# Omnidirectional Microphone with Bottom Port and Digital Output

Data Sheet

# ADMP421



## FEATURES

- Small and thin 3 mm × 4 mm × 1 mm surface-mount package
- High SNR of 61 dBA
- High sensitivity of −26 dBFS
- Flat frequency response from 100 Hz to 15 kHz
- Low current consumption: <650 µA
- Sleep mode for extended battery life
- High PSR of 80 dBFS
- Fourth-order Σ-Δ modulator
- Digital PDM output
- Compatible with Sn/Pb and Pb-free solder processes
- RoHS/WEEE compliant

## APPLICATIONS

- Smartphones and feature phones
- Teleconferencing systems
- Digital video cameras
- Bluetooth headsets
- Video phones
- Tablets

## GENERAL DESCRIPTION

The ADMP421 is a high performance, low power, digital output bottom-ported omnidirectional MEMS microphone. The ADMP421 consists of a MEMS microphone element and an impedance converter amplifier followed by a fourth-order Σ-Δ modulator. The digital interface allows for the pulse density modulated (PDM) output of two microphones to be time-multiplexed on a single data line using a single clock.

The ADMP421 has a high SNR and high sensitivity, making it an excellent choice for far field applications. The ADMP421 has a flat wideband frequency response, resulting in natural sound with high intelligibility. Low current consumption and a sleep mode enable long battery life for portable applications. A built-in particle filter provides high reliability. The ADMP421 complies with the TIA-920 *Telecommunications Telephone Terminal Equipment Transmission Requirements for Wideband Digital Wireline Telephones* standard.

The ADMP421 is available in a thin 3 mm × 4 mm × 1 mm surface-mount package. It is reflow solder compatible with no sensitivity degradation. The ADMP421 is halide free.

## FUNCTIONAL BLOCK DIAGRAM

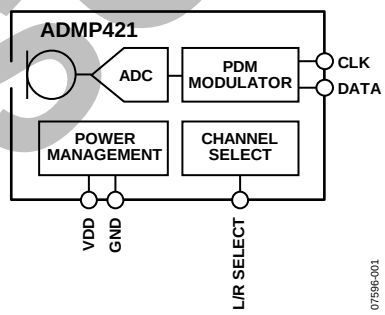


*Figure 1.*

Rev. D



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**8/11—Rev. B to Rev. C**

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**4/10—Revision 0: Initial Version**

# SPECIFICATIONS

$T_A$ = 25°C, $V_{DD}$ = 1.8 V, CLK = 2.4 MHz, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

**Table 1.**

| Parameter | Symbol | Test Conditions/Comments | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| PERFORMANCE | | | | | | |
| Directionality | | | | Omni | | |
| Sensitivity[1] | | 1 kHz, 94 dB SPL | −29 | −26 | −23 | dBFS |
| Signal-to-Noise Ratio | SNR | 20 kHz bandwidth, A-weighted | | 61 | | dBA |
| Equivalent Input Noise | EIN | 20 kHz bandwidth, A-weighted | | 33 | | dBA SPL |
| Dynamic Range | | Derived from EIN and maximum acoustic input | | 87 | | dB |
| Frequency Response[2] | | Low frequency −3 dB point | | 100 | | Hz |
| | | High frequency −3 dB point | | 15 | | kHz |
| | | Deviation limits from flat response within pass band | | −3/+2 | | dB |
| Total Harmonic Distortion | THD | 105 dB SPL | | | 3 | % |
| Power Supply Rejection | PSR | 217 Hz, 100 mV p-p square wave superimposed on $V_{DD}$ = 1.8 V | | 80 | | dBFS |
| Maximum Acoustic Input | | Peak | | 120 | | dB SPL |
| INPUT CHARACTERISTICS | | | | | | |
| Clock Frequency | CLK | | 1.0 | 2.4[3] | 3.3 | MHz |
| Clock Duty Ratio | | Clock frequency of 2.4 MHz or less | 40 | | 60 | % |
| Input Voltage High | $V_{IH}$ | | 0.65 × $V_{DD}$ | | | V |
| Input Voltage Low | $V_{IL}$ | | | | 0.35 × $V_{DD}$ | V |
| OUTPUT CHARACTERISTICS | | | | | | |
| Output Voltage High | $V_{OH}$ | $I_{LOAD}$ = 0.5 mA | 0.7 × $V_{DD}$ | $V_{DD}$ | | V |
| Output Voltage Low | $V_{OL}$ | $I_{LOAD}$ = 0.5 mA | | 0 | 0.3 × $V_{DD}$ | V |
| Latency | | | | <30 | | µs |
| Wake-Up Time | | From sleep mode, power on | | 10 | | ms |
| POWER SUPPLY | | | | | | |
| Supply Voltage | $V_{DD}$ | | 1.8 | | 3.3 | V |
| Supply Current | $I_S$ | Normal mode | | | 650 | µA |
| | | Sleep mode[4] | | | 50 | µA |

