

# **Procedures Guide**

## **Version 1.1**

**Tektronix**

### **Sink Devices**

## **Differential & Common Mode Impedance Measurement**

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# 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 DSA8300/DSA8200/TDS8000B/CSA8200)
TDR sampling module	1 ea.	Tektronix 80E04
50 $\Omega$ SMA terminator (female)	2 ea.	Tektronix part number 01 5-1 021-00
50 $\Omega$ SMA cable	2 ea.	HUBER+SUHNER SUCOFLEX 104PEA
Coaxial SMA Adapter	2 ea.	Pomona 4284 Coaxial Adapter
50 $\Omega$ DC BLOCK	2 ea.	MCL 15542 BLK-18 S+
TPA (test fixture)	1 ea.	Wilder Technologies MHL-TPA-P-WOSI, MHL-TPA-R-WOSO. Also available as TF-MHL-TPA-P-WOSI, TF-MHL-TPA-R-WOSO from Tektronix

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**OTE.** 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 Button

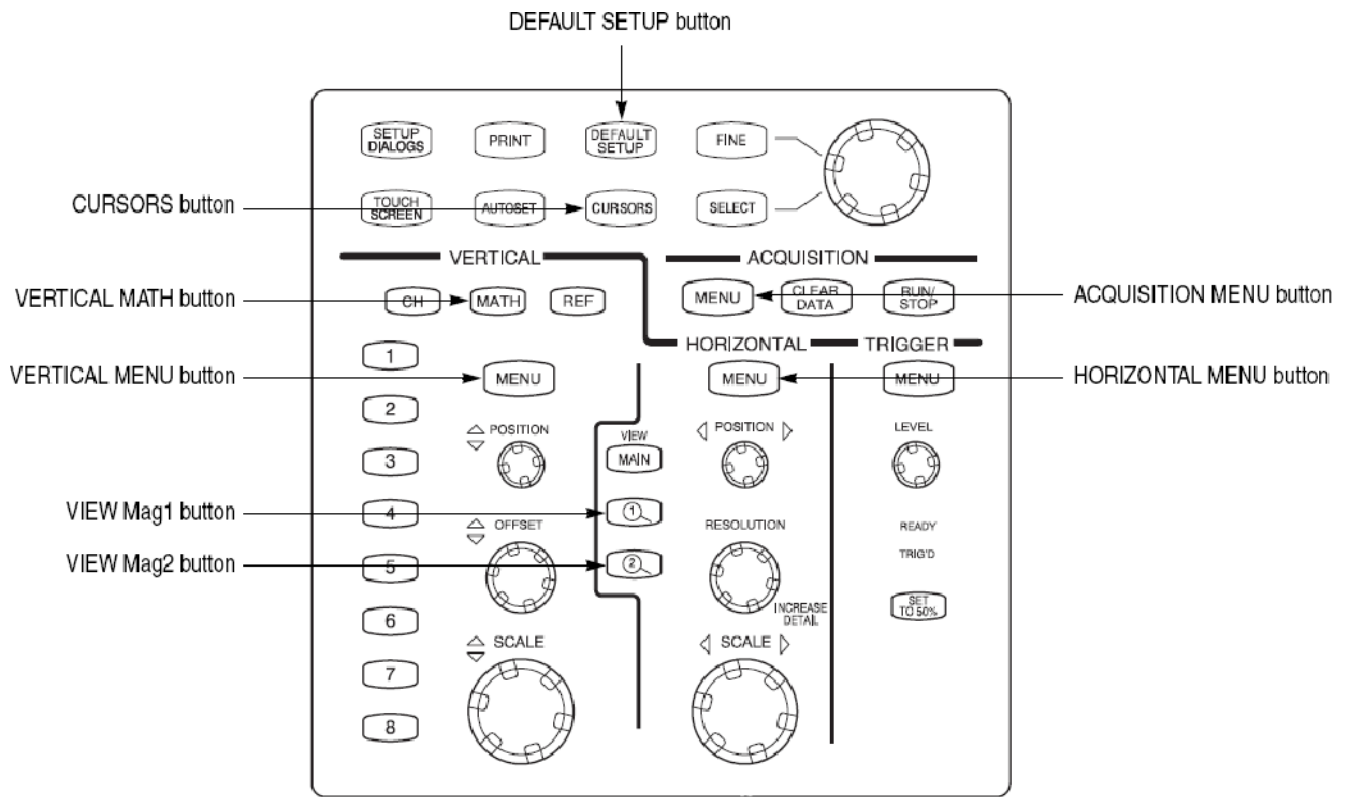


Figure 1: Front-panel buttons on the TDS8200

## Equipment Connections

1. Use DC block and 50Ohm SMA cable to connect the CH1 connector on the sampling module and the MHL + connector on the test fixture (see Figure 2).
2. Use DC block and 50 Ohm SMA cable to connect the CH2 connector on the sampling module and the MHL- connector on the test fixture (see Figure 2).

