DisplayPort Standard

Revision 0.9
11-19-2007

DisplayPort Standard
Tektronix MOI for Cable Tests
(DSA8200 based sampling instrument with IConnect software)

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Modification Records

October 15, 2007: Eugene Mayevskiy created a first draft

Acknowledgements

Tektronix Inc.: Eugene Mayevskiy-creation of the document

Instrumentation Requirements

Passive Cables

1. DSA8200 mainframe or equivalent.
2. 4 80E04 sampling modules[1]
3. IConnect software (80SSPAR)
4. A set of DisplayPort test fixtures: TPA-P and TPA-R fixtures from Efficere Technologies. Order a set as ET-DP-TPA-S.
5. 8 pcs. equal length (~1.5ft) SMA cables 18GHz bandwidth or equivalent
6. 2 pcs. SMA female-to-female adaptors.
7. 50 Ohm terminations to terminate unused channels

Active Cables

1. DSA8200 mainframe or equivalent.
2. 2pcs 80E04 sampling modules or equivalent.
3. 1 80A06 pattern sync module
4. IConnect software (80SSPAR)
5. 80SJNB software for jitter analysis
6. A set of DisplayPort test fixtures for active cable tests
7. 4 pcs. equal length short (~1.5ft) SMA cables 18GHz bandwidth or equivalent
8. 1 long (~3ft) SMA cable to connect from AWG to the pattern sync module
9. 1 short (~1ft) SMA cable to connect trigger from the pattern sync module
10. 2 pcs. SMA female-to-female adaptors.
11. 50 Ohm terminations to terminate unused channels
12. High Speed Signal Source: AWG7102 with options1,6.

[1] The testing can be performed with two 80E04s. However, this will require physical changes in the setup.

Perform instrument calibration and test setup for passive[2] cable tests

Outline of the testing

Perform compensation for all channels and the mainframe
Connect matched SMA cables to the sampling heads of the mainframe
Perform differential deskew procedure for all channels at the SMA interface (Appendix A)
Perform differential deskew procedure for all channels at the fixture interface[3]. The deskew should be done first at the SMA interface, and then calibrated with TDR steps at the open fixture in acquisition (Vertical menu).
Perform instrument settings, and save the following setups:

- **Inter-pair skew** measurements
- **Intra-pair skew** measurements
- **Far End Noise** measurements, and acquire reference waveforms
- **Bulk Cable and Connector** impedance measurements and acquire reference waveforms
- **Insertion Loss** measurements and acquire reference waveforms.
- **Near End Noise** measurements and acquire reference waveforms.

When acquiring time domain data for long cable it is important to acquire the waveforms that have enough time domain points (resolution) to ensure sufficient bandwidth in frequency. In general, someone needs to acquire at least 4000 points per each 50ns of time domain data. To acquire long data with IConnect Long Record mode should be enabled.

Connect the cable assembly to measurement instrument

The cable assembly has to be connected as shown in Figure 1. The differential stimulus will be applied to both pairs on the same side of the cable. The delay between TDTdd responses from the pairs have to be measured at the other side of the cable assembly.

[2] TDR based active cable tests (5.3 and 5.7) will require similar setup. Jitter test procedures for active cables are under development.
[3] Only acquisition deskew part is required, it can be performed by looking at the differential TDR response in "rho" mode for each channel and minimizing the delay between the rising edges.

Figure 1 DisplayPort passive cable test setup.

Inter-pair skew test (5.1)

This test is run on the instrument directly. The implementation can be automated using GPIB interface to set the sampling oscilloscope to measure delay at a specific location.

Set the TDR oscilloscope

Average Mode: 50 samples
Stop After Condition: Average Complete
Record Length: 4000pts
Horizontal scale: 500ps/div
Vertical Scale: 100mV/div
Calibrate rise time at the output of the 2x trace of the fixture to 50ps +/- 2ps (20-80%). This is a TDT measurement and single ended configuration can be used.
Generate diff TDR step at channels C1 and C2; set acquisition units to volts (V)
Generate diff TDR step at channels C3 and C4; set acquisition units to volts (V)
Set the math function M1 to C5-C6 and check On checkbox
Set the math function M2 to C7-C8 and check On checkbox
Set Measure 1 to measure time delay between M1 and M2 with Mid reference level of 15% for both sources.
Calibrate the time difference between the TDR step generators:

- Connect SMA cables using SMA female-to-female adaptor (test adaptors have to be disconnected).
- Display the TDR steps on the screen
- Run delay measurements (Measure 1) and record the number (TDRskew). This number will be subtracted from the measurements of the cable.

