Universal Serial Bus Device Class Definition for Billboard Devices

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1 Introduction

1.1 Scope

The USB Billboard Device Class definition describes the methods used to communicate the ~~Alternate Modes~~AUM supported by a Device Container to a host system. This includes string descriptors that can be used to provide support details in a human-readable format.

This specification does not describe the functionality/methodology by which the Device Container shall switch to an ~~Alternate Mode~~AUM. An example of a Device Container that shall support this class is one that supports PCIe over the USB Type-C connector.

1.2 Purpose

The purpose of this document is to describe the minimum capabilities and characteristics a Billboard Device shall support to be compliant.

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: http://www.usb.org/developers/docs).
- [USB3.2~~1~~] – Universal Serial Bus 3.2~~1~~ Specification, Revision 1.0, (including errata and ECNs through ~~March 1, 2016~~July 16, 2020) (referred to in this document as the USB 3.2~~1~~ Specification) (available at: http://www.usb.org/developers/docs.)
- [USBPD] – Universal Serial Bus Power Delivery Specification, Revision 3.0 February 07, 2020~~2.0, March 25, 2016~~ (referred to in this document as the USB PD Specification) (available at: http://www.usb.org/developers/docs.)
- [USBTYPEC] – Universal Serial Bus Universal Serial Bus Type-C Cable and Connector Specification, Revision 2.0 September 14, 2020~~1.2, March 25, 2016~~ (referred to in this document as the USB Type-C Specification) (available at: http://www.usb.org/developers/docs.)
- [USB4] – Universal Serial Bus 4 Specification, Revision 1.0, (including Errata and ECN through October 15, 2020) (referred to in this document as the USB4 Specification) (available at: http://www.usb.org/developers/docs.)

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]~~[USB3.1]~~, Section 1.5 in [USBTYPEC] and Section 1.6 in [USBPD].

Table 1-1: Terms and Abbreviations

Term	Description
Alternate Mode	Alternate data protocols supported on USB Type-C port, other than USB protocol and prior to USB4.
AUM	Alternate Mode or USB4 Mode. *Note: This term is added for readability to represent either or both Alternate & USB4 Modes.*
Billboard Device	Either a standalone USB device that adheres to this class specification or a Device Container that exposes other USB functionality but includes the Billboard Descriptors as part of its complete BOS descriptor

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Term	Description
Device Container	A group of one or more USB functions originated from the same physical device
USB4 Mode	Operation defined by the [USB4] that is associated with a SVID assigned by the USB-IF. Entry and exit into and from an USB4 Mode is as defined in [USBPD].

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 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 May

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

1.5.2.3 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 Normative

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

1.5.2.5 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 (optional normative).

1.5.2.6 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 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 Should

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

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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.

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2 Management Overview

The USB framework is well suited for describing a product and the intent of this specification is to describe ~~what Alternate modes~~the AUM supported by ~~that~~ this Device Container~~ supports~~. All Device Containers that support ~~Alternate Modes~~AUM shall also support USB 2.0 at a minimum.

USB has become a ubiquitous connector on modern PC's and mobile devices and is well understood by most consumers today. ~~This class ensures that Device Containers that support Alternate Modes that are connected to a host that doesn't support one or more of the Alternate Modes has an easy route by which the host can report the same to the user without any silent failures.~~ This class ensures that if a Host does not support one or more AUM that are supported by a connected Device Container, then this is reported to the user and does not lead to silent failures.

It is recommended to return strings that describe the Device Container and the ~~Alternate Modes~~AUM it supports. ~~, however, it is optional and t~~The choice of language~~s~~ for these strings is left ~~up~~ to the implementer of the Device Container. ~~implementer.~~

2.1 USB Operating Speed

All Device Containers that support this class shall ~~only~~ operate at USB 2.0 unless the Device Container already supports some form of USB functionality.

If the Device Container includes a USB hub, then that Device Container shall expose the Billboard Device as a USB device attached to a downstream port operating at USB 2.0 speeds (real or virtual) of the hub in that Device Container.

