UMA-16 v2

MICROPHONE ARRAY DEVELOPMENT BOARD

User Manual
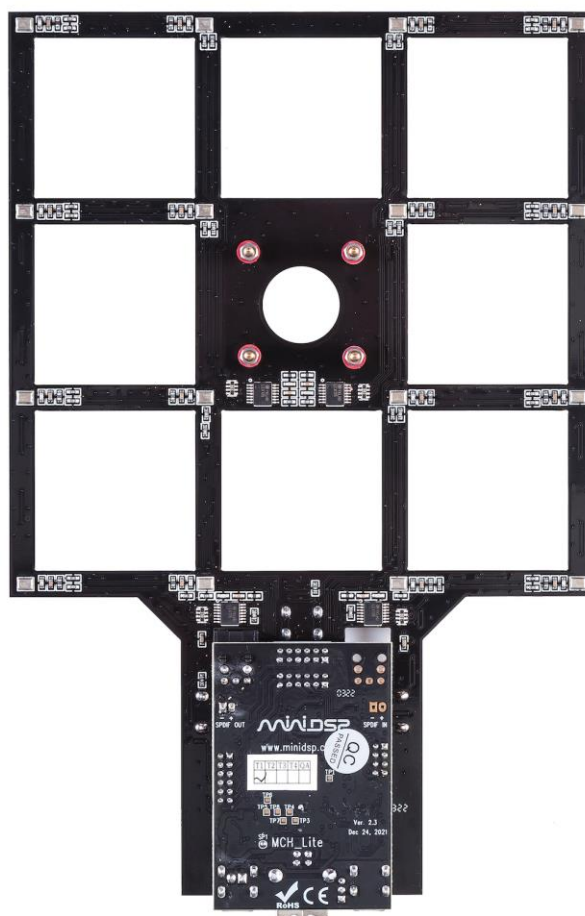
Revision history

Revision	Description	Date
V1.0	First version	18 Jan 2018
V1.1	Updated for MCHStreamer Lite interface (preliminary)	17 May 2022
V1.2	Public release, renamed UMA-16 v2	6 June 2022

TABLE OF CONTENTS

IMPORTANT INFORMATION

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

System Requirements

To configure the UMA-16 v2, you will require a Windows PC or Apple Mac computer with the following minimum specification:

Windows

- Microsoft• ® Windows® 7/8.1/10/11
- At least a dual core i3, i5, or i7 processor
- At least 2 GB RAM (4 GB or more preferred)
- One free USB 2.0 port
- Internet connection

macOS

- OS X 10.8 or higher, macOS 10.12 or higher
- At least a dual core i3, i5, or i7 processor, or an ARM processor (M1/Pro/Max)
- At least 2 GB RAM (4 GB or more preferred)
- One free USB 2.0 port
- Internet connection

Disclaimer/Warning

miniDSP cannot be held responsible for any damage that may result from the improper use of this product or incorrect configuration of its settings. As with any other product, we recommend that you carefully read this manual and other technical notes to ensure that you fully understand how to operate this product. The miniDSP audio processor is a powerful tool, and misuse or misconfiguration, such as incorrectly set gains or excessive boost, can produce signals that may damage your audio system.

As a general guideline, you should perform the initial configuration of the miniDSP audio processor before enabling audio through any connected output device or amplification. Doing so will help ensure that the software is correctly configured.

Finally, note that the miniDSP audio processor is a very flexible device, and many of the questions we receive at the tech 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 support. Thanks 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 miniDSP UMA-16 v2 has passed the test performed according to European Standard EN 55022 Class B.
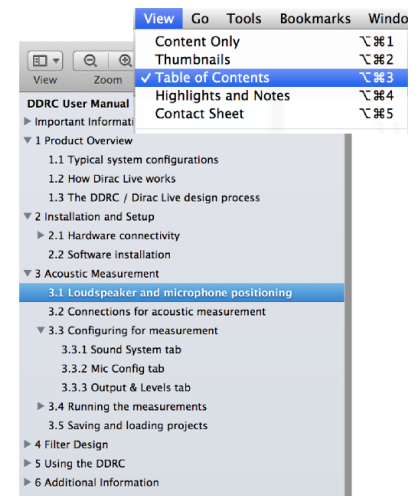
A note on this manual

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. Use the View menu (Preview on Mac) or the bookmarks sidebar (Adobe reader on Mac and Windows) to view this table of contents.
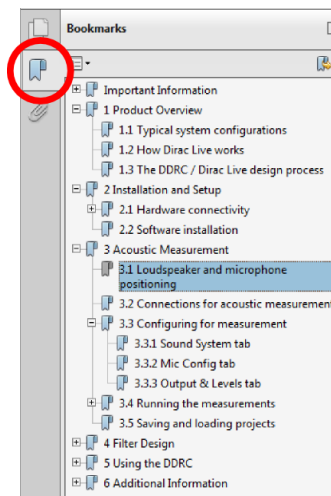
Adobe Reader on Windows   Preview on Mac

Acknowledgments

ASIO® is a registered trademark of Steinberg Media Technologies GmbH.

1   PRODUCT OVERVIEW

Thank you for choosing the UMA-16 v2. The UMA-16 v2 is a cost-effective sixteen-channel microphone array with plug-and-play USB audio connectivity. With its embedded XMOS interface, the UMA-16 v2 is the perfect fit for researchers looking to develop their own beam-forming algorithms.

The UMA-16 v2 system architecture is powered by two core elements:

- A microphone PCB with 16 x Knowles SPH1668LM4H MEMS microphones. A center hole fits an optional USB camera for applications such as acoustic cameras. The microphone PCB is a simple 2-layer design that can easily be customized to your needs by following our schematics included in this user manual.

- Stacked on top of the mic array is the MCHStreamer Lite USB interface. This XMOS XCORE interface allows for a high quality PDM to PCM conversion and presents all 16 channels of raw audio to the USB interface.

Please note that the following sections will highlight basic operation of the UMA-16 v2. Beamforming algorithm development or any 3rd party support for software (e.g. Matlab) is considered outside the scope of this manual and our support structure.

