

# USB Power Delivery ENGINEERING CHANGE NOTICE

## Title: SPR Adaptable Voltage Supply (AVS) Definition

### Applied to: USB Power Delivery Specification Revision 3.1 Version 1.8

<b>Brief description of the functional changes proposed:</b>
This ECN defines a normative SPR version of AVS for Sources with PDPs greater than 27W. The concept follows the EPR definition although has been adjusted to stay in alignment with the existing SPR Fixed Voltage Power Rules as it relates to 3A/5A requirements around the inflection point of 60W. The ECN also clarifies across all Power Rules to align with the new definitions for Port Maximum PDP and Port Present PDP.

<b>Benefits as a result of the proposed changes:</b>
Provides a standard solution to allowing Sink's to get intermediate voltages as opposed to relying on the availability of proprietary optional voltages that meet the needs of the Sink.

<b>An assessment of the impact to the existing revision and systems that currently conform to the USB specification:</b>
This is a new specification that defines a new normative feature – at some point, all USB chargers above PDP of 27W will be required to implement the new AVS feature based on the PDP rating for each of its ports.

<b>An analysis of the hardware implications:</b>
SPR w/AVS hardware will be more complex than SPR w/o AVS since it will now have to support SPR AVS in addition to SPR Fixed Voltages. Support for SPR PPS remains optional although with recent simplification of PPS requirements, it is possible that newer SPR chargers will support both AVS and PPS.

<b>An analysis of the software implications:</b>
SPR software/firmware will be more complex since it will now have to support SPR AVS in addition to SPR Fixed Voltages.

<b>An analysis of the compliance testing implications:</b>
All new.

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Changes requested shown as red-lined changes to original spec content.

## (a) Section 1.6, Table 1-1

From Text:

Table 1-1 Terms and Abbreviations

Term	Description
Adjustable Voltage Supply (AVS)	A power supply whose output Voltage can be adjusted to an operating Voltage within its Advertised range. These capabilities are exposed by the Adjustable Voltage Supply (AVS) APDO (see Section 6.4.1.2.5). Note unlike the SPR PPS, the EPR AVS does not support current limit.
Augmented Power Data Object (APDO)	Data Object used to expose a Source Port's power capabilities or a Sink's power requirements as part of a <i>Source_Capabilities</i> or <i>Sink_Capabilities</i> Message respectively. Programmable Power Supply Data Object is defined.
Current Limit (CL)	A current limiting feature of an SPR PPS Source. When a Sink operating in SPR PPS mode attempts to draw more current from the Source than the requested Current Limit value, the Source reduces its output Voltage so the current it supplies remains at or below the requested value. Note current limit is not supported by EPR AVS Sources.
EPR PDO	<ul style="list-style-type: none"><li>Fixed PDO that offers either 28V, 36V or 48V.</li><li>AVS APDO whose Maximum Voltage is highest voltage in the <i>EPR_Source_Capabilities</i> Message and no more than 240W.</li></ul>
Equivalent PDP Rating	For a Shared port, the remaining power, calculated as the Voltage times current (VA) of the remaining available power minus the required reserved power for all remaining unused ports within the group of Shared ports. For an Assured port, the labeled PDP.
PD Power (PDP)	The output power, in Watts, of a Source, as specified by the manufacturer and expressed in Fixed Supply PDOs as defined in Section 10.
Programmable Power Supply (PPS)	A power supply, operating in SPR Mode, whose output Voltage can be programmatically adjusted in small increments over its Advertised range, and also has a programmable output current fold back (note that the EPR AVS does not). The capabilities are exposed by the SPR Programmable Power Supply APDO (see Section 6.4.1.2.5).
SPR PPS	A power supply operating in SPR PPS Mode whose output Voltage and output current can be programmatically adjusted in small increments over its Advertised range. It supports current limit unlike EPR AVS. The capabilities are exposed by the Programmable Power Supply APDOs (see Section 6.4.1.2.5).
SPR PDO	<ul style="list-style-type: none"><li>Fixed PDO that offers up to 20V and no more than 100W.</li><li>Variable PDO whose Maximum Voltage offers up to 21V and no more than 100W.</li><li>Battery PDO whose Maximum Voltage offers up to 21V and no more than 100W.</li><li>Programmable APDO whose Maximum Voltage is up to 21V and no more than 100W.</li></ul>

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## To Text:

Table 1-1 Terms and Abbreviations

Term	Description
Adjustable Voltage Supply (AVS)	A power supply whose output Voltage can be adjusted to an operating Voltage within its Advertised range. These capabilities are exposed by the Adjustable Voltage Supply (AVS) APDO (see Section 6.4.1.2.5). Note unlike the SPR PPS, the <b>SPR AVS and EPR AVS</b> do not support current limit.
Augmented Power Data Object (APDO)	Data Object used to expose a Source Port's power capabilities or a Sink's power requirements as part of a <b>Source_Capabilities / EPR_Source_Capabilities</b> or <b>Sink_Capabilities / EPR_Sink_Capabilities</b> Message respectively. <b>SPR</b> Programmable Power Supply Data Object, <b>SPR Adjustable Voltage Supply Data Object</b> and <b>EPR Adjustable Voltage Supply Data Object</b> are defined.
Current Limit (CL)	A current limiting feature of an SPR PPS Source. When a Sink operating in SPR PPS mode attempts to draw more current from the Source than the requested Current Limit value, the Source reduces its output Voltage so the current it supplies remains at or below the requested value. Note current limit is not supported by <b>SPR and EPR AVS</b> Sources.
EPR PDO	<ul style="list-style-type: none"> <li>Fixed <b>Supply</b> PDO that offers either 28V, 36V or 48V.</li> <li><b>Adjustable Voltage Supply (AVS)</b> APDO whose Maximum Voltage is highest voltage in the <b>EPR_Source_Capabilities</b> Message and no more than 240W.</li> </ul>
<b>Equivalent PDP Rating</b>	<b>For a Shared port, the remaining power, calculated as the Voltage times current (VA) of the remaining available power minus the required reserved power for all remaining unused ports within the group of Shared ports. For an Assured port, the labeled PDP.</b>
PD Power (PDP)	The output power, in Watts, of a Source, as specified by the manufacturer and expressed in Fixed Supply PDOs as defined in Section 10.
Programmable Power Supply (PPS)	A power supply, operating in SPR Mode, whose output Voltage can be programmatically adjusted in small increments over its Advertised range, and also has a programmable output current fold back (note that the <b>SPR and EPR AVS</b> does not). The capabilities are exposed by the SPR Programmable Power Supply APDO (see Section 6.4.1.2.5).
<b>SPR AVS</b>	<b>A power supply operating in SPR mode whose output voltage can be adjusted to an operating voltage within its advertised range. Unlike SPR PPS, it does not support current limit. The AVS capabilities are exposed by the SPR Adjustable Voltage Supply APDO (see Section 6.4.1.2.5.3).</b>
SPR PPS	A power supply operating in SPR PPS Mode whose output Voltage and output current can be programmatically adjusted in small increments over its Advertised range. It supports current limit unlike <b>SPR and EPR AVS</b> . The capabilities are exposed by the Programmable Power Supply APDOs (see Section 6.4.1.2.5).
SPR PDO	<ul style="list-style-type: none"> <li>Fixed <b>Supply</b> PDO that offers up to 20V and no more than 100W.</li> <li>Variable <b>Supply</b> PDO whose Maximum Voltage offers up to 21V and no more than 100W.</li> <li>Battery <b>Supply</b> PDO whose Maximum Voltage offers up to 21V and no more than 100W.</li> <li><b>Adjustable Voltage Supply (AVS) APDO whose Maximum Voltage is up to 20V and no more than 100W.</b></li> <li>Programmable <b>Power Supply (PPS)</b> APDO whose Maximum Voltage is up to 21V and no more than 100W.</li> </ul>

## (b) Section 2.9.3

## From Text:

### 2.9.3 Adjustable Voltage Supply (AVS) Charging Models

USB Power Delivery operating in EPR mode includes support for Adjustable Voltage Supply (AVS) charging using a set of defined standard Voltage ranges based on the Source's PDP rating.

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The standard Voltage ranges available in the Extended Power Range (EPR) for AVS are summarized in Table 2 2.

Table 2-3 EPR Adjustable Voltage Supply Voltage Ranges

PDP	Minimum Voltage (V)	Maximum Voltage (V)
100...140W	15	28
>140...180W	15	36
>180...240W	15	48
Note: Available current is PDP/Maximum Voltage rounded down to the nearest 50mA.		

## To Text:

### 2.9.3 Adjustable Voltage Supply (AVS) Charging Models

USB Power Delivery operating in **SPR mode (when PDP is higher than 27W) and** EPR mode includes support for Adjustable Voltage Supply (AVS) charging using a set of defined standard Voltage ranges based on the Source's PDP rating.

The standard Voltage ranges available **in the Extended Power Range (EPR)** for AVS are summarized in Table 22-3.

Table 2-3 EPR-Adjustable Voltage Supply Voltage Ranges

PDP	SPR AVS			EPR AVS		
	Minimum Voltage (V)	Maximum Voltage (V)	Maximum Available Current <sup>3</sup>	Minimum Voltage (V)	Maximum Voltage (V)	Maximum Available Current
>27...45W	9	15	3A	Not applicable		
>45...60W	9	20	3A			
>60...100W	9	20	5A <sup>1</sup>			
100...140W	9	20	5A <sup>2</sup>	15	28	5A <sup>2</sup>
>140...180W	9	20	5A <sup>2</sup>	15	36	5A <sup>2</sup>
>180...240W	9	20	5A <sup>2</sup>	15	48	5A <sup>2</sup>
Note: Available current is PDP/Maximum Voltage rounded down to the nearest 50mA.						
<sup>1</sup> Requires a 5A Cable.						
<sup>2</sup> Requires an EPR Cable.						
<sup>3</sup> The maximum available SPR AVS current is determined by the maximum available current in the Fixed 15V PDO in the 9 – 15V range and Fixed 20V PDO in the 15 – 20V range.						

## (c) Section 6.4.1

### From Text:

#### 6.4.1 Capabilities Message

A Capabilities Message (**Source\_Capabilities** Message or **Sink\_Capabilities** Message) **Shall** have at least one Power Data Object for **vSafe5V**. The Capabilities Message **Shall** also contain the sending Port's information followed by up to 6 additional Power Data Objects. Power Data Objects in a Capabilities Message **Shall** be sent in the following order:

1. The **vSafe5V** Fixed Supply Object **Shall** always be the first object.
2. The remaining Fixed Supply Objects, if present, **Shall** be sent in Voltage order; lowest to highest.
3. The Battery Supply Objects if present **Shall** be sent in Minimum Voltage order; lowest to highest.
4. The Variable Supply (non-Battery) Objects, if present, **Shall** be sent in Minimum Voltage order; lowest to highest.
5. The Programmable Power Supply Objects, if present, **Shall** be sent in Maximum Voltage order; lowest to highest.

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There is one type of Augmented Power Data Object:

- Programmable Power Supply is used to expose a power supply whose output Voltage can be programmatically adjusted over the Advertised Voltage range.

The Augmented Power Data Object (APDO) is defined to allow support for more than the four PDO types by extending the Power Data Object field from 2 to 4 bits when the B31...B30 are 11b. The generic APDO structure is shown in Table 6-8.

Table 6-8 Augmented Power Data Object

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	00b – SPR Programmable Power Supply 01b – EPR Adjustable Voltage Supply 01b-11b - <i>Reserved</i>
B27...0	Specific Power Capabilities are described by the APDOs in the following sections.

## To Text:

### 6.4.1 Capabilities Message

A Capabilities Message (*Source\_Capabilities* Message or *Sink\_Capabilities* Message) **Shall** have at least one Power Data Object for *vSafe5V*. The Capabilities Message **Shall** also contain the sending Port's information followed by up to 6 additional Power Data Objects. Power Data Objects in a Capabilities Message **Shall** be sent in the following order:

1. The *vSafe5V* Fixed Supply Object **Shall** always be the first object.
2. The remaining Fixed Supply Objects, if present, **Shall** be sent in Voltage order; lowest to highest.
3. The Battery Supply Objects if present **Shall** be sent in Minimum Voltage order; lowest to highest.
4. The Variable Supply (non-Battery) Objects, if present, **Shall** be sent in Minimum Voltage order; lowest to highest.
5. The SPR Adjustable Voltage Supply Object, if present, **Shall** be sent.
6. The Programmable Power Supply Objects, if present, **Shall** be sent in Maximum Voltage order, lowest to highest.

**Note:** The EPR Capabilities message construction is defined in Section 6.5.15.1.

There ~~is one~~ **are three** types of Augmented Power Data Objects:

- **SPR** Programmable Power Supply is used to expose a power supply whose output Voltage can be programmatically adjusted over the Advertised Voltage range **and limited by the Source to a programmable current limit.**
- **SPR and EPR Adjustable Voltage Supply are used to expose a power supply whose output Voltage can be adjusted over the Advertised Voltage range but otherwise is equivalent to a fixed Voltage power supply (AVS does not support a programmable current limit).**

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The Augmented Power Data Object (APDO) is defined to allow support for more than the four PDO types by extending the Power Data Object field from 2 to 4 bits when the B31...B30 are 11b. The generic APDO structure is shown in Table 6-8.

