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
Table of Contents

1. Modification Record................................................................. 4
2. Instrumentation Requirements..................................................... 5
3. Outline of the testing ............................................................... 6
4. Test Port Cable and Fixture Connection........................................ 7
5. Description of Measurement Window........................................... 9
6. Perform Measurement Settings .................................................. 10
   6.1. Recall State File Procedure.................................................. 10
7. Perform Calibration ..................................................................... 11
   7.1. Time Domain Calibration Setup.............................................. 11
       7.1.1. Perform Deskew & Loss Compensation......................... 11
       7.1.2. Set DUT Length.............................................................. 15
       7.1.3. Set System Impedance (Optional)................................. 15
   7.2. TRL Calibration................................................................. 16
       7.2.1. Define Calkit ................................................................. 16
       7.2.2. TRL Calibration............................................................. 17
8. Measurement and Data Analysis .................................................. 19
   8.1. For Connector Impedance, Cable Impedance, Intra-Pair Skew, Insertion Loss and Mode Conversion ........................................... 19
       8.1.1. Measurement ................................................................. 19
       8.1.2. Data Analysis............................................................... 20
       8.1.3. Measurement Result Example......................................... 21
   8.2. For Near End Crosstalk ....................................................... 22
       8.2.1. Measurement ................................................................. 22
       8.2.2. Data Analysis............................................................... 22
       8.2.3. Measurement Result Example......................................... 23
   8.3. For Crosstalk Between D+/D- and Super Speed ...................... 24
8.3.1. Measurement ........................................................................................................... 24
8.3.2. Data Analysis ........................................................................................................... 26
8.3.3. Measurement Result Example ................................................................................... 26

8.4. For D+/D- Pair Propagation Delay, D+/D- Pair Intra-Pair Skew and D+/D- Pair Attenuation ........................................................................................................... 27
8.4.1. Measurement ........................................................................................................... 27
8.4.2. Data Analysis .......................................................................................................... 28
8.4.3. Measurement Result Example ................................................................................... 29

9. Appendix ......................................................................................................................... 30

9.1. Defining a calibration kit .............................................................................................. 30
9.2. Time domain Measurement Setup Manually ............................................................. 33
9.2.1. Starting Setup .......................................................................................................... 33
9.2.2. Mated Connector Impedance Measurements (Normative) .................................... 34
9.2.3. Raw Cable Impedance Measurements (Informative) .............................................. 36
9.2.4. Propagation Delay and Intra-Pair Skew Measurement (Informative) ................. 37
9.2.5. Differential Near End Crosstalk Measurements (Normative) ............................ 39
9.2.6. Differential Crosstalk between D+/D- and Super Speed Measurements (Normative) ........................................................................................................... 40

9.3. Frequency Domain Measurement Setup Manually ..................................................... 41
9.3.1. Channel and Trace Settings .................................................................................... 41
9.3.2. Common Settings .................................................................................................... 41
9.3.3. Insertion Loss Measurements (Normative) ............................................................ 41
9.3.4. Differential-to-Common-Mode Conversion Measurements (Normative) .......... 42
9.3.5. D+/D- Pair Attenuation Measurements (Normative) ............................................. 42

9.4. Limit Settings .............................................................................................................. 43
9.4.1. Displaying Judgment Result of Test ...................................................................... 43
9.4.2. Setting the Warning Beeper .................................................................................. 43
9.4.3. Defining the Limit Line ......................................................................................... 43
# 1. Modification Record

<table>
<thead>
<tr>
<th>Revision</th>
<th>Comments</th>
<th>Issue Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Draft.</td>
<td>Jun 16, 2009</td>
</tr>
<tr>
<td>1.1</td>
<td>- Added the Near End Crosstalk for Time Domain.</td>
<td>Dec 15, 2009</td>
</tr>
<tr>
<td></td>
<td>- Added the 4-Port ECal and De-Embedding.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Modified the test limit for the Near End Crosstalk and Far End Crosstalk.</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>- The Option TDR is supported.</td>
<td>Sep 7, 2010</td>
</tr>
</tbody>
</table>
2. **Instrumentation Requirements**

1. E5071C Network Analyzer (Must include option TDR and one of the following options 480/485/4D5/4K5)

2. USB 3.0 official test fixtures and calibration standards, or an equivalent set of fixtures and standards\(^1\).
   - List of calibration standards
     - Short
     - Thru
     - Load
     - Line1
     - Line2
     - Line3

   *Note: For more information, refer to Defining a calibration kit in 9.1.*

3. Four 3.5mm(f)-Type N(m) adapters (Agilent 1250-1744)
   - (Not required if E5071C includes option 4D5 or 4K5)

4. Four 3.5 mm cables 10GHz bandwidth or equivalent
   - (Cables of equal length and characteristics must be used for all test ports)

5. 50 ohm terminations to terminate unused channels (ex. Agilent 909D-301)

Reference Documents


2. Universal Serial Bus 3.0 Connectors and Cable Assemblies Compliance Document.

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\(^1\) For official fixtures and standards, please contact BitifEye.
3. Outline of the testing

