Revision 1.0

15-December 2008

VESA DisplayPort
PHY Compliance test Standard Version 1.1 Draft 12
Agilent Method of Implementation (MOI) for DisplayPort Cable Compliance Tests
Using Agilent E5071C Network Analyzer

Table of Contents

1. Modification Record

December 15, 2008 (Version 1.0)

Initial Release

2. Instrumentation Requirements

1. E5071C Network Analyzer (Must include option 010 and either of option 480/485/4K5)
2. N4431B Electronic Calibration Module (ECal Module) and TRL Calibration Kit. (If E5071C includes option 4K5, select N4433A ECal Module)
3. A set of DisplayPort test fixtures
4. Four 3.5mm(f)-Type N(m) adapters (1250-1744)
   (Not required if E5071C includes option 4K5)
5. Four 3.5 mm cables 10GHz bandwidth or equivalent
6. 50 Ohm terminations to terminate unused channels

3. Outline of the testing

Set measurement conditions.

Connect matched 3.5 mm cables to the test ports of the instruments.

Perform calibration at the 3.5 mm cables for all ports.

Frequency Domain Measurements

-Insertion Loss measurements (Normative).

-Return Loss measurements (Normative).

-Far End Noise measurements (Normative).

-Near End Noise measurements.

Time Domain Measurements

-Bulk Cable and Connector impedance measurements (Normative).

-Intra-pair skew measurements (Normative).

-Inter-pair skew measurements (Normative).

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

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

4. Calibration Methods

Frequency Domain Measurements and Time Domain Measurements have different calibration methods in this MOI.

Calibration for Frequency Domain Measurements

Please select from the following.

1. TRL Calibration (Refer to 4.1.1 TRL Calibration)
2. 4-port ECal (Full 4-port calibration) and De-Embedding (Refer to 4.1.2 4-port ECal (Full 4-port calibration) and De-Embedding)

Calibration for Time Domain Measurements

Please perform 4-port ECal (Full 4-port calibration) (Refer to 4.2 Calibration for Time Domain Measurements)

4.1. Calibration for Frequency Domain Measurements

4.1.1. TRL Calibration

TRL calibration requires defining calibration kit before performing measurement setup.

4.1.1.1. Define Calkit

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) Repeat step e) for the remaining Lines and enter definitions according to the fixture.

Example:

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**

5. Click **Return**.
6. Click **Specify CLSs** >

a) **Sub class1** >

1. **TRL Thru** > **Set All** > **Thru** > **Return**
2. **TRL Reflect** > **Short** or **Open**
3. **TRL Line/Match** > **Set All** > **Load** > **Return**

b) **Sub class2** >

1. **TRL Thru** > **Set All** > **Thru** > **Return**
2. **TRL Reflect** > **Short** or **Open**
3. **TRL Line/Match** > **Set All** > **Line1** > **Return**

c) Select next Sub classes for the remaining Lines according to step b).

Example:

Sub class3 >

1. **TRL Thru** > **Set All** > **Thru** > **Return**
2. **TRL Reflect** > **Short** or **Open**
3. **TRL Line/Match** > **Set All** > **Line2** > **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.

4.1.1.2. Calibrate

1. Refer to Chapter 5 DisplayPort Cable Measurements and perform measurement setup.
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** > **Thru/Line 1**.
   c) Click **Return**.
   d) Connect “Thru” standard between Port1 and Port3.
   e) Click **1-3 Thru/Line** > **Thru/Line 1**.
   f) Click **Return**.
   g) Connect “Thru” standard between Port3 and Port4.
   h) Click **3-4 Thru/Line** > **Thru/Line 1**.
   i) Click **Return**.
   j) Click **Return**.
6. Click **Reflect**.
   a) Connect “Short” or “Open” standard defined at subclass setting to Port1.
   b) Click **Port1 Reflect** > **Reflect 1**.
   c) Click **Return**.
   d) Connect “Short” or “Open” standard defined at subclass setting to Port2.
   e) Click **Port2 Reflect** > **Reflect 1**.
   f) Click **Return**.
   g) Connect “Short” or “Open” standard defined at subclass setting to Port3.
   h) Click **Port3 Reflect** > **Reflect 1**.
   i) Click **Return**.
   j) Connect “Short” or “Open” standard defined at subclass setting to Port4.

k) Click **Port4 Reflect** > **Reflect 1**.

l) Click **Return**.

m) Click **Return**.

7. Click **Line/Match**

   a) Click **1-2 Line/Match**.

   b) Connect “Line 1” standard between Port1 and Port2.

   c) Click **Line/Match 2[Line1]**.

   d) Repeat step b) and c) for the remaining defined Lines.

      Example: Connect “Line 2” standard between Port1 and Port2.

      Click **Line/Match 3[Line2]**.

   e) Click **Return**.

   f) Click **1-3 Line/Match** and repeat step b) to d).

   g) Click **3-4 Line/Match** and repeat step b) to d).

   h) 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.

9. Press **Save/Recall** > **Save Channel** > **State A**.

Note: Refer to “4-port TRL Calibration” in ENA online help for the detail.

4.1.2. 4-port ECal (Full 4-port calibration) and De-Embedding

De-Embedding function allows arbitrary networks, such as fixtures, in Touchstone data format to be removed from the total network.

1. Prepare two-port Touchstone data files (.s2p format) corresponding to the network to be de-embedded.
2. Connect ECal to test port cables.
3. Press **Cal** > **ECal** > **4-Port Cal**.
4. Press **Analysis** > **Fixture Simulator** > **De-Embedding**.
5. Click **Select Port**.
6. Click **1**, **2**, **3**, or **4** to select the test port for which the network de-embedding is applied.
7. Click **User File**.
8. Using the dialog box that appears, select the Touchstone data file defining the characteristics of the network to be de-embedded. Once the file is selected, the selection of **Select Type** automatically changes to **User**. To cancel a user-defined file that has been set up, click **Select Type** > **None**.
9. Repeat the procedure to set up the Touchstone data file for each port from which a network is to be de-embedded.
10. Click **De-Embedding** to turn the network de-embedding function **ON**.
11. Click **Return**.

Note: Refer to "Extending the Calibration Plane Using Network De-embedding" in ENA online help for the detail.

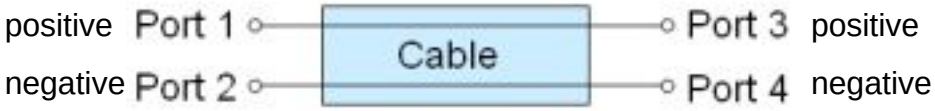
4.2. Calibration for Time Domain Measurements

1. Connect ECal to test port cables.
2. Press **Cal** > **ECal** > **4-Port Cal**.

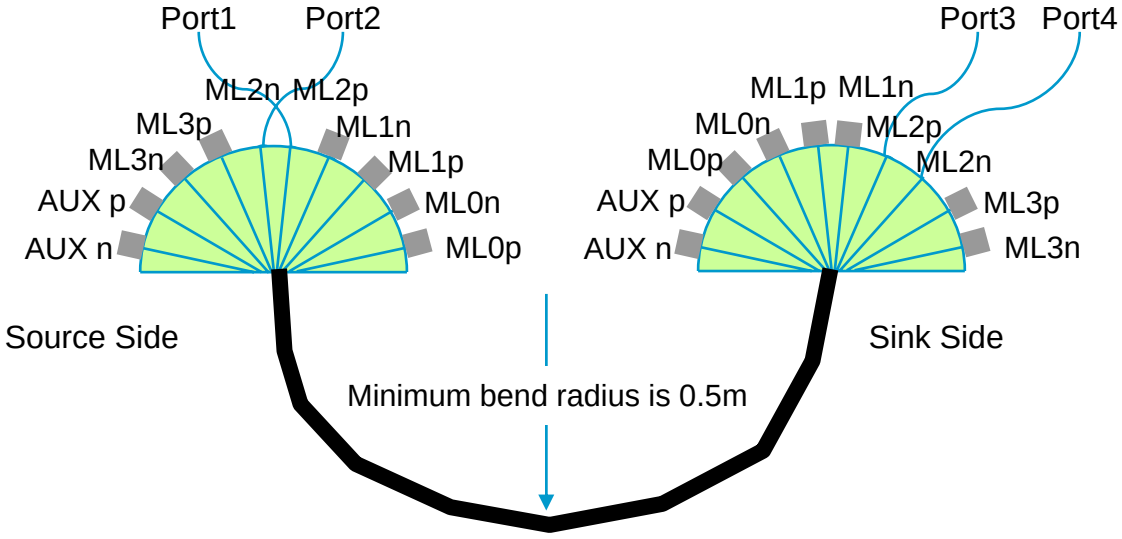
5. DisplayPort Cable Measurements

5.1. Test Port Cable and Fixture Connection

Cable under test will be tested in following manner



Example: Testing Insertion Loss configuration for Main Link (2).



5.2. Insertion Loss (Sdd21) Measurement (Normative)

5.2.1. Measurement Setup

1. Press **Preset** > **OK**.
2. Press **Sweep Setup** > **Sweep Type** > **Log Freq**.
3. Set **Points** to 1601.
4. Press **Start** > Set start value to 100 MHz. (If Reduced Bit Rate measurement then 10 MHz.)
5. Press **Stop** > Set stop value to 8.5 GHz.
6. Press **Avg** > Set **IF Bandwidth** to 1 kHz.
7. Press **Format** > **Log Mag**.
8. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** and turn it **ON**.
9. Click **BalUn** and turn it **ON**.
10. Click **Topology** > **Device** > **Bal-Bal**.
11. Click **Port1 (bal)** > **1-2**.
12. Click **Port2 (bal)** > **3-4**.
13. Click **Return**.
14. Click **Measurement** > **Sdd21**.
15. Press **Scale** > Set **Divisions** to 12.
16. Set **Scale/Div** to 5 dB/div.
17. Set **Reference position** to 11 Div.
18. Set **Reference Value** to 0 dB.

5.2.2. Calibration

Refer to 4.1.1.2 Calibrate for TRL Calibration.

Refer to 4.1.2 4-port ECal (Full 4-port calibration) and De-Embedding for 4-port ECal

and De-Embedding.

5.2.3. Measurement

1. Connect the test fixture to the test port cables according to the **Figure 5.2.1**. Unused terminals should be terminated.
2. Connect a Display Port cable to the test fixtures
3. Press **Trigger** > **Single**.
4. Measurement result is displayed. Refer to 5.2.4 Data Analysis for Pass/Fail criteria.
5. Using the same manner above, measure other channels.

