Universal Serial Bus
Device Class Definition
for
Audio/Video Devices

Basic Device Profile (BDP)

Release 1.0

June 12th, 2012

Scope of This Release

This document is the Release 1.0 of the Basic Profile Definition.

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1. Introduction

1.1. Scope

The Basic Device Profile (BDP) Definition is entirely based and compliant with the Audio/Video (AV) Device Class Definition. It is specifically targeted to Devices that incorporate an AVFunction as defined in [AVFUNCTION] (see below) and that are able to exchange audio/video content over USB or other external interfaces (such as HDMI). Furthermore, these Devices typically also expose some control facilities that allow the Controller (USB Host) to influence certain aspects of the video and audio streams that flow through the AVFunction. Typical examples are a PC monitor; a TV set that has USB Device capabilities; a webcam with built-in microphone, or a cell phone that has USB Device capabilities.

1.2. Purpose

The purpose of this document is to describe the minimum capabilities and characteristics a compliant BDP Device shall support. This document also provides recommendations for optional features.

1.3. Related Documents

- [USB2.0] – Universal Serial Bus Specification, Revision 2.0, April 27, 2000 (referred to in this document as the USB 2.0 Specification) (available at: http://www.usb.org/developers/docs).
- [USB3.0] – Universal Serial Bus 3.0 Specification, Revision 1.0 (including errata and ECN's through May 1, 2011), June 6, 2011 (referred to in this document as the USB 3.0 Specification) (available at: http://www.usb.org/developers/docs.)
- [AUDIO1.0] – Universal Serial Bus Device Class Definition for Audio Devices, Release 1.0, March 18, 1998 (available at: http://www.usb.org/developers/devclass_docs).
- [FORMATS1.0] – Universal Serial Bus Device Class Definition for Audio Data Formats, Release 1.0, March 18, 1998 (available at: http://www.usb.org/developers/devclass_docs).
- [TERMTYPES1.0] – Universal Serial Bus Device Class Definition for Terminal Types, Release 1.0, March 18, 1998 (available at: http://www.usb.org/developers/devclass_docs).
- [AUDIO2.0] – Universal Serial Bus Device Class Definition for Audio Devices, Release 2.0, May 31, 2006 (available at: http://www.usb.org/developers/devclass_docs).
- [FORMATS2.0] – Universal Serial Bus Device Class Definition for Audio Data Formats, Release 2.0, May 31, 2006 (available at: http://www.usb.org/developers/devclass_docs).
- [TERMTYPES2.0] – Universal Serial Bus Device Class Definition for Terminal Types, Release 2.0, May 31, 2006 (available at: http://www.usb.org/developers/devclass_docs).
- [USBCS] – Universal Serial Bus Device Class Definition for Content Security Devices – Content Security Framework, Revision 2.0 (available at: http://www.usb.org/developers/devclass_docs).
- [USBCSM-5] – Universal Serial Bus Device Class Definition for Content Security Devices – Content Security Method 5 – High-bandwidth Digital Content Protection 2.1 (HDCP 2.1) Implementation, Revision 1.0 (available at: http://www.usb.org/developers/devclass_docs).
- USBECNIAD – USB Engineering Change Notice: Interface Association Descriptors (available at: http://www.usb.org/developers/docs).
- [USBIADDCC] – USB Interface Association Descriptor Device Class Code and Use Model, Revision 1.0, July 23, 2003 (available at: http://www.usb.org/developers/whitepapers).
- [USBLANGIDS] – Universal Serial Bus Language Identifiers (LANGIDs), Revision 1.0, March 29, 2000 (available at: http://www.usb.org/developers/docs).
- [AVFUNCTION] – Universal Serial Bus Device Class Definition for Audio/Video Devices – AV Device Class Overview & AVFunction Definition, Release 1.0, December 07, 2011 (available at: http://www.usb.org/developers/devclass_docs).
- [AVFORMAT_1] – Universal Serial Bus Device Class Definition for Audio/Video Devices – AVFormat 1 – Video over Bulk, Release 1.0, December 07, 2011 (available at: http://www.usb.org/developers/devclass_docs).

- [AVFORMAT_2] – Universal Serial Bus Device Class Definition for Audio/Video Devices – AVFormat 2 – Isochronous Audio, Release 1.0, December 07, 2011 (available at: http://www.usb.org/developers/devclass_docs).
- [AVFORMAT_3] – Universal Serial Bus Device Class Definition for Audio/Video Devices – AVFormat 3 – Uncompressed Full Frame Isochronous Video, Release 1.0, December 07, 2011 (available at: http://www.usb.org/developers/devclass_docs).
- [AVSCHEMA] – Available at: http://avschemas.usb.org/v1/avschema.xsd
- [BDP] – Universal Serial Bus Device Class Definition for Audio/Video Devices – Basic Device Profile, Release 1.0, (available at: http://www.usb.org/developers/whitepapers).
- [ANSIS1_11] – ANSI S1.11-2004 (R2009) standard (available at: http://www.ansi.org).
- [IEC11172_3] – MPEG-1 standard ISO/IEC 11172-3:1993 Information technology – Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s – Part 3: Audio (available at http://www.iec.ch).
- [IEC13818_1] – MPEG-2 standard ISO/IEC 13818:2000 Information technology – Generic coding of moving pictures and associated audio information – Part 1: Systems (available at http://www.iec.ch).
- [IEC13818_3] – MPEG-2 standard ISO/IEC 13818:1998 Information technology – Generic coding of moving pictures and associated audio information – Part 3: Audio" (available at http://www.iec.ch).
- [AC_3] – Digital Audio Compression Standard (AC-3, Enhanced AC-3), ETSI TS 102 366 (available at http://www.etsi.org).
- [IEEE_754] – ANSI/IEEE-754 floating-point standard (available at http://www.ieee.org).
- [IEC60958] – ISO/IEC 60958 International Standard: Digital Audio Interface and Annexes (available at: http://www.iec.ch).
- [IEC61937] – ISO/IEC 61937 standard (available at: http://www.iec.ch).
- [ETSI_TS_102_114] – ETSI Specification TS 102 114, "DTS Coherent Acoustics; Core and Extensions" (available at http://www.etsi.org).
- [HDCP2.1] – High-bandwidth Digital Content Protection System. Interface Independent Adaptation. Revision 2.1, July 18, 2011 (available from http://www.digital-cp.com).
- [MLP] – DVD Specifications for High Definition Video: MLP Reference Information.
- [IEC14496_3] – MPEG-4 Standard ISO/IEC 14496-3 – Information Technology – Coding of audio-visual objects – Part 3: Audio (available at http://www.iec.ch).
- [IEC14496_10] – MPEG-4 Standard ITU-T H.264 and ISO/IEC 14496-10:2004 – Information Technology – Coding of audio-visual objects – Part 10: Advanced Video Coding. Second Edition 2004-10-01 (available at http://www.iec.ch).
- [WMA] – Audio compression format from Microsoft. For technical and licensing information, contact Microsoft directly (http://www.microsoft.com/windows/windowsmedia/default.aspx).
- [HDMI] – The official High Definition Multimedia Interface website http://www.hdmi.org.
- [RFC5646] – Tags for Identifying Languages, September 2009 (available at http://www.rfc-editor.org/rfc/rfc5646.txt).
- [KHRONOS] – The Khronos Group, Open Standards for Media Authoring and Acceleration (available at http://www.khronos.org).
- [CEA-861-E] – A DTV Profile for Uncompressed High Speed Digital Interfaces, March 2008 (available at http://www.cea.org).
- [VESA] – Video Electronics Standards Association (available at http://www.vesa.org).
- [IEC10918_4] – JPEG Standard ISO/IEC 10918-4 – Information technology – Digital compression and coding of continuous-tone still images: Registration of JPEG profiles, SPIFF profiles, SPIFF tags, SPIFF colour spaces, APPn markers, SPIFF compression types and Registration Authorities (REGAUT). First Edition 1999-08-15 (available at http://www.iec.ch).

