

R&S®RTP-K94

DDR5 Compliance Test

User Manual



1706706802
Version 02

ROHDE & SCHWARZ
Make ideas real



This document describes the DDR5 Compliance Test Procedures of the following option:

- R&S®RTP-K94 (1803.6926.02)

Other functionality of the option is described in the instrument's user manual.

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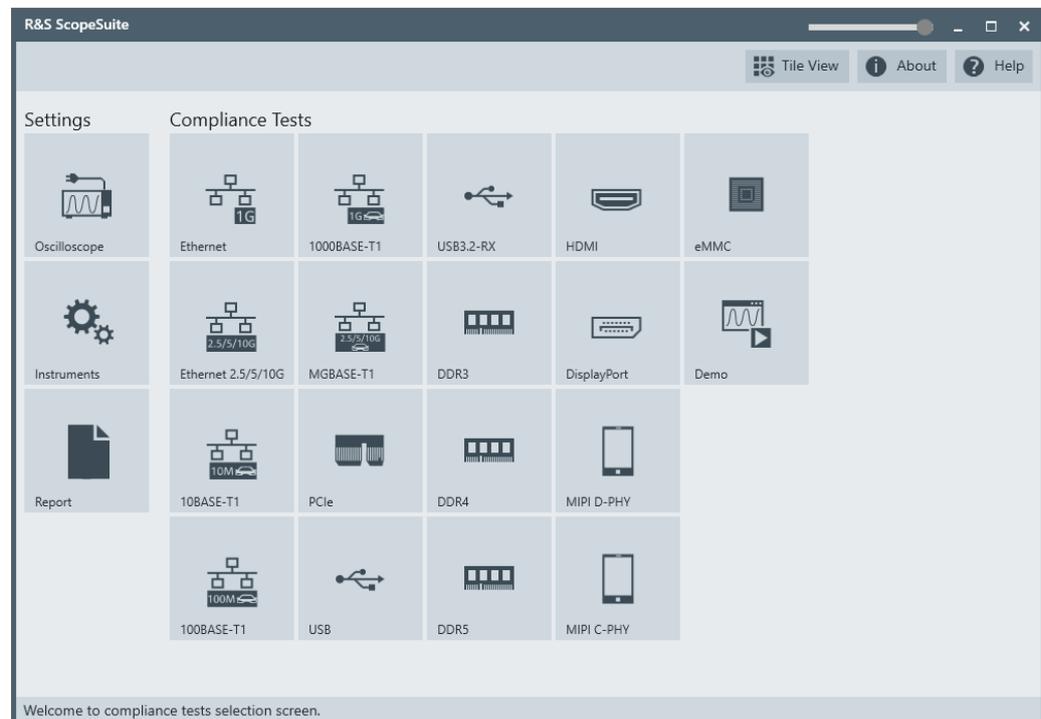
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1706.7068.02 | Version 02 | R&S®RTP-K94

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol.

1 R&S ScopeSuite overview

The R&S ScopeSuite software is used with R&S RTP oscilloscopes. It can be installed on a test computer or directly on the oscilloscope. For system requirements, refer to the Release Notes.



The R&S ScopeSuite main panel has several areas:

- "Settings": connection settings to oscilloscope and other instruments also default report settings
 - "Compliance Tests": selection of the compliance test
 - "Demo": accesses demo test cases that can be used for trying out the software without having a connection to an oscilloscope
 - : shift sideways to change the transparency of the dialog box
 - "Help": opens the help file, containing information about the R&S ScopeSuite configuration
 - "About": gives information about the R&S ScopeSuite software
 - "Tile View": allows a personalization of the compliance test selection
You can configure which tests are visible in the compliance test section and which are hidden, so that only the ones you use are displayed.
- To hide a test from the "Compliance Tests" view, do one of the following:

- a) Right-click on the compliance test that you want to hide.
The icon of the test changes, see [Figure 1-1](#). Now with a left click you can hide the test.

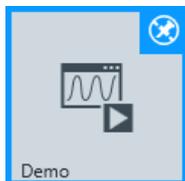


Figure 1-1: Unpin icon

- b) Click on "Title View" to show a list of the available test cases. By clicking a test case in the show list, you can pin/unpin it from the main panel.

2 Preparing the measurements

2.1 Test equipment

For DDR5 compliance tests, the following test equipment is needed:

- R&S RTP with 4 channels and minimum 8GHz bandwidth
- R&S RTP-K94 DDR5 compliance test option (required option, installed on the R&S RTP)
- Minimum 2 modular probes, R&S ZM90 with 9 GHz bandwidth.
- Minimum 2 modular probe tips R&S RT-ZMA10 or R&S RT-ZMA14.
- The free-of-charge R&S ScopeSuite software, which can be installed on a computer or directly on the R&S RTP.

2.2 Installing software and license

The preparation steps are performed only once for each computer and instrument that are used for testing.



Uninstall older versions of the R&S ScopeSuite

If an older version of the R&S ScopeSuite is installed, make sure to uninstall the old version before you install the new one. You can find the version number of the current installation in "Help" menu > "About". To uninstall the R&S ScopeSuite, use the Windows "Control Panel" > "Programs".

For best operation results, we recommend that the installed firmware versions of the R&S ScopeSuite and the oscilloscope are the same.

To install the R&S ScopeSuite

1. Download the latest R&S ScopeSuite software from the "Software" section on the Rohde & Schwarz R&S RTP website:
www.rohde-schwarz.com/product/rtp.html
2. Install the R&S ScopeSuite software:
 - On the computer that is used for testing, or
 - On the R&S RTP.

For system requirements, refer to the Release Notes.

To install the license key on the R&S RTP

- ▶ When you got the license key of the compliance test option, enable it on the oscilloscope using [Setup] > "SW Options".

For a detailed description, refer to the R&S RTP user manual, chapter "Installing Options", or to the online help on the instrument.

2.3 Setting up the network

If the R&S ScopeSuite software runs on a test computer, the computer and the testing oscilloscope require a LAN connection.

There are two ways of connection:

- LAN (local area network): It is recommended that you connect to a LAN with DHCP server. This server uses the Dynamic Host Configuration Protocol (DHCP) to assign all address information automatically.
- Direct connection of the instruments and the computer or connection to a switch using LAN cables: Assign fixed IP addresses to the computer and the instruments and reboot all devices.

To set up and test the LAN connection

1. Connect the computer and the instruments to the same LAN.
2. Start all devices.
3. If no DHCP server is available, assign fixed IP addresses to all devices.
4. Ping the instruments to make sure that the connection is established.
5. If VISA is installed, check if VISA can access the instruments.
 - a) Start VISA on the test computer.
 - b) Validate the VISA address string of each device.

See also:

- [Chapter 2.5, "Connecting the R&S RTP"](#), on page 7

2.4 Starting the R&S ScopeSuite

To start the R&S ScopeSuite on the test computer or on the oscilloscope:

- ▶ Double-click the R&S ScopeSuite program icon.

To start the R&S ScopeSuite on the instrument, in the R&S RTP firmware:

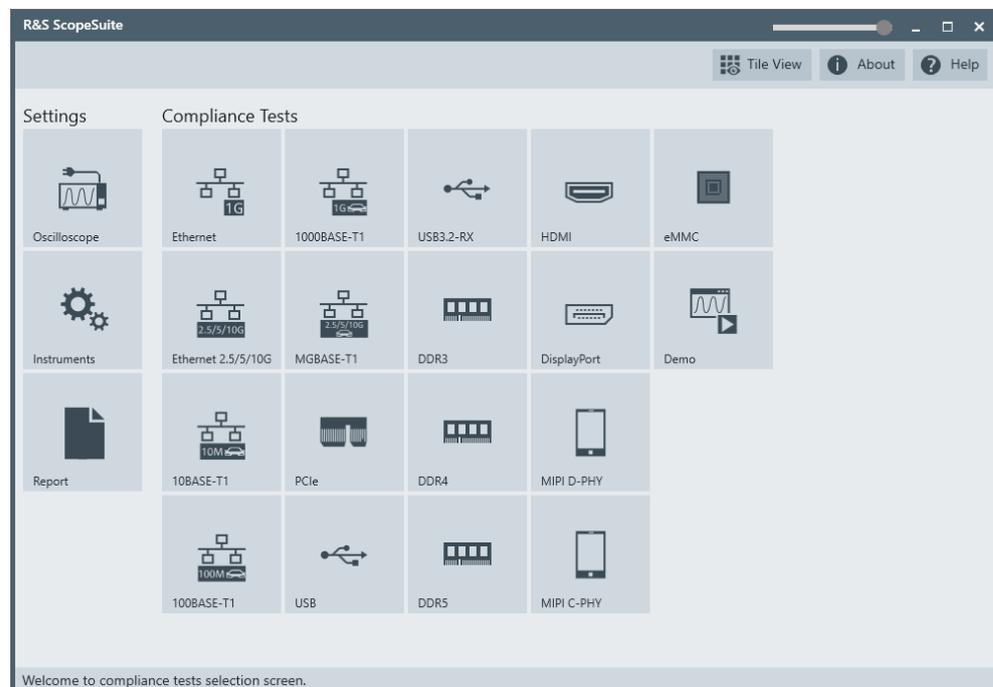
- ▶ In the "Apps" dialog, open the "Compliance" tab.

