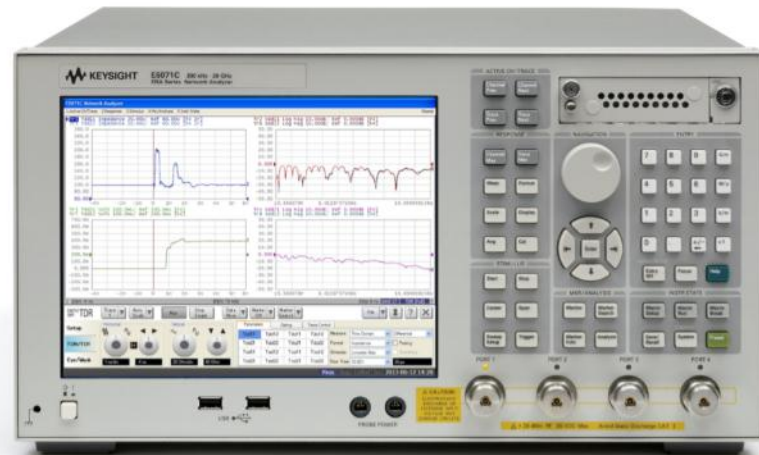


MIPI Tx/Rx Interface S-parameter & Impedance Measurements with ENA Option TDR

October 2014

Component Test Division - Kobe



Purpose

- This slide will show how to make measurements of **MIPI Tx/Rx Interface S-parameter & Impedance Measurements** Conformance Tests by using the Keysight E5071C ENA Option TDR.

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)
- **High-Definition Multimedia Interface (HDMI)**
- USB-Implementers Forum (USB-IF)
- Mobile Industry Processor Interface (MIPI) Alliance
- Optical Internetworking Forum (OIF)
- Mobile High-Definition Link (MHL) Consortium

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

Our customers test with highest confidence and achieve compliance faster

JEDEC

PCI
EXPRESS®

SERIAL
ATA

D

HDMI™
HIGH-DEFINITION MULTIMEDIA INTERFACE

USB

mi
pi
mobile industry
processor interface

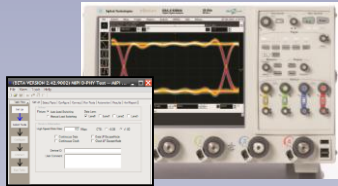
OIF OPTICAL
INTERNETWORKING
FORUM

MHL
Mobile High-Definition Link

Keysight MIPI D-PHY and M-PHY Solution Coverage

Transmitter Characterization

DSAQ93204A Infiniium



U7238A D-PHY app
U7249A M-PHY app

InfiniiMax Probes



N2809A PrecisionProbe



Receiver Characterization

N4903B JBERT



Option A02 Receiver SER Analysis

81250A ParBERT

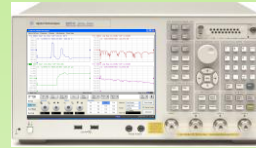


N5990A Automated characterization

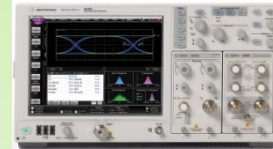


Impedance/Return Loss Validation

E5071C ENA Option TDR



DCA 86100D Wideband sampling oscilloscope



54754A
TDR/TDT



Protocol Stimulus and Analysis

U4421A CSI-2 / DSI Analyzer and Exerciser



Scope Protocol Decoder

N8802A CSI-2 / DSI

N8807A DigRF v4

N8808A UniPro

N8818A UFS

N8809A LLI

N8824A RFFE



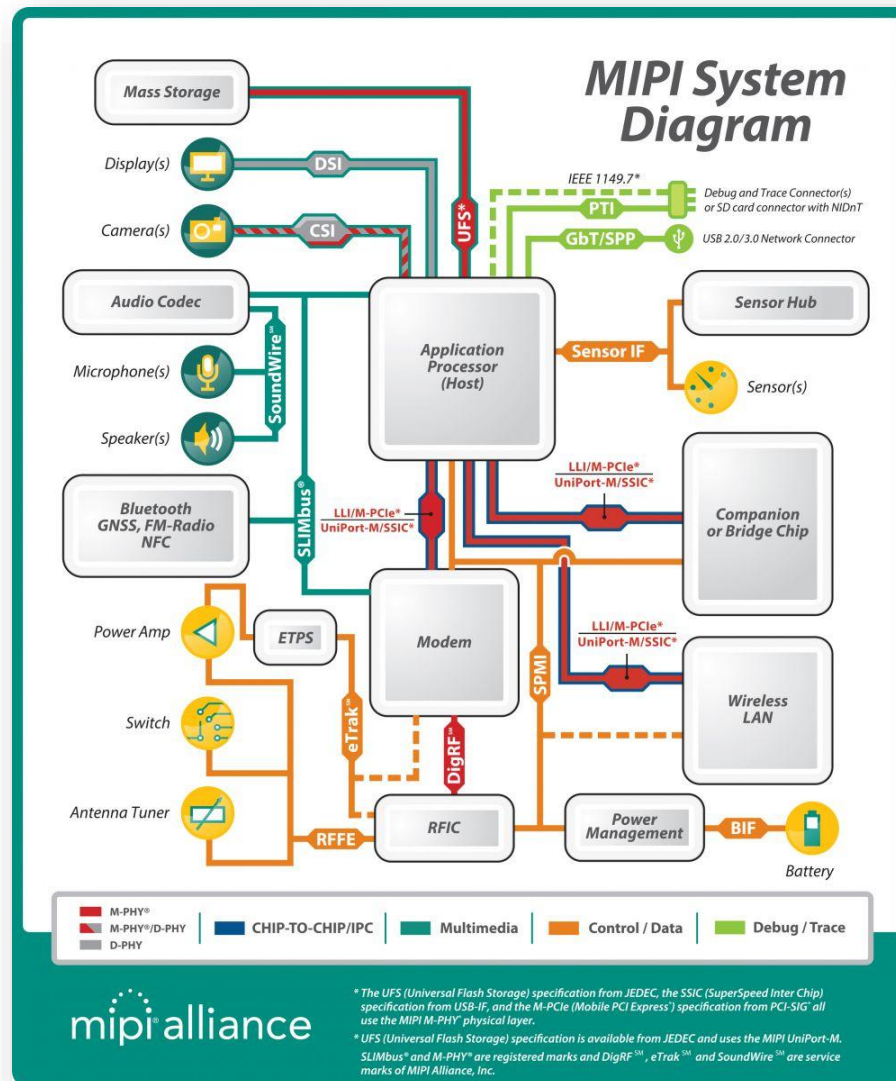
Industry's highest analog bandwidth, lowest noise floor/sensitivity, jitter measurement floor with unique cable/probe correction

Highest precision jitter lab source with automated compliance software for accurate, efficient, and consistent measurement

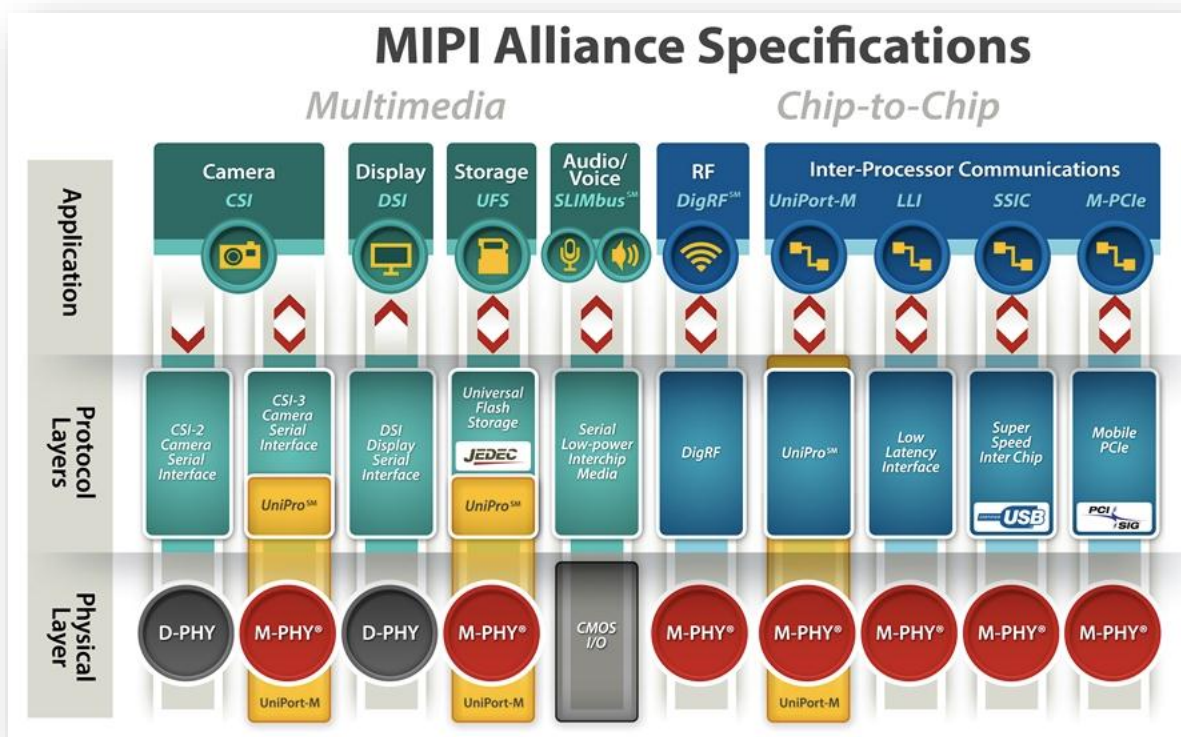
Precision impedance measurements and S-Parameter capability