If the Device Container does not include a USB hub but includes some other form of USB functionality, then that Device Container shall ~~only~~ be required to add the descriptors and optional strings defined in Section 3.1.6 to its existing set of descriptors.

If the Device Container does not include a USB hub or any other form of USB functionality, then the Device Container shall be required to expose the Billboard Device as a USB device.

If the Device Container ~~includes only~~ is limited to a Billboard device with ~~only~~ a Billboard interface, the Device Container shall include all descriptors from Section 3.1.

2.2 Billboard Device Connection Process

1. The Billboard capability shall ~~only~~ be exposed after ~~Alternate Mode~~ AUM negotiations are completed or after tAMEtimeout/tUSB4Timeout (as defined in Table 5.3.~~2~~ of [USBTYPEC]) whichever is earlier.

2. If the Port Pair successfully enters into Modal Operation or USB4 operation (as defined by [USBPD]) then the Device Container is not required to expose the Billboard Device. ~~It may still expose the Billboard Device if it wants to for informational purposes only.~~ Device Container may expose the Billboard Device for informational purposes.

    a. If the Port Pair successfully enters into Modal Operation or USB4 operation, and it wants to expose the Billboard Device, the **bmConfigured** field shall be set to 11b.

    b. The Billboard Device shall set the **bmConfigured** field to 11b upon any failure that occurs while in an ~~Alternate Mode~~AUM.

3. If the Port Pair does not enter into Modal Operation or USB4 operation, then the Device Container shall expose the Billboard Device.

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a. Upon failure to enter the ~~Alternate Mode~~AUM within tAMEtimeout/tUSB4Timeout due to no [USBPD] communication, the Billboard Device shall set the **bmConfigured** field to 01b and the **bAdditionalFailureInfo.bit1** to 1b.

b. Upon failure to enter the ~~Alternate Mode~~ AUM within tAMEtimeout/tUSB4Timeout due to insufficient power, the Billboard Device shall set the **bmConfigured** field to 01b and the **bAdditionalFailureInfo.bit0** to 1b.

c. Upon failure to enter the ~~Alternate Mode~~ AUM within tAMEtimeout/ tUSB4Timeout due to [USBPD] ~~Alternate Mode~~ AUM negotiation failure, the Billboard Device should set the **bmConfigured** field to 10b.

4. If the Device Container uses a static ~~list of device~~ Billboard ~~c~~Capability~~ies~~ Descriptor, then it shall ~~only~~ expose the Billboard Device on failure to enter into Modal Operation or USB4 operation and shall set the **bmConfigured** field to "Unspecified Error" (00b).

5. If the Port Pair enters into Modal Operation but the Device Container detects a subsequent error while operating in that Mode, that would cause a silent failure then the Device Container shall:

   a. If the Device Container already exposed a Billboard Device then it shall disconnect the Billboard Device from USB, update the **bmConfigured** field and expose the Billboard Device.

   b. If the Device Container had not previously exposed a Billboard Device, then it shall expose the Billboard Device with the updated **bmConfigured** field.

   c. If [USBPD] communication has failed, the Billboard Device shall set the **bmConfigured** field to 11b and the **bAdditionalFailureInfo.bit1** field to 1b.

   d. If the failure has occurred due to lack of sufficient power while in the ~~Alternate Mode~~ AUM, the Billboard Device should set the **bmConfigured** field to 11b and the **bAdditionalFailureInfo.bit0** to 1b. This failure can occur at any time while in an Alternate Mode. Following are ~~P~~possible scenarios where this ~~might~~ may occur: ~~are as follows:~~

      - ~~t~~The AMA requires more power and attempts to negotiate this via [USBPD] but this fails.
      - ~~, t~~The power contract has been negotiated via [USBPD] with mismatch and the AMA can't fully function.
      - ~~, t~~The power cord ~~being~~ is unplugged from the wall socket.