Table 6-8 Augmented Power Data Object

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	00b – SPR Programmable Power Supply 01b – EPR Adjustable Voltage Supply <b>10b – SPR Adjustable Voltage Supply</b> <del>01b</del> 11b - <b>Reserved</b>
B27...0	Specific Power Capabilities are described by the APDOs in the following sections.

## (d) Section 6.4.1.2.5

### From Text:

#### 6.4.1.2.5 Augmented Power Data Object (APDO)

These APDOs are used primarily for Sink Directed Charge of a Battery in the Sink. When applying a current to the Battery greater than the cable supports, a high efficiency fixed scaler **May** be used in the Sink to reduce the cable current.

The Voltage fields define the output Voltage range over which the power supply **Shall** be adjustable in 20mV steps in SPR PPS Mode and 100mV steps in EPR AVS Mode. The Maximum Current field contains the current the Programmable Power Supply **Shall** be capable of delivering over the Advertised Voltage range. See Section 7.1.3 for the electrical requirements of the power supply.

##### 6.4.1.2.5.1 SPR Programmable Power Supply APDO

Table 6-13 below describes the SPR Programmable Power Supply (1100b) APDO for a Source operating in SPR Mode and supplying 5V up to 21V.

Table 6-13 SPR Programmable Power Supply APDO – Source

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	00b – SPR Programmable Power Supply
B27	PPS Power Limited
B26...25	<b>Reserved</b> – <b>Shall</b> be set to zero
B24...17	Maximum Voltage in 100mV increments
B16	<b>Reserved</b> – <b>Shall</b> be set to zero
B15...8	Minimum Voltage in 100mV increments
B7	<b>Reserved</b> – <b>Shall</b> be set to zero
B6...0	Maximum Current in 50mA increments

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## 6.4.1.2.5.2 EPR Adjustable Voltage Supply APDO

Table 6-14 below describes the EPR Adjustable Voltage Supply (1101b) APDO for a Source operating in EPR Mode and supplying 15V up to 48V.

**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
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

### 6.4.1.2.5.2.1 PDP

The PDP field **Shall** contain the AVS Port's PDP Rating. For shared AVS Ports, this field **Shall** contain the AVS Port's Equivalent PDP Rating. See Section 10.2.3.3 and Figure 10-3 for more information regarding how PDP in the AVS APDO relates to maximum available current.

## To Text:

### 6.4.1.2.5 Augmented Power Data Object (APDO)

~~These APDOs are used primarily for Sink Directed Charge of a Battery in the Sink. When applying a current to the Battery greater than the cable supports, a high efficiency fixed scaler **May** be used in the Sink to reduce the cable current.~~

The Voltage fields define the output Voltage range over which the power supply **Shall** be adjustable in 20mV steps in SPR PPS Mode and 100mV steps in **both SPR AVS Mode and** EPR AVS Mode. The Maximum Current field contains the current the Programmable Power Supply **Shall** be capable of delivering over the Advertised Voltage range. See Section 7.1.3 for the electrical requirements of the power supply.

### 6.4.1.2.5.1 SPR Programmable Power Supply APDO

Table 6-13 below describes the SPR Programmable Power Supply (1100b) APDO for a Source operating in SPR Mode and supplying 5V up to 21V.

**Table 6-13 SPR Programmable Power Supply APDO – Source**

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	00b – SPR Programmable Power Supply
B27	PPS Power Limited
B26...25	<b>Reserved – Shall</b> be set to zero
B24...17	Maximum Voltage in 100mV increments
B16	<b>Reserved – Shall</b> be set to zero
B15...8	Minimum Voltage in 100mV increments
B7	<b>Reserved – Shall</b> be set to zero
B6...0	Maximum Current in 50mA increments

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These PPS APDOs are used primarily for Sink Directed Charge of a Battery in the Sink. When applying a current to the Battery greater than the cable supports, a high efficiency fixed scaler **May** be used in the Sink to reduce the cable current.

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## 6.4.1.2.5.2 EPR Adjustable Voltage Supply APDO

Table 6-14 below describes the EPR Adjustable Voltage Supply (1101b) APDO for a Source operating in EPR Mode and supplying 15V up to 48V.

**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
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

### 6.4.1.2.5.2.1 PDP

The PDP field **Shall** contain the AVS Port's **Advertised PDP Rating**. For shared AVS Ports, this field **Shall** contain the **AVS Port's Equivalent PDP Rating**. See Section 10.2.3.3 and Figure 10-3 for more information regarding how PDP in the AVS APDO relates to maximum available current.

## (e) New Section 6.4.1.2.5.3

### New Text:

## 6.4.1.2.5.3 SPR Adjustable Voltage Supply APDO

Table 6-16 below describes the SPR Adjustable Voltage Supply (1110b) APDO for a Source operating in SPR Mode and supplying 9V up to 20V.

**Table 6-16 SPR Adjustable Voltage Supply APDO – Source**

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	10b – SPR Adjustable Voltage Supply
B27...26	Peak Current (see Table 6-10)
B25...20	<b>Reserved – Shall</b> be set to zero
B19...10	For 9V – 15V range: Maximum Current in 10mA units equal to the Maximum Current field of the 15V Fixed Source PDO
B9...0	For 15V – 20V range: Maximum Current in 10mA units equal to the Maximum Current field of the 20V Fixed Source PDO, set to 0 if the Maximum voltage in the SPR AVS range is 15V.



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## 6.4.1.2.5.3.1 Peak Current

Peak Current for SPR AVS APDO follows the same definition for Fixed Supply PDOs (see Section 6.4.1.2.2.8 and Table 6-10).

### (f) Section 6.4.1.3.4

#### From Text:

#### 6.4.1.3.4 Augmented Power Data Object

Table 6-19 Programmable Power Supply APDO - Sink and Table 6-20 EPR Adjustable Voltage Supply APDO - Sink below describe the Programmable Power Supply (1100b) APDOs used by a Sink. See Section 7.1.3 for the electrical requirements of the power supply.

The Maximum and Minimum Voltage fields **shall** be set to the output Voltage range that the Sink requires to operate. The Operational Current field **shall** be set to the maximum current the Sink requires over the Voltage range. The Operating Current in the PPS APDO is defined as the maximum amount of current the device needs to fully support its function (e.g., Sink Directed Charge). The PDP in the AVS is defined as the PDP the device needs to fully support its function.

#### 6.4.1.3.4.1 SPR Programmable Power Supply APDO

Table 6-19 Programmable Power Supply APDO - Sink below describes a SPR Programmable Power Supply (1100b) APDO for a Sink operating in SPR Mode and consuming 21V or less.

**Table 6-19 Programmable Power Supply APDO – Sink**

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	00b – SPR Programmable Power Supply
B27...25	<b>Reserved</b> – <b>shall</b> be set to zero
B24...17	Maximum Voltage in 100mV increments
B16	<b>Reserved</b> – <b>shall</b> be set to zero
B15...8	Minimum Voltage in 100mV increments
B7	<b>Reserved</b> – <b>shall</b> be set to zero
B6...0	Maximum Current in 50mA increments

#### 6.4.1.3.4.2 EPR Adjustable Voltage Supply APDO

Table 6-20 EPR Adjustable Voltage Supply APDO - Sink below describes a EPR Adjustable Voltage Supply (1101b) APDO for a Sink operating in EPR Mode. The PDP in the AVS APDO is defined as the PDP the device needs to fully support its function.

**Table 6-20 EPR Adjustable Voltage Supply APDO - Sink**

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	01b – EPR Adjustable Voltage Supply
B27...26	Reserved – <b>shall</b> be set to zero
B25...17	Maximum Voltage in 100mV increments
B16	Reserved – <b>shall</b> be set to zero

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Bit(s)	Description
B15...8	Minimum Voltage in 100mV increments
B7...0	PDP in 1W increments

## To Text:

### 6.4.1.3.4 Augmented Power Data Object

~~Table 6-19 Programmable Power Supply APDO – Sink and Table 6-20 EPR Adjustable Voltage Supply APDO – Sink below describe the Programmable Power Supply (1100b) APDOs used by a Sink. See Section 7.1.3 for the electrical requirements of the power supply.~~

The Maximum and Minimum Voltage fields **shall** be set to the output Voltage range that the Sink requires to operate. The Operational Current field **shall** be set to the maximum current the Sink requires over the Voltage range. The Operating Current in the PPS APDO is defined as the maximum amount of current the device needs to fully support its function (e.g., Sink Directed Charge). The PDP in the AVS is defined as the PDP the device needs to fully support its function.

#### 6.4.1.3.4.1 SPR Programmable Power Supply APDO

Table 6-19 Programmable Power Supply APDO - Sink below describes a SPR Programmable Power Supply (1100b) APDO for a Sink operating in SPR Mode and consuming 21V or less. The Operational Maximum Current field **shall** be set to the maximum current the Sink requires over the Voltage range. The Operating Maximum Current in the PPS APDO is defined as the maximum amount of current the device needs to fully support its function (e.g., Sink Directed Charge).

**Table 6-19 Programmable Power Supply APDO – Sink**

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	00b – SPR Programmable Power Supply
B27...25	<b>Reserved</b> – <b>shall</b> be set to zero
B24...17	Maximum Voltage in 100mV increments
B16	<b>Reserved</b> – <b>shall</b> be set to zero
B15...8	Minimum Voltage in 100mV increments
B7	<b>Reserved</b> – <b>shall</b> be set to zero
B6...0	Maximum Current in 50mA increments

#### 6.4.1.3.4.2 EPR Adjustable Voltage Supply APDO

Table 6-20 EPR Adjustable Voltage Supply APDO - Sink below describes a EPR Adjustable Voltage Supply (1101b) APDO for a Sink operating in EPR Mode. The PDP in the **EPR** AVS APDO **for the Sink** is defined as the PDP the device needs to fully support its function.

**Table 6-20 EPR Adjustable Voltage Supply APDO - Sink**

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	01b – EPR Adjustable Voltage Supply
B27...26	Reserved – <b>shall</b> be set to zero
B25...17	Maximum Voltage in 100mV increments

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Bit(s)	Description
B16	Reserved – <b>shall</b> be set to zero
B15...8	Minimum Voltage in 100mV increments
B7...0	PDP in 1W increments

## (g) Section 10.2

### From Text:

#### 10.2 Source Power Rules

In order to meet the expectations of the user, the Maximum Current/Power in the Source Capabilities PDO or APDO for Sources with a PDP Rating of x Watts **shall** be as follows:

- Maximum current for Normative and Optional Fixed/Variable supply PDOs **shall** be either RoundUp(x/Voltage) or RoundDown(x/Voltage) to the nearest 10mA.
- Maximum current for Programmable Power Supply APDOs **shall** be as defined in Table 10-7. Note that when the Constant Power bit is set in the APDO, the programmable power supply's output current is as defined in Table 10-7 however the programmable power supply will limit its output current so that the product of its actual output Voltage times the output current does not exceed the PDP.
- Maximum current for Programmable Power Supply APDOs not defined in Table 10-7 **shall** be RoundDown (x/Max Voltage) to the nearest 50mA.
- If a 5V Prog, 9V Prog, 15V Prog or 20V Prog Programmable Power Supply APDO is advertised when not required by Table 10-7, then the maximum current **shall** be RoundDown (x/Prog Voltage) to the nearest 50mA. When the PPS Power Limited bit is clear the Source **shall** provide this current at Max Voltage.
- Maximum power for Optional Battery supply PDOs **shall** be  $\leq x$ .

### To Text:

#### 10.2 Source Power Rules

In order to meet the expectations of the user, the Maximum Current/Power in the Source Capabilities PDO or APDO for Sources with a PDP Rating of x Watts **shall** be as follows:

- Maximum current for Normative and Optional Fixed/Variable supply PDOs **shall** be either RoundUp(x/Voltage) or RoundDown(x/Voltage) to the nearest 10mA.
- Maximum current for **SPR** Programmable Power Supply APDOs **shall** be as defined in Table 10-7. Note that when the Constant Power bit is set in the APDO, the programmable power supply's output current is as defined in Table 10-7 however the programmable power supply will limit its output current so that the product of its actual output Voltage times the output current does not exceed the PDP.
- ~~Maximum current for Programmable Power Supply APDOs not defined in Table 10-7 **shall** be RoundDown (x/Max Voltage) to the nearest 50mA.~~
- If a 5V Prog, 9V Prog, 15V Prog or 20V Prog Programmable Power Supply APDO is advertised when not required by Table 10-7, then the maximum current **shall** be RoundDown (x/Prog Voltage) to the nearest 50mA. When the PPS Power Limited bit is clear the Source **shall** provide this current at Max Voltage.
- Maximum power for Optional Battery supply PDOs **shall** be  $\leq x$ .

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## (g) Section 10.2

### From Text:

#### 10.2.2 Normative Voltages and Currents

The Voltages and currents an SPR Source with a PDP Rating of x Watts **Shall** support are as defined in Table 10-2.

