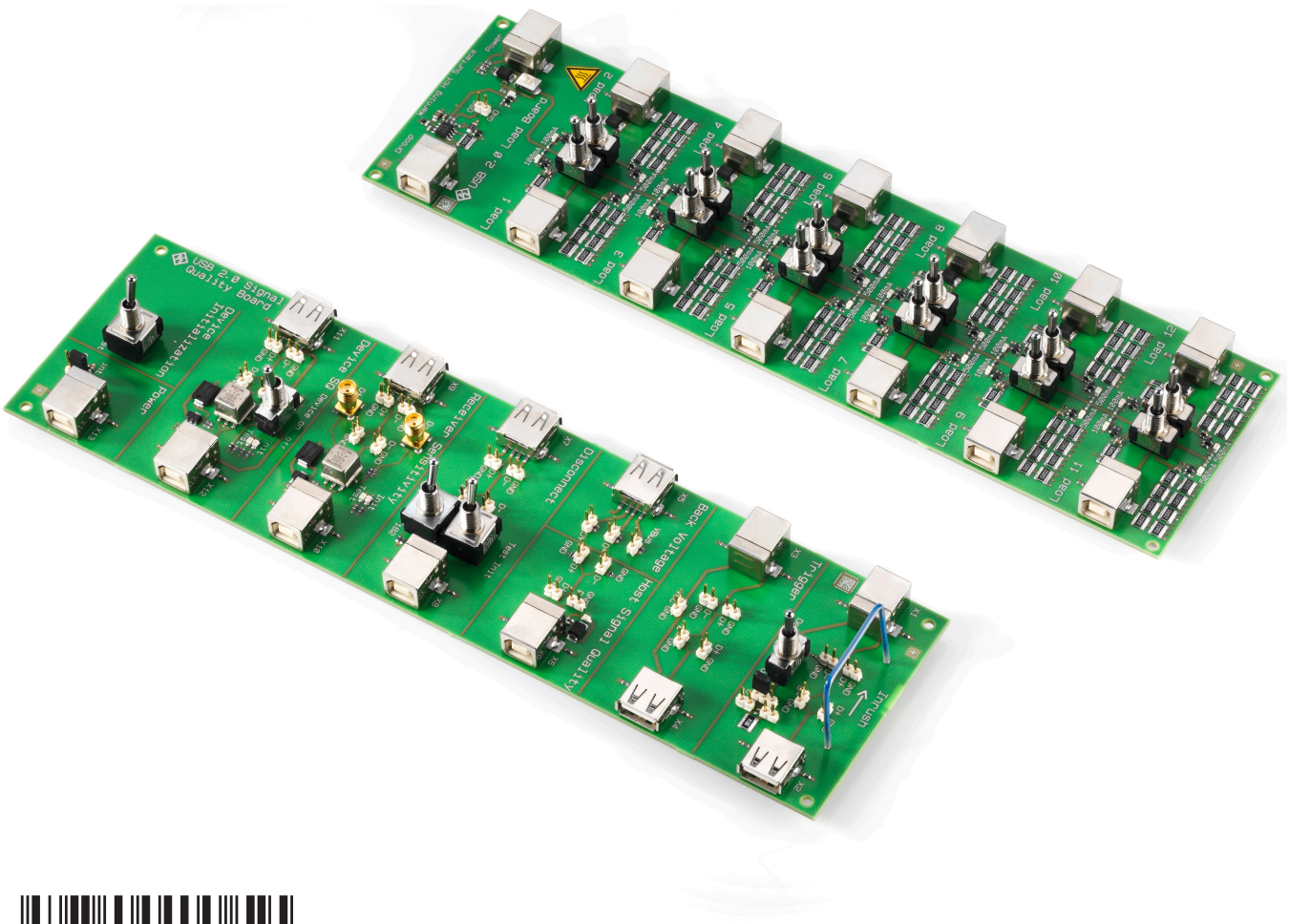
R&S®RTO-K21, R&S®RTO6-K21, R&S®RTP-K21/-K101/-K102 USB 2.0/3.2 Compliance Test User Manual



1317445502
Version 14

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This manual describes the USB 2.0/3.2 Compliance Test Procedures with option R&S®RTO-K21 (1317.4103.02) /R&S®RTO6-K21 (1801.6912.02) / R&S®RTP-K21 (1337.8685.02) / R&S®RTP-K101(1800.6948.02) / R&S®RTP-K102(1800.6990.02).

Revision History

Rev	Date	Chapter	Comments
01	Dec 10, 2012	all	Edit for final release
0101	Feb 12, 2013	3.1; 4.1 and 5.1	Update of model numbers
02	Apr 05, 2013	1.1/ 2.2 1.2; 1.4; 3.1.7 3.1.6, 4.1.5	Update of requirements/report formats New Added the arbitrary waveform generator
03	Dec 05, 2013	all	Update incorporates MOI review and changes in R&S ScopeSuite version 2.0
04	Feb 19, 2014	1.5 3.1.1, 4.1.1, 4.1.2 all test case chapters 3.1.5 Annex	Test configuration for USB DUTs New equipment for Signal Quality Tests Added info on connecting DUT to test fixture and/or test bed computer Edited test procedure J/K, SE0_NAK New chapter: Ordering information
05	Mar 17, 2014	1.5 3.1.4 4.1.3 3.1.5, 4.1.11, 5.1.5	New configuration for DC voltage measurement Improved measurement description Added info on USB-IF host test fixture connection Added info on ProbeMeter usage
06	Feb 19, 2016	all 1, 2.1, 2.7, 3.1, 3.2	Update to current R&S ScopeSuite version. New chapters
07	Jun 28, 2016	2.2	Deleted MATLAB Compiler Runtime, no longer required
08	Sep 01, 2016	1.1, 4.1.6, 4.1.7, 5.1.5	Corrected list of supported AWGs
09	Aug 01, 2018	all	Support of the R&S RTP oscilloscope
10	Mai 29, 2019	2.1, 4.1.6, 4.1.7, 5.1.5 Annex	Corrected list of test equipment and supported AWGs
11	Jan 2021	2.1, 4.2, 5.2, 6.2	New chapters for USB 3.2 test cases
12	Jul 2021	all	Support of R&S RTO6
13	May 2023	6	New chapter for USB 3.2-RX test cases

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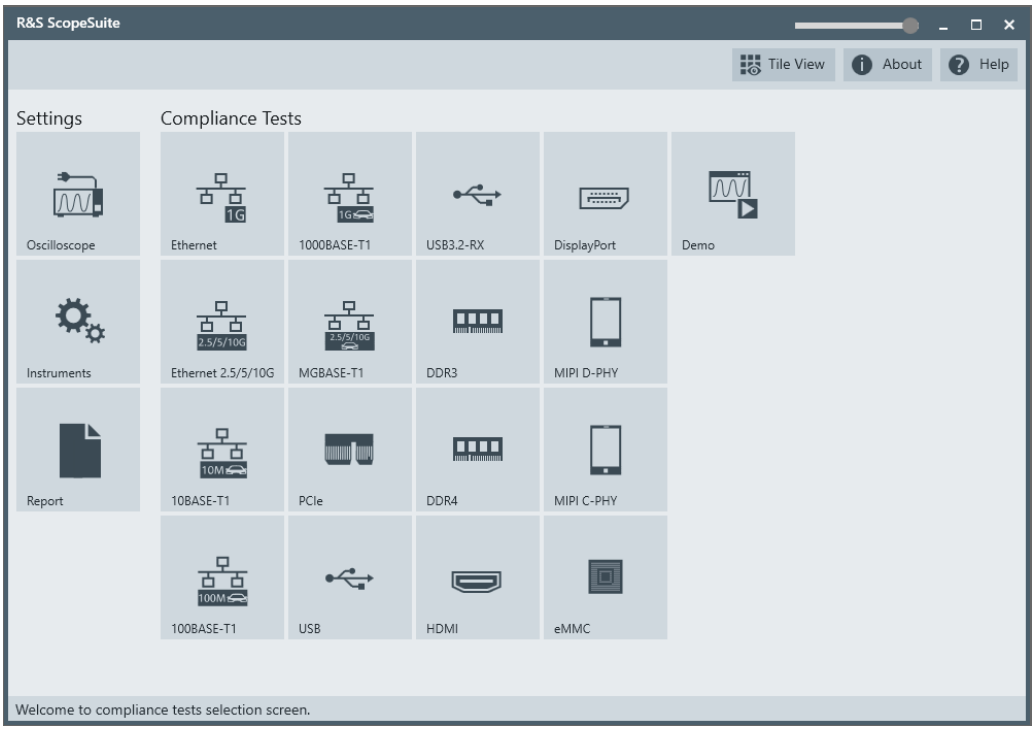
1317.4455.02 | Version 14 | R&S®RTO-K21, R&S®RTO6-K21, R&S®RTP-K21/-K101/-K102

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol , e.g. R&S®RTO is indicated as R&S RTO, and R&S®ScopeSuite is indicated as R&S ScopeSuite.

Contents

1 R&S ScopeSuite overview

The R&S ScopeSuite software is used with R&S RTO/RTO6/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.

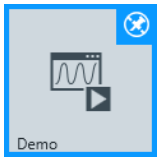


Figure 1-1: Unpin icon

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

USB 2.0 test equipment

For USB 2.0 compliance tests, the following test equipment is recommended:

- R&S RTO/RTO6/RTP oscilloscope with 4 channels and at least 2 GHz bandwidth.
- R&S RT-ZF1 USB 2.0 compliance test fixture set, which consists of the load board and the signal quality board.
- Probes:
  - 2x single-ended active probes with at least 2 GHz bandwidth
  - 1x differential active probe with at least 2 GHz bandwidth
- Tabor WX2182B/Tabor WX2182C arbitrary waveform generator for automatic receiver sensitivity tests.
  For manual receiver sensitivity tests, any AWG with at least 1.44 Gsample/s can be used.
- R&S ScopeSuite software, which can be installed on a computer or directly on the R&S RTO/RTO6/RTP.
- R&S RTO/RTO6/RTP-K21 USB 2.0 compliance test option (required option, installed on the oscilloscope)
- Make sure that you use the latest version of the USBHSET tool. To find downloads, search for *USBHSET* on the following websites:
  - USB 3.0 host: www.usb.org/developers/tools/
  - USB 2.0 host: www.usb.org/developers/tools/usb20_tools/

  Regularly check the USB-IF website compliance.usb.org/index.asp?UpdateFile=Electrical&Format=Standard for USB-IF compliance updates.

USB 3.2 Test Equipment

For USB 3.2 compliance tests, the following test equipment is recommended:

- R&S RTP oscilloscope with 4 channels and at least 16 GHz bandwidth.
- At least one of the following test fixture sets:
  - R&S RT-ZB2 USB 3.1 Demo Board 1
  - USB3ET - USB 3.0 Electrical Test Fixture Kit
  - USB31AET – USB 3.1 USB (10 GT/s) Type-A and Micro-B Electrical Test Fixture Kit
  - USB31CET – USB 3.1 USB (10 GT/s) Type-C Electrical Test Fixture Kit
- Cables / adapters:
  - 2x R&S RT-ZA16 BNC to SMA adapter
  - 2x SMA cable

- R&S RTP-B6/Tabor WX2182B/Tabor WX2182C arbitrary waveform generator to generate `Ping.LFPS` to toggle compliance pattern.
- R&S ScopeSuite software, which can be installed on a computer or directly on the R&S RTP).
- R&S RTP-K101 USB 3.2 compliance test option (required option, installed on the R&S RTP)

USB3.2-Rx Test Equipment

For USB 3.2-Rx compliance tests, the following test equipment is recommended:

- R&S RTP oscilloscope with 4 channels and at least 16 GHz bandwidth.
- At least one of the following test fixture sets:
  - USB 3.1 Compliance Load Board (5.6”, 7.1”, 8.1”)
  - USB 3.1 Mock Host (7.2”, 8.7”, 9.7”)
  - USB 3.1 Mock Device (7.2”, 8.7”, 9.7”)
  - Host PHY Tx Fixture USB 3.1
  - Dev PHY Tx Fixture USB 3.1
  - USB 3.1 Host Fixture 1A
  - USB 3.1 Dev Fixture 1A
  - Rx CAL Fixture
  - USB 3.1 Captive Cable Device Fixture Type-A
  - USB 3.1 Captive Cable Device Fixture Type-C
- Cables / adapters:
  - 3 m Type A - B cable
  - 1 m (6dB) cable
  - 2 m (7dB) cable
  - 2 Pair of matched SMA cables
  - Short A-B or A-uB Cable
  - 2 R&S RT-ZA16 adapters
- R&S RTP-B6/Tabor WX2182B/Tabor WX2182C arbitrary waveform generator to generate `Ping.LFPS` to toggle compliance pattern.
- Bit error rate tester (BERT): Anritsu MP1900A
- Anritsu MX183000A: high-speed serial data test software
- R&S ScopeSuite software, which can be installed on a computer or directly on the R&S RTP).
- R&S RTP-K102 USB 3.2-Rx compliance test option (required option, installed 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 RTO/RTO6/RTP website:
   www.rohde-schwarz.com/product/rtp.html
   www.rohde-schwarz.com/product/rto.html
2. Install the R&S ScopeSuite software:
   - On the computer that is used for testing, or
   - On the R&S RTO/RTO6/RTP.

   For system requirements, refer to the Release Notes.

To install the license key on the R&S RTO/RTO6/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 RTO/RTO6/RTP user manual, chapter "Installing Options", or to the online help on the instrument.

To install USBHSET on the USB host

1. Download the USBHSET tool kit (HS Electrical Test Tool):
   - USB 3.0 host: www.usb.org/developers/tools/
   - USB 2.0 host: www.usb.org/developers/tools/usb20_tools/
2. Install USBHSET on the USB host.

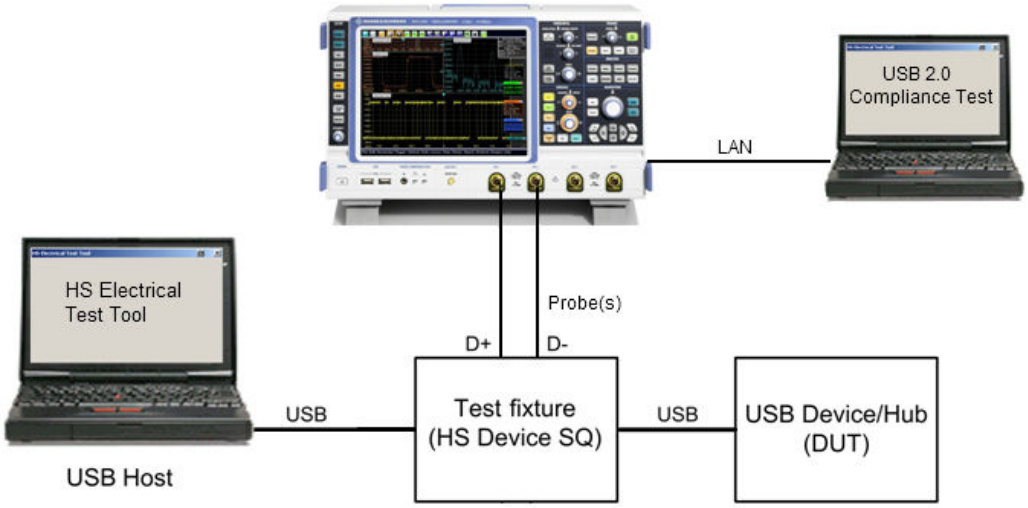


Figure 2-1: Test setup for USB device tests

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.
  If no DHCP server is available, or if the Tabor WX2182B or WX2182C is used for automatic testing, assign fixed IP addresses 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 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 RTO/RTO6/RTP", on page 13

- Chapter 2.6, "Connecting the arbitrary waveform generator", on page 15

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/RTO6/RTP firmware:

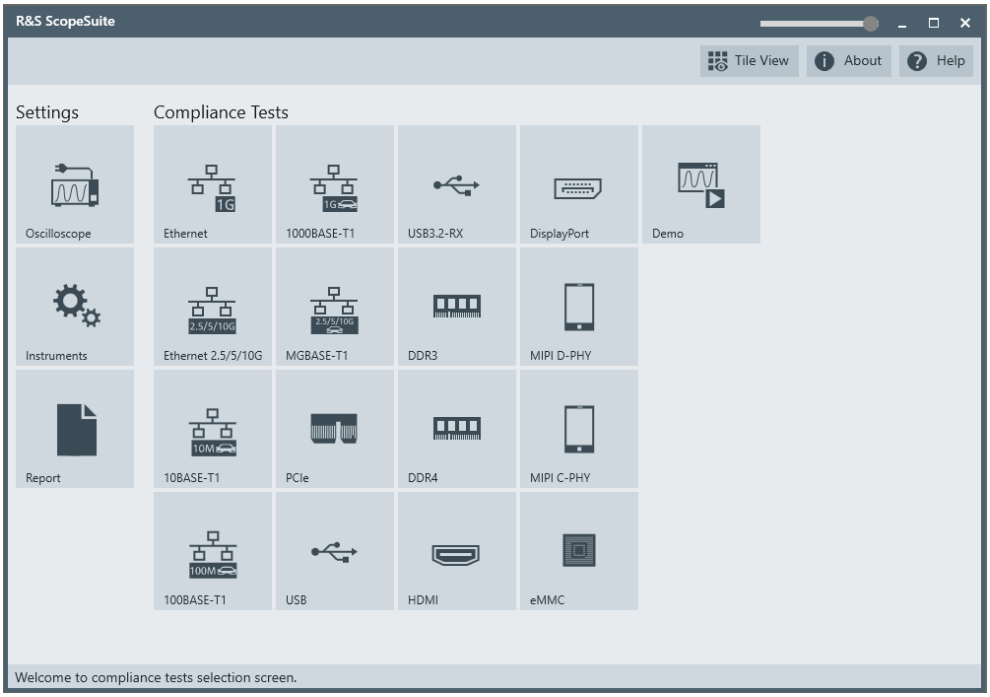
► In the "Apps" dialog, open the "Compliance" tab.

2.5 Connecting the R&S RTO/RTO6/RTP

If the R&S ScopeSuite is installed directly on the instrument, the software detects the R&S RTO/RTO6/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 12. The R&S ScopeSuite software needs the IP address of the oscilloscope to establish connection.

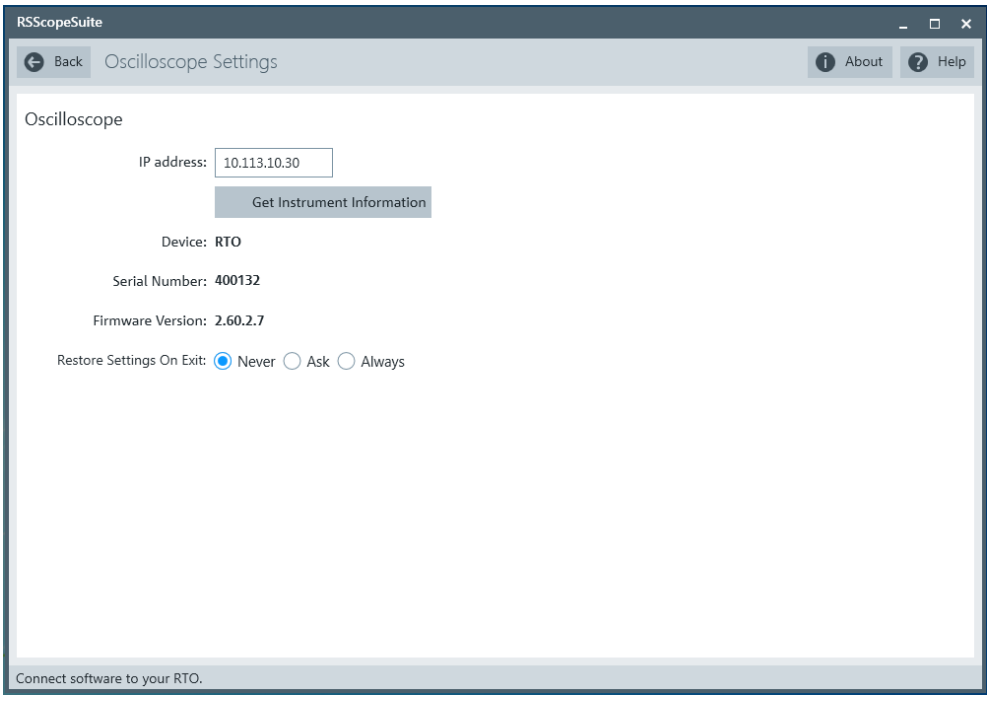
1. Start the R&S RTO/RTO6/RTP.
2. Start the R&S ScopeSuite software.
3. Click "Settings" > "Oscilloscope".



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 Connecting the arbitrary waveform generator

USB 2.0 tests

For USB receiver sensitivity tests, an arbitrary waveform generator (AWG) is required. The tests can be performed manually or automatically, depending on the available AWG.

Automatic test execution is possible with all instruments that are listed in the R&S ScopeSuite, in the "Instrument Settings" dialog box. In automatic mode, the R&S ScopeSuite configures the instrument and ensures that the AWG sends the required waveforms. Automatic mode requires a LAN connection and the installation of a VISA implementation (R&S VISA, see www.rohde-schwarz.com/rsvisa) on the computer that is running the R&S ScopeSuite. If the R&S ScopeSuite is installed on the R&S RTO/RTO6/RTP, no installation is needed because VISA is already installed on the instrument. If the Tabor WX2182B / WX2182C or Hameg HMF2550 is used for automatic testing, fixed IP addresses are required.

For manual test execution, it is recommended to use one of the listed AWGs, but you can also use another AWG with at least 1.44 Gsample/s. In manual mode, you connect the AWG to the test board and configure the instrument manually. VISA is not required. The R&S ScopeSuite uses VISA if it is installed, otherwise it uses the VXI-11 protocol.

USB 3.2 tests

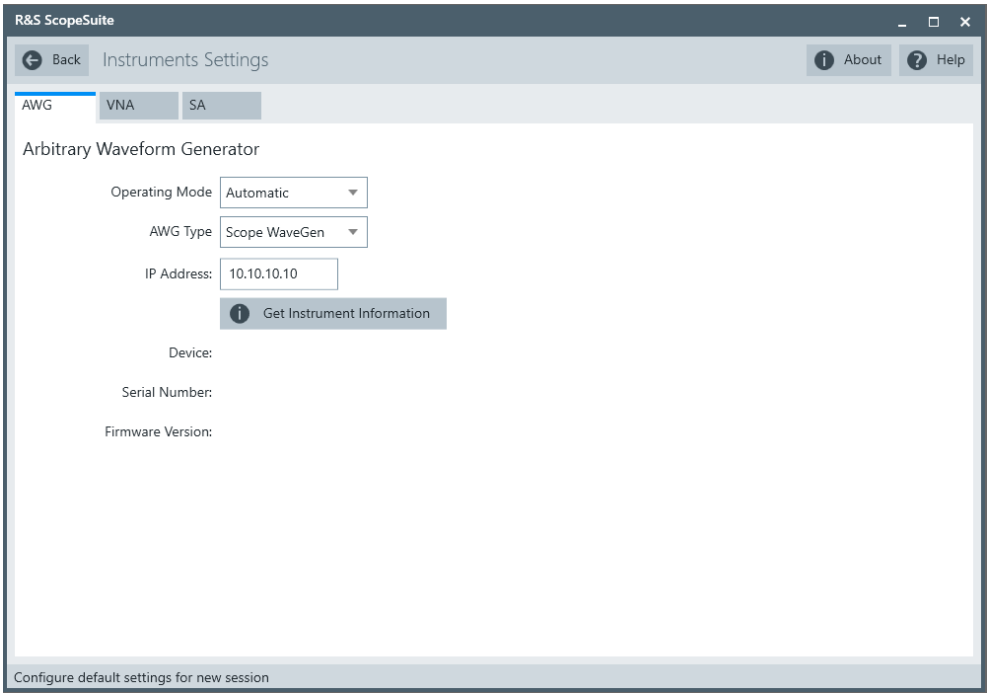
For all USB 3.2 tests, an arbitrary waveform generator (AWG) is required to generate the `Ping.LFPS` signal. It toggles the compliance pattern.

In the "Automatic" operating mode, the `Ping.LFPS` signal is generated automatically through the R&S ScopeSuite.

In the "Manual" operating mode, the `Ping.LFPS` has to be loaded to the waveform generator.

To configure the arbitrary waveform generator for automatic testing

1. Connect the computer and the AWG.
2. Set up the LAN connection. See Chapter 2.3, "Setting up the network", on page 12.
3. In the R&S ScopeSuite, click "Instruments".
   Alternatively, you can select the "Instrument" tab in the test case configuration dialog.
4. Click the "AWG" tab.
5. Select "Operating mode" = "Automatic".
6. Select a supported "AWG Type" and enter its IP address.
   For a list of the supported AWGs, see chapter "Test Equipment".



7. Click "Get Instrument Information".

   The computer or R&S RTO/RTO6/RTP connects with the instrument and retrieves the instrument data.

8. If the connection to the arbitrary waveform generator failed, check if the IP address is assigned correctly.

To configure the AWG for manual testing

For USB 2.0 tests

1. In the "AWG" tab, enable the "Manual" operating mode.
2. Connect the AWG to the test fixture as described in the test wizard. To create the test waveforms, use the files `MIN_ADD1.txt` and `IN_ADD1.txt`, which are provided in the installation directory of the R&S ScopeSuite.

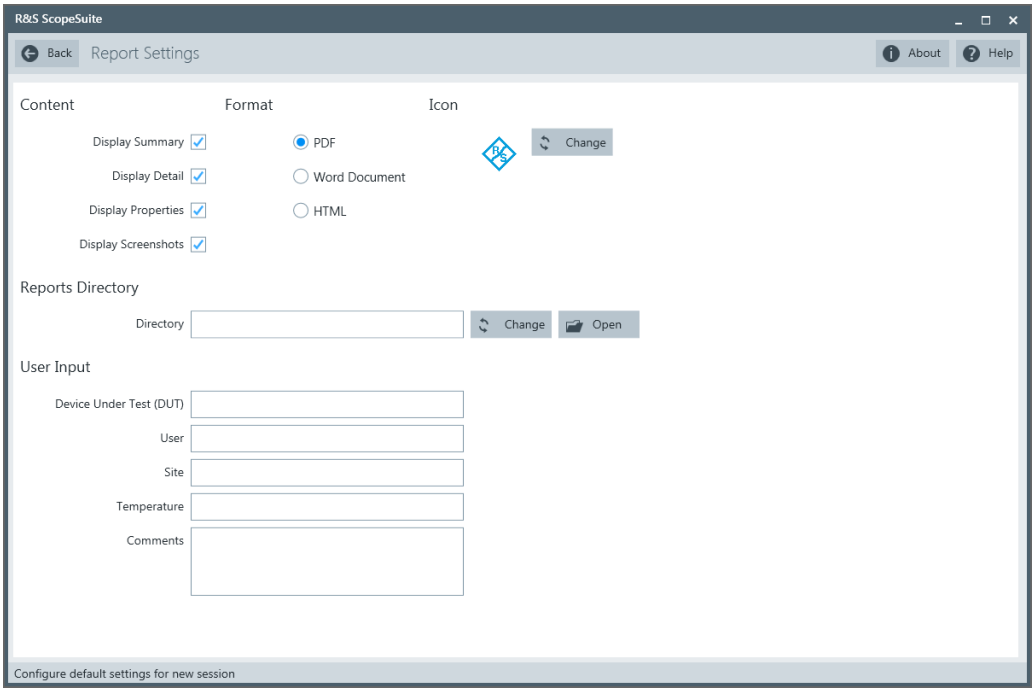
For USB 3.2 tests

1. In the "AWG" tab, enable the "Manual" operating mode.
2. Load `Ping.LFPS` waveform to the connected waveform generator.

2.7 Report configuration

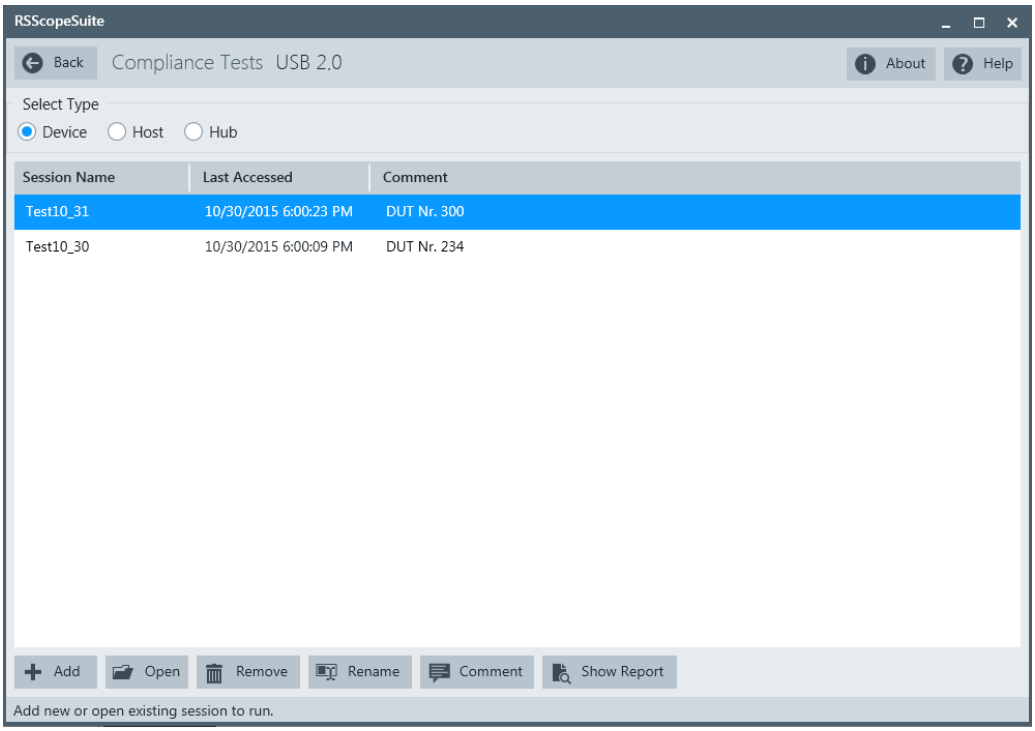
In the "Report Configuration" menu, you can select the format of the report and the details to be included in the report. You can also select an icon that is displayed in the upper left corner of the report.

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



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".

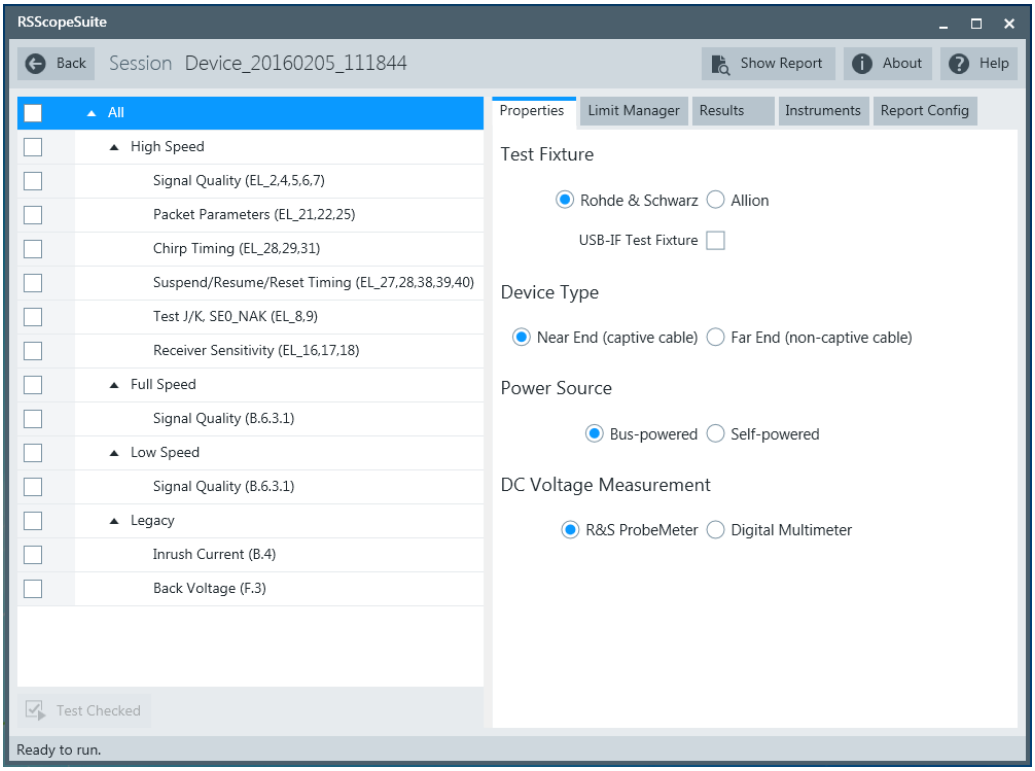
To show a report for a test session

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:
   - "USB"
   - "USB3.2-RX"
2. Open a test session, see Chapter 3.1, "Starting a test session", on page 18.
3. Adjust the "Properties" settings for the test cases you want to perform.
4. Click "Limit Manager" and edit the limit criteria, see Chapter 3.2.1.1, "Limit manager", on page 21.
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" are used. See Chapter 2.7, "Report configuration", on page 16.
6. 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 21.
- "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

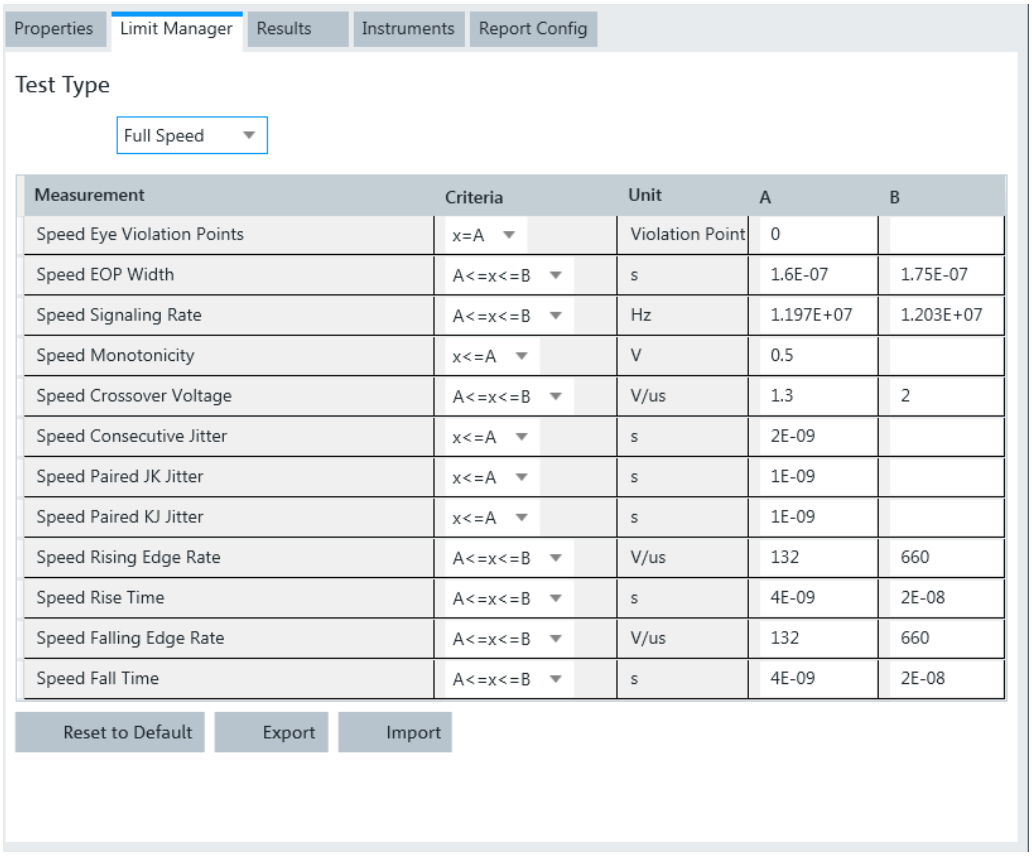
The "Limit Manager" shows the measurement limits that are used for compliance testing.

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".

1. Select the "Test Type".
2. Check and adjust the measurement limits.



3.2.2 Test configuration for USB 2.0 / USB 3.2

The test configuration consists of some USB 2.0/ USB 3.2 specific configuration settings that depend on the selected DUT type - "Device", "Host" or "Hub".

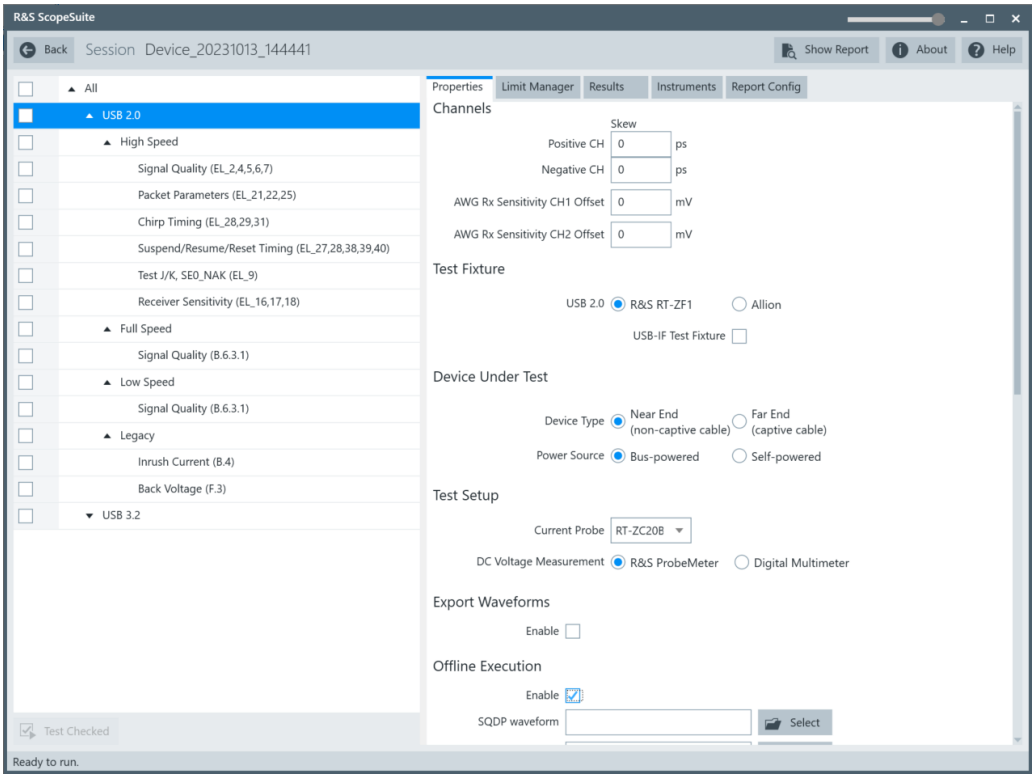


Figure 3-1: USB 2.0 Configuration

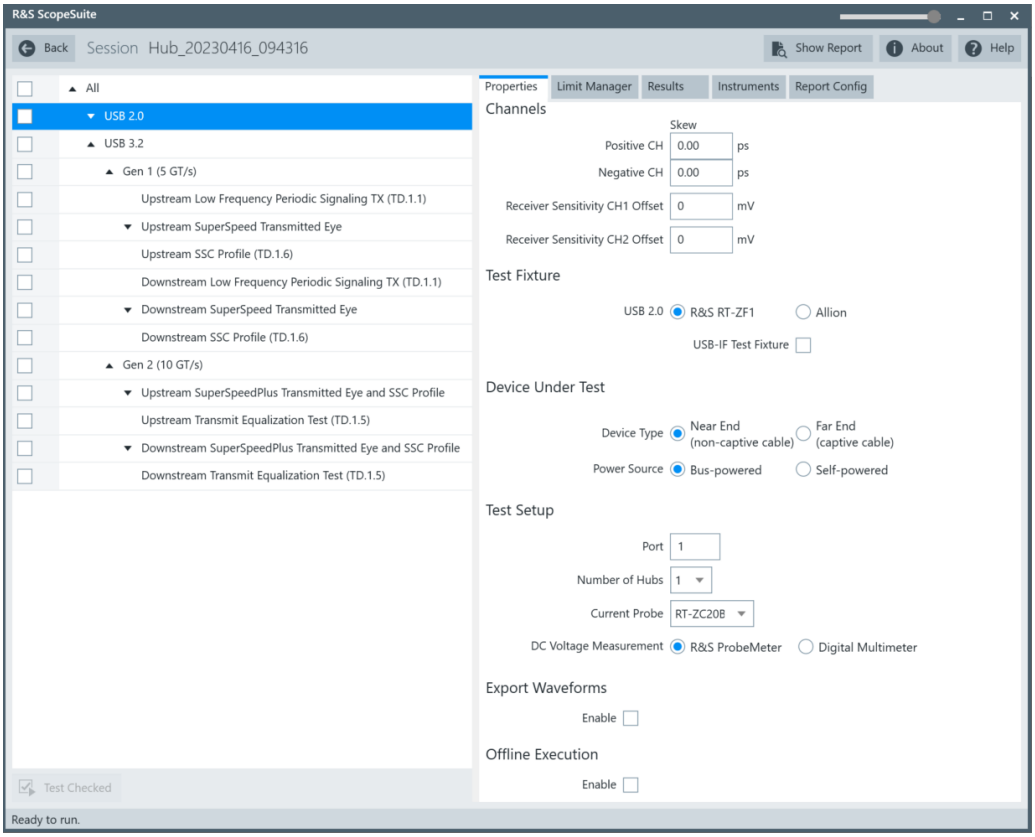


Figure 3-2: USB 3.2 Configuration

Channel Setup

In the "Channels" section you can select the channel of the probes used for the test setup and set the skew for each channel.

The skew compensates signal propagation differences between channels caused by the different length of cables, probes, and other sources.

AWG Rx Sensitivity CH Offset ← Channel Setup

Relevant only for USB 2.0 "Receiver sensitivity" tests.

The receiver sensitivity offset is used to configure the Tabor AWG.

"AWG Rx Sensitivity CH1 Offset" shifts the signal from a negative value back to zero reference level.

"AWG Rx Sensitivity CH2 Offset" shifts the signal from positive value back to zero reference level.

Test Fixture for USB 2.0

The R&S RTO-K21 supports three sets of test fixtures:

- R&S RT-ZF1: this set consists of a signal quality board and a load board. They can be used to run all tests that are required for USB high speed, full speed and low speed. For more information, refer to https://www.rohde-schwarz.com/sg/product/rto-productstartpage_63493-10790.html.
  To use this set of test fixtures, select "Rohde & Schwarz" under "Test Fixture".

- Allion USB-TF-FXS-1: this set consists of 8 pieces which can be bought together or separately from Allion. For more information, refer to www.allion.com/test_tool_usb.html.
  If you want to use this set of test fixtures, select Allion.
- USB-IF USB2.0 Hi-Speed Signal Quality Test Fixtures – this set consists of a device test fixture and a host test fixture. It is the only set of test fixtures approved by USB-IF and covers USB high-speed signal quality tests and hub downstream jitter test. These fixtures are connected to the oscilloscope using a pair of SMA cables instead a differential probe. For more information, refer to compliance.usb.org/index.asp?UpdateFile=Electrical&Format=Standard#86.
  If you want to use this set of fixtures, enable "USB-IF Test Fixture for High Speed Signal Quality Test".
  You can select the USB-IF USB2.0 test fixture set in addition to one of the other test fixture sets. The R&S ScopeSuite guides you to use the USB-IF fixtures for high-speed signal quality tests. For all other tests, it guides you to use the selected Allion or R&S RT-ZF1 test fixture set. If "USB-IF Test Fixture for High Speed Signal Quality Test" is disabled, the application guides you to use the selected test fixture set for all tests.

Test Fixture for USB 3.2
The R&S RTP-K101 supports two sets of test fixtures:
- Rohde & Schwarz: R&S RT-ZB2: the demo board can be used for compliance testing of USB 3.1 compatible devices.
  To use the demo board, select "Rohde & Schwarz" under "Test Fixture".
- USB-IF USB3.2 test fixture kits. According to the measurement setups, the following test fixture kits are required:
  – USB3ET - USB 3.0 Electrical Test Fixture Kit
  – USB31AET – USB 3.1 USB (10 GT/s) Type-A and Micro-B Electrical Test Fixture Kit
  – USB31CET – USB 3.1 USB (10 GT/s) Type-C Electrical Test Fixture Kit

Device Type
Relevant only for USB 2.0 tests.

If the DUT is a *device or hub (upstream port) without a captive cable*: enable "Near End (non-captive cable)".

If the DUT is a *device or hub (upstream port) with a captive cable*, enable "Far End (captive cable)".

By definition, a captive cable has a type A connector on one end and any connector other than type B on the other end (including soldered cable), see www.usb.org/developers/compliance/cable for details. Also refer to compliance.usb.org/index.asp?UpdateFile=Electrical#8 for further clarifications on "Near End" and "Far End".

Power Source
If the DUT is a *bus-powered device or hub (upstream port)*: enable "Bus-powered".

If the DUT is a *self-powered device or hub (upstream port)*, enable "Self-powered".

OTG or Embedded Host
Relevant only for USB 2.0 tests.

If the DUT is a USB On-The-Go (OTG) or embedded host, enable this setting.

HS-OPT
Relevant only for USB 2.0 tests.

Displayed only, if "OTG or Embedded Host" is enabled.

You can select to use "TestUSB" or "Allion" PIDVID for you tests. The default value for the OTG or embedded host test is "TestUSB".

Host or Hub Port Number
If the DUT is a *host or a hub (downstream ports)*: enter the port number of the downstream port under test.

Note that only one port number can be entered at one time. If you plan to test multiple downstream ports, remember to update this field before every test cycle.

DC Voltage Measurement
Relevant only for USB 2.0 tests.

The probes at least 2 GHz bandwidth and at least 2 GHz bandwidth contain a built-in digital voltmeter known as R&S ProbeMeter. It allows DC voltage measurements to be carried out automatically.

If you want to use the R&S ProbeMeter for DC voltage measurement, enable "R&S ProbeMeter".

If you want to use an external voltmeter for DC voltage measurement, enable "Digital Multimeter".

SigTest
Relevant only for USB 3.2 tests.

You can download the required SigTest version from the official website:

https://www.usb.org/compliancetools.

Install the required official SigTest versions to the `Program Files (x86)` directory:

- For USB 3.2 Gen 1 Tests: SigTest version 3.2.11.4
- For USB 3.2 Gen 1 SSC Profile tests: SigTest version 4.0.23.2
- For USB 3.2 Gen 2 tests: SigTest version 4.0.23.2

Channel Selection
Selects the "Positive Channel" (Ch1 or Ch2) and the "Negative Channel" (Ch3 or Ch4) for USB 3.2 tests.

Connector Source
Selects the connector source type, Standard A or Type-C.

Captive cable
Relevant only for USB 3.2 tests.

Enable this setting for DUTs with captive cables, a cable with one USB connector that is permanently attached or has a non-USB connector.

Current Probe
Relevant only for USB 2.0 tests.

Selects the current probe that is used for the measurement. Supported are R&S RT-ZC20, R&S RT-ZC20B and R&S RT-ZC30.

Export Waveforms
Enables you to export a waveform. You can later load the waveforms to run the tests in the offline mode, see "Offline Execution" on page 26.

