

USB Type-C ENGINEERING CHANGE NOTICE

Title: Source VCONN Discharge

Applied to: USB Type-C Specification Release 1.2

Brief description of the functional changes:

- 1) Add a new state, UnattachedWait.SRC, to the Source Connection State Diagram. No change is required to any other host/device state diagrams. A Source that was providing VCONN in the previous Attached.SRC state will transition from Attached.SRC to UnattachedWait.SRC. A source that was not providing VCONN shall transition to Unattached.SRC. In UnattachedWait.SRC, the source will complete the VCONN turn off and discharge the CC pin that was providing VCONN in the previous Attached.SRC state. The Source exits UnattachedWait.SRC when both the CC pin being discharged is below vVCONNDischarge and VCONN is turned off.
- 2) Modify VCONN Source Bulk Capacitance requirement to be similar to how the VBUS bypass capacitance is specified in USB 2.0 and 3.1.
- 3) Remove degenerate condition, under Table 4-4, for not supplying VCONN.

Benefits as a result of the changes:

- 1) There is an operability issue with cables that weaken R_a when connected to a port that employs the Source Connection State Diagram. The problem sequence is as follows: 1) The Source is connected to a Sink with a cable that weakens R_a when VCONN is applied. 2) The Source sees a Sink detach while the cable remains attached to the Source port. 3) The Source transitions to Unattached.SRC, removes VCONN and applies R_p to both CC pins. The R_p connected to the weakened cable R_a is strong enough to keep the cable from discharging its VCONN pin to the level needed to reset R_a to full strength. 4) Instead of the Source CC pin, connected to the cable VCONN pin, getting pulled below v_{Ra} (SRC. R_a), it instead hangs at a voltage within the v_{Rd} range (SRC. R_d) or above v_{OPEN} (SRCpen). 5) Since the port sees the wrong CC pin state, it no longer operates as expected. 6) For example, if the Source interprets the cable VCONN pin as a SRC. R_d , while the other end of the cable is detached, it will wrongly transition to Attached.SRC, apply VBUS, and report an incorrect super-speed line polarity. This state will persist until the cable is detached from the Source.
- 2) Note that this problem does not affect DRPs since a DRP goes to Unattached.SNK when it is in Attached.SRC and sees a Sink detach. The DRP will then apply an R_d to both CC pins which will discharge the cable VCONN pin.
- 3) This ECR will require the Source to turn off VCONN and discharge the CC pin, that was providing VCONN in the previous Attached.SRC state, to allow the cable to reset R_a to full strength before the Source identifies the electrical state of its CC pins.
- 4) To maintain operability with a connected port that uses Try.SRC Support, the Source in UnattachedWait.SRC must maintain a valid R_p connection on the CC pin connected through the cable.
- 5) The VCONN and VBUS bypass capacitance will be specified in a consistent manner.
- 6) A degenerate condition under Table 4-4 will be removed.

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An assessment of the impact to the existing revision and systems that currently conform to the USB specification:

- 1) Many existing Type-C Source controllers will be non-compliant with these changes. Most controllers do not currently have the ability to discharge the CC pins to the new discharge requirements. All hardware based controllers will not have the new UnattachedWait.SRC state.

An analysis of the hardware implications:

- 1) Non-compliant Type-C controllers will need to be redesigned to add the CC discharge function. Hardware based controllers will need to be redesigned to add the new UnattachedWait.SRC state.

An analysis of the software implications:

None

An analysis of the compliance testing implications:

- 1) Add a test to confirm that the source goes from Attached.SRC to UnattachedWait.SRC when the source is providing VCONN in Attached.SRC
- 2) Add a test to confirm that a valid Rdch termination is provided in UnattachedWait.SRC on the CC pin that was providing VCONN in the previous Attached.SRC state.
- 3) Add a test to confirm that a valid Rp termination is provided in UnattachedWait.SRC on the CC pin that was connected through the cable in the previous Attached.SRC state.
- 4) Add a test to confirm the pin being discharged is discharged below vVconnDischarge before exiting UnattachedWait.SRC.
- 5) Add a test to confirm VCONN is no longer supplied after leaving UnattachedWait.SRC.

