

Automated USB 3.0 Receiver and Transmitter Solutions

Test Name	Low Limit	Measure Value	High Limit	Margin	Pass/Fail Status
DJ-Tx deterministic Jitter-Dual Dir	NA	27.824ps	95.00ps	58.176ps,NA	✓ Pass
Eye Height - Transmitter Eye Mask	100.000mV	159.394mV	1.200V	1.041V,59.394mV	✓ Pass
LFPS Duty Cycle	49.807%	49.807%	60.000%	10.193%,9.807%	✓ Pass
LFPS Fall Time	NA	594.673ps	4.000ns	3.405ns,NA	✓ Pass
LFPS Rise Time	NA	577.316ps	4.000ns	3.423ns,NA	✓ Pass
LFPS TPeriod	20.000ns	32.002ns	100.000ns	67.999ns,12.002ns	✓ Pass
LFPS Vcm-AC	NA	-27.538mV	100.000mV	127.538mV,NA	✓ Pass
LFPS Vsv-DIFF-PP	800.000mV	977.079mV	1.200V	222.922mV,177.079mV	✓ Pass
Mask Hits	NA	0	NA	NA,NA	✓ Pass
Rj-Tx random jitter-Dual Dirac	NA	539.412ps	3.290ps	2.751ps,NA	✓ Pass
TCCDR_Slew_Max-Maximum Slew	NA	44.182uA/s	10.000mA/s	9.956mA/s,NA	✓ Pass
Tj-Tx total jitter-Dual Dirac at 10E	NA	35.412ps	132.000ps	96.588ps,NA	✓ Pass

- Predefined CTLE Function provided as per the USB 3.0 Specification, DUT-specific CTLE Functions can be Customized with Serial Data Link Analysis Software (Opt. SLA)
- Model the Host Channel Back Panel, Host Channel Front Panel, Cable, and Device Channel without Physical Channels or Cables
- Flexible Fixture Options provide access to both USB 3.0 Transmitter and Receiver Signals supporting Transmitter and Receiver Tests without Physical Cables
- Quickly Validate Test Status with Comprehensive Reports Detailing Test Margins and Pass/Fail Results

Receiver Testing

- Automated Receiver Compliance and Margin Testing Reduces the Complexity of Executing Receiver Tests
- Automated Stressed Eye Calibration
- Industry-leading Single-click Loopback Initiation
- Accurate and Fast BERT-based Jitter Tolerance Testing Maximizes Receiver Test Throughput
- Automation Software includes Hardware Configuration Help, Report Generation, and Test Database

Applications

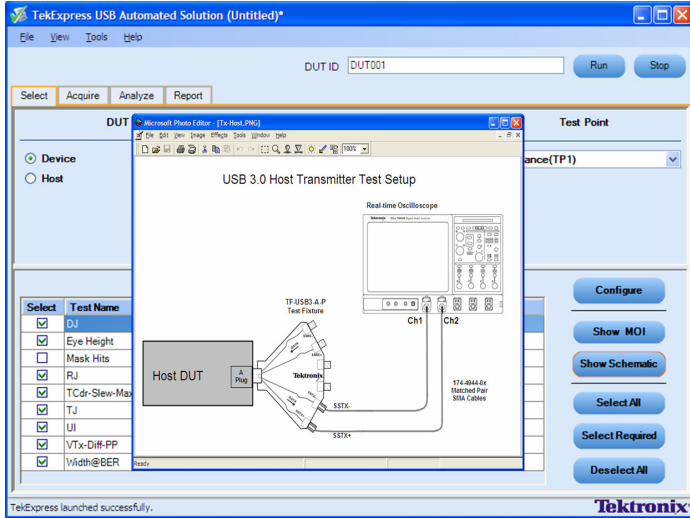
Transmitter and Receiver Testing

- USB 3.0 Transmitter and Receiver Testing for:
 - USB 3.0 Host and Device Silicon Validation
 - System Validation and Integration
 - Manufacturing Test

