Procedures Guide

Tektronix

HDMI Sink Instruments

Differential Impedance Measurement

Rev. 1.1: October 13, 2010

Measurement Procedures

Equipment Required

Table 1 lists the equipment required to perform the differential impedance measurement.

Table 1: Equipment required

Item	Qty.	Recommended equipment
Sampling oscilloscope	1 ea.	Tektronix TDS8200 (or DSA8200/TDS8000B/CSA8200)
TDR sampling module	1 ea.	Tektronix 80E04
50Ω SMA terminator (male)	6 ea.	Tektronix part number 015-1022-01
50Ω SMA terminator (female)	2 ea.	Tektronix part number 015-1021-00
50Ω SMA cable	2 ea.	HUBER+SUHNER SUCOFLEX 104PE, 1 meter length (typical)
TPA (test fixture)	1 ea.	Efficere Technologies EFF-HDMI-TPA-P , or Wilder Technologies TF-HDMI-TPA-P as an "Equivalent successor"

NOTE. *To protect the sampling module from damage due to electro-overstress (EOS) and electrostatic discharge (ESD), power off a device under test (DUT) to discharge the static voltage completely from it before performing the procedures.*

While performing the following procedures, be sure to wear a grounded antistatic wrist strap to discharge the static voltage from your body.

Front-Panel Buttons

Figure 1 shows the front-panel buttons on the TDS8200 used in the procedures.

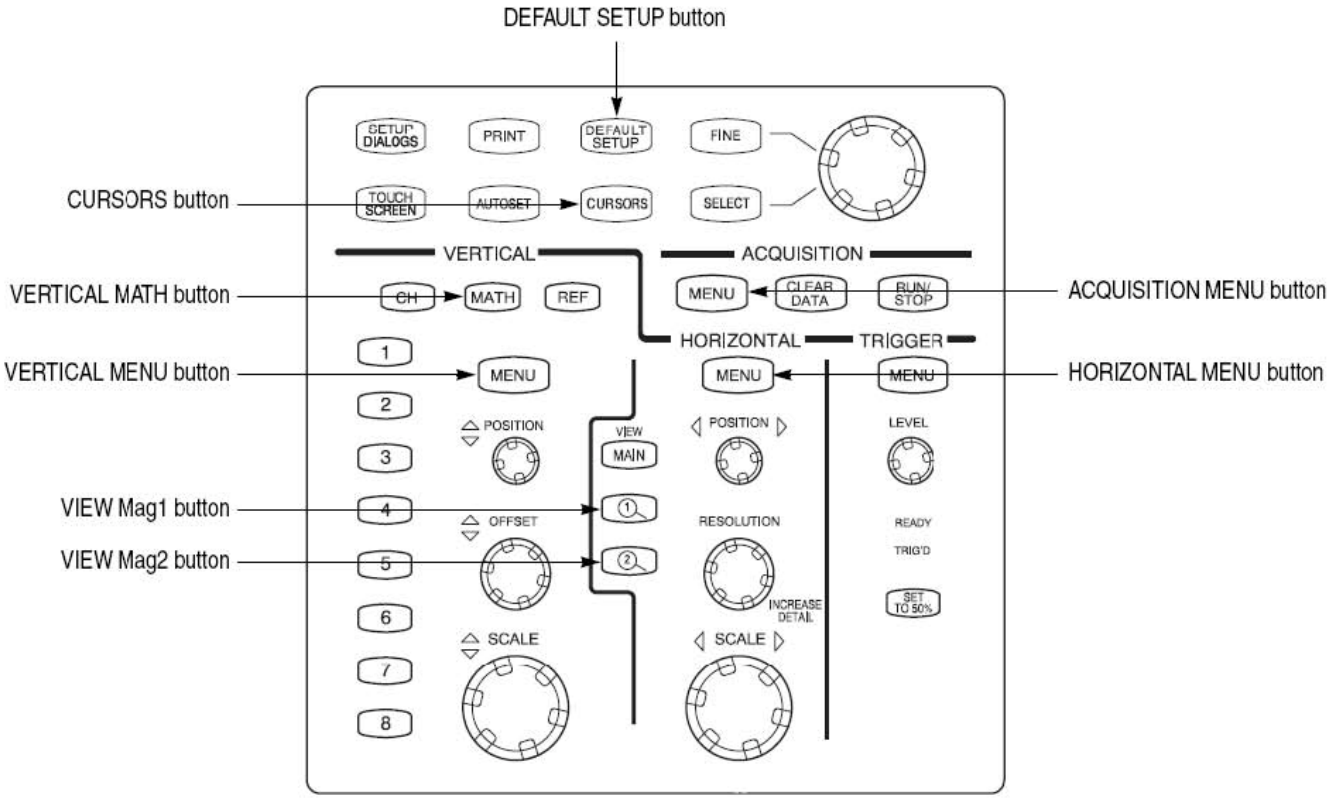

Figure 1 Front-panel buttons on the TDS8200

Equipment Connections

1. Use the 50 Ω SMA cable to connect the CH1 connector on the sampling module and the DATA0_P connector on the test fixture (see Figure 2).
2. Use the 50 Ω SMA cable to connect the CH2 connector on the sampling module and the DATA0_N connector on the test fixture (see Figure 2).
3. Use the 50 Ω SMA terminators (male) to terminate the unused connectors on the test fixture (see Figure 2).

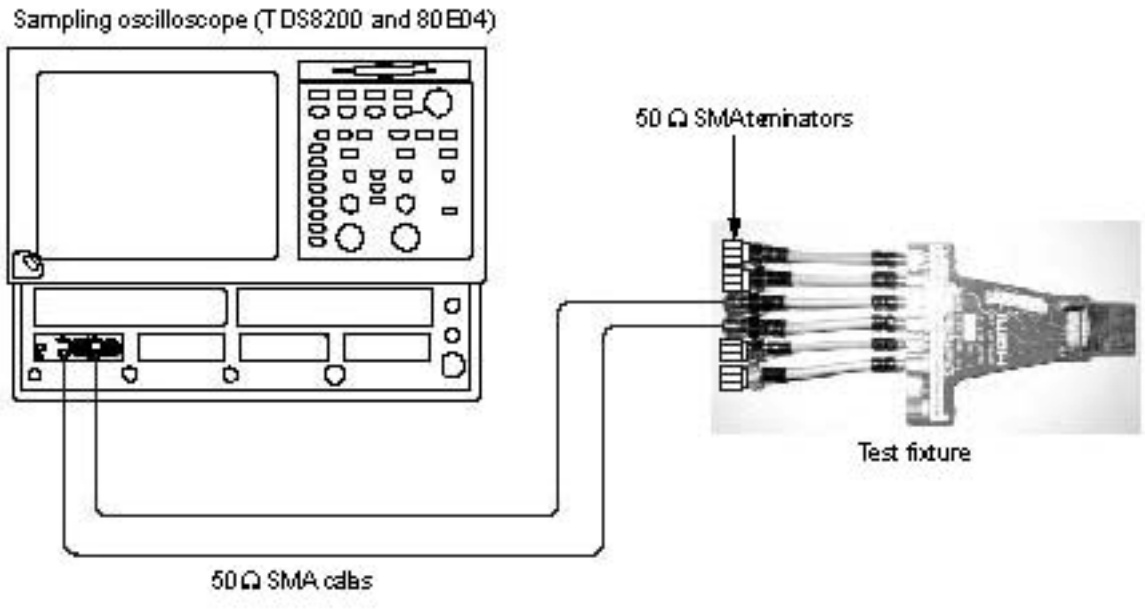

Figure 2 Initial equipment connections for the differential impedance measurement

