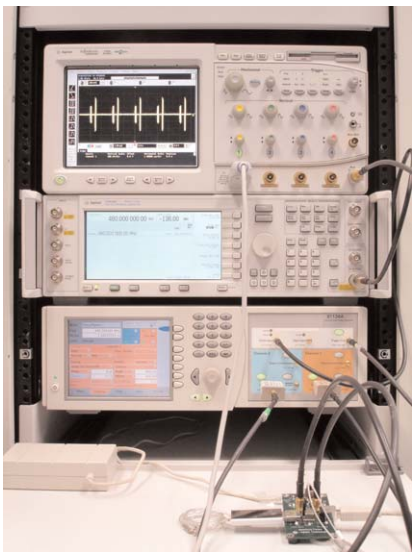
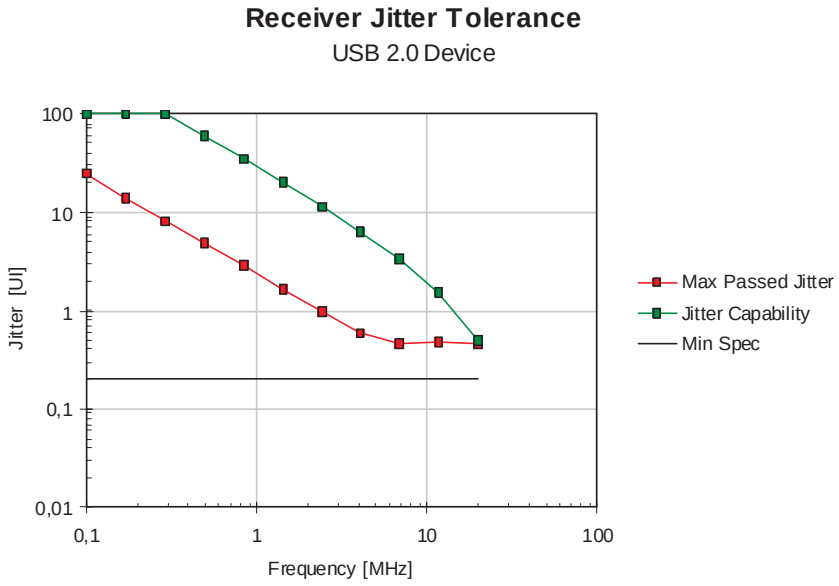


Automated USB 2.0 Receiver Compliance Test and Characterization with the Agilent N5990A Software Platform

Application Note



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Introduction

The universal serial bus (USB) is a well-established high-speed digital bus. Since its introduction in 1995, it has become very popular among equipment vendors and customers, for example in computer and consumer electronic products. Key benefits of USB are its hot-plug capability, ease-of-use and flexibility for example. For more information see [1].

To ensure interoperability, the products' design targets are defined by the USB specification on both the interface level and mechanism level. Compliance tests and device characterization are essential to verify that the design targets are met. The USB implementers forum (USB-IF, see [2]) has instituted a compliance program which provides reasonnable measures of acceptability.

Test equipment vendors provide ready-to-use compliance test suites which have been used for several years. See table 1 for an example.

So why still consider USB compliance tests today? Haven't all interfaces been qualified now? What surprises and issues can one expect from such a wide-spread technology standard?

In reality, issues with well-known interface technologies are still found today and some are very incovenient. Traditional designs are less often affected, however when working on more complex designs, such as advanced chip designs which combine established and emerging technologies, problems are more likely to exist. More than once, problems have been found in the apparently more simple part, the legacy interface.

To avoid these unexpected problems, full characterization and compliance tests are recommended for all interfaces available on a chip, device or in a system.

With the N5990A Test Automation Software Platform, a generic solution for automated high-speed bus compliance tests and characterization is now available. This product supports both traditional and emerging buses [4]. As the same user interface and the same design are used across all bus standards, productivity is significantly improved.

