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 Option TDR
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1. Modification Record

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<td>- Modified the limit value of D+/D- Pair Propagation Delay.</td>
<td>Dec 17, 2012</td>
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<td>- Instrumentation Requirements are revised.</td>
<td>Dec 16, 2010</td>
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<td>- Calibration method is revised for the time domain.</td>
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<td>- Calibration method is revised for the time domain.</td>
<td>Nov 15, 2010</td>
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<td>- The Option TDR is supported.</td>
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<td>- Added the Near End Crosstalk for Time Domain.</td>
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<td>- Added the 4-Port ECal and De-Embedding.</td>
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<td>- Modified the test limit for the Near End Crosstalk and Far End Crosstalk.</td>
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<td>Jun 16, 2009</td>
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2. **Instrumentation Requirements**

1. E5071C ENA Series Network Analyzer (Must include option TDR and one of the following options 480/485/4D5/4K5. Option 4D5 or 4K5 is recommended for more bandwidth and higher resolution)  
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
- 1/2 Thru
- Line 1, Line 2, Line 3

*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) for E5071C with option 480/485 or four 83059B coaxial adapter for E5071C with option 4D5/4K5
4. Four 3.5 mm quality cables (male to male) of 10 GHz bandwidth or more.
5. One of the following calibration kits to calibrate 3.5 mm cables.
   - N4431B-010 Electronic Calibration (ECal) Module or 85033E-100 Standard Mechanical Calibration Kit for E5071C with option 480/485
   - N4433A-010 Electronic Calibration (ECal) Module or 85052D Economy Mechanical Calibration Kit for E5071C with option 4DK/4K5
6. 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.

\(^1\) 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 instrument.
3. For Time Domain Measurements, perform Electronic Calibration (ECal) or Deskew & Loss Compensation and adjust the rise time on each trace.
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 (USB 2.0).
   - D+/D- Pair Propagation Delay measurements (USB 2.0).
   - 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 (USB 2.0).

**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.
### Table 4-1 Connection by connector type

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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 the following URL.

http://www.agilent.com/find/ena-tdr_usb3-cabcon

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

7.1. Time Domain Calibration Setup

There are two ways to perform Time Domain calibration. Please select to perform Electronic Calibration (ECal) in 7.1.1 or Deskew & Loss Compensation in 7.1.2.

7.1.1. Perform Electronic Calibration (ECal)

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

2. Click **ECal** (item 2) to launch the setup wizard.

3. Connect 3.5 mm cables to ECal module and click **Calibrate** (item 3). When ECal is completed and the check-mark appears, click **Next** (item 4).
4. Click Option (item 5), then Fixture Compensation Option dialog box appears.

5. Select Standard Type (item 6) to Short

6. Connect “Short” standard from USB 3.0 official test fixtures to Port 1.

7. Click Port 1 (item 7). Wait until the check-mark appears under Port 1.

8. Connect “Short” standard from USB 3.0 official test fixtures to Port 2.

9. Click Port 2 (item 8). Wait until the check-mark appears under Port 2.

10. Connect “Short” standard from USB 3.0 official test fixtures to Port 3.

11. Click Port 3 (item 9). Wait until the check-mark appears under Port 3.

12. Connect “Short” standard from USB 3.0 official test fixtures to Port 4.

13. Click Port 4 (item 10). Wait until the check-mark appears under Port 4.

14. Click OK (item 11).

15. Click Finish (item 12).
16. Proceed to 7.1.3 Set DUT Length followed by 7.1.4 Rise Time Adjustment.

7.1.2. Perform Deskew & Loss Compensation

1. Click Setup tab (item 1).

2. Click Deskew & Loss (item 2) to launch the setup wizard.

3. Leave the 3.5 mm cables “Open” as illustrated above and click Deskew (item 3).

   When Deskew is completed and the check-mark appears, click Next (item 4).
4. Connect 3.5 mm(f) to 3.5mm(f) adapter of 85033E or 85052D Mechanical Calibration Kit between 3.5 mm cables from Port 1 and Port 3 as illustrated above.

