INMP803
Low-Power Omnidirectional MEMS Microphones for Hearing Aids

GENERAL DESCRIPTION

The INMP803 is a high-performance MEMS microphone with a unique combination of very low self-noise, tiny package volume (7.3 mm³), and low power consumption. Running from a 1 V supply, the INMP803 consumes only 17 µA of current while providing an equivalent input noise of 27 dBA SPL with an analog 4.5 kΩ impedance output. These features, combined with the benefits of MEMS technology, reflow solder compatibility, and a highly stable response over time and temperature, make the INMP803 an ideal microphone choice for assistive listening devices (ALDs) such as hearing aids.

APPLICATIONS

- Hearing Aids
- Hearing Aid Accessories
- Assistive Listening/Alerting and Signaling Systems
- Audiometers
- Bone Conduction Devices
- Hearing Protection

FEATURES

- Small Surface-Mount Package: 3.35 × 2.5 × 0.98 mm
- Extra Ground Pin Improves Hand Assembly
- Equivalent Input Noise: 27 dBA SPL
- Sensitivity: −35 dBV
- Hearing Aid-Compatible Voltage Range: 0.9 to 1.3 V
- Low Current Consumption: 17 µA
- 0.8 Sec Startup to Within 0.2 dB of 1 kHz Sensitivity
- Flat Frequency Response
- Good Sensitivity and Frequency Response Matching
- Single-Ended Analog Output
- Compatible with Sn/Pb and Pb-Free Solder Processes
- RoHS/WEEE Compliant

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PART</th>
<th>TEMP RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INMP803IC-RO*</td>
<td>−5°C to +65°C</td>
</tr>
<tr>
<td>INMP803IC-R7†</td>
<td>−5°C to +65°C</td>
</tr>
</tbody>
</table>

* – 13” Tape and Reel
† – 7” Tape and reel is to be discontinued.
Contact sales@invensense.com for availability.

FUNCTIONAL BLOCK DIAGRAM

InvenSense reserves the right to change the detail specifications as may be required to permit improvements in the design of its products.
TABLE OF CONTENTS

General Description ................................................................................................................................................. 1
Applications ............................................................................................................................................................. 1
Features ................................................................................................................................................................... 1
Functional Block Diagram ........................................................................................................................................ 1
Ordering Information............................................................................................................................................... 1
Table of Contents..................................................................................................................................................... 2
Specifications .................................................................................................................................................................. 3
Table 1. Electrical Characteristics ............................................................................................................................ 3
Absolute Maximum Ratings ........................................................................................................................................ 4
Table 2. Absolute Maximum Ratings ....................................................................................................................... 4
Reflow Soldering...................................................................................................................................................... 4
ESD Caution ............................................................................................................................................................. 4
Pin Configurations And Function Descriptions ............................................................................................................... 5
Table 3. Pin Function Descriptions ........................................................................................................................... 5
Typical Performance Characteristics........................................................................................................................................ 6
Applications Information ................................................................................................................................................ 7
Output Impedance Consideration ........................................................................................................................... 7
Supporting Documents ................................................................................................................................................ 7
Evaluation Board User Guide ................................................................................................................................... 7
Application Notes .................................................................................................................................................... 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 ...................................................................................................................................................... 11
Revision History .................................................................................................................................................... 11
Compliance Declaration Disclaimer: ............................................................................................................................. 12
Environmental Declaration Disclaimer: ........................................................................................................................... 12
## SPECIFICATIONS

