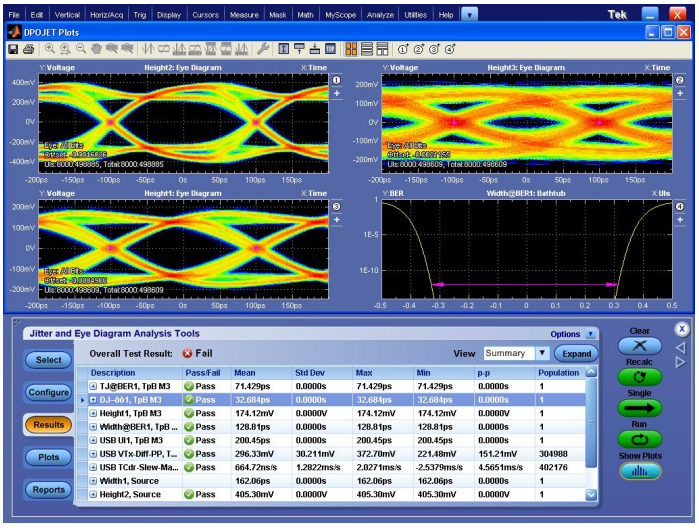
USB3 Transmitter and Receiver Solutions

USBSSP-TX, USB-TX, USB-RMT, BSAUSB31, BSAUSB3, GRL-USB-PD



The Tektronix USBSSP-TX and USB-TX Automated Transmitter solutions provide an easy way to validate and characterize emerging USB 3.1 host controllers, hubs and devices. The TekExpress USB-RMT software enables flexible and intuitive receiver margin testing of USB 3.0 designs with the AWG7000 series Arbitrary Waveform Generators. The BERTScope BSAUSB31 Automated USB 3.1 Receiver Solution is designed to provide fast and accurate BERT-based testing with high test throughput, fast margin testing and a wide range of debugging tools.

Key features

- Transmitter testing
  - Provides a comprehensive toolset for USB 3.1 verification, characterization, debug, and compliance test
  - Provides automatic processing of USB-IF SIGTEST results without manual intervention
  - Transmitter verification and debug of USB 3.1 10 Gb/s designs (Opt. USBSSP-TX)
  - Automatic DUT control and pattern validation to capture all required data patterns (CP0, CP1, CP9, CP10, etc.)
  - Automated USB 3.1 normative and informative transmitter tests – single-button execution with no user interaction required
  - Quickly test under different test conditions with independent controls for de-embedding, channel embedding, and equalization
  - Channel models and equalization can be customized with serial data link analysis (Opt. SDLA64)
  - Test fixtures provide access to both USB transmitter and receiver signals supporting transmitter and receiver tests without physical cables
  - Quickly validate test status with comprehensive reporting that details test margins, pass/fail results, and plots
  - Automated Physical Layer test support for USB Power Delivery 2.0 with packet decode.
- Receiver testing
  - Support for a broad range of serial standards, leveraging the BERTScope® and Arbitrary Waveform Generator capabilities
  - Fully automated receiver compliance and margin testing, including automated calibration and integration with a Tektronix power supply, reducing the test time and complexity of executing receiver tests
  - Industry leading single-click loopback initiation
  - Accurate and fast BERT-based jitter tolerance testing maximizes receiver test throughput
  - Robust automation software includes hardware configuration help, report generation, and test database
  - Flexible signal impairments covering ISI, SSC and SJ, enables emulating any length channel/cable combination, any SSC profile at any frequency, and multiple tones simultaneously
  - Automated calibration of signal impairments enables quick calibration of waveforms, and does not require you to understand detailed procedures for calibration
  - Programmatic interface enables integrating additional test procedures into the TekExpress® RMT automation framework

Applications

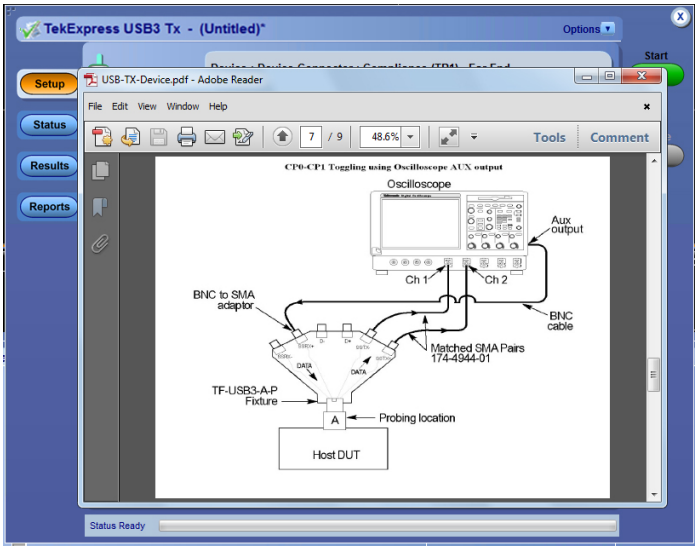
USB transmitter and receiver testing

- Host and Device silicon validation
- System, peripheral, and hub validation and integration
- Manufacturing test
- USB Power Delivery (PD) compliance test

Complete automation for USB testing

TekExpress USB 3.1 software (USBSSP-TX) provides an automated, simple, and efficient way to test USB 3.1 transmitters consistent with the requirements of the SuperSpeed USB Electrical Compliance Test Specification (CTS). SuperSpeed USB 3.0 receiver testing is automated on both the BERTScope (BSAUSB3) and AWG platforms (TEKEXP USB-RMT).

Compliance requirements per the Electrical Compliance Test Specification for USB consist of an eye diagram and jitter (Random, Deterministic, and Total Jitter and SSC Profile) tests. However, the SuperSpeed USB base specification also includes a set of informative measurements including tests for Slew, Voltage Levels, and others. The TekExpress USBSSP-TX software is an easy-to-use software package that automates the USB 3.1 (5 Gb/s and 10 Gb/s) Normative and Informative transmitter tests.



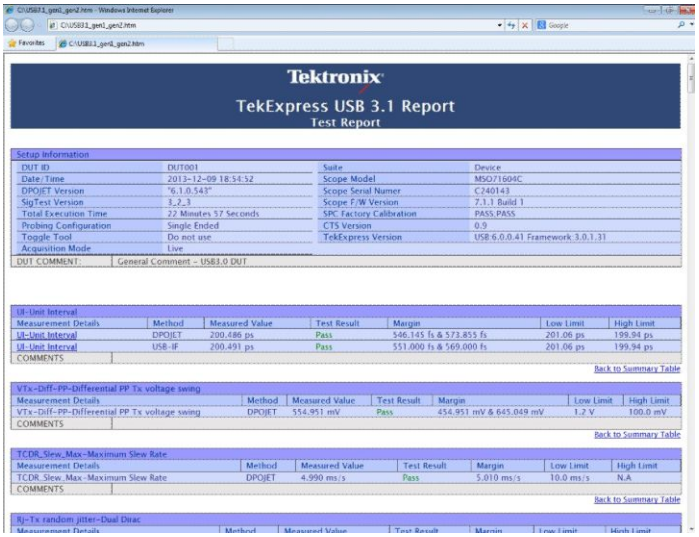
Show schematic

Option USBSSP-TX also includes a library of DPOJET setups for USB 3.1 (5 Gb/s and 10 Gb/s) Normative and Informative Transmitter measurements including limits, mask files, and specific reference channel files.

