DisplayPort Type-C Test Adapter

User Manual

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Introduction

This user's manual documents the DisplayPort Type-C Plug and Receptacle Test Adapters (DPC-TPA-P and DPC-TPA-R), and the associated Mode Control Board (DPC-TPA-CB). The two test adapter types, shown in Figures 1 and 2, test DisplayPort Type-C interface cables, hosts and devices against the DisplayPort Alt Mode on USB Type-C Standard and CTS.

The TPA-P and TPA-R test adapter assemblies allow easy access, via SMA connections, to measure or inject data signals. The test adapters also provide access to USB DP/DN, CC1, CC2, VBUS and Ground, via an 8-position low-speed connector. Additionally, the user can access VBUS and Ground through a 2-position Sense connector. Mating 8-position and 2-position connector housings and contact terminals are supplied with the test adapters to connect these signals to a wiring assembly provided by the user.

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.

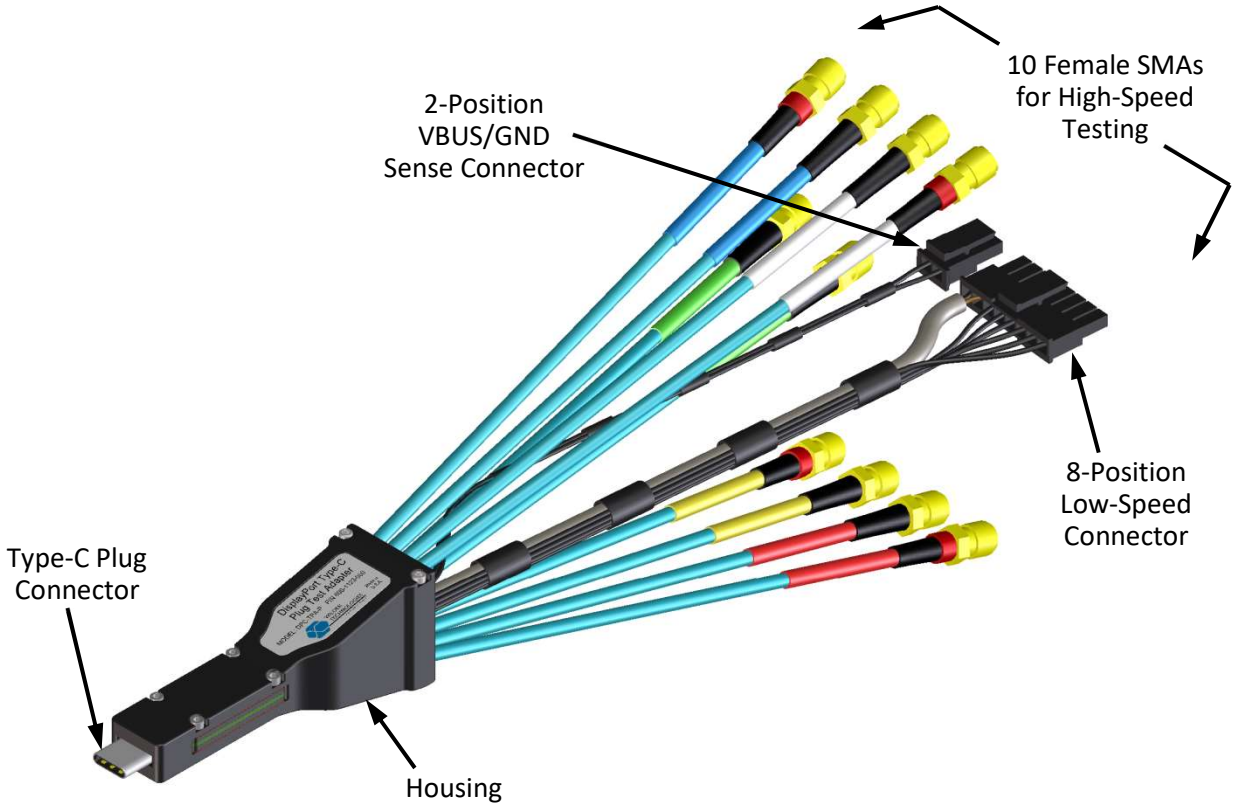


Figure 1. The DPC-TPA-P Test Adapter (Host Plug).

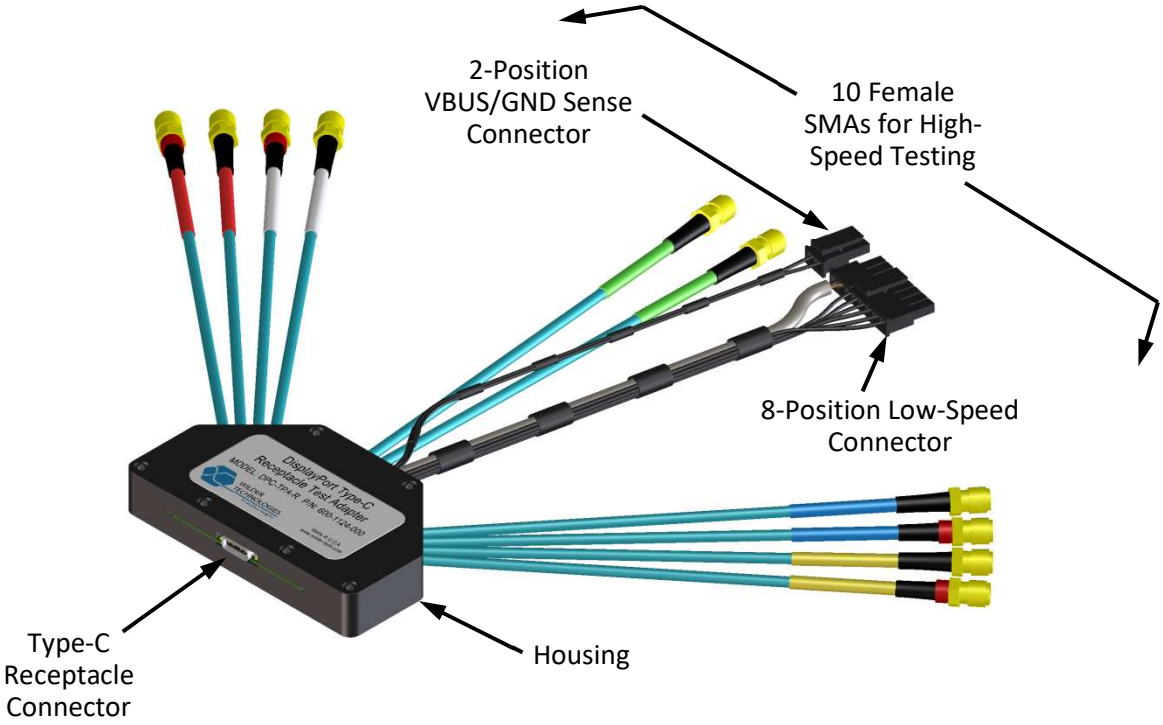


Figure 2. The DPC-TPA-R Test Adapter (Device Receptacle).

The 8-position keyed/latching connector part number is 43645-0800. The 2-position keyed/latching connector part number is 43645-0200. The mating plug connector housings and contact pins for 26-30awg wire are provided with each TPA assembly (Molex part numbers 43640-0801 for the 8-position plug housing, Molex 43640-0201 for the 2 position plug housing, and Molex 43031-0011 for the 26-30awg plug terminal contacts). Replacement connector parts can be purchased through Molex distributors.

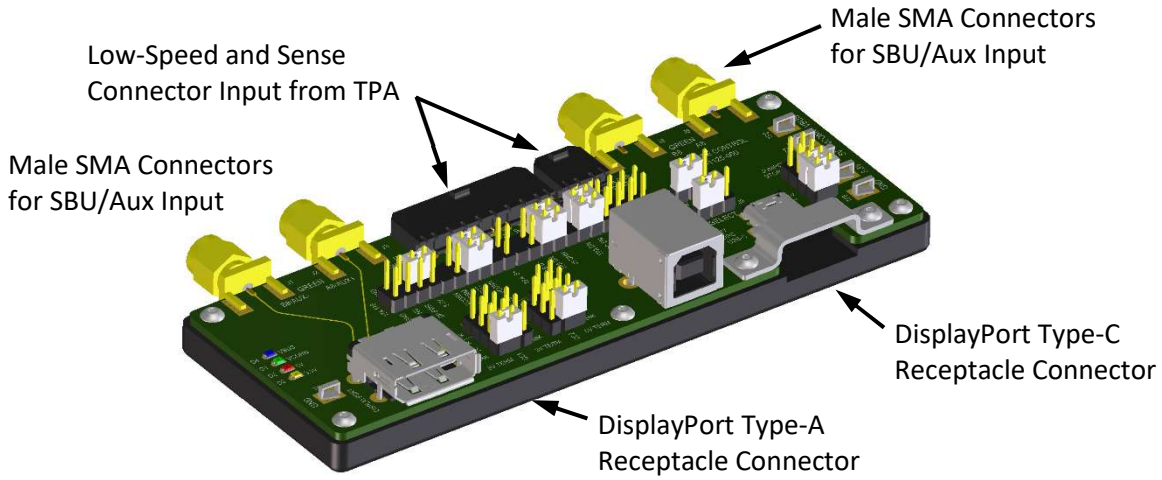


Figure 3. DPC-TPA-CB Mode Control Board

The DisplayPort Type-C Mode Control Board is used in conjunction with DPC TPAs to allow the user to configure test models, as appropriate, to the verification tests referenced in the DisplayPort Alt Mode on USB Type-C CTS.

Product Inspection

Upon receiving the DPC-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 DPC 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 DPC Test Adapter Care and Handling Precautions

The DPC 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 DPC-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 DPC-TPA as a unit, with one end held stationary, may damage or severely degrade performance. Adherence to Caution 5 (below) helps to avoid twisting.

- **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 DPC-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 DPC-TPA and cables. Use adjustable elevation stands or apparatus to accurately place and support the DPC-TPA.

- **CAUTION 4: Connect the DPC-TPA First**
  To prevent twisting, bending, or applying tension to the coaxial cables when connecting a DPC-TPA, always attach the DPC-TPA to the device under test (DUT) or cable under test before attaching any SMA connectors. Carefully align the DPC connectors and then gently push the connectors together until fully seated.

  If the DPC-TPA must be turned or twisted to make connection to the DUT, avoid using the DPC-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 DPC-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 DPC-TPA to or from the DUT. Pulling directly on the DPC-TPA cables or using them to insert the DPC-TPA may cause damage.

