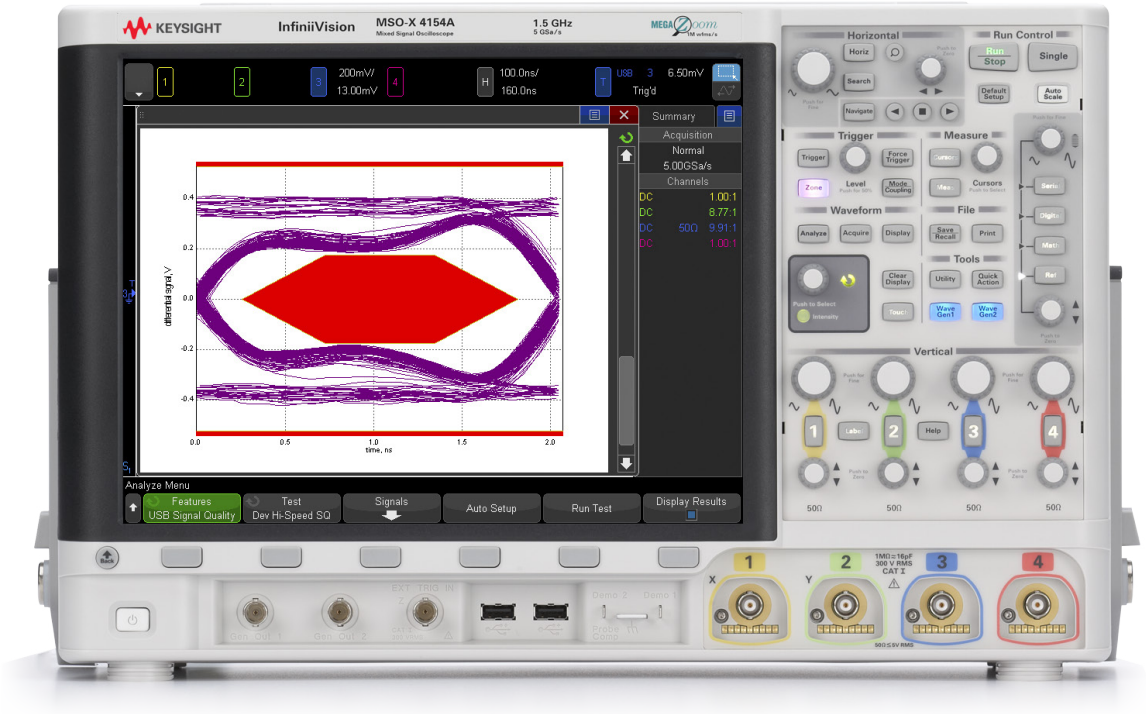
Keysight DSOX4USBSQ and DSOX6USBSQ

USB 2.0 Signal Quality Test Option for 4000 and 6000 X-Series

Data Sheet



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Unlocking Measurement Insights

Introduction

The low-speed, full-speed, and hi-speed USB 2.0 serial bus is used today for not only traditional computer/PC applications, but also for a broad range of embedded connectivity applications. For years, oscilloscopes have been the primary measurement tool used by electrical engineers to verify the signal integrity of their USB 2.0 serial bus designs. With the DSOX4USBSQ/DSOX6USBSQ signal quality test option licensed on a Keysight Technology, Inc. 4000 or 6000 X-Series oscilloscope, you can now quickly verify the analog quality of your signals generated by USB hubs, hosts, and devices based on USB-IF compliance standards.

Although USB-IF physical layer compliance testing and certification is not normally performed on embedded electronic products with USB 2.0 interfaces, for reliability purposes designers of embedded systems often need to test the physical layer of their designs based on USB-IF specified standards as a “reality check” to insure signal quality standards are met before releasing their products into production.

For USB 2.0-based products in the traditional computer/PC/peripheral industry where USB-IF physical layer testing and certification is normally performed, purchasing a complete suite of high-performance test equipment to perform full pre-compliance testing is often cost-prohibitive for smaller companies in this industry. But with Keysight’s USB 2.0 signal quality test option licensed on InfiniiVision 4000 or 6000 X-Series oscilloscopes, engineers now have a more affordable solution that can perform what many consider to be the most important series of USB 2.0 physical layer tests (signal quality) before running their final product through complete certification testing at a USB-IF designated workshop.