In this application note, USB 2.0 peripheral receiver and transmitter compliance tests and characterization are discussed.

Table 1: USB Compliance Tests

USB Test	Test Type	Report Output
Signal integrity	FSFE, LSFE, LSNE, HSFE, HSNE	Overall result, signal eye, EOP width measurement, signaling rate measurement Crossover voltage measurement, jitter measurement, signal data diagram, eye diagram
Inrush current	Hot Plug, Agilent Config, Agilent Resume, LP Config, LP Resume	Overall result, inrush current measurement, inrush current graph
Drop/droop	System, Self Powered Hub, Bus Powered Hub	Overall result, voltage no load measurement, voltage loaded measurement Drop measurement, droop measurement

(Source: see [3])

Automated Tests with N5990A

The general concept of the N5990A Test Automation Software Platform has been discussed in a previous application note [5]. To summarize, N5990A is a top-level software which combines ready-to-use transmitter and receiver tests. The transmitter tests typically run on oscilloscopes. The receiver tests are conducted with suitable stimulus hardware such as serial or parallel bit error ratio testers (BERTs) or pulse pattern generators.

For USB 2.0 transmitter tests, refer to [6]. USB 2.0 device receiver compliance tests and characterization are efficiently conducted with the N5990A option 102. The test setup comprises a dual-channel pulse pattern generator (Agilent 81134A), a signal generator (Agilent E44xx) used as the jitter source and an Agilent Infiniium oscilloscope with differential probe and accessories such as cables and test fixtures (see figure 1).

In the following, the receiver test procedure will be dicussed using a commercial USB 2.0 memory stick exemplarily as the DUT (device under test).

Agilent Technologies provides a range of USB test fixtures. For details see [7]. An example for a fixture used for receiver tests is shown in figure 2.

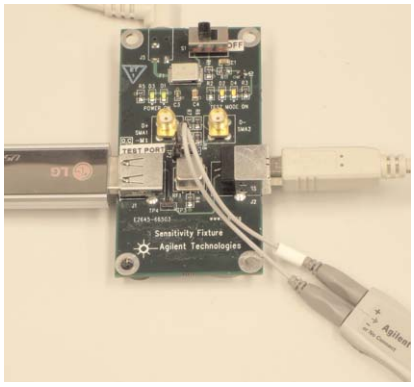

Figure 2: USB fixture with DUT and differential probe

In addition, transition time converters (TTCs) are needed to complete the test setup (see figure 3).

Figure 3: Transition time converters connected to the generator output.