2 BOARD LAYOUT AND CONNECTIVITY

2.1 BOARD LAYOUT

Figure 1 and Figure 2 show the layout of the UMA-16 v2. Sixteen MEMS microphones are laid out in a Uniform Rectangular Array (URA) distribution on a 42 mm grid. CAD drawings are available on request.
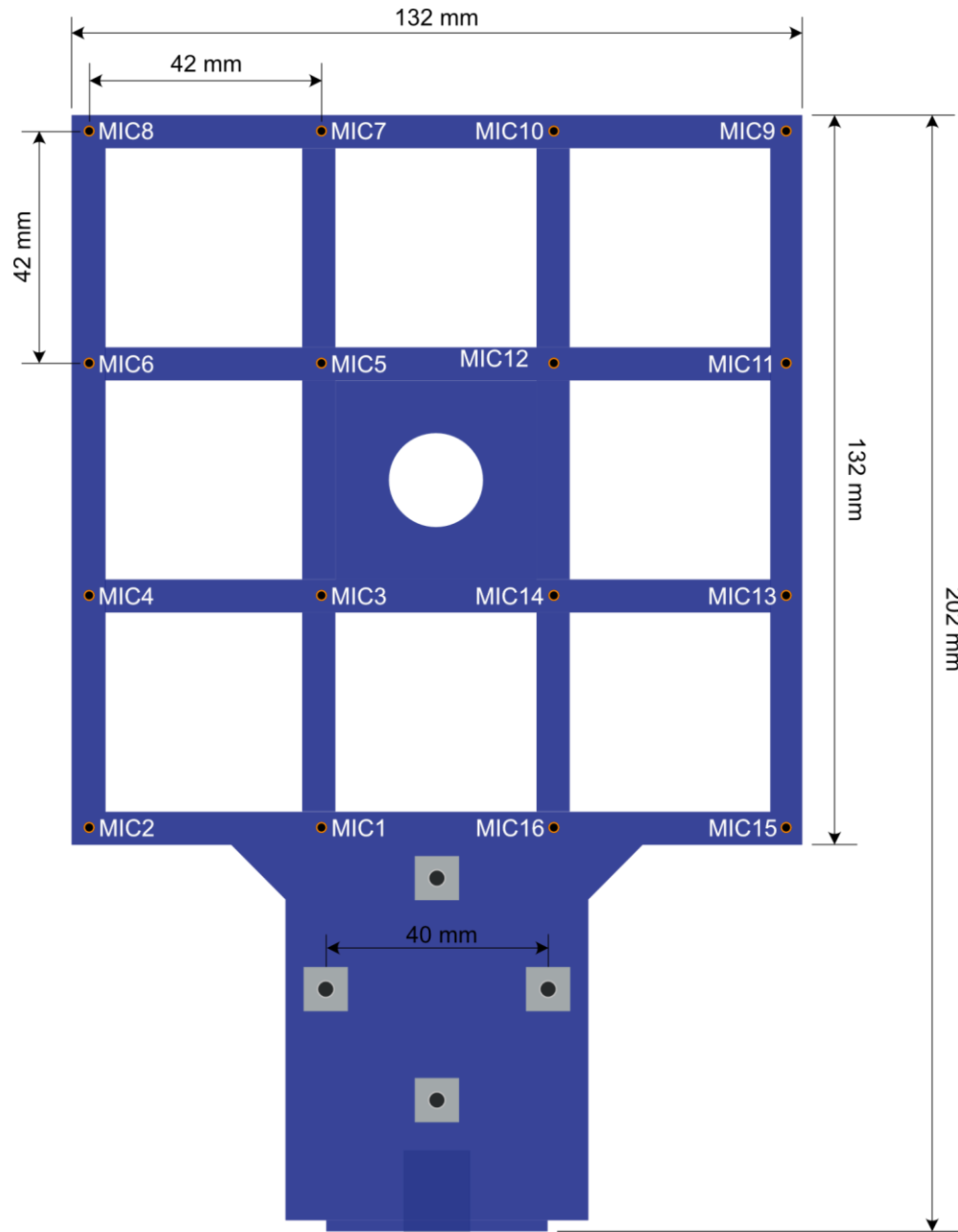

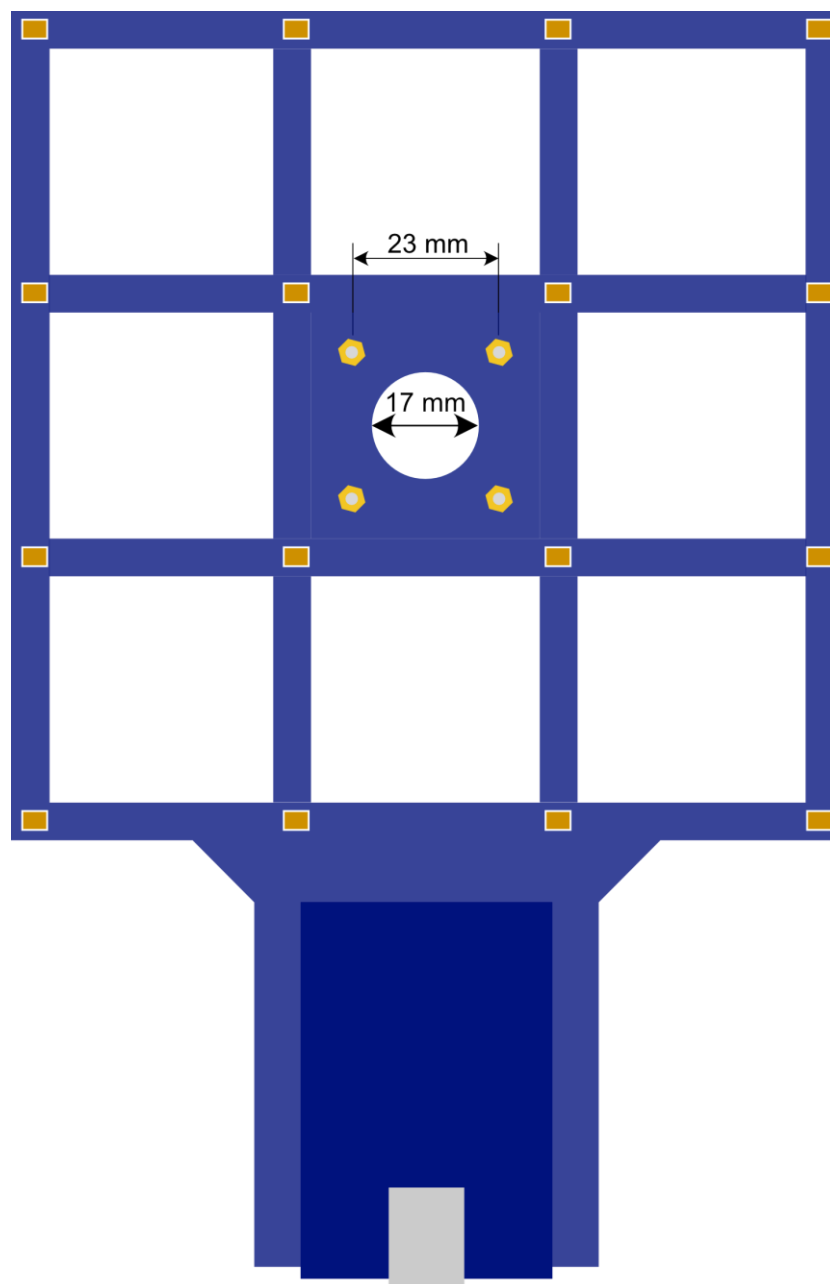*Figure 1. UMA-16 board layout and dimensions - sound source side*

Figure 2. UMA-16 board layout - component side

2.2 USB CONNECTIVITY

Connect the USB port (type B) to a computer. The USB port provides asynchronous USB Audio (Class 2) streaming at the sample rates 8, 11.025, 12, 16, 32, 44.1 and 48 kHz. See section 3 for more details on USB audio connectivity

The array is powered over the USB connection, so there is no need to separately connect power.

2.3 KNOWLES SPH1668LM4H-1 MICROPHONES

The UMA-16 v2 is fitted with 16 Knowles MEMS microphones. Please refer to the complete datasheet for more details.

