



User's Guide - DDR2 Compliance Test

Rev. 1, June 2010

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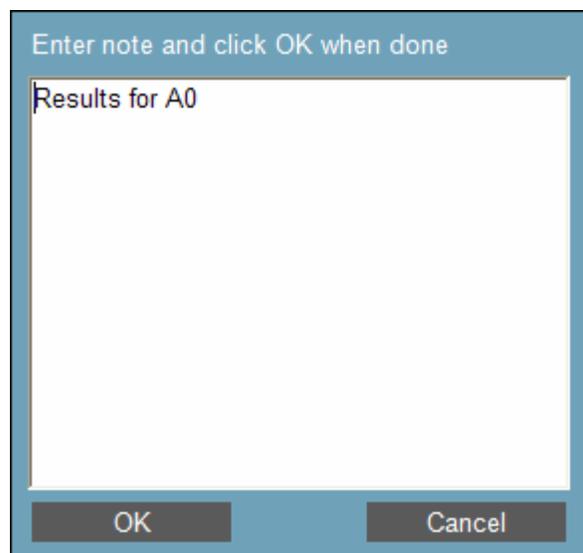
1 Introduction

The DDR2 Compliance Test uses the *JEDEC JESD 79-2E DDR2 SDRAM Electrical Specifications* as a reference. There are four data rates for DDR2: 400 Mbps, 533 Mbps, 667 Mbps, and 800 Mbps. The parameters and values tested vary for each of the four rates, so there are four TestScripts provided as part of the DDR2 Compliance Test. The operator should choose the appropriate TestScript for the data rate of the DUT.¹

Some dialogs, such as the **Individual Results Dialog**, occur commonly in the course of testing. Descriptions of such dialogs are provided in **Appendix A**, and are referred to in the course of the test descriptions. To find out what test will perform the measurement for a particular parameter, consult **Appendix B**.

Where possible, the title of the test indicates which signal is being tested. In some cases, however, a sequence of signals, such as address lines **A0** through **A15**, will be tested. In these cases, when the **Individual Test Results Dialog** appears, the operator should use the **Add Note** button to bring up the dialog on the right. The operator should enter a note indicating the signal that was tested; this note will be included in the final report for ease of identifying any signals that fail the testing.

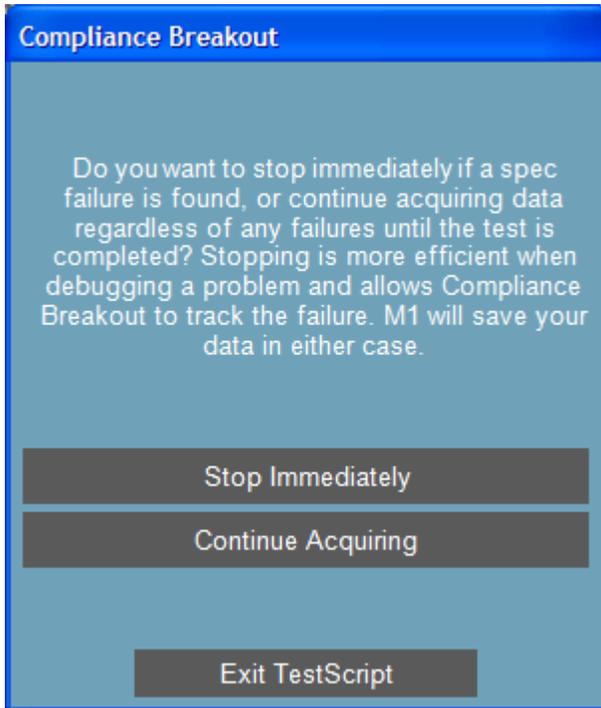
All tests start with two dialogs that tell what version of the JEDEC specification is being used, and the version of M1 OT that is needed to successfully run the Compliance Test. At the end of the test, the results of all testing may be saved to a file for documentation.



¹ Anything that gets written down is subject to interpretation, and interpretation is subject to ambiguities in what was written. The world of compliance specifications is, unfortunately, rich with instances of ambiguity. Every compliance test provider has to interpret these specifications but only ASA goes the extra step of providing information on how we interpreted these details and our reasoning behind those decisions. When available, this information is included in the Compliance App's Data Sheet, available for download from the M1 Apps Store.

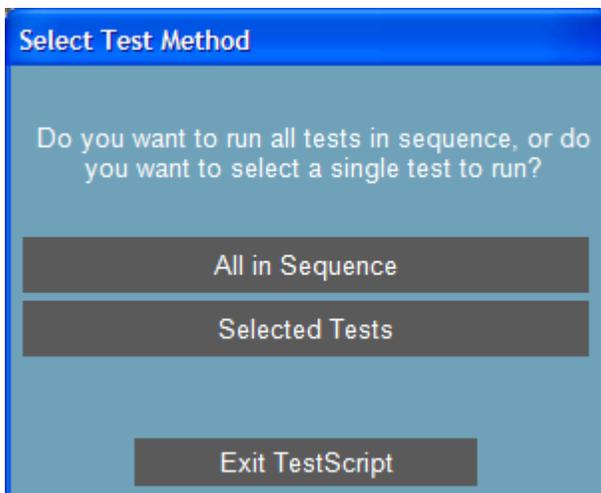


The operator will then see this dialog:



This dialog gives the option of either stopping when the first out-of-spec measurement is found, or continuing the test until the proper number for events has been detected. Selecting **Continue Acquiring** will make it more likely that all possible error conditions are found, since it is possible that not all out-of-spec conditions will happen at the same time. However, selecting **Stop Immediately** will ensure that the Compliance Breakout feature of M1 will be available to analyze the problematic waveform. The operator should make the selection based upon which scenario is appropriate. The mode selected will be applied to all tests that are conducted during this execution of the Compliance Test.

After the dialogs described above have appeared, the operator will see the **Select Test Method** dialog:



Operator Action: Click on **All in Sequence** to run all DDR2 Tests, or **Selected Tests** to select a single test to run. If **All in Sequence** is chosen, the operator will be given the option of running each test, or skipping the test.



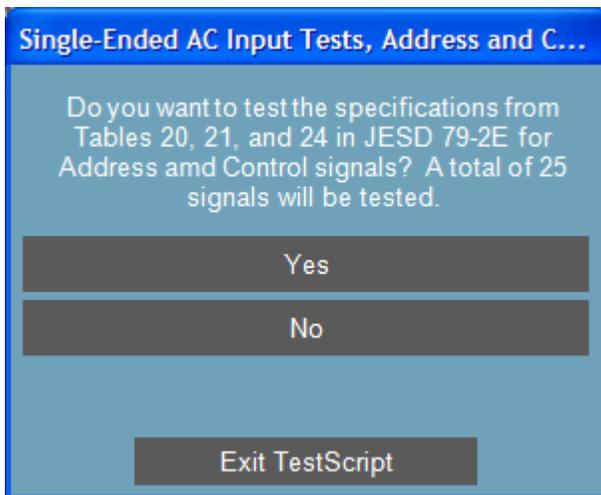
1.1 Probes Needed

The operator will need two single-ended probes. If the system has a differential Data Strobe (DQS), two differential probes will be needed; otherwise, one differential probe will be needed.

2 All in Sequence

2.1 Single-Ended AC Input Tests, Address and Control

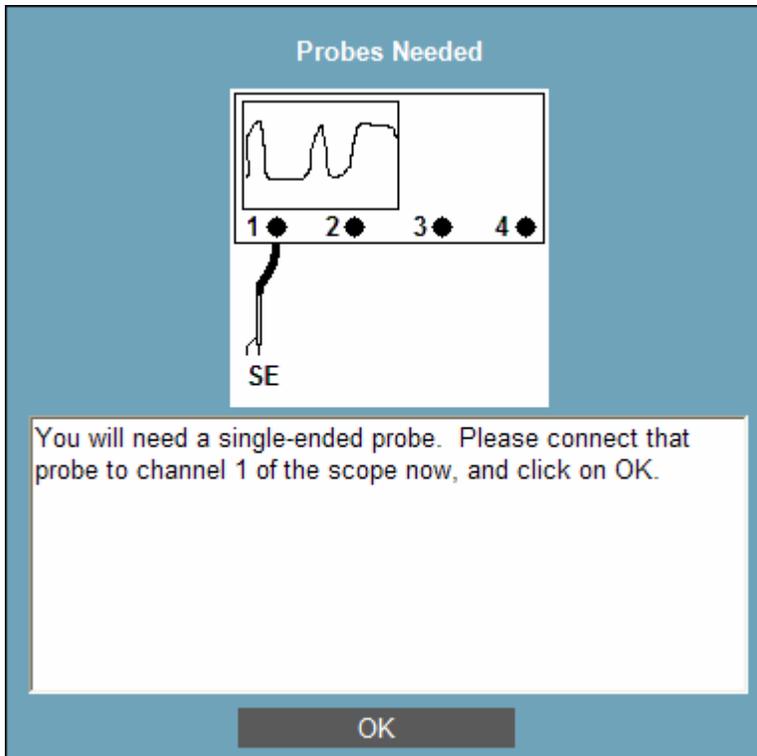
The operator will see this dialog:



Operator Action: Click **Yes** to perform the tests, or **No** to skip the tests. This document will assume that the operator clicks **Yes**. Otherwise, skip to the Section 2.2, **Single-Ended AC Tests, Data, Strobe, and Mask**.

