

Enhanced DisplayPort Test Adapter

User Manual



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Introduction

This user's guide documents the Enhanced DisplayPort Test Adapter (ENH-DP-TPA). The two test adapter types, shown in Figure 1, test Enhanced DisplayPort Interface (ENH-DP) cables and devices against the VESA DisplayPort™ PHY Compliance Test Specification and the VESA DisplayPort™ Interoperability Guideline. Interoperability of the Enhanced DisplayPort Test Adapters allows access to dual mode (supporting HDMI) and tethered cable operation. See the Aux Control User Manual, 910-0015-000, for more information.

The ENH-DP-TPA-P and ENH-DP-TPA-R test adapter assemblies allow access, via high-speed 2.92mm connections, to measure or inject Main Link and Auxiliary signals. These test adapters also provide access to Hot Plug Detect, DP Power, two Grounds, Config1, and Config2 via a 6-position low-speed connector.

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 Enhanced DisplayPort Test Adapter Plug (Left) and Receptacle (Right)

Enhanced DisplayPort Test Adapter (Plug)

The ENH-DP-TPA-P is used to test Enhanced DisplayPort host devices to the standards defined by the VESA DisplayPort™ PHY Compliance Test Specifications and the VESA DisplayPort™ Interoperability Guidelines.

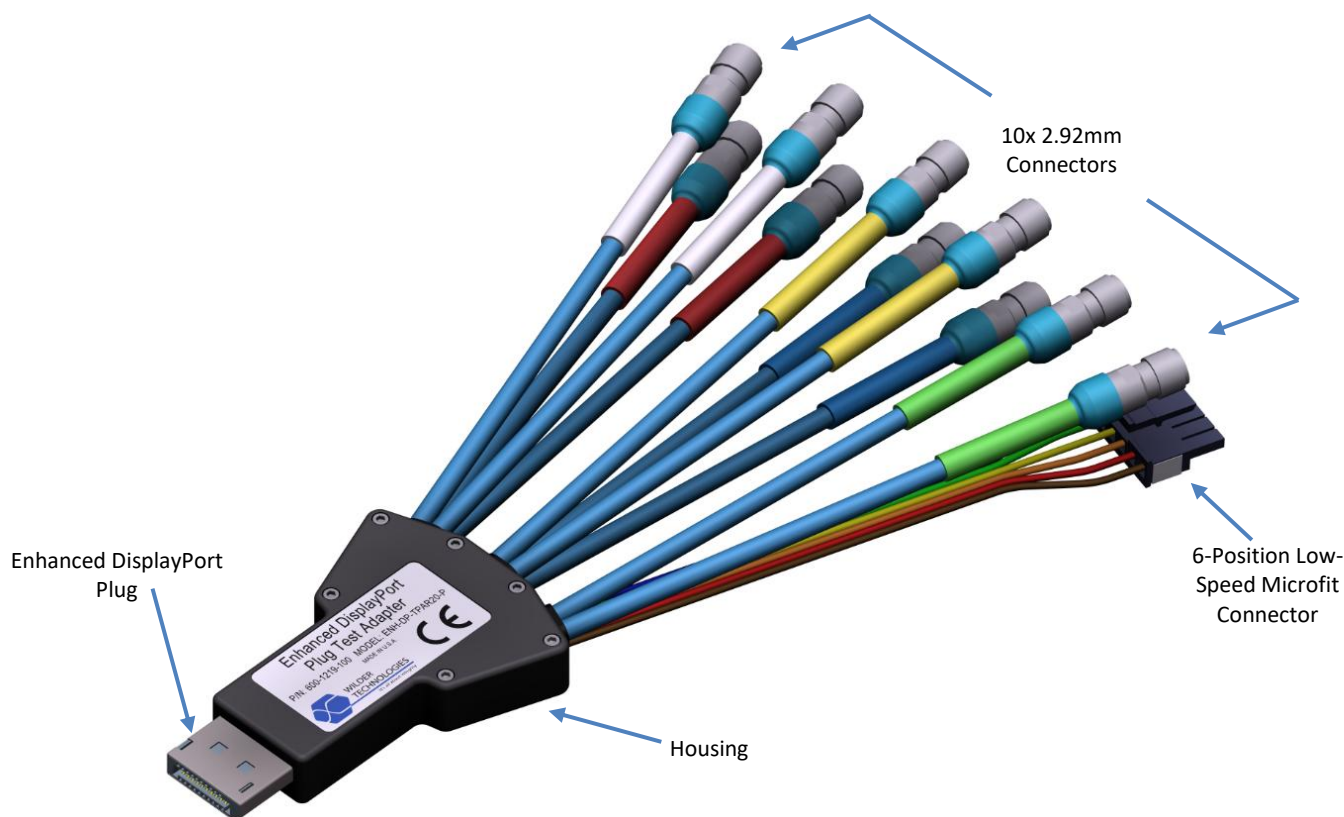


Figure 2. The Enhanced DisplayPort Test Adapter (Plug)

The ENH-DP-TPA-P features 10 2.92mm Female connectors for users to measure and inject Main Link and Auxiliary signals during the testing process. The 6-position low-speed cable provides access to Hot Plug Detect, DP Power, two Grounds, Config1, and Config2, and is used to interface with the Auxiliary control module and DPAC-CAM. (Ref. Auxiliary Control Module and DPAC-CAM User Manuals, 910-0015-000 and 910-0058-000 respectively).

The low-speed 6-position receptacle connector used on the ENH-DP-TPA-P is keyed and latching (Molex part number 43645-0600). Included with the ENH-DP-TPA-P is a spare 6 position Molex Microfit plug connector and set of 6 pin contacts for users to interface directly to the low-speed cable. (Molex part numbers 43640-0601 for the 6-position housing and 43031-0011 for the 26-30awg pin contact). Replacement parts can be purchased through Molex distributors.

Enhanced DisplayPort Test Adapter (Receptacle)

The ENH-DP-TPA-R is used to test Enhanced DisplayPort module devices to the standards defined by the VESA DisplayPort™ PHY Compliance Test Specifications and the VESA DisplayPort™ Interoperability Guidelines.