5.2.4. Data Analysis

For Pass/Fail refer to below Insertion Loss Lower Limit for High Bit Rate Cable Assemblies or Insertion Loss Lower Limit for Reduced Bit Rate Cable Assemblies.

Insertion Loss Lower Limit for High Bit Rate Cable Assemblies

$$IL_{\min}[dB] = \begin{cases} -8.7 \times \sqrt{\frac{f}{f_0}} & ; \quad 0.1 < f \le \frac{f_0}{3} \\ 8.78\sqrt{f} - 7.54 * f - 7.52 & ; \quad \frac{f_0}{3} < f \le 5 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35\ GHz$

Insertion Loss Lower Limit for Reduced Bit Rate Cable Assemblies

$$IL_{\min}[dB] = \begin{cases} -1 - 13.5 \times \sqrt{\frac{f}{f_0}} & ; \quad 0.01 < f \le \frac{f_0}{3} \\ -2.1 - [12(f - \frac{f_0}{3}) + 6.8] & ; \quad \frac{f_0}{3} < f \le 2.5 \end{cases}$$

Where:

f is given in *GHz*

$f_0 = 0.825$ *GHz*

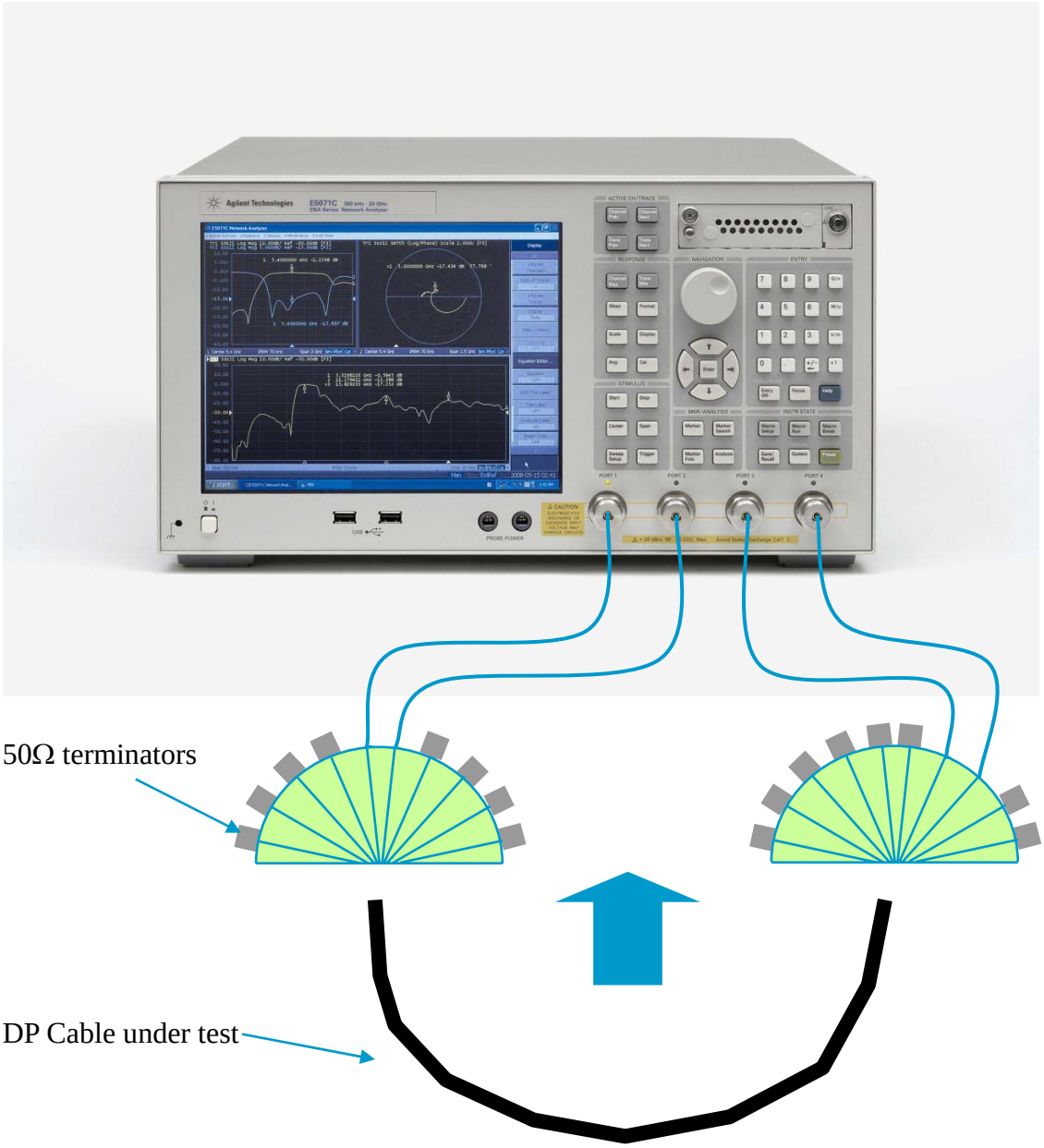


Figure 5.2.1 Connection Example for Insertion Loss measurement

Figure 5.2.2 Insertion Loss Measurement Result Example

5.3. Return Loss (Sdd11) Measurement (Normative)

5.3.1. Measurement Setup

1. Press **Preset** > **OK**.
2. Press **Sweep Setup** > **Sweep Type** > **Log Freq**.
3. Set **Points** to 1601.
4. Press **Start** > Set start value to 100 MHz.
5. Press **Stop** > Set stop value to 8.5 GHz.
6. Press **Avg** > Set **IF Bandwidth** to 1 kHz.
7. Press **Format** > **Log Mag**.
8. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** and turn it **ON**.
9. Click **BalUn** and turn it **ON**.
10. Click **Topology** > **Device** > **Bal-Bal**.
11. Click **Port1 (bal)** > **1-2**.
12. Click **Port2 (bal)** > **3-4**.
13. Click **Return**.
14. Click **Measurement** > **Sdd11**.
15. Press **Scale** > Set **Divisions** to 12.
16. Set **Scale/Div** to 5 dB/div.
17. Set **Reference position** to 11 Div.
18. Set **Reference Value** to 0 dB.

5.3.2. Calibration

Refer to 4.1.1.2 Calibrate for TRL Calibration.

Refer to 4.1.2 4-port ECal (Full 4-port calibration) and De-Embedding for 4-port ECal and De-Embedding.

5.3.3. Measurement

1. Connect the test fixture to the test port cables according to the **Figure 5.3.1**. Unused terminals should be terminated.
2. Connect a Display Port cable to the test fixtures
3. Press **Trigger** > **Single**.
4. Measurement result is displayed. Refer to 5.3.4 Data Analysis for Pass/Fail criteria.
5. Using the same manner above, measure other channels.

5.3.4. Data Analysis

For Pass/Fail refer to below Return Loss Upper Limit for High Bit Rate Cable Assemblies or Return Loss Upper Limit for Reduced Bit Rate Cable Assemblies.

Return Loss Upper Limit for High Bit Rate Cable Assemblies

$$RL_{\max.}[dB] = \begin{cases} -15 & ; \quad 0.1 < f \le \frac{f_0}{2} \\ -15 + 12.3\ Log_{10}\left(\frac{2f}{f_0}\right) & ; \quad \frac{f_0}{2} < f \le 7 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35\ GHz$

Return Loss Upper Limit for Reduced Bit Rate Cable Assemblies

$$RL_{\max.}[dB] = \begin{cases} -15 & ; \quad 0.1 < f \le \frac{f_0}{2} \\ -15 + 12\ Log_{10}\left(2x\frac{f}{f_0}\right) & ; \quad \frac{f_0}{2} < f \le 4.05 \end{cases}$$

Where:

f is given in GHz

$f_0 = 0.8\ GHz$

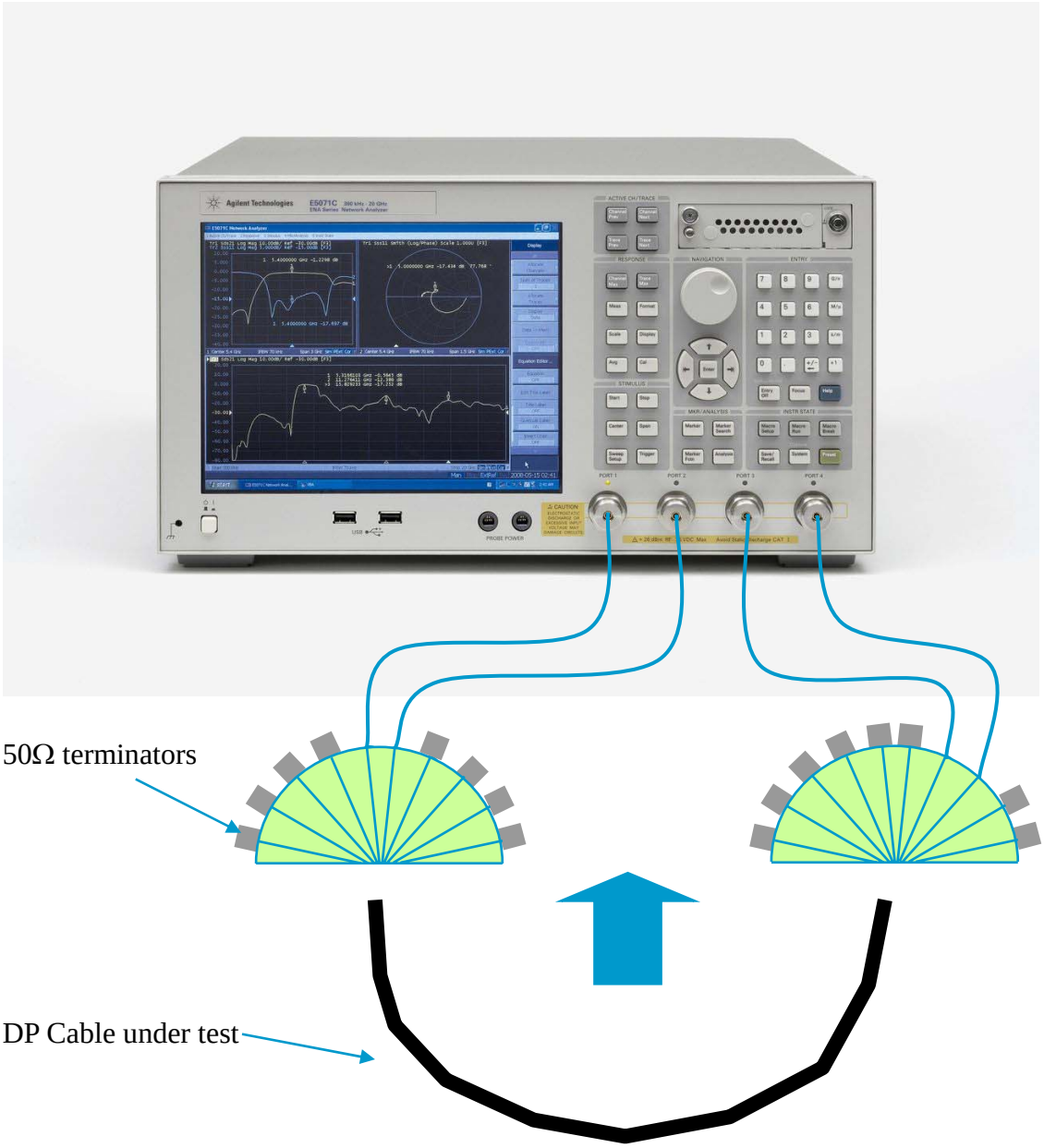


Figure 5.3.1 Connection Example for Return Loss measurement

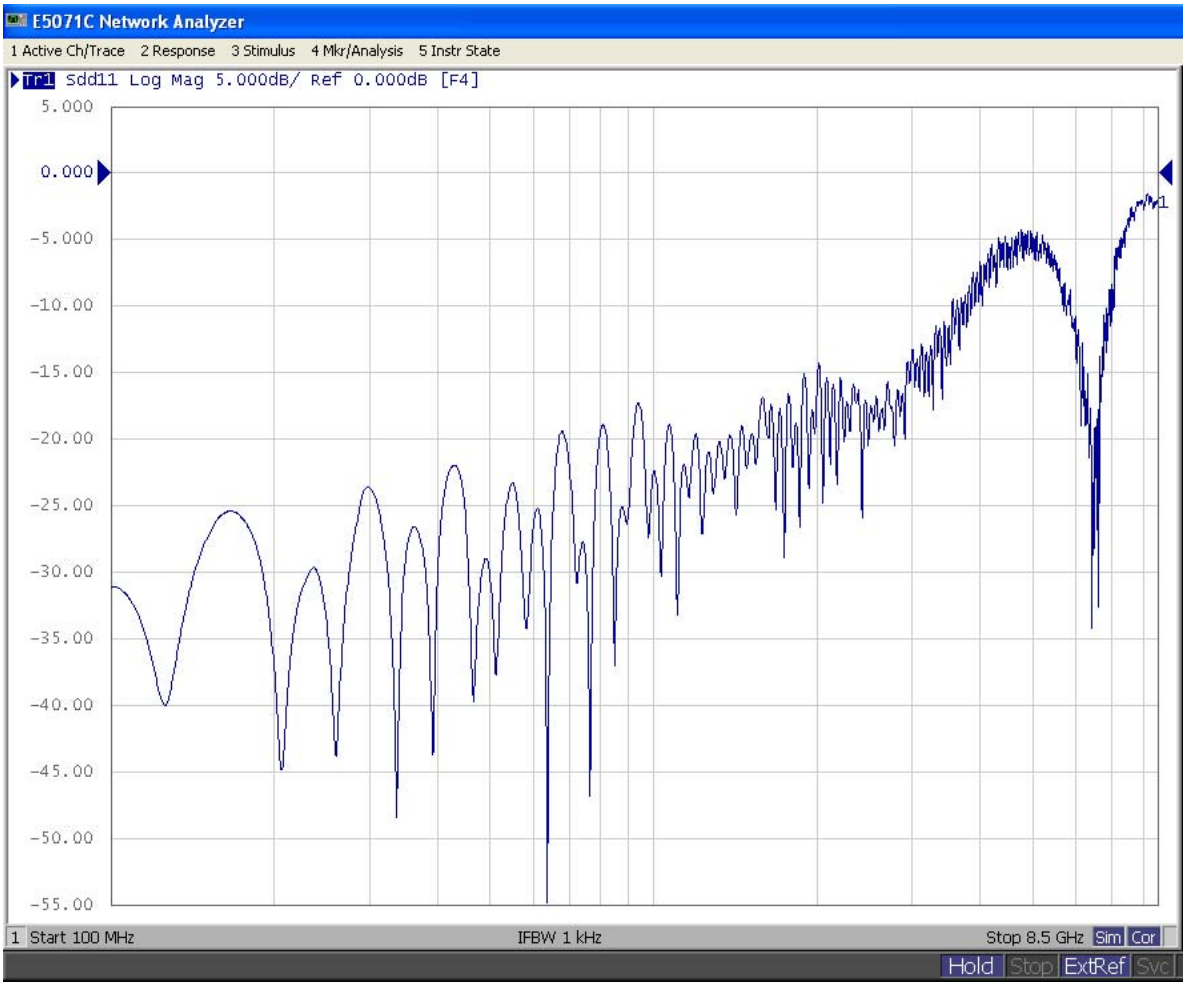


Figure 5.3.2 Return Loss Measurement Result Example

5.4. Far End Noise (Sdd21) Measurement (Normative)

With this procedures specify tests 1 and 5 in section 5.3.3 of the VESA DisplayPort PHY Compliance Test Specification can be tested. The referenced table is copied below:

Table 5.4.1 Victims and Aggressors

Test #	Aggressor(s) Channel(s) (Source Side)	Victim Channel (Sink Side)
1	Main Link(2)	Main Link(3)
2	Main Link(1) + Main Link(3)	Main Link(2)
3	Main Link(0) + Main Link(2)	Main Link(1)
4	Main Link(1) + AUX Ch.	Main Link(0)
5	Main Link(0)	AUX Ch.

For test number 2 to 4 (dual aggressor test) the procedure needs to be separately performed on each combination of victim-aggressor, and then combine the effects to calculate FEN. For instance, to obtain FEN for test 3, measure Main Link(0) and Main Link(1) crosstalk, then measure Main Link(2) and Main Link(1) crosstalk. The combined effects for dual aggressor uses power sum. The power summation formula is defined below (section 5.3.3 of the VESA DisplayPort PHY Compliance Test Specification).

Formula 5.4.1 The Power Summation Formula for Dual Aggressor Test (Test number 2-4 in the Table 5.4.1)

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

where FENn(f) is the far end noise of the individual contributor in dB.

5.4.1. Measurement Setup

1. Press **Preset** > **OK**.
2. Press **Sweep Setup** > **Sweep Type** > **Log Freq**.
3. Set **Points** to 1601.
4. Press **Start** > Set start value to 100 MHz.
5. Press **Stop** > Set stop value to 8.5 GHz.
6. Press **Avg** > Set **IF Bandwidth** to 1 kHz.
7. Press **Format** > **Log Mag**.
8. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** and turn it **ON**.
9. Click **BalUn** and turn it **ON**.
10. Click **Topology** > **Device** > **Bal-Bal**.
11. Click **Port1 (bal)** > **1-2**.
12. Click **Port2 (bal)** > **3-4**.
13. Click **Return**.
14. Click **Measurement** > **Sdd21**.
15. Press **Scale** > Set **Divisions** to 12.
16. Set **Scale/Div** to 5 dB/div.
17. Set **Reference position** to 11 Div.
18. Set **Reference Value** to 0 dB.

5.4.2. Calibration

Refer to 4.1.1.2 Calibrate for TRL Calibration.

Refer to 4.1.2 4-port ECal (Full 4-port calibration) and De-Embedding for 4-port ECal and De-Embedding.

5.4.3. Measurement

1. Press **Display** > if **Equation** is **ON**, click the key to turn it **OFF**.
2. Connect the test fixture to the test port cables according to the **Figure 5.4.1**. Unused terminals should be terminated.
3. Connect a Display Port cable to the test fixtures.
4. Press **Trigger** > **Single**.
5. If not Dual aggressor then go to step 18. (For Dual aggressor refer to Table 5.4.1 Victims and Aggressors)
6. Press **Display** > **Data** -> **Mem**.
7. Change connection to Aggressor 2 and terminate all unused terminals.
8. Press **Trigger** > **Single**.
9. Press **Display** > **Equation Editor…** > Enter an equation **"**10*log10(10^((20*log10(mag(data)))/10)+10^((20*log10(mag(mem)))/10))**"**.
   Note: This formula comes from Formula 5.4.1
10. Check **Equation Enabled** check box.
11. Click **Apply**.
12. Click **Close**.
13. Press **Format** > **Real**.
14. Press **Scale** > Set **Divisions** to 12.
15. Set **Scale/Div** to 5 U/div.
16. Set **Reference position** to 11 Div.
17. Set **Reference Value** to 0 U.
18. Measurement result is displayed. Refer to 5.4.4 Data Analysis for Pass/Fail criteria.
19. Using the same manner above, measure other channels.

5.4.4. Data Analysis

The observed isolation can be no more than -26dB measured from 100MHz to 4.05GHz for Reduced Bit Rate, and from 100MHz to 7GHz measured for High Bit Rate.