- **CAUTION 5: Carefully Make SMA Connections**
  To connect the DPC-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 DPC-TPA coaxial cable.

3. The DPC-TPA SMA connectors have flats that accept an open-end 1/4-inch or 6.5mm wrench. When attaching instrument cables to the DPC-TPA, it is recommended that the DPC-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 channel 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 DPC-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 DPC-TPA, ensure that all connectors are clean. Handle all cables carefully and store the DPC-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 DPC-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 an appropriately sized torque wrench (depends on SMA gender), 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 DPC-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 MΩ of isolation from ground. Acceptable ESD accessories may be purchased from a local supplier.

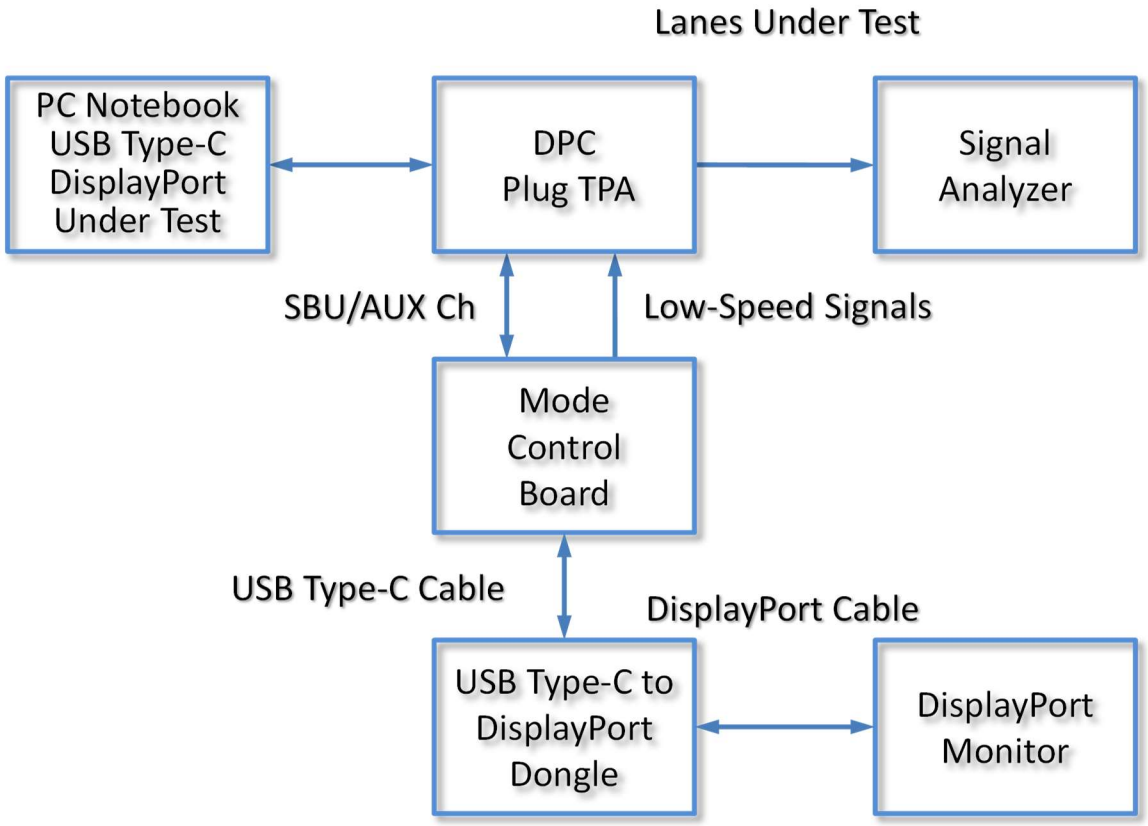
WARNING: These techniques for a static-safe work station should not be used when working on circuitry with a voltage potential greater than 500 volts.

User Models

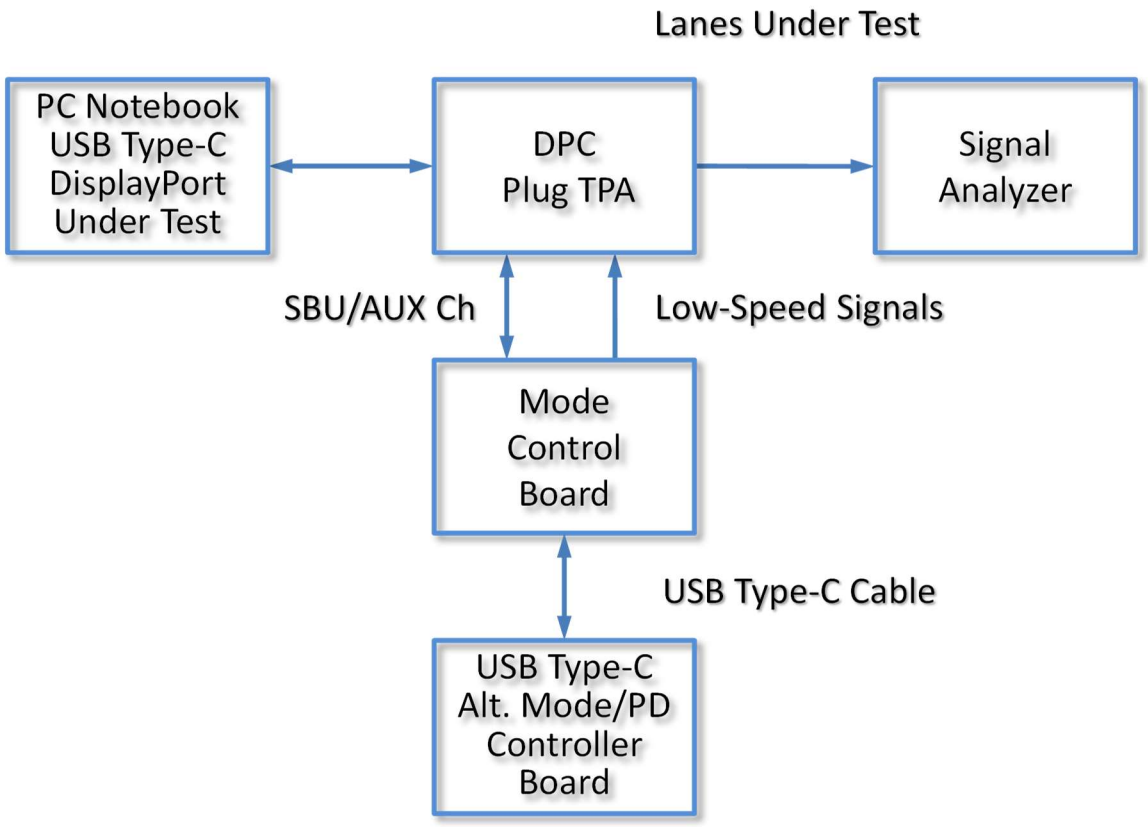
The DisplayPort Type-C TPA supports testing of the DisplayPort Alt Mode on USB Type-C CTS. It is capable of performing within the scope of measurements contained in the CTS PHY, limited only by the specifications, environmental, care and handling as stated in this document.

The following examples are suggestions and/or references for possible testing setups.

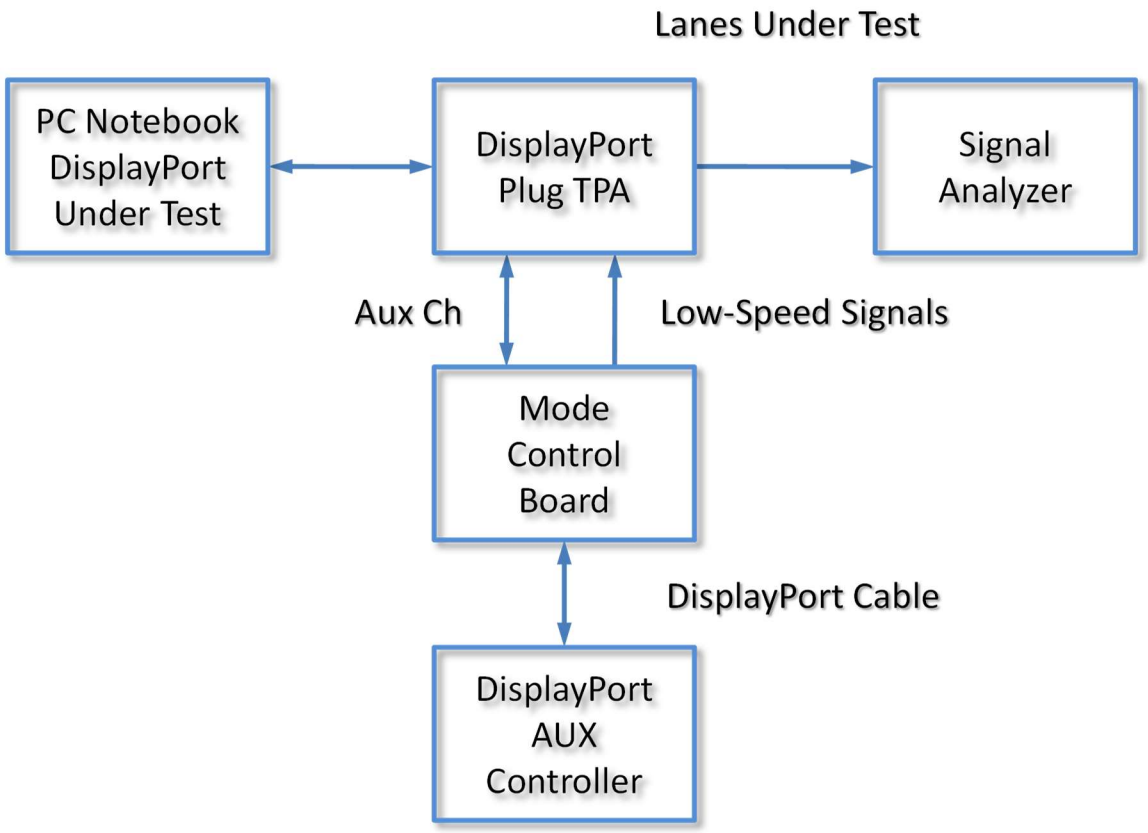
This first example illustrates a DP Type-C Host/Source test using a USB Type-C to DisplayPort Dongle to assert Alt Mode:



