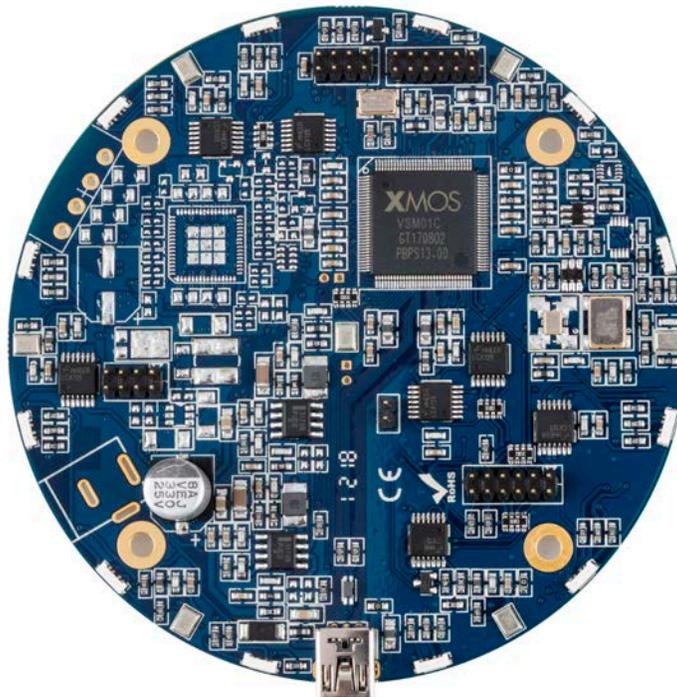


UMA-8 v2

USB MICROPHONE ARRAY WITH EMBEDDED DSP

User Manual





Revision history

Revision	Description	Date
1.0	First public release	22 May 2017
1.1	Adding Raw mode details	06 June 2017
1.2	Documenting API command	19 October 2017
1.3	New board version for XMOS XVF3000	09 May 2018
1.4	Adding DOA USB Api	14 September 2018



TABLE OF CONTENTS

Important Information	4
Minimum System Requirements – Windows	4
System Requirements – Mac OS X.....	4
Disclaimer/Warning.....	4
Warranty Terms.....	4
FCC Class B Statement	4
CE Mark Statement.....	5
Package Contents	5
A Note on this Manual.....	5
1 Product Overview	6
2 Hardware connectivity.....	7
2.1 Board overview.....	7
2.2 USB (Audio + DC power).....	8
2.3 I2S expansion header pinouts	8
2.4 Additional I2S usage notes	9
3 Driver Installation and Configuration – Windows	10
3.1 Installation.....	10
3.1.1 Download the latest driver.....	10
3.1.2 Connect your UMA-8.....	10
3.1.3 USB Driver installation.....	10
3.2 Configuration.....	11
3.2.1 Format	11
3.2.2 Buffer settings	11
4 Driver Installation and Configuration – Mac OS X	12
4.1 Installation.....	12
4.2 Configuration.....	12
5 Driver Installation and Configuration – LINUX.....	13
5.1 ALSA Installation.....	13
5.2 Raspberry Pi.....	13
6 USB API / Customization	14
6.1.1 Discovery of UMA-8.....	14
6.1.2 Voice Activated Detection (VAD) + Direction Of Arrival (DOA)	14
7 Firmware Upgrade	15
7.1 Precompiled Versions.....	15
7.2 Firmware Upgrade.....	15
7.2.1 Windows.....	16
7.3 Obtaining support.....	17
8 Additional Information	18
8.1 Specifications.....	18



IMPORTANT INFORMATION

Please read the following information before use. In case of any questions, please contact miniDSP via the support portal at minidsp.desk.com.

MINIMUM SYSTEM REQUIREMENTS – WINDOWS

- 1GHz or higher processor clock speed recommended / Intel® Pentium®/Celeron® family, or AMD K6®/AMD Athlon®/AMD Duron® family, or compatible processor recommended.
- 512 megabytes (MB) of RAM or higher recommended
- One free USB 2.0 port
- Microsoft® Windows® Win7/Win8/Win10

SYSTEM REQUIREMENTS – MAC OS X

- Intel Core Duo processor or greater
- 256 megabytes (MB) of RAM or higher recommended
- One free USB 2.0 port

DISCLAIMER/WARNING

miniDSP cannot be held responsible for any damage that may result from the improper use or incorrect configuration of this product. Please read this manual carefully to ensure that you fully understand how to operate and use this product, as incorrect use or use beyond the parameters and ways recommended in this manual have the potential to cause damage to your audio system.

Please also note that many of the questions we receive at the technical support department are already answered in this User Manual and in the online [application notes](#) on the miniDSP.com website. So please take the time to carefully read this user manual and the online technical documentation. Thank you for your understanding!

WARRANTY TERMS

miniDSP Ltd warrants this product to be free from defects in materials and workmanship for a period of one year from the invoice date. Our warranty does not cover failure of the product due to incorrect connection or installation, improper or undocumented use, unauthorized servicing, modification or alteration of the unit in any way, or any usage outside of that recommended in this manual. If in doubt, contact miniDSP prior to use.

FCC CLASS B STATEMENT

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.



- This device must accept any interference received, including interference that may cause undesired operation.

