



# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## General Description

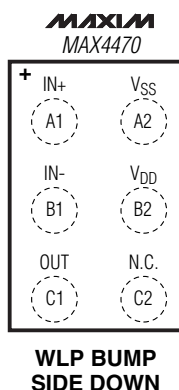
The MAX4464/MAX4470/MAX4471/MAX4472/MAX4474 family of micropower op amps operate from a single +1.8V to +5.5V supply and draw only 750nA of supply current. The MAX4470 family feature ground-sensing inputs and rail-to-rail output. The ultra-low supply current, low-operating voltage, and rail-to-rail output capabilities make these operational amplifiers ideal for use in single lithium ion (Li+), or two-cell NiCd or alkaline battery systems.

The rail-to-rail output stage of the MAX4464/MAX4470/MAX4471/MAX4472/MAX4474 amplifiers is capable of driving the output voltage to within 4mV of the rail with a 100k $\Omega$  load, and can sink and source 11mA with a +5V supply. These amplifiers are available in both fully compensated and decompensated versions. The single MAX4470, dual MAX4471, and the quad MAX4472 are unity-gain stable. The single MAX4464 and the dual MAX4474 are stable for closed-loop gain configurations of  $\geq +5V/V$ . These amplifiers are available in space-saving WLP, SC70, SOT23,  $\mu$ MAX<sup>®</sup>, and TSSOP packages.

## Applications

|                          |                             |
|--------------------------|-----------------------------|
| Battery-Powered Systems  | Electrometer Amplifiers     |
| Portable Instrumentation | Solar-Powered Systems       |
| Pagers and Cellphones    | Remote Sensor Active Badges |
| Micropower Thermostats   | pH Meters                   |

## Pin Configurations



Pin Configurations continued at end of data sheet.

$\mu$ MAX is a registered trademark of Maxim Integrated Products, Inc.

## Features

- ◆ Ultra-Low 750nA Supply Current Per Amplifier
- ◆ Ultra-Low +1.8V Supply Voltage Operation
- ◆ Ground-Sensing Input Common-Mode Range
- ◆ Outputs Swing Rail-to-Rail
- ◆ Outputs Source and Sink 11mA of Load Current
- ◆ No Phase Reversal for Overdriven Inputs
- ◆ High 120dB Open-Loop Voltage Gain
- ◆ Low 500 $\mu$ V Input Offset Voltage
- ◆ 9kHz Gain-Bandwidth Product (MAX4470/MAX4471/MAX4472)
- ◆ 40kHz Gain-Bandwidth Product (MAX4464/MAX4474)
- ◆ 250pF (min) Capacitive Load Capability
- ◆ Available in Tiny, 6-Bump WLP, 5-Pin SC70, and 8-Pin SOT23 Packages

## Ordering Information

| PART         | TEMP RANGE     | PIN-PACKAGE | TOP MARK |
|--------------|----------------|-------------|----------|
| MAX4464EXK+T | -40°C to +85°C | 5 SC70      | +ABT     |
| MAX4464EUK+T | -40°C to +85°C | 5 SOT23     | +ADPI    |
| MAX4470EXK+T | -40°C to +85°C | 5 SC70      | +ABS     |
| MAX4470EUK+T | -40°C to +85°C | 5 SOT23     | +ADPH    |
| MAX4470EWT+  | -40°C to +85°C | 6 WLP       | +BP      |
| MAX4471EKA+T | -40°C to +85°C | 8 SOT23     | +AAEK    |
| MAX4471ESA+  | -40°C to +85°C | 8 SO        | —        |
| MAX4472EUD+  | -40°C to +85°C | 14 TSSOP    | —        |
| MAX4472ESD+  | -40°C to +85°C | 14 SO       | —        |
| MAX4474EKA+T | -40°C to +85°C | 8 SOT23     | +AAEL    |
| MAX4474EUA+  | -40°C to +85°C | 8 $\mu$ MAX | —        |
| MAX4474ESA+  | -40°C to +85°C | 8 SO        | —        |

+Denotes a lead(Pb)-free/RoHS-compliant package.

## Selector Guide

| PART    | NO. OF AMPLIFIERS | GAIN-BANDWIDTH | MINIMUM STABLE GAIN |
|---------|-------------------|----------------|---------------------|
| MAX4464 | 1                 | 40kHz          | 5V/V                |
| MAX4470 | 1                 | 9kHz           | 1V/V                |
| MAX4471 | 2                 | 9kHz           | 1V/V                |
| MAX4472 | 4                 | 9kHz           | 1V/V                |
| MAX4474 | 2                 | 40kHz          | 5V/V                |



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## ABSOLUTE MAXIMUM RATINGS

V<sub>DD</sub> to V<sub>SS</sub> .....-0.3V to +6V  
 IN<sub>+</sub> or IN<sub>-</sub> .....(V<sub>SS</sub> - 0.3V) to (V<sub>DD</sub> + 0.3V)  
 OUT<sub>-</sub> Shorted to V<sub>SS</sub> or V<sub>DD</sub> .....Continuous  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
   5-Pin SC70 (derate 3.1mW/°C above +70°C) .....247mW  
   5-Pin SOT23 (derate 7.1mW/°C above +70°C) .....571mW  
   6-Bump WLP (derate 10.5mW/°C above +70°C) .....840mW  
   8-Pin SOT23 (derate 8.9mW/°C above +70°C) .....714mW  
   8-Pin  $\mu$ MAX (derate 4.5mW/°C above +70°C) .....362mW

8-Pin SO (derate 5.88mW/°C above +70°C) .....471mW  
 14-Pin TSSOP (derate 9.1mW/°C above +70°C) .....727mW  
 14-Pin SO (derate 8.33mW/°C above +70°C) .....667mW  
 Operating Temperature Range .....-40°C to +85°C  
 Junction Temperature .....+150°C  
 Storage Temperature Range .....-65°C to +150°C  
 Lead Temperature (soldering, 10s) .....+300°C  
 Soldering Temperature (reflow) .....+260°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>DD</sub> = +5V, V<sub>SS</sub> = 0V, V<sub>CM</sub> = 0V, V<sub>OUT</sub> = V<sub>DD</sub>/2, R<sub>L</sub> =  $\infty$  to V<sub>DD</sub>/2, T<sub>A</sub> = +25°C, unless otherwise noted.)

| PARAMETER                       | SYMBOL           | CONDITIONS                                                                            | MIN                            | TYP        | MAX                   | UNITS   |
|---------------------------------|------------------|---------------------------------------------------------------------------------------|--------------------------------|------------|-----------------------|---------|
| Supply Voltage Range            | V <sub>DD</sub>  | Guaranteed by PSRR tests                                                              | 1.8                            |            | 5.5                   | V       |
| Supply Current (Per Amplifier)  | I <sub>DD</sub>  | V <sub>DD</sub> = +1.8V                                                               |                                | 0.6        |                       | $\mu$ A |
|                                 |                  | V <sub>DD</sub> = +5.0V                                                               |                                | 0.75       | 1.2                   |         |
| Input Offset Voltage            | V <sub>OS</sub>  |                                                                                       |                                | $\pm 0.5$  | $\pm 7.0$             | mV      |
| Input Bias Current              | I <sub>B</sub>   |                                                                                       |                                | $\pm 200$  | $\pm 1500$            | pA      |
| Input Offset Current            | I <sub>OS</sub>  |                                                                                       |                                | $\pm 12.5$ |                       | pA      |
| Input Common-Mode Voltage Range | V <sub>CM</sub>  | Guaranteed by the CMRR test                                                           | V <sub>SS</sub>                |            | V <sub>DD</sub> - 1.1 | V       |
| Common-Mode Rejection Ratio     | CMRR             | Specified with V <sub>SS</sub> $\leq$ V <sub>CM</sub> $\leq$ (V <sub>DD</sub> - 1.1V) | 70                             | 95         |                       | dB      |
| Power-Supply Rejection Ratio    | PSRR             | +1.8V $\leq$ V <sub>DD</sub> $\leq$ +5.5V                                             | 70                             | 90         |                       | dB      |
| Large-Signal Voltage Gain       | A <sub>VOL</sub> | R <sub>L</sub> = 1M $\Omega$ , V <sub>OUT</sub> = 50mV to V <sub>DD</sub> - 50mV      | 90                             | 120        |                       | dB      |
|                                 |                  | R <sub>L</sub> = 100k $\Omega$ , V <sub>OUT</sub> = 200mV to V <sub>DD</sub> - 200mV  | 90                             | 112        |                       |         |
|                                 |                  | R <sub>L</sub> = 10k $\Omega$ , V <sub>OUT</sub> = 200mV to V <sub>DD</sub> - 200mV   |                                | 100        |                       |         |
| Output Voltage Swing            | V <sub>OH</sub>  | Swing high specified as V <sub>DD</sub> - V <sub>OH</sub>                             | R <sub>L</sub> = 1M $\Omega$   | 1          | 4                     | mV      |
|                                 |                  |                                                                                       | R <sub>L</sub> = 100k $\Omega$ | 4          | 10                    |         |
|                                 |                  |                                                                                       | R <sub>L</sub> = 10k $\Omega$  | 40         |                       |         |
|                                 | V <sub>OL</sub>  | Swing low specified as V <sub>OL</sub> - V <sub>SS</sub>                              | R <sub>L</sub> = 1M $\Omega$   | 0.5        | 5                     |         |
|                                 |                  |                                                                                       | R <sub>L</sub> = 100k $\Omega$ | 1          | 5                     |         |
|                                 |                  |                                                                                       | R <sub>L</sub> = 10k $\Omega$  | 10         |                       |         |
| Gain-Bandwidth Product          | GBW              | MAX4470/MAX4471/MAX4472                                                               |                                | 9          |                       | kHz     |
|                                 |                  | MAX4464/MAX4474                                                                       |                                | 40         |                       |         |
| Phase Margin                    | $\phi_M$         | MAX4470/MAX4471/MAX4472                                                               |                                | 90         |                       | degrees |
|                                 |                  | MAX4464/MAX4474                                                                       |                                | 80         |                       |         |