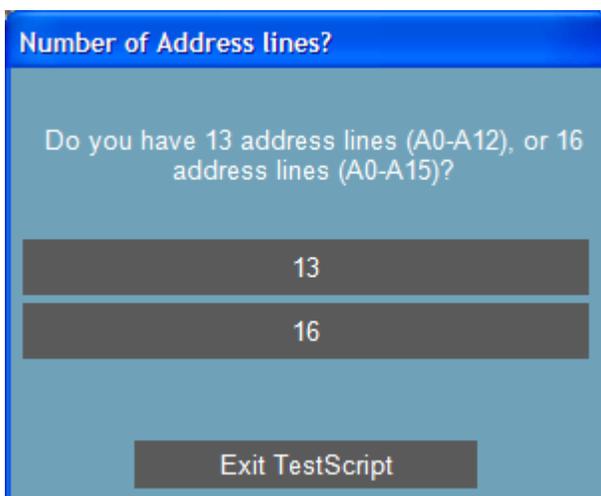


This dialog will appear:



Operator Action: Attach a single-ended probe to Channel 1. Probe A0 with the single-ended probe.

This dialog will appear:

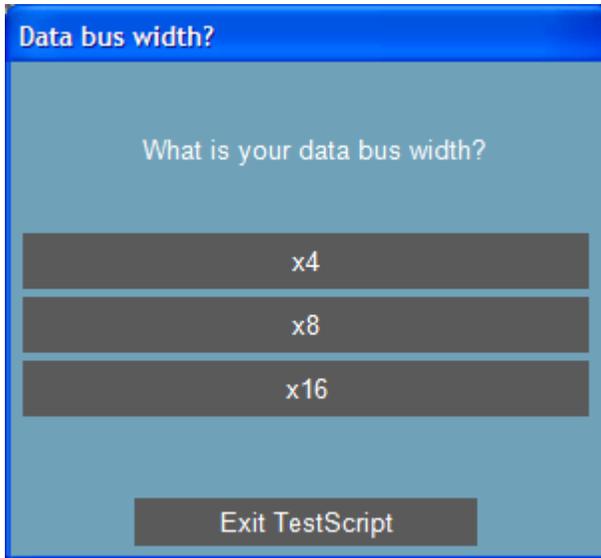


Operator Action: Click on the button that correctly indicates the number of address lines in the DUT.

Lines A0-A12 (or A0-A15 for 16 address lines), BA0-BA2, CS, RAS, CAS, WE, CKE, and ODT will be tested. The operator will be prompted to move the single-ended probe to the next line as needed. While the **Individual Test Results** dialog is up, the operator should not click on anything until all buttons are enabled. Once all buttons are enabled, use the **Add Note** button to note what signal was tested.



When these lines have been tested, the operator will see this dialog:



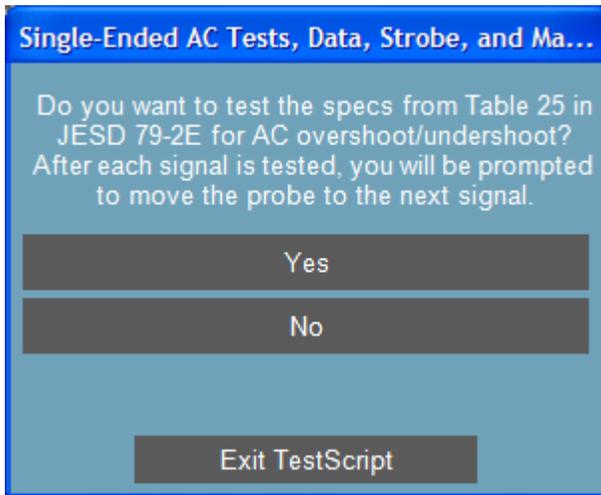
Operator Action: Click on the button that correctly indicates the data bus width for the DUT.

The tests that follow will differ only slightly, depending on the data bus width.



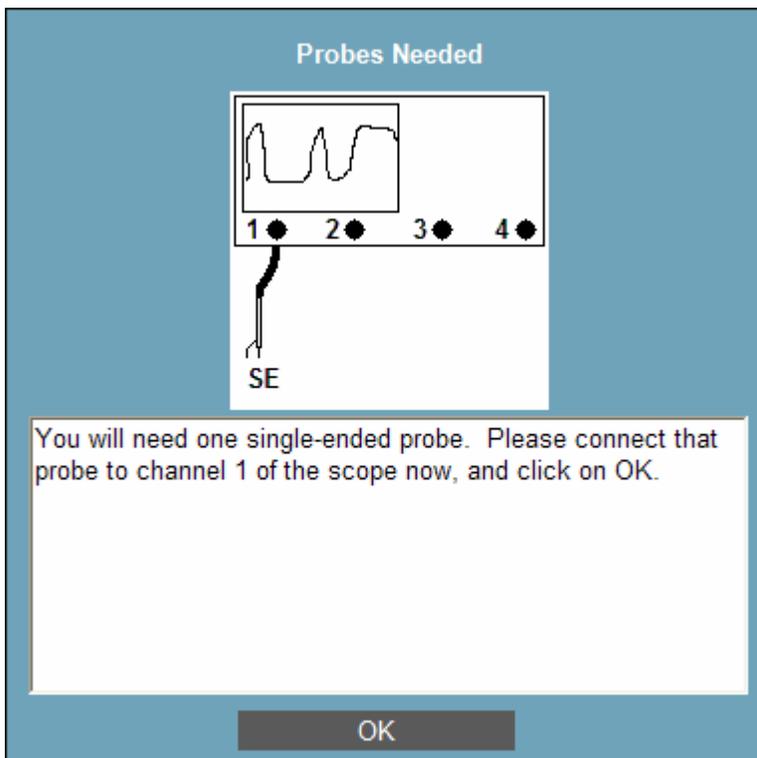
2.2 Single-Ended AC Tests, Data, Strobe, and Mask

The operator will see this dialog:



Operator Action: Click on Yes to conduct the tests. If the operator clicks on No to skip the tests, skip to the Section 2.3, **Differential Input Tests**.

The operator will see this dialog:



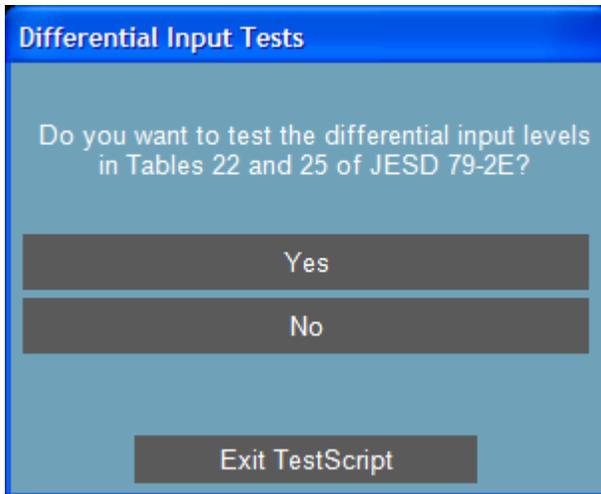
Operator Action: Connect a single-ended probe to Channels 1. Probe DQ0 with the probe attached Channel 1. Click on OK.

Lines DQ0-DQn (where n depends on the data bus width), DQS, DQS#, CK, CK#, and DM will be tested. If RDQS is enabled, RDQS and RDQS# will be tested instead of DQS and DQS#. The operator will be prompted to move the single-ended probe to the next line as needed. While the **Individual Test Results** dialog is up, the operator should not click on anything until all buttons are enabled. Once all buttons are enabled, use the **Add Note** button to note what signal was tested.



