

Procedures Guide Version 1.1

Tektronix

MHL Dongle Devices

Differential & Common Mode Impedance
Measurement

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

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

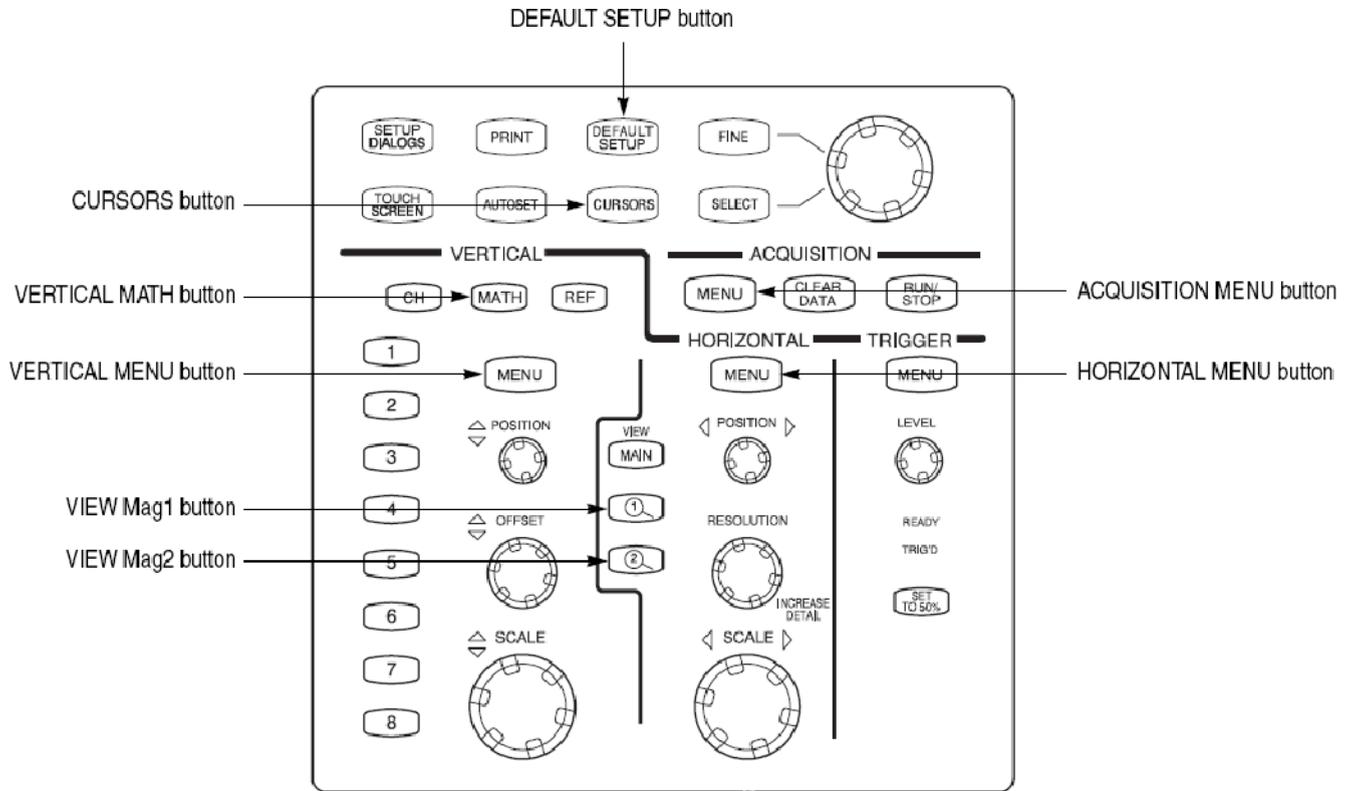
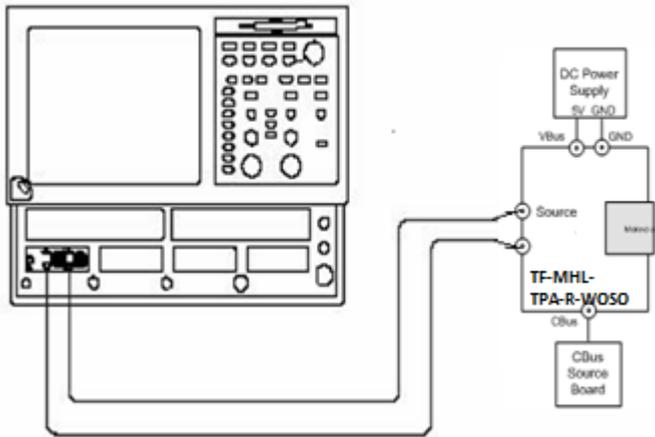


Figure 1: Front-panel buttons on the TDS8200

Equipment Connections

1. Use DC blocks and the 500ohm 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 blocks and the 500ohm SMA cable to connect the CH2 connector on the sampling module and the MHL- connector on the test fixture (see Figure 2).