1. Set measurement conditions.
2. Connect matched 3.5 mm cables to the test ports of the instruments.
3. For Time Domain Measurements, perform Deskew & Loss Compensation using setup wizard in the option TDR.
4. For Frequency Domain Measurements, perform TRL calibration at the 3.5 mm cables for all ports.
5. Perform Time Domain Measurements
   - Mated Connector Impedance measurements (Normative).
   - Raw Cable Impedance measurements (Informative).
   - Intra-Pair Skew measurements (Informative).
   - D+/D- Pair Intra-Pair Skew measurements (Informative).
   - D+/D- Pair Propagation Delay measurements (Informative).
   - Differential Near End Crosstalk measurements (Normative).
   - Differential Crosstalk Between D+/D- and Super Speed measurements (Normative).
6. Perform Frequency Domain Measurements
   - Insertion Loss measurements (Normative).
   - Differential-to-Common-Mode Conversion measurements (Normative).
   - D+/D- Pair Attenuation measurements (Normative).

Note: Hard Keys (Keys located on the Front panel of E5071C) are displayed in Blue color and **Bold**. (Example: **Avg**, **Analysis**)

Note: Soft keys (Keys on the screen) are displayed in **Bold**. (Example: **S11**, **Real**, **Transform**)

Note: Buttons (in the TDR) are displayed in **Green** color and **Bold**. (Example: **Trace**, **Rise Time**)

Note: Tabs (in the TDR) are displayed in **Brown** color and **Bold**. (Example: **Setup**, **Trace Control**)
4. Test Port Cable and Fixture Connection

Cable under test will be tested in the following manner:

Example: Testing Insertion Loss.
# Agilent MOI for USB 3.0 Connectors & Cable Assemblies Compliance Tests

## Table 4-1 Connection by connector type

<table>
<thead>
<tr>
<th>Connector Type</th>
<th>Standard-A(X) to Standard-B(Y)</th>
<th>Standard-A(X) to Micro-AB(Y)</th>
<th>Standard-A(X) to Standard-A(Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENA Port #</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>Connector Imp.</td>
<td></td>
<td>X8 X9 Y8 Y9</td>
<td>X8 X9 Y9 Y10</td>
</tr>
<tr>
<td>Cable Imp.</td>
<td></td>
<td>Y5 Y6 X5 X6</td>
<td>X6 Y7 X5 X6</td>
</tr>
<tr>
<td>Intra-Pair Skew</td>
<td></td>
<td>X6 Y7 X5 X6</td>
<td>X6 Y7 X5 X6</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td></td>
<td>X6 Y7 X5 X6</td>
<td>X6 Y7 X5 X6</td>
</tr>
<tr>
<td>Mode Conversion</td>
<td></td>
<td>X6 Y7 X5 X6</td>
<td>X6 Y7 X5 X6</td>
</tr>
<tr>
<td>Near End Crosstalk</td>
<td>X8 X9 X5 X6</td>
<td>X8 X9 X5 X6</td>
<td>X8 X9 X5 X6</td>
</tr>
<tr>
<td>Female PIN Number</td>
<td>Y5 Y6 X5 X6</td>
<td>Y5 Y6 X5 X6</td>
<td>Y5 Y6 X5 X6</td>
</tr>
<tr>
<td>D+/D- Propagation Delay</td>
<td>X2 X3 X3 X3</td>
<td>X2 X3 X3 X3</td>
<td>X2 X3 X3 X3</td>
</tr>
<tr>
<td>D+/D- Intra-Pair Skew</td>
<td>X2 X3 X3 X6</td>
<td>X2 X3 X3 X6</td>
<td>X2 X3 X3 X6</td>
</tr>
<tr>
<td>D+/D- Attenuation</td>
<td>X2 X3 X3 X3</td>
<td>X2 X3 X3 X3</td>
<td>X2 X3 X3 X3</td>
</tr>
</tbody>
</table>

## Connector Type

<table>
<thead>
<tr>
<th>ENA Port #</th>
<th>Micro-AB(X) to Micro-AB(Y)</th>
<th>Micro-AB(X) to Standard-B(Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector Imp.</td>
<td>X6 Y7 Y9 Y10</td>
<td>X6 Y7 Y9 Y9</td>
</tr>
<tr>
<td>Cable Imp.</td>
<td>Y6 Y7 Y9 X10</td>
<td>Y5 Y6 X9 X10</td>
</tr>
<tr>
<td>Intra-Pair Skew</td>
<td>X2 X3 X9 X10</td>
<td>X2 X3 X3 X3</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>X2 X3 X9 X10</td>
<td>X2 X3 X9 X10</td>
</tr>
<tr>
<td>Mode Conversion</td>
<td>X6 Y7 X2 Y3</td>
<td>X6 Y7 X2 Y3</td>
</tr>
<tr>
<td>Near End Crosstalk</td>
<td>X6 Y7 Y9 Y10</td>
<td>X5 Y6 Y9 Y9</td>
</tr>
<tr>
<td>Female PIN Number</td>
<td>Y6 Y7 Y9 Y10</td>
<td>Y5 Y6 Y9 Y9</td>
</tr>
<tr>
<td>D+/D- &amp; and Crosstalk</td>
<td>X2 X3 X9 X7</td>
<td>X2 X3 X3 X7</td>
</tr>
<tr>
<td>D+/D- Intra-Pair Skew</td>
<td>X2 X3 X9 X10</td>
<td>X2 X3 X3 X10</td>
</tr>
<tr>
<td>D+/D- Attenuation</td>
<td>X2 X3 X9 X10</td>
<td>X2 X3 X3 X10</td>
</tr>
<tr>
<td>D+/D- Propagation Delay</td>
<td>X2 X3 X2 X3</td>
<td>X2 X3 X2 X3</td>
</tr>
<tr>
<td>D+/D- Intra-Pair Skew</td>
<td>X2 X3 X2 X3</td>
<td>X2 X3 X2 X3</td>
</tr>
<tr>
<td>D+/D- Attenuation</td>
<td>X2 X3 X2 X3</td>
<td>X2 X3 X2 X3</td>
</tr>
</tbody>
</table>
5. Description of Measurement Window

