USB Power Delivery ENGINEERING CHANGE NOTICE

Title: Peak Current Overload Capability Support for EPR AVS APDO - Source
Applied to: USB Power Delivery Specification Revision 3.1 Version 1.1

Brief description of the functional changes proposed:
In the EPR specifications, both Fixed PDO and AVS APDO are mandatory profiles as part of the Source power rule. Fixed PDO supports Peak Current capability but it is missing from AVS APDO. This ECN includes a field for Peak Current in AVS APDO.

Benefits as a result of the proposed changes:
Hosts requiring surge currents exceeding the rated current for a short amount of time will benefit from this feature when operating with AVS APDO.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
No impact since there are no products out in the market supporting EPR with AVS.

An analysis of the hardware implications:
If the Source adaptor is already offering peak current capability in Fixed voltage mode, it is likely able to offer the same feature in AVS APDO mode without hardware changes.

An analysis of the software implications:
Software would need to comprehend peak current capability offered by AVS APDO through bits 27..26

An analysis of the compliance testing implications:
Compliance testing will be required for all adaptors that support Peak current capability

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Actual Change Requested

(a). Section 6.4.1.2.5.2, Page 148, Table 6-14
From Text:

Table 6-14 EPR Adjustable Voltage Supply APDO – Source

Bit(s)	Description
B31…30	11b – Augmented Power Data Object (APDO)
B29…28	01b – EPR Adjustable Voltage Supply 10b…11b - Reserved, Shall Not be used
B27…26	Reserved – Shall be set to zero
B25…17	Maximum Voltage in 100mV increments
B16	Reserved – Shall be set to zero
B15…8	Minimum Voltage in 100mV increments
B7…0	PDP in 1W increments

To Text:

Table 6-14 EPR Adjustable Voltage Supply APDO – Source

Bit(s)	Description
B31…30	11b – Augmented Power Data Object (APDO)
B29…28	01b – EPR Adjustable Voltage Supply 10b…11b - Reserved, Shall Not be used
B27…26	Peak Current (see Table 6-15)
B25…17	Maximum Voltage in 100mV increments
B16	Reserved – Shall be set to zero
B15…8	Minimum Voltage in 100mV increments
B7…0	PDP in 1W increments

b). New Section 6.4.1.2.5.2.2
New Text:

6.4.1.2.5.2.2 Peak Current

The USB Power Delivery EPR Adjustable Voltage Supply is only required to deliver the amount of current requested in the Operating Current (IOC) field of an AVS RDO. In some usages however, for example computer systems, where there are short bursts of activity, it might be desirable to overload the power source for short periods.

For example, when a computer system tries to maintain average power consumption, the higher the peak current, the longer the low current period needed to maintain such average power (see Section 7.2.8). The Peak Current field allows a power source to Advertise this additional capability. This capability is intended for direct Port to Port connections only and *Shall Not* be offered to downstream Sinks via a Hub.

Every EPR Adjustable voltage Supply PDO *Shall* contain a Peak Current field. Supplies that want to offer a set of overload capabilities *Shall* Advertise this through the Peak Current field in the corresponding EPR AVS PDO (see Table 6-15). Supplies that do not support an overload capability *Shall* set these bits to 00b in the corresponding EPR AVS PDO. Supplies that support an extended overload capability specified in the PeakCurrent1…3 fields of the *Source_Capabilities_Extended* Message (see Section 6.5.1) *Shall* set these bits to 00b. Sinks wishing to utilize these extended capabilities *Shall* first send a *Get_Source_Cap_Extended* Message to determine what capabilities, if any are supported by the Source.

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Table 6-15 EPR AVS Power Source Peak Current Capability

Bits 27…26	Description
00	Peak current equals I$_{OC}$ (default) or look at extended Source capabilities (send ***Get_Source_Cap_Extended*** Message)
01	Overload Capabilities: 1. Peak current equals 150% I$_{OC}$ for 1ms @ 5% duty cycle (low current equals 97% I$_{OC}$ for 19ms) 2. Peak current equals 125% I$_{OC}$ for 2ms @ 10% duty cycle (low current equals 97% I$_{OC}$ for 18ms) 3. Peak current equals 110% I$_{OC}$ for 10ms @ 50% duty cycle (low current equals 90% I$_{OC}$ for 10ms)
10	Overload Capabilities: 1. Peak current equals 200% I$_{OC}$ for 1ms @ 5% duty cycle (low current equals 95% I$_{OC}$ for 19ms) 2. Peak current equals 150% I$_{OC}$ for 2ms @ 10% duty cycle (low current equals 94% I$_{OC}$ for 18ms) 3. Peak current equals 125% I$_{OC}$ for 10ms @ 50% duty cycle (low current equals 75% I$_{OC}$ for 10ms)
11	Overload Capabilities: 1. Peak current equals 200% I$_{OC}$ for 1ms @ 5% duty cycle (low current equals 95% I$_{OC}$ for 19ms) 2. Peak current equals 175% I$_{OC}$ for 2ms @ 10% duty cycle (low current equals 92% I$_{OC}$ for 18ms) 3. Peak current equals 150% I$_{OC}$ for 10ms @ 50% duty cycle (low current equals 50% I$_{OC}$ for 10ms)

c). Section 7.1.11, Page 295

From Text:

A Source that has the Fixed Supply PDO Peak Current bits set to 01b, 10b and 11b ***Shall*** be designed to support one of the overload capabilities defined in Table 6-10. The overload conditions are bound in magnitude, duration and duty cycle as listed in Table 6-10. Sources are not required to support continuous overload operation. When overload conditions occur, the Source is allowed the range of ***vSrcPeak*** (instead of ***vSrcNew)*** relative to the nominal value (see Figure 7-15). When the overload capability is exceeded, the Source is expected take whatever action is necessary to prevent electrical or thermal damage to the Source. The Source ***May*** send a new ***Source_Capabilities*** Message with the Fixed Supply PDO Peak Current bits set to 00b to prohibit overload operation even if an overload capability was previously negotiated with the Sink.

To Text:

A Source that has the Fixed Supply PDO or EPR AVS APDO Peak Current bits set to 01b, 10b and 11b ***Shall*** be designed to support one of the overload capabilities defined in Table 6-10 or Table 6-15 respectively. The overload conditions are bound in magnitude, duration and duty cycle as listed in Table 6-10 or Table 6-15. Sources are not required to support continuous overload operation. When overload conditions occur, the Source is allowed the range of ***vSrcPeak*** (instead of ***vSrcNew)*** relative to the nominal value (see Figure 7-15). When the overload capability is exceeded, the Source is expected take whatever action is necessary to prevent electrical or thermal damage to the Source. The Source ***May*** send a new ***Source_Capabilities*** Message with the Fixed Supply PDO or EPR AVS APDO Peak Current bits set to 00b to prohibit overload operation even if an overload capability was previously negotiated with the Sink.

d). Section 7.1.12.4, Page 298

From Text:

The Source reports its ability to source peak current delivery in excess of the negotiated amount in the Peak Current field. The duration of peak current ***Shall*** be followed by a current consumption below the Operating Current (IoC) in order to maintain average power delivery below the IoC current.

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A Source *May* have greater capability to source peak current than can be reported using the Peak Current field in the Fixed Supply PDO. In this case the Source *Shall* report its additional capability in the Peak Current field in the *Source_Capabilities_Extended* Message.

Each overload period *Shall* be followed by a period of reduced current draw such that the rolling average current over the Overload Period field value with the specified Duty Cycle field value (see Section 6.5.1.10) *Shall Not* exceed the negotiated current. This is calculated as:

*Period of reduced current = (1 – value in Duty Cycle field/100) * value in Overload Period field*

To Text:

The Source reports its ability to source peak current delivery in excess of the negotiated amount in the Peak Current field. The duration of peak current *Shall* be followed by a current consumption below the Operating Current (IoC) in order to maintain average power delivery below the IoC current.
A Source *May* have greater capability to source peak current than can be reported using the Peak Current field in the Fixed Supply PDO or EPR AVS APDO. In this case the Source *Shall* report its additional capability in the Peak Current field in the *Source_Capabilities_Extended* Message.

Each overload period *Shall* be followed by a period of reduced current draw such that the rolling average current over the Overload Period field value with the specified Duty Cycle field value (see Section 6.5.1.10) *Shall Not* exceed the negotiated current. This is calculated as:

*Period of reduced current = (1 – value in Duty Cycle field/100) * value in Overload Period field*

d). Section 7.2.8, Page 304

From Text:

Sinks *Shall* only make use of a Source overload capability when the corresponding Fixed Supply PDO Peak Current bits are set to 01b, 10b and 11b (see Section 6.4.1.2.2.8). Sinks *Shall* manage thermal aspects of the overload event by not exceeding the average negotiated output of a Fixed Supply that supports Peak Current operation.

Sinks that depend on the Peak Current capability for enhanced system performance *Shall* also function correctly when Attached to a Source that does not offer the Peak Current capability or when the Peak Current capability has been inhibited by the Source.

To Text:

Sinks *Shall* only make use of a Source overload capability when the corresponding Fixed Supply PDO Peak Current (see Section 6.4.1.2.2.8) or EPR Adjustable Voltage Supply APDO Peak Current (see Section 6.4.1.2.5.2.2) bits are set to 01b, 10b and 11b (see Section 6.4.1.2.2.8). Sinks *Shall* manage thermal aspects of the overload event by not exceeding the average negotiated output of a Fixed Supply or EPR AVS that supports Peak Current operation.

Sinks that depend on the Peak Current capability for enhanced system performance *Shall* also function correctly when Attached to a Source that does not offer the Peak Current capability or when the Peak Current capability has been inhibited by the Source.

e). Section 7.4.1, Table 7-24, Page 360

From Text:

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Parameter	Description	MIN	TYP	MAX	UNITS	Reference
vSrcPeak	The range that a Fixed Supply in Peak Current operation is allowed when overload conditions occur.	PDO Voltage *0.90		PDO Voltage *1.05	V	Table 6-10 Figure 7-12

To Text:

Parameter	Description	MIN	TYP	MAX	UNITS	Reference
vSrcPeak	The range that a Fixed Supply or EPR AVS in Peak Current operation is allowed when overload conditions occur.	PDO Voltage *0.90		PDO Voltage *1.05	V	Table 6-10 Table 6-15 Figure 7-12