<table>
<thead>
<tr>
<th>Revision</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.0</td>
<td>First version</td>
<td>18 Jan 2018</td>
</tr>
<tr>
<td>V1.1</td>
<td>Updated for MCHStreamer Lite interface (preliminary)</td>
<td>17 May 2022</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

Table of contents ........................................................................................................................................... 3

**IMPORTANT INFORMATION** ......................................................................................................................... 4

1 **Product Overview** ........................................................................................................................................... 6

2 **Board Layout and Connectivity** ....................................................................................................................... 7
   2.1 Board layout .................................................................................................................................................. 7
   2.2 USB Connectivity ......................................................................................................................................... 8
   2.3 Knowles SPH1668LM4H-1 microphones ...................................................................................................... 8

3 **USB Audio** ..................................................................................................................................................... 10
   3.1 macOS ........................................................................................................................................................ 10
   3.2 Windows ..................................................................................................................................................... 11
      3.2.1 USB Driver installation .......................................................................................................................... 11
      3.2.2 Status .................................................................................................................................................. 11
      3.2.3 Buffer settings ...................................................................................................................................... 12
      3.2.4 Volume ............................................................................................................................................... 12
      3.2.5 Info .................................................................................................................................................... 13
   3.3 Compliant USB audio software .................................................................................................................... 13

4 **Custom Microphone Board Development** ....................................................................................................... 14
   4.1 Headers and pinouts ..................................................................................................................................... 14
   4.2 PDM overview ........................................................................................................................................... 16

5 **Additional Information** ..................................................................................................................................... 17
   5.1 Specifications ............................................................................................................................................. 17
   5.2 MCU firmware update ................................................................................................................................. 18
      5.2.1 Windows ........................................................................................................................................... 18
   5.3 Obtaining support ....................................................................................................................................... 20
   5.4 Schematics ............................................................................................................................................... 20
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, 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 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.

Acknowledgments

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

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

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

- A microphone array PCB with 16 x SPH1668LM4H MEMS Knowles with PDM outputs. A center hole fits an optional USB camera perfect in applications such as acoustic cameras. The microphone array 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 multicore CPU allows for a high quality PDM to PCM conversion and presents all 16 channels of raw audio to the ASIO USB audio driver.

Please note that the following sections will highlight basic operation of the UMA-16. 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

The below diagram shows the layout of the UMA-16 board. Sixteen MEMS microphone are laid out in a Uniform Rectangular Array (URA) distribution, with microphone offset set to 42mm. CAD drawings are available on request.
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 14.7/11.025/12/16/22.05/44.1/48kHz. 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 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)

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

**Typical Free Field Response**

Normalized to 1 kHz

$CLK=2.4$ MHz, $VDD=1.8$ V

![Graph showing typical free field response](image)
3 USB Audio

The miniDSP UMA-16 streams PCM audio at sample rates of 14.7k/11.025k/12k/16k/22.05k/44.1k/48k 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 will appear as “MCHStreamer micArray 16” in the list on the left-hand side. Clicking on it will show the input and output channels. Sample rate can be selected in the dropdown menus:
3.2  WINDOWS

3.2.1  USB Driver installation

1. Connect the UMA-16 to the computer using the supplied USB cable, and power it on with the 12V supply.

2. Navigate to the WinDrivers folder of the software download and double-click on the installer:
   - miniDSP_UAC2_v3.34.0_ForWin7_8_10.exe for Windows 7 or later (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.

The Windows PC will not be able to communicate properly with the UMA-16 if you did not have it connected by USB and powered on when you installed the driver. If that is the case, you will need to uninstall the driver, connect the UMA-16, power it on, and run the installer again.

To configure the UMA-16, open the miniDSP UAC2 Control Panel (from Start Menu -> miniDSP Ltd). It has several panes, described below.

3.2.2  Status

This panel shows the current sample rate of the UMA-16. This setting cannot be changed in the Control panel, but simply reflects the current sample rate of the UMA-16. This setting will be affected by the recording software when the USB audio stream starts.
3.2.3 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.

3.2.4 Volume

This panel contains the volume controls for input channels.

- To reset the master volume control or a pair of channels to 0 dB (no attenuation), click the 0dB button.
- To mute all channels, click either of the speaker icons.
- To control volume separately for each channel, click on the “Link” icon to turn it off.
3.2.5 Info

This panel shows information about the UMA-16. Important data includes the firmware and driver versions.

![miniDSP UAC2 Control Panel]

3.3 COMPLIANT USB AUDIO SOFTWARE

Please note that the UMA-16 requires a multichannel recording 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.

Also note that Matlab running the latest audio toolbox will support ASIO fine. 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 CUSTOM MICROPHONE BOARD DEVELOPMENT

In an effort to help the community, miniDSP is providing full schematics of the microphone board PCB (nanoSHARC kit not included). Please consult the appendix at the end of this manual. Based on a simple 2-layer design, one can easily route a test PCB to trial various microphone arrangements.

NOTE: Electronic engineering support is unfortunately outside miniDSP's support structure. If you were to design your own MEMS array and lack the engineering knowledge to do so, we strongly recommend that you to seek 3rd party engineering support. Thanks for your understanding!

