R&S®RTO-K21
USB2.0 Compliance Test
for R&S®RTO
digital oscilloscopes

ROHDE&SCHWARZ

Test & Measurement

Product Brochure | 02.01

R&S®RTO-K21 USB2.0 Compliance Test

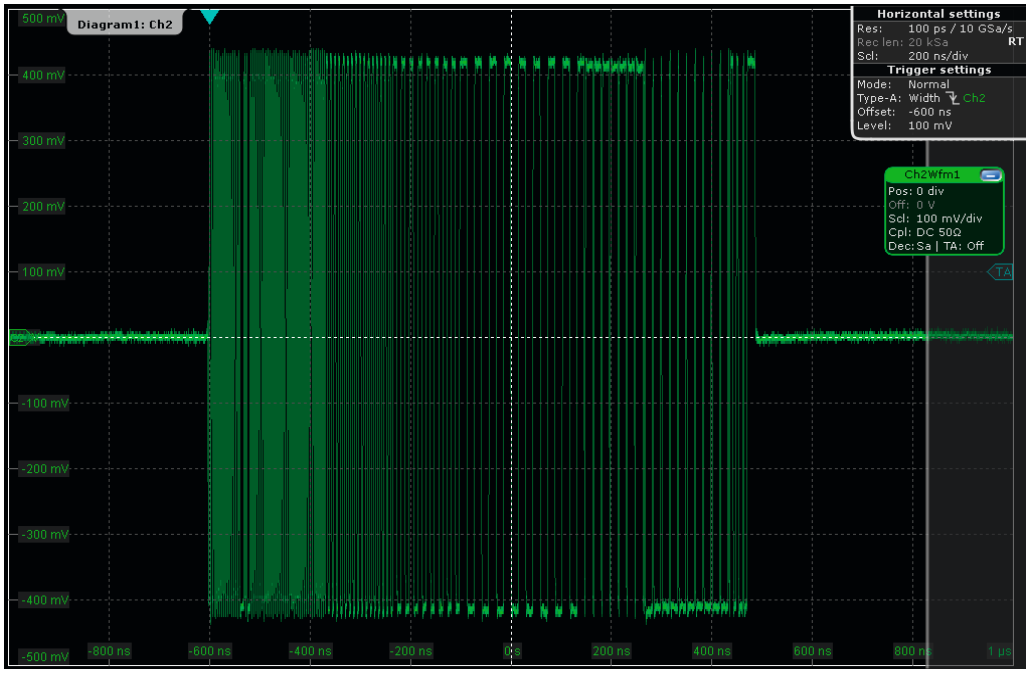
At a glance

The R&S®RTO-K21 software application checks the signal conformity of USB devices in line with the USB-IF compliance test procedures and ensures the interoperability of products that have USB interfaces.

The R&S®RTO-K21 USB2.0 compliance test software provides an automated solution for performing physical layer tests on USB2.0/1.1/1.0 interfaces. It covers devices, hubs and hosts. Integrated into the R&S®ScopeSuite software, the solution allows experts and novices alike to complete their tests quickly. Rohde&Schwarz offers the R&S®RT-ZF1 USB2.0 test fixture set for optimum contacting of the DUT. When a Tabor WX2182B arbitrary waveform generator is used, sensitivity tests for USB receivers are also fully automated.

Key facts

- Test solution for USB2.0 devices, hosts and hubs in line with USB2.0 compliance test procedures
- Support for all data rates: high speed (480 Mbit/s), full speed (12 Mbit/s) and low speed (1.5 Mbit/s)
- Predefined, automated test steps
- Step-by-step wizard for user guidance
- Clear and comprehensive test documentation



R&S®RTO-K21 USB2.0 Compliance Test

Benefits and key features

Comprehensive USB compliance testing

- All data rates and test scenarios
- Compliance tests from a single source: R&S®ScopeSuite
- Simple and fast test setup
- Automated receiver sensitivity test

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Intuitive user interface

- Simple and fast configuration
- Customized testing
- Step-by-step wizard
- Test sequence control
- Support for stability tests

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Clear and comprehensive test documentation

- Complete, versatile test documentation
- Quick overview plus detailed information
- Configurable test documentation
- Coherent test documentation

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R&S®RT-ZF1 for optimal test connections

- Test fixture set for fast measurements
- Signal quality board
- Load board for hub tests
- Accessories for quick startup

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Interface standard	Compliance test option	Recommended base unit	Recommended accessories
USB1.0/USB 1.1	R&S®RTO-K21	R&S®RTO1004 (600 MHz) or higher	▪ R&S®RT-ZF1 ▪ R&S®RT-ZS10 or higher ▪ R&S®RT-ZD10 or higher
USB2.0	R&S®RTO-K21	R&S®RTO1024 (2 GHz) or higher	▪ R&S®RT-ZF1 ▪ R&S®RT-ZS30 or higher ▪ R&S®RT-ZD30 or higher ▪ Tabor WX2182B 2.3 Gsample/s dual-channel arbitrary waveform generator