2.5 Connecting the R&S RTP

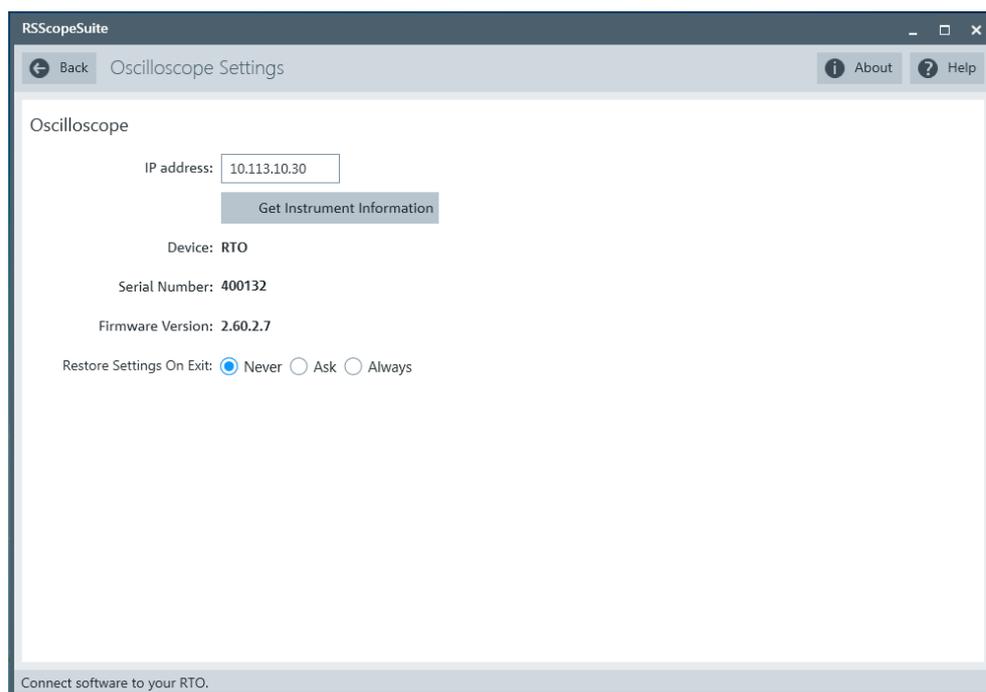
If the R&S ScopeSuite is installed directly on the instrument, the software detects the R&S RTP firmware automatically, and the "Oscilloscope" button is not available in the R&S ScopeSuite.

If the R&S ScopeSuite software runs on a test computer, the computer and the testing oscilloscope require a LAN connection, see [Chapter 2.3, "Setting up the network"](#), on page 6. The R&S ScopeSuite software needs the IP address of the oscilloscope to establish connection.

1. Start the R&S RTP.
2. Start the R&S ScopeSuite software.
3. Click "Settings" > "Oscilloscope".



4. Enter the IP address of the oscilloscope.
To obtain the IP address: press the Rohde & Schwarz logo at the top-right corner of the oscilloscope's display.
5. Click "Get Instrument Information".
The computer connects with the instrument and gets the instrument data.

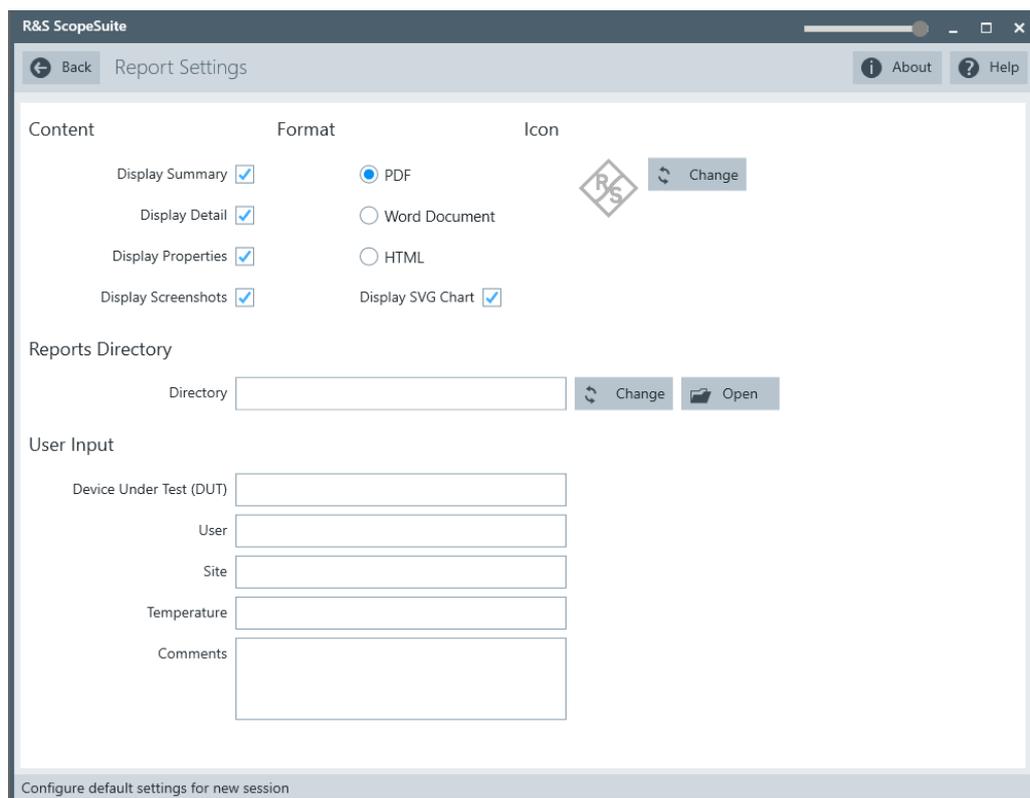


If the connection fails, an error message is shown.

2.6 Report configuration

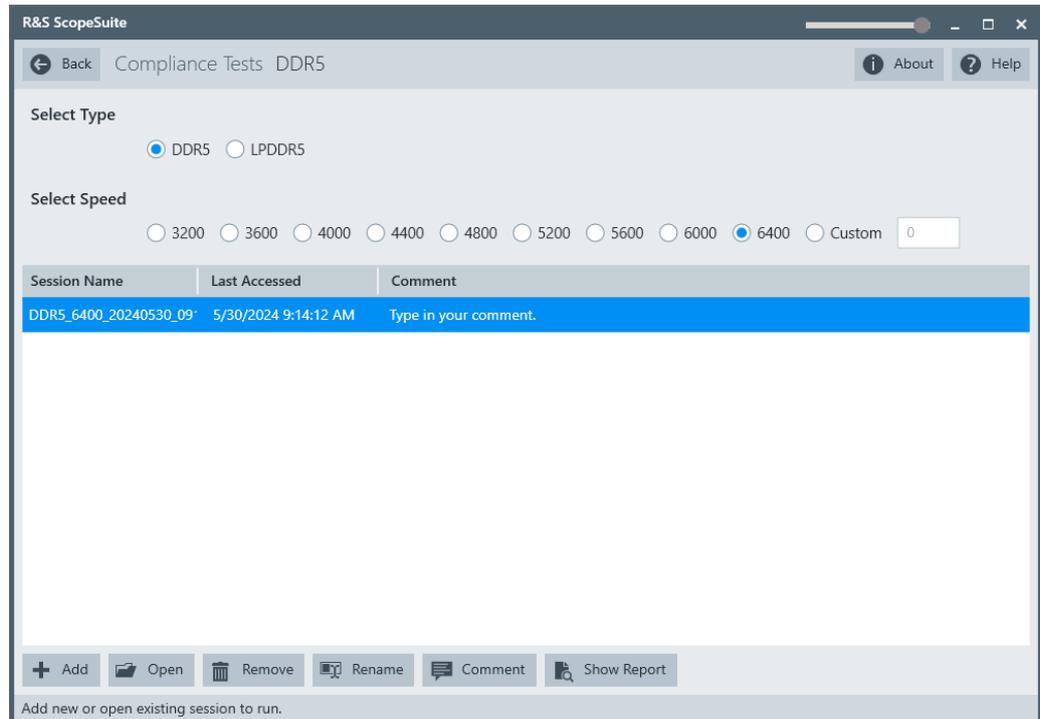
In the "Report Configuration" menu, you can select the format of the report and the details to be included in the report. You can also select an icon that is displayed in the upper left corner of the report.

Also, you can enter common information on the test that is written in the "General Information" section of the test report.



3 Performing tests

3.1 Starting a test session



LPDDR5 test cases are currently not supported for FW 5.40.1.

After you open a compliance test, the "Session Selection" dialog appears. In this dialog, you can create new sessions, open or view existing report.

The following functions are available for handling test sessions:

Function	Description
"Add"	Adds a new session
"Open"	Opens the selected session
"Remove"	Removes the selected session
"Rename"	Changes the "Session Name"
"Comment"	Adds a comment
"Show report"	Generates a report for the selected session

To add a test session

1. In the R&S ScopeSuite window, select the compliance test.
2. In the "Session Selection" dialog press "Add".
3. If necessary change the "Session Name"

To open a test session

1. In the R&S ScopeSuite window, select the compliance test.
2. In the "Session Selection" dialog, select the session you want to open and double click on it.
Alternatively, select the session and press "Open".

