USB 3.2 TRANSMITTER AND RECEIVER TEST APPLICATIONS

Application Brochure
Version 02.00

ROHDE&SCHWARZ
Make ideas real

The Rohde&Schwarz USB 3.2 Gen1 (5 Gbit/s) and Gen2 (10 Gbit/s) TX and RX test solution is USB-IF approved and reliably tests devices for compliance.

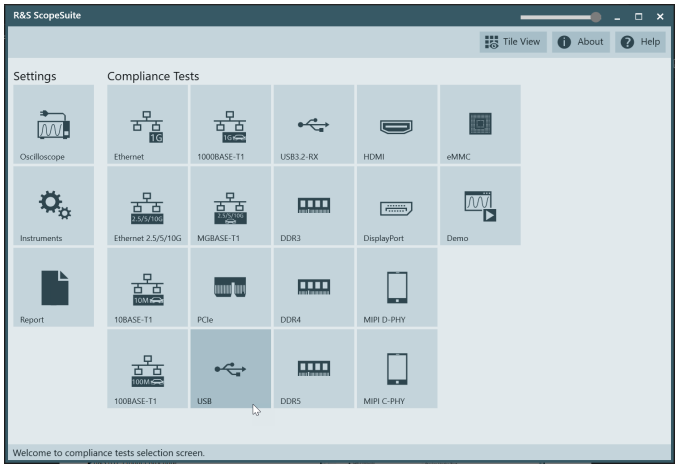
The R&S®RTP-K101 (TX) and R&S®RTP-K102 (RX) compliance test options included in the R&S®ScopeSuite compliance test software allow for ease of automating the complex tests per USB-IF compliance test specification (CTS). Additionally, the R&S®RTP-K101 option provides support for USB 2.0 TX and RX testing along with the support of USB 3.2 TX Gen1 and Gen2. Furthermore, the R&S®ScopeSuite software aids in debugging and characterizing devices under test (DUTs) by allowing customization of pass/fail criteria, pausing tests and changing various parameters to be no longer compliant to the CTS.

Key facts

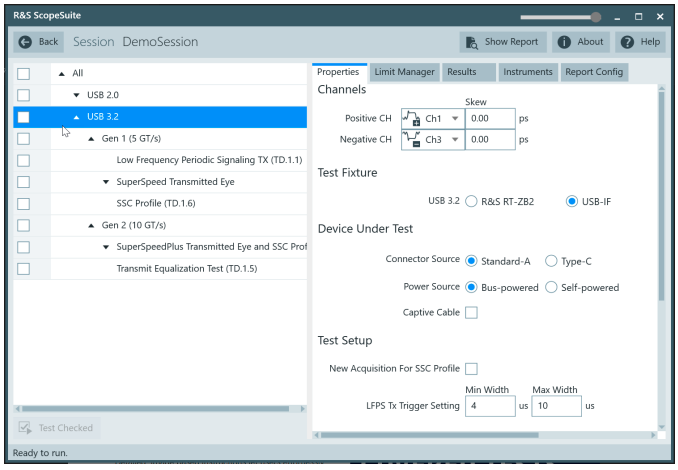
- USB-IF approved solution
- Capable of USB 3.2 Gen1 (5 Gbit/s) and Gen 2 (10 Gbit/s) compliance testing
- Automated testing with R&S®ScopeSuite compliance test software
- Detailed test reporting
- Capable of testing with USB-A, USB-B and USB-C connectors