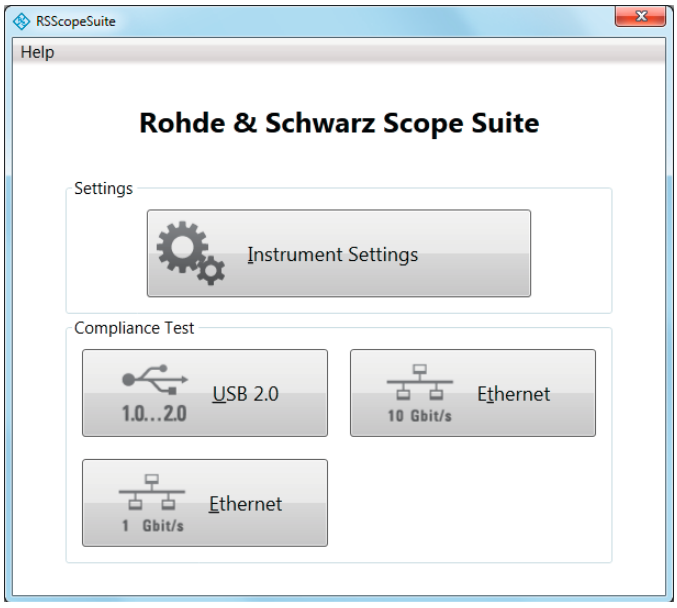
Comprehensive USB compliance testing

All data rates and test scenarios

As part of the USB-IF compliance program, the USB Implementers Forum (USB-IF) has specified test procedures intended to ensure flawless interaction between a wide variety of DUTs with USB interfaces, involving one host and a desired number of devices and hubs. Passing these tests is mandatory for a product to obtain certification. The tests also play a key role in the early detection of problems during development and in providing customers with convincing evidence of compliance with standards.

The R&S®RTO-K21 software automates the USB-IF tests for USB2.0/1.1/1.0 at the device, hub and host level (see table below), thereby allowing quick test completion.

R&S®ScopeSuite with USB2.0 compliance test.



Compliance tests from a single source: R&S®ScopeSuite

R&S®RTO-K21 is integrated in the R&S®ScopeSuite software, a tool developed by Rohde&Schwarz for automated compliance tests. From a Windows 7 PC, R&S®ScopeSuite uses the LAN interface to control the configuration of, and testing with, the R&S®RTO digital oscilloscope as well as signal generation by the Tabor WX2182B. This ensures that test steps are executed quickly and accurately. R&S®ScopeSuite is supplied as part of R&S®RTO-K21.

Supported compliance tests				Required probes	
	Device	Host	Hub	Differential	Single-ended
High-speed tests (2.0)					
Signal quality (SQ)	•	•	•	1	
Packet parameters	•	•	•	1	
Chirp timing	•	•	•		2 active or passive
Suspend/resume/reset	•	•	•		2 active
J/K, SE0_NAK levels	•	•	•		2 active
Receiver sensitivity	•		•	1	
Hub jitter			•	1	
Hub repeater			•	1	2 active
Full-speed test (1.1)					
Full-speed signal quality (SQ)	•	•	•	1	2 active or passive
Low-speed test (1.0)					
Low-speed signal quality (SQ)	•	•	•		2 active or passive
Legacy tests					
Inrush current	•		•		
Back voltage	•		•	1	2 active
Host drop		•	•		2 active
Host droop		•	•		2 active or passive

Simple and fast test setup

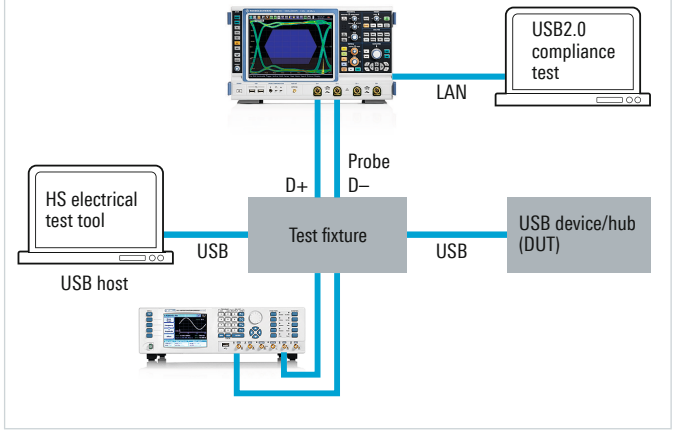
Different test setups are used depending on whether a device, hub or host is being tested and on the data rate to be verified. The block diagram on the left shows an example test setup for a high-speed signal quality test and receiver sensitivity test. R&S®ScopeSuite runs on a PC that controls the R&S®RTO digital oscilloscope. The oscilloscope is connected to the DUT via a differential probe and a test fixture. The USB-IF software (HS electrical test tool) sets the DUT to the desired test state. This software should be run on a separate PC because it switches the host's USB stack during operation.