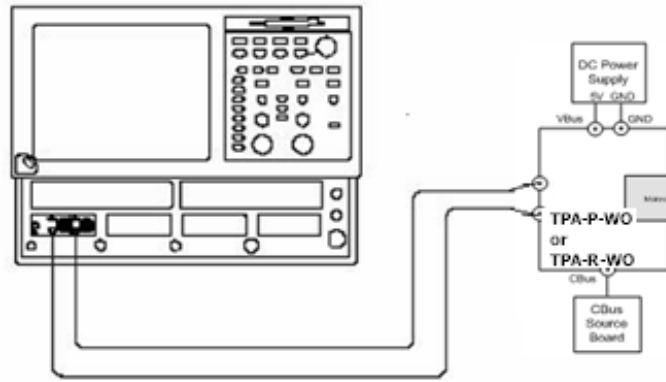


Figure 2: Initial equipment connections for the differential impedance measurement using the TF-MHL-TPA-P-WOSI

## 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 Ohm  $\Omega$ .
  - e. On the **Vert** tab, select **C1** from the **Waveform** field, and then set the **Setup Scale** to 10.00ohms/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 ohms/div and **Position** to -5.000 div.
  - g. Click **Horz** tab on **Setups** window.
  - h. Set **Time base Record Length** is **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 3).
  - 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 3).

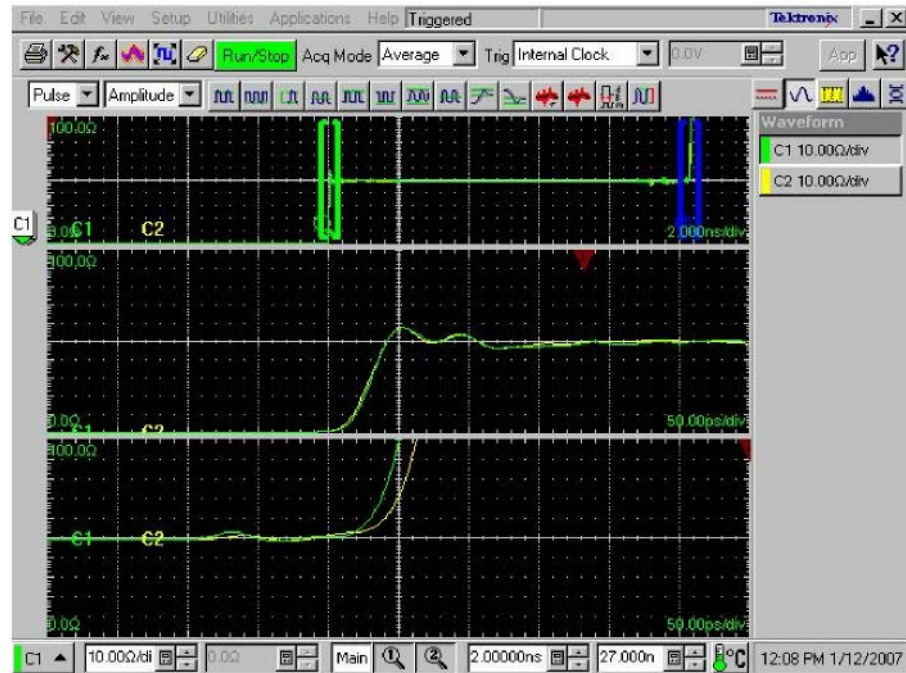


Figure 3: Magnifying the TDR step pulses and the waveforms at the open ends of the test fixture

3. If the Setup 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 7 Ohms/div 5.
  - 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 Ohms/div.
5. Adjust step skew 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 Des skew** drop-down list box.
  - b. Adjust the readings of ① and ② in Figure 4 are about the same value by changing the **Step Des skew** value (see ③ in Figure 4).

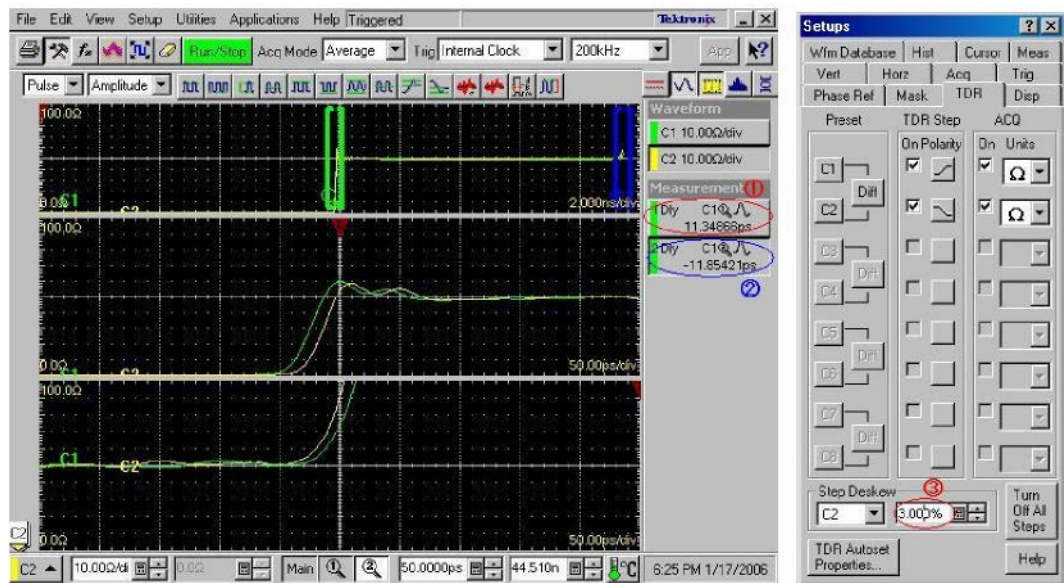


Figure 4: Adjusting the step skew

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 4 on page 6 has the minimum value by changing the Deskew value (see ④ in Figure 5).
  - c. Record Skew values for use with Differential measurements

