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# SPECIFICATIONS

## TABLE 1. ELECTRICAL CHARACTERISTICS

($T_A$ = −40 to 85°C, $V_{DD}$ = 1.6 to 3.3 V, 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.)

| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS | NOTES |
|---|---|---|---|---|---|---|
| **PERFORMANCE** | | | | | | |
| Directionality | | | Omni | | | |
| Sensitivity | 1 kHz, 94 dB SPL | −41 | −38 | −35 | dBV | |
| Signal-to-Noise Ratio (SNR) | | | 65 | | dBA | |
| Equivalent Input Noise (EIN) | | | 29 | | dBA SPL | |
| Dynamic Range | Derived from EIN and maximum acoustic input | | 91 | | dB | |
| Frequency Response | Low frequency −3 dB point | | 100 | | Hz | 1 |
| | High frequency −3 dB point | | >20 | | kHz | |
| Total Harmonic Distortion (THD) | 105 dB SPL | | | 3 | % | |
| Power-Supply Rejection (PSR) | 217 Hz, 100 mVp-p square wave superimposed on VDD = 1.8 V | | −70 | | dBV | |
| Maximum Acoustic Input | Peak | | 120 | | dB SPL | |
| **POWER SUPPLY** | | | | | | |
| Supply Voltage ($V_{DD}$) | | 1.6 | | 3.3 | V | |
| Supply Current ($I_S$) | | | | | | |
| | $V_{DD}$ = 1.8 V | | 180 | 200 | µA | |
| | $V_{DD}$ = 3.3 V | | 200 | 225 | µA | |
| **OUTPUT CHARACTERISTICS** | | | | | | |
| Output Impedance ($Z_{OUT}$) | | | 200 | | Ω | |
| Output DC Offset | | | 0.8 | | V | |
| Output Current Limit | | | 90 | | µA | |
| Maximum Output Voltage | 120 dB SPL input, peak | | 0.35 | | $V_{PEAK}$ | |
| Noise Floor | 20 Hz to 20 kHz, A-weighted, rms | | −103 | | dBV | |

**Note 1:** See Figure 3 and Figure 4.



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## 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

| PARAMETER | RATING |
|---|---|
| Supply Voltage (VDD) | −0.3 V to +3.6 V |
| Sound Pressure Level (SPL) | 160 dB |
| Mechanical Shock | 10,000 *g* |
| Vibration | Per MIL-STD-883 Method 2007, Test Condition B |
| Operating Temperature Range | −40°C to +85°C |
| Storage Temperature Range | −55°C to +150°C |

### 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.



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## SOLDERING PROFILE

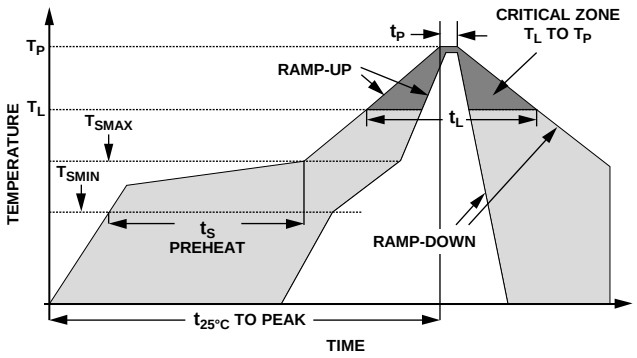


**Figure 1. Recommended Soldering Profile Limits**

## TABLE 3. RECOMMENDED SOLDERING PROFILE*

| PROFILE FEATURE | | Sn63 /Pb37 | Pb-Free |
|---|---|---|---|
| Average Ramp Rate ($T_L$ to $T_P$) | | 1.25°C/sec max | 1.25°C/sec max |
| Preheat | Minimum Temperature ($T_{SMIN}$) | 100°C | 100°C |
| | Minimum Temperature ($T_{SMIN}$) | 150°C | 200°C |
| | Time ($T_{SMIN}$ to $T_{SMAX}$), $t_S$ | 60 sec to 75 sec | 60 sec to 75 sec |
| Ramp-Up Rate ($T_{SMAX}$ to $T_L$) | | 1.25°C/sec | 1.25°C/sec |
| Time Maintained Above Liquidous ($t_L$) | | 45 sec to 75 sec | ~50 sec |
| Liquidous Temperature ($T_L$) | | 183°C | 217°C |
| Peak Temperature ($T_P$) | | 215°C +3°C/−3°C | 245°C +0°C/−5°C |
| Time Within +5°C of Actual Peak Temperature ($t_P$) | | 20 sec to 30 sec | 20 sec to 30 sec |
| Ramp-Down Rate | | 3°C/sec max | 3°C/sec max |
| Time +25°C ($t_{25°C}$) to Peak Temperature | | 5 min max | 5 min max |

