RF Hardened, Ultralow Noise Microphone with Bottom Port and Analog Output

ADMP510

FEATURES
Tiny, 3.35 mm × 2.5 mm × 0.98 mm surface-mount package
Noninverted signal output
Omnidirectional response
High SNR of 65 dBA
Sensitivity of −38 dBV
Sensitivity tolerance of ±2 dB
Extended frequency response from 60 Hz to 20 kHz
Enhanced radio frequency (RF) performance
Acoustic overload point of 124 dB SPL
Low current consumption of 180 µA
Single-ended analog output
High PSR of −78 dBV
Compatible with Sn/Pb and Pb-free solder processes
RoHS/WEEE compliant

APPLICATIONS
Smartphones and feature phones
Tablet computers
Teleconferencing systems
Digital still and video cameras
Bluetooth headsets
Notebook PCs
Security and surveillance

GENERAL DESCRIPTION
The ADMP510 is an RF hardened, analog output, bottom-ported, omnidirectional MEMS microphone with high performance, ultralow noise, and low power. The ADMP510 consists of a MEMS microphone element, an impedance converter, and an output amplifier. The ADMP510 sensitivity specification makes it an excellent choice for both near-field and far-field applications. The ADMP510 is pin compatible with the ADMP504 microphone.

The ADMP510 has a very high signal-to-noise ratio (SNR) and extended wideband frequency response, resulting in natural sound with high intelligibility. Low current consumption enables long battery life for portable applications.

The ADMP510 is available in an ultraminiature 3.35 mm × 2.5 mm × 0.98 mm surface-mount package. It is reflow solder compatible with no sensitivity degradation.

1 Protected by U.S. Patents 7,449,356; 7,825,484; 7,885,423; and 7,961,897. Other patents are pending.
TABLE OF CONTENTS

Features .............................................................................................. 1
Applications ....................................................................................... 1
Functional Block Diagram .............................................................. 1
General Description ......................................................................... 1
Revision History ............................................................................... 2
Specifications ..................................................................................... 3
Absolute Maximum Ratings ............................................................ 4
ESD Caution .................................................................................. 4
Soldering Profile ........................................................................... 4
Pin Configuration and Function Descriptions ............................. 5
Typical Performance Characteristics ............................................. 6
Applications Information .................................................................7
Interfacing with Analog Devices Codecs ....................................... 7
Supporting Documents ....................................................................... 7
PCB Design and Land Pattern Layout ............................................. 8
Handling Instructions ......................................................................... 9
Pick-and-Place Equipment ............................................................ 9
Reflow Solder .................................................................................. 9
Board Wash ..................................................................................... 9
Outline Dimensions ....................................................................... 10
Ordering Guide ............................................................................. 10

REVISION HISTORY

10/13—Rev. 0 to Rev. A
Change to Figure 5 ........................................................................ 6

7/13—Revision 0: Initial Version
SPECIFICATIONS

T_A = 25°C, VDD = 1.8 V, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions/Comments</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directionality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Polarity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td></td>
<td>1 kHz, 94 dB sound pressure level (SPL)</td>
<td>−40</td>
<td>−38</td>
<td>−36</td>
<td>dBV</td>
</tr>
<tr>
<td>Signal-to-Noise Ratio</td>
<td>SNR</td>
<td>20 Hz to 20 kHz, A-weighted</td>
<td>65</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Equivalent Input Noise</td>
<td>EIN</td>
<td>1 kHz, 94 dB sound pressure level (SPL)</td>
<td>−40</td>
<td>−38</td>
<td>−36</td>
<td>dBV</td>
</tr>
<tr>
<td>Dynamic Range</td>
<td>EIN</td>
<td>Derived from EIN and maximum acoustic input</td>
<td>29</td>
<td></td>
<td></td>
<td>dB SPL</td>
</tr>
<tr>
<td>Frequency Response</td>
<td></td>
<td>Low frequency −3 dB point</td>
<td>60</td>
<td></td>
<td></td>
<td>Hz</td>
</tr>
<tr>
<td>Signal-to-Noise Ratio</td>
<td></td>
<td>High frequency −3 dB point</td>
<td>&gt;20</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td>Power Supply Rejection</td>
<td>THD</td>
<td>105 dB SPL</td>
<td>0.2</td>
<td></td>
<td>1</td>
<td>%</td>
</tr>
<tr>
<td>Power Supply Rejection Ratio</td>
<td>PSRR</td>
<td>217 Hz, 100 mV p-p square wave superimposed on VDD = 1.8 V (A-weighted)</td>
<td>−78</td>
<td></td>
<td></td>
<td>dBV</td>
</tr>
<tr>
<td>Power Supply Overload Point</td>
<td></td>
<td>1 kHz, 100 mV p-p sine wave superimposed on VDD = 1.8 V</td>
<td>−55</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Power Supply Overload Point</td>
<td></td>
<td>10% THD</td>
<td>124</td>
<td></td>
<td></td>
<td>dB SPL</td>
</tr>
<tr>
<td>Power Supply</td>
<td>VDD</td>
<td></td>
<td>1.5</td>
<td>3.63</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Output Characteristics</td>
<td>ZOUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>Output Impedance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>Output DC Offset</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Maximum Output Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V rms</td>
</tr>
<tr>
<td>Noise Floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>dBV</td>
</tr>
</tbody>
</table>