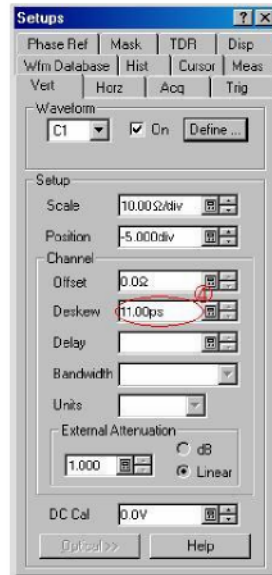


Figure 5: Changing the Deskew value

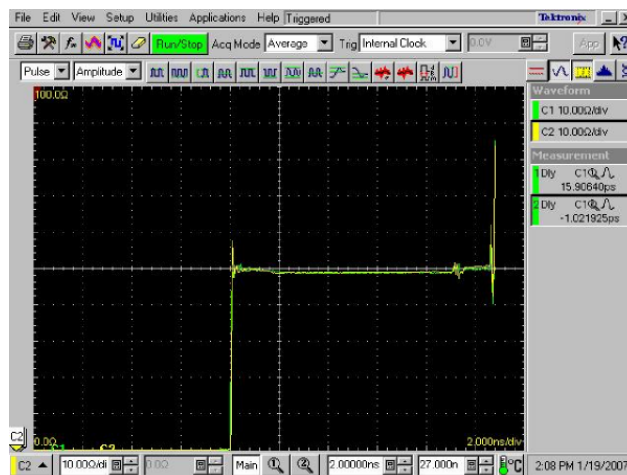


Figure 6: Screen image after turning off the Mag View feature

7. Turn off the Mag View feature (see Figure 6).
8. Set the Ch2 TDR pulse to positive and repeat steps 1 through 7 for Common mode deskew. Record values for use with common mode measurements.

## Setting the Rise Time

1. Click the **TDR** tab, and then set **ACQ on Units** to **V**.
  - a. Differential mode: Opposite Polarity of CH1 & CH2
  - b. Common mode: Same Polarity of CH1 & CH2
2. Define a math waveform:
  - a. **Differential mode**: Press the **VERTICAL MATH** button, and then enter **Filter (CH1-CH2)** in the **Math Expression** field in the **Define Math** window.
  - b. **Common mode**: Press the **VERTICAL MATH** button, and then enter **Filter (CH1+CH2)/2** in the **Math Expression** field in the **Define Math** window.
  - c. Set **Filter Mode** to **Centered**.
  - d. Select the **Math Waveform On** check box and then click **OK**.
  - e. Press the **VERTICAL MENU** button (if the Setups window is not displayed), and then click the **Vert** tab and select **M1**.
  - f. 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 **500ps/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.
  - d. Set **RefLevel** to **Relative** with **Reference Hi-Lo** to **80%-20%** respectively
6. Press the **VERTICAL MATH** button to display the **Define Math** window.



- For **Differential mode**, adjust the rise time so that the reading of ⑤ in Figure 7 is 200 ps by changing the **Filter Risetime** value (see ⑥ in Figure 8). If you cannot adjust the value to 200 ps exactly, set it to the nearest value below 200 ps.