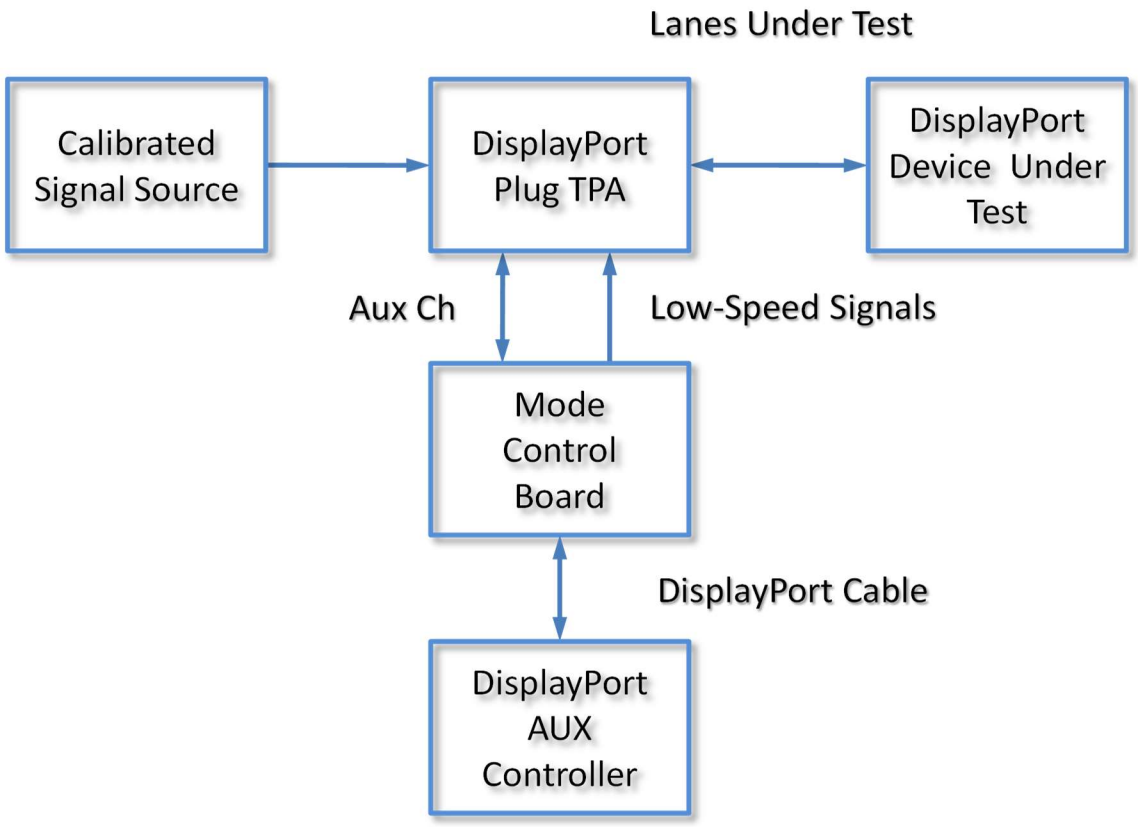
This second example illustrates DP Type-C Host/Source test with USB Alt Mode/PD Controller:



This third example shows, as a reference, a “Legacy” DisplayPort Host/Source test:



This fourth example shows, as a reference, a “Legacy” DisplayPort Device/Sink test:



Calibration Through De-Embedding

The DisplayPort Type-C Test Adapters are fully passive components. Therefore, calibration compensating for the losses must occur within the test instrumentation that drives the DisplayPort Type-C receiver or looks at the response of the DisplayPort Type-C transmitter.

The DPC-TPA's have Touchstone S4P files for de-embedding the electrical length and losses within the TPA up to the Type-C 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 un-calibrated 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 DPC-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
Plug Test Adapter Length (w/standard cables)	206 mm +/- 2 mm (8.12 inches +/- .08 inches) (Characteristic)
Receptacle Test Adapter Length (w/std. cables)	181 mm +/- 2 mm (7.12 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)

DPC-TPA-P Cable Pinout

The DPC-TPA-P cables provide 10 SMA connectors (access up to four lanes of differential TX and RX, and Aux signals), one 8-position low-speed connector, and one 2-position sense connector. Labels clearly mark each cable or connector. The following figure refers to pin-description tables for each of the three connector types.

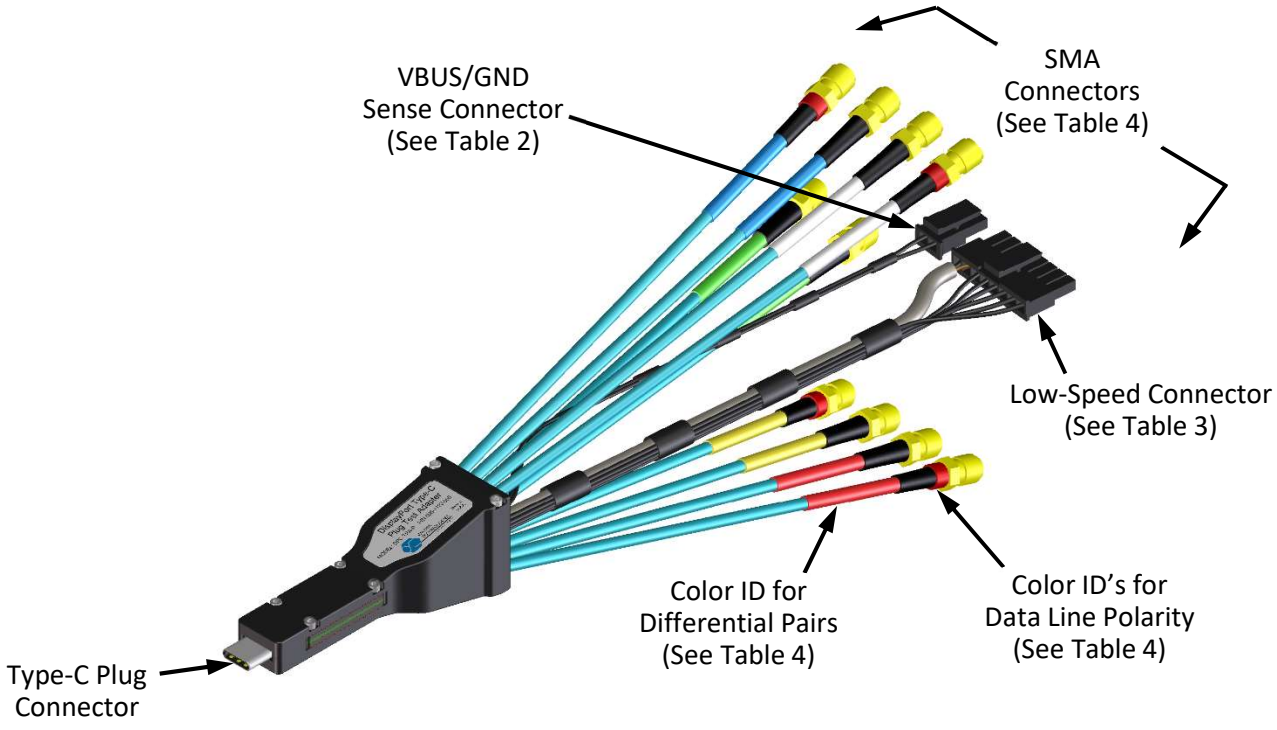


Figure 4. DPC-TPA-P (Plug) Cable Connectors

Table 2. DPC-TPA-P 2-Position Sense Connector

LABEL	PIN NO.	DESCRIPTION
GND	Pin 1	Ground Return (Sense)
VBSN	Pin 2	VBUS (Bus Power, Sense)

Table 3. DPC-TPA-P 8-Position Low-Speed Connector

LABEL	PIN NO.	DESCRIPTION
GND	Pin 1	Ground Return
VBUS	Pin 2	Bus Power
VBUS	Pin 3	Bus Power
GND	Pin 4	Ground Return
CC1	Pin 5	CC1/CC, Configuration Channel/Cable Logic (PD)
CC2	Pin 6	CC2/VCONN, Configuration Channel/Powers Cable Logic
DP	Pin 7	USB 2.0 Differential Pair, Positive
DN	Pin 8	USB 2.0 Differential Pair, Negative

Table 4. DPC-TPA-P (Plug) Pin Assignments

Pin Description	Connector Pin Number	Destination Name	Color ID for Data Line Polarity	Color ID for Differential Pair (Plug)
Signal Ground	A1	Signal Ground, GND	N/A	N/A
TX1+ (USB SuperSpeed, Transmit 1 Pos.)	A2	A2	Red	White
TX1- (USB SuperSpeed, Transmit 1 Neg.)	A3	A3	Black	White
VBUS (Bus Power)	A4	VBUS/VBSN	N/A	N/A
CC (Configuration Channel)	A5	CC1	N/A	N/A
D+ (USB 2.0 Differential Pair Positive)	A6	DP	N/A	N/A
D- (USB 2.0 Differential Pair Negative)	A7	DN	N/A	N/A
SBU1 (Side Band Use 1)	A8	A8	Black	Green
VBUS (Bus Power)	A9	VBUS/VBSN	N/A	N/A
RX2- (USB SuperSpeed, Receive 2 Neg.)	A10	A10	Black	Blue
RX2+ (USB SuperSpeed, Receive 2 Pos.)	A11	A11	Red	Blue
Signal Ground	A12	Signal Ground, GND	N/A	N/A
Signal Ground	B1	Signal Ground, GND	N/A	N/A
TX2+ (USB SuperSpeed, Transmit 2 Pos.)	B2	B2	Red	Yellow
TX2- (USB SuperSpeed, Transmit 2 Neg.)	B3	B3	Black	Yellow
VBUS (Bus Power)	B4	VBUS/VBSN	N/A	N/A
VCONN (USB Plug Power)	B5	CC2	N/A	N/A
Not Used	B6	N/A	N/A	N/A
Not Used	B7	N/A	N/A	N/A
SBU1 (Side Band Use 2)	B8	B8	Black	Green
VBUS (Bus Power)	B9	VBUS/VBSN	N/A	N/A
RX1- (USB SuperSpeed, Transmit 2 Neg.)	B10	B10	Black	Red
RX1+ (USB SuperSpeed, Transmit 2 Pos.)	B11	B11-	Red	Red
Signal Ground	B12	Signal Ground, GND	N/A	N/A

DPC-TPA-R Cable Pinout

The DPC-TPA-R cables provide 10 SMA connectors (access up to four lanes of differential TX and RX, and Aux signals), one 8-position low-speed connector, and one 2-position sense connector. Labels clearly mark each cable or connector. The following figure refers to pin-description tables for each of the three connector types.