2. Management Overview

The Universal Serial Bus Device Class Definition for AV Devices (AV Device Class Definition) is a very extensive specification that provides all the features and tools necessary to describe and design virtually any USB-based AV device of any complexity. As a consequence, designing a class driver that encompasses and supports the total richness offered by the AV Device Class Definition is a very complex task.

In many cases, depending upon the application, an AV device will only need to implement a small subset of the AV Device Class Definition to perform the tasks for which it has been designed. It would therefore be too much of an overhead to require any USB Host that wants to take advantage of the services offered by such a device, to have to implement a class driver that is able to handle all feature and topology combinations that a full AV Device Class Definition-compliant device may present.

By introducing the concept of a Profile, complexity can be greatly reduced. Indeed, an AV device that complies with the Profile Definition shall expose and use a small well-defined subset of the full AV Device Class Definition. Vendor-specific extensions may be present but they shall never interfere with the basic Profile-compliant operation of the Device. Specific USB Hosts can now be designed to only handle the features and topologies allowed by the Profile and claim compliance to the Profile rather than to the full AV Device Class Definition.

Since the Profile Definition is a compliant subset of the full AV Device Class Definition, AV devices designed to the Profile Definition are guaranteed to interoperate with a Host that does implement a class driver for the full AV Device Class Definition.

This Basic Device Profile (BDP) Definition addresses devices that have limited capabilities. The BDP supports devices that offer the following resources:

- Video rendering (display)
- Audio rendering (speakers, headphones)
- Video generation (webcam, cell phone generating a UI)
- Audio generation (microphone)

The BDP definition supports AVFunctions that expose combinations of the above-mentioned resources. In this specification we only describe the parts of the deivce that are exposed to the host system, some of which may only report notifications and others that allow control by the host.

3. Basic Device Profile Characteristics

The Basic Device Profile (BDP) adheres to the AV Device Class Definition but imposes certain restrictions on the allowable building blocks and the allowed topologies.

The BDP shall only use the following building blocks:

- Input Terminal
- Output Terminal
- Mixer Unit (Audio-only)
- Feature Unit
- Converter Unit
- Router Unit
- AVData FrameBuffer-In Entity or AVData VideoStreaming-In Interface
- AVData FrameBuffer-Out Entity or AVData VideoStreaming-Out Interface
- AVData Streaming Audio In Entity
- AVData Streaming Audio Out Entity
- AVData Generic-In Entity (e.g. Camera/Microphone)
- AVData Generic-Out Entity (e.g. Display/Speakers) or AVData HDMI-Out Entity
- AVData Generic-Out Entity (e.g. Headphones)

The BDP defines a general AVFunction topology as specified in Section 4.1, "Fully Populated BDP Topology". The general AVFunction topology describes a 'full-functionality' topology that is targeted by this Profile. A BDP compliant AVFunction may choose to implement just those parts of the general topology that it needs to expose its desired functionality. Several examples of such derived topologies can be found in Section 4.2, "Variations on the BDP Topology". Alternatively, vendors may extend the general topology (by adding additional building blocks, for example) but these extensions shall not interfere with the basic Profile-compliant operation of the Device.

Note that a device may support more than one alternate setting for the AVControl Interface but a host compliant to this version of the BDP specification will only select the first alternate setting.

3.1. Basic Device Profile Configuration

A BDP-compliant USB Device shall expose in its Default[1] Device Configuration at least one AVFunction through a single Control interface, zero or more AVData Video Streaming interfaces, and zero or more AVData Audio Streaming interfaces, bundled into an Interface Association. Exposing additional independent AVFunctions is allowed. Additional Device Configurations besides the Default Device Configuration are allowed but not recommended.

Vendors may choose to extend the baseline behavior by defining additional USB functions besides those defined by this specification and add them to the Default Device Configuration. It is also allowed to extend or modify the Default Device Configuration by adding basic building blocks (Entities/Units/Terminals) to the topology or by adding additional AVControls to existing building blocks of the AVFunction, as long as the AVFunction can still be controlled and can correctly operate without these additions and/or extensions needing intervention from the Controller. In other words, a modified AVFunction shall be able to operate and be controlled by Controller software that is designed to operate an AVFunction that strictly adheres to the BDP Definition. Controller software shall gracefully ignore any AVControls or basic building blocks that it does not recognize.

3.2. Basic Device Profile Requirements

The following tables summarize the features and their related requirements.

Requirements are organized by basic building blocks that may be present in a BDP-compliant AVFunction. Since all of the building blocks are optional, the requirements for a particular building block only apply when an AVFunction uses that building block. The tables reference the building blocks and their IDs as defined in Section 4.1, "Fully Populated

[1] The Default Device Configuration is the Device Configuration that is returned in response of a GetDescriptor(CONFIGURATION, 0) request.

BDP Topology". Note that ID number values can be chosen arbitrarily (except for the AVControl interface ID, which shall be one). All IDs within the AVFunction shall be unique. An implementation shall be one of the topologies decribed in Section 4.2 or a superset of one of the topologies, which means it is the topology plus additional components (additional topologies may be added in the future). The ID numbers used in the following tables and in Section 4.1, "Fully Populated BDP Topology" are therefore example values and only used to create a one-to-one relationship between the tables and the building blocks used in Figure 4-1, "Example of a Fully Populated BDP Topology".

In general, the following tables only list requirements and restrictions that are not already expressed in the AV Device Class Definition. As such, they impose *additional* requirements and restrictions beyond what may be allowed by the AV Device Class Definition. However, if there are requirements listed in this document that are in contradiction with statements in the AV Device Class Definition, the AV Device Class Defintion always takes precedence. Features that are allowed by the AV Class Definition and that are not mentioned in the following tables are considered to be optional for the BDP. Vendors may choose to include optional features in their particular implementation. Any driver software should expect the presence of optional features but does not have to be able to control them.

