USB Type-C ENGINEERING CHANGE NOTICE

Title: Charge-Through VCONN-Powered USB Devices
Applied to: USB Type-C Specification Release 1.3, July 14, 2017

Brief description of the functional changes proposed:
Defines an optional Charge-Through VCONN Powered USB device (VPD), and the mechanisms required to advertise, discover and take advantage of them.

Benefits as a result of the proposed changes:
The simple Charge-Through approach enables lower-cost audio docks, active phone cases, and low-end detachables.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
None. Hosts that implement PD can update their firmware to detect Charge-Through VPDs, although some implementations may not be flexible enough to fully take advantage of the capability.

An analysis of the hardware implications:
None. Hosts that want to support charge-through in VPDs will need to ensure that the control of their hardware is flexible enough to enter the additional states, but no additional circuitry should be necessary. During charge-through, VBUS may droop lower than 4V, so disconnect thresholds may need to be adjusted if the sink doesn't want to limit the input current. VPD designs that wish to add charge-through would require additional FETs, Comparators, Power Paths, and State Machine logic.

An analysis of the software implications:
Additional states are needed for hosts that wish to take advantage of the optional charge-through capability. Detection is done as part of the existing cable identification process.

An analysis of the compliance testing implications:
Additional testing to ensure that VPDs and VPD-supporting hosts comply with the new states and transitions outlined herein, and that the GND and VBUS DCRs match the SOP' advertisement in Charge-Through VPDs and are respected in Charge-Through supporting hosts.

USB Type-C ENGINEERING CHANGE NOTICE

Actual Change Requested

(a). Section 1.5, Terms and Abbreviations, Page 19

From Text:

VPD Charge-Through	A mechanism for a VCONN-Powered USB Device to pass power and CC communication from one port to the other without any interference or reregulation. This will be defined in a future specification.

To Text:

VPD Charge-Through (CTVPD)	A mechanism for a VCONN-Powered USB Device to pass power and CC communication from one port to the other without any interference or reregulation. ~~This will be defined in a future specification.~~

(b). Section 4.5.2, CC Functional and Behavioral Requirements, Page 144

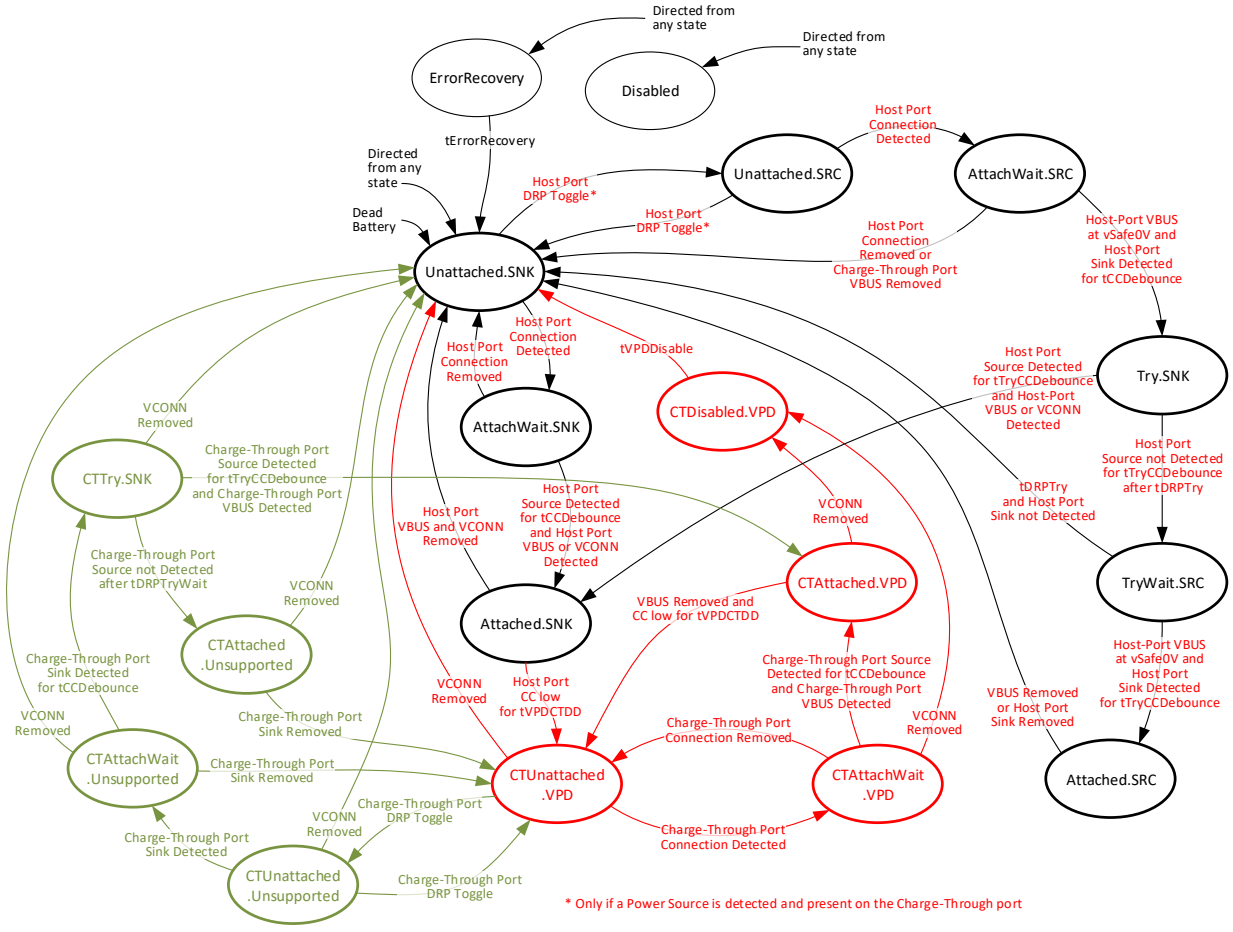
Add paragraph after bullets:

Note 1: A VCONN-Powered USB Device that supports the optional Charge-Through capability, once detected via PD messaging, will also change the Host-side port's power state without changing the port sourcing VCONN.

(c). Section 4.5.2.1, Figure 4-A, Connection State Diagram: Charge-Through VPD

Add Connection State Diagram:

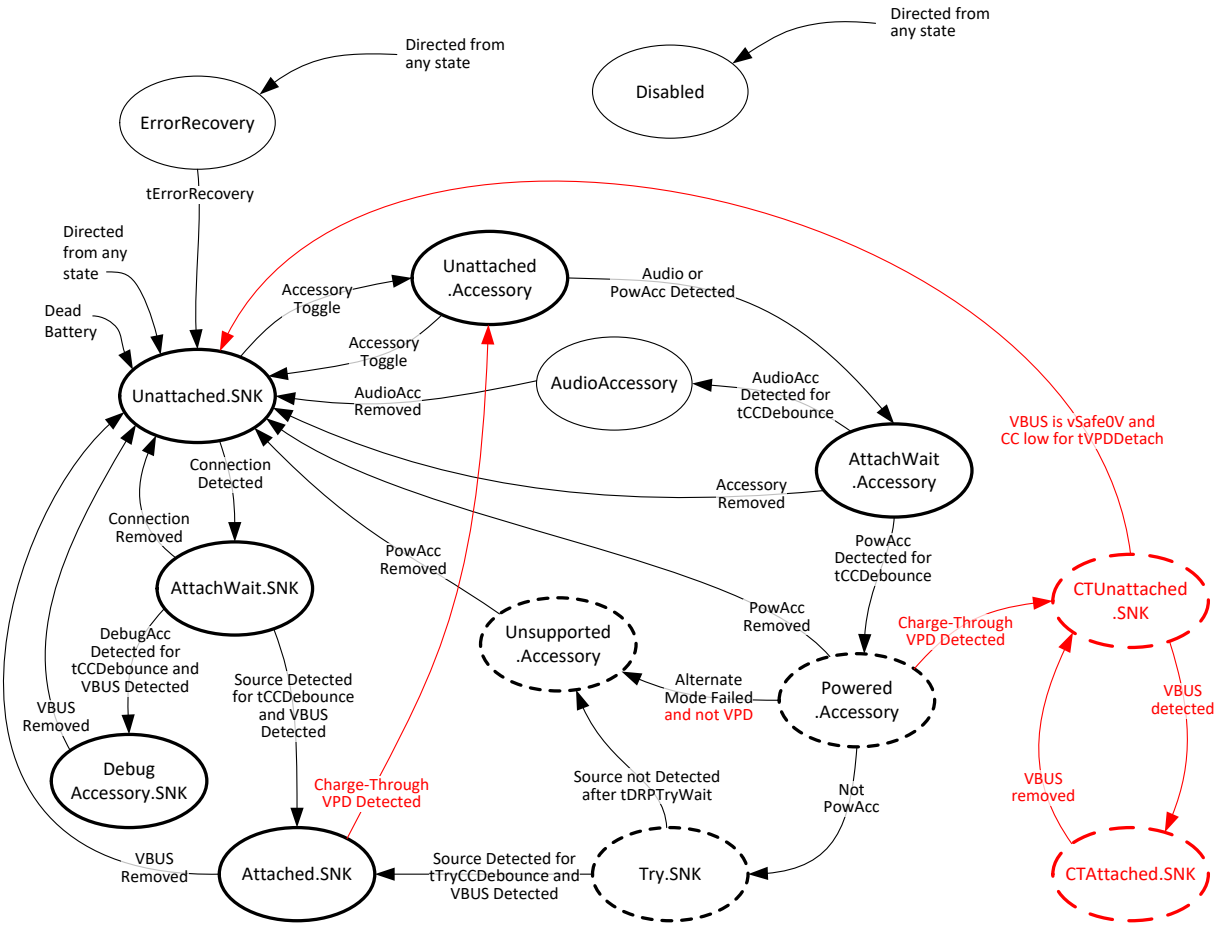
Figure 4-A, Connection State Diagram: Charge-Through VPD



(d). Section 4.5.2.1, Figure 4-14, Connection State Diagram: Sink with Accessory Support

Add states:

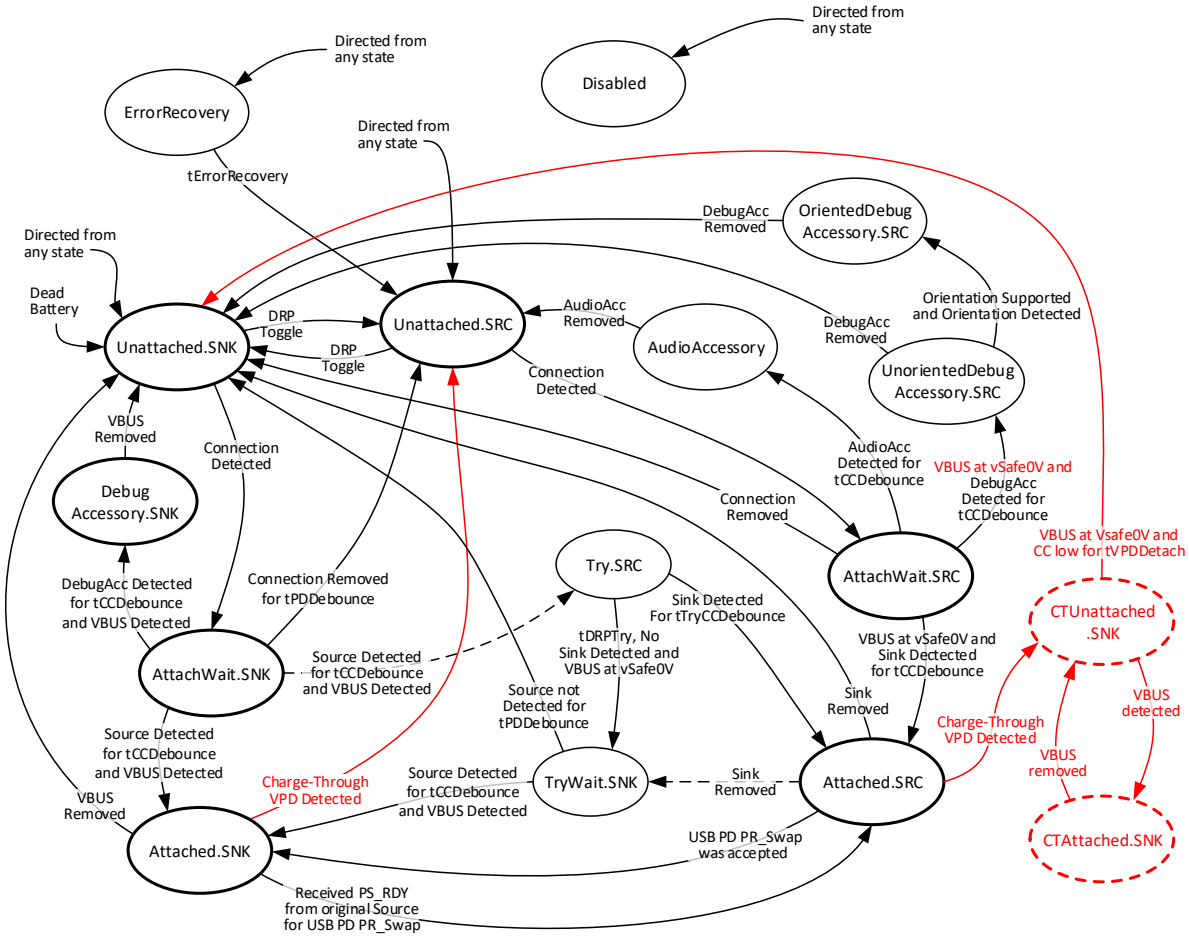
Figure 4-14, Connection State Diagram: Sink with Accessory Support