[1] Relative to the rms level of a sine wave with positive amplitude equal to 100% 1s density and negative amplitude equal to 0% 1s density.
[2] See Figure 5 and Figure 6.
[3] The microphone operates at any clock frequency between 1.0 MHz and 3.3 MHz. Some specifications may not be guaranteed at frequencies other than 2.4 MHz.
[4] The microphone enters sleep mode when the clock is turned off or the clock frequency is less than 1 kHz.

## TIMING CHARACTERISTICS

**Table 2.**

| Parameter | Description | Min | Max | Unit |
|---|---|---|---|---|
| Input | | | | |
| $t_{CLKIN}$ | Input clock period | 310 | 1000 | ns |
| Output | | | | |
| $t_{1OUTEN}$ | DATA1 driven after falling clock edge | 30 | | ns |
| $t_{1OUTDIS}$ | DATA1 disabled after rising clock edge | | 20 | ns |
| $t_{2OUTEN}$ | DATA2 driven after rising clock edge | 30 | | ns |
| $t_{2OUTDIS}$ | DATA2 disabled after falling clock edge | | 20 | ns |

### *Timing Diagram*

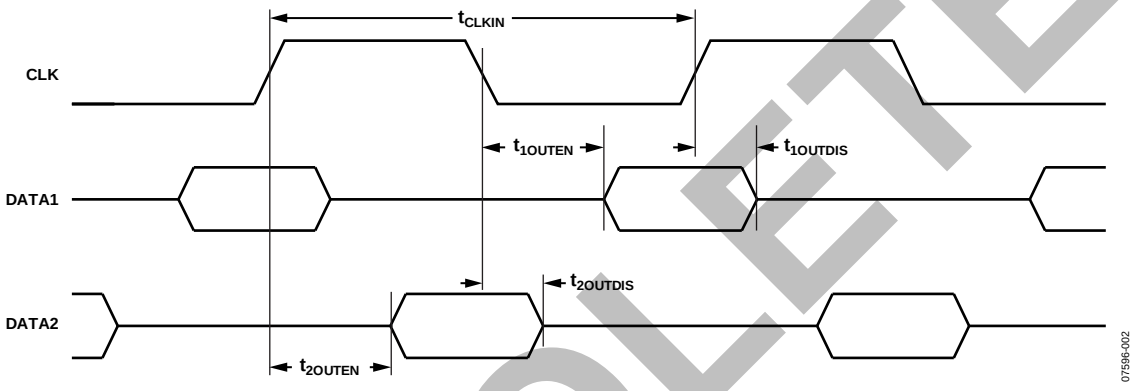


*Figure 2. Pulse Density Modulated Output Timing*

# ABSOLUTE MAXIMUM RATINGS

**Table 3.**

| Parameter | Rating |
|---|---|
| Supply Voltage | −0.3 V to 3.6 V |
| Digital Pin Input Voltage | −0.3 V to $V_{DD}$ + 0.3 V or 3.6 V, whichever is less |
| Sound Pressure Level (SPL) | 160 dB |
| Mechanical Shock | 10,000 *g* |
| Vibration | Per MIL-STD-883 Method 2007, Test Condition B |
| Temperature Range | −40°C to +85°C |

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.