The following figure is the description of the measurement window.

The following figure is the actual measurement example.
6. Perform Measurement Settings

This section describes how to recall a state file for Time Domain and Frequency Domain settings. A state file can be downloaded from http://www.agilent.com/find/ena-tdr_usb3. If you use your local PC to download, save the state file to a USB mass storage device in order to move it to E5071C. Connect the USB mass storage device into the front USB port of the E5071C.

For manual measurement settings, refer to 9.2 Time domain Measurement Setup Manually and 9.3 Frequency Domain Measurement Setup Manually.

6.1. Recall State File Procedure

1. If TDR setup wizard was appeared, click Close button in the TDR setup wizard.
2. Click Setup tab (item1).
3. Click Advanced Mode (item2).
4. A dialog box appears requesting for confirmation. Then click Yes. (Clear the check box for “Use Advanced Calibration Methods”)
5. Click File (item3) and Select Recall State to open the Recall State dialog box.
6. Specify a folder, enter a file name, and click Open.
7. Perform Calibration

7.1. Time Domain Calibration Setup

7.1.1. Perform Deskew & Loss Compensation

1. Click **Setup** tab (item1).

2. Click **Deskew&Loss** (item2) to launch the Deskew & Loss Compensation wizard.

3. Click **Options** (item3), then Deskew Options dialog box appears.
4. Select **standard type** (item 4) to Short.
5. Connect “Short” standard to Port1.
6. Click **Port1** (item 5). Wait until the check-mark appears under Port1.
7. Connect “Short” standard to Port2.
8. Click **Port2** (item 6). Wait until the check-mark appears under Port2.
9. Connect “Short” standard to Port3.
10. Click **Port3** (item 7). Wait until the check-mark appears under Port3.
11. Connect “Short” standard to Port4.
12. Click **Port4** (item 8). Wait until the check-mark appears under Port4.
13. Click **OK** (item 9).

14. Click **Next**.
15. Connect “Thru” standard between Port1 and Port3.
16. Click **Measure** (item 10).
17. Click **Next** (item 11).

19. Click **Measure** (item12).

20. Click **Next** (item13).


22. Click **Port1** (item14). Wait until the check-mark appears under Port1.

24. Click Port2 (item15). Wait until the check-mark appears under Port2.
25. Connect “Load” standard to Port3.
26. Click Port3 (item16). Wait until the check-mark appears under Port3.
27. Connect “Load” standard to Port4.
28. Click Port4 (item17). Wait until the check-mark appears under Port4.
29. Click Apply (item18).
30. Click Finish (item19).
7.1.2. Set DUT Length

1. Set DUT length to 16 ns (item 1).

7.1.3. Set System Impedance (Optional)

In case that Load standard is not 50 ohm, system impedance must be set to the actual Load impedance.

1. Press Cal > Set Z0 to actual impedance of the Load standard.
2. Click Return.
7.2. TRL Calibration
7.2.1. Define Calkit
7.2.1.1. Importing Definition File of Calibration Kit

The calkit definition file of the official calibration standards can be downloaded from

For manual settings, refer to 9.1 Defining a calibration kit.

1. Press Cal key.
2. Click Cal kit, then select a User.
3. Click Modify Cal Kit > Import Cal Kit… to open the dialog box.
4. Specify a folder, enter a file name, and click Open.
7.2.2. TRL Calibration

1. Press **Channel Next** key to select channel 2.
2. Press **Cal** key.
3. Click **Calkit** and select Calkit which you previously defined.
4. Click **Calibrate > 4-Port TRL Cal**.
5. Click **Thru/Line**.
   a) Connect “Thru” standard between Port1 and Port2.
   b) Click **1-2 Thru/Line**.
   c) Connect “Thru” standard between Port1 and Port3.
   d) Click **1-3 Thru/Line**.
   e) Connect “Thru” standard between Port3 and Port4.
   f) Click **3-4 Thru/Line**.
   g) Click **Return**.
6. Click **Reflect**.
   a) Connect “Short” standard defined at subclass setting to Port1.
   b) Click **Port1 Reflect**.
   c) Connect “Short” standard defined at subclass setting to Port2.
   d) Click **Port2 Reflect**.
   e) Connect “Short” standard defined at subclass setting to Port3.
   f) Click **Port3 Reflect**.
   g) Connect “Short” standard defined at subclass setting to Port4.
   h) Click **Port4 Reflect**.
   i) Click **Return**.
7. Click **Line/Match**
   a) Click **1-2 Line/Match**.
   b) Connect “Line1” standard between Port1 and Port2.
   c) Click **Line/Match 1[Line1]**.
   d) Connect “Line2” standard between Port1 and Port2.
e) Click Line/Match 2[Line2].