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## ELECTRICAL CHARACTERISTICS (continued)

( $V_{DD} = +5V$ ,  $V_{SS} = 0V$ ,  $V_{CM} = 0V$ ,  $V_{OUT} = V_{DD}/2$ ,  $R_L = \infty$  to  $V_{DD}/2$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

| PARAMETER                    | SYMBOL     | CONDITIONS                     |                         | MIN | TYP | MAX | UNITS          |
|------------------------------|------------|--------------------------------|-------------------------|-----|-----|-----|----------------|
| Slew Rate                    | SR         | $V_{OUT} = 4V$ step            | MAX4470/MAX4471/MAX4472 |     | 2   |     | V/ms           |
|                              |            |                                | MAX4464/MAX4474         |     | 20  |     |                |
| Input Voltage Noise          | $e_n$      | $f = 1kHz$                     |                         |     | 150 |     | $nV/\sqrt{Hz}$ |
|                              |            | $f = 10kHz$                    |                         |     | 120 |     |                |
| Output Short-Circuit Current |            | Shorted to $V_{SS}$ (sourcing) |                         |     | 11  |     | mA             |
|                              |            | Shorted to $V_{DD}$ (sinking)  |                         |     | 36  |     |                |
| Power-On Time                | $t_{ON}$   |                                |                         |     | 3   |     | ms             |
| Power-Off Time               | $t_{OFF}$  |                                |                         |     | 2   |     | $\mu s$        |
| Capacitive Load              | $C_{LOAD}$ | No sustained oscillations      |                         | 250 |     |     | pF             |

## ELECTRICAL CHARACTERISTICS

( $V_{DD} = +5V$ ,  $V_{SS} = 0V$ ,  $V_{CM} = 0V$ ,  $V_{OUT} = V_{DD}/2$ ,  $R_L = \infty$  to  $V_{DD}/2$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.) (Note 1)

| PARAMETER                                    | SYMBOL     | CONDITIONS                                                             |                    | MIN      | TYP | MAX            | UNITS            |
|----------------------------------------------|------------|------------------------------------------------------------------------|--------------------|----------|-----|----------------|------------------|
| Supply Voltage Range                         | $V_{DD}$   | Guaranteed by PSRR tests                                               |                    | 1.8      |     | 5.5            | V                |
| Supply Current (Per Amplifier)               | $I_{DD}$   | $V_{DD} = +5.0V$                                                       |                    |          |     | 1.5            | $\mu A$          |
| Input Offset Voltage                         | $V_{OS}$   |                                                                        |                    |          |     | $\pm 15$       | mV               |
| Input Offset Voltage Temperature Coefficient | $TCV_{OS}$ |                                                                        |                    |          | 8   |                | $\mu V/^\circ C$ |
| Input Bias Current                           | $I_B$      |                                                                        |                    |          |     | 4.25           | nA               |
| Input Common-Mode Voltage Range              | $V_{CM}$   | Guaranteed by the CMRR test                                            |                    | $V_{SS}$ |     | $V_{DD} - 1.1$ | V                |
| Common-Mode Rejection Ratio                  | CMRR       | $V_{SS} \leq V_{CM} \leq (V_{DD} - 1.1V)$                              |                    | 56       |     |                | dB               |
| Power-Supply Rejection Ratio                 | PSRR       | $+1.8V \leq V_{DD} \leq +5.5V$ , $0^\circ C \leq T_A \leq +85^\circ C$ |                    | 65       |     |                | dB               |
|                                              |            | $+2V \leq V_{DD} \leq +5.5V$ , $-40^\circ C \leq T_A \leq +85^\circ C$ |                    | 65       |     |                |                  |
| Large-Signal Voltage Gain                    | $A_{VOL}$  | $V_{OUT} = 50mV$ to $V_{DD} - 50mV$ , $R_L = 1M\Omega$                 |                    | 75       |     |                | dB               |
|                                              |            | $V_{OUT} = 200mV$ to $V_{DD} - 200mV$ , $R_L = 100k\Omega$             |                    | 75       |     |                |                  |
| Output Voltage Swing                         | $V_{OH}$   | Swing high specified as $V_{DD} - V_{OH}$                              | $R_L = 1M\Omega$   |          |     | 5              | mV               |
|                                              |            |                                                                        | $R_L = 100k\Omega$ |          |     | 15             |                  |
|                                              | $V_{OL}$   | Swing low specified as $V_{OL} - V_{SS}$                               | $R_L = 1M\Omega$   |          |     | 5              |                  |
|                                              |            |                                                                        | $R_L = 100k\Omega$ |          |     | 5              |                  |

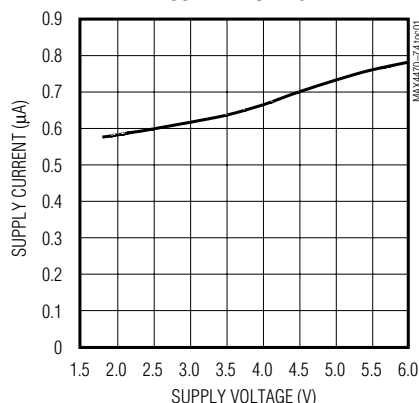
**Note 1:** All devices are production tested at  $T_A = +25^\circ C$ . All temperature limits are guaranteed by design.

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

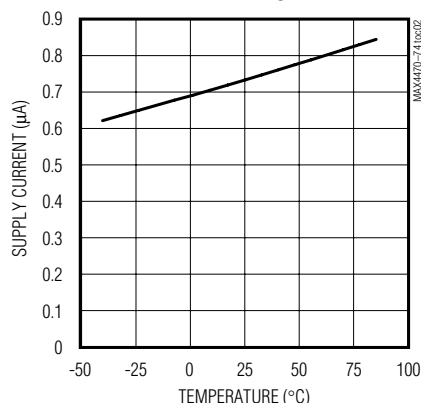
## Typical Operating Characteristics

( $V_{DD} = +5V$ ,  $V_{SS} = 0V$ ,  $V_{CM} = 0V$ ,  $R_L = 100k\Omega$  to  $V_{DD}/2$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

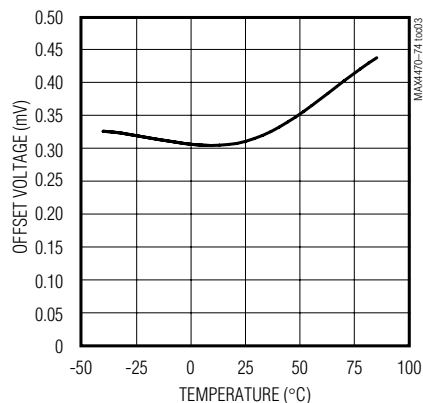
**SUPPLY CURRENT PER AMPLIFIER vs. SUPPLY VOLTAGE**



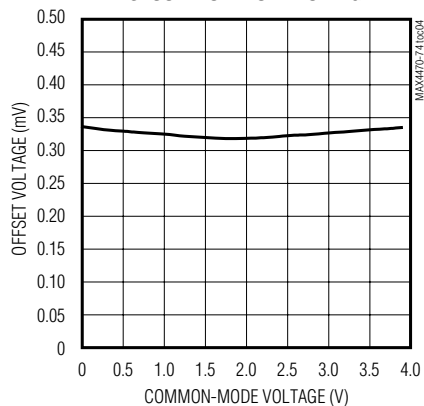
**SUPPLY CURRENT PER AMPLIFIER vs. TEMPERATURE**



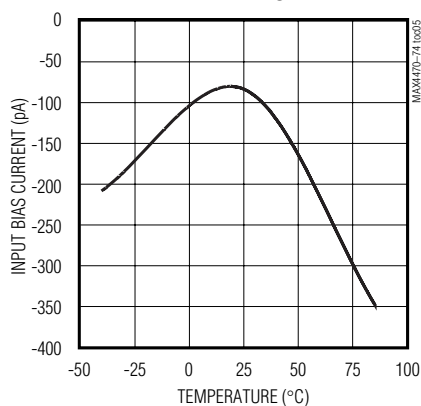
**OFFSET VOLTAGE vs. TEMPERATURE**



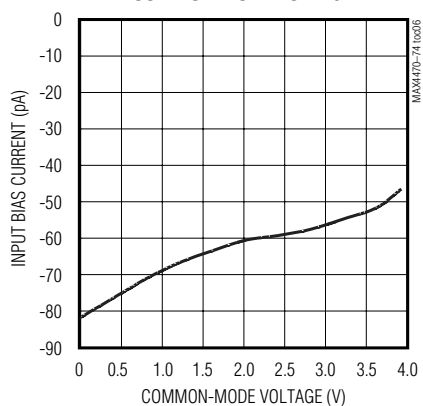
**OFFSET VOLTAGE vs. COMMON-MODE VOLTAGE**



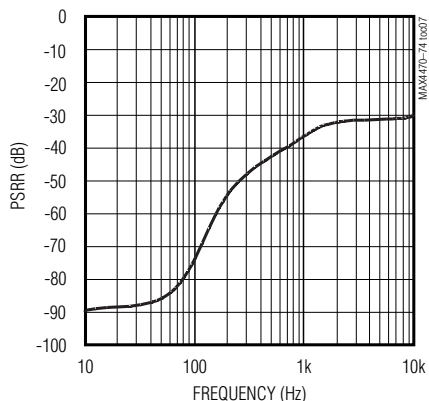
**INPUT BIAS CURRENT vs. TEMPERATURE**



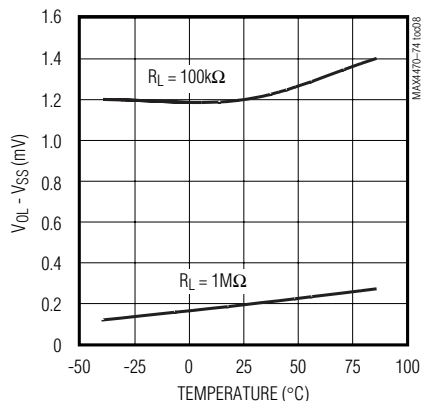
**INPUT BIAS CURRENT vs. COMMON-MODE VOLTAGE**



