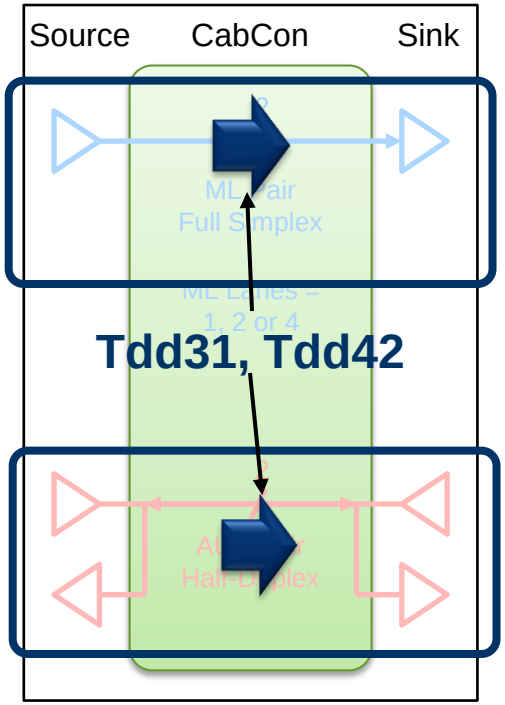
- Ensures the signal of differential pairs of main link and AUX of a cable assembly arrive at the receiver at the same time.
- Excessive Intra-pair skew can distort the rising edge of the signal, lead to significant differential to common mode conversion.

- Intra-pair skew must be no more than:
  - 50 ps (for HBR Cables)
  - 10 ps (for HBR Resizing Adaptors)
  - 35 ps (for HBR Extension Cables)
  - 250 ps (for RBR)

DisplayPort PHY Compliance Test Solution

Inter-Pair Skew





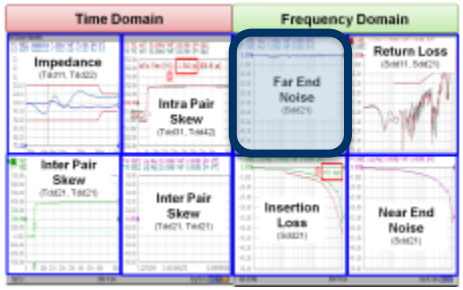
- Ensures the signal between two differential pairs of a cable assembly arrive at the receiver at the same time (to avoid logic errors within the systems)
- Inter-Pair skew results from electrical length difference between channels.

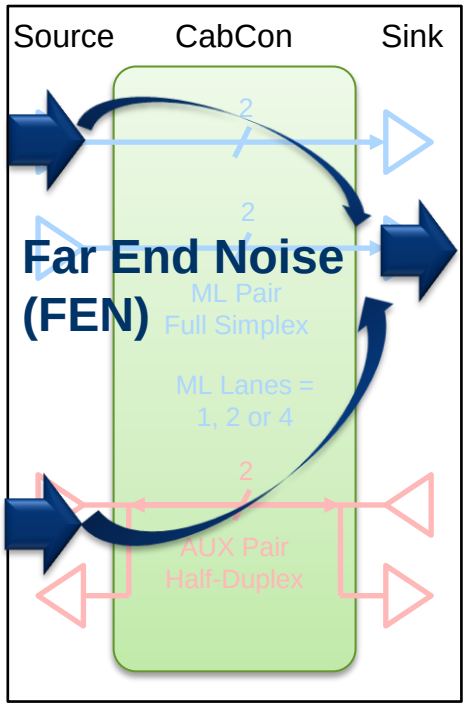
- Inter-pair skew must be no more than:
  - 2 UI (for HBR Cables)
  - 0.2 UI (for HBR Resizing Adaptors)
  - 1 UI (for HBR Extension Cables)
  - 2 UI (for RBR Cables)

Note: UI (Unit Interval) is the reciprocal of the bit rate. At 5.4 Gbps, the UI = 185 ps. At 2.7 Gbps, the UI = 370.4 ps. At 1.62 Gbps, the UI = 617 ps.

DisplayPort PHY Compliance Test Solution

Far End Noise (FEN)





- Far End Noise (FEN) is the magnitude of the coupled noise from a driven “aggressor” channel(s) at the source side on to a quiet “victim” channel at the sink side.
- The FEN from all aggressors are measured individually, the results will be added together as a power sum to derive the total aggressor combination.