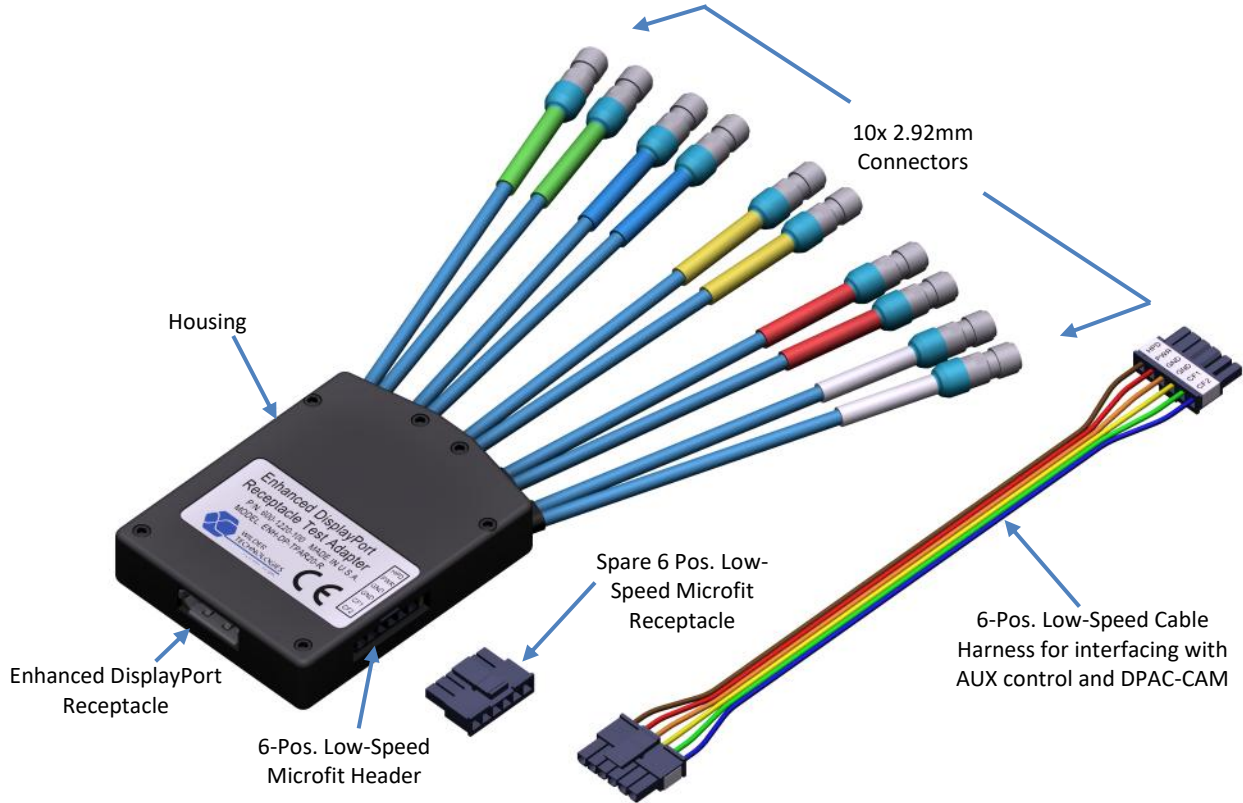


Figure 3. The Enhanced DisplayPort Test Adapter (Receptacle)

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

The ENH-DP-TPA-R features 10 2.92mm Female connectors for users to measure and inject Main Link and Auxiliary signals during the testing process. The 6 position low speed header provides access to Hot Plug Detect, DP Power, two Grounds, Config1, and Config2, and the included low-speed cable harness is used to interface with the Auxiliary control module and DPAC-CAM. (Ref. Auxiliary Control Module and DPAC-CAM User Manuals, 910-0015-000 and 910-0058-000 respectively).

The low-speed 6-position header connector used on the ENH-DP-TPA-R is keyed and latching (Molex part number 43650-0604). Included with the ENH-DP-TPA-R is a spare 6-position Molex Microfit Receptacle connector and set of 6 pin contacts for users to interface directly to the low-speed header as well as a separate 6-position low-speed cable harness. (Molex part numbers 43645-0600 for the 6-position housings and 43030-0011 for the 26-30awg pin contacts). Replacement parts can be purchased through Molex distributors.

Product Inspection

Upon receiving the ENH-DP-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 Enhanced DisplayPort Test Adapter when not in use.
- Locate the shipping list and verify that all items ordered were received.
- If product is defective or incomplete, please refer to the “Limited Warranty” section which discusses how to contact Wilder Technologies for technical assistance and/or how to package the product for return.

The Enhanced DisplayPort Test Adapter Care and Handling Precautions

The Enhanced DisplayPort Test Adapters require 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 ENH-DP-TPA's life, observe the following handling precautions:

- **CAUTION 1: Avoid Torque Forces (Twisting)**
Individual coaxial cables within the test adapter DO NOT have rotational freedom, twisting the ENH-DP-TPA as a unit, with one end held stationary, 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 ENH-DP-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 ENH-DP-TPA and cables. Use adjustable elevation stands or apparatus to accurately place and support the ENH-DP-TPA.
- **CAUTION 4: Connect the ENH-DP-TPA First**
To prevent twisting, bending, or applying tension to the coaxial cables when connecting a ENH-DP-TPA, always attach the ENH-DP-TPA to the device under test (DUT) or cable under test before attaching any 2.92mm connectors. Carefully align the Enhanced DisplayPort connectors and then gently push the connectors together until fully seated.

If the ENH-DP-TPA must be turned or twisted to make connection to the DUT, DO NOT use the ENH-DP-TPA to make this occur. It is required to first loosen or disconnect the 2.92mm connections at the ENH-DP-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 ENH-DP-TPA to or from the DUT. Pulling directly on the ENH-DP-TPA cables or using them to insert the ENH-DP-TPA may cause damage.

- **CAUTION 5: Carefully Make High-Speed (2.92mm) Connections**

To connect the ENH-DP-TPA 2.92mm connectors, follow these steps:

1. Hold the cable stationary by grasping the cable at the blue heat-shrink section near the High-Speed connector.
2. Insert the mating High-Speed connector barrel and hand-tighten the free-spinning 2.92mm connector nut onto the connector while avoiding pulling, bending, or twisting the ENH-DP-TPA coaxial cable.
3. The ENH-DP-TPA 2.92mm connectors have flats that accept an open-end 1/4-inch wrench, depending on configuration. When attaching instrument cables to the ENH-DP-TPA, it is recommended that the ENH-DP-TPA high-speed connectors be mechanically held and the test leads be tightened to the equipment manufacturer's torque recommendations, normally 5 in-lbs., using an open-end torque wrench.

If the test set-up requires repositioning, first loosen or disconnect the 2.92mm 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 ENH-DP-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.