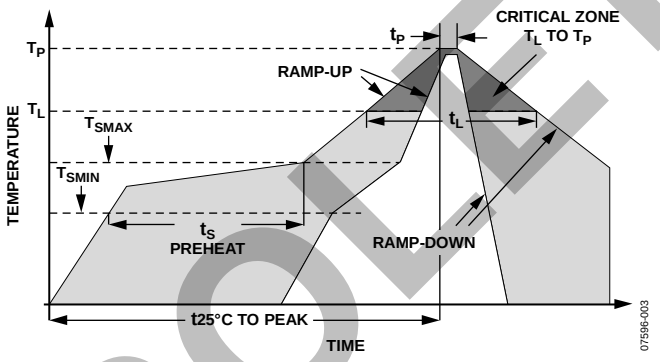


*Figure 3. Recommended Soldering Profile Limits*

**Table 4. Recommended Soldering Profile Limits**

| 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 |
| Maximum Temperature ($T_{SMAX}$) | 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 | 260°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 (t25°C) to Peak Temperature | 5 minute max | 5 minute max |

# PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

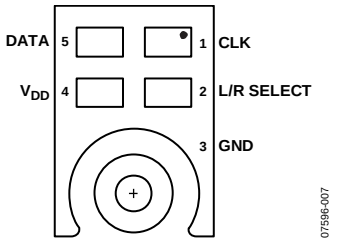


*Figure 4. Pin Configuration (Bottom View)*

**Table 5. Pin Function Descriptions**

| Pin No. | Mnemonic | Description |
|---|---|---|
| 1 | CLK | Clock Input to Microphone. |
| 2 | L/R SELECT | Left Channel or Right Channel Select.<br>DATA1 (right): L/R SELECT tied to GND.<br>DATA2 (left): L/R SELECT pulled to $V_{DD}$. |
| 3 | GND | Ground. |
| 4 | $V_{DD}$ | Power Supply. Placing a 0.1 µF (100 nF) ceramic type X7R capacitor between Pin 4 ($V_{DD}$) and ground is strongly recommended for best performance and to avoid potential parasitic artifacts. The capacitor should be placed as close to Pin 4 as possible. |
| 5 | DATA | Digital Output Signal (DATA1, DATA2). |