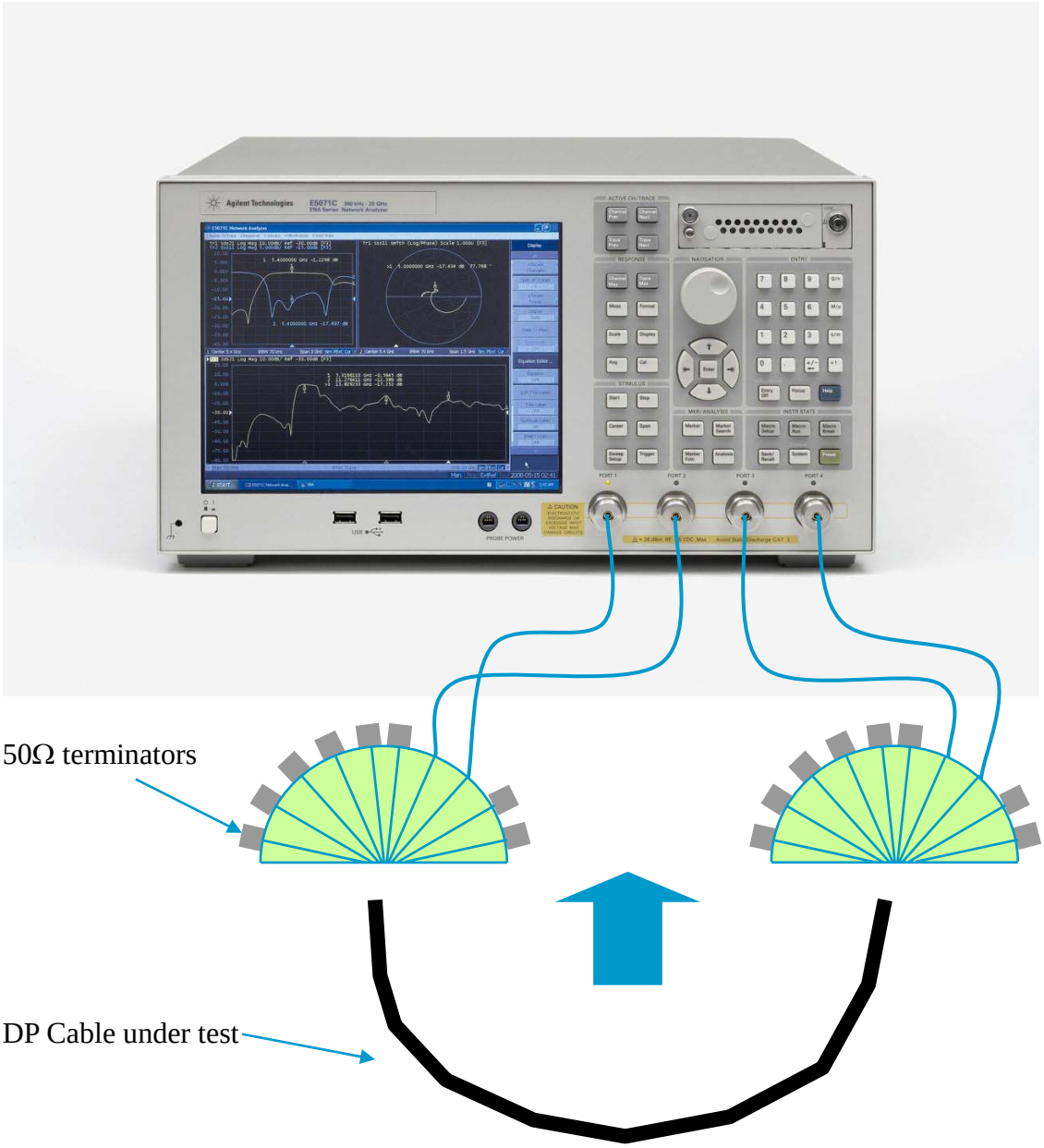


Figure 5.4.1 Connection Example for Far End Noise measurement

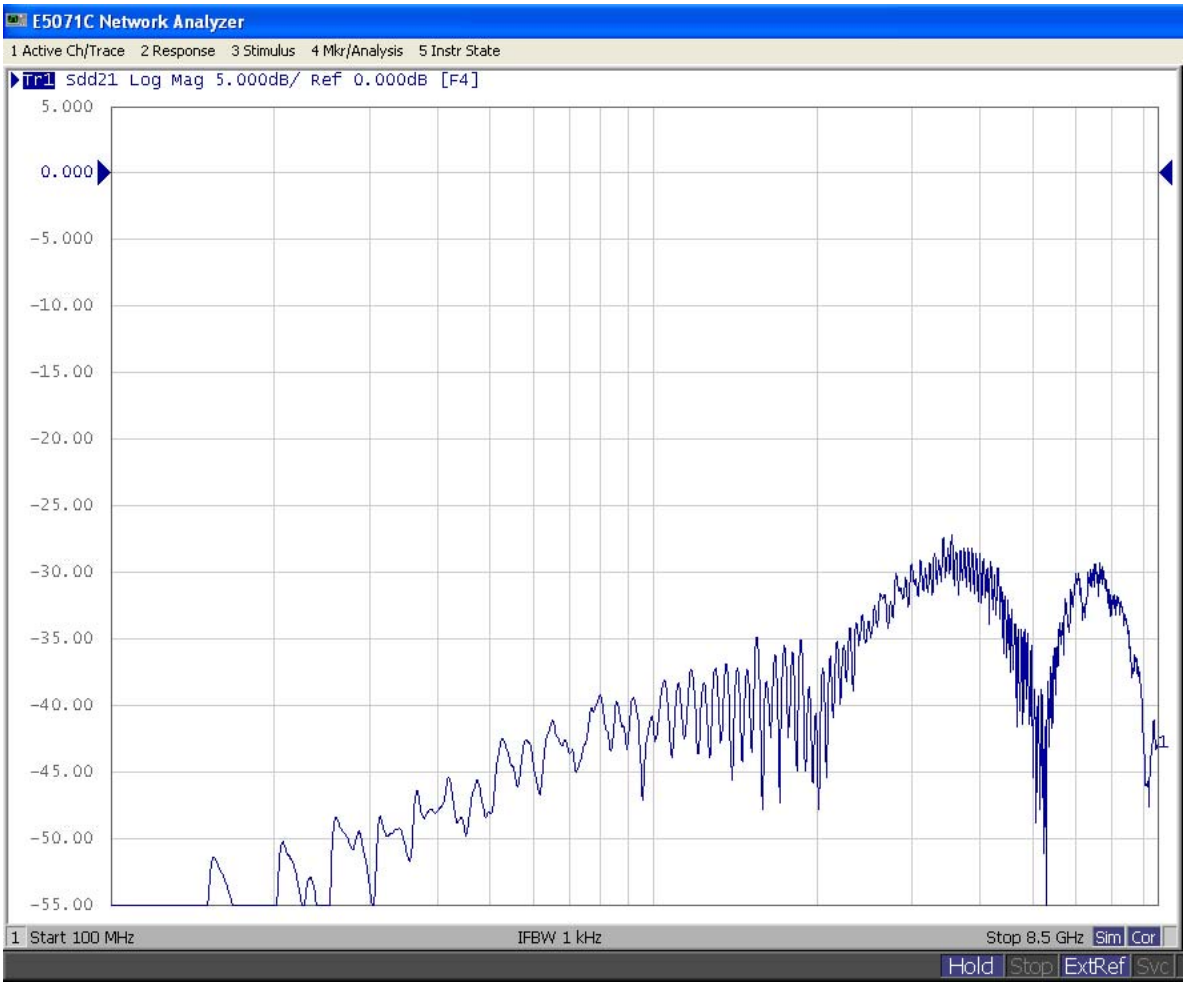


Figure 5.4.2 Far End Noise Measurement Result Example

5.5. Near End Noise (Sdd21) Measurement

5.5.1. Measurement Setup

1. Press **Preset** > **OK**.
2. Press **Sweep Setup** > **Sweep Type** > **Log Freq**.
3. Set **Points** to 1601.
4. Press **Start** > Set start value to 100 MHz.
5. Press **Stop** > Set stop value to 8.5 GHz.
6. Press **Avg** > Set **IF Bandwidth** to 1 kHz.
7. Press **Format** > **Log Mag**.
8. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** and turn it **ON**.
9. Click **BalUn** and turn it **ON**.
10. Click **Topology** > **Device** > **Bal-Bal**.
11. Click **Port1 (bal)** > **1-2**.
12. Click **Port2 (bal)** > **3-4**.
13. Click **Return**.
14. Click **Measurement** > **Sdd21**.
15. Press **Scale** > Set **Divisions** to 12.
16. Set **Scale/Div** to 5 dB/div.
17. Set **Reference position** to 11 Div.
18. Set **Reference Value** to 0 dB.

5.5.2. Calibration

Refer to 4.1.1.2 Calibrate for TRL Calibration.

Refer to 4.1.2 4-port ECal (Full 4-port calibration) and De-Embedding for 4-port ECal and De-Embedding.

5.5.3. Measurement

1. Connect the test fixture to the test port cables according to the **Figure 5.5.1**. Unused terminals should be terminated.
2. Connect a Display Port cable to the test fixtures.
3. Press **Trigger** > **Single**.
4. Measurement result is displayed. Refer to 5.5.4 Data Analysis for Pass/Fail criteria.
5. Using the same manner above, measure other channels.

5.5.4. Data Analysis

For Pass/Fail refer to below Near End Noise - Upper Limit for High Speed Cable Assemblies or Near End Noise - Upper Limit for Reduced Bit Rate Cable Assemblies.

Near End Noise - Upper Limit for High Speed Cable Assemblies

$$Isolation_{max}[dB] = \begin{cases} -26 & ; \quad 0.1 < f \le f_0 \\ -26 + 15\,Log_{10}\left(\frac{f}{f_0}\right) & ; \quad f_0 < f \le 7 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35\ GHz$

