

USB Type-C[®] Connector System Software Interface (UCSI) Specification

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1 Introduction

1.1 Scope

The USB Type-C Connector System Software Interface (UCSI) describes the registers and data structures used to interface with the USB Type-C connectors on a system. The system software component is referred to as the OS Policy Manager (OPM) in this specification.

This specification is intended for hardware component designers, system builders and device driver (software) developers. The reader is expected to be familiar with [USBTYPEPEC] and [USBPD]. In spite of due diligence, there may exist conflicts between this specification and either one or both of the above mentioned specifications. In such cases the [USBTYPEPEC] and [USBPD] take precedence.

The combination of hardware and firmware and any vendor-provided OS software that provides the interface to all the USB Type-C connectors on the platform is referred to as the Platform Policy Manager (PPM) in this specification. In addition, there may be individual policy managers for each USB Type-C connector on the platform. The individual policy managers are referred to as Local Policy Managers (LPM) in this specification.

This specification does not define the method to use (PCIe/ACPI/I2C/etc.) in order to interface with the PPM. It is left to individual system manufacturers to determine what bus/protocol they use to expose the PPM.

1.2 Purpose

The purpose of this document is to describe the minimum registers and data structures that a PPM shall support. These registers and data structures shall be used to communicate with the PPM. They shall be used to send commands to and retrieve capabilities and status from the PPM.

1.3 Related Documents

- [USB2.0] – Universal Serial Bus Specification, Revision 2.0, (including errata and ECNs through August 11, 2014) (referred to in this document as the USB 2.0 Specification) (available at: <https://www.usb.org/documents>.)
- [USB3.2] – Universal Serial Bus 3.2 Specification, Revision 1.0, released September 22, 2017 (including errata and ECNs through January 25, 2021) (referred to in this document as the USB 3.1 Specification) (available at: <https://www.usb.org/documents>.)
- [USBPD] – USB Power Delivery Specification Rev. 3.1, Version 1.2, October 2021 (referred to in this document as the USB PD Specification) (available at: <https://www.usb.org/documents>.)
- [USBTYPEPEC] – USB Type-C™ Cable and Connector Specification Revision 2.1, May 2021 (referred to in this document as the USB Type-C Specification) (available at: <https://www.usb.org/documents>.)
- [PDFU] USB Power Delivery Firmware Update Specification, Revision 1.0, September 15, 2016 (available at: <https://www.usb.org/documents>.)
- [USBAUTH] USB Type-C Authentication Rev 1.0 with ECN and Errata through January 7, 2019 (available at: <https://www.usb.org/documents>.)
- [VESA] DisplayPort Alt Mode on USB Type-C Version 1.0 22 September, 2014
- [USB4.0]- Universal Serial Bus 4.0 Specification, Version 1.0 with Errata and ECN through May 19 2021 2022 (referred to in this document as the USB 4.0 Specification) (available at: <https://www.usb.org/documents>.)

1.4 Terms and Abbreviations

This section defines terms and abbreviations used throughout this document. For additional terms and abbreviations that pertain to the Universal Serial Bus, see Chapter 2, “Terms and Abbreviations,” in [USB2.0] and [USB3.2], Section 1.8 in [USB4], Section 1.5 in [USBTYPEC] and Section 1.6 in [USBPD].

Table 1-1: Terms and Abbreviations

Term	Description
Connector	A USB Type-C connector that is attached to the platform.
LPM	Local Policy Manager. Hardware/firmware that manages an individual USB Type-C connector.
OPM	OS Policy Manager. Operating Software that interfaces with the PPM.
PPM	Platform Policy Manager. Hardware/firmware that manages all the USB Type-C connectors on the platform.

1.5 Conventions and Notations

1.5.1 Precedence

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

1.5.2 Keywords

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

1.5.2.1 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 and Software.

~~1.5.2.1~~1.5.2.2 Informative

Informative is a keyword that describes information with this specification that intends to discuss and clarify requirements and features as opposed to mandating them.

~~1.5.2.2~~1.5.2.3 May

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

~~1.5.2.3~~1.5.2.4 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.

~~1.5.2.4~~1.5.2.5 Normative

Normative is a keyword that describes features that are mandated by this specification.

~~1.5.2.5~~1.5.2.6 Optional/Optionally/Optional Normative

Optional is a keyword that describes features not mandated by this specification. However, if an optional feature is implemented, the feature shall be implemented as defined by this specification (optional normative).

~~1.5.2.6~~1.5.2.7 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, unless otherwise stated, 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, if received, shall be ignored by the receiver.

~~1.5.2.7~~1.5.2.8 Shall

Shall is a keyword indicating a mandatory (normative) requirement. Designers are mandated to implement all such requirements to ensure interoperability with other compliant Devices.

~~1.5.2.8~~1.5.2.9 Should

Should is a keyword indicating flexibility of choice with a preferred alternative. Equivalent to the phrase "it is recommended that".

1.5.3 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) are hexadecimal values. Numbers not immediately followed by either a "b", "B", or "h" are decimal values.

1.5.4 Byte Ordering

All multiple byte fields in this specification are interpreted as and moved over the bus in little-endian order, i.e., LSB to MSB unless otherwise specified.

2 ~~Management~~Specification Overview

This specification defines Physical Layer, Interface Protocol, and the various commands and notifications to manage a platform that exposes one or more USB Type-C connectors. It details the initialization sequence to determine the number of connectors on the system and capabilities of the system and each of the connectors on the platform.

The data structures are defined in Chapter ~~33~~4 and the Operational Model, State Machines and Commands are defined in Chapter ~~4~~6.

Note that this specification does not define the policy that the OPM is required to implement.

3 LPM Physical Layer

3.1 Physical Layer Overview

The Physical Layer (PHY Layer) defines the signaling technology for USB Type-C Connector Software Interface. This chapter defines electrical requirements and parameters of the UCSI PHY Layer required for interoperability between UCSI components and LPM.

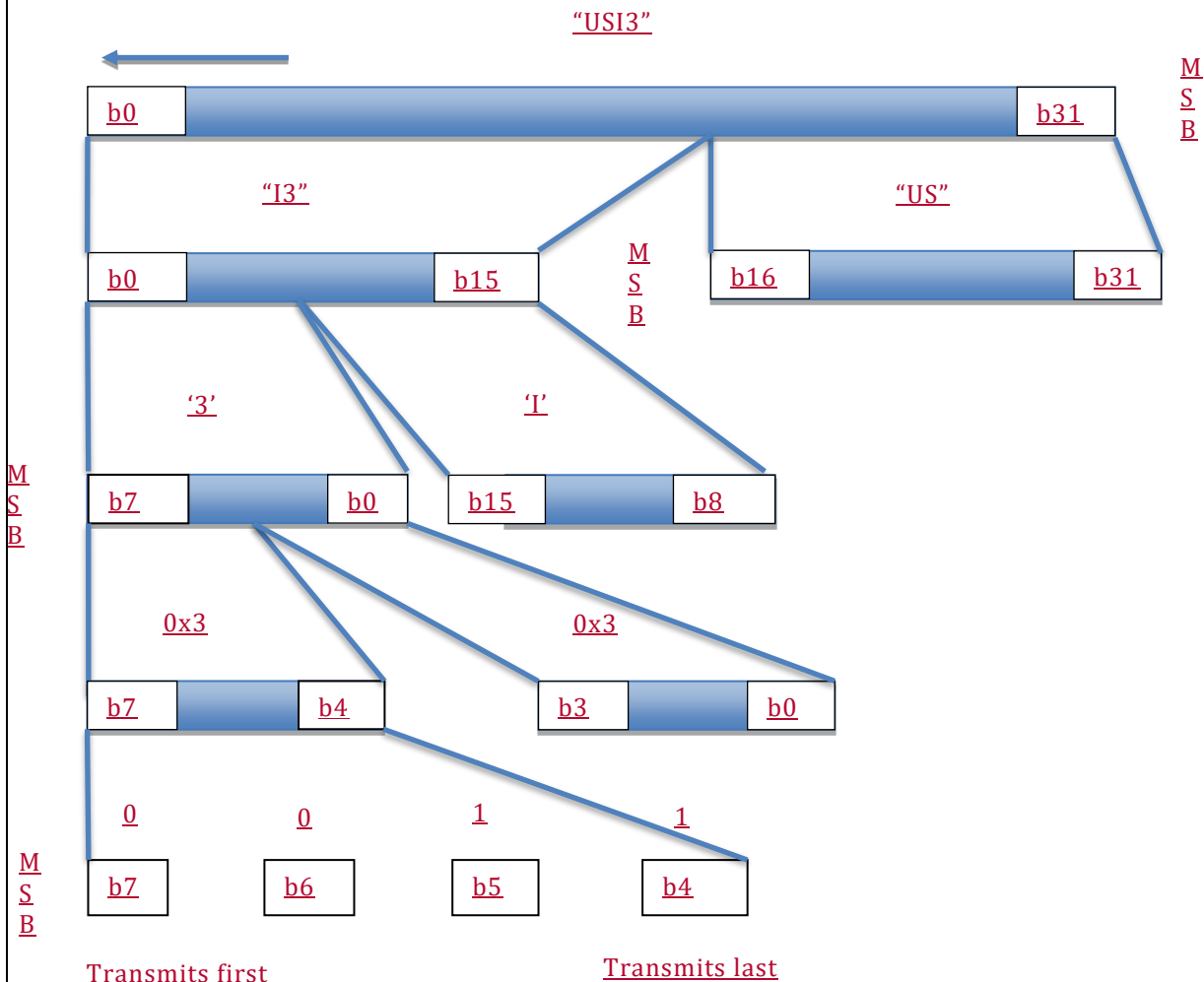
3.2 Physical Layer Description

USB Type-C Connector Software Interface supports Half-duplex, Synchronous Communication.

3.3 Transmit order of various sizes of data

This section describes the order of bits on the wire that shall be used when transmitting data of varying sizes. The possible data sizes are Byte, Word, DWord, and it shall be transmitted in the little-endian format

Figure 3-1 Transmit order of various Sizes Data



For example, “USI3” message will be transmitted as:

Byte 0: ‘3’ or 0x33

Byte 1: ‘T’ or 0x49

Byte 2: ‘S’ or 0x53

Byte 3: ‘U’ or ‘0x55’

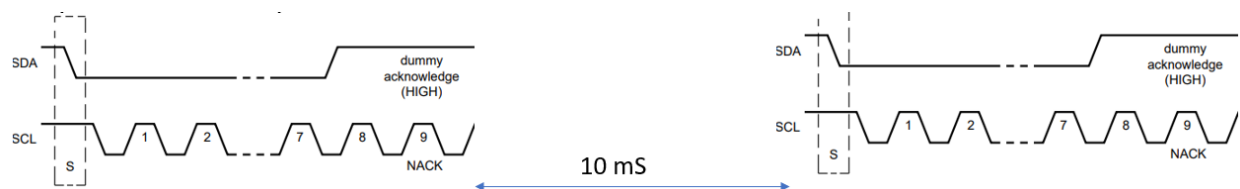
3.4 OPM/PPM behavior on No ACK on Addressing.

OPM and PPM communication with LPM is based off interfaces like I2C or SMBUS. Both I2C and SMBUS interfaces require a target device to have an address prior to the read or write message. The address byte is the first byte of the communication. The I2C specification does not have a strict requirement on the acknowledgement of the address vs. SMBUS where the failure to get acknowledgement on the address byte is considered as not recoverable. On the other side, there are several scenarios where not responding in time with an address acknowledgment could be expected. For example:

- LPM is processing another high priority task and does not have the stretching mechanism implemented.
- LPM is power gated and/or in a low power mode and does not have the stretching mechanism implemented.

For that reason, a PPM/OPM shall have 3 retries implemented for the address byte if the ACK is not received within the required time interval. The PPM/OPM shall wait at least 10mS between each retry from the Stop of the previous retry and the first bit of the new retry.

Figure 3-2 Time Interval between Address Byte Retries



3.4 Data Structures

This section defines the structure of the memory locations used to pass information between the OPM and PPM. ~~Table 4-1~~ ~~Table 4-1~~ lists the direction in which each memory location is used. OPM->PPM indicates that the OPM uses the memory location to pass information to the PPM. The location is Read Only (RO) as far as the PPM is concerned. Similarly, PPM->OPM indicates that the PPM uses the memory location to pass information to the OPM. The location is RO as far as the OPM is concerned.

Table 4-1: OPM-PPM Data Structures

Offset (Bytes)	Mnemonic	Memory Location Name	Direction	Size (bits)
0	VERSION	UCSI Version Number and UCSI LPM Register's Address	PPM/ LPM ->OPM	16 24
23	RESERVED	Reserved	N/A	16 8
4	CCI	USB Type-C Command Status and Connector Change Indication	PPM->OPM	32
8	CONTROL	USB Type-C Control	OPM->PPM	64
16	MESSAGE IN	USB Type-C Message In	PPM->OPM	2048 2040
271	RESERVED	Reserved	N/A	8
272	MESSAGE OUT	USB Type-C Message Out	OPM->PPM	2048 2040
527	RESERVED	Reserved	N/A	8

3.14.1 VERSION – USB Type-C Interface Version Number

The Version Data Structure contains the BCD version of the UCSI specification that the PPM is compliant to. The OPM shall only read from this Data Structure. The PPM shall update this Data Structure right after Power On or after a Reset. The value of the Version Data Structure is 0xJJMN for version JJ.M.N (JJ – major version number, M – minor version number, N – sub-minor version number), e.g. version 2.1.3 is represented with value 0x0213 and version 3.0.0 is represented with a value of 0x0300. The last byte of the Version Data Structure is a field for the other UCSI Data Structure registers address on LPM.

Table 4-2 Version Data Structure

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>UCSI Version</u>	<u>16</u>	<u>JJ.M.N: JJ – major version number, M – minor version number, N – sub-minor version number.</u>
<u>16</u>	<u>Other Data Structure Registers Address</u>	<u>8</u>	<u>Refer to Table 5-1 PPM-LPM Data StructuresTable 5-1 PPM-LPM Data Structures.</u>

3.24.2 CCI – USB Type-C Command Status and Connector Change Indication

Table 4-3: USB Type-C Command Status and Connector Change Indication Data Structure

Offset (Bits)	Field	Size (Bits)	Description
0	<i>End of Message Indicator</i>	1	This bit is used in multi--chunk commands such as a FW update request (FW Update <u>Request</u> Indicator =1) or security request (Security Request Indicator =1). For all other commands, it is reserved and shall be set to 0.
1	<i>Connector Change Indicator</i>	7	The PPM shall use this field to indicate the connector number that a change occurred on. Valid values are 0 to the maximum number of connectors supported on the platform. If this field is set to zero, then no change occurred on any of the connectors.
8	<i>Data Length</i>	8	Length of valid data in bytes. If this value is greater than zero, then the MESSAGE IN Data Structure contents are valid. The value in this register shall be less than or equal to MAX_DATA_LENGTH.
<u>16</u>	<u><i>Vendor Defined Message Indicator</i></u>	<u>1</u>	<u>This bit is set when a custom defined message is ready. It is mutually exclusive with any other Indicator. On some commands, like the FW update, this bit is repurposed.</u>
16 <u>17</u>	<i>Reserved</i>	7 <u>6</u>	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	For a Security Request, set to 1 when the request comes from the Port Partner (Asynchronous message). Otherwise set to 0b.
24	<i>FW Update Request Indicator</i>	1	For an LPM FW Update Request, set to 1 when the request comes from the Port Partner (Asynchronous message). Otherwise set to 0b.
25	<i>Not Supported Indicator</i>	1	The PPM shall set this field to one when it wants to indicate that it does not currently support a command. This field shall only be valid when the <i>Command Completed Indicator</i> field is set to one.
26	<i>Cancel Completed Indicator</i>	1	The PPM shall set this field to one when it has completed a CANCEL command. This field shall only be valid when the <i>Command Completed Indicator</i> field is set to one.
27	<i>Reset Completed Indicator</i>	1	The PPM shall set this field to one when it has completed a PPM_RESET command. If this field is set to one, then no other bits in this Data Structure shall be set by the PPM. The PPM shall clear this field on reception of the next command (not PPM_RESET) from the OPM.

Offset (Bits)	Field	Size (Bits)	Description
28	<i>Busy Indicator</i>	1	The PPM shall set this field to one when it wants to indicate that the PPM is currently busy and will complete the command sent to it by the OPM at a later time. If this field is set to one, then no other bits in this Data Structure shall be set by the PPM. When the PPM completes the command sent to it, it shall set this field to zero and update the other fields in this Data Structure appropriately before notifying the OPM.
29	<i>Acknowledge Command Indicator</i>	1	The PPM shall set this field to one when it completes the ACK_CC_CI (Acknowledge Command Completion and/or Change Indication) command. The PPM shall automatically reset this bit when it receives the next command from the OPM. If this field is set to one, then the only other field that can be set is the <i>Connector Change Indicator</i> field.
30	<i>Error Indicator</i>	1	The PPM shall set this field to one when it encounters an error when executing the command sent to it by the OPM. This field shall only be valid when the <i>Command Completed Indicator</i> field is set to one.
31	<i>Command Completed Indicator</i>	1	The PPM shall set this field to one when it wants to indicate that it completed the command sent to it by the OPM.

When the OPM is notified, it shall read this Data Structure to determine the reason for the notification.

3.34.3 CONTROL – USB Type-C Control

The CONTROL Data Structure indicates the command to be executed by the PPM. Depending on the command type, some fields in this Data Structure need to be interpreted differently. This section defines the high-level structure of the fields that are static and the fields that change based on the command. Subsequent sections define the structure of the CONTROL Data Structure for each type of command.

Table 4-4: USB Type-C Control Data Structure

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	The value in this field determines the command that OPM wants the PPM to execute. Bits 16-63 shall contain any parameters specific to this command.
8	<i>Data Length</i>	8	Length of valid data in bytes. If this value is greater than zero, then the MESSAGE OUT Data Structure contents are valid. The value in this field shall be less than or equal to MAX_DATA_LENGTH.
16	<i>Command Specific</i>	48	The definition of these bits is different for each command that can be sent to the PPM.

Section 6.5 describes the definition of the *Command Specific* field for each command that can be sent to a PPM.

The OPM is the only entity that can write to this Data Structure. The PPM shall only read from this Data Structure.

3.44.4 MESSAGE IN – USB Type-C Message In

The MESSAGE IN Data Structure contains the data that the PPM wants to send to the OPM. The format of this Data Structure is command specific. The OPM shall only read from this Data Structure when it gets a notification that the PPM has completed a command. The PPM shall only write to this Data Structure in response to a command (from the OPM) that requires data to be returned. If the PPM is required to return data, it shall write to this Data Structure before notifying the OPM.

3.54.5 MESSAGE OUT – USB Type-C Message Out

The MESSAGE OUT Data Structure contains the data to be sent to the PPM. The format of this Data Structure is command specific. The OPM shall only write to this Data Structure when there is no active command being executed by the PPM. The PPM shall only read from this Data Structure if the command (from the OPM) sent to it defines that data shall be present in this Data Structure.

5 PPM-LPM Interface Protocol

This section defines the Interface protocol that allows an OPM/PPM to communicate with an LPM by passing various data structures, independent of the type of bus used between them. The UCSI Interface can be utilized on any bus type, such as SMBUS, I2C, SPI, PCIe, etc.

I2C or SMBUS require addressing the LPM. The LPM address is followed by the UCSI Register Address, number of bytes, and then the actual data structure gets transmitted with a command ID.

There are five UCSI data structure. Addresses for those registers are defined in the table below.

Table 5-1 PPM-LPM Data Structures

<u>Mnemonic</u>	<u>Register Name</u>	<u>UCSI Register Address</u>
<u>VERSION</u>	<u>UCSI Version Number and UCSI LPM Register's Address</u>	<u>Fixed address 0x99</u>
<u>CCI</u>	<u>USB Type-C Command Status and Connector Change Indication</u>	<u>Address returned with the Version Data Structure – 0xYY</u>
<u>CONTROL</u>	<u>USB Type-C Control</u>	<u>0xYY + 1</u>
<u>MESSAGE IN</u>	<u>USB Type-C Message In</u>	<u>0xYY + 2</u>
<u>MESSAGE OUT</u>	<u>USB Type-C Message Out</u>	<u>0xYY + 3</u>

A typical write message from the PPM to LPM is depicted in the following figure

Figure 5-1 PPM Message

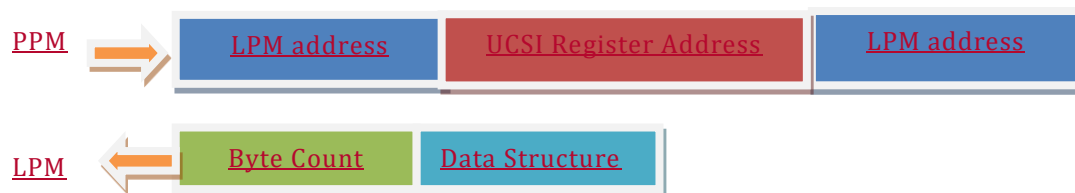


For example, to send a Control command to the LPM on address 0x26, the PPM constructs the following message:

Address: 0x26, UCSI Register (Control): 0x3C, Byte Count: 0x40, Data: 0XXXXXXX....

Since the LPMs are the secondary devices, in order to read data, the PPM omits the Data Structure, and the messages would look like:

Figure 5-2 Read Command Message



For the Control commands that have additional message out or message in payload the sequence would look like.

Figure 5-3 Message OUT sequence

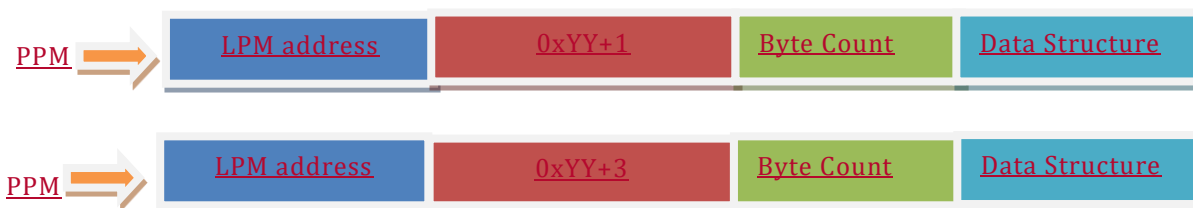
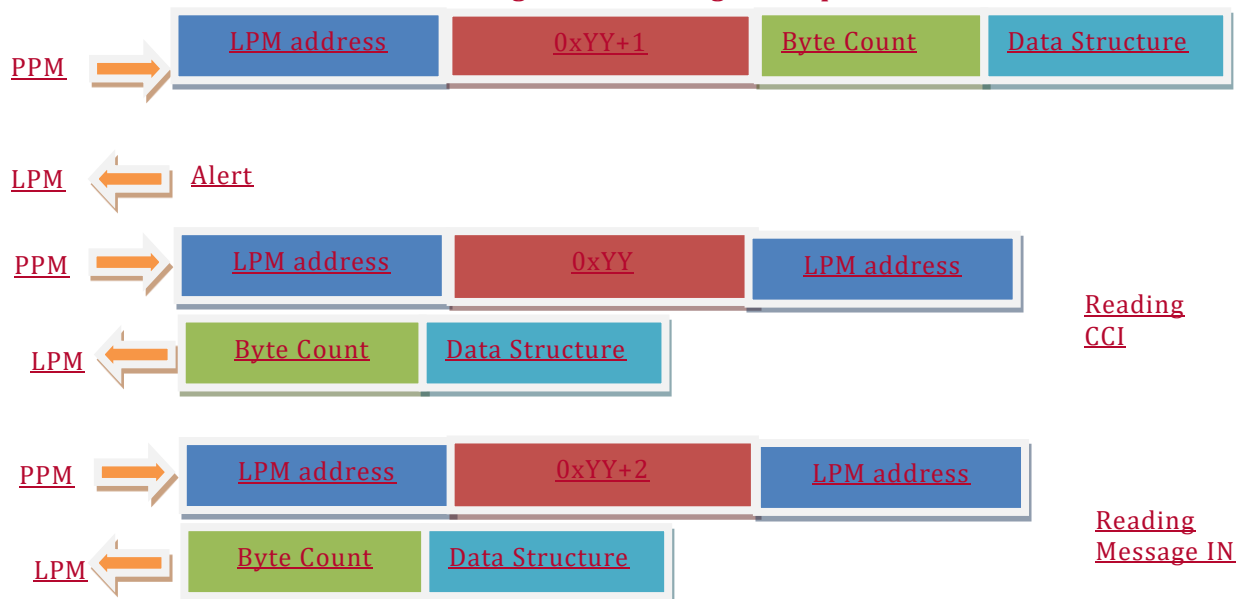


Figure 5-4 Message IN sequence



See [Appendix A.6](#) for examples of commands.

46 Operational Model

The general operational model describes how the OPM shall interact with the PPM. It also defines all the commands that the OPM may send to the PPM. ~~Some of the commands may be optional for the PPM to implement. This specification clearly states which commands are optional and which are mandatory.~~

The OPM shall send ~~at most~~no more than one command at a time to the PPM. The OPM shall wait until the PPM completes the current command before sending the next command. The PPM shall notify the OPM when it completes the command if the Command Completed notification is enabled. The only exceptions to the one command rule are CANCEL and PPM_RESET. A PPM_RESET command may be sent by the OPM at any time. The CANCEL command shall only be sent by the OPM when it wants to cancel an outstanding command that it ~~had~~ previously ~~got~~received a PPM Busy response for.