Warning: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Notice: Shielded interface cable must be used in order to comply with emission limits.

Notice: Changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

CE MARK STATEMENT

The UMA-8 has passed the test performed according to European Standard EN 55022 Class B.

PACKAGE CONTENTS

Your *UMA-8* package includes:

- One *UMA-8* USB far field microphone array module
- One USB cable for computer connectivity (1.5m)

A NOTE ON THIS MANUAL

This User Manual is designed for reading in both print and on the computer. If printing the manual, please print double-sided. The embedded page size is 8 ½" x 11". Printing on A4 paper will result in a slightly reduced size.

For reading on the computer, we have included hyperlinked cross-references throughout the manual. In addition, a table of contents is embedded in the PDF file. Displaying this table of contents will make navigation much easier:

- In Adobe Reader on Windows, click on the "bookmarks" icon at the left. The table of contents will appear on the left and can be unfolded at each level by clicking on the "+" icons.
- In Preview on the Mac, click on the **View** menu and select **Table of Contents**. The table of contents will appear on the left and can be unfolded at each level by clicking on the triangle icons.



1 PRODUCT OVERVIEW

Thank you for purchasing a miniDSP UMA-8 v2 USB microphone array. The **UMA-8 v2** is a high-performance yet low cost multichannel USB microphone array built around XMOS Vocal Fusion multicore technology. Seven high-performance MEMS microphones are configured in a circular arrangement to provide high-quality voice capture for a wide range of applications.

Leveraging the onboard XMOS DSP processing, the UMA-8 supports voice algorithms including beamforming, noise reduction, and acoustic echo cancellation. The UMA-8 is a fully compliant UAC2 audio interface with driverless support for Mac/Linux and ASIO drivers for Windows.

From DIYers to OEM, this pocket-size platform is engineered for flexibility in firmware, software and hardware. Precompiled firmware versions, expansion connectors providing connectivity for additional PDM microphones, I2S in/out expansion and GPIO... It's all there to grow with your application!

The UMA8 is provided with two precompiled firmware versions:

DSP mode: The UMA8 utilizes the XMOS Vocal Fusion DSP processing library to perform beamforming, noise reduction, autogain and AEC. This is the default mode of operation for plug&play operation as a far field microphone. The sample rate is fixed at 48kHz in this application.

RAW audio mode: This mode is for advanced users only. The raw microphone signal (without any processing/gain) from each MEMS microphone is recorded on a unique channel. The sample rate is also flexible in this configuration. This mode can be useful to a) develop your own beamforming algorithm b) witness the effect of beamforming on your application c) Other research applications.

Please read section 6.1 of this user manual for more details on specifics of each firmware.

The below sections will clarify how to install and configure the UMA-8. If any doubt/questions, feel free to contact our technical support team.

2 HARDWARE CONNECTIVITY

2.1 BOARD OVERVIEW

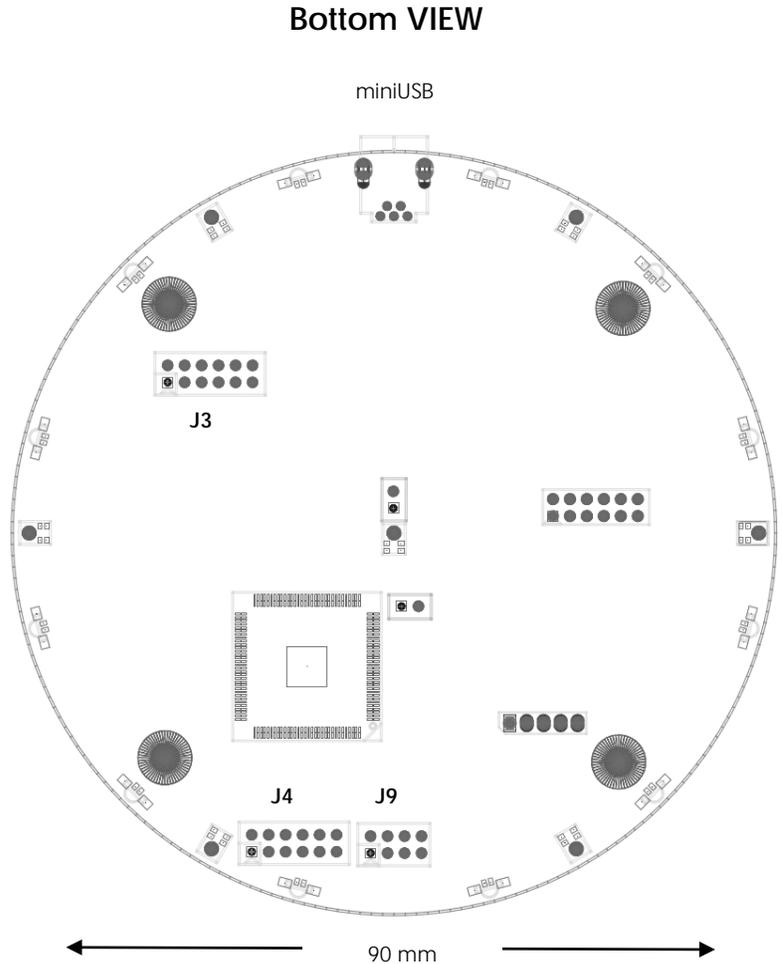
The UMA-8 has few exposed headers to help for customization of the product. Note that MEMS are up-firing(through the board) such that SW1/2/3/4 are on top.