Sampling oscilloscope (DSA8300 / DSA8200 / TDS8200 / CSA 8200 and 80E04)



Test fixture

Figure 2: Initial equipment connections for the differential impedance measurement using a TF-MHL-TPA-R-WOSO

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 Ohms.
 - e. On the **Vert** tab, select **C1** from the **Waveform** field, and then set the **SetupScale** to 10.00 Ohms/div and **Position** to -5.000 div.
 - f. On the **Vert** tab, select **C2** from the **Waveform** field, and then set the **SetupScale** to 10.00 Ohms/div and **Position** to -5.000 div.
 - g. Click **Horz** tab on **Setups** window.
 - h. Set **Timebase 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).

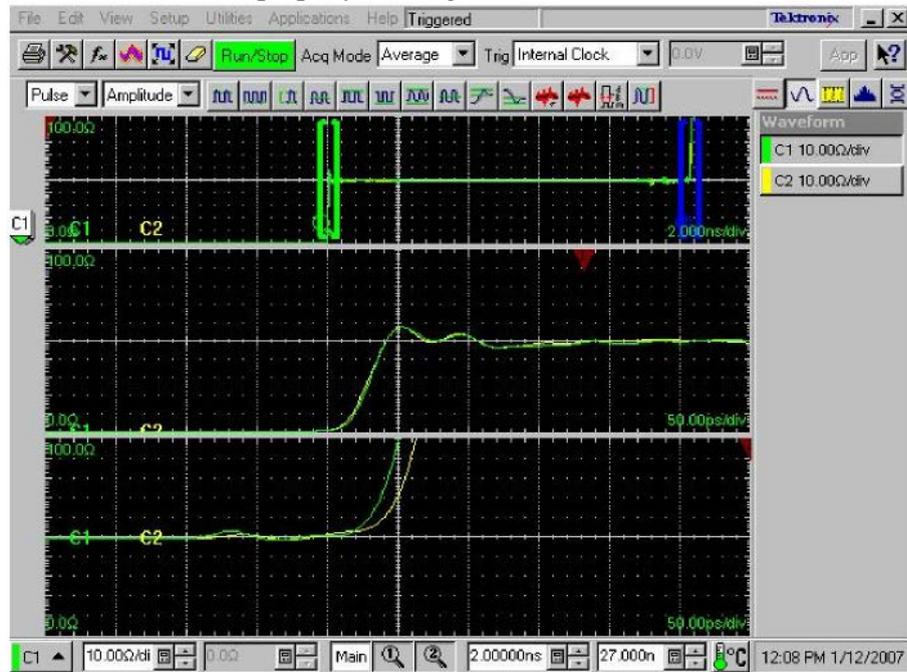


Figure 3: Magnifying the TDR step pulses and the waveforms at the open ends of the test fixture

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 **75 Ohms/div**.
 - 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 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 4 are about the same value by changing the **Step Deskew** value (see ③ in Figure 4).

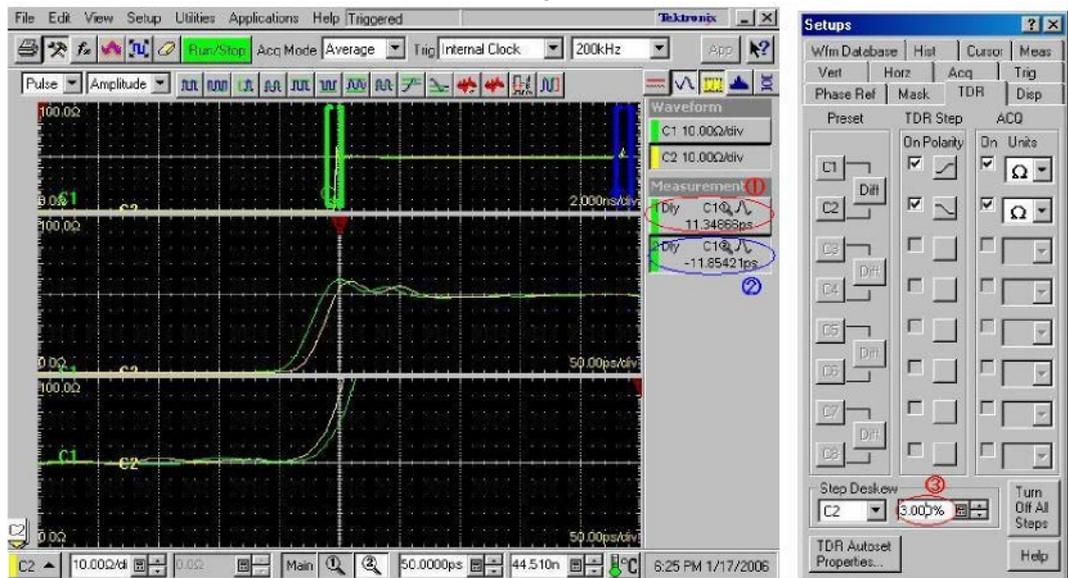


Figure 4: Adjusting the step deskew

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 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