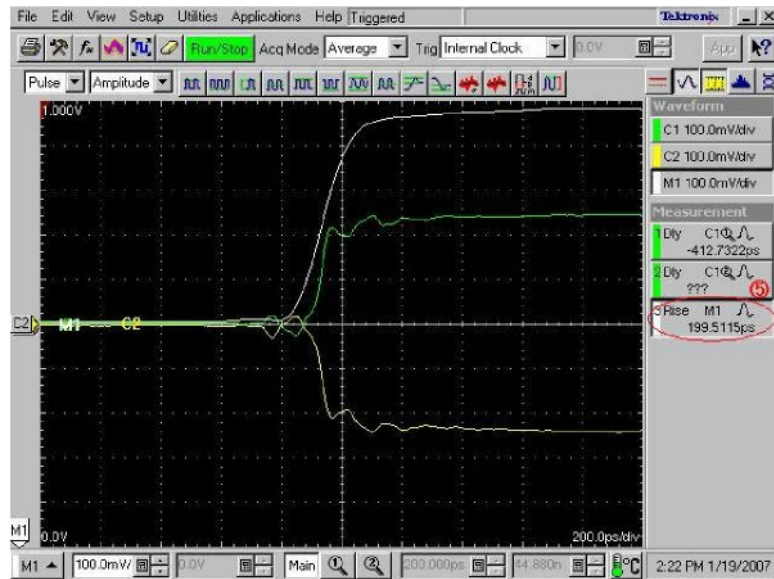


Figure 7: Adjusting the rise time

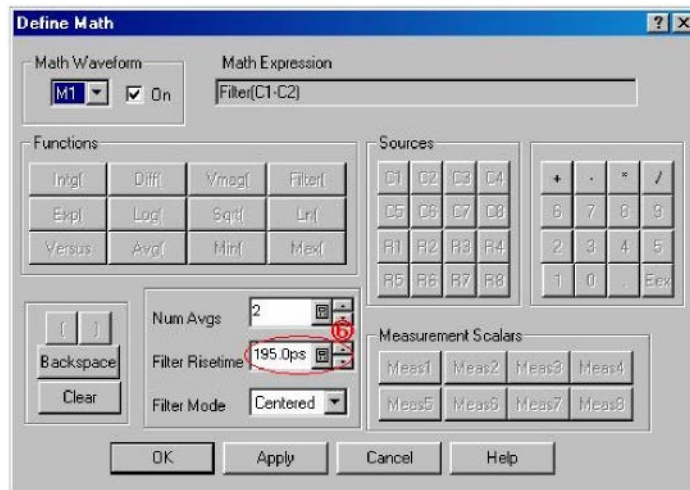


Figure 8: Changing the Filter Risetime value

- For **Common mode**, adjust the rise time so that the reading of ⑤ in Figure 7 is 600 ps by changing the **Filter Risetime** value (see ⑥ in Figure 8). If you cannot adjust the value to 600 ps exactly, set it to the nearest value below 600 ps.

## 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 Ohm
4. Change the math waveform:
  - a. Press the **VERTICAL MATH** button to display the **Define Math** window, and then click **Clear**.
  - b. **Differential mode**: Enter **Filter (CH1 +CH2)** in the **Math Expression** field.
  - c. **Common mode**: Enter **Filter (CH1 +CH2)/4** in the **Math Expression** field.
5. Press the **VERTICAL MENU** button.
6. Click the **Vert** tab, and then set **M1 Scale** to **10.00** Ohms/div and **M1 Position** to **-10.00** div or until the trace is about the middle of the display.
7. Set the **HORIZONTAL SCALE** to 500ps/div.
8. Adjust the **HORIZONTAL POSITION** knob so that the rise-time waveform is displayed at near 1 major division from the left side of the screen (see Figure 9).

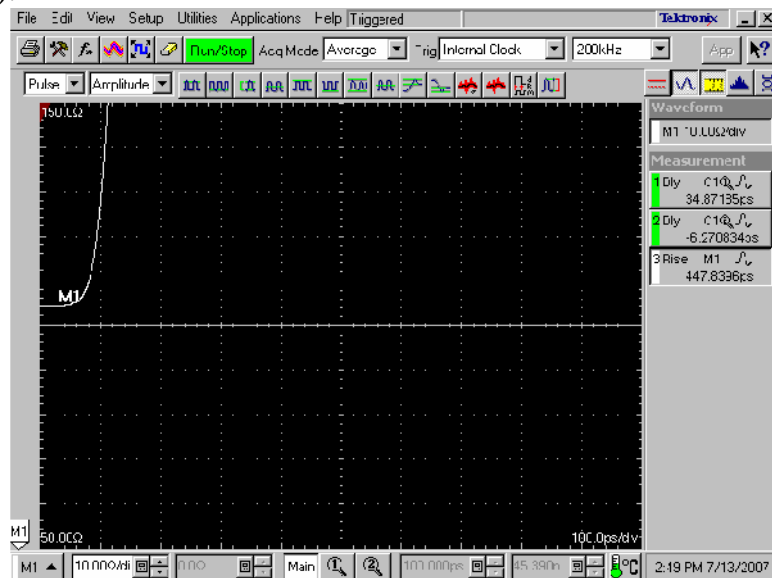


Figure 9: TDR rise-time waveform

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 test fixture from the 50Ω SMA cables.
14. Connect the 50Ω SMA terminators (female) or airlines to the end of the 50Ω SMA cables.

