Tektronix®

USB 2.0 Electrical Testing Software for 5 Series MSO

Option 5-CMUSB2 Datasheet

Get more visibility into your USB designs

USB 2.0 is a widely used system bus, due to its reliability and cost-effectiveness. The bus uses differential signaling and its bit rate ranges from 1.5 Mb/s (low speed) to 480 Mb/s (high speed). To ensure that USB 2.0 implementations are robust and interoperable, the standard defines a series of tests, including mask testing and parametric testing of low-speed, full-speed, and high-speed for devices, hosts, and hubs. This datasheet describes TekExpress USB2 Electrical Testing Software (option 5-CMUSB2) for the 5 Series MSO, which automates the standard tests.

Even without the USB2 Electrical Testing Software option, the 5 Series MSO offers a versatile range of signal analysis tools for design validation and debug.

It is recommended to perform pre-compliance testing of the measurements during the designing and prototyping stages to identify and address the potential USB 2.0 design issues and then send the product for compliance testing. This reduces the product failure risk at the USB workshop or at the test house. You can save time, reduce the expenses and also identify specification conditions by performing pre-compliance tests.

The USB Implementers Forum, Inc. (USB-IF) defines a suite of tests that determine compliance with the USB 2.0 standard. The goal of the testing is to confirm a design's reliability and compatibility. Designers must pass all compliance tests recommended by the USB-IF to use the USB-IF logo on their packaging. However, many designers also use the tests to perform validation and margin testing, thereby increasing confidence in their designs.

Manually performing the standard tests is difficult and requires significant expertise, but the 5 Series MSO, equipped with Option 5-CMUSB2, facilitates testing by handling oscilloscope setup, automating tests, evaluating pass/fail results, and report generation. The option is built on the proven TekExpress® automated serial compliance testing platform.

Design validation and debug

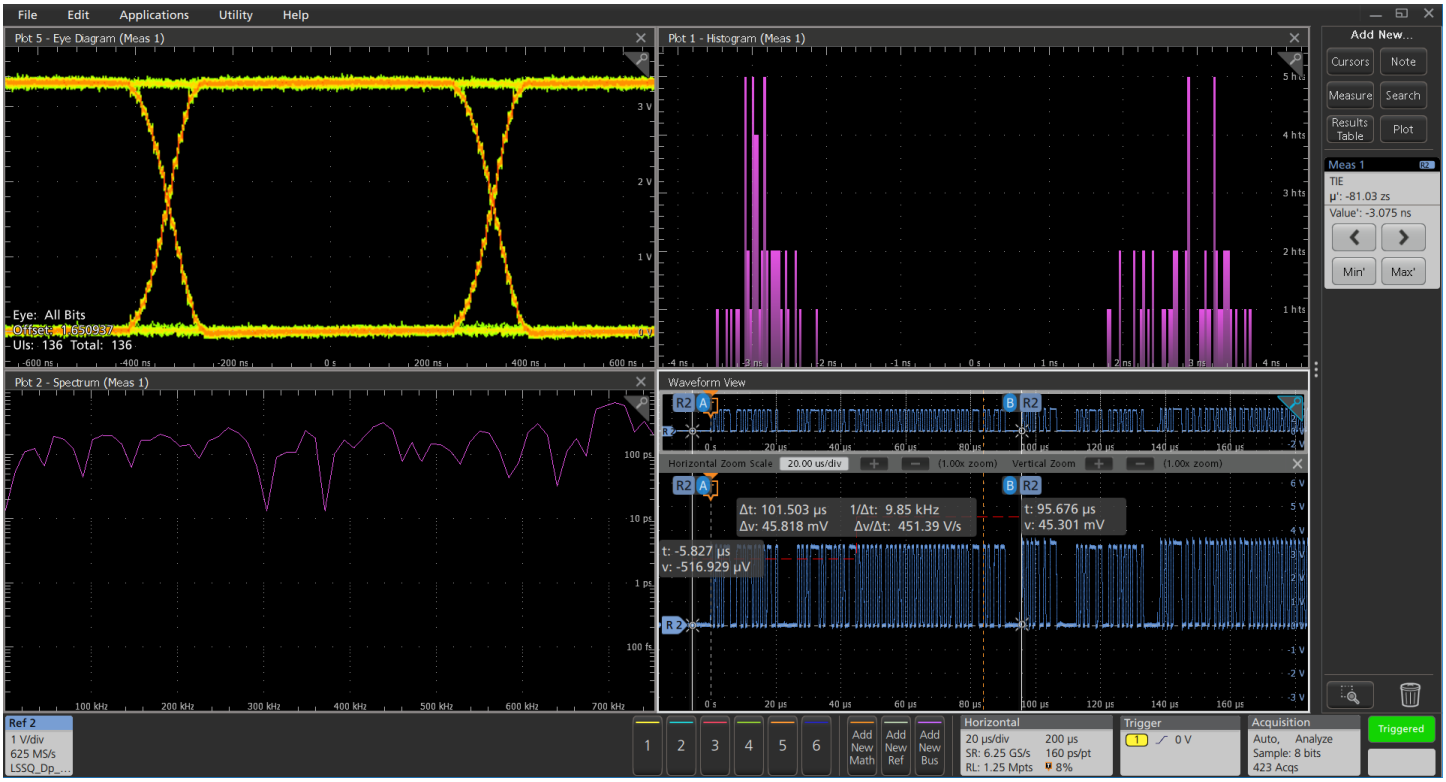
Testing the design can easily be accomplished early in the design process and ahead of final compliance testing by using the 5 Series MSO oscilloscope. The oscilloscope's standard measurement set, along with the optional 5-DJA Advanced Jitter and Timing Analysis software supports several of the key compliance tests including:

- Eye diagram analysis of USB signals
- Full characterization of jitter performance including TIE and histogram profiles
- Rise and fall time analysis

Eye pattern analysis is a proven technique to evaluate long data streams of complex communication signals. Eye pattern display is standard in the 5 Series MSO, but Advanced Jitter and Eye Analysis software (option 5-DJA) provides 31 additional measurements and jitter decomposition algorithms to help get to root cause.

Tektronix also offers an optional 5-SRUSB2 decode and trigger solution to perform USB specific protocol level analysis on the design.

Using the signal analysis and protocol decoder increases the likelihood of passing compliance tests, and can provide broader insight beyond the standard compliance tests.



Detailed analysis of a USB 2.0 signal using the 5 Series MSO measurement plots and optional Advanced Jitter Analysis (5-DJA) measurements

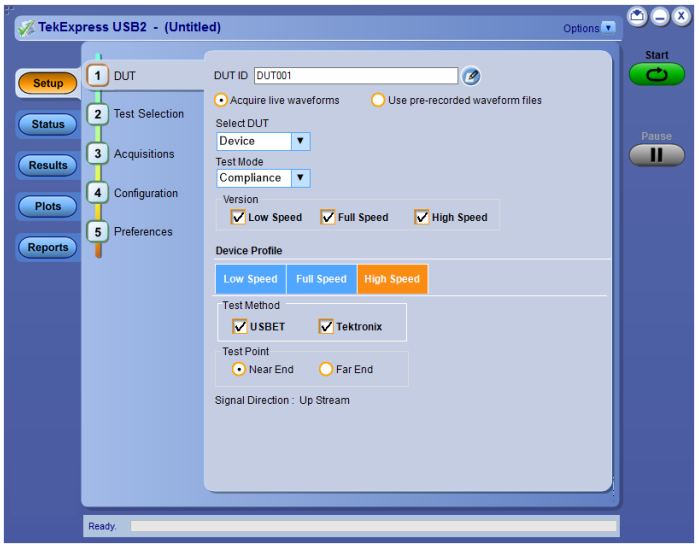
Automated USB 2.0 testing with option 5-CMUSB2

