

Universal Serial Bus Type-C (USB Type-C)

Functional Test Specification

Chapters 4 and 5

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Revision History

Revision	Issue Date	Comments
0.5	2/10/15	Initial revision for internal review only.
0.6	2/23/15	First revision for external review
0.6	3/8/15	Updated to reflect USB Type-C Specification Revision 1.1, mostly affecting Connection State Machines. More spec revisions in progress.
0.61	4/10/15	Updated to reflect finalized version of USB Type-C Specification Revision 1.1
0.63	5/13/15	Tests updated to reflect that Vconn can only be checked on PUT_Rs. Test implementation is underway
0.63	5/27/15	CVS block diagram added. Debug Accessory checks added.
0.64	6/17/15	Connection State tests implemented
0.65	7/22/15	Disconnect times are immediate, Vconn is optional
0.66	8/31/15	TDs are headings, TDs are revised per several ECRs
0.67	9/14/15	Update to reflect USB type-C Specification Revision 1.1 changes missed
0.68	10/8/15	Detach timer updates, TD 4.18, 4.31 updates
0.68.1	11/28/15	Requirement update (Product Section), addition to Source-Capable Tests and Sink-Capable Tests sections describing test initialization for PD DRPs with Source/Sink default.
0.7	1/6/16	Update TD Numbering to allow for changes ahead, Try.SNK and Try.SRC connection test placeholders added, various other edits
0.7	1/15/16	Fixed a couple TD Numbering errors
0.71	3/3/16	Updated to tPDDebounce checks out of AttachWait.SNK, tAMETimeout update, various other edits
0.73	6/17/16	Updated test applicability for each TD and included VIF field explanation in testing
0.75	10/18/16	Added Try.SNK and Try.SRC tests (18 new tests) and some updates to DRP tests accordingly
0.76	12/4/16	Misc. timings and inconsistent steps updates
0.77	1/3/18	Vconn 70mW, Attach and Detach timings, Safe state, clarify PD messaging, BC 1.2 current, Audio Accessory checks, Applicability Sections update, attach Ra for applicable tests, DRP attach states
0.78	3/21/18	TD 4.2.1 – Editorial change TD 4.7.3 – Update timers TD 4.8.3 – Updated to include Try.SNK TDs 4.10.1, 4.10.2 – SNK power sub-states update with USB Self and Bus-powered descriptor info VIF field update Type_C_Battery_Powered to Port_Battery_Powered. TD 4.11.2 – Updated to clarify PUT cannot source Rp TD 4.12.2 – Editorial change
0.79	5/28/18	TD 4.2.1, 4.5.1 – Terms present by 1s TD 4.2.4, 4.6.3 – Update timers TD 4.2.8, 4.11.1 – Applicability updated TD 4.5.4, 4.6.3 – Updated to Attached.SRC Exit ECN TD 4.7.5 – CVS acts as Active Cable 5A capability TD 4.9.4 – Refers to ACCEPT not PS_RDY

		TD 4.10.1, 4.10.2, 4.10.3 – Power check updates TD 4.11.2 – Dead battery clarification
0.81	3/28/2019	TD 4.1.1 – Captive Cable hot plug incorporated TD 4.1.2 – Unpowered CC Voltage test incorporated TD 4.1.1, 4.11.1 –USB 2.0 and USB 3.2 terms are not present checks TD 4.2.1, 4.5.1, 4.6.5, 4.7.5 – Emulate PD 3.0 and PD 2.0 Active Cable TD 4.2.1, 4.4.8, 4.5.1, 4.6.5, 4.7.5 – Vconn checks and SS terms timer Various TDs – Timers clarified, current measure timing clarified TD 4.3.4 – Try.SNK tCCTryDebounce TD 4.3.5, 4.10.6 – Alt Mode Exit Mode tested TD 4.4.8 – Unsupported.Accessory user notification check TD 4.5.4, 4.6.3, 4.7.2 – Vbus disconnect check TD 4.9.5 –Alt Mode Controller and no host support check TD 4.10.1 – USB Default Current depends on current data rate clarification TD 4.10.3 – Suspend power clarification TD 4.12.2 – Fix numUFP
0.82	7/8/2019	TD 4.1.2 – Add Port_Battery_Powered is NO to 3 rd applicability item, rework of procedure steps TD 4.2.1, 4.5.1, 4.6.4, 4.7.4 – Add LFPS timing check Source-Capable Tests – add Vconn_Swap for ports that need PR_Swap as part of test setup TD 4.10.1 – Specify enumeration does not configure device TD 4.11.2 – Add prompt for tester to visually check PUT for batteries, update applicability TD 4.3.1, 4.10.6 – Allow device enumeration to wait for PD contract TD 4.10.2 – Add tSinkAdj timing to step 15.j

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Contents

Introduction..... 5

Terminology..... 5

Assertions..... 6

Test Requirements 30

 Hardware..... 30

 Electrical 31

 Timing..... 31

Product	32
Tests	35
Connection Tests.....	37
Source Tests	38
Sink Tests.....	43
SNKAS Tests	47
DRP Tests	53
Try.SRC DRP Tests	59
Try.SNK DRP Tests.....	66
All DRPs Tests.....	72
Source-Capable Tests.....	74
Sink-Capable Tests	78
Miscellaneous Tests	86
Hub Ports Tests.....	88
Appendix A: TD Number Update.....	90

Introduction

These tests check that a USB Type-C connector is compliant to the USB Type-C Chapters 4 and 5 and Appendix A asserts and functional requirements.

There are a variety of different operational approaches for a USB Type-C connector. For example, a basic mouse will never host or source current to another device, so its USB Type-C connector only needs to support a UFP and Sink role. A smartphone may host a mouse or keyboard, and may be a device hosted by a USB Charger. The USB Type-C connector for the phone in this example needs to support both UFP and DFP, and both Source and Sink roles. A glance at the USB Type-C configuration matrix in Spec Table 4-23 gives an idea of the available USB Type-C Product Types covered in this spec.

Due to the variety of connections to be made with USB Type-C connectors, there is a variety of electrical and timing requirements that constrain their interaction and lead to functional connections.

Tests are groups by USB Type-C Connection State implementation, Source/Sink Capability, and whether the port belongs to a Hub.

Terminology

The following table describes the terms used in this document.

BC	Background Check – Used in the assertions table to indicate an assertion is implicitly verified as a function of running a Type-C Functional Test.
CabCon	USB Type-C Cable Assembly and Connector Tests – Used in the assertions table to indicate an assertion is verified by the USB Type-C Cable Assembly and Connector Test Suite.
CVS	USB Type-C Connection Verification System. Test equipment capable of performing the USB Type-C Functional tests defined in this document
DFP	Downstream Facing Port – a USB Type-C port that supports the USB 3.1 Link State Machine or USB 2.0 data as a downstream facing port.
DRP	Dual Role Port – A USB Type-C port that supports the USB Type-C Connection State Machines as a DRP. This port is capable of acting as a Source and a Sink.
DUT	Device Under Test – the USB-C product which incorporates the PUT referred to in each Test Definition.
IOP	Interoperability – Used in the assertions table to indicate an assertion is verified by the USB 3.1 Interoperability and Backwards Compatibility Test Suite
NT	Not tested – Used in the assertions table to indicate an assertion is not tested
PD	USB Power Delivery Tests – Used in the assertion table to indicate an assertion is verified by the USB Power Delivery Test Suite.
PUT	Port Under Test – The USB Type-C Connector port that is tested by the tests defined in this document.
PUT_C	PUT that is bound to a USB Type-C captive cable or direct attach plug
PUT_R	PUT that is bound to a USB Type-C receptacle.
PUT_V	PUT that is required to or capable of sourcing Vconn.
Sink	USB Type-C port that supports the USB Type-C Connection State Machines as a Sink
SNKAS	Sink with Accessory Support – A USB Type-C port that supports the USB Type-C Connection State Machine as a Sink with Accessory Support.
Source	USB Type-C port that supports the USB Type-C Connection State Machines as a Source
Operator	Person operating the test.
UFP	Upstream Facing Port – A USB Type-C port that supports the USB 3.1 Link State Machine or USB 2.0 data as an upstream facing port.
VIF	Vendor Info File – A USB-IF product certification tool that logs info about the PUT for tracking purposes and so a test vendor knows what tests are applicable.

Assertions

Compliance criteria are provided as a list of assertions that describe specific characteristics or behaviors that must be met. Each assertion provides a reference to the USB 3.1 specification or other documents from which the assertion was derived. In addition, each assertion provides a reference to the specific test description(s) where the assertion is tested.

Each test assertion is formatted as follows:

Assertion #	Test #	Assertion Description
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Assertion#: Unique identifier for each spec requirement. The identifier is in the form USB31_SPEC_SECTION_NUMBER#X, where X is a unique integer for a requirement in that section.

Assertion Description: Specific requirement from the specification

Test #: A label for a specific test description in this specification that tests this requirement. Test # can have one of the following values:

- NT** This item is not explicitly tested in a test description. Items can be labeled NT for several reasons – including items that are not testable, not important to test for interoperability, or are indirectly tested by other operations performed by the compliance test.
- X.X** This item is covered by the test described in test description X.X in this specification.
- IOP** This assertion is verified by the USB 3.1 Interoperability and Backwards Compatibility Test Suite.
- BC** This assertion is applied as a background check in all test descriptions.
- PD** This assertion is verified by the USB-IF Power Delivery Test Suite.
- CabCon** This assertion is verified by the USB Type-C Cable Assembly and Connector Test Suite

Test descriptions provide a high level overview of the tests that are performed to check the compliance criteria. The descriptions are provided with enough detail so that a reader can understand what the test does. The descriptions do not describe the actual step-by-step procedure to perform the test.

The following Table presents the USB Type-C Specification Chapter 4 and 5 asserts.

Assertion #	Test Name	Assertion Description
4.3 Side Band Use (SBU)		
4.3#1	4.1	The SBU pins on a port shall either be open circuit or have a weak pull-down to ground no stronger than zSBUTermination.
4.4 Power and Ground		
4.4.1 IR Drop		
4.4.1#1	CabCon	The maximum allowable cable IR drop for ground shall be 250 mV and for VBUS shall be 500 mV through the cable to the cable's maximum rated VBUS current capacity.
4.4.1#2	CabCon	When VCONN is being sourced, the IR drop for the ground shall still be met considering any additional VCONN return current.
4.4.2 VBUS		
4.4.2#1	4.2 4.4	The allowable default range for VBUS as measured at the DFP receptacle shall be as defined by the USB 2.0 Specification and USB 3.1 Specification.
4.4.2#2	4.1 4.2 4.4	The Source's USB Type-C receptacle VBUS pin shall remain unpowered and shall limit the capacitance between Vbus and GND as specified in Table 4-2 until a Sink is attached.
4.4.2#3	4.2 4.4	The Source's VBUS pin shall return to the unpowered state when the Sink is detached.

Assertion #	Test Name	Assertion Description
4.4.2#4	4.2	A DRP or DFP or UFP with Accessory Support implementing an Rp pull-up as its method of connection detection shall provide an impedance between VBUS and GND on its receptacle pins as specified in Table 4-2 when not sourcing power on VBUS (i.e., when in states Unattached.SRC or Unattached.Accessory)
4.4.3 VCONN		
4.4.3#1	BC	Initially, VCONN shall be sourced by all USB Type-C receptacles that source Vbus and utilize the SSTX and SSRX pins during specific connection states as described in Section 4.5.2.2.
4.4.3#2	BC	Table 4-4 provides the voltage and power requirements that shall be met for VCONN.
4.4.3#3	BC	The VCONN source shall disconnect the bulk capacitance from the receptacle when VCONN is powered off.
4.4.3#4	CabCon	Table 4-5 provides the requirements that shall be met for cables that consume VCONN power.
4.4.3#5	CabCon	A cable shall not present more than the equivalent inrush capacitance (10uF) to the VCONN source.
4.4.3#6	CabCon	tVCONNDischarge is the time from the point that the cable is detached until vVCONNDischarge shall be met.
4.5 Configuration Channel (CC)		
4.5.1 Architectural Overview		
4.5.1.1 USB Data Bus Interface and USB Type-C Plug Flip-ability		
4.5.1.2 Connecting DFPs and UFPs		
4.5.1.2#1	4.1	In the cases where no function results, neither port shall be harmed by this connection.
4.5.1.2#2	4.1	VBUS and VCONN shall not be applied by a Source (host) in a host-host connection.
4.5.1.3.2 UFP Configuration Channel Functional Model		
4.5.1.3.2#1	BC	The Sink shall manage its load to stay within the detected Source current limit.
4.5.2 CC functional and Behavioral Requirements		
4.5.2#1	BC	The plug on a direct connect device or a device with a captive cable shall behave as a plug on a cable that is attached at its other end in normal orientation to a receptacle.
4.5.2#2	BC	Devices with a plug on a direct connection or a captive cable shall apply and sense CC voltage levels on pin A5 only and pin B5 shall have an impedance above zOPEN, unless it is a Powered Accessory, in which case B5 shall have an impedance Ra.
4.5.2.2 Connection State Machine Requirements		
4.5.2.2#1	Not Tested	Entry into any unattached state "when directed from any state" shall not be used to override tDRP toggle.

Assertion #	Test Name	Assertion Description
4.5.2.2.1 Disabled State		
4.5.2.2.1#1	4.1	If the Disabled state is not supported, the port shall be directed to either the Unattached.SNK or Unattached.SRC states after power-on.
4.5.2.2.1.1 Disabled State Requirements		
4.5.2.2.1.1#1	4.1	The port shall not drive VBUS or VCONN, and shall present a high-impedance to ground (above zOPEN) on its CC pins.
4.5.2.2.1.2 Exiting From Disabled State		
4.5.2.2.1.2#1	Not Tested	A Sink shall transition to Unattached.SNK when directed.
4.5.2.2.1.2#2	Not Tested	A Source shall transition to Unattached.SRC when directed.
4.5.2.2.1.2#2	Not Tested	A DRP shall transition to either Unattached.SNK or Unattached.SRC when directed.
4.5.2.2.2 ErrorRecovery State		
4.5.2.2.2#1	Not Tested	If the ErrorRecovery state is not supported, the port shall be directed to the Disabled state if supported. IF the Disabled state is not supported, the port shall be directed to either the Unattached.SNK or Unattached.SRC states.
4.5.2.2.2.1 ErrorRecovery State Requirements		
4.5.2.2.2.1#1	Not Tested	The port shall not drive VBUS or VCONN, and shall present a high-impedance to ground (above zOPEN) on its CC pins.
4.5.2.2.2.2 Exiting from ErrorRecovery State		
4.5.2.2.2.2#1	Not Tested	A Sink shall transition to Unattached.SNK after tErrorRecovery
4.5.2.2.2.2#2	Not Tested	A Source shall transition to Unattached.SRC after tErrorRecovery
4.5.2.2.2.2#2	Not Tested	A DRP shall transition to Unattached.SNK or Unattached.SRC after tErrorRecovery
4.5.2.2.3 Unattached.SNK State		
4.5.2.2.3#1	4.37	A port with a dead battery shall enter this state while unpowered.
4.5.2.2.3.1 Unattached.SNK State Requirements		
4.5.2.2.3.1#1	4.8 4.9	The port shall not drive VBUS or VCONN
4.5.2.2.3.1#2	4.8 4.9	Both CC pins shall be independently terminated to ground through Rd.
4.5.2.2.3.2 Exiting from Unattached.SNK State		
4.5.2.2.3.2#1	4.8 4.9 4.17	If the port supports USB PD or accessories, the port shall transition to AttachWait.SNK when a Source connection is detected, as indicated by the SNK.Rp state on one of its CC pins

Assertion #	Test Name	Assertion Description
4.5.2.2.3.2#2	4.15 4.17	A DRP shall transition to Unattached.SRC within tDRPTransition after the state of both CC pins is SNK.Open for tDRP - dcSRC.DRP * tDRP or if directed.
4.5.2.2.3.2#3	4.12	A Sink with Accessory support shall transition to Unattached.Accessory within tDRPTransition after the state of both CC pins is SNK.Open for tDRP - dcSRC.DRP * tDRP or if directed.
4.5.2.2.4 AttachWait.SNK State		
4.5.2.2.4.1 AttachWait.SNK Requirements		
4.5.2.2.4.1#1	4.8 4.9	The port shall not drive VBUS or VCONN
4.5.2.2.4.1#2	4.8 4.9	Both CC pins shall be independently terminated to ground through Rd.
4.5.2.2.4.1#3		It is strongly recommended that a USB 3.1 SuperSpeed device hold off Vbus detection to the device controller until the Attached.SNK state or the DebugAccessory.SNK state is reached, i.e. at least one CC pin is in the SNK.Rp state.
4.5.2.2.4.2 Exiting from AttachWait.SNK State		
4.5.2.2.4.2#1	4.9	A Sink shall transition to Unattached.SNK when the state of both CC pins is SNK.Open for at least tPDDebounce.
4.5.2.2.4.2#2	4.17	A DRP shall transition to Unattached.SRC when the state of both CC pins is SNK.Open for at least tPDDebounce
4.5.2.2.4.2#3	4.8 4.9	The port shall transition to Attached.SNK after the state of only one of the CC1 or CC2 pins is SNK.Rp for at least tCCDebounce and VBUS is detected. Note the Source may initiate USB PD communications which will cause brief periods of the SNK.Open state on both CC pins, but this event will not exceed tPDDebounce.
4.5.2.2.4.2#4		If the port supports Debug Accessory Mode, the port shall transition to DebugAccessory.SNK if the state of both the CC1 and CC2 pins is SNK.Rp for at least tCCDebounce and Vbus is detected.
4.5.2.2.4.2#5		A DRP that strongly prefers the Source role may optionally transition to Try.SRC instead of Attached.SNK when the state of only one CC pin has been SNK.Rp for at least tCCDebounce and Vbus is detected.
4.5.2.2.5 Attached.SNK State		
4.5.2.2.5#1	Not Tested	A port that entered this state directly from Unattached.SNK due to detecting VBUS shall not determine orientation or availability of higher than Default USB Power and shall not use <i>USB PD</i> .
4.5.2.2.5.1 Attached.SNK State Requirements		
4.5.2.2.5.1#1	Untestable	If the port needs to determine the orientation of the connector, it shall do so only upon entry to this state by detecting which CC pin is connected through the cable (i.e., the CC pin that is in the SNK.Rp state).
4.5.2.2.5.1#2	4.8 4.9 4.26	If the port supports signaling on USB SuperSpeed pairs, it shall functionally connect the USB SuperSpeed pairs and maintain the connection during and after a USB PD PR_Swap.
4.5.2.2.5.1#3	4.8 4.9	If the port has entered the Attached.SNK state from the AttachWait.SNK or TryWait.SNK states, only one CC pin will be in the SNK.Rp state. The port shall continue to terminate this CC pin to ground through Rd.

Assertion #	Test Name	Assertion Description
4.5.2.2.5.1#4	4.34	If the port has entered the Attached.SNK state from the Attached.SRC state following a USB PD PR_Swap, the port shall terminate the connected CC pin to ground through Rd.
4.5.2.2.5.1#5	4.8 4.9	The port shall meet the UFP Power Sub-State requirements specified in Section 4.5.2.3.
4.5.2.2.5.1#6	4.8 4.9	By default, upon entry from AttachWait.SNK or Unattached.SNK, VCONN shall not be supplied in the Attached.SNK state.
4.5.2.2.5.1#7	4.26 4.34	If Attached.SNK is entered from Attached.SRC as a result of a USB PD PR_Swap, it shall maintain VCONN supply state, whether on or off, and its data role and connections.
4.5.2.2.5.1#8	4.35	When the port successfully executes USB PD VCONN_Swap operation and was not sourcing VCONN, it shall start sourcing VCONN within tVCONNON
4.5.2.2.5.1#9	4.35	The port shall execute the VCONN_Swap in a make-before-break sequence in order to keep active USB Type-C to USB Type-C cables powered.
4.5.2.2.5.1#10	4.35	When the port successfully executes USB PD VCONN_Swap and was sourcing VCONN, it shall stop sourcing VCONN within tVCONNOFF.
4.5.2.2.5.2 Exiting from Attached.SNK State		
4.5.2.2.5.2#1	4.8 4.9	A port that is not in the process of a USB PD PR_Swap or a USB PD Hard Reset shall transition to Unattached.SNK when VBUS falls below 3.67 V. Note that if Vbus has been adjusted by USB PD to operate above 5V, then the port shall transition to Unattached.SNK when Vbus falls below 80% of the negotiated value.
4.5.2.2.5.2#2	4.34	A port transitioning to Unattached.SNK, If supplying VCONN, shall cease to supply it within tVCONNOFF of exiting Attached.SNK.
4.5.2.2.5.2#3	4.34	After receiving a USB PD PS_RDY from the original Source during a USB PD PR_Swap the port shall transition directly to the Attached.SRC state (i.e. remove Rd from CC, assert Rp on CC and supply VBUS) but shall maintain its VCONN supply state, whether off or on, and its data role/connections.
4.5.2.2.6 Unattached.SRC State		
4.5.2.2.6.1 Unattached.SRC Requirements		
4.5.2.2.6.1#1	4.2 4.4	The port shall not drive VBUS or VCONN
4.5.2.2.6.1#2	4.2 4.4	The port shall source current on both CC pins independently.
4.5.2.2.6.1#3	4.2 4.4	The port shall provide a separate Rp termination on the CC1 and CC2 pins as specified in Table 4-15
4.5.2.2.6.2 Exiting from Unattached.SRC State		
4.5.2.2.6.2#1	4.2 4.4	The port shall transition to AttachWait.SRC when Vbus is vSafe0V and the SRC.Rd state is detected on at least one CC pin
4.5.2.2.6.2#2	4.19	The port shall transition to AttachWait.SRC when Vbus is vSafe0V and the SRC.Ra state is detected on both CC pins.
4.5.2.2.6.2#3	4.1	When a port detects SRC.Ra on one CC pin and SRC.Open on the other, the port shall not transition to AttachWait.SRC.

Assertion #	Test Name	Assertion Description
4.5.2.2.6.2#4	4.15 4.17	A DRP shall transition to Unattached.SNK within tDRPTransition after dcSRC.DRP * tDRP
4.5.2.2.6.2#5	4.15 4.17	A DRP shall transition to Unattached.SNK if directed.
4.5.2.2.7 AttachWait.SRC State		
4.5.2.2.7.1 AttachWait.SRC Requirements		
4.5.2.2.7.1#1	4.2 4.4 4.15	The port shall not drive VBUS or VCONN
4.5.2.2.7.1#2	4.2 4.4 4.15	The port shall source current on both CC pins independently.
4.5.2.2.7.1#3	4.2 4.4 4.15	The port shall provide a separate Rp termination on the CC1 and CC2 pins as specified in Table 4-15
4.5.2.2.7.2 Exiting from AttachWait.SRC State		
4.5.2.2.7.2#1	4.2 4.4 4.15	The port shall transition to Attached.SRC when Vbus is in vSafe0V and the SRC.Rd state is detected on exactly one of the CC pins for at least tCCDebounce.
4.5.2.2.7.2#2	4.5	If the port supports Audio Adapter Accessory Mode, it shall transition to AudioAccessory when the SRC.Ra state is detected on both CC pins for at least tCCDebounce.
4.5.2.2.7.2#3	Not Tested	If the port supports Debug Accessory Mode, it shall transition to UnorientedDebugAccessory.SRC when the SRC.Rd state is detected on both CC pins for at least tCCDebounce
4.5.2.2.7.2#4	4.3	A Source shall transition to Unattached.SRC and a DRP to Unattached.SNK when the SRC.Open state is detected on both CC pins.
4.5.2.2.7.2#5	4.2 4.15	A Source shall transition to Unattached.SRC and a DRP to Unattached.SNK when the SRC.Open state is detected on one CC pin and the SRC.Ra state is detected on the other CC pin.
4.5.2.2.7.2#6		A DRP that strongly prefers the Sink role may optionally transition to Try.SNK instead of Attached.SRC when Vbus is at vSafe0V and the SRC.Rd state is detected on exactly one of the CC1 or CC2 pins for at least tCCDebounce.
4.5.2.2.8 Attached.SRC State		
4.5.2.2.8.1 Attached.SRC Requirements		
4.5.2.2.8.1#1	Untestable	If the port needs to determine the orientation of the connector, it shall do so only upon entry to the Attached.SRC state by detecting which pin is in the SRC.Rd state
4.5.2.2.8.1#2	4.2 4.4 4.15	If the port has entered this state from the AttachWait.SRC state or the Try.SRC state, the SRC.Rd state will be on only one CC pin. The port shall source current on this CC pin and monitor its state.
4.5.2.2.8.1#3	4.34	If the port has entered this state from the Attached.SNK state as the result of a USB PD PR_Swap, the port shall source current on the connected CC pin and monitor its state.

Assertion #	Test Name	Assertion Description
4.5.2.2.8.1#4	4.2 4.4 4.15	The port shall provide an Rp as specified in Table 4-15.
4.5.2.2.8.1#5	4.2 4.4 4.15	The port shall supply Vbus current at the level it advertises on Rp.
4.5.2.2.8.1#6	4.2 4.4 4.15	The port shall supply Vbus within tVbusON of entering this state, and for as long as it is operating as a power source.
4.5.2.2.8.1#7	4.2 4.15 4.18	The port shall not initiate any USB_PD communications until Vbus reaches vSafe5V.
4.5.2.2.8.1#8	4.2 4.26	If the port supports signaling on USB SS pairs, it shall functionally connect the USB SS pairs
4.5.2.2.8.1#9	4.2	If the port supports signaling on USB SS pairs, is shall either apply Vconn unconditionally to the CC pin not in the SRC.Rd state, or apply Vconn to the CC pin in the SRC.Ra state.
4.5.2.2.8.1#10	4.2	If the port supplies Vconn, it shall do so within tVconnON
4.5.2.2.8.1#11	4.34	The port shall not supply Vconn if it has entered this state as a result of a USB PD PR_Swap and was not previously supplying Vconn.
4.5.2.2.8.1#12	4.27	When the port successfully executes USB PD Vconn_Swap operation and was sourcing Vconn, it shall stop sourcing Vconn within tVconnOFF.
4.5.2.2.8.1#13	4.27	The port shall execute the Vconn_Swap in a make-before-break sequence in order to keep active USB Type-C to USB Type-C cables powered.
4.5.2.2.8.1#14	4.27	When the port successfully executes USB PD Vconn_Swap operation and was not sourcing Vconn, it shall start sourcing Vconn within tVconnON.
4.5.2.2.8.2 Exiting from Attached.SRC State		
4.5.2.2.8.2#1	4.2	A Source shall transition to Unattached.SRC when the SRC.Open state is detected on the monitored CC pin.
4.5.2.2.8.2#2	4.15	When the SRC.Open state is detected on the monitored CC pin, a DRP shall transition to Unattached.SNK unless it strongly prefers the Source role.
4.5.2.2.8.2#3	4.15	When the SRC.Open state is detected on the monitored CC pin and a DRP strongly prefers the Source state, it shall transition TryWait.SNK.