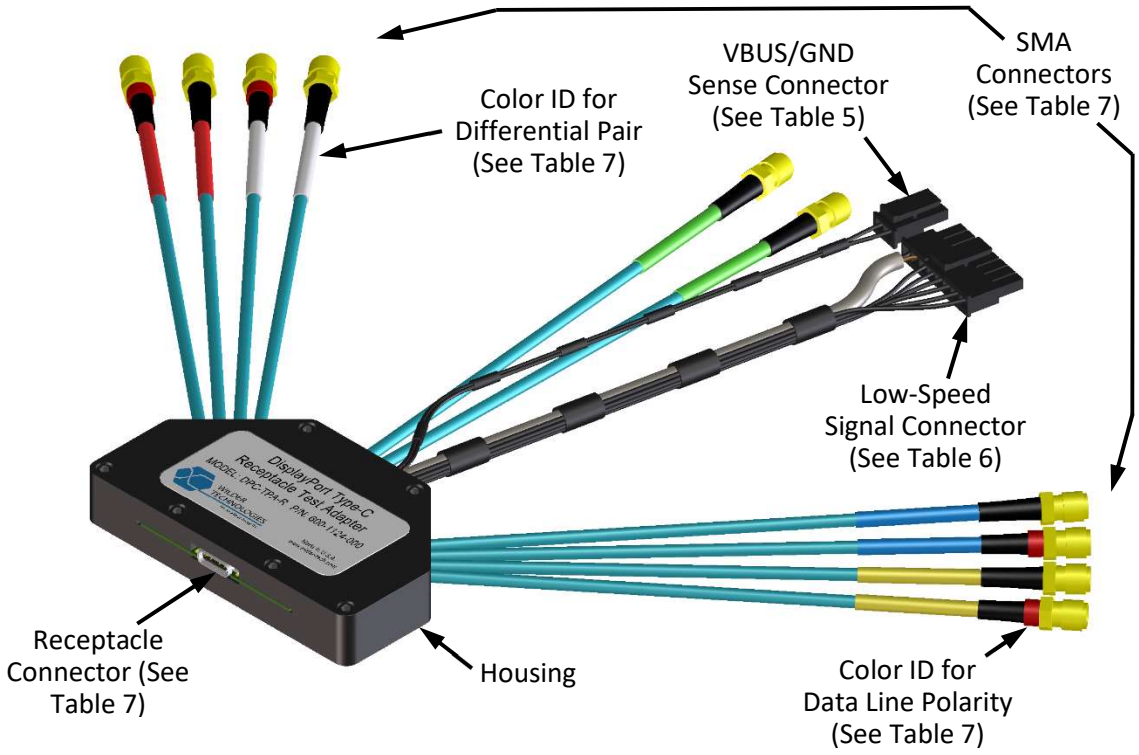


Figure 5. DPC-TPA-R (Receptacle) Cable Connectors

Table 5. DPC-TPA-R 2-Position Sense Connector

LABEL	PIN NO.	DESCRIPTION
GND	Pin 1	Ground Return (Sense)
VBSN	Pin 2	VBUS (Bus Power, Sense)

Table 6. DPC-TPA-R 8-Position Low-Speed Connector

LABEL	PIN NO.	DESCRIPTION
GND	Pin 1	Ground Return
VBUS	Pin 2	Bus Power
VBUS	Pin 3	Bus Power
GND	Pin 4	Ground Return
CC1	Pin 5	CC1/CC, Configuration Channel/Cable Logic (PD)
CC2	Pin 6	CC2/VCONN, Configuration Channel/Powers Cable Logic
DP	Pin 7	USB 2.0 Differential Pair, Positive
DN	Pin 8	USB 2.0 Differential Pair, Negative

Table 7. DPC-TPA-R (Receptacle) Pin Assignments

Pin Description	Connector Pin Number	Destination Name	Color ID for Data Line Polarity	Color ID for Differential Pair (Receptacle)
Signal Ground	A1	Signal Ground, GND	N/A	N/A
TX1+ (USB SuperSpeed, Transmit 1 Pos.)	A2	A2	Red	White
TX1- (USB SuperSpeed, Transmit 1 Neg.)	A3	A3	Black	White
VBUS (Bus Power)	A4	VBUS/VBSN	N/A	N/A
CC1 (Configuration Channel)	A5	CC1	N/A	N/A
D+ (USB 2.0 Differential Pair Positive)	A6	DP	N/A	N/A
D- (USB 2.0 Differential Pair Negative)	A7	DN	N/A	N/A
SBU1 (Side Band Use 1)	A8	A8	Black	Green
VBUS (Bus Power)	A9	VBUS/VBSN	N/A	N/A
RX2- (USB SuperSpeed, Receive 2 Neg.)	A10	A10	Black	Blue
RX2+ (USB SuperSpeed, Receive 2 Pos.)	A11	A11	Red	Blue
Signal Ground	A12	Signal Ground, GND	N/A	N/A
Signal Ground	B1	Signal Ground, GND	N/A	N/A
TX2+ (USB SuperSpeed, Transmit 2 Pos.)	B2	B2	Red	Yellow
TX2- (USB SuperSpeed, Transmit 2 Neg.)	B3	B3	Black	Yellow
VBUS (Bus Power)	B4	VBUS/VBSN	N/A	N/A
CC2 (Configuration Channel)	B5	CC2	N/A	N/A
D+ (USB 2.0 Differential Pair Positive)	B6	DP	N/A	N/A
D- (USB 2.0 Differential Pair Negative)	B7	DN	N/A	N/A
SBU1 (Side Band Use 2)	B8	B8	Black	Green
VBUS (Bus Power)	B9	VBUS/VBSN	N/A	N/A
RX1- (USB SuperSpeed, Transmit 2 Neg.)	B10	B10	Black	Red
RX1+ (USB SuperSpeed, Transmit 2 Pos.)	B11	B11-	Red	Red
Signal Ground	B12	Signal Ground, GND	N/A	N/A

DPC-TPA-CB Mode Control Board

The DPC Mode Control Board (DPC-TPA-CB) facilitates the low-speed connectivity and signal routing between the DPC-TPA-P or the DPC-TPA-R test signals, such as CC1, CC2/VCONN, VBUS, DN and DP, and the required test setup configuration.

The board allows the connection of a USB Type-C Controller, or PD Controller, or Dongles through a USB Type-C receptacle connector on the board to assert the various Alt Modes through the TPA for testing.

The Mode Control Board also provides high-speed connectivity for the DP Aux channel/USB Type-C SBU lines via board edge SMA connections to the test fixture. Various voltage sources (VBUS, USB +5V), can be used to emulate the DFP (Downstream Facing Port) source with selectable Rp (Pull-Up) and Rd (Pull-Down) resistor termination values on CC1/CC2 lines at +5V and at +3.3V.

See the “User Model” section of this document for examples of test setups. See page 32 of this User Manual for the DisplayPort Mode Control Board reference schematic.

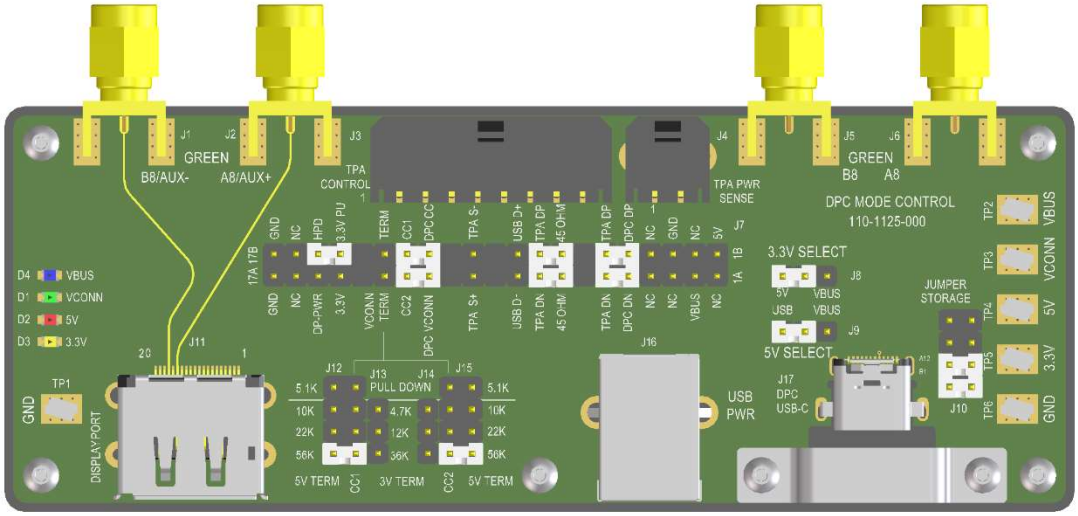


Figure 6. DPC-TPA-CB (DPC Mode Control Board)

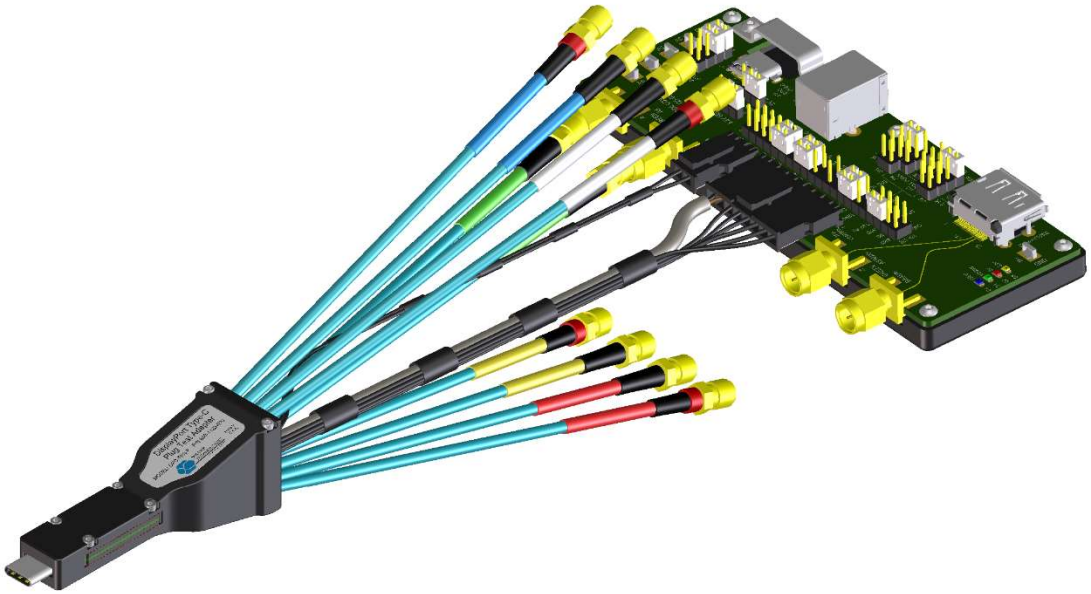


Figure 7. DPC Mode Control Board mated to a DPC-TPA-P (Plug) Test Adapter)

