Serial ATA
International Organization

Serial ATA Interoperability Program
Cable Test MOI for Agilent 86100C

TABLE OF CONTENTS

MODIFICATION RECORD

Revision	Description	By
0.1	Initial Release	J Most 2/10/2006
02	Section II change "near-end" to "mated", Section IX, change NEXT to test through both Receptacles ALL - clarify test steps	
0.3	Re-format for better thgouthput. Update Intra-Pair Skew measurement to divide by 2 to account for round-trip travel time. Update Differential Rise Time measurement to measure into a 50 ohm load (receiver) instead of an open.	J. Most 2/14/2006
0.4	Update Common Mode Impedance measurement to add the step to set responses to individual. Suggest 1-2 ns/div time base setting during each TDR cal to support wide range of cable lengths. Add note about using markers to set the measurement starting point at approximately 1.8 ns past the reference plane("after any vestige of the connector response") for Cable Differential Impedance, Cable Pair Matching and Common Mode Impedance Measurements.	J. Most 2/14/2006
0.9	Update equipment to reflect COMAX fixtures	J. Most 3/1/2006
0.9-1	Update reflecting 5 reviewers from Logo, CabCon: - Reference each test to the standard number (i.e. SI-08) - Add de-skew instructions to Appendix - Fix incorrect fixture P/N - Add description of Eye/Mask mode to ISI test - Point out measurement area of 500 ps where applicable - Change Intra-pair skew test to be done with 35ps rise time, not 70 ps	J. Most 3/31/2006
09-2	Update to reflect recent changes discussed in LOGO and in Unified Test Document, including: - Thru cal for rise time measurement uses barrel, not mated fixtures - Verify fixture NEXT as part of NEXT setup. Requires measuring mated fixtures (receptacle and plug and NO DUT) to ensure NEXT of fixture is -36 dB. To be done with EACH plug fixture (while mated to a receptacle). - Add requirement to capture at least 4X cable electrical length in time domain - Add requirement to verify NEXT of fixtures if a DUT fails the NEXT test	J.Most 5/12/2006
09-3	Add names of reviewers under *Acknowledgments* Update to reflect feedback received during LOGO review 5/25 and 5/30: - Fix typo in modification record for rev 9-2 – fixture NEXT to be -36 dB, not -37 dB - Change P/N of COMAX fixtures to reflect new, NEXT enhanced fixtures. - Change description of the Generator used in ISI test from "PRBS Generator" to "Pulse Pattern Generator" under *Resource Requirements* and in sections IG (ISI Set-up) and VII (ISI Measurement).	J. Most 5/30/06
1.0RC	Change revision to reflect approval by Logo Committee	J. Most 6/1/2006

ACKNOWLEDGMENTS

The SATA-IO would like to acknowledge the efforts of the following individuals in the development of this test suite.

Jeff Most, Agilent Technologies

Reviewed by:
      Brian Dees, Intel
      Steven Wong, COMAX
      Peter Deyring, Cruz Systems
      Andy Baldman, University of New Hampshire Interoperability Laboratory
      Sophia Liu, ETC

Purpose

This test procedure was written to explain how to use the Agilent 86100C DCA-J to make the measurements required per the Serial ATA specification rev 2.5 for internal Cable and connectors.

This procedure is formatted to group tests with similar set-up and connection requirements together. Test throughput can be improved by further optimizing this grouping and automating the process.

References

Serial ATA Revision 2.5
Serial ATA Interoperability Program Unified Test Document Revision 1.0RC2j
86100C DCA-J Differential TDR Deskew procedure

Resource Requirements

1-Agilent 86100C DCA-J with options 001, 200 and 202
2-Agilent 54754A TDR modules
7-high quality SMA cables
2 - Coax style SATA Cable test fixtures, Plug side, COMAX P/N H303000104A, distributed by Cruz Systems
1 - Coax style SATA Cable test fixture, Receptacle side, COMAX P/N H303000204A, distributed by Cruz Systems
1 – 5/16 inch torque wrench for SMA cables
1 – ¼ inch open end wrench
1 – Agilent N1024A Cal Kit
1 – Low jitter 3Gb/s Differential Pattern Generator such as the Agilent 81134A

Last Modification

- Change revision to reflect approval by Logo Committee

Procedure

I   Initial Set-up and Calibration

    A.   Instrument User Calibration and hook-up

        1   Remove all cables from the instrument and press the Default Setup button

        2   Ensure the DCA-J has been running for at least 1 hour for proper warm-up.

        3   Perform a module calibration for each measurement module

            (a)   Touch the calibrate drop-down menu

            (b)   Touch "all calibrations"

            (c)   Touch "calibrate left module" and follow prompts

            (d)   Touch "calibrate right module" and follow prompts

        4   Using the torque wrench, connect cables to channels 1,2,3 and 4.

    B.   Deskew for TDR

        1   Press the "TDR/TDT" button on the front panel to get into TDR mode

        2   Set averaging to 64:

            (a)   From the drop down menu choose "Setup" then "Averaging"

            (b)   In the "Number of Averages" box enter 64

        3   Deskew both pairs of cables using the procedure for TDR deskew found in the 86100C on-line help (Help-Contents-S-Skew-Differential TDR Skew) or refer to Appendix A. Save screen shots from each de-skewed pair

        4   Set averaging back to 16

    C.   Differential set-up for SATA cable pair "A" (2-3)

        1   Touch the TDR Set-Up icon on the left side of the screen

        2   Set-up the TDR for a two port device with differential stimulus (channels 1 and 2) and display the differential TDRresponse.

        3   Calibration

            (a)   Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process.

            (b)   Use the SHORTS and LOADS from the N1024A Cal Kit. Note that a 1 or 2 ns/div time base setting during the cal process allows for testing a wide range of cable lengths.

        4   Establish a differential stimulus rise time of 70 ps:

            (a)   Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the differential stimulus.