Automated receiver sensitivity test

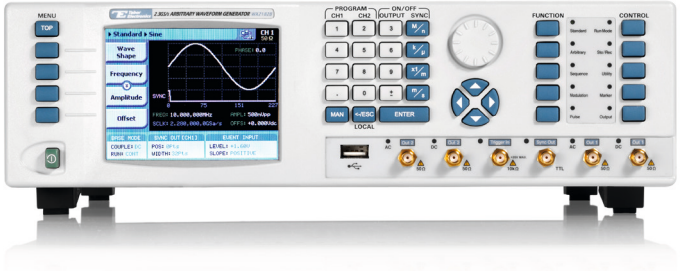
Receiver sensitivity tests require complex, predefined external signals. When using the Tabor WX2182B 2.3 Gsample/s dual-channel arbitrary waveform generator, the test steps are carried out fully automatically. R&S®RTO-K21 takes over the previously onerous tasks of generating test signals, configuring the arbitrary waveform generator and modifying the amplitudes step-by-step.

For other arbitrary waveform generators, R&S®RTO-K21 uses prompts to guide the user through the test sequence.

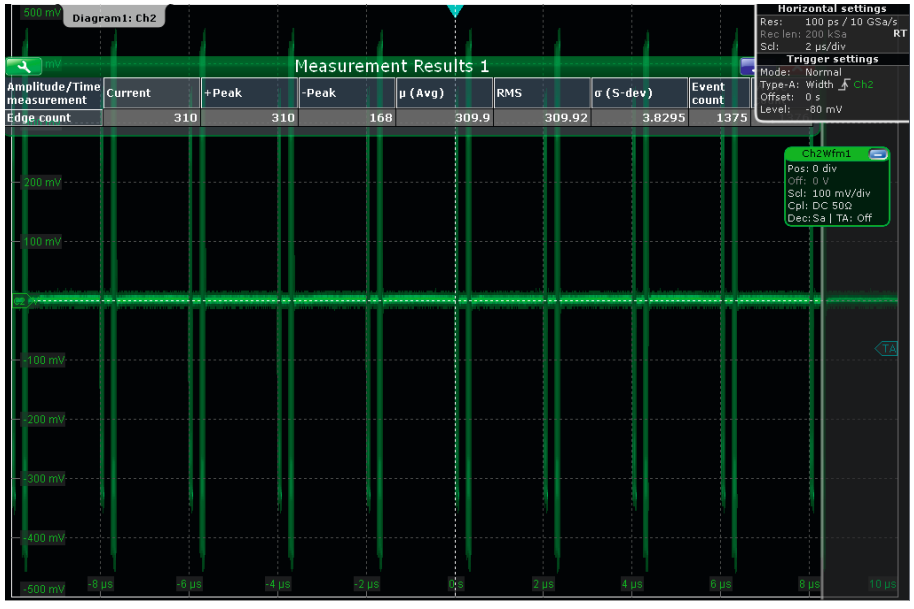
Test setup for high-speed signal quality test and receiver sensitivity test



Tabor WX2182B 2.3 Gsample/s dual-channel arbitrary waveform generator.



Trace for receiver sensitivity test: the smaller amplitudes show the stimulus signal from the arbitrary waveform generator, the larger amplitudes show the response from the DUT.



Intuitive user interface

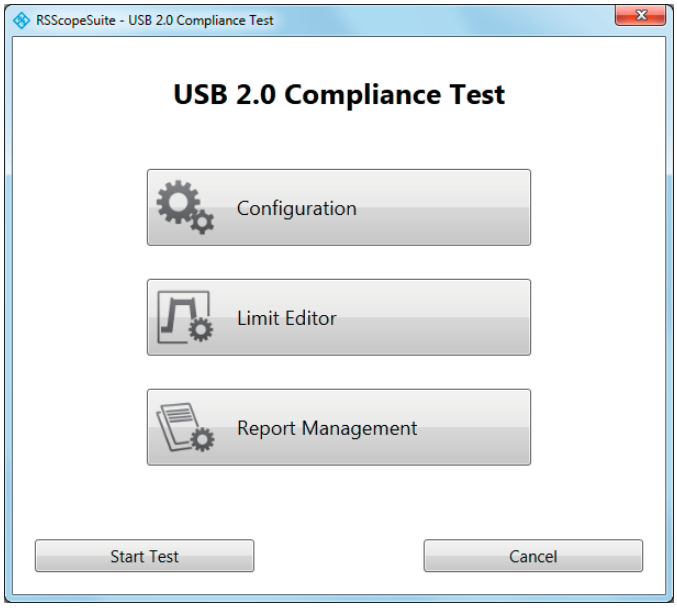
Simple and fast configuration

R&S®ScopeSuite provides fast and intuitive access to USB compliance testing. In the configuration dialog box, users can define user data, environmental parameters and output formats for the test documentation, and also configure the test setup. The limit editor can be used to modify USB-IF defined test limits. The report management dialog box offers a structured overview of the test documentation.

