

Thunderbolt Test Adapter

User Manual



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Introduction

This user's guide documents the Thunderbolt Test Adapter (TB-TPA) and Calibration Module. The two test adapter types, shown in Figures 1 and 2, test Thunderbolt Interface (TB) cables and devices against the Thunderbolt PHY Compliance Test Specification. The Calibration Module, shown on Page 12, is used to zero-out test adapter attributes (using SOLT, with either the 1X-THRU or the 2X-THRU).

The TB-TPA-P and TB-TPA-R test adapter assemblies allow easy access, via SMA connections, to measure or inject Main Link signals. These test adapters also provide access to Hot Plug Detect, High Voltage Power, DP Power, low speed transmit and receive, Config 1 and 2, and Ground by way of a 10-position low-speed connector. Two of the pins are no connects for future use.

NOTE: To avoid damaging the cables, use the handling techniques described in the Care and Handling section before making any connections or configuring a test setup.

Always use a static-safe workstation when performing tests, as explained in the "Electrostatic Discharge Information" section.

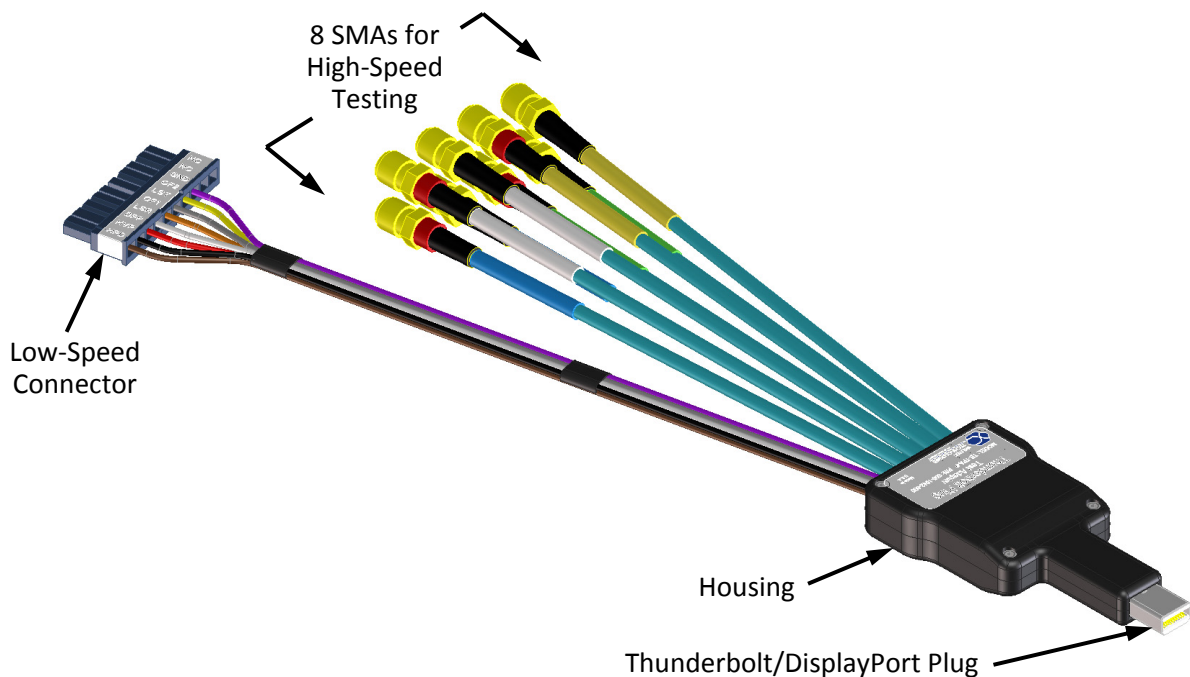


Figure 1. The Thunderbolt Test Adapter (Plug)

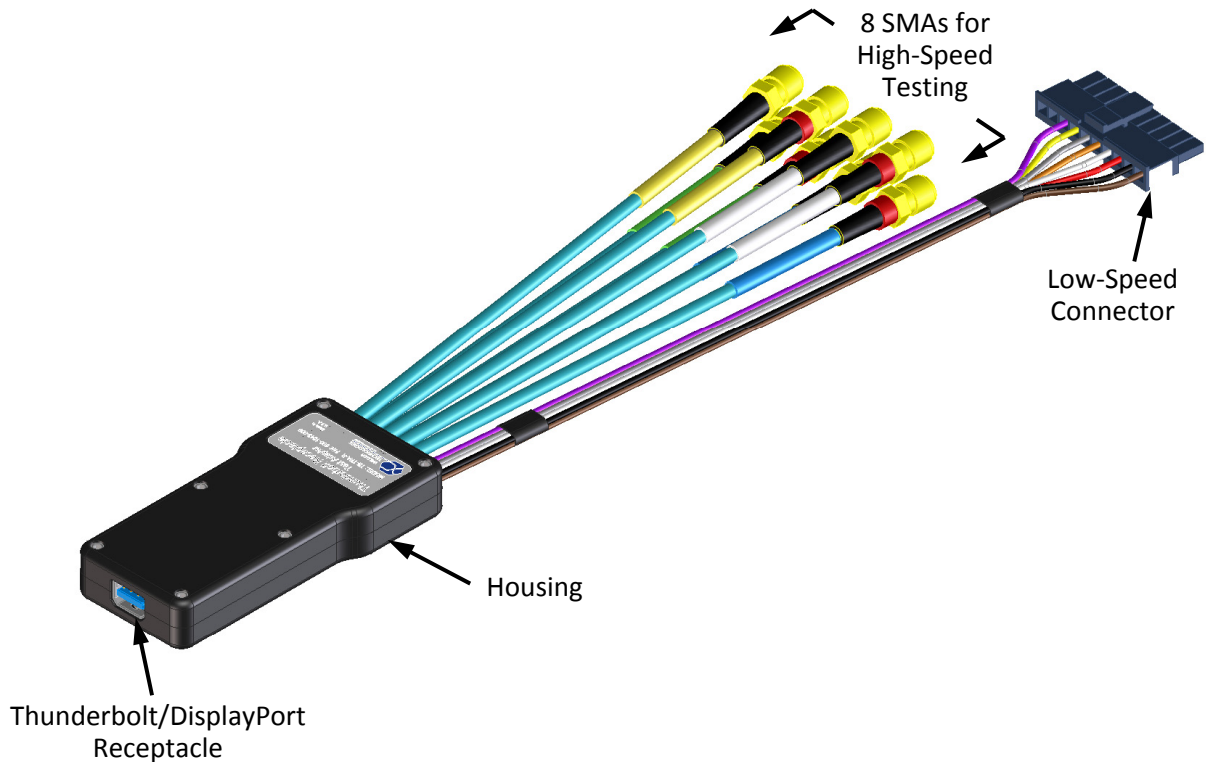


Figure 2. The Thunderbolt Test Adapter (Receptacle)

NOTE: The metal shell of both the plug (TB-TPA-P) and receptacle (TB-TPA-R) connectors are configured at the factory to tie high-speed ground to chassis ground.

The low-speed 10-position receptacle connector is keyed and latching (Molex part number 43645-1000). The mating plug connector housing and contact pins for 26-30awg wire are provided with each TB-TPA assembly (Molex part numbers 43640-1001 for the 10-position housing and 43031-0011 for the 26-30awg pin contact). Replacement plug parts can be purchased through Molex distributors.

NOTE: The receiver SMA connections for Thunderbolt are normally AC coupled. The Thunderbolt plug and receptacle TPAs do NOT have internal DC blocks. This allows for parametric testing through the TPAs. Normal testing may require DC blocks such as the Pico Pulse Labs 5500 series of DC blocks.

Product Inspection

Upon receiving the TB-TPA from Wilder Technologies, perform the following product inspection:

- Inspect the outer shipping container, foam-lined instrument case, and product for damage. Retain the outer cardboard shipping container until the contents of the shipment have been inspected for completeness and the product has been checked mechanically and electrically. Use the foam-lined instrument-case for secure storage of the Wilder Technologies Thunderbolt Test Adapter when not in use.
- Locate the shipping list and verify that all items ordered were received.
- In the unlikely event that the product is defective or incomplete, the “Limited Warranty” section discusses how to contact Wilder Technologies for technical assistance and/or how to package the product for return.

The Thunderbolt Test Adapter Care and Handling Precautions

The Thunderbolt Test Adapter requires careful handling to avoid damage. Improper handling techniques, or using too small a cable bend radius, can damage the coaxial cable connections within the adapter housing or the cables themselves. This can occur at any point along the cable. To achieve optimum performance and to prolong the TB-TPA's life, observe the following handling precautions:

- **CAUTION 1: Avoid Torque Forces (Twisting)**
While individual coaxial cables within the test adapter have some rotational freedom, twisting the TB-TPA as a unit, with one end held stationary, in excess of +/- 90° may damage or severely degrade performance. Adherence to Caution 5 (below) helps to avoid exceeding twist limits.
- **CAUTION 2: Avoid Sharp Cable Bends**
Never bend coaxial cables into a radius of 26 mm (1 -inch) or less. Never bend cables greater than 90°. Single or multiple cable bends must be kept within this limit. Bending the TB-TPA cables less than a 26mm (1-Inch) radius will permanently damage or severely degrade test adapter performance.
- **CAUTION 3: Avoid Cable Tension (Pull Forces)**
Never apply tension (pull forces) to an individual coaxial cable that is greater than 2.3 kg (5 lbs.). To avoid applying tension, always place accessories and equipment on a surface that allows adjustment to eliminate tension on the TB-TPA and cables. Use adjustable elevation stands or apparatus to accurately place and support the TB-TPA.
- **CAUTION 4: Connect the TB-TPA First**
To prevent twisting, bending, or applying tension to the coaxial cables when connecting a TB-TPA, always attach the TB-TPA to the device under test (DUT) or cable under test before attaching any SMA connectors. Carefully align the Thunderbolt connectors and then gently push the connectors together until fully seated.

If the TB-TPA must be turned or twisted to make connection to the DUT, avoid using the TB-TPA housing alone to make this occur. Try to distribute the torque forces along the length of the test setup and cabling. If this is not possible, it is recommended to first loosen or disconnect the SMA connections at the TB-TPA, make the connection to the DUT and then re-tighten or attach the test equipment leads.