J3 / Audio data & clocks

J3.1 - I2S_OUT_0	J3.2 - I2S_IN_0
J3.3 - I2S_OUT_1	J3.4 - I2S_IN_1
J3.5 - I2S_OUT_2	J3.6 - I2S_IN_2
J3.7 - I2S_OUT_3	J3.8 - I2S_OUT_4
J3.9 - MCLK	J3.10 - I2S_BCLK
J3.11 - GND	J3.12 - I2S_LRCLK

J2 / Control IO pins

J2.1 - GND	J2.2 - 3.3V
J2.3 - GND	J2.4 - 3.3V
J2.5 - N/A	J2.6 - UART_TX
J2.7 - UART_RX	J2.8 - XMOS_RST
J2.9 - I2C_SDATA	J2.10 - I2C_SCLK
J2.11 - N/A	J2.12 - N/A



2.2 USB (AUDIO + DC POWER)

The UMA-8 is USB self powered. A single USB connection to your PC/Mac will suffice to provide power to the unit and stream bidirectional audio simultaneously.

To record audio from the *UMA-8*, connect the USB port of the *UMA-8* to a USB 2.0 port on your computer using the supplied cable. The *UMA-8* should also be connected for initial driver installation under Windows.

2.3 I2S EXPANSION HEADER PINOUTS

I2S, or Inter IC Sound, is an electrical serial bus used to interface digital audio devices at the chip and circuit board level. An I2S interface consists of up to three clocks, and a data line for each pair of channels. There are three types of clock:

- MCLK** The master clock that the *UMA-8* uses internally. This clock is always provided as an output by the *UMA-8*, and connected circuitry can choose whether or not to use it.
- LRCLK** The frame synchronization clock, also known as the word clock. This clock is equal to the sampling frequency (F_s) of the audio signal.
- BCLK** The bit clock (also known as shift clock or system clock). This is always equal to $64 \times F_s$.

Table 1. I2S clock ratios

Firmware	Sample Rate (FS)	Master clock (MCLK)	Bit clock (BCLK)	MCLK/LRCLK
DSP Mode	48kHz	24.576 MHz	3.072 MHz	512
RAW Mode	11.2/16/32/44.1/48kHz	24.576 MHz	Depends on FS	Depends on FS

The timing of data lines is determined by the bit clock and the word clock, as illustrated in the following diagram:

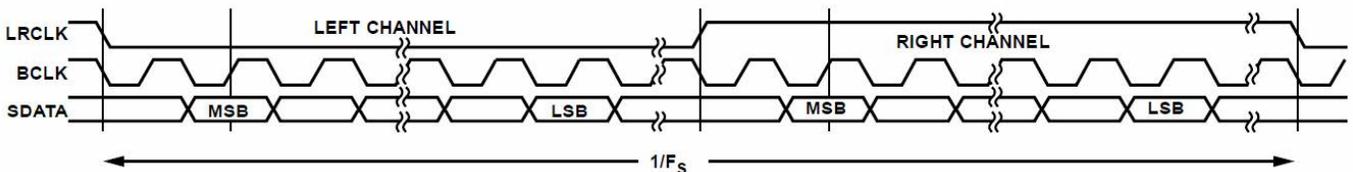


Figure 31. I2S Mode—16 Bits to 24 Bits per Channel

Headers J3 is provided for connection of I/O circuitry via I2S such as an external DAC, Bluetooth module or I2S amplifier.

In the current firmware, only J3.1 / I2S_OUT0 is enabled as “**SPEAKER OUTPUTS**”. (i.e. USB audio from PC to UMA8) for playback. In this mode the UMA8 is I2S master mode (providing the clocks). It can be used to connect to an external I2S slave device.

Table 2. J3 expansion header pinout

J3.1 - I2S_OUT_0	J3.2 - I2S_IN_0
J3.3 - I2S_OUT_1	J3.4 - I2S_IN_1

J3.5 - I2S_OUT_2	J3.6 - I2S_IN_2
J3.7 - I2S_OUT_3	J3.8 - I2S_OUT_4
J3.9 - MCLK	J3.10 - I2S_BCLK
J3.11 - GND	J3.12 - I2S_LRCLK

2.4 ADDITIONAL I2S USAGE NOTES

Note that I2S is not a “plug and play” protocol. It requires attention to technical details such as clocking and wire layout. It is a solution for OEMs and *advanced* DIYers (or professionals) with suitable knowledge, skills and measurement equipment.

Be sure to take the following precautions when designing your I2S interface and wiring:

General I2S usage notes

- Unbuffered I2S lines must be kept short to ensure clock and data integrity.
- If driving longer lines, buffers may be required for the clock signals (MCLK, LRCLK, and BCLK).
- Observe correct grounding and shielding, and keep analog and digital grounds separated.
- Ensure that the clock ratios (as listed in Table 2) are compatible with connected circuits.

3.3V logic level

All lines use a 3.3V logic level. Ensure that connected circuits use a compatible level (1.8V, for example, will not work).