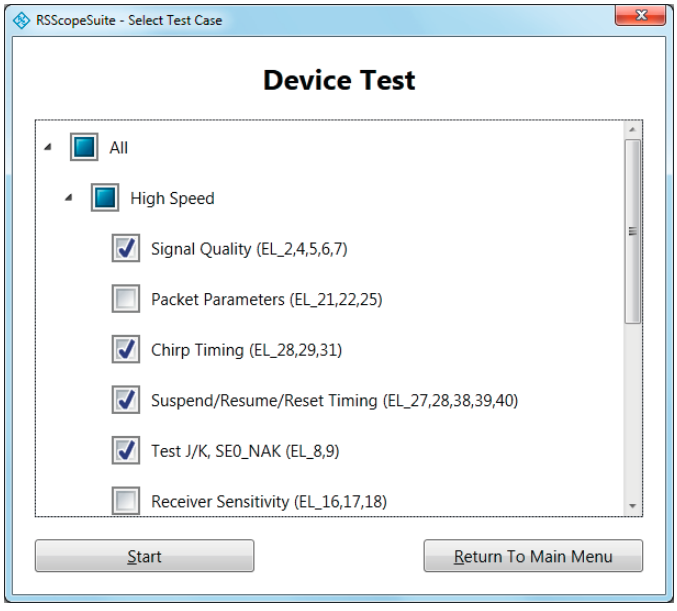
Customized testing

All tests specified under the USB-IF compliance program are predefined and can be enabled or disabled as needed. For troubleshooting or in-depth investigation, all parameters and logical test criteria can be modified as needed in the limit editor. Individual limit values can easily be exported or imported.

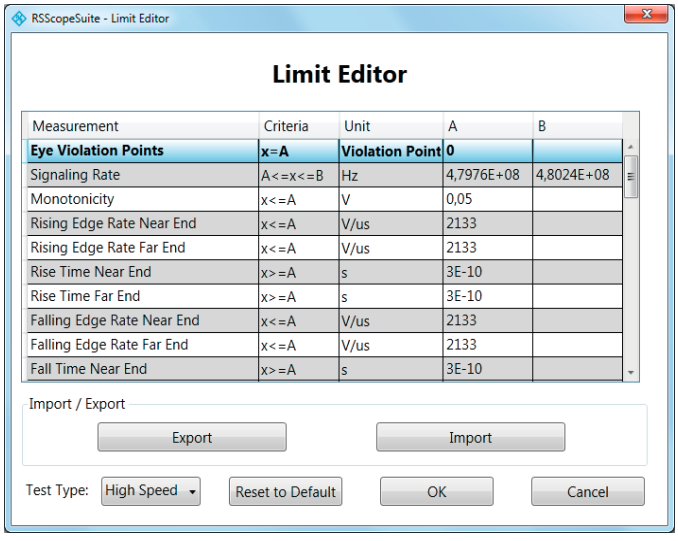
Configurator for USB2.0 compliance test.



Test selection dialog box for device testing.



All test criteria are listed in the limit editor and can be modified individually.



Step-by-step wizard

Based on the test setup and the selected test cases, R&S®ScopeSuite guides the user through the test cycle step-by-step.

Detailed instructions with illustrations and clear labeling help both novices and experts quickly make the correct connections between the oscilloscope and the test fixture used. The wizard supports the R&S®RTO-ZF1 and Allion pre-test USB compliance test fixtures. The USB-IF test fixture used in USB-IF compliance workshop testing for high-speed signal quality testing can also be used.

Test sequence control

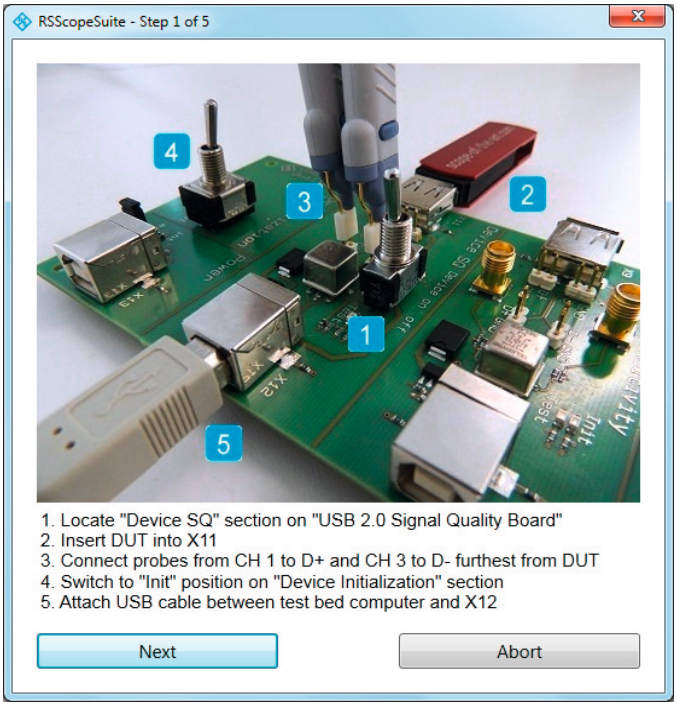
The test cycle dialog box in R&S®ScopeSuite provides the user with an overview of the tests to be performed, indicating the status of completed tests.