Fast upload and display, accurate capture, intuitive GUI and customizable hardware. Correlate physical and protocol layer.

MIPI Interfaces in a Mobile Platform



MIPI Alliance Specifications and Test Solutions

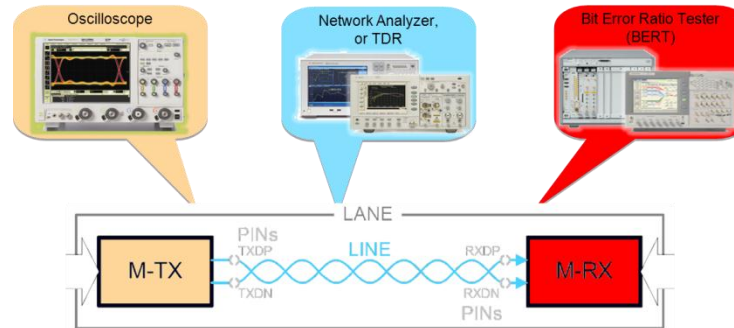


Test Solutions

Protocol Exerciser,
Analyzer Based Solution

Scope, BERT, ENA,
TDR Based Solution

PHY Conformance Test Suite(CTS) Requirements



Three test sections outlined in the CTS are:

- TX Timers and Signaling
 - Voltage, Eye-opening, Jitter, Rise/Fall time, Skew, Slew rate, etc
- RX Timers and Electrical Tolerances
 - Amplitude, Jitter, Termination, Skew tolerance, etc
- Interface S-parameters and Impedance
 - Return loss, impedance mismatch, etc

References

- MIPI Alliance Specification for M-PHY v3.0
- MIPI Alliance Conformance Test Suite for M-PHY Physical Layer v1.0
- MIPI Alliance Specification for D-PHY v1.1
- MIPI Alliance Conformance Test Suite for D-PHY Physical Layer v1.1 r03

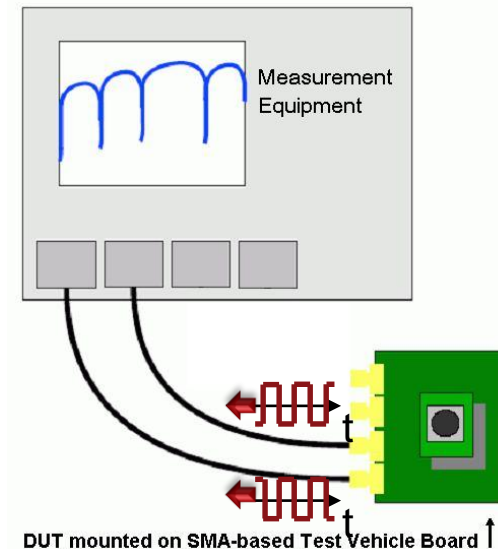
Measurements for M-PHY

◆ S-parameter Measurements

	Tx	Rx
Differential Return Loss	✓	✓
Common-mode Return Loss	✓	-

◆ Impedance Measurements

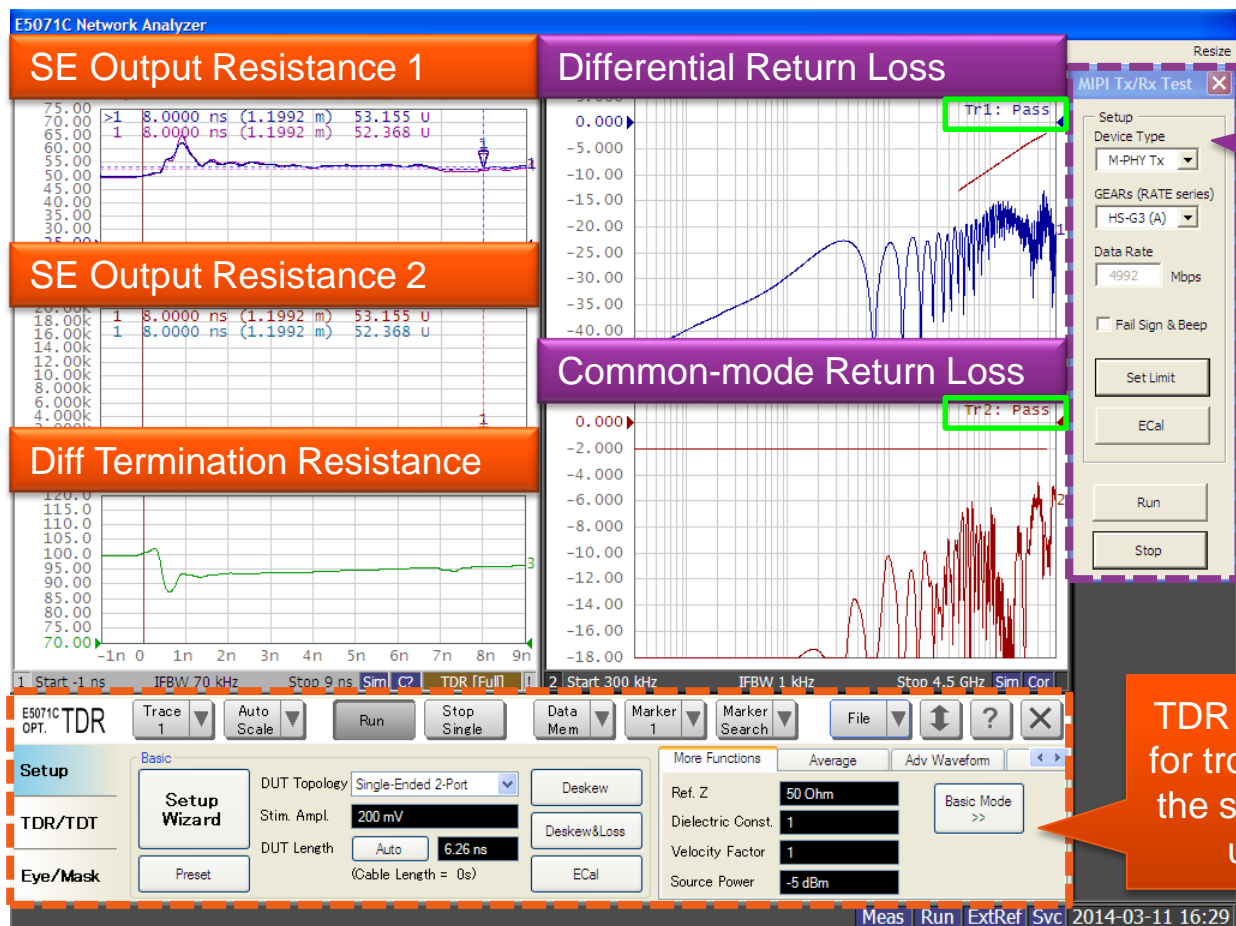
	Tx	Rx
Single-Ended Output Resistance (DIF-N/DIF-P and Stall/Sleep state)	✓	-
Single-Ended Output Resistance Mismatch	✓	-
Differential Termination Resistance	-	✓



Power on and configure the DUT to force its M-TX into a continuously transmitting HS state, transmitting a continuous CRPAT repeating pattern.