15. Measure the mean value of M1 (see Figure 10).

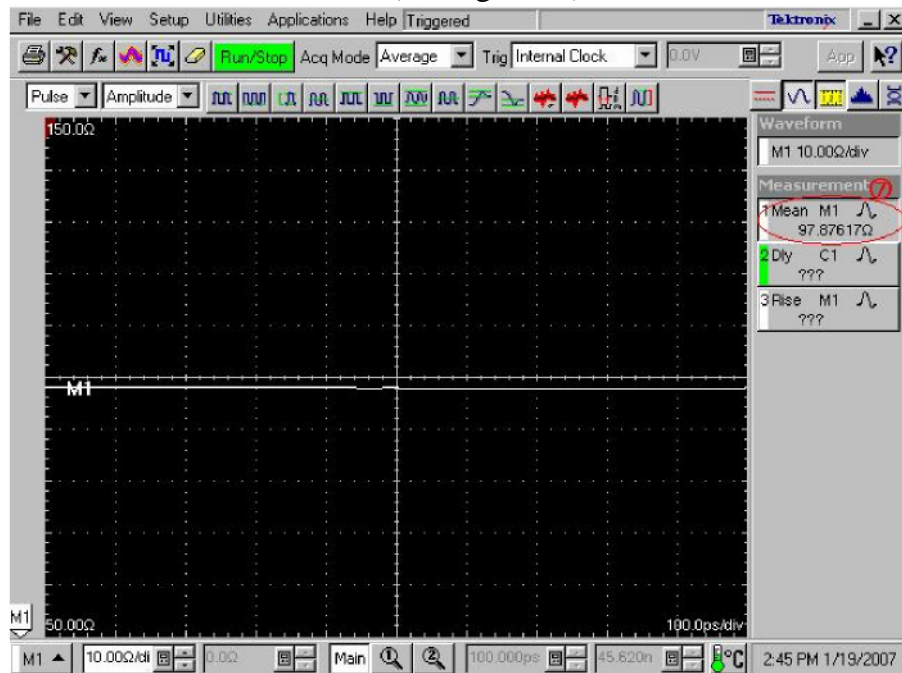


Figure 10: Measuring the M1 value

16. Press the **ACQUISITION MENU** button to display the **Math Expression** window as shown in Figure 11
17. Calculate the difference between 100 Ω and the value measured in step 16, and then enter the difference value in the **Math Expression** field. For instance, if the measured value is 97.8Ω, enter Filter (C1+C2) +2.2 in the field. For common mode measurements repeat steps 11 through 17 only calculate the difference between 25 and the measured value.

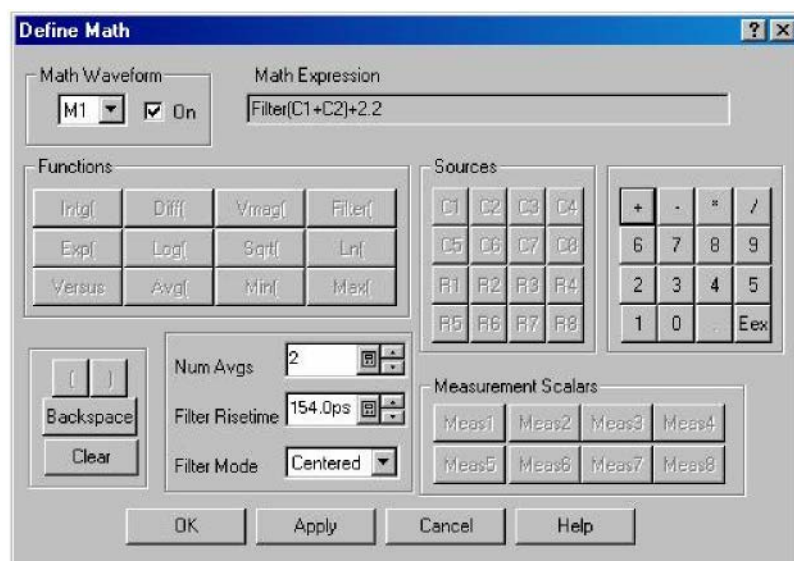


Figure 11: Entering the difference value

18. Press the **VERTICAL MENU** button (if the Setups window is not displayed), and click the **Vert** tab.
19. Set the **M1 Scale** to 10 $\Omega$ /div and **M1 Position** to -10 div.



Figure 12: M1 Vertical Setup

## 4.1.1.5 Differential Impedance

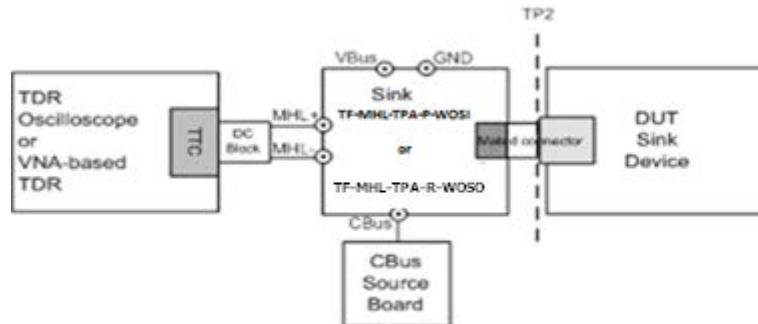


Figure 13: Differential Impedance measurement setup

1. From the TDR menu, set the pulse in diff mode using the 200ps rise time filter setup as shown in Figure 7.
2. Connect the DC blocks to the output of the TDR
3. Connect SMA Cables between the DC Blocks and the TF\_MHL-TPA-P-WOSI.
4. With the Horizontal position, place the Change point where the TDR reference and the connection of the DUT is on the first division from the left.