After each test cycle, the test sequence control displays the results of the individual test cases. If a test is not passed – because a connection is missing, for example – the Repeat Discard Previous function in the test case result dialog box can be used to immediately repeat the specific test case. The previous, failed test case is discarded and will not appear in the test report.

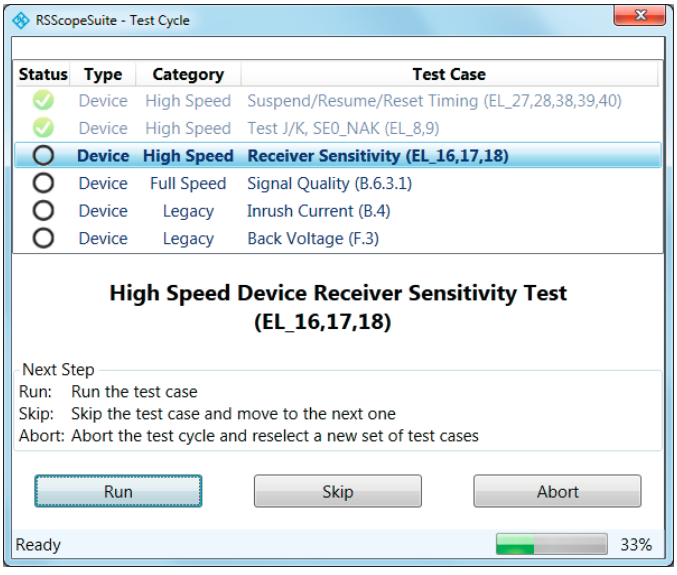
Support for stability tests

The Repeat Keep Previous function is useful for stability tests and during troubleshooting. It can be used to repeat measurements as often as desired, and all results are documented in the test report.

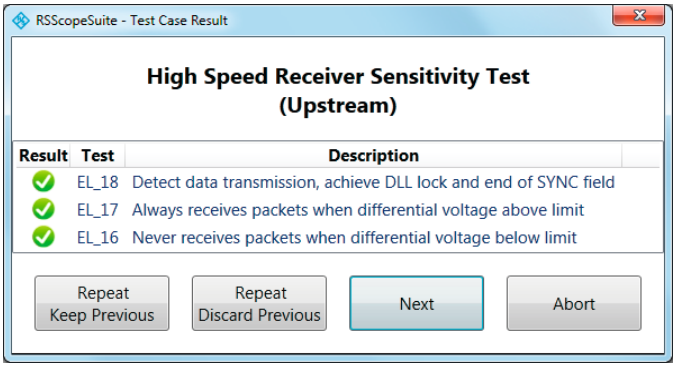
Detailed, step-by-step wizard covering every test case.



Test cycle overview indicating status of completed tests.



Flexible test sequence options at the end of a test case.



Clear and comprehensive test documentation

Complete, versatile test documentation

Complete documentation of test results is essential in compliance testing. R&S®ScopeSuite offers users an extensive range of documentation functions. For example, measurement details and oscilloscope screenshots can be included in the result documentation. Available output formats are PDF, MS Word and HTML.

Quick overview plus detailed information

The first page of the test report provides a summary of completed tests and their results. The corresponding item from the USB-IF compliance checklist (e.g. EL_4) is stated for each subtest to allow quick orientation. The subsequent pages provide the measured values, limit values and traces for each subtest, depending on the options selected in the configuration dialog box for the test documentation.

Example test documentation for a high-speed signal quality test including numerical results and eye pattern.

High Speed USB Device Test Report

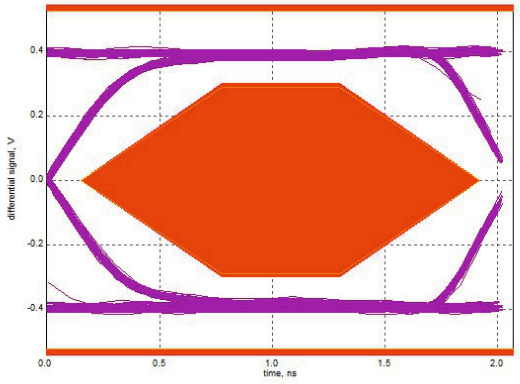
High Speed Signal Quality - EL_4

Description	Template 1 transform waveform at TP3
Run	1
Result	Pass
Time	07/12/2013 16:27:47

Additional Information

Measurement	Value	Limits
Signal Eye	Pass	Meet Tpl 1 Tx Wfm Rqmt
Consecutive Jitter RMS	9.186 ps	
Paired JK Jitter RMS	7.394001 ps	
Paired KJ Jitter RMS	6.45 ps	

High Speed Signal Quality - EL_4 - Signal Eye



Test result overview (excerpt from test documentation).