Save instrument setup in a file (DP5_1.stp)
Disconnect the SMA adaptors.

Measure the inter-pair skew of the cable assembly

Connect the test fixtures measurement instrument (if not connected already)
Carefully plug the cable into the test fixtures
Recall DP5_1.stp and press the RUN/STOP button
Rotate the Position knob counterclockwise to locate rising edge of the TDT response[4] and to position it in the middle of the screen
Record the delay value (Measure 1) as IntraDelay.
Compute the intra-pair skew: IntraSkew=IntraDelay-TDRskew.
Check pass/fail condition of this test:

If abs(IntraSkew)>200ps: Fail, else: Pass.

[4] When long cables are measured, you can increase the scale to locate the rising edge. When the edge is located and is in the middle of the screen, bring the horizontal scale back to 500ps/div.

Intra-pair skew test (5.2)

This test is run on the instrument directly. The implementation can be automated using GPIB interface to set the sampling oscilloscope to measure delay at a specific location.

Set the TDR oscilloscope

Average Mode: 50 samples
Stop After Condition: Average Complete
Record Length: 400pts
Horizontal scale: 200ps/div
Setup for channels C1 and C2:
Calibrate TDR rise time to 50ps (20-80%)
Generate diff TDR step at channels C1 and C2; set acquisition units to volts (V)
Set Measure 1 to measure time delay between C5 and C6:

- Select C5 as the Source1 with RefLevel of Mid value set to 15%
- Set the slope edges in Region tab to +/-
- Select C6 as the Source2 with RefLevel of Mid value set to 85%
- Set the slope edges in Region tab to +/-

Save instrument setup in a file (DP5_2_lane0.stp)
Setup for channels C3 and C4:
Calibrate TDR rise time to 50ps (20-80%)
Generate diff TDR step at channels C3 and C4; set acquisition units to volts (V)
Set Measure 1 to measure time delay between C7 and C8:

- Select C7 as the Source1 with RefLevel of Mid value set to 15%
- Set the slope edges in Region tab to +/-
- Select C8 as the Source2 with RefLevel of Mid value set to 85%
- Set the slope edges in Region tab to +/-

Save instrument setup in a file (DP5_2_lane1.stp)

Measure the intra-pair skew of the cable assembly

Connect the test fixtures measurement instrument (if not connected already)
Carefully plug the cable into the test fixtures
Recall DP5_2_lane0.stp and press the RUN/STOP button
Rotate the Position knob counterclockwise to locate rising edge of the TDT response[5] and to position it in the middle of the screen
Record the delay value (Measure 1) as InterDelayA.
Check pass/fail condition of this test:

If abs(InterDelayA)>50ps: Fail, else: Pass.

Recall DP5_2_lane1.stp and press the RUN/STOP button
Rotate the Position knob counterclockwise to locate rising edge of the TDT response and to position it in the middle of the screen

[5] When long cables are measured you can increase the scale to locate the rising edge. When the edge is located and is in the middle of the screen, bring the horizontal scale back to 500ps/div.

Record the delay value (Measure 1) as InterDelayB.
Check pass/fail condition of this test:

If abs(InterDelayA)>50ps: Fail, else: Pass.

Far End Noise tests (5.3)

This test uses IConnect to compute frequency domain S-parameters. The implementation can be automated using GPIB interface to acquire the data and IConnect's CLI to compute S-parameters.

Set the TDR oscilloscope

Average Mode: 500 samples
Stop After Condition: Average Complete
Record Length: better than 4000pts per 50ns window
Horizontal scale: ~4-5 times prop delay of the cable[6]

Acquire references for measuring FEN at lane 0:

- Set the M1 math function to display a difference between C5 and C6
- Set the differential TDR step at channels C3 and C4
- Check the acquisition checkboxes
- Physically connect C3 to C5 and C4 to C6 using 2x traces at the DisplayPort test adaptor carefully mating SMA connectors
- Save instrument setup in a file (DP5_3_FEN32.stp)
- Press Run/Stop button to measure TDT response from slot 2 to slot 3
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Tdd32.wfm file
- Disconnect the 2x traces of the test fixture from the SMA cables
- Press Run/Stop button to measure the noise in slot 3
- Acquire the noise reference waveform (MATH1) with IConnect and save it in Noise_Tdd32.wfm file

Acquire references for measuring FEN at lane 1:

- Set the M1 math function to display a difference between C7 and C8
- Set the differential TDR step at channels C1 and C2
- Physically connect C1 to C7 and C2 to C8 using 2x traces at the DisplayPort test adaptor carefully mating SMA connectors
- Save instrument setup in a file (DP5_3_FEN41.stp)
- Press Run/Stop button to measure TDT response from slot 1 to slot 4
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Tdd41.wfm file
- Disconnect the 2x traces of the test fixture from the SMA cables
- Press Run/Stop button to measure the noise in slot 4
- Acquire the noise reference waveform (MATH1) with IConnect and save it in Noise_Tdd41.wfm file

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[6] The prop delay of the cable can be found by measuring the time difference between the open reference position and the rising edge of the TDT response. Alternatively it can be approximated from the physical length of the cable by assuming the step propagates 1 foot in 1ns. For example, if a cable is 10 feet long, the corresponding time window can be approximated as follows: 10feet*1ns/foot*5=50ns or 5ns/div. When using IConnect use long acquisition feature when measuring the cables with window longer than 50ns.

Measure the Far End Noise

Connect the test fixtures measurement instrument (if not connected already)
Carefully plug the cable into the test fixtures

Perform measurements of the Far End Noise induced at lane0:

- Recall DP5_3_FEN32.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect
- Using Math function of IConnect subtract noise reference (Noise_Tdd32.wfm) from the MATH1 waveform and save it as FEN_Tdd32.wfm
- Using S-parameter computational function and Ref_Tdd32.wfm waveform compute S-parameter response
- Save the S-parameter response as Sdd32_FEN
- Using IConnect cursors measure the acquired waveform to test the compliance limits.

Perform measurements of the Far End Noise induced at lane1:

- Recall DP5_3_FEN41.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect
- Using Math function of IConnect subtract noise reference (Noise_Tdd41.wfm) from the MATH1 waveform and save it as FEN_Tdd41.wfm
- Using S-parameter computational function and Ref_Tdd41.wfm waveform compute S-parameter response
- Save the S-parameter response as Sdd41_FEN
- Using IConnect cursors measure the acquired waveform to test the compliance limits.

Bulk Cable and Connector Impedance measurements (5.4)

This test uses IConnect to compute time domain impedance profile with peeling algorithm. The implementation can be automated using GPIB interface to acquire the data and IConnect's CLI to compute impedance profile.

Set the TDR oscilloscope

Average Mode: 500 samples
Stop After Condition: Average Complete
Record Length: 4000
Horizontal scale: 300ps/div
Vertical scale: 100mV division

Acquire references for measuring the bulk cable and connector impedance of lane 0 at side A:

Set the differential TDR step at channels C1 and C2

- Adjust the time window do display an open from the end of the SMA in the middle of the leftmost division of the acquisition window.
- Calibrate rise time to 130ps (20-80%) or faster measured at the open fixture. Set the M1 math function to display a filtered difference between C1 and C2. The digital filter has to be set to 130ps (20-80%) or 179ps (10-90%) rise time. Finally adjust the filter value to measure 130ps (20-80%) rise time at the fixture output.
- Acquire open fixture reference waveform and same it as Fixture_Open_lane0.wfm.
- Disconnect the test fixture
- Save instrument setup in a file (DP5_4_Z_line0.stp)
- Press Clear Data and then Run/Stop buttons to measure differential TDR response from slot 1
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Z_Tdd11.wfm file
- Check the acquire box of C1, and connect a high-precision 50Ohm load to the SMA output from C1
- Press Run/Stop button to measure the 50Ohm response from C1 and acquire CH1 with IConnect
- Disconnect the 50 Ohm load from C1 and connect it to the SMA output from C2
- Uncheck the acquire box of C1, and check the acquire box of C2
- Press Clear Data and Run/Stop buttons to measure the 50Ohm response from C2 and acquire CH2 with IConnect
- Using IConnect's Waveform Math calculate the difference of CH1 and CH2 and save the resulting waveform as Cal_100Ohm_lane0.wfm.
- Uncheck acquire box of C2

Acquire references for measuring the bulk cable and connector impedance of lane 1 at side A:

- Set the M1 math function to display a filtered difference between C3 and C4. The digital filter has to be set to 130ps (20-80%) or 179ps (10-90%) rise time.
- Set the differential TDR step at channels C3 and C4
- Adjust the time window do display an open from the end of the SMA in the middle of the leftmost division of the acquisition window.
- Save instrument setup in a file (DP5_4_Z_line1.stp)
- Press Run/Stop button to measure differential TDR response from slot 2
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Z_Tdd22.wfm file
- Check the acquire box of C3, and connect a high-precision 50Ohm load to the SMA output from C3
- Press Run/Stop button to measure the 50Ohm response from C3 and acquire CH3 with IConnect
- Disconnect the 50 Ohm load from C3 and connect it to the SMA output from C4
- Uncheck the acquire box of C3, and check the acquire box of C4
- Press Run/Stop button to measure the 50Ohm response from C4 and acquire CH4 with IConnect
- Using IConnect's Waveform Math calculate the difference of CH3 and CH4 and save the resulting waveform as Cal_100Ohm_lane1.wfm.