4.1 HEADERS AND PINOUTS

The MCHStreamer Lite circuit board has three 12-pin headers for logic-level I/O, as shown in Figure 1 below. Most data lines are on header J1, while J2 carries auxiliary signaling and GPIO lines reserved for future enhancement. J3 is used only for PDM format. Two cables terminated with suitable (2x6, 2mm pitch) 12-pin headers are supplied with the MCHStreamer Lite kit version.

All lines are 3.3V logic levels. Connected circuits must use a compatible logic level.

Figure 1. MCHStreamer Lite board layout
The UMA-16 firmware supports 16 input channels at 8, 11.025, 12, 16, 32, 44.1 and 48 kHz. PDM input data is received on J3, with two channels per physical data line. These 16 channels are mirrored in I2S format on J1 and are also received by the computer over USB.

Table 1. PDM firmware pinouts

<table>
<thead>
<tr>
<th>J1 pin</th>
<th>J3 pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PDM Rx 1-2</td>
</tr>
<tr>
<td>2</td>
<td>PDM Rx 9-10</td>
</tr>
<tr>
<td>3</td>
<td>PDM Rx 3-4</td>
</tr>
<tr>
<td>4</td>
<td>PDM Rx 11-12</td>
</tr>
<tr>
<td>5</td>
<td>PDM Rx 5-6</td>
</tr>
<tr>
<td>6</td>
<td>PDM Rx 13-14</td>
</tr>
<tr>
<td>7</td>
<td>PDM Rx 7-8</td>
</tr>
<tr>
<td>8</td>
<td>PDM Rx 15-16</td>
</tr>
<tr>
<td>9</td>
<td>MCLK</td>
</tr>
<tr>
<td>10</td>
<td>BCLK</td>
</tr>
<tr>
<td>11</td>
<td>GND</td>
</tr>
<tr>
<td>12</td>
<td>LRCLK</td>
</tr>
</tbody>
</table>
4.2 PDM OVERVIEW

PDM stands for Pulse Density Modulation. It is an ideally suited digital audio transmission method for MEMS microphone as it brings benefits of digital audio (noise immunity, high quality audio) at very low cost.

**PDM CLK**  The PDM clock always runs at 3.072MHz.

**PDM[0..7]**  Each data lines carrying a stereo feed of 2 x microphones by using the SELECT PIN. The timing of data lines is as illustrated in the following diagram:

The UMA-16 uses one stereo PDM data line for two mics with a standard configuration as per Knowles app note. All lines use a 3.3V logic level. Ensure that connected circuits use a compatible logic level.

<table>
<thead>
<tr>
<th>Microphone</th>
<th>SELECT</th>
<th>Asserts DATA On</th>
<th>Latch DATA On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mic (High)</td>
<td>VDD</td>
<td>Rising Clock Edge</td>
<td>Falling Clock Edge</td>
</tr>
<tr>
<td>Mic (Low)</td>
<td>GND</td>
<td>Falling Clock Edge</td>
<td>Rising Clock Edge</td>
</tr>
</tbody>
</table>

Note: Bypass capacitors near each Mic VDD PIN are recommended to provide maximum SNR performance. It should not contain Class 2 dielectrics. Detailed information on acoustic, mechanical, and system integration can be found in the latest SiSonic™ Design Guide application note.
5 ADDITIONAL INFORMATION

5.1 SPECIFICATIONS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Driverless USB 2.0 control interface for Windows/macOS environments</td>
</tr>
<tr>
<td></td>
<td>A computer is only required for the initial configuration and for USB audio streaming</td>
</tr>
<tr>
<td>USB audio input</td>
<td>XMOS Xcore200 asynchronous USB audio up to 48 kHz, USB Audio Class 2 compliant</td>
</tr>
<tr>
<td></td>
<td>• ASIO drivers for Windows</td>
</tr>
<tr>
<td></td>
<td>• Driverless for macOS</td>
</tr>
<tr>
<td>PDM inputs</td>
<td>Up to 16 x MEMS microphone connections (8 x stereo PDM data lines)</td>
</tr>
<tr>
<td>MEMS microphone on UMA-16</td>
<td>16 x SPH1668LM4H</td>
</tr>
<tr>
<td>ADC/DAC Sample rate &amp;</td>
<td>Resolution: 24 bit</td>
</tr>
<tr>
<td>Resolution</td>
<td>Sample rate: 14.7k/11.025k/12k/16k/22.05k/44.1k/48k</td>
</tr>
<tr>
<td>USB port</td>
<td>USB port type B for audio streaming, real time control and firmware upgrade</td>
</tr>
<tr>
<td>Power supply</td>
<td>Provided over USB</td>
</tr>
<tr>
<td>Dimensions (H x W x D) mm</td>
<td>132 x 195 x 30 mm</td>
</tr>
<tr>
<td>Mounting</td>
<td>4 x M3 holders for front panel mounting / CAD drawings available on request</td>
</tr>
</tbody>
</table>
5.2 MCU FIRMWARE UPDATE

5.2.1 Windows

1. Connect the UMA-16 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:

   ![Upgrade progress bar](image)

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

   ![Upgrade success message](image)

8. Click on **Exit**.
5.3 **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 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.

5.4 **SCHEMATICS**

See next two pages.