Assertion #	Test Name	Assertion Description
4.5.2.2.8.2#4	4.15	A DRP that would enter Try.SRC from AttachWait.SNK shall enter TryWait.SNK for a Sink detach from Attached.SRC.
4.5.2.2.8.2#5	4.2 4.15	A port shall cease to supply VBUS within tVBUSOFF of exiting Attached.SRC
4.5.2.2.8.2#6	4.2 4.7 4.35	A port that is supplying VCONN shall cease to supply it within tVCONNOFF of exiting Attached.SRC, unless it is exiting as a result of a USB PD PR_Swap.
4.5.2.2.8.2#7	4.26	After a USB PD PR_Swap is accepted (Accept message is received or acknowledged), a DRP shall transition directly to the Attached.SNK state (remove Rp from CC, assert Rd on CC and stop supplying VBUS)
4.5.2.2.8.2#8	4.26	After a USB PD PR_Swap is accepted (Accept message is received or acknowledged), a DRP shall maintain its current data role, connection and VCONN supply state.
4.5.2.2.9 Try.SRC State		
4.5.2.2.9#1		Note: If both Try.SRC and Try.SNK mechanisms are implemented, only one shall be enabled by the port at a given time.
4.5.2.2.9.1 Try.SRC Requirements		
4.5.2.2.9.1#1	4.17 4.18	The port shall not drive VBUS or VCONN.
4.5.2.2.9.1#2	4.17 4.18	The port shall source current on both CC pins independently.
4.5.2.2.9.1#3	4.17 4.18	The port shall provide an Rp as specified in Table 4-15
4.5.2.2.9.2 Exiting from Try.SRC State		
4.5.2.2.9.2#1	4.18	The port shall transition to Attached.SRC when the SRC.Rd state is detected on exactly one of the CC pins for at least tPDDebounce.
4.5.2.2.9.2#2	4.17	The port shall transition to TryWait.SNK after tDRPtry and the SRC.Rd state has not been detected.
4.5.2.2.10 TryWait.SNK State		
4.5.2.2.10.1 TryWait.SNK Requirements		
4.5.2.2.10.1#1	4.17	The port shall not drive VBUS or VCONN.
4.5.2.2.10.1#2	4.17	Both CC pins shall be independently terminated to ground through Rd.
4.5.2.2.10.2 Exiting from TryWait.SNK State		
4.5.2.2.10.2#1	4.17	The port shall transition to Attached.SNK after tCCDebounce if or when VBUS is detected.
4.5.2.2.10.2#2	4.17	The port shall transition to Unattached.SNK when the state of both CC pins is SNK.Open for at least tPDDebounce
4.5.2.2.11 Try.SNK State		
4.5.2.2.11#1		Note: If both Try.SRC and Try.SNK mechanisms are implemented, only one shall be enabled by the port at a given time.
4.5.2.2.11.1 Try.SNK Requirements		
4.5.2.2.11.1#1		The port shall not drive Vbus or Vconn
4.5.2.2.11.1#2		Both the CC1 and CC2 pins shall be independently terminated to ground through Rd.

Assertion #	Test Name	Assertion Description
4.5.2.2.11.2 Exiting from Try.SNK State		
4.5.2.2.11.2#1		The port shall wait for tDRPTry and only then begin monitoring the CC1 and CC2 pins for the SNK.Rp state.
4.5.2.2.11.2#2		The port shall transition to Attached.SNK when the SNK.Rp state is detected on exactly one of the CC1 or CC2 pins for at least tPDDebounce and Vbus is detected.
4.5.2.2.11.2#3		The port shall transition to TryWait.SRC if SNK.Rp state is not detected for tPDDebounce.
4.5.2.2.11.2#4		A Sink with Accessory Support shall transition to Unsupported.Accessory if SNK.Rp state is not detected for tDRPTryWait.
4.5.2.2.12 TryWait.SRC State		
4.5.2.2.12.1 TryWait.SRC Requirements		
4.5.2.2.12.1#1		The port shall not drive Vbus or Vconn
4.5.2.2.12.1#2		The port shall source current on both CC pins.
4.5.2.2.12.1#3		The port shall provide a separate Rp termination on the CC1 and CC2 pins as specified in Table 4-15.
4.5.2.2.12.2 Exiting from TryWait.SRC State		
4.5.2.2.12.2#1		The port shall transition to Attached.SRC when Vbus is at vSafe0V and the SRC.Rd state is detected on exactly one of the CC pins for at least tCCDebounce.
4.5.2.2.12.2#2		The port shall transition to Unattached.SNK after tDRPTry if neither of the CC1 or CC2 pins are in the SRC.Rd state.
4.5.2.2.13 Unattached.Accessory State		
4.5.2.2.13.1 Unattached.Accessory Requirements		
4.5.2.2.13.1#1	4.1 4.12 4.14	The port shall not drive VBUS or VCONN.
4.5.2.2.13.1#2	4.12 4.14	The port shall source current on both CC pins independently.
4.5.2.2.13.1#3	4.12 4.14	The port shall provide an Rp as specified in Table 4-15.
4.5.2.2.13.2 Exiting from Unattached.Accessory State		
4.5.2.2.13.2#1	4.12	The port shall transition to AttachWait.Accessory when the state of both pins is SRC.Ra or SRC.Rd
4.5.2.2.13.2#2	4.14	A port that supports Vconn-Powered accessories also shall transition to AttachWait.Accessory when the state of one CC pin is SRC.Ra and the other is SRC.Rd

Assertion #	Test Name	Assertion Description
4.5.2.2.13.2#3	4.11	If at least one CC is in SRC.Open, or if SRC.Ra is on one CC pin and SRC.Rd is on the other and the port does not support Vconn-powered accessories, then the port shall transition to Unattached.SNK within tDRPTransition after dcSRC.DRP * tDRP, or if directed.
4.5.2.2.14 AttachWait.Accessory State		
4.5.2.2.14.1 AttachWait.Accessory Requirements		
4.5.2.2.14.1#1	4.12 4.14 4.19	The port shall not drive VBUS or VCONN.
4.5.2.2.14.1#2	4.12 4.14 4.19	The port shall source current on both CC pins independently.
4.5.2.2.14.1#3	4.12 4.14 4.19	The port shall provide an Rp as specified in Table 4-15.
4.5.2.2.14.2 Exiting from AttachWait.Accessory State		
4.5.2.2.14.2#1	4.12 4.19	If the port supports Audio Adapter Accessory Mode, it shall transition to AudioAccessory when the state of both CC pins is SRC.Ra for at least tCCDebounce
4.5.2.2.14.2#2	Not Teseted	If the port supports Debug Accessory Mode, it shall transition to DebugAccessory when the state of both CC pins is SRC.Rd for at least tCCDebounce.
4.5.2.2.14.2#3	4.14	The port shall transition to Unattached.SNK when the state of either CC pin is SRC.Open for at least tCCDebounce
4.5.2.2.14.2#4	4.14	If the port supports VCONN-powered accessories, it shall transition to PoweredAccessory state if the state of one to its CC pins is SRC.Rd and the state of the other CC pin is SRC.Ra concurrently for at least tCCDebounce
4.5.2.2.15 AudioAccessory State		
4.5.2.2.15.1 AudioAccessory Requirements		
4.5.2.2.15.1#1	4.5 4.12 4.19	The port shall reconfigure its pins as detailed in Appendix A.
4.5.2.2.15.1#2	4.5 4.12 4.19	The port shall not drive VBUS or VCONN.
4.5.2.2.15.1#3	4.12 4.19	A port that sinks current from the audio accessory over VBUS shall not draw more than 500 mA.
4.5.2.2.15.1#4	4.5 4.12 4.19	The port shall provide an Rp as specified in Table 4-15.
4.5.2.2.15.1#5	4.5 4.19	The port shall source current on at least one of the CC pins and monitor to detect when the CC pin state is no longer SRC.Ra.
4.5.2.2.15.1#6		If the port sources and monitors only one CC pin, then it shall ensure that the termination on the unmonitored CC pin does not affect the monitored signal when the port is connected to an Audio Accessory that may short both CC pins together.
4.5.2.2.15.2 Exiting from AudioAccessory State		

Assertion #	Test Name	Assertion Description
4.5.2.2.15.2#1	4.12 4.19	If the port is a Sink, the port shall transition to Unattached.SNK when the state of the monitored CC pin is SRC.Open for at least tCCDebounce.
4.5.2.2.15.2#2	4.5	If the port is a Source or DRP, the port shall transition to Unattached.SRC when the SRC.Open state is detected on the monitored CC pin for at least tCCDebounce.
4.5.2.2.16 DebugAccessory State		
4.5.2.2.16.1 DebugAccessory Requirements		
4.5.2.2.16.1#1	Not Tested	This mode is for debug only and shall not be used for communicating with commercial products.
4.5.2.2.16.1#2	4.6 4.13 4.20	The port shall not drive VBUS or VCONN.
4.5.2.2.16.1#3	Not Tested	The port shall drive Rp as specified in Table 4-13.
4.5.2.2.16.1#4	Not Tested	The port shall source current on at least one of the CC pins and monitor to detect when the CC pin state is no longer SRC.Rd.
4.5.2.2.16.1#5	Not Tested	If the port monitors only one CC pin, it shall source current on the monitored pin and may source current or not on the unmonitored pin.
4.5.2.2.16.3 Exiting from DebugAccessory State		
4.5.2.2.16.2#1	Not Tested	If the port is a Sink or DRP, the port shall transition to Unattached.SNK when the SRC.Open state is detected on the monitored CC pin(s).
4.5.2.2.16.2#2	Not Tested	If the port is a Source, the port shall transition to Unattached.SRC when the SRC.Open state is detected on the monitored CC pin(s).
4.5.2.2.19 Powered.Accessory State		
4.5.2.2.19.1 Powered.Accessory Requirements		
4.5.2.2.19.1#1	Untestable	If the port needs to determine the orientation of the connector, it shall do so only upon entry to the PoweredAccessory state by detecting which CC pin is connected through the cable (in the SRC.Rd state).
4.5.2.2.19.1#2	4.14	The port shall advertise either 1.5 A or 3.0 A (see Table 4-13) on the connected CC pin and monitor its state.
4.5.2.2.19.1#3	4.14	The port shall supply VCONN (2.7 V minimum) on the unused CC pin within tVCONNON-PA of entering the PoweredAccessory state.

Assertion #	Test Name	Assertion Description
4.5.2.2.19.1#4	4.14	The port shall not drive VBUS.
4.5.2.2.19.1#5	4.14	When the port initially enters the PoweredAccessory state it shall operate as a DFP.
4.5.2.2.19.1#6	4.14	The port shall use USB Power Delivery Structured Vendor Defined Messages (Structured VDMs) to identify this accessory and enter an Alternate Mode.
4.5.2.2.19.2 Exiting from PoweredAccessory State		
4.5.2.2.19.2#1	4.14	The port shall transition to Unattached.SNK when the SRC.Open state is detected on the monitored CC pin.
4.5.2.2.19.2#2	4.14	The port shall transition to Unattached.SNK if the attached device is not a VCONN-Powered Accessory.
4.5.2.2.19.2#3	4.14	The port shall transition to Unsupported.Accessory if it does not successfully enter an Alternate Mode within tAMETimeout (see Section 5.1).
4.5.2.2.19.2#4	4.14	The port shall cease to supply VCONN within tVCONNOff of exiting the PoweredAccessory state.
4.5.2.2.20 Unsupported.Accessory State		
4.5.2.2.20.1 Unsupported.Accessory Requirements		
4.5.2.2.20.1#1	4.14	Only one CC pin shall be in the SRC.Rd state.
4.5.2.2.20.1#2	4.14	The port shall advertise Default USB Power (see Table 4-13) on the connected CC pin and monitor its voltage.
4.5.2.2.20.1#3	4.14	The port shall not drive VBUS or VCONN.
4.5.2.2.20.1#4	4.14	A Sink with Accessory Support shall provide user notification that it does not recognize or support the attached accessory.
4.5.2.2.20.2 Exiting from Unsupported.Accessory		
4.5.2.2.20.2#1	4.14	The port shall transition to Unattached.SNK when the SRC.Open state is detected on the monitored CC pin.
4.5.2.3 UFP Power Sub-State Requirements		
4.5.2.3#1	4.31	When in the Attached.SNK state and the Source is supplying default VBUS, the port shall operate in one of the sub-states shown in Figure 4-17.
4.5.2.3#2	4.31	The port in Attached.SNK shall remain within the Sink Power Sub-States until either VBUS is removed or a USB PD contract is established with the Source.
4.5.2.3.1 PowerDefault.UFP Sub-State		
4.5.2.3.1.1 PowerDefault.UFP Requirements		
4.5.2.3.1.1#1	4.31	The port shall draw no more than the default USB power from VBUS.
4.5.2.3.1.1#2	4.31	If the port wants to consume more than the default USB power, it shall monitor vRd to determine if more current is available from the Source.

Assertion #	Test Name	Assertion Description
4.5.2.3.1.2 Exiting from PowerDefault.UFP		
4.5.2.3.1.2#1	4.31	For any change on CC indicating a change in allowable power, the port shall not transition until the new vRd on CC has been stable for tPDDebounce.
4.5.2.3.1.2#2	4.31	For a vRd in the vRd-1.5 range, the port shall transition to the Power1.5.SNK Sub-State.
4.5.2.3.1.2#3	4.31	For a vRd in the vRd-3.0 range, the port shall transition to the Power3.0.SNK Sub-State.
4.5.2.3.2 Power 1.5.UFP Sub-State		
4.5.2.3.2.1 Power 1.5.UFP Sub-State Requirements		
4.5.2.3.2.1#1	4.31	The port shall draw no more than the 1.5 A from VBUS.
4.5.2.3.2.1#2	4.31	The port shall monitor vRd while it is in this sub-state.
4.5.2.3.2.2 Exiting from Power 1.5.UFP Sub-State		
4.5.2.3.2.2#1	4.31	For any change on CC indicating a change in allowable power, the port shall not transition until the new vRd on CC has been stable for tPDDebounce.
4.5.2.3.2.2#2	4.31	For a vRd in the vRd-USB range, the port shall transition to the PowerDefault.SNK Sub-State and reduce its power consumption to the new range within tSinkAdj.
4.5.2.3.2.2#3	4.31	For a vRd in the vRd-3.0 range, the port shall transition to the Power3.0.SNK Sub-State.
4.5.2.3.3 Power3.0.UFP Sub-State		
4.5.2.3.3.1 Power3.0.UFP Requirements		
4.5.2.3.3.1#1	4.31	The port shall draw no more than the 3.0 A from VBUS.
4.5.2.3.3.1#2	4.31	The port shall monitor vRd while it is in this sub-state.
4.5.2.3.3.1 Power3.0.UFP Requirements		
4.5.2.3.3.2#1	4.31	For any change on CC indicating a change in allowable power, the port shall not transition until the new vRd on CC has been stable for tPDDebounce.
4.5.2.3.3.2#2	4.31	For a vRd in the vRd-USB range, the port shall transition to the PowerDefault.SNK Sub-State and reduce its power consumption to the new range within tSinkAdj.
4.5.2.3.3.2#3	4.31	For a vRd in the vRd-1.5 range, the port shall transition to the Power1.5.SNK Sub-State and reduce its power consumption to the new range within tSinkAdj.
4.5.3.2.2 Legacy Host Port to UFP Behavior		
4.5.3.2.2#1	4.29	The value of Rp shall indicate an advertisement of Default USB Power (See Table 4-10), even though the cable itself can carry 3 A.
4.5.3.2.4 Legacy Host Port to DRP Behavior		

Assertion #	Test Name	Assertion Description
4.5.3.2.4#1	4.29	The value of Rp shall indicate an advertisement of Default USB Power (See Table 4-10), even though the cable itself can carry 3 A.
4.6 Power		
4.6#1	4.25 4.31	All USB Type-C-based devices shall support USB Type-C Current and may support other USB-defined methods for power.
4.6#2	4.32	The following order of precedence of power negotiation shall be followed: USB BC 1.2 supersedes the USB 2.0 and USB 3.1 specifications, USB Type-C Current at 1.5 A and 3.0 A supersedes USB BC 1.2, and USB Power Delivery supersedes USB Type-C Current.
4.6#3	4.32	Once the PD mode (e.g. a power contract has been negotiated) has been entered, the device shall abide by that power contract ignoring any other previously made or offered by the USB Type-C Current, USB BC 1.2 or USB 2.0 and USB 3.1 specifications.
4.6#4	4.32	When the PD mode is exited, the device shall fallback in order to the USB Type-C Current, USB BC 1.2 or USB 2.0 and USB 3.1 specification power levels.
4.6#5	4.1	All USB Type-C ports shall tolerate being connected to USB power source supplying default USB power, e.g. a host being connected to a legacy USB charger that always supplies VBUS.
4.6.1 Power Requirements during USB Suspend		
4.6.1.1 VBUS Requirements during USB Suspend		
4.6.1.1#1	4.33	USB suspend power rules shall apply when the USB Type-C Current is at the Default USB Power level or when USB PD is being used and the Suspend bit is set appropriately.
4.6.1.2 VCONN Requirements during USB Suspend		
4.6.1.2#1	4.24	If the DFP supplies VBUS power during USB suspend, it shall also supply at least 70 mW to VCONN.
4.6.1.2#2	CabCon	Electronically marked cables shall draw no more than 70 mW from VCONN during USB suspend.
4.6.2 VBUS Power Provided Over a USB Type-C Cable		
4.6.2#1	CabCon PD	USB Power Delivery is an optional capability that is intended to work over un-modified USB Type-C to USB Type-C cables, therefore any USB Type-C cable assembly that incorporates electronics that gets its power from VBUS shall be tolerant up to 20 V.
4.6.2.1 USB Type-C Current		

Assertion #	Test Name	Assertion Description
4.6.2.1#1	4.31	A UFP that takes advantage of the additional current offered (e.g., 1.5 A or 3.0 A) shall monitor the CC pins and shall adjust its current consumption within tSinkAdj to remain within the value advertised by the DFP.
4.6.2.1#2	4.32	While a USB PD contract is in place, a UFP is not required to monitor USB Type-C Current advertisements and shall not respond to USB Type-C Current advertisements.
4.6.2.1#3	4.2	The DFP shall source VBUS to the UFP within tVBUSON.
4.6.2.1#4	4.25	VBUS shall be in the specified voltage range at the advertised current.
4.6.2.1#5	Not Tested	A port sourcing VBUS shall protect itself from a sink that draws current in excess of the port's USB Type-C Current advertisement.
4.6.2.1#6	4.31	If the UFP wants to consume more than the default USB current, it shall track vRd to determine the maximum current it may draw.
4.6.2.2 USB Battery Charging		
4.6.2.2#1	4.25	USB Type-C-based BC 1.2 chargers that are capable of supplying at least 1.5 A shall advertise USB Type-C Current at the 1.5 A level, otherwise the charger shall advertise USB Type-C Current at the Default USB Power level.
4.6.2.3 Proprietary Power Source		
4.6.2.3#1	4.25	A proprietary power source (i.e., battery charger) with a USB Type-C-captive cable or a USB Type-C receptacle that is capable of supplying at least 1.5 A and less than 3.0 A shall advertise USB Type-C Current at least at the 1.5 A level.
4.6.2.3#2	4.25	A proprietary power source with a USB Type-C-captive cable or a USB Type-C receptacle that is capable of supplying at least 3.0 A shall advertise USB Type-C Current at least at the 3.0 A level.
4.6.2.4 USB Power Delivery		
4.6.2.4#1	4.2	When USB PD is implemented, USB PD Bi-phase Mark Coded (BMC) carried on the CC wire shall be used for USB PD communications between USB Type-C ports.
4.6.2.4#2	4.2	At attach, VBUS shall be operationally stable prior to initiating USB PD communications.

Assertion #	Test Name	Assertion Description
4.6.2.4#3	4.25	While a USB PD contract is in place, the provider shall advertise a USB Type-C Current of either 1.5 A or 3.0 A.
4.6.3 Supporting USB PD BFSK in Addition to USB PD BMC		
4.6.3#1	Not Tested	USB Type-C-based products that support USB PD BFSK and request a voltage greater than 5V shall supply protect the CC inputs from termination voltages higher than 5V as some adapters may present an Rp pulled up to VBUS that may be as high as 20V.
4.6.3#2	Not Tested	USB PD BFSK shall only be used if USB PD BMC fails to establish PD communication, i.e. fails to receive a USB PD GoodCRC message in response to a USB PD Capabilities message following two hard resets.
4.6.3#3	Not Tested	USB Type-C-based UFPs that support USB PD BFSK and want to request more than 1.5 A shall supply VCONN and confirm that the cable is electronically marked and capable of the desired current level (see Section 5.2.2).
4.7 USB Hubs		
4.7#1	4.39	USB hubs implemented with one or more USB Type-C connectors shall comply with the USB 3.1 Specification.
4.7#2	4.40	USB hubs shall have one UFP that may be a Charging UFP (See Section 4.8.3).
4.7#3	IOP	The hub shall clearly identify to the user its UFP.
4.7#4	4.40	USB hub's DFPs shall not have DRP capability.
4.7#5	4.40	CC pins are used for port-to-port connections and shall be supported on all USB Type-C connections on the hub.
4.7#6	4.40	USB hub ports shall not implement or pass-through Alternate or Accessory Modes.
4.7#7	4.40	SBU pins shall not be connected (zSBU Termination) on any USB hub port.
4.7#8	4.25	The USB hub's DFPs shall support power source requirements for a DFP.
4.8 Chargers		
4.8.1 DFP as a Power Source		
4.8.1#1	4.25	When a charger with a USB Type-C receptacle or a USB Type-C captive cable, it shall follow all the applicable requirements.
4.8.1#2	4.25	A DFP shall expose its power capabilities using the USB Type-C Current method and it may additionally support other USB-standard methods (USB BC 1.2 or USB-PD).

Assertion #	Test Name	Assertion Description
4.8.1#3	4.25	A USB Type-C power provider advertising its current capability using USB BC 1.2 shall meet the requirements in Section 4.6.2.2 regarding USB Type-C Current advertisement.
4.8.1#4	4.25	A USB Type-C power provider that has negotiated a USB-PD contract shall meet the requirements in Section 4.6.2.4 regarding USB Type-C Current advertisement.
4.8.1#5	Untestable	If a USB Type-C power provider is capable of supplying a voltage greater than default VBUS, it shall fully conform to the USB-PD specification, and shall negotiate its power contracts using only USB-PD.
4.8.1#6	TD 4.15 TD 4.26 TD 4.34	If a USB Type-C power provider is capable of reversing source and sink power roles, it shall fully conform to the USB-PD specification, and shall negotiate its power contracts using only USB-PD.
4.8.1#7	Not Tested Untestable?	If a USB Type-C power provider is capable of supplying a current greater than 3.0 A, it shall use the USB-PD Discovery Identity to determine the current carrying capacity of the cable.
4.8.1.1 Chargers with USB Type-C Receptacles		
4.8.1.1#2	4.1	A charger with a USB Type-C receptacle (DFP) shall only apply power to VBUS when it detects a UFP is attached and shall remove power from VBUS when it detects the UFP is detached (vOPEN).
4.8.1.1#3	4.25	A charger with a USB Type-C receptacle shall not advertise current exceeding 3.0 A except when it uses the USB-PD Discover Identity mechanism to determine the cable's actual current carrying capability and then it shall limit the advertised current accordingly.
4.8.1.2 Chargers with USB Type-C Captive Cables		
4.8.1.2#1	4.1	A charger with a USB Type-C captive cable that supports USB PD shall only apply power to VBUS when it detects a UFP is attached and shall remove power from VBUS when it detects the UFP is detached (vOPEN).
4.8.1.2#2	PD/CabCon/ IOP	A charger with a USB Type-C captive cable shall limit its current advertisement so as not to exceed the current capability of the cable (up to 5 A).
4.8.2 Non-USB Charging Methods		

Assertion #	Test Name	Assertion Description
4.8.2#1	4.25	When implemented, a proprietary charging method shall only be used to establish identify and/or direct a current level at default VBUS voltage in a manner not defined by the USB methods.
4.8.2#2	Untestable	When implemented, a proprietary charging method shall only define the current level and shall not change the voltage delivered on VBUS.
4.8.2#3	Untestable	When implemented, a proprietary charging method shall not alter the DFP's role to source VBUS or the UFP's role to sink VBUS.
4.8.2#4	Untestable	A product with a USB Type-C connector that sinks power may support proprietary charging methods, these products shall not support methods that redefine VBUS voltage beyond what is defined by the USB 2.0 and USB 3.1 specifications.
4.8.3 Sinking UFP		
4.8.3#1	4.15 4.17 4.18	The Sinking DFP shall follow the rules for a DRP (See Section 4.5.1.4 and Figure 4-15).
4.8.3#2	4.15 4.17 4.18	The sinking DFP shall support USB PD and shall support the DR_Swap command.
4.8.4 Charging UFP		
4.8.4#1	4.15 4.17 4.18	The Charging UFP shall follow the rules for a DRP (See Section 4.5.1.4 and Figure 4-15).
4.8.4#2	4.25	The Charging UFP shall also follow the requirements for the DFP as Power Source (See Section 4.8.1).
4.8.4#3	4.22	The Charging UFP shall support USB PD and shall support the DR_Swap command.
4.8.5 Charging a System with a Dead Battery		
4.8.5#1	4.37	A system that supports being charged by USB whose battery is dead shall apply Rd to both CC1 and CC2 and follow all UFP rules.
4.9 Electronically Marked Cables		
4.9#1	PD	All USB Full-Featured Type-C cables shall be electronically marked.
4.9#2	PD	Electronically marked cables shall support USB Power Delivery Structured VDM Discover Identity command directed to SOP'.
4.9#3	PD	After an explicit USB PD contract has been negotiated, only the DFP shall communicate with SOP'.

