

## FEATURES

- Tiny, 3.35 mm × 2.50 mm × 0.88 mm surface-mount package
- Omnidirectional response
- Very high SNR of 65 dBA
- Sensitivity of -38 dBV
- Extended frequency response from 100 Hz to 20 kHz
- Low current consumption: 180  $\mu$ A
- Single-ended analog output
- 120 dB maximum SPL
- High PSR of 70 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 [ADMP504](#)<sup>1</sup> is a high performance, very low noise, low power, analog output, bottom-ported omnidirectional MEMS microphone. The [ADMP504](#) consists of a MEMS microphone element, an impedance converter and an output amplifier. The [ADMP504](#) sensitivity specification makes it an excellent choice for both near field and far field applications. The [ADMP504](#) is function- and pin-compatible with the [ADMP404](#) microphone, providing an easy upgrade path.

The [ADMP504](#) has very high SNR and extended wideband frequency response, resulting in natural sound with high

intelligibility. Low current consumption enables long battery life for portable applications. The [ADMP504](#) complies with the TIA-920 *Telecommunications Telephone Terminal Equipment Transmission Requirements for Wideband Digital Wireline Telephones* standard.

The [ADMP504](#) is available in an ultraminiature 3.35 mm × 2.5 mm × 0.88 mm surface-mount package. It is reflow solder compatible with no sensitivity degradation. The [ADMP504](#) is halide free.

## FUNCTIONAL BLOCK DIAGRAM

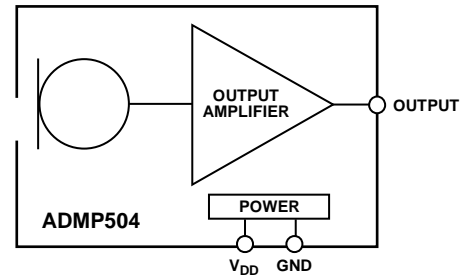


Figure 1.

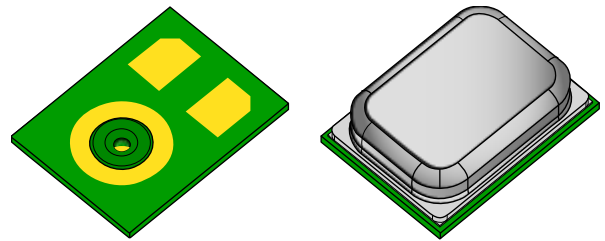


Figure 2. Isometric Views of [ADMP504](#) Microphone Package

<sup>1</sup> Protected by U.S. Patents 7,449,356; 7,825,484; 7,885,423; 7,961,897. Other patents are pending.

### Rev. A

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# IMPORTANT LINKS for the [ADMP504](#)\*

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## PARAMETRIC SELECTION TABLES

Find Similar Products By Operating Parameters

Consider [ADMP401](#): Omnidirectional Microphone with Bottom Port and Analog Output

Consider [ADMP404](#): Omnidirectional Microphone with Bottom Port and Analog Output

Consider [ADMP405](#): Omnidirectional Microphone with Bottom Port and Analog Output

Consider [ADMP421](#): Omnidirectional Microphone with Bottom Port and Analog Output

Consider [ADMP441](#): Omnidirectional Microphone with Bottom Port and Analog Output

Consider [ADMP521](#): Omnidirectional Microphone with Bottom Port and Analog Output

## DESIGN TOOLS, MODELS, DRIVERS & SOFTWARE

Microphone Beamforming Simulation Tool (32-bit)

- Documentation for the microphone beamforming simulator

Microphone Beamforming Simulation Tool (64-bit)

- Documentation for the microphone beamforming simulator

## PRODUCT RECOMMENDATIONS & REFERENCE DESIGNS

[CN-0262](#): Low Noise Analog MEMS Microphone and Preamp with Compression and Noise Gating

[CN-0207](#): High Performance Analog MEMS Microphone's Simple Interface to SigmaDSP Audio Codec

## SUGGESTED COMPANION PRODUCTS

Recommended Audio Codecs for the ADMP504

- For a low power SigmaDSP codec with headphone driver and PLL, we recommend the [ADAU1761](#).
- For a low power SigmaDSP codec with mono speaker driver and PLL, we recommend the [ADAU1781](#).
- For a low power, 24-bit audio codec with headphone driver and PLL, we recommend the [ADAU1361](#).
- For a low power, 24-bit audio codec with a fixed-function tunable signal processor, we recommend the [ADAU1381](#).
- For a low power, multi-channel, 24-bit audio codec in a wafer level chip scale package, we recommend the [ADAU1373](#).
- For a low power, stereo codec with mono microphone input, we recommend the [SSM2603](#).