f) Connect “Line3” standard between Port1 and Port2.

g) Click Line/Match 3[Line3].

h) Click Return.

i) Click 1-3 Line/Match and repeat step b) to h).

j) Click 3-4 Line/Match and repeat step b) to h).

k) Click Return.

8. Click Done to finish TRL 4-port calibration. At this point, the calibration coefficient is calculated and saved. The error correction function is automatically turned on.

*Note: Refer to “4-port TRL Calibration” in ENA online help for the detail.*
8. Measurement and Data Analysis
8.1. For Connector Impedance, Cable Impedance, Intra-Pair Skew, Insertion Loss and Mode Conversion
8.1.1. Measurement
1. Press Channel Next key to select channel 1.
2. Connect the test fixture to the test port cables according to the Table 8-1 Connector Impedance, Cable Impedance Intra-Pair Skew, Insertion Loss and Mode Conversion Connection Table 8-1 Connector Impedance, Cable Impedance Intra-Pair Skew, Insertion Loss and Mode Conversion Connection. Unused terminals should be terminated.
3. Connect USB 3.0 cable to the test fixture.
4. Click Stop Single for Time Domain measurement.

Table 8-1 Connector Impedance, Cable Impedance Intra-Pair Skew, Insertion Loss and Mode Conversion Connection

<table>
<thead>
<tr>
<th>ENA Port#</th>
<th>PIN #</th>
<th>Standard-A to Standard-B</th>
<th>Standard-A to Micro-AB</th>
<th>Standard-A to Standard-A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Port1</td>
<td>Port2</td>
<td>Port3</td>
</tr>
<tr>
<td>IPN</td>
<td></td>
<td>X8</td>
<td>X9</td>
<td>Y8</td>
</tr>
<tr>
<td>Y5 Y6</td>
<td></td>
<td>X5</td>
<td>X6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENA Port#</th>
<th>PIN #</th>
<th>Micro-AB to Micro-AB</th>
<th>Micro-AB to Standard-B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Port1</td>
<td>Port2</td>
</tr>
<tr>
<td>IPN</td>
<td></td>
<td>X6</td>
<td>X7</td>
</tr>
<tr>
<td>Y6 Y7</td>
<td></td>
<td>X9</td>
<td>X10</td>
</tr>
</tbody>
</table>
8.1.2. Data Analysis

For Pass/Fail refer to below.

8.1.2.1. Mated Connector Impedance Limit

<table>
<thead>
<tr>
<th>Limit</th>
<th>Start Time</th>
<th>End Time</th>
<th>Start Limit</th>
<th>End Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>0 s</td>
<td>600 ps</td>
<td>105 U</td>
<td>105 U</td>
</tr>
<tr>
<td>Lower</td>
<td>0 s</td>
<td>600 ps</td>
<td>75 U</td>
<td>75 U</td>
</tr>
</tbody>
</table>

“U”: impedance unit.

8.1.2.2. Raw Cable Impedance Limit

<table>
<thead>
<tr>
<th>Limit</th>
<th>Start Time</th>
<th>End Time</th>
<th>Start Limit</th>
<th>End Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>600 ps</td>
<td>1.5 ns</td>
<td>97 U</td>
<td>97 U</td>
</tr>
<tr>
<td>Lower</td>
<td>600 ps</td>
<td>1.5 ns</td>
<td>83 U</td>
<td>83 U</td>
</tr>
</tbody>
</table>

“U”: Impedance unit

8.1.2.3. Intra-Pair Skew Limit

1. Select Trace3.

2. Press Trace Max key to enlarge an image.

3. Read the Delta Time.

4. Press Trace Max key to normal an image.

If delta Time < 15 psec/m: Pass, else: Fail.

8.1.2.4. Insertion Loss Limit

<table>
<thead>
<tr>
<th>Start Frequency</th>
<th>End Frequency</th>
<th>Start Limit</th>
<th>End Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 MHz</td>
<td>1.25 GHz</td>
<td>-1.5 dB</td>
<td>-5 dB</td>
</tr>
<tr>
<td>1.25 GHz</td>
<td>2.5 GHz</td>
<td>-5 dB</td>
<td>-7.5 dB</td>
</tr>
<tr>
<td>2.5 GHz</td>
<td>7.5 GHz</td>
<td>-7.5 dB</td>
<td>-25 dB</td>
</tr>
</tbody>
</table>
8.1.2.5. Differential-to-Common-Mode Conversion Limit
IF (All measurement points from 100 MHz to 7.5 GHz) <= -20 dB: Pass, else: Fail.