6. If the Port Pair exits Modal Operation or a Data Reset occurs due to a fault condition, the Device Container shall expose the Billboard Device

   a. If the Device Container already exposed a Billboard Device then it shall disconnect the Billboard Device from USB, update the **bmConfigured** field and expose the Billboard Device.

   b. If the Device Container had not previously exposed a Billboard Device, then it shall expose the Billboard Device with the updated **bmConfigured** field.

   c. Fault conditions, which cause an exit of the ~~Alternate Mode~~ AUM, shall set the **bmConfigured** field to 01b.

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d. If [USBPD] communication caused exiting the ~~Alternate Mode~~ AUM, the Billboard Device should set the **bAdditionalFailureInfo.bit1** field to 1b.

If the device supports USB functionality, this re-connection process can cause disruption with the already exposed USB function. If that disruption is not acceptable from user scenario point of view, the device container shall expose the Billboard Device as a standalone USB function.

If a Port Pair determines that it needs to change the ~~Alternate Mode~~ AUM it is operating at, the Device Container shall disconnect over USB and go back to Step 1.

Note:~~-~~ ~~that i~~It may take additional time to negotiate a USB PD Explicit Contract between a Port Pair and hence this may lead to a significant delay in the enumeration of the Billboard Device.

2.3 Non user-facing Modes

A Device Container may support non user-facing Modes (e.g. diagnostic modes). When Modal Operation or USB4 operation fails for a non-user-facing Mode, the Device Container should not expose a Billboard Device, and, if it does, it should not report the failure in the **bmConfigured** field.

2.4 Support for Multiple Modes

If the Device Container supports multiple modes, and Modal Configuration for all modes fails, then the Device Container ~~is required to~~ shall expose a Billboard Device. ~~If one or more Modal Configurations succeeds, then it is optional as to whether the Device Container exposes a Billboard Device~~. Additionally, if a Device Container supports USB4 and other Alternate Modes, and if one or more Alternate Modes succeed, but the device falls back from USB4 to USB3.2 or USB2.0 the Device Container shall expose Billboard Device. A Device Container that exposes a Billboard Device, ~~If it does, then it~~ shall ensure that the **bmConfigured** field is set appropriately for all user-facing Modes. Refer Section 5.2.2 of [USBTYPEC] for USB4 functional requirements related to Billboard Device.

2.5 Use of URLs

The URL given by **iAdditionalInfoURL** in the Billboard Capability Descriptor (offset 3) is intended to be the URL of a web page providing descriptive useful information concerning the device and all the user-facing ~~Alternate Modes~~ AUM that it supports. This information is not intended specifically to provide help when an ~~Alternate Mode~~ AUM Configuration fails.

~~**iAlternateModeString[n]** for a specific Alternate Mode for a specific SVID is intended, as well as describing the protocol, to contain a URL of a web page providing "help" information to be displayed by the Host when entry to the Alternate Mode fails. An example string is DisplayPort to VGA adapter. For further assistance, see http://help.vesa.org/dp-usb-type-c/.~~ iAlternateOrUSB4ModeString[n] for a specific AUM of a specific SVID is intended to describe the protocol and provide a URL of a web page providing "help" information to be displayed by the Host when entry to the AUM fails. An example string is DisplayPort to VGA adapter: "For further assistance, see http://help.vesa.org/dp-usb-type-c/".

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3 Billboard Descriptors

The Billboard Descriptors are used to advertise the Alternate Modes and/or USB4 operation a Device Container supports through a BOS descriptor capability.

3.1 Standard Descriptors

A standalone Billboard Device is always defined at the device level and does not support any other endpoints apart from the default control endpoint. Therefore, it only supports the standard Device, Device Qualifier (only if it is a High-speed device), BOS, Configuration and Other_Speed_Configuration (only if it is a High-speed device) descriptors. And it uses standard USB mechanisms to return the descriptors.

The subsequent sections define the Device, Device Qualifier and Configuration descriptors a standalone Billboard Device shall return.

Note: ~~a~~A- Device Container that supports Alternate Modes and/or USB4 operation and one or more other USB Device functions (apart from a Device Container that exposes a USB hub) only needs to add the Container ID and Billboard Descriptor capability to the list of capabilities it returns when queried for its BOS descriptor.