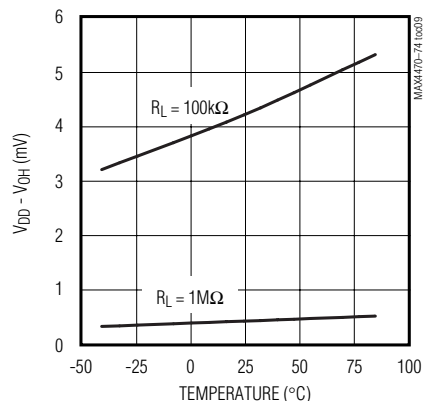
**POWER-SUPPLY REJECTION RATIO vs. FREQUENCY**



**OUTPUT VOLTAGE SWING LOW vs. TEMPERATURE**



**OUTPUT VOLTAGE SWING HIGH vs. TEMPERATURE**



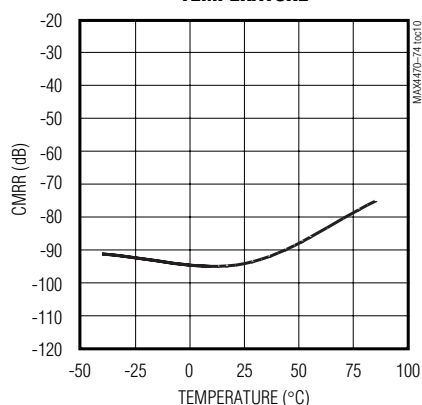
# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Typical Operating Characteristics (continued)

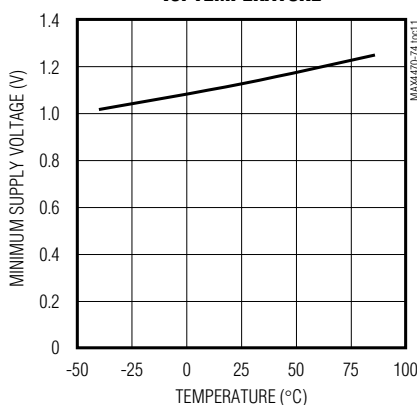
( $V_{DD} = +5V$ ,  $V_{SS} = 0V$ ,  $V_{CM} = 0V$ ,  $R_L = 100k\Omega$  to  $V_{DD}/2$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

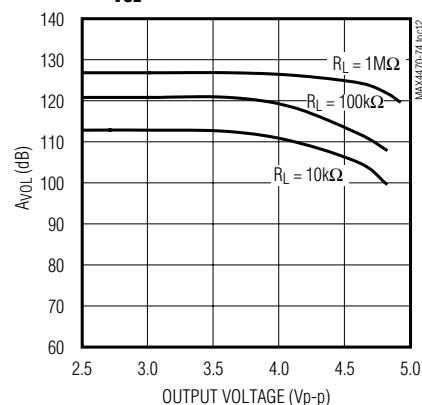
**COMMON-MODE REJECTION RATIO vs. TEMPERATURE**



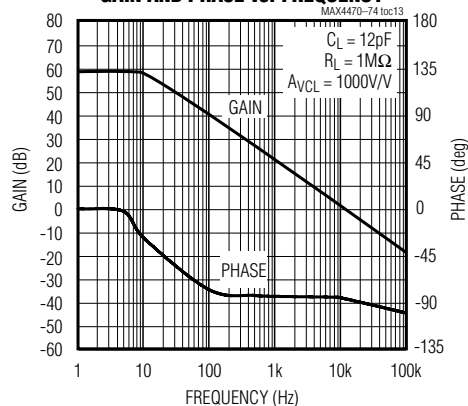
**MINIMUM SUPPLY VOLTAGE vs. TEMPERATURE**



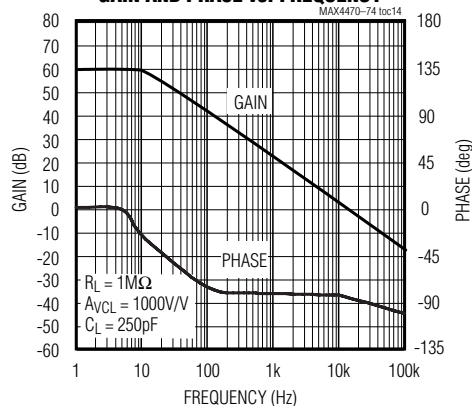
**$A_{VOL}$  vs. OUTPUT VOLTAGE SWING**



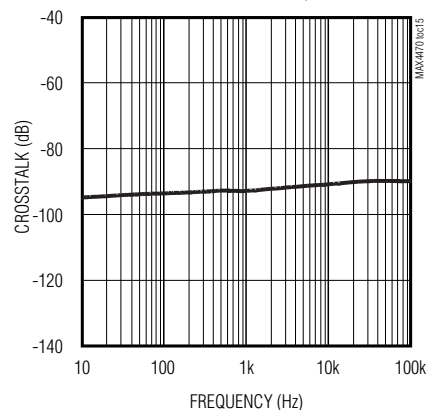
**MAX4470/MAX4471/MAX4472  
GAIN AND PHASE vs. FREQUENCY**



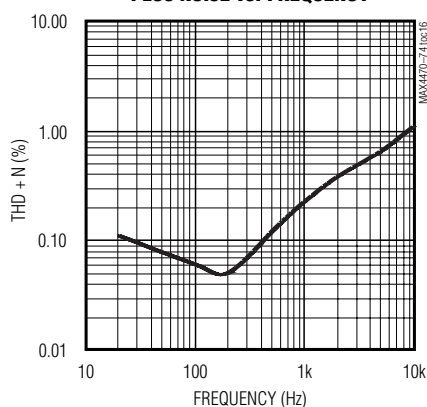
**MAX4470/MAX4471/MAX4472  
GAIN AND PHASE vs. FREQUENCY**



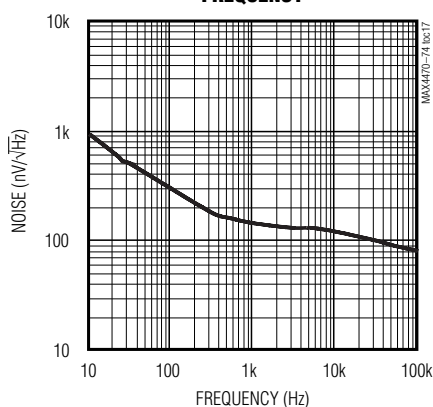
**CROSSTALK vs. FREQUENCY**



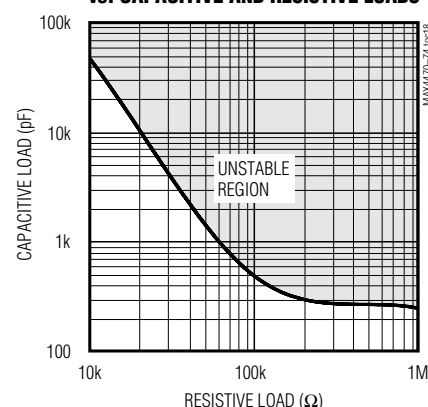
**MAX4470/MAX4471/MAX4472  
TOTAL HARMONIC DISTORTION  
PLUS NOISE vs. FREQUENCY**