NOTE: Only grip the test adapter housing when inserting or extracting the TB-TPA to or from the DUT. Pulling directly on the TB-TPA cables or using them to insert the TB-TPA may cause damage.

- **CAUTION 5: Carefully Make SMA Connections**
To connect the TB-TPA SMA connectors, follow these steps:
 1. Hold the cable stationary by grasping the cable at the black heat-shrink section near the SMA connector.

2. Insert the mating SMA barrel and hand-tighten the free-spinning SMA nut onto the connector while avoiding pulling, bending, or twisting the TB-TPA coaxial cable.
3. The TB-TPA SMA connectors have flats that accept an open-end 1/4-inch or 6.5mm wrench. When attaching instrument cables to the TB-TPA, it is recommended that the TB-TPA SMA connectors be mechanically held and the test leads be tightened to the equipment manufacturer's torque recommendations, normally 5 in-lbs, using a 5/16-inch open-end wrench.

If the test set-up requires repositioning, first loosen or disconnect the SMA connections to avoid twisting, bending, or tension.

NOTE: A drop in signal amplitude by half or 6db during the testing of a lane may indicate that a cable has been mechanically pulled free of coaxial cable connections internal to the assembly. This could be determined by checking if the cable has any lateral play relative to the TPA. This would only occur when the TPA has exceeded the pull force as specified within the mechanical specification. If the cable cannot be re-seated, the test adapter will need to be sent back to the factory for service.

- **CAUTION 6: Independently Support Instrument Cables or Accessories**
Excessive weight from instrument cables and/or accessories connected to the TB-TPA can cause damage or affect the test adapter performance. Be sure to provide appropriate means to support and stabilize all test set-up components.

General Test Adapter, Cable, and Connector

Observing simple precautions can ensure accurate and reliable measurements.

Handling and storage

Before each use of the TB-TPA, ensure that all connectors are clean. Handle all cables carefully and store the TB-TPA in the foam-lined instrument case when not in use, if possible. Do not set connectors contact end down. Install the SMA protective end caps when the TB-TPA is not in use.

Visual inspection

Be sure to inspect all cables carefully before making a connection. Inspect all cables for metal particles, scratches, deformed threads, dents, or bent, broken, or misaligned center conductors. Do not use damaged cables.

Cleaning

If necessary, clean the connectors using low-pressure (less than 60 PSI) compressed air or nitrogen with an effective oil-vapor filter and condensation trap. Clean the cable threads, if necessary, using a lint-free swab or cleaning cloth moistened with isopropyl alcohol. Always completely dry a connector before use. Do not use abrasives to clean the connectors. Re-inspect connectors, making sure no particles or residue remains.

Making Connections

Before making any connections, review the “Care and Handling Precautions” section. Follow these guidelines when making connections:

- Align cables carefully
- Make preliminary connection lightly
- To tighten, turn connector nut only
- Do not apply bending force to cable
- Do not over-tighten preliminary connections
- Do not twist or screw-in cables
- Use a torque wrench, and do not tighten past the “break” point of the torque wrench

Electrostatic Discharge Information

Protection against electrostatic discharge (ESD) is essential while connecting, inspecting, or cleaning the TB-TPA test adapter and connectors attached to a static-sensitive circuit (such as those found in test sets).

Electrostatic discharge can damage or destroy electronic components. Be sure to perform all work on electronic assemblies at a static-safe work station, using two types of ESD protection:

- Conductive table-mat and wrist-strap combination
- Conductive floor-mat and heel-strap combination

When used together, both of these types provide a significant level of ESD protection. Used alone, the table-mat and wrist-strap combination provide adequate ESD protection. To ensure user safety, the static-safe accessories must provide at least 1 M Ω of isolation from ground. Acceptable ESD accessories may be purchased from a local supplier.

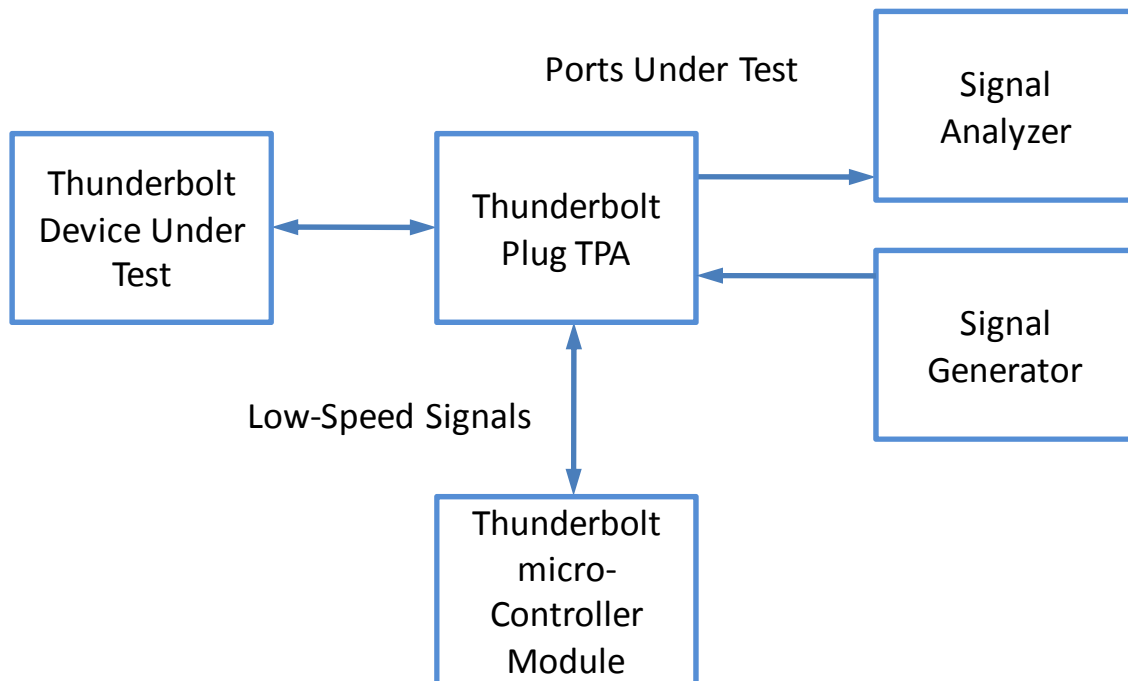
WARNING: These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.

User Model

The Thunderbolt TPA supports all testing of the Thunderbolt CTS PHY. It is capable of performing well beyond the scope of measurements contained in the CTS PHY, limited only by the specifications, environmental, care and handling as stated in this document.

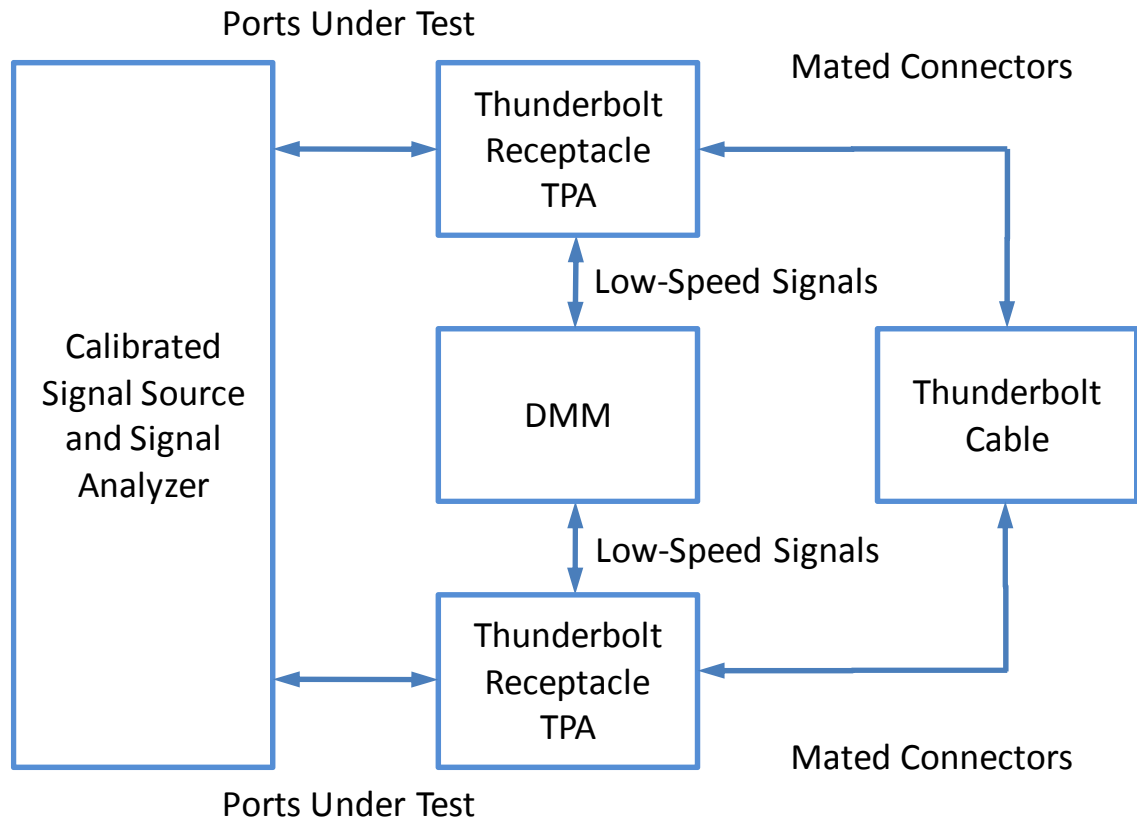
The following examples are suggestions for possible testing setups.

In this first example, a Thunderbolt plug TPA is connected to a Thunderbolt device:



NOTE: The receiver SMA connections for Thunderbolt are normally AC coupled. The Thunderbolt plug and receptacle TPAs do NOT have internal DC blocks. This allows for parametric testing through the TPAs. Normal testing may require DC blocks such as the Pico Pulse Labs 5500 series of DC blocks.

The second example shows two Thunderbolt receptacle TPAs testing a Thunderbolt cable:



Testing of DisplayPort functionality of a Thunderbolt Cable will require the use of two mDP-TPA receptacles.

NOTE: The receiver SMA connections for Thunderbolt are normally AC coupled. The Thunderbolt plug and receptacle TPAs do NOT have internal DC blocks. This allows for parametric testing through the TPAs. Normal testing may require DC blocks such as the Pico Pulse Labs 5500 series of DC blocks.