For a detailed description of the various fields in the tables in the following sections please refer to the definitions in [USB2.0] and [USB3.2].

3.1.1 Device Descriptor

Table 3-1: Device Descriptor

Offset	Field	Bytes	Value	Description
0	**bLength**	1	Number	Size of this Descriptor in bytes: 18.
1	**bDescriptorType**	1	Constant	DEVICE Descriptor Type.
2	**bcdUSB**	2	BCD	0x201H (minimum)
4	**bDeviceClass**	1	Class	BILLBOARD_CLASS. See Appendix
5	**bDeviceSubClass**	1	SubClass	BILLBOARD_SUBCLASS. See Appendix
6	**bDeviceProtocol**	1	Protocol	BILLBOARD_PROTOCOL. See Appendix
7	**bMaxPacketSize0**	1	Number	Maximum packet size for endpoint zero. (Only 8, 16, 32, or 64 are valid)
8	**idVendor**	2	ID	Vendor ID
10	**idProduct**	2	ID	Product ID
12	**bcdDevice**	2	BCD	Device release number in binary-coded decimal
14	**iManufacturer**	1	Index	Index of string descriptor describing manufacturer
15	**iProduct**	1	Index	Index of string descriptor describing product
16	**iSerialNumber**	1	Index	Index of string descriptor describing the device's serial number
17	**bNumConfigurations**	1	Number	1

3.1.2 Device Qualifier Descriptor (if the device is a High-speed device)

Table 3-2: Device Qualifier Descriptor

Offset	Field	Bytes	Value	Description
0	**bLength**	1	Number	Size of this Descriptor in bytes: 10.
1	**bDescriptorType**	1	Constant	DEVICE_QUALIFIER Descriptor Type.
2	**bcdUSB**	2	BCD	0x201H (minimum)
4	**bDeviceClass**	1	Class	BILLBOARD_CLASS. See Appendix
5	**bDeviceSubClass**	1	SubClass	BILLBOARD_SUBCLASS. See Appendix
6	**bDeviceProtocol**	1	Protocol	BILLBOARD_PROTOCOL. See Appendix

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Offset	Field	Bytes	Value	Description
7	**bMaxPacketSize0**	1	Number	Maximum packet size for endpoint zero for other speed.
8	**bNumConfigurations**	1	Number	1 (Number of Other-speed Configurations)
9	**bReserved**	1	Zero	Reserved for future use, shall be set to zero

3.1.3 Configuration Descriptor

Table 3-3: Configuration Descriptor

Offset	Field	Bytes	Value	Description
0	**bLength**	1	Number	Size of this Descriptor in bytes: 9.
1	**bDescriptorType**	1	Constant	CONFIGURATION Descriptor Type
2	**wTotalLength**	2	Number	Total length of data returned for this configuration.
4	**bNumInterfaces**	1	Number	1.
5	**bConfigurationValue**	1	Number	Values to use to select this configuration
6	**iConfiguration**	1	Index	Index of string descriptor describing this configuration
7	**bmAttributes**	1	Bitmap	Shall report whether the Device Container is Self-powered or not.
8	**bMaxPower**	1	mA	Maximum power consumption of this Device Container from VBUS.

3.1.4 Other_Speed_Configuration Descriptor (if the device is a High-speed device)

Table 3-4: Other_Speed_Configuration Descriptor

Offset	Field	Bytes	Value	Description
0	**bLength**	1	Number	Size of this Descriptor in bytes: 9.
1	**bDescriptorType**	1	Constant	OTHER_SPEED_CONFIGURATION Descriptor Type
2	**wTotalLength**	2	Number	Total length of data returned.
4	**bNumInterfaces**	1	Number	1.
5	**bConfigurationValue**	1	Number	Values to use to select this configuration
6	**iConfiguration**	1	Index	Index of string descriptor describing this configuration
7	**bmAttributes**	1	Bitmap	Same as Configuration descriptor.
8	**bMaxPower**	1	mA	Same as Configuration descriptor.