5. Click **Measure** (item 5). When the check-mark appears, click **Next** (item 6).

6. Connect 3.5 mm(f) to 3.5mm(f) adapter of 85033E or 85052D Mechanical Calibration Kit between 3.5 mm cables from Port 2 and Port 4 as illustrated above.
7. Click **Measure** (item 7). When the check-mark appears, click **Next** (item 8).

8. Connect “Load” standard of 85033E or 85052D Mechanical Calibration Kit to the 3.5 mm cable from Port 1.

9. Click **Port 1** (item 9). Wait until the check-mark appears under Port 1.

10. Connect “Load” standard of 85033E or 85052D Mechanical Calibration Kit to the 3.5 mm cable from Port 2.

11. Click **Port 2** (item 10). Wait until the check-mark appears under Port 2.

12. Connect “Load” standard of 85033E or 85052D Mechanical Calibration Kit to the 3.5 mm cable from Port 3.

13. Click **Port 3** (item 11). Wait until the check-mark appears under Port 3.

14. Connect “Load” standard of 85033E or 85052D Mechanical Calibration Kit to the 3.5 mm cable from Port 4.

15. Click **Port 4** (item 12). Wait until the check-mark appears under Port 4.

16. Click **Apply** (item 13).

17. Click **Finish** (item 14).

18. Press **Cal** key on the instrument front panel.
19. Click **Port Extensions**.
20. Click **Auto Port Extension**.
21. Click **Select Ports**.
22. Make sure check-marks are on all the ports. If there are ports without check-marks, click on the ports to activate them.
23. Click **Return**.
24. Click **Measure SHORT**.
25. Connect “Short” standard of USB 3.0 official test fixtures to the 3.5 mm cable from Port 1.
26. Click **Port 1**. Wait until the check-mark appears.
27. Connect “Short” standard of USB 3.0 official test fixtures to the 3.5 mm cable from Port 2.
28. Click **Port 2**. Wait until the check-mark appears.
29. Connect “Short” standard of USB 3.0 official test fixtures to the 3.5 mm cable from Port 3.
30. Click **Port 3**. Wait until the check-mark appears.
31. Connect “Short” standard of USB 3.0 official test fixtures to the 3.5 mm cable from Port 4.
32. Click **Port 4**. Wait until the check-mark appears.
33. Click **Return**.
34. Click **Return**.
35. Click **Return**.
36. Proceed to 7.1.3 Set DUT Length followed by 7.1.4 Rise Time Adjustment.
7.1.3. Set DUT Length

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

7.1.4. Rise Time Adjustment

1. Connect “1/2 Thru” standard of USB 3.0 official test fixtures to 3.5 mm cable from Port 1.

2. Click **TDR/TDT** tab (item 1).

3. Select **Trace 1** (item 2).

4. Press **Channel Max** key on the instrument front panel to enlarge the channel.
5. Press **Trace Max** key on the instrument front panel to enlarge the trace.

6. Set **Measure** (item 3) to “Single-Ended”.

7. Set **Format** (item 4) to “Volt”.

8. Click **Marker Search** (item 5) and select Rise Time (20-80%).

9. Set **Horizontal** (item 6) to 2 ns/div and -2 ns.

10. Set **Vertical** (item 7) to 50 mV/div and 100 mV.

11. Adjust **Rise Time** (item 9) until the measured rise time (item 10) is as close as to 50 ps.

12. Record the value at **Rise Time** (item 9) as the effective rise time for Mated Connector
    Impedance and Differential Near End Crosstalk measurements.

13. Click **Marker Search** (item 5) and select Rise Time (10-90%).

14. Change **Rise Time** (item 8) to “10-90%”.

15. Adjust **Rise Time** (item 9) until the measured rise time (item 10) is as close as to 200
    ps.

16. Record the value at **Rise Time** (item 9) as the effective rise time for Raw Cable
    Impedance, Intra-Pair Skew, and Propagation Delay measurements.

17. Adjust **Rise Time** (item 9) until the measured rise time (item 10) is as close as to 500
    ps.

18. Record the value at **Rise Time** (item 9) as the effective rise time for Differential
    Crosstalk between D+/D- and Super Speed measurement.