Assertion #	Test Name	Assertion Description
4.9#4	PD	Electronically marked cables that do not incorporate data bus signal conditioning circuits shall consume no more than 70 mW from VCONN.
4.9#5	PD	During USB suspend, electronically marked cables shall not draw more than 7.5 mA from VCONN, see Section 4.6.1.2.
4.9#6	PD	The isolation elements (Iso) shall prevent VCONN from traversing end-to-end through the cable.
4.9#7	PD	Active cables shall not draw more than 1 W from VCONN, see Section 4.4.3.
4.9#8	PD	When VCONN is not present, a powered cable shall not interfere with normal CC operation including UFP detection, current advertisement and USB PD operation.
4.10 VCONN-Powered Accessories		
4.10#1	4.23	When operating in the UFP role and when VBUS is not present, VCONN-powered accessories shall treat the application of VCONN as an attach signal, and shall respond to USB Power Delivery messages.
4.10#2	4.23	When powered by only VCONN, a VCONN-powered accessory shall negotiate an Alternate Mode.
4.10#3	4.23	VCONN-powered accessories shall be able to operate over a range of 2.7 V to 5.5 V on VCONN.
4.10#4	4.23	The removal of VCONN when VBUS is not present shall be treated as a detach event.
4.11 Parameter Values		
4.11.1 Termination Parameters		
4.11.1#1	BC	Table 4-13 provides the values that shall be used for the DFP's Rp or current source.
4.11.1#2	BC	Other pull-up voltages shall be allowed if they remain less than 5.5 V and fall within the correct voltage ranges on the UFP side – see Table 4-21, Table 4-22 and Table 4-23
4.11.1#3	CabCon	For Rp when implemented in the USB Type-C plug on a USB Type-C to USB 3.1 Standard-A Cable Assembly, a USB Type-C to USB 2.0 Standard-A Cable Assembly, a USB Type-C to USB 2.0 Micro-B Receptacle Adapter Assembly or a USB Type-C captive cable connected to a USB host, a value of 56 kOhms +- 5% shall be used, in order to provide tolerance to IR drop on VBUS and GND in the cable assembly.
4.11.1#4	BC	Transitions between Rd implementations that do not exceed tCCDebounce shall not be interpreted as exceeding the wider Rd range.

Assertion #	Test Name	Assertion Description
4.11.1#5	BC	Table 4-14 provides the methods and values that shall be used for the UFP's Rd implementation.
4.11.2 Timing Parameters		
4.11.2#1	BC	Table 4-18 provides the timing values that shall be met for delivering power over VBUS and VCONN.
4.11.2#2	BC	Table 4-19 provides the timing values that shall be met for DRPs.
4.11.2#3	BC	tDRP is the period a DRP shall complete a Source to Sink and back advertisement.
4.11.2#4	BC	dcDFP.DRP is the percent of time that a DRP shall advertise Source during tDRP.
4.11.2#5	BC	tDRRPTransition is the time a DRP shall complete transitions between Source and Sink roles during role resolution.
4.11.2#6	BC	For CC connections, tCCDebounce is the time a port shall wait before it can determine it is attached.
4.11.2#7	BC	For CC connections, tPDDebounce is the time a port shall wait before it can determine it is either detached or there has been a change in the USB Type-C current.
4.11.2#8	BC	For CC connections, tErrorRecovery is the time a self-powered port shall remain in the ErrorRecovery state.
4.11.3 Voltage Parameters		
4.11.3#1	BC	Table 4-21, Table 4-22 and Table 4-23 provide the CC voltage values that a Source shall use to detect what is attached based on the USB Type-C Current advertisement (Default USB, 1.5 A @ 5 V, or 3.0 A @ 5 V) that the Source is offering.
4.11.3#2	BC	Table 4-24 provides the CC voltage values that shall be detected across a Sink's Rd for a Sink that does not support higher than default USB Type-C Current Source advertisements.
4.11.3#3	BC	Table 4-25 provides the CC voltage values that shall be detected across a Sink's Rd for a Sink that implements detection of higher than default USB Type-C Current Source advertisements.
5 Functional Extensions		
5.1 Alternate Modes		
5.1#1	4.28 4.36	All hosts and devices (except chargers) using a USB Type-C receptacle shall expose a USB interface.

Assertion #	Test Name	Assertion Description
5.1#2	4.28 4.36	When a host or device supports Alternate Modes, the host and device shall use USB Power Delivery Structured Vendor Defined Messages (Structured VDMs) to discover, configure and enter/exit modes to enable Alternate Modes
5.1#3	4.28 4.36	When a host or device supports Alternate Modes, where no equivalent USB functionality is implemented, the device shall provide a USB interface exposing a USB Billboard Device Class used to provide information needed to identify the device
5.1#4	4.40	As Alternate Modes do not traverse the USB hub topology, they shall only be used between a directly connected host and device.
5.1.1 Alternate Mode Architecture		
5.1.1#1	Untestable	Only Structured VDMs shall be used to alter the USB functionality or reconfigure the pins the USB Type-C Connector exposes.
5.1.2 Alternate Mode Requirements		
5.1.2#1	4.28 4.36	The host and device shall negotiate a USB PD Explicit Contract before Structured VDMs may be used to discover or enter an Alternate Mode.
5.1.2#2	4.36	The ACK shall be sent after switching to the Alternate Mode has been completed by the UFP for Enter Mode and Exit Mode requests.
5.1.2#3	4.36	If a device fails to successfully enter an Alternate Mode within tAMTimeout then the device shall minimally expose a USB 2.0 interface (USB Billboard Device Class) that is powered by VBUS.
5.1.2#4	4.36	If the device enters the mode after a host sends Enter Mode, it shall respond with an ACK and discontinue exposing the USB Billboard Device Class interface.
5.1.2#5	PD	The current supplied over VCONN may be redefined by a specific Alternate Mode but the power shall not exceed the current rating of the pin (See Section 3.7.7.4).
5.1.2.1 Alternate Mode Pin Reassignment		
5.1.2.1#1	4.28 4.36	Figure 5-1 illustrates the only pins that shall be available for functional reconfiguration in a full-featured cable.
5.1.2.1#2	4.28 4.36	The pins highlighted in yellow (Fig 5-1) are the only pins that shall be reconfigured.

Assertion #	Test Name	Assertion Description
5.1.2.1#3	4.28 4.36	Figure 5-2 illustrates the only pins that shall be available for functional reconfiguration in direct connect applications such as a cradle dock, captive cable or a detachable notebook.
5.1.2.1#4	4.28 4.36	The pins highlighted in yellow (Fig 5-2) are the only pins that shall be reconfigured.
5.1.2.2 Alternate Mode Electrical Requirements		
5.1.2.2#1	4.28 4.36	Signaling during the use of Alternate Modes shall comply with all relevant cable assembly, adapter assembly and electrical requirements of Chapter 3.
5.1.2.2#2	4.28 4.36	When operating in an Alternate Mode and pin pairs A2, A3 (TX1) and B2, B3 (TX2) are used, these shall be AC coupled in or before the plug.
5.1.2.2#3	4.28 4.36	Alternate Mode signals being received at the USB Type-C receptacle shall not exceed the value specified for VTX-DIFF-PP in Table 6-17 of the USB 3.1 specification.
5.1.2.2#4	4.28 4.36	When in an Alternate Mode, activity on the SBU lines shall not interfere with USB PD BMC communications or interfere with detach detection.
5.1.2.2#5	4.28	SBU1/2 and SSTX/SSRX must transition to the USB Safe State before entering to or exiting from an Alternate Mode.
5.1.2.2#6	4.28	The DFP and UFP shall provide a discharge path to ground in USB Safe State when a connection to the USB Type-C receptacle is present.
5.1.3 Parameter Values		
5.1.3#1	4.28 4.36	While operating in an Alternate Mode, the signaling shall not cause noise ingress onto USB signals operating concurrently that exceeds the Vnoise parameters given in Table 5-3.
5.2 Managed Active Cables		
5.2#1	CabCon	Active cables that require configuration (managed active cable) shall use USB Power Delivery Structured VDMs to discover and configure the cable.
5.2.1#1	PD/CabCon	Figure 5-4 illustrates the process that shall be followed to assign SOP' and SOP'' to the ends attached to the DFP and UFP, respectively, at power on.
5.2.1#2	PD/CabCon	When VCONN is removed, the plug's local VCONN shall discharge to below its SOP' detection threshold within 20 ms.

Assertion #	Test Name	Assertion Description
5.2.1#3	PD/CabCon	A managed active cable shall assure that the two USB PD controllers are uniquely assigned via the mechanism described here, one as SOP' and the other as SOP''.
5.2.1#4	IOP	Managed active USB Type-C to USB Type-C cables shall by default support USB operation.
5.2.1#5	IOP	Multi-modal cables (e.g., an active cable that supports an Alternate Mode in addition to USB SuperSpeed) that use the TX/RX signal pairs shall minimally support USB 3.1 Gen 1 operation.
5.2.1#6	CabCon	On a managed active cable the isolation elements (Iso) shall prevent VCONN from traversing end-to-end through the cable.
5.2.1.1 Parameter Values		
5.2.1.1#1	PD/CabCon	tVCONNStable is the time between the application of VCONN until SOP' and SOP'' shall be ready for communication.
5.2.2 Cable Message Structure		
5.2.2#1	PD/CabCon	USB PD Structured VDMs shall be used to identify and manage active cables.
5.2.2#2	PD/CabCon	In all cases, Structured VDMs shall only use SOP' and SOP''
5.2.2#3	PD/CabCon	Structured VDMs shall not use SOP.
5.2.2#4	PD/CabCon	Only the DFP shall be allowed to communicate with SOP' and SOP'' after an explicit USB PD contract has been entered, except when a UFP has confirmed that it is communicating with a USB PD BFSK-based source and needs to communicate with SOP' to identify if the cable is capable of greater than 1.5 A.
5.2.2#5	PD/CabCon	For active cables that support both SOP' and SOP'', after attach or a USB PD Cable Reset, the plug directly connected to the DFP shall only respond to SOP' and the plug directly connected to the UFP shall only respond to SOP''.
5.2.2#6	PD/CabCon	The Discover Identity message shall start with SOP'.
5.2.3 Modal Cable Management		
5.2.3#1	PD/CabCon	In addition to supporting the Discover Identity message, managed active cables shall support the following USB Power Delivery Structured VDMs.
5.2.3#2	PD/CabCon	These following VDMs shall start with SOP': Discover SVIDs, Discover Modes, Enter Mode, Exit Mode

Assertion #	Test Name	Assertion Description
5.2.3.1 Discover SVIDs		
5.2.3.1#1	PD/CabCon	The managed active cable shall return a list of SVIDs that it supports.
5.2.3.2 Discover Modes		
5.2.3.2#1	PD/CabCon	The managed active cable shall return a list of Alternate Modes it supports for each SVID.
5.2.3.3 Enter Mode		
5.2.3.3#1	PD/CabCon	The managed active cable shall use the Enter Mode command to enter an Alternate Mode.
5.2.3.4 Exit Mode		
5.2.3.4#1	PD/CabCon	The managed active cable shall use the Exit Mode command to exit an alternate mode previously entered.
5.2.3.4#2	PD/CabCon	Exit Mode shall return the cable to its default USB operation.

Test Requirements

Hardware

The USB Type-C Connector Verification System (CVS) is a hardware solution capable of testing the verifications defined by this document. The CVS implements the following block diagram:

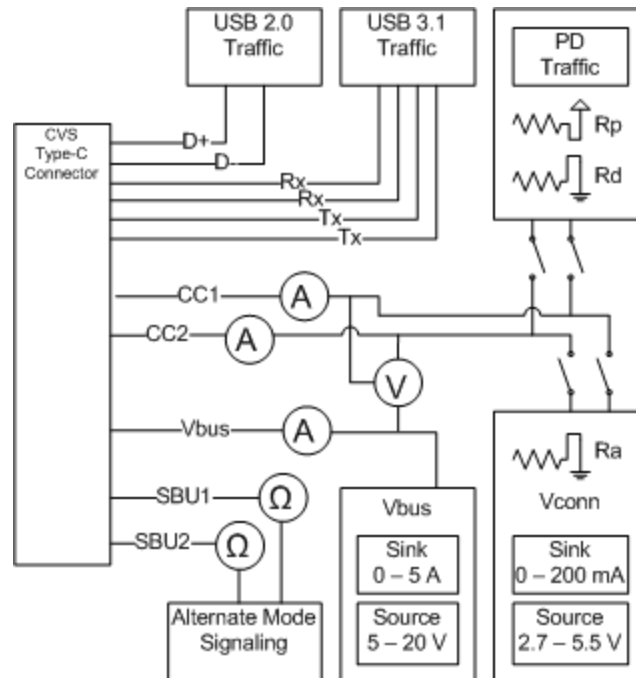


Figure 1: CVS Block Diagram

For a PUT bound to a USB Type-C receptacle, the CVS is required to emulate the USB Type-C Connector State Machines from the perspective of the PUT receptacle. So it must appear as the Source / Sink / SNKAS / DRP AND as the cable (Ra) at the same time. To accomplish this the CVS uses a special cable so that CVS hardware has access to both CC pins on a PUT receptacle. If the PUT is bound to a captive cable, then the test hardware emulates the USB Type-C Connector State Machines from the perspective of the captive cable connector, and does not emulate a cable at the same time.

Additionally, the CVS must be able to measure voltages and currents as defined in the Electrical Requirements section.

Electrical

The CVS determines PUT state by confirming that state's electrical requirements are detected. CC terminations Rp, Rd, and Ra and currents and voltages are defined in USB Type-C Spec Section 4.11.1 Termination Parameters and 4.11.3 Voltage Parameters. VBUS values are defined by the USB Type-C spec as well all the USB 2.0 and USB 3.1 specifications, USB BC 1.2, and USB Power Delivery specification depending on the context. VBUS current is defined by USB Type-C Specification. VCONN is defined by the USB Type-C spec and USB PD specification. The CVS verifications check against these defined values to confirm PUT state.

Timing

Transitions between states and other timers are defined in USB Type-C Spec Section 4.11.2 Timing Parameters. The CVS verifications check against these defined values to confirm PUT transitions.

In addition to those parameters defined in the table, there are some clarifying points and additional timers defined below:

1) **DRP PUT transition to Attached state**

The time from CVS transition to Unattached state to when CVS can verify one of:

- 1) PUT transitions to Attached.SNK
- 2) PUT transitions to Attached.SRC

is:

$$t_{DRP.DRPAAttach} = 5 \times t_{DRP}$$

2) **PUT transition out of Attached.SRC**

The PUT transition from Attached.SRC or PoweredAccessory to Unattached.SNK or Unattached.SRC is immediate as defined in the USB Type-C Specification. But the PUT has $t_{VbusOFF}$ or $t_{VconnOFF}$ to stop sourcing Vbus and Vconn (USB Type-C Spec Section 4.11.2). So for those transitions, the PUT may be sourcing Vbus or Vconn while in the Unattached.SNK or Unattached.SRC state. This is the only scenario where a PUT would be sourcing those voltages while in Unattached.SNK or Unattached.SRC, and the reader may note this is an exception to the spec requirement that those voltages are not sourced while in those states (USB Type-C Spec Sections 4.5.2.2.3.1 Unattached.SNK Requirements & 4.5.2.2.6.1 Unattached.SRC Requirements).

Although the spec defines the transition out of Attached.SRC or PoweredAccessory to be immediate when Rd is no longer detected, due to low clock speed on the CC pins and power saving implementations the PUT may not detect Rd has been removed for more than 2 ms. If USB PD is implemented on the product, it may be retrying a message and postponing far-end detection for more than 12ms.

For the purposes of Compliance testing we have given the PUT a timer of t_{Detach} to make the transition.

$$t_{Detach} = \max t_{PDDebounce} = 20ms$$

3) **PUT transition out of Attached.SNK**

When a PUT transitions from Attached.SNK to Unattached.SNK or Unattached.SRC, it must make the transition immediately upon detecting removal of Vbus. This can be immediate and may take up to $t_{VbusOFF}$.

Product

There are a few testing requirements based on the USB-C Product implementation.

The Vendor Info File (VIF) is used in conjunction with test software to indicate PUT product implementation. This file can be generated by the following tool:

<http://www.usb.org/developers/tools/#PDFFile>

Note: The VIF may be generated by test equipment vendors as well.

This sections lists VIF fields that are used or implicated in the USB Type-C Functional Test descriptions and gives a brief summary of how they are used.

Type_C_State_Machine
 Type_C_Implements_Try_SRC
 Type_C_Implements_Try_SNK
 Type_C_Supports_Audio_Accessory
 Type_C_Supports_VCONN_Powered_Accessory
 Type_C_Is_Vconn_Powered_Accessory
 Type_C_Is_Debug_Target_SNK
 Type_C_Is_Debug_Target_SRC

These fields' values are used in Connection Tests to determine applicability. Source Connection tests are only applicable when Type_C_State_Machine = 0 (SRC). Type_C_State_Machine is used in several Source-Capable or Sink-Capable Tests to constrain applicability as well.

Type_C_Can_Act_As_Host
 Type_C_Can_Act_As_Device
 Type_C_Host_Speed
 Type_C_Device_Speed

These fields' values are used in various tests to determine whether the PUT supports USB 3.1 or USB 2.0 and at what speed. With this information, the CVS will know which data conditions from the test description are applicable for the test run. A test step might refer to a PUT that supports USB 3.1 as a host. This is equivalent to Type_C_Can_Act_As_Host = YES and Type_C_Host_Speed = 1.

UUT_Device_Type

This field is used to ascertain whether the PUT supports PD. If the value is set to 6 (Type_C_Only) then the PUT is not PD capable. The PUT is PD capable with any other value. If UUT_Device_Type is not set to 6 (Type_C_Only) and Type_C_Can_Act_As_Host = YES then the Data_Capable_as_USB_Host_SOP field must also be set to YES in the VIF. Similarly, if Type_C_Can_Act_As_Device = YES then the Data_Capable_As_USB_Device_SOP field must be YES.

UUT_Device_Type is also used to determine whether Source-Capable or Sink-Capable Tests are applicable. If the value is in the set {0: Consumer Only, 1: Consumer/Provider, 2: Provider/Consumer, 4: DRP}, then the Sink-Capable Tests are required. If the value is set to one of {1: Consumer/Provider, 2: Provider/Consumer, 3: Provider Only, 4: DRP}, then the Source-Capable Tests are required.

For USB-IF Certification, a Provider/Consumer or Consumer/Provider with Type_C_State_Machine set to SRC or SNK are discouraged. These product schemes will limit a product's ability to connect with its link partner and creates a silent failure. The failure scenarios include the connection between a SNK which supports PR_Swap and a dead battery device.

Captive_Cable

The VIF field Captive_Cable set to NO indicates the PUT is a PUT_R, and the value YES indicates PUT is a PUT_C. More information about PUT_R and PUT_C is in the Tests section.

Rp_Value

If the VIF field Type_C_State_Machine is set to 0 (SRC) or 2 (DRP) then the PUT has an Rp pull up resistor on its CC pins. The value of this resistor indicates the Type-C Current level that the PUT can source. The value here indicates the PUT Rp resistor value on Attach.

Port_Battery_Powered

This field is used in TD 4.11.2 Sink Dead Battery Test, checking that a DUT with a Dead Battery implements a USB Type-C Sink State Machine.

If the DUT uses a Battery then it must run the Type-C Functional Tests once with a charged battery and again with a Dead Battery.

Type_C_Port_On_Hub

This field is used in TD Section 4.12 Hub tests.

Type_C_Power_Source

If the DUT is capable of being a UFP-powered device or an Externally-powered device (including charge-through), then the DUT must run Type-C Functional Tests with both connection scenarios. As a UFP-powered device, the DUT must implement a USB Type-C Sink Connection state machine.

Type_C_BC_1_2_Support

This field is used to determine if the PUT supports BC 1.2 and whether it is supported as a Source, as a Sink, or both. If the DUT is capable of sinking via USB BC 1.2 protocol, then its usage will be exercised during TD 4.10.2 Sink Power Precedence Test.

Type_C_Sources_Vconn

This field is used to determine if the PUT is a PUT_V and will be tested again Vconn requirements. Some PUTs are required to source Vconn as described in the PUT_V definition in the Tests section of this document. When a PUT is not required to source Vconn, it still may support doing so and in that case is still held to the Vconn requirements in the spec.

DR_Swap_To_DFP_Supported

DR_Swap_To_UFP_Supported

These fields are used in TD 4.11.1 DR_Swap Test to ascertain which directions to test. Usage described in the test steps.

If the VIF fields indicate either of the following:

- UUT_Device_Type != 6 (Type_C_Only) and Type_C_State_Machine is DRP
- Type_C_Can_Act_As_Host is YES and Type_C_Can_Act_As_Device is YES

Then at least one of the fields DR_Swap_To_DFP_Supported or DR_Swap_To_UFP_Supported must be YES.

VCONN_Swap_To_On_Supported

VCONN_Swap_To_Off_Supported

These fields are used in TD 4.9.4 Source Vconn_Swap Test and TD 4.10.5 Sink Vconn_Swap Test to ascertain which directions to test. Usage described in the test steps.

Modal_Operation_Supported_SOP

Attempts_Discov_SOP

These fields are used in TD 4.9.5 Source Alternate Modes Test and TD 4.10.6 Sink Alternate Mode Test to ascertain which directions to test. Usage described in the test steps.

Accepts_PR_Swap_As_Src
Accepts_PR_Swap_As_Snk

These fields are used in TD 4.9.3 Source PR_Swap Test and TD 4.10.4 Sink PR_Swap Test to ascertain which directions to test. Usage described in the test steps.

Tests

Many test steps require the CVS to emulate states defined in the USB Type-C Connection State machines. In the attached state this includes appropriate responses to capabilities messages and cable discovery as needed. During steps that require messaging, the CVS default behavior is to reject unexpected swap messages.

State emulation is accomplished slightly differently when the CVS is testing a PUT bound to a USB Type-C receptacle (PUT_R) vs. a PUT bound to a USB Type-C captive cable or a direct attach (PUT_C).

For a PUT_R, the CVS will apply the CC values indicated by a Type-C Connection State on only one CC pin. Note: for a test run, the one CC pin stays the same throughout the test. The other pin, unless otherwise indicated, remains in an Open state. The test steps will indicate if the other CC pin will be terminated with Ra.

For a PUT_C, the CVS will apply the CC values indicated by a Type-C Connection State on both CCs and monitors the CCs to ascertain to which CC the PUT is connected.

For instance, when a test step indicates that the CVS transitions to Unattached.SRC:

- For a PUT_R, the CVS will apply Rp on one CC and unless otherwise indicated, the other CC pin will remain in an Open state. The test step will indicate if the other CC pin will be terminated with Ra.
- For a PUT_C, the CVS will apply Rp on both CCs.

When a test step indicates that the CVS apply Rp, unless otherwise indicated, the Rp advertises the USB default current.

For tests that verify load on Vbus, the CVS will give a 5 ms delay starting at Vbus ON for inrush allowance before measuring current.

When a test step indicates it is verifying data communications:

- For USB 3.1 data communications, the tester verifies U0 is reached between CVS and PUT
- For USB 2.0 data communications, the tester verifies packets received from PUT

The following paragraphs describe the assumed initial testing state for a PUT_R and PUT_C.

For a PUT_R, every test is initialized with the following assumptions:

1. CVS starts in Disabled
2. PUT and CVS are physically connected through a cable.
3. The cable connecting the CVS and PUT has a through connection on both CC pins so the CVS can emulate a cable. This is so the CVS can generate and monitor VCONN sourcing and sinking

For a PUT_C, every test is initialized with the following assumptions:

1. CVS starts in Disabled
2. PUT and CVS are physically connected through the PUT captive cable.

The PUT will always be either a PUT_R or a PUT_C. In addition to that, the PUT will also be categorized as a PUT_V if it supports sourcing Vconn in the Attached.SRC state. A test step will indicate when a verification is only checked for a PUT_V.

If the PUT is a PUT_R and indicates point 1 and either 2 or 3 below:

1. VIF field Type_C_State_Machine is set to SRC or DRP or UUT_Device_Type is Consumer/Provider
2. VIF field Type_C_Host_Speed is USB 3.1 or Type_C_Device_Speed is USB 3.1 indicating PUT supports USB 3.1 signaling on its SS RX and SS TX pairs
3. VIF indicates any Source PDO with Max Current greater than 3A

Then the PUT is required to be capable of sourcing Vconn and shall also be referred to as a PUT_V in this document.

If the PUT has VIF field Type_C_Port_On_Hub set to YES and Type_C_Can_Act_As_Host set to YES, then CVS prompts the user to verify the UFP of the hub under test is plugged into a host.

Connection Tests

All USB Type-C Connectors participate in the Initial Voltage Test, TD 4.1. The rest of the Connection Tests check the CC initialization sequence between possible USB Type-C implementations. Tests are categorized by the type of Connection State Machine they implement in USB Type-C Spec Section 4.5.2.1 Connection State Diagrams and for the Accessories section, for a lack of Connection State Machine.