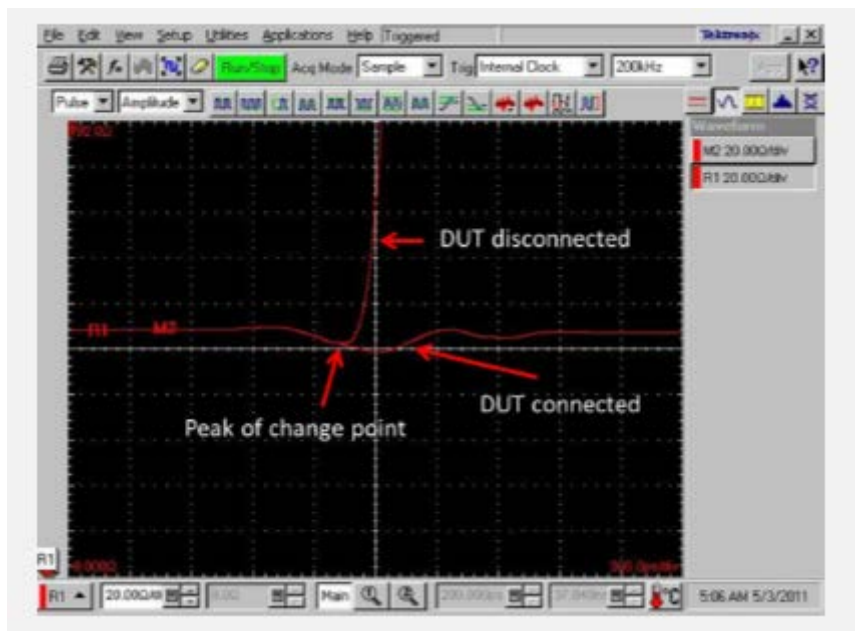


Figure 14: Set Reference point for Differential Mode

5. Place the Horizontal reference triangle at the top of the display to the far left side of the display
6. Using the Horizontal Scale knob set the time base window to be equal to or slightly

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- greater than the  $CDF\_SINK\_DF\_TERM\_DISTANCE + 1ns$ .
7. Connect the Power supply and Cbus source board to the TF\_MHL-TPA-P-WOSI fixture
  8. Connect the DUT to the TF-MHL-TPA-P-WOSI fixture
  9. From the Setup, measurement menu Select Pulse-Amplitude Max as Measurement1
  10. From the Setup, measurement menu Select Pulse-Amplitude Min as Measurement2
  11. From the Measurement menu select the region tab and click on the **On** check box turning on the gated region.
  12. In the G1 box enter in the number 9 (this will place the gate at  $T_{IN}$ ) and in the G2 box enter the number of divisions x10 (this converts it to a percentage) from the left that is equal to  $T_{term}$ . This will be equal to  $Z_{DTHROUGH}$
  13. Record the Max and Min value for  $Z_{DTHROUGH}$ , which is  $T_{in}$  to  $T_{term}$ .  
If measured  $Z_{DTHROUGH}$  is (85 ohms  $\leq Z_{DTHROUGH} \leq$  115 ohms) then it is pass . If there is an excursion and the impedance in the excursion range is (75 ohms  $\leq Z_{DTHROUGH} <$  85 ohms) , OR (115 ohms  $< Z_{DTHROUGH} \leq$  125 ohms ) and if the duration of excursion is less than 250ps and if only one excursion exists in the range , then it is pass.
  14. In the G1 box enter in the number used in step 12 for G2 (this will place the gate at  $T_{term}$ ) and in the G2 box enter the number of divisions x 10 (to convert to percentage) from the left that is equal to  $T_{term} + 1ns$  (should be close to 100%). This will be equal to  $Z_{DT}$
  15. If  $Z_{DT}$  is (90 ohms  $\leq Z_{DT} \leq$  110 ohms), then it is pass.
  16. If the step 13 and 15 is pass, then it is pass, all the other cases Fail.

### *If the DUT is direct attach device, then*

1. Connect SMA Cables between the DC Blocks and the TF-MHL-TPA-R-WOSO.
2. From the Setup, measurement menu Select Pulse-Amplitude Max as Measurement1
3. From the Setup, measurement menu Select Pulse-Amplitude Min as Measurement2
4. From the Measurement menu select the region tab and click on the on check box
5. In the G1 box enter in the number 2 (this will place the gate at  $T_{IN}$ ) and in the G2 box enter the number of divisions X 10 (converts the number to a percentage) from the left to the cable start point as defined in the MHL CTS 2.1. This is the  $Z_{DTHROUGH1}$
6. Record the Max and Min value. If the measured  $Z_{DTHROUGH1}$  is 85 ohms  $\leq Z_{DTHROUGH1} \leq$  115 ohms then it is pass. If there is an excursion and the impedance in the excursion range is (65 ohms  $\leq Z_{DTHROUGH1} <$  85 ohms) ,OR(115 ohms  $< Z_{DTHROUGH1} \leq$  125 ohms) and if the duration of excursion is less than 350ps and if only one excursion exists in the range then it is Pass.
7. In the G1 box enter in the number used for G2 in step 5 and in the G2 box enter the number of divisions X 10 (converts the number to a percentage) from the left to the cable end point as defined in the MHL CTS 2.1. This is the  $Z_{Dincrement\_A}$
8. Calculate  $Z_{Dincrement\_B}$ , if  $Z_{Dincrement\_A}$  is less than 0 then  $Z_{Dincrement\_B}$  is equal to 0. If  $Z_{Dincrement\_A}$  is greater than or equal to 0 then  $Z_{Dincrement\_B} = Z_{Dincrement\_A}$
9. Change the G1 value to equal G2 in step 7. Then change the G2 value to the number of divisions X 10 (converts the number to a percentage) from the left to the  $T_{term}$  as defined by the MHL CTS 2.1. This will be the  $Z_{DTHROUGH2\_WITHCABLE}$
10. Record the Max and Min Value of  $Z_{DTHROUGH2\_WITHCABLE}$  ,then subtract  $Z_{Dincrement\_B}$  equals

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$Z_{DTHROUGH2}$ .