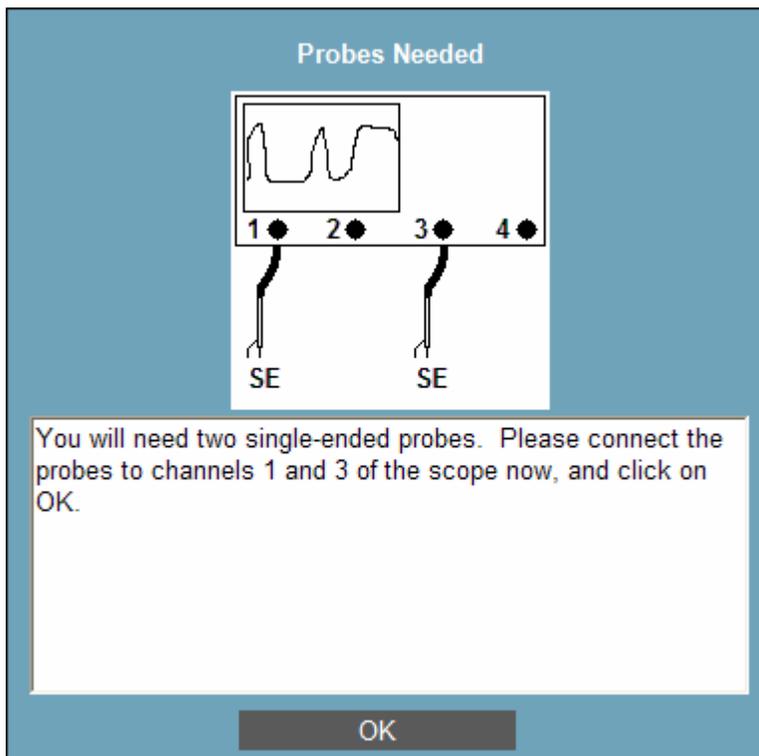
2.3 Differential Input Tests

The Compliance Test will now ask whether your DUT has a differential DQS, or RDQS, if RDQS is enabled.



Operator Action: Click on **Yes** to conduct the tests. If the operator clicks on **No** to skip the tests, skip to the Section 2.4, **Differential Output**.

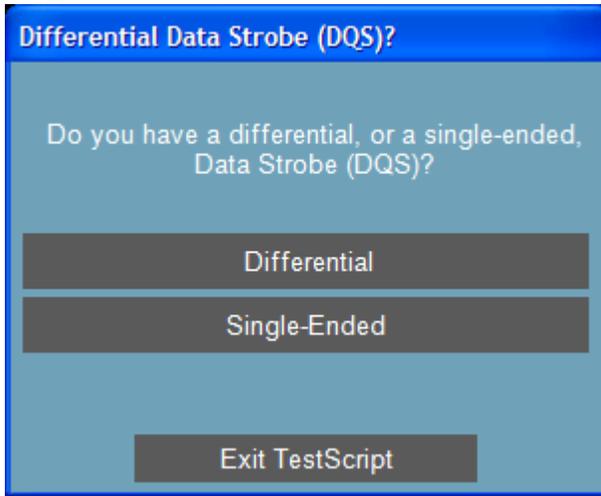
The operator will see this dialog:



Operator Action: Connect two **single-ended** probes to Channels 1 and 3 of the scope. Probe **DQ0** with the probe attached channel 1. Click on **OK**.



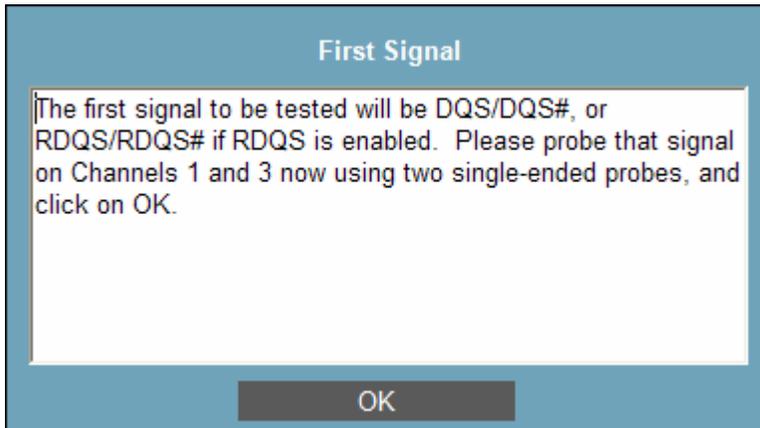
The operator will see this dialog:



Operator Action: Click on the selection that describes your DUT.

2.3.1 If the operator clicks on Differential:

The operator will see this dialog:



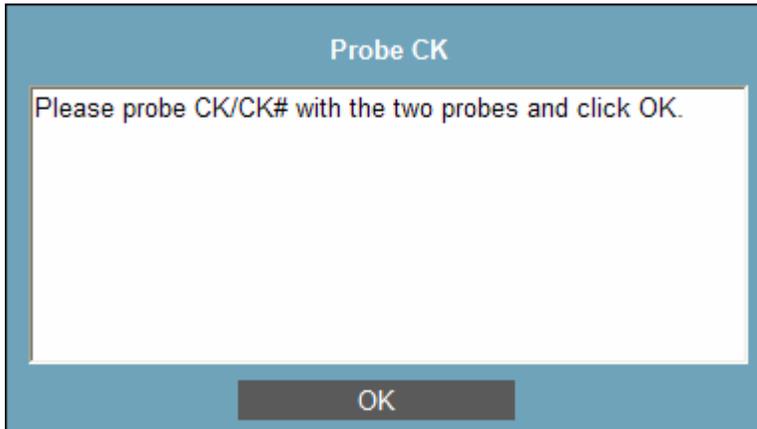
Operator Action: Probe DQS/DQS# with the two probes, or RDQS/RDQS# if RDQS is enabled.

After DQS/DQS# is tested, the operator will be prompted to probe CK/CK#.



2.3.2 If the operator clicks on Single-Ended:

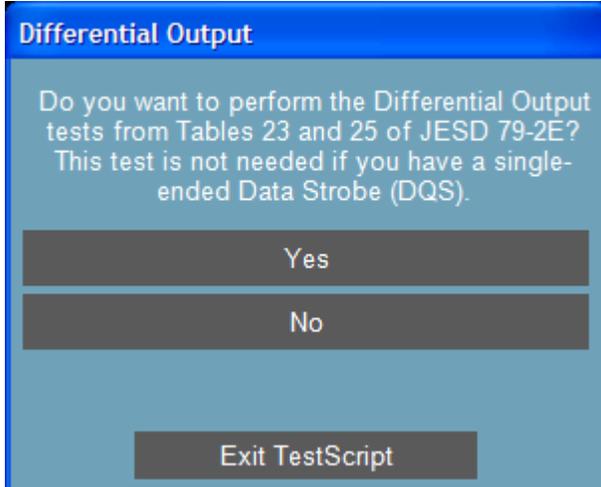
The operator will see this dialog:



Operator Action: Probe CK/CK# with the two probes, and click on OK.

2.4 Differential Output

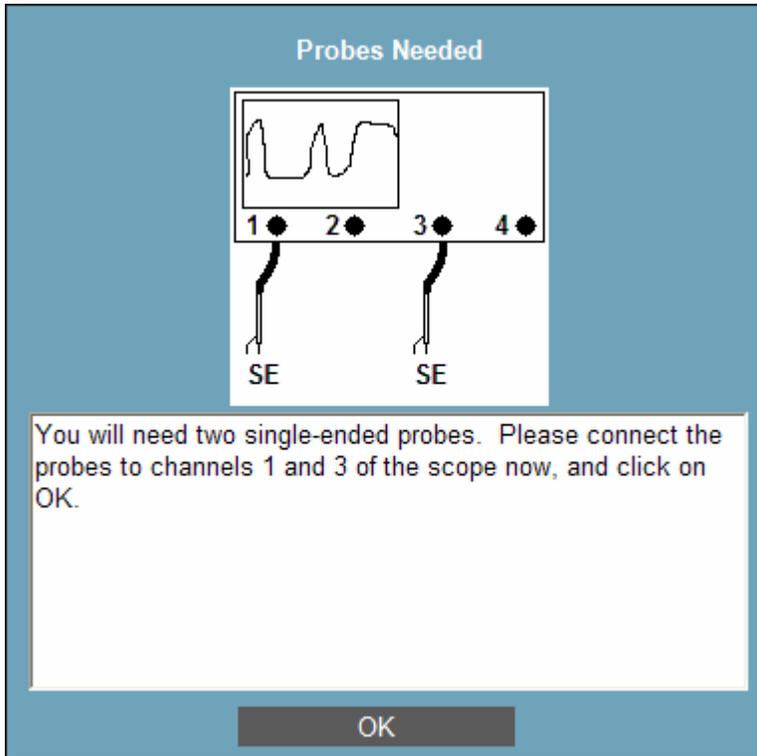
After the Differential Input tests are complete, the operator will see:



Operator Action: Click on Yes to conduct the tests. If the operator clicks on No to skip the tests, skip to the Section 2.5, **Data Timing**.



