USB-grænseflader for data og energi – Del 1-2: Fælles komponenter – USB-strømforsyningsspecifikation

Universal serial bus interfaces for data and power – Part 1-2: Common components – USB Power Delivery specification

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Part 1-2: Common components – USB Power Delivery specification

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Draft	Report on voting
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1 Introduction

USB has evolved from a data interface capable of supplying limited power to a primary provider of power with a data interface. Today many devices charge or get their power from USB ports contained in laptops, cars, aircraft or even wall sockets. USB has become a ubiquitous power socket for many small devices such as cell phones, MP3 players and other hand-held devices. Users need USB to fulfill their requirements not only in terms of data but also to provide power to, or charge, their devices simply, often without the need to load a driver, in order to carry out “traditional” USB functions.

There are, however, still many devices which either require an additional power connection to the wall, or exceed the USB rated current in order to operate. Increasingly, international regulations require better energy management due to ecological and practical concerns relating to the availability of power. Regulations limit the amount of power available from the wall which has led to a pressing need to optimize power usage. The USB Power Delivery Specification has the potential to minimize waste as it becomes a standard for charging devices that are not satisfied by ***[USBBC 1.2]***.

Wider usage of wireless solutions is an attempt to remove data cabling but the need for “tethered” charging remains. In addition, industrial design requirements drive wired connectivity to do much more over the same connector.

USB Power Delivery is designed to enable the maximum functionality of USB by providing more flexible power delivery along with data over a single cable. Its aim is to operate with and build on the existing USB ecosystem; increasing power levels from existing USB standards, for example Battery Charging, enabling new higher power use cases such as USB powered Hard Disk Drives (HDDs) and printers.

With USB Power Delivery the power direction is no longer fixed. This enables the product with the power (Host or Peripheral) to provide the power. For example, a display with a supply from the wall can power, or charge, a laptop. Alternatively, USB power bricks or chargers are able to supply power to laptops and other battery powered devices through their, traditionally power providing, USB ports.

USB Power Delivery enables hubs to become the means to optimize power management across multiple peripherals by allowing each device to take only the power it requires, and to get more power when required for a given application. For example, battery powered devices can get increased charging current and then give it back temporarily when the user’s HDD requires spinning up. ***Optionally*** the hubs can communicate with the PC to enable even more intelligent and flexible management of power either automatically or with some level of user intervention.

USB Power Delivery allows Low Power cases such as headsets to negotiate for only the power they require. This provides a simple solution that enables USB devices to operate at their optimal power levels.

The Power Delivery Specification, in addition to providing mechanisms to negotiate power also can be used as a side-band channel for standard and vendor defined messaging. Power Delivery enables alternative modes of operation by providing the mechanisms to discover, enter and exit Alternate Modes. The specification also enables discovery of cable capabilities such as supported speeds and current levels.

1.1 Overview

This specification defines how USB Devices can negotiate for more current and/or higher or lower Voltages over the USB cable (using the USB Type-C® CC wire as the communications channel) than are defined in the ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 2.0]*** or ***[USBBC 1.2]*** specifications. It allows Devices with greater power requirements than can be met with today’s specification to get the power they require to operate from V_{BUS} and negotiate with external power sources (e.g., Wall Warts). In addition, it allows a Source and Sink to swap power roles such that a Device could supply power to the Host. For example, a display could supply power to a notebook to charge its battery.

The USB Power Delivery Specification is guided by the following principles:

- Works seamlessly with legacy USB Devices
- Compatible with existing spec-compliant USB cables

- Minimizes potential damage from non-compliant cables (e.g., 'Y' cables etc.)
- Optimized for low-cost implementations.

This specification defines mechanisms to discover, enter and exit Modes defined either by a standard or by a particular vendor. These Modes can be supported either by the Port Partner or by a cable connecting the two Port Partners.

The specification defines mechanisms to discover the capabilities of cables which can communicate using Power Delivery.

This specification adds a mechanism to swap the data roles such that the upstream facing Port becomes the downstream facing Port and vice versa. It also enables a swap of the end supplying VCONN to a powered cable.

To facilitate optimum charging, the specification defines two mechanisms a USB Charger can Advertise for the Device to use:

1. A list of fixed Voltages each with a maximum current. The Device selects a Voltage and current from the list. This is the traditional model used by Devices that use internal electronics to manage the charging of their battery including modifying the Voltage and current actually supplied to the battery. The side-effect of this model is that the charging circuitry generates heat that may be problematic for small form factor devices.

2. A list of programmable Voltage ranges each with a maximum current (PPS). The Device requests a Voltage (in 20mV increments in SPR PPS Mode and in 100mV increments in EPR AVS Mode) that is within the Advertised range and a maximum current. The USB Charger delivers the requested Voltage until the maximum current is reached at which time the USB charger reduces its output Voltage so as not to supply more than the requested maximum current. During the high current portion of the charge cycle, the USB Charger can be directly connected (through an appropriate safety device) to the battery. This model is used by Devices that want to minimize the thermal impact of their internal charging circuitry.

1.2 Purpose

The USB Power Delivery specification defines a power delivery system covering all elements of a USB system including: Hosts, Devices, Hubs, Chargers and cable assemblies. This specification describes the architecture, protocols, power supply behavior, connectors and cabling necessary for managing power delivery over USB at up to 100W. This specification is intended to be fully compatible and extend the existing USB infrastructure. It is intended that this specification will allow system OEMs, power supply and peripheral developers adequate flexibility for product versatility and market differentiation without losing backwards compatibility.