The following abbreviations are used in the column labeled AVF (AVFunction):

- R: The feature is required when the building block is implemented.
- CR: The feature is conditionally required when the building block is implemented. The condition is stated in the Comments column of the table.
- P: The feature is defined in the AVFunction Definition but its use is prohibited when the building block is implemented in a BDP compliant AVFunction.

3.2.1. General Requirements

Table 3-1: General Requirements

General		AVF	Comments
1	**AVFunction Compliance**	R	• The AVFunction shall expose a topology that is identical to the topology described in Section 4.1, "Fully Populated BDP Topology" or a subset of that topology. Examples of the various derived topologies can be found in Section 4.2, "Variations on the BDP Topology" of this document. Vendor extensions are allowed as long as the AVFunction can operate as expected by this specification.
2	**Single VideoTrack**	CR	• The AVFunction shall only support single VideoTrack VideoClusters and VideoBundles. As a consequence, VideoTrack Selectors shall not be present in the AVFunction.
3	**Single AudioTrack**	CR	• The AVFunction shall only support single AudioTrack AudioClusters and AudioBundles. As a consequence, AudioTrack Selectors shall not be present in the AVFunction.

Note: While both Single Video Track and Single Audio Track are conditionally required, at least one of them must be implemented in the device.

3.2.2. AVControl Interface ID1 Requirements

AVControl ID1 should conform to the [AVFUNCTION] specification.

3.2.3. AVData FrameBuffer-In/Video Streaming-InEntity ID2 Requirements

Table 3-2: AVData FrameBuffer-In/Video Streaming-InEntity ID2 Requirements

AVData FrameBuffer-In/Video Streaming-INEntity ID2		AVF	Comments
4	**Terminal Association**	R	• The AVData FrameBuffer-In/Video Streaming-In Entity ID2 shall be associated with Input Terminal ID5.
5	**Active Alternate Setting**	R	• The AVData FrameBuffer-In/Video Streaming-In Entity shall implement the Active Alternate Setting Control if it is an AVData Frame Buffer-In Entity. If it is a VideoStreaming-In Entity this control is prohibited because alternate setting changes are performed through standard USB requests.
5.1	**SourceData**	R	• The SourceData Control shall be WO.
5.2	**Bitmap Formats in Alternate Setting 1**		
5.2.1	• Uncompressed, partial bitmap update (RGB 888)	R	• See [AVFORMAT_1]
5.3	**VideoFrame Dimensions and Timings in Alternate Setting 1**		
5.3.1	• 640X480P, 60Hz	R	• See [AVFORMAT_1]

3.2.4. AVData Audio Streaming In Interface ID3 Requirements

Table 3-3: AVData Audio Streaming In Interface ID3 Requirements

AVData Audio Streaming In Interface ID3		AVF	Comments
6	**Terminal Association**	R	• The AVData Audio Streaming In interface ID3 shall be associated with Input Terminal ID6.
7	**Audio in Alternate Setting 1**		
7.1	**PCM Audio**		• This is the baseline requirement. See [AVFORMAT_2]. See Section 4.1, “Type I Formats” for more details.
7.1.1	• PCM-encoded Audio • 2 audio channels • 16 bits per audio sample • 48 kHz sampling frequency	R	• The AVData Audio Streaming interface shall support this audio format.

3.2.5. AVData Generic-In Entity ID4 Requirements

Table 3-4: AVData Generic-In Entity ID4 Requirements

AVData Generic-In Entity ID4		AVF	Comments
8	**Terminal Association**	R	• The AVData Generic-In Entity ID4 shall be associated with Input Terminal ID7.

3.2.6. Input Terminal ID5 Requirements

Table 3-5: Input Terminal ID5 Requirements

Input Terminal ID5		AVF	Comments
9	**AVData Entity Association**	R	• The Input Terminal ID5 shall be associated with AVData Entity ID2.
10	**Clock Input Connected**	P	• The Clock Input Pin shall **not** be connected to an explicit Clock Domain.
11	**Output Channel Configuration**		
11.1	• Video: 2D	R	• The Input Terminal shall support 2D video (single video channel – OL001).

3.2.7. Input Terminal ID6 Requirements

Table 3-6: Input Terminal ID6 Requirements

Input Terminal ID6		AVF	Comments
12	**AVData Entity Association**	R	• The Input Terminal ID6 shall be associated with AVData Entity ID3.
13	**Clock Input Connected**	R	• The Clock Input Pin shall be connected to an explicit Clock Domain.
14	**Output Channel Configuration**		
14.1	• Audio: 2.0	R	• The Input Terminal shall support stereo audio (FL and FR).

3.2.8. Input Terminal ID7 Requirements

Table 3-7: Input Terminal ID7 Requirements

Input Terminal ID7		AVF	Comments
15	**AVData Entity Association**	R	• The Input Terminal ID7 shall be associated with AVData Entity ID4.
16	**Output Channel Configuration**		
16.1	• Video: 2D	CR	• If Video is supported, then the Input Terminal shall support 2D video (single video channel – OL001).
16.2	• Audio: 1.0 or 2.0	CR	• If Audio is supported, then the Input Terminal shall support either mono audio (1.0 - FC) or stereo audio (2.0 - FL and FR).

Note: While both Video: 2D and Audio: 1.0 or 2.0 are conditionally required, atleast one of them must be implemented in the device.

3.2.9. Router Unit ID8 Requirements

Table 3-8: Router Unit ID8 Requirements

Router Unit ID8		AVF	Comments
17	**Input Configuration**		
17.1	• 2 Input Pins	R	• The Router Unit shall support at least 2 Input Pins. A path shall exist between Input Pin 1 and the Output Pin of Input Terminal ID5. Also, a path shall exist between Input Pin 2 and the Output Pin of Input Terminal ID6.
18	**Video Input Pin Selector**	R	• The Router Unit shall support only one Video Input Pin Selector. As a consequence, the outgoing VideoCluster can at most contain one VideoTrack.
19	**Audio Input Pin Selector**	R	• The Router Unit shall support only one Audio Input Pin Selector. As a consequence, the outgoing AudioCluster can at most contain one AudioTrack.

Note: A Router Unit that supports more than 2 input pinsshall always route the outputs of ID5 (Video) and ID6 (Audio) to the output Pin of ID8.