Example Using ENA Option TDR

◆ All Measurements in One Screen



VBA Macro automatically sets the limit lines for your desired parameters.

TDR application serves for trouble shooting with the simple and intuitive user-interface.

Measurements for D-PHY

◆ S-parameter Measurements

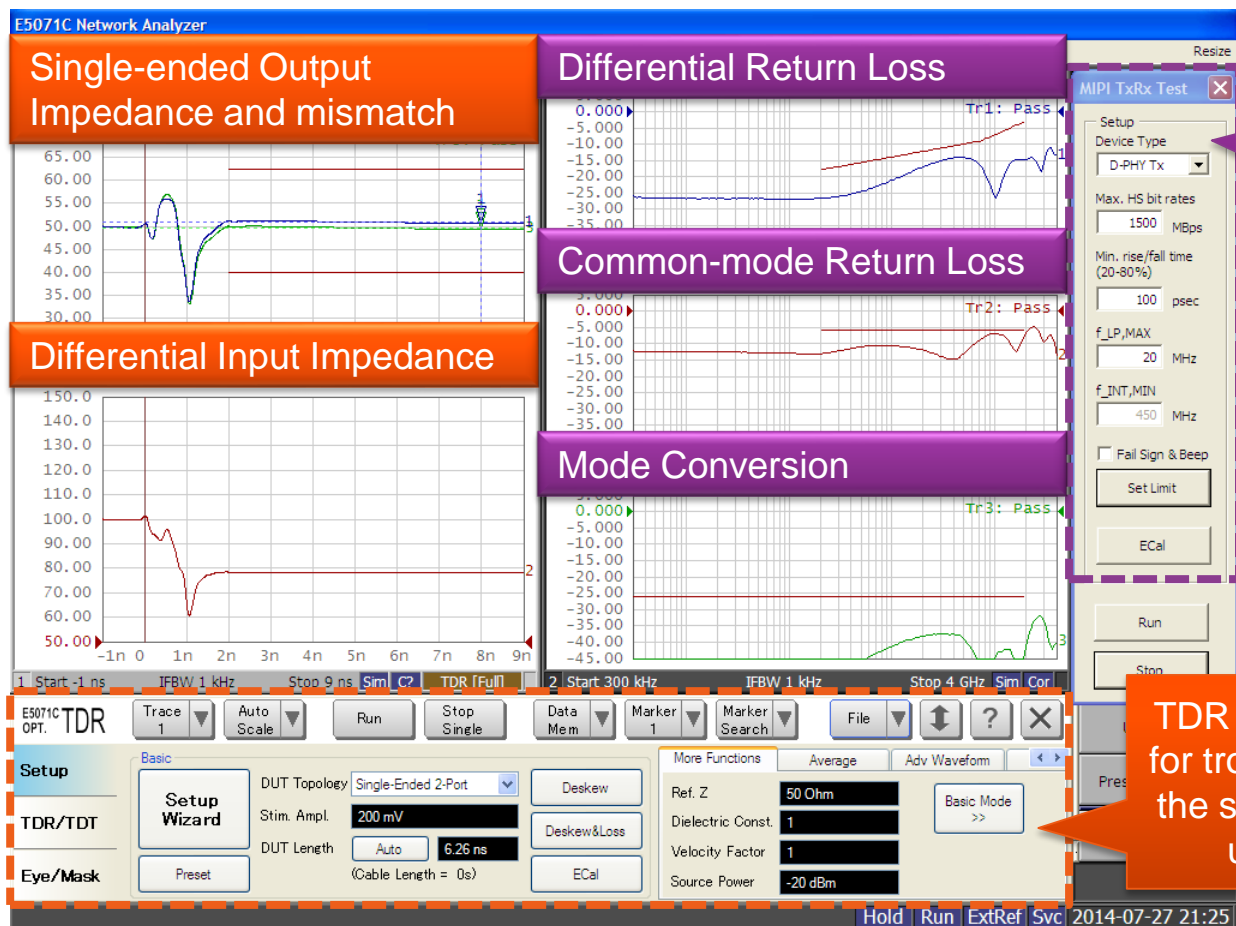
	Tx	Rx
Differential Return Loss	✓	✓
Common-mode Return Loss	✓	✓
CMN-Diff Mode Conversion	✓	✓

◆ Impedance Measurements

	Tx	Rx
Single-Ended Output Impedance	✓	-
Single-Ended Output Impedance Mismatch	✓	-
Differential Input Impedance	-	✓

Example Using ENA Option TDR

◆ All Measurements in One Screen



VBA Macro automatically sets the limit lines for your desired parameters.

TDR application serves for trouble shooting with the simple and intuitive user-interface.

MOIs & State Files are available from A.com

www.keysight.com/find/ena-tdr_compliance

Standards supported by E5071C-TDR

Standards		MOIs & State Files		Test Solution Overview
		Cable-Connector Assembly	Tx/Rx Impedance	
USB	USB2.0	Coming soon...	Coming soon...	Coming soon...
	USB3.0	Available	-	Available
	USB3.1	Coming soon...	-	Coming soon...
HDMI	HDMI 1.4b	Available	-	Available
	HDMI 2.0	(*2)	Available	Coming soon...
SATA		Available	Available	Available
DisplayPort		Available	-	Available
MIPI™	D-PHY	-	Available	Available
	M-PHY	-	Available	Available
Ethernet	100BASE-TX	Available	-	Available
	10GBASE-T	Available	-	Available
	10GBASE-KR / 40GBASE-KR4	Available (*3)	Available	Available
MHL		Available	Coming soon...	Coming soon...
PCIe®		Available	-	Available
Thunderbolt ⓘ		-	Available (*1)	Available
BroadR-Reach ⓘ		Available (*1)	-	Available
SD Card ⓘ	UHS-II	-	Available (*1)	Available
Cfast ⓘ		-	Available (*1)	Available

*1: Contact Keysight sales representative for more detail.

*2: HDMI 2.0 uses the same cable as HDMI 1.4b.

*3: Backplane interconnect tests

Download MOIs and test packages

Documents & Downloads

[Agilent Method of Implementation \(MOI\) for MIPI M-PHY Conformance Tests ⓘ](#)
Agilent Method of Implementation (MOI) for MIPI M-PHY Conformance Tests Using Agilent E5071C ENA Network Analyzer Option TDR

PDF 918 KB

Application Note

2011-12-01

[E5071C-TDR Test Package for MIPI M-PHY Tx/Rx Devices](#)

This package includes the E5071C-TDR state files and vba macro software that support the measurements described in the MOI.