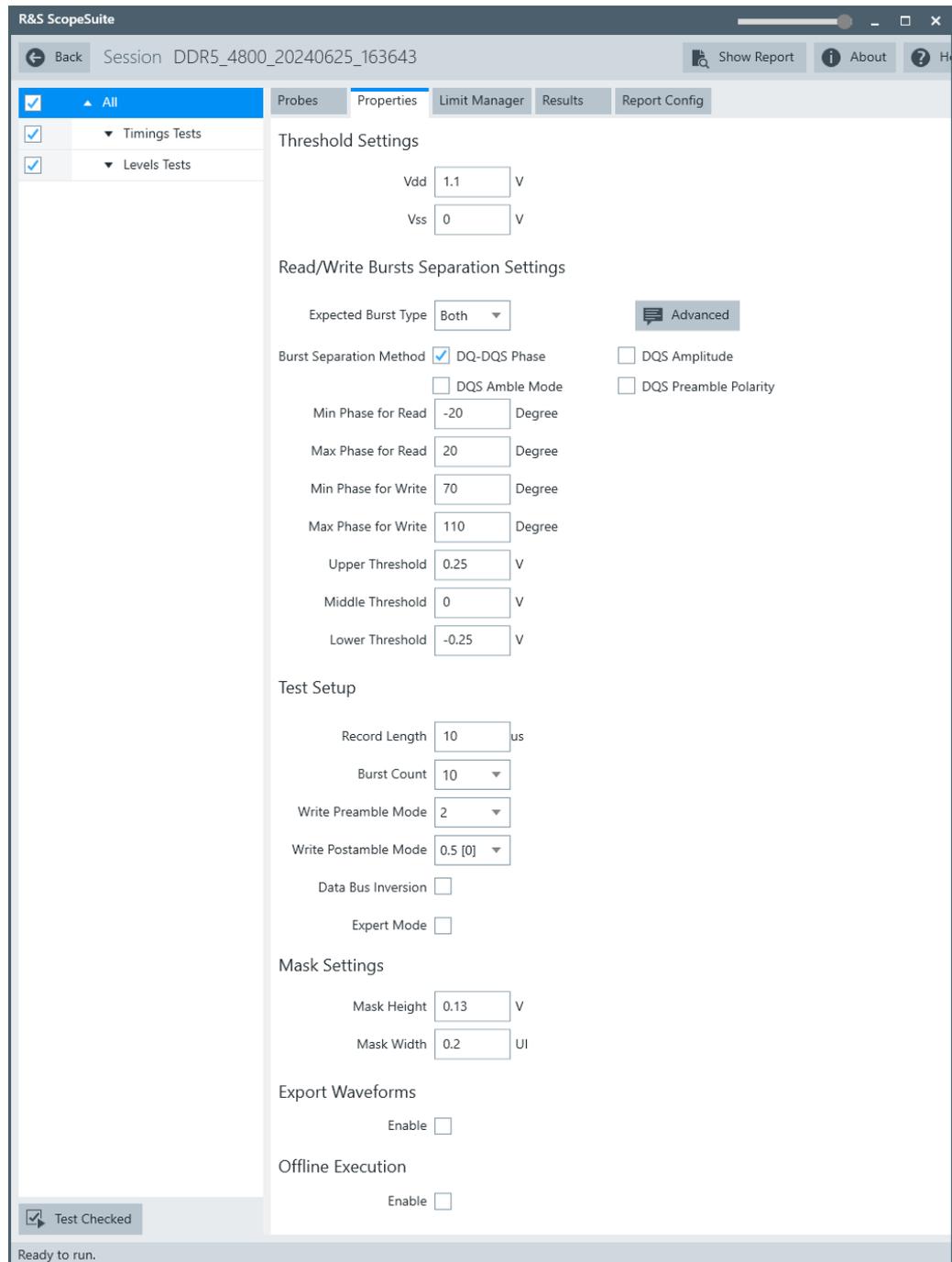
To show a report for a test session

1. In the R&S ScopeSuite window, select the compliance test.
2. In the "Session Selection" dialog, select the session you want the report for and press "Show report".

3.2 Configuring the test

1. In the R&S ScopeSuite window, select the compliance test to be performed:
 - "DDR5"
2. Select the DDR5 type and the speed.
3. Open a test session, see [Chapter 3.1, "Starting a test session"](#), on page 10.
4. Adjust the "Properties" settings for the test cases you want to perform.
5. Click "Limit Manager" and edit the limit criteria, see [Chapter 3.2.1.1, "Limit manager"](#), on page 13.
6. If you want to use special report settings the "Report Config" tab to define the format and contents of the report. Otherwise the settings defined in "RSScopeSuite" > "Settings" > "Report" are used. See [Chapter 2.6, "Report configuration"](#), on page 8.
7. Click "Test Checked"/"Test Single" and proceed as described in the relevant test case chapter.

3.2.1 General test settings



Each session dialog is divided into several sections:

- "Properties": shows the settings that can be made for the test case selected on the left side of the dialog. You can differentiate between the "All" and the sub test properties
In the "All" > "Properties" tab you can configure the settings for all test cases in the current session. Once you change and save a setting in this tab, the changes will

be done for all test in the sessions. At the same time, there will be a special marking for the functions that have different settings for different sub tests.

- "Limit Manager": sets the measurement limits that are used for compliance testing, see [Chapter 3.2.1.1, "Limit manager"](#), on page 13.
- "Results": shows an overview of the available test results for this session.
- "Instruments": defines instruments settings for connecting to external devices, that are specific for this test session.
When a session is first created the global settings ("RSScopeSuite" > "Settings" > "Instruments") are copied to the session. This "Instruments" tab can be used to change those copied defaults.
- "Report Config": defines the format and contents of the report for this session.
When a session is first created the global settings ("RSScopeSuite" > "Settings" > "Report") are copied to the session. This "Report Config" tab can be used to change those copied defaults.
- "Test Checked"/ "Test Single": starts the selected test group.

3.2.1.1 Limit manager

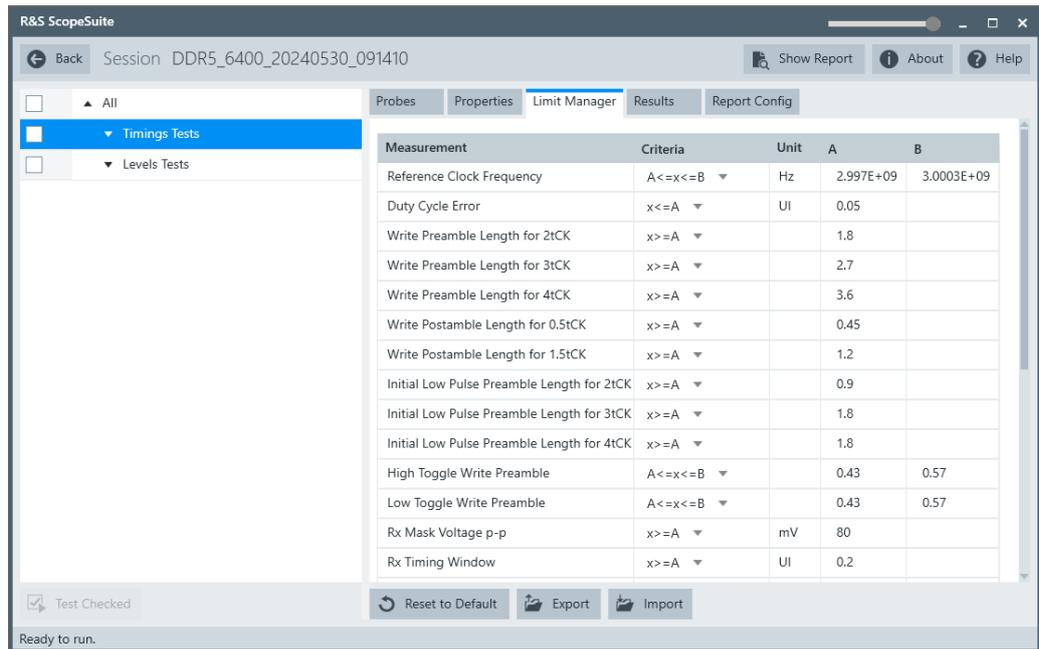
The "Limit Manager" shows the measurement limits that are used for compliance testing.

Each limit comprises the comparison criterion, the unit, the limit value A, and a second limit value B if the criterion requires two limits.

You can set the values to defaults, change the values in the table, export the table in xml format, or import xml files with limit settings.

You can also return the values to the original limits with "Reset to default".

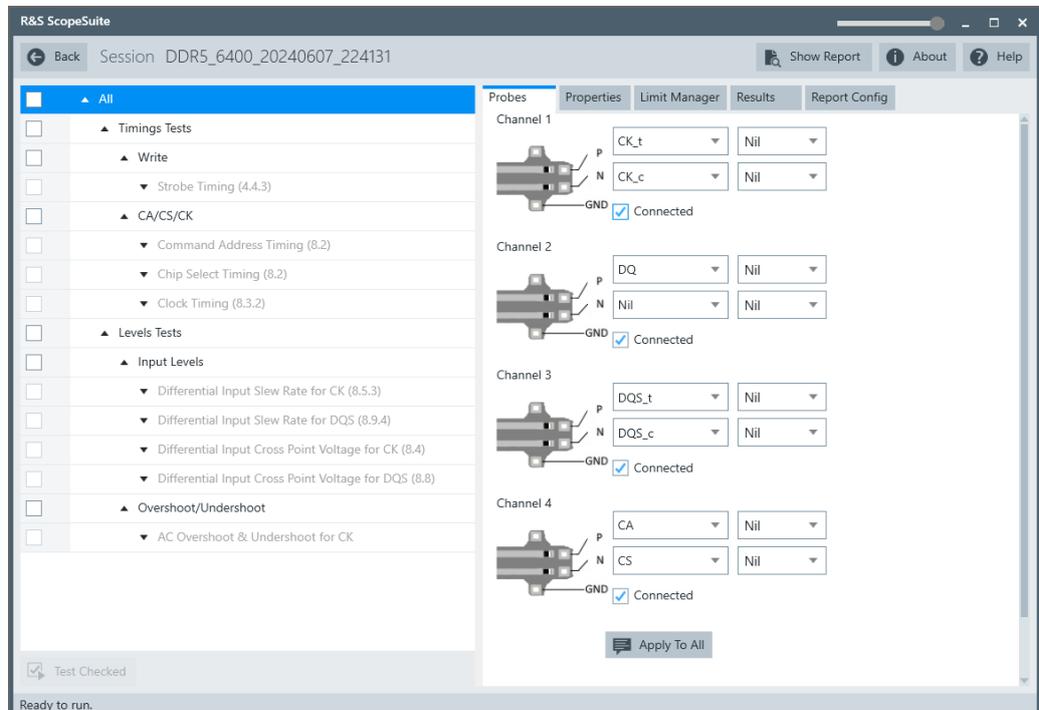
- ▶ Check and adjust the measurement limits.