Features

- Low Distortion of 1.6% at 120dBSPL

- High SNR of 65.5dB

- Flat Frequency Response

- RF Shielded

- Zero-Height Mic™

- Supports Dual Multiplexed Channels

- Standard SMD Reflow

- Omnidirectional

Acoustic performance under the Performance Mode (default)

Performance Mode

TEST CONDITIONS: f_{CLOCK} = 2.4 MHz, V_{DD}=1.8 V, unless otherwise indicated

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Supply Current[1,2,3]	I_{DD}		-	626	700	µA
Sensitivity[1]	S	94 dB SPL @ 1 kHz	-30	-29	-28	dBFS
Signal to Noise Ratio	SNR	94 dB SPL @ 1 kHz, A-weighted, f_{CLOCK}=3.072 MHz	-	65.5	-	dB(A)
Total Harmonic Distortion	THD	94 dB SPL @ 1 kHz	-	0.1	-	%
		120 dB SPL @ 1 kHz	-	1.6	-	
Acoustic Overload Point	AOP	10% THD @ 1 kHz	-	122	-	dB SPL
Power Supply Rejection Ratio	PSRR	200 mVpp sinewave @ 1 kHz	-	64	-	dBV/FS
Power Supply Rejection	PSR+N	100 mVpp 1/8 duty cycle rectangular waveform @ 217 Hz, A-weighted	-	-91	-	dBFS(A)

Typical Free Field Response
### Normalized to 1 kHz
CLK=2.4MHz VDD=1.8V
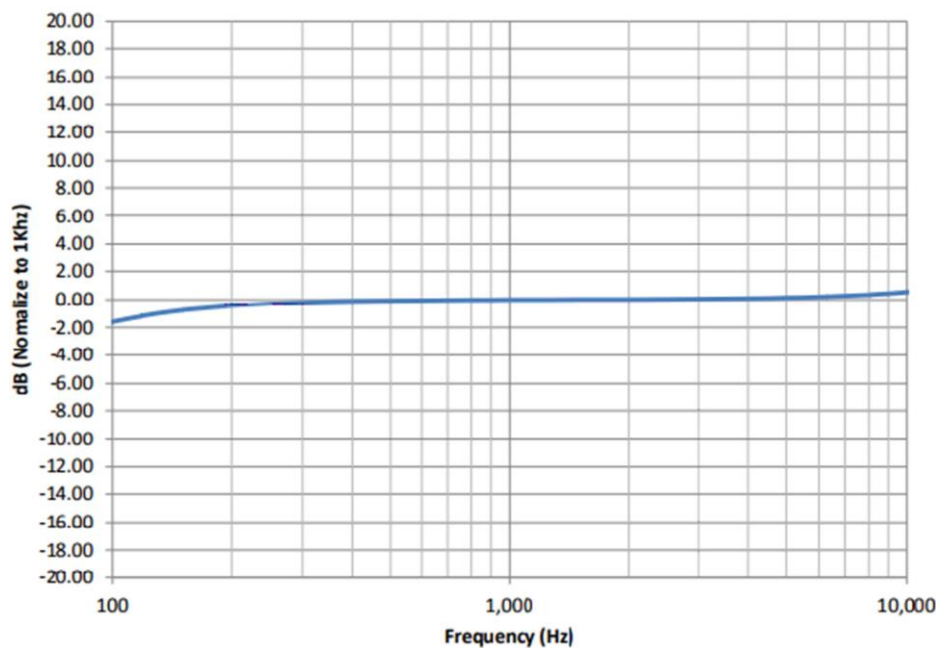
3 USB AUDIO

The miniDSP UMA-16 v2 streams PCM audio at sample rates of 8, 11.025, 12, 16, 32, 44.1 and 48 kHz over its USB Audio Class 2 (UAC2) compliant interface. Here are more details on setup and configuration.

3.1 MACOS

Open the program **Audio MIDI Setup** (in **Applications**->**Utilities**). The UMA-16 v2 will appear in the list on the left-hand side. Clicking on it and selecting "Input" will display the input channels. The operating sample rate can be selected from the dropdown menu:
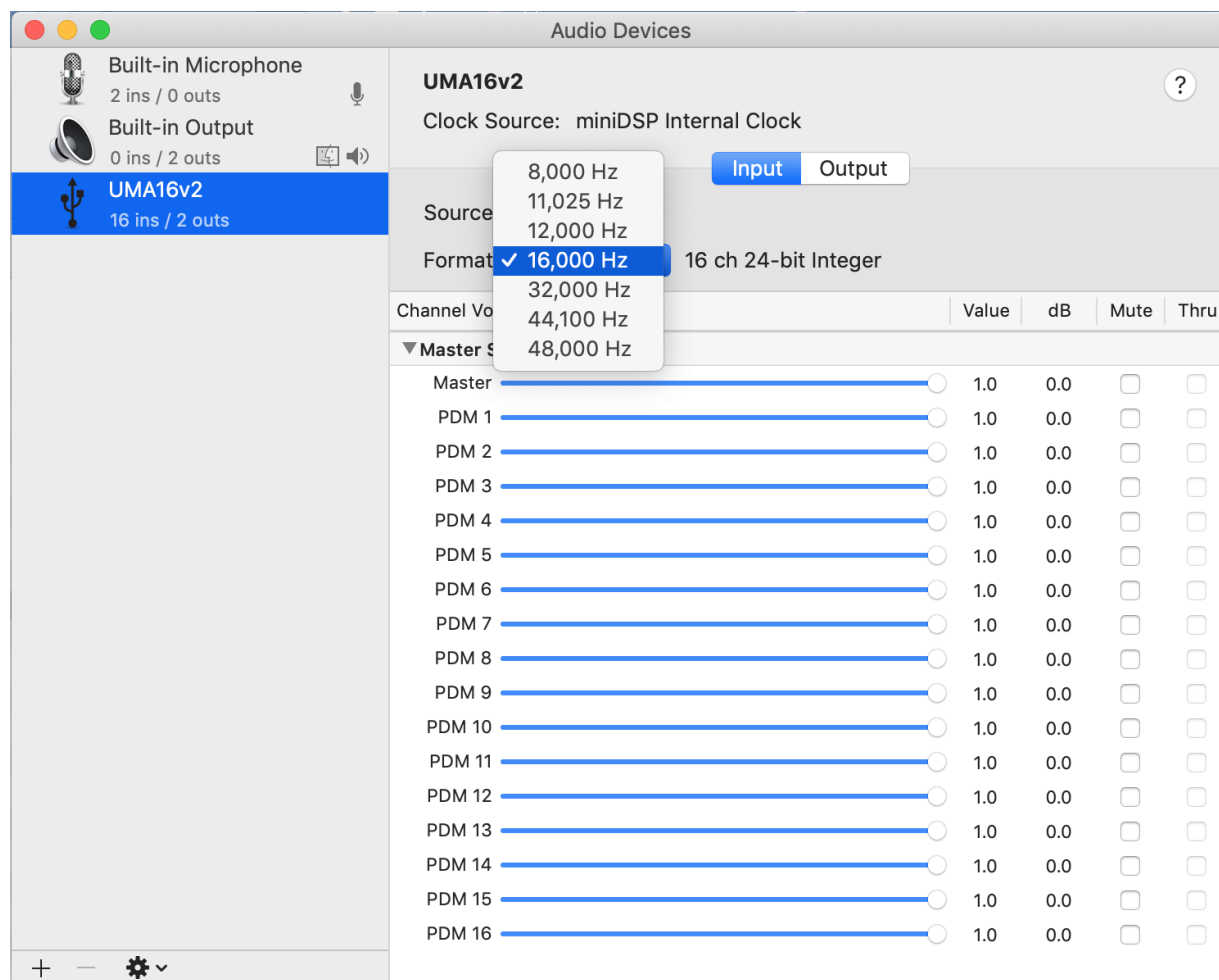
Note that there are two output channels visible for the UMA-16 v2. However, these are not physically accessible on the MCHStreamer Lite board, so can be ignored.