After running a USB 2.0 signal quality test, a complete test report with color-coded pass/fail measurement results are shown on the scope’s display with a scroll-bar to view all tests and screen images as shown in Figure 1. In addition, the complete test report can be saved as a HTML file for test documentation purposes. Figure 2 shows an example test report from a far-end, hi-speed device signal quality test. In this test, the device marginally failed the EOP bit-width test, but was granted a waiver.

Introduction (Continued)

Features

- Pass/fail test comparison standards based on low-speed, full-speed, hi-speed, far-end, near-end, host, and device specifications
- Real-time eye test
- Consecutive, paired JK, and paired KJ jitter
- Sync test
- Cross-over voltage (low- and full-speed only)
- EOP bit-width
- Signaling rate
- Edge monotonicity
- Rise/fall edge rate
- Edge rate match (low- and full-speed only)
- HTML pass/fail report generation

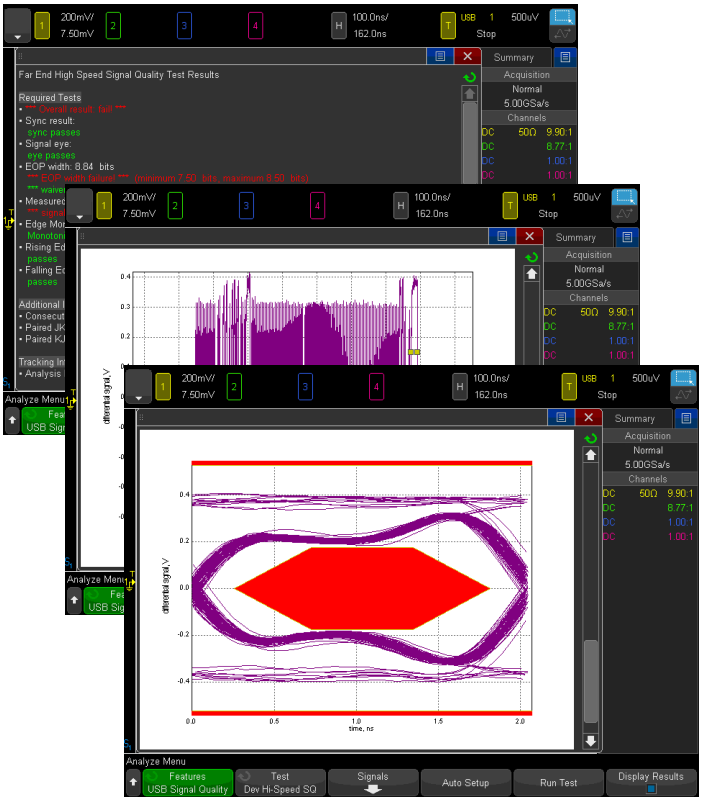

Figure 1. Scrollable on-screen signal quality test report.

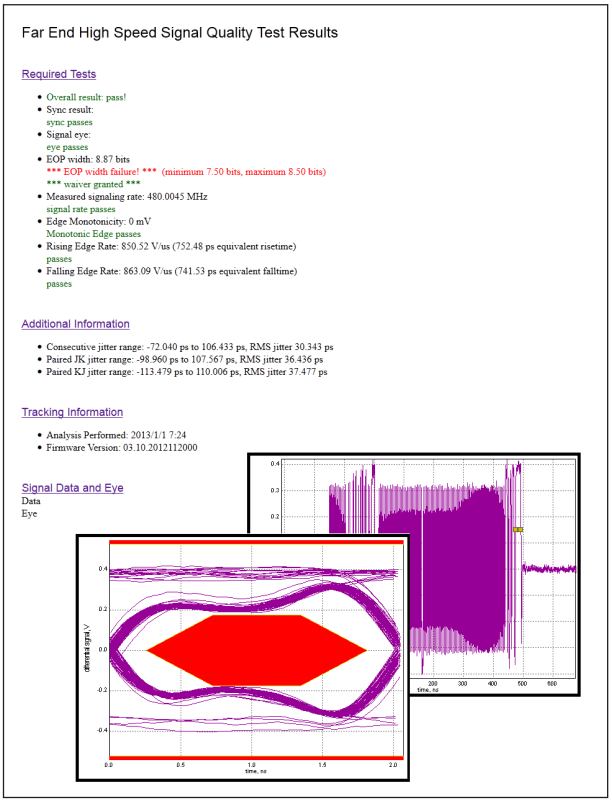

Figure 2. USB 2.0 signal quality test report in HTML format.

Probing the USB 2.0 Differential Bus

To test USB 2.0 low- and full-speed designs, the only probes required are two 10:1 passive probes, which are shipped as standard accessories with every Keysight InfiniiVision X-Series oscilloscope.

