

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

ABSOLUTE MAXIMUM RATINGS

V_{DD} to V_{SS} -0.3V to +6V
 IN₊ or IN₋ (V_{SS} - 0.3V) to (V_{DD} + 0.3V)
 OUT₋ Shorted to V_{SS} or V_{DD} Continuous
 Continuous Power Dissipation (T_A = +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 μ 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_{DD} = +5V, V_{SS} = 0V, V_{CM} = 0V, V_{OUT} = V_{DD}/2, R_L = ∞ to V_{DD}/2, T_A = +25°C, unless otherwise noted.)

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} = +1.8V		0.6		μ A
		V _{DD} = +5.0V		0.75	1.2	
Input Offset Voltage	V _{OS}			± 0.5	± 7.0	mV
Input Bias Current	I _B			± 200	± 1500	pA
Input Offset Current	I _{OS}			± 12.5		pA
Input Common-Mode Voltage Range	V _{CM}	Guaranteed by the CMRR test	V _{SS}		V _{DD} - 1.1	V
Common-Mode Rejection Ratio	CMRR	Specified with V _{SS} $\leq$ V _{CM} $\leq$ (V _{DD} - 1.1V)	70	95		dB
Power-Supply Rejection Ratio	PSRR	+1.8V $\leq$ V _{DD} $\leq$ +5.5V	70	90		dB
Large-Signal Voltage Gain	A _{VOL}	R _L = 1M Ω , V _{OUT} = 50mV to V _{DD} - 50mV	90	120		dB
		R _L = 100k Ω , V _{OUT} = 200mV to V _{DD} - 200mV	90	112		
		R _L = 10k Ω , V _{OUT} = 200mV to V _{DD} - 200mV		100		
Output Voltage Swing	V _{OH}	Swing high specified as V _{DD} - V _{OH}	R _L = 1M Ω	1	4	mV
			R _L = 100k Ω	4	10	
			R _L = 10k Ω	40		
	V _{OL}	Swing low specified as V _{OL} - V _{SS}	R _L = 1M Ω	0.5	5	
			R _L = 100k Ω	1	5	
			R _L = 10k Ω	10		
Gain-Bandwidth Product	GBW	MAX4470/MAX4471/MAX4472		9		kHz
		MAX4464/MAX4474		40		
Phase Margin	ϕ_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		μs
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)