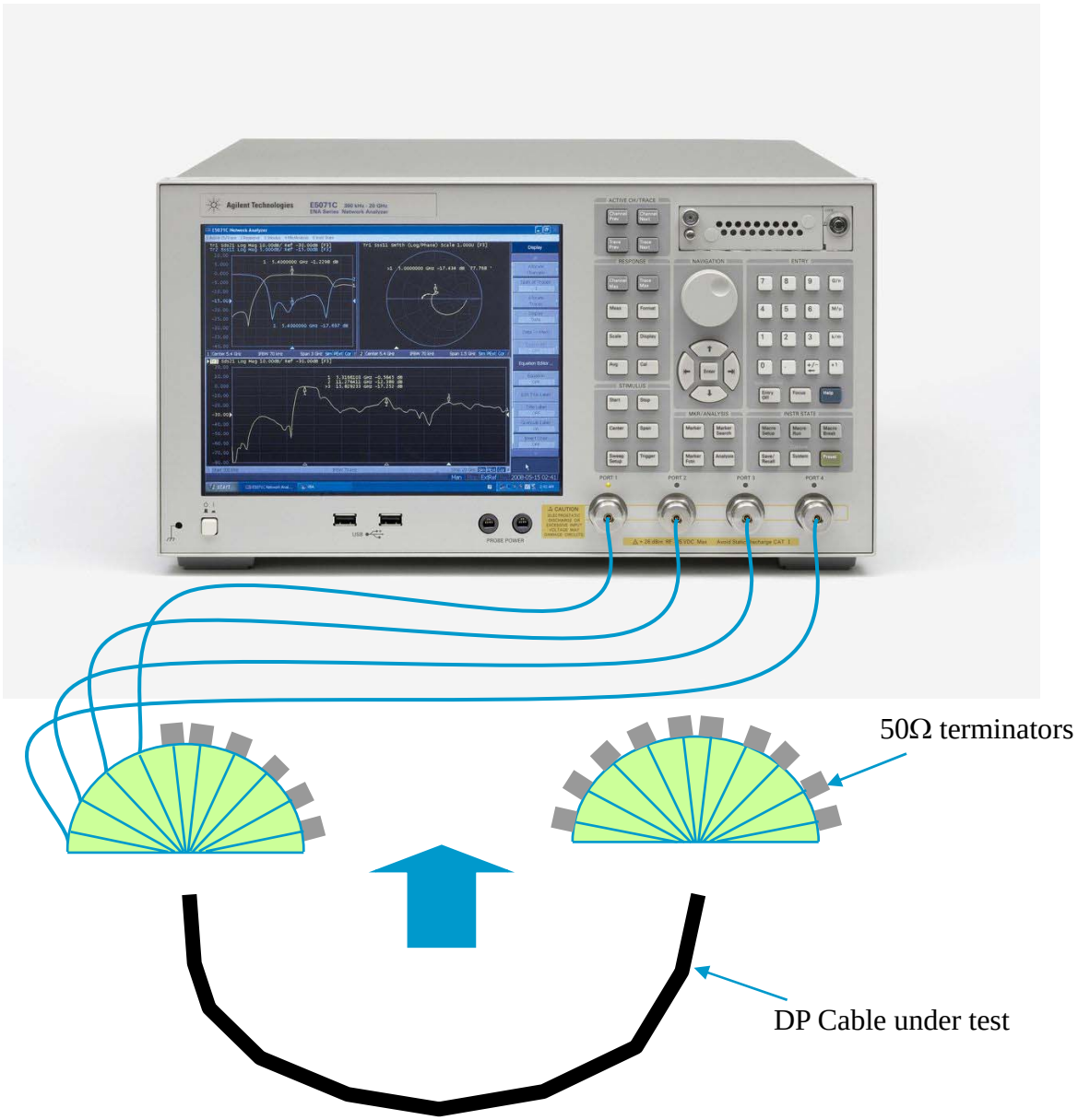
Near End Noise - Upper Limit for Reduced Bit Rate Cable Assemblies

$$Isolation_{\max}[dB] = \begin{cases} -26 & ; \quad 0.1 < f \le f_0 \\ -26 + 15\,Log_{10}\left(\frac{f}{f_0}\right) & ; \quad f_0 < f \le 7 \end{cases}$$

Where:

f is given in GHz

$f_0 = 0.8\ GHz$



Example: Aggressor (ML3) –Victim (AUX)

Figure 5.5.1 Connection Example for Near End Noise measurement

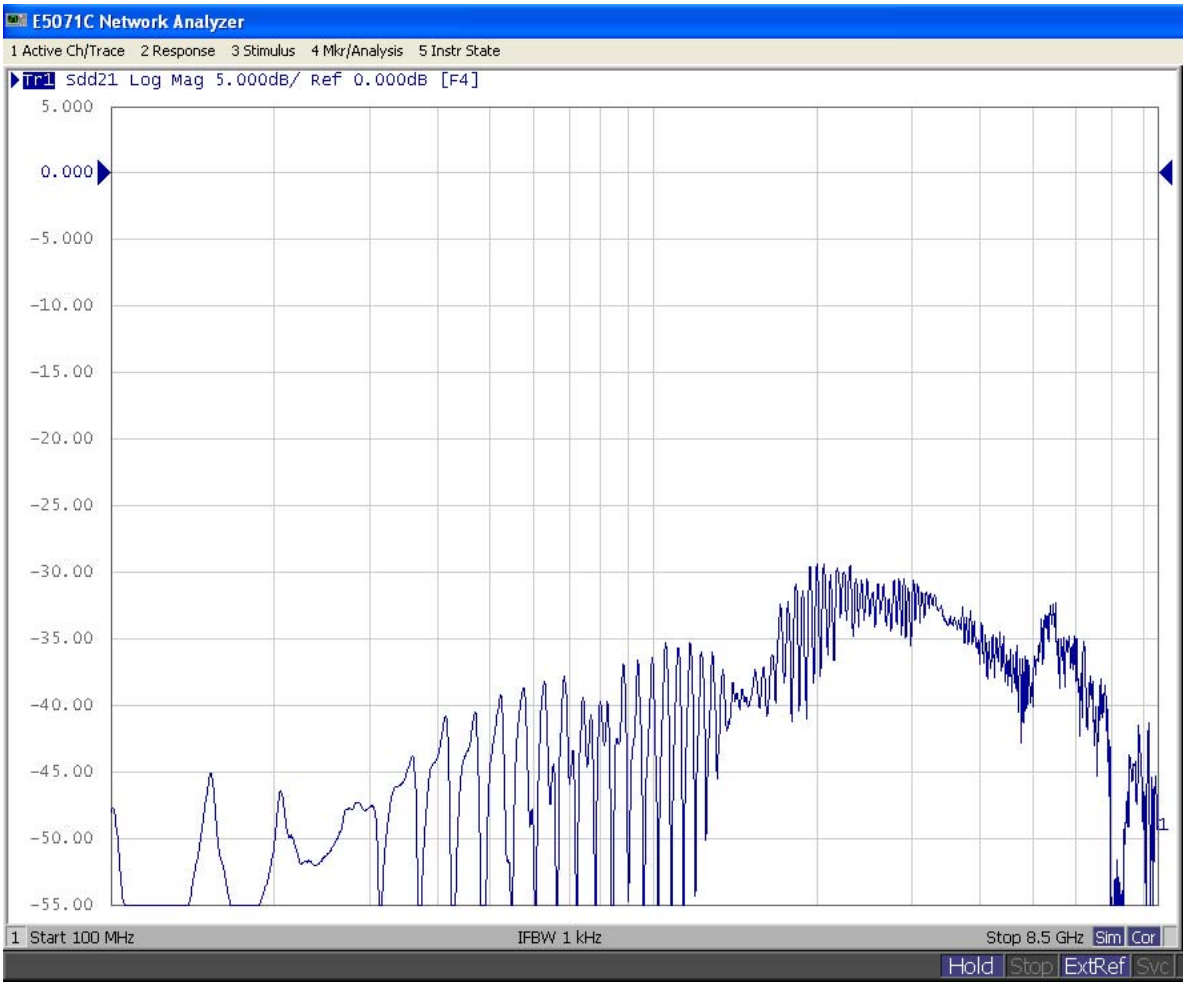


Figure 5.5.2 Near End Noise Measurement Result Example

5.6. Impedance (Sdd11-Zconv) Measurement (Normative)

5.6.1. Measurement Setup

1. Press **Preset** > **OK**.
2. Press **Sweep Setup** > **Sweep Type** > **Lin Freq**.
3. Set **Points** to 1601.
4. Press **Start** > Set start value to 300 kHz.
5. Press **Stop** > Set stop value to 8.5 GHz.
6. Press **Avg** > Set **IF Bandwidth** to 70 kHz.
7. Press **Format** > **Real**.
8. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** and turn it **ON**
9. Click **BalUn** and turn it **ON**.
10. Click **Topology** > **Device** > **Bal-Bal**.
11. Click **Port1 (bal)** > **1-2**.
12. Click **Port2 (bal)** > **3-4**.
13. Click **Return**.
14. Click **Measurement** > **Sdd11**.
15. Press **Analysis** > **Transform** > **Transform** and turn it **ON**.
16. Click **Type** > **Lowpass Step**.
17. Click **Set Freq Low pass**.
18. Set **Start** to 0 sec.
19. Set **Stop** to 1.5 nsec.
20. Click **Window** > Set **Step Rise** to 130 psec.
21. Press **Analysis** > **Conversion** > **Conversion** and turn it **ON**.
22. Click **Function** > **Z:Reflection**.
23. Press **Scale** > Set **Divisions** to 12.
24. Set **Scale/Div** to 5 U/div.

25. Set **Reference position** to 5 Div.
26. Set **Reference Value** to 100 U.

5.6.2. Calibration

Refer to 4.2 Calibration for Time Domain Measurements.

5.6.3. Measurement

1. Connect the test fixture to the test port cables according to the **Figure 5.6.2**. Unused terminals should be terminated.
2. Connect a Display Port cable to the test fixtures.
3. Press **Trigger** > **Single**.
4. Measurement result is displayed. Refer to 5.6.4 Data Analysis for Pass/Fail criteria.
5. Using the same manner above, measure other channels.

5.6.4. Data Analysis

For Pass/Fail refer to Table 5.6.1 Impedance and Tolerances and Figure 5.6.1 Impedance Profile Measurement Impedance Limits & Connector Profile Example.

Table 5.6.1 Impedance and Tolerances

Segment	Differential Impedance Value	Maximum Tolerance	Comment
Fixture	100 Ω	± 10%	See Note 1
Connector	100 Ω		
Cable Management	100 Ω		Transition from ±10% to ±5% shall have a slope of 5Ω/80ps See Note 2
Cable	100 Ω	± 5%	

Note 1: Fixture's trace shall have sufficient length to exhibit propagation delay of a minimum of 180ps (TDT) or 360ps (TDR) displayed on the screen.

Note 2: Bulk cable's impedance measurement start that the 5% tolerance mask.

