

UNIVERSAL SERIAL BUS
DEVICE CLASS DEFINITION
FOR
BASIC AUDIO FUNCTIONS

Release 3.0

September 22, 2016

SCOPE OF THIS RELEASE

This document is the Release 3.0 of this specification.

CONTRIBUTORS

Joe Scanlon	Advanced Micro Devices
Rhoads Hollowell	Apple Inc.
Girault Jones	Apple Inc.
Matthew X. Mora	Apple Inc.
Tzung-Dar Tsai	C-Media Electronics, Inc.
Brad Lambert	Cirrus Logic, Inc.
Dan Bogard	Conexant Systems, Inc.
Pete Burgers	DisplayLink (UK), Ltd.
David Roh	Dolby Laboratories, Inc.
Leng Ooi	Google, Inc.
Pierre-Louis Bossart	Intel Corporation
David Hines	Intel Corporation
Abdul Rahman Ismail (Co-Chair)	Intel Corporation
Devon Worrell	Intel Corporation
Chandrashekhar Rao	Logitech, Inc.
Terry Moore	MCCI Corporation
Alex Lin	MediaTek, Inc.
Bala Sivakumar	Microsoft Corporation
Geert Knapen (Co-Chair & Editor)	NXP Semiconductors PL Mobile Audio 411 E. Plumeria drive San Jose, CA 95134, USA Phone: +1 (408) 518-5514 E-mail: geert.knapen@nxp.com
James Goel	Qualcomm, Inc.
Andre Schevciw	Qualcomm, Inc.
Jin-Sheng Wang	Qualcomm, Inc.
Morten Christiansen	Synopsys

REVISION HISTORY

Rev.	Date	Filename	Description
1.0	Nov. 24, 09	BasicAudioDevice-10.pdf	Release 1.0
3.0	Sep. 22, 16	BasicAudioDevice30.pdf	Release 3.0

**Copyright © 1997-2016 USB Implementers Forum, Inc.
All rights reserved.**

INTELLECTUAL PROPERTY DISCLAIMER

A LICENSE IS HEREBY GRANTED TO REPRODUCE THIS SPECIFICATION FOR INTERNAL USE ONLY. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, IS GRANTED OR INTENDED HEREBY.

USB-IF AND THE AUTHORS OF THIS SPECIFICATION EXPRESSLY DISCLAIM ALL LIABILITY FOR INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS RELATING TO IMPLEMENTATION OF INFORMATION IN THIS SPECIFICATION. USB-IF AND THE AUTHORS OF THIS SPECIFICATION ALSO DO NOT WARRANT OR REPRESENT THAT SUCH IMPLEMENTATION(S) WILL NOT INFRINGE THE INTELLECTUAL PROPERTY RIGHTS OF OTHERS.

THIS SPECIFICATION IS PROVIDED "AS IS" AND WITH NO WARRANTIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE. ALL WARRANTIES ARE EXPRESSLY DISCLAIMED. USB-IF, ITS MEMBERS AND THE AUTHORS OF THIS SPECIFICATION PROVIDE NO WARRANTY OF MERCHANTABILITY, NO WARRANTY OF NON-INFRINGEMENT, NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, AND NO WARRANTY ARISING OUT OF ANY PROPOSAL, SPECIFICATION, OR SAMPLE.

IN NO EVENT WILL USB-IF, MEMBERS OR THE AUTHORS BE LIABLE TO ANOTHER FOR THE COST OF PROCURING SUBSTITUTE GOODS OR SERVICES, LOST PROFITS, LOSS OF USE, LOSS OF DATA OR ANY INCIDENTAL, CONSEQUENTIAL, INDIRECT, OR SPECIAL DAMAGES, WHETHER UNDER CONTRACT, TORT, WARRANTY, OR OTHERWISE, ARISING IN ANY WAY OUT OF THE USE OF THIS SPECIFICATION, WHETHER OR NOT SUCH PARTY HAD ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

NOTE: VARIOUS USB-IF MEMBERS PARTICIPATED IN THE DRAFTING OF THIS SPECIFICATION. CERTAIN OF THESE MEMBERS MAY HAVE DECLINED TO ENTER INTO A SPECIFIC AGREEMENT LICENSING INTELLECTUAL PROPERTY RIGHTS THAT MAY BE INFRINGED IN THE IMPLEMENTATION OF THIS SPECIFICATION. PERSONS IMPLEMENT THIS SPECIFICATION AT THEIR OWN RISK.

Dolby™, AC-3™, Pro Logic™ and Dolby Surround™ are trademarks of Dolby Laboratories, Inc.

All other product names are trademarks, registered trademarks, or service marks of their respective owners.

Please send comments via electronic mail to audio-chair@usb.org

TABLE OF CONTENTS

Scope of This Release	2
Contributors.....	2
Revision History	2
Table of Contents	4
List of Tables.....	6
List of Figures.....	7
1 Introduction.....	8
1.1 Scope	8
1.2 Purpose.....	8
1.3 Related Documents	8
1.4 Terms and Abbreviations.....	8
2 Management Overview	10
3 Classification.....	11
4 General Requirements.....	13
4.1 Host and Basic Audio Device Interoperability.....	13
4.2 BADD AudioStreaming Interfaces	13
4.2.1 USB Speeds	13
4.2.2 Burst Modes.....	13
4.2.3 Synchronization Type.....	13
4.2.4 Sampling Frequency & Bit Depth.....	13
4.2.5 Cluster Descriptors.....	14
4.3 Power Considerations.....	15
4.3.1 Power Domains.....	15
5 Topologies	16
5.1 BAOF Topology	16
5.2 BAIF Topology	16
5.3 BAIOF Topology	17
6 Descriptors.....	19
6.1 Standard Descriptors	19
6.2 Interface Descriptors	19
6.2.1 Interface Association Descriptor.....	19
6.2.2 AudioControl Interface Descriptors	20
6.2.3 AudioControl Endpoint Descriptors	27
6.2.4 AudioStreaming Interface Descriptors	27
6.3 String Descriptors	31
7 Requests	32

USB Audio Device Class Definition for Basic Audio Functions

7.1.1	Standard Requests	32
7.1.2	Class-specific Requests	32
8	BADD Profiles.....	34
8.1	Generic I/O Profile	34
8.2	Headphone Profile	36
8.3	Speaker Profile.....	36
8.4	Microphone Profile	37
8.5	Headset Profile	38
8.6	Headset Adapter Profile	38
8.7	Speakerphone Profile	39

LIST OF TABLES

Table 4-1: Mono Cluster Descriptor	14
Table 4-2: Stereo Cluster Descriptor	15
Table 6-3: Interface Association Descriptor	19
Table 6-4: Standard AC Interface Descriptor	20
Table 6-5: Class-Specific AC Interface Header Descriptor	20
Table 6-6: Input Terminal ID1 Descriptor	21
Table 6-7: Input Terminal ID4 Descriptor	21
Table 6-8: Output Terminal ID3 Descriptor	22
Table 6-9: Output Terminal ID6 Descriptor	22
Table 6-10: Connectors Descriptor	23
Table 6-11: Connectors Descriptor	23
Table 6-12: Mixer Unit Descriptor	24
Table 6-13: Feature Unit ID2 Descriptor	24
Table 6-14: Feature Unit ID5 Descriptor	25
Table 6-15: Feature Unit ID7 Descriptor	25
Table 6-16: Clock Source Descriptor	26
Table 6-17: Power Domain ID10 Descriptor	26
Table 6-18: Power Domain ID11 Descriptor	27
Table 6-19: Standard AC Interrupt Endpoint Descriptor	27
Table 6-20: Standard AS Interface Descriptor (Alt. Set. 0)	28
Table 6-21: Standard AS Interface Descriptor	28
Table 6-22: Class-Specific AS Interface Descriptor	29
Table 6-23: Standard AS Isochronous Audio Data Endpoint Descriptor	29
Table 6-24: Class-Specific AS Isochronous Audio Data Endpoint Descriptor	30
Table 6-25: Standard AS Explicit Feedback Endpoint Descriptor	30
Table 8-26: Number of Channels	34
Table 8-27: Generic Profile Descriptor Variables	35
Table 8-28: Headphone Profile Descriptor Variables	36
Table 8-29: Speaker Profile Descriptor Variables	36
Table 8-30: Microphone Profile Descriptor Variables	37
Table 8-31: Headset Profile Descriptor Variables	38
Table 8-32: Headset Adapter Profile Descriptor Variables	39
Table 8-33: Speakerphone Profile Descriptor Variables	40

LIST OF FIGURES

Figure 5-1:	BAOF Topology	16
Figure 5-2:	BAIF Topology	17
Figure 5-3:	BAIOF Topology	18

1**INTRODUCTION****1.1 SCOPE**

The *USB Audio Device Class Definition for Basic Audio Functions* applies to all USB Audio Functions that are based on the *Universal Serial Bus Device Class Definition for Audio Devices Release 3.0*. It defines baseline audio functionality for all ADC 3.0 compliant Hosts and Devices.