The Thunderbolt Plug and receptacle Test Adapters are passive components. Therefore

SOLT

SHORT, OPEN, LOAD, and 2X-THRU (SOLT) are calibration standards used to compensate for errors associated with the TPA when used for Jitter measurement, TDR, TDT, and VNA testing. SOLT represents the same electrical length and losses as the TPA through the Thunderbolt connector pad, and enables the test engineer to compensate for the following six repeatable, systematic errors that occur when moving the reference plane:

- Signal leakage effects: *Directivity errors*
- Signal leakage effects: *Crosstalk errors*
- Reflection effects: *Source Impedance Mismatching errors*
- Reflection effects: *Load Impedance Mismatching errors*
- Bandwidth effects: *Receiver Transmission in Test Equipment errors*
- Bandwidth effects: *Receiver Reflection-tracking in Test Equipment errors*

These errors need to be corrected on each port. Refer to the Instrument Manual for instructions on the instrument's specific calibration process.

NOTE: The reference plane is the boundary, both physically and electrically, between the calibrated and uncalibrated portions of the circuit. Everything outside the reference plane is considered part of the DUT. Any instrument that does not use calibration defines the DUT as the total of externally connected components. If the TB-TPA-C is not used, the entire Thunderbolt TPA and the 6-inch cables, as well as cables connecting the 6-inch cables to the test instrument, would be a part of the DUT.

Non-repeatable errors, such as drift or random errors can be reduced but not corrected. Drift errors aggregate over time or with environmental changes such as temperature shift. To eliminate drift errors, perform another calibration.

A random error cannot be corrected through calibration since the error occurred randomly. Random errors are typically associated with either test instrument noise or test repeatability problems. Reduce test instrument noise by increasing source power, lowering the IF bandwidth, or averaging results over multiple sweeps. Reduce test repeatability problems through the use of a torque wrench or, again, by averaging over multiple sweeps.

1X-THRU

The 1X-THRU is a calibration feature used to calibrate time domain instrumentation (for example, pre-emphasized pulse generators or AWGs, arbitrary waveform generators). 1X-THRU calibration compensates two error sources – cable losses and group delay:

- **Cable Losses** – Cable losses associated with the Thunderbolt plug TPA, and its respective cabling that's connected to the test source, consist of skin loss and, to a lesser extent, dielectric loss. Pre-emphasis or de-emphasis is used at the signal source to correct for these cable losses. Pre-emphasis is a boost of the signal level just after an edge transition; de-emphasis is a reduction in the low-speed amplitude of the signal source. Typically, on a de-emphasized signal the levels have to be reset to attain the same output levels. Resultant signals from either pre-emphasis or de-emphasis are identical relative to the DUT.

For the purposes of this discussion, pre-emphasis will be used. To set the pre-emphasis, first determine the amount of signal boost by connecting the signal source, via the 1X-THRU and the respective cable used to connect the DUT to the source to a high-speed oscilloscope or a jitter measurement device. Trigger the oscilloscope or jitter measurement device using a trigger from the source. The trigger, a single event, indicates the start of the signal being sent to the DUT. Adjust pre-emphasis to maximize the eye opening.

- **Group Delay** – Group delay is the second error source for 1X-THRU calibration. When the DUT generates an output signal, it can be used to measure delay. To create a baseline delay measurement, connect the output signal cable to the input signal cable and the 1X-THRU. To determine corrected DUT delay, subtract this baseline measurement from the DUT delay measurements.

Mechanical and Environmental Specifications

NOTE: All specifications in this manual are subject to change.

Table 1. General Specifications

ITEM	DESCRIPTION
Usage Environment	Controlled indoor environment
Test Adapter Length (w/standard cables)	235.1 mm +/- 2 mm (9.26 inches +/- .08 inches) (Characteristic)
Operating Temperature	0°C to +55°C (32°F to +131°F) (Characteristic)
Storage Temperature	-40°C to +70°C (-40°F to +158°F) (Characteristic)

TB-TPA Cable Pinout

The TB-TPA cables provide eight SMA connectors (dual-Port signals) and one low-speed connector. Labels clearly mark each cable or connector. The following figure refers to pin-description tables for each of the two connector types.

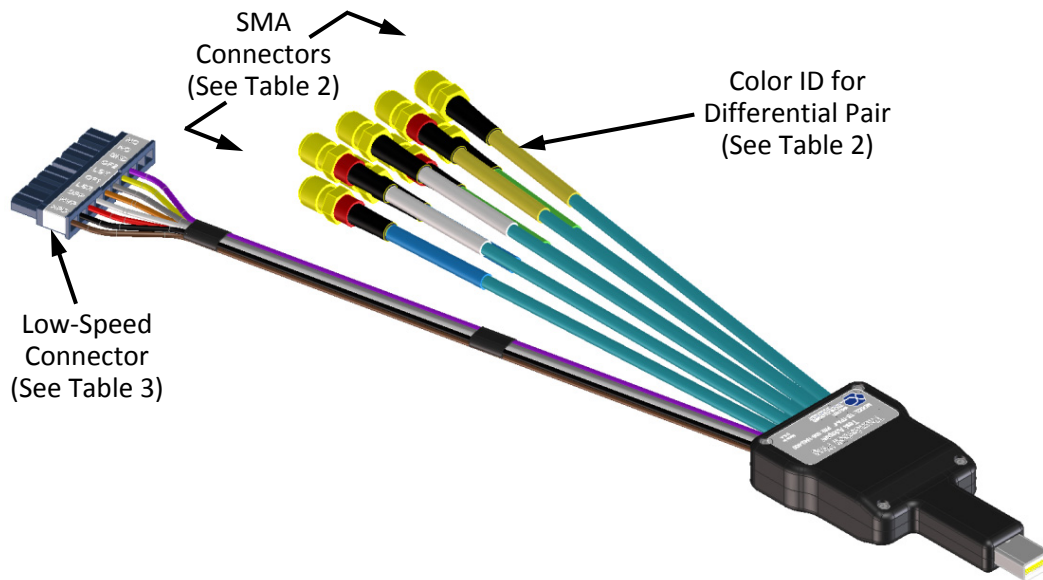


Figure 4. Cable Connectors (TB-TPA-P shown)
























Table 2. SMA Cable Connectors (High-Speed)

LABEL	COLOR ID FOR DIFFERENTIAL PAIR	DESCRIPTION
Tx0_P	White	Differential Transmit Data 0+
Tx0_N	White	Differential Transmit Data 0-
Rx0_P	Blue	Differential Receive Data 0+
Rx0_N	Blue	Differential Receive Data 0-
Tx1_P	Yellow	Differential Transmit Data 1+
Tx1_N	Yellow	Differential Transmit Data 1-
Rx1_P	Green	Differential Receive Data 1+
Rx1_N	Green	Differential Receive Data 1-

Table 3. TB-TPA 10-position Cable Connector “P2” (Low-Speed)

LABEL	PIN NO.	COLOR ID FOR TPA	DESCRIPTION
HPD	Pin 1	Brown	Hot Plug Detect
HVP	Pin 2	Black	High Voltage Power
DPP	Pin 3	Red	DisplayPort Power
LST	Pin 4	White	Low-speed Transmit
CF1	Pin 5	Orange	Configure 1
LSR	Pin 6	Gray	Low-speed Receive
CF2	Pin 7	Yellow	Configure 2
GND	Pin 8	Violet	Ground
NC	Pin 9		No Connect
NC	Pin 10		No Connect

Table 4. Thunderbolt Plug and Receptacle Pin Assignments

Pin Description	Connector Pin Number	Destination Number (Source/Sink)	Color Identification (Plug/Receptacle)	
High Voltage Power, filtered	1	P2 Pin 2 (HVP)	Black Insulation	
Hot Plug Detect	2	P2 Pin 1 (HPD)	Brown Insulation	
Port 0 transmit positive	3	Tx0_P	White Label	
Port 0 receive positive	4	Rx0_P	Blue Label	
Port 0 transmit negative	5	Tx0_N	White Label	
Port 0 receive negative	6	Rx0_P	Blue Label	
Grounded through 12 ohms	7	Ground	N/A	
Grounded through 12 ohms	8	Ground	N/A	
Low-speed Receive	9	P2 Pin 6 (LST)	Gray Insulation	
No-connect, internally terminated to 50 ohms	10	NC	N/A	
Low-speed Transmit	11	P2_Pin 4 (LSR)	White Insulation	
No-connect, internally terminated to 50 ohms	12	NC	N/A	
Grounded through 12 ohms	13	Ground	N/A	
Grounded through 12 ohms	14	Ground	N/A	
Port 1 transmit positive	15	Tx1_P	Yellow Label	
Port 1 receive positive	16	Rx1_P	Green Label	
Port 1 transmit negative	17	Tx1_N	Yellow Label	
Port 1 receive negative	18	Rx1_P	Green Label	
Return current Ground, filtered	19	Return	N/A	
DP_PWR, filtered	20	P2 Pin 3 (DPP)	Red Insulation	
Ground	7,8,13,14,19	P2 Pin 8 (GND)	Violet Insulation	
Config 1 – Filtered from Tx0_P	4	P2 Pin 5 (CF1)	Orange Insulation	
Config 2 – Filtered from Tx0_N	6	P2 Pin 7 (CF2)	Yellow Insulation	

Electrical Specifications

NOTE: All specifications in this manual are subject to change.