**Table 10-2 SPR Normative Voltages and Minimum Currents**

PDP Rating (W)	Current at 5V (A)	Current at 9V (A)	Current at 15V (A)	Current at 20V (A)
$0.5 \leq x \leq 15$	$PDP/5^3$			
$15 < x \leq 27$	$3^2$	$PDP/9^3$		
$27 < x \leq 45$	$3^2$	$3^2$	$PDP/15^3$	
$45 < x \leq 60$	$3^2$	$3^2$	$3^2$	$PDP/20^3$
$60 < x \leq 100$	$3^2$	$3^2$	$3^2$	$PDP/20^{1,3}$

1. Requires a 5A cable.  
 2. The Fixed PDOs Maximum Current field **Shall** advertise at least 3A, but **May** advertise up to RoundUp (PDP/Voltage) to the nearest 10mA. Requires a 5A cable if over 3A is advertised.  
 3. The Fixed PDOs Maximum Current field **Shall** advertise either RoundDown (PDP/Voltage) or RoundUp (PDP/Voltage) to the nearest 10mA

Figure 10-1 illustrates the minimum current that an SPR Source **Shall** support at each Voltage for a given PDP Rating. Note: Not illustrated are that currents higher than 3A are allowed to be offered up to a limit of 5A given that a 5A cable is detected by the Source and the Voltage times current remains within the Source PDP Rating.

**Figure 10-1 SPR Source Power Rule Illustration**

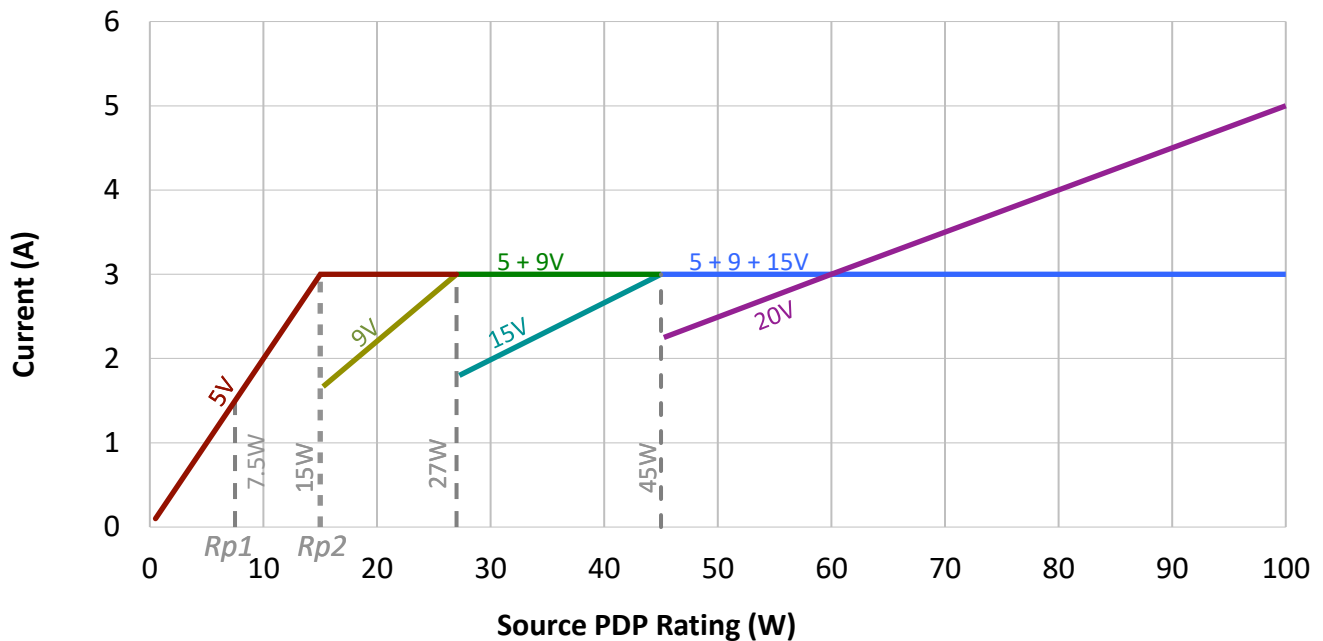
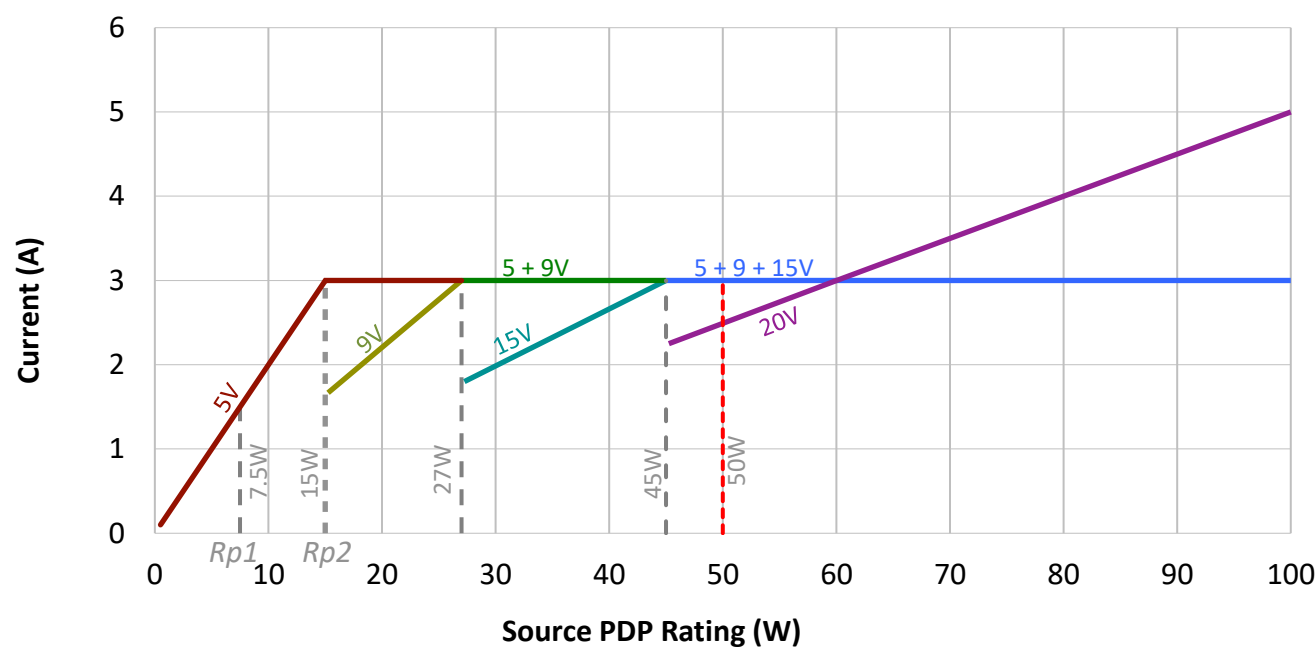


Figure 10-2 shows an example of an adapter with a rating at 50W. The adapter is required to support 20V at 2.5A, 15V at 3A, 9V at 3A and 5V at 3A.

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Figure 10-2 SPR Source Power Rule Example



To Text:

## 10.2.2 Normative Voltages and Currents

The Voltages and currents an SPR Source with a PDP Rating of x Watts *shall* support are as defined in Table 10-2.

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**Table 10-2 SPR Normative Voltages and Minimum Currents Source Capabilities based on Port Maximum PDP**

Port Maximum PDP Rating (W)	5V Fixed Current at 5V (A)	9V Fixed Current at 9V (A)	15V Fixed Current at 15V (A)	20V Fixed Current at 20V (A)	SPR AVS
$0.5 \leq x \leq 15$	$(PDP/5)A^3$				
$15 < x \leq 27$	$3A^2$	$(PDP/9)A^3$			
$27 < x \leq 45$	$3A^2$	$3A^2$	$(PDP/15)A^3$		(9V – 15V): (15V Fixed Max Current) A
$45 < x \leq 60$	$3A^2$	$3A^2$	$3A^2$	$(PDP/20)A^3$	(9V – 15V): (15V Fixed Max Current) A <sup>4</sup> (15V – 20V): (20V Fixed Max Current) A
$60 < x \leq 100$	$3A^2$	$3A^2$	$3A^2$	$(PDP/20)A^{1,3}$	(9V – 15V): (15V Fixed Max Current) A <sup>4,5</sup> (15V – 20V): (20V Fixed Max Current) A <sup>1,5</sup>
<ol style="list-style-type: none"> <li>Requires a 5A cable.</li> <li>The Fixed PDOs Maximum Current field <b>shall</b> advertise at least 3A, but <b>may</b> advertise up to RoundUp (PDP/voltage) to the nearest 10mA. Requires a 5A cable if over 3A is advertised.</li> <li>The Fixed PDOs Maximum Current field <b>shall</b> advertise either RoundDown (PDP/voltage) or RoundUp (PDP/voltage) to the nearest 10mA.</li> <li>SPR AVS current for this voltage range is the maximum current as advertised by the 15V Fixed Source PDO. This current may be higher than 3A (refer to Note 2). Requires a 5A cable if over 3A is advertised.</li> <li>The Sink is allowed to request up to the 20V Fixed Max Current when the requested voltage is 15.0V.</li> </ol>					

**Table 10-3 SPR Source Capabilities When Port Present PDP is less than Port Maximum PDP**

Port Present PDP (W)	5V Fixed	9V Fixed	15V Fixed	20V Fixed	SPR AVS with Max Voltage of 15V or 20V per Table 10-2 <sup>6</sup>
0.5 ≤ x ≤ 15	(PDP/5)A <sup>3</sup>	(PDP/9)A <sup>3, 7</sup>	(PDP/15)A <sup>3, 7</sup>	(PDP/20)A <sup>3, 7</sup>	(9V – 15V): (15V Fixed Max Current) A <sup>4</sup> (15V – 20V): (20V Fixed Max Current) A
15 < x ≤ 27	3A <sup>2</sup>	(PDP/9)A <sup>3</sup>			
27 < x ≤ 45	3A <sup>2</sup>	3A <sup>2</sup>			
45 < x ≤ 60	3A <sup>2</sup>	3A <sup>2</sup>	3A <sup>2</sup>	(PDP/20)A <sup>3</sup>	
60 < x ≤ 100	3A <sup>2</sup>	3A <sup>2</sup>	3A <sup>2</sup>	(PDP/20)A <sup>1, 3</sup>	(9V – 15V): (15V Fixed Max Current) A <sup>4, 5</sup> (15V – 20V): (20V Fixed Max Current) A <sup>1, 5</sup>
<div>1. Requires a 5A cable.</div> <div>2. The Fixed PDOs Maximum Current field <b>shall</b> advertise at least 3A, but <b>may</b> advertise up to RoundUp (PDP/voltage) to the nearest 10mA. Requires a 5A cable if over 3A is advertised.</div> <div>3. The Fixed PDOs Maximum Current field <b>shall</b> advertise either RoundDown (PDP/voltage) or RoundUp (PDP/voltage) to the nearest 10mA.</div> <div>4. SPR AVS current for this voltage range is the maximum current as advertised by the 15V Fixed Source PDO. This current may be higher than 3A (refer to Note 2). Requires a 5A cable if over 3A is advertised.</div> <div>5. The Sink is allowed to request up to the 20V Fixed Max Current when the requested voltage is 15.0V.</div> <div>6. The Max Voltage for SPR AVS is what is allowed by Table 10-2 based on the port's Port Maximum PDP.</div> <div>7. This SPR Fixed voltage is only available if allowed by Table 10-2 based on the port's Port Maximum PDP.</div>					

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**Note:** SPR Managed Capability ports when power constrained are defined to offer higher voltages at lower Port Present PDP (as per Table 10-3) than the port's Port Maximum PDP (as per Table 10-2) because these voltages would otherwise be available if the Managed Capability port power hadn't been constrained. Managed Capability ports are required to be properly identified to the user based on the port's Port Maximum PDP.

In reference to Table 10-3, Table 10-4 gives examples of which SPR capabilities are Advertised based on Port Present PDP on a Managed Capability port and the port's Port Maximum PDP and cable's current rating.

