Embedded USB Host Audio Class Driver User Guide

Version 2.00

For use with USBH Audio Class Driver versions 3.11 and above

Exported on 02/13/2019

Table of Contents

1 System Overview

This chapter contains the fundamental information for this module.

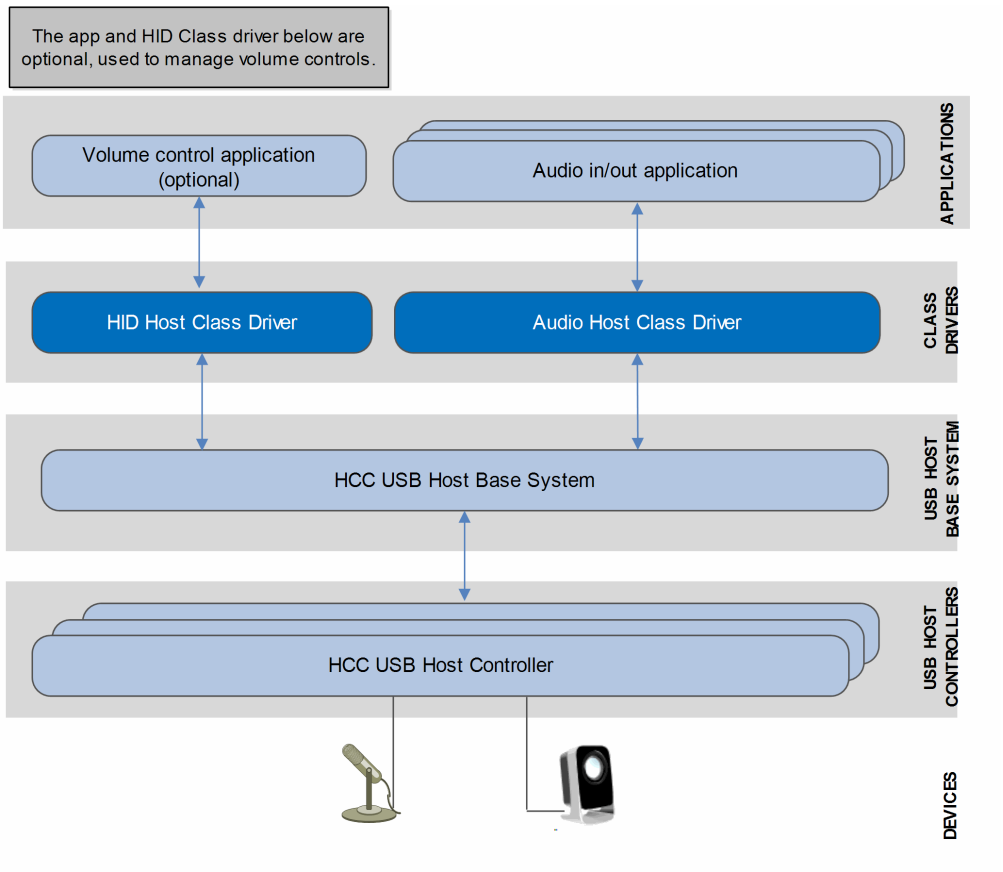
The component sections are as follows:

- Introduction – describes the main elements of the module.
- Feature Check – summarizes the main features of the module as bullet points.
- Packages and Documents – the *Packages* section lists the packages that you need in order to use this module. The *Documents* section lists the relevant user guides.
- Change History – lists the earlier versions of this manual, giving the software version that each manual describes.

1.1 Introduction

This guide is for those who want to implement an embedded USB host class driver to control audio USB devices (speakers or microphones). The **usbh_cd_audio** package provides an audio host class driver for a USB stack. This is used for connecting audio devices over a USB link to a host.

The system structure is shown in the diagram below:



The lower layer interface is designed to use HCC Embedded's USB Host Interface Layer. This layer is standard over different host controller implementations; this means that the code is unchanged, whichever HCC USB host controller it is interfaced to. For detailed information about this layer, consult the HCC USB Host Base System User Guide that is shipped with the base system.