USB Power Delivery is designed to operate independently of the existing USB bus defined mechanisms used to negotiate power which are:

- ***[USB 2.0]***, ***[USB 3.2]*** in band requests for high power interfaces.
- ***[USBBC 1.2]*** mechanisms for supplying higher power (not mandated by this specification).
- ***[USB Type-C 2.0]*** mechanisms for supplying higher power.

Initial operating conditions remain the USB Default Operation as defined in ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 2.0]*** or ***[USBBC 1.2]***.

- The DFP sources ***vSafe5V*** over V_{BUS}.
- The UFP consumes power from V_{BUS}.

1.3 Scope

This specification is intended as an extension to the existing ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 2.0]*** and ***[USBBC 1.2]*** specifications. It addresses only the elements required to implement USB Power Delivery. It is targeted at power supply vendors, manufacturers of ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 2.0]*** and ***[USBBC 1.2]*** Platforms, Devices and cable assemblies.

Normative information is provided to allow interoperability of components designed to this specification. Informative information, when provided, illustrates possible design implementation.

1.4 Conventions

1.4.1 Precedence

If there is a conflict between text, figures, and tables, the precedence ***Shall*** be tables, figures, and then text.

In there is a conflict between a generic statement and a more specific statement, the more specific statement ***Shall*** apply.

1.4.2 Keywords

The following keywords differentiate between the levels of requirements and options.

1.4.2.1 Conditional Normative

Conditional Normative is a keyword used to indicate a feature that is mandatory when another related feature has been implemented. Designers are mandated to implement all such requirements, when the dependent features have been implemented, to ensure interoperability with other compliant Devices.

1.4.2.2 Deprecated

Deprecated is a keyword used to indicate a feature, supported in previous releases of the specification, which is no longer supported.

1.4.2.3 Discarded

Discard, ***Discards*** and ***Discarded*** are equivalent keywords indicating that a Packet when received ***Shall*** be thrown away by the PHY Layer and not passed to the Protocol Layer for processing. No ***GoodCRC*** Message ***Shall*** be sent in response to the Packet.

1.4.2.4 Ignored

Ignore, ***Ignores*** and ***Ignored*** are equivalent keywords indicating Messages or Message fields which, when received, ***Shall*** result in no special action by the receiver. An ***Ignored*** Message ***Shall*** only result in returning a ***GoodCRC*** Message to acknowledge Message receipt. A Message with an ***Ignored*** field ***Shall*** be processed normally except for any actions relating to the ***Ignored*** field.

1.4.2.5 Invalid

Invalid is a keyword when used in relation to a Packet indicates that the Packet's usage or fields fall outside of the defined specification usage. When ***Invalid*** is used in relation to an Explicit Contract it indicates that a previously established Explicit Contract which can no longer be maintained by the Source. When ***Invalid*** is used in relation to individual K-codes or K-code sequences indicates that the received Signaling falls outside of the defined specification.

1.4.2.6 May

May is a keyword that indicates a choice with no implied preference.

1.4.2.7 May Not

May Not is a keyword that is the inverse of ***May***. Indicates a choice to not implement a given feature with no implied preference.

1.4.2.8 N/A

N/A is a keyword that indicates that a field or value is not applicable and has no defined value and ***Shall Not*** be checked or used by the recipient.

1.4.2.9 Optional/Optionally/Optional Normative

Optional, Optionally and ***Optional Normative*** are equivalent keywords that describe features not mandated by this specification. However, if an ***Optional*** feature is implemented, the feature ***Shall*** be implemented as defined by this specification.

1.4.2.10 Reserved

Reserved is a keyword indicating reserved bits, bytes, words, fields, and code values that are set-aside for future standardization. Their use and interpretation ***May*** be specified by future extensions to this specification and ***Shall Not*** be utilized or adapted by vendor implementation. A ***Reserved*** bit, byte, word, or field ***Shall*** be set to zero by the sender and ***Shall*** be ***Ignored*** by the receiver. ***Reserved*** field values ***Shall Not*** be sent by the sender and ***Shall*** be ***Ignored*** by the receiver.

1.4.2.11 Shall/Normative

Shall and ***Normative*** are equivalent keywords indicating a mandatory requirement. Designers are mandated to implement all such requirements to ensure interoperability with other compliant Devices.

1.4.2.12 Shall Not

Shall Not is a keyword that is the inverse of ***Shall*** indicating non-compliant operation.

1.4.2.13 Should

Should is a keyword indicating flexibility of choice with a preferred alternative; equivalent to the phrase “it is recommended that…”.

1.4.2.14 Should Not

Should Not is a keyword is the inverse of ***Should***; equivalent to the phrase “it is recommended that implementations do not…”.

1.4.2.15 Valid

Valid is a keyword that is the inverse of ***Invalid*** indicating either a Packet or Signaling that fall within the defined specification or an Explicit Contract that can be maintained by the Source.

1.4.3 Numbering

Numbers that are immediately followed by a lowercase "b" (e.g., 01b) are binary values. Numbers that are immediately followed by an uppercase "B" are byte values. Numbers that are immediately followed by a lowercase "h" (e.g., 3Ah) or are preceded by “0x” (e.g., 0xFF00) are hexadecimal values. Numbers not immediately followed by either a "b", “B”, or "h" are decimal values.