Test Summary

High Speed Signal Quality

Result	Test	Description	Run
✓	SQ	Signal quality	1
✓	EL_4	Template 1 transform waveform at TP3	1
✓	EL_2	Transmitter data rate	1
✓	EL_7	Monotonic data transitions in appropriate eye pattern template	1
✓	EL_6	Differential rise & fall times	1

Configurable test documentation

Test reports can be configured as needed for the intended purpose, i.e. depending on whether certification is desired, a customer requires a test report, or stability tests are to be performed during product development. In addition to the summary of passed and failed tests, detailed numerical results and screenshots can be added for each subtest.

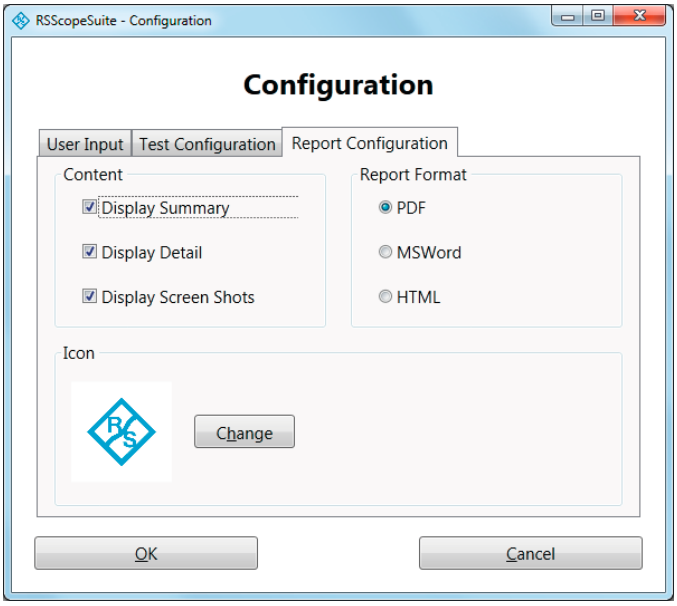
Coherent test documentation

Using the test management and report management dialog boxes, users can control new and running test sessions and manage the associated documentation.

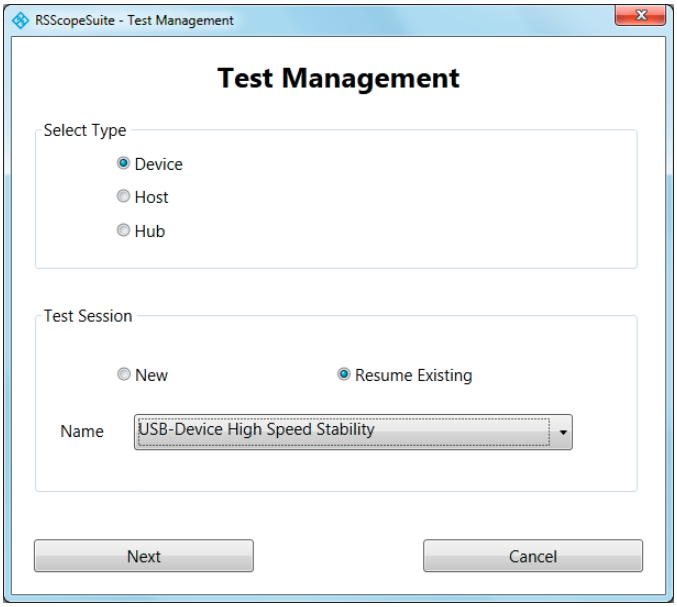
In the test management dialog box, new test sessions can be started, and interrupted tests resumed. The Resume Existing function ensures coherent test documentation. Problems occurring in documentation as a result of test interruptions are a thing of the past.

The report management dialog box delivers a clear overview of completed tests, even if many different test cases and DUTs are involved. Grouped by type (device, host, hub), all reports can be displayed individually and configured for the intended purpose. Reports that are no longer needed can be removed with a mouseclick.