1.2 PURPOSE

The purpose of this specification is to create a higher level of interoperability among Hosts and Audio Devices. By establishing a set of essential audio features, users can expect a consistent experience, Device manufacturers have a solid template to follow, and Host drivers may be simplified.

1.3 RELATED DOCUMENTS

- *Universal Serial Bus Specification, Revision 2.0* (referred to in this document as the *USB Specification*). In particular, see Chapter 5, “USB Data Flow Model” and Chapter 9, “USB Device Framework.”
- *Universal Serial Bus 3.1 Specification*, Revision 1.0 (referred to in this document as the *USB 3.1 Specification*). This document covers details specific to SuperSpeed and SuperSpeed+ devices.
- *Universal Serial Bus Device Class Definition for Audio Devices Release 3.0* (referred to in this document as Audio 3.0 Specification or ADC 3.0 in short).
- *Universal Serial Bus Device Class Definition for Audio Data Formats Release 3.0* (referred to in this document as Audio 3.0 Data Formats).
- *Universal Serial Bus Device Class Definition for Terminal Types Release 3.0* (referred to in this document as Audio 3.0 Terminal Types).
- Device Class Definition for Human Interface Devices (HID) Version 1.11. June 27, 2001.
- *HID Usage Tables* Version 1.12. October 28, 2004. Please visit www.usb.org for the latest additions to the HID Usage Tables.

1.4 TERMS AND ABBREVIATIONS

This section defines terms used throughout this document. For additional terms that pertain to the Universal Serial Bus, see the “Terms and Abbreviations” section in the *USB Specification* and for terms that pertain to the Audio Device Class, see the “Terms and Abbreviations” section in the *Audio 3.0 Specification*.

Note: the terms “Audio Device” and “Audio Function” are used interchangeably in this document. Since audio functionality always resides at the interface level, the term Audio Device is strictly speaking only valid for devices that contain audio functionality only.

BADD:	Acronym for Basic Audio Device Definition.
BAIF:	Acronym for Basic Audio Input Function.
BAIFT:	Acronym for Basic Audio Input Function Topology.
BAIOF:	Acronym for Basic Audio Input/Output Function.
BAIOFT:	Acronym for Basic Audio Input/Output Function Topology.

BAOF:	Acronym for Basic Audio Output Function.
BAOFT:	Acronym for Basic Audio Output Function Topology.
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.

2**MANAGEMENT OVERVIEW**

The *USB Device Class Definition for Audio Devices* is a very rich specification, designed to cover virtually all Audio Functions and make them controllable via USB. As a result, a generic Audio Device Class driver tends to become rather complex, as it needs to be able to handle all the mandatory and optional features that are available in the specification.

For some audio applications where on one hand, the Host capabilities are inherently limited (such as handheld devices) and on the other hand the peripheral device complexity is limited (such as a headset), it is worthwhile to create a derived *USB Audio Device Class Definition for Basic Audio Functions* (this document) or *Basic Audio Device Definition* (BADD) in short, based on the existing *Audio 3.0 Specification*. The *Basic Audio Device Definition* defines a subclass specification to which compliant Audio Functions shall adhere. Since the *Basic Audio Device Definition* is only defining restrictions and limitations on the existing *Audio 3.0 Specification*, any Audio Function that is compliant with the *Basic Audio Device Definition* is automatically also compliant with the standard *Audio 3.0 Specification*.

3**CLASSIFICATION**

This specification creates the *Basic Audio Device Definition* (BADD), which is based on, compliant with, and a subset of the *Audio 3.0 specification*. It defines a baseline behavior for Basic Audio Functions and contains a set of rules, normative limitations, and informative descriptions that are applied to the *Audio 3.0 specification* to define a specific scope and use for this specification. It does not create new requirements that are not already part of the *Audio 3.0 specification* so that any Audio Function that complies with BADD is intrinsically compliant with the *Audio 3.0 specification*. In other words, BADD always defines a *subset specification* and never extends the *Audio 3.0 specification*.

BADD defines a number of very specific Audio Functions, called Profiles, each identifiable via a unique Profile Identifier. The Profile ID is reported via the **bFunctionSubClass** field of the Interface Association Descriptor. Once a driver has retrieved that Profile ID, it knows exactly the entire nature and capabilities of the Audio Function. All class-specific descriptors are fixed by this specification and therefore *shall not be included* in the Device's Configuration descriptor. Only standard USB descriptors for the Audio Function shall be present. Once a Host driver knows the Profile ID, it needs to refer to this BADD specification for the exact layout of the class-specific descriptors, based on the identifier and can assume that the BADD Audio Function is built exactly according to this document.

Device implementations shall not deviate from the Audio Function specification as presented in this document in any form.

Only three types of Audio Functions are allowed under the *Basic Audio Device Definition*. These are:

- Basic Audio Output Function (BAOF):

Contains one or more transducers that convert electrical signals into sound. These electrical signals are generated from digital data streams that are delivered over the USB to the BAOF. Some basic audio control functionality is also provided.
- Basic Audio Input Function (BAIF):

Contains one or more transducers that convert sound into electrical signals. These electrical signals are then converted into digital data streams that are delivered over the USB to a Host. Some Basic audio control functionality is also provided.
- Basic Audio I/O Function (BAIOF):

A combination of a BAIF and BAOF into a single Audio Function. In addition to the components found in a BAIF and BAOF, a BAIOF also contains a signal path from the input signal path to the output signal path so that the sound picked up by the audio input can be made audible through the audio output (Side-tone mixing).

Each BADD compliant Audio Function is based on one or a combination of the above types. This specification exhaustively defines the allowed combinations as distinct Profiles. For more details on currently defined Profiles, refer to Section 8, "BADD Profiles."

General requirements that apply to all Profiles are described in Section 4, "General Requirements". The allowed topologies for a BAOF, BAIF, and BAIOF are highlighted in Section 5, "Topologies". Section 6, "Descriptors" presents some of the standard descriptors with their specific field values as they apply to a BADD compliant Device as well as a full set of all possible class-specific descriptors that are needed to describe all of the supported Profiles. Note that the class-specific descriptors are not implemented into the BADD device but must be inferred from this specification, based on the Profile ID the BADD Device exposes. Section 7, "Requests" presents an overview of all

possible requests a BADD Device may need to support. Finally, Section 8, “BADD Profiles” provides details about each Profile as defined by this specification.

4**GENERAL REQUIREMENTS****4.1 HOST AND BASIC AUDIO DEVICE INTEROPERABILITY**

A Host can claim interoperability with BADD when it supports all BADD Profiles.

BADD Devices shall be constructed in full compliance with this specification and provide all necessary Configurations as described in the Backwards Compatibility Section of the ADC 3.0 specification.

It is highly recommended that a Basic Audio Function assume default values for all of its settings that provide a good user experience without the need for prior Host intervention. For example, in the case of a BAIOF, the Volume Control of the Sidetone Feature Unit (see further) should have a default value (out-of-the-box) such that a comfortable sidetone level is mixed into the output path.

4.2 BADD AUDIOSTREAMING INTERFACES

All BADD AudioStreaming interfaces shall be of the type USB Streaming. There shall be at most one AudioStreaming IN interface and at most one AudioStreaming OUT interface. MIDISreaming interfaces are not allowed.

4.2.1 USB SPEEDS

A Device that incorporates a BADD compliant Audio Function may support any USB-defined operating speed that supports isochronous transfers.

4.2.2 BURST MODES

All BADD AudioStreaming interfaces shall at least (besides the mandatory zero-bandwidth Alternate Setting #0) support an Active Alternate Setting #1 that supports Continuous Mode with a Service Interval set to 1 ms. For the currently defined USB speeds, this translates into a bInterval field value equal to 1 for full-speed Devices and a bInterval field value equal to 4 for high-speed and SuperSpeed Devices. Additional Alternate Settings are allowed to support different levels of Bursting.

4.2.3 SYNCHRONIZATION TYPE

Basic Audio Functions shall support the same Synchronization Type on all of their streaming endpoints. Only Synchronous or Asynchronous Synchronization Types are allowed.

The implemented Synchronization Type is indicated in the **bmAttributes** field of the standard Endpoint descriptor of the AudioStreaming interface.