3 DRIVER INSTALLATION AND CONFIGURATION – WINDOWS

3.1 INSTALLATION

The UMA-8 is a USB Audio Class 2.0 device. For use with Microsoft Windows, driver installation is required.

3.1.1 Download the latest driver

When you receive notification that your order has shipped, your installation software download will be available at the *User Downloads* section of the miniDSP website:

<http://www.minidsp.com/userdownloads>

(If you are unable to access this section of the website, please login first.)

Download the installation zip file under the **USB Microphone array series** heading and unzip the folder on your PC.

3.1.2 Connect your UMA-8

In order to automatically detect the UMA-8 during driver installation, connect the UMA-8 to your PC and power it on before going to the following step.

3.1.3 USB Driver installation

1. Connect the UMA-8 to the computer using the supplied USB cable, and power it on.
2. Navigate to the **WinDrivers** folder of the software download and double-click on the appropriate installer:
 - **miniDSP_UAC2_v3.34.0_ForWin7_8_10.exe** for Windows 7, 8, and 10

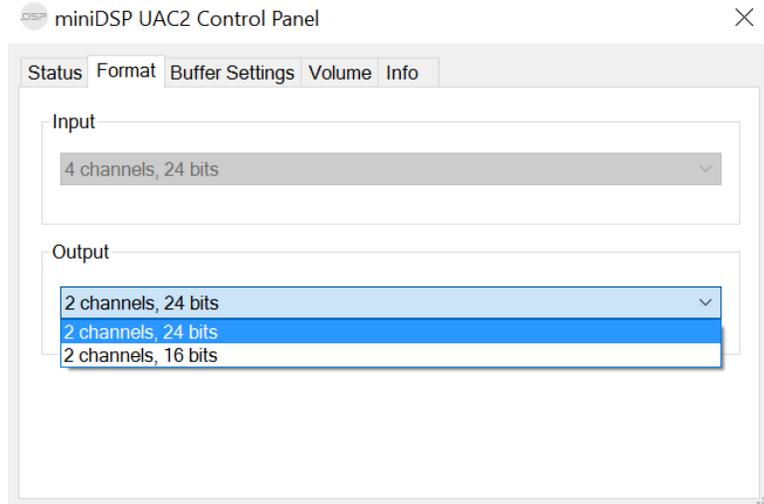
We recommend accepting the default installation location. Once the driver installation completes, click the **Finish** button.

3.2 CONFIGURATION

To configure the UMA-8, open the **USB Audio Control Panel** (from Start Menu -> miniDSP Ltd -> UAC2 Control Panel). It has several panes, described below.

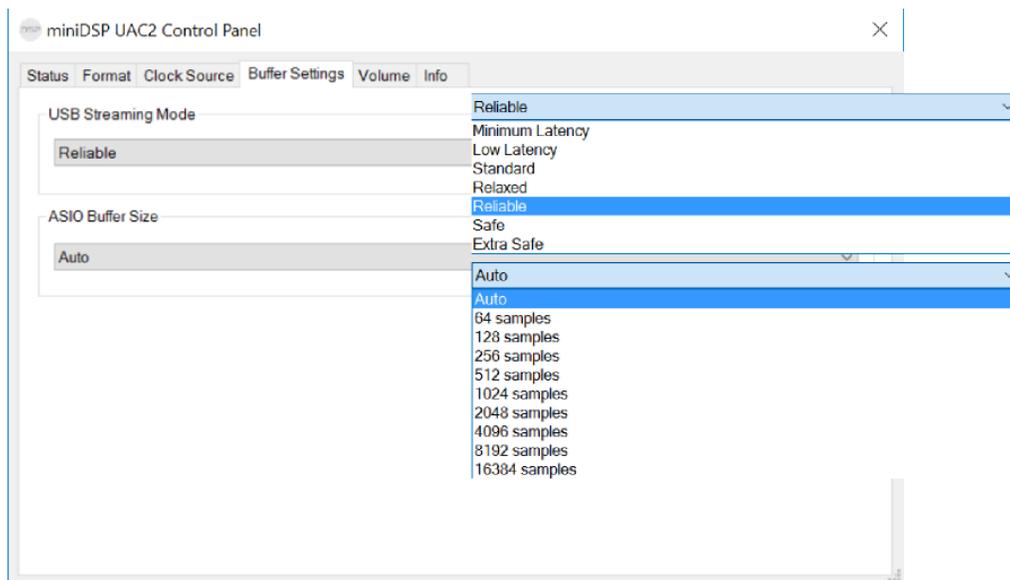
3.2.1 Format

This panel selects the input and output data format. The screenshot here shows the DSP mode.



3.2.2 Buffer settings

The buffer settings are for those looking to optimize buffering and latency settings. Note that changing these settings may result in unstable operation. For example, the lowest latency settings require high amounts of CPU and memory, and may not work on some machines. If you do not require lowest latency, we recommend that you do not depart from the default safe settings.