3.2.2 Test configuration for DDR5

The test configuration consists of some test-specific configuration settings.

3.2.2.1 Probes



In this dialog you can define the probe connections for the test setup.

For each connected probe with a tip cable, you can define the signal to which the P, N and GND tips are connected to:

- **DQ**: Data input/output signal.
- **DQS_t, DQS_c**: Data strobe signal.
- **CK_t, CK_c**: Clock input signal.
- **CA**: Command /address Inputs
- **CS**: Chip select signal
- **Gnd**: Ground

For maximizing the oscilloscope bandwidth during testing, the following probe setup is recommended:

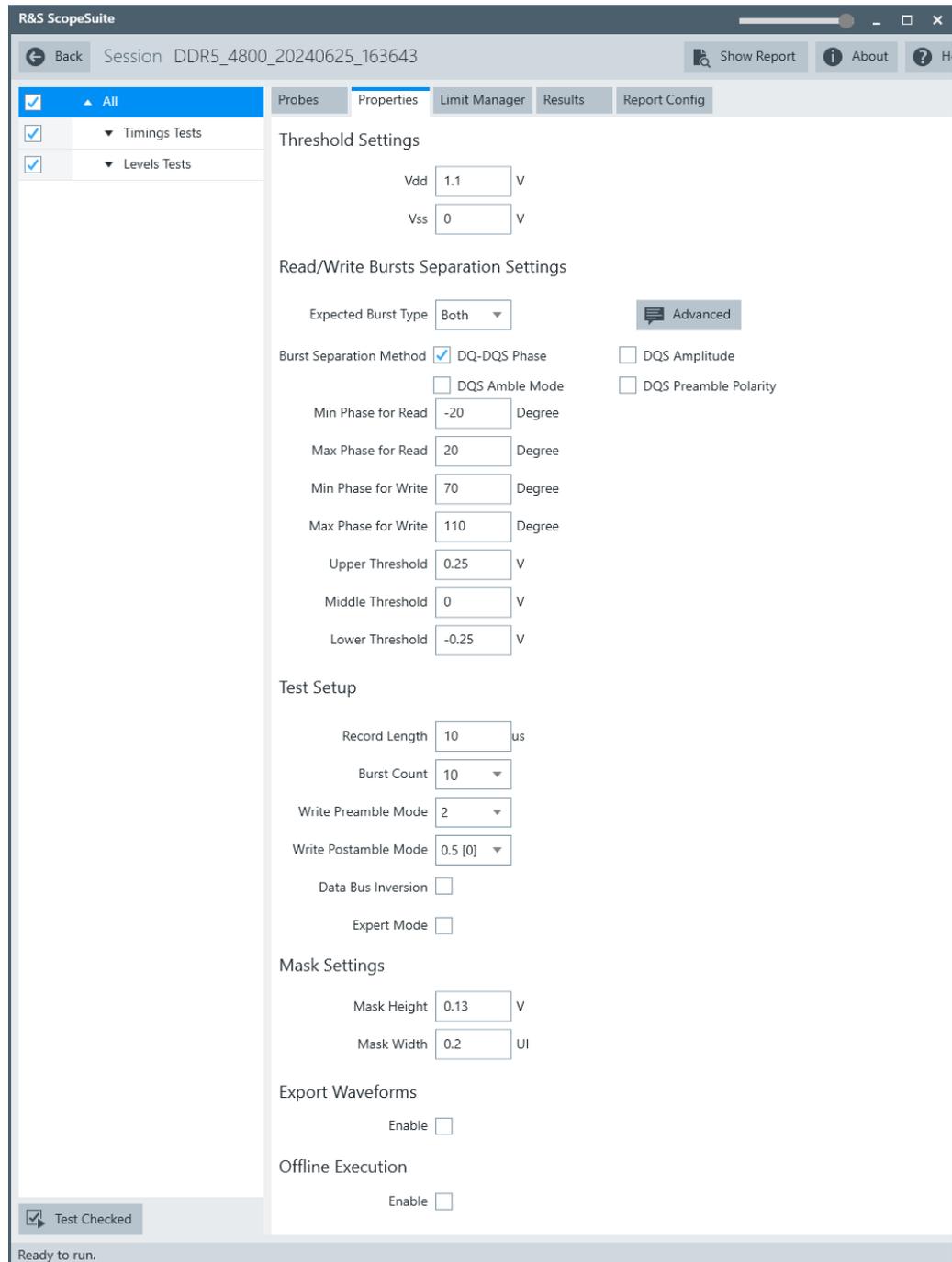
- Channel 1: CK_t and CK_c
- Channel 2: DQ
- Channel 3: DQS_t and DQS_c
- Channel 4: CA and CS



Press "Apply to all" after you have selected the correct signal for all connected probes. Only then the changes are considered for the subsequent test cases.

3.2.2.2 Test configuration for DDR5

The test configuration consists of some test-specific configuration settings. The values for the settings in this tab depend on the selected "Speed" and "Type" of standard.



Threshold Settings

The following threshold settings are defined:

"V_{DD}" Power supply

"V_{SS}" Ground

Expected Burst Type

Selects the expected burst type of the DUT. You can select between "Read only", "Write only" or "Both".

Bus Separation Method

Selects the separation method.

"DQ-DQS Phase"

Checks the phase difference between DQ and DQS to differentiate the type (read or write) of burst.

"DQS Amplitude"

Checks the peak-peak amplitude difference between read and write signals on DQS to differentiate the type (read or write) of burst.

"DQS Amble Mode"

Checks the DQS amble period. The amble period is a low-power state where the DQS signal is driven to a known state before starting the preamble.

"DQS Preamble Polarity"

Checks the DQS preamble polarity for Read and Write.

Settings for DQ-DQS Phase

If "Bus Separation Method" is set to "DQ-DQS Phase", you can define the following settings:

"Min Phase for Read"

Sets the minimum phase for read in degree.

"Max Phase for Read"

Sets the maximum phase for read in degree.

"Min Phase for Write"

Sets the minimum phase for write in degree.

"Max Phase for Write"

Sets the maximum phase for write in degree.

Settings for DQS Amplitude

If "Bus Separation Method" is set to "DQS Amplitude", you can define the following settings:

"Amplitude Relationship"

Sets if the "Amplitude Relationship" is "Read > Write" or "Write > Read".

"P-P Amplitude Threshold"

Sets the peak-to-peak amplitude threshold, the voltage difference between the highest and lowest points of the signal waveform.

Settings for DQS Amble Mode

If "Bus Separation Method" is set to "DQS Amble Mode", you can define the following settings:

"Write Preamble Mode"

Selects the value of the write preamble mode: 2 tCK, 3 tCK or 4 tCK.

"Write Postamble Mode"

Selects the value of the write postamble mode: 0.5 [0] tCK or 1[000] tCK.

"Read Preamble Mode"

Selects the value of the write preamble mode: 1 [10] tCK, 2 [0010] tCK, 3 [000010] tCK or 4 [00001010] tCK.

"Read Postamble Mode"

Selects the value of the read postamble mode: 0.5 tCK or 1 tCK.

"Consecutive Reads (tCCD)"

Sets how the minimum time between consecutive read commands is defined.

"Consecutive Writes (tCCD)"

Sets the how the minimum time between consecutive write commands is defined.

Settings for DQS Preamble Polarity

If "Bus Separation Method" is set to "DQS Preamble Polarity", you can define the following settings:

"Write Preamble Polarity"

Selects if the DQS write preamble polarity is "Positive" or "Negative".

"Read Preamble Polarity"

Selects if the DQS read preamble polarity is "Positive" or "Negative".

Advanced

The following settings are for expert users.

Threshold Mode ← Advanced

Selects between the absolute and relative threshold mode.

Upper/Middle/Lower Threshold ← Threshold Mode ← Advanced

Sets the upper/middle/lower for the absolute threshold mode.

Top/Middle/Base Ratio ← Threshold Mode ← Advanced

Set the top/middle/base ratio for the relative threshold mode.

Apply for Measurements ← Advanced

If enabled, the Middle Threshold/Ratio value is not only used for DQS read write separation, but also for DQS timing measurements.

Record Length

Sets the number of waveform samples in one waveform record.

Burst Count

Sets the burst count.

Data Burst Inversion

Sets the data burst inversion.

Expert Mode

If enabled, the "Expert Mode" allows you to bypass the guided steps of the test case.

Mask Settings

For "Command Address timing (8.2)" and "Chip Select timing (8.2)" tests you can set the "Mask Height" and "Mask Width" for the mask.

Export Waveforms

Enable you to export a waveform. You can later load the waveforms to run the tests in the offline mode, see [Offline Execution](#).

You can define an export directory, or use the default one:

```
MyDocuments\Rohde-Schwarz\RSScopeSuite\<<Version>\Waveforms\  
<ComplianceTest>\<SubTest>\<Speed>\<SessionName>
```

For example:

```
MyDocuments\Rohde-Schwarz\RSScopeSuite\5.40.1\Waveforms\DDR5\  
DDR5\3200\DDR5_3200_20240414_144116
```

Offline Execution

If enabled allows you to use exported waveforms as a source for the execution of the compliance test.

You can select one waveform for each needed signal.

3.3 Initiating the test

To perform compliance tests, the device under test is connected to the test board in a test-specific way. Using a probe, the test board is connected with the R&S RTP. The probe connections are test-specific. The R&S ScopeSuite guides you step-by-step through the connection setup and the test sequence.

1. Set the test setup on a nonconductive, static-approved work surface.
2. In the R&S ScopeSuite window, select the compliance test.
3. Open a test session, see [Chapter 3.1, "Starting a test session"](#), on page 10.
4. Check the test configuration settings and adjust, if necessary. See: [Chapter 3.2, "Configuring the test"](#), on page 11.
5. Click "Test Checked" for starting all checked test cases or "Test Single" for starting only the selected test case.