NOTE: ~~If a command takes longer than MIN_TIME_TO_RESPOND_WITH_BUSY msTlpm max for the PPM (excluding LPM/PPM to OPM communication latency) to complete, then the LPM/PPM shall respond to the command by setting the CCI Busy Indicator and notify the OPM. Subsequently, when between MIN TIME TO RESPOND WITH BUSY and Tlpm max. Upon receiving the PPM actually completes Busy bit indicator, the OPM may do one of the following:~~

- ~~Reset the timer and continue waiting for the command, the PPM completion. OPM shall notify the OPM of the outcome reset the timer when it sends ACK CCI + Tppm ack. On the other hand, the PPM/LPM resets the timer when it receives the last bit of ACK CCI from OPM~~
- ~~Cancel the command via an asynchronous notification associated with that command.~~
- Reset PPM/LPM

The LPM/PPM shall send ~~at most~~no more than one Connection Change notification at a time to the OPM. The LPM/PPM shall wait until the OPM Acknowledges the notification (due to an asynchronous event) before sending the next notification. The LPM/PPM shall not set the Connector Change Indicator if the change on the connector occurred as a direct result of a command sent to that connector unless the LPM/PPM will require more time to process the command.

On reception of a command (neither CANCEL nor PPM_RESET), the LPM/PPM shall:

1. If the LPM/PPM is Busy or the LPM/PPM will take more than MIN_TIME_TO_RESPOND_WITH_BUSY msTlpm max to complete the command, then it shall set the Busy Indicator in the CCI Data Structure. ~~between~~MIN TIME TO RESPOND WITH BUSY and Tlpm max. Go to step 4.
2. The LPM/PPM shall execute the command.
3. The LPM/PPM shall set the CCI Data Structure and optionally update the STATUS and MESSAGE IN Data Structures as detailed in the sections for each command.
4. If the "Command Completed" notification was enabled by the OPM then the LPM/PPM shall notify the OPM.

On reception of a CANCEL command, the LPM/PPM shall:

1. If the LPM/PPM was not currently processing a command, then go drop the CANCEL request.

2. Cancel the current operation(s) it was performing.
3. The PPM shall complete the CANCEL command successfully and update the CCI Data Structure with the "Cancel Completed Indicator" set to one.
4. If the "Command Completed" notification was enabled by the OPM then the PPM shall notify the OPM.

On reception of a PPM_RESET command, the PPM shall:

1. Disable all notifications.
2. The PPM shall transition to the "PPM Idle (Notifications Disabled)" state.
3. Reset itself and set the Reset Completed Indicator in the CCI Data Structure.
4. The OPM shall poll for the Reset Completed Indicator in the CCI Data Structure.

When an asynchronous event occurs on one or more of the connectors, then the PPM shall:

1. Update the CCI and STATUS Data Structures.
2. If the corresponding notification was enabled by the OPM, then notify the OPM.

Once the OPM is notified of either a command completion and/or an asynchronous event it shall:

1. Read the CCI and optionally the STATUS Data Structures.
2. It shall send any other commands it needs to get details on the event.
3. Acknowledge the notification via the ACK_CC_CI (Acknowledge Command Completion and/or Change Indication) command. ~~The only notification that is~~In the following cases notifications are not acknowledged by the OPM~~is the command completion notification for the ACK_CC_CI or the PPM_RESET command.:~~
 - The command completion notification for the ACK CC CI or the PPM RESET command.
 - When a Control command is followed by MESSAGE IN.

Figure 6-1 PPM State Machine (Core)

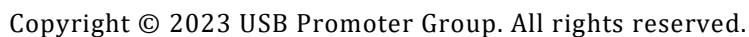
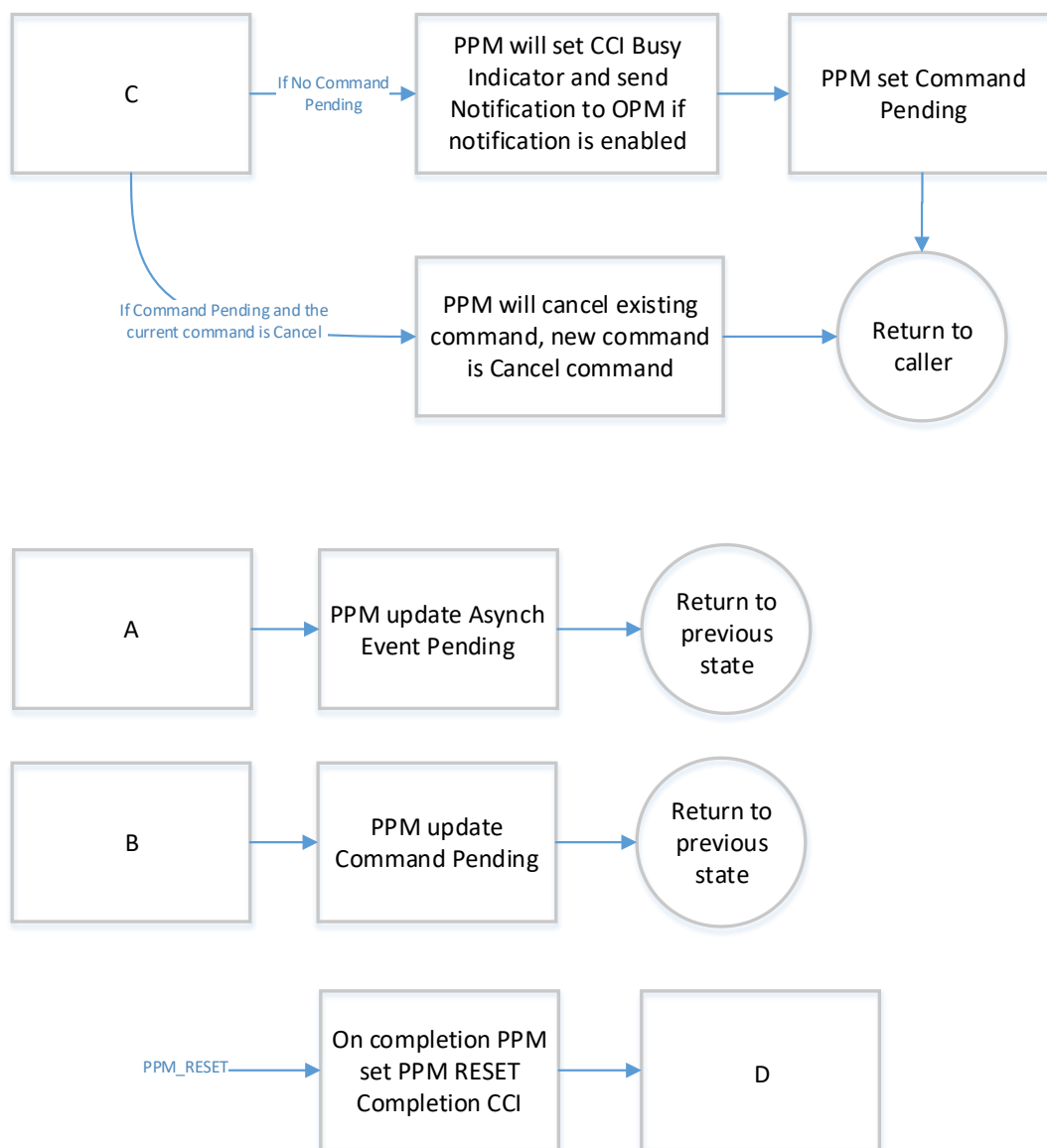
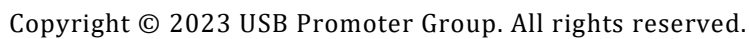


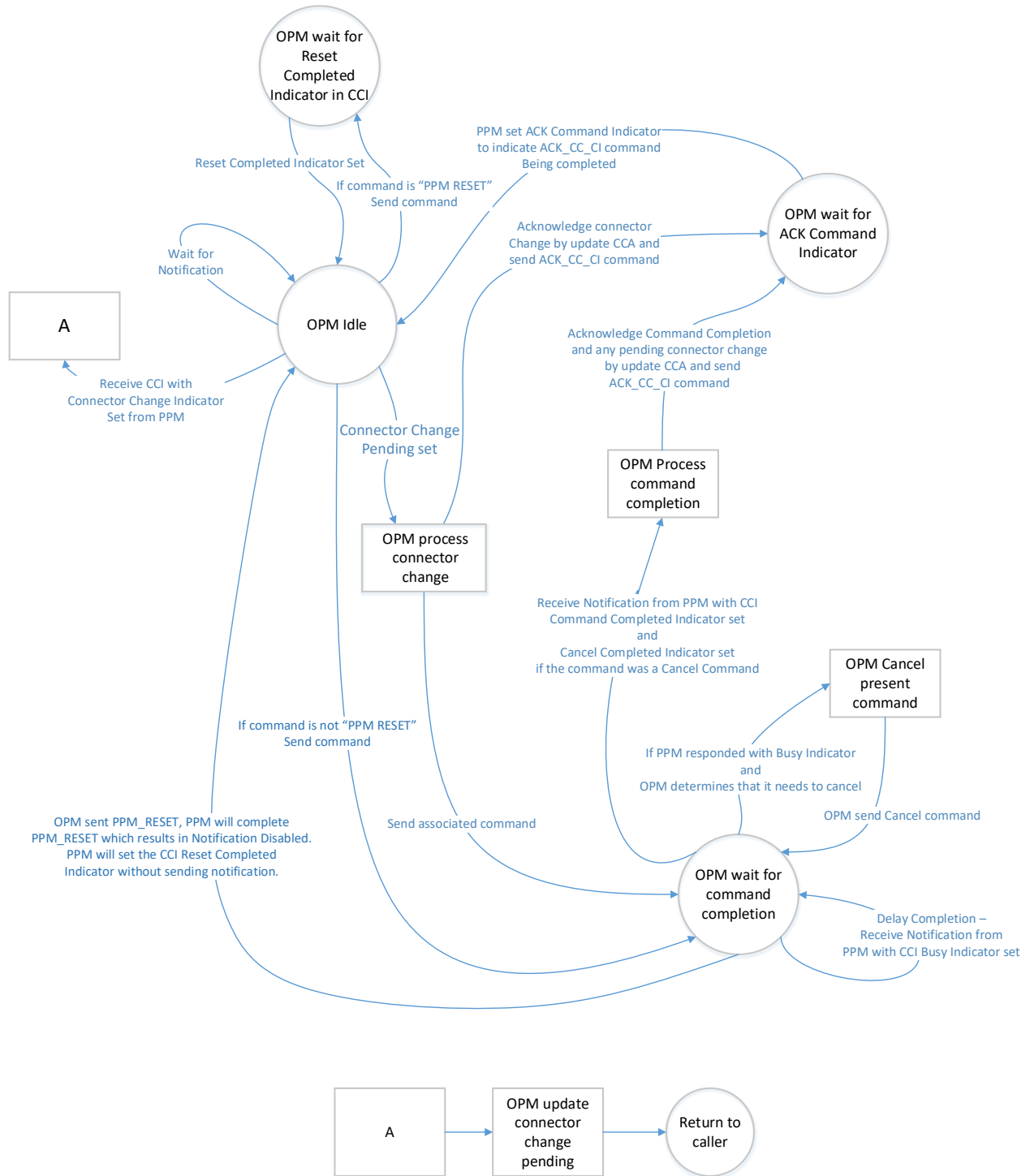
Figure 6-2 PPM State Machine (Extended)



~~4-26.2~~ OPM State Machine

Figure 6-3 OPM State Machine





4.36.3 PPM Initialization

The PPM is expected to function without any OS interaction. On completion of internal initialization, the PPM shall be in the "PPM Idle (Notifications Disabled)"/" state. The PPM shall not notify the OPM

until the OPM enables one or more notifications via the SET_NOTIFICATION_ENABLE command. On successful completion of the SET_NOTIFICATION_ENABLE command the PPM shall transition to the “PPM Idle (Notifications Enabled)” state.

The only commands the PPM is required to process in the “PPM Idle (Notifications Disabled)” state are SET_NOTIFICATION_ENABLE and PPM_RESET.

Not all notifications are required to be supported by the PPM. Hence, the OPM shall first enable only the “Command Completed” notification, query the PPM for supported notifications using the GET_CAPABILITY command, and then enable the rest of the supported notifications. Alternatively, the OPM may choose to enable only those notifications that this specification requires the PPM to support.

An example of the PPM Initialization flow is given below:

1. Optionally send a PPM_RESET.
2. Enable the “Command Completed” notification.
3. Determine platform capability by sending GET_CAPABILITY command:
 - a. Indicates the number of connectors supported by the PPM.
 - b. Indicates the notifications supported by the PPM.
4. Enable as many of the notifications supported by the PPM as needed by sending a SET_NOTIFICATION_ENABLE command.
5. For each of the connectors, the OPM sends GET_CONNECTOR_CAPABILITY command to determine the capabilities of each connector.
6. If Alternate Modes are supported by the Platform and the connector, the OPM can use the GET_ALTERNATE_MODES on each connector to determine the Alternate Modes supported by the PPM. Then, the OPM can use the GET_CAM_SUPPORTED to determine the Alternate Modes supported by each connector.
7. If there is a device connected (indicated by the Connector Change Indicator) on a connector, the OPM can use the GET_ALTERNATE_MODES (Recipient field equal to SOP’, SOP” and SOP) to determine the Alternate Modes supported by the cable and the connected device respectively.
8. If additional information about the cable is needed and the PPM supports it, OPM can use the GET_CABLE_PROPERTY command to determine the same.

NOTE: The Result of Steps 5, 6, 7 and 8 can be used to create an Alternate Mode support bitmap of the current system configuration (Platform/connector/cable/device).

9. The OPM can use the GET_CURRENT_CAM command to determine the current Alternate Mode that a connector is operating in.
10. The OPM can use the SET_NEW_CAM to set the connector in new Alternate Mode, if needed and the PPM supports it.

4.46.4 PPM Suspend/Resume

This Suspend/Resume behavior is dependent on the underlying method (PCIe/ACPI/I2C etc.) used to interface with the PPM and hence this specification does not define the behavior of the OPM/PPM during Suspend/Resume.

4.56.5 PPM Controller Commands

This section describes each of the commands that an OPM may send to the PPM and the requirements of the PPM when it receives the command. ~~It also indicates in the title of the command whether support for the command is required or optional. An (R) at the end stands for “Required” and (O) stands for “Optional”. Certain notifications and fields in the data structures are also optional and are indicated similarly.~~

4.5.16.5.1 PPM RESET (~~R~~)

This command is used to reset the PPM. It may be sent at any time by the OPM to the PPM. Note that, if the OPM wants to reset the connectors on the PPM then it shall perform a CONNECTOR_RESET on each individual connector before sending the PPM a PPM_RESET. The format of the CONTROL Data Structure for this command is given in ~~Table 6-1~~ **Table 6-1**.

Table 6-1: PPM_RESET Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to PPM_RESET.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Reserved</i>	48	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in ~~Table 6-2~~ **Table 6-2**.

Table 6-2: PPM_RESET Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	Set to 0x00.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 1b. The PPM shall clear this field on reception of the next command from the OPM.
28	<i>Busy Indicator</i>	1	Set to 0b.
29	<i>Acknowledged</i>	1	Set to 0b.

	<i>Command Indicator</i>		
30	<i>Error Indicator</i>	1	Set to 0b.
31	<i>Command Completed Indicator</i>	1	Set to 0b.

NOTE: The OPM shall poll this Data Structure to determine when the PPM completes the PPM_RESET command.

~~4.5.26.5.2~~ CANCEL (R)

This command is used to cancel a command previously sent to the PPM/LPM. The OPM shall only send this command if it received a response with the CCI Busy Indicator set for the previous command it sent. If the PPM has already completed the command by the time, it received the CANCEL command, it shall drop the CANCEL command.

The format of the CONTROL Data Structure for this command is given in ~~Table 6-3~~Table 6-3.

Table 6-3: CANCEL Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to CANCEL.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Reserved</i>	48	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in ~~Table 6-4~~Table 6-4.

Table 6-4: CANCEL Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	96	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.

25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 1b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	Set to 0b.
31	<i>Command Completed Indicator</i>	1	Set to 1b.

4.5.36.5.3 Connector Reset ~~(R)~~

This command is used to reset the connector specified in the command. The PPM shall send a command completion once it starts the Reset process and send an Asynchronous notification after the Reset process is completed on the connector.

There are two options:

- 1) Hard Reset. On successful completion of a Connect Reset, the connector shall go through a disconnect-connect sequence.

If a USB Type-C charger is connected to the connector being reset and if there is no other power source (e.g. Dead Battery condition), then the PPM shall fail the Connector Reset request. The OPM can determine the cause of the failure by reading Bit 5 of Get Error Status Command.

- 2) Data Reset. This command is used to reset the USB data connection and exit all ~~Alternative~~Alternate Modes with a Port Partner while preserving the power on VBUS. Data Reset follows the behavior of Data_Reset Message from [USBPD]. A Port that supports USB4 capability shall support this command. A Port that does not support USB4 may not implement Data_Reset. In this case the PPM/LPM shall set the Not Supported indicator to 1.

The PPM/LPM shall set the Command Completed Indicator within tSenderResponse + tDataReset + LPM_BUSY_ATOMIC_TIME upon success, where tSenderResponse and tDataReset commands are defined in [USBPD]. Otherwise, the PPM/LPM sets the Error Indicator.

The format of the CONTROL Data Structure for this command is given in ~~Table 6-5~~Table 6-5.

Table 6-5: CONNECTOR_RESET Command

Offset (Bits)	Field	Size (Bits)	Description
---------------	-------	-------------	-------------

0	Command	8	This field shall be set to CONNECTOR_RESET.							
8	Data Length	8	Set to 0x00.							
16	Connector Number	7	This field shall be set to the connector being reset.							
23	Reset Type	1	<table><tr><th>Field Value</th><th>Reset Type</th></tr><tr><td>0</td><td>Hard Reset (Default)</td></tr><tr><td>1</td><td>Data Reset</td></tr></table>		Field Value	Reset Type	0	Hard Reset (Default)	1	Data Reset
Field Value	Reset Type									
0	Hard Reset (Default)									
1	Data Reset									
24	Reserved	40	Reserved and shall be set to zero.							

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-6](#).

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Table 6-6: CONNECTOR_RESET Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
17	<i>Reserved</i>	7	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	If the <i>Reset Type</i> field is set to <i>Data Reset</i> and the port does not support USB4, this field may be set to 1b, otherwise this field shall be set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

4.5.4.5.4 Acknowledge Command Completion and/or Change Indication ~~(R)~~

This command is used to acknowledge to the PPM/LPM that the OPM received and processed a Command Completion and/or a Connector Change Indication. The OPM acknowledges either the Command Completion or the Connector Change or both by setting the appropriate fields in the CONTROL Data Structure. It is not required to set Acknowledge Command Completion for the

Connector Change that require to read Message In. Examples for such commands are LPM FW Request Command and Security Request initiated by the Port Partner (refer to Appendix A3. LPM FW Update from the port partner). The format of the CONTROL Data Structure for this command is given in Table 6-7~~Table 6-7~~.

Table 6-7: ACK_CC_CI Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to ACK_CC_CI.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Change Acknowledge</i>	1	The OPM shall set this field to a one to acknowledge a connector change that occurred on the connector indicated by the PPM in the CCI Data Structure.
17	<i>Command Completed Acknowledge</i>	1	The OPM shall set this field to a one to acknowledge that a command completed.
18	<i>Reserved</i>	46	Reserved and shall be set to zero.

On completion of the command the PPM /LPM shall set the CCI Data Structure as described in Table 6-8~~Table 6-8~~.

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Table 6-8: ACK_CC_CI Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	Set to 0x00.
8	<i>Data Length</i>	8	Set to 0x00.
<u>16</u>	<u><i>Vendor Defined Message Indicator</i></u>	<u>1</u>	<u>Set to 0.</u>
<u>16</u> 17	<i>Reserved</i>	<u>7</u> 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b.

29	<i>Acknowledge Command Indicator</i>	1	Set to 1b.
30	<i>Error Indicator</i>	1	Set to 0b.
31	<i>Command Completed Indicator</i>	1	Set to 0b.

~~4.5.56.5.5~~ Set Notification Enable ~~(R)~~

This command is used to set the list of asynchronous events that the PPM may send notifications about to the OPM. The OPM may update the list at any time. The format of the CONTROL Data Structure for this command is given in ~~Table 6-9~~ [Table 6-9](#).

The OPM shall not attempt to enable any notifications that the PPM does not support. [Table 6-9](#) ~~Table 6-9~~ indicates which notifications are ~~required~~ **Normative** and which are ~~optional using a convention similar to that used for commands in this specification-Optional (O)~~.

NOTE: If any notification is enabled, it is imperative that the Command Completed notification is also enabled.

Table 6-9: SET_NOTIFICATION_ENABLE Command

Offset (Bits)	Field	Size (Bits)	Description																																				
0	Command	8	This field shall be set to SET_NOTIFICATION_ENABLE.																																				
8	Data Length	8	Set to 0x00.																																				
16	Notification Enable	17	<div>The list of notifications that the OPM wants to Enable.<table><tr><th>Bit</th><th>Notification Enabled when Set to 1</th></tr><tr><td>0</td><td>Command Completed (R)</td></tr><tr><td>1</td><td>External Supply Change (O)</td></tr><tr><td>2</td><td>Power Operation Mode Change (R)</td></tr><tr><td>3</td><td>Attention (O)</td></tr><tr><td>4</td><td>LPM FW Update Request from Port Partner(O)</td></tr><tr><td>5</td><td>Supported Provider Capabilities Change (O)</td></tr><tr><td>6</td><td>Negotiated Power Level Change (O)</td></tr><tr><td>7</td><td>PD Reset Complete (O)</td></tr><tr><td>8</td><td>Supported CAM Change (O)</td></tr><tr><td>9</td><td>Battery Charging Status Change (R)</td></tr><tr><td>10</td><td>Security Request from Port Partner(O)</td></tr><tr><td>11</td><td>Connector Partner Change (R)</td></tr><tr><td>12</td><td>Power Direction Change (R)</td></tr><tr><td>13</td><td>Set Re-timer Mode(O)</td></tr><tr><td>14</td><td>Connect Change (R)</td></tr><tr><td>15</td><td>Error (R)</td></tr><tr><td>16</td><td>Sink Path Status Change(R)</td></tr></table></div>	Bit	Notification Enabled when Set to 1	0	Command Completed (R)	1	External Supply Change (O)	2	Power Operation Mode Change (R)	3	Attention (O)	4	LPM FW Update Request from Port Partner(O)	5	Supported Provider Capabilities Change (O)	6	Negotiated Power Level Change (O)	7	PD Reset Complete (O)	8	Supported CAM Change (O)	9	Battery Charging Status Change (R)	10	Security Request from Port Partner(O)	11	Connector Partner Change (R)	12	Power Direction Change (R)	13	Set Re-timer Mode(O)	14	Connect Change (R)	15	Error (R)	16	Sink Path Status Change (R)
Bit	Notification Enabled when Set to 1																																						
0	Command Completed (R)																																						
1	External Supply Change (O)																																						
2	Power Operation Mode Change (R)																																						
3	Attention (O)																																						
4	LPM FW Update Request from Port Partner(O)																																						
5	Supported Provider Capabilities Change (O)																																						
6	Negotiated Power Level Change (O)																																						
7	PD Reset Complete (O)																																						
8	Supported CAM Change (O)																																						
9	Battery Charging Status Change (R)																																						
10	Security Request from Port Partner(O)																																						
11	Connector Partner Change (R)																																						
12	Power Direction Change (R)																																						
13	Set Re-timer Mode(O)																																						
14	Connect Change (R)																																						
15	Error (R)																																						
16	Sink Path Status Change (R)																																						

33	<i>Reserved</i>	31	Reserved and shall be set to zero.
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On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-10](#).

Table 6-10: SET_NOTIFICATION_ENABLE Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16-17	<i>Reserved</i>	7-6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

~~4.5.6.5.6~~ Get Capability ~~(R)~~

This command is used to get the PPM capabilities. The format of the CONTROL Data Structure for this command is given in [Table 6-11](#).

Table 6-11: GET_CAPABILITY Command

Offset (Bits)	Field	Size	Description
---------------	-------	------	-------------

		(Bits)	
0	<i>Command</i>	8	This field shall be set to GET_CAPABILITY.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Reserved</i>	48	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-12](#).

Table 6-12: GET_CAPABILITY Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful set to 0x10 else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16-17	<i>Reserved</i>	76	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in [Table 6-13](#).

Table 6-13: GET_CAPABILITY Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>bmAttributes</i>	32	Bitmap encoding of supported PPM features. See Table 6-14 for a description of each bit.
32	<i>bNumConnectors</i>	7	This field indicates the number of Connectors that this PPM supports. A value of zero is illegal in this field.
39	<i>Reserved</i>	1	Reserved and shall be set to zero.

Offset (Bits)	Field	Size (Bits)	Description
40	<i>bmOptionalFeatures</i>	24	Bitmap encoding indicating which optional features are supported by the PPM. This field is described in detail in Section 6.5.27.
64	<i>bNumAltModes</i>	8	This field indicates the number of Alternate Modes that this PPM supports. A value of zero in this field indicates that the PPM does not support Alternate Modes. The complete list of Alternate Modes supported by the PPM can be obtained using the GET_ALTERNATE_MODE command. The maximum number of Alternate Modes a PPM can support is limited to MAX_NUM_ALT_MODE.
72	<i>Reserved</i>	8	Reserved and shall be set to zero.
80	<i>bcdBCVersion</i>	16	Battery Charging Specification Release Number in Binary-Coded Decimal (e.g., V1.20 is 120H). This field shall only be valid if the device indicates that it supports BC in the <i>bmAttributes</i> field.
96	<i>bcdPDVersion</i>	16	USB Power Delivery Specification Revision Number in Binary-Coded Decimal (e.g. Revision 3.0 is 300h). This field shall only be valid if the device indicates that it supports PD in the <i>bmAttributes</i> field.
112	<i>bcdUSBTypeCVersion</i>	16	USB Type-C Specification Release Number in Binary-Coded Decimal (e.g. Release 2.0 is 200h). This field shall only be valid if the device indicates that it supports USB Type-C in the <i>bmAttributes</i> field.

