Comprehensive USB 3.1 Test Suite

Key Features

- Single vendor solution for the full range of USB 3.1 tests
- Fully automated Transmitter and Receiver testing
- **Transmitter Testing**
  - Support for Gen1 and Gen2 DUTs
  - Automated compliance pattern (CP) change with PeRT³
  - Seamless SigTest integration
- **Receiver Testing**
  - Automated Rx calibration
  - True protocol handshake support
  - Jitter Tolerance Testing
  - USB 3.1 Compliance Patterns
- **Protocol Testing**
  - Multi-function analyzer system with integrated USB 3.1 exerciser
  - Support for Type-C, USB 3.1, and Power Delivery 2.0 & 3.0
  - T.A.P.3™ probing for fast signal lock, seamless state change detection and accurate LFPS detection
- **Characterization and Debug**
  - Eye diagram and jitter analysis
  - Simultaneous multi-lane testing
  - Decode Link Layer traffic

Teledyne LeCroy is the only vendor which offers a full line of USB 3.1 test solutions for compliance, characterization, and debug. Transmitter and receiver tests are covered in one automated physical layer test package, QPHY-USB3.1-Tx-Rx, enabling streamlined testing. The M310P protocol analyzer can test the link layer for protocol compliance. Teledyne LeCroy provides the right solution for every stage of USB 3.1 development.

**Transmitter Testing**
QPHY-USB3-Tx-Rx offers a fully automated compliance test package for USB 3.1 transmitter compliance testing. Tests can be performed using the latest SigTest software for official compliance results. Alternatively, tests can be run using SDAIII to provide the ideal interface for debugging any USB 3.1 failures.

**Protocol Testing**
Supporting the Type-C, 3.1 and Power Delivery 2.0 & 3.0 specifications, the Voyager USB analyzer platform provides the industry’s most accurate capture of the USB protocol. This multifunction validation platform is available with an integrated exerciser providing host and device emulation.

**Characterization and Debug**
The SDAIII analysis package provides faster time to insight when performing characterization or isolating the root cause. The USB decoder annotates link layer information on the physical layer waveform, providing the ability to view protocol traffic on the oscilloscope and verify that the link is alive and transmitting properly.
Successful development of new USB 3.1 products requires a coordinated end-to-end test program to cover all aspects of the USB 3.1 design. For transmitter testing it is essential to verify eye diagrams, jitter, and other performance measurements. Receiver testing plays a vital role in ensuring reliable data transfer under stressed conditions. Finally, no design is complete without verifying the protocol layer to ensure functionality and compliance to USB 3.1 requirements.

The Right Solution for Every Stage of Development

Teledyne LeCroy is the only vendor which offers a complete line of USB 3.1 test solutions covering transmitter test to protocol test, and every step in between for comprehensive verification, debug, and compliance. All USB 3.1 testing can be accomplished with a single point of procurement and support.

Furthermore, these uniquely integrated test solutions combine test capabilities at multiple levels and merge the results for more accurate and meaningful information.

Experience and leadership in providing high-speed serial data test tools make Teledyne LeCroy the natural choice as a test partner for USB 3.1 development.

Teledyne LeCroy’s test tools cover the full range of test needs: industry-leading oscilloscopes for transmitter testing, protocol analyzers and exercisers to cover all USB speeds and Power Delivery, and unique products such as the Protocol-enabled Receiver and Transmitter Tolerance Tester (PeRT³).
Developed and promoted through the USB Implementers Forum (USB-IF), USB has been long established as the interconnect system of choice for peripheral systems.

USB 3.1 doubles the maximum data transfer rate from 5 Gb/s to 10 Gb/s, enables enhanced power capabilities (up to 100 W), and introduces the Type-C connector platform. Each of these new features require new design approaches, high quality manufacturing processes, and comprehensive testing and debug procedures to achieve reliable data transfer and interoperability.

The USB 3.1 Compliance Test Specification requires the use of reference channels and Continuous Time Linear Equalization (CTLE) and Decision Feedback Equalization (DFE) equalization schemes for compliance measurements. The Eye Doctor™ II analysis package has the ability to emulate the reference channel and the CTLE/DFE as specified. In addition to increasing the transfer rate, USB 3.1 implements a new 128b/132b encoding scheme. In order to effectively test and debug USB 3.1 receivers, the PeRT³ offers true SKP symbol injections and SKP filtering during BER testing, as well as 128b/132b pattern generation and detection.