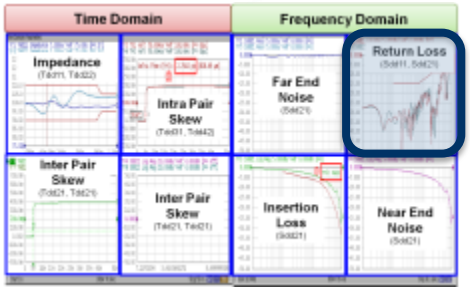
$$PSFEN(f) = 10 \times \log \sum_{1}^{n} 10^{\left(\frac{FENn(f)}{10}\right)}$$

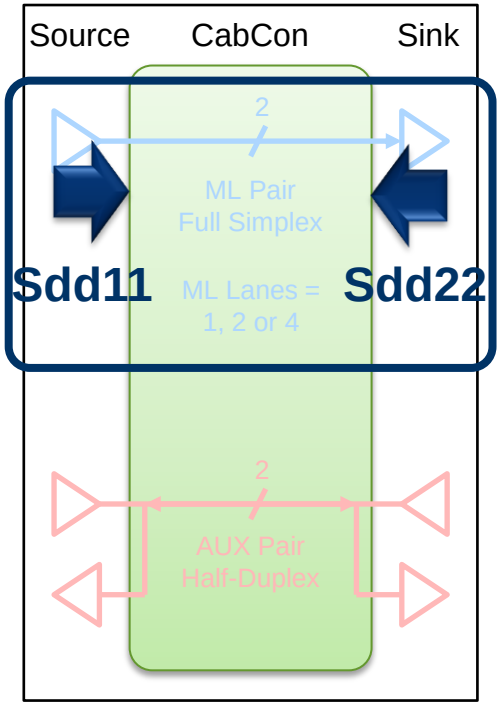
$$PSELFEN(f) = PSFEN(f) - IL(f)$$

Where FENn(f) is the far-end noise in dB, IL(f) is the victim lane insertion loss in dB

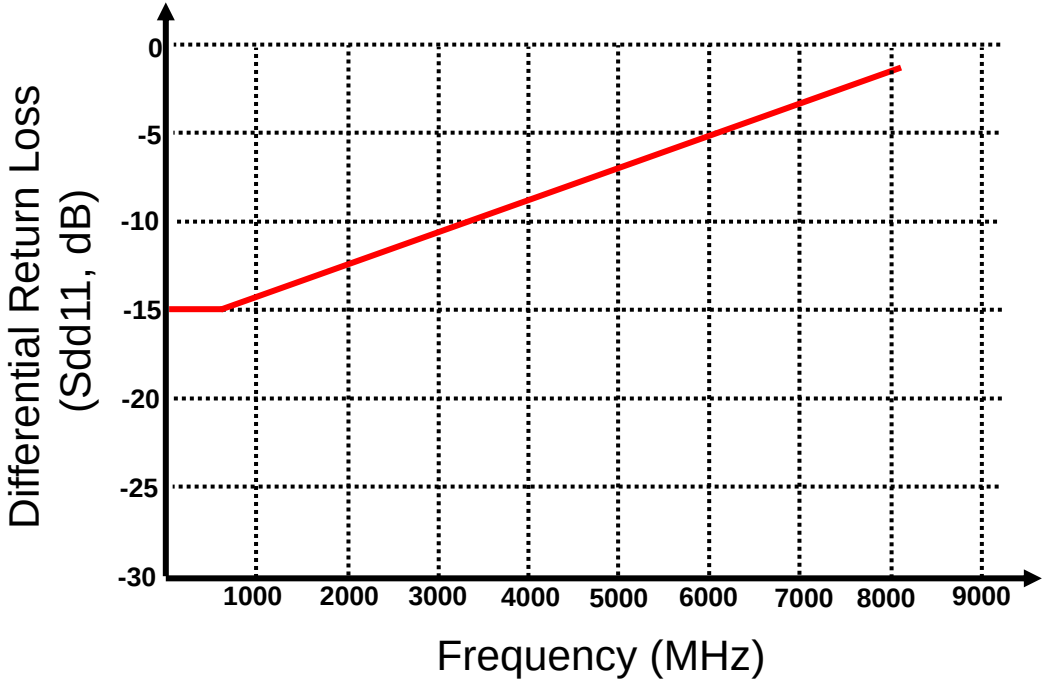
DisplayPort PHY Compliance Test Solution

Return Loss (RL/Sdd11)





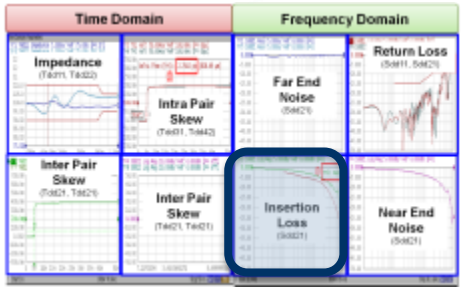
- Return loss is the ratio of the incident and reflected power of differential pairs.
- Return loss originate at impedance discontinuities and reflected signals can affect the rising edge of the signal.