Table 6-14: bmAttributes Field Description

Bit	Description
0	Disabled State Support This bit shall be set to one to indicate this platform supports the Disabled State as defined in Section 4.5.2.2.1 in the [USBTYPEPEC].
1	Battery Charging This bit shall be set to one to indicate this platform supports the Battery Charging Specification as per the value reported in the <i>bcdBCVersion</i> field.
2	USB Power Delivery This bit shall be set to one to indicate this platform supports the USB Power Delivery Specification as per the value reported in the <i>bcdPDVersion</i> field.
5:3	Reserved Shall be set to zero.
6	USB Type-C Current This bit shall be set to one to indicate this platform supports power capabilities defined in the USB Type-C Specification as per the value reported in the <i>bcdUSBTypeCVersion</i> field.
7	Reserved Shall be set to zero.
15:8	bmPowerSource

	At least one of the following bits 8, 10 and 14 shall be set to indicate which power sources are supported.	
	Bit	Description
	8	AC Supply.
	9	Reserved and shall be set to zero.
	10	Other.
	13:11	Reserved and shall be set to zero.
	14	Uses VBUS.
	15	Reserved and shall be set to zero.
31:16	Reserved Shall be set to zero.	

~~4.5-76.5.7~~ Get Connector Capability-~~(R)~~

This command is used to get the capabilities of a connector. The format of the CONTROL Data Structure for this command is given in [Table 6-15](#)~~Table 6-15~~.

Table 6-15: GET_CONNECTOR_CAPABILITY Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_CONNECTOR_CAPABILITY.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field indicates the connector whose capabilities are to be retrieved. A value of zero in this field is illegal.
23	<i>Reserved</i>	41	Reserved and shall be set to zero.

On completion of the command the PPM ~~/LPM~~ shall set the CCI Data Structure as described in [Table 6-16](#)~~Table 6-16~~.

Table 6-16: GET_CONNECTOR_CAPABILITY Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful set to 0x04 else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16	<i>Reserved</i>	7	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in ~~Table 6-17~~ [Table 6-17](#).

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Table 6-17: GET_CONNECTOR_CAPABILITY Data

Offset (Bits)	Field	Size (Bits)	Description																		
0	Operation Mode	8	<div><p>This field shall indicate the mode that the connector can support.</p><p><i>Note: Additional capabilities are described in the Extended Operation Mode field.</i></p><table><tr><th>Bit</th><th>Meaning</th></tr><tr><td>0</td><td>Rp only</td></tr><tr><td>1</td><td>Rd only</td></tr><tr><td>2</td><td>DRP (Rp/Rd)</td></tr><tr><td>3</td><td>Analog Audio Accessory Mode (Ra/Ra)</td></tr><tr><td>4</td><td>Debug Accessory Mode (Rd/Rd)</td></tr><tr><td>5</td><td>USB2</td></tr><tr><td>6</td><td>USB3</td></tr><tr><td>7</td><td>Alternate Mode</td></tr></table></div>	Bit	Meaning	0	Rp only	1	Rd only	2	DRP (Rp/Rd)	3	Analog Audio Accessory Mode (Ra/Ra)	4	Debug Accessory Mode (Rd/Rd)	5	USB2	6	USB3	7	Alternate Mode
Bit	Meaning																				
0	Rp only																				
1	Rd only																				
2	DRP (Rp/Rd)																				
3	Analog Audio Accessory Mode (Ra/Ra)																				
4	Debug Accessory Mode (Rd/Rd)																				
5	USB2																				
6	USB3																				
7	Alternate Mode																				
8	Provider	1	This bit is valid only when the operation mode is DRP or Rp only. This bit shall be set to one if the connector is capable of providing power on this connector. [Either PD, USB Type-C Current or BC 1.2].																		
9	Consumer	1	This bit is valid only when the operation mode is DRP or Rd only. This bit shall be set to one if the connector is capable of consuming power on this connector. [Either PD, USB Type-C Current or BC 1.2].																		
10	Swap to DFP	1	This bit is valid only when the operation mode is DRP or Rp only or Rd only. This bit shall be set to one if the connector is capable of accepting swap to DFP.																		
11	Swap to UFP	1	This bit is valid only when the operation mode is DRP or Rp only or Rd only. This bit shall be set to one if the connector is capable of accepting swap to UFP.																		
12	Swap to SRC	1	This bit is valid only when the operation mode is DRP. This bit shall be set to one if the connector is capable of accepting swap to SRC.																		
13	Swap to SNK	1	This bit is valid only when the operation mode is DRP. This bit shall be set to one if the connector is capable of accepting swap to SNK.																		
14	Extended Operation Mode	8	<table><tr><th>Bit</th><th>Meaning</th></tr><tr><td>0</td><td>USB4 V1Gen 2</td></tr><tr><td>1</td><td>EPR Source</td></tr><tr><td>2</td><td>EPR Sink</td></tr><tr><td>3</td><td>USB4 Gen 3</td></tr><tr><td>4</td><td>USB4 Gen 4</td></tr><tr><td>15-7</td><td>Reserved</td></tr></table>	Bit	Meaning	0	USB4 V1 Gen 2	1	EPR Source	2	EPR Sink	3	USB4 Gen 3	4	USB4 Gen 4	15 -7	Reserved				
Bit	Meaning																				
0	USB4 V1 Gen 2																				
1	EPR Source																				
2	EPR Sink																				
3	USB4 Gen 3																				
4	USB4 Gen 4																				
15 -7	Reserved																				

Offset (Bits)	Field	Size (Bits)	Description	
22	<i>Miscellaneous Capabilities</i>	4		
			Bit	Feature
			0	FW Update
			1	Security
			2	Reserved
26	<i>Reverse Current Protection Support</i>	1		
			3	Reserved
			This is debug level information. This bit shall be set to one if the LPM supports this feature. Otherwise, this bit shall be set to zero.	
			Partner's major USB PD Revision from the Specification Revision field of the USB PD message Header.	
			Set to zero.	
27	<i>Partner PD Revision</i>	2		
29	<i>Reserved</i>	3		

4.5.86.5.8 Set CC Operation Mode (0)

This command is used to set the CC operation mode that the OPM wants the connector to operate at. The CC operation mode set by the OPM shall be a subset of the supported operation modes that the PPM reported that the connector can operate at. The effect of this command is to change the USB Type-C state machine that the connector shall operate under.

The value set by this command gets reset when the PPM is reset. If the connector supports being a DRP, the default value on reset is DRP. The format of the CONTROL Data Structure for this command is given in [Table 6-18](#).

This command sets CC operation mode. If LPM does not support the role that it was requested, LPM shall return as not supported except for Disable. If LPM does not support Disable, it shall direct the port to either Unattached.SNK or Unattached.SRC.

Table 6-18: SET_CCOM Command

Offset (Bits)	Field	Size (Bits)	Description
0	Command	8	This field shall be set to SET_CCOM.
8	Data Length	8	This field shall be set to zero.
16	Connector Number	7	This field indicates the connector whose CC operational mode is to be modified. A value of zero in this field is illegal.

Offset (Bits)	Field	Size (Bits)	Description	
23	CC Operation Mode	34	Bit	Meaning
			0	If this bit is set, then the connector shall operate as Rp Only.
			1	If this bit is set, then the connector shall operate as Rd Only.
			2	If this bit is set, then the connector shall operate as a DRP.
			<u>3</u>	<u>If this bit is set, then the connector shall bring it to Disabled state by removing all terminations from the CC pins. It shall be done in accordance with Type-C specification i.e., for example, when the port transitions to the Disabled state from Attached.SNK, it shall keep all terminations on the CC pins removed for a minimum of tErrorRecovery.</u>
			It is illegal for the OPM to set all these bits to zero. These bits are valid only if Get Connector Capability returns DRP.	
26 27	Reserved	38 37	Reserved and shall be set to zero.	

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-19](#).

Table 6-19: SET_CCOM Status

Offset (Bits)	Field	Size (Bits)	Description
0	Reserved	1	Reserved and shall be set to zero.
1	Connector Change Indicator	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	Data Length	8	Set to 0x00.
16	<u>Vendor Defined Message Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
46 17	Reserved	76	Reserved and shall be set to zero.
23	Security Request Indicator	1	Set to 0b.
24	FW Update Request Indicator	1	Set to 0b.
25	Not Supported Indicator	1	Set to 0b.
26	Cancel Completed Indicator	1	Set to 0b.

Offset (Bits)	Field	Size (Bits)	Description
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

~~4.5.96.5.9~~ Set USB Operation Role ~~(R)~~

This command is used to set the USB operation role that the OPM wants the connector to operate at, for the current connection. If the connector does not have an active connection, this command has no effect and the command ~~should~~shall be failed. If the connector is already in the operation role that is being requested, the command should be completed successfully. If the connector does not support the role requested, this command has no effect and should be failed.

The USB operation role set by the OPM shall be compatible with the current operation mode. If the operation mode is DRP, bit 2 will denote whether connector will accept any data role swaps that may be initiated by the ~~port~~partner.

The execution of this command might require PPM to initiate a data role swap. The PPM might achieve the role swap by using the PD role swap mechanism. The successful completion of this command indicates that a successful connection was established in the new operation mode. If the change of the operation mode did not result in a successful connection, the command should return an error. If the command returns error for any reason, the ~~CCUSB~~ operation mode should remain unchanged. Note that if the execution of the command resulted in a successful data role swap, it should not result in a connector status change notification.

The value set by this command gets reset when either PPM is reset or is power cycled or the remote device gets detached.

This command will return error in these cases – Port Partner rejected Swap, Hard reset occurred while performing this command, or PPM detects policy conflict and sets the Error Information field to PPM Policy Conflict.

The format of the CONTROL Data Structure for this command is given in ~~Table 6-20~~Table 6-20.

Table 6-20: SET_UOR Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to SET_UOR.
8	<i>Data Length</i>	8	This field shall be set to zero.

Offset (Bits)	Field	Size (Bits)	Description	
16	Connector Number	7	This field indicates the connector whose USB operational mode is to be modified. A value of zero in this field is illegal.	
23	USB Operation Role	3	Bit	Meaning
			0	If this bit is set, then the connector shall initiate swap to DFP if not already operating in DFP mode.
			1	If this bit is set, then the connector shall initiate swap to UFP if not already operating in UFP mode.
			2	If this bit is set, then the connector shall accept role swap change requests from the port partner. If this bit is cleared, then connector shall reject Role Swap change requests from the port partner.
			It is illegal for the OPM to set/clear Bit0 and Bit1 at the same time. This command is valid only if connector supports PD.	
26	Reserved	38	Reserved and shall be set to zero.	

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-21](#).

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Table 6-21: SET_UOR Status

Offset (Bits)	Field	Size (Bits)	Description
0	Reserved	1	Reserved and shall be set to zero.
1	Connector Change Indicator	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	Data Length	8	Set to 0x00.
16	Vendor Defined Message Indicator	1	Set to 0b.
16 17	Reserved	76	Reserved and shall be set to zero.
23	Security Request Indicator	1	Set to 0b.
24	FW Update Request Indicator	1	Set to 0b.
25	Not Supported Indicator	1	Set to 0b.
26	Cancel Completed Indicator	1	Set to 0b.

Offset (Bits)	Field	Size (Bits)	Description
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

~~4.5.10~~ 5.10 Set Power Direction Role (R)

This command is used to set the Power direction that the OPM wants the connector to operate at, for the current connection. If the connector does not have an active connection, or the [Port](#) partner is not PD-capable, this command has no effect and the command should be failed. If the power direction is already the one that is being requested the command should be completed successfully. If the connector does not support the role requested, this command has no effect and should be failed. The default behavior prior to execution of this command is to accept power swaps.

The execution of this command might require PPM to initiate a power role swap. If the power role swap fails for any reason, the command returns, and error and the power direction should remain unchanged. Note that if the execution of the command resulted in a successful power role swap, it should not result in a connector status change notification.

The value set by this command gets reset when either PPM is reset or is power cycled or the remote device gets detached. The format of the CONTROL Data Structure for this command is given in [Table 6-22](#).

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Table 6-22: SET_PDR Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to SET_PDR.
8	<i>Data Length</i>	8	This field shall be set to zero.
16	<i>Connector Number</i>	7	This field indicates the connector whose Power Direction Role is to be modified. A value of zero in this field is illegal.

Offset (Bits)	Field	Size (Bits)	Description	
23	Power Direction Role	3	Bit	Meaning
			0	If this bit is set then the connector shall initiate swap to Source, if not already operating as Source
			1	If this bit is set then the connector shall initiate swap to Sink, if not already operating as Sink
			2	If this bit is set, then the connector shall accept power swap change requests from the port partner. If this bit is cleared, then the connector shall reject power swap change requests from the port partner
			It is illegal for the OPM to set all these bits to zero.	
26	Reserved	38	Reserved and shall be set to zero.	

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-23](#).

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Table 6-23: SET_PDR Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

~~4.5.11~~ 4.5.11 Get Alternate Modes ~~(0)~~

This command is used to get the Alternate Modes that the Connector/Cable/Attached Device is capable of supporting. If the Connector/Cable/Attached device does not support the number of Alternate Modes requested, starting from the value in the Alternate Mode offset field, it shall return only (six times the number of Alternate Mode) bytes to report the number of Alternate Modes it supports.

The format of the CONTROL Data Structure for this command is given in ~~Table 6-24~~ **Table 6-24**.

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Example flow for a connector that supports three alternate modes:

1. OPM sends GET_ALTERNATE_MODES to the connector to query the first two alternate modes. Recipient = 0. Alternate Mode Offset = 0. Number of Alternate Modes = 1.
2. **PPMLPM** returns SVID[0], MID[0], SVID[1], MID[1]. Data length = 0xC (96 bits in GET_ALTERNATE_MODES_DATA = 12 bytes).
3. OPM sends GET_ALTERNATE_MODES again to the connector to query the next two alternate modes. Recipient = 0. Alternate Mode Offset = 2. Number of Alternate Modes = 1.
4. **PPMLPM** returns SVID[2], MID[2] and leaves the other data fields blank. Data length = 0x6 (48 bits in GET_ALTERNATE_MODES_DATA = 6 bytes).

Table 6-24: GET_ALTERNATE_MODES Command

Offset (Bits)	Field	Size (Bits)	Description	
0	Command	8	This field shall be set to GET_ALTERNATE_MODES.	
8	Data Length	8	Set to 0x00.	
16	Recipient	3	Value	Meaning
			0	Connector
			1	SOP
			2	SOP'
			3	SOP''
			4-7	Reserved. Shall be set to zero.
19	Reserved	5	Reserved and shall be set to zero.	
24	Connector Number	7	This field shall be set to the connector being queried.	
31	Reserved	1	Reserved and shall be set to zero.	
32	Alternate Mode Offset	8	Starting offset of the first Alternate Mode to be returned.	
40	Number of Alternate Modes	2	Number of Alternate Modes to return starting from the <i>Alternate Mode Offset</i> . The number of Alternate Modes to return is the value in this field plus 1. The maximum value of this field is 1.	
42	Reserved	22	Reserved and shall be set to zero.	

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-25](#).

Table 6-25: GET_ALTERNATE_MODES Status

Offset (Bits)	Field	Size (Bits)	Description
0	Reserved	1	Reserved and shall be set to zero.
1	Connector Change Indicator	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.

Offset (Bits)	Field	Size (Bits)	Description
8	<i>Data Length</i>	8	If successful, set to the number of bytes returned in GET_ALTERNATE_MODES Data up to MAX_DATA_LENGTH. Else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in [Table 6-26](#)~~Table 6-26~~.

Table 6-26: GET_ALTERNATE_MODES Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>SVID[0]</i>	16	Standard or Vendor ID.
16	<i>MID[0]</i>	32	Mode ID for associated with the above SVID.
48	<i>SVID[1]</i>	16	Standard or Vendor ID (If supported).
64	<i>MID[1]</i>	32	Mode ID for associated with the above SVID.

~~4.5.126.5.12~~ Get Connector Alternate Modes Supported ~~(0)~~

This command is used to get the list of Alternate Modes that are currently supported on the connector identified by this command. This shall be a subset of the complete list of Alternate Modes that the Connector is capable of supporting if the Alternate Mode resources are being used by some other connector and are not available currently for this connector. The complete list of Alternate Modes that the Connector is capable of supporting is returned by GET_ALTERNATE_MODES with Connector as Recipient. For this command, the list is returned as a bit vector with one bit per Alternate Mode supported in the order that they were returned by the Connector in response to the GET_ALTERNATE_MODES commands. The PPM shall return floor (Number of Alternate Modes + 7)/8) number of bytes to the OPM in response to this command. The format of the CONTROL Data Structure for this command is given in [Table 6-27](#)~~Table 6-27~~.

Table 6-27: GET_CAM_SUPPORTED Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_CAM_SUPPORTED.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried.
23	<i>Reserved</i>	41	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-28](#).

Table 6-28: GET_CAM_SUPPORTED Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful set to $\lfloor \frac{\text{Floor}(\text{Number of Alternate Modes} + 7)}{8} + 1 \rfloor$, else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	96	Reserved and shall be set to zero.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in [Table 6-29](#).

Table 6-29: GET_CAM_SUPPORTED Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>bmAlternateModeSupported</i>	N	If an Alternate Mode is supported, then that bit position shall be set to one. Else it shall be set to zero.
N	<i>ZeroBits</i>	M	If (N Mod 8 == 0) then M = 0, else M = (8 - (N Mod 8)). The PPM shall set these bits to zero.

4.5.136.5.13 Get Current Connector Alternate Mode (0)

This command is used to get the current Alternate Mode that the connector is operating in. The format of the CONTROL Data Structure for this command is given in [Table 6-30](#)~~Table 6-30~~.

Table 6-30: GET_CURRENT_CAM Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_CURRENT_CAM.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried.
23	<i>Reserved</i>	41	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-31](#)~~Table 6-31~~.

Table 6-31: GET_CURRENT_CAM Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful, set to the number of Alternate Modes that the connector is currently operating in. Else set to 0x00.
16 16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	76	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.

28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the **PPM/LPM** shall set the MESSAGE IN Data Structure as described in [Table 6-32](#). The GET_CURRENT CAM Data structure shall contain the same number of Current Alternate Mode offsets as given in the *Data Length* field of the GET_CURRENT_CAM Status.

Table 6-32: GET_CURRENT_CAM Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Current Alternate Mode[0]</i>	8	First offset into the list of Alternate Modes that the connector is currently operating in. This is an offset into the list of Alternate Modes supported by the PPM. If the connector is not operating in an alternate mode, the PPM shall set this field to 0xFF.
8	<i>Current Alternate Mode[1]</i>	8	Second offset into the list of Alternate Modes that the connector is currently operating in (if connector is currently operating in multiple Alternate Modes).
16	...	varies	...
N * 8	<i>Current Alternate Mode[N]</i>	8	Final offset into the list of Alternate Modes that the connector is currently operating in (if connector is currently operating in multiple Alternate Modes).

4.5.14.5.14 Set New Connector Alternate Mode-0

This command is used to set ~~the~~ new Alternate Mode for a current and future connections that the OPM wants the PPM to operate in. If the connector is already in the operation role that is being requested, the command should be completed successfully. If the connector does not support the role requested, or it operates in a USB mode, this command has no effect and should be failed. If the "New CAM" field is set to 0xFF, the LPM exits all AMs and does not enter any new ones.

The PPM shall respond with "PPM Busy" on reception ~~execution~~ of this command might require the PPM/LPM to initiate exit of all other alternate modes. The LPM might achieve the new alternate modes through additional PD commands for exit of AM. The successful completion of this command indicates that either a successful connection was established in the new AM when connected or the LPM is prepared to work in this mode for the future connection. If the change of the new AM did not result in a successful connection or the LPM has not accepted the new mode, the command should return an error. If the command returns error for any reason, the AM modes should remain unchanged. Note that if it will take longer than MIN_TIME_TO_RESPOND_WITH_BUSY ms to complete the same the execution of the command resulted in a successful AM, it should not result in a connector status change notification.

The value set by this command gets reset when either PPM/LPM is reset or when the platform is power cycled

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The format of the CONTROL Data Structure for this command is given in ~~Table 4-33~~[Table 6-33](#)~~Table 6-33~~.

Table 6-33: SET_NEW_CAM Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to SET_NEW_CAM.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried.
23	<i>EnterOrExit</i>	1	This field shall be set to one if the OPM wants to enter this Alternate Mode. This field shall be set to zero if the OPM wants to exit this Alternate Mode.
24	<i>New CAM</i>	8	This field shall be set to an offset into the list of Alternate Modes that the OPM wants the connector to operate in. This shall be an offset into the list of Alternate Modes supported by the PPM. <u>If the offset is set to 0xFF indicates that no new AM shall be advertised or entered.</u>
32	<i>AMSpecific</i>	32	This field shall be set by the OPM as per the requirements of the Standard or Vendor specific Alternate Mode. For example, if the Alternate Mode being changed is the DP Alternate Mode, then this field shall be a byte in length and shall contain the configuration within the DP Alternate Mode that the OPM wants the connector to operate in.

NOTE: A command to enter an Alternate Mode that has already been entered is not an error and similarly, a command to exit an Alternate Mode that has already been exited is not an error.

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-34](#)~~Table 6-34~~.

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Table 6-34: SET_NEW_CAM Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.

26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

~~4.5.15~~ 4.5.15 Get PDOS ~~(0)~~

This command is used to get the Sink or Source PDOs associated with the connector identified with the command. For the connector, this command can be used to get the Source PDOs/Capabilities as defined below:

- **Maximum Supported Source Capabilities**
 - The Maximum Provider Capabilities that the Source can support. These wouldn't change for a connector.
- **Current Supported Source Capabilities**
 - The Provider Capabilities that the Source currently supports. These could change dynamically and could be lower than the Maximum Source Capabilities if the system is Reaching Power Budget Limit due to multiple connected Sinks or if the Power Budget has been lowered due to it being unplugged from external power supply.
- **Advertised Source Capabilities**
 - The Provider Capabilities that are advertised by the Source during PD contract negotiation. These could be lower due to the Cable's current carrying capabilities. This is only valid when a port partner is present.

In addition, this command can be used to return the Sink or Source PDOs of the device that is connected to this connector. The format of the CONTROL Data Structure for this command is given in [Table 6-35](#).

Table 6-35: GET_PDOS Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_PDOS.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried.
23	<i>Partner PDO</i>	1	This field shall be set to one if the OPM wants to retrieve the PDOS of the device attached to the connector.
24	<i>PDO Offset</i>	8	Starting offset of the first PDO to be returned. Valid values are 0 through 7 for the SPR range, 0 through 4 for the EPR range, 0 through 11 for SPR and EPR ranges. Other values shall not be used.

Offset (Bits)	Field	Size (Bits)	Description										
32	Number of PDOs	2	Number of PDOs to return starting from the PDO Offset. The number of PDOs to return is the value in this field plus 1.										
34	Source or Sink PDOs	1	This field shall be set to one if the OPM wants to retrieve the Source PDOs otherwise it wants to retrieve the Sink PDOs.										
35	Source Capabilities Type	2	<div>This field indicates the type of Source Capabilities requested. This field is valid only if OPM sets <i>Partner PDO</i> to 0 and <i>Source or Sink PDOs</i> to 1.</div> <table><tr><th>Value</th><th>Meaning</th></tr><tr><td>0</td><td>Current Supported Source Capabilities</td></tr><tr><td>1</td><td>Advertised Capabilities</td></tr><tr><td>2</td><td>Maximum Supported Source Capabilities</td></tr><tr><td>3</td><td>Not Used</td></tr></table>	Value	Meaning	0	Current Supported Source Capabilities	1	Advertised Capabilities	2	Maximum Supported Source Capabilities	3	Not Used
Value	Meaning												
0	Current Supported Source Capabilities												
1	Advertised Capabilities												
2	Maximum Supported Source Capabilities												
3	Not Used												
37	Range	2	<div>This field shall be set to the value for range/s</div> <table><tr><th>Value</th><th>Meaning</th></tr><tr><td>0</td><td>SPR Range</td></tr><tr><td>1</td><td>EPR Range</td></tr><tr><td>2</td><td>SPR+EPR Range</td></tr><tr><td>3</td><td>Not Used</td></tr></table>	Value	Meaning	0	SPR Range	1	EPR Range	2	SPR+EPR Range	3	Not Used
Value	Meaning												
0	SPR Range												
1	EPR Range												
2	SPR+EPR Range												
3	Not Used												
39	Reserved	2725	Reserved and shall be set to zero.										

On completion of the command the **PPMLPM** shall set the CCI Data Structure as described in [Table 6-36](#).

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Table 6-36: GET_PDOS Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to four times the number of PDOs returned. If not successful, shall be set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.

Offset (Bits)	Field	Size (Bits)	Description
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully and the *Data Length* field is not 0x00 then the **PPMLPM** shall set the MESSAGE IN Data Structure as described in [Table 6-37](#) ~~Table 6-37~~.

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Table 6-37: GET_PDO Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>PDO[0]</i>	32	First PDO at PDO Offset.
32	<i>PDO[1]</i>	32	Next PDO (If present).
64	<i>PDO[2]</i>	32	Next PDO (If present).
96	<i>PDO[3]</i>	32	Next PDO (If present).