### TABLE 1. ELECTRICAL CHARACTERISTICS

(T<sub>A</sub> = −5 to 65°C, V<sub>DD</sub> = 1.0V, 200 kΩ load unless otherwise noted. All minimum and maximum specifications are guaranteed across temperature and voltage, and are specified in Table 1, unless otherwise noted. Typical specifications are not guaranteed.)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP&lt;sup&gt;1&lt;/sup&gt;</th>
<th>MAX</th>
<th>UNITS</th>
<th>NOTES</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>Omni</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>1 kHz, 94 dB SPL</td>
<td>−38</td>
<td>−35</td>
<td>−32</td>
<td>dBV</td>
<td></td>
</tr>
<tr>
<td>Equivalent Input Noise (EIN)</td>
<td>8 kHz bandwidth, A-weighted</td>
<td>27</td>
<td>29</td>
<td>29</td>
<td>dBA SPL</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>20 kHz bandwidth, A-weighted</td>
<td>29</td>
<td></td>
<td></td>
<td>dBA SPL</td>
<td>2</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>Low frequency −3 dB point</td>
<td>80</td>
<td></td>
<td></td>
<td>Hz</td>
<td></td>
</tr>
<tr>
<td>Resonant Peak</td>
<td>10.2 kHz</td>
<td></td>
<td></td>
<td></td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td>Total Harmonic Distortion (THD)</td>
<td>105 dB SPL</td>
<td>1.3</td>
<td>2.5</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply Rejection Ratio (PSRR)</td>
<td>1 kHz, 100 mV p-p sine wave superimposed on V&lt;sub&gt;DD&lt;/sub&gt;</td>
<td>−40</td>
<td>−53</td>
<td>dB</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Input-Refereed Vibration Sensitivity</td>
<td>1 kHz acceleration, axial direction</td>
<td>62</td>
<td></td>
<td></td>
<td>dB SPL/g</td>
<td></td>
</tr>
<tr>
<td>Acoustic Overload Point</td>
<td>10% THD</td>
<td>108</td>
<td>110</td>
<td>dB SPL</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Start-Up Time</td>
<td>To within ±0.2 dB of final sensitivity</td>
<td>0.8</td>
<td></td>
<td>sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POWER SUPPLY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage (V&lt;sub&gt;DD&lt;/sub&gt;)</td>
<td>Unloaded; no tone applied</td>
<td>0.9</td>
<td>1.3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Current (I&lt;sub&gt;s&lt;/sub&gt;)</td>
<td>Unloaded; no tone applied</td>
<td>10</td>
<td>17</td>
<td>23</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 0.9 V</td>
<td>16</td>
<td></td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 1.3 V</td>
<td>19.5</td>
<td></td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OUTPUT CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Impedance (Z&lt;sub&gt;OUT&lt;/sub&gt;)</td>
<td></td>
<td>2.9</td>
<td>4.5</td>
<td>10.5</td>
<td>kΩ</td>
<td>2</td>
</tr>
<tr>
<td>Output DC Bias Voltage</td>
<td>500</td>
<td>570</td>
<td>650</td>
<td>mV</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Output Current Limit</td>
<td>25</td>
<td></td>
<td></td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Output Voltage</td>
<td>110 dB SPL input, peak</td>
<td>159</td>
<td></td>
<td>mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise Floor</td>
<td>20 Hz to 20 kHz, A-weighted, RMS</td>
<td>−100</td>
<td></td>
<td>dBV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>Note 1:</sup> Typical specifications at 25°C  
<sup>Note 2:</sup> Guaranteed by design and/or characterization
ABSOLUTE MAXIMUM RATINGS

Stress above those listed as Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to the absolute maximum ratings conditions for extended periods may affect device reliability.

TABLE 2. ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage (VDD)</td>
<td>−0.3 V to +1.45 V</td>
</tr>
<tr>
<td>Sound Pressure Level</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>Operating Temperature Range</td>
<td>−5°C to +65°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>−55°C to +150°C</td>
</tr>
</tbody>
</table>

REFLOW SOLDERING

Reflow soldering must be performed in accordance with the JEDEC J-STD-020D Pb-free reflow profile for temperatures (260°C maximum), ramp rates, and dwell times. The INMP803 can withstand many different reflow profiles, but a review of the AN-1068 Application Note, *Reflow Soldering of the MEMS Microphone*, is recommended for suggestions on ways to prevent flux contamination from entering the microphone.

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.
PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

Figure 1. Pin Configuration

Figure 2. Pin Configuration Images (Bottom View and Top View)

TABLE 3. PIN FUNCTION DESCRIPTIONS

<table>
<thead>
<tr>
<th>PIN</th>
<th>NAME</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OUTPUT</td>
<td>Analog Output Signal</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>VDD</td>
<td>Power Supply</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>
TYPICAL PERFORMANCE CHARACTERISTICS

Figure 3. Typical Frequency Response

Figure 4. High Frequency Response

Figure 5. Typical Third-Octave Noise
APPLICATIONS INFORMATION

OUTPUT IMPEDANCE CONSIDERATION

The INMP3001 has an output impedance of 4.5 kΩ, which is significantly higher than the impedance of many other MEMS microphones. This higher output impedance enables the microphone to operate with a very low supply current, but also needs to be considered in the design of the signal chain following the microphone. The input impedance of the device to which the microphone’s output is connected should be much higher than 4.5 kΩ to ensure no loss of signal amplitude through the signal chain.

SUPPORTING DOCUMENTS

For additional information, see the following documents.