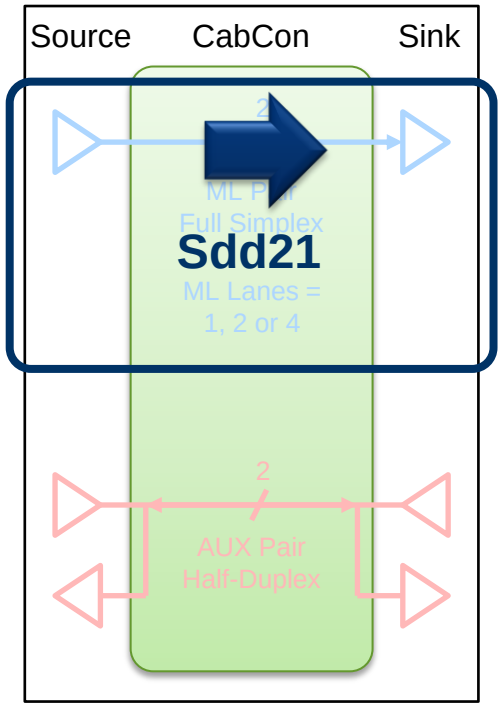
Differential Return Loss Requirement for HBR Cable Assembly

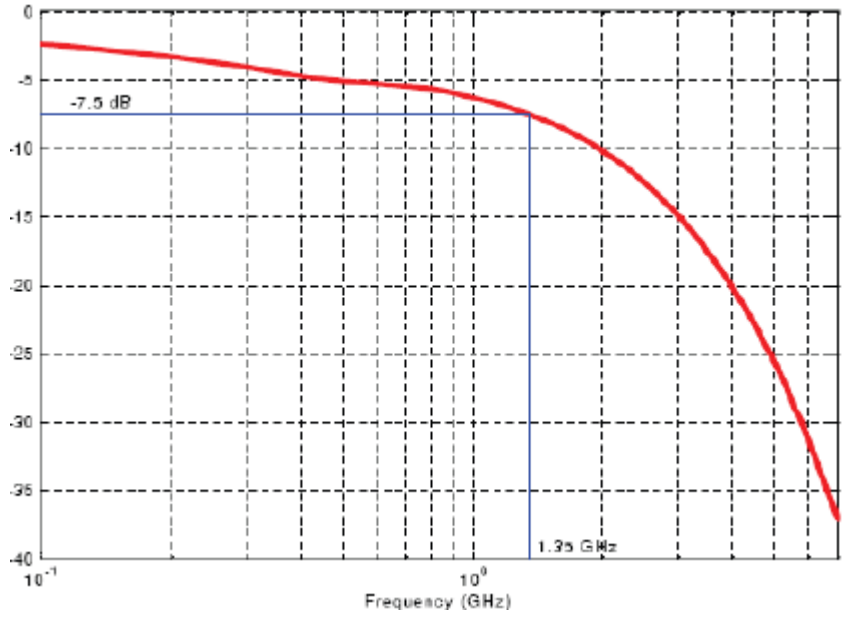
DisplayPort PHY Compliance Test Solution

Insertion Loss (IL/Sdd21)



- Insertion loss is the sink to source loss through the differential pairs.
- Has important consequences for the rise time degradation and the maximum supportable bandwidth.