8.1.3. Measurement Result Example
8.2. For Near End Crosstalk

8.2.1. Measurement

1. Connect the test fixture to the test port cables according to the Table 8-2 Near End Crosstalk Connection. Unused terminals should be terminated.

2. Connect a USB 3.0 Cable to the test fixtures.

3. Click **Stop Single**.

4. Read the peak-to-peak (p-p) value.

5. Using the same manner above, measure the other pair.

### Table 8-2 Near End Crosstalk Connection

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN #</td>
<td>Port1</td>
<td>Port2</td>
<td>Port3</td>
</tr>
<tr>
<td>X8 Y5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X9 Y6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X5 Y8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X6 Y9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENA Port#</th>
<th>Micro-AB to Micro-AB</th>
<th>Micro-AB to Standard-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN #</td>
<td>Port1</td>
<td>Port2</td>
</tr>
<tr>
<td>X6 Y6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X7 Y7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X9 Y8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.2.2. Data Analysis

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard-A</td>
<td>If p-p &lt;= 3.6 mV: Pass, else: Fail</td>
</tr>
<tr>
<td>Standard-B</td>
<td>If p-p &lt;= 7.2 mV: Pass, else: Fail</td>
</tr>
<tr>
<td>Micro-AB</td>
<td>If p-p &lt;= 4.8 mV: Pass, else: Fail</td>
</tr>
</tbody>
</table>
8.2.3. Measurement Result Example
8.3. For Crosstalk Between D+/D- and Super Speed

8.3.1. Measurement

1. Connect the test fixture to the test port cables according to the Table 8-3 Crosstalk Between D+/D- and Super Speed Connection. Unused terminals should be terminated.

2. Connect a USB 3.0 Cable to the test fixtures.

3. Click **Stop Single**.

4. Read the peak-to-peak (p-p) value.

5. Using the same manner above, measure the other pair.
## Agilent MOI for USB 3.0 Connectors & Cable Assemblies Compliance Tests

### Table 8-3 Crosstalk Between D+/D- and Supper Speed Connection

<table>
<thead>
<tr>
<th>ENA Port#</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PIN #</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<table>
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<tr>
<th>ENA Port#</th>
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<td>Y8</td>
<td>Y9</td>
<td>Y2</td>
<td>Y3</td>
<td>Y8</td>
</tr>
</tbody>
</table>
8.3.2. Data Analysis

<table>
<thead>
<tr>
<th>Standard</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard-A</td>
<td>If ( p-p \leq 8.0 \text{ mV} ): Pass, else: Fail</td>
</tr>
<tr>
<td>Standard-B</td>
<td>If ( p-p \leq 8.0 \text{ mV} ): Pass, else: Fail</td>
</tr>
<tr>
<td>Micro-AB</td>
<td>If ( p-p \leq 8.0 \text{ mV} ): Pass, else: Fail</td>
</tr>
</tbody>
</table>

8.3.3. Measurement Result Example
Agilent MOI for USB 3.0 Connectors & Cable Assemblies Compliance Tests

8.4. For D+/D- Pair Propagation Delay, D+/D- Pair Intra-Pair Skew and D+/D- Pair Attenuation

8.4.1. Measurement

1. Connect the test fixture to the test port cables according to the Table 8-4 D+/D- Pair Propagation Delay, D+/D- Pair Intra-Pair Skew and D+/D- Pair Attenuation Connection
2. Connect USB 3.0 cable to the test fixture.
3. Click Stop Single for Time Domain measurement.

Table 8-4 D+/D- Pair Propagation Delay, D+/D- Pair Intra-Pair Skew and D+/D- Pair Attenuation Connection

<table>
<thead>
<tr>
<th>ENA Port#</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN #</td>
<td>X2</td>
<td>X3</td>
<td>Y2</td>
<td>Y3</td>
<td>X2</td>
<td>X3</td>
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<td>Y3</td>
<td>X2</td>
<td>X3</td>
<td>Y2</td>
<td>Y3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENA Port#</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN #</td>
<td>X2</td>
<td>X3</td>
<td>Y2</td>
<td>Y3</td>
<td>X2</td>
<td>X3</td>
<td>Y2</td>
<td>Y3</td>
</tr>
</tbody>
</table>
8.4.2. Data Analysis

8.4.2.1. D+/D- Pair Propagation Delay

1. Select **Trace3**.
2. Press **Trace Max** key to enlarge an image.
3. Read Marker Value1 on Trace3.
4. Press **Trace Max** key to normal an image.

<table>
<thead>
<tr>
<th>Standard-A to Standard-B</th>
<th>If the time at the rising edge &lt; 26 nsec: Pass, else: Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard-A to Standard-A</td>
<td>If the time at the rising edge &lt; 16 nsec: Pass, else: Fail</td>
</tr>
<tr>
<td>Standard-A to Micro-AB</td>
<td></td>
</tr>
<tr>
<td>Micro-AB to Micro-AB</td>
<td></td>
</tr>
<tr>
<td>Micro-AB to Standard-B</td>
<td></td>
</tr>
</tbody>
</table>

8.4.2.2. D+/D- Pair Intra-Pair Skew

1. Select **Trace3**.
2. Press **Trace Max** key to enlarge an image.
3. Read the Delta Time.
4. Press **Trace Max** key to normal an image.