# TYPICAL PERFORMANCE CHARACTERISTICS

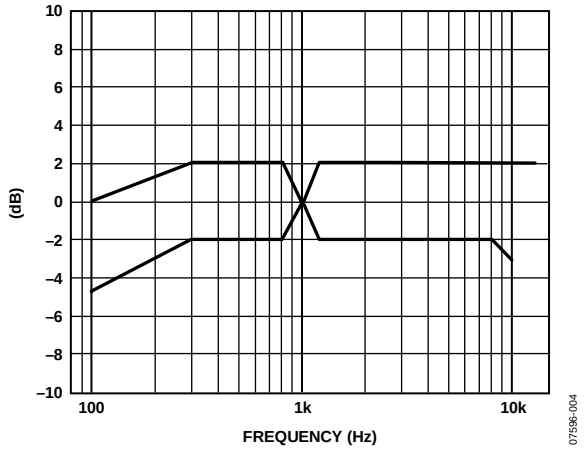


*Figure 5. Frequency Response Mask*

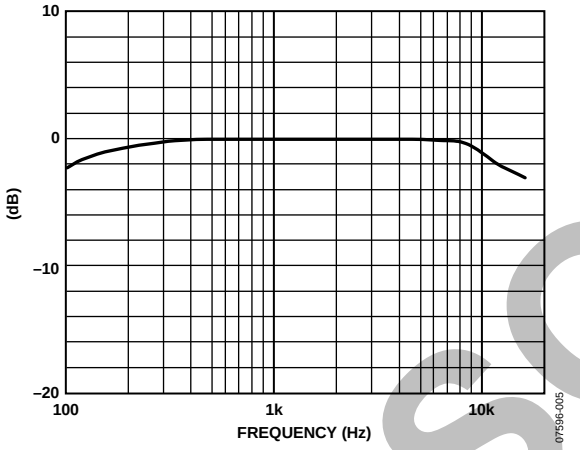


*Figure 6. Typical Frequency Response (Measured)*

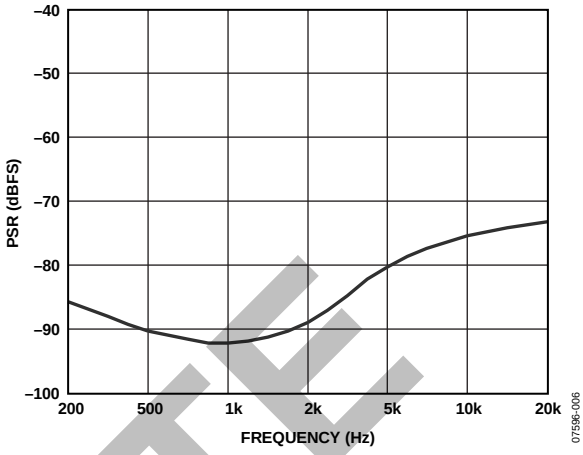


*Figure 7. Typical Power Supply Rejection vs. Frequency*

# PCB LAND PATTERN LAYOUT

The recommended PCB land pattern for the ADMP421 should be laid out to a 1:1 ratio to the solder pads on the microphone package, as shown in Figure 8. Care should be taken 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.