For an Asynchronous Sink implementation, the AudioStreaming interface shall implement an Explicit Feedback endpoint for synchronization purposes, so that the Sink endpoint can operate independently from a Source endpoint that may be present in the same Audio Function. This allows the Host to selectively bring the input section Power Domain of the Audio Function into a lower Power State when not in use.

4.2.4 SAMPLING FREQUENCY & BIT DEPTH

All BADD AudioStreaming interfaces shall only support 48 kHz. They shall support both 16 bits and 24 bits sample sizes.

4.2.5 CLUSTER DESCRIPTORS

A BADD Device can only support one of two Cluster configurations.

4.2.5.1 MONO CLUSTER DESCRIPTOR

Table 4-1: Mono Cluster Descriptor

	Offset	Field	Size	Value	Description
Header	0	wLength	2	0x0010	Total length of the Cluster descriptor, in bytes: 16.
	2	bDescriptorType	1	0x26	CS_CLUSTER descriptor type.
	3	bDescriptorSubtype	1	0x00	SUBTYPE_UNDEFINED descriptor subtype.
	4	wDescriptorID	2	0x0001	Unique ID of this Cluster descriptor.
	6	bNrChannels	1	1	Mono Cluster.
Channel 1 Block	7	wLength	2	0x0006	Length of the Information Segment, in bytes.
	9	bSegmentType	1	0x20	CHANNEL_INFORMATION.
	10	bChPurpose	1	0x00	Generic Audio.
	11	bChRelationship	1	0x01	Mono.
	12	bChGroupID	1	0x00	ID used to group channels together.
	13	wLength	2	0x0003	Length of the End Segment, in bytes.
	15	bSegmentType	1	0xFF	END_SEGMENT.

4.2.5.2 STEREO CLUSTER DESCRIPTOR

Table 4-2: Stereo Cluster Descriptor

		Offset	Field	Size	Value	Description
Header		0	wLength	2	0x0019	Total length of the Cluster descriptor, in bytes: 25.
		2	bDescriptorType	1	0x26	CS_CLUSTER descriptor type.
		3	bDescriptorSubtype	1	0x00	SUBTYPE_UNDEFINED descriptor subtype.
		4	wDescriptorID	2	0x0002	Unique ID of this Cluster descriptor.
		6	bNrChannels	1	2	Stereo Cluster.
Channel1 Block	Information Segment	7	wLength	2	0x0006	Length of the Information Segment, in bytes.
		9	bSegmentType	1	0x20	CHANNEL_INFORMATION.
		10	bChPurpose	1	0x00	Generic Audio.
		11	bChRelationship	1	0x02	Left.
		12	bChGroupID	1	0x00	ID used to group channels together.
	End	13	wLength	2	0x0003	Length of the End Segment, in bytes.
		15	bSegmentType	1	0xFF	END_SEGMENT.
Channel2 Block	Information Segment	16	wLength	2	0x0006	Length of the Information Segment, in bytes.
		18	bSegmentType	1	0x20	CHANNEL_INFORMATION.
		19	bChPurpose	1	0x00	Generic Audio.
		20	bChRelationship	1	0x03	Right.
		21	bChGroupID	1	0x00	ID used to group channels together.
	End	22	wLength	2	0x0003	Length of the End Segment, in bytes.
		24	bSegmentType	1	0xFF	END_SEGMENT.

4.3 POWER CONSIDERATIONS

Per the ADC 3.0 specification, a bus-powered Device that contains an Audio Function shall support the LPM/L1 power state. Refer to the ADC 3.0 specification for further details.

Note that the use of audio bursting and LPM/L1 enables considerable power savings.

4.3.1 POWER DOMAINS

The Output functionality of the Basic Audio Function, if present shall reside in its own independent Power Domain. Likewise, the Input functionality, if present, shall also reside in its own independent Power Domain. This allows the Host to selectively reduce power consumption when parts of the Basic Audio Function are currently not being used.

5**TOPOLOGIES****5.1 BAOF TOPOLOGY**

All Basic Audio Output Functions shall use the BAOF topology (BAOFT) presented below.

Input Terminal ID1 represents the AudioStreaming Interface that is used to stream the BAOF data from the Host to the BAOF (mono or stereo). The Output Pin of Input Terminal ID1 is connected to the Input Pin of Feature Unit ID2. The Output Pin of Feature Unit ID2 is connected to the Input Pin of Output Terminal ID3, which represents the physical audio output of the device.

All building blocks (Input Terminal, Feature Unit, etc.) shall be present as indicated in Figure 5-1 below and the ID fields of the respective Entity descriptors shall be assigned as follows:

- Input Terminal ID1: **bTerminalID** = 1
- Feature Unit ID2: **bUnitID** = 2
- Output Terminal ID3: **bTerminalID** = 3
- Clock Source Entity ID9: **bClockID** = 9
- Power Domain ID10: **bPowerDomainID** = 10

The single Clock Source Entity ID9 provides the sampling clock for the entire BAOFT. All of its timing aspects are referenced to the Start of Bus Interval on the USB.

Input Terminal ID1 and Output Terminal ID3 belong to the single Power Domain ID10.

The audio signal path may be mono ($x = 1$) or stereo ($x = 2$). If the AudioStreaming interface supports both mono and stereo Alternate Settings, then the audio signal path shall be stereo.

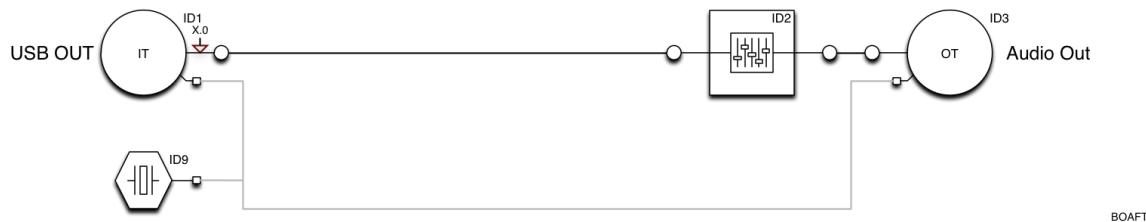


Figure 5-1:BAOFT Topology

5.2 BAIF TOPOLOGY

All Basic Audio Input Functions shall use the BAIF topology (BAIFT) presented below.

Input Terminal ID4 represents the physical input to the device (mono or stereo). The Output Pin of Input Terminal ID4 is connected to the Input Pin of Feature Unit ID5. The Output Pin of Feature Unit ID5 is connected to the Input Pin of Output Terminal ID6, which represents the AudioStreaming Interface that is used to stream the audio data to the Host.

All building blocks (Input Terminal, Feature Unit, etc.) shall be present as indicated in Figure 5- below and the **bTerminalID** and **bUnitID** fields of the respective Entity descriptors shall be assigned as follows:

- Input Terminal ID4: **bTerminalID** = 4

- Feature Unit ID5: **bUnitID** = 5
- Output Terminal ID6: **bTerminalID** = 6
- Clock Source Entity ID9: **bClockID** = 9
- Power Domain ID11: **bPowerDomainID** = 11

The single Clock Source Entity ID9 provides the sampling clock for the entire BAIF. All of its timing aspects are referenced to the Start of Bus Interval on the USB.

Input Terminal ID4 and Output Terminal ID6 all belong to Power Domain ID11.

The audio signal path may be mono ($y = 1$) or stereo ($y = 2$). If the AudioStreaming interface supports both mono and stereo Alternate Settings, then the audio signal path shall be stereo.



Figure 5-2:BAIF Topology

5.3 BAIOF TOPOLOGY

All Basic Audio Input/Output Functions shall use the BAIOF topology (BAIOFT) presented below.

Input Terminal ID4 represents the physical audio input. The Output Pin of Input Terminal ID4 is connected to the Input Pin of Feature Unit ID5. The Output Pin of Feature Unit ID5 is connected to the Input Pin of Output Terminal ID6, which represents the AudioStreaming Interface that is used to stream the audio data to the Host.

Input Terminal ID1 represents the AudioStreaming Interface that is used to stream the data from the Host to the BADD device. The Output Pin of Input Terminal ID1 is connected to Input Pin 1 of Mixer Unit ID8. The Output Pin of Mixer Unit ID8 is connected to the Input Pin of Feature Unit ID2. The Output Pin of Feature Unit ID2 is connected to the Input Pin of Output Terminal ID3, which represents the physical audio output.

Input Terminal ID4 (the microphone) is also connected to the Input Pin of Feature Unit ID7. The Output Pin of Feature Unit ID7 is connected to Input Pin 2 of Mixer Unit ID8. This connection creates the side tone-mixing signal path between audio input and audio output.

