R&S®RTO-K92
eMMC Compliance Test
Test Procedures

1333.0380.02 ─ 01

Test & Measurement

Test Procedures

ROHDE&SCHWARZ

This manual describes the eMMC compliance test procedures with the following options:

- R&S®RTO-K92 (1329.6958.02)/(1333.0444.02) -eMMC

The tests require the R&S ScopeSuite software.

The software contained in this product makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgement" document, which is available for download from the R&S RTO product page at http://www.rohde-schwarz.com/product/rto.html > "Software".
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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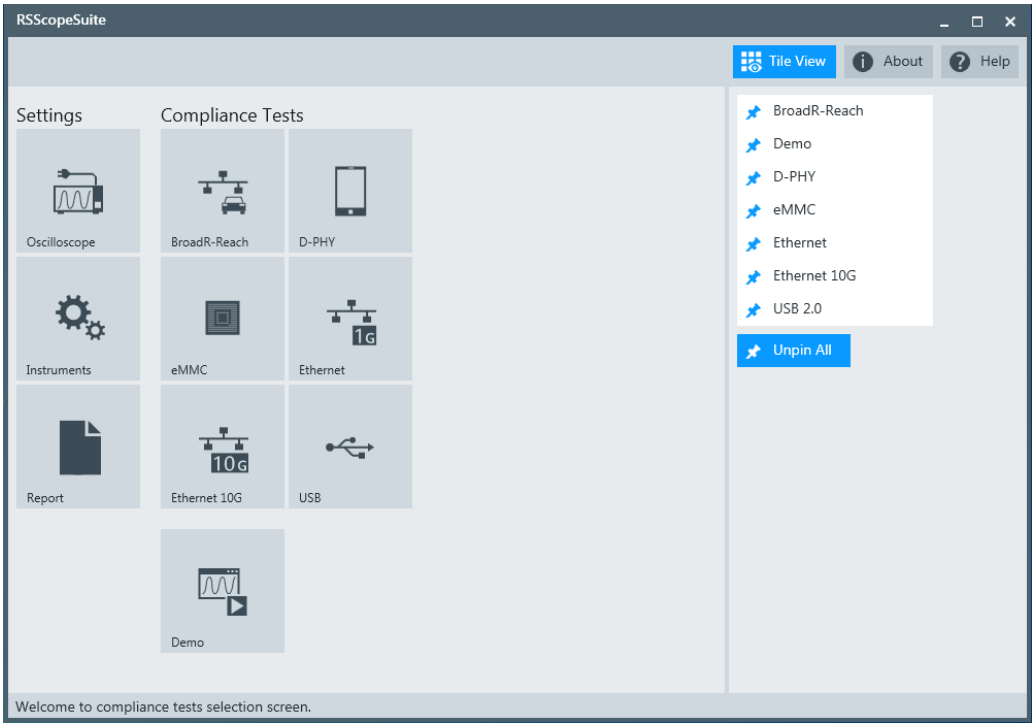
The following abbreviations are used throughout this manual: R&S®RTO is abbreviated as R&S RTO, and R&S®ScopeSuite is abbreviated as R&S ScopeSuite.

Contents

1 R&S ScopeSuite Overview

The R&S ScopeSuite software is used with R&S RTO oscilloscopes. It can be installed on a test computer or directly on the R&S RTO if the instrument has the Windows 7 operating system.



The R&S ScopeSuite main panel has several areas:

- "Settings": connection settings to oscilloscope and other instruments as well as 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
- "Help": opens the help file, conatining 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 you want to hide.
The icon of the test changes, see Figure 1-1. Now with a left click you can hide the test

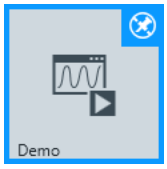


Figure 1-1: Unpin icon

b) Click on "Title View" to show a list of the available test cases. By clicking on 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 eMMC compliance tests, the following test equipment is needed:

- R&S RTO oscilloscope with at least 1 GHz bandwidth
- A probe with at least 1 GHz bandwidth
- R&S RTO-K92 eMMC compliance test option (required option, installed on the R&S RTO)

2.2 Installing Software and License

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

NOTICE

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".

To install the R&S ScopeSuite

1. Download the R&S ScopeSuite software from the "Software" section on the Rohde & Schwarz R&S RTO website: www.rohde-schwarz.com/product/rto.html.
2. Install the R&S ScopeSuite software:
   - Either on the computer that is used for testing,
   - or on the R&S RTO if the instrument has a Windows 7 operating system.

To install the license key on the R&S RTO

► When you got the license key of the compliance test option, enable it on the R&S RTO using SETUP > "SW Options".
For a detailed description, refer to the R&S RTO 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 R&S RTO 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.
  If no DHCP server is available, or if the Tabor WX2182B is used for automatic testing, assign fixed IP adresses to all devices.
- 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 has been 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 RTO", on page 11

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 RTO firmware:

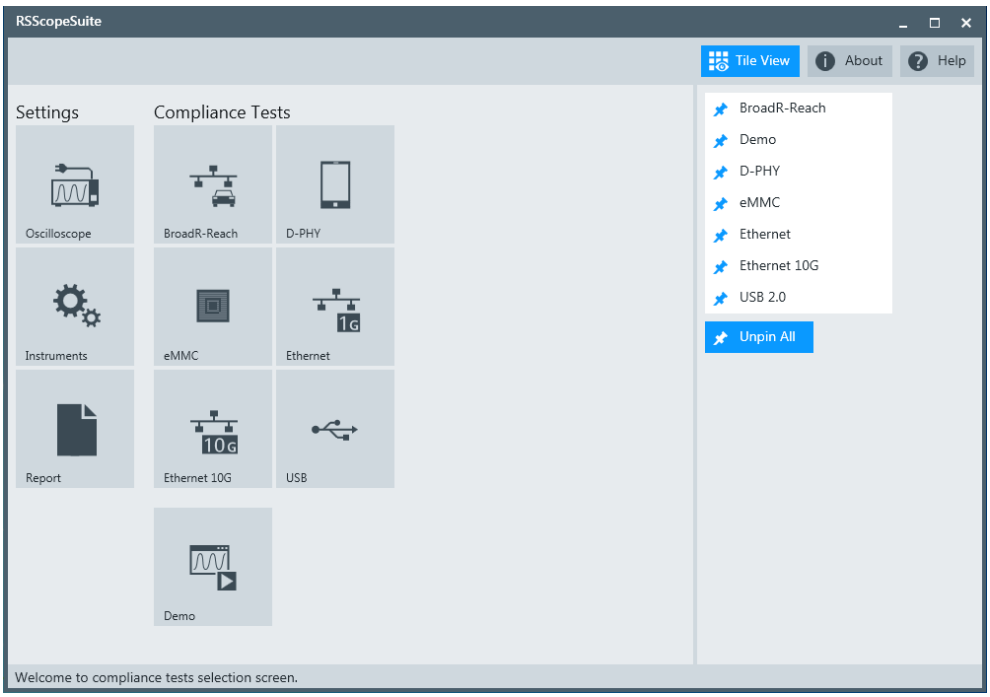
► On the "Analysis" menu, tap "Start Compliance Test".

2.5 Connecting the R&S RTO

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

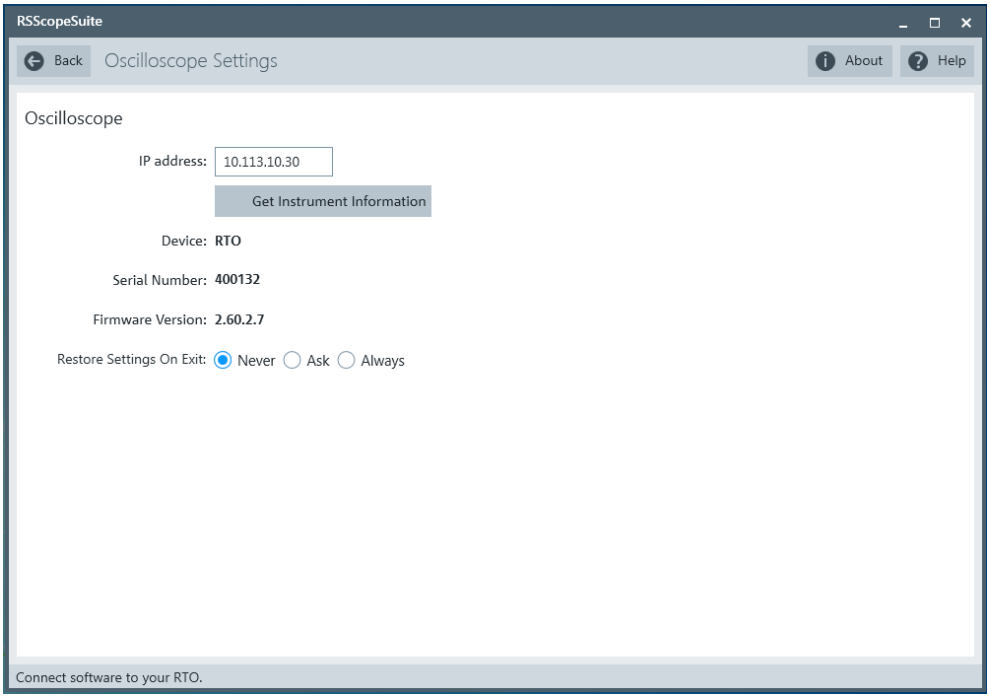
If the R&S ScopeSuite software runs on a test computer, the computer and the testing R&S RTO require a LAN connection, see Chapter 2.3, "Setting Up the Network", on page 10. The R&S ScopeSuite software needs the IP address of the R&S RTO to establish connection.

1. Start the R&S RTO.
2. Start the R&S ScopeSuite software.
3. Click "Settings" > "Osilloscope".



4. Enter the IP address of the R&S RTO.
   To obtain the IP address: Press the SETUP key on the instrument and tap the "System" tab.
5. Click "Get Instrument Information".

   The computer connects with the instrument and gets the instrument data.

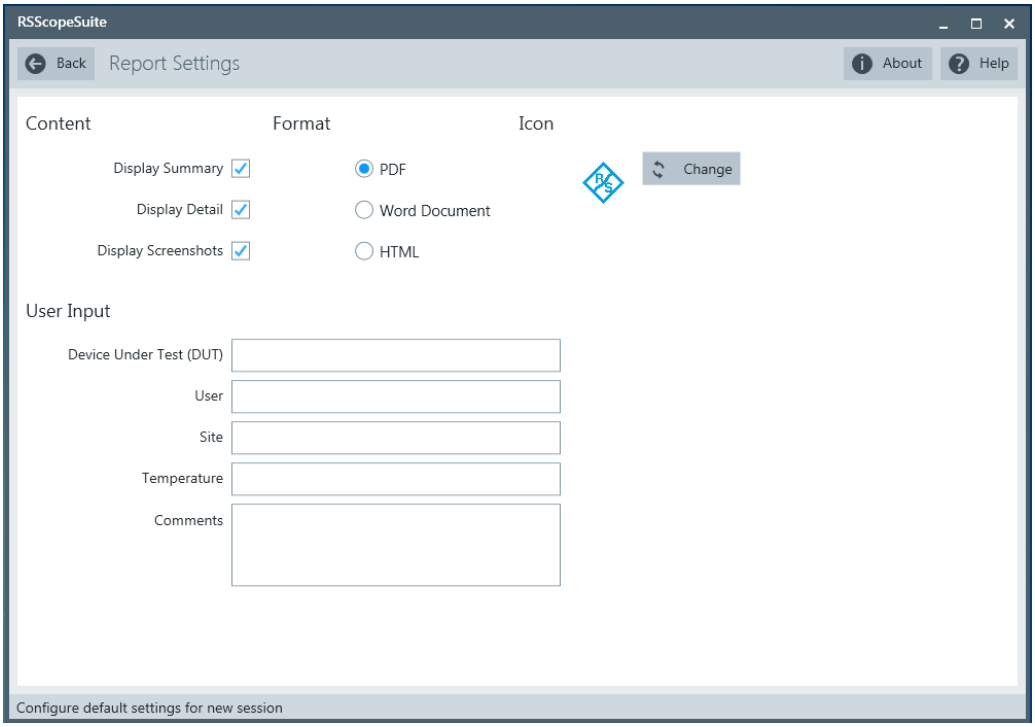


If the connection fails, an error message is shown.

2.6 Report Configuration

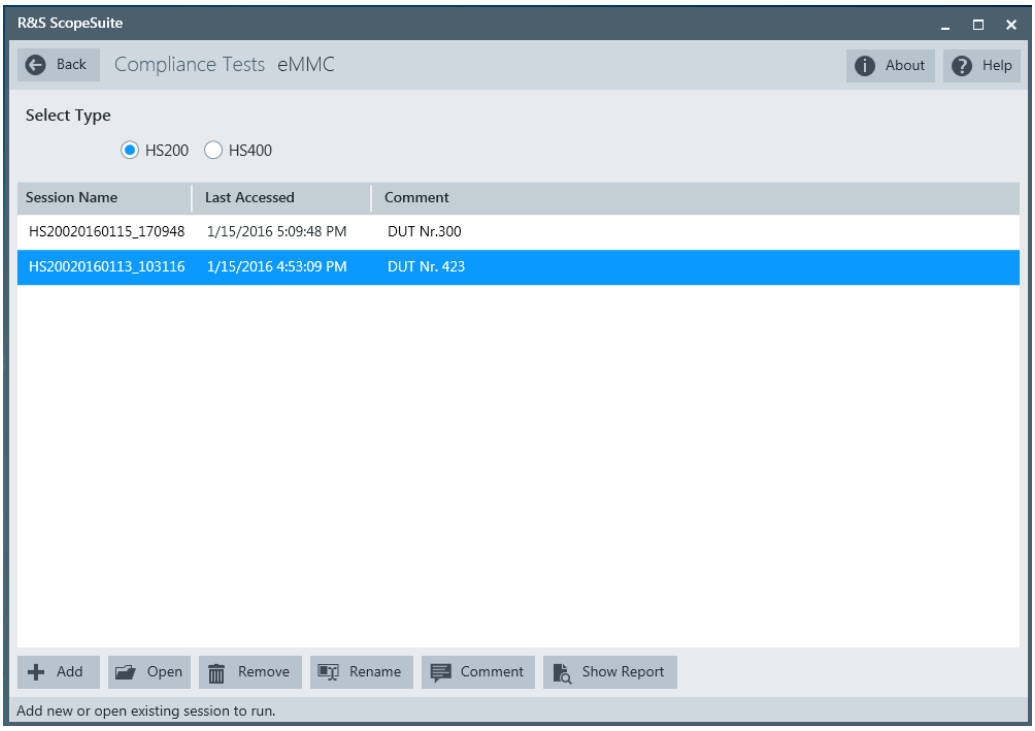
In the "Report Configuration" menu, you can select the format of the report and the details to be included in the report. You can also select an icon that will be displayed in the upper left corner of the report.

Additionally, you can enter common information on the test that will be written in the "General Information" section of the test report.


RSScopeSuite
Back
Report Settings
About
Help
Content
Format
Icon
Display Summary
Display Detail
Display Screenshots
PDF
Word Document
HTML
Change
User Input
Device Under Test (DUT)
User
Site
Temperature
Comments
Configure default settings for new session

3 Performing Tests

3.1 Starting a Test Session



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

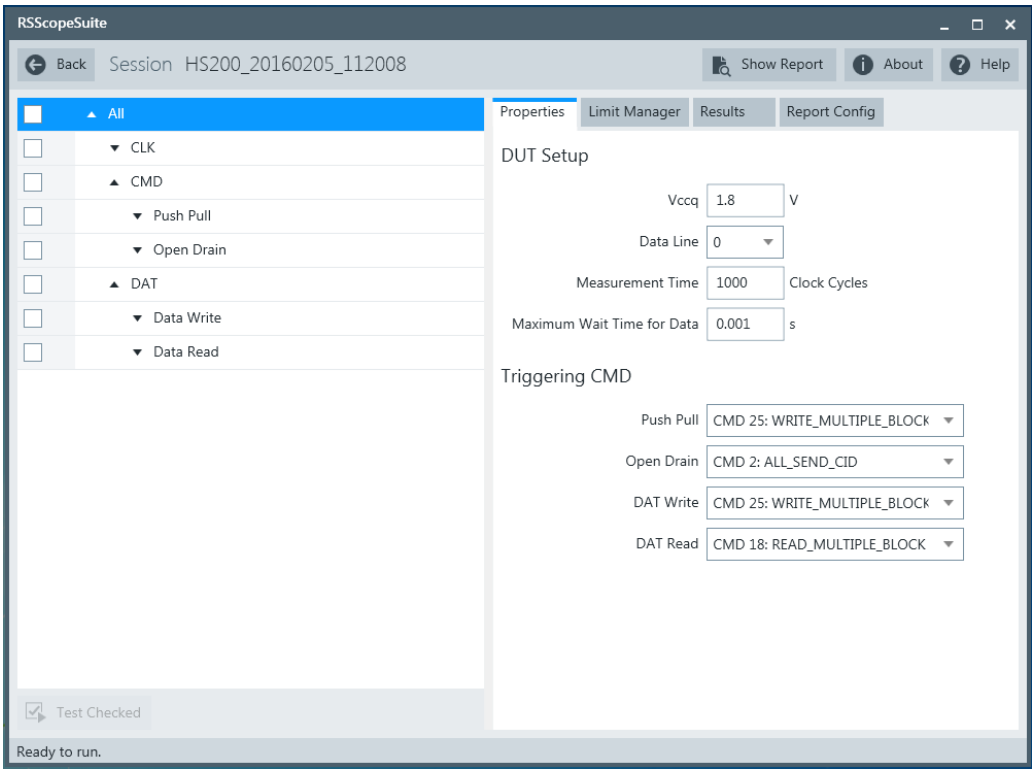
The following functions are available for handling test sessions:

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

3.2 Configuring the Test

1. In the R&S ScopeSuite window, select the compliance test to be performed:
   - "eMMC"
2. Open a test session, see Chapter 3.1, "Starting a Test Session", on page 14.
3. Adjust the "Properties" settings for the test cases you want to perform.
4. Click "Limit Manager" and edit the limit criterias, see Chapter 3.2.1.1, "Limit Manager", on page 16.
5. 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" will be used. See Chapter 2.6, "Report Configuration", on page 12.
6. Click "Test Checked"/"Test Single" and proceed as descibed 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 16.
- "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 t est 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.

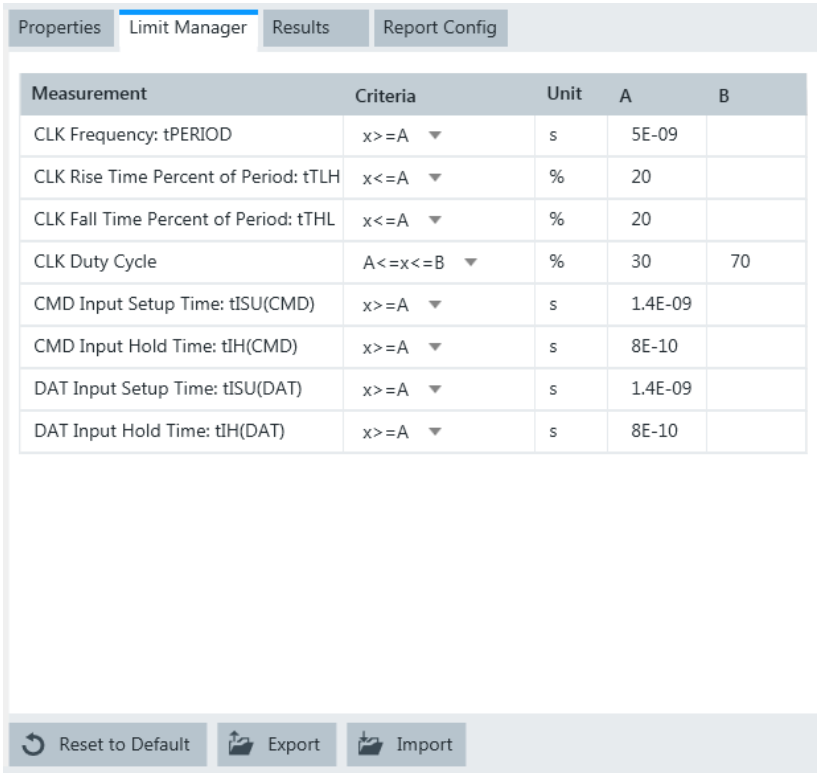
3.2.1.1 Limit Manager

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.

► Check and adjust the measurement limits.



3.2.2 eMMC Test Configuration

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

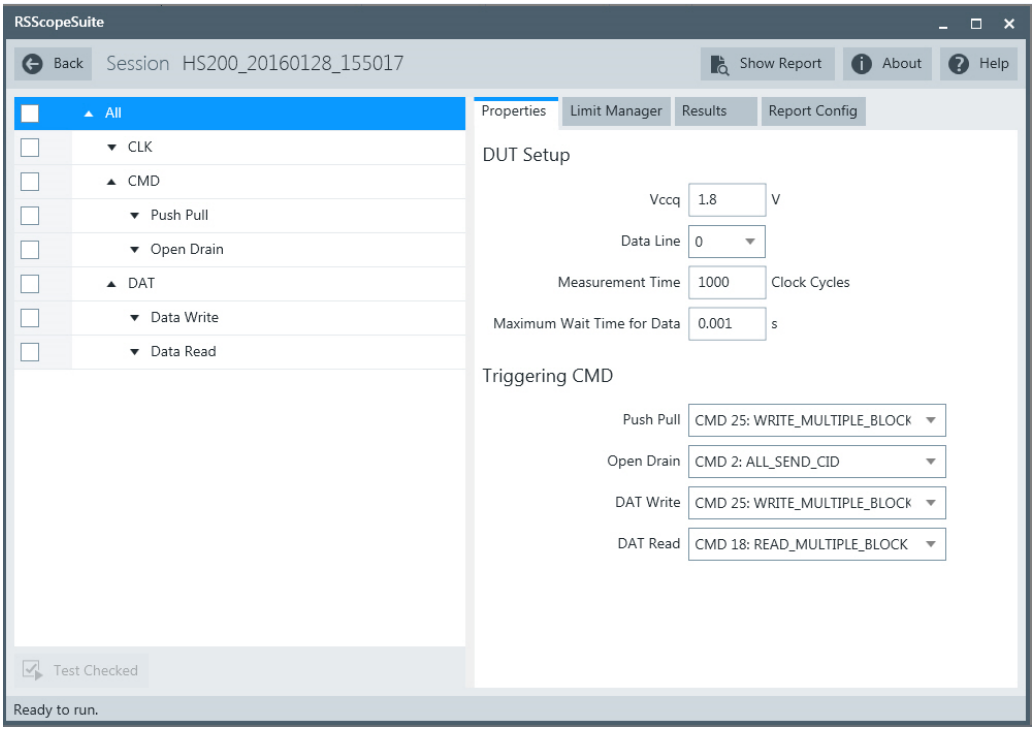


Figure 3-1: Configuration for eMMC compliance tests

V_{ccq}
Sets the supply voltage for the I/O.