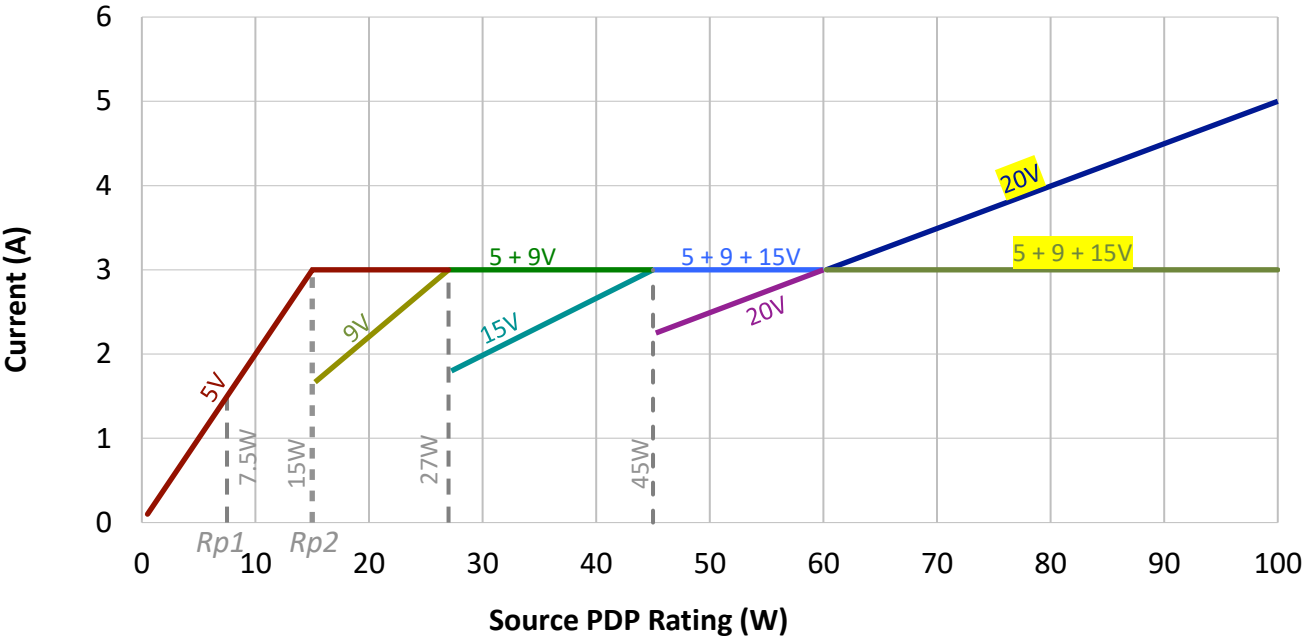
**Table 10-4 SPR Source Port Present PDP less than Port Maximum PDP Examples**

Port Maximum PDP and Cable Rating	Port Present PDP	Offers				
		5V Fixed	9V Fixed	15V Fixed	20V Fixed	SPR AVS
80W / 5A	65W	3A <sup>1</sup>	3A <sup>1</sup>	3A <sup>1</sup>	3.25A	9V – 15V: 3A 15V – 20V: 3.25A
80W / 5A	40W	3A <sup>1</sup>	3A <sup>1</sup>	2.67A	2A	9V – 15V: 2.67A 15V – 20V: 2A
80W / 3A	40W	3A <sup>1</sup>	3A	2.67A	2A	9V – 15V: 2.67A 15V – 20V: 2A
40W / 5A	40W	3A <sup>1</sup>	3A <sup>1</sup>	2.67A	Not Offered	9V – 15V: 2.67A
40W / 3A	40W	3A <sup>1</sup>	3A	2.67A	Not Offered	9V – 15V: 2.67A
80W / 5A	20W	3A <sup>1</sup>	2.22A	1.33A	1A	9V – 15V: 1.33A 15V – 20V: 1A
80W / 3A	20W	3A <sup>1</sup>	2.22A	1.33A	1A	9V – 15V: 1.33A 15V – 20V: 1A
40W / 5A	20W	3A <sup>1</sup>	2.22A	1.33A	Not Offered	9V – 15V: 1.33A
40W / 3A	20W	3A <sup>1</sup>	2.22A	1.33A	Not Offered	9V – 15V: 1.33A
Note 1: The Fixed PDO Maximum Current field will advertise at least 3A but may advertise up to RoundUp (PDP/voltage) to the nearest 10mA.						

Figure 10-1 illustrates the minimum current that an SPR Source **Shall** support at each Voltage for a given PDP Rating. Note: Not illustrated are that currents higher than 3A are allowed to be offered up to a limit of 5A given that a 5A cable is detected by the Source and the Voltage times current remains within the Source PDP Rating.

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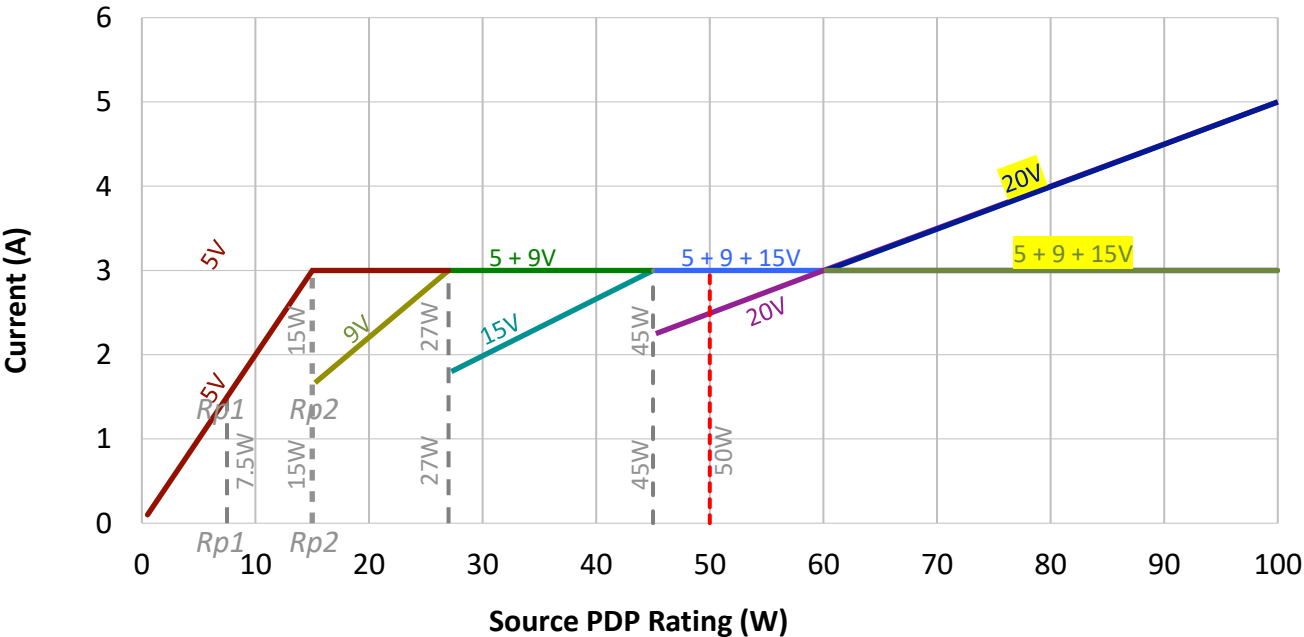
Figure 10-1 SPR Source Power Rule Illustration for Fixed PDOs



## 10.2.2.1 Fixed PDOs

Figure 10-2 shows an example of an adapter with a rating at 50W. The adapter is required to support 20V at 2.5A, 15V at 3A, 9V at 3A and 5V at 3A.

Figure 10-2 SPR Source Power Rule Example for Fixed PDOs

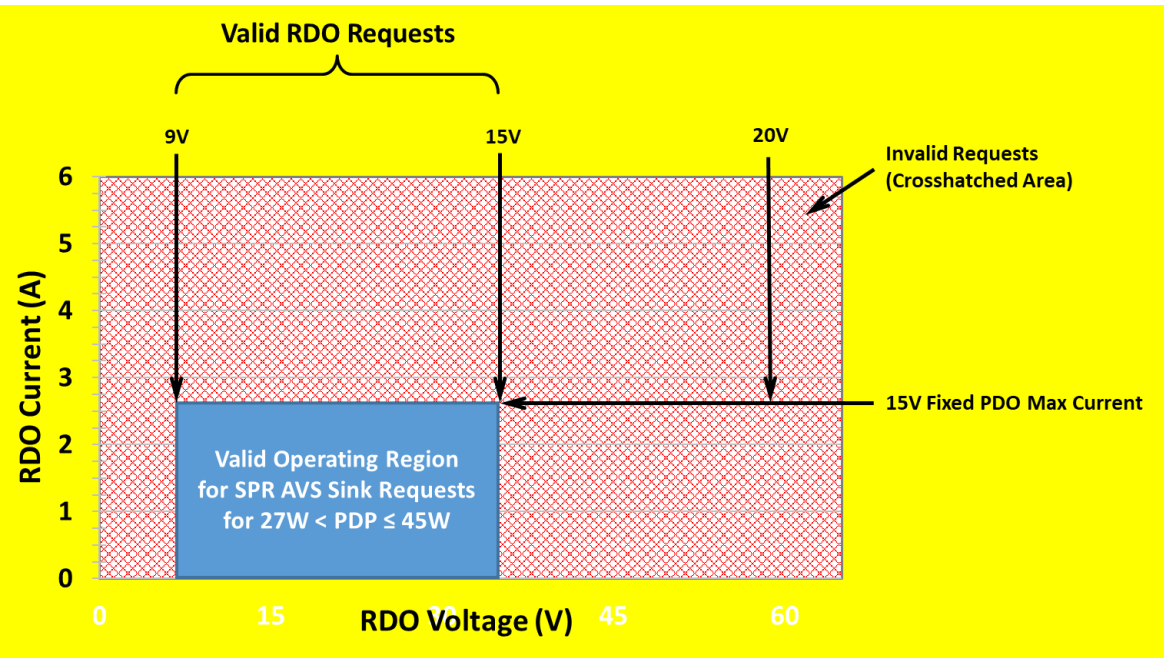




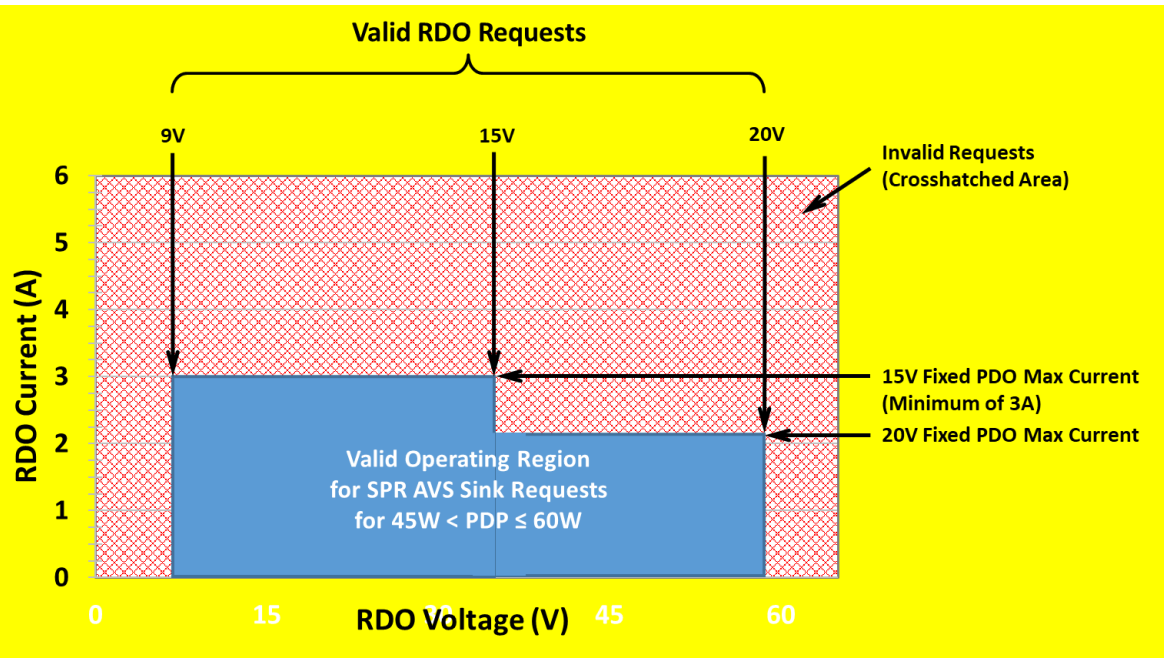
# USB Power Delivery ENGINEERING CHANGE NOTICE

For SPR AVS, Figure 10-3, Figure 10-4 and Figure 10-5 illustrates the valid operating region for SPR AVS RDO requests in the ranges of  $27W < PDP \leq 45W$ ,  $45W < PDP \leq 60W$  and  $60W < PDP \leq 100W$ , respectively.

