USB Type-C ENGINEERING CHANGE NOTICE

Title: USB Type-C ECR Vconn Requirements
Applied to: USB Type-C Specification Release 1.2, March 25, 2016

Brief description of the functional change:

1) Modify VCONN Sources to allow VCONN from 3.0 to 5.5V.
2) Require Electronically Marked passive cables and active cables to function with VCONN from 3.0 to 5.5V
3) Require Electronically Marked cables to remove or weaken Ra to reduce power consumption when VCONN is in the valid VCONN voltage range. Sources that do not support USB-PD are unable to remove VCONN. This ECR requires the power dissipation of cables to be reduced to save battery life.
4) Require Electronically Marked cables to present Ra when VCONN is less than vRaReconnect. Define vRaReconnect as 0.8V minimum.
5) Lower the maximum power of electronically marked passive cables to account for the power savings of weakening Ra.
6) Clarify the cable maximum current draw in USB Suspend only applies to active cables. Lower the maximum current of active cables in USB suspend to account for the power savings of weakening Ra.
7) Add a state machine for the Electronic Marker in the cable for clarification.
8) Reorganize content in sections 4.6.1.2, 4.9 and 5.2 to be consistent with above changes.

Benefits as a result of the changes:

1) All DFPs or DRPs may connect VCONN directly to the battery if it is the range of 3.0 to 5.5V and are not required to provide 4.75-5.5V VCONN to a cable. This will save adding a voltage boost in many cases.
2) Electronically Marked cables will be required to reduce their power consumption once VCONN is in the valid VCONN voltage range. This will help with battery drain if the cable is connected and VCONN is applied.
3) Electronically Marked cables will be required to connect Ra when VCONN is less than vRaReconnect (0.8V).

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

1) Some full-featured cables and cable controllers will be non-compliant with these changes. Cables and cable controllers may 1) not currently implement Ra weakening or 2) implement Ra weakening but not meet the new power requirements.

An analysis of the hardware implications:

1) Non-compliant cables and cable controllers will need to be redesigned to meet the new Ra weakening and power requirements.
2) DFPs and DRPs may implement a switch to Source both Vbus and Vconn at 5V if they wish to communicate with existing electronically marked passive cables or provide functionality with existing active cables.

An analysis of the software implications:

None

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An analysis of the compliance testing implications:
1) The Vconn Source voltage range shall be modified to 3.0 to 5.5V. 2) Add a test to confirm power dissipation when V_{CONN} is in the valid V_{CONN} voltage range 3) Add a test to confirm Ra is present when V_{CONN} < vRaReconnect.

Actual Change

(a). Section 4.4.3 VCONN

From Text:

VCONN is provided by the DFP to power cables with electronics in the plug. VCONN is provided over the CC pin that is determined not to be connected to the CC wire of the cable.

Initially, VCONN shall be sourced on all DFP USB Type-C receptacles that utilize the SSTX and SSRX pins during specific connection states as described in Section 4.5.2.2. Subsequently, VCONN may be removed under some circumstances as described in Table 4-3. VCONN may also be sourced by USB Type-C receptacles that do not utilize the SSTX and SSRX pins as described in Section 4.5.2.2. *USB PD* VCONN_Swap command also provides the DFP a means to request that the attached UFP source VCONN

Table 4-3 USB Type-C Source Port's VCONN Requirements Summary

D+/D–	SSTX/SSRX	> 3 A	VCONN Requirements
No	No	No	Not required to source VCONN
Yes	No	No	Not required to source VCONN
Yes	Yes	No	Required to source 1 W. VCONN power may be removed after the source has read the cable's eMarker and has determined that it is not an active cable.
No	No	Yes	Required to source 1 W. 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 1 W. 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 1 W. 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.

Table 4-4 provides the voltage and power requirements that shall be met for VCONN. See Section 4.9 for more details about Electronically Marked Cables. See Section 4.10 for a wider VCONN voltage operating range for VCONN-powered accessories. See Section 5.1 regarding optional support for an increased VCONN power range in Alternate Modes.

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.

To aid in reducing the power associated with supplying Vconn, a Source is allowed to either not sourc 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 the tCCDebounce when the other CC pin is in the SRC.Open state and supports Vconn-powered accessories.
- If there is no GoodCRC response to *USB PD* Discover Identity messages

Table 4-5 provides the requirements that shall be met for cables that consume VCONN power.

Table 4-5 VCONN Sink Characteristics

	Minimum	Maximum	Notes
Inrush Capacitance		10 µF	A cable shall not present more than the equivalent inrush capacitance to the VCONN source. The active cable is responsible for discharging its capacitance.
Power for Electronically Marked Cables		70 mW	See Section 4.9.
Power for Active Cables		1.0 W	See Section 5.2.
tVCONNDischarge		250 ms	The time from the point that the cable is detached until vVCONNDischarge shall be met.
vVCONNDischarge		150 mV	The VCONN voltage following cable detach and self-discharge.

The cable may remove or weaken Ra when VCONN is above 1.0 V as long as the other requirements are met. See Section 4.5.1.2.1.

To Text:

VCONN is provided by the DFP to power cables with electronics in the plug. VCONN is provided over the CC pin that is determined not to be connected to the CC wire of the cable.