The added Power Delivery functionality will provide widespread benefits for consumers; however, it greatly complicates protocol level design. The Voyager M310P includes full support for Type-C, USB 3.1, and the USB Power Delivery 2.0 & 3.0 specifications.

The Type-C connector allows for additional protocols (i.e., DisplayPort or HDMI) to be run over the same interface as USB 3.1 using alternate modes. The Alt Mode entry and exit sequence can be monitored and verified using an oscilloscope. The additional protocols can be tested for compliance using automated compliance packages, just like it would be done over the classical interconnect.

Challenges with Adopting USB 3.1
Automated Transmitter Testing
QPHY-USB3.1-Tx-Rx offers a fully automated test package for USB 3.1 transmitter compliance testing, characterization, and debug. It provides connection diagrams to ensure the proper setup for the required measurements, automates the oscilloscope for performing these measurements, and provides a comprehensive report of results including pass/fail results and screenshots.

Using the PeRT³ for Tx Testing
While other vendors require you to purchase a separate piece of equipment to request the DUT to output the required compliance pattern (CP), the PeRT³, which is used for Rx testing, can be used for this purpose, reducing the required investment and simplifying the setup.

QPHY-USB3.1-Tx-Rx can control the PeRT³ communication with the DUT on the protocol layer by sending a specific number of Ping.LFPS commands in order to stimulate it to output the required CP for each test. This enables fully automated transmitter compliance testing. Alternatively, the QPHY-USB3.1-Tx-Rx script can prompt the user to manually change the CP, which can be useful for DUTs early in the design stage which don’t yet have full protocol support implemented.

QualiPHY USB 3.1 Test Coverage

<table>
<thead>
<tr>
<th>Category</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Frequency Periodic Signaling (LFPS)</td>
<td>Eye Diagram</td>
</tr>
<tr>
<td>Spread Spectrum Test</td>
<td>AC and DC Common Mode Voltage</td>
</tr>
<tr>
<td>Jitter</td>
<td>Differential Voltage</td>
</tr>
<tr>
<td>Phase Jitter Slew Rate</td>
<td>De-emphasis</td>
</tr>
</tbody>
</table>
QualiPHY

QualiPHY is designed to reduce the time, effort, and specialized knowledge needed to perform compliance testing on high-speed serial buses.

- Guides the user through each test setup
- Performs each measurement in accordance with the relevant test procedure
- Compares each measured value with the applicable specification limits
- Fully documents all results
- QualiPHY helps the user perform testing the right way — every time

Compliance Reports contain all of the tested values, the specific test limits and screen captures. Compliance Reports can be created as HTML, PDF or XML.

Complete SigTest Support

SigTest is the official software provided by the USB-IF for compliance testing. By incorporating SigTest into QPHY-USB3.1-Tx-Rx, pre-compliance testing can be confidently performed prior to attending a USB-IF workshop. QPHY will automatically pass waveforms to SigTest and incorporate the results in the complete QualiPHY report.

QPHY-USB3.1-Tx-Rx extends beyond SigTest to provide a number of informative tests which aren't covered in SigTest. Tests which are covered in SigTest can also be run using Teledyne LeCroy's SDAIII software which easily lends itself to debugging any failures whereas SigTest is rather limited.

Advanced Debug Tools

The Eye Doctor II analysis software enables channel emulation and receiver equalization. For testing USB 3.1 at the far end of the channel, a design engineer has the option of using a physical channel or they can use channel emulation to see what their serial data signal would look like if it had been transmitted through the channel. It is possible to experiment with the multiple CTLE and DFE combinations from the USB 3.1 standard or to define a custom CTLE for debugging purposes.

Additionally, when using the SDAIII software to measure eye diagrams or perform jitter measurements, the specific PLL for USB 3.1 is selectable from a list of pre-configured PLLs or the user can chose to define a custom PLL.

