

# USB Power Delivery ENGINEERING CHANGE NOTICE

**Title: iPpsCLTransient Clarification**

**Applied to: USB Power Delivery Specification Revision 3.0  
Version 1.1**

<b>Brief description of the functional changes proposed:</b>
The transient response to load step changes is not clearly specified. This ECR breaks down the responses to load step changes into 4 groups: those that occur entirely within CV, those that occur entirely within CL, those that result in a transition from CV to CL and those that result in a transition from CL to CV.

<b>Benefits as a result of the proposed changes:</b>
Adds clarity to the specification. Relaxes the requirements for large load step changes.

<b>An assessment of the impact to the existing revision and systems that currently conform to the USB specification:</b>
None as no PPS chargers have been certified.

<b>An analysis of the hardware implications:</b>
Relaxes existing requirement

<b>An analysis of the software implications:</b>
none

<b>An analysis of the compliance testing implications:</b>
No change to testing process. Change to interpretation of the results.

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## Actual Change Requested

### (a). Section 7.1.4.4

#### From Text:

Any current overshoot or undershoot that occurs due to a load change during Current Foldback **Shall Not** exceed ***iPpsCfTransient*** and **Shall** settle to the Operating Current value within ***tPpsCfSettle***. Voltage overshoot or undershoot caused by a transition from Current Foldback mode to Constant Voltage mode **Shall Not** exceed ***vPpsCfCvTransient*** and **Shall** settle to the Operating Voltage value within ***tPpsCfCvTransient***. Likewise, current overshoot or undershoot caused by a transition from Constant Voltage mode to Current Foldback mode **Shall Not** exceed ***iPpsCvCfTransient*** and **Shall** settle to the Operating Current value within ***tPpsCvCfTransient***.

The PPS **Shall** maintain its output voltage within the Minimum Voltage and Maximum Voltage values advertised in the PPS APDO for all static and dynamic load conditions during Current Foldback operation. The PPS is not expected to deliver power if the load condition results in an output voltage that is lower than the Minimum Voltage value advertised in the PPS APDO. Rather, the Source **Shall** send **Hard Reset** Signaling and discharge  $V_{BUS}$  to **vSafe0V** then resume default operation at **vSafe5V**.

The relationship between PPS programmable output voltage and PPS programmable Current Foldback **Shall** be as shown in Figure 7-7.

#### To Text:

~~Any current overshoot or undershoot that occurs due to a load change during Current Foldback **Shall Not** exceed ***iPpsCfTransient*** and **Shall** settle to the Operating Current value within ***tPpsCfSettle***. Voltage overshoot or undershoot caused by a transition from Current Foldback mode to Constant Voltage mode **Shall Not** exceed ***vPpsCfCvTransient*** and **Shall** settle to the Operating Voltage value within ***tPpsCfCvTransient***. Likewise, current overshoot or undershoot caused by a transition from Constant Voltage mode to Current Foldback mode **Shall Not** exceed ***iPpsCvCfTransient*** and **Shall** settle to the Operating Current value within ***tPpsCvCfTransient***.~~

~~The PPS **Shall** maintain its output voltage within the Minimum Voltage and Maximum Voltage values advertised in the PPS APDO for all static and dynamic load conditions during Current Foldback operation. The PPS is not expected to deliver power if the load condition results in an output voltage that is lower than the Minimum Voltage value advertised in the PPS APDO. Rather, the Source **Shall** send **Hard Reset** Signaling and discharge  $V_{BUS}$  to **vSafe0V** then resume default operation at **vSafe5V**.~~

~~The response of a PPS to a load change depends on the Operating mode of the PPS and the magnitude of the load change. These dependencies lead to one of four possible responses of a PPS to any load change. They are differentiated by the value of the PPS Status OMF Flag before and after the load change.~~