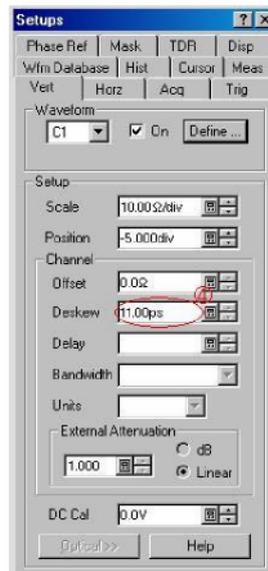


Figure 5: Changing the Deskew value

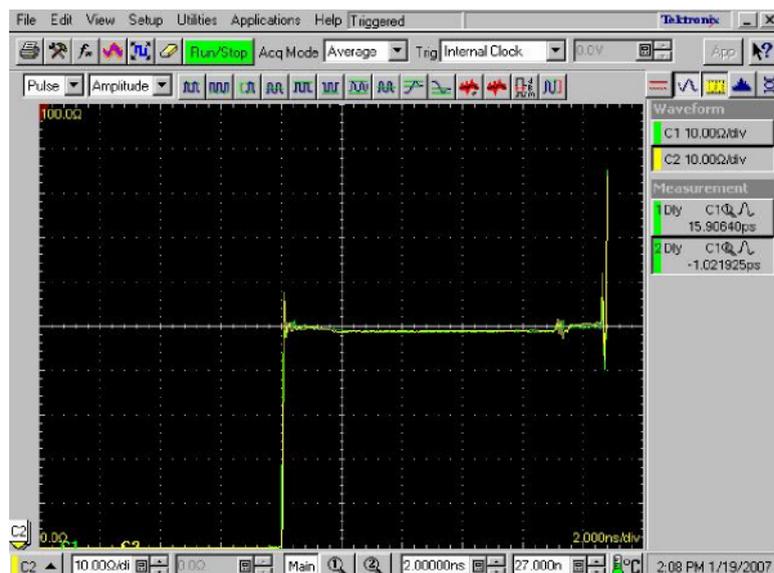


Figure 6: Screen image after turning off the Mag View feature

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 **500 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.
 - 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.

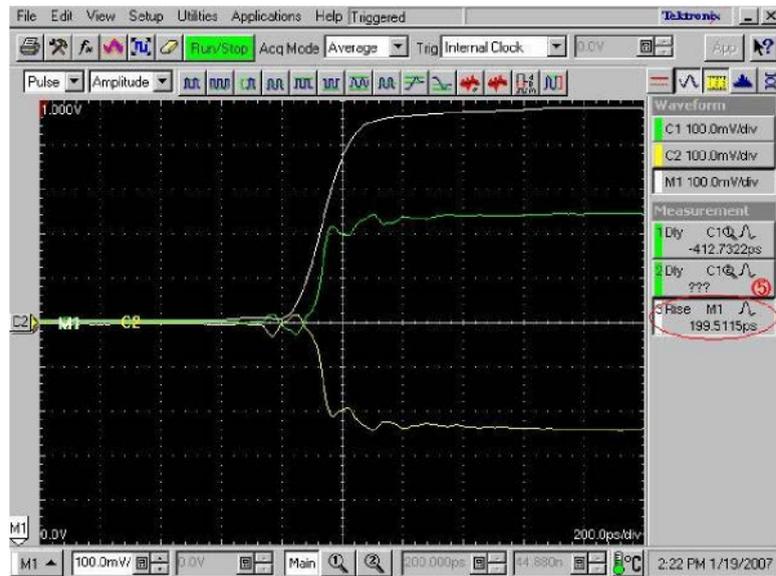


Figure 7: Adjusting the rise time

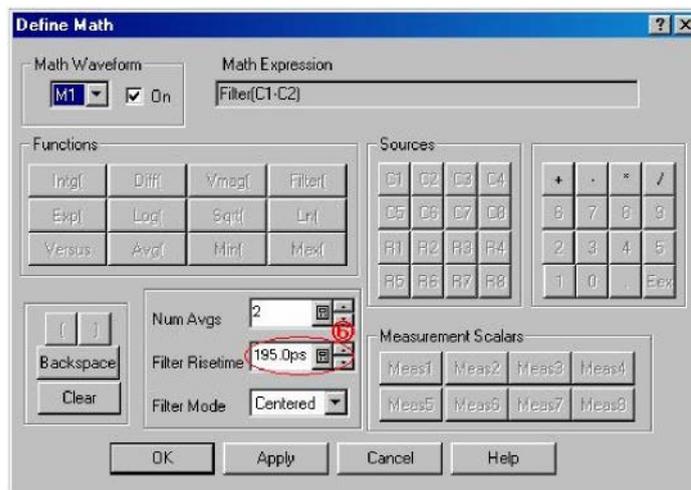


Figure 8: Changing the Filter Risetime value

- 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).