V_{cc}
Sets the supply voltage for the core.

Data Line
Selects the data line.

Measurement time
Sets the measurement time as the number of entered clock cycles.

Maximum Wait Time for Data
Sets the maximum wait time for data.

Triggering CMD
Select the triggering CMD condition. The settings are dependant on the selected test case.

3.3 Getting Test Results

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

```
%ProgramData%\Rohde-Schwarz\RSScopeSuite\3.0\Sessions\eMMC\
<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 12). 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".

4 HS200 Tests

4.1 Starting HS200 Tests

1. Select "eMMC" in the R&S ScopeSuite start window.
2. In the "Session Selection" dialog, set "Select Type" > "HS200".
3. Add a new test session and open it, see Chapter 3.1, "Starting a Test Session", on page 14.
4. Check the test configuration settings and adjust, if neccessary. See:
   - Chapter 3.2.2, "eMMC Test Configuration", on page 17
   - Chapter 3.2.1.1, "Limit Manager", on page 16
5. Select/check the test cases you want to run and click "Test Single"/"Test checked".
6. 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.

4.2 Connecting Probes to the DUT

In order to get precise test results it is important to consider the experimental setup.

Special care should be taken when connecting the probes to the DUT as the connection may affect the resulting measurement bandwidth. Especially when doing measurements in the HS400 Mode with data rates of up to 400 MBit/s you should make sure that the measurement signal bandwidth of 1 GHz is available. Smaller measurement bandwidth may lead to incorrect results.

There are different solutions you can use for connecting the probes to the DUT such as flexible sockets, special interposers or dedicated measurement points. It is important to consider during the design of your DUT.

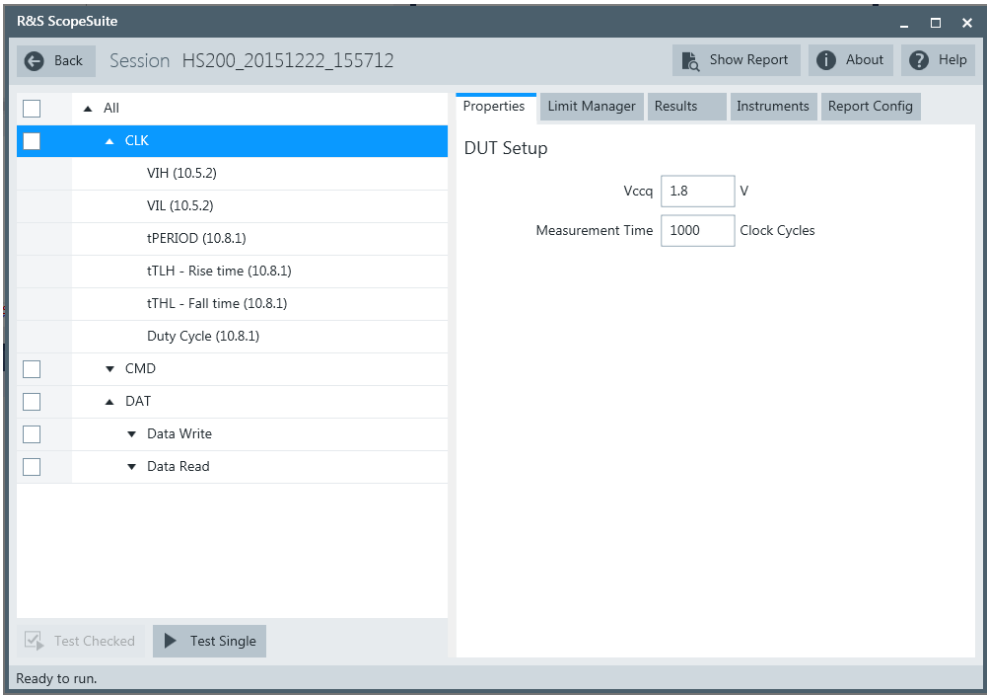
4.3 HS200 CLK test

4.3.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS200	1

4.3.2 Performing the Tests

1. Start the test as described in Chapter 4.1, "Starting HS200 Tests", on page 20.
2. Select "CLK".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

4.3.3 Purpose

The purpose of CLK test case is to verify bus signal levels and timing requirements specific to eMMC device clock signal.

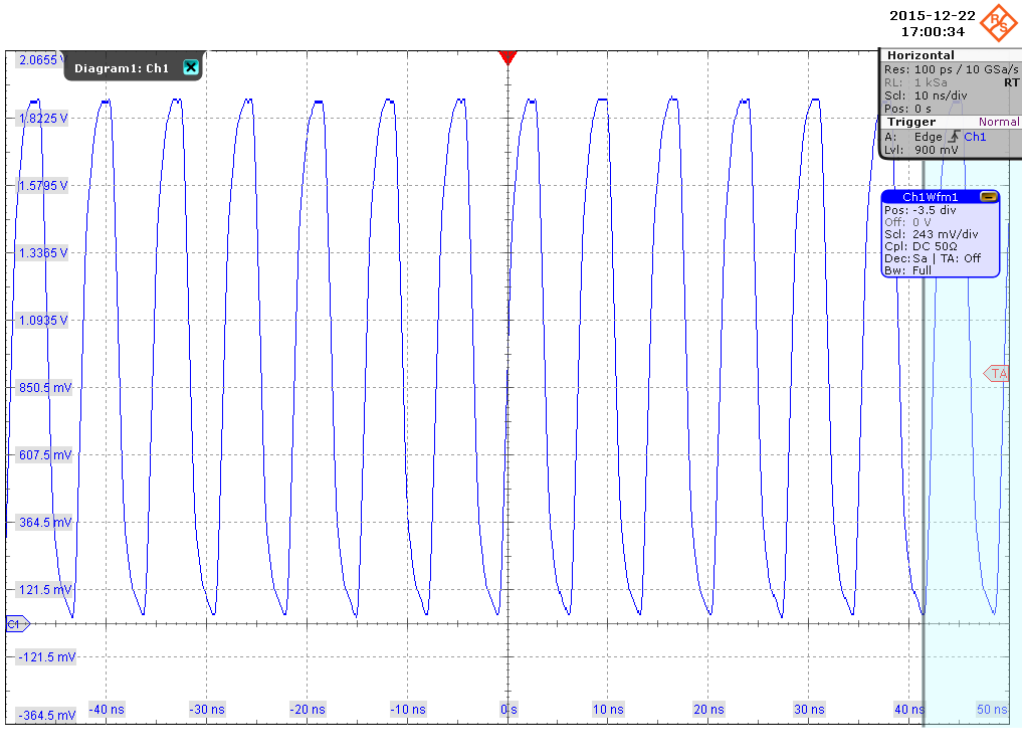
4.3.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock signal.

4.3.4.1 Waveform Requirements

A typical eMMC CLK signal waveform from this test case is shown in the figure below.



The software requires a single capture of CLK signal to perform the test and measurement correctly and successfully.

4.3.5 Measurements

HS200 CLK test case consists of 6 measurements which perform bus signal levels and timing tests on a single capture of the CLK signal.

4.3.5.1 Input High Level Voltage (V_{IH})

Purpose

The purpose of this test case is to verify the Input High Level Voltage (V_{IH}) of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture a certain length of clock signal waveform according to the "Measurement Time" set in the "Configuration" tab.

V_{IH} is measured using the R&S RTO "High" measurement against the whole waveform, as shown in Figure 4-1.

The conformance range for V_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

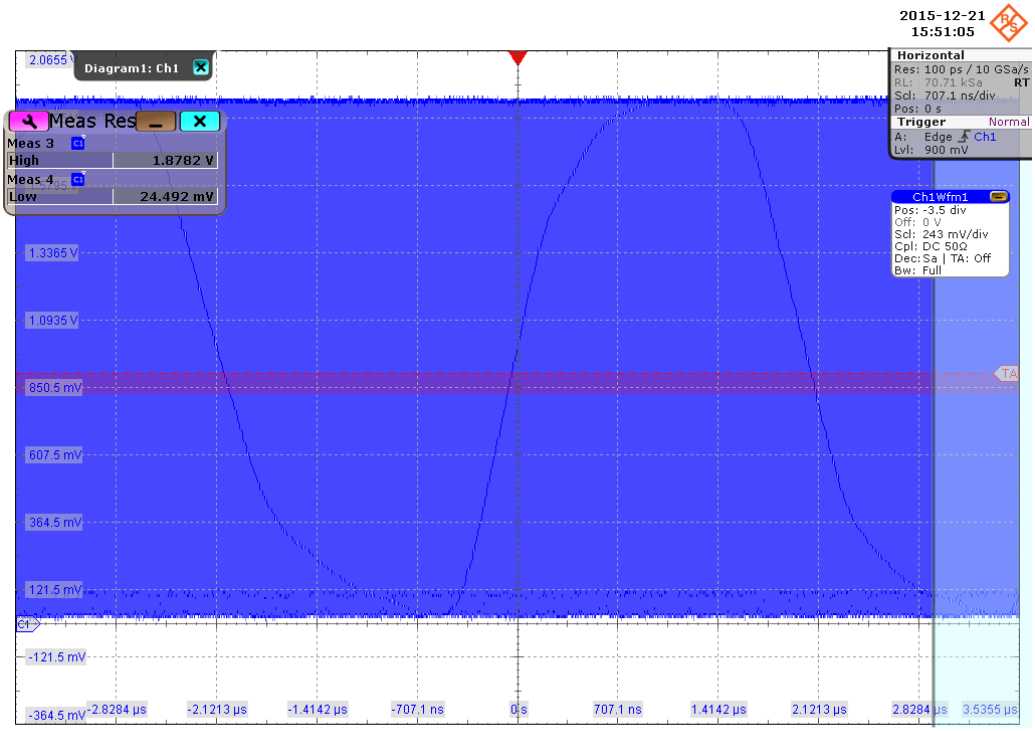


Figure 4-1: HS200 CLK input level voltage

4.3.5.2 Input Low Level Voltage (V_{IL})

Purpose

The purpose of this test case is to verify the Input Low Level Voltage (V_{IL}) of the CLK signal is within the conformance limits.

Measurements

Measures the clock frequency and then captures a certain length of clock signal waveform according to the "Measurement Time" set in the "Configuration" tab.

V_{IL} is measured using the R&S RTO "Low" measurement against the whole waveform, as shown in Figure 4-1.

The conformance range for V_{IL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

4.3.5.3 Period (T_{PERIOD})

Purpose

The purpose of this test case is to verify the period of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture a certain length of clock signal waveform according to the "Measurement Time" set in the "Configuration" tab.

T_{PERIOD} is measured using the R&S RTO "Period " measurement against the whole waveform, as shown in Figure 4-2. "Statistics" is enabled and the "Minimum" value is used as the final result.

The conformance range for T_{PERIOD} is specified in the tables of the JESD84-B50 standard (Section 10.8.1 HS200 Clock Timing).

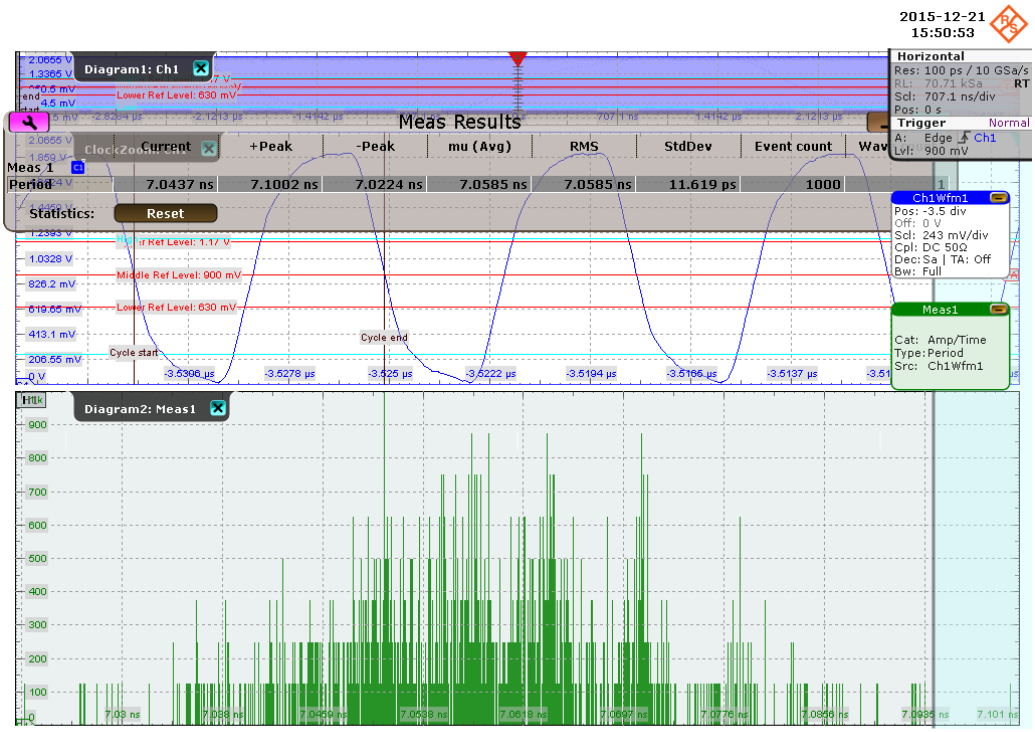


Figure 4-2: Period meausurement

4.3.5.4 Rise Time (T_{TLH})

Purpose

The purpose of this test case is to verify the rise time of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture a certain length of clock signal waveform according to the "Measurement Time" set in the "Configuration" tab.

T_{TLH} is measured using the R&S RTO "Rise Time" measurement against the whole waveform, see Figure 4-3. "Statistics" is enabled and the "Maximum" value is used as the final result.

The conformance range for T_{TLH} is specified in the tables of the JESD84-B50 standard (Section 10.8.1 HS200 Clock Timing).

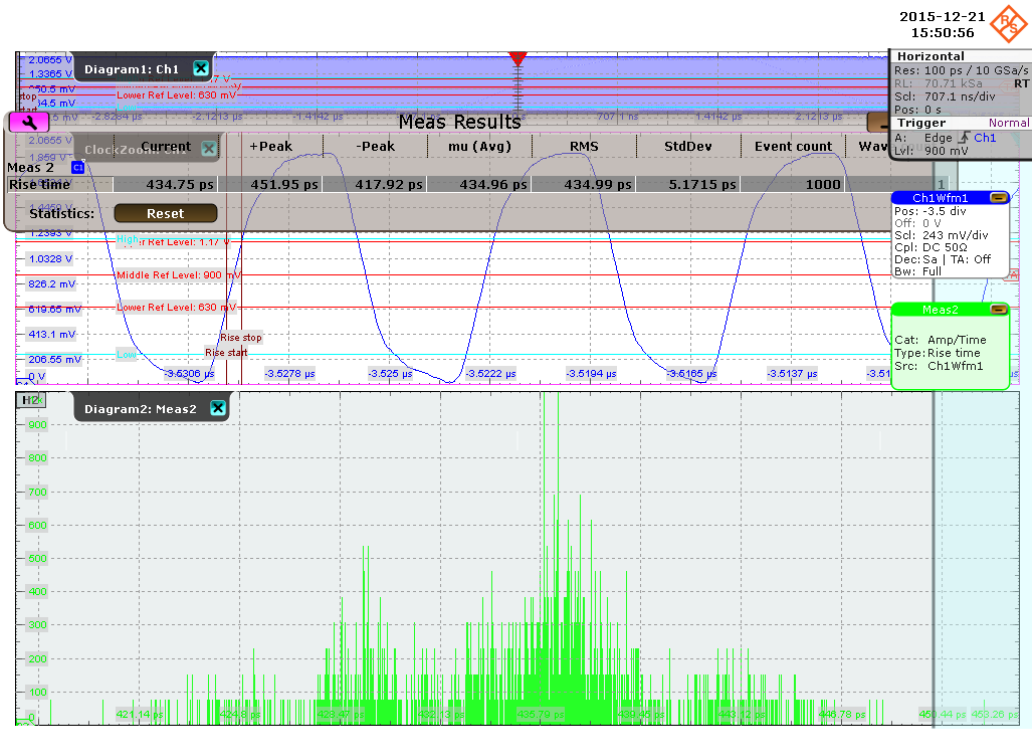


Figure 4-3: HS200 CLK rise time measurement

4.3.5.5 Fall Time (T_{TLL})

Purpose

The purpose of this test case is to verify the fall time of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture a certain length of clock signal waveform according to the "Measurement Time" set in the "Configuration" tab.

T_{TLL} is measured using the R&S RTO "Fall Time" measurement against the whole waveform, as shown in the figure below. "Statistics" is enabled and "Maximum" value is used as the final result.

The conformance range for T_{TLL} is specified in the tables of the JESD84-B50 standard (Section 10.8.1 HS200 Clock Timing).

4.3.5.6 Duty Cycle

Purpose

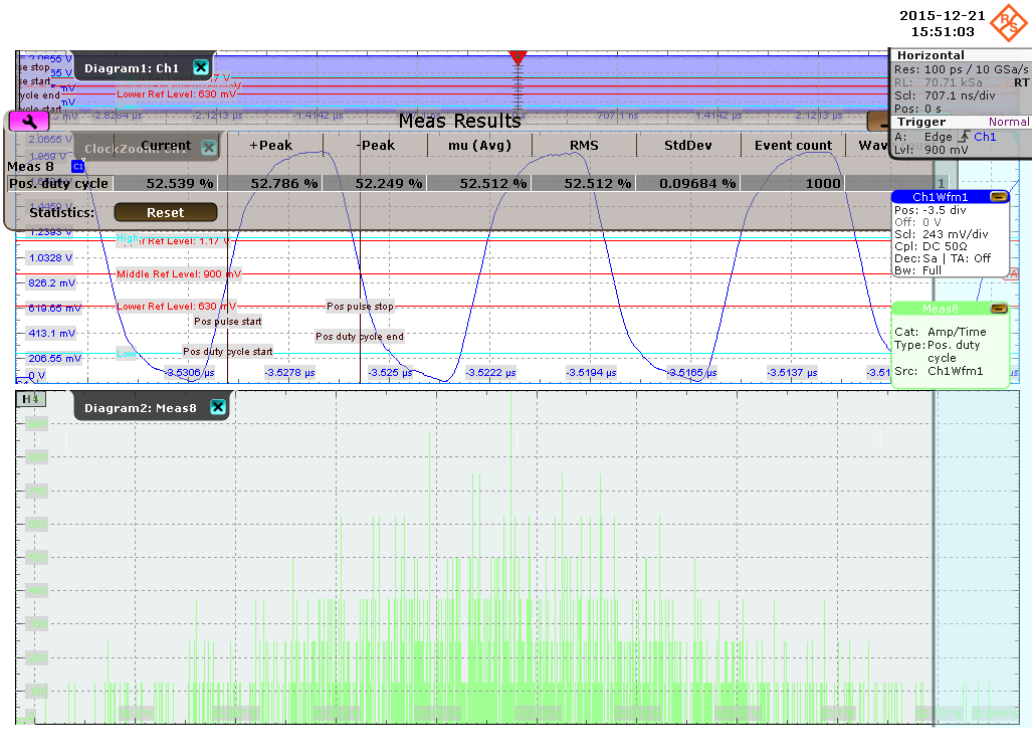
The purpose of this test case is to verify the duty cycle of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture a certain length of clock signal waveform according to the Measurement Time set in the "Configuration" tab.

