USB3.1 Type-C Transmitter and Receiver Solutions
USBSSP-TX, USB-TX, BSAUSB31, BSXUSB31, 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 Type-C host controllers, hubs and devices with Tektronix MSO/DPO/70000DX/SX series oscilloscopes. The BERTScope 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 automated and manual toolset for USB 3.1 Gen1 (5 Gbps) and Gen2 (10 Gbps) verification, characterization, debug, and compliance test
  - Supports Type-C, Standard and Micro connectors for USB 3.1 Specification
  - Provides automatic processing of USB-IF SIGTEST results without manual intervention
  - DPOJET plugin for USB 3.1 Type-C, Standard and Micro connectors which supports USB3.1 specification and CTS (Gen1 & Gen2) with setup files and MOI
  - Automatic DUT control and pattern validation to capture all required data patterns (CP0, CP1, CP9, CP10, etc.)
  - Automated USB 3.1 Gen1 and Gen2 normative and informative transmitter tests – single-button execution with no user interaction required
  - Support embedding all Channels and their respective filter files for Type-C, Standard and Micro Connectors using SDLA
  - Quickly validate test status with comprehensive reporting that details test margins, pass/fail results, and plots in PDF, MHT and CSV formats.
  - Manual Lane Switching – Support for reversible Type-C connector
  - Automated Physical Layer test support for USB Power Delivery 2.0 with packet decode

BER contour for USB 3.1 Gen 2 at 10Gbps extrapolated at 1E-12
Receiver testing
- Support for a broad range of serial standards, leveraging the BERTScope® platform
- Fully automated receiver compliance and margin testing, including automated calibration
- The BSX BERTScope series provides the tools and flexibility you need to visualize and control the handshaking and link training process for USB 3.1 devices
- Sophisticated error analysis tools such as Pattern Sequencing and Error location analysis, built into the BSX Series help to understand underlying causes of bit errors
- 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

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 3.1 receiver testing is automated on the BERTScope platform.

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.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>SJ (5 Gb/s)</th>
<th>SJ (10 Gb/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 kHz</td>
<td>400 ps</td>
<td>476 ps</td>
</tr>
<tr>
<td>1 MHz</td>
<td>200 ps</td>
<td>203 ps</td>
</tr>
<tr>
<td>2 MHz</td>
<td>100 ps</td>
<td>87 ps</td>
</tr>
<tr>
<td>4 MHz</td>
<td>N/A</td>
<td>37 ps</td>
</tr>
<tr>
<td>4.9 MHz</td>
<td>40 ps</td>
<td>N/A</td>
</tr>
<tr>
<td>7.5 MHz</td>
<td>N/A</td>
<td>17 ps</td>
</tr>
<tr>
<td>10 MHz</td>
<td>40 ps</td>
<td>N/A</td>
</tr>
<tr>
<td>15 MHz</td>
<td>N/A</td>
<td>17 ps</td>
</tr>
<tr>
<td>20 MHz</td>
<td>40 ps</td>
<td>N/A</td>
</tr>
<tr>
<td>33 MHz</td>
<td>40 ps</td>
<td>N/A</td>
</tr>
<tr>
<td>30 MHz</td>
<td>N/A</td>
<td>17 ps</td>
</tr>
<tr>
<td>50 MHz</td>
<td>40 ps</td>
<td>17 ps</td>
</tr>
<tr>
<td>100 MHz</td>
<td>N/A</td>
<td>17 ps</td>
</tr>
</tbody>
</table>

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.
The automated solution for USB 3.1 on the BERTScope simplifies 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. The BERTScope solution provides all of the required signal impairments for USB3.1, including SJ, RJ, SSC, and De-emphasis.

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.

USB 3.1 Gen1 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.
USB 3.1 Gen1 (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/MSO7000 oscilloscope (or other supported oscilloscope) equipped with DPOJET (Jitter and Eye Diagram Analysis Tools). The software requires a DPO/MSO7000 oscilloscope (12.5 GHz or higher required for compliance testing) with DPOJET (Opt. DJA).

USB 3.1 Gen2 (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.
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 Biphasic 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.