3.1.5 Interface Descriptor

Table 3-5: Interface Descriptor

Offset	Field	Bytes	Value	Description
0	**bLength**	1	Number	Size of this descriptor in bytes: 9
1	**bDescriptorType**	1	Constant	INTERFACE Descriptor Type
2	**bInterfaceNumber**	1	Number	0
3	**bAlternateSetting**	1	Number	0
4	**bNumEndpoints**	1	Number	0
5	**bInterfaceClass**	1	Class	BILLBOARD_CLASS. See Appendix
6	**bInterfaceSubClass**	1	SubClass	BILLBOARD_SUBCLASS. See Appendix
7	**bInterfaceProtocol**	1	Protocol	BILLBOARD_PROTOCOL. See Appendix
8	**iInterface**	1	Index	Index of string descriptor describing this interface

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3.1.6 BOS Descriptor

Table 3-6: BOS Descriptor

Offset	Field	Bytes	Value	Description
0	bLength	1	Number	Size of descriptor:5
1	bDescriptorType	1	Constant	BOS Descriptor type
2	wTotalLength	2	Number	Length of this descriptor and all of its sub descriptors
4	bNumDeviceCaps	1	Number	The number of separate device capability descriptors in the BOS At a minimum, the device shall have to return the Billboard Capability and Container ID descriptors as part of its BOS descriptor.

3.1.6.1 Container ID

A Billboard Device shall implement a Container ID capability as defined in [USB3.2]. This capability must be returned by Billboard Devices operating at USB 2.0 speeds as well. The value in the **ContainerID** field may be used by software to uniquely identify the components of the Device Container when it is connected to the system.

3.1.6.2 Billboard Capability Descriptor

This descriptor lists the ~~Alternate Modes~~ AUM the Device Container supports and optional string for each ~~Alternate Mode~~ AUM supported. This descriptor is returned as part of the Device Container's BOS Descriptor set.

Table 3-7: Billboard Capability Descriptor

Offset	Field	~~Size~~Bytes	Value	Description
0	**bLength**	1	Number	Size of this Descriptor in bytes.
1	**bDescriptorType**	1	Constant	Descriptor type: DEVICE CAPABILITY Type.
2	**bDevCapabilityType**	1	Number	BILLBOARD CAPABILITY
3	**iAddtionalInfoURL**	1	Index	Index of string descriptor providing a URL where the user can go to get more detailed information about the product and the various AUM ~~Alternate Modes~~ it supports.
4	**bNumberOfAlternateOrUSB4 Modes**	1	Number	Number of ~~Alternate modes~~ AUM supported. The maximum value that this field can be set to is MAX_NUM_ALT_OR_USB4_MODE.
5	**bPreferredAlternate OrUSB4Mode**	1	Number	Index of the preferred ~~Alternate Mode~~ AUM. If USB4 mode is supported, it shall be the preferred mode and this field shall be set to 0x0 (for version 1.2.2 of this specification). This field shall be set to 0xFF to indicate no preference. System software may use this information to provide the user with a better user experience.