11. Record the Max and Min value. If the measured  $Z_{DTHROUGH2}$  is ( $85 \text{ ohms} \leq Z_{DTHROUGH2} \leq 115 \text{ ohms}$ ) then it is pass. If there is an excursion and the impedance in the excursion range is ( $65 \text{ ohms} \leq Z_{DTHROUGH2} < 85 \text{ ohms}$ ), OR ( $115 \text{ ohms} < Z_{DTHROUGH2} \leq 125 \text{ ohms}$ ) and if the duration of excursion is less than 350ps and if only one excursion exists in the range then it is Pass.
12. Change the G1 value to equal to the G2 value used in step 9, Then change the G2 value to the number of divisions X 10 (converts the number to a percentage) from the left to the  $T_{\text{term}} + 1\text{ns}$ . This will be the  $Z_{DT\_WITHCABLE}$
13. Record the Min and Max values then subtract  $Z_{\text{Dincrement\_B}}$  equals  $Z_{DT}$ .  
If ( $90 \text{ ohms} \leq Z_{DT} \leq 110 \text{ ohms}$ ) then it is pass.
14. If the step 6,11, and 13 is pass , the test is pass ,all the other case it is fail.

### 4.1.1.6 Common-mode Impedance

1. From the TDR menu, set the pulse in Common mode using the 600ps rise time filter setup step 8 in page no 9.
2. Connect the DC blocks to the output of the TDR
3. Connect SMA Cables between the DC Blocks and the TF-MHL-TPA-P-WOSI.
4. With the Horizontal position, place the Change point where the TDR reference and the connection of the DUT is on the first division from the left.

