



# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

## General Description

The MAX9812/MAX9813 are single/dual-input, 20dB fixed-gain microphone amplifiers. They offer tiny packaging and a low-noise, integrated microphone bias, making them ideal for portable audio applications such as notebook computers, cell phones, and PDAs. These amplifiers feature a 500kHz bandwidth, Rail-to-Rail® outputs, an industry-leading 100dB power-supply rejection ratio, and a very low 0.015% THD+N. Power-saving features include very low 230µA supply current and a total shutdown mode that cuts the combined supply and BIAS currents to only 100nA.

The MAX9812 is a single amplifier in a 6-pin SC70 package (2mm x 2.1mm) and the MAX9813 is a dual-input amplifier available in an 8-pin SOT23 (3mm x 3mm) package. The MAX9813 has two inputs allowing two microphones to be multiplexed to a single output.

The MAX9812/MAX9813 are offered in two grades. The MAX9812L/MAX9813L are optimized for 3.3V supply operation (2.7V to 3.6V). The MAX9812H/MAX9813H are PC2001 compliant and are optimized for 5V operation (4.5V to 5.5V). Both devices are specified over the -40°C to +85°C extended operating temperature range.

## Applications

Notebook Computers  
PDAs  
Smart Phones  
Car Kit Adapters  
Digital Cameras  
Video Tape Recorders

## Features

- ◆ PC2001 Compliant
- ◆ 100dB at 217Hz Power-Supply Rejection Ratio
- ◆ Very Low 230µA Quiescent Current
- ◆ Low 0.015% THD+N
- ◆ Available in Two Versions
  - MAX9812L/MAX9813L—2.7V to 3.6V
  - MAX9812H/MAX9813H—4.5V to 5.5V
- ◆ Internal Low-Noise Microphone Bias Supply
  - 2.3V for MAX9812L/MAX9813L
  - 4.0V for MAX9812H/MAX9813H
- ◆ 100nA Low-Power Shutdown Mode
- ◆ Rail-to-Rail Outputs
- ◆ 20dB Fixed Gain
- ◆ Available in Tiny 6-Pin SC70 (2mm x 2.1mm) and 8-Pin SOT23 (3mm x 3mm) Packages
- ◆ Extended Temperature Range -40°C to +85°C

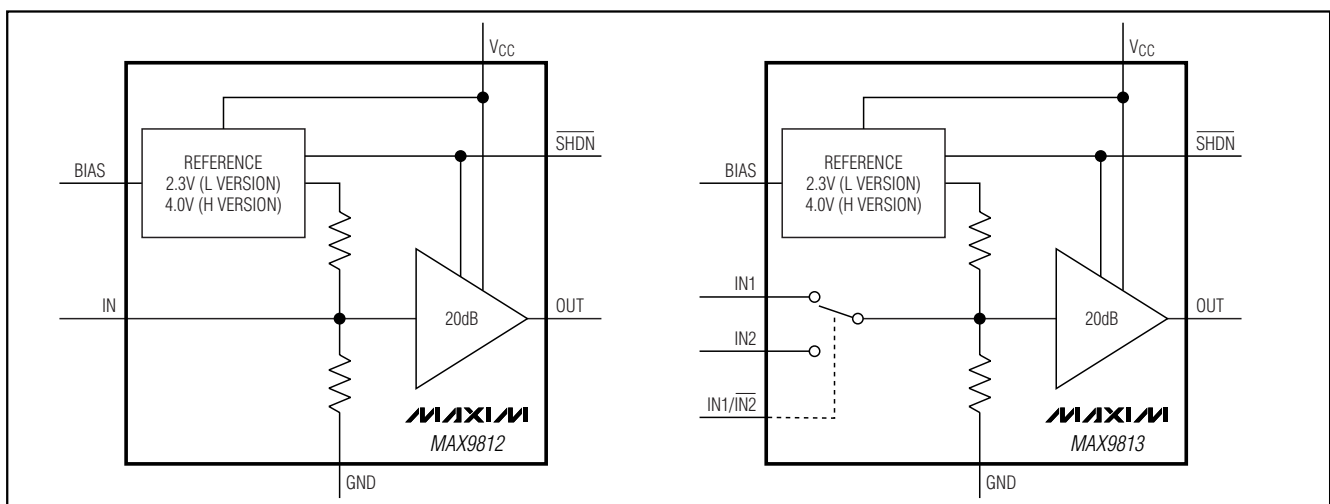
## Ordering Information

| PART          | TEMP RANGE     | PIN-PACKAGE | V <sub>CC</sub> (V) |
|---------------|----------------|-------------|---------------------|
| MAX9812LEXT-T | -40°C to +85°C | 6 SC70-6    | 2.7 to 3.6          |
| MAX9812HEXT-T | -40°C to +85°C | 6 SC70-6    | 4.5 to 5.5          |
| MAX9813LEKA-T | -40°C to +85°C | 8 SOT23-8   | 2.7 to 3.6          |
| MAX9813HEKA-T | -40°C to +85°C | 8 SOT23-8   | 4.5 to 5.5          |

*Pin Configurations, Selector Guide, and Typical Operating Circuits appear at end of data sheet.*

*Rail-to-Rail is a trademark of Nippon Motorola Ltd.*

## Simplified Block Diagrams



# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

## ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND)

|   |                                   |
|---|-----------------------------------|
| V <sub>CC</sub> .....   | -0.3V to +6.0V                    |
| All Other Pins .....  | -0.3V to (V <sub>CC</sub> + 0.3V) |
| Continuous Current (I <sub>N</sub> , $\overline{\text{SHDN}}$ , I <sub>N1</sub> , I <sub>N2</sub> , I <sub>N1/IN2</sub> ) ..... | ±20mA                             |
| OUT, BIAS Short-Circuit Duration (to GND or V <sub>CC</sub> ) ...   | Continuous                        |
| Continuous Power Dissipation (T <sub>A</sub> = +70°C)   |                                   |
| 6-Pin SC70 (derate 3.1mW/°C above +70°C) .....  | 245mW                             |
| 8-Pin SOT23 (derate 8.9mW/°C above +70°C) .....   | 714mW                             |

|   |                 |
|---|-----------------|
| Operating Temperature Range .....       | -40°C to +85°C  |
| Storage Temperature Range .....         | -65°C to +150°C |
| Junction Temperature .....              | +150°C          |
| Lead Temperature (soldering, 10s) ..... | +300°C          |