Repeat aforementioned measurements for side B if needed.

Measure the bulk cable and connector impedance

Connect the test fixtures measurement instrument (if not connected already)
Carefully plug the cable into the test fixtures

Perform measurements of the impedance of lane0 at side A:

- Recall DP5_4_Z_line0.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect and save it as ZTdd11.wfm
- Using Z-line computational load ZRef_Tdd11.wfm, Cal_100Ohm_lane0.wfm, and ZTdd11.wfm into IConnect and compute true impedance profile.
- Save the waveform as ZlineTdd11.wfm
- Using IConnect cursors measure the acquired waveform to test the compliance limits.

Perform measurements of the impedance of lane1at side B:

- Recall DP5_4_Z_line1.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect and save it as ZTdd22.wfm
- Using Z-line computational load ZRef_Tdd22.wfm, Cal_100Ohm_lane1.wfm, and ZTdd22.wfm into IConnect and compute true impedance profile.
- Save the waveform as ZlineTdd22.wfm
- Using IConnect cursors measure the acquired waveform to test the compliance limits.
- Repeat aforementioned measurements for side B if needed.

Insertion Loss measurements (5.5)

This test uses IConnect to compute frequency domain S-parameters. The implementation can be automated using GPIB interface to acquire the data and IConnect's CLI to compute S-parameters.

Set the TDR oscilloscope

Average Mode: 500 samples
Stop After Condition: Average Complete
Record Length: better than 4000pts per 50ns window
Horizontal scale: ~4-5 times prop delay of the cable[7]

Acquire references for measuring the Insertion Loss of lane 0:

- Set the M1 math function to display a difference between C5 and C6
- Set the differential TDR step at channels C1 and C2
- Physically connect C1 to C5 and C2 to C6 using 2x traces at the DisplayPort test adaptor carefully mating SMA connectors
- Save instrument setup in a file (DP5_5_IL31.stp)
- Press Run/Stop button to measure TDT response from slot 1 to slot 3
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Tdd31.wfm file
- Disconnect the 2x traces of the test fixture from the SMA cables
- Press Run/Stop button to measure the noise in slot 3
- Acquire the noise reference waveform (MATH1) with IConnect and save it in Noise_Tdd31.wfm file (Noise_Tdd32.wfm can be reused)

Acquire references for measuring the Insertion Loss of lane 1:

- Set the M1 math function to display a difference between C7 and C8
- Set the differential TDR step at channels C3 and C4
- Physically connect C3 to C7 and C4 to C8 using 2x traces at the DisplayPort test adaptor carefully mating SMA connectors
- Save instrument setup in a file (DP5_5_IL42.stp)
- Press Run/Stop button to measure TDT response from slot 2 to slot 4
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Tdd42.wfm file
- Disconnect the 2x traces of the test fixture from the SMA cables
- Press Run/Stop button to measure the noise in slot 4
- Acquire the noise reference waveform (MATH1) with IConnect and save it in Noise_Tdd42.wfm file (Noise_Tdd41.wfm can be reused)

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[7] The prop delay of the cable can be found by measuring the time difference between the open reference position and the rising edge of the TDT response. Alternatively it can be approximated from the physical length of the cable by assuming the step propagates 1 foot in 1ns. For example, if a cable is 10 feet long, the corresponding time window can be approximated as follows: 10feet*1ns/foot*5=50ns or 5ns/div

Measure the Insertion Loss

Connect the test fixtures measurement instrument (if not connected already)
Carefully plug the cable into the test fixtures

Perform measurements of the Insertion Loss at lane0:

- Recall DP5_5_IL31.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect
- Using Math function of IConnect subtract noise reference (Noise_Tdd31.wfm) from the MATH1 waveform and save it as IL_Tdd31.wfm
- Using S-parameter computational function and Ref_Tdd31.wfm waveform compute S-parameter response
- Save the S-parameter response as Sdd31_IL.wfm
- Using IConnect cursors measure the acquired waveform to test the compliance limits.

Perform measurements of the Insertion Loss at lane1:

- Recall DP5_5_IL42.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect
- Using Math function of IConnect subtract noise reference (Noise_Tdd42.wfm) from the MATH1 waveform and save it as IL_Tdd42.wfm
- Using S-parameter computational function and Ref_Tdd42.wfm waveform compute S-parameter response
- Save the S-parameter response as Sdd42_IL.wfm
- Using IConnect cursors measure the acquired waveform to test the compliance limits.