To test USB 2.0 hi-speed designs based on pre-compliance standards with the appropriate device or host test fixture, 50-Ω SMA cables with SMA-to-BNC adapters are all that is required. For this use-model of testing, the test fixture is programmed to generate a specific test pattern. However, during the design and debug phase of product development, engineers often need to test “live traffic” in their hi-speed designs (non-compliance testing). In this case, a test fixture is not required, but a differential active probe with sufficient bandwidth is required. For this use-model of testing, Keysight recommends an InfiniiMode N2750A Series differential active probe shown in Figure 3.

The N2750A Series probe is more than just a differential probe. With the press of the InfiniiMode button on the probe, you can quickly toggle between viewing the differential signal, high-side (D+) relative to ground, low-side (D-) relative to ground, or the common-mode signal. Although ultimately it is the quality of the differential signal that really matters, if signal integrity issues do exist on the differential bus, they can often be caused by issues such as system noise coupling into just one side of the bus (or perhaps improper PC board layout and termination related to just one side of the bus).

Figure 3. Keysight’s InfiniiMode N2750A Series differential active probe.

USB 2.0 Test Fixtures

For testing “live traffic” (non-compliance testing) using recommended probing, test fixtures are not required.

For testing low- and full-speed products based on USB-IF compliance standards (pre-compliance signal quality testing), Keysight recommends using the E2646B “SQuIDD” test fixture shown in Figure 4. This test fixture provides easy-access probing test points for Keysight’s N2800 Series 10:1 passive probes.

For testing a USB 2.0 hi-speed device based on USB-IF compliance standards (pre-compliance signal quality testing), Keysight recommends using the E2666B test fixture kit shown in Figure 5. Testing hi-speed devices using a programmed test pattern only requires that you connect the D+ and D- signals to the scope’s input channels using SMA cabling along with the appropriate SMA-to-BNC adapters.

For testing USB 2.0 hi-speed hosts based on USB-IF compliance standards (pre-compliance signal quality testing), Keysight recommends using the E2667B test fixture kit shown in Figure 6. Testing hi-speed hosts using a programmed test pattern only requires that you connect the D+ and D- signals to the scope’s input channels using SMA cabling along with the appropriate SMA-to-BNC adapters.

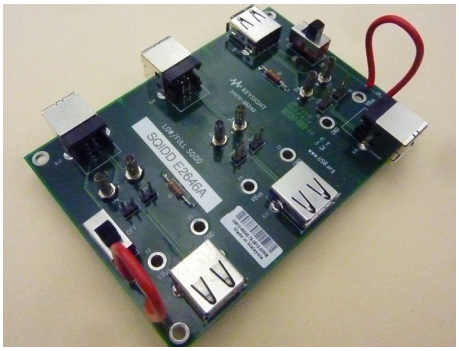

Figure 4. E2646B “SQuIDD” test fixture for testing USB 2.0 low- and full-speed products.

Figure 5. E2666B hi-speed device test fixture.

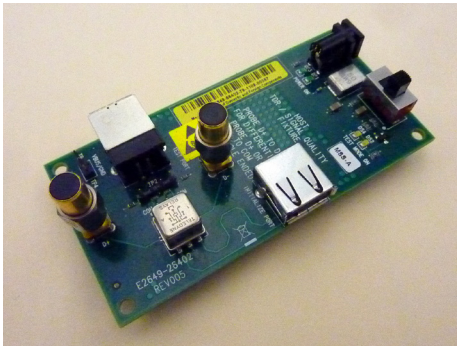

Figure 6. E2667B hi-speed host test fixture.

Related Products

If you need to perform complete USB 2.0 pre-compliance testing (beyond the series of signal quality tests provided by the DSOX4USBSQ option running on a Keysight InfiniiVision 4000 or 6000 X-Series oscilloscope), Keysight recommends a Windows-based Infiniium Series oscilloscope with the N5416A USB 2.0 compliance test software shown in Figure 7.

To learn more about USB 2.0 serial bus testing and to better understand the differences between the InfiniiVision X-Series Signal Quality Test option versus Infiniium’s USB 2.0 full compliance test option (N5416A), refer to the application note titled, “Physical Layer Testing of the USB 2.0 Serial Bus” listed at the end of this document.