Initially, VCONN shall be sourced on all DFP USB Type-C receptacles that utilize the SSTX and SSRX pins during specific connection states as described in Section 4.5.2.2. Subsequently, VCONN may be removed under some circumstances as described in Table 4-3. VCONN may also be sourced by USB Type-C receptacles that do not utilize the SSTX and SSRX pins as described in Section 4.5.2.2. *USB PD* VCONN_Swap command also provides the DFP a means to request that the attached UFP source VCONN

Table 4-3 USB Type-C Source Port's VCONN Requirements Summary

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No	No	No	Not required to source VCONN
Yes	No	No	Not required to source VCONN
Yes	Yes	No	Required to source 1 W. VCONN power may be removed after the source has read the cable's eMarker and has determined that it is not an active cable.
No	No	Yes	Required to source 1 W. 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 1 W. 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 1 W. 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.

Table 4-4 provides the voltage and power requirements that shall be met for VCONN. See Section 4.9 for more details about Electronically Marked Cables. See Section 5.1 regarding optional support for an increased VCONN power range in Alternate Modes.

Table 4-4 VCONN Source Characteristics

	Minimum	Maximum	Notes
Voltage	3.0 V	5.5 V	
Power	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 in USB Suspend	70mW		Minimum power Source must provide in USB Suspend. 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.

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 the tCCDebounce when the other CC pin is in the SRC.Open state and supports Vconn-powered accessories
- If there is no GoodCRC response to *USB PD* Discover Identity messages

Table 4-5 provides the requirements that shall be met for cables that consume VCONN power.

Table 4-5 Cable VCONN Sink Characteristics

	Minimum	Maximum	Notes
Voltage	3.0	5.5V	Voltage range at which this Table applies
Inrush Capacitance		10 µF	A cable shall not present more than the equivalent inrush capacitance to the VCONN source. The active cable is responsible for discharging its capacitance.
Power for Electronically Marked Passive Cables		20mW	See Section 4.9. Measured with no USB PD traffic at least 500ms after VCONN applied Note: 75mW max allowed for the first 500ms after VCONN applied.
Power for Active Cables		1.0 W	See Section 5.2.
Power for Active Cables in USB Suspend		70mW	Maximum power for active cables in USB suspend. Measured with no USB PD traffic at least 500ms after VCONN applied
.tVCONNDischarge		230ms	Time from cable disconnect to vVCONNDischarge met.
vVCONNDischarge		800mV	VCONN voltage after tVCONNDischarge
vRaReconnect	800mV		Voltage at which the cable shall reapply Ra on the falling edge of VCONN.

The cable shall remove or weaken Ra when VCONN is in the valid voltage range. The cable shall reapply Ra when VCONN falls below vRaReconnect as defined in Table 4-5. The cable shall discharge VCONN to below vVCONNDischarge on a cable disconnect. The cable shall take into account the VCONN capacitance present in the cable when discharging VCONN.

Implementation Note: Increasing Ra to 20KOhm will meet both the power dissipation for Electronically Marked Passive Cables and discharge 10uF to less than vVCONNDischarge in tVCONNDischarge.

The maximum power consumption while in an Alternate Mode is defined by the Alternate Mode.

Table 4-6 VCONN Powered Accessory Sink Characteristics

	Minimum	Maximum	Notes
Voltage	3.0V	5.5V	Voltage range at which this Table applies
Inrush Capacitance		10µF	An accessory shall not present more than the equivalent inrush capacitance to the VCONN source. The accessory is responsible for discharging its capacitance when detached from a port.
Power before Alternate Mode Entry		35mW	Maximum power in USB suspend Note: Power shall be reduced 5s after VCONN is applied if no Alternate Mode Entry has occurred. A VCONN power cycle may be required to re-enable USB-PD communication.
tVCONNDischarge		230ms	Time from cable disconnect to vVCONNDischarge met.
vVCONNDischarge		800mV	VCONN voltage after tVCONNDischarge
vRaReconnect	800mV		Voltage at which the cable shall reapply Ra on the falling edge of VCONN.

The VCONN powered accessory shall remove or weaken Ra when VCONN is in the valid voltage range. The VCONN powered accessory shall reapply Ra when VCONN falls below vRaReconnect as defined in Table 4-6. The VCONN powered accessory shall take into account the VCONN capacitance present in the accessory when discharging VCONN.

The maximum power consumption while in an Alternate Mode is defined by the Alternate Mode.

(b). Add new Cable State Machine Requirements Section

New Text and Figures:

4.5.2.4 Cable State Machine Requirements

Figure 4-18 illustrates the passive cable Electronic Marker connection state diagram. Figure 4-19 illustrates the active cable Electronic Marker connection state diagram.