The package provides a set of Application Programming Interface (API) functions for controlling access to a device. These are described here, with separate sections for module and audio management.

1.2 Feature Check

The main features of the class driver are the following:

- Conforms to the HCC Advanced Embedded Framework.
- Designed for integration with both RTOS and non-RTOS based systems.
- Compatible with all HCC USB host controllers.
- Supports multiple devices connected simultaneously.
- Supports speakers for playing sound.
- Supports microphone for recording.
- Works with HCC USB HID class driver to manage volume control.
- Uses a system of callbacks for user-specified events.

1.3 Packages and Documents

Packages

The table below lists the packages that you need in order to use this module:

Package	Description
hcc_base_doc	This contains the two guides that will help you get started.
usbh_base	The USB host base package. This is the framework used by USB class drivers to communicate over USB using a specific USB host controller package.
usbh_cd_audio	The USB device audio host class driver package described by this document.
usbh_cd_hid	The Human Interface Device (HID) module. This is only required if volume knob/mute button handling is required on the audio device.

Documents

For an overview of HCC's embedded USB stacks, see Product Information on the main HCC website.

Readers should note the points in the HCC Documentation Guidelines on the HCC documentation website.

HCC Firmware Quick Start Guide

This document describes how to install packages provided by HCC in the target development environment. Also follow the *Quick Start Guide* when HCC provides package updates.

HCC Source Tree Guide

This document describes the HCC source tree. It gives an overview of the system to make clear the logic behind its organization.

HCC USB Host Base System User Guide

This document defines the USB host base system upon which the complete USB stack is built.

HCC Embedded USB Host Audio Class Driver User Guide

This is this document.

HCC Embedded USB Host HID Class Driver User Guide

This document describes the Human Interface Device (HID) module.

1.4 Change History

This section describes past changes to this manual.

- To view this manual as a PDF, see USB Host PDFs.
- For the history of changes made to the package code itself, see History: usbh_cd_audio.

The current version of this manual is 2.00.

Manual version	Date	Software version	Reason for change
2.00	2019-02-13	3.11	First online release.

2 Source File List

The following sections describe all the source code files included in the system. These files follow the HCC Embedded standard source tree system, described in the HCC Source Tree Guide. All references to file pathnames refer to locations within this standard source tree, not within the package you initially receive.

> **Note:** Do not modify any files except the configuration files.

2.1 API Header File

The file **src/api/api_usbh_audio.h** should be included by any application using the system. This is the only file that should be included by an application using this module. For details of the API functions, see Application Programming Interface.

2.2 Configuration Files

The following files in the directory **src/config** contain all the configurable parameters of the system. Configure these as required.

File	Description
config_usbh_audio.h	Audio configuration options.
config_usbh_audio_pcm.h	Pulse Code Modulation (PCM) configuration options.

2.3 Version File

The file **src/version/ver_usbh_audio.h** contains the version number of this module. This version number is checked by all modules that use this module to ensure system consistency over upgrades.

2.4 Source Code Files

These files are in the directory **src/usb-host/class-drivers/audio**. **These files should only be modified by HCC**.

File	Description
pcm.c	PCM conversion module. This is required to play a stream with characteristics different from those that the audio device supports.
pcm.h	PCM header file.
usbh_audio.c	Main audio code.
usbh_audio.h	Audio header file.
usbh_audio_dsc.h	Audio descriptor-related information and macros.
usbh_audio_hid.c	Audio Human Interface Device (HID) module. This is for volume and mute controls.
usbh_audio_hid.h	Audio HID header file.

3 Configuration Options

This section lists the available configuration options and their default values.

3.1 Audio Configuration Options

Set the following audio options in the file **src/config/config_usbh_audio.h**.

USBH_AUDIO_TASK_STACK_SIZE

The size of the audio task stack. The default is 4096.

USBH_AUDIO_MAX_UNITS

The maximum number of audio units. The default is 1.

USBH_AUDIO_MAX_STREAMS

The maximum number of simultaneous play/record streams. The default is 2.

USBH_AUDIO_MAX_AS_IFC

The maximum number of audio streaming interfaces on a device. The default is 4.