3.2.10. Converter Unit ID9 and ID10 Requirements

Table 3-9: Converter Unit ID9 and ID10 Requirements

Converter Unit ID9 and ID10		AVF	Comments
20	**Input Channel Configuration**		
20.1	• Video	P	• Video is not supported
20.2	• Audio	R	• The Audio Input Channel Configuration shall be identical to the Audio Output Channel Configuration of the Entity to which this Feature Unit is connected.
21	**Output Channel Configuration**		

Converter Unit ID9 and ID10		AVF	Comments
21.1	• Video	P	• Video is not supported
21.2	• Audio: Headphones	R	• The Converter Unit shall support the (Stereo) HPL and HPR Channel Configuration.
22	**Cluster Control**	R	• The Converter Unit shall support the Cluster Control.
23	**AudioMode Control**	R	• The Converter Unit shall support at least one AudioMode (AudioMode(0)) whereby the incoming AudioCluster is converted into a 2-channel (HPL, HPR) AudioCluster. In this case, the Control is Single Value Read-Only and the AVFunction may choose not to physically implement the Control but only report its existence.

3.2.11. Feature Unit ID11 Requirements

Table 3-10: Feature Unit ID11 Requirements

Feature Unit ID11		AVF	Comments
24	**Input Channel Configuration**		
24.1	• Video	R	• The Video Input Channel Configuration shall be identical to the Video Output Channel Configuration of the Entity to which this Feature Unit is connected. The incoming VideoCluster, if any, is passed unaltered as the outgoing VideoCluster (no video processing).
24.2	• Audio	R	• The Audio Input Channel Configuration shall be identical to the Audio Output Channel Configuration of the Entity to which this Feature Unit is connected.
25	**Delay Control**		
25.1	• Master	R	• The Master Delay Control shall be RW.

3.2.12. Mixer Unit ID12 Requirements

Table 3-11: Mixer Unit ID12 Requirements

Mixer Unit ID12		AVF	Comments
26	**Video**	P	• Video Mixer functionality shall not be supported.
27	**Audio**	R	• Audio Mixer functionality shall be supported.
28	**Input Pins**	R	• The Mixer Unit shall support 2 Input Pins only.
29	**Input Channel Configuration**	R	• The Input Channel Configuration shall be indentical for both Input Pins.
29.1	• Audio	R	• The Audio Input Channel Configuration shall be identical to the Audio Output Channel Configuration of the Entity to which this Input Pin of the Mixer Unit is connected.
30	**Output Channel Configuration**		
30.1	• Audio	R	• The Audio Output Channel Configuration shall be indentical to the Audio Input Channel Configurations (of both Input Pins).
31	**Level Control**	R	• The Audio Mixer Unit shall implement a Level Control on each crossing of an input and output channel of the same Channel Type (ICN=OCN). The Audio Mixer Unit shall not implement a Level Control on any crossing of an input and output channel of different Channel Type (ICN<>OCN).

3.2.13. Feature Unit ID13 Requirements

Table 3-12: Feature Unit ID13 Requirements

Feature Unit ID13		AVF	Comments
32	**Input Channel Configuration**		
32.1	• Video	R	• The Video Input Channel Configuration shall be identical to the Video Output Channel Configuration of the Entity to which this Feature Unit is connected.
32.2	• Audio	CR	• The Audio Input Channel Configuration shall be identical to the Audio Output Channel Configuration of the Entity to which this Feature Unit is connected.
33	**Mute Control**		
33.1	• Master	CR	• The Master Mute Control shall be RW.
34	**Volume Control**		
34.1	• Master	CR	• The Master Volume Control shall be RW.
35	**Brightness Control**		
35.1	• Master	R	• The Master Brightness Control shall be RoW.

3.2.14. Feature Unit ID14 Requirements

Table 3-13: Feature Unit ID14 Requirements

Feature Unit ID14		AVF	Comments
36	**Input Channel Configuration**		
36.1	• Video	P	• Video is not supported
36.2	• Audio	R	• The Audio Input Channel Configuration shall be identical to the Audio Output Channel Configuration of the Entity to which this Feature Unit is connected.
37	**Mute Control**		
37.1	• Master	R	• The Master Mute Control shall be RW.
38	**Volume Control**		
38.1	• Master	R	• The Master Volume Control shall be RW.

3.2.15. Feature Unit ID15 Requirements

Table 3-14: Feature Unit ID15 Requirements

Feature Unit ID15		AVF	Comments
39	**Input Channel Configuration**		
39.1	• Video	R	• The Video Input Channel Configuration shall be identical to the Video Output Channel Configuration of the Entity to which this Feature Unit is connected.
39.2	• Audio	R	• The Audio Input Channel Configuration shall be identical to the Audio Output Channel Configuration of the Entity to which this Feature Unit is connected.
40	**Mute Control**		
40.1	• Master	R	• The Master Mute Control shall be RW.
41	**Volume Control**		
41.1	• Master	R	• The Master Volume Control shall be RW.

3.2.16. Output Terminal ID16 Requirements

Table 3-15: Output Terminal ID16 Requirements

Output Terminal ID16		AVF	Comments
42	**AVData Entity Association**	R	• The Output Terminal ID16 shall be associated with AVData Entity ID20.

3.2.17. Output Terminal ID17 Requirements

Table 3-16: Output Terminal ID17 Requirements

Output Terminal ID17		AVF	Comments
43	**AVData Entity Association**	R	• The Output Terminal ID17 shall be associated with AVData Entity ID21.

3.2.18. Output Terminal ID18 Requirements

Table 3-17: Output Terminal ID18 Requirements

Output Terminal ID18		AVF	Comments
44	**AVData Entity Association**	R	• The Output Terminal ID18 shall be associated with AVData Entity ID22.
45	**Clock Input Connected**	R	• Shall be connected to an explicit Clock Domain.

3.2.19. Output Terminal ID19 Requirements

Table 3-18: Output Terminal ID19 Requirements

Output Terminal ID19		AVF	Comments
46	**AVData Entity Association**	R	• The Output Terminal ID19 shall be associated with AVData Entity ID23.
47	**Clock Input Connected**	P	• Shall **not** be connected to an explicit Clock Domain.

3.2.20. AVData Generic-Out Entity/AVData HDMI-Out Entity ID20 Requirements

Table 3-19: AVData Generic-Out Entity/ AVData HDMI-Out Entity ID20 Requirements

AVData Generic-Out Entity/AVData HDMI-Out Entity ID20		AVF	Comments
48	**Terminal Association**	R	• The AVData Generic-Out Entity/ AVData HDMI-Out Entity ID20 shall be associated with Output Terminal ID16.

3.2.21. AVData Generic-Out Entity ID21 Requirements

Table 3-20: AVData Generic-Out Entity ID21 Requirements

AVData Generic-Out Entity ID21		AVF	Comments
49	**Terminal Association**	R	• The AVData Generic-Out Entity ID21 shall be associated with Output Terminal ID17.