(e). Section 4.5.2.1, Figure 4-16, Connection State Diagram: DRP with Accessory and Try.SRC Support

Add states:

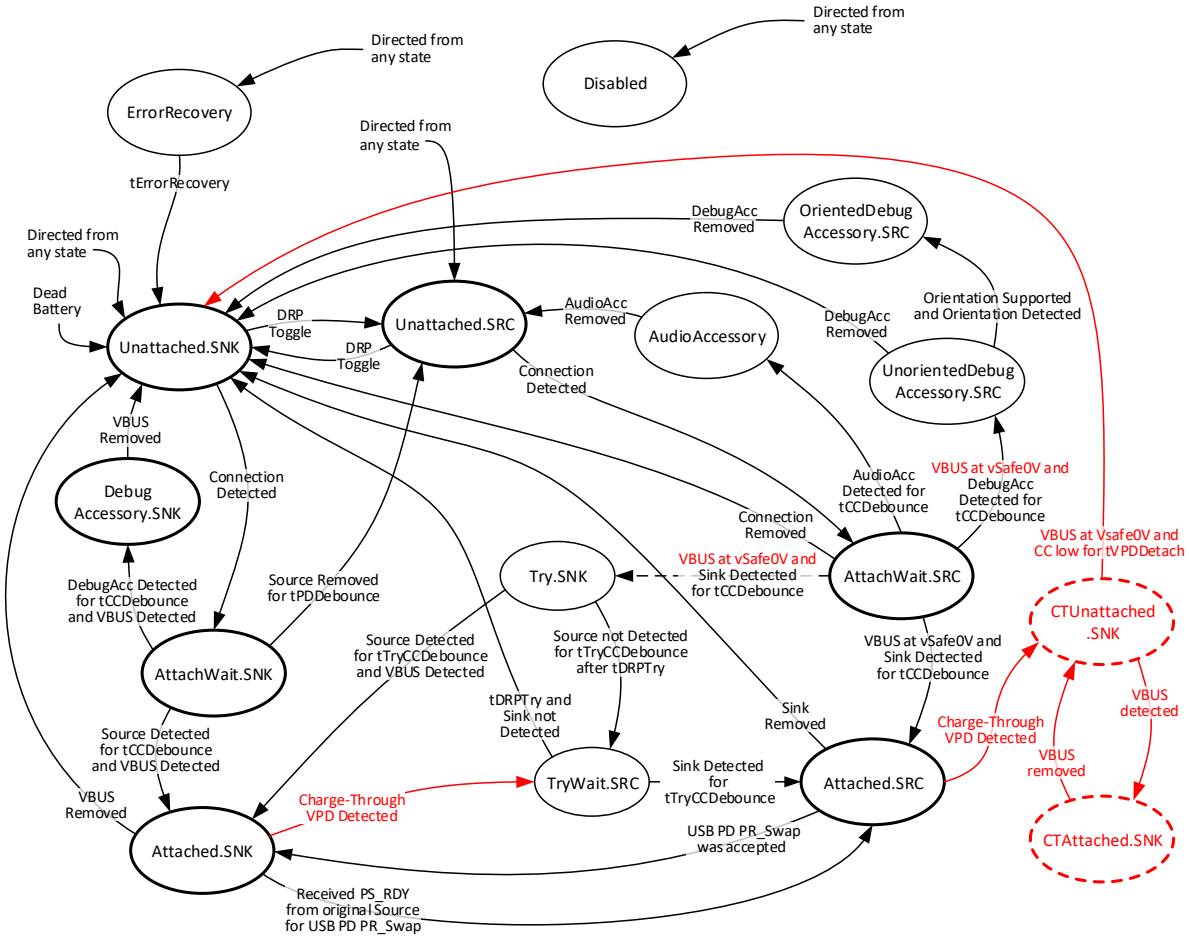
Figure 4-16, Connection State Diagram: DRP with Accessory and Try.SRC Support



(f). Section 4.5.2.1, Figure 4-17, Connection State Diagram: DRP with Accessory and Try.SNK Support

Add states:

Figure 4-17, Connection State Diagram: DRP with Accessory and Try.SNK Support



(g). Section 4.5.2.2.3 Unattached.SNK State, Page 152

From Text:

This state appears in Figure 4-13, Figure 4-14, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Unattached.SNK state, the port is waiting to detect the presence of a Source.

A port with a dead battery shall enter this state while unpowered.

To Text:

This state appears in Figure 4-A, Figure 4-13, Figure 4-14, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Unattached.SNK state, the port is waiting to detect the presence of a Source.

A port with a dead battery shall enter this state while unpowered.

(h). Section 4.5.2.2.3.1 Unattached.SNK Requirements, Page 152

From Text:

The port shall not drive VBUS or VCONN.

Both CC1 and CC2 pins shall be independently terminated to ground through Rd.

To Text:

The port shall not drive VBUS or VCONN.

Both CC1 and CC2 pins shall be independently terminated to ground through Rd.

A Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS, and independently terminate its Charge-Through port's CC1 and CC2 pins and Host-side port's CC pin to ground through Rd.

(i). Section 4.5.2.2.3.2 Exiting from Unattached.SNK State, Page 152

From Text:

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 at least one of its CC pins.

A USB 2.0 only Sink that doesn't support accessories and is self-powered or requires only default power and does not support USB PD may transition directly to Attached.SNK when VBUS is detected.

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.

A Sink with Accessory support shall transition to Unattached.Accessory within tDRPTransition after the state of both the CC1 and CC2 pins is SNK.Open for tDRP – dcSRC.DRP · tDRP, or if directed.

To Text:

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 at least one of its CC pins.

A USB 2.0 only Sink that doesn't support accessories and is self-powered or requires only default power and does not support USB PD may transition directly to Attached.SNK when VBUS is detected.

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.

A Sink with Accessory support shall transition to Unattached.Accessory within tDRPTransition after the state of both the CC1 and CC2 pins is SNK.Open for tDRP – dcSRC.DRP · tDRP, or if directed.

A Charge-Through VCONN-Powered USB Device shall transition to Unattached.SRC within tDRPTransition after the state of the Host-side port's CC pin is SNK.Open for tDRP – dcSRC.DRP · tDRP and both of the following is detected on the Charge-Through port.

- SNK.Rp state is detected on exactly one of the CC1 or CC2 pins for at least tCCDebounce
- VBUS is detected

A Charge-Through VCONN-Powered USB Device shall transition to AttachWait.SNK when a Source connection is detected, as indicated by the SNK.Rp state on its Host-side port's CC pin.

(j). Section 4.5.2.2.4 AttachWait.SNK State, Page 153

From Text:

This state appears in Figure 4-13, Figure 4-14, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the AttachWait.SNK state, the port has detected the SNK.Rp state on at least one of its CC pins and is waiting for VBUS.

To Text:

This state appears in Figure 4-A, Figure 4-13, Figure 4-14, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the AttachWait.SNK state, the port has detected the SNK.Rp state on at least one of its CC pins and is waiting for VBUS.

When in the AttachWait.SNK state, the Charge-Through VCONN-Powered USB Device has detected the SNK.Rp state on its Host-side port's CC pin and is waiting for host-side VBUS.

(k). Section 4.5.2.2.4.1 AttachWait.SNK Requirements, Page 153

From Text:

The port shall not drive VBUS or VCONN.

Both the CC1 and CC2 pins shall be independently terminated to ground through Rd.

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. Otherwise, it may connect as USB 2.0 when attached to a legacy host or hub's DFP.

To Text:

The port shall not drive VBUS or VCONN.

Both the CC1 and CC2 pins shall be independently terminated to ground through Rd.

A Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS, and independently terminate its Charge-Through port's CC1 and CC2 pins and Host-side port's CC pin to ground through Rd.

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. Otherwise, it may connect as USB 2.0 when attached to a legacy host or hub's DFP.

(l). Section 4.5.2.2.4.2 Exiting from AttachWait.SNK state, Page 153

From Text:

A Sink shall transition to Unattached.SNK when the state of both the CC1 and CC2 pins is SNK.Open for at least tPDDebounce.

A DRP shall transition to Unattached.SRC when the state of both the CC1 and CC2 pins is SNK.Open for at least tPDDebounce.

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 one of the CC pins with the state of the other CC pin remaining SNK.Open, but this event will not exceed tPDDebounce.

If the port is a VCONN-Powered Accessory or a VCONN-Powered USB Device, the port shall transition to Attached.SNK when either VCONN or VBUS is detected. The port may transition without waiting tCCDebounce on CC.

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. Note the DAM Source may initiate USB PD communications which will cause brief periods of the SNK.Open state on one of the CC pins with the state of the other CC pin remaining SNK.Rp, but this event will not exceed tPDDebounce.

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.

To Text:

A Sink shall transition to Unattached.SNK when the state of both the CC1 and CC2 pins is SNK.Open for at least tPDDebounce.

A DRP shall transition to Unattached.SRC when the state of both the CC1 and CC2 pins is SNK.Open for at least tPDDebounce.

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 one of the CC pins with the state of the other CC pin remaining SNK.Open, but this event will not exceed tPDDebounce.

If the port is a VCONN-Powered Accessory or a VCONN-Powered USB Device, the port shall transition to Attached.SNK when either VCONN or VBUS is detected. The port may transition without waiting tCCDebounce on CC.

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. Note the DAM Source may initiate USB PD communications which will cause brief periods of the SNK.Open state on one of the CC pins with the state of the other CC pin remaining SNK.Rp, but this event will not exceed tPDDebounce.

A Charge-Through VCONN-Powered USB Device shall transition to Attached.SNK after the state of the Host-side port's CC pin is SNK.Rp for at least tCCDebounce and either host-side VCONN or VBUS is detected.

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.

(m). Section 4.5.2.2.5 Attach.SNK State, Page 154

From Text:

This state appears in Figure 4-13, Figure 4-14, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Attached.SNK state, the port is attached and operating as a Sink. When the port initially enters this state it is also operating as a UFP. The power and data roles can be changed using USB PD commands.

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 USB PD.

To Text:

This state appears in Figure 4-A, Figure 4-13, Figure 4-14, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Attached.SNK state, the port is attached and operating as a Sink. When the port initially enters this state it is also operating as a UFP. The power and data roles can be changed using USB PD commands.

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 USB PD.

(n). Section 4.5.2.2.5.1, Attached.SNK Requirements, Page 154

From Text:

If the port needs to determine the orientation of the connector, it shall do so only upon entry to this state by detecting which of the CC1 or CC2 pins is connected through the cable (i.e., the CC pin that is in the SNK.Rp state).

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.

If the port has entered the Attached.SNK state from the AttachWait.SNK or TryWait.SNK states, only one the CC1 or CC2 pins will be in the SNK.Rp state. The port shall continue to terminate this CC pin to ground through Rd.

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.

The port shall meet the Sink Power Sub-State requirements specified in Section 4.5.2.3.

If the port is a VCONN-Powered USB Device, it shall respond to USB PD Discover Identity queries on SOP'. It shall not send or respond to messages on SOP. It shall ensure there is sufficient capacitance on CC to meet cReceiver as defined in USB PD.

The port may negotiate a USB PD PR_Swap, DR_Swap or VCONN_Swap.

By default, upon entry from AttachWait.SNK or Unattached.SNK, VCONN shall not be supplied in the Attached.SNK state. 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/connections. A USB PD DR_Swap has no effect on which port sources VCONN.

The port may negotiate a USB PD VCONN_Swap. When the port successfully executes USB PD VCONN_Swap operation and was not sourcing VCONN, it shall start sourcing VCONN within tVCONNON. 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. When the port successfully executes USB PD VCONN_Swap operation and was sourcing VCONN, it shall stop sourcing VCONN within tVCONNOFF.