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = 3.3V, I<sub>BIAS</sub> = 500µA (MAX9812L/MAX9813L), V<sub>CC</sub> = 5V, I<sub>BIAS</sub> = 800µA (MAX9812H/MAX9813H), GND = 0V, R<sub>L</sub> = open,  $\overline{\text{SHDN}}$  = V<sub>CC</sub>, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Note 1)

| PARAMETER                        | SYMBOL               | CONDITIONS                                  | MIN                     | TYP                    | MAX  | UNITS |
|----------------------------------|----------------------|---|-------------------------|------------------------|------|-------|
| <b>GENERAL</b>                   |                      |   |                         |                        |      |       |
| Supply Voltage Range             | V <sub>CC</sub>      | MAX9812L/MAX9813L                           | Inferred from PSRR test | 2.7                    | 3.6  | V     |
|                                  |                      | MAX9812H/MAX9813H                           |                         | 4.5                    | 5.5  |       |
| Supply Current                   | I <sub>CC</sub>      | I <sub>BIAS</sub> = 0                       |                         | 230                    | 400  | µA    |
| Shutdown Supply Current          | I <sub>CC_SHDN</sub> | $\overline{\text{SHDN}}$ = GND              |                         | 0.1                    | 1    | µA    |
| Amplifier Output Bias Voltage    | V <sub>OUT_DC</sub>  | MAX9812L/MAX9813L                           | 1.35                    | 1.5                    | 1.65 | V     |
|                                  |                      | MAX9812H/MAX9813H                           | 2.25                    | 2.5                    | 2.75 |       |
| Input Resistance                 | R <sub>IN</sub>      |   |                         | 85                     |      | kΩ    |
| Voltage Gain                     | A <sub>V</sub>       |   | 19                      | 20                     | 21   | dB    |
| Power-Supply Rejection Ratio     | PSRR <sub>OUT</sub>  | Input referred, T <sub>A</sub> = +25°C      | DC                      | 90                     | 100  | dB    |
|                                  |                      |   | f = 217Hz               |                        | 100  |       |
|                                  |                      |   | f = 1kHz                |                        | 100  |       |
|                                  |                      |   | f = 10kHz               |                        | 90   |       |
| Output Voltage Swing             | V <sub>OH</sub>      | R <sub>L</sub> = 10kΩ to V <sub>CC</sub> /2 |                         | V <sub>CC</sub> - 0.1  |      | V     |
|                                  |                      | R <sub>L</sub> = 1kΩ to V <sub>CC</sub> /2  | V <sub>CC</sub> - 0.25V | V <sub>CC</sub> - 0.1V |      |       |
|                                  | V <sub>OL</sub>      | R <sub>L</sub> = 10kΩ to V <sub>CC</sub> /2 |                         | 0.1                    |      |       |
|                                  |                      | R <sub>L</sub> = 1kΩ to V <sub>CC</sub> /2  |                         | 0.1                    | 0.25 |       |
| Output Short-Circuit Current     | I <sub>OUT_SC</sub>  | Sinking or sourcing                         | 3                       | 12                     | 24   | mA    |
| Small-Signal -3dB Bandwidth      | BW                   | V <sub>OUT</sub> = 10mV <sub>P-P</sub>      |                         | 400                    |      | kHz   |
| Output Capacitive-Load Stability | C <sub>L</sub>       | No sustained oscillations                   |                         | 50                     |      | pF    |
| Output Impedance                 | Z <sub>OUT</sub>     | f = 1kHz                                    |                         | 0.5                    |      | Ω     |
| Output Slew Rate                 | SR                   | V <sub>OUT</sub> = 1V step                  |                         | 1                      |      | V/µs  |

# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

MAX9812/MAX9813

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = 3.3V$ ,  $I_{BIAS} = 500\mu A$  (MAX9812L/MAX9813L),  $V_{CC} = 5V$ ,  $I_{BIAS} = 800\mu A$  (MAX9812H/MAX9813H),  $GND = 0V$ ,  $R_L = \text{open}$ ,  $\overline{SHDN} = V_{CC}$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