R&S®ScopeSuite overview

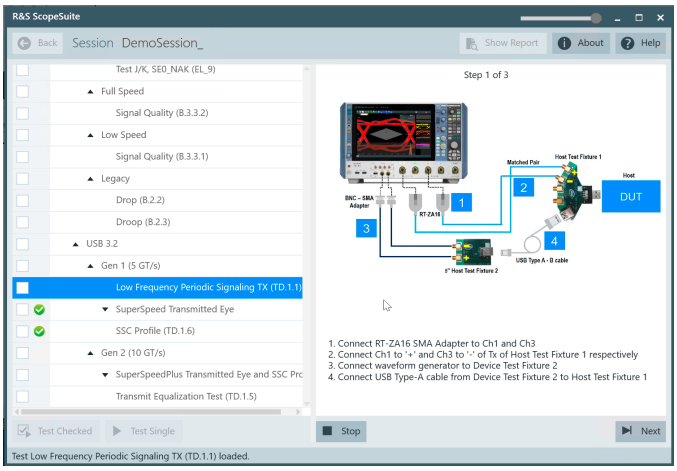
R&S®ScopeSuite streamlines automation for various digital interface standards, including USB 3.2 transmitter (TX) and receiver (RX) testing. The USB 3.2 TX and RX test solution encompasses all pertinent test cases. For ease of reference, the software's intuitive homepage conveniently lists all supported and readily available standards.



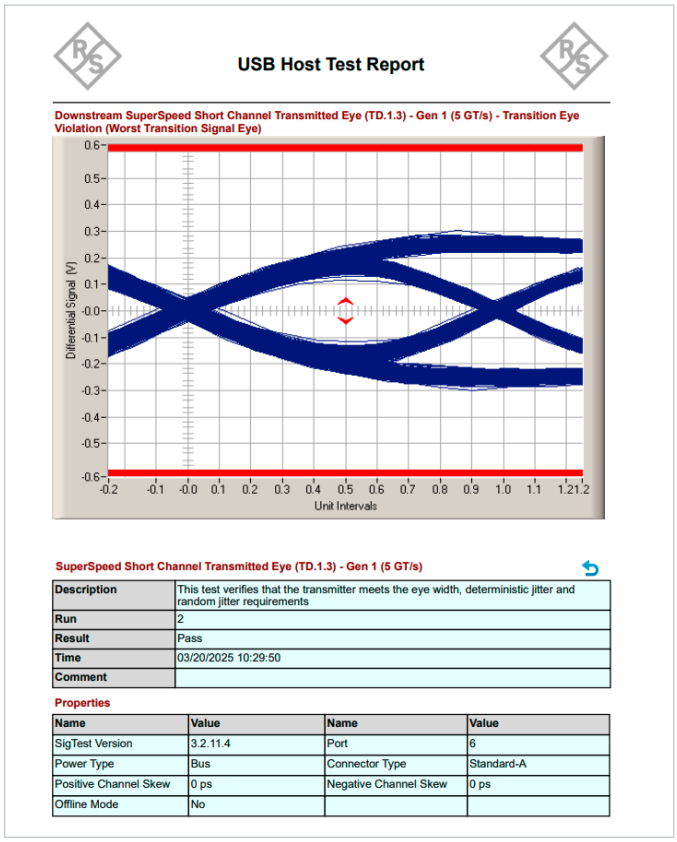
R&S®ScopeSuite software completely controls the connected R&S®RTP high-performance oscilloscope for seamless compliance testing and precise measurements in line with the test specification standards. Selecting test cases may also require additional, specialized instruments such as a bit error rate tester (BERT). R&S®ScopeSuite provides comprehensive control and support for all necessary instruments for a fully integrated, end-to-end compliance test solution.



Detailed, image based instructions let users effortlessly and correctly configure setups with an oscilloscope, its accompanying probes, the designated test fixtures and the device under test. This user-friendly approach significantly minimizes the likelihood of setup-related errors.



All test results are fully documented in a PDF report. This report can include only specific test cases, numerical result data or instrument screenshots based on user preferences.



USB Host Test Report

Downstream SuperSpeed Short Channel Transmitted Eye (TD.1.3) - Gen 1 (5 GT/s) - Transition Eye Violation (Worst Transition Signal Eye)

SuperSpeed Short Channel Transmitted Eye (TD.1.3) - Gen 1 (5 GT/s)

Description	This test verifies that the transmitter meets the eye width, deterministic jitter and random jitter requirements
Run	2
Result	Pass
Time	03/20/2025 10:29:50
Comment	

Properties

Name	Value	Name	Value
SigTest Version	3.2.11.4	Port	6
Power Type	Bus	Connector Type	Standard-A
Positive Channel Skew	0 ps	Negative Channel Skew	0 ps
Offline Mode	No		