Duty Cycle is measured using the R&S RTO "Positive Duty Cycle" measurement against the whole waveform, as shown in the figure below. "Statistics" is enabled and "Maximum" and "Minimum" values are reported as the final results.

The conformance range for Duty Cycle is specified in the tables of the JESD84-B50 standard (Section 10.8.1 HS200 Clock Timing).



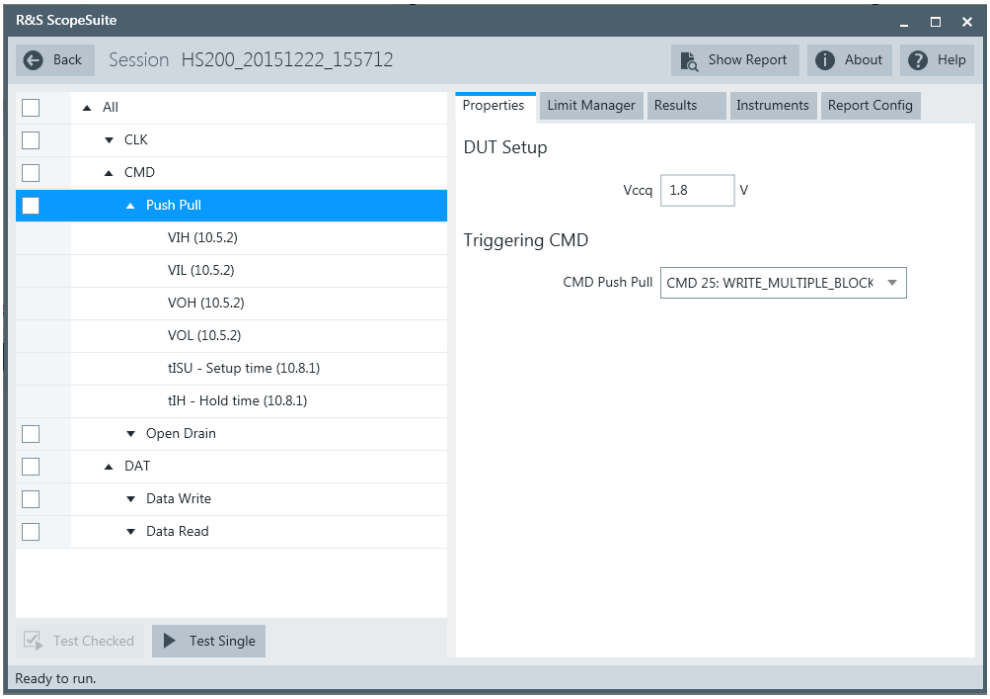
4.4 HS200 CMD Push Pull test

4.4.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS200	1

4.4.2 Performing the Tests

1. Start the test as described in Chapter 4.1, "Starting HS200 Tests", on page 20.
2. Select "CMD" > "Push Pull".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

4.4.3 Purpose

The purpose of CMD Push Pull test case is to verify bus signal levels and timing requirements specific to eMMC device command signal in Push Pull mode.

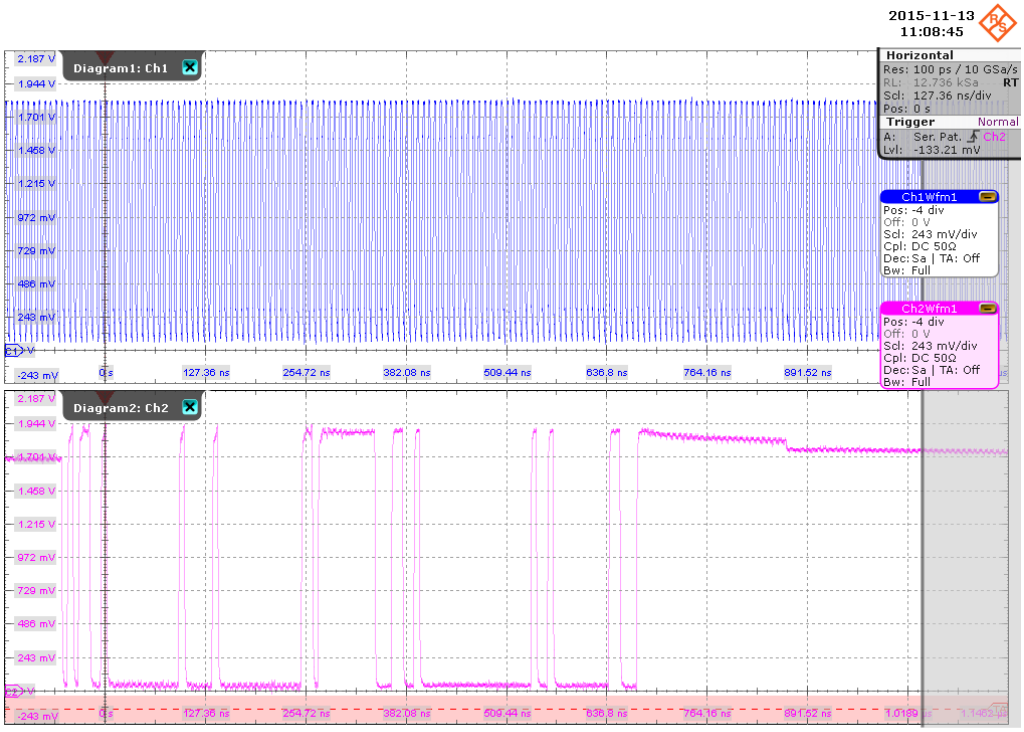
4.4.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock and command signals under Push Pull mode.

4.4.4.1 Waveform Requirements

A typical eMMC Command with Clock signal waveforms in Push Pull mode from this test case are as shown in the figure below.



The software requires a single capture of CMD and CLK signals to perform the test and measurement correctly and successfully.

4.4.5 Measurements

HS200 CMD Push Pull test case consists of 6 test measurements which perform bus signal levels and timing tests on a single capture of the CMD with CLK signals.

4.4.5.1 Input High Level Voltage (V_{IH})

Purpose

The purpose of this test case is to verify the Input High Level Voltage (V_{IH}) of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration " tab.

V_{IH} is measured using the R&S RTO "High" measurement against the portion of the host command, as shown in Figure 4-4.

The conformance range for V_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

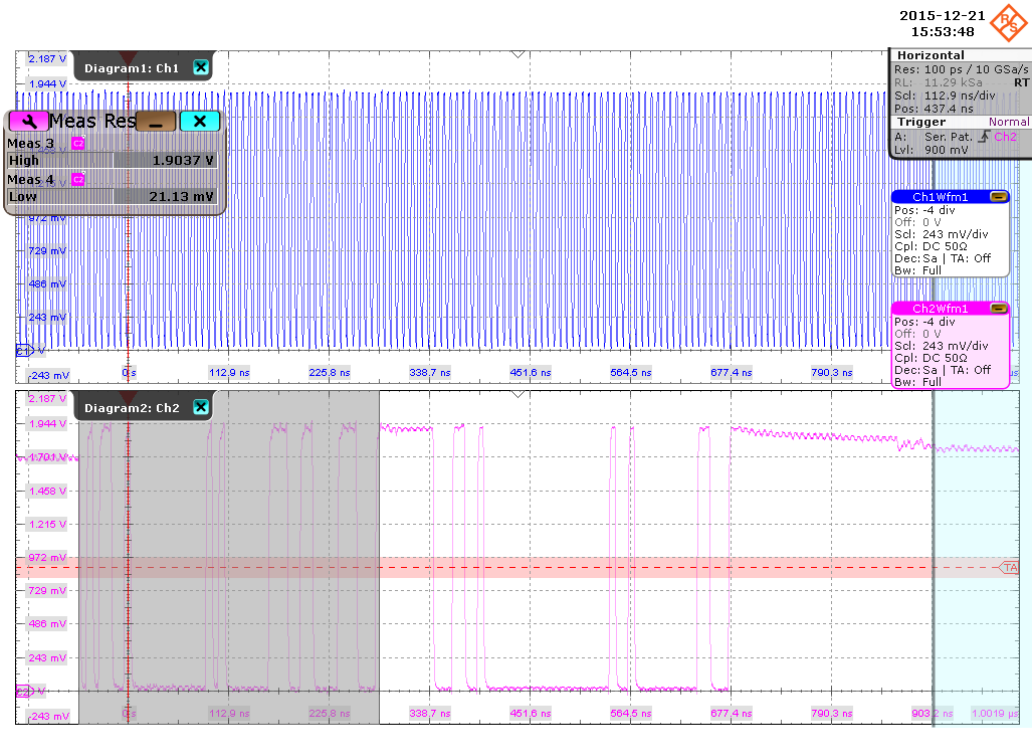


Figure 4-4: HS200 CMD Push Pull input level voltage

4.4.5.2 Input Low Level Voltage (V_{IL})

Purpose

The purpose of this test case is to verify the Input Low Level Voltage (VIL) of the CMD signal in Push Pull mode is within the conformance limits

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

V_{IL} is measured using the R&S RTO "Low" measurement against the portion of the host command, as shown in Figure 4-4.

The conformance range for V_{IL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

4.4.5.3 Output High Level Voltage (V_{OH})

Purpose

The purpose of this test case is to verify the Output High Level Voltage (V_{OH}) of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

V_{OH} is measured using the R&S RTO "High" measurement against the portion of the command response, as shown in Figure 4-5.

The conformance range for V_{OH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

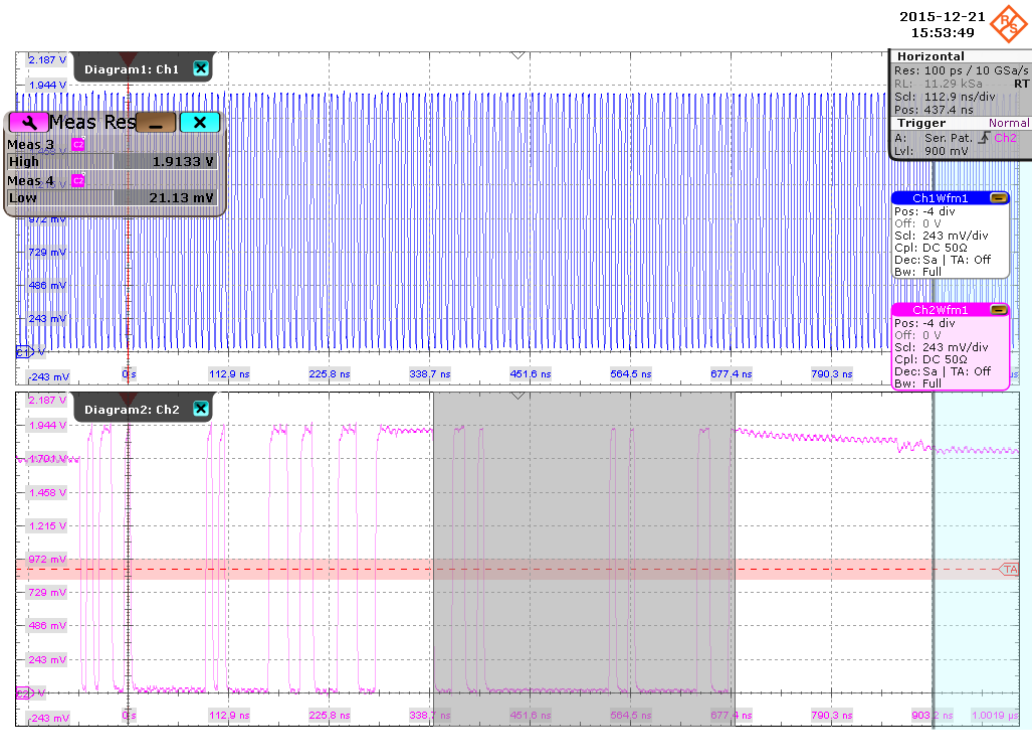


Figure 4-5: HS200 CMD Push Pull output level voltage

4.4.5.4 Output Low Level Voltage (V_{OL})

Purpose

The purpose of this test case is to verify the Output Low Level Voltage (V_{OL}) of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

V_{OL} is measured using the R&S RTO "Low" measurement against the portion of the command response, as shown in Figure 4-5.

The conformance range for V_{OL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

4.4.5.5 Setup Time (T_{ISU})

Purpose

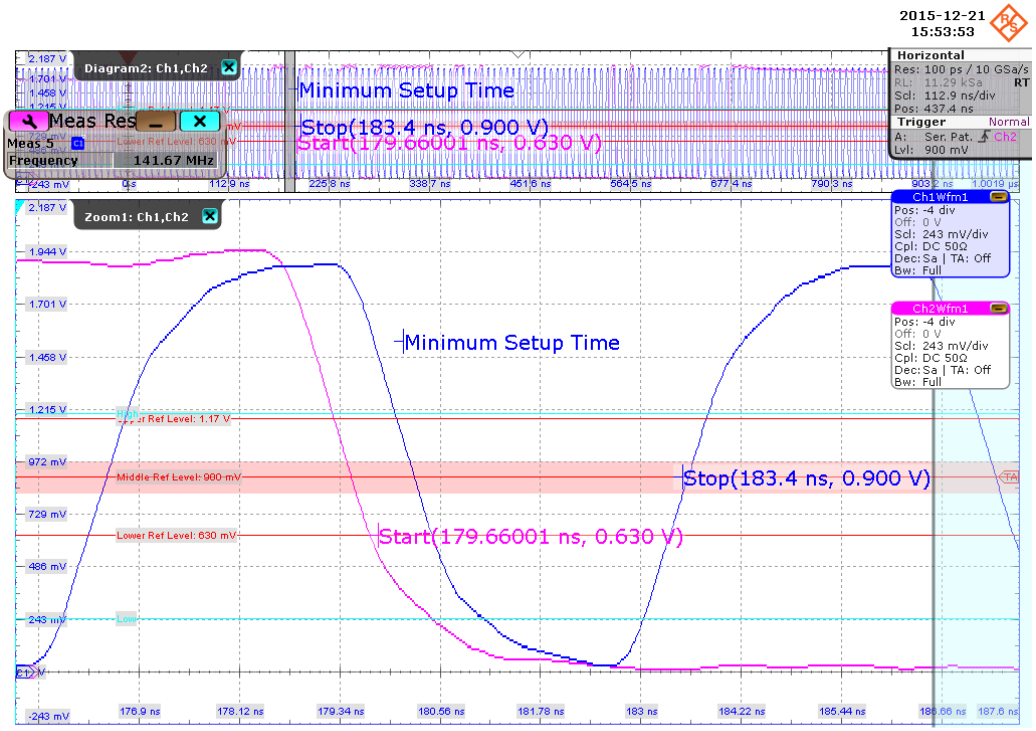
The purpose of this test case is to verify the setup time of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

T_{ISU} is calculated based on the R&S RTO "Edge detection" against the portion of the host command, as shown in the figure below. Minimum setup time is reported as the final result.

The conformance range for T_{ISU} is specified in the tables of the JESD84-B50 standard (Section 10.8.2 HS200 Device Input Timing).



4.4.5.6 Hold Time (T_{IH})

Purpose

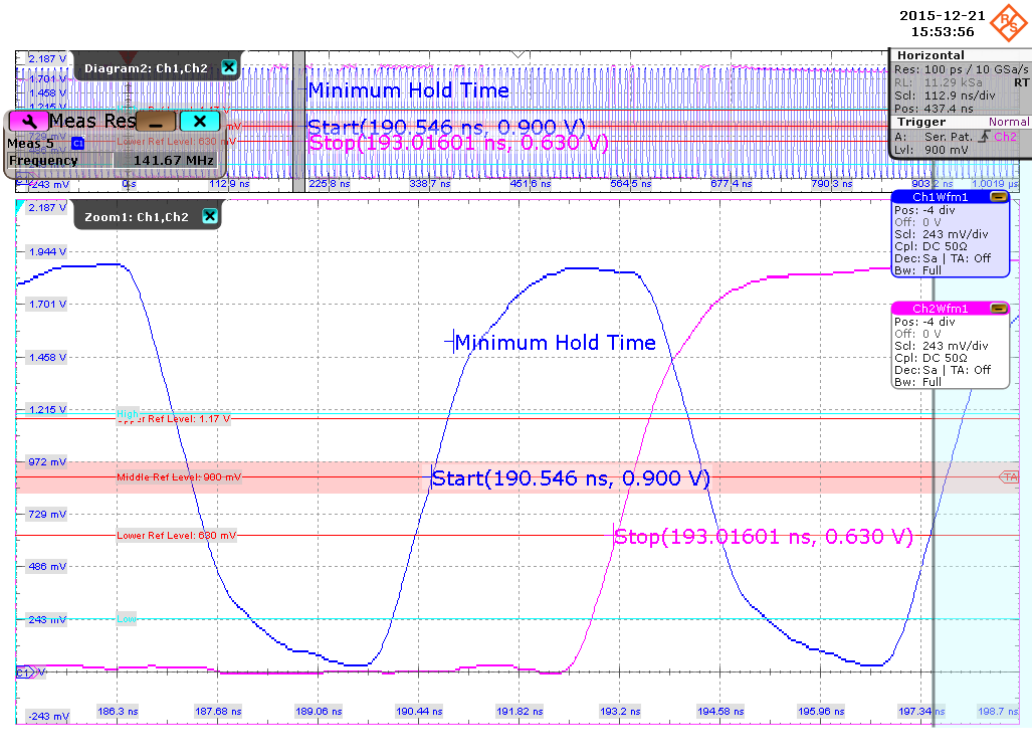
The purpose of this test case is to verify the hold time of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

T_{IH} is calculated based on the R&S RTO "Edge detection" against the portion of the host command, as shown in the figure below. Minimum hold time is reported as the final result.

The conformance range for T_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.8.2 HS200 Device Input Timing).



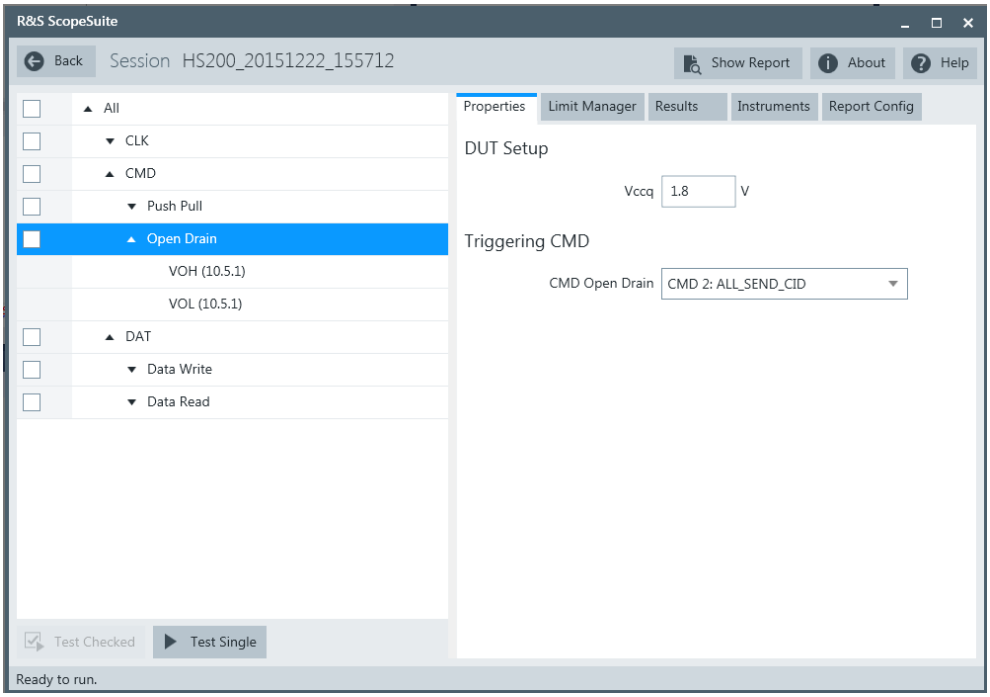
4.5 HS200 CMD Open Drain test

4.5.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS200	1

4.5.2 Performing the Tests

1. Start the test as described in Chapter 4.1, "Starting HS200 Tests", on page 20.
2. Select "CMD" > "Open Drain".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

4.5.3 Purpose

The purpose of CMD Open Drain test case is to verify bus signal levels requirements specific to eMMC device command signal in Open Drain mode.

4.5.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock and command signals under Open Drain mode.

4.5.4.1 Waveform Requirements

A typical eMMC Command with Clock signal waveforms in Open Drain mode from this test case are as shown in the figure below:

The software requires a single capture of CMD and CLK signals to perform the test and measurement correctly and successfully.

4.5.5 Measurements

HS200 CMD Open Drain test case consists of 2 measurements which perform bus signal levels tests on a single capture of the CMD with CLK signals.

4.5.5.1 Output High Level Voltage (V_{OH})

Purpose

The purpose of this test case is to verify the Output High Level Voltage (V_{OH}) of the CMD signal in Open Drain mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Open Drain" set in the "Configuration" tab.

V_{OH} is measured using the R&S RTO "High" measurement against the portion of the command response, as shown in the figure below.

The conformance range for V_{OH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

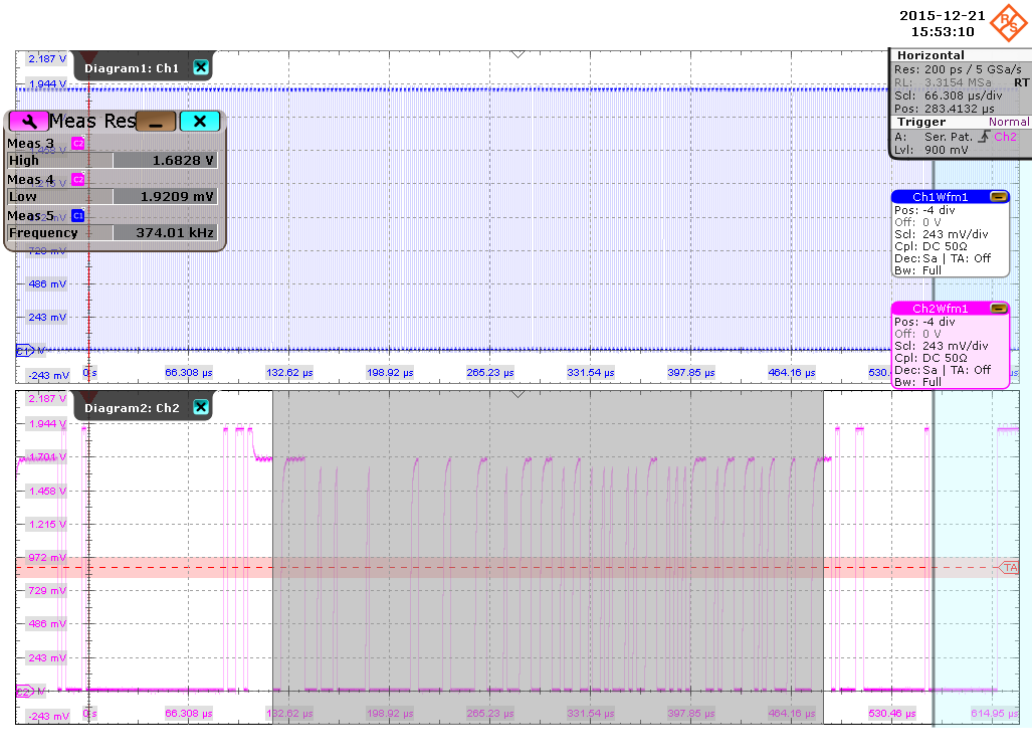


Figure 4-6: HS200 CMD open drain measurement results

4.5.5.2 Output Low Level Voltage (V_{OL})

Purpose

The purpose of this test case is to verify the Output Low Level Voltage (V_{OL}) of the CMD signal in Open Drain mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Open Drain" set in the "Configuration" tab.