ZIP 293 KB

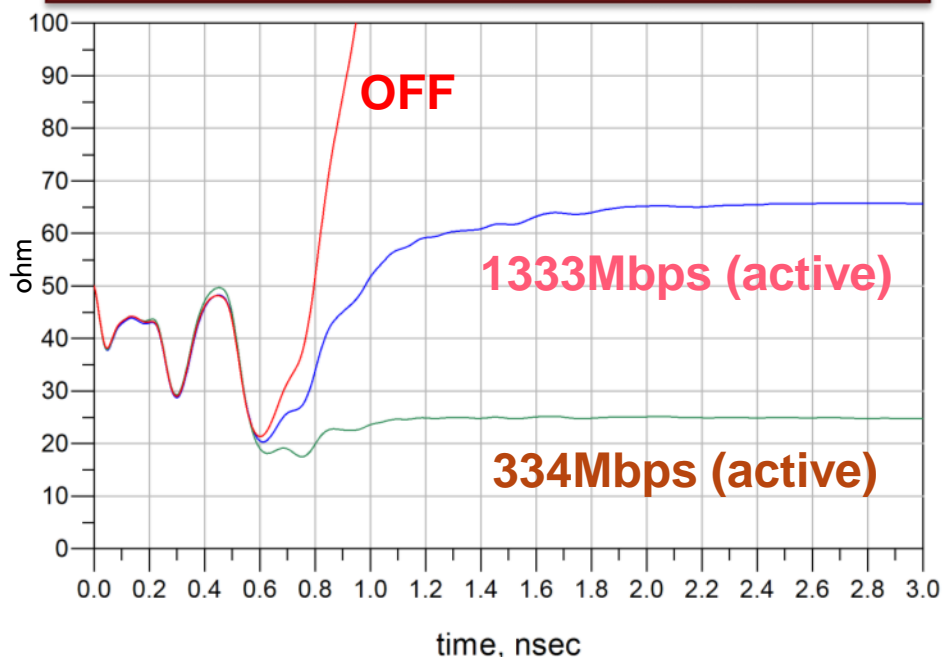
Programming Example

2011-12-01

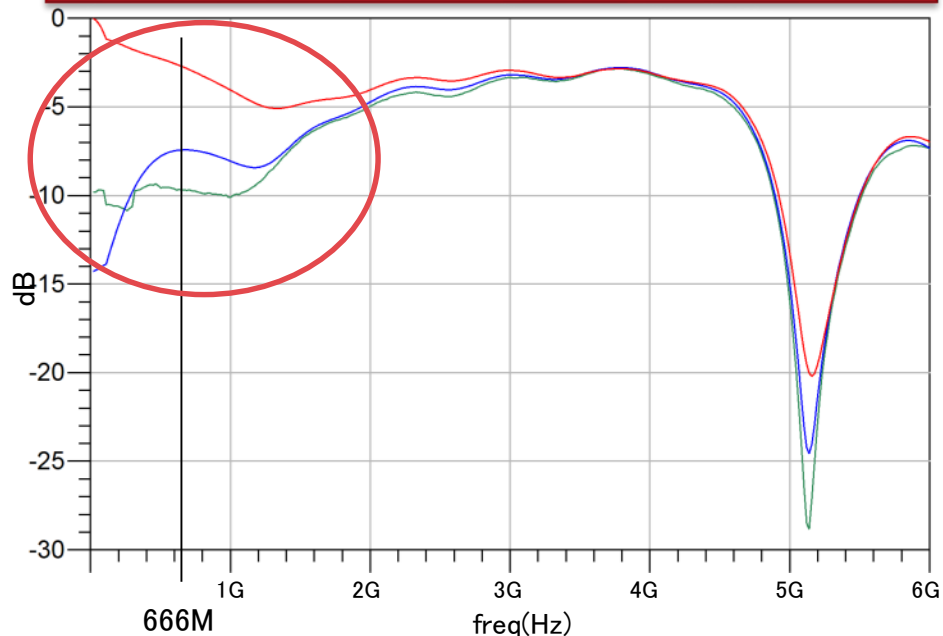
Hot TDR Measurements - Why Measure?

- **Hot TDR** measurement is the impedance analysis of active devices under actual operation conditions.
- Typically, impedance of the device in the OFF state and ON state (Hot TDR) is significantly different. Impedance may vary with the data rate as well.

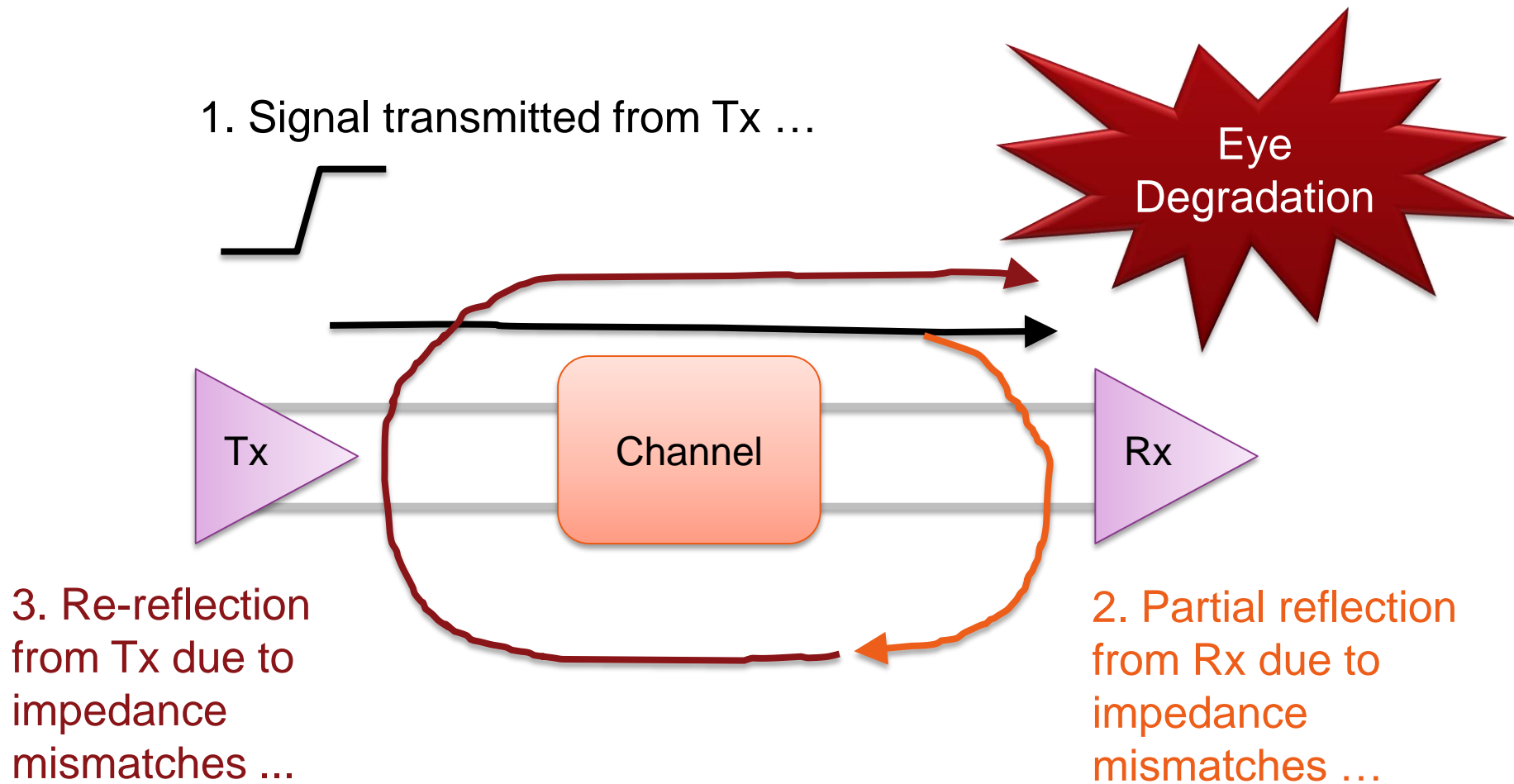
TDR(Time Domain)



Return Loss (Freq Domain)

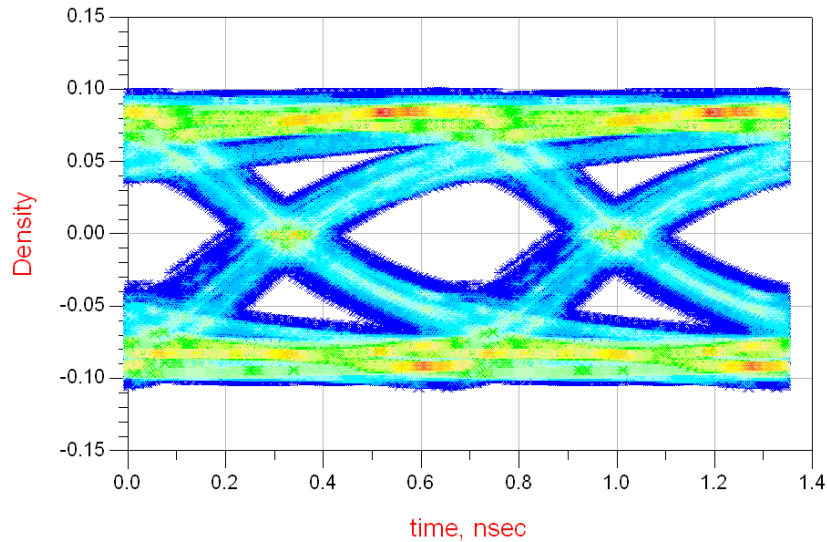


Hot TDR Measurements - Why Measure?

