Agilent Technologies

MHL (Mobile High-definition Link) Cable Compliance Test

Test Solution Overview Using the Agilent E5071C ENA Option TDR

Last Update 2013/02/22 (TH)

Purpose

• This slide will show how to make measurements of MHL (Mobile High-definition Link) Cable Compliance Tests by using the Agilent E5071C ENA Option TDR.

Agilent Digital Standards Program

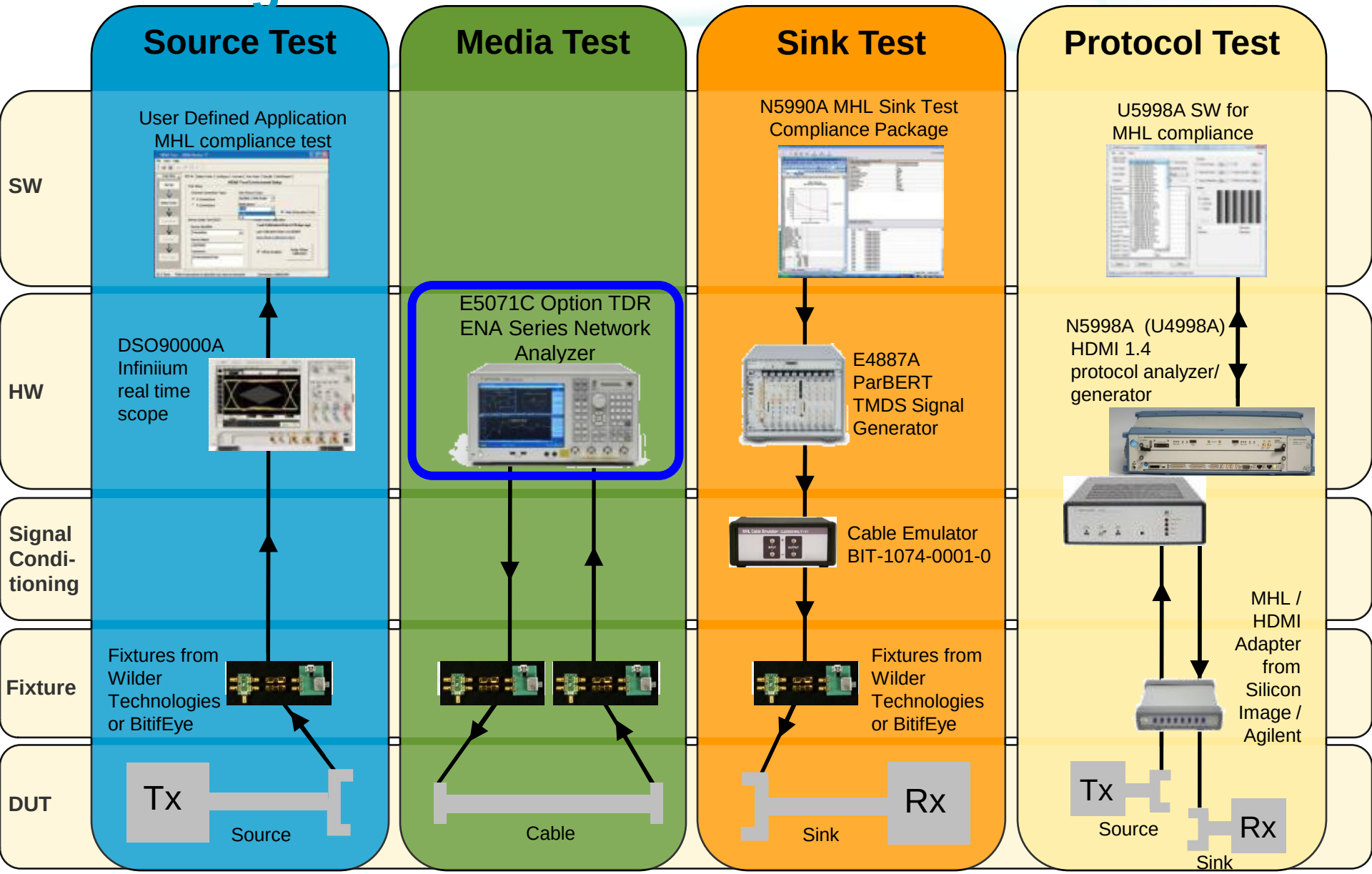
Our solutions are driven and supported by Agilent experts involved in international standards committees:

- 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)
- 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

MHL – Agilent Test Solution Overview

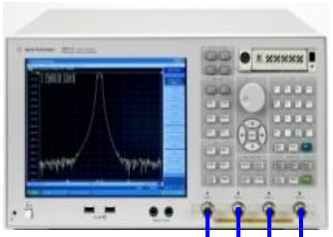


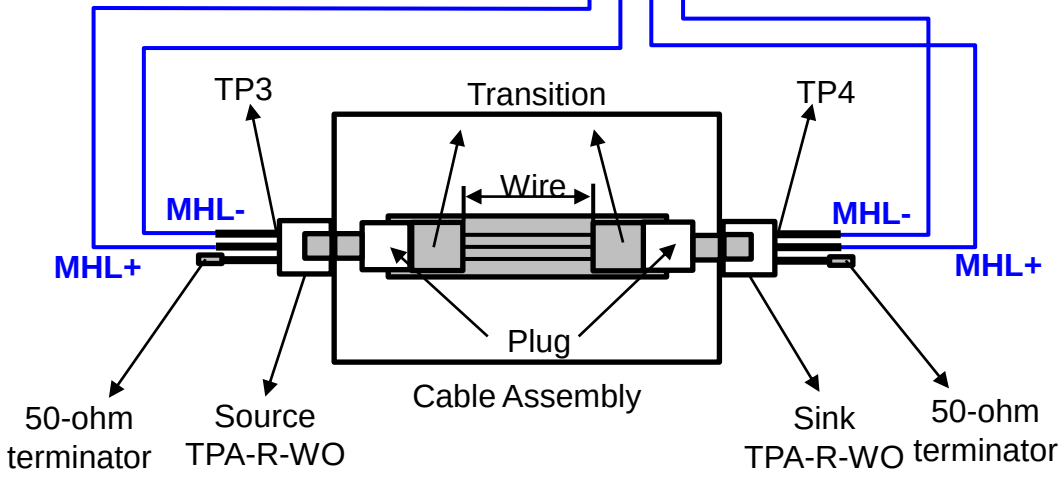
Reference Document

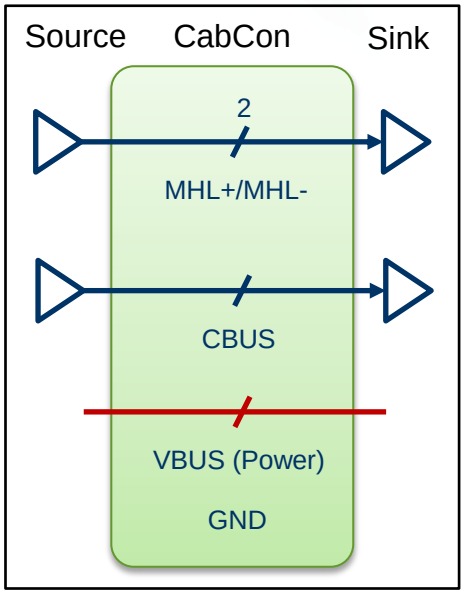
- MHL (Mobile High-definition Link) Specification Revision 2.0
- MHL (Mobile High-definition Link) Compliance Test Specification Revision 2.0