**The reflow profile in Table 3 is recommended for board manufacturing with InvenSense MEMS microphones. All microphones are also compatible with the J-STD-020 profile.*



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## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

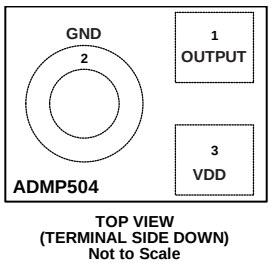


**Figure 2. Pin Configuration**

### TABLE 4. PIN FUNCTION DESCRIPTIONS

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | OUTPUT | Analog Output Signal |
| 2 | GND | Ground |
| 3 | VDD | Power Supply |



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## TYPICAL PERFORMANCE CHARACTERISTICS

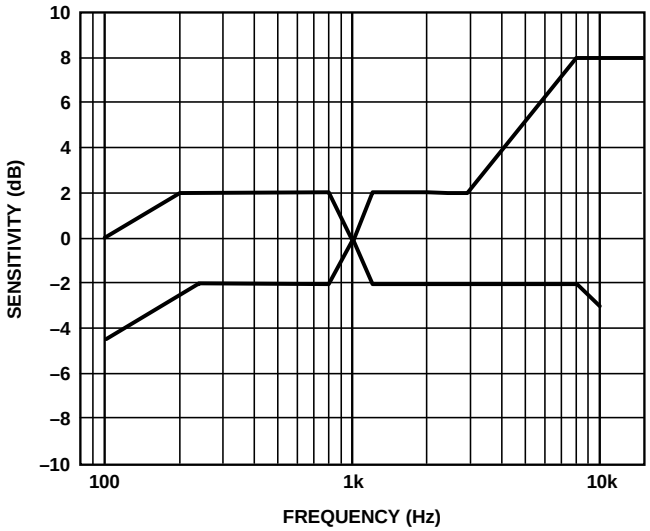


Figure 3. Frequency Response Mask

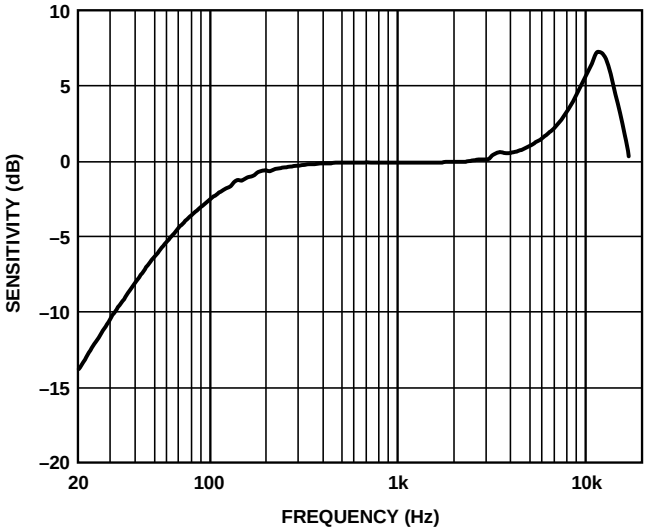


Figure 4. Typical Frequency Response (Measured)

