

High-Performance Analog MEMS Microphone Simple Interface to SigmaDSP Audio Codec

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 allows up to two analog MEMS microphones to be interfaced to an audio codec. The INMP404 consists of a MEMS microphone element and an output amplifier. InvenSense 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 INMP404 MEMS microphones can be input to an ADAU1761 low power codec's two ADCs.

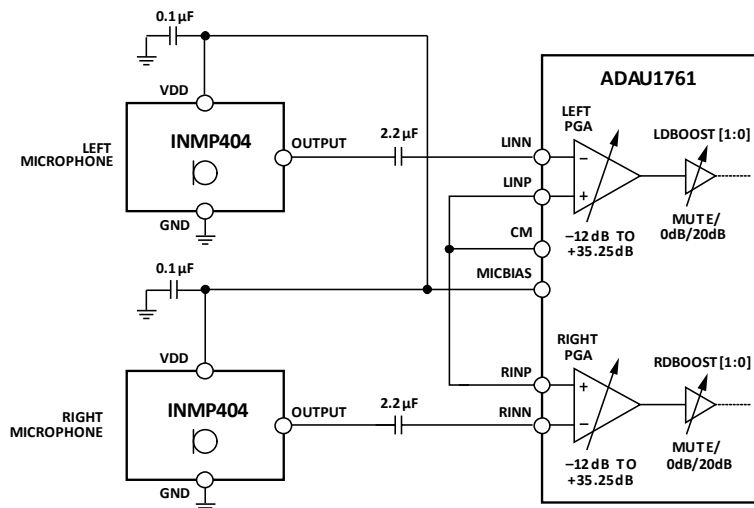
CIRCUIT DESCRIPTION

The INMP404 analog MEMS microphones are connected to the ADAU1761 LINN and RINN input pins. These pins are connected to the inverting inputs of the internal PGAs. The only necessary passive components in this circuit are a single 0.1 μF bypass capacitor for each INMP404 and a 2.2 μF capacitor in series with each MEMS microphone output. The bypass capacitors should be placed as close to the INMP404 VDD pin (Pin 3) as possible. The ADAU1761 LINP and RINP should be connected directly to the codec CM pin.

The INMP404 power supply is provided from the ADAU1761 MICBIAS pin. MICBIAS can be set to either $0.9 \times \text{AVDD}$ or $0.65 \times \text{AVDD}$, where allowable values of AVDD for the ADAU1761 are between 1.8 V and 3.3 V. The INMP404 VDD supply should be between 1.5 V and 3.6 V.

The INMP404 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 codec's input impedance for a given PGA gain setting. For a +20 dB gain setting (9.1 k Ω input impedance) and a 2.2 μF capacitor, the high-pass filter's corner is 8 Hz. Increasing the PGA gain settings raises the filter corner frequency, 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. Setting 1 to Setting 4 should be repeated for the register bit fields controlling the right channel if two MEMS microphones are used. These settings are

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

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

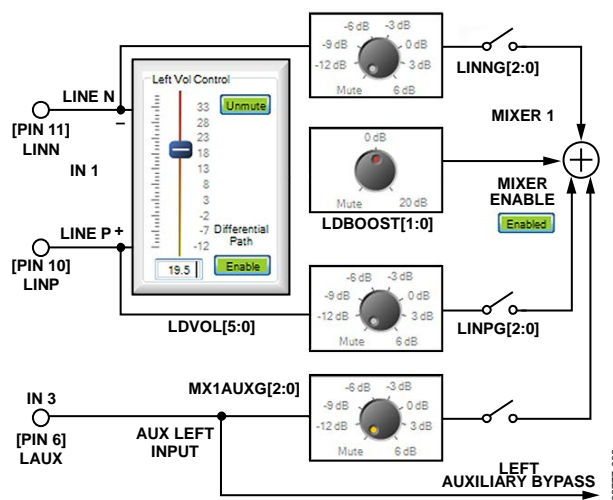


Figure 2. SigmaStudio PGA Input Configuration for the ADMP404 MEMS Microphone Input to the ADAU1761

In its default performance setting (MPERF = 0), the MICBIAS output sources up to approximately 2 mA of current to supply the microphone VDD supply. The INMP404 draws a maximum 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 codec’s high-performance bias mode 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 INMP404 can be set up by simply removing one of the INMP404 MEMS microphones and its associated capacitors. The other connections remain the same in this mono configuration.

The INMP404 can also be replaced with an INMP401, INMP405, INMP504, or INMP510 which are also analog MEMS microphones. The INMP401 has a -42 dBV sensitivity, whereas the INMP404 has a -38 dBV sensitivity. The INMP405 is identical to the INMP404 except that the INMP405 has a low frequency cutoff at 200 Hz vs. the INMP404’s 100 Hz cutoff. This higher frequency cutoff makes the INMP405 attractive for reducing low frequency wind noise. The INMP504 and INMP510 have the same -38 dBV sensitivity as the INMP404, but their noise floors are 3 dB lower. The INMP510, INMP504, INMP405 and INMP404 are pin and footprint compatible.

CIRCUIT EVALUATION AND TEST

Evaluation boards for the INMP404 and ADAU1761 are available and can easily be connected as described below.

Equipment Needed

The SigmaStudio GUI software requires a PC with the following: Windows® 7, Windows Vista, or Windows XP Professional or Home Edition with SP2, 128 MB of RAM (256 MB recommended), 50 MB of available hard disk space, 1024 × 768 screen resolution, and USB 1.1/2.0 data port.

In addition, the ADAU1761 Evaluation Board (EVAL-ADAU1761Z) and the INMP404 Evaluation Board (EV_INMP404-FX) are required.

Getting Started

The EV_INMP404-FX has three output wires: VDD, GND, and OUTPUT. The VDD wire should be connected to J15 or J18 on the EVAL-ADAU1761Z board to supply power from the ADAU1761 MICBIAS pin. The output wire of the INMP404 board can be connected to the tip of a mono 3.5 mm audio plug, with ground connected to the ring. This plug connects to the ADAU1761 evaluation board’s two analog input jacks: J20 and J22. The ADAU1761 evaluation board has 10 µF ac-coupling capacitors rather than the 2.2 µF capacitors shown in Figure 1.

From this point, follow the documentation for the EVAL-ADAU1761Z regarding software installation, setup, and operation of the system.

The SigmaStudio software is used to program and tune the registers and SigmaDSP core in the ADAU1761. SigmaStudio can be downloaded from <http://www.analog.com/sigmastudio>.

Functional Block Diagram

The documentation for the ADAU1761 evaluation board (EVAL-ADAU1761Z) describes the system setup and gives a complete schematic of the board. The only external connections required are the USB connection to the PC and to the audio outputs of the ADAU1761 evaluation board.

Setup and Test

See the EVAL-ADAU1761Z board documentation for additional details regarding circuit description, jumper settings, setup, and testing.

REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
02/22/2014	1.0	Initial Release

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