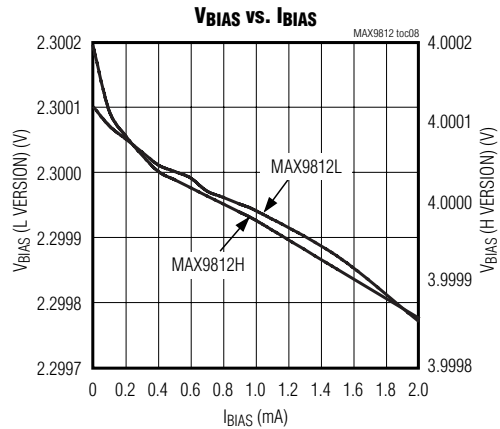
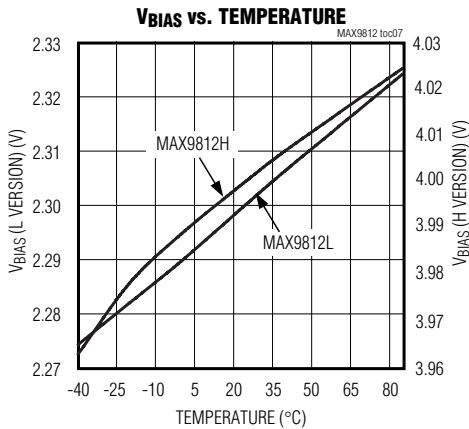
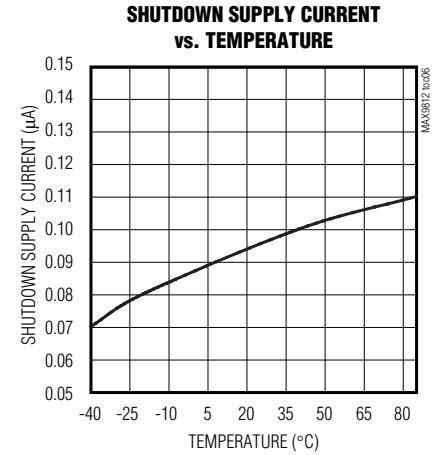
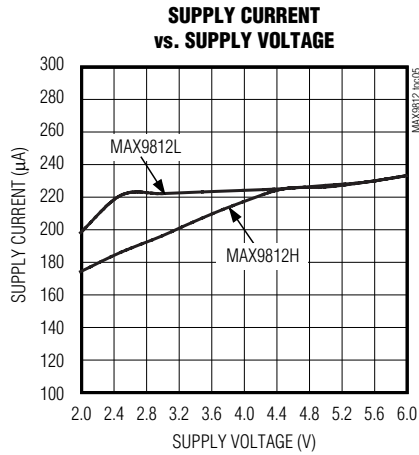
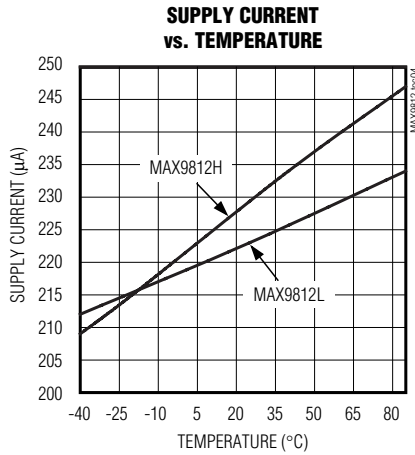
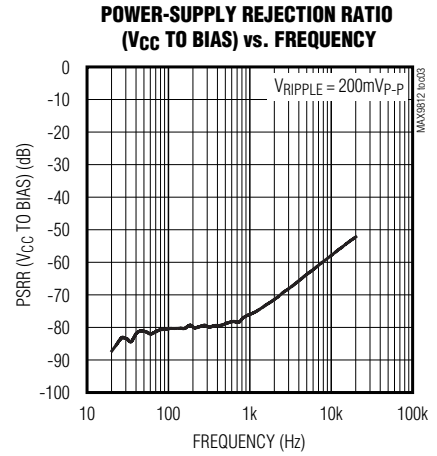
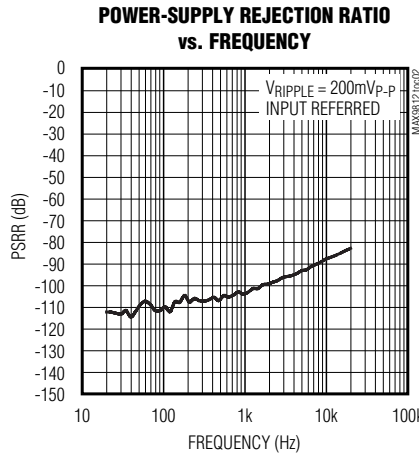
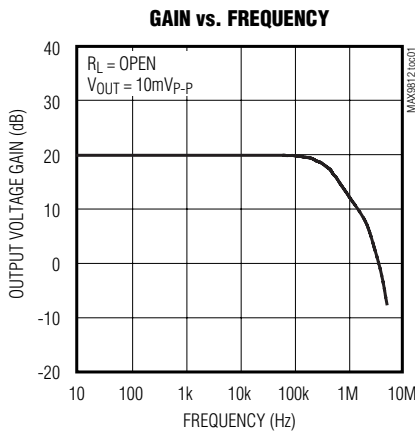
| PARAMETER   | SYMBOL                     | CONDITIONS  |                                  | MIN | TYP   | MAX     | UNITS          |
|---|----------------------------|---|----------------------------------|-----|-------|---------|----------------|
| Amplifier Input Voltage-Noise Density                         | $e_n$                      | Inputs at AC GND  | $f = 1kHz$                       |     | 40    |         | $nV/\sqrt{Hz}$ |
| Total Integrated Input Noise                                  | $V_n$                      | 22Hz to 22kHz BW, inputs at AC GND                                |                                  |     | 5     |         | $\mu V_{RMS}$  |
| Off-Isolation   |                            | Input referred, MAX9813 only                                      | 1kHz                             |     | 75    |         | dB             |
|   |                            |   | 10kHz                            |     | 60    |         |                |
| Total Harmonic Distortion Plus Noise                          | THD+N                      | $f = 1kHz$ , $R_L = 10k\Omega$ to $V_{CC}/2$ , BW = 22Hz to 22kHz | $V_{OUT} = 1V_{P-P}$ (L version) |     | 0.04  |         | %              |
|   |                            |   | $V_{OUT} = 4V_{P-P}$ (H version) |     | 0.015 |         |                |
| <b>BIAS</b>   |                            |   |                                  |     |       |         |                |
| Bias Output Voltage Range                                     | $V_{BIAS}$                 | MAX9812L/MAX9813L   |                                  | 2.1 | 2.30  | 2.55    | V              |
|   |                            | MAX9812H/MAX9813H   |                                  | 3.6 | 4.0   | 4.4     |                |
| Bias Output Resistance  | $R_{BIAS}$                 |   |                                  |     | 0.1   |         | $\Omega$       |
| Power-Supply Rejection Ratio ( $V_{CC}$ to BIAS)              | $PSRR_{BIAS}$              | DC, $T_A = +25^\circ C$   |                                  | 70  | 80    |         | dB             |
|   |                            | $f = 217Hz$   |                                  |     | 80    |         |                |
|   |                            | $f = 1kHz$  |                                  |     | 75    |         |                |
|   |                            | $f = 10kHz$   |                                  |     | 55    |         |                |
| BIAS Current Limit  | $I_{BIAS\_SC}$             | BIAS short to GND   |                                  | 5   | 22    | 50      | mA             |
| BIAS Capacitive-Load Stability                                | $C_{BIAS}$                 | No sustained oscillations   |                                  |     | 50    |         | pF             |
| Total Integrated BIAS Noise                                   | $V_n$                      | 22Hz to 22kHz BW  |                                  |     | 29    |         | $\mu V_{RMS}$  |
| <b>DIGITAL INPUTS (<math>\overline{SHDN}</math>, IN1/IN2)</b> |                            |   |                                  |     |       |         |                |
| Logic-Low Threshold   | $V_{IL}$                   |   |                                  |     |       | 0.8     | V              |
| Logic-High Threshold  | $V_{IH}$                   |   |                                  | 2.0 |       |         | V              |
| Logic Input Current   | $I_{IN}$                   | $\overline{SHDN} = GND$ or $V_{CC}$                               |                                  |     |       | $\pm 1$ | $\mu A$        |
| Shutdown Enable Time  | $t_{\overline{SHDN\_ON}}$  | 95% of settled value  |                                  |     | 10    |         | ms             |
| Shutdown Disable Time   | $t_{\overline{SHDN\_OFF}}$ |   |                                  |     | 50    |         | $\mu s$        |
| IN1/IN2 Select Time   | $t_{SEL}$                  |   |                                  |     | 10    |         | $\mu s$        |