While other manufacturers promote standard-specific compliance software, the Tektronix solution provides a comprehensive verification, characterization, debug, and compliance environment. Receiver testing is a requirement for SuperSpeed USB certification. The increase of data rate makes it critical that the receiver properly interprets the incoming bit stream. The receiver test is a jitter tolerance test that stresses the receiver over defined sinusoidal jitter frequencies and amplitudes as defined in the CTS. All other impairments (RJ, SSC, De-emphasis) remain constant while the SJ is swept across the frequencies defined in the standard. The following table lists the required test frequencies for USB 3.1 SuperSpeed receiver testing.

Frequency	SJ (5 Gb/s)	SJ (10 Gb/s)
500 kHz	400 ps	476 ps
1 MHz	200 ps	203 ps
2 MHz	100 ps	87 ps
4 MHz	N/A	37 ps
4.9 MHz	40 ps	N/A
7.5 MHz	N/A	17 ps
50 MHz	40 ps	17 ps
100 MHz	N/A	17 ps

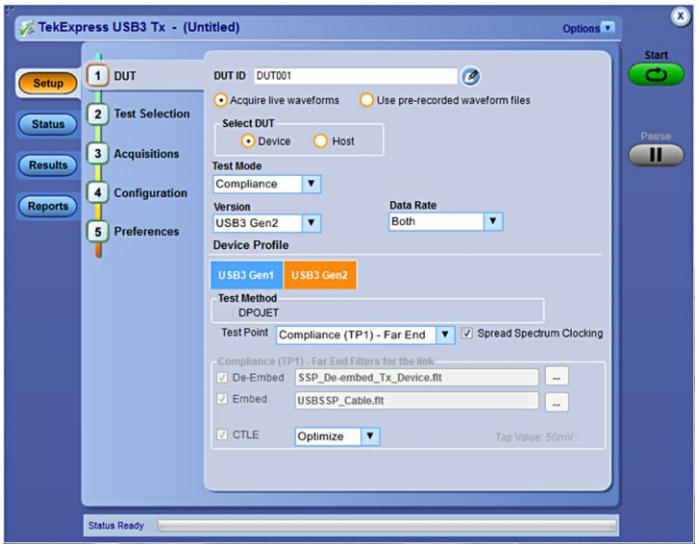
Automated solutions BSAUSB31 for the BERTScope and USB-RMT for the AWG simplify receiver testing. No longer is it a requirement that the end user be an expert in USB. The process of defining test parameters, putting the device into the proper test mode (loopback), measuring errors, showing results after each frequency is executed, and printing/storing the test results is fully automated for the user. Both solutions provide all of the required signal impairments for SuperSpeed USB3, including SJ, RJ, SSC, and De-emphasis.



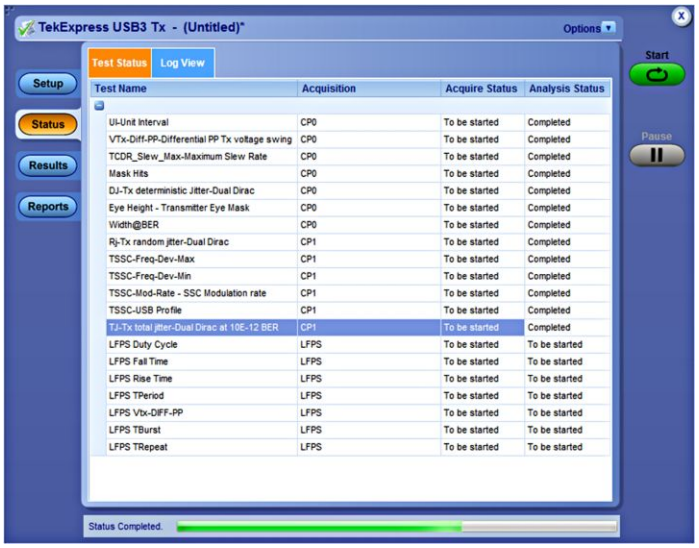
View report

Required test procedures (MOI) can be found at:

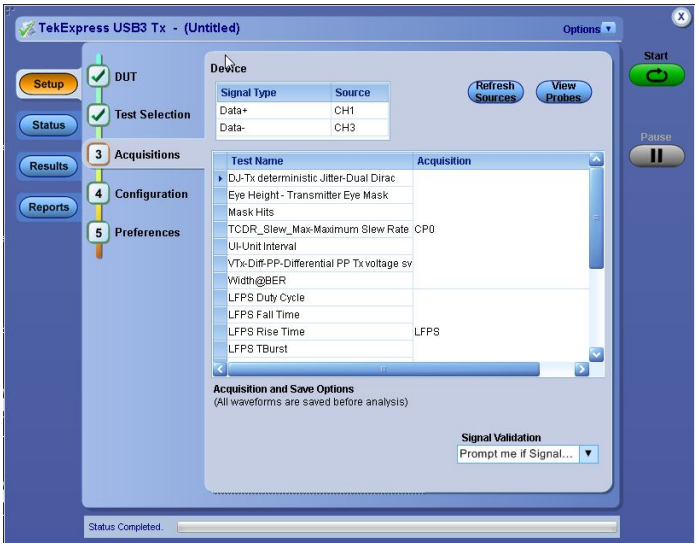
www.tektronix.com/usb



Quickly start compliance testing by selecting the DUT type. All necessary default settings are configured automatically.



Real-time test status is updated upon measurement completion.



Acquisitions panel

Automated transmitter testing – save time and resources

There is no longer a need to be an expert on transmitter testing procedures. Remembering the exact steps to take is time consuming and often requires going back to the Test Specification. USBSSP-TX takes the guesswork out of conducting SuperSpeed USB transmitter testing. Even if you remember how to use the test equipment, it is common for even the most experienced operators to forget steps in the procedure or to set up the correct parameters, like applying the correct filters or clock recovery technique. USBSSP-TX enables engineers to simply select and run the desired tests, and work on other tasks while the tests are being executed.