Table 5. Electrical Specifications

SPECIFICATION	MINIMUM	TYPICAL	MAXIMUM	NOTES
Insertion Loss (GHz), at -3 db	12	15		2X-THRU with six-inch cables
Return Loss (GHz), at -20 db	7	17		2X-THRU with six-inch cables
Insertion Loss (GHz), at -3 db		24.7		1X-THRU with three-inch cables
Return Loss (GHz), at -20 db		17		1X-THRU with three-inch cables
VSWR, at 12 GHz	1.21:1			2X-THRU with six-inch cables
Differential Impedance (ohms), at 100ps Rise Time	95		105	All Ports, Receptacle and Plug, excluding Thunderbolt connector
Impedance (ohms), at 100ps Rise Time	47.5		52.5	All Ports, Receptacle and Plug, excluding Thunderbolt connector
Impedance (ohms), at 100ps Rise Time	47.5		52.5	SHORT, OPEN, LOAD, 1X-THRU, and 2X-THRU
Intra-lane Skew (ps)	-6		6	Within each differential pair, including mated Receptacle and Plug
Inter-lane Skew (ps)	-20		20	Between all differential pairs, including mated Receptacle and Plug
NEXT (db), at 5.0 GHz, at 15.0 GHz	-35	-42 -38		Between differential pairs, single aggressor, without TB connector, with six-inch cables and terminations
Current Carrying (A)	1.2			High Voltage Power, DisplayPort Power, and Return