3.2.22. AVData Audio Streaming Out Interface ID22 Requirements

Table 3-21: AVData Audio Streaming Out Interface ID22 Requirements

AVData Audio Streaming Out Interface ID22		AVF	
50	**Terminal Association**	R	• The AVData Audio Streaming Out interface ID22 shall be associated with Input Terminal ID18.
51	**AudioStream Configurations**		
51.1	**AudioStreamConfig 1**		• This is the baseline requirement. See [AVFORMAT_2]. See Section 4.1, “Type I Formats” for more details.
51.1.1	• PCM-encoded Audio • 2 audio channels (FL, FR) • Single AudioTrack • 16 bits per audio sample • 48 kHz sampling frequency	R	• The AVData Audio Streaming interface shall support this audio format.

3.2.23. AVData FrameBuffer-Out/Video Streaming-Out Entity ID23 Requirements

Table 3-22: AVData FrameBuffer-Out/Video Streaming-OutEntity ID23 Requirements

AVData FrameBuffer-Out/Video Streaming-OutEntity ID23		AVF	Comments
52	**Terminal Association**	R	• The AVData FrameBuffer-Out/Video Streaming-Out Entity ID23 shall be associated with Output Terminal ID19.
53	**Active Alternate Setting**	R	• The AVData FrameBuffer-Out/Video Streaming-OutEntity shall implement the Active Alternate Setting Control if it is an AVData Frame Buffer-OutEntity. If it is a VideoStreaming-In Entity this control is prohibited because alternate setting changes are performed through standard USB requests.

3.2.24. Clock Source Entity ID25 and ID26 Requirements

Table 3-23: Clock Source Entity ID25 and ID26 Requirements

Clock Source Entity ID25 and ID26		AVF	Comments
54	**Video Sampling Frequency Control**	P	• The Clock Source Entity shall not support a video clock.
55	**Audio Sampling Frequency Control**		
55.1	• Single Frequency	R	• The Clock Source Entity shall support one sampling frequency of 48 kHz. If it only supports this frequency then the AVFunction may choose not to physically implement the Control but only report its existence in the AVDD.
56	**ClocksValid Control**	R	• The Clock Source Entity shall support the ClocksValid Control.

4. Topology

To support the features and characteristics listed above, a fully populated BDP AVFunction topology is defined in the following section. Subsequent sections define various variations on that fully populated topology by omitting one or more optional components of the fully populated BDP AVFunction topology.

4.1. Fully Populated BDP Topology

The BDP Topology describes an AVFunction that optionally includes:

- A main video/audio output, such as a built-in screen and speakers, or an HDMI-Out, or any type of AVData Generic-Out Entity
- A Headphone output
- A main video/audio input, such as a built-in camera and microphone
- Provisions for sidetone mixing

The following figure presents a topology overview.

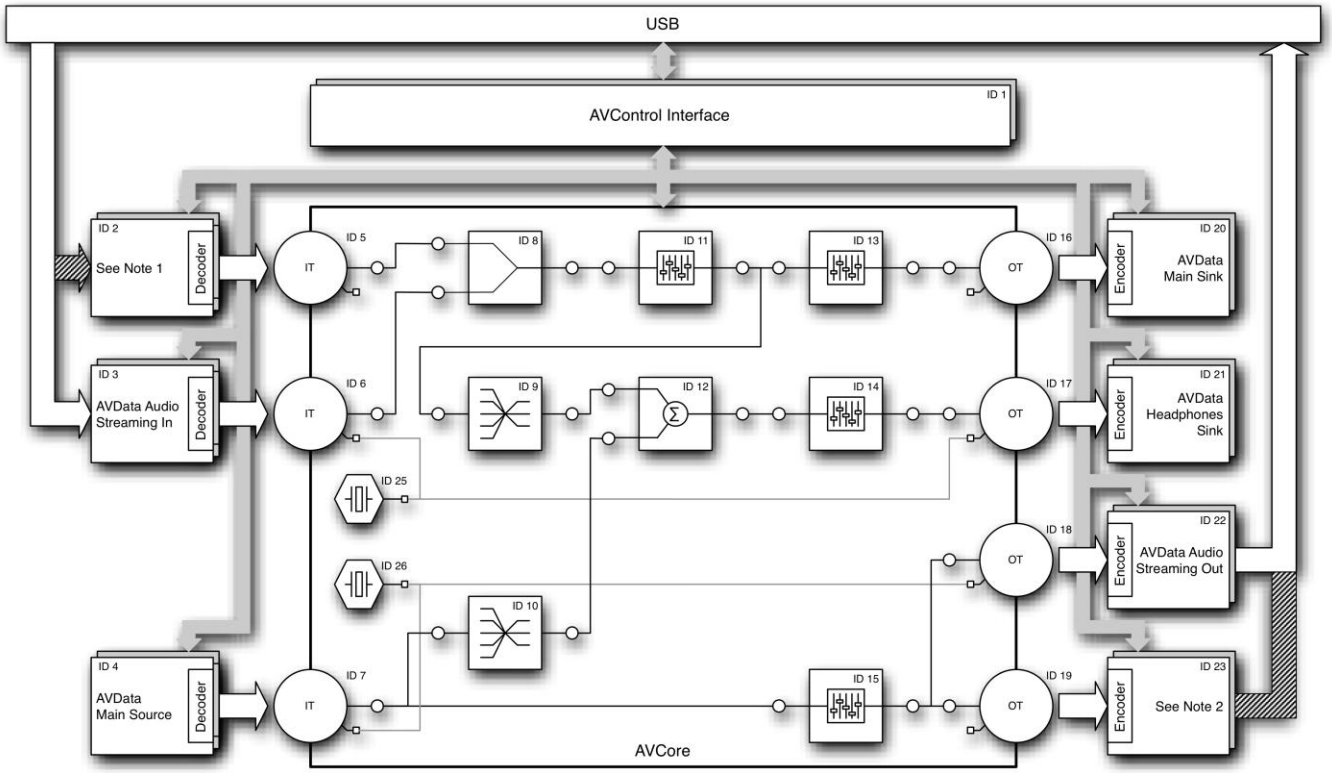

Figure 4-1: Example of a Fully Populated BDP Topology

Note 1: Entity ID2 can be either an AVData FrameBuffer-In Entity or an AVData Video Streaming-In interface. In the former case, VideoStreams are transported over the CBP and the hatched connection arrow is not present. In the latter case, VideoStreams are transported via the dedicated isochronous data endpoint of the AVData Video Streaming In interface.

Note 2: Entity ID23 can be either an AVData FrameBuffer-Out Entity or an AVData Video Streaming-Out interface. In the former case, VideoStreams are transported over the CBP and the hatched connection arrow is not present. In the latter case, VideoStreams are transported via the dedicated isochronous data endpoint of the AVData Video Streaming Out interface.

In Figure 4-1, the upper part of the diagram represents the output functionality of the BDP AVFunction whereas the lower part represents the input functionality.