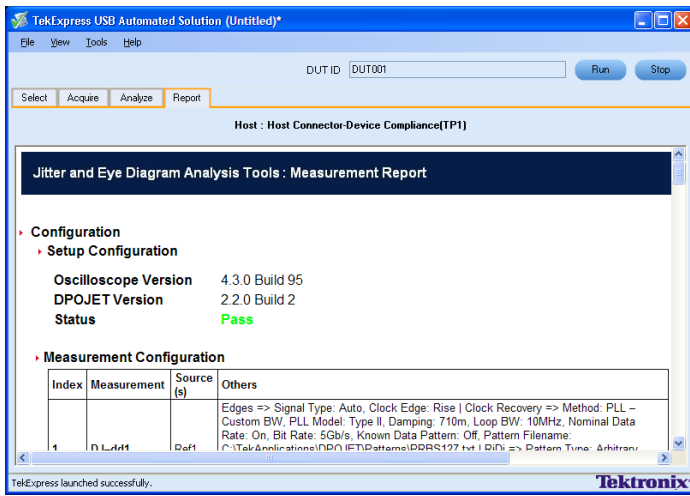
Features & Benefits

Transmitter Testing

- Provides a Comprehensive Toolset for USB 3.0 Verification, Characterization, Debug, and Compliance Test
- Integrated with USB-IF, SIGTEST provides Automatic Processing of SIGTEST Results without Manual Intervention
- Automatic DUT Control and Pattern Validation to Capture All Required Data Patterns (LFPS, CP0, CP1, etc.)
- Automated USB 3.0 Normative and Informative Transmitter Tests – Single-button execution with no user interaction required
- Full Control of Analysis Parameters enables Seamless Integration between Compliance and Debug Environments



Show Schematic (Available for USB-TX).



View Report (Available for USB-TX and USB3).

Complete Automation for USB 3.0 Testing

The Tektronix Automated Test Software is a Windows-based application that runs on any Windows XP*1 computer operating system including many Tektronix Windows-based instruments. TekExpress software ordered with Option USB-TX provides an automated, simple, and efficient way to test USB 3.0 Transmitter and Receiver hosts and devices consistent with the

requirements of the SuperSpeed Universal Serial Bus Electrical Compliance Test Specification (CTS).

*1 See host system requirements in Ordering Information section.

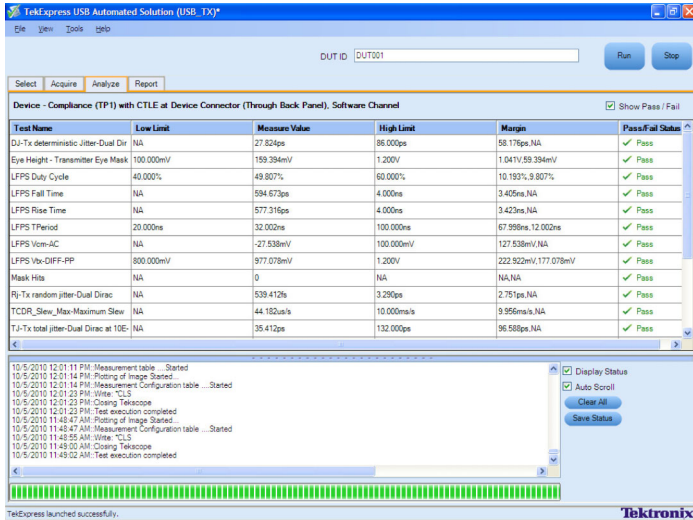
100% USB 3.0 Test Coverage

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 USB 3.0 base specification also includes a set of informative measurements including tests for Slew, Voltage Levels, and others. The TekExpress Option USB-TX software is an easy-to-use software package that automates the USB 3.0 Normative and Informative Transmitter Tests. The DPOJET Option USB3 provides semi-automation of the USB 3.0 Normative and Information Transmitter Measurements and Setup Library. While other manufacturers promote standard-specific compliance software, the Tektronix solution provides a comprehensive verification, characterization, debug, and compliance environment. The Tektronix USB 3.0 test bench includes a real-time oscilloscope (DPO/DSA/MSO70000 Series), BERTScope BSA, DPP, CR, and Switch, a USB 3.0 test fixture set, and USB 3.0 test software (USB-TX or USB3 for Transmitter test and BSAUSB3SFT for Receiver test).

Receiver testing is a requirement for SuperSpeed USB certification. The 10x increase of data rate (5 Gb/s) makes it critical that the Receiver properly interprets the incoming bit stream. The Receiver test is a jitter tolerance test which stresses the Receiver over defined sinusoidal jitter frequencies and amplitudes which are defined in the CTS. The table below outlines the required test frequencies for USB 3.0 Receiver Testing. All other impairments (RJ, SSC, De-emphasis, ISI) remain constant while the SJ is swept across the frequencies defined in the standard.