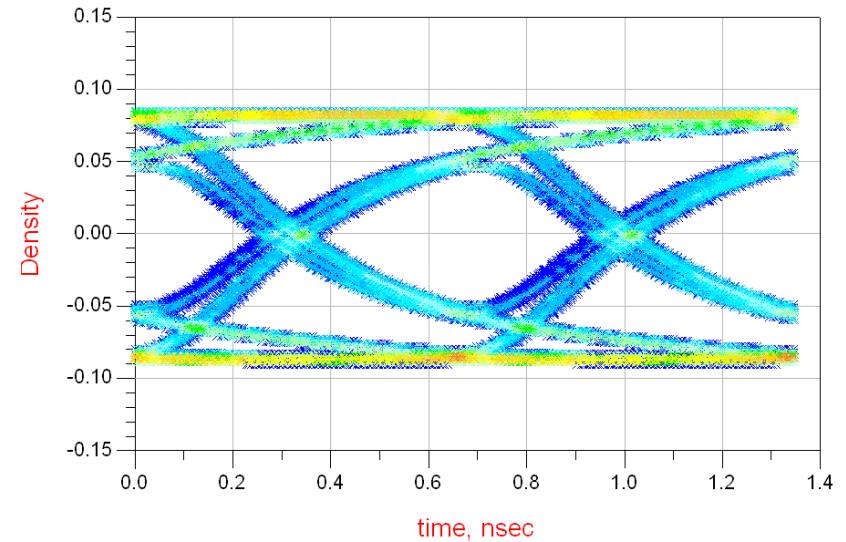


Hot TDR Measurements - Why Measure?

Source Termination Effects



Source Impedance **NOT** Matched

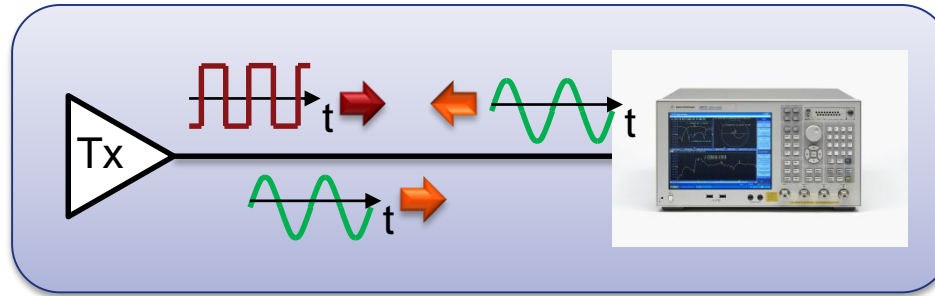


Source Impedance Matched

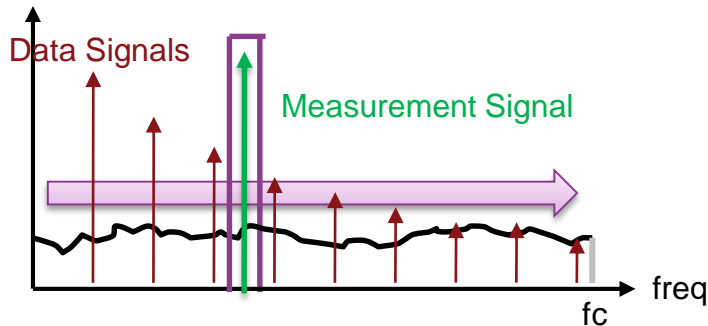
Advantages of VNA Based Solution

Fast and Accurate Measurements

Since the measurements must be performed while the device is turned on, data signals from the transmitter cause measurement error. ENA can resolve this trouble in a smart way.

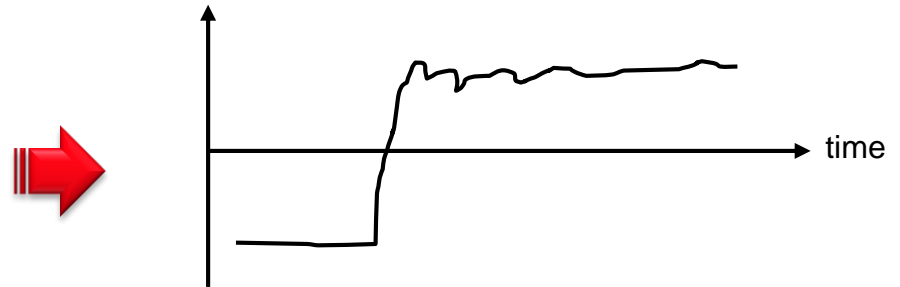


Narrowband receiver minimizes the effects of the data signal from the transmitter



ENA sweeps across desired frequency range. The spurious frequencies can be avoided during the sweep.

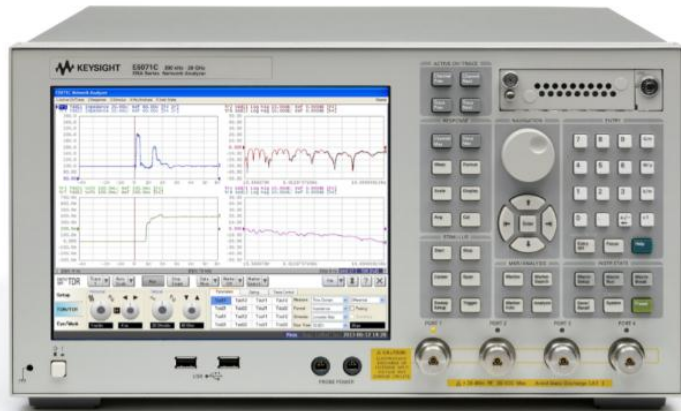
S-parameter can be converted into TDR.



Averaging is not necessary to obtain a stable waveform.

Advantages of VNA Based Solution

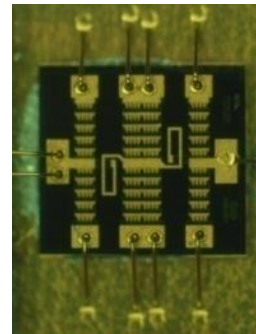
ESD Robustness



ENA has ESD protection circuits inside

ESD Survival:

IEC 801-2 Human Body Model. (150 pF, 330 Ω) RF Output Center pins tested to **3,000 V**, 10 cycles

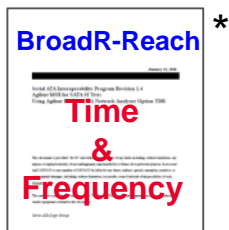
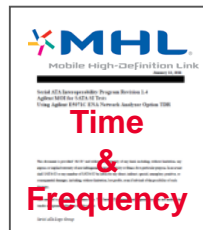
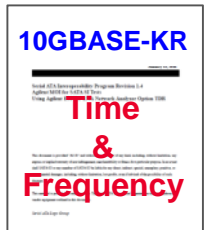
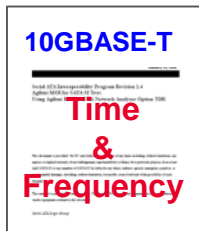
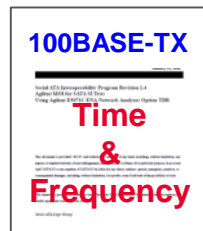
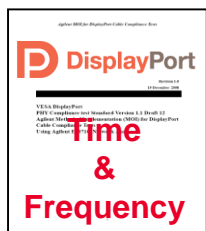
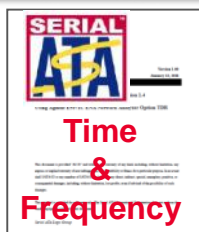
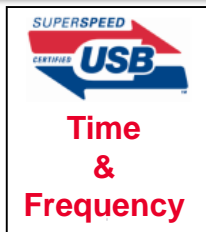


Proprietary ESD protection chip significantly increase ESD robustness, while at the same time maintaining **excellent RF performance** (22ps rise time for 20GHz models).

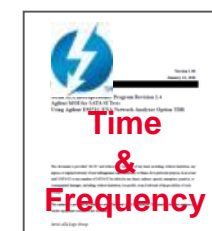
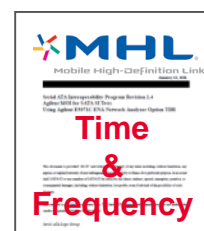
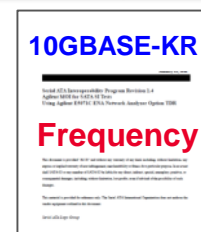
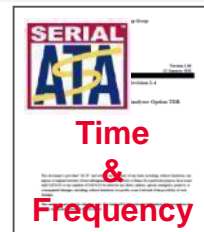
ENA Option TDR Compliance Test Solution

Certified MOIs available at www.keysight.com/find/ena-tdr_compliance

Cable/Connector/Interconnect



Transmitter/Receiver (Hot TDR/Hot Return Loss)



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





Questions?