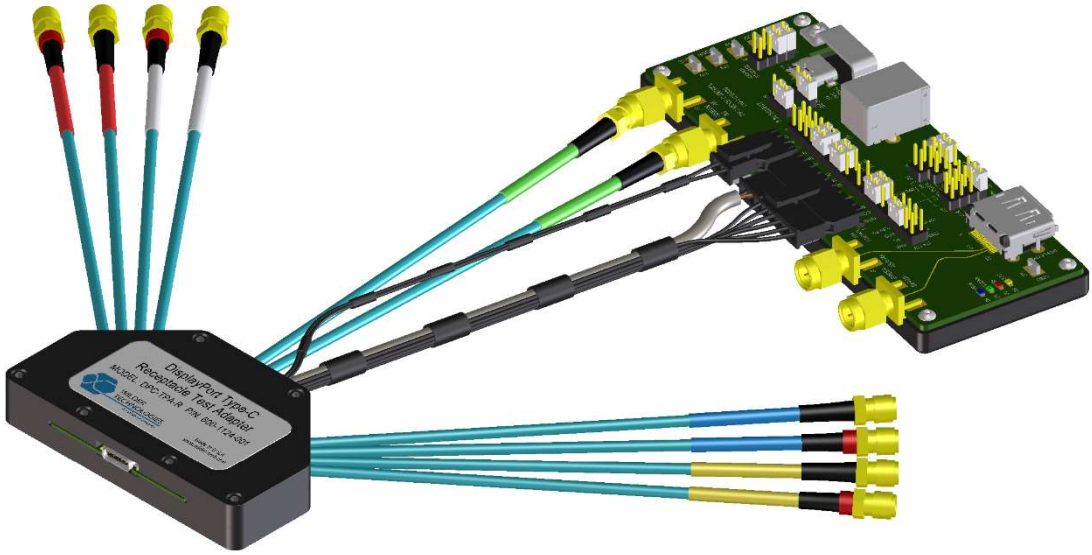


Figure 8. DPC Mode Control Board mated to a DPC-TPA-R (Receptacle) Test Adapter

Electrical Specifications

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

Table 8. Electrical Specifications

SPECIFICATION	MINIMUM	TYPICAL	MAXIMUM	NOTES
TX and RX Differential Pair Insertion Loss (GHz), at -3 dB		>9		All TX and RX Differential Pairs, Mated Plug and Receptacle TPAs with Connectors and Pads.
TX and RX Differential Pair Insertion Loss (GHz), at -3 dB		>23		All TX and RX Differential Pairs, Plug TPA without Connector and Pad.
TX and RX Differential Pair Insertion Loss (GHz), at -3 dB		>22		All TX and RX Differential Pairs, Receptacle TPA without Connector and Pad.
SBU/Aux Differential Pair Insertion Loss (GHz), at -3 dB		5		SBU/Aux Differential Pair, Mated Plug and Receptacle TPAs with Connectors and Pads.
TX and RX Differential Pair Return Loss (GHz), at -10 dB		11		All TX and RX Differential Pairs, Mated Plug and Receptacle TPAs with Connectors and Pads.
SBU/Aux Differential Pair Return Loss (GHz), at -10 dB		20		SBU/Aux Differential Pair, Mated Plug and Receptacle TPAs with Connectors and Pads.
Differential Impedance (ohms), 50 ps Rise Time, 10 – 90 percent	>95		<105	All Differential Pairs (High-Speed Only), Receptacle and Plug, excluding the USB Type-C connector.
Single-Ended Impedance (ohms), 50 ps Rise Time, 10 – 90 percent	>47.5		<52.5	All Single-Ended Conductors (High-Speed Only), Receptacle and Plug, excluding USB Type-C connector.
Intra-pair Skew (ps)		<5		All Differential Pairs, Mated Plug and Receptacle TPAs.
NEXT (dB), at 7 GHz		Better Than -36		Near-End Crosstalk, all differential pairs, single aggressor, Mated Plug and Receptacle TPAs.
FEXT (dB), at 8 GHz		Better Than -33		Far-End Crosstalk, all differential pairs, single aggressor, Mated Plug and Receptacle TPAs.
Current Carrying (A) Per Pin			1.25	+5V Power (Nominal).

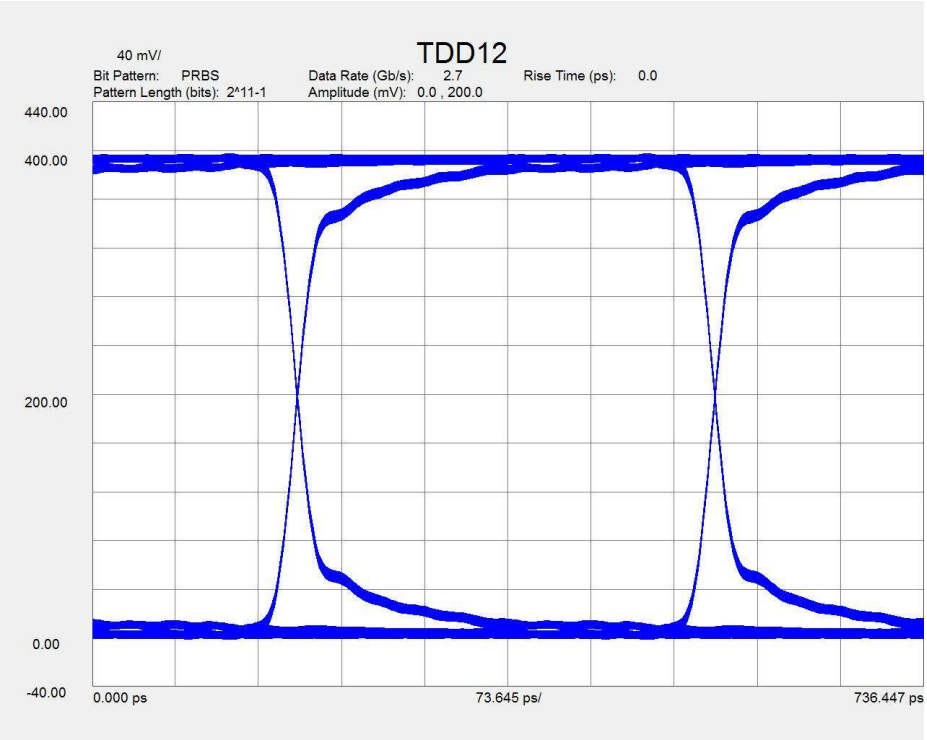


Figure 9. Typical mated pair 2.7 Gb/s eye diagram.

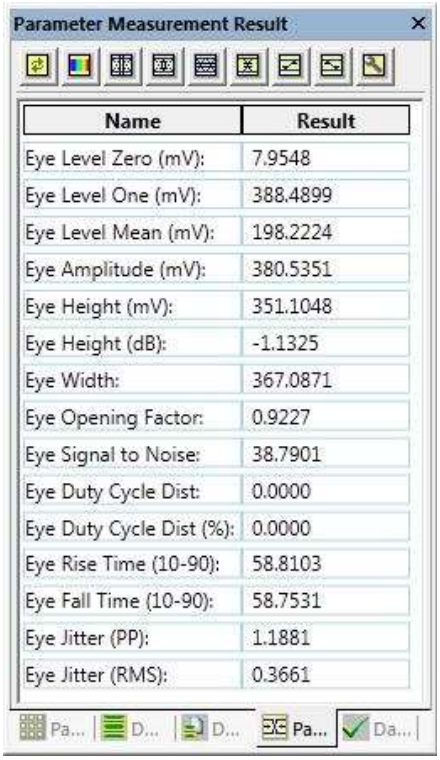


Figure 10. Typical mated pair 2.7 Gb/s eye data.

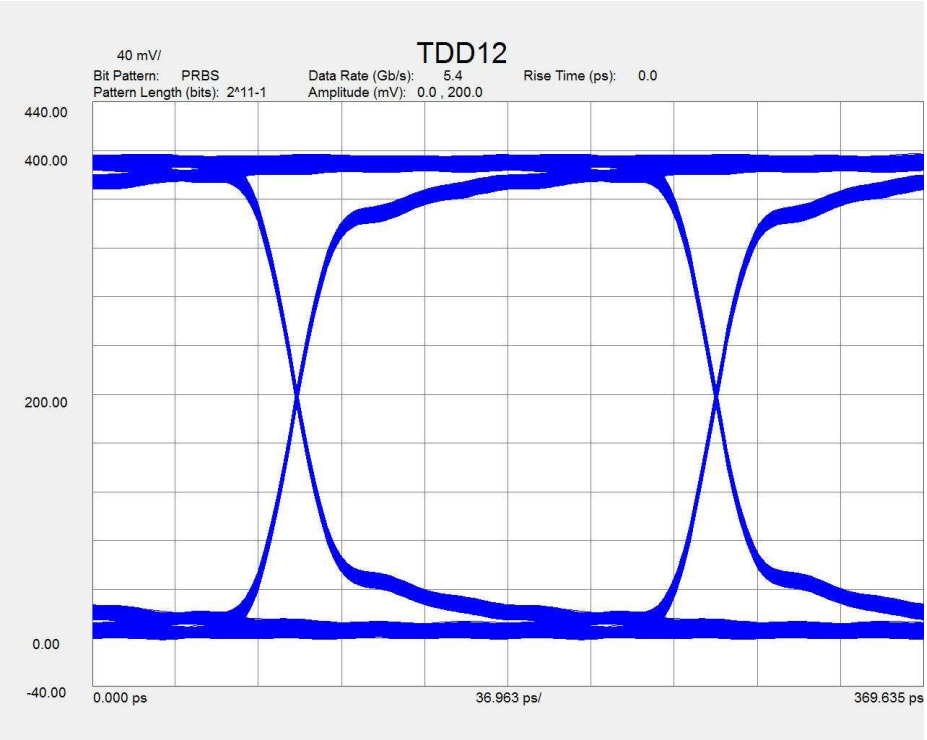


Figure 11. Typical mated pair 5.4 Gb/s eye diagram.