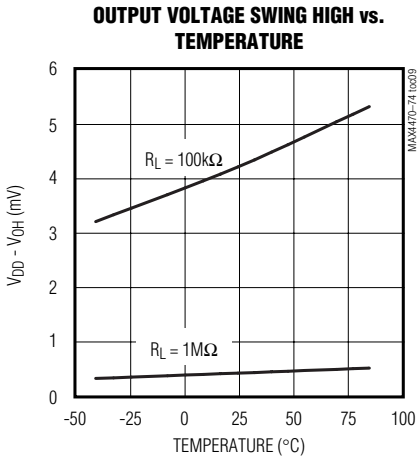
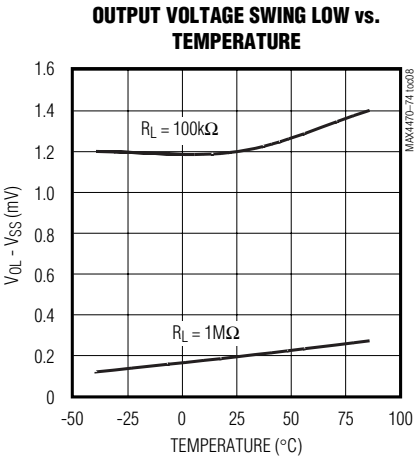
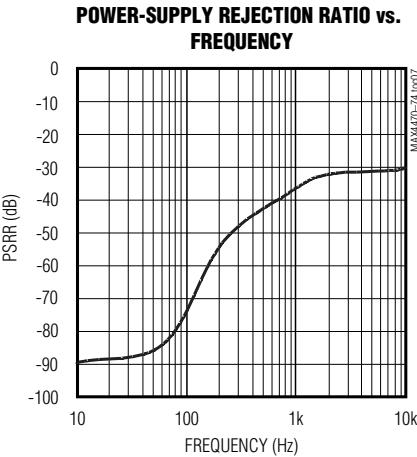
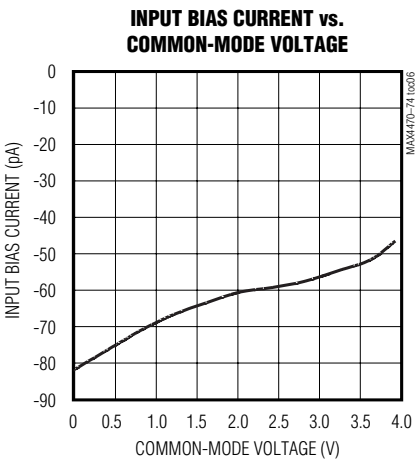
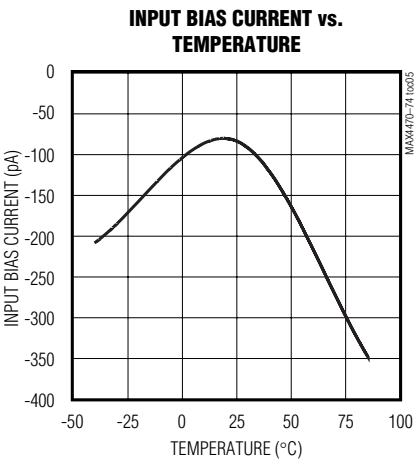
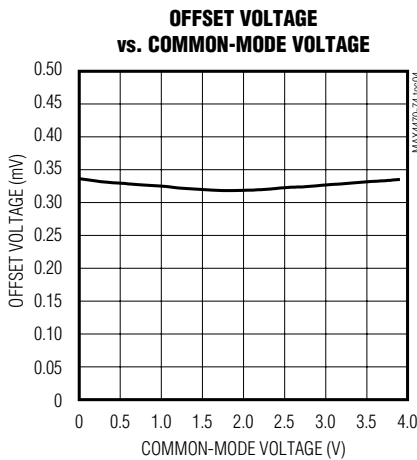
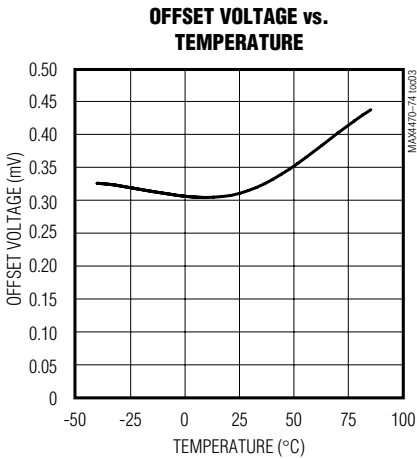
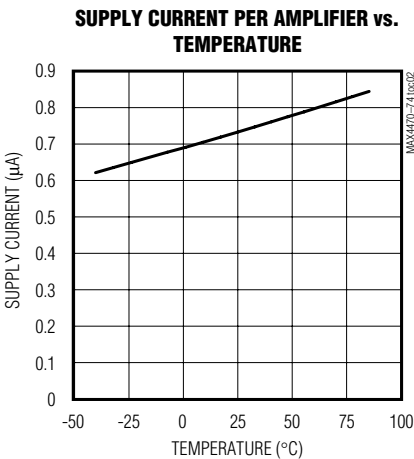
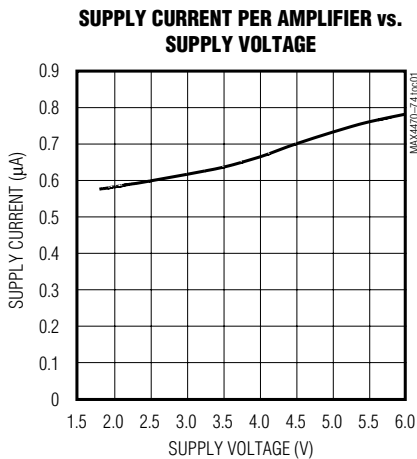
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{DD}	Guaranteed by PSRR tests		1.8		5.5	V
Supply Current (Per Amplifier)	I_{DD}	$V_{DD} = +5.0V$				1.5	μA
Input Offset Voltage	V_{OS}					± 15	mV
Input Offset Voltage Temperature Coefficient	TCV_{OS}				8		$\mu V/^\circ C$
Input Bias 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.

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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.)