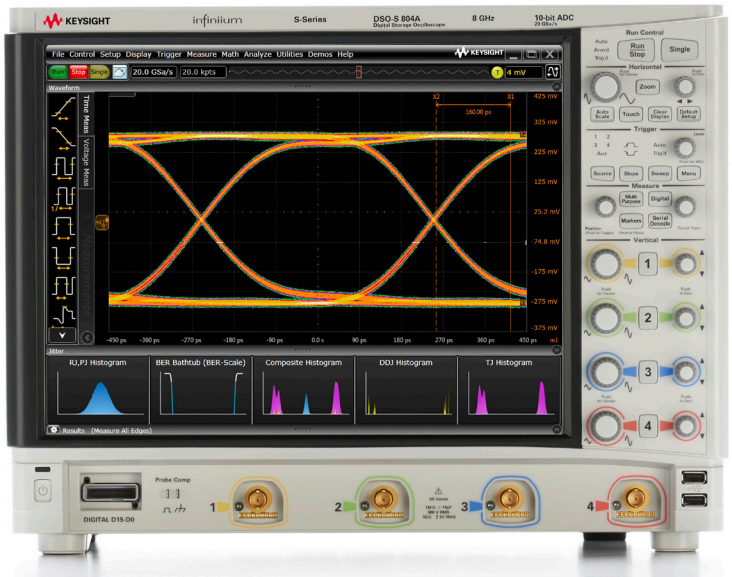

Figure 7.

Infiniium Series USB 2.0 Compliance Test Application Capabilities

The following table summarizes the features of Keysight's various USB test analysis options in InfiniiVision 6000 X-Series and Infiniium oscilloscopes:

Table 1. USB Testing coverage comparison

USB measurement	Signal integrity testing with InfiniiVision 4000/6000X with the USBSQ option	Complete USB-IF electrical compliance testing with Infiniium S-Series N5416A option
EL_2 EL_4 EL_5 Data Eye and Mask Test High speed SQ	√	√
Consecutive, paired JK, and paired KJ jitter	√	√
Full and Low speed signal quality	√	√
Sync test	√	√
Cross-over voltage (low- and full-speed only)	√	√
EOP bit-width	√	√
Signaling rate	√	√
EL_6 Device Rise and Fall Time	√[1]	√
Edge rate match (low- and full-speed only)	√	√
HTML pass/fail report generation	√	√
EL_7 Device Non-Monotonic Edge Test	√	√
EL_22 Interpacket Gap Tests		√
EL_28 Chirp-K Latency		√
EL_29 Device CHIRP-K Duration		√
EL_31 Host Hi-Speed Terminations Enable and D+ Disconnect Time		√
EL_38 EL_39 Device Suspend Timing Response		√
EL_40 Device Resume Timing Response		√
EL_27 Device CHIRP Response to Reset from Hi-Speed Operation		√
EL_28 Device CHIRP Response to Reset from Suspend		√
EL_8 Device J Test		√
EL_8 Device K Test		√
EL_9 Device SE0_NAK Test		√
Inrush Current Test		√
Drop/Droop Vbus tests		√
VBus Backdrive tests		√

1. To accurately measure USB 2.0 rise and fall times with less than 10% error for sub 500 ps edges the measurement BW must be at least 2.5 GHz as required for official USB-IF compliance testing.

Recommended Oscilloscope Configuration

The signal quality test option (DSOX4USBSQ or DSOX6USBSQ) is compatible with any InfiniiVision 4000 X-Series oscilloscope running on firmware version 3.10 or later, or 6000 X-Series oscilloscope. However, signal quality tests on hi-speed devices and hosts require an InfiniiVision 1.5-GHz or higher bandwidth model.

Although the USB 2.0 trigger and decode options are not required in order to run USB signal quality tests, if you plan to run these tests on "live traffic" (non-compliance testing), the USB trigger and decode options are recommended for isolating specific packets to test.

Even though one of the USB 2.0 signal quality tests is an eye-diagram mask test, the DSOX4MASK or DSOX6MASK mask test option is not required.

Ordering Information

Refer to the InfiniiVision 4000 and 6000 X-Series oscilloscope data sheets for ordering information about specific oscilloscope models and other licensed options.