USB 2.0 electrical testing requires an oscilloscope with minimum bandwidth of 2 GHz. TekExpress USB2 software for the 5 Series MSO (5-CMUSB2) provides automated pre-compliance testing for USB 2.0 serial bus verification, including:

- High-speed tests: Signal Quality, Receiver Sensitivity, Chirp, Reset, Reset from High Speed, Reset from Suspend, Resume, and Suspend
- Eye diagram, Jitter, Rise time, Fall time, and EOP width
- Packet Parameter and Monotonicity
- Power measurements: Droop and Inrush current

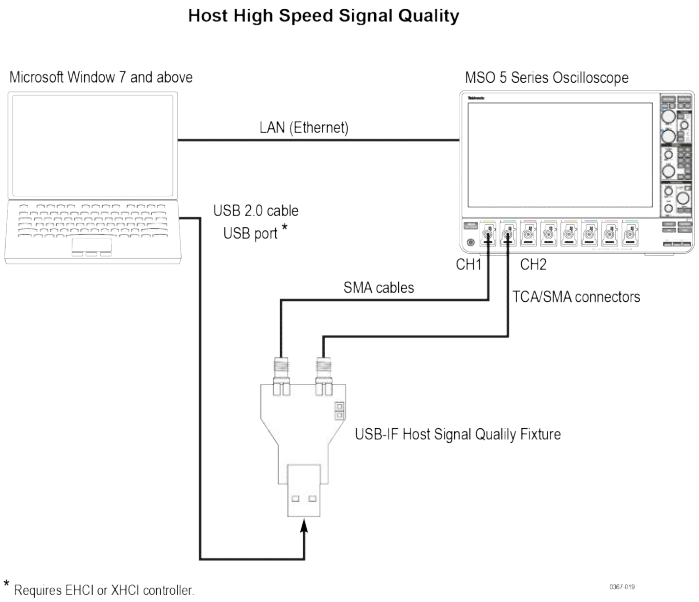
TekExpress USB2 supports Device, Host, and Hub test suites and each suite includes approximately 50 measurements. Executing all the measurements manually is extremely time-consuming. TekExpress USB2 software has an automation framework built around these measurements, so that you can execute all the measurements with fewer clicks and intervene only to change connections.

TekExpress USB2 software allows you to select complete or selective testing of any of the transmitter electrical specifications. Tests are configured by following a step-by-step process. The software sets up the oscilloscope and automates the testing, guiding you to accurate and repeatable results. It generates a comprehensive, date-stamped test report with pass/fail results, waveforms, and data plots.



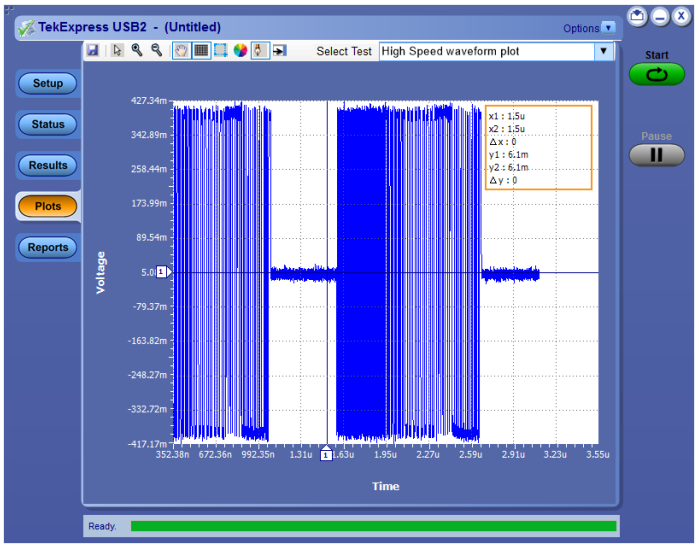
TekExpress USB2 DUT panel configures the DUT specific settings

Software navigation follows a logical workflow for quick test setups, changes and review of test results. Valid testing requires proper cabling, probes, and connections between fixtures, instruments, and the device under test (DUT). The software provides setup instructions for each test, with images and reference illustrations showing correct configurations.