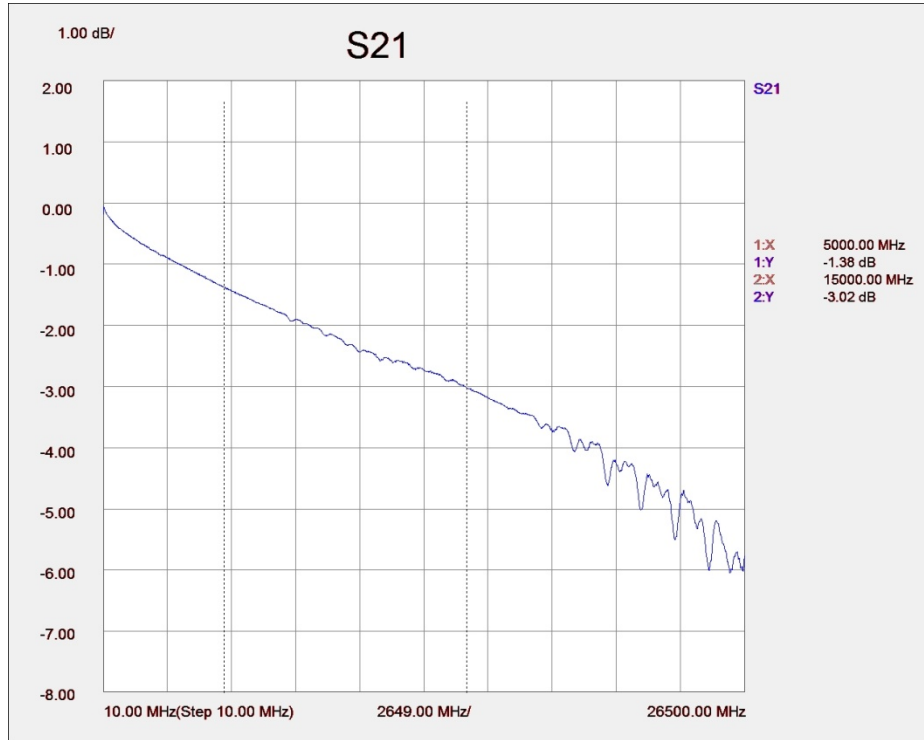


Figure 5. Typical 2X-THRU insertion loss

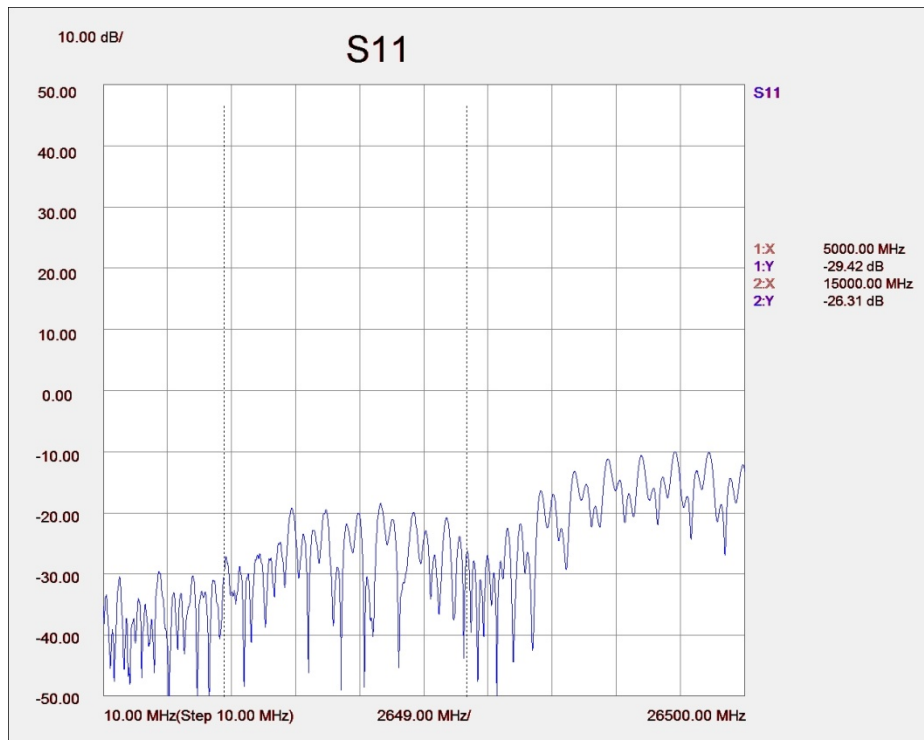


Figure 6. Typical 2X-THRU return loss

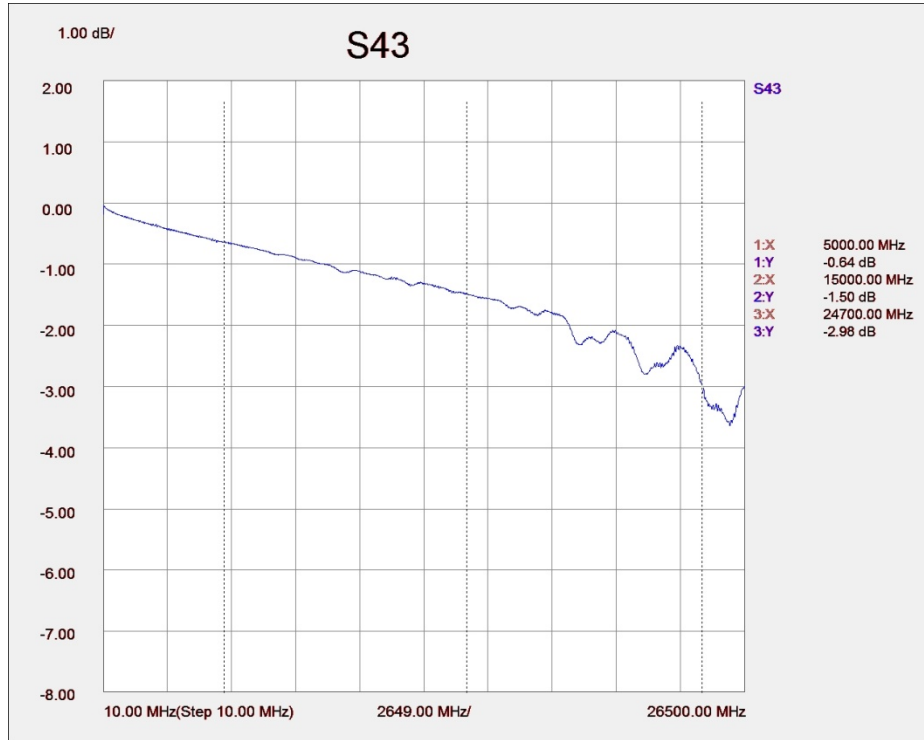


Figure 7. Typical 1X-THRU insertion loss

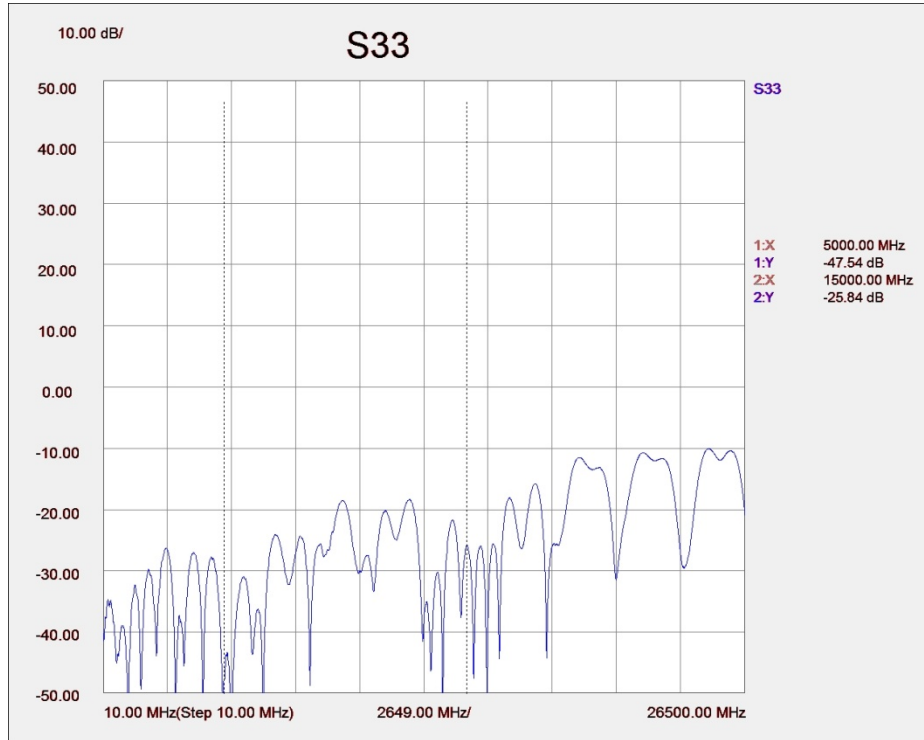


Figure 8. Typical 1X-THRU return loss

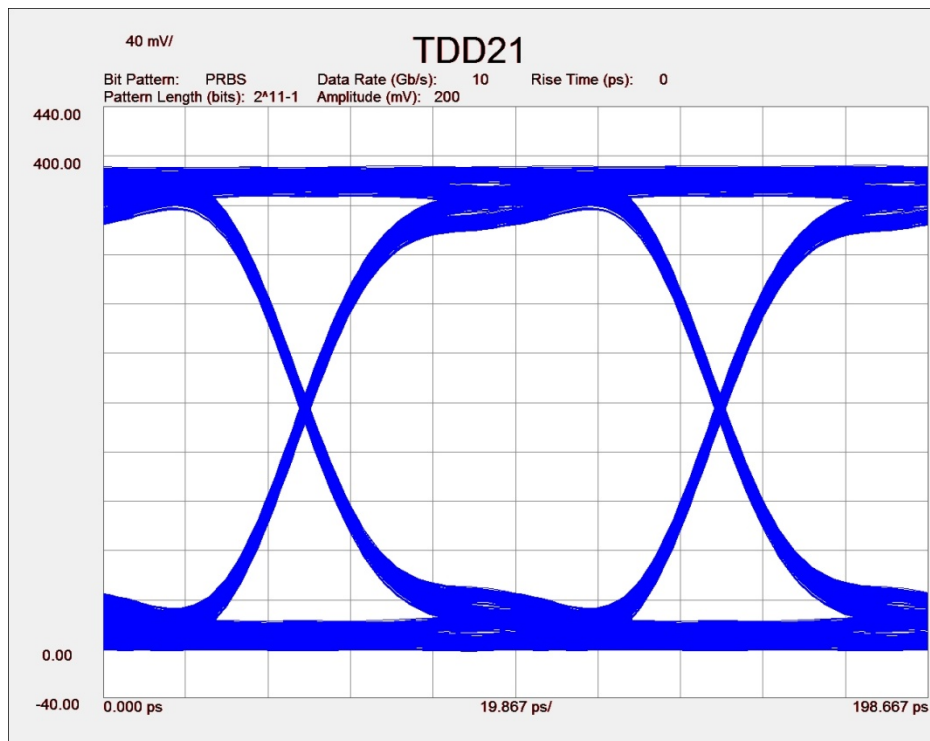
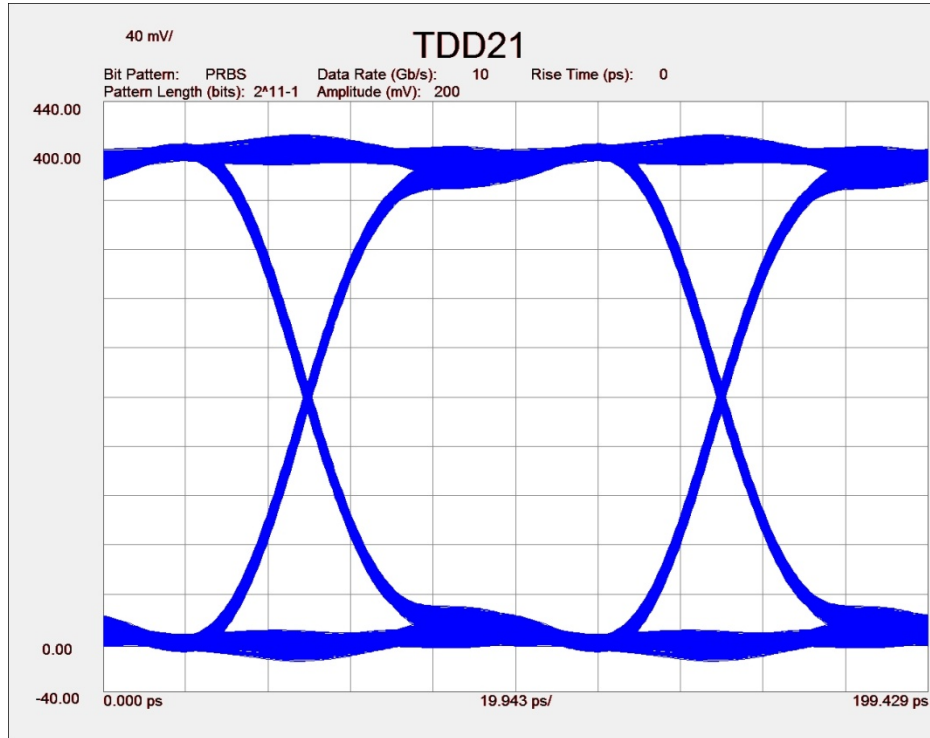


Figure 9. Typical mated pair 10 Gb/s eye diagram, with calibration (top) and without calibration (bottom)

Parameter Measurement Result	
Name	Measurement Result
Eye Level Zero(mV)	8.12
Eye Level One(mV)	390.68
Eye Level Mean(mV)	199.40
Eye Amplitude(mV)	382.56
Eye Height(mV)	345.42
Eye Height(db)	-4.62
Eye Width	9.71e-011
Eye Opening Factor	0.90
Eye Signal_to_Noise	26.70
Eye Duty Cycle Dist	-4.68e-014
Eye Duty Cycle Dist(%)	-0.05
Eye Rise Time (20-80)	2.24e-011
Eye Fall Time (80-20)	2.24e-011
Eye Jitter(PP)	2.88e-012
Eye Jitter(RMS)	5.98e-013

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Parameter Measurement Result	
Name	Measurement Result
Eye Level Zero(mV)	21.47
Eye Level One(mV)	369.39
Eye Level Mean(mV)	195.43
Eye Amplitude(mV)	347.92
Eye Height(mV)	293.08
Eye Height(db)	-5.33
Eye Width	9.67e-011
Eye Opening Factor	0.84
Eye Signal_to_Noise	14.09
Eye Duty Cycle Dist	-1.78e-014
Eye Duty Cycle Dist(%)	-0.02
Eye Rise Time (20-80)	2.53e-011
Eye Fall Time (80-20)	2.53e-011
Eye Jitter(PP)	3.33e-012
Eye Jitter(RMS)	6.99e-013

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Figure 10. Typical mated pair 10 Gb/s eye measurements, with calibration (top) and without calibration (bottom)

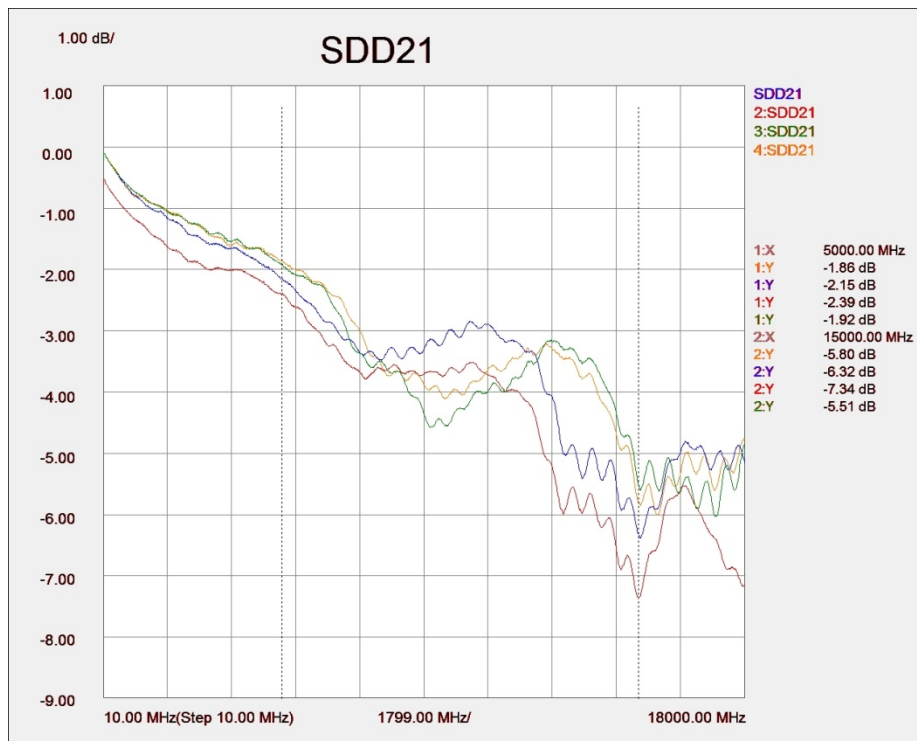
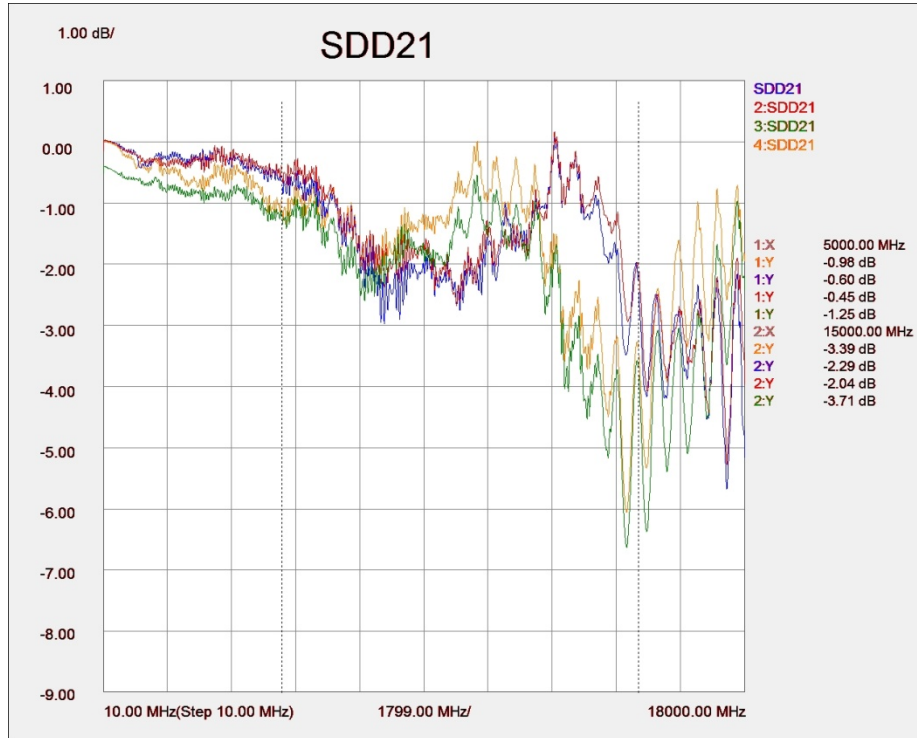


Figure 11. Typical mated pair balanced insertion loss, with calibration (top) and without calibration (bottom)