Multi-Point Simultaneous Analysis

SDAIII-CompleteLinQ is capable of simultaneously analyzing multiple lanes. This enables either looking at the Host or Device transmitted signals at different stages of the transmission path or multiple transmit lanes on a Hub. Four "lanes" of analysis are available, allowing users to analyze data streams from different locations in their USB channel(s). For example, Lane 1 can show the Tx output, Lane 2 can show the signal at the far end of an emulated channel, Lane 3 can show the equalized far end signal, and Lane 4 the far end signal with a different CTLE/DFE equalization scheme. Plots are displayed using LaneScape Comparison Mode, a unique display capability that compares results from 1, 2 or all lanes at a time.
Key Features

- QPHY-USB3.1-Tx-Rx offers fully automated transmitter and receiver testing
- Automated receiver calibration process reduces complexity and saves time during testing
- True protocol handshake support in PeRT³ for loopback initialization and TSEQ training during receiver compliance testing
- Bit Error Rate tester with protocol aware capabilities
- Jitter Tolerance Testing for characterization
- All pass/fail results documented in QualiPHY report
- Built in 3 tap de-emphasis generator
- User defined test scripting functions for jitter tolerance, equalization optimization search, and multi-parameter sweep testing

Receiver Compliance Testing

The PeRT³ is designed to test receivers under conditions of stress by starting with a clean signal and gradually introducing measured levels of a variety of different stress types into the signal, and simultaneously monitoring the bit error rate (BER) to explore the full performance envelope of the receiver system.

The PeRT³ can be used in a stand alone mode or in conjunction with QPHY-USB3.1-Tx-Rx. QPHY-USB3.1-Tx-Rx is able to control the PeRT³ to automate the loopback initiation process. Once the device is in loopback, QPHY-USB3.1-Tx-Rx will perform the mandated test for receiver compliance.

Automated Rx Test Calibration

Receiver test specifications require calibration of the jitter output sources for the test instrument. When using the PeRT³ in conjunction with a Teledyne LeCroy oscilloscope, this calibration is done automatically by the QPHY-USB3.1-Tx-Rx application.

Following the calibration procedure, the transmitter of the PeRT³ can be routed through the compliance test channel to the oscilloscope. The QualiPHY framework will automate the calibration process adjusting the output of the PeRT³ depending upon what is measured on the oscilloscope. Performing this calibration process by hand would be extremely time consuming.

<table>
<thead>
<tr>
<th>QualiPHY USB 3.1 Test Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen1 - Long Channel Jitter Tolerance</td>
</tr>
<tr>
<td>Gen1 - Short Channel Jitter Tolerance</td>
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<tr>
<td>Gen1 - LFPS Rx Test</td>
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</tbody>
</table>
Protocol Aware
PeRT³ Phoenix System supports all the jitter and equalization generation required of USB 3.1, as well as the protocol level handshake that is critical to put the device under test into proper test modes and optimal equalization conditions. PeRT³ Phoenix System also offers true SKP symbol injections and SKP filtering during BER testing, as well as 128b/132b pattern generation and detection. It also adds support for the newly defined USB 3.1 compliance patterns.

Jitter Tolerance Testing
All signal source and jitter parameters can be swept during BER testing. For example, by sweeping the de-emphasis and pre-shoot values, the user can identify the optimized equalization window. Each connect sequence provides the user with a list of options to customize the test criteria and debugging conditions. Pass/Fail information is plotted against the stress parameters under test. See what happened for every test case—in real-time.

Ease of Use
With a single integrated system, the PeRT³ replaces up to 6–8 other instruments. PeRT³ greatly simplifies experimental setup, increases the ease of designing and conducting fully automated testing. It provides specific test suites to ensure receiver compliance to USB 3.1 specifications. The simple, intuitive interface for creating automated test scripts can, with a few clicks, set up automated tests that initialize the DUT and record error rates while sweeping through any user defined range of jitter parameters.
Key Features

- Most complete jitter decomposition, eye diagram and analysis tools
- Up to four simultaneous eye diagrams
- Up to 4-lane measurement and analysis capability
- Unique Reference Lane and LaneScape Comparison Mode
- Vertical noise measurements
- Crosstalk analysis
- Single CompleteLinQ dialog
- Integration of EyeDr and VirtualProbe functionality enables pre-emphasis and equalizer emulation, channel embedding, and fixture de-embedding

SDAIII Core Toolset

Teledyne LeCroy provides the most powerful toolset in the industry for jitter measurements and eye diagram/jitter analysis. Rj and Dj are separated and Dj is decomposed using one of three dual-dirac algorithms. Eye diagrams containing all acquired unit intervals are rendered 10-100x faster than competitive systems. Eye diagram analysis tools, such as the extrapolated IsoBER plot, aid insight. Multiple additional tools, such as jitter Tracks, Histograms, and Spectrum waveforms, speed root-cause diagnosis. Sophisticated pattern analysis tools like Intersymbol Interference (ISI) measurements and plots provide deep insight into Data Dependent Jitter (DDj) behavior.