V_{OL} is measured using the R&S RTO "Low" measurement against the portion of the command response, as shown in Figure 4-6.

The conformance range for V_{OL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

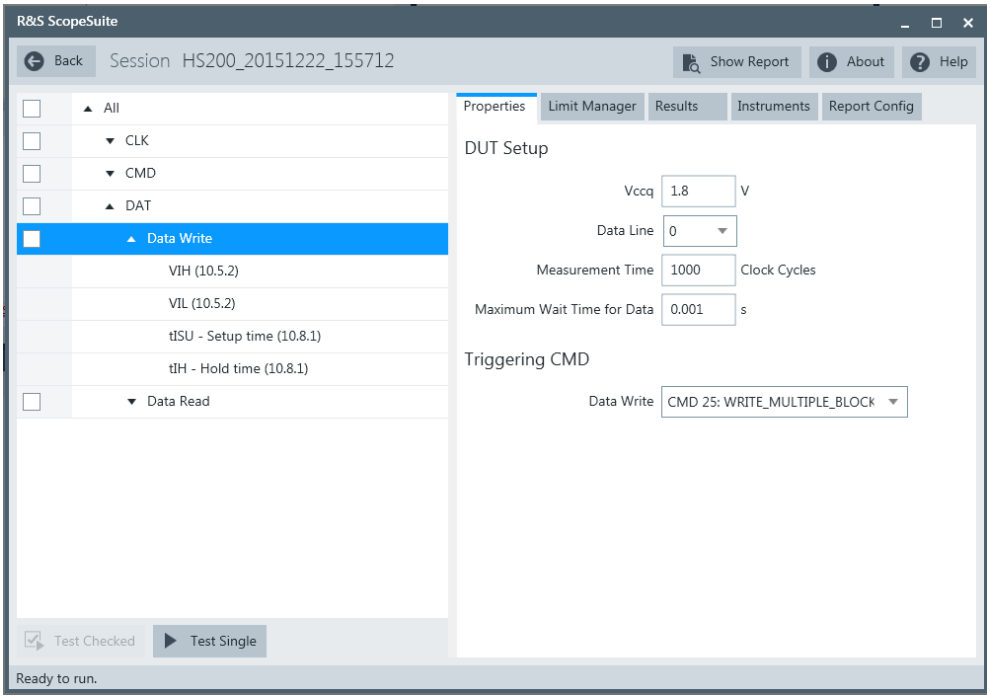
4.6 HS200 Data Write test

4.6.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS200	1

4.6.2 Performing the Tests

1. Start the test as described in Chapter 4.1, "Starting HS200 Tests", on page 20.
2. Select "DAT" > "Data Write".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

4.6.3 Purpose

The purpose of Data Write test case is to verify bus signal levels and timing requirements specific to eMMC device data write signal.

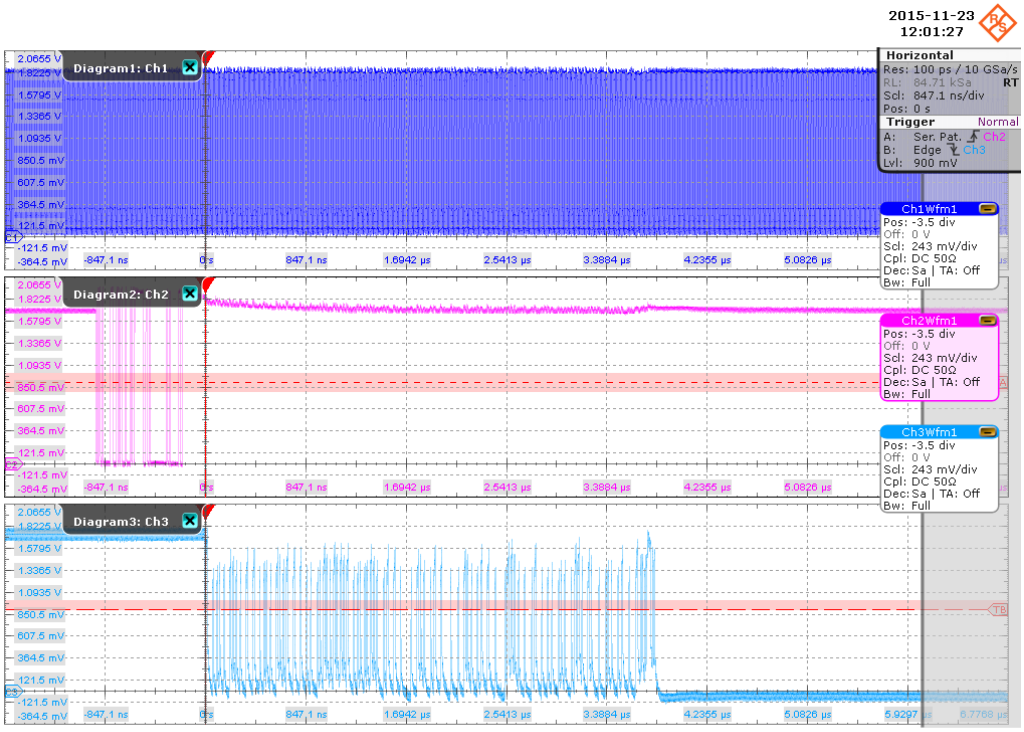
4.6.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock, command and data signals.

4.6.4.1 Waveform Requirements

A typical eMMC Data Write with Command and Clock signal waveforms from this test case are as shown in the figure below.



The software requires a single capture of DAT and CMD with CLK signals to perform the test and measurement correctly and successfully.

4.6.5 Measurements

HS200 Data Write test case consists of 4 test measurements which perform bus signal levels and timing tests on a single capture of the DAT and CMD with CLK signals.

4.6.5.1 Input High Level Voltage (V_{IH})

Purpose

The purpose of this test case is to verify the Input High Level Voltage (V_{IH}) of the DAT Write signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Write and Measurement Time" set in the "Configuration" tab.

V_{IH} is measured using the R&S RTO "High" measurement against the portion of data write, as shown in Figure 4-7.

The conformance range for V_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

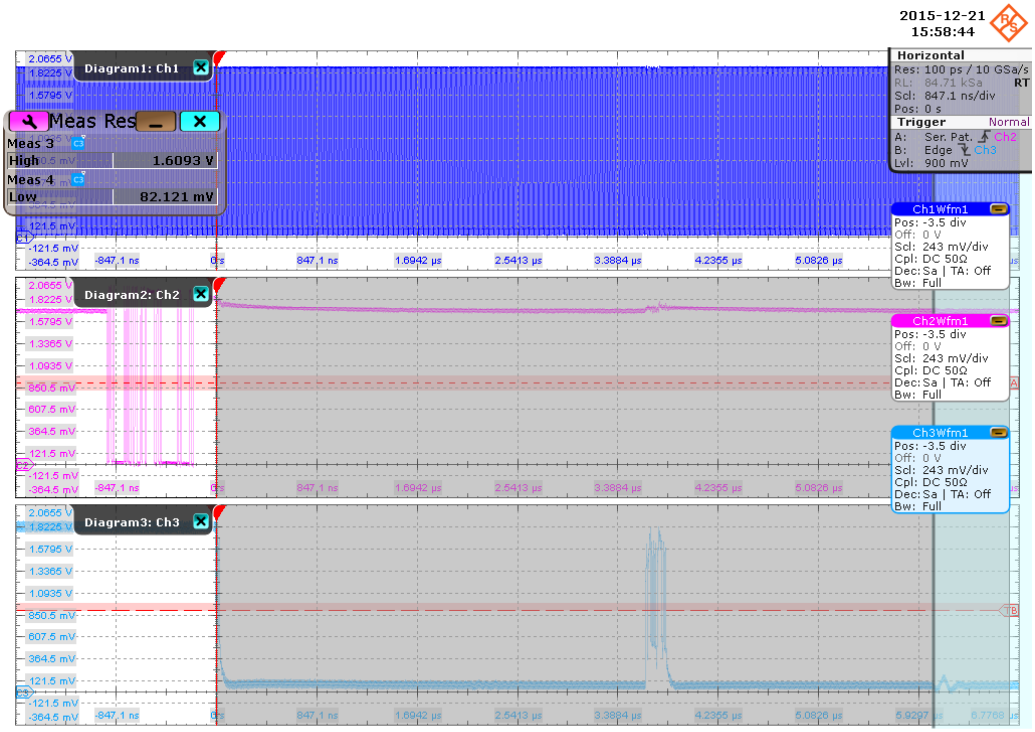


Figure 4-7: HS200 Data Write input level voltage

4.6.5.2 Input Low Level Voltage (V_{IL})

Purpose

The purpose of this test case is to verify the Input Low Level Voltage (V"IL") of the DAT Write signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Write and Measurement Time" set in the "Configuration" tab.

V_{IL} is measured using the R&S RTO "Low" measurement against the portion of data write, as shown in Figure 4-7.

The conformance range for V_{IL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

4.6.5.3 1.5.3 Setup Time (T_{ISU})

Purpose

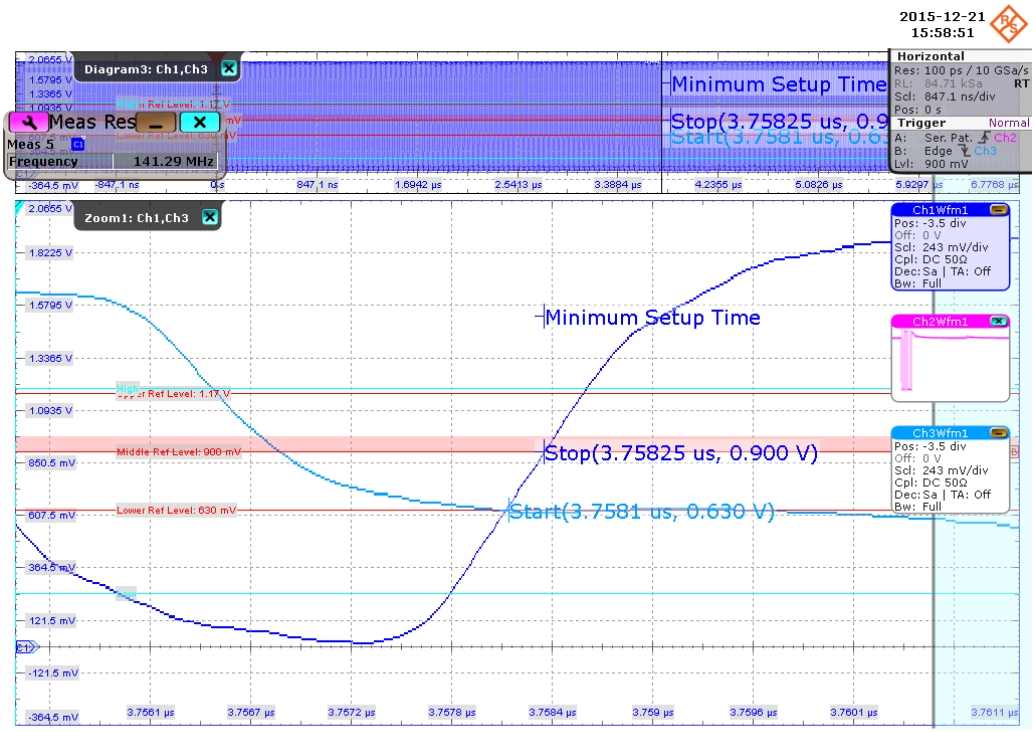
The purpose of this test case is to verify the setup time of the DAT Write signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Write and Measurement Time" set in the "Configuration" tab.

T_{ISU} is calculated based on the R&S RTO "Edge detection" against the portion of data write,as shown in the figure below. Minimum setup time is reported as the final result.

The conformance range for T_{ISU} is specified in the tables of the JESD84-B50 standard (Section 10.8.2 HS200 Device Input Timing).



4.6.5.4 1.5.4 Hold Time (T_{IH})

Purpose

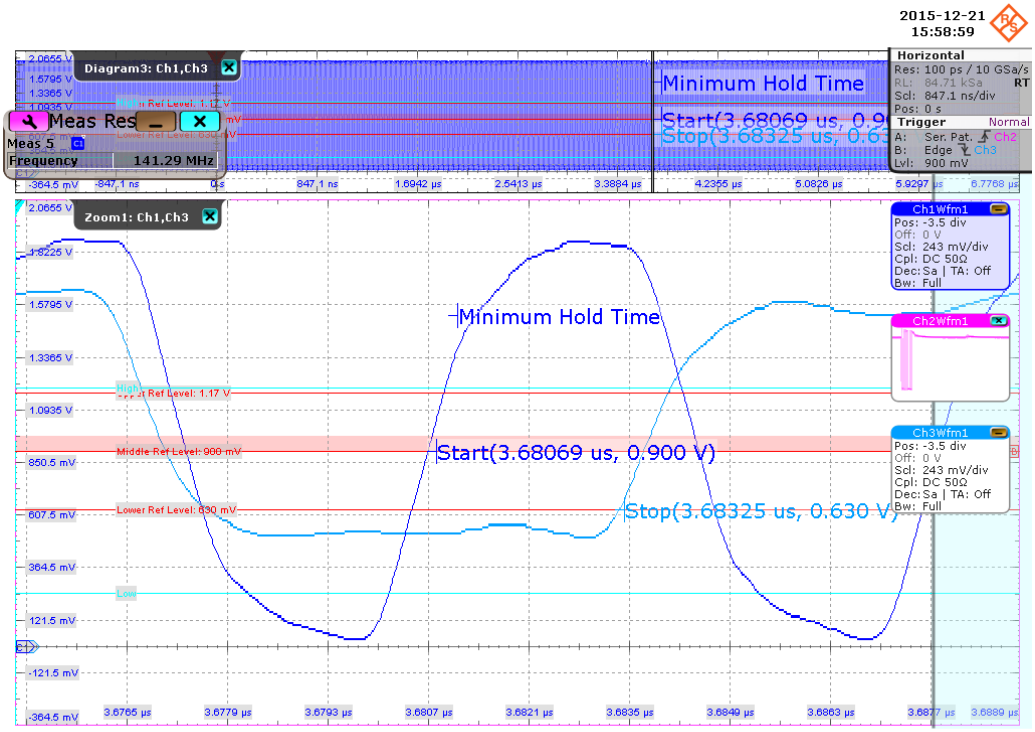
The purpose of this test case is to verify the hold time of the DAT Write signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Write and Measurement Time" set in the "Configuration" tab.

T_{IH} is calculated based on the R&S RTO "Edge detection" against the portion of data write, as shown in the figure below. Minimum hold time is reported as the final result.

The conformance range for T_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.8.2 HS200 Device Input Timing).



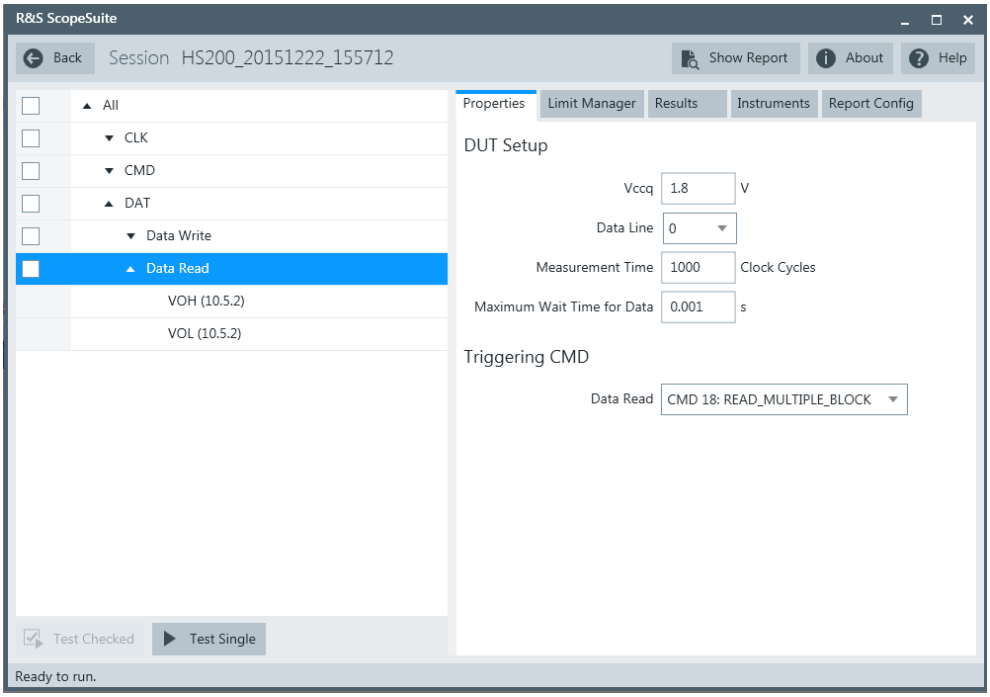
4.7 HS200 Data Read test

4.7.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS200	1

4.7.2 Performing the Tests

1. Start the test as described in Chapter 4.1, "Starting HS200 Tests", on page 20.
2. Select "DAT" > "Data Read".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

4.7.3 Purpose

The purpose of Data Read test case is to verify bus signal levels requirements specific to eMMC device data read signal.

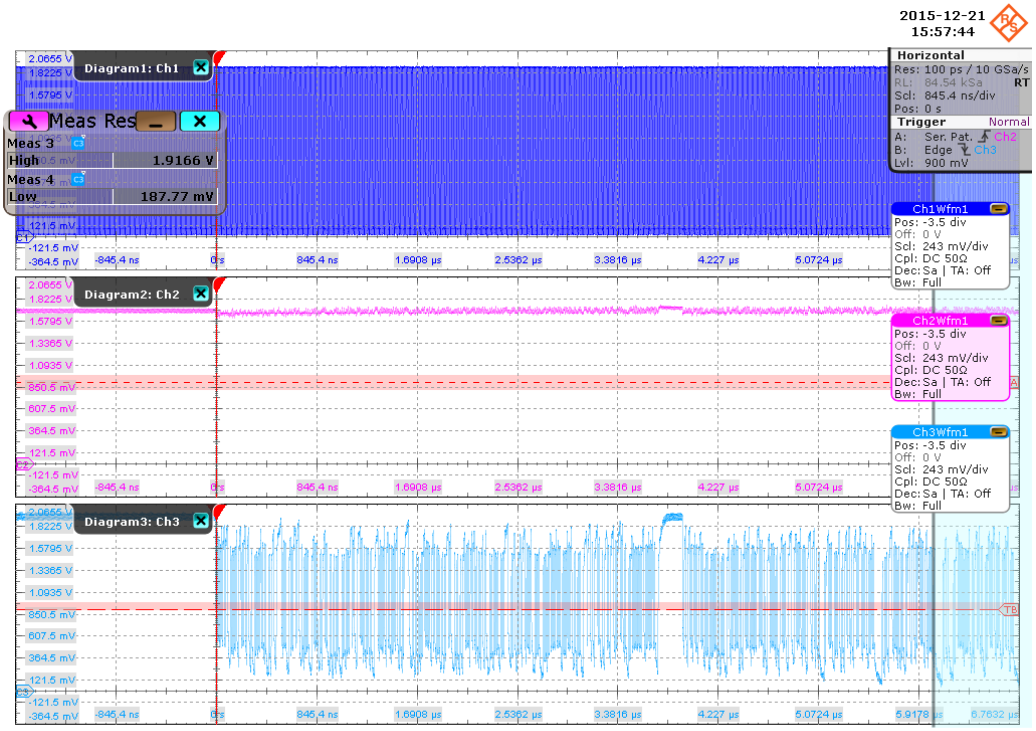
4.7.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock, command and data signals

4.7.4.1 Waveform Requirements

A typical eMMC Data Read with Command and Clock signal waveforms from this test case are as shown in the figure below.



The software requires a single capture of DAT and CMD with CLK signals to perform the test and measurement correctly and successfully.

4.7.5 Measurements

HS200 Data Read test case consists of 2 test measurements which perform bus signal levels tests on a single capture of the DAT and CMD with CLK signals.

4.7.5.1 Output High Level Voltage (V_{OH})

Purpose

The purpose of this test case is to verify the Output High Level Voltage (V_{OH}) of the DAT Read signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Read and Measurement Time" set in the "Configuration" tab.

V_{OH} is measured using RTO "High" measurement against the portion of data read, as shown in Figure 4-8.

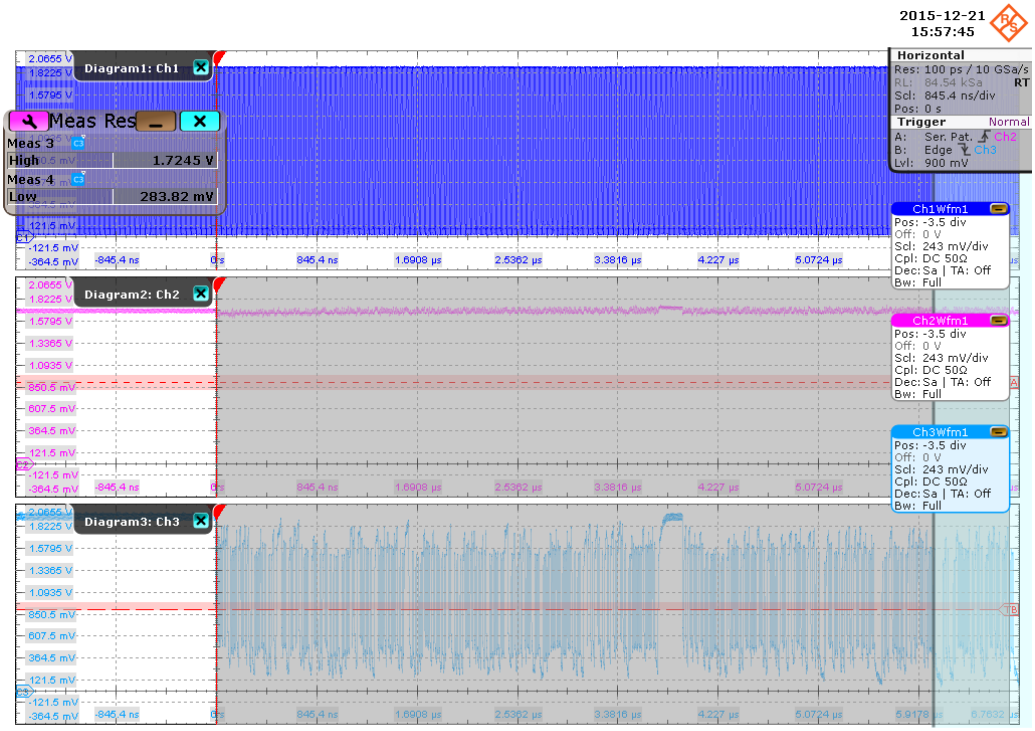


Figure 4-8: HS200 Data Read output voltage

The conformance range for V_{OH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

4.7.5.2 Output High Level Voltage (V_{OL})

Purpose

The purpose of this test case is to verify the Output Low Level Voltage (V_{OL}) of the DAT Read signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Read and Measurement Time" set in the "Configuration" tab.

V_{OL} is measured using the R&S RTO "Low" measurement against the portion of data read, as shown in Figure 4-8.

The conformance range for V_{OL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5 HS400 Tests

5.1 Starting HS400 Tests

1. Select "eMMC" in the R&S ScopeSuite start window.
2. In the "Session Selection" dialog, set "Select Type" > "HS400".
3. Add a new test session and open it, see Chapter 3.1, "Starting a Test Session", on page 14.
4. Check the test configuration settings and adjust, if neccessary. See:
   - Chapter 3.2.2, "eMMC Test Configuration", on page 17
   - Chapter 3.2.1.1, "Limit Manager", on page 16
5. Select/check the test cases you want to run and click "Test Single"/"Test checked".