1.5 Related Documents

Document references listed below are inclusive of all approved and published ECNs and Errata:

- ***[USB 2.0]*** – Universal Serial Bus Specification, Revision 2.0, http://www.usb.org/developers/docs/usb20_docs/.
- ***[USB 3.2]*** – Universal Serial Bus 3.2 Specification, Revision 1.0, September 22, 2017. www.usb.org/developers/docs.
- ***[USBTypeCAuthentication 1.0]***, Universal Serial Bus Type-C Authentication Specification, Revision 1.0, March 25, 2016. www.usb.org/developers/docs.
- ***[USBPDFirmwareUpdate 1.0]***, Universal Serial Bus Power Delivery Firmware Update Specification, Revision 1.0, September 15, 2016. http://www.usb.org/developers/powerdelivery/
- ***[USBBC 1.2]*** – Universal Serial Bus Battery Charging Specification, Revision 1.2 plus Errata (referred to in this document as the Battery Charging specification). www.usb.org/developers/devclass_docs#approved.

- ***[USBBridge 1.1]*** – Universal Serial Bus Type-C Bridge Specification, Revision 1.1, October 10, 2017. www.usb.org/developers/docs.
- ***[USBTypeCBridge 1.0]*** – Universal Serial Bus Type-C Bridge Specification, Revision 1.0, March 25, 2016. www.usb.org/developers/docs.
- ***[USBPD 2.0]*** – Universal Serial Bus Power Delivery Specification, Revision 2, Version 1.2, March 25, 2016. www.usb.org/developers/docs.
- ***[USBPDCompliance]*** – USB Power Delivery Compliance Plan Version 1.0, Revision 1.1, September 2020 http://www.usb.org/developers/docs/devclass_docs/.
- ***[USB Type-C 2.1]*** – Universal Serial Bus Type-C Cable and Connector Specification, Revision 2.1, May 2021 www.usb.org/developers/docs.
- ***[IEC 60958-1]*** IEC 60958-1 Digital Audio Interface Part:1 General Edition 3.0 2008-09 www.iec.ch
- ***[IEC 60950-1]*** IEC 60950-1:2005 Information technology equipment – Safety – Part 1: General requirements: Amendment 1:2009, Amendment 2:2013
- ***[IEC 62368-1]*** IEC 62368-1 Audio/Video, information and communication technology equipment – Part 1: Safety requirements
- ***[IEC 62368-3]*** IEC 62368-1 Audio/video, information and communication technology equipment - Part 3: Safety aspects for DC power transfer through communication cables and ports
- ***[IEC 63002]*** IEC 63002, Interoperability specifications and communication method for external power supplies used with computing and consumer electronics devices
- ***[ISO 3166]*** ISO 3166 international Standard for country codes and codes for their subdivisions. http://www.iso.org/iso/home/standards/country_codes.htm.
- ***[USB4]*** – Universal Serial Bus 4 Specification (USB4™), Version 1.0, August 2019. www.usb.org/developers/docs.
- ***[DPTC2.0]*** DisplayPort™ Alt Mode on USB Type-C® Standard, Version 2.0, 12 March 2020. www.vesa.org.
- ***[TBT3]*** see ***[USB4]*** Chapter 13 for Thunderbolt™ 3 device operation.

1.6 Terms and Abbreviations

This section defines terms used throughout this document. For additional terms that pertain to the Universal Serial Bus, see Chapter 2, “Terms and Abbreviations,” in ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 2.0]*** and ***[USBBC 1.2]***.

Table 1-1 Terms and Abbreviations

Term	Description
Active Cable	A cable with a USB Plug on each end at least one of which is a Cable Plug supporting SOP’, that also incorporates data bus signal conditioning circuits. The cable supports the Structured VDM ***Discover Identity*** Command to determine its characteristics in addition to other Structured VDM Commands (Electronically Marked Cable see ***[USB Type-C 2.0]***).
Active Mode	A Mode which has been entered and not exited.
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.
Advertised	An offer made by a Source in the Capabilities/EPR Capabilities message (e.g., an APDO or PDO).
Alternate Mode	As defined in ***[USB Type-C 2.0]***. Equivalent to Mode in the PD Specification.
Alternate Mode Adapter (AMA)	A PDUSB Device which supports Alternate Modes as defined in ***[USB Type-C 2.0]***. Note that since an AMA is a PDUSB Device it has a single UFP that is only addressable by SOP Packets.