If the PPM receives an otherwise valid GET_PDOS Command for which the target cannot provide any PDOs, it shall set the Error Indicator to 0b in the GET_PDOS Status and shall set the Data Length field to 0. The PPM shall not return any GET_PDO data.

If the PPM receives a GET_PDOS Command in which the sum of the *PDO Offset* field and the *Number of PDOs* field is greater than 7, the maximum valid value for the specified Range (i.e., 7 for SPR, 4 for EPR, 11 for SPR+EPR), it shall set the Error Indicator to 1b in the GET_PDOS Status and shall set the Invalid Command Specific Parameters bit to 1b in the GET_ERROR_STATUS Data.

If the PPM receives a GET_PDOS Command with the *Partner PDO* field set to 1 when no PD device is attached, it shall set the Error Indicator to 1b in the GET_PDOS Status and shall set the Incompatible Connector Partner bit to 1b in the GET_ERROR_STATUS Data.

If the PPM receives a GET_PDOS command with the *Partner PDO* field set to 1 when no Connector partner is present, it shall set the Error Indicator to 1b in the GET_PDOS Status and shall set the CC Communication Error bit to 1b in the GET_ERROR_STATUS Data.

If the PPM receives a GET_PDOS Command with the *Partner PDOs* field set to 0 that is inappropriate for the target (e.g. requesting Source PDOs from a Sink-only target), it shall set the Error Indicator to 1b in the GET_PDOS Status and shall set the Invalid Command Specific Parameters bit to 1b in the GET_ERROR_STATUS Data.

If the PPM receives a GET_PDOS Command with the *Partner PDOs* field set to 1 that is inappropriate for the target (e.g. requesting Source PDOs from a Sink-only target), it shall set the Error Indicator

to 1b in the GET_PDOS Status and shall set the Incompatible Connector Partner bit to 1b in the GET_ERROR_STATUS Data.

~~4.5.16~~ 5.16 Get Cable Property ~~(Q)~~

This command is used to get the Cable properties on the connector identified by this command. The format of the CONTROL Data Structure for this command is given in ~~Table 6-38~~ [Table 6-38](#).

Table 6-38: GET_CABLE_PROPERTY Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_CABLE_PROPERTY.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector on which the cable is connected.
23	<i>Reserved</i>	41	Reserved and shall be set to zero.

On completion of the command the ~~PPMLPM~~ shall set the CCI Data Structure as described in ~~Table 6-39~~ [Table 6-39](#).

Table 6-39: GET_CABLE_PROPERTY Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful set to 0x05 else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the **PPMLPM** shall set the MESSAGE IN Data Structure as described in **Table 6-40**.

Table 6-40: GET_CABLE_PROPERTY Data

Offset (Bits)	Field	Size (Bits)	Description		
0	<i>bmSpeedSupported</i>	16	Bit	Description	
			1:0	Speed Exponent (SE). This field defines the base 10 exponent times 3, that shall be applied to the Speed Mantissa (SM) when calculating the maximum bit rate that this Cable supports.	
				Value	Meaning
				0	Bits per second
				1	Kb/s
				2	Mb/s
3	Gb/s				
15:2	This field defines the mantissa that shall be applied to the SE when calculating the maximum bit rate.				
16	<i>bCurrentCapability</i>	8	Return the amount of current the cable is designed for in 50ma units.		
24	<i>VBUSInCable</i>	1	The PPM shall set this field to a one if the cable has a VBUS connection from end to end.		
25	<i>CableType</i>	1	The PPM shall set this field to one if the cable is an Active cable otherwise it shall set this field to zero if the cable is a Passive cable.		
26	<i>Directionality</i>	1	The PPM shall set this field to one if the lane directionality is configurable else it shall set this field to zero if the lane directionality is fixed in the cable.		
27	<i>Plug End Type</i>	2	Value	Meaning	
			0	USB Type-A	
			1	USB Type-B	
			2	USB Type-C	
			3	Other (Not USB)	
29	<i>Mode Support</i>	1	This field shall only be valid if the <i>CableType</i> field is set to one. This field shall indicate that the cable supports Alternate Modes. The OPM can use the GET_ALTERNATE_MODE command to get the list of modes this cable supports.		
30	<i>Cable PD Revision</i>	2	Cable’s major USB PD Revision from the Specification Revision field of the USB PD Message Header		
32	<i>Latency</i>	4	See Table 6-2841 in the [USBPD] for additional information on the contents of this field.		
36	<i>Reserved</i>	428	Reserved and shall be set to zero.		

4.5.176.5.17 Get Connector Status ~~(R)~~

This command is used to get the current status of the connector identified by this command. The format of the CONTROL Data Structure for this command is given in [Table 6-41](#)~~Table 6-41~~.

When a device ~~got~~^{is} connected, the *Power Reading Ready* field in GET_CONNECTOR_STATUS shall be set initially to 0b and ~~then~~ set to 1b only after the default *Time To Read* elapsed (no alarm raised) unless the new command READ_POWER_LEVEL command is issued.

The Power Reading Ready field shall be set to 1b for the first measurement only after device connection or the READ_POWER_LEVEL command is issued. On the consequent GET_CONNECTOR_STATUS without the READ_POWER_LEVEL command the field shall be reset to 0b.

The LPM shall continuously update the current and voltage fields and provide the latest measurements upon the GET_CONNECTOR_STATUS command either using the default values of *Time to Read* and *Time Interval* fields or specified in the READ_POWER_LEVEL command if it has been issued.

Upon the connectors power state change, reset or disconnect the average values shall be zeroed.

Table 6-41: GET_CONNECTOR_STATUS Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_CONNECTOR_STATUS.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector on which the cable is connected.
23	<i>Reserved</i>	41	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-42](#)~~Table 6-42~~.

Table 6-42: GET_CONNECTOR_STATUS Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful set to 0x100x13 . Else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.

Offset (Bits)	Field	Size (Bits)	Description
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in [Table 6-43](#)~~Table 6-43~~.

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Table 6-43: GET_CONNECTOR_STATUS Data

Offset (Bits)	Field	Size (Bits)	Description																		
0	Connector Status Change	16	A bitmap indicating the types of status changes that have occurred on the connector. See Table 6-44 Table 6-44 for a description of each bit.																		
16	Power Operation Mode	3	<div>This field is only valid when the <i>Connect Status</i> field is set to one. This field shall indicate the current power operation mode of the connector.</div> <table><tr><th>Value</th><th>Meaning</th></tr><tr><td>0</td><td>Reserved</td></tr><tr><td>1</td><td>USB Default Operation</td></tr><tr><td>2</td><td>BC</td></tr><tr><td>3</td><td>PD</td></tr><tr><td>4</td><td>USB Type-C Current – 1.5A</td></tr><tr><td>5</td><td>USB Type-C Current – 3A</td></tr><tr><td>6</td><td>USB Type-C Current – 5A</td></tr><tr><td>7</td><td>Reserved</td></tr></table>	Value	Meaning	0	Reserved	1	USB Default Operation	2	BC	3	PD	4	USB Type-C Current – 1.5A	5	USB Type-C Current – 3A	6	USB Type-C Current – 5A	7	Reserved
Value	Meaning																				
0	Reserved																				
1	USB Default Operation																				
2	BC																				
3	PD																				
4	USB Type-C Current – 1.5A																				
5	USB Type-C Current – 3A																				
6	USB Type-C Current – 5A																				
7	Reserved																				
19	Connect Status	1	This field indicates the current connect status of the connector. This field shall be set to one when a device is connected to this connector.																		
20	Power Direction	1	<div>This field is only valid when the <i>Connect Status</i> field is set to one. The field shall indicate whether the connector is operating as a consumer or provider.</div> <table><tr><th>Value</th><th>Meaning</th></tr><tr><td>0</td><td>Connector is operating as a consumer</td></tr><tr><td>1</td><td>Connector is operating as a provider</td></tr></table>	Value	Meaning	0	Connector is operating as a consumer	1	Connector is operating as a provider												
Value	Meaning																				
0	Connector is operating as a consumer																				
1	Connector is operating as a provider																				

Offset (Bits)	Field	Size (Bits)	Description																		
21	Connector Partner Flags	8	<div>This field is only valid when the <i>Connect Status</i> field is set to one. This field indicates the current mode the connector is operating in.</div> <table><tr><th>Bit</th><th>Meaning</th></tr><tr><td>0</td><td>USB (USB 2.0 or USB 3.x)</td></tr><tr><td>1</td><td>Alternate Mode</td></tr><tr><td>2</td><td>USB4 V1gen 3</td></tr><tr><td>3</td><td>USB4 gen 4</td></tr><tr><td>34-7</td><td>Reserved</td></tr></table>	Bit	Meaning	0	USB (USB 2.0 or USB 3.x)	1	Alternate Mode	2	USB4 V1 gen 3	3	USB4 gen 4	3 4-7	Reserved						
Bit	Meaning																				
0	USB (USB 2.0 or USB 3.x)																				
1	Alternate Mode																				
2	USB4 V1 gen 3																				
3	USB4 gen 4																				
3 4-7	Reserved																				
29	Connector Partner Type	3	<div>This field is only valid when the <i>Connect Status</i> field is set to one. This field indicates the type of connector partner detected on this connector.</div> <table><tr><th>Value</th><th>Meaning</th></tr><tr><td>0</td><td>Reserved</td></tr><tr><td>1</td><td>DFP attached</td></tr><tr><td>2</td><td>UFP attached</td></tr><tr><td>3</td><td>Powered cable/No UFP attached</td></tr><tr><td>4</td><td>Powered cable/UFP attached</td></tr><tr><td>5</td><td>Debug Accessory attached</td></tr><tr><td>6</td><td>Audio Adapter Accessory attached</td></tr><tr><td>7</td><td>Reserved</td></tr></table>	Value	Meaning	0	Reserved	1	DFP attached	2	UFP attached	3	Powered cable/No UFP attached	4	Powered cable/UFP attached	5	Debug Accessory attached	6	Audio Adapter Accessory attached	7	Reserved
Value	Meaning																				
0	Reserved																				
1	DFP attached																				
2	UFP attached																				
3	Powered cable/No UFP attached																				
4	Powered cable/UFP attached																				
5	Debug Accessory attached																				
6	Audio Adapter Accessory attached																				
7	Reserved																				
32	Request Data Object (0)	32	<div>This field is only valid when the <i>Connect Status</i> field is set to one and the <i>Power Operation Mode</i> field is set to PD. Additionally, this is an optional field, and is valid only if the PPM has indicated support for the appropriate feature, as described in Section 6.5.6. This field shall return the currently negotiated power level. See Tables 6-13, 6-14, 6-15 and 6-16 in the [USBPD] for additional information on the contents of this data structure.</div>																		
64	Battery Charging Capability Status	2	<div>This field is only valid if the connector is operating as a Sink. Slow or very slow charging rate shall be indicated only if the PPM determines that the currently negotiated contract (or current level) is not sufficient for nominal charging rate.</div> <div>As an example, if the nominal charging rate capability is 45W:</div> <ul style="list-style-type: none">Slow charging rate capability is indicated when the negotiated power level is between 27W and 45W_⌊.Very slow charging rate capability is indicated when the negotiated power level is between 15W and 27W_⌊.No charging capability is indicated when the negotiated power level is less than 15W_⌊. <table><tr><th>Value</th><th>Meaning</th></tr><tr><td>0</td><td>Not charging</td></tr><tr><td>1</td><td>Nominal charging rate</td></tr><tr><td>2</td><td>Slow charging rate</td></tr><tr><td>3</td><td>Very slow charging rate</td></tr></table>	Value	Meaning	0	Not charging	1	Nominal charging rate	2	Slow charging rate	3	Very slow charging rate								
Value	Meaning																				
0	Not charging																				
1	Nominal charging rate																				
2	Slow charging rate																				
3	Very slow charging rate																				

Offset (Bits)	Field	Size (Bits)	Description
66	<i>Provider Capabilities Limited Reason</i>	4	<p>A bitmap indicating the reasons why the Provider capabilities of the connector have been limited. This field is only valid if the connector is operating as a provider.</p> <p>If the PPM has lowered the capabilities but the reason doesn't fall into any of the predefined categories, it can choose to not set any of these bits. Also, if the Provider Capabilities change and are no longer limited, the PPM shall clear these bits.</p> <p>See Table 4-51Table 6-45Table 6-45 for description of each bit.</p>
70	<i>bcdPDVersion Operation Mode</i>	16	<p>This field indicates the USB Power Delivery Specification Revision Number the connector uses during an Explicit Contract (as described in the [USBPD]), and the format is in Binary-Coded Decimal (e.g., Revision 3.0 is 300H).</p> <p>This field shall only be valid if the <i>Power Operation Mode</i> field is set to PD. Additionally, this is an optional field, and is valid only if the PPM has indicated support for the appropriate feature, as described in Section 6.5.6.</p>
86	<i>Orientation</i>	1	<p>This field shall be set to 0 when the connection is in the direct orientation.</p> <p>This field shall be set to 1 when the connection is in the flipped orientation.</p>
87	<i>Sink Path Status</i>	1	<p>This field shall indicate the status of the Sink Path. The bit shall be set to one if the sink path is enabled and set to zero if the sink is disabled. The PPM can disable or enable the Sink Path without OPM knowledge. In this case, the Sink Path Status Change bit shall be set to one and the Sink Path Status bit shall be set accordingly.</p>
88	<i>Reverse Current Protection Status</i>	1	<p>This field is valid if the <i>Reverse Current Protection Support</i> field is set to one in the GET_CONNECTOR_CAPABILITY. This field shall be set to one when the Reverse Current Protection happens. Otherwise, this bit shall be set to zero.</p>
89	<i>Power Reading <u>Ready</u></i>	1	<p>This field is set to 1 if the power reading is valid.</p>
90	<i>Scale</i>	3	<p>This field indicates the current resolution.</p> <p>Each bit is 5mA.</p> <p>Example of values:</p> <p>1b – 5mA</p> <p>101b – 25mA</p>
93	<i>Peak Current</i>	16	<p>This field is a peak current measurement reading.</p> <p>If the ADC supports only less than 16 bits, the most significant bits shall be set to 0</p>
109	<i>Average Current</i>	16	<p>This field represents the moving average for the minimum time interval specified either in the READ_POWER_LEVEL command or default 100mS of total time with interval of 5mS if the READ_POWER_LEVEL command has not been issued.</p> <p>If the ADC supports less than 16 bits, the most significant bits shall be set to 0.</p>

Offset (Bits)	Field	Size (Bits)	Description
125	<i>Scale</i>	4	This field indicates the voltage resolution. Each bit is 5mV. Example of values: 010b – 10mV 0101b – 25mV 1010b – 50mV
129	<i>Voltage Reading</i>	16	This field is the most recent VBUS voltage measurement within the time window specified by the READ_POWER_LEVEL command “Time to Read Power” or 100mS which is the default value. If the ADC supports less than 16 bits, the most significant bits shall be set to 0.
145	<i>Reserved</i>	<u>Z</u>	Reserved and shall be set to zero.

The Power Reading Ready field shall be set by LPM in response to READ_POWER_LEVEL command when data is ready for OPM collection. This field shall be cleared to 0 after OPM read the values.

Table 6-44: Connector Status Change Field Description

Bit	Description
0	Reserved Shall be set to zero.
1	External Supply Change When set to 1b, the OPM can get the current status of the supply attached to the PPM by using the GET_PDO command.
2	Power Operation Mode Change When set to 1b, the Power Operation Mode field in the STATUS Data Structure shall indicate the current power operational mode of the connector.
3	Attention This bit shall be set to 1b when an LPM receives an attention from the port partner.
4	Reserved Shall be set to zero
5	Supported Provider Capabilities Change When set to 1b, the OPM shall get the updated Power Data Objects by using the GET_PDOS command. The Supported Provider Capabilities Limited Reason field shall indicate the reason if the provider capabilities are limited.
6	Negotiated Power Level Change When set to 1b, the Request Data Object field in the STATUS Data Structure shall indicate the newly negotiated power level. Note that this bit shall be set by the PPM whenever a Power contract is established or renegotiated.
7	PD Reset Complete This bit shall be set to 1b when the PPM completes a PD Hard Reset requested by the connector partner.

Bit	Description
8	Supported CAM Change When set to 1b, the OPM shall get the updated Alternate Modes supported by using the GET_CAM_SUPPORTED command.
9	Battery Charging Status Change This bit shall be set to 1b when the Battery Charging status changes.
10	Reserved Shall be set to zero.
11	Connector Partner Changed This bit shall be set to 1b when the Connector Partner Type field or Connector Partner Flags change.
12	Power Direction Changed This bit shall be set to 1b when the PPM completes a Power Role Swap requested by the connector partner or due to the PPM autonomously performing a Power Role Swap or as a side effect of the OPM issuing a Data Role Swap command. The Power Direction field in the STATUS Data Structure shall indicate the new Power Role.
13	Sink Path Status Change This bit shall be set to 1b when the Sink Path Status changes.
14	Connect Change This bit shall be set to 1b when a device gets either connected or disconnected and the Connect Status field in the GET_CONNECTOR_STATUS Data Structure changes. This bit shall be reset to 0b when OPM/PPM reads GET_CONNECTOR_STATUS Data Structure. <u>The Operation Mode field in the STATUS Data Structure shall indicate the current operational mode of the connector.</u>
15	Error When set to 1b, this field shall indicate that an error has occurred on the connector.

Table 6-45: Provider Capabilities Limited Reason Field Description

Bit	Description
0	Power Budget Lowered When set to 1b, indicates that the Power Budget for the PPM has been lowered due to it being unplugged from an External Supply.
1	Reaching Power Budget Limit When set to 1b, indicates that the PPM is reaching the Power Budget Limit due to too many connected Sink devices.
2	Reserved Shall bet set to zero.
3	Reserved Shall bet set to zero.

~~4.5.186.5.18~~ **Get Error Status-(R)**

This command is used to get details about an error, if one is reported by the PPM. The OPM may send this command to get additional details on why a command failed, which is indicated by the PPM by completing the command with the Error Indicator set. The OPM may also send this command to get additional details on the error associated with a connector change event

with the Error bit set. In either case, the PPM may clear the Error Status Data after the OPM has acknowledged the command completion or connector change notification, or after receiving a PPM_RESET Command but not before. The format of the CONTROL Data Structure for this command is given in [Table 6-46](#).

Table 6-46: GET_ERROR_STATUS Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_ERROR_STATUS.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector on which the cable is connected.
23	<i>Reserved</i>	41	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-47](#).

Table 6-47: GET_ERROR_STATUS Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful set to GET_ERROR_STATUS_DATA_LENGTH else set to 0x00.
<u>16</u>	<u><i>Vendor Defined Message Indicator</i></u>	<u>1</u>	<u>Set to 0b.</u>
16 <u>17</u>	<i>Reserved</i>	7 <u>6</u>	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.

Offset (Bits)	Field	Size (Bits)	Description
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	Set to 0b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in [Table 6-48](#) ~~Table 6-48~~.

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Table 6-48: GET_ERROR_STATUS Data

Offset (Bits)	Field	Size (Bits)	Description	
0	<i>Error Information</i>	16	This field indicates the reason for the error reported by the PPM.	
			Bit	Meaning
			0	Unrecognized command
			1	Non-existent connector number
			2	Invalid command specific parameters
			3	Incompatible connector partner
			4	CC communication error
			5	Command unsuccessful due to dead battery condition
			6	Contract negotiation failure
			7	Overcurrent
			8	Undefined
			9	Port partner rejected swap
			10	Hard Reset
			11	PPM Policy Conflict
			12	Swap Rejected
			13	Reverse Current Protection
14	Set Sink Path Rejected			
15	Reserved and shall be set to zero			
16	<i>Vendor Defined</i>	N	This contents of this filed are vendor specific.	
16+N	<i>Reserved</i>	112-N	Reserved and shall be set to zero.	

~~4.5.196.5.19~~ Set Power Level ~~(R)~~

This command is used by the OPM to set the maximum negotiable power level of Sink or Source associated with the connector identified with the command, for the current connection. If the connector does not have an active connection, this command has no effect, and the PPM shall set the Error Information field to indicate Invalid Command Specific Parameters. If the power direction of the current connection does not match the command, this command has no effect, and the PPM shall set the Error Information field to indicate Invalid Command Specific Parameters. The default behavior prior to execution of this command is PPM determining the maximum negotiable power level of the connector.

If the PPM receives a SET_POWER_LEVEL command while there is an active connection, the PPM shall notify the OPM that it has completed the command and then renegotiate a power contract if necessary.

NOTE: If the PPM negotiates a new power contract after receiving a SET_POWER_LEVEL command and the new power contract is for a power level that is different than the previous power level, the PPM will send a Negotiated Power Level Change notification (if supported).

The format of the CONTROL Data Structure for this command is given in ~~Table 6-49~~Table 6-49. The port may offer other Type-C Current or PDO(s) with lower power capability than the maximum negotiable power level within this command.

The value set by this command is reset when one of the following occurs:

1. PPM is reset
2. PPM is power cycled
3. The connector is reset
4. The connector is detached

~~Setting the value of the “Max Power” field to 0xFF would disable this command and result in PPM determining the maximum negotiable power level of the connector.~~ If the PPM detects a policy conflict (for example, the maximum negotiable power level identified within this command cannot be supported by the PPM), the PPM shall set the Error Information field to indicate PPM Policy Conflict.

Table 6-49: SET_POWER_LEVEL Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to SET_POWER_LEVEL.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried. A value of zero in this field indicates that the <i>USB PD Max Power</i> field is the total power for all ports.
23	<i>Source or Sink</i>	1	This field shall be set to one if the OPM wants to set the Source power level. Otherwise, the OPM wants to set the Sink power level.
24	<i>USB PD Max Power</i>	8	This field shall indicate the maximum negotiable power level the connector shall advertise/request in 0.5W units <u>units or 1.0W units based on the LsbControl bit.</u> This field shall only be valid for USB implicit/not PD-capable connectors-based connections, it may be ignored by LPM.

Offset (Bits)	Field	Size (Bits)	Description										
			If this field is set to 0x00 then the PPM shall determine the maximum negotiable power level of the connector by itself, <u>based on voltage and current fields.</u>										
32	USB Type-C Current	3	<div>This field shall indicate the maximum current the connector shall advertise/consume. This field shall be set to zero when the <i>Connector Number</i> field is set to zero.</div> <table><tr><th>Value</th><th>Meaning</th></tr><tr><td>0</td><td>PPM defined default</td></tr><tr><td>1</td><td>3A</td></tr><tr><td>2</td><td>1.5A</td></tr><tr><td>3</td><td>USB Type-C Default</td></tr></table>	Value	Meaning	0	PPM defined default	1	3A	2	1.5A	3	USB Type-C Default
Value	Meaning												
0	PPM defined default												
1	3A												
2	1.5A												
3	USB Type-C Default												
<u>35</u>	<u>LsbControl</u>	<u>1</u>	<u>This bit shall be set to 0b for 0.5W/20mV or 1b for 1.0W/25mV.</u>										
<u>36</u>	<u>Operating Current</u>	<u>7</u>	<u>Current in 50 mA Steps. Current shall not exceed 5A. If the current exceeds 5A, the command shall be Errored.</u>										
<u>43</u>	<u>Reserved</u>	<u>2</u>	<u>Shall be set to 0s.</u>										
<u>3545</u>	<u>Output Voltage Reserve</u>	<u>2912</u>	<div>Voltage in 20mV steps if LsbControl=0b. Voltage level shall not exceed 21V. If the voltage exceeds 21V, the command shall be Errored.</div> <div>Voltage in 25mV steps if LsbControl=1b. The least significant bits shall be zero making the effective LSB 100mV. Voltage level shall not exceed 48V. If the voltage exceeds 48V, the command shall be errored.</div> <div>This parameter only applies when formulating an AVS or PPS Request Message. It follows the USB-PD definition and is used directly in the new Request Message. Set to 0x00 if AVS and PPS are not supported. Reserved and shall be set to zero.</div>										
<u>57</u>	<u>Reserved</u>	<u>7</u>	<u>Reserved and shall be set to zero.</u>										

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-50](#).

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Table 6-50: SET_POWER_LEVEL Status

Offset (Bits)	Field	Size (Bits)	Description
0	Reserved	1	Reserved and shall be set to zero.
1	Connector Change Indicator	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	Data Length	8	Set to 0x00.
<u>16</u>	<u>Vendor Defined Message Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>4617</u>	<u>Reserved</u>	<u>76</u>	Reserved and shall be set to zero.

Offset (Bits)	Field	Size (Bits)	Description
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

4.5.206.5.20 Get PD Message ~~(0)~~

This command is used by the OPM to retrieve the USB Power Delivery response message of the identified connector, the port partner, or the cable plug of the identified connector.

There are two scenarios of the OPM retrieving a USB PD response message from the **PPMLPM**:

- If the OPM wants to retrieve a USB PD response message from the port partner or the cable plug of the identified connector, the **PPMLPM** requests data by sending the appropriate request message. For example, when the OPM sends a GET_PD_MESSAGE command with the *Response Message Type* field set to Sink_Capabilities_Extended and the *Recipient* field is set to 1, the **PPMLPM** sends the Get_Sink_Cap_Extended to the port partner using SOP then returns the Sink_Capabilities_Extended response message. This process applies to the messages provided in the *Response Message Type* field in GET_PD_MESSAGE Command.
- If the OPM wants to retrieve a USB PD response message from the identified connector, the **PPMLPM** returns the response message that the platform would send upon receiving the corresponding request message from its port partner. For example, when the OPM sends a GET_PD_MESSAGE command with the *Response Message Type* field set to Sink_Capabilities_Extended and the *Recipient* field is set to 0, the **PPMLPM** returns the Sink Capabilities Extended response message that the platform would send upon receiving the Get_Sink_Cap_Extended. This process applies to the messages provided in the *Response Message Type* field in GET_PD_MESSAGE Command.