USBH_AUDIO_MAX_AS_ALT_IFC

The maximum number of alternate audio streaming interfaces on a device. Alternate interfaces belong to audio streaming interfaces. The default is 20.

USBH_AUDIO_MAX_NODES

The maximum number of nodes. Nodes are required if an entity on the audio control interface connects to multiple entities, for example if an input terminal is connected to multiple feature units.

This number defines how many entities of this type can be present in a path from input terminal to output terminal. Generally the required number of nodes on a path is zero, but sometimes it is 1 or 2. Leaving this number at the default 6 provides a safe margin.

USBH_AUDIO_DSC_BUFFER_SIZE

The descriptor buffer size for an audio device. This buffer is used to store (part of) the descriptor of all the audio control entities, the audio streaming desciptor and the audio streaming format descriptor. After enumeration, links between AC entities are built in this buffer; this is required in order to find the correct path between input and output terminals when playing or recording. The default is 512.

USBH_AUDIO_HID_ENABLE

Set this to enable audio Human Interface Device (HID) support. This is required for audio devices with mute, volume and other controls. The default is 0.

USBH_AUDIO_FEEDBACK_RATE

The default feedback time in ms (if a feedback channel is present). The default is 100.

USBH_AUDIO_OPTIMIZE_RECORD

Set this to enable optimize record. The default is 0.

> **Note:** This feature can cause 0.2% inaccuracy in the worst case, but on slow systems it can be very useful.

If this is enabled then remainder samples are dropped when recording. When the required number of frames (up to USBH_AUDIO_MAX_FRAME_PER_CLBUF) has arrived at one cluster buffer, the system calls the user write function. With this option enabled, this is called once with the total available data in the buffer. Otherwise, if the number of samples/frame can vary (for example, 44.1 kHz), it is called as many times as there are frames in the cluster buffer.

For example, assume a 44100 sample rate: 44 samples will be requested for 9 frames and 45 in the 10th, giving a gap of 1 sample for 9 frames.

USBH_AUDIO_PCM_CONVERT_ENABLE

Set this to enable PCM conversion capability. This is required if **usbh_audio_play()** is called with stream parameters different from those the device supports. The default is 1.

USBH_AUDIO_MAX_TASK_LOOP

The maximum number of loops in a transfer task for buffer reading/writing when in polled mode. The default is 16.

Cluster buffers are required to hold samples during streaming. This buffer is allocated at run time using the hcc_mem module so **config_hcc_mem.h** needs to be configured correctly.

USBH_AUDIO_CL_BUF_CNT

The number of cluster buffers for streaming. Cluster is the term used to represent one sample for all channels. For example, if there are 6 channels and 16 bits/sample then the size of one cluster is 6*2=12 bytes. The default is 4.

USBH_AUDIO_CL_BUF_SIZE

The size of a cluster buffer in bytes. The default is 3240.

USBH_AUDIO_MAX_FRAME_PER_CLBUF

The maximum number of USB frames in a cluster buffer for streaming. The default is 8.

3.2 PCM Configuration Options

Set the following Pulse Code Modulation (PCM) conversion options in the file **src/config/config_usbh_audio_pcm.h**.

PCM_MAX_CONVERSIONS

The maximum number of simultaneous conversions. The default is 2.

PCM_PRECISION

The conversion precision. If the sample rate differs, stretching or dropping of samples may be required. Increase this number for more precise conversion. The default is 2.

PCM_BUF_SIZE

The size of the buffer which raw PCM data is read to. The default is 4096.

PCM_USE_MEMCPY

Enable this to use the internal PSP memcopy, **psp_memcpy()**, or set it to zero to copy directly from the code. The default is 1.

4 Application Programming Interface

This section documents the Application Programming Interface (API). It includes all the functions that are available to an application program.

4.1 Module Management

The functions are the following:

Function	Description
usbh_audio_init()	Initializes the module and allocates the required resources.
usbh_audio_start()	Starts the module.
usbh_audio_stop()	Stops the module.
usbh_audio_delete()	Deletes the module and releases the resources it used.

usbh_audio_init

Use this function to initialize the class driver and allocate the required resources.