Term	Description
Alternate Mode Controller (AMC)	A DFP that supports connection to AMAs as defined in ***[USB Type-C 2.0]***. A DFP that is an AMC can also be a PDUSB Host.
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 ***Source_Capabilities*** or ***Sink_Capabilities*** Message respectively. Programmable Power Supply Data Object is defined.
Atomic Message Sequence (AMS)	A fixed sequence of Messages as defined in Section 8.3.2 typically starting and ending in one of the following states: ***PE_SRC_Ready***, ***PE_SNK_Ready*** or ***PE_CBL_Ready***. An AMS can be Interruptible or Non-interruptible.
Attach	Mechanical joining of the Port Pair by a cable.
Attached	USB Power Delivery ports which are mechanically joined with USB cable.
Battery	A power storage device residing behind a Port that can either be a source or sink of power.
Battery Slot	A physical location where a Hot Swappable Battery can be installed. A Battery Slot might or might not have a Hot Swappable Battery present in a Battery Slot at any given time.
Battery Supply	A power supply that directly applies the output of a Battery to V_{BUS}. This is exposed by the Battery Supply PDO (see Section 6.4.1.2.4)
Binary Frequency Shift Keying (BFSK)	A Signaling Scheme now ***Deprecated*** in this specification. BFSK used a pair of discrete frequencies to transmit binary (0s and 1s) information over V_{BUS}. See ***[USBPD 2.0]*** for further details.
Biphase Mark Coding (BMC)	Modification of Manchester coding where each zero has one transition and a one has two transitions (see ***[IEC 60958-1]***).
BIST	Built-In Self-Test – Power Delivery testing mechanism for the PHY Layer.
BIST Data Object (BDO)	Data Object used by ***BIST*** Messages.
BIST Mode	A BIST receiver or transmitter test mode enabled by a ***BIST*** Message.
Cable Discovered	USB Power Delivery ports that have exchanged a Message and a ***GoodCRC*** Message response with a Cable Plug or a VPD using the USB Power Delivery protocol so that both the Port and the Cable Plug know that each is PD Capable.
Cable Plug	Term used to describe a PD Capable element in a Multi-Drop system addressed by SOP'/SOP'' Packets. Logically the Cable Plug is associated with a USB plug at one end of the cable. In a practical implementation the electronics might reside anywhere in the cable.
Cable Reset	This is initiated by ***Cable Reset*** Signaling from the DFP. It restores the Cable Plugs to their default, power up condition and resets the PD communications engine to its default state. It does not reset the Port Partners but does restore V_{CONN} to its Attachment state.
Charge Through	A mechanism for a V_{CONN}-powered USB Device (VPD) to pass power and CC communication from one Port to the other without any interference or re-regulation.
Charge Through Port	The USB Type-C receptacle on a USB Device that is designed to allow a Source to be connected through the USB Device to charge a system it is Attached to. Most common use is to allow a single Port Host to support a USB device while being charged.
Chunk	A ***MaxExtendedMsgChunkLen*** (26 byte) or less portion of a Data Block. Data Blocks can be sent either as a single Message or as a series of Chunks.
Chunking	The process of breaking up a Data Block larger than ***MaxExtendedMsgLegacyLen*** (26-bytes) into two of more Chunks.
Cold Socket	A Port that does not apply ***vSafe5V*** on V_{BUS} until a Sink is Attached.
Command	Request and response pair defined as part of a Structured Vendor Defined Message (see Section 6.4.4.2)
Configuration Channel (CC)	Single wire used by the BMC PHY Layer Signaling Scheme (see ***[USB Type-C 2.0]***).
Connected	USB Power Delivery ports that have exchanged a Message and a ***GoodCRC*** Message response using the USB Power Delivery protocol so that both Port Partners know that each is PD Capable.
Consumer	The capability of a PD Port (typically a Device's UFP) to sink power from the power conductor (e.g., V_{BUS}). This corresponds to a USB Type-C Port with Rd asserted on its CC Wire.
Consumer/Provider	A Consumer with the additional capability to act as a Provider. This corresponds to a Dual-Role Port with Rd asserted on its CC Wire.

Term	Description
Continuous BIST Mode	A BIST Mode where the Port or Cable Plug being tested sends a continuous stream of test data.
Constant Voltage (CV)	A mode in which the Source output Voltage remains constant as the load changes.
Contract	An agreement on both power level and direction reached between a Port Pair. A Contract could be explicitly negotiated between the Port Pair or could be an Implicit power level defined by the current state. While operating in Power Delivery mode there will always be either an Explicit or Implicit Contract in place. The Contract can only be altered in the case of a (re-)negotiation, Power Role Swap, Data Role Swap, Hard Reset or failure of the Source.
Control Message	A Message is defined as a Control Message when the ***Number of Data Objects*** field in the Message Header is set to 0. The Control Message consists only of a Message Header and a CRC.
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.
Data Block	An Extended Message payload data unit. The size of each type of Data Block is specified as a series of bytes up to ***MaxExtendedMsgLen*** bytes in length. This is distinct from a Data Object used by a Data Message which is always a 32-bit object.
Data Message	A Data Message consists of a Message Header followed by one or more Data Objects. Data Messages are easily identifiable because the ***Number of Data Objects*** field in the Message Header is a non-zero value.
Data Object	A Data Message payload data unit. This 32-bit object contains information specific to different types of Data Message. Power, Request, BIST and Vendor Data Objects are defined.
Data Role Swap	Process of exchanging the DFP (Host) and UFP (Device) roles between Port Partners using the ***[USB Type-C 2.0]*** connector.
Dead Battery	A device has a Dead Battery when the Battery in a device is unable to power its functions.
Detach	Mechanical unjoining of the Port Pair by removal of the cable.
Detached	USB Power Delivery ports which are no longer mechanically joined with USB cable.
Device	When lower cased (device), it refers to any USB product, either USB Device or USB Host. When in upper case refers to a USB Device (Peripheral or Hub).
Device Policy Manager (DPM)	Module running in a Source or Sink that applies Local Policy to each Port in the Device via the Policy Engine.
Discovery Process	Command sequence using Structured Vendor Defined Messages resulting in identification of the Port Partner, its supported SVIDs and Modes.
Downstream Facing Port (DFP)	Indicates the Port's position in the USB topology which typically corresponds to a USB Host Root Port or Hub Downstream Port as defined in ***[USB Type-C 2.0]***. At connection the Port defaults to operation as a USB Host (when USB Communication is supported) and Source.
Dual-Role Data (DRD)	Capability of operating as either a DFP or UFP.
Dual-Role Data Port	A Port Capable of operating as DRD.
Dual-Role Power (DRP)	Capability of operating as either a Source or Sink.
Dual-Role Power Device	A product containing one or more Dual-Role Power Ports that are capable of operating as either a Source or a Sink.
Dual-Role Power Port	A Port capable of operating as a DRP.
End of Packet (EOP)	K-code marker used to delineate the end of a packet.
Enter Mode Process	Command sequence using Structured Vendor Defined Messages resulting in the Port Partners entering a Mode.
Error Recovery	Port enters the Error Recovery State as defined in ***[USB Type-C 2.0]***.