- ~~• If the PPS Status OMF Flag is cleared both before and after the load change, the PPS responds solely by maintaining the output voltage. The PPS output voltage shall remain within vPpsValid range. The PPS response to the load change shall settle within the vPpsNew tolerance band by the time tPpsTransient. The Operating Mode Flag shall remain cleared during the load change response of the PPS.~~
- ~~• If the PPS Status OMF Flag is cleared before the load change and set after the load change, the PPS responds by reducing its output voltage to limit the PPS output current. The PPS output current shall stay within the iPpsCVCLTransient range once it reaches the iPpsCVCLTransient range. The PPS response to the load change shall settle within the iPpsCLNew tolerance band by the time tPpsCvCITransient. The Operating Mode Flag shall be set when the PPS load change response settles.~~

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- If the PPS Status OMF Flag is set both before and after the load change, the PPS responds by adjusting its output voltage to maintain the output current. The PPS output current shall stay within the *iPpsCLTransient* range. The PPS response to the load change shall settle within the *iPpsCLNew* tolerance band by the time *tPpsCLSettle*. The Operating Mode Flag shall remain set during the load change response of the PPS.
- If the PPS Status OMF Flag is set before the load change and cleared after the load change, the PPS responds to the load change by increasing its output voltage to *vPpsNew* and then maintaining it. The PPS output voltage shall stay within the *vPpsCICvTransient* range. The PPS response to the load change shall settle within the *vPpsNew* tolerance band by the time *tPpsCICvTransient*. The Operating Mode Flag shall be cleared when the PPS load change response settles.

The PPS **shall** maintain its output voltage within the Minimum Voltage and Maximum Voltage values advertised in the PPS APDO for all static and dynamic load conditions during Current Limit operation. The PPS is not expected to deliver power if the load condition results in an output voltage that is lower than the Minimum Voltage value advertised in the PPS APDO. In this case, the Source **May** send **Hard Reset** Signaling and **shall** discharge  $V_{BUS}$  to **vSafe0V** then resume default operation at **vSafe5V**.

When the Sink attempts to draw more current than the Operating Current in the RDO, the Source **shall** limit its output current. The current available from the Source during Current Limit mode shall meet **iPpsCLNew** plus **iPpsCLOperating**. The Sink **May Not** reduce its Operating Current request in the RDO when the PPS Status OM Flag is set.

Current limiting **shall** be performed by the PPS Source. Sinks **May Not** limit their input current with respect to the RDO but **shall** meet the requirements of Section 7.2.9. The Source **shall Not** shutdown or otherwise disrupt the available output power while in Current Limit mode unless another protection mechanism as outlined in Section 7.1.7 is engaged to protect the Source from damage.

The relationship between PPS programmable output voltage and PPS programmable Current Limit **shall** be as shown in Figure 7-7. The transition between the Constant Voltage mode and the Current Limit mode occurs between points a and b. The PPS Status OM Flag shall be set or cleared within this region. In Current Limit mode when the load resistance decreases the output current of the Source shall never decrease nor increase more than *iPpsCLOperating*. The proper behavior is represented by c. Likewise, as the load resistance increases, the output current of the Source **shall Not** increase. The proper behavior is represented by d.

## (b). Section 7.2.2, Page 233

### From Text:

Table 7-22 Source Electrical Parameters

Parameter	Description	MIN	TYP	MAX	UNITS	Reference
<i>iPpsCfTransient</i>	CF load transient current bounds.	-250		250	mA	Section 7.1.4.4
<i>iPpsCvCfTransient</i>	CV to CF transient current bounds assuming the Operating Voltage reduction of Section 7.2.3.1.	-100		500	mA	Section 7.1.4.4

### To Text:

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Table 7-22 Source Electrical Parameters

Parameter	Description	MIN	TYP	MAX	UNITS	Reference
<b><i>iPpsCLTransient</i></b>	Allowed output current overshoot when a load increase occurs while in CL mode.			New load + 100	mA	Section 7.1.4.4
	Allowed output current undershoot when a load decrease occurs while in CL mode.	New load – 100			mA	Section 7.1.4.4
<b><i>iPpsCVCLTransient</i></b>	CV to CL transient current bounds assuming the Operating Voltage reduction of Section 7.2.3.1.	<b><i>iPpsCL</i></b> New - 100		New load + 500	mA	Section 7.1.4.4