Revision 2.00

Nov-1, 2010

VESA Display Port
PHY Compliance test Standard Version 1 Revision 2
Agilent Method of Implementation (MOI) for Display Port Cable Compliance Tests
Using Agilent E5071C ENA Network Analyzer Option TDR

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1. Modification Record

Revision	Comments	Issue Date
1.00	Initial Release.	Dec 15, 2008
2.00	Revised measurement procedure for the option TDR	Nov 1, 2010

2. Purpose

This test procedure was written to explain how to use the Agilent E5071C ENA Network Analyzer Option TDR to make the measurements required per VESA DisplayPort Standard Version 1, Revision 2.

3. References

VESA DisplayPort Standard Version 1, Revision 2

VESA DisplayPort PHY Compliance Test Specification Version 1.1a

4. Resource Requirements

1. E5071C Network Analyzer with option TDR and one of the following options 48x/4D5/4K5
2. Display Port test fixtures BitifEye BIT-DP-CBL-0001, or an equivalent set of fixtures and standards.
3. Four 3.5 mm(f)-Type N(m) adapters (Agilent 1250-1744)
   (Not required if E5071 includes option 4D5 or 4K5)
4. Four 3.5 mm cables 20 GHz bandwidth or equivalent
   (Cables of equal length and characteristics must be used for all test ports)
5. 50 Ohm terminators to terminate unused channels (ex. Agilent 909D-301)

5. Test Procedure

5.1. Outline of Test Procedure

1. **Connect 3.5 mm test cables to every test ports on the instrument.**
2. **Set measurement conditions.**
3. **Perform Calibration**
4. **Measurements and Data Analysis**

   Time Domain Measurements

   - Bulk Cable and Connector Impedance Measurements (Normative).
   - Intra-pair Skew Measurements (Normative).
   - Inter-pair Skew Measurements (Normative).

   Frequency Domain Measurements

   - Insertion Loss Measurements (Normative).
   - Return Loss Measurements (Normative).
   - Near End Noise Measurements.
   - Power Sum Equal Level Far End Noise 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**)

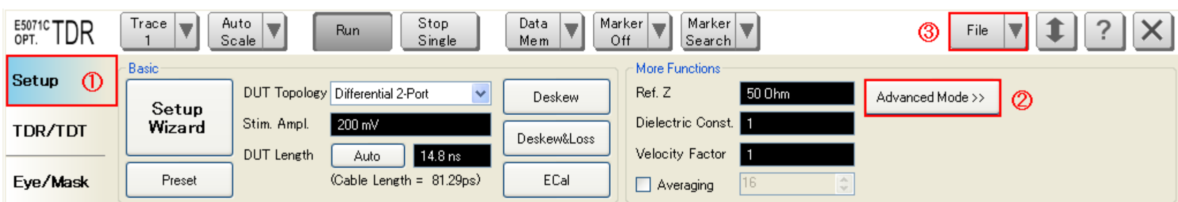
*Note: Tabs (in the TDR) are displayed in Brown color and **Bold**. (Example:* **Setup**, **Trace Control**)

5.2. Instrument Setup

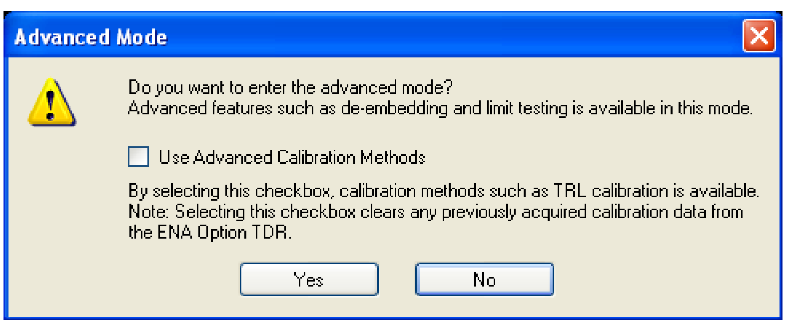
This section describes how to recall a state file for DisplayPort compliance test settings. The state file can be downloaded from www.agilent.com/find/ena-tdr_dp-cabcon.

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 settings, refer to Appendix.

1. If TDR setup wizard appears, click **Close** button on the wizard.
2. Open **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 and a file name, and click **Open**.

5.3. Connection Configuration

This Section describes the screen configuration of the E5071C-TDR and the cable connection.

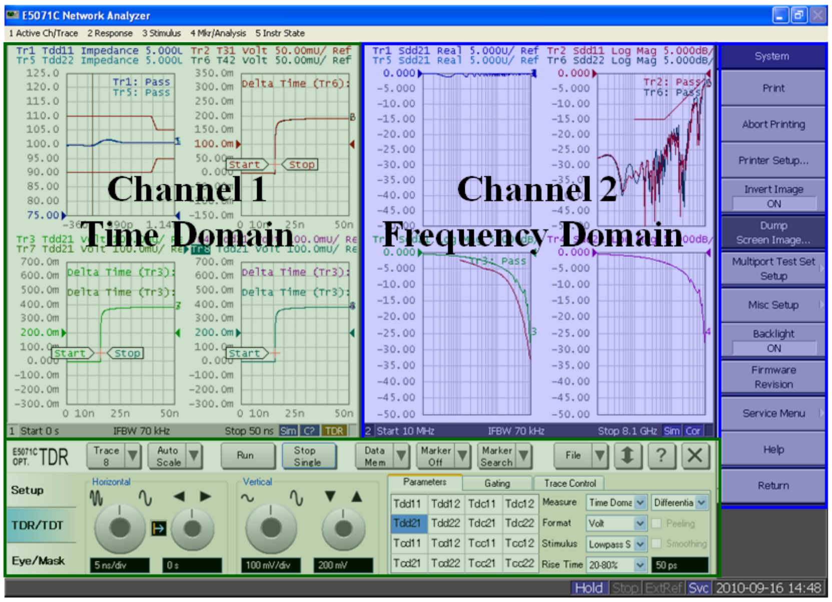


Figure 5-1: Measurement screen description.

Channel1 for time domain measurement is controlled by the TDR user interface at the bottom of the screen and Channel2 for frequency domain measurement is controlled by the soft-key on the right-side of the screen and hard-key on the instrument front panel.

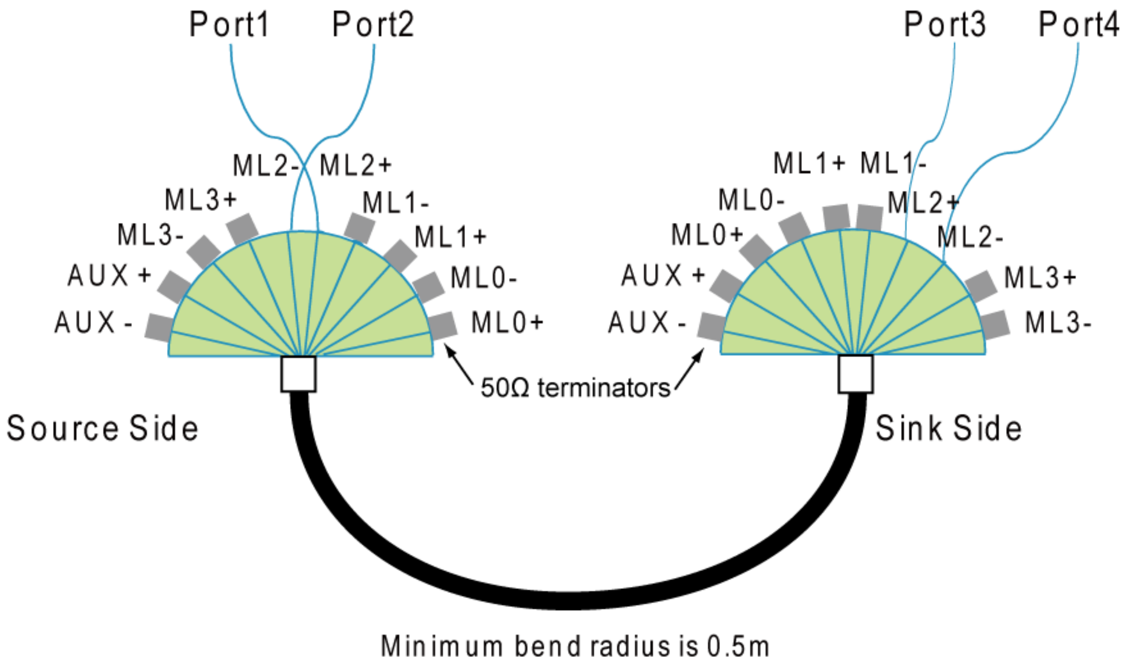


Figure 5-2: Cable connection

The cables and fixtures should be connected to the instrument as shown in the figure above. Table 5-1 shows the cable connection for each measurement item. The measurement items of the same cable connection can be done simultaneously.