SDAIII-CompleteLinQ

SDAIII-CompleteLinQ integrates class-leading additional capabilities into a single user-friendly interface.

Multi-lane measurements: See lane-to-lane differences in jitter measurements, eye diagrams, and jitter analysis on up to four lanes simultaneously.

EyeDoctorII: Easily configure basic de-embed/emulation scenarios, CTLE, DFE and FFE equalizers, and transmitter emphasis/de-emphasis.

VirtualProbe: Configure a multi-block model using S-parameters, and display the signal as it would appear before or after any block in the circuit.

Vertical Noise and Crosstalk: The Crosstalk and CrossLinQ packages provide vertical noise measurements and crosstalk analysis tools for complete aggressor/victim analysis.
USB 3.1 Gen1, 2.0, and 1.x decoding simplifies debug and turns the oscilloscope into a protocol analyzer.

**Key Features**
- Supports USB 3.1 Gen1, 2.0, and 1.x
- Recognizes scrambled or unscrambled data
- Intuitive, color-coded overlays
- Decode overlay adjusts as acquisition length is changed
- Interactive and customizable table
- Built-in search and navigate feature
- Trigger on USB primitives with 8b/10b trigger

**Oscilloscopes with USB Protocol Analysis**
Turn the oscilloscope into a protocol analyzer with the USB 3.0/3.1 Gen1 decode option for Teledyne LeCroy oscilloscopes. The USB decoder annotates link layer information on the physical layer waveform, providing the ability to view protocol traffic on the oscilloscope and verify that the link is alive and transmitting properly.

**Interactive Tabular Display**
Up to four different decoded signals of any type may be simultaneously displayed in a single time-interleaved table. Customize the table to show only the data of interest and touch a row in the table to automatically zoom to it and display it on the screen. The table can be exported as a .csv file for further offline analysis.

**Intuitive, Color-Coded Overlays**
A transparent overlay with color-coding for specific portions of the USB protocol and frame makes it easy to understand your serial data information. Unlike other solutions, with protocol decode information away from the signal, our solution correlates the waveform and the protocol decode directly on the display. As the acquisition length is expanded or shortened, the decode overlay will adjust to show you just the right amount of information.

**Pattern Search and Navigate**
All decoders provide ability to search through a long record of decoded data by using a variety of search criteria, or values, or simply finding the next occurrence. Pattern Search automatically creates a zoom trace of the acquired waveform and displays the selected location complete with the transparent color-coded overlay.
**Key Features**

- Captures 2.0, 3.0 and 3.1 protocol traffic concurrently.
- USB Power Delivery 2.0 & 3.0 support
- Interface with Type-C or standard connectors
- Integrated 3.1 Exerciser
- 16 GB Recording Memory
- Turnkey Protocol layer Compliance Test Suite
- Power Tracker Option provides graphical display of VBus measurements and protocol traffic simultaneously

**USB Protocol Verification**

The Voyager M310P is Teledyne LeCroy’s USB protocol verification system designed for the latest evolutions of universal serial bus, USB 3.1, Type-C and USB Power Delivery 2.0 & 3.0. Leveraging Teledyne LeCroy’s extensive expertise in high-speed serial data analysis, the Voyager M310P provides traffic generation and recording of USB 3.1, 3.0 and 2.0 at data rates up to 10 Gb/s. Utilizing the USB industry’s de facto CATC Trace and loaded with innovative features that help uncover elusive protocol errors, the Voyager platform is the intelligent choice for USB Type-C 3.1 validation.

**Flexible Hardware**

The Voyager M310P is a true multifunction platform capable of 10G USB 3.1, 3.0 and 2.0 protocol verification. It is available in 3.0 configurations and is upgradeable to 3.1. There is an integrated exerciser option supporting both host and device emulation that allows error injection functionality and compliance verification. The Voyager M310P platform has up to 16 GB of recording memory plus both GBe and SuperSpeed USB data upload ports for fast access to captured traffic.