Figure 4-18 Passive Cable Electronic Marker State Diagram

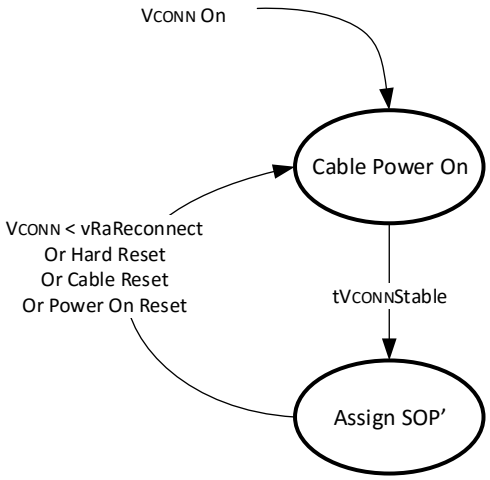
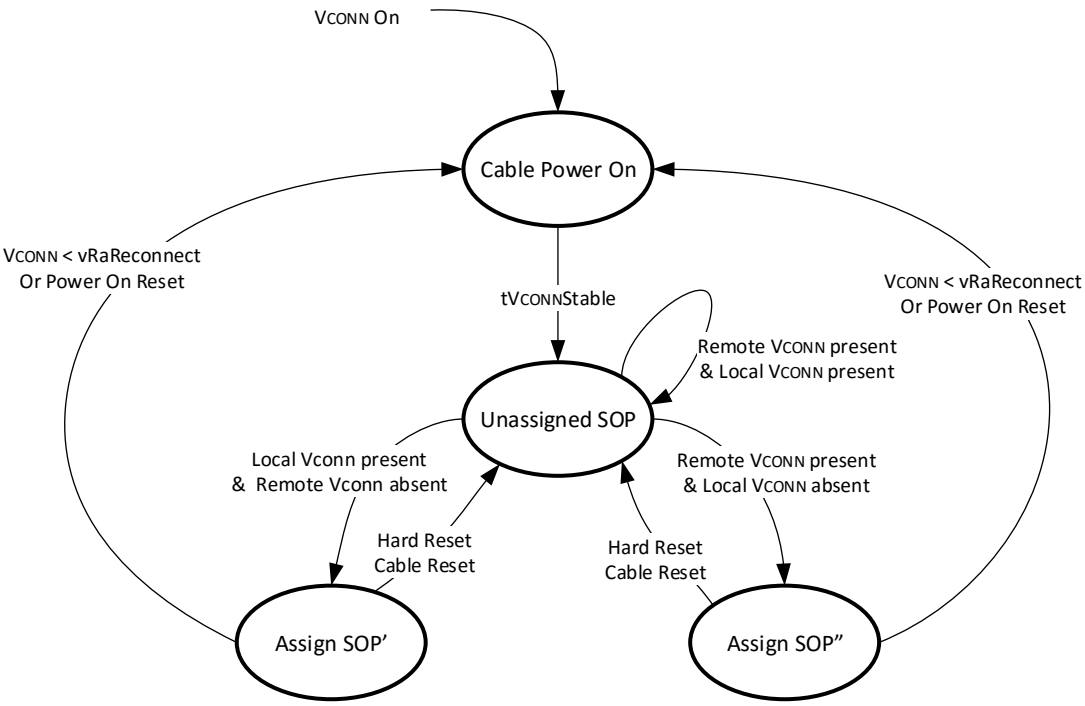


Figure 4-19 Active Cable Electronic Marker State Diagram



4.5.2.4.1 Cable Power On State

This state appears in Figure 4-18 and Figure 19. This is the initial power on state for the Electronic Marker in the cable when VCONN is applied.

4.5.2.4.1.2 Cable Power On State Requirements

The Electronic Marker in the cable shall present Ra when no VCONN is applied.

The Electronic Marker in the cable shall power on may continue to present Ra in this state.

The cable shall not respond to SOP' and SOP" commands in this state.

4.5.2.4.1.3 Exiting from Cable Power On State

The Electronic Marker in a passive cable shall transition to Assign SOP' when it has completed its boot process. The Electronic Marker in the passive cable shall transition to Assign SOP' within tVCONNStable, Table 5-4.

The Electronic Marker in an active cable shall transition to Unassigned SOP when it has completed its boot process. The Electronic Marker in the active cable shall transition to Unassigned SOP within tVCONNStable, Table 5-4.

4.5.2.4.2 Unassigned SOP State

This state appears in Figure 4-19. The Electronic Marker in the active cable can detect the voltage on VCONN in this state and is waiting to assign SOP' and SOP" if supported.

4.5.2.4.2.1 Unassigned SOP State Requirements

The Electronic Marker in the active cable shall not respond to any USB PD communication sent to SOP' or SOP" while in this state.

The cable shall weaken or remove Ra if it has not already done so.

The Active cable shall meet the Power for Active Cables defined in Table 4-5.

The Electronic Marker in the active cable shall detect VCONN on the local cable plug or on the remote cable plug.

4.5.2.4.2.3 Exiting from Unassigned SOP State

The Electronic Marker in the active cable shall transition to Assign SOP' when it detects VCONN present on its local cable plug and no VCONN being received from the remote cable plug.

The Electronic Marker in the active cable shall transition to Assign SOP" when it detects VCONN being received from the remote cable plug and it does not detect VCONN from its local cable plug. The Electronic Marker in the active cable may stay in Unassigned SOP if it does not supports SOP".

The Electronic Marker in the active cable should remain in Unassigned SOP if it detects VCONN present on the local cable plug and the remote cable plug at the same time.

4.5.2.4.3 Assign SOP' State

This state appears in Figure 4-18 and Figure 4-19. The cable Electronic Marker responds to SOP' in this state.