Term	Description
EPR Mode	A Power Delivery mode of operation where maximum allowable Voltage is increased to 48V. The Sink complies to the requirements of ***[IEC 62368-1]*** for operation with a PS3 Source. The Source complies to the requirements of ***[IEC 62368-1]*** for operation with a PS3 Sink. The cable complies with ***[IEC 62368-1]***. Entry into the EPR Mode requires an EPR Source is attached to an EPR Sink with an EPR cable. The Source will only enter the EPR Mode when requested to do so by the Sink and it has determined it is attached to the Sink with an EPR capable cable. Only the ***EPR_Source_Capabilities*** and the ***EPR_Request*** Messages are allowed to negotiate EPR power contracts. The SPR messages (***Source_Capabilities*** and ***Request***) are not allowed to be used while in EPR Mode.
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.
Extended Power Range (EPR)	Extends the power range from a maximum of 100W (SPR) to a maximum of 240W. When operating in the EPR Mode, only EPR specific Messages (the ***EPR_Source_Capabilities*** Message and the ***EPR_Request*** Messages) are used to Negotiate Explicit Contracts.
EPR PDO	• Fixed PDO that offers more than 20V. • AVS APDO whose Maximum Voltage is up to 48V and no more than 240W.
EPR AVS	A power supply operating in EPR 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 Adjustable Voltage Supply APDO (see Section 6.4.1.2.5).
EPR Source	A Source that supports both SPR Mode and EPR Mode.
Exit Mode Process	Command sequence using Structured Vendor Defined Messages resulting in the Port Partners exiting a Mode.
Explicit Contract	An agreement reached between a Port Pair as a result of the Power Delivery negotiation process. An Explicit Contract is established (or continued) when a Source sends an ***Accept*** Message in response to a ***Request*** Message sent by a Sink followed by a ***PS_RDY*** Message indicating that the power supply is ready; this corresponds to the ***PE_SRC_Ready*** state for a Source Policy Engine and the ***PE_SNK_Ready*** state for a Sink Policy Engine. The Explicit Contract can be altered through the re-negotiation process. All Port pairs are required to make an Explicit Contract.
Extended Message (EM)	A Message containing Data Blocks. The Extended Message is defined by the ***Extended*** field in the Message Header being set to one and contains an Extended Message Header immediately following the Message Header.
Extended Message Header	Every Extended Message contains a 16-bit Extended Message Header immediately following the Message Header containing information about the Data Block and any Chunking being applied.
Fast Role Swap	Process of exchanging the Source and Sink roles between Port Partners rapidly due to the disconnection of an external power supply.
Fast Role Swap Request	An indication from an initial Source to the initial Sink that a Fast Role Swap is needed. The Fast Role Swap Request is indicated by driving the CC line to Ground; it is not a Message or a Signal.
Fixed Battery	A Battery that is not easily removed or replaced by an end user e.g., requires a special tool to access or is soldered in.
Fixed Supply	A well-regulated fixed Voltage power supply. This is exposed by the Fixed Supply PDO (see Section 6.4.1.2.2)
Frame	Generic term referring to an atomic communication transmitted by PD such as a Packet, Test Frame or Signaling.
Hard Reset	This is initiated by ***Hard Reset*** Signaling from either Port Partner. It restores V_{BUS} to USB Default Operation and resets the PD communications engine to its default state in both Port Partners as well as in any Attached Cable Plugs. It restores both Port Partners to their default Data Roles and returns the V_{CONN} Source to the Source Port.
HDD	A Hard Disk Drive.