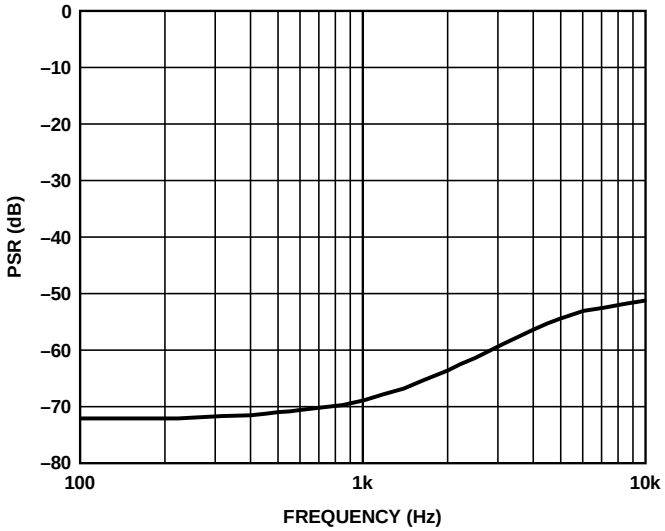


Figure 5. Typical Power Supply Rejection Ratio vs. Frequency



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# APPLICATIONS INFORMATION

## CONNECTING TO AUDIO CODECS

The INMP504 output can be connected to a dedicated codec microphone input (see Figure 6) or to a high input impedance gain stage (see Figure 7.) A 0.1 µF ceramic capacitor placed close to the INMP504 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

$$f_C = 1/(2\pi \times C \times R)$$

where *R* is the input impedance of the codec.

A minimum value of 2.2 µF is recommended in Figure 6 because the input impedance of the codecs 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 7 shows the INMP504 connected to an op amp configured as a non-inverting preamplifier.

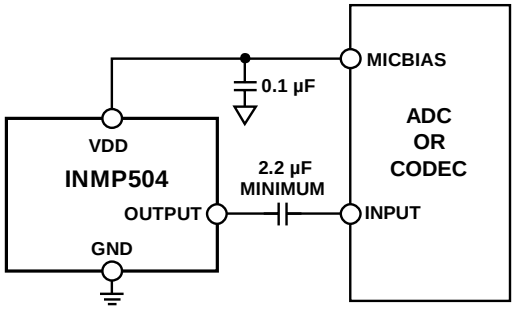


**Figure 6. INMP504 Connected to a Codec**

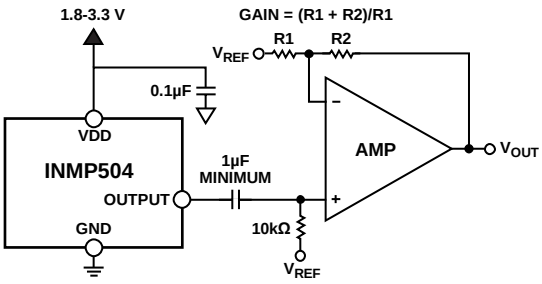


**Figure 7. INMP504 Connected to an Op Amp**



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## SUPPORTING DOCUMENTS

For additional information, see the following documents.

### EVALUATION BOARD USER GUIDE

UG-325 Analog Output MEMS Microphone Flex Evaluation Board

### APPLICATION NOTES (PRODUCT SPECIFIC)

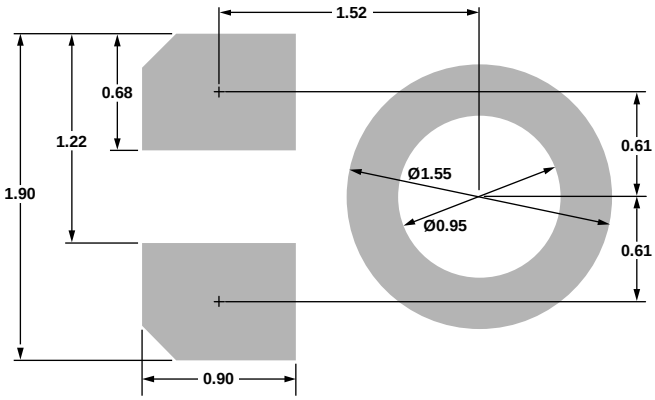
AN-0207 High Performance Analog MEMS Microphone's Simple Interface to SigmaDSP Audio Codec
AN-0262 Low Noise Analog MEMS Microphone and Preamp with Compression and Noise Gating

### APPLICATION NOTES (GENERAL)

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
AN-1181 Using a MEMS Microphone in a 2-Wire Microphone Circuit

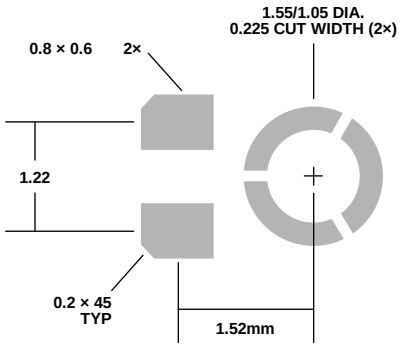
## PCB DESIGN AND LAND PATTERN LAYOUT

The recommended PCB land pattern for the INMP504 should be laid out to a 1:1 ratio to the solder pads on the microphone package, as shown in Figure 8. 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 9. 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.