COVERED TESTS

USB 3.2 TX

- Gen1 (5 GT/s)
  - Low Frequency Periodic Signaling TX (TD.1.1)
  - Short Channel Transmitted Eye (TD.1.3)
  - Long Channel Transmitted Eye (TD.1.3)
  - SSC Profile (TD.1.6)
- Gen2 (10 GT/s)
  - Short Channel Transmitted Eye (TD.1.4)
  - Long Channel Transmitted Eye (TD.1.4)
  - SSC Profile (TD.1.7)
  - Transmit Equalization Test (TD.1.5)

USB 3.2 RX

- Gen 1 (5 GT/s)
  - Amplitude and De-emphasis Calibration (TD.1.8)
  - Short Channel Calibration (TD.1.8)
  - Upstream Rj, Sj and Eye Height Calibration-over legacy connectors (TD.1.8)
  - Downstream Rj, Sj and Eye Height Calibration-over legacy connectors (TD.1.8)
  - Rj and Sj Calibration for Type-C (TD.1.9)
  - Receiver Jitter Tolerance Test-over legacy connectors (TD.1.8)
  - Receiver Jitter Tolerance Test-over Type-C connector (TD.1.9)
- Gen 2 (10 GT/s)
  - Amplitude, Pre-shoot and De-emphasis Calibration (TD.1.10)
  - Short Channel Calibration (TD.1.10)
  - Upstream Facing Port CLB Analysis-over legacy and Type-C connectors (TD.1.10)
  - Upstream Eye Width and Eye Height Calibration-over legacy and Type-C connectors (TD.1.10)
  - Downstream Facing Port CLB Analysis-over legacy and Type-C connectors (TD.1.10)
  - Downstream Eye Width and Eye Height Calibration-over legacy and Type-C connectors (TD.1.10)
  - Receiver Jitter Tolerance Test-over legacy and Type-C connectors (TD.1.10)

Debugging methods and options

When an issue with compliance testing arises, the R&S®RTP oscilloscope offers powerful debugging tools.

The R&S®RTP-K136 advanced eye analysis (8 Gbit/s CDR) and R&S®RTP-K137 advanced eye analysis (16 Gbit/s CDR) options offer a unique hardware implemented clock data recovery (HW-CDR) to bit slice a serial data stream with an embedded clock. You can configure the nominal bit rate (between 21 kbit/s and 16 Gbit/s) as well as the tracking bandwidth or the relative bandwidth. The hardware CDR in the R&S®RTP continuously follows the drift of the input signal. Traditional eye diagrams use software CDR functions in postprocessing. This is time-consuming and requires a PLL settling time per waveform acquisition, leading to more time between you and the results.

The R&S®RTP-K133 jitter decomposition and R&S®RTP-K134 jitter and noise decomposition options provide new functions to gain more insights into the signal characteristic and root causes of failures. This allows users to reconstruct synthetic eye diagrams including periodic and data-dependent components. You can also calculate and display BER bathtub curves for selected jitter and noise components. Additionally, the options calculate and display the system characteristic step response. As a matter of course, the individual jitter and noise components can be displayed as histogram, track or in spectrum view.

The R&S®RTP-K122 deembedding, real-time extension option allows waveform correction based on S-parameters of the involved measurement blocks. The correction parameters of a cable or a modified probe can also be determined by using a proven cable or proven probe.

The signal configurator is a tool built into the base oscilloscope firmware. It is the central entry point for signal integrity analysis. Interface standards based on configurations, such as symbol rate, PAM order, CDR settings and equalizer coefficients are supported. Just select an input channel as source, the appropriate standard and configure deembedding, embedding and equalization, before starting an in-depth analysis with automated measurements, eye, jitter and noise tools.

Connectivity and RX testing

We utilize third-party products in our solution for USB 3.2 Gen1 and Gen2 TX testing. For USB-C fixtures, we work with Wilder Technologies; for legacy connector fixtures, we work with Fixture Solutions. These fixtures must be purchased directly from these vendors and cannot be bundled with Rohde&Schwarz equipment.