Table 5-1 Cable and Fixture Connection

<table>
<tr><td colspan="2">ENA Port Number</td><td>Port1</td><td>Port2</td><td>Port3</td><td>Port4</td></tr>
<tr><td rowspan="6">Fixture PIN Number</td><td rowspan="5">Bulk Cable and Connector Impedance
Intra-pair Skew
Insertion Loss
Return Loss</td><td>A ML0+</td><td>A ML0-</td><td>B ML0+</td><td>B ML0-</td></tr>
<tr><td>A ML1+</td><td>A ML1-</td><td>B ML1+</td><td>B ML1-</td></tr>
<tr><td>A ML2+</td><td>A ML2-</td><td>B ML2+</td><td>B ML2-</td></tr>
<tr><td>A ML3+</td><td>A ML3-</td><td>B ML3+</td><td>B ML3-</td></tr>
<tr><td>A AUX+</td><td>A AUX-</td><td>B AUX+</td><td>B AUX-</td></tr>
<tr><td>Inter-pair Skew</td><td>A ML0+
A ML1+
A ML2+</td><td>A ML0-
A ML1-
A ML2-</td><td>B ML0+
B ML1+
B ML2+</td><td>B ML0-
B ML1-
B ML2-</td></tr>
</table>

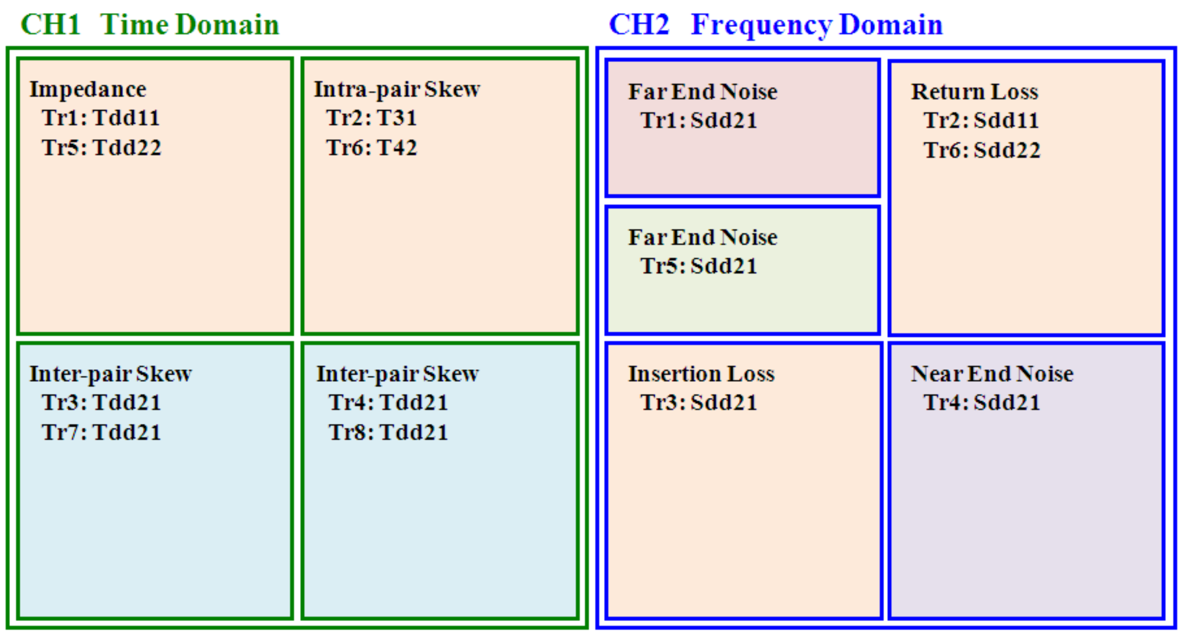
		A ML3+ A AUX+	A ML3- A AUX-	B ML3+ B AUX+	B ML3- B AUX-
	Near End Noise	A ML0+ A ML1+	A ML0- A ML1-	A AUX+ A AUX+	A AUX- A AUX-
		A ML2+	A ML2-	A AUX+	A AUX-
		A ML3+	A ML3-	A AUX+	A AUX-
		B AUX+	B AUX-	B ML0+	B ML0-
		B AUX+	B AUX-	B ML1+	B ML1-
		B AUX+	B AUX-	B ML2+	B ML2-
		B AUX+	B AUX-	B ML3+	B ML3-
	Power Sum Equal Level Far End Noise[1]	A ML1+ A AUX+	A ML1- A AUX-	B ML0+	B ML0-
		A ML0+ A ML2+	A ML0- A ML2-	B ML1+	B ML1-
		A ML1+ A ML3+	A ML1- A ML3-	B ML2+	B ML2-
		A ML2+	A ML2-	B ML3+	B ML3-
		A ML0+	A ML0-	B AUX+	B AUX-

A: Source Side

B: Sink Side

[1] Switch the Display Port cable end and repeat the same measurement for the opposite direction.

Description of Measurement Window



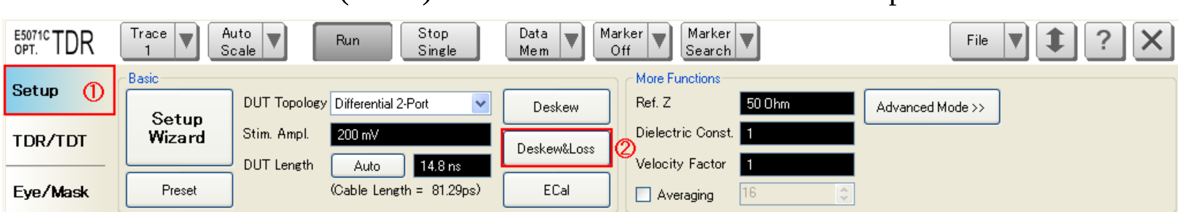
Background colors coincide with the table in the previous page.

5.4. Calibration

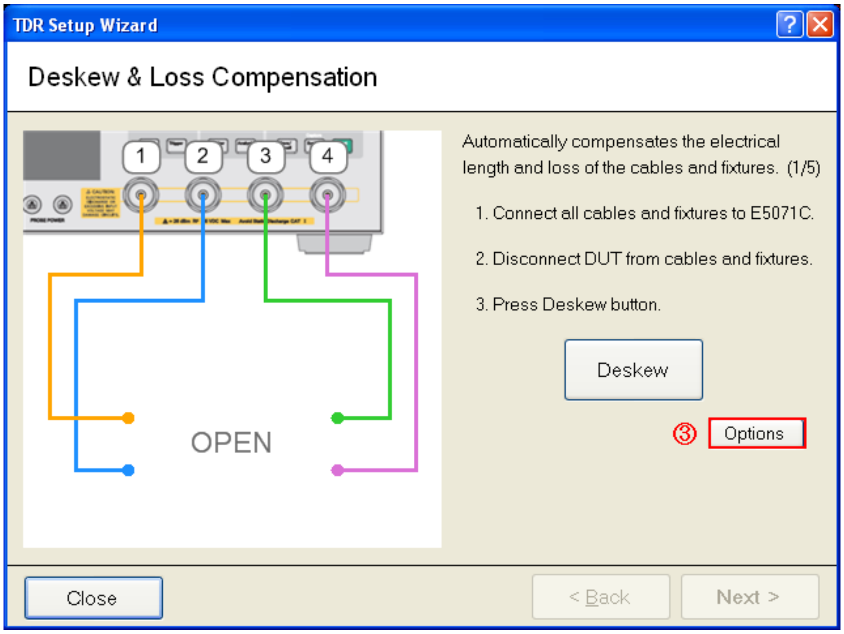
5.4.1. Time Domain Calibration

5.4.1.1. Deskew & Loss Compensation Calibration

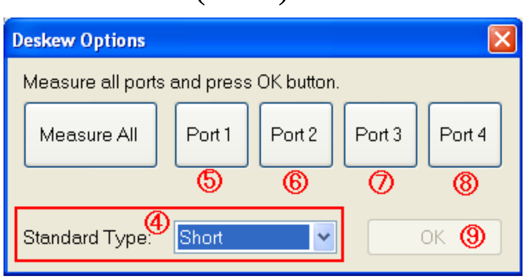
1. Press **Channel Next** key to select Channel1.
2. Open **Setup** tab (item1).
3. Click **Deskew&Loss** (item2) to launch the Deskew & Loss Compensation wizard.



4. Click **Options** (item3), then Deskew Options dialog box appears.

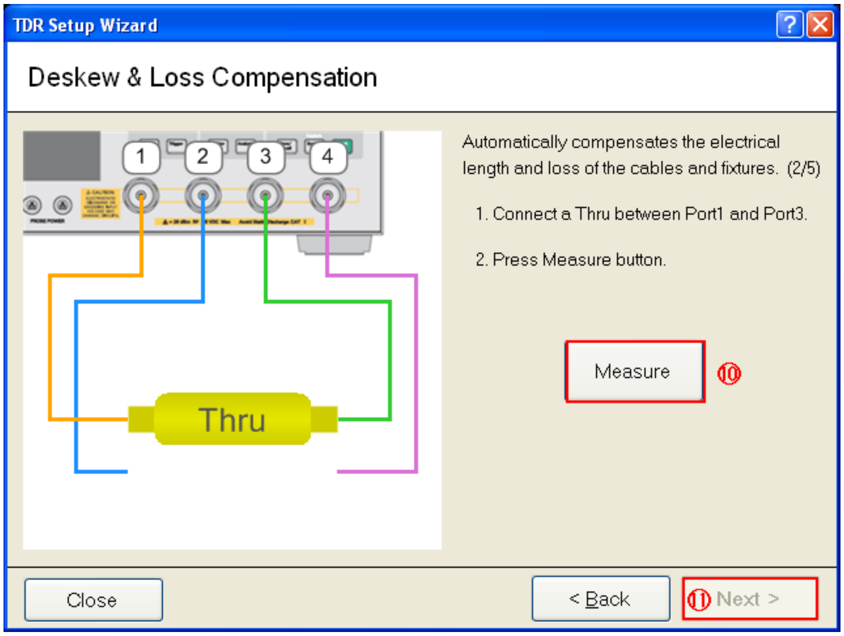


5. Select **standard type** (item4) to Short.
6. Connect "Short" standard to Port1.
7. Click **Port1** (item5). Wait until the check-mark appears under Port1.
8. Connect "Short" standard to Port2.
9. Click **Port2** (item6). Wait until the check-mark appears under Port2.
10. Connect "Short" standard to Port3.
11. Click **Port3** (item7). Wait until the check-mark appears under Port3.
12. Connect "Short" standard to Port4.
13. Click **Port4** (item8). Wait until the check-mark appears under Port4.
14. Click **OK** (item9).