Recommended Microphone Preamplifiers for the ADMP504

- For low noise, variable compression and noise gating, we recommend the [SSM2166](#) or the [SSM2167](#).
- For low power, ultralow noise, low distortion, we recommend the [ADA4075-2](#) dual opamp.

## DOCUMENTATION

[AN-1181](#): Using a MEMS Microphone in a 2-Wire Microphone Circuit

[AN-1165](#): Op Amps for MEMS Microphone Preamp Circuits

[AN-1140](#): Microphone Array Beamforming

[AN-1124](#): Recommendations for Sealing Analog Devices, Inc., Bottom-Port MEMS Microphones from Dust and Liquid Ingress

[AN-1112](#): Microphone Specifications Explained

[AN-1068](#): Reflow Soldering of the MEMS Microphone

[AN-1003](#): Recommendations for Mounting and Connecting Analog Devices, Inc., Bottom-Ported MEMS Microphones

[CN-0262](#): Low Noise Analog MEMS Microphone and Preamp with Compression and Noise Gating

ADI MEMS Mics Set New Bar in Noise Performance

[UG-325](#): Analog Output MEMS Microphone Flex Evaluation Board

[MS-2472](#): Analog and Digital MEMS Microphone Design Considerations

[MS-2348](#): Low Self Noise: The First Step to High Performance MEMS Microphone Applications

[MS-2275](#): Common Inter-IC Digital Interfaces for Audio Data Transfer

A History of Consumer Microphones:

Analog Devices Sets High-Performance Benchmark With The Industry's Lowest-Noise MEMS Microphone

## EVALUATION KITS & SYMBOLS & FOOTPRINTS

MEMS Microphone Evaluation Boards

ADMP504 Flex Eval Board

Symbols and Footprints

## DESIGN COLLABORATION COMMUNITY



[Collaborate Online](#) with the ADI support team and other designers about select ADI products.

## SAMPLE & BUY

[ADMP504](#)

- View Price & Packaging
- Request Evaluation Board
- Request Samples
- Check Inventory & Purchase

[Find Local Distributors](#)

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**REVISION HISTORY**

**6/12—Rev. 0 to Rev. A**

Changes to Figure 2.....	1
Changes to General Description Section .....	1
Change to Power Supply Rejection Parameter, Table 1 .....	3
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**10/11—Revision 0: Initial Version**

## SPECIFICATIONS

$T_A = 25^\circ\text{C}$ ,  $V_{DD} = 1.8\text{ V}$ , 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
<b>PERFORMANCE</b>						
Directionality				Omni		
Sensitivity		1 kHz, 94 dB SPL	-41	-38	-35	dBV
Signal-to-Noise Ratio	SNR	20 Hz to 20 kHz, A-weighted		65		dB
Equivalent Input Noise	EIN	20 Hz to 20 kHz, A-weighted		29		dB SPL
Dynamic Range		Derived from EIN and maximum acoustic input		91		dB
Frequency Response <sup>1</sup>		Low frequency -3 dB point		100		Hz
		High frequency -3 dB point		>20		kHz
Total Harmonic Distortion	THD	104 dB SPL			3	%
Power Supply Rejection	PSR	217 Hz, 100 mV p-p square wave superimposed on $V_{DD} = 1.8\text{ V}$		-70		dBV
Maximum Acoustic Input		Peak, 10% THD		120		dB SPL
<b>POWER SUPPLY</b>						
Supply Voltage	$V_{DD}$		1.6		3.3	V
Supply Current	$I_S$	$V_{DD} = 1.8\text{ V}$		180	200	$\mu\text{A}$
		$V_{DD} = 3.3\text{ V}$		200	225	$\mu\text{A}$
<b>OUTPUT CHARACTERISTICS</b>						
Output Impedance	$Z_{OUT}$			200		$\Omega$
Output DC Offset				0.8		V
Output Current Limit				90		$\mu\text{A}$
Maximum Output Voltage		120 dB SPL input, peak		0.25		V
Noise Floor		20 Hz to 20 kHz, A-weighted, rms		-103		dBV

<sup>1</sup> See Figure 5 and Figure 7.

## ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	-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
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.

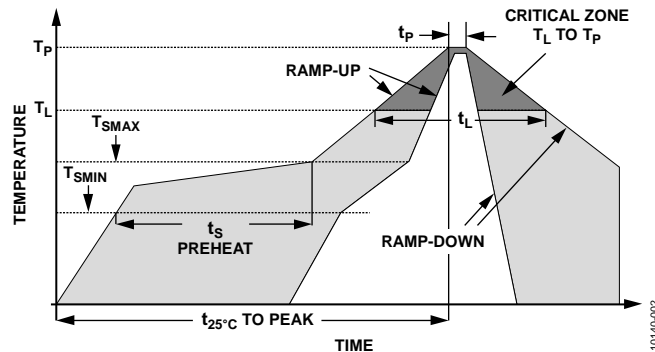
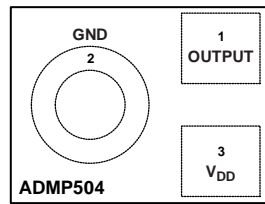


Figure 3. Recommended Soldering Profile Limits

Table 3. Recommended Soldering Profile Limits

Profile Feature	Sn63/Pb37	Pb-Free
Average Ramp Rate ( $T_L$ to $T_P$ )	1.25°C/sec maximum	1.25°C/sec maximum
Preheat		
Minimum Temperature ( $T_{SMIN}$ )	100°C	150°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 maximum	3°C/sec maximum
Time 25°C to Peak Temperature	5 minutes maximum	5 minutes maximum

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



TOP VIEW  
(TERMINAL SIDE DOWN)  
Not to Scale

10140-003

Figure 4. Pin Configuration

Table 4. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	OUTPUT	Analog Output Signal
2	GND	Ground
3	V <sub>DD</sub>	Power Supply

TYPICAL PERFORMANCE CHARACTERISTICS

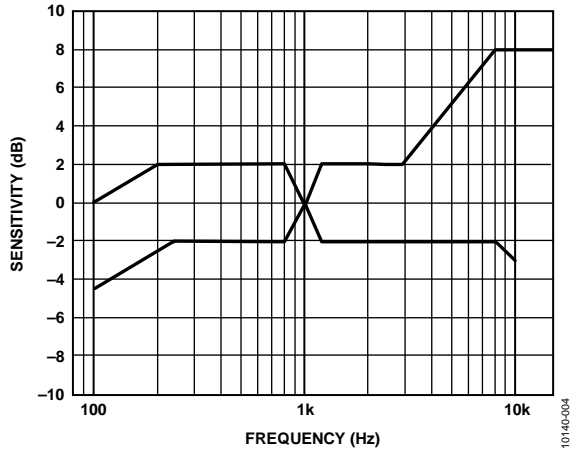


Figure 5. Frequency Response Mask

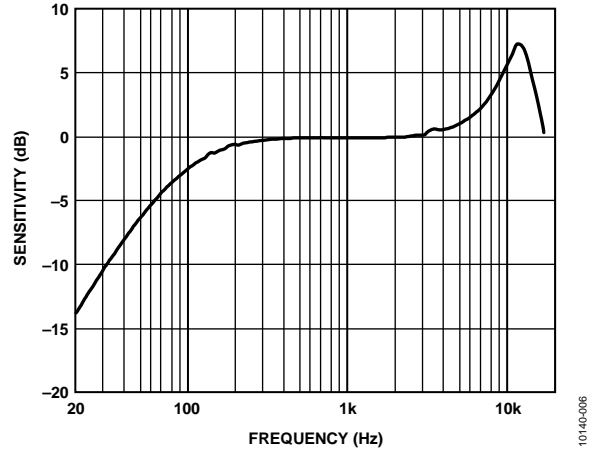


Figure 7. Typical Frequency Response (Measured)