**Dimensions shown in millimeters**

**Figure 8. PCB Land Pattern Layout**




**Dimensions shown in millimeters**

**Figure 9. Suggested Solder Paste Stencil Pattern Layout**



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# 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, the soldering profile must 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 1 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.



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## OUTLINE DIMENSIONS

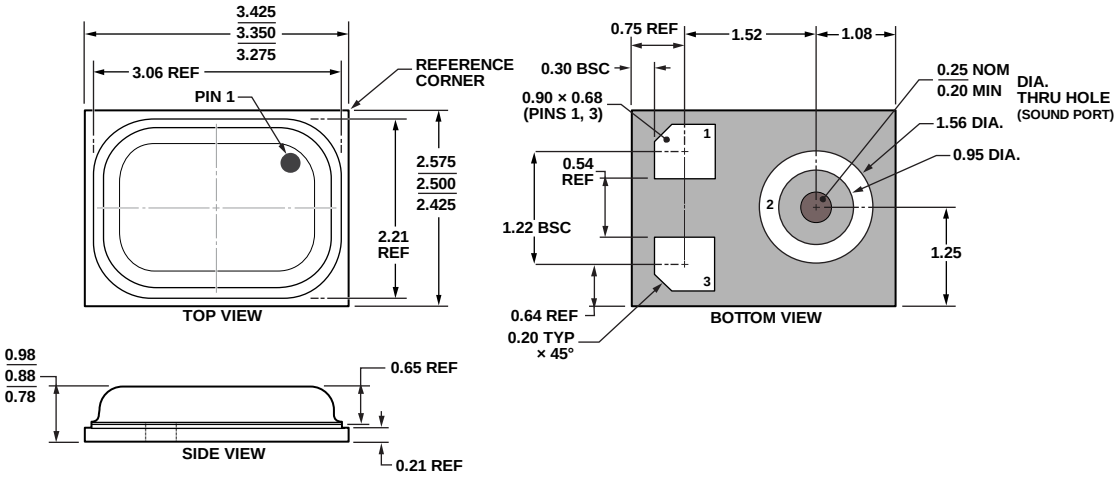


**Figure 10. 3-Terminal Chip Array Small Outline No-Lead Cavity [LGA_CAV]**
**3.35 × 2.50 × 0.88 mm Body**
**Dimensions shown in millimeters**

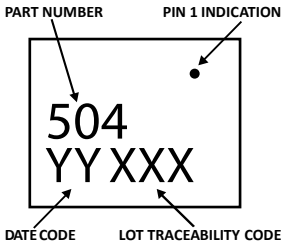


**Figure 11. Package Marking Specification (Top View)**



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## ORDERING GUIDE

| PART | TEMP RANGE | PACKAGE | QUANTITY |
|---|---|---|---|
| **INMP504ACEZ-R0**[1]* | −40°C to +85°C | 3-Terminal LGA_CAV | 10,000 |
| **INMP504ACEZ-R7**[1]† | −40°C to +85°C | 3-Terminal LGA_CAV | 1,000 |
| **EV_INMP504-FX** | — | Flex Evaluation Board | — |

* – 13” Tape and Reel
† – 7” Tape and Reel to be discontinued. Check with sales@invensense.com for availability.
[1]Z = RoHS-Compliant Part

## REVISION HISTORY

| REVISION DATE | REVISION | DESCRIPTION |
|---|---|---|
| 02/06/2014 | 1.0 | Initial Release |
| 05/14/2014 | 1.1 | Corrected typo in Features section |

## COMPLIANCE DECLARATION DISCLAIMER

InvenSense believes the environmental and other compliance information given in this document to be correct but cannot guarantee accuracy or completeness. Conformity documents substantiating the specifications and component characteristics 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.



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