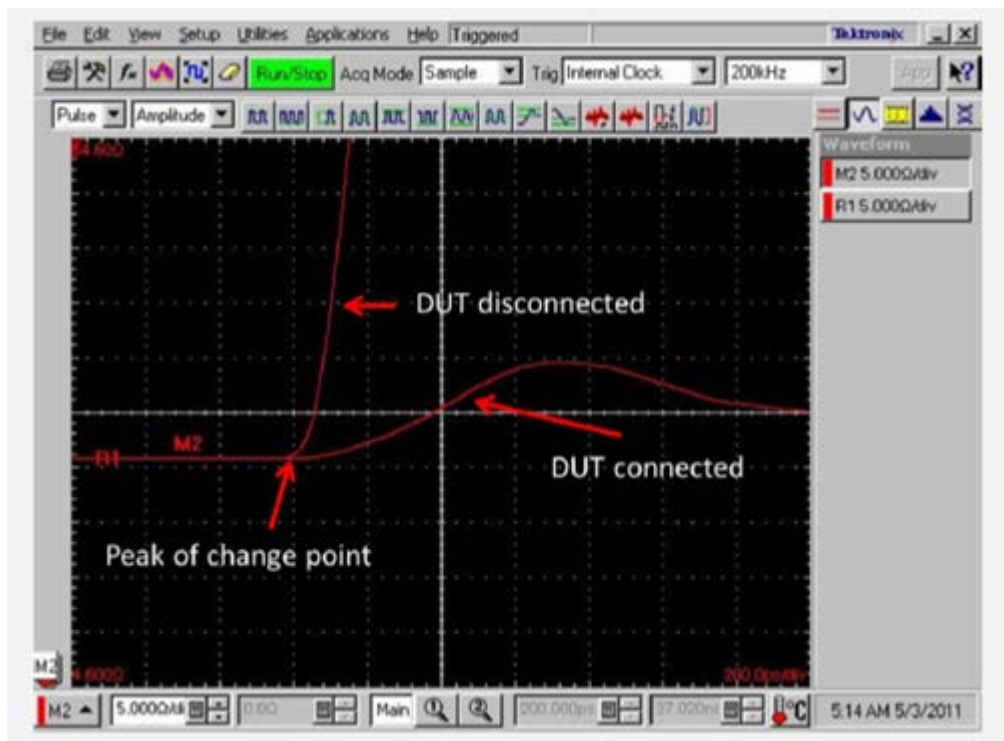


Figure 15 : Set reference point for common mode

5. Place the Horizontal reference triangle at the top of the display to the far left side of



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the display

6. Using the Horizontal Scale knob set the time base window to be equal to or slightly greater than the  $CDF\_SINK\_CM\_TERM\_DISTANCE + 3ns$
7. Connect the Power supply and Cbus source board to the TF-MHL- TPA-P-WOSI fixture
8. Connect the DUT to the TF-MHL-TPA-P-WOSI fixture
9. From the Setup, measurement menu Select Pulse-Amplitude Max as Measurement1
10. From the Setup, measurement menu Select Pulse-Amplitude Min as Measurement2
11. From the Measurement menu select the region tab and click on the on check box
12. In the G1 box enter in the number 9 (this should place the gate at  $T_{IN}$ ) and in the G2 box enter the number of divisions  $\times 10$  (this converts it to a percentage) from the left that is equal to  $T_{term.}$ , which is equal to  $Z_{CTHROUGH}$ .
13. Record the Max and Min Value for  $Z_{CTrough}$ , which is  $T_{in}$  to  $T_{term.}$   
If measured  $Z_{CTHROUGH}$  is ( $24ohms \leq Z_{CTHROUGH} \leq 36 ohms$ ), then it is pass. If there is an excursion and the impedance in the excursion range is ( $20 ohms \leq Z_{CTHROUGH} < 24 ohms$ ) OR ( $36 ohms < Z_{CTHROUGH} \leq 40 ohms$ ) and if the duration of excursion is less than 500ps and if only one excursion exists in the range , then it is pass.
14. In the G1 box enter in the number used in step 12 for G2 (this will place the gate at  $T_{term}$ ) and in the G2 box enter the number of divisions  $\times 10$  (to convert to percentage) from the left that is equal to  $T_{term} + 3ns$  (should be close to 100%). This will be equal to  $Z_{CT}$ .
15. If impedance  $Z_{CT}$  is ( $25 ohms \leq Z_{CT} \leq 35 ohms$ ), condition is Pass.
16. If the Step 13 and 15 is pass, then it is pass, all the other condition is fail.

*If the DUT is direct attach device, then*

1. Connect the DUT to the TF-MHL-TPA-R-WOSO fixture
2. From the Setup, measurement menu Select Pulse-Amplitude Max as Measurement1
3. From the Setup, measurement menu Select Pulse-Amplitude Min as Measurement2
4. From the Measurement menu select the region tab and click on the check box.
5. In the G1 box enter in the number 2 (this will place the gate at  $T_{IN}$ ) and in the G2 box enter the number of divisions  $\times 10$  (converts the number to a percentage) from the left to the cable start point as defined in the MHL CTS 2.1. This is the  $Z_{CTHROUGH1}$
6. Record the Max and Min value.  
If the measured  $Z_{CTHROUGH1}$  is ( $24ohms \leq Z_{CTHROUGH1} \leq 36 ohms$ ), then it is pass. If there is an excursion and the impedance in the excursion range is ( $20 ohms \leq Z_{CTHROUGH1} < 24 ohms$ ) OR ( $36 ohms < Z_{CTHROUGH1} \leq 40 ohms$ ) and if the duration of excursion is less than 500ps and if only one excursion exists in the range ,then it is pass.
7. In the G1 box enter in the number used for G2 in step 5 and in the G2 box enter the number of divisions  $\times 10$  (converts the number to a percentage) from the left to the cable end point as defined in the MHL CTS 2.1. This is the  $Z_{Cincrement\_A}$
8. Calculate  $Z_{Cincrement\_B}$ , if  $Z_{Cincrement\_A}$  is less than 0 then  $Z_{Cincrement\_B}$  is equal to 0. If  $Z_{Cincrement\_A}$  is greater than 0 then  $Z_{Cincrement\_B} = Z_{Cincrement\_A}$
9. Change the G1 value to equal G2 in step 7. Then change the G2 value to the number of divisions  $\times 10$  (converts the number to a percentage) from the left to the  $T_{term}$  as defined by the MHL CTS 2.1. This will be the  $Z_{CTHROUGH2\_WITHCABLE}$



10. Record the Max and Min Value then subtract  $Z_{C_{\text{increment}_B}}$  equals  $Z_{C_{\text{THROUGH2}}}$ . If the measured  $Z_{C_{\text{THROUGH2}}}$  is ( $24\text{ohms} \leq Z_{C_{\text{THROUGH2}}} \leq 36\text{ ohms}$ ), then it is pass. If there is an excursion and the impedance in the excursion range is ( $20\text{ ohms} \leq Z_{C_{\text{THROUGH2}}} < 24\text{ ohms}$ ) OR ( $36\text{ ohms} < Z_{C_{\text{THROUGH2}}} \leq 40\text{ ohms}$ ) and if the duration of excursion is less than 500ps and if only one excursion exists in the range , then it is pass.
11. Change the G1 value to equal to the G2 value used in step 9, Then change the G2 value to the number of divisions X 10 (converts the number to a percentage) from the left to the  $T_{\text{term}} + 3\text{ns}$ . This will be the  $Z_{C_{\text{T}_W\text{ITHCABLE}}}$
12. Record the Min and Max values then subtract  $Z_{C_{\text{increment}_B}}$  equal  $Z_{C_{\text{T}}}$ .  
If the measured  $Z_{C_{\text{T}}}$  ( $25\text{ ohms} \leq Z_{C_{\text{T}}} \leq 35\text{ ohms}$ ) then condition is a Pass.
13. The Test is pass if the step 6 , 10 ,12 is pass, all the other condition fail.

Note: If DUT is direct attach device, then direct attach extension cable should be less than 300mm.

— End of Procedures —