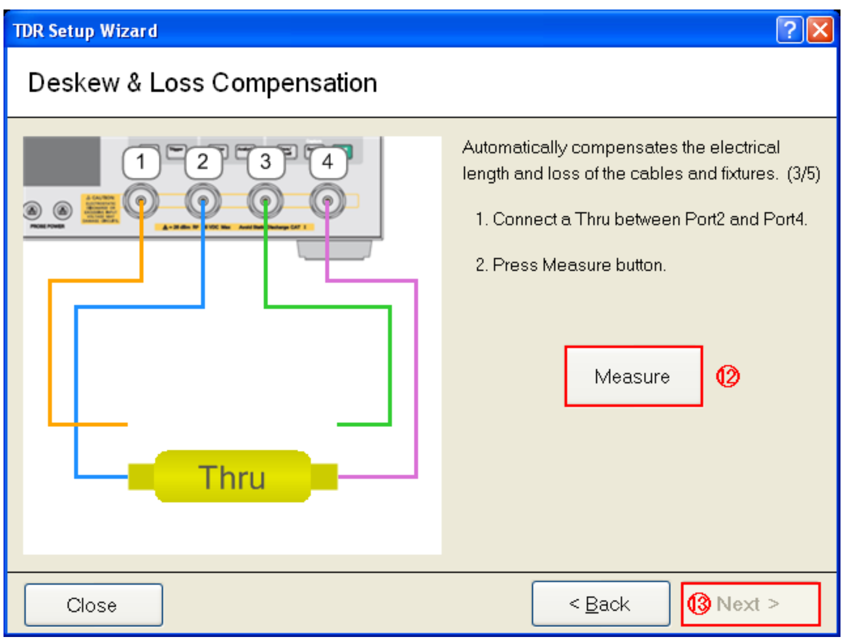


15. Click **Next**.
16. Connect "Thru" standard between Port1 and Port3.

17. Click **Measure** (item10).
18. Click **Next** (item11).

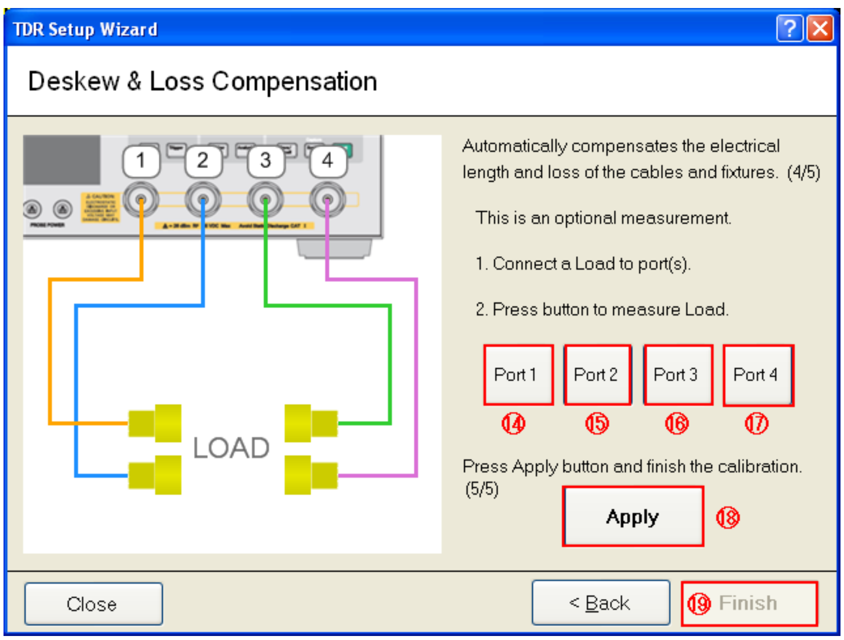


19. Connect "Thru" standard between Port2 and Port4.
20. Click **Measure** (item12).
21. Click **Next** (item13).



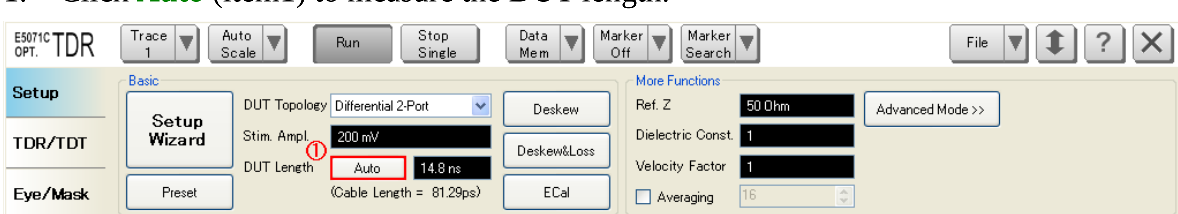
22. Connect "Load" standard to Port1.

23. Click **Port1** (item14). Wait until the check-mark appears under Port1.
24. Connect "Load" standard to Port2.
25. Click **Port2** (item15). Wait until the check-mark appears under Port2.
26. Connect "Load" standard to Port3.
27. Click **Port3** (item16). Wait until the check-mark appears under Port3.
28. Connect "Load" standard to Port4.
29. Click **Port4** (item17). Wait until the check-mark appears under Port4.
30. Click **Apply** (item18).
31. Click **Finish** (item19).



5.4.1.2. Set DUT Length

1. Click **Auto** (item1) to measure the DUT length.

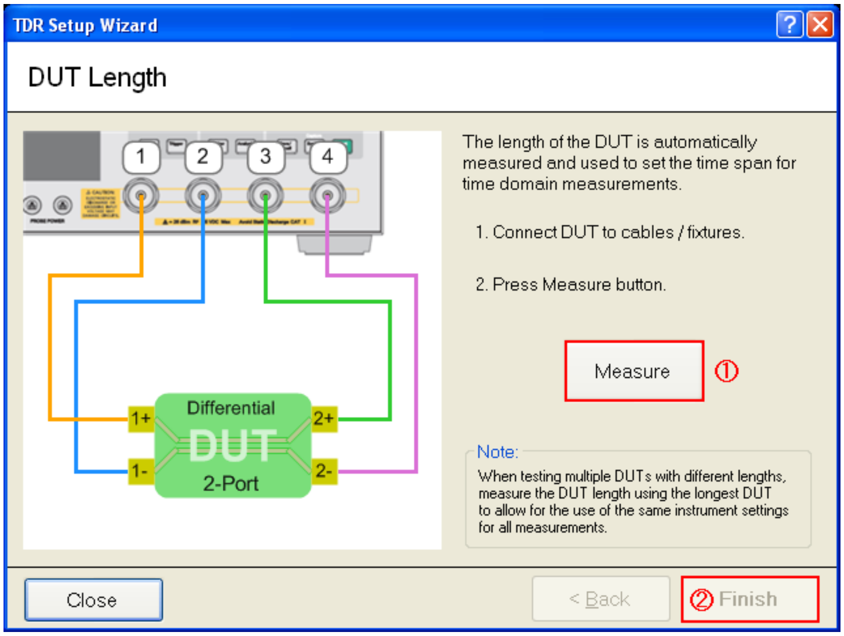


2. Connect the test fixture and DUT as follows.

ENA Port Number	Port1	Port2	Port3	Port4
Fixture Pin Number	A ML0+	A ML0-	B ML0+	B ML0-

A: Source Side, B: Sink Side

3. Click **Measure** (item1).
4. Click **Finish** (item2).



5.4.2. Frequency Domain Calibration

5.4.2.1. Define Calkit

The calkit definition file shall be provided by the fixture supplier or created according to 6.1 Defining a calibration Kit.

1. Press **Cal** key to select channel 2.
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**.

5.4.2.2. 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" or "Open" standard defined at subclass setting to Port1.
    b) Click **Port1 Reflect**.
    c) Connect "Short" or "Open" standard defined at subclass setting to Port2.
    d) Click **Port2 Reflect**.
    e) Connect "Short" or "Open" standard defined at subclass setting to Port3.
    f) Click **Port3 Reflect**.
    g) Connect "Short" or "Open" 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 "Load" standard between Port1 and Port2.
    c) Click **Line/Match 1[Load]**.
    d) Connect "Line1" standard between Port1 and Port2.

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

f) Connect “Line2” standard between Port1 and Port2.