4.5.2.4.3.1 Assign SOP' State Requirements

The Electronic Marker in the passive or active cable shall be able to respond to any USB PD communication sent to SOP'.

The Electronic Marker in the passive cable shall weaken or remove Ra if it has not already done so.

Passive cables shall meet the Power for Electronically Marked Passive Cables defined in Table 4-5.

Active Cables shall meet the Power for Active cables in Table 4-5.

4.5.2.4.3.2 Exiting from Assign SOP' State

The Electronic Marker in the passive or active cable shall transition to Cable Power On upon sensing VCONN less than vRaReconnect defined in Table 4-5 or upon a Power On Reset event.

The Electronic Marker in the passive cable shall transition to Cable Power On upon sensing a Hard Reset or Cable Reset.

The Electronic Marker in the active cable shall transition to Unassigned SOP upon sensing a Hard Reset or Cable Reset.

4.5.2.4.4 Assign SOP" State (Optional Normative)

This state appears in Figure 4-19. The active cable Electronic Marker responds to SOP" in this state. This state is not required to be supported by an active cable.

4.5.2.4.4.1 Assign SOP" State Requirements

The Electronic Marker in the active cable shall be able to respond to any USB PD communication sent to SOP".

The Electronic Marker shall weaken or remove Ra to meet the maximum power defined in Table 4-5 if it has not already done so.

4.5.2.4.4.2 Exiting from Assign SOP" State

The Electronic Marker in the active cable shall transition to Cable Power On upon sensing Vconn less than vRaReconnect defined in Table 4-5 or on a Power On Reset event.

The Electronic Marker in the active cable shall transition to Unassigned SOP upon sensing a Hard Reset or Cable Reset.

(c). Section 4.6.1.2 VCONN Requirements during USB Suspend, Page 168

From Text:

4.6.1.2 VCONN Requirements during USB Suspend

If the Source supplies VBUS power during USB suspend, it shall also supply at least 7.5 mA to VCONN.

Electronically marked cables shall draw no more than 7.5 mA from VCONN during USB suspend.

To Text:

4.6.1.2 VCONN Requirements during USB Suspend

If the Source supplies VBUS power during USB suspend, it shall also supply VCONN and meet the requirements defined in Table 4-4.

Electronically marked cables shall meet the requirements in Table 4-5 during USB suspend.

VCONN powered accessories shall meet the requirements defined in Table 4-6 during USB suspend.

(d). Section 4.10 VCONN – Powered Accessories, Page 176

From Text:

A VCONN-powered accessory is a direct-attach Sink that implements an Alternate Mode (See Section 5.1) and can operate with just 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:

A VCONN-powered accessory is a direct-attach Sink that implements an Alternate Mode (See Section 5.1) and can operate with just 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 Sink 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 comply with Table 4-6.

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.

(e). Section 4.9 Electronically Marked Cables, Pages 175 - 176

From Text:

4.9 Electronically Marked Cables

All USB Full-Featured Type-C cables shall be electronically marked. USB 2.0 Type-C cables may be electronically marked.

Electronically marked cables shall support *USB Power Delivery* Structured VDM Discover Identity command directed to SOP'. This provides a method to determine the characteristics of the cable, e.g. its current carrying capability, its performance, vendor identification, etc. This may be referred to as the USB Type-C Cable ID function.

Prior to an explicit *USB PD* contract, a Sourcing Device is allowed to use SOP' to discover the cable's identity. After an explicit *USB PD* contract has been negotiated, only the Source shall communicate with SOP' and SOP" (see Section 5.2.2).

An electronically marked cable incorporates electronics that require VCONN, although VBUS or another source may be used. Electronically marked cables that do not incorporate data bus signal conditioning circuits shall consume no more than 70 mW from VCONN. During USB suspend, electronically marked cables shall not draw more than 7.5 mA from VCONN, see Section 4.6.1.2.

Figure 4-37 illustrates a typical electronically marked cable. The isolation elements (Iso) shall prevent VCONN from traversing end-to-end through the cable. Ra is required in the cable to allow the Source to determine that VCONN is needed.