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

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

For example:

```
MyDocuments\Rohde-Schwarz\RSScopeSuite\4.80.0\Waveforms\USB\USB\
Device_20201030_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 RTO/RTO6/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. In the "Session Selection" dialog, select the DUT type.
4. Open a test session, see Chapter 3.1, "Starting a test session", on page 18.
5. Check the test configuration settings and adjust, if necessary. See: Chapter 3.2, "Configuring the test", on page 19.
6. 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 detailed test description can be found in the following chapters:
   - Chapter 4, "USB 2.0 compliance tests", on page 28
   - Chapter 5, "USB 3.2 compliance tests", on page 163
   - Chapter 6, "USB3.2 Rx compliance tests", on page 191

3.4 Getting test results

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

For each test, the test data - report, diagrams and waveform files - is saved in the following folder:
`%ProgramData%\Rohde-Schwarz\RSScopeSuite\3.0\Sessions\USB\<DUT_Types>\<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 2.7, "Report configuration", on page 16). 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 USB 2.0 compliance tests

4.1 USB 2.0 device tests

4.1.1 High-speed device tests

4.1.1.1 Signal quality

Table 4-1: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the device you want to test	1
Signal quality board, "Device SQ" section or USB-IF USB2.0 hi-speed signal quality device test fixture	R&S RT-ZF1	1
Differential probe or a pair of matched SMA cables if USB-IF device test fixture is used	differential probe with at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

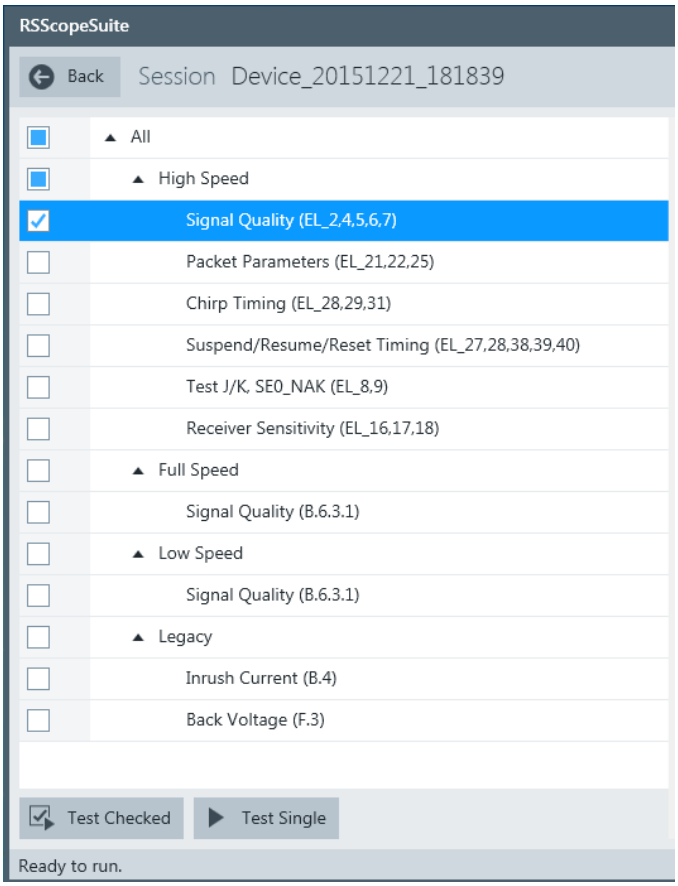
Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Device"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Signal Quality (EL_2,4,5,6,7)" test case and click "Start".



2. Connect the DUT to the test fixture as shown in the picture.

Figure 4-1: R&S RT-ZF1: connection to DUT

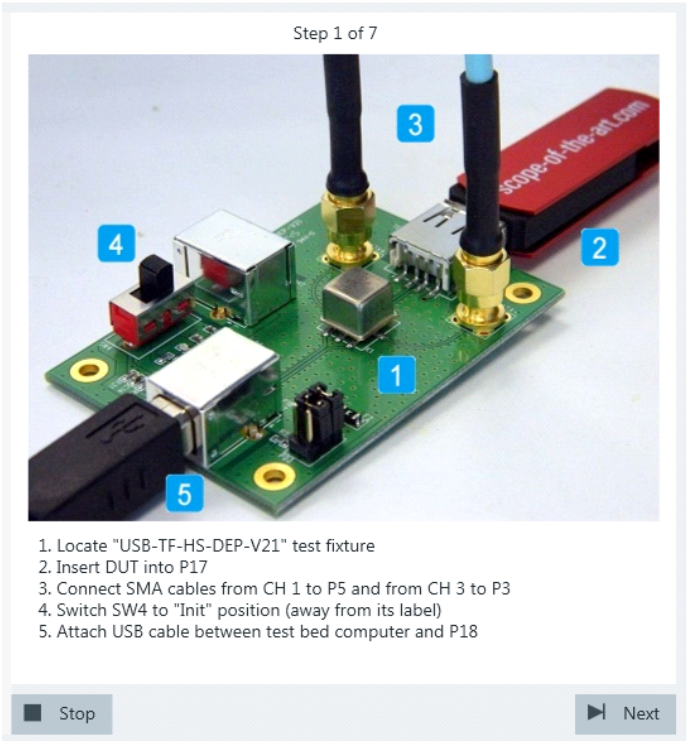
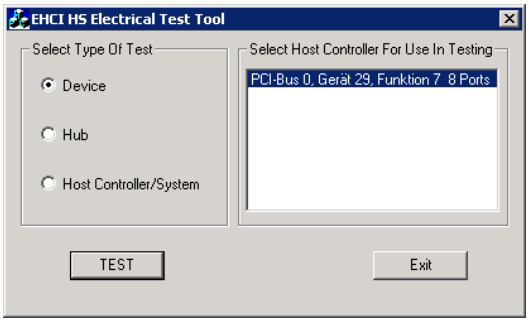


Figure 4-2: USB-IF USB2.0 Hi-Speed Signal Quality device test fixture: connection to DUT

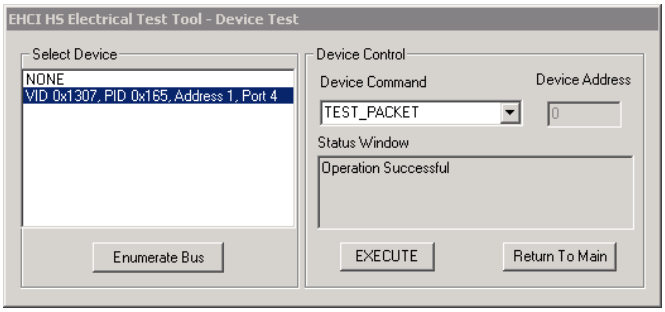
If the DUT has a type A connector attached, plug it into the test fixture directly. Otherwise, connect the DUT to the test fixture using a 4-inch cable.
Use a 1-meter non-captive cable to connect the test bed computer to the test fixture.

Note: Make sure the "Device Type" setting in the "Test Configuration" is enabled correctly according to compliance.usb.org/index.asp?UpdateFile=Electrical#8 (see Chapter 3.2, "Configuring the test", on page 19).

3. Click "Next".
4. Start the HS Electrical Test Tool on the test bed computer.
5. Select "Device" on the left side, and the host controller to which the DUT is connected on the right side.
   Note: the values in the list may vary.



6. Click "TEST".
7. Select "TEST_PACKET" from the "Device Command" list.



8. Click "EXECUTE" and wait until "Operation Successful" is shown under "Status Window".
9. On the test fixture, switch to "Test" position as shown in the picture.

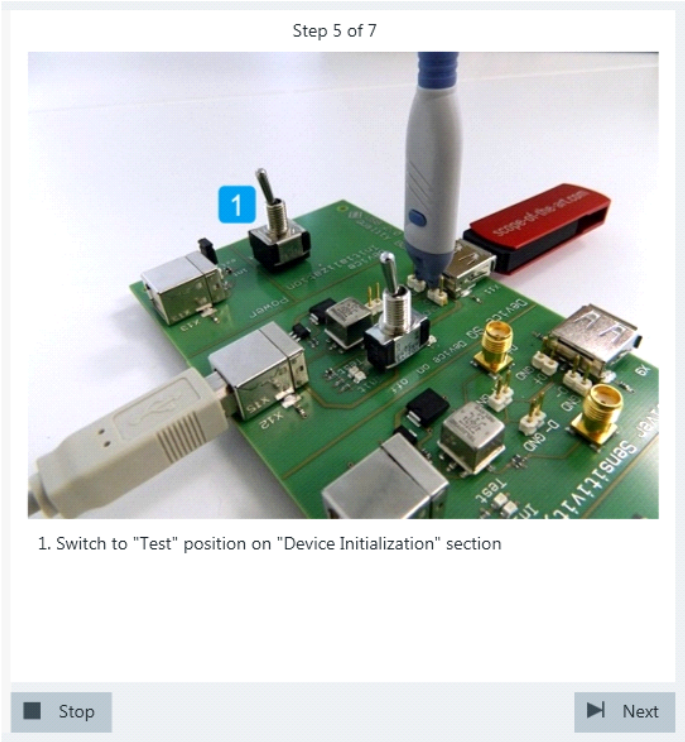


Figure 4-3: R&S RT-ZF1: "Test" position

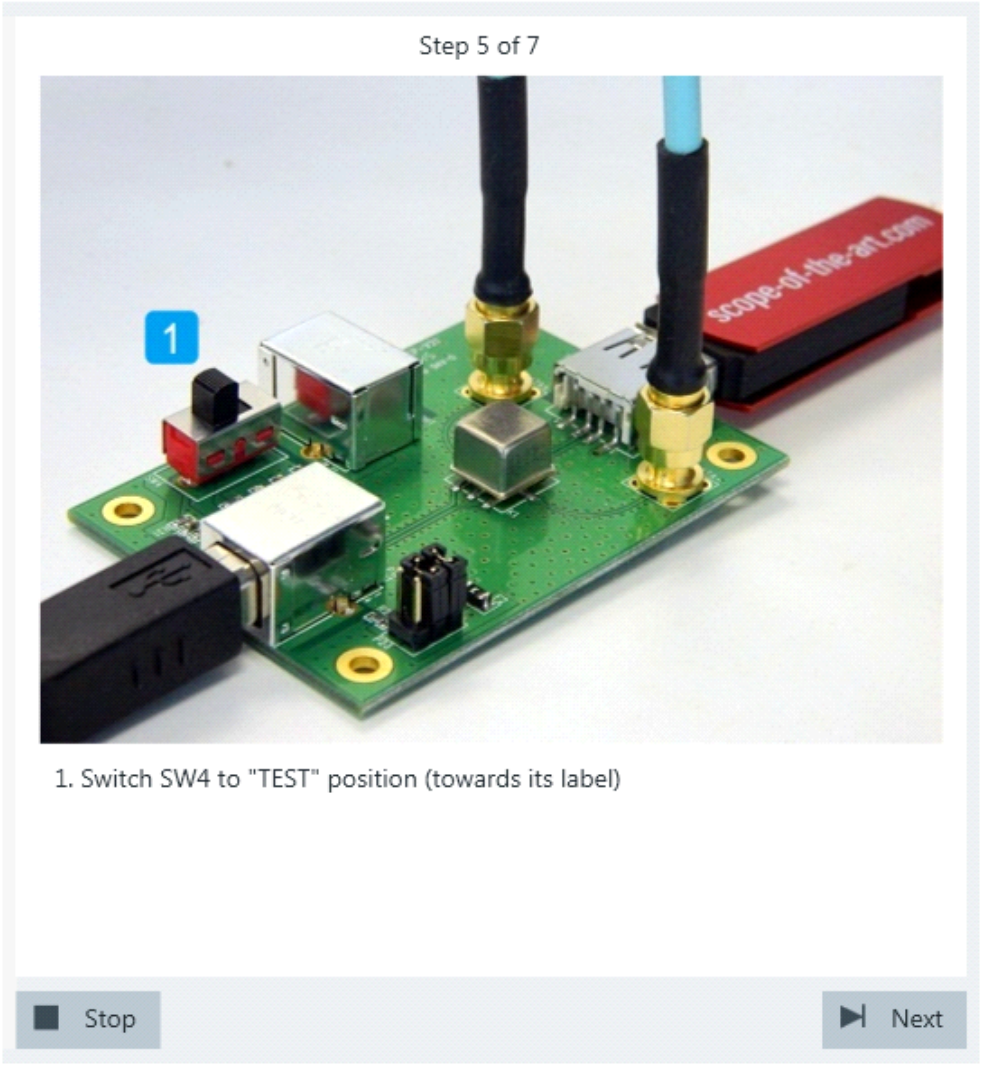
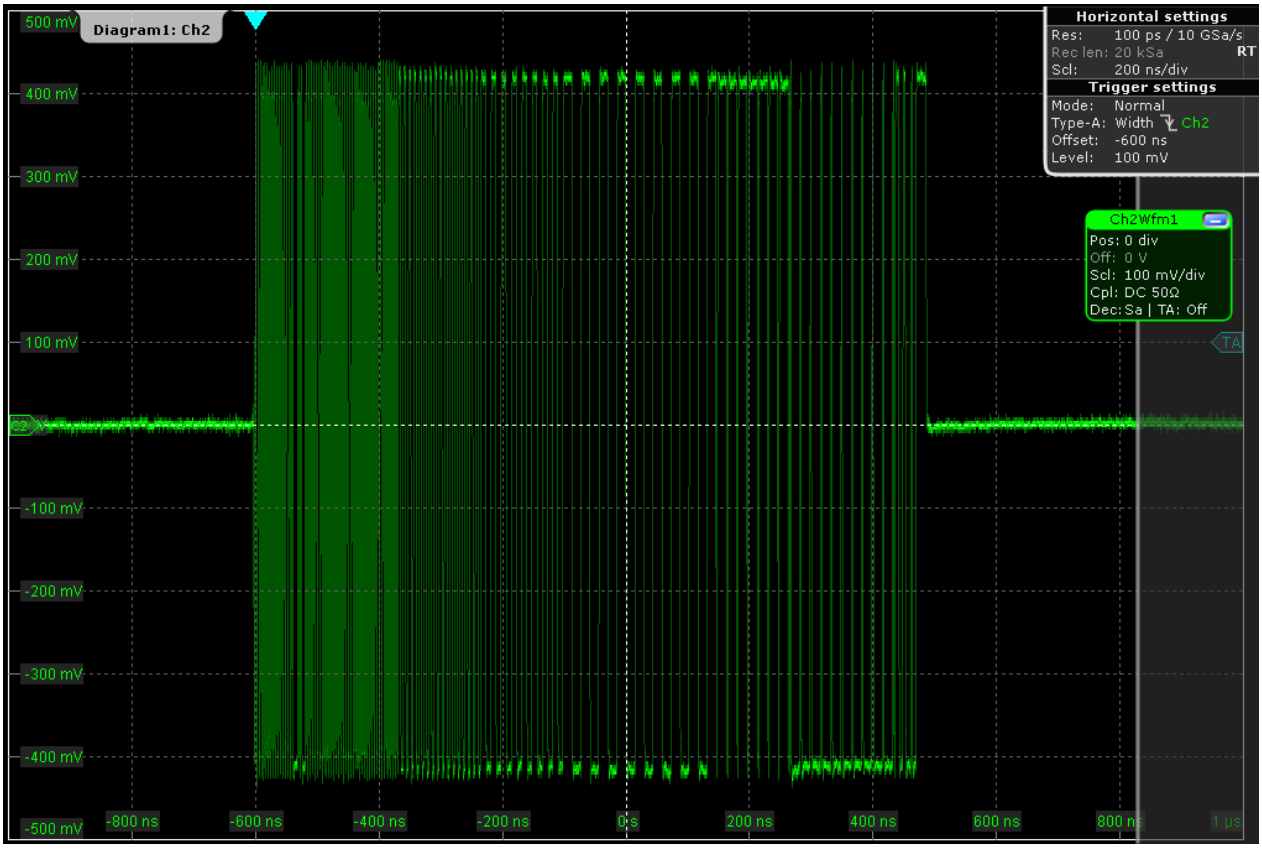


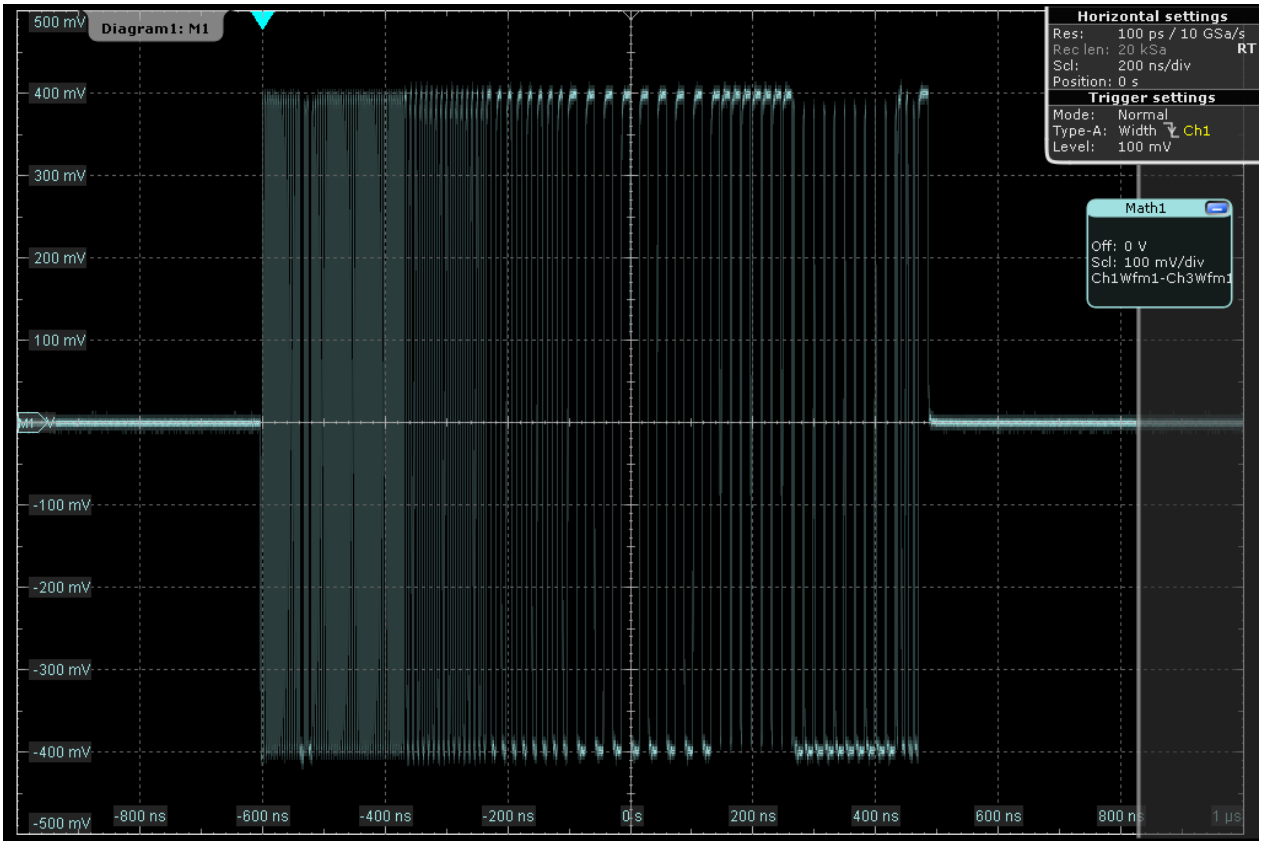
Figure 4-4: USB-IF USB 2.0 hi-speed signal quality device test fixture: "Test" position

10. Click Next.

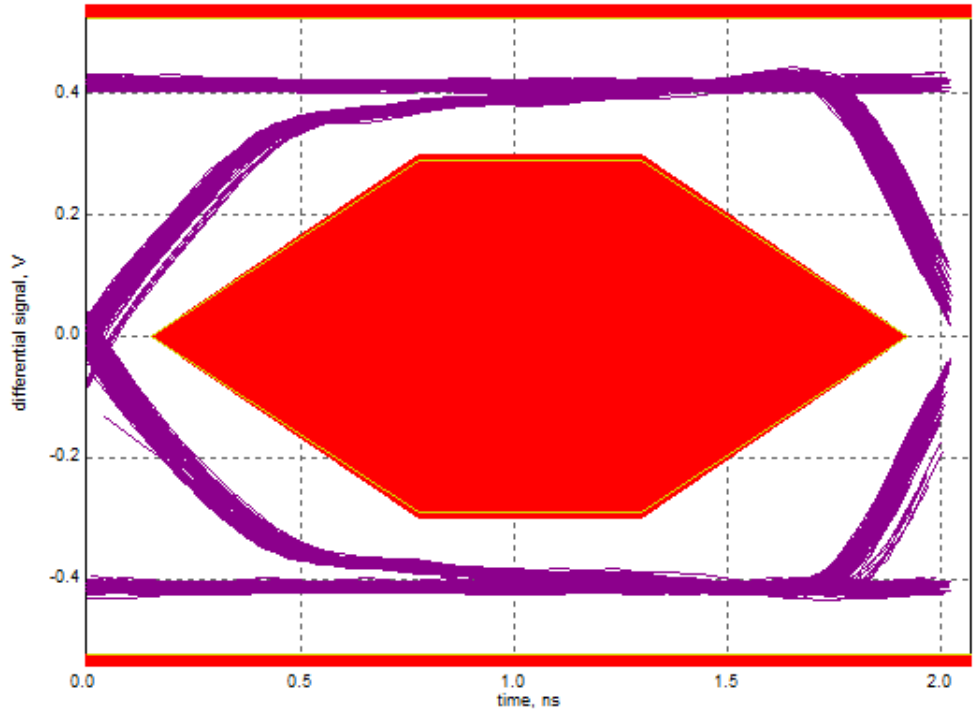
    The DUT sends test packets that look like this:



If USB-IF USB2.0 Hi-Speed Signal Quality device test fixture is used, the application uses the built-in math function to create the differential signal of D+ and D-. The waveform will look like this:



11. These packages are analyzed in an eye diagram.



The results are saved and can be viewed in the report.

4.1.1.2 Packet parameters

Table 4-2: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the device you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Differential probe	at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

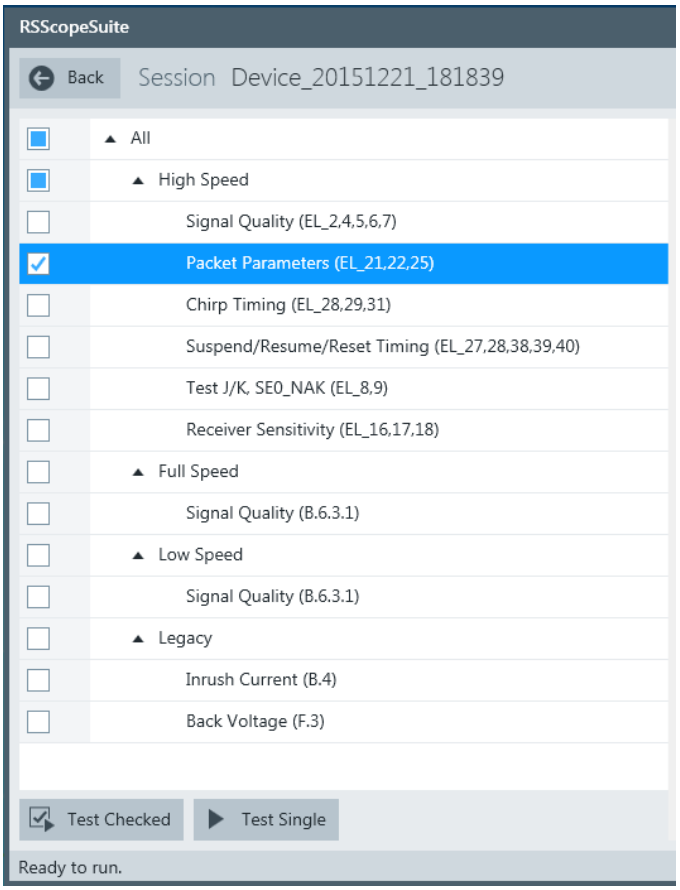
Test preparation

Before you run the test, complete the following actions:

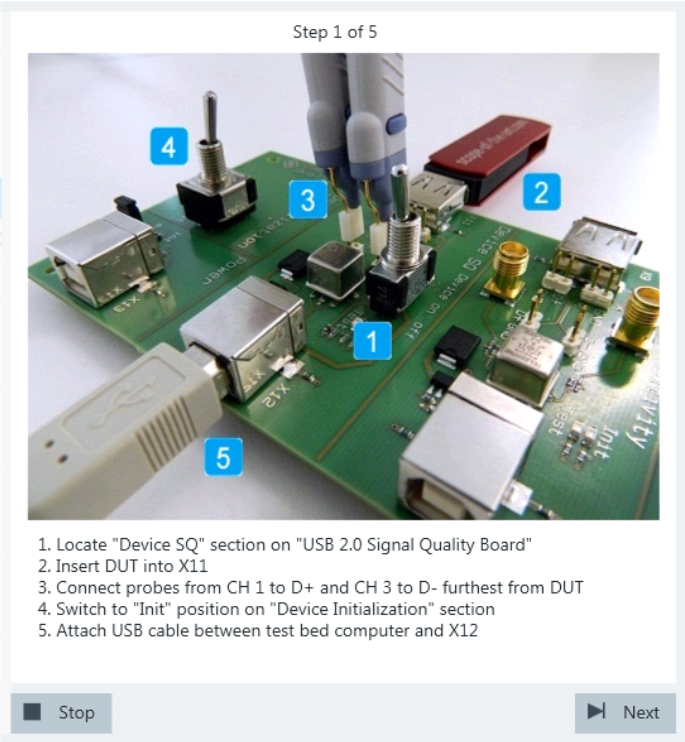
- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Device"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Packet Parameters (EL_21,22,25)" test case and click "Test Single".

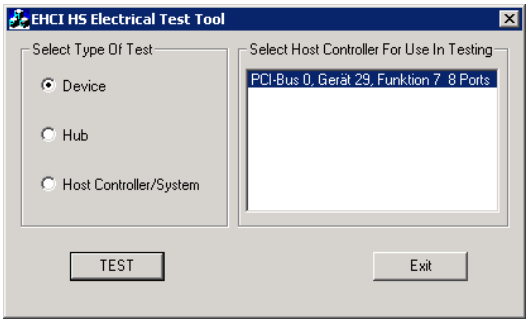


2. Connect the DUT to the test fixture as shown in the picture.

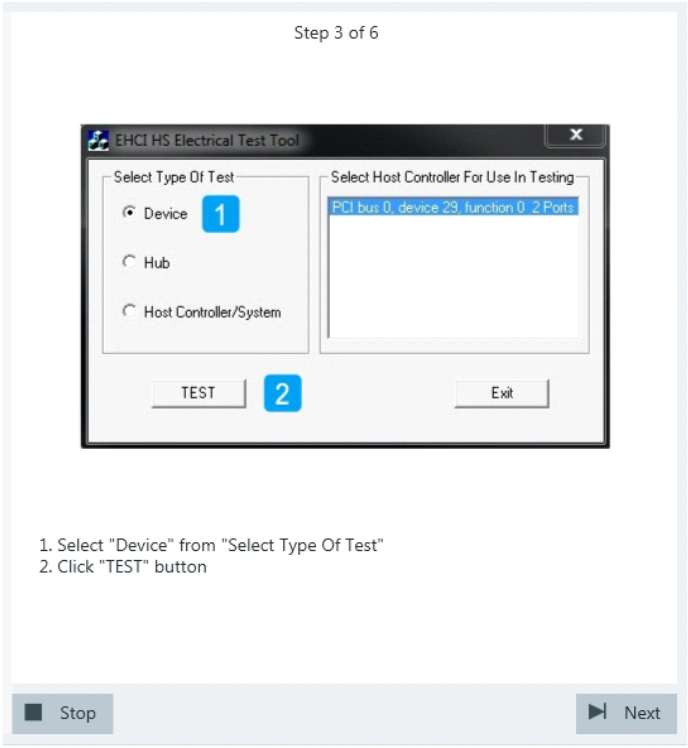


If the DUT has a type A connector attached, plug it into the test fixture directly. Otherwise, connect the DUT to the test fixture using a 4-inch cable.
Use a 1-meter non-captive cable to connect the test bed computer to the test fixture.

3. Click "Next".
4. Start the HS Electrical Test Tool on the test bed computer.
5. Select "Device" on the left side, and the host controller to which the DUT is connected on the right side.
   Note: the values in the list may vary.

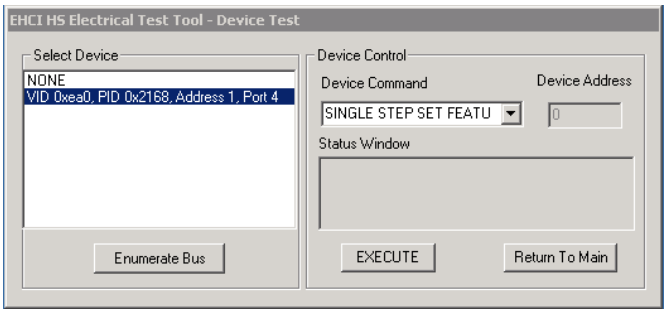


6. Click "TEST".
7. Click "Next" in the R&S ScopeSuite.



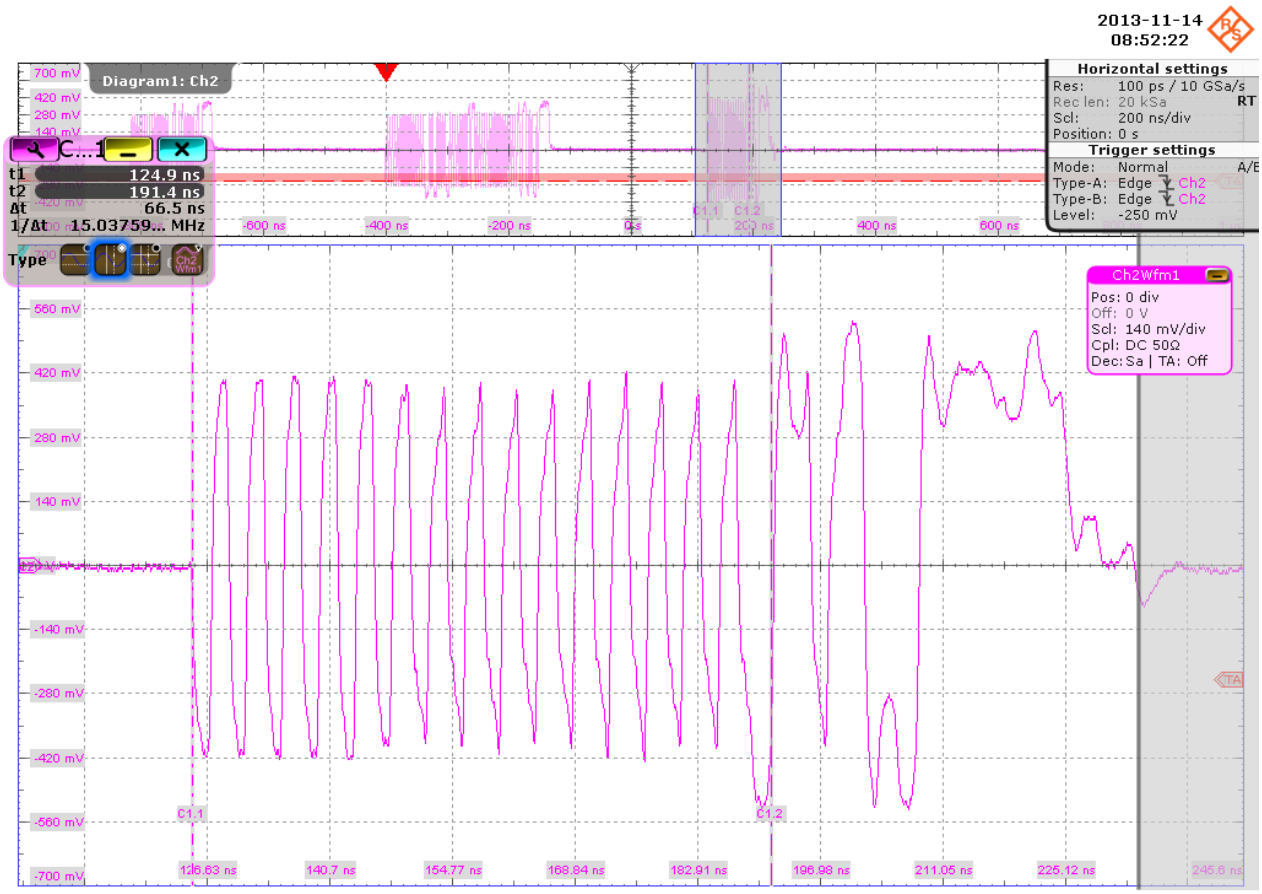
The RTO is set to trigger on the packets sent between host (Set_Feature Packet) and device.

8. Select "SINGLE STEP SET FEATURE" on the "Device Command" list.

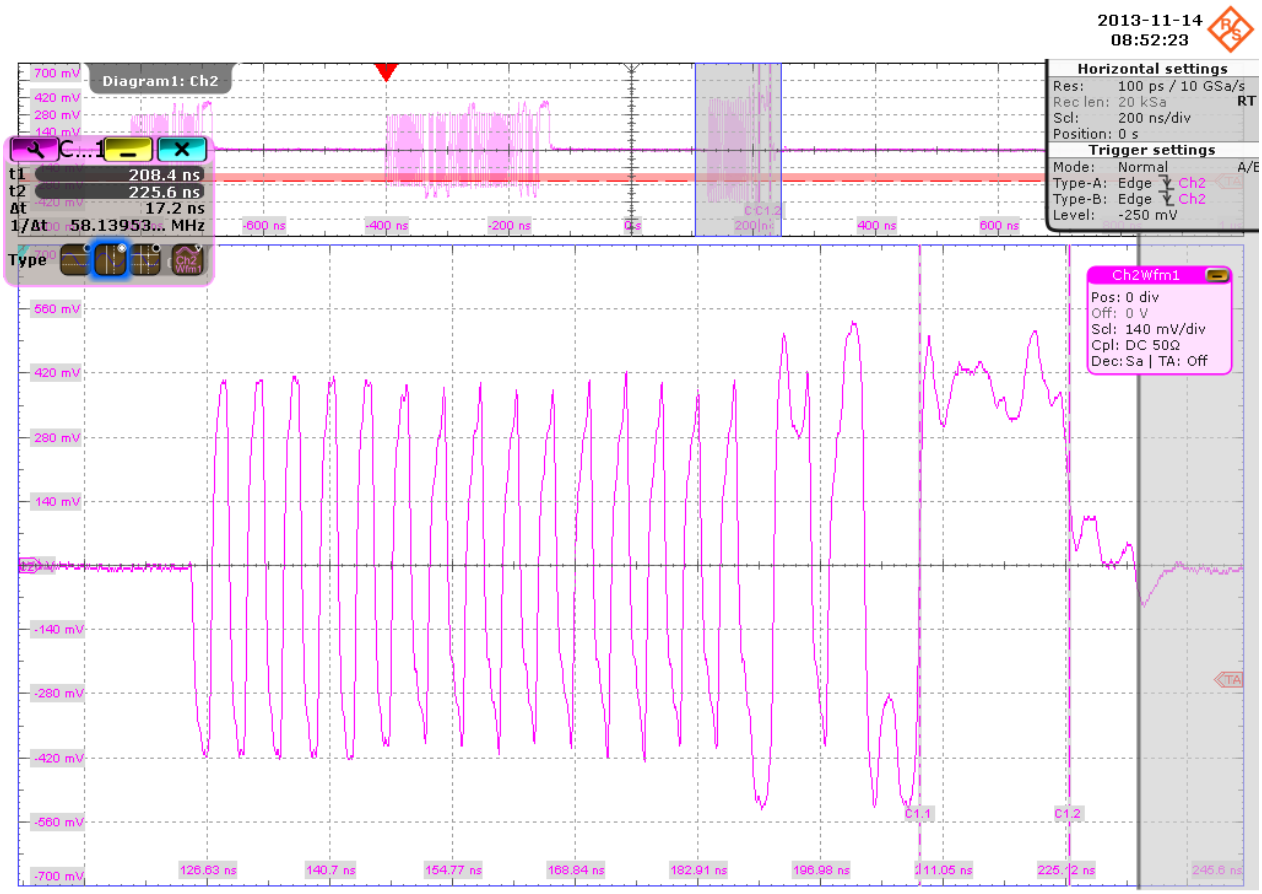


9. Click "EXECUTE" and wait for its change to "Step".

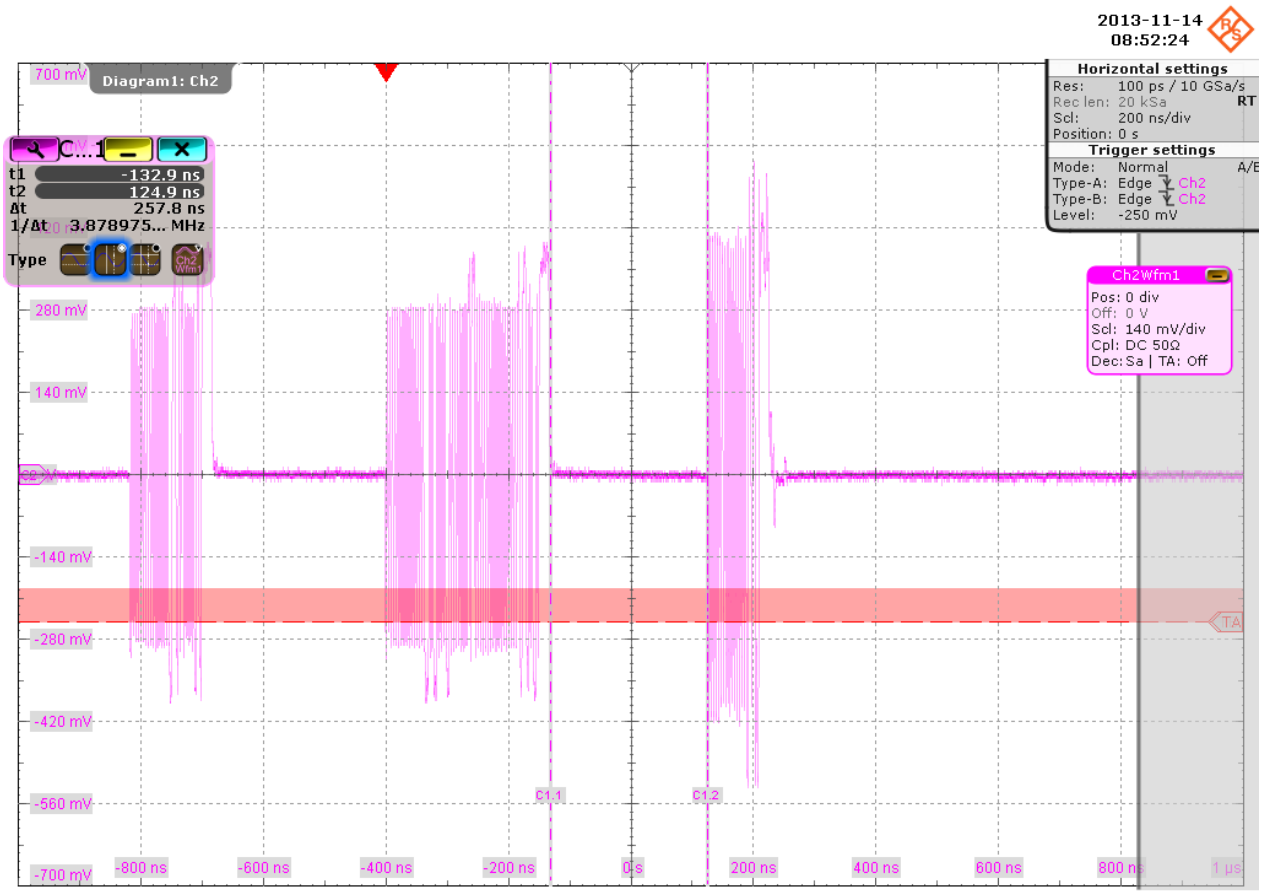
   A waveform is captured as pictured below.



The first packet on the left is an "IN" packet sent by the test bed computer. It is followed by a "Set Feature" packet (middle) also sent from the test bed computer. On the right you can see the answer from the DUT with higher amplitude than the packets from the test bed computer.
The application counts the number of bits in the DUT packet SYNC field by measuring the duration of the first 31 pulses. This is EL_21.

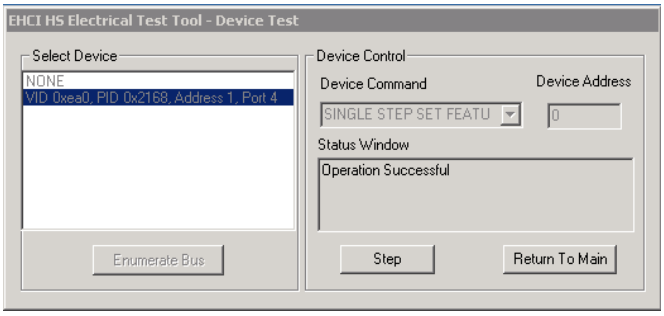


The application counts the number of bits in the DUT packet EOP field by measuring the duration of the widest pulse. This is EL_25.

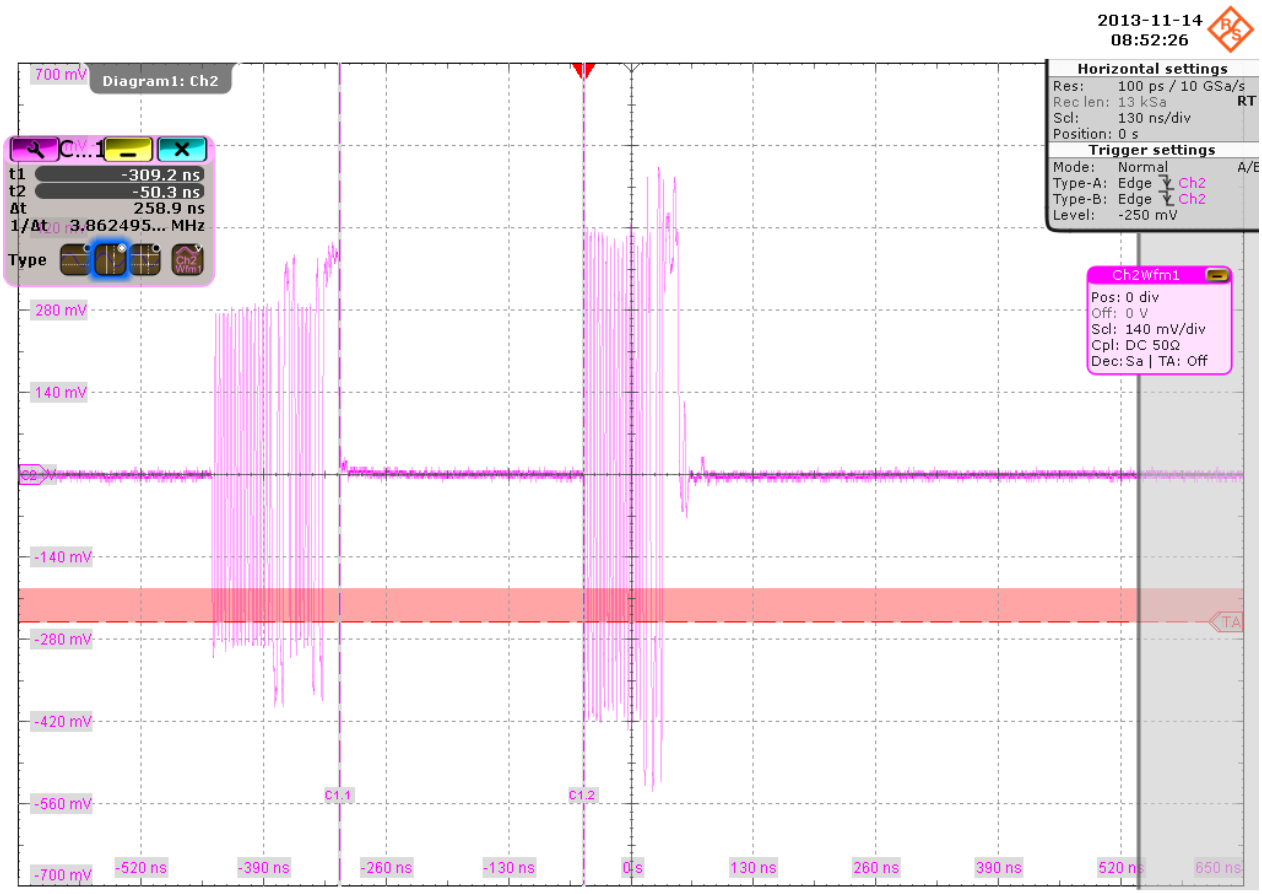


The application measures the time between the “Set Feature” packet and DUT packet. This is EL_22.

10. Click "Step" and wait until "Operation Successful" is shown under "Status Window".



A waveform is captured as pictured below.



The first packet (left) is an "IN Packet" sent by the host. The second packet with higher amplitude is the answer from the device. The application measures the time between the two packets. This is EL_22.

The results are saved and can be viewed in the report.

4.1.1.3 Chirp timing

Table 4-3: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the device you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

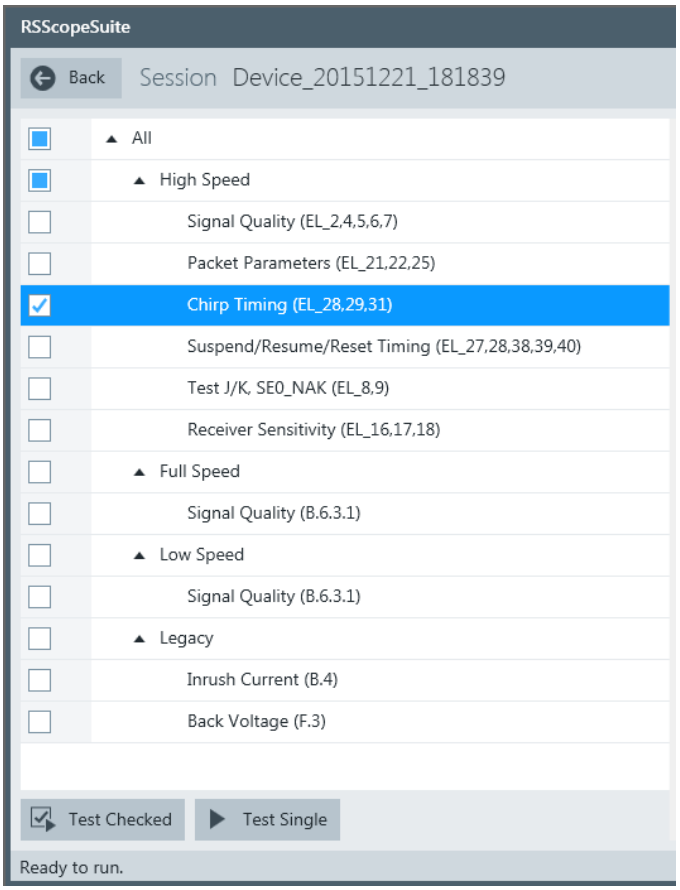
Test preparation

Before you run the test, complete the following actions:

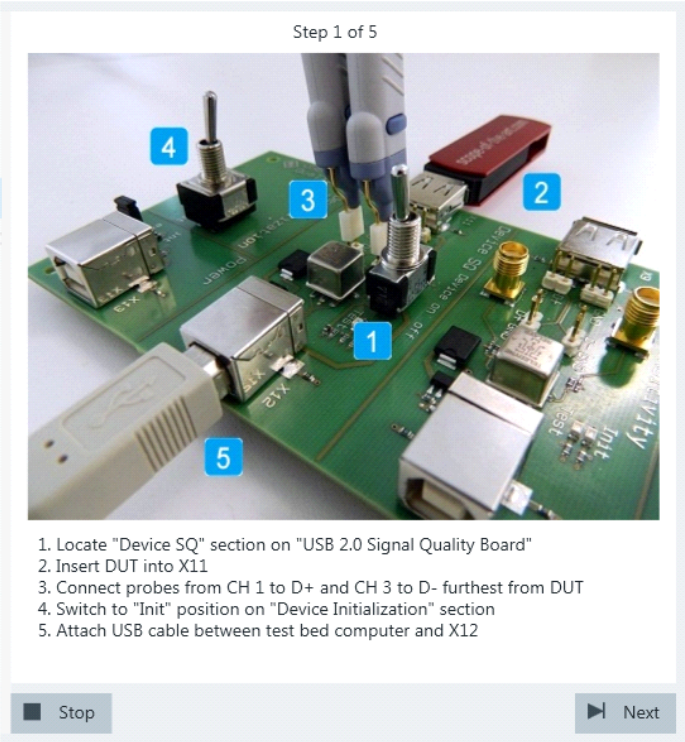
- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Device"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Chirp Timing (EL_28,29,31)" test case and click "Test Single".

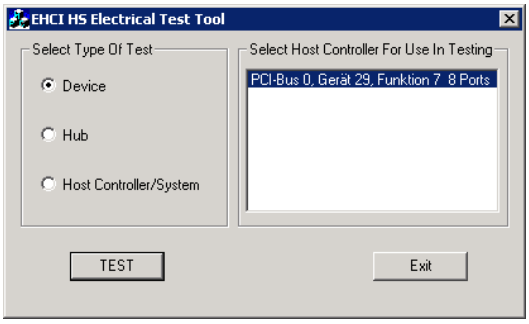


2. Connect the DUT to the test fixture as shown in the picture.

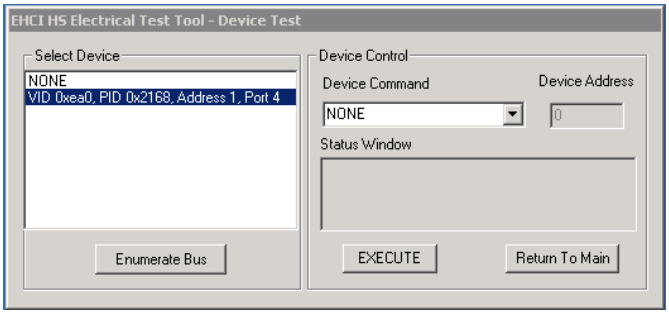


If the DUT has a type A connector attached, plug it into the test fixture directly. Otherwise, connect the DUT to the test fixture using a 4-inch cable.
Use a 1-meter non-captive cable to connect the test bed computer to the test fixture.

3. Click "Next".
4. Start the HS Electrical Test Tool on the test bed computer.
5. Select "Device" on the left side, and the host controller to which the DUT is connected on the right side.
Note: the values in the list may vary.



6. Click "TEST".
7. Click "Enumerate Bus" in the HS Electrical Test Tool.



8. Click "Next" in the R&S ScopeSuite.

   The Figure 4-5 shows an overview over D+/D- when a host is negotiating high-speed with the device.

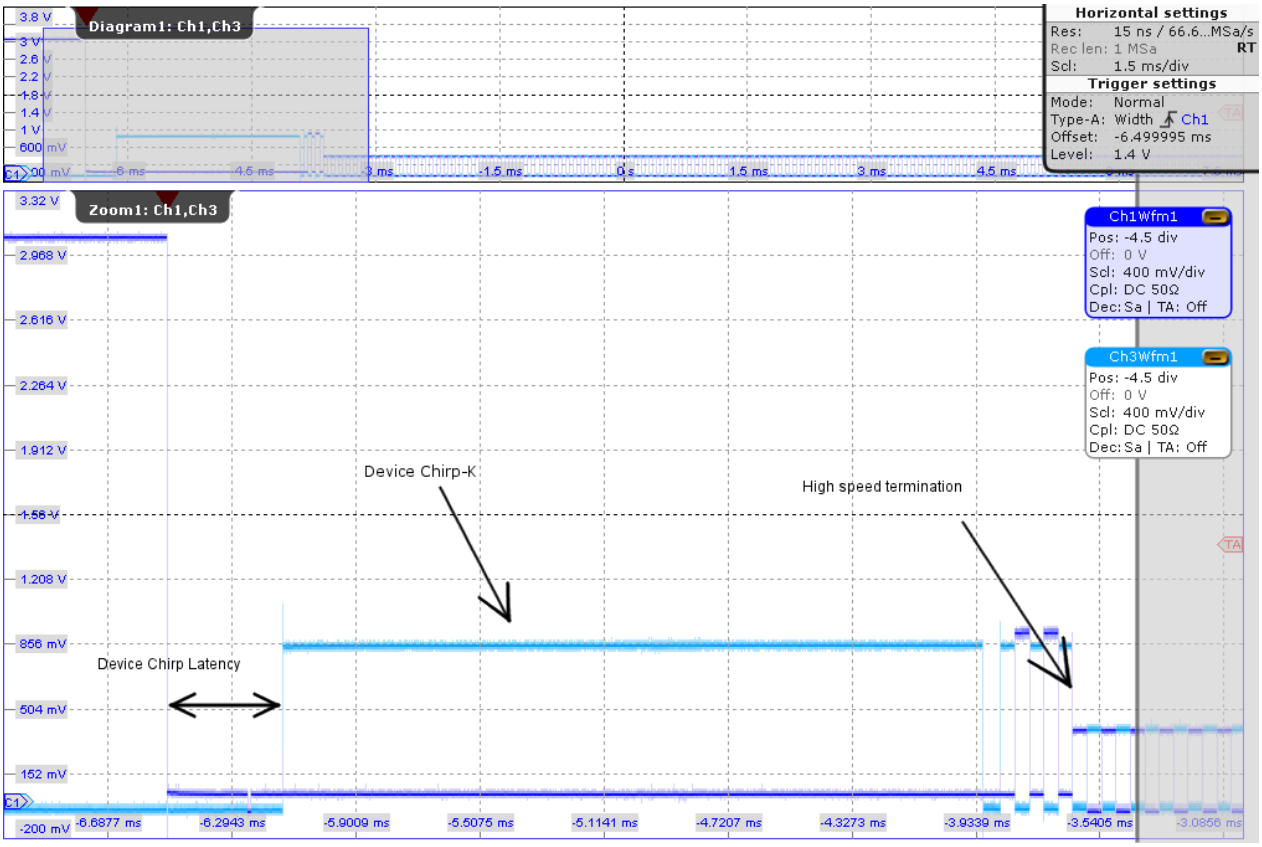


Figure 4-5: High-speed communication of host and device

To start a communication with a device, the host pulls down both data lines to low levels. Big drop of D+ (Ch1Wfm1) is shown on the right side. The device has now 2.5us seconds to respond with a rise of D-. We call this Chirp K Latency and the EL_28 measurement has to be in the range from 2.5us to 6ms. The host sees this Device Chirp-K (800mV on D-) and has to respond to it within 1ms and latest within 7ms. The answer is a series of K-J chirp pairs. The length of the Device Chirp-K time corresponds to the EL_29 measurement. After at least 3 K-J chirp pairs the device can assume that the host is high speed capable. When sure, the device applies the 45 Ohm terminations and by this pulls down the voltage of the chirps to 400mV. This drop can be seen in more detail in Figure 4-6. The time from the third Chirp till the drop has to be in the range from 0s to 500us. We store this measurement under EL_31 High Speed Termination After Chirp.

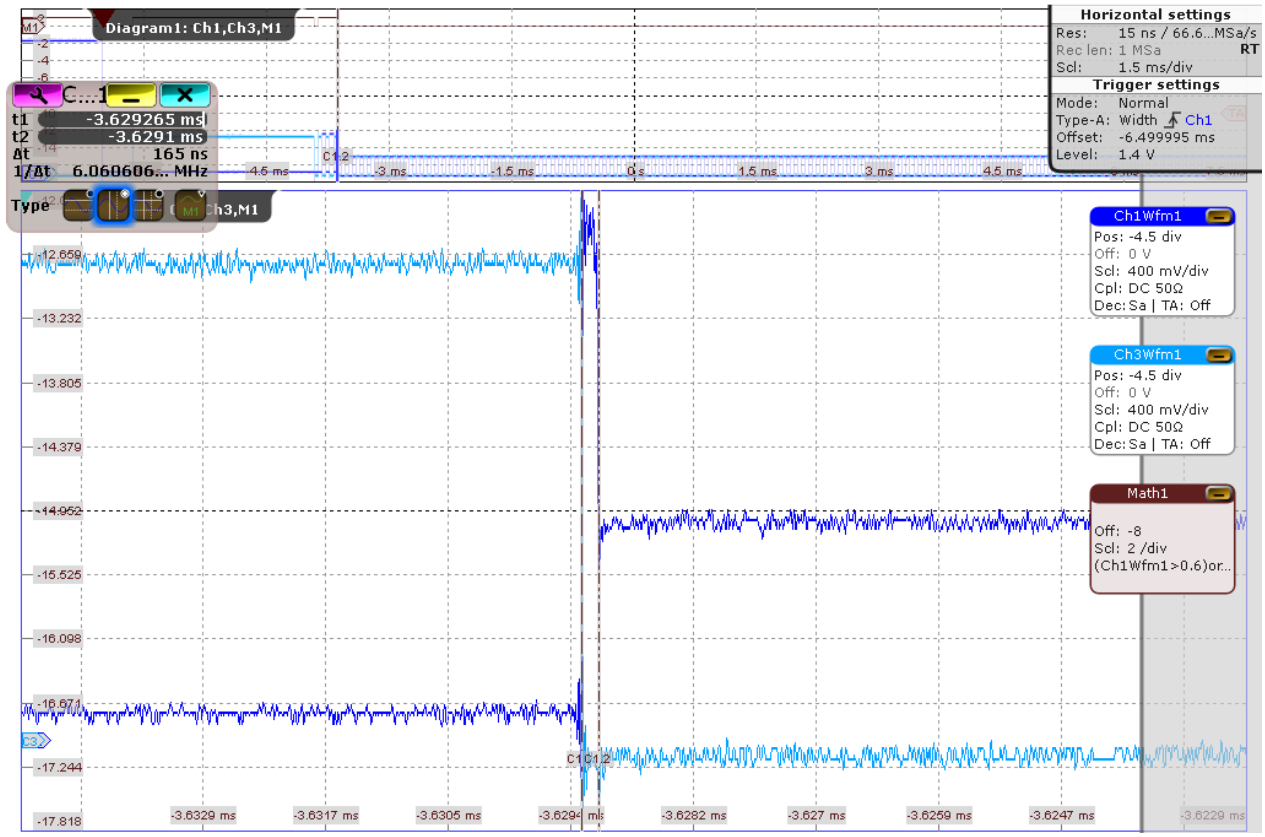


Figure 4-6: EL_31 chirp drop

The results are saved and can be viewed in the report.

4.1.1.4 Suspend/resume/reset timing

Table 4-4: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the device you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

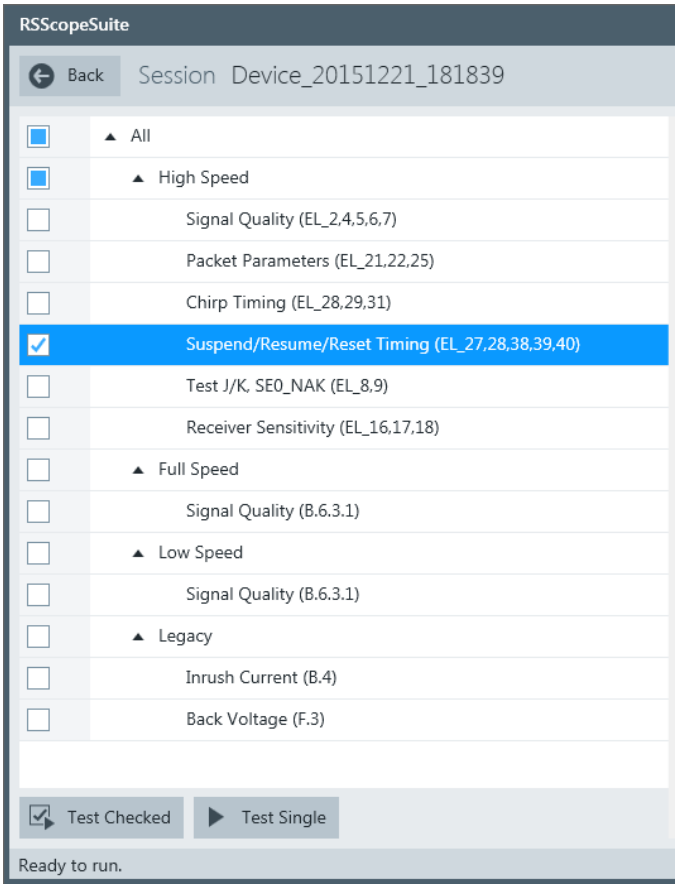
Test preparation

Before you run the test, complete the following actions:

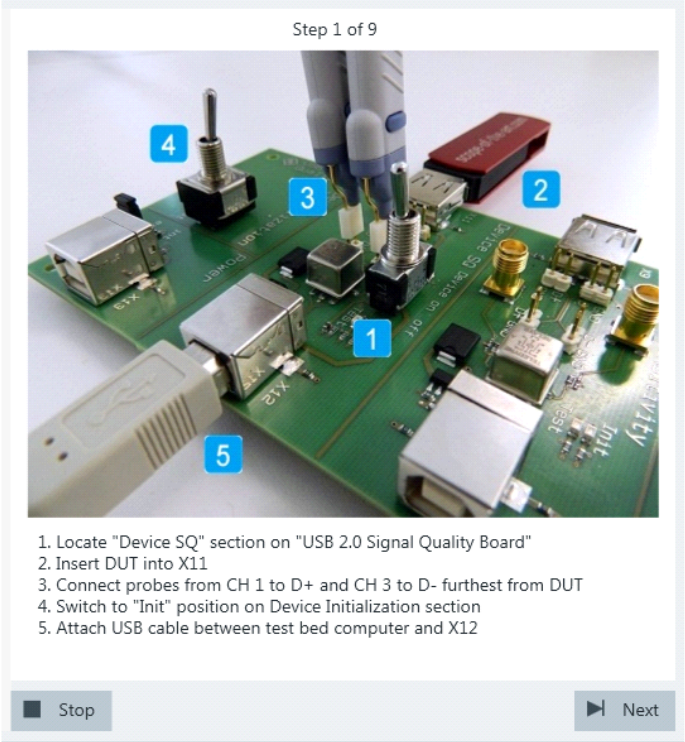
- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Device"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Suspend/Resume/Reset Timing (EL_27,28,38,39,40)" test case and click "Test Single".

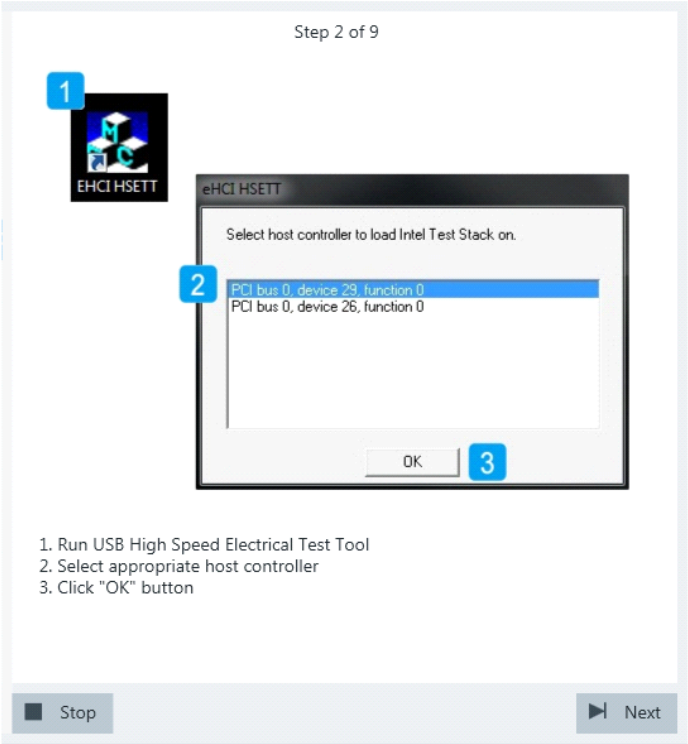


2. Connect the DUT to the test fixture as shown in the picture.

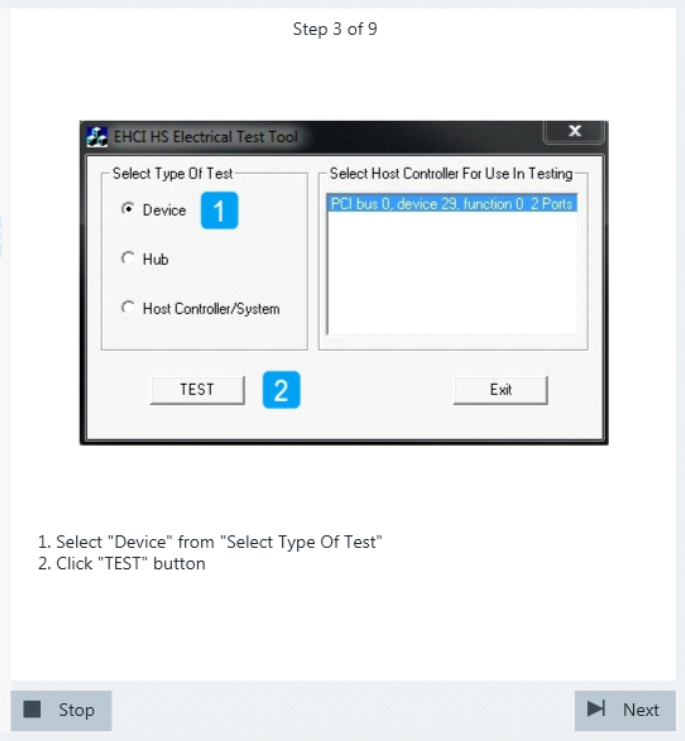


If the DUT has a type A connector attached, plug it into the test fixture directly. Otherwise, connect the DUT to the test fixture using a 4-inch cable.
Use a 1-meter non-captive cable to connect the test bed computer to the test fixture.

3. Click "Next".
4. Start the HS Electrical Test Tool on the test bed computer.
5. Select the host controller to which the DUT is connected and click OK.
   Note: the values in the list may vary.
   Click "Next" in the R&S ScopeSuite.

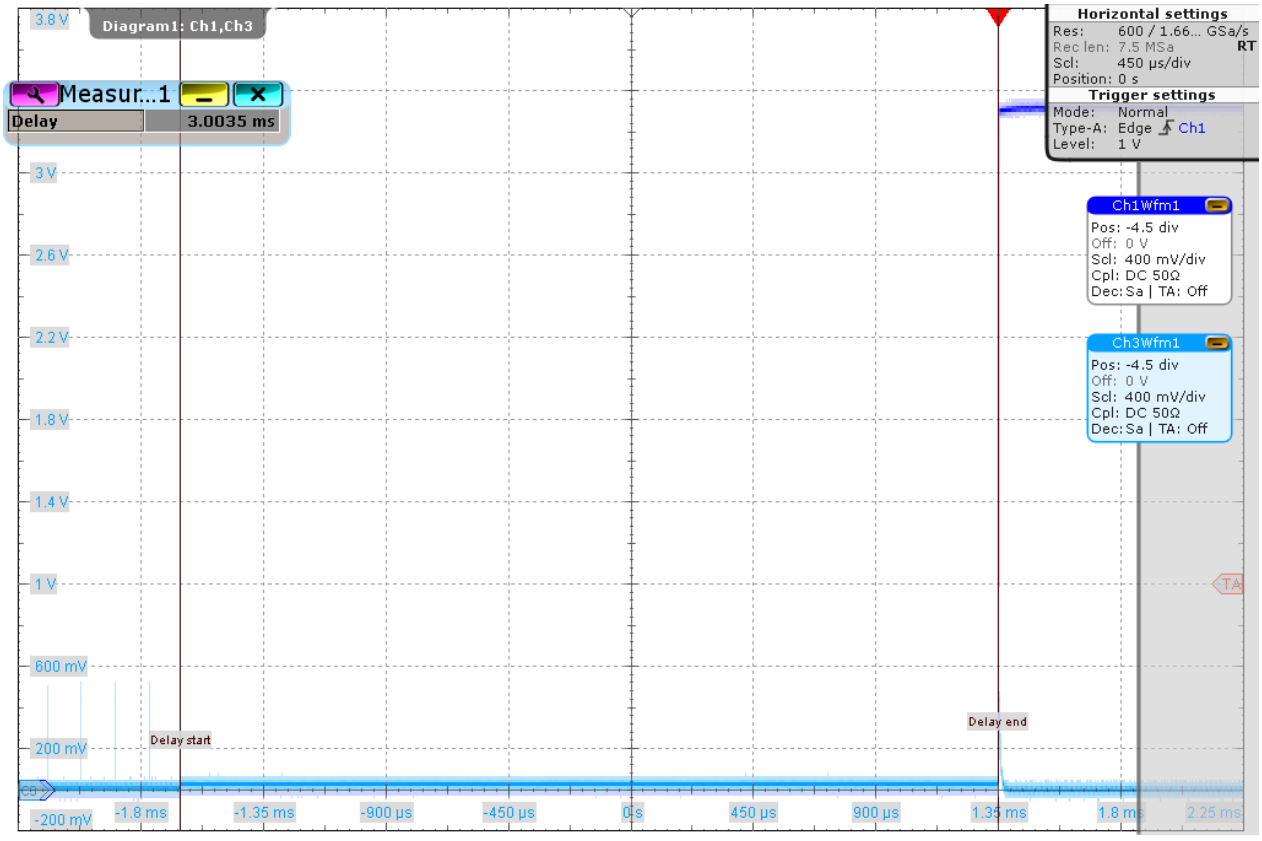


6. Select "Device" on the left side and click "TEST"

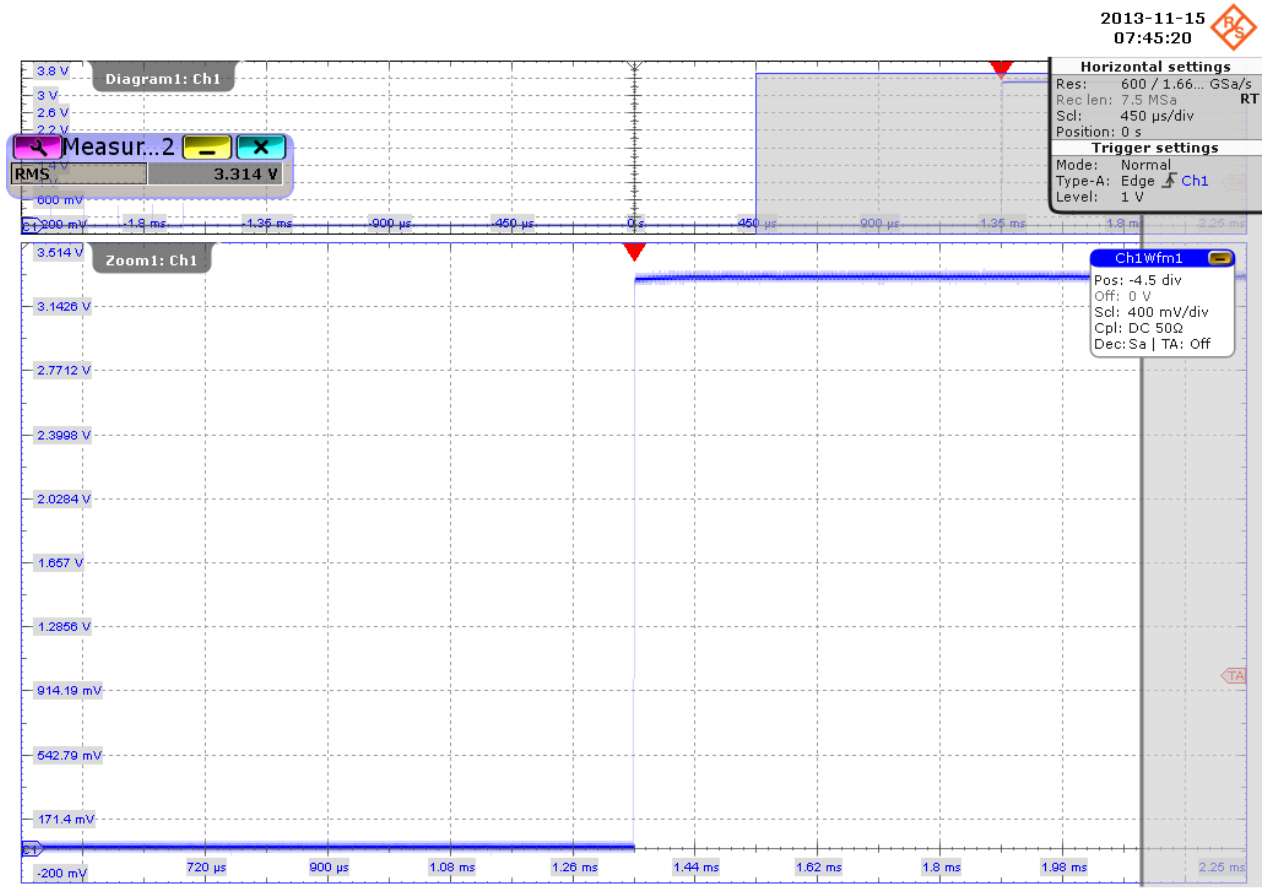


7. Configure the HS Electrical Test Tool as shown in the picture.

Waveforms are captured as pictured below.



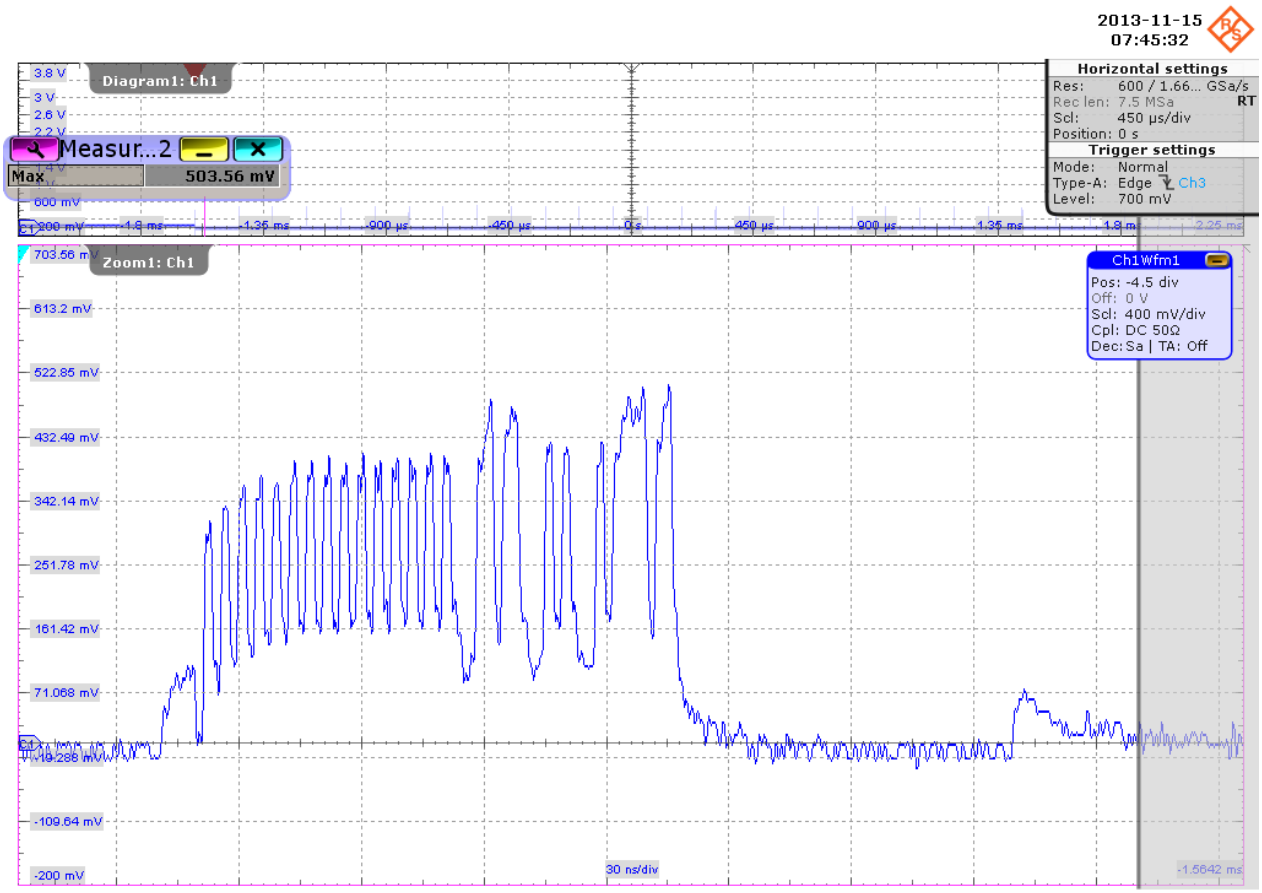
The application measures the time between the last falling edge of the last “Start of Frame” packet and the start of the suspended state. This is EL_38.

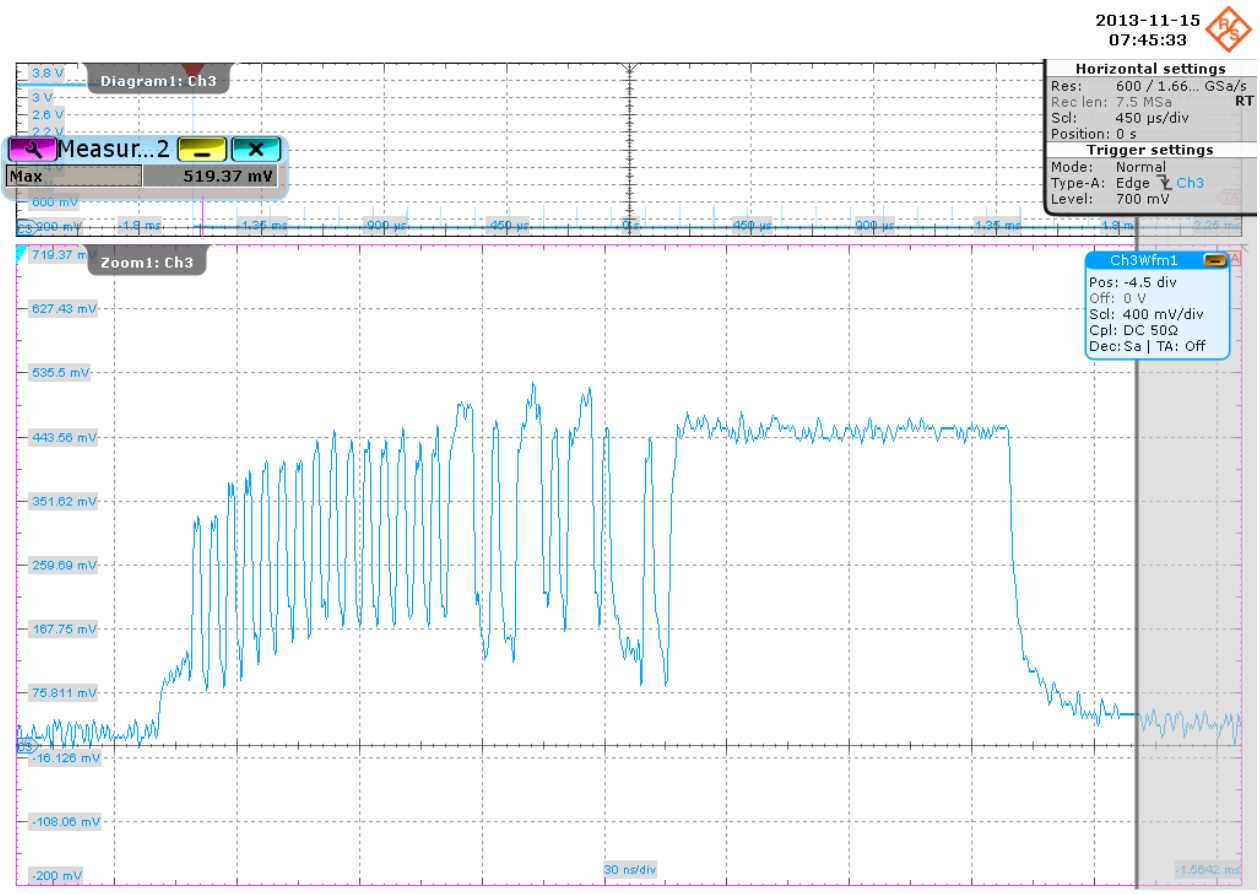


When entering the suspended state, DUT pulls D+ from ~0 V to ~3 V (as shown in the picture above) and D- remains in ~0 V. The application zooms into the suspended state and measures the voltage of D+/-. This is EL_39.

8. Proceed in the HS Electrical Test Tool as shown in the picture.

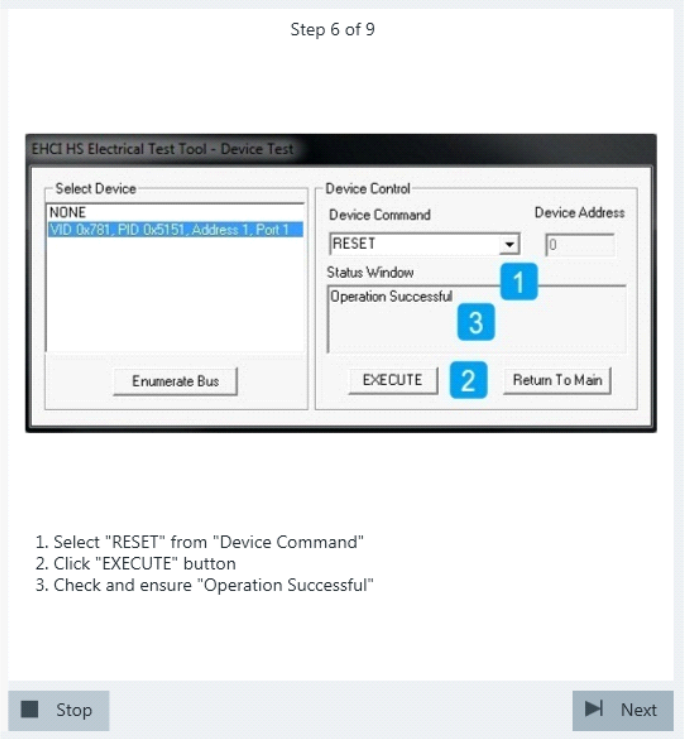
Waveforms are captured as pictured below.


2013-11-15
07:45:32
Horizontal settings
Res: 600 / 1.66... GSa/s
Rec len: 7.5 MSa
RT
Scl: 450 µs/div
Position: 0 s
Trigger settings
Mode: Normal
Type-A: Edge Ch3
Level: 700 mV
Diagram1: Ch1
Measur...2
Max 503.56 mV
Zoom1: Ch1
Ch1Wfm1
Pos: -4.5 div
Off: 0 V
Scl: 400 mV/div
Cpl: DC 50Ω
Dec: Sa | TA: Off
703.56 mV
613.2 mV
522.85 mV
432.49 mV
342.14 mV
251.78 mV
161.42 mV
71.068 mV
-109.64 mV
-200 mV
30 ns/div

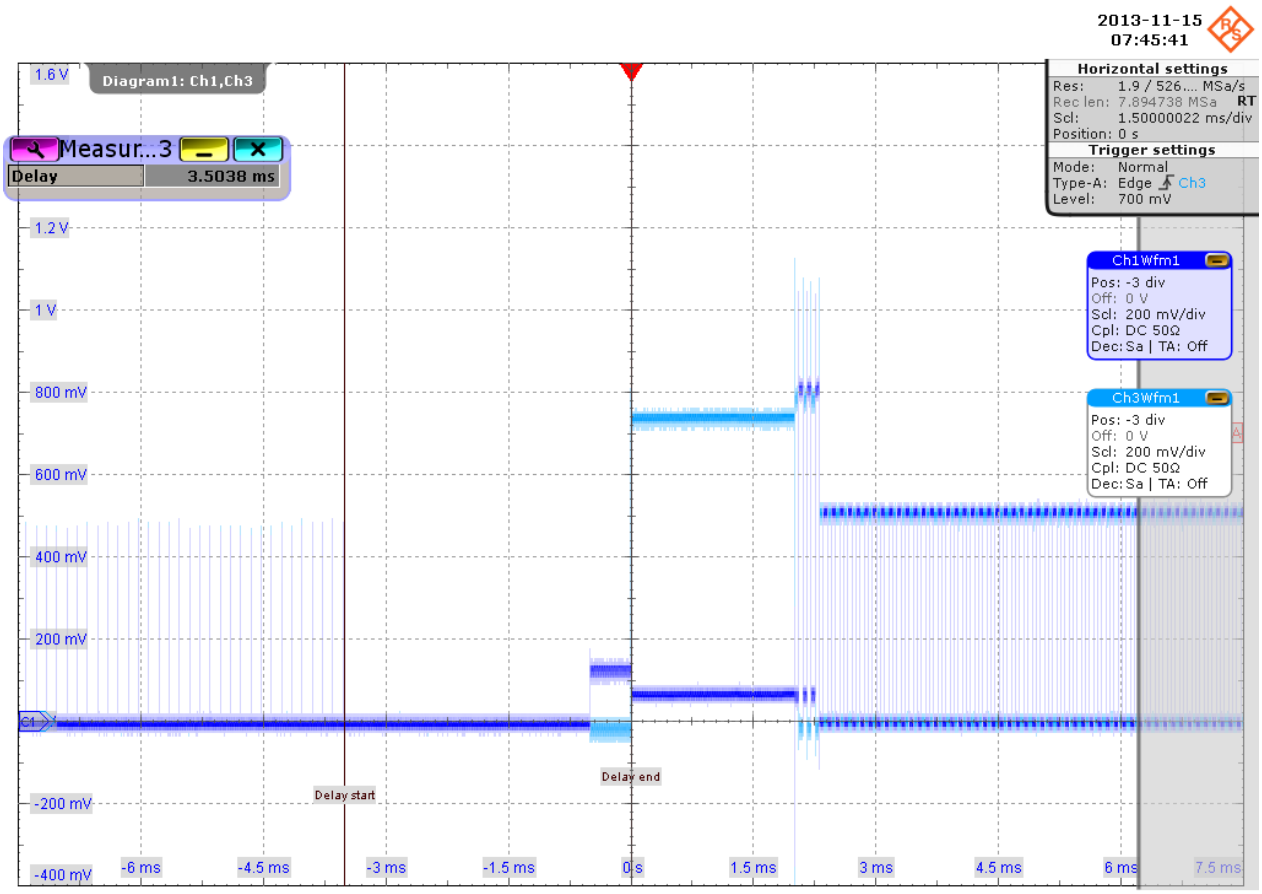


The application zooms into the first “Start of Frame” packet and measures the maximum voltage of D+ and D-. This is EL_40.

9. Proceed in the HS Electrical Test Tool as shown in the picture.



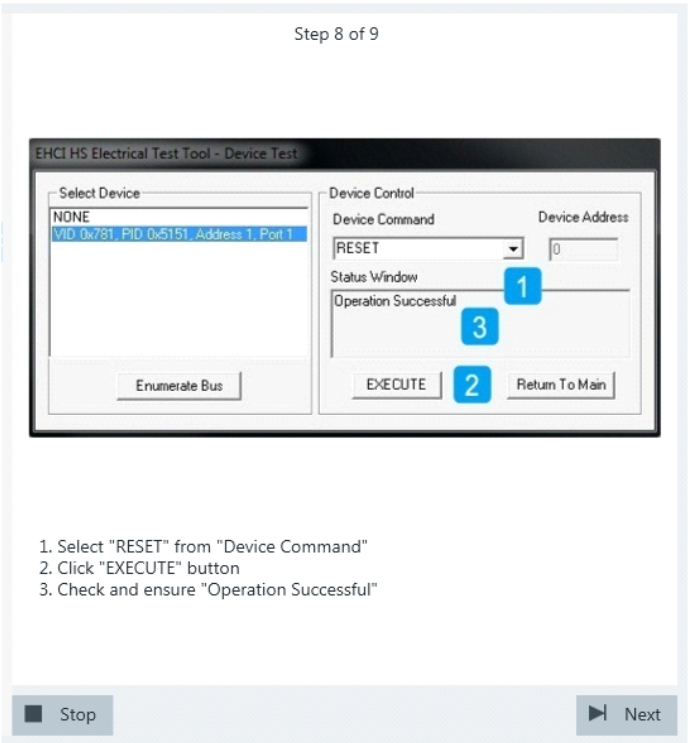
A waveform is captured as pictured below.



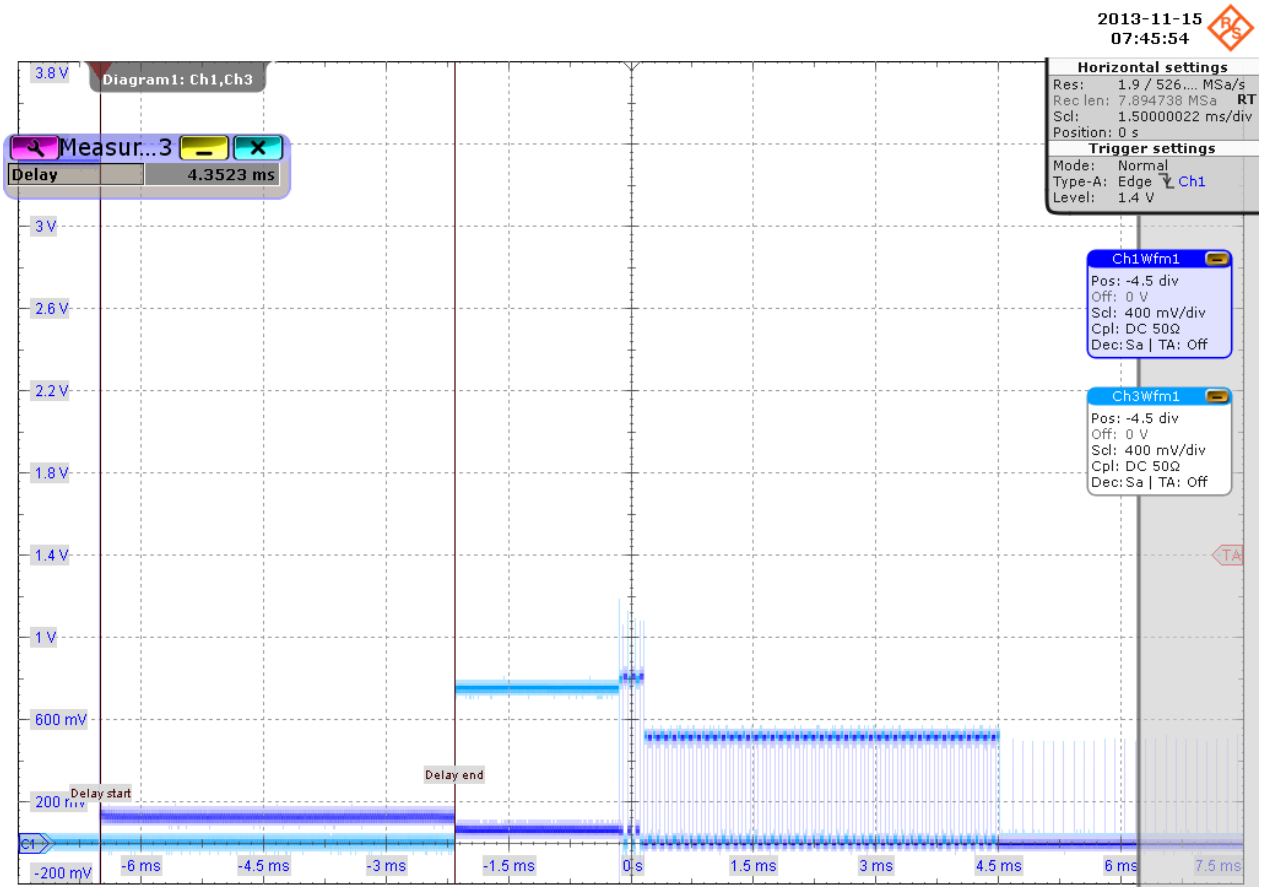
The application measures the time between the DUT reset from the non-suspended state (i.e., the last falling edge of the last “Start of Frame” packet) and the start of the chirp handshake (i.e., the assertion of Chirp K). This is EL_27.

10. Proceed in the HS Electrical Test Tool as shown in the picture.

11. Proceed in the HS Electrical Test Tool as shown in the picture.

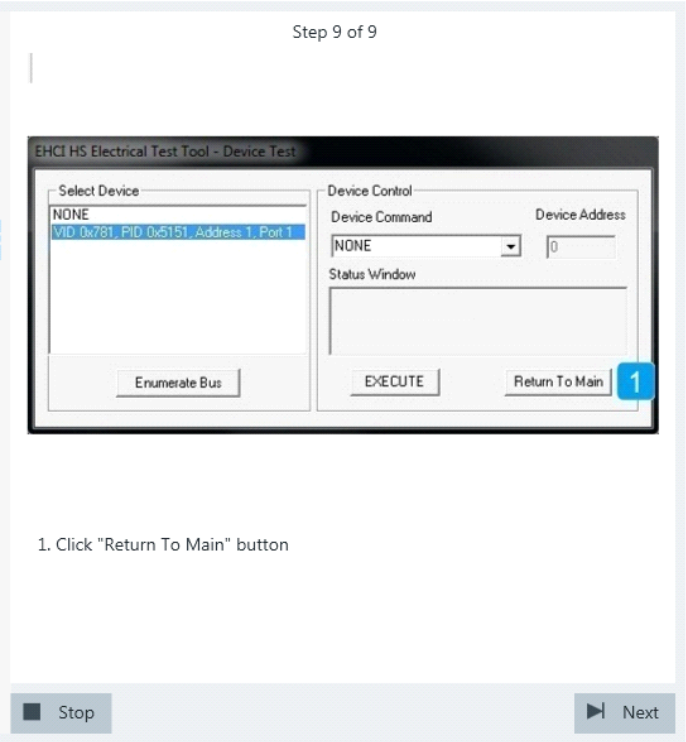


Waveforms are captured as pictured below.



The application measures the time between the DUT reset from the suspended state (i.e., D+ pulls from ~+3 V to ~0 V) and the start of the chirp handshake (i.e, the assertion of Chirp K). This is EL_28.

12. Finish the test as shown in the picture.



The results are saved and can be viewed in the report.

4.1.1.5 Test J/K, SE0_NAK

Table 4-5: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable 1.3 m	to connect computer and test fixture	1

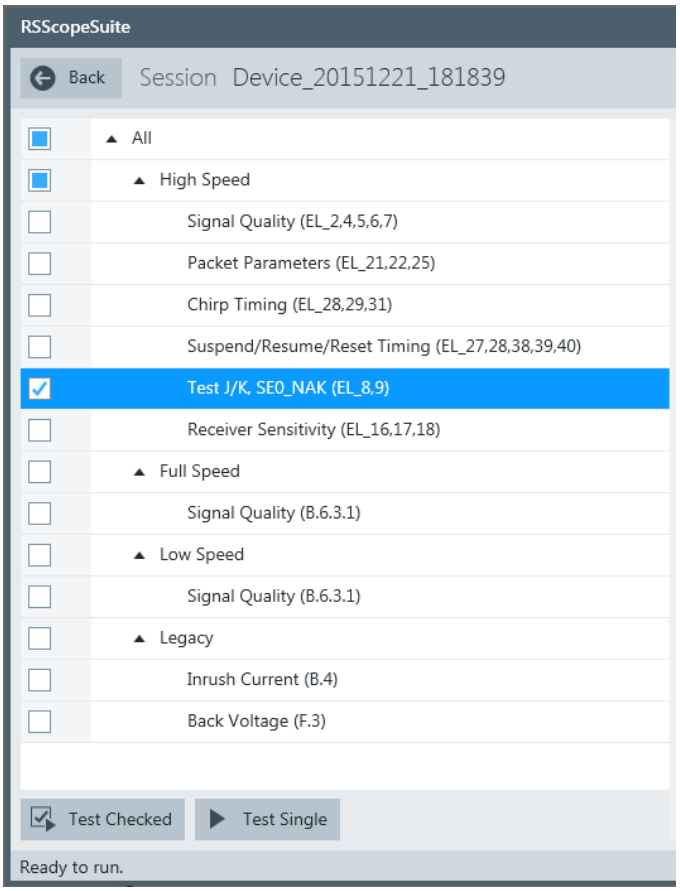
Test preparation

Before you run the test, complete the following actions:

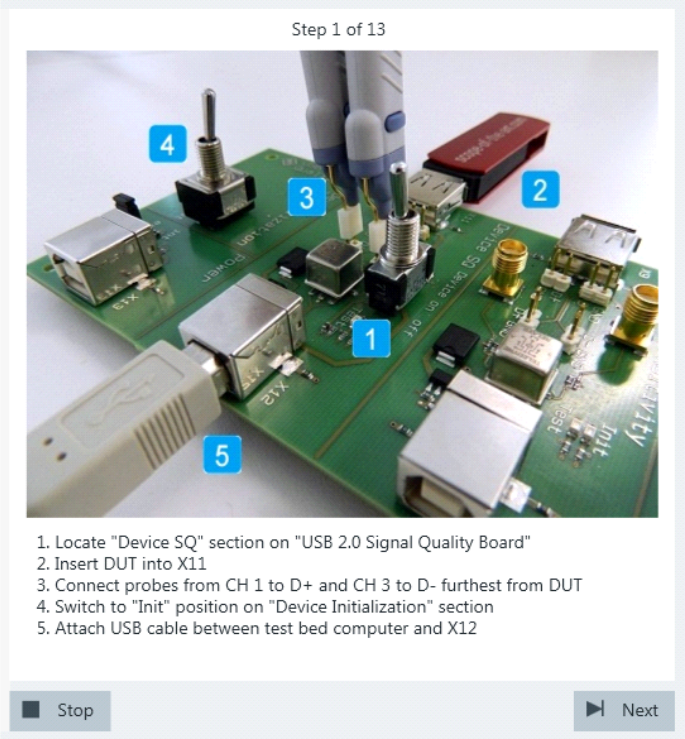
- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Device"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

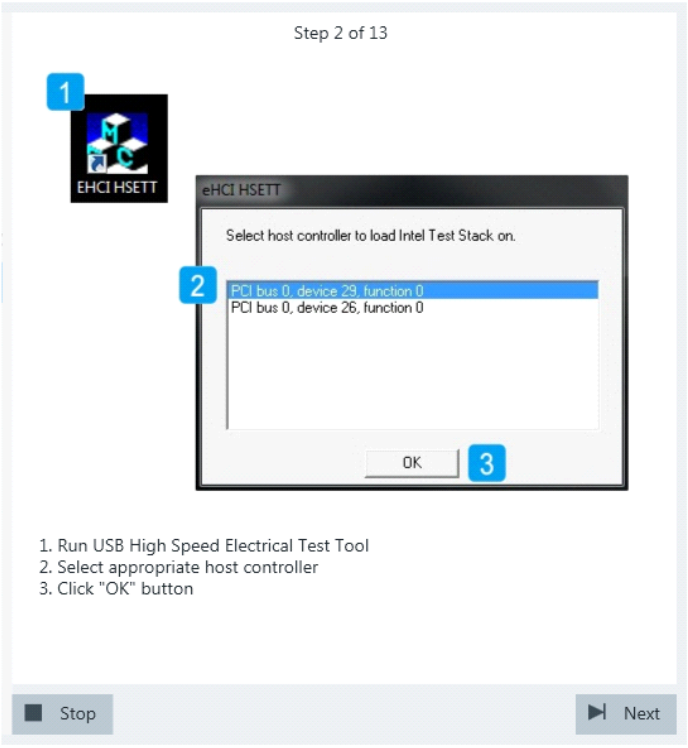
1. Select the "Test J/K, SE0_NAK" test case and click "Test Single".



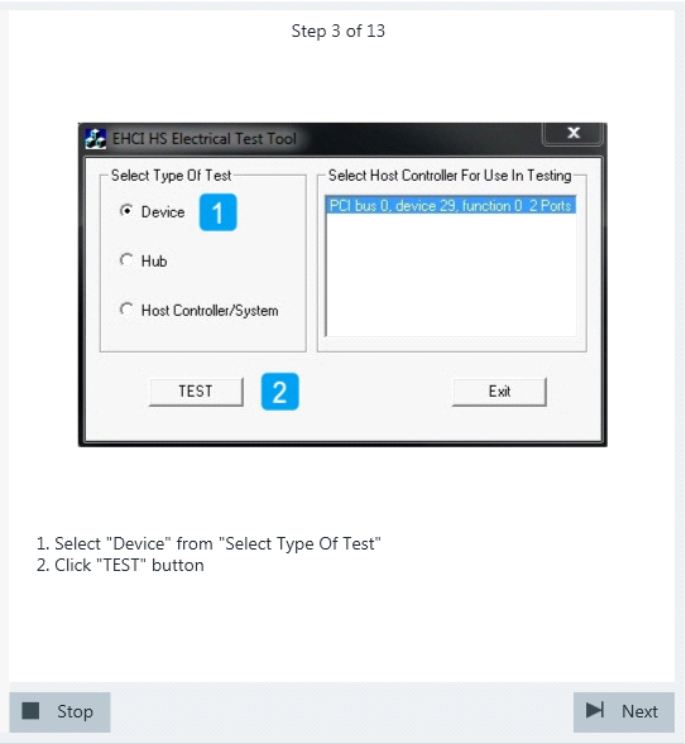
2. Connect the DUT to the test fixture as shown in the picture and click "Next".



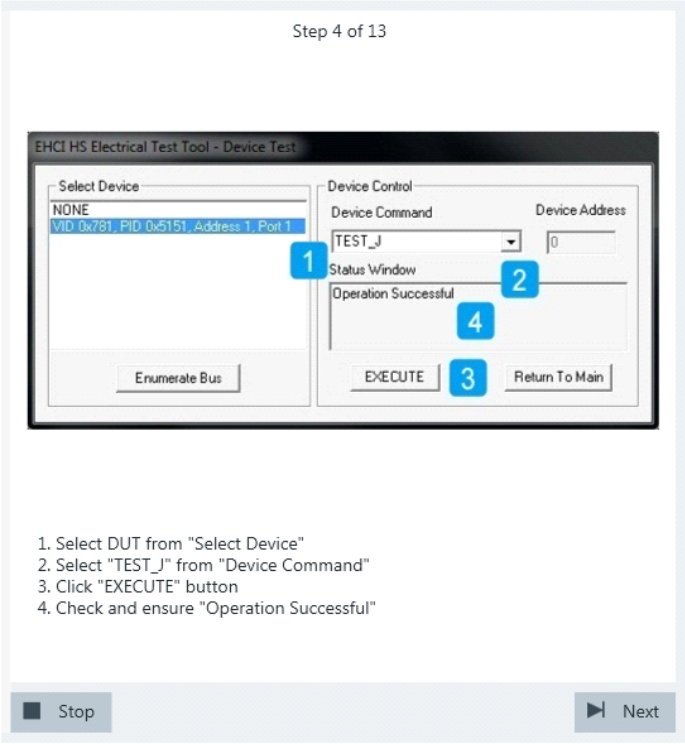
3. Start the HS Electrical Test Tool on the test bed computer.
4. Select the host controller to which the DUT is connected and click OK.
   Note: the values in the list may vary.
   Click "Next" in the R&S ScopeSuite.



5. Select "Device" on the left side and click "TEST"



6. Configure the HS Electrical Test Tool as shown in the picture.



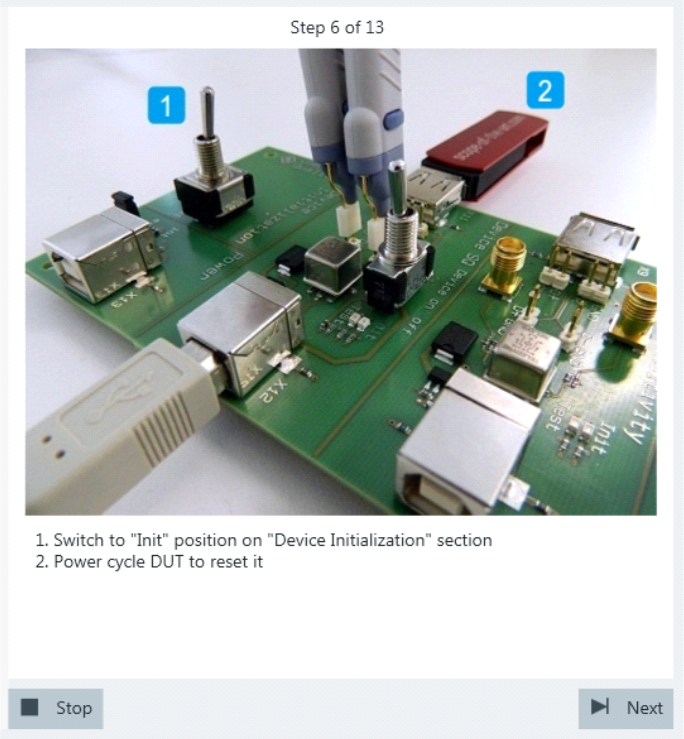
If the DUT has a type A connector attached, plug it into the test fixture directly. Otherwise, connect the DUT to the test fixture using a 4-inch cable.
Use a 1-meter non-captive cable to connect the test bed computer to the test fixture.

7. Switch the "Device Initialization" switch to "Test" position.

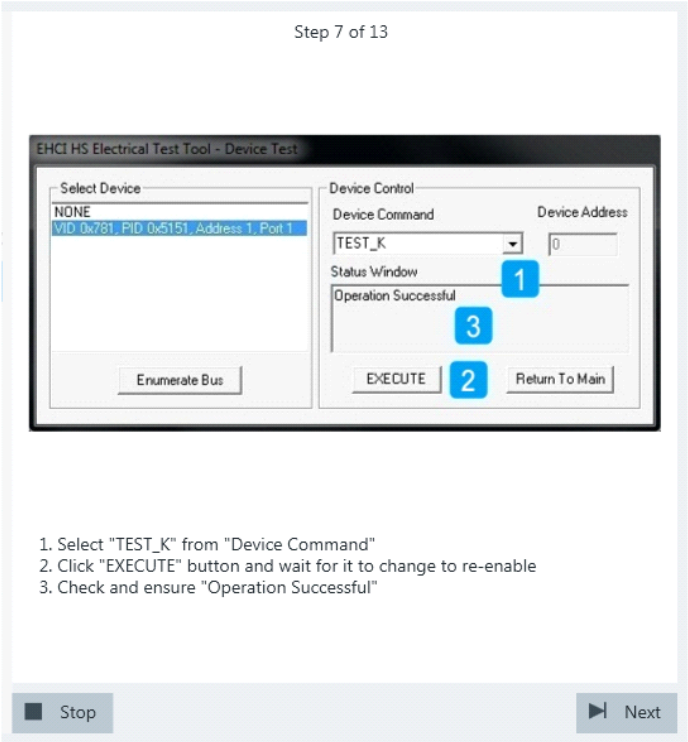
The probe at least 2 GHz bandwidth contains a built-in digital voltmeter known as ProbeMeter. The application automatically reads the voltages of D+ and D- from the ProbeMeter. However, if the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-.

8. Switch the "Device Initialization" switch to "Init" position and reset the DUT. If the DUT is bus-powered, simply toggle the "Device on off" switch.

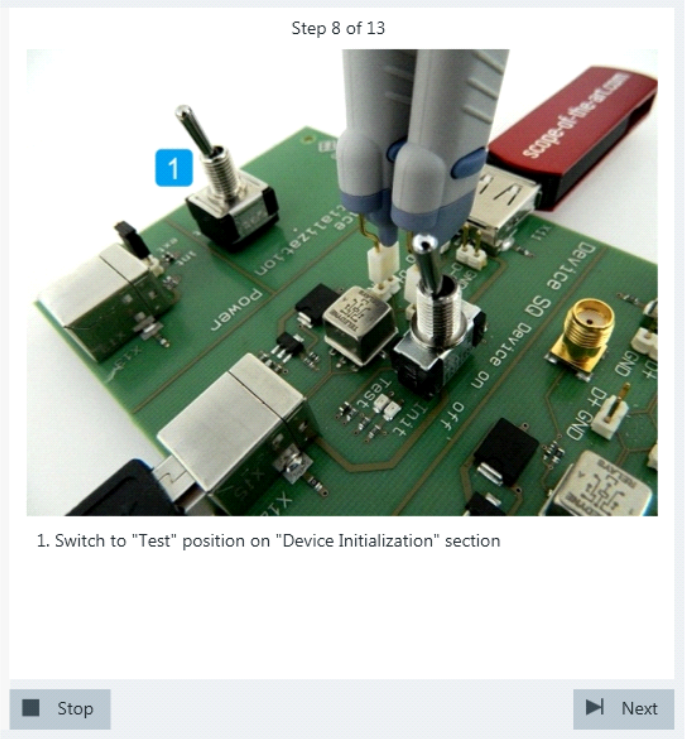
If the DUT is self-powered, switch it off and switch it back on.



9. Configure the HS Electrical Test Tool as shown in the picture and execute the test.



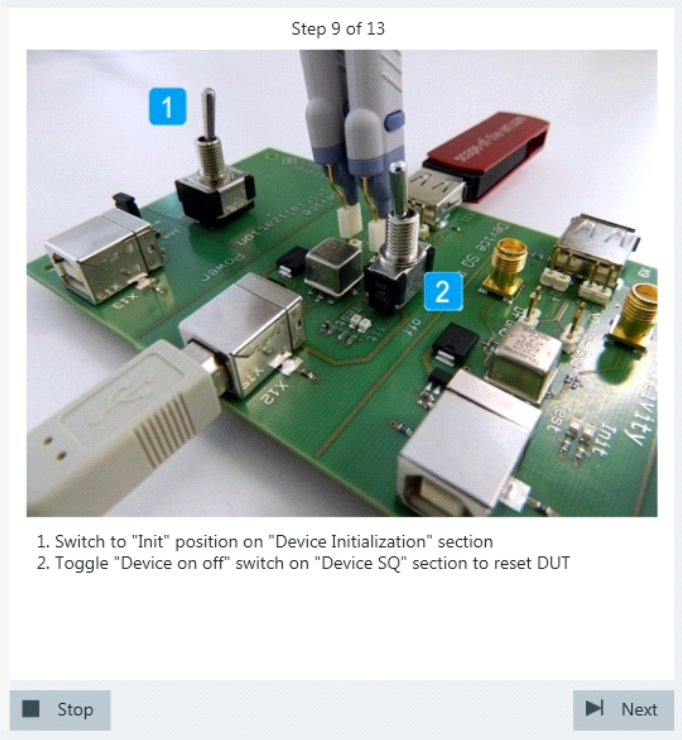
10. Switch the "Device Initialization" switch to "Test" position.



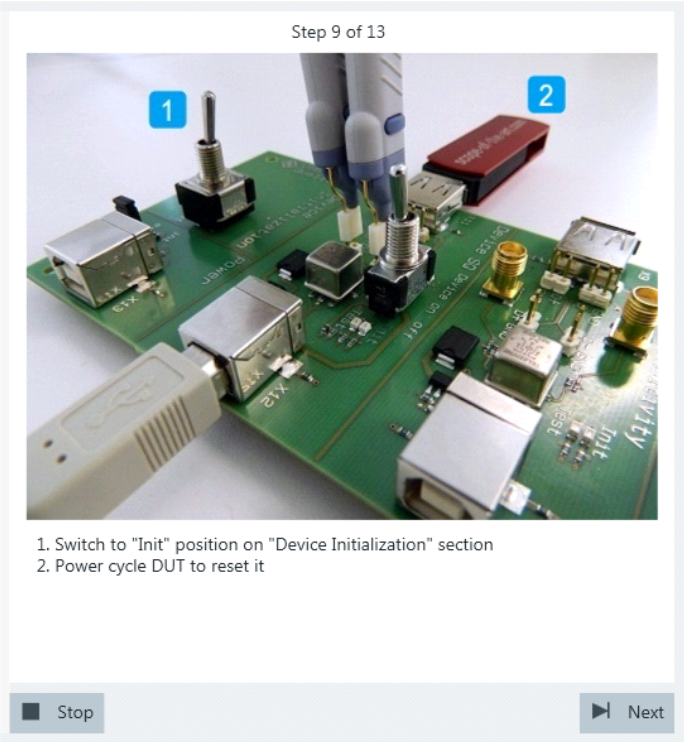
If the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user

to enter the voltages of D+ and D-. Otherwise it automatically reads them from the ProbeMeter.

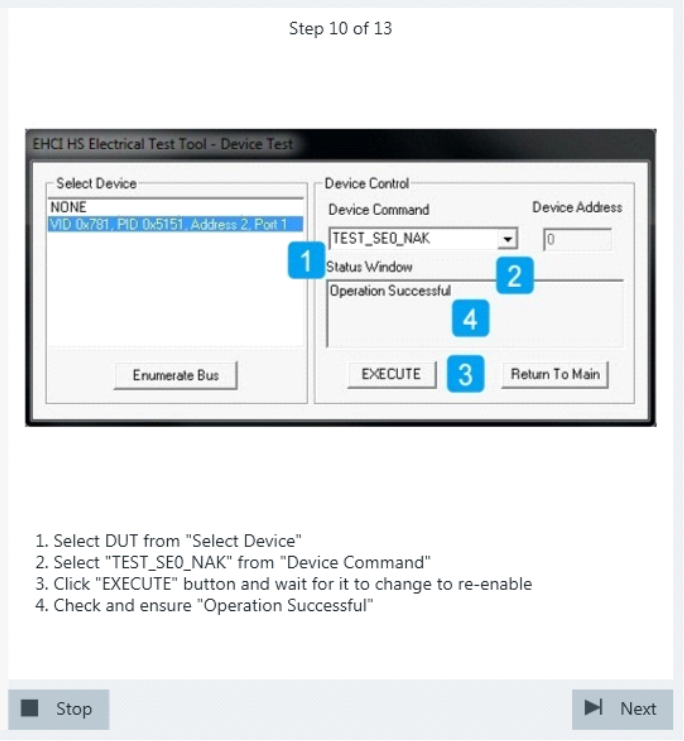
11. Switch the "Device Initialization" switch to the "Init" position and reset the DUT.
If the DUT is bus-powered, simply toggle the "Device on off" switch.



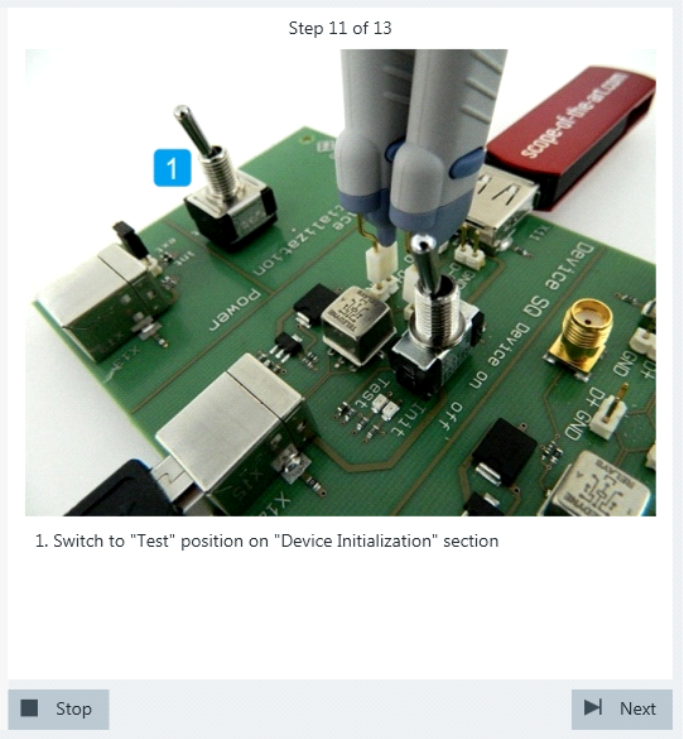