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

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

i) Click **Line/Match 4[Line3]**.

j) Connect “Line4” standard between Port1 and Port2.

k) Click **Line/Match 4[Line4]**.

l) Click **Return**.

m) Click **1-3 Line/Match** and repeat step b) to l).

n) Click **3-4 Line/Match** and repeat step b) to l).

o) 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.

5.4.3. 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 **Set Z0** to actual impedance of the Load standard.
2. Click **Return**.

5.5. Measurement and Data Analysis

5.5.1. Bulk Cable and Connector Impedance

5.5.1.1. Load Limit File

Using limit line files distributed on www.agilent.com/find/ena-tdr_dp-cabcon, the ENA automatically performs pass/fail test. Since pass/fail criteria vary depending on the Bit rate, cable category or connector type, appropriate limit line files should be loaded prior to making measurements.

1. Select a trace on which a limit line should be set.
2. Press **Analysis** > **Limit Test** > **Edit Limit Line** > **Import from CSV File…** to display the **Open** dialog box.
3. Select an appropriate limit file according to the table for each measurement item.
4. Click **Return**.

Table 5-2: Impedance Limit File for Trace1 and Trace5 in Channel1

Bit Rate	Cable Category	Connector Type	File Name
All	All	Full-size DP	DP_ImpedanceProfile_Full.CSV
All	All	Mini DP	DP_ImpedanceProfile_Mini.CSV

5.5.1.2. Measurement

1. Connect the test fixture to the test cables according to Table 5-3. Unused test ports should be terminated.

Table 5-3 Impedance, Intra-pair Skew, Insertion Loss and Return Loss Connection

ENA Port Number	Port1	Port2	Port3	Port4
Fixture PIN Number	A ML0+	A ML0-	B ML0+	B ML0-
	A ML1+	A ML1-	B ML1+	B ML1-
	A ML2+	A ML2-	B ML2+	B ML2-
	A ML3+	A ML3-	B ML3+	B ML3-
	A AUX+	A AUX-	B AUX+	B AUX-

A: Source Side, B: Sink Side

2. Connect Display Port cable to the test fixture.
3. Press **Channel Next** key to select Channel1.
4. Press **Channel Max** key to enlarge Channel1.
5. Click **Stop Single** for Time Domain measurement.

5.5.1.3. Data Analysis

Read Pass/Fail signs on Trace1 and Trace5. (item1 in Figure 5-3)

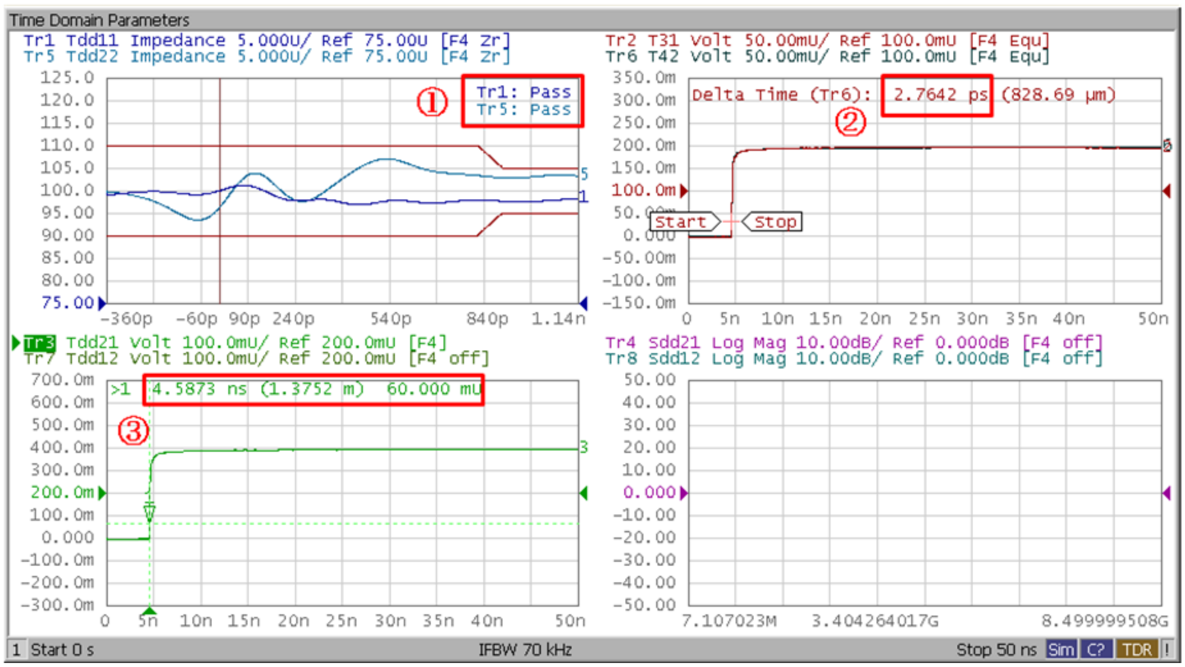


Figure 5-3: Time Domain Measurement Example

5.5.2. Intra-Pair Skew

5.5.2.1. Measurement

Refer to 5.5.1.2.

5.5.2.2. Data Analysis

Read the delta time between Trace2 and Trace6. (item2 in Figure 5-3).

Intra-pair Skew Upper Limit for High Bit Rate Cable Assembly

Cable Category	Limit
Cable Assembly	delta time <= 50 ps, then Pass. Otherwise Fail.
Connector Resizing Adaptor	delta time <= 10 ps, then Pass. Otherwise Fail.
Extension Cable	delta time <= 35 ps, then Pass. Otherwise Fail.

Intra-pair Skew Upper Limit for Reduced Bit Rate Cable Assembly

Cable Category	Limit
Any	delta time <= 250 ps, then Pass. Otherwise Fail.

5.5.3. Insertion Loss

5.5.3.1. Load Limit file

Refer to 5.5.1.1.

Table 5-4 Insertion Loss Limit Line File for Trace3 in Channel2

Bit Rate	Cable Category	Connector Type	File Name
HBR	Cable	All	DP_HBR_InsertionLoss_Cable.CSV
	Resizing Adaptor	All	DP_HBR_InsertionLoss_Adapter.CSV
	Extension Cable	All	DP_HBR_InsertionLoss_ExtCable.CSV
RBR	All	All	DP_RBR_InsertionLoss.CSV

5.5.3.2. Measurement

1. Connect the test fixture to the test cables according to the Table 5-3. Unused test ports should be terminated.
2. Connect Display Port cable to the test fixture.
3. Press **Channel Next** key to select Channel1.
4. Press **Channel Max** key to enlarge Channel1.
5. Press **Trigger** > **Single** for frequency domain measurement.

5.5.3.3. Data Analysis

Read Pass/Fail signs on Trace3. (item1 in Figure 5-4).

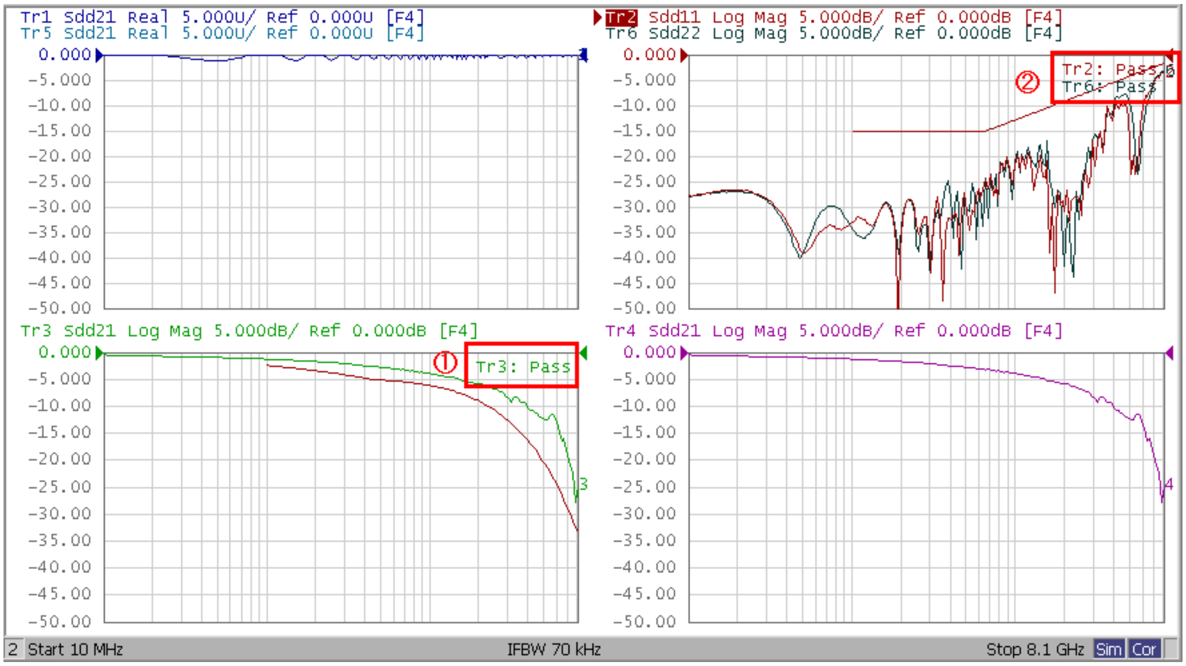


Figure 5-4: Frequency Domain Measurement Example

5.5.4. Return Loss

5.5.4.1. Load Limit File

Refer to 5.5.1.1.