Figure 12. Typical mated pair 5.4 Gb/s eye data.

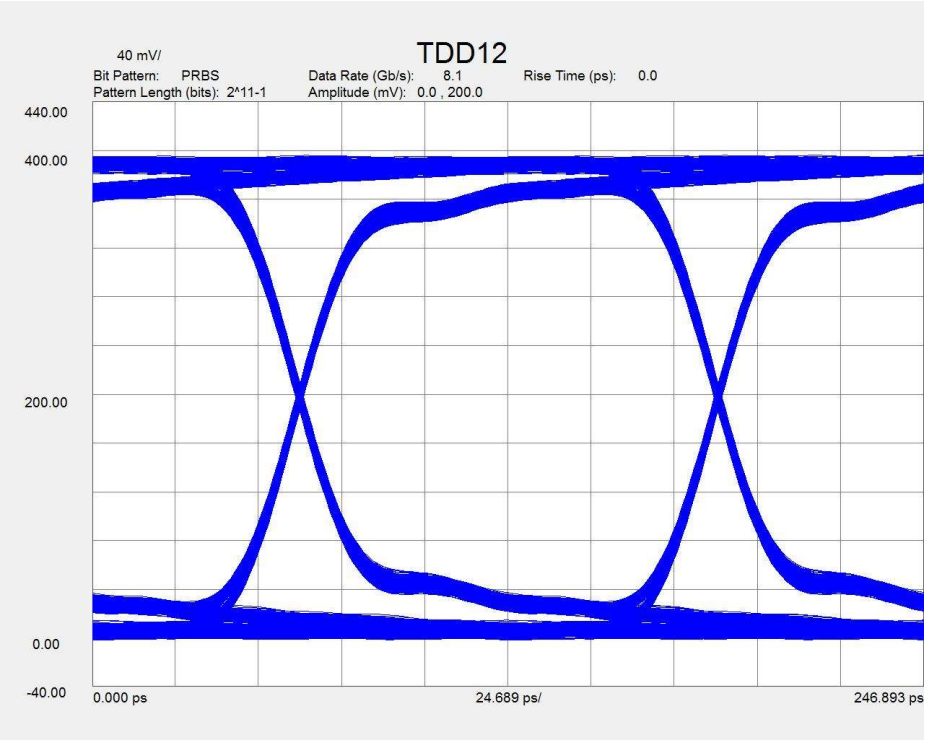


Figure 13. Typical mated pair 8.1 Gb/s eye diagram.

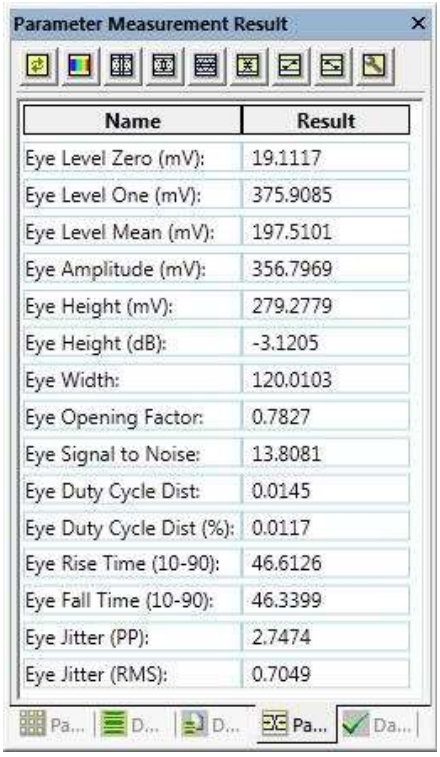


Figure 14. Typical mated pair 8.1 Gb/s eye data.

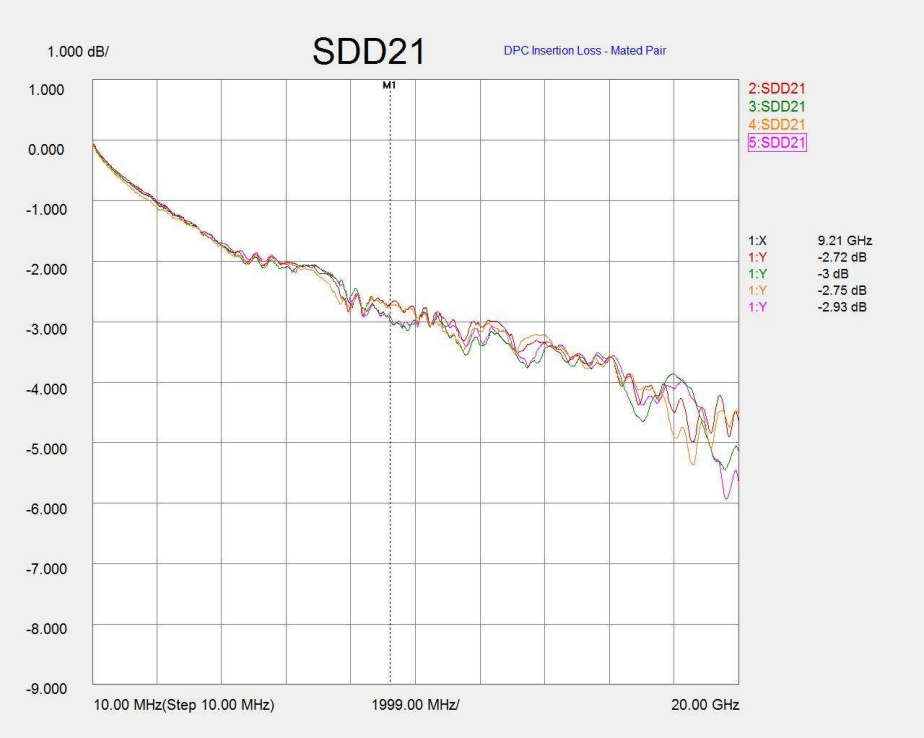


Figure 15. All TX and RX differential mated pairs, balanced insertion loss.

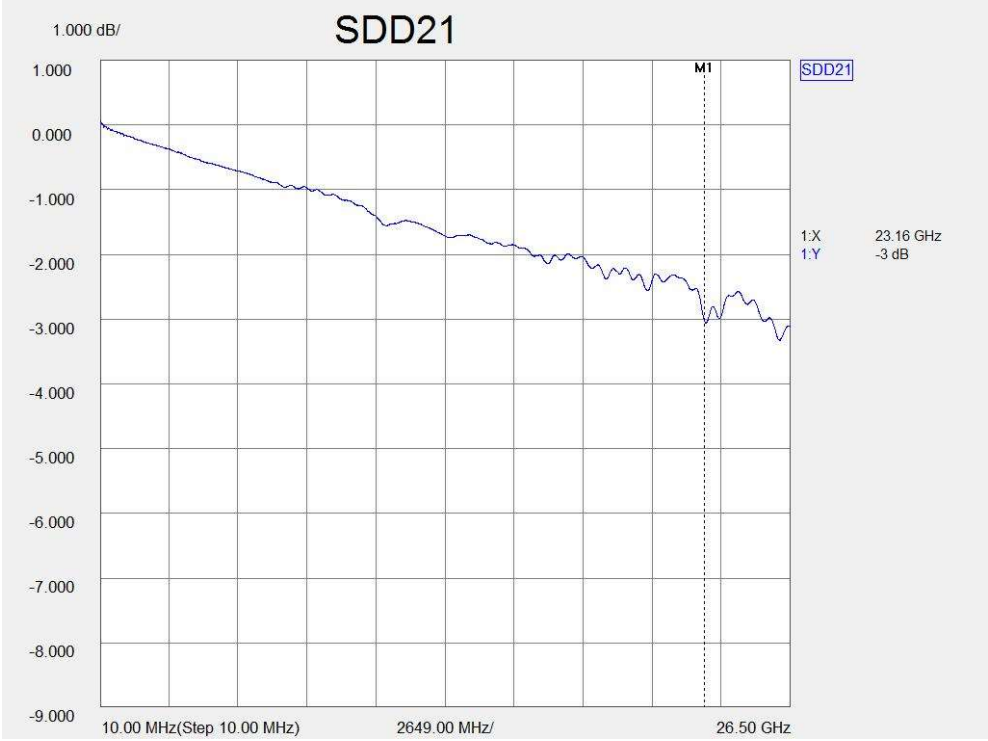


Figure 16. Typical TX and RX differential pairs, plug TPA without connector and pad.

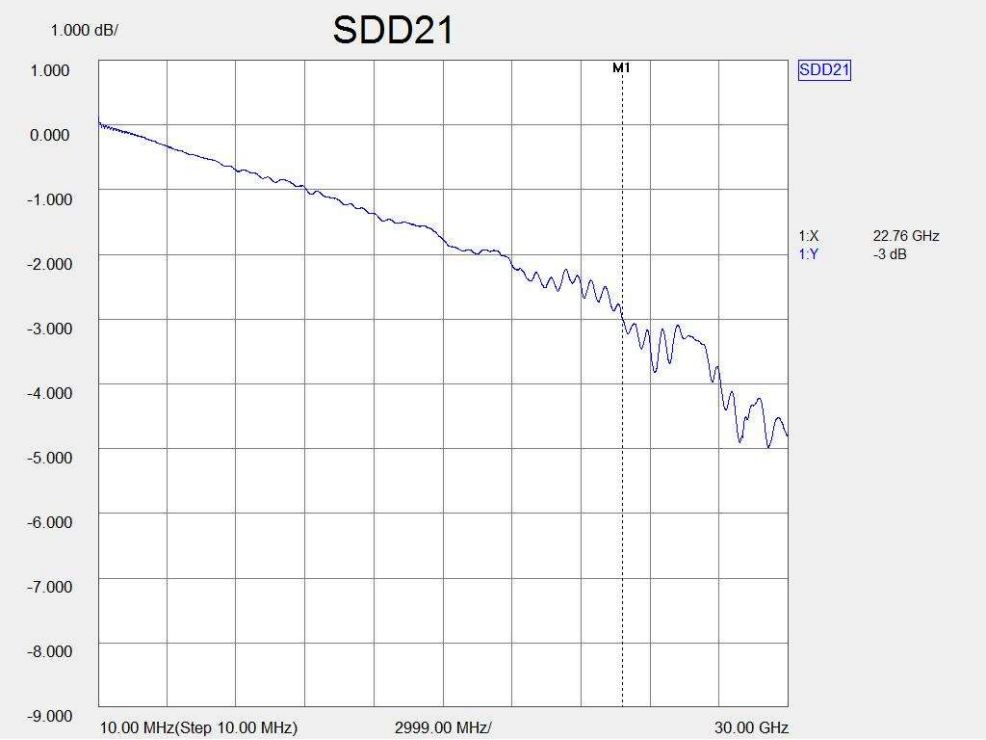


Figure 17. Typical TX and RX differential pairs, receptacle TPA without connector and pad.