If the DUT is self-powered, switch it off and switch it back on.



12. Configure the HS Electrical Test Tool as shown in the picture and execute the test.

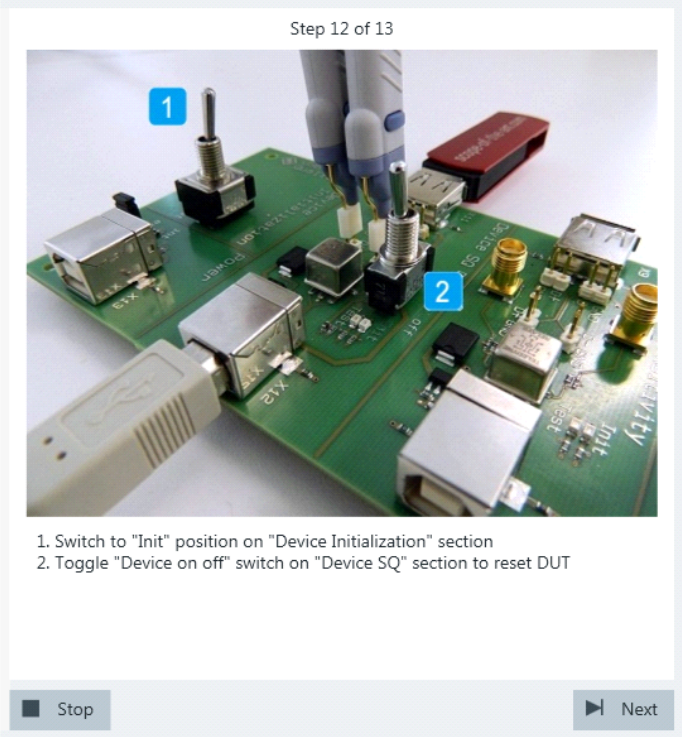


13. Switch the "Device Initialization" switch to "Test" position.

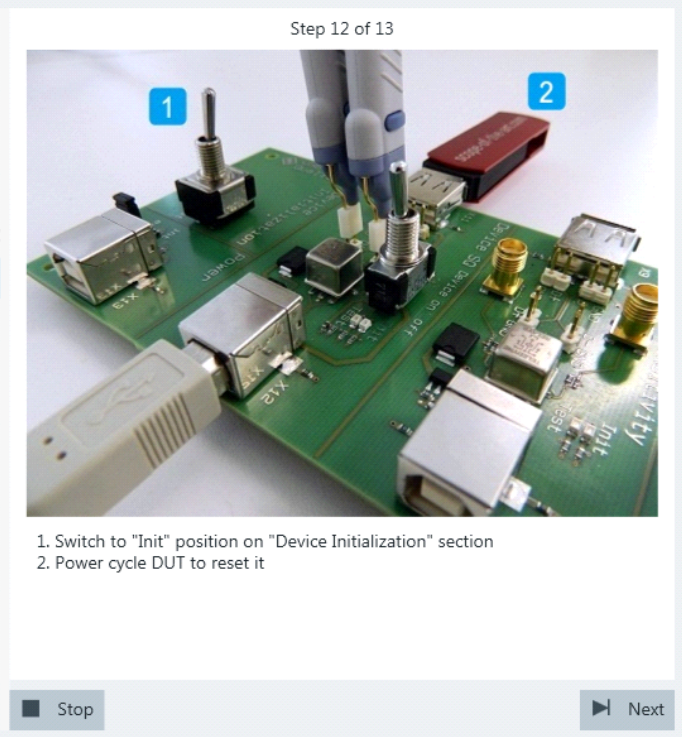


If the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-. Otherwise it automatically reads them from the ProbeMeter.

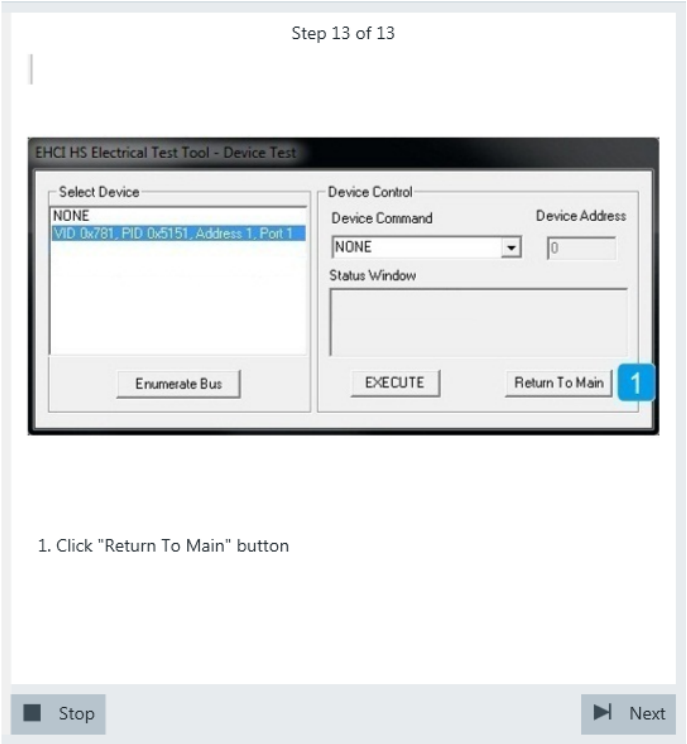
14. Switch the "Device Initialization" switch to the "Init" position and reset the DUT.
If the DUT is bus-powered, simply toggle the "Device on off" switch.



If the DUT is self-powered, switch it off and switch it back on.



15. Proceed in the HS Electrical Test Tool as shown in the picture.



The results are saved and can be viewed in the report.

4.1.1.6 Receiver sensitivity

Table 4-6: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
Signal quality board, "Reveiver Sensitivity" section	R&S RT-ZF1	1
Dual channel arbitrary waveform generator (AWG)	e.g. Tabor WX2182B/Tabor WX2182C	1
SMA cable	to connect the signal generator to the test fixture	2
50 Ω SMA terminators	to terminate unused outputs of the AWG	2
Differential probe	at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

Test preparation comprises common preparation steps and the connection of the AWG.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Device"**, see Chapter 3.3, "Initiating the test", on page 26

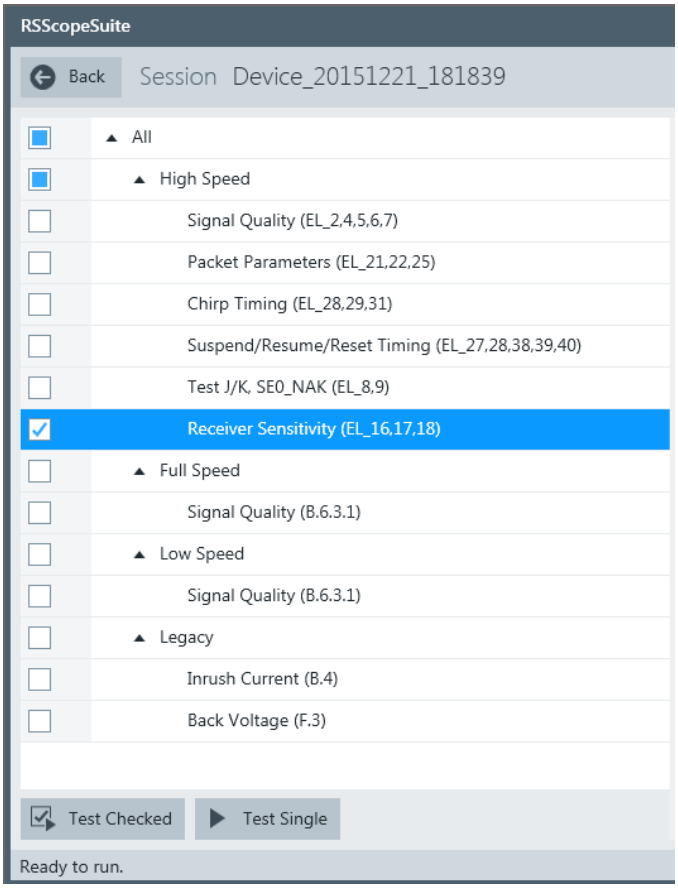
Additional preparation step:

- LAN connection of the AWG and the computer running the R&S ScopeSuite, see Chapter 2.6, "Connecting the arbitrary waveform generator", on page 15.
- Make sure that all unsued outputs of the AWG waveform generator are terminated with a 50 Ω SMA terminators.

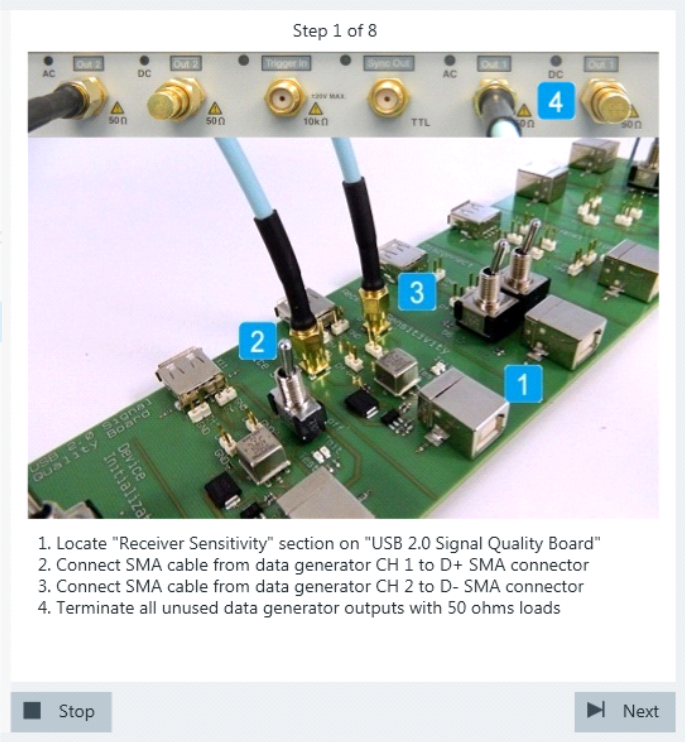
To execute the receiver sensitivity test in manual mode, the AWG has to output waveforms that simulate the IN token. These waveforms are described in Chapter 4.1.1.7, "Setup of Test Waveforms", on page 82.

Running the test

1. Select the "Receiver Sensitivity (EL_16,17,18)" test case and click "Test Single".

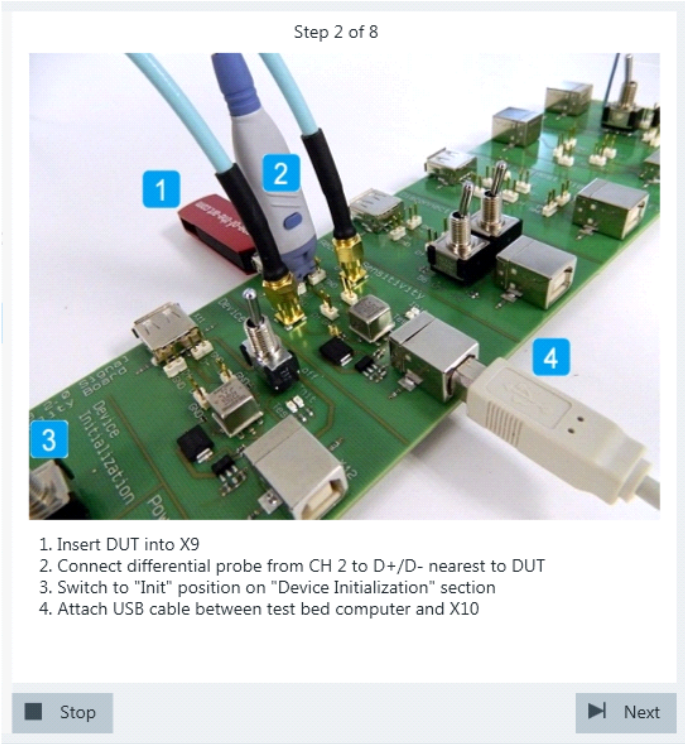


2. Connect the Tabor generator to the test fixture as shown in the picture.



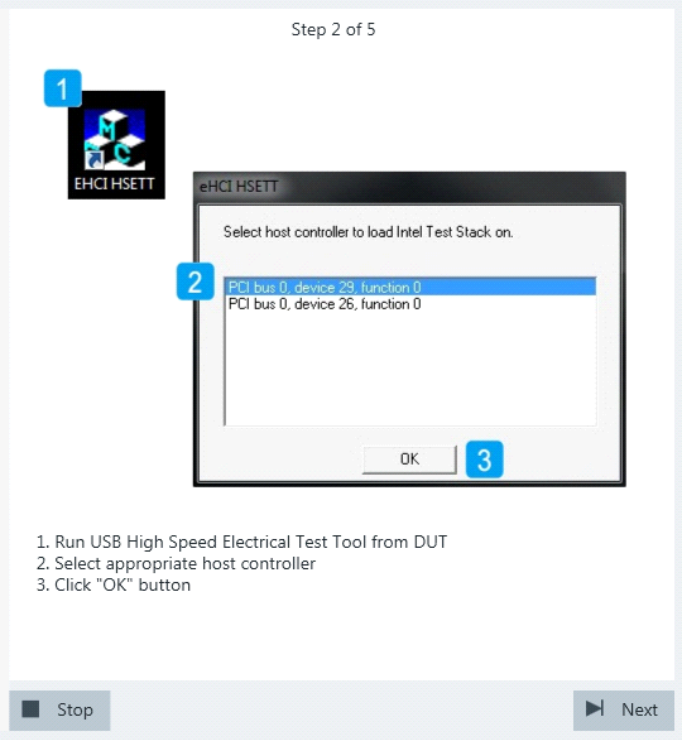
Click "Next".

3. Connect the DUT to the test fixture as shown in the picture and click "Next".

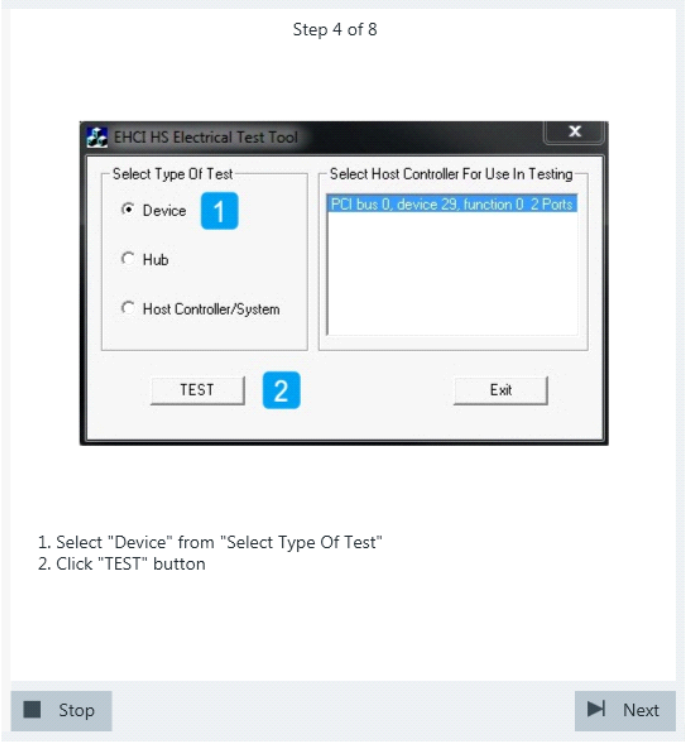


If the DUT has a type A connector attached, plug it into the test fixture directly. Otherwise, connect the DUT to the test fixture using a 4-inch cable.
Use a 1-meter non-captive cable to connect the test bed computer to the test fixture.

4. Start the HS Electrical Test Tool on the test bed computer.
5. Select the host controller to which the DUT is connected and click OK.
Note: the values in the list may vary.

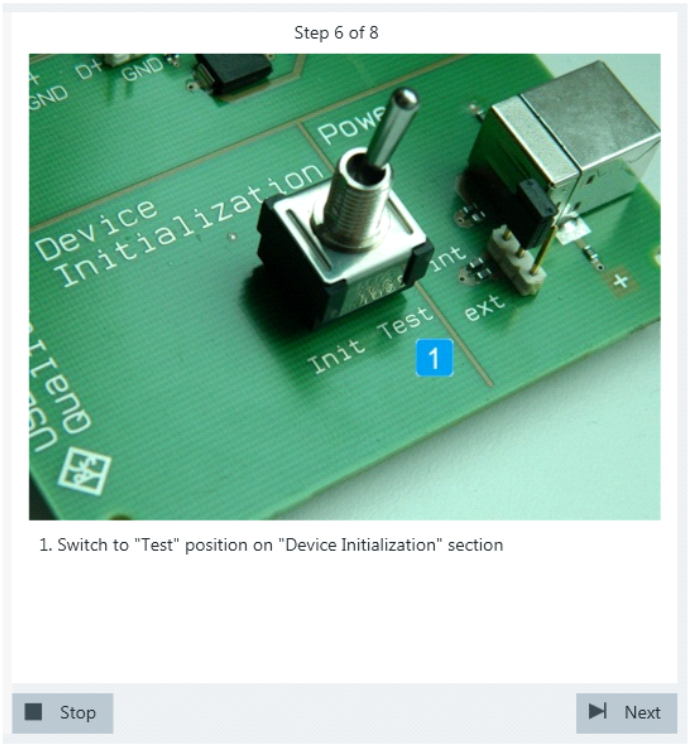


6. Select "Device" on the left side.
Note: the values in the list may vary.
Click "TEST".

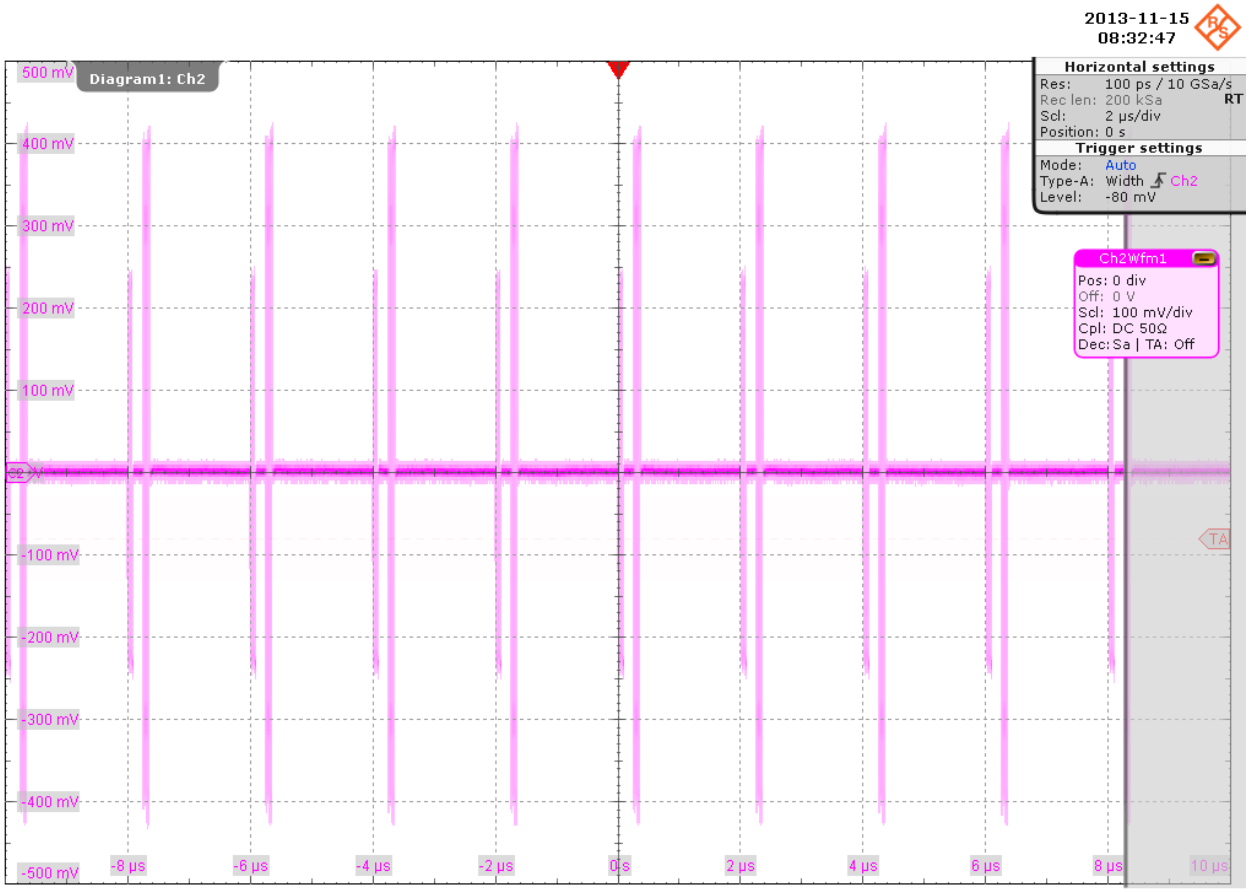


7. Select DUT from "Select Device"
   Select "Test_SE0_NAK" from "Device Command".
   Click "EXECUTE" and wait until "Operation Successful" is shown in "Status Window".

8. Switch to "Test" position on "Device Initalization" section. Now the device (negative) acknowledges all signals send by the Tabor generator.

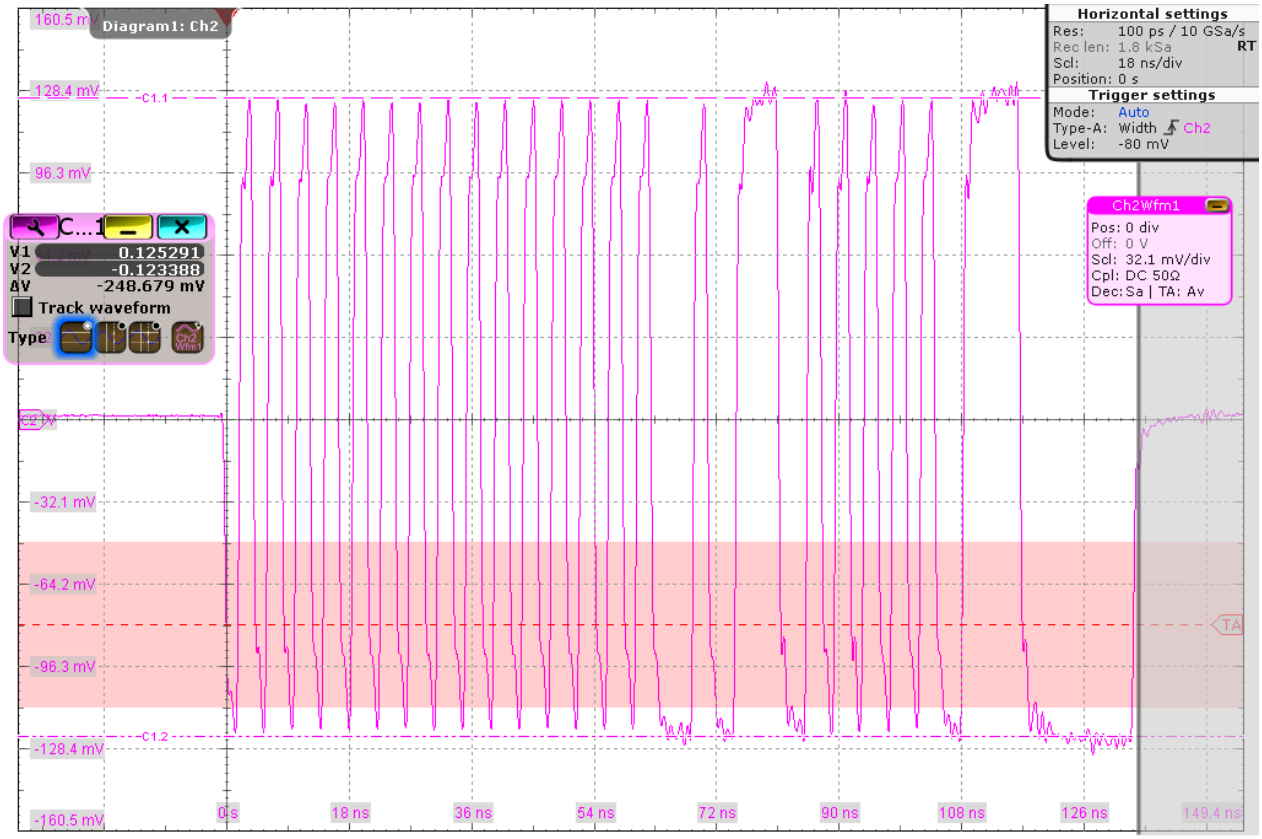


9. The application loads the “MIN_ADD1” waveform onto the Tabor generator. A waveform like this is captured.



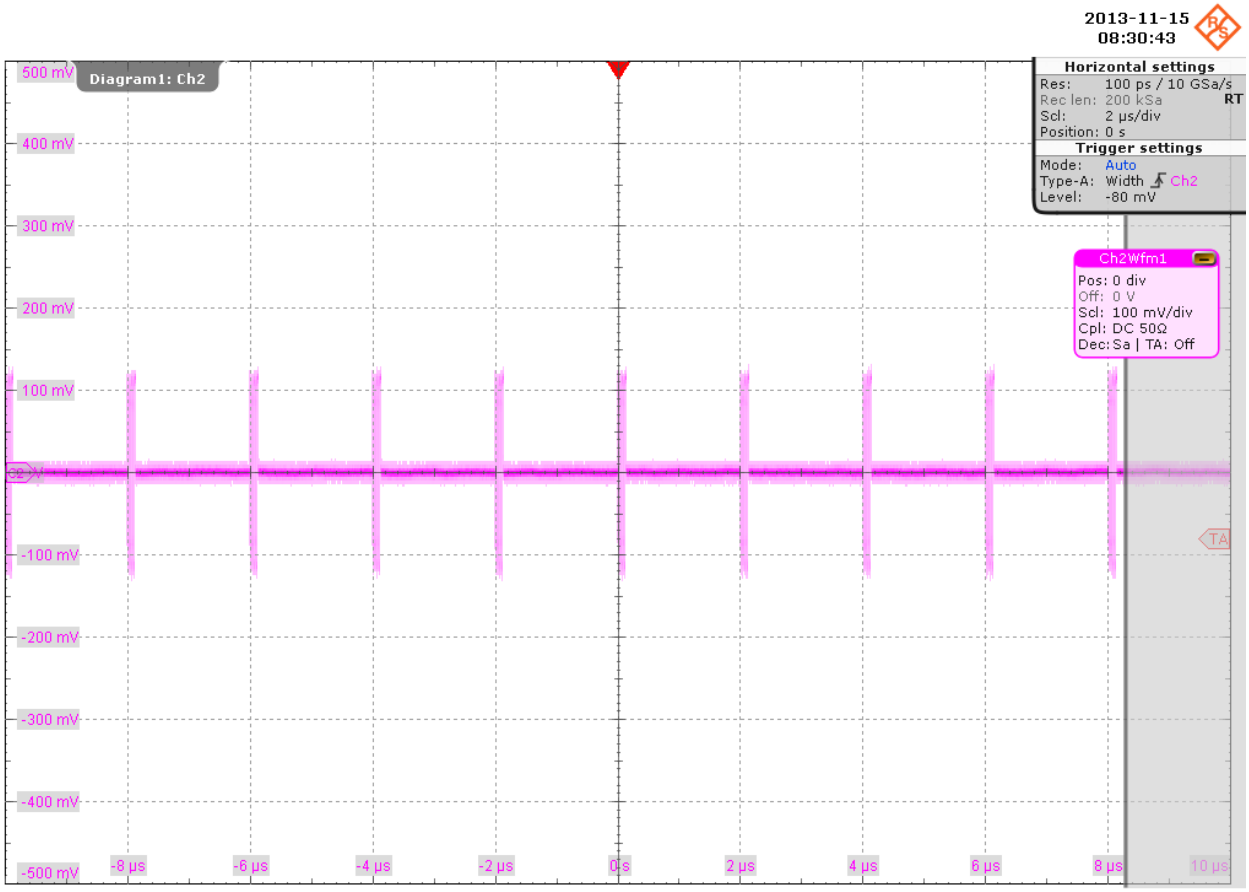
The bigger peak is the (negative) acknowledgement of the device and the smaller peak is the packet sent by the Tabor generator.
The application verifies that all packets from the Tabor generator are (negative) acknowledged. This is EL_18.

10. The application loads the “IN_ADD1” waveform onto the Tabor generator.
The waveform looks like this:

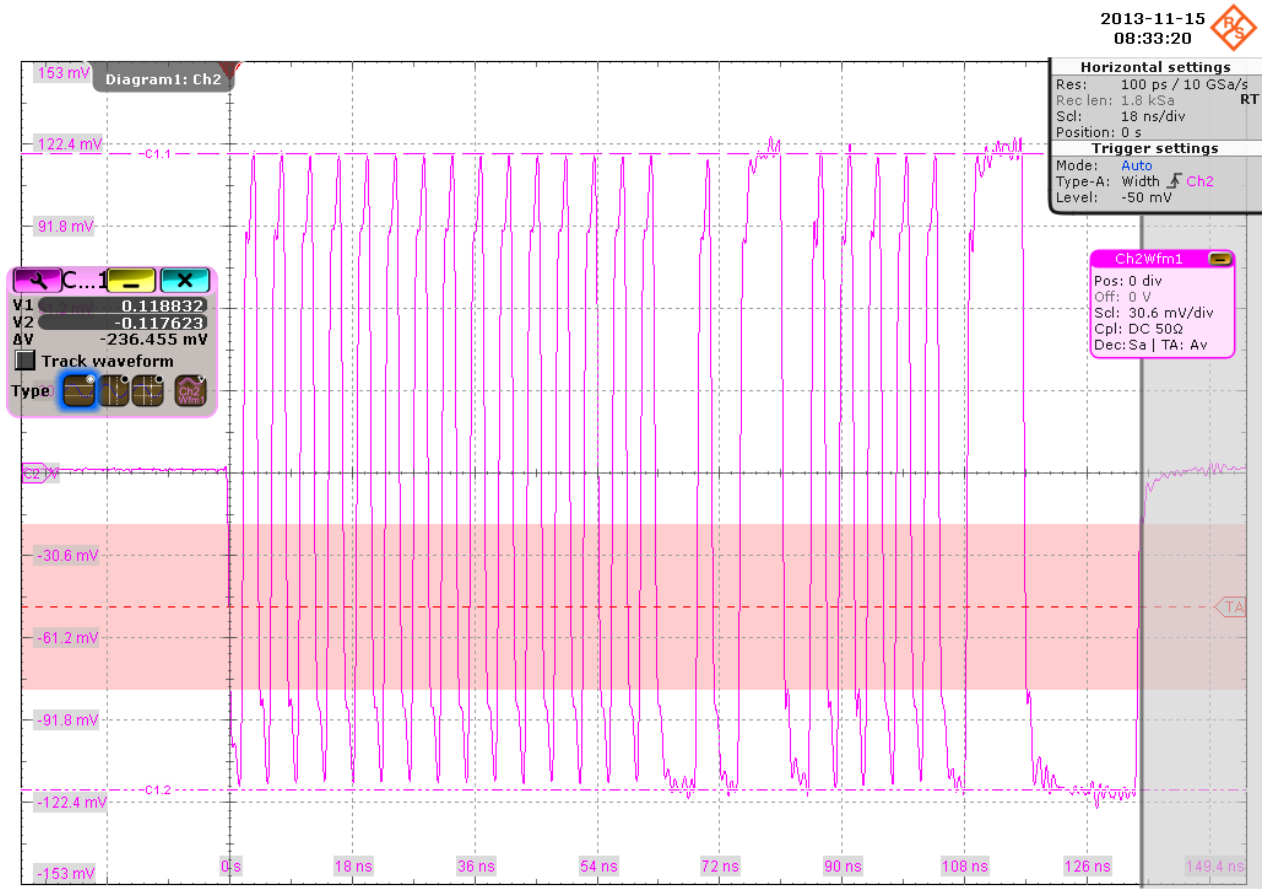


The application decreases the output voltages of the Tabor generator in a step size of 50 mV until the (negative) acknowledgement packets begin to become intermittent.
The application then increases the output voltages of the Tabor generator in a step size of 5 mV until all packets from the Tabor generator are (negative) acknowledged again. The application measures the D+ and D- voltages of the packet from the Tabor generator. The reading is taken at the plateaus of the wider pulses to avoid inflated reading due to overshoots. This is EL_17.

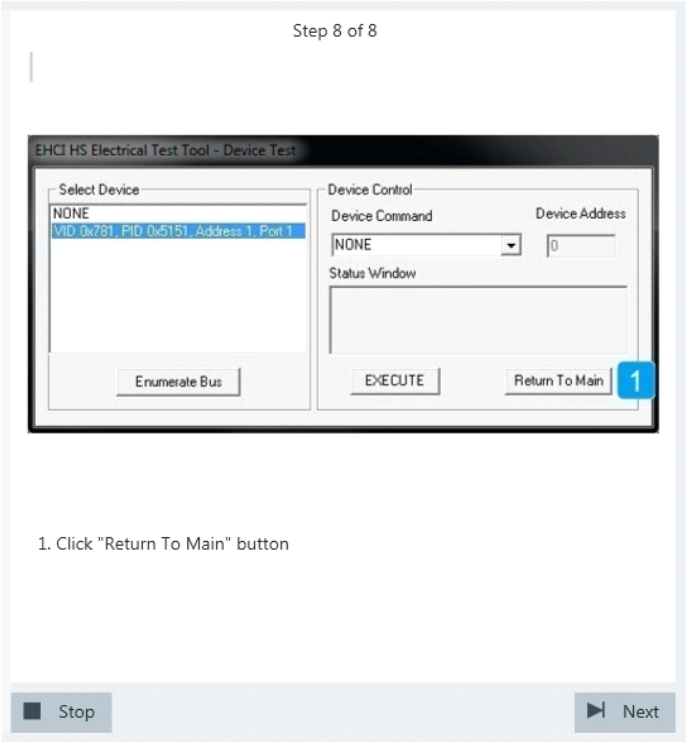
11. The application decreases the output voltages of the Tabor generator in a step size of 5 mV until there is no more (negative) acknowledgement packet like this:



The application measures the D+ and D- voltages of the packet from the Tabor generator. The reading is taken at the plateaus of the wider pulses to avoid inflated reading due to overshoots. This is EL_16.



12. In the HS Electrical Test Tool, click “Return to Main”.



The results are saved and can be viewed in the report.

4.1.1.7 Setup of Test Waveforms

This section describes the characteristics of the required waveforms used for device or hub receiver sensitivity testing. For these tests, a Tabor WX2182B/Tabor WX2182C 2.3 GS/s dual channel arbitrary waveform generator or similar can be used. If you use the Tabor generator, you can create the waveforms using the Waveform Composer with the files `MIN_ADD1.txt` and `IN_ADD1.txt`. The files are provided in the installation directory of the R&S ScopeSuite.

`MIN_ADD1`

- IN token of nominal bit rate and amplitude with shortest allowable sync field (12 bits)
- Bit rate: 480 Mb/s
- High level (both channels): 350 mV
- Low level (both channels): 0 mV
- Pattern length: 44 bits
- Repetition rate: 2 µs (both channels should be at 0 mV for 916 bits following the pattern)

Table 4-7: Pattern bits of MIN_ADD1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CH1 (D+)	0	1	0	1	0	1	0	1	0	1	0	0	0	1	0
CH2 (D-)	1	0	1	0	1	0	1	0	1	0	1	1	1	0	1

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
CH1 (D+)	0	1	1	1	0	0	1	0	1	0	1	0	1	0	1
CH2 (D-)	1	0	0	0	1	1	0	1	0	1	0	1	0	1	0

	31	32	33	34	35	36	37	38	39	40	41	42	43	44
CH1 (D+)	0	0	1	1	1	1	0	0	0	0	0	0	0	0
CH2 (D-)	1	1	0	0	0	0	1	1	1	1	1	1	1	1

IN_ADD1

- IN token of nominal bit rate, amplitude and sync field (32 bits)
- Bit rate: 480 Mb/s
- High level (both channels): 350 mV
- Low level (both channels): 0 mV
- Pattern length: 64 bits
- Repetition rate: 2 µs (both channels should be at 0 mV for 896 bits following the pattern)

Table 4-8: Pattern bits of IN_ADD1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CH1 (D+)	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
CH2 (D-)	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
CH1 (D+)	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0
CH2 (D-)	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
CH1 (D+)	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
CH2 (D-)	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
CH1 (D+)	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0
CH2 (D-)	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1

4.1.2 Full speed, low speed and legacy device tests

In addition to the high-speed tests described in the preceeding chapter, the device under test must also pass a set of full speed and low speed compliance tests applicable to high-speed devices. The documentation of these legacy tests can be found in the "USB-IF Full and Low Speed Compliance Test Procedure" manual issued by the USB-IF. The manual is available at http://www.usb.org/developers.

To perform full speed and low speed compliance tests, you can use also a 4-channel R&S RTO/RTO6/RTP with less than 2 GHz bandwidth.

4.2 USB 2.0 hub tests

4.2.1 High-Speed hub tests

4.2.1.1 Upstream signal quality

Table 4-9: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Device SQ" section or USB-IF USB2.0 hi-speed signal quality device test fixture	R&S RT-ZF1	1
Differential probe or a pair of matched SMA cables if USB-IF device test fixture is used	differential probe with at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

The upstream signal quality test for hubs is mainly the same as the signal quality test for devices. Follow the instructions in the R&S ScopeSuite, and refer to the test description in Chapter 4.1.1.1, "Signal quality", on page 28. Make sure to select "Hub" in the "HS Electrical Test Tool" (step 5).

4.2.1.2 Downstream signal quality

Table 4-10: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Host Signal Quality" section, or USB-IF USB2.0 hi-speed signal quality host test fixture	R&S RT-ZF1	1
Differential probe or a pair of matched SMA cables if USB-IF host test fixture is used	differential probe with at least at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

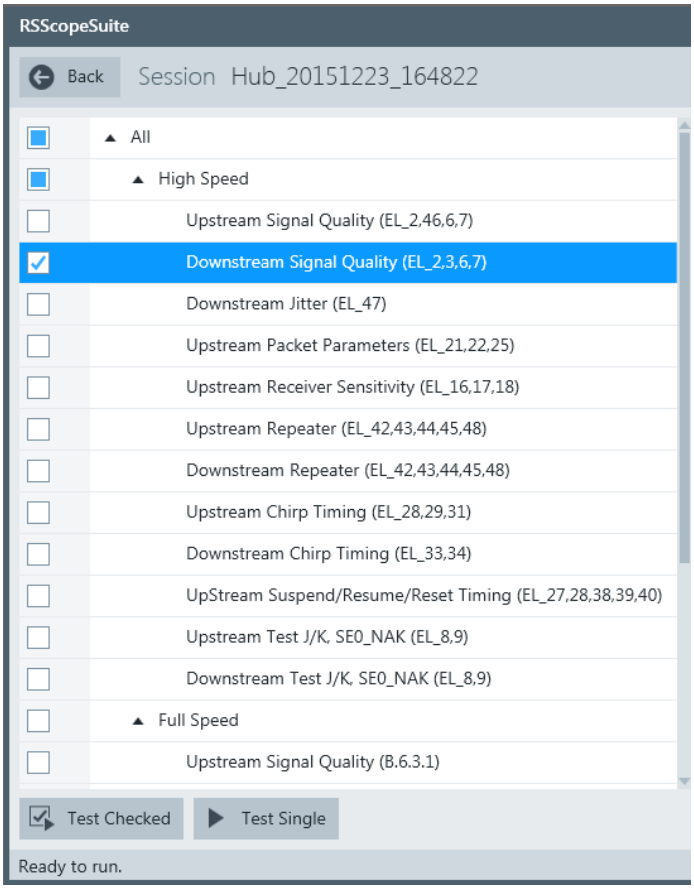
Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Downstream Signal Quality (EL_2,3,6,7)" test case and click "Test Single".



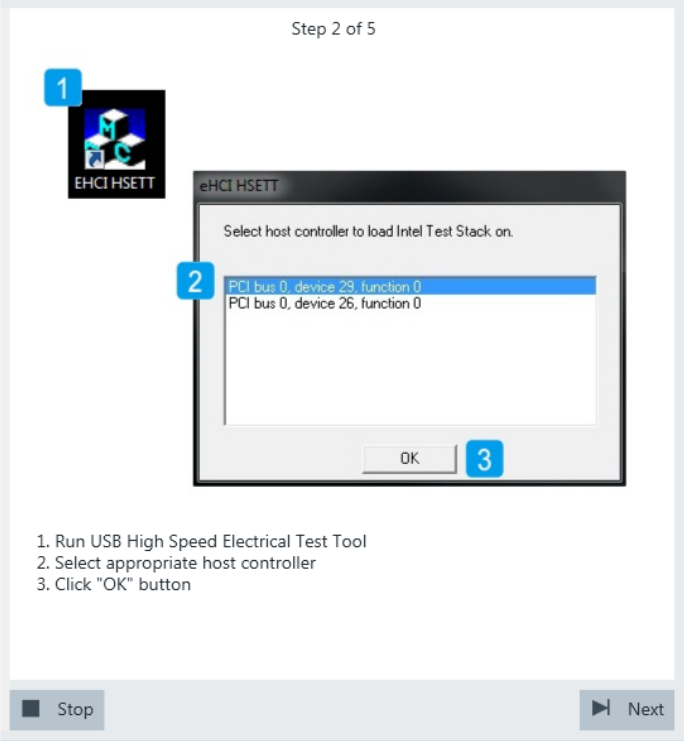
2. Connect the DUT to the test fixture as shown in the picture.

Figure 4-7: R&S RT-ZF1: connection to DUT

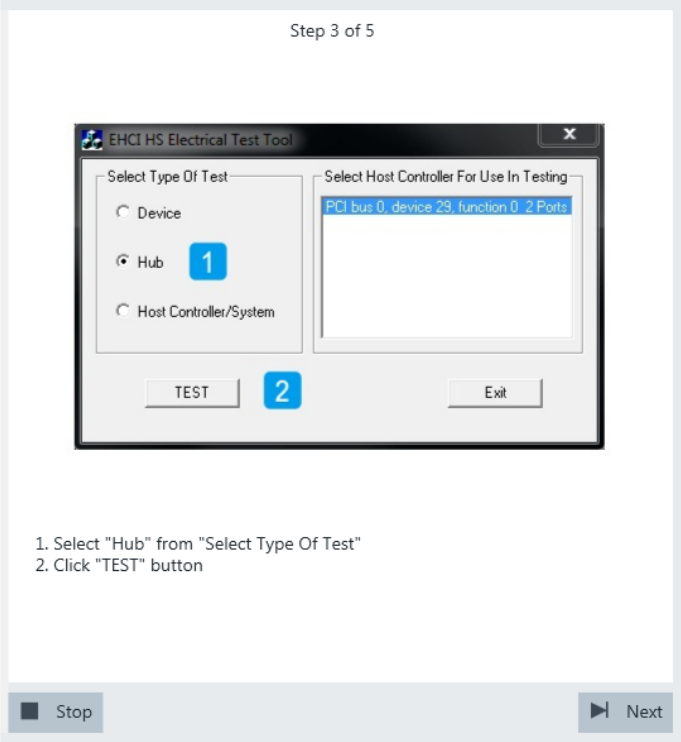
Figure 4-8: USB-IF USB2.0 Hi-Speed Signal Quality host test fixture: connection to DUT

If R&S test fixture is used, connect the test fixture to the downstream port under test with a 4-inch non-captive cable. If USB-IF test fixture is used, connect the test fixture directly to the downstream port under test.
If the DUT has a cable attached, plug it into the test bed computer directly. Otherwise, use a 1-meter cable to connect the test bed computer to the upstream port.
Click "Next".

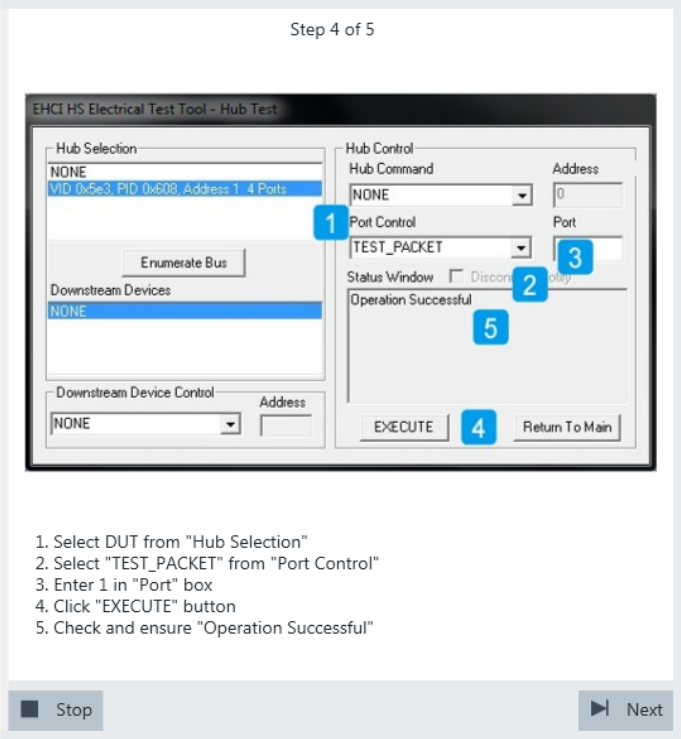
3. Start the HS Electrical Test Tool on the test bed computer.
4. Select the host controller to which the DUT is connected and click OK.
Note: the values in the list may vary.
Click "Next" in the R&S ScopeSuite.



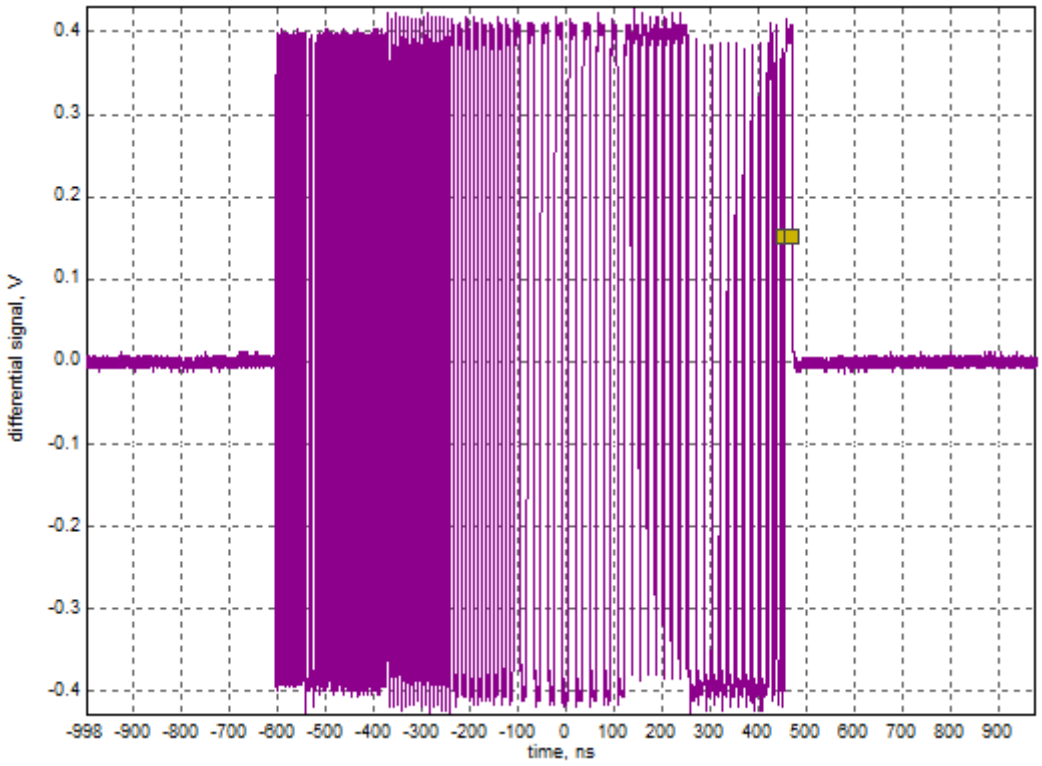
5. Select "Hub" on the left side, and click "TEST"

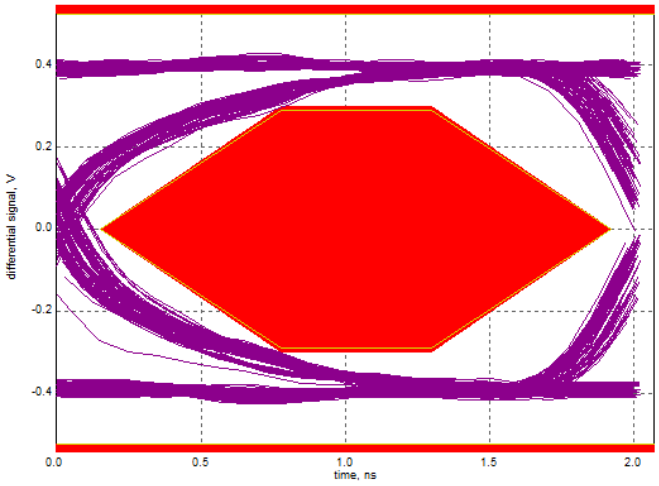


6. Configure the HS Electrical Test Tool as shown in the picture.

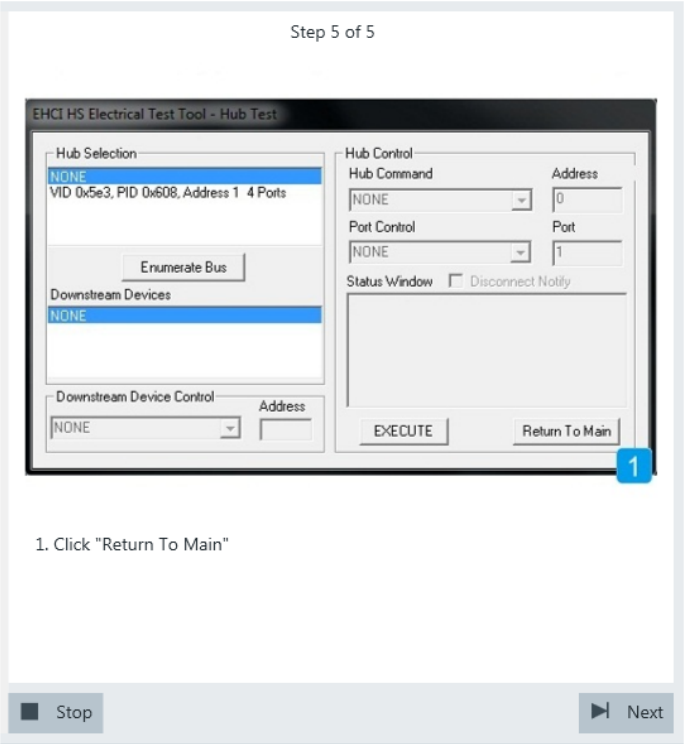


The test packets are sent to the oscilloscope. They are analyzed in an eye diagram.





7. Proceed in the HS Electrical Test Tool as shown in the picture.



The results are saved and can be viewed in the report.

4.2.1.3 Downstream jitter

Table 4-11: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Host Signal Quality" section, or USB-IF USB2.0 hi-speed signal quality host test fixture	R&S RT-ZF1	1
Differential probe, or a pair of matched SMA cables if USB-IF host test fixture is used	Differential probe with at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

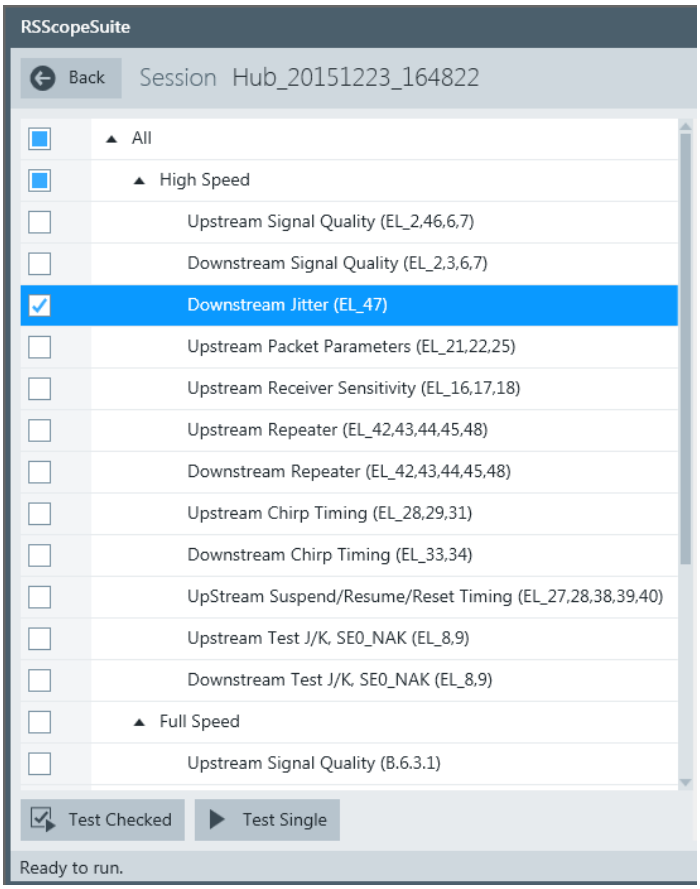
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10

- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Downstream Jitter (EL_47)" test case and click "Test Single".



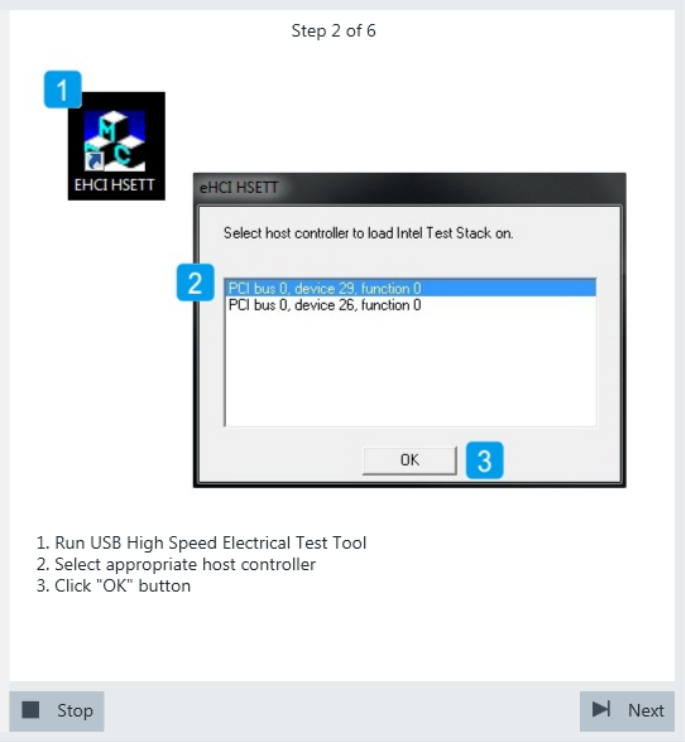
2. Connect the DUT to the test fixture as shown in the picture.

Figure 4-9: R&S RT-ZF1: connection to DUT

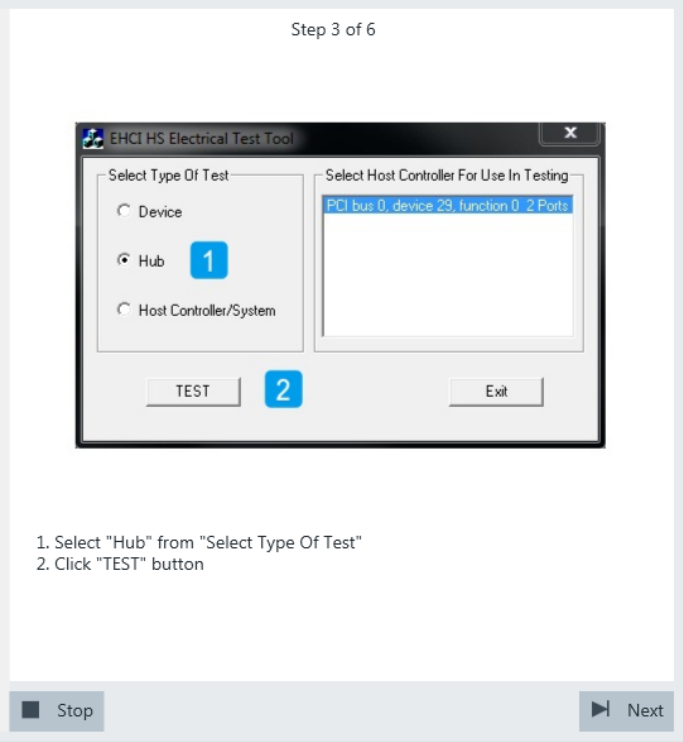
Figure 4-10: USB-IF USB2.0 hi-speed signal quality host test fixture: connection to DUT

If the DUT has an attached cable, connect it directly to the test bed computer. Otherwise, use a 1-meter cable to connect the upstream port and the test bed computer.
Click Next.

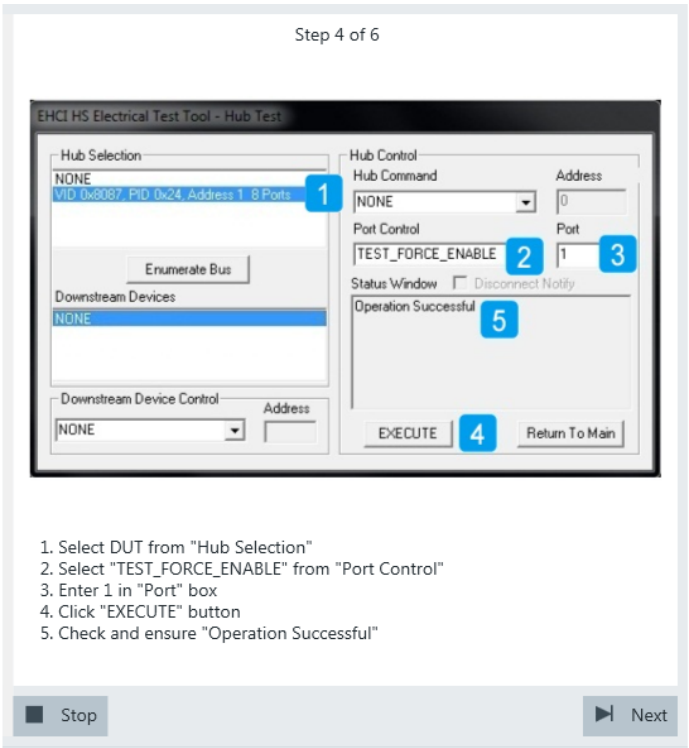
3. Start the HS Electrical Test Tool on the test bed computer.
4. Select the host controller to which the DUT is connected and click OK.
Note: the values in the list may vary.



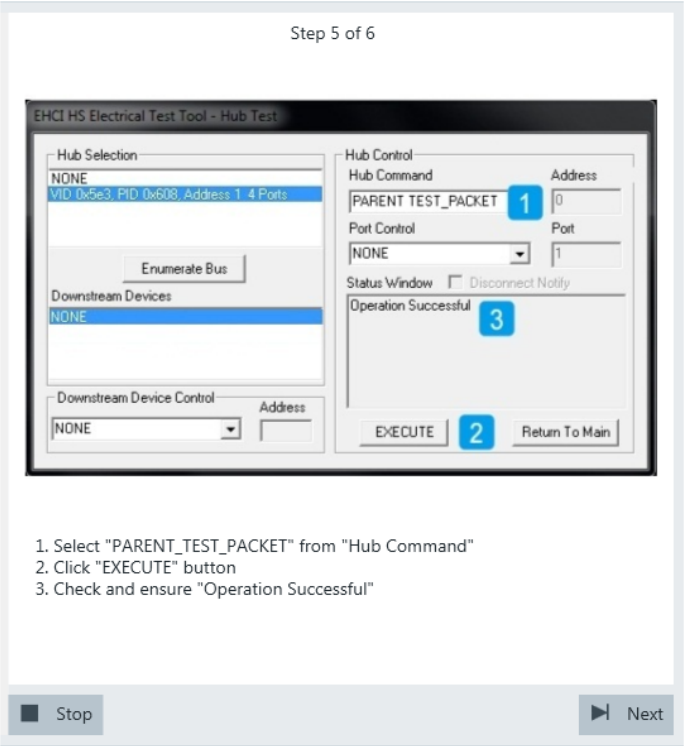
5. Select "Hub" on the left side, and click "TEST"



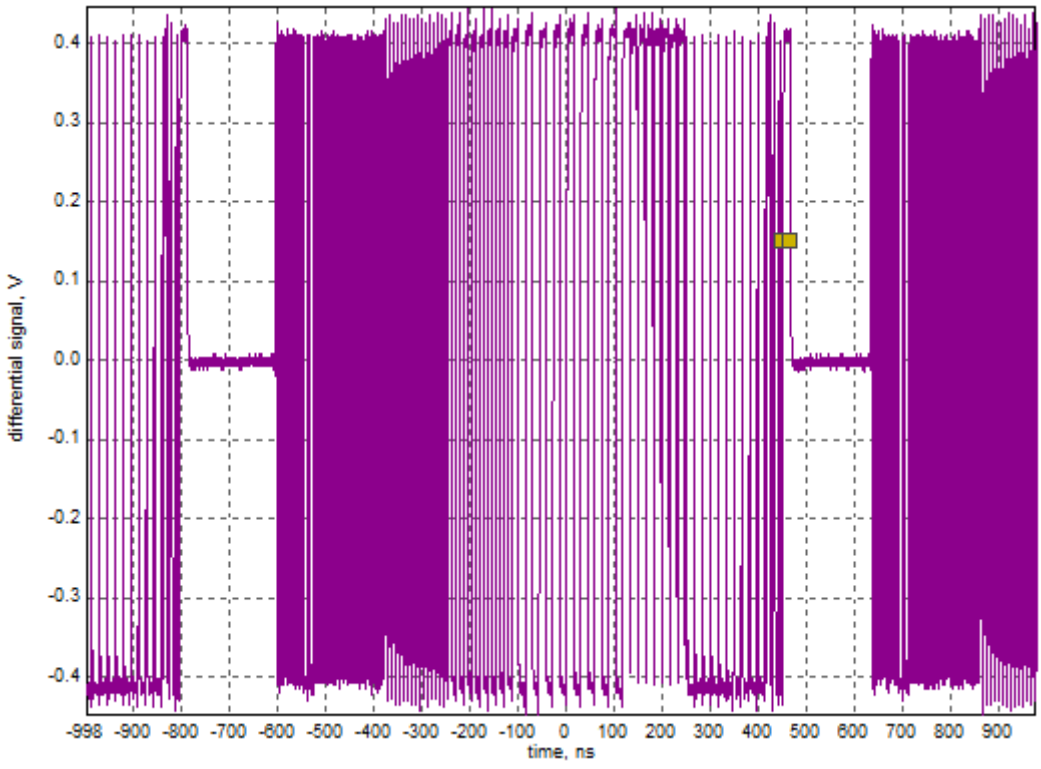
6. Configure the HS Electrical Test Tool as shown in the picture.

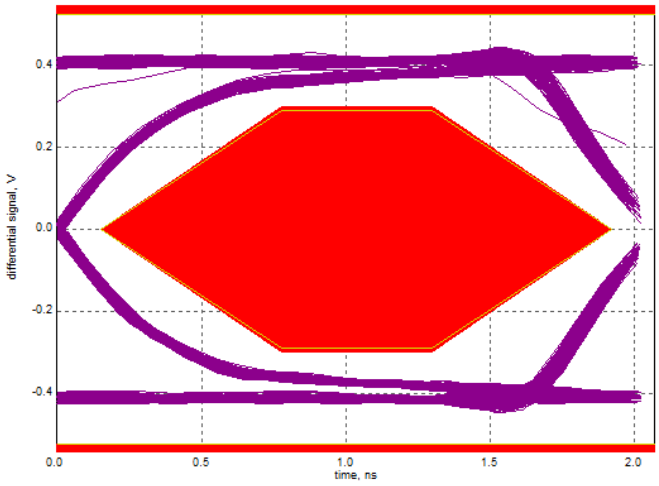


7. Configure the HS Electrical Test Tool as shown in the picture.



The test packets are sent to the oscilloscope. They are analyzed in an eye diagram.





The results are saved and can be viewed in the report.

4.2.1.4 Upstream packet parameters

Table 4-12: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Differential probe	at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

The upstream packet parameter test for hubs is mainly the same as the packet parameter test for devices. Follow the instructions in the R&S ScopeSuite, and refer to the test description in Chapter 4.1.1.2, "Packet parameters", on page 36. Make sure to select "Hub" in the "HS Electrical Test Tool" (step 5).

4.2.1.5 Upstream receiver sensitivity

Table 4-13: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Receiver Sensitivity" section	R&S RT-ZF1	1
Dual channel arbitrary waveform generator (AWG)	Tabor WX2182B/Tabor WX2182C 2.3 GS/s	1
SMA cable	to connect the signal generator to the test fixture	2
Differential probe	at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

Test preparation comprises common preparation steps and the connection of the AWG.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Additional preparation step:

- LAN connection of the AWG and the computer running the R&S ScopeSuite, see Chapter 2.6, "Connecting the arbitrary waveform generator", on page 15.

Running the test

The upstream receiver sensitivity test for hubs is mainly the same as the receiver sensitivity test for devices. Follow the instructions in the R&S ScopeSuite, and refer to the test description in Chapter 4.1.1.6, "Receiver sensitivity", on page 72. Make sure to select "Hub" in the "HS Electrical Test Tool" (step 6).

4.2.1.6 Upstream repeater

Table 4-14: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Receiver Sensitivity" section	R&S RT-ZF1	1
Differential probe	at least 2 GHz bandwidth	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

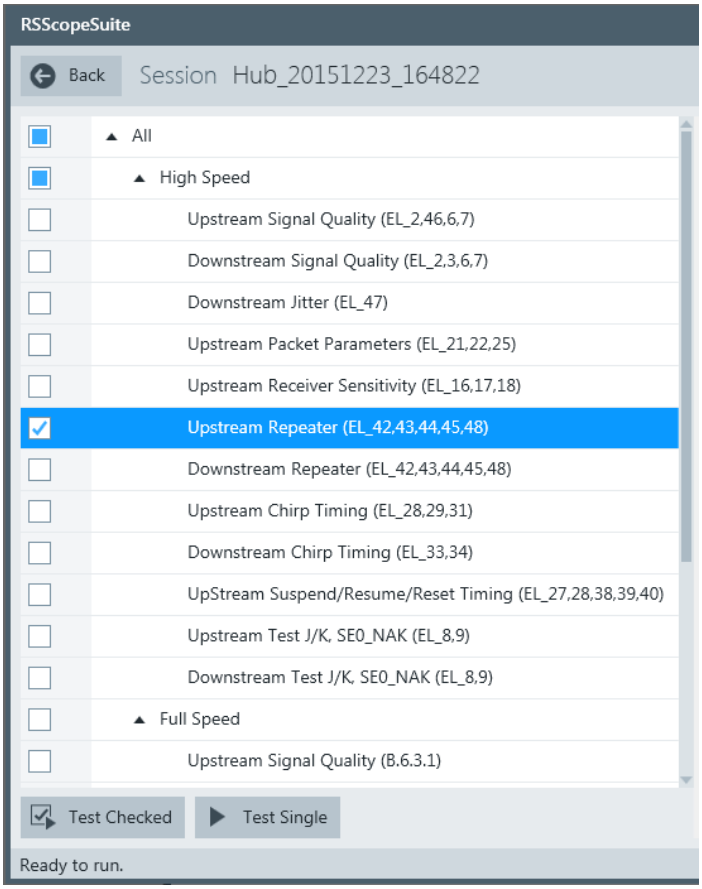
Test preparation

Before you run the test, complete the following actions:

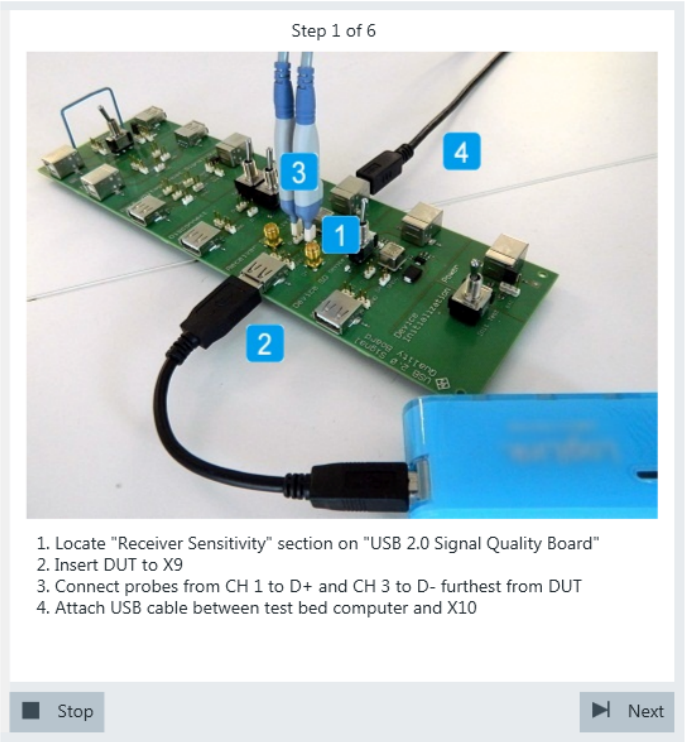
- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the “Upstream Repeater (EL_42,43,44,45,48)” test case and click "Test Single".

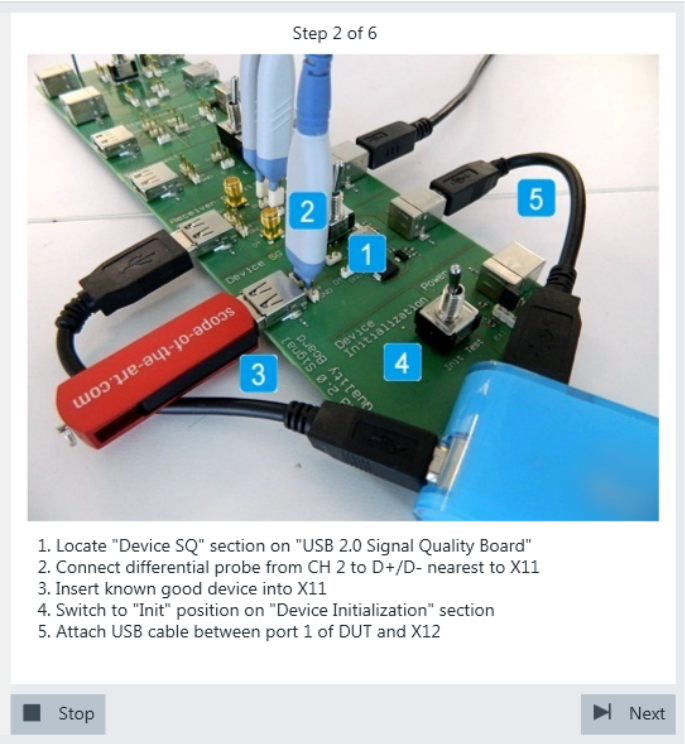


2. Connect the DUT to the “Receiver Sensitivity” section of the test fixture as shown in the picture, and click "Next".



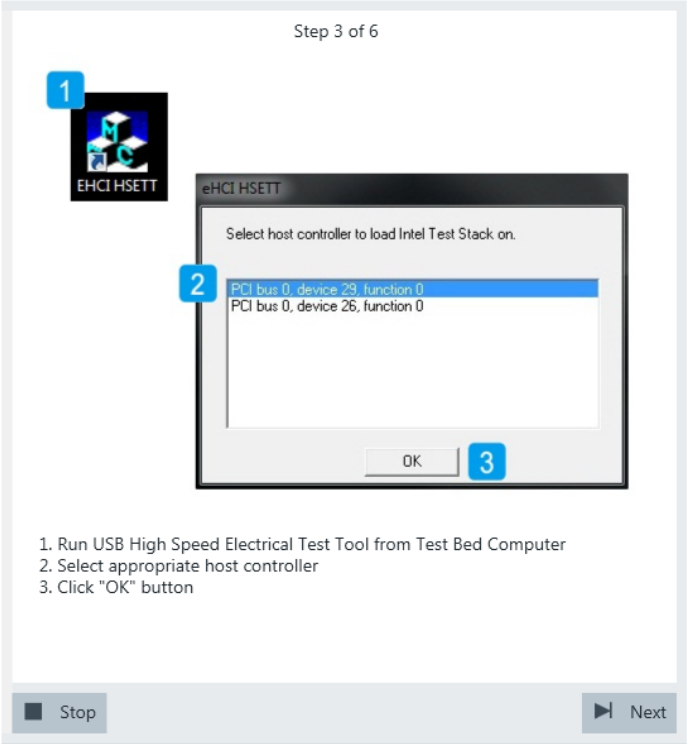
If the DUT has a cable attached, plug it into the test fixture directly. Otherwise, use a 4-inch non-captive cable to connect the test fixture to the upstream port.
Use a 1-meter cable to connect the test fixture to the test bed computer.

3. Connect the DUT to the “Device SQ” section of the test fixture as shown in the picture and click "Next".

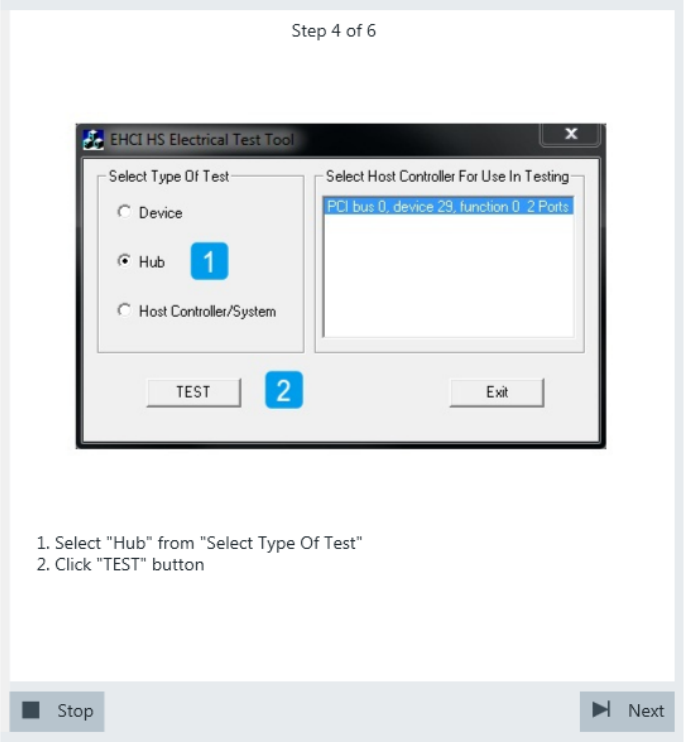


Use a 4-inch non-captive cable to connect the downstream port to the test fixture.

4. Start the HS Electrical Test Tool on the test bed computer.
5. Select the host controller to which the DUT is connected and click OK.
   Note: the values in the list may vary.

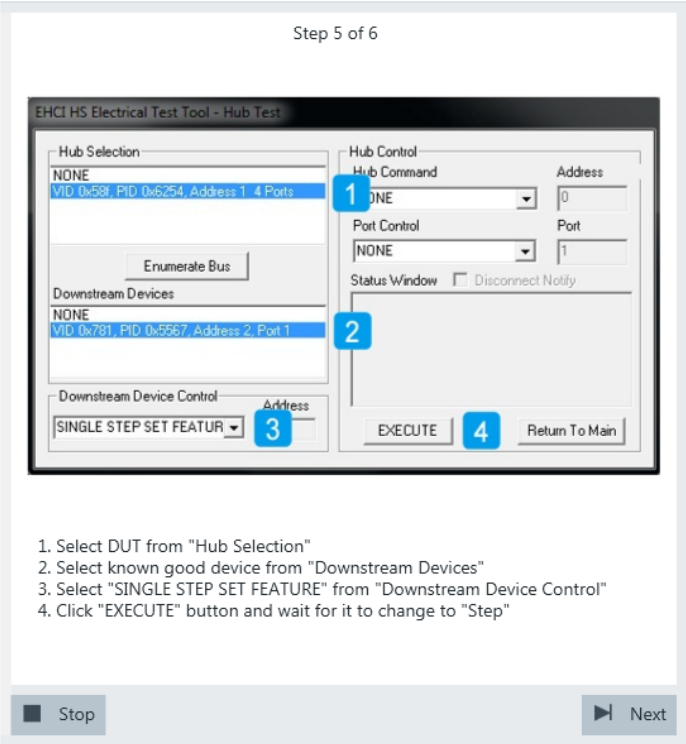


6. Select “Hub” on the left side, and click “TEST”.

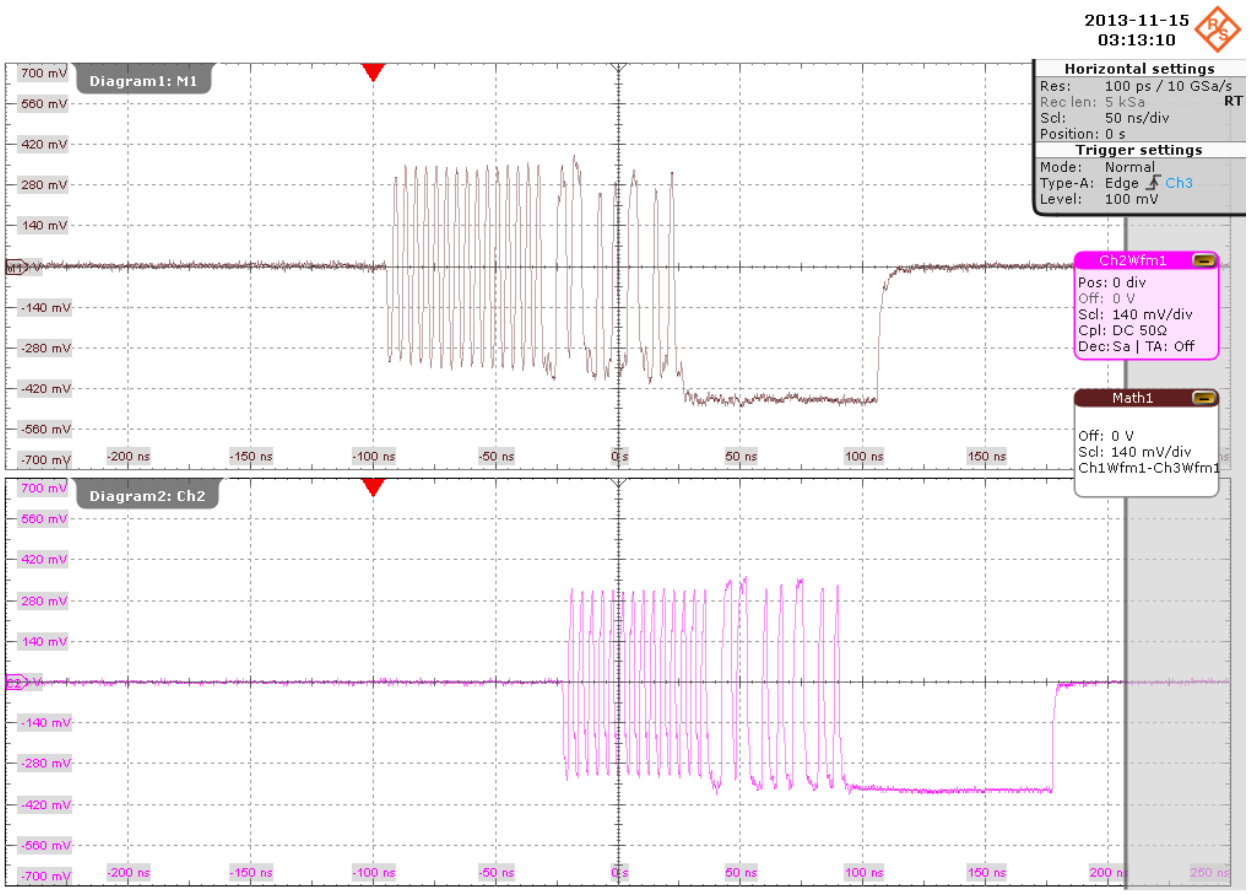


7. Configure the HS Electrical Test Tool:
   a) Under “Hub Selection”, click “DUT”.

b) Under “Downstream Devices”, select a known good device.
c) Under “Downstream Device Control”, click “Single Step Set Feature”.
d) Click “EXECUTE” and wait until the button changes to “Step”.