Instrument Calibration

Instrument Compensation

1. Power on the instrument and wait 20 minutes for the warm-up period.
2. Select **Compensation…**.

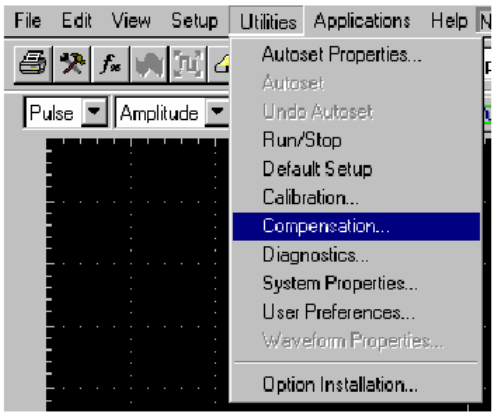

Figure 3 Utilities menu

3. Click the **Execute** button on the Compensation window.

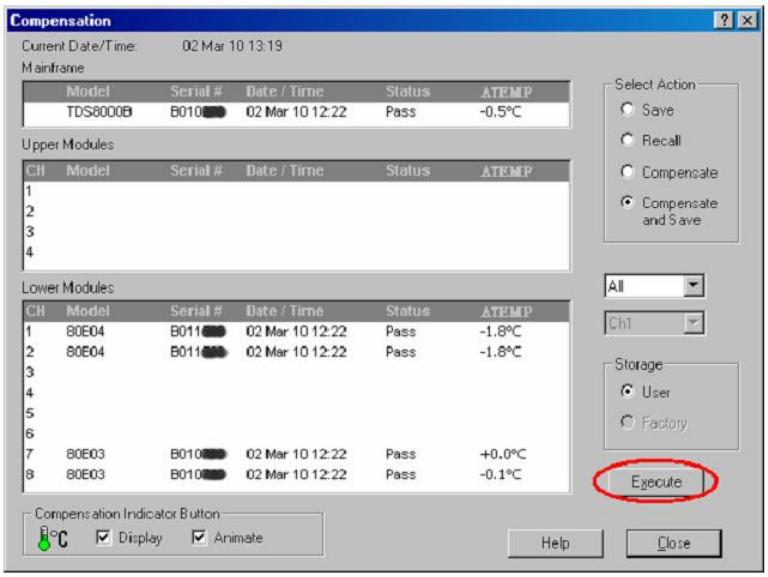

Figure 4 Compensation window

Skew Calibration

1. Output TDR step pulses from the sampling oscilloscope, and then set the oscilloscope so that both the TDR step pulses and waveforms at the open ends of the test fixture are displayed on the screen:
   a. Press the **DEFAULT SETUP** button, and then click **Yes**.
   b. Press the **ACQUISITION MENU** button to display the **Setups** window.
   c. Click **TDR** tab on **Setups** window.
   d. Click the **C1-C2 Diff** button on the **TDR** tab, and then set the **ACQ On Units** to Ω.
   e. On the **Vert** tab, select **C1** from the **Waveform** field, and then set the **SetupScale** to 10.00 Ω/div and **Position** to -5.000 div.
   f. On the **Vert** tab, select **C2** from the **Waveform** field, and then set the **Setup Scale** to 10.00 Ω/div and **Position** to -5.000 div.
   g. Click **Horz** tab on **Setups** window.
   h. Set Timebase Record Length to 4000.
2. Use the sampling oscilloscope Mag View feature to magnify the TDR step pulses and waveforms at the open ends of the test fixture in other windows:
   a. Press the **VIEW Mag1** button, and then use the **HORIZONTAL POSITION** knob and **HORIZONTAL SCALE** knob to display the TDR step pulses properly (see Figure 5).
   b. Press the **VIEW Mag2** button, and then use the **HORIZONTAL POSITION** knob and **HORIZONTAL SCALE** knob to display the waveforms at the open ends of the test fixture properly (see Figure 5).

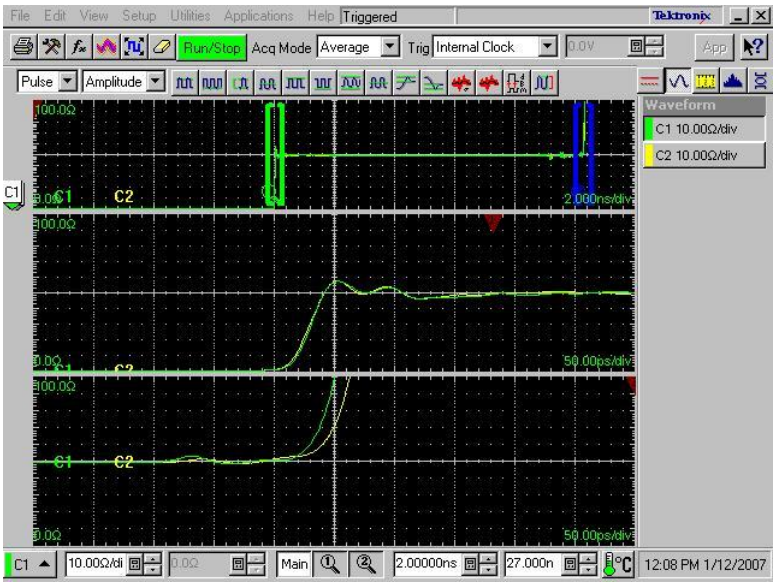

Figure 5 Magnifying the TDR step pulses and the waveforms at the open ends of the test fixture

3. If the **Setups** window is not displayed, press the **HORIZONTAL MENU** button.
4. Set the sampling oscilloscope so that the delay between the CH1 and CH2 can be measured in the magnified window:
   a. Press the **VIEW Mag1** button, and then click the **Meas** tab.
   b. Click the **Select Meas** button, and then select **Pulse-Timing** > **Delay**.
   c. Click **Source1**, and then select **Mag1 C1** on the **Source** tab.
   d. Click the **Region** tab, and then set **Edge Slope** to + and **Direction** to -->.
   e. Click **Source2**, and then select **Mag1 C2** on the **Source** tab.
   f. Click the **Region** tab, and then set **Edge Slope** to + and **Direction** to -->.
   g. Press the **VIEW Mag2** button, and then click the **Meas** tab.
   h. Select **Meas2**, and then click the **Select Meas** button and select **Pulse-Timing** > **Delay**.
   i. Click **Source1**, and then select **Mag2 C1** on the **Source** tab.
   j. Click the **Region** tab, and then set **Edge Slope** to + and **Direction** to -->.
   k. Click the **RefLevel** tab, and then select **Absolute**. Set **Mid** to 75 Ω.
   l. Click **Source2**, and then select **Mag2 C2** on the **Source** tab.
   m. Click the **Region** tab, and then set **Edge Slope** to + and **Direction** to -->.
   n. Click the **RefLevel** tab, and then select **Absolute**. Set **Mid** to 75 Ω.
5. Adjust step deskew so that the delay between the TDR step pulses is equal to the delay between waveforms at the open ends of the test fixture:
   a. Click the **TDR** tab, and then select **C2** in the **Step Deskew** drop-down list

box.

b. Adjust the readings of ① and ② in Figure 6 are about the same value by changing the **Step Deskew** value (see ③ in Figure 6).

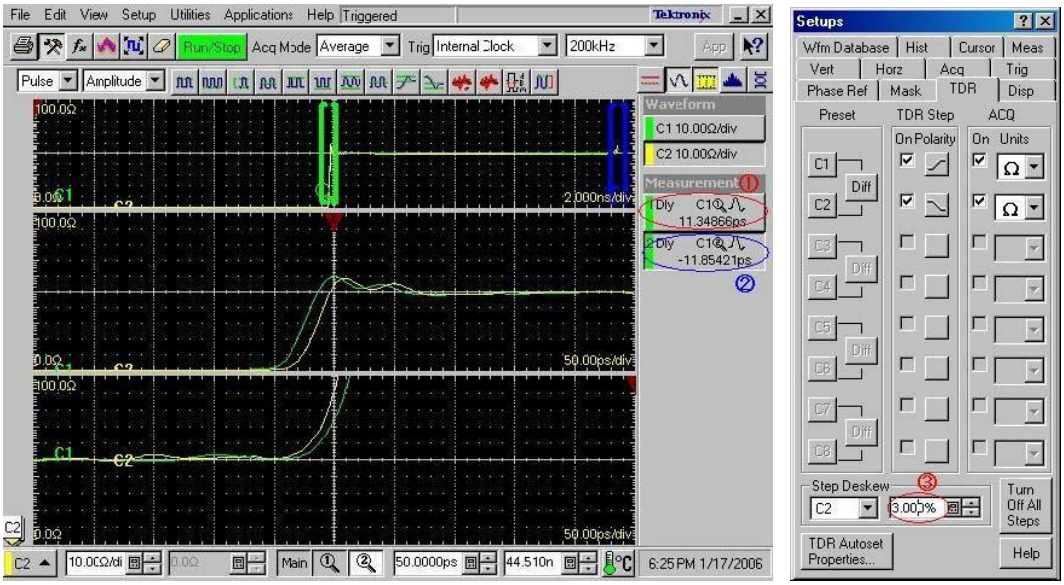

Figure 6 Adjusting the step deskew

6. Adjust deskew so that the delay between the waveforms at the open ends of the test fixture has the minimum value:

a. Click the **Vert** tab, and then select **Deskew**.

b. Adjust the deskew so that the reading of ② in Figure 6 has the minimum value by changing the Deskew value (see ④ in Figure 7).