TD 4.1.1 Initial Voltage Test

- A. Purpose:
 1. Verify that SBU pins are terminated with 1M or higher, and there is no signal
 2. An unconnected PUT that is not a charger with a captive cable does not source voltage/current on its CC pins.
 3. Verify Source – Source connection does no damage
- B. Applicability:
 1. This test applies to all USB Type-C Ports, indicated with VIF field UUT_Device_Type field not set to Cable.
- C. Asserts:
 1. 4.3#1
 2. 4.4.2#2,4
 3. 4.5.1.2#1,2
 4. 4.5.2.2.1#1
 5. 4.5.2.2.1.1#1
 6. 4.5.2.2.6.2#3
 7. 4.5.2.2.13.1#1
 8. 4.8.1.1#1
 9. 4.8.1.2#1
 10. 4.6#5
- D. Procedure:
 1. CVS verifies that the SBU pins on the PUT are at least 950k to ground. (4.3#1)
 2. If the PUT sources Vbus:
 - a. CVS Verifies:
 - i. VIF field USB_PD_Support is set to NO
 - ii. VIF field Type_C_State_Machine is set to SRC
 - iii. VIF field Captive_Cable is set to YES
 - iv. VIF field Type_C_Can_Act_As_Host is set to NO
 - v. VIF field Type_C_Can_Act_As_Device is set to NO
 - b. If the VIF fields in step 2.a are all verified, the test is over. The only other applicable Type_C_Functional test is TD 4.9.2.
 3. CVS verifies that the VBUS pins do not source VBUS (4.5.2.2.1#1)
 4. For a Source-capable PUT:
 - a. CVS transitions to Unattached.SRC state.
 - b. Wait 750ms.
 - c. CVS verifies PUT does not source VBUS (4.5.1.2#2)
 - d. For a PUT_R:
 - i. CVS transitions to Disabled for 750ms.
 - ii. CVS terminates 1 CC pin with Ra.
 - iii. Wait 750ms.
 - iv. CVS verifies PUT does not source VBUS
 - v. CVS verifies PUT does not source VCONN (4.5.2.2.6.2#3)
 - e. CVS transitions to Disabled for 750ms.
 5. For a Sink and SNKAS PUT:
 - a. CVS transitions to Unattached.SNK state for 50ms

- b. CVS transitions to Unattached.Accessory state for 50ms
 - c. CVS transitions to Unattached.SNK state for 50ms
 - d. CVS transitions to Disabled for 750ms.
6. For a Sink-capable PUT:
 - a. CVS applies USB 3.1/2.0 DFP terms
 - b. Wait 2s
 - c. CVS verifies PUT did not apply D+ pull-up or SS terms
 7. CVS applies 53.2k resistance from Vbus to CC pin.
 8. CVS verifies PUT does not source Vbus after tCCDebounce.
 9. CVS removes 53.2k resistance from Vbus to CC pin.
 10. CVS presents VBUS for 1s.
 11. This test must be performed before the DUT is tested at the USB-IF Interoperability Test Suites.

TD 4.1.2 Unpowered CC Voltage Test

- A. Purpose:
 1. Verify that a product which is powered off does not present Rd
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SRC
 2. This test applies when VIF field Type_C_State_Machine is DRP and Port_Battery_Powered is NO.
 3. This test applies when VIF field Type_C_State_Machine is SNK and Type_C_Power_Source is 0 (“Externally Powered”) and Port_Battery_Powered is NO.
- C. Asserts:
 1. TBD
- D. Procedure:
 1. If Type_C_State_Machine is DRP, CVS verifies that Type_C_Power_Source is not set to 1 (UFP-Powered)
 2. CVS prompts the user to unplug external power to the product so that the PUT is unpowered
 3. CVS applies Rp in the USB Default Current range
 4. If Type_C_State_Machine is DRP and Type_C_Power_Source is 2 (Both), CVS verifies that PUT applies Rd and does not toggle.
 5. Else, CVS verifies that CC voltage is in vOPEN range
 6. CVS transitions to Disabled for 500ms
 7. CVS applies Rp in the USB Type-C Current 1.5 A range
 8. If Type_C_State_Machine is DRP and Type_C_Power_Source is 2 (Both), CVS verifies that PUT applies Rd and does not toggle.
 9. Else, CVS verifies that CC voltage is in vOPEN range
 10. CVS transitions to Disabled for 500ms
 11. CVS applies Rp in the USB Type-C Current 3.0 A range
 12. If Type_C_State_Machine is DRP and Type_C_Power_Source is 2 (Both), CVS verifies that PUT applies Rd and does not toggle.
 13. Else, CVS verifies that CC voltage is in vOPEN range
 14. CVS prompts the test operator to replug external power to the product so that the PUT is powered

These tests are for USB Type-C connectors that implement the Source connection state machine in USB Type-C Specification Figure 4-12.

TD 4.2.1 Source Connect Sink Test

- A. Purpose:
 1. Verify a Source transitions to Attached.SRC according to spec
 2. Verify a Source transitions to Unattached.SRC when Sink removed
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SRC
- C. Asserts:
 1. 4.4.2#1-3
 2. 4.5.2.2.6.1#1-3
 3. 4.5.2.2.6.2#1
 4. 4.5.2.2.7.1#1-3
 5. 4.5.2.2.7.2#1,5
 6. 4.5.2.2.8.1#2,4-10
 7. 4.5.2.2.8.2#1
 8. 4.6.2.1#3
 9. 4.6.2.4#1,2
- D. Conditions:
 1. CVS emulates USB PD 2.0 5A Active Cable
 2. CVS emulates USB PD 3.0 5A Active Cable
- E. Procedure:
 1. CVS verifies PUT does not apply Rd for the remainder of the test (Note: This is to check for toggling between Rd/Rp for connect)
 2. If VIF field Type_C_Sources_Vconn is NO, CVS verifies PUT does not source Vconn for the remainder of this test.
 3. CVS transitions to Unattached.SNK.
 4. For a PUT_R:
 - a. CVS terminates one CC pin with Ra for the duration of the test.
 - b. CVS emulates an Active Emarked cable with the first Condition from section D above
 - c. CVS verifies PUT has transitioned to Unattached.SRC
 - i. PUT applies Rp simultaneously on both CC pins
 - d. CVS waits 80ms
 - e. CVS transitions to Disabled except for one CC maintaining Ra
 - f. CVS verifies PUT transitions to Unattached.SRC
 - g. Wait 750ms.
 - h. CVS transitions to Unattached.SNK
 5. CVS verifies that:
 - a. CVS detects SNK.Rp on its Rd terminated CC pin
 - b. PUT transitions to Attached.SRC by sourcing VBUS after tCCDebounce and before tCCDebounce + tVBUSON expires after CVS detects SNK.Rp
 6. Vconn_tested = false
 7. If PUT supports USB PD:
 - a. CVS verifies that:
 - i. PUT stabilizes VBUS before initiating USB PD communications
 - ii. CVS and PUT negotiate a contract.
 - b. If PUT source capabilities include a Max Current > 3 A:
 - i. CVS verifies that for a PUT_R, it supplied Vconn within tVconnON
 - ii. Vconn_tested = true
 8. If PUT supports USB 3.1 DFP:
 - a. CVS verifies that:

- i. PUT attaches eSS terms within 80ms of Vbus on
 - ii. For a PUT_R and not Vconn_tested:
 - 01 It supplied VCONN within tVCONN
 - 02 Vconn_tested = true
 - iii. PUT transmits LFPS within 121ms of attaching eSS terms
 - b. CVS loads 1W on Vconn
 - c. Wait 1s
9. If the PUT is a PUT_V and not Vconn_tested:
 - a. CVS verifies that for a PUT_R, it supplied Vconn within tVconnON
10. CVS transitions to Disabled
11. CVS verifies that PUT transitions to Unattached.SRC within tDetach
 - a. PUT removes Vbus within tVbusOFF
 - b. For a PUT that supports USB 3.1 DFP, Vconn was sourced until after step 10
 - c. All signaling has stopped
12. CVS waits 1 second, checking that PUT does not toggle
13. The CVS continues the test with step 2, using the next Condition from section D above

TD 4.2.2 Source Connect SNKAS Test

- A. Purpose:
 1. Verify a Source transitions to Attached.SRC according to spec when link partner is Sink with Accessory Support (SNKAS).
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SRC
- C. Asserts:
 1. See TD 4.2 Asserts.
 2. 4.5.2.2.7.2#4
- D. Procedure:
 1. CVS transitions to Unattached.SNK for 5ms.
 2. CVS transitions to Unattached.Accessory for max dcSRC.DRP x max tDRP.
 3. CVS verifies Source is in Unattached.SRC:
 - a. For a PUT_R, both CCs advertise Rp
 - b. For a PUT_C, the CC connected to Rd advertises Rp
 4. CVS transitions to Unattached.SNK
 5. CVS verifies that the PUT:
 - a. Advertises VBUS capabilities with Rp throughout the test
 - b. Sources VBUS after tCCDebounce deadline and before tCCDebounce + VBUSON expires.

TD 4.2.3 Source Connect DRP

- A. Purpose:
 1. Verify a Source transitions to Attached.SRC according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SRC
- C. Asserts:
 1. 4.4.2#1-3
 2. 4.5.2.2.6.1#1-3
 3. 4.5.2.2.6.2#1
 4. 4.5.2.2.7.1#1-3
 5. 4.5.2.2.7.2#1
 6. 4.5.2.2.8.1#2,4-6
- D. Procedure:

1. CVS transitions to Unattached.SNK for 1.5 ms
2. CVS transitions to Unattached.SRC for max dcSRC.DRP x min tDRP
3. CVS transitions to Unattached.SNK
4. CVS verifies the PUT is in Unattached.SRC providing Rp
5. CVS verifies the PUT transitions to Attached.SRC after tCCDebounce expires:
 - a. PUT sources VBUS within tVBUSON
 - b. If PUT supports USB PD:
 - i. CVS and PUT negotiate an explicit contract

TD 4.2.4 Source Connect Try.SRC DRP

- A. Purpose:
 1. Verify a Source transitions to Attached.SRC according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SRC
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.SNK for 10 ms
 2. CVS transitions to Unattached.SRC for 50 ms
 3. CVS transitions to Unattached.SNK
 4. CVS verifies the PUT is in Unattached.SRC providing Rp
 5. CVS transitions to AttachWait.SNK for tCCDebounce max
 6. CVS verifies the PUT transitions to Attached.SRC
 7. CVS transitions to Try.SRC
 8. CVS verifies the PUT transitions to Unattached.SRC
 - a. PUT has removed Vbus within tVbusOff
 - b. PUT has ceased all clocked signaling
 9. If Vbus is not within vSafe0V after max tDRPTry from step 7, wait min tTryTimeout from step 7
 10. CVS transitions to TryWait.SNK
 11. CVS verifies the PUT and CVS transitions to Attached.SRC and Attached.SNK after tCCDebounce expires:
 - a. PUT sources VBUS within tVBUSON
 - b. If PUT supports USB PD:
 - i. CVS and PUT negotiate an explicit contract
 - c. PUT may transition to Attached.SRC and back to Unattached.SRC before time expires

TD 4.2.5 Source Connect Try.SNK DRP

- A. Purpose:
 1. Verify a Source transitions to Attached.SRC according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SRC
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.SNK for 1.5 ms
 2. CVS transitions to Unattached.SRC for min dcSRC.DRP x min tDRP
 3. CVS transitions to Unattached.SNK
 4. CVS verifies the PUT is providing Rp
 5. CVS verifies the PUT transitions to Attached.SRC after tCCDebounce expires:

- a. PUT sources VBUS within tVBUSON
- b. If PUT supports USB PD:
 - i. CVS and PUT negotiate an explicit contract

TD 4.2.6 Source Connect Audio Accessory

- A. Purpose:
 1. Verify a Source that supports Audio Accessories connects according to spec requirements
- B. Applicability:
 1. This test applies for a PUT_R when VIF field Type_C_State_Machine is SRC and Captive_Cable is NO
- C. Asserts:
 1. 4.5.2.2.7.2#2
 2. 4.5.2.2.15.1#1,2,4,5
 3. 4.5.2.2.15.2#2
- D. Procedure:
 1. CVS presents Audio Accessory CC terms with Ra
 2. CVS verifies PUT provides Rp on both CCs (PUT in Unattached.SRC)
 3. If VIF field Type_C_Supports_Audio_Accessory is YES:
 - a. CVS verifies PUT transitions to AudioAccessory after tCCDebounce:
 - i. The PUT reconfigures its pins as defined in Appendix A
 - ii. The PUT does not drive VBUS or VCONN
 - iii. If the PUT sinks current over VBUS, it shall not be more than 500mA
 - iv. The PUT applies Rp on at least one CC
 4. If VIF field Type_C_Supports_Audio_Accessory is NO:
 - a. CVS verifies PUT does not transition to Attached.SRC or supply Vbus
 5. CVS transitions to Disabled
 6. If VIF field Type_C_Supports_Audio_Accessory is YES:
 - a. CVS verifies PUT transitions to Unattached.SRC after tCCDebounce

TD 4.2.7 Source Connect Debug Accessory

- A. Purpose:
 1. Verify a Source that supports Debug Accessories does source Vbus
- B. Applicability:
 1. This test applies for a PUT_R when VIF field Type_C_State_Machine is SRC and Captive_Cable is NO
- C. Asserts
 1. 4.5.2.2.16.1#2
- D. Procedure:
 1. CVS presents DTS (Debug and Test System) Sink with Rds on both CCs
 2. CVS verifies PUT provides Rp on both CCs (PUT in Unattached.SRC)
 3. If VIF field Type_C_Is_Debug_Target_SRC is YES:
 - a. CVS verifies PUT sources Vbus after tCCDebounce and within tVbusON.
 4. Else If VIF field Type_C_Is_Debug_Target_SRC is NO or not defined:
 - a. CVS verifies PUT does not source Vbus after tCCDebounce expires

TD 4.2.8 Source Connect VCONN Accessory

- A. Purpose:
 1. Verify the Source connects with an Accessory that uses VCONN.
- B. Applicability:

1. This test is applicable for a PUT_R with VIF field Type_C_State_Machine set to SRC and Captive_Cable is NO and Type_C_Sources_Vconn is YES
- C. Asserts:
1. 4.5.2.2.8.1#10
 2. 4.5.2.2.8.2#6
 3. 4.5.2.2.19.1#5
- D. Procedure:
1. CVS presents a Vconn-powered Accessory by terminating one CC with Rd and one CC with Ra.
 2. CVS verifies that:
 - a. PUT transitions to Attached.SRC by sourcing VBUS after tCCDebounce and before tCCDebounce + tVBUSON expires
 - b. PUT advertises VBUS capability over Rp
 - c. PUT_V sources VCONN within tVCONNON
 - d. For a PUT with PD (VIF field UUT_Device_Type is not set to Type_C_Only):
 - i. PUT initiates a PD Explicit Contract
 - ii. For a PUT with VIF field Attempts_Discov_SOP set to YES:
 1. PUT initiates Alternate Mode discovery with Structured VDMs
 3. CVS transitions to Disabled
 4. CVS verifies:
 - a. PUT stops sourcing VCONN within tVCONNOFF
 - b. PUT stops sourcing VBUS within tVBUSOFF

Sink Tests

These tests are for USB Type-C connectors that implement the USB Type-C Sink Connection State Diagram in Figure 4-14.

TD 4.3.1 Sink Connect Source Test

- A. Purpose:
1. Verify a Sink transitions to Attached.SNK according to spec
 2. Verify that removing VBUS transitions the PUT to Unattached.SNK
- B. Applicability:
1. This test applies when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory is NO and Type_C_Supports_VCONN_Accessory is NO.
- C. Asserts:
1. 4.5.2.2.3.1#1-2
 2. 4.5.2.2.3.2#1
 3. 4.5.2.2.4.1#1-2
 4. 4.5.2.2.4.2#3
 5. 4.5.2.2.5.1#2-3,5-6
 6. 4.5.2.2.5.2#1
- D. Procedure:
1. CVS verifies the PUT does not apply Rp for the remainder of the test.
 2. CVS transitions to Unattached.SRC
 3. For a PUT_R, CVS terminates one CC pin with Ra in any state other than Disabled for the remainder of the test.
 4. CVS verifies PUT presents Rd for tCCDebounce
 5. CVS transitions to Attached.SRC when it detects connection from PUT:
 - a. PUT must start USB communications on its SS or D+/D- pairs within 1 second

- b. PUT may wait for PD contract before connecting on SS or D+/D- pairs
6. CVS verifies that PUT transitions to Attached.SNK:
 - a. If PUT data connection before PD contract, verify PUT sinks current according to CVS advertisement.
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If VIF field PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 - e. For a PUT_R, VCONN is not supplied
7. CVS transmits Discover ID PD messaging for 200ms.
8. CVS verifies that PUT:
 - a. If UUT_Device_Type is not 6:
 - i. Responds with valid GoodCRC messages.
 - ii. If Responds_To_Discov_SOP is YES:
 - 01 Transmits valid Responder ACK messages.
 - b. Remains in Attached.SNK during and for 500ms after step 6.
9. CVS transitions to Disabled
10. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires:
 - a. PUT data communication has ceased.
11. CVS waits 1 second

TD 4.3.2 Sink Connect DRP Test

- A. Purpose
 1. Verify a Sink transitions to Attached.SNK according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory is NO and Type_C_Supports_VCONN_Accessory is NO.
- C. Asserts:
 1. 4.5.2.2.3.1#1-2
 2. 4.5.2.2.3.2#1
 3. 4.5.2.2.4.1#1-2
 4. 4.5.2.2.4.2#1,3
 5. 4.5.2.2.5.1#2-3,5-6
 6. 4.5.2.2.5.2#1
- D. Procedure:
 1. CVS transitions to Unattached.SRC for 5ms
 2. CVS transitions to Unattached.SNK for 30ms
 3. CVS transitions to Unattached.SRC
 4. CVS verifies PUT continued to provide Rd on the CC pin for the duration of steps 1-3 and for tCCDebounce after
 - a. For a PUT_R, verify this for both CC pins
 5. CVS transitions to Attached.SRC
 6. CVS verifies that PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement
 - b. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - c. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair
 - d. For a PUT_R, VCONN is not applied
 7. CVS transitions to Disabled

8. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires
 - a. PUT data communication has ceased
 - b. PUT is not sourcing Vbus (Vbus is at vSafe0V)
 - c. PUT is not sourcing Vconn

TD 4.3.3 Sink Connect Try.SRC DRP Test

- A. Purpose
 1. Verify a Sink transitions to Attached.SNK according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory is NO and Type_C_Supports_VCONN_Accessory is NO.
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.SRC for 5ms
 2. CVS transitions to Unattached.SNK for 30ms
 3. CVS transitions to Unattached.SRC
 4. CVS verifies PUT continued to provide Rd on the CC pin for the duration of steps 1-3 and for tCCDebounce after
 - a. For a PUT_R, verify this for both CC pins
 5. CVS transitions to Attached.SRC
 6. CVS verifies that PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement
 - b. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - c. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair
 - d. For a PUT_R, VCONN is not applied
 7. CVS transitions to Disabled
 8. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires
 - a. PUT data communication has ceased
 - b. PUT is not sourcing Vbus (Vbus is at vSafe0V)
 - c. PUT is not sourcing Vconn

TD 4.3.4 Sink Connect Try.SNK DRP Test

- A. Purpose
 1. Verify a Sink transitions to Attached.SNK according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory is NO and Type_C_Supports_VCONN_Accessory is NO.
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.SRC for 5ms

2. CVS transitions to Unattached.SNK for 30ms
3. CVS transitions to Unattached.SRC
4. CVS verifies PUT continues to provide Rd on the CC pin for the duration of this test
 - a. For a PUT_R, verify Rd is provided on both CC pins until Attached, and then on at least one CC for the duration of this test.
5. CVS transitions to AttachWait.SRC for max tCCDebounce
6. CVS transitions to Try.SNK for max tDRPtry + max tCCTryDebounce
7. CVS transitions to TryWait.SRC for max tCCTryDebounce
8. CVS transitions to Attached.SRC
9. CVS verifies that PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement
 - b. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - c. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair
 - d. For a PUT_R, VCONN is not applied
10. CVS transitions to Disabled
11. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires
 - a. PUT data communication has ceased
 - b. PUT is not sourcing Vbus (Vbus is at vSafe0V)
 - c. PUT is not sourcing Vconn

TD 4.3.5 Sink Connect SNKAS Test

- A. Purpose:
 1. Verify a Sink VCONN Powered Accessory configures an Alternate Mode when VCONN is present
- B. Applicability:
 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Is_VCONN_Powered_Accessory is set to YES.
- C. Asserts:
 1. 4.10#1-4
- D. Procedure:
 1. CVS does not present Vbus for the duration of this test.
 2. CVS presents VCONN to the PUT CC pin terminated with Ra
 3. CVS and PUT negotiate a PD Explicit Contract
 4. CVS initiates negotiations for an Alternate Mode (Discover ID, SVIDs and Modes)
 5. CVS verifies PUT supports an Alternate Mode
 6. CVS initiates an Enter Mode command with a PUT supported Mode
 7. CVS verifies:
 - a. PUT follows all electrical constraints for SBU and any reconfigured pins (i.e. USB Safe States).
 - b. PUT sends ACK for Enter Mode
 8. CVS initiates an Exit Mode command for the active mode
 9. CVS verifies:
 - a. PUT follows all electrical constraints for SBU and any reconfigured pins (i.e. USB Safe States).
 - b. PUT sends ACK for Exit Mode after successfully exiting the mode.
 10. CVS removes VCONN
 11. CVS verifies PUT transitions to Unattached.SNK within tVCONNOFF
 - a. All clocked signaling ceases

TD 4.3.6 Sink Connect Accessories Test

- A. Purpose
 - 1. Verify a Sink PUT does not interact with Accessories.
- B. Applicability:
 - 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory is NO and Type_C_Supports_VCONN_Accessory is NO
- C. Asserts
 - 1.
- D. Procedure
 - 1. CVS applied Rd to both CCs.
 - 2. CVS verifies no activity on the DUT.
 - 3. CVS applied Ra to both CCs.
 - 4. CVS verifies no activity on the DUT.
 - 5. CVS applies Rd and Ra on CC1 and CC2.
 - 6. CVS verifies no activity on the DUT.

SNKAS Tests

These tests are for USB Type-C Connectors that implement the USB Type-C Sink with Accessory Support (SNKAS) Connection State Diagram in Figure 4-15

TD 4.4.1 SNKAS Connect Source Test

- A. Purpose
 - 1. Verify a SNKAS PUT transitions to Attached.SNK according to spec
- B. Applicability
 - 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory or Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts
 - 1. See TD 4.8
- D. Procedure
 - 1. CVS transitions to Unattached.SRC.
 - 2. For a PUT_R, CVS terminates one CC pin with Ra for the duration of the test.
 - 3. CVS and PUT transition through the Type-C Connection State Machines to Attached.SRC and Attached.SNK
 - 4. CVS verifies PUT transitions to Attached.SNK after tCCDebounce and before tCCDebounce + (dcSRC.DRP x tDRP) expires.
 - a. PUT sinks current according to CVS advertisement
 - b. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - c. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 - d. For a PUT_R, VCONN is not applied

5. CVS transmits Discover ID PD messaging for 200ms.
6. CVS verifies that PUT:
 - a. If UUT_Device_Type is not 6:
 - i. Responds with valid GoodCRC messages.
 - ii. If Responds_To_Discov_SOP is YES:
 - 01 Transmits valid Responder ACK messages.
 - b. Remains in Attached.SNK during and for 500ms after step 5.
7. CVS transitions to Disabled
8. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires
 - a. PUT data communication has ceased.
 - b. PUT is cycling between Unattached.SNK and Unattached.Accessory.

TD 4.4.2 SNKAS Connect DRP Test

- A. Purpose:
 1. Verify a SNKAS PUT transitions to Attached.SNK correctly with DRP
 2. Verify transition to Attached.SNK succeeds given varying measurements of tDRP and dcSRC.DRP
- B. Applicability
 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory or Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts:
 1. See TD 4.9
 2. 4.5.2.2.13.2#3
- D. Conditions on CVS DRP:
 1. tDRP = 50ms, dcSRC.DRP = 30%
 2. tDRP = 75ms, dcSRC.DRP = 30%
 3. tDRP = 100ms, dcSRC.DRP = 30%
 4. tDRP = 50ms, dcSRC.DRP = 50%
 5. tDRP = 75ms, dcSRC.DRP = 50%
 6. tDRP = 100ms, dcSRC.DRP = 50%
 7. tDRP = 50ms, dcSRC.DRP = 70%
 8. tDRP = 75ms, dcSRC.DRP = 70%
 9. tDRP = 100ms, dcSRC.DRP = 70%
- E. Procedure:
 1. CVS uses Condition 1 above for tDRP and dcSRC.DRP
 2. CVS transitions to Unattached.SNK for 5ms
 3. CVS transitions to Unattached.SRC for (dcSRC.DRP x tDRP). If this test step is reached more than once after step 1:
 - a. CVS monitors CCs for Rd and transitions to AttachedWait.SRC when it is detected
 - b. If Rd is present for longer than tCCDebounce, CVS transitions to Attached.SRC. Continue to step 5.
 4. CVS transitions to Unattached.SNK for tDRP – (dcSRC.DRP x tDRP).
 - a. If the PUT has reached step 4 less than 5 times since step 1, transition to step 3.
 - b. Else, the test fails.
 5. CVS verifies PUT transitions to Attached.SNK before 5 x tDRP expires.
 - a. PUT sinks no more Vbus current than CVS advertisement
 - b. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - c. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.

- d. For a PUT_R, VCONN is not applied
6. CVS transitions to Disabled
7. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires
 - a. PUT data communication has ceased
 - b. PUT is cycling between Unattached.SNK and Unattached.Accessory.
8. Continue at Step 1 with the next Condition

TD 4.4.3 SNKAS Connect Try.SRC DRP Test

- A. Purpose:
 1. Verify a SNKAS PUT transitions to Attached.SNK correctly with DRP
 2. Verify transition to Attached.SNK succeeds when its port partner uses Try.SRC
- B. Applicability
 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory or Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts:
 1. See TD 4.9
 2. 4.5.2.2.13.2#3
- D. Procedure:
 1. CVS attaches Ra on one of its CCs for the duration of the test
 2. CVS transitions to Unattached.SRC for 5ms
 3. CVS transitions to Unattached.SNK and starts timer max dcSRC.DRP x max tDRP (70ms).
 4. CVS monitors CCs for Rp and verifies that Rp is connected before the timer expires.
 5. CVS transitions to AttachWait.SNK for max tCCDebounce.
 6. CVS verifies that Vbus is not detected after tCCDebounce.
 7. CVS remains in AttachWait.SNK and starts tAMETimeout
 8. CVS verifies that PUT attaches Rds (transitions to Try.SNK) before tAMETimeout expires
 9. CVS transitions through Unattached.SRC to AttachWait.SRC after min tPDDebounce.
 10. CVS transitions to Attached.SRC after max tCCDebounce
 11. CVS verifies that PUT transitions to Attached.SNK:
 - a. If PUT supports USB PD:
 - i. PUT and CVS establish an explicit contract
 - b. If PUT supports USB data:
 - i. PUT starts USB communication on its SS or D+/D- pairs.

