USB Type-C ENGINEERING CHANGE NOTICE

Title: VCONN-powered USB Devices

Applied to: USB Type-C Specification Release 1.2

Brief description of the functional changes proposed:
Defines a 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:
VPDs can be powered from either VCONN, which may be a lower voltage than VBUS, or VBUS itself. These devices benefit from lower overall system power, which is critical for extended usage of mobile accessories such as headphones, keyboards, gamepads and credit card readers.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
None. VPDs will work normally as basic USB devices. Hosts that implement PD can update their firmware to detect the VPDs, although some implementations may not be flexible enough to fully take advantage of the power savings.

An analysis of the hardware implications:
None. Single-chip accessory designs that want to be a VPD will need to add an eMarker to their silicon, which is estimated to be a 10% silicon area increase to common USB device class implementations.

An analysis of the software implications:
Additional states are needed for hosts that wish to take advantage of VPDs. 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.

Actual Change Requested

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

From Text:

Vconn-powered accessory	An accessory that is powered from VCONN to operate in an Alternate Mode

To 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.
Vconn-powered accessory (VPA)	An accessory that is powered from VCONN to operate in an Alternate Mode. VPAs cannot implement the charge-through mechanism described for VPDs, and instead must intermediate by negotiating USB Power Delivery with both the connected host and source in order to enable similar functionality
Vconn-powered USB device (VPD)	A USB device that can be powered solely from either Vconn or Vbus. VPDs may optionally support the VPD charge-through capability

(b). Section 4.4.3, Vconn

Based on Type-C ECN Vconn for Power Adapters, section (a).

Table 4-3, Vconn Source Requirements:

D+/D-	**SSTX/SSRX, VPD**	**> 3A VCONN**	**Requirements**
No	No	No	Not required to source VCONN
Yes	No	No	Not required to source VCONN
Yes	Yes	No	Required to source 1W. VCONN power may be removed after the source has read the cable's eMarker and has determined that it is not an active cable nor a VPD.
No	No	Yes	Required to source 100mW. VCONN power may be removed after the source has read the cable's eMarker

			and has determined the cable's current carrying capacity.
Yes	No	Yes	Required to source 100mW. VCONN power may be removed after the source has read the cable's eMarker and has determined the cable's current carrying capacity.
Yes	Yes	Yes	Required to source 1W. VCONN power may be removed after the source has read the cable's eMarker and has determined the cable's current carrying capacity and that it is not an active cable nor a VPD.

Table 4-4, Vconn Source Characteristics:

	Minimum	Maximum	Notes
Voltage	3.0 V	5.5 V	
Power for Sources with SuperSpeed Signals or VPD support	1.0 W		Source may latch-off VCONN if excessive power is drawn beyond the specified inrush and mode wattage Source may disable VCONN per Table 4-3 Alternate modes may require higher power.
Power for Sources in USB Suspend or without SuperSpeed Signals	100mW		Minimum power Source must provide in USB Suspend or without SuperSpeed signals Source may disable VCONN per Table 4-3
Bulk Capacitance	10 µF	220 µF	The VCONN source shall disconnect the bulk capacitance from the receptacle when VCONN is powered off.

Append to section:

Table 4-A VCONN Powered USB Device Sink Characteristics

	Minimum	Maximum	Notes
Voltage	3.0V	5.5V	Voltage range at which this Table applies
Inrush Capacitance		10µF	A VPD shall not present more than the equivalent inrush capacitance to the VCONN source. The VPD is responsible for discharging its capacitance when detached from a port.

Power before USB enumeration		35mW	Maximum power in USB suspend
Power when active		500 mW (USB2) 750 mW (USB3)	A VPD shall only expose a low-power interface over USB.
tVCONNDischarge		230ms	Time from VPD disconnect to vVCONNDischarge met.
vVCONNDischarge		800mV	VCONN voltage after tVCONNDischarge
vRaReconnect	800mV		Voltage at which the VPD shall reapply Ra on the falling edge of VCONN.
vVCONNDisconnect	800mV	2.4V	Threshold used to detect VCONN disconnect.

The VPD shall remove or weaken Ra when VCONN is in the valid voltage range.
The VPD shall reapply Ra when VCONN falls below vRaReconnect as defined in Table 4-A. The VPD shall take into account the VCONN capacitance present in the device when discharging VCONN.

(c). Section 4.5.1.2.1, Table 4-7, Port state from source perspective

From Text:

Powered cable with Sink or Vconn-powered Accessory attached

To Text:

Powered cable with Sink, Vconn-powered Accessory (VPA), or Vconn-powered USB Device (VPD) attached

(d). Section 4.5.1.2.1, Table 4-8, Source/sink behaviors by state

From Text:

Powered cable with Sink or Vconn-powered Accessory attached	•Sense CC for orientation •Sense CC for detach •Apply VBUS and VCONN	•If accessories are supported, see Source Behavior with exception that VBUS is not applied., otherwise, N/A.