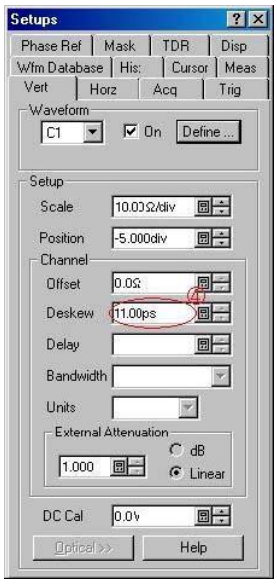

Figure 7 Changing the Deskew value

7. Turn off the Mag View feature (see Figure 8).

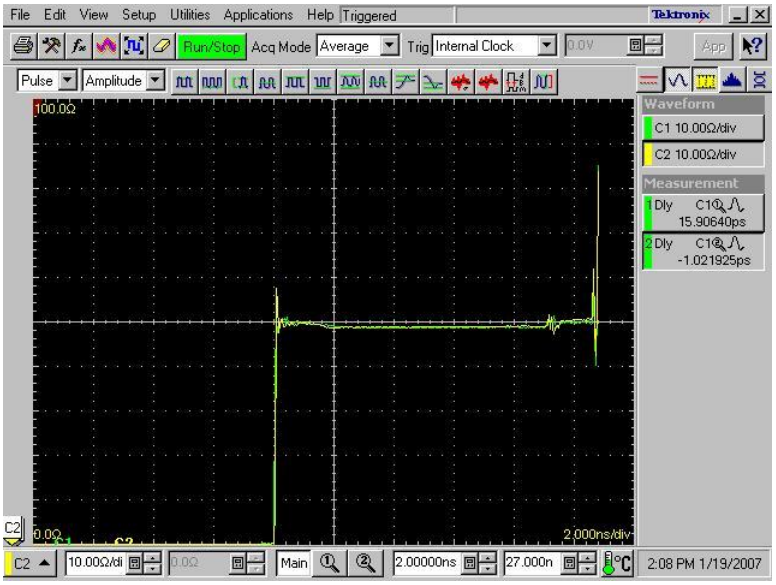

Figure 8 Screen image after turning off the Mag View feature

Setting Rise Time

1. Click the **TDR** tab, and then set **ACQ On Units** to **V**.
2. Define a math waveform:
   a. Press the **VERTICAL MATH** button, and then enter *Filter (C1-C2)* in the **Math Expression** field in the **Define Math** window.

b. Set **Filter Mode** to **Centered**.

c. Select the **Math Waveform On** check box, and then click **OK**.

d. Press the **VERTICAL MENU** button (if the Setups window is not displayed), and then click the **Vert** tab and select **M1**.

e. Set **Scale** to 100.0 mV/div and **Position** to -5.00 div.

3. Use the **HORIZONTAL SCALE** knob to set the horizontal scale to 200 ps/div.

4. Use the **HORIZONTAL POSITION** knob to display the math waveform at the center of the screen.

5. Set the sampling oscilloscope to measure the rise time of the waveform:

a. Press the **VERTICAL MENU** button (if the Setups window is not displayed), and then click the **Meas** tab.

b. Select **Meas3**, and then click the **Select Meas** button and select **Pulse-Timing** > **Rise Time**.

c. Click **Source1**, and then select **Main M1** on the **Source** tab.

6. Press the **VERTICAL MATH** button to display the **Define Math** window.

7. Adjust the rise time so that the reading of ⑤ in Figure 9 is 200 ps by changing the **Filter Risetime** value (see ⑥ in Figure 10). If you cannot adjust the value to 200 ps exactly, set it to the nearest value below 200 ps.

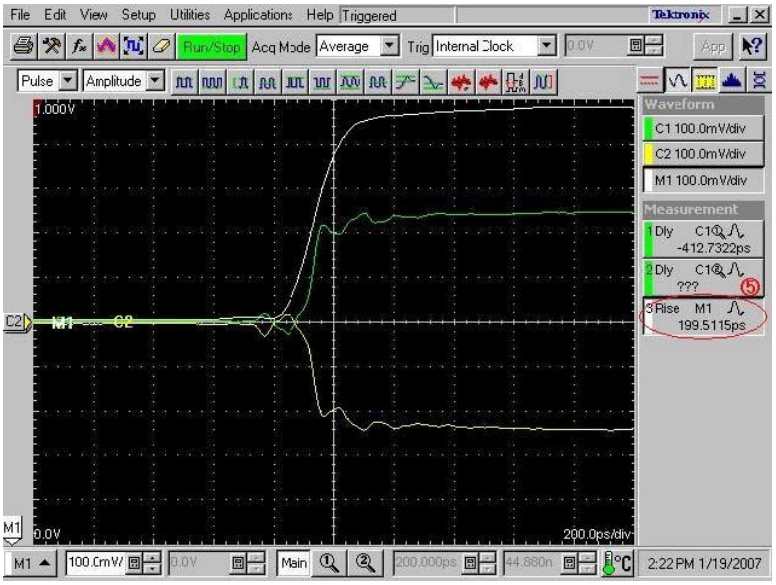

Figure 9 Adjusting the rise time

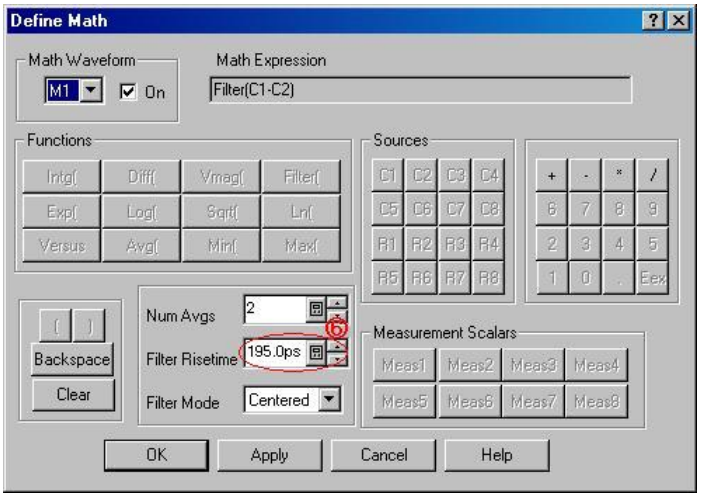

Figure 10 Changing the Filter Risetime value

Offset Calibration

1. Clear the **C1** and **C2** waveforms.
2. Press the **ACQUISITION MENU** button, and then click the **TDR** tab.
3. Set **ACQ On Units** to Ω.
4. Change the math waveform:
   a. Press the **VERTICAL MATH** button to display the **Define Math** window, and then click **Clear**.
   b. Change the math expression from *Filter (C1 – C2)* to *Filter (C1 +C2)* in the **Math Expression** field. **Filter Risetime** value is unchanged.
5. Press the **VERTICAL MENU** button.
6. Click the **Vert** tab, and then set **M1 Scale** to 10.00 Ω/div and **M1 Position** to -10.00 div.
7. Set the **HORIZONTAL SCALE** to 100 ps/div.
8. Adjust the **HORIZONTAL POSITION** knob so that the rising edge of the waveform is displayed at near 1 major division from the left edge of the screen (see Figure 11).