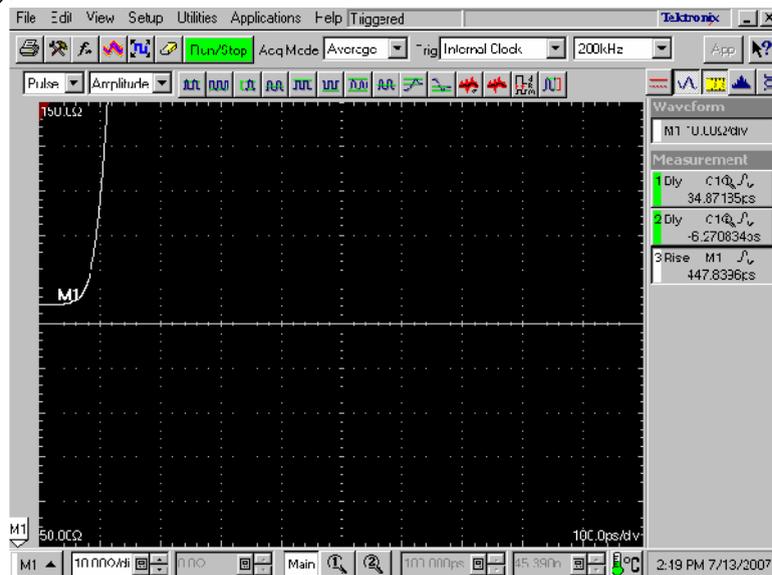


Figure 9: TDR rise-time waveform

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).

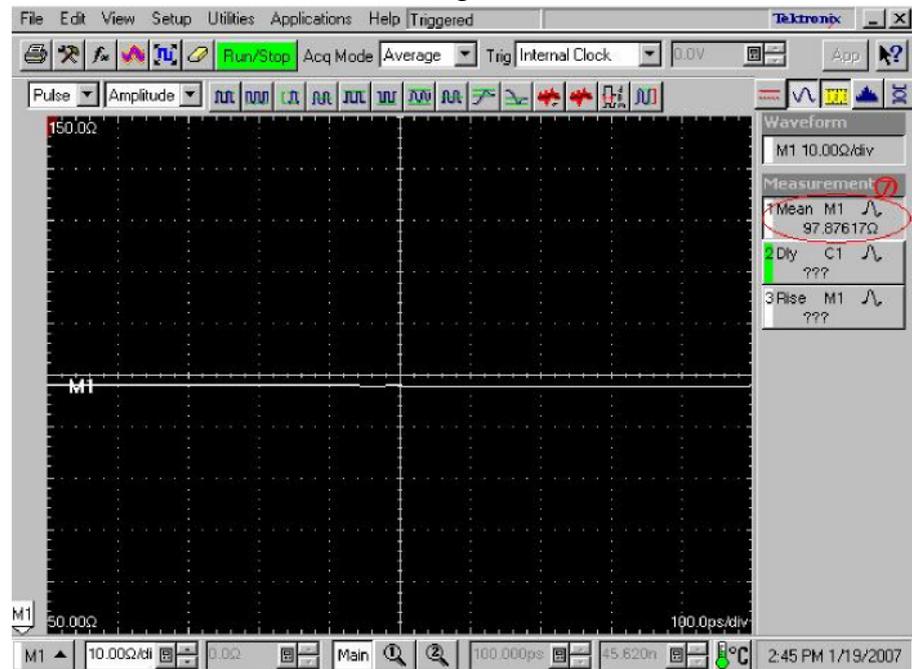


Figure 10: Measuring the M1 value

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 97.8 Ω, enter $\text{Filter}(C1+C2)+2.2$ in the field. For common mode measurements repeat steps 11 through 17 only calculate the difference between 25 and the measured value.