The Receiver test is simplified by the BSAUSB Automated Receiver Test Solution for SuperSpeed USB. No longer is it a requirement that the end user be an expert in USB 3.0. 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. BSAUSB is based on the BERTScope and is uniquely suited to provide all of the required signal impairments for USB 3.0 including SJ, RJ, SSC, De-emphasis, and ISI.

Required test procedures (MOI) can be found at:
www.tektronix.com/usb



Test Status.

Automated Transmitter Testing – Save Time and Resources

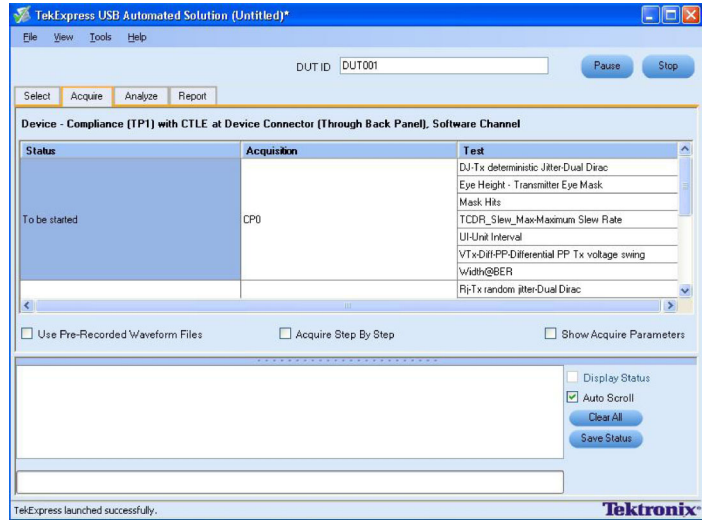
There is no longer a need to be an expert on Transmitter testing procedures. Remembering the exact steps to take is time consuming and often requires going back to the USB 3.0 Test Specification. USB-TX takes the guesswork out of conducting USB 3.0 Transmitter Testing. Even if you remember how to use 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. USB-TX allows engineers to simply select the desired tests to run and work on other tasks while the tests are being executed.

USB 3.0 Transmitter Test

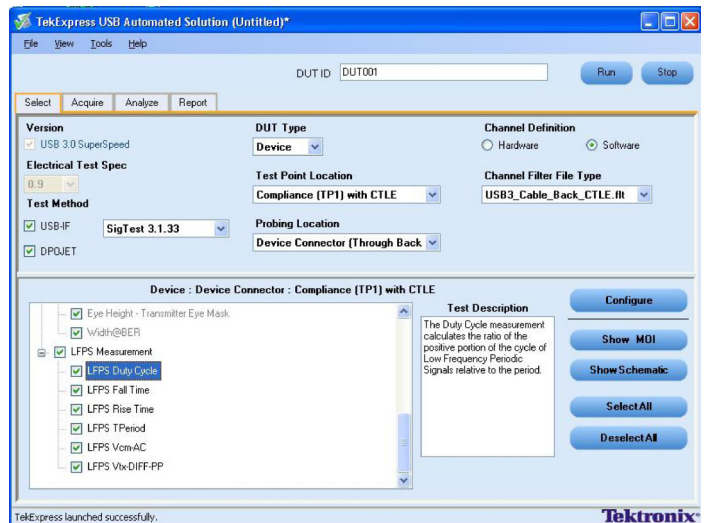
USB 3.0 Transmitter Testing with USB3 Essentials

USB 3.0 Essentials DPOJET Measurements and Setup Library (Opt. USB3) for the DSO/DSA/MSO70000 Series oscilloscopes provides a semi-automated USB 3.0 Transmitter solution. USB3 provides a precise verification, characterization, and debug environment built upon the general-purpose analysis capabilities of DPOJET. USB3 enables the execution of all USB 3.0 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 3.0 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.