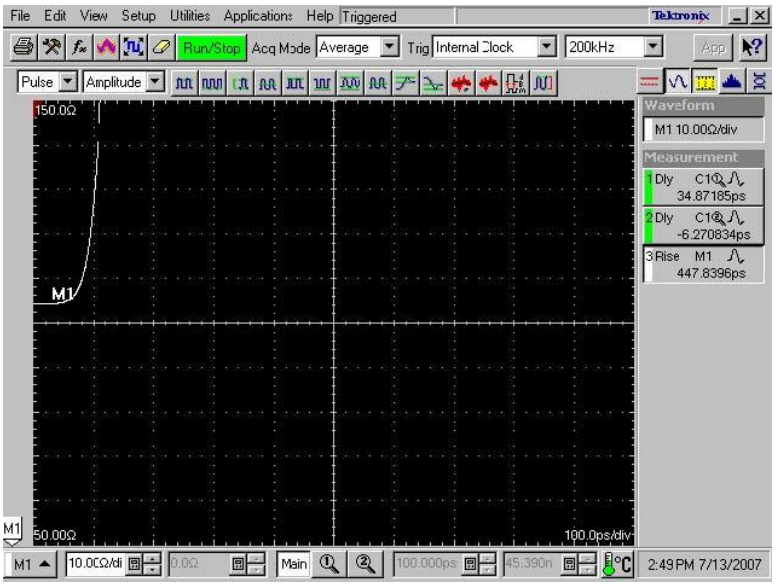

Figure 11 TDR rising edge waveform

9. Click **Horz** tab, and then Set **Horizontal reference** to 10.0%.
10. Click the **Meas** tab.
11. Select **Meas1**, and then click the **Select Meas** button and select **Pulse-Amplitude** > **Mean**.
12. Click **Source1**, and then select **M1** in the **Source** tab.
13. Disconnect the 50 Ω SMA cables from the test fixture.
14. Connect the 50 Ω SMA terminators (female) or airlines to the end of the 50 Ω SMA cables.
15. Measure the mean value of **M1** (see Figure 12).

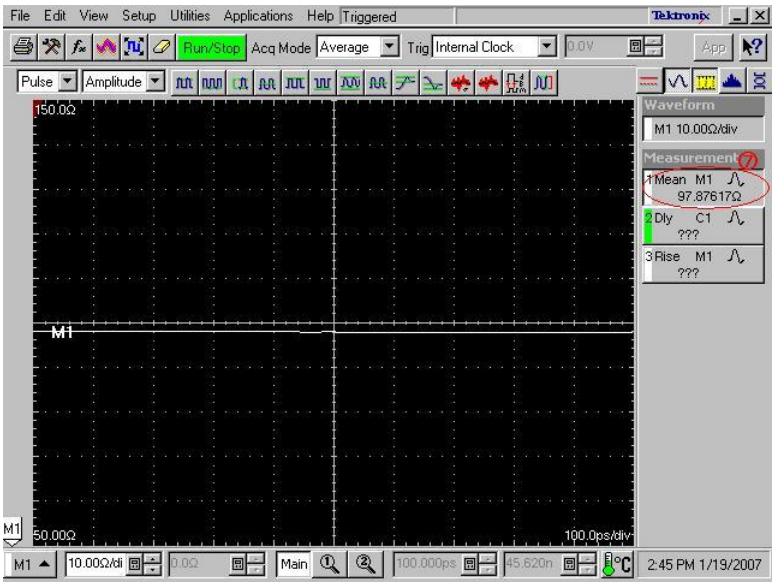

Figure 12 Measuring the M1 value

16. Press the **ACQUISITION MENU** button to display the **Math Expression** window.

17. Calculate the difference between 100 Ω and the value measured in step 15, and then enter the difference value in the **Math Expression** field. For instance, if the measured value is 97.8 Ω, enter *Filter (C1 + C2) + 2.2* in the field.

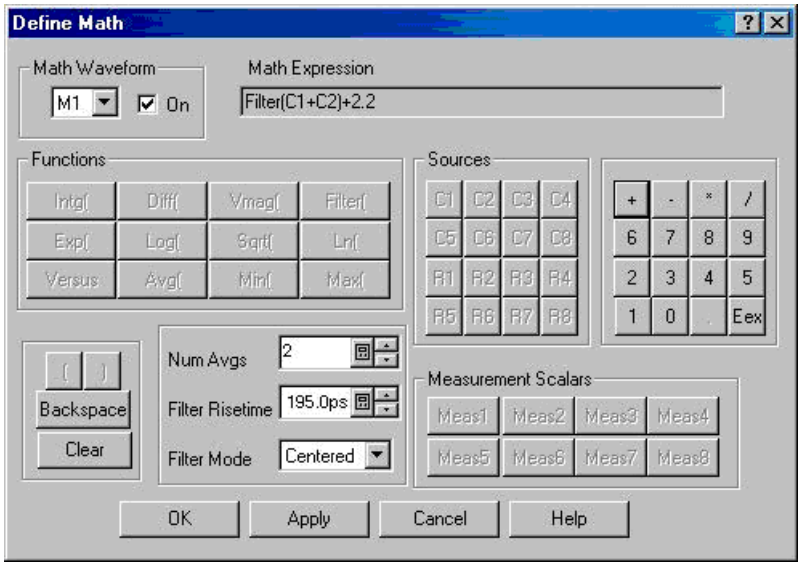

Figure 13 Entering the difference value

Defining Reference Waveform

Unfiltered impedance waveform needs to be defined in order to determine the horizontal reference position precisely during measuring differential impedance. This will reduce the impact of uncertainty on horizontal positioning caused by using the filtered impedance waveform.

1. Select **Math Waveform** to **M2**, and enter *C1+C2+<value of Offset compensation >* in the **Math Expression** field. (The offset compensation value corresponds to the measured value at step 15 in the Offset Calibration.)

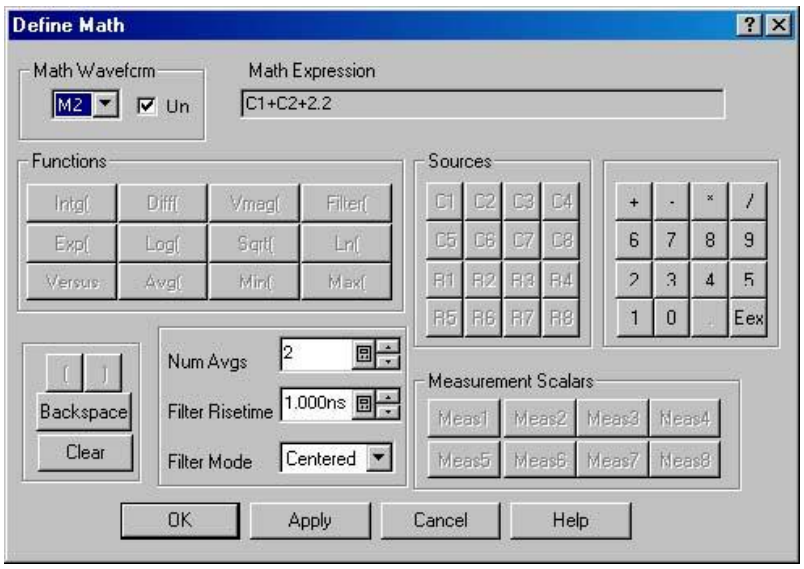

Figure 14 M2 Define Math

2. Press the **VERTICAL MENU** button (if the Setups window is not displayed), and click the **Vert** tab.
3. Set the **M1 Scale** to 10 Ω/div and **M1 Position** to -10 div.
4. Select **M1** in the **Waveform** drop-down list box on the **Vert** tab.
5. Set the **Waveform On** check box for **M1** to OFF in order to hide the filtered differential impedance waveform.
6. Set the **M2 Scale** to 10 Ω/div and **M2 Position** to -10 div.
7. Select **M2** in the **Waveform** drop-down list box on the **Vert** tab.
8. Set the **Waveform On** check box for **M2** to ON in order to show the unfiltered differential impedance waveform.

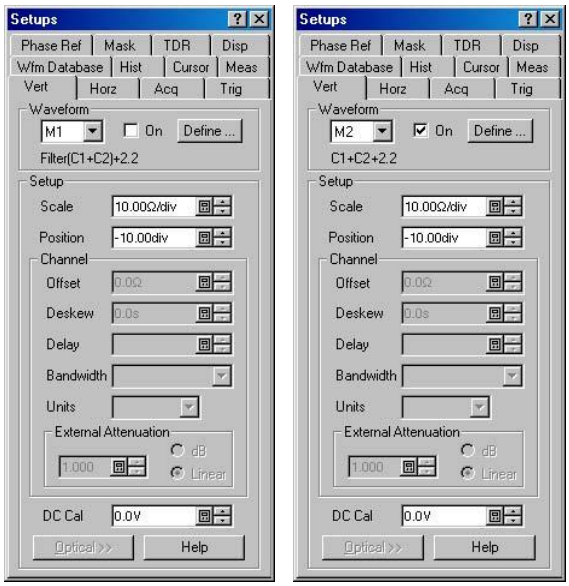

Figure 15 Setting filtered M1 to OFF, unfiltered M2 to ON

Setting Horizontal Position and Scale

If "Sink_Term_Distance" of the CDF is defined

I. If "Sink_Term_Distance" <= 150 ps (else go to step II in page 17)

1. Press the **HORZONTAL MENU** button.
2. Select the **MainTB** in **Timebase** field.
3. Set the **Scale** to 50.0 ps/div.
4. Set the **Horizontal Reference** to 30.0%.