Term	Description
Hot Swappable Battery	A Battery that is easily accessible for a user to remove or change for another Battery.
ID Header VDO	The VDO in a ***Discover Identity*** Command immediately following the VDM Header. The ID Header VDO contains information corresponding to the Power Delivery Product.
Implicit Contract	An agreement on power levels between a Port Pair which occurs, not as a result of the Power Delivery negotiation process, but as a result of a Power Role Swap or Fast Role Swap. Implicit Contracts are transitory since the Port pair is required to immediately negotiate an Explicit Contract after the Power Role Swap. An Implicit Contract ***Shall*** be limited to USB Type-C Current (see ***[USB Type-C 2.0]***).
Initiator	The initial sender of a Command request in the form of a query.
Interruptible	An AMS that, on receiving a Protocol Error, returns to the appropriate ready state in order to process the incoming Message is said to be Interruptible. Every AMS is Interruptible until the first Message in the AMS has been sent (a ***GoodCRC*** Message has been received). An AMS of Vendor Messages is Interruptible during the entire sequence.
IoC	The negotiated current value as defined in ***[IEC 63002]***.
IR Drop	The Voltage drop across the cable and connectors between the Source and the Sink. It is a function of the resistance of the ground and power wire in the cable plus the contact resistance in the connectors times the current flowing over the path.
K-code	Special symbols provided by the 4b5b coding scheme. K-codes are used to signal Hard Reset and Cable reset and delineate Packet boundaries.
Local Policy	Every PD Capable device has its own Policy, called the Local Policy that is executed by its Policy Engine to control its power delivery behavior. The Local Policy at any given time might be the default policy, hard coded or modified by changes in operating parameters or one provided by the system Host or some combination of these. The Local Policy ***Optionally*** can be changed by a System Policy Manager.
LPS	Limited Power Supply as defined in ***[IEC 62368-1]***.
Message	The packet payload consisting of a Message Header for Control Messages and a Message Header and data for Data Messages and Extended Messages as defined in Section 6.
Message Header	Every Message starts with a 16-bit Message Header containing basic information about the Message and the PD Port's Capabilities.
Messaging	Communication in the form of Messages as defined in Chapter 6.
Modal Operation	State where there are one or more Active Modes. Modal Operation ends when there are no longer any Active Modes.
Mode	Operation defined by a Vendor or Standard's organization, which is associated with a SVID, whose definition is outside the scope of USB-IF specifications. Entry to and exit from the Mode uses the Enter Mode and Exit Mode Processes. Modes are equivalent to "Alternate Modes" as described in ***[USB Type-C 2.0]***.
Multi-Drop	Refers to a Power Delivery system with one or more Cable Plugs where communication is to the Cable Plugs rather than the Port Partner. Multi-Drop systems share the Power Delivery communication channel with the Port Partners.
Negotiation	This is the PD process whereby: 1. The Source Advertises its capabilities. 2. The Sink requests one of the Advertised capabilities. 3. The Source acknowledges the request and alters its output to satisfy the request. The result of the negotiation is a Contract for power delivery/consumption between the Port Pair.
Non-interruptible	An AMS that, on receiving a Protocol Error, generates either a Soft Reset or Hard Reset. Any power related AMS is Non-interruptible once the first Message in the AMS has been sent (a ***GoodCRC*** Message has been received).
OCP	Over-Current Protection
OTP	Over-Temperature Protection
OVP	Over-Voltage Protection

Term	Description
Packet	One entire unit of PD communication including a Preamble, ***SOP****, payload, CRC and ***EOP*** as defined in Section 5.6.
Passive Cable	Cable with a USB Plug on each end at least one of which is a Cable Plug supporting SOP' that does not incorporate data bus signal conditioning circuits. Supports the Structured VDM ***Discover Identity*** to determine its characteristics (Electronically Marked Cable see ***[USB Type-C 2.0]***). Note this specification does not discuss Passive Cables which are not Electronically Marked Cables.
PD	USB Power Delivery
PD Capable	A Port that supports USB Power Delivery.
PD Connection	See Connected.
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.
PDP Rating	Manufacturer declared PDP for a Source Port. The Port is labeled to indicate its PDP Rating.
PDUSB	USB Device Port or USB Host Port that is both PD capable and capable of USB Communication. See also PDUSB Host, PDUSB Device and PDUSB Hub.
PDUSB Device	A USB Device with a PD Capable UFP. A PDUSB Device is only addressed by SOP Packets.
PDUSB Host	A USB Host which is PD Capable on at least one of its DFPs. A PDUSB Host is only addressed by SOP Packets.
PDUSB Hub	A port expander USB Device with a UFP and one or more DFPs which is PD Capable on at least one of its Ports. A PDUSB Hub is only addressed by SOP Packets. A self-powered PDUSB Hub is treated as a USB Type-C Multi-Port Charger.
PDUSB Peripheral	A USB Device with a PD Capable UFP which is not a PDUSB Hub. A PDUSB Peripheral is only addressed by SOP Packets.
PHY Layer	The Physical Layer responsible for sending and receiving Messages across the USB Type-C CC wire between a Port Pair.
Policy	Policy defines the behavior of PD capable parts of the system and defines the capabilities it Advertises, requests made to (re)negotiate power and the responses made to requests received.
Policy Engine (PE)	The Policy Engine interprets the Device Policy Manager's input in order to implement Policy for a given Port and directs the Protocol Layer to send appropriate Messages.
Port	An interface typically exposed through a receptacle, or via a plug on the end of a hard-wired captive cable. USB Power Delivery defines the interaction between a Port Pair.
Port Pair	Two Attached PD Capable Ports.
Port Partner	A Contract is negotiated between a Port Pair connected by a USB cable. These ports are known as Port Partners.
Power Conductor	The wire delivering power from the Source to Sink. For example, USB's V_{BUS}.
Power Consumer	See Consumer
Power Data Object (PDO)	Data Object used to expose a Source Port's power capabilities or a Sink's power requirements as part of a ***Source_Capabilities*** / ***EPR_Source_Capabilities*** or ***Sink_Capabilities*** / ***EPR_Sink_Capabilities*** Message respectively. Fixed, Variable and Battery Power Data Objects are defined; SPR Mode uses all four while EPR mode uses only Fixed and Variable PDOs.
Power Delivery Mode	Operation after a Contract has initially been established between a Port pair. This mode persists during normal Power Delivery operation, including after a Power Role Swap. Power Delivery mode can only be exited by Detaching the ports, applying a Hard Reset or by the Source removing power (except when power is removed during the Power Role Swap procedure).
Power Provider	See Provider
Power Reserve	Power which is kept back by a Source in order to ensure that it can meet total power requirements of Attached Sinks on at least one Port.
Power Role Swap	Process of exchanging the Source and Sink roles between Port Partners.
Preamble	Start of a transmission which is used to enable the receiver to lock onto the carrier. The Preamble consists of a 64-bit sequence of alternating 0s and 1s starting with a "0" and ending with a "1" which is not 4b5b encoded.