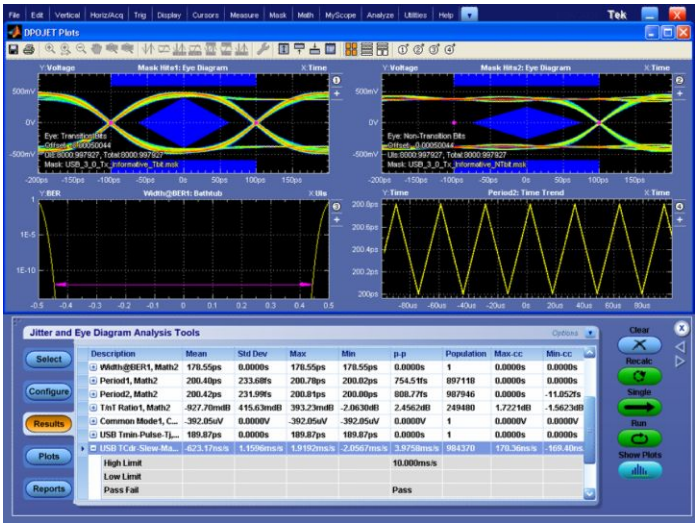
SuperSpeed USB 3.1 transmitter testing with USBSSP-TX

SuperSpeed USB transmitters must pass a signal quality test using SigTest. SigTest is a post-processing electrical test tool available from the USB-IF (www.usb.org) that measures amplitude, jitter, and mask hits. In order to simplify testing, USBSSP-TX automatically configures the oscilloscope, acquires the waveforms, and automates SigTest measurements.

A choice is available at run time to process the measurements using SigTest or, if debug and further analysis is required, with DPOJET.

Compliance testing requires three different test patterns: CP0, CP1, LFPS for USB 3.1 Gen1 and CP9, CP10, LFPS, SCD1/2, LBPM and PWM for USB 3.1 Gen2. Controlling the device under test to transmit the required test patterns is simple with USBSSP-TX. State control is fully automated by using a supported Tektronix Arbitrary Function Generator (AFG) or Arbitrary Waveform Generator (AWG). The option is also available to control the DUT using the Auxiliary output of the oscilloscope (though this method is not guaranteed for all DUTs). In the event that the DUT is not able to generate the desired test pattern, the user has the flexibility to skip all measurements requiring that pattern without losing any acquired test data. Once all necessary patterns have been acquired all measurements are fully automated with USBSSP-TX.

Upon completion of the testing, the application generates a comprehensive report that lists the measurements, test limits, and margin. The report also shows plots representing the eye diagram and SSC profile which are useful to determine the source of failures or results with minimal margin. In the event that measurements need to be redone, USBSSP-TX provides an option to use prerecorded waveforms. This is useful in situations where data sharing is required and a DUT is not physically available.



Advanced analysis with USB3 for verification and debug.

USB 3.1 SuperSpeed (5 Gb/s) transmitter testing with USB-TX

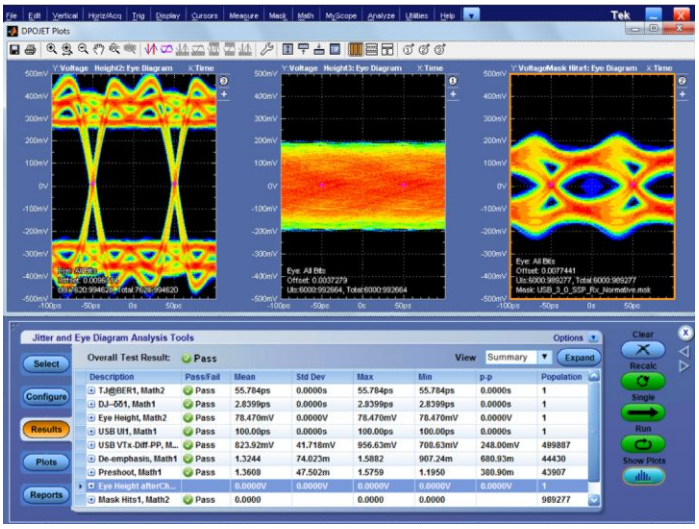
USB 3.1 (5 Gb/s) transmitter measurements (Opt. USB-TX) for the DPO/MSO70000 Series oscilloscopes provides an automated USB 3.1 transmitter solution. USB-TX provides a precise verification, characterization, and debug environment built upon the general-purpose analysis capabilities of DPOJET. USB-TX enables the execution of all USB 3.1 Gen1 Normative and Informative transmitter tests. A comprehensive analysis environment is provided allowing the user to quickly compare the results from multiple test configurations. For example, multiple eye diagrams can be displayed at one time allowing the user to analyze the effects of different clock recovery techniques or software channel models. USB 3.1 Gen1 requires the analysis of the eye diagram with and without the transition bit. With DPOJET the user can easily compare the results of both eye diagrams at the same time.

A supported configuration includes a DPO/MSO70000 oscilloscope (or other supported oscilloscope) equipped with DPOJET (Jitter and Eye Diagram Analysis Tools). The software requires a DPO/MSO70000 oscilloscope (12.5 GHz or higher required for compliance testing) with DPOJET (Opt. DJA).

USB 3.1 SuperSpeedPlus (10 Gb/s) transmitter testing with Option USB 3.1

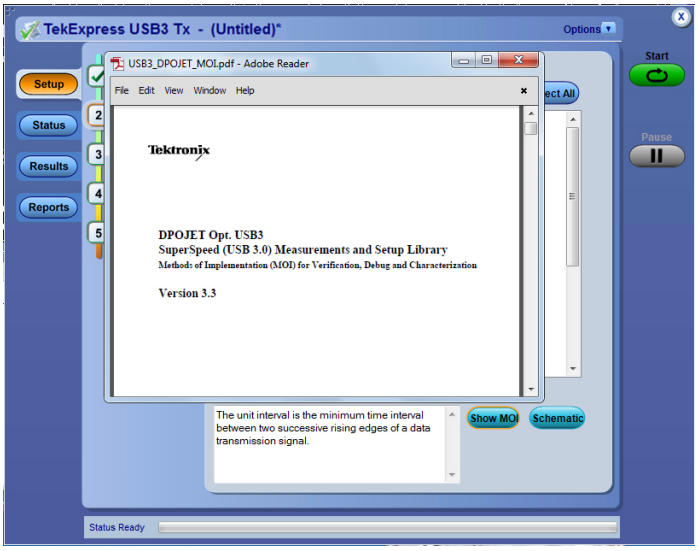
USB 3.1 (5 and 10 Gb/s) transmitter measurements for the DPO/MSO70000 Series oscilloscopes provides an automated USB 3.1 5 and 10 Gb/s transmitter test solution. USBSSP-TX, like Option USB-TX, leverages the general-purpose analysis capabilities of DPOJET and enables thorough verification and debug of SuperSpeedPlus designs. As USB 3.1 requires backward compatibility, Option USBSSP-TX provides the same measurements for USB 3.1 5 Gb/s as well the 10 Gb/s transmitter measurements.

New silicon validation is easier with the integrated debug tools offered with DPOJET, SDLA Visualizer, and Option USBSSP-TX. Evaluating design margin is a critical step while migrating to the 10 Gb/s data rate. For example, a shrinking channel loss budget will require more attention than before to the impact of equalization on far end signal quality. Multi-cycle acquisition and regression analysis, and DPOJET visualization tools, can provide insight into design optimizations. Also with SDLA Visualizer you can easily compare results with the reference transmitter equalization while varying CTLA/DFE parameters to find the best combination to maximize margins.