**Figure 10-3 Valid SPR AVS Operating Region for a Source advertising in the range of  $27W < PDP \leq 45W$**

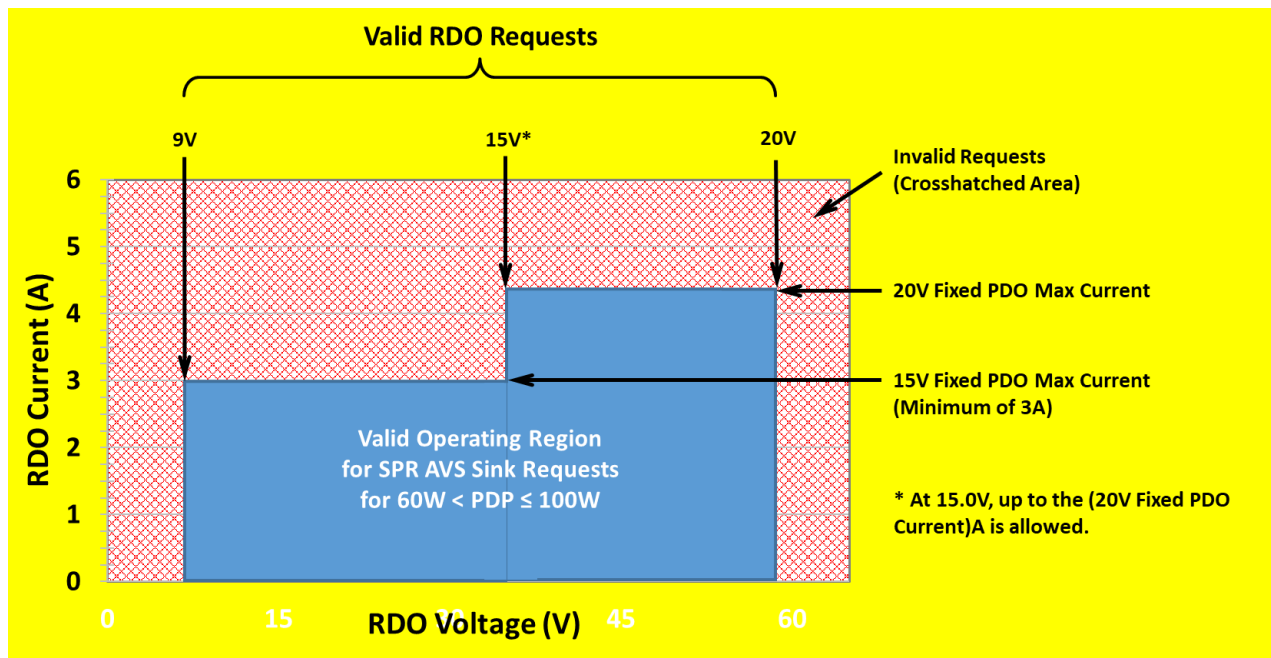


**Figure 10-4 Valid SPR AVS Operating Region for a Source advertising in the range of  $45W < PDP \leq 60W$**



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**Figure 10-5 Valid SPR AVS Operating Region for a Source advertising in the range of  $60W < PDP \leq 100W$**



## 10.2.2.2.1 SPR Adjustable Voltage Supply (AVS) Voltage Ranges

Table 10-9 shows the Minimum and Maximum Voltage for the SPR AVS ranges.

**Table 10-9 SPR Adjustable Voltage Supply (AVS) Voltage Ranges**

	AVS Voltage Ranges	
	15V AVS	20V AVS
Maximum Voltage	15V	20V
Minimum Voltage	9V	9V

The Voltage output at the Source's connector **Shall** be +/-5% for both the Maximum Voltage and the Minimum Voltage.

## (h) Section 10.2.3.1

### From Text:

#### 10.2.3.1 Optional Normative Fixed, Variable and Battery Supply

In addition to the Voltages and currents specified in Section 10.2.2, an SPR Source that is optimized for use with a specific Sink or a specific class of Sinks **May Optionally** supply additional Voltages and increased currents. However, the optional Voltages **Shall Not** exceed 20V.

Optional Voltages **Shall Not** be implemented on EPR Sources including for both SPR and EPR modes of operation. Additionally, while operating in EPR mode, Variable and Battery supplies are not allowed.

See Section 10.2 for the rules that **Shall** apply to Optional PDOs in order to be consistent with the declared PDP Rating and the Normative Voltages and currents.

# USB Power Delivery ENGINEERING CHANGE NOTICE

## To Text:

### 10.2.3.1 Optional Normative Fixed, Variable and Battery Supply

In addition to the Voltages and currents specified in Section 10.2.2, an SPR Source that is optimized for use with a specific Sink or a specific class of Sinks **May Optionally** supply additional Voltages and increased currents. However, the optional Voltages **Shall Not** exceed **20V9V**.

**Optional** Voltages **Shall Not** be implemented on EPR Sources including for both SPR and EPR modes of operation. Additionally, while operating in EPR mode, Variable and Battery supplies are not allowed.

While allowed, the use of **Optional** voltages and currents is not recommended as two Sources with the same PDP rating but not supporting the same **Optional** voltages and currents may behave differently thus confusing the user.

See Section 10.2 for the rules that **Shall** apply to Optional PDOs in order to be consistent with the declared PDP Rating and the Normative Voltages and currents.

## (i) Section 10.2.3.2

## From Text:

### 10.2.3.2 Optional Normative SPR Programmable Power Supply

The Voltages and currents a Programmable Power Supply with a PDP Rating of x Watts **Shall** support are as defined Table 10-7.

When **Optional** Programmable Power Supply APDOs are offered, the following requirements **Shall** apply:

- A Source that Advertises **Optional** Programmable Power Supply APDOs **Shall** Advertise the PDOs and APDOs shown in Table 10-7.
- A Source **Shall** Advertise **Optional** Programmable Power Supply APDOs with Maximum Voltage and Minimum Voltages for nominal Voltage as defined in Table 10-8.
- A Source **Shall Not** advertise a Programmable Power Supply APDO that does not follow the Minimum Voltage and Maximum Voltage defined in Table 10-8.
- In no case **Shall** a Source Advertise a current that exceeds the attached cable's current rating.
- The Max Voltage **Shall Not** exceed 21V while in SPR mode.

Table 10-7 SPR Programmable Power Supply PDOs and APDOs based on the PDP

PDP Rating (W)	5V fixed	9V fixed	15V fixed	20V fixed	9V Prog <sup>5</sup>	15V Prog <sup>5</sup>	20V Prog <sup>5</sup>
x < 15W	PDP/5 <sup>4</sup>	-	-	-	-	-	-
15W	3A	-	-	-	-	-	-
15 < x < 27W	3A <sup>3</sup>	PDP/9 <sup>4</sup>	-	-	PDP/9 <sup>1</sup>	-	-
27W	3A <sup>3</sup>	3A	-	-	3A	-	-
27 < x < 45W	3A <sup>3</sup>	3A <sup>3</sup>	PDP/15 <sup>4</sup>	-	3A <sup>2</sup>	PDP/15 <sup>1</sup>	-
45W	3A <sup>3</sup>	3A <sup>3</sup>	3A	-	-	3A	-
45 < x < 60W	3A <sup>3</sup>	3A <sup>3</sup>	3A <sup>3</sup>	PDP/20 <sup>4</sup>	-	3A <sup>2</sup>	PDP/20 <sup>1</sup>
60W	3A <sup>3</sup>	3A <sup>3</sup>	3A <sup>3</sup>	3A	-	-	3A
60 < x < 100W	3A <sup>3</sup>	3A <sup>3</sup>	3A <sup>3</sup>	PDP/20 <sup>4</sup>	-	-	PDP/20 <sup>1</sup>

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PDP Rating (W)	5V fixed	9V fixed	15V fixed	20V fixed	9V Prog <sup>5</sup>	15V Prog <sup>5</sup>	20V Prog <sup>5</sup>
100W	3A <sup>3</sup>	3A <sup>3</sup>	3A <sup>3</sup>	5A	-	-	5A

## 10.2.3.2.1 SPR Programmable Power Supply Voltage Ranges

The SPR Programmable Power Supply Voltage ranges map to the Fixed Supply Voltages. For each Fixed Voltage there is a defined Voltage range for the matching Programmable Power Supply APDO. Table 10-8 shows the Minimum and Maximum Voltage for the Programmable Power Supply that corresponds to the Fixed nominal Voltage.

**Table 10-8 SPR Programmable Power Supply Voltage Ranges**

	Fixed Nominal Voltage		
	9V Prog	15V Prog	20V Prog
Maximum Voltage	11V	16V	21V
Minimum Voltage	5V	5V	5V

The Voltage output at the Source's connector **shall** be +/-5% for both the Maximum Voltage and the Minimum Voltage.

## 10.2.3.2.2 Examples of the use of SPR Programmable Power Supplies

The following examples illustrate what a power adapter that Advertises a particular PDP Rating **May** offer:

1. PDP 27W
  - 5V @ 3A, 9V @ 3A, 9V Prog @ 3A is the baseline.
2. PDP 36W
  - 5V @ 3A, 9V @ 3A, 15 @ 2.4A, 9V Prog @ 3 A and 15V Prog @ 2.4A is the baseline.
  - 5V @ 3A, 9V @ 3A, 15 @ 2.4A, 9V Prog @ >3A up to 4A (with a 5A cable) and 15V Prog @ 2.4A.
3. PDP 50W
  - 5V @ 3A, 9V @ 3A, 15 @ 3A, 20V @ 2.5A, 15V Prog @ 3A, and 20V Prog @ 2.5A is the baseline.

The first example illustrates a basic example of a supply that can only support 5V and 9V.

The second example illustrates as the PDP Rating goes higher there are more possible combinations that meet the power rules. Although there are multiple ways to meet the power rules, while operating in SPR Mode no more than a combination of seven SPR PDOs and APDOs can be offered.

The third example shows that the 15V Prog @ 3A fully covers the 9V Prog @3A range so it is not necessary to advertise both.

## To Text:

### 10.2.3.2 Optional Normative SPR Programmable Power Supply

The Voltages and currents a Programmable Power Supply with a PDP Rating of x Watts **shall** support are as defined Table 10-7.

When **Optional** Programmable Power Supply APDOs are offered, the following requirements **shall** apply:

- A Source that Advertises **Optional** Programmable Power Supply APDOs **shall** Advertise the PDOs and APDOs shown in Table 10-7.
- A Source **shall** Advertise **Optional** Programmable Power Supply APDOs with Maximum Voltage and Minimum Voltages for nominal Voltage as defined in Table 10-8.

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- A Source **Shall Not** advertise a Programmable Power Supply APDO that does not follow the Minimum Voltage and Maximum Voltage defined in Table 10-8.
- In no case **Shall** a Source Advertise a current that exceeds the attached cable's current rating.
- The Max Voltage **Shall Not** exceed 21V while in SPR mode.

**Table 10-7 SPR Programmable Power Supply PDOs and APDOs based on the Port Maximum PDP**

Port Maximum PDP Rating (W)	5V fixed	9V fixed	15V fixed	20V fixed	SPR Fixed and AVS	9V Prog <sup>35</sup>	15V Prog <sup>35</sup>	20V Prog <sup>35</sup>
x < 15W	PDP/5 <sup>4</sup>	1	1	1	Required per Table 10-2 (or Table 10-2X when applicable)	-	-	-
15W	3A	1	1	1		-	-	-
15 < x < 27W	3A <sup>2</sup>	PDP/9 <sup>4</sup>	1	1		PDP/9 <sup>1</sup>	-	-
27W	3A <sup>2</sup>	3A	1	1		3A	-	-
27 < x < 45W	3A <sup>2</sup>	3A <sup>2</sup>	PDP/15 <sup>4</sup>	1		3A <sup>2</sup>	PDP/15 <sup>1</sup>	-
45W	3A <sup>2</sup>	3A <sup>2</sup>	3A	1		-	3A	-
45 < x < 60W	3A <sup>2</sup>	3A <sup>2</sup>	3A <sup>2</sup>	PDP/20 <sup>4</sup>		-	3A <sup>2</sup>	PDP/20 <sup>1</sup>
60W	3A <sup>2</sup>	3A <sup>2</sup>	3A <sup>2</sup>	3A		-	-	3A
60 < x < 100W	3A <sup>2</sup>	3A <sup>2</sup>	3A <sup>2</sup>	PDP/20 <sup>4</sup>		-	-	PDP/20 <sup>1</sup>
100W	3A <sup>2</sup>	3A <sup>2</sup>	3A <sup>2</sup>	5A		-	-	5A
1. The SPR PPS APDOs Maximum Current field <b>Shall</b> advertise RoundDown (PDP/Prog Voltage) to the nearest 50mA. 2. The SPR PPS APDOs Maximum Current field <b>Shall</b> advertise at least 3A, but <b>May</b> advertise up to RoundDown(PDP/Prog Voltage) to the nearest 50mA. 3. Applies to APDOs regardless of value of the PPS Power Limited bit.								

## 10.2.3.2.1 SPR Programmable Power Supply Voltage Ranges

The SPR Programmable Power Supply Voltage ranges map to the Fixed Supply Voltages. For each Fixed Voltage there is a defined Voltage range for the matching Programmable Power Supply APDO. Table 10-8 shows the Minimum and Maximum Voltage for the Programmable Power Supply that corresponds to the Fixed nominal Voltage.

**Table 10-8 SPR Programmable Power Supply Voltage Ranges**

	Fixed Nominal Voltage		
	9V Prog	15V Prog	20V Prog
Maximum Voltage	11V	16V	21V
Minimum Voltage	5V	5V	5V

The Voltage output at the Source's connector **Shall** be +/-5% for both the Maximum Voltage and the Minimum Voltage.

## 10.2.3.2.2 Examples of the use of SPR Programmable Power Supplies

The following examples illustrate what a power adapter that Advertises a particular PDP Rating **May** offer:

1. PDP 27W **implementation includes:**
  - 5V @ 3A
  - 9V @ 3A, **and**
  - 9V Prog @ 3A **is the baseline.**
2. PDP 36W **implementation includes:**
  - 5V @ 3A,
  - 9V @ 3A,

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- 15 @ 2.4A,
- SPR AVS with 9V – 15V @ 2.4A,
- 9V Prog @ 3 A, and
- 15V Prog @ 2.4A is the baseline.