**Note 1:** All specifications are 100% tested at  $T_A = +25^\circ C$ . Temperature limits are guaranteed by design.

# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

## Typical Operating Characteristics

( $V_{CC} = 3.3V$  (MAX9812L/MAX9813L),  $V_{CC} = 5V$  (MAX9812H/MAX9813H),  $GND = 0V$ ,  $R_L = 10k\Omega$  to  $V_{CC}/2$ ,  $\overline{SHDN} = V_{CC}$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

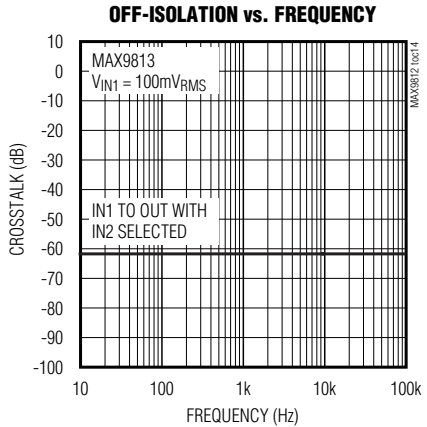
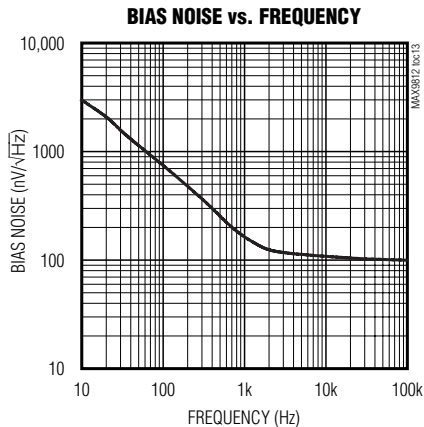
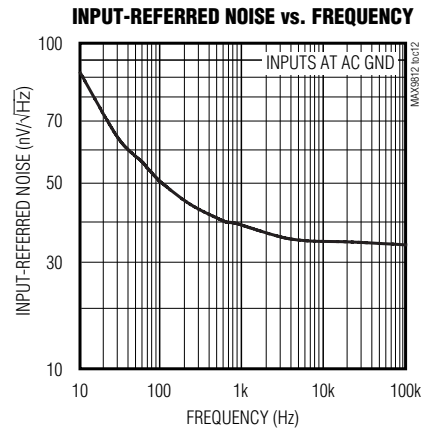
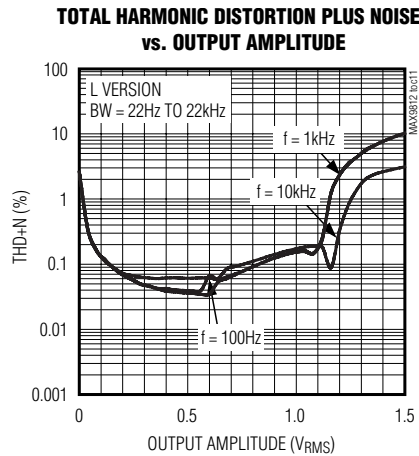
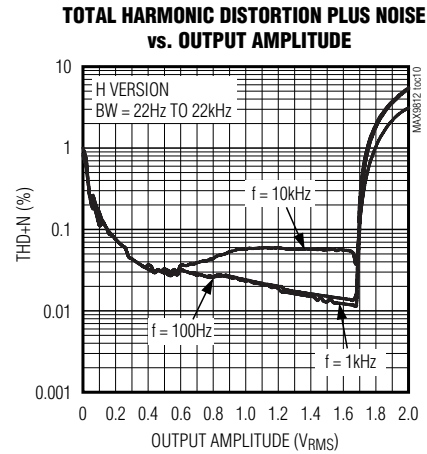
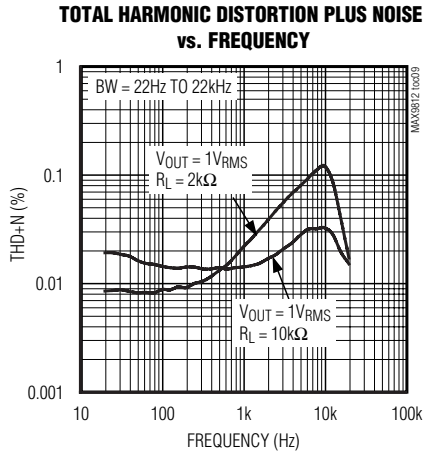


# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

MAX9812/MAX9813

## Typical Operating Characteristics (continued)

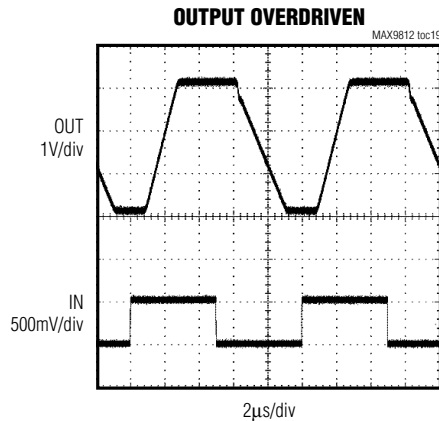
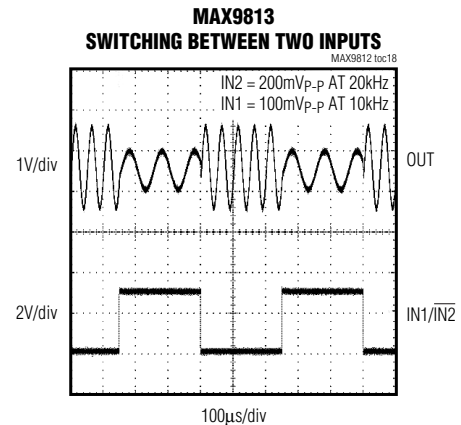
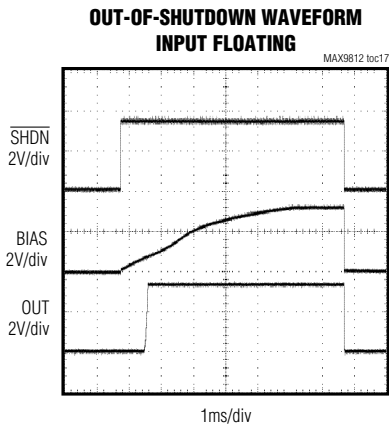
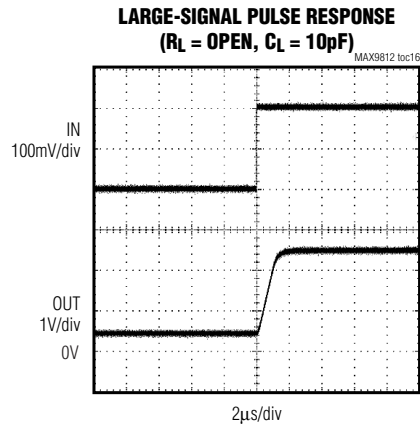
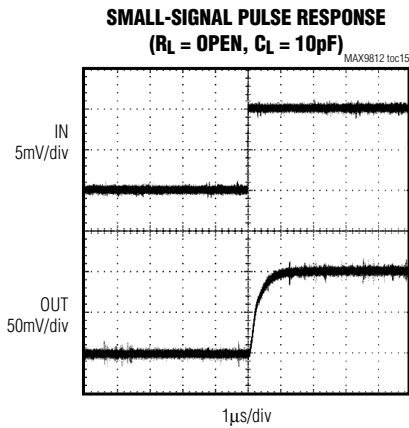
( $V_{CC} = 3.3V$  (MAX9812L/MAX9813L),  $V_{CC} = 5V$  (MAX9812H/MAX9813H),  $GND = 0V$ ,  $R_L = 10k\Omega$  to  $V_{CC}/2$ ,  $\overline{SHDN} = V_{CC}$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

## Typical Operating Characteristics (continued)

( $V_{CC} = 3.3V$  (MAX9812L/MAX9813L),  $V_{CC} = 5V$  (MAX9812H/MAX9813H),  $GND = 0V$ ,  $R_L = 10k\Omega$  to  $V_{CC}/2$ ,  $\overline{SHDN} = V_{CC}$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

MAX9812/MAX9813

## Pin Description

| PIN                   |                       | NAME                         | FUNCTION   |
|-----------------------|-----------------------|------------------------------|--|
| MAX9812L/<br>MAX9812H | MAX9813L/<br>MAX9813H |                              |  |
| 1                     | 3                     | $\overline{\text{SHDN}}$     | Active-Low Shutdown Input. Connect $\overline{\text{SHDN}}$ to $V_{CC}$ for normal operation. Connect $\overline{\text{SHDN}}$ to GND for shutdown. $\overline{\text{SHDN}}$ is a high-impedance input; do not leave floating. |
| 2                     | 2                     | GND                          | Ground   |
| 3                     | 1                     | OUT                          | Amplifier Output   |
| 4                     | 8                     | $V_{CC}$                     | Positive Supply. Bypass $V_{CC}$ to GND with a 0.1 $\mu$ F capacitor.  |
| 5                     | 7                     | BIAS                         | Low-Noise Microphone Bias Output. 2.3V output for MAX9812L/MAX9813L. 4V output for MAX9812H/MAX9813H.  |
| 6                     | —                     | IN                           | Amplifier Input (MAX9812)  |
| —                     | 6                     | IN1                          | Amplifier Input 1 (MAX9813)  |
| —                     | 5                     | IN2                          | Amplifier Input 2 (MAX9813)  |
| —                     | 4                     | IN1/ $\overline{\text{IN2}}$ | Input Selector. When IN1/ $\overline{\text{IN2}}$ is high, IN1 is selected. When IN1/ $\overline{\text{IN2}}$ low, IN2 is selected.  |

## Detailed Description

The MAX9812\_/MAX9813\_ are low-power fixed-gain microphone amplifiers available in a single- or dual-input configuration. The gain is set at 10V/V (20dB) with a 400kHz, -3dB bandwidth. They also feature a low-noise, integrated microphone input bias voltage.

### Single/Dual Input

The MAX9812L/MAX9812H are single-input amplifiers and the MAX9813L/MAX9813H are dual-input amplifiers. All devices typically have an input impedance of 85k $\Omega$ . The inputs to the dual version are controlled through a fast 2:1 mux, selectable through the IN1/ $\overline{\text{IN2}}$  pin. Driving IN1/ $\overline{\text{IN2}}$  high selects IN1 and driving the IN1/ $\overline{\text{IN2}}$  low selects IN2. IN1/ $\overline{\text{IN2}}$  is designed to be driven by a logic high of  $\geq 2\text{V}$  and a logic low  $\leq 0.8\text{V}$ . The IN1/ $\overline{\text{IN2}}$  has a 10 $\mu$ s switching time from one channel to the other.

### PC2001 Low-Noise Microphone BIAS

The MAX9812\_/MAX9813\_ provide a low-noise voltage BIAS designed for biasing electret condenser microphone (ECM) cartridges. The BIAS output is regulated to typically 2.3V for the MAX9812L/MAX9813L and 4V for the MAX9812H/MAX9813H. In the single-input version (MAX9812\_), the BIAS output can source up to 1mA. In the dual-input version (MAX9813\_), the BIAS output can source up to 2mA. The MAX9812H/MAX9813H provides a PC2001-compliant BIAS voltage.

### Output Stage

The MAX9812\_/MAX9813\_ rail-to-rail output (OUT) typically swings to within 100mV of the rails when driving 10k $\Omega$ .

The output DC bias point is set to 1.5V for the MAX9812L/MAX9813L and 2.5V for the MAX9812H/MAX9813H.