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Actual Change

(a). Section 4.4.3 Vconn, Page 119

From Text:

Table 4-4 VCONN Source Characteristics

	Minimum	Maximum	Notes
Voltage	4.75 V	5.5 V	Ports that support VCONN-powered accessories are allowed to supply at a lower minimum of 2.7 V when operating in the Powered.Accessory state.
Power	1.0 W		Source may latch-off VCONN if excessive power is drawn beyond the specified inrush and mode wattage.
Bulk Capacitance	10 μ F	220 μ F	The VCONN source shall disconnect the bulk capacitance from the receptacle when VCONN is powered off.

To aid in reducing the power associated with supplying VCONN, a Source is allowed to either not source VCONN or turn off Vconn under any of the following conditions:

- Ra is not detected on the CC pin after tCCDebounce when the other CC pin is in the SRC.Rd state
- Ra is not detected on the CC pin after tCCDebounce when the other CC pin is in the SRC.Open state and the port supports VCONN-powered accessories
- If there is no GoodCRC response to *USB PD* Discover Identity messages

To Text:

Table 4-4 VCONN Source Characteristics

	Minimum	Maximum	Notes
Voltage	4.75 V	5.5 V	Ports that support VCONN-powered accessories are allowed to supply at a lower minimum of 2.7 V when operating in the Powered.Accessory state.
Power	1.0 W		Source may latch-off VCONN if excessive power is drawn beyond the specified inrush and mode wattage.
Bulk Capacitance	10 μF	220 μF	The VCONN source shall disconnect the bulk capacitance from the receptacle when VCONN is powered off.
Rdch	30 Ω	6120 Ω	Discharge resistance applied in UnattachedWait.SRC between the CC pin being discharged and GND.

To aid in reducing the power associated with supplying VCONN, a Source is allowed to either not source VCONN or turn off V~~CONN~~ under any of the following conditions:

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- Ra is not detected on the CC pin after tCCDebounce when the other CC pin is in the SRC.Rd state
- ~~Ra is not detected on the CC pin after tCCDebounce when the other CC pin is in the SRC.Open state and the port supports VCONN-powered accessories~~
- If there is no GoodCRC response to *USB PD* Discover Identity messages

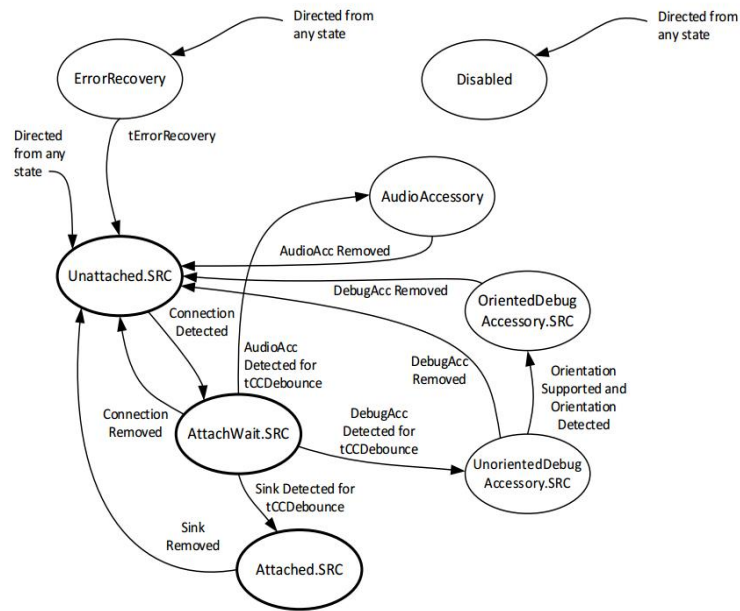
If the power source used to supply VCONN power is a shared power source for other USB VCONN and VBUS outputs, it must be bypassed with capacitance identical to the VBUS capacitance requirements of USB 3.1 Section 11.4.4 - Dynamic Attach and Detach. Any VCONN power source bypass capacitance must be isolated from the CC pins when VCONN is not being provided.