6. 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.

5.2 Connecting Probes to the DUT

In order to get precise test results it is important to consider the experimental setup.

Special care should be taken when connecting the probes to the DUT as the connection may affect the resulting measurement bandwidth. Especially when doing measurements in the HS400 Mode with data rates of up to 400 MBit/s you should make sure that the measurement signal bandwidth of 1 GHz is available. Smaller measurement bandwidth may lead to incorrect results.

There are different solutions you can use for connecting the probes to the DUT such as flexible sockets, special interposers or dedicated measurement points. It is important to consider during the design of your DUT.

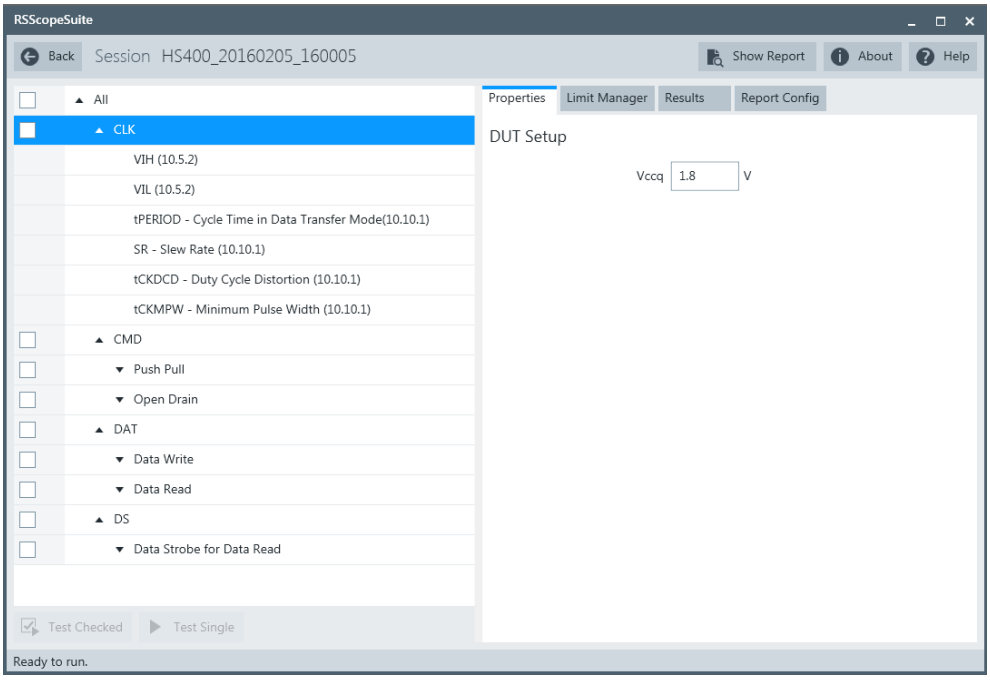
5.3 HS400 CLK test

5.3.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Active probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS400	1

5.3.2 Performing the Tests

1. Start the test as described in Chapter 5.1, "Starting HS400 Tests", on page 51.
2. Select "CLK".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

5.3.3 Purpose

The purpose of CLK test case is to verify bus signal levels and timing requirements specific to eMMC device clock signal.

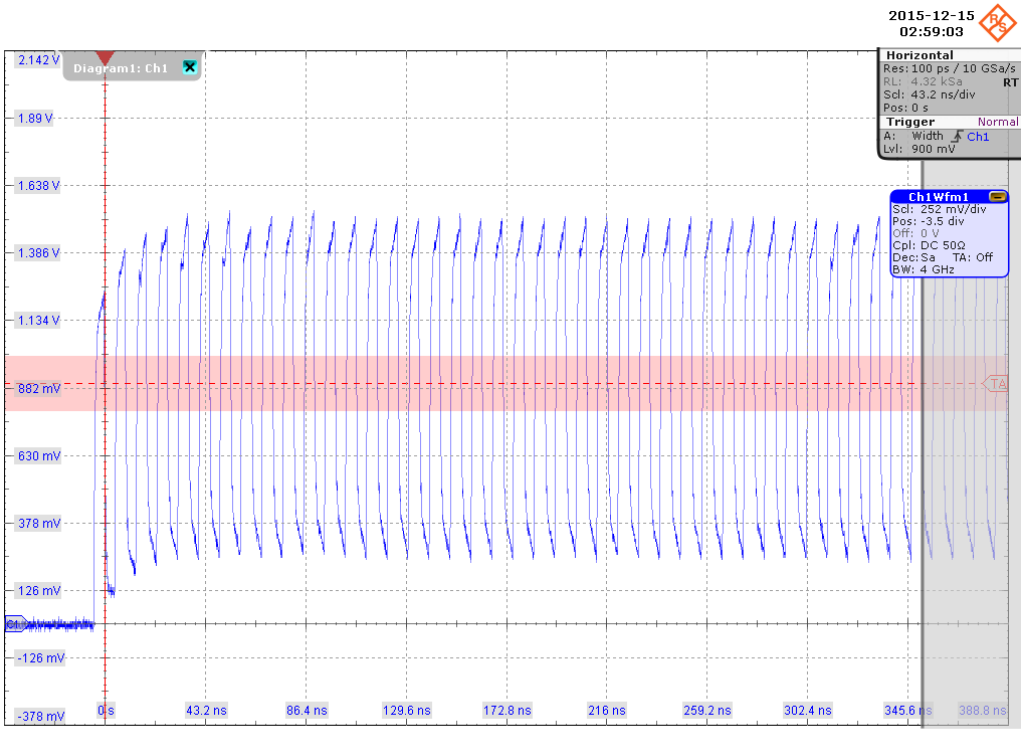
5.3.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock signal.

5.3.4.1 Waveform Requirements

A typical eMMC CLK signal waveform from this test case is shown in the figure below.



The software requires a single capture of CLK signal to perform the test and measurement correctly and successfully.

5.3.5 Measurements

HS400 CLK test case consists of 6 measurements which perform bus signal levels and timing tests on a single capture of the CLK signal.

5.3.5.1 Input High Level Voltage (V_{IH})

Purpose

The purpose of this test case is to verify the Input High Level Voltage (V_{IH}) of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture 48 cycles length of clock signal waveform in data transfer mode..

V_{IH} is measured using the R&S RTO "High" measurement against the whole waveform, as shown in Figure 5-1.

The conformance range for V_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

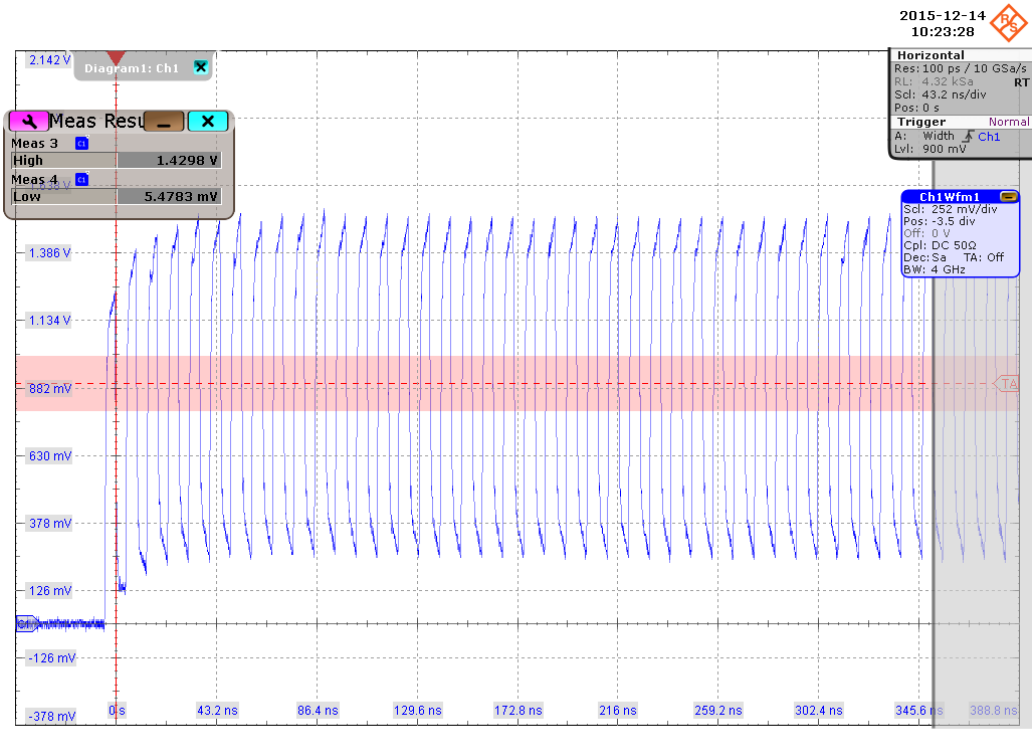


Figure 5-1: HS400 CLK input level voltage

5.3.5.2 Input Low Level Voltage (V_{IL})

Purpose

The purpose of this test case is to verify the Input Low Level Voltage (V_{IL}) of the CLK signal is within the conformance limits.

Measurements

Measures the clock frequency and then captures a certain length of clock signal waveform according to the "Measurement Time" set in the "Configuration" tab.

V_{IL} is measured using the R&S RTO "Low" measurement against the whole waveform, as shown in Figure 5-1.

The conformance range for V_{IL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.3.5.3 Cycle Time Data Transfer Mode (T_{PERIOD})

Purpose

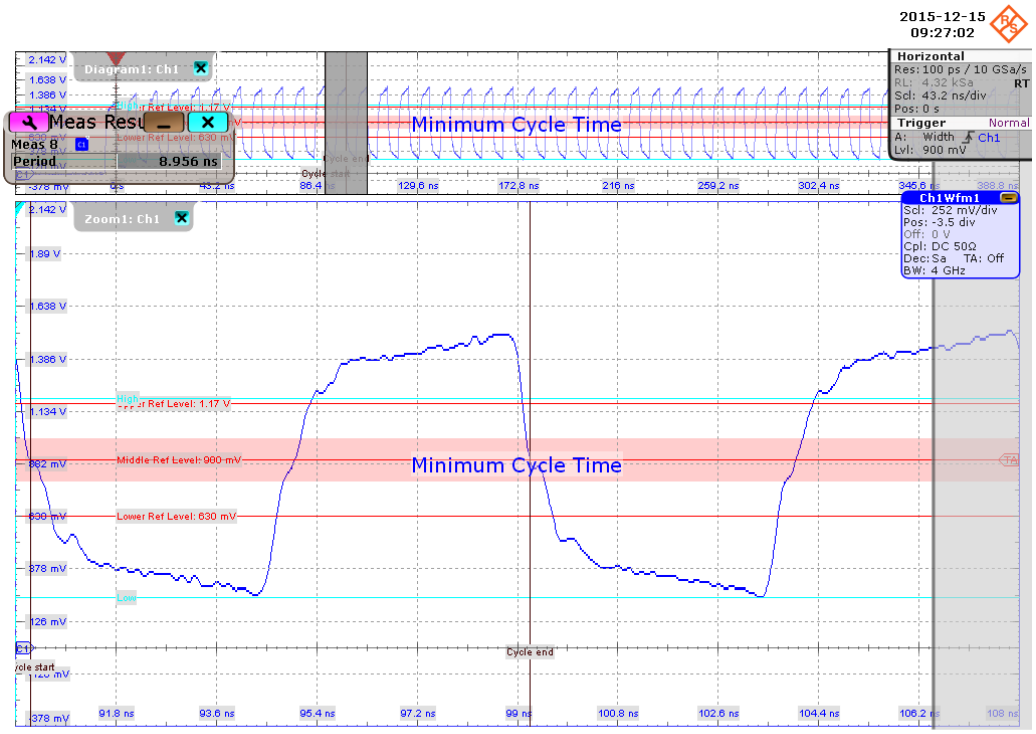
The purpose of this test case is to verify the period of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and capture 48 cycles length of clock signal waveform in data transfer mode.

T_{PERIOD} is measured using the R&S RTO "Period " measurement coupled with a gate by gate measurment against the whole waveform, as shown in the figure below. The "Minimum" value is used as the final result.

The conformance range for T_{PERIOD} is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Clock Timing).



5.3.5.4 Slew Rate (SR)

Purpose

The purpose of this test case is to verify the slew rate of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture 48 cycles length of clock signal waveform in data transfer mode.

SR is calculated based on the R&S RTO "Period","Rise Time" and "Fall Time" measurements coupled with a gate by gate measurment against the whole waveform, as shown in Figure 5-2. Each "Slew Rate" is calculated based on the results from each gate measurement. The "Minimum Slew Rate" is used as the final result.

The conformance range for SR is specified in the tables of the JESD84-B50 standard (Section Section 10.10.1 HS400 Clock Timing).

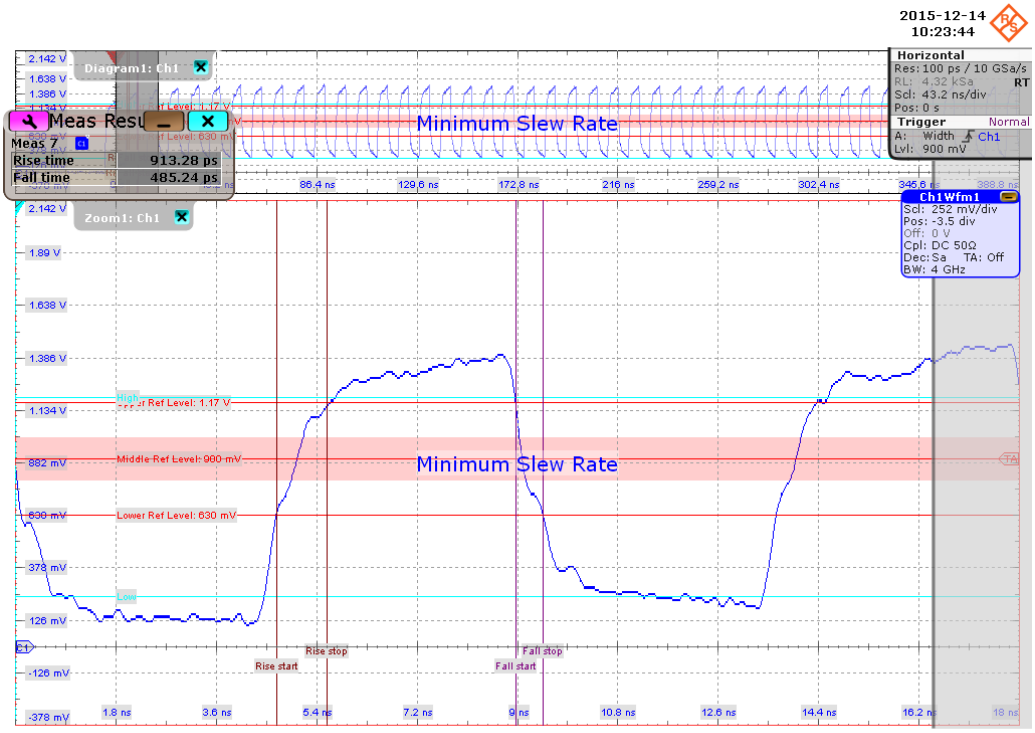


Figure 5-2: HS400 CLK slew rate measurement

5.3.5.5 Duty Cycle Distortion (T_{CKDCD})

Purpose

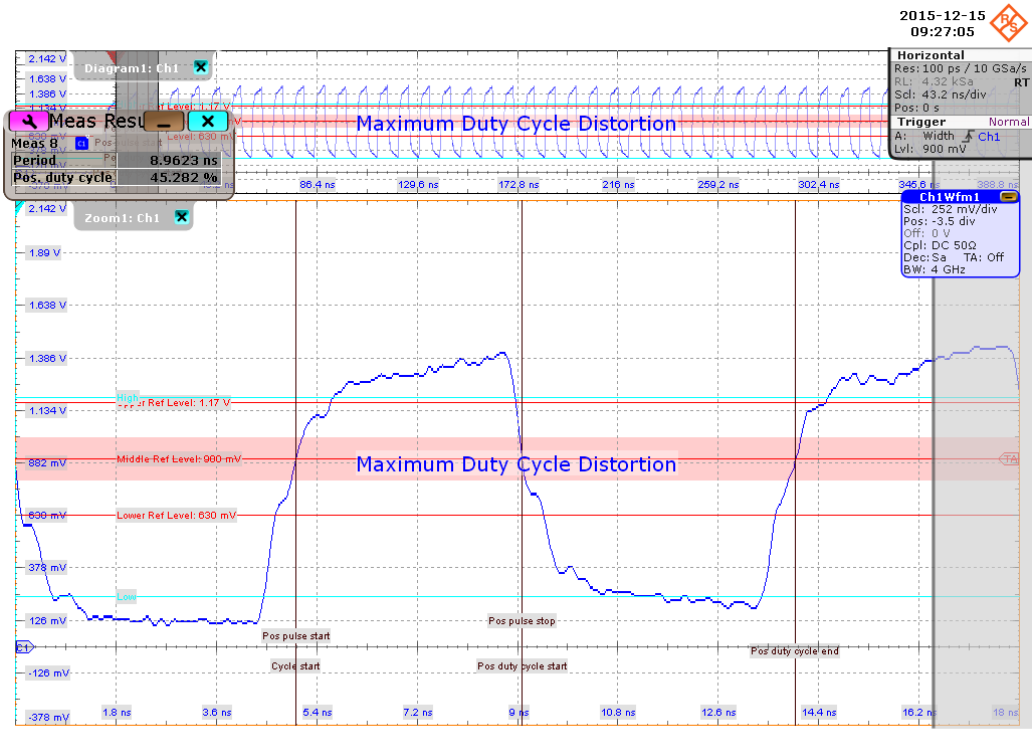
The purpose of this test case is to verify the duty cycle distortion of the CLK signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture 48 cycles length of clock signal waveform in data transfer mode

T_{CKDCD} is measured using the R&S RTO "Positive Duty Cycle" measurements coupled with a gate by gate measurment against the whole waveform, as shown in the figure below. Each duty cycle distortion is calculated based on results from each gate measurement. "Maximum" duty cycle distortion is used as the final result

The conformance range for T_{CKDCD} is specified in the tables of the JESD84-B50 standard (Section 10.10.1 HS400 Clock Timing).



5.3.5.6 Minimum Pulse Width (T_{CKMPW})

Purpose

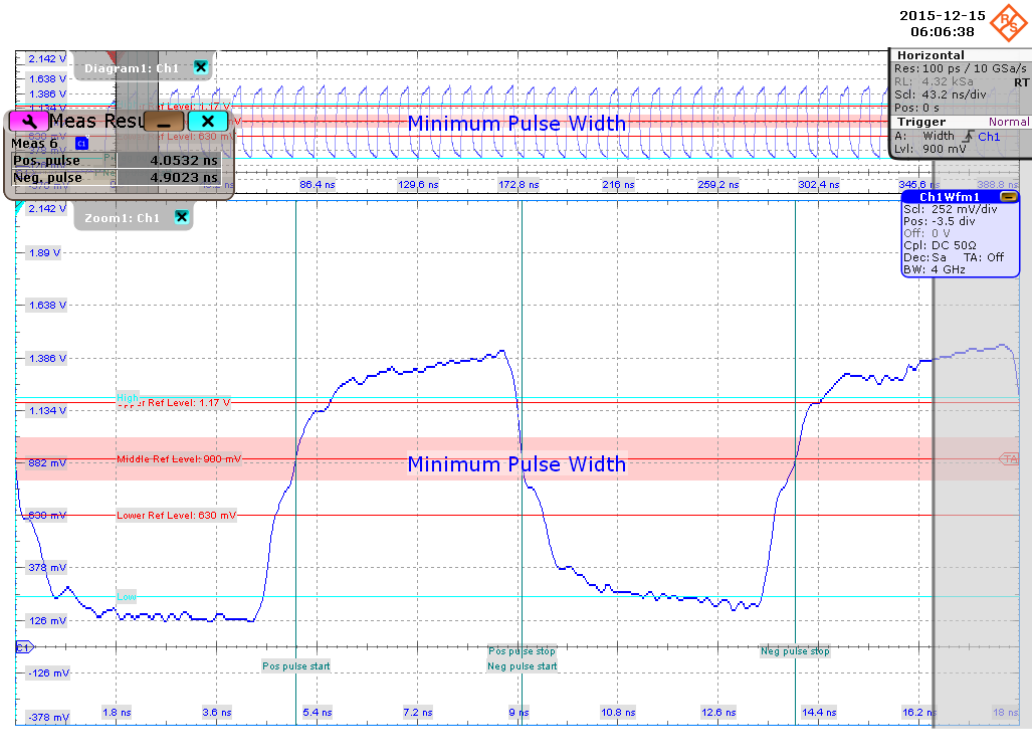
The purpose of this test case is to verify the minimum pulse width of the CLK signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture 48 cycles length of clock signal waveform in data transfer mode.

T_{CKMPW} is measured using the R&S RTO "Period", "Positive Pulse" and "Negative Pulse" measurements coupled with a gate by gate measurment against the whole waveform, as shown in the figure below. Each pulse width is calculated based on results from each gate measurement. "Minimum pulse width" is used as the final result.

The conformance range for T_{CKMPW} is specified in the tables of the JESD84-B50 standard (Section 10.10.1 HS400 Clock Timing).



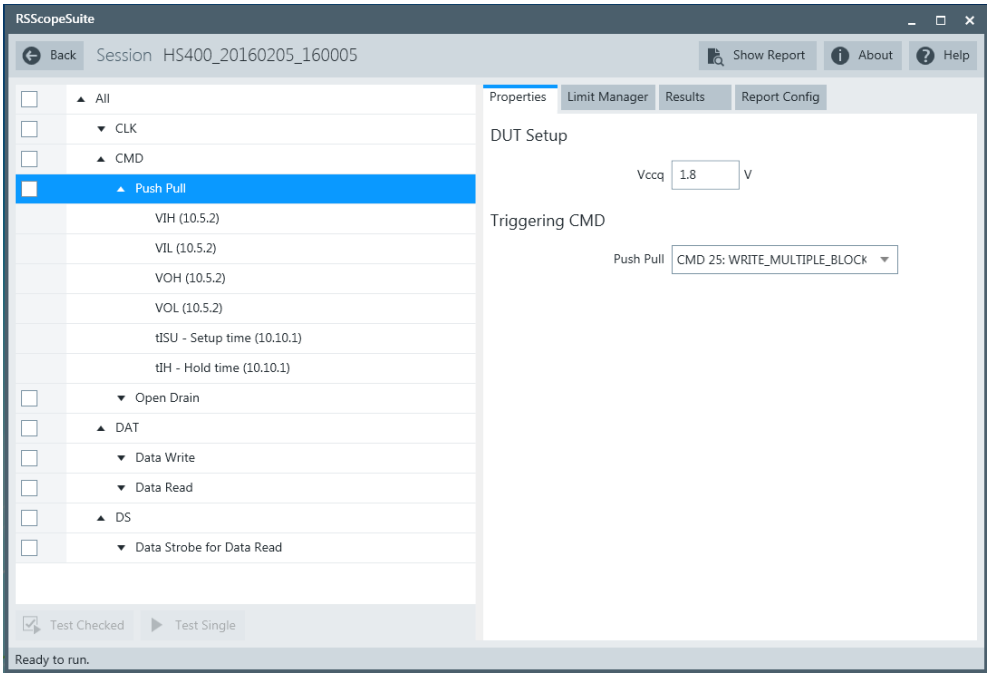
5.4 HS400 CMD Push Pull test

5.4.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Active probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS400	1

5.4.2 Performing the Tests

1. Start the test as described in Chapter 5.1, "Starting HS400 Tests", on page 51.
2. Select "CMD" > "Push Pull".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

5.4.3 Purpose