MHL Cable Compliance Test Solution

Cable Test Setup



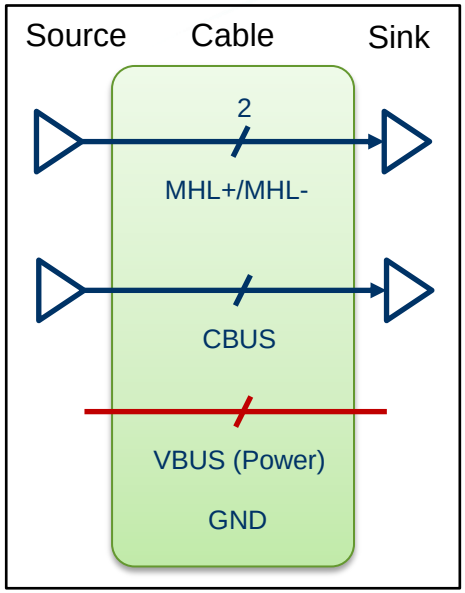




- MHL has <u>one physical data channel</u> composed of the single differential pair carrying TMDS data.
- CBUS is MHL Link Control Bus. This is a single-wire bus used to carry auxiliary data between an MHL source and MHL sink.
- VBUS is MHL Voltage Bus, a one-wire interconnect between Source and Sink.

MHL Cable Compliance Test Solution

Measurement Parameters



Time Domain Measurements

- Differential Intra Pair Skew
- Common-mode Intra Pair Skew
- Differential Characteristic Impedance
- Common-mode Characteristic Impedance
- CBUS Cable Delay

Frequency Domain Measurements

- Differential Insertion Loss
- Common-mode Insertion Loss
- Differential to Common-mode Conversion
- CBUS Insertion Loss
- CBUS Line Capacitance
- Far-End Crosstalk

MHL Cable Compliance Test Solution

Solution Overview

•MHL cable compliance testing requires parametric measurements in both time and frequency domains.

Frequency Domain
- •Differential Insertion Loss
- •Common-mode Insertion Loss
- •Differential to Common-mode Conversion
- •CBUS Insertion Loss
- •Far-End Crosstalk
- •CBUS Line Capacitance

Time Domain
- •Differential Intra Pair Skew
- •Common-mode Intra Pair Skew
- •Differential Characteristic Impedance
- •Common-mode Characteristic Impedance
- •CBUS Cable Delay

Traditional Solution

Vector Network Analyzer (VNA)

TDR Scope

New Solution

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

One-box Solution !!

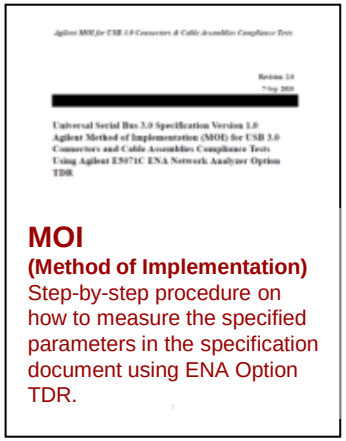
MHL Cable Compliance Test Solution

ENA Option TDR Solution

- ENA Mainframe
  - E5071C-480: 4-port, 9 kHz to 8.5 GHz
  - E5071C-485: 4-port, 100 kHz to 8.5 GHz
  - E5071C-4D5: 4-port, 300 kHz to 14 GHz
  - E5071C-4K5: 4-port, 300 kHz 20 GHz
- Enhanced Time Domain Analysis Option (E5071C-TDR)
- ECal Module
  - N4431B for E5071C-480/485
  - N4433A for E5071C-4D5/4K5

ENA Option TDR is a certified solution for MHL Cable Compliance test.
http://mhlconsortium.org/

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



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

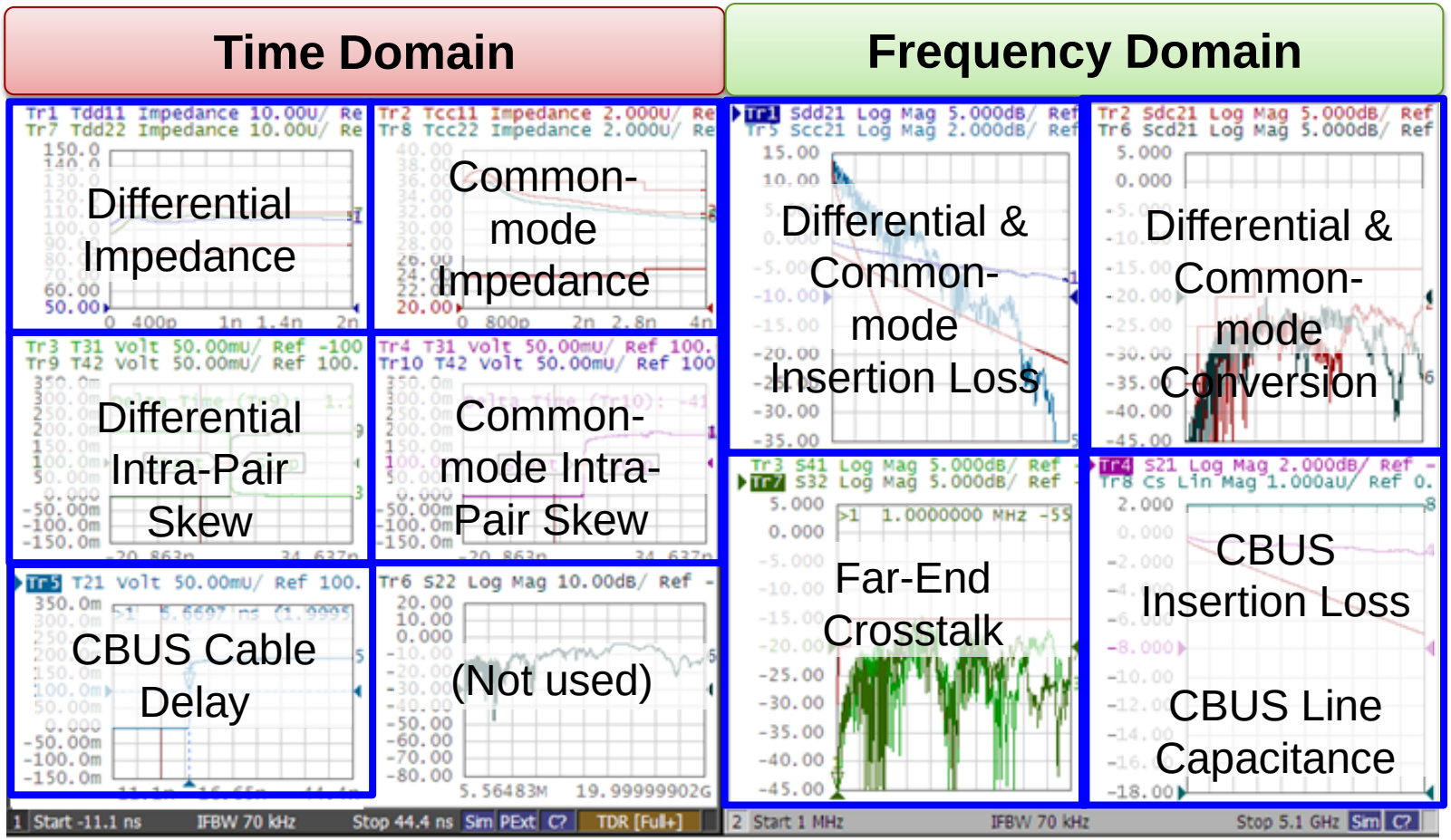
www.agilent.com/find/ena-tdr_compliance
www.agilent.com/find/ena-tdr_mhl-cabcon