3.2 WINDOWS

3.2.1 Download USB driver

If you purchased your product directly from miniDSP, your software will be available from the User Downloads section of the miniDSP website when your order ships. You will need to be logged into the website with the account you created when purchasing to access the download.

If you purchased your product from a miniDSP dealer, you will receive a coupon together with the product. Redeem this coupon and select the Plugin Group "UMA-16 Microphone Array" at the link below:

- https://www.minidsp.com/support/redeem-coupon

The User Downloads link is visible from the dropdown menu at the top right of the website page:
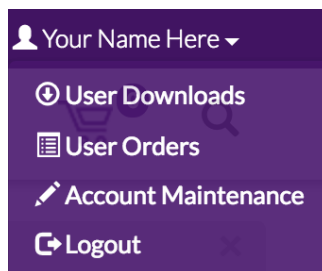
Navigate to the **USB Microphone Array Series** and download the zip file under the heading **UMA16 Drivers**. Unzip the downloaded file by right-clicking on it and selecting "Extract All…".

3.2.2 USB Driver installation

 The USB Driver must be installed **before** connecting the UMA-16 v2 to your Windows PC.

Follow these steps:

1. Navigate to the **WinDrivers** folder of the software download and double-click on the installer. It will be named **miniDSP_UAC2_v4.82.0_2020-06-09_setup.exe** (the version number embedded in the filename may be different).

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

2. Connect the UMA-16 v2 to the computer using the supplied USB cable.

3.2.3   Control panel

In Windows 10 or 11, open the Control Panel, then go to Hardware and Sound, then Manage Audio Devices. The UMA-16 appears as "MCHStreamer Multi-channels." Here you can set the UMA-16 v2 as the default audio input device if needed, and set its sample rate and bit depth by clicking on the Properties button:
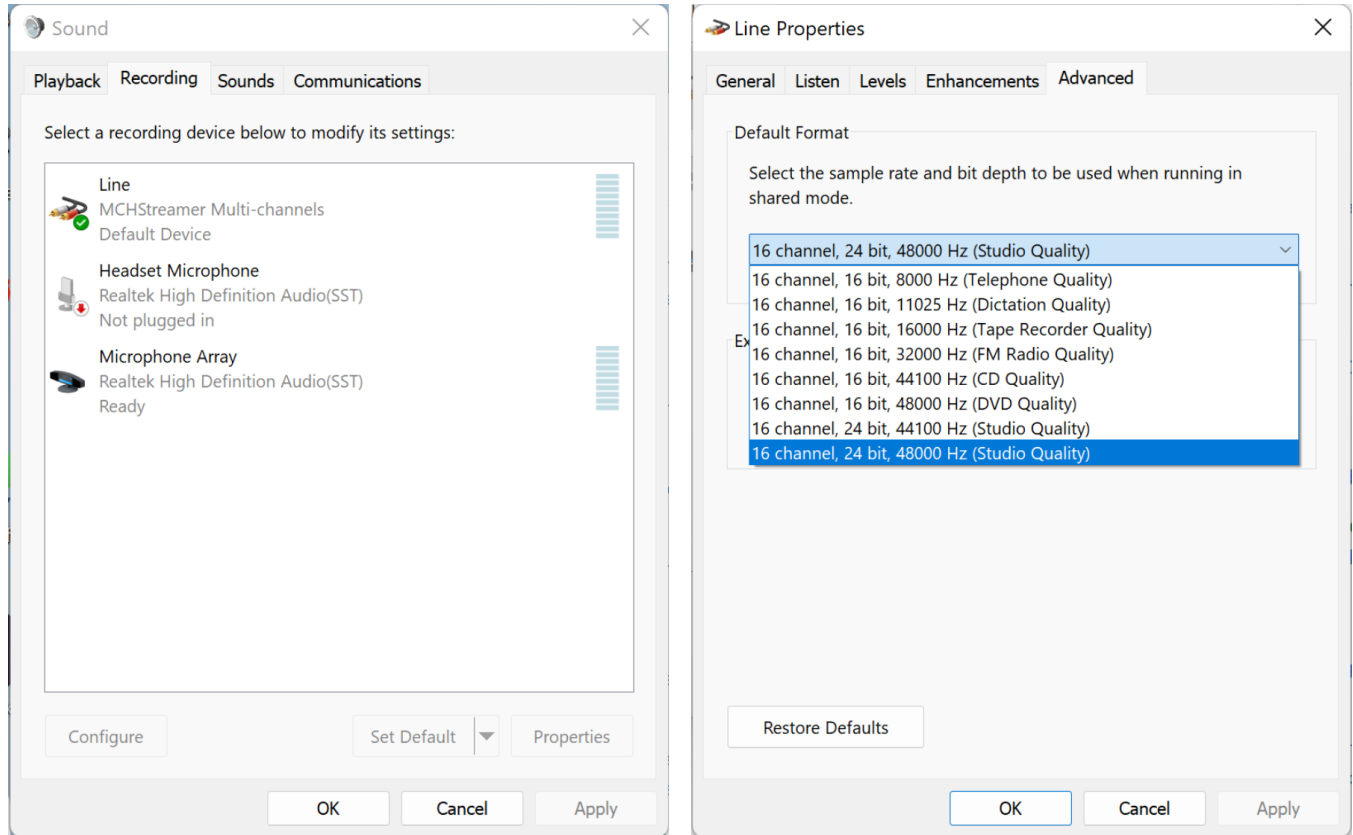

Notes:

1. Recording and measurement programs may set the sample rate themselves, overriding the setting made manually in the Control Panel.

2. There are two output channels visible for the UMA-16 v2. However, these are not physically accessible on the MCHStreamer Lite board, so can be ignored.
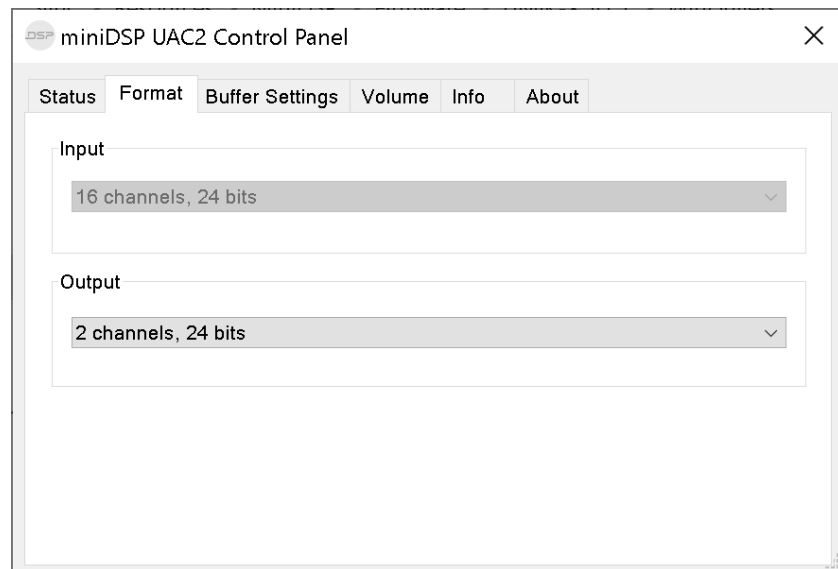
3.2.3.1 Status