The R&S ScopeSuite test wizard explains the following individual setup steps. A test description can be found in the "R&S Test Procedures" manual for the selected compliance test.

The R&S ScopeSuite test wizard explains the following individual setup steps. A detailed test description can be found in the following chapters:

- [Chapter 3.5, "Starting DDR5 tests"](#), on page 20

3.4 Getting test results

For each test, the test data - report, diagrams and waveform files - is saved in the following folder:

```
%ProgramData%\Rohde-Schwarz\RSScopeSuite\5.40.1\Sessions\  
<Protocolgroup>\<Protocol>\<Session_Name>.
```

For each Ethernet test, the test data - report, diagrams and waveform files - is saved in the following folder:

```
%ProgramData%\Rohde-Schwarz\RSScopeSuite\5.40.1\Sessions\  
Sessions\<DDR category>\<Session_Name>
```

If you resume an existing session, new measurements are appended to the report, new diagrams and waveform files are added to the session folder. Existing files are not deleted or replaced. Sessions data remain until you delete them in the "Results" tab of the session.

The report format can be defined in "RSScopeSuite" > "Settings" > "Report" for all compliance tests (see also [Chapter 2.6, "Report configuration"](#), on page 8). If you want to use special report settings for a session, you can define the format and contents of the report in the "Report Config" tab of the session.

All test results are listed in the "Results" tab. Reports can be provided in PDF, MSWord, or HTML format. To view and print PDF reports, you need a PDF viewer, for example, the Acrobat Reader.

The test report file can be created at the end of the test, or later in the "Session Selection" dialog.

To show a test report

1. In the R&S ScopeSuite window, select the compliance test to be performed.
2. Select the session name in the "Session Selection" dialog and click "Show report".
The report opens in a separate application window, depending on the file format.
You can check the test results and print the report.

To delete the results, diagrams and waveform files of a session

1. In the "Session Selection" dialog select the session and open it.
2. In the "Results" tab, select the result to be deleted.
3. Click "Remove".

3.5 Starting DDR5 tests

Before you run the test, complete the following actions:

- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see [Chapter 2.5, "Connecting the R&S RTP"](#), on page 7

1. Select "DDR5" in the R&S ScopeSuite start window.
2. In the "Session Selection" dialog, set the "Select Type" standard. The following "Types" are available:
 - "DDR5": Double data rate type three. Used for desktops and servers.
3. Set the "Select Speed". There are preset speeds you can select from:
"3200"/"3600"/"4000"/"4400"/"4800"/"5200"/"5600"/"6000"/"6400"
"Custom": user selected value. The values in the "Limit Manager" tab are set according to the selected speed.
4. Add a new test session.
5. Open the session. For details, see [Chapter 3.1, "Starting a test session"](#), on page 10.
6. Check the test configuration settings. Adjust, if necessary. See:
 - [Chapter 3.2.2, "Test configuration for DDR5"](#), on page 14
 - [Chapter 3.2.1.1, "Limit manager"](#), on page 13
7. Select/check the test cases you want to run and click "Test Single"/"Test checked".
8. A step-by step guide explains the following individual setup steps. When you have finished all steps of the step-by-step guide, the compliance test runs automatically.

4 Timing tests

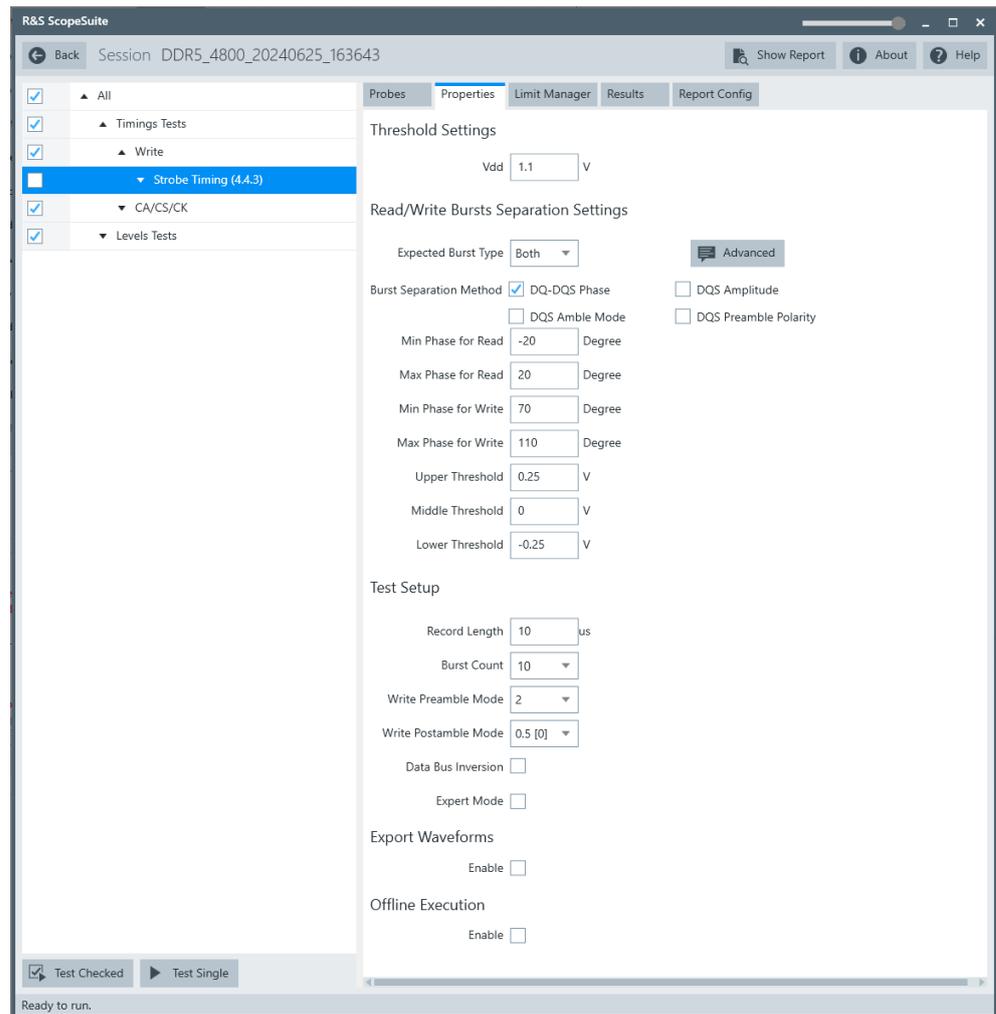
4.1 Strobe timing

4.1.1 Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	probe with minimum 9 GHz bandwidth	1
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	1
DUT	DDR5 device that supports the selected type	1

4.1.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections, according to your test setup.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Timing Tests" > "Write" > "Strobe Timing".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see ["Offline Execution"](#) on page 19.

4.1.3 Measurements

The strobe timing measurements consist of up to five measurements. They test the limits as defined in section 4.4.3 of the JESD79-5B(DDR5) specifications.

4.1.3.1 Write preamble - t_{WPREX}

This test aims to verify that the strobe differential WRITE preamble is within the limits defined in the specification.

Depending on the selected "Write Preamble Mode" one of the following tests are performed for:

- $2t_{CK}$ Preamble mode: t_{WPRE2}
- $3t_{CK}$ Preamble mode: t_{WPRE3}
- $4t_{CK}$ Preamble mode: t_{WPRE4}

4.1.3.2 Write postamble - t_{WPSTx}

This test aims to verify that the strobe differential WRITE postamble is within the limits defined in the specification.

Depending on the selected "Write Postamble Mode" one of the following tests are performed for:

- $0.5 t_{CK}$: $t_{WPST0.5}$
- $1.5 t_{CK}$: $t_{WPST1.5}$

4.1.3.3 Initial low pulse width during write preamble region of the DQS signal - $t_{DQSLxPRE}$

This test aims to verify that the initial low pulse width during Write Preamble region of the DQS signal is within the limits defined in the specification.

Depending on the selected "Write Preamble Mode" one of the following tests are performed for:

- $2t_{CK}$ Preamble: $t_{DQSL2PRE}$
- $3t_{CK}$ Preamble: $t_{DQSL3PRE}$
- $4t_{CK}$ Preamble: $t_{DQSL4PRE}$

4.1.3.4 Strobe's window of differentially high during write preamble - t_{DQSH_PRE}

This test aims to verify that the strobe's window of differentially high during write preamble is within the limits defined in the specification.

4.1.3.5 Strobe's window of differentially low during write preamble - t_{DQSL_PRE}

This test aims to verify that the strobe's window of differentially low during write preamble is within the limits defined in the specification.