Test Fixture
Fixtures for testing MHL cable assemblies are available for purchase through Wilder Technology.
http://www.wilder-tech.com/

MHL Cable Compliance Test Solution

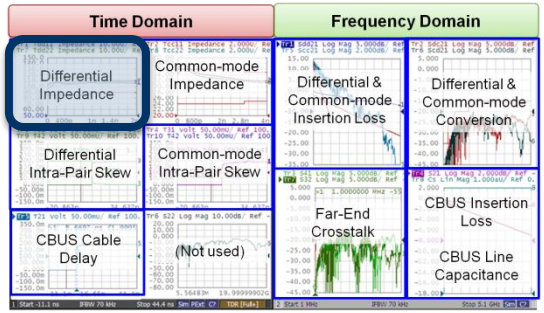
Measurement Parameters

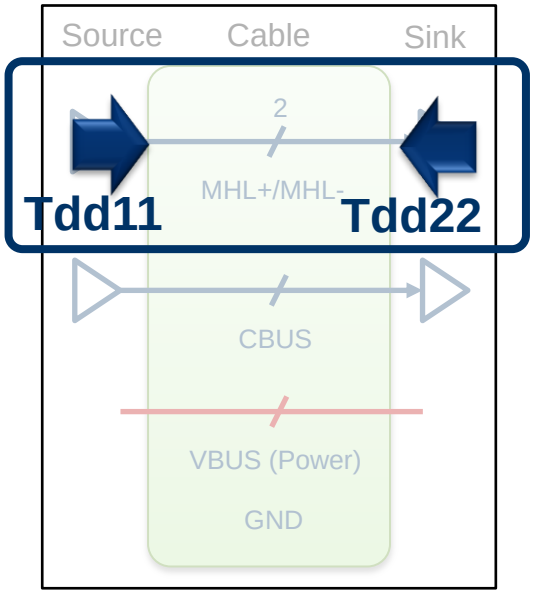
ENA Option TDR Compliance Testing Solution is one-box solution which provides complete characterization of interconnects (time domain, frequency domain.)



MHL Cable Compliance Test Solution

Differential Characteristic 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

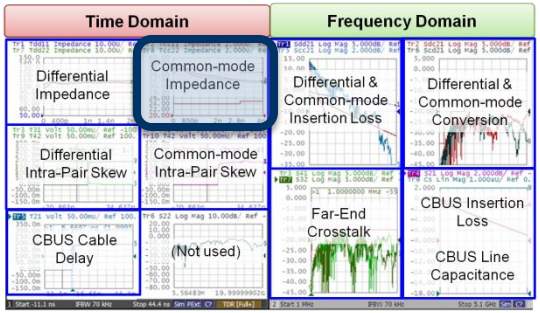
Impedance Limit @ rise time (20%-80%) of 200 ps

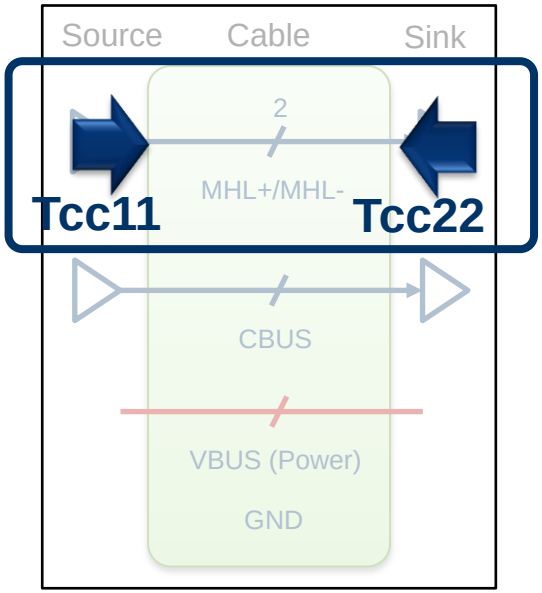
	Min	Max	Unit	Note
MHL+ and MHL- Differential Impedance	85	115	Ohm	*1
	90	110	Ohm	*2

*1. Connection point and transition area, up to 1 ns distance. A single excursion is permitted out to 65-125 ohms, no wider than 250 ps.
*2. Cable area, from 1 ns to 2 ns distance

MHL Cable Compliance Test Solution

Common-mode Characteristic 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

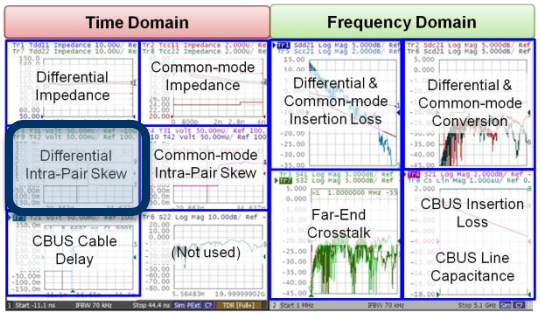
Impedance Limit @ rise time (20%-80%) of 600 ps

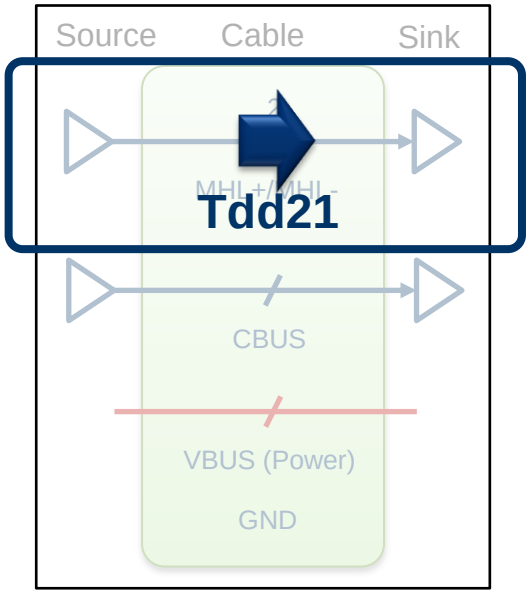
	Min	Max	Unit	Note
MHL Clock Common-mode Impedance	24	36	Ohm	*1
	25	35	Ohm	*2

*1. Connection point and transition area, up to 3 ns distance. A single excursion is permitted out to 20-40 ohms, no wider than 500 ps.
*2. Cable area, from 3 ns to 4 ns distance.