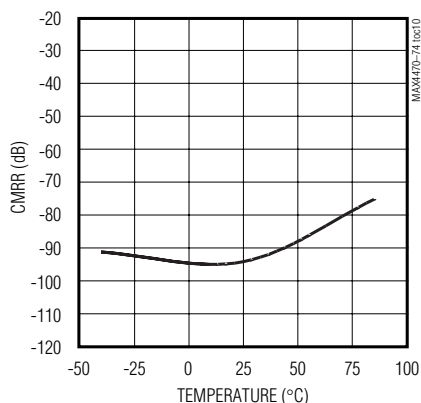
Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

Typical Operating Characteristics (continued)

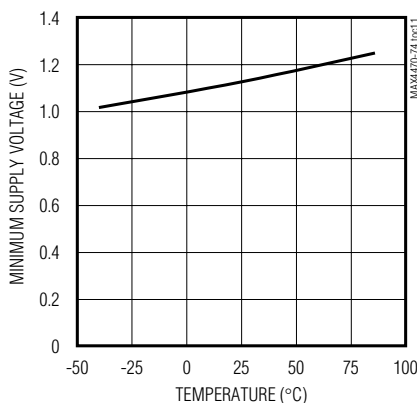
($V_{DD} = +5V$, $V_{SS} = 0V$, $V_{CM} = 0V$, $R_L = 100k\Omega$ to $V_{DD}/2$, $T_A = +25^\circ C$, unless otherwise noted.)

MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

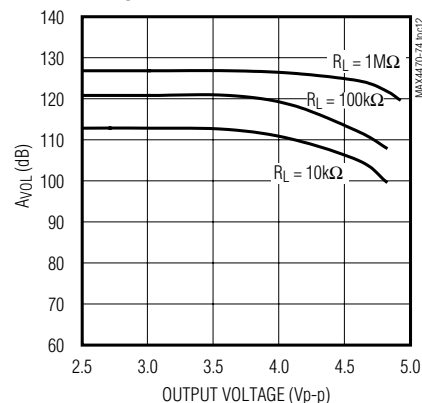
COMMON-MODE REJECTION RATIO vs. TEMPERATURE



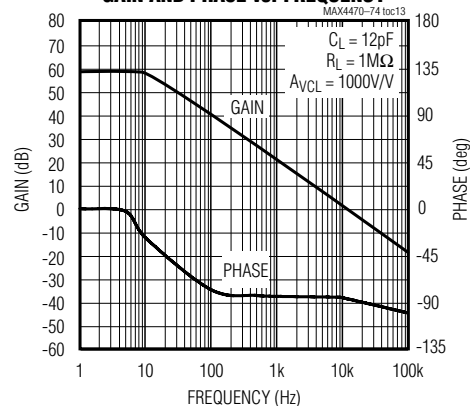
MINIMUM SUPPLY VOLTAGE vs. TEMPERATURE



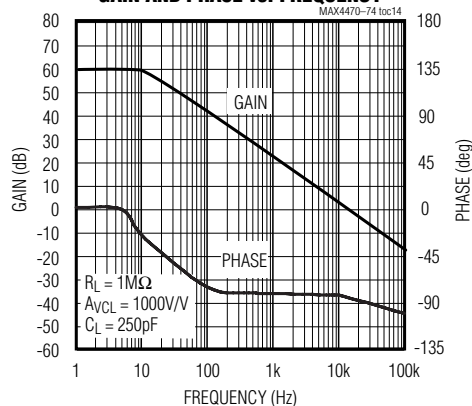
A_{VOL} vs. OUTPUT VOLTAGE SWING



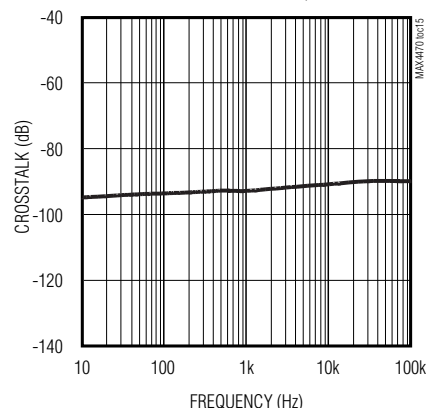
MAX4470/MAX4471/MAX4472 GAIN AND PHASE vs. FREQUENCY



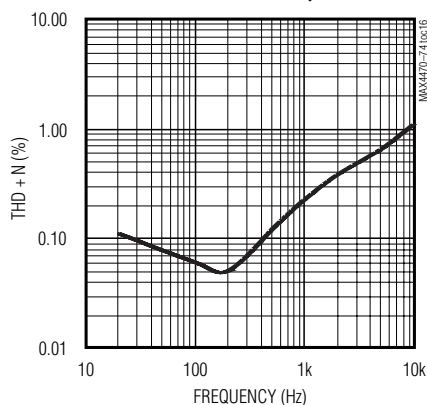
MAX4470/MAX4471/MAX4472 GAIN AND PHASE vs. FREQUENCY