1 See Figure 5 and Figure 6.
ABSOLUTE MAXIMUM RATINGS

Table 2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>−0.3 V to +3.63 V</td>
</tr>
<tr>
<td>Sound Pressure Level (SPL)</td>
<td>160 dB</td>
</tr>
<tr>
<td>Mechanical Shock</td>
<td>10,000 g</td>
</tr>
<tr>
<td>Vibration</td>
<td>Per MIL-STD-883 Method 2007, Test Condition B</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>−40°C to +85°C</td>
</tr>
</tbody>
</table>

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

SOLDERING PROFILE

![Soldering Profile Diagram]

Figure 3. Recommended Soldering Profile Limits

Table 3. Recommended Soldering Profile Limits

<table>
<thead>
<tr>
<th>Profile Feature</th>
<th>Sn63/Pb37</th>
<th>Pb-Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Ramp Rate (Tt to Tp)</td>
<td>1.25°C/sec maximum</td>
<td>1.25°C/sec maximum</td>
</tr>
<tr>
<td>Preheat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Temperature (TSMIN)</td>
<td>100°C</td>
<td>150°C</td>
</tr>
<tr>
<td>Maximum Temperature (TSMAX)</td>
<td>150°C</td>
<td>200°C</td>
</tr>
<tr>
<td>Time, TSMIN to TSMAX (tS)</td>
<td>60 sec to 75 sec</td>
<td>60 sec to 75 sec</td>
</tr>
<tr>
<td>Ramp-Up Rate (TSMAX to TL)</td>
<td>1.25°C/sec</td>
<td>1.25°C/sec</td>
</tr>
<tr>
<td>Time Maintained Above Liquidous (tL)</td>
<td>45 sec to 75 sec</td>
<td>~50 sec</td>
</tr>
<tr>
<td>Liquidous Temperature (TL)</td>
<td>183°C</td>
<td>217°C</td>
</tr>
<tr>
<td>Peak Temperature (TP)</td>
<td>215°C +3°C/−3°C</td>
<td>260°C +0°C/−5°C</td>
</tr>
<tr>
<td>Time Within 5°C of Actual Peak Temperature (tL)</td>
<td>20 sec to 30 sec</td>
<td>20 sec to 30 sec</td>
</tr>
<tr>
<td>Ramp-Down Rate</td>
<td>3°C/sec maximum</td>
<td>3°C/sec maximum</td>
</tr>
<tr>
<td>Time 25°C (t25°C) to Peak Temperature</td>
<td>5 minutes maximum</td>
<td>5 minutes maximum</td>
</tr>
</tbody>
</table>
PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

Figure 4. Pin Configuration

Table 4. Pin Function Descriptions

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VDD</td>
<td>Power Supply</td>
</tr>
<tr>
<td>2</td>
<td>OUTPUT</td>
<td>Analog Output Signal</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>
TYPICAL PERFORMANCE CHARACTERISTICS

Figure 5. Frequency Response Mask

Figure 6. Typical Frequency Response (Measured)

Figure 7. Typical Power Supply Rejection Ratio vs. Frequency

Figure 8. THD + N vs. Input SPL

Figure 9. Linearity

Figure 10. Clipping Characteristics
APPLICATIONS INFORMATION
INTERFACING WITH ANALOG DEVICES CODECS

The output of the ADMP510 can be connected to a dedicated codec microphone input (see Figure 11) or to a high input impedance gain stage (see Figure 12). A 0.1 μF ceramic capacitor placed close to the ADMP510 supply pin is used for testing and is recommended to adequately decouple the microphone from noise on the power supply. A dc blocking capacitor is required at the output of the microphone. This capacitor creates a high-pass filter with a corner frequency at

\[ f_c = \frac{1}{2\pi CR} \]

where \( R \) is the input impedance of the codec.