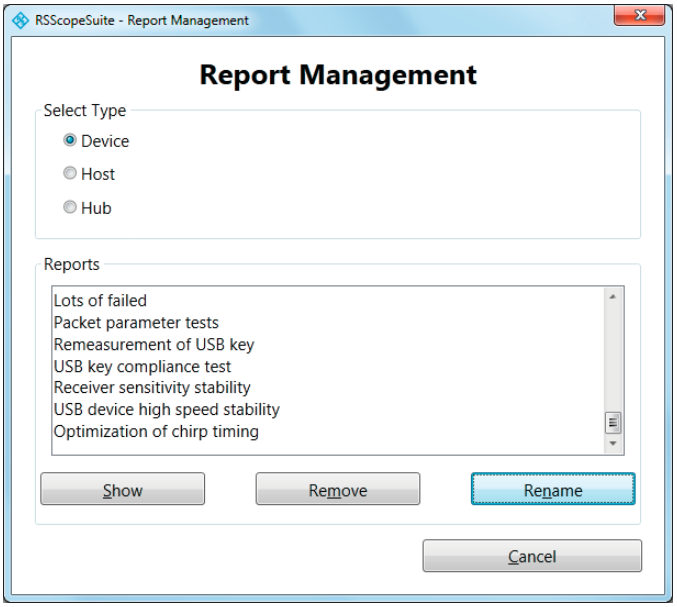
Configuration dialog box for test documentation.



Defining test session name prior to start of test.

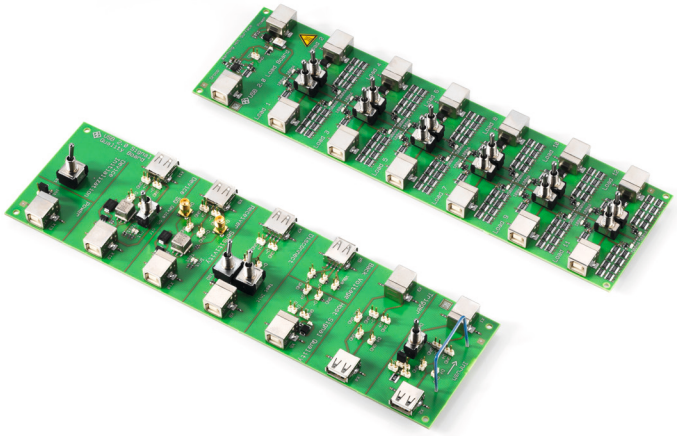


Management of test documentation.

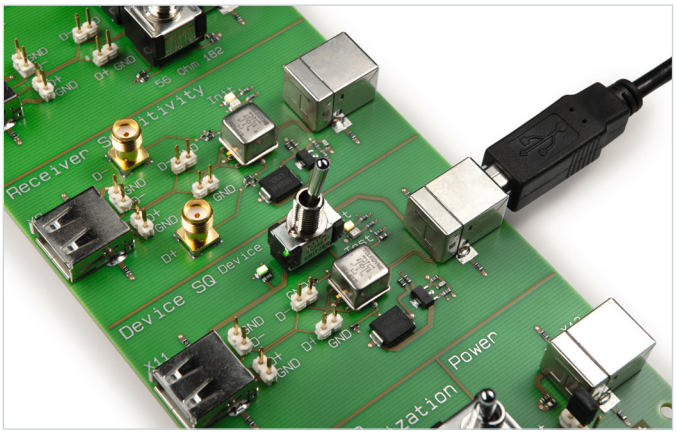


R&S®RT-ZF1 for optimal test connections

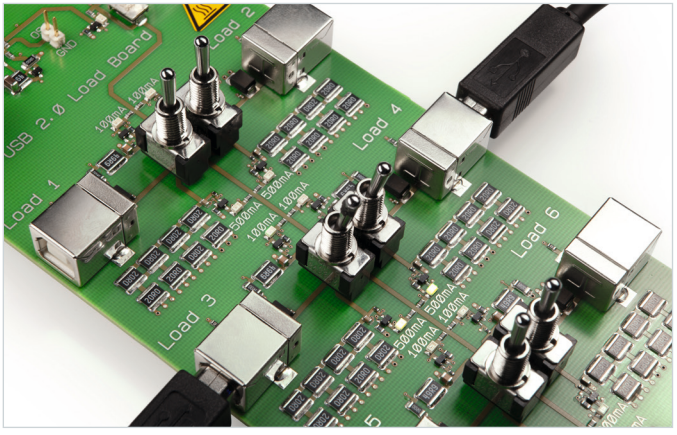
Test fixture set for USB2.0 compliance testing: load board (top), signal quality board (bottom).



Device signal quality segment on signal quality board.



Detail of a load board segment.



Test fixture set for fast measurements

In the USB-IF compliance program, the connections between the test equipment and the DUT are defined for each test case. Having optimal, efficient connections provides a time advantage and permits fast and reliable measurements. Rohde&Schwarz offers a specialized test fixture set that consists of a signal quality board and a load board. Using these boards, users can establish all connections required for USB2.0/1.1/1.0 tests as well as legacy tests in line with the USB-IF compliance test program. Power is supplied via USB.