19. Set **Rise Time** (item 8) to “20-80%”.

20. Set **Rise Time** (item 9) back to the recorded value in step 12.

21. Set **Measure** (item 3) to “Differential”.

22. Set **Format** (item 4) to “Impedance”.

23. Click **Marker Search** (item 5) and disable the rise time marker.

24. Set **Horizontal** (item 6) to 150 ps/div and 0 ns.

25. Set **Vertical** (item 7) to 5 Ohm/div and 65 Ohm.

26. Select **Trace 5** (item 2).

27. Set **Rise Time** (item 9) to the recorded value in step 12.
28. Select Trace 4 (item 2).
29. Set Rise Time (item 9) to the recorded value in step 12.
30. Select Trace 2 (item 2).
31. Set Rise Time (item 9) to the recorded value in step 16.
32. Select Trace 6 (item 2).
33. Set Rise Time (item 9) to the recorded value in step 16.
34. Select Trace 3 (item 2).
35. Set Rise Time (item 9) to the recorded value in step 16.
36. Select Trace 7 (item 2).
37. Set Rise Time (item 9) to the recorded value in step 16.
38. Select Trace 8 (item 2).
39. Set Rise Time (item 9) to the recorded value in step 18.
40. Press Trace Max key on the instrument front panel to shrink the trace.
41. Press Channel Max key on the instrument front panel to shrink the channel.
7.2. Frequency Domain Calibration Setup

7.2.1. Define Calkit

7.2.1.1. Importing Definition File of Calibration Kit

The calkit definition file of the USB 3.0 official test fixtures and calibration standards can be downloaded from http://www.agilent.com/find/ena-tdr_usb3-cabcon.

For manually defining calkit definition, refer to 9.1 Defining a calibration kit.

1. Press Cal key on the instrument front panel.
2. Click Cal kit, then select User.
3. Click Modify Cal Kit > Import Cal Kit… to open the dialog box.
4. Specify the folder and click Open.

7.2.2. TRL Calibration

1. Press Channel Next key on the instrument front panel to select channel 2.
2. Press Cal key on the instrument front panel.
3. Click Calkit and select the calkit definition file.
4. Click Calibrate > 4-Port TRL Cal.
5. Click Thru/Line.
   a) Connect “Thru” standard of USB 3.0 official test fixtures between 3.5 mm cables from Port 1 and Port 2.
   b) Click 1-2 Thru/Line.
   c) Connect “Thru” standard of USB 3.0 official test fixtures between 3.5 mm cables from Port 1 and Port 3.
   d) Click 1-3 Thru/Line.
   e) Connect “Thru” standard of USB 3.0 official test fixtures between 3.5 mm cables from Port 3 and Port 4.
   f) Click 3-4 Thru/Line.
   g) Click Return.
6. Click **Reflect**.
   
a) Connect “Short” standard of USB 3.0 official test fixtures to 3.5 mm cable from Port 1.
   
b) Click **Port1 Reflect**.
   
c) Connect “Short” standard of USB 3.0 official test fixtures to 3.5 mm cable from Port 2.
   
d) Click **Port2 Reflect**.
   
e) Connect “Short” standard of USB 3.0 official test fixtures to 3.5 mm cable from Port 3.
   
f) Click **Port3 Reflect**.
   
g) Connect “Short” standard of USB 3.0 official test fixtures to 3.5 mm cable from Port 4.
   
h) Click **Port4 Reflect**.
   
i) Click **Return**.

7. Click **Line/Match**
   
a) Click **1-2 Line/Match**.
   
b) Connect “Line 1” standard of USB 3.0 official test fixtures between 3.5 mm cables from Port 1 and Port 2.
   
c) Click **Line/Match 1[Line1]**.
   
d) Connect “Line 2” standard of USB 3.0 official test fixtures between 3.5 mm cables from Port 1 and Port 2.
   
e) Click **Line/Match 2[Line2]**.
   
f) Connect “Line 3” standard of USB 3.0 official test fixtures between 3.5 mm cables from Port 1 and Port 2.
   