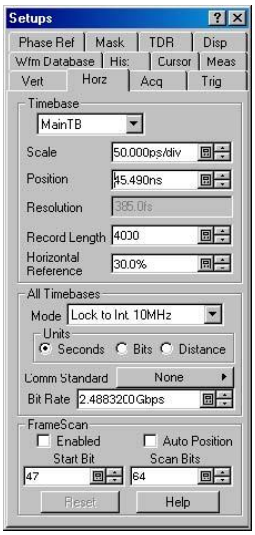

Figure 16 Horizontal Setups Window

5. Connect the test fixture to the HDMI connector on a DUT (see Figure 17).

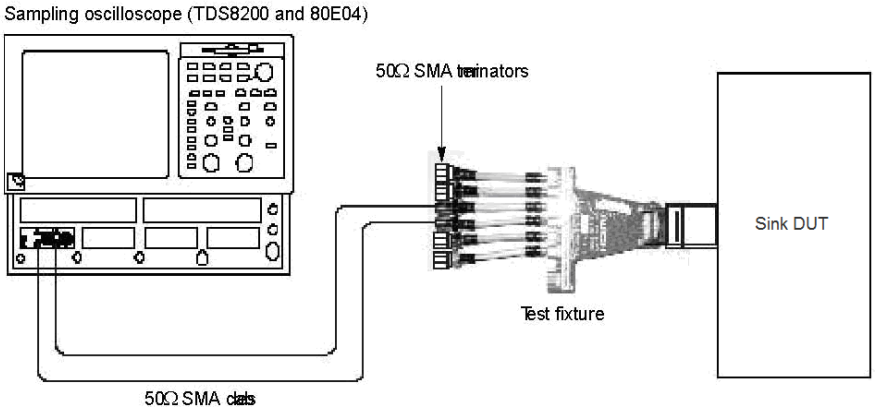

Figure 17 Connecting a Sink DUT to the test fixture

6. Adjust the **HORIZONTAL POSITION** knob so that a **M2** (unfiltered impedance) waveform peak of change point becomes 3 divisions from left (see Figure 18.).

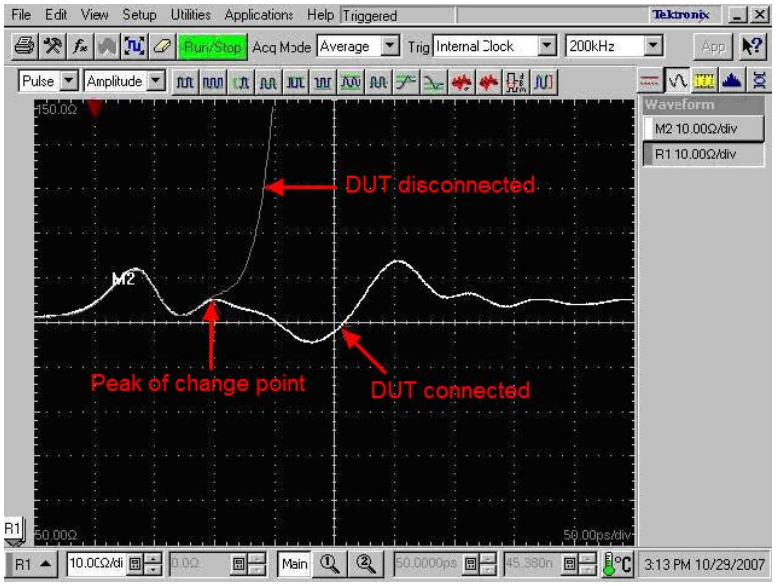

Figure 18 Adjust Horizontal Position

7. Press the **VERTICAL MENU** button.
8. Select **M1** in the **Waveform** drop-down list box on the **Vert** tab.
9. Set the **Waveform On** check box for **M1** to ON in order to show the filtered differential impedance waveform again.
10. Select **M2** in the **Waveform** drop-down list box on the **Vert** tab.
11. Set the **Waveform On** check box for **M2** to OFF in order to hide the unfiltered differential impedance waveform.

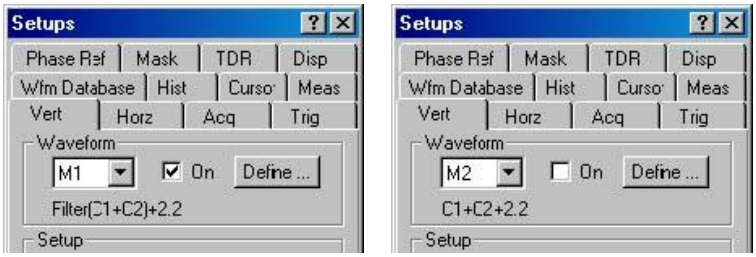

Figure 19 Setting filtered M1 to ON, unfiltered M2 to OFF

12. Go to “Measuring Impedance” in page 23.

II. If 150 ps < “Sink_Term_Distance” <= 600 ps (else go to Step III in page 19)

1. Press the **HORZONTAL MENU** button.
2. Select the **MainTB** in **Timebase** field.
3. Set the **Scale** to 100.0 ps/div.
4. Set the **Horizontal Reference** to 20.0%.

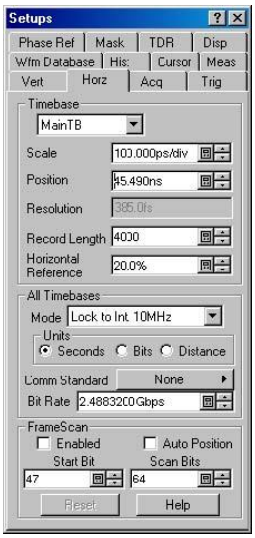

Figure 20 Horizontal Setups Window

5. Connect the test fixture to the HDMI connector on a DUT (see Figure 17).
6. Adjust the **HORIZONTAL POSITION** knob so that a **M2** (unfiltered impedance) waveform peak of change point becomes 2 divisions from left (see Figure 21).

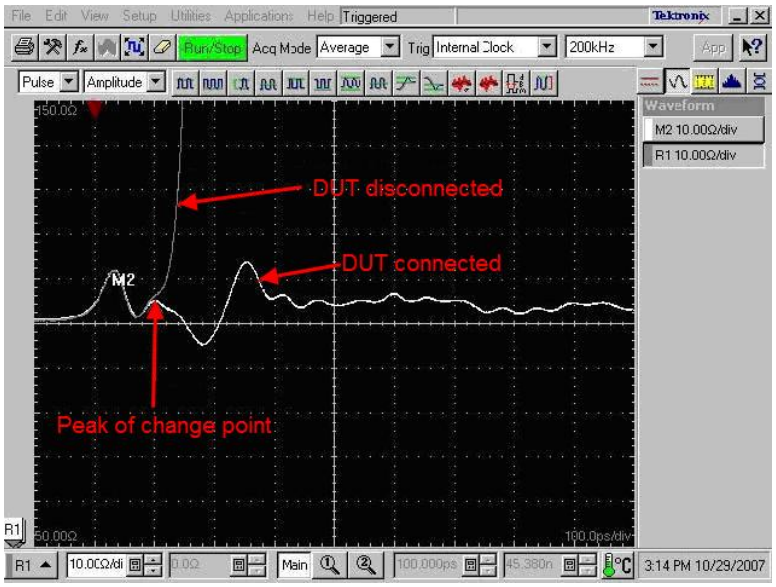

Figure 21 Adjust Horizontal Position

7. Press the **VERTICAL MENU** button.
8. Select **M1** in the **Waveform** drop-down list box on the **Vert** tab.
9. Set the **Waveform On** check box for **M1** to ON in order to show the filtered differential impedance waveform again.
10. Select **M2** in the **Waveform** drop-down list box on the **Vert** tab.