Tx (left), Far End (middle), and Post Rx EQ (right) response with SSP measurement suite

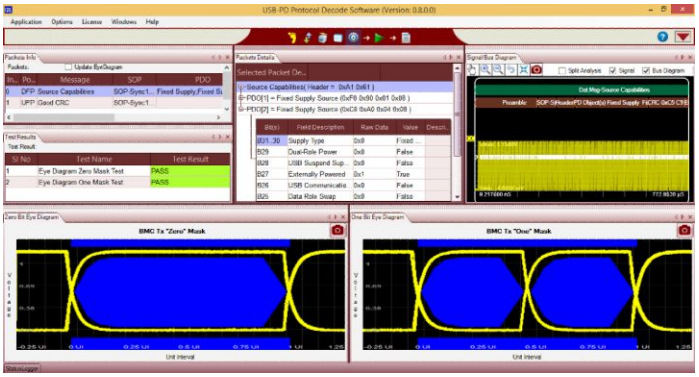
A supported configuration includes a DPO/MSO70000 Series oscilloscope (or other supported oscilloscope) equipped with DPOJET (Jitter and Eye Diagram Analysis Tools) and SDLA Visualizer (SDLA64). The software requires a DPO/MSO70000 Series oscilloscope (greater or equal than 16 GHz with DPOJET (Opt. DJA) and SDLA Visualizer (Opt. SDLA64)).



Show MOI

USB Power Delivery electrical compliance and decode with GRL-USB-PD

GRL-USB-PD power delivery test software for the MSO/DPO5000, DPO7000 and MSO/DPO70000 Series oscilloscopes provide support for the latest USB PD test specification. Bidirectional communication across the Configuration Channel is transmitted with Biphase Mark Coding (BMC) and this data is compared to a zero and one eye mask at both near and far end. Other supported parametric measurements include rise time and reference bit rate as well as a CC line packet decode for proper data transmission and detection.



USB Power Delivery electrical test and decode with GRL-USB-PD

Automated receiver testing

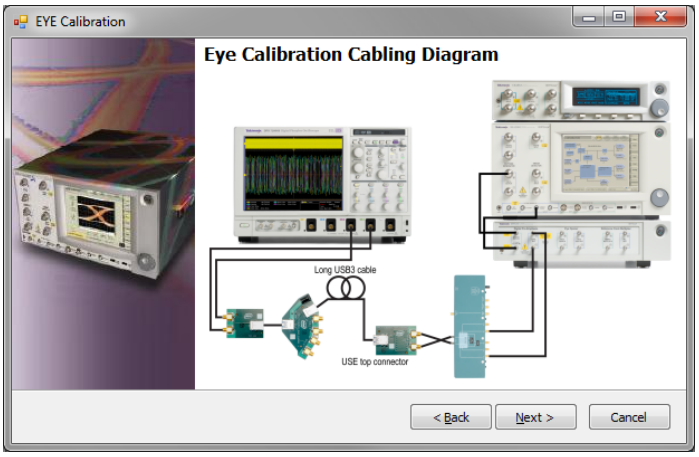
USB 3.0 is prevalent in an array of markets ranging from consumer electronics to computing applications. Often multiple technologies must be tested to bring these products to market. The Tektronix USB 3.0 receiver portfolio of the BERTScope and AWG provides broad support for these standards. Regardless of the technologies at hand that must be tested with USB 3.0, Tektronix has a solution. Leading-edge technologies such as PCI Express 3.0 and SAS-3 that require complex transmitter equalization are supported with the BERTScope. The unique requirements such as cable emulation for HDMI and pulse width jitter for MIPI are supported with the AWG platform. Both solutions provide an automated test environment for USB 3.0 receiver compliance and margin testing.

BERTScope automated receiver testing

The BERTScope USB 3.1 Automated receiver test solution is designed to streamline the often tedious and labor-intensive receiver test workflow. No longer is expert USB 3.1 domain knowledge required to configure, calibrate, test, and document the results. Fast and accurate BERT-based testing provides high test throughput, intuitive and fast margin testing, and availability of a wide range of debugging tools when further investigation is required. The result is high test productivity starting from setup through to the documentation of results.

Test configuration wizard

The BERTScope BSAUSB31 Test Configuration Wizard provides step-by-step guidance for receiver test equipment setup and software setup. Clearly drawn Block diagrams, cabling configurations, and descriptions simplify the test configuration step.



Test configuration wizard.

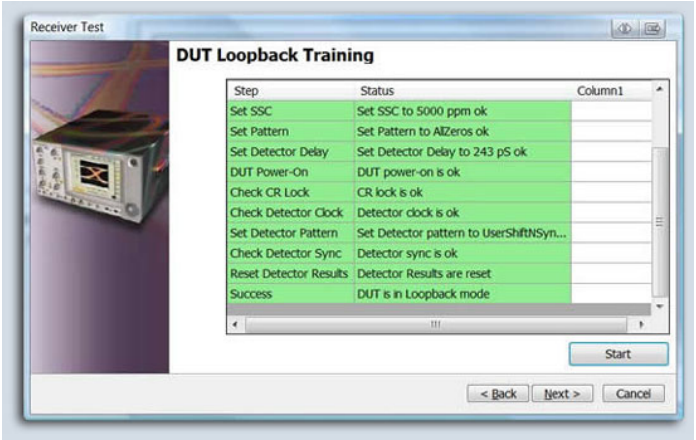
Automated stress calibration

An important step in preparing for receiver testing is the stress sources calibration, to make sure that the stress applied at the test fixture to the device under test is truly compliant with the test standard. In the past, these calibrations were often the most tedious and error-prone steps in the receiver test setup process. With the BSAUSB31 Automation Software, the calibration of the stress "recipe" is completely automated, including saving the calibration data. For test configurations that do not change, this step needs to be run only once, and the stored calibration data is immediately available. Test engineers can now spend less time calibrating, and more time testing.

Loopback initiation

Before the receiver test can start, the device under test must be put in the proper test mode, called Loopback, where the device is retransmitting the exact same data that was received. Entering Loopback mode is challenging because of the variety of loopback negotiation sequences across the range of USB 3.1 devices, and compatibility with test equipment characteristics.

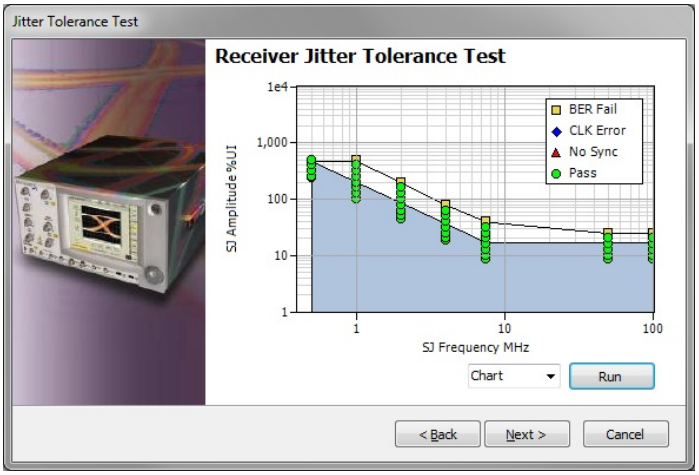
The BERTScope BSAUSB31 automation software, operating with the Tektronix Instrument Switch (BSASWITCH), provides a robust, hands-off system for initiating loopback for both Host and Device-style targets. In addition, recovery from loss of synchronization is handled through the use of word-alignment patterns, often avoiding the need to retrain loopback and interrupt the test process.