            (b)   Touch the "setup/info" button to the right of the measurement results, choose "Configure Meas…" and choose 20%,50%,80% for the threshold.

            (c)   Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 70 ps (set to $70 + 0 – 5$ ps). Save a screen shot.

            (d)   Change the units of channels 1 and 2 to ohms.

        5   Save Configuration

            (a)   Save the set-up as "Pair A"

            (b)   Save the cal as "Pair A"

    D.   Differential set-up for SATA cable pair "B" (5-6)

        1   Touch the TDR Set-Up icon on the left side of the screen

         2   Set-up the TDR for a two port device with differential stimulus (channels 3 and 4) and display the differential TDRresponse.

         3   Calibration

             (a)   Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process.

            (b)   Use the SHORTS and LOADS from the N1024A Cal Kit. Note that a 1 or 2 ns/div time base setting during the cal process allows for testing a wide range of cable lengths.

        4   Establish a differential stimulus rise time of 70 ps:

            (a)   Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the differential stimulus (should already be configured for a 20-80 measurement).

            (b)   Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 70 ps (set to $70 + 0 – 5$ ps). Save a screen shot.

            (c)   Change the units of channels 3 and 4 to ohms.

5   Save Configuration
    (a) Save the set-up as "Pair B"
    (b) Save the cal as "Pair B"

E.   Single-ended Impedance Setups
    1   Z1
       (a) Touch the TDR set-up icon on the left side of the screen
          (i)   Set up the TDR for a 1 port device with single ended stimulus using channel 1.
          (ii) Turn on the stimulus for channel 1.
          (iii) Turn on the SE TDR response
       (b) Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process. Use the SHORTS and LOADS from the N1024A Cal Kit, as needed. Note that a 1 or 2 ns/div time base setting during the cal process allows for testing a wide range of cable lengths.
       (c) Establish a stimulus rise time of 70 ps:
          (i)   Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the stimulus (should already be configured for a 20-80 measurement).
          (ii) Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 70 ps (set to 70 + 0 – 5 ps). Save a screen shot.
       (d) Change the units of channel 1 to ohms.
       (e) Save the set-up as "Z1"
       (f) Save the calibration as "Z1"
    2   Z2
       (a) Touch the TDR set-up icon on the left side of the screen
          (i)   Set up the TDR for a 1 port device with single ended stimulus using channel 2.
          (ii) Turn on the stimulus for channel 2.
          (iii) Turn on the SE TDR response
       (b) Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process. Use the SHORTS and LOADS from the N1024A Cal Kit, as needed. Note that a 1 or 2 ns/div time base setting during the cal process allows for testing a wide range of cable lengths.
       (c) Establish a stimulus rise time of 70 ps:
          (i)   Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the stimulus (should already be configured for a 20-80 measurement).
          (ii) Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 70 ps (set to 70 + 0 – 5 ps). Save a screen shot.
       (d) Change the units of channel 2 to ohms.
       (e) Save the set-up as "Z2"
       (f) Save the calibration as "Z2"
    3   Z3
       (a) Touch the TDR set-up icon on the left side of the screen
          (i)   Set up the TDR for a 1 port device with single ended stimulus using channel 3.
          (ii) Turn on the stimulus for channel 3.
          (iii) Turn on the SE TDR response
       (b) Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process. Use the SHORTS and LOADS from the N1024A Cal Kit, as needed. Note that a 1 or 2 ns/div time base setting during the cal process allows for testing a wide range of cable lengths.
       (c) Establish a stimulus rise time of 70 ps:
          (i)   Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the stimulus (should already be configured for a 20-80 measurement).
          (ii) Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 70 ps (set to 70 + 0 – 5 ps). Save a screen shot.
       (d) Change the units of channel 3 to ohms.
       (e) Save the set-up as "Z3"
       (f) Save the calibration as "Z3"
    4   Z4
       (a) Touch the TDR set-up icon on the left side of the screen
          (i)   Set up the TDR for a 1 port device with single ended stimulus using channel 4.
          (ii) Turn on the stimulus for channel 4.

(iii) Turn on the SE TDR response
- (b) Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process. Use the SHORTS and LOADS from the N1024A Cal Kit, as needed. Note that a 1 or 2 ns/div time base setting during the cal process allows for testing a wide range of cable lengths.
- (c) Establish a stimulus rise time of 70 ps:
    - (i) Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the stimulus (should already be configured for a 20-80 measurement).
    - (ii) Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 70 ps (set to 70 + 0 – 5 ps). Save a screen shot.
- (d) Change the units of channel 4 to ohms.
- (e) Save the set-up as "Z4"
- (f) Save the calibration as "Z4"

F. Thru Measurement set-ups:
1 Touch the TDR Set-Up icon on the left side of the screen
2 Set-up the TDR for a four port device with differential stimulus (channels 1 and 2) and display the differential responses.
3 Deskew for TDT
- (a) Set averaging to 64:
    - (i) From the drop down menu choose "Setup" then "Averaging"
    - (ii) In the "Number of Averages" box enter 64
- (b) Configure for a TDT skew measurement
    - (i) Connect channels 1 and 3 together using a barrel from the Cal Kit.
    - (ii) Connect channels 2 and 4 together using the other barrel from the Cal Kit.
- (c) Deskew following the procedures in 86100C on-line help (Help-Contests-S-Skew-Differential TDR Skew) or refer to the instructions in Appendix A. Save a screen shot.
- (d) Disconnect the channels from each other and remove the barrels
- (e) Set averaging back to 16
4 Insertion Loss and Skew
- (a) In the TDR setup screen, clear the calibration data
- (b) Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process. Note that a 1 or 2 ns/div time base setting during the cal process allows for testing a wide range of cable lengths.
    - (i) Use the SHORTS and LOADS from the N1024A Cal Kit
    - (ii) When performing a "thru" calibration (connecting channel 1 to channel 3 and channel 2 to channel 4):
        - (i) Connect channels 1 and 2 to Pair A of a fixture with a plug
        - (ii) Connect channels 3 and 4 to Pair A of a fixture with a receptacle.
        - (iii) Connect the fixtures together
- (c) Establish a stimulus rise time of 35 ps:
    - (i) Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the differential stimulus (should already be configured for a 20-80 measurement).
    - (ii) Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 25 to 35 ps. Save a screen shot.
    - (iii) Remove the fixtures.
- (d) Save Configuration
    - (i) Save the set-up as "IL&SKEW"
    - (ii) Save the calibration as "IL&SKEW "
5 NEXT and Differential Rise Time
- (a) From the TDT/TDR Setup screen touch the "Clear Cal Data" button to reset the TDR cal.
- (b) Set the time base for 3 ns/div
- (c) Touch the Calibration Wizard icon at the bottom of the set-up screen which will guide you through the TDR calibration process.
    - (i) Use the SHORTS and LOADS from the N1024A Cal Kit
    - (ii) When performing a "thru" calibration, connect channel 1 to channel 3 using a barrel from the cal kit and connect channel 2 to channel 4 using the second barrel from the cal kit.
- (d) Establish a stimulus rise time of 35 ps:

> (i) Touch the "Measure" tab on the left side of the screen and choose "rise time" to measure the rise time of the differential stimulus (should already be configured for a 20-80 measurement).
> (ii) Go back to the TDR SET-Up screen and adjust the effective rise time until the measured rise time is 25 to 35 ps. Save a screen shot.

(e) Save Configuration
- (i) Save the set-up as "NEXT&DRT"
- (ii) Save the calibration as "NEXT&DRT "

(f) Verify NEXT of the fixtures.
- (i) Connect the DCA-J to one of the plug fixtures: CH1 to line 2, CH2 to line 3, CH3 to line 5, CH4 to line6.
- (ii) Plug the receptacle fixture into the plug fixture and terminate the 4 SMA lines from the receptacle fixture with 50 ohm loads
- (iii) Measure NEXT per step VI of this procedure.
- (iv) Adjust the time base to display frequencies up to 5 or 10GHz. Ensure the maximum NEXT between 10 MHZ and 4500 MHz is < or = -36 dB. Save a screen shot.
- (v) Remove the first plug fixture, replace it with the second plug fixture and repeat the measurement. Save a screen shot.
- (vi) Any fixture not meeting the requirement cannot be used to test cables for NEXT.

G. ISI Setup for PG

1. Configure the Pulse Pattern Generator for differential data, 500 mV p-p, 3 Gb/s, "lone" bit pattern (see 7.2.4.3.5 of SATA spec).
2. Turn off the outputs of the PG.
3. Save the setup as "SATA ISI"

H. ISI Setup for DCA-J, Pair A

1. Press the Eye/Mask button
2. Set-up a differential trace
   - (a) Touch the "Measure" drop down menu, then select "Math"
   - (b) Turn on function 3, choose "subtract" as the operator, "Channel 1" as Source 1 and "Channel 2" as source 2.
   - (c) Close the Math dialog box
3. On the front panel, turn off all channels so only the Math function is displayed on the screen.
4. Save the setup as "SATA ISI A"

I. ISI Setup for DCA-J, Pair B

1. Press the Eye/Mask button
2. Set-up a differential trace
   - (a) Touch the "Measure" drop down menu, then select "Math"
   - (b) Turn on function 1, choose "subtract" as the operator, "Channel 3" as Source 1 and "Channel 4" as source 2.
   - (c) Close the Math dialog box
3. On the front panel, turn off all channels so only the Math function is displayed on the screen.
4. Save the setup as "SATA ISI B"

II **Mated Connector Impedance (SI-01) Cable Absolute Impedance (SI-02) and Common Mode Impedance (SI-04), Pair A**

  A. Set-up
1. Connect cables to the plug fixture (ch1 to line2, ch2 to line 3, ch3 to line 5, ch4 to line 6).
2. Recall set-up for Pair A
    (a) Touch the file drop down menu
    (b) Choose "open" then "Instrument Setup" then "Pair A .set"
    (c) Choose "open" then "TDR/TDT Calibration" then "Pair A.tdr"

  B. Measure Mated Connector Impedance (SI-01), Receptacle B, Pair A
1. Plug-in receptacle B
2. Adjust the scope timebase and delay to display the mated connector impedance on the screen.
3. Using the min/max measurement functions, measure and record the maximum and minimum values of mated connector differential impedance. Save a screen shot.
4. Observable Results: Mated connector differential impedance must be 100 ohms $\pm$ 15%

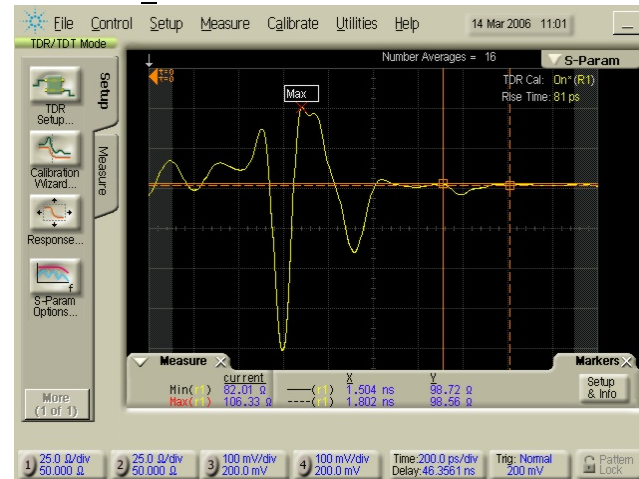 **C. Measure Mated Connector Impedance (SI-01), Receptacle A, Pair A**
1. Unplug DUT receptacle B, plug in receptacle A
2. Adjust the scope timebase and delay to display the mated connector impedance on the screen.
3. Using the min/max measurement functions, measure and record the maximum and minimum values of mated connector differential impedance. Save a screen shot.
4. Observable Results: Mated connector differential impedance must be 100 ohms $\pm$ 15%

  D. Measure Cable Absolute Differential Impedance (SI-02), Receptacle A, Pair A
1. Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. You can use a vertical marker to tag the point on the trace where you want to start the measurement (typically 1.5 to 1.8 ns beyond the reference plane - see picture at right), move that point to the left of the screen and set the time/div to 50 ps.