Table 5-5 Return Loss Limit Line File for Trace2 and Trace6 in Channel2

Bit Rate	Cable Category	Connector Type	File Name
HBR	All	All	DP_HBR_ReturnLoss.CSV
RBR	All	All	DP_RBR_ReturnLoss.CSV

5.5.4.2. Cable Connection

Refer to 5.5.1.2.

5.5.4.3. Data Analysis

Read Pass/Fail signs on Trace3. (item2 in Figure 5-4).

5.5.5. Inter- pair Skew

Measurement

1. Connect the test fixture to the test cables according to Table 5-3. Unused test ports should be terminated.
2. Connect Display Port cable to the test fixture.
3. Press **Channel Next** key to select Channel1.
4. Press **Channel Max** key to enlarge Channel1.
5. Click **Stop Single** for Time Domain measurement.
6. Read the propagation delay (item3 in Figure 5-3), and write it down.
7. Repeat step1 to step6 for every channel.

5.5.5.1. Data Analysis

Find the maximum and minimum value among the measured propagation delay. Then, Inter-pair Skew = Absolute(maximum value – minimum value)

Inter-pair Skew Upper Limit for High Bit Rate Cable Assembly

Types	**Limit**
Cable Assembly	delta time <= 4 ns, then Pass. Otherwise Fail.
Connector Resizing Adaptor	delta time <= 500 ps, then Pass. Otherwise Fail.
Extension Cable	delta time <= 2 ns, then Pass. Otherwise Fail.

5.5.6. Near End Noise

5.5.6.1. Load Limit File

Refer to 5.5.1.1.

Table 5-6 Near End Noise Limit File for Trace4 in Channel2

Bit Rate	Cable Category	Connector Type	File Name
HBR	All	All	DP_HBR_NearEndNoise.CSV
RBR	All	All	DP_RBR_NearEndNoise.CSV

5.5.6.2. Measurement

1. Connect the test fixture to the test port cables according to Table 5-7. Unused test ports should be terminated.

Table 5-7: Near End Noise Connection

ENA Port Number	Port1	Port2	Port3	Port4
Fixture PIN Number	A ML0+	A ML0-	A AUX+	A AUX-
	A ML1+	A ML1-	A AUX+	A AUX-
	A ML2+	A ML2-	A AUX+	A AUX-
	A ML3+	A ML3-	A AUX+	A AUX-
	B AUX+	B AUX-	B ML0+	B ML0-
	B AUX+	B AUX-	B ML1+	B ML1-
	B AUX+	B AUX-	B ML2+	B ML2-
	B AUX+	B AUX-	B ML3+	B ML3-

A: Source Side, B: Sink Side

2. Connect Display Port cable to the test fixture.
3. Press **Channel Next** key to select Channel2.
4. Press **Channel Max** key to enlarge Channel2.
5. Press **Trigger** > **Single** for Frequency Domain measurement.

5.5.6.3. Data Analysis

Read Pass/Fail sign on Trace4 (item1 in Figure 5-5).

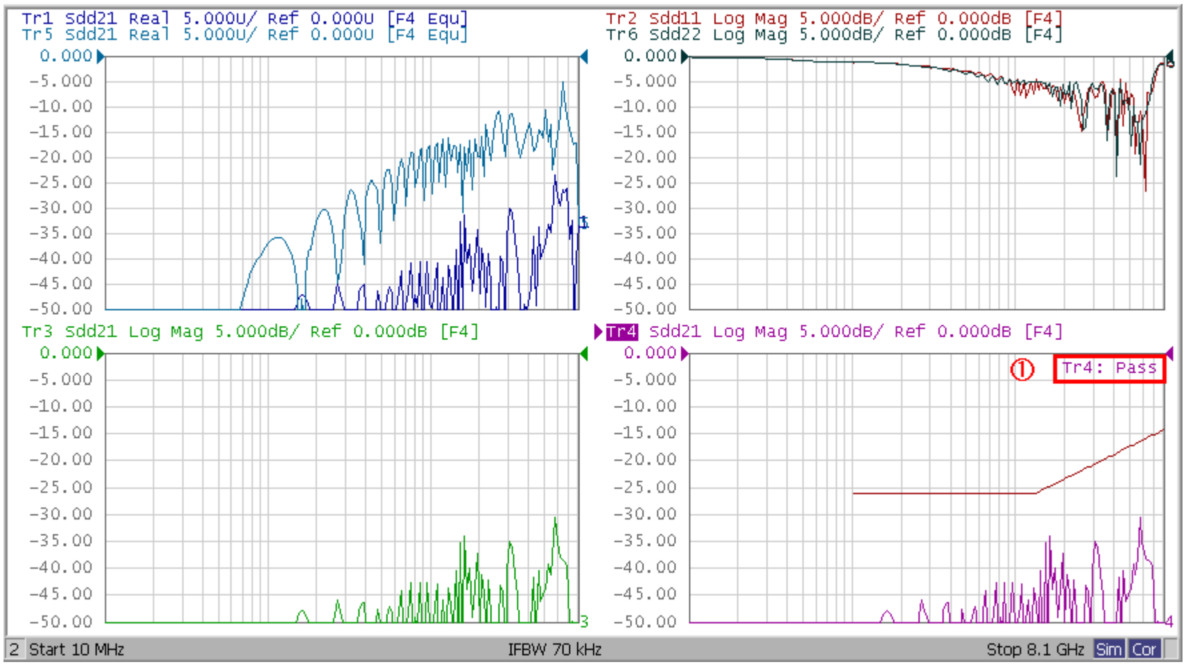


Figure 5-5: Near End Noise Measurement Example.

5.5.7. Power Sum Equal Level Far End Noise (PSELFEN)

The PSELFEN represents the difference between cable insertion loss and the total power sum far end noise from aggressor cable lanes. Prior to measuring the far-end noise between the victim and aggressor channels, the insertion loss of the victim channel must be measured on Trace3, and saved to the trace memory.

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

$$PSELFEN(f) = PSFEN(f) - IL(f)$$

Where:

$FENn(f)$ is the far-end noise in dB

$IL(f)$ is the victim lane insertion loss in dB

Since the number of aggressor channels depends on the victim channel, use an appropriate trace for each test according to the Table 5-8. For test number 2 to 4 (dual aggressor test), the crosstalk measurements need to be performed separately on each combination of victim-aggressor, and combine the results to calculate Far End Noise. For instance, to obtain Far End Noise for test 3, measure Sdd21 between Main Link(0) and Main Link(1) crosstalk, then measure Sdd21 between Main Link(2) and Main Link(1).

Table 5-8 Victims and Aggressors

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

5.5.7.1. Load Limit File

Refer to 5.5.1.1.

Table 5-9 Power Sum Equal Level Far End Noise Limit Line File for Trace1 and Trace5 in Channel2

Bit Rate	Cable Category	Connector Type	File Name
HBR	All	All	DP_HBR_FarEndNoise.CSV
RBR	All	All	DP_RBR_FarEndNoise.CSV

5.5.7.2. Insertion Loss Measurement of Victim channel

1. Connect the test cables to the victim channel according to Table 5-10. Unused test ports should be terminated.
2. Select trace3.
3. Press **Trigger** > **Single**.
4. Press **Display** > **Data -> Mem**.

Table 5-10 Insertion Loss Connection of Victim Channel

ENA Port Number	Test#	Port1	Port2	Port3	Port4
Fixture PIN Number	1	A ML3+	A ML3-	B ML3+	B ML3-
	2	A ML2+	A ML2-	B ML2+	B ML2-
	3	A ML1+	A ML1-	B ML1+	B ML1-
	4	A ML0+	A ML0-	B ML0+	B ML0-
	5	A AUX+	A AUX-	B AUX+	B AUX-

5.5.7.3. Measurement Setup for Single-Aggressor

1. Connect the test fixture to the test port cables according to Table 5-11. Unused test ports should be terminated.

Table 5-11 Far End Noise Connection for Single Aggressor

ENA Port Number	Test#	Port1	Port2	Port3	Port4
Fixture PIN Number	1	A ML2+	A ML2-	B ML3+	B ML3-
	5	A ML0+	A ML0-	B AUX+	B AUX-

A: Source Side, B: Sink Side

2. Select trace1.
3. Press **Trigger** > **Single**.
4. Press **Display** > **Equation** to turn it **ON**.

5.5.7.4. Measurement Setup for Dual-Aggressor

1. Connect the test fixture to the test port cables according to Table 5-12. Unused test ports should be terminated.

Table 5-12 Far End Noise Connection for Dual Aggressor 1

ENA Port Number	Test#	Port1	Port2	Port3	Port4
Fixture PIN Number	2	A ML1+	A ML1-	B ML2+	B ML2-
	3	A ML0+	A ML0-	B ML1+	B ML1-

	4	A ML1+	A ML1-	B ML0+	B ML0-

A: Source Side, B: Sink Side

5. Select trace5.
6. Press **Display** > **Equation** to turn it **OFF**.
7. Press **Trigger** > **Single**.
8. Press **Display** > **Data -> Mem**.
9. Connect the test fixture to the test port cables according to Table 5-13. Unused test ports should be terminated.