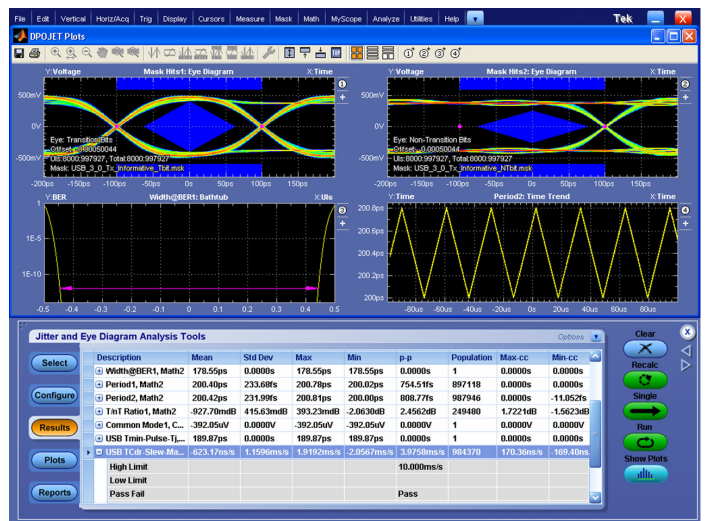
A supported configuration includes a DPO/DSA/MSO70000 Series Digital Serial Analyzer (or other supported oscilloscope) equipped with DPOJET (Jitter and Eye Diagram Analysis Tools). The software requires a DPO/DSA/MSO70000 Series Digital Serial Analyzer (greater than 8 GHz) with DPOJET (Opt. DJA).



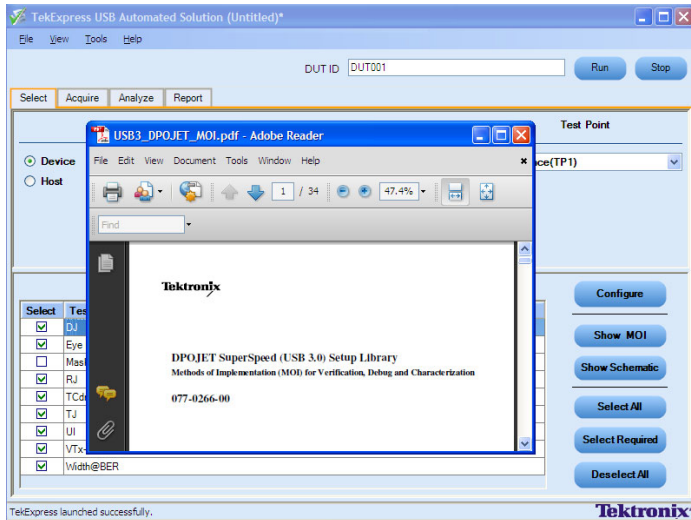
Configuration Panel.



Basic Operation.



Transition and Nontransition Bit Analysis.



Show MOI.

One-button Testing

Once the test bench is set up and the DUT is properly connected, simply press the Run button to perform the selected test suite.

Online Help and Show MOI

Online Help is available through the Help menu and direct access to the USB 3.0 Transmitter MOI (Method of Implementation) through the Show MOI button. The approved MOI documents step-by-step how the test is being performed by the TekExpress™ software. This allows users to understand the theory behind the measurements and better understand test results.

Pass/Fail Report

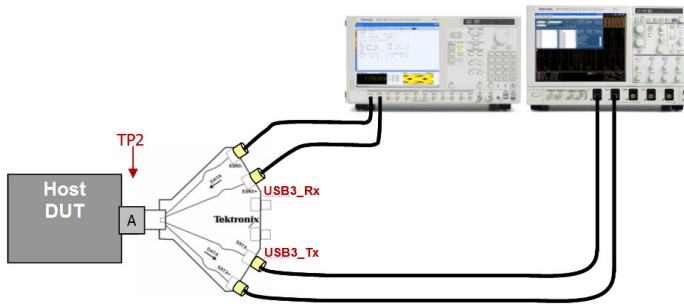
The Report tab provides an view of test results along with Pass/Fail status, test margin, and images supporting the test results.

Powered by NI TestStand™

The TekExpress automated compliance software uses NI (National Instruments) TestStand to manage and execute its test sequences. A Windows user interface is provided in the TekExpress software for simple and complete operation of compliance measurements. However, if your validation and debug needs go beyond the features offered by the TekExpress software, a full version of NI TestStand can be used to develop higher-level automation sequences to control the TekExpress software.

NI TestStand is the de facto industry standard test management environment for automating test and validation systems. NI TestStand is used to develop, manage, and execute test sequences, as well as to integrate test modules written in any test programming language through an open and flexible architecture. Customers who own NI TestStand and purchase the TekExpress software will be able to write scripts using NI TestStand that call the TekExpress software with a limited command set. The limited command set allows the NI TestStand user to recall and save TekExpress software setups, start execution, query current execution status, and receive measurement results.