To Text:

If the port needs to determine the orientation of the connector, it shall do so only upon entry to this state by detecting which of the CC1 or CC2 pins is connected through the cable (i.e., the CC pin that is in the SNK.Rp state).

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.

If the port has entered the Attached.SNK state from the AttachWait.SNK or TryWait.SNK states, only one the CC1 or CC2 pins will be in the SNK.Rp state. The port shall continue to terminate this CC pin to ground through Rd.

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.

The port shall meet the Sink Power Sub-State requirements specified in Section 4.5.2.3.

If the port is a VCONN-Powered USB Device, it shall respond to USB PD Discover Identity queries on SOP'. It shall not send or respond to messages on SOP. It shall ensure there is sufficient capacitance on CC to meet cReceiver as defined in USB PD.

A Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS, present a high-impedance to ground (above zOPEN) on its Charge-Through port's CC1 and CC2 pins and terminate its Host-side port's CC pin to ground through Rd.

A Charge-Through VCONN-Powered USB Device shall start a Charge-Through Support Timer when it enters the Attached.SNK state. If a Charge-Through VCONN-Powered USB Device fails to exit the Attached.SNK state before the Charge-Through Support Timer exceeds tAMETimeout, it shall present a *USB Billboard Device Class* interface indicating that it does not support Charge-Through.

A Charge-Through VCONN-Powered USB Device shall reset the Charge-Through Support Timer when it first receives any USB PD Structured VDM Command it supports. If a Charge-Through VCONN-Powered USB Device receives a Structured VDM Command multiple times, it shall only reset the Charge-Through Support Timer once. This ensures a Charge-Through VCONN-Powered USB Device will present a *USB Billboard Device Class* interface if it fails to exit Attached.SNK while receiving repeated or continuous Structured VDM Commands (e.g., Discover Identity).

A Charge-Through VCONN-Powered USB Device shall reset the Charge-Through Support Timer when it receives any Data Message it supports. A Charge-Through VCONN-Powered USB Device shall hold the Charge-Through Support Timer in reset while it is in any USB PD BIST mode.

Except for a VCONN-Powered USB Device or Charge-Through VCONN-Powered USB Device, the port may negotiate a USB PD PR_Swap, DR_Swap or VCONN-Swap.

If the port supports Charge-Through VCONN-Powered USB devices, and an explicit PD contract has failed to be negotiated, the port shall query the identity of the cable via USB PD on SOP'.

By default, upon entry from AttachWait.SNK or Unattached.SNK, VCONN shall not be supplied in the Attached.SNK state. 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/connections. A USB PD DR_Swap has no effect on which port sources VCONN.

The port may negotiate a USB PD VCONN_Swap. When the port successfully executes USB PD VCONN_Swap operation and was not sourcing VCONN, it shall start sourcing VCONN within tVCONNON. 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. When the port successfully executes USB PD VCONN_Swap operation and was sourcing VCONN, it shall stop sourcing VCONN within tVCONNOFF.

(o). Section 4.5.2.2.5.2, Exiting from Attached.SNK, Page 154

From Text:

A port that is not a VCONN-Powered USB Device and is not in the process of a USB PD PR_Swap or a USB PD Hard Reset or a USB PD FR_Swap shall transition to Unattached.SNK within tSinkDisconnect when VBUS falls below vSinkDisconnect for VBUS operating at or below 5 V or below vSinkDisconnectPD when negotiated by USB PD to operate above 5 V.

A VCONN-Powered USB Device shall return to Unattached.SNK when VBUS has fallen below vSinkDisconnect and VCONN has fallen below vVCONNDisconnect.

A port that has entered into USB PD communications with the Source and has seen the CC voltage exceed vRd-USB may monitor the CC pin to detect cable disconnect in addition to monitoring VBUS.

A port that is monitoring the CC voltage for disconnect (but is not in the process of a USB PD PR_Swap or USB PD FR_Swap) shall transition to Unattached.SNK within tSinkDisconnect after the CC voltage remains below vRd-USB for tPDDebounce.

If supplying VCONN, the port shall cease to supply it within tVCONNOFF of exiting Attached.SNK.

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.

To Text:

A port that is not a VCONN-Powered USB Device and is not in the process of a USB PD PR_Swap or a USB PD Hard Reset or a USB PD FR_Swap shall transition to Unattached.SNK within tSinkDisconnect when VBUS falls below vSinkDisconnect for VBUS operating at or below 5 V or below vSinkDisconnectPD when negotiated by USB PD to operate above 5 V.

A VCONN-Powered USB Device shall return to Unattached.SNK when VBUS has fallen below vSinkDisconnect and VCONN has fallen below vVCONNDisconnect.

A port that has entered into USB PD communications with the Source and has seen the CC voltage exceed vRd-USB may monitor the CC pin to detect cable disconnect in addition to monitoring VBUS.

A port that is monitoring the CC voltage for disconnect (but is not in the process of a USB PD PR_Swap or USB PD FR_Swap) shall transition to Unattached.SNK within tSinkDisconnect after the CC voltage remains below vRd-USB for tPDDebounce.

If supplying VCONN, the port shall cease to supply it within tVCONNOFF of exiting Attached.SNK.

A Charge-Through VCONN-Powered USB Device shall transition to CTUnattached.VPD if VCONN is present and the state of its Host-side port's CC pin is SNK.Open for tVPDCTDD.

A port that via SOP' has detected an attached Charge-Through VCONN-Powered USB device shall transition to TryWait.SRC if implemented, or transition to Unattached.SRC or Unattached.Accessory if TryWait.SRC is not supported. This transition may be delayed until the device has sufficient battery charge needed to remain powered until it reaches the CTAttached.SNK state.

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.

(p). Section 4.5.2.2.7 Unattached.SRC State, Page 155

From Text:

This state appears in Figure 4-12, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Unattached.SRC state, the port is waiting to detect the presence of a Sink or an Accessory.

To Text:

This state appears in Figure 4-A, Figure 4-12, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Unattached.SRC state, the port is waiting to detect the presence of a Sink or an Accessory.

When in the Unattached.SRC state, the Charge-Through VCONN-Powered USB Device has detected a Source on its Charge-Through port and is independently monitoring its Host-side port to detect the presence of a Sink.

(q). Section 4.5.2.2.7.1 Unattached.SRC Requirements, Page 155

From Text:

The port shall not drive VBUS or VCONN.

The port shall source current on both the CC1 and CC2 pins independently.

The port shall provide a separate Rp termination on the CC1 and CC2 pins as specified in Table 4-20. Note: A Source with a captive cable or just a plug presents a single Rp termination on its CC pin (A5).

To Text:

The port shall not drive VBUS or VCONN.

The port shall source current on both the CC1 and CC2 pins independently.

The port shall provide a separate Rp termination on the CC1 and CC2 pins as specified in Table 4-20. Note: A Source with a captive cable or just a plug presents a single Rp termination on its CC pin (A5).

The Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS. The Charge-Through VCONN-Powered USB Device shall ensure that it is powered by VBUS from the Charge-Through port.

Upon entry into this state, the Charge-Through VCONN-Powered USB Device shall remove its Rd termination to ground on the Host-side port CC and provide an Rp termination instead advertising Default USB Power, as specified in Table 4-20, and continue to independently terminate its Charge-Through port's CC1 and CC2 pins to ground through Rd.

(r). Section 4.5.2.2.7.2 Exiting from Unattached.SRC State, Page 156

From Text:

The port shall transition to AttachWait.SRC when VBUS is vSafe0V and:

- The SRC.Rd state is detected on either CC1 or CC2 pin or
- The SRC.Ra state is detected on both the CC1 and CC2 pins.

Note: A cable without an attached device can be detected, when the SRC.Ra state is detected on one of the CC1 or CC2 pins and the other CC pin is SRC.Open. However in this case, the port shall not transition to AttachWait.SRC.

A DRP shall transition to Unattached.SNK within tDRPTransition after dcSRC.DRP · tDRP, or if directed.

To Text:

The port shall transition to AttachWait.SRC when VBUS is vSafe0V and:

- The SRC.Rd state is detected on either CC1 or CC2 pin or
- The SRC.Ra state is detected on both the CC1 and CC2 pins.

Note: A cable without an attached device can be detected, when the SRC.Ra state is detected on one of the CC1 or CC2 pins and the other CC pin is SRC.Open. However in this case, the port shall not transition to AttachWait.SRC.

The Charge-Through VCONN-Powered USB Device shall transition to AttachWait.SRC when host-side VBUS is vSafe0V and SRC.Rd state is detected on the Host-side port's CC pin.

A DRP shall transition to Unattached.SNK within tDRPTransition after dcSRC.DRP · tDRP, or if directed.

A Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK within tDRPTransition after dcSRC.DRP · tDRP, or if Charge-Through VBUS is removed.

(s). Section 4.5.2.2.8 AttachWait.SRC State, Page 156

From Text:

This state appears in Figure 4-12, Figure 4-15, Figure 4-16 and Figure 4-17.

The AttachWait.SRC state is used to ensure that the state of both of the CC1 and CC2 pins is stable after a Sink is connected.

To Text:

This state appears in Figure 4-A, Figure 4-12, Figure 4-15, Figure 4-16 and Figure 4-17.

The AttachWait.SRC state is used to ensure that the state of both of the CC1 and CC2 pins is stable after a Sink is connected.

When in the AttachWait.SRC state, the Charge-Through VCONN-Powered USB Device ensures that the state of Host-side port's CC pin is stable after a Sink is connected.

(t). Section 4.5.2.2.8.2 Exiting from AttachWait.SRC State, Page 156

From Text:

The port shall transition to 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.

If the port supports Audio Adapter Accessory Mode, it shall transition to AudioAccessory when the SRC.Ra state is detected on both the CC1 and CC2 pins for at least tCCDebounce.

If the port supports Debug Accessory Mode, it shall transition to UnorientedDebugAccessory.SRC when VBUS is at vSafe0V and the SRC.Rd state is detected on both the CC1 and CC2 pins for at least tCCDebounce.

A Source shall transition to Unattached.SRC and a DRP to Unattached.SNK when the SRC.Open state is detected on both the CC1 and CC2 pins. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

A Source shall transition to Unattached.SRC and a DRP to Unattached.SNK when the SRC.Open state is detected on either the CC1 or CC2 pin and the other CC pin is SRC.Ra. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

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.

To Text:

The port shall transition to 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.

The Charge-Through VCONN-Powered USB Device shall transition to Try.SNK when the host-side VBUS is at vSafe0V and the SRC.Rd state is on the Host-side port's CC pin for at least tCCDebounce.

If the port supports Audio Adapter Accessory Mode, it shall transition to AudioAccessory when the SRC.Ra state is detected on both the CC1 and CC2 pins for at least tCCDebounce.

If the port supports Debug Accessory Mode, it shall transition to UnorientedDebugAccessory.SRC when VBUS is at vSafe0V and the SRC.Rd state is detected on both the CC1 and CC2 pins for at least tCCDebounce.

A Source shall transition to Unattached.SRC and a DRP to Unattached.SNK when the SRC.Open state is detected on both the CC1 and CC2 pins. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

A Source shall transition to Unattached.SRC and a DRP to Unattached.SNK when the SRC.Open state is detected on either the CC1 or CC2 pin and the other CC pin is SRC.Ra. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

A Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK when the SRC.Open state is detected on the Host-side port's CC or if Charge-Through VBUS falls below vSinkDisconnect. The Charge-Through VCONN-Powered USB Device shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

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.

(u). Section 4.5.2.2.9 Attached.SRC State, Page 156

From Text:

This state appears in Figure 4-12, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Attached.SRC state, the port is attached and operating as a Source. When the port initially enters this state it is also operating as a DFP. Subsequently, the initial power and data roles can be changed using USB PD commands.

To Text:

This state appears in Figure 4-A, Figure 4-12, Figure 4-15, Figure 4-16 and Figure 4-17.

When in the Attached.SRC state, the port is attached and operating as a Source. When the port initially enters this state it is also operating as a DFP. Subsequently, the initial power and data roles can be changed using USB PD commands.

When in the Attached.SRC state, the Charge-Through VCONN-Powered USB Device has detected a Sink on its Host-side port and has connected the Charge-Through port VBUS to the Host-side port VBUS.

(v). Section 4.5.2.2.9.1, Attached.SRC Requirements, Page 157

From Text:

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 of the CC1 or CC2 pins is connected through the cable, i.e., which CC pin is in the SRC.Rd state.

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 of the CC1 or CC2 pins. The port shall source current on this CC pin and monitor its state.

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.

The port shall provide an Rp as specified in Table 4-20.

The port shall supply VBUS current at the level it advertises on Rp.

The port shall supply VBUS within tVBUSON of entering this state, and for as long as it is operating as a power source.

The port shall not initiate any USB PD communications until VBUS reaches vSafe5V.