Figure 4-37 Electronically Marked Cable with VCONN connected through the cable

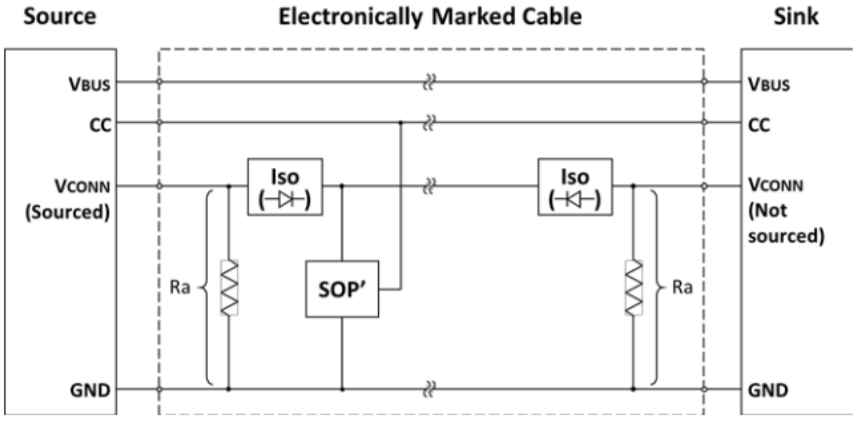
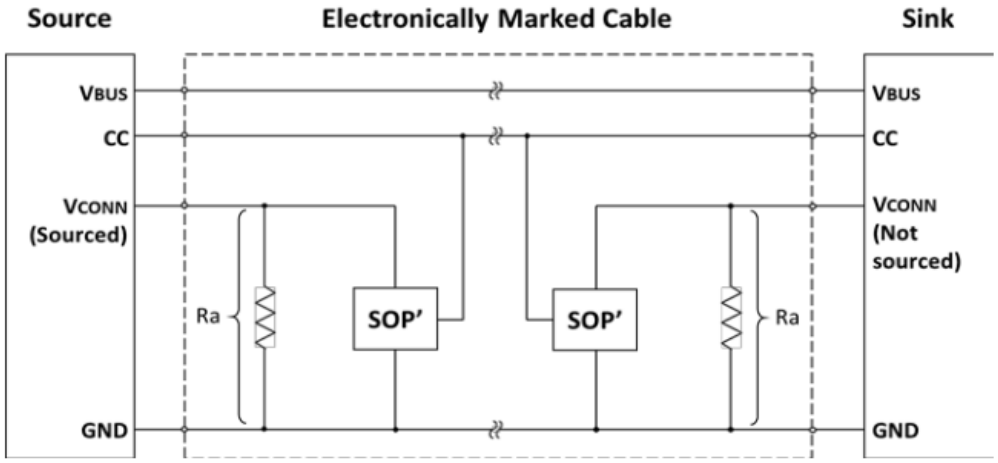


Figure 4-38 illustrates an electronically marked cable where the VCONN wire does not extend through the cable, therefore an SOP' element is required at each end of the cable. In this case, no isolation elements are needed.

Figure 4-38 Electronically Marked Cable with SOP' at both ends



For cables that only respond to SOP', the location of the responder is not relevant.

An active cable is an electronically marked cable that incorporates data bus signal conditioning circuits, for example to allow for implementing longer cables. Active cables shall not draw more than 1 W from VCONN, see Section 4.4.3.

Active cables may or may not require configuration management. Requirements for active cables that require configuration management are provided in Section 5.2.

Refer to Section 4.4.3 for the requirements of a Source to supply VCONN. When VCONN is not present, a powered cable shall not interfere with normal CC operation including Sink detection, current advertisement and *USB PD* operation.

To Text:

4.9 Electronically Marked Cables

All USB Full-Featured Type-C cables shall be electronically marked. USB 2.0 Type-C cables may be electronically marked.

Electronically marked cables shall support *USB Power Delivery* Structured VDM Discover Identity command directed to SOP'. This provides a method to determine the characteristics of the cable, e.g. its current carrying capability, its performance, vendor identification, etc. This may be referred to as the USB Type-C Cable ID function.

Prior to an explicit *USB PD* contract, a Sourcing Device is allowed to use SOP' to discover the cable's identity. After an explicit *USB PD* contract has been negotiated, only the Source shall communicate with SOP' and SOP" (see Section 5.2.2).

Electronically marked passive cables shall follow the Cable State Machine defined in 4.5.2.4 and Figure 4-18.

~~An~~ Electronically marked cable~~s incorporates electronics that require~~ are generally powered from VCONN, although VBUS or another source may be used. Electronically marked cables ~~that do not incorporate data bus signal conditioning circuits shall consume no more than 70 mW from VCONN.~~ shall meet

the maximum power defined in Table 4-5. ~~During USB suspend, electronically marked cables shall not draw more than 7.5 mA from VCONN, see Section 4.6.1.2.~~

Refer to Table 4-4 for the requirements of a Source to supply VCONN. When VCONN is not present, a powered cable shall not interfere with normal CC operation including Sink detection, current advertisement and USB PD operation.

Figure 4-37 illustrates a typical electronically marked cable. The isolation elements (Iso) shall prevent VCONN from traversing end-to-end through the cable. Ra is required in the cable to allow the Source to determine that VCONN is needed.