To Text:

Powered cable with Sink, Vconn-powered Accessory, or Vconn-powered USB Device attached	•Sense CC for orientation •Sense CC for detach •Apply VBUS and VCONN •Detect VPD and remove VBUS	•If accessories or VPDs are supported, see Source Behavior with exception that VBUS is not applied., otherwise, N/A.

(e). Section 4.5.2.2.4.2 Exiting from AttachWait.SNK state, Page 142

From Text:

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.

To Text:

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.

(f). Section 4.5.2.2.5.1, Attached.SNK Requirements, Page 143

From Text:

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

To Text:

If the port is a Vconn-powered USB Device, it shall respond to USB PD cable 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.

(g). Section 4.5.2.2.5.2, Exiting from Attached.SNK, Page 143

From Text:

A port that is not in the process of a USB PD PR_Swap or a USB PD Hard Reset shall transition to Unattached.SNK when [...]

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 shall transition to Unattached.SNK when [...]

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

(h). Section 4.5.2.2.8.1, Attached.SRC Requirements, Page 145

From Text:

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

To Text:

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.

(i). Section 4.5.2.2.19, PoweredAccessory State, Page 150

From Text:

When in the PoweredAccessory state, the port is powering a VCONN–Powered Accessory.

To Text:

When in the PoweredAccessory state, the port is powering a VCONN–powered accessory or Vconn-powered USB Device.

(j). Section 4.5.2.2.19.1, PoweredAccessory Reqs, Page 151

From Text:

The port shall use USB Power Delivery Structured Vendor Defined Messages (Structured VDMs) to identify the accessory and enter an Alternate Mode.

To Text:

The port shall do at least one of the following:

1. Use USB Power Delivery Structured Vendor Defined Messages (Structured VDMs) to identify the accessory and enter an Alternate Mode.
2. Use USB Power Delivery to query the identity of the cable to confirm that it is connected to a Vconn-powered USB Device. The port may also initiate other SOP' communication, such as to update the VPD firmware.

(k). Section 4.5.2.2.19.2, Exiting from PoweredAccessory, Page 151

From Text:

The port shall transition to Try.SNK if the attached device is not a VCONN–Powered Accessory. 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.

To Text:

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.

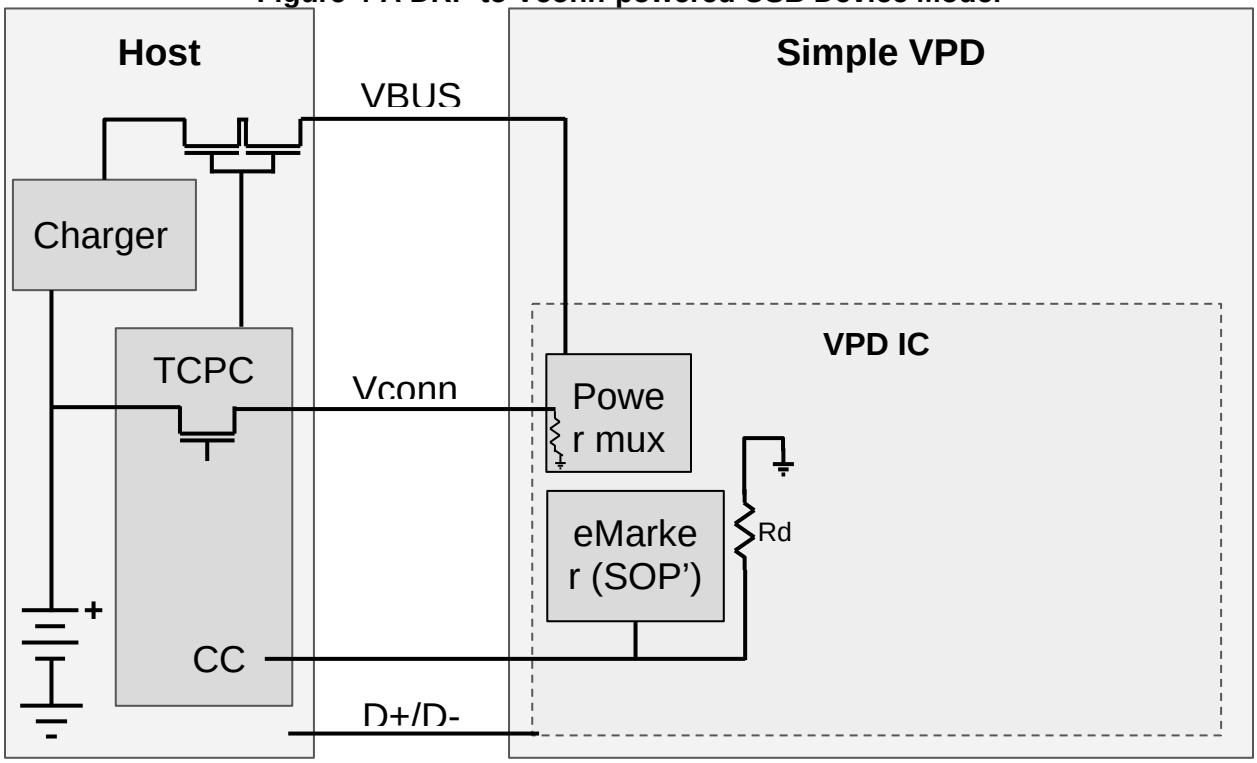
(L). Section 4.5.3.1.7, DRP to VPD behavior, Page 162