All building blocks (Input Terminals, Feature Units, etc.) shall be present as indicated in Figure 5- below and the ID fields of the respective Entity descriptors shall be assigned as follows. Also, Pin numbers shall be assigned as indicated in the figures:

- Input Terminal ID1: **bTerminalID** = 1
- Feature Unit ID2: **bUnitID** = 2
- Output Terminal ID3: **bTerminalID** = 3
- Input Terminal ID4: **bTerminalID** = 4
- Feature Unit ID5: **bUnitID** = 5
- Output Terminal ID6: **bTerminalID** = 6
- Feature Unit ID7: **bUnitID** = 7

- Mixer Unit ID8: **bUnitID** = 8
 - Clock Source Entity ID9: **bClockID** = 9
 - Power Domain ID10: **bPowerDomainID** = 10
 - Power Domain ID11: **bPowerDomainID** = 11

The single Clock Source Entity ID9 provides the sampling clock for the entire BAIOF. All of its timing aspects are referenced to the Start of Bus Interval on the USB.

Input Terminal ID1 and Output Terminal ID3 belong to Power Domain ID10.

Input Terminal ID4 and Output Terminal ID6 belong to Power Domain ID11.

The audio IN signal path shall always be mono.

The audio OUT signal path may be mono ($x = 1$) or stereo ($x = 2$). If the AudioStreaming OUT interface supports both mono and stereo Alternate Settings, then the audio signal path shall be stereo.

The side tone signal shall be mixed equally into all channels of the output signal path.

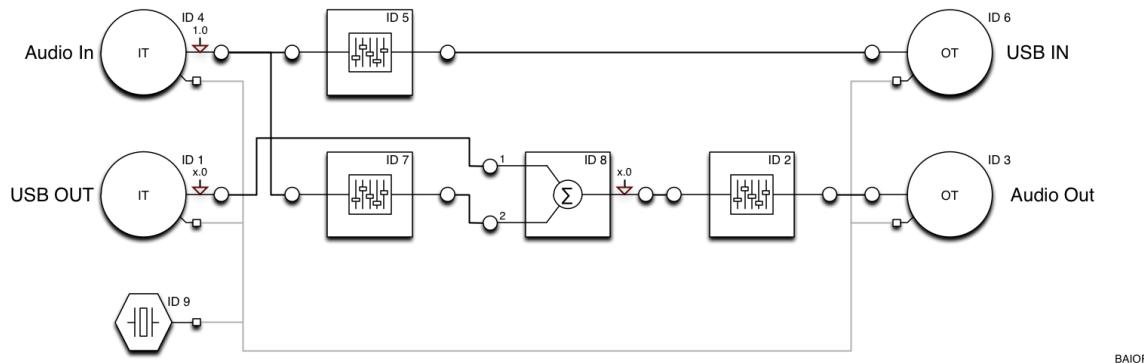


Figure 5-3:BAIOF Topology

6**DESCRIPTORS**

To allow for backward compatible extensions, additional fields may be added to the class-specific descriptors in future versions of this specification. Therefore, descriptor parsers should be tolerant of descriptor lengths that are larger than currently specified in the **bLength** fields of these descriptors. See the *USB Specification* for more details.

6.1 STANDARD DESCRIPTORS

This class specification does not define a specific audio device descriptor because audio functionality always resides at the interface level. For *audio-only* devices, the device descriptor shall indicate that class information is to be found at the interface level. Therefore, the **bDeviceClass**, **bDeviceSubClass** and **bDeviceProtocol** fields of the device descriptor shall contain the values 0xEF, 0x02, and 0x01 respectively so that enumeration software looks down at the interface level to determine the Interface Class and to also ensure that IAD-aware enumeration software gets loaded. All other fields of the device descriptor shall comply with the definitions in the *USB Specification*.

6.2 INTERFACE DESCRIPTORS

For a general description and overview of the Audio Device Class Interface descriptors, refer to the most recent *USB Device Class Definition for Audio Devices*. The following sections describe the standard and class-specific USB Interface descriptors as they relate to a BADD Function.

6.2.1 INTERFACE ASSOCIATION DESCRIPTOR

The **bFunctionSubClass** field contains the Profile ID that uniquely identifies the Profile to which the Basic Audio Function is compliant. For a list of supported Profiles, refer to Section 8, “BADD Profiles.” For a list of associated Profile ID values, refer to the Function SubClass table in the Appendix of the ADC 3.0 specification.

Table 6-3: Interface Association Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor: 8.
1	bDescriptorType	1	0x0B	INTERFACE ASSOCIATION descriptor type.
2	bFirstInterface	1	Implementation-dependent	Interface Number of the first interface that is associated with this function.
3	bInterfaceCount var=IAD1	1	Profile-dependent	Number of interfaces in this Association.
4	bFunctionClass	1	0x01	AUDIO.
5	bFunctionSubClass	1	Implementation-dependent	Profile ID.
6	bFunctionProtocol	1	0x30	ADC 3.0.
7	iFunction	1	Index	Index of a string descriptor that describes this interface. If no string is provided, shall be set to 0x00.

6.2.2 AUDIOCONTROL INTERFACE DESCRIPTORS

6.2.2.1 STANDARD AC INTERFACE DESCRIPTOR

The standard AC interface descriptor is identical to the standard interface descriptor defined in the *USB Specification*, except that most fields now have dedicated values.

The AudioControl interface uses the default pipe (endpoint 0) for all communication purposes. Class-specific AudioControl Requests are sent using the default pipe. A Status Interrupt endpoint shall be present if one or more Audio Controls in the Audio Function require change report capabilities.

Table 6-4: Standard AC Interface Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor: 9
1	bDescriptorType	1	0x04	INTERFACE descriptor type
2	bInterfaceNumber	1	Implementation-dependent	Number of the AudioControl interface. The AudioControl interface shall be the first interface in the collection.
3	bAlternateSetting	1	0x00	Only Alternate Setting 0 for the AudioControl interface.
4	bNumEndpoints	1	0x00	No status endpoint present.
			0x01	A status interrupt endpoint is present.
5	bInterfaceClass	1	0x01	AUDIO.
6	bInterfaceSubClass	1	0x01	AUDIOCONTROL.
7	bInterfaceProtocol	1	0x30	Number that describes the compliance level of the BADD.
8	iInterface	1	Index	Index of a string descriptor that describes this interface. If no string is provided, shall be set to 0x00.

6.2.2.2 CLASS-SPECIFIC AC INTERFACE DESCRIPTOR (INFERRED)

A BADD Audio Function shall support accurate latency reporting on all of its building blocks through the presence of Latency Controls on all Terminals and Units.

Table 6-5: Class-Specific AC Interface Header Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0A	Size of this descriptor: 10.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x01	HEADER descriptor subtype.
3	bCategory var=ACID1	1	Profile-dependent	
4	wTotalLength var=ACID2	2	Profile-dependent	Total number of bytes returned for the class-specific AudioControl interface descriptor.
6	bmControls	4	0x00000001	Read-Only Latency Control.

6.2.2.3 INPUT TERMINAL ID1 DESCRIPTOR (INFERRED)

Table 6-6: Input Terminal ID1 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x14	Size of this descriptor: 20.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL descriptor subtype.
3	bTerminalID	1	0x01	Input Terminal ID1.
4	wTerminalType	2	0x0101	USB Streaming.
6	bAssocTerminal	1	0x00	No associated Terminal.
7	bCSourceID	1	0x09	Clock Source ID9.
8	bmControls	4	0x00000000	No Controls.
12	wClusterDescrID var=IT1D1	2	Implementation-dependent	ID of the Cluster descriptor for this Input Terminal.
14	wExTerminalDescrID	2	0x0000	No Extended Terminal.
16	wConnectorsDescrID	2	0x0000	No Connectors descriptor for this Input Terminal.
18	wTerminalDescrStr	2	0x0000	Not used.

6.2.2.4 INPUT TERMINAL ID4 DESCRIPTOR (INFERRED)

Table 6-7: Input Terminal ID4 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x14	Size of this descriptor: 20.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL descriptor subtype.
3	bTerminalID	1	0x04	Input Terminal ID4.
4	wTerminalType var=IT4D1	2	Profile-dependent	
6	bAssocTerminal var=IT4D2	1	Profile-dependent	
7	bCSourceID	1	0x09	Clock Source ID9.
8	bmControls var=IT4D3	4	Profile-dependent	D1..0: Insertion Control may be present.
12	wClusterDescrID var=IT4D4	2	Implementation-dependent	ID of the Cluster descriptor for this Input Terminal.
14	wExTerminalDescrID	2	0x0000	No Extended Terminal.
16	wConnectorsDescrID var=IT4D5	2	Profile-dependent	ID of the Connectors descriptor for this Input Terminal.
18	wTerminalDescrStr	2	0x0000	Not used.