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.*
7.3. Saving Calibration Information

Calibration information can be saved in a state file and recalled again. Calibration information is effective only when there has no change in measurement conditions before saving the state file and after recalling it. Changes in measurement conditions can be disconnect of 3.5 mm cables, bending 3.5mm cables, use of different 3.5 mm cables, different fixtures, change in temperature, etc.

7.3.1. Saving Calibration Information in a State File

1. Press **Save/Recall** key on the instrument front panel.
2. Click **Save Type**.
3. Change save type to “State & Cal”.
4. Click **File** (item 1).
5. Select “Save State”.
6. Enter file name and save the state file with calibration information.

7.3.2. Recalling a State File with Calibration Information

Refer to 6.1 Recall State File Procedure.

*Note: When using calibration information in the state file, it is recommended to measure a device with known characteristics to verify calibration effectiveness before performing actual measurements.*
8. Measurement and Data Analysis

8.1. Connector Impedance, Cable Impedance, Intra-Pair Skew, Insertion Loss, and Mode Conversion

8.1.1. Measurement

1. Press **Channel Next** key on the instrument front panel to select channel 1.
2. Connect USB 3.0 official test fixtures to the test port cables according to the Table 8-1 Connector Impedance, Cable Impedance Intra-Pair Skew, Insertion Loss, and Mode Conversion Connection. Unused terminals should be terminated.
3. Connect an USB 3.0 cable to the test fixtures.
4. Click **Stop Single** for Time Domain measurements.

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

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<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>X6</td>
<td>X7</td>
<td>Y9</td>
<td>Y10</td>
<td>X6</td>
<td>X7</td>
<td>Y8</td>
<td>Y9</td>
<td>X7</td>
<td>Y8</td>
<td>X9</td>
<td>X10</td>
</tr>
<tr>
<td></td>
<td>Y6</td>
<td>Y7</td>
<td>X9</td>
<td>X10</td>
<td>Y5</td>
<td>Y6</td>
<td>X9</td>
<td>X10</td>
<td>Y5</td>
<td>Y6</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 Trace 3.
2. Press Trace Max key on the instrument front panel to enlarge the trace.
3. Read the Delta Time.
4. Press Trace Max key on the instrument front panel to shrink the trace.

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. Near End Crosstalk

8.2.1. Measurement

1. Connect USB 3.0 official test fixtures to the test port cables according to the Table 8-2 Near End Crosstalk Connection. Unused terminals should be terminated.

2. Connect an 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>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>X8</td>
<td>X9</td>
<td>X5</td>
<td>X6</td>
<td>X8</td>
<td>X9</td>
<td>X5</td>
<td>X6</td>
<td>X8</td>
<td>X9</td>
<td>X5</td>
<td>X6</td>
</tr>
<tr>
<td></td>
<td>Y5</td>
<td>Y6</td>
<td>Y8</td>
<td>Y9</td>
<td>Y6</td>
<td>Y7</td>
<td>Y9</td>
<td>Y10</td>
<td>Y8</td>
<td>Y9</td>
<td>Y5</td>
<td>Y6</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>X6</td>
<td>X7</td>
<td>X9</td>
<td>X10</td>
<td>X6</td>
<td>X7</td>
<td>X9</td>
<td>X10</td>
</tr>
<tr>
<td></td>
<td>Y6</td>
<td>Y7</td>
<td>Y9</td>
<td>Y10</td>
<td>Y5</td>
<td>Y6</td>
<td>Y8</td>
<td>Y9</td>
</tr>
</tbody>
</table>