2. Using the min/max measurement functions measure and record the minimum and maximum differential impedance. Save a screen shot.
3. Observable Results: Cable absolute differential impedance must be 100 ohms $\pm$ 10%

  E. Measure Common Mode Impedance (SI-04), Receptacle A, Pair A
1. Set-up for Common Mode:
    (a) Click the Setup tab
    (b) Touch the TDR set-up icon on the left side of the screen
        (i) Change stimulus to common mode
        (ii) Close the set-up screen
    (c) Touch the TDR response icon on the let side of the screen
        (i) Set response 1 to individual and turn it on
        (ii) Set response 2 to individual and turn it on
2. Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. (See step IID1).
3. Using the average measurement function measure and note the average impedance for response 1 (line 2) and response 2 (line 3). That is the average even mode impedance for each line. Save a screen shot.
4. Divide the average even mode impedance for each line by 2 and record the values. This is what the standard calls the "Common Mode Impedance".
5. Observable Results: Common Mode Impedance must be 25-40 ohms.

III **Mated Connector Impedance (SI-01) Cable Absolute Impedance (SI-02) and Common Mode Impedance (SI-04), Pair B**

  A. Set-up
Recall set-up for Pair B
1. Touch the file drop down menu
2. Choose "open" then "Instrument Setup" then "Pair B .set"
3. Choose "open" then "TDR/TDT Calibration" then "Pair B.tdr"

B. Measure Mated Connector Impedance (SI-01), Receptacle B, Pair B
   1   Plug-in receptacle B
   2   Adjust the scope timebase and delay to display the mated connector impedance on the screen.
   3   Using the min/max measurement functions, measure and record the maximum and minimum values of mated connector differential impedance for receptacle B, Pair B Save a screen shot.
   4   Observable Results: Mated connector differential impedance must be 100 ohms $\pm$ 15%

C. Measure Mated Connector Impedance (SI-01), Receptacle A, Pair B
   1   Unplug DUT receptacle B, plug in receptacle A
   2   Adjust the scope timebase and delay to display the mated connector impedance on the screen.
   3   Using the min/max measurement functions, measure and record the maximum and minimum values of mated connector differential impedance. Save a screen shot.
   4   Observable Results: Mated connector differential impedance must be 100 ohms $\pm$ 15%

D. Measure Cable Absolute Differential Impedance (SI-02), Receptacle A, Pair B
   1   Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. (see step IID1).
   2   Using the min/max measurement functions measure and record the minimum and maximum differential impedance. Save a screen shot.
   3   Observable Results: Cable absolute differential impedance must be 100 ohms $\pm$ 10%

E. Measure Common Mode Impedance (SI-04), Receptacle A, Pair B
   1   Set-up for Common Mode:
       (a) Click the Setup tab
       (b) Touch the TDR set-up icon on the left side of the screen
          (i) Change stimulus to common mode
          (ii) Close the set-up screen
       (c) Touch the TDR response icon on the let side of the screen
          (i) Set response 3 to individual and turn it on
          (ii) Set response 4 to individual and turn it on
   2   Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. You can use a vertical marker to tag the point on the trace where you want to start the measurement (typically 1.5 to 1.8 ns beyond the reference plane), move that point to the left of the screen and set the time/div to 50 ps.
   3   Using the average measurement function measure and note the average impedance for response 3 (line 5) and response 4 (line 6). That is the average even mode impedance for each line. Save a screen shot.
   4   Divide the average even mode impedance for each line by 2 and record the values. This is what the standard calls the "Common Mode Impedance".
   5   Observable Results: Common Mode Impedance must be 25-40 ohms.

IV Measure Cable Pair Matching (SI-03), Receptacle A, Pair A
A. Single-ended impedance, Z1
   1   Recall set-up
       (a) Touch the file drop down menu
       (b) Choose "open" then "Instrument Setup" then "Z1.set"
       (c) Choose "open" then "TDR/TDT Calibration" then "Z1.tdr"
   2   Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. (See step IID1).
   3   Using the min/max measurement functions measure and note the minimum and maximum impedance for channel 1 (Z1 min and Z1 max). Save a screen shot.

B. Single-ended impedance, Z2
   1   Recall set-up
       (a) Touch the file drop down menu
       (b) Choose "open" then "Instrument Setup" then "Z2.set"
       (c) Choose "open" then "TDR/TDT Calibration" then "Z2.tdr"
   2   Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. (See step IID1).
   3   Using the min/max measurement functions measure and note the minimum and maximum impedance for channel 2 (Z2 min Z2 and max). Save a screen shot.

C. Calculate and record the Match for Pair A: ZAmax =Z1max-Z2max and ZAmin=Z1min-Z2min.
D. Observable Results: Cable pair match must be $\pm$ 5 ohms