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(b). Section 4.5.2.1 Connection State Diagrams, Figure 4-12, Page 134

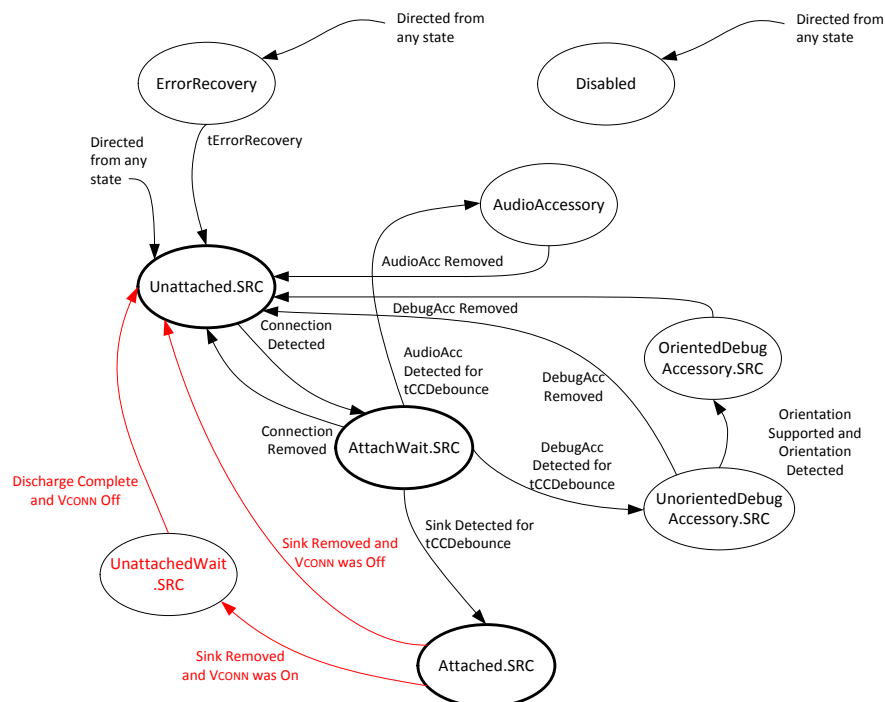
From Figure:

Figure 4-12 Connection State Diagram: Source



To Figure:

Figure 4-12 Connection State Diagram: Source



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(c). Section 4.5.2.2.8.2 Exiting from Attached.SRC State, Page 145

From Text:

A Source shall transition to Unattached.SRC when the SRC.Open state is detected on the monitored CC pin.

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.

A Source that is not supplying VCONN shall transition to Unattached.SRC when the SRC.Open state is detected on the monitored CC pin.

(d). Add new UnattachedWait.SRC section

New Text:

4.5.2.2.9 UnattachedWait.SRC State

This state appears in Figure 4-12.

When in the UnattachedWait.SRC state, the port is discharging the CC pin that was providing VCONN in the previous Attached.SRC state.

4.5.2.2.9.1 UnattachedWait.SRC Requirements

The port shall not enable VBUS or VCONN.

The port shall complete the VCONN turn off initiated when leaving the previous Attached.SRC state.

The port shall continue to provide an Rp termination, as specified in Table 4-14, on the CC pin not being discharged.

The port shall not provide an Rp termination on the CC pin being discharged.

The port shall provide an Rdch termination, as specified in Table 4-4, on the CC pin being discharged.

The port shall discharge the CC pin being discharged below vVCONNDischarge.

4.5.2.2.9.2 Exiting from UnattachedWait.SRC

The port shall transition to Unattached.SRC when both the CC pin is below vVCONNDischarge and VCONN is turned off.

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(f). Section 4.5.2.4 Connection States Summary, Page 154

From Text:

4.5.2.4 Connection States Summary

Table 4-13 defines the mandatory and optional states for each type of port.