- **CAUTION 7: ESD Sensitivity**

The ENH-DP-TPA test adapters are passive components and are not in themselves sensitive to electrostatic discharge. However, when an active DUT is installed, that device becomes susceptible to ESD. Observe proper ESD precautions, further discussed later in this document.

General Test Adapter, Cable, and Connector

Observing simple precautions can ensure accurate and reliable measurements.

Handling and Storage

Before each use of the ENH-DP-TPA, ensure that all connectors are clean. Handle all cables carefully and store the ENH-DP-TPA in the foam-lined instrument case when not in use, if possible. Do not set connectors contact end down. Install the high-speed connector protective end caps when the ENH-DP-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 the 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 on the Instrument Cables only
- Do not apply bending force to cable
- Do not over-tighten preliminary connections
- Do not twist or screw-in cables
- Use an appropriately sized torque wrench, and do not tighten past the “break” point of the torque wrench (normally set to 5 in-lbs.)

Electrostatic Discharge Information

Protection against electrostatic discharge (ESD) is essential while connecting, inspecting, or cleaning the ENH-DP-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 workstation, 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 workstation should not be used when working on circuitry with a voltage potential greater than 500 volts.

User Model Examples

The Enhanced DisplayPort TPA supports all testing of the DisplayPort PHY CTS. It is capable of performing well beyond the scope of measurements contained in the PHY CTS, 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, the Enhanced DisplayPort plug TPA acts as a sink:

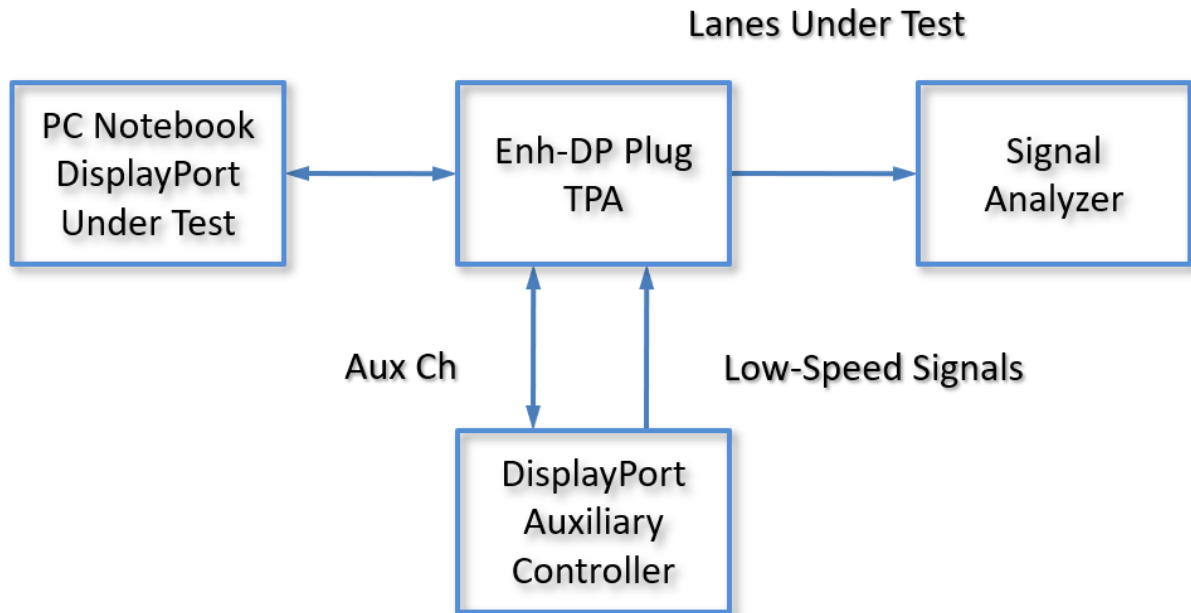


Figure 4. Block Diagram Depicting ENH-DP-TPA-P as Sink

In the second example, the Enhanced DisplayPort plug acts as a source:

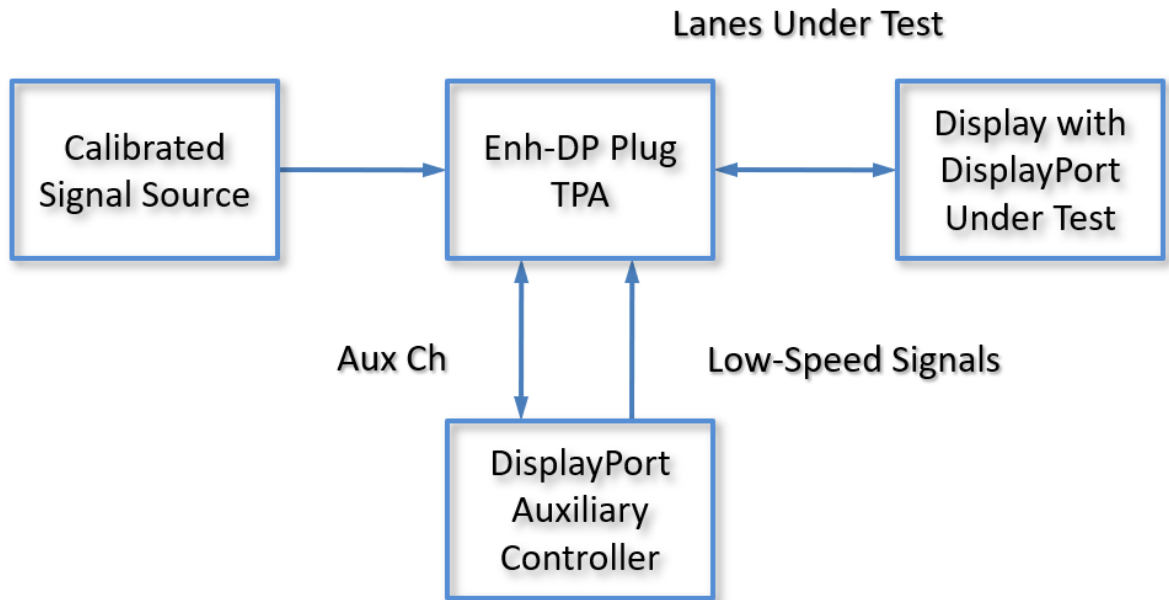


Figure 5. Block Diagram Depicting ENH-DP-TPA-P as Source

The third example shows two Enhanced DisplayPort receptacle TPAs acting as source and sink:

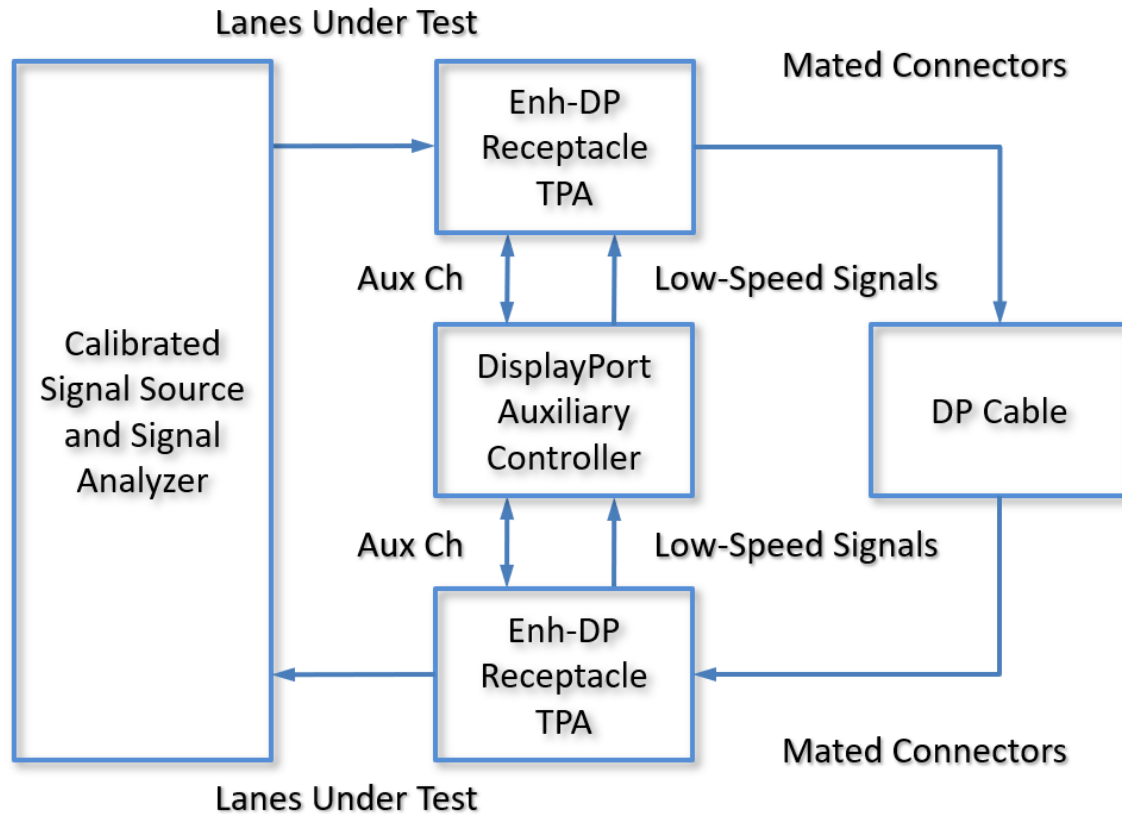


Figure 6. Block Diagram Depicting ENH-DP-TPA-R as Source and Sink

Calibration Through De-Embedding

The Enhanced DisplayPort Plug and Receptacle Test Adapters are passive components. Therefore, calibration compensating for the losses must occur within the test instrumentation that drives the sink or looks at the response of the source.

The Enhanced DisplayPort Test Adapters have Touchstone S4P files for de-embedding the electrical length and losses within the TPA up to the DisplayPort connector interface pads. (Contact Wilder Technologies, support@wilder-tech.com, to obtain a copy of the S4P files.) The Touchstone S4P files enable the test engineer to compensate for the last four of 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 are corrected on each port. Refer to the Instrument Manual for instructions on the instrument's specific de-embedding 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 or de-embedding of the test fixture defines the DUT as the total of externally connected components. If the de-embedding file is not used, all of the ENH-DP-TPA and associated coaxial cables, as well as cables connecting the TPA assembly 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 an instrumentation-level 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.

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)	196.9 mm +/- 2 mm (7.75 inches +/- .08 inches)
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)

ENH-DP-TPA Cable Pinout

The Enhanced DisplayPort Test Adapters provide ten 2.92mm connectors (Main Link and Auxiliary 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.

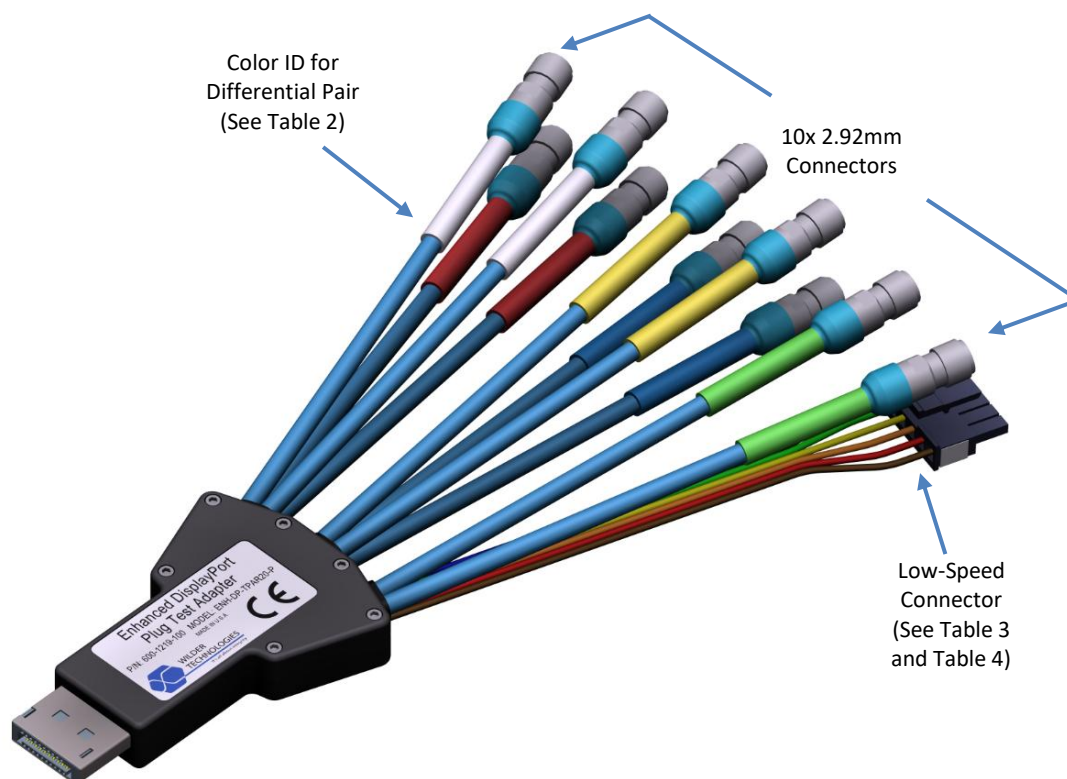


Figure 7. Cable Connectors (ENH-DP-TPA-P shown)