For device validation, it's often desirable to make multiple runs of a single device using different operating conditions such as temperature and power supply voltages. This is sometimes referred to as 'four-corners testing', (testing to low-high temperature and low-high supply voltages). For four-corners testing, NI TestStand supports drivers for a wide range of temperature chambers and power supplies. NI TestStand can be used to control the temperature chamber and then call the TekExpress software for a compliance test using the limited command set. For adjusting power supply voltages, the power supply control sequence file within the TekExpress software can be modified using a standard NI TestStand sequence file. Thus, if your company already uses NI TestStand for automation, your test engineers can incorporate commands to run the TekExpress compliance software directly into their test sequences.



SuperSpeed USB Host Setup for Transmitter and Receiver Testing.

BERTScope Automated Receiver Testing

The BERTScope USB 3.0 Automated Receiver test solution is designed to streamline the often tedious and labor-intensive receiver test workflow. No longer is expert USB 3.0 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 BSAUSB3 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 calibration of the stress sources to ensure 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 BSAUSB3 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 only needs to be performed 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 re-transmitting 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 3.0 devices, and compatibility with test equipment characteristics. The BERTScope BSAUSB3 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 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.

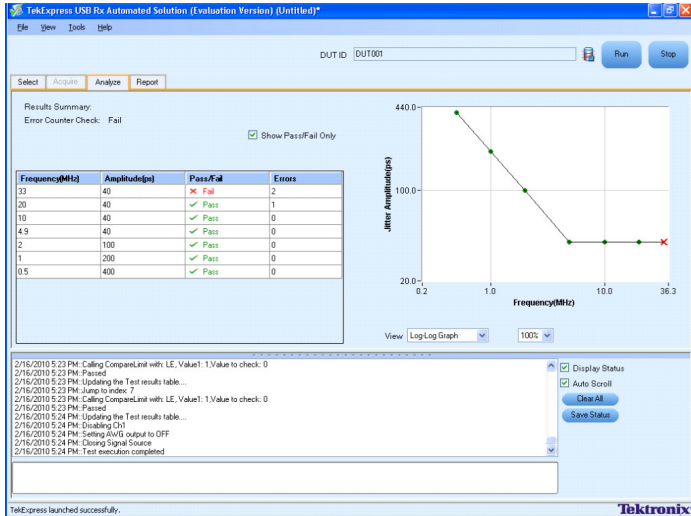
Beyond testing compliance, the automation software also provides a single-click solution for finding the ultimate tolerance limits of the device under test, termed "search for margin".

Remote Control Protocol

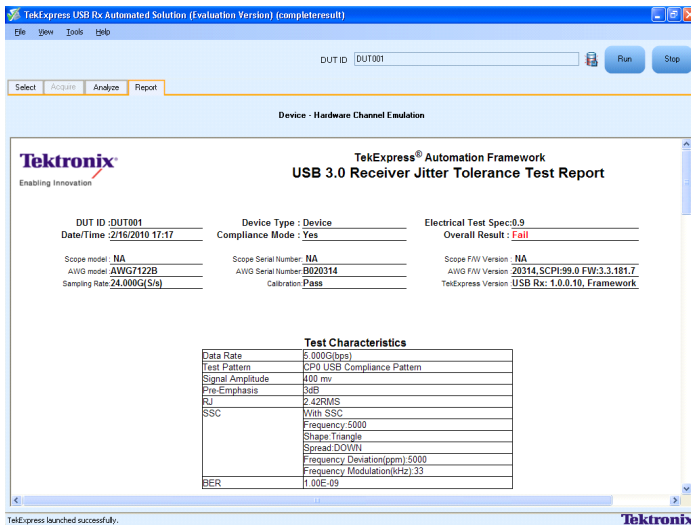
Test software can be operated remotely through ASCII commands sent through TCP/IP, giving test engineers further flexibility in designing "beyond compliance" tests.

Debugging 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.



Ellisys Protocol Analyzer Error Detection.



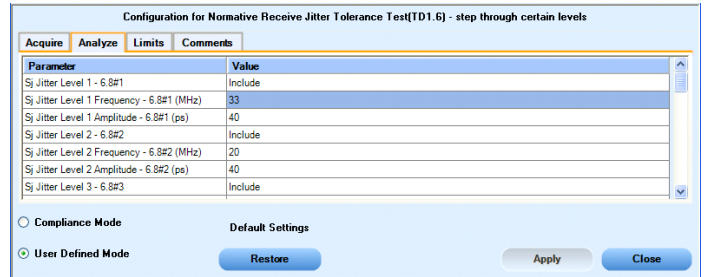
Test Report.