Table 4-13 Mandatory and Optional States

	DFP	UFP	DRP	USB PD Communication
<u>Disabled</u>	Optional	Optional	Optional	Not Permitted
<u>ErrorRecovery</u>	Optional	Optional	Optional	Not Permitted
<u>Unattached.SNK</u>	N/A	Mandatory	Mandatory	Not Permitted
<u>AttachWait.SNK</u>	N/A	Mandatory ¹	Mandatory	Not Permitted
<u>Attached.SNK</u>	N/A	Mandatory	Mandatory	Permitted
<u>Unattached.SRC</u>	Mandatory	N/A	Mandatory	Not Permitted
<u>AttachWait.SRC</u>	Mandatory	N/A	Mandatory	Not Permitted
<u>Attached.SRC</u>	Mandatory	N/A	Mandatory	Permitted
<u>Try.SRC</u> ⁴	N/A	N/A	Optional	Not Permitted
<u>TryWait.SNK</u> ²	N/A	N/A	Optional	Not Permitted
<u>Try.SNK</u> ⁴	N/A	N/A	Optional	Not Permitted
<u>TryWait.SRC</u> ⁵	N/A	N/A	Optional	Not Permitted
<u>AudioAccessory</u>	Optional	Optional	Optional	Not Permitted
<u>UnorientedDebugAccessory.SRC</u>	Optional ⁶	N/A	Optional ⁶	Not Permitted
<u>OrientedDebugAccessory.SRC</u>	Optional ⁶	N/A	Optional ⁶	Permitted
<u>DebugAccessory.SNK</u>	N/A	Optional	Optional	Permitted
<u>Unattached.Accessory</u>	N/A	Optional	N/A	Not Permitted
<u>AttachWait.Accessory</u>	N/A	Optional	N/A	Not Permitted
<u>Powered.Accessory</u>	N/A	Optional	N/A	Permitted
<u>Unsupported.Accessory</u> ³	N/A	Optional	N/A	Not Permitted
<u>PowerDefault.SNK</u>	N/A	Mandatory	Mandatory	Permitted
<u>Power1.5.SNK</u>	N/A	Optional	Optional	Permitted
<u>Power3.0.SNK</u>	N/A	Optional	Optional	Permitted

Note:

- Optional for UFP applications that are USB 2.0-only, consume USB Default Power and do not support *USB PD* or accessories.
- TryWait.SNK is mandatory when Try.SRC is supported.
- Unsupported.Accessory is mandatory when PoweredAccessory is supported.
- Try.SRC and Try.SNK shall not be supported at the same time, although an unattached device may dynamically choose between Try.SRC and Try.SNK state machines based on external factors.
- TryWait.SRC is mandatory when Try.SNK is supported.
- UnorientedDebugAccessory.SRC is required for any Source or DRP that supports Debug Accessory Mode. OrientedDebugAccessory.SRC is only required if orientation detection is necessary in Debug Accessory Mode.

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4.5.2.4 Connection States Summary

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<u>Disabled</u>	Optional	Optional	Optional	Not Permitted
<u>ErrorRecovery</u>	Optional	Optional	Optional	Not Permitted
<u>Unattached.SNK</u>	N/A	Mandatory	Mandatory	Not Permitted
<u>AttachWait.SNK</u>	N/A	Mandatory ¹	Mandatory	Not Permitted
<u>Attached.SNK</u>	N/A	Mandatory	Mandatory	Permitted
<u>Unattached.SRC</u>	Mandatory	N/A	Mandatory	Not Permitted
<u>AttachWait.SRC</u>	Mandatory	N/A	Mandatory	Not Permitted
<u>Attached.SRC</u>	Mandatory	N/A	Mandatory	Permitted
<u>UnattachedWait.SRC</u>	Mandatory or N/A ⁷	N/A	N/A	Not Permitted
<u>Try.SRC</u> ⁴	N/A	N/A	Optional	Not Permitted
<u>TryWait.SNK</u> ²	N/A	N/A	Optional	Not Permitted
<u>Try.SNK</u> ⁴	N/A	N/A	Optional	Not Permitted
<u>TryWait.SRC</u> ⁵	N/A	N/A	Optional	Not Permitted
<u>AudioAccessory</u>	Optional	Optional	Optional	Not Permitted
<u>UnorientedDebugAccessory.SRC</u>	Optional ⁶	N/A	Optional ⁶	Not Permitted
<u>OrientedDebugAccessory.SRC</u>	Optional ⁶	N/A	Optional ⁶	Permitted
<u>DebugAccessory.SNK</u>	N/A	Optional	Optional	Permitted
<u>Unattached.Accessory</u>	N/A	Optional	N/A	Not Permitted
<u>AttachWait.Accessory</u>	N/A	Optional	N/A	Not Permitted
<u>Powered.Accessory</u>	N/A	Optional	N/A	Permitted
<u>Unsupported.Accessory</u> ³	N/A	Optional	N/A	Not Permitted
<u>PowerDefault.SNK</u>	N/A	Mandatory	Mandatory	Permitted
<u>Power1.5.SNK</u>	N/A	Optional	Optional	Permitted
<u>Power3.0.SNK</u>	N/A	Optional	Optional	Permitted