Term	Description
Product Type	Product categorization returned as part of the ***Discover Identity*** Command.
Product Type VDO	VDO identifying a certain Product Type in the ID Header VDO of a ***Discover Identity*** Command.
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).
Protocol Error	An unexpected Message during an Atomic Message Sequence. A Protocol Error during a Non-interruptible AMS will result in either a Soft Reset or a Hard Reset. A Protocol Error during an Interruptible AMS will result in a return to the appropriate ready state where the Message will be handled.
Protocol Layer	The entity that forms the Messages used to communicate information between Port Partners.
Provider	A capability of a PD Port (typically a Host, Hub, or Wall Wart DFP) to source power over the power conductor (e.g., V_{BUS}). This corresponds to a USB Type-C Port with Rp asserted on its CC Wire.
Provider/Consumer	A Provider with the additional capability to act as a Consumer. This corresponds to a Dual-Role Power Port with Rp asserted on its CC Wire.
PS1, PS2, PS3	Classification of electrical power as defined in ***[IEC 62368-1].***
PSD	Sink which draws power but has no other USB or Alternate Mode communication function e.g., a power bank.
Rd	Pull-down resistor on the USB Type-C CC wire used to indicate that the Port is a Sink (see ***[USB Type-C 2.0]***).
Reattach	Attach of the Port Pair by a cable after a previous Detach.
Re-negotiation	A process wherein one of the Port Partners wants to alter the negotiated Contract.
Request Data Object (RDO)	Data Object used by a Sink Port to negotiate a Contact as a part of a ***Request*** Message.
Re-run	Start an Interruptible AMS again from the beginning after a Protocol Error.
Responder	The receiver of a Command request sent by an Initiator that replies with a Command response.
Rp	Pull-up resistor on the USB Type-C CC wire used to indicate that the Port is a Source (see ***[USB Type-C 2.0]***).
Safe Operation	Sources must have the ability to tolerate ***vSafe5V*** applied by both Port Partners.
Signaling	A Preamble followed by an ordered set of four K-codes used to indicate a particular line symbol e.g., ***Hard Reset*** as defined in Section 5.4.
Signaling Scheme	Physical mechanism used to transmit bits. Only the BMC Signaling Scheme is defined in this specification. Note: the BFSK Signaling Scheme supported in previous Revisions of this specification has been ***Deprecated***.
Single-Role Port	A Port that is a Port only capable of operating as a Source or Sink, but not both.
Sink	The Port consuming power from V_{BUS}; most commonly a Device.
Sink Directed Charge	A charging scheme whereby the Sink connects the Source to its battery through safety and other circuitry. When the SPR PPS Current Limit feature is activated, the Source automatically controls its output current by adjusting its output Voltage.
Soft Reset	A process that resets the PD communications engine to its default state.
SOP Communication	Communication using SOP Packets also implies that a Message sequence is being followed.
SOP Packet	Any Power Delivery Packet which starts with an ***SOP***.
SOP* Communication	Communication with a Cable Plug using SOP* Packets, also implies a Message sequence is being followed.
SOP* Packet	A term referring to any Power Delivery Packet starting with either ***SOP***, ***SOP'*** or ***SOP''***.
SOP' Communication	Communication with a Cable Plug using SOP' Packets, also implies that a Message sequence is being followed.
SOP' Packet	Any Power Delivery Packet which starts with an ***SOP'*** used to communicate with a Cable Plug.

Term	Description
SOP'' Communication	Communication with a Cable Plug using SOP'' Packets, also implies that a Message sequence is being followed.
SOP'' Packet	Any Power Delivery Packet which starts with an ***SOP''*** used to communicate with a Cable Plug when SOP' Packets are being used to communicate with the other Cable Plug.
Source	A role a Port is currently taking to supply power over V_{BUS}; most commonly a Host or Hub downstream port.
SPR Mode	The classic mode of PD operation where power contracts are negotiated using SPR PDOs.
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 Source	A Source which only supports SPR Mode and does not support EPR Mode.
Standard Power Range (SPR)	Only the ***Source_Capabilities*** and the ***Request*** Messages are allowed to negotiate SPR power contracts. The EPR Messages (the ***EPR_Source_Capabilities*** Message and the ***EPR_Request*** Messages) are not allowed to be used while in SPR mode.
SPR PDO	• Fixed PDO that offers up to 20V and no more than 100W. • Variable PDO whose Maximum Voltage offers up to 21V and no more than 100W. • Battery PDO whose Maximum Voltage offers up to 21V and no more than 100W. • Programmable APDO whose Maximum Voltage is up to 21V and no more than 100W.
Standard ID (SID)	16-bit unsigned value assigned by the USB-IF to a given industry standard.
Standard or Vendor ID (SVID)	Generic term referring to either a VID or a SID. SVID is used in place of the phrase "Standard or Vendor ID".
Start of Packet (SOP)	K-code marker used to delineate the start of a packet. Three start of packet sequences are defined: ***SOP, SOP'*** and ***SOP''***, with ***SOP**** used to refer to all three in place of ***SOP***/***SOP'***/***SOP''.***
System Policy	Overall system policy generated by the system, broken up into the policies required by each Port Pair to affect the system policy. It is programmatically fed to the individual devices for consumption by their Policy Engines.
System Policy Manager (SPM)	Module running on the USB Host. It applies the System Policy through communication with PD capable Consumers and Providers that are also connected to the Host via USB.
Test Frame	Frame consisting of a Preamble, ***SOP****, followed by test data (See Section 5.9).
Test Pattern	Continuous stream of test data in a given sequence (See Section 5.9)
Tester	The Tester is assumed to be a piece of test equipment that manages the BIST testing process of a PD UUT.
Unexpected Message	Message that a Port supports but has been received in an incorrect state.
Unit Interval (UI)	The time to transmit a single data bit on the wire.
Unit Under Test (UUT)	The PD device that is being tested by the Tester and responds to the initiation of a particular BIST test sequence.
Unrecognized Message	Message that a Port does not understand e.g., a Message using a ***Reserved*** Message type, a Message defined by a higher specification Revision than the Revision this Port supports, or an Unstructured Message for which the VID is not recognized.
Unsupported Message	Message that a Port recognizes but does not support. This is a Message defined by the specification, but which is not supported by this Port.
Upstream Facing Port (UFP)	Indicates the Port's position in the USB topology typically a Port on a Device as defined in ***[USB Type-C 2.0]***. At connection the Port defaults to operation as a USB Device (when USB Communication is supported) and Sink.
USB Attached State	Synonymous with the ***[USB 2.0]*** and ***[USB 3.2]*** definition of the Attached state
USB Default Operation	Operation of a Port at Attach or after a Hard Reset where the DFP Source applies ***vSafe0V*** or ***vSafe5V*** on V_{BUS} and the UFP Sink is operating at ***vSafe5V*** as defined in ***[USB 2.0]***, ***[USB 3.2]***, ***[USB Type-C 2.0]*** or ***[USBBC 1.2]***.
USB Device	Either a hub or a peripheral device as defined in ***[USB 2.0]*** and ***[USB 3.2]***.