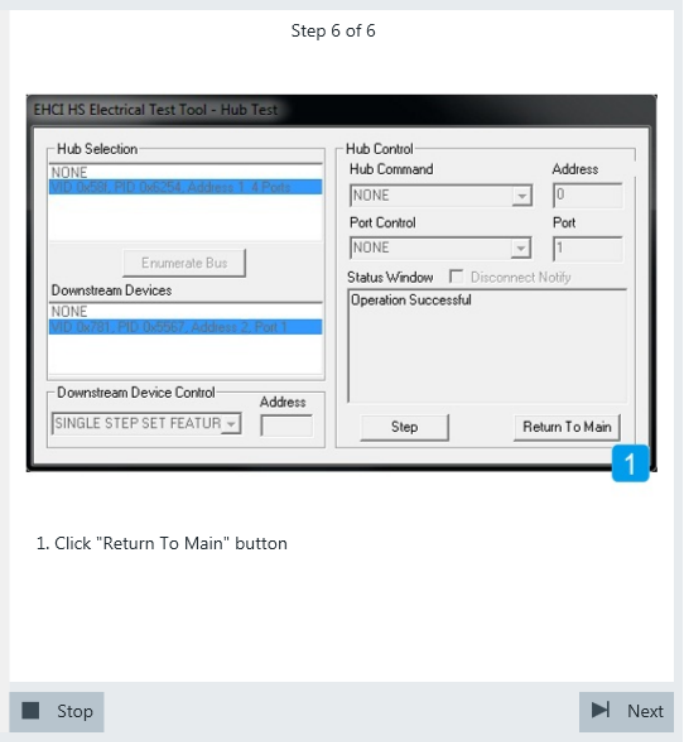


Waveforms like this are captured.



The packets at the top are captured from the upstream port of the DUT.
The packets at the bottom are captured from the downstream port of the DUT.
The two packets with lower amplitude at the top left are sent by the test bed computer. They are repeated downstream by the DUT to the known good device (bottom left).
The packet with higher amplitude at the bottom right is response from the known good device. It is repeated upstream by the DUT to the test bed computer (top right).
The application downloads the waveforms and compares the differences between the two response packets in term of the number of truncated bits in the SYNC field, the number of added bits in the EOP field and the time taken for the response packet to move upstream.

8. In the HS Electrical Test, click “Return to Main”.



The results are saved and can be viewed in the report.

4.2.1.7 Downstream repeater

Table 4-15: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Receiver Sensitivity" section	R&S RT-ZF1	1
Differential probe	at least 2 GHz bandwidth	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

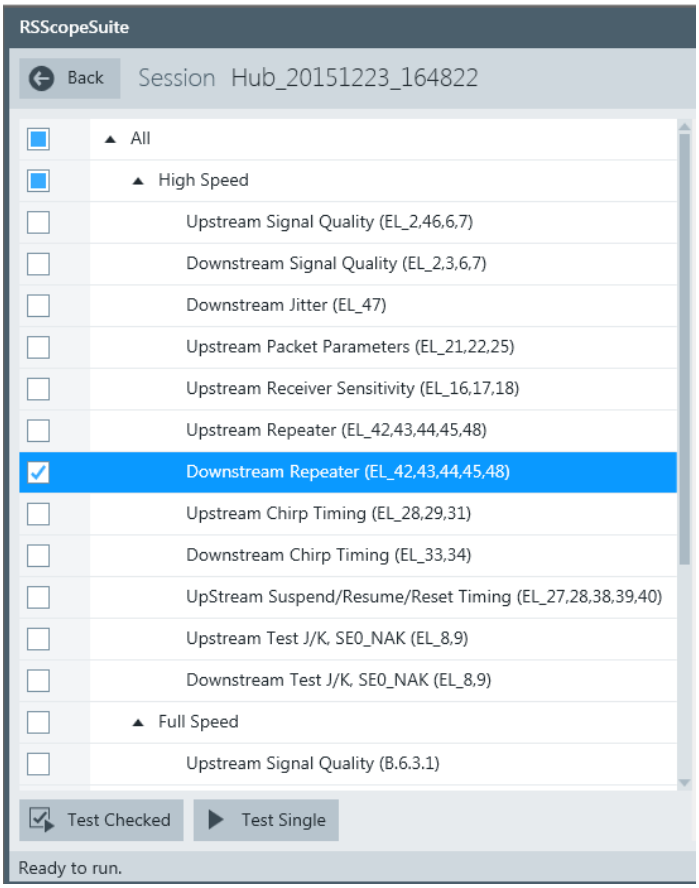
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10

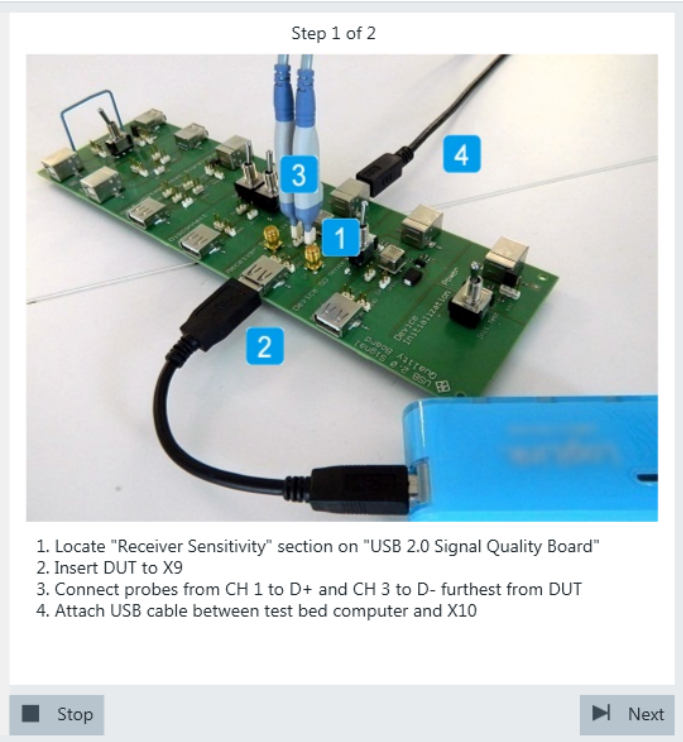
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Downstream Repeater Test (EL_42,43,44,45,48)" test case and click "Test Single".

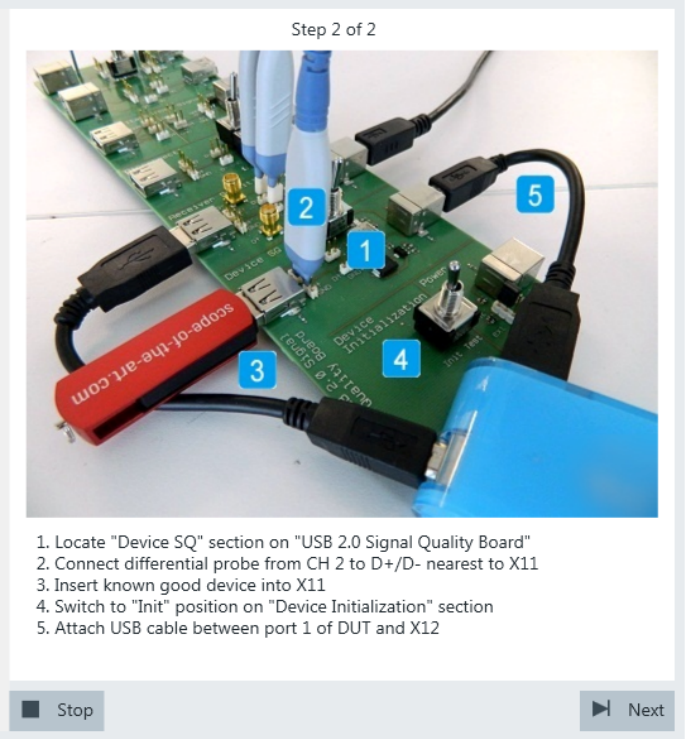


2. Connect the DUT to the "Receiver Sensitivity" section of the test fixture as shown in the picture, and click "Next".

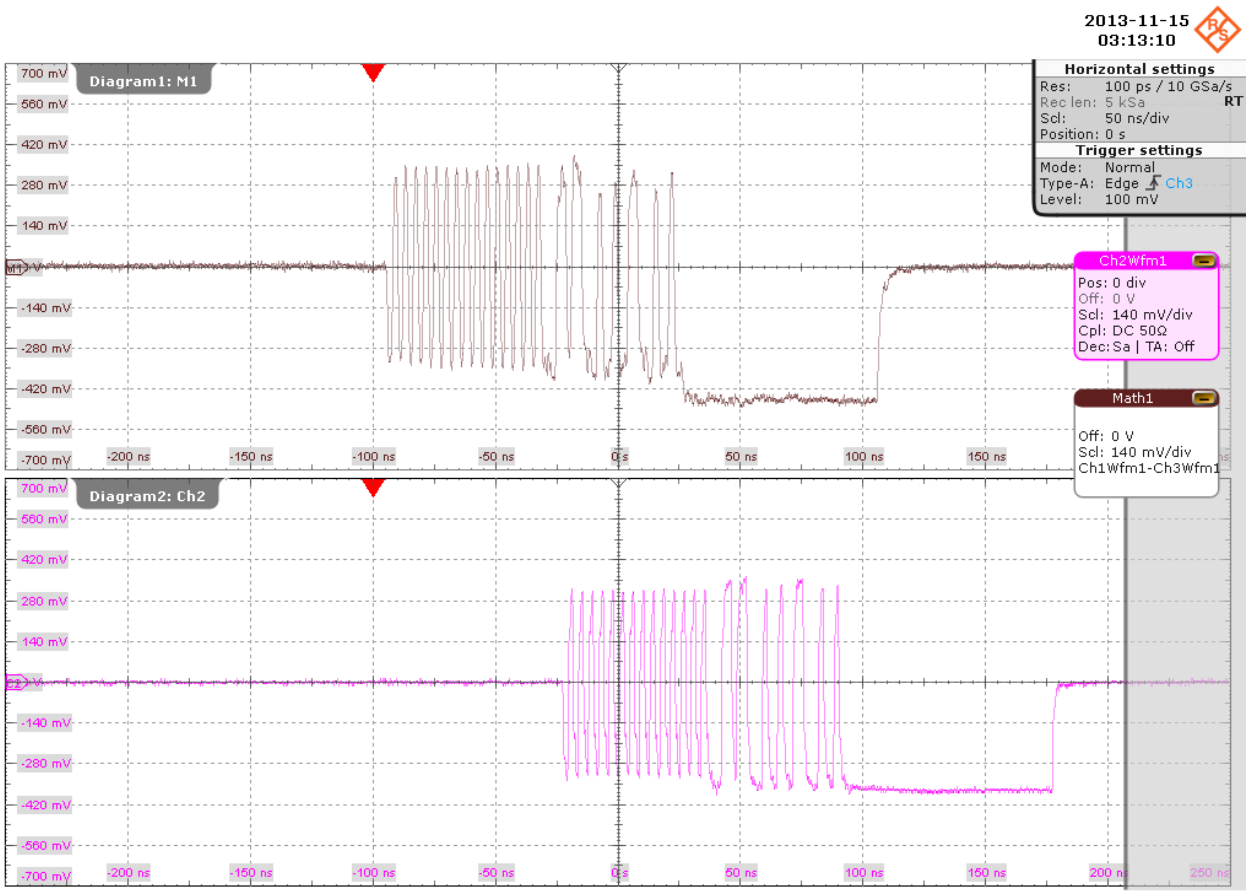


If the DUT has a cable attached, plug it into the test fixture directly. Otherwise, use a 4-inch non-captive cable to connect the test fixture to the upstream port.
Use a 1-meter cable to connect the test fixture to the test bed computer.

3. Connect the DUT to the "Device SQ" section of the test fixture as shown in the picture, and click "Next".



Use a 4-inch non-captive cable to connect the downstream port to the test fixture. Waveforms like this are captured.



The packet at the top is the “Start of Frame” packet from the test bed computer. The packet at the bottom is the repeated “Start of Frame” packet from the DUT. The application downloads the waveforms and compares the differences between the two packets in term of the number of truncated bits in the SYNC field, the number of added bits in the EOP field and the time taken for the “Start of Frame” packet to move downstream.

The results are saved and can be viewed in the report.

4.2.1.8 Upstream chirp timing

Table 4-16: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2

Item	Description, model	Quantity
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

The upstream chirp timing test for hubs is mainly the same as the chirp timing test for devices. Follow the instructions in the R&S ScopeSuite, and refer to the test description in Chapter 4.1.1.3, "Chirp timing", on page 43. Make sure to select "Hub" in the "HS Electrical Test Tool" (step 5).

4.2.1.9 Upstream suspend/resume/reset timing

Table 4-17: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

The upstream suspend/resume/reset timing test for hubs is mainly the same as the suspend/resume/reset timing test for devices. Follow the instructions in the R&S ScopeSuite, and refer to the test description in Chapter 4.1.1.4, "Suspend/resume/reset timing", on page 48. Make sure to select "Hub" in the "HS Electrical Test Tool" (step 7).

4.2.1.10 Upstream test J/K, SE0_NAK

Table 4-18: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

The upstream test J/K, SE0_NAK for hubs is mainly the same as the test J/K, SE0_NAK for devices. Follow the instructions in the R&S ScopeSuite, and refer to the test description in Chapter 4.1.1.5, "Test J/K, SE0_NAK", on page 61. Make sure to select "Hub" in the "HS Electrical Test Tool" (step 6).

4.2.1.11 Downstream test J/K, SE0_NAK

Table 4-19: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the hub you want to test	1

Item	Description, model	Quantity
Signal quality board, "Host Signal Quality" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

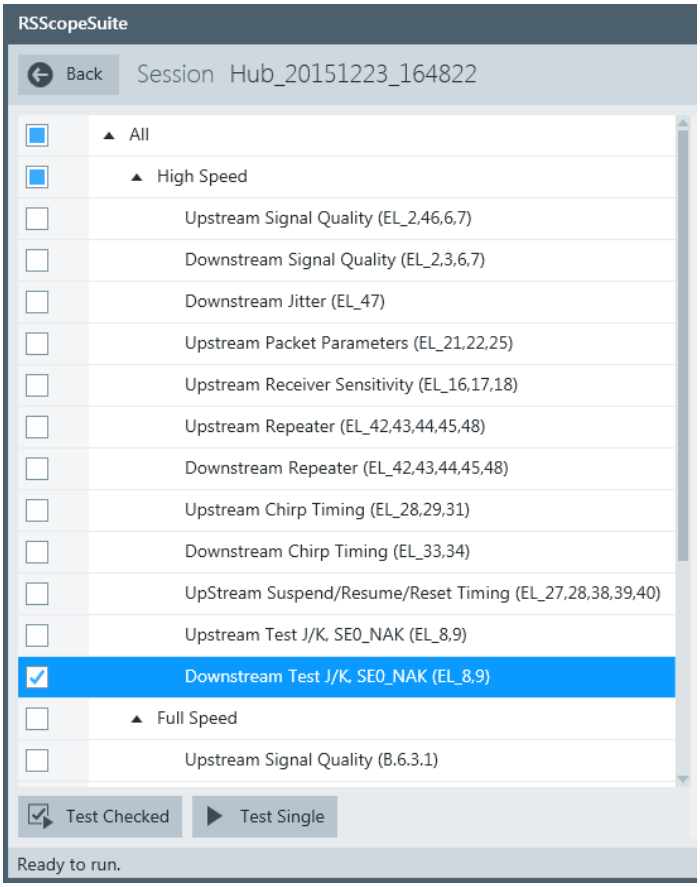
Test preparation

Before you run the test, complete the following actions:

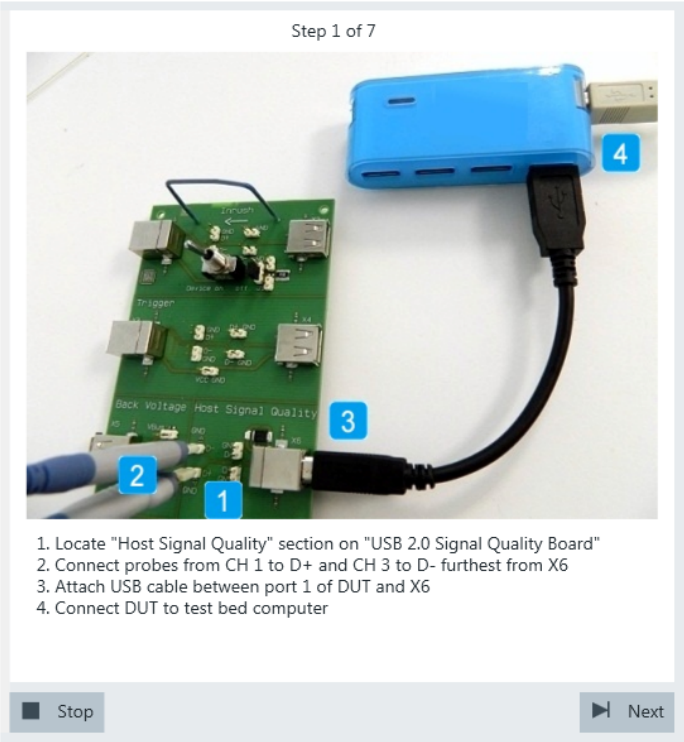
- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Downstream Test J/K, SE0_NAK (EL_8,9)" test case and click "Test Single".

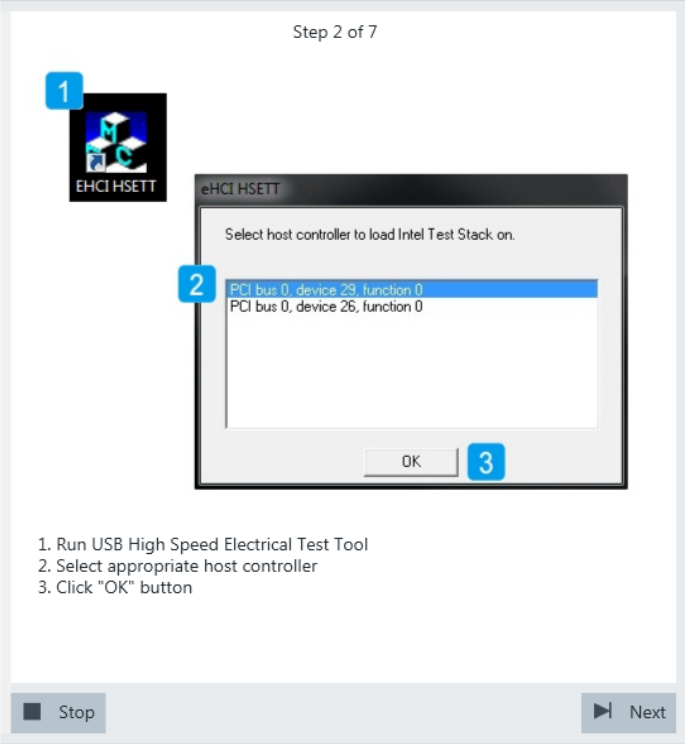


2. Connect the DUT to the test fixture as shown in the picture, and click "Next".

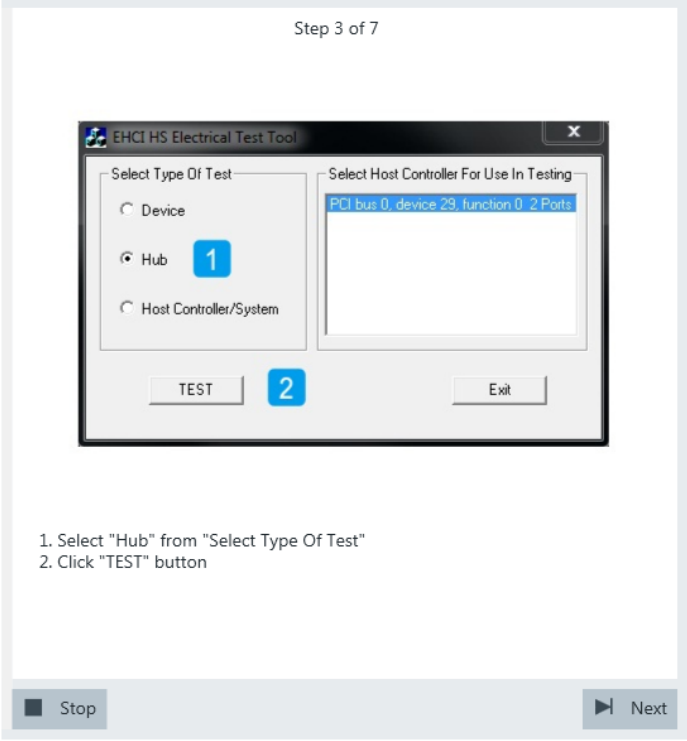


Use a 4-inch non-captive cable to connect the downstream port to test fixture.
If the DUT has a cable attached, plug it into the test bed computer directly. Otherwise, use a 1-meter cable to connect the upstream port to the test bed computer.

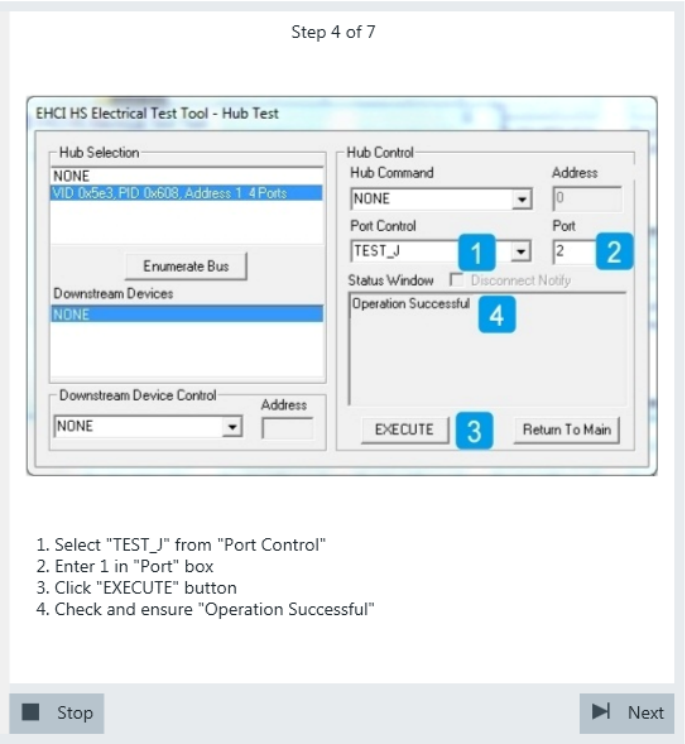
3. Start the HS Electrical Test Tool on the test bed computer.
4. Select the host controller to which the DUT is connected and click OK.
Note: the values in the list may vary.



5. Select "Hub" on the left side, and click "TEST"

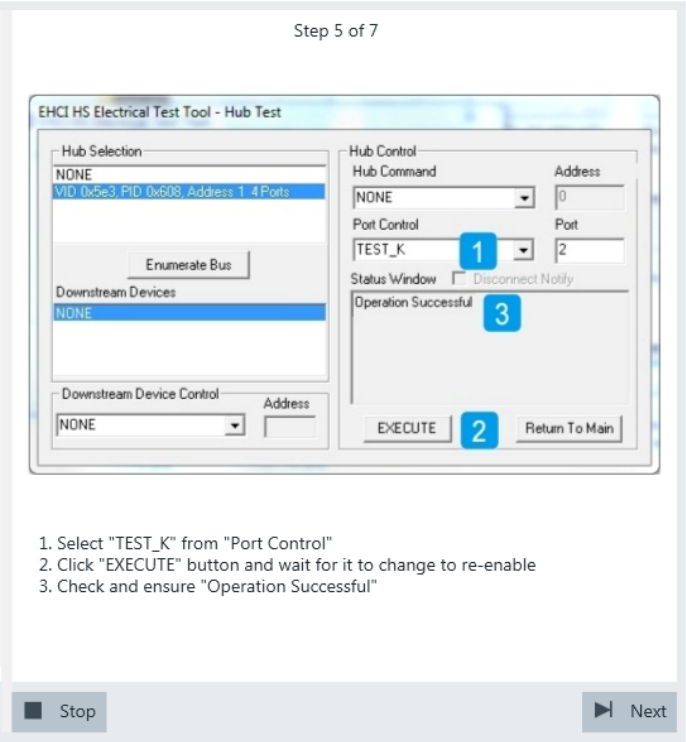


6. Configure the HS Electrical Test Tool as shown in the picture.



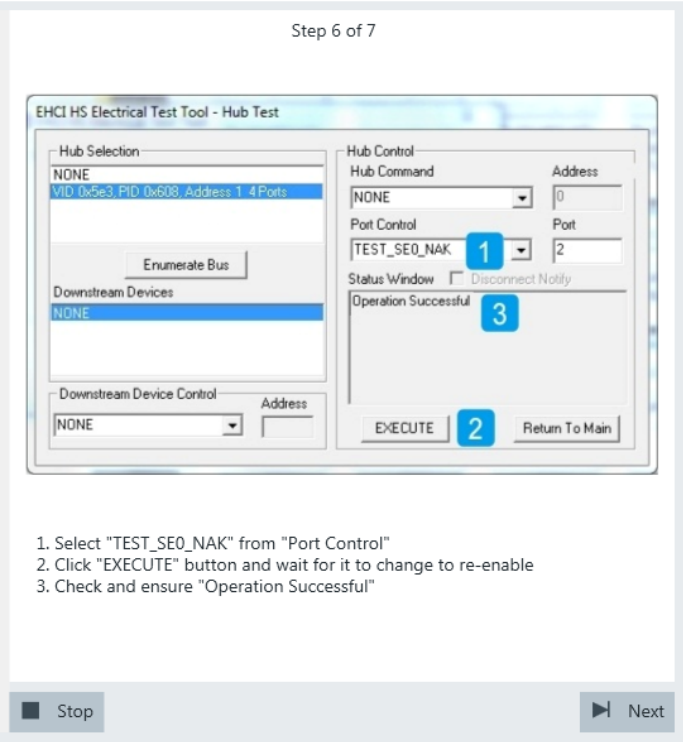
The probe at least 2 GHz bandwidth contains a built-in digital voltmeter known as ProbeMeter. The application automatically reads the voltages of D+ and D- from the ProbeMeter. However, if the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-.

7. Configure the HS Electrical Test Tool as shown in the picture.



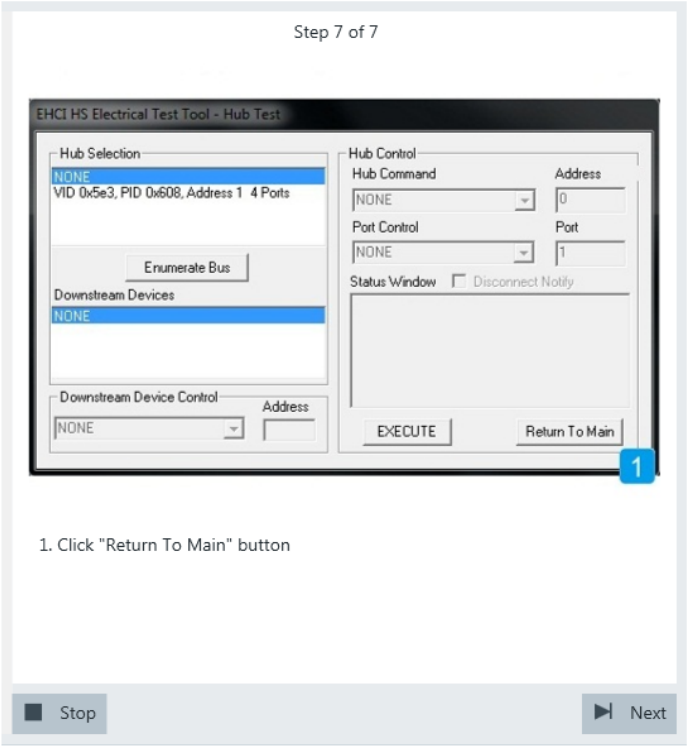
If the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-. Otherwise it automatically reads them from the ProbeMeter.

8. Configure the HS Electrical Test Tool as shown in the picture.



If the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-. Otherwise it automatically reads them from the ProbeMeter.

9. Proceed in the HS Electrical Test Tool as shown in the picture.



The results are saved and can be viewed in the report.

4.2.2 Full speed, low speed and legacy hub tests

In addition to the high-speed tests described in the preceeding chapter, the device under test must also pass a set of full speed and low speed compliance tests applicable to high-speed devices. The documentation of these legacy tests can be found in the "USB-IF Full and Low Speed Compliance Test Procedure" manual issued by the USB-IF. The manual is available at http://www.usb.org/developers.

To perform full speed and low speed compliance tests, you can use also a 4-channel R&S RTO/RTO6/RTP with less than 2 GHz bandwidth.

4.3 USB 2.0 Host tests

4.3.1 High-Speed Host Tests

4.3.1.1 Signal Quality

Table 4-20: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the host you want to test	1
Signal quality board, "Host Signal Quality" section or USB-IF USB2.0 hi-speed signal quality host test fixture	R&S RT-ZF1	1
Differential probe or a pair of matched SMA cables if USB-IF host test fixture is used	at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

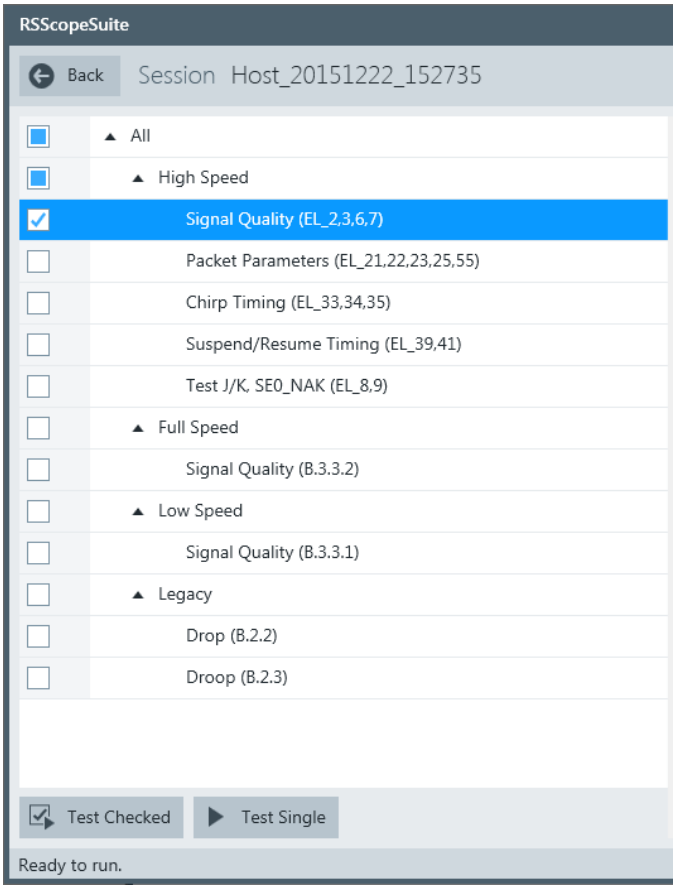
Test preparation

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Signal Quality (EL_2,3,6,7)" test case and click "Test Single".



2. Connect the DUT to the test fixture as shown in the picture.

Figure 4-11: R&S RT-ZF1: connection to DUT

Use a 4-inch non-captive cable to connect the DUT to the test fixture.

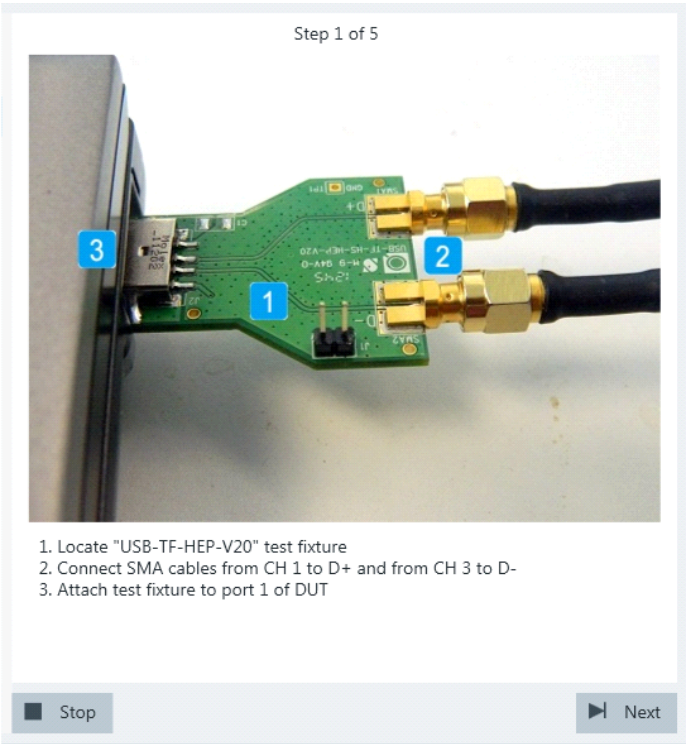
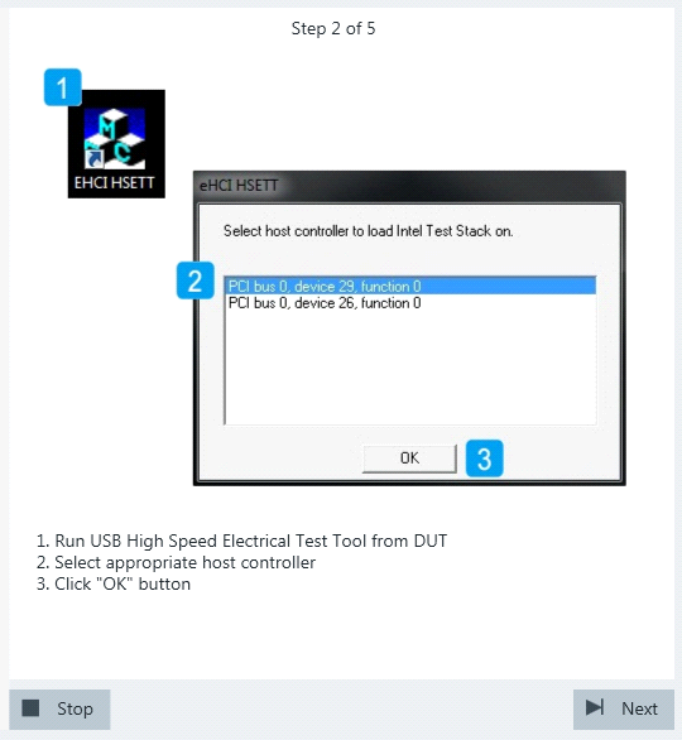
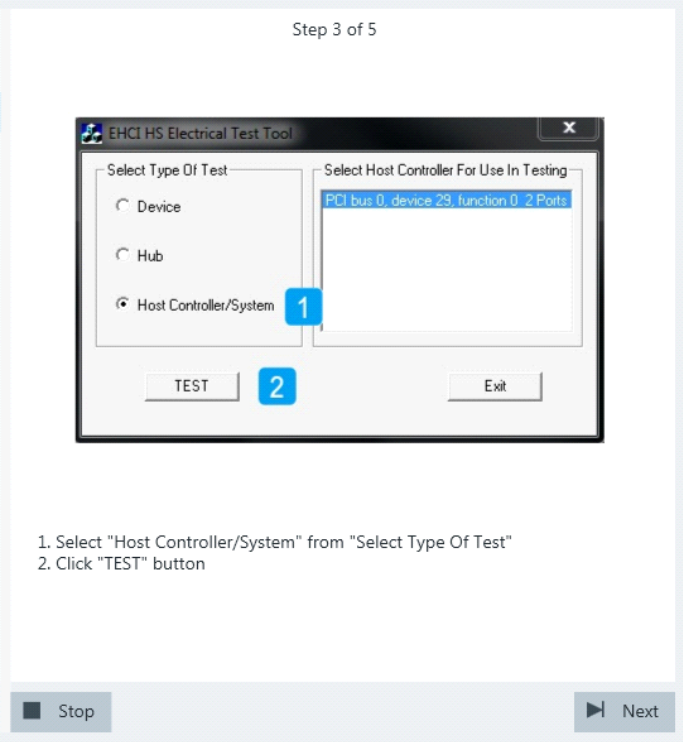


Figure 4-12: USB-IF USB2.0 Hi-Speed Signal Quality host test fixture: connection to DUT

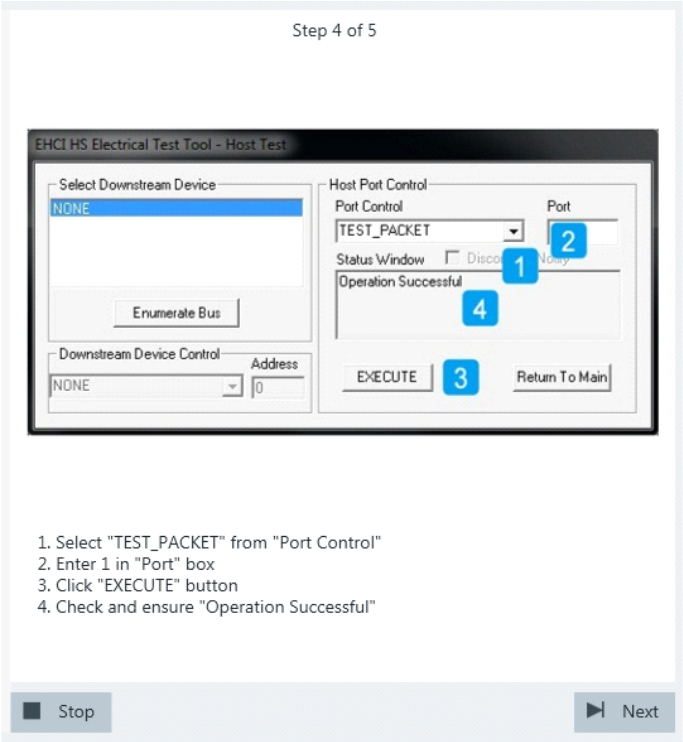
3. Click "Next".
4. Start the HS Electrical Test Tool on the DUT.
5. Select the DUT from the list of host controllers and click OK.
   Note: the values in the list may vary.



6. Select "Host Controller/System" on the left side.
   Click "TEST".

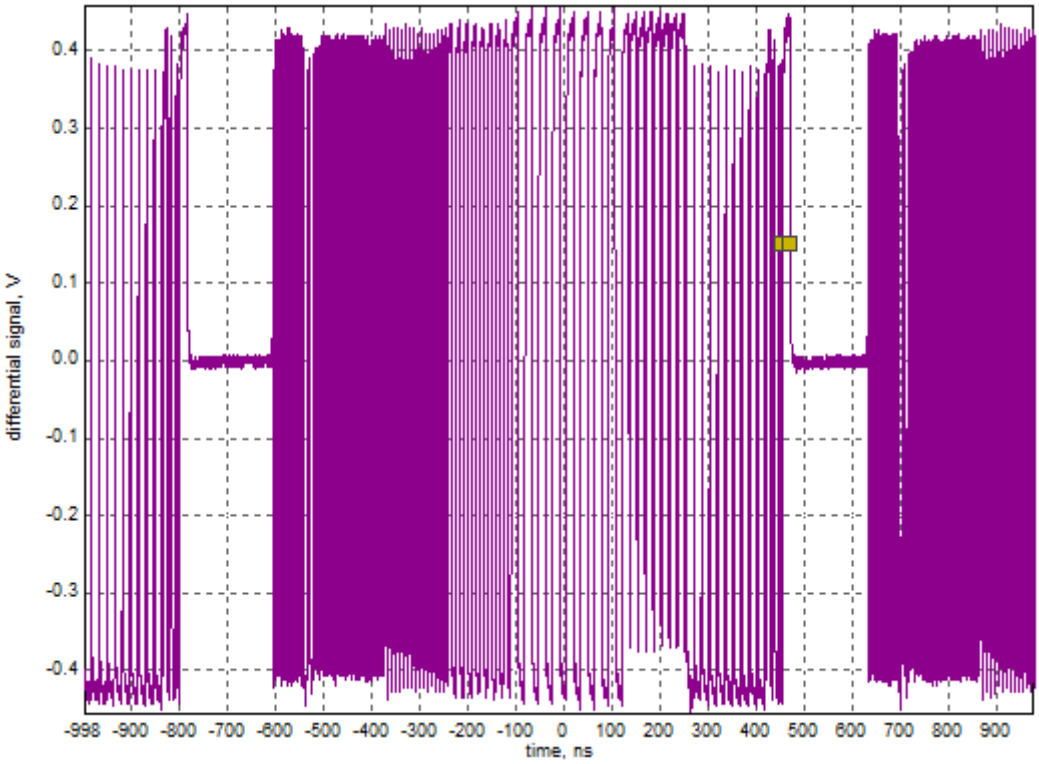


7. Select "Test_Packet" from "Port Control".
   Enter the "Port" of the host you are testing.
   Click "EXECUTE" and wait until "Operation Successful" is shown under "Status Window".

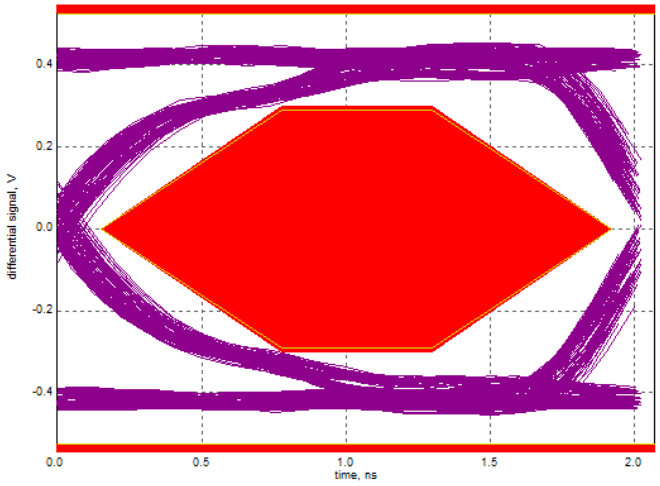


8. Click Next.

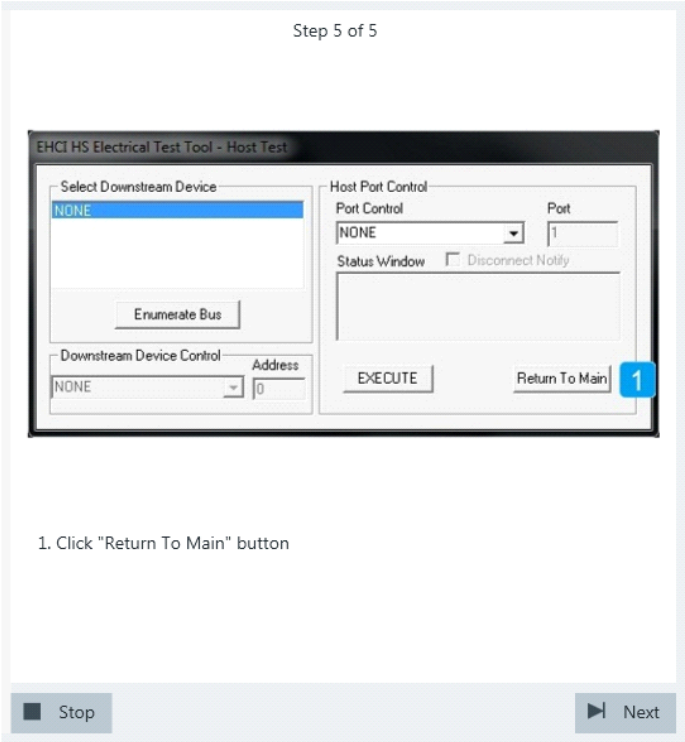
   The DUT sends Test Packets that look like this:



9. These packages are analyzed in an eye diagram.



10. In the Electrical Test Tool, return to the "Main" menu.



The results are saved and can be viewed in the report.

4.3.1.2 Packet Parameters

Table 4-21: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the host you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Differential probe	at least 2 GHz bandwidth	1
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1
USB Device	known good device	1

Test preparation

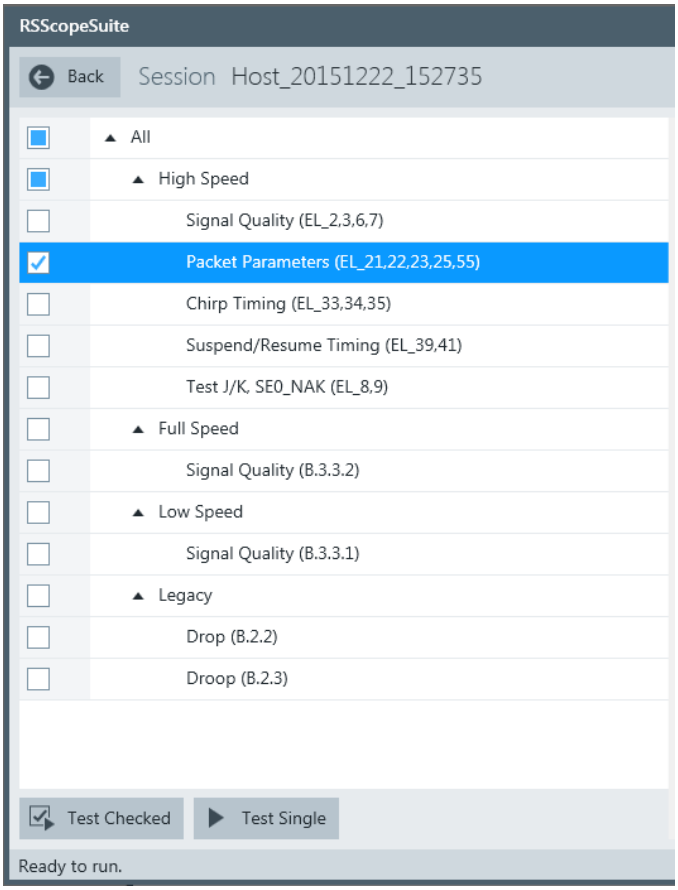
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13

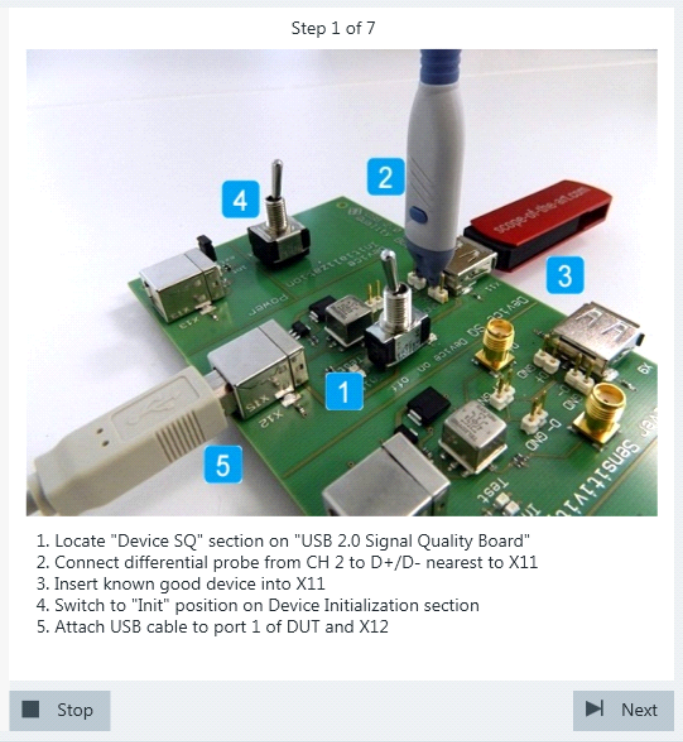
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Packet Parameters (EL_21,22,23,25,55)" test case and click "Test Single".

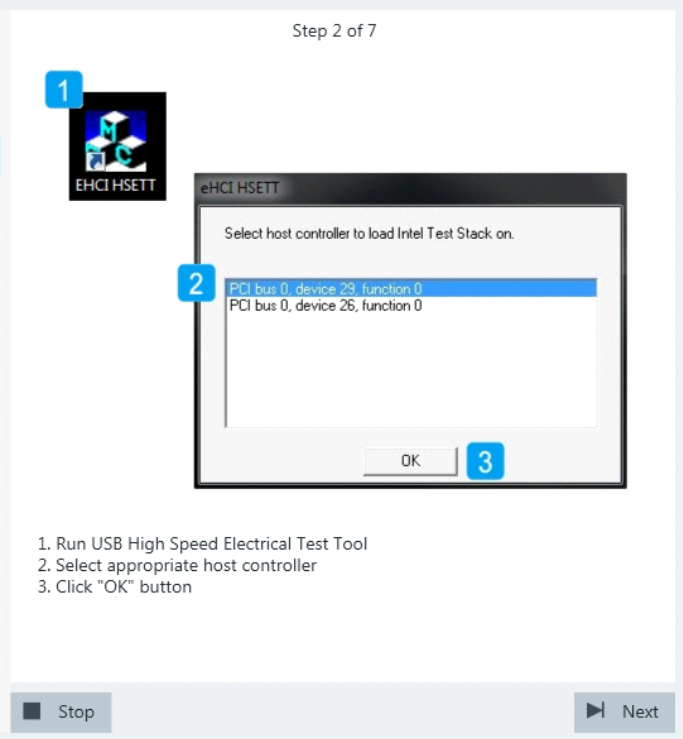


2. Connect the DUT to the test fixture as shown in the picture.

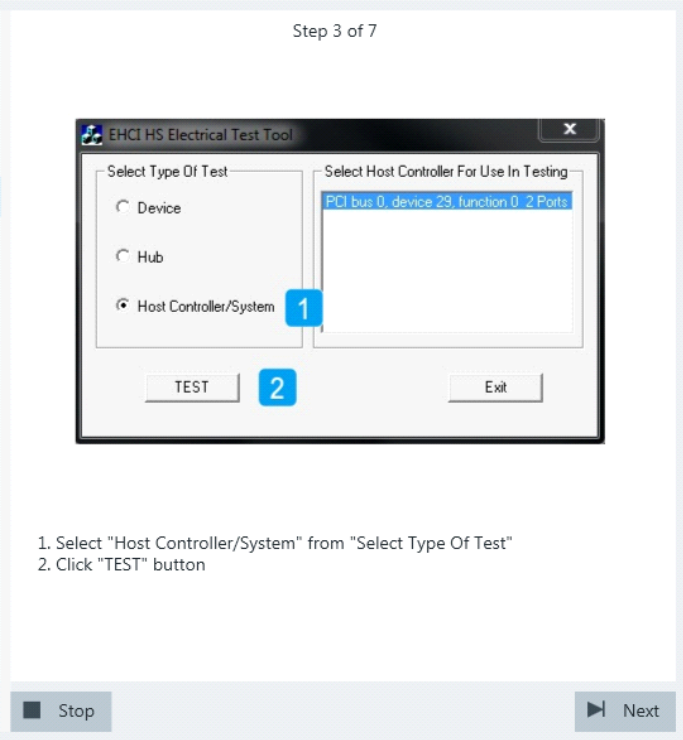


Use a 4-inch non-captive cable to connect the DUT to the test fixture.

3. Click "Next".
4. Start the HS Electrical Test Tool on the DUT.
5. Select the DUT from the list of host controllers and click OK.
   Note: the values in the list may vary.

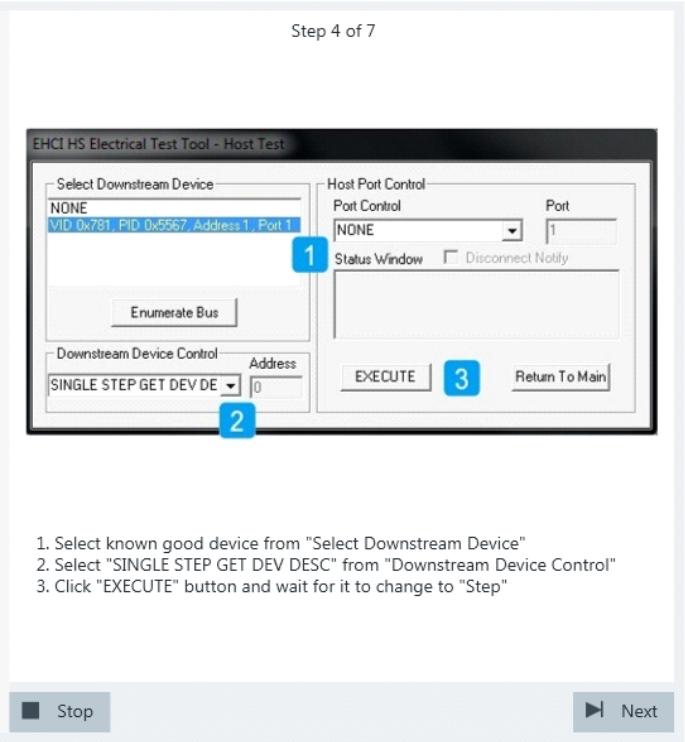


6. Select "Host Controller/System" on the left side.
   Click "TEST".

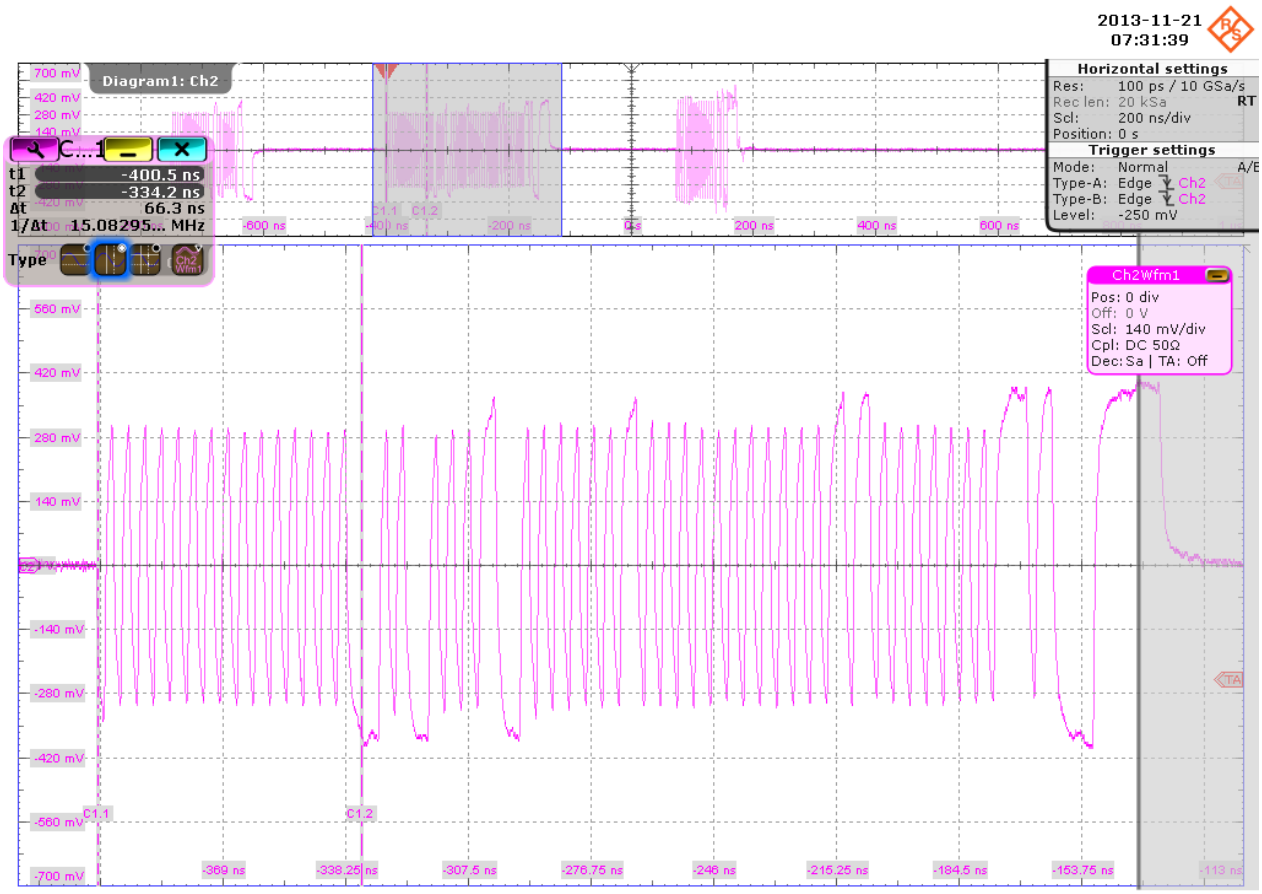


7. Select known good device from "Select Downstream Device".
   Select "SINGLE STEP GET DEV DESC" from "Downstream Device Control".

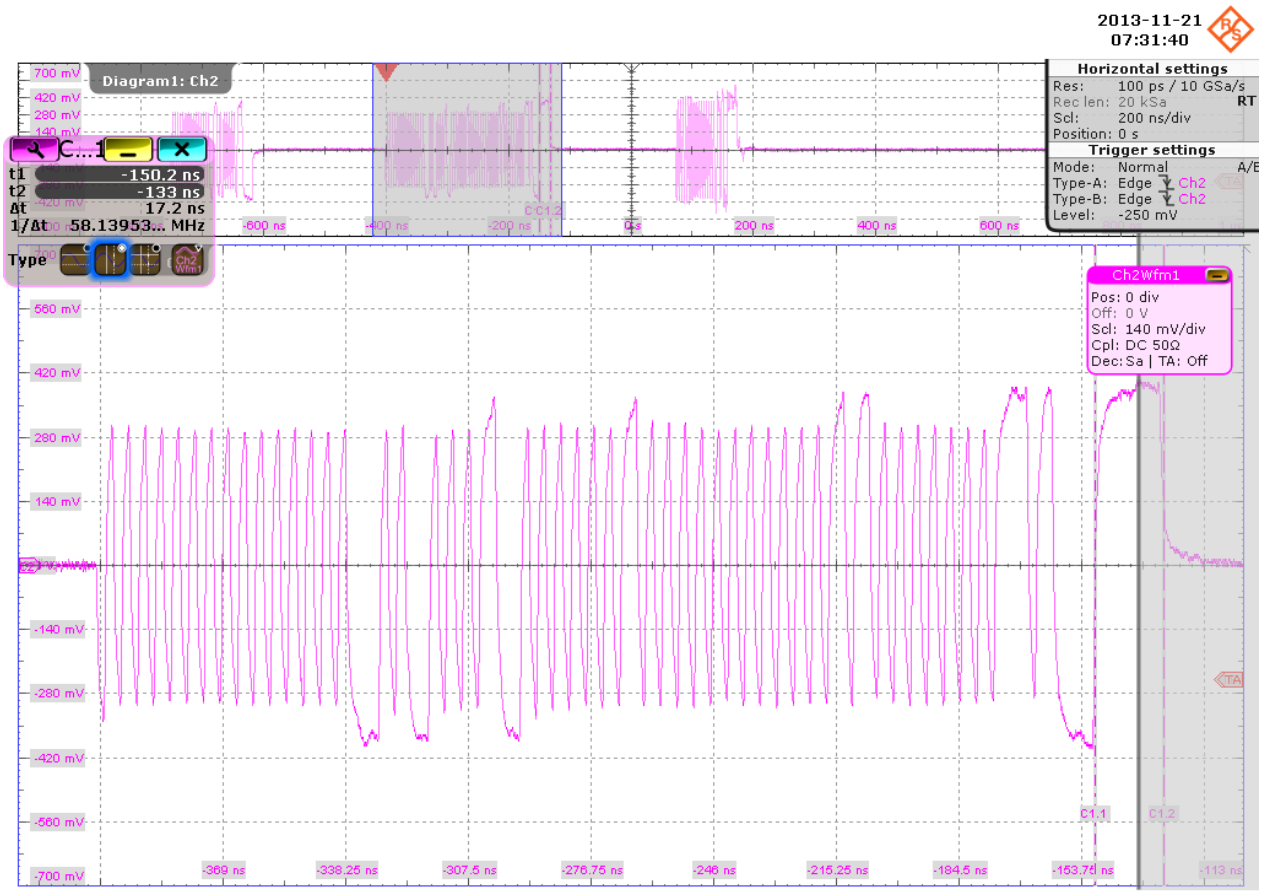
Click "EXECUTE" and wait until "Step" is shown on the button.



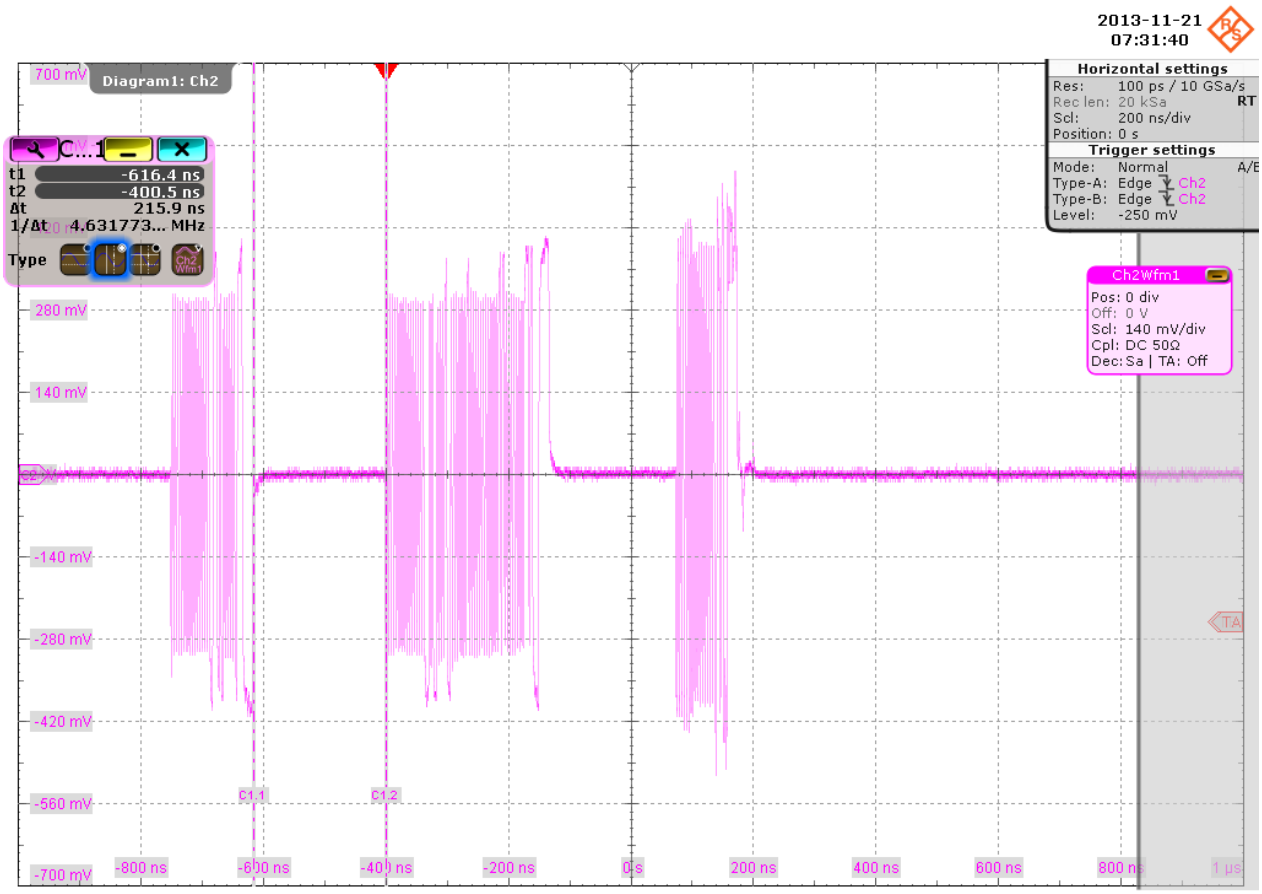
A waveform is captured as pictured below.



The first packet on the left is an "IN" packet sent by the DUT. It is followed by a "Get Device Descriptor" packet (middle) also sent from the DUT. On the right you can see the answer from the known good device with higher amplitude than the packets from the DUT.
The application counts the number of bits in the "Get Device Descriptor" packet SYNC field by measuring the duration of the first 30.5 pulses (the 31st pulse contains 4 'K's). This is EL_21.

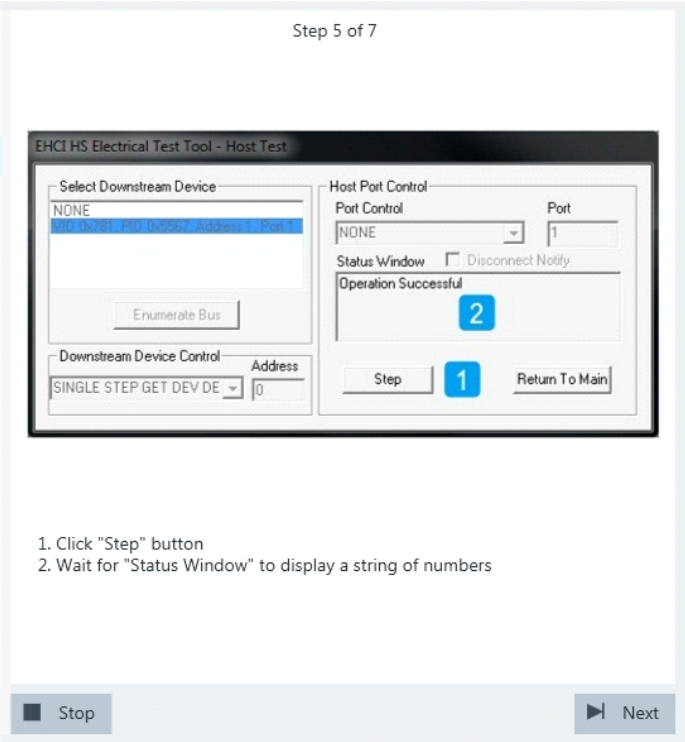


The application counts the number of bits in the "Get Device Descriptor" packet EOP field by measuring the duration of the widest pulse. This is EL_25.

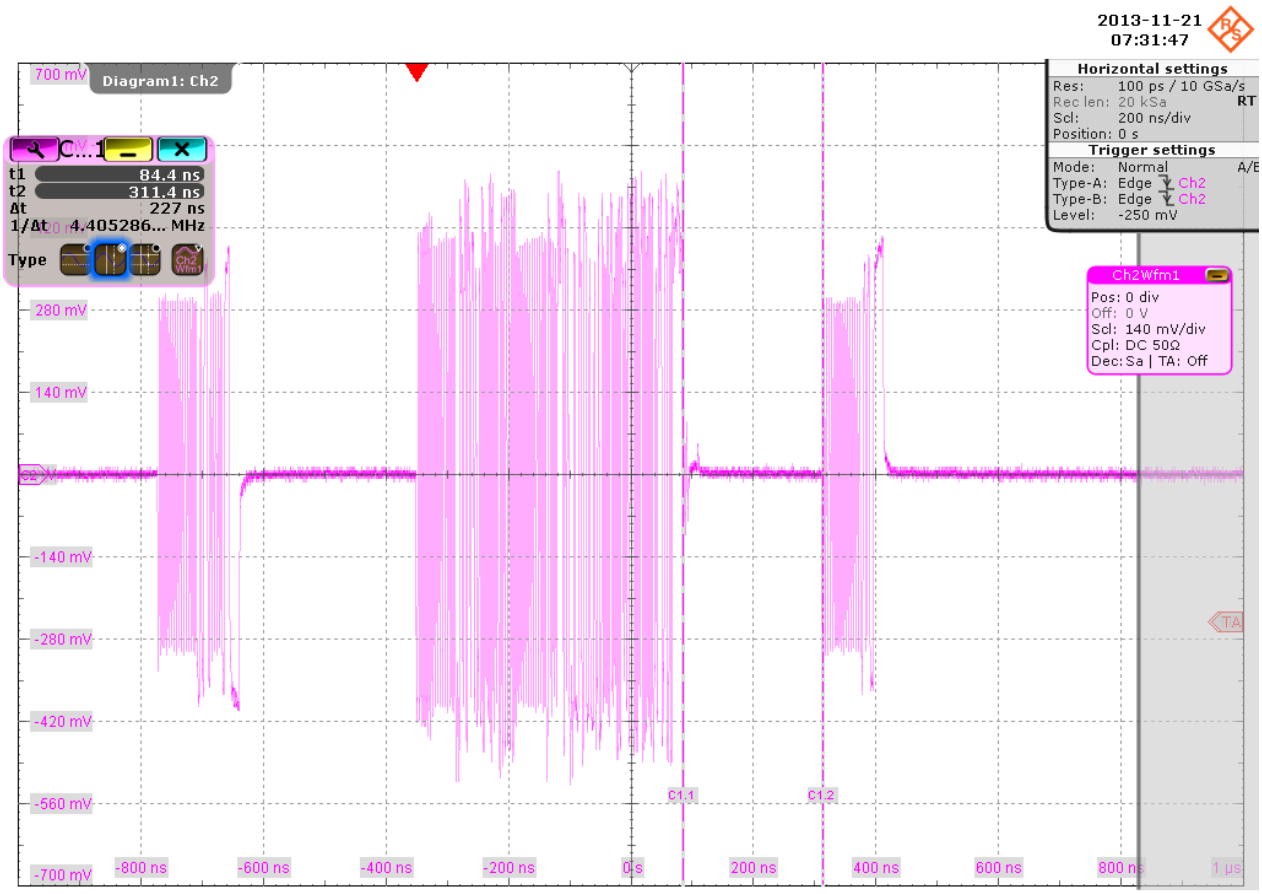


The application measures the time between the “IN” packet and the "Get Device Descriptor” packet. This is EL_23.

8. Click "Next".
9. Click "Step" and wait until a string of numbers is shown under "Status Window".

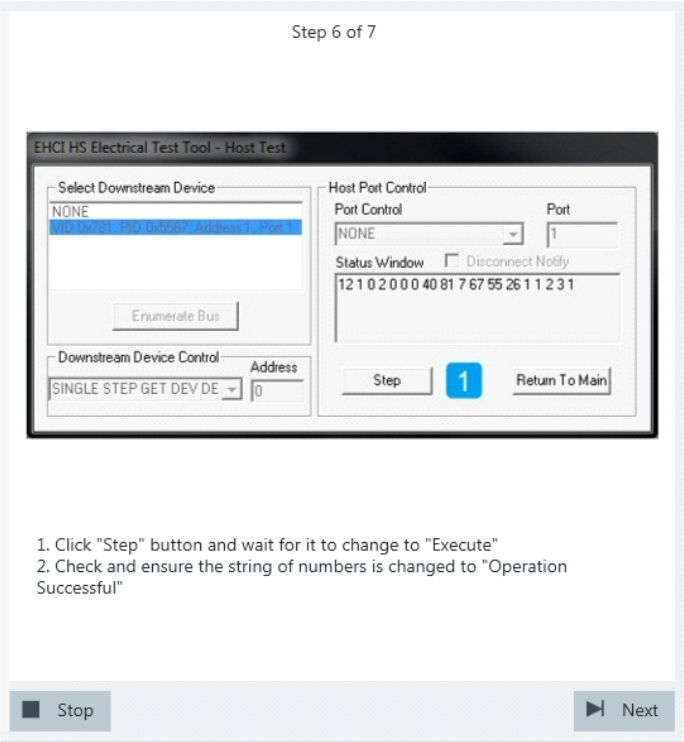


A waveform is captured as pictured below.

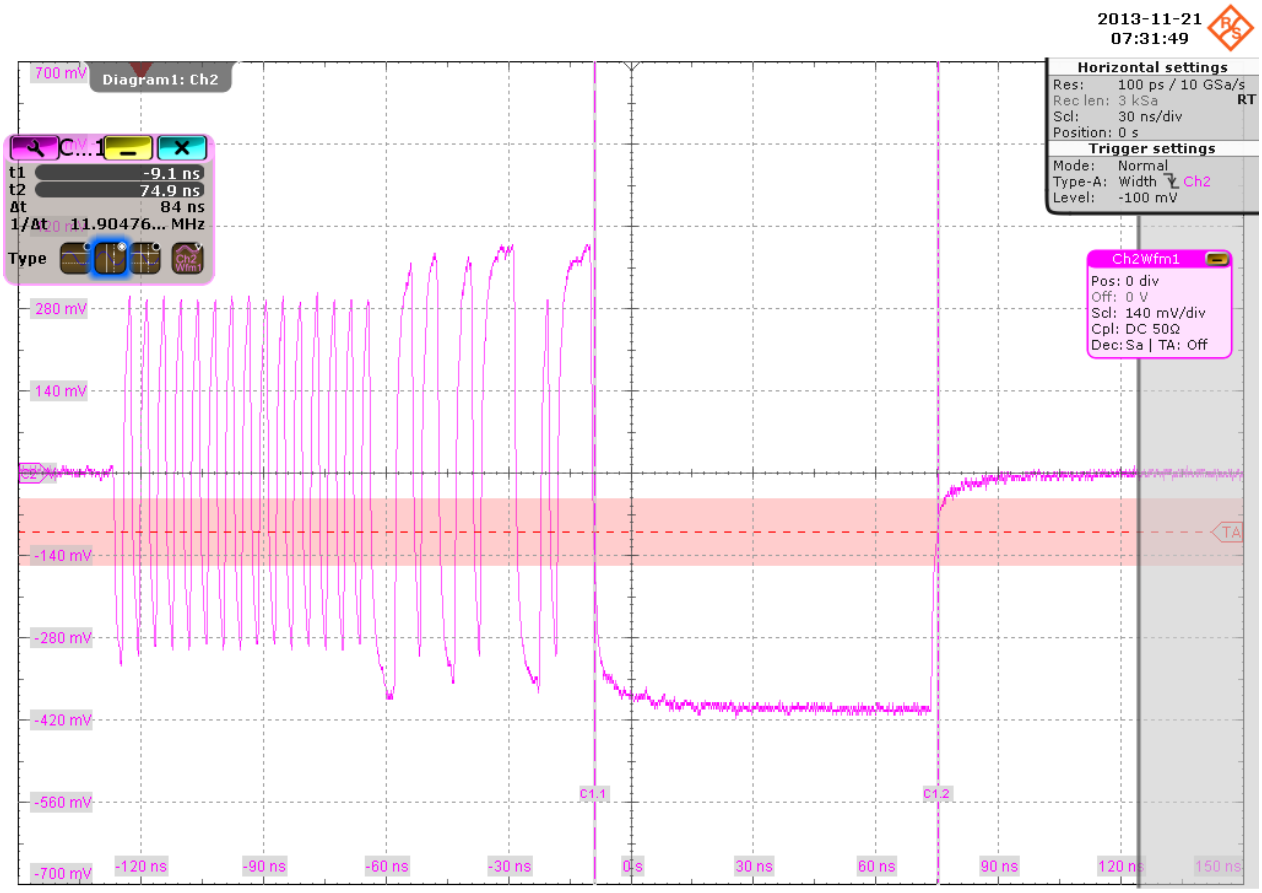


The second packet in the middle is sent by the known good device. The last packet on the right is the acknowledgement packet from the DUT.
The application measures the time between these two packets. This is EL_22.

10. Click "Step" and wait until "Execute" is shown on the button.
    Ensure that the string of numbers is replaced by "Operation Successful" in the "Status Window".

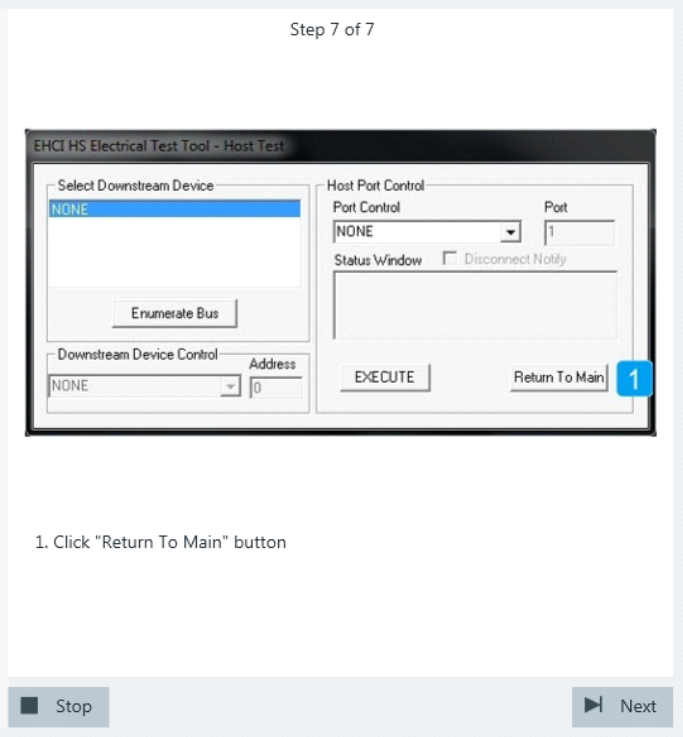


A waveform is captured as pictured below.



This is a “Start of Frame” packet sent by the DUT. The application counts the number of bits in the EOP field by measuring the duration of the widest pulse. This is EL_55.

11. Return in the HS Electrical Test Tool to the Main menu.



The results are saved and can be viewed in the report.

4.3.1.3 Chirp Timing

Table 4-22: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the host you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1
USB Device	known good device	1

Test preparation

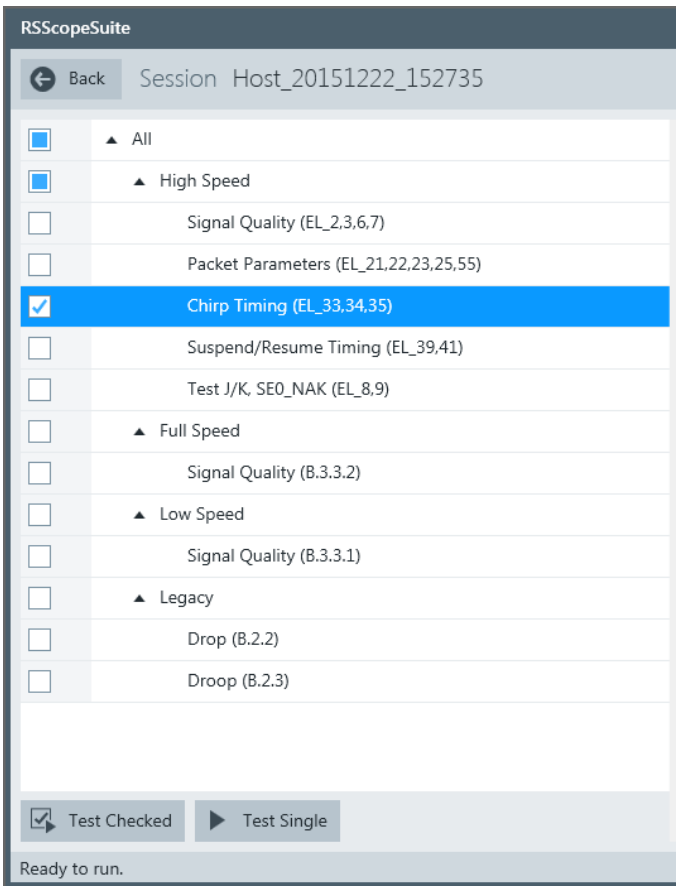
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13

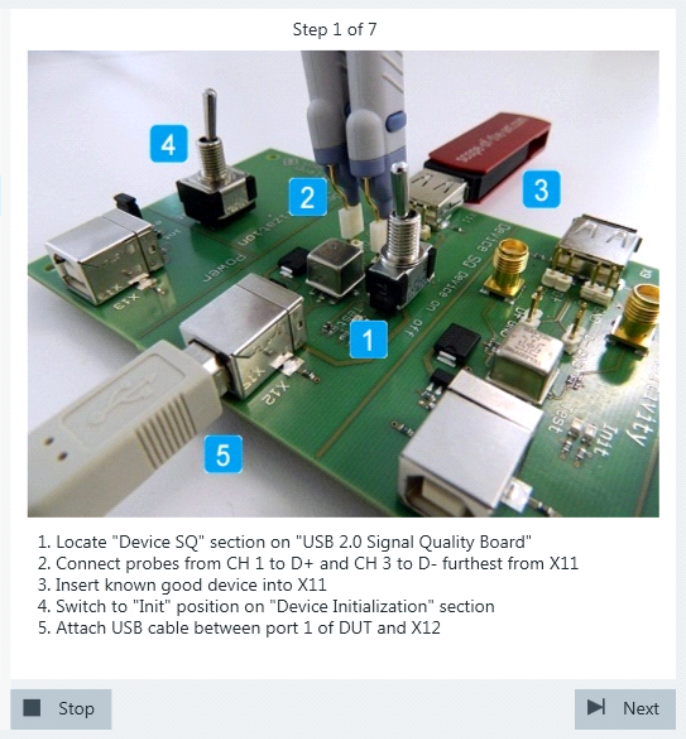
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Chirp Timing (EL_33,34,35)" test case and click "Test Single".

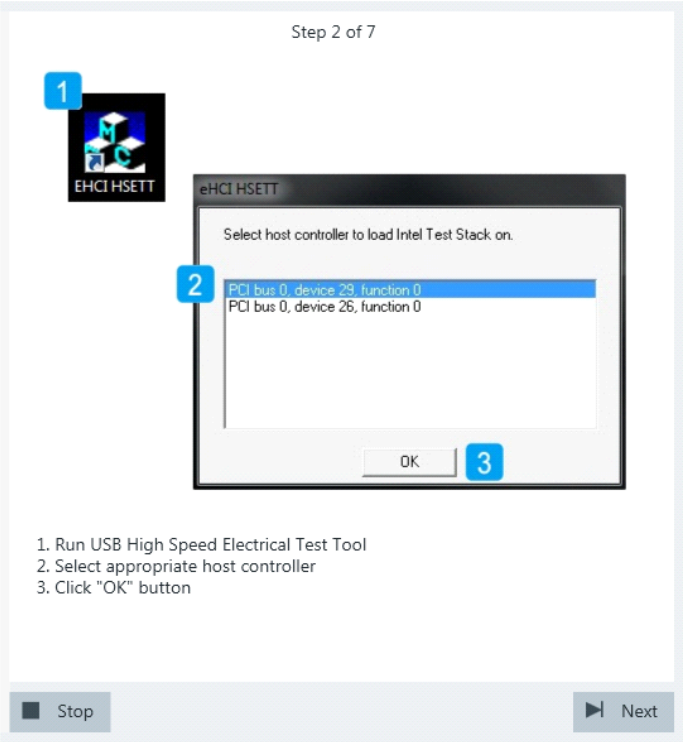


2. Connect the DUT to the test fixture as shown in the picture.

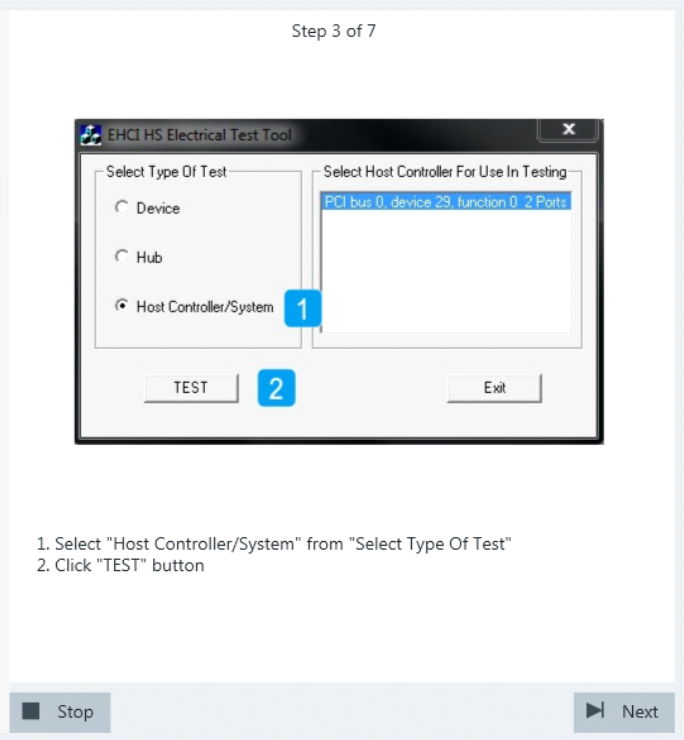


Use a 4-inch non-captive cable to connect the DUT to the test fixture.

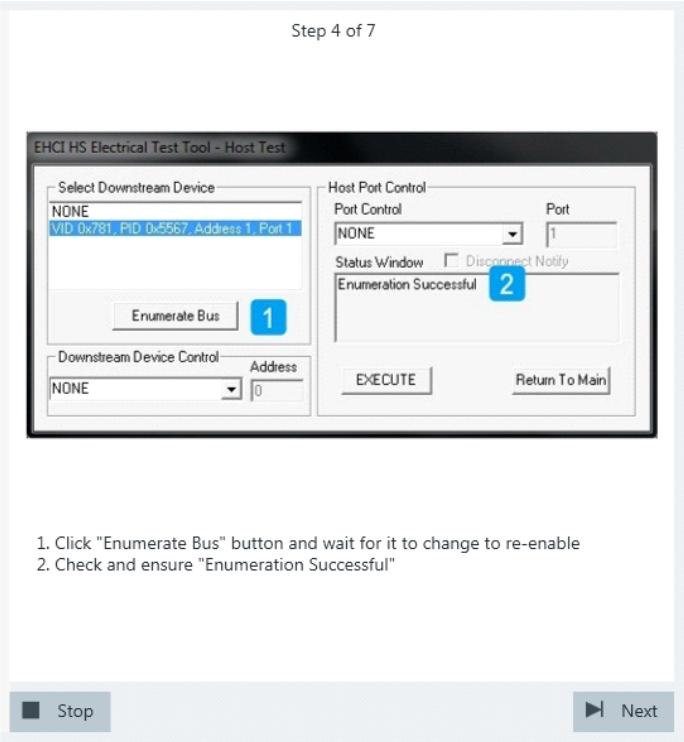
3. Click "Next".
4. Start the HS Electrical Test Tool on the DUT.
5. Select the DUT from the list of host controllers and click OK.
   Note: the values in the list may vary.



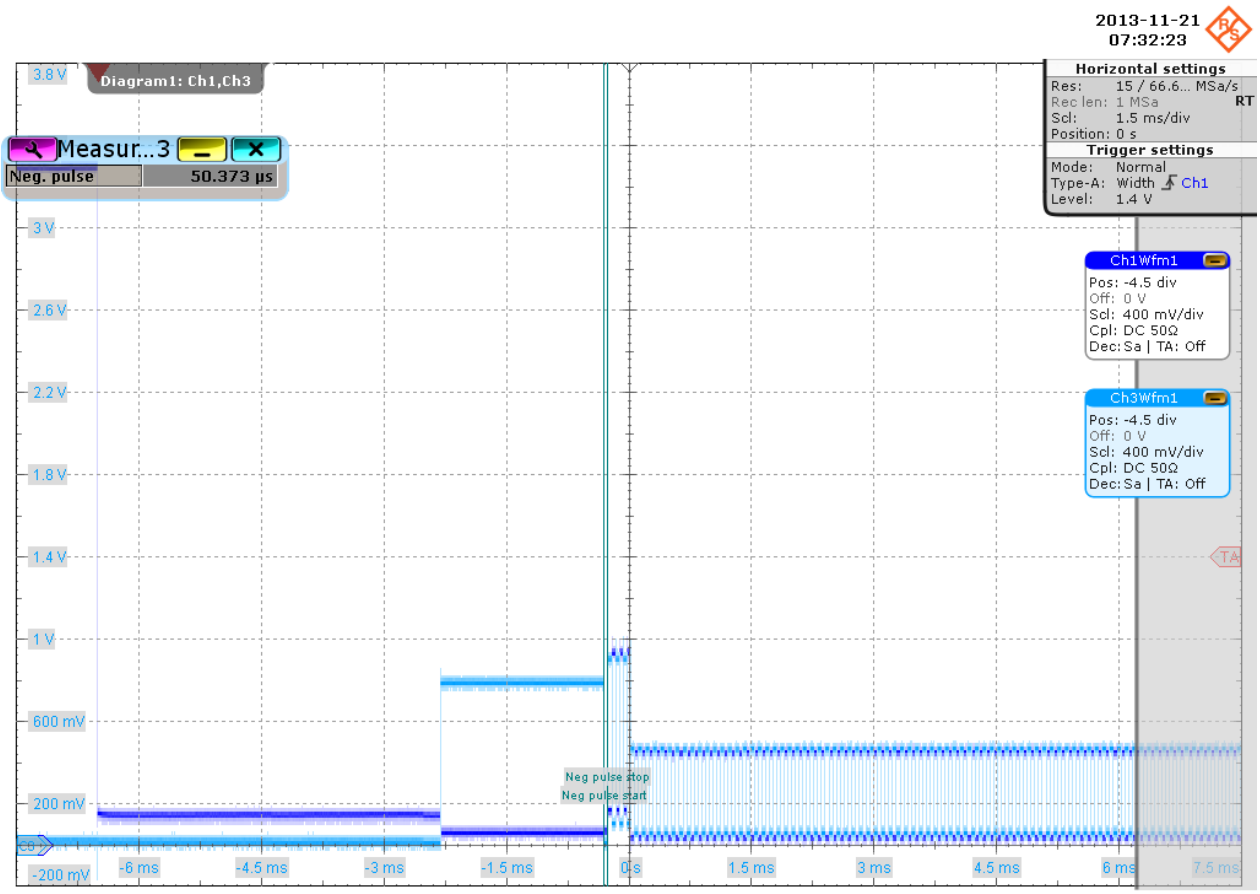
6. Select "Host Controller/System" on the left side.
   Click "TEST".



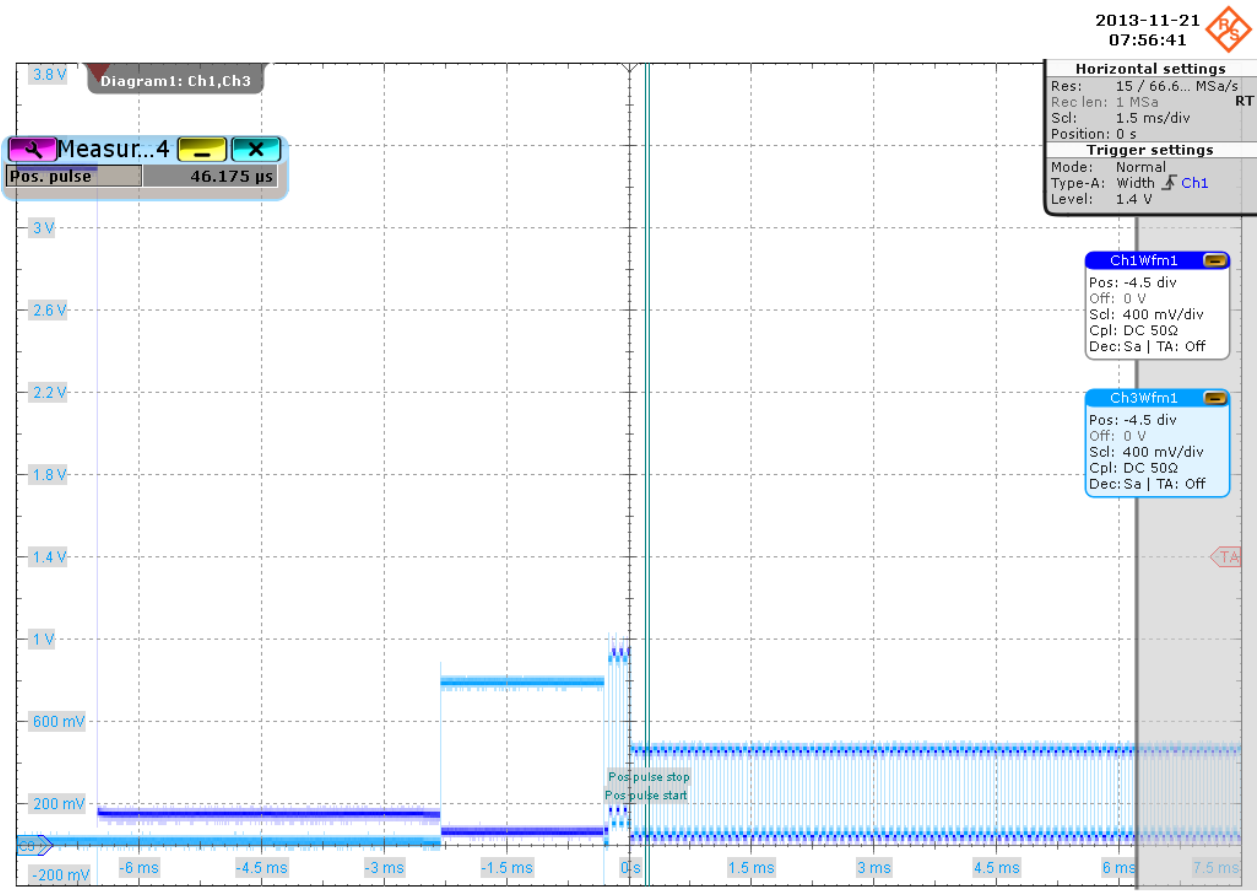
7. Click "Enumerate Bus" and wait until it re-enables.
   Make sure that "Operation Successful" is shown under "Status Window".



Waveforms are captured as pictured below.

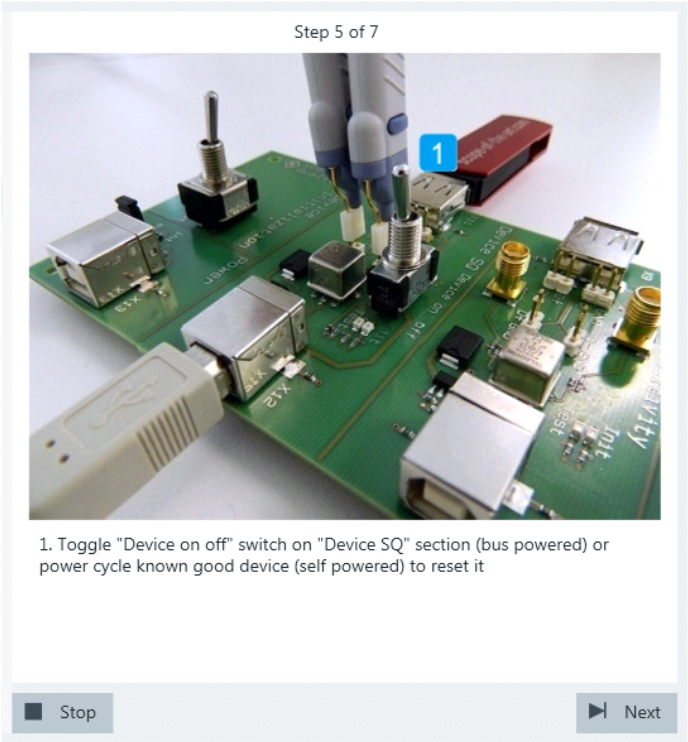


The pulse in the middle is the Chirp K from the known good device. The alternating sequence of Chirp K's and J's are sent by the DUT.
The application measures the time between the known good device Chirp K and the start of the alternating sequence of Chirp K's and J's. This is EL_33.

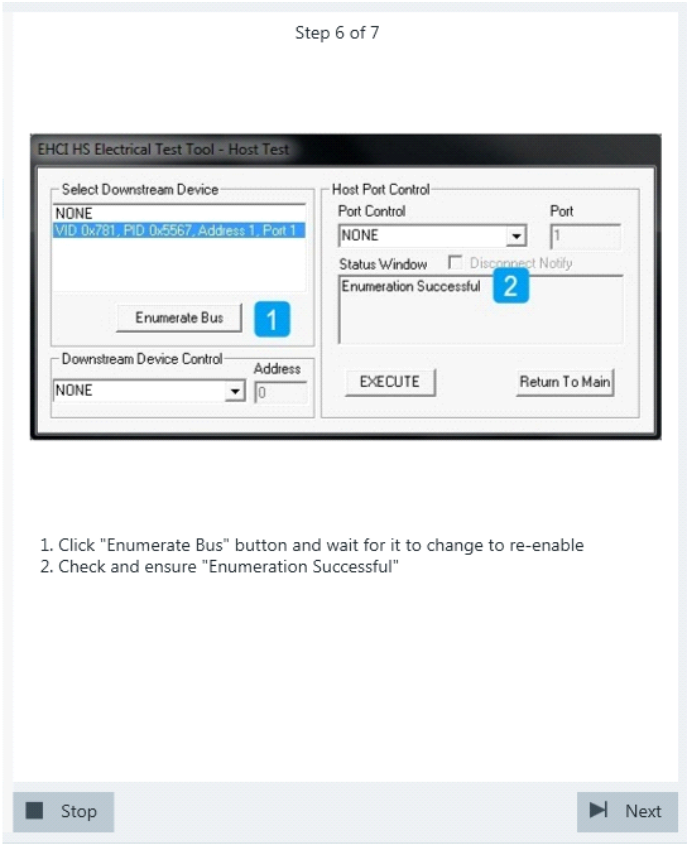


The application measures the durations of the alternating sequence of Chirp K's and J's captured in the waveforms. This is EL_34.

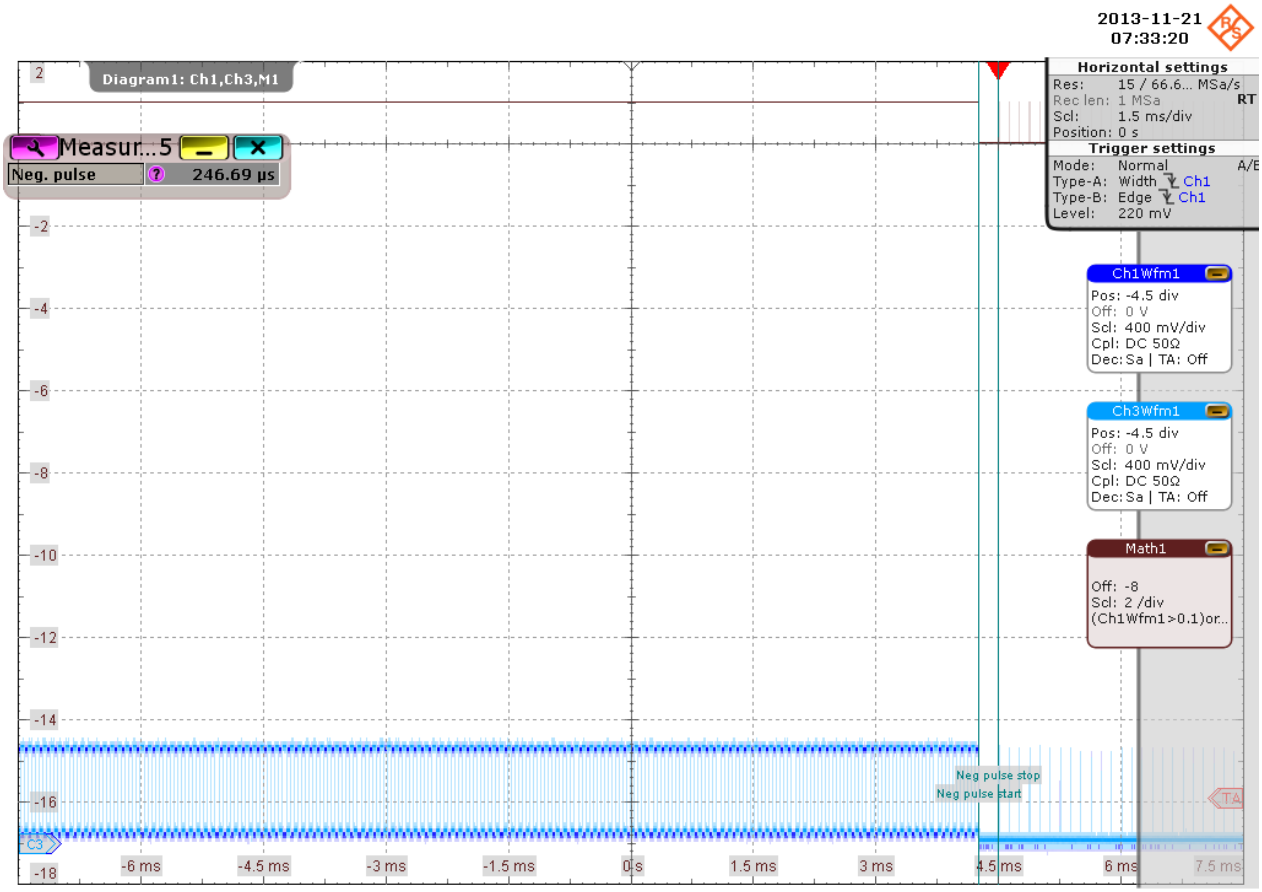
8. Click "Next".
9. Reset the known good device.
   If it is bus-powered, simply toggle the "Device SQ" section's "Device on off" switch.
   If it is self-powered, switch it off and switch it back on.



10. Click "Enumerate Bus" and wait until it re-enables.
    Make sure that "Operation Successful" is shown under "Status Window".

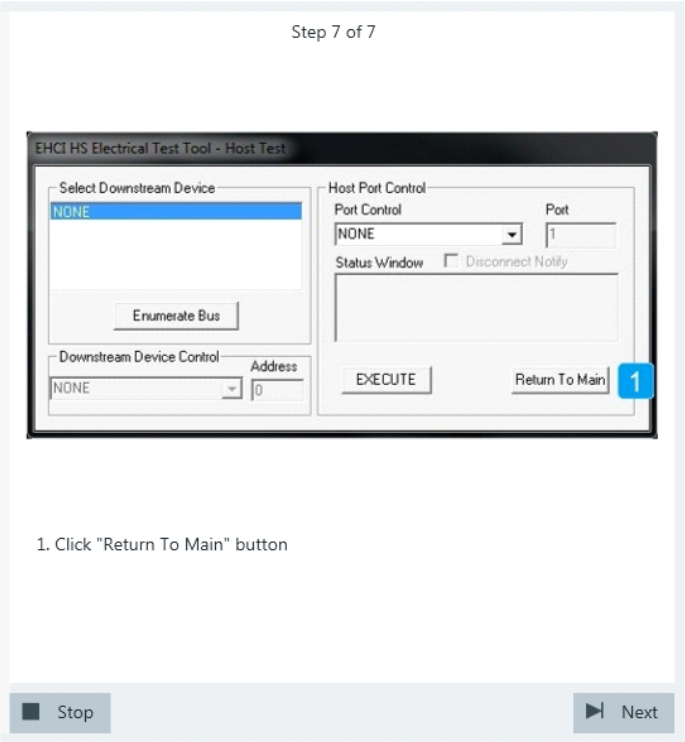


Waveforms are captured as pictured below.



Shortly after the last chirp, the DUT starts sending “Start of Frame” packets. The application measures the time between the last chirp and the first “Start of Frame” packet. This is EL_35.

11. Return in the HS Electrical Test Tool to the Main menu.



The results are saved and can be viewed in the report.

4.3.1.4 Suspend/Resume Timing

Table 4-23: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the host you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1
USB Device	known good device	1

Test preparation

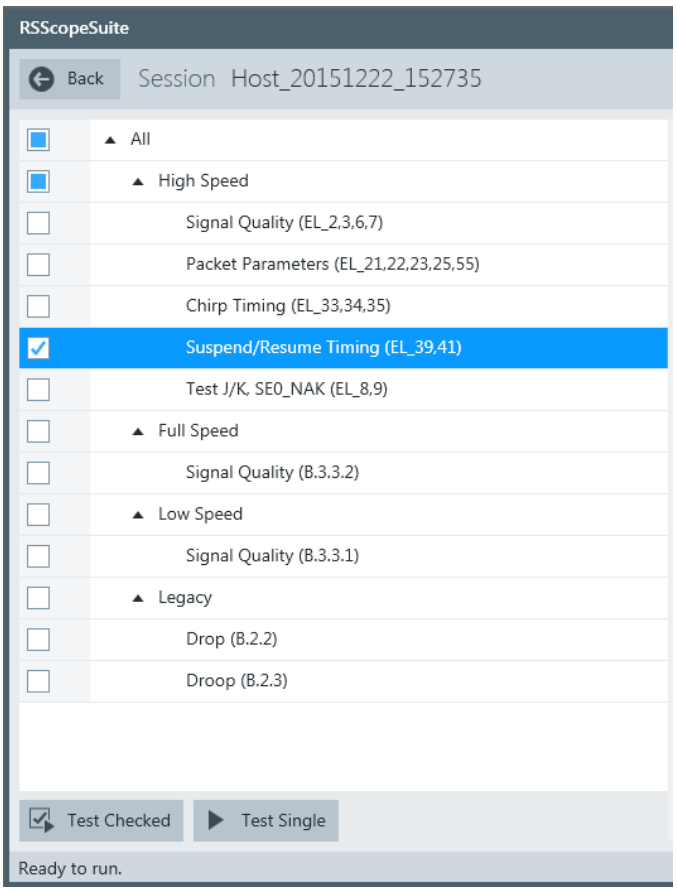
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13

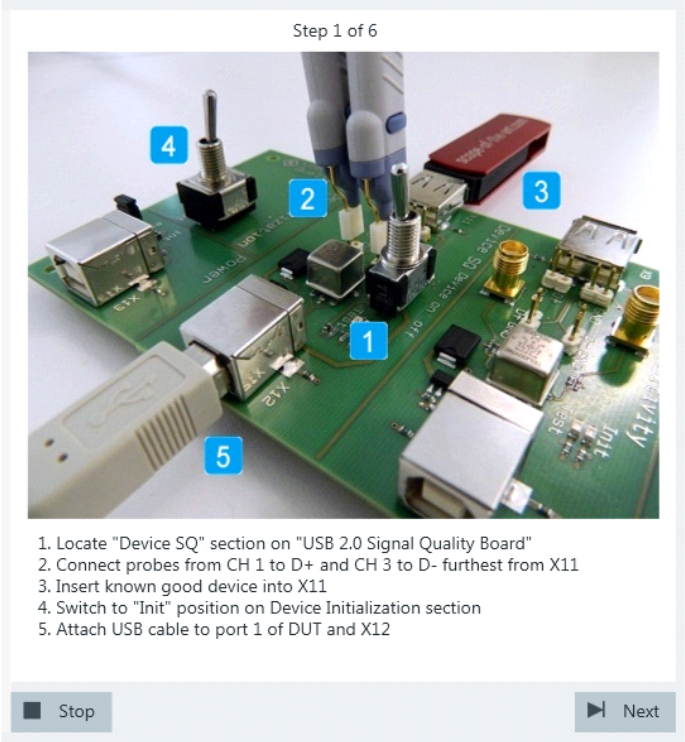
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Suspend/Resume Timing (EL_39,41)" test case and click "Test Single".

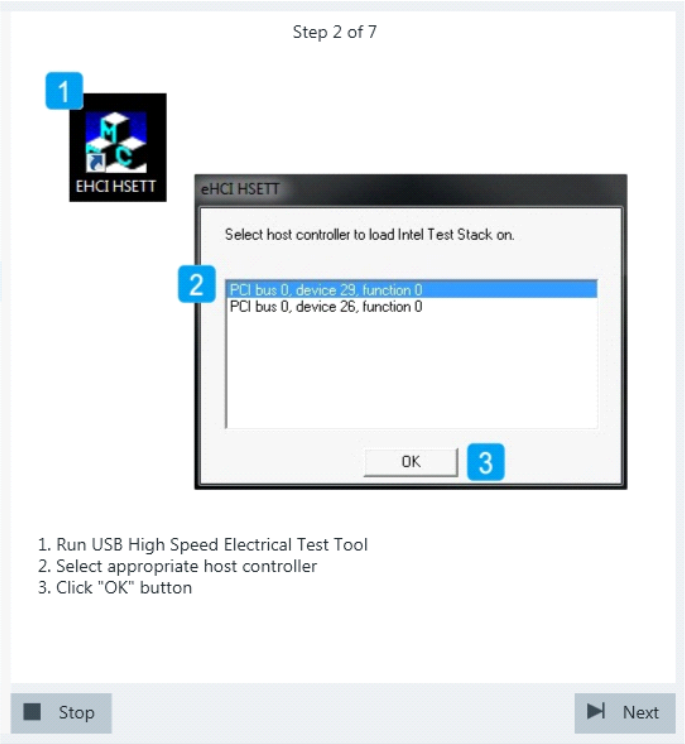


2. Connect the DUT to the test fixture as shown in the picture.

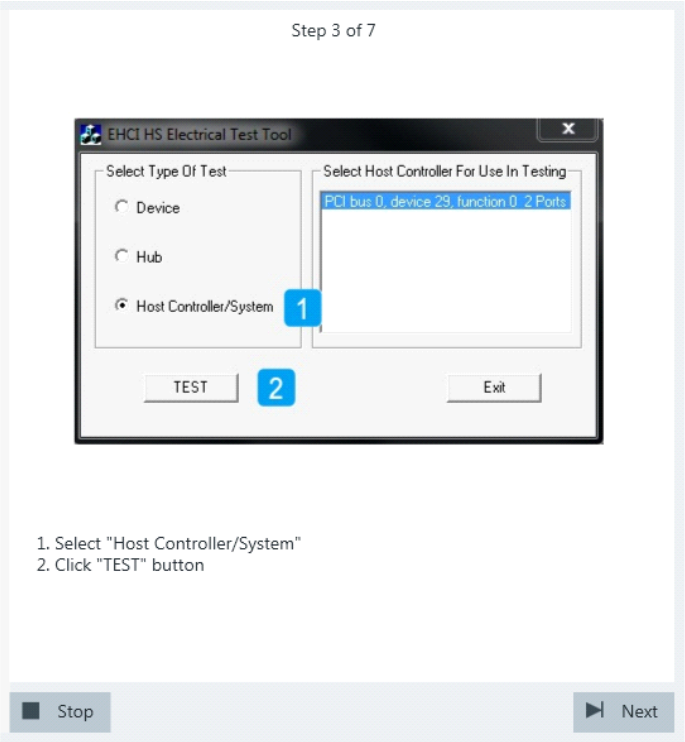


Use a 4-inch non-captive cable to connect the DUT to the test fixture.

3. Click "Next".
4. Start the HS Electrical Test Tool on the DUT.
5. Select the DUT from the list of host controllers and click OK.
   Note: the values in the list may vary.

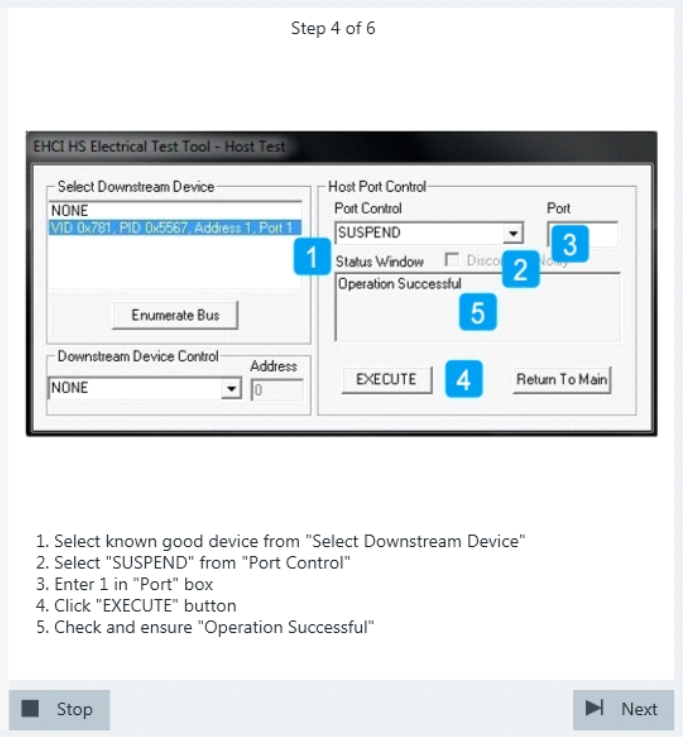


6. Select "Host Controller/System" on the left side.
Click "TEST".

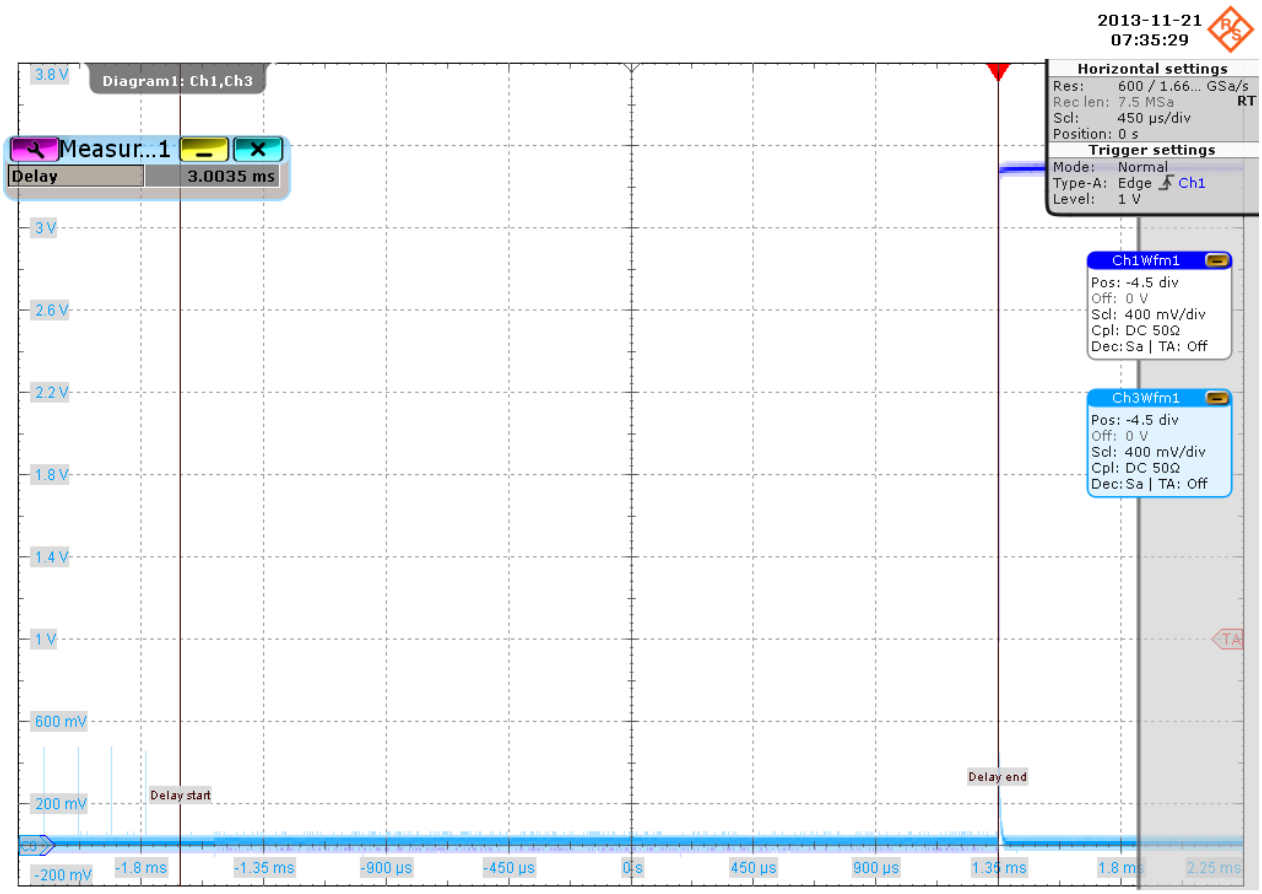


7. Select known good device from "Select Downstream Device".
Select "SUSPEND" from "Port Control".