### Shutdown Mode

$\overline{\text{SHDN}}$  controls whether the MAX9812\_/MAX9813\_ is active or in shutdown mode. Driving  $\overline{\text{SHDN}}$  low forces a low-power (100nA) shutdown mode. In this mode, the OUT pin is set to a high-impedance state and the BIAS pin is pulled down (70k $\Omega$ ). Driving  $\overline{\text{SHDN}}$  high enables the MAX9812\_/MAX9813\_.  $\overline{\text{SHDN}}$  is a high-impedance input and cannot be left floating.

### Driving Capacitive Loads

The MAX9812\_/MAX9813\_ output can drive up to 50pF of capacitance without sustained oscillations.

### Thermal Shutdown

The thermal shutdown feature protects the MAX9812\_/MAX9813\_ from destruction due to overheating caused by shorting the outputs. This protection feature causes OUT and BIAS to shut down and go high impedance when the die temperature reaches +140°C. The device restarts after the die temperature falls below +120°C.

## Applications Information

### Power-Up

The MAX9812\_/MAX9813\_ output typically settles to 95% within 10ms after power-up.

### Typical Application Circuit

Figure 1 shows the MAX9813H used as a preamplifier with the MAX9760 3W audio power amplifier.

# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

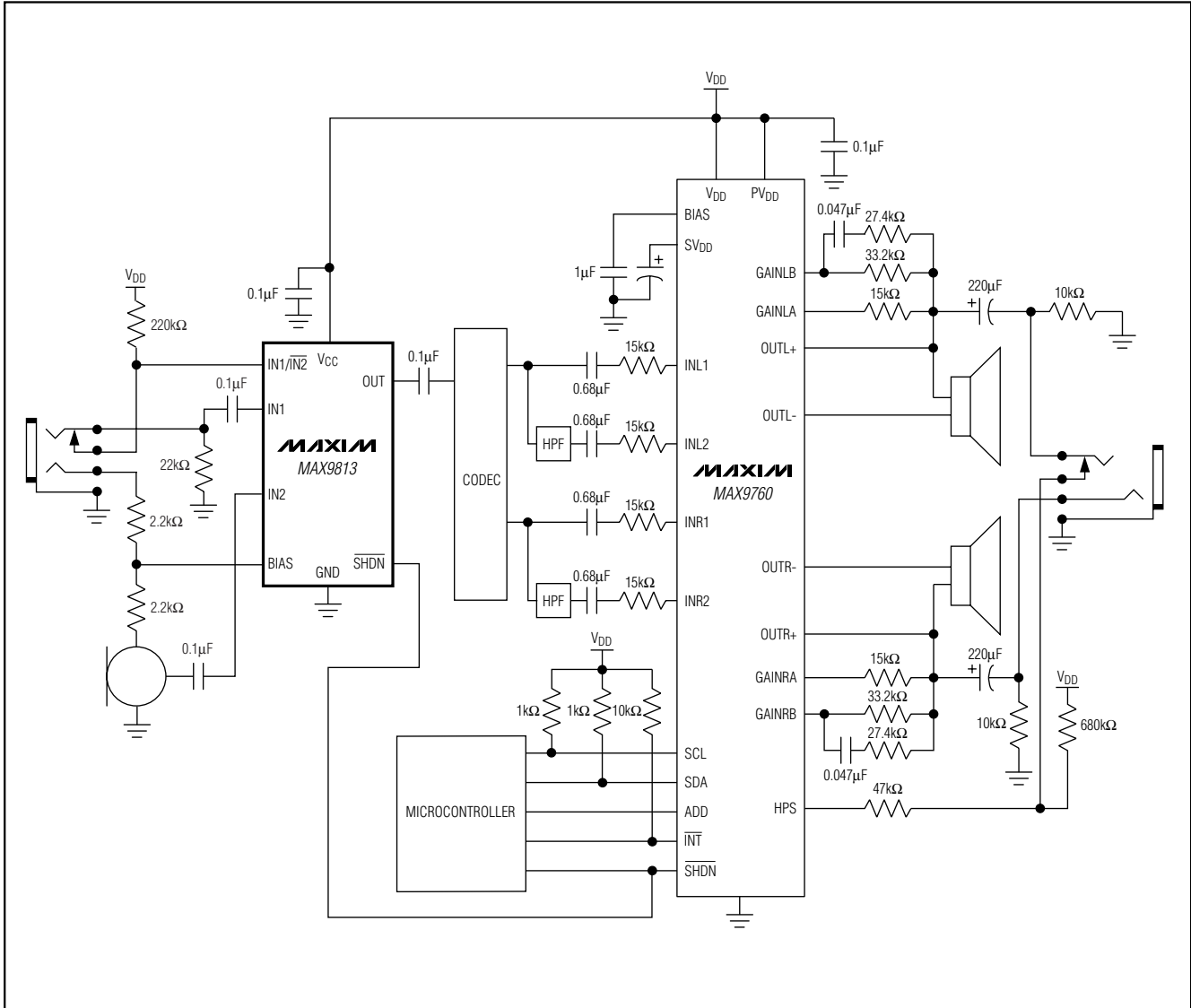


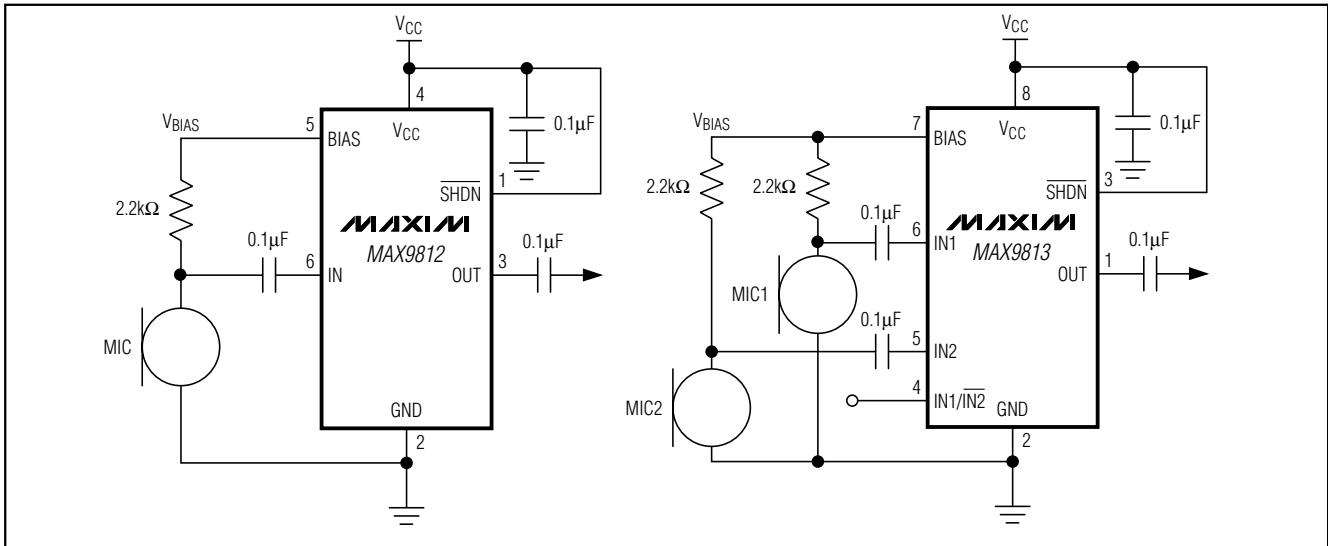
Figure 1. Typical Application Circuit



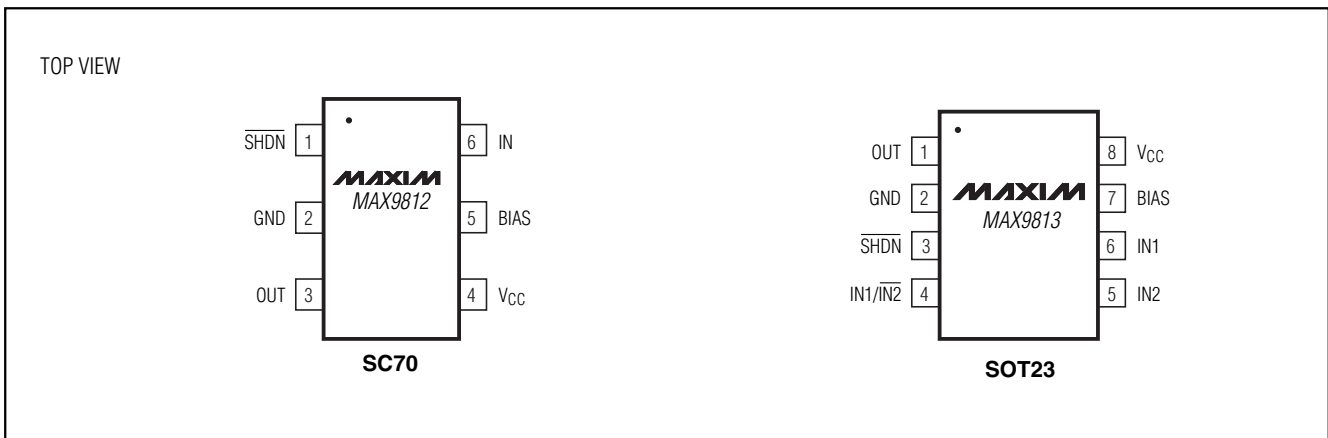
# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

## Typical Operating Circuits

MAX9812/MAX9813



## Pin Configurations



## Selector Guide

| PART          | PIN-PACKAGE | V <sub>CC</sub> (V) | TOP MARK |
|---------------|-------------|---------------------|----------|
| MAX9812LEXT-T | 6 SC70-6    | 2.7 to 3.6          | ABJ      |
| MAX9812HEXT-T | 6 SC70-6    | 4.5 to 5.5          | ABK      |
| MAX9813LEKA-T | 8 SOT23-8   | 2.7 to 3.6          | AEEU     |
| MAX9813HEKA-T | 8 SOT23-8   | 4.5 to 5.5          | AEEV     |