Term	Description
USB Host	The host computer system where the USB host controller is installed as defined in ***[USB 2.0]*** and ***[USB 3.2]***.
USB Powered State	Synonymous with the ***[USB 2.0]*** and ***[USB 3.2]*** definition of the powered state.
USB Safe State	State of the USB Type-C connector when there are pins to be re-purposed (see ***[USB Type-C 2.0]***) so they are not damaged by and do not cause damage to their Port Partner.
USB Type-A	Term used to refer to any A plug or receptacle including USB Micro-A plugs and USB Standard-A plugs and receptacles. USB Micro-AB receptacles are assumed to be a combination of USB Type-A and USB Type-B.
USB Type-B	Terms used to refer to any B-plug or receptacle including USB Micro-B plugs and USB Standard-B plugs and receptacles, including the PD and non-PD versions. USB Micro-AB receptacles are assumed to be a combination of USB Type-A and USB Type-B.
USB Type-C	Term used to refer to the USB Type-C connector plug, or receptacle as defined in ***[USB Type-C 2.0]***.
USB-IF PD SID (PD SID)	Standard ID allocated to this specification by the USB Implementer's Forum.
Variable Supply	A very poorly regulated power supply that is not a Battery. This is exposed by the Variable Supply PDO (see Section 6.4.1.2.3).
VCONN Powered Accessory	An accessory that is powered from VCONN to operate in a Mode (see ***[USB Type-C 2.0]***).
VCONN Powered USB Device (VPD)	A captive cable USB Device that may be powered by either VCONN or V_{BUS} as defined in ***[USB Type-C 2.0]***. A VPD is a captive cable USB device that may be powered by either VCONN or V_{BUS} and only responds to SOP' messages as defined in the Tables in Section 6.12 (Message Applicability). It only responds to messages sent with a Specification Revision of at least Revision 3.0. A VPD is not allowed to support Alternate Modes. The term VPD refers to either a VPD or a CT-VPD with no charger connected.
VCONN Powered USB Charge Through Device (CT-VPD)	A CT-VPD is a VPD with an additional port for connecting a Source (e.g., a charger) as defined in ***[USB Type-C 2.0]***. When no charger is connected, a CT-VPD behaves as a VPD. When a charger is connected, no PD communication to the CT-VPD itself is possible as CC is connected to the charger port. Hence all PD communication then is with the charger and the cable with which it is connected.
VCONN Source	The USB Type-C Port responsible for sourcing VCONN.
VCONN Swap	Process of exchanging the VCONN Source between Port Partners.
VDM Header	The first Data Object following the Message Header in a Vendor Defined Message. The VDM Header contains the SVID relating to the VDM being sent and provides information relating to the Command in the case of a Structured VDM (see Section 6.4.4).
Vendor Data Object (VDO)	Data Object used to send Vendor specific information as part of a ***Vendor_Defined*** Message.
Vendor Defined Message (VDM)	PD Data Message defined for vendor/standards usage. These are further partitioned into Structured VDM Messages, where Commands are defined in this specification, and Unstructured VDM Messages which are entirely Vendor Defined (see Section 6.4.4).
Vendor ID (VID)	16-bit unsigned value assigned by the USB-IF to a given Vendor.
VI	Same as power (i.e., Voltage * current = power)
Wall Wart	A power supply or "power brick" that is plugged into an AC outlet. It supplies DC power to power a device or charge a Battery.

1.7 Parameter Values

The parameters in this specification are expressed in terms of absolute values. For details of how each parameter is measured in compliance please see ***[USBPDCompliance]***.

1.8 Changes from Revision 3.0

Extended Power Range (EPR) including Adjustable Voltage Supply (AVS) has been added.

1.9 Compatibility with Revision 2.0

Revision 3.1 of the USB Power Delivery specification is designed to be fully interoperable with *[USBPD 2.0]* systems using BMC signaling over the *[USB Type-C 2.0]* connector and to be compatible with Revision 2.0 hardware.

Please see Section 2.3 for more details of the mechanisms defined to enable compatibility.