If delta Time < 100 psec: Pass, else: Fail

8.4.2.3. D+/D- Pair Attenuation

<table>
<thead>
<tr>
<th>Start Frequency</th>
<th>End Frequency</th>
<th>Start Limit</th>
<th>End Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 MHz</td>
<td>24 MHz</td>
<td>-670 dB</td>
<td>-950 dB</td>
</tr>
<tr>
<td>24 MHz</td>
<td>48 MHz</td>
<td>-950 dB</td>
<td>-1.35 dB</td>
</tr>
<tr>
<td>48 MHz</td>
<td>96 MHz</td>
<td>-1.35 dB</td>
<td>-1.9 dB</td>
</tr>
<tr>
<td>96 MHz</td>
<td>200 MHz</td>
<td>-1.9 dB</td>
<td>-3.2 dB</td>
</tr>
<tr>
<td>200 MHz</td>
<td>400 MHZ</td>
<td>-3.2 dB</td>
<td>-5.8 dB</td>
</tr>
</tbody>
</table>
8.4.3. Measurement Result Example
9. Appendix

9.1. Defining a calibration kit

To change the definition of a calibration kit, follow the procedure below.

1. Press Cal key.
2. Click Cal Kit > User
3. Click Modify Kit > Label Kit [User], then type in a name you want.
4. Click Define STDs >
   a) 1. No Name >
      1. Label : "Thru"
      2. STD Type : Delay/Thru
      3. Offset Delay : Value defined by the fixture
      4. Offset Z0 : Value defined by the fixture
      5. Offset Loss : Value defined by the fixture
      6. Min. Frequency : Value defined by the fixture
      7. Max. Frequency : Value defined by the fixture
      8. Return
   b) 2. No Name >
      1. Label : "Short"
      2. STD Type : Short
      3. Offset Delay : Value defined by the fixture
      4. Offset Z0 : Value defined by the fixture
      5. Offset Loss : Value defined by the fixture
      6. Min. Frequency : Value defined by the fixture
      7. Max. Frequency : Value defined by the fixture
      8. Return
   c) 3. No Name >
      1. Label : "Open"
      2. STD Type : Open
3. Offset Delay : Value defined by the fixture
4. Offset Z0 : Value defined by the fixture
5. Offset Loss : Value defined by the fixture
6. Min. Frequency : Value defined by the fixture
7. Max. Frequency : Value defined by the fixture
8. Return
d) 4.No Name >
   1. Label : "Load"
   2. STD Type : Load
   3. Offset Delay : Value defined by the fixture
   4. Offset Z0 : Value defined by the fixture
   5. Offset Loss : Value defined by the fixture
   6. Min. Frequency : Value defined by the fixture
   7. Max. Frequency : Value defined by the fixture
   8. Return
e) 5.No Name >
   1. Label : "Line1"
   2. STD Type : Delay/Thru
   3. Offset Delay : Value defined by the fixture
   4. Offset Z0 : Value defined by the fixture
   5. Offset Loss : Value defined by the fixture
   6. Min. Frequency : Value defined by the fixture
   7. Max. Frequency : Value defined by the fixture
   8. Return
f) 6.No Name >
   1. Label : "Line2"
   2. STD Type : Delay/Thru
   3. Offset Delay : Value defined by the fixture
4. **Offset Z0**: Value defined by the fixture
5. **Offset Loss**: Value defined by the fixture
6. **Min. Frequency**: Value defined by the fixture
7. **Max. Frequency**: Value defined by the fixture
8. **Return**

g) 7. **No Name >**
   1. **Label**: “Line3”
   2. **STD Type**: Delay/Thru
   3. **Offset Delay**: Value defined by the fixture
   4. **Offset Z0**: Value defined by the fixture
   5. **Offset Loss**: Value defined by the fixture
   6. **Min. Frequency**: Value defined by the fixture
   7. **Max. Frequency**: Value defined by the fixture
   8. **Return**

5. Click **Return**.
6. Click **Specify CLSs >**
   
h) **Sub class1 >**
   1. **TRL Thru**: Set All > Thru > **Return**
   2. **TRL Reflect**: Short or Open
   3. **TRL Line/Match**: Set All > Line1 > **Return**
   
i) **Sub class2 >**
   4. **TRL Line/Match**: Set All > Line2 > **Return**
   
j) **Sub class3 >**
   5. **TRL Line/Match**: Set All > Line3 > **Return**

7. Click **Return**
8. Click **Export Calkit…** to open the dialog box and Save user Calkit.
9. Specify a folder, enter a file name, and click **Save**.