11. Set the **Waveform On** check box for **M2** to OFF in order to hide the unfiltered differential impedance waveform.

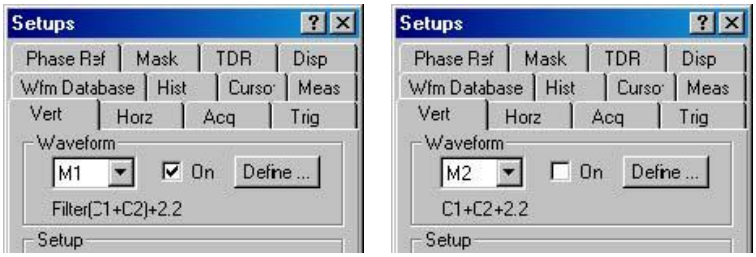

Figure 22 Setting filtered M1 to ON, unfiltered M2 to OFF

12. Go to "Measuring Impedance" in page 23.

III. If 600 ps < "Sink_Term_Distance"

1. Set the Horizontal scale and position.

a. Press the **HORZONTAL MENU** button.

b. Select the **MainTB** in **Timebase** field.

c. Set the **Scale** to 200.0 ps/div.

d. Set the **Horizontal Reference** to 10.0%.

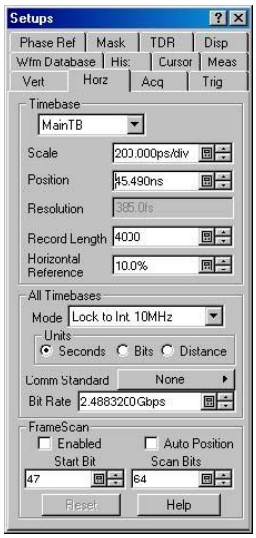

Figure 23 Horizontal Setups Window

e. Connect the test fixture to the HDMI connector on a device under test (DUT) (see Figure 17).

f. Adjust the **HORIZONTAL POSITION** knob so that a **M2** (unfiltered impedance) waveform peak of change point becomes 1 division from left (see Figure 24).

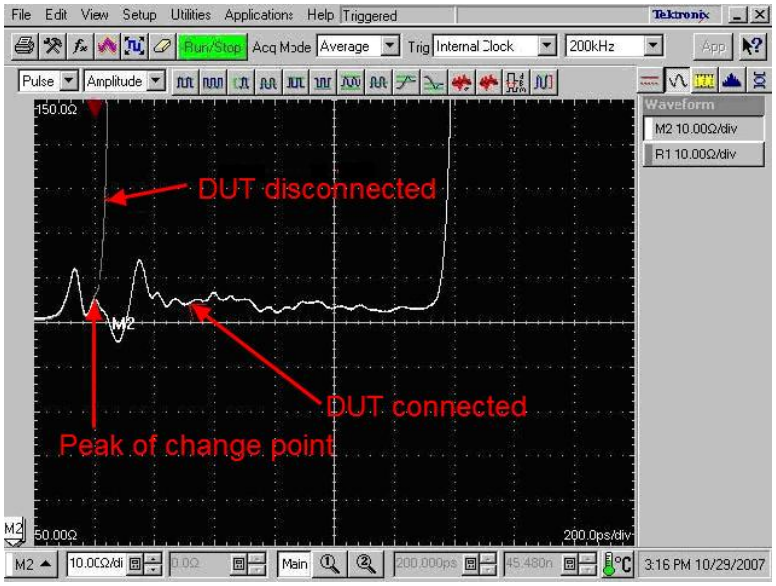

Figure 24 Adjust Horizontal Position

2. If "Sink_Term_Distance" <= 1.6 ns (else go to step 3)
   a. Go to step 6 in page 21.
3. If 1.6ns < "Sink_Term_Distance" <= 2.4 ns (else go to step 4)
   a. Press the **HORZONTAL MENU** button.
   b. Select the **MainTB** in **Timebase** field.
   c. Set the **Scale** to 300.0 ps/div.

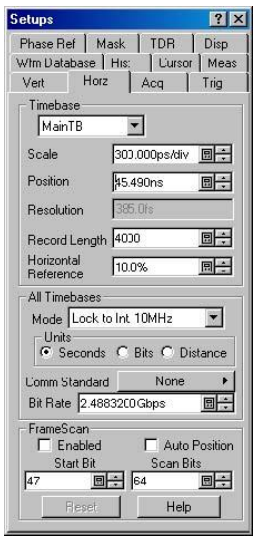

Figure 25 Horizontal Setups Window

   d. Go to step 6 in page 21.
4. If 2.4 ns < "Sink_Term_Distance" <= 4.0 ns (else go to step 5 in page 21)

a. Press the **HORZONTAL MENU** button.

b. Select the **MainTB** in **Timebase** field.

c. Set the **Scale** to 500.0 ps/div.

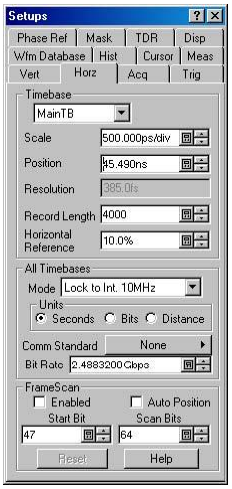

Figure 26 Horizontal Setups Window

d. Go to step 6 in page 21.

5. If 4.0 ns < "Sink_Term_Distance" <= 8.0 ns

a. Press the **HORZONTAL MENU** button.

b. Select the **MainTB** in **Timebase** field.

c. Set the **Scale** to 1.0 ns/div.

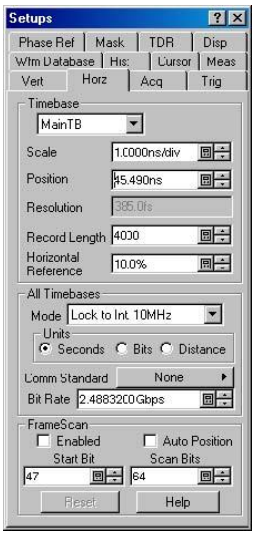

Figure 27 Horizontal Setups Window

6. Press the **VERTICAL MENU** button.

7. Select **M1** in **Waveform** drop-down list box on the **Vert** tab.

8. Set the **Waveform On** check box for **M1**to ON in order to show the filtered differential impedance waveform again.
9. Select **M2** in the **Waveform** drop-down list box on the **Vert** tab.
10. Set the **Waveform On** check box for **M2** to OFF in order to hide the unfiltered differential impedance waveform.

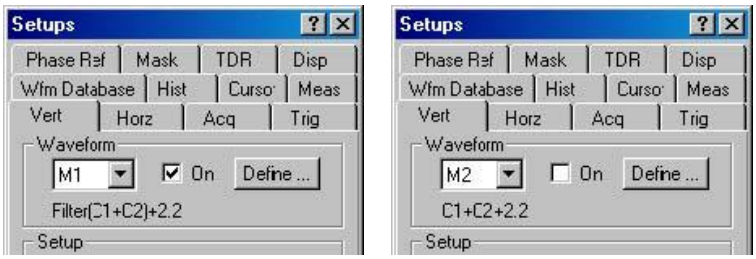

Figure 28 Setting filtered M1 to ON, unfiltered M2 to OFF

11. Go to “Measuring Impedance” in page 23.

If “Sink_Term_Distance of the CDF” is not defined

1. Connect the test fixture to the HDMI connector on a DUT (see Figure 17).
2. Set the **HORIZONTAL SCALE** to longer as waveform stabilizes.