The purpose of CMD Push Pull test case is to verify bus signal levels and timing requirements specific to eMMC device command signal in Push Pull mode.

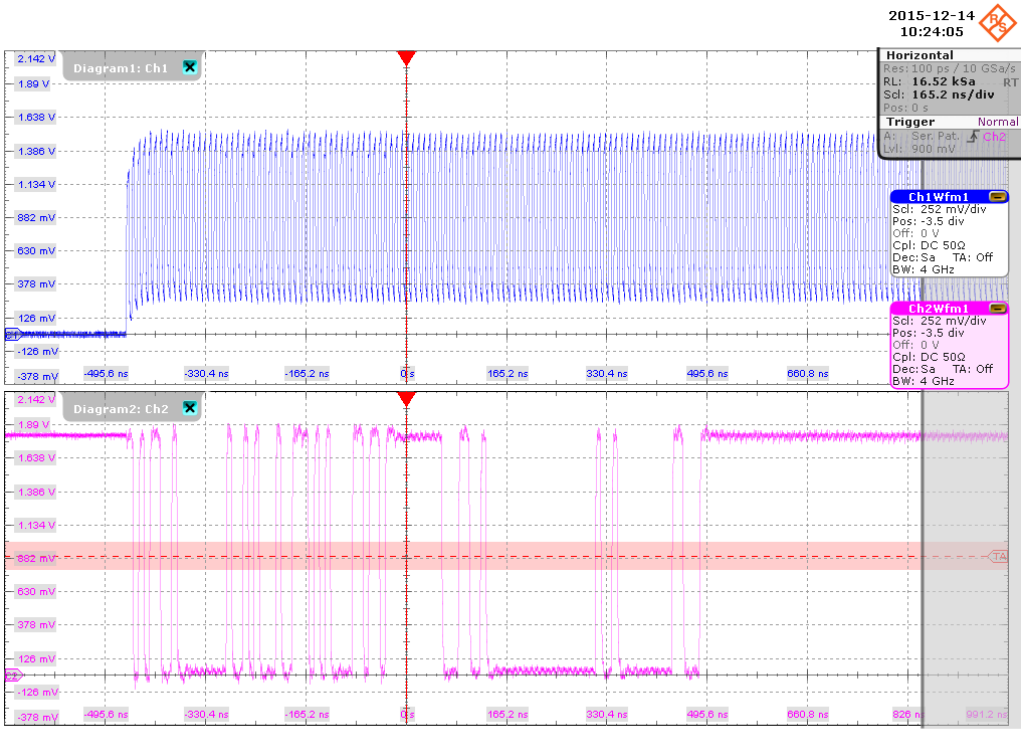
5.4.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock and command signals under Push Pull mode.

5.4.4.1 Waveform Requirements

A typical eMMC Command with Clock signal waveforms in Push Pull mode from this test case are as shown in the figure below.



The software requires a single capture of CMD and CLK signals to perform the test and measurement correctly and successfully.

5.4.5 Measurements

HS400 CMD Push Pull test case consists of 6 test measurements which perform bus signal levels and timing tests on a single capture of the CMD with CLK signals.

5.4.5.1 Input High Level Voltage (V_{IH})

Purpose

The purpose of this test case is to verify the Input High Level Voltage (V_{IH}) of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration " tab.

V_{IH} is measured using the R&S RTO "High" measurement against the portion of the host command, as shown in Figure 5-3.

The conformance range for V_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

Figure 5-3: HS400 CMD Push Pull input level voltage

5.4.5.2 Input Low Level Voltage (V_{IL})

Purpose

The purpose of this test case is to verify the Input Low Level Voltage (VIL) of the CMD signal in Push Pull mode is within the conformance limits

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

V_{IL} is measured using the R&S RTO "Low" measurement against the portion of the host command, as shown in Figure 5-3.

The conformance range for V_{IL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.4.5.3 Output High Level Voltage (V_{OH})

Purpose

The purpose of this test case is to verify the Output High Level Voltage (V_{OH}) of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

V_{OH} is measured using the R&S RTO "High" measurement against the portion of the command response, as shown in Figure 5-4.

The conformance range for V_{OH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

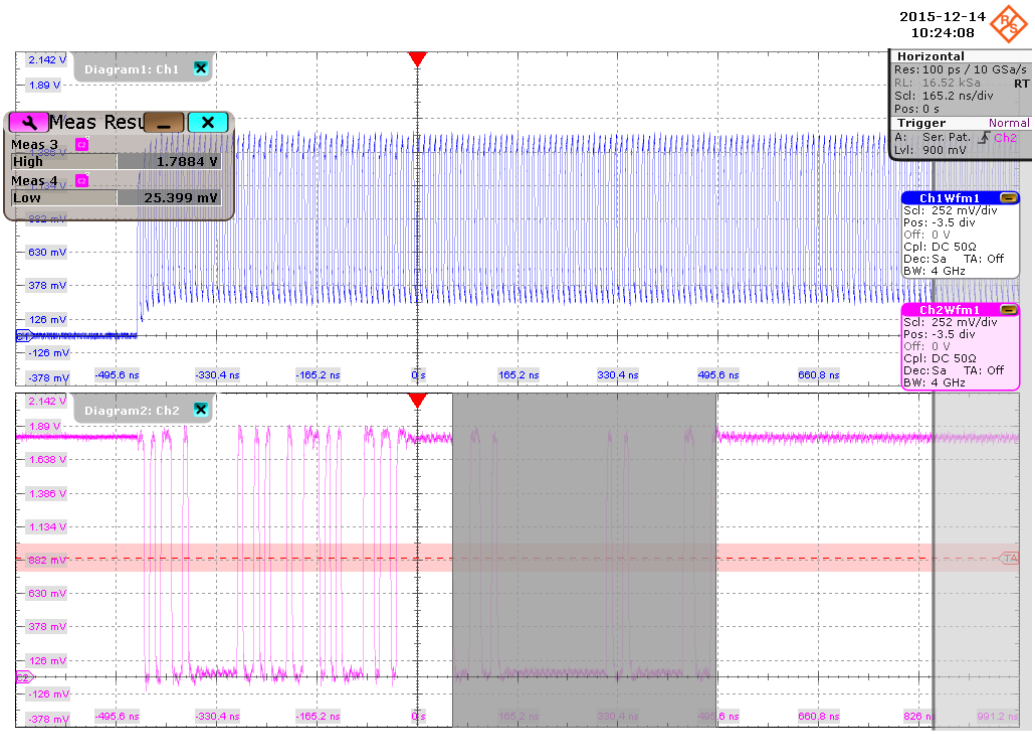


Figure 5-4: HS400 CMD Push Pull output level voltage

5.4.5.4 Output Low Level Voltage (V_{OL})

Purpose

The purpose of this test case is to verify the Output Low Level Voltage (V_{OL}) of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

V_{OL} is measured using the R&S RTO "Low" measurement against the portion of the command response, as shown in Figure 5-4.

The conformance range for V_{OL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.4.5.5 Setup Time (T_{ISU})

Purpose

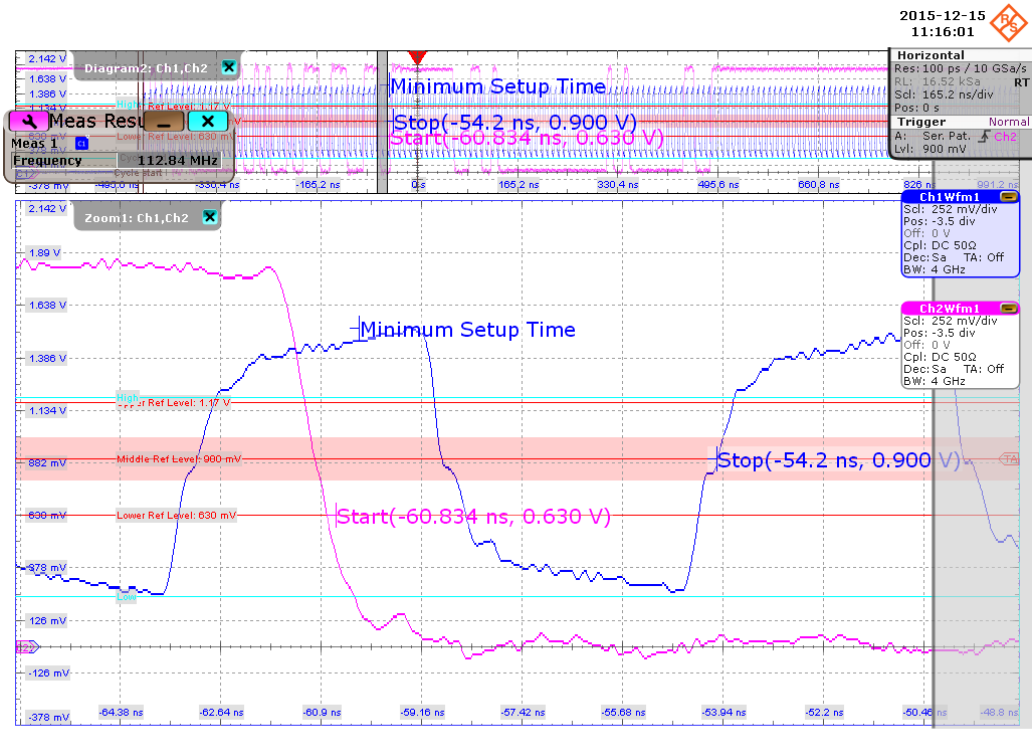
The purpose of this test case is to verify the setup time of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

T_{ISU} is calculated based on the R&S RTO "Edge detection" against the portion of the host command, as shown in the figure below. Minimum setup time is reported as the final result.

The conformance range for T_{ISU} is specified in the tables of the JESD84-B50 standard (Section 10.10.1 H400 Device Input Timing).



5.4.5.6 Hold Time (T_{IH})

Purpose

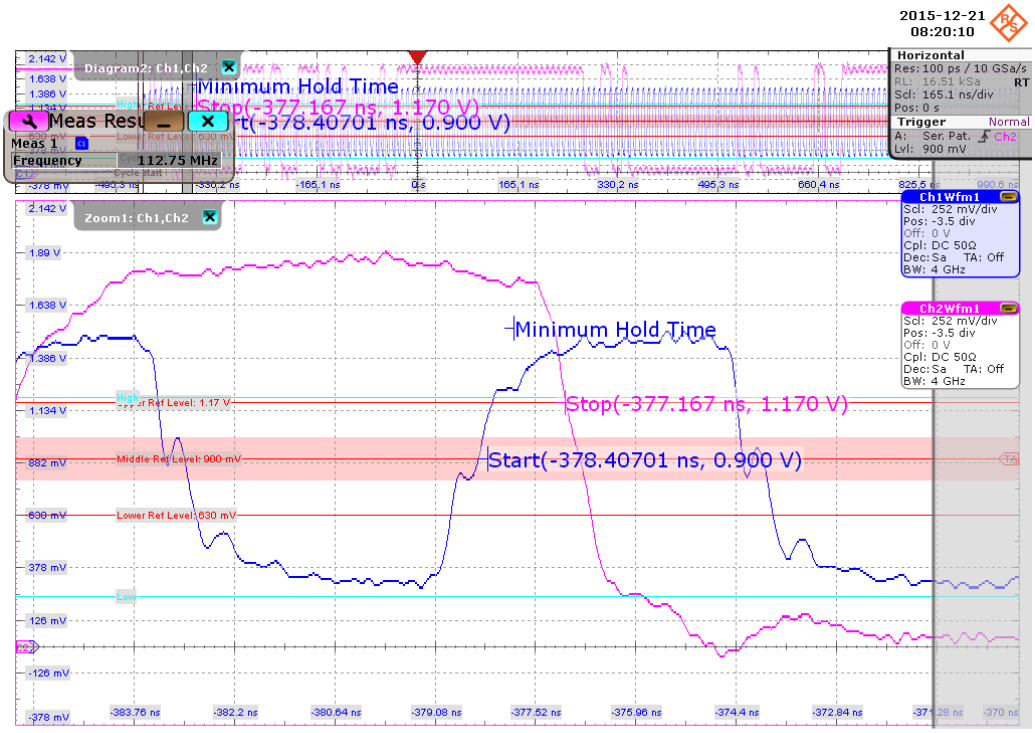
The purpose of this test case is to verify the hold time of the CMD signal in Push Pull mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Push Pull" set in the "Configuration" tab.

T_{IH} is calculated based on the R&S RTO "Edge detection" against the portion of the host command, as shown in the figure below. Minimum hold time is reported as the final result.

The conformance range for T_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.10.1 HS400 Device Input Timing).



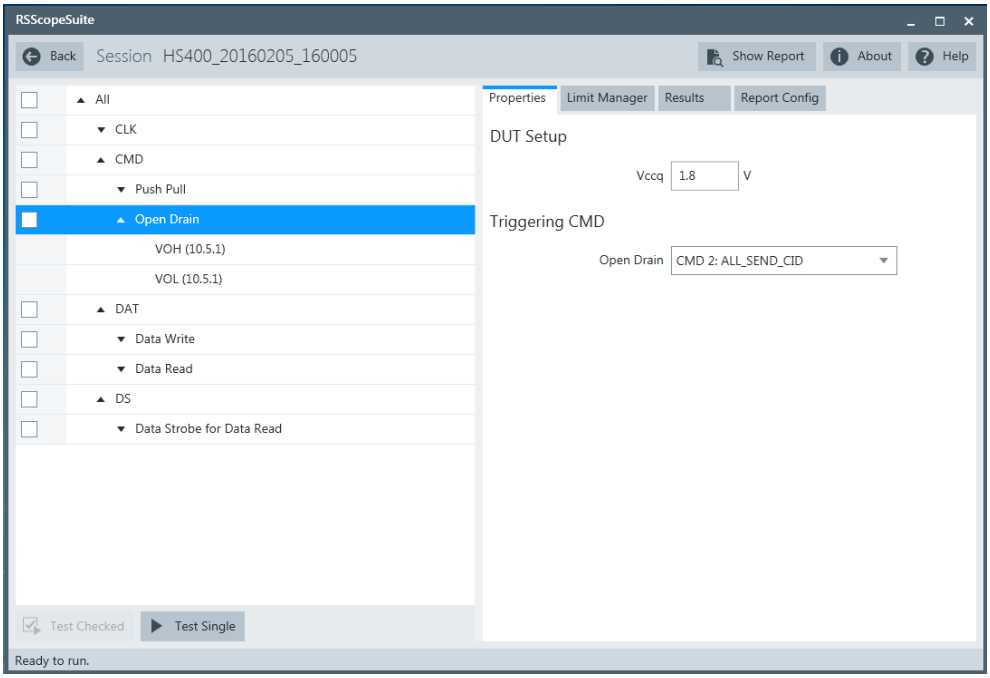
5.5 HS400 CMD Open Drain test

5.5.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Active probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS400	1

5.5.2 Performing the Tests

1. Start the test as described in Chapter 5.1, "Starting HS400 Tests", on page 51.
2. Select "CMD" > "Open Drain".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

5.5.3 Purpose

The purpose of CMD Open Drain test case is to verify bus signal levels requirements specific to eMMC device command signal in Open Drain mode.

5.5.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock and command signals under Open Drain mode.

5.5.4.1 Waveform Requirements

A typical eMMC Command with Clock signal waveforms in Open Drain mode from this test case are as shown in the figure below.

The software requires a single capture of CMD and CLK signals to perform the test and measurement correctly and successfully.

5.5.5 Measurements

HS400 CMD Open Drain test case consists of 2 measurements which perform bus signal levels tests on a single capture of the CMD with CLK signals.

5.5.5.1 Output High Level Voltage (V_{OH})

Purpose

The purpose of this test case is to verify the Output High Level Voltage (V_{OH}) of the CMD signal in Open Drain mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Open Drain" set in the "Configuration" tab.

V_{OH} is measured using the R&S RTO "High" measurement against the portion of the command response, as shown in Figure 5-5.

The conformance range for V_{OH} is specified in the tables of the JESD84-B50 standard (Section 10.5.1 Bus signal levels).

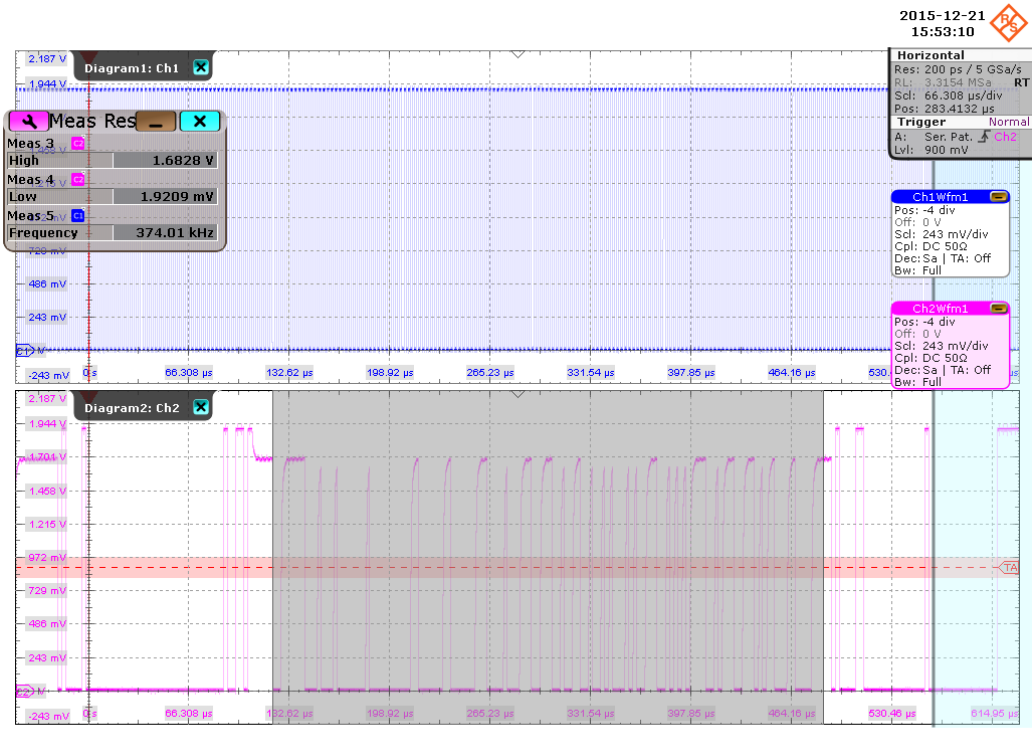


Figure 5-5: HS400 CMD open drain measurement results

5.5.5.2 Output Low Level Voltage (V_{OL})

Purpose

The purpose of this test case is to verify the Output Low Level Voltage (V_{OL}) of the CMD signal in Open Drain mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the command with response and clock signal waveforms according to the "CMD Open Drain" set in the "Configuration" tab.

V_{OL} is measured using the R&S RTO "Low" measurement against the portion of the command response, as shown in Figure 5-5.

The conformance range for V_{OL} is specified in the tables of the JESD84-B50 standard (Section 10.5.1 Bus signal levels).

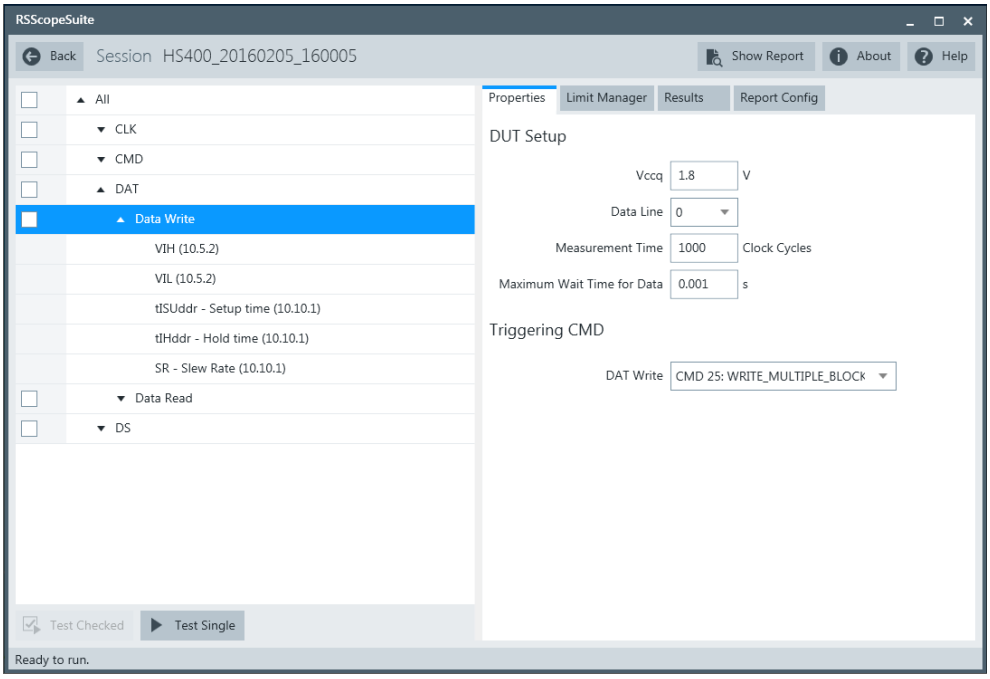
5.6 HS400 Data Write test

5.6.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS400	1

5.6.2 Performing the Tests

1. Start the test as described in Chapter 5.1, "Starting HS400 Tests", on page 51.