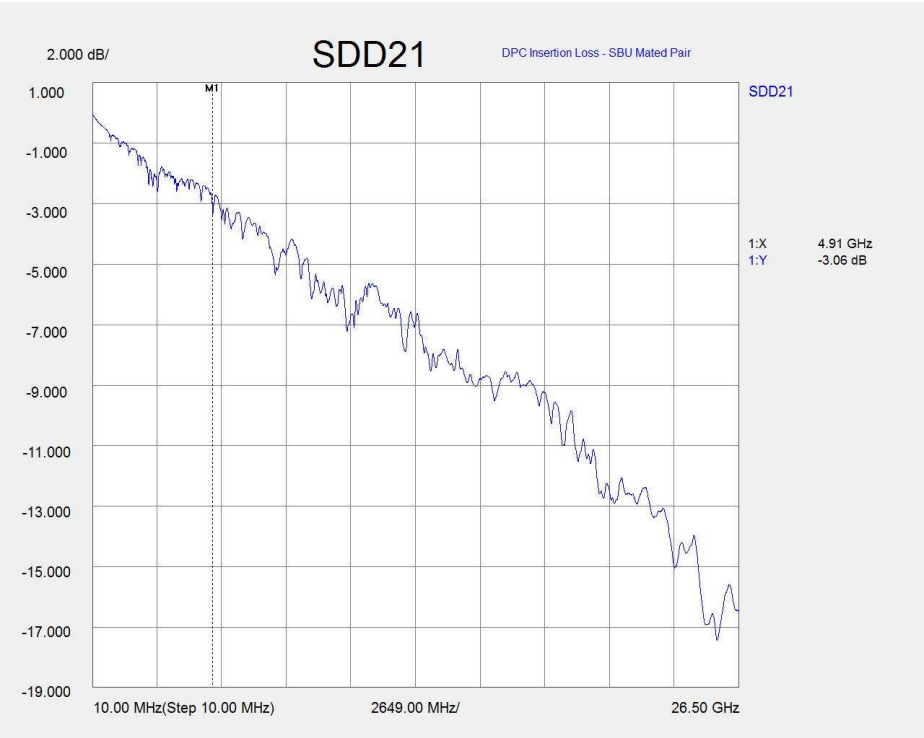


Figure 18. SBU/Aux differential mated pair, balanced insertion loss.

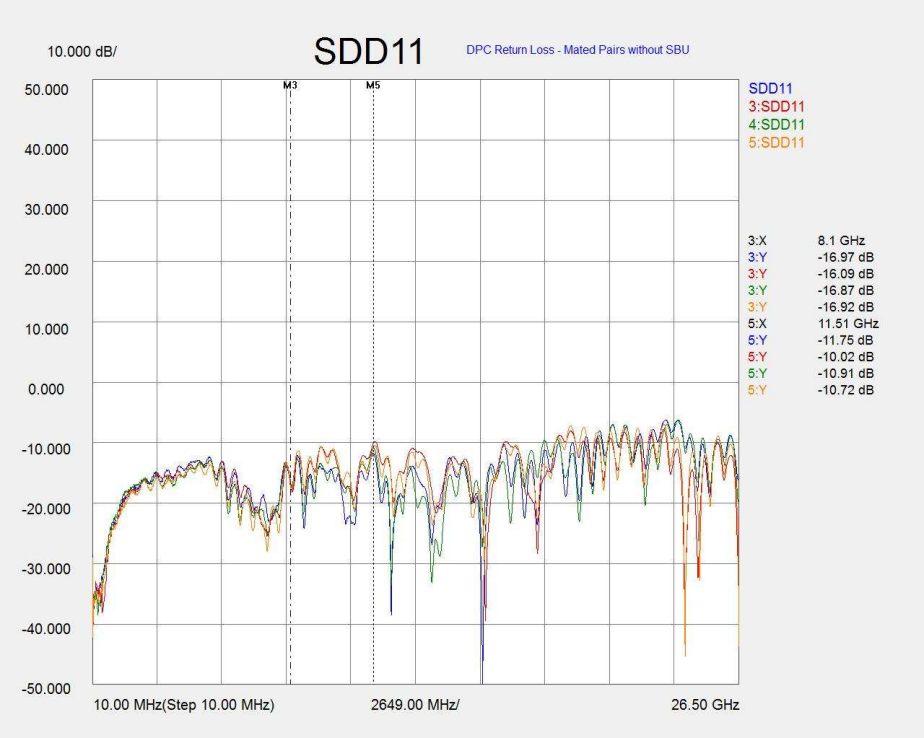


Figure 19. All TX and RX differential mated pairs, balanced return loss.

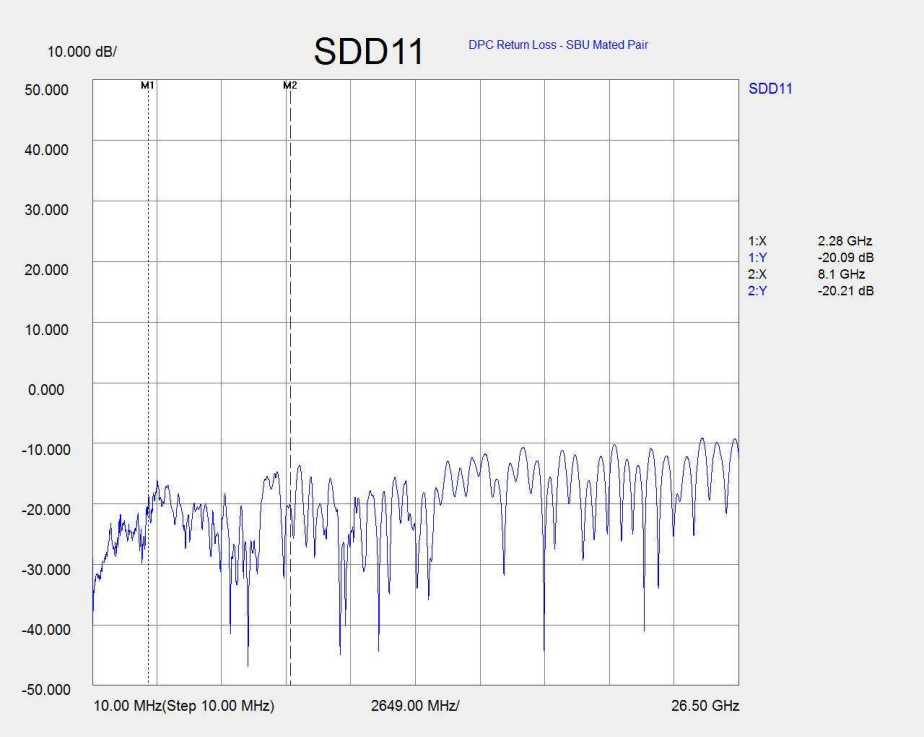


Figure 20. SBU/Aux differential mated pair, balanced return loss.

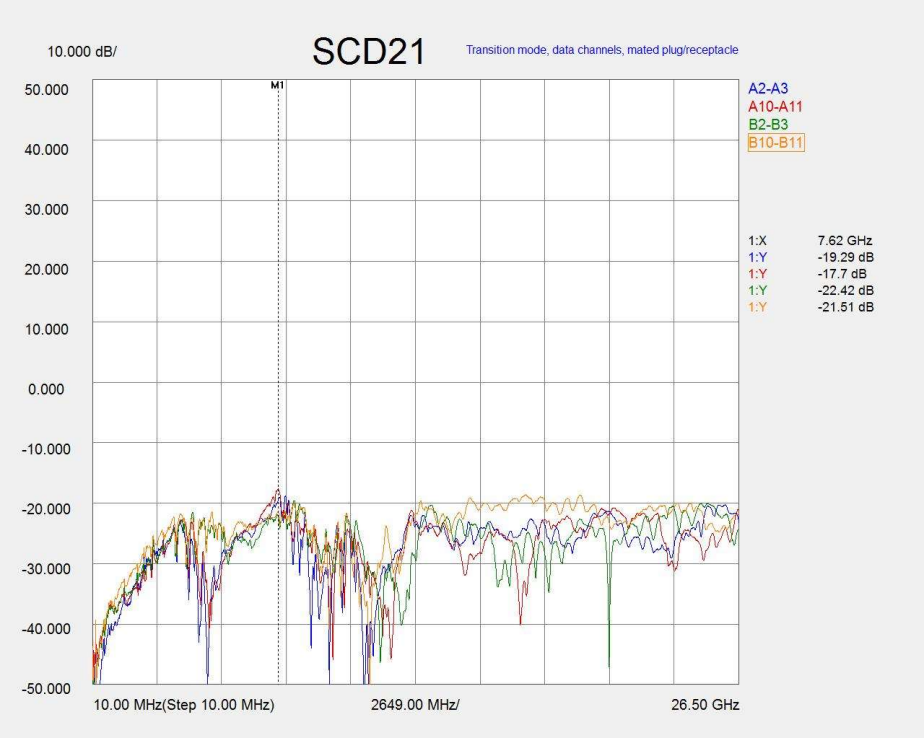


Figure 21. Typical mated pair differential to common mode conversion.