Ellisys Protocol Analyzer Error Detection

An alternative to using the scope-based error detection is to use an external USB 3.0 protocol analyzer. The Ellisys USB Explorer 280 5 Gb/s Error Detector is completely integrated into USB-RMT and reports both 8b/10b character errors and disparity errors while ignoring SKP ordered sets.

Test Status

Once the test has been properly configured, USB-RMT will automatically set up and configure the test equipment. As the test points are being executed the 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. The Test Status screenshot above shows a compliance test that has passed all of the required frequencies with the exception of 33 MHz. The pass results are denoted by a green circle and the failed results are denoted by a red 'X'.



Jitter Tolerance Test.

Test Report

Upon completion of the test, a comprehensive report will be 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.

Testing Beyond Compliance

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.

Complex SSC Profiles

One source of system failures or PHY non-compliance is SSC. With USB-RMT, the user can quickly modify the SSC deviation and/or frequency modulation in order to determine if the SSC is the cause of bit errors. Furthermore, the AWG with SerialXpress can be used to generate complex df/dt profiles in order to fully characterize the Receiver's pll.

Stress the RX over Various Channel Configurations

Using the AWG and USB-RMT enables the stressing of the Receiver under various channel and cable conditions. The AWG is uniquely suited to stress the Receiver by emulating the channel and USB cable in software. By using S-parameters or allowing ISI to be specified in absolute terms (for example .3 UI) users can quickly configure a test under multiple different operating conditions without requiring physical hardware channels or USB cables. Another benefit from using software emulation is that variability from mechanical wear or different physical channels and cables is not an issue.

USB 3.0 Transmitter Testing with USB-TX TekExpress™ Software

TekExpress Software (with Opt. USB-TX) provides automation of the Tektronix USB 3.0 Transmitter Measurements MOI. A supported configuration includes a DPO/DSA/MSO70000 Series Digital Serial Analyzer (or other supported oscilloscope) equipped with DPOJET (Jitter and Eye Diagram Analysis Tools). USB-TX also includes USB3 Essentials DPOJET Measurements and Setup Library.

The following table outlines the key differences between the USB3 and the USB-TX software solutions. USB3 Essentials is included with USB-TX and thus all product features included with USB3 Essentials are also included with USB-TX.

Table 1 – Key Differences between USB3 Essentials and USB-TX

Feature	USB3 Essentials	USB-TX
Automatic measurement selections based on device type, test type, test points, and selected probes		X
Automatic selection of Receiver CTLE filter		X
Automatic selection of Tx Channel Modeling for Software Channel Emulation		X
Complete coverage of USB 3.0 Normative and Informative Tests (see Table 2)	X	X
Single-button execution for all selected measurements	X	X
Comprehensive debug environment allows isolation of spec violations, editing of test limits	X	X
Detailed or Summary Reports	Detailed Only	Detailed and Summary
Automatically save test reports and waveforms		X
Re-analyze prerecorded waveforms	X	X
USB-specific user interface		X
Quickly move between precompliance and debug		X
Automated Tj measurement based on Dj (CP0) and Rj (CP1)		X
Single test report for all measurements		X
Automated LFPS Measurements (Setup files only)		X
Automated DUT Toggle		X
Automated SIGTEST Measurements		X