MHL Cable Compliance Test Solution

Differential Intra-Pair Skew



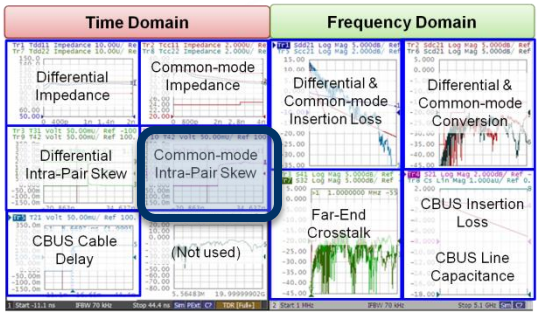


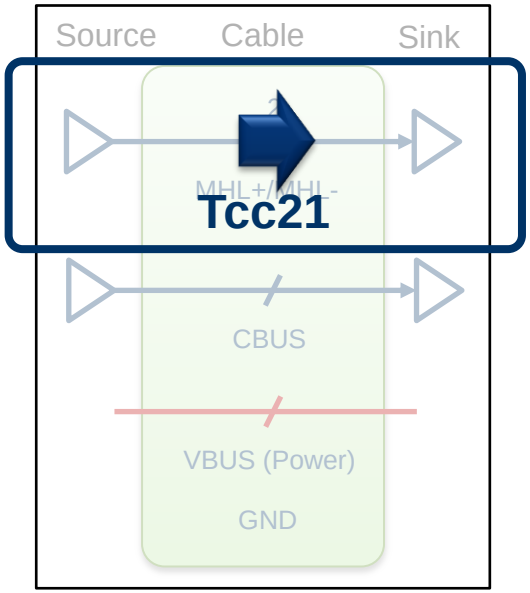
- Ensures the signal of differential pairs of MHL+ and MHL- of a cable assembly arrive at the receiver at the same time.
- Excessive Intra-pair skew can distort the rising edge of the signal, lead to significant differential to common mode conversion.

- If differential intra-pair skew is less than or equal to 43 ps, then PASS. Otherwise FAIL.
- Need to compensate the differential intra-skew caused by the test fixtures (TPA boards and cables)

MHL Cable Compliance Test Solution

Common-mode Intra-Pair Skew



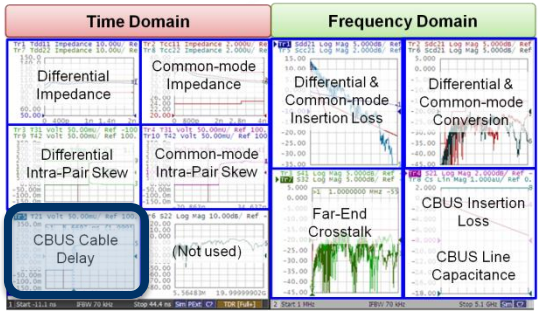


- Ensures the signal of differential pairs of MHL+ and MHL- of a cable assembly arrive at the receiver at the same time.
- Excessive Intra-pair skew can distort the rising edge of the signal, lead to significant differential to common mode conversion.

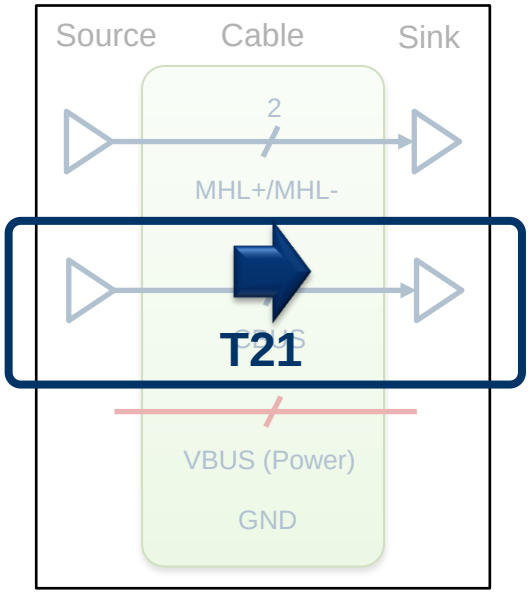
- If common-mode intra-pair skew is less than or equal to 43 ps, then PASS. Otherwise FAIL.
- Need to compensate the common-mode intra-skew caused by the test fixtures (TPA boards and cables)

MHL Cable Compliance Test Solution

CBUS Cable Delay



•Confirms that the CBUS cable delay is within the spec.

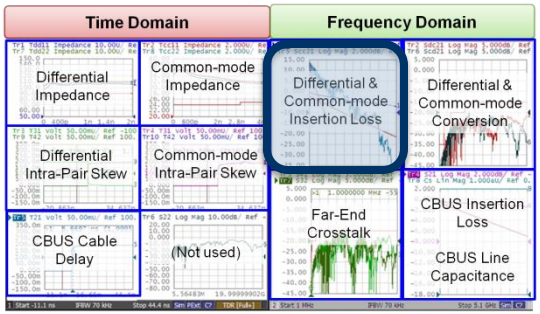


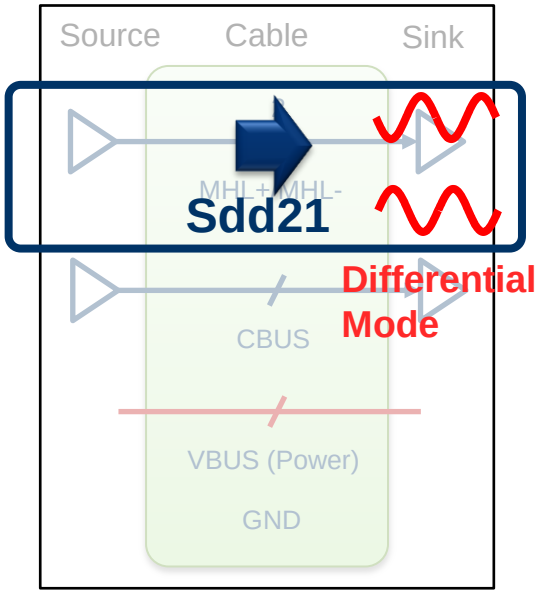
•If CBUS cable delay is less than or equal to 35 ns, then PASS. Otherwise FAIL.