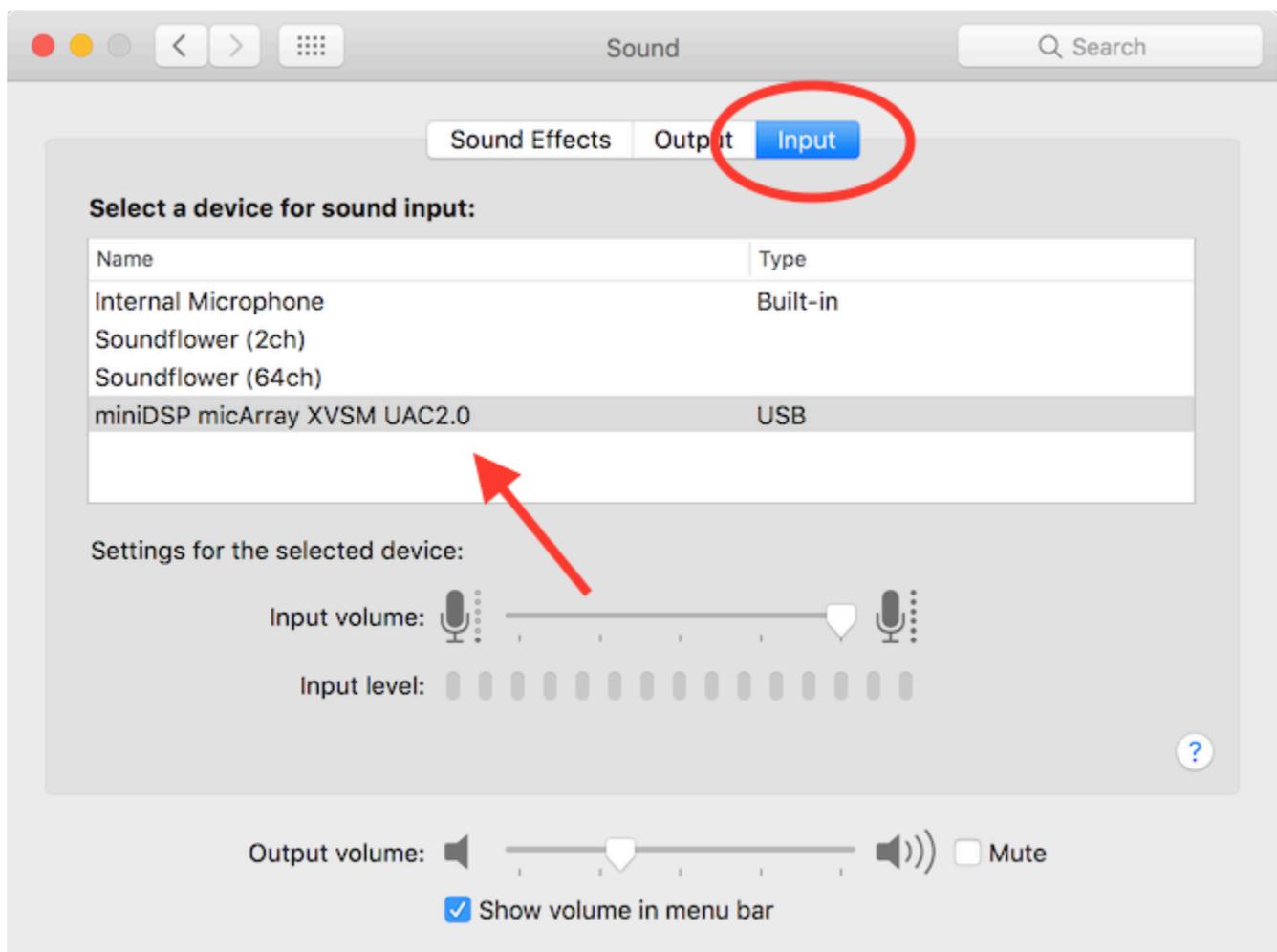
4 DRIVER INSTALLATION AND CONFIGURATION – MAC OS X

4.1 INSTALLATION

Mac OS X has native support for USB Audio class 2.0 devices, so no driver installation is required. The UMA-8 will automatically be detected by Mac OS X as a compliant multichannel USB audio interface.

4.2 CONFIGURATION

Open the program **Audio MIDI Setup** (in **Applications->Utilities**). The UMA-8 will appear automatically in the list on the left hand side, as a **miniDSP micArray XVSM UAC2.0**