Typical USB 2.0 setup configuration

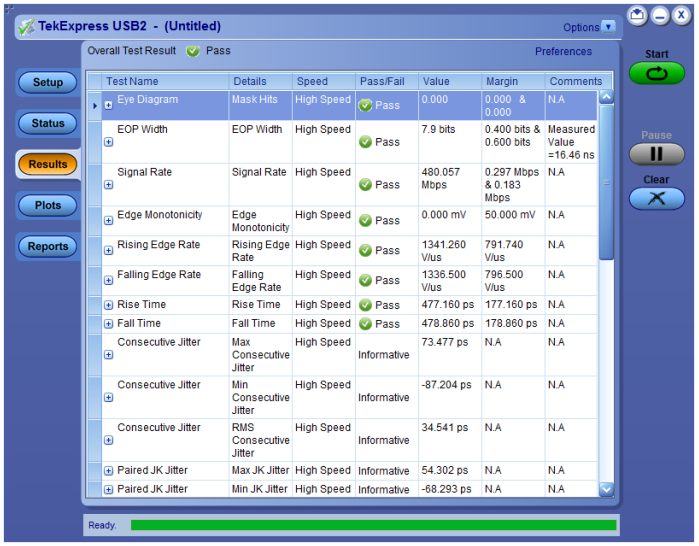
TekExpress USB2 software requires a Tektronix 5 Series MSO oscilloscope with Option 5-WIN or SUP5-WIN (Microsoft Windows 10). This is a Windows application and the software displays TekExpress USB2 software and test reports on the oscilloscope display. However, for convenience an external monitor may be connected to the 5 Series MSO so test controls and reports can be viewed on the external display, while signal acquisition is observed on the primary oscilloscope display.



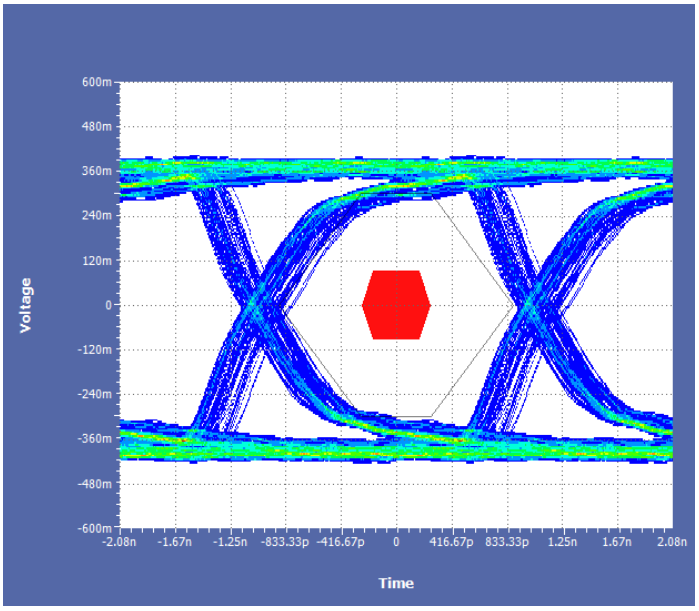
Displaying the high speed signal quality plot during execution

For each test, the DUT must be placed in specific operating modes using industry standard HS electrical test tool software (USBHSET.exe) from the USB Implementers Forum, Inc (USB-IF). The USBHSET tool runs on a Windows PC. The PC can be connected to the 5 Series MSO via LAN (Ethernet), allowing TekExpress USB2 to communicate with the USBHSET tool to automatically put the DUT in the correct mode for each test.

For each test or series of tests, you select the test of interest. The TekExpress software shows you how to configure the DUT with proper test fixtures, cables or probes. You initiate the test and the software performs all the necessary instrument setups and prompts you only when needed. Quick Pass/Fail tests substantiated with results makes USB 2.0 application the preferred solution for USB 2.0 physical-layer validation. The user-defined measurement limits and custom-mask testing also helps you to perform tolerance testing.