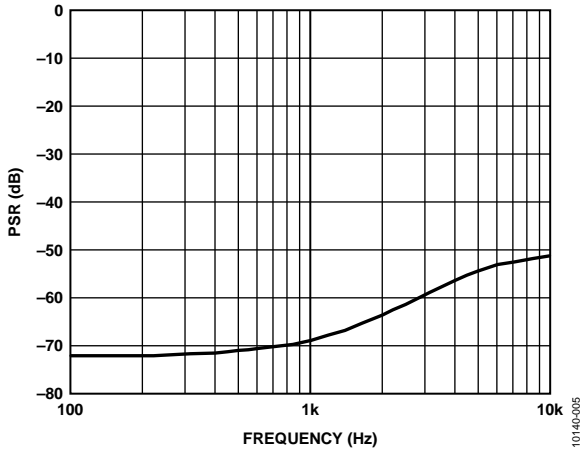


Figure 6. Typical Power Supply Rejection vs. Frequency

## APPLICATIONS INFORMATION

The **ADMP504** output can be connected to a dedicated codec microphone input (see Figure 8) or to a high input impedance gain stage (see Figure 9). A 0.1  $\mu\text{F}$  ceramic capacitor placed close to the **ADMP504** 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 codec's input impedance.

A minimum value of 2.2  $\mu\text{F}$  is recommended in Figure 8 because the input impedance of the **ADAU1361/ADAU1761** can be as low as 2  $\text{k}\Omega$  at its highest PGA gain setting, which would result in a high-pass filter corner frequency at about 37 Hz.

Figure 9 shows the **ADMP504** connected to an **ADA4897-1** op amp configured as a noninverting preamplifier.

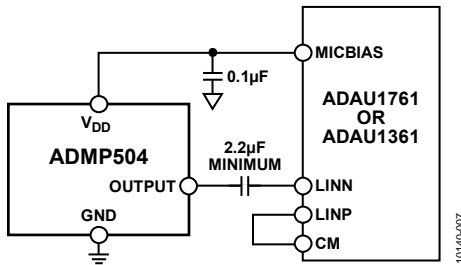


Figure 8. **ADMP504** Connected to the Analog Devices **ADAU1761** or **ADAU1361** Codec

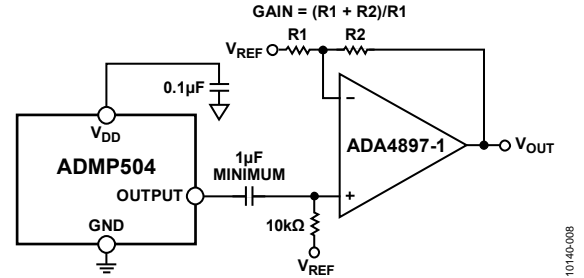


Figure 9. **ADMP504** Connected to the **ADA4897-1** Op Amp

## SUPPORTING DOCUMENTS

### Evaluation Board User Guide

[UG-325, EVAL-ADMP504Z-FLEX: Bottom-Ported Analog Output MEMS Microphone 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 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](#)



## 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.
- Use care during pick-and-place to ensure that no high shock events above 10 kg are experienced because this 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 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 3.

### 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.

### PCB LAND PATTERN LAYOUT

The recommended PCB land pattern for the ADMP504 should be laid out to a 1:1 ratio to the solder pads on the microphone package, as shown in Figure 10. 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 11. 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.