Figure 4-37 Electronically Marked Cable with VCONN connected through the cable

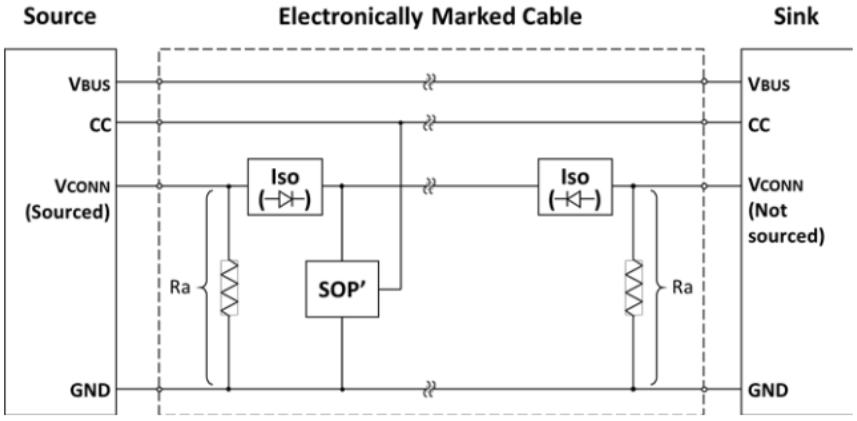
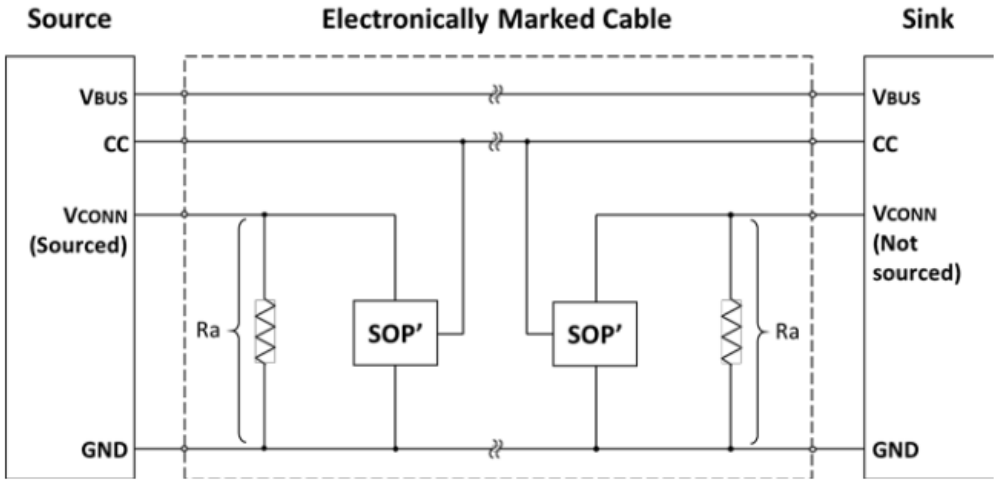


Figure 4-38 illustrates an electronically marked cable where the VCONN wire does not extend through the cable, therefore an SOP' element is required at each end of the cable. In this case, no isolation elements are needed.

Figure 4-38 Electronically Marked Cable with SOP' at both ends



For cables that only respond to SOP', the location of the responder is not relevant.

4.9.1 Parameter Values

Table 4-15 provides the power on timing requirements for SOP' and SOP" to be ready to communicate.

Table 4-15 SOP' and SOP" Timing

	Maximum	Description
tVCONNStable	50ms	The time between the application of VCONN until SOP' and SOP" shall be ready for communication.

4.9.2 Active Cables

An active cable is an electronically marked cable that incorporates data bus signal conditioning circuits, for example to allow for implementing longer cables. Active cables with data bus signal conditioning in both plugs shall implement SOP' and may implement SOP". Active cables shall ~~not draw more than 1 W from VCONN, see Section 4.4.3.~~ meet the power requirements defined in Table 4-5.

Active cables may support either one SSTX/SSRX pair or two SSTX/SSRX pairs. The Electronic Marker in the cable shall identify the number of SSTX/SSRX lanes supported.

Active cables may or may not require configuration management for alternate modes. ~~Requirements for a~~Active cable~~s that require~~ configuration management is defined ~~are provided~~ in Section 5.2.

(f). Section 5.2 Managed Active Cables, Pages 190 - 192

From Text:

5.2 Managed Active Cables

Active cables that require configuration (managed active cable) shall use *USB Power Delivery* Structured VDMs to discover and configure the cable.

USB Power Delivery Structured VDMs provide a standardized mechanism for identifying and managing the functionality of active cables.

Some managed active cables only have a single *USB PD* controller in the cable that responds to *USB PD* Structured VDMs sent to SOP'.

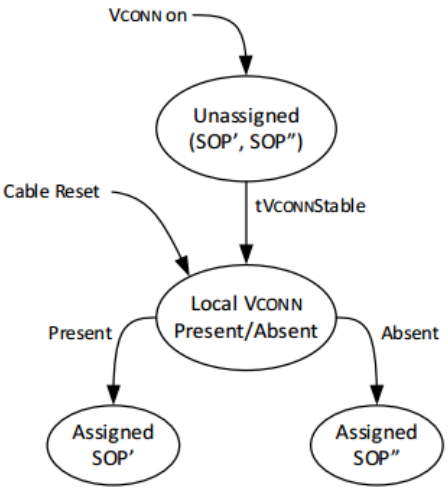
When a managed active cable requires independent management at each end of the cable, separate *USB PD* controllers responding to *USB PD* Structured VDMs sent to SOP' and SOP" can be located in each plug.

5.2.1 Requirements for Managed Active Cables that respond to SOP' and SOP"

After a power-on reset event or a *USB PD* Hard Reset, the *USB PD* controller attached to the Source is assigned SOP' and the *USB PD* controller attached to the Sink is assigned SOP". After a *USB PD* Cable Reset, the plug being supplied VCONN responds to SOP' independent of whether it is the plug attached to the Source or Sink. The controllers can sense whether they are SOP' or SOP" based on the presence of VCONN at the plug's VCONN pin as only one port supplies VCONN.

Figure 5-6 illustrates the process that shall be followed to assign SOP' and SOP" to the ends attached to the Source and Sink, respectively, at power on. In the Unassigned state, the active cable will not respond to any *USB PD* communication sent to SOP' or SOP". The parameter tVCONNStable allows time for the active cable to set up to communicate.