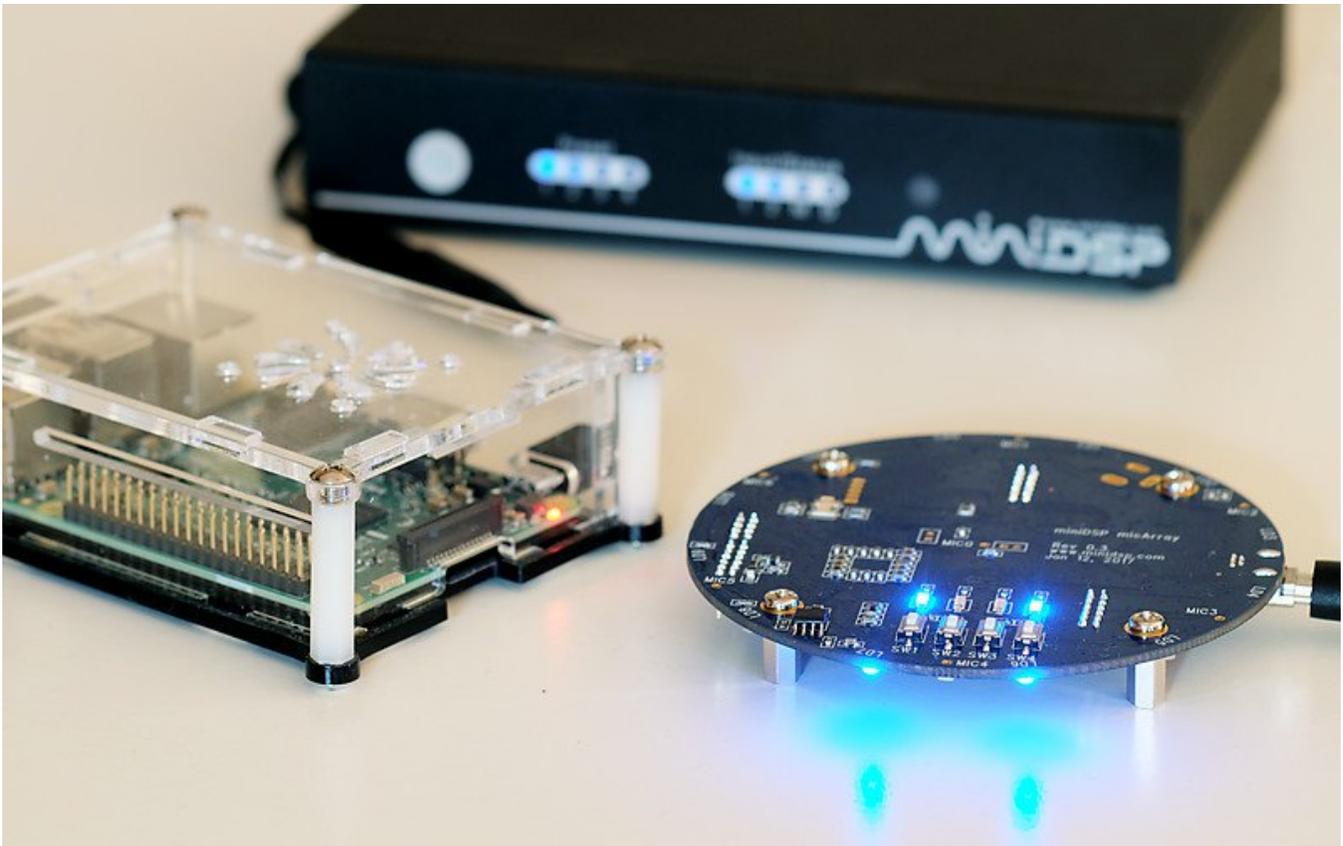
5 DRIVER INSTALLATION AND CONFIGURATION – LINUX

5.1 ALSA INSTALLATION

The UMA-8 is a fully compliant UAC 2 (USB Audio Class) device. While miniDSP's technical support team unfortunately can't provide email/phone support for Linux due to the large number of distributions, we know from experience that the UMA-8 is Plug&Play with Alsa 2.0 drivers. For more information/support on ALSA driver, please consult [ALSA project](#).

5.2 RASPBERRY PI

The UMA-8 was tested to be plug&play with AlexaPi. A complete app note with step by step instructions to build your DIY Alexa speaker is provided at the [following link](#).



6 USB API / CUSTOMIZATION

For advanced DIYers, the UMA-8 may be controlled directly using a basic USB API. Note that the below sections assumes you have basic knowledge of USB HID libraries. miniDSP unfortunately won't be able to provide support to debug/test your code or provide support on basics of HID control. The good news is that there isn't shortage of USB API libraries online.

6.1.1 Discovery of UMA-8

On power up, Mic-Array will be recognized by the computer as an HID device with Vendor ID=0x2752. Product ID=0x1C, some USB library can be used to connect to this device and send / receive commands to / from it.

6.1.2 Voice Activated Detection (VAD) + Direction Of Arrival (DOA)

When voice is detected (VAD active) or the direction of arrival (DOA) changed, the microphone array will send a command to the USB host through USB interrupt. The command format is shown below:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
0x06	0x36	VAD	Angle.HB	Angle.LB	Dir

VAD = 1 / Voice is detected, the Dir byte has to be read to determine the Direction of Arrival.

VAD = 0 / No more voice signal detected

Dir = Direction of Arrival, represented by a number correspond to mic position. Can range from 1 ~ 6 for Mic1~6 as per below diagram. .

Angle = angle of the direction number as specified by Dir, in degrees. Range from 0 ~ 360

Angle.HB = high byte of the angle

Angle.LB = low byte of the angle

7 FIRMWARE UPGRADE

7.1 PRECOMPILED VERSIONS

The UMA-8 is provided with 2 precompiled binaries available under the [User Downloads](#) section of miniDSP.com website. To insure you're running the latest version, make sure to login to your user downloads section.

- **DSP mode (Default):** The UMA8 utilizes the XMOS Vocal Fusion DSP processing library to perform beamforming, noise reduction, autogain and AEC. This is the default mode of operation for plug&play operation as a far field microphone. The sample rate is fixed at 48kHz in this application. The UMA8 is advertised as a 2xIN, 2 x OUT USB audio interface in your OS.