The operator will see this dialog:

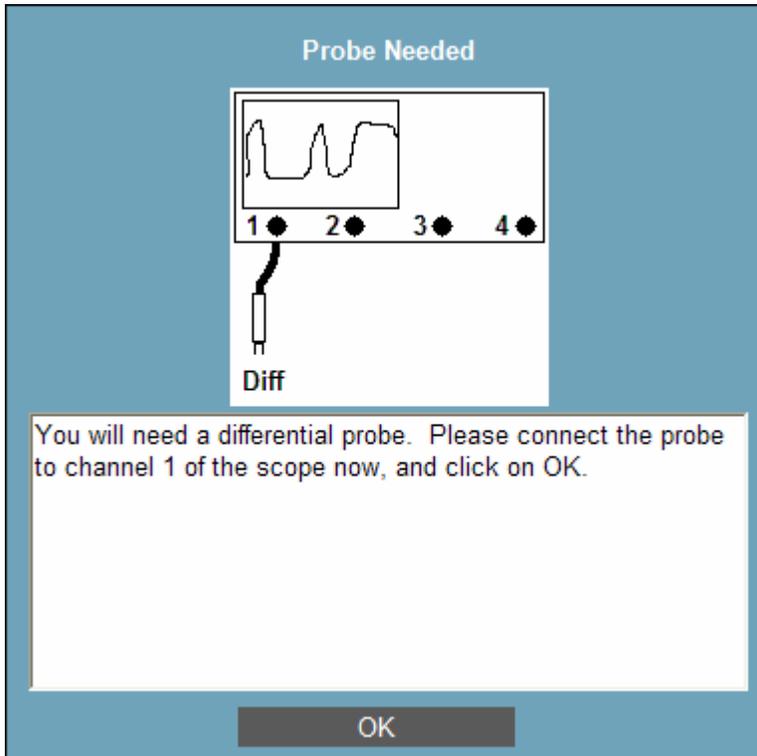


Operator Action: Connect two single-ended probes to Channels 1 and 3 of the scopes, and probe DQS/DQS#. Click on **OK**.

If the Data Bus Width is 16, LDQS/LDQS# will be tested first, then the operator will be prompted to move the probes to UDQS/UDQS#.



After the tests using the single-ended probes have completed, the operator will see:

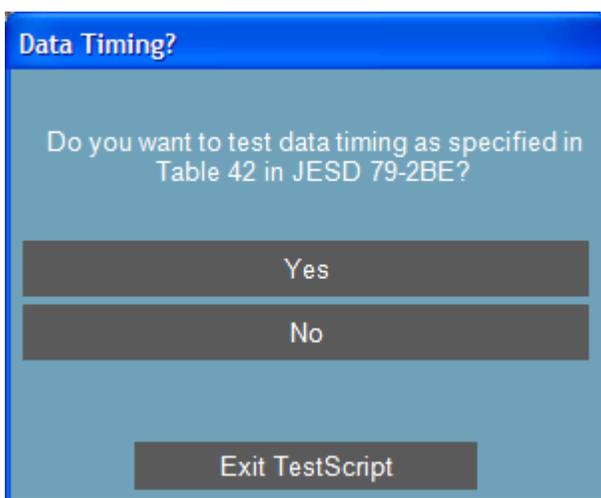


Operator Action: Connect a differential probe to Channel 1 of the scope, and probe **DQS/DQS#** with it. Click on **OK**.

If the Data Bus Width is 16, **LDQS/LDQS#** will be tested first, then the operator will be prompted to move the probes to **UDQS/UDQS#**. The operator will be prompted to move the differential probe to the next line as needed. While the **Individual Test Results** dialog is up, the operator should not click on anything until all buttons are enabled. Once all buttons are enabled, use the **Add Note** button to note what signal was tested.

2.5 Data Timing

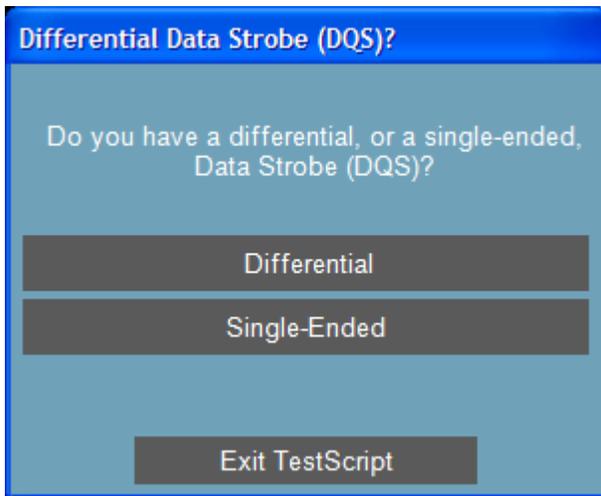
The operator will see this dialog:



Operator Action: Click on **Yes** to conduct the tests. If the operator clicks on **No** to skip the tests, skip to the Section 2.6, **Data Strobe Timing**.

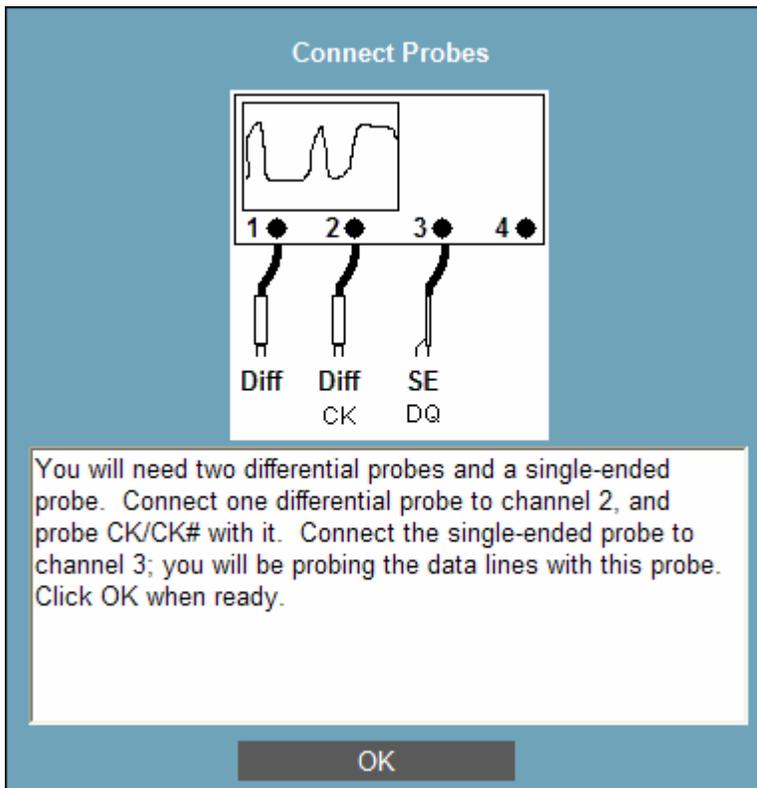


The operator will see this dialog:



Operator Action: Click on the button that corresponds with the design of the DUT.

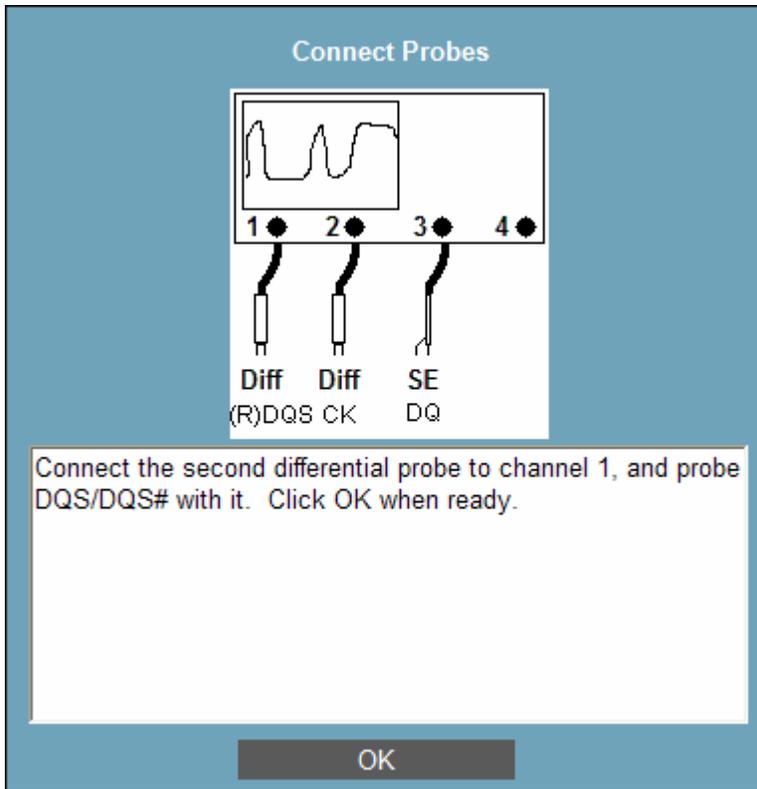
2.5.1 If the operator clicks on Differential:



Operator Action: Connect a differential probe to Channel 2 of the scope, and probe CK/CK# with it. Connect a single-ended probe to Channel 3, and probe DQ0 with it. Click on OK.