## 3. PDP 36W implementation that optionally includes higher current in the 9V Prog PPS:

- 5V @ 3A,
- 9V @ 3A,
- 15 @ 2.4A,
- SPR AVS with 9V – 15V @ 2.4A,
- 9V Prog @ >3A up to 4A (with a 5A cable), and
- 15V Prog @ 2.4A

## 4. PDP 50W implementation includes:

- 5V @ 3A,
- 9V @ 3A,
- 15 @ 3A,
- 20V @ 2.5A,
- SPR AVS with 9V – 15V @ 3A & 15V – 20V @ 2.5A,
- 15V Prog @ 3A, and
- 20V Prog @ 2.5A.

## 5. PDP 80W implementation includes:

- 5V @ 3A,
- 9V @ 3A,
- 15 @ 3A,
- 20V @ 4A,
- SPR AVS with 9V – 15V @ 3A & 15V – 20V @ 4A,
- 15V Prog @ 3A, and
- 20V Prog @ 4A.

The first example illustrates a basic example of a supply that can only support 5V and 9V.

The second and third examples illustrates as the PDP Rating goes higher there are more possible combinations that meet the power rules. These examples also add SPR AVS. Although there are multiple ways to meet the power rules, while operating in SPR Mode no more than a combination of seven SPR PDOs and APDOs can be offered.

The third fourth and fifth examples shows that the 15V Prog @ 3A fully covers the 9V Prog @3A range so it is not necessary to advertise both. These examples also illustrate SPR AVS being extended up to 20V with separate current limits for the 9V – 15V and 15V – 20V ranges – a single SPR AVS APDO covers advertising both ranges.

## (j) Section 10.2.3.3

### From Text:

#### 10.2.3.3 Optional Normative Extended Power Range (EPR)

Support of EPR Mode is **Optional**. An EPR-capable charger may include multiple ports and these ports can be functionally implemented as Shared or Assured ports as defined in [USB Type-C 2.2]. An EPR-capable charger port **May** operate in either SPR mode or EPR mode when operating at 100W or less. Any port on an EPR charger that has a PDP rating of 100W or less **shall** follow the normative requirements for SPR Source ports and **shall** operate only in SPR mode.

Table 10-9 and Table 10-10 define the normative requirements for ports on EPR Source Ports.

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- When an EPR Source port is capable of supplying its PDP Rating, it **Shall** adhere to the requirements defined in Table 10-9 based on its PDP Rating of x Watts.
- When a Source Port on an EPR charger is unable to provide its PDP Rating, it **Shall** adhere to the requirements defined in Table 10-10 based on an Equivalent PDP Rating of x Watts. Some examples:
  - An EPR Source port may be unable to provide its rated PDP because it is thermally constrained at the time of power negotiation.
  - A Shared port on a multi-port EPR Charger that is limited by the remaining available power.
- When an EPR charger is in an Adjustable Voltage Source (AVS) contract:
  - It **Shall** Reject all Requests outside of the defined Voltage range (see Table 10-12) or for a requested Voltage and Current that results in a power level that is more than the Port's Advertised PDP.
  - In no case **Shall** a Source Advertise a Current or accept a Current requested by a Sink that exceeds the attached cable's current rating.
- The Max Voltage offered by an EPR Source Shall Not exceed 48V.

**Table 10-9 EPR Source Capabilities based in the Port's PDP**

PDP Rating (W)	5V Fixed	9V Fixed	15V Fixed	20V Fixed <sup>9</sup>	28V Fixed <sup>3</sup>	36V Fixed <sup>3</sup>	48V Fixed <sup>3</sup>	AVS <sup>3, 7, 8</sup>
100 < x ≤ 140	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>1</sup> , 5A <sup>2</sup>	(PDP/28) A <sup>3, 6</sup>	NA <sup>4</sup>	NA <sup>4</sup>	(15V – PDP/5A): 5A (>PDP/5A – 28V): (PDP/AVS Voltage) A
140 < x ≤ 180	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>1</sup> , 5A <sup>2</sup>	5A	(PDP/36) <sup>6</sup>	NA <sup>4</sup>	(15V – PDP/5A): 5A (>PDP/5A – 36V): (PDP/AVS Voltage) A
180 < x ≤ 240	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>1</sup> , 5A <sup>2</sup>	5A	5 <sup>3</sup>	PDP/48 <sup>3, 6</sup>	(15V – PDP/5A): 5A (>PDP/5A – 48V): (PDP/AVS Voltage) A

Notes:

1. When used with a 3A cable.
2. Requires a 5A cable.
3. Requires an EPR-capable cable and operating in EPR mode.
4. EPR Sources are disallowed from offering Fixed Voltages that are above the defined Voltages for a given PDP, e.g., 36V is disallowed for any PDP of 140W or lower.
5. The Fixed PDOs Maximum Current field **Shall** advertise at least 3A, but **May** advertise up to RoundUp (PDP/Voltage.) to the nearest 10mA. Requires a 5A cable if over 3A is advertised.
6. The Fixed PDOs Maximum Current field **Shall** advertise either RoundDown (PDP/Voltage) or RoundUp (PDP/Voltage) to the nearest 10mA.
7. EPR Sources **Shall** reject any request for more than the Advertised PDP, i.e., the maximum current requested by the Sink will be rounded down to the nearest 50 mA with a Voltage within the defined AVS Voltage range.
8. The current available for a given AVS Voltage is as indicated in this column. The current defined here is describing the top edge of the Valid Operating Region as illustrated in Figure 10-3. The AVS APDO does not have a Maximum Current field, so the maximum current has to be calculated from the PDP.
9. The Source, when operating in SPR Mode, **May** offer less than 5A due to design tolerances in order to meet applicable safety standards. For best user experience it should be as close to 100W as possible.



# USB Power Delivery ENGINEERING CHANGE REQUEST FORM

**Table 10-10 EPR Source Capabilities based on a Shared Port's Equivalent PDP**

Equivalent PDP Rating (W)	5V Fixed	9V Fixed	15V Fixed	20V Fixed <sup>12</sup>	28V Fixed <sup>3</sup>	36V Fixed <sup>3,9</sup>	48V Fixed <sup>3,9</sup>	AVS with Max Voltage of 28V, 36V or 48V per Table 10-9 <sup>3,7,10,11</sup>
$7.5 \leq x \leq 15$	(PDP/5) A <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>8</sup>
$15 < x \leq 27$	3A <sup>5</sup>	(PDP/9) A <sup>6</sup>	(PDP/15) A <sup>6</sup>	(PDP/20) A <sup>6</sup>	(PDP/28) A <sup>6</sup>	(PDP/36) A <sup>6</sup>	(PDP/48) A <sup>6</sup>	(15V – PDP/5A): 5A (>PDP/5A – Max Voltage): (PDP/AVS Voltage) A
$27 < x \leq 45$	3A <sup>5</sup>	3A <sup>5</sup>	(PDP/15) A <sup>6</sup>	(PDP/20) A <sup>6</sup>				
$45 < x \leq 60$	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	(PDP/20) A <sup>6</sup>				
$60 < x \leq 100$	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>1</sup> (PDP/20) A <sup>2,6</sup>				
$100 < x \leq 140$	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>1</sup> , 5A <sup>2</sup>	5A	5A		
$140 < x \leq 180$	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>1</sup> , 5A <sup>2</sup>				
$180 < x \leq 240$	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>5</sup>	3A <sup>1</sup> , 5A <sup>2</sup>	5A	5A		
<b>Notes:</b> <ol style="list-style-type: none"> <li>When used with 3A cable.</li> <li>Requires a 5A cable.</li> <li>Requires operation in EPR mode and the use of an EPR-capable cable.</li> <li>EPR Sources are disallowed from offering this Fixed Voltage at this Equivalent PDP Rating.</li> <li>The Fixed PDOs Maximum Current field <b>Shall</b> Advertise at least 3A, but <b>May</b> Advertise up to RoundUp (PDP/voltage) to the nearest 10mA. Requires a 5A cable if over 3A is Advertised.</li> <li>The Fixed PDOs Maximum Current field <b>Shall</b> Advertise either RoundDown (PDP/Voltage) or RoundUp (PDP/Voltage) to the nearest 10mA.</li> <li>EPR Sources <b>Shall</b> reject any Request for more than the Advertised PDP, i.e., the maximum current requested by the Sink will be rounded down to the nearest 50 mA with a voltage within the defined AVS voltage range.</li> <li>EPR Sources <b>Shall Not</b> offer an AVS APDO at this Equivalent PDP Rating.</li> <li>This EPR Fixed voltage is only available if allowed by Table 10-9 based on the port's PDP Rating.</li> <li>The Max Voltage for AVS is what is allowed by Table 10-9 based on the port's PDP Rating.</li> <li>The current available based on AVS voltage is as indicated in this column. The current defined here is describing the top edge of the Valid Operating Region as illustrated in Figure 10-3. AVS APDO does not have a Maximum Current field, so the maximum current has to be calculated from the PDP.</li> <li>The Source, when operating in SPR Mode, <b>May</b> offer less than 5A due to design tolerances in order to meet applicable safety standards. For best user experience it should be as close to 100W as possible.</li> </ol>								

**Note:** EPR Shared Capacity ports when power constrained are defined to offer higher voltages at lower Equivalent PDP Ratings (as per Table 10-10) than the port's PDP Rating (as per Table 10-9) because these voltages would otherwise be available if the Shared Capacity port power hadn't been constrained. Shared Capacity ports are required to be properly identified to the user based on the port's PDP Rating.

In reference to Table 10-10, Table 10-11 gives examples of which EPR capabilities, in addition to the required SPR Fixed PDOs, are Advertised based on Equivalent PDP and the port's Rated PDP.



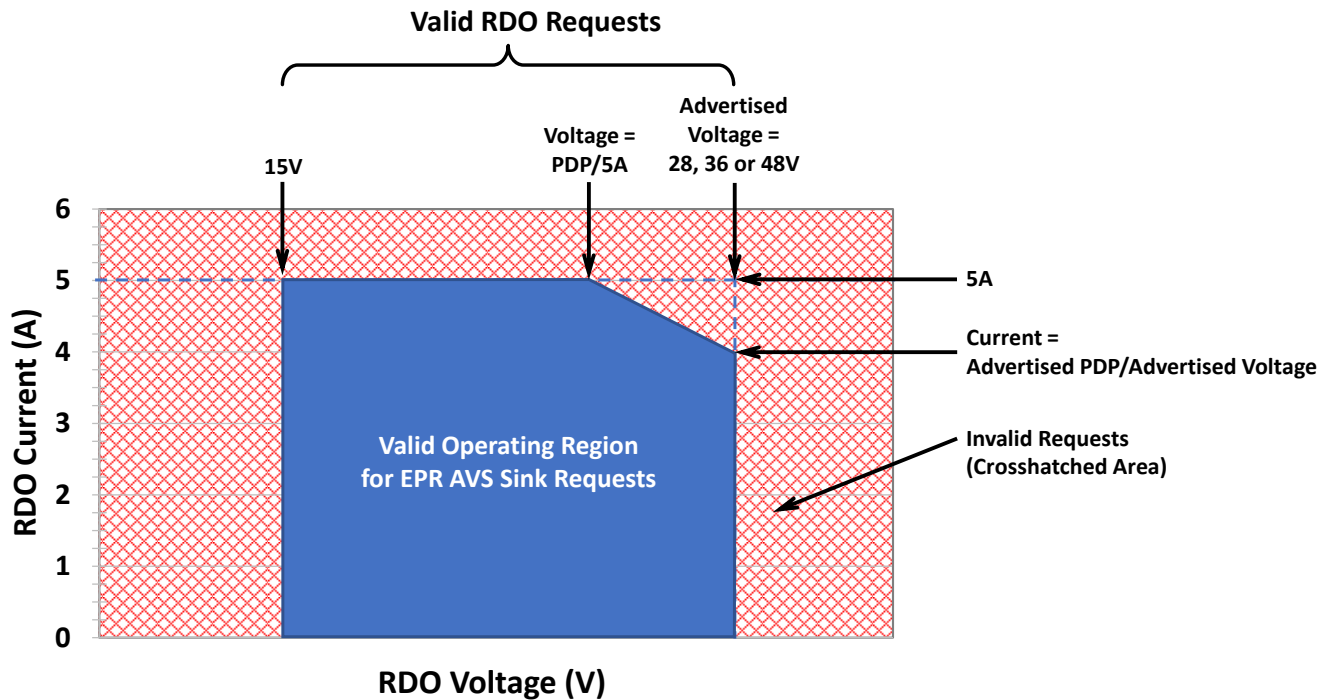
# USB Power Delivery ENGINEERING CHANGE NOTICE

Table 10-11 EPR Source Equivalent PDP Examples

PDP Rating	Equivalent PDP	Offers			
		28V Fixed	36V Fixed	48V Fixed	AVS
200W	108W	3.86A	3A	2.25A	48V@108W
160W	108W	3.86A	3A	Not offered	36V@108W
120W	108W	3.86A	Not offered	Not offered	28V@108W
200W	72W	2.57A	2A	1.5A	48V@72W
160W	72W	2.57A	2A	Not offered	36V@72W
120W	72W	2.57A	Not offered	Not offered	28V@72W
200W	36W	1.29A	1A	0.75A	48V@36W
160W	36W	1.29A	1A	Not offered	36V@36W
120W	36W	1.29A	Not offered	Not offered	28V@36W

EPR Sources when operating in an AVS contract are required to stay within their PDP as such they **Shall** respond to any request (VA) for more than the PDP with a **Reject** Message. Figure 10-3 illustrates the definition of the valid operating range for an EPR Source operating in an AVS contract based on its Advertised PDP.