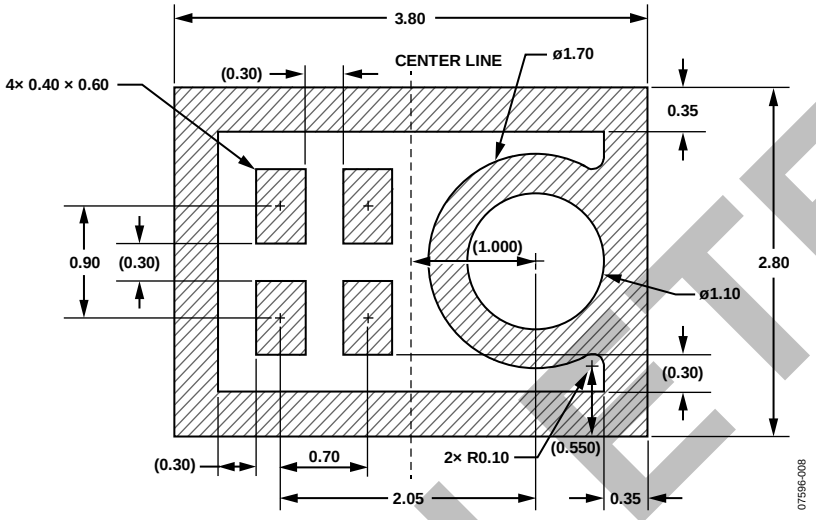


*Figure 8. Suggested PCB Land Pattern Layout*

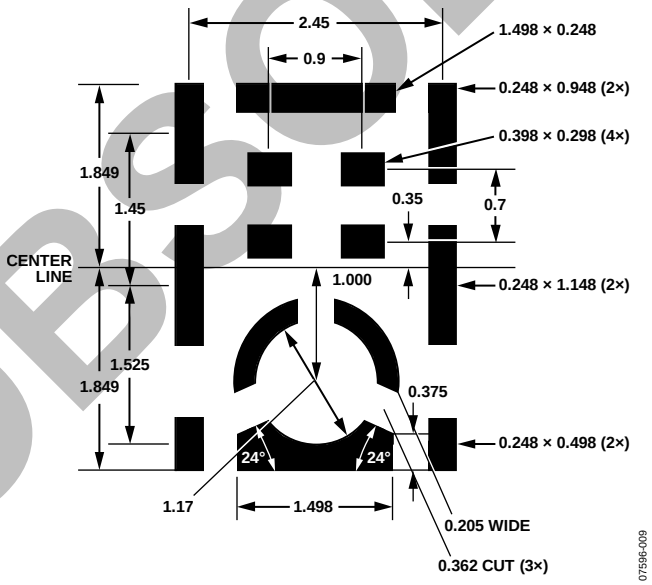


*Figure 9. Suggested Solder Paste Stencil Pattern Layout*

## ALTERNATE PCB LAND PATTERNS

The ADMP421's standard PCB land pattern has a solid ring around the edge of the footprint, which may make routing the microphone signals more difficult in some board designs. This ring is used to improve the RF immunity performance of the ADMP421, but it is not necessary to have this full ring connected for electrical functionality. If a design can tolerate reduced RF immunity then this ring can either be broken or removed completely from the PCB footprint. Figure 10 shows an example land pattern with no enclosing ring around the edge of the part, and Figure 11 shows an example pattern with the ring broken on two sides so that the inner pads can be more easily routed on the PCB.

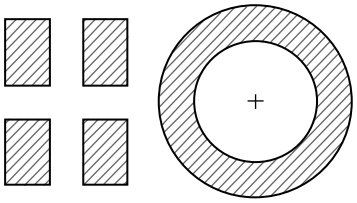


*Figure 10. Example PCB Land Pattern with No Enclosing Ring*

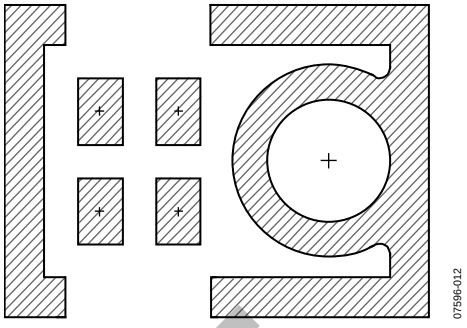


*Figure 11. Example PCB Land Pattern with Broken Enclosing Ring*

Note that in both of these patterns, the solid ring around the sound port is still present; this ring is needed to ground the microphone and for acoustic performance. The pad on the package connected to this ring is ground and still needs a solid electrical connection to the PCB ground. If a pattern like one of these two examples is used on a PCB, take care that the unconnected ring on the bottom of the ADMP421 is not placed directly over any exposed copper. This ring on the microphone is still at ground and any PCB traces routed underneath it need to be properly masked to avoid short circuits.

# APPLICATIONS INFORMATION

## INTERFACING WITH ANALOG DEVICES CODECS

Analog Devices ADAU1361, ADAU1761, and ADAU1781 codecs feature digital microphone inputs that support the ADMP421 PDM output data format. See the connection diagrams shown in Figure 12, and refer to the AN-1003 Application Note and the codecs' respective data sheets for more details on the digital microphone interface.

## SLEEP MODE

The microphone enters sleep mode when the clock is turned off or the clock frequency falls below 1 kHz. In sleep mode, the microphone data output is in high impedance state and the current consumption is less than 50 µA.

## POWER SAVINGS WHEN DISABLING ONE MICROPHONE IN A MULTIMICROPHONE APPLICATION

The ADMP421 has a unique power-saving feature when used in systems where two or more microphones share the same clock and/or data lines. The microphone is designed to present high impedance on both the clock and data pins when the power supply ($V_{DD}$) pin is at 0 V or floating. This disabled microphone presents no load to and consumes no power from other active microphones.