> **Note:** You must call this before any other function.

Format

```
int usbh_audio_init ( void )
```

Arguments

Parameter
None.

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_start

Use this function to start the module.

> **Note:** You must call **usbh_audio_init()** before this function.

Format

```
int usbh_audio_start ( void )
```

Arguments

Parameter
None.

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_stop

Use this function to stop the module.

Format

```
int usbh_audio_stop ( void )
```

Arguments

Parameter
None.

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_delete

Use this function to delete the module and release the associated resources.

Format

```
int usbh_audio_delete ( void )
```

Arguments

Parameter
None.

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

4.2 Device Management

The functions are the following:

Function	Description
usbh_audio_change_mute()	Toggles the current mute state.
usbh_audio_change_volume()	Changes the volume.
usbh_audio_find_first_terminal()	Gets the first terminal type for playing/recording.
usbh_audio_find_next_terminal()	Gets the next terminal type for playing/recording.
usbh_audio_play()	Starts audio play on a terminal.
usbh_audio_stop_play()	Stops playing on a terminal.
usbh_audio_record()	Starts audio recording on a terminal.
usbh_audio_stop_record()	Stops recording on a terminal.
usbh_audio_present()	Checks whether an audio device is connected.
usbh_audio_state()	Gets the current state of the terminal.
usbh_audio_get_stream_info()	Gets terminal stream information.
usbh_audio_get_port_hdl()	Gets the port handle.
usbh_audio_register_ntf()	Registers a notification function for a specified event type.

usbh_audio_change_mute

Use this function to toggle the current mute state.

Format

```
int usbh_audio_change_mute ( t_terminal_info * p_tinf )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_change_volume

Use this function to change the volume.

The physical volume change command is only sent if the streaming interface supports volume control and the stream is active (playing/recording is in progress).

Format

```
int usbh_audio_change_volume (
    t_terminal_info *   p_tinf,
    int                 volume )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *
volume	The volume relative to the current volume (for example, 1000 or -1000).	int

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_find_first_terminal

Use this function to get the first terminal type for playing/recording.

This function fills a terminal information structure (p_tinf) that can be used for any further audio functions. This returns a terminal type.

Format

```
int usbh_audio_find_first_terminal (
    t_usbh_unit_id      uid,
    uint8_t             mode,
    t_terminal_info *   p_tinf,
    uint16_t *          p_terminal_type )
```

Arguments

Parameter	Description	Type
uid	The unit ID.	t_usbh_unit_id
mode	T_ST_PLAY or T_ST_RECORD.	uint8_t
p_tinf	A pointer to the terminal information (allocated in user space).	t_terminal_info *
p_terminal_type	The type of terminal found for the specific mode.	uint16_t *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_find_next_terminal

Use this function to get the next terminal type for playing/recording.

This function fills a terminal information structure (p_tinf) that can be used for any further audio functions. This returns a terminal type.

Format

```
int usbh_audio_find_next_terminal (
    t_usbh_unit_id      uid,
    uint8_t             mode,
    t_terminal_info *   p_tinf,
    uint16_t *          p_terminal_type )
```

Arguments

Parameter	Description	Type
uid	The unit ID.	t_usbh_unit_id
mode	T_ST_PLAY or T_ST_RECORD.	uint8_t
p_tinf	A pointer to the terminal information (allocated in user space).	t_terminal_info *
p_terminal_type	The type of terminal found for the specific mode.	uint16_t *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_play

Use this function to start audio play on a terminal.

Format

```
int usbh_audio_play (
    t_terminal_info *   p_tinf,
    t_stream_info *     p_sinf,
    t_rw_data_info *    p_rwinf )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *
p_sinf	A pointer to source/destination stream information.	t_stream_info *
p_rwinf	A pointer to stream read/write information.	t_rw_data_info *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_stop_play

Use this function to stop playing on a terminal.

Format

```
int usbh_audio_stop_play ( t_terminal_info * p_tinf )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_record

Use this function to start audio recording on a terminal.