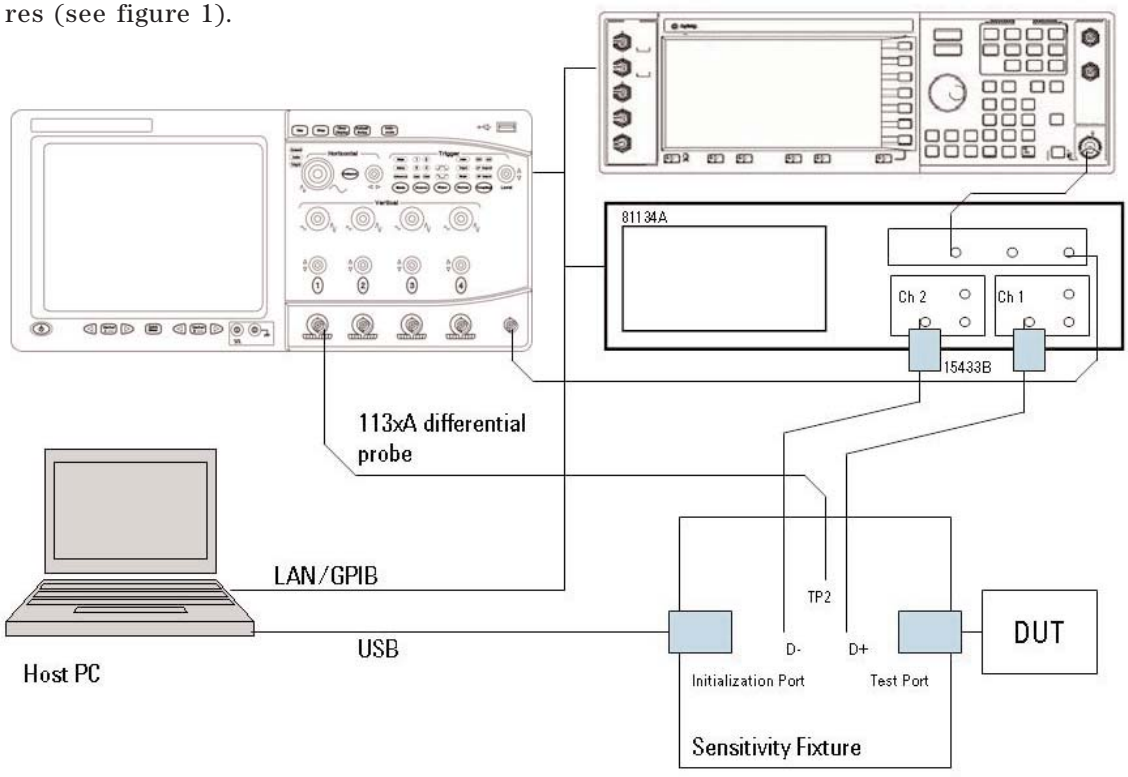

Figure 1 : USB peripheral receiver test setup

Next, the desired N5990A test station is selected and configured as shown in figure 4. In this example, the test automation software supports USB as well as PCI Express.

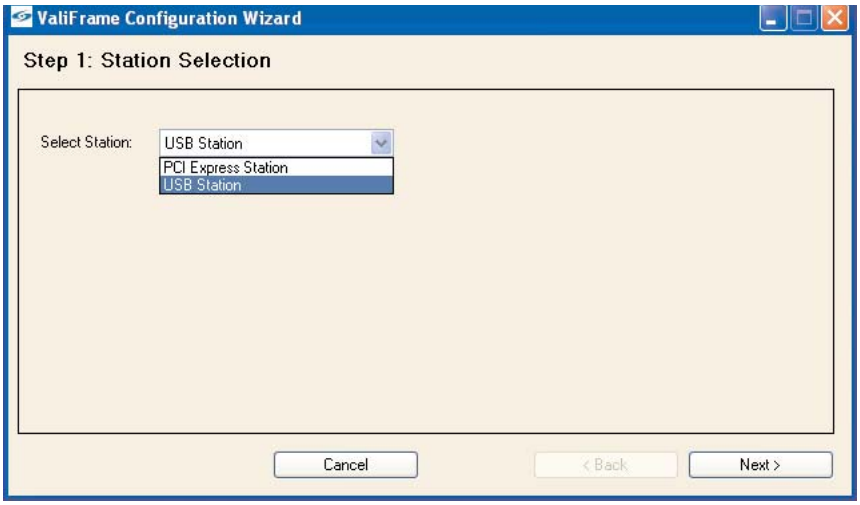

Figure 4: Test station selection

The common test automation software platform user interface allows operators to conduct USB receiver compliance tests. Advanced users have access to all relevant test parameters for tasks such as in-depth characterization in the N5990A expert mode. Figure 5 gives an example of the USB receiver intra-pair skew test. This particular test will produce a pass/fail test result.