Table 2. Connectors (High-Speed)

LABEL	COLOR ID FOR DIFFERENTIAL PAIR	DESCRIPTION
T0_P/R3_N	White	Differential Data Lane 0+ for Source, Lane 3- for Sink
T0_N/R3_P	White	Differential Data Lane 0- for Source, Lane 3+ for Sink
T1_P/R2_N	Red	Differential Data Lane 1+ for Source, Lane 2- for Sink
T1_N/R2_P	Red	Differential Data Lane 1- for Source, Lane 2+ for Sink
T2_P/R1_N	Yellow	Differential Data Lane 2+ for Source, Lane 1- for Sink
T2_N/R1_P	Yellow	Differential Data Lane 2- for Source, Lane 1+ for Sink
T3_P/R0_N	Blue	Differential Data Lane 3+ for Source, Lane 0- for Sink
T3_N/R0_P	Blue	Differential Data Lane 3- for Source, Lane 0+ for Sink
AUX_P	Green	Differential Auxiliary Channel Positive (+)
AUX_N	Green	Differential Auxiliary Channel Negative (-)

Table 3. ENH-DP-TPA 6-position Cable Connector “P2” (Low-Speed).

LABEL	PIN NO.	COLOR ID FOR TPA	DESCRIPTION
HPD	Pin 1	Brown	Hot Plug Detect
PWR	Pin 2	Red	DP_PWR
GND	Pin 3	Orange	Ground
GND	Pin 4	Yellow	Ground
CF1	Pin 5	Green	Config1
CF2	Pin 6	Blue	Config2

Table 4. Enhanced DisplayPort Plug and Receptacle Pin Assignments

Pin Description	Connector Pin Number	Destination Number (Source/Sink)	Color Identification (Plug/Receptacle)
ML Lane 0 (p) – Source ML Lane 3 (n) – Sink	1	T0_P/R3_N	White Label
Ground	2	Ground	N/A
ML Lane 0 (n) – Source ML Lane 3 (p) – Sink	3	T0_N/R3_P	White Label
ML Lane 1 (p) – Source ML Lane 2 (n) – Sink	4	T1_P/R2_N	Red Label
Ground	5	Ground	N/A
ML Lane 1 (n) – Source ML Lane 2 (p) – Sink	6	T1_N/R2_P	Red Label
ML Lane 2 (p) – Source ML Lane 1 (n) – Sink	7	T2_P/R1_N	Yellow Label
Ground	8	Ground	N/A
ML Lane 2 (n) – Source ML Lane 1 (p) – Sink	9	T2_N/R1_P	Yellow Label
ML Lane 3 (p) – Source ML Lane 0 (n) – Sink	10	T3_P/R0_N	Blue Label
Ground	11	Ground	N/A
ML Lane 3 (n) – Source ML Lane 0 (p) – Sink	12	T3_N/R0_P	Blue Label
Pulled to Ground	13	Ground	N/A
Pulled to Ground	14	Ground	N/A
AUX CH (p)	15	AUX_P	Green Label
Ground	16	Ground	N/A
AUX CH (n)	17	AUX_N	Green Label
Hot Plug Detect	18	P2 Pin 1	Brown/Violet Insulation
Return DP_PWR	19	P2 Pin 3	Orange/White Insulation
DP_PWR	20	P2 Pin 2	Red/Gray Insulation
Ground	2, 5, 8, 11, 13, 14, 16	P2 Pin 4	Yellow/Black Insulation

Electrical Specifications

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

Table 5. Electrical Specifications

SPECIFICATION	MINIMUM	TYPICAL	MAXIMUM	NOTES
Plug Fixture Insertion Loss @ 10GHz (dB)		1.14		Measured from test fixture SMA connectors, up to but not including the connector pads.
Receptacle Fixture Insertion Loss @ 10GHz (dB)		1.65		Measured from test fixture SMA connectors, up to but not including the connector pads.
Differential Impedance (ohms), at 25ps Rise Time	95		105	All lanes and Aux CH, Receptacle and Plug, excluding Enhanced DisplayPort connector
Intra-lane Skew (ps)		0.5	1	All lanes and Aux CH, including mated Receptacle and Plug
Inter-lane Skew (ps)	-20		20	All lanes and Aux CH, including mated Receptacle and Plug
Current Carrying (A)	0.5			DP_PWR and Return

Note: Compliance test specifications are currently under development by VESA. Test results will be included in future revisions of this manual once the specifications are released.

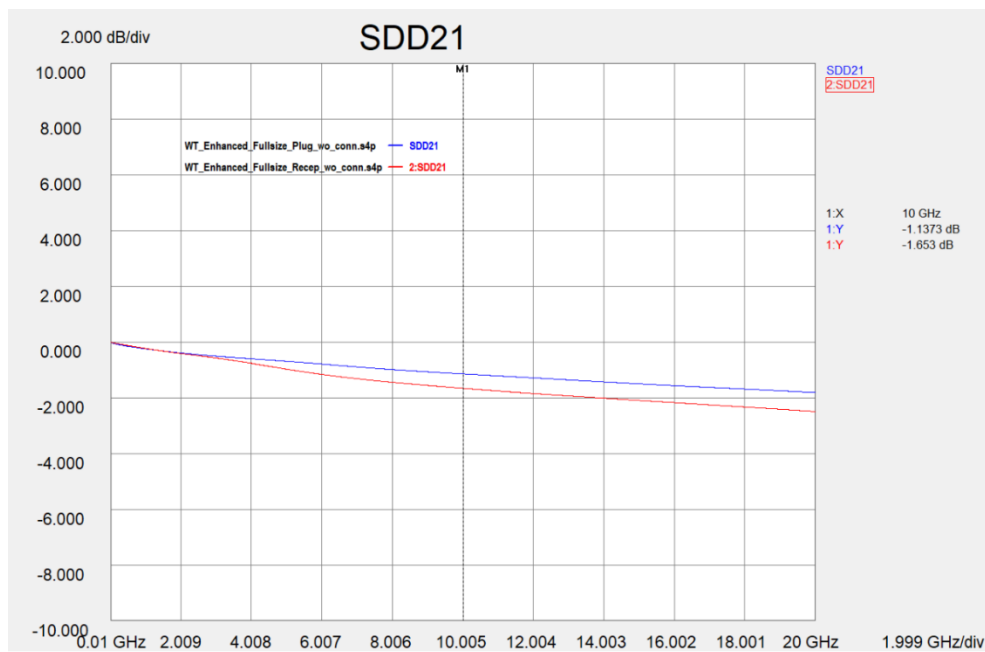


Figure 8. Typical De-embed File Insertion Loss (Plug BLUE, Receptacle RED)