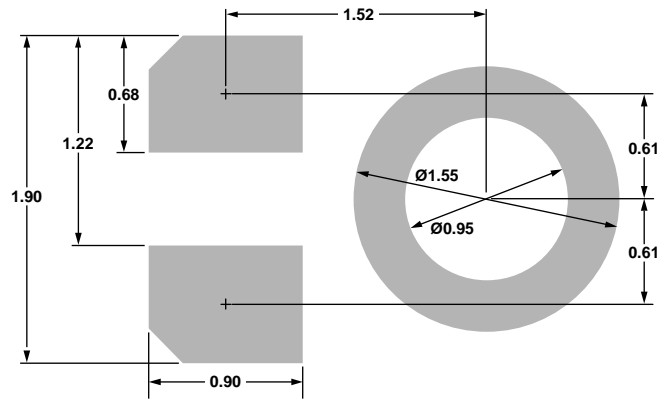


Figure 10. PCB Land Pattern Layout

10146-009

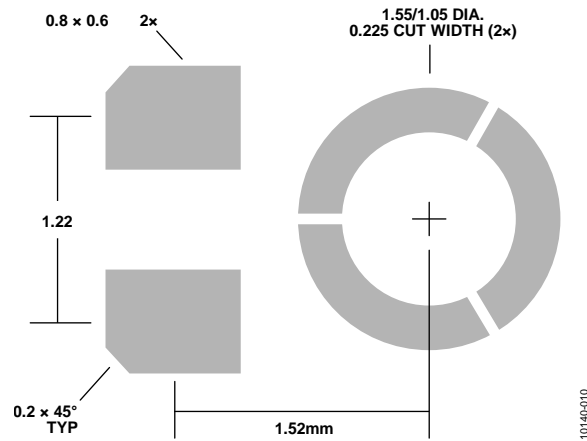


Figure 11. Suggested Solder Paste Stencil Pattern Layout

10146-010

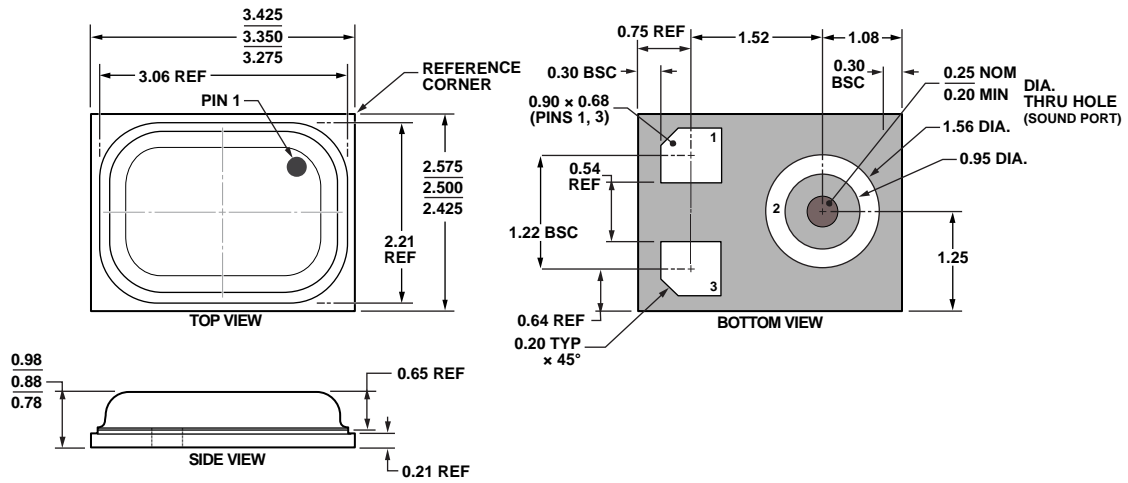
## RELIABILITY SPECIFICATIONS

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

Table 5.

Stress Test	Description
Low Temperature Operating Life	−40°C, 1000 hrs, powered
High Temperature Operating Life	+125°C, 1000 hrs, powered
Temperature Humidity Bias (THB)	+85°C/+85% relative humidity (RH), 1000 hrs, powered
Temperature Cycle	−40°C/+125°C, one cycle per hour, 1000 cycles
High Temperature Storage	+150°C, 1000 hrs
Low Temperature Storage	−40°C, 1000 hrs
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



06-16-2010-A

## ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option <sup>2</sup>	Ordering Quantity
ADMP504ACEZ-RL	-40°C to +85°C	3-Terminal LGA_CAV, 13" Tape and Reel	CE-3-2	10,000
ADMP504ACEZ-RL7	-40°C to +85°C	3-Terminal LGA_CAV, 7" Tape and Reel	CE-3-2	1,000
EVAL-ADMP504Z-FLEX		Flex Evaluation Board		

<sup>1</sup> Z = RoHS Compliant Part.

<sup>2</sup> This package option is halide free.

**NOTES**