• Need to compensate the propagation delay caused by the test fixtures.

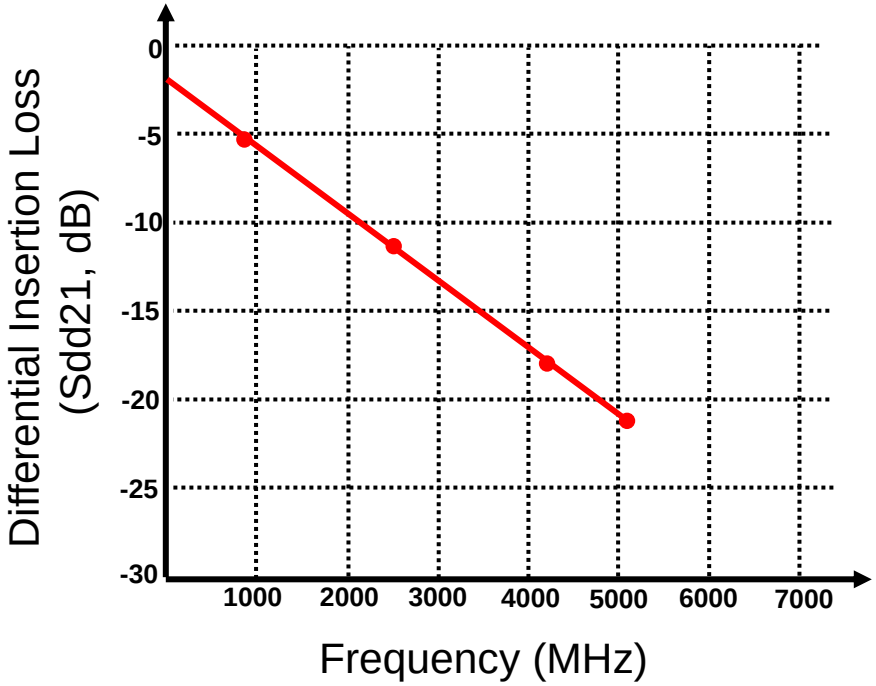
MHL Cable Compliance Test Solution

Differential Insertion Loss





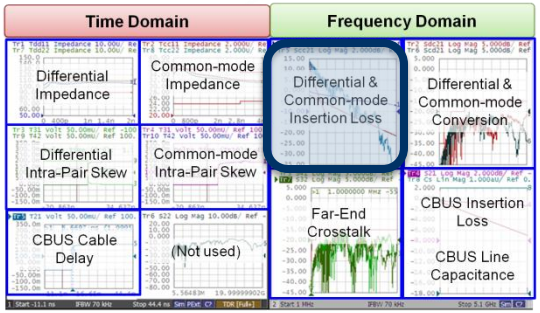
- Insertion loss is the loss through the differential pairs.
- Has important consequences for the rise time degradation and the maximum supportable bandwidth.

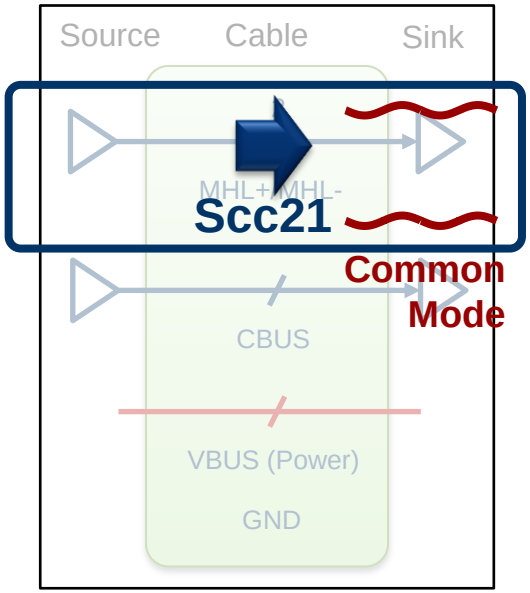


Differential Insertion Loss Requirement for MHL data signals

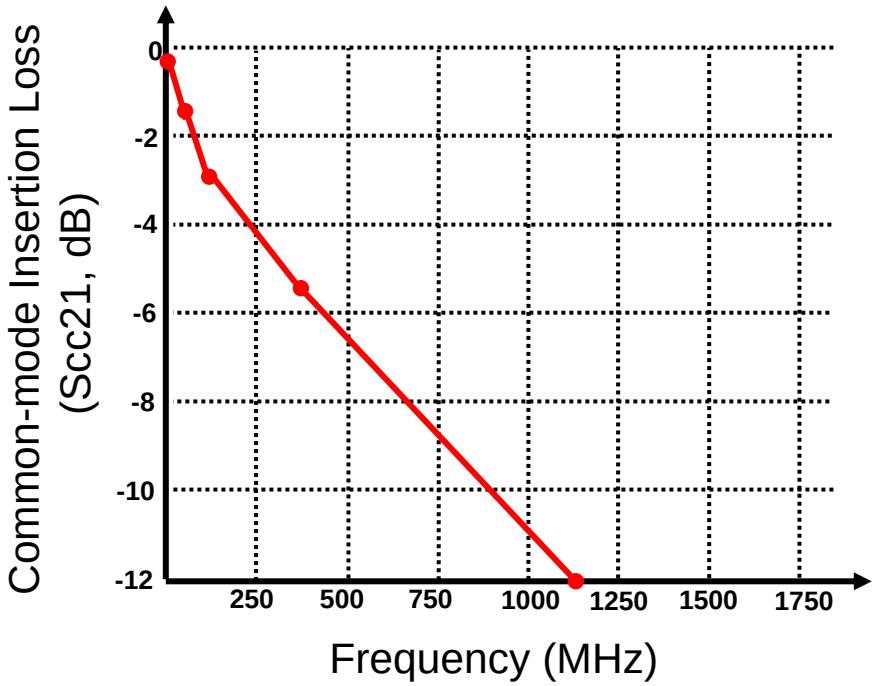
MHL Cable Compliance Test Solution

Common-Mode Insertion Loss





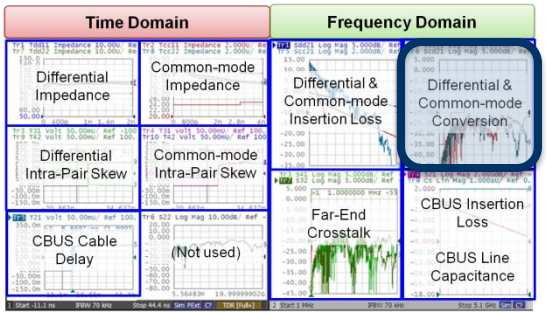
- Common-mode current is directly responsible for EMI.