Jitter measurement results displayed in a table, along with limits and margin

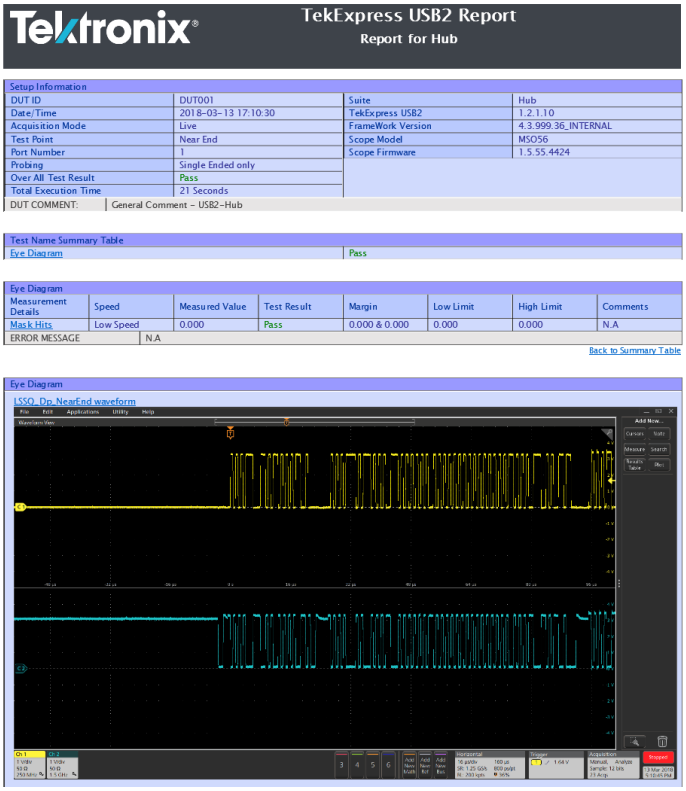


Custom Mask (red) with standard USB-IF mask (black) as reference

The TekExpress USB2 application has a dedicated Plots panel, which helps you to analyze eye diagrams and signal quality. The panel also allows you to place cursors, zoom into the plot and save the plot as an image. This allows you to perform eye diagram analysis with custom masks and evaluate device margins.

Pass/fail reports

Creating test documentation is quick and easy with summary reports available in MHTML, CSV, or PDF formats. The report is generated automatically when the test execution is complete and provides Pass/Fail status for measurements. The report also includes test configuration details, waveform plots, oscilloscope displays and margin analysis, to provide more insights into your design.


TekExpress USB2 Report
Report for Hub

Setup Information

DUT ID	DUT001	Suite	Hub
Date/Time	2018-03-13 17:10:30	TekExpress USB2	1.2.1.10
Acquisition Mode	Live	FrameWork Version	4.3.999.36_INTERNAL
Test Point	Near End	Scope Model	MSO56
Port Number	1	Scope Firmware	1.5.55.4424
Probing	Single Ended only		
Over All Test Result	Pass		
Total Execution Time	21 Seconds		
DUT COMMENT:	General Comment – USB2-Hub		

Test Name Summary Table

Eye Diagram	Pass

Eye Diagram

Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Mask Hits	Low Speed	0.000	Pass	0.000 & 0.000	0.000	0.000	N.A
ERROR MESSAGE	N.A						

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Eye Diagram

LSSQ_Dp_NearEnd waveform

TekExpress USB2 report showing setup details and measurement results

Probing and test fixtures

The following probes are recommended for USB 2.0 testing:

- Differential probes: P6248, P6330, TDP1500, and TDP3500
- Single-ended probes: P6245, TAP1500, and TAP2500
- Current probe for Inrush current test: TCP0030A

Fixtures provide connection points for USB 2.0 electrical testing.

The TDSUSBF test fixture set provides connections for Low-speed and Full-speed signal quality including both SMA and probe connections, Inrush Current, Drop and Droop, Receiver Sensitivity and Impedance Measurement tests. Probing points make it convenient for validation, but for pre-compliance testing, USBSIGQUAL must be used. TDSUSBF is available from Tektronix.