Enter the “Port” number of the DUT you are testing.
Click "EXECUTE" and wait until "Operation Successful" in the "Status Window" is shown.

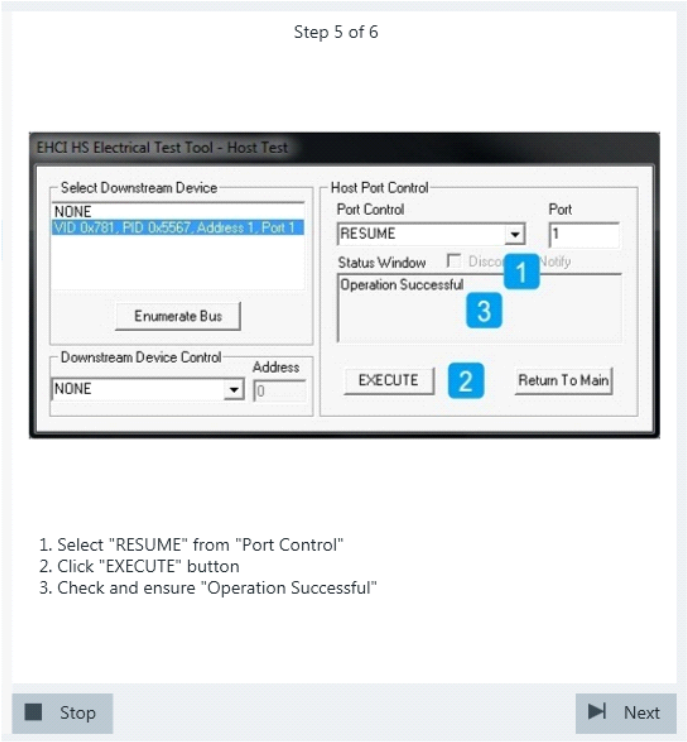


Waveforms are captured as pictured below.

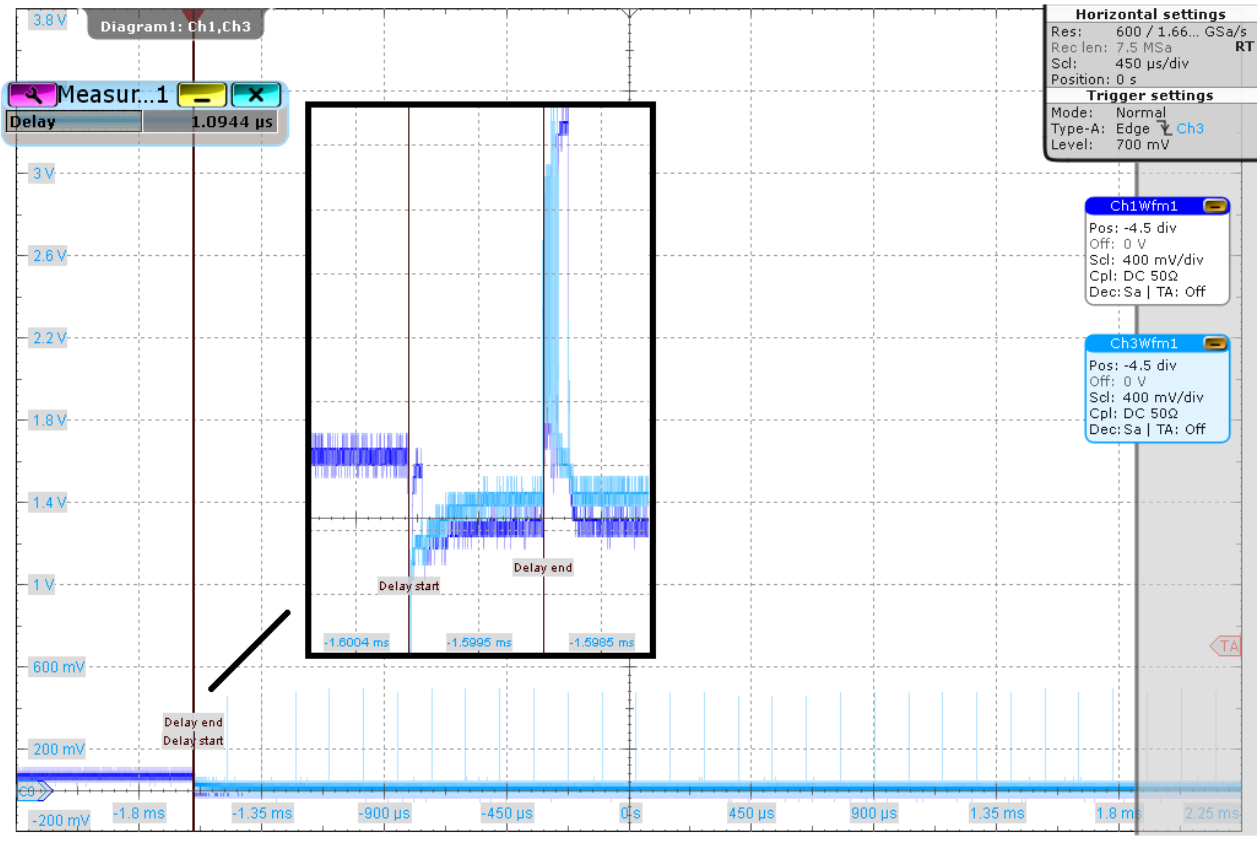


The application measures the time between the last falling edge of the last “Start of Frame” packet and the start of the suspended state. This is EL_39.

8. Click "Next".
9. Select "RESUME" from "Port Control".
   Click "EXECUTE" and wait until "Operation Successful" in the "Status Window" is shown.

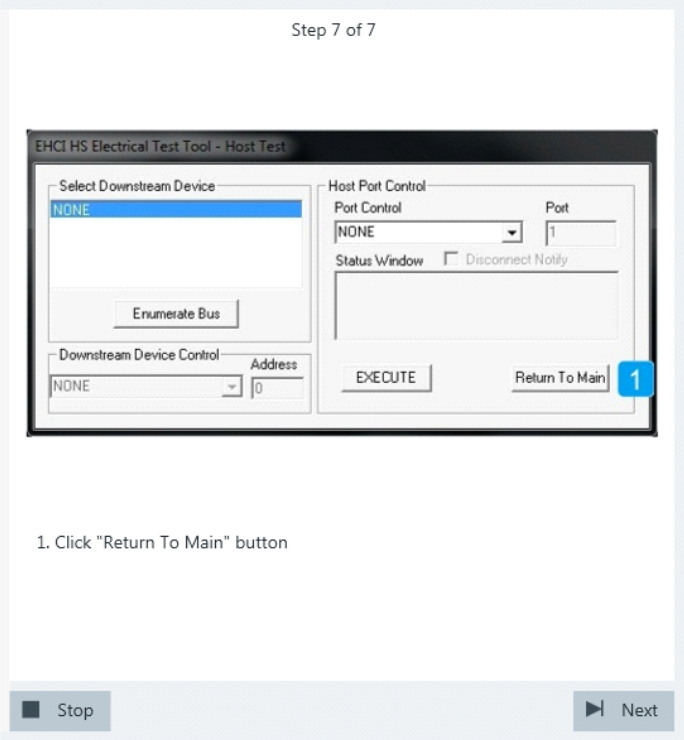


Waveforms are captured as pictured below.



The application measures the time between the end of the suspended state (i.e., D + pulls from ~+3 V to ~0 V) and the first “Start of Frame” packet (i.e., high-speed operation resumes). This is EL_41.

10. Return in the HS Electrical Test Tool to the Main menu.



The results are saved and can be viewed in the report.

4.3.1.5 Test J/K, SE0_NAK

Table 4-24: Equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTO/RTO6/RTP with 4 channels and at least 2 GHz bandwidth	1
DUT	the host you want to test	1
Signal quality board, "Device SQ" section	R&S RT-ZF1	1
Single-ended probe	at least 2 GHz bandwidth	2
Host test bed computer	any computer with high-speed USB ports and HS Electrical Test Tool	1
USB cable	to connect computer and test fixture	1

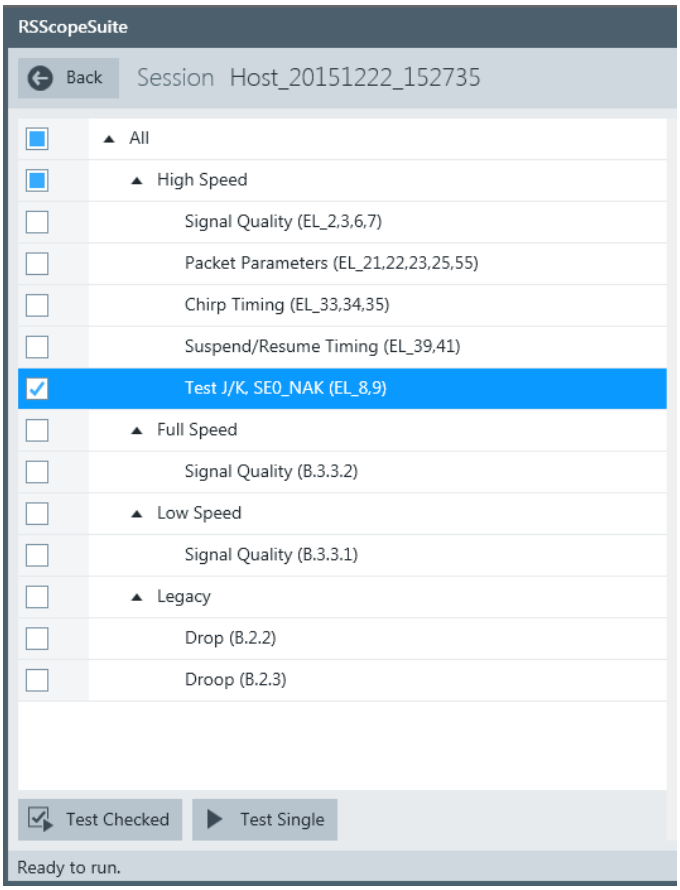
Test preparation

Before you run the test, complete the following actions:

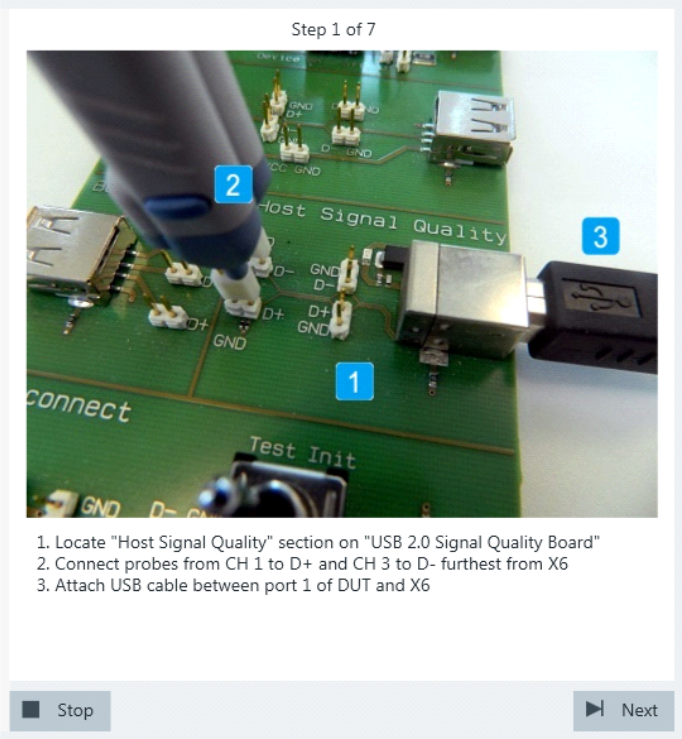
- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Test J/K, SE0_NAK (EL_8,9)" test case and click "Test Single".

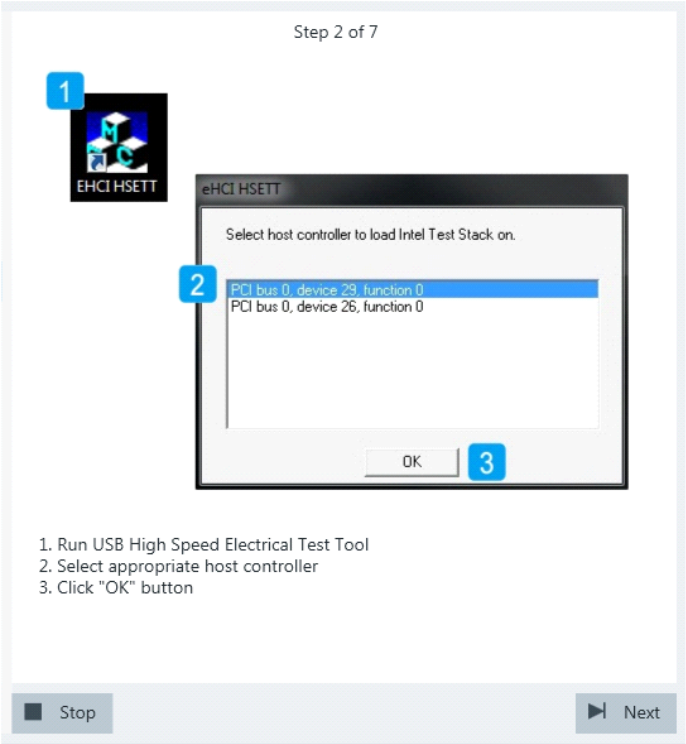


2. Connect the DUT to the test fixture as shown in the picture.

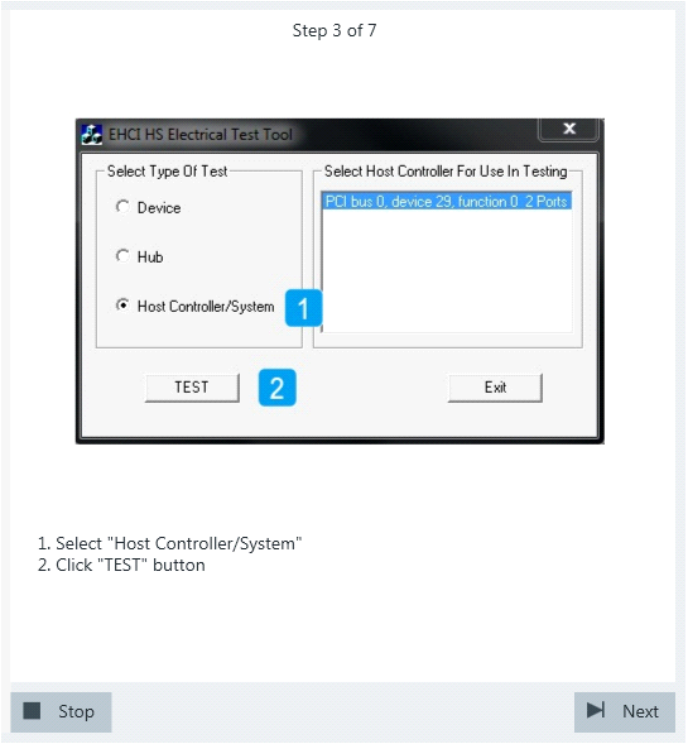


Use a 4-inch non-captive cable to connect the DUT to the test fixture.

3. Click "Next".
4. Start the HS Electrical Test Tool on the DUT.
5. Select the DUT from the list of host controllers and click OK.
   Note: the values in the list may vary.

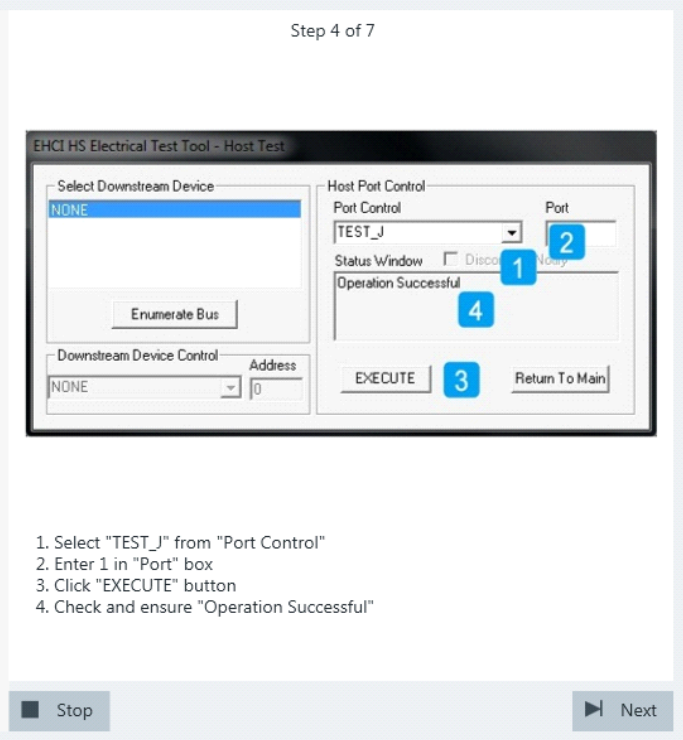


6. Select "Host Controller/System" on the left side.
   Click "TEST".



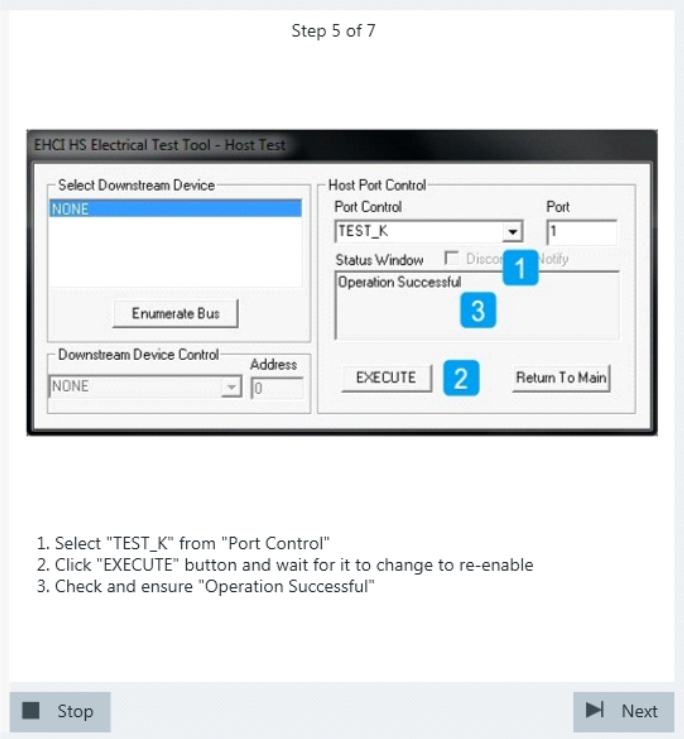
7. Select"TEST_J" from "Port Control".
   Enter the “Port” number of the DUT you are testing.

Click "EXECUTE" and wait until "Operation Successful" in the "Status Window" is shown.



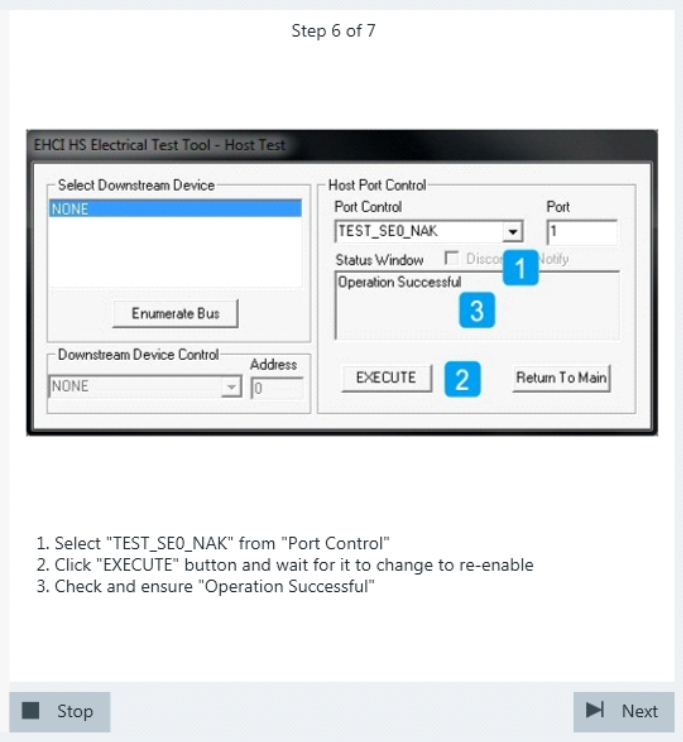
The probe at least 2 GHz bandwidth contains a built-in digital voltmeter known as ProbeMeter. The application automatically reads the voltages of D+ and D- from the ProbeMeter. However, if the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-.
Click "Next".

8. Select"TEST_K" from "Port Control".
   Click "EXECUTE" and wait until "Operation Successful" in the "Status Window" is shown.



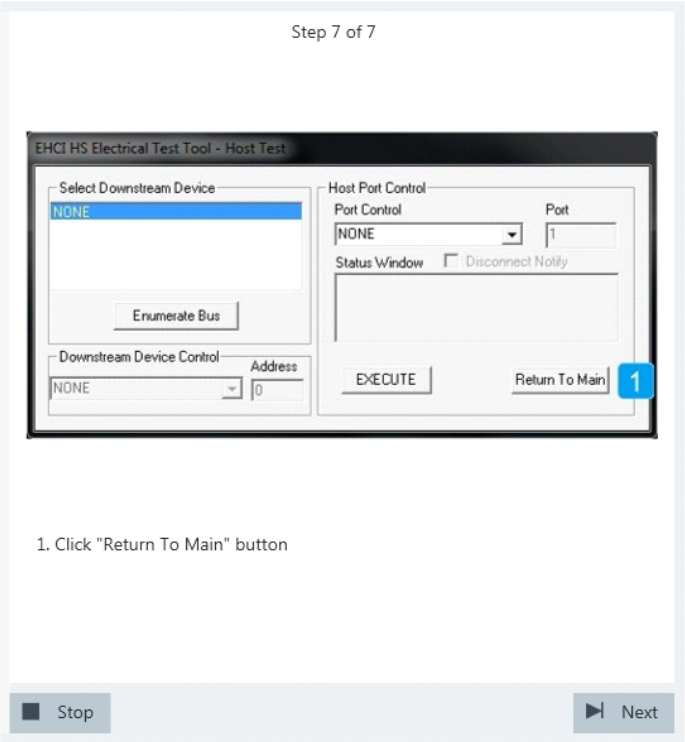
If the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-. Otherwise it automatically reads them from the ProbeMeter.

9. Select "TEST_SE0_NAK" from "Port Control".
   Click "EXECUTE" and wait until "Operation Successful" in the "Status Window" is shown.



If the user has selected "Digital Multimeter (Manual)" in the test configuration (see Chapter 3.2, "Configuring the test", on page 19), the application prompts the user to enter the voltages of D+ and D-. Otherwise it automatically reads them from the ProbeMeter.

10. Return in the HS Electrical Test Tool to the Main menu.



The results are saved and can be viewed in the report.

4.3.2 Full Speed, Low Speed and Legacy Host Tests

In addition to the high-speed tests described in the preceeding chapter, the device under test must also pass a set of full speed and low speed compliance tests applicable to high-speed devices. The documentation of these legacy tests can be found in the "USB-IF Full and Low Speed Compliance Test Procedure" manual issued by the USB-IF. The manual is available at http://www.usb.org/developers.

To perform full speed and low speed compliance tests, you can use also a 4-channel R&S RTO/RTO6/RTP with less than 2 GHz bandwidth.

5 USB 3.2 compliance tests

USB 3.2 compliance tests require option R&S RTP-K101.

The USB 3.2 comliance tests, test the limits as defined in the "Electrical Compliance Test Specification Enhanced SuperSpeed Universal Serial Bus, Rev1" specification.

5.1 USB 3.2 device tests

5.1.1 Measurement setups

When performing USB 3.2 device compliance tests, you can use one of the following setups:

5.1.1.1 Gen 1 device type-A test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source" = "Standard-A"

The required equipment is listed in the following table.

Table 5-1: Gen 1 device Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB3ET device test fixtures	Device test fixture 1	1
	Device test fixture 2	1
DUT	The device you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
Short A-B or A-uB Cable	To connect the DUT and the test fixture	1
USB type A-B cable	To connect the two test fixtures	1

5.1.1.2 Gen 2 device type-A test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source"="Standard-A"

The required equipment is listed in the following table.

Table 5-2: Gen 2 device Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31AET device test fixtures	Device test fixture 1A	1
	5.6 " CLB test fixture	1
DUT	The device you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
USB type A-uB Cable	To connect the two test fixtures	1

5.1.1.3 Gen 2 captive cable device type-A test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source"="Standard-A"
- "Captive Cable" = "Enabled"

The required equipment is listed in the following table.

Table 5-3: Gen 2 device captive cable Type-A test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31AET device test fixtures	Captive cable device fixture type-A	1
DUT	The captive cable device you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1

5.1.1.4 Gen 2 device type-C test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source"="Type-C"

The required equipment is listed in the following table.

Table 5-4: Gen 2 device Type-C tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31CET device test fixtures	Device test fixture 1C	1
	5.6 " CLB test fixture	1
DUT	The device you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
USB type C Cable	To connect the two test fixtures	1

5.1.1.5 Gen 2 captive cable device type-C test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source" = "Type- C"
- "Captive Cable" = "Enabled"

The required equipment is listed in the following table.

Table 5-5: Gen 2 device captive cable Type-C test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31CET device test fixtures	Captive cable device fixture type C	1
DUT	The captive cable device you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1

5.1.1.6 Device tests with R&S RT-ZB2

Required settings:

- "Test Fixture for USB 3.2" = "Rohde & Schwarz"
- "Connector source" = "Standard-A"

The required equipment is listed in the following table.

Table 5-6: Device Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Test fixture	R&S RT-ZB2	1
DUT	The device you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables	-	1
BNC- SMA adapters	-	1
USB cable	To connect the fixture and the oscilloscope	1
Waveform generator (optional)	R&S RTP-B6/Tabor WX2182B/Tabor WX2182C	1
DUT	The device you want to test	1

5.1.2 Gen1 (5GT/s) low frequency periodic signaling Tx

This test verifies that the low frequency periodic signal transmitter meets the timing requirements as defined in the specification.

Test preparation

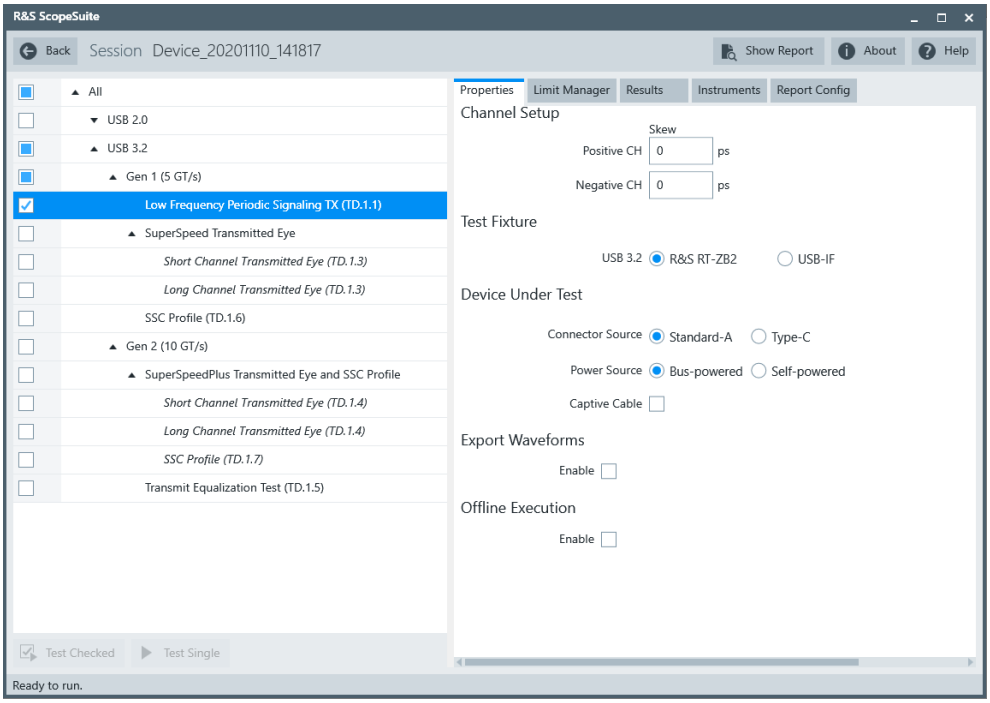
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Device"**, see Chapter 3.3, "Initiating the test", on page 26

For an overview of the needed equipment, see Chapter 5.1.1, "Measurement setups", on page 163.

Running the test

1. Select the "Gen1 (5GT/s) Low Frequency Periodic Signaling Tx (TD.1.1)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2 USB 3.2 Hub test

5.2.1 Measurement setups

When performing USB 3.2 device compliance tests, you can use one of the following setups:

5.2.1.1 Gen 1 Hub Type-A setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source" = "Standard-A"

The required equipment is listed in the following table.

Table 5-7: Gen 1 hub Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB3ET test fixtures	Device test fixture 1	1
	Device test fixture 2	
DUT	Upstream tests: The hub you want to test	1
	Downstream tests: The hub and the host/hub controller you want to test	
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
Short A-B or A-uB Cable	To connect the DUT and the test fixture	
USB type A-B cable	To connect the two test fixtures	1

5.2.1.2 Gen 2 Hub Type-A test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source" = "Standard-A"

The required equipment is listed in the following table.

Table 5-8: Gen 2 hub Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31AET test fixtures	Device test fixture 1A	1
	5.6 " CLB test fixture	1
DUT	Upstream tests: The hub you want to test	1
	Downstream tests: The hub and the host/hub controller you want to test	
Adapters	R&S RT-ZA16 adapter	2

Item	Description, model	Quantity
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
USB type A-uB Cable (1m)	To connect the two test fixtures	1

5.2.1.3 Gen 2 upstream captive cable hub type-A test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source"="Standard-A"
- "Captive Cable" = "Enabled"

The required equipment is listed in the following table.

Table 5-9: Gen 2 upstream hub captive cable Type-A test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31AET test fixtures	Captive cable fixture type-A	1
DUT	The captive cable hub you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	at least 2 GHz bandwidth	1

5.2.1.4 Gen 2 hub type-C test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source" = "Type- C"

The required equipment is listed in the following table.

Table 5-10: Gen 2 hub Type-C tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31CET test fixtures	Device test fixture 1C	1
	5.6 " CLB test fixture	1
DUT	Upstream tests: The hub you want to test	1
	Downstream tests: The hub and the host/hub controller you want to test	
Adapters	R&S RT-ZA16 adapter	2

Item	Description, model	Quantity
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
USB type C Cable	To connect the two test fixtures	1

5.2.1.5 Gen 2 upstream captive cable hub type-C Test setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source" = "Type- C"
- "Captive Cable" = "Enabled"

The required equipment is listed in the following table.

Table 5-11: Gen 2 upstream hub captive cable Type-C test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31CET test fixtures	Captive cable device fixture	1
DUT	The captive cable hub you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1

5.2.1.6 Hub tests with R&S RT-ZB2

Required settings:

- "Test Fixture for USB 3.2" = "Rohde & Schwarz"
- "Connector source" = "Standard-A"

The required equipment is listed in the following table.

Table 5-12: Hub Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Test fixture	R&S RT-ZB2	1
DUT	The device you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables	-	1
BNC-SMA adapters	-	1
USB cable	To connect the DUT and the fixture	1

Item	Description, model	Quantity
	To connect the fixture and the oscilloscope	1
Waveform generator (optional)	R&S RTP-B6/Tabor WX2182B/Tabor WX2182C	1
DUT	The hub you want to test	1

5.2.2 Gen1 (5GT/s) upstream low frequency periodic signaling Tx

This test verifies that the upstream low frequency periodic signal transmitter meets the timing requirements as defined in the specification.

Test preparation

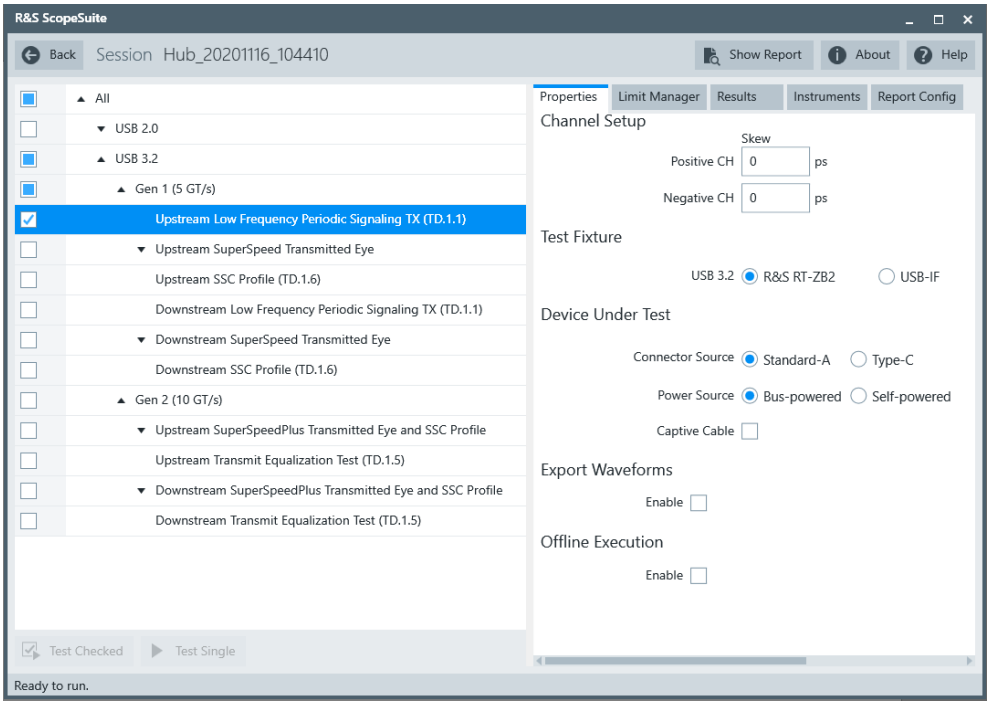
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) Upstream Low Frequency Periodic Signaling Tx (TD.1.1)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.3 Gen1 (5GT/s) Upstream SuperSpeed transmitted eye test

This test verifies that the transmitter meets the eye width, deterministic jitter and random jitter requirements for the test conditions described in the specification for short and long channel reference equalizer.

Test preparation

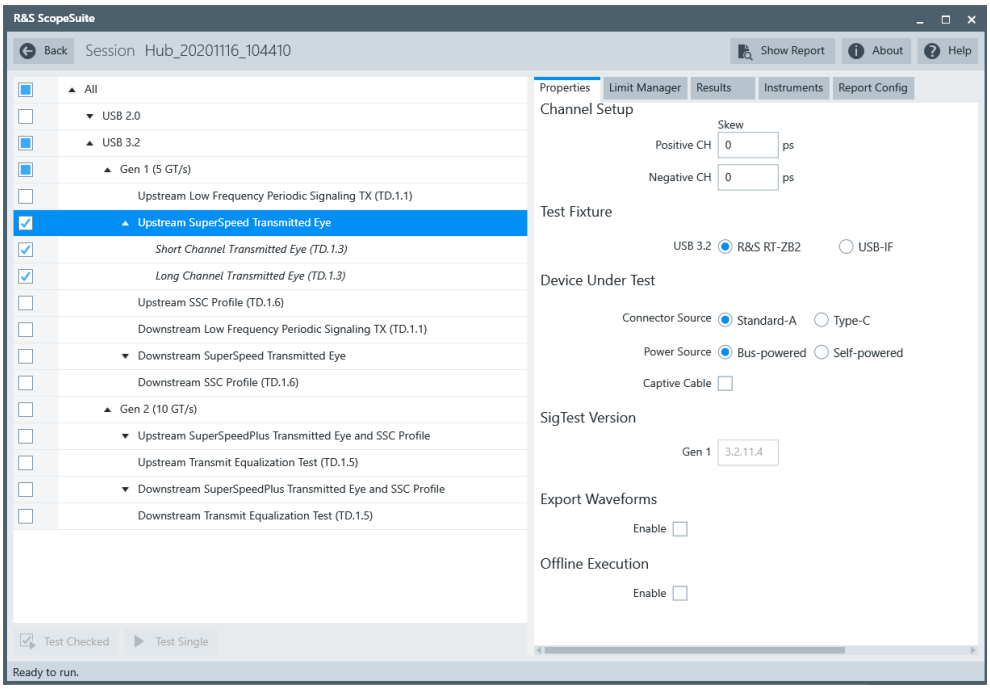
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) Upstream SuperSpeed Transmitted Eye" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.4 Gen1 (5GT/s) upstream SSC profile test

The test verifies that the transmitter meets SSC profile requirements, for measurements at the compliance test port with spec required TX equalization as defined in the specification.

Test preparation

For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

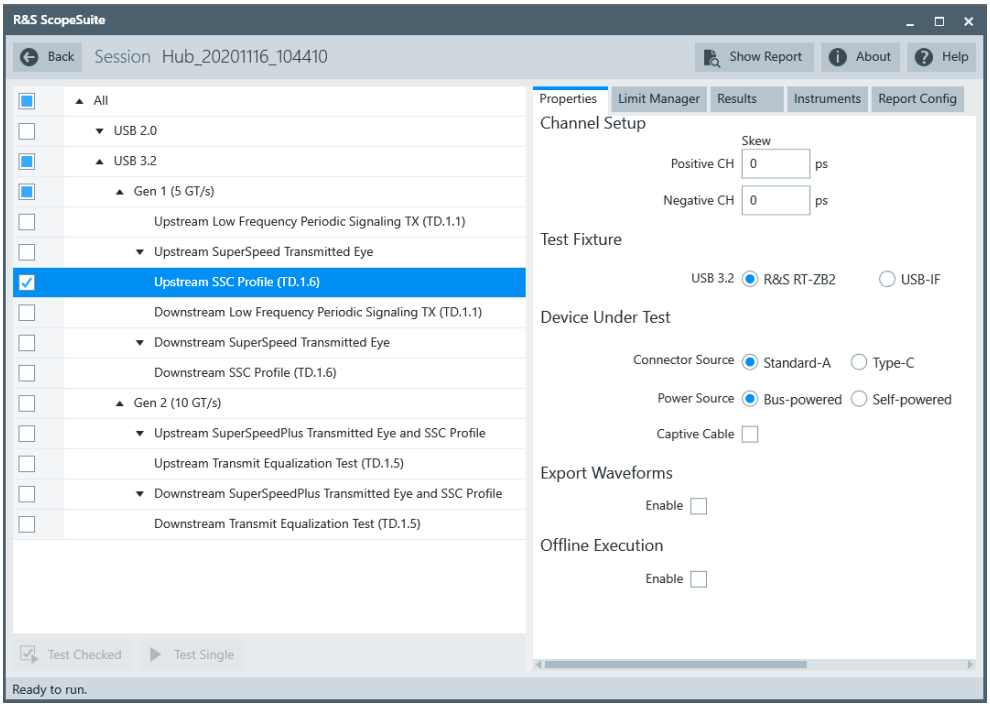
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13

- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) Upstream SSC Profile Test (TD.1.6)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.5 Gen1 (5GT/s) downstream low frequency periodic signaling Tx

This test verifies that the downstream low frequency periodic signal transmitter meets the timing requirements as defined in the specification.

Test preparation

For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

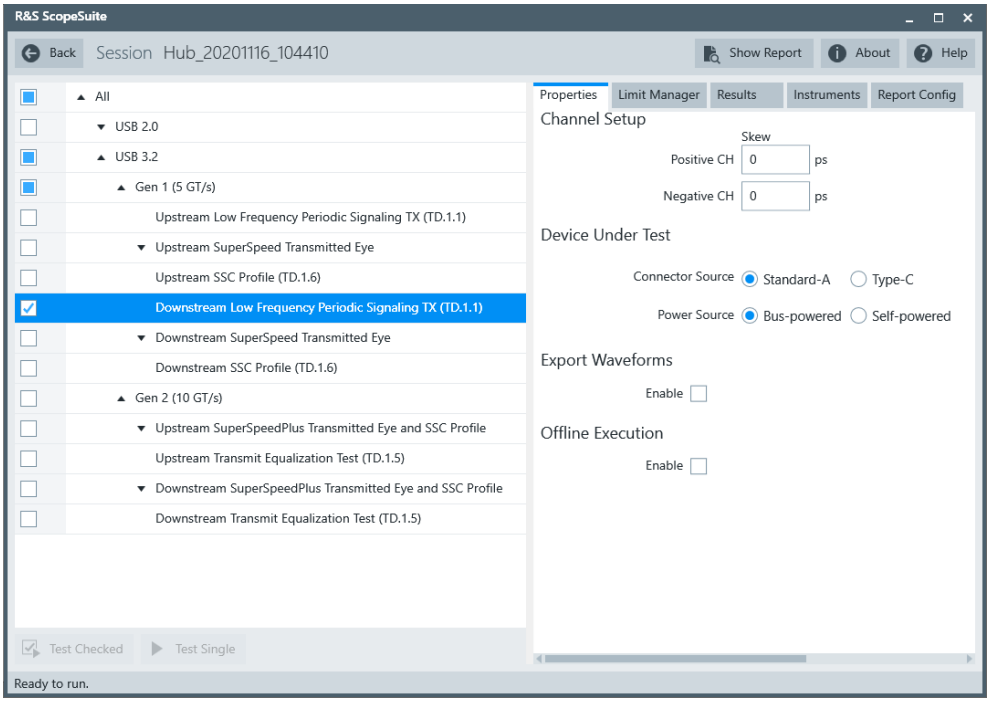
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10

- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) Downstream Low Frequency Periodic Signaling Tx (TD.1.1)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.6 Gen1 (5GT/s) downstream SuperSpeed transmitted eye test and SSC profile

This test verifies that the transmitter meets the eye width, deterministic jitter and random jitter requirements for the test conditions described in the specification for long and short channel reference equalizer.

Test preparation

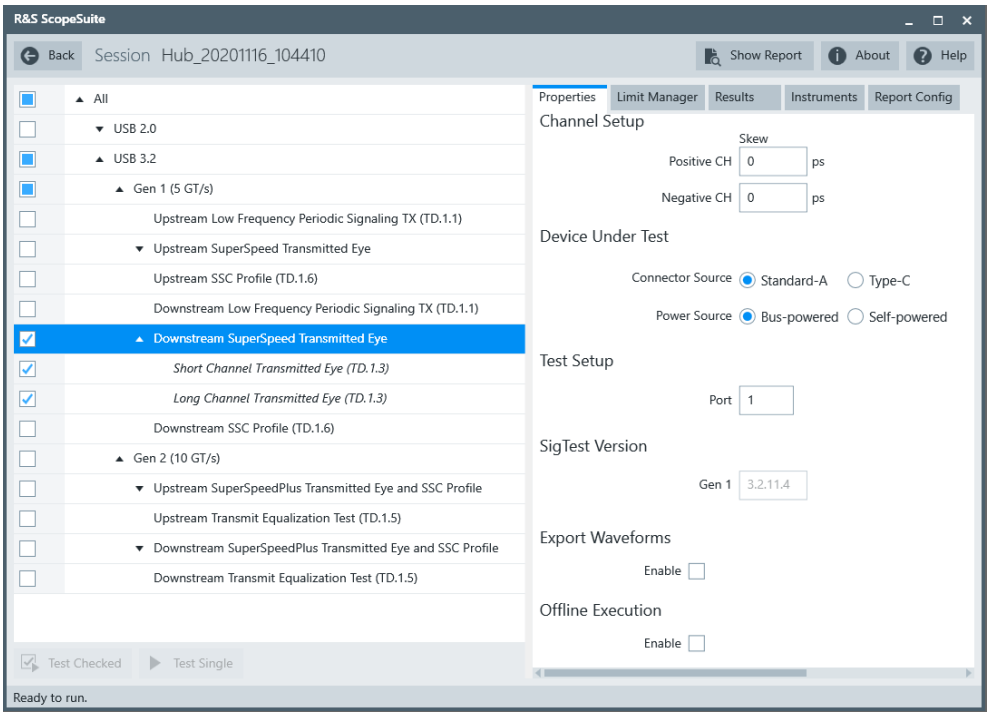
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) Downstream SuperSpeed Transmitted Eye" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.7 Gen1 (5GT/s) downstream SSC profile test

The test verifies that the transmitter meets SSC profile requirements, for measurements at the compliance test port with spec required TX equalization as defined in the specification.

Test preparation

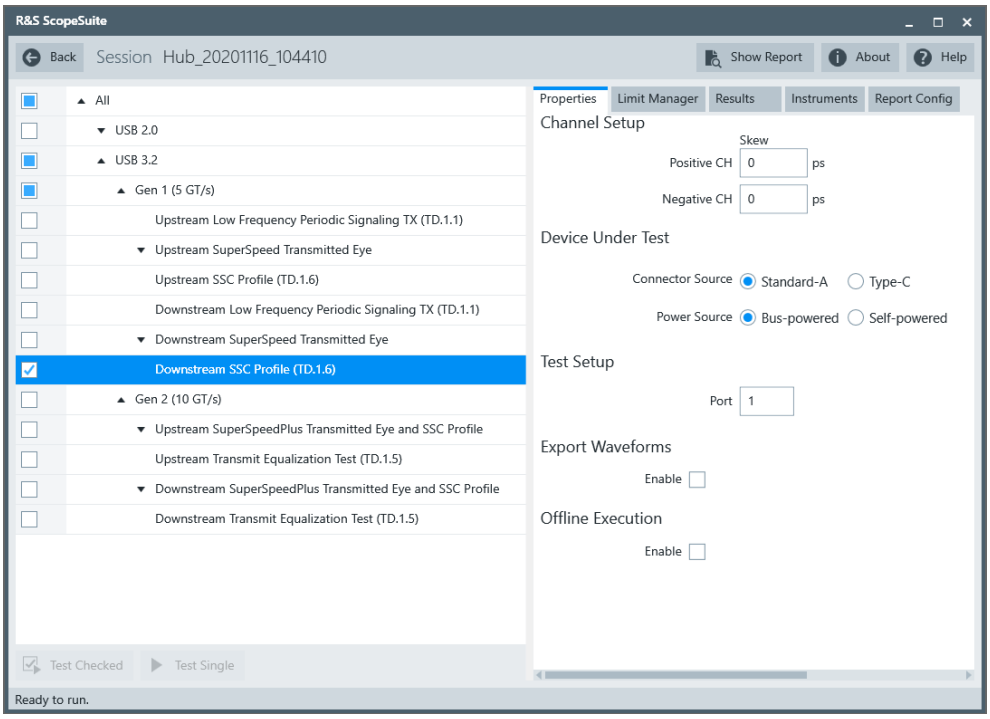
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) Downstream SSC Profile Test" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.8 Gen2 (10GT/s) upstream SuperSpeed transmitted eye test and SSC profile

This test verifies that the transmitter meets the eye width, eye height, deterministic jitter and random jitter requirements for the test conditions described in the specification for long and channel reference equalizer.

The "SSC Profile Test" verifies that the transmitter meets SSC profile requirements, for measurements at the compliance test port with spec required TX equalization as defined in the specification.

Test preparation

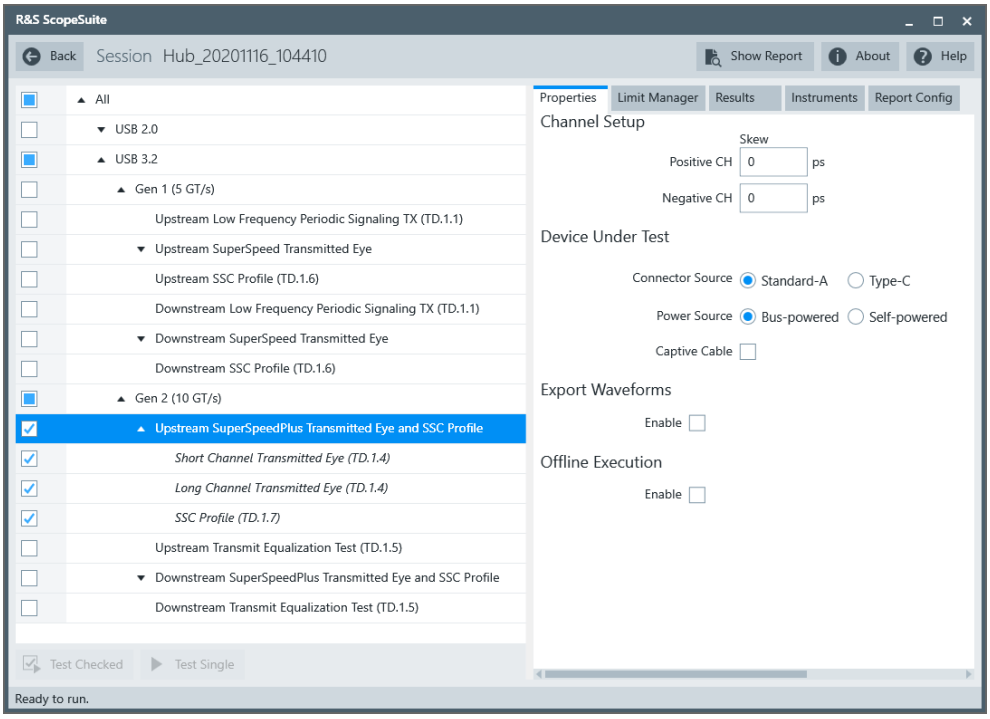
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen2 (10GT/s) Upstream SuperSpeed Transmitted Eye Test and SSC Profile" test case .



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.9 Gen2 (10GT/s) upstream transmit equalization test

This test verifies that the transmitter meets requirements for transmit equalization as defined in the specification.

Test preparation

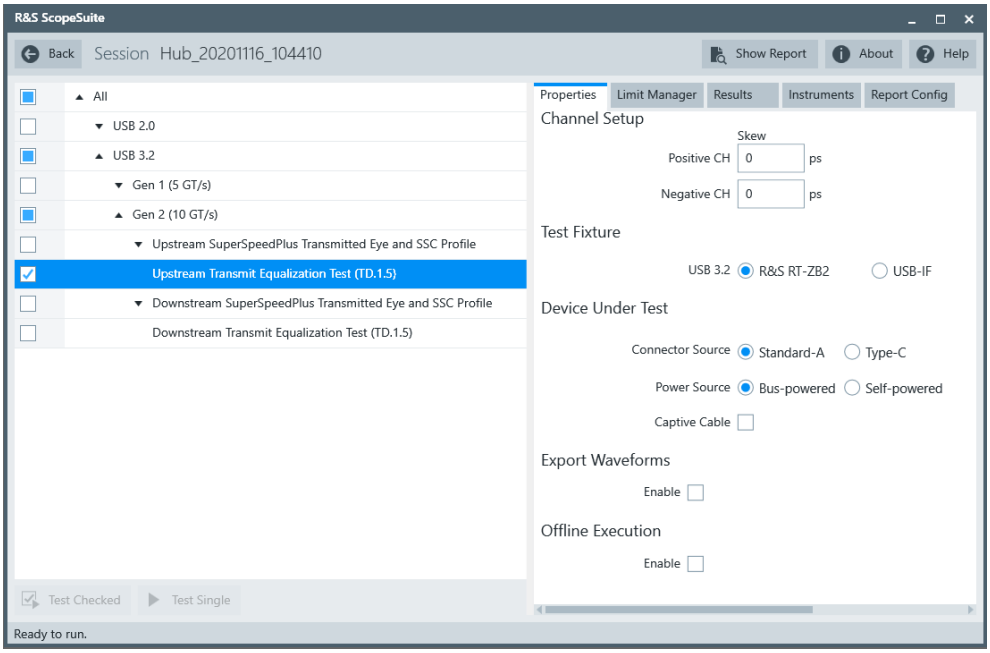