The following rules shall be followed when the OPM sends GET_PD_MESSAGE command with *Recipient* field set to 1, 2 or 3:

- When the OPM sends a GET_PD_MESSAGE command with the *Message Offset* field set to 0 and the *Recipient* field set to 1, 2 or 3, the PPM shall initiate sending a USB PD request message and return the new USB PD response message.
- The **PPMLPM** shall return a cached response message when it receives GET_PD_MESSAGE Command with the *Message Offset* field set to non-zero value and *Recipient* field set to 1, 2 or 3. If the PPM does not have a cached response message (because the OPM has not sent GET_PD_MESSAGE command for the corresponding response message with *Message Offset* field set to 0), then the PPM shall set the *Error Indicator* bit to 1b in the GET_PD_MESSAGE Status and shall set the *CC Communication Error* bit to 1b in the GET_ERROR_STATUS Data.

Table 6-51: GET_PD_MESSAGE Command

Offset (bits)	Field	Size (bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_PD_MSG.
8	<i>Data Length</i>	8	Shall be set to 0x0.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried.
23	<i>Recipient</i>	3	<p>This field shall be set to zero if the OPM wants to retrieve the USB PD response message from the identified connector.</p> <p>This field shall be set to 1, 2 or 3 if the OPM wants to retrieve the USB PD response message from either the port partner or the cable plug of the identified connector. This field shall provide a valid Start of Packet (SOP*) that matches the <i>Response Message Type</i> field as specified in Chapter 6 of [USBPD] (e.g. the only valid <i>Recipient</i> value, which is non-zero, for Sink_Capabilities_Extended response message is SOP).</p> <p>0: Connector 1: SOP 2: SOP' 3: SOP'' 4-7: Reserved</p>
26	<i>Message Offset</i>	8	<p>This field indicates the starting offset (in bytes) of the message to be returned.</p> <p>If the response message is an Extended Message, then the valid values are less than the Data Size in the Extended Message header (as defined in [USBPD]).</p> <p>If the response message is a Data Message or a Structured VDM, then the valid values are multiples of four that are less than four times the Number of Data Objects in the message.</p>
34	<i>Number of Bytes</i>	8	<p>This field indicates the number of bytes to return starting from the offset.</p> <p>Valid values in this field are less than or equal to MAX_DATA_LENGTH.</p> <p>If the response message is a Data Message, then the valid values are non-zero multiples of four.</p>

Offset (bits)	Field	Size (bits)	Description		
42	Response Message Type	6			
			Value	PD Response Message	Corresponding PD Request Message
			0	Sink_Capabilities_Extended (Extended Message)	Get_Sink_Cap_Extended
			1	Source_Capabilities_Extended (Extended Message)	Get_Source_Cap_Extended
			2	Battery_Capabilities (Extended Message)	Get_Battery_Cap
			3	Battery_Status (Data Message)	Get_Battery_Status
			4	Discover Identity Response – ACK, NAK or BUSY (Structured VDM)	Discover Identity Request
			5	Revision (Data Message)	Get_Revision
			6-63	Reserved	Reserved
48	Reserved	16	Reserved and shall be set to zero.		

On completion of the command the PPM shall set the CCI Data Structure as described in [Table 6-52](#).

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Table 6-52: GET_PD_MESSAGE Status

Offset (bits)	Field	Size (bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	<p>The PPM shall set this field to the number of bytes returned. This field shall not exceed the value in the <i>Number of Bytes</i> field in the GET_PD_MESSAGE command.</p> <p><i>Note: When the value in this field is zero or less than the Number of Bytes field in the GET_PD_MESSAGE command, it indicates that the OPM has requested more data than the PPM can return. For example, if the OPM assumes a revision of [USBPD] that defines a larger data size.</i></p> <p>If the command was not successful or there isn't any data to be returned, the PPM shall set this field to 0x00.</p>
16	<i>Vendor Defined Message Indicator</i>	1	<i>Set to 0b.</i>
17	<i>Reserved</i>	7	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.

Offset (bits)	Field	Size (bits)	Description
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero. Otherwise, set to 0b.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set to 1b.

If the command completed successfully and the *Data Length* field (in GET_PD_MESSAGE Status) is not 0x00, then the PPM shall return the entire Data Block of *Extended Message*, the Data Object(s) of *Data Message*, or the VDM Header and Object(s) of *Structured VDM Command* in the MESSAGE IN Data Structure. Note that the PPM shall not include *Message Header* and *Extended Message Header* (as defined by [USBPD]) in the MESSAGE IN Data Structure. The PPM shall return the entire Data Block of the *Extended Message* in one whole message in the MESSAGE IN Data Structure i.e. the PPM shall merge a Chunked Extended Message before returning as a PD response message.

[Table 6-53](#) and [Table 6-54](#) provide examples that assume the identified connector supports USB Power Delivery Revision 3.0, Version 2.0 and the Data Size of *Sink Capabilities Extended* message is 21 bytes. If the PPM receives a GET_PD_MESSAGE Command in which the *Response Message Type* is Sink Capabilities Extended, the *Message Offset* is 0 and the *Number of Bytes* is 16, then the PPM sets the *Data Length* field (in GET_PD_MESSAGE Status) to 16 and the MESSAGE IN Data Structure as described in [Table 6-53](#). If the PPM receives a GET_PD_MESSAGE Command in which the *Response Message Type* is Sink Capabilities Extended, the *Message Offset* is 16 and the *Number of Bytes* is more than 5, then the PPM sets the *Data Length* field (in GET_PD_MESSAGE Status) to 5 and the MESSAGE IN Data Structure as described in [Table 6-54](#).

Table 6-53: GET_PD_MESSAGE Data (Example: 1st Part of Sink Capabilities Extended)

Offset (bits)	Field	Size (bits)	Description
0	<i>VID</i>	16	Refer to [USBPD]
16	<i>PID</i>	16	Refer to [USBPD]
32	<i>XID</i>	32	Refer to [USBPD]
64	<i>FW Version</i>	8	Refer to [USBPD]
72	<i>HW Version</i>	8	Refer to [USBPD]
80	<i>SKEDB Version</i>	8	Refer to [USBPD]
88	<i>Load Step</i>	8	Refer to [USBPD]
96	<i>Sink Load Characteristics</i>	16	Refer to [USBPD]
112	<i>Compliance</i>	8	Refer to [USBPD]
120	<i>Touch Temp</i>	8	Refer to [USBPD]

Table 6-54: GET_PD_MESSAGE Data (Example: 2nd Part of Sink Capabilities Extended)

Offset (bits)	Field	Size (bits)	Description
0	<i>Battery Info</i>	8	Refer to [USBPD]
8	<i>Sink Modes</i>	8	Refer to [USBPD]
16	<i>Sink Minimum PDP</i>	8	Refer to [USBPD]
24	<i>Sink Operational PDP</i>	8	Refer to [USBPD]
32	<i>Sink Maximum PDP</i>	8	Refer to [USBPD]

If the PPM receives a GET_PD_MESSAGE Command with the *Recipient* field set to 1, 2 or 3 and a port partner is not present, it shall set the *Error Indicator* bit to 1b in the GET_PD_MESSAGE Status and shall set the *CC Communication Error* bit to 1b in the GET_ERROR_STATUS Data.

If the PPM receives a GET_PD_MESSAGE Command with the *Recipient* field set to 1, 2 or 3 and the responder either responds with an *Ignored Message* (as defined in [USBPD]) or a *Not Supported Message*, then the PPM shall set the *Error Indicator* bit to 1b in the GET_PD_MESSAGE Status and shall set the *Incompatible Connector Partner* bit to 1b in the GET_ERROR_STATUS Data.

If the PPM receives a GET_PD_MESSAGE Command with the *Recipient* field set to 0 and the USB PD request message is not supported by the connector, then the PPM shall set the *Error Indicator* bit to 1b in the GET_PD_MESSAGE Status and shall set the *Invalid Command Specific Parameters* bit to 1b in the GET_ERROR_STATUS Data.

If the PPM receives a GET_PD_MESSAGE Command with an invalid Start of Packet (SOP*) (as specified in Chapter 6 of [USBPD]) in the *Recipient* field, then the PPM shall set the *Error Indicator* bit to 1b in the GET_PD_MESSAGE Status and shall set the *Invalid Command Specific Parameters* bit to 1b in the GET_ERROR_STATUS Data.

4.5.216.5.21 Get Attention VDO (0)

This command is used to get a VDO after an ATTENTION command is received from the port partner device. The format of the control data structure for the Get Attention VDO command is given in

[Table 6-55](#) ~~Table 6-55~~.

Format

Table 6-55: GET_ATTENTION Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_ATTENTION_VDO.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field identifies the connector being queried.
23	<i>Reserved</i>	48 41	Reserved and shall be set to zero.

On completion of this command, the PPM shall set the CCI Data Structure as described in [Table 6-56](#)~~Table 6-56~~.

Table 6-56: GET_ATTENTION_VDO Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful, set to the number of bytes returned in the GET_ATTENTION_VDO Data (up to 33). Else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	7 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 1 if the connector does not support this command. Else set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. if PPM is Busy, then PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed, PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in [Table 6-57](#)~~Table 6-57~~.

Table 6-57: GET_ATTENTION_VDO Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Alt Mode Index</i>	16	First offset into the list of Alternate Modes that the connector is currently operating in. This is an offset into the list of Alternate Modes supported by the PPM. If the connector is not operating in an Alternate Mode, the PPM shall set this field to 0xFF.
16	<i>Number of VDOs</i>	3	Number of returned VDOs. Shall be set to 1 if a VDO is returned or 0 if a VDO is not returned.
19	<i>Reserved</i>	2	Reserved and shall be set to zero.
21	<i>Sequence Number</i>	3	A number that identifies the ordering of the GET_ATTENTION_VDO completion data. This number increments by 1 for each returned set of GET_ATTENTION_VDO completion data. The number rolls over to 0 after the maximum value is reached.
24	<i>VDM Header</i>	32	Contains the VDM Header.
56	<i>VDO</i>	32	Contains the VDO.

4.5.226.5.22 Get Current Alternate Mode Configuration and Status ~~(R)~~

This command is used to get the configuration and status of one of the current ~~Alternative~~Alternate Mode of the connector (e.g. DP_SID and DP status).

The following is a possible set of commands that OPM can issue to find about the current configuration and status of the connector:

- GET_ALTERNATE_MODES – Gets a set of possible Alternate Modes
- GET_CAM_SUPPORTED – Gets the Alternate Modes currently supported by a connector
- GET_CURRENT_CAM – Gets an array of indexes 0-N for currently supported Alternate Modes on a connector
- GET_CAM_CS – Gets the configuration and status of one of the current Alternate Modes *i*, where $0 \leq i \leq N$.

Table 6-58: GET_CAM_CS Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to GET_CAM_CS.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried.
23	<i>Reserved</i>	1	Reserved and shall be set to zero.
24	<i>Current Alt Mode</i>	8	$0 \leq i \leq N$ - One of the Current Alternate Modes obtained from GET_CURRENT_CAM.

On completion of the GET_CAM_CS command, the PPM shall set the CCI Data Structure as described in [Table 6-59](#).

Table 6-59: GET_CAM_CS Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If successful, set to the number of bytes returned in GET_CAM_CS Data, else set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	8 6	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 1b if the connector does not support this command. Else set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. if PPM is Busy, then PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed, PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully then the PPM shall set the MESSAGE IN Data Structure as described in [Table 6-60](#). If there is no data to return, the PPM shall complete the command successfully and return 0 VDOs.

Table 6-60: GET_CAM_CS Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Current Alternate Mode</i>	8	The index of the Alternative Alternate Mode that is currently being used. This index is from the array of indexes obtained by the GET_CURRENT_CAM command.
8	<i>Status</i>	32	The status of the Current Alternate Mode. The Status for an Alternative Alternate Mode is defined in the specification that

Offset (Bits)	Field	Size (Bits)	Description
			defines that Alternate Mode. If a status is not defined for the Alternative Alternate Mode, this field shall be set to 0.
40	Number of VDOs	8	Number of returned VDOs (N).
48+N*32	VDO[N]	32	Contains N VDOs.

The tables with DisplayPort status and Configuration VDOs can be obtained from “VESA DisplayPort Alt Mode on USB Type-C” on page 84 Table 5-3 and page 86 Table 5-4 correspondingly.

~~4.5.23~~ 5.23 LPM Firmware Update Request ~~(0)~~

This command is used to initiate a firmware update using the mechanism defined in [PDFU].

An OPM may broadcast a firmware update by setting the connector number to 7Fh in the LPM Firmware Update Request Command. When the connector number is set to 7Fh the PPM shall send the command to all LPMs. The broadcasting option is intended for use in factory only. It is not recommended if different LPMs require different firmware updates.

Table 6-61: LPM_FIRMWARE_UPDATE_REQUEST Command

Offset (Bits)	Field	Size (Bits)	Description										
0	Command	8	This field shall be set to LPM_FW_UPDATE_REQUEST.										
8	Data Length	8	If the Direction Field is set to “OPM-LPM”, “OPM-PortPartner” or “OPM-Cable Plug” the field will be set to the length of the FW Update chunk in the Message OUT data structure (in bytes). If the Direction Field is set to “Update from PortPartner” the maximum length of chunk in Message In shall not exceed this number specified in this field.										
16	Connector Number	7	The connector number which FW has to be updated. To update all connectors at the same time, the number shall be set to 7Fh.										
23	Direction	2	<table><tr><th>Value</th><th>Direction</th></tr><tr><td>0</td><td>OPM-LPM</td></tr><tr><td>1</td><td>OPM-Port Partner</td></tr><tr><td>2</td><td>OPM-Cable Plug</td></tr><tr><td>3</td><td>Update from Port Partner</td></tr></table>	Value	Direction	0	OPM-LPM	1	OPM-Port Partner	2	OPM-Cable Plug	3	Update from Port Partner
Value	Direction												
0	OPM-LPM												
1	OPM-Port Partner												
2	OPM-Cable Plug												
3	Update from Port Partner												
25	FW Update Request	8	Firmware Update Message Request Types. The values are defined in [PDFU]. This field shall be used only if the Direction field is set to “OPM-Port Partner” or “OPM-Cable Plug”, Otherwise this field shall be set to 0.										

Offset (Bits)	Field	Size (Bits)	Description
34 33	<i>Data Index</i>	7	The index of the FW Update message chunk. If a FW Update message is bigger than 256 255 bytes, it is broken into chunks as described in [USBPD]. The index increments by 1 for each FW Update message chunk. The index shall roll over to 0 after the maximum value (7Fh) is reached. This field gets updated at the entity that is responsible for UCSI translation. If the LPM implements the UCSI interface, LPM will update this field. Similarly, with PPM, if the PPM implements the UCSI interface, the PPM is responsible for updating this field.
44 40	<i>End of Message</i>	1	Set to 1 if this chunk is the only chunk or the last chunk in a message. Otherwise, shall be 0.
42-63 41	<i>Reserved</i>	24 23	Reserved and shall be set to zero.

On completion of the LPM Firmware Update Request Command, the PPM shall set the CCI Data Structure as described in ~~Table 6-62~~Table 6-62.

Table 6-62: LPM_FIRMWARE_UPDATE_REQUEST Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>End of Message Indicator</i>	1	Set to 1 if chunk is the only chunk or the last chunk in a message. Otherwise, shall be 0.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	If error indicator is set, the data length is set to 0x02. Otherwise, contains the length of the Firmware Update Response.
16	<i>Data index</i>	7	The index of the FW Update message chunk. If a FW Update message is bigger than 256 255 bytes, it is broken into chunks as described in [USBPD]. The index increments by 1 for each FW Update message chunk. The index shall roll over to 0 after the maximum value (7Fh) is reached.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 1 when the request comes from the Port Partner (Asynchronous message).
25	<i>Not Supported Indicator</i>	1	Set to 1 if the Port Partner does not support this command.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. if PPM is Busy, then PPM shall set this field to a 1b and all other fields to zero.

Offset (Bits)	Field	Size (Bits)	Description
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed, PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

The response data contains the FW Update Response for the FW Update Request in the FIRMWARE_UPDATE_REQUEST Command. See [PDFU] for more information on FW Update messages.

The Data Index is used to synchronize the OPM/PPM and LPM. If the Data Index in the status does not match the Data Index in the command, the OPM/PPM shall consider the command as fail. It is per OPM/PPM discretion how to proceed from this point (e.g. re-send data, cancel operation, reset the connector, etc.).

The FW Update Request Indicator shall not be set at the same time as the Security Request Indicator.

If OPM is initiator of the FW UPDATE, the MESSAGE_OUT structure contains Data Payload.

Table 6-63: LPM_FIRMWARE_UPDATE_REQUEST MESSAGE_OUT Structure

Offset (Bytes)	Field	Size (Bytes)	Description
0	<i>Data Payload</i>	0-N	Data payload. Size should match to Data Length, where N cannot exceed 255.

If the FW update request is coming from the PD port partner device, the MESSAGE_IN structure shall be populated as depicted in ~~Table 4-4~~~~Table 6-64~~~~Table 6-64~~~~Table 6-64~~~~Table 6-64~~. The Direction field of the FW Update Command in this case shall be set to “From Port Partner”.

Table ~~4-4~~6-64 LPM_FIRMWARE_UPDATE_REQUEST MESSAGE_IN Structure

Offset (Bytes)	Field	Size (Bytes)	Description
0	<i>FW Update Request</i>	1	Firmware Update Message Request Types. The values defined in [PDFU].
1	<i>Data Payload</i>	1- 255 <u>254</u>	Data payload. Size should match to Data Length.

NOTE: The LPM should have a recovery mechanism for when a firmware update does not complete.

~~4.5.24~~**5.24 Security Request** ~~(O)~~

This command is used to authenticate a USB PD Source or Sink as defined in [USBAUTH].

Table 4-5-6-65 SECURITY_REQUEST Command

Offset (Bits)	Field	Size (Bits)	Description										
0	Command	8	This field shall be set to SECURITY_REQUEST.										
8	Data Length	8	If the Direction Field is set to “OPM-LPM”, “OPM-Port Partner” or “OPM-Cable Plug” the field will be set to the length of the Security Authentication chunk in the Message OUT data structure (in bytes). If the Direction Field is set to “Update from Port Partner” the maximum length of chunk in Message In shall not exceed this number specified in this field.										
16	Connector Number	7	This field indicates the connector to authenticate.										
23	Direction	2	<table><tr><th>Value</th><th>Direction</th></tr><tr><td>0</td><td>OPM-LPM</td></tr><tr><td>1</td><td>OPM-Port Partner</td></tr><tr><td>2</td><td>OPM-Cable Plug</td></tr><tr><td>3</td><td>Request from Port Partner</td></tr></table>	Value	Direction	0	OPM-LPM	1	OPM-Port Partner	2	OPM-Cable Plug	3	Request from Port Partner
Value	Direction												
0	OPM-LPM												
1	OPM-Port Partner												
2	OPM-Cable Plug												
3	Request from Port Partner												
25	Security Request	1	Set 0 when request comes from PPM/OPM to authenticate LPM (for example, prior FW update to prevent malicious application from accessing the LPM). Set to 1 when the request goes to the Port Partner (Asynchronous message).										
26	Auth Protocol Revision	8	Authentication protocol version as defined in [USBAUTH]. This field is valid when the request comes from OPM. If the request from PortPartner this field shall be set to 0b.										
34	Authentication Message	8	Authentication Request Types as defined in [USBAUTH]. This field is valid when the request comes from OPM. If the request from PortPartner this field shall be set to 0b.										
42	Data Index	7	The index of the requested security message chunk. If a security message is bigger than 256 255 bytes, it is broken into chunks as described in [USBPD]. The index increments by 1 for each chunk in the security message. The index shall roll over to 0 after the maximum value (7Fh) is reached.										
51 49	End of Message	1	Set 0 when message transmitted partially, Set 1 when the last chunk is sent.										
52-63 50	Reserved	11 14	Reserved and shall be set to zero.										

On completion of the Security Request Command, the PPM shall set the CCI Data Structure as described in ~~Table 4-Table 6-66~~Table 6-66.

Table 4-67:6-66 SECURITY_REQUEST Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>End of Message Indicator</i>	1	Set to 1 if this chunk is the only chunk or the last chunk in a message. Otherwise, shall be 0.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Contains the length of the Authentication Response.
16	<i>Data Index</i>	7	The index of the security message chunk returned in the Response Data. The index increments by 1 for each security message chunk. The index shall roll over to 0 after the maximum value (7Fh) is reached.
23	<i>Security Request Indicator</i>	1	Set to 1b if the Port Partner requested authentication.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 1 if the Port Partner does not support this command.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. if PPM is Busy, then PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed, PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

The response data contains the Authentication Response for the Authentication Request in the SECURITY_REQUEST Command. See [USBAUTH] for more information on Authentication messages.

The Data Index is used to synchronize the OPM/PPM and LPM. If the Data Index in the status does not match the Data Index in the command, the OPM/PPM shall consider the command as fail. It is per OPM/PPM discretion how to proceed from this point (e.g. re-send data, cancel operation, reset the connector, etc.).

The Security Request Indicator shall not be set at the same time as The FW Update Request Indicator.

If OPM is initiator of the Security Request, the MESSAGE_OUT structure contains Data Payload.

Table 4-67:6-67 LPM_SECURITY_UPDATE_REQUEST MESSAGE_OUT Structure

Offset (Bytes)	Field	Size (Bytes)	Description
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0	<i>Data Payload</i>	0-N	Data payload. Size should match to Data Length, where N cannot exceed 255.
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If the Security Request is coming from the PD port partner device, the MESSAGE_IN structure shall be populated as depicted in [Table 6-68](#) ~~Table 6-68~~.

Table ~~4-68~~:6-68 SECURITY REQUEST MESSAGE_IN Structure

Offset (Bytes)	Field	Size (Bytes)	Description
0	<i>Security Header</i>	4	Security Header defined in [USBAUTH].
4	<i>Data Payload</i>	4- 255 <u>251</u>	Data payload. Shall equal the Data Length.

~~4.5.25~~6.5.25 Set Re-Timer Mode ~~(0)~~

This command sets the functional mode for a re-timer. This Command is intended for the FW update and EV/DV calibration routines.

Table 6-69: SET_RETIMER_MODE Command

Offset (Bits)	Field	Size (Bits)	Description																
0	Command	8	This field shall be set to SET_RETIMER_MODE.																
8	Data Length	8	Set to 0x0 if the Function is not Flashing Mode with Payload. Otherwise set to number of bytes of FW chunk.																
16	Connector Number	7	This field shall be set to the connector.																
23	Re-timer Number	2	Selects the re-timer (there can be up to two). If there is only a single re-timer, the value shall be set to 1. <table><tr><th>Value</th><th>State</th></tr><tr><td>0</td><td>Reserved</td></tr><tr><td>1</td><td>Re-timer facing connector (default)</td></tr><tr><td>2</td><td>Re-timer facing SoC</td></tr><tr><td>3</td><td>Both re-timers at the same time</td></tr></table>	Value	State	0	Reserved	1	Re-timer facing connector (default)	2	Re-timer facing SoC	3	Both re-timers at the same time						
Value	State																		
0	Reserved																		
1	Re-timer facing connector (default)																		
2	Re-timer facing SoC																		
3	Both re-timers at the same time																		
25	State	3	<table><tr><th>Value</th><th>State</th></tr><tr><td>0</td><td>Off</td></tr><tr><td>1</td><td>On/Force Power</td></tr><tr><td>2</td><td>Low Power Mode</td></tr><tr><td>3</td><td>Compliance Mode</td></tr><tr><td>4</td><td>Flashing Mode</td></tr><tr><td>5</td><td>Flashing Mode with Payload</td></tr><tr><td>6-7</td><td>Reserved</td></tr></table>	Value	State	0	Off	1	On/Force Power	2	Low Power Mode	3	Compliance Mode	4	Flashing Mode	5	Flashing Mode with Payload	6-7	Reserved
Value	State																		
0	Off																		
1	On/Force Power																		
2	Low Power Mode																		
3	Compliance Mode																		
4	Flashing Mode																		
5	Flashing Mode with Payload																		
6-7	Reserved																		

Offset (Bits)	Field	Size (Bits)	Description																												
28	Functional Mode	4	<div>The Functional Mode is valid if State is set to 1, else this field is ignored.</div> <table><tr><th>Value</th><th>Mode</th></tr><tr><td>0</td><td>USB 3.2 Gen 1</td></tr><tr><td>1</td><td>USB 3.2 Gen 2</td></tr><tr><td>2</td><td>USB 3.2 2x2</td></tr><tr><td>3</td><td>USB4 Gen 2</td></tr><tr><td>4</td><td>USB4 Gen 3</td></tr><tr><td>5</td><td>USB4 Gen 4</td></tr><tr><td>6</td><td>TBT3</td></tr><tr><td>6</td><td>TBT4</td></tr><tr><td>7</td><td>DP1.4</td></tr><tr><td>8</td><td>DP2.0</td></tr><tr><td>9</td><td>MFD USB3.2 + DP</td></tr><tr><td>10</td><td>Debug accessory</td></tr><tr><td>11-15</td><td>Reserved</td></tr></table>	Value	Mode	0	USB 3.2 Gen 1	1	USB 3.2 Gen 2	2	USB 3.2 2x2	3	USB4 Gen 2	4	USB4 Gen 3	5	USB4 Gen 4	6	TBT3	6	TBT4	7	DP1.4	8	DP2.0	9	MFD USB3.2 + DP	10	Debug accessory	11-15	Reserved
Value	Mode																														
0	USB 3.2 Gen 1																														
1	USB 3.2 Gen 2																														
2	USB 3.2 2x2																														
3	USB4 Gen 2																														
4	USB4 Gen 3																														
5	USB4 Gen 4																														
6	TBT3																														
6	TBT4																														
7	DP1.4																														
8	DP2.0																														
9	MFD USB3.2 + DP																														
10	Debug accessory																														
11-15	Reserved																														
32	DP Source-Sink	1	Zero if the connected device is a DP source. One if the connected device is a DP sink.																												
33	Gain	8	The Amplification Gain field is valid if state is set to 1, else this field could be ignored.																												
41	Orientation	1	Set to 0 if direct orientation, else set to 1 – flipped orientation.																												
42	Reserved	4	Reserved and shall be set to zero.																												
46	Data Index	7	<div>The index of the requested data chunk. This field is only valid if the State field is set to “Flashing Mode with Payload”. When valid, the index increments by 1 for each chunk. The index rolls over to 0 after the maximum value (FFh) is reached.</div> <div>When not valid, this field shall be set to 0 and the Index shall not increment.</div>																												
53	End of Message	1	Indicates end of the message. This field is valid only if State is “Flashing mode with payload”.																												
54-63	Reserved	8	Reserved and shall be set to zero.																												