4.2 CA/CS/CK

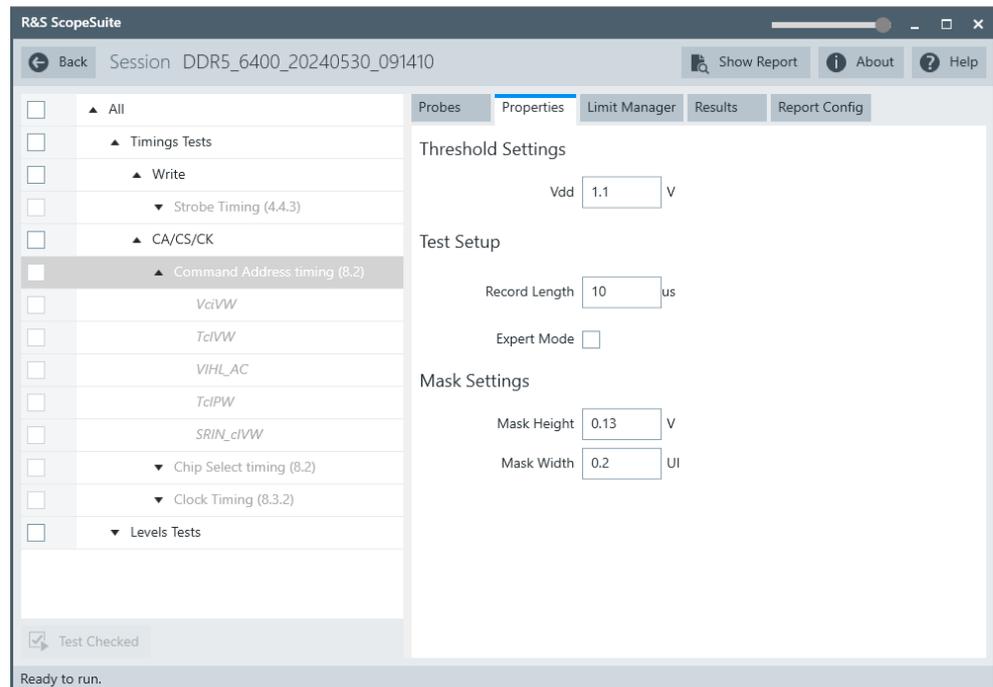
4.2.1 Command address timing

4.2.1.1 Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	probe with minimum 9 GHz bandwidth	1
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	1
DUT	DDR5 device that supports the selected type	1

4.2.1.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections, according to your test setup.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Timing Tests" > "CA/CK" > "Command Address timing (8.2)".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see "[Offline Execution](#)" on page 19.

4.2.1.3 Measurements

The command address measurements consist of up to five measurements. It tests the limits as defined in section 8.2 of the JESD79-5B(DDR5) specifications.

Rx Mask voltage - p-p V_{ciVW}

This test aims to verify that the Rx Mask voltage - p-p is within the limits defined in the specification.

Rx timing window T_{ciVW}

This test aims to verify that the Rx timing window is within the limits defined in the specification.

CA input pulse amplitude V_{IHL_AC}

This test aims to verify that the CA input pulse amplitude is within the limits defined in the specification.

CA input pulse width T_{cIPW}

This test aims to verify that the CA input pulse width is within the limits defined in the specification.

Input slew rate over V_{cIVW} $SRIN_{cIVW}$

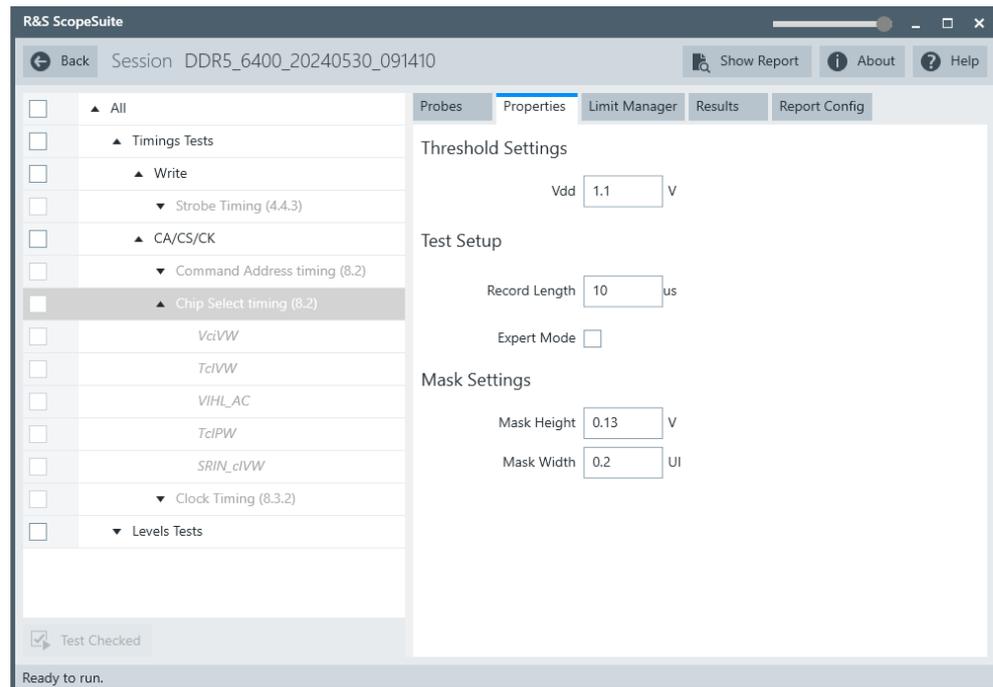
This test aims to verify that the input slew rate over V_{cIVW} is within the limits defined in the specification.

4.2.2 Chip select timing**4.2.2.1 Test equipment**

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	probe with minimum 9 GHz bandwidth	1
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	1
DUT	DDR5 device that supports the selected type	1

4.2.2.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections, according to your test setup.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Timing Tests" > "CA/CK" > "Chip select timing (8.2)".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see "[Offline Execution](#)" on page 19.

4.2.2.3 Measurements

The chip select measurements consist of up to five measurements. It tests the limits as defined in section 8.2 of the JESD79-5B(DDR5) specifications.

Rx mask voltage - p-p V_{ciVW}

This test aims to verify that the Rx mask voltage - p-p is within the limits defined in the specification.

Rx timing window T_{ciVW}

This test aims to verify that the Rx timing window is within the limits defined in the specification.

CA input pulse amplitude V_{IHL_AC}

This test aims to verify that the CA input pulse amplitude is within the limits defined in the specification.

CA input pulse width T_{cIPW}

This test aims to verify that the CA input pulse width is within the limits defined in the specification.

Input slew rate over V_{cIVW} $SRIN_{cIVW}$

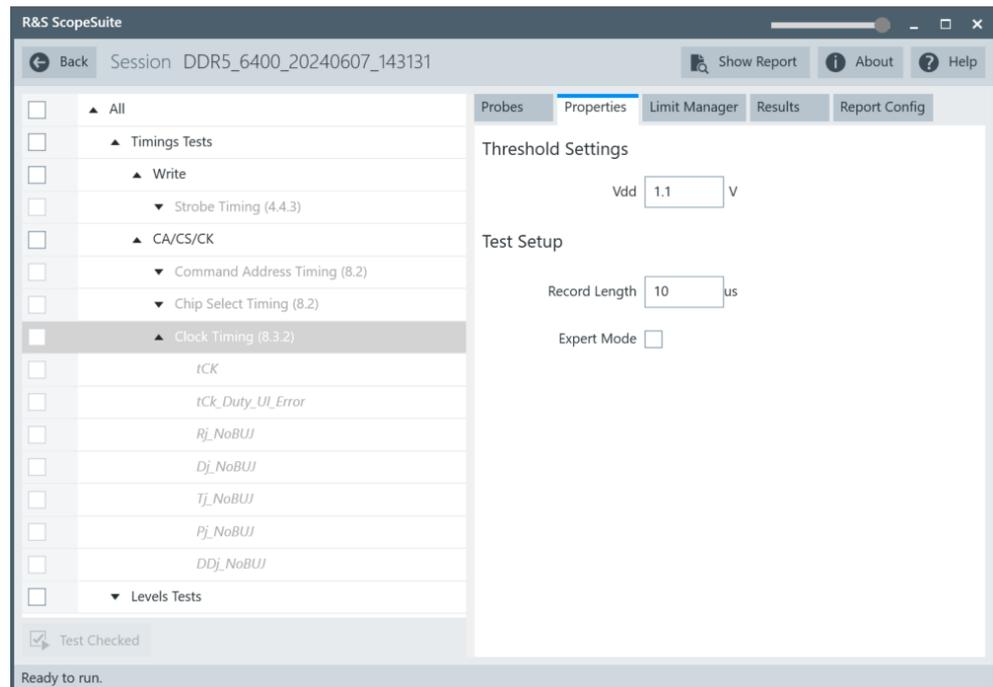
This test aims to verify that the input slew rate over V_{cIVW} is within the limits defined in the specification.

4.2.3 Clock timing**4.2.3.1 Test equipment**

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	probe with minimum 9 GHz bandwidth	1
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	1
DUT	DDR5 device that supports the selected type	1

4.2.3.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections, according to your test setup.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Timing Tests" > "Write" > "Clock Timing".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see "[Offline Execution](#)" on page 19.

4.2.3.3 Measurements

The clock timing measurements consist of up to eight measurements. They test the limits as defined in section 8.3.2 of the JESD79-5B(DDR5) specifications.

DRAM Reference clock frequency - t_{CK}

This test aims to verify that the DRAM reference clock frequency is within the limits defined in the specification.

Duty Cycle Error - $t_{CK_Duty_UI_Error}$

This test aims to verify that it is within the limits defined in the specification.

Rj RMS value of 1-UI Jitter - $t_{CK_1UI_Rj_NoBUJ}$

This test aims to verify that the random jitter RMS Value of 1-UI Jitter without BUJ is within the limits defined in the specification.

Dj pp value of 1-UI Jitter - $t_{CK_1UI_Dj_NoBUJ}$

This test aims to verify that the deterministic jitter peak-to-peak value of 1-UI without BUJ is within the limits defined in the specification.

Tj value of 1-UI Jitter - $t_{CK_1UI_Tj_NoBUJ}$

This test aims to verify that the total jitter value of 1-UI without BUJ is within the limits defined in the specification.

Pj value of 1-UI Jitter - $t_{CK_1UI_Pj_NoBUJ}$

This test aims to verify that the periodic jitter value of 1-UI without BUJ is within the limits defined in the specification.

DDj value of 1-UI Jitter - $t_{CK_1UI_DDj_NoBUJ}$

This test aims to verify that the data-dependent jitter value of 1-UI without BUJ is within the limits defined in the specification.