### 8.2.2. Data Analysis

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

8.3.1. Measurement

1. Connect USB 3.0 official test fixtures 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 an 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 other pairs.
### 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>PIN #</td>
<td>X2</td>
<td>X3</td>
<td>X5</td>
<td>X6</td>
<td>X2</td>
<td>X3</td>
<td>X5</td>
<td>X6</td>
<td>X2</td>
<td>X3</td>
<td>X5</td>
<td>X6</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>X3</td>
<td>X8</td>
<td>X9</td>
<td>X2</td>
<td>X3</td>
<td>X8</td>
<td>X9</td>
<td>X2</td>
<td>X3</td>
<td>X8</td>
<td>X9</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>X3</td>
<td>Y5</td>
<td>Y6</td>
<td>X2</td>
<td>X3</td>
<td>Y6</td>
<td>Y7</td>
<td>X2</td>
<td>X3</td>
<td>Y5</td>
<td>Y6</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>X3</td>
<td>Y8</td>
<td>Y9</td>
<td>X2</td>
<td>X3</td>
<td>Y9</td>
<td>Y10</td>
<td>X2</td>
<td>X3</td>
<td>Y8</td>
<td>Y9</td>
</tr>
<tr>
<td></td>
<td>X5</td>
<td>X6</td>
<td>Y2</td>
<td>Y3</td>
<td>X5</td>
<td>X6</td>
<td>Y2</td>
<td>Y3</td>
<td>X5</td>
<td>X6</td>
<td>Y2</td>
<td>Y3</td>
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<tr>
<td></td>
<td>X8</td>
<td>X9</td>
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<td>Y3</td>
<td>X8</td>
<td>X9</td>
<td>Y2</td>
<td>Y3</td>
<td>X8</td>
<td>X9</td>
<td>Y2</td>
<td>Y3</td>
</tr>
<tr>
<td></td>
<td>Y5</td>
<td>Y6</td>
<td>Y2</td>
<td>Y3</td>
<td>Y6</td>
<td>Y7</td>
<td>Y2</td>
<td>Y3</td>
<td>Y5</td>
<td>Y6</td>
<td>Y2</td>
<td>Y3</td>
</tr>
<tr>
<td></td>
<td>Y8</td>
<td>Y9</td>
<td>Y2</td>
<td>Y3</td>
<td>Y9</td>
<td>Y10</td>
<td>Y2</td>
<td>Y3</td>
<td>Y8</td>
<td>Y9</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>
</tr>
</thead>
<tbody>
<tr>
<td>PIN #</td>
<td>X2</td>
<td>X3</td>
<td>X6</td>
<td>X7</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>X3</td>
<td>X9</td>
<td>X10</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>X3</td>
<td>Y6</td>
<td>Y7</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>X3</td>
<td>Y9</td>
<td>Y10</td>
</tr>
<tr>
<td></td>
<td>X6</td>
<td>X7</td>
<td>Y2</td>
<td>Y3</td>
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<tr>
<td></td>
<td>X9</td>
<td>X10</td>
<td>Y2</td>
<td>Y3</td>
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<tr>
<td></td>
<td>Y6</td>
<td>Y7</td>
<td>Y2</td>
<td>Y3</td>
</tr>
<tr>
<td></td>
<td>Y9</td>
<td>Y10</td>
<td>Y2</td>
<td>Y3</td>
</tr>
</tbody>
</table>
8.3.2. Data Analysis

| Standard-A | If p-p <= 8.0 mV: Pass, else: Fail |
| Standard-B | If p-p <= 8.0 mV: Pass, else: Fail |
| Micro-AB   | If p-p <= 8.0 mV: Pass, else: Fail |

8.3.3. Measurement Result Example

![Measurement Result Example](image_url)
8.4. D+/D- Pair Propagation Delay, D+/D- Pair Intra-Pair Skew and D+/D- Pair Attenuation

8.4.1. Measurement

1. Connect USB 3.0 official test fixtures 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 an USB 3.0 cable to the test fixtures.

3. Click **Stop Single** for Time Domain measurements.


---

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ENA Port#</td>
<td>Port1</td>
<td>Port2</td>
<td>Port3</td>
</tr>
<tr>
<td>PIN #</td>
<td>X2</td>
<td>X3</td>
<td>Y2</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 Trace 3.