The operator will see the dialog:



Operator Action: Connect a second differential probe to Channel 1, and probe DQS/DQS# with it. Click on OK.

As the test proceeds, the operator will be prompted to move the single-ended probe on Channel 3 to the other DQ lines. After the DQ lines have been tested, the operator will be prompted to move the single-ended probe on Channel 3 to the DM line. While the **Individual Test Results** dialog is up, the operator should not click on anything until all buttons are enabled. Once all buttons are enabled, use the **Add Note** button to note what signal was tested.



2.5.2 If the operator clicks on Single-Ended:

Connect Probes

1 ● 2 ● 3 ● 4 ●

SE Diff SE

 CK/CK# DQ

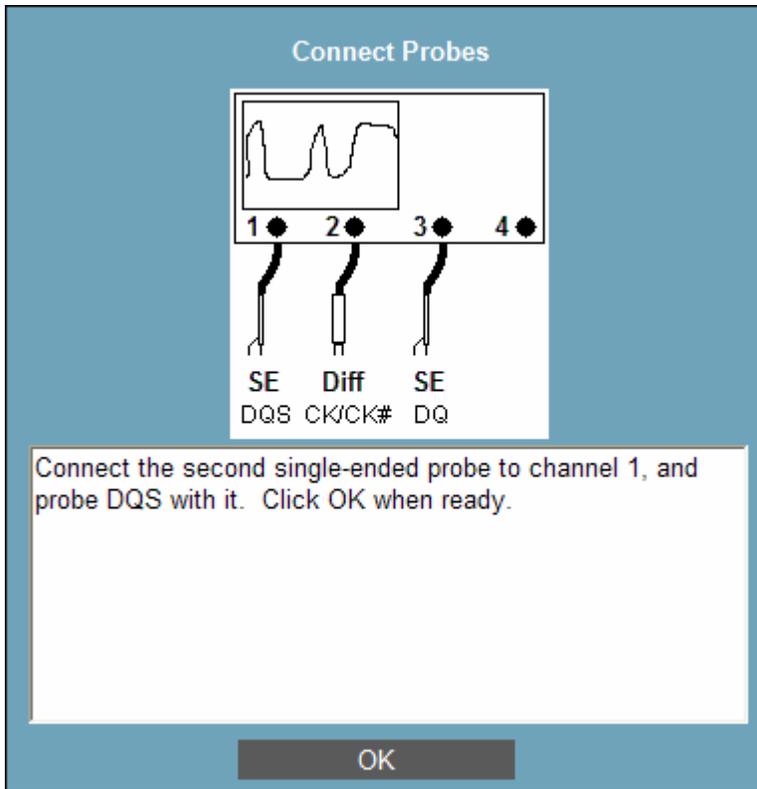
You will need one differential probe and two single-ended probes. Connect the differential probe to channel 2, and probe CK/CK# with it. Connect a single-ended probe to channel 3; you will be probing the data lines with this probe. Click OK when ready.

OK

Operator Action: Attach a **single-ended** probe to Channel 1, a **differential** probe to Channel 2, and another **single-ended** probe to Channel 3. Probe **CK/CK#** with the differential probe. Probe **DQ0** with the probe on Channel 3.



The operator will see:



Operator Action: Probe **DQS** with the probe on Channel 1, and click on **OK**.

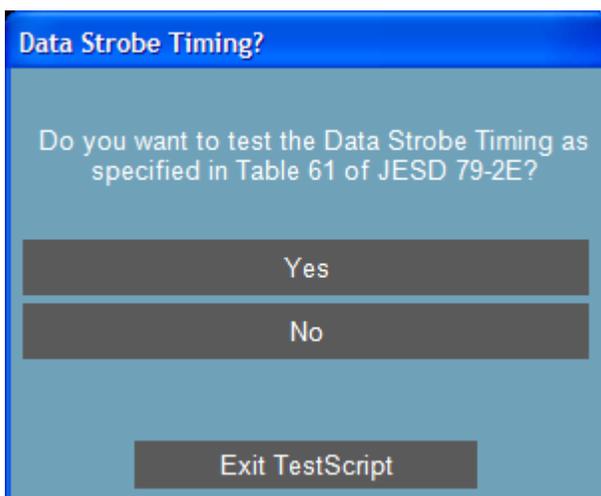
As the test proceeds, the operator will be prompted to move the single-ended probe on Channel 3 to the other **DQ** lines. After the **DQ** lines have been tested, the operator will be prompted to move the **single-ended** probe on Channel 3 to the **DM** line.

If the Data Bus Width is 16, LDQS/LDQS# will be used for DQ0-DQ7; the probe on Channel 1 should be moved to UDQS for DQ8-DQ15.

The operator will be prompted to move the single-ended probe to the next line as needed. While the **Individual Test Results** dialog is up, the operator should not click on anything until all buttons are enabled. Once all buttons are enabled, use the **Add Note** button to note what signal was tested.

2.6 Data Strobe Timing

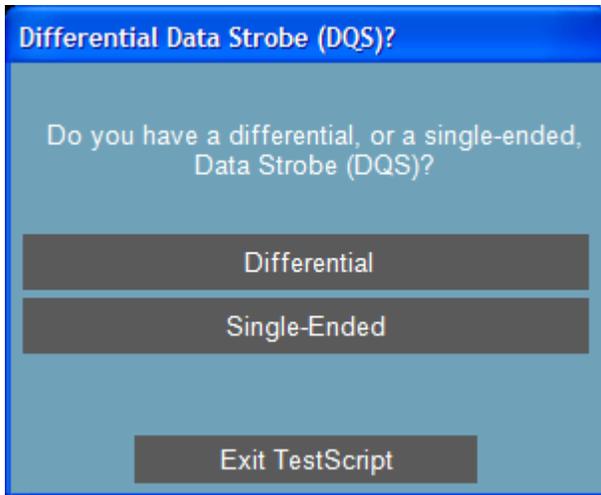
The operator will see this dialog:



Click on **Yes** to conduct the tests. If the operator clicks on **No** to skip the tests, skip to the Section 2.7, **Clock Tests**.



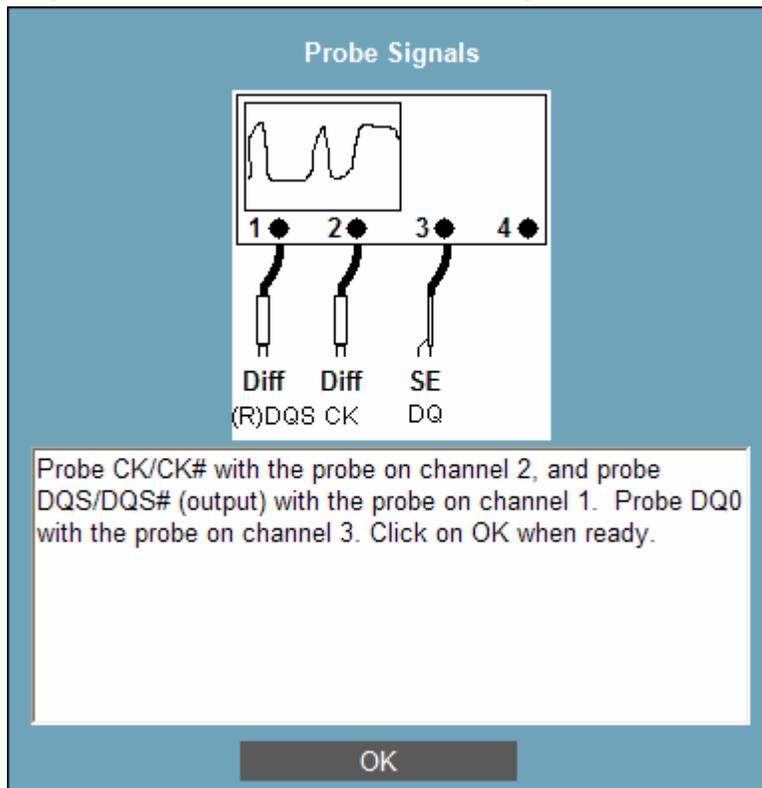
The operator will see this dialog:



Operator Action: Click on the button that corresponds with the design of the DUT.

2.6.1 If the operator clicks on Differential:

Operator Action: Connect a **differential** probe to Channel 1 of the scope, connect a **differential**



probe to Channel 2 of the scope, and connect a **single-ended** probe to channel 3 of the scope. Probe **DQS/DQS#** with the probe on Channel 1. Probe **CK/CK#** with the probe on Channel 2. Probe **DQ0** with the probe on Channel 3. Click on **OK**.

If the Data Bus Width is 16, LDQS/LDQS# will be tested first, then the operator will be prompted to move the probe on Channel 1 to UDQS/UDQS#.