TD 4.4.4 SNKAS Connect Try.SNK DRP Test

- A. Purpose:
 1. Verify a SNKAS PUT transitions to Attached.SNK correctly with DRP
 2. Verify transition to Attached.SNK succeeds when its port partner uses Try.SNK
- B. Applicability
 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory or Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts:

1. See TD 4.9
 2. 4.5.2.2.13.2#3
- D. Procedure:
1. CVS applies Ra to one CC for the duration of the test
 2. CVS transitions to Unattached.SNK for 5ms
 3. CVS transitions to Unattached.SRC and starts timer max dcSRC.DRP x max tDRP (70ms).
 4. CVS monitors CCs for Rd and verifies that Rd is connected before the timer expires.
 5. CVS transitions to AttachWait.SRC for tCCDebounce.
 6. CVS transitions to Try.SNK and starts tDRPTry
 7. CVS verifies that PUT transitions to attaching Rp (Unattached.Accessory) after tPDDebounce and then before max dcSRC.DRP x max tDRP (70ms).
 8. If PUT attaches Rp before tDRPTry + tPDDebounce expires:
 - a. CVS remains in Try.SNK
 - b. CVS verifies PUT attaches Rd (transitions to Try.SNK) after tCCDebounce and then within tAMETimeout.
 - c. When PUT attaches Rd, CVS transitions to TryWait.SRC after tPDDebounce.
 - d. Skip to step 10.
 9. CVS transitions to TryWait.SRC after max tDRPTry + max tPDDebounce expires.
 10. CVS verifies PUT transitions to Unattached.SNK after tPDDebounce
 11. CVS transitions to Attached.SRC after max tCCDebounce.
 12. CVS verifies that PUT transitions to Attached.SNK:
 - a. If PUT supports USB PD:
 - i. PUT and CVS establish an explicit contract
 - b. If PUT supports USB data:
 - i. PUT starts USB communication on its SS or D+/D- pairs.

TD 4.4.5 SNKAS Connect SNKAS Test

- A. Purpose:
1. Verify a SNKAS PUT interacts correctly with SNKAS
- B. Applicability
1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory or Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts:
1. See TD 4.9
 2. 4.5.2.2.13.2#3
- D. Procedure:
1. CVS toggles between Unattached.SNK (and AttachWait.SNK) and Unattached.Accessory while performing steps 2 and 3.
 2. CVS waits 500ms.
 3. CVS verifies that PUT also toggles between Unattached.SNK (and AttachWait.SNK) and Unattached.Accessory.
 4. If PUT is not a PUT_R, the test is over.
 5. CVS applies Ra on one CC for the remainder of the test.
 6. If Type_C_Supports_Vconn_Powered_Accessory is NO:
 - a. CVS verifies that PUT continues to toggle between Unattached.SNK (and AttachWait.SNK) and Unattached.Accessory.
 - b. The test is over.
 7. CVS transitions to Unattached.Accessory and starts timer max dcSRC.DRP x max tDRP (70ms).

8. CVS monitors CCs for Rd and verifies that Rd is connected before the timer expires.
9. CVS transitions to AttachWait.Accessory for tCCDebounce.
10. CVS transitions to PoweredAccessory and sources Vconn
11. If PUT VIF field Type_C_Is_Vconn_Powered_Accessory is YES
 - a. CVS verifies that PD signaling has commenced
 - b. The test is over.
12. CVS transitions to Try.SNK.
13. CVS verifies that:
 - a. PUT transitions to attaching Rp (Unattached.Accessory) after tPDDebounce and then before dcSRC.DRP x tDRP max (70ms).
 - b. PUT attaches Rd (transitions to Try.SNK) after tCCDebounce and then within tAMETimeout.
14. When PUT attaches Rd, CVS waits tDRPTryWait min and then transitions to Unsupported.Accessory.
15. CVS verifies that CVS and PUT remain in Unsupported.Accessory and Try.SNK for tAMETimeout * 2.

TD 4.4.6 SNKAS Connect Audio Accessory

- A. Purpose:
 1. Verify a SNKAS PUT transitions to AudioAccessory Mode correctly with Audio Accessory
- B. Applicability
 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory or Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts
 1. 4.5.2.2.3.2#3
 2. 4.5.2.2.13.1#1-3
 3. 4.5.2.2.13.2#1
 4. 4.5.2.2.14.1#1-3
 5. 4.5.2.2.14.2#1
 6. 4.5.2.2.15.1#1-4
 7. 4.5.2.2.15.2#1
- D. Procedure:
 1. CVS presents an Audio Accessory (Both CC pins terminated with Ra).
 2. CVS verifies PUT transitions to Unattached.Accessory within dcSRC.DRP x tDRP
 3. If the VIF field Type_C_Supports_Audio_Accessory is YES:
 - a. CVS verifies PUT transition to AudioAccessory after tCCDebounce
 - i. The PUT shall reconfigure its pins as defined in Appendix A
 - ii. The PUT does not drive VBUS or VCONN
 - iii. If the PUT sinks current over VBUS, it shall not be more than 500mA
 - iv. The PUT applies Rp on at least one CC
 4. If the VIF field Type_C_Supports_Audio_Accessory is NO:
 - a. Wait tAMETimeout.
 - b. CVS verifies no Attached state is reached.
 5. CVS transitions to Disabled
 6. CVS verifies PUT transitions to Unattached.SNK within tCCDebounce.
 - a. The PUT terminates its CC(s) with Rd

TD 4.4.7 SNKAS Connect Debug Accessory

- A. Purpose:
 - 1. Verify a SNKAS PUT transitions to DebugAccessory Mode and does not source Vbus
- B. Applicability
 - 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_Audio_Accessory or Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts
 - 1. 4.5.2.2.14.1#2
- D. Procedure:
 - 1. CVS present a DTS (Debug and Test System) SNK by terminating CC pins with Rd
 - 2. CVS verifies PUT transitions to Unattached.Accessory within $dcSRC.DRP \times tDRP$
 - 3. CVS verifies PUT does not source Vbus after tCCDebounce.

TD 4.4.8 SNKAS Connect Powered.Accessory

- A. Purpose:
 - 1. Verify a SNKAS PUT transitions to Powered.Accessory Mode correctly with a VCONN powered Accessory
- B. Applicability
 - 1. This test is required when VIF field Type_C_State_Machine is SNK and Type_C_Supports_VCONN_Powered_Accessory is YES.
- C. Asserts
 - 1. 4.5.2.2.13.1#1-3
 - 2. 4.5.2.2.13.2#2
 - 3. 4.5.2.2.14.1#1-3
 - 4. 4.5.2.2.14.2#3-4
 - 5. 4.5.2.2.19.1#2-6
 - 6. 4.5.2.2.19.2#1-4
 - 7. 4.5.2.2.20.1#1-3
 - 8. 4.5.2.2.20.2#1
- D. Procedure:
 - 1. CVS presents a VCONN powered Accessory (one CC pin terminated with Ra and one with Rd, D+/D- and SS terms present)
 - 2. CVS verifies the PUT transitions to Unattached.Accessory within $dcSRC.DRP \times tDRP$
 - 3. Wait 10ms.
 - 4. CVS removes the Rd termination.
 - 5. CVS verifies the PUT transitions to Unattached.SNK within tDetach.
 - a. PUT ceases to supply Vconn within tVconnOFF
 - b. PUT presents Rd terminations
 - 6. CVS presents 1 CC pin in the vRa range and one in Rd like a VCONN powered Accessory.
 - 7. CVS verifies the PUT transitions to Unattached.Accessory within $dcSRC.DRP \times tDRP$
 - 8. CVS verifies the PUT transitions to PoweredAccessory after tCCDebounce
 - a. PUT provides VCONN within tVCONNON-PA
 - b. PUT advertises vRd-1.5 or vRd-3.0 on Rp
 - c. PUT does not drive VBUS
 - d. PUT does not drive USB Host 3.1 or 2.0 traffic.
 - 9. CVS verifies PUT transitions to Unattached.SNK within tAMETimeout
 - a. PUT ceases to supply Vconn within tVconnOFF
 - b. PUT presents Rd terminations

10. CVS verifies PUT transitions through Unattached.Accessory to PoweredAccessory within 200ms (tDRP + tCCDebounce).
11. CVS transitions to Disabled.
12. CVS verifies the PUT transitions to Unattached.SNK within tDetach
 - a. PUT ceases to source Vconn within tVconnOFF
 - b. PUT presents Rd on its CCs
13. CVS presents a Vconn powered Accessory.
14. CVS verifies the PUT transitions to PoweredAccessory after tCCDebounce and within tCCDebounce + dcSRC.DRP x tDRP:
 - a. PUT provides Vconn within tVconnON-PA
 - b. PUT initiates a PD Explicit Contract
 - c. PUT initiates Alternate Mode discovery with Structured VDMs
15. CVS loads 1W on Vconn
16. CVS responds to Discover SVIDs with 1 bogus SVID
17. CVS waits max tAMETimeout (1.5s).
18. CVS verifies the PUT transitions to Unsupported.Accessory.
 - a. The PUT ceases to supply Vconn within tVconnOFF
 - b. The PUT does not drive VBUS
 - c. The PUT applies Rp on one CC pin, advertising default USB current
19. CVS prompts the test operator whether a user notification has been provided by the product.
20. CVS verifies the test operator responded YES to the prompt.
21. CVS transitions to Disabled.
22. CVS verifies the PUT transitions to Unattached.SNK within tDetach.

DRP Tests

These tests are for USB Type-C Connectors that implement the USB Type-C DRP Connection State Diagram in Figure 4-16. These tests are not applicable to DRPs that implement a Try.SNK State.

TD 4.5.1 DRP Connect Sink Test

- A. Purpose:
 1. Verify a DRP transitions through Unattached states to Attached.SRC
 2. Verify a DRP transitions to Unattached.SNK when the link partner is removed
- B. Applicability:
 1. This test is applicable when Type_C_State_Machine is DRP and Type_C_Implements_Try_SNK is NO and Type_C_Implements_Try_SRC is NO
- C. Asserts:
 1. 4.5.2.2.3.2#2
 2. 4.5.2.2.6.2#4
 3. 4.5.2.2.7.1#1-3
 4. 4.5.2.2.7.2#1,5
 5. 4.5.2.2.8.1#2,3-7
 6. 4.5.2.2.8.2#2-5
 7. 4.5.2.2.10.2#2
 8. 4.8.3#1
 9. 4.8.4#1
- D. Conditions:
 1. CVS emulates USB PD 2.0 5A Active Cable
 2. CVS emulates USB PD 3.0 5A Active Cable
- E. Procedure:

1. If VIF field Type_C_Sources_Vconn is NO, CVS verifies that the PUT does not source Vconn for the remainder of the test.
2. CVS transitions to Unattached.SNK
3. CVS waits 5ms
4. For a PUT_R:
 - a. CVS terminates one CC pin with Ra for the duration of the test.
 - b. CVS emulates an Active Emarked cable with the first Condition from section D above
 - c. CVS verifies PUT has transitioned to Unattached.SRC
 - i. PUT applies Rp simultaneously on both CC pins
 - d. CVS waits 80ms
 - e. CVS verifies PUT has applied Rp since step 2.b
 - f. CVS transitions to Disabled except for one CC maintaining Ra
 - g. CVS verifies PUT transitions to Unattached.SNK
 - h. Wait 750ms.
 - i. CVS transitions to Unattached.SNK
5. CVS verifies:
 - a. PUT attaches Rp within max dcSRC.DRP x max tDRP
 - b. After tCCDebounce, PUT supplies VBUS within tVBUSON
 - c. PUT sources current at the level it advertises with Type-C Current
6. Vconn_tested = false
7. If PUT supports USB PD:
 - a. CVS verifies that:
 - i. PUT stabilizes VBUS before initiating USB PD communications
 - ii. CVS and PUT negotiate a contract.
 - b. If PUT source capabilities include a Max Current > 3 A:
 - i. CVS verifies that for a PUT_R, it supplies Vconn within tVconnON
 - ii. Vconn_tested = true
8. If PUT supports USB 3.1 DFP:
 - a. CVS verifies that:
 - i. PUT attaches eSS terms within 80ms of Vbus on
 - ii. For a PUT_R and not Vconn_tested:
 - 01 It supplies VCONN within tVCONNON
 - 02 Vconn_tested = true
 - iii. PUT transmits LFPS within 121ms of attaching eSS terms
 - b. CVS load 1W on Vconn
 - c. CVS waits 1s
9. If the PUT is a PUT_V and not Vconn_tested:
 - a. CVS verifies that for a PUT_R, it supplies Vconn within tVconnON
10. CVS transitions to Disabled
11. CVS verifies that PUT transitions to Unattached.SNK within tDetach.
 - a. If PUT supports USB 3.1 DFP, Vconn remained on until after step 10
 - b. PUT_V removes Vconn within tVconnOFF.
 - c. PUT removes VBUS within tVBUSOFF
 - d. PUT presents Rd terminations on its through CC pin
 - i. For a PUT_R, verify both CC pins terminated to Rd
12. The CVS continues the test with step 2, using the next Condition from section D above

TD 4.5.2 DRP Connect SNKAS Test

- A. Purpose:
 1. Verify a DRP transitions to Attached.SRC when connected to a SNKAS
- B. Applicability:

1. This test is required for VIF field Type_C_State_Machine set to DRP and Type_C_Implements_Try_SNK is NO and Type_C_Implements_Try_SRC is NO.
- C. Asserts
1. See TD 4.14
- D. Procedure:
1. CVS transitions to Unattached.Accessory
 2. CVS waits 5ms
 3. CVS verifies that PUT attaches Rd within max dcSRC.DRP x max tDRP
 4. If PUT is a PUT_C and Ra is attached to its Vconn pin:
 - a. Complete steps 13 – 16.
 - b. Skip to step 7
 5. CVS transitions to Unattached.SNK after min dcSRC.DRP x min tDRP.
 6. CVS verifies that PUT attaches Rp within max dcSRC.DRP x max tDRP
 7. CVS verifies that PUT transitions to Attached.SRC after tCCDebounce:
 - a. PUT supplies VBUS within tVBUSON
 - b. If PUT supports USB PD:
 - i. VBUS reaches vSafe5V before initiating USB PD communications
 8. CVS transitions to Disabled
 9. CVS verifies that PUT transitions to Unattached.SNK within tDetach.
 - a. PUT removes VBUS within tVBUSOFF
 - b. PUT presents Rd terminations on its through CC pin
 - i. For a PUT_R, verify both CC pins terminated to Rd
 10. For a PUT_C the test is over.
 11. CVS terminates one CC pin with Ra to look like an Emarked cable for the duration of the test.
 12. Repeat steps 1 –3.
 13. CVS transitions to PoweredAccessory after max tCCDebounce
 14. If PUT has VIF field Type_C_Is_Vconn_Powered_Accessory set to YES then the test is over.
 15. CVS transitions to Try.SNK and starts tDRPtry
 16. CVS verifies PUT attaches Rp within tPDDebounce min and tPDDebounce max + tDRPTransition
 17. Repeat steps 7-9.

TD 4.5.3 DRP Connect Source Test

- A. Purpose:
1. Verify a DRP transitions through Unattached states to Attached.SNK
- B. Applicability
1. This test is required when VIF field Type_C_State_Machine is DRP and and Type_C_Implements_Try_SRC is NO and Type_C_Implements_Try_SNK is NO.
- C. Asserts:
1. 4.5.2.2.3.2#1-2
 2. 4.5.2.2.4.2#2
 3. 4.5.2.2.6.2#4
 4. 4.5.2.2.9.1#1-3
 5. 4.5.2.2.9.2#1-2
 6. 4.5.2.2.10.1#1-2
 7. 4.5.2.2.10.2#2
 8. 4.8.3#1
 9. 4.8.4#1
- D. Procedure:
1. CVS transitions to Unattached.SRC

2. CVS waits 5ms
3. For a PUT_R, CVS terminates one CC pin with Ra for the duration of the test, except when CVS is in Disabled.
4. CVS verifies:
 - a. PUT attaches Rd within max dcSRC.DRP x max tDRP
 - i. For a PUT_R, both CCs are terminated with Rd.
5. CVS waits max tDRP
6. CVS verifies PUT has applied Rd continuously since step 4
7. CVS transitions to Disabled for 100ms
8. CVS verifies PUT transitioned to Unattached.SRC within step 7
9. Wait 750ms.
10. CVS transitions to Unattached.SRC
11. Wait 5ms
12. CVS verifies:
 - a. PUT attaches Rd within max dcSRC.DRP x max tDRP
 - i. For a PUT_R, both CCs are terminated with Rd.
13. CVS transitions to Attached.SRC after max tCCDebounce.
14. CVS verifies PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement
 - b. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - c. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 - d. For a PUT_R, VCONN is not supplied
15. CVS transitions to Disabled
16. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires
 - a. PUT ceases data communication
 - b. PUT stops sinking current over Vbus

TD 4.5.4 **DRP Connect DRP Test**

- A. Purpose:
 1. Verify a DRP transitions to an attached state
 2. Verify a DRP can support varying times of tDRP and dcSRC.DRP
- B. Applicability
 1. This test is required when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is NO and Type_C_Implements_Try_SNK is NO.
- C. Asserts
 1. 4.5.2.2.7.2#1
 2. 4.5.2.2.8.1#7
 3. 4.5.2.2.9.1#1-3
 4. 4.5.2.2.9.2#2
 5. 4.5.2.2.10.1#1-2
 6. 4.5.2.2.10.2#1
 7. 4.8.3#1
- D. Timing Conditions:
 1. tDRP = 50ms, dcSRC.DRP = 30%
 2. tDRP = 75ms, dcSRC.DRP = 30%
 3. tDRP = 100ms, dcSRP.DRP = 30%
 4. tDRP = 50ms, dcSRC.DRP = 50%
 5. tDRP = 75ms, dcSRC.DRP = 50%
 6. tDRP = 100ms, dcSRC.DRP = 50%
 7. tDRP = 50ms, dcSRC.DRP = 70%
 8. tDRP = 75ms, dcSRC.DRP = 70%

9. $t_{DRP} = 100\text{ms}$, $dcSRC.DRP = 70\%$

E. Procedure:

1. CVS uses Condition 1 above for t_{DRP} and $dcSRC.DRP$
2. CVS transitions to Unattached.SRC for $(dcSRC.DRP \times t_{DRP})$.
 - a. CVS monitors CCs for R_d and transitions to AttachedWait.SRC if it is detected
 - b. If R_d is present for $t_{CCDebounce}$:
 - i. CVS transitions to Attached.SRC.
 - ii. Skip to step 9.
3. CVS transitions to Unattached.SNK for $t_{DRP} - (dcSRC.DRP \times t_{DRP})$.
 - a. CVS monitors CCs for R_p and transitions to AttachedWait.SNK if it is detected.
 - b. If R_p is present for $t_{CCDebounce}$ continue to step 4.
 - c. If the PUT has reached this step less than 5 times since step 1, transition to step 2.
4. CVS verifies PUT transitions to Attached.SRC:
 - a. PUT advertises VBUS capability over R_p
 - b. PUT sources VBUS within $t_{CCDebounce} + t_{VBUSOn}$
 - c. If PUT supports USB PD:
 - i. PUT stabilizes VBUS before initiating USB PD communications
 - ii. PUT waits for $t_{DRPHold}$ before initiating USB PD Swap communications
5. CVS transitions to Disabled
6. CVS verifies that PUT transitions to Unattached.SNK within t_{Detach} .
 - a. Vbus reaches v_{Save0V} before $t_{VBUSOFF}$ expires
 - b. PUT ceases PD communications
 - c. PUT terminates CC with R_d
 - i. If PUT is a PUT_R, it terminates both CCs with R_d
7. CVS transitions to Unattached.SRC
 - a. For a PUT_R, one CC is terminated with R_a
8. CVS transitions to Attached.SRC
9. CVS verifies PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement
 - b. If PUT supports PD, CVS and PUT establish a PD contract.
 - c. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 - e. For a PUT_R, VCONN is not supplied
10. CVS transmits Discover ID PD messaging for 200ms
11. CVS verifies PUT:
 - a. If UUT_Device_Type is not 6:
 - i. Responds with valid GoodCRC messages.
 - ii. If Responds_To_Discov_SOP is YES:
 - 01 Transmits valid Responder ACK messages.
12. CVS programs Vbus source to meet 3.7V at the PUT connector.
13. CVS verifies PUT remains in Attached.SNK.
 - a. PUT maintains R_d on its CC
 - b. For a PUT that supports USB 3.2 or USB 2.0 signaling, the data signaling is maintained.
14. CVS removes R_p s. CVS USB 2.0 and USB 3.1 signaling behaves as though it is in Attached.SRC as long as PUT is in Attached.SNK.
15. CVS decreases Vbus voltage by 0.1V.
 - a. Wait 100ms
 - b. If PUT removes R_d or Vbus source voltage is below 800mV, continue to step 16
 - c. CVS verifies PUT maintained Attached.SNK
 - i. PUT maintains R_d on its CC

- ii. For a PUT that supports USB 3.2 or USB 2.0 signaling, the data signaling is maintained
 - iii. PUT does not source Vbus
 - d. Continue to step 15
 16. CVS applies Rd
 17. CVS verifies PUT transitions to AttachWait.SRC within max tDRP:
 - a. PUT applies and maintains Rp on its CC
 - i. For a PUT_R, Rp is applied on both CCs
 - b. PUT does not source Vbus
 - c. All data signaling ceases
 18. If Vbus is below 800 mV, continue to step 20
 19. CVS verifies PUT remains in AttachWait.SRC for 500ms
 20. CVS removes Vbus source
 21. CVS verifies that PUT sources Vbus after Vbus is in vSafe0V, and before tVbusON expires.
 22. CVS transitions to Disabled
 23. CVS continues to Step 1 with the next Condition listed above.

TD 4.5.5 DRP Connect Try.SRC DRP Test

- A. Purpose:
 1. Verify a DRP transitions to Attached.SNK according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is NO and Type_C_Implements_Try_SNK is NO
- C. Asserts:
 1. 4.5.2.2.3.2#2
 2. 4.5.2.2.5.1#2-3,5
 3. 4.5.2.2.5.2#1
 4. 4.5.2.2.6.1#1-3
 5. 4.5.2.2.6.2#1
 6. 4.5.2.2.7.1#1-3
 7. 4.5.2.2.7.2#6
 8. 4.5.2.2.11.1#1-2
 9. 4.5.2.2.11.2#2
- D. Procedure:
 1. CVS transitions to Unattached.SNK
 2. CVS waits 5ms
 3. CVS verifies:
 - a. PUT presents Rp within tDRP – dcSRC.DRP x tDRP
 - b. PUT transitions from Rd to Rp within tDRPTransition
 - c. PUT transitions to Attached.SRC after tCCDebounce:
 - i. PUT sources Vbus within tVbusON.
 4. CVS transitions to Try.SRC.
 5. CVS verifies that PUT transitions to Unattached.SNK within tDetach.
 6. CVS transitions to Attached.SRC after min tPDDebounce.
 7. CVS verifies that PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement.
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If VIF field PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.

8. CVS transitions to Disabled
9. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires:
 - a. PUT data communication has ceased.

TD 4.5.6 DRP Connect Try.SNK DRP Test

- A. Purpose:
 1. Verify a DRP transitions to Attached.SRC according to spec
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is NO and Type_C_Implements_Try_SNK is NO
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.SRC
 2. CVS waits 5ms
 3. CVS verifies PUT:
 - a. Presents Rd within max dcSRC.DRP x max tDRP
 - b. Transitions from Rp to Rd within tDRPTransition
 - c. Applies Rd for tCCDebounce
 4. CVS transitions to Try.SNK.
 5. CVS verifies PUT attaches Rp within tPDDebounce min and tPDDebounce max + tDRPTransition
 6. CVS verifies that PUT transitions to Attached.SRC after tCCDebounce:
 - a. PUT source Vbus with tVbusON.
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 7. CVS transitions to Disabled
 8. CVS verifies that PUT transitions to Unattached.SNK within tDetach:
 - a. PUT stops sourcing Vbus within tVbusOFF
 - b. PUT data communication has ceased.

Try.SRC DRP Tests

TD 4.6.1 Try.SRC DRP Connect Source Test

- A. Purpose:
 1. Verify a Try.SNK DRP transitions to Attached.SNK according to spec
 2. Verify that removing VBUS transitions the PUT to Unattached.SNK
- B. Applicability:

1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is YES
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.SRC
 2. CVS waits 5ms
 3. For a PUT_R, CVS terminates one CC pin with Ra in any state other than Disabled for the remainder of the test.
 4. CVS verifies PUT presents Rd within max dcSRC.DRP x max tDRP
 5. CVS transitions to Attached.SRC after tCCDebounce:
 6. CVS verifies that PUT transitions to Try.SRC after Vbus is present.
 - a. PUT removes Rd and applies Rp.
 7. CVS transitions to Unattached.SRC at tDetach – 1ms, but Vbus does not reach vSafe0V until the max tVbusOFF
 8. CVS verifies that PUT transitions to TryWait.SNK after tTryTimeout.
 - a. PUT removes Rp and applies Rd.
 9. CVS transitions to Attached.SRC after max tCCDebounce.
 10. CVS verifies that PUT transitions to Attached.SNK when Vbus reaches vSafe5V:
 - a. PUT sinks current according to CVS advertisement.
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If VIF field PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 - e. For a PUT_R, VCONN is not supplied
 11. CVS transmits Discover ID PD messaging for 200ms.
 12. CVS verifies that PUT:
 - a. If UUT_Device_Type is not 6:
 - i. Responds with valid GoodCRC messages.
 - ii. If Responds_To_Discov_SOP is YES:
 - 01 Transmits valid Responder ACK messages.
 - b. Remains in Attached.SNK during and for 500ms after step 6.
 13. CVS transitions to Disabled
 14. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires:
 - a. PUT data communication has ceased.