6.2.2.5 OUTPUT TERMINAL ID3 DESCRIPTOR (INFERRED)

Table 6-8: Output Terminal ID3 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x13	Size of this descriptor: 19.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL descriptor subtype.
3	bTerminalID	1	0x03	Output Terminal ID3.
4	wTerminalType var=OT3D1	2	Profile-dependent	
6	bAssocTerminal var=OT3D2	1	Profile-dependent	
7	bSourceID	1	0x02	Connected to Feature Unit ID2.
8	bCSourceID	1	0x09	Clock Source ID9.
9	bmControls var=OT3D3	4	Profile-dependent	D1..0: Insertion Control may be present.
13	wExTerminalDescrID	2	0x0000	ID of the Extended Terminal descriptor for this Output Terminal.
15	wConnectorsDescrID var=OT3D4	2	Profile-dependent	ID of the Connectors descriptor for this Output Terminal.
17	wTerminalDescrStr	2	0x0000	Not used.

6.2.2.6 OUTPUT TERMINAL ID6 DESCRIPTOR (INFERRED)

Table 6-9: Output Terminal ID6 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x13	Size of this descriptor: 19.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL descriptor subtype.
3	bTerminalID	1	0x06	Output Terminal ID6.
4	wTerminalType	2	0x0101	USB Streaming.
6	bAssocTerminal	1	0x00	No associated Terminal.
7	bSourceID	1	0x05	Connected to Feature Unit ID5.
8	bCSourceID	1	0x09	Clock Source ID9.
9	bmControls	4	0x00000000	No Controls.
13	wExTerminalDescrID	2	0x0000	ID of the Extended Terminal descriptor for this Output Terminal.
15	wConnectorsDescrID	2	0x0000	No Connectors descriptor for this Output Terminal.
17	wTerminalDescrStr	2	0x0000	Not used.

6.2.2.7 CONNECTORS DESCRIPTOR

In case the BADD Device is actually a Headset adapter (the physical (analog) device can be detached from the adapter), it shall support the Connectors descriptor and Insertion Control.

6.2.2.7.1 CONNECTORS DESCRIPTOR ASSOCIATED WITH INPUT TERMINAL 4 (INFERRED)

Table 6-10: Connectors Descriptor

Offset	Field	Size	Value	Description
0	wLength	2	0x0012	Size of this descriptor: 18.
2	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
3	bDescriptorSubtype	1	0x0F	CONNECTORS descriptor subtype.
4	wDescriptorID	2	0x0003	Unique ID for the High Capability Connectors descriptor.
6	bNrConnectors	1	0x01	The number of Connectors associated with this Terminal: 1.
7	bConID	1	0x01	Unique identifier for the Connector.
8	waClusterDescrID(1)	2	0x0001	Mono Cluster.
10	baConType(1)	1	0x02	3.5 mm Phone connector.
11	bmaConAttributes(1)	1	0x06	Female connector with insertion detection.
12	waConDescrStr(1)	2	0x0000	Not used.
14	daConColor(1)	4	0x01000000	Color unspecified.

6.2.2.7.2 CONNECTORS DESCRIPTOR ASSOCIATED WITH OUTPUT TERMINAL 3 (INFERRED)

Table 6-11: Connectors Descriptor

Offset	Field	Size	Value	Description
0	wLength	2	0x0012	Size of this descriptor: 18.
2	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
3	bDescriptorSubtype	1	0x0F	CONNECTORS descriptor subtype.
4	wDescriptorID	2	0x0004	Unique ID for the High Capability Connectors descriptor.
6	bNrConnectors	1	0x01	The number of Connectors associated with this Terminal: 1.
7	bConID	1	0x01	Unique identifier for the Connector.
8	waClusterDescrID(1)	2	0x0002	Stereo Cluster.
10	baConType(1)	1	0x02	3.5 mm Phone connector.
11	bmaConAttributes(1)	1	0x06	Female connector with insertion detection.
12	waConDescrStr(1)	2	0x0000	Not used.
14	daConColor(1)	4	0x01000000	Color unspecified.

6.2.2.8 MIXER UNIT ID8 DESCRIPTOR (INFERRED)

Table 6-12: Mixer Unit Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x10	Size of this descriptor: 16.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x05	MIXER_UNIT descriptor subtype.
3	bUnitID	1	0x08	Mixer Unit ID8.
4	bNrInPins	1	0x02	Number of Input Pins
5	baSourceID(1)	1	0x01	Connected to Input Terminal ID1.
6	baSourceID(2)	1	0x07	Connected to Feature Unit ID7.
7	wClusterDescrID var=MUD1	2	Implementation-dependent	Mono or Stereo Output Cluster.
9	bmMixerControls	1	0x00	All Mixer Controls are non-programmable.
10	bmControls	4	0x00000000	No Controls.
14	wMixerDescrStr	2	0x0000	Not used.

6.2.2.9 FEATURE UNIT ID2 DESCRIPTOR (INFERRED)

Only a Mute Control shall be present in the Master Channel.

Only a Volume Control shall be present in Channel 1 and Channel 2 (if present).

No other Audio Controls shall be present.

Table 6-13: Feature Unit ID2 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0F 0x13	15 bytes for mono Cluster. 19 bytes for stereo Cluster.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT descriptor subtype.
3	bUnitID	1	0x02	Feature Unit ID2.
4	bSourceID var=FU2D1	1	Profile-dependent	Connected to IT ID1 for BAOF. Connected to MU ID8 for BAIOF.
5	bmaControls(0)	4	0x00000003	Mute Control.

If Mono Cluster:

9	bmaControls(1)	4	0x0000000C	Volume Control for logical channel 1.
13	wFeatureDescrStr	2	0x0000	Not used.

If Stereo Cluster:

9	bmaControls(1)	4	0x0000000C	Volume Control for logical channel 1.
13	bmaControls(2)	4	0x0000000C	Volume Control for logical channel 2.

17	wFeatureDescrStr	2	0x0000	Not used.
----	------------------	---	--------	-----------

6.2.2.10 FEATURE UNIT ID5 DESCRIPTOR (INFERRED)

Only a Mute Control shall be present in the Master Channel.

Only a Volume Control shall be present in Channel 1 and Channel 2 (if present).

No other Audio Controls shall be present.

Table 6-14: Feature Unit ID5 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0F 0x13	15 bytes for mono Cluster. 19 bytes for stereo Cluster.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT descriptor subtype.
3	bUnitID	1	0x05	Feature Unit ID5.
4	bSourceID	1	0x04	connected to IT ID4.
5	bmaControls(0)	4	0x00000003	Mute Control.

If Mono Cluster:

9	bmaControls(1)	4	0x0000000C	Volume Control for logical channel 1.
13	wFeatureDescrStr	2	0x0000	Not used.

If Stereo Cluster:

9	bmaControls(1)	4	0x0000000C	Volume Control for logical channel 1.
13	bmaControls(2)	4	0x0000000C	Volume Control for logical channel 2.
17	wFeatureDescrStr	2	0x0000	Not used.

6.2.2.11 FEATURE UNIT ID7 DESCRIPTOR (INFERRED)

Only a Mute Control shall be present in the Master Channel.

Only a Volume Control shall be present in Channel 1.

No other Audio Controls shall be present.

Table 6-15: Feature Unit ID7 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0F	15 bytes for mono Cluster.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT descriptor subtype.
3	bUnitID	1	0x07	Feature Unit ID7.
4	bSourceID	1	0x04	Connected to IT ID4.
5	bmaControls(0)	4	0x00000003	Mute Control.

Offset	Field	Size	Value	Description
9	bmaControls(1)	4	0x0000000C	Volume Control for logical channel 1.
13	wFeatureDescrStr	2	0x0000	Not used.

6.2.2.12 CLOCK SOURCE DESCRIPTOR (INFERRED)

Table 6-16: Clock Source Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor: 12.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x0B	CLOCK_SOURCE descriptor subtype.
3	bClockID	1	0x09	Clock Source ID9.
4	bmAttributes	1	Implementation-dependent	D0 = 0b1. Internal Clock. D1 is derived from the endpoint Synchronization Type. D1 = 0b0 for Asynchronous. D1 = 0b1 for Synchronous.
5	bmControls	4	0x00000001	Read-Only Clock Frequency Control. 48 kHz fixed.
9	bReferenceTerminal	1	0x00	Clock not derived from a Terminal.
10	wClockSourceStr	2	0x0000	Not used.