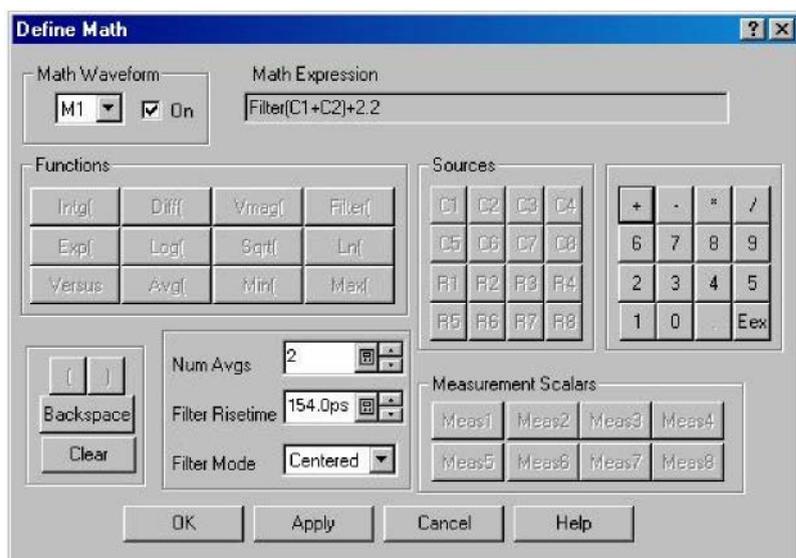


Figure 11: Entering the difference value

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 Ω /div and **M1 Position** to -10 div.

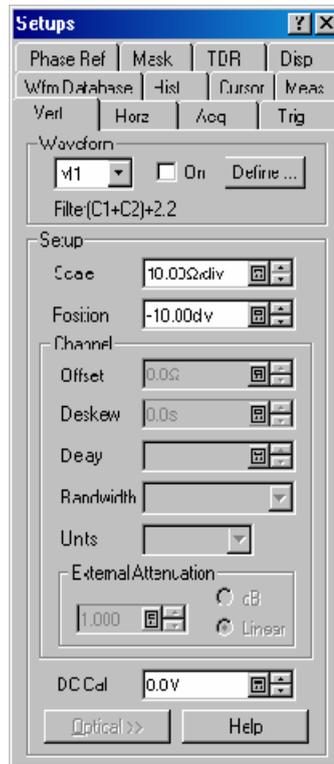


Figure 12: M1 Vertical Setup

5.1.1.5 Differential Impedance

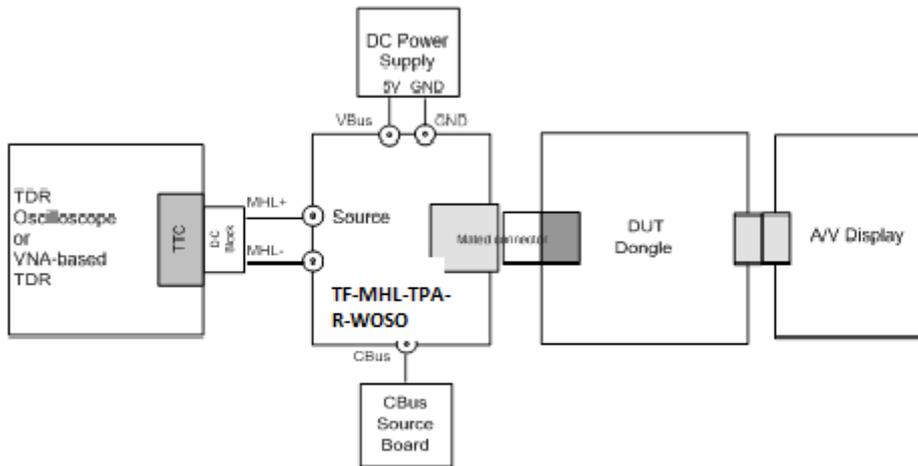


Figure 13 : Dingle Differential Impedance Test setup

1. From the TDR menu, set the pulses into differential mode using the 200ps rise time filter setup as shown in Figure 8.
2. Connect the DC blocks to the output of the TDR
3. Connect SMA Cables between the DC Blocks and the TF-MHL-TPA-R-WOSO.
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.