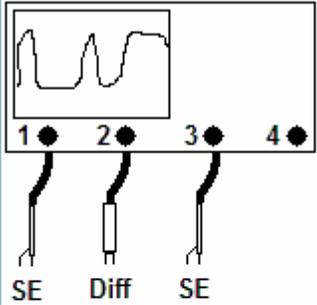
After the output signal is tested, the operator will be prompted to move the probe on Channel 1 to **DQS** (input) or **RDQS** (input).

If the Data Bus Width is 16, LDQS/LDQS# will be tested first, then the operator will be prompted to move the probe on Channel 1 to UDQS/UDQS#.



2.6.2 If the operator clicks on Single-Ended:

Probes Needed



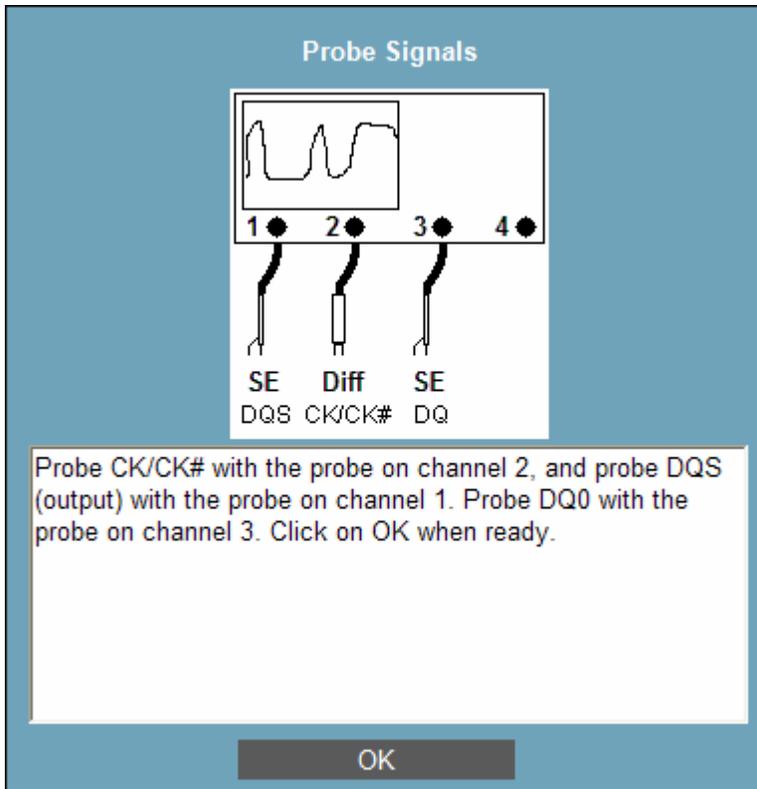
You will need one differential probe and two single-ended probes. Connect the differential probe to channel 2 of the scope, and connect the single-ended probes to channels 1 and 3 of the scope. Click on OK when ready.

OK

Operator Action: Connect a **single-ended** probe to Channel 1, a **differential** probe to Channel 2, and another **single-ended** probe to Channel 3. Click on **OK**.



The operator will see this dialog:



Operator Action: Probe **CK/CK#** with the probe attached to Channel 2, probe **DQ0** with the probe attached to Channel 3, and probe **DQS** (or **RDQS**) output with the probe attached to Channel 1. Click on **OK**.

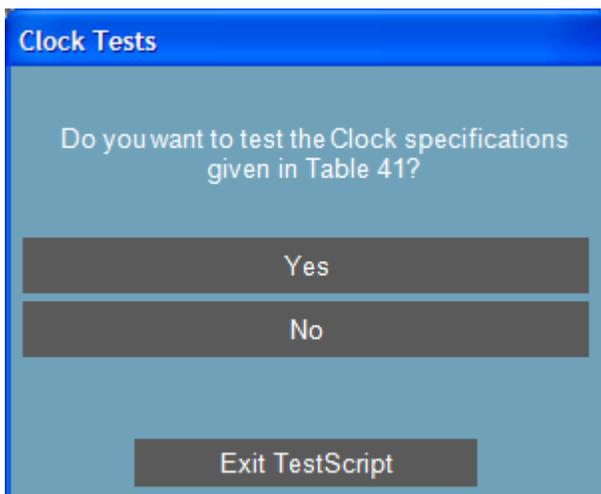
If the Data Bus Width is 16, LDQS will be tested first, then the operator will be prompted to move the probe on Channel 1 to UDQS

After the output signal is tested, the operator will be prompted to move the probe on Channel 1 to **DQS** (input) or **RDQS** (input).

If the Data Bus Width is 16, LDQS will be tested first, then the operator will be prompted to move the probe on Channel 1 to UDQS.

2.7 Clock Tests

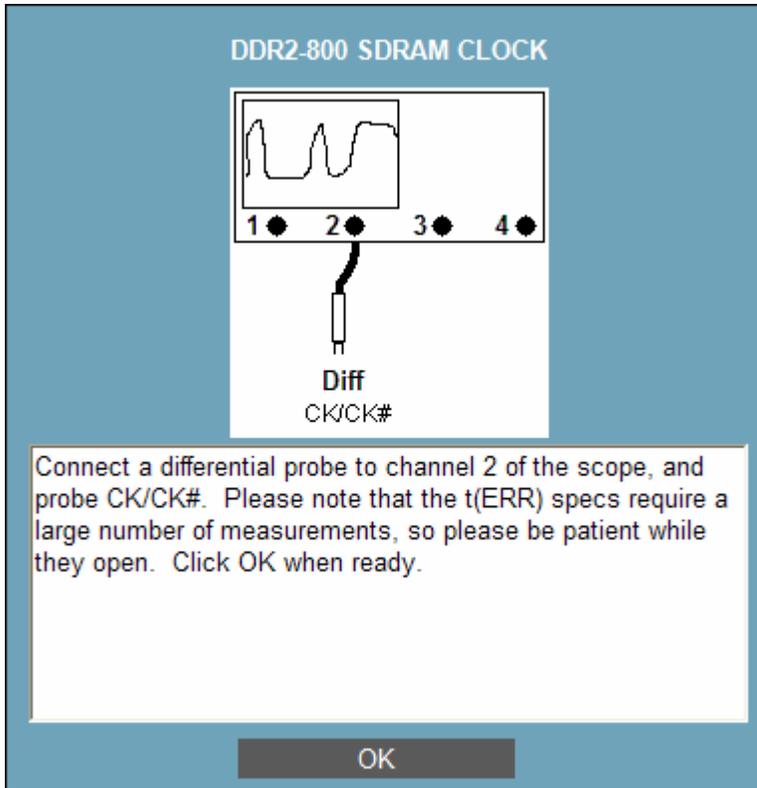
The operator will see this dialog box:



Operator Action: Click **Yes** to perform the test, or **No** to skip the test. This document will assume that the operator clicks **Yes**. Otherwise, skip to Section 2.2, **Command and Address Timing**.



The operator will see this dialog box:

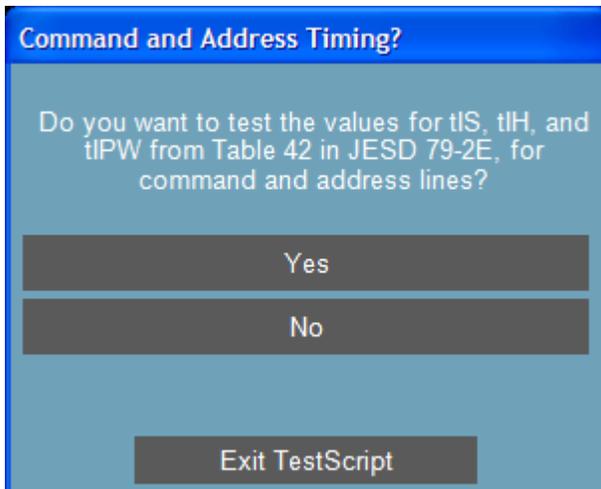


Operator Action: Connect a differential probe to Channel 2 of the scope. Probe CK/CK# with the differential probe. Click OK.

M1 will perform a series of acquisitions. While the acquisitions are being made, the **Individual Test Results** dialog will be displayed; see **Appendix A** for a description of the dialog. The operator should not click on anything until all buttons are enabled. Once all buttons are enabled, click on **Close and Continue**.