Figure 5-6 Managed Active Cable Plug SOP' and SOP" Assignment



When VCONN is removed, the plug's local VCONN shall discharge to below its SOP' detection threshold within 20 ms.

A managed active cable shall assure that the two *USB PD* controllers are uniquely assigned via the mechanism described here, one as SOP' and the other as SOP".

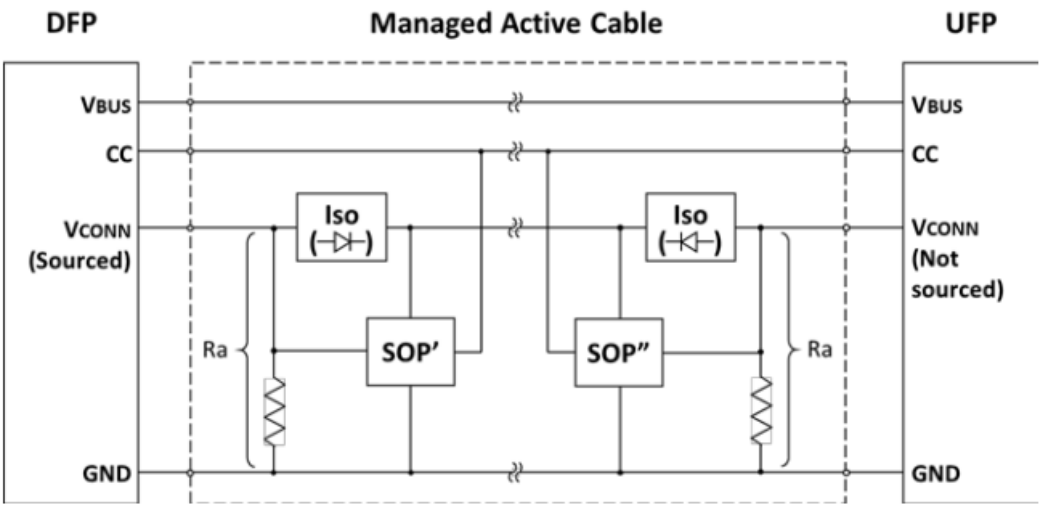
USB PD supports three types of USB Type-C-related swaps that may or may not impact VCONN:

- *USB PD* VCONN_Swap – The port previously not supplying VCONN sources VCONN and the assignment of SOP' and SOP" remain unchanged.
- *USB PD* DR_Swap – The assignment of SOP' and SOP" remain unchanged.
- *USB PD* PR_Swap – The assignment of SOP' and SOP" remain unchanged.

Managed active USB Type-C to USB Type-C cables shall by default support USB operation. Multi-modal cables (e.g., an active cable that supports an Alternate Mode in addition to USB SuperSpeed) that use the TX/RX signal pairs shall minimally support *USB 3.1* Gen 1 operation. They are encouraged to support both Gen 1 and Gen 2 operation.

Figure 5-7 illustrates a typical managed active cable. The isolation elements (Iso) shall prevent VCONN from traversing end-to-end through the cable. Ra is required in the cable to allow the DFP to determine that VCONN is needed.

Figure 5-7 Managed Active Cable



5.2.1.1 Parameter Values

Table 5-2 provides the power on timing requirements for SOP' and SOP" to be ready to communicate.

Table 5-4 SOP' and SOP" Timing

	Maximum	Description
tVconnStable	50ms	The time between the application of VCONN until SOP' and SOP" shall be ready for communication.

5.2.2 Cable Message Structure

USB PD Structured VDMs shall be used to identify and manage active cables. Cables that require additional functionality, for example to program parameters in the active electronics, may define proprietary Structured VDMs to provide the necessary functionality. In all cases, these messages shall only use SOP' and SOP". They shall not use SOP.

SOP' and SOP" are defined to allow a vendor to communicate individually with each end the cable.

For active cables that support both SOP' and SOP", after attach or a *USB PD* Cable Reset, the plug directly connected to the Source shall only respond to SOP' and the plug directly connected to the Sink shall only respond to SOP".

The assignment of SOP' and SOP" to each plug remains persistent until VCONN is removed or a subsequent *USB PD* Cable Reset.

The Discover Identity message shall start with SOP'.

To Text:

5.2 Managed Active Cables

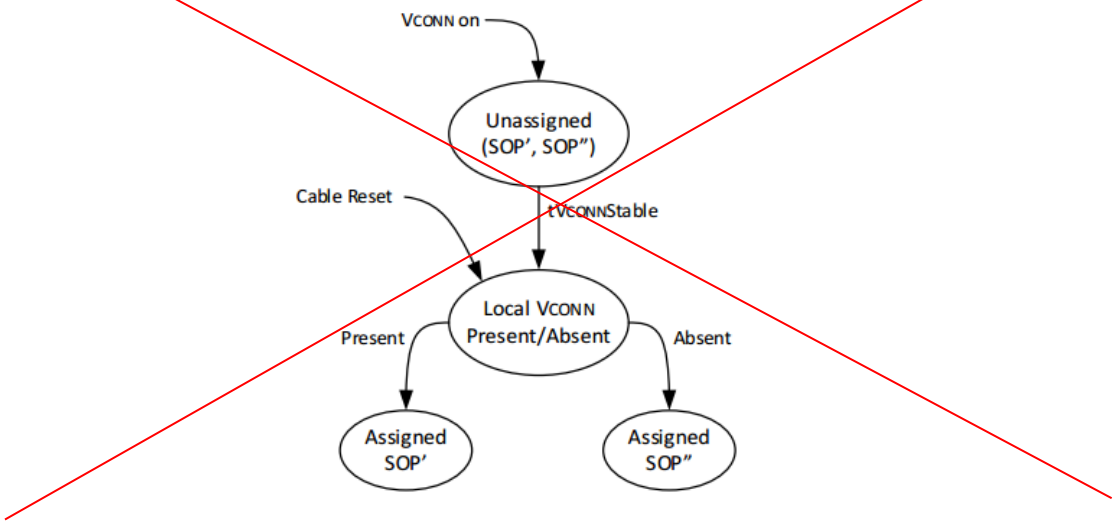
Managed active cables may have a single *USB PD* controller in the cable that responds to *USB PD* Structured VDMs sent to SOP' if independent management of each end is not required.

All managed active cables shall identify if they respond to SOP' only or to both SOP' and SOP" using the Discover Identity command defined in *USB Power Delivery*.

5.2.1 Requirements for Managed Active Cables that respond to SOP' and SOP"

Managed active cables shall implement the Cable State Machine defined in 4.5.2.4 and Figure 4-19.

Figure 5-6 Managed Active Cable Plug SOP' and SOP" Assignment



A managed active cable which supports two *USB PD* controllers shall ensure the cable plugs are uniquely assigned via the mechanism described here, one as SOP' and the other as SOP".

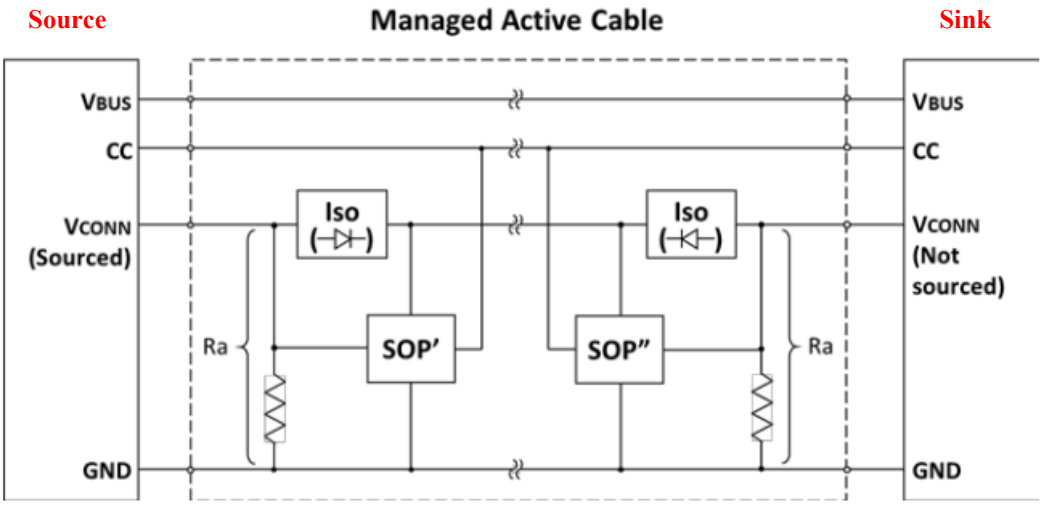
USB PD supports three types of USB Type-C-related swaps that may or may not impact VCONN:

- *USB PD* VCONN_Swap – The port previously not supplying VCONN sources VCONN and the assignment of SOP' and SOP" remain unchanged.
- *USB PD* DR_Swap – The assignment of SOP' and SOP" remain unchanged.
- *USB PD* PR_Swap – The assignment of SOP' and SOP" remain unchanged.

Managed active USB Type-C to USB Type-C cables shall by default support USB operation. Modal cables (e.g., an active cable that supports an Alternate Mode in addition to USB SuperSpeed) that use the TX/RX signal pairs shall minimally support *USB 3.1* Gen 1 operation and are encouraged to support both Gen 1 and Gen 2 operation.

Figure 5-7 illustrates a typical managed active cable. The isolation elements (Iso) shall prevent VCONN from traversing end-to-end through the cable. Ra must be present when no VCONN is applied to allow the DFP to determine that VCONN is needed.

Figure 5-7 Managed Active Cable



5.2.1.1 Parameter Values

Table 5-2 provides the power on timing requirements for SOP' and SOP" to be ready to communicate.

Table 5-4 SOP' and SOP" Timing

	Maximum	Description
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5.2.2 Cable Message Structure

USB PD Structured VDMs shall be used to identify and manage active cables. Cables that require additional functionality, for example to program parameters in the active electronics, may define proprietary Structured VDMs to provide the necessary functionality. In all cases, these messages shall only use SOP' and SOP". They shall not use SOP.

SOP' and SOP" are defined to allow a vendor to communicate individually with each cable end.

The Discover Identity message shall start with SOP'.