Table 5-13 Far End Noise Connection for Dual Aggressor 2

ENA Port Number	Test#	Port1	Port2	Port3	Port4
Fixture PIN Number	2	A ML3+	A ML3-	B ML2+	B ML2-
	3	A ML2+	A ML2-	B ML1+	B ML1-
	4	A AUX+	A AUX-	B ML0+	B ML0-

A: Source Side, B: Sink Side

10. Press **Trigger** > **Single**.
11. Press **Display** > **Equation** to turn it **ON**.

5.5.7.5. Data Analysis

For Single Aggressor, read Pass/Fail signs on Trace1.

For Dual Aggressor, read Pass/Fail signs on Trace5.

Note: Once you finish the measurement, switch the Display Port cable end and repeat the same measurement for the opposite direction.

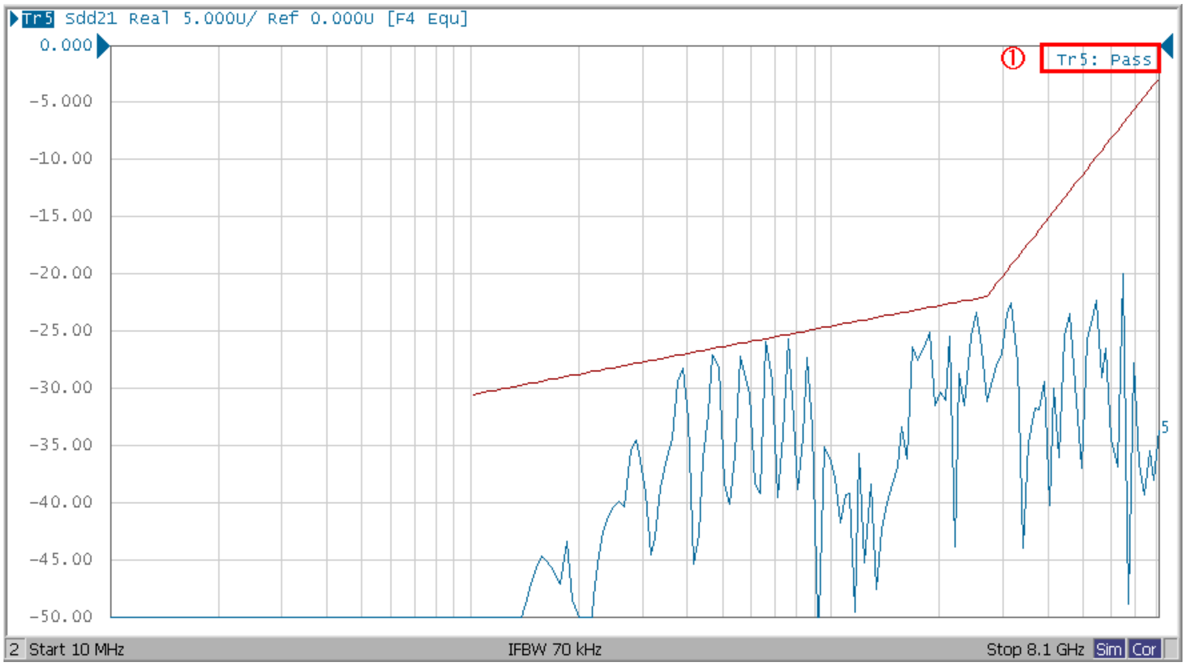


Figure 5-6: Far End Noise Measurement Example.

6. Appendix

6.1. 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** >

Label : ”Thru”

1. **STD Type** : Delay/Thru
2. **Offset Delay** : Value defined by the fixture
3. **Offset Z0** : Value defined by the fixture
4. **Offset Loss** : Value defined by the fixture
5. **Min. Frequency** : Value defined by the fixture
6. **Max. Frequency** : Value defined by the fixture
7. **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**

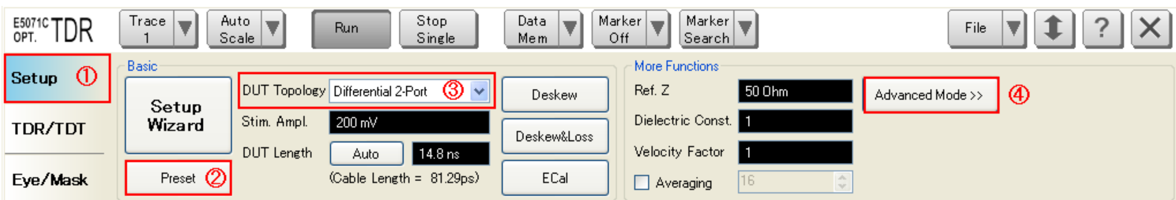
5. Click **Return**.
6. Click **Specify CLSs** >
  - h) **Sub class1** >
    1. **TRL Thru** > **Set All** > **Thru** > **Return**
    2. **TRL Reflect** > **Short** or **Open**
    3. **TRL Line/Match** > **Set All** > **Line1** > **Return**
  - i) **Sub class2** >
    4. **TRL Line/Match** > **Set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

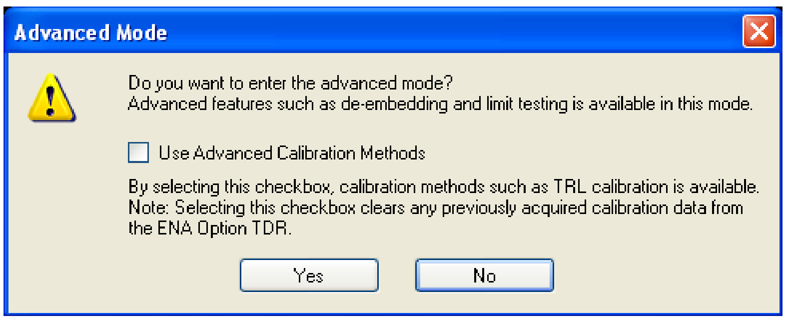
6.2. Manual Setup for Time Domain Measurement

6.2.1. Starting Setup

1. If TDR setup wizard was appeared, click **Close** button in the TDR setup wizard.
2. Open **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. Set **DUT Topology** (item3) to “Differential 2-port”.
6. Click **Advanced Mode** (item4).

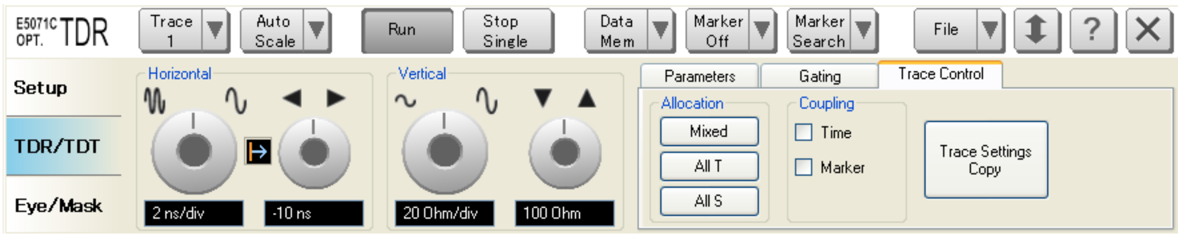


7. A dialog box appears requesting for confirmation. Then click **Yes**. (Clear the check box for “Use Advanced Calibration Methods”)



6.2.2. Bulk Cable and Connector Impedance Measurements (Normative)

6.2.2.1. Measurement Setup



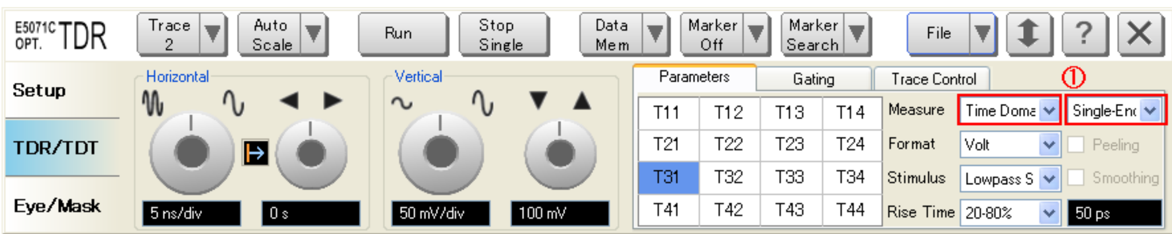
1. Click **Stop Single**.
2. Open **TDR/TDT** tab.
3. Click **Trace Control** tab.
4. Clear **Time** and **Marker** check box under Coupling.
5. Open **Parameters** tab.
6. Select **Trace1**.
7. Select **Rise Time** to 20-80 % and input value to 130 psec.
8. Click the box below the left knob under Horizontal. Then Entry dialog box appear.
9. Input horizontal scale to 150 ps/div.
10. Click the box below the right knob under Horizontal. Then Entry dialog box appear.
11. Input horizontal position to -360 ps.
12. Click the box below the left knob under Vertical. Then Entry dialog box appear.
13. Input vertical scale to 5 ohm/div.
14. Click the box below the right knob under Vertical. Then Entry dialog box appear.
15. Input vertical position to 75 ohm.
16. Open **Trace Control** tab.
17. Click **Trace Settings Copy**.
18. Trace Settings Copy dialog box appears.
19. Select the **Trace1** in the From list.
20. Select the **Trace5** in the To list.
21. Click **Copy**.