Keysight 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 receiver

8530A replacement



PNA-X, NVNA

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



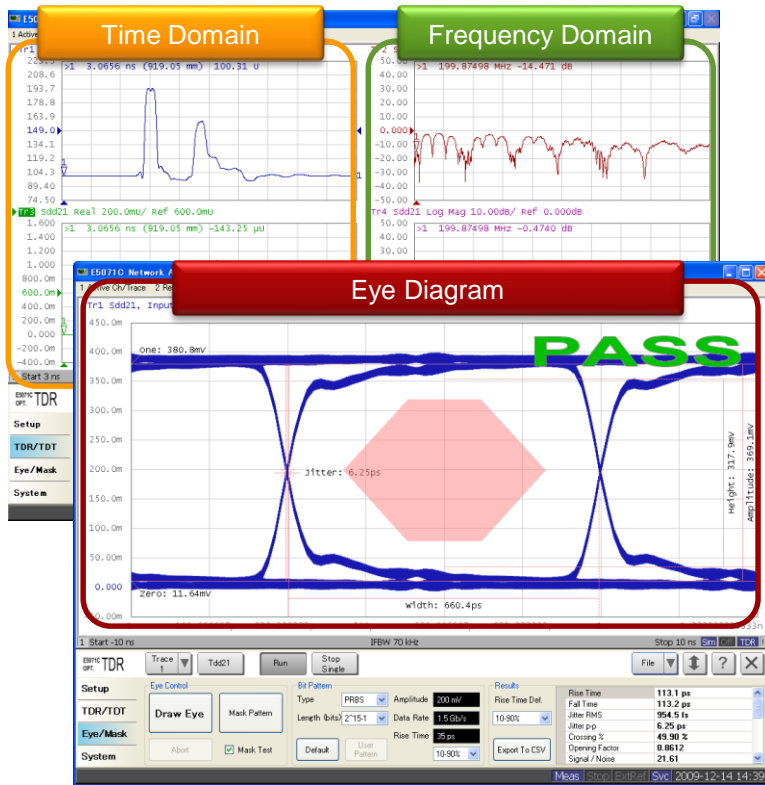
Mm-wave solutions

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.

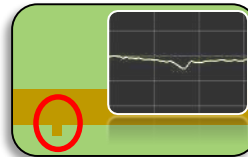


3 Breakthroughs

for Signal Integrity Design and Verification



Simple and Intuitive Operation



Fast and Accurate Measurements



ESD Robustness

What is ENA Option TDR?

[Video]

Keysight ENA Option TDR

Change the world of Time Domain Reflectometry (TDR) Measurements

- youtu.be/uBHXkzk4lzk?list=PLG98L-F0jgVj-jeYUheKdpGhr5z1Jg4q_
- www.keysight.com/find/ena-tdr



Additional Resources

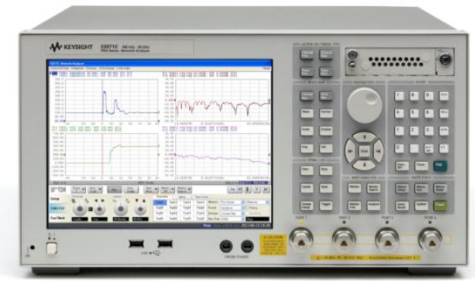
•ENA Option TDR Reference Material

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



Appendix

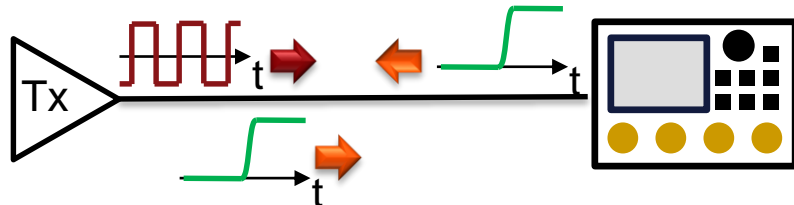
Page 26

Advantages of ENA Option TDR

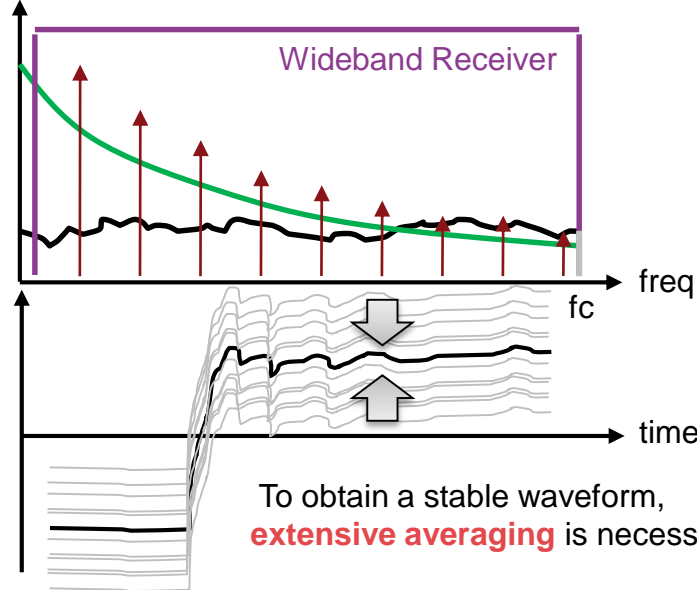
Fast and Accurate Measurements

For Hot TDR measurements, data signals from the transmitter cause measurement error...

TDR Scopes

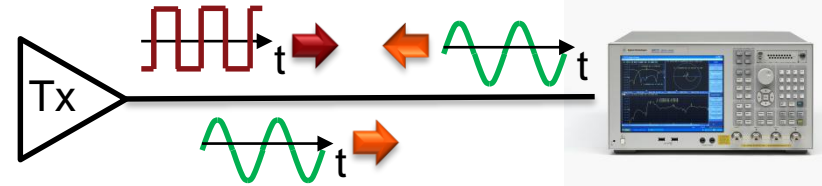


• **wideband receiver** captures all of the signal energy from the transmitter

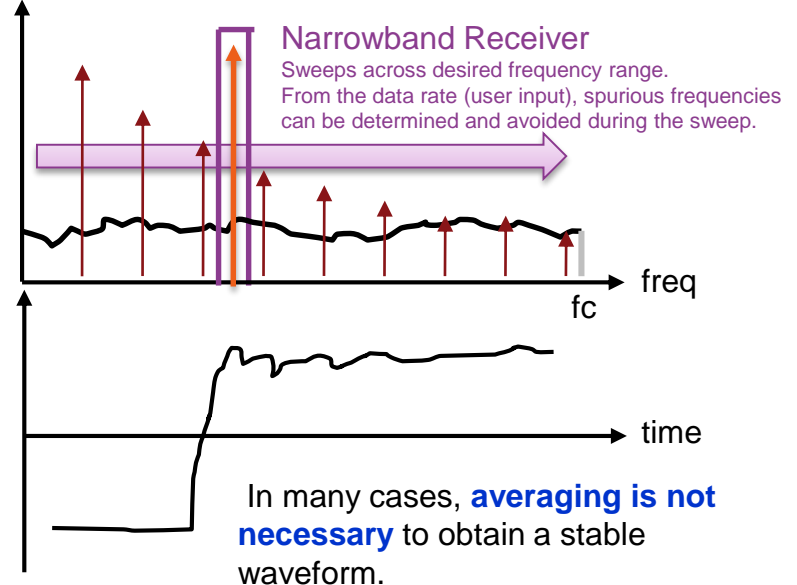


To obtain a stable waveform, **extensive averaging** is necessary.

ENA Option TDR



• **narrowband receiver** minimizes the effects of the data signal from the transmitter



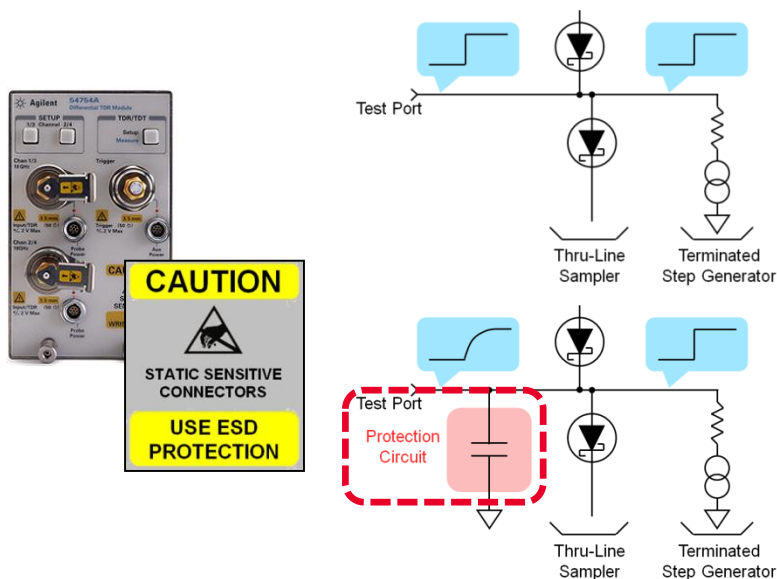
In many cases, **averaging is not necessary** to obtain a stable waveform.