V Measure Cable Pair Matching (SI-03), Receptacle A, Pair B
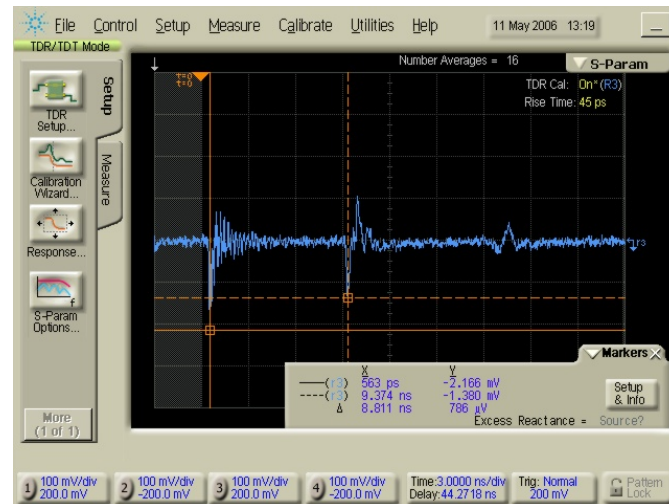A. Single-ended impedance, Z3
   1 Recall set-up
      (a) Touch the file drop down menu
      (b) Choose "open" then "Instrument Setup" then "Z3.set"
      (c) Choose "open" then "TDR/TDT Calibration" then "Z3.tdr"
   2 Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. (See step IID1).
   3 Using the min/max measurement functions measure and note the minimum and maximum impedance for channel 3 (Z3 min and Z3 max). Save a screen shot.
B. Single-ended impedance, Z4
   1 Recall set-up
      (a) Touch the file drop down menu
      (b) Choose "open" then "Instrument Setup" then "Z4.set"
      (c) Choose "open" then "TDR/TDT Calibration" then "Z4.tdr"
   2 Adjust the scope delay and time base to show the first 500 ps of cable response after any vestige of the connector response. (See step IID1).
   3 Using the min/max measurement functions measure and note the minimum and maximum impedance for channel 4 (Z4 min Z4 and max). Save a screen shot.
C. Calculate and record the Match for Pair B: ZBmax =Z3max-Z4max and ZBmin=Z3min-Z4min.
D. Observable Results: Cable pair match must be $\pm$ 5 ohms

VI Measure Differential to Differential Cross Talk: NEXT (SI-08)
A. Set-up
   1 Connect a second plug fixture to receptacle B of the DUT and install 50 ohm loads on each of the 4 lines
   2 Recall set-up
      (a) Touch the file drop down menu
      (b) Choose "open" then "Instrument Setup" then "NEXT&DRT .set"
      (c) Choose "open" then "TDR/TDT Calibration" then "NEXT&DRT .tdr"
B. Measure NEXT (SI-08) Receptacle A:
   1 Display the differential TDT response and adjust the time/div to display 4-6X the cable length on the screen (see picture at right, markers at start and 2X).
   2 Wait for 16 averages to complete, touch the S-Parameter tab on the top of the display and the shade will drop down displaying NEXT.
   3 Adjust the time base to display frequencies up to 5 or 10 GHz.
   4 Using a marker, find and record the maximum NEXT between 10 MHZ and 4500 MHz. Save a screen shot.
C. Measure NEXT (SI-08) Receptacle B:
   1 Remove the DUT and plug receptacle B of the DUT into the fixture connected to the scope, receptacle A into the fixture with the loads.
   2 Display the differential TDT response , wait for 16 averages to complete, touch the S-Parameter tab on the top of the display and the shade will drop down displaying NEXT.
   3 Adjust the time base to display frequencies up to 5 or 10 GHz.
   4 Using a marker, find and record the maximum NEXT between 10 MHZ and 4500 MHz. Save a screen shot.
D. If the cable fails the NEXT test in either direction, re-verify the NEXT of the fixtures used per step IF5f of this procedure
E. Observable Results: Differential to Differential Cross Talk from 10 to 4500 MHz must be less than -26 dB.

VII Inter-Symbol Interference (SI-09) for Pairs A and B

A. Setup for Pair A:
    1   On the PPG, recall setup "SATA ISI"
    2   On the DCA-J recall setup "SATA ISI A"
        (a)   Touch the file drop down menu
        (b)   Choose "open" then "Instrument Setup" then "SATA ISI A"
    3   Disconnect the loads from the fixture on receptacle A and connect the differential outputs of the PPG to Pair A (lines 2 and 3) of the same fixture.
    4   Turn on the data outputs of the PPG
B. Measure ISI (SI-09) for Pair A
    1   Press the Jitter button. The DCA-J will determine the data rate and clock rate and the jitter shade will drop displaying jitter graphs and the jitter data table
    2   From the table record the value for ISI. Save a screen shot.
    3   Turn off the outputs of the PG.
C. Setup For Pair B:
    1   On the DCA-J recall setup "SATA ISI B"
        (a)   Touch the file drop down menu
        (b)   Choose "open" then "Instrument Setup" then "SATA ISI B"
    2   Disconnect the differential outputs of the PPG from Pair A of the fixture on Receptacle A and connect them to Pair B (lines 5 and 6) of the same fixture.
    3   Turn on the outputs of thePPG.
D. Measure ISI (SI-09) for Pair B
    1   Press the Jitter button. The DCA-J will determine the data rate and clock rate and the jitter shade will drop displaying jitter graphs and the jitter data table
    2   From the table record the value for ISI Save a screen shot..
    3   Turn off the outputs of the PG and disconnect it from the fixture.
E. Observable Results: Inter-Symbol Interference must be less than 50 ps