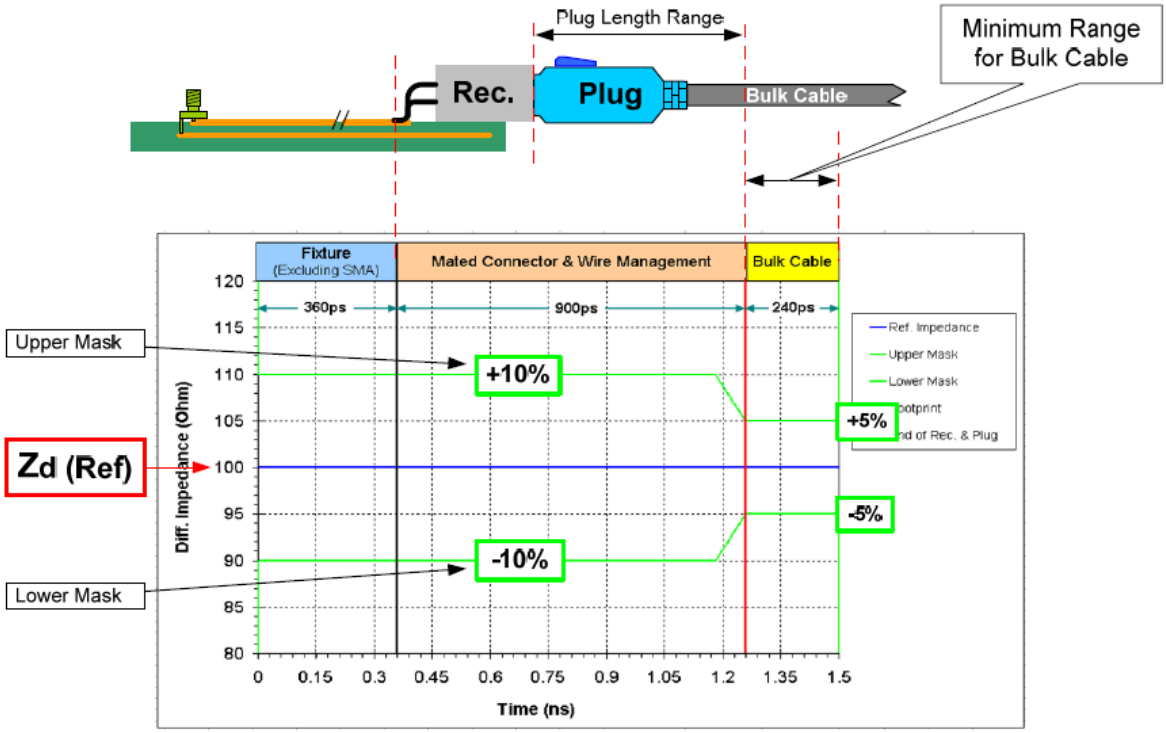
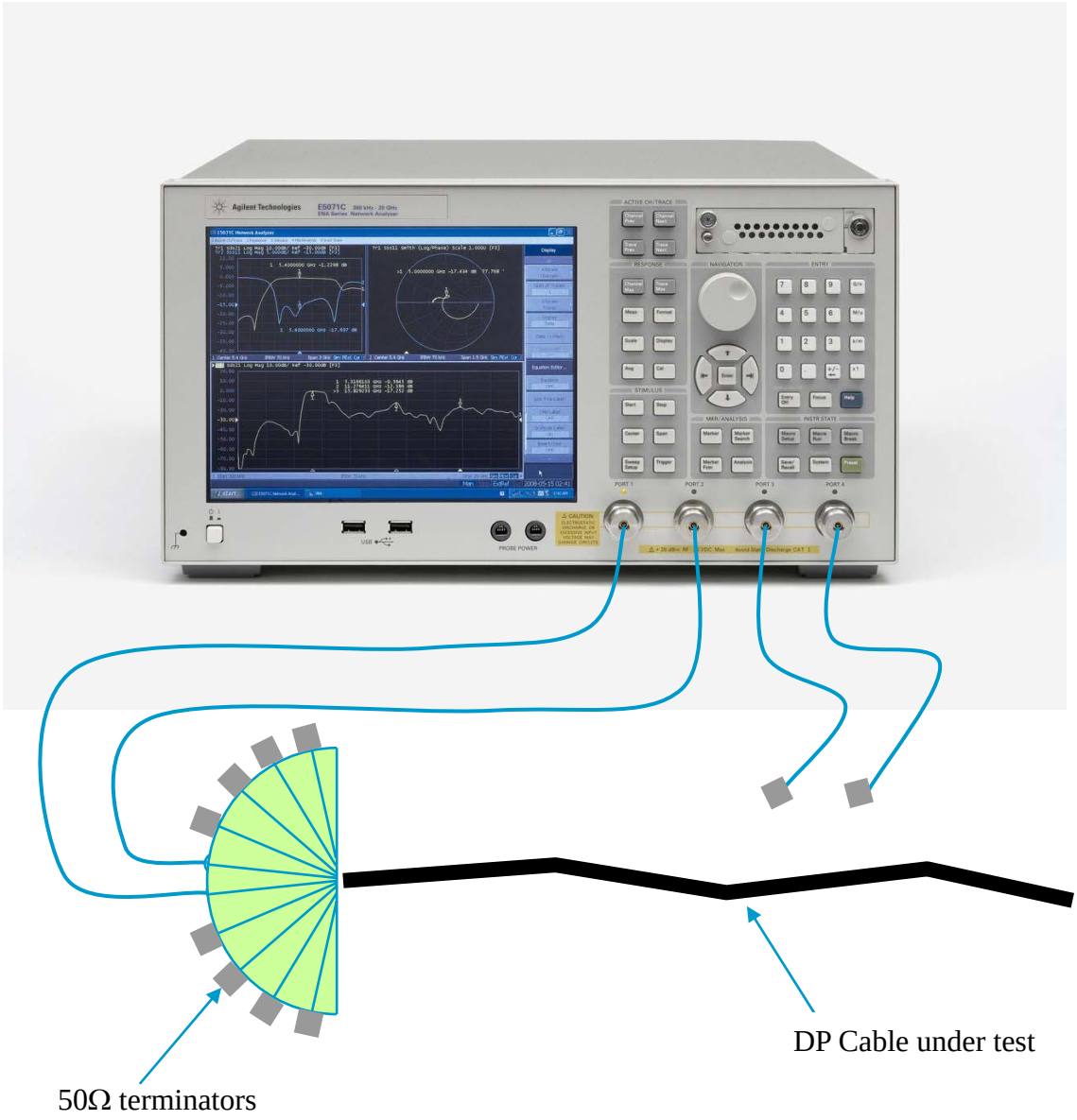


Figure 5.6.1 Impedance Profile Measurement Impedance Limits & Connector Profile Example



Example: Source(ML2)

Figure 5.6.2 Connection Example for Impedance measurement

Figure 5.6.3 Impedance Measurement Result Example

5.7. Intra-Pair Skew Measurement (Normative)

5.7.1. Measurement Setup

1. Press **Preset** > **OK**.
2. Click **Num of Traces** > **4**.
3. Press **Sweep Setup** > **Sweep Type** > **Lin Freq**.
4. Set **Points** to 1601.
5. Press **Start** > Set start value to 300 kHz.
6. Press **Stop** > Set stop value to 8.5 GHz.
7. Press **Avg** > Set **IF Bandwidth** to 70 kHz.
8. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
9. Press **Meas** > **S11**.
10. Press **Trace Next**/**Trace Prev** keys to select the trace 2.
11. Press **Meas** > **S22**.
12. Press **Trace Next**/**Trace Prev** keys to select the trace 3.
13. Press **Meas** > **S33**.
14. Press **Trace Next**/**Trace Prev** keys to select the trace 4.
15. Press **Meas** > **S44**.
16. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
17. Press **Format** > **Real**.
18. Press **Analysis** > **Transform** > **Transform** and turn it **ON**.
19. Click **Type** > **Lowpass Step**.
20. Click **Set Freq Low pass**. (Only required for initial trace.)
21. Set **Center** to 0 sec.
22. Set **Span** to 20 nsec.
23. Press **Scale** > Set **Divisions** to 12.
24. Set **Scale/Div** to 200 mU/div.

25. Set **Reference position** to 5 Div.
26. Set **Reference Value** to 500 mU.
27. Repeat step 16 to step 26 for trace 2, 3, 4.

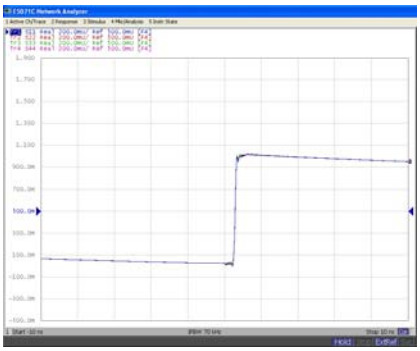


Figure 5.7.1 Calibration result before Fixture DeSkew

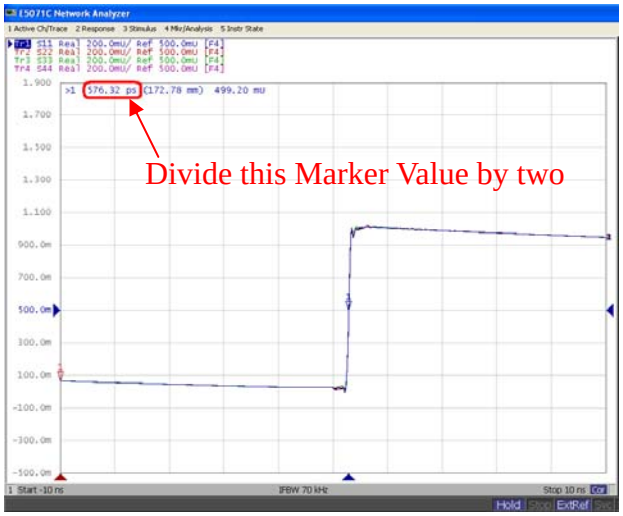
5.7.2. Calibration

Refer to 4.2 Calibration for Time Domain Measurements.

5.7.3. Fixture DeSkew

1. Press **Display** > if **Equation** is **ON**, click the key to turn it **OFF**.
2. Connect the test fixture to the test port cables according to the **Figure 5.7.5**. Unused terminals should be terminated.
3. With open condition of the test fixture. (no cable connected)
4. Press **Trigger** > **Single**.
5. Press **Marker Fctn** > **Couple** > **ON**.
6. Press **Marker** key.
7. Press **Marker Fctn** > **Couple** > **OFF**.
8. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
9. Press **Marker Search** > **Target** > Set **Target Value** to 500 mU.
10. Click **Search Target**.
11. Press **Trigger** > **Single**.
12. Press **Cal** > **Port Extensions** > **Extension Port 1** > Set **Coax. Extension** to Marker Value divided by two. (Refer to Figure 5.7.2 Marker Value for Port Extensions)

Note: Here Port extension is measured with reflection method. It is required to divide the Marker Value by two because the electrical length of the fixture is half the length measured by reflection method.



Extension Port 1 = Trace 1 Marker Value divided by two

Extension Port 2 = Trace 2 Marker Value divided by two

Extension Port 3 = Trace 3 Marker Value divided by two

Extension Port 4 = Trace 4 Marker Value divided by two

Figure 5.7.2 Marker Value for Port Extensions

13. Repeat step 8 to step 12 for trace 2, 3, 4 and input Marker Value divided by two into extension port number accordingly.
14. Click **Return**.
15. Click **Extensions** and turn it **ON**.
16. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
17. Press **Analysis** > **Transform** > Set **Span** to 500 psec.
18. Click **Window** > Set **Kaiser Beta** to 3.
19. Press **Marker** > Set **Marker 1** to 0 sec.
20. Repeat step 16 to step 19 for trace 2, 3, 4.

