Keysight Technologies
Achieve High-Quality Compliance Test Results Using A Top-Quality Test Fixture

Application Note
Introduction

When you perform compliance testing, you require the test results to confirm that a device operates as it should -- without problems at every supported speed, with every supported controller type, under hubs, and on buses loaded with other devices. You are verifying that the device meets all test specification requirements. To achieve the best test results for a high-speed serial bus, you need a top-quality test fixture such as the Keysight N7015A high-speed Type-C test fixture with high signal integrity. You can maintain signal integrity by de-embedding the effects of the fixture.
The Importance of a Top-Quality Test Fixture

The test fixture you use for high-speed serial bus compliance testing provides an interface between a DUT (device under test) and measurement/analysis equipment such as an oscilloscope. It provides access to the transmitter or receiver measurement points required for compliance testing. It also enables you to verify compliance systems and components to the PHY test specification. The test fixture is a critical element for performing quality compliance testing because its characteristics (such as reliability and repeatability) often compromise the specification margins for passing the electrical signal quality tests. Figure 1 shows the Keysight N27015A test fixture between a DUT and an oscilloscope.
USB 3.1 Type-C Testing

The new USB 3.1 standard (enhanced SuperSpeed USB) defines up to 10 Gbps of data transfer rate, which is twice as fast as USB 3.0 or 20 times faster than USB 2.0. These enhanced data rates are creating a need for new consumer products such as Type-C test fixtures. The new Type-C connection can carry USB 3.1 Gen 2 signals, transmit DisplayPort signals at up to 4K resolution, and handle up to 100 W of electrical power, all at the same time. USB Type-C is gaining dominance among USB connectors, for good reasons. USB Type-C ports can support many different protocols using alternate modes, which allow you to use adapters that can output HDMI, VGA, DisplayPort, or other connection types from a single USB port.

Why Signal Integrity Matters

Higher data rates means test fixtures and cabling can cause more signal loss. To maintain high measurement accuracy, you can use de-embedding techniques in your high-speed compliance tests to remove the test fixture and cabling effects from measurements. Then you can see the actual performance of the DUT. To achieve the de-embedding, you characterize the fixture through the measurement of S-parameters. For even better signal representation, you can combine this technique with a test fixture that is already designed for minimal signal loss.

High insertion loss can compromise test margins and cause unwanted test failure. A high-quality test fixture such as the N7015A addresses the problem of insertion loss. Another issue is cable loss. All cables have losses that limit the performance of a test system. The amount of the cable loss depends on the quality of the cable and its loss specifications. The longer the cable is, the greater the signal loss. Therefore, you need a cable with the lowest possible signal loss and shortest possible length. Figure 2 shows how insertion loss can help you determine the quality of a test fixture.

Figure 2. Insertion loss can help you determine a test fixture's quality.
De-embedding the Effects of Test Fixtures

When you run a compliance test, the test signals from the DUT pass through devices such as cables or test fixtures before they are measured. As a result, you are actually measuring a combination of both the DUT signal and the effects added from the test fixture and cables used to access the DUT. By using de-embedding software such as Keysight’s InfiniiSim application you can isolate the DUT to measure its performance separately from the measure signal. Figure 3 shows an example where the eye diagram pattern of the PRBS signal is measured. The cable and two fixtures in the signal path are removed by de-embedding them. To de-embed the cable and fixtures, the S-parameters of each cable pair and fixture are measured and pre-installed in the InfiniiSim software. InfiniiSim then analyzes the measurement and simulation circuits and generates a correction transfer function. When the transfer function is applied to the measured waveform \( V_{\text{Meas}}(t) \), the desired simulated waveform \( V_{\text{Sim}}(t) \) appears on the oscilloscope’s display.

Figure 3. De-embedding software such as Keysight’s InfiniiSim lets you extract a DUT’s signal from a measured signal.
The next three figures illustrate the effects of a fixture on a signal, before and after de-embedding. Figure 4 shows an example of a 13.5 Gbps PRBS signal from a J-BERT directly into a 33 GHz Keysight V-Series Infiniium oscilloscope.

Figure 4. A 13.5 Gbps PRBS signal from a J-BERT directly into a 33 GHz Keysight Infiniium oscilloscope.

Figure 5 shows the signal measured through Keysight’s N7015A high-speed test fixture, which is inserted between the signal source (BERT) and the oscilloscope. Note the pronounced rise/fall time degradation and the closed eye.

Figure 5. Note the rise/fall time degradation and closed eye when the fixture and cable are inserted.
Figure 6 shows the signal measurement when using Keysight’s InfiniiSim de-embedding function, which corrects for the loss of both the test fixture and the 1 m coax cable. You can see that the signal is almost perfectly restored by de-embedding the effect of the fixture.

Figure 6. The signal is almost perfectly restored by de-embedding the effects of the fixture/cable.

Summary

High-quality compliance testing requires a top-quality test fixture. Because test fixture characteristics such as insertion loss can compromise the specification margins for passing electrical signal quality tests, you need a solution that maintains signal integrity both before and after de-embedding. Using Keysight’s N7015A high-speed Type C test fixture and InfiniiSim de-embedding software ensure you will get better margins and better measurements.
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