



# sw\_usb\_audio: USB Audio reference designs (README)

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### vendor

XMOS

### version

9.0.0

### scope

General Use

### description

USB Audio reference designs

### category

Audio

### keywords

USB Audio, DFU, USB, I2S, ADAT, SPDIF, TDM

### hardware

XK-AUDIO-216-MC, XK-AUDIO-316-MC, XK-EVK-XU316

## 1 Summary

The XMOS USB Audio solution provides *USB Audio Class* compliant devices over USB 2.0 (high-speed or full-speed). Based on the XMOS xcore-200 (XS2) and xcore.ai (XS3) architectures, it supports USB Audio Class 2.0 and USB Audio Class 1.0, asynchronous mode (synchronous as an option) and sample rates up to 384kHz.

The complete source code, together with the free XMOS XTC development tools and xCORE multi-core micro-controller devices, allow the developer to select the exact mix of interfaces and processing required.

The XMOS USB Audio solution is deployed as a framework (see [lib\\_xua](#)) with reference design applications extending and customising this framework. These reference designs have particular qualified feature sets and an accompanying reference hardware platform.

Please note, Alpha and Beta releases may not accurately reflect the final release and documentation may not be complete. These early releases are not suitable for a production context, and are provided for evaluation purposes only. See 'Release Quality & QA'.

Refer to CHANGELOG.rst for detailed change listing.



For full software documentation please see the USB Audio User Guide document.

This release is built and tested using version 15.3.0 of the XMOS tool set. Build or functionality issues could be experienced with any other version.

This repository contains applications (or instances) of the XMOS USB Audio Reference Design framework. These applications typically relate to a specific hardware platform. This repository contains the following:

App Name	Relevant Board(s)	Description
app_usb_aud_xk_216_mc	xk-audio-216-mc	xcore-200 Multi-channel Audio Board
app_usb_aud_xk_316_mc	xk-audio-316-mc	xcore.ai Multi-channel Audio Board
app_usb_aud_xk_evk_xu316	xk-evk-xu316	xcore.ai Evaluation Kit

Please refer to individual README files in these apps for more detailed information.

Each application contains a “core” folder, this folder contains items that are required to use and run the USB Audio application framework. Mandatory files per application include:

- ▶ An XN file describing the board including required port defines.
- ▶ xua\_conf.h header file containing configuration items such as channel count, strings etc.

Each application also contains an “extensions” folder which includes board specific extensions such as CODEC configuration etc.

Additionally some options are contained in application *CMakeLists.txt* files for building multiple configurations of an application. For example an application may provide configurations with and without MIDI enabled. See the USB Audio Software User Guide for full details.

## 2 Features

Key features of the various applications in this repository are listed below. Refer to the application README the specific feature set supported by that application.

- ▶ USB Audio Class 1.0/2.0 Compliant
- ▶ Fully Asynchronous operation (Synchronous mode as an option)
- ▶ Support for the following sample frequencies: 8, 11.025, 12, 16, 32, 44.1, 48, 88.2, 96, 176.4, 192, 352.8, 384kHz
- ▶ Input/output channel and individual volume/mute controls supported
- ▶ Support for dynamically selectable output audio formats (e.g. resolution)
- ▶ Field firmware upgrade compliant to the USB Device Firmware Upgrade (DFU) Class Specification
- ▶ S/PDIF output
- ▶ S/PDIF input
- ▶ ADAT output
- ▶ ADAT input
- ▶ MIDI input/output (Compliant to USB Class Specification for MIDI devices)
- ▶ DSD output (“Native” and DoP mode) at DSD64 and DSD128 rates

- ▶ Mixer with flexible routing
- ▶ Simple playback controls via Human Interface Device (HID)

Note, not all features may be supported at all sample frequencies, simultaneously or on all devices. Some features also require specific host driver support.