TD 4.6.2 Try.SRC DRP Connect DRP Test

- A. Purpose:
 1. Verify a DRP that transitions to Try.SRC transitions through to an Attached state
 2. Verify a DRP can support varying times of tDRP and dcSRC.DRP
- B. Applicability
 1. This test is required when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is YES.
- C. Asserts
 1. 4.5.2.2.3.1#1-2
 2. 4.5.2.2.3.2#1
 3. 4.5.2.2.4.1#1-2
 4. 4.5.2.2.4.2#3

5. 4.5.2.2.5.1#2-3,5-6
6. 4.5.2.2.5.2#1
7. 4.5.2.2.6.1#1-3
8. 4.5.2.2.6.2#1
9. 4.5.2.2.7.1#1-3
10. 4.5.2.2.7.2#6
11. 4.5.2.2.11.1#1-2
12. 4.5.2.2.11.2#2
13. TBD

D. Timing Conditions:

1. tDRP = 50ms, dcSRC.DRP = 30%
2. tDRP = 75ms, dcSRC.DRP = 30%
3. tDRP = 100ms, dcSRP.DRP = 30%
4. tDRP = 50ms, dcSRC.DRP = 50%
5. tDRP = 75ms, dcSRC.DRP = 50%
6. tDRP = 100ms, dcSRC.DRP = 50%
7. tDRP = 50ms, dcSRC.DRP = 70%
8. tDRP = 75ms, dcSRC.DRP = 70%
9. tDRP = 100ms, dcSRC.DRP = 70%

E. Procedure:

1. CVS uses Condition 1 above for tDRP and dcSRC.DRP
2. For a PUT_R, one CC is terminated with Ra for the test.
3. CVS transitions to Unattached.SRC for (dcSRC.DRP x tDRP).
 - a. CVS monitors for the presence of Rd and transitions to AttachedWait.SRC if it is detected.
 - b. If Rd is present for min tCCDebounce:
 - i. CVS keeps tCCDebounce timer running
 - ii. CVS transitions to Attached.SRC
 - iii. If vSafe5V is present before tCCDebounce max expires, CVS verifies that PUT attaches Rps within tDetach of tCCDebounce expiration.
 - iv. Else, CVS verifies PUT attaches Rps within tDetach of vSafe5V detection.
 - v. CVS transitions through Unattached.SNK to AttachWait.SNK for max tCCDebounce
 - vi. Skip to step 5
4. CVS transitions to Unattached.SNK for tDRP – (dcSRC.DRP x tDRP).
 - a. CVS monitors for the presence of Rp and transitions to AttachedWait.SNK if it is detected.
 - b. If Rp is present for tCCDebounce:
 - i. CVS transitions to Attached.SNK.
 - ii. Continue to step 5.
 - c. If the PUT has reached this step less than 5 times since step 1, transition to step 3.
5. CVS verifies PUT transitions to Attached.SRC:
 - a. PUT sources Vbus within tVbusON.
 - b. If PUT supports USB PD:
 - i. PUT stabilizes VBUS before initiating USB PD communications
 - ii. PUT waits for tDRPHold before initiating USB PD Swap communications
 - c. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 - e. For a PUT_V, VCONN is supplied
6. CVS transitions to Disabled
7. CVS verifies that PUT transitions to TryWait.SNK before tVBUSOFF expires:

- a. PUT ceases all data communications
8. CVS verifies that PUT transitions to Unattached.SRC after tPDDebounce and then within max dcSRC.DRP x max tDRP.
9. Wait 750ms.
10. CVS continues to Step 1 with the next Condition listed above.

TD 4.6.3 Try.SRC DRP Connect Try.SRC DRP Test

- A. Purpose:
 1. Verify a Try.SRC DRP transitions to an Attached state according to spec
 2. Verify that a Try.SRC DRP will connect with another Try.SRC DRP
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is YES
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.SNK
 2. CVS waits 5ms
 3. CVS verifies:
 - a. PUT presents Rp within max dcSRC.DRP x max tDRP
 - b. PUT transitions from Rd to Rp within tDRPTransition
 4. CVS transitions to AttachWait.SNK
 5. CVS verifies PUT transitions to Attached.SRC after tCCDebounce:
 - a. PUT sources Vbus within tVbusON
 6. CVS transitions to Try.SRC.
 7. CVS verifies PUT transitions to TryWait.SNK within 50 ms after CVS removes Rd.
 8. CVS transitions to Attached.SRC after max tCCTryDebounce.
 9. CVS verifies PUT transition to Attached.SNK:
 - a. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - b. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - c. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 10. CVS programs Vbus source to meet 3.7V at the PUT connector.
 11. CVS verifies PUT remains in Attached.SNK.
 - a. PUT maintains Rd on its CC
 - b. For a PUT that supports USB 3.2 or USB 2.0 signaling, the data signaling is maintained.
 12. CVS removes Rps. CVS USB 2.0 and USB 3.1 signaling behaves as though it is in Attached.SRC as long as PUT is in Attached.SNK.
 13. CVS decreases Vbus voltage by 0.1V.
 - a. Wait 100ms
 - b. If PUT removes Rd or Vbus source voltage is below 800mV, continue to step 14
 - c. CVS verifies PUT maintained Attached.SNK
 - i. PUT maintains Rd on its CC
 - ii. For a PUT that supports USB 3.2 or USB 2.0 signaling, the data signaling is maintained
 - iii. PUT does not source Vbus
 - d. Continue to step 13
 14. CVS applies Rd
 15. CVS verifies PUT transitions to AttachWait.SRC within tDRP:

- a. PUT applies and maintains Rp on its CC
 - i. For a PUT_R, Rp is applied on both CCs
 - b. PUT does not source Vbus
 - c. All data signaling ceases
16. If Vbus is below 800 mV, continue to step 18
17. CVS verifies PUT stays in AttachWait.SRC for 500ms
18. CVS removes Vbus source
19. CVS verifies that PUT sources Vbus after Vbus is in vSafe0V, and before tVbusON expires.
20. CVS transitions to Disabled

TD 4.6.4 Try.SRC DRP Connect Try.SNK DRP Test

- E. Purpose:
 1. Verify a Try.SRC DRP transitions to Attached.SRC according to spec
- F. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is YES
- G. Asserts:
 1. TBD
- H. Procedure:
 1. CVS transitions to Unattached.SRC
 2. CVS waits 5ms
 3. CVS verifies PUT:
 - a. Presents Rd within max dcSRC.DRP x max tDRP
 - b. Transitions from Rp to Rd within tDRPTransition
 4. CVS transitions to AttachWait.SRC
 5. CVS verifies PUT keeps Rd attached since step 3 for tCCDebounce
 6. CVS transitions to Try.SNK
 7. CVS verifies PUT attaches Rp after tPDDebounce
 8. CVS waits max tDRPTry.
 9. CVS verifies that PUT and CVS attach with PUT in Attached.SRC:
 - a. PUT source Vbus with tVbusON.
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 10. CVS transitions to Disabled
 11. CVS verifies that PUT transitions to Unattached.SNK within tDetach:
 - a. PUT stops sourcing Vbus within tVbusOFF
 - b. PUT data communication has ceased.

TD 4.6.5 Try.SRC DRP Connect Sink Test

- A. Purpose:
 1. Verify a Try.SRC DRP transitions to Attached.SRC according to spec
 2. Verify a PUT transitions to Unattached.SNK when Sink removed
- B. Applicability:

1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is YES
- C. Asserts:
1. 4.4.2#1-3
 2. 4.5.2.2.6.1#1-3
 3. 4.5.2.2.6.2#1
 4. 4.5.2.2.7.1#1-3
 5. 4.5.2.2.7.2#1,5
 6. 4.5.2.2.8.1#2,4-10
 7. 4.5.2.2.8.2#1
 8. 4.6.2.1#3
 9. 4.6.2.4#1,2
- D. Conditions:
1. CVS emulates USB PD 2.0 5A Active Cable
 2. CVS emulates USB PD 3.0 5A Active Cable
- E. Procedure:
1. If VIF field Type_C_Sources_Vconn is NO, CVS verifies the PUT does not source Vconn for the remainder of the test
 2. CVS transitions to Unattached.SNK.
 3. CVS waits 5ms
 4. For a PUT_R:
 - a. CVS terminates one CC pin with Ra for the duration of the test.
 - b. CVS emulates an Active Emarked cable with the first Condition from section D above
 - c. CVS verifies PUT transitions to Unattached.SRC within tDRP
 - i. PUT applies Rp simultaneously on both CC pins
 - d. CVS waits 80ms
 - e. CVS transitions to Disabled except for one CC maintaining Ra
 - f. CVS verifies PUT transitions to Unattached.SNK
 - g. Wait 750ms.
 - h. CVS transitions to Unattached.SNK
 - i. Wait 5ms
 5. CVS verifies that:
 - a. CVS detects SNK.Rp on its Rd terminated CC pin within tDRP
 - b. PUT transitions to Attached.SRC by sourcing VBUS after tCCDebounce and before tCCDebounce + tVBUSON expires after CVS detects SNK.Rp
 - c. PUT sources current at the level advertised with Type-C Current.
 6. Vconn_tested = false
 7. If PUT supports USB PD:
 - a. CVS verifies that:
 - i. PUT stabilizes VBUS before initiating USB PD communications
 - ii. CVS and PUT negotiate a contract.
 - b. If PUT source capabilities include a Max Current > 3 A:
 - i. CVS verifies that for a PUT_R, it supplies Vconn within tVconnON
 - ii. Vconn_tested = true
 8. If PUT supports USB 3.1 DFP:
 - a. CVS verifies that:
 - i. PUT attaches eSS terms within 80ms of Vbus on
 - ii. For a PUT_R and not Vconn_tested:
 - 01 It supplies VCONN within tVCONN
 - 02 Vconn_tested = true
 - iii. PUT transmits LFPS within 121ms of attaching eSS terms
 - b. CVS load 1W on Vconn
 - c. CVS waits 1s
 9. If the PUT is a PUT_V and not Vconn_tested:
 - a. CVS verifies that for a PUT_R, it supplies Vconn within tVconnON

10. CVS transitions to Disabled
11. CVS verifies that PUT transitions to TryWait.SNK within tDetach:
 - a. PUT removes Vbus within tVbusOFF
 - b. If PUT supports USB 3.1 DFP, it keeps sourcing Vconn until after step 10
 - c. All clocked signaling has stopped
 - d. PUT attaches Rd on its CC
 - i. For a PUT_R, it attaches Rd on both CCs
12. The CVS continues the test with step 2, using the next Condition from section D above

TD 4.6.6 Try.SRC DRP Connect SNKAS Test

- A. Purpose:
 1. Verify a Try.SNK PUT transitions to Attached.SRC correctly with SNKAS
- B. Applicability
 1. This test is required when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SRC is YES
- C. Asserts:
 1. TBD
- D. Procedure:
 1. CVS transitions to Unattached.Accessory
 2. CVS Wait 5ms
 3. CVS monitors CCs for Rd and verifies that Rd is connected within max dcSRC.DRP x max tDRP.
 4. If PUT is a PUT_C with an Ra on its plug's Vconn pin:
 - a. Complete steps 14 – 16.
 - b. Skip to step 7.
 5. CVS transitions to Unattached.SNK after max dcSRC.DRP x max tDRP
 6. CVS verifies PUT applies Rp after tPDDebounce.
 7. CVS verifies PUT and CVS transition to Attached.SRC and Attached.SNK after tCCDebounce
 - a. PUT sources Vbus within tVbusOn
 - b. If PUT supports PD messaging:
 - i. PUT and CVS negotiate an explicit contract
 - c. If PUT supports USB 3.1
 - i. PUT starts USB communications on its SS pairs
 - d. If PUT supports USB 2.0
 - i. PUT starts USB communications on its D+/D- pair
 8. CVS transitions to Disabled for 750ms
 9. CVS verifies PUT transitions to TryWait.SNK before tVBUSOFF expires:
 - a. PUT data communication has ceased
 10. If the PUT is not a PUT_R the test is over.
 11. CVS waits min tPDDebounce
 12. CVS attaches Ra to one CC to appear as an Emarked Cabled for the remainder of the test
 13. Repeat steps 1-3.
 14. CVS transitions to PoweredAccessory after max tCCDebounce
 15. If PUT has VIF field Type_C_Is_Vconn_Powered_Accessory set to YES:
 - a. CVS verifies PUT responds with PD signaling.
 - b. CVS transitions to Disabled for 750ms.
 - c. CVS transitions to Unattached.SNK
 16. Else Type_C_Is_Vconn_Powered_Accessory is NO:
 - a. CVS transitions to Try.SNK after 1 second and starts tDRPtry
 - b. CVS verifies PUT transitions to Unattached.SRC after tPDDebounce

17. Repeat steps 7-9.

Try.SNK DRP Tests

TD 4.7.1 Try.SNK DRP Connect Source Test

- A. Purpose:
 1. Verify a Try.SNK DRP transitions to Attached.SNK according to spec
 2. Verify that removing VBUS transitions the PUT to Unattached.SRC
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SNK is YES
- C. Asserts:
 1. 4.5.2.2.3.2#1
 2. 4.5.2.2.4.1#1-2
 3. 4.5.2.2.4.2#3
 4. 4.5.2.2.5.1#2-3,5-6
 5. 4.5.2.2.5.2#1
 6. 4.5.2.2.6.2#4
- D. Procedure:
 1. CVS transitions to Unattached.SRC
 2. CVS waits 5ms
 3. For a PUT_R, CVS terminates one CC pin with Ra in any state other than Disabled for the remainder of the test.
 4. CVS verifies:
 - a. PUT presents Rd within max dcSRC.DRP x max tDRP
 - b. PUT transitions from Rp to Rd within tDRPTransition
 - c. PUT applies Rd for tCCDebounce
 5. CVS transitions to Attached.SRC
 6. CVS verifies that PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement.
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If VIF field PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
 - e. For a PUT_R, VCONN is not supplied
 7. CVS transmits Discover ID PD messaging for 200ms.
 8. CVS verifies that PUT:
 - a. If UUT_Device_Type is not 6:
 - i. Responds with valid GoodCRC messages.
 - ii. If Responds_To_Discov_SOP is YES:
 - 01 Transmits valid Responder ACK messages.
 - b. Remains in Attached.SNK during and for 500ms after step 6.
 9. CVS transitions to Disabled
 10. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires:
 - a. PUT data communication has ceased.

TD 4.7.2 Try.SNK DRP Connect DRP Test

- A. Purpose:
1. Verify a DRP that transitions to Try.SNK transitions through to an Attached state
 2. Verify a DRP can support varying times of tDRP and dcSRC.DRP
- B. Applicability
1. This test is required when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SNK is YES.
- C. Asserts
1. 4.5.2.2.3.1#1-2
 2. 4.5.2.2.3.2#1
 3. 4.5.2.2.4.1#1-2
 4. 4.5.2.2.4.2#3
 5. 4.5.2.2.5.1#2-3,5-6
 6. 4.5.2.2.5.2#1
 7. 4.5.2.2.6.1#1-3
 8. 4.5.2.2.6.2#1
 9. 4.5.2.2.7.1#1-3
 10. 4.5.2.2.7.2#6
 11. 4.5.2.2.11.1#1-2
 12. 4.5.2.2.11.2#2
- D. Timing Conditions:
1. tDRP = 50ms, dcSRC.DRP = 30%
 2. tDRP = 75ms, dcSRC.DRP = 30%
 3. tDRP = 100ms, dcSRC.DRP = 30%
 4. tDRP = 50ms, dcSRC.DRP = 50%
 5. tDRP = 75ms, dcSRC.DRP = 50%
 6. tDRP = 100ms, dcSRC.DRP = 50%
 7. tDRP = 50ms, dcSRC.DRP = 70%
 8. tDRP = 75ms, dcSRC.DRP = 70%
 9. tDRP = 100ms, dcSRC.DRP = 70%
- E. Procedure:
1. CVS uses Condition 1 above for tDRP and dcSRC.DRP
 2. For a PUT_R, one CC is terminated with Ra for the test.
 3. CVS transitions to Unattached.SNK for tDRP – (dcSRC.DRP x tDRP).
 - a. CVS monitors CCs for Rp and transitions to AttachedWait.SNK if it is detected
 - b. If Rp is present for tDRP:
 - i. CVS verifies that PUT attaches Rds after tCCDebounce.
 - ii. CVS transitions through Unattached.SRC and AttachWait.SRC to Attached.SRC
 - iii. Skip to step 5
 4. CVS transitions to Unattached.SRC for (dcSRC.DRP x tDRP).
 - a. CVS monitors CCs for Rd and transitions to AttachedWait.SRC if it is detected.
 - b. If Rd is present for longer than tCCDebounce, CVS transitions to Attached.SRC. Continue to step 5.
 - c. If the PUT has reached this step less than 5 times since step 1, transition to step 3.
 5. CVS verifies PUT transitions to Attached.SNK:
 - a. If PUT supports USB PD:
 - i. PUT stabilizes VBUS before initiating USB PD communications
 - ii. PUT waits for tDRPHold before initiating USB PD Swap communications
 - b. PUT sinks current according to CVS advertisement
 - c. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.

- d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
- e. For a PUT_R, VCONN is not supplied
6. CVS transmits Discover ID PD messaging for 200ms
7. CVS verifies PUT:
 - a. If UUT_Device_Type is not 6:
 - i. Responds with valid GoodCRC messages.
 - ii. If Responds_To_Discov_SOP is YES:
 - 01 Transmits valid Responder ACK messages.
 - b. Remains in Attached.SNK during and for 500ms after step 6.
8. CVS programs Vbus source to meet 3.7V at the PUT connector.
9. CVS verifies PUT remains in Attached.SNK.
 - a. PUT maintains Rd on its CC
 - b. For a PUT that supports USB 3.2 or USB 2.0 signaling, the data signaling is maintained.
10. CVS removes Rps. CVS USB 2.0 and USB 3.1 signaling behaves as though it is in Attached.SRC as long as PUT is in Attached.SNK.
11. CVS decreases Vbus voltage by 0.1V.
 - a. Wait 100ms
 - b. If PUT removes Rd or Vbus source voltage is below 800mV, continue to step 12
 - c. CVS verifies PUT maintained Attached.SNK
 - i. PUT maintains Rd on its CC
 - ii. For a PUT that supports USB 3.2 or USB 2.0 signaling, the data signaling is maintained
 - iii. PUT does not source Vbus
 - d. Continue to step 11
12. CVS applies Rd
13. CVS verifies PUT transitions to AttachWait.SRC within tDRP:
 - a. PUT applies and maintains Rp on its CC
 - i. For a PUT_R, Rp is applied on both CCs
 - b. PUT does not source Vbus
 - c. All data signaling ceases
14. If Vbus is below 800 mV, continue to step 16
15. CVS verifies PUT remains in AttachWait.SRC for 500ms
16. CVS removes Vbus source
17. CVS verifies that PUT transitions to Try.SNK:
 - a. PUT applies Rd
18. CVS transitions to Disabled
19. CVS continues to Step 1 with the next Condition listed above.

TD 4.7.3 Try.SNK DRP Connect Try.SRC DRP Test

- E. Purpose:
 1. Verify a Try.SNK DRP transitions to Attached.SNK according to spec
- F. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SNK is YES
- G. Asserts:
 1. 4.5.2.2.3.2#2
 2. 4.5.2.2.5.1#2-3,5
 3. 4.5.2.2.5.2#1
 4. 4.5.2.2.6.1#1-3

5. 4.5.2.2.6.2#1
6. 4.5.2.2.7.1#1-3
7. 4.5.2.2.7.2#6
8. 4.5.2.2.11.1#1-2
9. 4.5.2.2.11.2#2

H. Procedure:

1. CVS transitions to Unattached.SNK
2. CVS waits 5ms
3. CVS verifies:
 - a. PUT presents Rp within $t_{DRP} - dcSRC.DRP \times t_{DRP}$
 - b. PUT transitions from Rd to Rp within $t_{DRPTransition}$
4. CVS transitions to AttachWait.SNK
5. CVS verifies PUT keeps Rp attached since step 3 for $t_{CCDebounce}$
6. CVS verifies PUT transitions to Try.SNK within $t_{CCDebounce} \max + t_{DRPTransition}$ since step 2:
 - a. PUT presents Rd
7. CVS transitions to Unattached.SRC after $t_{PDDebounce}$, and on to AttachWait.SRC for $t_{CCDebounce}$
8. CVS transitions to Attached.SRC:
9. CVS verifies that PUT transitions to Attached.SNK:
 - a. PUT sinks current according to CVS advertisement.
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If VIF field PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
10. CVS transitions to Disabled
11. CVS verifies that PUT transitions to Unattached.SNK before $t_{VBUSOFF}$ expires:
 - a. PUT data communication has ceased.

TD 4.7.4 Try.SNK DRP Connect Try.SNK DRP Test

A. Purpose:

1. Verify a Try.SNK DRP transitions to an Attached state according to spec
2. Verify that a Try.SNK DRP will connect with another Try.SNK DRP

B. Applicability:

1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SNK is YES

C. Asserts:

1. TBD

D. Procedure:

1. CVS transitions to Unattached.SNK
2. CVS waits 5ms
3. CVS verifies PUT presents Rp within $\max dcSRC.DRP \times \max t_{DRP}$
4. CVS transitions to AttachWait.SNK
5. CVS verifies:
 - a. PUT keeps Rp attached since step 3 for $t_{CCDebounce}$
 - b. PUT removes Rp and presents Rd
6. CVS transitions to Unattached.SRC after $\min t_{PDDebounce}$, and on to AttachWait.SRC for $\max t_{CCDebounce}$
7. CVS transitions to Try.SNK for t_{DRPTry}

8. CVS verifies PUT presents Rp after tPDDebounce
9. CVS verifies PUT and CVS transition to Attached.SRC and Attached.SNK:
 - a. PUT sources Vbus within tVbusON
 - b. If PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract.
 - c. If PUT supports USB 3.1:
 - i. PUT starts data communications on its SuperSpeed pairs.
 - d. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
10. CVS transitions to Disabled
11. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires:
 - a. PUT data communication has ceased.

TD 4.7.5 Try. SNK DRP Connect Sink Test

- A. Purpose:
 1. Verify a Try.SNK DRP transitions to Attached.SRC state with SNK
- B. Applicability:
 1. This test applies when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SNK is YES
- C. Asserts:
 1. TBD
- D. Conditions:
 1. CVS emulates USB PD 2.0 5A Active Cable
 2. CVS emulates USB PD 3.0 5A Active Cable
- E. Procedure:
 1. If VIF field Type_C_Vconn_Source is NO, CVS verifies the PUT does not source Vconn for the remainder of the test.
 2. CVS transitions to Unattached.SNK with Ra on one CC.
 3. CVS waits 5ms
 4. CVS emulates an Active Emarked cable with the first Condition from section D above
 5. CVS verifies PUT presents Rp within max dcSRC.DRP x maxtDRP
 6. CVS transitions to AttachWait.SNK
 7. CVS verifies:
 - a. PUT keeps Rp attached since step 5 for tCCDebounce
 - b. PUT removes Rp and presents Rd for tDRPtry + tPDDebounce
 - c. PUT removes Rd and presents Rp for tPDDebounce
 8. CVS verifies PUT and CVS transition to Attached.SRC and Attached.SNK:
 - a. PUT sources Vbus within tVbusON
 - b. PUT sources current at the level it advertises with Type-C Current.
 - c. Vconn_tested = false
 - d. If PUT supports USB PD:
 - i. CVS verifies that:
 - 01 PUT stabilizes VBUS before initiating USB PD communications
 - 02 CVS and PUT negotiate a contract.
 - ii. If PUT source capabilities include a Max Current > 3 A:
 - 01 CVS verifies that for a PUT_R, it supplies Vconn within tVconnON
 - 02 Vconn_tested = true
 - e. If PUT supports USB 3.1 DFP:
 - i. CVS verifies that:

- 01 PUT attaches eSS terms within 80ms of Vbus on
- 02 For a PUT_R and not Vconn_tested:
 - 1. It supplies VCONN within tVCONNON
 - 2. Vconn_tested = true
- 03 PUT transmits LFPS within 121ms of attaching eSS terms
 - ii. CVS loads 1W on Vconn
 - iii. CVS waits 1s
- f. Else if PUT supports USB 2.0:
 - i. PUT starts data communications on its D+/D- pair.
- g. If the PUT is a PUT_V and not Vconn_tested:
 - i. CVS verifies that for a PUT_R, it supplies Vconn within tVconnON
- 9. CVS transitions to Disabled
- 10. CVS verifies that PUT transitions to Unattached.SNK before tVBUSOFF expires:
 - a. If PUT supports USB 3.1 DFP, it sourced Vconn up until after step 8
 - b. PUT data communication has ceased.
 - c. PUT attaches Rd on its CC pins.
- 11. The CVS continues the test with step 2, using the next Condition from section D above

TD 4.7.6 Try.SNK DRP Connect SNKAS Test

- E. Purpose:
 - 1. Verify a Try.SNK PUT transitions to Attached.SRC correctly with SNKAS
- F. Applicability
 - 1. This test is required when VIF field Type_C_State_Machine is DRP and Type_C_Implements_Try_SNK is YES
- G. Asserts:
 - 1. TBD
- H. Procedure:
 - 1. CVS transitions to Unattached.SNK
 - 2. CVS waits 5ms
 - 3. CVS monitors CCs for Rp and verifies that Rp is connected within max dcSRC.DRP x max tDRP.
 - 4. CVS transitions to AttachWait.SNK
 - 5. CVS verifies that PUT removes Rp and attaches Rd after tCCDebounce (transitions to Try.SNK)
 - 6. CVS transitions to Unattached.SNK after max tPDDebounce, then Unattached.Accessory after min tDRP x min dcSRC.DRP
 - 7. If PUT is a PUT_C with Ra on its plug's Vconn pin:
 - a. Complete steps 16 – 18.
 - b. Skip to step 10.
 - 8. CVS toggles between Unattached.SNK and Unattached.Accessory for tDRPtry
 - 9. CVS verifies PUT attaches Rp after CVS transitions to Unattached.SNK for tPDDebounce
 - 10. CVS verifies PUT and CVS transition to Attached.SRC and Attached.SNK after tPDDebounce:
 - a. PUT sources Vbus within tVbusOn
 - b. If PUT supports PD messaging:
 - i. PUT and CVS negotiate an explicit contract
 - c. If PUT supports USB 3.1
 - i. PUT starts USB communications on its SS pairs
 - d. If PUT supports USB 2.0
 - i. PUT starts USB communications on its D+/D- pair

11. CVS transitions to Disabled for 750ms
12. CVS verifies PUT transitions to Unattached.SNK before tVBUSOFF expires:
 - a. PUT data communication has ceased
13. If the PUT is not a PUT_R the test is over.
14. CVS attaches Ra to one CC to appear as an Emarked Cabled for the remainder of the test
15. Repeat steps 1-6.
16. CVS transitions to PoweredAccessory after max tCCDebounce
17. If PUT has VIF field Type_C_Is_Vconn_Powered_Accessory set to YES:
 - a. CVS verifies that PUT responds to PD signaling
 - b. CVS transitions to Disabled for 750ms
 - c. CVS transitions to Unattached.SNK
18. Else Type_C_Is_Vconn_Powered_Accessory set to NO:
 - a. CVS transitions to Try.SNK and starts tDRPtry
 - b. CVS verifies PUT transitions to TryWait.SRC after tPDDebounce
19. Repeat steps 10-12.