**Unmatched Accuracy**

The Voyager M310P features custom probe technology known as T.A.P.3 (Transparent Acquisition Probing) which has been field proven in Teledyne LeCroy’s market-leading PCIe 3.0 and SAS 12G analyzers. Designed to non-intrusively record both 5 and 10 Gbps links, T.A.P.3 technology provides unprecedented accuracy and reliability without compromising link integrity.
USB Power Delivery 2.0 & 3.0
The M310P captures all "CC" events over the CC wire in the USB Type-C™ cables. In addition, power measurements of voltage, current and power on VBus are captured. Support for USB Power Delivery 2.0 & 3.0 is enhanced with the Voyager M310P Power Tracker™ option. Power Tracker provides a time based graphical display of VBus measurements and helps users correlate actual power usage with logical link state changes.

Automated Compliance Reports
The Compliance Suite provides “one-button” operation that manages the Voyager test system and runs the verification software. After each test case is run, the system displays a pass/fail result. If a test should fail, the system can automatically save trace files to help users identify root cause issues. Markers with a description of the error are automatically inserted on the packet in question. Reports can be generated in HTML, XML or text. Full source code is provided allowing individual scripts to be modified for custom verification tasks.

Verifying Power Management
USB 3.1 power management support is implemented at the link layer which adds new behaviors that must be thoroughly tested. The Voyager M310P records and timestamps all upstream and downstream power state changes. The Compliance Suite adds specific test cases that verify power management protocol including proper entry and exit.
## Product Description

### Transmitter Test

**SDA 816Zi-B Oscilloscope**

16 GHz, 80 GS/s, 128 Mpts/Ch Serial Data Analyzer with 15.3” WXGA Color Display, 50 Ω and 1 MΩ Input  

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Electrical and Receiver Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDA 816Zi-B</td>
<td>✓</td>
</tr>
</tbody>
</table>

- Eye Doctor Advanced Signal Integrity Tools  
- Qualiphy Enabled USB 3.1 Software Option  
- USB-IF USB 3.1 Electrical Test Fixture (Type-C or Standard-A/Micro-B) Orderable through the USB-IF eStore  
- USB 3.0 and USB 3.1 Test Fixture Set ("A" male, "A" female, "B" female)  
- Upgrade Bundle - Multi-Lane SDA LinQ Framework, including Eye, Jitter, Noise, Crosstalk Measurements, with EyeDrill & VirtualProbe  
- 32 GB RAM Upgrade (recommended with purchase of SDA8Zi-CompleteLinQ)

### Receiver Test

**PeRT³ Platform**

Phoenix PeRT³ System – 1 Channel  
10 Gb/s Options for PeRT³ Phoenix  
Phoenix Receiver Tolerance Test Suite  
Phoenix USB 3.0 Receiver Test Suite  
Phoenix USB 3.1 Receiver Test Suite  

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<thead>
<tr>
<th>Product Code</th>
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<tbody>
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<td>PER-R008-10G-A</td>
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<td>PER-R006-008-A</td>
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<tr>
<td>USB-R008-PLS-A</td>
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</tbody>
</table>

### Protocol Test

**Voyager Analyzer Systems**

- Voyager M310P USB 3.1 Analyzer Exerciser System  
- Voyager M310P USB 3.1 Analyzer System  
- Voyager M310P USB 2.0 PD Compliance Bundle  
- Voyager M310P USB Type-C Compliance Bundle  
- Voyager USB 3.0 Compliance Suite  
- Voyager M3i Power Tracker option  

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<tr>
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<td>USB-TZA2-V07-X</td>
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<tr>
<td>USB-TZC2-V07-X</td>
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<td>USB-AC05-V01-A</td>
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<td>USB-AC04-V01-A</td>
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</table>

- Indicates required for compliance testing.  
- Indicates recommended for debug.

### Accessories

<table>
<thead>
<tr>
<th>Product Code</th>
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<tr>
<td>Matched-SMA-Cables-12inch-Pair</td>
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<tr>
<td>Matched-SMA-Cables-18inch-Pair</td>
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