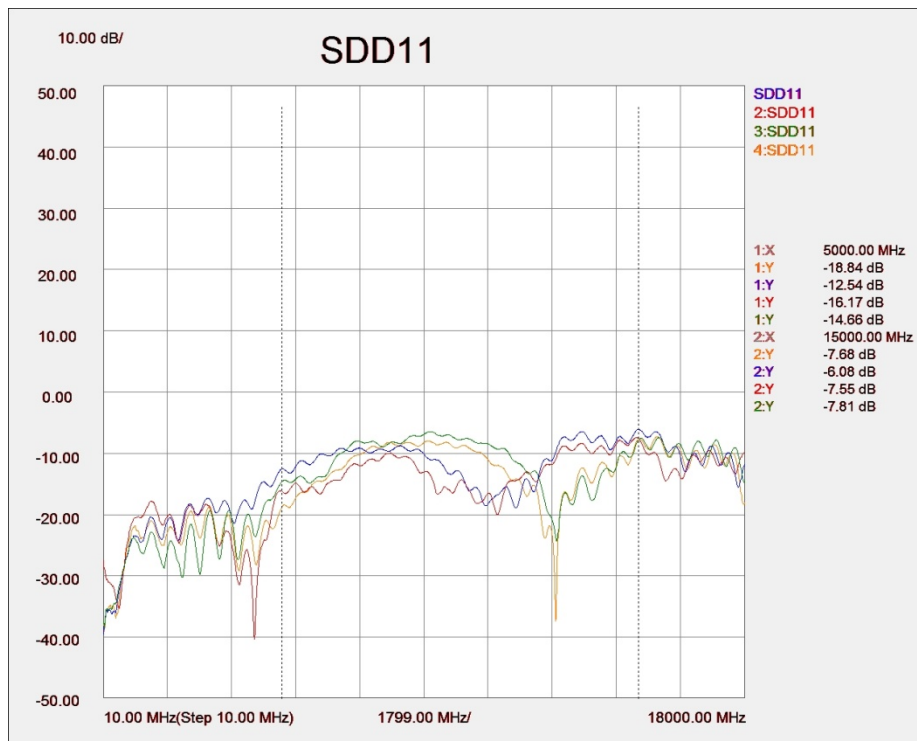
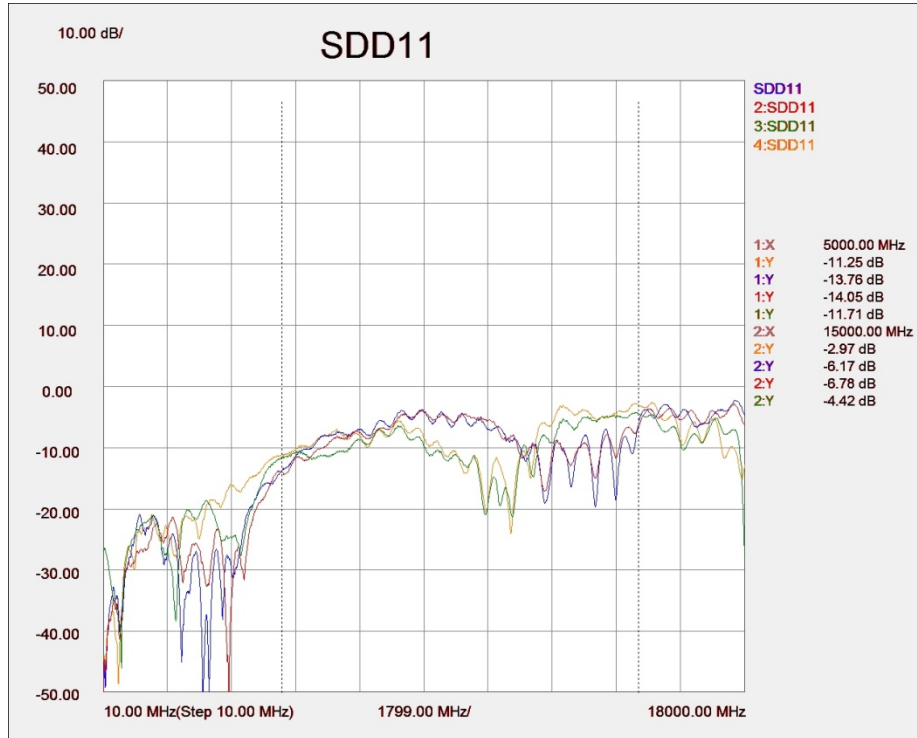


Figure 12. Typical mated pair balanced return loss, with calibration (top) and without calibration (bottom)

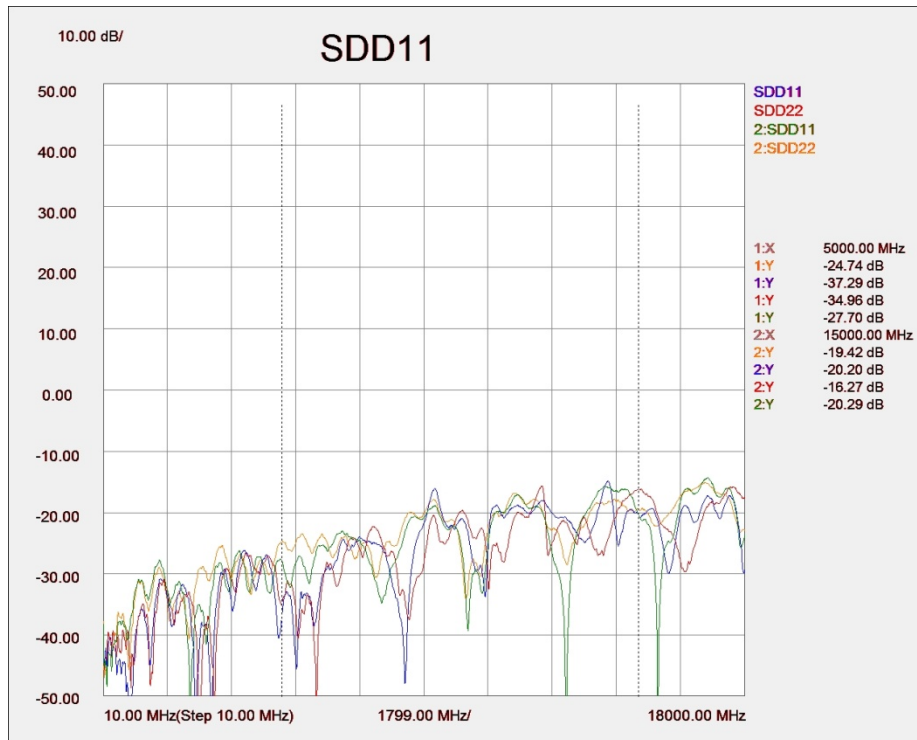
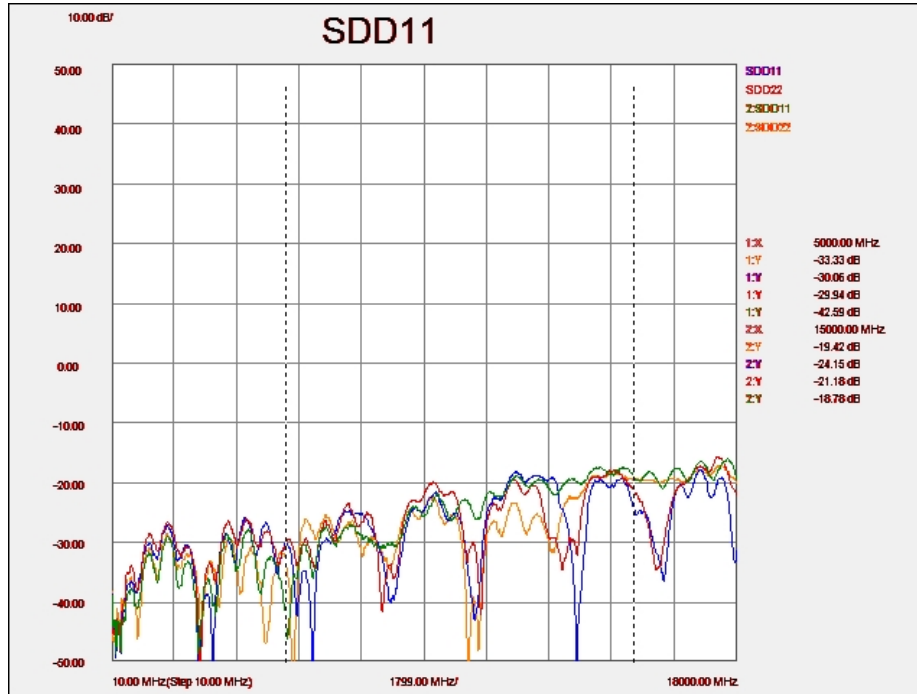


Figure 13. Typical mated board only return loss, plug (top) and receptacle (bottom), terminations replacing main connectors.

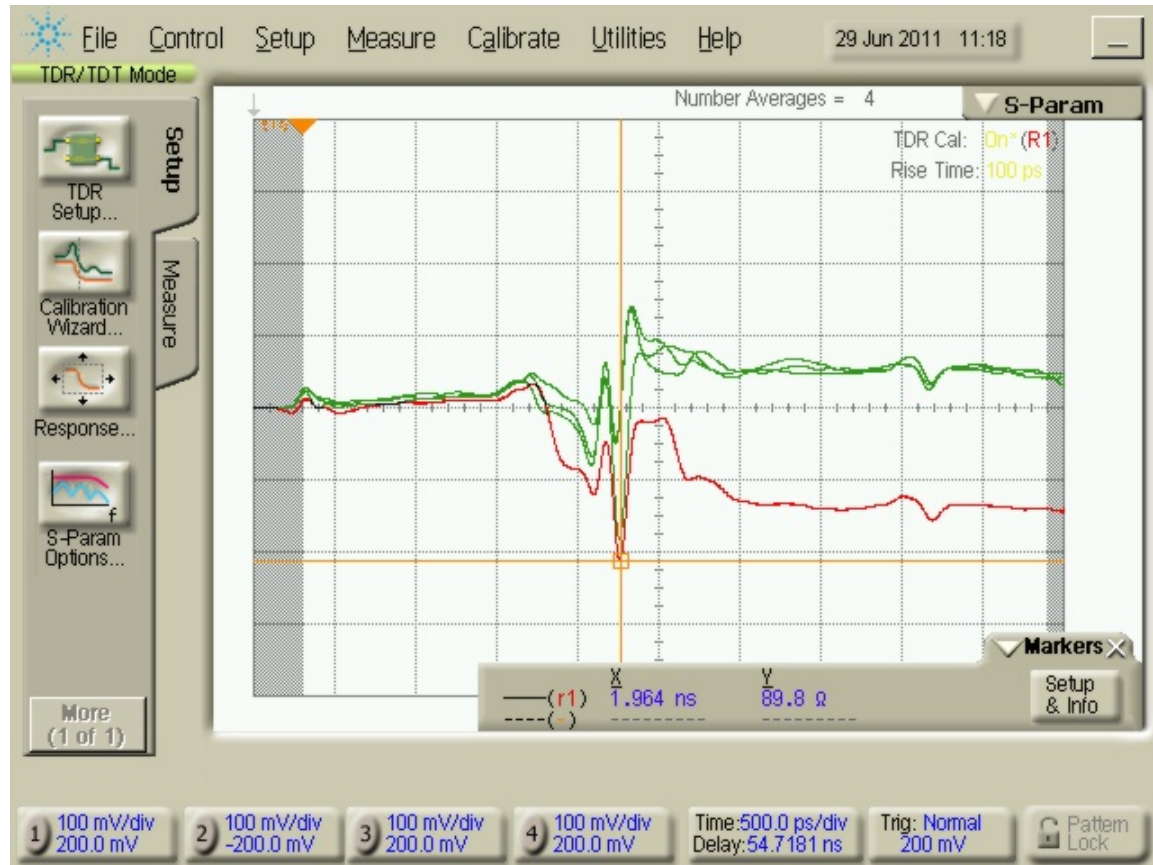


Figure 14. Typical Differential TDR of TPA-P connected to TPA-R at 100 ps Rise Time. Note- RX0 has 1k ohm sense lines on the plug and receptacle TPAs that impact the resulting impedance.