Table 2 – Supported USB 3.0 Transmitter Measurements

Spec Reference	Parameter	Symbol(s)
Table 6-10	Unit Interval including SSC*2	UI
Table 6-8 Table 6-12	Tj – Dual Dirac at 10 ⁻¹² BER*2	tTX—TJ-DD
Table 6-8 Table 6-12	Tx Deterministic Jitter – Dual Dirac*2	tTX—DJ-DD
Table 6-8 Table 6-12	Tx Random Jitter – Dual Dirac*2	tTX—RJ-DD
Table 6-9	SSC Modulation Rate	tSSC-MOD-RATE
Table 6-9	SSC Deviation	tSSC-FREQ-DEVIATION
Table 6-10	Differential p-p Tx Voltage Swing	VTX-DIFF-PP
Table 6-10	Low-power Differential p-p Tx Voltage Swing	VTX-DIFF-PP-LOW
Table 6-10	De-emphasized Output Voltage Ratio	Tx de-emphasis
Table 6-10	Maximum Slew Rate	tCDR_SLEW_MAX
Table 6-11	Tx Min Pulse	tMIN-PULSE-TJ
Table 6-11	Deterministic Min Pulse	tMIN-PULSE-DJ
Table 6-11	Transmitter Eye – Dual Dirac at 10 ⁻¹² BER	tTX-EYE
Table 6-11	Transmitter DC Common Mode Voltage	VTX-DC-CM
Table 6-11	Tx AC Common Mode Voltage Active	VTX-CM-ACPP_ACTIVE
Table 6-20	LFPS UI Duration	tPeriod
Table 6-20	LFPS Common Mode Voltage	VCM-AC-LFPS
Table 6-20	LFPS Differential Voltage	VCM-DFF-PP-LFPS
Table 6-20	LFPS Rise Time	tRise
Table 6-20	LFPS Fall Time	tFall
Table 6-20	LFPS Duty Cycle	Duty Cycle

*2 Denotes normative tests, all other tests are informative.

Required Equipment for USB 3.0 Testing

For a complete list of required equipment please visit

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

Simple Setup, Test Execution, and Reporting

Setup and test execution is simple with the TekExpress software. The oscilloscope is controlled through the TekExpress automation framework. The TekExpress software provides a Graphical User Interface (GUI) and provides an intuitive workflow through setup and testing.

Setting up the Bench

When setting up a test, nothing can be simpler than hooking up the test system by looking at a schematic. View the schematic of the selected test with a push of a button.

Instrument Bench Discovery

TekExpress™ software automatically (or on demand) scans and detects supported instruments connected in your test bench (both Visa supported and non-Visa supported instruments), whether they are connected through LAN, GPIB, or USB. A quick check of the Instrument Bench menu confirms all instruments are networked correctly.

Ordering Information

USB3 Essentials

Model	Description
DPO/DSA/ MSO70000	DPO (Digital Phosphor Oscilloscope), DSA (Digital Serial Analyzer), or MSO (Mixed Signal Oscilloscope) Oscilloscopes – 8 GHz and above with DPOJET installed
DPO/DSA/ MSO70000 Opt. USB3*3	USB 3.0 Essentials for USB 3.0 Transmitter Testing
DPO-UP Opt. USB3*3	USB 3.0 Essentials for USB 3.0 Transmitter Testing Upgrade
DPOFL-USB3*3	USB 3.0 Essentials for USB 3.0 Transmitter Testing Upgrade (Floating License version)

Automated TekExpress™ USB 3.0 Transmitter Measurements*3

Model	Description
DSA/DPO/ MSO70000 Opt. TEKEXP TEKEXP	TekExpress™ Automated Compliance Test Software. Order this option (TEKEXP) and Opt. USB-TX if TekExpress (TEKEXP) is not already owned. The software installs on the controller PC. A USB key dongle with software key enables the selected option set
DSA/DPO/ MSO70000 Opt. USB-TX	USB 3.0 Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software. 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
TEKEXPUP Opt. USB-TX	USB 3.0 Transmitter Normative and Informative Tests for TekExpress Automated Compliance Test Software. Order this option, if TekExpress (TEKEXP) is already owned. The USB key dongle will be upgraded with Opt. USB-TX. 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

Automated BERTScope USB 3.0 Receiver Margin and Compliance Test

Model	Description
BSAUSB3 Receiver Test Bundle	Includes: BSAUSBSOFT – USB 3.0 Automation Software, BSASWITCH – BERTScope Intelligent Switch with driver Requires: BSA85C BERTScope, DPP125B Digital Pre-emphasis Processor, CR125A Clock Recovery

Prerequisite Host System Software Requirements for USB-TX and USB-RMT

- Microsoft XP OS with SP2 or later
- Microsoft Excel 2002 or above
- Microsoft Explorer 6.0 SP1 or later
- Microsoft Photo Editor 3.0 or equivalent for viewing image files
- Adobe Reader 6.0 or equivalent software for viewing Portable Document Format (PDF) files
- Microsoft Access

USB 3.0 Test Fixtures*4

Fixture	Description
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 Includes: 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 Includes: USB 3.0 Type A to Type B Short Cable

*3 Requires DPOJET Jitter and Eye Analysis Tools (Opt. DJA) and ≥8 GHz oscilloscope.

*4 Please contact your Account Manager for availability.



Product(s) are manufactured in ISO registered facilities.



Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

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