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

Application Note

Receiver Jitter Tolerance
USB 2.0 Device

Jitter vs. Frequency

- Max Passed Jitter
- Jitter Capability
- Min Spec
**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 reasonable 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 inconvenient. 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.

**Table 1: USB Compliance Tests**

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

(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 discussed 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.

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

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.

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.
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/)
[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 Sheet
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