Tektronix provides the most comprehensive solution to serve the needs of engineers designing Thunderbolt 3 and Thunderbolt 4 Integrated (SoC) and Discrete products. Tektronix TekExpress Thunderbolt application provides one-button testing for the Thunderbolt 3 and Thunderbolt 4 measurements as per the USB4 Electrical Compliance Test Specification (Appendix E). TekExpress Thunderbolt automates the measurements allowing engineers to perform the required tests efficiently and reliably right on their bench. The DPO/MSO7000SX/DX Series (BW ≥21 GHz) oscilloscopes are designed to meet the challenges of the next generation of serial data standards such as Thunderbolt. These oscilloscopes provides the industry's leading vertical noise performance with the highest number of Effective bits (ENOB) and flattest frequency response among oscilloscopes in their class.

**Features and benefits**

- Signal Validation feature validates the compliance pattern to ensure the accuracy of the results.
- Pre-Recorded Mode supports the offline analysis and baseline for future specification changes.
- Automatic DUT Control mode captures all the compliance test patterns. So the USB4 Transmitter testing completes without user intervention.
- Automatic DUT Control supports both TBT3 and 4 Discrete and Integrated (SoC) products.
- Quickly validate test results with comprehensive reporting that details test margins, pass/fail results, and plots in PDF, MHT, and CSV formats.

**Applications**

- Thunderbolt 3 and Thunderbolt 4 Transmitter testing:
  - Thunderbolt Silicon Testing: Host, Device, and Hub
  - Thunderbolt Peripheral Testing: Host, Device, and Hub
  - Manufacturing testing

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**Figure 1: Thunderbolt physical-layer Tx compliance measurements**
DPOJET TBT3 plug-in debug solution

With its fast data rate and multi-lane topology, Thunderbolt presents a number of test and measurement challenges, including fixture effects and the need to isolate crosstalk. The coupling of energy from adjacent signaling lanes adds noise and jitter that can affect system interoperability. Effective debugging requires jitter analysis tools that can properly separate and classify the jitter components of a signal, including those stemming from crosstalk.

Before the measurements are computed the cable must be de-embedded. De-embed filters can be easily created using Serial Data Link Analysis software (SDLA) and then quickly entered into the DPOJET TBT3 measurement setup and saved for future use. In addition to jitter, DPOJET TBT3 also provides voltage, Spread Spectrum Clocking (SSC), and other AC parametric measurements.

TekExpress Thunderbolt automation solution

For compliance testing, TekExpress TBT automates the instrument setup as required by the Thunderbolt specification including an adequate time window for SSC analysis and Phase locked loop (PLL) settings for jitter/eye analysis. The port microcontroller enables automated device automation through test pattern initiation. TekExpress TBT allows the user to automate test modes while integrating the required scripts or step through the test modes with manual device control. A test status window indicates the current status of waveform acquisitions, signal analysis, and results documentation. The TekExpress TBT software can be run in Offline mode which allows the user to quickly recalculate test results using saved waveforms. A detailed test report provides color-coded pass/fail indications along with test margins. TekExpress TBT can be run in the user-defined mode to debug test failures with custom settings and test limits.
Ordering information

TekExpress TBT3 transmitter compliance and debug solution

DPO/MSO70000SX/DX
Tektronix DPO (Digital Phosphor Oscilloscope) or MSO (Mixed Signal Oscilloscope) - 23 GHz and above with DPOJET (DJA) and SDLA64 installed.

DPO/MSO70000SX/DX Opt. TBT3
TekExpress TBT3 Tx Compliance and DPOJET: TBT3 Tx/Rx Measurement Plugin Solution (Requires Opt. CIO, DJA, and SDLA64)

DPO-UP TBT3
TekExpress TBT3 Tx Compliance and DPOJET: TBT3 Tx/Rx Measurement Plugin Solution (Requires Opt. CIO, DJA, and SDLA)

DPOFL-TBT3
TekExpress TBT3 Tx Compliance and DPOJET: TBT3 Tx/Rx Measurement Plugin Solution (Requires Opt. CIO, DJA, and SDLA64); Floating

DPOFT-TBT3
TekExpress TBT3 Tx Compliance and DPOJET: TBT3 Tx/Rx Measurement Plugin Solution (Requires Opt. CIO, DJA, and SDLA64); Floating Trial

Recommended TBT3 controller, high-speed test fixture, and accessories

<table>
<thead>
<tr>
<th>Item</th>
<th>Vendor</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBT3 Controller and High-Speed Test Fixtures: 640-0961-000 OR 640-0535-000 and 640-0847-000</td>
<td>Wilder Technologies</td>
<td>1</td>
</tr>
<tr>
<td>SMP(F) to 2.92 mm(F) Adapter: SM8852</td>
<td>Fairview Microwave</td>
<td>Min 4</td>
</tr>
<tr>
<td>[Optional] SMP Terminators: ST2643</td>
<td>Fairview Microwave</td>
<td>4</td>
</tr>
<tr>
<td>PMCABLE1M Phase Matched SMA cable set</td>
<td>Tektronix</td>
<td>2</td>
</tr>
</tbody>
</table>

Oscilloscope and software prerequisite requirements

<table>
<thead>
<tr>
<th>Required software</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>DPO/MSO70000SX/DX with Microsoft Windows 10 OS</td>
</tr>
<tr>
<td>DUT Control Tool</td>
<td>If using the USB4-TPA-UC controller, then the USB4 Electrical Test Tool (ETT) v 0.9.7 (or above) should be available on the oscilloscope. The USB4ETT is available on the USB-IF Test Tools site (<a href="http://www.usb.org/document-library/usb4ett">www.usb.org/document-library/usb4ett</a>). If using the TBT-TPA-UHG2 controller, then Intel TenLira or TDT (Thunderbolt Diagnostic Tool) software with Thunderbolt Electrical Scripts should be available on the oscilloscope. Intel’s software can be downloaded from Intel’s Resource &amp; Design Center site.</td>
</tr>
<tr>
<td>Controller Driver and Software</td>
<td>Wilder Technologies Controller Driver and Software should be available on the oscilloscope. Contact Wilder Technologies for software support.</td>
</tr>
</tbody>
</table>

2. Requires Opt. CIO, DJA, and SDLA64, and ≥ 21 GHz oscilloscope. Thunderbolt 4 included in the opt. TBT3.
3. Select the Wilder USB4-TPA-UC-K kit if the Thunderbolt chipset/soc used in the product is Ice Lake, Goshen Ridge, Maple Ridge, or Tiger Lake.
4. Select the Wilder TBT-TPA-UHG2 controller and TBT-TPA-PR fixture if the Thunderbolt chipset used in the product is Titan Ridge or Alpine Ridge.