Description	Model Number
USB 2.0 signal quality test option	DSOX4USBSQ or DSOX6USBSQ
USB 2.0 low- and full-speed trigger and decode option	DSOX4USBFL or DSOX6USBFL
USB 2.0 hi-speed trigger and decode option	DSOX4USBH or DSOX6USBH
1.5 GHz InfiniiMode differential active probe	N2750A
3.5 GHz InfiniiMode differential active probe	N2751A
USB 2.0 low- and full-speed test fixture (SQuIDD)	E2646B
USB 2.0 hi-speed device test fixture kit	E2666B
USB 2.0 hi-speed host test fixture kit	E2667B

Related Keysight Literature

Publication title	Publication number
Physical Layer Testing of the USB 2.0 Serial Bus – Application Note	5991-4167EN
Characterizing Hi-Speed USB 2.0 Serial Buses In Embedded Designs - Data Sheet	5991-1148EN
Serial Bus Options for InfiniiVision X-Series Oscilloscopes - Data Sheet	5990-6677EN
InfiniiVision 4000 X-Series Oscilloscopes - Data Sheet	5991-1103EN
InfiniiVision 6000 X-Series Oscilloscopes - Data Sheet	5991-4087EN
Using Oscilloscope Segmented Memory for Serial Bus Applications - Application Note	5990-5817EN
N2750A/51A/52A InfiniiMode Differential Active Probes – Data Sheet	5991-0560EN
Triggering on Infrequent Anomalies and Complex Signals using Zone Trigger - Application Note	5991-1107EN

Product web site

For the most up-to-date and complete application and product information, please visit our product web site at:
www.keysight.com/find/4000XSeries
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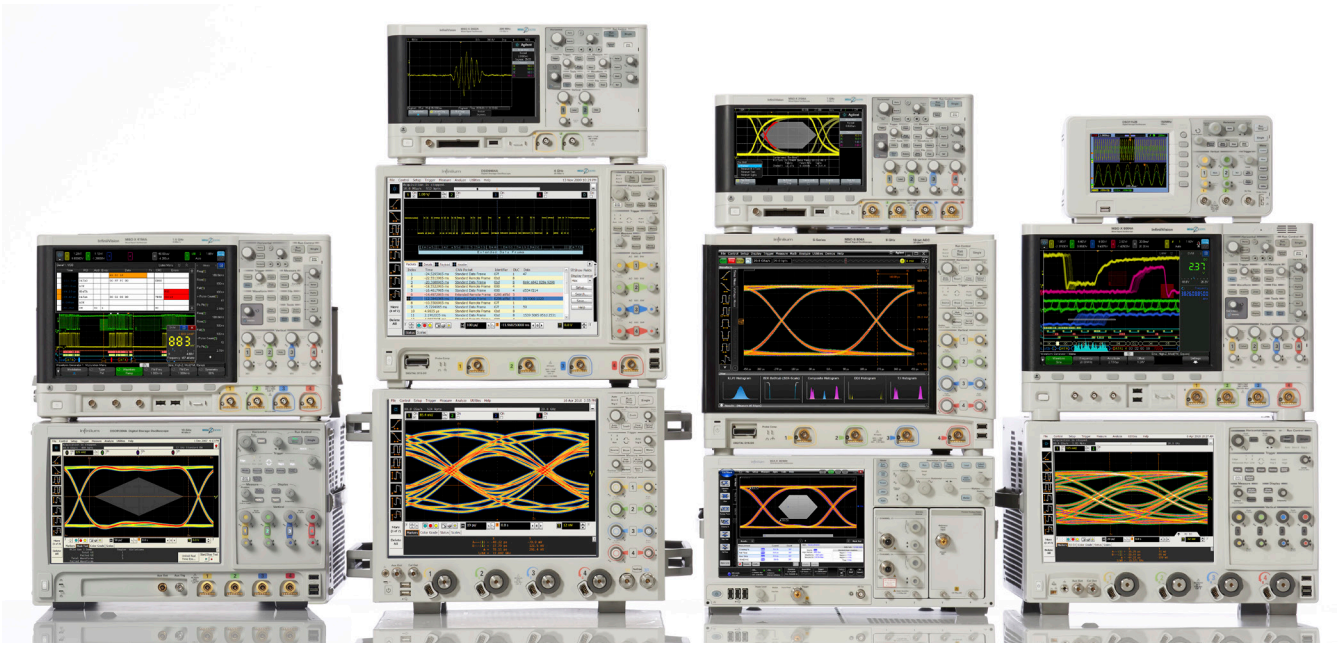

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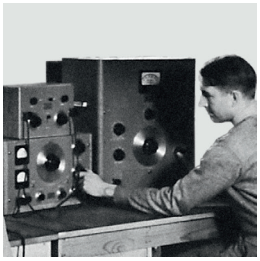

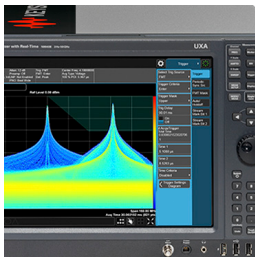

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