VIII   Insertion Loss (SI-07), Differential Rise Time (SI-05), and Intra-Pair Skew (SI-06), Receptacle A, Pair A
A. Differential Rise Time Set-up
    1   Connect scope channels 1 and 2 to pair A on the fixture (ch1 to line 2, ch2 to line3) plugged into Receptacle A of the DUT.
    2   Connect scope channels 3 and 4 to Pair A on the fixture (ch3 to line 2, ch 4 to line 3) plugged into receptacle B of the DUT.
    3   Recall set-up
        (a)   Touch the file drop down menu
        (b)   Choose "open" then "Instrument Setup" then "NEXT&DRT.set"
        (c)   Choose "open" then "TDR/TDT Calibration" then "NEXT&DRT.tdr"
B. Measure Differential Rise Time (SI-05)
    1   Using the rise time measurement, measure and record the rise time of the differential response. Save a screen shot.
    2   Observable results: Differential Rise Time must be less than or equal to 85 ps.
C. Recall the Insertion Loss and Differential Skew Set-up
    1   Touch the file drop down menu
    2   Choose "open" then "Instrument Setup" then "IL&SKEW.set"
    3   Choose "open" then "TDR/TDT Calibration" then "IL&SKEW.tdr"
D. Measure Insertion Loss (SI-07)
    1   Dieplay the TDT response, wait for 16 averages to complete, touch the S-Parameter tab on the top of the display. The shade will drop down displaying Insertion Loss.
    2   Adjust the time base to display frequencies up to 5 or 10GHz. Using a marker, find and record the maximum Insertion Loss between 10 MHZ and 4500 MHz. Save a screen shot.
    3   Observable Results: Insertion Loss from 10 to 4500 Mhz must be less than or equal to 6 dB
    4   Touch the S-Parameter tab at the bottom of the shade to raise the shade.
E. Measure Intra-Pair Skew (SI-06)
    1   Unplug the cable from the fixture connected to channels 3 and 4.
    2   Go to the response menu and select "individual" for channels 1 and 2 and turn both responses on.
    3   Using the delta time measurement, measure the skew between responses 1 and 2 (it may be negative) as the step exits the cable. Since the measurement includes transit time to the cable end and back, divide the measured value by 2. This is the OUTPUT skew. Note the value and save a screen shot.

4   Remove the cable and, using the delta time measurement, measure the skew between responses 1 and 2 (it may be negative) as the step exits the fixture. Since the measurement includes transit time to the fixture end and back, divide the measured value by 2. This is the INPUT skew. Note the value and save a screen shot.

5   Calculate the Intra-pair Skew as ABS(Input Skew-Output Skew)

6   Observable results: Intra-Pair skew must be less than or equal to 10 ps.

IX Insertion Loss (SI-07), Differential Rise Time (SI-05) and Intra-Pair Skew (SI-06), Receptacle A, Pair B

A. Differential Rise Time Setup
   1. Disconnect scope channels 1 and 2 from lines 2 and 3 of the fixture for receptacle A and install them on lines 5 and 6 of the same fixture (ch1 to line 5, ch2 to line 6).
   2. Disconnect scope channels 3 and 4 from lines 2 and 3 of the plug fixture for receptacle B and install them on lines 5 and 6 of the same fixture (ch3 to line 5, ch4 to line 6)
   3. Recall set-up
      (a) Touch the file drop down menu
      (b) Choose "open" then "Instrument Setup" then "NEXT&DRT.set"
      (c) Choose "open" then "TDR/TDT Calibration" then "NEXT&DRT.tdr"

B. Measure Differential Rise Time (SI-05)
   1. Using the rise time measurement, measure and record the rise time of the differential response. Save a screen shot.
   2. Observable results: Differential Rise Time must be less than or equal to 85 ps

C. Recall the Insertion Loss and Differential Skew Set-up
   1. Touch the file drop down menu
   2. Choose "open" then "Instrument Setup" then "IL&SKEW.set"
   3. Choose "open" then "TDR/TDT Calibration" then "IL&SKEW.tdr"

D. Measure Insertion Loss (SI-07)
   1. Display the TDT response, wait for 16 averages to complete, touch the S-Parameter tab on the top of the display. The shade will drop down displaying Insertion Loss.
   2. Adjust the time base to display frequencies up to 5 or 10 GHz. Using a marker, find and record the maximum Insertion Loss between 10 MHZ and 4500 MHz. Save a screen shot.
   3. Observable Results: Insertion Loss from 10 to 4500 MHz must be less than or equal to 6 dB
   4. Touch the S-Parameter tab at the bottom of the shade to raise the shade.

E. Measure Intra-Pair Skew (SI-06)
   1. Unplug the cable from the fixture connected to channels 3 and 4.
   2. Go to the response menu and select "individual" for channels 1 and 2 and turn both responses on
   3. Using the delta time measurement, measure the skew between responses 1 and 2 (it may be negative) as the step exits the cable. Since the measurement includes transit time to the cable end and back, divide the measured value by 2. This is the OUTPUT skew. Note the value and save a screen shot.
   4. Remove the cable and, using the delta time measurement, measure the skew between responses 1 and 2 (it may be negative) as the step exits the fixture. Since the measurement includes transit time to the fixture end and back, divide the measured value by 2. This is the INPUT skew. Note the value and save a screen shot.
   5. Calculate the Intra-pair Skew as ABS(Input Skew-Output Skew)
   6. Observable results: Intra-Pair skew must be less than or equal to 10 ps.

Appendix A TDR/TDT Deskew

Differential TDR Skew

Differential TDR skew allows you to use two cables of unequal lengths to make differential or common stimulus measurements. This button is only visible in the setup wizard when differential or common stimulus is selected. Also, the button can not be selected if the stimulus is turned off.

The actual skew adjustment consists of applying equal amounts of TDR and Horizontal skew to minimize round-trip measurement errors. During the skew adjustment, only the front-panel time-per-division, time delay, and autoscale functions are active. After adjusting the skew, you can continue to make selections in the Setup Wizard.

When you know the propagation delay (Δ) of the longer cable, enter 50% of that value in the **Horizontal Skew** box for the channel the cable is connected to. In the **TDR Skew** box for the same channel, enter the negative percentage value necessary to completely skew the delay until the apparent delay of both cables is equal.
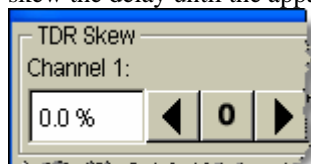
TDR skew regulates the time differential between the launches of TDR steps.
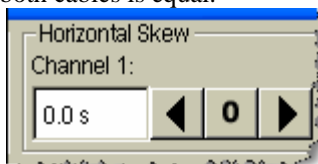
Horizontal skew adjusts the time differential between sampling for both channels and changes the timebase delay for an individual target channel.