5 Level tests

5.1 Input levels

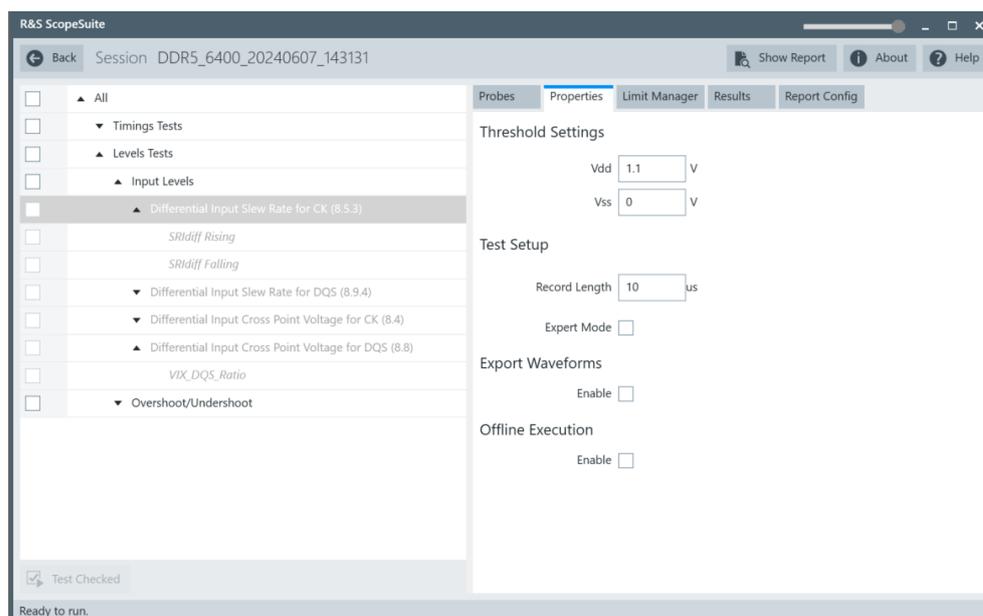
5.1.1 Differential input slew rate for CK

5.1.1.1 Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	Probe with minimum 9 GHz bandwidth	1
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	1
DUT	DDR5 device that supports the selected type	1

5.1.1.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections for CK_t and CK_c.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Level Tests" > "Input Levels" > "Differential Input Slew Rate for CK (8.5.3)".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see ["Offline Execution"](#) on page 19.

5.1.1.3 Test setup

The software guides you to make the proper connections. Follow the steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the relevant signals.

5.1.1.4 Measurements

The input slew rates for clock measurements consist of up to two measurements. It tests the limits as defined in section 8.5.3 off the JESD79-5B(DDR5)) specifications.

To measure the slew rate of the clock signal a measurement of $V_{IL,diff}$ CK and $V_{IH,diff}$ CK is used.

$V_{IH,diff}$ CK is the differential input high measurement level at 0.75 of the mean high voltage minus the mean low voltage.

$V_{IL,diff}$ CK is the differential input high measurement level at 0.25 of the mean high voltage minus the mean low voltage.

Differential input slew rate rising - SR(diff) rising

This test aims to verify that the setup slew rate for rising signal is within the limits defined in the specification. It is measured from $V_{IL,diff}$ CK to $V_{IH,diff}$ CK. The measurement is performed on a write burst.

Differential input slew rate falling - SR(diff) falling

This test aims to verify that the setup slew rate for falling signal is within the limits defined in the specification. It is measured from $V_{IH,diff}$ CK to $V_{IL,diff}$ CK. The measurement is performed on a write burst.

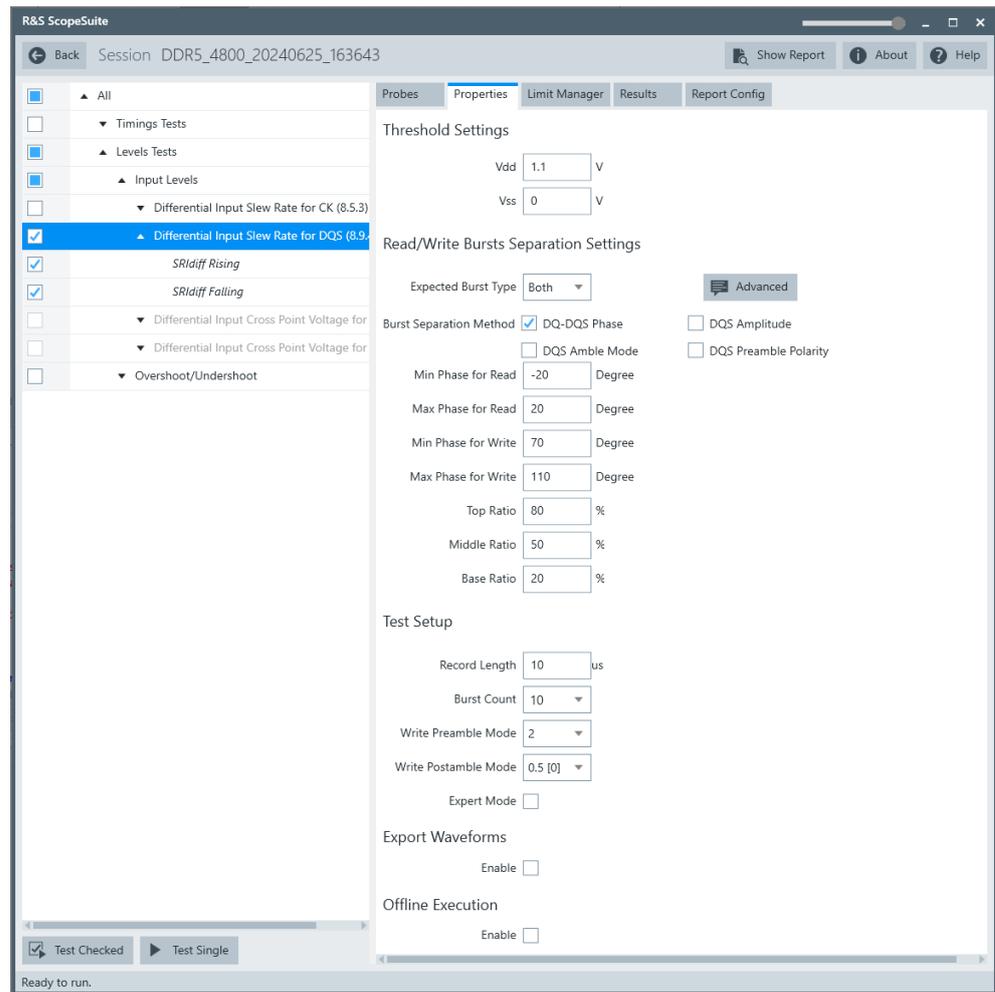
5.1.2 Differential input slew rate for DQS

5.1.2.1 Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	Probe with minimum 9 GHz bandwidth	1
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	1
DUT	DDR5 device that supports the selected type	1

5.1.2.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections for DQS_t and DQS_c.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Level Tests" > "Input Levels" > "Differential Input Slew Rate for DQS (8.9.4)".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see ["Offline Execution"](#) on page 19.

5.1.2.3 Test setup

The software guides you to make the proper connections. Follow the steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the relevant signals.

5.1.2.4 Measurements

The input slew rates for data strobe consist of up to two measurements. It tests the limits as defined in section 8.9.4 of the JESD79-5B(DDR5) specifications.

To measure the DQS slew rate a measurement of $V_{IL,diff}$ DQS and $V_{IH,diff}$ DQS is used.

$V_{IH,diff}$ DQS is the differential input high measurement level at 0.75 of the mean high voltage minus the mean low voltage. The measurement is performed on a write burst.

$V_{IL,diff}$ DQS is the differential input high measurement level at 0.25 of the mean high voltage minus the mean low voltage. The measurement is performed on a write burst.

Differential input slew rate rising - SR(diff) rising

This test aims to verify that the setup slew rate for rising signal is within the limits defined in the specification. It is measured from $V_{IL,diff}$ DQS to $V_{IH,diff}$ DQS. The measurement is performed on a write burst.

Differential input slew rate falling - SR(diff) falling

This test aims to verify that the setup slew rate for falling signal is within the limits defined in the specification. It is measured from $V_{IH,diff}$ DQS to $V_{IL,diff}$ DQS. The measurement is performed on a write burst.

5.1.3 Differential cross point voltage for CK

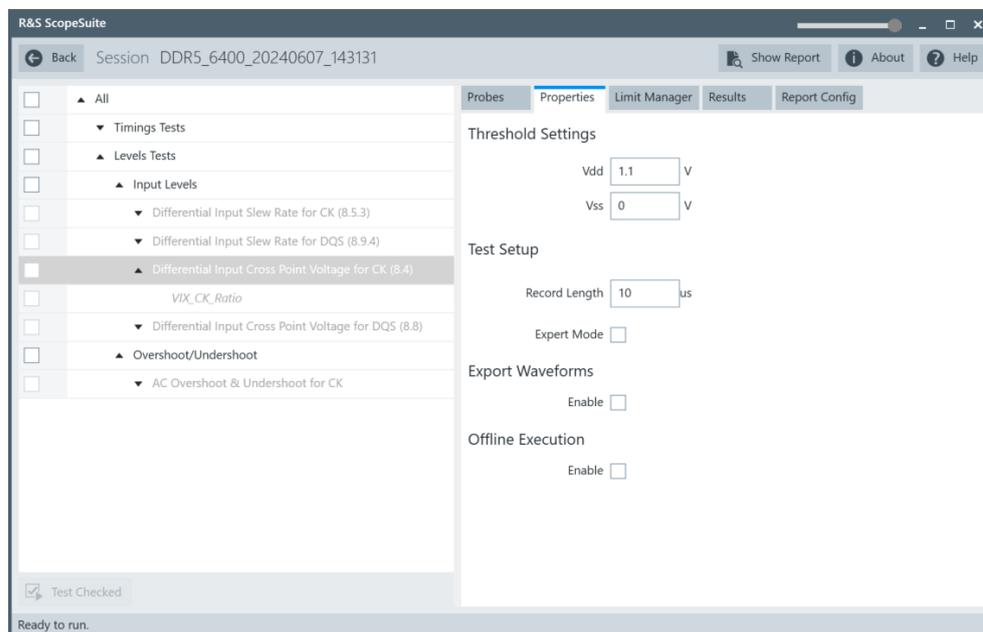
5.1.3.1 Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	Probe with minimum 9 GHz bandwidth	2
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	2
DUT	DDR5 device that supports the selected type	1

5.1.3.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections for CK_t and CK_c at two different channels.
To keep the oscilloscope working at maximum bandwidth, preferably connect one signal to Channel 1/Channel 2 and the other signal to Channel 3/Channel 4.
3. Press "Apply to all" to confirm the probe settings.