6.2.2.13 POWER DOMAIN ID10 DESCRIPTOR (INFERRED)

Table 6-17: Power Domain ID10 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0D	Size of this descriptor: 13.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x10	POWER_DOMAIN descriptor subtype.
3	bPowerDomainID	1	0x0A	Power Domain ID10.
4	waRecoveryTime(1)	2	0x0258	Time to recover from D1 to D0. 30 ms, expressed in 50 µs increments.
6	waRecoveryTime(2)	2	0x1770	Time to recover from D2 to D0. 300 ms, expressed in 50 µs increments.
8	bNrEntities	1	0x02	Number of Entities belonging to this Power Domain.
9	baEntityID(1)	1	0x01	Input Terminal ID1.
10	baEntityID(2)	1	0x03	Output Terminal ID3.
11	wPDomainDescrStr	2	0x0000	Not used.

6.2.2.14 POWER DOMAIN ID11 DESCRIPTOR (INFERRED)

Table 6-18: Power Domain ID11 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0D	Size of this descriptor: 13
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x10	POWER_DOMAIN descriptor subtype.
3	bPowerDomainID	1	0x0B	Power Domain ID11.
4	waRecoveryTime(1)	2	0x0258	Time to recover from D1 to D0. 30 ms, expressed in 50 µs increments.
6	waRecoveryTime(2)	2	0x1770	Time to recover from D2 to D0. 300 ms, expressed in 50 µs increments.
8	bNrEntities	1	0x02	Number of Entities belonging to this Power Domain.
9	baEntityID(1)	1	0x04	Input Terminal ID4.
10	baEntityID(2)	1	0x06	Output Terminal ID6.
11	wPDomainDescrStr	2	0x0000	Not used.

6.2.3 AUDIOCONTROL ENDPOINT DESCRIPTORS

The AudioControl interface uses the default endpoint 0. Therefore, there is no dedicated standard and class-specific control endpoint descriptor. A Status Interrupt endpoint shall be present if one or more Audio Controls in the Audio Function require change report capabilities. Only the Headset Adapter Profile requires the status interrupt endpoint to report insertion events.

6.2.3.1 STANDARD AC INTERRUPT ENDPOINT DESCRIPTOR

Table 6-19: Standard AC Interrupt Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor: 7
1	bDescriptorType	1	0x05	ENDPOINT descriptor type
2	bEndpointAddress	1	Implementation-dependent	IN endpoint.
3	bmAttributes	1	0x03	Interrupt endpoint.
4	wMaxPacketSize	2	0x06	6-byte interrupt information.
6	bInterval	1	Implementation-dependent	Interval for polling the Interrupt endpoint.

6.2.4 AUDIOSTREAMING INTERFACE DESCRIPTORS

The AudioStreaming Interface descriptors shall follow the AudioControl Interface descriptors.

The AudioStreaming interface has two possible alternate settings.

6.2.4.1.1 ZERO-BANDWIDTH ALTERNATE SETTING 0

Alternate setting 0 is a zero-bandwidth setting, used to relinquish the claimed bandwidth on the bus when the AudioStreaming interface is not in use. It is the default setting after power-up. The zero bandwidth is implemented by specifying that this Alternate Setting of the interface has no endpoints associated with it (bNumEndpoints=0). The collection of descriptors for this Alternate Setting reduces to the standard interface descriptor.

6.2.4.1.1.1 STANDARD AS INTERFACE DESCRIPTOR

Table 6-20: Standard AS Interface Descriptor (Alt. Set. 0)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor: 9
1	bDescriptorType	1	0x04	INTERFACE descriptor type
2	blInterfaceNumber	1	Implementation-dependent	Number of the AudioStreaming interface.
3	bAlternateSetting	1	0x00	Index of this alternate setting.
4	bNumEndpoints	1	0x00	0 endpoints.
5	blInterfaceClass	1	0x01	AUDIO.
6	blInterfaceSubClass	1	0x02	AUDIO_STREAMING.
7	blInterfaceProtocol	1	0x30	ADC 3.0.
8	ilInterface	1	Index	Index of a string descriptor, describing the interface. If no string is provided, shall be set to 0x00.

6.2.4.1.2 OPERATIONAL ALTERNATE SETTING(S)

An AudioStreaming interface may have one or more operational Alternate Settings, each representing a different operating mode of the interface.

6.2.4.1.2.1 STANDARD AS INTERFACE DESCRIPTOR

Table 6-21: Standard AS Interface Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor: 9
1	bDescriptorType	1	0x04	INTERFACE descriptor type
2	blInterfaceNumber	1	Implementation-dependent	Number of the AudioStreaming interface.
3	bAlternateSetting	1	Implementation-dependent	Index of this alternate setting.
4	bNumEndpoints	1	0x01	Isochronous data endpoint only.
			0x02	Isochronous data and feedback endpoint. Only for Asynchronous AudioStreaming OUT interface.
5	blInterfaceClass	1	0x01	AUDIO.
6	blInterfaceSubClass	1	0x02	AUDIO_STREAMING.

Offset	Field	Size	Value	Description
7	bInterfaceProtocol	1	0x30	ADC 3.0.
8	iInterface	1	Index	Index of a string descriptor, describing the interface. If no string is provided, shall be set to 0x00.

6.2.4.1.2.2 CLASS-SPECIFIC AS INTERFACE DESCRIPTOR (INFERRED)

Table 6-22: Class-Specific AS Interface Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x15	Size of this descriptor: 23.
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor type.
2	bDescriptorSubtype	1	0x01	AS_GENERAL descriptor subtype.
3	bTerminalLink	1	Implementation-dependent	0x01 if this descriptor is part of the AudioStreaming OUT interface. 0x06 if this descriptor is part of the AudioStreaming IN interface.
4	bmControls	4	0x00000000	No Controls.
8	wClusterDescrID	2	Implementation-dependent	0x0001 if the Alternate Setting of the interface supports a mono audio stream. 0x0002 if the Alternate Setting of the interface supports a stereo audio stream.
10	bmFormats	8	0x00000000 00000001	PCM.
18	bSubslotSize	1	Implementation-dependent	0x02 (2 bytes) if the Alternate Setting of the interface supports 16 bit. 0x03 (3 bytes) if the Alternate Setting of the interface supports 24 bit. See Section 8, "BADD Profiles".
19	bBitResolution	1	Implementation-dependent	0x10 (16) if the Alternate Setting of the interface supports 16 bit. 0x18 (24) if the Alternate Setting of the interface supports 24 bit. See Section 8, "BADD Profiles".
20	bmAuxProtocols	2	0x0000	No Auxiliary protocols.
22	bControlSize	1	0x00	No Control Channel.

6.2.4.1.2.3 STANDARD AS AUDIO DATA ENDPOINT DESCRIPTOR

Depending on the number of channels in the signal path (mono or stereo) and the implemented Synchronization Type, the standard AS Audio Data Endpoint descriptor is slightly different.

Table 6-23: Standard AS Isochronous Audio Data Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor: 7

Offset	Field	Size	Value	Description
1	bDescriptorType	1	0x05	ENDPOINT descriptor.
2	bEndpointAddress	1	Implementation-dependent	AudioStreaming OUT: 0b0000xxxx. AudioStreaming IN: 0b1000xxxx.
3	bmAttributes	1	Implementation-dependent	0x05 for Isochronous Asynchronous endpoint. 0x0D for Isochronous Synchronous endpoint.
4	wMaxPacketSize	2	Profile-dependent	See Table Table 8-26, "Number of Channels".
6	bInterval	1	Implementation-dependent	Alternate Setting 1 requires the following: 0x01 for full-speed endpoint. 0x04 for high-speed or SuperSpeed endpoint.

6.2.4.1.2.4 CLASS-SPECIFIC ISOCHRONOUS AUDIO DATA ENDPOINT DESCRIPTOR (INFERRED)

Table 6-24: Class-Specific AS Isochronous Audio Data Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0A	Size of this descriptor: 10
1	bDescriptorType	1	0x25	CS_ENDPOINT descriptor type.
2	bDescriptorSubtype	1	0x01	EP_GENERAL descriptor subtype.
3	bmControls	4	0x00000000	No Controls.
7	bLockDelayUnits	1	0x00	Unused. Shall be set to 0x00.
8	wLockDelay	2	0x0000	Unused. Shall be set to 0x0000.

6.2.4.1.2.5 STANDARD AS EXPLICIT FEEDBACK ENDPOINT DESCRIPTOR

This descriptor is only present in an AudioStreaming OUT interface when the implemented Synchronization Type is Asynchronous.