4.1.1. Output Functionality

AV content is delivered from the Controller to the AVFunction through the AVData FrameBuffer-InEntity ID2 via the CBP for video content. Alternatively Entity ID2 could be an AV Data Video Streaming In Interface using the Isochronous endpoints for receiving the video content. Additionally, the AVData Audio Streaming In interface Entity ID 3 may be used for audio content.

The Controller packetizes the video content (if present) as defined in the [AVFORMAT_1] specification for transporting via Bulk and in the [AVFORMAT_3] for transporting via Isochronous. The Controller sends audio content (if present) via the isochronous pipe that is part of the AVData Audio Streaming In interface using one of the Audio Formats described in [AVFORMAT_2].

After decoding and converting the video data into a proper single VideoTrack 2D or 3D2 VideoCluster, the VideoCluster enters the AVCore via Input Terminal ID5. After decoding and converting the audio data into a proper single AudioTrack AudioCluster, the AudioCluster enters the AVCore via Input Terminal ID6. Router Unit ID8 then combines the VideoCluster and AudioCluster into a single AVCluster.

The resulting AVCluster is then routed into Feature Unit ID11. Feature Unit ID11 contains an AVControl to allow for audio delay compensation. After this compensation, the AVCluster flows into the main output path. This path consists of Feature Unit ID13, which provides manipulation of the VideoCluster (Brightness) and the AudioCluster (Mute, Volume) before leaving the AVCore through Output Terminal ID16 and, after proper encoding and conversion, on to AVData Entity ID20, which represents the main output facility of the AVFunction (either a built-in screen and/or speakers or an HDMI-Out connection, or any type of AVData Generic-Out Entity).

The AVCluster from Feature Unit ID11 may also be routed to Converter Unit ID9. The Converter Unit converts the AudioCluster from multi-channel into 2 channels, specifically prepared for headphone use. (The algorithms to do this are implementation-dependent.) The resulting 2-channel AudioCluster is then routed to Audio Mixer Unit ID12. The Audio Mixer Unit ID12 can be used to locally mix the audio content from the input path into the headphone audio path (sidetone mixing). The mixed AudioCluster is then routed to Feature Unit ID14, which contains separate Mute and Volume Controls for the headphone. The output of Feature Unit ID14 flows into Output Terminal ID17 and, after proper encoding and conversion, on to AVData Sink Entity ID21, the headphone connection on the AVFunction.

4.1.2. Input Functionality

AVData Source Entity ID4 represents the main input facility of the AVFunction (either an internal or external microphone and/or a camera). After proper decoding and conversion of the video (if present) and audio (if present) streams, the resulting AVCluster enters the AVCore through Input Terminal ID7 and is routed into Feature Unit ID15. Feature Unit ID15 contains some AVControls to allow for simple audio corrections (Mute, Volume). After those modifications are applied, the AVCluster flows into Output Terminals ID18 and ID19.

Output Terminal ID18 selects the AudioCluster only and, after proper encoding and conversion, sends the result to AVData Audio Streaming Out interface ID22. The audio stream is formatted using one of the methods described in the [AVFORMAT_2] document and streamed up to the Controller.

Output Terminal ID19 selects the VideoCluster only and, after proper encoding and conversion, sends the result to AVData FrameBuffer-OutEntity (or AVData Video Streaming-Out Interface) ID23.

AVData FrameBuffer-OutEntity (or AVData Video Streaming-Out Interface) ID23 packetizes the video content (if present) as specified in [AVFORMAT_1] specification for transporting via Bulk and in the [AVFORMAT_3] for transporting via Isochronous.

4.1.3. Input-to-Output Functionality

The output of Input Terminal ID7 can also be routed to Converter Unit ID10. The Converter Unit selects the AudioCluster and converts it from multi-channel into 2 channels, specifically prepared for headphone use. (The algorithms to do this are implementation-dependent.) The resulting 2-channel AudioCluster is then routed to the Audio Mixer Unit ID12 where it can be mixed with the main headphone audio content.

4.1.4. Clock Functionality

Clock Source Entity ID25 drives the audio Out clock domain of the AVFunction. Input Terminal ID6 and optionally, Output Terminal ID17 are connected to this Clock Source Entity. Clock Source Entity ID26 drives the audio IN clock domain of the AVFunction. Output Terminal ID18 and optionally, Input Terminal ID7 are connected to this Clock Source Entity. Implementations are also allowed to only implement a single audio clock domain for the entire AVFunction. In this case, Input Terminals ID6 and ID7, and Output Terminals ID17 and ID18 can be connected to the single Clock Source Entity ID25.

4.2. Variations on the BDP Topology

The BDP Topology as presented above provides the maximum AV functionality that is targeted by the Basic Device Profile. However, virtually all components of this topology are optional for a device to implement. This way, many different types of AVFunctions with reduced functionality can be derived from this single Basic Device Profile while still being fully compliant with the Basic Device Profile. As mentioned before, vendors may choose to extend the functionality of the AVFunction as long as those extensions do not interfere with the basic operation of the Device.

The following section provides one variation on the BDP Topology. Other variations are possible but are not explicitly documented here. The variation was named after its most common use. Other usages may re-use the named variations for slightly different purposes.

4.2.1. Basic Display Example

4.2.1.1. Topology

This profile describes the basic building blocks that are necessary to implement a Basic Display.