2. Select "DAT" > "Data Write".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

5.6.3 Purpose

The purpose of Data Write test case is to verify bus signal levels and timing requirements specific to eMMC device data write signal.

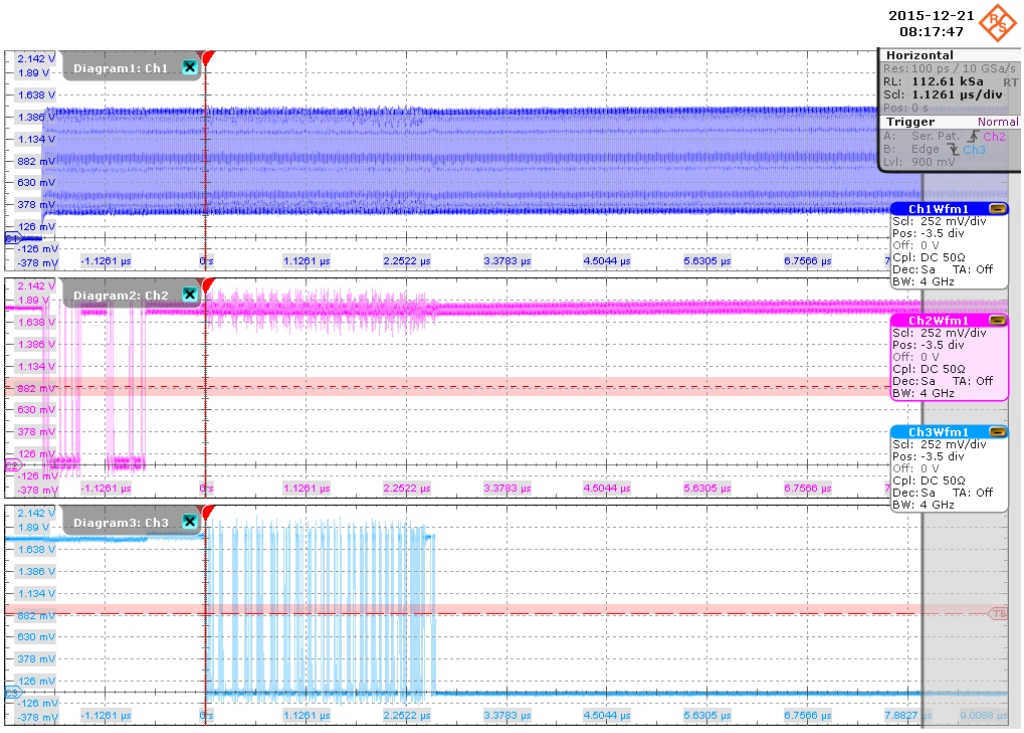
5.6.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock, command and data signals.

5.6.4.1 Waveform Requirements

A typical eMMC Data Write with Command and Clock signal waveforms from this test case are as shown in the figure below.



The software requires a single capture of DAT and CMD with CLK signals to perform the test and measurement correctly and successfully.

5.6.5 Measurements

HS400 Data Write test case consists of 5 test measurements which perform bus signal levels and timing tests on a single capture of the DAT and CMD with CLK signals.

5.6.5.1 Input High Level Voltage (V_{IH})

Purpose

The purpose of this test case is to verify the Input High Level Voltage (V_{IH}) of the DAT Write signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Write and Measurement Time" set in the "Configuration" tab.

V_{IH} is measured using the R&S RTO "High" measurement against the portion of data write, as shown in Figure 5-6.

The conformance range for V_{IH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

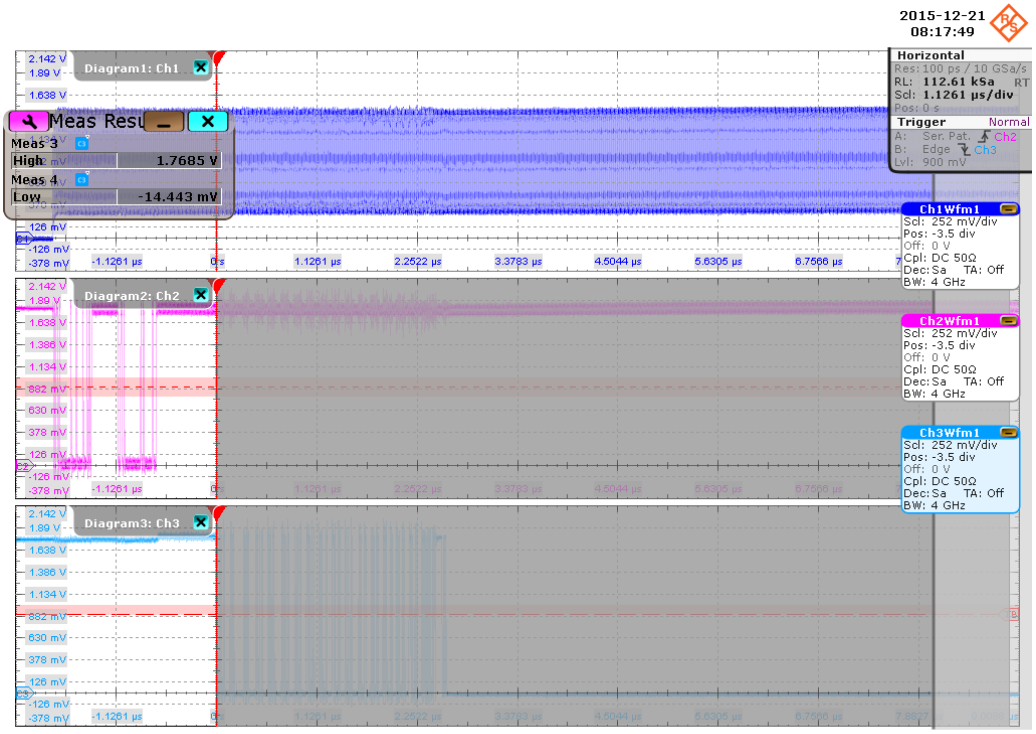


Figure 5-6: HS400 Data Write input level voltage

5.6.5.2 Input Low Level Voltage (V_{IL})

Purpose

The purpose of this test case is to verify the Input Low Level Voltage (V"IL") of the DAT Write signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Write and Measurement Time" set in the "Configuration" tab.

V_{IL} is measured using the R&S RTO "Low" measurement against the portion of data write, as shown in Figure 5-6.

The conformance range for V_{IL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.6.5.3 Setup Time (T_{ISUddr})

Purpose

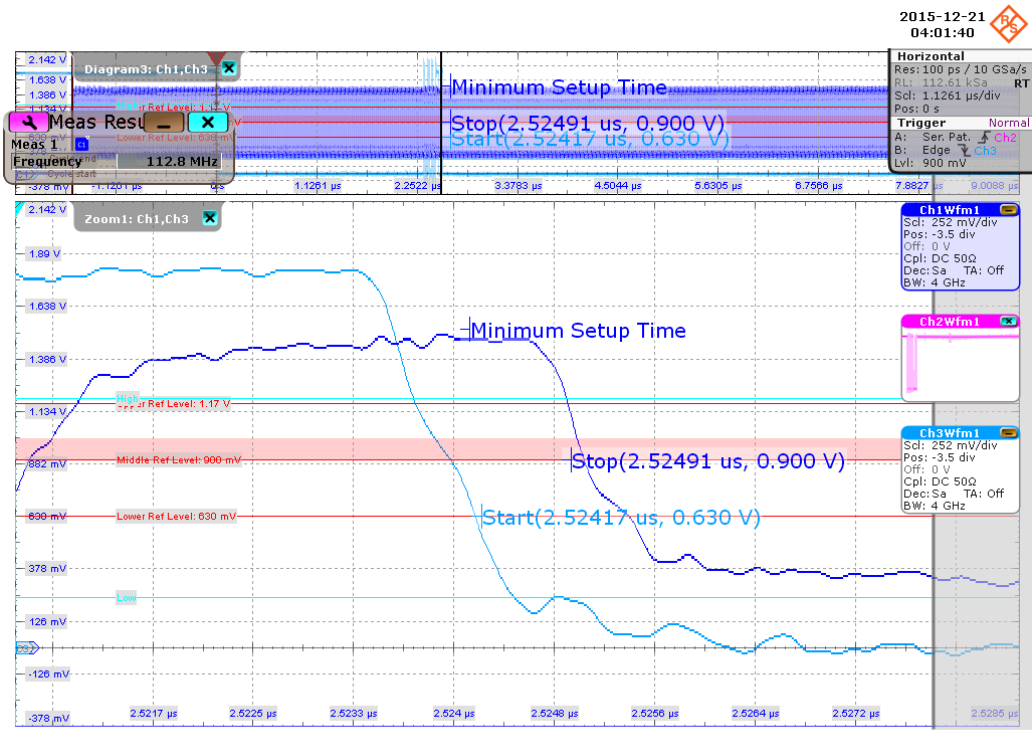
The purpose of this test case is to verify the setup time of the DAT Write signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD DAT Write and Measurement Time" set in the "Configuration" tab.

T_{ISUddr} is calculated based on the R&S RTO "Edge detection" against the portion of data write,as shown in the figure below. Minimum setup time is reported as the final result.

The conformance range for T_{ISUddr} is specified in the tables of the JESD84-B50 standard (Section 10.10.1 HS400 Device Input Timing).



5.6.5.4 Hold Time (T_{IHddr})

Purpose

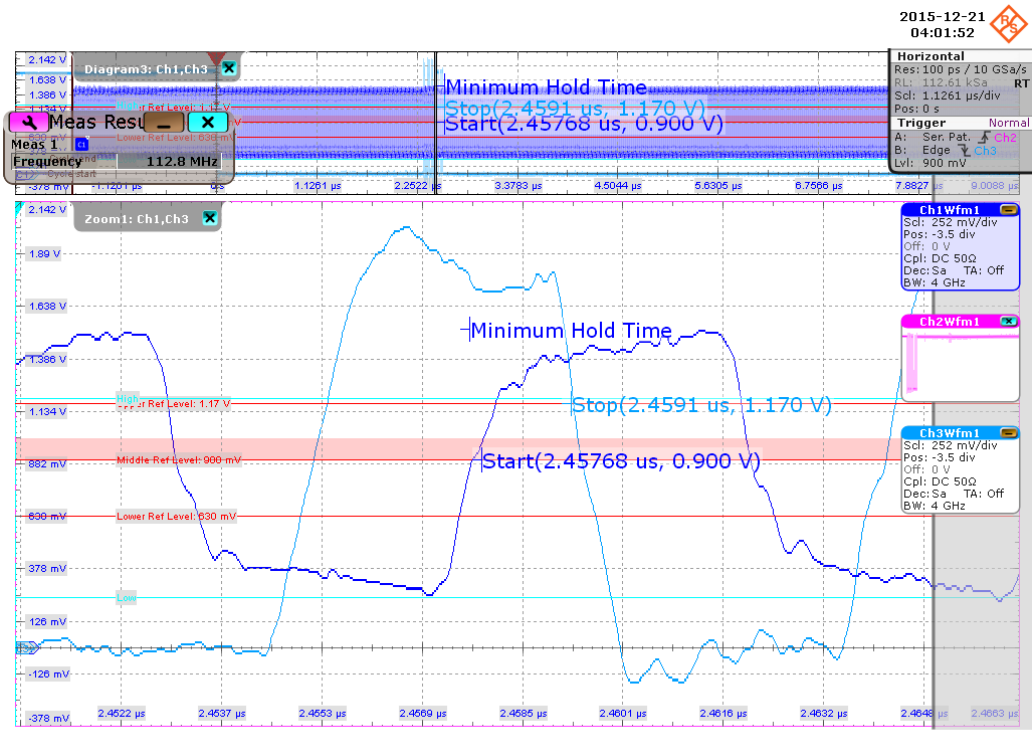
The purpose of this test case is to verify the hold time of the DAT Write signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD Data Write " and "Measurement Time" set in the "Configuration" tab.

T_{IHddr} is calculated based on the R&S RTO "Edge detection" against the portion of data write, as shown in the figure below. Minimum hold time is reported as the final result.

The conformance range for T_{IHddr} is specified in the tables of the JESD84-B50 standard (Section 10.10.1 HS400 Device Input Timing).



5.6.5.5 Slew Rate (SR)

Purpose

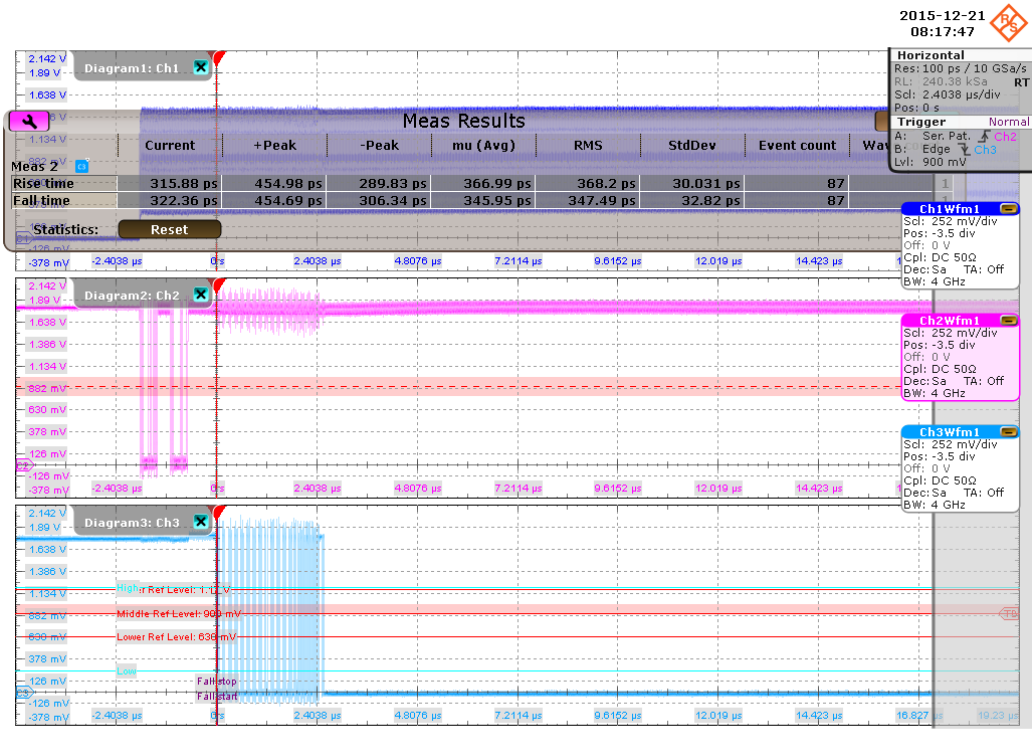
The purpose of this test case is to verify the slew rate of the DAT Write signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD Data Write " and "Measurement Time" set in the "Configuration" tab.

SR is calculated based on the R&S RTO "Period","Rise Time" and "Fall Time" measurements cagainst the portion of data write, as shown in the figure below.The "Minimum Slew Rate" is used as the final result.

The conformance range for SR is specified in the tables of the JESD84-B50 standard (Section Section 10.10.1 HS400 Clock Timing).



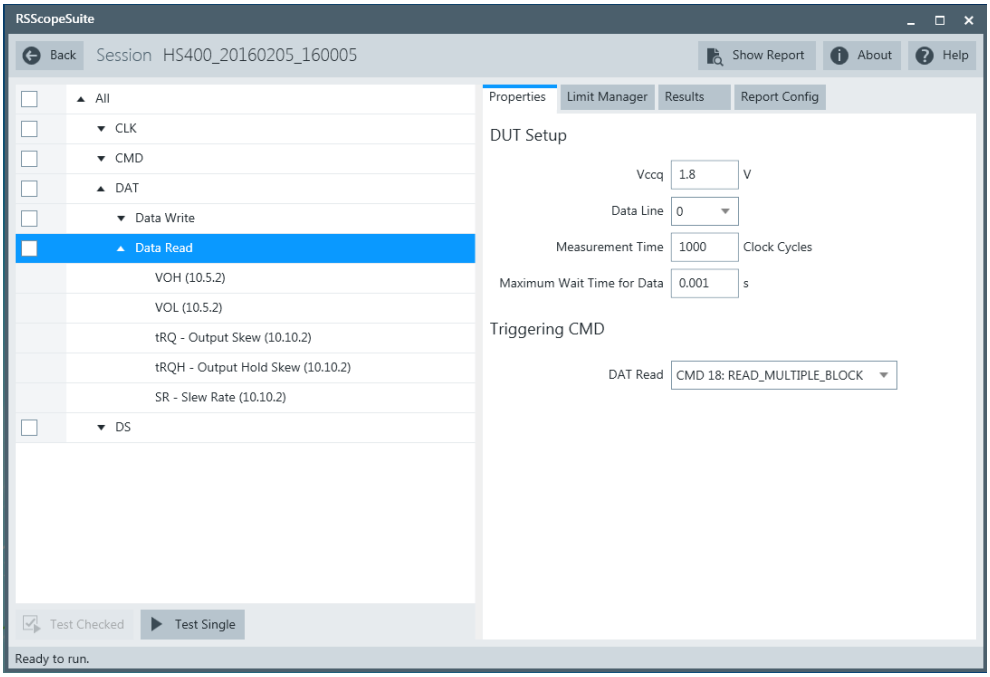
5.7 HS400 Data Read test

5.7.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS400	1

5.7.2 Performing the Tests

1. Start the test as described in Chapter 5.1, "Starting HS400 Tests", on page 51.
2. Select "DAT" > "Data Read".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

5.7.3 Purpose

The purpose of Data Read test case is to verify bus signal levels requirements specific to eMMC device data read signal.

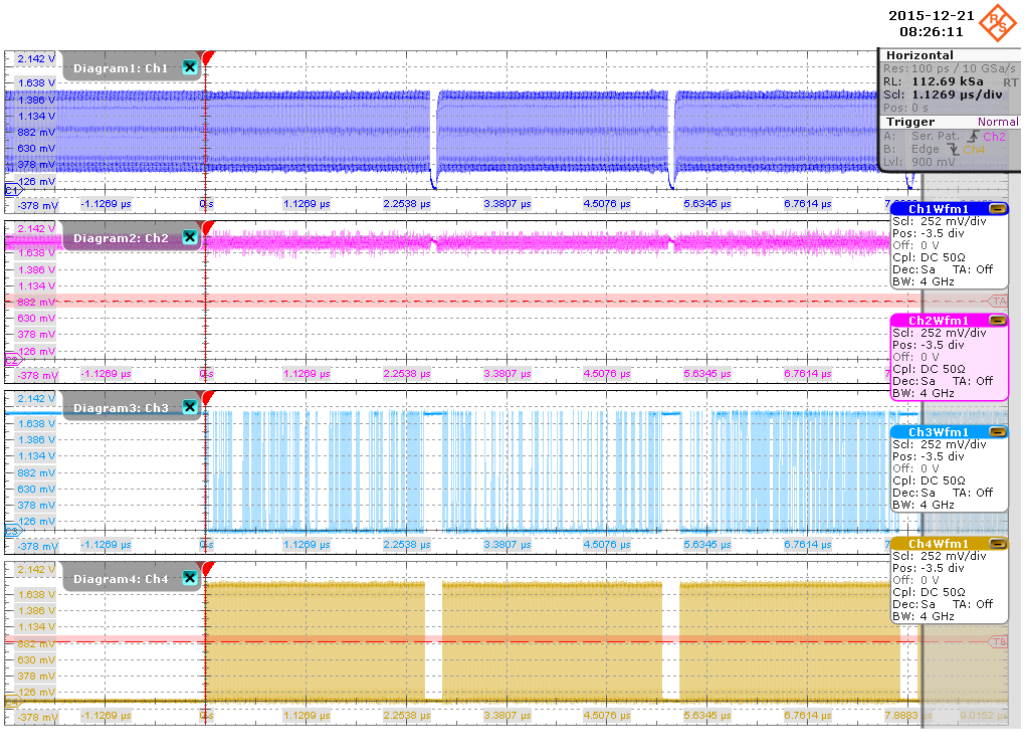
5.7.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock, command and data signals

5.7.4.1 Waveform Requirements

A typical eMMC Data Read with Command and Clock signal waveforms from this test case are as shown in the figure below.



The software requires a single capture of DAT and CMD with CLK signals to perform the test and measurement correctly and successfully.

5.7.5 Measurements

HS400 Data Read test case consists of 5 test measurements which perform bus signal levels tests on a single capture of the DAT and CMD with CLK and Data Strobe signals.

5.7.5.1 Output High Level Voltage (V_{OH})

Purpose

The purpose of this test case is to verify the Output High Level Voltage (V_{OH}) of the DAT Read signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

V_{OH} is measured using RTO "High" measurement against the portion of data read, as shown in Chapter 5.7.5.1, "Output High Level Voltage (V_{OH})", on page 81.

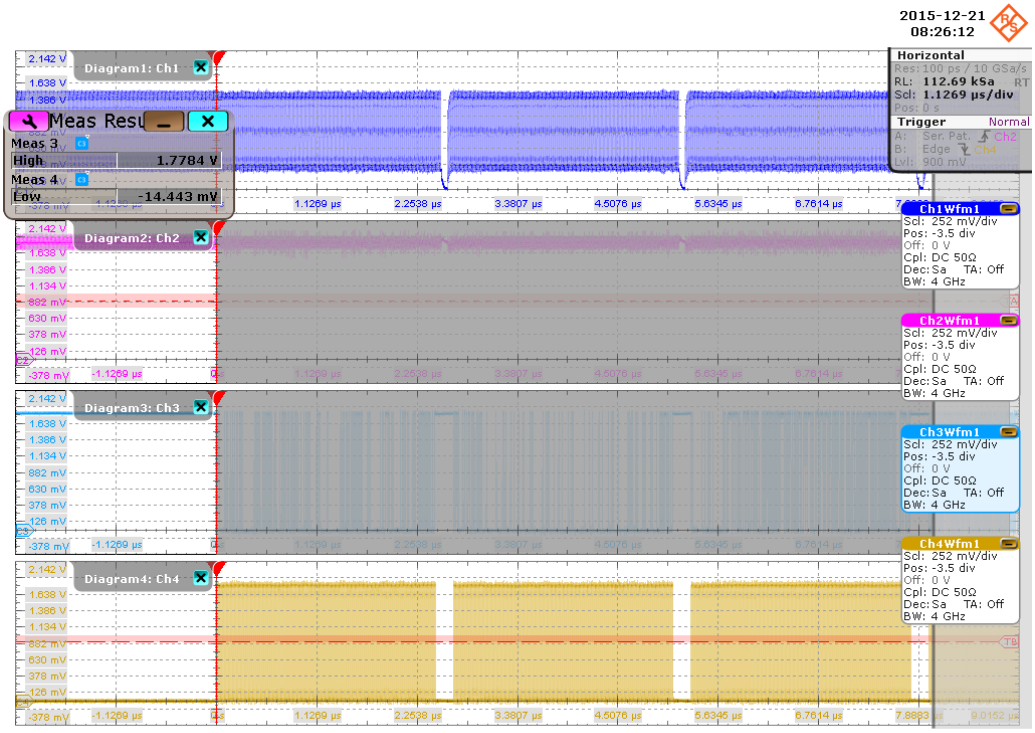


Figure 5-7: HS400 Data Read output voltage

The conformance range for V_{OH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.7.5.2 Output Low Level Voltage (V_{OL})

Purpose

The purpose of this test case is to verify the Output Low Level Voltage (V_{OL}) of the DAT Read signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

V_{OL} is measured using the R&S RTO "Low" measurement against the portion of data read, as shown in Chapter 5.7.5.1, "Output High Level Voltage (V_{OH})", on page 81.

The conformance range for V_{OL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.7.5.3 Output Skew (T_{RQ})

Purpose

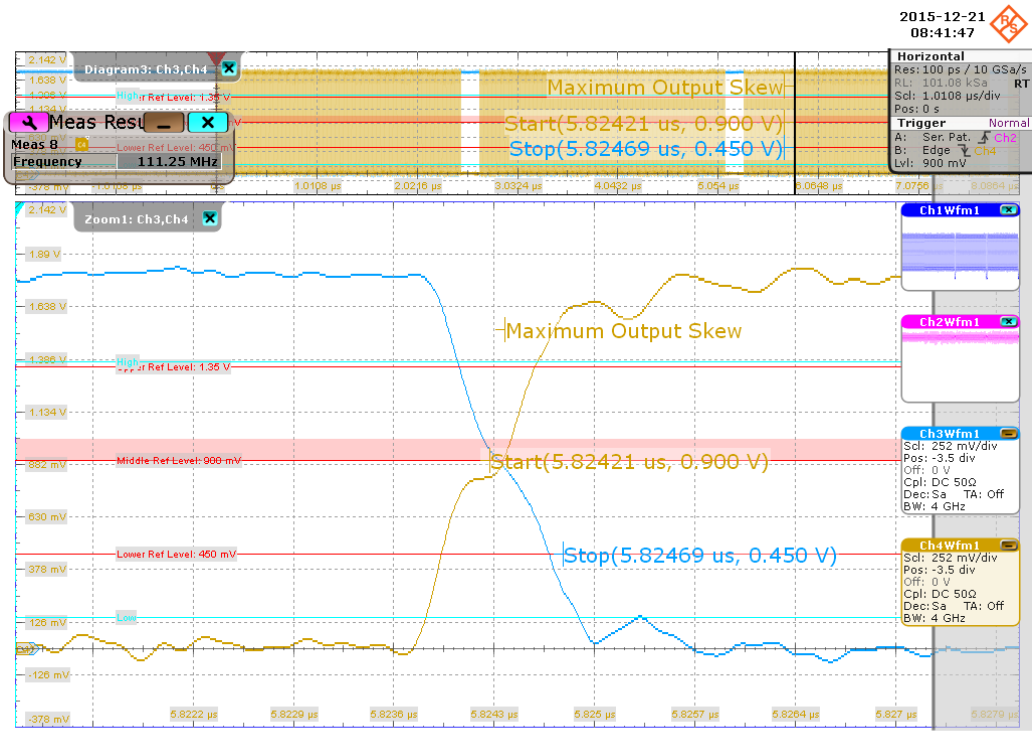
The purpose of this test case is to verify the output skew of the DAT Read signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms and data strobe waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