Automated loopback initiation.

Jitter tolerance testing

Jitter Tolerance testing is the essence of the USB 3.0 receiver test, and a single-click operation is part of the BSAUSB3 software solution. With real-time stress adjustment, quick synchronization, and BER testing capability, the BERTScope provides the ideal platform for fast jitter compliance testing. Test results are stored using the built-in database for later recall and report generation.



Receiver jitter tolerance margin test.

BERTScope USB 3.1 Receiver Testing

RECEIVER TEST RESULTS

Printed 11/17/2014 11:30:29 AM

Identification

Name: [Example Device Compliance]
Creator: Operator
Description:
Comment:
Passed: Passed (7)

Date/Time: 9/17/2014 4:02:13 PM
DUT Type: Device

Test Calibrations

EYE: rjsjbefore1
DPP: bsa175CwSSC-1

DPP S/N: QU10001
BSC S/N: 280572
CR S/N: Not Present

Test Signals

PG: (All Stresses Disabled) RJ 1.0 pS-RMS
SSC: SSC Disabled
DPP: Preshoot 2.7 dB, Deemphasis -2.8 dB, Amplitude 821 mV, Amplitude Setting 645.0 mV
ED: PRBS7
CR: Not Present
PG Pattern: PRBS7
Det Pattern: PRBS7

Stressed Eye

Amplitude: 821.00 mV
RJ: 1.00 pS
Eye Height: 100.00 mV

Preshoot: 2.70 dB
Deemphasis: -2.80 dB
Eye Width: 50.00 pS

Jitter Tolerance Configuration

Test Mode: Compliance
Test Bits: 3.00e010
Margin: 5.00%

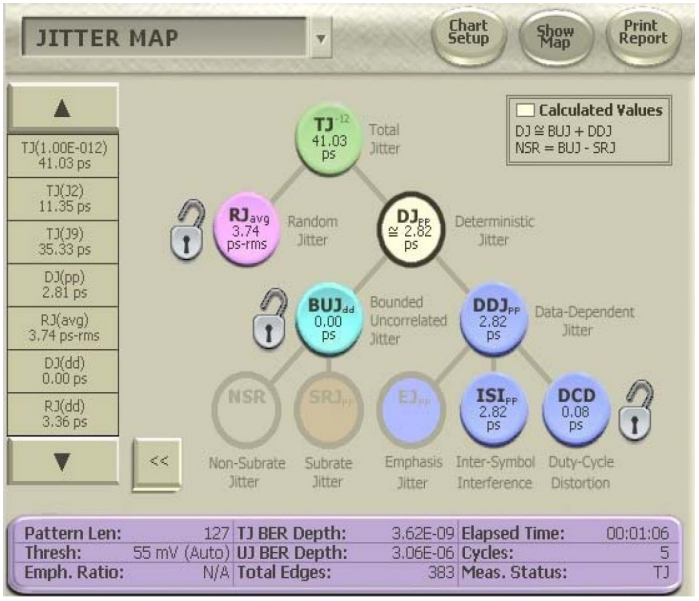
Max Errors: 1

Result Chart

Jitter Tolerance Summary

MHZ	Test	Template	Bits	Errors	BER	Status	Margin	Template Target	Template Mean
0.50	499.80%	476.00%	3.00e010	0	0.00e000	Passed	5.00%	476.00 pS	475.01 pS
1.00	213.15%	203.00%	3.00e010	0	0.00e000	Passed	5.00%	203.00 pS	203.43 pS
2.00	91.35%	87.00%	3.00e010	0	0.00e000	Passed	5.00%	87.00 pS	87.56 pS
4.00	38.85%	37.00%	3.00e010	0	0.00e000	Passed	5.00%	37.00 pS	36.86 pS
7.50	17.85%	17.00%	3.00e010	0	0.00e000	Passed	5.00%	17.00 pS	15.83 pS
50.00	17.85%	17.00%	3.00e010	0	0.00e000	Passed	5.00%	17.00 pS	17.99 pS
100.00	17.85%	17.00%	3.00e010	0	0.00e000	Passed	5.00%	17.00 pS	17.11 pS

Receiver test report.



BERTScope jitter decomposition.

Beyond testing compliance, the automation software also provides a single-click solution for finding the ultimate tolerance limits of the device under test, termed "search for margin".

Remote control protocol

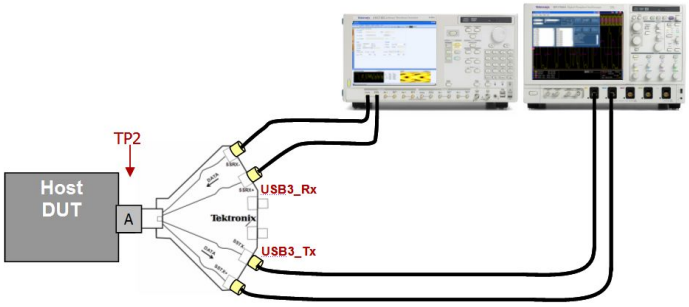
Test software can be operated remotely through ASCII commands sent through TCP/IP, giving test engineers further flexibility in designing "beyond compliance" tests.

Debug tools

When a device fails to meet the test requirements, the operator has the power of the full range of BERTScope debugging tools. From intuitive and fast manual stress adjustment to exclusive error analysis capability and jitter decomposition, the BERTScope can help identify subtle issues that other instruments might miss.

AWG automated receiver testing

Configuring test equipment for receiver testing can often be time consuming and cumbersome. The AWG is the only receiver test solution for USB 3.0 that provides a common test configuration for transmitter and receiver testing. Where other configurations rely on switches, physical USB cables, and reference channels, the AWG7000 and DPO/MSO70000 Series instruments provide a simplified test configuration.



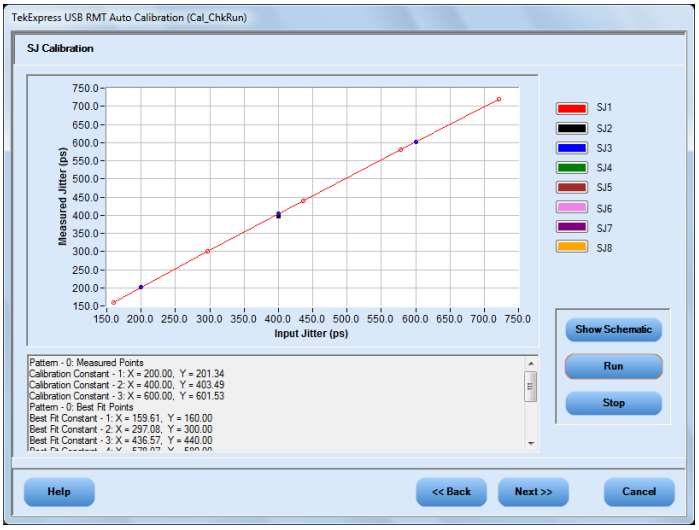
AWG SuperSpeed USB Host setup for transmitter and receiver testing.