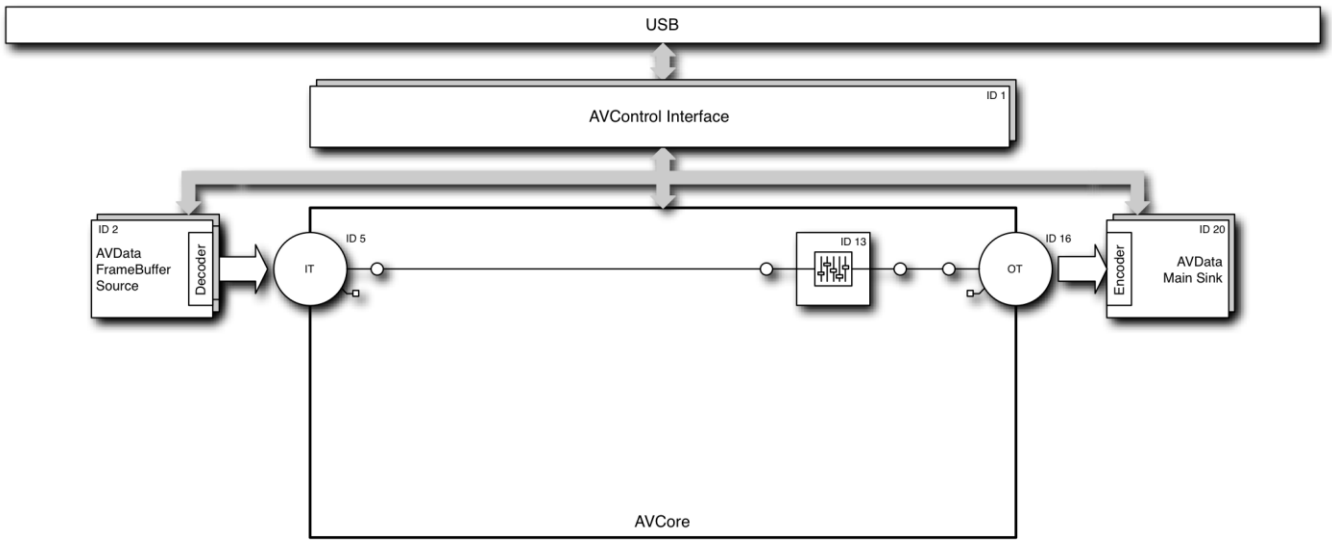

Figure 4-2: Basic PC Monitor Topology

4.2.1.2. AVDD Document

The AVDD document has been generated using AVDD_Creator V1.0. At the time of this writing this is the latest version.

The project file for this document - *BasicDisplay.avd* - is part of the Basic Device Profile documentation.

```
<?xml version="1.0" encoding="UTF-8"?>
<avConfiguration
   xsi:schemaLocation=" http://avschemas.usb.org/v1/AVSchema http://avschemas.usb.org/v1/AVSchema.xsd"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns="http://avschemas.usb.org/v1/AVSchema">
   <specVersion>
      <major>1</major>
      <minor>0</minor>
   </specVersion>
   <avControlInterface id="1">
```

```
<avddInfo/>
<avddContent/>
<alternateSetting>
  <inputTerminal id="5" avDataId="2">
    <outputPin>
      <outputChannelConfig>
        <videoPath>
          <channels>
            <OL001/>
          </channels>
        </videoPath>
      </outputChannelConfig>
      <cluster/>
    </outputPin>
  </inputTerminal>
  <outputTerminal id="16" avDataId="20">
    <inputPin>
      <sourceID>13</sourceID>
    </inputPin>
  </outputTerminal>
  <featureUnit id="13">
    <inputPin>
      <sourceID>5</sourceID>
      <inputChannelConfig>
        <videoPath>
          <channels>
            <OL001/>
          </channels>
        </videoPath>
      </inputChannelConfig>
    </inputPin>
    <video>
      <brightness rw="RW">
        <channels>
          <MASTER/>
        </channels>
        <ranges>
          <range>
            <min>0</min>
            <max>100</max>
            <res>1</res>
          </range>
        </ranges>
      </brightness>
    </video>
    <audio/>
  </featureUnit>
  <avDataGeneric-OutEntity id="20" terminalID="16">
    <genericType>
      <videoType>DISPLAY</videoType>
      <audioType>NONE</audioType>
    </genericType>
    <activeAltSetting rw="RW"/>
    <alternateSetting/>
  </avDataGeneric-OutEntity>
  <avDataFrameBuffer-InEntity id="2" terminalID="5">
    <activeAltSetting rw="RW"/>
    <edid/>
    <sourceData wr="WO"/>
    <streamSelector rw="RW"/>
    <videoBulkStreamConfigList>
      <videoBulkStreamConfig hdcp="false">
        <videoBundle>
          <videoTrack>
            <channels>
              <OL001/>
            </channels>
          </videoTrack>
        </videoBundle>
        <videoFrame>
```

```
                <clock>
                    <frequency>60</frequency>
                </clock>
                <foid2D>
                    <vfid640X480P/>
                </foid2D>
            </videoFrame>
            <videoSampleTypeII>
                <vsidRGB888>
                    <vcidPARTIAL/>
                </vsidRGB888>
            </videoSampleTypeII>
        </videoBulkStreamConfig>
    </videoBulkStreamConfigList>
    <alternateSetting/>
</avDataFrameBuffer-InEntity>
</alternateSetting>
</avControlInterface>
</avConfiguration>
```

4.2.1.3. Legacy-View Descriptors

4.2.1.3.1. Device Descriptor

Offset	Field	Size	Value
0	bLength	1	18
1	bDescriptorType	1	DEVICE(1)
2	bcdUSB	2	Device-Specific
4	bDeviceClass	1	0xEF
5	bDevice SubClass	1	0x02
6	bDeviceProtocol	1	0x01
7	bMaxPacketSize	1	Device-Specific
8	idVendor	2	Device-Specific
10	idProduct	2	Device-Specific
12	bcdDevice	2	Device-Specific
14	iManufacturer	1	Device-Specific
15	iProduct	1	Device-Specific
16	iSerialNumber	1	Device-Specific
17	bNumConfigurations	1	Device-Specific

4.2.1.3.2. Configuration Descriptor

Offset	Field	Size	Value
0	bLength	1	9
1	bDescriptorType	1	CONFIGURATION(2)
2	wTotalLength	2	227
4	bNumInterfaces	1	1
5	bConfigurationValue	1	1
6	iConfiguration	1	0
7	bmAttributes	1	0x80
8	bMaxPower	1	Device-Specific

4.2.1.3.2.1. Interface Association Descriptor

Offset	Field	Size	Value
0	bLength	1	8
1	bDescriptorType	1	IAD(11)
2	bFirstInterface	1	0
3	bInterfaceCount	1	1
4	bFunctionClass	1	0x10
5	bFunctionSubClass	1	0x00
6	bFunctionProtocol	1	0x00
7	iFunction	1	0

4.2.1.3.2.2. Control Interface Descriptor (Inactive Alternate Setting)

Offset	Field	Size	Value
0	bLength	1	9
1	bDescriptorType	1	INTERFACE(4)
2	bInterfaceNumber	1	0
3	bAlternateSetting	1	0
4	bNumEndpoints	1	0
5	bInterfaceClass	1	0x10
6	bInterfaceSubClass	1	0x00
7	bInterfaceProtocol	1	0x00
8	iInterface	1	0

4.2.1.3.2.3. Control Interface Descriptor (Active Alternate Setting)

Offset	Field	Size	Value
0	bLength	1	9
1	bDescriptorType	1	INTERFACE(4)
2	bInterfaceNumber	1	0
3	bAlternateSetting	1	1
4	bNumEndpoints	1	2
5	bInterfaceClass	1	0x10
6	bInterfaceSubClass	1	0x00
7	bInterfaceProtocol	1	0x00
8	iInterface	1	0

4.2.1.3.2.4. AV Control Interface Descriptor

Offset	Field	Size	Value
0	bLength	1	4
1	bDescriptorType	1	AVCONTROL_IF (0x21)
2	bcdAVFunction	2	0x100

4.2.1.3.2.5. AVDD Info Control Descriptor

Offset	Field	Size	Value

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	AC_AVDD_INFO (1)
4	wRWN	2	Read-Only (0)