## 2.1 Release quality & QA

Feature	Quality
Audio Class 1.0 Streaming	Release
Audio Class 2.0 Streaming	Release
I2S Master	Release
I2S Slave	Release
TDM Master	Release
TDM Slave	Release
S/PDIF Receive	Release
S/PDIF Transmit	Release
ADAT Receive	Release
ADAT Transmit	Release
MIDI I/O	Release
DSD Playback	Beta
Mixer	Release
HID Controls	Beta
DFU	Release

## 3 Known issues

General known issues with this release are listed below. For board/application specific known issues please see README in relevant app directory

- ▶ (xmos/sw\_usb\_audio#54) When DFU flash access fails the xcore sends NAKs to the USB host forever, rather than a STALL
- ▶ (xmos/sw\_usb\_audio#97) Documentation missing for XK-EVK-316
- ▶ (xmos/sw\_usb\_audio#99) Input via TDM master unreliable due to low-level timing issues (xc0re-200 only)
- ▶ (xmos/sw\_usb\_audio#120) Playback glitches experienced at 44.1/48kHz when using ASIO4ALL (v2.15) with built-in windows drivers. USB bus traces prove that these originate from the host driver.
- ▶ (#14762) When in DSD mode with S/PDIF output enabled, DSD samples are transmitted over S/PDIF if the DSD and S/PDIF channels are shared, this may or may not be desired
- ▶ (#14173) I2S input is completely disabled when DSD output is active - any input stream to the host will contain 0 samples
- ▶ (#14780) Operating the design at a sample rate of less than or equal to the SOF rate (i.e. 8kHz at HS, 1kHz at FS) may expose a corner case relating to 0 length packet handling in both the driver and device and should be considered unsupported at this time.
- ▶ (#14883) Before DoP mode is detected a small number of DSD samples will be played out as PCM via I2S

- ▶ (#14887) Volume control settings currently affect samples in both DSD and PCM modes. This results in invalid DSD output if volume control not set to 0
- ▶ Windows XP volume control very sensitive. The Audio 1.0 driver built into Windows XP (usbaudio.sys) does not properly support master volume AND channel volume controls, leading to a very sensitive control. Descriptors can be easily modified to disable master volume control if required (one byte - bmaControls(0) in Feature Unit descriptors)
- ▶ 88.2kHz and 176.4kHz sample frequencies are not exposed in Windows control panels. These are known OS restrictions in Windows 7 and earlier.
- ▶ Compatibility issues exist with the Microsoft built in UAC1.0 driver (usbaudio.sys) and Intel Smart Sound Technology (SST) can result in audible distortions. This can be worked around by disabling the SST driver.

## 4 Development repo

- ▶ [sw\\_usb\\_audio](#)

## 5 Host system requirements

### 5.1 USB Audio Class 1.0

- ▶ macOS version 10.6 or later
- ▶ Windows 10 or 11 with built-in USB Audio Class 1.0 driver.

### 5.2 USB Audio Class 2.0

- ▶ macOS version 10.6 or later
- ▶ Windows 10 or 11 with built-in USB Audio Class 2.0 driver.
- ▶ Windows 10 or 11 using built-in or Thesycon Audio Class 2.0 driver for Windows (Tested against version Thesycon driver version 5.70.0)

## 6 Required tools

- ▶ XMOS XTC Tools: 15.3.0

## 7 Required libraries (dependencies)

- ▶ [lib\\_sw\\_pll](#)
- ▶ [lib\\_xua](#)
- ▶ [lib\\_adat](#)
- ▶ [lib\\_locks](#)
- ▶ [lib\\_logging](#)
- ▶ [lib\\_mic\\_array](#)
- ▶ [lib\\_xassert](#)
- ▶ [lib\\_xcore\\_math](#)
- ▶ [lib\\_spdif](#)
- ▶ [lib\\_xud](#)
- ▶ [lib\\_i2c](#)
- ▶ [lib\\_i2s](#)

## 8 Related application notes

- ▶ AN02019: Using Device Firmware Upgrade (DFU) for USB Audio
- ▶ AN00136: Example USB Vendor Specific Device
- ▶ AN02026: Blocked DSP inside USB Audio
- ▶ AN01009: Optimizing USB Audio for stereo output, battery powered device

## 9 Support

This package is supported by XMOS Ltd. Issues can be raised against the software at <http://www.xmos.com/support>



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