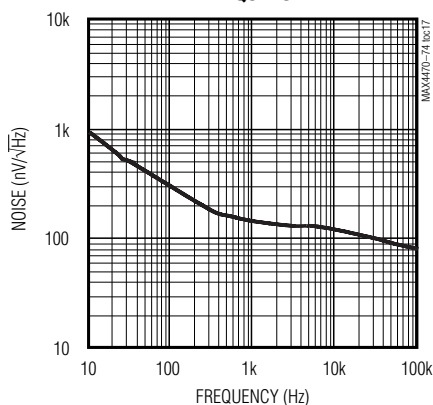
CROSSTALK vs. FREQUENCY



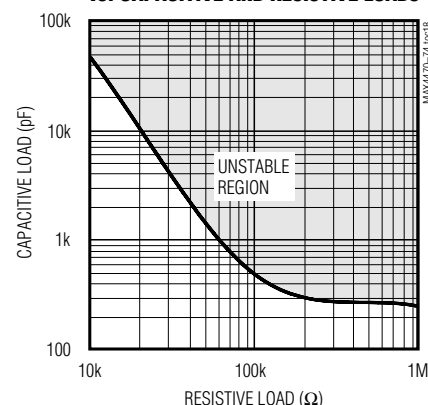
MAX4470/MAX4471/MAX4472 TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY



VOLTAGE NOISE DENSITY vs. FREQUENCY



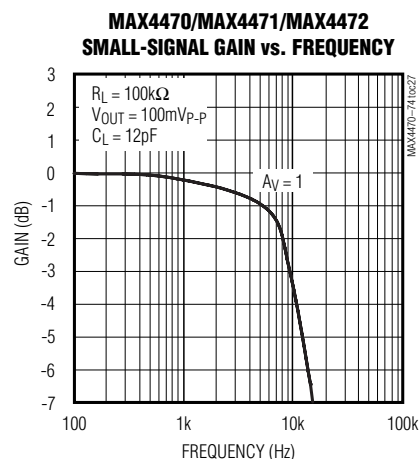
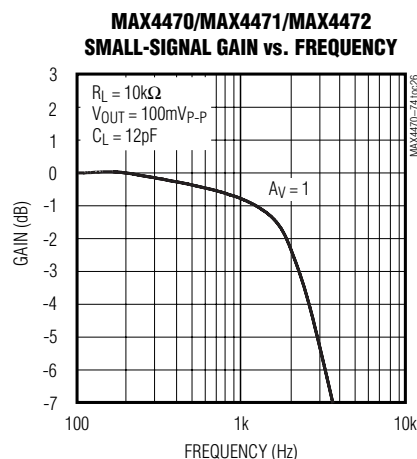
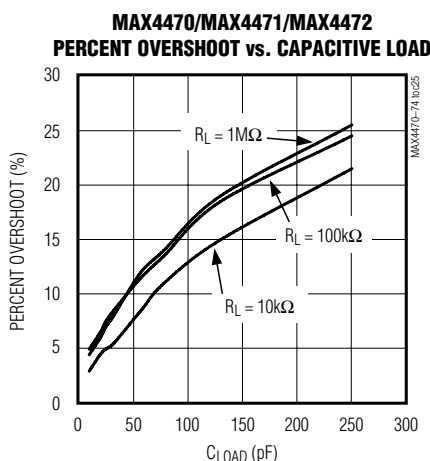
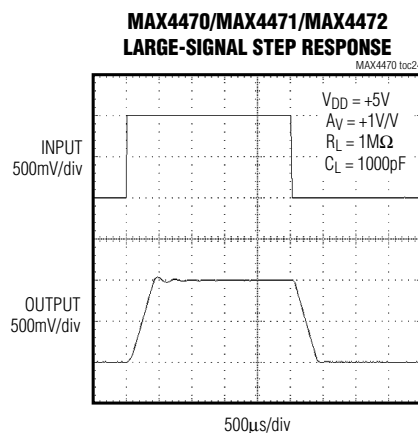
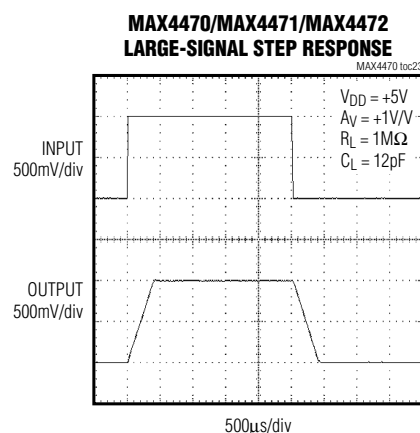
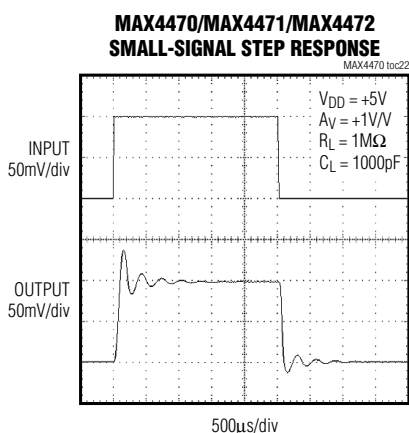
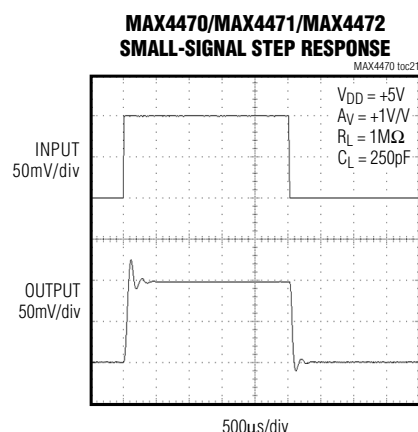
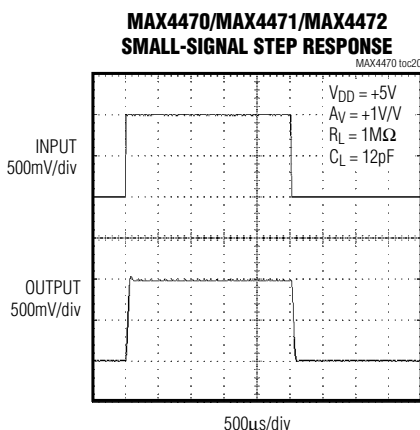
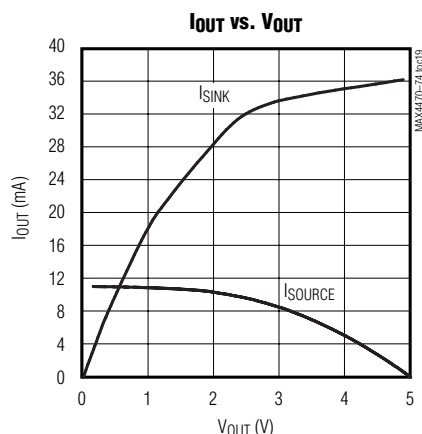
MAX4470/MAX4471/MAX4472 STABILITY vs. CAPACITIVE AND RESISTIVE LOADS