EVALUATION BOARD USER GUIDE

UG-325 Analog Output MEMS Microphone Flex Evaluation Board

APPLICATION NOTES

AN-1003 Recommendations for Mounting and Connecting the Invensense, Bottom-Ported MEMS Microphones
AN-1068 Reflow Soldering of the MEMS Microphone
AN-1112 Microphone Specifications Explained
AN-1124 Recommendations for Sealing Invensense, Bottom-Port MEMS Microphones from Dust and Liquid Ingress
AN-1140 Microphone Array Beamforming
AN-1165 Op Amps for MEMS Microphone Preamp Circuits
PCB DESIGN AND LAND PATTERN LAYOUT

The recommended PCB land pattern for the INMP803 should be laid out to a 1:1 ratio to the solder pads on the microphone package, as shown in Figure 6. Take care to avoid applying solder paste to the sound hole in the PCB. A suggested solder paste stencil pattern layout is shown in Figure 7. 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 6. PCB Land Pattern Layout
Dimensions shown in millimeters

Figure 7. Suggested Solder Paste Stencil Pattern Layout
Dimensions shown in millimeters
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 on the bottom of the package, the pickup tool can make contact with any part of the lid surface.
- Do not pick up the microphone with a vacuum tool that makes contact with the bottom side of the microphone. Do not pull air out of or blow air into the microphone port.
- Do not use excessive force to place the microphone on the PCB.

REFLOW SOLDER
For best results, ensure that the soldering profile is in accordance with the recommendations of the manufacturer of the solder paste used to attach the MEMS microphone to the PCB. Perform all reflow soldering in accordance with the JEDEC J-STD-020 Pb-free reflow profile for temperatures (260°C maximum), ramp rates, and dwell times. The INMP803 can withstand many different reflow profiles; however, for suggestions on how to prevent flux contamination from entering the microphone, see the AN-1068 Application Note, Reflow Soldering of the MEMS Microphone.

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 8. 3-Terminal Chip Array Small Outline No-Lead Cavity [LGA_CAV]
3.35 × 2.50 × 0.98 mm Body
Dimensions shown in millimeters

Figure 9. Package Marking Specification (Top View)
# ORDERING GUIDE

<table>
<thead>
<tr>
<th>PART</th>
<th>TEMP RANGE</th>
<th>PACKAGE</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>INMP803JCEZ-R0*</td>
<td>−5°C to +65°C</td>
<td>4-Terminal LGA_CAV</td>
<td>10,000</td>
</tr>
<tr>
<td>INMP803JCEZ-R7†</td>
<td>−5°C to +65°C</td>
<td>4-Terminal LGA_CAV</td>
<td>1,000</td>
</tr>
</tbody>
</table>

* – 13” Tape and Reel † = RoHS-Compliant Part
† – 7” Tape and reel is to be discontinued. Contact sales@invensense.com for availability.

# REVISION HISTORY

<table>
<thead>
<tr>
<th>REVISION DATE</th>
<th>REVISION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>02/06/2014</td>
<td>1.0</td>
<td>Initial Release</td>
</tr>
</tbody>
</table>
Compliance Declaration Disclaimer:
InvenSense believes this compliance information to be correct but cannot guarantee accuracy or completeness. Conformity documents for the above component constitutes are on file. InvenSense subcontracts manufacturing and the information contained herein is based on data received from vendors and suppliers, which has not been validated by InvenSense.

Environmental Declaration Disclaimer:
InvenSense believes this environmental information to be correct but cannot guarantee accuracy or completeness. Conformity documents for the above component constitutes are on file. InvenSense subcontracts manufacturing and the information contained herein is based on data received from vendors and suppliers, which has not been validated by InvenSense.

This information furnished by InvenSense is believed to be accurate and reliable. However, no responsibility is assumed by InvenSense for its use, or for any infringements of patents or other rights of third parties that may result from its use. Specifications are subject to change without notice. InvenSense reserves the right to make changes to this product, including its circuits and software, in order to improve its design and/or performance, without prior notice. InvenSense makes no warranties, neither expressed nor implied, regarding the information and specifications contained in this document. InvenSense assumes no responsibility for any claims or damages arising from information contained in this document, or from the use of products and services detailed therein. This includes, but is not limited to, claims or damages based on the infringement of patents, copyrights, mask work and/or other intellectual property rights.

Certain intellectual property owned by InvenSense and described in this document is patent protected. No license is granted by implication or otherwise under any patent or patent rights of InvenSense. This publication supersedes and replaces all information previously supplied. Trademarks that are registered trademarks are the property of their respective companies. InvenSense sensors should not be used or sold in the development, storage, production or utilization of any conventional or mass-destructive weapons or for any other weapons or life threatening applications, as well as in any other life critical applications such as medical equipment, transportation, aerospace and nuclear instruments, undersea equipment, power plant equipment, disaster prevention and crime prevention equipment.

©2014 InvenSense, Inc. All rights reserved. InvenSense, MotionTracking, MotionProcessing, MotionProcessor, MotionFusion, MotionApps, DMP, AAR, and the InvenSense logo are trademarks of InvenSense, Inc. Other company and product names may be trademarks of the respective companies with which they are associated.

©2014 InvenSense, Inc. All rights reserved.