If the port supports signaling on USB SuperSpeed pairs, it shall:

- Functionally connect the USB SuperSpeed pairs
- For VCONN, do one of two things:
    - 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.

A port that does not support signaling on USB SuperSpeed pairs may supply VCONN in the same manner described above.

The port may negotiate a USB PD PR_Swap, DR_Swap or VCONN_Swap.

If the port supplies VCONN, it shall do so within tVCONNON.

The port may query the identity of the cable via USB PD on SOP'. If it detects that it is connected to a VCONN-Powered USB Device, the port may remove VBUS and discharge it to vSafe0V, while continuing to remain in this state with VCONN applied. The port may also initiate other SOP' communication, such as to update the VPD firmware.

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. A USB PD DR_Swap has no effect on which port sources VCONN.

The port may negotiate a USB PD VCONN_Swap. When the port successfully executes USB PD VCONN_Swap operation and was sourcing VCONN, it shall stop sourcing VCONN within tVCONNOFF. 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. When the port successfully executes USB PD VCONN_Swap operation and was not sourcing VCONN, it shall start sourcing VCONN within tVCONNON.

To Text:

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 of the CC1 or CC2 pins is connected through the cable, i.e., which CC pin is in the SRC.Rd state.

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 of the CC1 or CC2 pins. The port shall source current on this CC pin and monitor its state.

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.

The port shall provide an Rp as specified in Table 4-20.

The port shall supply VBUS current at the level it advertises on Rp.

The port shall supply VBUS within tVBUSON of entering this state, and for as long as it is operating as a power source.

The port shall not initiate any USB PD communications until VBUS reaches vSafe5V.

If the port supports signaling on USB SuperSpeed pairs, it shall:

- Functionally connect the USB SuperSpeed pairs
- For VCONN, do one of two things:
    - 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.

A port that does not support signaling on USB SuperSpeed pairs may supply VCONN in the same manner described above.

The port may negotiate a USB PD PR_Swap, DR_Swap or VCONN_Swap.

If the port supplies VCONN, it shall do so within tVCONNON.

The port may query the identity of the cable via USB PD on SOP'. If it detects that it is connected to a VCONN-Powered USB Device, the port may remove VBUS and discharge it to vSafe0V, while continuing to remain in this state with VCONN applied. The port may also initiate other SOP' communication.

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. A USB PD DR_Swap has no effect on which port sources VCONN.

The port may negotiate a USB PD VCONN_Swap. When the port successfully executes USB PD VCONN_Swap operation and was sourcing VCONN, it shall stop sourcing VCONN within tVCONNOFF. 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. When the port successfully executes USB PD VCONN_Swap operation and was not sourcing VCONN, it shall start sourcing VCONN within tVCONNON.

The Charge-Through VCONN-Powered USB Device shall continue to isolate its Host-side port's CC pin from its Charge-Through CC pins.

The Charge-Through VCONN-Powered USB Device shall maintain its Rp termination advertising Default USB Power on the Host-side port's CC pin, and continue to independently terminate its Charge-Through port's CC1 and CC2 pins to ground through Rd.

The Charge-Through VCONN-Powered USB Device shall immediately connect the Charge-Through port's VBUS through to the Host-side port's VBUS.

The Charge-Through VCONN-Powered USB Device shall ensure that it is powered entirely by VBUS.

The Charge-Through VCONN-Powered USB Device shall only respond to USB PD Discover Identity queries on SOP' on its Host-side port and complete any active queries prior to exiting this state. It shall ensure there is sufficient capacitance on the Host-side port CC to meet cReceiver as defined in USB PD.

(w). Section 4.5.2.2.9.2, Exiting from Attached.SRC, Page 157

From Text:

A Source that is supplying VCONN shall transition to UnattachedWait.SRC when the SRC.Open state is detected on the monitored CC pin. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

A Source that is not supplying VCONN shall transition to Unattached.SRC when the SRC.Open state is detected on the monitored CC pin. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

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. In that case, it shall transition to TryWait.SNK. This transition to TryWait.SNK is needed so that two devices that both prefer the Source role do not loop endlessly between Source and Sink. In other words, a DRP that would enter Try.SRC from AttachWait.SNK shall enter TryWait.SNK for a Sink detach from Attached.SRC.

A port shall cease to supply VBUS within tVBUSOFF of exiting Attached.SRC.

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.

After a USB PD PR_Swap is accepted (i.e., either an Accept message is received or acknowledged), a DRP shall transition directly to the Attached.SNK state (i.e., remove Rp from CC, assert Rd on CC and stop supplying VBUS) and maintain its current data role, connection and VCONN supply state.

To Text:

A Source that is supplying VCONN shall transition to UnattachedWait.SRC when the SRC.Open state is detected on the monitored CC pin. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

A Source that is not supplying VCONN shall transition to Unattached.SRC when the SRC.Open state is detected on the monitored CC pin. The Source shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

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. In that case, it shall transition to TryWait.SNK. This transition to TryWait.SNK is needed so that two devices that both prefer the Source role do not loop endlessly between Source and Sink. In other words, a DRP that would enter Try.SRC from AttachWait.SNK shall enter TryWait.SNK for a Sink detach from Attached.SRC.

A DRP that supports Charge-Through VCONN-Powered USB Devices shall transition to CTUnattached.SNK if the connected device identifies itself as a Charge-Through VCONN-Powered USB Device in its Discover Identity Command response. The DRP may delay this transition in order to perform further SOP' communication.

A port shall cease to supply VBUS within tVBUSOFF of exiting Attached.SRC.

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 or is transitioning into the CTUnattached.SNK state.

After a USB PD PR_Swap is accepted (i.e., either an Accept message is received or acknowledged), a DRP shall transition directly to the Attached.SNK state (i.e., remove Rp from CC, assert Rd on CC and stop supplying VBUS) and maintain its current data role, connection and VCONN supply state.

A Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK when VBUS falls below vSinkDisconnect or the Host-side port's CC pin is SRC.Open. The Charge-Through VCONN-Powered USB Device shall detect the SRC.Open state within tSRCDisconnect, but should detect it as quickly as possible.

(x). Section 4.5.2.2.12, Try.SNK State, Page 159

From Text:

This state appears in Figure 4-14 and Figure 4-17.

When in the Try.SNK state, the port is querying to determine if the port partner supports the Source role.

Note: if both Try.SRC and Try.SNK mechanisms are implemented, only one shall be enabled by the port at any given time. Deciding which of these two mechanisms is enabled is product design-specific.

To Text:

This state appears in Figure 4-A, Figure 4-14 and Figure 4-17.

When in the Try.SNK state, the port is querying to determine if the port partner supports the Source role.

When in the Try.SNK state, the Charge-Through VCONN-Powered USB Device is querying to determine if the port partner on the Host-side port supports the Source role.

Note: if both Try.SRC and Try.SNK mechanisms are implemented, only one shall be enabled by the port at any given time. Deciding which of these two mechanisms is enabled is product design-specific.

(y). Section 4.5.2.2.12.1, Try.SNK Requirements, Page 159

From Text:

The port shall not drive VBUS or VCONN.

Both the CC1 and CC2 pins shall be independently terminated to ground through Rd.

To Text:

The port shall not drive VBUS or VCONN.

Both the CC1 and CC2 pins shall be independently terminated to ground through Rd.

The Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS. The Charge-Through VCONN-Powered USB Device shall ensure that it is powered by VBUS from the Charge-Through port.

The Charge-Through VCONN-Powered USB Device shall remove its Rp termination (Default USB Power advertisement) on the Host-side port CC and provide an Rd termination to ground instead, as specified in Table 4-20 and remain to independently terminate its Charge-Through port's CC1 and CC2 pins to ground through Rd.

(z). Section 4.5.2.2.12.2, Exiting from Try.SNK State, Page 159

From Text:

The port shall wait for tDRPTry and only then begin monitoring the CC1 and CC2 pins for the SNK.Rp state.

The port shall then transition to Attached.SNK when the SNK.Rp state is detected on exactly one of the CC1 or CC2 pins for at least tTryCCDebounce and VBUS is detected.

Alternatively, the port shall transition to TryWait.SRC if SNK.Rp state is not detected for tTryCCDebounce.

A Sink with Accessory Support shall transition to Unsupported.Accessory if SNK.Rp state is not detected for tDRPTryWait.

Note: The Source may initiate USB PD communications which will cause brief periods of the SNK.Open state on both the CC1 and CC2 pins, but this event will not exceed tTryCCDebounce.

To Text:

The port shall wait for tDRPTry and only then begin monitoring the CC1 and CC2 pins for the SNK.Rp state.

The port shall then transition to Attached.SNK when the SNK.Rp state is detected on exactly one of the CC1 or CC2 pins for at least tTryCCDebounce and VBUS is detected.

Alternatively, the port shall transition to TryWait.SRC if SNK.Rp state is not detected for tTryCCDebounce.

The Charge-Through VCONN-Powered USB Device shall wait for tDRPTry and only then begin monitoring the Host-side port's CC pin for the SNK.Rp state.

The Charge-Through VCONN-Powered USB Device shall then transition to Attached.SNK when the SNK.Rp state is detected on the Host-side port's CC pin for at least tTryCCDebounce and VBUS or VCONN is detected on Host-side port.

Alternatively, the Charge-Through VCONN-Powered USB Device shall transition to TryWait.SRC if Host-side SNK.Rp state is not detected for tTryCCDebounce.

A Sink with Accessory Support shall transition to Unsupported.Accessory if SNK.Rp state is not detected for tDRPTryWait.

Note: The Source may initiate USB PD communications which will cause brief periods of the SNK.Open state on both the CC1 and CC2 pins, but this event will not exceed tTryCCDebounce.

(aa). Section 4.5.2.2.13, TryWait.SRC State, Page 159

From Text:

This state appears in Figure 4-17.

When in the TryWait.SRC state, the port has failed to become a Sink and is waiting to attach as a Source.

To Text:

This state appears in Figure 4-A and Figure 4-17.

When in the TryWait.SRC state, the port has failed to become a Sink and is waiting to attach as a Source.

When in the TryWait.SRC state, the Charge-Through VCONN-Powered USB Device has failed to become a Sink on its Host-side port and is waiting to attach as a Source on its Host-side port.

(ab). Section 4.5.2.2.13.2, Exiting from TryWait.SRC State, Page 159

From Text:

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 tTryCCDebounce.

The port shall transition to Unattached.SNK after tDRPTry if neither of the CC1 or CC2 pins are in the SRC.Rd state.

To Text:

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 tTryCCDebounce.

The Charge-Through VCONN-Powered USB Device shall transition to Attached.SRC when host-side VBUS is at vSafe0V and the SRC.Rd state is detected on the Host-side port's CC pin for at least tTryCCDebounce.

The port shall transition to Unattached.SNK after tDRPTry if neither of the CC1 or CC2 pins are in the SRC.Rd state.

The Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK after tDRPTry if the Host-side port's CC pin is not in the SRC.Rd state.

(ac). Section 4.5.2.2.20.2, Exiting from PoweredAccessory State, Page 163

From Text:

The port shall transition to Unattached.SNK when the SRC.Open state is detected on the monitored CC pin.

The port shall transition to Try.SNK if the attached device is not a VCONN–Powered Accessory or VCONN-Powered USB Device. For example, the attached device does not support USB PD or does not respond to USB PD commands required for a VCONN–Powered Accessory (e.g., Discover SVIDs, Discover Modes, etc.) or is a Sink or DRP attached through a Powered Cable.

The port shall transition to Unsupported.Accessory if the attached device is a VCONN–Powered Accessory but the port has not successfully entered an Alternate Mode within tAMETimeout (see Section 5.1).

The port shall cease to supply VCONN within tVCONNOFF of exiting the PoweredAccessory state.

To Text:

The port shall transition to Unattached.SNK when the SRC.Open state is detected on the monitored CC pin.

The port shall transition to Try.SNK if the attached device is not a VCONN–Powered Accessory or VCONN-Powered USB Device. For example, the attached device does not support USB PD or does not respond to USB PD commands required for a VCONN–Powered Accessory (e.g., Discover SVIDs, Discover Modes, etc.) or is a Sink or DRP attached through a Powered Cable.

The port shall transition to Unsupported.Accessory if the attached device is a VCONN–Powered Accessory but the port has not successfully entered an Alternate Mode within tAMETimeout (see Section 5.1).

A port that supports Charge-Through VCONN-Powered USB Devices shall transition to CTUnattached.SNK if the connected device identifies itself as a Charge-Through VCONN-Powered USB Device in its Discover Identity Command response. The port may delay this transition in order to perform further SOP' communication.

The port shall cease to supply VCONN within tVCONNOFF of exiting the PoweredAccessory state, unless it is transitioning into the CTUnattached.SNK state.