Format

```
int usbh_audio_record (
    t_terminal_info *   p_tinf,
    t_stream_info *     p_sinf,
    t_rw_data_info *    p_rwinf )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *
p_sinf	A pointer to source/destination stream information.	t_stream_info *
p_rwinf	A pointer to stream read/write information.	t_rw_data_info *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_stop_record

Use this function to stop recording on a terminal.

Format

```
int usbh_audio_stop_record ( t_terminal_info * p_tinf )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_present

Use this function to check whether an audio device is connected.

Format

```
int usbh_audio_present ( t_usbh_unit_id uid )
```

Arguments

Parameter	Description	Type
uid	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
0	No audio device is connected.
1	An audio device is connected.
Else	See Error Codes.

usbh_audio_state

Use this function to get the current state of the terminal.

Format

```
int usbh_audio_state (
    t_terminal_info *   p_tinf,
    uint8_t *           p_state )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *
p_state	A bitmask showing the terminal state.	uint8_t *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_get_stream_info

Use this function to get terminal stream information.

Fill the *t_stream_info* structure with the desired streaming parameters. The system changes the values to the closest matching values that can be used on the streaming interface.

Format

```
int usbh_audio_get_stream_info (
    t_terminal_info *   p_tinf,
    t_stream_info *     sinf )
```

Arguments

Parameter	Description	Type
p_tinf	A pointer to the terminal information structure. To get this, use one of the following functions: • **usbh_audio_find_first_terminal()** • **usbh_audio_find_next_terminal()**.	t_terminal_info *
sinf	A pointer to the streaming information.	t_stream_info *

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

usbh_audio_get_port_hdl

Use this function to get the port handle.

Format

```
t_usbh_port_hdl usbh_audio_get_port_hdl ( t_usbh_unit_id uid )
```

Arguments

Parameter	Description	Type
uid	The unit ID.	t_usbh_unit_id

Return Values

Return value	Description
The port handle	Successful execution.
USBH_PORT_HDL_INVALID	Invalid port handle.
Else	See Error Codes.

usbh_audio_register_ntf

Use this function to register a notification function for a specified event type.

When a device is connected or disconnected, the notification function is called.

> **Note:** It is the user's responsibility to provide any notification functions required by the application. Providing such functions is optional.

Format

```
int usbh_audio_register_ntf (
    t_usbh_unit_id   uid,
    t_usbh_ntf       ntf,
    t_usbh_ntf_fn    ntf_fn )
```

Arguments

Parameter	Description	Type
uid	The unit ID.	t_usbh_unit_id
ntf	The notification type.	t_usbh_ntf
ntf_fn	The notification function to use when an event occurs.	t_usbh_ntf_fn

Return Values

Return value	Description
USBH_AUDIO_SUCCESS	Successful execution.
Else	See Error Codes.

4.3 Error Codes

The first table below shows the meaning of the audio-specific error codes, the second table shows the generic USB host error codes.

Audio-specific Error Codes

Return Code	Value	Description
USBH_AUDIO_SUCCESS	0	Successful execution.
USBH_AUDIO_PENDING	1	Operation is not complete yet.
USBH_AUDIO_ERR_NOTSUPPORTED	2	Operation is not supported.
USBH_AUDIO_ERR_BADFORMAT	3	Input/output stream is not supported by the device. This may be because the sample rate is not processable, the number of channels required, and so on.
USBH_AUDIO_ERR_NOTPRESENT	4	No device is connected.
USBH_AUDIO_ERR_BUSY	5	Audio device is busy or there is no free stream to complete the operation.
USBH_AUDIO_ERR_ALLOCATION	6	Allocation error. This is returned if the cluster buffer cannot be allocated for playing/ recording. This buffer is allocated at runtime from a pool that can be used directly by the host controller. In this way the system can avoid making extra copies before/after transmitting/receiving data.
USBH_AUDIO_ERROR	7	General error occurred.

Generic USB Host Error Codes

If a function executes successfully it returns with a USBH_SUCCESS code, a value of 0. The following table shows the meaning of the error codes:

Return Code	Value	Description
USBH_SUCCESS	0	Successful execution.
USBH_SHORT_PACKET	1	IN transfer completed with short packet.
USBH_PENDING	2	Transfer still pending.
USBH_ERR_BUSY	3	Another transfer in progress.
USBH_ERR_DIR	4	Transfer direction error.
USBH_ERR_TIMEOUT	5	Transfer timed out.
USBH_ERR_TRANSFER	6	Transfer failed to complete.
USBH_ERR_TRANSFER_FULL	7	Cannot process more transfers.
USBH_ERR_SUSPENDED	8	Host controller is suspended.
USBH_ERR_HC_HALTED	9	Host controller is halted.
USBH_ERR_REMOVED	10	Transfer finished due to device removal.
USBH_ERR_PERIODIC_LIST	11	Periodic list error.
USBH_ERR_RESET_REQUEST	12	Reset request during enumeration.
USBH_ERR_RESOURCE	13	OS resource error.
USBH_ERR_INVALID	14	Invalid identifier/type (HC, EP HDL, and so on).
USBH_ERR_NOT_AVAILABLE	15	Item not available.
USBH_ERR_INVALID_SIZE	16	Invalid size.
USBH_ERR_NOT_ALLOWED	17	Operation not allowed.
USBH_ERROR	18	General error.

4.4 Types and Definitions

This section describes the notification function, the standard notification codes, and the terminal and stream types that are defined in the API header file.

t_usbh_ntf_fn

The **t_usbh_ntf_fn** definition specifies the format of the notification function. It is defined in the USB host base system in the file **api_usb_host.h**.

Standard notification codes are defined in the USB host base system in the file **api_usb_host.h**. There are no additional notification codes for this module.

Format