Advantages of ENA Option TDR

ESD Robustness

TDR Scopes

TDR scopes are sensitive to ESD.

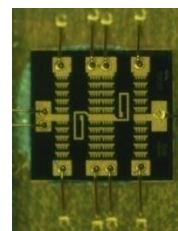
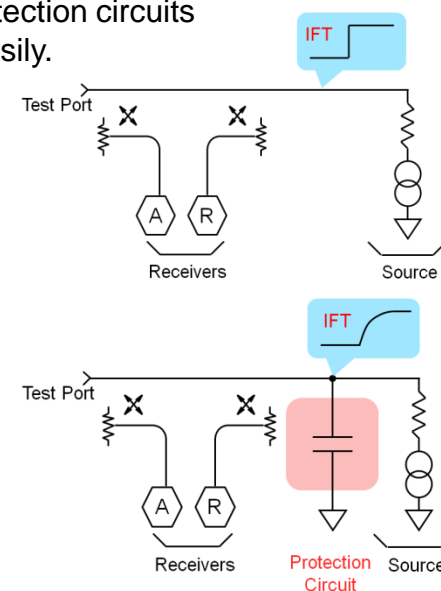


Implementing a protection circuit is difficult, because it will slow down the rise time of the step stimulus.

ENA Option TDR

ENA Option TDR has higher robustness against ESD, because protection circuits can be implemented more easily.

ENA Option TDR measures the vector ratios of the transmitted and received signals. Therefore, the effects of the protection circuit will be canceled out.

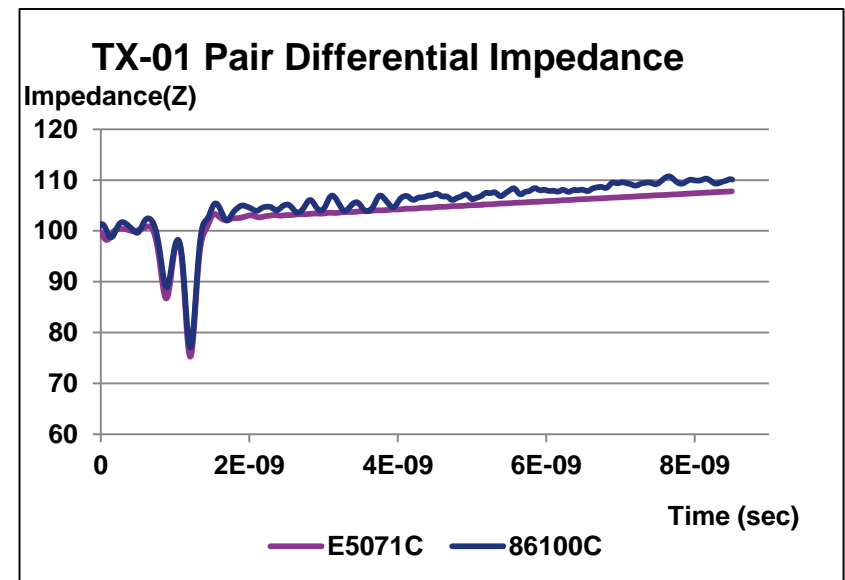
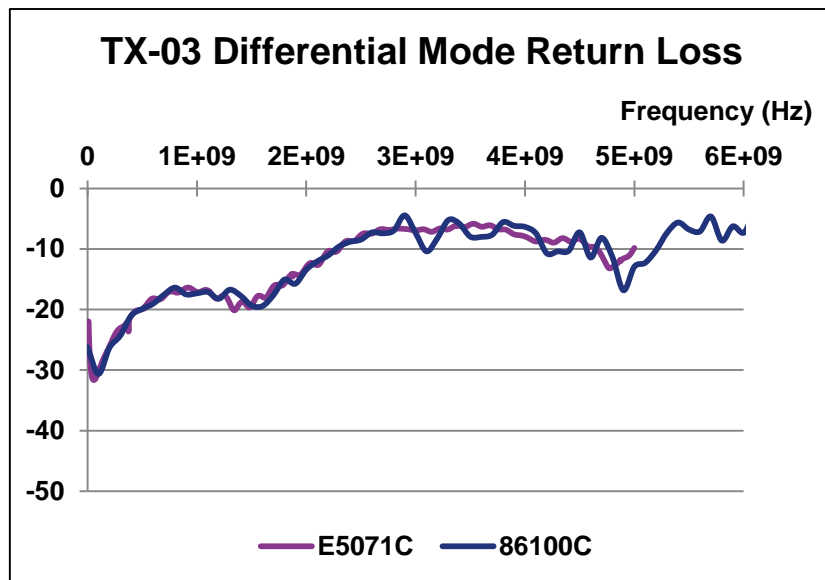


Proprietary ESD protection chip significantly increases ESD robustness, while at the same time maintaining **excellent RF performance** (22ps rise time for 20GHz models).