A minimum value of 2.2 μF is recommended in Figure 11 because the input impedance of the ADAU1761/ADAU1361 can be as low as 2 kΩ at its highest PGA gain setting, which results in a high-pass filter corner frequency at about 37 Hz.

![Figure 11. ADMP510 Connected to the ADAU1761 or ADAU1361 Codec](image1)

Figure 12 shows the ADMP510 connected to an ADA4075-2 op amp configured as a noninverting preamplifier.

![Figure 12. ADMP510 Connected to the ADA4075-2 Op Amp](image2)

SUPPORTING DOCUMENTS

For additional information, see the following documents.

**Evaluation Board User Guide**

UG-325, Analog Output MEMS Microphone Flex Evaluation Board

**Circuit Note**

CN-0207, High Performance Analog MEMS Microphone's Simple Interface to SigmaDSP Audio Codec

**Application Notes**

AN-1003, Recommendations for Mounting and Connecting the Analog Devices, Inc., Bottom-Ported MEMS Microphones
AN-1068, Reflow Soldering of the MEMS Microphone
AN-1112, Microphone Specifications Explained
AN-1124, Recommendations for Sealing Analog Devices, Inc., Bottom-Port MEMS Microphones from Dust and Liquid Ingress
AN-1140, Microphone Array Beamforming
AN-1165, Op Amps for MEMS Microphone Preamp Circuits
AN-1181, Using a MEMS Microphone in a 2-Wire Microphone Circuit
PCB DESIGN AND LAND PATTERN LAYOUT

Lay out the PCB land pattern for the ADMP510 at a 1:1 ratio to the solder pads on the microphone package (see Figure 13). Take care to avoid applying solder paste to the sound hole in the PCB. Figure 14 shows a suggested solder paste stencil pattern layout.

The diameter of the sound hole in the PCB should be larger than the diameter of the sound port of the microphone. A minimum diameter of 0.5 mm is recommended.

Figure 13. Suggested PCB Land Pattern Layout

Figure 14. Suggested Solder Paste Stencil Pattern Layout
HANDLING INSTRUCTIONS

PICK-AND-PLACE EQUIPMENT

The MEMS microphone can be handled using standard pick-and-place and chip shooting equipment. Take care to avoid damage to the MEMS microphone structure as follows:

- Use a standard pickup tool to handle the microphone. Because the microphone hole is located on the bottom surface of the package (see Figure 2), the pickup tool can make contact with any part of the top lid surface.
- Do not pick up the microphone with a vacuum tool that makes contact with the bottom side of the microphone.
- Do not use excessive force to place the microphone on the PCB.

REFLOW SOLDER

For best results, the soldering profile should be in accordance with the recommendations of the manufacturer of the solder paste used to attach the MEMS microphone to the PCB. It is recommended that the solder reflow profile not exceed the limit conditions specified in Figure 3 and Table 3.

BOARD WASH

When washing the PCB, ensure that water does not make contact with the microphone port. Do not use blow-off procedures or ultrasonic cleaning.
OUTLINE DIMENSIONS

Figure 15. 3-Terminal Chip Array Small Outline No Lead Cavity [LGA_CAV]
3.35 mm × 2.5 mm Body
(CE-3-5)
Dimensions shown in millimeters

ORDERING GUIDE

<table>
<thead>
<tr>
<th>Model</th>
<th>Temperature Range</th>
<th>Package Description</th>
<th>Package Option²</th>
<th>Ordering Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMP510ACEZ-RL</td>
<td>−40°C to +85°C</td>
<td>3-Terminal LGA_CAV, 13” Tape and Reel</td>
<td>CE-3-5</td>
<td>10,000</td>
</tr>
<tr>
<td>ADMP510ACEZ-RL7</td>
<td>−40°C to +85°C</td>
<td>3-Terminal LGA_CAV, 7” Tape and Reel Flexible Evaluation Board</td>
<td>CE-3-5</td>
<td>1,000</td>
</tr>
<tr>
<td>EVAL-ADMP510Z-FLEX</td>
<td>−40°C to +85°C</td>
<td>3-Terminal LGA_CAV, 13” Tape and Reel Flexible Evaluation Board</td>
<td>CE-3-5</td>
<td>1,000</td>
</tr>
</tbody>
</table>

¹ Z = RoHS Compliant Part.
² This package option is halide free.