## SUPPORTING DOCUMENTS

### *Evaluation Board User Guides*

UG-118, *EVAL-ADMP421Z Bottom Port Digital Output MEMS Microphone Evaluation Board*

UG-183, *EVAL-ADMP421Z-FLEX: Bottom-Ported Digital Output MEMS Microphone Evaluation Board*

### *Circuit Note*

CN-0078, *iMEMS Digital Microphone Simplifies the Interface to a SigmaDSP Audio Codec*

### *Application Notes*

AN-1003, *Recommendations for Mounting and Connecting 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*



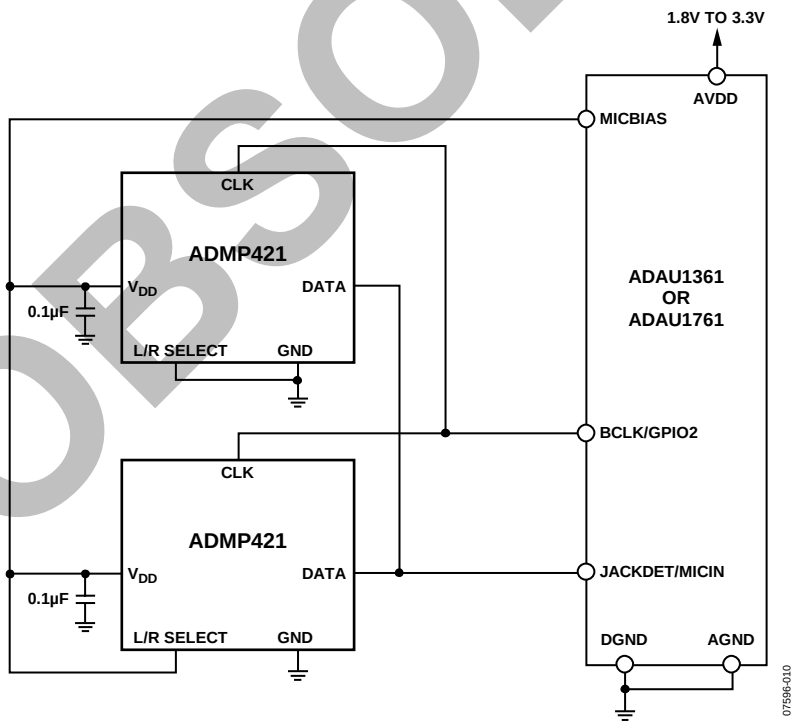


*Figure 12. ADAU1361 and ADAU1761 Stereo Interface Block Diagram*

# HANDLING INSTRUCTIONS

## PICK-AND-PLACE EQUIPMENT

The MEMS microphone can be handled using standard pick-and-place and chip shooting equipment. Care should be taken 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.
- Use care during pick-and-place to ensure that no high shock events above 10 k*g* are experienced because such events may cause damage to the microphone.
- 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 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 4.

## BOARD WASH

When washing the PCB, ensure that water does not make contact with the microphone port. Blow-off procedures and ultrasonic cleaning must not be used.

# RELIABILITY SPECIFICATIONS

The microphone sensitivity after stress must deviate by no more than 3 dB from the initial value.

**Table 6.**

| Stress Test | Description |
|---|---|
| Low Temperature Operating Life | −40°C, 500 hours, powered |
| High Temperature Operating Life | +125°C, 500 hours, powered |
| Temperature Humidity Bias (THB) | +85°C/85% relative humidity (RH), 500 hours, powered |
| Temperature Cycle | −40°C/+125°C, one cycle per hour, 1000 cycles |
| High Temperature Storage | +150°C, 500 hours |
| Low Temperature Storage | −40°C, 500 hours |
| Component CDM ESD | All pins, 0.5 kV |
| Component HBM ESD | All pins, 1.5 kV |
| Component MM ESD | All pins, 0.2 kV |