T_{RQ} is calculated based on the R&S RTO "Data strobe" and "Data edges detection " against the portion of data read, as shown in the figure below. "Maximum output skew" is reported as the final result.

The conformance range for SR is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Device Output Timing).



5.7.5.4 Output Hold Skew (T_{RQH})

Purpose

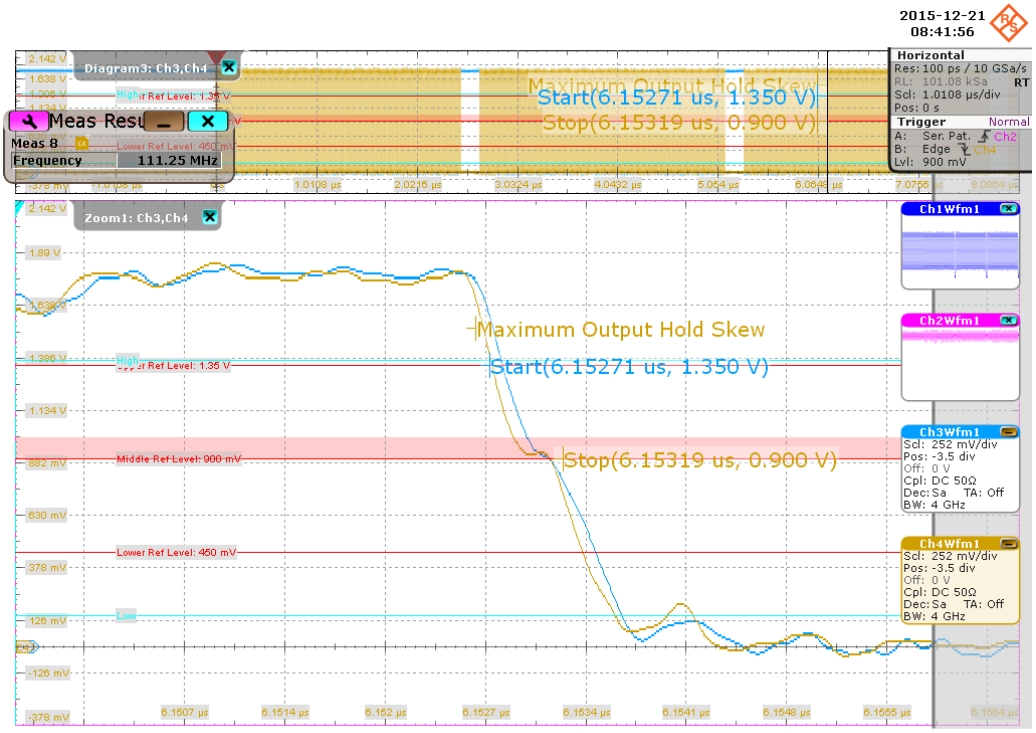
The purpose of this test case is to verify the output skew of the DAT Read signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms and data strobe waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

T_{RQH} is calculated based on the R&S RTO "Data strobe" and "Data edges detection " against the portion of data read, as shown in the figure below. "Maximum output hold skew" is reported as the final result.

The conformance range for SR is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Device Output Timing).



5.7.5.5 Slew Rate (SR)

Purpose

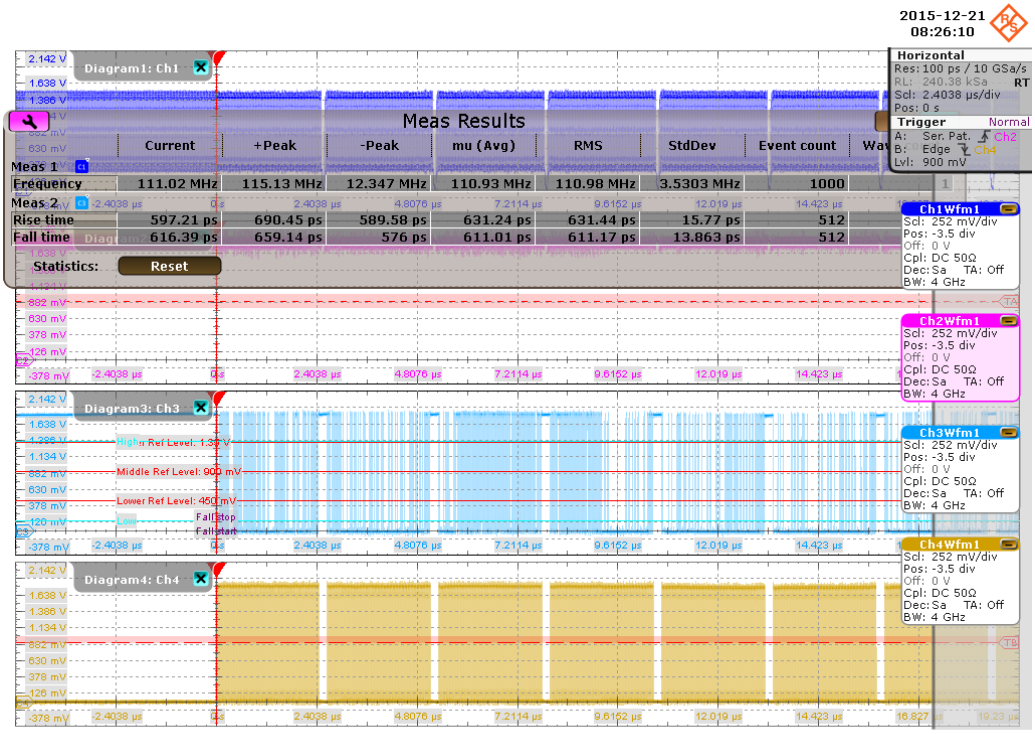
The purpose of this test case is to verify the slew rate of the DAT Read signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms and data strobe waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

SR is calculated based on the R&S RTO "Period","Rise Time" and "Fall Time" measurede against the portion of data write, as shown in the figure below. The "Minimum Slew Rate" is used as the final result.

The conformance range for SR is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Device Output Timing).



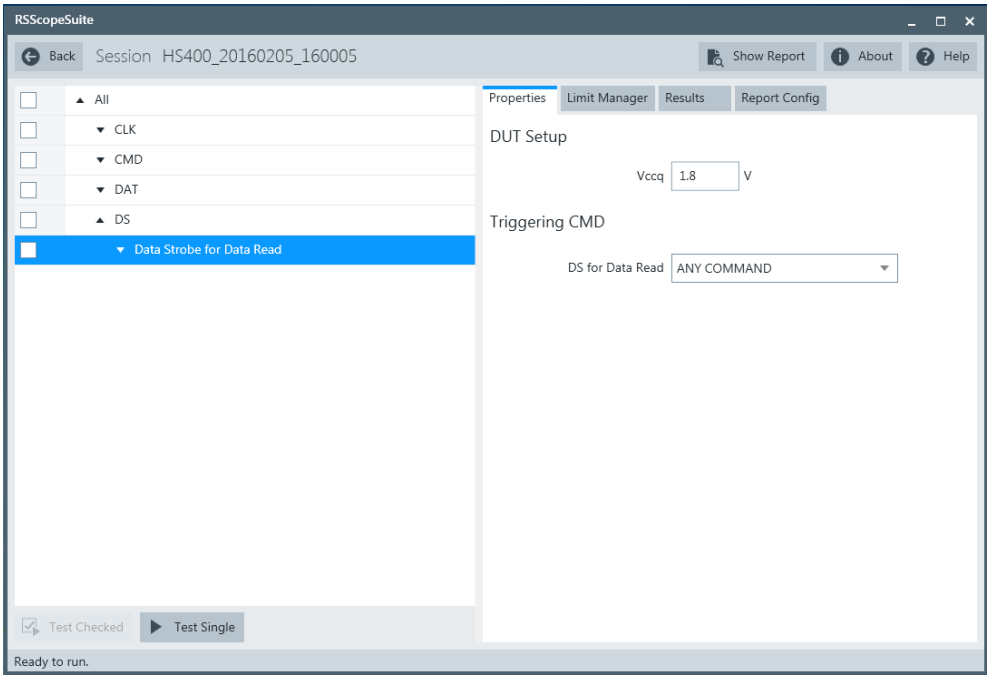
5.8 HS400 Data Strobe Test

5.8.1 Test Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO with minimum 1 GHz bandwidth	1
Probe	Active probe with minimum 1 GHz bandwidth	1
DUT	eMMC device that supports HS400	1

5.8.2 Performing the Tests

1. Start the test as described in Chapter 5.1, "Starting HS400 Tests", on page 51.
2. Select "DS" > "Data Strobe".



3. Click "Test Single".
4. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

5.8.3 Purpose

The purpose of DS test case is to verify bus signal levels and timing requirements specific to eMMC device data strobe signal.

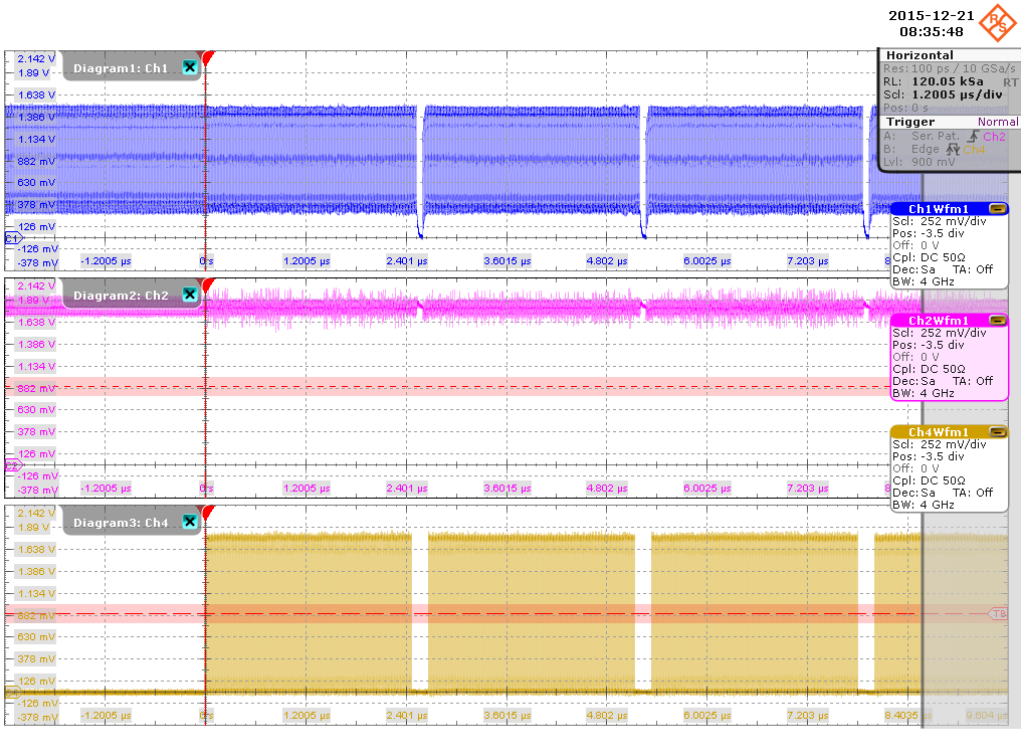
5.8.4 Test Setup

The software will guide you to make proper connections and follow a few steps to conduct the test.

The software is intended to facilitate the execution of a set of measurements on the clock signal.

5.8.4.1 Waveform Requirements

A typical eMMC Data Strobe signal waveform from this test case is as shown in the figure below.



The software requires a single capture of Data Strobe signal to perform the test and measurement correctly and successfully.

5.8.5 Measurements

HS400 Data Strobe test case consists of 6 test measurements which perform bus signal levels and timing tests on a single capture of the Data Strobe signal.

5.8.5.1 Output High Level Voltage (V_{OH})

Purpose

The purpose of this test case is to verify the Output High Level Voltage (V_{OH}) of the Data Strobe signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

V_{OH} is measured using RTO "High" measurement against the portion of data read, as shown in Figure 5-8.

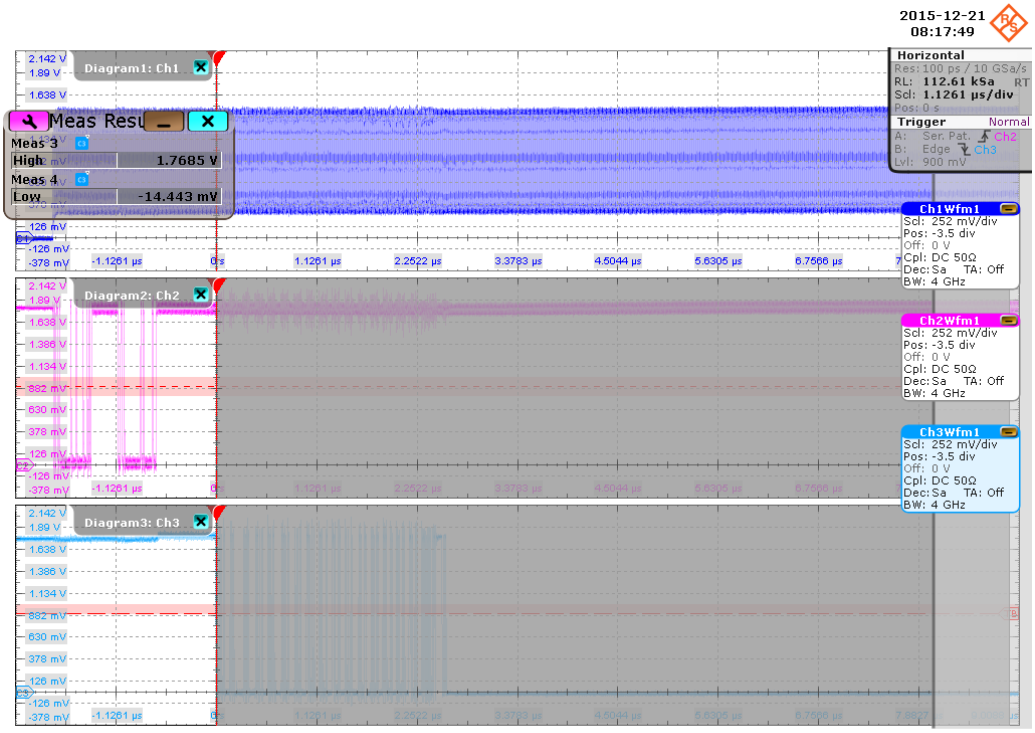


Figure 5-8: HS400 Data Strobe output voltage

The conformance range for V_{OH} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.8.5.2 Output Low Level Voltage (V_{OL})

Purpose

The purpose of this test case is to verify the Output Low Level Voltage (V_{OL}) of the DAT Read signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

V_{OL} is measured using the R&S RTO "Low" measurement against the portion of data read, as shown in Figure 5-8.

The conformance range for V_{OL} is specified in the tables of the JESD84-B50 standard (Section 10.5.2 Bus signal levels).

5.8.5.3 Cycle Time Data Transfer Mode (T_{PERIOD})

Purpose

The purpose of this test case is to verify the cycle time of the Data Strobe signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

T_{PERIOD} is measured using the R&S RTO "Period " against the whole waveform, as shown in Figure 5-9. The "Minimum" value is used as the final result.

The conformance range for T_{PERIOD} is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Clock Timing).

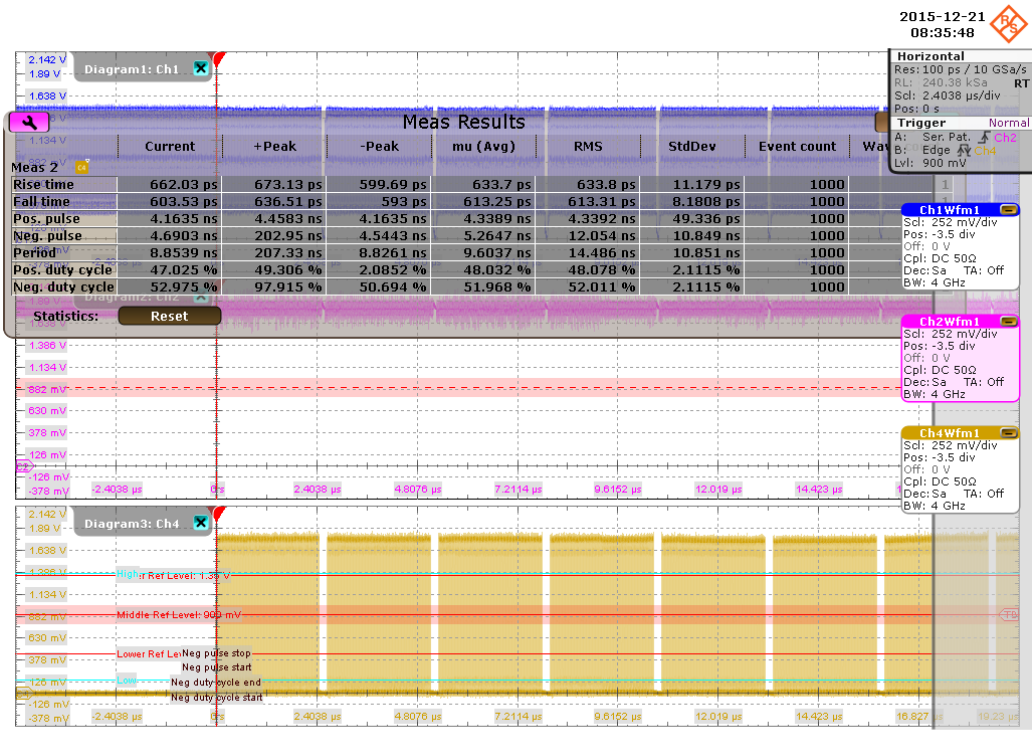


Figure 5-9: HS400 Data Strobe measurement

5.8.5.4 Slew Rate (SR)

Purpose

The purpose of this test case is to verify the slew rate of the Data Strobe signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms and data strobe waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

SR is calculated based on the R&S RTO "Period","Rise Time" and "Fall Time" measurede against the portion of data write, as shown in Figure 5-9.The "Minimum Slew Rate" is used as the final result.

The conformance range for SR is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Clock Timing).

5.8.5.5 Duty Cycle Distortion (T_{DSDCD})

Purpose

The purpose of this test case is to verify the duty cycle distortion of the Data Strobe signal in data transfer mode is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms and data strobe waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

T_{DSDCD} is measured using the R&S RTO "Positive Duty Cycle" and "Negative Duty Cycle" measurements against the whole waveform, as shown in Figure 5-9. Both "Minimum duty cycle distortion" and "Maximum duty cycle distortion" are used as the final results.

The conformance range for T_{DSDCD} is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Clock Timing).

5.8.5.6 Minimum Pulse Width (T_{DSMPW})

Purpose

The purpose of this test case is to verify the minimum pulse width of the Data Strobe signal is within the conformance limits.

Measurements

Measure the clock frequency and then capture the data and command with clock signal waveforms and data strobe waveforms according to the "CMD Data Read " and "Measurement Time" set in the "Configuration" tab.

T_{DSMPW} is measured using the R&S RTO "Positive Duty Cycle" and "Negative Duty Cycle" measurements against the whole waveform, as shown in Figure 5-9. "Minimum pulse width" is used as the final result.

The conformance range for T_{DSMPW} is specified in the tables of the JESD84-B50 standard (Section 10.10.2 HS400 Clock Timing).