Near End Noise Measurements (5.6)

This test uses IConnect to compute frequency domain S-parameters. The implementation can be automated using GPIB interface to acquire the data and IConnect's CLI to compute S-parameters.

Set the TDR oscilloscope

Average Mode: 500 samples
Stop After Condition: Average Complete
Record Length: better than 4000pts per 50ns window
Horizontal scale: ~4-5 times prop delay of the cable[8]

Acquire references for measuring NEN at side A:

- Set the M1 math function to display a difference between C1 and C2
- Set the differential TDR step at channels C3 and C4
- Physically connect C3 to C1 and C4 to C2 using 2x traces at the DisplayPort test adaptor carefully mating SMA connectors
- Save instrument setup in a file (DP5_6_NEN12.stp)
- Press Run/Stop button to measure TDT response from slot 2 to slot 1
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Tdd12.wfm file
- Disconnect the 2x traces of the test fixture from the SMA cables
- Press Run/Stop button to measure the noise in slot 1
- Acquire the noise reference waveform (MATH1) with IConnect and save it in Noise_Tdd12.wfm file

Acquire references for measuring NEN at side B:

- Set the M1 math function to display a difference between C5 and C6
- Set the differential TDR step at channels C7 and C8
- Physically connect C5 to C7 and C6 to C8 using 2x traces at the DisplayPort test adaptor carefully mating SMA connectors
- Save instrument setup in a file (DP5_6_NEN34.stp)
- Press Run/Stop button to measure TDT response from slot 4 to slot 3
- Acquire the reference waveform (MATH1) with IConnect and save it as Ref_Tdd34.wfm file
- Disconnect the 2x traces of the test fixture from the SMA cables
- Press Run/Stop button to measure the noise in slot 3
- Acquire the noise reference waveform (MATH1) with IConnect and save it in Noise_Tdd41.wfm file

[8] The prop delay of the cable can be found by measuring the time difference between the open reference position and the rising edge of the TDT response. Alternatively it can be approximated from the physical length of the cable by assuming the step propagates 1 foot in 1ns. For example, if a cable is 10 feet long, the corresponding time window can be approximated as follows: 10feet*1ns/foot*5=50ns or 5ns/div

Measure the Near End Noise

Connect the test fixtures measurement instrument (if not connected already)
Carefully plug the cable into the test fixtures

Perform measurements of the Near End Noise at side A:

- Recall DP5_6_NEN12.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect
- Using Math function of IConnect subtract noise reference (Noise_Tdd12.wfm) from the MATH1 waveform and save it as NEN_Tdd12.wfm
- Using S-parameter computational function and Ref_Tdd12.wfm waveform compute S-parameter response
- Save the S-parameter response as Sdd12_NEN
- Using IConnect cursors measure the acquired waveform to test the compliance limits

Perform measurements of the Near End Noise at side B:

- Recall DP5_6_NEN34.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect
- Using Math function of IConnect subtract noise reference (Noise_Tdd34.wfm) from the MATH1 waveform and save it at NEN_Tdd34.wfm
- Using S-parameter computational function and Ref_Tdd34.wfm waveform compute S-parameter response
- Save the S-parameter response as Sdd34_NEN.wfm

Using IConnect cursors measure the acquired waveform to test the compliance limits.

Return Loss Measurements (5.7)

This test uses IConnect to compute frequency domain S-parameters. The implementation can be automated using GPIB interface to acquire the data and IConnect's CLI to compute S-parameters.

Set the TDR oscilloscope

Average Mode: 500 samples
Stop After Condition: Average Complete
Record Length: better than 4000pts per 50ns window
Horizontal scale: ~4-5 times prop delay of the cable[9]

Acquire references for measuring the return loss of lane 0 at side A:

- Set the M1 math function to display a difference between C1 and C2.
- Set the differential TDR step at channels C1 and C2
- Adjust the time window do display an open response from MATH1 in the middle of the leftmost division of the acquisition window.
- Acquire MATH1 with IConnect
- Save the resulting waveform as Ref_Tdd11.wfm
- Save instrument setup in a file (DP5_7_RL_line0.stp)

Acquire references for measuring the return loss of lane 1 at side A:

- Set the MATH2 math function to display a difference between C3 and C4.
- Set the differential TDR step at channels C3 and C4
- Adjust the time window do display an open response from MATH2 in the middle of the leftmost division of the acquisition window.
- Acquire the MATH2 with IConnect
- Using IConnect save the resulting waveform as Ref_Tdd22.wfm

Save instrument setup in a file (DP5_7_RL_line1.stp)

Measure the Return Loss

Connect the test fixtures measurement instrument (if not connected already)
Carefully plug the cable into the test fixtures

Perform measurements of the return loss of lane0 at side A:

- Recall DP5_7_RL_line0.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect and save it as Tdd11.wfm
- Using S-parameter computational tool load Ref_Tdd11.wfm and Tdd11.wfm into IConnect and compute the return loss.
- Save the waveform as Sdd11.wfm
- Using IConnect cursors measure the acquired waveform to test the compliance limits.