Once you have entered the correct values needed for TDR and Horizontal skew, you can save your settings in an instrument setup file. Saving the setup allows you to avoid repeating the propagation measurement when using the same cables in the future.

> Follow the TDR and TDT skew procedures carefully. The procedures are not difficult to follow. Improperly performed skew adjustments can result in unexpected measurement behavior.
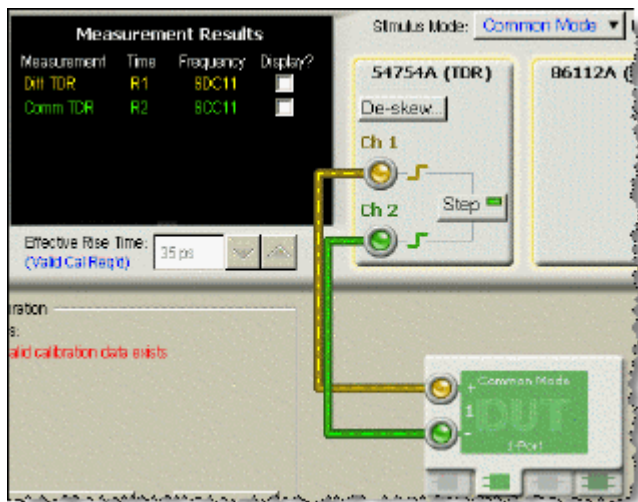
To adjust differential TDR skew

Use this procedure to compensate for unequal cable lengths in differential TDR test setups. Skew adjustments can only be performed when differential or common stimulus is active on differential TDR modules.

1. In order to match the steps in this procedure, install the TDR module in the mainframe's left slot. Although this procedure uses channels 1 and 2, you could install the module in the right slot and use channels 3 and 4.

2. Turn on the instrument, and allow the instrument to warm up for one hour.

3. Press the **Default Setup** button.

4. Press the **TDR/TDT Mode** button.

5. On the **Calibrate** menu, click **All Calibrations**. Select the **Modules** tab.

6. Click **Calibrate Left Module** to calibrate the TDR module. Follow any prompts to complete the calibration. When prompted to connect high quality termination, enter the measured resistance of the load termination. Always use high quality terminations for the best results.

7. Optional step to make waveforms easier to view: On the **Setup** toolbar, click on **S-Param Options**, if it is displayed. In the dialog box, clear the **Show Windowed Region** and click **Close**. This feature is only installed on instruments having Option 202, Enhanced Impedance and S-Parameter Software.

8. Connect the test setup cables and adapters for your test setup. The end of the cables will be the measurement reference plane, where you will connect your test device. Do not connect the test device.
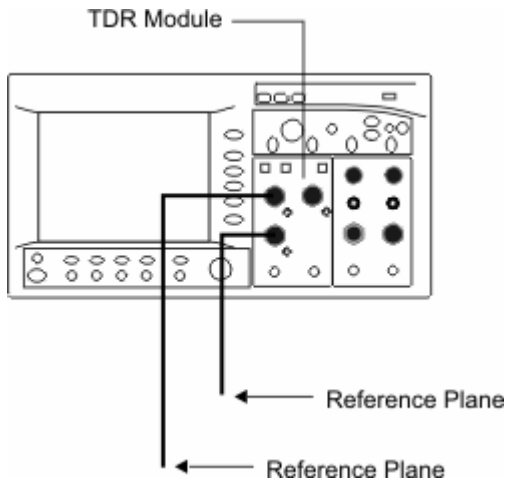
9. On the **Setup** toolbar, click **TDR Setup**.

10. In the dialog box, select the one-port balanced test device with the connections as shown in the following figure. For **Stimulus Mode**, select **Common** or **Differential**, as the procedure for either stimulus is the same. The pictures in this topic were taken with **Common** stimulus. You can also change the stimulus after completing this procedure.

11. Clear all the measurements listed in **Measurement Results**.

12. Click **De-skew**. The **Differential TDR Skew** dialog box is displayed, and the **Stop** and **Start** marker annotations are placed on the waveform.
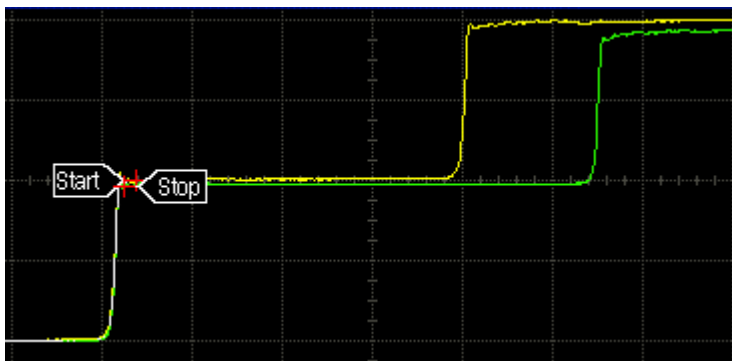

13. If the markers are located on the incident (first) step response as shown above, you must move them to the reflected (second) step response. Adjust the horizontal position knob to move the incident step response off the left edge of the display. The markers will automatically move to the reflected step response.

14. In the **Measure** table, locate the **mean** delta time value. This represents the added travel time (out and back) introduced by the additional cable length.

15. Identify the channel with the longest path (waveform closest to the display's right edge). The yellow waveform identifies Channel 1; the green waveform identifies Channel 2.

16. In the **Differential TDR Skew** dialog box's **Horizontal Skew** setting for the longest channel, enter half the **mean** delta time value. In this example, 370 ps on channel 2.