5.7.4. Mutual coupling compensation

1. Connect a Display Port cable to the test fixtures.
2. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
3. Press **Meas** > **S31**.
4. Press **Display** > **Equation Editor…** > Enter an equation **"S31-S32= S31-S32"**.
5. Check **Equation Enabled** check box.

6. Click **Apply**.
7. Click **Close**.
8. Press **Trace Next**/**Trace Prev** keys to select the trace 2.
9. Press **Meas** > **S42**.
10. Press **Display** > **Equation Editor…** > Enter an equation **"S42-S41= S42-S41"**.
11. Check **Equation Enabled** check box.
12. Click **Apply**.
13. Click **Close**.
14. Press **Trace Next**/**Trace Prev** keys to select the trace 3.
15. Press **Meas** > **S32**.
16. Press **Trace Next**/**Trace Prev** keys to select the trace 4.
17. Press **Meas** > **S41**.

5.7.5. Measurement

1. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
2. Press **Analysis** > **Transform**.
3. Set **Start** to 0 sec.
4. Set **Stop** to 180 nsec.
5. Press **Trigger** > **Single**.
6. Press **Marker Search** > **Target** > Set **Target Value** to 150 mU.
7. Click **Search Target**.
8. Press **Trigger** > **Single**.
9. Press **Analysis** > **Transform** > Set **Center** to Marker Value. (Refer to Figure 5.7.3 Marker Value to set Center)

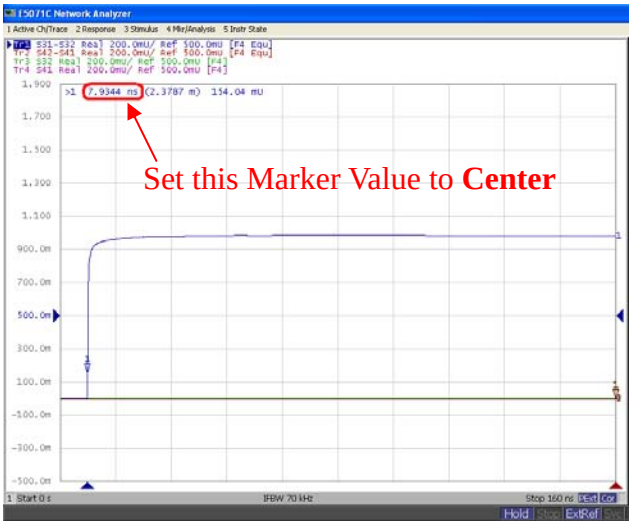


Figure 5.7.3 Marker Value to set Center

10. Set **Span** to 200 psec.

Note: This procedure allows higher resolution.

11. Press **Trigger** > **Single**.

12. Press **Marker Search** > **Target** > **Search Target**.

13. Write down the Marker Value for Intra-Pair Skew calculation. (Refer to Figure 5.7.4 Marker Value for Intra-Pair Skew)

Figure 5.7.4 Marker Value for Intra-Pair Skew

14. Repeat step 1 to step 13 for trace 2.
15. Refer to 5.7.6 Data Analysis for Pass/Fail criteria.
16. Using the same manner above, measure other channels.

5.7.6. Data Analysis

1. Intra-Pair Skew = Absolute(Trace 1 Marker Value - Trace 2 Marker Value)
2. If (Intra-Pair Skew) > 50 psec: Fail, else: Pass.

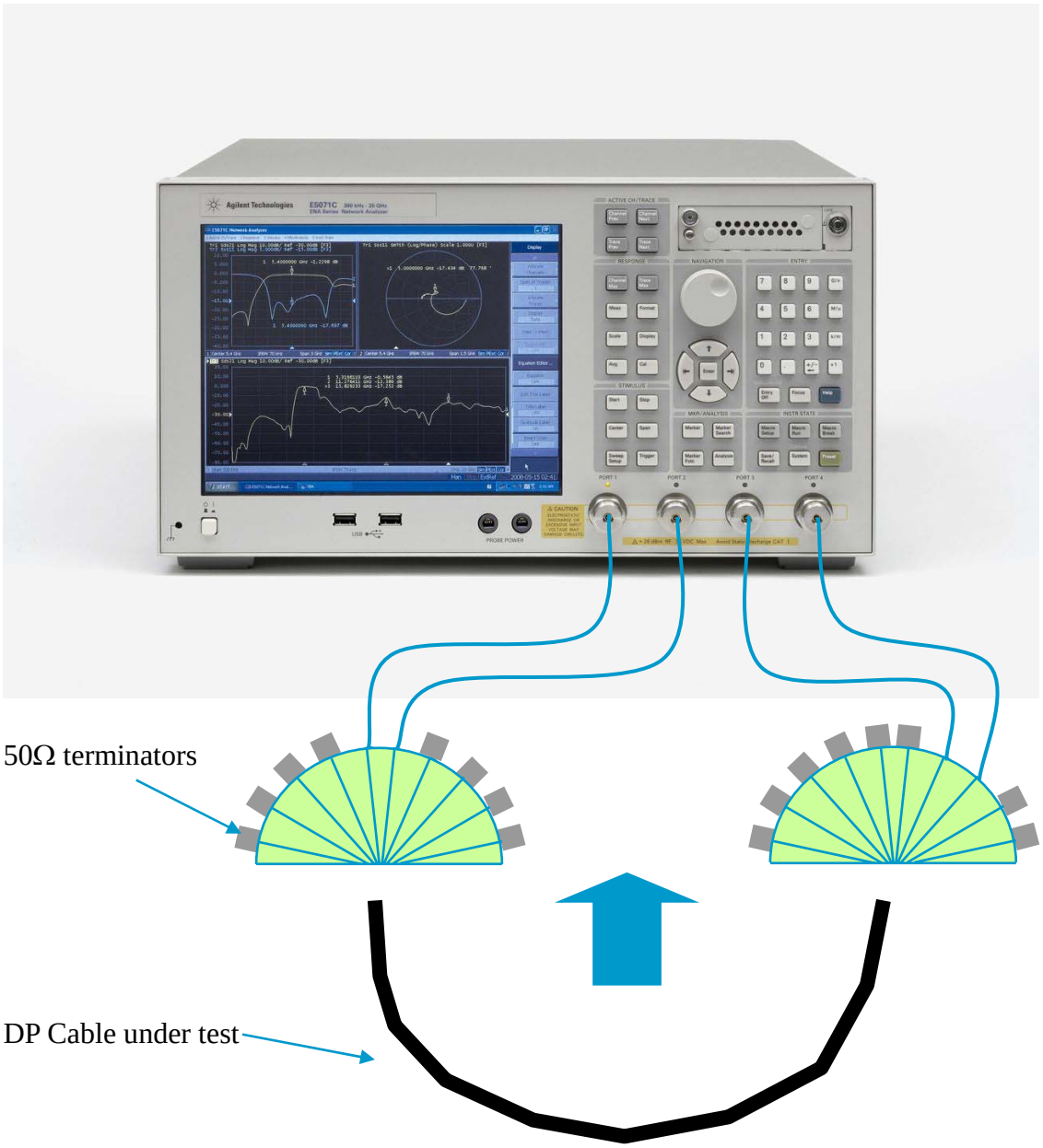


Figure 5.7.5 Connection Example for Intra-Pair Skew measurement

Figure 5.7.6 Intra-Pair Skew Measurement Result Example

5.8. Inter-Pair Skew Measurement (Normative)

5.8.1. Measurement Setup

1. Press **Preset** > **OK**.
2. Press **Display** > **Allocate Channels** > 

3. Press **Channel Next**/**Channel Prev** keys to select the channel 1.
4. Click **Num of Traces** > **4**.
5. Press **Sweep Setup** > **Sweep Type** > **Lin Freq**.
6. Set **Points** to 1601.
7. Press **Start** > Set start value to 300 kHz.
8. Press **Stop** > Set stop value to 8.5 GHz.
9. Press **Avg** > Set **IF Bandwidth** to 70 kHz.
10. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
11. Press **Meas** > **S11**.
12. Press **Trace Next**/**Trace Prev** keys to select the trace 2.
13. Press **Meas** > **S22**.
14. Press **Trace Next**/**Trace Prev** keys to select the trace 3.
15. Press **Meas** > **S33**.
16. Press **Trace Next**/**Trace Prev** keys to select the trace 4.
17. Press **Meas** > **S44**.
18. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
19. Press **Format** > **Real**.
20. Press **Analysis** > **Transform** > **Transform** and turn it **ON**.
21. Click **Type** > **Lowpass Step**.
22. Click **Set Freq Low pass**. (Only required for initial trace.)
23. Set **Center** to 0 sec.

24. Set **Span** to 20 nsec.
25. Press **Scale** > Set **Divisions** to 12.
26. Set **Scale/Div** to 200 mU/div.
27. Set **Reference position** to 5 Div.
28. Set **Reference Value** to 500 mU.
29. Repeat step 18 to step 28 for trace 2, 3, 4.

Figure 5.8.1 Calibration result before Fixture DeSkew

5.8.2. Calibration

Refer to 4.2 Calibration for Time Domain Measurements. After calibration is performed copy channel 1 information to channel 2 according to the following procedure.

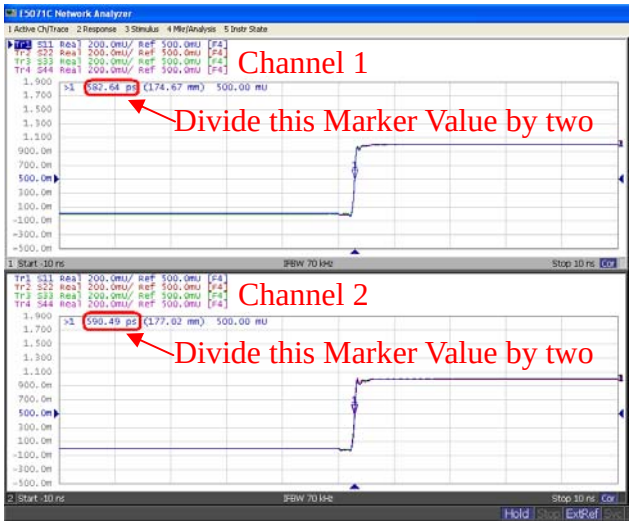
1. Press **Save/Recall** > **Save Channel** > **State B**.
2. Press **Channel Next**/**Channel Prev** keys to select the channel 2.
3. Click **Return**.
4. Click **Recall Channel** > **State B**.