For USB 3.2 Gen1 and Gen2 RX testing, we utilize the Anritsu MP1900A BERT fully integrated with our R&S®ScopeSuite compliance test software. This product must be purchased directly from Anritsu. Rohde&Schwarz will provide configuration information for the Anritsu BERT, allowing easy integration with our solution.

Transmitter test configurations

USB 3.2 TX Gen1		
	Reference configuration	
Remarks	**Product**	**Quantity**
Oscilloscope, 13 GHz bandwidth	R&S®RTP134B	1
USB 3.2 compliance test	R&S®RTP-K101	1
Arbitrary waveform generator for test pattern toggling	R&S®RTP-B6	1
High-precision and low-loss matched cable pair	R&S®RT-ZA17	2 (1 for TX, 1 for RX)
Precision BNC to SMA adapter	R&S®RT-ZA16	2, included in R&S®RTP
Purchased via USB.org	USB3ET	1
Optional: Precompliance board for Gen1 only	R&S®RT-ZB2	1
Optional: For deskew	R&S®RTP-B7	1
Optional: For deembedding	R&S®RTP-K121	1
Optional: For signal integrity debugging	R&S®RTP-K122	1
Optional: For signal integrity debugging	R&S®RTP-K141	1
Optional: For signal integrity debugging	R&S®RTP-K134	1

USB 3.2 TX Gen2		
	Reference configuration	
Remarks	**Product**	**Quantity**
Oscilloscope, 16 GHz bandwidth	R&S®RTP164B	1
USB 3.2 compliance test	R&S®RTP-K101	1
Arbitrary waveform generator for test pattern toggling	R&S®RTP-B6	1
High-precision and low-loss matched cable pair	R&S®RT-ZA17	2 (1 for TX, 1 for RX)
Precision BNC to SMA adapter	R&S®RT-ZA16	2, included in R&S®RTP
Purchased via USB.org	USB31AET	1
Purchased via USB.org	USB31CET	1
Optional: For deskew	R&S®RTP-B7	1
Optional: For deembedding	R&S®RTP-K121	1
Optional: For signal integrity debugging	R&S®RTP-K122	1
Optional: For signal integrity debugging	R&S®RTP-K141	1
Optional: For signal integrity debugging	R&S®RTP-K134	1

Configuration information for USB 3.2 RX testing

Slot	Module	Model number	Options	Description	Comment
	mainframe	Anritsu MP1900A			
2	clock synthesizer	Anritsu MU181000B		generates the clean clock signal	occupies two slots (1 and 2)
4	jitter module	Anritsu MU181500B		adds jitter to the clean clock from the synthesizer	
6	error detector	Anritsu MU195040A	▶ 10 – 1ch ED ▶ 11 – 1ch CTLE ▶ 22 – clock recovery		
1	channel NRZ error detector				
7	NRZ pattern generator	Anritsu MU195020A	▶ 10 – 1ch data output ▶ 11 – 1ch 10Tap emphasis	one channel NRZ pattern generator; max. bit rate: 21.5 Gbit/s	
8	noise module	Anritsu MU195050A		adds vertical noise to the pattern; features two parallel channels	An NRZ pattern can be fed into one channel and a PAM signal can be fed to the other channel. However, this combination is not allowed for USB 3.2 RX testing.

Note: The noise module can be replaced by bias tees. For details, refer to the Anritsu documentation.

MORE INFORMATION

- www.rohde-schwarz.com/manual/rtp/
- R&S®RTP high-performance oscilloscope product brochure (PD 3683.5616.12)
- Signal model based approach to joint jitter and noise decomposition white paper, PD 3608.5241.52
- R&S®RTP-K101: Compliance test for USB 3.2 Gen 1&2 fact sheet, PD 3609.6812.32
- R&S®RTP-K136/-K137 8/16 Gbps advanced eye analysis fact sheet, PD 3683.9328.32

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Sustainable product design
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- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

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USB 3.2 Transmitter and Receiver Test Applications
Data without tolerance limits is not binding | Subject to change