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

Typical Operating Characteristics (continued)

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

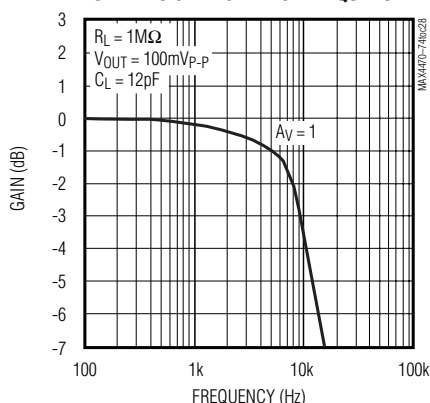


Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

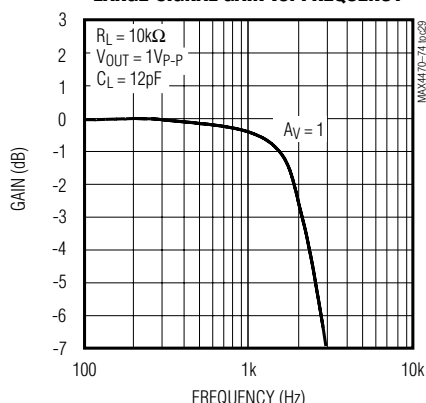
Typical Operating Characteristics (continued)

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

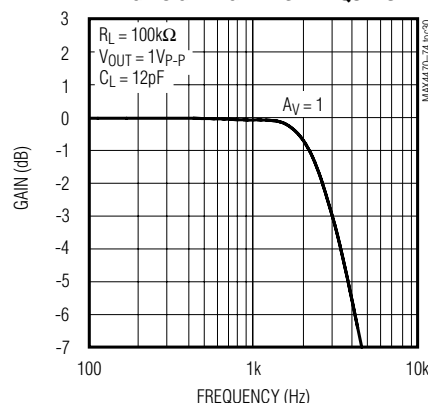
**MAX4470/MAX4471/MAX4472
SMALL-SIGNAL GAIN vs. FREQUENCY**