2.8 Command and Address Timing

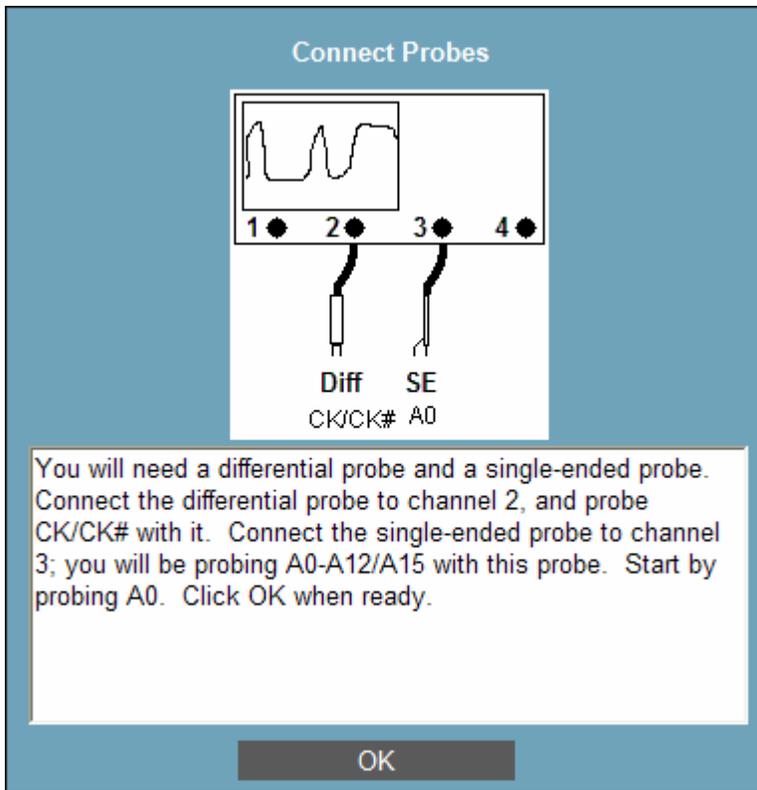
This dialog will appear:



Operator Action: Click Yes to perform the test, or No to skip the test. This document will assume that the operator clicks Yes. Otherwise, testing is complete, and the test results summary will be shown.

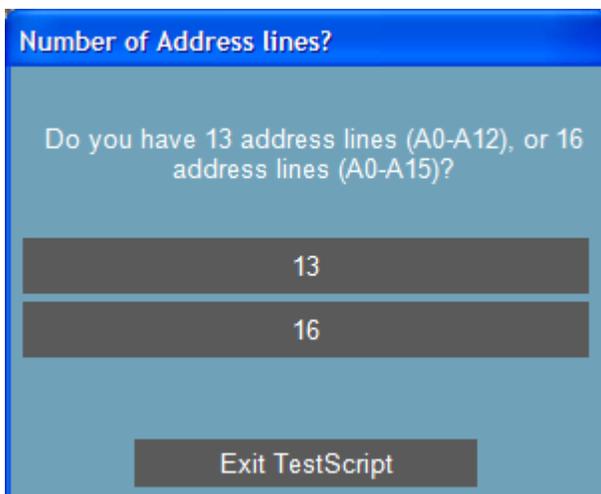


The operator will see this dialog:



Operator Action: Connect a **differential** probe to Channel 2 of the scope. Probe **CK/CK#** with the differential probe. Connect a **single-ended** probe to Channel 3 of the scope. Probe **A0** with the single-ended probe. Click **OK**.

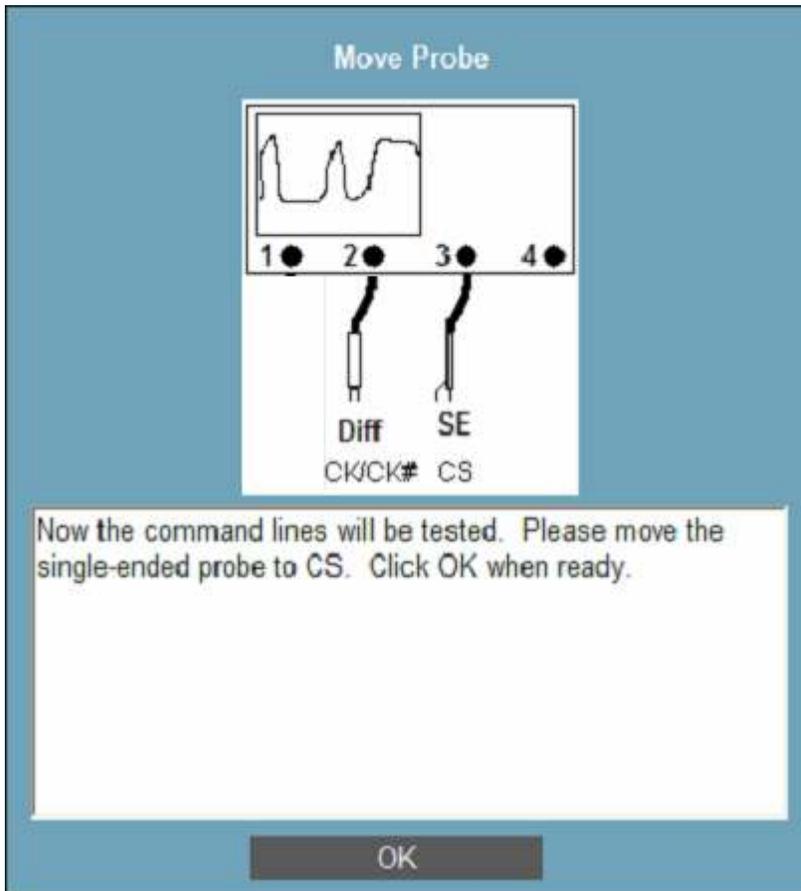
The operator will see this dialog:



Operator Action: Click on the button that correctly indicates the number of address lines in the DUT.



Testing will continue, with prompting to move the single-ended probe to the next address line. Each time the **Individual Test Results** dialog appears, the operator should enter a note to indicate which address line was tested. When the last address line has been probed (either **A12** or **A15**, depending on the number of address lines), the operator will be prompted to move the probe to the “next” address line; this dialog should be ignored, as it will be followed by the next dialog:



Operator Action: Move the single-ended probe on Channel 3 to CS. Leave the **differential** probe on Channel 2 connected to **CK/CK#**. Click on OK.

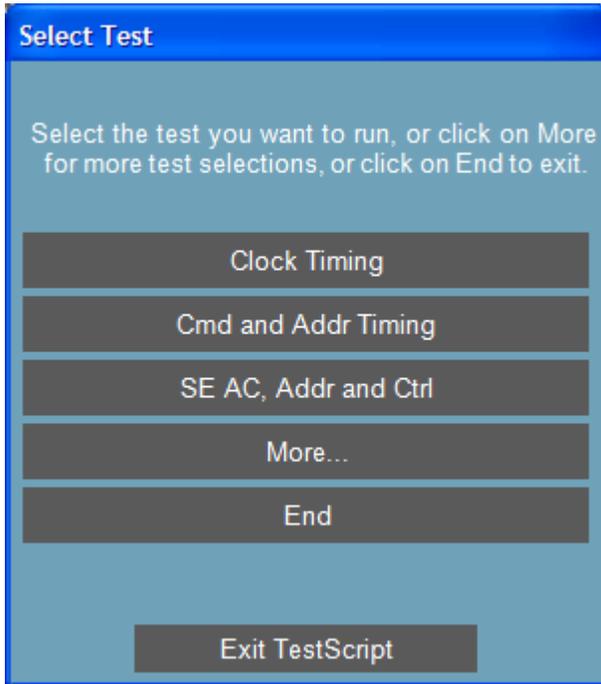
M1 will perform a series of acquisitions. While the acquisitions are being made, the **Individual Test Results** dialog will be displayed; see **Appendix A** for a description of the dialog. The signals being tested will be **CS**, **RAS**, **CAS**, **WE**, **BA0**, **BA1**, and **BA2**. The operator will be prompted to move the single-ended probe to the next line as needed. While the **Individual Test Results** dialog is up, the operator should not click on anything until all buttons are enabled. Once all buttons are enabled, use the **Add Note** button to note what signal was tested.

This dialog may not appear for all data speeds.



3 Selected Tests

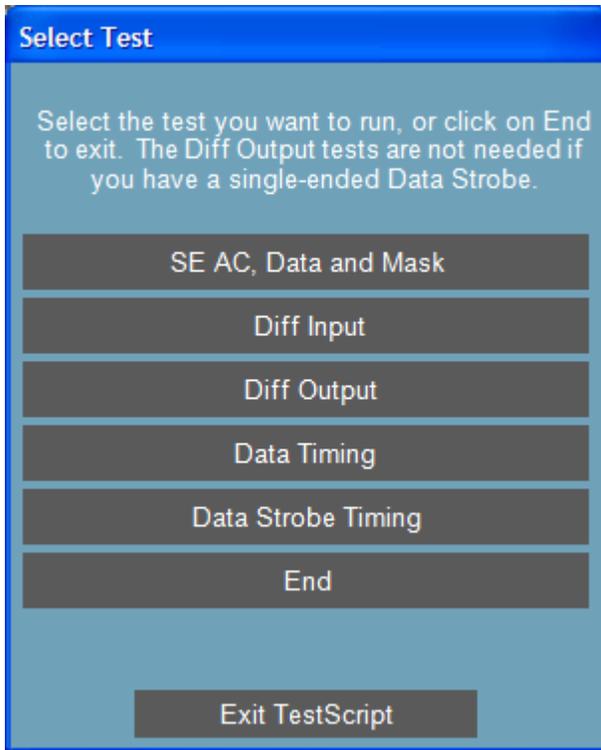
The operator will see this dialog:



Operator Action: If the desired test is shown on this dialog, the operator should click on the test and see the instructions in the appropriate section above; it may help to refer to the Table of Contents. If the desired test is not shown, the operator should click on **More...**



Clicking on **More...** will display this dialog:



Operator Action: If the desired test is shown on this dialog, the operator should click on the test and see the instructions in the appropriate section above; it may help to refer to the Table of Contents. The operator should click on **End** to exit the Compliance Test.