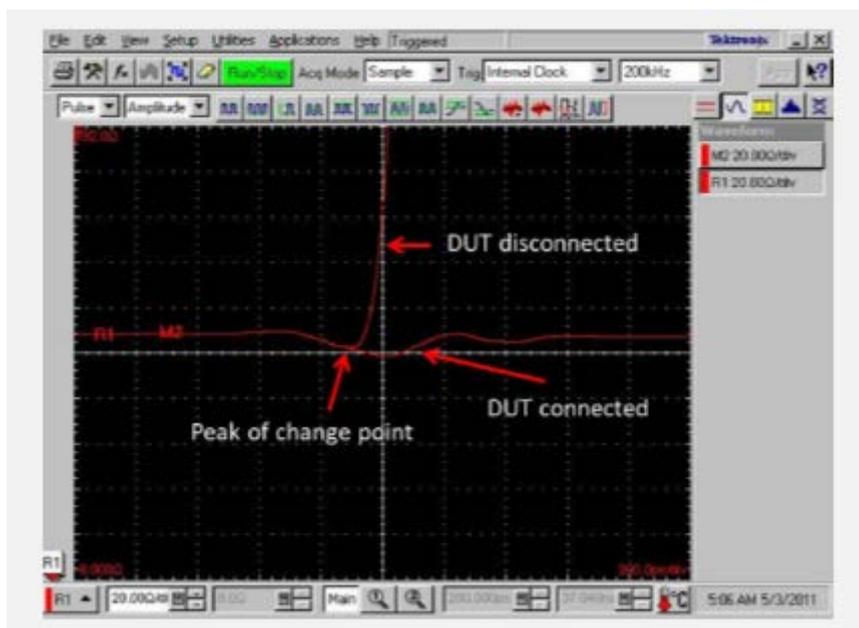


Figure 14 : Set Reference point for differential Mode

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 or slightly greater than $CDF_D_DF_TERM_DISTANCE + 1ns$.
7. Connect the Power supply and Cbus source board to the TF-MHL-TPA-R-WOSO fixture, Do not provide powersupply if DUT is powered Dongle.
8. Connect the DUT to the TF-MHL-TPA-R-WOSO fixture

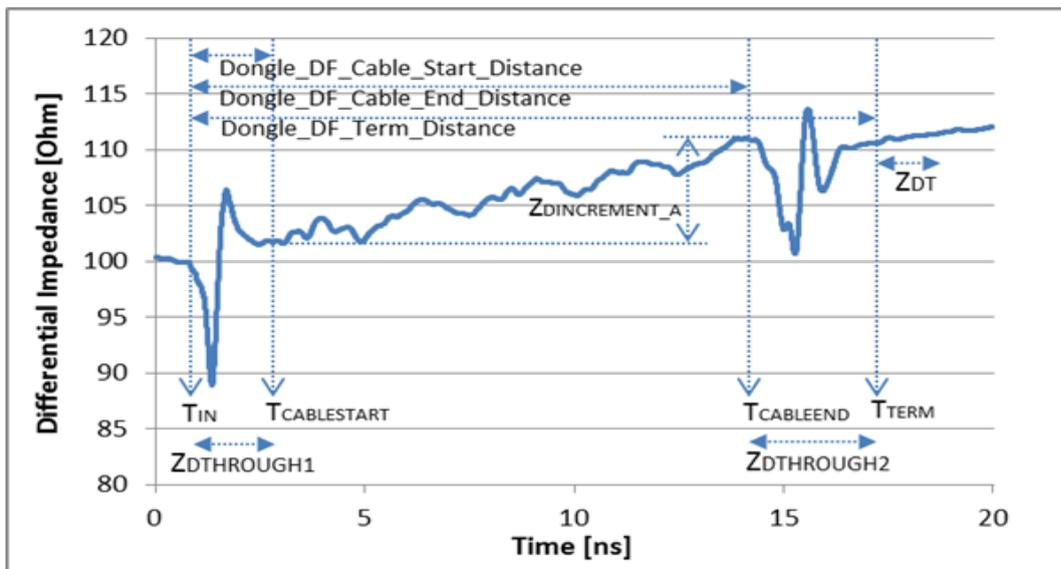


Figure 15 : Differneital Impedance Test symbology

9. Using figure15 as a guideline, measure dongle differential impedance
10. From the Setup, measurement menu Select Pulse-Amplitude Max as Measurement1
11. From the Setup, measurement menu Select Pulse-Amplitude Min as Measurement2
12. From the Measurement menu select the region tab and click on the check box
13. 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 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 $Z_{DTHROUGH1}$
14. Record the Max and Min value of $Z_{DTHROUGH1}$. If the measured $Z_{DTHROUGH1}$ is $(85ohms \leq Z_{DTHROUGH1} \leq 115ohms)$, then it is Pass. If there is an excursion and the impedance in the excursion range is $(65ohms \leq Z_{DTHROUGH1} < 85 ohms)$ OR $(115ohms < Z_{DTHROUGH1} \leq 125ohms)$ and if the duration of excursion is less than 350ps and if only one excursion exists in the range then it is Pass.
15. In the G1 box enter in the number used for G2 in step 13 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 $Z_{DINCREMENT_A}$
16. 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 $Z_{DINCREMENT_B} = Z_{DINCREMENT_A}$
17. Change the G1 value to equal G2 in step 15. 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