```
int ( * t_usbh_ntf_fn )(
    t_usbh_unit_id   uid,
    t_usbh_ntf       ntf )
```

Arguments

Parameter	Description	Type
uid	The unit ID.	t_usbh_unit_id
ntf	The notification code.	t_usbh_ntf

Notification Codes

The standard notification codes shown below are defined in the USB host base system in the file **api_usb_host.h**. This module has no specific notification codes of its own.

Notification	Value	Description
USBH_NTF_CONNECT	1	Connection notification code.
USBH_NTF_DISCONNECT	2	Disconnection notification code.

Terminal States

The possible terminal states are as follows:

Return Value	Default Setting	Description
T_ST_NONE	0	Inactive.
T_ST_PLAY	1	Playing.
T_ST_RECORD	2	Recording.
T_ST_END	4	Finished.

Terminal Group Macro

The macro used to get the terminal group is:

Return Value	Default Setting
TERMINAL_GROUP(v)	(v) & 0xFF00

Stream Types

There is just one stream type:

Return Value	Default Setting	Description
AUDIO_TYPE_PCM	1	The only supported stream type.

Invalid States

There are two invalid states, as follows:

Return Value	Default Setting	Description
INVALID_TERMINAL	0xFF	Invalid terminal type.
INVALID_NODE	0xFF	Invalid node type.

t_terminal_info

The *t_terminal_info* structure describes a terminal:

Element	Type	Description
audio_device_pos	t_usbh_unit_id	Audio device position.
stream_ifc_pos	uint8_t	The stream interface position of the audio device.
usage_count	uint8_t	The usage count.
terminal	uint8_t	The terminal to search for.
i_terminal	uint8_t	The input terminal.
o_terminal	uint8_t	The output terminal.
node_cnt	uint8_t	The number of nodes in the nodes buffer.
nodes [USBH_AUDIO_MAX_NODES]	uint8_t	The nodes.

t_rw_data_info

The *t_rw_data_info* structure describes read/write data access information:

Element	Type	Description
rw	t_rw_data	The read/write function.
par	void *	The read/write function parameter.
close	t_close_data	The close function.

t_stream_info

The *t_stream_info* structure describes stream information:

Element	Type	Description
type	uint8_t	The stream type.
sr	uint32_t	The sampling rate.
bps	uint8_t	The bits/sample.
channels	uint8_t	The number of channels.

4.5 Terminal Types

To find out which group a terminal belongs to, you can use the TERMINAL_GROUP macro. Provide the terminal type as a parameter to get a match to any TGROUP_....

For example:

```
TERMINAL_GROUP( terminal_type ) == TGROUP_OT
```

Input Terminal Types

The input terminal types are as follows:

Return Value	Default Setting	Description
TGROUP_IT	0x0200	
TTYPE_IT_UNDEF	0x0200	Undefined type.
TTYPE_IT_MIC	0x0201	Microphone.
TTYPE_IT_DESKTOP_MIC	0x0202	Desktop microphone.
TTYPE_IT_PERSONAL_MIC	0x0203	Personal microphone.
TTYPE_IT_OMNI_DIR_MIC	0x0204	Omni-directional microphone.
TTYPE_IT_MIC_ARRAY	0x0205	Microphone array.
TTYPE_IT_PROC_MIC_ARRAY	0x0206	Processing microphone array.

Output Terminal Types

The output terminal types are as follows:

Return Value	Default Setting	Description
TGROUP_OT	0x0300	
TTYPE_OT_UNDEF	0x0300	Undefined type.
TTYPE_OT_SPEAKER	0x0301	Speaker.
TTYPE_OT_HEADPHONES	0x0302	Headphones.
TTYPE_OT_HEAD_MOUNTED_DISP	0x0303	Head mounted display audio.
TTYPE_OT_DESKTOP_SPEAKER	0x0304	Desktop speaker.
TTYPE_OT_ROOM_SPEAKER	0x0305	Room speaker.
TTYPE_OT_COMM_SPEAKER	0x0306	Communication speaker.
TTYPE_OT_LOW_FREQ_SPEAKER	0x0307	Low frequency effects speaker.

Bidirectional Terminal Types

The bidirectional terminal types are as follows:

Return Value	Default Setting	Description
TGROUP_BIDIR	0x0400	
TTYPE_BIDOR_UNDEF	0x0400	Undefined type.
TTYPE_BIDIR_HANDSET	0x0401	Handset.
TTYPE_BIDIR_HEADSET	0x0402	Headset.
TTYPE_BIDIR_SPKPHONE_NE	0x0403	No echo reduction speakerphone.
TTYPE_BIDIR_SPKPHONE_ES	0x0404	Echo-suppressing speakerphone.
TTYPE_BIDIR_SPKPHONE_EC	0x0405	Echo-canceling speakerphone.

Telephony Terminal Types

The telephony terminal types are as follows:

Return Value	Default Setting	Description
TGROUP_TPH	0x0500	
TTYPE_TPH_UNDEF	0x0500	Undefined type.
TTYPE_TPH_PHONE_LINE	0x0501	Phone line.
TTYPE_TPH_TELEPHONE	0x0502	Telephone.
TTYPE_TPH_DOWN_LINE_PHONE	0x0503	Down line phone.

External Terminal Types

The external terminal types are as follows:

Return Value	Default Setting	Description
TGROUP_EXT	0x0600	
TTYPE_EXT_UNDEF	0x0600	Undefined type.
TTYPE_EXT_ANALOG	0x0601	Analog connector.
TTYPE_EXT_DIGITAL	0x0602	Digital audio interface.
TTYPE_EXT_LINE	0x0603	Line connector.
TTYPE_EXT_LEGACY	0x0604	Legacy audio connector.
TTYPE_EXT_SPDIF	0x0605	S/PDIF interface.
TTYPE_EXT_1394_DA	0x0606	IEEE 1394 DA stream.
TTYPE_EXT_1394_DV	0x0607	IEEE 1394 DV stream soundtrack.
TTYPE_EXT_ADAT	0x0608	ADAT Lightpipe.
TTYPE_EXT_TDIF	0x0609	TDIF.
TTYPE_EXTMADI	0x060A	MADI.

Embedded Function Terminal Types

The embedded function terminal types are as follows:

Return Value	Default Setting	Description
TGROUP_EMB	0x0700	
TTYPE_EMB_UNDEF	0x0700	Undefined type.
TTYPE_EMB_LEVEL_CNOISE	0x0701	Level calibration noise.
TTYPE_EMB_EQUALIZATION	0x0702	Equalization noise.
TTYPE_EMB_CD_PLAYER	0x0703	CD player.
TTYPE_EMB_DAT	0x0704	DAT.
TTYPE_EMB_DCC	0x0705	DCC.
TTYPE_EMB_COMPRESSED	0x0706	Compressed audio player.
TTYPE_EMB_ANALOG_TAPE	0x0707	Analog tape
TTYPE_EMB_PHONOGRAPH	0x0708	Phonograph
TTYPE_EMB_VCR	0x0709	VCR audio
TTYPE_EMB_VIDEO_DISC	0x070A	Video disc audio
TTYPE_EMB_DVD	0x070B	DVD audio.