(ad). Section 4.5.2.2.22, CTUnattached.VPD

Add Section:

4.5.2.2.22 CTUnattached.VPD State

This state appears in Figure 4-A.

When in the CTUnattached.VPD state, the Charge-Through VCONN-Powered USB Device has detected SNK.Open on its host port for tVPDCTDD, indicating that it is connected to a Charge-Through capable Source, and is independently monitoring its Charge-Through port for the presence of a pass-through Power Source.

This state may also have been entered through detach of a Power Source on the Charge-Through port or detach of a sink from the CTVPD's Charge-through port.

4.5.2.2.22.1 CTUnattached.VPD Requirements

The Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS. The Charge-Through VCONN-Powered USB Device shall ensure that it is powered by VCONN, does not consume more than ICCS (USB 3.2) / ICCSH (USB 2.0)

from VBUS for monitoring, and is sufficiently isolated from VBUS to tolerate high voltages during Charge-Through operation.

Upon entry into this state, the device shall remove its Rd termination to ground (if present) on the Host-side port CC and provide an Rp termination advertising 3.0 A instead, as specified in Table 4-20. Note that because VBUS is not provided, the Rp termination signals continued connection to the port partner but does not carry with it any current advertisement.

The Charge-Through VCONN-Powered USB Device shall only respond to USB PD Discover Identity queries on SOP' on its Host-side port. It shall ensure there is sufficient capacitance on the Host-side port CC to meet cReceiver as defined in USB PD.

The Charge-Through VCONN-Powered USB Device shall independently terminate both the Charge-Through port's CC1 and CC2 pins to ground through Rd.

The Charge-Through VCONN-Powered USB Device shall provide a bypass capacitance of C_{CTB} on the Charge-Through Port's VBUS pins

4.5.2.2.22.2 Exiting from CTUnattached.VPD State

The Charge-Through VCONN-Powered USB Device shall transition to CTAttachWait.VPD when a Source connection is detected on the Charge-Through port, as indicated by the SNK.Rp state on exactly one of the Charge-Through port's CC pins.

Debug accessories are not supported on the Charge-Through port.

The Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK if VCONN falls below vVCONNDisconnect.

The Charge-Through VCONN-Powered USB Device shall transition to CTUnattached.Unsupported within tDRPTransition after the state of both the Charge-Through port's CC1 and CC2 pins is SNK.Open for tDRP-dcSRC.DRP · tDRP, or if directed.

(ae). Section 4.5.2.2.23, CTAttachWait.VPD

Add Section:

4.5.2.2.23 CTAttachWait.VPD State

This state appears in Figure 4-A.

When in the CTAttachWait.VPD state, the device has detected the SNK.Rp state on exactly one of its Charge-Through port's CC pins and is waiting for VBUS on the Charge-Through port.

4.5.2.2.23.1 CTAttachWait.VPD Requirements

The Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS. The Charge-Through VCONN-Powered USB Device shall ensure that it is powered by VCONN, does not consume more than ICCS (USB 3.2) / ICCSH (USB 2.0) from VBUS for monitoring, and is sufficiently isolated from VBUS to tolerate high voltages during Charge-Through operation.

The Charge-Through VCONN-Powered USB Device shall maintain its Rp termination advertising 3.0 A on the Host-side port's CC pin, as well as the independent terminations to ground through Rd on the Charge-Through port's CC1 and CC2 pins.

The Charge-Through VCONN-Powered USB Device shall only respond to USB PD Discover Identity queries on SOP' on its Host-side port, and complete any active queries prior to exiting this state. It shall ensure there is sufficient capacitance on the Host-side port CC to meet cReceiver as defined in USB PD.

4.5.2.2.23.2 Exiting from CTAttachWait.VPD State

The Charge-Through VCONN-Powered USB Device shall transition to CTUnattached.VPD when the state of both the Charge-Through port's CC1 and CC2 pins are SNK.Open for at least tPDDebounce.

The Charge-Through VCONN-Powered USB Device shall transition to CTAttached.VPD after the state of only one of the Charge-Through port's CC1 or CC2 pins is SNK.Rp for at least tCCDebounce and VBUS on the Charge-Through port is detected.
Note the Charge-Through Source may initiate USB PD communications which will cause brief periods of the SNK.Open state on one of the Charge-Through port's CC pins with the state of the Charge-Through port's other CC pin remaining SNK.Open, but this event will not exceed tPDDebounce.

The Charge-Through VCONN-Powered USB Device shall transition to CTDisabled.VPD if VCONN falls below vVCONNDisconnect.

(af). Section 4.5.2.2.24, CTAttached.VPD

Add Section:

4.5.2.2.24 CTAttached.VPD State

This state appears in Figure 4-A.

When in the CTAttached.VPD state, the Charge-Through VCONN-Powered USB Device has detected a Power Source on its Charge-Through port and has connected the Charge-Through port's CC and VBUS pins directly to the Host-side port's CC and VBUS pins. Hence all power delivery, negotiation and USB PD communication are performed directly between the unit on Host-side port and the Power Source connected to the Charge-Through port.

4.5.2.2.24.1 CTAttached.VPD Requirements

Upon entry to this state, the Charge-Through VCONN-Powered USB Device shall detect which of the Charge-Through port's CC1 or CC2 pins is connected through the cable (i.e., the CC pin that is in the SNK.Rp state). The device shall then immediately, in the following order:

1. Remove or reduce any additional capacitance on the Host-side CC port that was introduced in order to meet cReceiver as defined in USB PD to present on CC a value equal to or less than two times the maximum value for cCablePlug_CC as defined in the USB Type-C Specification.
2. Disable the Rp termination advertising 3.0 A on the host port's CC pin.

3. Passively multiplex the detected Charge-Through port's CC pin through to the host port's CC pin with an impedance of less than RccCON.
4. Disable the Rd on the Charge-Through port's CC1 and CC2 pins.
5. Connect the Charge-Through port's VBUS through to the host port's VBUS.

These steps shall be completed within tVPDDetach_min of entering this state.

The Charge-Through VCONN-Powered USB Device shall ensure that it is powered by VCONN, does not consume more than ICCS (USB 3.2) / ICCSH (USB 2.0) from VBUS for monitoring, and is sufficiently isolated from VBUS to tolerate high voltages during Charge-Through operation.

The Charge-Through VCONN-Powered USB Device shall not respond to any USB PD communication on any CC pin in this state. Any active queries on SOP' shall have been completed prior to entering this state.

4.5.2.2.24.2 Exiting from CTAttached.VPD State

The Charge-Through VCONN-Powered USB Device shall transition to CTUnattached.VPD when VBUS falls below vSinkDisconnect and the state of the passed-through CC pin is SNK.Open for tVPDCTDD.

The Charge-Through VCONN-Powered USB Device shall transition to CTDisabled.VPD if VCONN falls below vVCONNDisconnect.

(ag). Section 4.5.2.2.25, CTDisabled.VPD

Add Section:

4.5.2.2.25 CTDisabled.VPD State

This state appears in Figure 4-A.

When in the CTDisabled.VPD state, the Charge-Through VCONN-Powered USB Device has detected the detach on its Host-side port but may still potentially be connected to a Power Source on the Charge-Through port, and is thus ensuring that the VBUS from the Power Source is removed.

4.5.2.2.25.1 CTDisabled.VPD Requirements

The Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS.

The device shall present a high-impedance to ground (above zOPEN) on the Host-side port's CC pin and on the Charge-Through port CC1 and CC2 pins.

The Charge-Through VCONN-Powered USB Device shall ensure that it is powered entirely by VBUS.

4.5.2.2.25.2 Exiting from CTDisabled.VPD State

The Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK after tVPDDisable.

(ah). Section 4.5.2.2.26, CTUnattached.SNK

Add Section:

4.5.2.2.26 CTUnattached.SNK State

This state appears in Figure 4-14, Figure 4-16 and Figure 4-17.

When in the CTUnattached.SNK state, the port has detected that it is attached to a Charge-Through VCONN-Powered USB Device and is ready if a Power Source is attached to the Charge-Through VCONN-Powered device.

This state may also have been entered through detach of a Charge-Through Power Source.

4.5.2.2.26.1 CTUnattached.SNK Requirements

Upon entry to this state, the port shall remove its Rp termination (if present) and terminate CC to ground through Rd.

The port shall continue to supply VCONN.

The port shall stop sourcing or sinking VBUS and discharge it.

In PD 2.0, the port shall act as a bus master for the purposes of initiating PD messages.

The port may query the state of the attached VCONN-Powered USB Device by sending SOP' messages on USB PD to read the VPD's eMarker.

4.5.2.2.26.2 Exiting from CTUnattached.SNK State

The port shall transition to CTAttached.SNK when VBUS is detected. Note that by this point, the VCONN-Powered USB Device has already debounced the passed-through CC pin.

The port shall transition to Unattached.SNK if the state of the CC pin is SNK.Open for tVPDDetach after VBUS is vSafe0V.

(ai). Section 4.5.2.2.27, CTAttached.SNK

Add Section:

4.5.2.2.27 CTAttached.SNK State

This state appears in Figure 4-14, Figure 4-16 and Figure 4-17.

When in the CTAttached.SNK state, the port is connected to a Charge-Through VCONN-Powered USB Device, which in turn is passing through the connection to a Power Source.

4.5.2.2.27.1 CTAttached.SNK Requirements

The port shall continue to terminate CC to ground through Rd. Since there is now a Power Source connected through to VBUS and CC, the port shall operate in one of the Sink Power Sub-States shown in Figure 4-18, and remain within the Sink Power Sub-States, until either VBUS is removed or a USB PD contract is established with the source.

The port shall not negotiate a voltage on VBUS higher than the maximum voltage specified in the Charge-Through VCONN Powered USB Device's Discover Identity Command response.

The port shall continue to supply VCONN.

The port shall reject a VCONN swap request.

The port shall not perform BC1.2 primary detection, as that will interfere with VPD functionality.

In PD 2.0, the port shall act as a bus slave for the purposes of initiating PD messages, although it remains a DFP for USB data.

The port shall neither initiate nor respond to any SOP' communication.

The port shall meet the Sink Power Sub-State requirements specified in Section 4.5.2.3.

The port shall meet the additional maximum current constraints described in Section 4.6.2.5.

The port shall follow the restrictions on USB PD messages described in Section 4.10.2.

The port shall alter its advertised capabilities to UFP role/sink only role as described in Section 4.10.2

4.5.2.2.27.2 Exiting from CTAttached.SNK State

A port that is not in the process of a USB PD Hard Reset shall transition to CTUnattached.SNK within tSinkDisconnect when VBUS falls below vSinkDisconnect for VBUS operating at or below 5 V or below vSinkDisconnectPD when negotiated by USB PD to operate above 5 V.

A port that has entered into USB PD communications with the Source and has seen the CC voltage exceed vRd-USB may monitor the CC pin to detect cable disconnect in addition to monitoring VBUS.

A port that is monitoring the CC voltage for disconnect shall transition to CTUnattached.SNK within tSinkDisconnect after the CC voltage remains below vRd-USB for tPDDebounce.

(aj). Section 4.5.2.2.28, CTUnattached.Unsupported

Add Section:

4.5.2.2.28 CTUnattached.Unsupported State

This state appears in Figure 4-A.

When in the CTUnattached.Unsupported state, the Charge-Through VCONN-Powered USB Device has previously detected SNK.Open on its host port for tVPDCTDD, indicating that it is connected to a Charge-Through Capable Source, and is now monitoring its Charge-Through port for the presence of an unsupported sink.

A Charge-Through VCONN-Powered USB Device does not support Sinks, Debug Accessory Mode, or Audio Adapter Accessory Mode.

4.5.2.2.28.1 CTUnattached.Unsupported Requirements

The Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS. The Charge-Through VCONN-Powered USB Device shall

ensure that it is powered by VCONN, does not consume more than ICCS (USB 3.2) / ICCSH (USB 2.0) from VBUS for monitoring, and is sufficiently isolated from VBUS to tolerate high voltages during Charge-Through operation.

Upon entry into this state, the Charge-Through VCONN-Powered USB Device shall maintain its Rp termination advertising 3.0 A on the Host-side port's CC pin, remove its Rd terminations to ground on the Charge-Through port's CC1 and CC2 pins, and provide a Rp termination advertising Default USB Power instead.

The Charge-Through VCONN-Powered USB Device shall only respond to USB PD Discover Identity queries on SOP' on its Host-side port. It shall ensure there is sufficient capacitance on the Host-side port CC to meet cReceiver as defined in USB PD.

4.5.2.2.28.2 Exiting from CTUnattached.Unsupported State

The Charge-Through VCONN-Powered USB Device shall transition to CTAttachWait.Unsupported when a Sink connection is detected on the Charge-Through port, as indicated by the SRC.Rd state on at least one of the Charge-Through port's CC pins or SRC.Ra state on both the CC1 and CC2 pins.

The Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK if VCONN falls below vVCONNDisconnect.

Otherwise, a Charge-Through VCONN-Powered USB Device shall transition to CTUnattached.VPD within tDRPTransition after dcSRC.DRP · tDRP, or if directed.

(ak). Section 4.5.2.2.29, CTAttachWait.Unsupported

Add Section:

4.5.2.2.29 CTAttachWait.Unsupported State

This state appears in Figure 4-A.

The CTAttachWait.Unsupported state is used to ensure that the state of both the Charge-Through Port's CC1 and CC2 pins are stable for at least tCCDebounce.

4.5.2.2.29.1 CTAttachWait.Unsupported Requirements

The requirements for this state are identical to CTUnattached.Unsupported state.

4.5.2.2.29.2 Exiting from CTAttachWait.Unsupported State

The Charge-Through VCONN-Powered USB Device shall transition to CTTry.SNK if the state of at least one of the Charge-Through port's CC pins is SRC.Rd, or if the state of both the CC1 and CC2 pins is SRC.Ra. for at least tCCDebounce.

The Charge-Through VCONN-Powered USB Device shall transition to CTUnattached.VPD when the state of either the Charge-Through Port's CC1 or CC2 pin is SRC.Open for at least tCCDebounce.

The Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK if VCONN falls below vVCONNDisconnect.

(al). Section 4.5.2.2.30, CTTry.SNK

Add Section:

4.5.2.2.30 CTTry.SNK State

This state appears in Figure 4-A.

When in the CTTry.SNK state, the Charge-Through VCONN-Powered USB device is querying to determine if the port partner on the Charge-Through port supports the source role.

4.5.2.2.30.1 CTTry.SNK Requirements

The requirements for this state is identical to CTUnattached.VPD state.

4.5.2.2.30.2 Exiting from CTTry.SNK State

The Charge-Through VCONN-Powered USB Device shall wait for tDRPTry and only then begin monitoring the Charge-Through port's CC pins for the SNK.Rp state.

The Charge-Through VCONN-Powered USB Device shall then transition to CTAttached.VPD when the SNK.Rp state is detected on the Charge-Through port's CC pins for at least tTryCCDebounce and VBUS is detected on Charge-Through port.

A Charge-Through VCONN-Powered USB Device shall transition to CTAttached.Unsupported if SNK.Rp state is not detected for tDRPTryWait.

Note: The Source may initiate USB PD communications which will cause brief periods of the SNK.Open state on both the CC1 and CC2 pins, but this event will not exceed tTryCCDebounce.

The Charge-Through VCONN-Powered USB Device shall transition to Unattached.SNK if VCONN falls below vVCONNDisconnect.

(am). Section 4.5.2.2.31, CTAttached.Unsupported

Add Section:

4.5.2.2.31 CTAttached.Unsupported State

This state appears in Figure 4-A.

If the port partner to the Charge-Through VCONN-Powered USB Device's Charge-Through port either does not support the source power role, or failed to negotiate the source role, the CTAttached.Unsupported state is used to wait until that device is unplugged before continuing.

4.5.2.2.31.1 CTAttached.Unsupported Requirements

The Charge-Through VCONN-Powered USB Device shall isolate its Host-side port from its Charge-Through port, including CCs and VBUS. The Charge-Through VCONN-Powered USB Device shall ensure that it is powered by VCONN, does not consume more than ICCS (USB 3.2) / ICCSH (USB 2.0)

from VBUS for monitoring, and is sufficiently isolated from VBUS to tolerate high voltages during Charge-Through operation.

Upon entry into this state, the Charge-Through VCONN-Powered USB Device shall maintain its Rp termination advertising 3.0 A on the Host-side port's CC pin, remove its Rd terminations to ground on the Charge-Through port's CC1 and CC2 pins, and provide a Rp termination advertising Default USB Power instead.

At least one of the CC1 or CC2 pins will be in the SRC.Rd state or both will be in the SRC.Ra state. The Charge-Through port shall advertise Default USB Power (see Table 4-20) on its CC pins and monitor their voltage.

The Charge-Through VCONN-Powered USB Device shall present a *USB Billboard Device Class* interface indicating that it does not recognize or support the attached accessory or device.

4.5.2.2.31.2 Exiting from CTAttached.Unsupported State

The Charge-Through VCONN-Powered USB Device shall transition to CTUnattached.VPD when SRC.Open state is detected on both the Charge-Through port's CC pins or the SRC.Open state is detected on one CC pin and SRC.Ra is detected on the other CC pin.

(an). Section 4.5.2.3, Sink Power Sub-State Requirements, Page 164

From Text:

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 4-18. The initial Sink Power Sub-State is PowerDefault.SNK. Subsequently, the Sink Power Sub-State is determined by Source's USB Type-C current advertisement. 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.

To Text:

When in the Attached.SNK or CTAttached.SNK states and the Source is supplying default VBUS, the port shall operate in one of the sub-states shown in Figure 4-18. The initial Sink Power Sub-State is PowerDefault.SNK. Subsequently, the Sink Power Sub-State is determined by Source's USB Type-C current advertisement. 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.

Note that for the CTAttached.SNK state, there are further limitations on maximum current. These are described in Section 4.6.2.5.

(ao). Section 4.5.2.5, Table 4-16, Mandatory and Optional States, Page 169

Modified rows:

	SOURCE	SINK	DRP	USB PD Communication
Try.SNK[4,8]	N/A	N/A	Optional	Not Permitted
TryWait.SRC[5,8]	N/A	N/A	Optional	Not Permitted

Add rows:

	SOURCE	SINK	DRP	USB PD Communication
CTUnattached.VPD	N/A	N/A	Optional	SOP' Permitted
CTAttachWait.VPD[8]	N/A	N/A	Optional	SOP' Permitted
CTAttached.VPD[8]	N/A	N/A	Optional	Not Permitted
CTDisabled.VPD[8]	N/A	N/A	Optional	Not Permitted
CTUnattached.SNK	N/A	N/A	Optional	SOP' Permitted
CTAttached.SNK[9]	N/A	N/A	Optional	Permitted
CTUnattached.Unsupported[8]	N/A	N/A	Optional	SOP' Permitted
CTAttachWait.Unsupported[8]	N/A	N/A	Optional	SOP' Permitted
CTTry.SNK[8]	N/A	N/A	Optional	SOP' Permitted
CTAttached.Unsupported[8]	N/A	N/A	Optional	SOP' Permitted

8. CTAttachWait.VPD, CTAttached.VPD, CTDisabled.VPD, Try.SNK, TryWait.SRC, CTUnattached.Unsupported, CTAttachWait.Unsupported, CTAttached.Unsupported, and CTTry.SNK are mandatory when CTUnattached.VPD is supported.
9. CTAttached.SNK is mandatory when CTUnattached.SNK is supported.

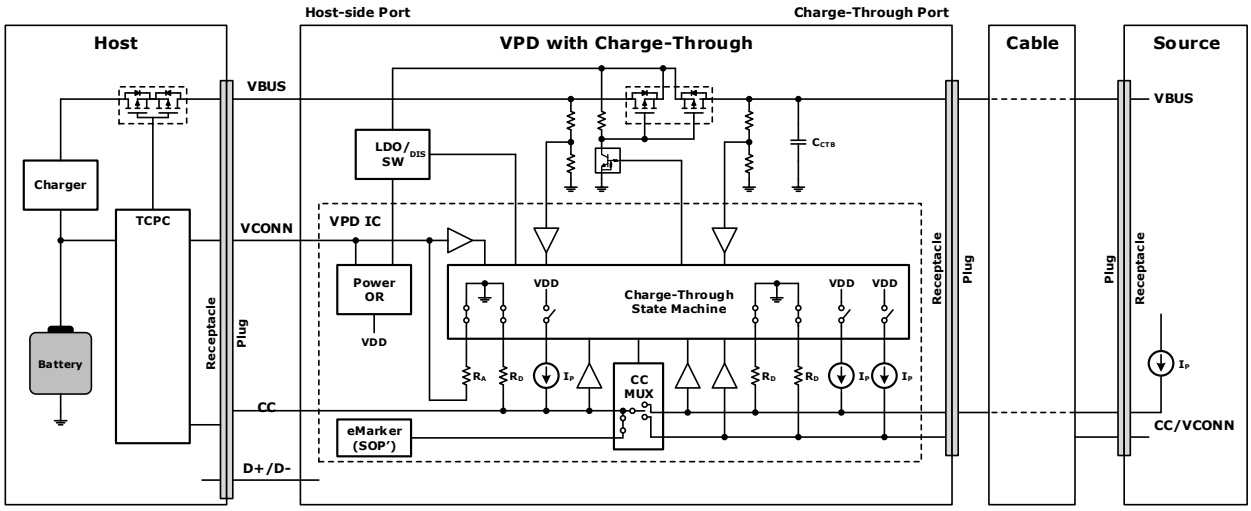
(ap). Section 4.5.3.1.8, DRP to VCONN-Powered USB Device (CTVPD) Behavior

Add section:

4.5.3.1.8 DRP to VCONN-Powered USB Device (CTVPD) Behavior

Figure 4-B illustrates the functional model for a DRP connected to a Charge-Through VCONN-Powered USB Device, with a Source attached to the Charge-Through port on the VCONN-Powered USB Device.

Figure 4-B Example DRP to Charge-Through VCONN-Powered USB Device Model



CASE 1: The following describes the behavior when a DRP is connected to a Charge-Through VCONN-Powered USB Device (abbreviated CTVPD), with no Power Source attached to the Charge-Through port on the CTVPD.

1. DRP and CTVPD are both in the unattached state
    a. DRP alternates between Unattached.SRC and Unattached.SNK
    b. CTVPD has applied Rd on its Charge-Through port's CC1 and CC2 pins and Rd on the Host-side port's CC pin
2. DRP transitions from Unattached.SRC to AttachWait.SRC to Attached.SRC
    a. DRP in Unattached.SRC detects the CC pull-down of CTVPD which is in Unattached.SNK and DRP enters AttachWait.SRC
    b. DRP in AttachWait.SRC detects that pull down on CC persists for tCCDebounce, enters Attached.SRC and turns on VBUS and VCONN
3. CTVPD transitions from Unattached.SNK to Attached.SNK through AttachWait.SNK.
    a. CTVPD detects the host-side CC pull-up of the DRP and CTVPD enters AttachWait.SNK
    b. CTVPD in AttachWait.SNK detects that pull up on the Host-side port's CC persists for tCCDebounce, VCONN present and enters Attached.SNK
    c. CTVPD present a high-impedance to ground (above zOPEN) on its Charge-Through port's CC1 and CC2 pins

4. While DRP and CTVPD are in their respective attached states, DRP discovers the Charge-Through CTVPD and transitions to CTUnattached.SNK
    a. DRP (as Source) queries the device identity via USB PD (Device Identity Command) on SOP'.
    b. CTVPD responds on SOP', advertising that it is a Charge-Through VCONN-Powered USB Device
    c. DRP (as Source) removes VBUS
    d. DRP (as Source) changes its Rp to a Rd
    e. DRP (as Sink) continues to provide VCONN and enters CTUnattached.SNK
5. CTVPD transitions to CTUnattached.VPD
    a. CTVPD detects VBUS removal, VCONN presence, the low Host-side CC pin and enters CTUnattached.VPD
    b. CTVPD changes its host-side Rd to a Rp advertising 3.0 A
    c. CTVPD isolates itself from VBUS
    d. CTVPD apply Rd on its Charge-Through port's CC1 and CC2 pins
6. While the CTVPD in CTUnattached.VPD state and the DRP in CTUnattached.SNK state:
    a. CTVPD monitors Charge-Though CC pins for a source or sink; when a Power Source attach is detected, enters CTAttachWait.VPD; when a sink is detected, enters CTAttachWait.Unsupported
    b. CTVPD monitors VCONN for Host detach and when detected, enters Unattached.SNK
    c. DRP monitors VBUS and CC for CTVPD detach for tVPDDetach and when detected, enters Unattached.SNK
    d. DRP monitors VBUS for Power Source attach and when detected, enters CTAttached.SNK

CASE 2: The following describes the behavior when a Power Source is connected to a Charge-Through VCONN-Powered USB Device (abbreviated CTVPD), with a Host already attached to the Host-side port on the CTVPD.