Automated receiver testing

USB 3.1 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. 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 also supported with the BERTScope.

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 USB 3.1 Receiver Software 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.
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 USB 3.1 Receiver 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 USB 3.1 Receiver 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.

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 USB 3.0 Receiver 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.
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.

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.

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

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

DPO/MSO70000 ¹  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

USBSSP-UP  Upgrade USB-TX (Supports 5G only) software to USBSSP-TX software package (Supports 5G & 10G)

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

DPO-UP 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

Recommended test fixtures, cables, and tools

<table>
<thead>
<tr>
<th>Item</th>
<th>Vendor</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB31AET Type A &amp; Micro B Test Fixture Kit</td>
<td>USB-IF</td>
<td>1</td>
</tr>
<tr>
<td>USB31CET Type C Test Fixture</td>
<td>USB-IF</td>
<td>1</td>
</tr>
<tr>
<td>PMCABLE1M Phase Matched SMA cable set</td>
<td>Tektronix</td>
<td>2</td>
</tr>
<tr>
<td>AFG3101C and above, AWG5000C, AWG7000C or AWG70000 (DUT State Control)</td>
<td>Tektronix</td>
<td>1</td>
</tr>
<tr>
<td>015-0572-00 BNC to SMA adapter</td>
<td>Tektronix</td>
<td>2</td>
</tr>
<tr>
<td>PWS4000 Tektronix Power Supply (optional for automatic power cycling)</td>
<td>Tektronix</td>
<td>1</td>
</tr>
</tbody>
</table>

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

DPO/MSO70000 ¹  Tektronix DPO (Digital Phosphor Oscilloscope) or MSO (Mixed Signal Oscilloscope) Oscilloscopes – 12.5 GHz and above with DPOJET and SDLA64 installed

DPO/MSO70000 Opt. USB-TX ¹  USB 3.1 5 Gb/s Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software

DPOFL-USB-TX ²  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

DPO-UP 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

Recommended test fixtures, cables, and tools

<table>
<thead>
<tr>
<th>Item</th>
<th>Vendor</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB31AET Type A &amp; Micro B Test Fixture Kit</td>
<td>USB-IF</td>
<td>1</td>
</tr>
<tr>
<td>USB31CET Type C Test Fixture</td>
<td>USB-IF</td>
<td>1</td>
</tr>
<tr>
<td>PMCABLE1M Phase Matched SMA cable set</td>
<td>Tektronix</td>
<td>2</td>
</tr>
</tbody>
</table>

¹ Requires Noise Analysis Tools (Opt. DJAN and DJA) for BER Contour support.

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.
## 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: BSAUSB3SOFTWARE – USB 3.1 Automation Software, BSASWITCH – BERTScope Intelligent Switch with driver.

Requires: BSX125 or higher BERTScope, CR125A Clock Recovery.

**BSXUSB31 Receiver Test Bundle**

Includes: USB 3.1 (Gen1/Gen2) Receiver Automation Software, BSASWITCH – BERTScope Intelligent Switch with driver.

Requires: BSX125 or higher BERTScope, CR125A Clock Recovery.

**BSXUSBUP**

Includes: Upgrade from BSAUSB3 or BSAUSB31 to BSXUSB31.

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

**BSAUSB3 Receiver Test Bundle**

Includes: BSAUSB3SOFTWARE – USB 3.0 Automation Software, BSASWITCH – BERTScope Intelligent Switch with driver.

Requires: BSA85C or higher BERTScope, DPP125C Digital Pre-emphasis Processor, CR125A Clock Recovery.

## Prerequisite host system software requirements

For USBSSP-TX and USB-TX

DPO/MSO70000 Series oscilloscope with Microsoft Windows 7 or later OS.

For BSAUSB31 and BSXUSB31

Microsoft Win7 OS

Microsoft Access (BSAUSB3 only)

Tektronix PWS4000 ¹ Power Supply with output current ≥1.2 A

## 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

---

¹ Note: Symbol Filtering (Opt.SF) must be ordered separately when ordering BSX125 or higher with option STR.

² Standard copper wire is required to make use of the power supply DUT power cycle.