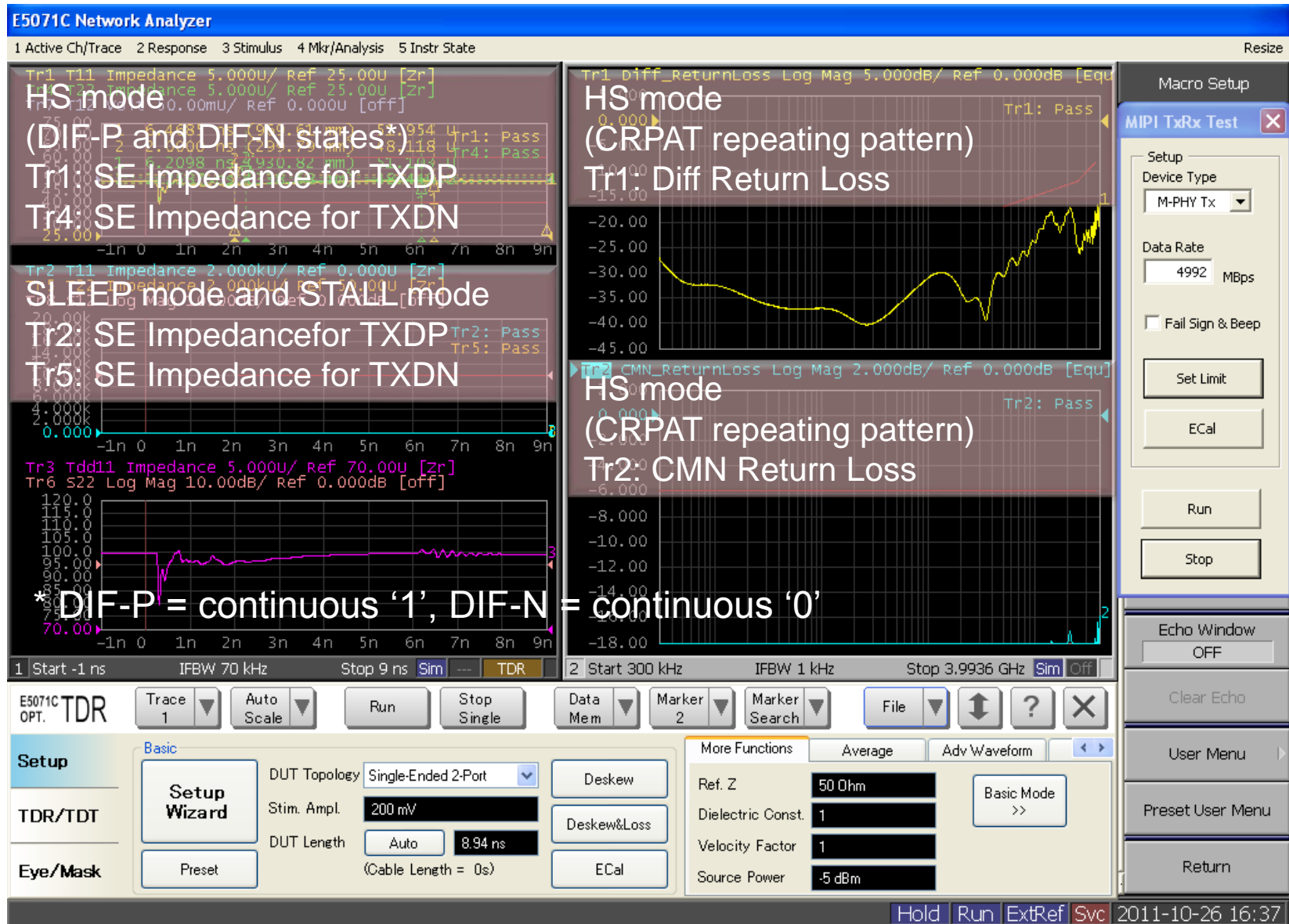
Advantages of ENA Option TDR

Fast and Accurate Measurements

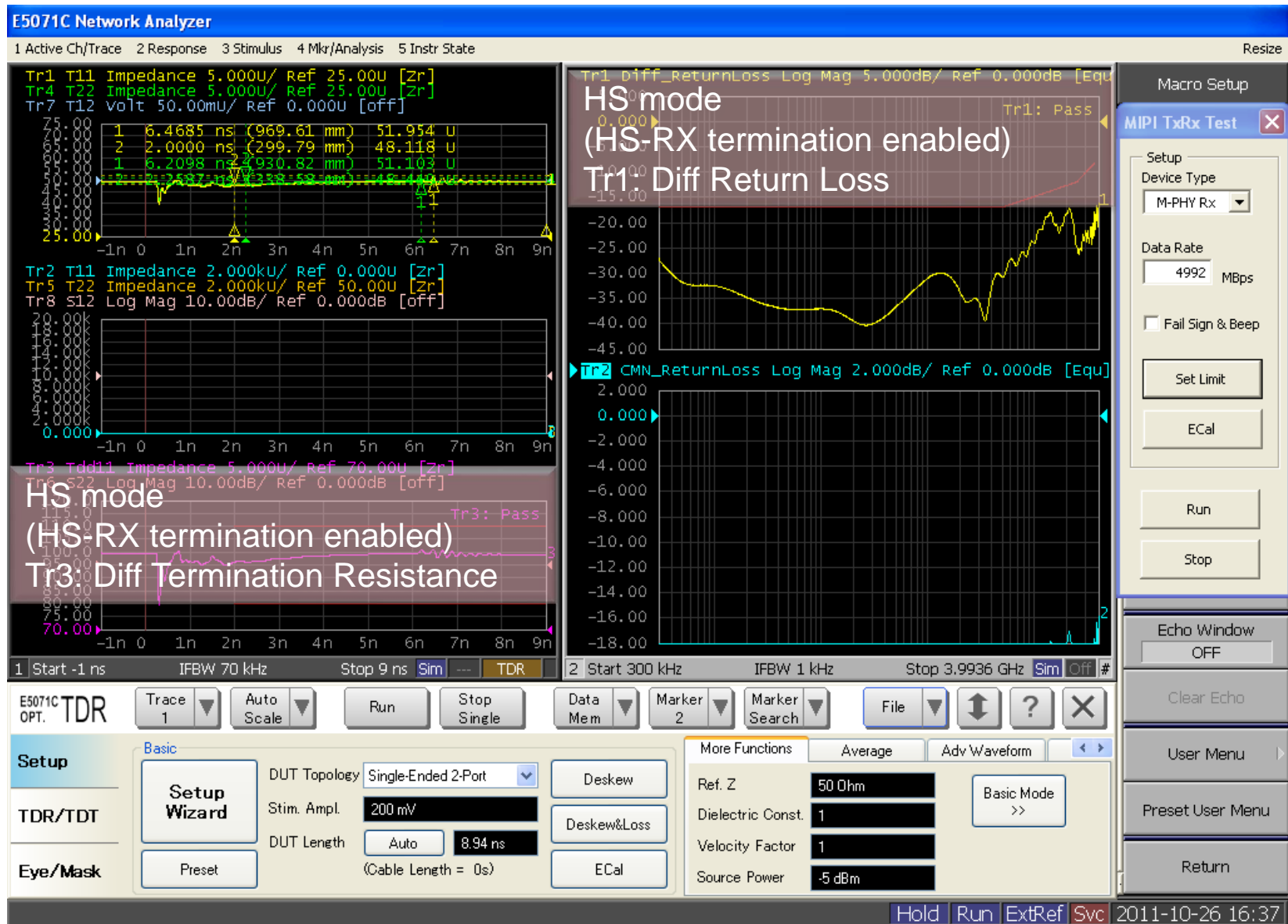
Correlation between 86100C TDR oscilloscope and E5071C ENA Option TDR



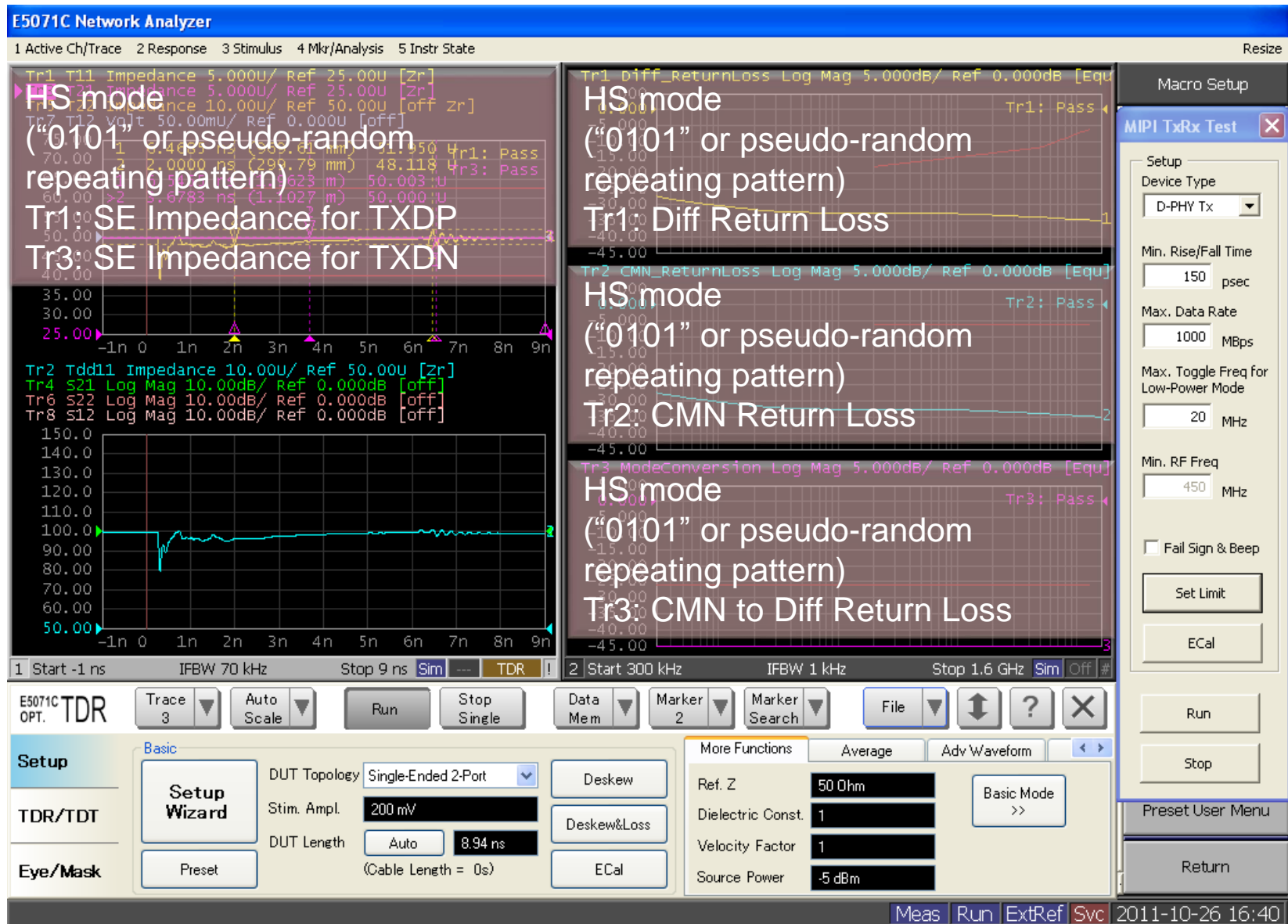
M-PHY Tx Device



M-PHY Rx Device



D-PHY Tx Device



D-PHY Rx Device