**VOLTAGE NOISE DENSITY vs. FREQUENCY**



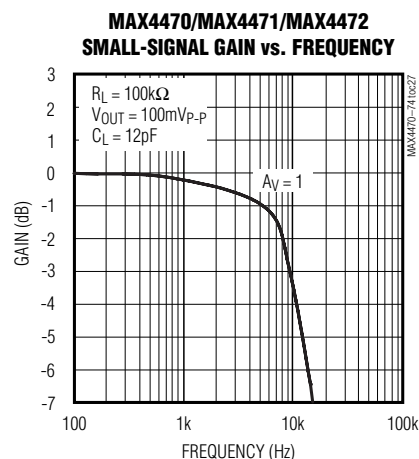
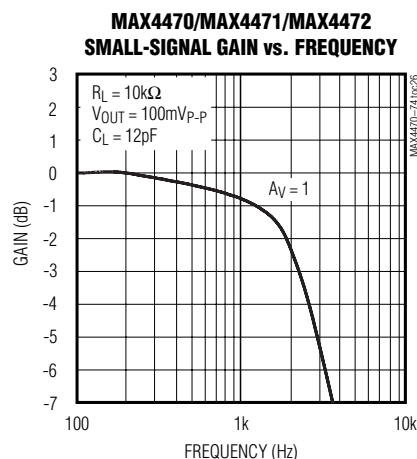
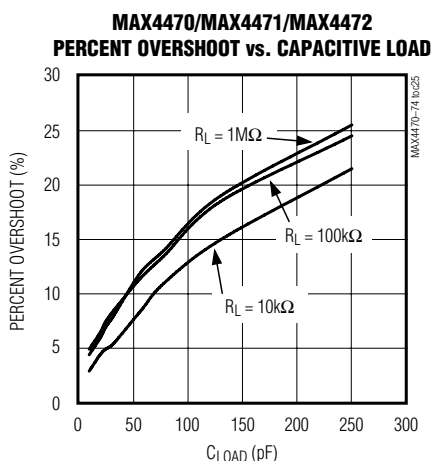
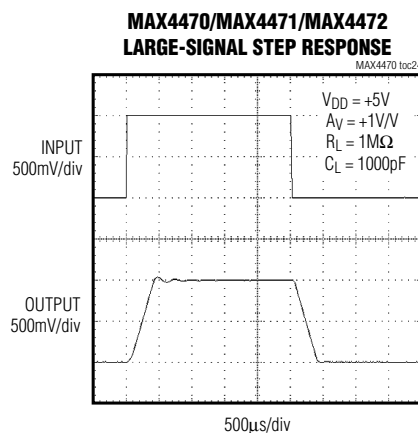
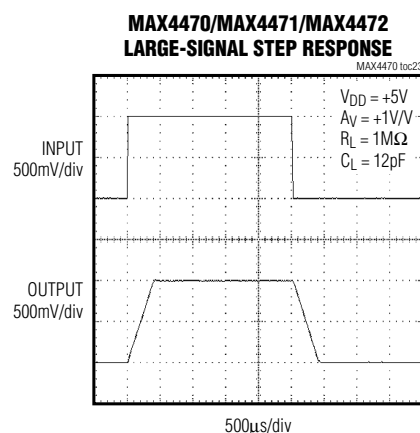
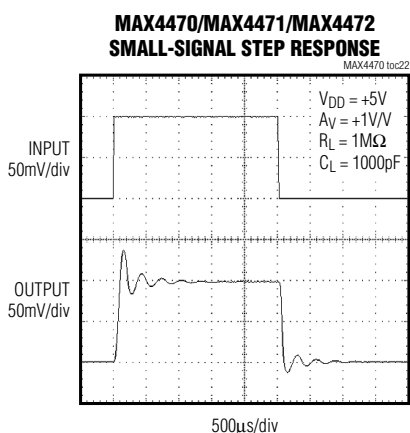
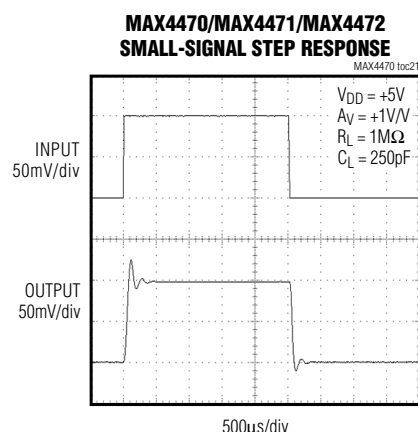
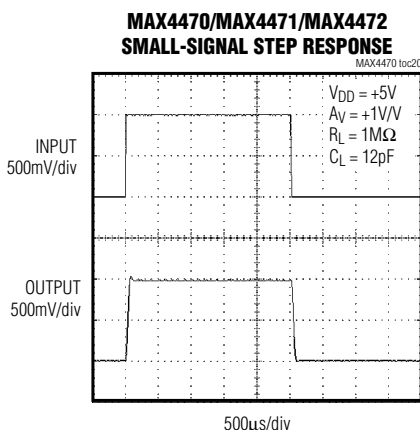
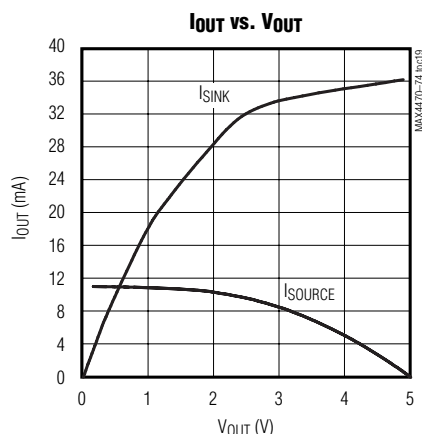
**MAX4470/MAX4471/MAX4472 STABILITY  
vs. CAPACITIVE AND RESISTIVE LOADS**



# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Typical Operating Characteristics (continued)

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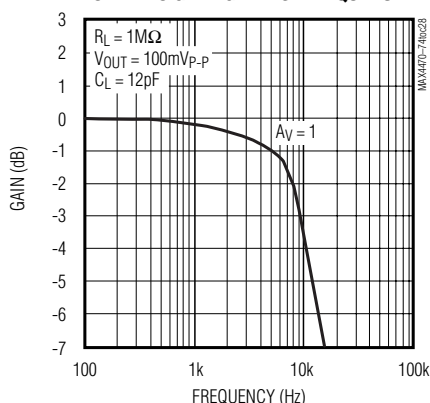


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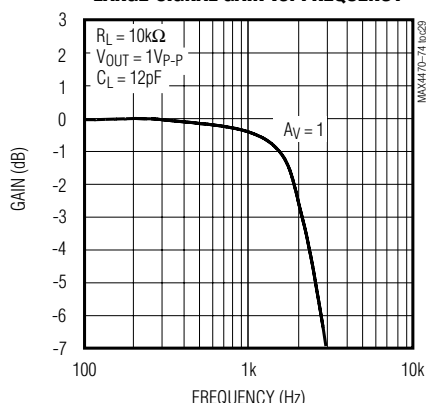
## Typical Operating Characteristics (continued)

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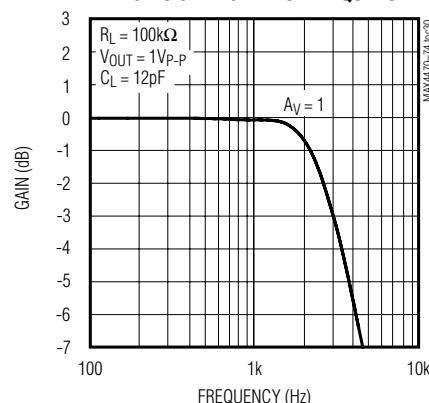
**MAX4470/MAX4471/MAX4472  
SMALL-SIGNAL GAIN vs. FREQUENCY**



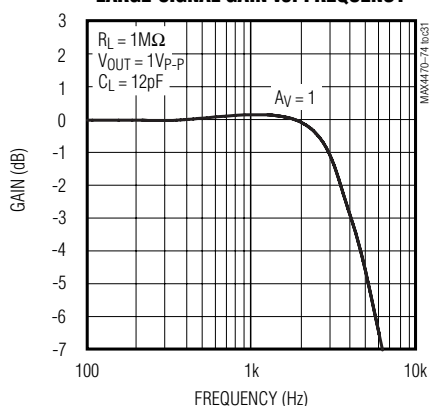
**MAX4470/MAX4471/MAX4472  
LARGE-SIGNAL GAIN vs. FREQUENCY**



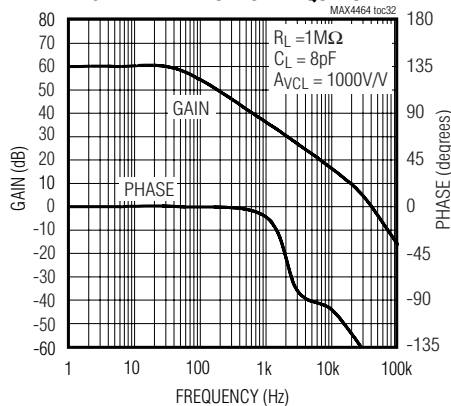
**MAX4470/MAX4471/MAX4472  
LARGE-SIGNAL GAIN vs. FREQUENCY**



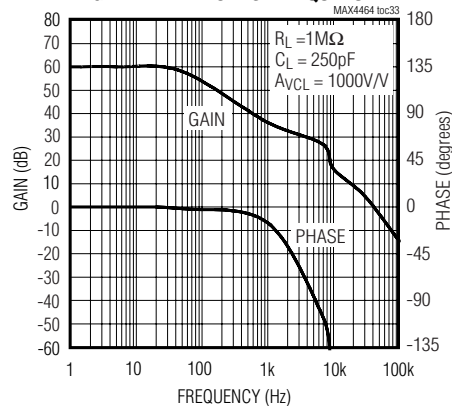
**MAX4470/MAX4471/MAX4472  
LARGE-SIGNAL GAIN vs. FREQUENCY**



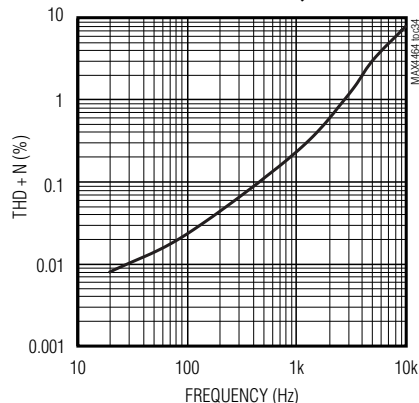
**MAX4464/MAX4474  
GAIN AND PHASE vs. FREQUENCY**



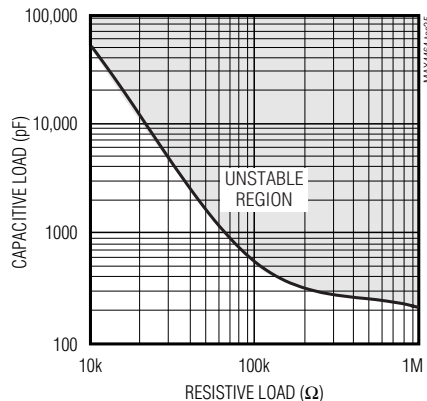
**MAX4464/MAX4474  
GAIN AND PHASE vs. FREQUENCY**



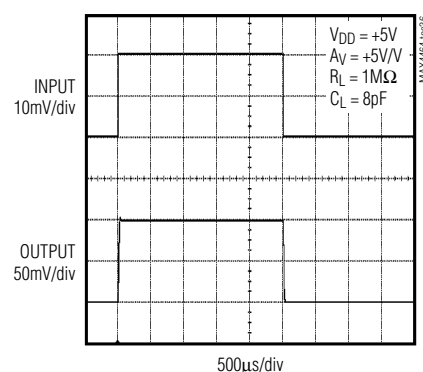
**MAX4464/MAX4474  
TOTAL HARMONIC DISTORTION  
PLUS NOISE vs. FREQUENCY**



**MAX4464/MAX4474  
STABILITY vs. CAPACITIVE  
AND RESISTIVE LOADS**



**MAX4464/MAX4474  
SMALL-SIGNAL STEP RESPONSE**



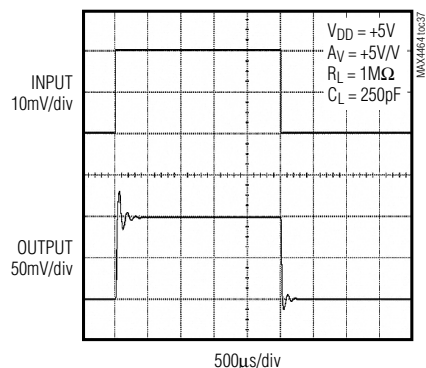
MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