1. DRP is in CTUnattached.SNK state, CTVPD in CTUnattached.VPD, and Power Source in the unattached state
    a. CTVPD has applied Rd on the Charge-Through port's CC1 and CC2 pins and Rp termination advertising 3.0 A on the Host-side port's CC pin
2. Power Source transitions from Unattached.SRC to Attached.SRC through AttachWait.SRC.
    a. Power Source detects the CC pull-down of the CTVPD and enters AttachWait.SRC
    b. Power Source in AttachWait.SRC detects that pull down on CC persists for tCCDebounce, enters Attached.SRC and turns on VBUS
3. CTVPD transitions from CTUnattached.VPD through CTAttachWait.VPD to CTAttached.VPD
    a. CTVPD detects the Source's Rp on one of its Charge-Through CC pins, and transitions to CTAttachWait.VPD
    b. CTVPD finishes any active USB PD communication on SOP' and ceases to respond to SOP' queries
    c. CTVPD in CTAttachWait.VPD detects that the pull up on Charge-Through CC pin persists for tCCDebounce, detects VBUS and enters CTAttached.VPD
    d. CTVPD connects the active Charge-Through CC pin to the Host-side port's CC pin
    e. CTVPD disables its Rp termination advertising 3.0 A on the Host-side port's CC pin
    f. CTVPD disables its Rd on the Charge-Through CC pins
    g. CTVPD connects VBUS from the Charge-Through side to the Host side
4. DRP (as Sink) transitions to CTAttached.SNK

   a. DRP (as Sink) detects VBUS, monitors vRd for available current and enter CTAttached.SNK
5. While the devices are all in their respective attached states:
   a. CTVPD monitors VCONN for DRP detach and when detected, enters CTDisabled.VPD
   b. CTVPD monitors VBUS and CC for Power Source detach and when detected, enters CTUnattached.VPD within tVPDCTDD
   c. DRP (as Sink) monitors VBUS for Charge-Through Power Source detach and when detected, enters CTUnattached.SNK
   d. DRP (as Sink) monitors VBUS and CC for CTVPD detach and when detected, enters Unattached.SNK (and resumes toggling between Unattached.SNK and Unattached.SRC)
   e. Power Source monitors CC for CTVPD detach and when detected, enters Unattached.SRC

CASE 3: The following describes the behavior when a Power Source is connected to a Charge-Through VCONN-Powered USB Device (abbreviated CTVPD), with no Host attached to the Host-side port on the CTVPD.

1. CTVPD and Power Source are both in the unattached state
   a. CTVPD has applied Rd on the Charge-Through port's CC1 and CC2 pins and Rd on the Host-side port's CC pin
2. Power Source transitions from Unattached.SRC to Attached.SRC through AttachWait.SRC.
   a. Power Source detects the CC pull-down of the CTVPD and enters AttachWait.SRC
   b. Power Source in AttachWait.SRC detects that pull down on CC persists for tCCDebounce, enters Attached.SRC and turns on VBUS
3. CTVPD alternates between Unattached.SNk and Unattached.SRC
   a. CTVPD detects the Source's Rp on one of its Charge-Through CC pins, detects VBUS for tCCDebounce and starts alternating between Unattached.SRC and Unattached.SNK
4. While the CTVPD alternates between Unattached.SRC and Unattached.SNK state and the Power Source in Attached.SRC state:
   a. CTVPD monitors the Host-side port's CC pin for device attach and when detected, enters AttachWait.SRC
   b. CTVPD monitors VBUS for Power Source detach and when detected, enters Unattached.SNK
   c. Power Source monitors CC for CTVPD detach and when detected, enters Unattached.SRC

CASE 4: The following describes the behavior when a DRP is connected to a Charge-Through VCONN-Powered USB Device (abbreviated CTVPD), with a Power Source already attached to the Charge-Through side on the CTVPD.

1. DRP and CTVPD are in unattached state and Power Source in Attached.SRC state
   a. DRP alternates between Unattached.SRC and Unattached.SNK
   b. CTVPD alternates between Unattached.SRC and Unattached.SNK
   c. CTVPD has applied Rd on the Charge-Through port's CC1 and CC2 pins
   d. Power Source has applied VBUS
2. DRP transitions from Unattached.SNK to AttachWait.SNK

   a. DRP in Unattached.SNK detects the CC pull-up of CTVPD which is in Unattached.SRC and DRP enters AttachWait.SNK
3. CTVPD transitions from Unattached.SRC to Try.SNK through AttachWait.SRC
   a. CTVPD in Unattached.SRC detects the CC pull-down of DRP which is in Unattached.SNK and CTVPD enters AttachWait.SRC
   b. CTVPD in AttachWait.SRC detects that pull down on CC persists for tCCDebounce and enters Try.SNK
   c. CTVPD disables Rp termination advertising Default USB Power on the Host-side port's CC pin
   d. CTVPD enables Rd on the Host-side port's CC pin
4. DRP transitions from AttachWait.SNK to Attached.SRC through Unattached.SRC and AttachWait.SRC
   a. DRP in AttachWait.SNK detects the CC pull-up removal of CTVPD which is in Try.SNK and DRP enters Unattached.SRC
   b. DRP in Unattached.SRC detects the CC pull-down of CTVPD which is in Try.SNK and DRP enters AttachWait.SRC
   c. DRP in AttachWait.SRC detects that pull down on CC persists for tCCDebounce. It then enters Attached.SRC and enable VBUS and VCONN
5. CTVPD transitions from Try.SNK to Attached.SNK
   a. CTVPD detects the CC pull-up of the DRP persists for tTryCCDebounce
   b. CTVPD detects VBUS on the Host-side port and enters Attached.SNK
6. While DRP and CTVPD are in their respective attached states, DRP discovers the Charge-Through CTVPD and transitions to CTUnattached.SNK
   a. DRP (as Source) queries the device identity via USB PD (Discover Identity Command) on SOP'.
   b. CTVPD responds on SOP', advertising that it is a Charge-Through VCONN-Powered USB Device
   c. DRP (as Source) removes VBUS
   d. DRP (as Source) changes its Rp into an Rd
   e. DRP (as Sink) continues to provide VCONN and enters CTUnattached.SNK
7. CTVPD transitions to CTUnattached.VPD
   a. CTVPD detects VBUS removal, VCONN presence, and the low CC pin on its host port and enters CTUnattached.VPD
   b. CTVPD changes its host-side Rd into an Rp termination advertising 3.0 A
   c. CTVPD isolates itself from VBUS
8. CTVPD transitions from CTUnattached.VPD through CTAttachWait.VPD to CTAttached.VPD
   a. CTVPD detects the Source's Rp on one of its Charge-Through CC pins, and transitions to CTAttachWait.VPD
   b. CTVPD in CTAttachWait.VPD detects that pull up on Charge-Through CC pin persists for tCCDebounce, detects VBUS and enters CTAttached.VPD
   c. CTVPD finishes any active USB PD communication on SOP' and ceases to respond to SOP' queries
   d. CTVPD connects the active Charge-Through CC pin to the host-side CC pin
   e. CTVPD disables its Rp termination advertising 3.0 A on the Host-side port's CC pin
   f. CTVPD disables its Rd on the Charge-Through CC pins
   g. CTVPD connects VBUS from the Charge-Through side to the Host side
9. DRP (as Sink) transitions to CTAttached.SNK
   a. DRP (as Sink) detects VBUS and monitors vRd for available current and enter CTAttached.SNK
10. While the devices are all in their respective attached states:

a. CTVPD monitors VCONN for DRP detach and when detected, enters CTDisabled.VPD
b. CTVPD monitors VBUS and CC for Power Source detach and when detected, enters CTUnattached.VPD within tVPDCTDD
c. DRP (as Sink) monitors VBUS for Charge-Through Power Source detach and when detected, enters CTUnattached.SNK
d. DRP (as Sink) monitors VBUS and CC for CTVPD detach and when detected, enters Unattached.SNK (and resumes toggling between Unattached.SNK and Unattached.SRC)
e. Power Source monitors CC for CTVPD detach and when detected, enters Unattached.SRC

CASE 5: The following describes the behavior when a Power Source is connected to a Charge-Through VCONN-Powered USB Device (abbreviated CTVPD), with a DRP (with dead battery) attached to the Host-side port on the CTVPD.

1. DRP, CTVPD and Power Source are all in the unattached state
   a. DRP apply dead battery Rd
   b. CTVPD apply Rd on the Charge-Through port's CC1 and CC2 pins and Rd on the Host-side port's CC pin
2. Power Source transitions from Unattached.SRC to Attached.SRC through AttachWait.SRC.
   a. Power Source detects the CC pull-down of the CTVPD and enters AttachWait.SRC
   b. Power Source in AttachWait.SRC detects that pull down on CC persists for tCCDebounce, enters Attached.SRC and enable VBUS
3. CTVPD alternates between Unattached.SNk and Unattached.SRC
   a. CTVPD detects the Source's Rp on one of its Charge-Through CC pins, detects VBUS for tCCDebounce and starts alternating between Unattached.SRC and Unattached.SNK
4. CTVPD transitions from Unattached.SRC to Try.SNK through AttachWait.SRC
   a. CTVPD in Unattached.SRC detects the CC pull-down of DRP which is in Unattached.SNK and CTVPD enters AttachWait.SRC
   b. CTVPD in AttachWait.SRC detects that pull down on CC persists for tCCDebounce and enters Try.SNK
   c. CTVPD disables Rp termination advertising Default USB Power on the Host-side port's CC
   d. CTVPD enables Rd on the Host-side port's CC
5. DRP in dead battery condition remains in Unattached.SNK
6. CTVPD transitions from Try.SNK to Attached.SRC through TryWait.SRC
   a. CTVPD didn't detect the CC pull-up of the DRP for tTryDebounce after tDRPTry and enters TryWait.SRC
   b. CTVPD disables Rd on the Host-side port's CC
   c. CTVPD enables Rp termination advertising Default USB Power on the Host-side port's CC
   d. CTVPD detects the CC pull-down of the DRP for tTryCCDebounce and enters Attached.SRC
   e. CTVPD connects VBUS from the Charge-Through side to the Host side
7. DRP transitions from Unattached.SNK to Attached.SNK through AttachWait.SNK
   a. DRP in Unattached.SNK detects the CC pull-up of CTVPD which is in Attached.SRC and DRP enters AttachWait.SNK
   b. DRP in AttachWait.SNK detects that pull up on CC persists for tCCDebounce, VBUS present and enters Attached.SNK

8. While the devices are all in their respective attached states:
    a. CTVPD monitors the Host-side port's CC pin for device attach and when detected, enters Unattached.SNK
    b. CTVPD monitors VBUS for Power Source detach and when detected, enters Unattached.SNK
    c. Power Source monitors CC for CTVPD detach and when detected, enters Unattached.SRC
    d. DRP monitors VBUS for CTVPD detach and when detected, enters Unattached.SNK
    e. Additionally, the DRP may query the identity of the cable via USB PD on SOP' when it has sufficient battery power and when a Charge-Through VPD is identified enters TryWait.SRC if implemented, or enters Unattached.SRC if TryWait.SRC is not supported

CASE 6: The following describes the behavior when a DRP is connected to a Charge-Through VCONN-Powered USB Device (abbreviated CTVPD) and a Sink is attached to the Charge-Through port on the CTVPD.