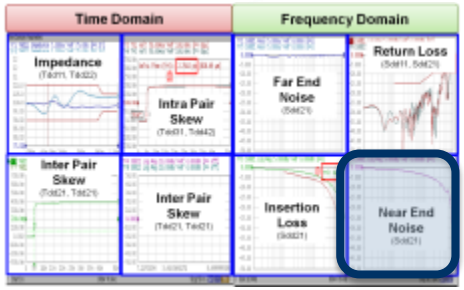


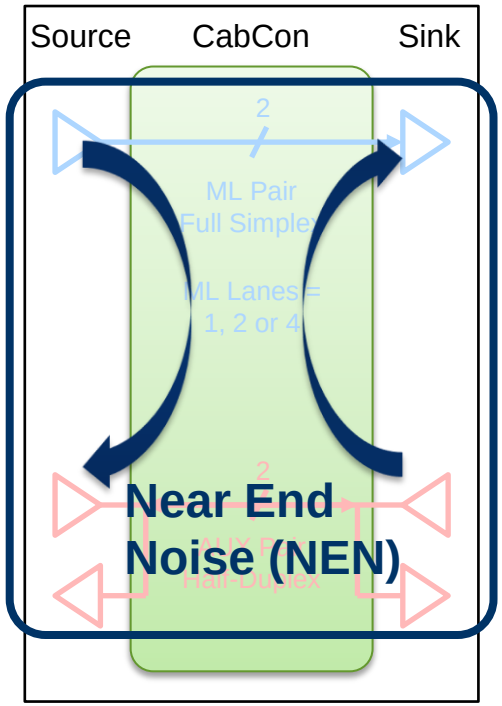


Differential Insertion Loss Requirement for HBR Cable Assembly

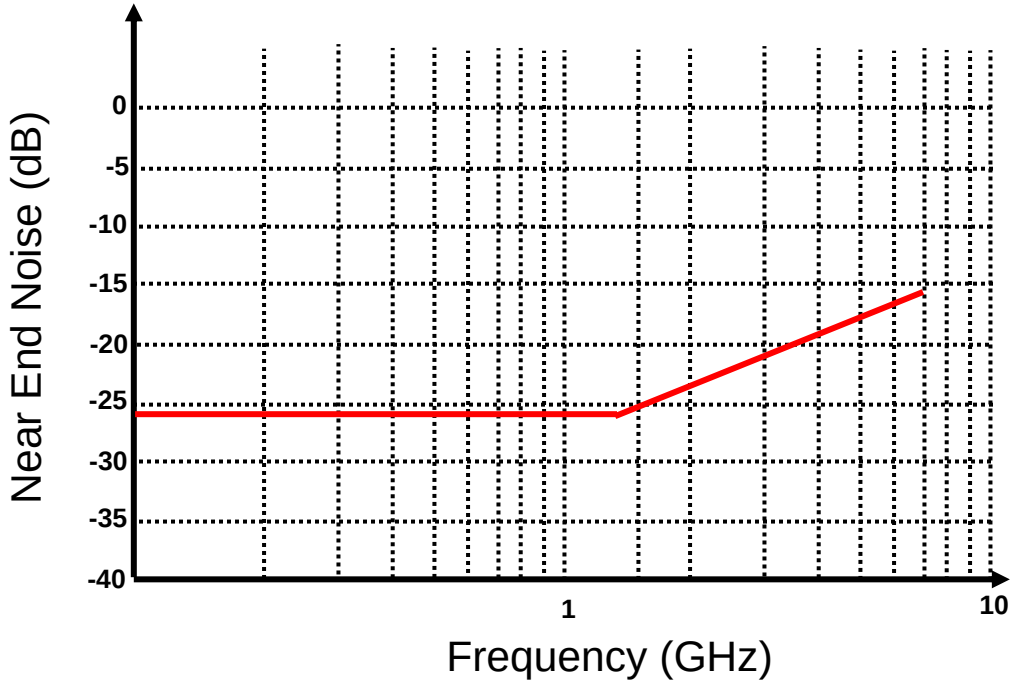
DisplayPort PHY Compliance Test Solution

Near End Noise (NEN)





•Near End Noise (FEN) is the magnitude of the coupled noise from a driven “aggressor” channel at the source side on to a quiet “victim” channel at the source side.



Near-End Noise Requirement for HBR Cable Assembly

ENA Option TDR Compliance

One-box Solution for TDR/S-parameter Compliance Test

Certified MOIs

- Cable/Connector

SUPERSPEED USB — Time & Frequency

DisplayPort — Time & Frequency

MHL Mobile High-Definition Link — Time & Frequency

SERIAL ATA — Time & Frequency

HDMI HIGH-DEFINITION MULTIMEDIA INTERFACE — Frequency

- Transmitter/Receiver (Hot TDR)

SERIAL ATA — Time & Frequency

mipi alliance — Time & Frequency

More Standards Currently Under Investigation

Test Centers Support ENA Option TDR

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

For more detail about compliance test solution by the ENA Option TDR, visit **www.agilent.com/find/ena-tdr_compliance**

DisplayPort PHY 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

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
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