Signal quality board

Seven segments on the signal quality board make it possible to precisely access the signals required for compliance testing and to inject the arbitrary waveform generator signals. All ports are labeled and clearly referenced in the compliance test software. This facilitates correct and rapid test setup. Various modes can be selected via switches. An LED indicates the current mode.

Load board for hub tests

The load board provides twelve separately switchable 100 mA and 500 mA loads as well as a 100 mA load oscillated at 3 Hz. This permits users to perform drop/droop compliance tests for hubs and hosts with a large number of ports. Additional fixtures are not needed.

Accessories for quick startup

The test fixture sets come with a comprehensive set of accessories, such as leads in various lengths and adapters for mini and micro B USB connectors, for rapid test startup.

Adapters and leads in accessory set for R&S®RT-ZF1 USB2.0 test fixture set.

Specifications in brief

Specifications in brief		
USB compliance tests supported by R&S®RTO-K21		
USB device tests	high-speed	signal quality (EL_2, 4, 5, 6, 7)
		packet parameters (EL_21, 22, 25)
		chirp timing (EL_28, 29, 31)
		suspend/resume/reset timing (EL_27, 28, 38, 39, 40)
		J/K, SE0_NAK (EL_8, 9)
		receiver sensitivity (EL_16, 17, 18)
	full-speed and low-speed	low-speed signal quality upstream
		full-speed signal quality upstream
		back drive voltage; inrush current
USB host tests	high-speed	signal quality (EL_2, 3, 6, 7)
		packet parameters (EL_21, 22, 23, 25, 55)
		disconnect detect (EL_36, 37)
		chirp timing (EL_33, 34, 35)
		suspend/resume/reset timing (EL_39, 41)
		J/K, SE0_NAK (EL_8, 9)
	full-speed and low-speed	low-speed signal quality downstream
		full-speed signal quality downstream
		droop
USB hub tests	high-speed	signal quality upstream (EL_2, 46, 6, 7)
		signal quality downstream (EL_2, 3, 6, 7)
		jitter downstream (EL_47)
		disconnect detect (EL_36, 37)
		packet parameters upstream (EL_21, 22, 25)
		hub receiver sensitivity upstream (EL_16, 17)
		device receiver sensitivity (EL_16, 17, 18)
		repeater downstream (EL_42, 43, 44, 45, 48)
		repeater upstream (EL_42, 43, 44, 45)
		chirp timing upstream (EL_28, 29, 31)
		suspend/resume/reset timing upstream (EL_27, 28, 38, 39, 40)
		J/K, SE0_NAK upstream (EL_8, 9)
		J/K, SE0_NAK downstream (EL_8, 9)
	full-speed and low-speed	low-speed signal quality downstream
		full-speed signal quality upstream
		full-speed signal quality downstream
		inrush current upstream
		droop downstream
		back drive voltage
Electrical specifications for R&S®RT-ZF1		
Temperature ranges	operating temperature	0 °C to +45 °C
	storage temperature	–40 °C to +70 °C
Power supply		5.0 V DC ± 0.25 V via USB

Ordering information

Designation	Type	Order No.
USB2.0 Compliance Test	R&S®RTO-K21	1317.4103.02
The R&S®RTO-K21 option requires that the host PC be connected to an R&S®RTO 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 set		
USB2.0 Test Fixture Set	R&S®RT-ZF1	1317.3420.02
Supported oscilloscopes		
Digital Oscilloscope, four channels	R&S®RTO	1316.1000.x4
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®RT-ZD10	1410.4715.02
1.5 GHz, active, differential, 1 MΩ || 0.6 pF, R&S®ProbeMeter, micro button	R&S®RT-ZD20	1410.4409.02
3.0 GHz, active, differential, 1 MΩ || 0.6 pF, R&S®ProbeMeter, micro button	R&S®RT-ZD30	1410.4609.02
4.5 GHz, active, differential, 1 MΩ || 0.4 pF, R&S®ProbeMeter, micro button	R&S®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
Automated arbitrary waveform generator		
2.3 Gsample/s Dual-Channel Arbitrary Waveform Generator (16 Mpoints memory)	Tabor WX2182B	9030.9861.02
2.3 Gsample/s Dual-Channel Arbitrary Waveform Generator (32 Mpoints memory)	Tabor WX2182B-1	9035.6619.02

From pre-sale to service. At your doorstep.

The Rohde & Schwarz network in over 70 countries ensures optimum on-site support by highly qualified experts. User risks are reduced to a minimum at all stages of a project:

- Solution finding/purchase
- Technical startup/application development/integration
- Training
- Operation/calibration/repair

Service that adds value

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

About Rohde&Schwarz

The Rohde&Schwarz electronics group is a leading supplier of solutions in the fields of test and measurement, broadcasting, secure communications, and radiomonitoring and radiolocation. Founded more than 80 years ago, this independent global company has an extensive sales network and is present in more than 70 countries.
The company is headquartered in Munich, Germany.

Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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