The High Speed Signal Quality fixture set (USB2SIGQUAL) provides SMA connections for performing eye diagram and other signal quality measurements. This fixture is used for compliance testing and is available from the USB-IF.

The USB 2.0 / 3.0 Drop-Droop fixture (USB2/3_DD) from USB-IF provides sufficient loads for testing voltage drop and droop levels while testing Host or Hubs (downstream ports supplying VBUS).

USB 2.0 test fixture set

Specifications

USB tests	Host, Hub, and Device
Signal Quality tests	Eye Diagram Test, Jitter (JK, KJ, and Consecutive), Crossover Voltage Range, Signal Rate, End-of-Packet Width, Rising Edge Rate, and Falling Edge Rate
High-speed tests	Receiver Sensitivity, Chirp, Reset, Resume, Reset from High Speed, Reset from Suspend, Packet Parameter, and Edge Monotonicity
Inrush Current check	Data-sufficiency readout. Coulombs and Capacitance listed across inrush regions
Droop test	Volts readout
Speed selection	Low-speed (LS), Full-speed (FS), and High-speed (HS)
Signal direction	Upstream and Downstream
Test Point selection	Near End and Far End
Report Generation format	MHTML, PDF, and CSV formats

Ordering information

Required hardware

Oscilloscope	5 Series MSO oscilloscope with minimum bandwidth of 350 MHz (option 5-BW-350, 5-BW-500, 5-BW-1000) for Low-speed and Full-speed USB
	5 Series MSO oscilloscope with minimum bandwidth of 2 GHz (option 5-BW-2000) for Low-speed, Full-speed, and High-speed USB
Supported instruments	MSO54, MSO56, MSO58
Option	5-WIN or SUP5-WIN (removable SSD with Microsoft Windows 10 operating system)

Required software

Application	Option	License Type
TekExpress USB 2.0 electrical testing software	5-CMUSB2	New instrument license
	SUP5-CMUSB2	Upgrade license
	SUP5-CMUSB2-FL	Floating license

Recommended options

Option	Application
5-DJA or SUP5-DJA	Advanced Jitter and Eye Analysis measurements
5-SRUSB2 or SUP5-SRUSB2	Automated Trigger and Decode for USB 2.0

Probing

Recommended

Probes	Quantity
TDP1500 or TDP3500 Differential probe	1
TAP1500 or TAP2500 Single-ended probe	3
TCP0030A Current probe	1

Supported

Probes	Quantity
P6248 or P6330	1
P6245	3

Signal sources

Recommended Tektronix AWG5000C signal source

Supported Tektronix AWG5000C, AWG7000C, AWG70000A signal source

Recommended test fixtures

Test Fixtures	Vendor
TDSUSBF USB 2.0 fixture set [1]	Tektronix
USB2SIGQUAL USB-IF High-speed Signal Quality test fixture set	Sold through USB-IF [2]
USB2/3_DD USB-IF Droop-Drop fixture	Sold through USB-IF [2]

Recommended cables SMA to SMA Cable Pair (174-5771-xx)

Recommended extras External PC monitor, USB keyboard, USB mouse

1 USB2SIGQUAL fixture requires one phase matched SMA cable (PMCABLE1M or 174-5771-00) and two sets of SMA receptacle to BNC plug adapters (015-0572-00).

2 Please visit www.usb.org/home for fixture details.

Additional information

Tektronix offers a range of solutions for USB testing, including HSIC (High Speed Inter Connect) and USB 3.0. To see a comprehensive listing, and download the latest resources, visit www.tek.com/usb.

For all probing related information, visit www.tek.com/probe-selector.

For exploring other supported application and capabilities of latest Tektronix 5 series MSO oscilloscope, visit www.tek.com/oscilloscope/5-series-mso-mixed-signal-oscilloscope.

For USB 2.0 standards documents and test procedures, as well as USBHSET software and test fixtures, please visit www.usb.org/home.

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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.tek.com.

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