4. Select "Level Tests" > "Input levels" > "Differential Input Cross Point Voltage for CK".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see ["Offline Execution"](#) on page 19.

5.1.3.3 Test setup

The software guides you to make the proper connections. Follow the steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the relevant signals.

5.1.3.4 Measurements

The differential cross point voltage for clock measurement consists of one measurement. It tests the limits as defined in section 8.4 of the JESD79-5B(DDR5) specification.

Differential input cross point voltage - $V_{IX(CK_Ratio)}$

This test aims to verify that the differential input crosspoint voltage is within the limits defined in the specification. It is measured from the actual crosspoint of true and complement signals to the midlevel between of VDD and VSS.

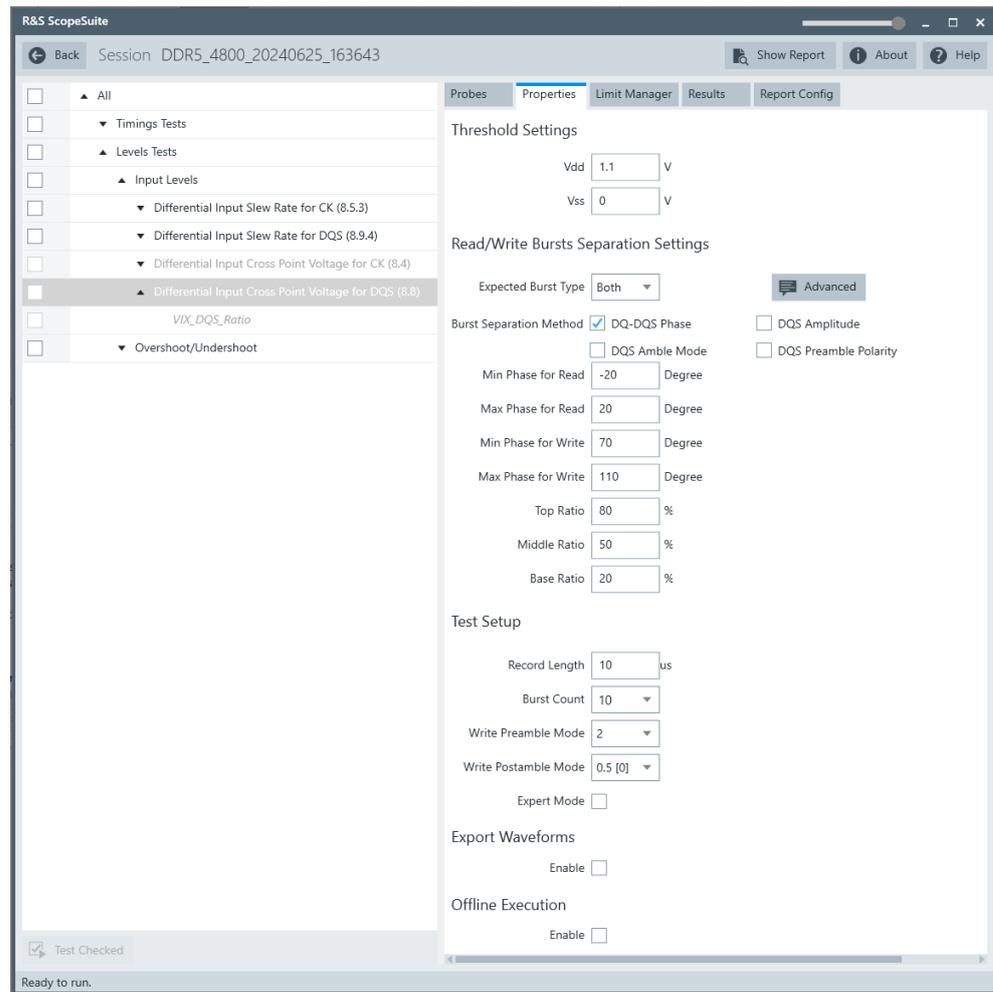
5.1.4 Differential cross point voltage for DQS

5.1.4.1 Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	Probe with minimum 9 GHz bandwidth	2
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	2
DUT	DDR5 device that supports the selected type	1

5.1.4.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections for DQS_t and DQS_c at two different channels.
To keep the oscilloscope working at maximum bandwidth, preferably connect one signal to Channel 1/Channel 2 and the other signal to Channel 3/Channel 4.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Level Tests" > "Input levels" > "Differential Input Cross Point Voltage for DQS".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see ["Offline Execution"](#) on page 19.

5.1.4.3 Test setup

The software guides you to make the proper connections. Follow the steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the relevant signals.

5.1.4.4 Measurements

The differential cross point voltage for data strobe measurement consists of one measurement. It tests the limits as defined in section 8.8 of the JESD79-5B(DDR5) specification.

Differential input cross point voltage ratio- $V_{IX(DQS_Ratio)}$

This test aims to verify that the differential input crosspoint voltage ratio is within the limits defined in the specification.

5.2 Overshoot/Undershoot

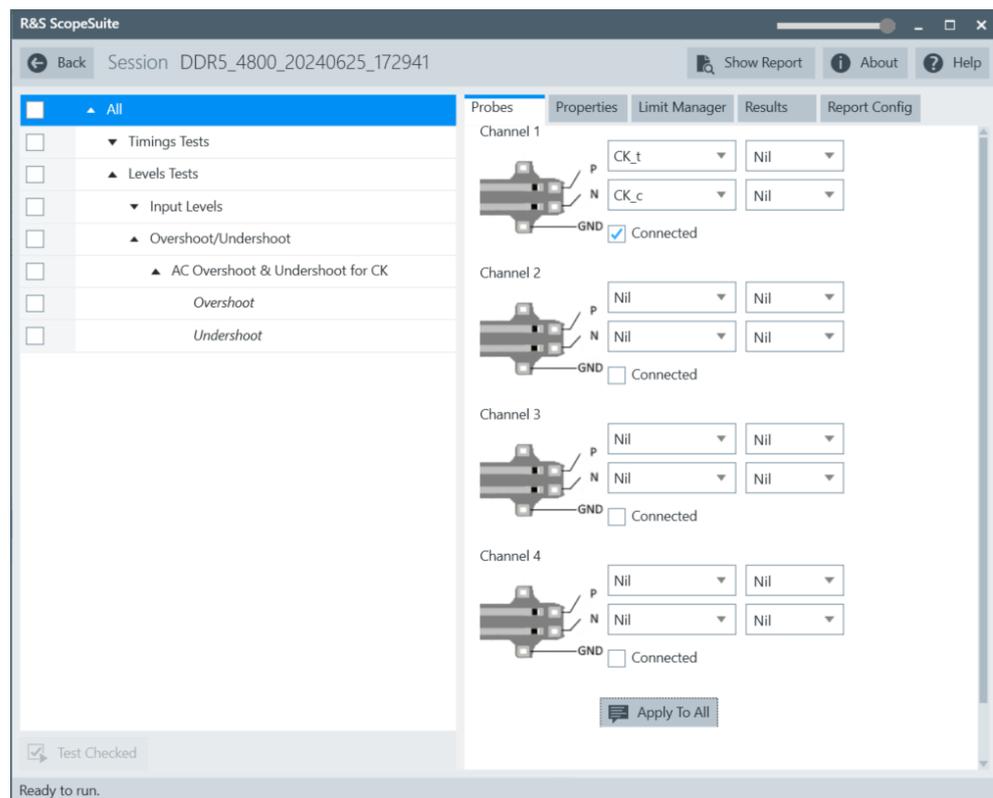
5.2.1 AC overshoot & undershoot for CK

5.2.1.1 Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and minimum 8GHz bandwidth	1
Modular probe	Probe with minimum 9 GHz bandwidth	1
Probe tip	R&S RT-ZMA10 or R&S RT-ZMA14	1
DUT	DDR5 device that supports the selected type	1

5.2.1.2 Performing the tests

1. Start the test as described in [Chapter 3.5, "Starting DDR5 tests"](#), on page 20.
2. In the "Probes" setup dialog, configure the probes connections, according to your test setup.
3. Press "Apply to all" to confirm the probe settings.
4. Select "Level tests" > "Overshoot/Undershoot" > "AC overshoot & undershoot for CK".



5. Enable the tests that you want to run.
6. Click "Test Single".
7. Follow the instructions of the step-by-step guide.
When you have finished all steps, the compliance test runs automatically.
8. You can also run the test in offline mode, using downloaded waveforms. For details, see ["Offline Execution"](#) on page 19.

5.2.1.3 Test setup

The software guides you to make the proper connections. Follow the steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the relevant signals.

5.2.1.4 Measurements

The overshoot and undershoot for clock measurements consist of up to two measurements. It tests the limits as defined in the JESD79-4D(DDR4) specification.

Overshoot

This test aims to verify the maximum value for CK_t and CK_c is within the limits defined in the specification.

Undershoot

This test aims to verify the minimum value for CK_t and CK_c is within the limits defined in the specification.