*Note: Refer to “Modifying Calibration Kit Definition” in ENA online help for the detail.*
9.2. Time domain Measurement Setup Manually

9.2.1. Starting Setup

1. If TDR setup wizard was appeared, click Close button in the TDR setup wizard.
2. Click Setup tab (item1).
3. Click Preset (item2) under Basic to preset the E5071C.
4. A dialog box appears requesting for confirmation. Then click OK.
5. Select DUT Topology (item3) to Differential 2-port.
6. Click Advanced Mode (item4).
7. A dialog box appears requesting for confirmation. Then click Yes. (Clear the check box for “Use Advanced Calibration Methods”)
9.2.2. Mated Connector Impedance Measurements (Normative)

9.2.2.1. Impedance Profile

The impedance profile of the mated connector is defined from the receptacle through the plug cable mated area.

![Impedance Profile Diagram](image)

9.2.2.2. Measurement Setup

1. Click Stop Single.
2. Click TDR/TDT tab.
3. Click Trace Control tab.
4. Clear Time check box under Coupling.
5. Clear Marker check box under Coupling
6. Click **Parameters** tab.
7. Select **Trace1**.
8. Select **Rise Time** to 20-80 % and input value to 50 psec.
9. Click the box below the left knob under **Horizontal**. Then Entry dialog box appear.
10. Input horizontal scale to 150 psec.
11. Click the box below the right knob under **Horizontal**. Then Entry dialog box appear.
12. Input horizontal position to 0 sec.
13. Click the box below the left knob under **Vertical**. Then Entry dialog box appear.
15. Click the box below the right knob under **Vertical**. Then Entry dialog box appear.
16. Input vertical position to 65 ohm.
17. Click **Trace Control** tab.
18. Click **Trace Settings Copy**.
19. Trace Settings Copy dialog box appears.
20. Select the **Trace1** in the **From** list.
21. Select the **Trace5** in the **To** list.
22. Click **Copy**.
23. Click **Close**.
24. Select **Trace5**.
25. Click **Parameters** tab.
26. Click **Tdd22**.
9.2.3. Raw Cable Impedance Measurements (Informative)

9.2.3.1. Impedance Profile

Refer to 9.2.2.1 Impedance Profile

9.2.3.2. Measurement Setup

1. Click **Trace Control** tab.
2. Click **Trace Settings Copy**.
3. Trace Settings Copy dialog box appears.
4. Select the **Trace1** in the From list.
5. Select the **Trace2** in the To list.
6. Click **Copy**.
7. Click **Close**.
8. Select **Trace2**.
9. Click **Parameters** tab.
10. Select **Rise Time** to 10-90 % and input value to 200 psec.
11. Click **Trace Control** tab.
12. Click **Trace Settings Copy**.
13. Trace Settings Copy dialog box appears.
14. Select the **Trace2** in the From list.
15. Select the **Trace6** in the To list.
16. Click **Copy**.
17. Click **Close**.
18. Select **Trace6**.
19. Click **Parameters** tab.
20. Click **Tdd22**.
9.2.4. Propagation Delay and Intra-Pair Skew Measurement (Informative)

9.2.4.1. Measurement Setup

1. Select **Trace3**.
2. Click **Parameters** tab.
3. Select the **Topology** (item1) of DUT to Single-Ended.
4. Select **Format** to **Volt**.
5. Click **T31**.
6. Select **Rise Time** to 10-90 % and input value to 200 psec.
7. Click the box below the left knob under **Horizontal**. Then Entry dialog box appear.
8. Input horizontal scale to 3 ns/div.
9. Click the box below the right knob under **Horizontal**. Then Entry dialog box appear.
10. Input horizontal position to 0 ns.
11. Click the box below the left knob under **Vertical**. Then Entry dialog box appear.
12. Input vertical scale to 50 mV/div.
13. Click the box below the right knob under **Vertical**. Then Entry dialog box appear.
14. Input vertical position to 100 mV.
15. Click **Trace Control** tab.
16. Click **Trace Settings Copy**.
17. Trace Settings Copy dialog box appears.
18. Select the **Trace3** in the From list.
19. Select the **Trace7** in the To list.
20. Click **Copy**.
21. Click **Close**.
22. Select Trace7.
23. Click Parameters tab.
24. Click T42.
25. Select Trace3.
26. Click Marker Search and select Δ Time.
28. Check the Δ Time check box.
29. Select Target (Stop) to Trace7.
30. Click OK.
31. Click Marker Search > Target > Target Value, and enter 100 mU.
32. Turn Tracking on.

9.2.4.2. Crosstalk Compensation
1. Select Trace3.
2. Press Display > Equation Editor… > Enter an equation “Intra+= S31-S32”.
3. Check Equation Enabled check box.
4. Click Apply.
5. Click Close.
7. Press Display > Equation Editor… > Enter an equation “Intra-= S42-S41”.
8. Check Equation Enabled check box.
9. Click Apply.
10. Click Close.
9.2.5. Differential Near End Crosstalk Measurements (Normative)