Perform measurements of the return loss of lane1 at side A:

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[9] The prop delay of the cable can be found by measuring the time difference between the open reference position and the rising edge of the TDT response. Alternatively it can be approximated from the physical length of the cable by assuming the step propagates 1 foot in 1ns. For example, if a cable is 10 feet long, the corresponding time window can be approximated as follows: 10feet*1ns/foot*5=50ns or 5ns/div

- Recall DP5_7_RL_line1.stp and press the RUN/STOP button
- Acquire MATH1 waveform with IConnect and save it as Tdd22.wfm
- Using S-parameter computational tool load Ref_Tdd22.wfm and Tdd22.wfm into IConnect and compute the return loss.
- Save the waveform as Sdd22.wfm
- Using IConnect cursors measure the acquired waveform to test the compliance limits.

Appendix A – Differential TDR Alignment and Acquisition Setup

Summary

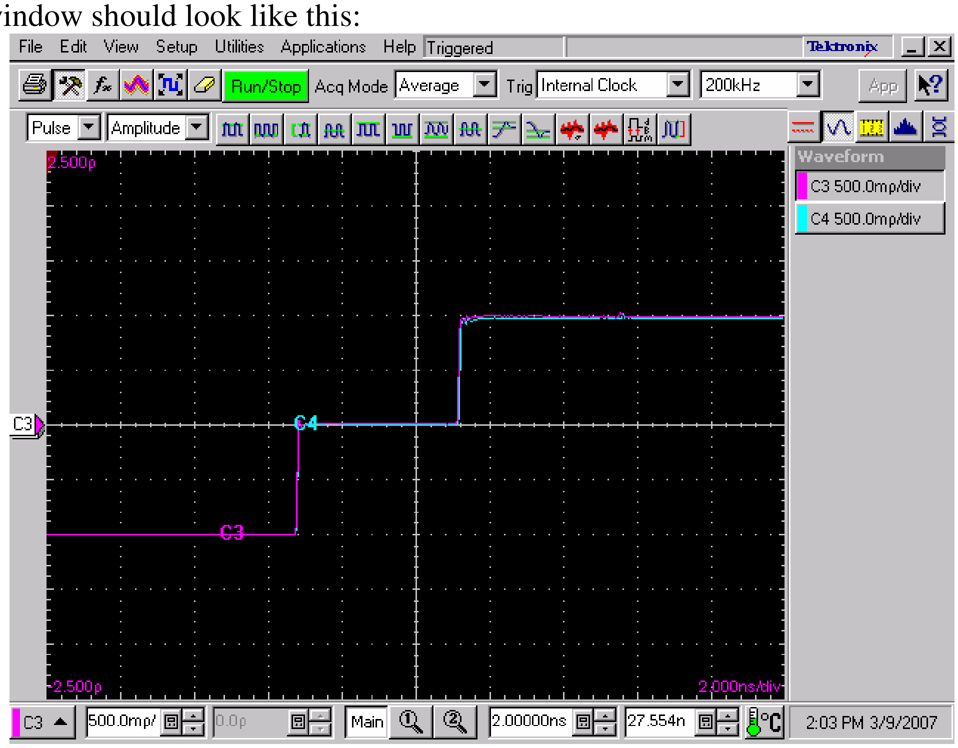
This procedure describes how to perform differential TDR deskew on a single 80E04 module installed on CSA/TDS/DSA8200 mainframe. The procedure is less accurate than the independent source deskew but provides a valuable alternative in cases when independent channel is not available. The differential deskew procedure can also be useful when it is desired to deskew at the end of the fixture or probe. The expected skew after performing this procedure is within 2ps for 80E04 module.

Deskew Procedure

1. Prepare the instrument:
    a. Perform compensation of the TDR module.
    b. Connect cables and fixtures or probes.

2. Display differential TDR steps
    a. Press **Default Setup** on the instrument's front panel.
    b. Activate TDR menu in **Setup**.
    c. Click on **Diff** button in **TDR Preset** field. Units should be set to ρ
    d. Change **Record Length** in **Horz** menu to 4000 points.