Automated calibration in RMT

Automated calibration of signal impairments provides calibration routines that are USB3 standard specific, enables quickly calibration of waveforms and does not require you to understand detailed procedures for calibration. The objective of calibration is to compensate the patterns for specific jitter parameters. The typical parameters are de-emphasis, random and sinusoidal jitter, and stressed eye. The procedure sequences through all the patterns and each pattern is calibrated independently. These values are used for the jitter-controlled generation of patterns and are injected into DUT during loopback.

The Final Tj check using Calibrated Rj, Sj (50 MHz) and De-emphasis are within a range of 85 ps to 100 ps.

The calibration results can be viewed at any time as values and as graphical plots. Using quadratic fit (also known as curve-fit) for all the target values gives the characteristic curve. The curve fit is useful for estimation if any of the target values shows nonlinear nature. The respective calibrated values are derived from the characteristic curve.



Automated calibration.

Loopback negotiation

Before the receiver test can start, the device under test must be put into the proper test mode, called loopback. In this mode, the DUT is sending the exact same data pattern on its transmit pair as it received. Loopback negotiation is one of the most difficult and time-consuming aspects of performing receiver testing. The flexibility of the AWG is unparalleled in the ability to put devices into loopback. The power is in the real-time sequencing of the AWG that enables the user to create infinite waveform loops, jumps, and conditional branches.

This process is fully automated with the USB-RMT, following the sequence described in the SuperSpeed USB Compliance Test Specification. For devices that require a custom loopback method, a custom sequence file can be created and used with USB-RMT. However, for certification the intent is to require that the device can go into loopback following the sequence described in the CTS.

Error detection

Once the device is in loopback, an error detection mechanism is required to validate that the data pattern being retransmitted from the DUT is what was sent from the AWG. Error detection for USB 3.0 requires the use of an error detector that works with asynchronous reference clocks. For USB 3.0, the Tx and Rx are on separate reference clocks, which requires the use of SKP ordered sets to compensate for the frequency delta caused by the separate reference clocks and SSC. A transmitter is required to send SKP ordered sets every 354 symbols, however, the SKP ordered sets may not be inserted in a packet. The result is that the number of transmitted SKP ordered sets by the AWG may not match the number of SKP ordered sets sent by the DUT. In this event, the error detector must be able to ignore SKP ordered sets while executing the test.

Realtime oscilloscope error detect

Error detection for USB 3.0 is supported in the DPO/MSO70000 Series of real-time oscilloscopes. USB-RMT automates the interfaces of the error detector, so no configuration is required. For times when debugging is required the error detector includes a user-friendly control interface that enables the setup and configuration of the error detector.

Testing CP0 compliance pattern with tektronix serial error detector

The process of visually validating that a device is in loopback is simplified with the real-time oscilloscope. For example, in many cases a device may not be in loopback, but may simply be in the Compliance mode, and this is easily detected on the real-time oscilloscope. While turning the signal generator off the loopback signal should go to an idle state, otherwise the device is in a compliance mode.

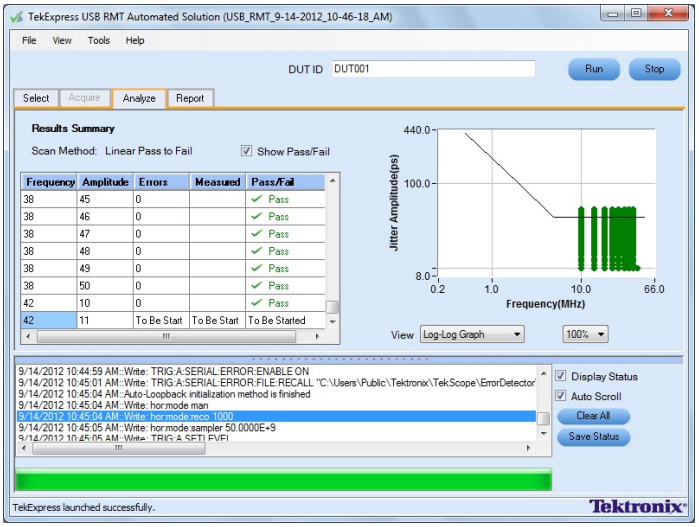
Error detection with the real-time oscilloscope supports symbol errors, which goes beyond simple character and disparity error detection. While operating in Symbol Error mode, the error detector is looking at 10-bit blocks of data that have been transmitted from the AWG and comparing those 10 bits to what is received by the error detector. At the same time, a count is maintained which displays how many of those errors were character errors versus disparity errors.

In some cases, the disparity of the SKP ordered set can be reversed when the signal is retransmitted. The error detector is smart enough to ignore SKP ordered sets regardless of the disparity.

The last mode of operation is Bit Error mode. Bit Error mode compares each bit that is transmitted from the signal generator to the data being transmitted to the error detector. While in Bit Error mode, the error detector is flexible enough to still ignore SKP ordered sets, to properly count the number of receiver errors.

Test status

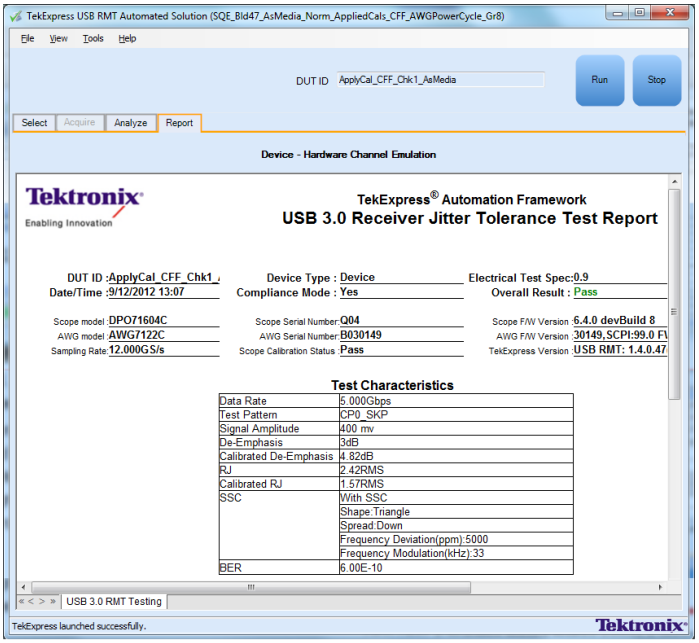
Once the test is properly configured, USB-RMT will automatically set up and configure the test equipment. As the test points are completed, USB-RMT will update the results dynamically. The results of the tests are shown in a tabular format and a graphical display. The graphical display supports both logarithmic and linear scales. Passing results are denoted by a green circle and failing results are denoted by a red 'X'.