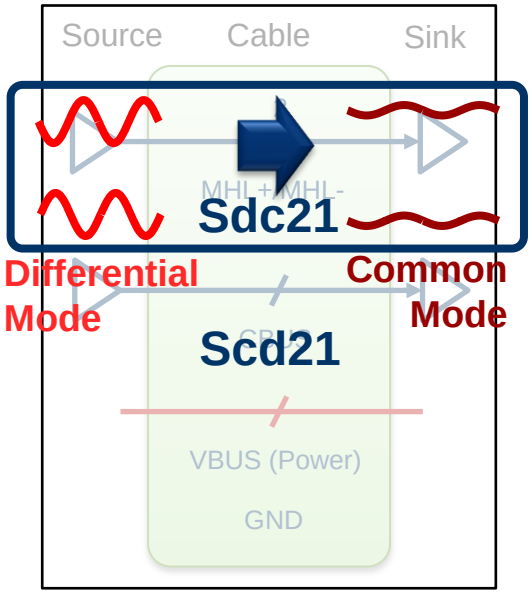


Common-mode Insertion Loss Requirement for MHL clock signals

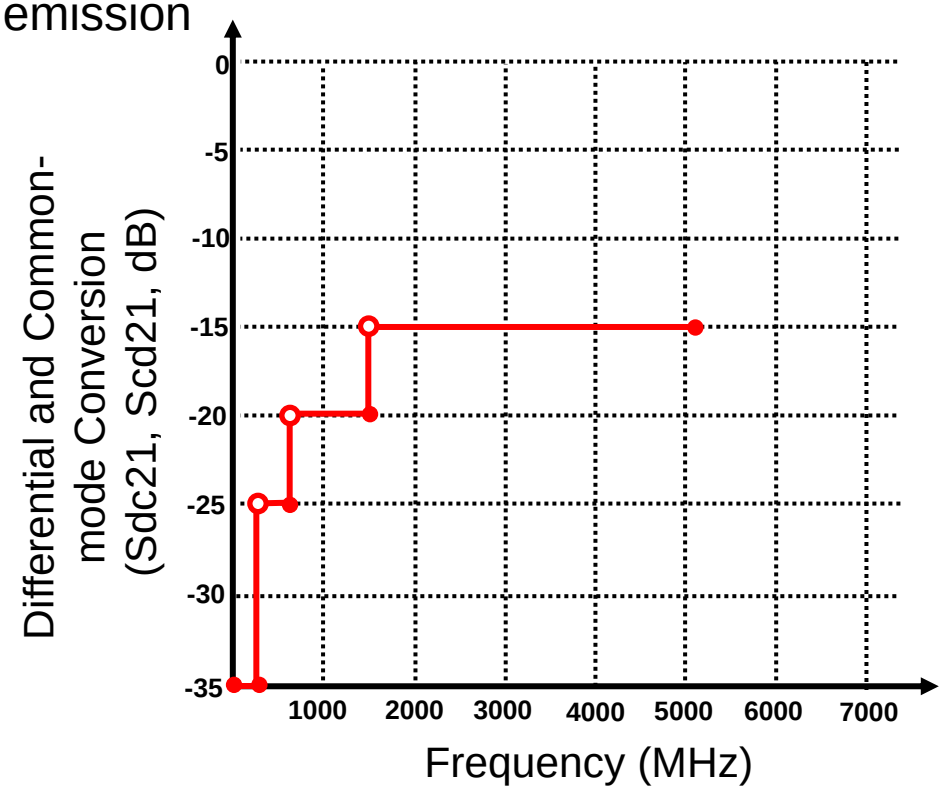
MHL Cable Compliance Test Solution

Differential and Common-Mode Conversion (Sdc21, Scd21)





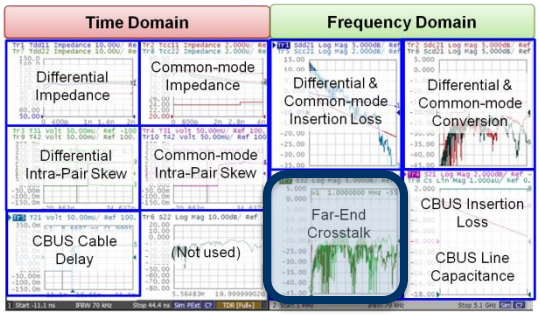
- Common-mode current is directly responsible for EMI and Scd21 is a measure of EMI generation
- Main purpose of this requirement is to limit EMI emission

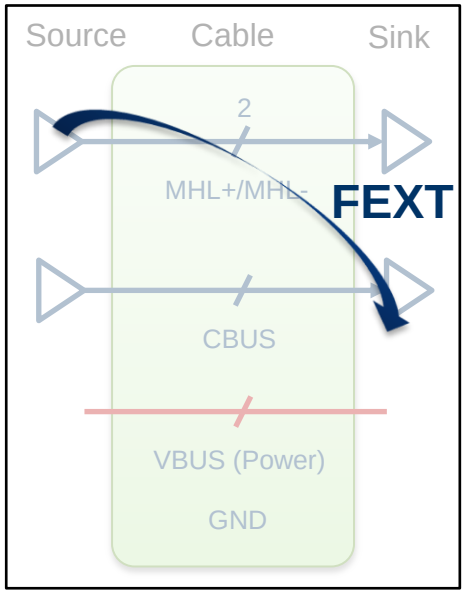


Differential Insertion Loss Requirement for MHL data signals

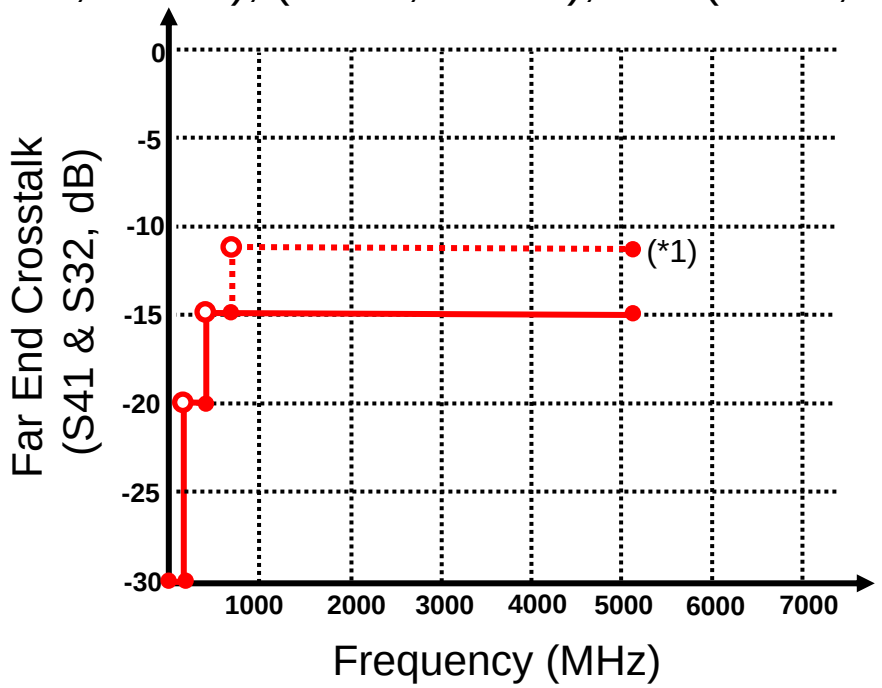
MHL Cable Compliance Test Solution

Far-End Crosstalk (MHL <=> CBUS or VBUS)





•Measure of coupling between the lanes: (MHL+, CBUS), (MHL+, VBUS), (MHL-, CBUS), and (MHL-, VBUS).