- RECORDING: The 7 MEMS are processed (post beamforming + noise reduction + AEC) to a mono signal for the PC. This mono signal is copied to both input channels. The signal is 24Bit/48kHz.

- PLAYBACK: Knowing the XVSM3000 is only Mono AEC, the incoming stereo signal is mixed to a mono output. This mono signal is then copied to both channels of the I2S_OUT pin.

Use the micArray_vf_spk_vX.0_up.bin for the DSP mode of operation.

- **RAW mode (Advanced users only):** This mode is for advanced users only. The raw microphone signal (without any processing/gain) from each MEMS microphone is recorded as a separate channel. The sample rate is also flexible in this configuration. The UMA8 will appear as a 8 x IN, 2 x OUT USB audio interface in your OS:

- RECORDING: 8ch of audio (7ch coming from the MEMS microphone + 1 ch from spare PDM input) are available as raw audio (non processed). Sample rates are available as 11.2/16/32/44.1/48kHz.

WARNING: The UMA-8 will output the RAW signal from the MEMS without any digital gain (typically applied in 2ch DSP mode). You may require your own application to gain the signal digitally as it's done in the DSP mode.

- PLAYBACK: Knowing the XVSM3000 is only Mono AEC, the incoming stereo signal is mixed to a mono output. This mono signal is then copied to both channels of the I2S_OUT pin.

Use the micArray_vf_raw_vX.X_up.bin for the RAW mode of operation.

7.2 FIRMWARE UPGRADE

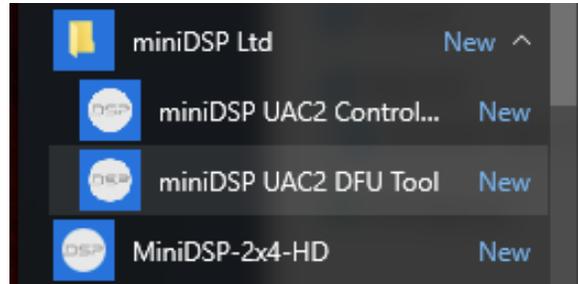
miniDSP may occasionally provide an upgrade to the UMA-8 MCU firmware to enable new features. To upgrade the MCU firmware, first download and install the latest version of the Mic Array plugin from the **User Downloads** section of the miniDSP website.



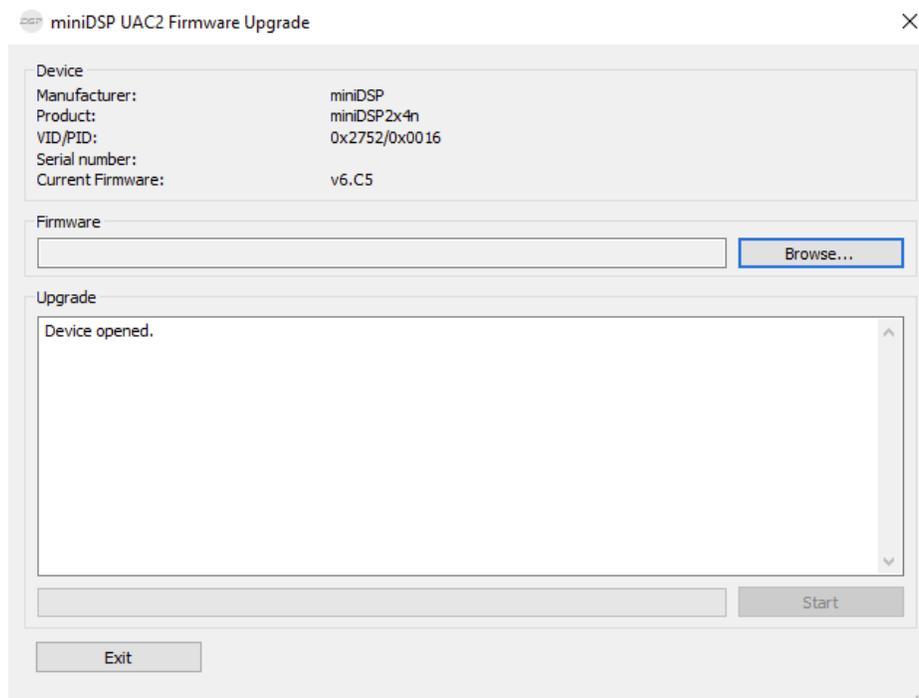
DO NOT DISCONNECT THE USB CABLE OR POWER FROM THE *UMA-8* WHILE FIRMWARE UPGRADE IS IN PROGRESS. DOING SO MAY "BRICK" YOUR *UMA-8*