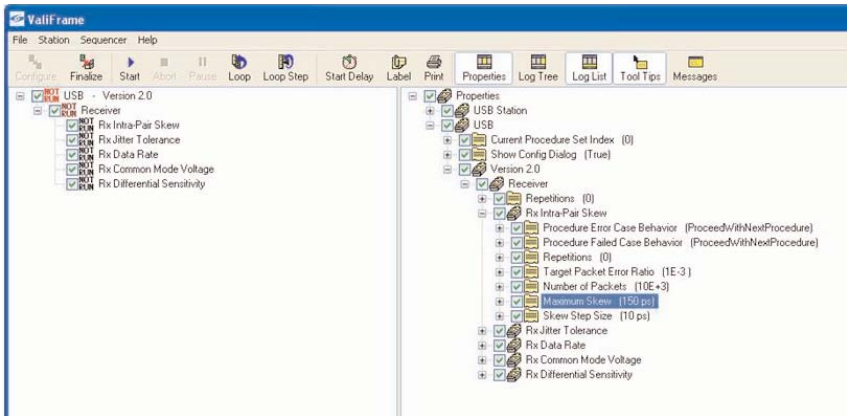

Figure 5: USB receiver intra-pair skew test in expert mode

In contrast, the receiver jitter tolerance test will produce a results graphic (see figure 6). In addition the N5990A Test Automation Software Platform always provides the adjacent data table in Excel format for convenient data handling and fast post-processing on a standard PC.

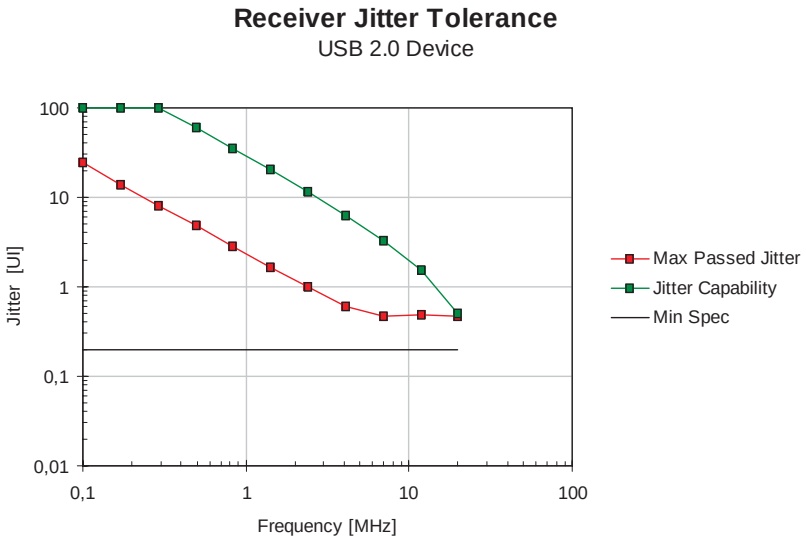

Figure 6: USB receiver jitter tolerance test

References

[1] Suemnicht, R., USB pre-compliance testing can be fast, reliable, and easy to do, PC/104 Embedded Solutions 2003 (http://www.smallformfactors.com/articles/suemnicht/)

[2] www.usb.org

[3] Application Note 1400, USB 2.0 Compliance Testing with Agilent Infiniium, Agilent Technologies pub-no. 5988-6219EN, November 2006

[4] N5990A Test Automation Software Platform Data Sheet, Agilent Technologies pub-no. 5989-5483EN, October 2006

[5] Automated PCI Express Receiver Compliance Test and Characterization with the Agilent N5990A Software Platform, Agilent Technologies pub-no. 5989-5500EN, August 2006

[6] PCI Express Transmitter Electrical Validation and Compliance Testing, Agilent Technologies Application Note 1496, 5989-1275EN, July 2004

[7] Infiniium USB Test Option N5416A Data Sheet, Agilent Technologies pub-no. 5989-4044EN, October 2006

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Related Literature	Pub. No.
Test Automation Software Platform N5990A Data Sheet	**5989-5483EN**
Agilent Automated PCI Express Receiver Test Application Note	**5989-5500EN**
HDMI Sink and Source Compliance Test and Characterization Data Sheet	**5989-4959EN**
81133A and 81134A, 3,35 GHz Pulse Pattern Generators Data Sheet	**5988-5549EN**
N5416A Infiniium USB Test Option Data Sheeet	**5989-4044EN**

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