Real-time test status across jitter and frequency ranges

Test report

Upon completion of the test, a comprehensive report is generated in .MHT format. The results of the test will also be stored in an Excel .XLS file that can be used for further data analysis. Included in the test report are the configuration settings for the test equipment, the static parameters for the test (i.e. RJ, Amplitude, SSC Profile, De-emphasis level), a graphical display of the test results, and a tabular display of the test results.

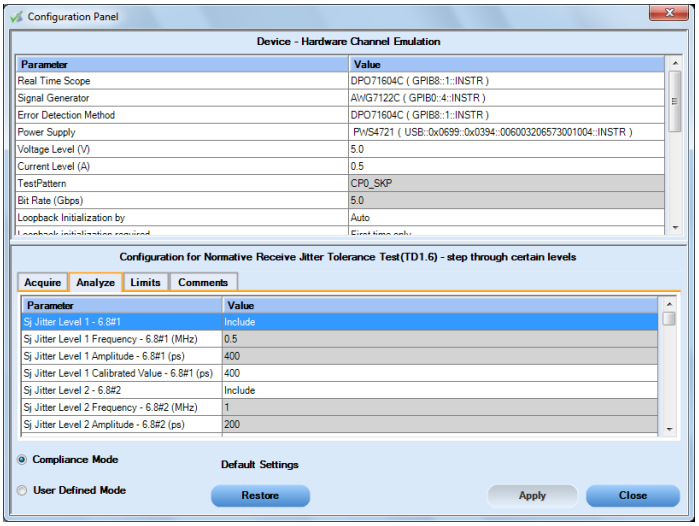


Test report.

Margin testing

While the CTS requires a Jitter Tolerance Test and specific frequencies and amplitudes, it is often necessary to understand at what point the receiver stops interpreting the incoming data correctly, which determines the margin of the device under test. Margin testing is often a long tedious process. USB-RMT automates margin testing across a range of SJ frequencies so the user is not required to interface with the software while the test is being executed.

The user also has the flexibility to change the SJ amplitude of the compliance test points. For example, a compliance test can be run with 20% margin by easily changing the amplitude of jitter at each frequency and saving that setup. The setup can be recalled at a later point in time and the test can be run under tighter conditions.



Jitter tolerance test.

Complex SSC profiles

One source of system failures or PHY noncompliance is SSC. With USB-RMT, the user can quickly modify the SSC deviation and/or frequency modulation to determine if the SSC is the cause of bit errors.

USB-TX and USBSSP-TX software

TekExpress Software (with Opt. USB-TX and USBSSP-TX) provides automation of the Tektronix USB 3.1 transmitter measurements MOI. A supported configuration includes a DPO/MSO70000 Series oscilloscope (or other supported oscilloscope) equipped with DPOJET (Jitter and Eye Diagram Analysis Tools) and SDLA Visualizer (SDLA64, optional for USB-TX and required for USBSSP-TX).

The following table lists the key differences between the USB-TX and the USBSSP-TX software solutions.

Key differences between USB-TX and USBSSP-TX

Feature	USB-TX	USBSSP-TX
Automatic measurement selections based on device type, test type, test points, and selected probes	X	X
Automatic selection of receiver CTLE filter	CTLE only	CTLE/DFE
Automatic selection of Tx channel modeling for software channel emulation	X	X
Complete coverage of USB 3.1 Normative and Informative tests (see next table)	Gen1 (5 Gb/s)	Gen1 (5 Gb/s) and Gen2 (10 Gb/s)
Automatically save test reports and waveforms	X	X
Re-analyze prerecorded waveforms	X	X
Single test report for all measurements	Gen1 (5 Gb/s)	Gen1 (5 Gb/s) and Gen2 (10 Gb/s)
Automated LFPS measurements (setup files only)	X	X
Automated DUT toggle	X	X
Automated SIGTEST measurements	X	

Supported USB3.1 transmitter measurements

Spec reference	Parameter	Symbol(s)
Table 6-17	Unit Interval including SSC	UI
Table 6-15 Table 6-19	Tj – Dual Dirac at 10^{-12} BER	tTX-TJ-DD
	Tx Deterministic Jitter - Dual Dirac	tTX-DJ-DD
	Tx Random Jitter - Dual Dirac	tTX-RJ-DD
Table 6-16	SSC Modulation Rate	tSSC-MOD-RATE
	SSC Deviation	tSSC-FREQ-DEVIATION
Table 6-17	Differential p-p Tx Voltage Swing	VTX-DIFF-PP
	Low-power Differential p-p Tx Voltage Swing	VTX-DIFF-PP-LOW
	De-emphasized Output Voltage Ratio [1] (5 GT/s)	Tx de-emphasis
	Maximum Slew Rate (5 GT/s)	tCDR_SLEW_MAX
	SSC df/dt (10 GT/s)	SSCdf/dt
Table 6-18	Tx Min Pulse [1]	tMIN-PULSE-TJ
	Deterministic Min Pulse [1]	tMIN-PULSE-DJ
	Transmitter Eye - Dual Dirac at 10^{-12} BER	tTX-EYE
	Transmitter DC Common Mode Voltage [1]	VTX-DC-CM
	Tx AC Common Mode Voltage Active [1]	VTX-CM-ACPP_ACTIVE
Table 6-28	LFPS UI Duration	tPeriod
	LFPS Common Mode Voltage	VCM-AC-LFPS
	LFPS Differential Voltage	VCM-DFF-PP-LFPS
	LFPS Rise Time	tRise
	LFPS Fall Time	tFall
	LFPS Duty Cycle	Duty Cycle
	LFPS tPeriod	tPeriod
	LFPS tPeriod-SSP (10 GT/s)	tPeriod-SSP
Table 6-29	LFPS tBurst	tBurst
	LFPS tRepeat	tRepeat
Table 6-31	LFPS tRepeat-0 (10 GT/s)	tRepeat-0
	LFPS tRepeat-1 (10 GT/s)	tRepeat-1
Table 6-32	LFPS Pulse Width Modulation (10 GT/s)	tPWM
	tLFPS-0 (10 GT/s)	tLFPS-0
	tLFPS-1 (10 GT/s)	tLFPS-1

1 Denotes Informative tests, all other tests are Normative.

Ordering information

Automated TekExpress USB 3.1 (5 Gb/s and 10 Gb/s) transmitter measurements

DPO/MSO70000	Tektronix DPO (Digital Phosphor Oscilloscope) or MSO (Mixed Signal Oscilloscope) Oscilloscopes – 16 GHz and above with DPOJET and SDLA64 installed
DPO/MSO70000 Opt. USBSSP-TX [2]	USB 3.1 5 and 10 Gb/s Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software
DPO-UP Opt. USBSSP-TX [2]	Upgrade for USB 3.1 5 Gb/s and 10 Gb/s Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software
DPOFL-USBSSP-TX [2]	Floating license upgrade for USB 3.1 5 Gb/s and 10 Gb/s Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software

