

High Performance Analog MEMS Microphone's Simple Interface to SigmaDSP Audio Codec

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 allows up to two analog microelectromechanical systems (MEMS) microphones to be interfaced to an audio codec. The ADMP404 consists of a MEMS microphone element and an output amplifier. The ADMP MEMS microphones have a high signal-to-noise ratio (SNR) and a flat wideband frequency response, making them an excellent choice for high performance, low power applications.

Up to two ADMP404 MEMS microphones can be input to the two analog-to-digital converters (ADCs) of an ADAU1761 low power codec.

CIRCUIT DESCRIPTION

Table 1. Devices Connected/Referenced

Product	Description
ADAU1761	SigmaDSP® stereo, low power, 96 kHz, 24-bit audio codec with integrated phase-locked loop (PLL)
ADMP404	Analog MEMS microphone

The ADMP404 analog MEMS microphones are connected to the LINN input pin and the RINN input pin of the ADAU1761. These input pins are connected to the inverting inputs of the internal programmable gain amplifiers (PGAs). The only necessary passive components in this circuit are a single 0.1 μF bypass capacitor for each ADMP404, and a 2.2 μF capacitor in series with each MEMS microphone output. Place the bypass capacitors as close to the VDD pin (Pin 3) of the ADMP404 as possible. Connect the LINP pin and the RINP pin of the ADAU1761 directly to the CM pin of the codec.

The MICBIAS pin of the ADAU1761 provides the power supply of the ADMP404. The MICBIAS pin can be set to either $0.9 \times AVDD$ or $0.65 \times AVDD$, where allowable values of AVDD for the ADAU1761 are between 1.8 V and 3.3 V. The VDD supply of the ADMP404 is between 1.5 V and 3.6 V.

The ADMP404 has a sensitivity of -38 dBV. In most applications, the MEMS microphone outputs must have some additional gain, which is provided by the ADAU1761 internal PGAs. The input PGAs can be set for up to 35.25 dB of gain in 0.75 dB steps, with an additional fixed 20 dB boost available following the PGAs.

The PGA input and the ac coupling capacitor, between the MEMS microphone and codec, form a high-pass filter. The -3 dB corner frequency of this filter is $1/(2\pi RC)$, where C is the capacitor size, and R is the input impedance of the codec for a given PGA gain setting. For a +20 dB gain setting (9.1 kΩ input impedance) and a

2.2 μF capacitor, the corner frequency of the high-pass filter is 8 Hz. Increasing the PGA gain settings raises the corner frequency of the filter, whereas increasing the capacitor size lowers the corner frequency. See the ADAU1761 data sheet for details on the input impedance at different settings.

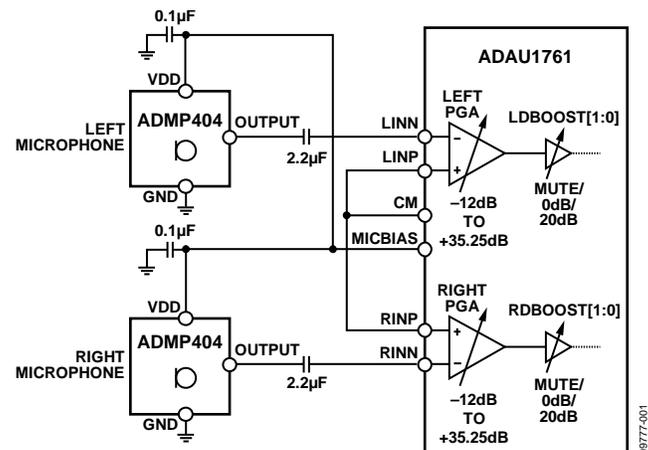


Figure 1. Analog MEMS Microphone Connection to the Audio Codec (Simplified Schematic: Power Supply Decoupling and All Connections Not Shown)

REGISTER SETTINGS

The following register bit fields must be set in the ADAU1761 to enable its PGAs and ADCs for microphone input on the left channel. Repeat Setting 1 to Setting 4 for the register bit fields controlling the right channel if two MEMS microphones are used. These settings are

1. MX1EN in Register R4, Bit 0, to 0b1—enables the left channel input mixer.
2. LDBOOST[1:0] in Register R5, Bits[4:3], to 0b01 for 0 dB additional boost and to 0b10 for 20 dB additional boost.
3. LDVOL[5:0] in Register R8, Bits[7:2]—sets the PGA input gain between -12 dB and +35.35 dB.
4. LDEN in Register R8, Bit 0, to 0b1—enables the left differential input path.
5. MBI in Register R10, Bit 2, to 0b0 for $0.90 \times AVDD$ or to 0b1 for $0.65 \times AVDD$ —sets the voltage level of the MICBIAS pin output.
6. MBIEN in Register R10, Bit 0, to 0b1—enables the MICBIAS pin output.
7. LDMUTE in Register R8, Bit 1, to 0b1—unmutes the left differential input channel. Set this bit last to avoid pops and clicks.