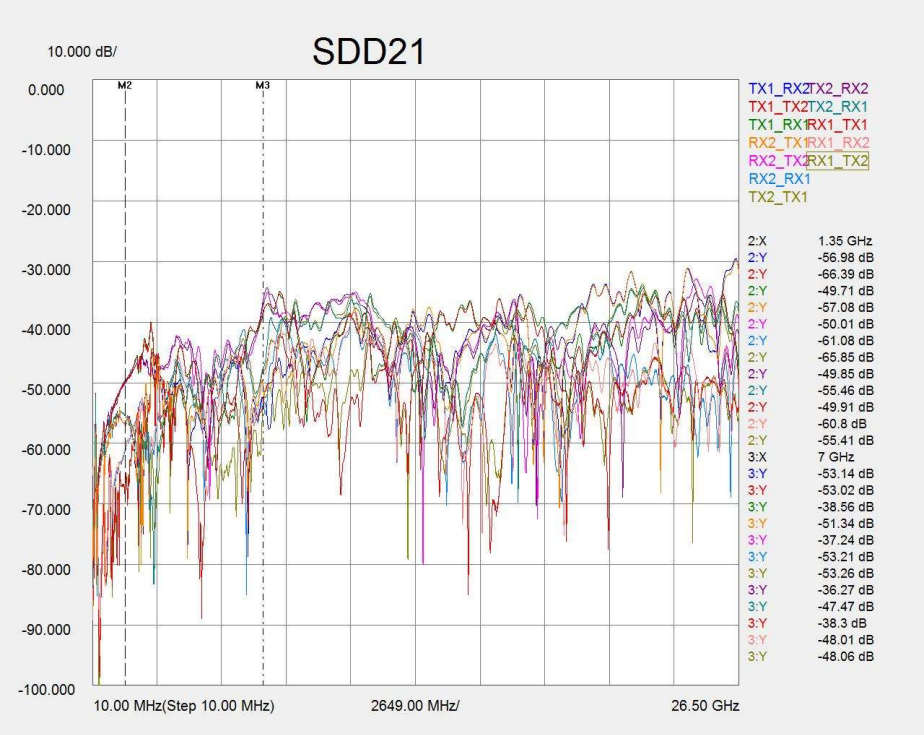


Figure 22. Typical Differential NEXT, with mated Plug and Receptacle TPAs, adjacent differential pairs, all differential pairs terminated at both ends. (Excludes SBU channel.)

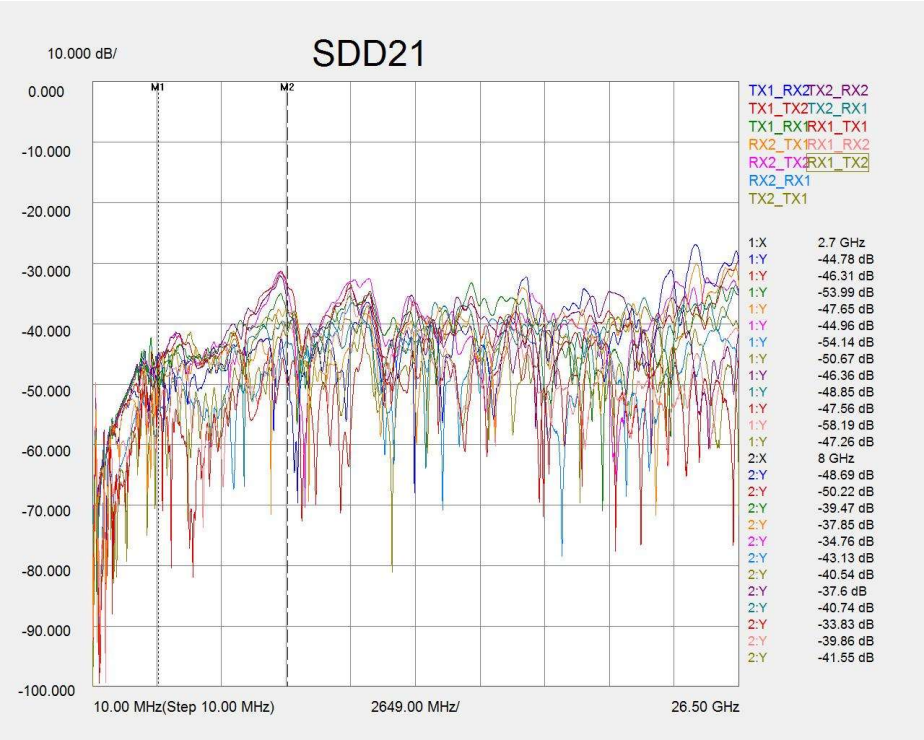
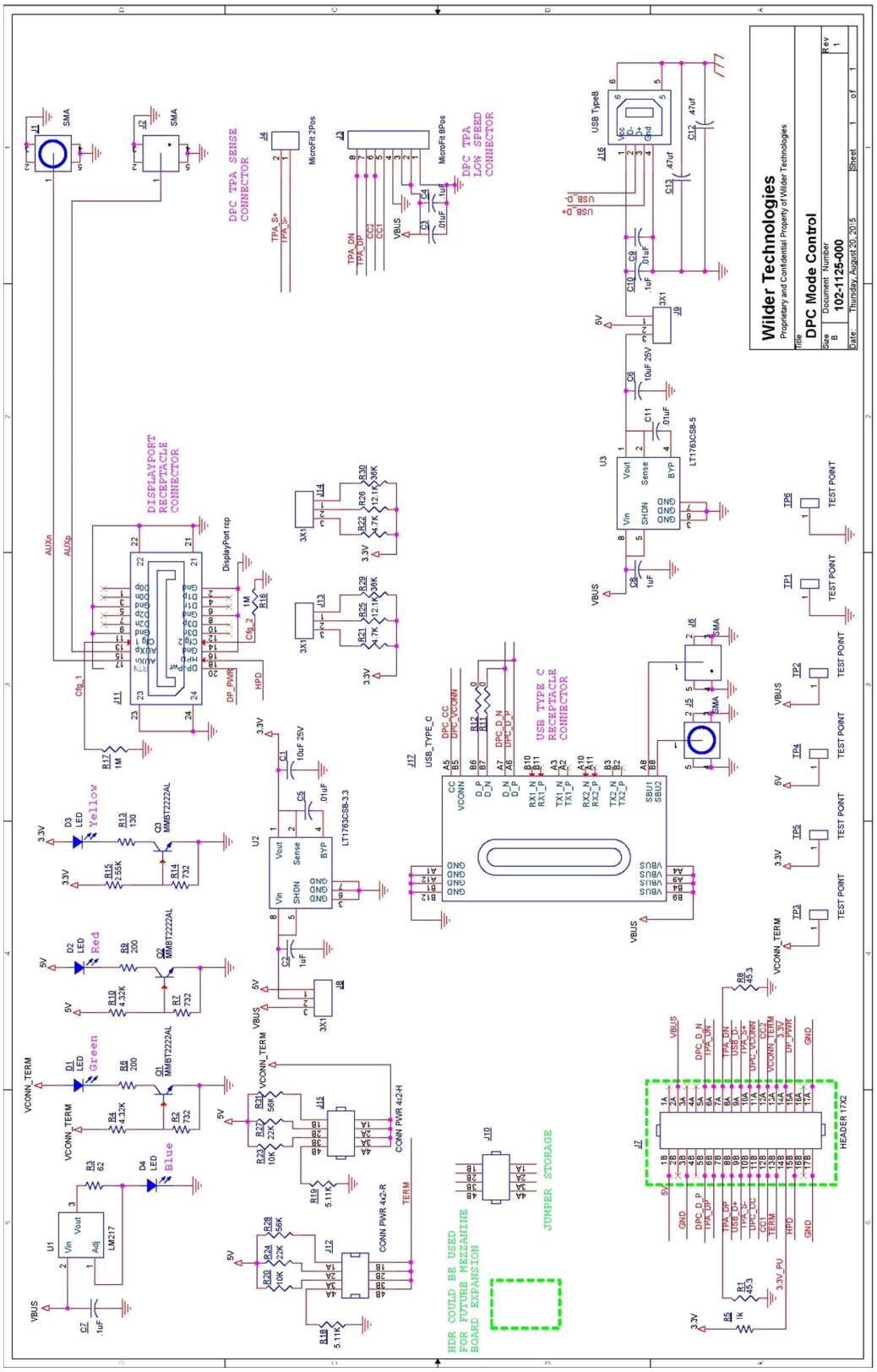


Figure 23. Typical Differential FEXT, with mated Plug and Receptacle TPAs, adjacent differential pairs, both transmit and receive terminated at both ends. (Excludes SBU channel.)

DisplayPort Type-C Mode Control Board Reference Schematic



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, with the exceptions of the HDMIA2 (HDMI v2.0), HDMID2 (HDMI v2.0), SFP28, QSFP28, DPC, and USBC Test Adapters, whereby are warranted for a period of 6 months, all other aspects of the Wilder Technologies, LLC warranty apply.

See Consumable and Fragile Material Warranty for exceptions to the 6 and 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 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.

Glossary of Terms

TERMINOLOGY	DEFINITION
Alternate Mode	Operation defined by a vendor or standards organization that is associated with a SVID assigned by the USB-IF. Entry and exit into and from an Alternate Mode is controlled by *USB PD r2.0 v1.1* Structured VDM Enter Mode and Exit Mode commands.
Captive Cable	Cable that is terminated on one end with a USB Type-C plug and has a vendor-specific means with which to connect (hard-wired or custom detachable) on the opposite end.
CC	Configuration Channel
DUT	Device Under Test
Far-End Crosstalk or FEXT	Crosstalk that is propagated in a disturbed channel in the same direction as the propagation of a signal in the aggressor channel. The terminals of the aggressor channel and the victim channel are usually close to each other.
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.
Initiator	Port that initiates a *USB PD r2.0 v1.1* Vendor-Defined Message. It is independent of the port's PD role (e.g., Provider, Consumer, Provider/Consumer, or Consumer/Provider).
Insertion loss	The ratio, expressed in dB, of incident power to delivered power.
MOI	Method of implementation.
Near-End Crosstalk or NEXT	Crosstalk that is propagated in a disturbed channel in the opposite direction as the propagation of a signal in the aggressor channel. The terminals of the aggressor channel and the victim channel are usually close to each other.
Normative	The designation of a test that is required for compliance.
Passive Cable	Cable that does not incorporate any electronics to condition the data path signals. May or may not be electronically marked.
Physical Link	Two differential signal pairs, one pair in each direction, that connect two physical phys.
Responder	Port that responds to the Initiator of a *USB PD r2.0 v1.1* Vendor-Defined Message. Independent of the port's PD role (e.g., Provider, Consumer, Provider/Consumer, or Consumer/Provider).
Return Loss	The ratio, expressed in dB, of incident power to reflected power.
SBU	Sideband Use.
USB Type-C	Generic reference to a USB Type-C Plug, USB Type-C Port, USB Type-C Receptacle, or USB Type-C Cable Assembly, as specified in *USB Type-C r1.1*.
VCONN-Powered	Accessory that is powered from VCONN to operate in an Alt Mode.
Victim	A signal carrier on a system that has a response imposed on it by other signals in the system.

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