9.2.5.1. Measurement Setup

1. Select Trace4.
2. Click Parameters tab.
3. Select Measurement to Time Domain.
4. Select Format to Volt.
5. Select Rise Time to 20-80% and input value to 50 psec.
6. Click Tdd21.
7. Click the box below the left knob under Horizontal. Then Entry dialog box appear.
8. Input horizontal scale to 300 ps/div.
9. Click the box below the right knob under Horizontal. Then Entry dialog box appear.
10. Input horizontal position to 0 s.
11. Click the box below the left knob under Vertical. Then Entry dialog box appear.
12. Input vertical scale to 2 mV/div.
13. Click the below the right knob under vertical. Then Entry dialog box appear.
14. Input vertical scale to 0 V.
15. Press Marker Fctn > Statistics and turn it ON.
9.2.6. Differential Crosstalk between D+/D- and Super Speed Measurements (Normative)

1. Click Trace Control tab.
2. Click Trace Settings Copy.
3. Trace Settings Copy dialog box appears.
4. Select the Trace4 in the From list.
5. Select the Trace8 in the To list.
6. Click Copy.
7. Click Close.
8. Select Trace8.
9. Click Parameters tab.
10. Select Rise Time to 10-90% and input value to 500 psec.
11. Press Marker Fctn > Statistics and turn it ON.
9.3. Frequency Domain Measurement Setup Manually

9.3.1. Channel and Trace Settings

1. Press **Display**.
2. Click **Allocate Channels** >
3. Press **Channel Next**.
4. Click **Num of Traces** > 3.
5. Click **Allocate Traces** >

9.3.2. Common Settings

1. Press **Sweep Setup** > **Sweep Type** > **Lin Freq**.
2. Set **Points** to 201.
3. Press **Start** > Set start value to 100 MHz.
4. Press **Stop** > Set stop value to 8.5 GHz.
5. Press **Avg** > Set **IF Bandwidth** to 10 kHz.
6. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** and turn it **ON**.
7. Click **Port ZConversion** and turn it **ON**.
8. Set **Port1 Z0 Real**, **Port2 Z0 Real**, **Port3 Z0 Real** and **Port4 Z0 Real** to 45 ohm.
9. Click **Return**.

9.3.3. Insertion Loss Measurements (Normative)

1. Select **Trace1**.
2. Click **Topology** > **Device** > **Bal-Bal**.
3. Click **Port1 (bal)** > **1-2**.
4. Click **Port2 (bal)** > **3-4**.
5. Click **Return**.
6. Click **BalUn** and turn it **ON**.
7. Click **Measurement** > **Sdd21**.
8. Press **Scale** > Set **Divisions** to 12.
10. Set Reference position to 10 Div.
11. Set Reference Value to 0 dB.

9.3.4. Differential-to-Common-Mode Conversion Measurements (Normative)

1. Press Trace Next.
2. Press Analysis.
3. Click Fixture Simulator > BalUn and turn it ON.
5. Press Scale > Set Divisions to 12.
7. Set Reference position to 8 Div.
8. Set Reference Value to -20 dB.

9.3.5. D+/D- Pair Attenuation Measurements (Normative)

1. Press Trace Next.
2. Press Analysis.
3. Click Fixture Simulator > BalUn and turn it ON.
5. Press Scale > Set Divisions to 12.
6. Set Scale/Div to 1 dB/div.
7. Set Reference position to 10 Div.
8. Set Reference Value to 0 dB.
9.4. Limit Settings

9.4.1. Displaying Judgment Result of Test

If a channel has a judgment result of fail, the fail message appears on the screen. It will be judged as failed if one or more unsatisfactory trace exists within the channel.

Follow the procedure below.

1. Press **Analysis** > **Limit Test** > **Fail Sign** to switch the fail sign ON/OFF.

9.4.2. Setting the Warning Beeper

Beep sound that occurs when the judgment result is fail.

Follow the procedure below.

1. Press **System** > **Misc Setup** > **Beeper** > **Beep Warning** to switch the warning beeper ON/OFF.

9.4.3. Defining the Limit Line

Follow the steps below to make entries in the limit table for trace 1 of Time Domain Measurement.

1. Press **Channel Next** key to select channel 1.
2. Select trace 1.
3. Press **Analysis** > **Limit Test** > **Edit Limit Line** to display the limit table shown below (Initially, no segments are entered in the limit table). Using the limit table, create/edit a segment.
4. Enter the setup data in the limit table for trace 1.

<table>
<thead>
<tr>
<th>Type</th>
<th>Begin Stimulus</th>
<th>End Stimulus</th>
<th>Begin Response</th>
<th>End Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Max</td>
<td>0 s</td>
<td>600 ps</td>
<td>205 U</td>
</tr>
<tr>
<td>2</td>
<td>Min</td>
<td>0 s</td>
<td>600 ps</td>
<td>75 U</td>
</tr>
</tbody>
</table>
### Segment Parameter | Description
--- | ---
Type | MIN: Segment at which the minimum is specified  
MAX: Segment at which the maximum is specified
Begin Stimulus | Specify stating point for stimulus value on the limit line
End Stimulus | Specify ending point for stimulus value on the limit line
Begin Response | Specify starting point for response value on the limit line
End Response | Specify ending point for response value on the limit line

5. Click **Return**.

6. Click **Limit Line** and turn it **ON**.

7. Click **Limit Test** and turn it **ON**.