1. DRP, CTVPD and Sink are all in the unattached state
    a. DRP alternates between Unattached.SRC and Unattached.SNK
    b. CTVPD has applied Rd on its Charge-Through port's CC1 and CC2 pins and Rd on the Host-side port's CC pin
2. DRP transitions from Unattached.SRC to AttachWait.SRC to Attached.SRC
    a. DRP in Unattached.SRC detects the CC pull-down of CTVPD which is in Unattached.SNK and DRP enters AttachWait.SRC
    b. DRP in AttachWait.SRC detects that pull down on CC persists for tCCDebounce, enters Attached.SRC and turns on VBUS and VCONN
3. CTVPD transitions from Unattached.SNK to Attached.SNK through AttachWait.SNK.
    a. CTVPD detects the host-side CC pull-up of the DRP and CTVPD enters AttachWait.SNK
    b. CTVPD in AttachWait.SNK detects that pull up on the Host-side port's CC persists for tCCDebounce, VCONN present and enters Attached.SNK
    c. CTVPD present a high-impedance to ground (above zOPEN) on its Charge-Through port's CC1 and CC2 pins
4. While DRP and CTVPD are in their respective attached states, DRP discovers the Charge-Through CTVPD and transitions to CTUnattached.SNK
    a. DRP (as Source) queries the device identity via USB PD (Discover Identity Command) on SOP'.
    b. CTVPD responds on SOP', advertising that it is a Charge-Through VCONN-Powered USB Device
    c. DRP (as Source) removes VBUS
    d. DRP (as Source) changes its Rp to a Rd
    e. DRP (as Sink) continues to provide VCONN and enters CTUnattached.SNK
5. CTVPD transitions to CTUnattached.VPD
    a. CTVPD detects VBUS removal, VCONN presence, the low Host-side CC pin and enters CTUnattached.VPD
    b. CTVPD changes its host-side Rd to a Rp termination advertising 3.0 A
    c. CTVPD isolates itself from VBUS
    d. CTVPD apply Rd on its Charge-Through port's CC1 and CC2 pins
6. CTVPD alternates between CTUnattached.VPD and CTUnattached.Unsupported

   a. CTVPD detects SRC.open on its Charge-Through CC pins and starts alternating between CTUnattached.VPD and CTUnattached.Unsupported
7. CTVPD transitions from CTUnattached.Unsupported to CTTry.SNK through CTAttachWait.Unsupported
   a. CTVPD in CTUnattached.Unsupported detects the CC pull-down of the Sink which is in Unattached.SNK and CTVPD enters CTAttachWait.Unsupported
   b. CTVPD in CTAttachWait.Unsupported detects that pull down on CC persists for tCCDebounce and enters CTTry.SNK
   c. CTVPD disables Rp termination advertising Default USB Power on the Charge-Through port's CC pins
   d. CTVPD enables Rd on the Charge-Through port's CC pins
8. CTVPD transitions from CTTry.SNK to CTAttached.Unsupported
   a. CTVPD didn't detect the CC pull-up of the potential Source for tDRPTryWait after tDRPTry and enters CTAttached.Unsupported
9. While the CTVPD in CTAttached.Unsupported state, the DRP in CTUnattached.SNK state and the Sink in Unattached.SNK state:
   a. CTVPD disables the Rd termination on the Charge-Through port's CC pins and applies Rp termination advertising Default USB Power
   b. CTVPD exposes a USB Billboard Device Class to the DRP indicating that it is connected to an unsupported device on its Charge Through port
   c. CTVPD monitors Charge-Though CC pins for Sink detach and when detected, enters CTUnattached.VPD
   d. CTVPD monitors VCONN for Host detach and when detected, enters Unattached.SNK
   e. DRP monitors CC for CTVPD detach for tVPDDetach and when detected, enters Unattached.SNK
   f. DRP monitors VBUS for CTVPD Charge-Through source attach and, when detected, enters CTAttached.SNK

(aq). Section 4.6.2.5, VPD Charge-Through current

Add section:

4.6.2.5 VPD Charge-Through current limitations

Since Charge-Through VCONN-Powered USB Devices implement charging by passively connecting the Source's CC and VBUS to the Host, the VCONN-Powered USB Device is effectively increasing the impedance on VBUS, GND, and CC between the Power Source and the Host, resulting in impedances that can exceed the maximum allowed for cables. To avoid communication issues and false disconnects from the increased GND and VBUS drops, the following shall occur:

1. The Charge-Through VCONN-Powered USB Device shall report its worst-case GND and VBUS impedance (including the extra mated connector pair and FETs) in its Discover Identity Command response on SOP'.
2. The Host that supports VPD Charge-Through shall use this information, along with inferred information about the cable, to limit its maximum current in the case where the Power Source advertises a current greater than what VPD Charge-Through would allow.

The Host has no way to query the cable, as its VCONN source is consumed by the VCONN-Powered USB Device. Instead, the Host may assume the cable is 5A for the purposes of calculating the

Charge-Through current limit only if it receives a USB PD SourceCapability PDO of greater than 3A (even if the Host ultimately does not Request that PDO, or if the host requests a current of 3A or less).

The Host shall further limit its maximum current beyond that advertised by the Power Source, based on the reported GND impedance and the inferred cable capability. GND impedance is reported in the VPD Discover Identity Command Response in 1-milliohm steps and is used in the following formulas:

- GND-limited current with a 3A cable inferred = 0.25V / (0.25V / 3A + VPD_GND_DCR)
- GND-limited current with a 5A cable inferred = 0.25V / (0.25V / 5A + VPD_GND_DCR)

Some examples are in Table 4-A.

Table 4-A Example VPD Charge-Through Sink Maximum Currents based on GND Impedance

Reported GND Impedance	3A Cable Inferred[1]	5A Cable Inferred[2]
0.010Ω	2.679A	4.167A
0.015Ω	2.542A	3.846A
0.020Ω	2.419A	3.571A
0.025Ω	2.308A	3.333A
0.030Ω	2.206A	3.125A
0.035Ω	2.113A	2.941A
0.040Ω	2.027A	2.778A

Notes:
1. As calculated by 0.25V / (0.25V / 3A + VPD_GND_DCR)
2. As calculated by 0.25V / (0.25V / 5A + VPD_GND_DCR)

In addition, the increased VBUS impedance could result in a greater than 1V VBUS drop as measured at the input to the Host. Based on the VBUS impedance reported in the VPD Discover Identity Command Response in 2-milliohm steps and the inferred cable capability, the Host shall either lower its VBUS detach threshold or further limit its maximum current based on the following formulas:

- VBUS and GND-limited current with a 3A cable inferred = 0.75V / (0.75V / 3A + VPD_VBUS_DCR + VPD_GND_DCR)
- VBUS and GND-limited current with a 5A cable inferred = 0.75V / (0.75V / 5A + VPD_VBUS_DCR + VPD_GND_DCR)

Table 4-B Example VPD Charge-Through Sink Maximum Currents based on VBUS impedance and GND Impedance

Reported VBUS Impedance	Reported GND Impedance	3A Cable Inferred[1]	5A Cable Inferred[2]

0.020Ω	0.010Ω	2.679A	4.167A
0.030Ω	0.015Ω	2.542A	3.846A
0.040Ω	0.020Ω	2.419A	3.571A
0.050Ω	0.025Ω	2.308A	3.333A
0.060Ω	0.030Ω	2.206A	3.125A
0.070Ω	0.035Ω	2.113A	2.941A
0.080Ω	0.040Ω	2.027A	2.778A

Notes:
1. As calculated by 0.75V / (0.75V / 3A + VPD_VBUS_DCR + VPD_GND_DCR)
2. As calculated by 0.75V / (0.75V / 5A + VPD_VBUS_DCR + VPD_GND_DCR)
3. Table does not show all allowable combinations, only a subset provided for illustration.

(ar). Section 4.10.2 VCONN-Powered, Page 196

From Text:

4.10.2 VCONN-Powered USB Devices (VPDs)

A VCONN-Powered USB Device shall implement a USB UFP endpoint.

VCONN-Powered USB Devices shall comply with Table 4-8.

When VBUS is not present, VCONN-Powered USB Devices shall treat the application of VCONN as an attach signal.

A VCONN-powered USB Device shall only respond to USB PD messaging on SOP'.

When VBUS is supplied, the VCONN-Powered USB Device shall behave like a normal UFP Sink, but still only respond to USB PD messaging on SOP'. If VBUS is subsequently removed while VCONN remains applied, the VCONN-Powered USB Device shall remain connected, and use VCONN as the sole detach signal.

Since VCONN-Powered USB Devices do not respond to USB PD on SOP, they cannot enter traditional alternate modes.

To Text:

4.10.2 VCONN-Powered USB Devices (VPDs)

A VCONN-Powered USB Device shall implement a USB UFP endpoint.

VCONN-Powered USB Devices shall comply with Table 4-8.

When VBUS is not present, VCONN-Powered USB Devices shall treat the application of VCONN as an attach signal.

A VCONN-powered USB Device shall only respond to USB PD messaging on SOP'.

A Charge-Through VCONN-Powered USB Device shall discard all USB PD messages while a connection is enabled between the host port CC and Charge-Through port CC.

When VBUS is supplied by the Host, the VCONN-Powered USB Device shall behave like a normal UFP Sink, but still only respond to USB PD messaging on SOP'. If VBUS is subsequently removed while VCONN remains applied, the VCONN-Powered USB Device shall remain connected, and use VCONN as the sole detach signal.

Since VCONN-Powered USB Devices do not respond to USB PD on SOP, they cannot enter traditional alternate modes.

A VCONN-Powered USB Device may provide Charge-Through functionality via VPD Charge-Through. VCONN-Powered USB Devices shall not provide any data pass-through to the Charge-Through port other than the CC wire.

Since the power and CC negotiation is passed through directly, the Sink shall limit its maximum current based on the additional impedance introduced by the VCONN-Powered USB Device.

Additionally, since power can only flow from the Charge-Through port to the Host, VCONN must be provided by the host, and there is no data connection beyond the CC wire passed through to the connected source, there are limitations on what the Host can advertise and support via USB PD:

- The Host shall not negotiate or accept a PR_Swap or VCONN_Swap
- The Host shall not enable FR_Swap
- The Host may only negotiate a DR_Swap when using USB PD 2.0, and only for the purpose of switching which side is the PD bus master. The Host will always remain a DFP for USB data.
- The Host shall not advertise dual-role data or dual-role power in its SourceCapability or SinkCapability messages – Host changes its advertised capabilities to UFP role/sink only role.
- The Host shall not negotiate any USB PD Alternate Modes that change the function of pins on the connector.
- The Host shall represent itself to the Charge-Through Source using USB PD as if it were a Sink-only, data-less device.

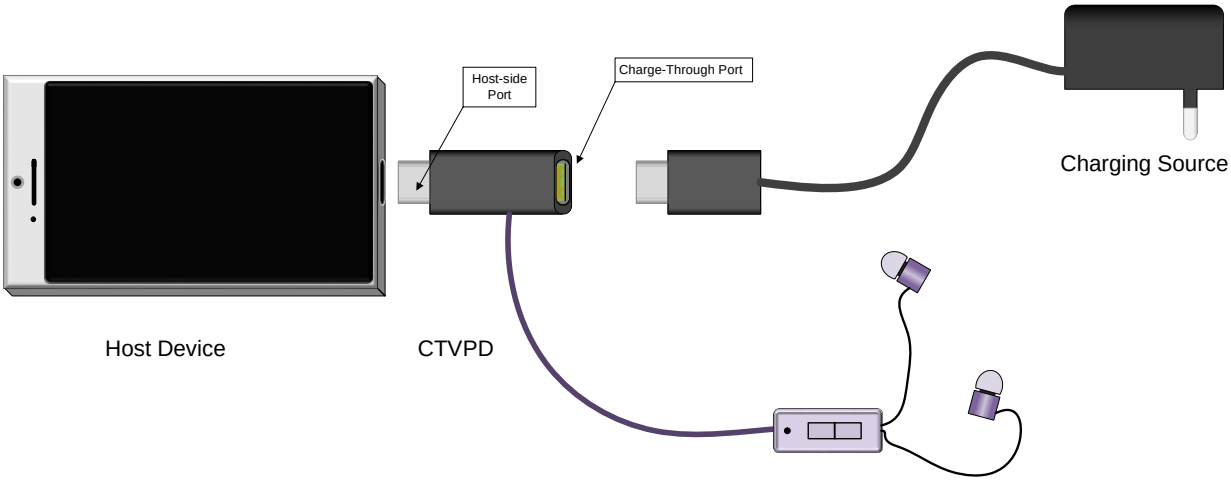
Table 4-C Charge-Through VPD CC Impedance (RccCON) Requirements

	Minimum	Maximum	Description
RccCON		15Ω	Impedance in the Charge-Though VPD while a connection is enabled between the host port CC and Charge-Through port CC.
	zOPEN		Impedance between the host port CC and Charge-Through CC when a connection is disabled

Table 4-D Charge-Through VPD Charge-Through Port VBUS bypass Requirements

	Minimum	Maximum	Description
C_{CTB}	1uF	10uF	Bypass capacitance on Charge-Through port VBUS connection to support ADP max C_{ADP_THR}

Figure 4-C Example Charge-Through VCONN-Powered USB Device Use Case



(as). Section 4.11.2, Timing Parameters, Page 200

Add Row to Table 4-26:

	Minimum	Maximum	Description
tVPDDetach	10ms	20ms	Time for a DRP to detect that the connected Charge-Through VCONN-Powered USB Device has been detached, after VBUS has been removed.

Add Row to Table 4-27:

	Minimum	Maximum	Description
tVPDCTDD	30µs	5ms	Time for a Charge-Through VCONN-Powered USB Device to detect that the Charge-Through source has disconnected from CC after VBUS has been removed, transition to CCUnattached.VPD, and re-apply its Rp termination advertising 3.0 A on the host port CC.

tVPDDisable	25ms		Time for a Charge-Through VCONN-Powered USB Device shall remain in CTDisabled.VPD state

(at). Section 3.7.2.3, Table 3-24 Coupling Matrix for Low Speed Signals, Page 88

Modified Row:

Coupling Matrix	D- (SE)	D+/D- (DF)	VBUS	SBU_B/SBU_A (SE)
CC	FF, CT	FF, CT	FF, CT, CTVPD	FF

Modify Footnote:

DF: Differential; FF: Full-featured cable; CT: Charge-through cable (including USB 2.0 function); CTVPD: Charge-Through VCONN-Powered USB Device.