Automated TekExpress USB 3.1 (5 Gb/s) transmitter measurements

DPO/MSO70000	Tektronix DPO (Digital Phosphor Oscilloscope) or MSO (Mixed Signal Oscilloscope) Oscilloscopes – 12.5 GHz and above with DPOJET installed
DPO/MSO70000 Opt. USB-TX [3]	USB 3.1 5 Gb/s Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software
DPO-UP Opt. USB-TX [3]	Upgrade for USB 3.1 5 Gb/s Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software **Includes**: Latest TekExpress product software DVD kit and upgrade software key. Online documentation and printable manual in PDF format are supplied
DPOFL-USB-TX [3]	Floating license upgrade for USB 3.1 5 Gb/s Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software **Includes**: Latest TekExpress product software DVD kit and upgrade SW key. Online documentation and printable manual in PDF format are supplied

Automated USB Power Delivery test software

GRL-USB-PD	USB Power Delivery Electrical Compliance and Decode Software. Requires MSO/DPO5000, DPO7000, or MSO/DPO70000 Series oscilloscope **Includes:** Latest GRL-USB-PD product software CD kit and upgrade software key. Online documentation and printable PDF format are supplied.

Automated BERTScope USB 3.1 receiver margin and compliance test (5 & 10 Gb/s)

BSAUSB31 Receiver Test Bundle	**Includes:** BSAUSBSOFT – USB 3.1 Automation Software, BSASWITCH – BERTScope Intelligent Switch with driver **Requires:** BSA125C or higher BERTScope [4], DPP125C Digital Pre-emphasis Processor, CR125A Clock Recovery

Automated BERTScope USB 3.0 receiver margin and compliance test (5 Gb/s)

BSAUSB3 Receiver Test Bundle	**Includes**: BSAUSBSOFT – USB 3.0 Automation Software, BSASWITCH – BERTScope Intelligent Switch with driver **Requires**: BSA85C or higher BERTScope [4], DPP125C Digital Pre-emphasis Processor, CR125A Clock Recovery

2 Requires DPOJET Jitter and Eye Analysis Tools (Opt. DJA) and ≥16 GHz oscilloscope and SDLA Visualizer (SDLA64).

3 Requires DPOJET Jitter and Eye Analysis Tools (Opt. DJA) and ≥12.5 GHz oscilloscope.

4 Note: Symbol Filtering (Opt. SF) must be ordered separately when ordering BSA125C or higher with option STR.

Automated TekExpress USB 3.0 receiver margin and compliance test

DPO/MSO70000 Opt. ERRDT	Frame and Bit Error Rate Detector for high-speed serial standards
DPO/MSO70000	Automated TekExpress USB 3.0 Receiver Margin and Compliance Test Software. Order this option (TEKEXP) and Opt. USB-RMT if TekExpress (TEKEXP) is not already owned. The software installs on the controller PC. A USB key dongle with software key enables the selected set
TEKEXP Opt. USB-RMT, TEKEXPUP Opt. USB-RMT	Automated TekExpress USB 3.0 Receiver Margin and Compliance Test Software Order this option if you already own TekExpress (TEKEXP). The USB key dongle will be upgraded with Opt. USB-RMT **Includes**: Latest TekExpress product software DVD kit (P/N 020-2913-xx) and upgrade SW key. Online documentation and printable manual in PDF format are supplied

Prerequisite host system software requirements

For USBSSP-TX and USB-TX	DPO/MSO70000 Series oscilloscope with Microsoft Windows 7 or later OS
For USB-RMT, BSAUSB31, and BSAUSB3	Microsoft XP OS with SP2 or later Microsoft Excel 2002 or above (USB-RMT only) Microsoft Access (BSAUSB3 only) Tektronix PWS4000 [5] Power Supply with output current ≥1.2 A

USB 3.0 test fixtures and cables [6]

TF-USB3-AB-KIT	USB 3.0 A/B fixture/cable Kit Includes: USB 3.0 Type A to Type B short cable, USB 3.0 calibration board, USB 3.0 Type A plug fixture (TF-USB3-A-P), USB 3.0 Type A receptacle fixture (TF-USB3-A-R), USB 3.0 Type B receptacle fixture (TF-USB3-B-R)
TF-USB3-A-P	USB 3.0 Type A plug fixture
TF-USB3-A-R	USB 3.0 Type A receptacle Includes: USB 3.0 Type A receptacle fixture and USB 3.0 Type A to Type B short cable
TF-USB3-B-R	USB 3.0 Type B receptacle Includes: USB 3.0 Type B receptacle fixture and USB 3.0 Type A to Type B short cable
174-5772-xx	USB 3.0 Type A to Type B short cable

Required equipment for USB 3.1 testing

For a complete list of required equipment please go to:

http://www.tek.com/Measurement/applications/serial_data/usb.html

5 Standard copper wire is required to make use of the power supply for DUT power cycle.

6 Tektronix test fixtures are low-loss fixtures designed to minimize the impact of fixturing on measurements and for using software emulation of a hardware channel with the AWG7000 Series. Fixtures used for certification can be ordered directly from the USB-IF (www.usb.org).

ASEAN / Australasia (65) 6356 3900
Belgium 00800 2255 4835*
Central East Europe and the Baltics +41 52 675 3777
Finland +41 52 675 3777
Hong Kong 400 820 5835
Japan 81 (3) 6714 3010
Middle East, Asia, and North Africa +41 52 675 3777
People's Republic of China 400 820 5835
Republic of Korea 001 800 8255 2835
Spain 00800 2255 4835*
Taiwan 886 (2) 2656 6688

Austria 00800 2255 4835*
Brazil +55 (11) 3759 7627
Central Europe & Greece +41 52 675 3777
France 00800 2255 4835*
India 000 800 650 1835
Luxembourg +41 52 675 3777
The Netherlands 00800 2255 4835*
Poland +41 52 675 3777
Russia & CIS +7 (495) 6647564
Sweden 00800 2255 4835*
United Kingdom & Ireland 00800 2255 4835*

Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
Canada 1 800 833 9200
Denmark +45 80 88 1401
Germany 00800 2255 4835*
Italy 00800 2255 4835*
Mexico, Central/South America & Caribbean 52 (55) 56 04 50 90
Norway 800 16098
Portugal 80 08 12370
South Africa +41 52 675 3777
Switzerland 00800 2255 4835*
USA 1 800 833 9200

* European toll-free number. If not accessible, call: +41 52 675 3777

For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tektronix.com.

Copyright © Tektronix, Inc. All rights reserved. Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specification and price change privileges reserved. TEKTRONIX and TEK are registered trademarks of Tektronix, Inc. All other trade names referenced are the service marks, trademarks, or registered trademarks of their respective companies.

23 Dec 2014 55W-23929-11

www.tektronix.com

Tektronix®