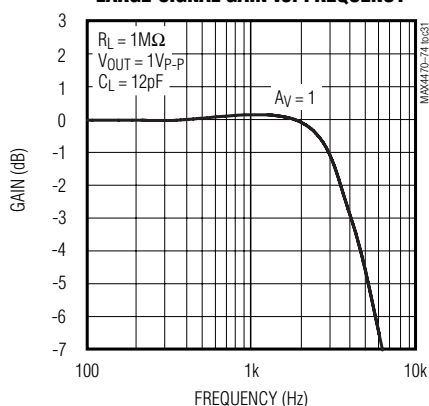
**MAX4470/MAX4471/MAX4472
LARGE-SIGNAL GAIN vs. FREQUENCY**



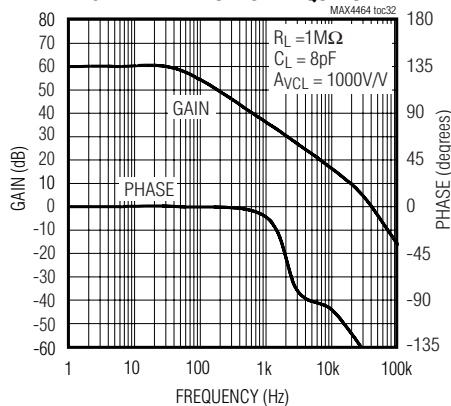
**MAX4470/MAX4471/MAX4472
LARGE-SIGNAL GAIN vs. FREQUENCY**



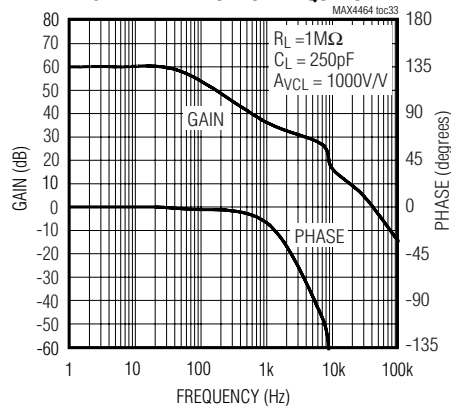
**MAX4470/MAX4471/MAX4472
LARGE-SIGNAL GAIN vs. FREQUENCY**



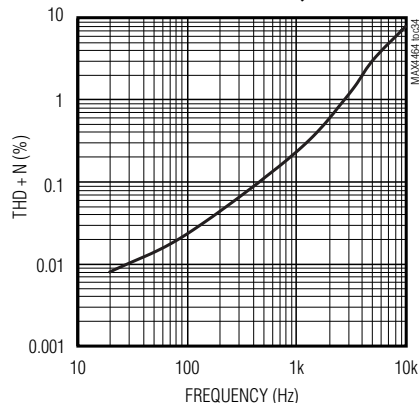
**MAX4464/MAX4474
GAIN AND PHASE vs. FREQUENCY**



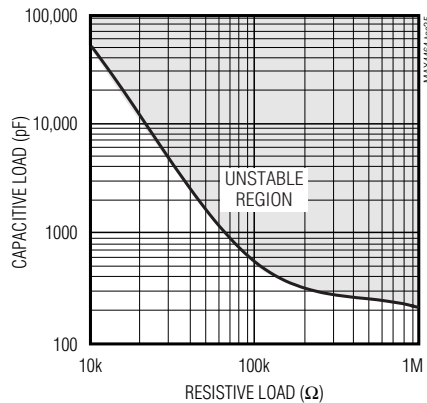
**MAX4464/MAX4474
GAIN AND PHASE vs. FREQUENCY**



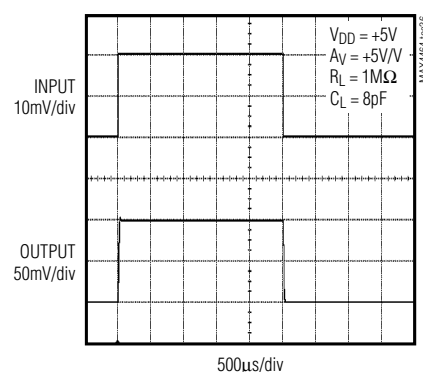
**MAX4464/MAX4474
TOTAL HARMONIC DISTORTION
PLUS NOISE vs. FREQUENCY**