4 Testing Complete

Summary of Results for: Sample test

Worst case	Margin	Condition
Final results: 3 of 6 tests failed.		
M1 Oscilloscope Tools v6.05.2, AT DSO81204A, SN SLABIF201 4 GSa/s for 10 Kpts @ off/200/200/off mV/div, 5/27/2010 2:48:12 PM Thresholds: Ch. 2/3(0%/diff/0%)		
This is an individual test		
Passed	(459.745ps) 8%	Analysis1_SB2.Max > 500ps
Passed	(670.944mV) 27%	Analysis4_SB0.Max > 920mV
Failed	(1.574ns) -31%	Analysis1_SB2.Peak > 1.2ns
This is a second test		
Failed	(520.68ps) -4%	Analysis1_SB2.Max > 500ps

Add Note Print Report Save Report Close and Continue

When testing is complete, a summary of all tests run will be presented in a dialog. At this time the operator should use **Add Note** to add any notes regarding any unexpected events during the test, and click on **Save Report** to save the results of the testing in an appropriate place and format.



Appendix A – Individual Test Results Dialog

The **Individual Test Results** dialog appears while acquisitions are being taken to perform a test. Some of the buttons on the bottom will be disabled while testing is being done; when they are all enabled, the test has completed. The operator should not take any action if any of the buttons on the bottom are disabled.

The main text display shows a summary line telling the overall results, as well as information about the scope being used, the acquisition settings of the scope, and the time the acquisitions started. The remainder of the main text display tells the status of each condition being tested (**PASS** or **FAIL**).

The **Add Note** button brings up a dialog that will let the operator enter a note about the test. It is recommended that the operator add a note for each signal that is tested, so that failure or success may be associated with the correct signal for later analysis. For instance, if lines **DQ0-DQ15** are being tested, the text **“DQ0”**, **“DQ1”**, etc. would be entered as each data line was tested. These notes will automatically be stored with the test results for the final report; it is not necessary to save each individual test result separately.

If none of the tests failed, the right-hand portion of the dialog (**“Failed Tests”**) will not be visible.

	Condition	Worst case	Margin
Results: 3 of 9 tests failed.			
M1 Oscilloscope Tools v6.05.2, 0x000-20C74 20 GSa/s for 1.025 Mpts, 5/27/2009 1:25:35 PM Thresholds: Ch. 1(10%/50%/90%) Ch. 2(10%/50%/90%) Ch. 3(10%/50%/90%)			
Number of Events >100000: NO (4982 out of 100000)			
FAIL	tDS(base) min DataTiming.Mean < 50ps	(0fs)	-100%
FAIL	tDH(base) min DataTiming.Min < 125ps	(0fs)	-100%
PASS	tDQSQ DQSQ.tDQSQ(max) > 200ps	(88.302ps)	55%
PASS	tAC,min tAC. < -400ps	(0fs)	100%
PASS	tAC,max	(0fs)	100%

Failed Tests

- tDS(base) min
- tDH(base) min
- tLZ(DQ) max

Show View

Compliance Breakout Demo

This feature is only available if the condition is a simple comparison with a constant. Use Shift+Click or Ctrl+Click to select multiple items.

Add Note Save Acquisition Print Report Save Report Close and Continue



Appendix B – Parameters Tested

This appendix lists the parameters tested by this Compliance Test, in which section the parameter is tested, and which signal lines are tested. Section numbers refer to section numbers in this document.

Parameter	Tested in Section	Signals Tested
Max overshoot area above VDD	2.1 Single-Ended AC Input Tests, Address and Control	A*, BA0-BA2, CS, RAS, WE, CKE, ODT
Max undershoot area below VSS	2.1 Single-Ended AC Input Tests, Address and Control	A*, BA0-BA2, CS, RAS, WE, CKE, ODT
Overshoot area	2.2 Single-Ended AC Tests, Data, Strobe, and Mask	DQ, DQS, DQS#, LDQS, LDQS#, UDQS, UDQS#, CK, CK#, DM
Overshoot area	2.3 Differential Input Tests	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#, CK/CK#
Overshoot area max	2.4 Differential Output	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#
Overshoot Peak max	2.3 Differential Input Tests	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#, CK/CK#
Overshoot Peak max	2.4 Differential Output	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#
SLEW min (fall time)	2.1 Single-Ended AC Input Tests, Address and Control	A*, BA0-BA2, CS, RAS, WE, CKE, ODT
SLEW min (rise time)	2.1 Single-Ended AC Input Tests, Address and Control	A*, BA0-BA2, CS, RAS, WE, CKE, ODT
tAC min, max	2.5 Data Timing	DQ
tCH (avg)	2.7 Clock Tests	CK/CK#
tCK (avg)	2.7 Clock Tests	CK/CK#
tCL (avg)	2.7 Clock Tests	CK/CK#
tDH (base) min	2.5 Data Timing	DQ
tDIPW	2.5 Data Timing	DQ, DM
tDQSK min, max	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (output)
tDQSH min	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input)
tDQSL min	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input)



Parameter	Tested in Section	Signals Tested
tDQSQ	2.5 Data Timing	DQ
tDQSS min, max	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input)
tDS (base) min	2.5 Data Timing	DQ
tDSH	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input, output)
tDSS	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input, output)
tERR (Nper), N = 2 - 50	2.7 Clock Tests	CK/CK#
tIH (base) min	2.8 Command and Address Timing	A*, CS, RAS, CAS, WE, BA0, BA1, BA2
tIPW min	2.8 Command and Address Timing	A*, CS, RAS, CAS, WE, BA0, BA1, BA2
tIS (base) min	2.8 Command and Address Timing	A*, CS, RAS, CAS, WE, BA0, BA1, BA2
tJIT (cc) min, max	2.7 Clock Tests	CK/CK#
tJIT (duty) min, max	2.7 Clock Tests	CK/CK#
tJIT (per) min, max	2.7 Clock Tests	CK/CK#
tLZ(DQ) min, max	2.5 Data Timing	DQ
tLZ(DQS) min, max	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input, output)
tQH min	2.5 Data Timing	DQ
tRPRE min, max	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input, output)
tRPST min, max	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input, output)
tWPRE min	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input, output)
tWPST min, max	2.6 Data Strobe Timing	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS# (input, output)



Parameter	Tested in Section	Signals Tested
Undershoot area	2.2 Single-Ended AC Tests, Data, Strobe, and Mask	DQ, DQS, DQS#, LDQS, LDQS#, UDQS, UDQS#, CK, CK#, DM
Undershoot area	2.3 Differential Input Tests	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#, CK/CK#
Undershoot area max	2.4 Differential Output	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#
Undershoot Peak min	2.3 Differential Input Tests	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#, CK/CK#
Undershoot Peak min	2.4 Differential Output	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#
VID (ac) min, max	2.3 Differential Input Tests	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#, CK/CK#
VIH(ac) min, max	2.1 Single-Ended AC Input Tests, Address and Control	A*, BA0-BA2, CS, RAS, WE, CKE, ODT
VIL(ac) min, max	2.1 Single-Ended AC Input Tests, Address and Control	A*, BA0-BA2, CS, RAS, WE, CKE, ODT
VIX (ac) min, max	2.3 Differential Input Tests	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#, CK/CK#
Vmax(overshoot)	2.2 Single-Ended AC Tests, Data, Strobe, and Mask	DQ, DQS, DQS#, LDQS, LDQS#, UDQS, UDQS#, CK, CK#, DM
Vmin(undershoot)	2.2 Single-Ended AC Tests, Data, Strobe, and Mask	DQ, DQS, DQS#, LDQS, LDQS#, UDQS, UDQS#, CK, CK#, DM
VOX (ac) min, max	2.4 Differential Output	DQS/DQS#, LDQS/LDQS#, UDQS/UDQS#
VSWING(MAX)	2.1 Single-Ended AC Input Tests, Address and Control	A*, BA0-BA2, CS, RAS, WE, CKE, ODT