7.2.1 Windows

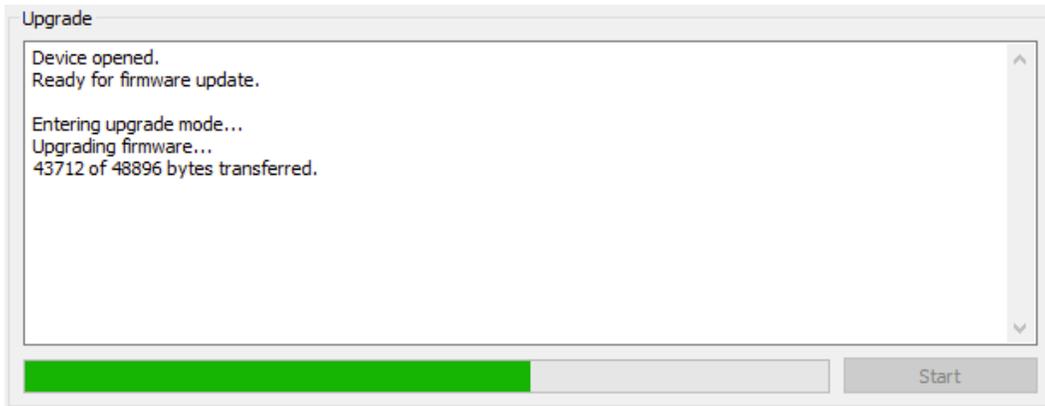
1. Connect the UMA-8 to your computer via USB (if not already connected) and power it on.
2. Start the **miniDSP UAC2 DFU Tool**.



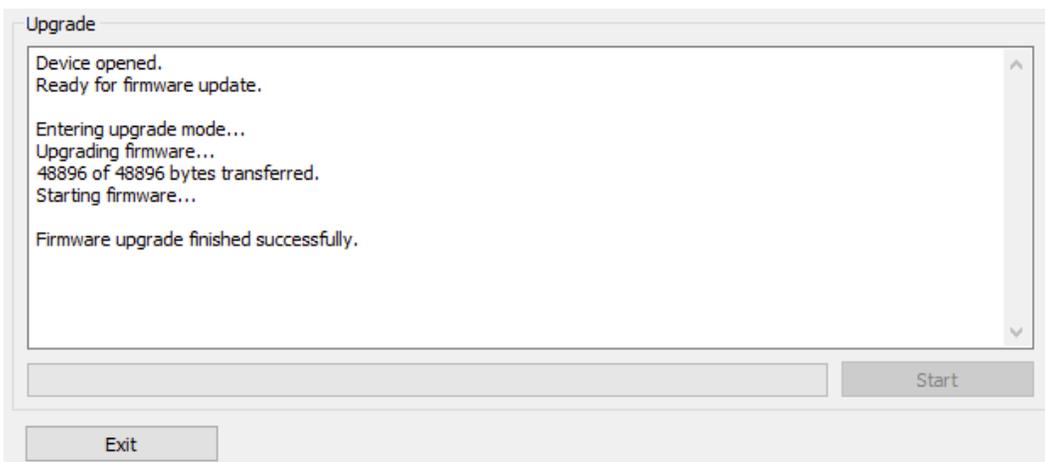
3. The upgrade program will start:



4. Click on the **Browse** button, navigate to the folder **XMOS_Firmware** in the plugin download folder, and select the firmware file.
5. Click on the **Start** button.
6. You will get a progress bar as upgrade proceeds:



7. Once the firmware upgrade completes, you will see a message that the upgrade completed successfully:



8. Click on **Exit**.
9. That's it! You're done. You can now use your 2x4 HD with the new functionality.

7.3 OBTAINING SUPPORT

1. Check the forums on minidsp.com to see if this issue has already been raised and a solution or solutions provided.
2. Contact miniDSP via the support portal at support.minidsp.com with:
 - a. The product information including OS version and version of driver installed (for Windows).
 - b. A clear explanation of the symptoms you are seeing.
 - c. A description of the troubleshooting steps you performed and the results obtained.

8 ADDITIONAL INFORMATION

8.1 SPECIFICATIONS

Item	Description
USB streaming engine	XMOS XVF3000 - Multicore USB audio processor with embedded DSP
USB audio capabilities	USB audio recording in 2 possible modes depending on firmware: - RAW MODE: 8ch recording / No processing applied - DSP MODE: 2ch recording processed by onboard Vocal Fusion XMOS DSP library USB audio playback: Stereo I2S channel for I2S out (e.g. external amplifier/DAC board.)
Vocal Fusion Processing (prebuilt firmware)	Beamforming with configurable beam width (up to 20dB attenuation) - Perceptual acoustic echo cancellation (up to 80dB attenuation) - Noise suppression (up to 20dB attenuation) - De-reverb (up to 20dB attenuation)
UAC2.0 drivers	Driverless interface for Mac OS X v10.6.4 and up Thesycon Windows ASIO driver (All versions) Linux Alsa 2.0 compliant Control via HID interface for advanced settings and active microphone
Resolution / Sample rate	RAW MODE: 24bit @ 11/16/32/44.1/48 kHz DSP MODE: 24bit @ 48kHz
I2S port	Output: I2S_OUT enabled
MEMS microphones	7 x Knowles SPH1668LM4H with low noise buffer and high performance modulator - Low distortion: 1.6% @ 120 dB SPL - High SNR: 65 dB and flat frequency response - RF shielded against mobile interference - Ominidirectional pick-up pattern
LED	12 x RGB LED / Bottom mounted - Circular light guide included
Expansion connector	2 x 12-pin, 2 mm pitch expansion connector for connectivity to hardware. XMOS JTAG connector for custom code.
Power supply	USB powered
Dimensions (diameter) mm	90 mm diameter / 20mm height with LED ring, 14mm height without LED ring