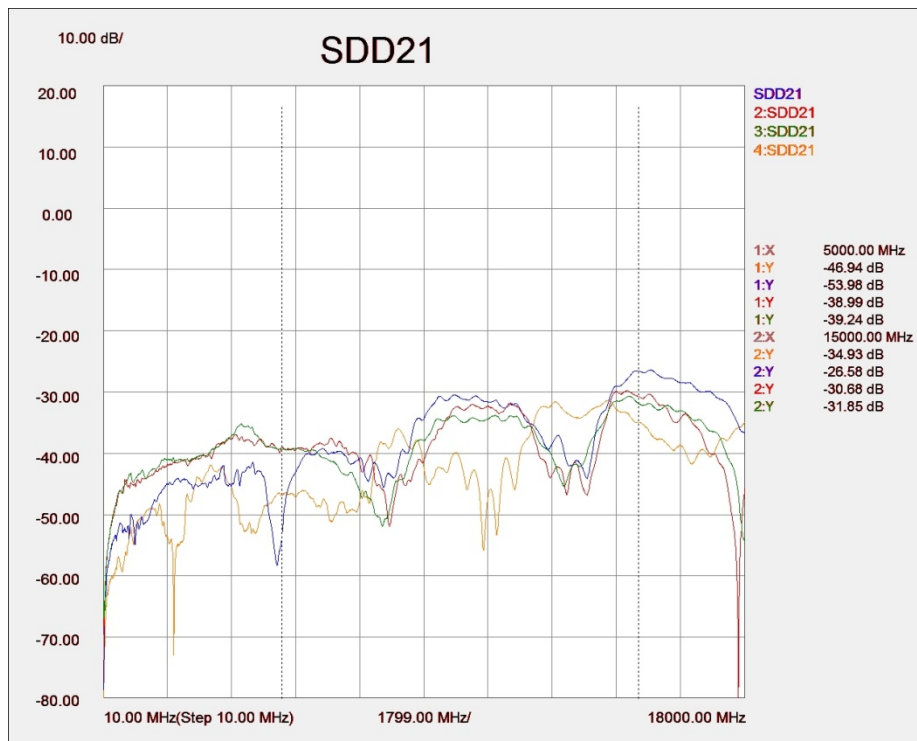
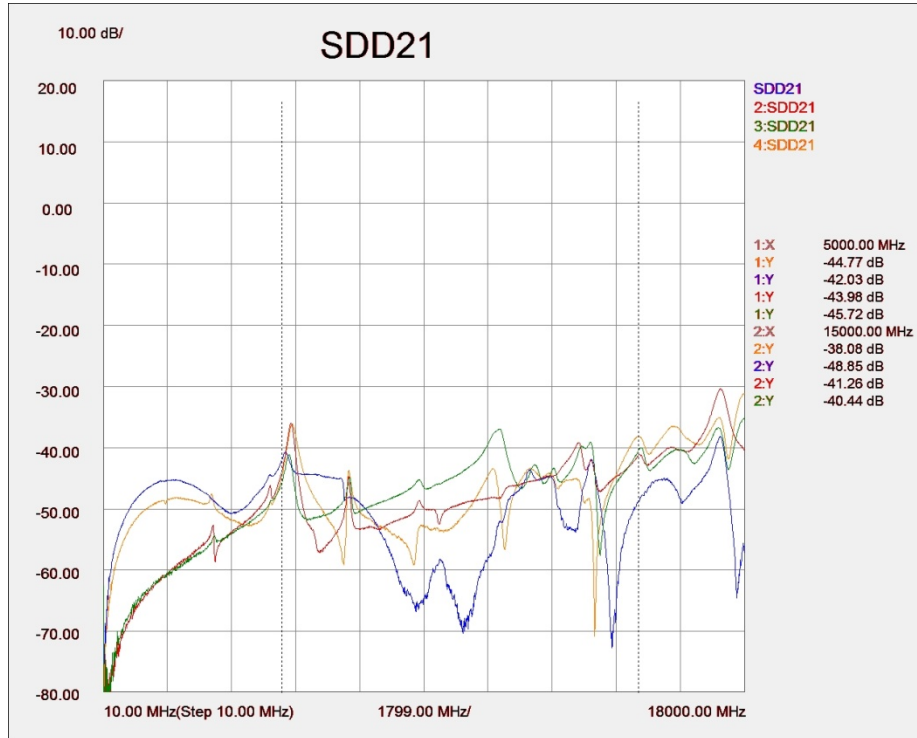


Figure 15. Typical Differential NEXT for Plug TPA, without connector (top) and with mated connectors, adjacent numbered lanes, all lanes terminated at both ends

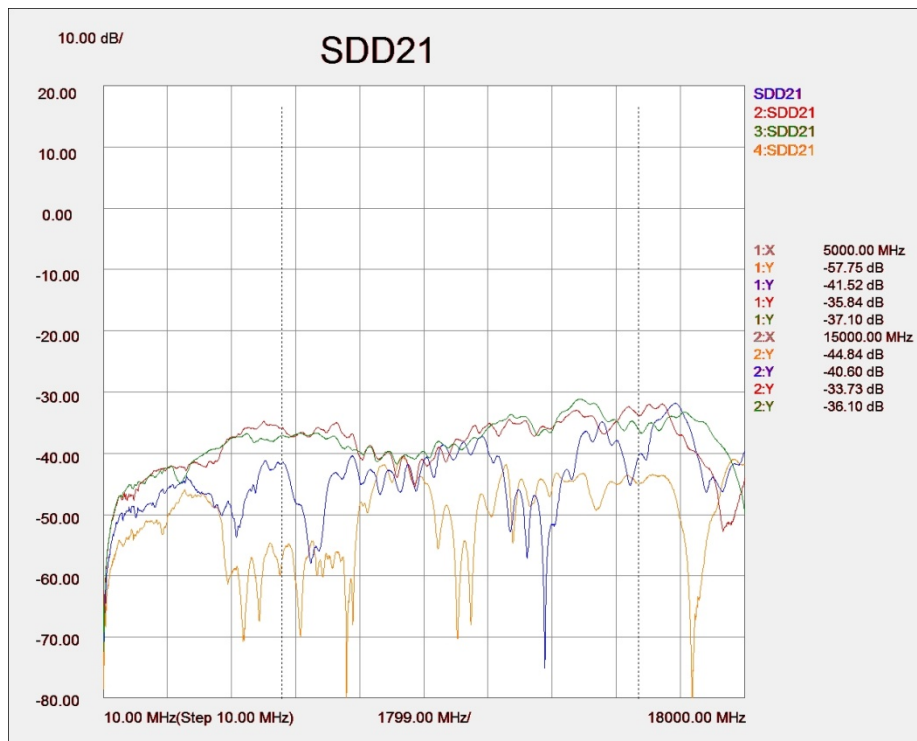
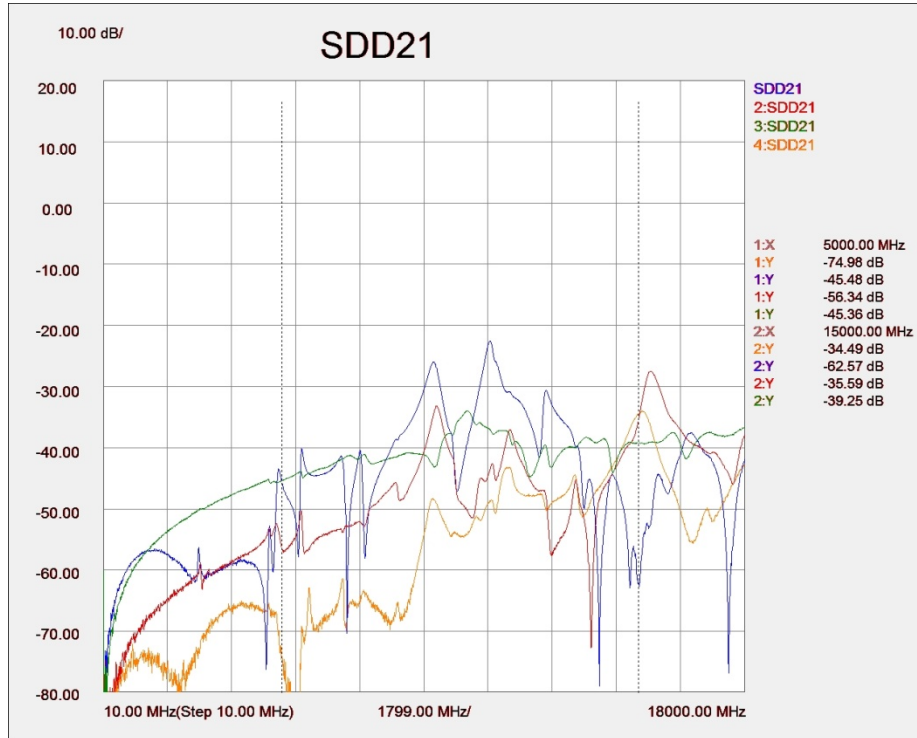


Figure 16. Typical Differential NEXT for Receptacle TPA, without connector (top) and with mated connectors, adjacent numbered lanes, all lanes terminated at both ends

Wilder Technologies, LLC – Limited Warranty

Wilder Technologies, LLC warrants that each Test Adapter, 1) is free from defects in materials and workmanship and, 2) conforms to Wilder Technologies specifications for a period of 12 months. **See Consumable and Fragile Material Warranty for exceptions to the 12 month warranty**

The warranty period for a Test Adapter is a specified, fixed period commencing on the date of ship from Wilder Technologies, LLC. If you did not purchase your Test Adapter directly from Wilder Technologies, LLC, the serial number and a valid proof of purchase will be required to establish your purchase date. If you do not have a valid proof of purchase, the warranty period will be measured from the date of ship from Wilder Technologies, LLC.