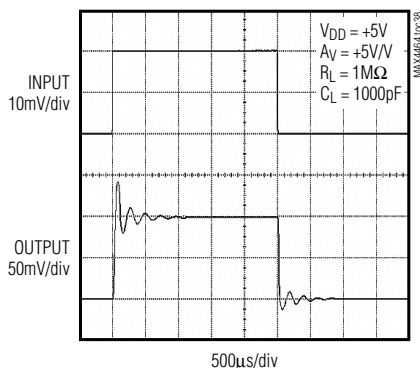
## Typical Operating Characteristics (continued)

( $V_{DD} = +5V$ ,  $V_{SS} = 0V$ ,  $V_{CM} = 0V$ ,  $R_L = 100k\Omega$  to  $V_{DD}/2$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

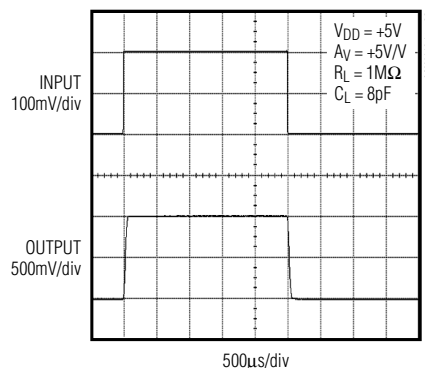
**MAX4464/MAX4474  
SMALL-SIGNAL STEP RESPONSE**



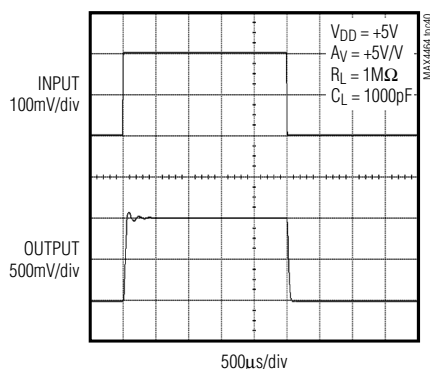
**MAX4464/MAX4474  
SMALL-SIGNAL STEP RESPONSE**



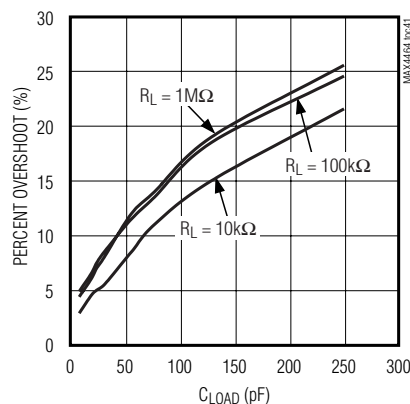
**MAX4464/MAX4474  
LARGE-SIGNAL STEP RESPONSE**



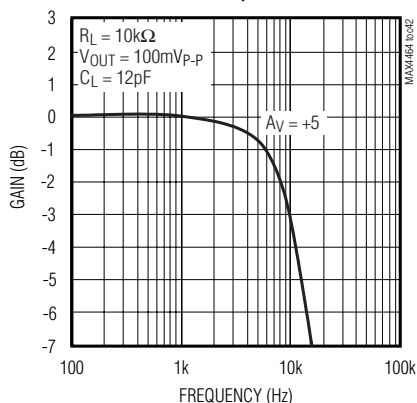
**MAX4464/MAX4474  
LARGE-SIGNAL STEP RESPONSE**



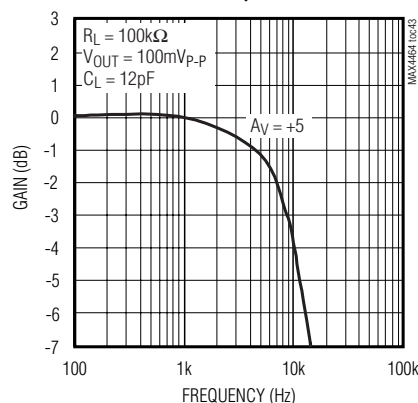
**MAX4464/MAX4474  
PERCENT OVERSHOOT vs. CAPACITIVE LOAD**



**MAX4464/MAX4474  
SMALL-SIGNAL NORMALIZED GAIN  
vs. FREQUENCY**



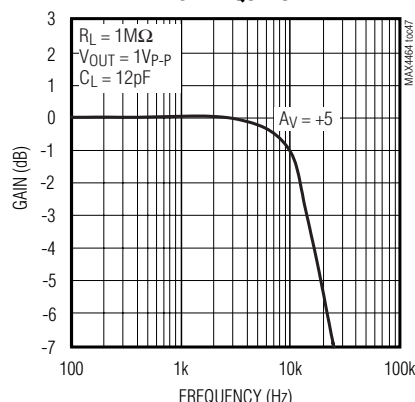
**MAX4464/MAX4474  
SMALL-SIGNAL NORMALIZED GAIN  
vs. FREQUENCY**



**MAX4464/MAX4470/MAX4471/MAX4472/MAX4474**

( $V_{DD} = +5V$ ,  $V_{SS} = 0V$ ,  $V_{CM} = 0V$ ,  $R_L = 100k\Omega$  to  $V_{DD}/2$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

**MAX4464/MAX4474  
LARGE-SIGNAL NORMALIZED GAIN  
vs. FREQUENCY**



| PIN                 |                  |                     |         | NAME | FUNCTION                                 |
|---------------------|------------------|---------------------|---------|------|------------------------------------------|
| MAX4464/<br>MAX4470 | MAX4470<br>(WLP) | MAX4471/<br>MAX4474 | MAX4472 |      |                                          |
| 1                   | A1               | —                   | —       | IN+  | Noninverting Amplifier Input             |
| —                   | —                | 3                   | 3       | INA+ | Noninverting Amplifier Input (Channel A) |
| 2                   | A2               | 4                   | 11      | VSS  | Negative Power-Supply Voltage            |
| 3                   | B1               | —                   | —       | IN-  | Inverting Amplifier Input                |
| 4                   | C1               | —                   | —       | OUT  | Amplifier Output                         |
| —                   | —                | 2                   | 2       | INA- | Inverting Amplifier Input (Channel A)    |

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Pin Description (continued)

| PIN                 |                  |                     |         | NAME            | FUNCTION                                 |
|---------------------|------------------|---------------------|---------|-----------------|------------------------------------------|
| MAX4464/<br>MAX4470 | MAX4470<br>(WLP) | MAX4471/<br>MAX4474 | MAX4472 |                 |                                          |
| —                   | —                | 1                   | 1       | OUTA            | Amplifier Output (Channel A)             |
| —                   | —                | 6                   | 6       | INB-            | Inverting Amplifier Input (Channel B)    |
| —                   | —                | 5                   | 5       | INB+            | Noninverting Amplifier Input (Channel B) |
| —                   | —                | 7                   | 7       | OUTB            | Amplifier Output (Channel B)             |
| —                   | —                | —                   | 9       | INC-            | Inverting Amplifier Input (Channel C)    |
| —                   | —                | —                   | 10      | INC+            | Noninverting Amplifier Input (Channel C) |
| —                   | —                | —                   | 8       | OUTC            | Amplifier Output (Channel C)             |
| —                   | —                | —                   | 13      | IND-            | Inverting Amplifier Input (Channel D)    |
| —                   | —                | —                   | 12      | IND+            | Noninverting Amplifier Input (Channel D) |
| —                   | —                | —                   | 14      | OUTD            | Amplifier Output (Channel D)             |
| 5                   | B2               | 8                   | 4       | V <sub>DD</sub> | Positive Power-Supply Voltage            |
| —                   | C2               | —                   | —       | N.C.            | No Connection. Not internally connected. |

## Applications Information

### Ground Sensing

The common-mode input range of the MAX4470 family extends down to ground, and offers excellent common-mode rejection. These devices are guaranteed not to undergo phase reversal when the input is overdriven.

### Power Supplies and Layout

The MAX4470 family operates from a single +1.8V to +5.5V power supply. Bypass power supplies with a 0.1μF ceramic capacitor placed close to the V<sub>DD</sub> pin.

Ground layout improves performance by decreasing the amount of stray capacitance and noise at the op amp's inputs and outputs. To decrease stray capacitance, minimize PC board lengths and resistor leads, and place external components close to the op amps' pins.

### Bandwidth

The MAX4470/MAX4471/MAX4472 are internally compensated for unity-gain stability and have a typical gain-bandwidth of 9kHz. The MAX4464/MAX4474 have a 40kHz typical gain-bandwidth and are stable for a gain of +5V/V or greater.

### Stability

The MAX4464/MAX4470/MAX4471/MAX4472/MAX4474 maintain stability in their minimum gain configuration while driving capacitive loads. Although this product family is primarily designed for low-frequency applications, good layout is extremely important because low-power requirements demand high-impedance circuits. The layout should also minimize stray capacitance at the amplifier inputs. However some stray capacitance may be unavoidable, and it may be necessary to add a 2pF to 10pF capacitor across the feedback resistor as shown in Figure 1. Select the smallest capacitor value that ensures stability.