On completion of the Set Re-Timer Mode Command, the PPM shall set the CCI Data Structure as described in ~~Table 4-Table 6-69~~Table 6-69.

Table 4-70:6-69 SET_RETIMER_MODE Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.

Offset (Bits)	Field	Size (Bits)	Description
8	<i>Data Length</i>	8	Set to 0x0.
16	<i>Data Index</i>	7	The index of the data chunk that was processed. This field is only valid if the State field is set to "Flashing Mode with Payload" otherwise shall be set to 0. When valid, the index increments by 1 for each data chunk. The index shall roll over to 0 after the maximum value (7Fh) is reached. When not valid, this field shall be set to 0 and the Index shall not increment.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 1 if the LPM does not support this command.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. if PPM is Busy, then PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed, PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

The Data Index is used to synchronize the OPM/PPM and the LPM. If the Data Index in the status does not match the Data Index in the command, the OPM/PPM shall consider the command as failed. It is per OPM/PPM discretion how to proceed from this point (e.g. re-send data, cancel operation, reset the connector, etc.).

~~4.5.26~~ **4.5.26.5.26 Set Sink Path-(R)**

This command is used to either enable the sink path to get power from the port partner or disable the sink path. An attempt to enable the sink path when the LPM is in the power provider mode or when no port partner is connected shall result in the Error Indicator bit getting set to 1b.

The format of the Sink Path Command Structure for this command is given in ~~Table 4-~~Table 6-70~~Table 6-70.~~

Table ~~4-71~~6-70 SET_SINK_PATH Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to SET_SINK_PATH.
8	<i>Data Length</i>	8	This field shall be set to zero.
16	<i>Connector Number</i>	7	This field indicates the connector whose Power Direction Role is to be modified. A value of zero in this field is illegal.
23	<i>Sink Path</i>	1	This bit should be set to one to enable the sink path on the specified connector. To disable the sink path this bit shall be set to zero.
24	<i>Reserved</i>	40	Reserved and shall be set to zero.

On completion of the command the PPM shall set the CCI Data Structure as described in [Table ~~6-71~~Table 6-71](#).

Table ~~72~~6-71 SET_SINK_PATH Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero.
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
46 17	<i>Reserved</i>	76	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed, the PPM shall set this field to 1b. Also, if the LPM is in the source mode, this bit shall be set to 1b. Get_Error_Status command can provide additional information.
31	<i>Command Completed Indicator</i>	1	Set this field to 1b if the command is completed successfully.

4.5.276.5.27 Chunking Support ~~(0)~~

This command is used by the OPM to determine PPM/LPMs maximum chunking size used for UCSI MESSAGE_IN and MESSAGE_OUT.

If the LPM/PPM does not support chunking, the *Not Supported Indicator* field shall be set in the CCI Data structure. If the Not Support Indicator is set, the LPM/OPM shall support chunking up to the maximum payload size for the current UCSI specification defined in the Data Structure Table for MESSAGE_IN and MESSAGE_OUT.

It is recommended for systems with more than one LPM to not use LPMs with a different *Chunking size*.

It is recommended for LPMs to use the chunking size equal to the size of the current MESSAGE_IN/MESSAGE_OUT specified in the UCSI version that the LPM/PPM supports or not less than 16 bytes (size of MESSAGE_IN/MESSAGE_OUT in the UCSI 1.2).

Table 6-~~73~~-72 CHUNKING_SUPPORT Command

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Command</i>	8	This field shall be set to CHUNKING_SUPPORT_.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Connector Number</i>	7	This field shall be set to the connector being queried. If this field is set to zero, the PPM may broadcast this command to all LPMs and reply to the OPM with the lowest Chunking Size.
23	<i>Reserved</i>	41	Reserved and shall be set to zero.

On successful completion of the command the PPM shall set the CCI Data Structure as described in Table below.

Table 6-~~74~~-73 CHUNKING_SUPPORT Status

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Reserved</i>	1	Reserved and shall be set to zero
1	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set <i>If successful set to 0x01, else set</i> to 0x00.
16	<i>Vendor Defined Message Indicator</i>	1	Set to 0b.
16 17	<i>Reserved</i>	76	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b.
24	<i>FW Update Request Indicator</i>	1	Set to 0b.
25	<i>Not Supported Indicator</i>	1	Set to 0b if LPM/PPM supports chunking. Otherwise set this field to 1b.
26	<i>Cancel Completed Indicator</i>	1	Set to 0b.

Offset (Bits)	Field	Size (Bits)	Description
27	<i>Reset Completed Indicator</i>	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	<i>Acknowledge Command Indicator</i>	1	Set to 0b.
30	<i>Error Indicator</i>	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	<i>Command Completed Indicator</i>	1	Set this field to a 1b.

If the command completed successfully, then the PPM shall set the MESSAGE_IN Data Structure as described in the following table.

Table 6-~~75~~-74 CHUNKing_SUPPORT Data

Offset (Bits)	Field	Size (Bits)	Description
0	<i>Chunking Size</i>	8	Maximum chunking size in bytes supported by LPM/PPM. The OPM may use any chunking size up to the maximum reported by the field.

~~4.5.28 SET_PDOS (R)~~

6.5.28 Set PDOS

This command is used for overwriting all Source or Sink Capabilities PDOS in either SPR or EPR range on a connector.

This command can update Sink or Source Capability PDOS within an atomic sequence using the End of Message field. If an LPM receives command for changing either Sink or Source Capability PDOS with the End of Message indicator set to 0b before an Explicit Contract is established, the LPM shall postpone establishing an Explicit Contract until it receives the SET_PDOS command with the End of Message indicator set to 1b. This should prevent the OPM from power over subscription on the multi-port system.

When the LPM receives the SET_PDOS command with the End of Message indicator set 0b, and replies with Command Completion Indicator, the OPM shall send another SET_PDOS command within SENDER_RESPONSE_TIMEOUT to complete the series. The sender response timer shall be counted from the moment of clearing the alert by lpm upon receiving the ACK CCI. If the SENDER_RESPONSE_TIMEOUT elapsed and the LPM has not received this SET_PDOS command, it may proceed with pending contract negotiation.

To speed up the process of updating PDOS on all LPMs, there is an option to broadcast command to all LPMs by OPM setting the connector number to 0. In that case PPM shall aggregate status from LPMs before forwarding them to OPM.

If a command is broken in chunks, the Data Index field will serve as a synchronization mechanism between OPM, PPM and LPM and also for error handling. As an example, if an error happened for one of the chunks, OPM has a choice either to retry sending the same chunk and keep the Data Index the same or restart the SET_PDOS command from the first chunk and set Data Index to 0. It is recommended to send all PDOS within a single SET_PDOS command chunk if possible.

The OPM shall send the PDOs in the correct order. The LPM shall not re-order the PDOs.

When the LPM receives a SET_PDOS command it deletes the old PDOs and sets the new ones from the SET_PDOS command.

The SET_PDOS command supersedes the SET_POWER_LEVEL command, or in other words SET_POWER_LEVEL shall change power within available PDO levels. The SET_PDOS command shall result in the LPM negotiating a new Explicit Contract if necessary.

For the SET_PDOS command example see Appendix A.1.

The format of the Set PDOs Command Structure for this command is given in the table below.

Table 6-75 SET_PDOS Command

Offset (Bits)	Field	Size (Bits)	Description
0	Command	8	This field shall be set to SET_PDOS.
8	Data Length	8	This field shall be set to the length of the number PDOs multiplied by 4bytes/PDO.
16	Connector Number	7	This field indicates the connector number who's PDOs shall set. A value of zero in this field indicates that this command shall be broadcasted to all connectors.
23	Reserved	3	Reserved and shall be set to 0b.
26	Source or Sink Capabilities PDO	1	This bit shall be set to one if source capabilities PDO and zero if sink capabilities PDO.
27	Number of PDOs	4	This field shall be set to total number of PDOs written to the LPM in this command. The number of PDOs shall not exceed the maximum number permitted by the PD specification for the specified range. Example: SPR – 7. If the SET_PDOS command is chunked, the first chunk of the command shall have this field populated. For the following chunks this field is optional .
31	Data Index	7	The index of the SET_PDOS command chunk. The SET_PDOS command could be broken into chunks. The maximum number of chunks shall not exceed the number of total PDOs. The index increments by 1 for each SET_PDO chunk. The index shall roll over to 0 after the maximum value (7Fh) is reached.
38	End of Message	1	This field indicates the end of the command series. If this field is set to 0b, the series is not completed. If this field is set to 1b, the series is completed. As an example, the OPM may send SPR PDOs first with this bit set to 0b, and then send EPR PDOs with this bit set to 1b indicating the end of sequence. The OPM shall update “Number of PDOs” consecutive PDOs starting from PDO[0] with one command or with a command series.
39-63	Reserved	25	Reserved and shall be set to 0.

The MESSAGE_INOUT Structure shall look like in the table below.

Table 6-~~77~~-76 SET_PDOS MESSAGE_OUT Structure

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>PDO[0]</u>	<u>32</u>	<u>First PDO at PDO Offset.</u>
<u>32</u>	<u>PDO[1]</u>	<u>32</u>	<u>Next PDO (If present).</u>
<u>...</u>	<u>...</u>	<u>...</u>	<u>...</u>
<u>N*32</u>	<u>PDO[N]</u>	<u>32</u>	<u>Next PDO (If present).</u>

<u>On successful completion of the command the LPM/PPM shall set the CCI Data Structure as described below.</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>PDO[0]</u>	<u>32</u>	<u>First PDO at PDO Offset.</u>
<u>32</u>	<u>PDO[1]</u>	<u>32</u>	<u>Next PDO (If present).</u>
<u>...</u>	<u>...</u>	<u>...</u>	<u>...</u>
<u>N*32</u>	<u>PDO[N]</u>	<u>32</u>	<u>Next PDO (If present).</u>

~~On successful completion of the command the LPM/PPM shall set the CCI Data Structure as described below.~~

Table 6-77 SET_PDOS Status

Offset (Bits)	Field	Size (Bits)	Description
0	Reserved	1	Reserved and shall be set to zero.
4	Connector Change Indicator	7	If an asynchronous event occurred on a connector then the PPM shall set this field to the connector number on which the change occurred.
1	Connector Change Indicator	7	If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.
8	Data Length	8	Set to 0x00.
16	Data Index	7	The index of the message chunk. The index increments by 1 for each SET_PDOS chunk. The index shall roll over to 0 after the maximum value(7Fh) is reached.
23	Security Request Indicator	1	Set to 0b
24	FW Update Request Indicator	1	Set to 0b
25	Not Supported Indicator	1	Set to 1b if the command is not supported, otherwise set to 0b
16	Data Index	7	The index of the message chunk. The index increments by 1 for each SET_PDOS chunk. The index shall roll over to 0 after the maximum value(7Fh) is reached.

<u>23</u>	<u>Security Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>24</u>	<u>FW Update Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>25</u>	<u>Not Supported Indicator</u>	<u>1</u>	<u>Set to 1b if the command is not supported, otherwise set to 0b.</u>
26	Cancel Completed Indicator	1	Set to 0b.
27	Reset Completed Indicator	1	Set to 0b.
28	Busy Indicator	1	Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.
29	Acknowledge Command Indicator	1	Set to 0b.
30	Error Indicator	1	If the command was not successfully completed the PPM shall set this field to 1b. Also, if the Number of PDOs/RDOs exceeds allowed by the spec, this bit shall be set to 1b.
31	Command Completed Indicator	1	Set this field to 1b if the command is completed successfully.

See Appendix for Updating Fixed PDO Example on multiple LPMs at the same time.

6.5.29 Vendor Defined Command

The Vendor Defined Command (VDC) is provided to allow vendors to exchange information between OPM, PPM and LPM outside of that defined by this specification.

To ensure the commands uniqueness, all VDCs shall contain Vendor ID.

Table 6-78 VDM Command

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>Command</u>	<u>8</u>	<u>This field shall be set to Vendor Defined Command.</u>
<u>8</u>	<u>Data Length</u>	<u>8</u>	<u>This field shall be set to the length of data in Message OUT if any.</u>
<u>16</u>	<u>Connector Number</u>	<u>7</u>	<u>This field indicates the connector which is the target of this command.</u> <u>A value of zero shall indicate that this command is for PPM.</u> <u>Otherwise, the command is for specific connector.</u>
<u>23</u>	<u>Vendor Defined Command</u>	<u>5</u>	<u>Command defined by a vendor for a specified product.</u>
<u>28</u>	<u>VDC Structure Version</u>	<u>4</u>	<u>This field indicates the VDC structure version. On this revision it shall be set to 1.</u>
<u>32</u>	<u>Vendor ID</u>	<u>16</u>	<u>Vendor ID of the command requestor.</u>
<u>48</u>	<u>Product ID</u>	<u>16</u>	<u>Product ID of the command requestor.</u>

If the command is intended to read data, the MESSAGE IN structure shall be set as following.

Table 6-79 VDM MESSAGE IN Structure

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>Vendor ID</u>	<u>16</u>	<u>Vendor ID</u>
<u>16</u>	<u>Product ID</u>	<u>16</u>	<u>Product ID</u>
<u>32</u>	<u>Message Body</u>	<u>..</u>	<u>Vendor defined message</u>

Message Out has a vendor defined structure per specific command.

6.5.30 Get LPM PPM Info

This command is used to get HW and FW version of either PPM or LPM.

Table 6-80 Get LPM PPM Info Command

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>Command</u>	<u>8</u>	<u>This field shall be set to GET LPM PPM INFO.</u>
<u>8</u>	<u>Data Length</u>	<u>8</u>	<u>Set to 0x00.</u>
<u>16</u>	<u>Connector Number</u>	<u>7</u>	<u>This field shall be set to the connector being queried. If this field is set to 0, the command is addressed to PPM.</u>
<u>23</u>	<u>Reserved</u>	<u>41</u>	<u>Reserved and shall be set to 0.</u>

Table 6-81 Get LPM PPM Info Status

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>Reserved</u>	<u>1</u>	<u>Reserved and shall be set to zero.</u>
<u>1</u>	<u>Connector Change Indicator</u>	<u>7</u>	<u>If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.</u>
<u>8</u>	<u>Data Length</u>	<u>8</u>	<u>If successful set to 0x10, else set to 0x00.</u>
<u>16</u>	<u>Vendor Defined Message Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>17</u>	<u>Reserved</u>	<u>6</u>	<u>Reserved and shall be set to zero.</u>
<u>23</u>	<u>Security Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>24</u>	<u>FW Update Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>25</u>	<u>Not Supported Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>26</u>	<u>Cancel Completed Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>27</u>	<u>Reset Completed Indicator</u>	<u>1</u>	<u>Set to 0b.</u>

<u>28</u>	<u>Busy Indicator</u>	<u>1</u>	<u>Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.</u>
<u>29</u>	<u>Acknowledge Command Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>30</u>	<u>Error Indicator</u>	<u>1</u>	<u>If the command was not successfully completed the PPM shall set this field to 1b.</u>
<u>31</u>	<u>Command Completed Indicator</u>	<u>1</u>	<u>Set this field to a 1b.</u>

If the command completed successfully and the Data Length field is not 0x00 then the PPM shall set the MESSAGE IN Data Structure as described in Table 6-82Table 6-82.

Table 6-82 Get LPM PPM Info Data

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>VID</u>	<u>16</u>	<u>Vendor ID of LPM/PPM.</u>
<u>16</u>	<u>PID</u>	<u>16</u>	<u>Product ID of LPM/PPM.</u>
<u>32</u>	<u>XID</u>	<u>32</u>	<u>Value Provided by the USB-IF assigned to the product.</u>
<u>64</u>	<u>FW Version Upper</u>	<u>32</u>	<u>FW Version.</u>
<u>96</u>	<u>FW Version Lower</u>	<u>32</u>	<u>Sub. FW Version.</u>
<u>32</u>	<u>HW Version</u>	<u>32</u>	<u>HW version of LPM/PPM.</u>

6.5.31 Set USB

OPM uses the Set USB command to disable or enable USB modes for current and future connections. Upon receiving this command from OPM with the 'USB.X Enable' field is set to 0b, LPM shall:

- Stop advertising a USB.X mode for the future connections.
- Do Data Reset on the present connection if the connection is in the USB mode.

On the other hand, if 'USB.X Enable' field is set to 1b, LPM shall:

- Start advertising the USB.X mode for the future connections with the given EUDO field where applicable.
- Do Data Reset on the present connection if the connection is not in the USB mode.

If the LPM Reset happened, the USB.X Enable field is set to default setting.

For examples on how to use the SET USB command, see Appendix A.7.

Table 6-83 SET USB Command

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>Command</u>	<u>8</u>	<u>This field shall be set to SET USB.</u>
<u>8</u>	<u>Data Length</u>	<u>8</u>	<u>This field shall be set to zero.</u>
<u>16</u>	<u>Connector Number</u>	<u>7</u>	<u>This field indicates the connector whose USB operational mode is to be modified.</u> <u>A value of zero in this field is illegal.</u>

<u>23</u>	<u>USB3 Enable</u>	<u>1</u>	<u>0: Disable USB3 Mode.</u> <u>1: Enable USB3 Mode.</u>
<u>24</u>	<u>USB4 Enable</u>	<u>1</u>	<u>0: Disable USB4 Mode.</u> <u>1: Enable USB4 Mode.</u>
<u>25</u>	<u>Reserved</u>	<u>4</u>	<u>Reserved and shall be set to zero.</u>
<u>29</u>	<u>EUDO</u>	<u>32</u>	<u>Enter USB Data Object (EUDO).</u>
<u>61</u>	<u>Reserved</u>	<u>3</u>	<u>Reserved and shall be set to 0.</u>

Table 6-84 SET USB Status

Offset (Bits)	Field	Size (Bits)	Description
<u>0</u>	<u>Reserved</u>	<u>1</u>	<u>Reserved and shall be set to zero.</u>
<u>1</u>	<u>Connector Change Indicator</u>	<u>7</u>	<u>If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.</u>
<u>8</u>	<u>Data Length</u>	<u>8</u>	<u>Set to 0x00.</u>
<u>16</u>	<u>Vendor Defined Message Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>17</u>	<u>Reserved</u>	<u>6</u>	<u>Reserved and shall be set to zero.</u>
<u>23</u>	<u>Security Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>24</u>	<u>FW Update Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>25</u>	<u>Not Supported Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>26</u>	<u>Cancel Completed Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>27</u>	<u>Reset Completed Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>28</u>	<u>Busy Indicator</u>	<u>1</u>	<u>Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.</u>
<u>29</u>	<u>Acknowledge Command Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>30</u>	<u>Error Indicator</u>	<u>1</u>	<u>If the command was not successfully completed the PPM shall set this field to 1b.</u>
<u>31</u>	<u>Command Completed Indicator</u>	<u>1</u>	<u>Set this field to a 1b upon successful completion of command.</u>

6.5.32 READ POWER LEVEL

This command is used by the OPM to read a port's peak power and average power levels from the LPM that is in the sourcing mode. If the connector does not have an active connection or the LPM is in the sink mode, this command has no effect, and the PPM shall set the Error Information field to indicate Invalid Command Specific Parameters.

If the PPM receives a READ_POWER_LEVEL command while there is an active connection, the PPM shall notify the OPM that it has completed the command.

The alarm shall be raised and the CCI bit changed only when measurements are ready after the READ_POWER_LEVEL command is issued. No alarm shall be raised on the consecutive reads or upon device connection without the READ_POWER_LEVEL command. If the READ_POWER_LEVEL command has not been issued, the LPM shall use default values (see the Average current and Voltage fields in the GET_CONNECTOR_STATUS, Table 6-41Table 6-41).

It is the OPM's responsibility to trace the *Time to Read* and *Time Interval* fields (default or specified in the READ_POWER_LEVEL command).

The following is an example of the READ_POWER_LEVEL command:

Command: 0x1E

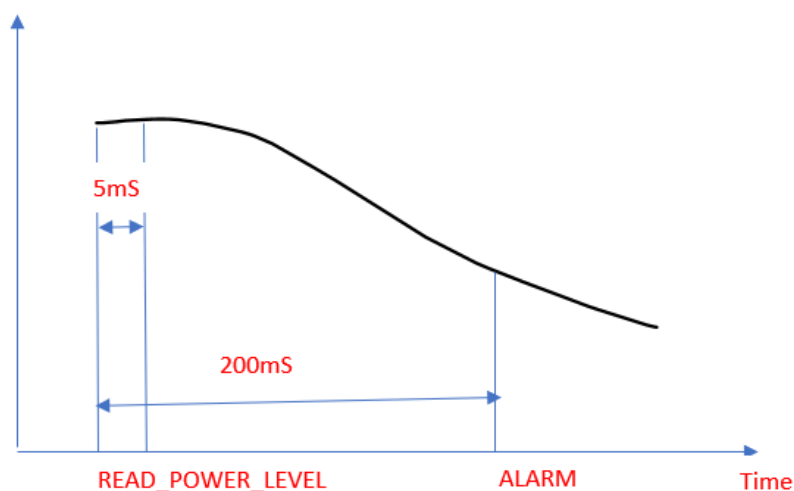
Data Length: 0x0

Connector Number: 0x1

Time To Read Power: 0x1 (200ms)

Time Interval between readings: 0x1 (5ms)

Figure 6-4 Power Reading Example



When LPM is ready to provide the data LPM sets the Connector Change Indicator, and the data shall be a part of the MESSEGE_IN of the GET_CONNECTOR_STATUS.

Table 6-85 READ_POWER_LEVEL Command

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>Command</u>	<u>8</u>	<u>This field shall be set to READ_POWER_LEVEL.</u>
<u>8</u>	<u>Data Length</u>	<u>8</u>	<u>Set to 0x00.</u>
<u>16</u>	<u>Connector Number</u>	<u>7</u>	<u>This field shall be set to the connector being queried.</u>
<u>23</u>	<u>Time to Read Power</u>	<u>5</u>	<u>This field shall be set to the time interval during which the measurement happens. 1 bit matches to 100ms.</u>

			<u>If the field is set to 0 – 100ms, 1 – 200ms, etc.</u>
<u>28</u>	<u>Reserved</u>	<u>3</u>	<u>Shall be set to zero.</u>
<u>31</u>	<u>Time Interval between readings</u>	<u>2</u>	<u>This field shall be set to the time interval between measurements. 1 bit matches to 5mS.</u>
<u>33</u>	<u>Reserved</u>	<u>31</u>	<u>Reserved and shall be set to zero.</u>

On successful completion of the command the PPM shall set the CCI Data Structure as described below.

Table 6-86. READ_POWER_LEVEL Status

<u>Offset (Bits)</u>	<u>Field</u>	<u>Size (Bits)</u>	<u>Description</u>
<u>0</u>	<u>Reserved</u>	<u>1</u>	<u>Reserved and shall be set to zero.</u>
<u>1</u>	<u>Connector Change Indicator</u>	<u>7</u>	<u>If an asynchronous event occurred on a connector, then the PPM shall set this field to the connector number on which the change occurred.</u>
<u>8</u>	<u>Data Length</u>	<u>8</u>	<u>Set to 0x00.</u>
<u>16</u>	<u>Reserved</u>	<u>7</u>	<u>Reserved and shall be set to zero.</u>
<u>23</u>	<u>Security Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>24</u>	<u>FW Update Request Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>25</u>	<u>Not Supported Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>26</u>	<u>Cancel Completed Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>27</u>	<u>Reset Completed Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>28</u>	<u>Busy Indicator</u>	<u>1</u>	<u>Set to 0b. If the PPM is Busy, then the PPM shall set this field to a 1b and all other fields to zero.</u>
<u>29</u>	<u>Acknowledge Command Indicator</u>	<u>1</u>	<u>Set to 0b.</u>
<u>30</u>	<u>Error Indicator</u>	<u>1</u>	<u>If the command was not successfully completed the PPM shall set this field to 1b.</u>
<u>31</u>	<u>Command Completed Indicator</u>	<u>1</u>	<u>Set this field to a 1b.</u>

See Appendix A.5 for the READ_POWER_LEVEL example.

6.6 Command Applicability

N – Normative: Shall be supported by OPM/PPM/LPM.

CN – Conditional Normative: Shall be supported by OPM/PPM/LPM based on the feature.

NA – Not applicable.

NS- Not Supported: Shall report in not supported message.