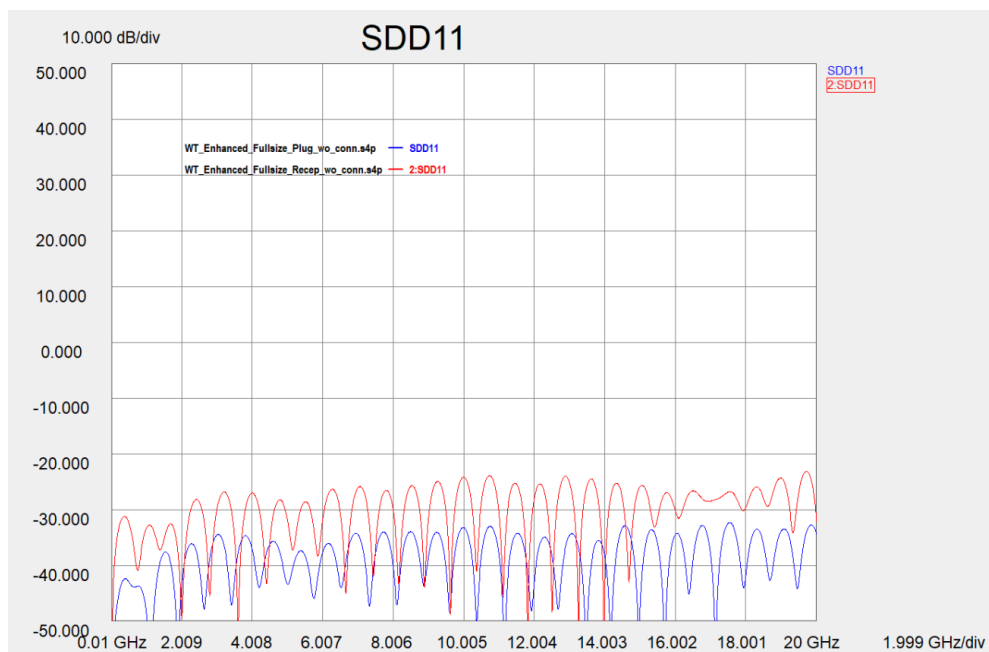


Figure 9. Typical De-embed File Return Loss (Plug BLUE, Receptacle RED)

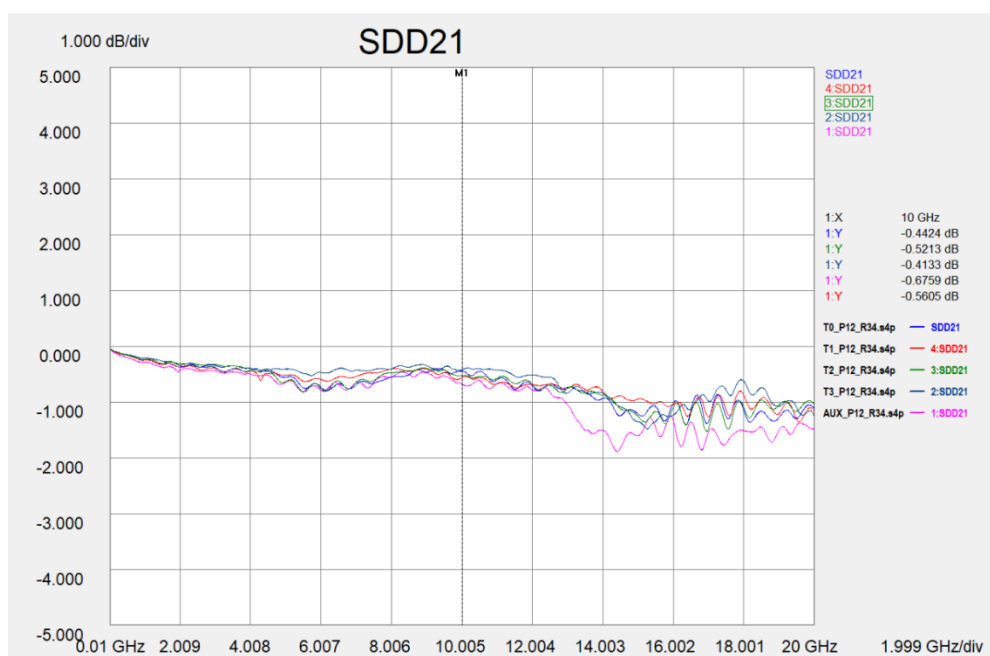
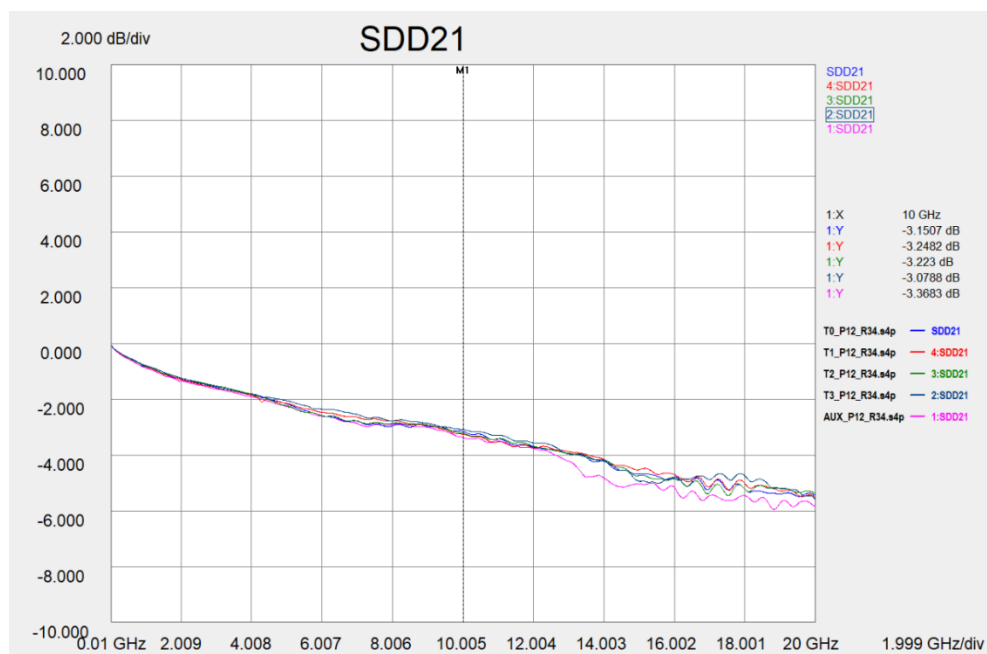