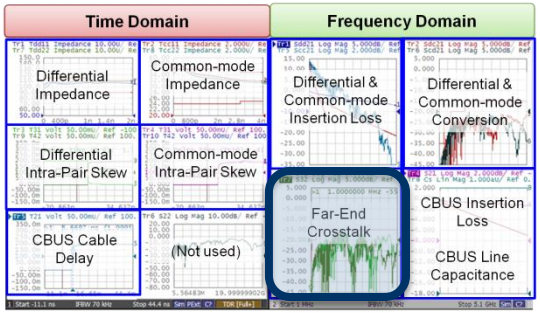
Far-End Crosstalk (between MHL and VBUS or VBUS) Requirement

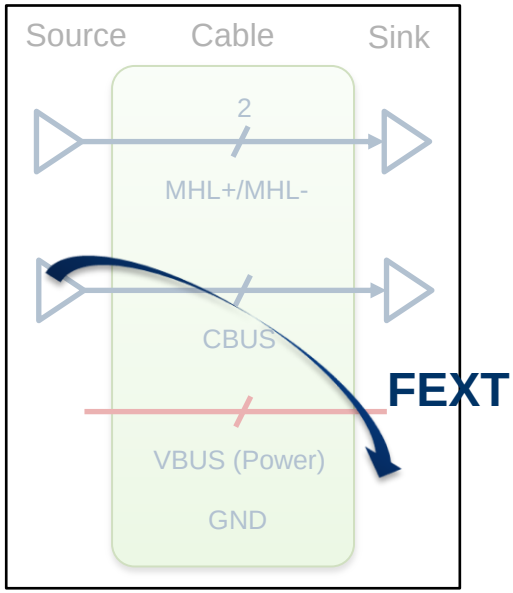
*1. Excursions are permitted if the differential insertion loss of the MHL cable meets the below specification.

Frequency (MHz)	0	825	2475	4125	5100
Attenuation (dB)	2.0	2.0	8.0	14.5	18.0

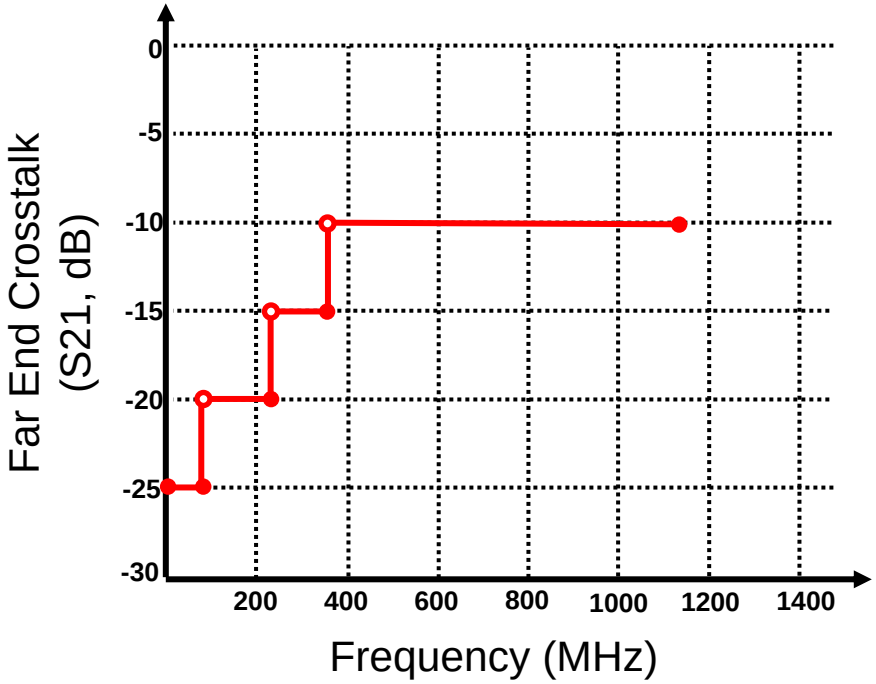
MHL Cable Compliance Test Solution

Far-End Crosstalk (CBUS <=> VBUS)





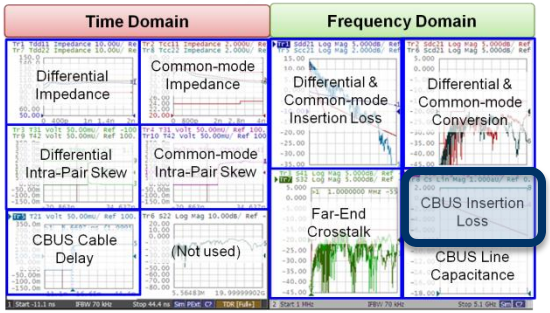
- Measure of coupling between CBUS and VBUS.