Figure 10-3 Valid EPR AVS Operating Region



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## To Text:

### 10.2.3.3 Optional Normative Extended Power Range (EPR)

Support of EPR Mode is **Optional**. An EPR-capable charger may include multiple ports and these ports can be functionally implemented as Shared or Assured ports as defined in [USB Type-C 2.0]. An EPR-capable ~~charger~~Source port **May** operate in either SPR mode or EPR mode when operating at 100W or less.

Any port on an EPR ~~Source~~charger that has a **Port Present** PDP ~~Rating~~ of 100W or less **Shall** follow the normative requirements for SPR Source ~~P~~ports and **Shall** operate only in SPR mode. **Any port on an EPR Source that is operating with a cable that is not EPR-capable *Shall* operate only in SPR mode. An EPR Source, when operating in SPR Mode with a 5A cable, *May* offer less than 5A due to design tolerances in order to meet applicable safety standards. For best user experience it *Should* be as close to 100W as possible.**

Table 10-9 and Table 10-10 define the normative requirements for ports on EPR Source Ports.

- When an EPR Source port is capable of supplying its PDP Rating, it **Shall** adhere to the requirements defined in Table 10-9 based on its PDP Rating of x Watts.
- When a Source Port on an EPR charger is unable to provide its **Port Maximum** PDP ~~Rating~~, it **Shall** adhere to the requirements defined in Table 10-10 based on an **Equivalent-Port Present** PDP ~~Rating~~ of x Watts. Some examples:
  - An EPR Source port may be unable to provide its rated PDP because it is thermally constrained at the time of power negotiation.
  - A Shared port on a multi-port EPR Charger that is limited by the remaining available power.
- When an EPR charger is in an Adjustable Voltage Source (AVS) contract:
  - It **Shall** Reject all Requests outside of the defined Voltage range (see Table 10-12) or for a requested Voltage and Current that results in a power level that is more than the Port's Advertised PDP.
  - In no case **Shall** a Source Advertise a Current or accept a Current requested by a Sink that exceeds the attached cable's current rating.
- The Max Voltage offered by an EPR Source Shall Not exceed 48V.

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Table 10-12 EPR Source Capabilities based in the **Port Maximum PDP** and using an EPR-capable cable

Port Maximum PDP Rating (W)	5V fixed	9V fixed	15V fixed	20V fixed	SPR Fixed and AVS	28V Fixed <sup>3</sup>	36V Fixed <sup>3</sup>	48V Fixed <sup>3</sup>	EPR AVS <sup>3,7-8,4</sup>
100 < x ≤ 140	Per Table 10-2 with a Port Maximum of 100W					(PDP/28)A <sup>2,3,6</sup>	NA <sup>14</sup>	NA <sup>14</sup>	(15V – PDP/5A): 5A (>PDP/5A – 28V): (PDP/AVS Voltage)A
140 < x ≤ 180						5A	(PDP/36)A <sup>2,6</sup>	NA <sup>14</sup>	(15V – PDP/5A): 5A (>PDP/5A – 36V): (PDP/AVS Voltage)A
180 < x ≤ 240						5A	5A <sup>3</sup>	(PDP/48)A <sup>2,3,6</sup>	(15V – PDP/5A): 5A (>PDP/5A – 48V): (PDP/AVS Voltage)A
<div>1. <del>When used with a 3A cable.</del></div> <div>2. <del>Requires a 5A cable.</del></div> <div>3. <del>Requires an EPR-capable cable and operating in EPR mode.</del></div> <div>1. <del>4-EPR Sources are disallowed from offering Fixed Voltages that are above the defined Voltages for a given PDP, e.g., 36V is disallowed for any PDP of 140W or lower.</del></div> <div>5. <del>The Fixed PDOs Maximum Current field Shall advertise at least 3A, but May advertise up to RoundUp (PDP/Voltage) to the nearest 10mA. Requires a 5A cable if over 3A is advertised.</del></div> <div>2. <del>6-The Fixed PDOs Maximum Current field <b>Shall</b> advertise either RoundDown (PDP/Voltage) or RoundUp (PDP/Voltage) to the nearest 10mA.</del></div> <div>3. <del>7-EPR Sources <b>Shall</b> reject any request for more than the Advertised PDP, i.e., when output voltage and operating current requested in the Sink RDO is outside of the defined AVS voltage and current range represented by the advertised PDP, the RDO will be rejected.</del></div> <div>4. <del>8-The current available for a given AVS Voltage is as indicated in this column. The current defined here is describing the top edge of the Valid Operating Region as illustrated in Figure 10 3. The AVS APDO does not have a Maximum Current field so the maximum current has to be calculated from the PDP.</del></div> <div>9. <del>The Source, when operating in SPR Mode, <b>May</b> offer less than 5A due to design tolerances in order to meet applicable safety standards. For best user experience it should be as close to 100W as possible.</del></div>									

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**Table 10-13 EPR Source Capabilities when Port Present PDP is less than Port Maximum PDP based on a Shared Port's Equivalent PDP and using an EPR-capable cable**

Port Present PDP Rating (W)	5V fixed	9V fixed	15V fixed	20V fixed	SPR Fixed and AVS	28V Fixed <sup>3</sup>	36V Fixed <sup>4,9</sup>	48V Fixed <sup>4,9</sup>	EPR AVS with Max Voltage of 28V, 36V or 48V per Table 10-12 <sup>2, 5, 6, 7, 10, 11</sup>
$7.5 \leq x \leq 15$	(PDP/5) A <sup>4</sup>					NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>
$7.5 \leq x \leq 15$	Per Table 10-3					(PDP/28) A <sup>16</sup>	(PDP/36) A <sup>16</sup>	(PDP/48) A <sup>16</sup>	(15V – PDP/5A): 5A (>PDP/5A – Max Voltage): (PDP/AVS Voltage) A
$15 < x \leq 27$									
$27 < x \leq 45$									
$45 < x \leq 60$									
$60 < x \leq 100$									
$100 < x \leq 140$	Per Table 10-3 with a Port Present PDP of 100W					5A	5A	5A	
$140 < x \leq 180$						5A			
$180 < x \leq 240$						5A	5A	5A	

## Notes:

- The Fixed PDOs Maximum Current field **shall** Advertise either RoundDown (PDP/Voltage) or RoundUp (PDP/Voltage) to the nearest 10mA.
- EPR Sources **shall** reject any Request for more than the Advertised PDP, i.e., when output voltage and operating current requested in the Sink RDO is outside of the defined AVS voltage and current range represented by the advertised PDP, the RDO will be rejected.
- EPR Sources **shall not** offer an AVS APDO at this Port Present PDP.
- This EPR Fixed voltage is only available if allowed by Table 10-9 based on the port's PDP Rating.
- The Max Voltage for AVS is what is allowed by Table 10-9 based on the port's Port Maximum PDP.
- The current available based on AVS voltage is as indicated in this column. The current defined here is describing the top edge of the Valid Operating Region as illustrated in Figure 10-6. AVS APDO does not have a Maximum Current field so the maximum current has to be calculated from the PDP.

1. When used with 3A cable:

2. Requires a 5A cable.

3. Requires operation in EPR mode and the use of an EPR-capable cable.

4. EPR Sources are disallowed from offering this Fixed Voltage at this Equivalent PDP Rating.

5. The Fixed PDOs Maximum Current field Shall Advertise at least 3A, but May Advertise up to RoundUp (PDP/voltage) to the nearest 10mA. Requires a 5A cable if over 3A is Advertised.

6. The Fixed PDOs Maximum Current field Shall Advertise either RoundDown (PDP/Voltage) or RoundUp (PDP/Voltage) to the nearest 10mA.

7. EPR Sources **shall** reject any Request for more than the Advertised PDP, i.e., the maximum current requested by the Sink will be rounded down to the nearest 50 mA with a voltage within the defined AVS voltage range.

8. EPR Sources **shall not** offer an AVS APDO at this Equivalent PDP Rating.

9. This EPR Fixed voltage is only available if allowed by Table 10.9 "EPR Source Capabilities based in the Port's PDP" based on the port's PDP Rating.

10. The Max Voltage for AVS is what is allowed by Table 10.9 "EPR Source Capabilities based in the Port's PDP" based on the port's PDP Rating.

11. The current available based on AVS voltage is as indicated in this column. The current defined here is describing the top edge of the Valid Operating Region as illustrated in Figure 10 3 "Valid EPR AVS Operating Region". AVS APDO does not have a Maximum Current field, so the maximum current has to be calculated from the PDP.

12. The Source, when operating in SPR Mode, May offer less than 5A due to design tolerances in order to meet applicable safety standards. For best user experience it should be as close to 100W as possible.

**Note:** EPR **Managed Capability Shared Capacity** ports when power constrained are defined to offer higher voltages at lower **Equivalent Port Present PDP Ratings** (as per Table 10-10) than the port's **Port Maximum PDP Rating** (as per Table 10-9) because these voltages would otherwise be available if the **Managed Capability Shared Capacity** port power hadn't been constrained. **Managed Capability Shared Capacity** ports are required to be properly identified to the user based on the port's **Port Maximum PDP Rating**.

In reference to Table 10-10, Table 10-11 gives examples of which EPR capabilities, in addition to the required SPR Fixed PDOs and SPR AVS APDO, are Advertised based on **Equivalent Port Present PDP** and the port's **Rated Port Maximum PDP**.

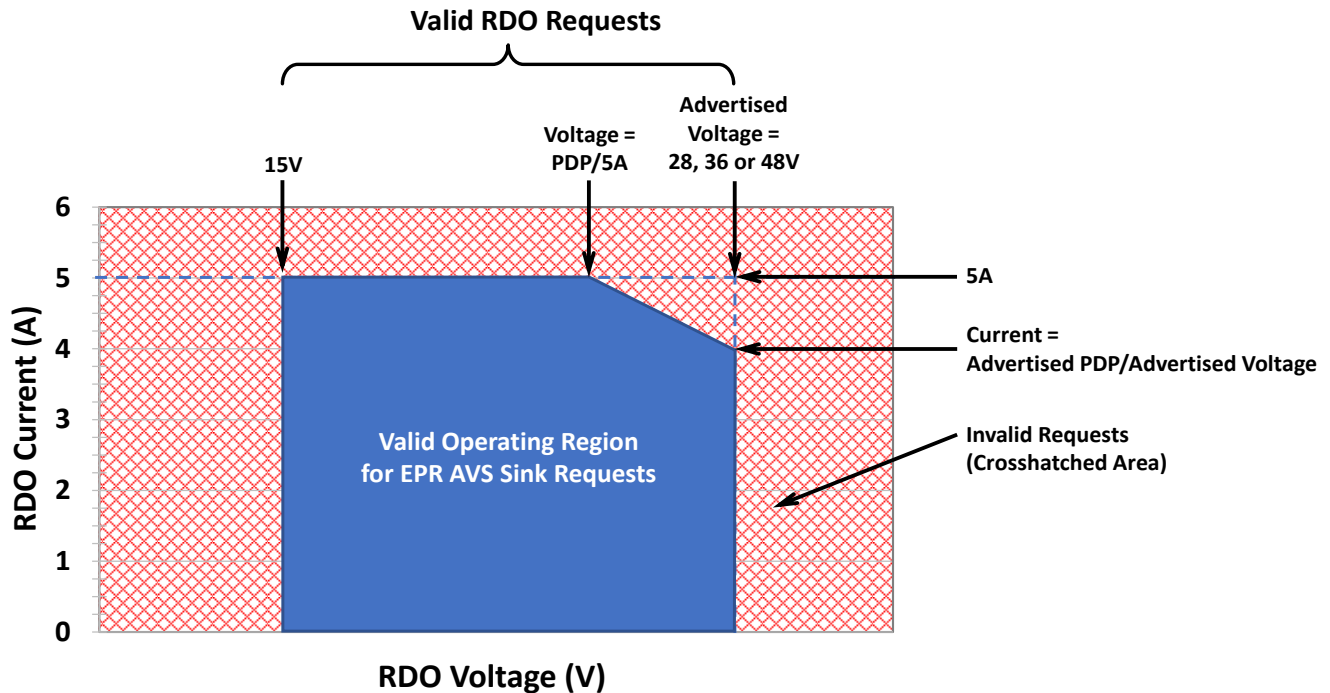
# USB Power Delivery ENGINEERING CHANGE NOTICE

Table 10-11 EPR Source **Equivalent PDP** Examples when Port Present PDP is less than Port Maximum PDP

Port Maximum PDP Rating	Equivalent Port Present PDP	Offers			
		28V Fixed	36V Fixed	48V Fixed	AVS
200W	108W	3.86A	3A	2.25A	48V@108W
160W	108W	3.86A	3A	Not offered	36V@108W
120W	108W	3.86A	Not offered	Not offered	28V@108W
200W	72W	2.57A	2A	1.5A	48V@72W
160W	72W	2.57A	2A	Not offered	36V@72W
120W	72W	2.57A	Not offered	Not offered	28V@72W
200W	36W	1.29A	1A	0.75A	48V@36W
160W	36W	1.29A	1A	Not offered	36V@36W
120W	36W	1.29A	Not offered	Not offered	28V@36W

EPR Sources when operating in an AVS contract are required to stay within their PDP as such they **Shall** respond to any request (VA) for more than the PDP with a **Reject** Message. Figure 10-3 illustrates the definition of the valid operating range for an EPR Source operating in an AVS contract based on its Advertised PDP.