Mm-wave solutions
Up to 2 THz

PNA-X receiver
8530A replacement

PNA Series

E5072A
Best performance ENA
30 kHz to 4.5, 8.5 GHz

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

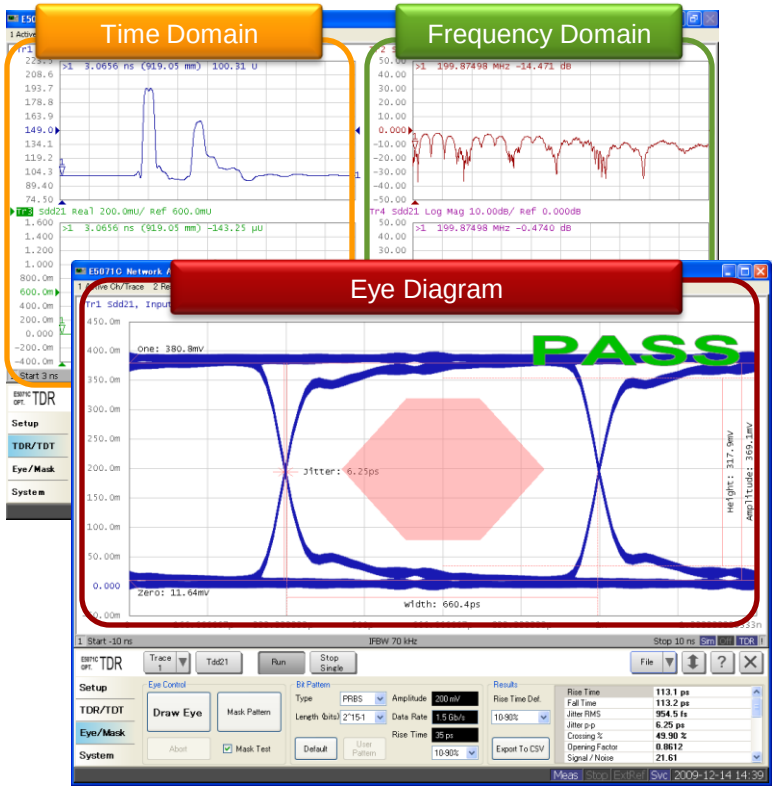
E5061B
NA + ZA in one-box
5 Hz to 3 GHz
Low cost RF VNA
100 k to 1.5/3.0 GHz

ENA Series

FieldFox
Handheld RF Analyzer
5 Hz to 4/6 GHz

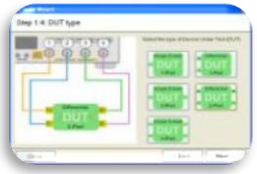
What is ENA Option TDR?

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

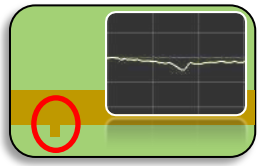


3 Breakthroughs

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=hwQNlyyJ5hI&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)

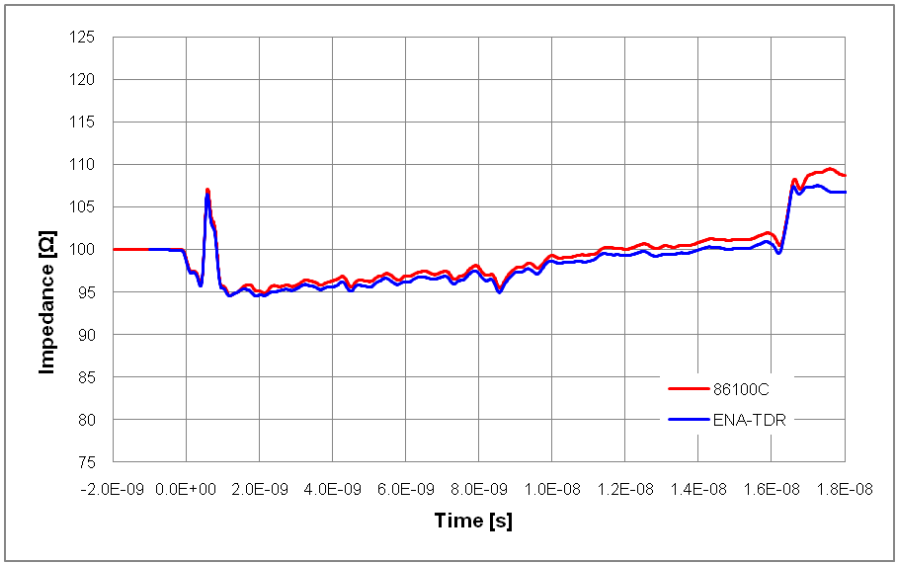
•Method of Implementation (MOI) for High Speed Digital Standards