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



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

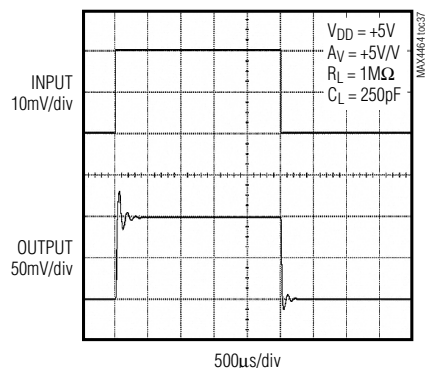


Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

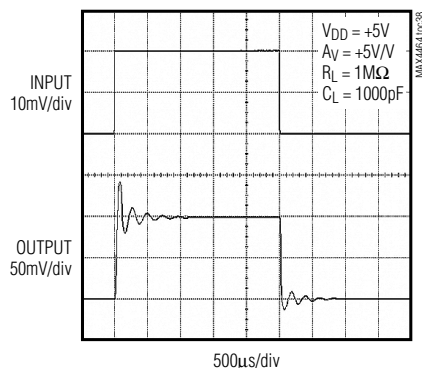
Typical Operating Characteristics (continued)

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

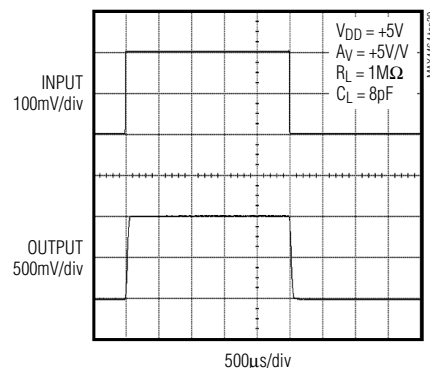
**MAX4464/MAX4474
SMALL-SIGNAL STEP RESPONSE**



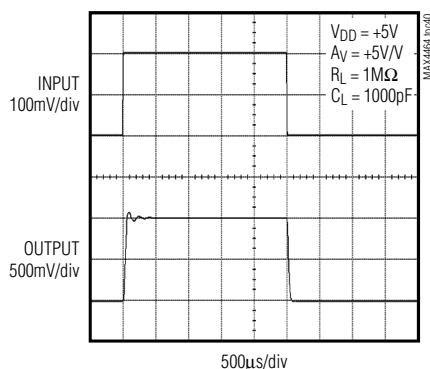
**MAX4464/MAX4474
SMALL-SIGNAL STEP RESPONSE**



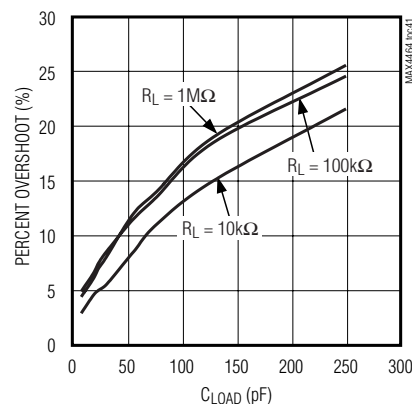
**MAX4464/MAX4474
LARGE-SIGNAL STEP RESPONSE**



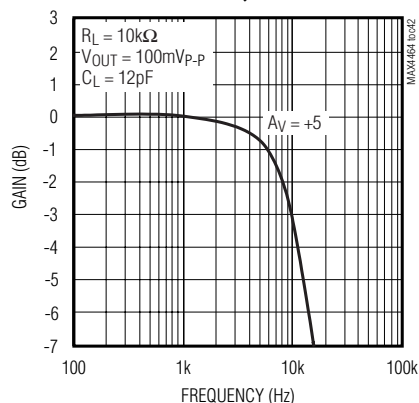
**MAX4464/MAX4474
LARGE-SIGNAL STEP RESPONSE**



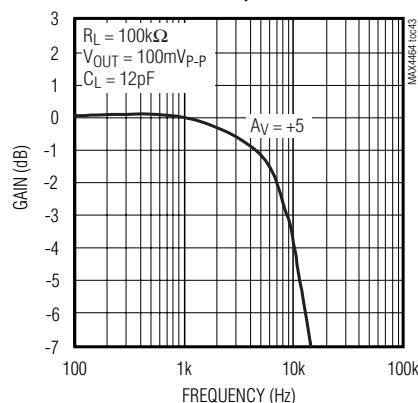
**MAX4464/MAX4474
PERCENT OVERSHOOT vs. CAPACITIVE LOAD**