This tab shows the current sample rate of the UMA-16 v2. This setting cannot be changed here, but simply displays the current sample rate. The sample rate is chosen in the Windows Control Panel (above) or the software being used for recording or measurement.
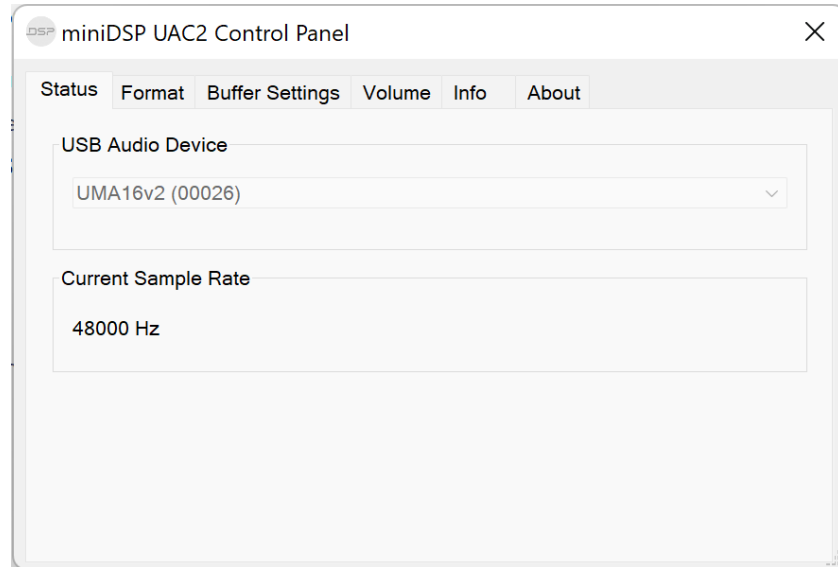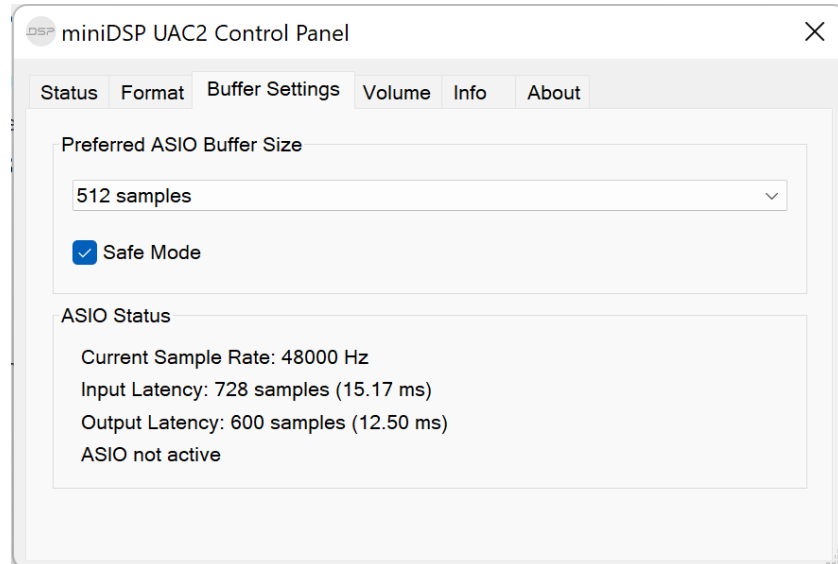

3.2.3.2 Format

This tab shows the input and output channel word lengths:
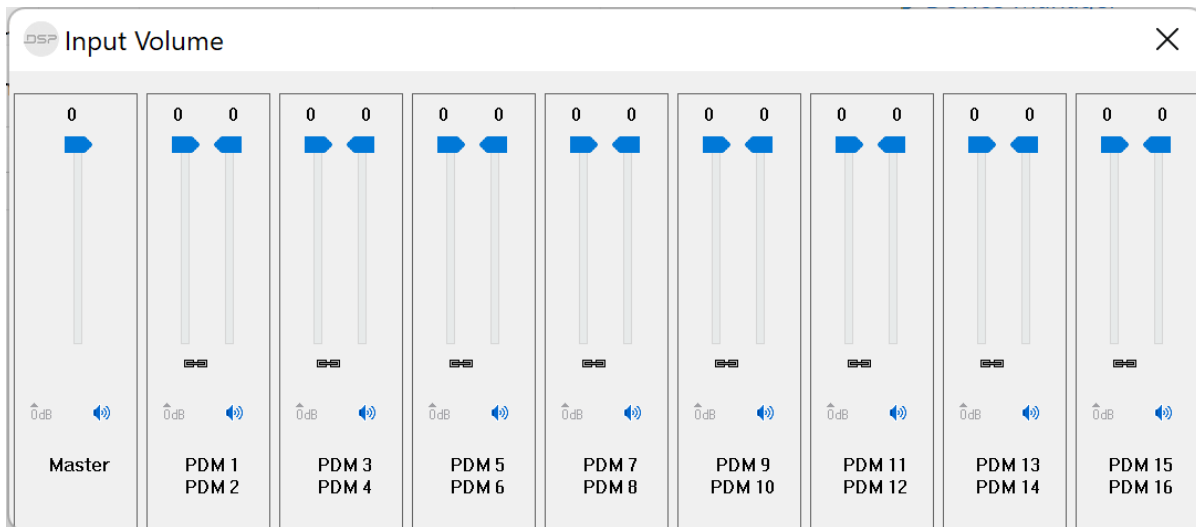
![miniDSP logo]

3.2.3.3 Buffer settings

The buffer settings are for those looking to optimize buffering and latency settings. Changing these settings may result in unstable operation. We recommend that you leave them at the defaults.


3.2.3.4 Volume

This panel contains the volume controls for input channels.

- o   To reset the master volume control or a pair of channels to 0 dB (no attenuation), click the **0dB** button.

- o   To mute all channels, click either of the speaker icons.

- o   To control volume separately for each channel, click on the "Link" icon to turn it off