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen2 (10GT/s) Upstream Transmit Equalization Test (TD.1.5)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.10 Gen2 (10GT/s) downstream SuperSpeedPlus transmitted eye test and SSC profile

This test verifies that the transmitter meets the eye width, eye height, deterministic jitter and random jitter requirements for the test conditions described in the specification for long and short channel reference equalizer.

The "SSC Profile Test" test verifies that the transmitter meets SSC profile requirements, for measurements at the compliance test port with spec required TX equalization as defined in the specification.

Test preparation

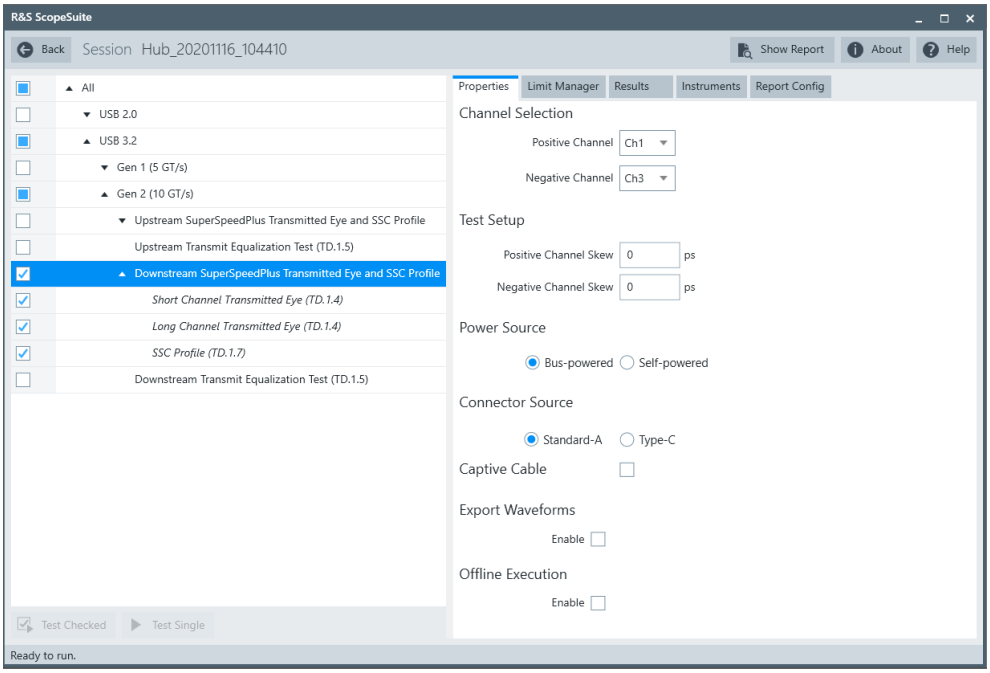
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen2 (10GT/s) Downstream SuperSpeedPlus Transmitted Eye Test and SSC Profile" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.2.11 Gen2 (10GT/s) downstream transmit equalization test

This test verifies that the transmitter meets requirements for transmit equalization as defined in the specification.

Test preparation

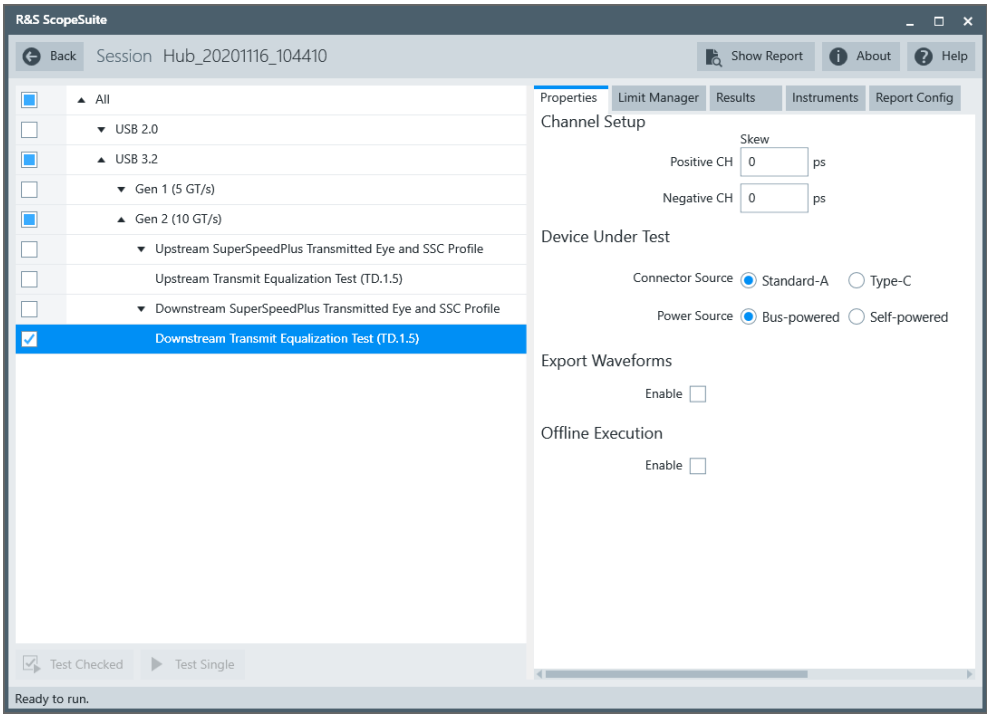
For an overview of the needed equipment, see Chapter 5.2.1, "Measurement setups", on page 167.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Hub"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen2 (10GT/s) Downstream Transmit Equalization Test (TD.1.5)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.3 USB 3.2 Host tests

5.3.1 Measurement Setups

When performing USB 3.2 host compliance tests, you can use one of the following set-ups:

5.3.1.1 Gen 1 Host Type-A Test Setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source"="Standard-A"

The required equipment is listed in the following table.

Table 5-13: Gen 1 host Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB3ET test fixtures	Host test fixture 1	1
	5 " Device test fixture 2	1
DUT	The host you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
USB Type A-B cable	To connect the two test fixtures	1

5.3.1.2 Gen 2 Host Type-A Test Setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source"="Standard-A"

The required equipment is listed in the following table.

Table 5-14: Gen 2 host Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31AET host test fixtures	Host test fixture 1A	1

Item	Description, model	Quantity
	5.6 " CLB test fixture	1
DUT	The host you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
USB Type A-uB Cable (1m)	To connect the two test fixtures	1

5.3.1.3 Gen 2 Host Type-C Test Setup

Required settings:

- "Test Fixture for USB 3.2" = "USB-IF"
- "Connector source"="Type-C"

The required equipment is listed in the following table.

Table 5-15: Gen 2 host Type-C tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
USB31AET test fixtures	Host test fixture 1C	1
	5.6 " CLB test fixture	1
DUT	The host you want to test	1
Adapters	R&S RT-ZA16 adapter	2
A pair of matched SMA cables if USB-IF host test fixture is used	-	1
USB Type C Cable	To connect the two test fixtures	1

5.3.2 Gen1 (5GT/s) Low Frequency Periodic Signaling Tx

This test verifies that the low frequency periodic signal transmitter meets the timing requirements as defined in the specification.

Test preparation

For an overview of the needed equipment, see Chapter 5.3.1, "Measurement Setups", on page 183.

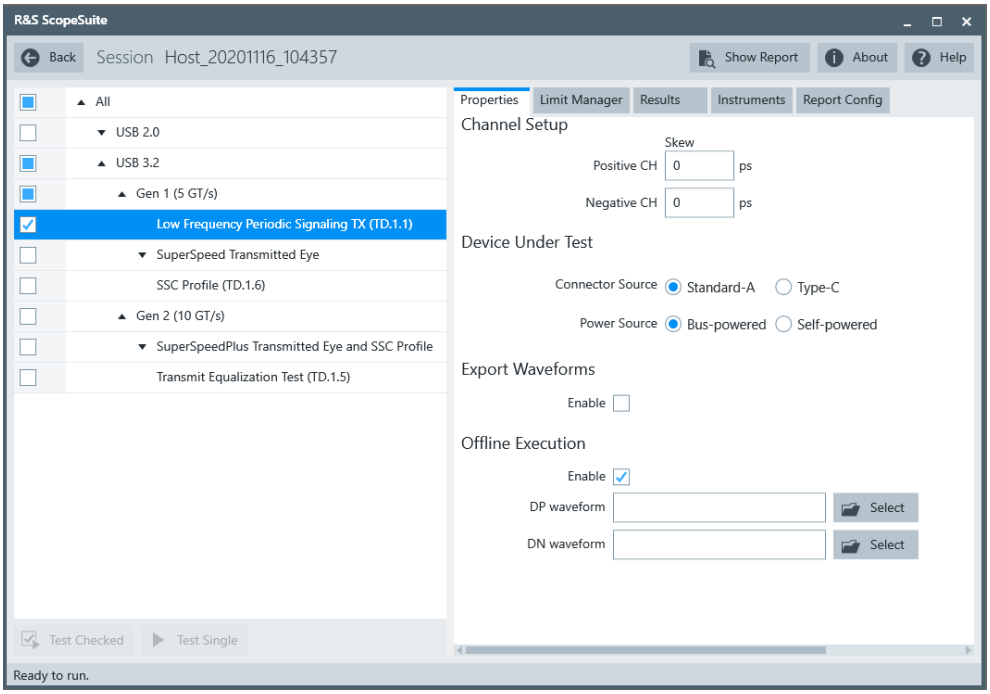
Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13

- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) Low Frequency Periodic Signaling Tx (TD.1.1)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.3.3 Gen1 (5GT/s) SuperSpeed Transmitted Eye

This test verifies that the transmitter meets the eye width, deterministic jitter and random jitter requirements for the test conditions described in the specification for short and long channel reference equalizer.

Test preparation

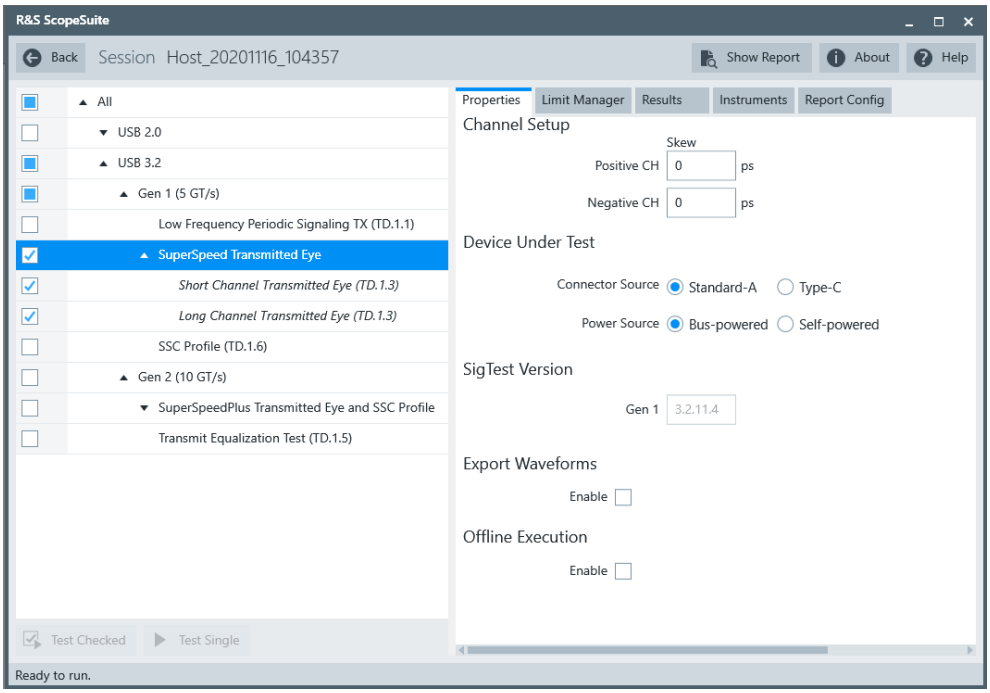
For an overview of the needed equipment, see Chapter 5.3.1, "Measurement Setups", on page 183.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) SuperSpeed Transmitted Eye" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.3.4 Gen1 (5GT/s) SSC Profile Test

The test verifies that the transmitter meets SSC profile requirements, for measurements at the compliance test port with spec required TX equalization as defined in the specification.

Test preparation

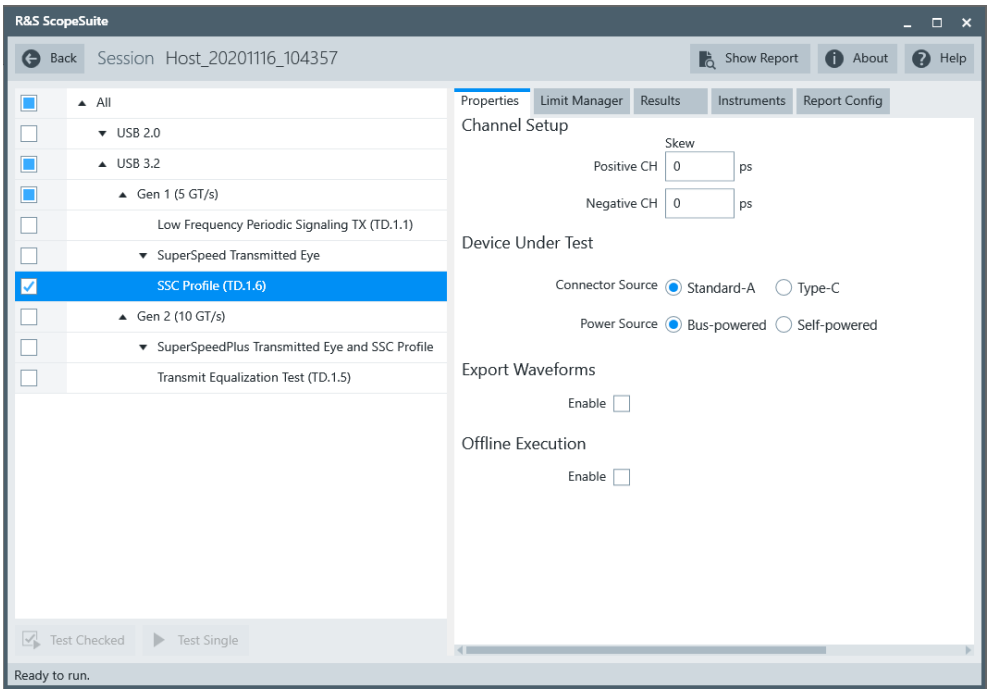
For an overview of the needed equipment, see Chapter 5.3.1, "Measurement Setups", on page 183.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen1 (5GT/s) SSC Profile Test (TD.1.6)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.3.5 Gen2 (10GT/s) SuperSpeedPlus Transmitted Eye and SSC Profile

This test verifies that the transmitter meets the eye width, eye height, deterministic jitter and random jitter requirements for the test conditions described in the specification for short and long channel reference equalizer.

The "SSC Profile Test" verifies that the transmitter meets SSC profile requirements, for measurements at the compliance test port with spec required TX equalization as defined in the specification.

Test preparation

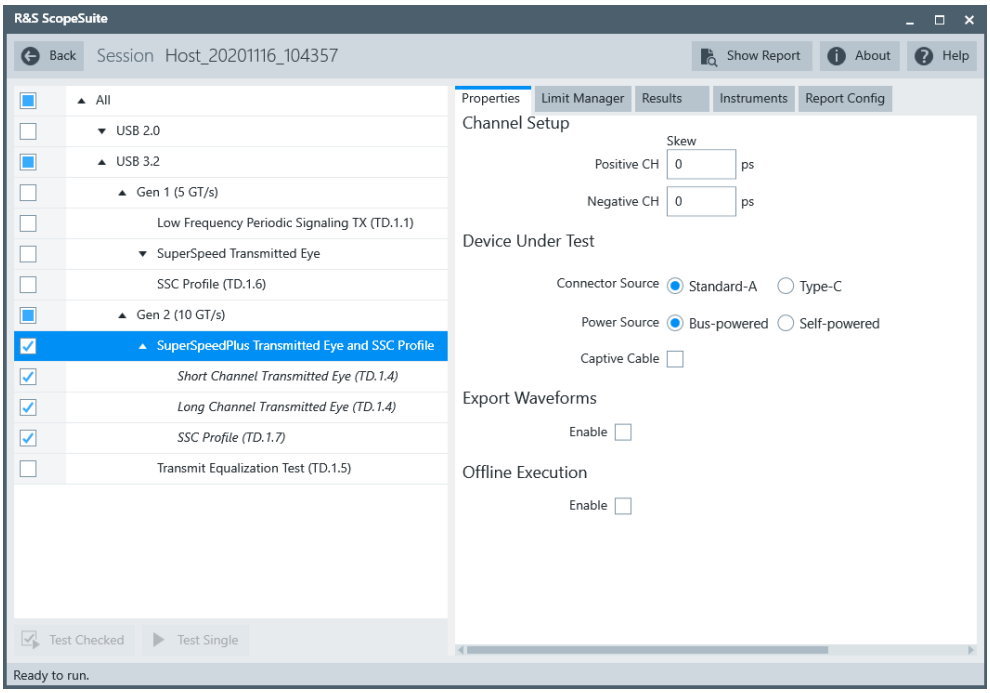
For an overview of the needed equipment, see Chapter 5.3.1, "Measurement Setups", on page 183.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "(10GT/s) SuperSpeedPlus Transmitted Eye and SSC Profie" test case.



2. Click "Test Single".
3. Follow the instructions of the step-by step guide.

When you have finished all steps, the compliance test runs automatically.

The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

5.3.6 Gen2 (10GT/s) Transmit Equalization Test

This test verifies that the transmitter meets requirements for transmit equalization as defined in the specification.

Test preparation

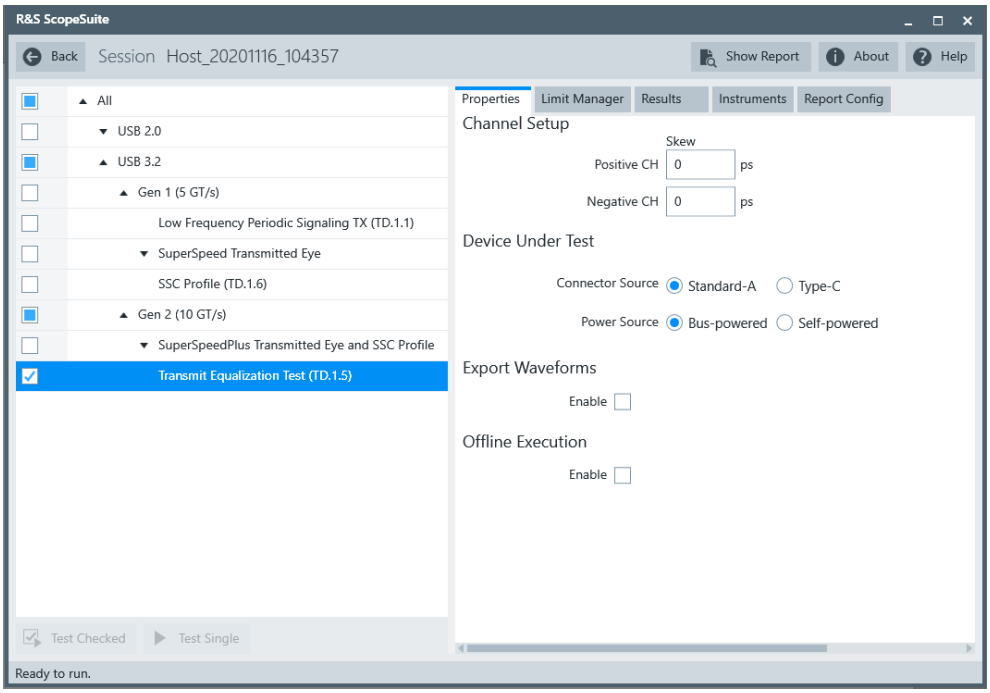
For an overview of the needed equipment, see Chapter 5.3.1, "Measurement Setups", on page 183.

Before you run the test, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S Scope-Suite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Configure and initiate the test with DUT type = **"Host"**, see Chapter 3.3, "Initiating the test", on page 26

Running the test

1. Select the "Gen2 (10GT/s) Transmit Equalization Test (TD.1.5)" test case.



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

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6 USB3.2 Rx compliance tests

USB 3.2 receiver compliance tests you can test your USB devices, to the limits defined in:

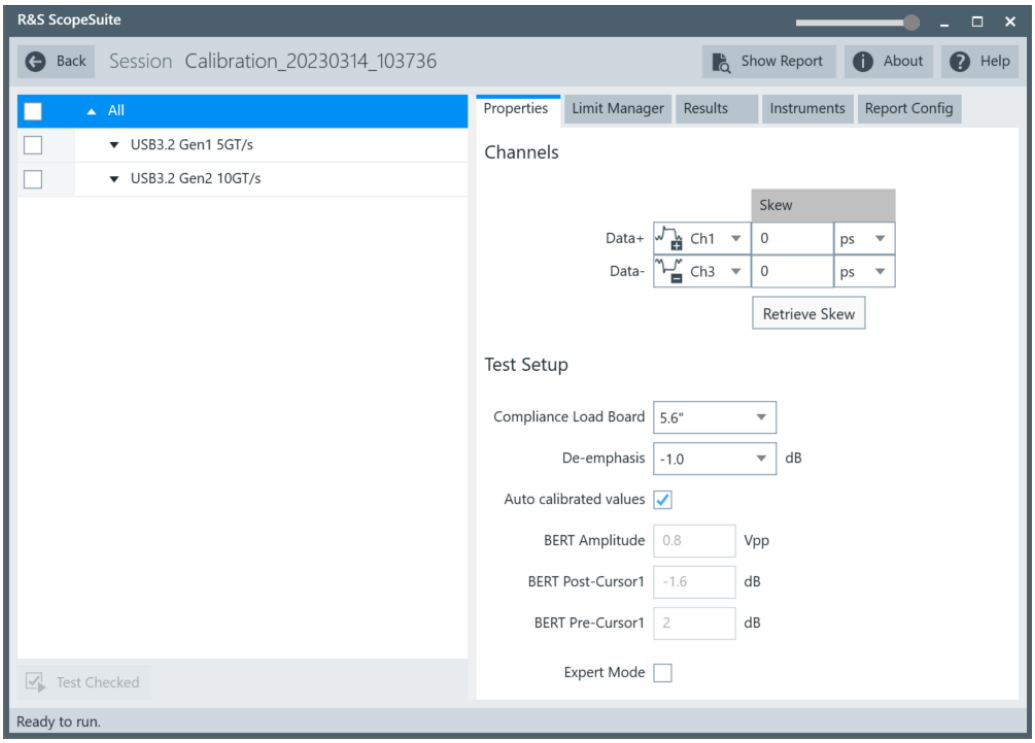
- For USB 3.2 Gen1 (5 GT/s) with legacy connectors: SuperSpeedPHYComplianceTest_Spec1_0a
- For USB 3.2 Gen2 (10 GT/s) and Gen1 (5 GT/s) with Type-C connectors: EnhancedSuperSpeedPHYComplianceTestSpec

USB 3.2 Rx compliance tests require option R&S RTP-K102.

6.1 Test configuration for USB3.2-RX

6.1.1 Test configuration for calibration

In this dialog, you can configure the properties for the calibration.



Channels
In this section you can select the oscilloscope channels used for the Data +/ Data - setup and set the skew for each channel.

Skew ← Channels
The skew compensates signal propagation differences between channels caused by the different length of cables, probes, and other sources.

When creating a session, the skew values are read from the oscilloscope and the skew fields are updated. You can also enter the skew value for each channel. Measure the deskew of each channel before you start the compliance test.

Retrieve skew ← Channels
The skew values are read from the oscilloscope and updated.

Compliance Load Board
Selects the used compliance load board: "5.6"", "7.1"", "8.1".

De-emphasis
Selects the value of the De-emphasis.

Auto calibrated values
If enabled, uses the auto-calibrated value for the BERT obtained when running the "TD.1.10.1 Amplitude, Pre-shoot and Deemphasis" calibration test.

If "Auto calibrated values" is not enabled, you can specify the amplitude, pre-cursor and post-cursor values manually.

BERT settings
When using a bit error rate tester, you can define some of its properties manually. This is only possible, if "Auto calibrated values" is deactivated.

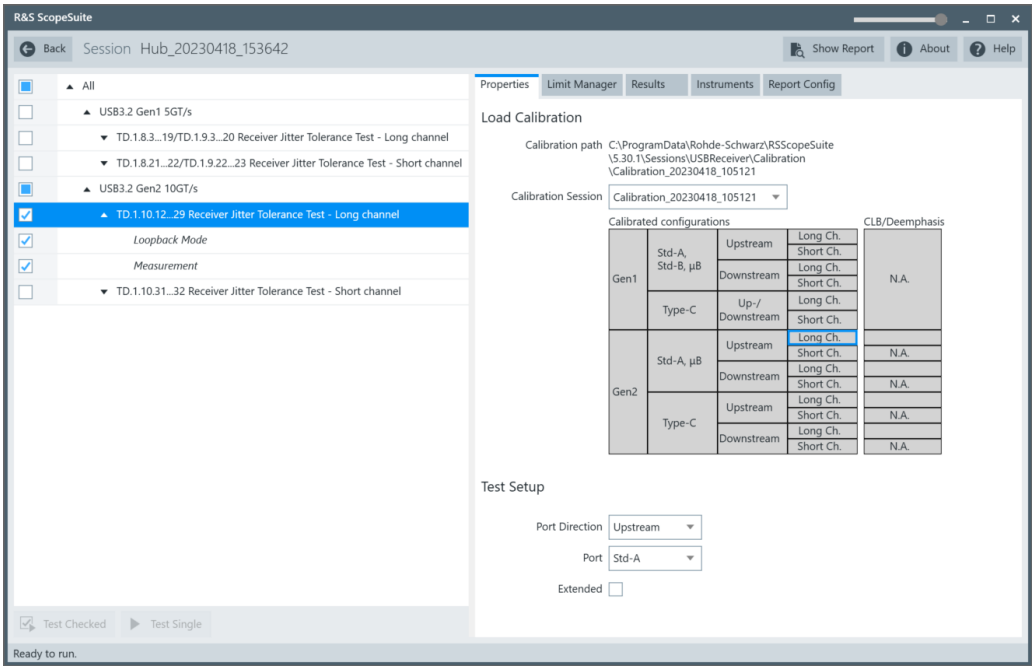
Manual input of the BERT values is only recommended for de-bugging purpose when "TD.1.10.1 Amplitude, Pre-shoot and Deemphasis" calibration does not return desired results.

"BERT Amplitude"	Amplitude of the BERT in Vpp.
"BERT Post-Cursor1"	The Post-Cursor1 value of the BERT in dB.
"BERT Pre-Cursor1"	The Pre-Cursor1 value of the BERT in dB.

Expert Mode
If enabled, the guided step images are not shown during the test run. It is assumed that the hardware setup is already available.

6.1.2 Test configuration for device, hub and host

In this dialog, you can configure the properties for the calibration.

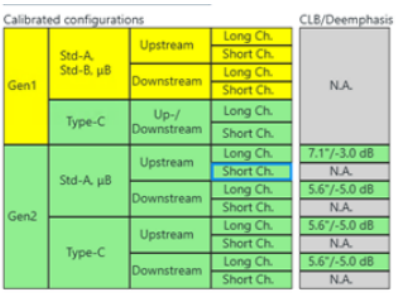


Calibration path
Displays the absolute path to the selected calibration folder specified in "Calibration" session.

Calibration session
Chooses a calibration session. You have to perform a calibration before performing measurement tests.

A calibration has to be performed, each time an item of the measurement equipment is changed.

Calibration table
The calibration table displays the calibration status of the available test setups. Thus it displays which measurement tests can be currently performed.



The calibration table It displays an overview of all available test setups and contains the following information:

- USB3.2 generation: Gen1 or Gen2
- Port standard: Std-A, Std-B, µB, Type-C
- Port direction: upstream and downstream
- Channel: long and short

- CLB/ Deemphasis: displays information about which compliance load board (CLB) is used and its deemphasis value.

The values of the table are color coded and the colors represent the current calibration status for the respective test setup:

- Grey: no calibration values available. You cannot perform a test.
- Green: calibration values are available. You can perform tests for the respective test.
- Yellow: calibration values are available, but not fully within calibration standard. You can perform tests for the respective test.
- Blue frame: highlights the currently selected test setup.

Port Direction
Selects the port direction: upstream (device) or downstream (host).

Port
Defines the port. You can select one of the available port standards:

- "Std-A"
- "Std-B": available only for "Port Direction" = "Upstream "
- "Micro-B": available only for "Port Direction" = "Upstream "
- "Type -C"
- "[Gen1] Tethered (standard A plug)": available only for "Port Direction" = "Upstream "
- "[Gen2] Captive (Std-A plug)": available only for "Port Direction" = "Upstream "
- "[Gen2] Captive (Type-C plug)": available only for "Port Direction" = "Upstream "

For "Host"/"Hub" test cases, it also sets the port number. Once a standard has been selected for a certain port,

Extended
If enabled, the bit error is measured on signal injected with a range of Sinusoidal Jitter (SJ) amplitudes (min to max).

If disabled, the signal bit error is measured with the lowest compliant SJ amplitude.

6.2 USB 3.2-RX calibration

Before performing any USB 3.2-RX measurements, you have to calibrate your test setup.

The calibration test cases have to be performed in the given order.

6.2.1 USB 3.2 Gen1 5GT/s amplitude and de-emphasis calibration

This test performs calibration of the test setup for the amplitude and de-emphasis for USB 3.2 Gen1 5GT/s tests.

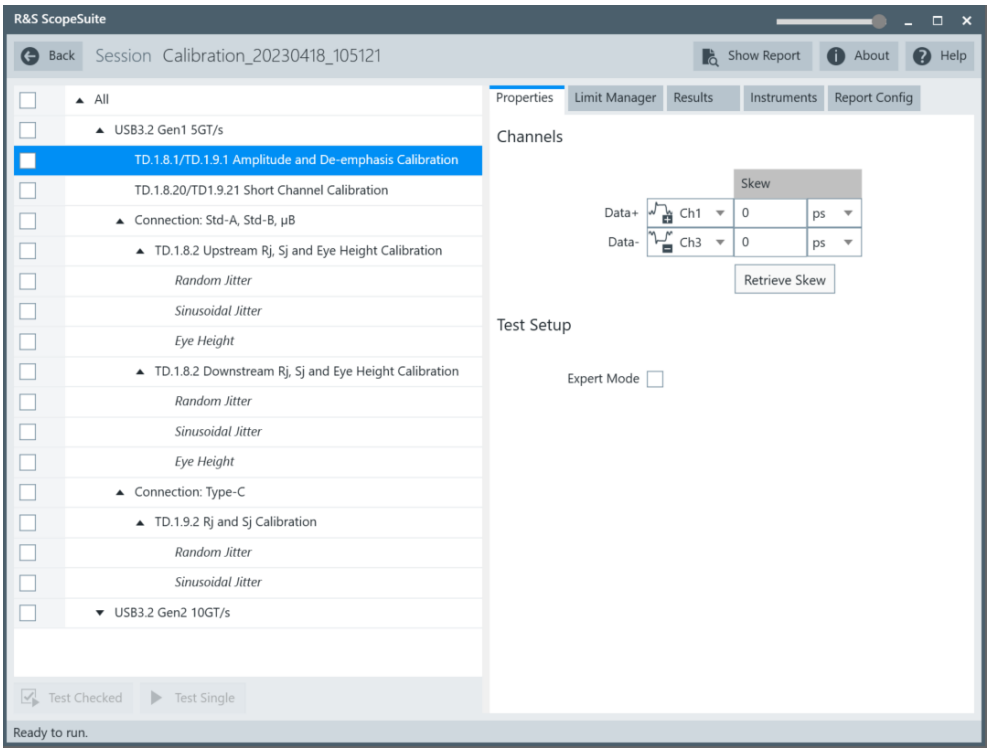
Test equipment

Table 6-1: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.1/ TD 1.9.1 Amplitude and De-emphasis calibration" test case.



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

   The results are saved and can be viewed in the report.

Measurements

Using a test pattern of 64 ones, 64 zeros followed by 128 bits of a 1010 clock pattern, the amplitude is calibrated by adjusting the output amplitude of the BERT until the scope measures a peak to peak amplitude of 800 mV. The de-emphasis is calibrated

by adjusting Post-Cursor1 of the BERT until the scope measures a de-emphasis of 3.0 dB.

6.2.2 USB 3.2 Gen1 5GT/s short channel calibration

This test performs calibration of the test setup for the short channel of USB 3.2 Gen1 5GT/s tests.

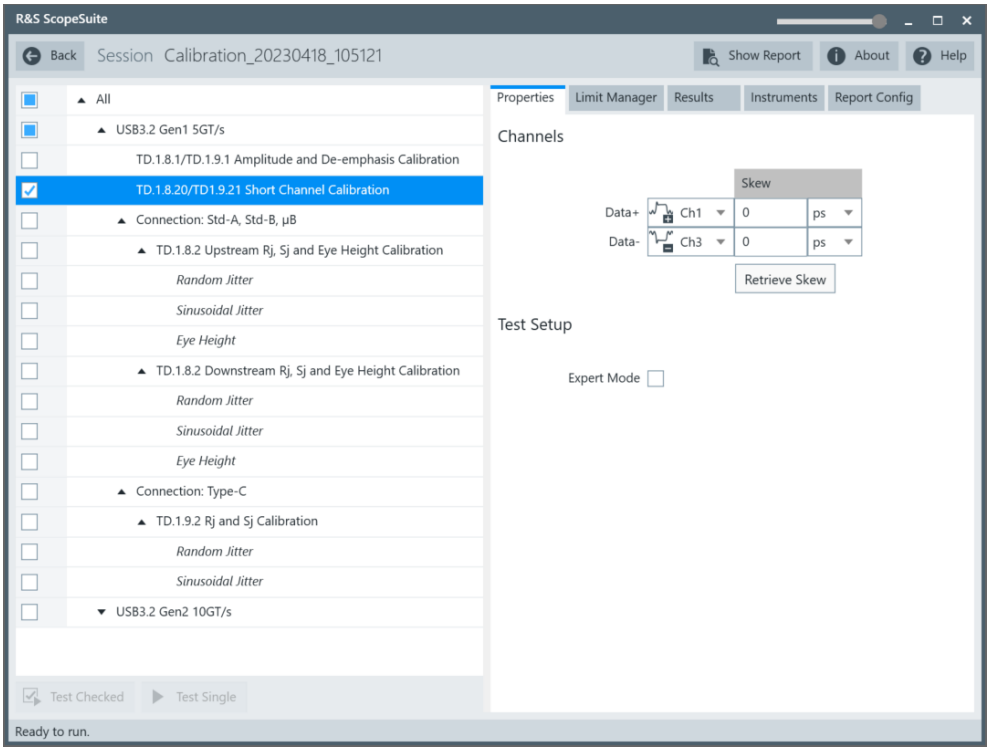
Test equipment

Table 6-2: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.20/ TD 1.9.21 Short Channel calibration" test case.



2. Click "Test Single".
3. Follow the instructions of the step-by step guide.

When you have finished all steps, the compliance test runs automatically.

The results are saved and can be viewed in the report.

Measurements

Using a test pattern of 64 ones, 64 zeros followed by 128 bits of a 1010 clock pattern, the amplitude is calibrated by adjusting the output amplitude of the BERT until the scope measures a peak to peak amplitude of 1200 mV. The de-emphasis is calibrated by adjusting Post-Cursor1 of the BERT until the scope measures a de-emphasis of 3.0 dB.

6.2.3 USB 3.2 Gen1 5GT/s connection: Std-A, Std-B, µB

6.2.3.1 Upstream Rj, Sj and eye height calibration

This test performs calibration of the test setup for the Std-A, Std-B, µB of USB 3.2 Gen1 5GT/s upstream tests.

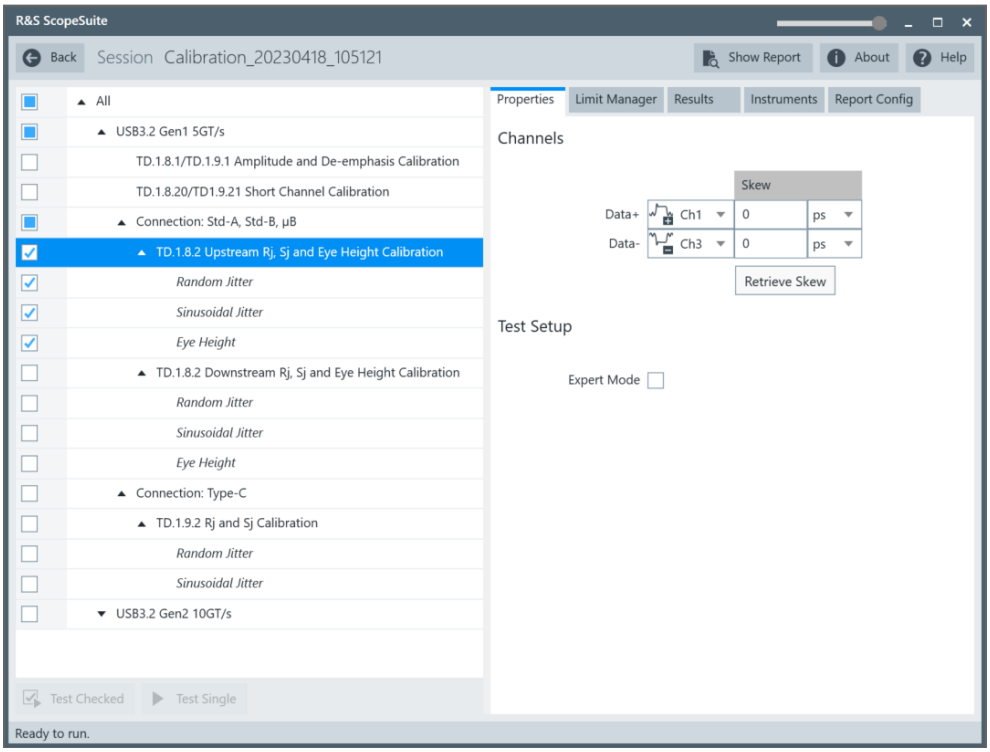
Test equipment

Table 6-3: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen1 (5GT/s) > Connection:Std-A, Std-B, µB > TD.1.8.2 Upstream Rj, Sj and Eye Height Calibration" test case.



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

   The results are saved and can be viewed in the report.

Measurements

Random jitter

Using test pattern CP1 generated from the BERT, a waveform is captured and its random jitter is analyzed using SigTest. Based on the measured random jitter, the random jitter amplitude of the jitter modulation source of the BERT is adjusted until a random jitter value of 2.42 ps is achieved.

Sinusoidal jitter

Using test pattern CP0 generated from the BERT, a waveform is captured and its sinusoidal jitter is analyzed using SigTest. Based on the measured sinusoidal jitter, the sinusoidal jitter amplitude of the jitter modulation source of the BERT is adjusted until a sinusoidal jitter value of 40 ps is achieved.

Upstream eye height

Using test pattern CP0 generated from the BERT, a waveform is captured and its eye height is analyzed using SigTest. Based on the measured eye height, the output amplitude of the BERT is adjusted until an eye height value of 145 mV is achieved. Upon

successful calibration of the eye height, it is verified that the total jitter is between 90 ps and 95 ps.

6.2.3.2 Downstream Rj, Sj and eye height calibration

This test performs calibration of the test setup for the Std-A, Std-B, µB of USB 3.2 Gen1 5GT/s downstream tests.

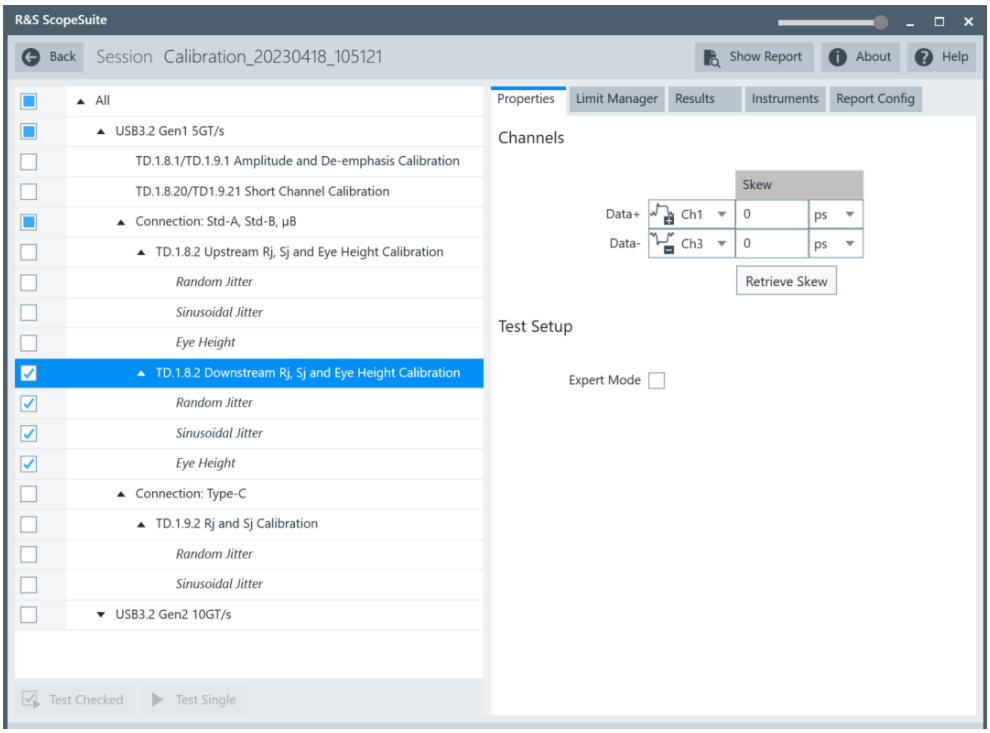
Test equipment

Table 6-4: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen1 (5GT/s) > Connection:Std-A, Std-B, µB > TD.1.8.2 Downstream Rj, Sj and Eye Height Calibration" test case.



2. Click "Test Single".
3. Follow the instructions of the step-by step guide.

When you have finished all steps, the compliance test runs automatically.

The results are saved and can be viewed in the report.

Measurements

Random jitter