Figure 10. Typical Mated Pair Balanced Insertion Loss, with calibration (top) and without calibration (bottom)

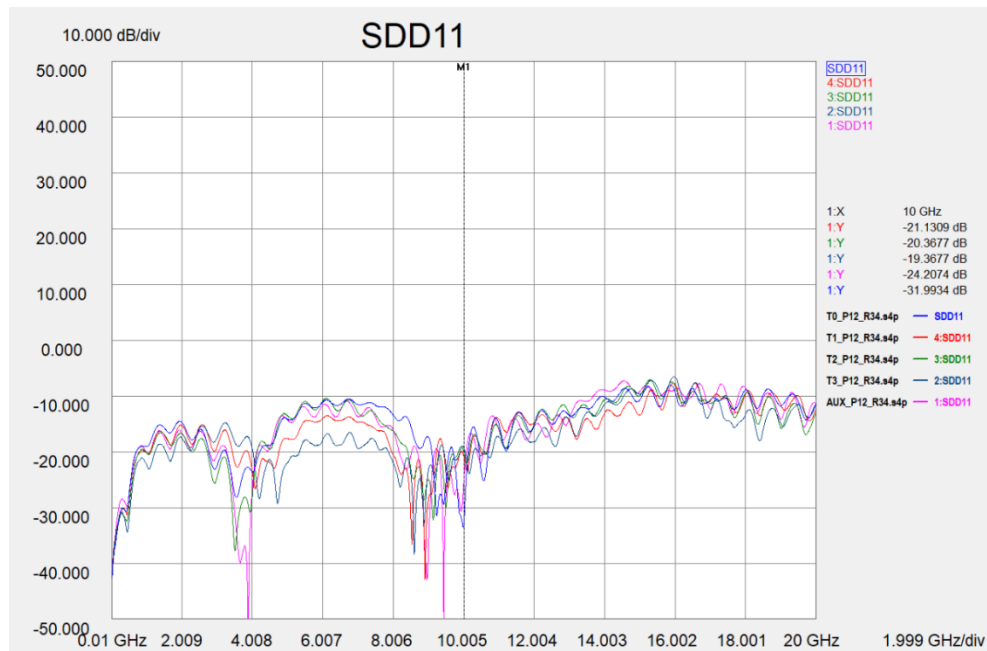
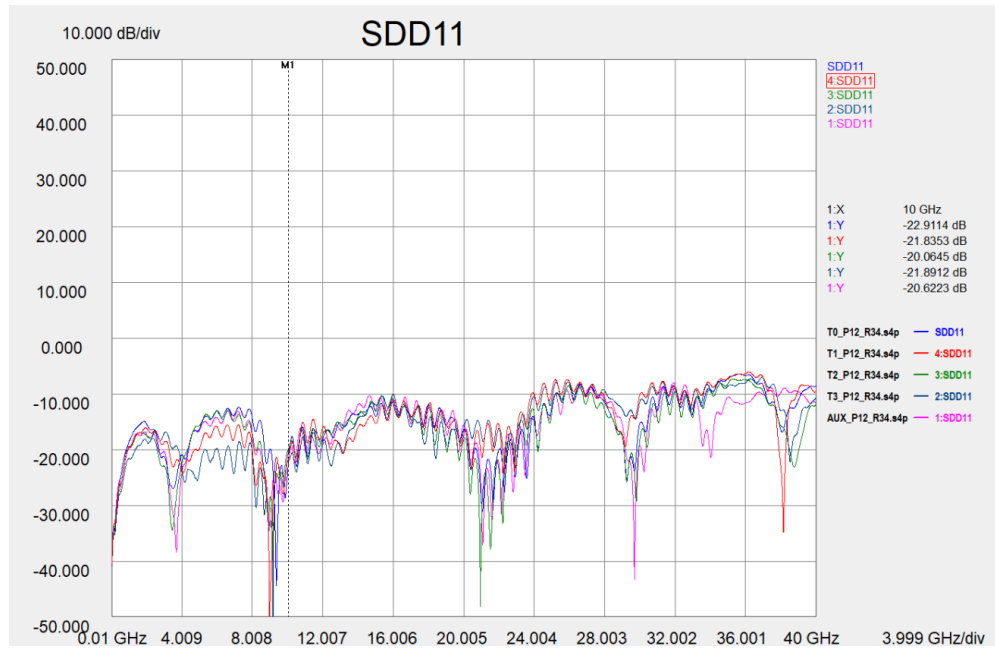


Figure 11. Typical Mated Mair Balanced Return Loss, with calibration (top) and without calibration (bottom)

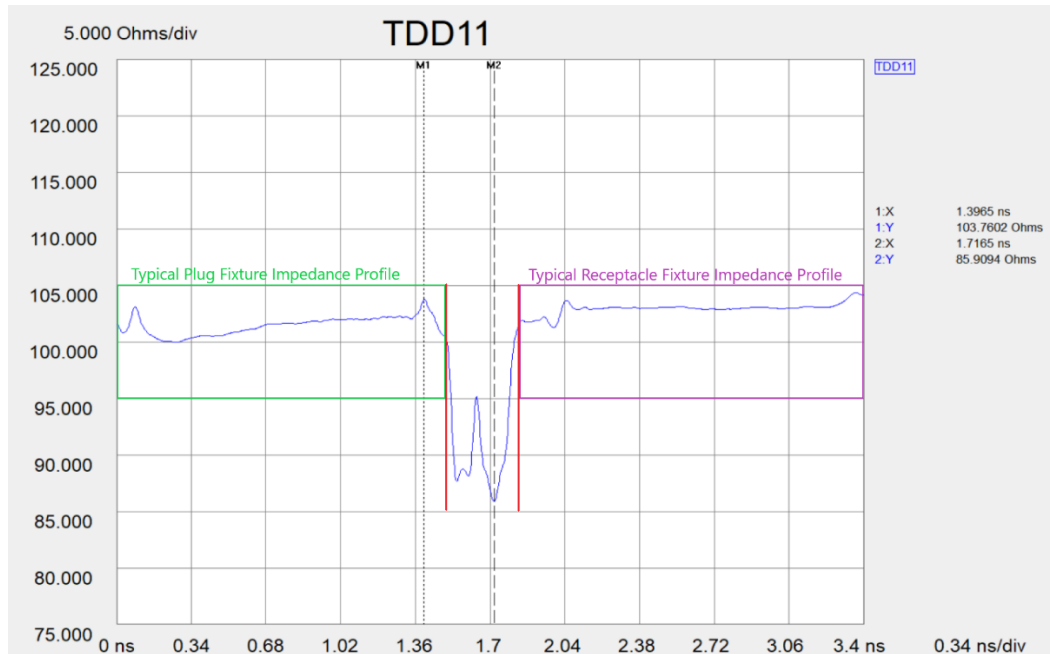


Figure 12. Typical Differential TDR of TPA-P connected to TPA-R at 25ps Rise Time (20/80%)