Measurement Procedures

defined by the MHL CTS 2.1. This will be the $Z_{DTHROUGH2_WITH\ CABLE}$

18. Record the Max and Min value of $Z_{DTHROUGH2_WITH\ CABLE}$, then subtract $Z_{Dincrement_B}$ equals $Z_{DTHROUGH2}$. 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 condition is Pass.
19. Change the G1 value to equal to the G2 value used in step 17, Then change the G2 value to the number of divisions X 10 (converts the number to a percentage) from the left to the $T_{tem} + 1\text{ns}$. This will be the $Z_{DT_WITHCABLE}$
20. Record the Min and Max values of $Z_{DT_WITHCABLE}$ then subtract $Z_{Dincrement_B}$ equals Z_{DT} . If the measured Z_{DT} ($90\text{ ohms} \leq Z_{DT} \leq 110\text{ ohms}$) then condition is Pass.
21. The Test is pass if the step 14, 18 and 20 is pass ,all other case are fail.

5.1.1.6 Common-mode Impedance

1. From the TDR menu set the pulse in Common mode using the 600ps rise time filter setup as stated in step 8 of rise time setup procedure.
2. Connect the DC blocks to the output of the TDR
3. Connect SMA Cables between the DC Blocks and the TF-MHL-TPA-R-WOSO.
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.

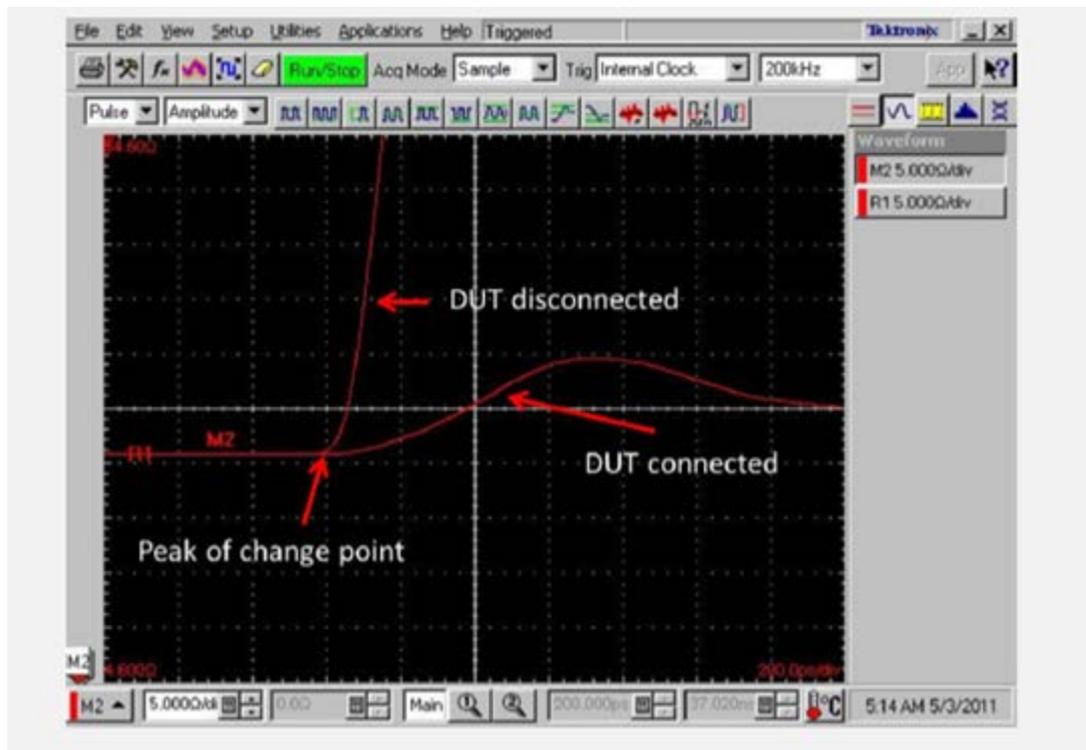


Figure 16 :Set Reference point for common mode

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 to be equal or slightly larger than $CDF_D_CM_TERM_DISTANCE + 3ns$.
7. Connect the Power supply and Cbus source board to the TF-MHL-TPA-R-WOSO fixture. Do not apply the powersupply if DUT is powered dongle.
8. Connect the DUT to the TF-MHL-TPA-R-WOSO fixture