All DRPs Tests

These tests are for USB Type-C Connectors that implement the USB Type-C DRP Connection State Diagram in Figure 4-16 and variations shown in Figure 4-17. USB Type-C Chargers and DFPs that Sink are required to pass these tests.

TD 4.8.1 DRP Connect Audio Accessory Test

- A. Purpose:
 1. This test verifies that a DRP can connect with an Audio Accessory according to the USB Type-C spec requirements.
- B. Applicability:
 1. This test is required for a PUT_R with VIF field Type_C_State_Machine is DRP and Captive_Cable is NO
- C. Asserts
 1. 4.5.2.2.6.2#2
 2. 4.5.2.2.14.1#1-3
 3. 4.5.2.2.14.2#1
 4. 4.5.2.2.15.1#1-5
 5. 4.5.2.2.15.2#1
- D. Procedure:
 1. CVS present an Audio Accessory by terminating CC pins with Ra
 2. CVS verifies PUT transitions to Unattached.SRC within tDRP – (dcSRC.DRP x tDRP)
 3. If VIF field Type_C_Supports_Audio_Accessory is YES:
 - a. CVS verifies PUT transition to AudioAccessory within tCCDebounce
 - i. The PUT reconfigures its pins as defined in Appendix A
 - ii. The PUT does not drive VBUS or VCONN
 - iii. If the PUT sinks current over VBUS, it shall not be more than 500mA
 - iv. The PUT applies Rp on at least one CC
 4. If VIF field Type_C_Supports_Audio_Accessory is NO:
 - a. Wait tAMETimeout
 - b. CVS verifies that no Attached state is reached.
 5. CVS transitions to Disabled
 6. If VIF field Type_C_Supports_Audio_Accessory is YES:
 - a. CVS verifies PUT transitions to Unattached.SRC or Disabled within tCCDebounce.

- i. PUT CCs are terminated with Rp or not terminated

TD 4.8.2 DRP Connect Debug Accessory Test

- A. Purpose:
 - 1. This test verifies that a DRP can connect to a Debug Accessory as appropriate.
- B. Applicability:
 - 1. This test is applicable when VIF field Type_C_State_Machine set to DRP and Captive_Cable is NO
- C. Asserts
 - 1. 4.5.2.2.16.1#1-3
 - 2. 4.5.3.3.16.2#2
 - 3. 4.5.2.2.19.1#2
- D. Procedure:
 - 1. CVS present a DTS (Debug and Test Accessory) Sink by terminating CC pins with Rd
 - 2. CVS verifies PUT transitions to Unattached.SRC within tDRP – (dcSRC.DRP x tDRP)
 - 3. If VIF field Type_C_Is_Debug_Target_SRC is YES:
 - a. CVS verifies PUT sources Vbus after tCCDebounce and within tVbusON.
 - 4. Else if VIF field Type_C_Is_Debug_Target_SRC is NO or not defined:
 - a. CVS verifies PUT does not source Vbus after tCCDebounce expires.

TD 4.8.3 DRP Connect Vconn Accessory Test

- A. Purpose:
 - 1. Verify DRP that supports Alternate Modes attaches to a VCONN powered Accessory as described in the spec
- B. Applicability:
 - 1. This test is applicable when VIF field Type_C_State_Machine set to DRP and Captive_Cable is NO
- C. Asserts
 - 1. See TD 4.4.8
- D. Procedure:
 - 1. CVS presents 1 CC pin in the vRa range and one in rRd like a VCONN powered Accessory.
 - 2. CVS verifies the PUT transitions to Unattached.SRC within tDRP – (dcSRC.DRP x tDRP).
 - 3. If VIF field Type_C_Implements_Try_SNK is YES:
 - a. CVS verifies:
 - i. PUT transitions to Try.SNK within tCCDebounce
 - ii. PUT transitions to TryWait.SRC within tTryCCDebounce + tDRPTry after entering Try.SNK
 - 4. CVS verifies that PUT transitions to Attached.SRC:
 - a. If VIF field Type_C_Implements_Try_SNK is YES:
 - i. PUT sources Vbus after tTryCCDebounce and before tTryCCDebounce + tVbusON expires
 - b. If VIF field Type_C_Implements_Try_SNK is NO:
 - i. PUT sources VBUS after tCCDebounce and before tCCDebounce + tVBUSON expires
 - c. PUT advertises VBUS capability over Rp
 - d. If the PUT supports PD:
 - i. PUT and CVS negotiate an explicit contract
 - e. If the PUT is a PUT_V:
 - i. PUT sources Vconn within tVconnON

- ii. If PUT has VIF field Attempts_Discov_SOP set to YES:
 - 01 PUT initiates Alternate Mode discovery with Structured VDMs
- 5. CVS transitions to Disabled
- 6. CVS verifies the PUT transitions to Unattached.SNK within tDetach.
 - a. PUT stops sourcing VCONN within tVCONNOFF
 - b. PUT stops sourcing Vbus within tVbusOFF
 - c. PUT attaches Rd on its CCs

Source-Capable Tests

These tests are for any USB Type-C connector that is capable of operating as a Source. Some tests are for connectors that support specific uses like USB PD or legacy connections. Read each test purpose and applicability carefully to determine if the test applies.

If the DUT VIF field Type_C_State_Machine is SNK and either PD_Port_Type is 1 (Consumer/Provider) or Accepts_PR_Swap_As_Src is YES or Accept_PR_Swap_As_Snk is YES, the following Source-Capable Tests are applicable:

- TD 4.9.1 Source Suspend Test
- TD 4.9.3 Source PR_Swap Test
- TD 4.9.4 Source VCONN Swap Test
- TD 4.9.5 Source Alternate Modes Test

The CVS and PUT swap initial roles in each test to connect up to Attached.SRC and Attached.SNK. Then the CVS initiates PR_Swap to transition the PUT into Attached.SRC. For PUT_V, the CVS will perform a PD Vconn_Swap request if necessary so that PUT is sourcing Vconn. The CVS follows the test steps in each test from the point that the PUT enters Attached.SRC. Note that this type of product scheme is discouraged since it will defy user-expectation that the product will charge a dead battery.

TD 4.9.1 Source Suspend Test

- A. Purpose:
 - 1. Verify a Source that continues sourcing VBUS during suspend also continues sourcing VCONN.
- B. Applicability:
 - 1. This test is applicable when VIF field Type_C_Can_Act_as_Host is YES and Host_Suspend_Supported = YES and the PUT is a PUT_V
- C. Asserts:
 - 1. 4.6.1.2#1
- D. Procedure:
 - 1. CVS transitions to Unattached.SNK
 - 2. CVS presents Ra on one CC for the duration of the test and simulates an Emarked Active Cable connected on the CC.
 - 3. CVS and PUT transition through Type-C Connection States to Attached.SNK and Attached.SRC
 - 4. CVS verifies that the PUT sources Vconn within tVconnON

5. CVS sinks 100 mW over VCONN
6. If PUT is USB 3.1 capable:
 - a. CVS and PUT link to U0.
 - b. The Operator suspends the link using whatever method is available. If the PUT is attached to a PC, the Operator clicks a USB31CV prompt
 - c. CVS verifies that if the PUT still provides VBUS, it must also continue to source VCONN
 - d. The Operator resumes the link using whatever method is available.
7. If PUT is USB 2.0 capable:
 - a. CVS and PUT enter HS/FS/LS Default state.
 - b. The Operator suspends the link using whatever method is available. If the PUT is attached to a PC, the Operator clicks a USB31CV prompt
 - c. CVS verifies that if the PUT still provides VBUS, it must also continue to source VCONN
 - d. The Operator resumes the link using whatever method is available.

TD 4.9.2 USB Type-C Current Advertisement Test

- A. Purpose:
 1. Verify a USB Type-C PUT advertises an Rp value in the legal range
 2. Verify a USB Type-C and PD PUT advertises an Rp of at least 1.5 A while a contract exists.
- B. Applicability:
 1. This test is applicable when VIF field Type_C_State_Machine is DRP or SRC
- C. Assert:
 1. 4.6#1
 2. 4.6.2.1#4
 3. 4.6.2.2#1
 4. 4.6.2.3#1,2
 5. 4.6.2.4#3
 6. 4.7#8
 7. 4.8.1#1-4
 8. 4.8.1.1#2
 9. 4.8.2#1
 10. 4.8.4#2
- D. Procedure:
 1. CVS transitions to Unattached.SNK
 2. CVS verifies that PUT applies Rp at a voltage range within vRd-USB or vRd-1.5 or vRd-3.0 range.
 3. CVS and PUT transition into Attached.SNK and Attached.SRC
 4. Wait tVbusON
 5. If the PUT supports USB BC 1.2:
 - a. If the BC 1.2 PUT is capable of providing 1.5 A, CVS verifies Rp is in the vRd-1.5 or vRd-3.0 range.
 6. If the PUT supports USB PD:
 - a. CVS adds one CC terminating Ra
 - b. CVS disables any USB PD transmission.
 - c. CVS reads PUT Source Capabilities.
 - i. For a PUT_R:
 - 01 CVS verifies no Source PDOs advertise more than 3 A current.
 - ii. If the PUT 5V PDO reports a max current of 3 A or higher:

- 01 CVS checks Rp is in the vRd-3.0 range
 - iii. ELSE If the PUT 5V PDO reports a max current of 1.5 A or higher:
 - 01 CVS checks Rp is in the vRd-1.5 range
 - iv. ELSE If the PUT 5V PDO reports a max current of default or higher:
 - 01 CVS checks Rp is in the vRd-USB range.
- d. CVS transitions to Disabled
- e. Wait 750ms.
- f. CVS transitions to Unattached.SNK and applies Ra on one CC.
- g. CVS and PUT transition to Attached.SNK and Attached.SRC.
- h. CVS enables USB PD SOP and SOP' transmission.
- i. For a PUT_R:
 - i. CVS responds to PUT Discover Identity as a cable with a max current of 3 A.
 - ii. CVS verifies that PUT advertises Source Capabilities with a max current of 3 A or less.
- j. CVS verifies:
 - i. CVS and PUT successfully negotiate an Explicit Contract (5V at max current advertised).
 - ii. PUT advertises Rp in the 1.5 A or 3.0 A range.

TD 4.9.3 Source PR_Swap Test

- A. Purpose:
 - 1. Verify a PUT with PD PR_Swap support follows specification requirements
- B. Applicability:
 - 1. This test is applicable if VIF field Accepts_PR_Swap_As_Src is set to YES
- C. Asserts:
 - 1. 4.5.2.2.5.1#2,4,7
 - 2. 4.5.2.2.8.2#7,8
- D. VIF Fields Used:
 - 1. Accepts_PR_Swap_As_Src
 - 2. Accepts_PR_Swap_As_Snk
- E. Data Conditions:
 - 1. PUT supports USB 3.1 as DFP
 - 2. PUT supports USB 2.0 as DFP
- F. Procedure:
 - 1. CVS transitions to Unattached.SNK
 - 2. For a PUT_R, CVS terminates one CC pin with Ra for the duration of the test. CVS emulates an Emarker Active Cable on the CC terminated with Ra.
 - 3. CVS verifies PUT transitions to Attached.SRC
 - 4. CVS transitions to Attached.SNK.
 - 5. CVS and PUT initiate the next PUT supported Data Condition above if applicable.
 - 6. CVS initiates and together with PUT completes PD PR_Swap request
 - 7. CVS verifies:
 - a. PUT terminates the CC to ground through Rd
 - b. PUT maintains data role
 - c. PUT stops supplying VBUS
 - d. PUT_V maintains VCONN supply
 - 8. CVS transitions to Disabled
 - 9. CVS verifies PUT transitions to Unattached before tVBUSOFF
 - a. If Type_C_State_Machine is SRC, CVS verifies PUT applies Rp
 - b. If Type_C_State_Machine is DRP or SNK, CVS verifies PUT applied Rd

10. CVS continues to Step 1 until all PUT supported Data Conditions are exhausted

TD 4.9.4 Source VCONN Swap Test

- A. Purpose:
 1. Verifies a PUT that supports PD implements a VCONN swap according to requirements
- B. Applicability:
 1. This test is applicable to a PUT_V when VIF field VCONN_Swap_To_Off_Supported is YES
- C. Asserts:
 1. 4.5.2.2.8.1#12
 2. 4.5.2.2.8.1#13
 3. 4.5.2.2.8.1#14
- D. Procedure:
 1. CVS transitions to Unattached.SNK
 2. For a PUT_R, CVS terminates one CC pin with Ra for the duration of the test. CVS emulates an Emarked Active Cable on the port.
 3. CVS verifies:
 - a. PUT transitions to Attached.SRC
 - b. PUT sources Vconn within tVconnON
 4. CVS transitions to Attached.SNK
 5. CVS and PUT complete the PD VCONN_Swap request
 6. If the PUT was sourcing VCONN when CVS initiated the swap request, CVS verifies the PUT stops sourcing VCONN within tVCONNOff after the CVS transmits PS_RDY
 7. If VIF field VCONN_Swap_To_On_Supported is YES:
 - a. CVS and PUT complete the PD VCONN_Swap request
 - b. CVS verifies the PUT starts sourcing VCONN before sending PS_RDY

TD 4.9.5 Source Alternate Modes Test

- A. Purpose:
 1. Verifies a Source supports Alternate Modes according to requirements
- B. Applicability:
 1. Test only applies to PUTs that support PD and Alternate Modes as indicated by VIF fields Type_C_Is_Alt_Mode_Controller set to YES
- C. Asserts:
 1. 5.1#1-3
 2. 5.1.2#1
 3. 5.1.2.1#1-4
 4. 5.1.2.2#1-4,6
 5. 5.1.2.2#5
 6. 5.1.3#1
- D. CVS Supported Alternate Modes:
 1. DisplayPort
- E. Data Conditions:
 1. PUT supports USB 3.1
 2. PUT supports USB 2.0
 3. PUT does not support USB data as host
- F. Procedure:
 1. CVS verifies VIF field Type_C_Can_Act_As_Host is YES (NOTE: Data Condition 3 is required so that products who set this field incorrectly will run the test and fail this step)
 2. CVS transitions to Unattached.SNK
 3. CVS attaches Ra to one CC for the duration of the test

4. CVS verifies:
 - a. PUT transitions to Unattached.SRC for tCCDebounce
 - b. PUT transitions to Attached.SRC
5. CVS transitions to Attached.SNK
6. CVS exposes a USB data interface using the next relevant Data Condition from above.
 Note: Once the CVS and PUT have established USB Data communications, the Operator maintains packet traffic between CVS and PUT via GetDescriptor() every 50ms through USB3CV.
7. CVS and PUT complete PD Explicit Power Contract.
8. CVS verifies PUT does not send any Structured VDMs used for Alternate Modes discovery during PD Explicit Power Contract negotiation.
9. CVS responds to all standard VDM requests with CVS Supported Alternate Mode 1 info
10. If PUT sends Enter Mode:
 - a. CVS transitions to Alternate Mode 1 and ACKs the host.
 - b. CVS verifies:
 - i. PUT follows all electrical constraints for SBU and any reconfigured pins (i.e. USB Safe States).
 - ii. For a PUT_R, it follows all electrical constraints for VCONN
 - c. CVS transitions to Disabled.
 - d. CVS verifies PUT transition to Unattached within tDetach:
 - i. If Type_C_State_Machine is DRP, CVS verifies PUT applies Rd
 - ii. If Type_C_State_Machine is SRC, CVS verifies PUT applies Rp
 - iii. PUT stops sourcing VBUS within tVBUSOFF
 - iv. For a PUT_R, it stops sourcing VCONN within tVCONN OFF
11. Continue to step 1 with next CVS Supported Alternate Mode.
12. Continue to step 1 with next Data Condition.

Sink-Capable Tests

These tests are for a USB Type-C connector that is capable of operating as a Sink. Some tests are for connectors that support specific uses like USB PD, Alternate Modes, legacy connections or that use batteries. Read each test purpose carefully to determine if the test applies.

If the DUT VIF field Type_C_State_Machine is SRC and either PD_Port_Type is 2 (Provider/Consumer) or Accepts_PR_Swap_As_Src is YES or Accepts_PR_Swap_As_Snk is YES, the following Sink-Capable Tests are applicable:

TD 4.10.3	Sink Suspend Test
TD 4.10.4	Sink PR_Swap Test
TD 4.10.5	Sink VCONN_Swap Test
TD 4.10.6	Sink Alternate Mode Test

The CVS and PUT swap roles in each test to connect up to Attached.SNK and Attached.SRC. Then the CVS initiates PR_Swap to transition the PUT into Attached.SNK. For PUT_V, the CVS will perform a PD Vconn_Swap request if necessary so that CVS is sourcing Vconn. The CVS follows the test steps in each test from the point that the PUT enters Attached.SNK. For TD 4.10.3 Sink Suspend Test the CVS follows the test steps starting at step C.14.

TD 4.10.1 Sink Power Sub-States Test

- A. Purpose:

1. Verify a Sink uses USB Type-C Current for initial power handshake
- B. Applicability:
 1. Test is applicable when VIF field Type_C_State_Machine is DRP or SNK
- C. Asserts:
 1. 4.5.2.3#1,2
 2. 4.5.2.3.1.1#1,2
 3. 4.5.2.3.1.2#1-3
 4. 4.5.2.3.2.1#1,2
 5. 4.5.2.3.2.2#1-3
 6. 4.5.2.3.3.1#1,2
 7. 4.5.2.3.3.2#1-3
 8. 4.6#1
 9. 4.6.2.1#1,6
- D. Procedure:
 1. CVS presents SS terms and D+/D-
 2. CVS transitions to Unattached.SRC state with vRd in vRd-USB range.
 3. The CVS and PUT link to Attached.SRC and Attached.SNK. NOTE: CVS waits sufficiently after Attached.SNK detected to assure a Try.SRC PUT is securely in Attached.SNK.
 4. If Type_C_Power_Source = 1 (UFP-powered) or 2 (Both), CVS saves default USB power according to PUT type:
 - a. If Type_C_Can_Act_As_Device is YES and Type_C_Device_Speed is HS, default USB power is 100 mA.
 - b. If Type_C_Can_Act_As_Device is YES and Type_C_Device_Speed is SS or above, default USB power is 150 mA
 - c. If Type_C_Can_Act_As_Device is NO, default USB power is 500 mA
 5. If Type_C_Power_Source = 0 (Externally-powered), CVS verifies PUT draws < 1 mA for the duration of the test.
 6. CVS verifies the PUT draws no more than default USB power since step 3.
 7. CVS transitions vRd to vRd-1.5 range
 8. CVS verifies:
 - a. The PUT draws no more than default USB power before min tPDDebounce.
 - b. The PUT draws no more than 1.5 amps after max tPDDebounce.
 9. CVS transitions vRd to vRd-USB range
 10. CVS verifies:
 - a. The PUT draws no more than default USB power after max tSinkAdj.
 11. CVS transitions vRd to vRd-3.0 range
 12. CVS verifies:
 - a. The PUT draws no more than default USB power before min tPDDebounce.
 - b. The PUT draws no more than 3.0 amps after max tPDDebounce.
 13. CVS transitions vRd to vRd-1.5 range
 14. CVS verifies:
 - a. The PUT draws no more than 1.5 amps after max tSinkAdj.
 15. CVS transitions vRd to vRd-3.0 range
 16. CVS verifies:
 - a. The PUT draws no more than 1.5 amps before min tPDDebounce
 - b. The PUT draws no more than 3.0 amps after max tPDDebounce
 17. CVS transitions vRd to vRd-USB range
 18. CVS verifies:
 - a. The PUT draws no more than default USB power after max tSinkAdj.
 19. CVS transitions to Disabled for 200ms.
 20. CVS presents SS terms and D+/D-
 21. CVS transitions to Unattached.SRC with vRd in the vRd-1.5 range.
 22. The CVS and PUT link to Attached.SRC and Attached.SNK. NOTE: CVS waits sufficiently after Attached.SNK detected to assure a Try.SRC PUT is securely in Attached.SNK.

23. CVS verifies:
 - a. The PUT does not draw more than default USB power for min tPDDebounce.
 - b. The PUT draws no more than 1.5 amps after max tPDDebounce.
24. If PUT supports USB 3.1 as a device:
 - a. CVS enumerates the PUT device at USB 3.1 Gen 1 speed stopping short of setting a configuration
 - b. For each configuration discovered during enumeration, if the configuration bMaxPower field is greater than 0, CVS verifies that the PUT draws no more than 150 mA.
 - c. CVS removes ss terms.
25. If PUT supports USB 2.0 as a device:
 - a. CVS enumerates the PUT device at USB 2.0 stopping short of setting a configuration
 - b. For each configuration discovered during enumeration, if the configuration bMaxPower field is greater than 0, CVS verifies that the PUT draws no more than 100 mA.
26. CVS transitions to Disabled for 200ms.
27. CVS presents SS terms and D+/D-
28. CVS transitions to Unattached.SRC with vRd in the vRd-3.0 range
29. CVS and PUT link to Attached.SRC and Attached.SNK
30. CVS verifies:
 - a. The PUT draws no more than default USB power before min tPDDebounce.
 - b. The PUT draws no more than 3.0 amps after max tPDDebounce.
31. If PUT supports USB 3.1 as a device:
 - a. CVS enumerates the PUT device at USB 3.1 Gen 1 speed stopping short of setting a configuration
 - b. For each configuration discovered during enumeration, if the configuration bMaxPower field is greater than 0, CVS verifies that the PUT draws no more than 150 mA.
 - c. CVS removes ss terms.
32. If PUT supports USB 2.0 as a device:
 - a. CVS enumerates the PUT device at USB 2.0 stopping short of setting a configuration
 - b. For each configuration discovered during enumeration, if the configuration bMaxPower field is greater than 0, CVS verifies that the PUT draws no more than 100 mA.

TD 4.10.2 Sink Power Precedence Test

- A. Purpose:
 1. Verify a port receiving power negotiations from multiple avenues uses the correct precedence requirements
- B. Applicability:
 1. This test is applicable when VIF field Type_C_State_Machine is DRP or SNK
- C. Asserts
 1. 4.6#2-4
 2. 4.6.2.1#2
- D. Procedure:
 1. CVS transitions to Unattached.SRC advertising USB Default Current with Rp.
 2. CVS and PUT transition to Attached.SRC and Attached.SNK
 3. For a PUT_R, CVS emulates an Emarker cable capable of supporting 5A.
 4. If the PUT Supports USB 2.0 as a device:
 - a. CVS enumerates the PUT device at HS
 - b. For the first configuration discovered during enumeration, CVS sends SetConfiguration(iConfiguration)

- c. If Type_C_Power_Source = 0 (Externally-powered), CVS verifies:
 - i. The PUT draws < 1 mA over Vbus
 - ii. USB configuration bmAttributes bit D6 is set to 1
 - iii. USB configuration field bMaxPower is set to 0
 - d. If Type_C_Power_Source = 1 (UFP-powered), CVS Verifies:
 - i. The PUT draws no more than the maximum power consumption indicated in the bMaxPower field.
 - ii. USB configuration bmAttributes bit D6 is set to 0
 - iii. USB configuration field bMaxPower is greater than 0
 - e. If Type_C_Power_Source = 2 (Both), CVS verifies:
 - i. If USB configuration field bMaxPower is set to 0, the PUT draws < 1 mA over Vbus.
 - ii. If USB configuration field bMaxPower is set greater than 0, the PUT draws no more than the maximum power consumption indicated in the bMaxPowerField.
 - f. Continue to step 4.b and use the next configuration. After the last configuration, continue to the next step.
5. If VIF field BC_1_2_Supports is 1 (“Portable Device”) or 3 (“Both”):
 - a. CVS verifies it detects VDP_SRC on D+ within 1s
 - b. CVS provides VDM_SRC on D- while VDP_SRC is present
 - c. CVS verifies Sink draws current within BC 1.2 power requirements.
 6. CVS advertises vRd-3.0 on its Rp.
 7. CVS verifies the Sink draws up to 3 A
 8. CVS transitions to Disabled for 200ms.
 9. CVS transitions to Unattached.SRC with Rp in the vRd-USB range
 10. CVS and PUT transition to Attached.SRC and Attached.SNK
 11. If the PUT supports USB 3.1 as a device:
 - a. CVS enumerates the PUT device at USB 3.1 Gen 1 speed.
 - b. For the first configuration discovered during enumeration, CVS sends SetConfiguration(iConfiguration)
 - c. If Type_C_Power_Source = 0 (Externally-powered), CVS verifies:
 - i. The PUT draws < 1 mA over Vbus
 - ii. USB configuration bmAttributes bit D6 is set to 1
 - iii. USB configuration field bMaxPower is set to 0
 - d. If Type_C_Power_Source = 1 (UFP-powered), CVS Verifies:
 - i. The PUT draws no more than the maximum power consumption indicated in the bMaxPower field.
 - ii. USB configuration bmAttributes bit D6 is set to 0
 - iii. USB configuration field bMaxPower is greater than 0
 - e. If Type_C_Power_Source = 2 (Both), CVS verifies:
 - i. If USB configuration field bMaxPower is set to 0, the PUT draws < 1 mA over Vbus.
 - ii. If USB configuration field bMaxPower is set greater than 0, the PUT draws no more than the maximum power consumption indicated in the bMaxPowerField.
 - f. Continue to step 4.b and use the next configuration. After the last configuration, continue to the next step.
 12. If the PUT supports BC 1.2:
 - a. CVS verifies it detects VDP_SRC on D+ within 1s
 - b. CVS provides VDM_SRC on D- while VDP_SRC is present
 - c. CVS verifies Sink draws current within BC 1.2 power requirements.
 13. CVS advertises vRd-3.0 on its Rp.
 14. CVS verifies the Sink draws up to 3 A
 15. If the PUT supports USB PD:
 - a. CVS advertises vRd-1.5 on its Rp and a Source Capabilities PDO with 5V 1.5A
 - b. CVS verifies:

- i. PUT and CVS establish a contract
 - ii. After tSinkAdj expires the PUT draws no more than 1.5A
 - c. If PUT supports USB 3.1 as a device:
 - i. CVS sends Warm Reset and enumerates the PUT device
 - ii. For each configuration discovered during enumeration, CVS verifies:
 - 01 The configuration bmAttributes bit D6 is set to 1
 - 02 The configuration bMaxPower field is set to 0
 - iii. CVS removes ss terms.
 - d. If PUT supports USB 2.0 as a device:
 - i. CVS resets and enumerates the PUT device at USB 2.0.
 - ii. For each configuration discovered during enumeration, CVS verifies:
 - 01 The configuration bmAttributes bit D6 is set to 1
 - 02 The configuration bMaxpower field is set to 0
 - e. CVS advertises vRd-3.0 on its Rp
 - f. CVS verifies the Sink does not draw more than 1.5A current after tSinkAdj + 500ms expires.
 - g. CVS transmits a PD Hard Reset.
 - h. CVS advertises vRd-USB on its Rp
 - i. CVS does not communicate via PD messaging after Hard Reset and D+/D- terms are present.
 - j. CVS verifies:
 - i. If Type_C_Can_Act_As_Device is YES and Type_C_Device_Speed is HS, CVS verifies that PUT sinks no more than 100 mA after tSinkAdj.
 - ii. If Type_C_Can_Act_As_Device is YES and Type_C_Device_Speed is SS or above, CVS verifies that PUT sinks no more than 150 mA after tSinkAdj.
 - iii. If Type_C_Can_Act_As_Device is NO, CVS verifies that PUT sinks no more than 500 mA after tSinkAdj.