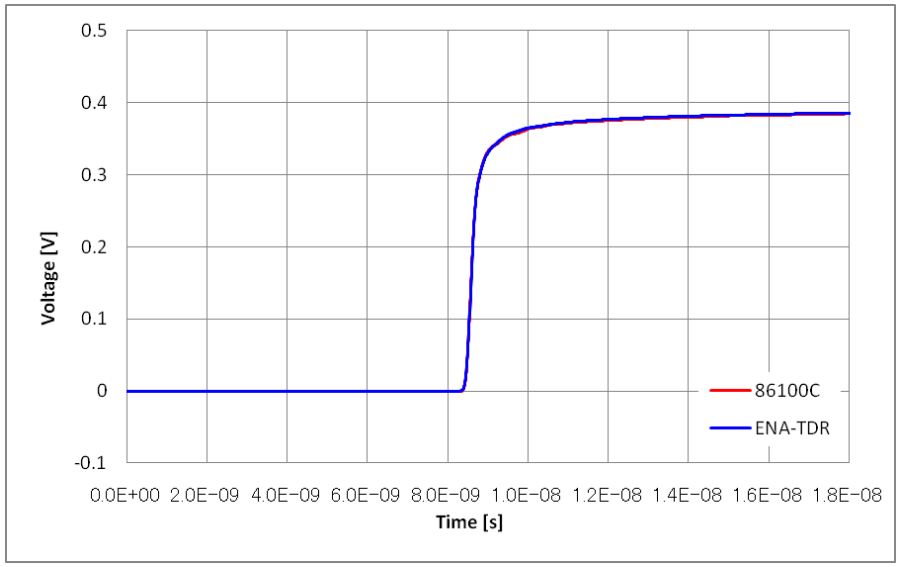
www.agilent.com/find/ena-tdr_compliance

Measurement Correlation

TDR/TDT

- DUT: DisplayPort Cable
- 130 ps rise time (20-80%)

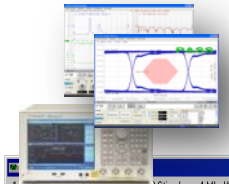




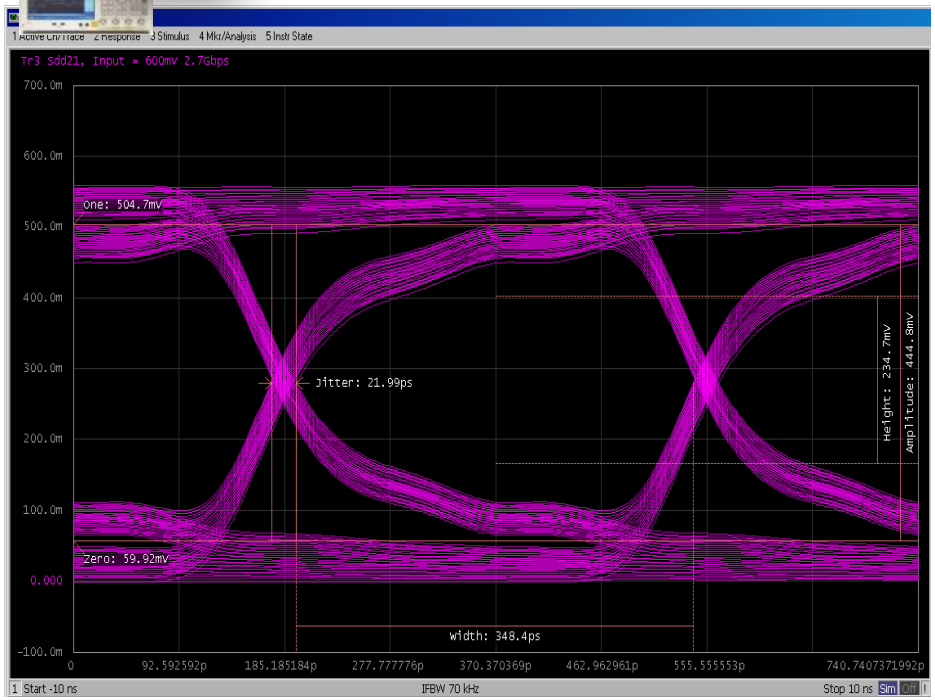
Measurement Correlation

Eye Diagram

- DUT: DisplayPort Cable
- PRBS (2^7-1) @ 2.7 Gbps



ENA Option TDR
(simulated)



N4903B + 86100C
(live)