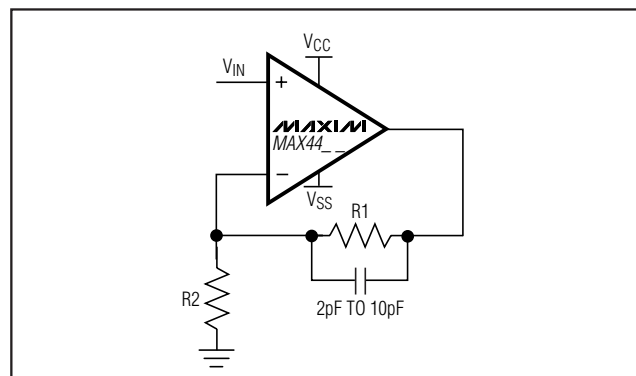
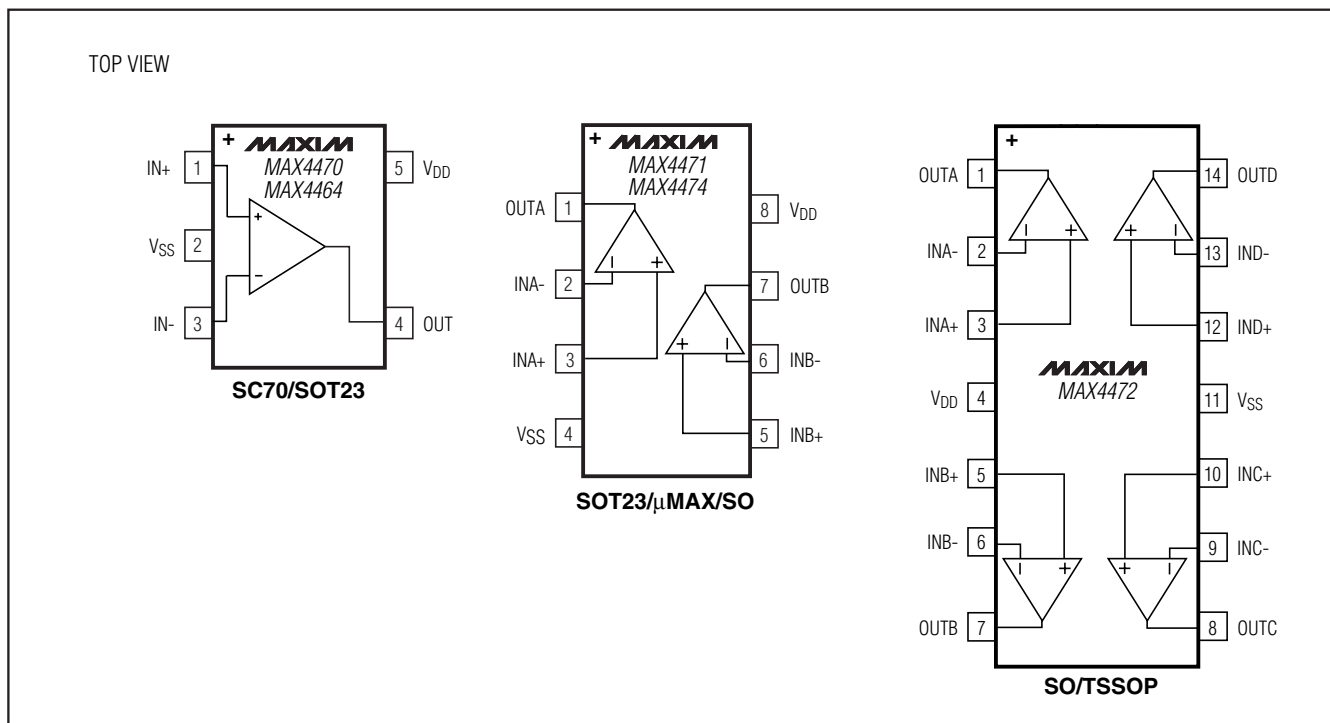


Figure 1. Compensation for Feedback Node Capacitance

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Pin Configurations (continued)



## Chip Information

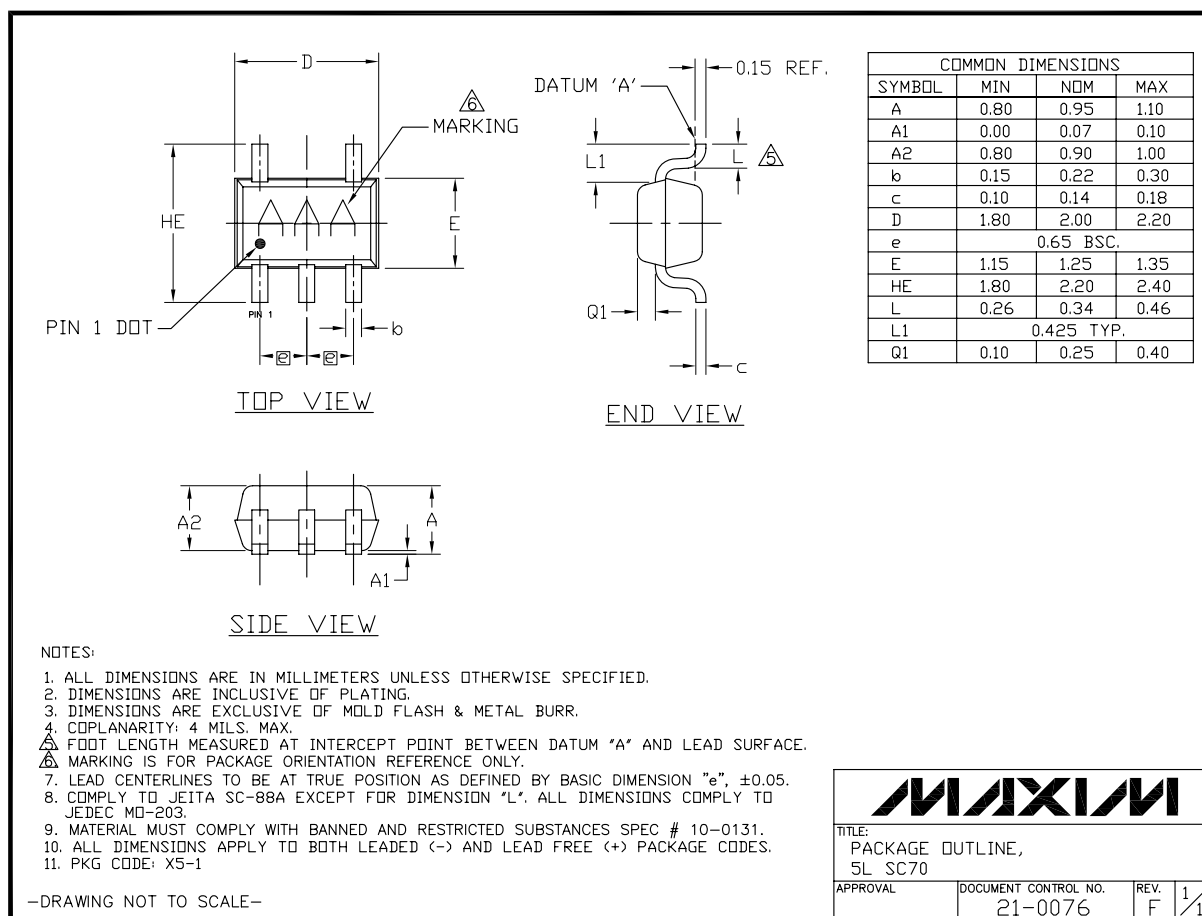
PROCESS: BiCMOS

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Package Information

For the latest package outline information and land patterns (footprints), go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

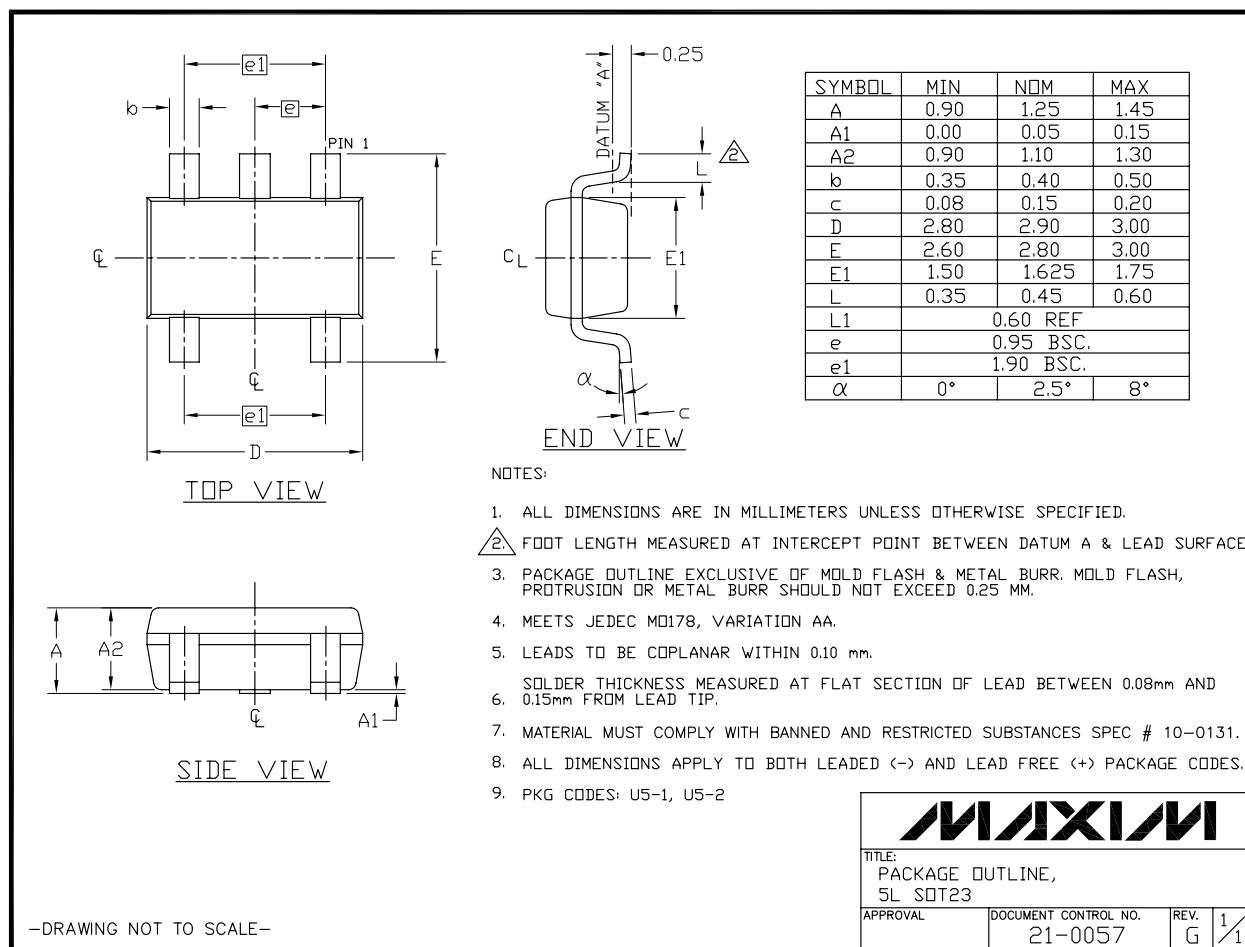
| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO.            | LAND PATTERN NO.                               |
|--------------|--------------|-------------------------|------------------------------------------------|
| 5 SC70       | X5+1         | <a href="#">21-0076</a> | <a href="#">90-0188</a>                        |
| 5 SOT23      | U5+1         | <a href="#">21-0057</a> | <a href="#">90-0174</a>                        |
| 6 WLP        | W61B1+1      | <a href="#">21-0217</a> | Refer to <a href="#">Application Note 1891</a> |
| 8 $\mu$ MAX  | U8+1         | <a href="#">21-0036</a> | <a href="#">90-0092</a>                        |
| 8 SOT23      | K8+5         | <a href="#">21-0078</a> | <a href="#">90-0176</a>                        |
| 8 SOIC       | S8+2         | <a href="#">21-0041</a> | <a href="#">90-0096</a>                        |
| 14 SOIC      | S14+1        | <a href="#">21-0041</a> | <a href="#">90-0096</a>                        |
| 14 TSSOP     | U14+1        | <a href="#">21-0066</a> | <a href="#">90-0117</a>                        |



# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Package Information (continued)

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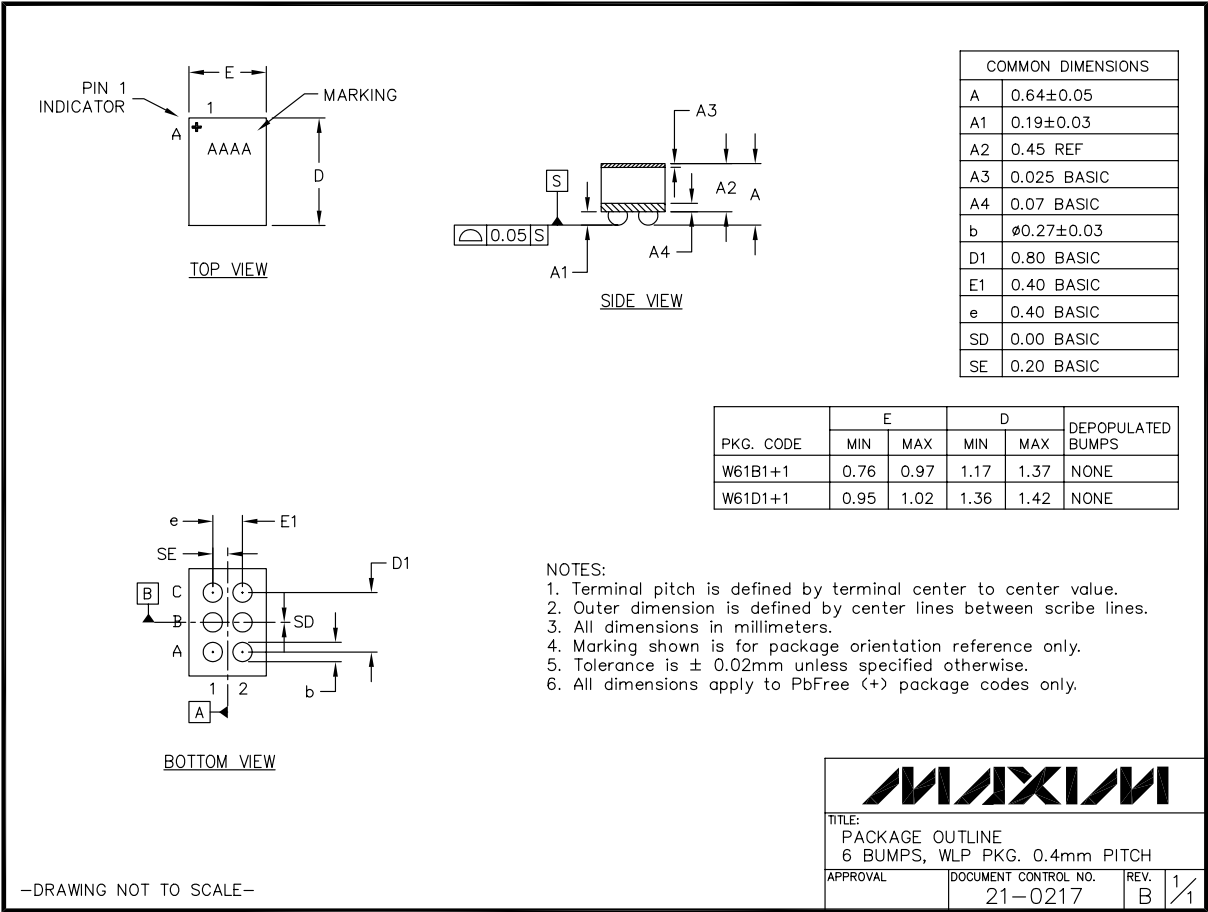


MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Package Information (continued)

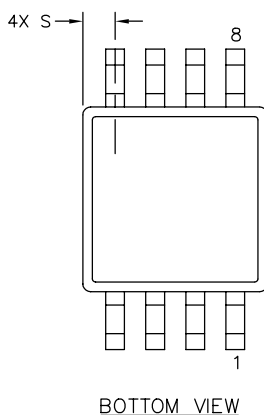
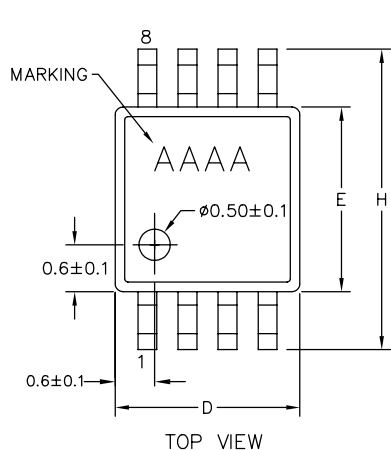
For the latest package outline information and land patterns (footprints), go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a “+”, “#”, or “-” in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

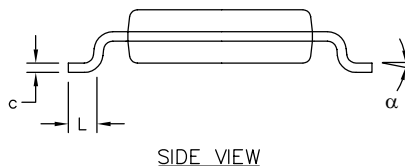
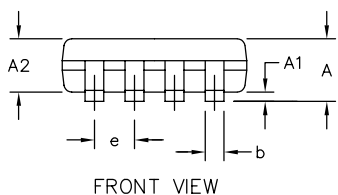
## Package Information (continued)

For the latest package outline information and land patterns (footprints), go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



| DIM | INCHES |       | MILLIMETERS |      |
|-----|--------|-------|-------------|------|
|     | MIN    | MAX   | MIN         | MAX  |
| A   | —      | 0.043 | —           | 1.10 |
| A1  | 0.002  | 0.006 | 0.05        | 0.15 |
| A2  | 0.030  | 0.037 | 0.75        | 0.95 |
| b   | 0.010  | 0.014 | 0.25        | 0.36 |
| c   | 0.005  | 0.007 | 0.13        | 0.18 |
| D   | 0.114  | 0.122 | 2.90        | 3.10 |
| e   | 0.0256 | BSC   | 0.65        | BSC  |
| E   | 0.114  | 0.122 | 2.90        | 3.10 |
| H   | 0.188  | 0.198 | 4.78        | 5.03 |
| L   | 0.016  | 0.026 | 0.41        | 0.66 |
| α   | 0°     | 6°    | 0°          | 6°   |
| S   | 0.0207 | BSC   | 0.5250      | BSC  |

PKG. CODES:  
U8-1; U8-3; U8CN-1



### NOTES:

1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. COMPLIES TO JEDEC MO-187, LATEST REVISION, VARIATION AA.
5. MARKING SHOWN IS FOR PKG. ORIENTATION ONLY.
6. ALL DIMENSIONS APPLY TO BOTH LEADED (-) AND PbFREE (+) PKG. CODES.