O – Optional; Optional is a keyword that describes features not mandated by this specification. However, if an optional feature is implemented, the feature shall be implemented as defined by this specification.

Table 6-87 Command Applicability Table

Control Command	OPM	PPM	LPM
<u>PPM RESET</u>	<u>CN¹</u>	<u>N</u>	<u>NS²</u>
<u>CANCEL</u>	<u>N</u>	<u>N</u>	<u>N</u>
<u>Connector Reset</u>	<u>N</u>	<u>NA</u>	<u>N</u>
<u>ACK CCI</u>	<u>N</u>	<u>N</u>	<u>CN³</u>
<u>Notification Enable</u>	<u>O</u>	<u>N</u>	<u>N</u>
<u>Get Capability</u>	<u>O</u>	<u>N</u>	<u>CN³</u>
<u>Get Connector Capability</u>	<u>N</u>	<u>NA</u>	<u>N</u>
<u>CC Operation Mode</u>	<u>O</u>	<u>O</u>	<u>CN⁵</u>
<u>Set USB Operation Mode</u>	<u>N</u>	<u>NA</u>	<u>N</u>
<u>Power Direction Role</u>	<u>N</u>	<u>NA</u>	<u>N</u>
<u>Get Alternate Modes</u>	<u>O</u>	<u>O</u>	<u>CN⁶</u>
<u>Get Connector Alternate Modes Supported</u>	<u>O</u>	<u>O</u>	<u>CN⁶</u>
<u>Get Current Connector Alternate Mode</u>	<u>O</u>	<u>O</u>	<u>CN⁶</u>
<u>Set New Connector Alternate Mode</u>	<u>O</u>	<u>NA</u>	<u>CN⁶</u>
<u>Set USB</u>	<u>O</u>	<u>CN⁴</u>	<u>CN¹⁰</u>
<u>Get PDOs</u>	<u>N</u>	<u>NA</u>	<u>N</u>
<u>Get Cable Property</u>	<u>O</u>	<u>O</u>	<u>N</u>
<u>Get Connector Status</u>	<u>N</u>	<u>N</u>	<u>N</u>
<u>Get Error Status</u>	<u>N</u>	<u>N</u>	<u>N</u>
<u>Set Power Level</u>	<u>N</u>	<u>N</u>	<u>N</u>
<u>Get PD Message</u>	<u>O</u>	<u>NA</u>	<u>CN⁹</u>
<u>Get Attention VDO</u>	<u>O</u>	<u>NA</u>	<u>CN⁹</u>
<u>Get Current Alternate Mode Configuration and Status</u>	<u>O</u>	<u>NA</u>	<u>CN⁶</u>
<u>LPM FW Update Request</u>	<u>O</u>	<u>NA</u>	<u>O</u>
<u>Security Request</u>	<u>O</u>	<u>NA</u>	<u>O</u>
<u>Set Retimer Mode</u>	<u>O</u>	<u>NA</u>	<u>O</u>
<u>Set Sink Path</u>	<u>N</u>	<u>NA</u>	<u>R</u>
<u>Chunking Support</u>	<u>N</u>	<u>NA</u>	<u>CN⁸</u>
<u>Set PDOs</u>	<u>N</u>	<u>NA</u>	<u>N</u>
<u>Vendor Defined Command</u>	<u>O</u>	<u>NA</u>	<u>O</u>
<u>Get LPM PPM Info</u>	<u>N</u>	<u>N</u>	<u>N</u>
<u>Read Power Level</u>	<u>N</u>	<u>NA</u>	<u>N</u>

Notes:

1 – Not applicable if system does not have PPM or PPM works in the pass-through mode.

2 – If the LPM controls two connectors and performs PPM role it shall still report as not supported.

Control Command	OPM	PPM	LPM
<u>3 - Applicable if the PPM is in pass through mode or in OPM-LPM configuration.</u> <u>5 - Supports only if the connector is DRP.</u> <u>6 - Shall support this command if the connector supports any Alternate modes.</u> <u>7 - Shall support if connector supports more than one Alternate mode.</u> <u>8 - Applicable if Message In and Message Out data structures supported by PPM/LPM are less than prescribed by Table 4-1Table 4-1.</u> <u>9 - If the port partner device is PD capable, and the command is supported.</u> <u>10 - If OPM supports this command and it supports USB3 and/or USB4 modes.</u>			

4-66.7 Optional Features

Features are groups of commands and/or notifications that the PPM/LPM may optionally support. The *bmOptionalFeatures* field in the GET_CAPABILITY Data indicates which optional features the PPM supports. This section lists the optional features, and the commands and/or notifications associated with each.

~~Table 4-65~~Table 6-88~~Table 6-88~~ describes each of the bits in the *bmOptionalFeatures* field in GET_CAPABILITY Data. Each bit corresponds to a Feature, which is described in a subsequent section.

Table 6-88: *bmOptionalFeatures* Field Description

Bit	Description
0	SET_CCOM supported
1	SET_POWER_LEVEL supported*
2	Alternate mode details supported
3	Alternate mode override supported
4	PDO details supported
5	Cable details supported
6	External supply notification supported
7	PD reset notification supported
8	GET_PD_MESSAGE supported
9	Get Attention VDO
10	FW Update Request
11	Negotiated Power Level Change
12	Security Request
13	Set Re-timer Mode
14	Chunking Support

* The field shall be set to always supported. It is needed for backward compatibility.

~~4-6-16.7.1~~ SET_CCOM Supported

This feature indicates that the PPM supports the SET_CCOM command.

If the SET_CCOM Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives a SET_CCOM command.

4.6.26.7.2 SET_POWER_LEVEL Supported

This command is required and shall be set to always supported.

4.6.36.7.3 Alternate Mode Details Supported

This feature indicates that the PPM can report details about supported alternate modes to the OPM. The following commands may be used by the OPM:

- GET_ALTERNATE_MODES
- GET_CAM_SUPPORTED
- GET_CURRENT_CAM

If the Alternate Mode Details Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives a GET_ALTERNATE_MODES, GET_CAM_SUPPORTED, or GET_CURRENT_CAM command.

The following notifications are also supported, and may be enabled by the OPM:

- Supported CAM Change

4.6.46.7.4 Alternate Mode Override Supported

This feature indicates that the PPM allows the OPM to change the currently negotiated alternate mode using the SET_NEW_CAM command.

If the Alternate Mode Override Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives SET_NEW_CAM command.

4.6.56.7.5 PDO Details Supported

This feature indicates that the PPM can report details of Power Delivery Power Data Objects to the OPM. The following commands may be used by the OPM:

- GET_PDOS

If the PDO Details Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives GET_PDOS command.

The following notifications are also supported, and may be enabled by the OPM:

- Negotiated Power Level Change
- Supported Provider Capabilities Change

The *Request Data Object* field in the GET_CONNECTOR_STATUS Data will be valid.

4.6.66.7.6 Cable Details Supported

This feature indicates that the PPM supports the GET_CABLE_PROPERTY command.

If the Cable Details Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives GET_CABLE_PROPERTY command.

4.6.76.7.7 External Supply Notification Supported

This feature indicates that the PPM supports the External Supply Change notification.

~~4.6.86.7.8~~ PD Reset Notification Supported

This feature indicates that the PPM supports the PD Reset notification.

~~4.6.96.7.9~~ GET_PD_MESSAGE Supported

This feature indicates that the **PPMLPM** supports the GET_PD_MESSAGE command.

If the GET_PD_MESSAGE Supported bit in the *bmOptionalFeatures* field is 0b, the **PPMLPM** shall set the Not Supported Indicator in the CCI Data Structure if it receives GET_PD_MESSAGE command.

~~4.6.106.7.10~~ Get Attention VDO Supported

This feature indicates that the **PPMLPM** supports GET_ATTENTION_VDO command.

If the GET_ATTENTION_VDO Supported bit in the *bmOptionalFeatures* field is 0b, the **PPMLPM** shall set the Not Supported Indicator in the CCI Data Structure if it receives GET_ATTENTION_VDO command.

~~4.6.116.7.11~~ FW_UPDATE_REQUEST Supported

This feature indicates that the PPM supports FW_UPDATE_REQUEST command.

If the FW_UPDATE_REQUEST Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives FW_UPDATE_REQUEST command.

~~4.6.126.7.12~~ Negotiated Power Level Changed Supported

This feature indicates that the PPM supports Power Level Notifications.

~~4.6.136.7.13~~ Security Request Supported

This feature indicates that the PPM supports SECURITY_REQUEST command.

If the SECURITY_REQUEST Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives SECURITY_REQUEST command.

~~4.6.146.7.14~~ Set Re-timer Mode Supported

This feature indicates that the PPM supports SET_RETIMER_MODE command.

If the SET_RETIMER_MODE Supported bit in the *bmOptionalFeatures* field is 0b, the PPM shall set the Not Supported Indicator in the CCI Data Structure if it receives SET_RETIMER_MODE command.

~~4.6.156.7.15~~ CHUNKING Supported

This feature indicates that the PPM supports the chunking of MESSAGE_IN and MESSAGE_OUT.

~~4.6.16 READ POWER LEVEL (R)~~

7 ~~This command is used by the OPM to read ports~~ Timing Requirements

For the successful completion of a command, the OPM, PPM, or LPM has to receive command and acknowledgement within the allocated time. This helps power management frameworks create robust policies with the proper error handling and recovery mechanisms.

Figure 7-1 Sequence Diagram with Timing

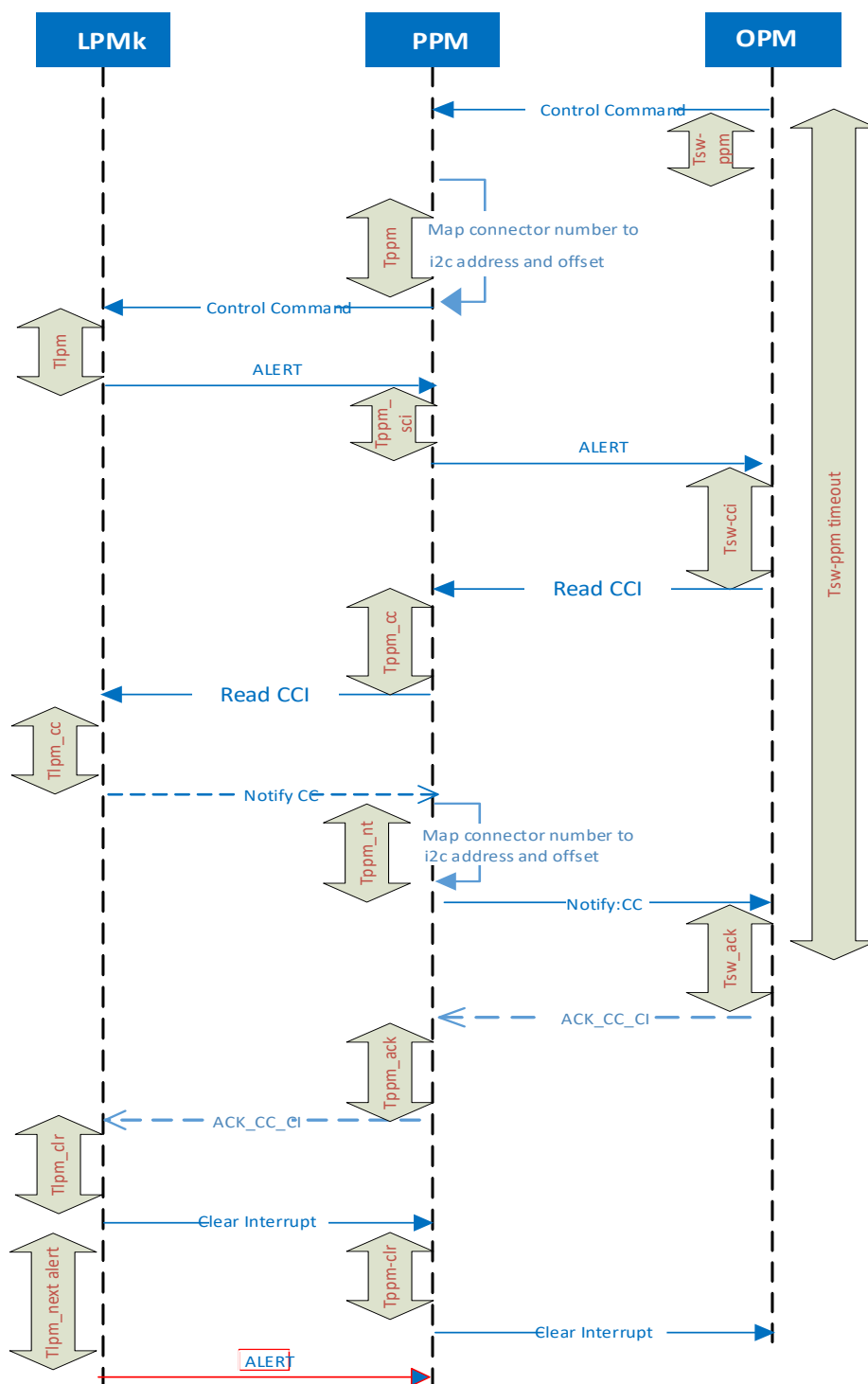


Table 7-1 Timing Requirements

<u>Time</u>	<u>Limits</u>	<u>Comment</u>
<u>Tsw_ppm</u>	<u>50mS</u>	<u>Time between OPM SW issuing a command and PPM FW receiving the last bit. Bus speed range is 20-66Mhz. Maximum data size to transfer is 255 bytes. (2048/20E6 = 102.4 uSec) + other OS related latencies.</u>
<u>Tppm</u>	<u>2mS</u>	<u>Time for FW ppm to process the command and send it to LPM. The bus speed is 400kHz (640uSec), PPM + other latencies.</u>
<u>Tlpm</u>	<u>Command dependent</u>	<u>Round time between LPM receives a command and sets alert response back*.</u>
<u>Tppm_sci</u>	<u>2mS</u>	<u>Time for ppm to assert alert/sci.</u>
<u>Tsw_cci</u>	<u>50mS</u>	<u>Time between SCI is asserted and for SW request CCI.</u>
<u>Tppm_cc</u>	<u>2mS</u>	<u>Time between PPM receives CCI request and forwards it to lpm.</u>
<u>Tlpm_cc</u>	<u>10mS</u>	<u>Time between LPM gets CCI request and sends to PPM CCI notification.</u>
<u>Tppm_nt</u>	<u>10mS</u>	<u>Time between PPM receives notification and sends it to OPM including 128 bytes of data.</u>
<u>Tsw_ack</u>	<u>50mS</u>	<u>Time between SW PPM gets command completion and sending acknowledgement back to PPM.</u>
<u>Tppm_ack</u>	<u>2mS</u>	<u>Time between PPM receives acknowledgement and forwards it to LPM.</u>
<u>Tlpm_clr</u>	<u>3mS</u>	<u>Time between LPM receives acknowledgment and clears alert.</u>
<u>Tppm_clr</u>	<u>2mS</u>	<u>Time between PPM gets alert cleared and clears SCI to OPM.</u>
<u>Tlpm_next alert</u>	<u>10mS</u>	<u>Allowed Time between the cleared alert and new one.</u>

*Depending on a command applicability this will be either ppm or lpm command timeout

Tlpm timeout varies with a type of command being issued. See Table 7-2

Table 7-2 Command Timeout

Command	Timeout max	Comment
<u>PPM RESET</u>	<u>200 ms</u>	<u>Sum of all latencies + ~10% overhead</u>
<u>GET CAPABILITY</u>	<u>200 ms</u>	
<u>SET NOTIFICATION</u>	<u>200 ms</u>	
<u>GET CONNECTOR CAPABILITY</u>	<u>200 ms</u>	
<u>CONNECTOR CAPABILITY</u>	<u>200 ms</u>	
<u>CONNECTOR RESET</u>	<u>1000 ms</u>	<u>It includes LPM Reset. The time specified here is for the Hard Reset. Data Reset is specified in the Connector Reset section</u>
<u>SET CCOM</u>	<u>200 ms</u>	
<u>SET USB Operation Role</u>	<u>400 ms</u>	
<u>SET POWER DIRECTTON ROLE</u>	<u>1000 ms</u>	<u>It involves negotiation with the port partner devices.</u>
<u>GET ALTERNATE MODES</u>	<u>200 ms</u>	
<u>GET CAM SUPPORTED</u>	<u>200 ms</u>	
<u>GET CURRENT CAM</u>	<u>200 ms</u>	
<u>GET PDOs</u>	<u>200 ms</u>	
<u>GET CABLE PROPERTIES</u>	<u>200 ms</u>	
<u>GET CONNECTOR STATUS</u>	<u>200 ms</u>	
<u>GET ERROR STATUS</u>	<u>200 ms</u>	
<u>SET POWER LEVEL</u>	<u>700 ms</u>	<u>require additional 300mS on the power contract re-negotiation with the port partner</u>
<u>SET NEW CAM</u>	<u>400 ms + 1000 ms</u>	<u>This command may require data reset</u>
<u>SET SINK PATH</u>	<u>400 ms</u>	
<u>SET USB</u>	<u>1000 ms</u>	
<u>LPM FW UPDATE REQUEST</u>	<u>400 ms + 2000 ms</u>	<u>400mS for the command itself and 2000mS for the 128-byte Message OUT potentially intended for the port partner device</u>
<u>SEQUIRITY REQUEST</u>	<u>400 ms + 2000 ms</u>	<u>400mS for the command itself and 2000mS for the 128-byte Message OUT potentially intended for the port partner device</u>
<u>SET RETIMER MODE</u>	<u>400 ms + 2000 ms</u>	<u>400mS for the command itself and 2000mS for the 128-byte Message OUT</u>
<u>SET PDOs</u>	<u>200ms</u>	
<u>GET PD MESSAGE</u>	<u>200ms</u>	
<u>GET ATTENTION VDO</u>	<u>200ms</u>	
<u>READ POWER LEVEL</u>	<u>200ms</u>	
<u>CHUNKING SUPPORT</u>	<u>200ms</u>	
<u>GET LPM PPM INFO</u>	<u>200ms</u>	

A PCIe Add-In-Card may have LPMs on it. Add-In-Cards could be connected and disconnected at any time. This nature of Add-In-Cards does not allow to pre-configure PPM or OPM I2C communication with LPM, for example. However, LPMs could be discovered by the PCIe driver if the Add-In-Card (AIC) exposes them with DVSEC that has the UCSI data structures registers as a part of the config space.

Figure 8-1 PCIe Extended Capability for UCSI on AIC

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Where:

- PCIe extended capability for UCSI on AIC is 0023h.
- **Length** is number of bytes of the entire DVSEC section for the UCSI section.
- **Topology** describes AIC's configuration and the way it communicates with OPM (see Table 8-1 Table 8-1).
- **Version** is the UCSI DVSEC version.
- **Resource** is LPMs bus address offset and way to alarm OPM (see Error! Reference source not found.).
- **UCSI Version – MSG OUT** UCSI data structures.
- **Virtual Alert** is the alert to OPM.

Table 8-1 AIC Topology

<u>Field</u>	<u>Bits</u>	<u>Value</u>	<u>Meaning</u>	<u>Comment</u>
<u>PM Topology</u>	<u>2:0</u>	<u>0</u>	<u>No LPM, PPM</u>	<u>AIC does not have PM capability.</u>
		<u>1</u>	<u>LPM</u>	<u>AIC does not have the PPM capability and will not be able to reply to commands intended for PPM, but has the LPM capability.</u>
		<u>2</u>	<u>AIC has PPM and LPM</u>	<u>AIC implemented both PPM and LPM and can process both type of commands.</u>
		<u>3</u>	<u>AIC has PM w/o external support</u>	<u>AIC has internal PM and does not require external PM support (OS driver).</u>
<u>LPM FW Update</u>	<u>3</u>	<u>0</u>	<u>No FW Update capability</u>	
		<u>1</u>	<u>Has FW Update Capability</u>	
<u>Repeaters</u>	<u>5:4</u>	<u>0</u>	<u>No repeaters</u>	
		<u>1</u>	<u>One or more</u>	<u>One or more repeaters per port w/o FW update capability.</u>
		<u>2</u>	<u>One repeater with FW update capability</u>	
		<u>3</u>	<u>Two repeaters with FW update capability</u>	
<u>AIC configuration</u>	<u>7:6</u>	<u>0</u>	<u>All commands to LPMs are sent directly over specific protocol</u>	<u>If, for example, I2C controller sits on the PCIe bus (see Figure 8-2Figure 8-2Error! Reference source not found.Error! Reference source not found.) and enables communication with PD controllers, the UCSI commands could be sent directly over I2C bus to the PD controllers without need to place commands to the CCL, Control, Mesg In/Out PCIe registers.</u>
		<u>1</u>	<u>All commands to LPMs are sent via MCU</u>	<u>To reach the LPMs, UCSI commands shall be placed to the CCL, Mesg In/Out, and Control PCIe registers, and then MCU would forward those commands to LPM.</u>
		<u>2</u>	<u>All TCPC commands are sent directly over I2C</u>	<u>If, for example, I2C controller sits on the PCIe bus (see Figure 8-2Figure 8-2Error! Reference source not found.Error! Reference source not found.) and enables communication with TCPC controllers, the TCPC commands could be sent directly over I2C bus to the TCPC controllers.</u>

		<u>3</u>	<u>Reserved</u>	
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Figure 8-2 Resource

(R)	Reserved	Protocol	00h
(R)	Address		04h
(R)	Offset		08h
(R)	Interrupt		0Ch

~~peak power and average power levels from the LPM that is in the sourcing mode. If the connector does not have an active connection or the LPM is in the sink mode, this command has no effect, and the PPM shall set the Error Information field to indicate Invalid Command Specific Parameters.~~

~~If the PPM receives a READ_POWER_LEVEL command while there is an active connection, the PPM shall notify the OPM that it has completed the command.~~

~~The alarm shall be raised and the CCI bit changed only when measurements are ready after the READ_POWER_LEVEL command is issued. No alarm shall be raised on the consecutive reads or upon device connection without the READ_POWER_LEVEL command. If the READ_POWER_LEVEL command has not been issued, the LPM shall use default values. (see Average current and Voltage fields in the GET_CONNECTOR_STATUS table)~~

~~It is the OPM responsibility to trace Time to Read and Time Interval fields (default or specified in the READ_POWER_LEVEL command)~~

~~Here is an example of the command:~~

~~Command: 0x1E~~

~~Data Length: 0x0~~

~~Connector Number: 0x1~~

~~Time To Read Power: 0x2 (200mS)~~

~~Time Interval between readings: 0x1 (5mS)~~

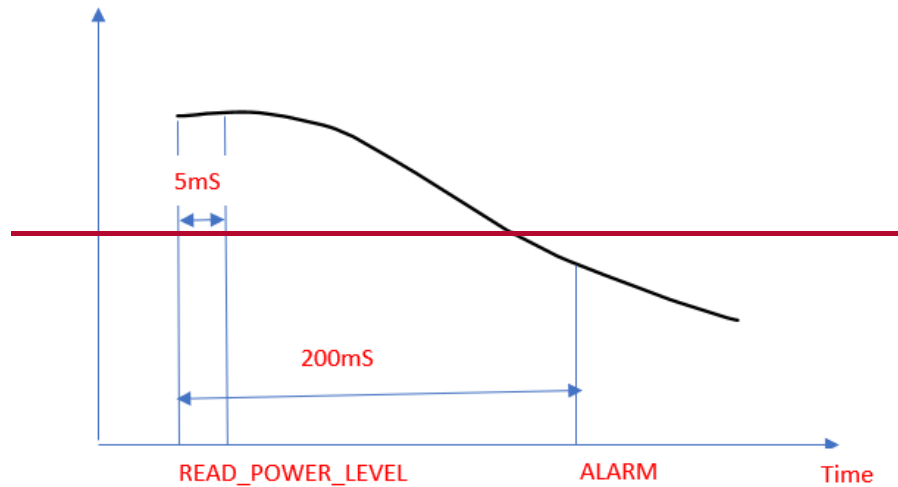


Figure 4 Power Reading example

~~When LPM is ready to provide the data LPM sets the Connector Change Indicator, and the data shall be a part of the MESSAGE_IN of the GET_CONNECTOR_STATUS.~~

Table 4-80 READ_POWER_LEVEL Command

Offset (Bits)	Field	Size (Bits)	Description
0	Command	8	This field shall be set to READ_POWER_LEVEL.
8	Data Length	8	Set to 0x00.
16	Connector Number	7	This field shall be set to the connector being queried.
23	Time to Read Power	5	This field shall be set to the time interval during which the measurement happens. 1 bit matches to 100mS. If the field is set to 0 — 100mS, 1 — 200mS, and etc.
28	Reserved	3	Shall be set to zero
34	Time Interval between readings	2	This field shall be set to the time interval between measurements. 1 bit matches to 5mS.
33	Reserved	34	Reserved and shall be set to zero.

~~On successful completion of the command the PPM shall set the CCI Data Structure as described below.~~

Table 4-81 READ_POWER_LEVEL Status

Offset (Bits)	Field	Size (Bits)	Description
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0	<i>Reserved</i>	1	Reserved and shall be set to zero.
4	<i>Connector Change Indicator</i>	7	If an asynchronous event occurred on a connector then the PPM shall set this field to the connector number on which the change occurred.
8	<i>Data Length</i>	8	Set to 0x00.
16	<i>Reserved</i>	7	Reserved and shall be set to zero.
23	<i>Security Request Indicator</i>	1	Set to 0b
24	<i>FW Update Request Indicator</i>	1	Set to 0b
25	Not Supported Indicator	1	Set to 0b.
26	Cancel Completed Indicator	1	Set to 0b.
27	Reset Completed Indicator	1	Set to 0b.
28	<i>Busy Indicator</i>	1	Set to 0b. If the PPM is Busy then the PPM shall set this field to a 1b and all other fields to zero.
29	Acknowledge Command Indicator	1	Set to 0b.
30	Error Indicator	1	If the command was not successfully completed the PPM shall set this field to 1b.
31	Command Completed Indicator	1	Set this field to a 1b.