Using test pattern CP1 generated from the BERT, a waveform is captured and its random jitter is analyzed using SigTest. Based on the measured random jitter, the random jitter amplitude of jitter modulation source of the BERT is adjusted until a random jitter value of 2.42 ps is achieved.

Sinusoidal jitter

Using test pattern CP0 generated from the BERT, a waveform is captured and its sinusoidal jitter is analyzed using SigTest. Based on the measured sinusoidal jitter, the sinusoidal jitter amplitude of jitter modulation source of the BERT is adjusted until a sinusoidal jitter value of 40 ps is achieved.

Downstream Eye Height

Using test pattern CP0 generated from the BERT, a waveform is captured and its eye height is analyzed using SigTest. Based on the measured eye height, the output amplitude of the BERT is adjusted until an eye height value of 180 mV is achieved. Upon successful calibration of eye height, the total jitter is verified to be between 90 ps and 95 ps.

6.2.4 USB 3.2 Gen1 5GT/s connection: type-C

6.2.4.1 Rj and Sj calibration

This test performs calibration of the test setup for Type-C of USB 3.2 Gen1 5GT/s Rj and Sj tests.

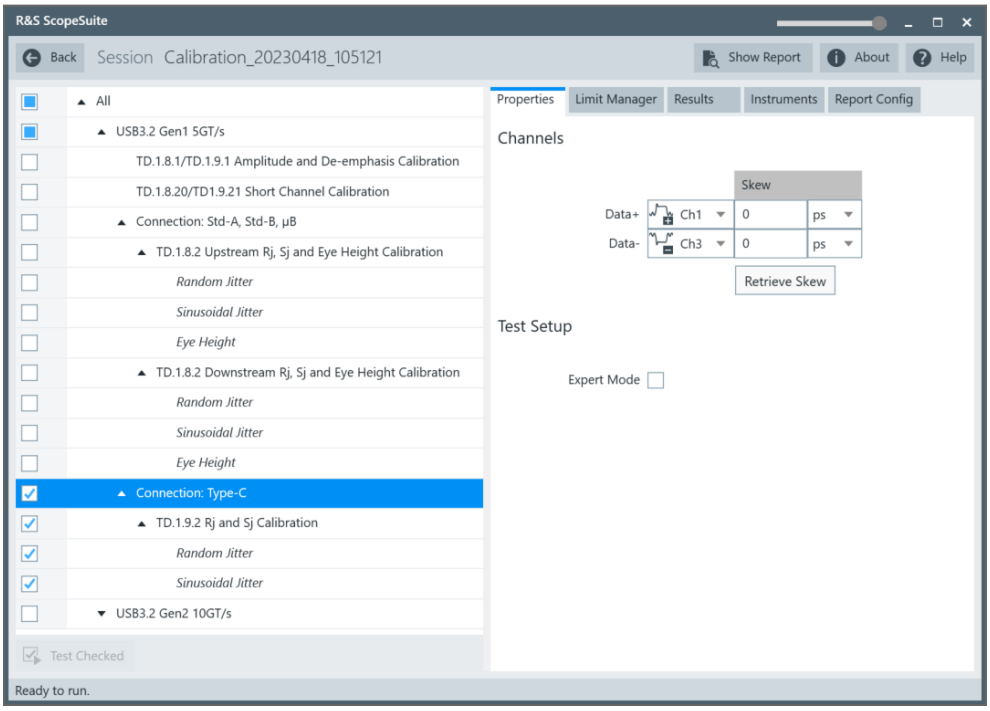
Test equipment

Table 6-5: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
USB3ET device test fixtures	Full Type-C Breakout fixture	1
DUT	The device you want to test	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen1 (5GT/s) > Connection:Type C > TD.1.9.2 Rj and Sj Calibration" test case.



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

   The results are saved and can be viewed in the report.

Measurements

Random jitter

Using test pattern CP1 generated from the BERT, a waveform is captured and its random jitter is analyzed using SigTest. Based on the measured random jitter, the random jitter amplitude of the jitter modulation source of the BERT is adjusted until a random jitter value of 2.42 ps is achieved.

Sinusoidal jitter

Using test pattern CP0 generated from the BERT, a waveform is captured and its sinusoidal jitter is analyzed using SigTest. Based on the measured sinusoidal jitter, the sinusoidal jitter amplitude of the jitter modulation source of the BERT is adjusted until a sinusoidal jitter value of 40 ps is achieved.

6.2.5 USB 3.2 Gen2 10GT/s amplitude, pre-shoot and de-emphasis calibration

This test performs calibration of the amplitude, pre-shoot and de-emphasis of the test setup for USB 3.2 Gen2 10GT/s.

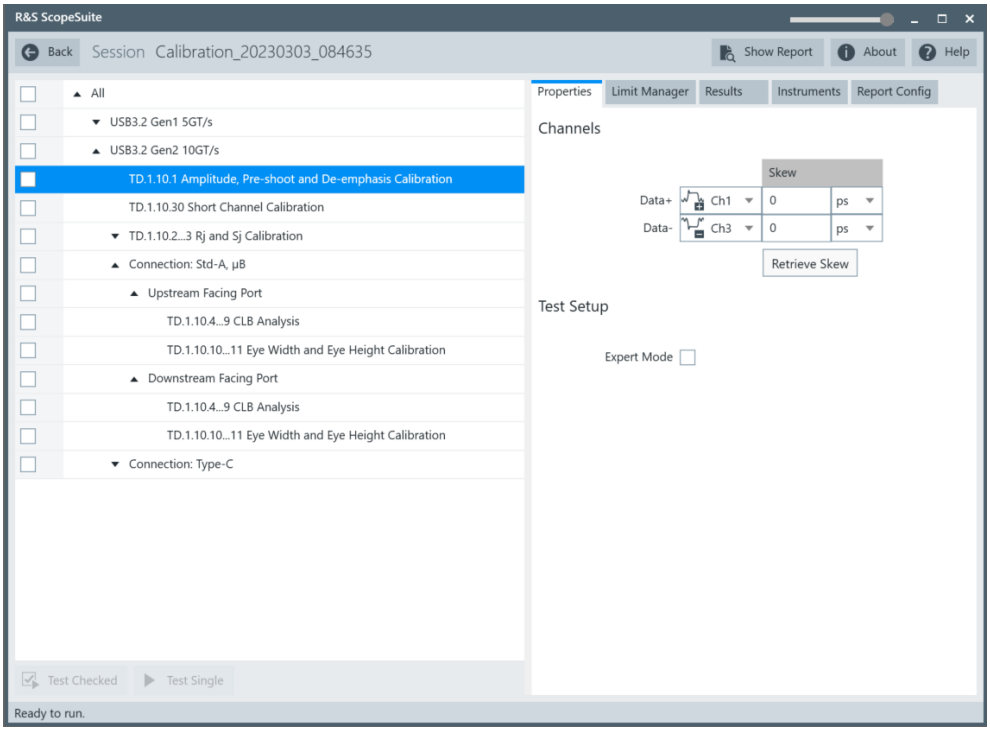
Test equipment

Table 6-6: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.1 Amplitude, Pre-Shoot and De-emphasis calibration" test case.



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

   The results are saved and can be viewed in the report.

Measurements

Using a test pattern of 64 ones, 64 zeros followed by 128 bits of a 1010 clock pattern, the amplitude is calibrated by adjusting the output amplitude of the BERT until the scope measures a peak to peak amplitude of 800 mV. The preshoot is calibrated next by adjusting Pre-Cursor1 of the BERT unto; the scope measures a preshoot value of 2.2 dB. The de-emphasis is calibrated lastly by adjusting Post-Cursor1 of the BERT until the scope measures a de-emphasis of -1.0 dB, -3.0 dB and -5.0 dB respectively.

6.2.6 USB 3.2 Gen2 10GT/s short channel calibration

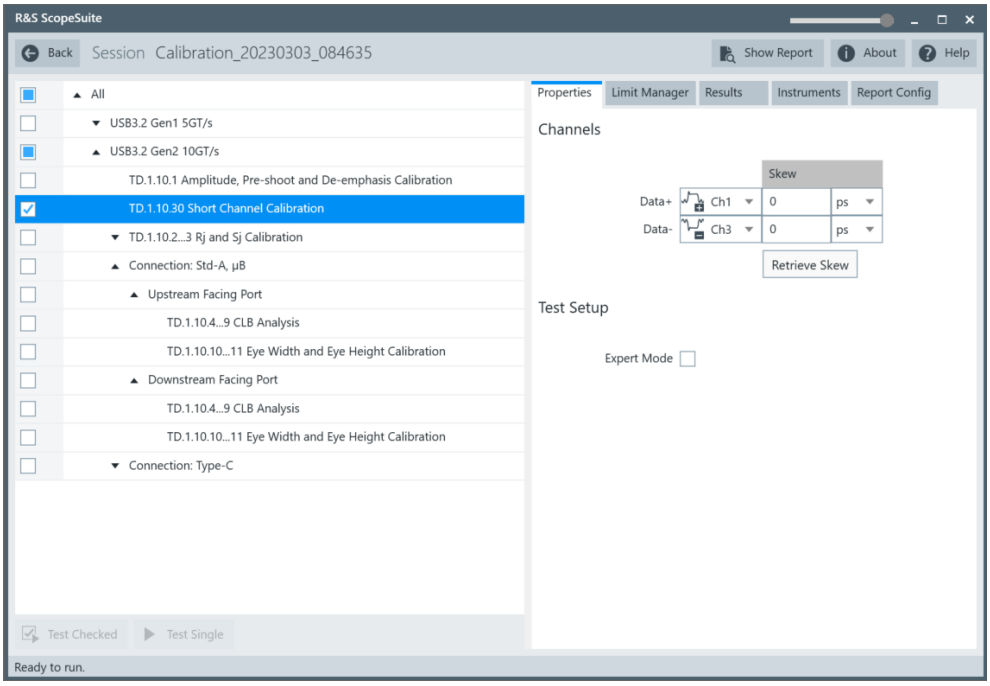
This test performs calibration of the test setup for the short channel of USB 3.2 Gen2 10GT/s tests.

Table 6-7: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.30 Short Channel Calibration" test case.



2. Click "Test Single".

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

   The results are saved and can be viewed in the report.

Measurements

Using a test pattern of 64 ones, 64 zeros followed by 128 bits of a 1010 clock pattern, the amplitude is calibrated by adjusting the output amplitude of the BERT until the scope measures a peak to peak amplitude of 1200 mV.

6.2.7 USB 3.2 Gen2 10GT/s R_j and S_j calibration

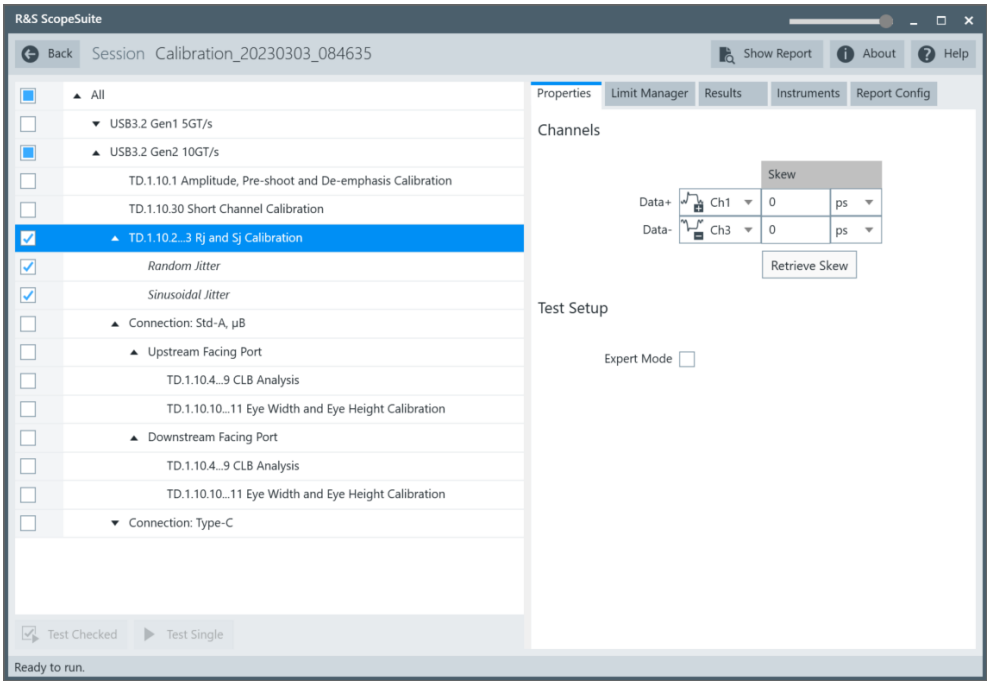
This test performs calibration of the test setup for Rj and Sj USB 3.2 Gen2 10GT/s tests.

Table 6-8: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.2...3 R_j and S_j Calibration" test case.



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

   The results are saved and can be viewed in the report.

Measurements

Random jitter

Using test pattern CP10 generated from the BERT, a waveform is captured and its random jitter is analyzed using SigTest. Based on the measured random jitter, the random jitter amplitude of jitter modulation source of the BERT is adjusted until a random jitter value of 0.95 ps is achieved.

Sinusoidal jitter

Using test pattern CP9 generated from the BERT, a waveform is captured and its sinusoidal jitter is analyzed using SigTest. Based on the measured sinusoidal jitter, the sinusoidal jitter amplitude of jitter modulation source of the BERT is adjusted until a sinusoidal jitter value of 17 ps is achieved.

6.2.8 USB 3.2 Gen2 10GT/s connection: Std-A, µB

6.2.8.1 Upstream facing port: CLB analysis

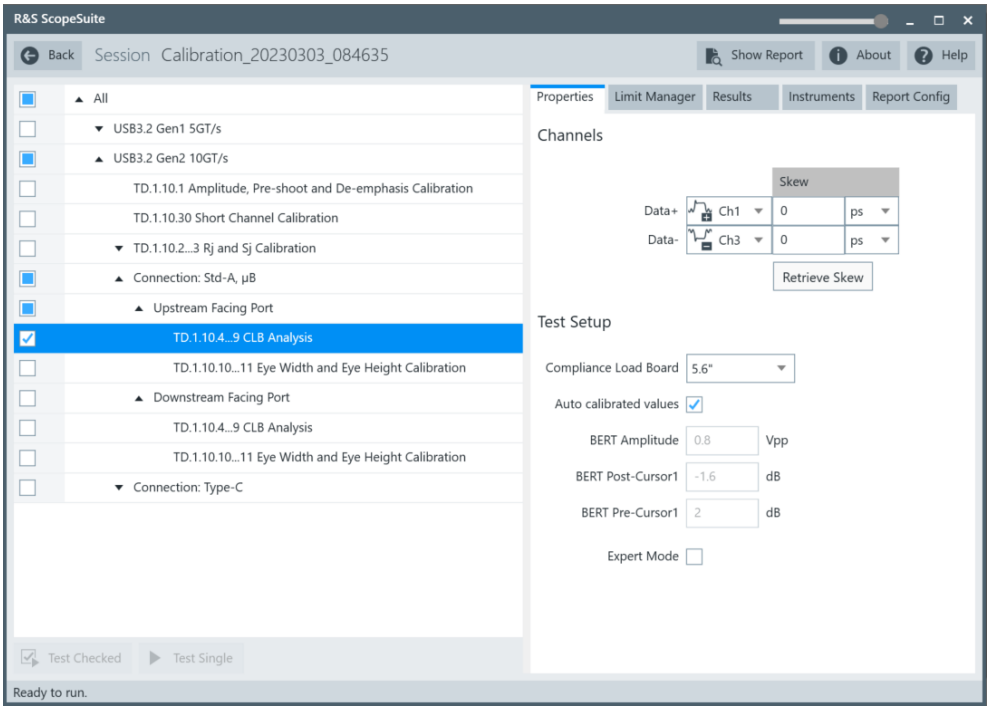
This test performs calibration of the test setup for the upstream facing port of the CLB for Std-A, Std-B, µB USB 3.2 Gen2 10GT/s tests.

Table 6-9: Gen 2 Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
USB31AET host test fixtures	7.2” Mock Host	1
	Host test fixture 1A	1
	CLB test fixture	1
DUT	The host you want to test	1
1 m (6dB) cable	To connect the test fixtures to the CLB	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Std-A, µB > Upstream Facing Port > TD 1.10.4...9 CLB Analysis " test case.



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

   The results are saved and can be viewed in the report.

Measurements

This test case aims to analyze the eye height and eye width measured using compliance load boards (CLB) of different sizes. Using test pattern CP9 with the previously calibrated output amplitude, preshoot, de-emphasis, Rj and Sj values as input, the output waveform is captured and analyzed using SigTest. Three sets of eye height and eye width values are reported using three sets of de-emphasis and preshoot values respectively. The CLB having the eye height measurement closest to 70 mV and eye width measurement closest to 48 ps is deemed most preferable.

6.2.8.2 Upstream facing port: eye width and eye height calibration

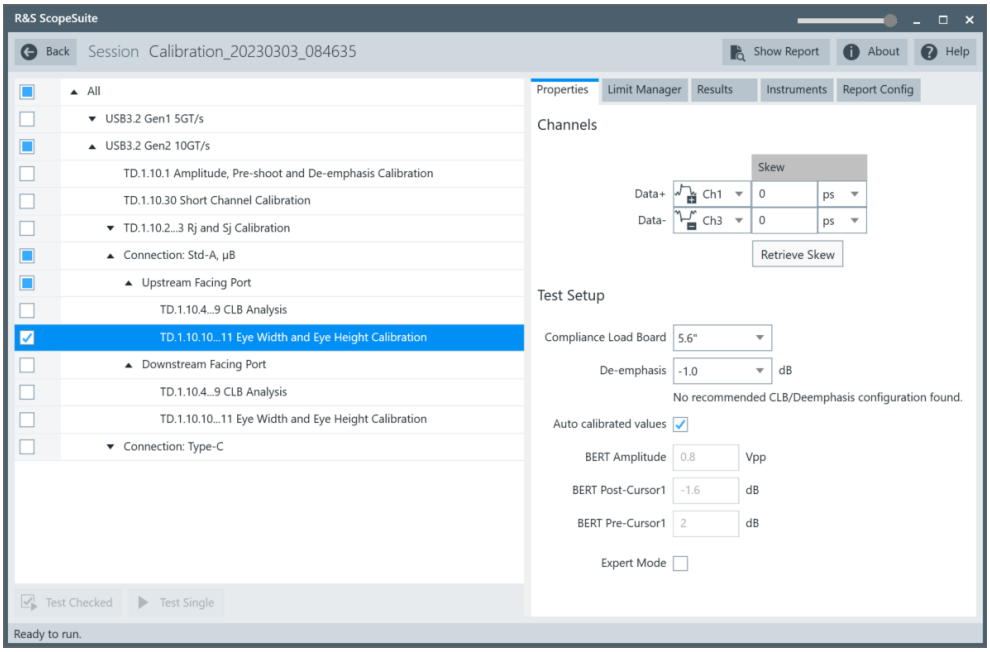
This test performs calibration of the test setup for eye width and eye height calibration of the upstream facing port for Std-A, Std-B, µB USB 3.2 Gen2 10GT/s tests.

Table 6-10: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Std-A, µB > Upstream Facing Port > TD 1.10.10...11 Eye Width and Eye Height Calibration " test case.



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

   The results are saved and can be viewed in the report.

Measurements

This calibration test case adjusts the BERT settings so that the eye width measurement of 48 ps and the eye height measurement of 70 mV are achieved with the selected compliance load board (CLB). Using test pattern CP9 with the previously calibrated BERT parameters (amplitude, preshoot, de-emphasis, Rj and Sj) as input, the waveform is captured and analyzed using SigTest. The eye width is first adjusted either by adding a second Sj tone or reducing the primary Sj tone, followed by the eye height by output amplitude adjustment.

6.2.8.3 Downstream facing port: CLB analysis

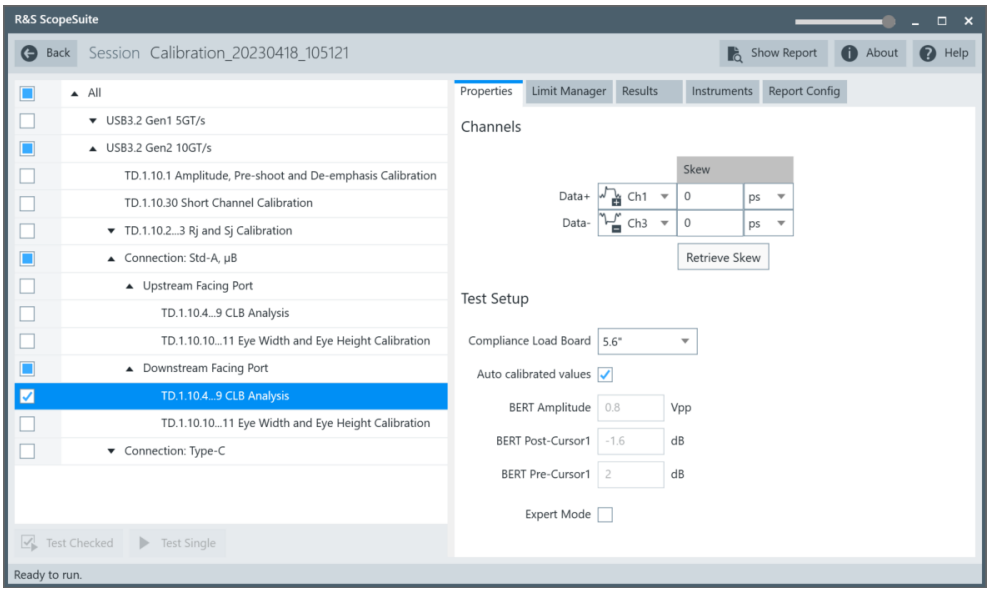
This test performs calibration of the test setup for the downstream facing port of the CLB for Std-A, Std-B, µB USB 3.2 Gen2 10GT/s tests.

Table 6-11: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Std-A, µB > Downstream Facing Port > TD 1.10.4...9 CLB Analysis " test case.



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

   The results are saved and can be viewed in the report.

Measurements

This test case aims to analyze the eye height and eye width measured using compliance load boards (CLB) of different sizes. Using test pattern CP9 with the previously calibrated output amplitude, preshoot, de-emphasis, Rj and Sj values as input, the output waveform is captured and analyzed using SigTest. Three sets of eye height and eye width values are reported using three sets of de-emphasis and preshoot values

respectively. The CLB having the eye height measurement closest to 70 mV and eye width measurement closest to 48 ps is deemed most preferable.

6.2.8.4 Downstream facing port: eye width and eye height calibration

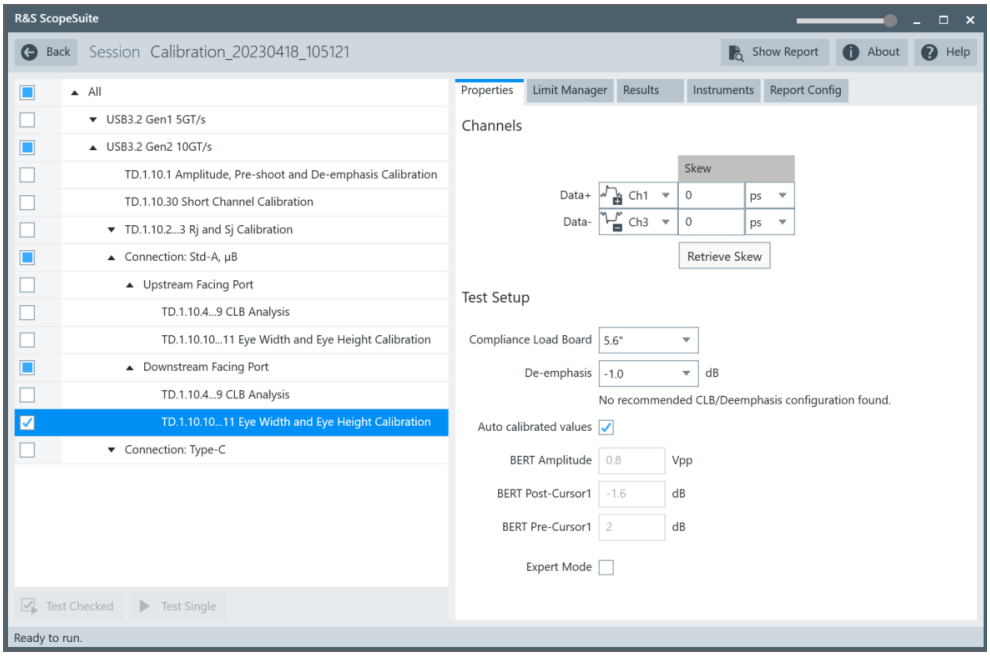
This test performs calibration of the test setup for eye width and eye height calibration of the downstream facing port for Std-A, Std-B, µB USB 3.2 Gen2 10GT/s tests.

Table 6-12: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Std-A, µB > Downstream Facing Port > TD 1.10.10..11 Eye Width and Eye Height Calibration " test case.



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

   The results are saved and can be viewed in the report.

Measurements

This calibration test case adjusts the BERT settings so that the eye width measurement of 48 ps and the eye height measurement of 70 mV are achieved with the selected compliance load board (CLB). Using test pattern CP9 with the previously calibrated BERT parameters (amplitude, preshoot, de-emphasis, Rj and Sj) as input, the waveform is captured and analyzed using SigTest. The eye width is first adjusted either by adding a second Sj tone or reducing the primary Sj tone, followed by the eye height by output amplitude adjustment.

6.2.9 USB 3.2 Gen2 10GT/s connection: Type C

6.2.9.1 Upstream facing port: CLB analysis

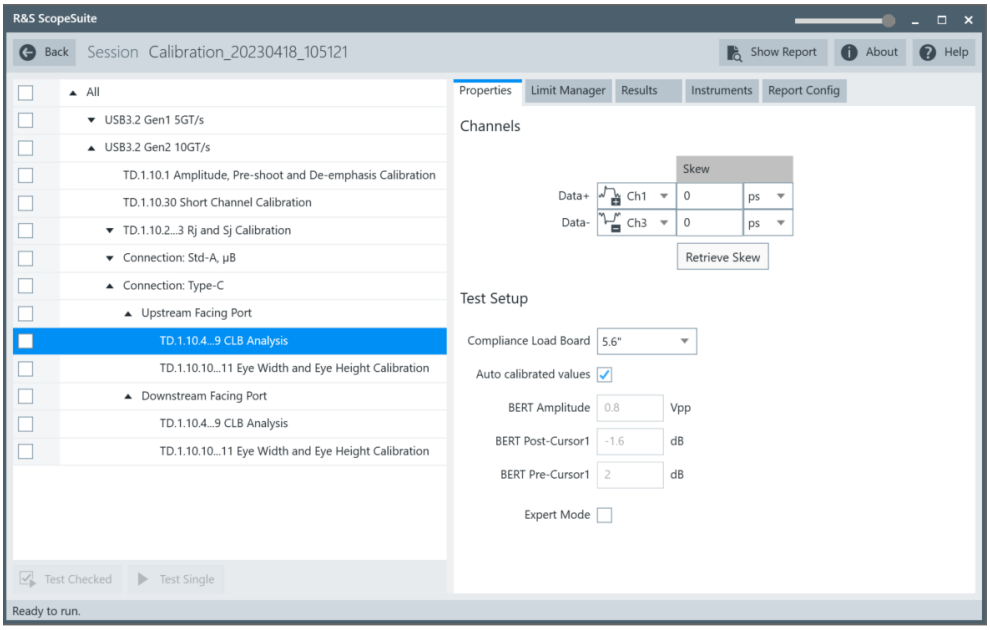
This test performs calibration of the test setup for the upstream facing port of the CLB for Type-C USB 3.2 Gen2 10GT/s tests.

Table 6-13: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Type C > Upstream Facing Port > TD 1.10.4...9 CLB Analysis " test case.



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

   The results are saved and can be viewed in the report.

Measurements

This test case aims to analyze the eye height and eye width measured using compliance load boards (CLB) of different sizes. Using test pattern CP9 with the previously calibrated output amplitude, preshoot, de-emphasis, Rj and Sj values as input, the output waveform is captured and analyzed using SigTest. Three sets of eye height and eye width values are reported using three sets of de-emphasis and preshoot values respectively. The CLB having the eye height measurement closest to 70 mV and eye width measurement closest to 48 ps is deemed most preferable.

6.2.9.2 Upstream facing port: eye width and eye height calibration

This test performs calibration of the test setup for eye width and eye height calibration of the upstream facing port for Type-C USB 3.2 Gen2 10GT/s tests.

Table 6-14: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Type C > Upstream Facing Port > TD 1.10.10...11 Eye Width and Eye Height Calibration " test case.
2. Click "Test Single".
3. Follow the instructions of the step-by step guide.
   When you have finished all steps, the compliance test runs automatically.

   The results are saved and can be viewed in the report.

Measurements

This calibration test case adjusts the BERT settings so that the eye width measurement of 48 ps and the eye height measurement of 70 mV are achieved with the selected compliance load board (CLB). Using test pattern CP9 with the previously calibrated BERT parameters (amplitude, preshoot, de-emphasis, Rj and Sj) as input, the waveform is captured and analyzed using SigTest. The eye width is first adjusted either by adding a second Sj tone or reducing the primary Sj tone, followed by the eye height by output amplitude adjustment.

6.2.9.3 Downstream facing port: CLB analysis

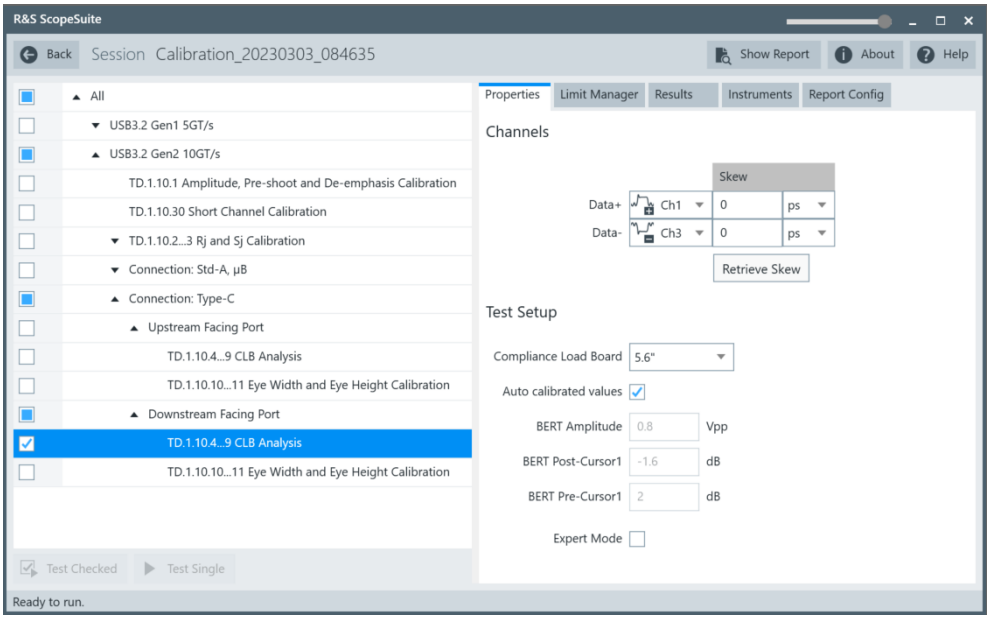
This test performs calibration of the test setup for the downstream facing port of the CLB for Type-C USB 3.2 Gen2 10GT/s tests.

Table 6-15: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Type C > Downstream Facing Port > TD 1.10.4...9 CLB Analysis " test case.



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

   The results are saved and can be viewed in the report.

Measurements

This test case aims to analyze the eye height and eye width measured using compliance load boards (CLB) of different sizes. Using test pattern CP9 with the previously calibrated output amplitude, preshoot, de-emphasis, Rj and Sj values as input, the output waveform is captured and analyzed using SigTest. Three sets of eye height and eye width values are reported using three sets of de-emphasis and preshoot values respectively. The CLB having the eye height measurement closest to 70 mV and eye width measurement closest to 48 ps is deemed most preferable.

6.2.9.4 Downstream facing port: eye width and eye height calibration

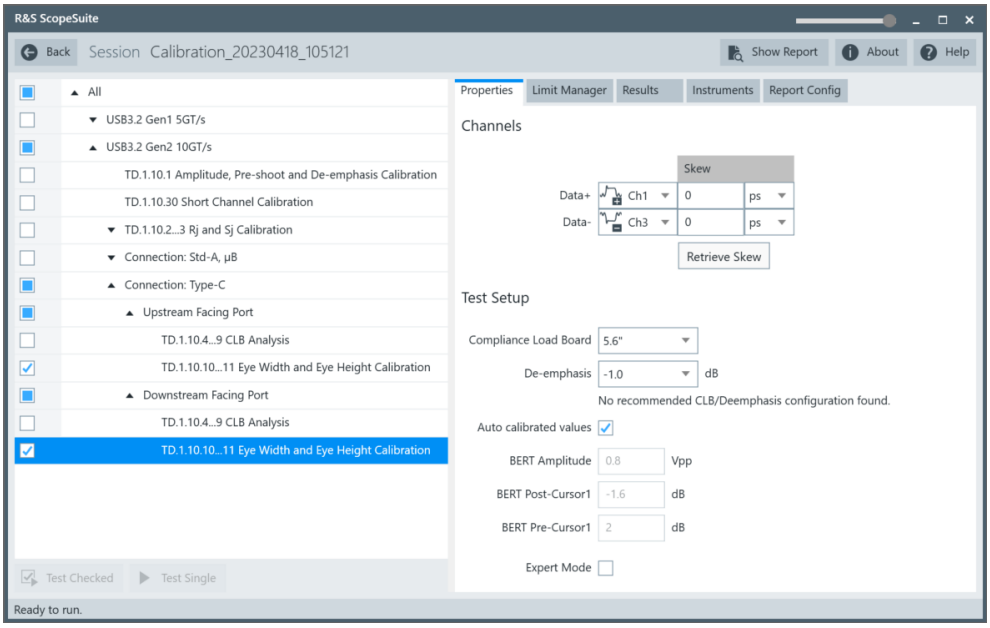
This test performs calibration of the test setup for eye width and eye height calibration of the downstream facing port for Type-C USB 3.2 Gen2 10GT/s tests.

Table 6-16: Test equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

Running the test

1. Select the "USB3.2 Gen2 (10GT/s) > Connection: Type C > Downstream Facing Port > TD 1.10.10..11 Eye Width and Eye Height Calibration " test case.



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

   The results are saved and can be viewed in the report.

Measurements

This calibration test case adjusts the BERT settings so that the eye width measurement of 48 ps and the eye height measurement of 70 mV are achieved with the selected compliance load board (CLB). Using test pattern CP9 with the previously calibrated BERT parameters (amplitude, preshoot, de-emphasis, Rj and Sj) as input, the waveform is captured and analyzed using SigTest. The eye width is first adjusted either by adding a second Sj tone or reducing the primary Sj tone, followed by the eye height by output amplitude adjustment.

6.3 USB 3.2-RX device tests

This chapter describes the configuration of USB 3.2-RX device compliance tests.

6.3.1 Starting USB 3.2-RX device tests

Before you run the tests, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Calibrate the test setups, see Chapter 6.2, "USB 3.2-RX calibration", on page 194.

1. In the R&S ScopeSuite start window, select USB 3.2-RX.
2. In the "Session Selection" dialog, select type "Device".
3. Add a new test session and open it, see Chapter 3.1, "Starting a test session", on page 18.
4. Check the test configuration settings and adjust them, if necessary.
   Calibrate the test setup, see Chapter 6.2, "USB 3.2-RX calibration", on page 194.
   - Chapter 6.1.2, "Test configuration for device, hub and host", on page 192
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.

6.3.2 Measurement setups

When performing USB 3.2-RX device compliance tests, you can use one of the following setups:

6.3.2.1 Gen 1 device Std-A test setup

Required settings:

- "Port"="Std-A"

Table 6-17: Gen 1 device Std-A

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
Bit error rate tester (BERT)	Anritsu MP1900A	1
	MX183000A: high-speed serial data test software	1
USB3ET device test fixtures	Device test fixture 1	1
	Device test fixture 2, 11”	1
DUT	The device you want to test	1
3 m Type A - B cable	To connect the two test fixtures	1

Item	Description, model	Quantity
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2