Add Section:

4.5.3.1.7 DRP to Vconn-powered USB Device Behavior

Figure 4-A illustrates the functional model for a DRP connected to a Vconn-powered USB Device that does not feature Charge-through.

Figure 4-A DRP to Vconn-powered USB Device Model



The following describes the behavior when a DRP that supports Vconn-powered USB devices is connected to a Vconn-powered USB Device (abbreviated VPD).

1. DRP and VPD in the unattached state
    - DRP alternates between Unattached.SRC and Unattached.SNK
2. DRP transitions from Unattached.SRC to AttachWait.SRC to Attached.SRC
    - DRP in Unattached.SRC detects the CC pull-down of VPD which is in Unattached.SNK and DRP enters AttachWait.SRC
    - DRP in AttachWait.SRC detects that pull down on CC persists for tCCDebounce. It then enters Attached.SRC and turns on VBUS and Vconn
3. VPD transitions from Unattached.SNK to Attached.SNK through AttachWait.SNK.
    - VPD detects Vconn and enters Attached.SNK
4. While DRP and VPD are in their respective attached states, DRP discovers the VPD and removes VBUS
    - DRP (as Source) queries the cable identity via USB PD on SOP'.
    - VPD responds on SOP', advertising that it is a Vconn-powered USB Device that does not support Charge-through
    - DRP (as Source) removes VBUS
    - DRP (as Source) maintains its Rp
5. DRP and VPD for detach
    - DRP (as Source) monitors CC for detach and when detected, enters Unattached.SNK (and resumes toggling between Unattached.SNK and Unattached.SRC)
    - VPD monitors Vconn for detach and when detected, enters Unattached.SNK

(m). Section 4.10 Vconn-powered, Page 176

From Text:

4.10 VCONN-Powered Accessories

A VCONN-powered accessory is a direct-attach Sink that implements an Alternate Mode (See Section 5.1) and can be powered from VCONN.

The VCONN-powered accessory exposes a maximum impedance to ground of Ra on the VCONN pin and Rd on the CC pin.

When operating in the UFP role and when VBUS is not present, VCONN-powered accessories shall treat the application of VCONN as an attach signal, and shall respond to USB Power Delivery messages.

When powered by only VCONN, a VCONN-powered accessory shall negotiate an Alternate Mode. If it fails to negotiate an Alternate Mode within tAMETimeout, its port partner removes VCONN.

VCONN-powered accessories shall be able to operate over a range of 2.7 V to 5.5 V on VCONN. The removal of VCONN when VBUS is not present shall be treated as a detach event.

When VBUS is supplied, a VCONN-powered accessory is subject to all of the requirements for Alternate Modes, including presenting a USB Billboard Device Class interface if negotiation for an Alternate Mode fails.

To Text:

4.10 VCONN-Powered Accessories and Vconn-powered USB Devices

Vconn-powered accessories and Vconn-powered USB Devices are both direct-attach Sinks that can operate with just Vconn.

Both expose a maximum impedance to ground of Ra on the Vconn pin and Rd on the CC pin.

Both shall be able to operate in the VCONN voltage range specified in Table 4-A. The removal of VCONN when VBUS is not present shall be treated as a detach event.

4.10.1 Vconn-Powered Accessories

A VCONN-powered accessory implements an Alternate Mode (See Section 5.1).

When operating in the UFP role and when VBUS is not present, VCONN-powered accessories shall treat the application of VCONN as an attach signal, and shall respond to USB Power Delivery messages.

When powered by only VCONN, a VCONN-powered accessory shall negotiate an Alternate Mode. If it fails to negotiate an Alternate Mode within tAMETimeout, its port partner shall remove VCONN.

When VBUS is supplied, a VCONN-powered accessory is subject to all of the requirements for Alternate Modes, including presenting a USB Billboard Device Class interface if negotiation for an Alternate Mode fails.

Should a Vconn-powered accessory wish to provide Charge-through functionality, it must do so by negotiating voltage and current independently on both the Host and Charge-through ports, and possibly re-regulating the voltage from the Source before passing it through to the Sink. The Sink is able to take the full current that is advertised to it by the Vconn-powered accessory.

4.10.2 Vconn-powered USB Devices

A Vconn-powered USB Device shall implement a USB UFP endpoint.

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

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

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.