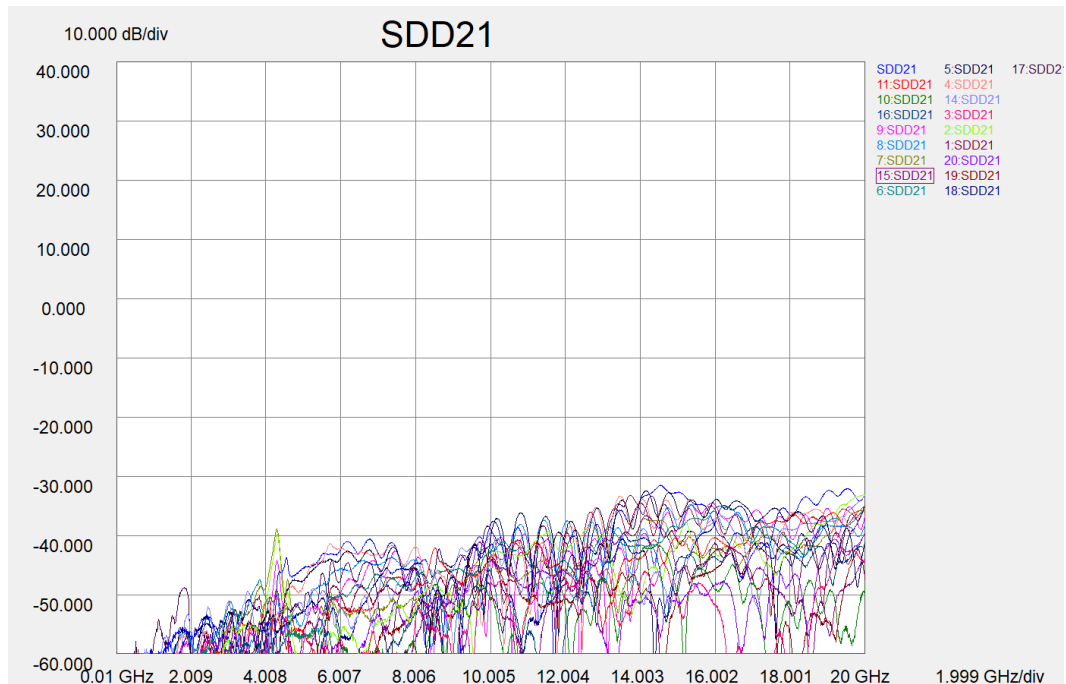
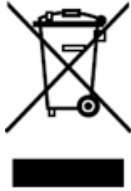


Figure 13. Typical Mated Pair Differential FEXT with all unused lanes terminated to 50Ω.

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 EG Metals Inc. – Metal and Electronics Recycling of Hillsboro, Oregon, www.egmetalrecycling.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.



Compliance To RoHS 2 Substance Restrictions

Wilder Technologies, LLC certifies that the parts described in this document are compliant to the substance restrictions of Directive 2011/65/EU and Amendment Directive (EU) 2015/863 of the European Parliament, and of the Council of 8 June, 2011 and 31 March, 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 2 Directive), prohibiting the use in homogeneous materials in excess of the listed maximum concentration value, except in cases where use is allowed by applicable exemptions listed in Annex III and Annex IV of the Directive.

Compliance with RoHS 2 has been verified through internal controls at design and production sites, including establishment of processes for specifying and controlling materials and segregation of non-compliant parts, receipt of supplier declarations of compliance and/or analytical test.

Glossary of Terms

TERMINOLOGY	DEFINITION
Aggressor	A signal imposed on a system (i.e., cable assembly) to measure response on other signal carriers.
AUX Channel	Half-duplex, bi-directional channel between the DisplayPort transmitter and DisplayPort receiver. Consists of one differential pair transporting self-clocked data. The DisplayPort AUX Channel supports a bandwidth of 1Mbps over the DisplayPort link. DisplayPort Source is the master that initiates an AUX Channel transaction. DisplayPort Sink is the slave that replies to the AUX Channel transaction initiated by the Requester.
Box-to-box connection	DisplayPort link between two boxes detachable by an end user. A DisplayPort cable-connector assembly for the box-to-box connection shall have four Main Link lanes.
DDC/CI	Display Data Channel/Command Interface (VESA)
DisplayPort Receiver	Circuitry that receives the incoming DisplayPort Main Link data. Also contains the transceiver circuit for AUX Channel. Located in Sink Device and the upstream port of Intermediate Device.
DisplayPort Transmitter	Circuitry that transmits the DisplayPort Main Link data. Also contains the transceiver circuit for AUX CH. Located in Source Device and in the downstream port of Intermediate Device.
ENH-DP-TPA	Enhanced DisplayPort Test Point Access. A specialized assembly that interfaces to an Enhanced DisplayPort receptacle or plug and enables access to signals for measurement or stimulation. "Interoperability" allows access to Config1 and Config2.
Dual-standard Device Source or Sink	Device that supports both DisplayPort and DVI/HDMI operating modes.
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.
Main Link	Unidirectional channel for isochronous stream transport from DisplayPort Source to DisplayPort Sink. Consists of one, 2, or 4 lanes, or differential pairs. Supports 3 bit rates: 5.4 Gb/s per lane (referred to as "High Bit Rate 2"), 2.7Gb/s per lane (referred to as "High Bit Rate") and 1.62Gb/s per lane (referred to as "Reduced Bit Rate").
Normative	The designation of a test that is required for compliance.
Sink Device	A device that contains A/V stream sinks for display and/or sound.
Source Device	A device that contains a stream source and originates an isochronous A/V stream.
Victim	A signal carrier on a system that has a response imposed on it by other signals in the system.

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