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Offset	Field	~~Size~~Bytes	Value	Description
6	**VCONN Power**	2	Bitmap	**Bit** / **Description** 2..0 — V_{CONN} Power needed by the adapter for full functionality 000b = 1W 001b = 1.5W 010b = 2W 011b = 3W 100b = 4W 101b = 5W 110b = 6W 111b = reserved 14..3 — Reserved for future use, shall be set to zero. 15 — The adapter does not require any V_{CONN} Power. The value in Bits 2..0 are ignored when this bit is set.
8	**bmConfigured**	32	Bitmap	Each bit pair in this field indicates the state of the Alternate Modes identified by the combination of **wSVID[i]** and **bAlternateOrUSB4Mode[i]**. A Device Container may support a maximum of MAX_NUM_ALT_OR_USB4_MODE ~~Alternate Modes~~AUM. System software will determine what to display, if anything, based on the value of the bits in this field. **Value** / **Description** 00b — Unspecified Error 01b — ~~Alternate Mode~~ AUM configuration not attempted or exited 10b — ~~Alternate Mode~~ AUM configuration attempted but unsuccessful and not entered 11b — ~~Alternate Mode~~ AUM configuration successful This bitmap corresponds to the ~~Alternate Mode~~AUM as follows: Bit 0: First ~~Alternate Mode~~ AUM defined (at Offset 44) Bit 2: Second AUM ~~Alternate Mode~~ defined (at Offset 48) .... Bit (n-1) * 2: Nth AUM ~~Alternate Mode~~ defined
40	**bcdVersion**	2	BCD	Billboard Capability version number in Binary-Coded Decimal (e.g., 1.10 is 0x0110H). This field identifies the release of the Billboard Specification with which the Billboard descriptors are compliant. All Device Containers compliant to this version of the specification shall set the value to 0x012~~1~~2H. A value of 0x0000H indicates that the device was built to the first version of this specification. A value of 0x0120H in this field is reserved.

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Offset	Field	~~Size~~Bytes	Value	Description
42	**bAdditionalFailureInfo**	1	Bitmap	**Bit** / **Description** 0: If this field is set to one then the Device Container failed due to lack of power. 1: If this field is set to one then the Device Container failed due to no USB-PD communication. This field is only valid if **bmConfigured** field for the preferred ~~Alternate mode~~AUM is not set to 11b. 7..2: Reserved for future use, shall be set to zero. This field is only valid if the **bcdVersion** field is set to 0x0110h or higher.
43	**bReserved**	1	Zero	Reserved for future use, shall be set to zero
44	**wSVID[0]**	2	Number	Standard or Vendor ID. This shall match one of the SVIDs returned in response to a USB PD Discover SVIDs command. 0xFF00 shall be used as the SVID for USB4 devices and used in wSVID[0] location when the USB PD Discover Identity response includes USB4 Device Capable in UFP VDO1.
46	**bAlternate~~Alternate~~OrUSB4Mode[0]**	1	Number	Index of the ~~Alternate Mode~~AUM within the SVID as returned in response to a Discover Modes command. Example: 0 – first Mode entry, 1 – second mode entry. With respect to USB4 when wSVID[0] is set to 0xFF00, this field shall be set as 0x00 allowing for new revisions to be set from 0x01 to 0xFF.
47	**iAlternate ~~Alternate~~OrUSB4ModeString[0]**	1	Index	Index of string descriptor describing protocol. It is optional to support this string.
…	…	…	…	…
44+ (n * 4)	**wSVID[n]**	2	Number	Standard or Vendor ID. This shall match one of the SVIDs returned in response to a USB PD Discover SVIDs command. If there is more than one ~~Alternate Mode~~AUM in the same SVID, the wSVID[n] should be repeated for each ~~Alternate Mode~~AUM.
46 + (n * 4)	**bAlternate~~Alternate~~OrUSB4Mode[n]**	1	Number	Index of the ~~Alternate Mode~~AUM within the SVID as returned in response to a Discover Modes command
47 + (n * 4)	**iAlternate ~~Alternate~~OrUSB4ModeString[n]**	1	Index	Index of string descriptor describing protocol. It is optional to support this string.

3.1.6.2.1 Example usage of wSVID[n], bAlternate~~Alternate~~OrUSB4Mode[n], iAlternate~~Alternate~~OrUSB4ModeString[n]:

In this example, the USB PD Discover SVIDs Command returns the USB PD SID 0xFF00, Intel VID 0x8087 and the DP_SID 0xFF01.

USB4 Mode is returned for the USB PD SID 0xFF00. bAlternateOrUSB4Mode[0] contains USB4 Mode. Details on the interpretation of the Enter USB Data Object for USB4 entry are available in the USB PD Specification.