Table 6-25: Standard AS Explicit Feedback Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor: 7
1	bDescriptorType	1	0x05	ENDPOINT descriptor.
2	bEndpointAddress	1	Implementation-dependent	IN Endpoint: 0b1000xxxx.
3	bmAttributes	1	0x11	Isochronous, Feedback.
4	wMaxPacketSize	2	Implementation-dependent	0x0003 for full-speed endpoint. 0x0004 for high-speed endpoint. 0x0008 for SuperSpeed endpoint.
6	bInterval	1	Implementation-dependent	

6.3 STRING DESCRIPTORS

No class-specific String descriptors are allowed.

7.1.1 STANDARD REQUESTS

The BADD Device shall support at a minimum the following standard requests:

- Clear Feature
- Get Configuration
- Get Descriptor
- Get Interface
- Get Status
- Set Address
- Set Configuration
- Set Feature
- Set Interface

See *USB Specification* for details.

7.1.2 CLASS-SPECIFIC REQUESTS

The following sections define the class-specific requests a BADD Device shall support.

7.1.2.1 TERMINAL REQUESTS

If the Device is a Headset adapter, then it shall support the Get request for the following Control:

- Connectors Control

Refer to the *USB Device Class Definition for Audio Devices* for details.

7.1.2.2 MIXER UNIT REQUESTS

If the Device incorporates a Mixer Unit, then it shall support the Get request for the following Control:

- Mixer Control

Refer to the *USB Device Class Definition for Audio Devices* for details.

7.1.2.3 FEATURE UNIT REQUESTS

The Device shall support the Set and Get request for the following Controls:

- Mute Control
- Volume Control

Refer to the *USB Device Class Definition for Audio Devices* for details.

7.1.2.4 CLOCK SOURCE REQUESTS

The Device shall support the Get request for the following Control:

- Clock Frequency Control

Refer to the *USB Device Class Definition for Audio Devices* for details.

7.1.2.5 POWER DOMAIN REQUESTS

The Device shall support the Set and Get request for the following Control:

- Power Domain Control

Refer to the *USB Device Class Definition for Audio Devices* for details.

8**BADD PROFILES**

A BADD Device shall adhere to exactly one Profile. Each Profile is identified by a unique identifier, the Profile ID. A Profile should be selected that provides the highest level of functionality, appropriate for the Audio capabilities of the Device.

The following BADD Profiles are currently defined:

- Generic I/O
- Headphone
- Speaker
- Microphone
- Headset
- Headset Adapter
- Speakerphone

Details are provided in subsequent Sections.

Since all class-specific descriptors are inferred and not exposed by the Basic Audio Function, a driver should derive the exact nature of the BADD from the Profile ID. However, to limit the number of Profiles, certain characteristics of the Basic Audio Function can be *derived* from field values exposed by the standard descriptors in the Device:

- The number of AudioStreaming interfaces together with the direction of the associated endpoint (bit D7 in the **bEndpointAddress** field of the Standard AS Audio Data Endpoint descriptor) indicates whether the Basic Audio Function is a BAOF, BAIF, or a combination of both. Note that a BAIOF is already indicated by its Profile ID.
- The number of Channels in an AudioStreaming interface and the audio sample bit resolution (16 bits or 24 bits) can be derived from the **wMaxPacketSize** field in the Standard AS Audio Data Endpoint descriptor in Alternate Setting 1 (Continuous Mode):

Table 8-26: Number of Channels

Configuration	wMaxPacketSize (dec)	
	Synchronous	Asynchronous
Mono, 16 bits	0x0060 (96)	0x0062 (98)
Mono, 24 bits	0x0090 (144)	0x0093 (147)
Stereo, 16 bits	0x00C0 (192)	0x00C4 (196)
Stereo, 24 bits	0x0120 (288)	0x0126 (294)

- The internal topology of the Basic Audio Function should be derived from the widest (mono or stereo) channel configuration necessary to accommodate all of the Alternate settings of the AudioStreaming interface.
- If buttons are present that are intended to influence BADD Audio Controls, these buttons shall be implemented as HID Controls and generate HID reports. These buttons shall not affect local Audio Controls in the Audio Function directly. It is the responsibility of Host software to translate button presses into appropriate Audio Control requests.

8.1**GENERIC I/O PROFILE**

This Profile shall be used in all ADC 3.0 compliant Devices that do not fit any of the other Profiles, defined in this specification. The Generic I/O Profile can be a BAOF, a BAIF or a combination of both.

Note that the combination is different from the BAIOF as there is no provision for side tone-mixing and the input and output path operate independently.

The following configurations are allowed:

- Generic Out, mono (m) or stereo (s)
- Generic In, mono (m) or stereo (s)
- Generic I/O, [mono in/mono out] (m/m), [mono in/stereo out] (m/s), [stereo in/mono out] (s/m), [stereo in/stereo out] (s/s)

If the BAOF or BAI is stereo, then the associated AudioStreaming interface shall support at least one stereo Alternate Setting and may also support mono Alternate Settings.

The following table provides information about the presence (✓) or absence (✗) of each descriptor, and the values of the Profile-dependent fields in each descriptor for all Generic combinations.

Table 8-27: Generic Profile Descriptor Variables

Descriptor	Field	var	Generic Out	Generic In	Generic I/O
Interface Association	bInterfaceCount	IAD1	0x02	0x02	0x03
CS AC Interface (10)	bCategory	ACID1	0x08	0x08	0x08
	wTotalLength	ACID2	0x0059 (m) 0x005D (s)	0x0059 (m) 0x005D (s)	0x009C (m/m) 0x00A0 (m/s or s/m) 0x00A4 (s/s)
Input Terminal ID1 (20)	wClusterDescrID	IT1D1	0x0001 (m) 0x0002 (s)	✗	0x0001 (m) 0x0002 (s)
Input Terminal ID4 (20)	wTerminalType	IT4D1	✗	0x0200	0x0200
	bAssocTerminal	IT4D2		0x00	0x00
	bmControls	IT4D3		0x00000000	0x00000000
	wClusterDescrID	IT4D4		0x0001 (m) 0x0002 (s)	0x0001 (m) 0x0002 (s)
	wConnectorsDescrID	IT4D5		0x0000	0x0000
Output Terminal ID3 (19)	wTerminalType	OT3D1	0x0300	✗	0x0300
	bAssocTerminal	OT3D2	0x00		0x00
	bmControls	OT3D3	0x00000000		0x00000000
	wConnectorsDescrID	OT3D4	0x0000		0x0000
Output Terminal ID6 (19)	---	---	✗	✓	✓
Feature Unit ID2 (15/19)	bSourceID	FU2D1	0x01	✗	0x01
Feature Unit ID5 (15/19)	---	---	✗	✓	✓
Clock Source (12)	---	---	✓	✓	✓
Power Domain ID10 (13)	---	---	✓	✗	✓
Power Domain ID11 (13)	---	---	✗	✓	✓
CS AS General (23)	---	---	✓	✓	✓
CS Endpoint (10)	---	---	✓	✓	✓

8.2 HEADPHONE PROFILE

This Profile shall be used for an ADC 3.0 compliant Headphone Device. A Headphone Device consists of a pair of small electroacoustic transducers that are designed to be worn on or around the head over or inside a user's ears.

This Profile always is a BAOF. Only one stereo configuration is allowed. The AudioStreaming OUT interface shall support at least one stereo Alternate Setting and may also support mono Alternate Settings.

The following table provides information about the presence (✓) of each descriptor, and the values of the Profile-dependent fields in each descriptor for the Headphone Profile.

Table 8-28: Headphone Profile Descriptor Variables

Descriptor	Field	var	Headphone
Interface Association	bInterfaceCount	IAD1	0x02
CS AC Interface (10)	bCategory	ACID1	0x0D
	wTotalLength	ACID2	0x005D (s)
Input Terminal ID1 (20)	wClusterDescrID	IT1D1	0x0002 (s)
Output Terminal ID3 (19)	wTerminalType	OT3D1	0x0302
	bAssocTerminal	OT3D2	0x00
	bmControls	OT3D3	0x00000000
	wConnectorsDescrID	OT3D4	0x0000
Feature Unit ID2 (19)	bSourceID	FU2D1	0x01
Clock Source (12)	---	---	✓
Power Domain ID10 (13)	---	---	✓
CS AS General (23)	---	---	✓
CS Endpoint (10)	---	---	✓

8.3 SPEAKER PROFILE

This Profile shall be used for an ADC 3.0 compliant Speaker Device. A Speaker Device consists of one or more electroacoustic transducers that are designed to reproduce sound in a room, theater, or other listening environment.

This Profile shall always be a BAOF. Both mono (m) and stereo (s) configurations are allowed. In the latter case, the AudioStreaming OUT interface shall support at least one stereo Alternate Setting and may also support mono Alternate Settings.