22. Click **Close**.
23. Select **Trace5**.
24. Open **Parameters** tab.
25. Click **Tdd22**.

6.2.3. Intra-Pair Skew Measurement (Normative)

6.2.3.1. Measurement Setup

1. Select **Trace2**.
2. Open **Parameters** tab.
3. Select **Measure** to Time Domain and Single-Ended (item1).



4. Select **Format** to Volt.
5. Click **T31**.
6. Select **Rise Time** to 20-80 % and input value to 50 psec.
7. Click the box below the left knob under Horizontal. Then Entry dialog box appear.
8. Input horizontal scale to 5 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. Open **Trace Control** tab.
16. Click **Trace Settings Copy**.
17. Trace Settings Copy dialog box appears.

18. Select the **Trace2** in the From list.
19. Select the **Trace6** in the To list.
20. Click **Copy**.
21. Click **Close**.
22. Select **Trace6**.
23. Open **Parameters** tab.
24. Click **T42**.
25. Select **Trace2**.
26. Click **Marker Search** and select **Δ Time**.
27. Delta Time dialog box appear.
28. Check the **Δ Time** check box.
29. Select **Target (Stop)** to Trace6 (T42).
30. Input **Position (%)** to 15.
31. Click **OK**.

6.2.3.2. Crosstalk Compensation

1. Select **Trace2**.
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 **Trace6**.
7. Press **Display** > **Equation Editor…** > Enter an equation **"Intra-= S42-S41"**.
8. Check **Equation Enabled** check box.
9. Click **Apply**.
10. Click **Close**.

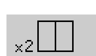
6.2.4. Inter-pair Skew Measurements (Normative)

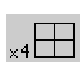
6.2.4.1. Measurement Setup

1. Select **Trace3**.
2. Open **Parameters** tab.
3. Select **Rise Time** to 20-80 % and input value to 50 psec.
4. Click the box below the left knob under Horizontal. Then Entry dialog box appear.
5. Input horizontal scale to 5 ns/div.
6. Click the box below the right knob under Horizontal. Then Entry dialog box appear.
7. Input horizontal position to 0 s.
8. Click the box below the left knob under Vertical. Then Entry dialog box appear.
9. Input vertical scale to 100mV/div.
10. Click the below the right knob under vertical. Then Entry dialog box appear.
11. Input vertical scale to 200 mV.
12. Press **Marker Search** > **Target** > Target Value and enter “60 mUnits”.
13. Click **Return**.
14. Click **Tracking** to turn it on.
15. Select **Trace4**.
16. Click **Data Mem** and select **OFF**.
17. Repeat step15 to step16 for **Trace7** and **Trace8**.

6.3. Manual Setup for Frequency Domain Measurement

6.3.1. Channel and Trace Settings

1. Press **Display**.
2. Click **Allocate Channels** > 

.
3. Press **Channel Next**.
4. Click **Num of Traces** > **6**.
5. Click **Allocate Traces** > 

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6.3.2. Common Settings

1. Press **Sweep Setup** > **Sweep Type** > **Log Freq**.
2. Set **Points** to 201.
3. Press **Start** > Set start value to 10 MHz.
4. Press **Stop** > Set stop value to 8.1 GHz.
5. Press **Avg** > Set **IF Bandwidth** to 70 kHz.
6. Press **Analysis** > **Fixture Simulator** > **Fixture Simulator** 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**.

6.3.3. Power Sum Equal Level Far End Noise Measurement (Normative)

1. Select Trace1.
2. Press **Analysis**.
3. Click **Fixture Simulator** > **BalUn** and turn it **ON**.
4. Click **Measurement** > **Sdd21**.
5. Press **Format** > **Real**.
6. Press **Scale** > Set **Divisions** to 10.
7. Set **Scale/Div** to 5 dB/div.
8. Set **Reference position** to 10 Div.
9. Set **Reference Value** to 0 dB.
10. Press **Display** > **Equation Editor…** > Enter an equation "Single Aggressor=20*log10(mag(data))-20*log10(mag(mem(3)))"
11. Select Trace5.
12. Repeat from step 2 to step 9.
13. Press **Display** > **Equation Editor…** > Enter an equation

"DualAggressor=10*log10(mag(data)^2+mag(mem)^2)-20*log10(mag(mem(3)))"

6.3.4. Return Loss Measurement (Normative)

1. Select Trace2.
2. Press **Analysis**.
3. Click **Fixture Simulator** > **BalUn** and turn it **ON**.
4. Click **Measurement** > **Sdd11**.
5. Press **Scale** > Set **Divisions** to 10.
6. Set **Scale/Div** to 5 dB/div.
7. Set **Reference position** to 10 Div.
8. Set **Reference Value** to 0 dB.
9. Select Trace6.
10. Press **Analysis**.
11. Click **Fixture Simulator** > **BalUn** and turn it **ON**.
12. Click **Measurement** > **Sdd22**.
13. Repeat from step5 to step8.

6.3.5. Insertion Loss Measurement (Normative)

1. Select Trace3.
2. Press **Analysis**.
3. Click **Fixture Simulator** > **BalUn** and turn it **ON**.
4. Click **Measurement** > **Sdd21**.
5. Press **Scale** > Set **Divisions** to 10.
6. Set **Scale/Div** to 5 dB/div.
7. Set **Reference position** to 10 Div.
8. Set **Reference Value** to 0 dB.

6.3.6. Near End Noise Measurement

1. Select Trace4.
2. Press **Analysis**.
3. Click **Fixture Simulator** > **BalUn** and turn it **ON**.
4. Click **Measurement** > **Sdd21**.
5. Press **Scale** > Set **Divisions** to 10.
6. Set **Scale/Div** to 5 dB/div.
7. Set **Reference position** to 10 Div.
8. Set **Reference Value** to 0 dB.

6.4. Limit Test Settings

6.4.1. 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.

6.4.2. 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.

6.4.3. Defining the Limit Line

Set limit lines to perform pass/fail tests on the following measurement items.

1. Bulk Cable and Connector Impedance (Trace1, 5 in Channel1)
2. Insertion Loss (Trace3 in Channel2)
3. Return Loss (Trace2, 6 in Channel2)

   4. Near End Noise (Trace4 in Channel2)
   5. Power Sum Equal Level Far End Noise (Trace1, 5 in Channel2)

1. Press **Channel Next** key and **Trace Next** key to activate the trace on which limit lines should be set.
2. 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.

	Type	Begin Stimulus	End Stimulus	Begin Response	End Response
1	MAX	0 s	600 ps	105 U	105 U
2	MIN	0 s	600 ps	75 U	75 U
3					

3. Enter the limit line data following the tables below.
4. Click **Return**.
5. Click **Limit Line** and turn it **ON**.
6. Click **Limit Test** and turn it **ON**.
7. Repeat 1 to 6 for each Measurement items.

6.5. Calculating formula for Limit Line

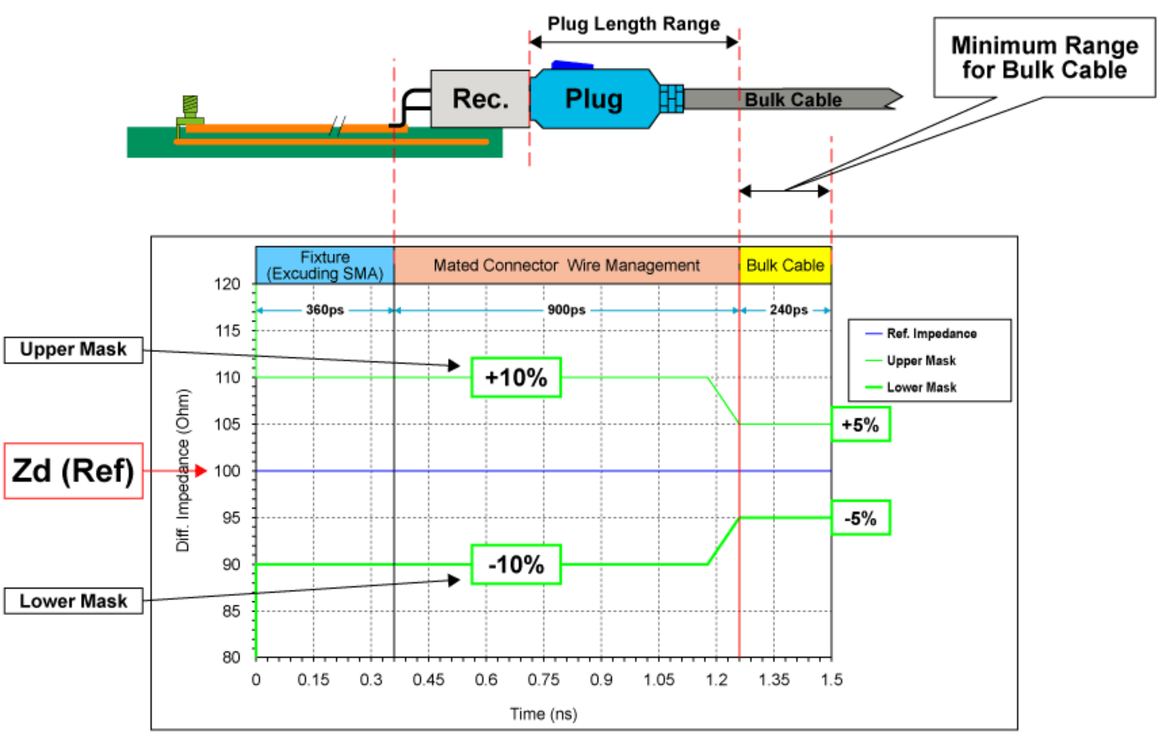
6.5.1. Bulk Cable and Connector Impedance