5.8.3. Fixture DeSkew

1. Connect the test fixture to the test port cables according to the **Figure 5.8.5**. Unused terminals should be terminated.
2. With open condition of the test fixture. (no cable connected)
3. Press **Channel Next**/**Channel Prev** keys to select the channel 1.
4. Press **Trigger** > **Single**.
5. Press **Marker Fctn** > **Couple** > **ON**.
6. Press **Marker** key.

7. Press **Marker Fctn** > **Couple** > **OFF**.
8. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
9. Press **Marker Search** > **Target** Set > **Target Value** to 500 mU.
10. Click **Search Target**.
11. Press **Trigger** > **Single**.
12. Press **Cal** > **Port Extensions** > **Extension Port 1** > Set **Coax. Extension** to Marker Value divided by two. (Refer to Figure 5.8.2 Marker Value for Port Extensions)

Note: Here Port extension is measured with reflection method. It is required to divide the Marker Value by two because the electrical length of the fixture is half the length measured by reflection method.



Extension Port 1 = Trace 1 Marker Value divided by two

Extension Port 2 = Trace 2 Marker Value divided by two

Extension Port 3 = Trace 3 Marker Value divided by two

Extension Port 4 = Trace 4 Marker Value divided by two

Figure 5.8.2 Marker Value for Port Extensions

13. Repeat step 8 to step 12 for trace 2, 3, 4 and input Marker Value divided by two into Extension port number accordingly.
14. Click **Return**.
15. Click **Extensions** and turn it **ON**.
16. Press **Trace Next**/**Trace Prev** keys to select the trace 1.
17. Press **Analysis** > **Transform** > Set **Span** to 500 psec.

18. Click **Window** > Set **Kaiser Beta** to 3.
19. Press **Marker** > Set **Marker 1** to 0 sec.
20. Repeat step 16 to step 19 for trace 2, 3, 4.
21. Change connection to channel 2 and terminate all unused terminals.
22. Press **Channel Next**/**Channel Prev** keys to select the channel 2.
23. Repeat step 4 to step 20 for channel 2.

5.8.4. Measurement

1. Change connection to channel 1 and terminate all unused terminals.
2. Connect a Display Port cable to the test fixtures.
3. Press **Channel Next**/**Channel Prev** keys to select the channel 1.
4. Press **Display** > **Num of Traces** > **1**.
5. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** and turn it **ON**.
6. Click **BalUn** and turn it **ON**.
7. Click **Topology** > **Device** > **Bal-Bal**.
8. Click **Port1 (bal)** > **1-2**.
9. Click **Port2 (bal)** > **3-4**.
10. Click **Return**.
11. Click **Measurement** > **Sdd21**.
12. Press **Analysis** > **Transform** > Set **Start** to 0 sec.
13. Set **Stop** to 180 nsec.
14. Press **Trigger** > **Single**.
15. Press **Marker Search** > **Target** > Set **Target Value** to 150 mU.
16. Click **Search Target**.
17. Press **Trigger** > **Single**.
18. Press **Analysis** > **Transform** > Set **Center** to Marker Value. (Refer to Figure 5.8.3 Marker Value to set Center)

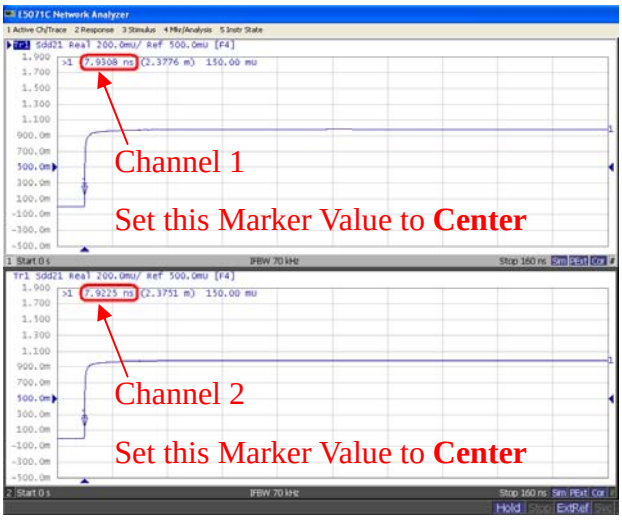


Figure 5.8.3 Marker Value to set Center

19. Set **Span** to 200 psec.

Note: This procedure allows higher resolution.

20. Press **Trigger** > **Single**.

21. Press **Marker Search** > **Target** > **Search Target**.

22. Write down the Marker Value for Inter-Pair Skew calculation. (Refer to Figure 5.8.4 Marker Value for Inter-Pair Skew)

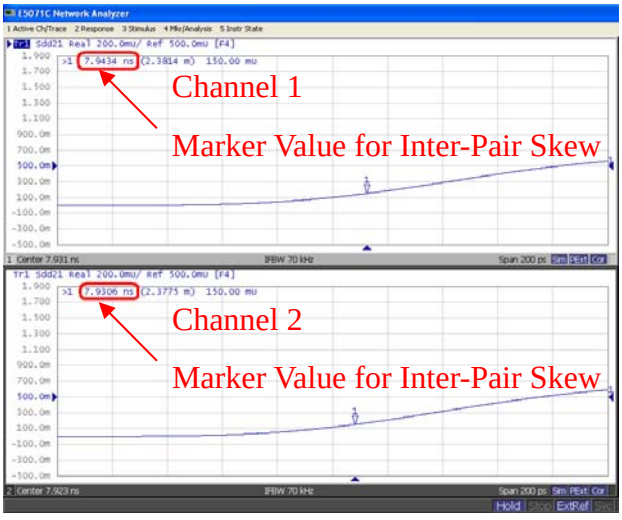


Figure 5.8.4 Marker Value for Inter-Pair Skew

23. Change connection to channel 2 and terminate all unused terminals.
24. Press **Channel Next**/**Channel Prev** keys to select the channel 2.
25. Repeat step 4 to step 22 for channel 2.
26. Refer to 5.8.5 Data Analysis for Pass/Fail criteria.
27. Using the same manner above, measure other channels.

5.8.5. Data Analysis

1. Inter-Pair Skew = Absolute(Channel 1 Trace 1 Marker Value - Channel 2 Trace 1 Marker Value)
2. If (Inter-Pair Skew) > 2UI: Fail, else: Pass.

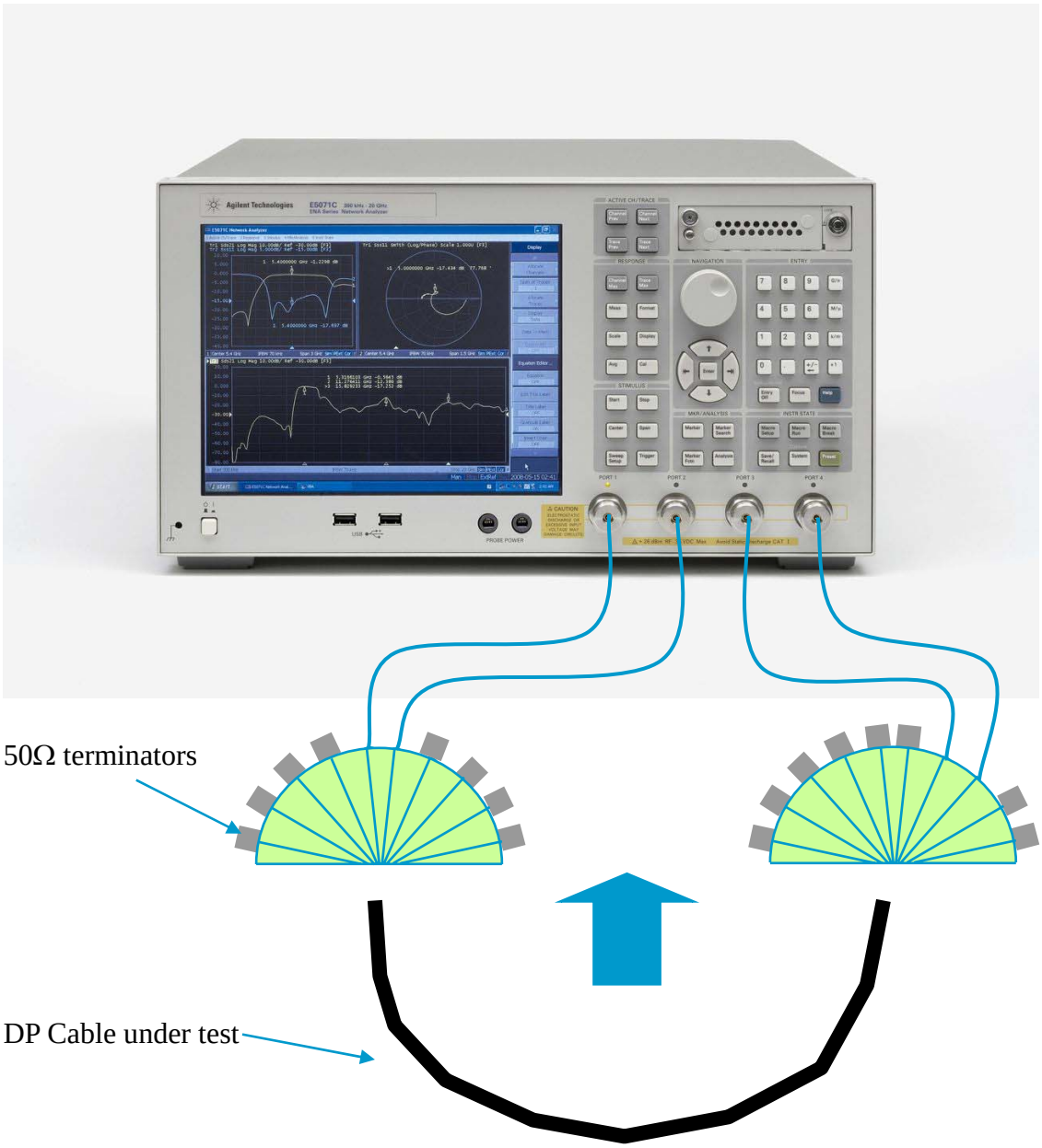


Figure 5.8.5 Connection Example for Inter-Pair Skew measurement

Figure 5.8.6 Inter-Pair Skew Measurement Result Example