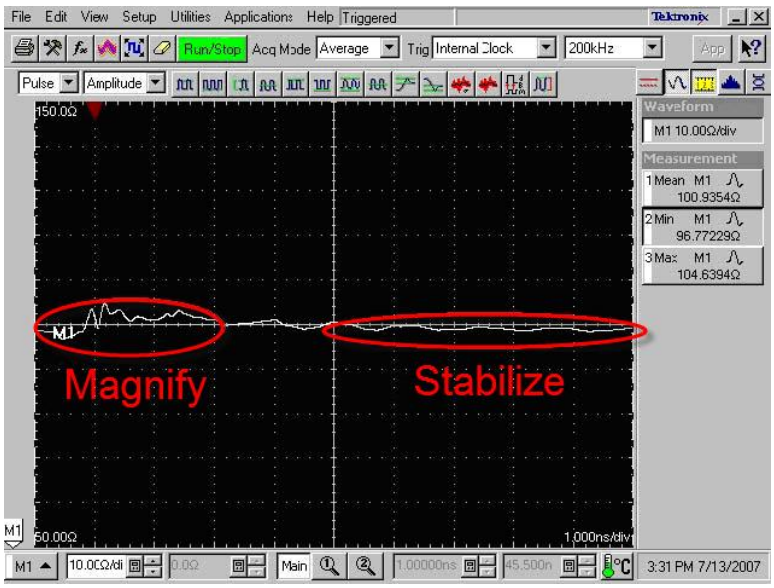

Figure 29 Waveform Stabilizes

3. Set the **HORIZONTAL SCALE** magnified before waveform stabilizes.

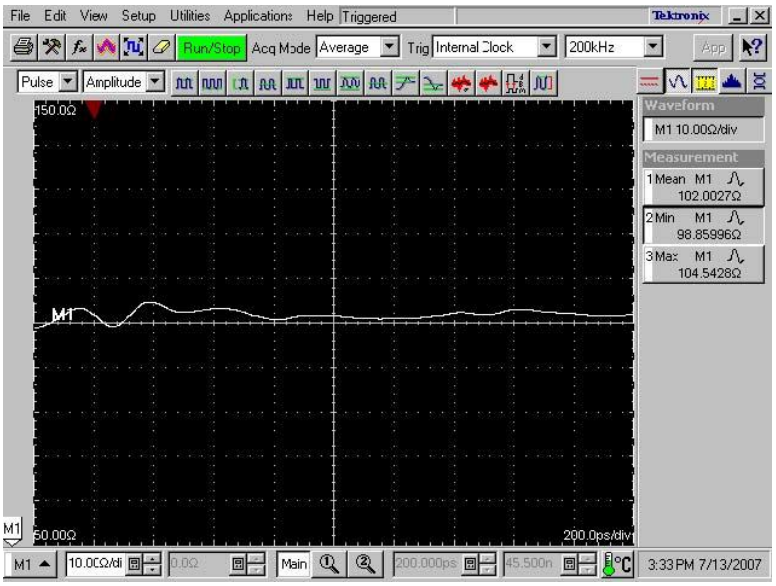

Figure 30 Magnified Waveform

Measuring Impedance

If "Sink_Term_Distance" of the CDF is defined

1. Set the Measurement tab.
   a. Press the **VERTICAL MENU** button, and then click the **Meas** tab.
   b. Select **Meas1**, and then click the **Select Meas** button and select **Pulse-Amplitude** > **Max**.
   c. Click **Source**, and then select **Main M1** on the **Source** tab.
   d. Click **Region**, and then select **Gate On** check box on the **Region** tab.
   e. Set **Gate G1** to same value of the **Horizontal Reference**.

      If "Sink_Term_Distance" <= 150 ps then set G1to30%.

      If 150 ps < "Sink_Term_Distance" <= 600 ps then set G1 to 20%.

      If 600 ps < "Sink_Term_Distance" then set G1to 10%.

   f. Set **Gate G2** to the calculated value of *G1+("Sink_Term_Distance" / Horizontal Scale * 10)*

      If "Sink_Term_Distance" = 800 ps then set G1 to 10% and G2 to 10+(800/200*10)=50%.

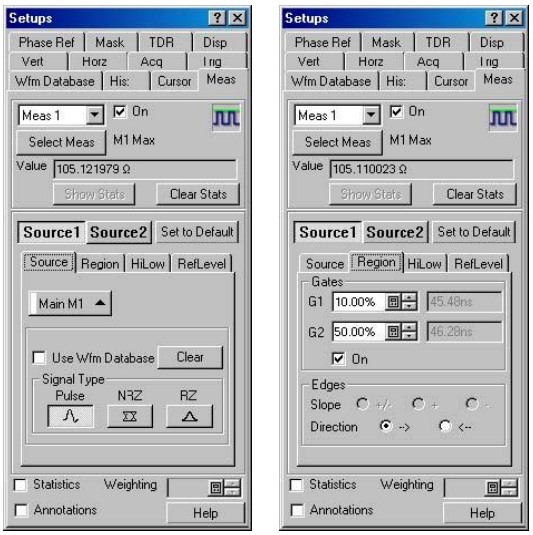

Figure 31 Set Meas1 to Max

g. Select **Meas2**, and then click the **Select Meas** button and select **Pulse-Amplitude** > **Min**.

h. Click **Source**, and then select **Main M1** on the **Source** tab.

i. Click **Region**, and then select **Gate On** check box on the **Region** tab.

j. Set **Gate G1** to same value of the **Horizontal Reference**.

k. Set **Gate G2** to the calculated value of *G1 + ("Sink_Term_Distance" / Horizontal Scale * 10)*

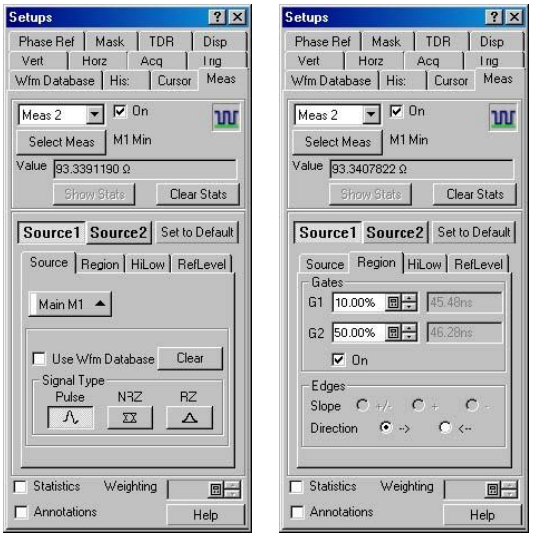

Figure 32 Set Meas2 to Min

l. Select **Meas3**, and then click the **Select Meas** button and select **Pulse-Amplitude** > **Means.**

m. Click **Source**, and then select **Main M1** on the **Source** tab.

n. Click **Region**, and then select **Gate On** check box on the **Region** tab.

o. Set **Gate G1** to same value of the **Horizontal Reference**.

p. Set **Gate G2** to calculated value of *G1 + ("Sink_Term_Distance" / Horizontal Scale * 10)*

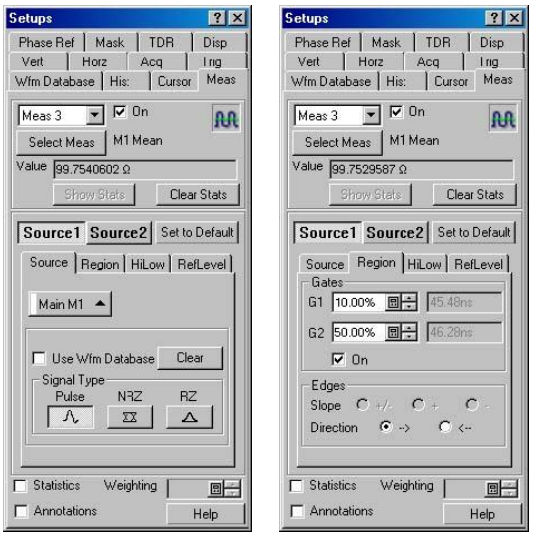

Figure 33 Set Meas2 to Mean

2. Set Cursor.

a. Click **Cursor** tab.

b. Press the **HORZONTAL MENU** button.

c. Select the **Horizontal Bars** in **Function** field.

d. Set the **Cursor1 Source** to **Main M1** and **Position** to 85 Ω.

e. Set the **Cursor2 Source** to **Main M1** and **Position** to 115 Ω.

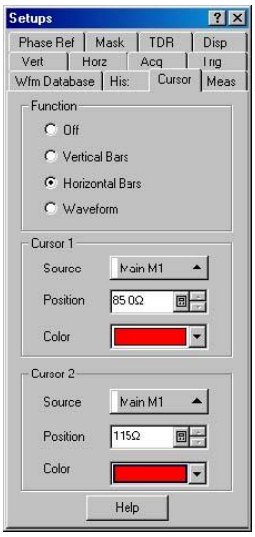

Figure 34 Cursor Setups Window

f. Measure the Max and Min value. (see Figure 35).