17. Next, adjust the **TDR Skew** setting. Entered values represent the percentage of available adjustment range. Try entering a positive 20% value for the channel with the longest path and a negative 20% value for the channel with the shortest path. Adjust as needed to adjust the **mean** delta time value to as close to a value of zero as possible.
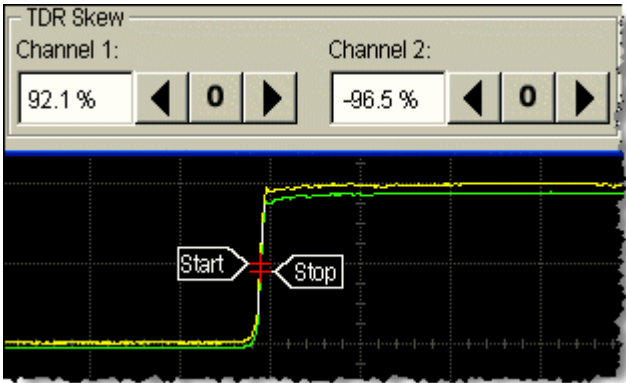
18. Click **Close**.

19. Close the **TDR Setup**.

20. On the **File** menu, click **Save**, **Instrument Setups** to save your skew settings. As long as you use the identical channels, cables, and connections, you can recall these settings for future measurements and avoid having to repeat the skew measurement and setup steps.

21. On the **Setup** toolbar, click **TDR Setup**. Select all the measurements that you want to view.

22. Connect your test device at the end of the cables, and click **Calibration Wizard** to perform a TDT/TDR calibration.

> Do not perform a module calibration after adjusting the channel skew. Performing a module calibration after adjusting the channel skew could affect the values that you entered in this procedure.

23. After the calibration procedure completes, close the **Calibration Wizard** and **TDR Setup**.

To adjust differential TDT skew

Use this procedure to compensate for unequal cable lengths in differential TDT test setups. Skew adjustments can only be performed when differential or common stimulus is active on differential TDR modules. Before you begin this procedure, you should be familiar with using TDR/TDT Setup and the Calibration Wizard.

1. In order to match the steps in this procedure, install the TDR module in the mainframe's left slot and the receiver in the right slot. Although this procedure uses the TDR module in the left slot, you could swap the positions of the two modules.

2. Turn on the instrument, and allow the instrument to warm up for one hour.

3. Complete the steps in the procedure To adjust differential TDR skew .

4. Connect the test setup cables and adapters for your TDT test setup completing the path from the TDR module channels to the input channels on the receiver module. Use adapters in the place of your test device. Do not connect the test device.

5. On the **Setup** toolbar, click **TDR Setup**.

6. In the dialog box, select the two-port balanced test device {bmc tdr_wiz103.bmp} and make the connections as shown in the following figure. Select **Common**. After this procedure, if you plan to make a differential stimulus measurement, return to **TDR Setup** and change this setting.
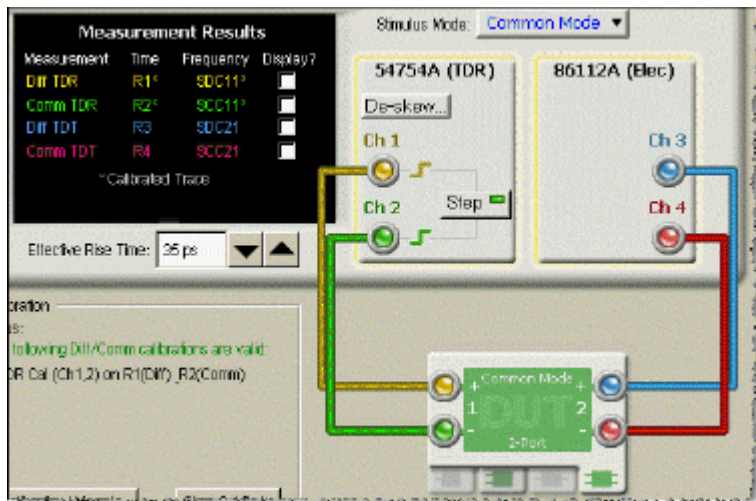
7. Clear all the measurements listed in **Measurement Results**. Click **Close**.

8. Press the front-panel channel buttons to turn on the display of Channels 3 and 4.

9. Adjust the horizontal position knob to center the responses.

10. On the **Calibrate** menu, select **Horizontal Skew Adjust**, **Manual**.

11. Turn on the TDR marker, assign it to channel 3, and place it on the rising-edge of the step response.

12. Turn on the TDR marker, assign it to channel 4, and place it on the rising-edge of the step response.

13. In the **Horizontal Skew Adjust** dialog box, identify the channel (3 or 4) with the shortest path. Entry the absolute value of the delta time marker as the skew adjust for this channel.
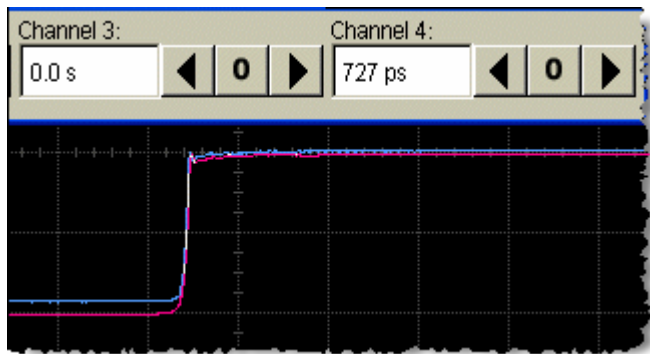
14. Click **Close**, and turn off the markers.

15. Press the front-panel channel buttons to turn off the display of Channels 3 and 4.

16. On the **File** menu, click **Save**, **Instrument Setups** to save your skew settings. As long as you use the identical channels, cables, and connections, you can recall these settings for future measurements and avoid having to repeat the skew measurement and setup steps.

17. On the **Setup** toolbar, click **TDR Setup**. Select all the measurements that you want to view.

18. Click **Calibration Wizard**, and perform a TDT/TDR calibration.

> Do not perform a module calibration after adjusting the channel skew. Performing a module calibration after adjusting the channel skew could affect the values that you entered in this procedure.

19. After the calibration procedure completes, close the **Calibration Wizard** and **TDR Setup**.