A screen shot of the SigmaStudio™ register controls for the analog input is shown in Figure 2.

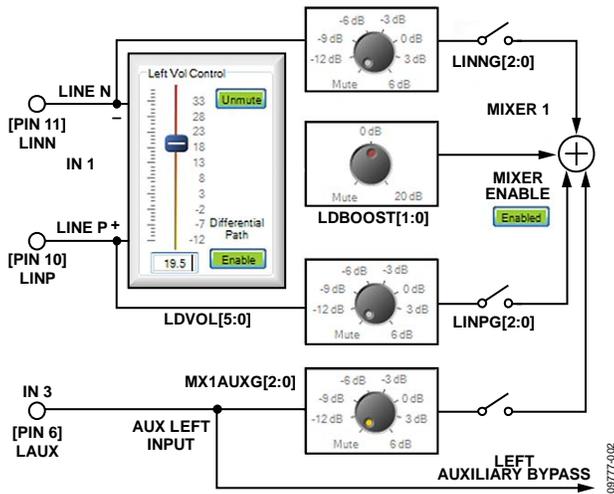


Figure 2. SigmaStudio PGA Input Configuration for the ADMP404 MEMS Microphone Input to the ADAU1761

In its default performance setting (MPERF = 0), the output of the MICBIAS pin sources up to approximately 2 mA of current to supply the VDD supply of the microphone. The ADMP404 draws a maximum current of 250 μ A; therefore, this bit does not need to be set to high performance (MPERF = 1), even to supply power to two microphones. The high performance bias mode of the codec is only needed when biasing electret microphones, not for providing supply to MEMS microphones.

COMMON VARIATIONS

This circuit can also be set up with an ADAU1361 instead of an ADAU1761. The primary difference between these two codecs is that the ADAU1761 has a SigmaDSP processor core and the ADAU1361 does not. The ADAU1781 SigmaDSP codec can also be used.

A mono microphone circuit using a single ADMP404 can be set up by removing one of the ADMP404 MEMS microphones and its associated capacitors. The other connections remain the same in this mono configuration.

The ADMP404 can also be replaced with the ADMP401, the ADMP405, or the ADMP504, which are also analog MEMS microphones. The ADMP401 has a -42 dBV sensitivity, whereas the ADMP404 has a -38 dBV sensitivity. The ADMP405 is identical to the ADMP404 except that the ADMP405 has a low frequency cutoff at 200 Hz vs. the 100 Hz cutoff of the ADMP404. This higher frequency cutoff makes the ADMP405 attractive for reducing low frequency wind noise. The ADMP504 has the same -38 dBV sensitivity as the ADMP404, but its noise floor is

3 dB lower. The ADMP504 and the ADMP404 are pin-compatible and footprint-compatible.

LEARN MORE

The ADMP MEMS microphone products mentioned in this application note are manufactured by InvenSense, 1745 Technology Dr., San Jose, California 95110.

Elko, Gary W. and Kieran P. Harney. “A History of Consumer Microphones: The Electret Condenser Microphone Meets Micro-Electro-Mechanical-Systems,” *Acoustics Today*, 2009.

Lewis, Jerad. AN-1112 Application Note, *Microphone Specifications Explained*. Analog Devices, Inc., 2013.

Nielsen, Jannik, Hammel Nielsen, and Claus Fürst. *Toward More Compact Digital Microphones*, Analog Dialogue Volume 41, September 2007, Analog Devices, Inc.

Data Sheets and Evaluation Boards

[ADAU1761 Data Sheet](#)

[ADAU1761 Evaluation Board](#)

[ADAU1361 Data Sheet](#)

[ADAU1361 Evaluation Board](#)

[ADAU1781 Data Sheet](#)

[ADAU1781 Evaluation Board](#)

REVISION HISTORY

11/14—Rev. A to Rev. B

Changed Title of Document from CN-0207 to AN-1324	Universal
Deleted Evaluation and Design Support Section	1
Added Table 1; Renumbered Sequentially	1
Changes to Circuit Description Section and Register Settings Section, and Learn More Section	2
Deleted Circuit Evaluation and Test Section	2
Changes to Data Sheets and Evaluation Boards Section	2

12/11—Rev. 0 to Rev. A

Changes to Circuit Note Title	1
Changes to Evaluation and Design Support	1
Changes to Circuit Function and Benefits	1
Changes to Circuit Description	1
Changes to Common Variations	2

4/11—Revision 0: Initial Version