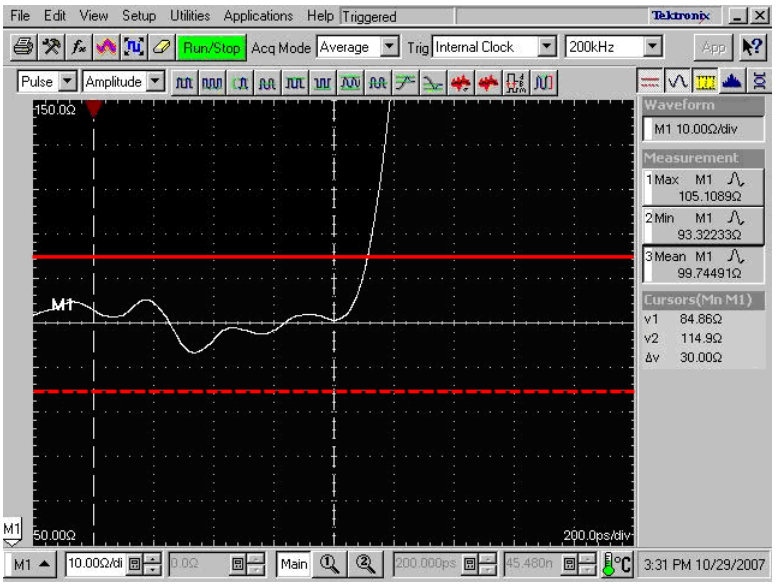

Figure 35 Measurement Result

3. Repeat step for all the TMDS lines.

If “Sink_Term_Distance” of the CDF is not defined

1. Display the horizontal cursors and align them to the 85 Ω and 115 Ω points on the impedance waveform:
   a. Press the **CURSORS** button twice to display the horizontal cursors.
   b. Use the multipurpose knob to adjust the reading value of v1 at the right side of the screen to 115 Ω.
   c. Press the **SELECT** button to toggle selection between the two cursors.
   d. Use the multipurpose knob to adjust the reading value of v1 at the right side of the screen to 85 Ω.

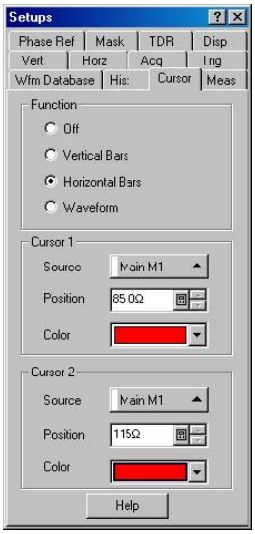

Figure 36 Cursor Setups Window

2. Use the automatic measurement feature to measure the Max and Min values of the impedance waveform. At this time, use the gating feature to specify the measurement area.
   a. Select **Pulse** and **Amplitude** from the pull-down menus in the measurement tool bar.
   b. Click **Max** and **Min** on the tool bar to specify the measurement items.
   c. Right-click **Max** in the measurement area at the left side of the screen to display the Setup dialog box for setting Max.
   d. On the **Region** tab, set the **G1** (Gate1) to **0** and **G2** (Gate2) to **50**, and then select the **On** check box.

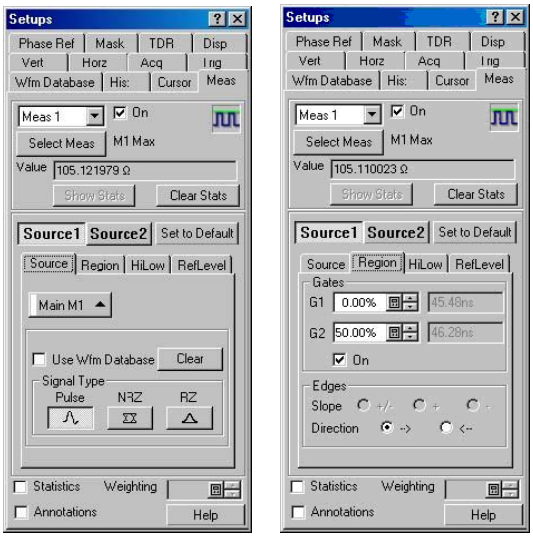

Figure 37 Set Meas1 to Max

e. Right-click **Min** in the measurement area at the left side of the screen to display the Setup dialog box for setting Min.

f. On the **Region** tab, set the **G1** to **0** and **G2** to **50**, and then select the **On** check box.

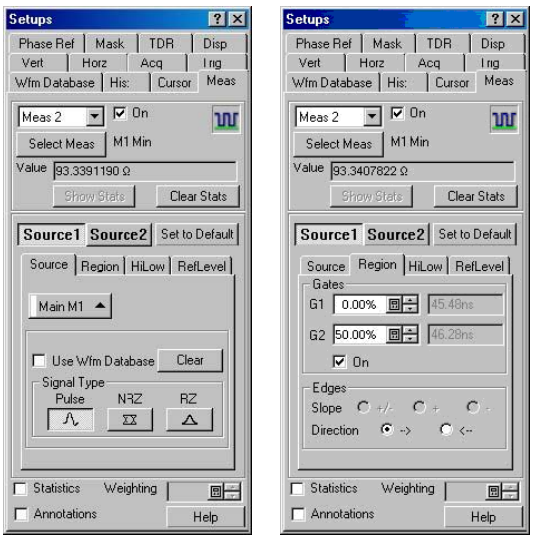

Figure 38 Set Meas2 to Min

g. When you select Max or Min in the Measurement area at the left side of the screen, each gate position is indicated by the vertical cursor.

h. Adjust the gates so that the measurement area is between the gates using a mouse.

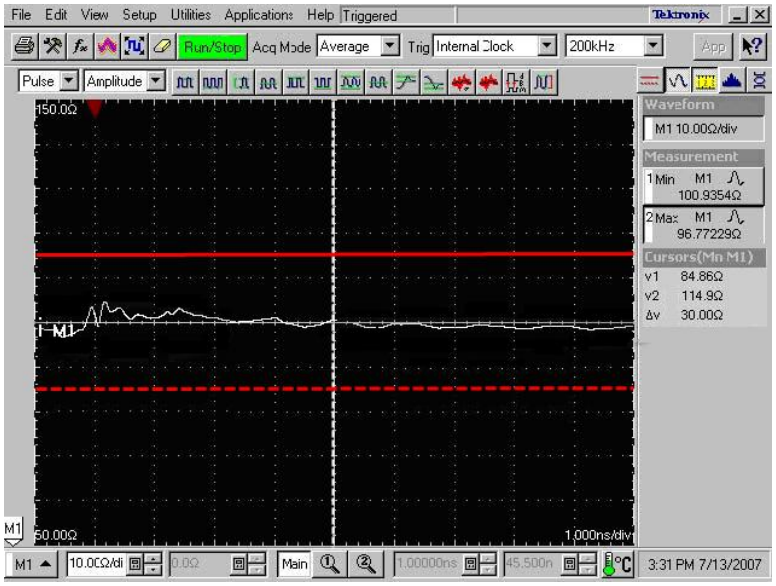

Figure 39 Measurement Result

I. When "Sink_Diff_PowerOn" field of the CDF is "Y":

1. Measure the impedance between the HDMI connector on the DUT and the receive IC pin. The measurement period (time width) is defined in the "Sink_Term_Distance" field of the CDF.

a. If the measurement value is less than or equal to 75 Ω, or more than or equal to 125 Ω, the differential lines being measured are Fail.

b. If an area that has the value less than or equal to 85 Ω or more than or equal to 115 Ω lasts for more than and equal to 250 ps, the differential lines being measured are Fail (even if an area that has the any of the above values lasts for less than or equal to 250 ps, if the area appears twice, the differential lines being measured are Fail).

c. If any of the above cases do not apply, the differential lines being measured are Pass.

II. When "Sink_Diff_PowerOn" field of the CDF is "N":

1. Measure the impedance between the HDMI connector on the DUT and the point that the impedance settles at the terminal impedance.

a. If the measurement value is less than or equal to 75 Ω, or more than or equal to 125 Ω, the differential lines being measured are Fail.

b. If an area that has the value less than or equal to 85 Ω, or more than or equal to 115 Ω, lasts for more than or equal to 250 ps, the differential lines being measured are Fail (even if an area that has the any of the above values lasts for or equal to 250 ps, if the area appears twice, the differential lines being measured are Fail).

c. If the terminal impedance is less than or equal to 75 Ω, or more than or equal

to125 Ω, the differential lines being measured are Fail.

d. If any of the above cases do not apply, the differential lines being measured are Pass.

2. Repeat step for all the TMDS lines.