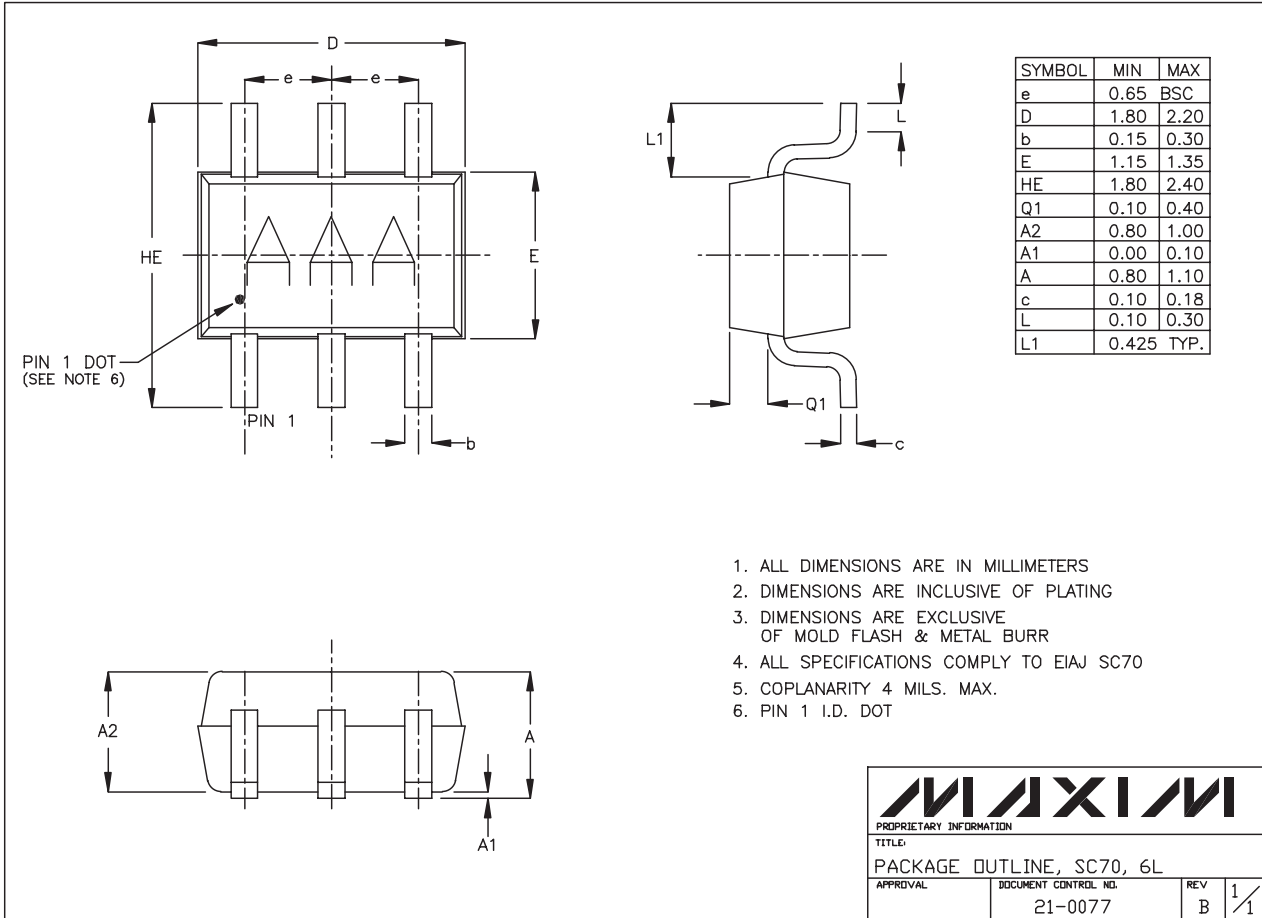
## Chip Information

MAX9812 TRANSISTOR COUNT: 264  
 MAX9813 TRANSISTOR COUNT: 269  
 PROCESS: BiCMOS

# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



1. ALL DIMENSIONS ARE IN MILLIMETERS
2. DIMENSIONS ARE INCLUSIVE OF PLATING
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR
4. ALL SPECIFICATIONS COMPLY TO EIAJ SC70
5. COPLANARITY 4 MILS. MAX.
6. PIN 1 I.D. DOT

|  |                                     |                    |                    |
|--|-------------------------------------|--------------------|--------------------|
| <b>MAXIM</b>                           |                                     |                    |                    |
| <small>PROPRIETARY INFORMATION</small> |                                     |                    |                    |
| <small>TITLE:</small>                  |                                     |                    |                    |
| PACKAGE OUTLINE, SC70, 6L              |                                     |                    |                    |
| <small>APPROVAL</small>                | <small>DOCUMENT CONTROL NO.</small> | <small>REV</small> | <small>1/1</small> |
|  | 21-0077                             | B                  |                    |

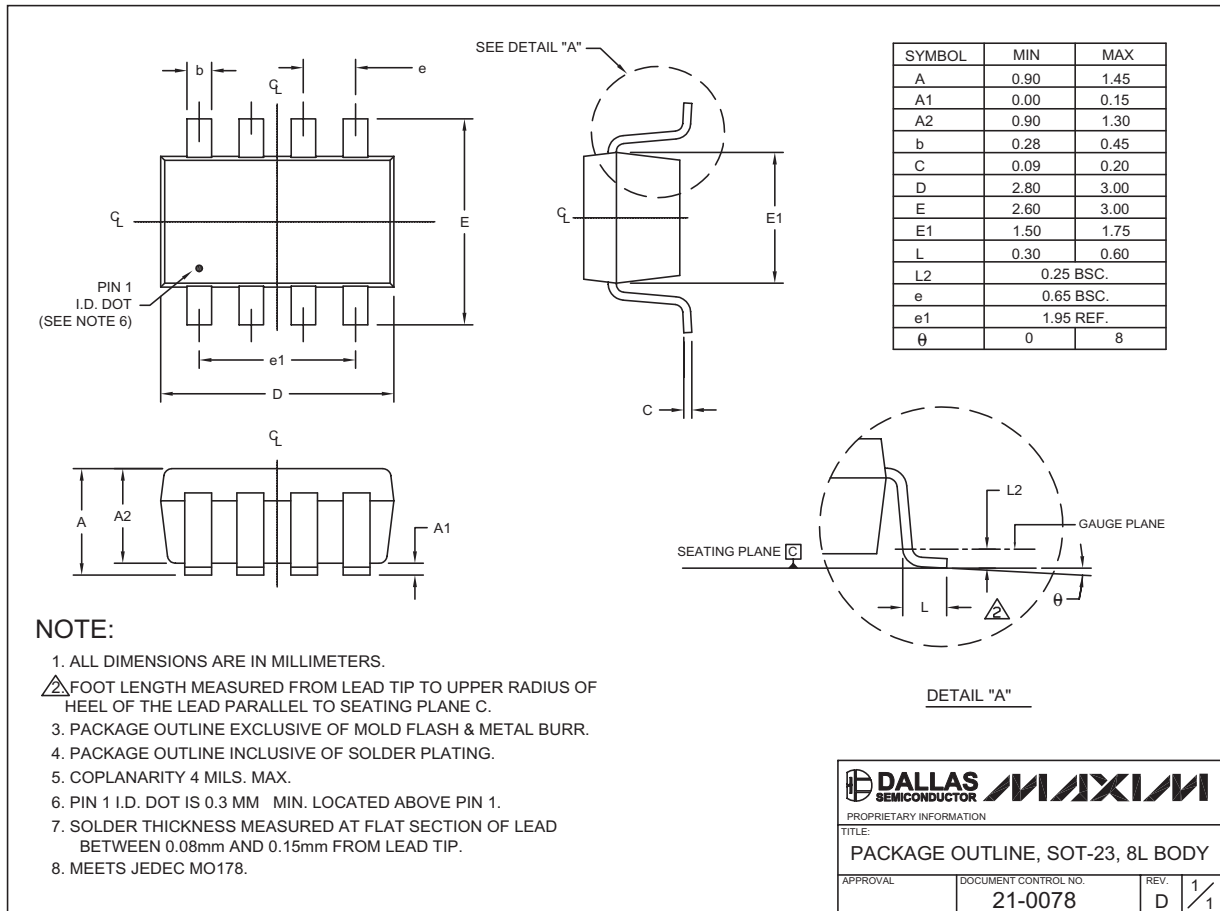
SC70, 6LEFS

# Tiny, Low-Cost, Single/Dual-Input, Fixed-Gain Microphone Amplifiers with Integrated Bias

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

MAX9812/MAX9813



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