6.5.1.1. Impedance Profile

Impedance Profile Through Full-size Display Port Connector

Segment	**Differential Impedance Value**	**Maximum Tolerance**	**Comment**
Fixture	100 ohm	+-10 %	Fixture should have trace lengths of no

			more than 50 mm (2-inches)
Connector			
Wire management			Transition from +-10% to +- 5% must have a slope of 5 ohm/80ps
Cable		+-5 %	

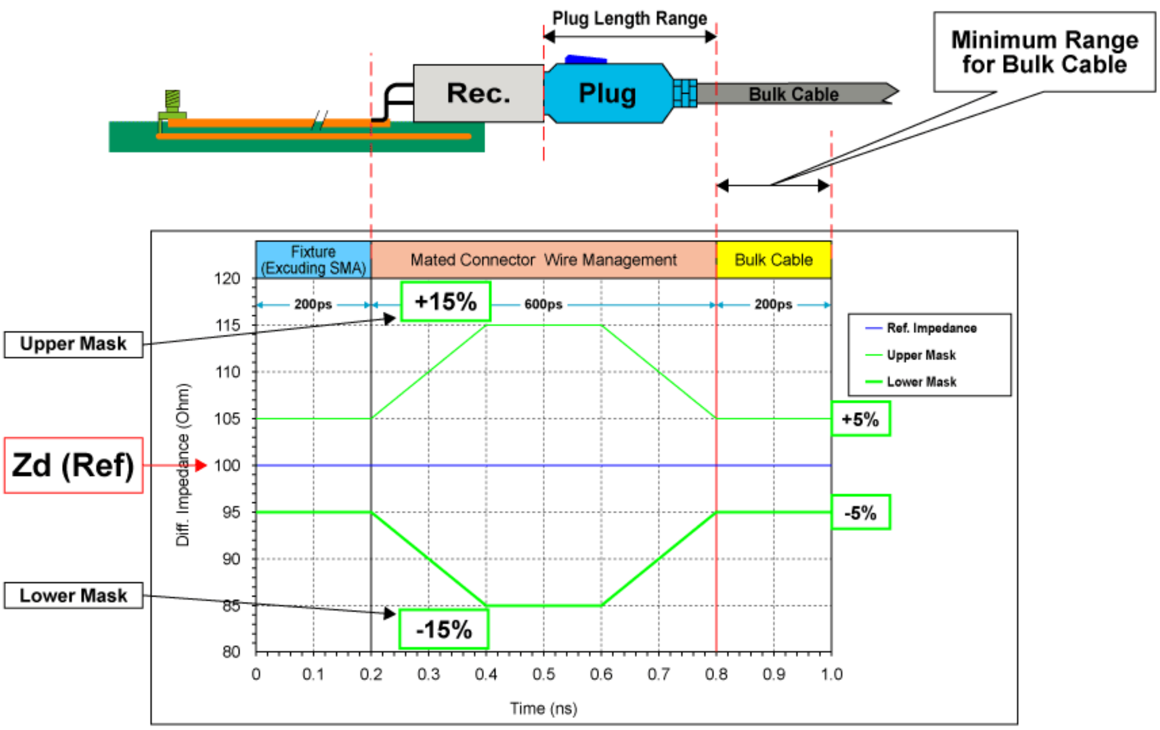


Impedance Profile Measurement Impedance Limits & Connector Profile Example

Impedance Profile Through Mini Display Port Connector

Segment	**Differential Impedance Value**	**Maximum Tolerance**	**Comment**
Fixture	100 ohm	+- 5 %	Fixture should have trace lengths of no more than 50 mm (2-inches)
Connector outside of exception window			Exception window peak duration of 200ps. Transition from +-15% to +-5%

Connector exception window		+-15 %	must have a slope of 1 ohm/200ps
Wire management		+-5 %	
Cable			



6.5.2. Insertion Loss

Insertion Loss Lower Limit for High Bit Rate Cable Assembly

$$IL_{\min}[dB] = \begin{cases} -8.7 \times \sqrt{\dfrac{f}{f_0}} - 0.072; & 0.1 < f \le \dfrac{f_0}{3} \\ 5.68\sqrt{f} - 5.3 * f - 6.52; & \dfrac{f_0}{3} < f \le 8.1 \end{cases}$$

Where:

f is given in GHz

f0 = 1.35*GHz*

Insertion Loss Lower Limit for High Bit Rate Resizing Adaptors

$$IL_{\min.}[dB]=\begin{cases} -1.6\times\sqrt{\frac{f}{f_0}}; & 0.1< f\le\frac{f_0}{3} \\ 1.75\sqrt{f}-1.65*f-1.31; & \frac{f_0}{3}< f\le 8.1 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35GHz$

Insertion Loss Lower Limit for Extension Cable

$$IL_{\min.}[dB]=\begin{cases} -5.22\times\sqrt{\frac{f}{f_0}}-0.043; & 0.1< f\le\frac{f_0}{3} \\ 3.41\sqrt{f}-3.18*f-3.91; & \frac{f_0}{3}< f\le 8.1 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35GHz$

Insertion Loss Lower Limit for Reduced Bit Rate Cable Assembly

$$IL_{\min.}[dB]=\begin{cases} -1-13.5\times\sqrt{\frac{f}{f_0}} & ;\ 0.01< f\le\frac{f_0}{3} \\ -2.1-[12(f-\frac{f_0}{3})+6.8] & ;\ \frac{f_0}{3}< f\le 4 \end{cases}$$

Where:

f is given in GHz

$f0 = 0.825GHz$

6.5.3. Return Loss

Return Loss Upper Limit for High Bit Rate Cable Assembly/Adaptor (full-size DP connector)

$$RL_{max.}[dB] = \begin{cases} -15; \quad 0.1 < f \le \dfrac{f_0}{2} \\ -15 + 12.3\,Log_{10}\left(\dfrac{2f}{f_0}\right); \quad \dfrac{f_0}{2} < f \le 8.1 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35GHz$

Return Loss Upper Limit for High Bit Rate Cable Assembly/Adaptor/Extension Cable (mini DP connector)

$$RL_{max.}[dB] = \begin{cases} -15; \quad 0.1 < f \le \dfrac{f_0}{2} \\ -15 + 12.3\,Log_{10}\left(\dfrac{2f}{f_0}\right); \quad \dfrac{f_0}{2} < f \le 8.1 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35GHz$

Return Loss Upper Limit Reduced Bit Rate Cable Assembly

$$RL_{max.}[dB] = \begin{cases} -15 & ; \quad 0.1 < f \le \dfrac{f_0}{2} \\ -15 + 12\,Log_{10}\left(2x\dfrac{f}{f_0}\right) & ; \quad \dfrac{f_0}{2} < f \le 4 \end{cases}$$

Where:

f is given in GHz

$f_0 = 0.8GHz$

6.5.4. Near End Noise

Near End Noise Upper Limit for High Bit Rate Cable Assembly

$$Isolation_{max.}[dB] = \begin{cases} -26 & ; \quad 0.1 < f \le f_0 \\ -26 + 15\,Log_{10}\left(\dfrac{f}{f_0}\right) & ; \quad f_0 < f \le 8.1 \end{cases}$$

Where:

f is given in GHz

$f_0 = 1.35GHz$

Near End Noise Upper Limit for Reduced Bit Rate Cable Assembly

$$Isolation_{max.}[dB] = \begin{cases} -26 & ; \quad 0.1 < f \le f_0 \\ -26 + 15\,Log_{10}\left(\dfrac{f}{f_0}\right) & ; \quad f_0 < f \le 4 \end{cases}$$

Where:

f is given in GHz

$f_0 = 0.8GHz$

6.5.5. Power Sum Equal Level Far End Noise

The Power Sum Equal Level Far End Noise specification applies to all cable assembly types. The Power Sum Equal Level Far End Noise represents the difference between cable insertion loss and the total power sum far end noise from aggressor cable lanes.

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

$$PSELFEN(f) = PSFEN(f) - IL(f)$$

Where:

$FENn(f)$ is the far-end noise in dB

$IL(f)$ is the victim lane insertion loss in dB

Power Sum Equal Level Far End Noise Upper Limit for High Bit Rate Cable Assembly

$$PSELFEN_{max.}[dB] = \begin{cases} -22 + 6Log_{10}\left(\frac{f}{f_0}\right); & 0.1 < f \le f_0 \\ -22 + 40Log_{10}\left(\frac{f}{f_0}\right); & f_0 < f \le 8.1 \end{cases}$$

Where:

f is given in GHz

$f_0 = 2.7GHz$

Power Sum Equal Level Far End Noise Upper Limit for Reduced Bit Rate Cable Assembly

$PSELFEN_{max}[dB] = -26$