4.2.1.3.2.6. AVDD Content Control Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	AC_AVDD_CONTENT (2)
4	wRWN	2	Read-Only (0)

4.2.1.3.2.7. Input Terminal Descriptor

Offset	Field	Size	Value
0	bLength	1	8
1	bDescriptorType	1	TERMINAL (0x22)
2	wTerminalType	2	INPUT (1)
4	wEntityID	2	5
6	wAssocEntityID	2	2

4.2.1.3.2.8. Input Terminal Output Pin Descriptor

Offset	Field	Size	Value
0	bLength	1	2
1	bDescriptorType	1	OUTPUT_PIN (0x2A)

4.2.1.3.2.9. Input Terminatl Output Pin Channel Configuration Descriptor

Offset	Field	Size	Value
0	bLength	1	10
1	bDescriptorType	1	CH_CFG (0x2C)
2	bNrAudioChannel	1	0
3	bNrVideoChannels	1	1
4	wAudioChannelConfig	2	0
6	wVideoChannelConfig	2	OL001(0x1)
8	iAudioChannelNames	1	0
9	iVideoChannelNames	1	0

4.2.1.3.2.10. Cluster Control Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	TE_CLUSTER (1)
4	wRWN	2	RO (0)

4.2.1.3.2.11. Output Terminal Descriptor

Offset	Field	Size	Value
0	bLength	1	8
1	bDescriptorType	1	TERMINAL (0x22)
2	wTerminalType	2	OUTPUT (2)
4	wEntityID	2	16
6	wAssocEntityID	2	20

4.2.1.3.2.12. Output Terminal Source Pin Descriptor

Offset	Field	Size	Value
0	bLength	1	4
1	bDescriptorType	1	INPUT_PIN (0x2A)
2	wSourceID	2	13

4.2.1.3.2.13. Video Control Feature Unit Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	UNIT (0x23)
2	wUnitType	2	FEATURE (3)
4	wEntityID	2	13

4.2.1.3.2.14. Video Control Feature Unit Source Pin Descriptor

Offset	Field	Size	Value
0	bLength	1	4
1	bDescriptorType	1	INPUT_PIN (0x2A)
2	wSourceID	2	5

4.2.1.3.2.15. Video Control Feature Unit Source Pin Channel Configuration Descriptor

Offset	Field	Size	Value
0	bLength	1	10
1	bDescriptorType	1	CH_CFG (0x2C)
2	bNrAudioChannel	1	0
3	bNrVideoChannels	1	1
4	wAudioChannelConfig	2	0
6	wVideoChannelConfig	2	OL001(0x1)
8	iAudioChannelNames	1	0
9	iVideoChannelNames	1	0

4.2.1.3.2.16. Brightness Control Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	FU_BRIGHTNESS (2)
4	wRWN	2	RW (1)

4.2.1.3.2.17. Brightness Range Descriptor

Offset	Field	Size	Value
0	bLength	1	16
1	bDescriptorType	1	RANGES (0x26)
2	wRangeType	2	RANGE (1)
4	dwMin	4	0
8	dwMax	4	100
12	dwResolution	4	1

4.2.1.3.2.18. AVData Generic Out Descriptor

Offset	Field	Size	Value
0	bLength	1	10
1	bDescriptorType	1	AVDATA (0x24)
2	wEntityType	2	GENERIC (1)
4	wEntityID	2	20
6	wClockDomain	2	No Affiliation (0)
8	wClockDomainID	2	0

4.2.1.3.2.19. Active Alternate Control Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	AD_ACT_ALT_SETTING (3)
4	wRWN	2	RW (1)

4.2.1.3.2.20. AVData Framebuffer Descriptor

Offset	Field	Size	Value
0	bLength	1	10
1	bDescriptorType	1	AVDATA (0x24)
2	wEntityType	2	FRAMEBUFFER (2)
4	wEntityID	2	2
6	wClockDomain	2	No Affiliation (0)
8	wClockDomainID	2	0

4.2.1.3.2.21. Active Alternate Setting Control Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	AD_ACT_ALT_SETTING (3)
4	wRWN	2	RW (1)

4.2.1.3.2.22. EDID Control Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	AD_EDID (0x000C)
4	wRWN	2	RO (0)

4.2.1.3.2.23. Source Data Control Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	AD_SOURCEDATA (9)
4	wRWN	2	WO (2)

4.2.1.3.2.24. Stream Selector Descriptor

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	AVCONTROL (0x25)
2	wControlSelector	2	AD_STREAM_SELECTOR (0x000B)
4	wRWN	2	RW (1)

4.2.1.3.2.25. Video Bulk Stream Config Descriptor

Offset	Field	Size	Value
0	bLength	1	20
1	bDescriptorType	1	VIDEOBULK (0x27)
2	bmAttributes	2	HDCP Not Supported (0)
4	wChannels	2	OL001 (1)
6	wVideoFrameRate	2	60
8	wFrameOrganization	2	2D (1)
10	wFrameFormat	2	640x480P (2)
12	wVideoSampleFormat	2	RGB888 (3)
14	wSubSlotSize	2	0
16	wBitResolution	2	0
18	wVideoCompression	2	PARTIAL (2)

4.2.1.3.2.26. Bulk OUT Endpoint

Offset	Field	Size	Value
0	bLength	1	7
1	bDescriptorType	1	ENDPOINT (0x5)
2	bEndpointAddress	1	EP1-OUT (0x01)
3	bmAttributes	1	BULK (2)
4	wMaxPacketSize	2	Device-Specific
6	bInterval	1	0

4.2.1.3.2.27. Bulk OUT Endpoint Companion (SuperSpeed Only)

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	SUPERSPEED_USB_ENDPOINT_COMPANION (0x30)
2	bMaxBurst	1	Device-Specific
3	bmAttributes	1	No Streams Defined (0)
4	wBytesPerInterval	2	Device-Specific

4.2.1.3.2.28. Bulk IN Endpoint

Offset	Field	Size	Value
0	bLength	1	7
1	bDescriptorType	1	ENDPOINT (0x5)
2	bEndpointAddress	1	EP2-IN (0x82)
3	bmAttributes	1	BULK (2)
4	wMaxPacketSize	2	Device-Specific
6	bInterval	1	0

4.2.1.3.2.29. Bulk IN Endpoint Companion (SuperSpeed Only)

Offset	Field	Size	Value
0	bLength	1	6
1	bDescriptorType	1	SUPERSPEED_USB_ENDPOINT_COMPANION (0x30)
2	bMaxBurst	1	Device-Specific
3	bmAttributes	1	No Streams Defined (0)
4	wBytesPerInterval	2	Device-Specific

4.2.1.3.3. Other Descriptors

BOS, String, Device_Qualifier and Other_Speed_Configuration descriptors are not affected by this specification and shall be reported depending on speed and USB specification number, as they would for any device.