~~See Appendix for the READ_POWER_LEVEL example.~~

A Values of Constants

A.1. Commands

Table A-1 Command Code

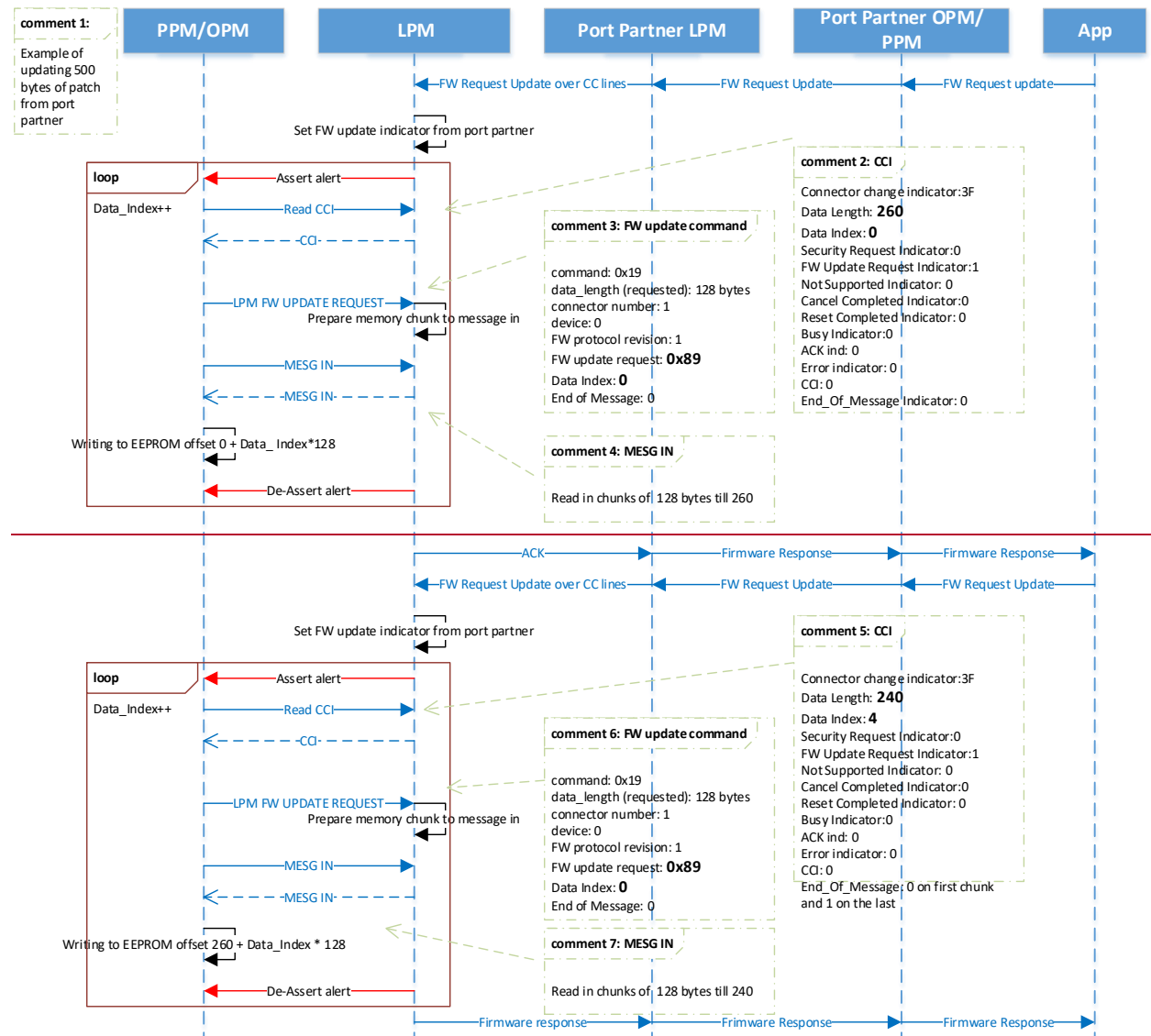
Command	Value
RESERVED	0x00
PPM_RESET	0x01
CANCEL	0x02
CONNECTOR_RESET	0x03
ACK_CC_CI	0x04
SET_NOTIFICATION_ENABLE	0x05
GET_CAPABILITY	0x06
GET_CONNECTOR_CAPABILITY	0x07
SET_CCOM	0x08
SET_UOR	0x09
SET_PDM (obsolete)	0x0A
SET_PDR	0x0B
GET_ALTERNATE_MODES	0x0C
GET_CAM_SUPPORTED	0x0D
GET_CURRENT_CAM	0x0E
SET_NEW_CAM	0x0F
GET_PDOS	0x10
GET_CABLE_PROPERTY	0x11
GET_CONNECTOR_STATUS	0x12
GET_ERROR_STATUS	0x13
SET_POWER_LEVEL	0x14
GET_PD_MESSAGE	0x15
GET_ATTENTION_VDO	0x16
Reserved	0x17
GET_CAM_CS	0x18
LPM_FW_UPDATE_REQUEST	0x19
SECURITY_REQUEST	0x1A
SET_RETIMER_MODE	0x1B
SET_SINK_PATH	0x1C
SET_PDOS	0x1D
READ_POWER_LEVEL	0x1E
CHUNKING_SUPPORT	0x1F
<u>VENDOR DEFINED COMMANDs</u>	<u>0x20</u>
<u>SET_USB</u>	<u>0x21</u>
<u>GET_LPM_PPM_INFO</u>	<u>0x22</u>

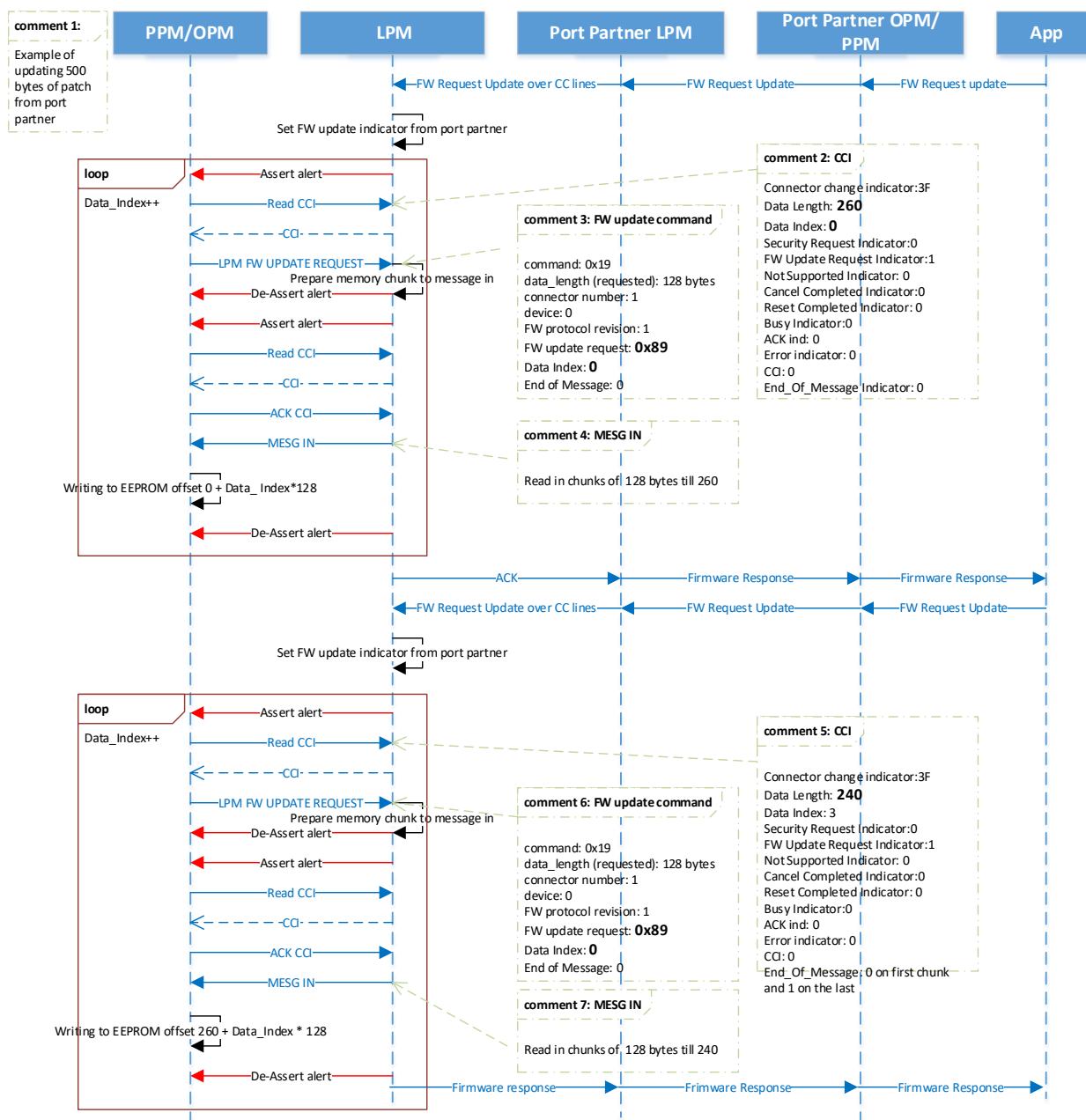
A.2. Parameter Values

Table A-2 Parameter Values

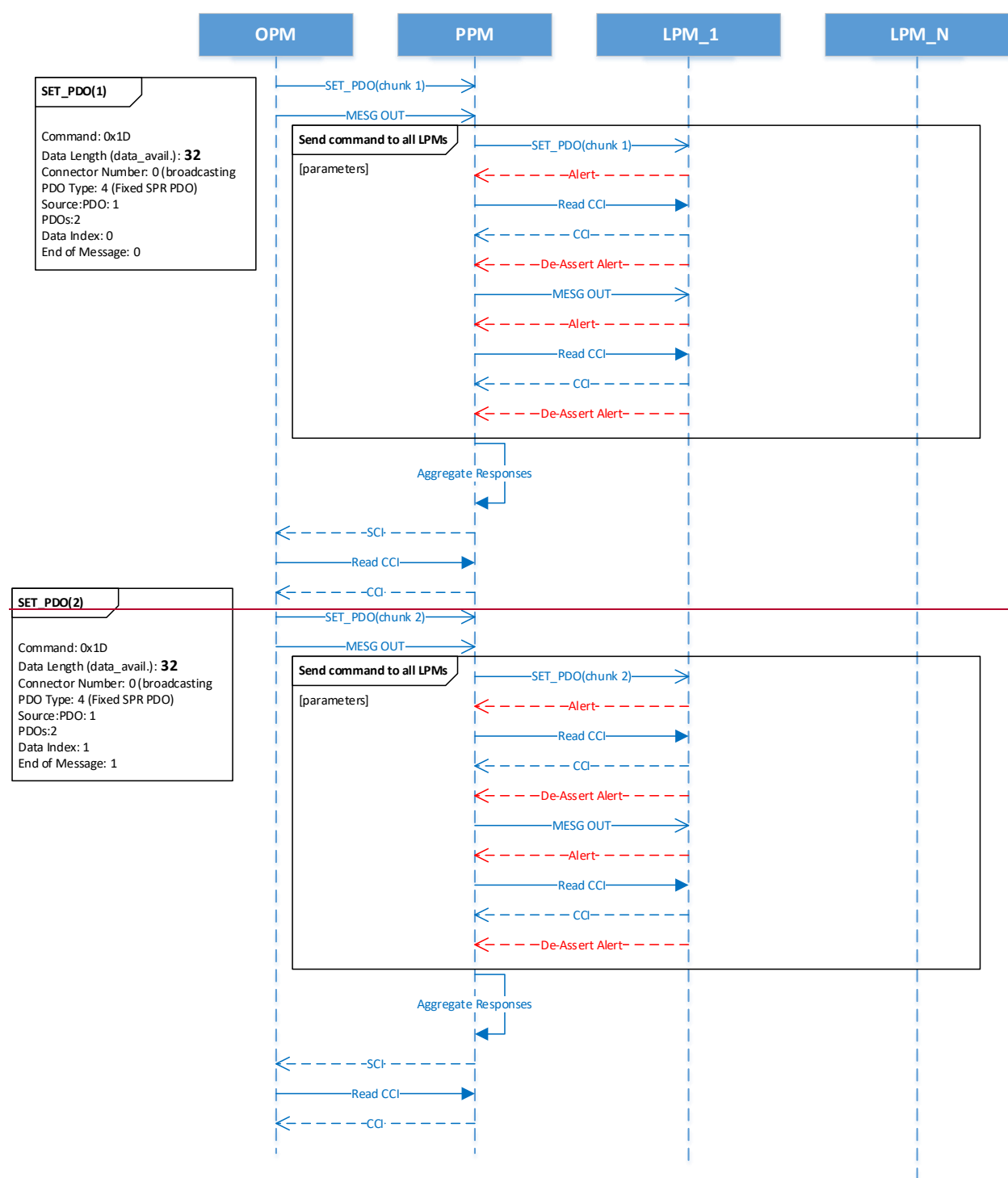
CONSTANT	Minimum Value	Maximum Value	Units
MAX_DATA_LENGTH	N/A	0xFF	bytes
MAX_NUM_ALT_MODE	N/A	0x80	
MIN_TIME_TO_RESPOND_WITH_BUSY	0x0A0xBE	N/A	ms
GET_ERROR_STATUS_DATA_LENGTH	N/A	0x10	bytes
LPM_BUSY_ATOMIC_TIME	0xF0	N/A	ms
<u>SENDER_RESPONSE_TIMEOUT</u>	<u>N/A</u>	<u>0x3C</u>	<u>ms</u>

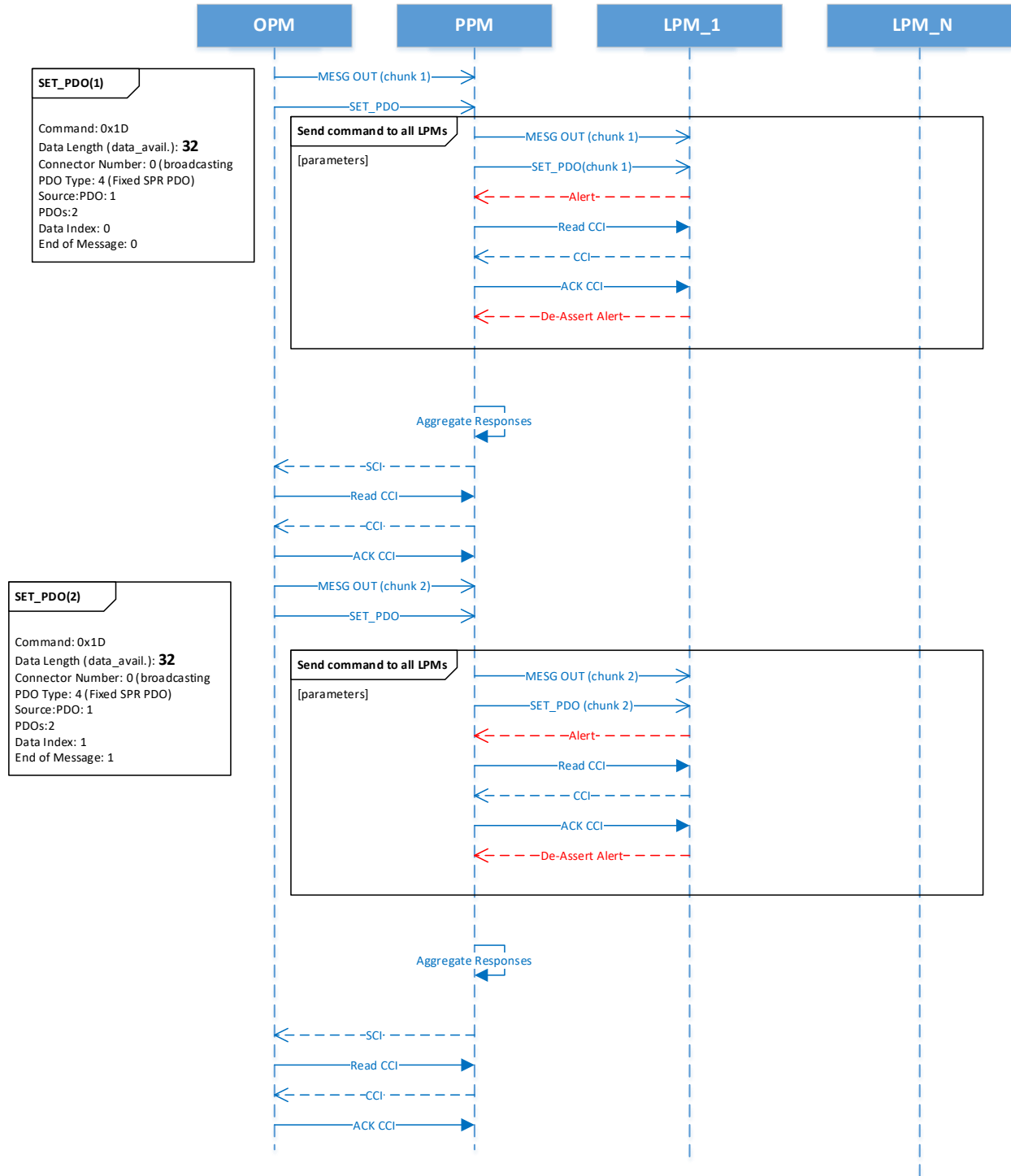
A.3. Example of LPM FW Update from the Port Partner



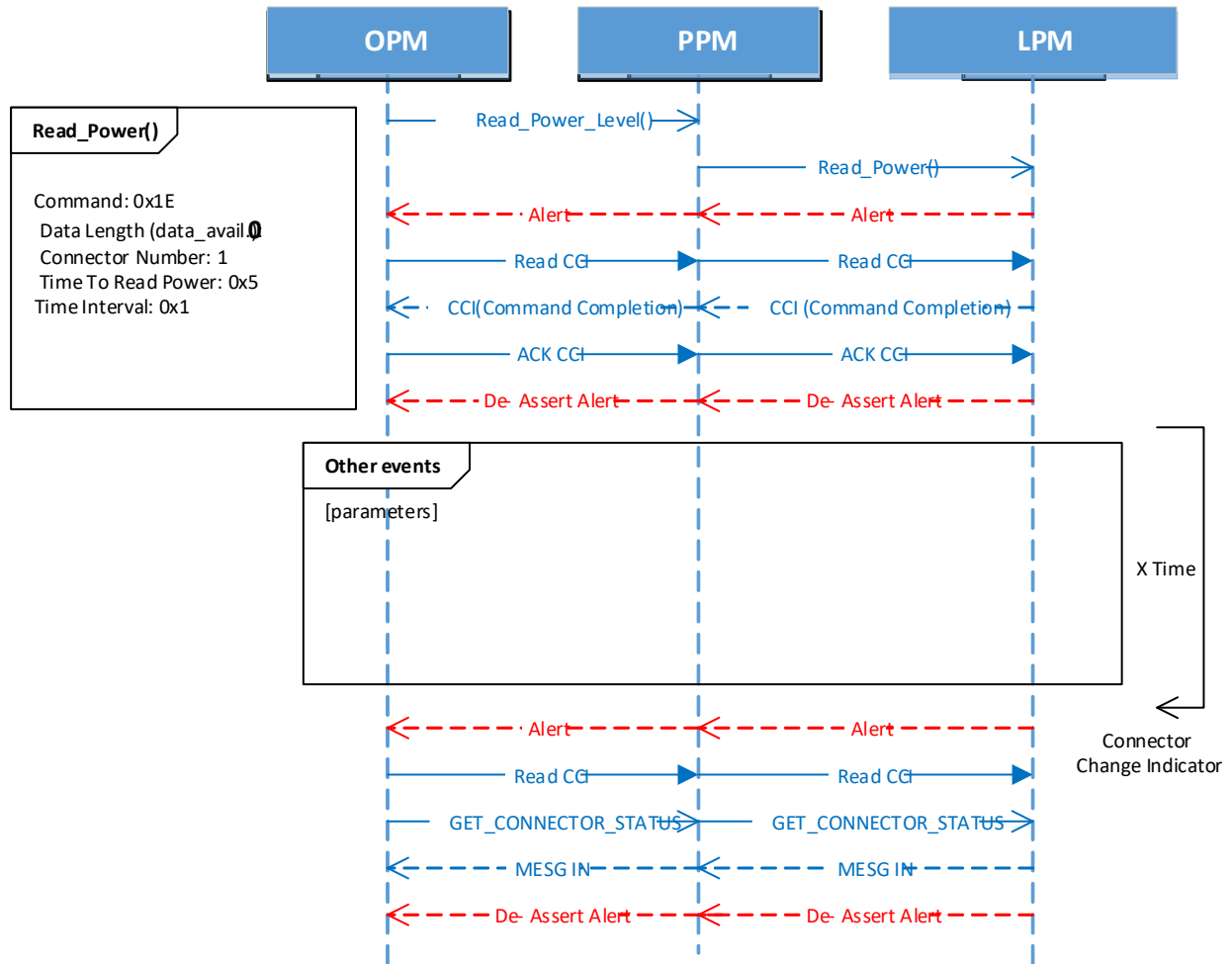


A.4. Example of Updating Fixed PDOs on Multiple LPMs at the Same Time

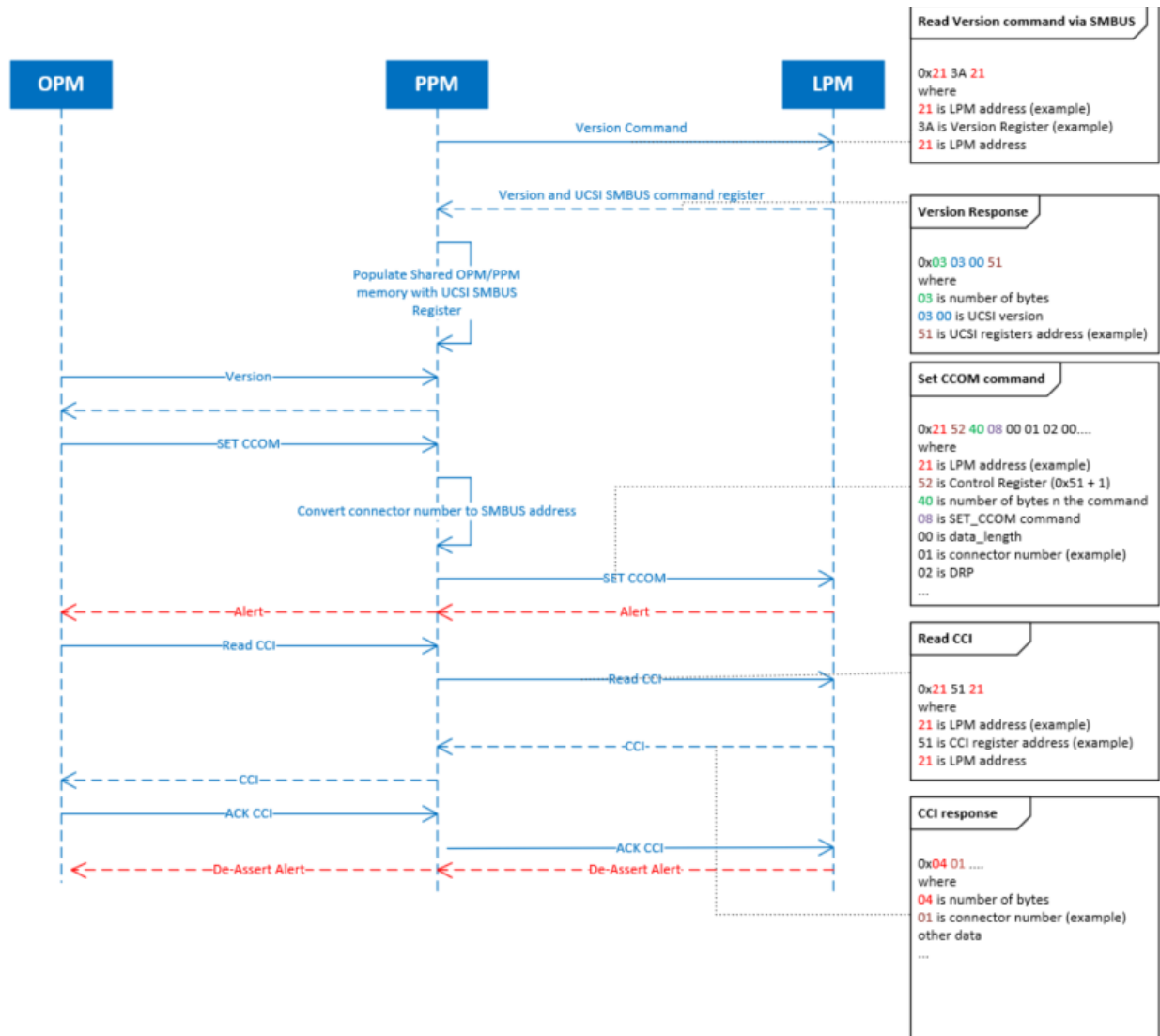




A.5. Example of the Reading Power Level Command



A.6. PPM-LPM Command Structure Example



A.7. Examples of OPM Controlling USB4/Alternate Mode Entry