3.2.3.5   Info

This panel shows information about the UMA-16 v2. Important data includes the firmware version.
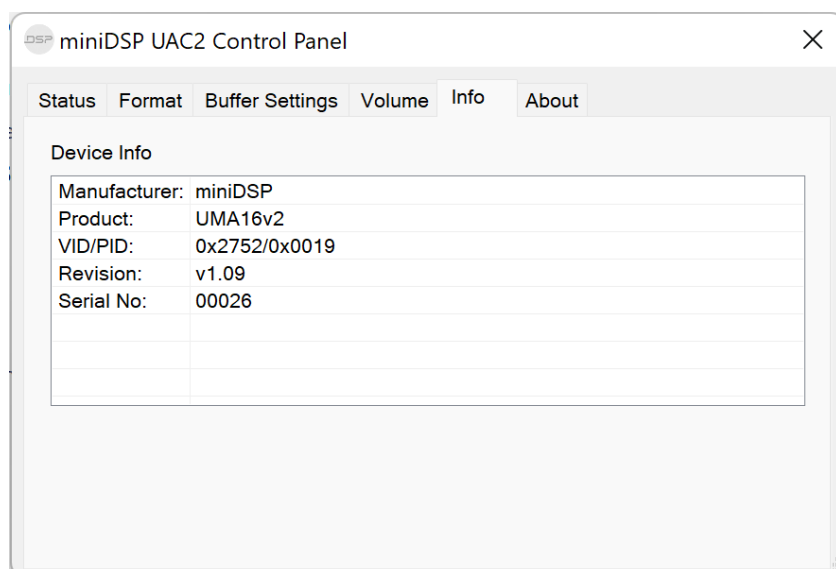
3.2.3.6   About
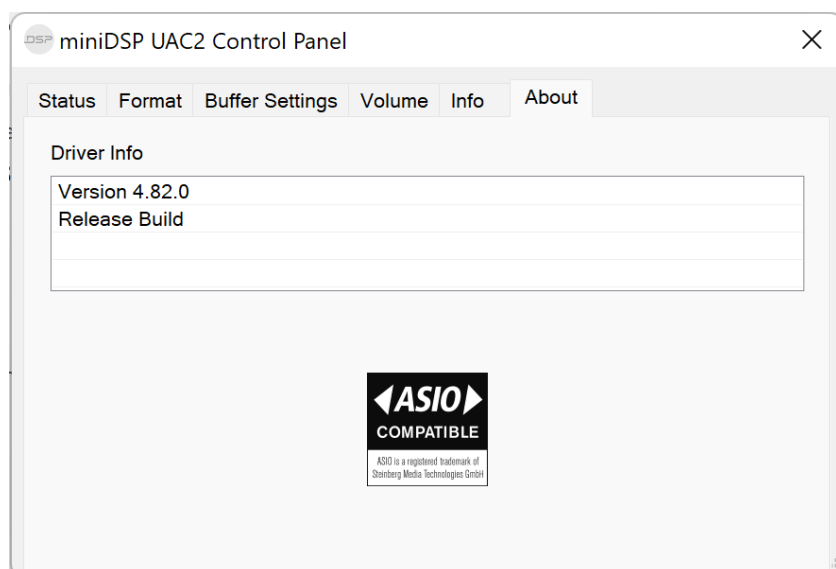
3.3 COMPLIANT USB AUDIO SOFTWARE

Please note that the UMA-16 requires multichannel recording or measurement software with ASIO support. Not all software supports such needs. For example, the Audacity freeware only supports WDM and therefore won't work.

We recommend a Digital Audio Workstation (DAW) such as Reaper/Cubase/Protools for a reliable experience. For acoustic measurement, we recommend Room EQ Wizard with the Pro upgrade for multichannel support.

Also note that Matlab running the latest audio toolbox will support ASIO. Please consult Matlab tech support for more details. For an introduction to using the UMA-16 with Matlab, see this app note on our website:

- [Using the miniDSP UMA-16 / UMA-8 microphone array with Matlab](#)

4 ROOM EQ WIZARD MULTICHANNEL MEASUREMENT

The UMA-16 can be used for audio measurement with Room EQ Wizard (REW). To enable multi-channel measurement with REW, the Pro upgrade is required. This can be purchased here:

- https://www.roomeqwizard.com/upgrades.html

(Note: the REW Pro upgrade is included with a purchase of the miniDSP UMIK-X, but is **not** included with the UMA-16.)

For an example application using REW for multi-channel measurement, see this application note on our website:

- Microphone Techniques for Measurements in Car Cabins

4.1 ENABLING THE LICENSE

To enable your license, drop down the Upgrades menu and select Multichannel measurement. Paste in your license code.
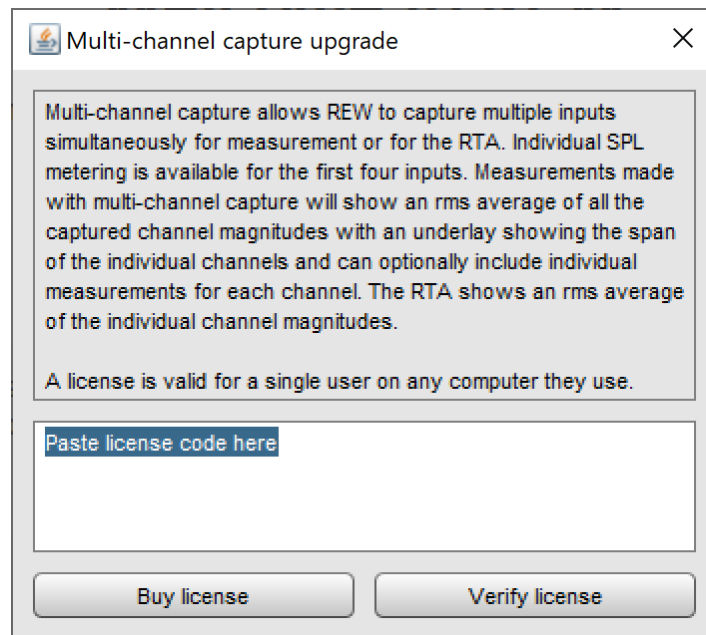
You will need to quit and restart REW for the license to take effect.

4.2 REW SETTINGS – WINDOWS

For real-time measurement with REW, you will need an ASIO wrapper such as FlexASIO:

- https://github.com/dechamps/FlexASIO

Download and install FlexASIO, then start REW and open its Preferences. Under Drivers, select "ASIO then click on the ASIO Control Panel button.

The FlexASIO control panel will pop up. Select the UMA-16 as the input device. Also select the desired output device (our example shows the miniDSP SHD):
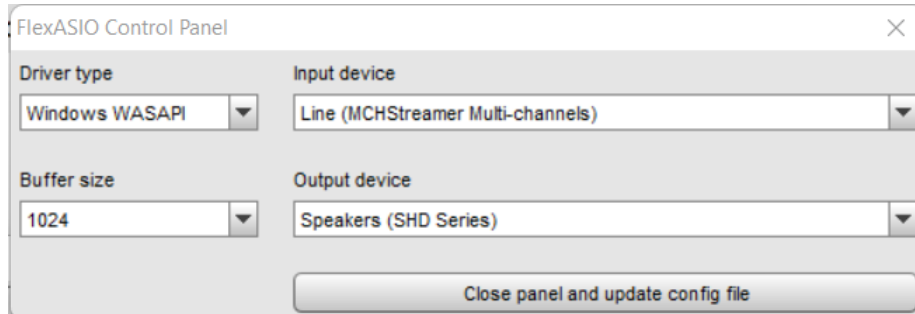
Click on "Close panel and update config file." In the REW Preferences, ensure that the "Multiple inputs" checkbox is checked. Select IN 0 as the first input and IN 15 as the last:
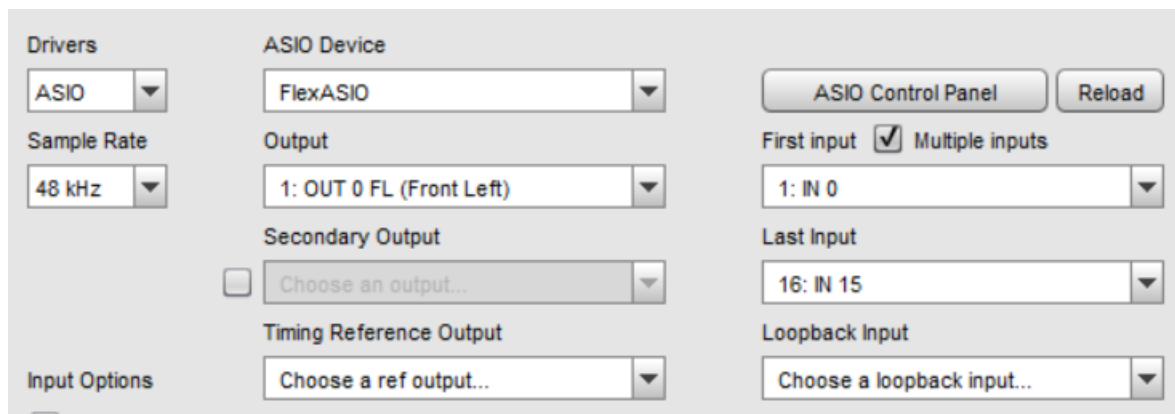
4.3   REW SETTINGS – MACOS

Start REW and open the Preferences. Select your output device (our example shows the miniDSP Flex). Select the UMA16v2 as the input device and check the "Multiple inputs" checkbox.