TD 4.10.3 Sink Suspend Test

- A. Purpose:
 - 1. Verify a PUT correctly draws power during suspend state
- B. Applicability:
 - 1. This test is applicable when both of the following are true:
 - a. VIF field Type_C_State_Machine is DRP or SNK, or UUT_Device_Type is 2 (Provider/Consumer).
 - b. VIF field Type_C_Can_Act_As_Device is YES
- C. Asserts:
 - 1. 4.6.1.1#1
- D. Procedure:
 - 1. CVS transitions to Unattached.SRC
 - 2. CVS and PUT transition to Attached.SRC and Attached.SNK
 - 3. If the PUT is USB 3.1 Capable:
 - a. CVS presents ssrc, sstx terms
 - b. CVS brings PUT through the Link-Up Initialization Sequence (LIS) as defined in the USB 3.1 Link Test Specification to U0.
 - c. CVS suspends the PUT to U3 with SetPortFeature(PLS=U3)
 - d. Wait 1 second
 - e. If the PUT implements BC 1.2 as a sink, CVS verifies the PUT draws suspend current up to 100mA.
 - f. Else, CVS verifies the PUT draws suspend current as defined in the USB 3.1 and 2.0 specs.
 - g. CVS removes ssrc, sstx.

4. If the PUT is USB 2.0 Capable:
 - a. CVS brings PUT to the HS/FS/LS Default state.
 - b. CVS suspends PUT.
 - c. Wait 1 second.
 - d. If the PUT implements BC 1.2 as a sink, CVS verifies the PUT draws suspend current up to 100mA.
 - e. Else, CVS verifies the PUT draws suspend current as defined in the USB 2.0 Spec.
5. CVS transitions to Disabled
6. CVS transitions to Unattached.SRC advertising vRd-1.5 with Rp
7. If the PUT is USB 3.1 Capable:
 - a. CVS presents ssrc, sstx terms and brings a 3.1 PUT through the LIS to U0.
 - b. CVS suspends the PUT to U3 with SetPortFeature(PLS=U3)
 - c. Wait 1 second
 - d. CVS verifies the PUT draws suspend current up to 1.5 amps.
 - e. CVS removes ssrc, sstx terms.
8. If the PUT is USB 2.0 Capable:
 - a. CVS brings PUT to the HS/FS/LS Default state.
 - b. CVS suspends PUT.
 - c. Wait 1 second
 - d. CVS verifies the PUT draws suspend current up to 1.5 amps.
9. CVS transitions to Disabled
10. CVS transitions to Unattached.SRC advertising vRd-3.0 with Rp
11. If the PUT is USB 3.1 Capable:
 - a. CVS present ssrc, sstx terms and brings a 3.1 PUT through the LIS to U0.
 - b. CVS suspends the PUT to U3 with SetPortFeature(PLS=U3)
 - c. Wait 1 second
 - d. CVS verifies the PUT draws suspend current up to 3 amps.
 - e. CVS removes ssrc, sstx terms
12. If the PUT is USB 2.0 Capable:
 - a. CVS brings PUT to the HS/FS/LS Default state.
 - b. CVS transitions PUT to SUSPEND.
 - c. Wait 1 second
 - d. CVS verifies the PUT draws suspend current up to 3 amps.
13. CVS transitions to Disabled
14. If the PUT is PD Capable:
 - a. If VIF field Type_C_Port_On_Hub is YES, CVS prompts the test operator to enter the number of DFP ports on the hub, and CVS notes the number as nHubDFP. CVS then saves $pSuspend = 25 + (25 * \min(4, nHubDFP))$ mW.
 - b. Else CVS saves $pSuspend = 25$ mW.
 - c. CVS transitions to Unattached.SRC advertising vRd-3.0 with Rp
 - d. CVS negotiates largest current draw contract available from Sink PUT with PD. CVS indicates in its Source Capabilities that it supports USB Suspend.
Note: If the PUT is USB 3.1 capable, run step 14.b concurrently to 14.c.i, or the PUT may drop to eSS.Disabled since it does not see a link partner.
 - e. If the PUT is USB 3.1 capable:
 - i. CVS presents ss terms and brings a 3.1 PUT through the LIS to U0.
 - ii. CVS suspends PUT to U3 with SetPortFeature(PLS=U3)
 - iii. CVS verifies PUT draws power $\leq pSuspend$
 - f. If the PUT is USB 2.0 capable:
 - i. CVS brings PUT to the HS/FS/LS Default state.
 - ii. CVS transitions PUT to SUSPEND
 - iii. Wait 1 second
 - iv. CVS verifies PUT draws power $\leq pSuspend$

TD 4.10.4 Sink PR_Swap Test

- A. Purpose:
 - 1. Verify that a Sink and Source Capable PUT transitions between Sink and Source correctly according to USB Type-C Connection State Machine
- B. Applicability:
 - 1. This test is applicable when VIF field Accepts_PR_Swap_As_Snk is YES
- C. Asserts:
 - 1. 4.5.2.2.5.1#4,7
 - 2. 4.5.2.2.5.2#2-3
 - 3. 4.5.2.2.8.1#3,11
- D. Data Conditions:
 - 1. PUT supports USB 3.1
 - 2. PUT supports USB 2.0
- E. Procedure:
 - 1. CVS transitions to Unattached.SRC
 - 2. For a PUT_R, CVS terminates one CC pin with Ra for the duration of the test.
 - 3. CVS verifies PUT transitions to Unattached.SNK for tCCDebounce
 - 4. CVS transitions to Attached.SRC
 - 5. CVS verifies PUT transitions to Attached.SNK.
 - 6. CVS and PUT initiate the next PUT supported Data Condition above if applicable.
 - 7. CVS initiates and together with PUT completes PD PR_Swap. Note: Please retry if PUT responds with Wait message for up to 10 seconds
 - 8. CVS verifies:
 - a. PUT sources current and asserts Rp on the CC pin connected to the cable
 - b. For a PUT_R it does not source VCONN.
 - c. PUT maintains its data role
 - 9. CVS transitions to Disabled
 - 10. CVS verifies PUT transitions to Unattached within tDetach.
 - a. If Type_C_State_Machine is SRC, CVS verifies that Rp is applied
 - b. If Type_C_State_Machine is DRP or SNK, CVS verifies that Rd is applied
 - c. PUT stops sourcing VBUS within tVBUSOFF (Vbus reaches vSafe0V)
 - 11. Continue to step one until all supported Data Conditions are exhausted.

TD 4.10.5 Sink VCONN_Swap Test

- A. Purpose:
 - 1. Verify a port sourcing VCONN removes it according to spec requirements.
- B. Applicability:
 - 1. This test is applicable when VIF field VCONN_Swap_To_On_Supported is YES
- C. Assert:
 - 1. 4.5.2.2.5.1#8
 - 2. 4.5.2.2.5.1#9
 - 3. 4.5.2.2.5.1#10
- D. Procedure:
 - 1. CVS transitions to Unattached.SRC
 - 2. CVS terminates one CC pin with Ra for the duration of the test.
 - 3. CVS verifies PUT transitions to Unattached.SNK for tCCDebounce
 - 4. CVS transitions to Attached.SRC
 - 5. CVS verifies PUT transitions to Attached.SNK
 - 6. CVS initiates and together with PUT advances through a PD VCONN_Swap transaction
 - 7. CVS verifies PUT sources VCONN before it sends a PS_RDY to the CVS as the final message in the VCONN_Swap transaction.
 - 8. If VIF field VCONN_Swap_To_Off_Supported is YES:

- a. CVS initiates and together with PUT completes a PD VCONN_Swap transaction.
- b. CVS verifies the PUT stops sourcing VCONN within tVCONN_{OFF} after the CVS sends the PS_RDY to the CVS as the final message in the VCONN_Swap transaction.

TD 4.10.6 Sink Alternate Mode Test

- A. Purpose:
 1. Verify a PUT that supports Alternate Mode follows spec requirements
- B. Applicability:
 1. This test is applicable when Type_C_Is_Alt_Mode_Device is YES.
- C. Asserts:
 1. 5.1#1-3
 2. 5.1.2#1-4
 3. 5.1.2.1#1-4
 4. 5.1.2.2#1-4,6
 5. 5.1.2.2#5
 6. 5.1.3#1
- D. Data Conditions:
 1. PUT supports USB 3.1 and Type_C_Port_On_Hub is NO
 2. PUT supports USB 2.0
- E. Procedure:
 1. CVS verifies that VIF field Type_C_Can_Act_As_Device is YES
 2. CVS transitions to Unattached.SRC
 3. CVS verifies PUT transitions to Unattached.SNK for tCCDebounce
 4. CVS presents D+/D- and SS terms as applicable to next relevant Data Condition from above
 5. CVS transitions to Attached.SRC
 6. CVS verifies PUT transitions to Attached.SNK.
 7. CVS starts tAMETimeout timer.
 8. CVS initiates and together with PUT completes PD Explicit Power Contract.
 9. CVS verifies that PUT starts USB communications within 1 second of CVS presenting terms. Note that this state may be entered before or after the PD contract. If PUT goes to SS.Disabled or Compliance mode, LVS will issue Warm Reset to recover device.
 10. CVS maintains packet traffic with PUT via GetDescriptor() every 50ms.
 11. CVS verifies PUT exposes USB Billboard Device Class Interface in Descriptor after tAMETimeout and then within 500ms. Note: If VIF field Type_C_Port_On_Hub is YES, CVS looks for the exposed USB Billboard Device Class Interface in the descriptors of a downstream non-removable port. In this case, tAMETimeout starts from the first status change indicators from the downstream port.
 12. CVS sends Discover ID, SVID, and Modes to get the Alternate Modes that PUT supports.
 13. CVS sends Enter Mode for a PUT supported Alternate Mode.
 14. CVS verifies:
 - a. The PUT successfully enters the Alternate Mode with PD messaging before ACKing
 - b. PUT follows all electrical constraints for SBU and any reconfigured pins (i.e. USB Safe States).
 - c. For a PUT_R, it follows all electrical constraints for VCONN
 15. CVS waits 1s
 16. CVS sends Exit Mode for the Alternate Mode
 17. CVS verifies:
 - a. The PUT successfully exits the Alternate Mode before sending the PD messaging response

- b. PUT follows all electrical constraints for SBU and any reconfigured pins (i.e. USB Safe States).
18. CVS transitions to Disabled.
19. CVS verifies PUT transition to Unattached within tVBUSOFF
 - a. If Type_C_State_Machine is DRP or SRC, CVS verifies PUT applies Rp
 - b. If Type_C_State_Machine is SNK, CVS verifies PUT applies Rd
20. Continue to step 2 with next Data Condition above until supported Data Conditions are exhausted

Miscellaneous Tests

These tests don't belong in the other categories. The DR_Swap test is required for DRPs and DRDs. The Dead Battery Test is required for all battery-powered products.

TD 4.11.1 DR_Swap Test

Test is required for DRDs that do not implement Type-C DRPs and Type-C DRPs that implement USB communications as a Host or Device. Steps 1-9 are applicable for a Type-C Source as defined in Figure 4-12. Steps 10-15 are applicable for a Type-C Sink as defined in Figure 4-13. All steps are applicable to any port that supports both DR_Swaps as indicated in its VIF.

- A. Purpose:
 1. Verify a DRP supports DR_Swap
 2. Verify a Sinking DFP and Charging UFP support DR_Swap
 3. Verify a DRD supports DR_Swap
- B. Applicability:
 1. When VIF field Type_C_State_Machine is SNK or DRP and DR_Swap_To_DFP_Supported is YES, then test steps 1-10 are required.
 2. When VIF field Type_C_State_Machine is SRC or DRP and DR_Swap_To_UFP_Supported is YES, then test steps 1, 11-17 are required.
 3. When VIF field Type_C_Can_Act_As_Host is YES and Type_C_Can_Act_As_Device is YES then:
 - a. When VIF field Type_C_State_Machine is SRC then test steps 1, 11-17 are required.
 - b. When VIF field Type_C_State_Machine is SNK then test steps 1-10 are required.
 4. When VIF field Type_C_State_Machine is DRP then:
 - a. When VIF field Type_C_Can_Act_As_Host is YES and Type_C_Can_Act_As_Device is NO then steps 1-10 are required.
 - b. When VIF field Type_C_Can_Act_As_Host is NO and Type_C_Can_Act_As_Device is YES then steps 1, 11-17 are required.
- C. Asserts:
 1. 4.8.3#2
 2. 4.8.4#3
- D. Procedure:

Swap to Host:

1. CVS monitors for D+/D- and SS terms throughout the test
 - a. If VIF field Type_C_Can_Act_As_Host is YES and Type_C_Can_Act_As_Device is YES:
 - i. CVS verifies D+/D- pull-ups (device terminations) are present only when Vbus is present and DUT is in a UFP role
 - ii. CVS issues a Warning if SS terms are present before Vbus is present
 - b. If VIF field Type_C_Can_Act_As_Host is YES and Type_C_Can_Act_As_Device is NO:
 - i. CVS verifies that D+/D- pull-ups (device terminations) are not present for the duration of the test.
 - ii. CVS issues a Warning if SS terms are present before Vbus is present
 - iii. CVS issues a Warning if SS terms are present when DUT is in a UFP role
 - c. If VIF field Type_C_Can_Act_As_Host is NO and Type_C_Can_Act_As_Device is YES, CVS verifies D+/D- pull-ups (device terminations) and SS terminations are present only when Vbus is present and DUT is in a UFP role
 - d. If VIF field Type_C_Can_Act_As_Host is NO and Type_C_Can_Act_As_Device is NO, CVS verifies D+/D- pull-ups (device terminations) and SS terminations are not present for the duration of the test.
2. CVS transitions to Unattached.SRC
3. For a PUT_R, CVS terminates one CC pin with Ra for the duration of the test. CVS emulates an Emarker Active Cable on the pin.
4. CVS verifies PUT transitions to Unattached.SNK for at least tCCDebounce
5. CVS transitions to Attached.SRC
6. CVS verifies that PUT transitions to Attached.SNK by tDRPTry + tCCDebounce
7. CVS initiates and together with PUT completes a PD DR_Swap
8. CVS verifies that:
 - a. The PUT does not source VBUS
 - b. For a PUT_R, it does not source VCONN
 - c. The PUT maintains its CC termination
 - d. If VIF field Type_C_Can_Act_As_Host is YES:
 - i. The PUT USB 3.1 or 2.0 link starts Host communication
 - e. ELSE
 - i. The PUT USB 3.1 or 2.0 link has ceased signaling
9. If VIF field DR_Swap_To_UFP_Supported is YES:
 - a. CVS verifies that Type_C_Port_On_Hub is NO
 - b. CVS initiates and together with PUT completes a PD DR_Swap
 - c. CVS verifies that:
 - i. The PUT maintains its CC termination state
 - ii. If VIF field Type_C_Can_Act_As_Device is YES:
 - 01 The PUT USB 3.1 or 2.0 link starts Device communication
 - iii. ELSE
 - 01 The PUT USB 3.1 or 2.0 link has ceased signaling
10. CVS transitions to Disabled for 200ms

Swap to Device:

11. CVS transitions to Unattached.SNK
12. For a PUT_R, CVS terminates one CC pin with Ra for the duration of the test. CVS emulates an Emarker Active Cable on the pin.
13. CVS verifies that PUT transitions to Attach.SRC within tDRP.DRPAttach
14. CVS transitions to Attached.SNK
15. CVS initiates and together with PUT completes PD DR_Swap
16. CVS verifies that:
 - a. The PUT continues to source VBUS

- b. For a PUT_V it continues to source VCONN
 - c. The PUT maintains its CC termination
 - d. If VIF field Type_C_Can_Act_As_Device is YES:
 - i. The PUT USB 3.1 or 2.0 link starts Device communication
 - e. ELSE
 - i. The PUT USB 3.1 or 2.0 link has ceased signaling
17. If VIF field DR_Swap_To_DFP_supported is YES:
- a. CVS verifies that Type_C_Port_On_Hub is NO
 - b. CVS initiates and together with PUT completes PD DR_Swap
 - c. CVS verifies that:
 - i. The PUT maintains its CC termination
 - ii. If VIF field Type_C_Can_Act_As_Host is YES:
 - 01 The PUT USB 3.1 or 2.0 link starts Host communication
 - iii. ELSE
 - 01 The PUT USB 3.1 or 2.0 link has ceased signaling

TD 4.11.2 Sink Dead Battery Test

- A. Purpose:
 - 1. Verify a PUT with a dead battery enters Unattached.SNK
- B. Applicability:
 - 1. This test is applicable to every USB Type-C Port
- C. Asserts:
 - 1. 4.5.2.2.3#1
 - 2. 4.8.5#1
- D. Procedure:
 - 1. CVS prompts the test operator to visually identify whether a battery is connected to the PUT
 - a. If operator answers YES, CVS verifies that VIF field Port_Battery_Powered is set to YES
 - b. If operator answers NO, CVS verifies that VIF field Port_Battery_Powered is set to NO. The test is over.
 - 2. CVS prompts the test operator to verify a dead battery is connected to the PUT.
Note: For most cases (i.e. laptop, phone, flashlight, power bank) when the battery is “dead” it is not able to power the product’s function and needs to be recharged.
 - 3. CVS verifies that Rp is never applied on the PUT for the duration of the test
 - 4. CVS transitions to the Unattached.SRC state with Rp in vRd-USB.
 - 5. Wait for max tDRP timeout
 - 6. CVS verifies that the PUT presents Rd termination on through CC pin.
 - a. For a PUT_R, check both CC pins for Rd
 - 7. CVS presents VBUS
 - 8. CVS waits 1 seconds
 - 9. CVS verifies that the PUT current draw has not exceeded 500mA.
 - 10. CVS transitions to Disabled.
 - 11. CVS prompts the test operator to disconnect the dead battery and connect a charged battery if they wish to continue testing.

Hub Ports Tests

TD 4.12.1 Hub Port 3.1 Test

This test has been removed.

TD 4.12.2 Hub Port Types Test

- A. Purpose:
 - 1. Verify a hub has only one UFP connector
- B. Applicability:
 - 1. This test is applicable for a PUT that is part of a hub, as indicated with VIF field Type_C_Port_On_Hub set to YES.
 - 2. For this test, the test operator cycles through each exposed USB Type-C port on the hub under test
 - 3. This test is only required to be run once per hub or compound device.
- C. Asserts
 - 1. 4.7#2,4-7
 - 2. 5.1#4
- D. Procedure:
 - 1. Unplug all hub ports
 - 2. Set numUFPs = 0
 - 3. For each Hub port in succession:
 - a. Set bUFP = false
 - b. Plug in the port.
 - c. If PUT transitions to Unattached.SRC:
 - i. CVS transitions to presenting both CC pins in vRa range
 - ii. Wait longer than max tAccDetect
 - iii. Verify PUT pin states remain unchanged.
 - iv. CVS transitions to presenting both CC pins in vRd range
 - v. Wait longer than max tAccDetect
 - vi. Verify PUT pin states remain unchanged.
 - vii. CVS transitions to presenting one CC pin in vRa range and one CC pin in vRd range
 - viii. Verify PUT transitions to Attached.SRC
 - ix. If PUT supports USB PD:
 - 01 CVS and PUT negotiate Explicit Power contract.
 - 02 Wait 3 * tAMETimeout
 - 03 CVS verifies PUT does not initiate Discover SVIDs, Discover Modes or Enter Mode requests.
 - 04 If PUT requests DR_Swap then numUFPs++ and bUFP = true
 - d. CVS transitions to Disabled for 200ms.
 - e. CVS transitions to Unattached.SRC
 - f. If PUT transitions to Unattached.SNK:
 - i. Wait tDRP
 - ii. Verify PUT did not transition to Unattached.Accessory
 - iii. Verify PUT did not transition to Unattached.SRC
 - iv. CVS transitions to Attached.SRC
 - v. Verify PUT presents zSBUTermination on SBU pins (open)
 - vi. If PUT does not support USB PD and bUFP = false, then numUFPs++
 - vii. If PUT supports USB PD:
 - 01 CVS and PUT negotiate an Explicit Power contract

- 02 Wait 3 * tAMETimeout
- 03 If PUT does not request DR_Swap and bUFP = false,
 then numUFPs++
- 04 Else if PUT does request DR_Swap:
 - 1. CVS completes DR_Swap with PUT.
 - 2. Wait 3 * tAMETimeout
 - 3. CVS verifies PUT does not initiate Discover SVIDs,
 Discover Modes or Enter Mode requests.
- g. Unplug Port
- h. Skip to step 1 next port until all ports are exhausted
- 4. If numUFPs == 1
 - a. CVS prompts the test operator to verify there are no USB Type-B or Micro-B
 ports on the product.
- 5. Else If numUFPs == 0:
 - a. CVS prompts the test operator to verify that either the hub is embedded or there
 is exactly 1 USB Type-B or Micro-B port on the product.
- 6. Else if numUFP > 1, the test fails.

Appendix A: TD Number Update

The Test Specification has been revised to include more connection tests as defined in the USB Type-C Spec 1.2. Effort has been made to maintain a test category taxonomy that is ontologically sound. As a result the Test Definitions have changed number indicator. The table below lists the previous tests and maps them to the current test numbers.

Test Name	Old TD Number	New TD Number
Initial Voltage Test	4.1	4.1.1
Source Connect Sink Test	4.2	4.2.1
Source Connect SNKAS Test	4.3	4.2.2
Source Connect DRP	4.4	4.2.3
Source Connect Audio Acc.	4.5	4.2.6
Source Connect Debug Acc.	4.6	4.2.7
Source Connect Vconn Acc.	4.7	4.2.8
Sink Connect Source Test	4.8	4.3.1
Sink Connect DRP Test	4.9	4.3.2
SNKAS Connect Source Test	4.10	4.4.1
SNKAS Connect DRP Test	4.11	4.4.2
SNKAS Connect Audio Acc.	4.12	4.4.6
SNKAS Connect Debug Acc.	4.13	4.4.7
SNKAS Connect PoweredAcc.	4.14	4.4.8
DRP Connect Sink Test	4.15	4.5.1
DRP Connect SNKAS Test	4.16	4.5.2
DRP Connect Source Test	4.17	4.5.3
DRP Connect DRP Test	4.18	4.5.4
DRP Connect Audio Acc. Test	4.19	4.8.1
DRP Connect Debug Acc. Test	4.20	4.8.2
DRP Connect Alternate Mode	4.21	4.8.3
DR_Swap Test	4.22	4.11.1

Vconn Powered Acc. Test	4.23	4.3.5 (Sink Connect SNKAS Test)
Source Suspend Test	4.24	4.9.1
USB Type-C Current Adv. Test	4.25	4.9.2
Source PR_Swap Test	4.26	4.9.3
Source Vconn_Swap Test	4.27	4.9.4
Source Alternate Mode Test	4.28	4.9.5
Legacy Host Adapter Test	4.29	Moved to EPC Test Spec
PD BFSK Capable Test	4.30	Removed
Sink Power Sub-States Test	4.31	4.10.1
Sink Power Precedence Test	4.32	4.10.2
Sink Suspend Test	4.33	4.10.3
Sink PR_Swap Test	4.34	4.10.4
Sink Vconn_Swap Test	4.35	4.10.5
Sink Alternate Mode Test	4.36	4.10.6
PD BFSK Capable Test	4.37	Removed
Sink Dead Battery Test	4.38	4.11.2
Hub Port 3.1 Test	4.39	4.12.1
Hub Port Types Test	4.40	4.12.2