The~~T~~ other two Alternate Modes are returned for the Intel VID 0x8087. bAlternateOrUSB4Mode[1~~0~~] contains Mode 1 (~~Fictional Application~~Thunderbolt 3) and bAlternateOrUSB4Mode[2~~1~~] contains Mode 2 (Fictional Debug). These are Intel Corporation proprietary Alternate Modes.

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One Alternate Mode is returned for the DP_SID 0xFF01. bAlternateOrUSB4Mode[32] contains Mode 1 for the DisplayPort SID. Details on interpretation of the Mode VDO response are available in the VESA DisplayPort Alt Mode on USB Type-C Standard.

Table 3-8 Example Values for wSVID, bAlternateOrUSB4Mode, iAlternateOrUSB4ModeString

wSVID[0]	0xFF00	USB PD SID
bAlternateOrUSB4Mode[0]	0x00	USB4 Mode
iAlternateOrUSB4ModeString[0]	0x10	Index to a string describing USB4 Mode operation
wSVID[10]	0x8087	Intel VID
bAlternateOrUSB4Mode[10]	0x00	Mode1 for Thunderbolt 3 in list of modes (Fictional Application)
iAlternateOrUSB4ModeString[01]	0x1100	Index to a string describing Thunderbolt 3 operation. the Fictional Application Alternate Mode.
wSVID[21]	0x8087	Intel VID
bAlternateOrUSB4Mode[12]	0x01	Mode2 in list of modes (Fictional Debug)
iAlternateOrUSB4ModeString[12]	0x1201	Index to a string describing the Intel Fictional Debug Alternate Mode.
wSVID[32]	0xFF01	DP_SID
bAlternateOrUSB4Mode[32]	0x00	Mode1 in list of modes (DisplayPort)
iAlternateOrUSB4ModeString[32]	0x1302	Index to a string describing the DisplayPort Alternate Mode.

3.1.6.3 Billboard Alternate ModeAUM Capability Descriptor

This descriptor is used in addition to the Billboard capability descriptor to describe additional properties for a given alternate modeAUM. There shall be one such descriptor for each alternate mode.

Table 3-9: Billboard Alternate ModeAUM Capability Descriptor

Offset	Field	Bytes	Value	Description
0	**bLength**	1	Number	Size of this Descriptor in bytes.
1	**bDescriptorType**	1	Constant	Descriptor type: DEVICE CAPABILITY Type.
2	**bDevCapabilityType**	1	Number	BILLBOARD AUMALTERNATE MODE CAPABILITY
3	**bIndex**	1	Number	Index at which the AUMAlternate Mode appears in the array of Alternate Modes described in the Billboard Capability Descriptor
4	**dwAlternateModeVdo**	4	Number	Contents of the Mode VDO for the AUMalternate mode identified by bIndex. Refer to the Standard or Vendor specification for details on information contained in the Mode VDO. For USB4, the EUDO sent by the DFP port partner shall be reflected here.

3.1.6.3.1 Example usage of Billboard Alternate Mode AUM Capability Descriptor:

In this example, the USB PD Discover SVIDs Command returns the USB PD SID 0xFF00, the Intel VID 0x8087 and the DP_SID 0xFF01.

USB4 Mode is returned for the USB PD SID 0xFF00. dwAlternateModeVdo for the corresponding descriptor contains Enter USB Data Object (EUDO). Details on interpretation of the EUDO response are available in the USB Power Delivery Specification. USB4 Mode is located at index 0 in the Billboard descriptor.

Two Alternate Modes are returned for the Intel VID 0x8087. These modes will each be described by an alternate mode AUM Ccapability dDescriptor. For the first alternate mode AUM Ccapability

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~~d~~Descriptor, dwAlternateModeVdo contains Mode VDO 1 (Fictional Application) and for the second ~~alternate mode~~ AUM C~~c~~apability ~~d~~Descriptor, dwAlternateModeVdo contains Mode VDO 2 (Fictional Debug). These are Intel Corporation proprietary Alternate Modes. These two alternate modes are located at index 1~~0~~ and 2~~1~~ in the Billboard descriptor.