The following table provides information about the presence (✓) of each descriptor, and the values of the Profile-dependent fields in each descriptor for the Speaker Profile.

Table 8-29: Speaker Profile Descriptor Variables

Descriptor	Field	var	Speaker
Interface Association	bInterfaceCount	IAD1	0x02
CS AC Interface (10)	bCategory	ACID1	0x0E
	wTotalLength	ACID2	0x0059 (m) 0x005D (s)

Descriptor	Field	var	Speaker
Input Terminal ID1 (20)	wClusterDescrID	IT1D1	0x0001 (m) 0x0002 (s)
Output Terminal ID3 (19)	wTerminalType	OT3D1	0x0301
	bAssocTerminal	OT3D2	0x00
	bmControls	OT3D3	0x00000000
	wConnectorsDescrID	OT3D4	0x0000
Feature Unit ID2 (15/19)	bSourceID	FU2D1	0x01
Clock Source (12)	---	---	✓
Power Domain ID10 (13)	---	---	✓
CS AS General (23)	---	---	✓
CS Endpoint (10)	---	---	✓

8.4 MICROPHONE PROFILE

This Profile shall be used for an ADC 3.0 compliant Microphone Device. A Microphone Device consists of one or more electroacoustic transducers that are designed to transform sound into electrical signals, typically for recording purposes.

This Profile shall always be a BAIF. Both mono (m) and stereo (s) configurations are allowed. In the latter case, the AudioStreaming IN interface shall support at least one stereo Alternate Setting and may also support mono Alternate Settings.

The following table provides information about the presence (✓) of each descriptor, and the values of the Profile-dependent fields in each descriptor for the Microphone Profile.

Table 8-30: Microphone Profile Descriptor Variables

Descriptor	Field	var	Microphone
Interface Association	blInterfaceCount	IAD1	0x02
CS AC Interface (10)	bCategory	ACID1	0x03
	wTotalLength	ACID2	0x0059 (m) 0x005D (s)
Input Terminal ID4 (20)	wTerminalType	IT4D1	0x0201
	bAssocTerminal	IT4D2	0x00
	bmControls	IT4D3	0x00000000
	wClusterDescrID	IT4D4	0x0001 (m) 0x0002 (s)
	wConnectorsDescrID	IT4D5	0x0000
Output Terminal ID6 (19)	---	---	✓
Feature Unit ID5 (15/19)	---	---	✓
Clock Source (12)	---	---	✓
Power Domain ID11 (13)	---	---	✓
CS AS General (23)	---	---	✓
CS Endpoint (10)	---	---	✓

8.5 HEADSET PROFILE

This Profile shall be used for an ADC 3.0 compliant Headset Device. A Headset Device consists of a pair of small electroacoustic transducers that are designed to be worn on or around the head over or inside a user's ears. In addition, there is a mono microphone that is mainly used to capture human voice.

This Profile shall always be a BAIOF. Both [mono in/mono out] and [mono in/stereo out] configurations are allowed. In the latter case, the AudioStreaming OUT interface shall support at least one stereo Alternate Setting and may also support mono Alternate Settings.

The following table provides information about the presence (✓) of each descriptor, and the values of the Profile-dependent fields in each descriptor for the Headphone Profile.

Table 8-31: Headset Profile Descriptor Variables

Descriptor	Field	var	Headset
Interface Association	blInterfaceCount	IAD1	0x03
CS AC Interface (10)	bCategory	ACID1	0x04
	wTotalLength	ACID2	0x00BB (m/m) 0x0BF (s/m)
Input Terminal ID1 (20)	wClusterDescrID	IT1D1	0x0001 (m) 0x0002 (s)
Input Terminal ID4 (20)	wTerminalType	IT4D1	0x0402
	bAssocTerminal	IT4D2	0x03
	bmControls	IT4D3	0x00000000
	wClusterDescrID	IT4D4	0x0001 (m)
	wConnectorsDescrID	IT4D5	0x0000
Output Terminal ID3 (19)	wTerminalType	OT3D1	0x0402
	bAssocTerminal	OT3D2	0x04
	bmControls	OT3D3	0x00000000
	wConnectorsDescrID	OT3D4	0x0000
Output Terminal ID6 (19)	---	---	✓
Mixer Unit (16)	wClusterDescrID	MUD1	0x0001 (m) 0x0002 (s)
Feature Unit ID2 (15/19)	bSourceID	FU2D1	0x08
Feature Unit ID5 (15)	---	---	✓
Feature Unit ID7 (15)	---	---	✓
Clock Source (12)	---	---	✓
Power Domain ID10 (13)	---	---	✓
Power Domain ID11 (13)	---	---	✓
CS AS General (23)	---	---	✓
CS Endpoint (10)	---	---	✓

8.6 HEADSET ADAPTER PROFILE

This Profile shall be used for an ADC 3.0 compliant Headset Adapter Device. A Headset Adapter Device includes an audio jack that can be used to connect an analog external headset.

This Profile shall always be a BAIOF. Only one [mono in/stereo out] configuration is allowed. The AudioStreaming OUT interface shall support at least one stereo Alternate Setting and may also support mono Alternate Settings.

The following table provides information about the presence (✓) of each descriptor, and the values of the Profile-dependent fields in each descriptor for the Headphone Profile.

Table 8-32: Headset Adapter Profile Descriptor Variables

Descriptor	Field	var	Headset Adapter
Interface Association	bInterfaceCount	IAD1	0x03
CS AC Interface (10)	bCategory	ACID1	0x0F
	wTotalLength	ACID2	0x00E3 (s/m)
Input Terminal ID1 (20)	wClusterDesrlD	IT1D1	0x0002 (s)
Input Terminal ID4 (20)	wTerminalType	IT4D1	0x0402
	bAssocTerminal	IT4D2	0x03
	bmControls	IT4D3	0x00000001
	wClusterDesrlD	IT4D4	0x0001 (m)
	wConnectorsDesrlD	IT4D5	0x0003
Output Terminal ID3 (19)	wTerminalType	OT3D1	0x0402
	bAssocTerminal	OT3D2	0x04
	bmControls	OT3D3	0x00000001
	wConnectorsDesrlD	OT3D4	0x0004
Output Terminal ID6 (19)	---	---	✓
Connectors (IT4) (18)	---	---	✓
Connectors (ID3) (18)	---	---	✓
Mixer Unit (16)	wClusterDesrlD	MUD1	0x0002 (s)
Feature Unit ID2 (19)	bSourceID	FU2D1	0x08
Feature Unit ID5 (15)	---	---	✓
Feature Unit ID7 (15)	---	---	✓
Clock Source (12)	---	---	✓
Power Domain ID10 (13)	---	---	✓
Power Domain ID11 (13)	---	---	✓
CS AS General (23)	---	---	✓
CS Endpoint (10)	---	---	✓

8.7 SPEAKERPHONE PROFILE

This Profile shall be used for an ADC 3.0 compliant Speakerphone Device. A Speakerphone Device consists of one or more electroacoustic transducers that are designed to reproduce sound. In addition, there are one or more mono microphones that are used to capture human voice.

This Profile shall always be a combination of a mono BAOF and a mono BAIF. The AudioStreaming interfaces shall only support a mono Alternate Setting.

The following table provides information about the presence (✓) of each descriptor, and the values of the Profile-dependent fields in each descriptor for the Headphone Profile.

Table 8-33: Speakerphone Profile Descriptor Variables

Descriptor	Field	var	Speakerphone
Interface Association	bInterfaceCount	IAD1	0x03
CS AC Interface (10)	bCategory	ACID1	0x10
	wTotalLength	ACID2	0x009C (m/m)
Input Terminal ID1 (20)	wClusterDescrID	IT1D1	0x0001 (m)
Input Terminal ID4 (20)	wTerminalType	IT4D1	0x0403
	bAssocTerminal	IT4D2	0x03
	bmControls	IT4D3	0x00
	wClusterDescrID	IT4D4	0x0001 (m)
	wConnectorsDescrID	IT4D5	0x0000
Output Terminal ID3 (19)	wTerminalType	OT3D1	0x0403
	bAssocTerminal	OT3D2	0x04
	bmControls	OT3D3	0x00
	wConnectorsDescrID	OT3D4	0x0000
Output Terminal ID6 (19)	---	---	✓
Feature Unit ID2 (15)	bSourceID	FU2D1	0x01
Feature Unit ID5 (15)	---	---	✓
Clock Source (12)	---	---	✓
Power Domain ID10 (13)	---	---	✓
Power Domain ID11 (13)	---	---	✓
CS AS General (23)	---	---	✓
CS Endpoint (10)	---	---	✓