TTYPE_EMB_TV_TUNER	0x070C	TV tuner audio.
TTYPE_EMB_SATELLITE_REC	0x070D	Satellite receiver audio.
TTYPE_EMB_CABLE_TUNER	0x070E	Cable tuner audio.
TTYPE_EMB_DSS	0x070F	DSS audio.
TTYPE_EMB_RADIO_REC	0x0710	Radio receiver.
TTYPE_EMB_RADIO_TR	0x0711	Radio transmitter.
TTYPE_EMB_MULTI_TRACK	0x0712	Multi-track recorder.
TTYPE_EMB_SYNTHESIZER	0x0713	Synthesizer.
TTYPE_EMB_PIANO	0x0714	Piano.
TTYPE_EMB_GUITAR	0x0715	Guitar.
TTYPE_EMB_DRUMS	0x0716	Drums/rhythm.

Return Value	Default Setting	Description
TTYPE_EMB_OTHER	0x0717	Other musical instrument.

5 Integration

This section specifies the elements of this package that need porting, depending on the target environment.

5.1 OS Abstraction Layer (OAL)

All HCC modules use the OS Abstraction Layer (OAL) that allows the module to run seamlessly with a wide variety of RTOSes, or without an RTOS.

The module uses the following OAL components:

OAL Resource	Number Required
Tasks	1
Mutexes	1
Events	1

5.2 PSP Porting

The Platform Support Package (PSP) is designed to hold all platform-specific functionality, either because it relies on specific features of a target system, or because this provides the most efficient or flexible solution for the developer.

The module makes use of the following standard PSP functions:

Function	Package	Component	Description
psp_memcpy()	psp_base	psp_string	Copies a block of memory. The result is a binary copy of the data.
psp_memset()	psp_base	psp_string	Sets the specified area of memory to the defined value.

The module makes use of the following standard PSP macros:

Macro	Package	Component	Description
PSP_RD_LE16	psp_base	psp_endianness	Reads a 16 bit value stored as little-endian from a memory location.
PSP_RD_LE24	psp_base	psp_endianness	Reads a 24 bit value stored as little-endian from a memory location.
PSP_WR_LE16	psp_base	psp_endianness	Writes a 16 bit value stored as little-endian to a memory location.
PSP_WR_LE24	psp_base	psp_endianness	Writes a 24 bit value stored as little-endian to a memory location.

6 Sample Code

This section shows example code for the class driver.

6.1 Initialization

This example shows the code used to initialize a USB host with the class driver.

```
/*
** Initialize USB host with Audio class driver.
*/

int usb_host_init ( void )
{
    int  rc;
    rc = hcc_mem_init();

    /* Initialize the USB host module */
    if ( rc == USBH_SUCCESS )
    {
        rc = usbh_init();
    }

    /* Initialize the specific USB host controller */
    if ( rc == USBH_SUCCESS )
    {
        rc = usbh_hc_init( 0, usbh_stm32uh_hc, 0 );
    }

    /* Initialize the Audio class driver module */
    if ( rc == USBH_SUCCESS )
    {
        rc = usbh_audio_init();
    }

    /* Start the Audio class driver */
    if ( rc == USBH_SUCCESS )
    {
        rc = usbh_audio_start();
    }

    /* Start the USB host stack */
    if ( rc == USBH_SUCCESS )
    {
        rc = usbh_start();  /* Start the USB host */
    }

    return rc;

} /* usb_host_init */
```