Short A-B or A-uB Cable	To connect the DUT and the test fixture	1

6.3.2.2 Gen 1 device Std-B test setup

Required settings:

- "Port"="Std-B"

Table 6-18: Gen 1 device Std-B tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
	MX183000A: High-Speed serial data test software	1
USB3ET device test fixtures	Device test fixture 1	1
	Device test fixture 2, 11”	1
DUT	The device you want to test	1
1m Type A - B cable	To connect the two test fixtures	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2
Short A-B or A-uB Cable	To connect the DUT and the test fixture	1

6.3.2.3 Gen 1 device Std-µB test setup

Required settings:

- "Port"="Micro-B"

Table 6-19: Gen 1 device Micro-B tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
	MX183000A: high-speed serial data test software	1
USB3ET device test fixtures	Device test fixture 1	1
	Device test fixture 2, 11”	1
DUT	The device you want to test	1

Item	Description, model	Quantity
1m Type A - B cable	To connect the two test fixtures	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2
Short A-B or A-uB Cable	To connect the DUT and the test fixture	1

6.3.2.4 Gen 1 device Std-C test setup

Required settings:

- "Port"="Std-C"

Table 6-20: Gen 1 device Std-C

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
	MX183000A: high-speed serial data test software	1
USB3ET device test fixtures	Device Fixture 1C	1
	14.4” 5G Host/ Device Fixture 2	1
DUT	The device you want to test	1
2 m (7dB) cable	To connect the two test fixtures	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.3.2.5 Gen 2 device Std-A

Required settings:

- "Port"="Std-A"

Table 6-21: Gen 2 device Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
	MX183000A: high-speed serial data test software	1
USB31AET host test fixtures	Device test fixture 1A	1
	CLB test fixture	1
DUT	The host you want to test	1

Item	Description, model	Quantity
1 m (6dB) cable	To connect the test fixtures to the CLB	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.3.2.6 Gen 2 Captive Cable device Std-A

Required settings:

- "Port"="Std-A"

Table 6-22: Gen 2 device Captive Cable Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
	MX183000A: high-speed serial data test software	1
USB31AET test fixtures	Captive Cable Device Fixture Type-A	1
DUT	The host you want to test	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.3.2.7 Gen 2 device Std-C

Required settings:

- "Port"="Std-C"

Table 6-23: Gen 2 device Type-C tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
	MX183000A: high-speed serial data test software	1
USB31AET host test fixtures	Device test fixture 1C	1
	CLB test fixture	1
DUT	The host you want to test	1
1 m (6dB) cable	To connect the test fixtures to the CLB	1

Item	Description, model	Quantity
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.3.2.8 Gen 2 Captive cable device Std-C

Required settings:

- "Port"="Std-C"

Table 6-24: Gen 2 device Captive Cable Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
	MX183000A: high-speed serial data test software	1
USB31AET test fixtures	Captive Cable Device Fixture Type-C	1
DUT	The host you want to test	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.3.3 USB 3.2-RX Gen1 5GT/s

6.3.3.1 Receiver jitter tolerance test long channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for long channel.

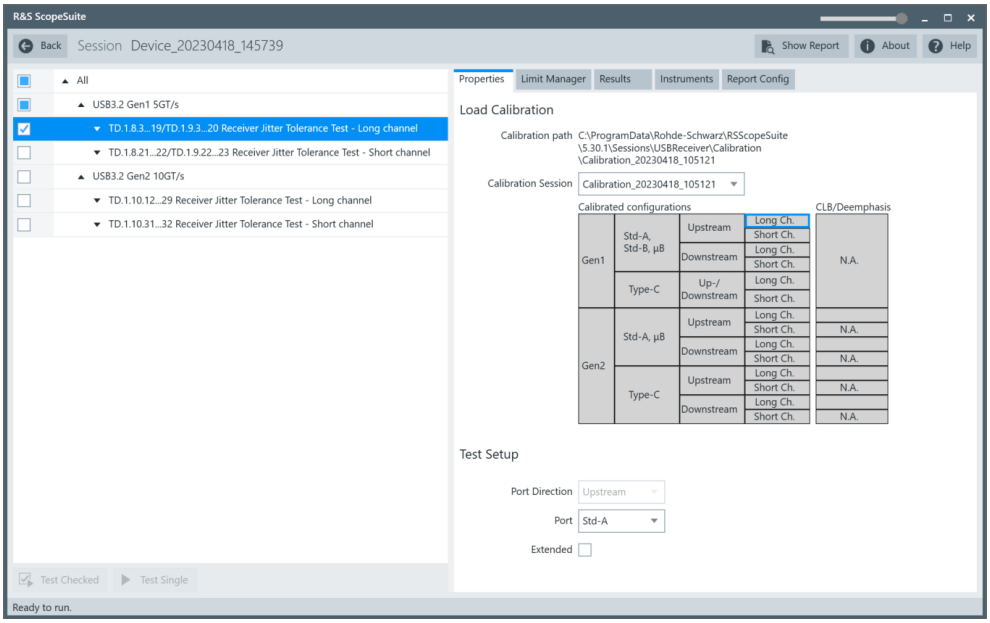
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.3.1, "Starting USB 3.2-RX device tests", on page 215.
2. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.3...19/TD 1.9.3...20 Receiver Jitter Tolerance Test - Long channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.3.3.2 Receiver jitter tolerance test short channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for short channel.

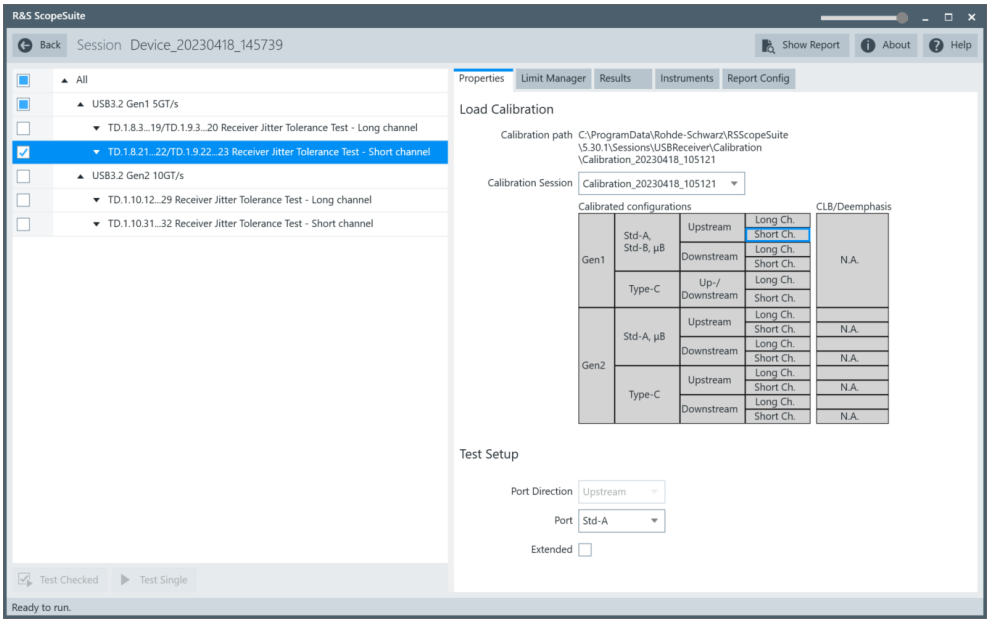
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.3.1, "Starting USB 3.2-RX device tests", on page 215.
2. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.21...22/ TD 1.9.22...23 Receiver Jitter Tolerance Test - Short channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.3.4 USB 3.2-RX Gen2 10GT/s

6.3.4.1 Receiver jitter tolerance test long channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for long channel.

You can perform "Loopback Mode" tests and "Measurement".

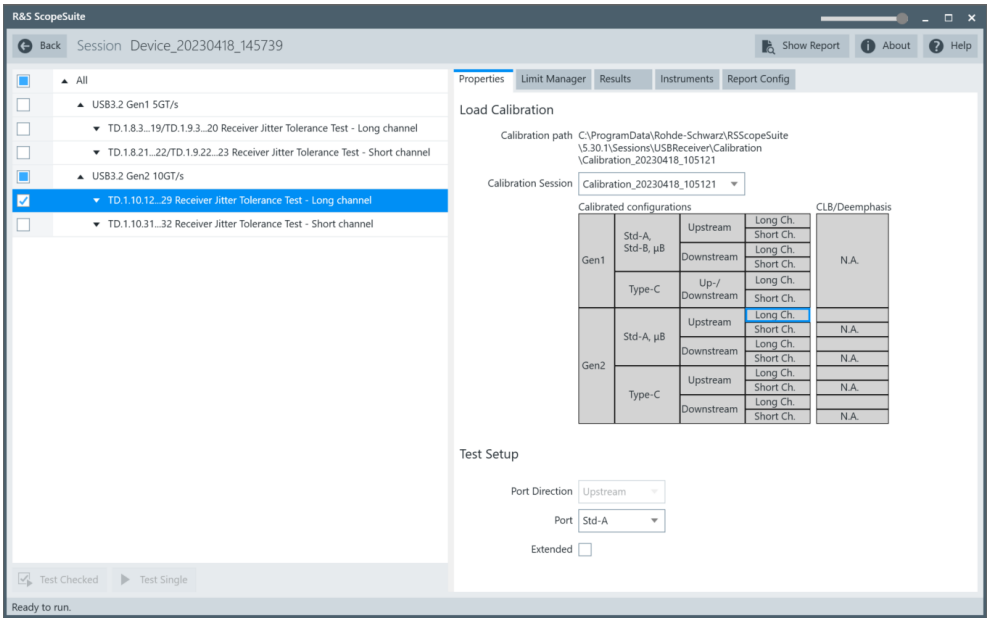
In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.3.1, "Starting USB 3.2-RX device tests", on page 215.

2. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.12...29 Receiver Jitter Tolerance Test - Long channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.3.4.2 Receiver jitter tolerance test short channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for short channel.

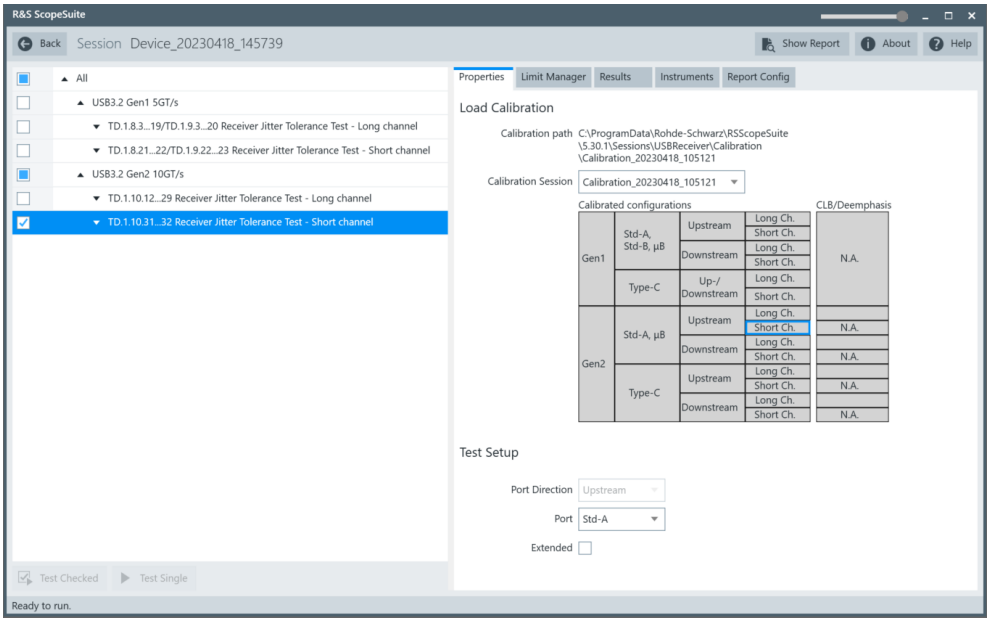
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.3.1, "Starting USB 3.2-RX device tests", on page 215.
2. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.31...32 Receiver Jitter Tolerance Test - Short channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.4 USB 3.2-RX host tests

This chapter desscribes the configuration of USB 3.2-RX host compliance tests.

6.4.1 Starting USB 3.2-RX host tests

Before you run the tests, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Calibrate the test setup, see Chapter 6.2, "USB 3.2-RX calibration", on page 194.

1. In the R&S ScopeSuite start window, select USB 3.2-RX.
2. In the "Session Selection" dialog, select type "Host".

3. Add a new test session and open it, see Chapter 3.1, "Starting a test session", on page 18.
4. Check the test configuration settings and adjust them, if necessary.
   Calibrate the test setup, see Chapter 6.2, "USB 3.2-RX calibration", on page 194.
   - Chapter 6.1.2, "Test configuration for device, hub and host", on page 192
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.

6.4.2 Measurement setups

When performing USB 3.2-RX host compliance tests, you can use one of the following setups:

6.4.2.1 Gen 1 host Std-A test setup

Required settings:

- "Port"="Std-A"

Table 6-25: Gen 1 host Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
USB3ET test fixtures	Host test fixture 1	1
	Host test fixture 2, 5 "	1
	5 " Device test fixture 1	
DUT	The host you want to test	1
3 m Type A - B cable	To connect the two host fixtures	
USB Type A-B cable	To connect the two test fixtures	1

6.4.2.2 Gen 1 host Std-C test setup

Required settings:

- "Port"="Std-C"

Table 6-26: Gen 1 host Std-C

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1

Item	Description, model	Quantity
USB3ET device test fixtures	Host Fixture 1C	1
	14.4” 5G Host/Device Fixture 2	1
DUT	The device you want to test	1
2 m (7dB) cable	To connect the two test fixtures	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.4.2.3 Gen 2 host Std-A

Required settings:

- "Port"="Std-A"

Table 6-27: Gen 2 host Type-A tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
USB31AET host test fixtures	7.2” Mock Host	1
	Host test fixture 1A	1
	CLB test fixture	1
DUT	The host you want to test	1
1 m (6dB) cable	To connect the test fixtures to the CLB	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.4.2.4 Gen 2 host Std-C

Required settings:

- "Port"="Std-C"

Table 6-28: Gen 2 host Type-C tests equipment

Item	Description, model	Quantity
Rohde & Schwarz oscilloscope	R&S RTP with 4 channels and at least 16 GHz bandwidth	1
BERT	Anritsu MP1900A	1
USB31AET host test fixtures	Host test fixture 1C	1
	CLB test fixture	1
DUT	The host you want to test	1

Item	Description, model	Quantity
1 m (6dB) cable	To connect the test fixtures to the CLB	1
Pair of matched cables	To connect fixtures to BERT	2
Precision BNC to SMA adapter	R&S RT-ZA16	2

6.4.3 USB 3.2-RX Gen1 5GT/s

6.4.3.1 Receiver jitter tolerance test long channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for long channel.

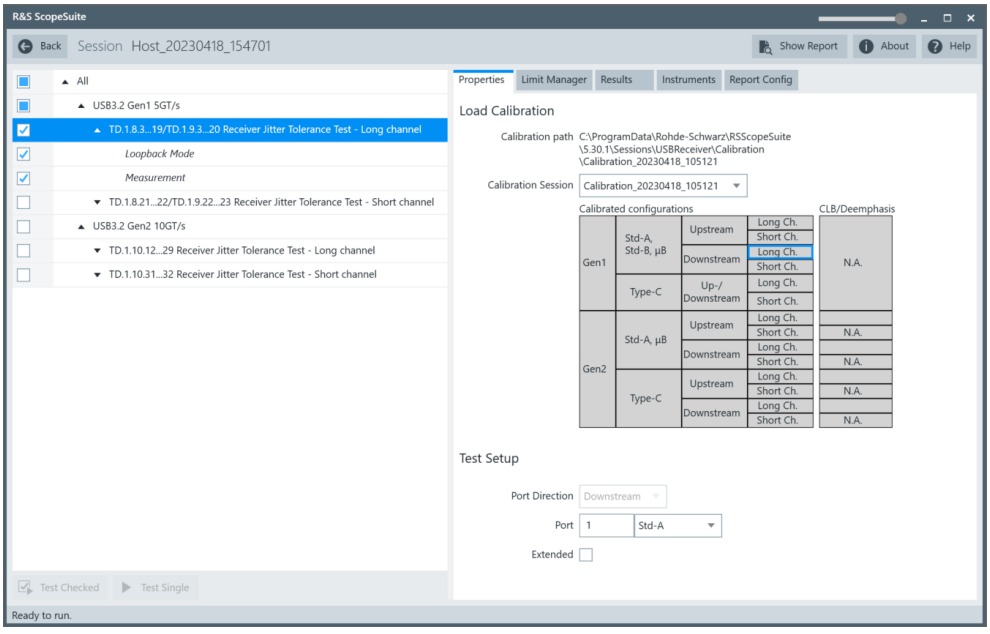
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.4, "USB 3.2-RX host tests", on page 223.
2. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.3...19/TD 1.9.3...20 Receiver Jitter Tolerance Test - Long channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.4.3.2 Receiver jitter tolerance test short channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for short channel.

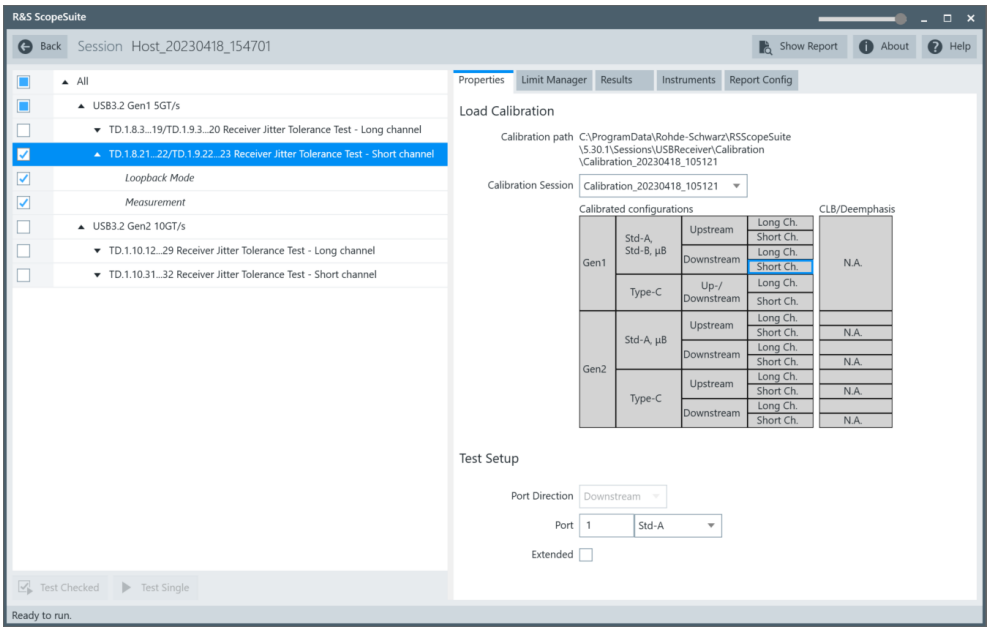
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.4, "USB 3.2-RX host tests", on page 223.
2. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.21...22/ TD 1.9.22...23 Receiver Jitter Tolerance Test - Short channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.4.4 USB 3.2-RX Gen2 10GT/s

6.4.4.1 Receiver jitter tolerance test long channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for long channel.

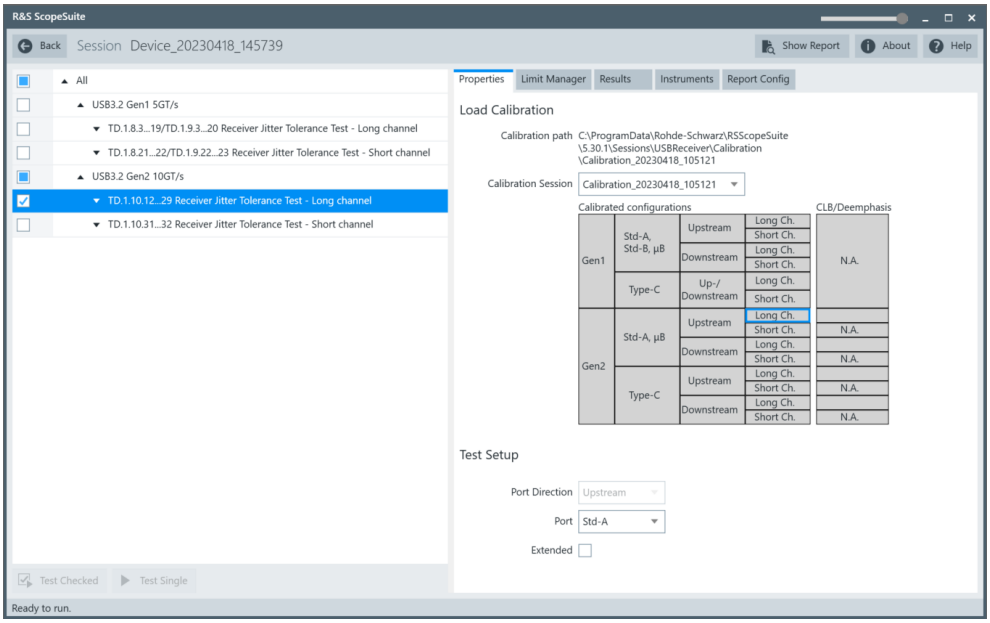
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.4, "USB 3.2-RX host tests", on page 223.
2. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.12...29 Receiver Jitter Tolerance Test - Long channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.4.4.2 Receiver jitter tolerance test short channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for short channel.

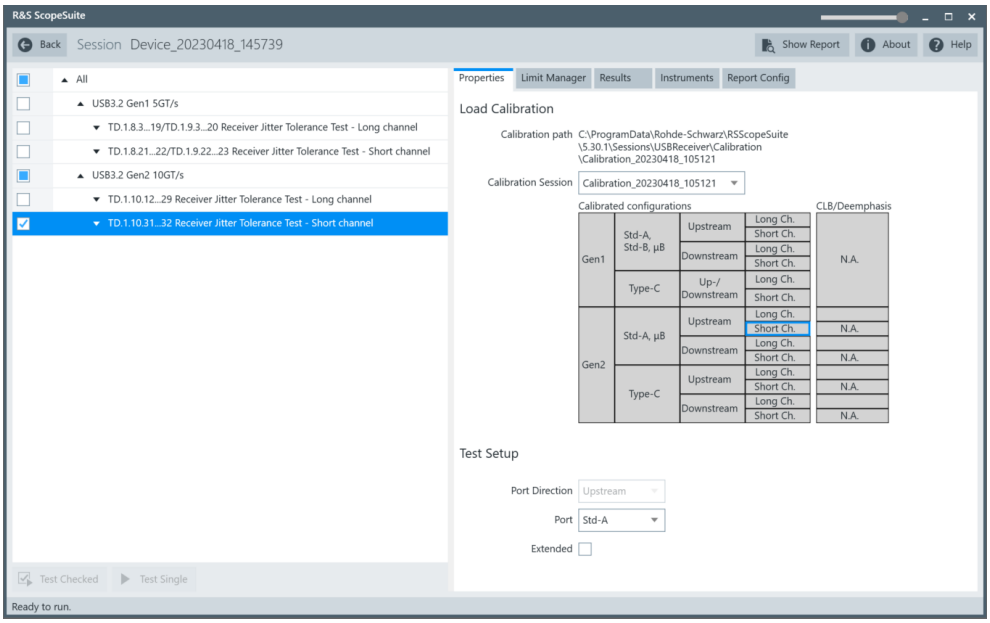
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.4, "USB 3.2-RX host tests", on page 223.
2. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.31...32 Receiver Jitter Tolerance Test - Short channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.5 USB 3.2-RX hub tests

This chapter desscribes the configuration of USB 3.2-RX hub compliance tests.

6.5.1 Starting USB 3.2-RX hub tests

Before you run the tests, complete the following actions:

- Initial setup of the equipment, see Chapter 2.2, "Installing software and license", on page 10
- LAN connection of the oscilloscope and the computer running the R&S ScopeSuite, see Chapter 2.5, "Connecting the R&S RTO/RTO6/RTP", on page 13
- Calibrate the test setup, see Chapter 6.2, "USB 3.2-RX calibration", on page 194.

1. In the R&S ScopeSuite start window, select USB 3.2-RX.
2. In the "Session Selection" dialog, select type "Hub".
3. Add a new test session and open it, see Chapter 3.1, "Starting a test session", on page 18.
4. Check the test configuration settings and adjust them, if necessary.
   Calibrate the test setup, see Chapter 6.2, "USB 3.2-RX calibration", on page 194.
   - Chapter 6.1.2, "Test configuration for device, hub and host", on page 192
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.

6.5.2 Measurement setups

When performing USB 3.2-RX hub compliance tests, you can use different setups, depending on the selected "Port Direction":

- For "Port Direction" = "Upstream", refer to the test setups described in Chapter 6.3, "USB 3.2-RX device tests", on page 214.
- For "Port Direction" = "Downstream", refer to the test setups described in Chapter 6.4.2, "Measurement setups", on page 224.

6.5.3 USB 3.2-RX Gen1 5GT/s

6.5.3.1 Receiver jitter tolerance test long channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for long channel.

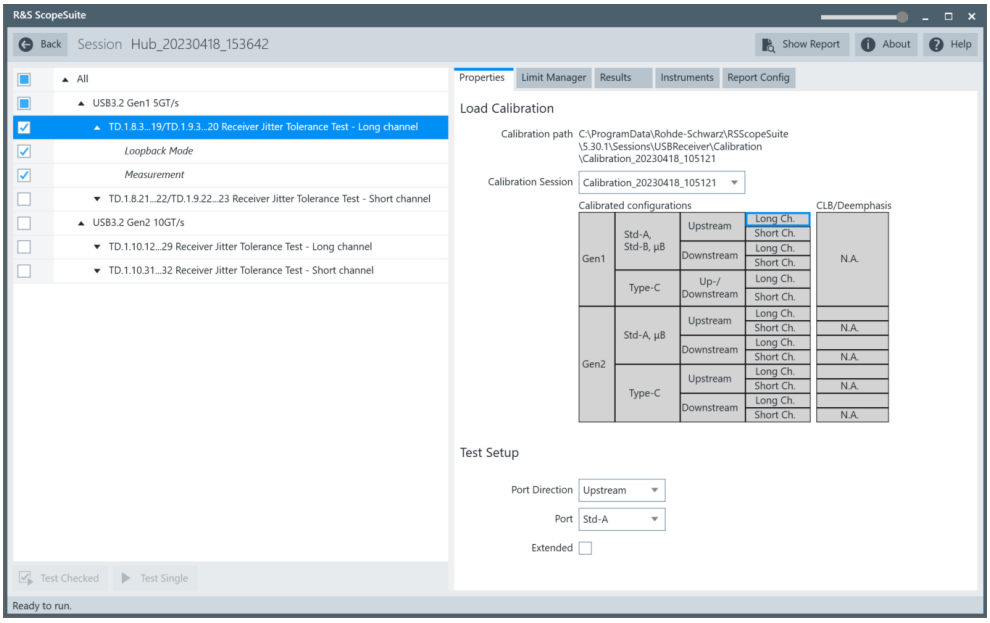
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.5.1, "Starting USB 3.2-RX hub tests", on page 230.
2. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.3...19/TD 1.9.3...20 Receiver Jitter Tolerance Test - Long channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.5.3.2 Receiver jitter tolerance test short channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for short channel.

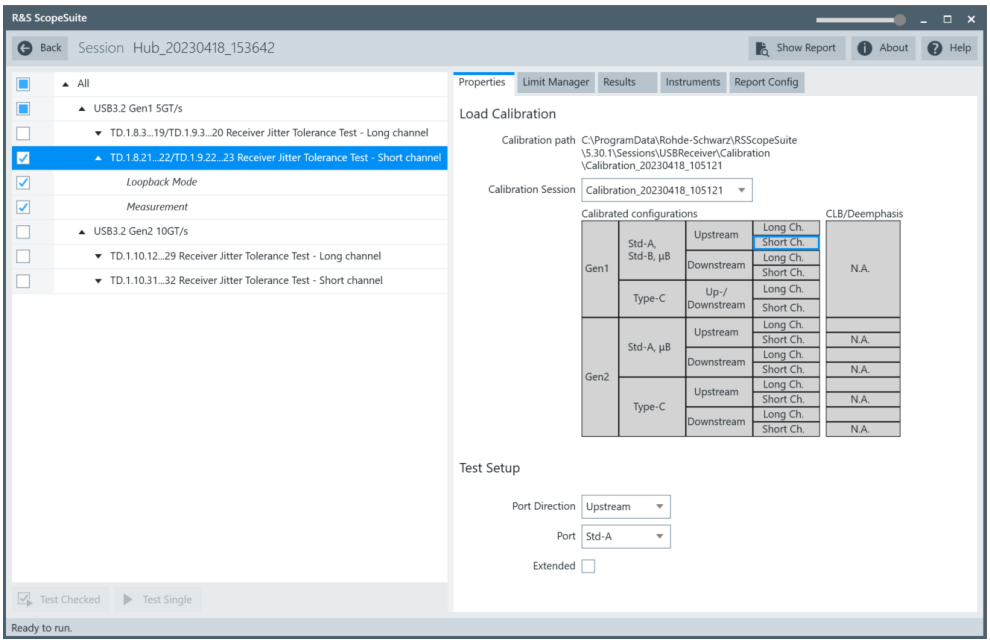
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.5.1, "Starting USB 3.2-RX hub tests", on page 230.
2. Select the "USB3.2 Gen1 (5GT/s) > TD 1.8.21...22/ TD 1.9.22...23 Receiver Jitter Tolerance Test - Short channel" test case.



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.

   The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.5.4 USB 3.2-RX Gen2 10GT/s

6.5.4.1 Receiver jitter tolerance test long channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for long channel.

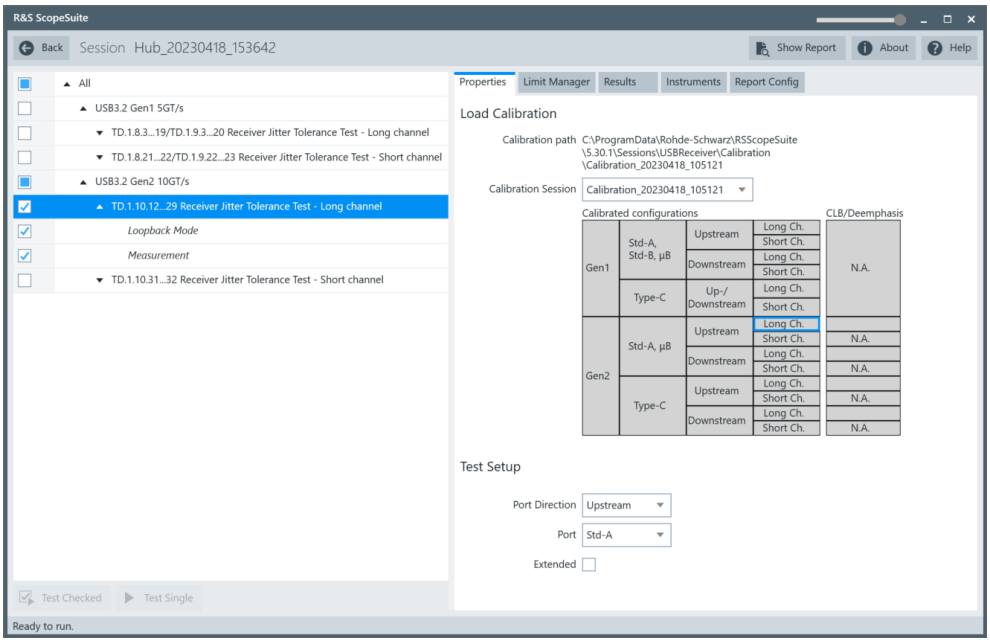
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.5.1, "Starting USB 3.2-RX hub tests", on page 230.
2. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.12...29 Receiver Jitter Tolerance Test - Long channel" test case.



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.

The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

6.5.4.2 Receiver jitter tolerance test short channel

This test verifies that the receiver meets the jitter tolerance requirements for the test conditions described in the specification for short channel.

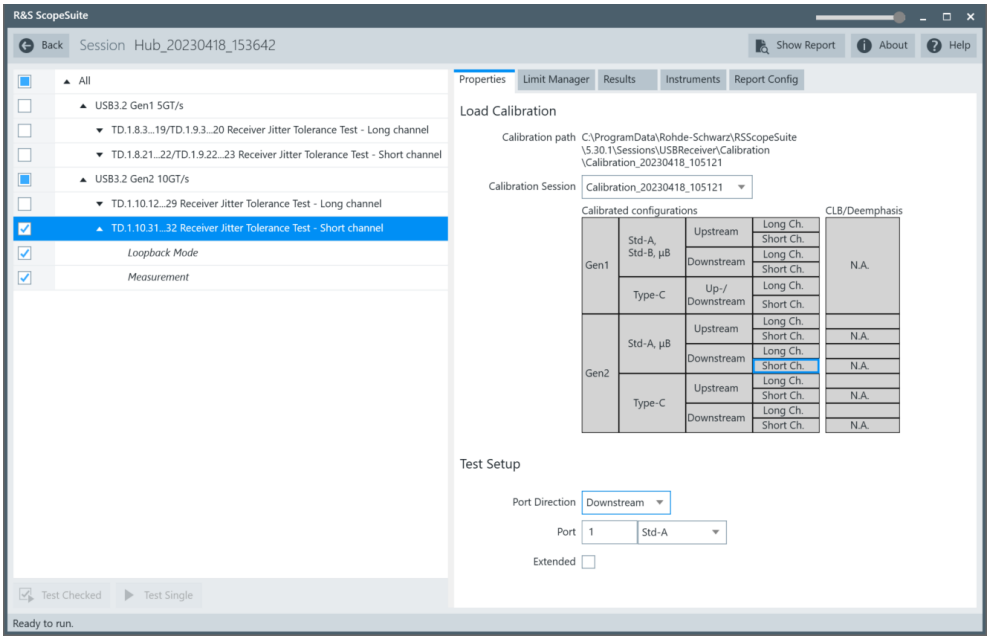
You can perform "Loopback Mode" tests and "Measurement".

In "Loopback Mode", BERT tries to synchronize with the DUT, allowing for verification that port is functioning properly. This is a condition that must be met before "Measurements" can be done.

"Measurement " measures the Bit Error Rate of the DUT with various disturbing components like Sinusoidal Jitter at different frequencies and amplitudes.

Running the test

1. Prepare the test, as described in Chapter 6.5.1, "Starting USB 3.2-RX hub tests", on page 230.
2. Select the "USB3.2 Gen2 (10GT/s) > TD 1.10.31...32 Receiver Jitter Tolerance Test - Short channel" test case.



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.

The results are saved and can be viewed in the report.

Further steps:

- Chapter 3.4, "Getting test results", on page 27

Annex

A Ordering Information

Designation	Type	Order No.
USB 2.0 Compliance Test - Software	R&S®RTO-K21	1317.4103.02
	R&S®RTP-K21	1337.8685.02
The R&S®RTO/RTP-K21 option requires that the host PC be connected to an R&S®RTO/RTP digital oscilloscope via LAN.		
System requirements		
Windows 7 with .NET Framework 4 Redistributable Package, LAN with installed VISA driver for remote device control.		
Test Fixture		
USB 2.0 Test Fixture Set	R&S®RT-ZF1	1317.3420.02
Supported oscilloscopes		
Digital Oscilloscope, four channels	R&S®RTO	1316.1000.xx
Digital Oscilloscope, four channels	R&S®RTP	1320.5007.xx
Supported probes		
Single-ended probes		
1.0 GHz, active, 1 MΩ ||0.8 pF, R&S®ProbeMeter, micro button	R&S®RT-ZS10	1410.4080.02
1.5 GHz, active, 1 MΩ ||0.8 pF, R&S®ProbeMeter, micro button	R&S®RT-ZS20	1410.3502.02
3.0 GHz, active, 1 MΩ ||0.8 pF, R&S®ProbeMeter, micro button	R&S®RT-ZS30	1410.4309.02
6.0 GHz, active, 1 MΩ ||0.3 pF, R&S®ProbeMeter, micro button	R&S®RT-ZS60	1418.7307.02
Differential probes		
1.0 GHz, active, differential, 1 MΩ ||0.6 pF, R&S®ProbeMeter, micro button, including 10:1 external attenuator, 1.3 pF, 70 V DC, 46 V AC (peak)	R&S®RTO RT-ZD10	1410.4715.02
1.5 GHz, active, differential, 1 MΩ ||0.6 pF, R&S®ProbeMeter, micro button	R&S®RTO RT-ZD20	1410.4409.02
3.0 GHz, active, differential, 1 MΩ ||0.6 pF, R&S®ProbeMeter, micro button	R&S®RTO RT-ZD30	1410.4609.02
4.5 GHz, active, differential, 1 MΩ ||0.4 pF, R&S®ProbeMeter, micro button	R&S®RTO RT-ZD40	1417.0867.02
Current probes		
100 MHz, current probe, AC/DC, 0.1 V/A, 30 A (RMS)	R&S®RT-ZC20	1409.7766.02
Probe Power Supply	R&S®RT-ZA13	1409.7789.02

Designation	Type	Order No.
Automated arbitrary waveform generator		
2.3 Gsample/s Dual-Channel Arbitrary Waveform Generator	WX2182B WX2182C	available from Tabor

Check the brochure for updates, if available:
https://www.rohde-schwarz.com/brochure-datasheet/rtp/
https://www.rohde-schwarz.com/brochure-datasheet/rto/