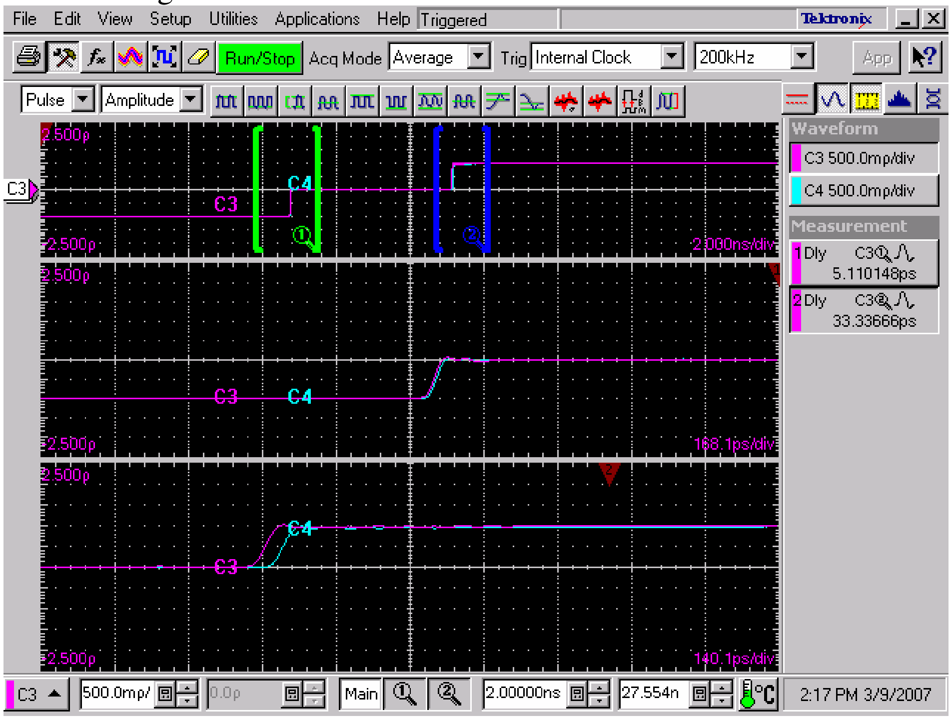
The resulting window should look like this:



3. Activate delay measurements in magnified time bases:
    a. Activate **Mag1TB** by clicking on **Toggle/Select Mag 1 Graticule** button, and zoom in on the first TDR step.

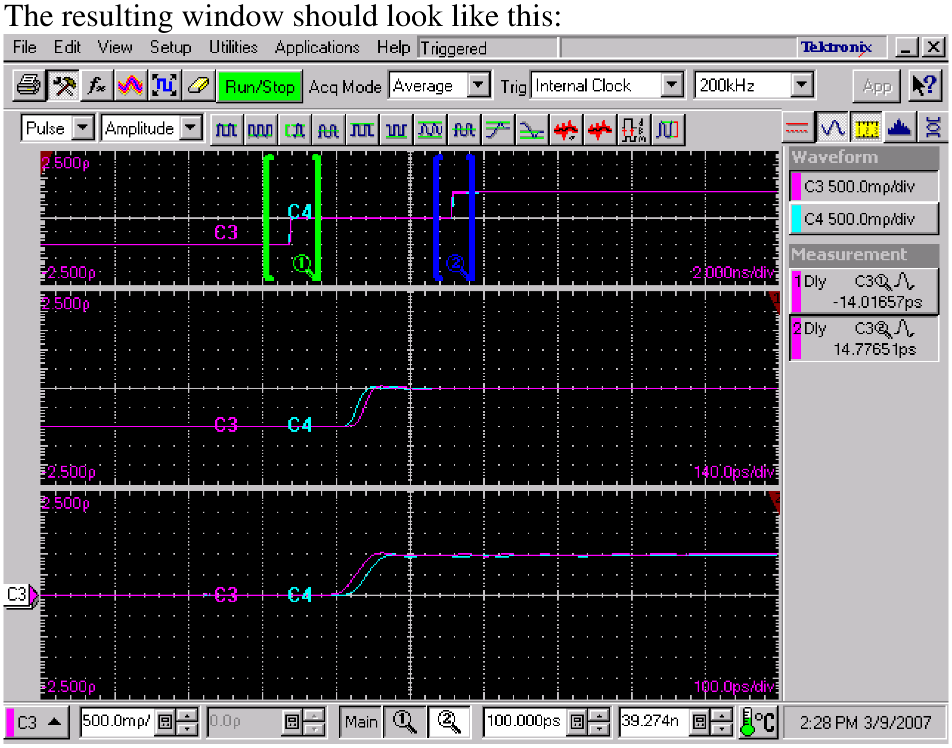
b. Activate **Mag2TB** by clicking on **Toggle/Select Mag 2 Graticule** button, and zoom in on the second TDR step.
c. Set time delay measurements to measure delay: delay 1 - between the channels in **Mag1TB** (first TDR step), and delay 2 - between the channels in **Mag2TB** (second TDR step).