2. Press Trace Max key on the instrument front panel to enlarge the trace.

3. Read Marker Value 1 on Trace 3.

4. Press Trace Max key on the instrument front panel to shrink the trace.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>If the time at the rising edge &lt; 26 nsec: Pass, else: Fail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If the time at the rising edge &lt; 10 nsec: Pass, else: Fail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

1. Select Trace 3.

2. Press Trace Max key on the instrument front panel to enlarge the trace.

3. Read the Delta Time.

4. Press Trace Max key on the instrument front panel to shrink the trace.

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 on the instrument front panel.
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 appears, click **Close** button in the TDR setup wizard.
2. Click **Setup** tab (item 1).
3. Click **Preset** (item 2) under Basic to preset the E5071C.
4. A dialog box appears requesting for confirmation. Then click **OK**.
5. Select **DUT Topology** (item 3) to Differential 2-port.
6. Click **Advanced Mode** (item 4).

7. A dialog box appears requesting for confirmation. Then click **Yes**. (Clear the checkbox 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.

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 **Trace 1**.
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 appears.
10. Input horizontal scale to 150 psec/div.
11. Click the box below the right knob under **Horizontal**. Then Entry dialog box appears.
12. Input horizontal position to 0 sec.
13. Click the box below the left knob under **Vertical**. Then Entry dialog box appears.
15. Click the box below the right knob under **Vertical**. Then Entry dialog box appears.
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 **Trace 1** in the From list.
21. Select the **Trace 5** in the To list.
22. Click **Copy**.
23. Click **Close**.
24. Select **Trace 5**.
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 **Trace 1** in the From list.
5. Select the **Trace 2** in the To list.
6. Click **Copy**.
7. Click **Close**.
8. Select **Trace 2**.
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 **Trace 2** in the From list.
15. Select the **Trace 6** in the To list.
16. Click **Copy**.
17. Click **Close**.
18. Select **Trace 6**.
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 Trace 3.
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 appears.
8. Input horizontal scale to 3 ns/div.
9. Click the box below the right knob under Horizontal. Then Entry dialog box appears.
10. Input horizontal position to 0 ns.
11. Click the box below the left knob under Vertical. Then Entry dialog box appears.
12. Input vertical scale to 50 mV/div.
13. Click the box below the right knob under Vertical. Then Entry dialog box appears.
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 Trace 3 in the From list.
19. Select the Trace 7 in the To list.
20. Click Copy.
21. Click Close.
22. Select **Trace 7**.
23. Click **Parameters** tab.
24. Click **T42**.
25. Select **Trace 3**.
26. Click **Marker Search** and select **Δ Time**.
28. Check the **Δ Time** check box.
29. Select **Target (Stop)** to Trace 7.
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 **Trace 3**.
2. Press **Display > Equation Editor… > Enter an equation “Intra+= S31-S32”**.
3. Check **Equation Enabled** check box.
4. Click **Apply**.
5. Click **Close**.
6. Select **Trace 7**.
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 Trace 4.
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 appears.
8. Input horizontal scale to 300 ps/div.
9. Click the box below the right knob under Horizontal. Then Entry dialog box appears.
10. Input horizontal position to 0 s.
11. Click the box below the left knob under Vertical. Then Entry dialog box appears.
12. Input vertical scale to 2 mV/div.
13. Click the below the right knob under vertical. Then Entry dialog box appears.
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 **Trace 4** in the From list.
5. Select the **Trace 8** in the To list.
6. Click **Copy**.
7. Click **Close**.
8. Select **Trace 8**.
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** key on the instrument front panel.
2. Click **Allocate Channels** > 4.
3. Press **Channel Next** key on the instrument front panel.
4. Click **Num of Traces** > 3.
5. Click **Allocate Traces** > 4.

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.
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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 key on the instrument front panel.
2. Press Analysis key on the instrument front panel.
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 key on the instrument front panel.
2. Press Analysis key on the instrument front panel.
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 on the instrument front panel 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>0 s</td>
<td>600 ps</td>
<td>205 Ω</td>
<td>205 Ω</td>
</tr>
<tr>
<td>2</td>
<td>0 s</td>
<td>600 ps</td>
<td>75 Ω</td>
<td>75 Ω</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segment Parameter</td>
<td>Description</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Type              | MIN: Segment at which the minimum is specified  
                  | MAX: Segment at which the maximum is specified  |
| Begin Stimulus    | Specify starting 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**.