# OUTLINE DIMENSIONS

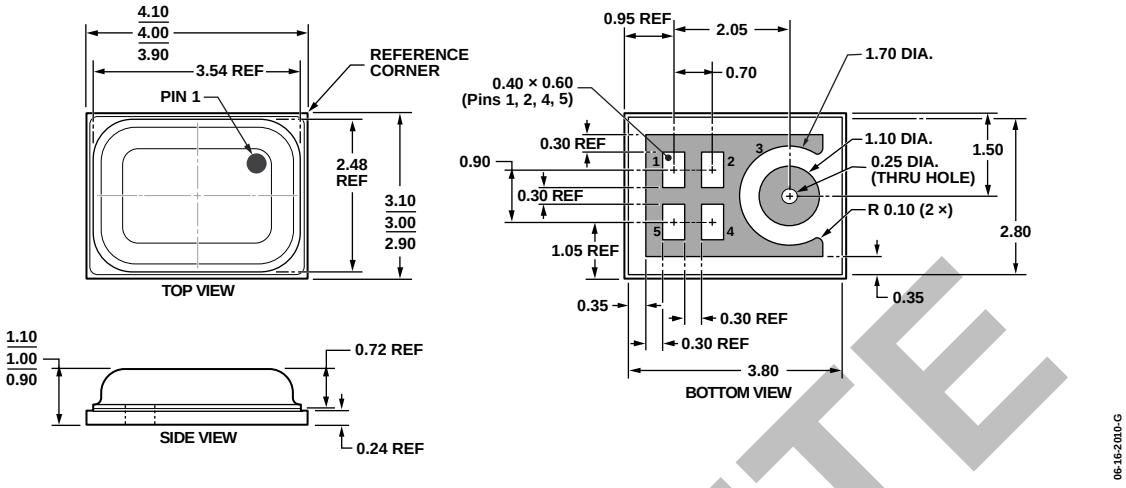


*Figure 13. 5-Terminal Chip Array Small Outline No Lead Cavity [LGA_CAV]*
*4 mm × 3 mm Body*
*(CE-5-1)*
*Dimensions shown in millimeters*

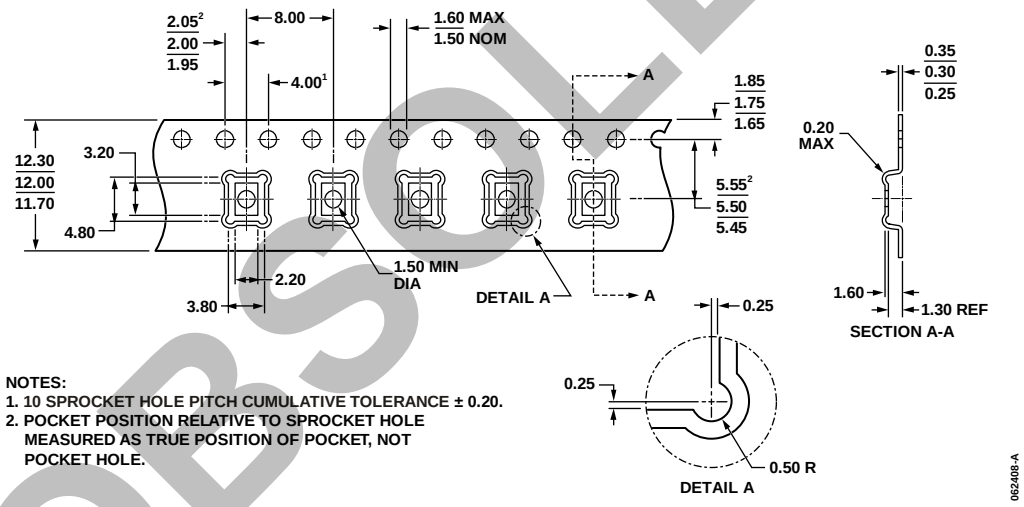


*Figure 14. LGA_CAV Tape and Reel Outline Dimensions*
*Dimensions shown in millimeters*



## ORDERING GUIDE

| Model[1] | Temperature Range | Package Description | Package Option[2] | Ordering Quantity |
|---|---|---|---|---|
| ADMP421BCEZ-RL | −40°C to +85°C | 5-Terminal LGA_CAV, 13″Tape and Reel | CE-5-1 | 5,000 |
| ADMP421BCEZ-RL7 | −40°C to +85°C | 5-Terminal LGA_CAV, 7″Tape and Reel | CE-5-1 | 1,000 |
| EVAL-ADMP421Z | | Evaluation Board | | |
| EVAL-ADMP421Z-FLEX | | Flex Evaluation Board | | |

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

## NOTES

## NOTES

## NOTES




D07596-0-11/11(D)

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

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