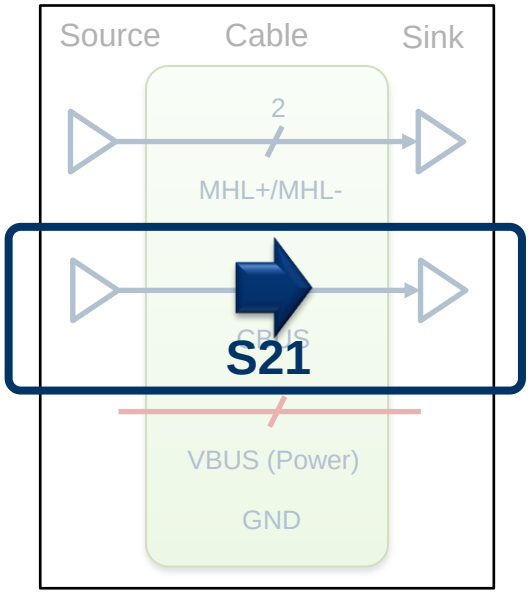


Far-End Crosstalk (between VBUS and VBUS) Requirement

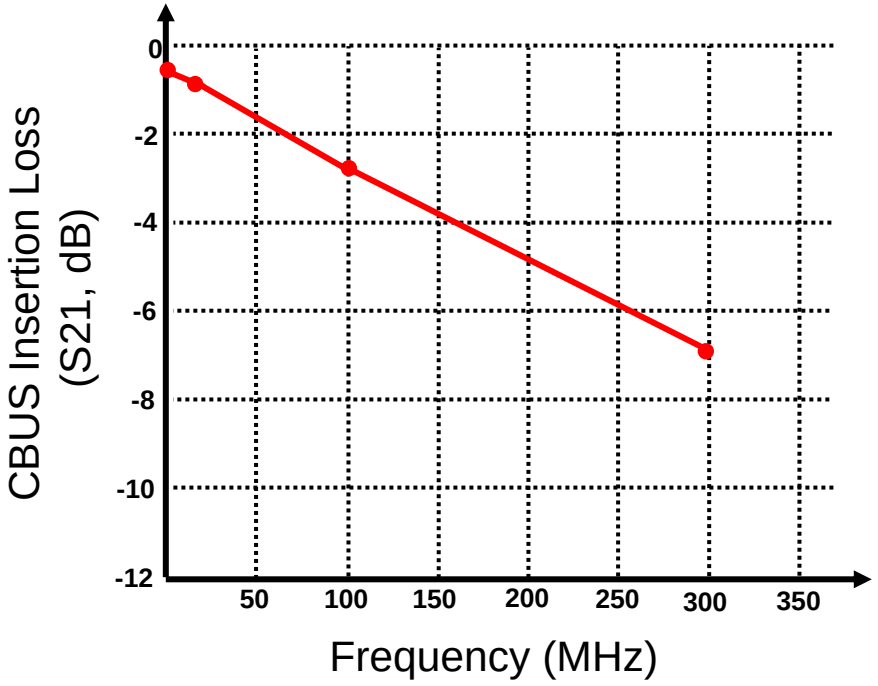
MHL Cable Compliance Test Solution

CBUS Insertion Loss





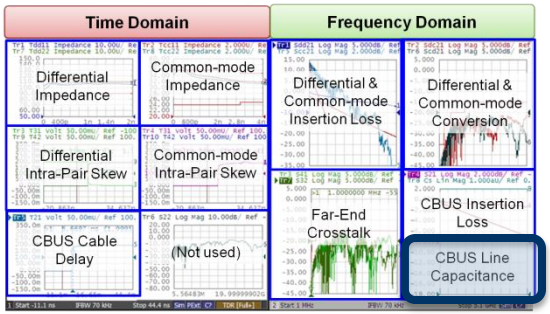
- Confirms insertion loss of CBUS line meets the spec.



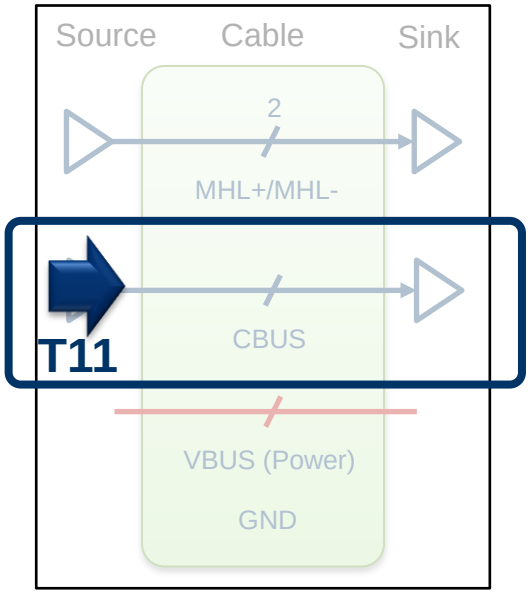
MHL CBUS Signal Insertion Loss Requirement

MHL Cable Compliance Test Solution

CBUS Line Capacitance



- Confirms that the capacitance value of the CBUS line in an MHL cable is within the spec.
- Capacitance of the CBUS (C_{CBUS}) is C_{TOTAL} - $C_{FIXTURE}$, where total capacitance with the fixture (C_{TOTAL}) subtracted by fixture capacitance ($C_{FIXTURE}$).



Specification

	Min	Max	Unit	Note
CBUS Line Capacitance	30	350	pF	*1

*1. Minimum capacitance on CBUS is required to limit rise and fall times when connecting with minimum load, as from a Source to Dongle with minimum cable length.

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**

MHL 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

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

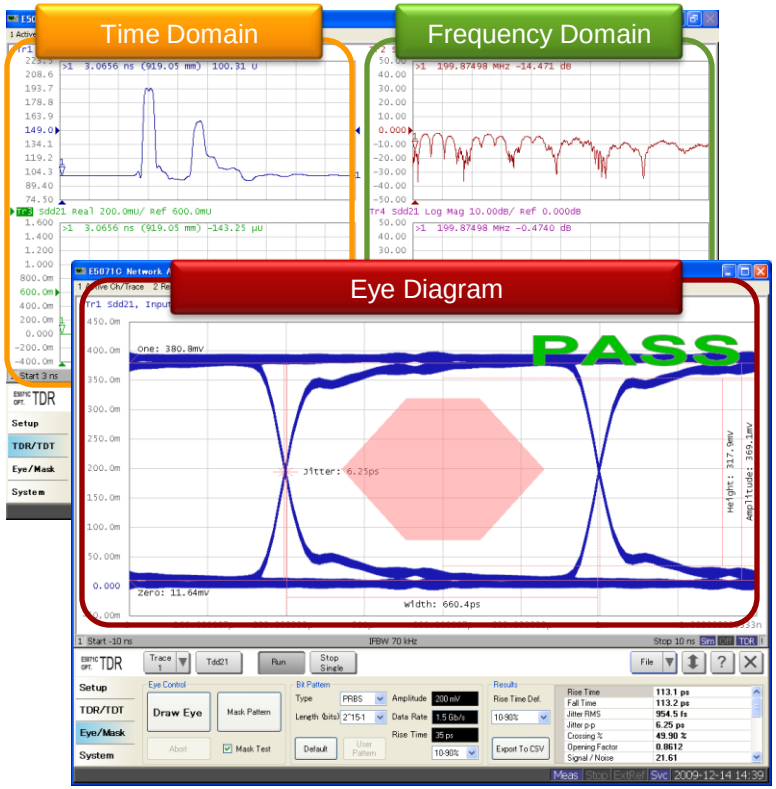
E5061B
NA + ZA in one-box
5 Hz to 3 GHz
Low cost RF VNA
100 k to 1.5/3.0 GHz

ENA Series

FieldFox
Handheld RF Analyzer
5 Hz to 4/6 GHz

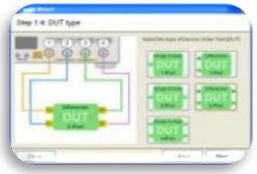
What is ENA Option TDR?

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

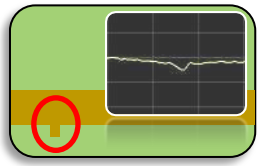


3 Breakthroughs

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