—DRAWING NOT TO SCALE—

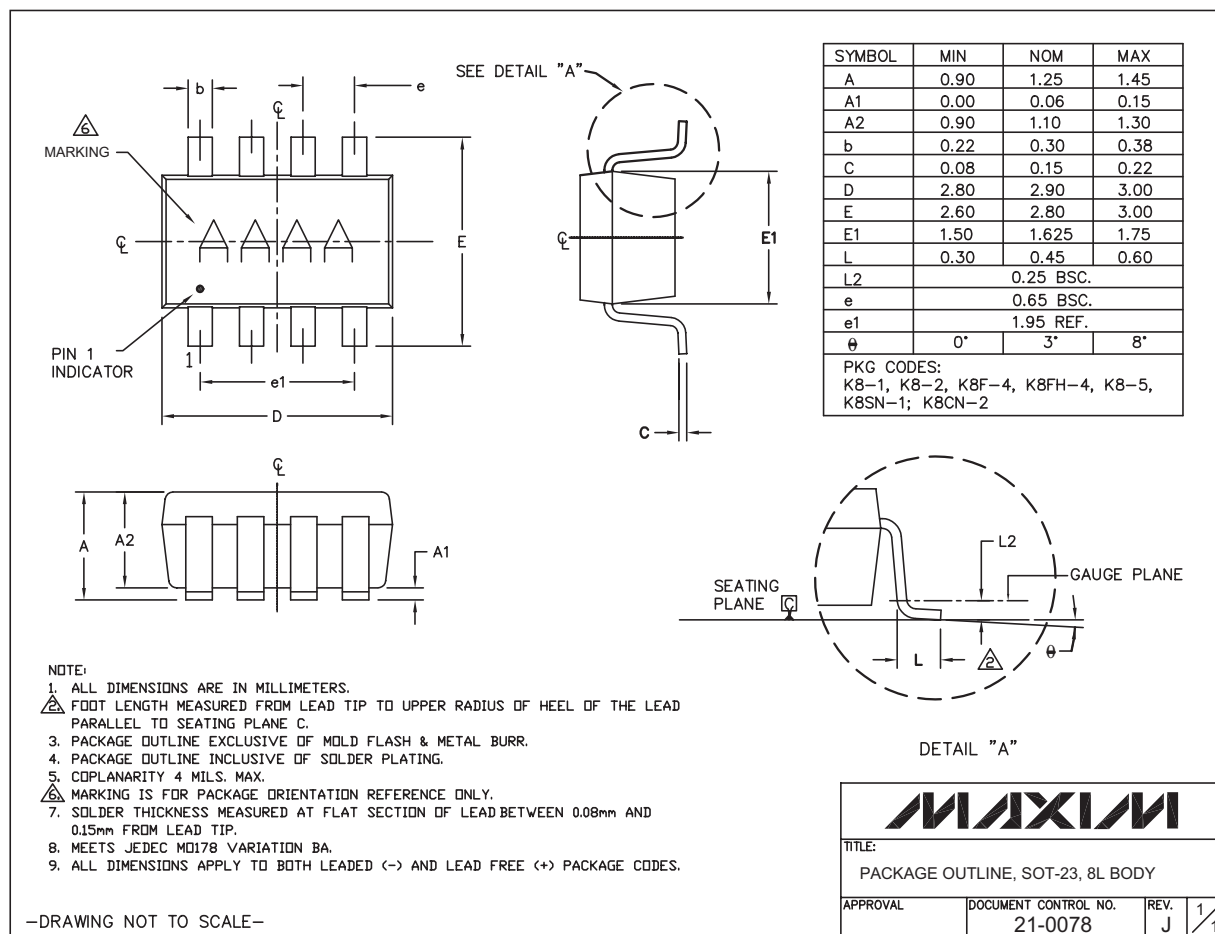
|                                         |                                 |           |     |
|-----------------------------------------|---------------------------------|-----------|-----|
| <b>MAXIM</b>                            |                                 |           |     |
| TITLE:<br>PACKAGE OUTLINE, 8L uMAX/uSOP |                                 |           |     |
| APPROVAL                                | DOCUMENT CONTROL NO.<br>21-0036 | REV.<br>L | 1/1 |

MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Package Information (continued)

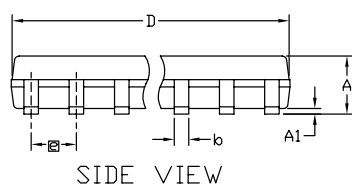
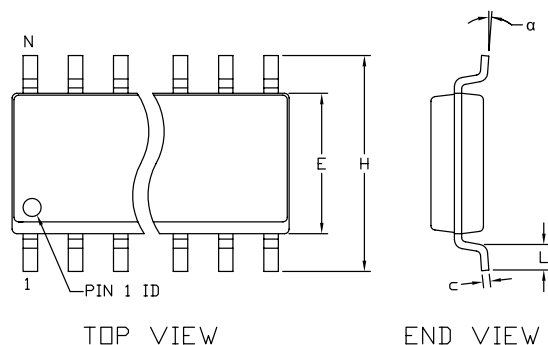
For the latest package outline information and land patterns (footprints), go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Package Information (continued)

For the latest package outline information and land patterns (footprints), go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



| SYMBOL | INCHES |      | MM   |      |
|--------|--------|------|------|------|
|        | MIN.   | MAX. | MIN. | MAX. |
| A      | .053   | .069 | 1.35 | 1.75 |
| A1     | .004   | .010 | 0.10 | 0.25 |
| b      | .014   | .019 | 0.35 | 0.49 |
| c      | .007   | .010 | 0.19 | 0.25 |
| E      | .150   | .157 | 3.80 | 4.00 |
| e      | .050   | BSC  | 1.27 | BSC  |
| H      | .228   | .244 | 5.80 | 6.20 |
| L      | .016   | .050 | 0.40 | 1.27 |
| α      | 0°     | 8°   | 0°   | 8°   |

| SYMBOL    | INCHES                                                        |      | MM   |      |
|-----------|---------------------------------------------------------------|------|------|------|
|           | MIN.                                                          | MAX. | MIN. | MAX. |
| D         | .189                                                          | .197 | 4.80 | 5.00 |
| N         | 8                                                             |      |      |      |
| MS012     | AA                                                            |      |      |      |
| PKG. CODE | S8-2, S8-4, S8-5, S8-6F, S8-7F, S8-8F, S8-10F, S8-11F, S8-16F |      |      |      |

| SYMBOL    | INCHES                                                     |      | MM   |      |
|-----------|------------------------------------------------------------|------|------|------|
|           | MIN.                                                       | MAX. | MIN. | MAX. |
| D         | .337                                                       | .344 | 8.55 | 8.75 |
| N         | 14                                                         |      |      |      |
| MS012     | AB                                                         |      |      |      |
| PKG. CODE | S14-1, S14-4, S14-5, S14-6, S14M-4, S14M-5, S14M-6, S14M-7 |      |      |      |

| SYMBOL    | INCHES                                                                     |      | MM   |       |
|-----------|----------------------------------------------------------------------------|------|------|-------|
|           | MIN.                                                                       | MAX. | MIN. | MAX.  |
| D         | .386                                                                       | .394 | 9.80 | 10.00 |
| N         | 16                                                                         |      |      |       |
| MS012     | AC                                                                         |      |      |       |
| PKG. CODE | S16-1, S16-3, S16-5, S16-6, S16-8, S16-7F, S16-9F, S16-10F, S16M-3, S16M-6 |      |      |       |

### NOTES:

- ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
- MATERIAL MUST COMPLY WITH BANNED AND RESTRICTED SUBSTANCES SPEC # 10-0131.
- DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE MOLD PROTRUSION IS 0.15 MM (.006") PER SIDE.
- LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
- MEETS JEDEC MS012
- ALL DIMENSIONS APPLY TO BOTH LEADED (-) AND PbFREE (+) PKG. CODES.

-DRAWING NOT TO SCALE-

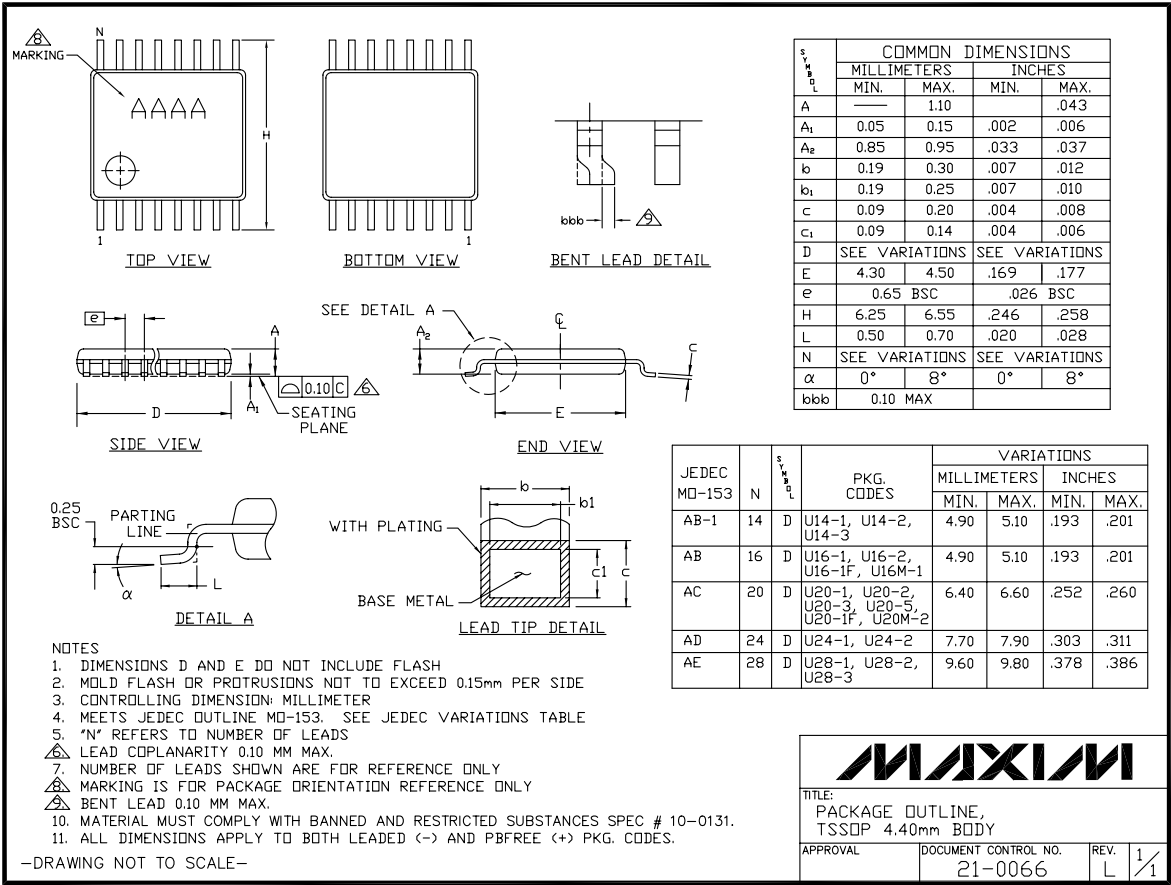
|                                                           |                                 |            |
|-----------------------------------------------------------|---------------------------------|------------|
|                                                           |                                 |            |
| TITLE:<br>PACKAGE OUTLINE,<br>8L, 14L, 16L SDIC .150 INCH |                                 |            |
| APPROVAL                                                  | DOCUMENT CONTROL NO.<br>21-0041 | REV. C 1/1 |

MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Package Information (continued)

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# Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

## Revision History

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION                         | PAGES<br>CHANGED |
|--------------------|------------------|-------------------------------------|------------------|
| 3                  | 6/10             | Added WLP package                   | 1, 2, 9, 10, 11  |
| 4                  | 7/11             | Updated power-on time specification | 3                |

MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

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Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 19