If, during the warranty period, the Test Adapter is not in good working order, Wilder Technologies, LLC will, at its option, repair or replace it at no additional charge, except as is set forth below. In some cases, the replacement Test Adapter may not be new and may have been previously installed. Regardless of the Test Adapter's production status, Wilder Technologies, LLC appropriate warranty terms apply.

Consumable and Fragile Material Warranty

Wilder Technologies, LLC warrants that consumable materials and all fragile materials supplied by Wilder Technologies, LLC either as part of an instrument or system, or supplied separately, will be free from defects in material and workmanship at the time of shipment.

Extent of Warranty

The warranty does not cover the repair or exchange of a Test Adapter resulting from misuse, accident, modification, unsuitable physical or operating environment, improper maintenance by you, or failure caused by a product for which Wilder Technologies, LLC is not responsible. The warranty is voided by removal or alteration of Test Adapter or parts identification labels. The initial three months are unconditional; the remaining months excludes plugs, receptacles and SMA connectors. Connectors are wear items and excluded from the warranty after the initial three months.

These warranties are your exclusive warranties and replace all other warranties or conditions, express or implied, including but not limited to, the implied warranties or conditions or merchantability and fitness for a particular purpose. These warranties give you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction. Some jurisdictions do not allow the exclusion or limitation of express or implied warranties, so the above exclusion or limitation may not apply to you. In that event, such warranties are limited in duration to the warranty period. No warranties apply after that period.

Items Not Covered by Warranty

Wilder Technologies, LLC does not warrant uninterrupted or error-free operation of a Test Adapter.

Any technical or other support provided for a Test Adapter under warranty, such as assistance via telephone with "how-to" questions and those regarding Test Adapter set-up and installation, will be provided **WITHOUT WARRANTIES OF ANY KIND**.

Warranty Service

Warranty service may be obtained from Wilder Technologies, LLC by returning a Wilder Technologies, LLC Returns Material Authorization and the Test Adapter to Wilder Technologies, LLC during the warranty period. To obtain RMA number, contact support@wilder-tech.com.

You may be required to present proof of purchase or other similar proof of warranty entitlement. You are responsible for any associated transportation charges, duties and insurance between you and Wilder Technologies, LLC. In all instances, you must ship Test Adapters in Wilder Technologies, LLC approved packaging. Information on packaging guidelines can be found at: www.wilder-tech.com. Wilder Technologies, LLC will ship repaired or replacement Test Adapter Delivery Duty Prepaid (DDP) and will pay for return shipment. You will receive title to the repaired or replacement Test Adapter and you will be the importer of record.

Wilder Technologies, LLC – Terms & Conditions of Sale

1. **Other Documents:** This Agreement may NOT be altered, supplemented, or amended by the use of any other document(s) unless otherwise agreed to in a written agreement signed by both you and Wilder Technologies, LLC. If you do not receive an invoice or acknowledgement in the mail, via e-mail, or with your Product, information about your purchase may be obtained at support@wilder-tech.com or by contacting your sales representative.
2. **Payment Terms, Orders, Quotes, Interest:** Terms of payment are within Wilder Technologies, LLC's sole discretion, and unless otherwise agreed to by Wilder Technologies, LLC, payment must be received by Wilder Technologies, LLC prior to Wilder Technologies, LLC's acceptance of an order. Payment for the products will be made by credit card, wire transfer, or some other prearranged payment method unless credit terms have been agreed to by Wilder Technologies, LLC. Invoices are due and payable within the time period noted on your invoice, measured from the date of the invoice. Wilder Technologies, LLC may invoice parts of an order separately. Your order is subject to cancellation by Wilder Technologies, LLC, in Wilder Technologies, LLC's sole discretion. Unless you and Wilder Technologies, LLC have agreed to a different discount, Wilder Technologies, LLC's standard pricing policy for Wilder Technologies, LLC-branded systems, which includes hardware, software and services in one discounted price, allocates the discount off list price applicable to the service portion of the system to be equal to the overall calculated percentage discount off list price on the entire system. Wilder Technologies, LLC is not responsible for pricing, typographical, or other errors in any offer by Wilder Technologies, LLC and reserves the right to cancel any orders resulting from such errors.
3. **Shipping Charges; Taxes; Title; Risk of Loss:** Shipping, handling, duties and tariffs are additional unless otherwise expressly indicated at the time of sale. Title to products passes from Wilder Technologies, LLC to Customer on shipment from Wilder Technologies, LLC's facility. Loss or damage that occurs during shipping by a carrier selected by Wilder Technologies, LLC is Wilder Technologies, LLC's responsibility. Loss or damage that occurs during shipping by a carrier selected by you is your responsibility. You must notify Wilder Technologies, LLC within 7 days of the date of your invoice or acknowledgement if you believe any part of your purchase is missing, wrong or damaged. Unless you provide Wilder Technologies, LLC with a valid and correct tax exemption certificate applicable to your purchase of Product and the Product ship-to location, you are responsible for sales and other taxes associated with the order. **Shipping dates are estimates only.**
4. **WARRANTY:** WILDER TECHNOLOGIES, LLC, warrants that the item(s) manufactured under the Buyer's contract shall be free from defects in materials and workmanship furnished by WILDER TECHNOLOGIES, LLC, and shall conform to the applicable drawings and specifications. WILDER TECHNOLOGIES, LLC'S liability herein, for breach of warranty, contract or negligence in manufacturing, shall be limited to repair or replacement. Repair or replacement of defective items will be applicable only if the Buyer notifies WILDER TECHNOLOGIES, LLC, by written notice within 30-days of delivery. All claims shall be addressed to: support@wilder-tech.com or WILDER TECHNOLOGIES, LLC, 6101A East 18th Street, Vancouver, Washington 98661 U.S.A.; ATTENTION: Customer Service Manager. WILDER TECHNOLOGIES, LLC, reserves the right to inspect at the Buyer's plant all items claimed to be defective or nonconforming prior to authorizing their return. WILDER TECHNOLOGIES, LLC, assumes no liability for the results of the use of its components in conjunction with other electric, electronic or mechanical components, circuits and/or systems. The foregoing constitutes the sole and exclusive remedy of the Buyer and the exclusive liability of WILDER TECHNOLOGIES, LLC, and is IN LIEU OF ANY AND ALL OTHER WARRANTIES, STATUTORY, IMPLIED OR EXPRESSED AS TO MERCHANTABILITY, FITNESS FOR THE PURPOSE SOLD, DESCRIPTION, QUALITY, and PRODUCTIVENESS OR ANY OTHER MATTER. Without limiting the foregoing, in no event shall WILDER TECHNOLOGIES, LLC, be liable for loss of use, profit or other collateral, or for special and/or consequential damages.
5. **RETURNED GOODS:** WILDER TECHNOLOGIES, LLC, will accept only those goods for return that have been authorized for return. All goods authorized for return shall be assigned a Returned Material Authorization (RMA) Number. The RMA Number shall be clearly marked on the shipping container(s) and all documentation accompanying the goods authorized for return. The RMA Number shall be assigned by WILDER TECHNOLOGIES, LLC pursuant to the conditions set forth in Paragraph 4, WARRANTY.
6. **UNITED STATES GOVERNMENT CONTRACTS:** In the event this offer is accepted under Government contract, WILDER TECHNOLOGIES, LLC, agrees to accept clauses required by Government regulations and to waive WILDER TECHNOLOGIES, LLC conditions inconsistent therewith. WILDER TECHNOLOGIES, LLC, certifies that it is a regular manufacturer or dealer of the goods and/or services offered herein and that the prices offered do not exceed those charged to any customer for like quantities, services or materials under the same conditions.

Compliance with Environmental Legislation

Wilder Technologies, LLC, is dedicated to complying with the requirements of all applicable environmental legislation and regulations, including appropriate recycling and/or disposal of our products.



WEEE Compliance Statement

The European Union adopted Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE), with requirements that went into effect August 13, 2005. WEEE is intended to reduce the disposal of waste from electrical and electronic equipment by establishing guidelines for prevention, reuse, recycling and recovery.

Wilder Technologies has practices and processes in place to conform to the requirements in this important Directive.

In support of our environmental goals, effective January 1st, 2009 Wilder Technologies, LLC has partnered with E-Tech Recycling of Beaverton, Oregon, www.etechrecycling.com, to recycle our obsolete and electronic waste in accordance with the European Union Directive 2002/96/EC on waste electrical and electronic equipment ("WEEE Directive").

As a service to our customers, Wilder Technologies is also available for managing the proper recycling and/or disposal of all Wilder Technologies products that have reached the end of their useful life. For further information and return instructions, contact support@wilder-tech.com.

Glossary of Terms

TERMINOLOGY	DEFINITION
Aggressor	A signal imposed on a system (i.e., cable assembly) to measure response on other signal carriers.
Daisy-chain	Thunderbolt link between multiple boxes, going from box to box to box, detachable by an end user. A Thunderbolt cable-connector assembly for the box-to-box connection shall have two ports. DisplayPort Sinks can only be at the end of the Daisy-chain.
Dual-protocol	Thunderbolt runs PCIe and DisplayPort protocols
TB-TPA	Thunderbolt Test Point Access. A specialized assembly that interfaces to a Thunderbolt receptacle or plug and enables access to signals for measurement or stimulation.
Informative	The designation of a test that is not required for compliance but is considered important from a characterization standpoint. It is provided for informational purposes only.
Port	Bidirectional channel for isochronous stream transport from Thunderbolt Source to Thunderbolt Sink. Thunderbolt contains two ports in this application.
Normative	The designation of a test that is required for compliance.
Victim	A signal carrier on a system that has a response imposed on it by other signals in the system.

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