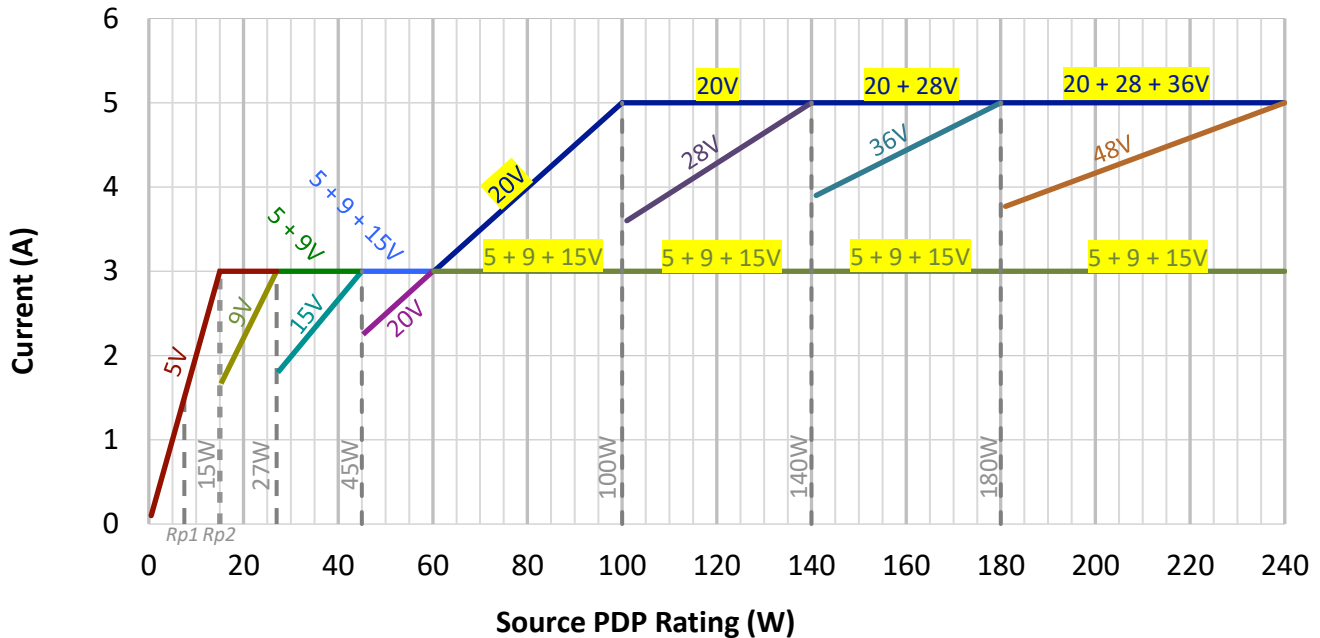
Figure 10-3 Valid EPR AVS Operating Region



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Figure 10-4 illustrates the minimum current that an EPR Source **shall** support at each Voltage for a given PDP Rating. Note: Not illustrated are that currents higher than 3A are allowed to be offered up to a limit of 5A given that a 5A cable is detected by the Source and the Voltage times current remains within the Source PDP Rating.

**Figure 10-4 EPR Source Power Rule Illustration for Fixed PDOs**



## (k) Section 10.2.4

### From Text:

#### 10.2.4 Power sharing between ports

The Source power rules defined in Section 10.2.2 and Section 10.2.3 **shall** apply independently to each port on a system with multiple ports.

When applying the power rules to a given port, only the power rules appropriate for the remaining available PDP (i.e., the remaining available port power) at the time of the Advertisement **shall** be applied.

#### EPR Examples of power sharing

For an EPR-capable Fixed Voltage charger (per the power rules of Table 10-9) with EPR-capable Sinks in EPR mode with two Shared Capacity ports with a PDP rating of 140W with an overall charger capacity of 220W, the following is an example of power sharing between ports.

1. Sharing when >100W capacity is not available for both ports simultaneously after the first port contract is established.
  - a. The first shared port negotiates a Fixed Voltage contract for 28V @ 5A.
  - b. The Advertisement for the second port will be based on a PDP of 80W, therefore the highest offer that can be made is a Fixed Voltage contract for 20V @ 4A. No offers higher than 20V can be made at this remaining available power level.
2. Sharing when >100W capacity is available for both ports simultaneously after the first port contract is established.

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- a. The first shared port negotiates a Fixed Voltage contract of 28V @ 4A.
- b. The Advertisement for the second port will be based on a PDP of 108W, therefore the highest offer that can be made is a Fixed Voltage contract for 28V @ 3.85A.

## To Text:

### 10.2.4 Power sharing between ports

The Source power rules defined in Section 10.2.2 and Section 10.2.3 **shall** apply independently to each port on a system with multiple ports.

When applying the power rules to a given port, only the power rules appropriate for the remaining available PDP (i.e., the remaining available port power) at the time of the Advertisement **shall** be applied.

#### EPR Examples of power sharing

For an EPR-capable Fixed Voltage charger (per the power rules of Table 10-9) with EPR-capable Sinks in EPR mode with two **Shared Capacity Managed Capability** ports with a PDP rating of 140W with an overall charger capacity of 220W, the following is an example of power sharing between ports.

3. Sharing when >100W capacity is not available for both ports simultaneously after the first port contract is established.
  - a. The first shared port negotiates a Fixed Voltage contract for 28V @ 5A.
  - b. The Advertisement for the second port will be based on a PDP of 80W, therefore the highest offer that can be made is a Fixed Voltage contract for 20V @ 4A. No offers higher than 20V can be made at this remaining available power level.
4. Sharing when >100W capacity is available for both ports simultaneously after the first port contract is established.
  - a. The first shared port negotiates a Fixed Voltage contract of 28V @ 4A.
  - b. The Advertisement for the second port will be based on a PDP of 108W, therefore the highest offer that can be made is a Fixed Voltage contract for 28V @ 3.85A.

## (I) Section 10.3.2

### From Text:

#### 10.3.2 Normative Sink Rules

Sinks designed to use Sources with a PDP Rating of x W **shall**:

- Either operate or charge from Sources that have a PDP Rating  $\geq x$  W.
- Either operate, charge or indicate a capability mismatch (see Section 6.4.2.3) from Sources that have a PDP Rating  $< x$  W and  $\geq 0.5$ W.

A Sink optimized for a Source with **Optional** Voltages and currents or power as described in Section 10.2.3 with a PDP Rating of x W **shall** provide a similar user experience when powered from a Source with a PDP Rating of  $\geq x$  W that supplies only the **Normative** Voltages and currents as specified in Section 10.2.2. For example, a 60W source might not offer 9V Prog or 15V Prog since 20V Prog is a suitable substitute for both (as shown in Table 10-7).

The Operational Current/Power in the Sink Capabilities PDO for Sinks with an Operational PDP of x Watts **shall** be as follows:

- Operational current for Fixed/Variable supply PDOs: RoundDown( $x/\text{Voltage}$ ) to the nearest 10mA.
- Operational power for Battery supply PDOs:  $\leq x$ .
- Operational current for Programmable Power Supply APDOs as defined in Table 10-7: RoundDown ( $x/\text{Prog Voltage}$ ) to the nearest 50mA.

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Operational current for Programmable Power Supply APDOs not defined in Table 10-7 **shall** be RoundDown (x/Max Voltage) to the nearest 50mA.

The Maximum Current/Power in the Sink RDO for Sinks with an Operational PDP of x Watts and Maximum PDP of y Watts **shall** be as follows:

- Maximum current for Fixed/Variable Supply RDOs from Sinks without a Battery: RoundDown(x/Voltage) to the nearest 10mA.
- Maximum current for Fixed/Variable Supply RDOs from Sinks with a Battery: RoundDown(y/Voltage) to the nearest 10mA.
- Maximum power for Battery Supply RDOs from Sinks without a Battery:  $\leq x$ .
- Maximum power for Battery Supply RDOs from Sinks with a Battery:  $\leq y$ .
- Maximum current for PPS Supply RDOs from Source PDOs not defined in Table 10-7: RoundDown (x/Prog Voltage) to the nearest 50mA.
- Maximum current for PPS Supply RDOs from Source PDOs as defined in Table 10-7 or Table 10-11: RoundDown (y/Prog Voltage) to the nearest 50mA.
- Maximum current for AVS RDOs from Source PDOs not defined in Table 10-9 and Table 10-10: RoundDown (PDP Rating/Voltage) to the nearest 50mA.

The following requirements **shall** apply to the Advertised Sink Capabilities:

- A Sink **shall Not** Advertise Fixed Supply PDO maximum Voltages and currents that exceed the PDP Rating they were designed to use.
- A Sink **shall Not** Advertise Variable Supply PDO maximum Voltages and currents that exceed the PDP Rating they were designed to use.
- A Sink **shall Not** Advertise a Battery Supply PDO maximum allowable power that exceeds the PDP Rating they were designed to use.
- A Sink **shall Not** Advertise a PPS APDO maximum allowable power that exceeds the PDP Rating they were designed to use.

## To Text:

### 10.3.2 Normative Sink Rules

Sinks designed to use Sources with a PDP Rating of x W **shall**:

- Either operate or charge from Sources that have a PDP Rating  $\geq x$  W.
- Either operate, charge or indicate a capability mismatch (see Section 6.4.2.3) from Sources that have a PDP Rating  $< x$  W and  $\geq 0.5$ W.

A Sink optimized for a Source with **Optional** Voltages and currents or power as described in Section 10.2.3 with a PDP Rating of x W **shall** provide a similar user experience when powered from a Source with a PDP Rating of  $\geq x$  W that supplies only the **Normative** Voltages and currents as specified in Section 10.2.2. For example, a 60W source might not offer 9V Prog or 15V Prog since 20V Prog is a suitable substitute for both (as shown in Table 10-7).

The Operational Current/Power in the Sink Capabilities PDO for Sinks with an Operational PDP of x Watts **shall** be as follows:

- Operational current for Fixed/Variable supply PDOs: RoundDown(x/Voltage) to the nearest 10mA.
- Operational power for Battery supply PDOs:  $\leq x$ .
- Operational current for Programmable Power Supply APDOs as defined in Table 10-7: RoundDown (x/Prog Voltage) to the nearest 50mA.



# USB Power Delivery ENGINEERING CHANGE NOTICE

- ~~Operational current for Programmable Power Supply APDOs not defined in Table 10-7 **Shall** be RoundDown (x/Max Voltage) to the nearest 50mA.~~

The Maximum Current/Power in the Sink RDO for Sinks with an Operational PDP of x Watts and Maximum PDP of y Watts **Shall** be as follows:

- Maximum current for Fixed/Variable Supply RDOs from Sinks without a Battery: RoundDown(x/Voltage) to the nearest 10mA.
- Maximum current for Fixed/Variable Supply RDOs from Sinks with a Battery: RoundDown(y/Voltage) to the nearest 10mA.
- Maximum power for Battery Supply RDOs from Sinks without a Battery:  $\leq x$ .
- Maximum power for Battery Supply RDOs from Sinks with a Battery:  $\leq y$ .
- ~~Maximum current for PPS Supply RDOs from Source PDOs not defined in Table 10-7: RoundDown (x/Prog Voltage) to the nearest 50mA.~~
- Maximum current for PPS Supply RDOs from Source PDOs as defined in Table 10-7 or Table 10-11: RoundDown (y/Prog Voltage) to the nearest 50mA.
- ~~Maximum current for AVS RDOs from Source PDOs not defined in Table 10-9 and Table 10-10: RoundDown (PDP Rating/Voltage) to the nearest 50mA.~~

The following requirements **Shall** apply to the Advertised Sink Capabilities:

- A Sink **Shall Not** Advertise Fixed Supply PDO maximum Voltages and currents that exceed the PDP Rating they were designed to use.
- A Sink **Shall Not** Advertise Variable Supply PDO maximum Voltages and currents that exceed the PDP Rating they were designed to use.
- A Sink **Shall Not** Advertise a Battery Supply PDO maximum allowable power that exceeds the PDP Rating they were designed to use.
- A Sink **Shall Not** Advertise a PPS APDO maximum allowable power that exceeds the PDP Rating they were designed to use.