The resulting window should look like this:



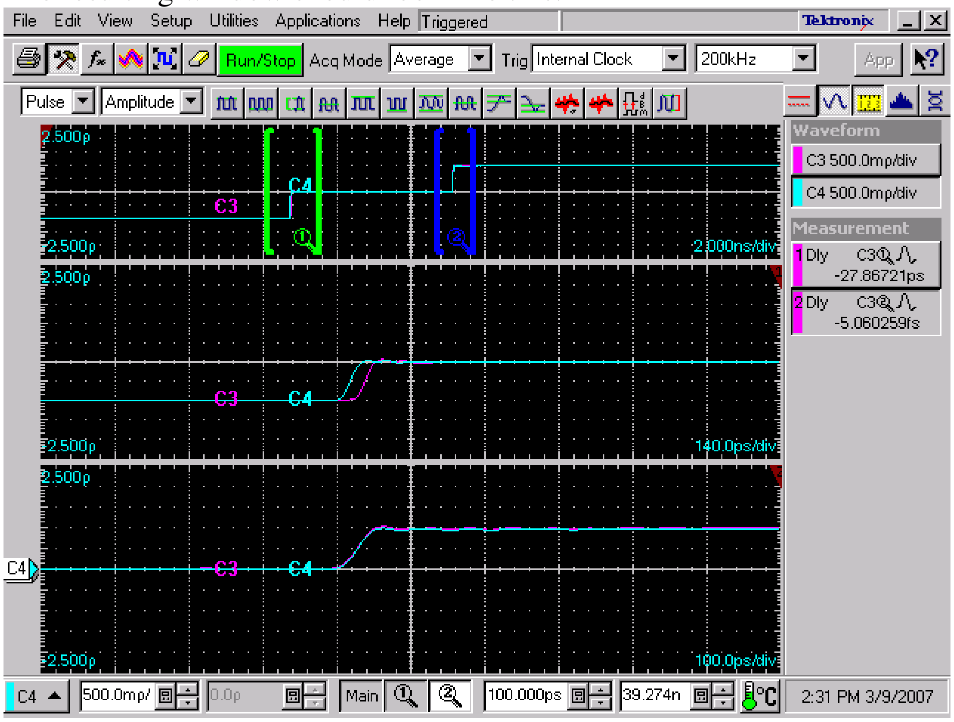
4. Perform TDR steps deskew:
    a. Adjust **Step Deskew** in TDR menu of **Setups** dialog to obtain absolute values of **1Dly** and **2Dly** equal approximately within 1ps.
    b. To get the best results you might want to use **Fine** button on the front panel of the instrument.

The resulting window should look like this:



5. Acquisition deskew:
    a. Adjust **2Dly** in **Vert** menu of **Setups** to be less than 1ps. You can adjust just one of the selected channels.
    b. To get the best results you might want to use **Fine** function of the instrument.

The resulting window should look like this:



6. The deskew is done. Turn off the **Mag1TB** and **Mag2TB** and save instrument settings. Accurately performed differential deskew procedure will deskew the channels within 2ps.

Appendix B - TDNA Measurement System Accuracy

Table B.1 summarizes characteristics of the TDNA system used for passive and active cable tests. The system is based on a standard 80E04 module that allows to perform both return and insertion loss measurements from time domain data.

Table B.1 TDR System Characteristics with a standard 80E04 module

Characteristics	Value
Input Impedance	50 ±0.5Ω
TDR Step Amplitude	250 mV
TDR System Reflected Rise Time (10% to 90%)	≤35 ps
TDR System Incident Rise Time (10% to 90%)	≤28 ps (typical)
TDR Step Maximum Repetition Rate	200 kHz
DC Vertical Range Accuracy within 2℃ of Compensated Temperature	±[2 mV + 0.007 (Offset) + 0.02 (Vertical Value-Offset)]
RMS Noise (typical/maximum)	600 µV/≤1.2 mV
Bandwidth	20GHz
Dynamic Range	50-60dB