Select channel 1 as the first input and channel 16 as the last:

4.4   MEASUREMENT

To run a measurement, use the Measure button as usual. On the measurement settings windows, ensure that "Multiple inputs" is checked. If "Generate individual measurements" is not checked, REW will generate a single plot that displays the average of all 16 microphones and the spread between them indicated as a grey shadow:
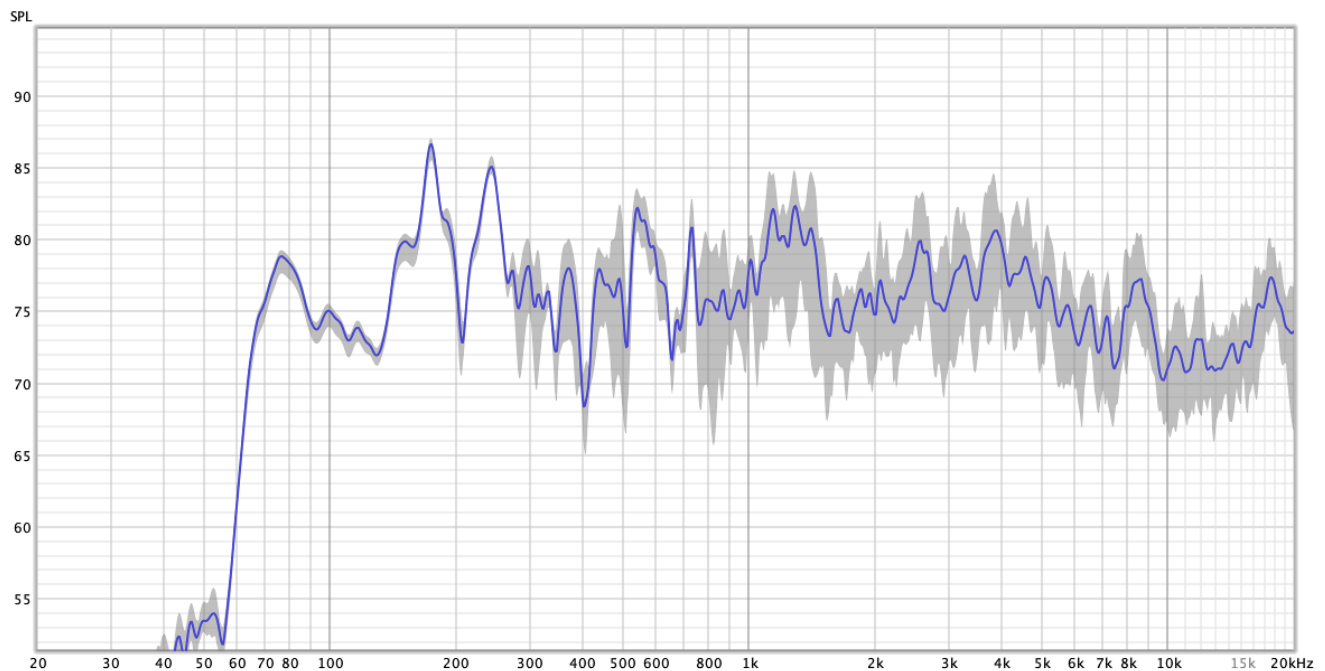
If "Generate individual measurements" is checked, REW will *also* generate plots for each microphone (so a total of 17 plots for each sweep).

5 ADDITIONAL INFORMATION

5.1 SPECIFICATIONS

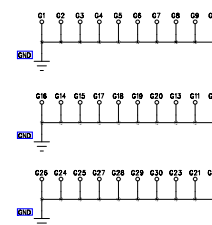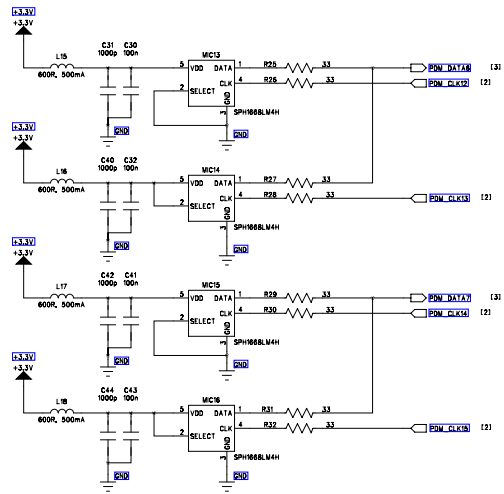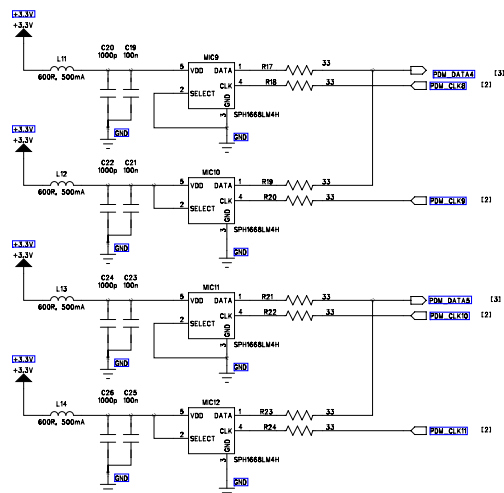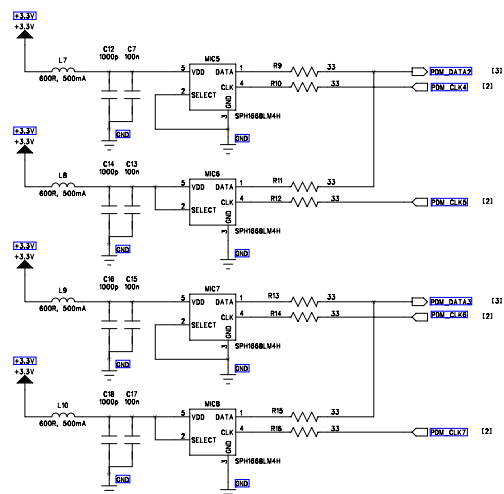| Item	Description
Control	Driverless USB 2.0 control interface for Windows/macOS environments
USB audio input	XMOS Xcore200 asynchronous USB audio up to 48 kHz, USB Audio Class 2 compliant • ASIO drivers for Windows • Driverless for macOS
MEMS microphone	16 x Knowles SPH1668LM4H
ADC/DAC Sample rate & Resolution	Resolution: 24 bit Sample rate: 8, 11.025, 12, 16, 32, 44.1 and 48 kHz
USB port	USB port type B for audio streaming
Power supply	Provided over USB
Dimensions (H x W x D) mm	132 x 202 x 18 mm
Mounting	4 x M3 holders for front panel mounting / CAD drawings available on request

5.2 OBTAINING SUPPORT
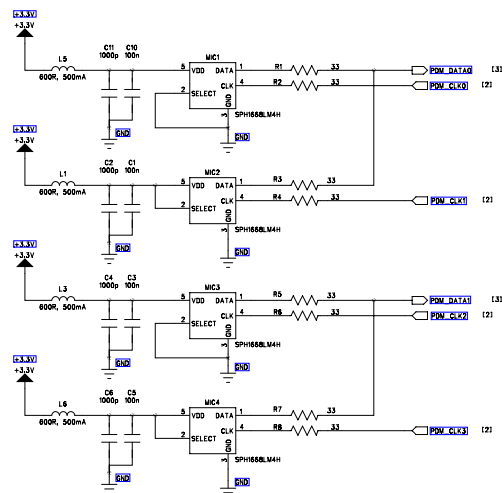
1. Check the forums on miniDSP.com to see if this issue has already been raised and a solution provided.