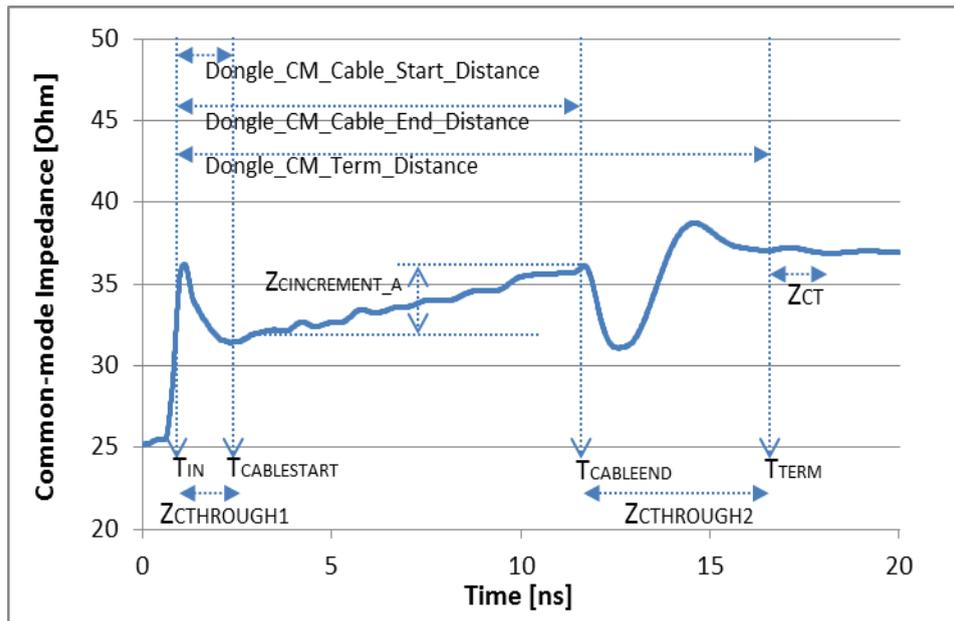


Figure 17 : Common mode impedance Test Symboly

9. Using figure17 as a guide line to measure dongle common-mode impedance
10. From the Setup, measurement menu Select Pulse-Amplitude Max as Measurement1
11. From the Setup, measurement menu Select Pulse-Amplitude Min as Measurement2
12. From the Measurement menu select the region tab and click on the on check box
13. 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 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 $Z_{CTHROUGH1}$
14. Record the Max and Min value of $Z_{CTHROUGH1}$. If the measured $Z_{CTHROUGH1}$ is ($24ohms \leq Z_{CTHROUGH1} \leq 36 ohms$) then condition is Pass . If the there is an excursion and the impedance in the excursion range is ($20ohms \leq Z_{CTHROUGH1} < 24 ohms$) OR ($36ohms < Z_{CTHROUGH1} \leq 40ohms$) and if the duration of the excursion is less than 500ps and if only one excursion exists in the range then condition is Pass.
15. In the G1 box enter in the number used for G2 in step 13 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 $Z_{Cincrement_A}$
16. 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 or equal to 0 then $Z_{Cincrement_B} = Z_{Cincrement_A}$
17. Change the G1 value to equal G2 in step 15. 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 $Z_{CTHROUGH2_WITH\ CABLE}$
18. Record the Max and Min value of $Z_{CTHROUGH2_WITH\ CABLE}$, then subtract $Z_{Cincrement_B}$ equals $Z_{CTHROUGH2}$.

If the measured $Z_{CTHROUGH2}$ ($24\text{ohms} \leq Z_{CTHROUGH2} \leq 36\text{ ohms}$) then condition is Pass . If there is an excursion and the impedance in the excursion range is ($20\text{ohms} \leq Z_{CTHROUGH2} < 24\text{ ohms}$) OR ($36\text{ohms} < Z_{CTHROUGH2} \leq 40\text{ohms}$) and if the duration of the excursion is less than 500ps and if only one excursion exists in the range then condition is Pass.

19. Change the G1 value to equal to the G2 value used in step 17, 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 $Z_{CT_WITHCABLE}$
20. Record the Min and Max values then subtract $Z_{\text{CIncrement}_B}$ equals to Z_{CT} . If the measured Z_{CT} is ($25\text{ ohms} \leq Z_{CT} \leq 35\text{ ohms}$) then condition is a Pass.
21. The test is pass if the step 14,18 and 20 is pass , All the other case is fail
22. If the Cable length is less than 30 cm,
 - a. Follow the steps 9 through 13
 - b. Record the Max and Min value $Z_{CTHROUGH1}$. If $24\text{ohms} \leq Z_{CTHROUGH1} \leq 140\text{ ohms}$. Then condition is pass.
 - c. Follow the step 15 to 18
 - d. Record the Max and Min value $Z_{CTHROUGH2}$. If $24\text{ohms} \leq Z_{CTHROUGH2} \leq 140\text{ ohms}$. Then condition is pass.
 - e. Follow the step 19 ,20, if $25\text{ ohms} \leq Z_{ct} \leq 35\text{ ohms}$, then condition is Pass.
 - f. The test is pass if steps b,d and e are pass.all the other case it is fail.

— End of Procedures —