Note:

1. Optional for UFP applications that are USB 2.0-only, consume USB Default Power and do not support *USB PD* or accessories.

2. TryWait.SNK is mandatory when Try.SRC is supported.

3. Unsupported.Accessory is mandatory when PoweredAccessory is supported.

4. Try.SRC and Try.SNK shall not be supported at the same time, although an unattached device may dynamically choose between Try.SRC and Try.SNK state machines based on external factors.

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5. TryWait.SRC is mandatory when Try.SNK is supported.

6. UnorientedDebugAccessory.SRC is required for any Source or DRP that supports Debug Accessory Mode. OrientedDebugAccessory.SRC is only required if orientation detection is necessary in Debug Accessory Mode.

7. **Mandatory for a DFP that was providing VCONN in the previous Attached.SRC state. N/A for a DFP that was not providing VCONN in the previous Attached.SRC state.**

(e). Section 4.11.2 Timing Parameters, Table 4-20, Page 179

From Text:

4.11.2 Timing Parameters

Table 4-20 provides the timing values that shall be met for delivering power over VBUS and VCONN.

Table 4-20 VBUS and VCONN Timing Parameters

	Minimum	Maximum	Notes
tVBUSON	0 ms	275 ms	From entry to Attached.SRC until VBUS reaches the minimum vSafe5V threshold as measured at the source's receptacle.
tVBUSOFF	0 ms	650 ms	From the time the Sink is detached until the Source removes VBUS and reaches vSafe0V (See <i>USB PD</i>).
tVCONNON	Note 1	2 ms	From the time the Source supplied VBUS in the Attached.SRC state. Measured from vSafe5V to the minimum VCONN voltage (see Table 4-4)
tVCONNON-PA	0 ms	100 ms	From the time a Sink with accessory support enters the PoweredAccessory state until the Sink sources minimum VCONN voltage (see Table 4-4)
tVCONN OFF	0 ms	35 ms	From the time that a Sink is detached or as directed until the VCONN supply is disconnected and bulk capacitance is removed.
tSinkAdj	tPDDebounce	60 ms	Response time for a Sink to adjust its current consumption to be in the specified range due to a change in USB Type-C Current advertisement

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4.11.2 Timing Parameters

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Table 4-20 VBUS and VCONN Timing Parameters

	Minimum	Maximum	Notes
tVBUSON	0 ms	275 ms	From entry to Attached.SRC until VBUS reaches the minimum vSafe5V threshold as measured at the source's receptacle.
tVBUSOFF	0 ms	650 ms	From the time the Sink is detached until the Source removes VBUS and reaches vSafe0V (See <i>USB PD</i>).
tVCONNON	Note 1	2 ms	From the time the Source supplied VBUS in the Attached.SRC state. Measured from vSafe5V to the minimum VCONN voltage (see Table 4-4)
tVCONNON-PA	0 ms	100 ms	From the time a Sink with accessory support enters the PoweredAccessory state until the Sink sources minimum VCONN voltage (see Table 4-4)
tVCONNOFF	0 ms	35 ms	From the time that a Sink is detached or as directed until the VCONN supply is disconnected and bulk capacitance is removed.
tSinkAdj	tPDDebounce	60 ms	Response time for a Sink to adjust its current consumption to be in the specified range due to a change in USB Type-C Current advertisement