2. Contact miniDSP via the support portal at minidsp.desk.com with:

   a. The specific product you are having an issue with (in this case, UMA-16 v2 board or accessories).

   b. A clear explanation of the symptoms you are seeing.

   c. A description of troubleshooting steps (see Troubleshooting above) performed and your results.

Please note that miniDSP is only able to provide support for the hardware and functions documented in this manual, and only for problems specifically related to the miniDSP hardware and software functions. Any other items, such as designing or debugging your PDM interface circuitry or layout or interfaces to third-party hardware, are specifically excluded from the scope of miniDSP support.

5.3 SCHEMATICS

See next three pages.

PDM MIC

miniDSP Ltd, Hong Kong / www.minidsp.com / Features and specifications subject to change without prior notice

CLOCK schematic sheet for UMA-16_Lite, showing PDM clock buffer circuitry using 74LCX125 buffers (U4, U17, U20, U21) distributing PDM_CLK-IN to PDM_CLK0 through PDM_CLK15, an LED indicator (LD1), and PDM buffer VDD power supply filtering (PDM_BUF_VDD1–VDD4).
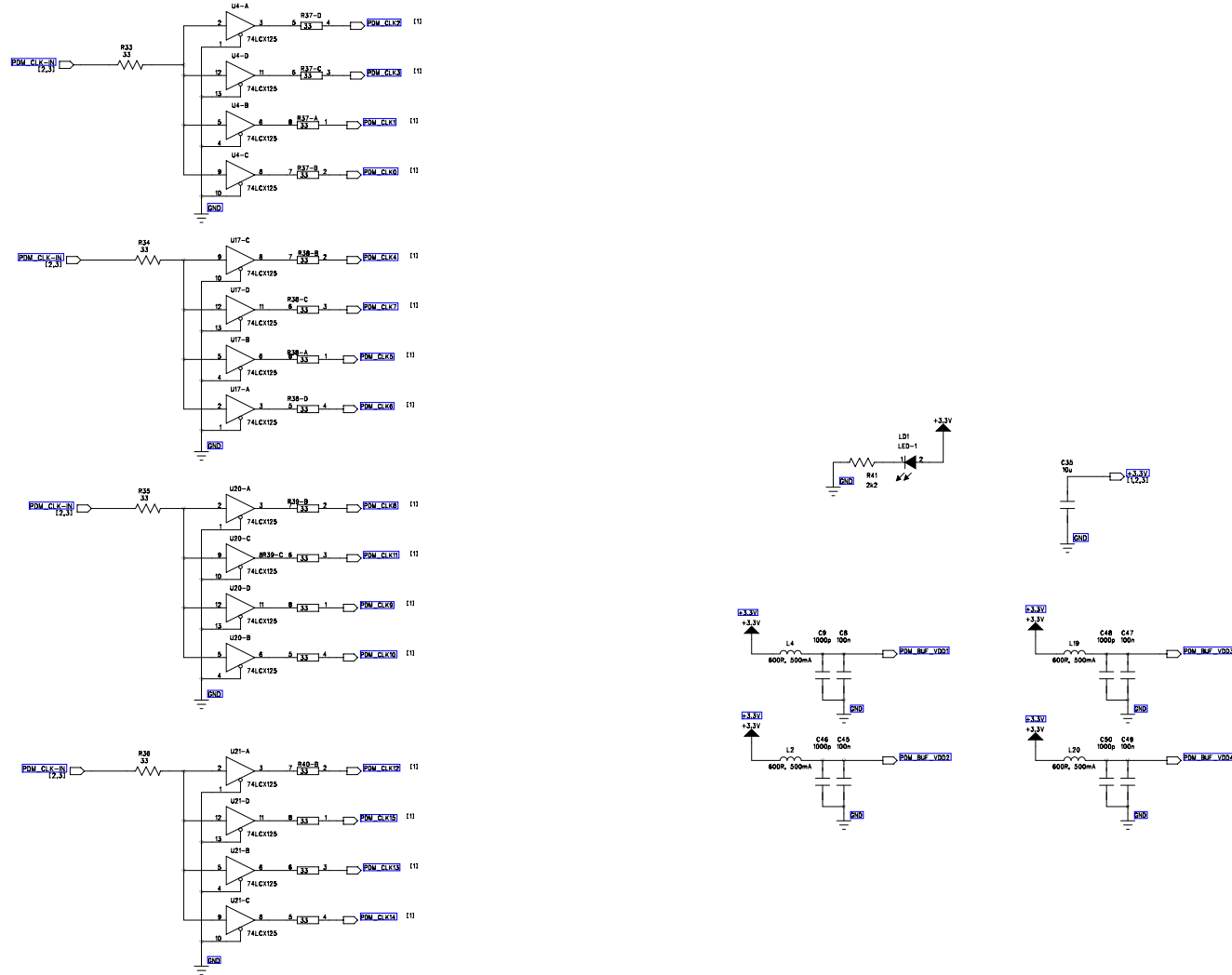
CONNECTOR—MCH

mirror MCH

+3.3V

R52 0

Net	Pin
	J3-1
CONN_PDM_DATA1 [3]	J3-3
CONN_PDM_DATA3 [3]	J3-5
CONN_PDM_DATA5 [3]	J3-7
CONN_PDM_DATA7 [3]	J3-9
	J3-11

Pin	Net
J3-2	
J3-4	CONN_PDM_DATA0 [3]
J3-6	CONN_PDM_DATA2 [3]
J3-8	CONN_PDM_DATA4 [3]
J3-10	CONN_PDM_DATA6 [3]
J3-12	CONN_PDM_CLK [3]

GND

C29 10u   C27 10u   +3.3V [1,2,3]

GND

J4-1 J4-2
J4-3 J4-4
J4-5 J4-6
J4-7 J4-8
GND

CONNECTOR—MCH

[1] PDM_DATA1 — R42 33 — CONN_PDM_DATA1 [3]
[1] PDM_DATA3 — R43 33 — CONN_PDM_DATA3 [3]
[1] PDM_DATA5 — R44 33 — CONN_PDM_DATA5 [3]
[1] PDM_DATA7 — R45 33 — CONN_PDM_DATA7 [3]

[3] CONN_PDM_DATA0 — R46 33 — PDM_DATA0 [1]
[3] CONN_PDM_DATA2 — R47 33 — PDM_DATA2 [1]
[3] CONN_PDM_DATA4 — R48 33 — PDM_DATA4 [1]
[3] CONN_PDM_DATA6 — R49 33 — PDM_DATA6 [1]
[3] CONN_PDM_CLK — R50 33 — PDM_CLK-IN [2]
R51 33

GND