One Alternate Mode is returned for the DP_SID 0xFF01. dwAlternateModeVdo for the corresponding descriptor contains Mode 1 VDO. Details on interpretation of the Mode VDO response are available in the VESA DisplayPort Alt Mode on USB Type-C Standard. This A~~a~~lternate ~~m~~Mode is located at index 3~~2~~ in the Billboard descriptor.

This will result in three separate Billboard ~~Alternate Mode~~ AUM Capability Descriptors in series. These descriptors should follow the Billboard Capability Descriptor. Each Billboard AUM ~~Alternate Mode~~ Descriptor is 8 bytes long. Adding the three descriptors increases the BOS Descriptor wTotalLength by 24 and bNumDeviceCaps by 3.

Table 3-10 Example Billboard ~~Alternate Mode~~ AUM Capability Descriptors

bLength	8	Size of this Descriptor in bytes
bDescriptorType	DEVICE CAPABILITY	Descriptor type
bDevCapabilityType	BILLBOARD AUM CAPABILITY	Device Capability Type
bIndex	0x00	Location of Intel Fictional Application Alternate Mode in the Billboard Descriptor
dwAlternateModeVdo	0x2045E000	USB4 EUDO
bLength	8	Size of this Descriptor in bytes
bDescriptorType	DEVICE CAPABILITY	Descriptor type
bDevCapabilityType	BILLBOARD ~~ALTERNATE MODE~~ AUM CAPABILITY	Device Capability Type
bIndex	0x01~~0~~	Location of Intel Fictional Application Alternate Mode in the Billboard Descriptor
dwAlternateModeVdo	0x00000010	Mode1 VDO (Fictional Application) – from USB PD Mode response
bLength	8	Size of this Descriptor in bytes.
bDescriptorType	DEVICE CAPABILITY	Descriptor type
bDevCapabilityType	BILLBOARD AUM~~ALTERNATE MODE~~ CAPABILITY	Device Capability Type
bIndex	0x02~~1~~	Location of Intel Fictional Debug Alternate Mode in the Billboard Descriptor
dwAlternateModeVdo	0x00000002	Mode2 VDO (Fictional Debug) – from USB PD Mode response
bLength	8	Size of this Descriptor in bytes.
bDescriptorType	DEVICE CAPABILITY	Descriptor type
bDevCapabilityType	BILLBOARD AUM~~ALTERNATE MODE~~ CAPABILITY	Device Capability Type
bIndex	0x03~~2~~	Location of DisplayPort Mode1 Alternate Mode in the Billboard Descriptor
dwAlternateModeVdo	0x000C00C5	Mode1 VDO – from USB PD Mode response Refer to the VESA DP Alt Mode on USB Type-C Standard for details

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4 Requests and Control Sequences

4.1 Standard Requests

The Billboard Device Class shall support at least the following standard requests described in Section 9, "USB Device Framework" of the USB Specification. The Billboard Device Class places no specific requirements on the values for the standard requests:

- Get Configuration
- Get Descriptor
- Get Status
- Set Address
- Set Configuration

4.2 Class-Specific Requests

This class does not support any class specific requests.

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A Values of Constants

A.1. Billboard Class Code

Table 4-1 Billboard Class Code

Billboard Class Code	Value
BILLBOARD_CLASS	0x11

A.2. Billboard Subclass Codes

Table 4-2 Billboard Subclass Code

Billboard SubClass Code	Value
BILLBOARD_SUBCLASS	0x00

A.3. Billboard Protocol Codes

Table 4-3 Billboard Protocol Code

Billboard Protocol Code	Value
BILLBOARD_PROTOCOL	0x00

A.4. Billboard Descriptor Types

Table 4-4 Billboard Capability Descriptor Types

Billboard Capability Descriptor Type	Value
BILLBOARD	0x0D
BILLBOARD_AUM~~ALTERNATE_MODE~~	0x0F

A.5. Parameter Values

Table 4-5 Parameter Values

CONSTANT	Minimum Value	Maximum Value
MAX_NUM_ALT_OR_USB4_MODE	N/A	0x34

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