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



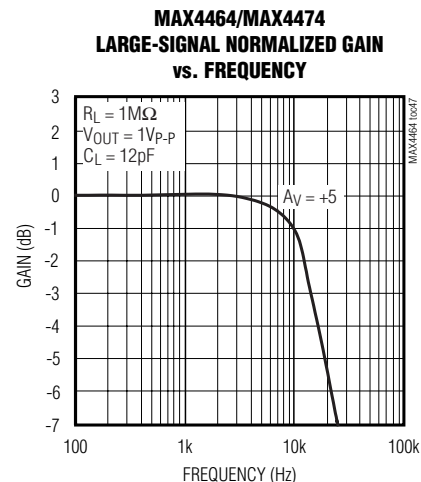
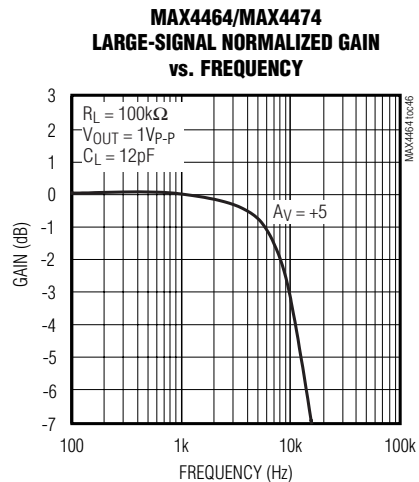
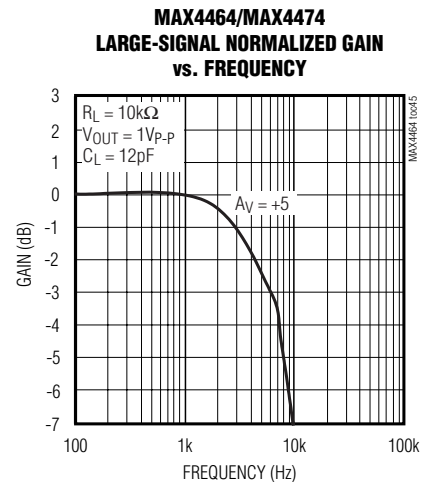
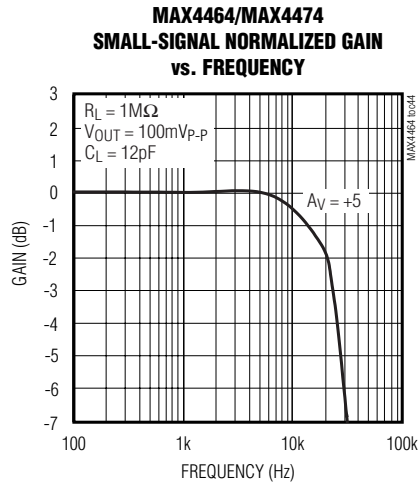
**MAX4464/MAX4474
SMALL-SIGNAL NORMALIZED GAIN
vs. FREQUENCY**



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.)



Pin Description

PIN				NAME	FUNCTION
MAX4464/ MAX4470	MAX4470 (WLP)	MAX4471/ MAX4474	MAX4472		
1	A1	—	—	IN+	Noninverting Amplifier Input
—	—	3	3	INA+	Noninverting Amplifier Input (Channel A)
2	A2	4	11	V_{SS}	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/ MAX4470	MAX4470 (WLP)	MAX4471/ 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 _{DD}	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_{DD} 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.

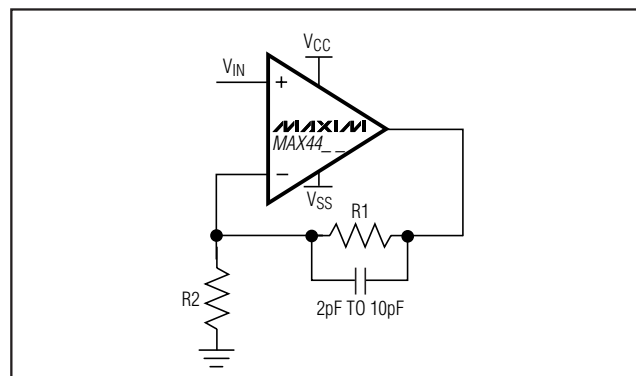
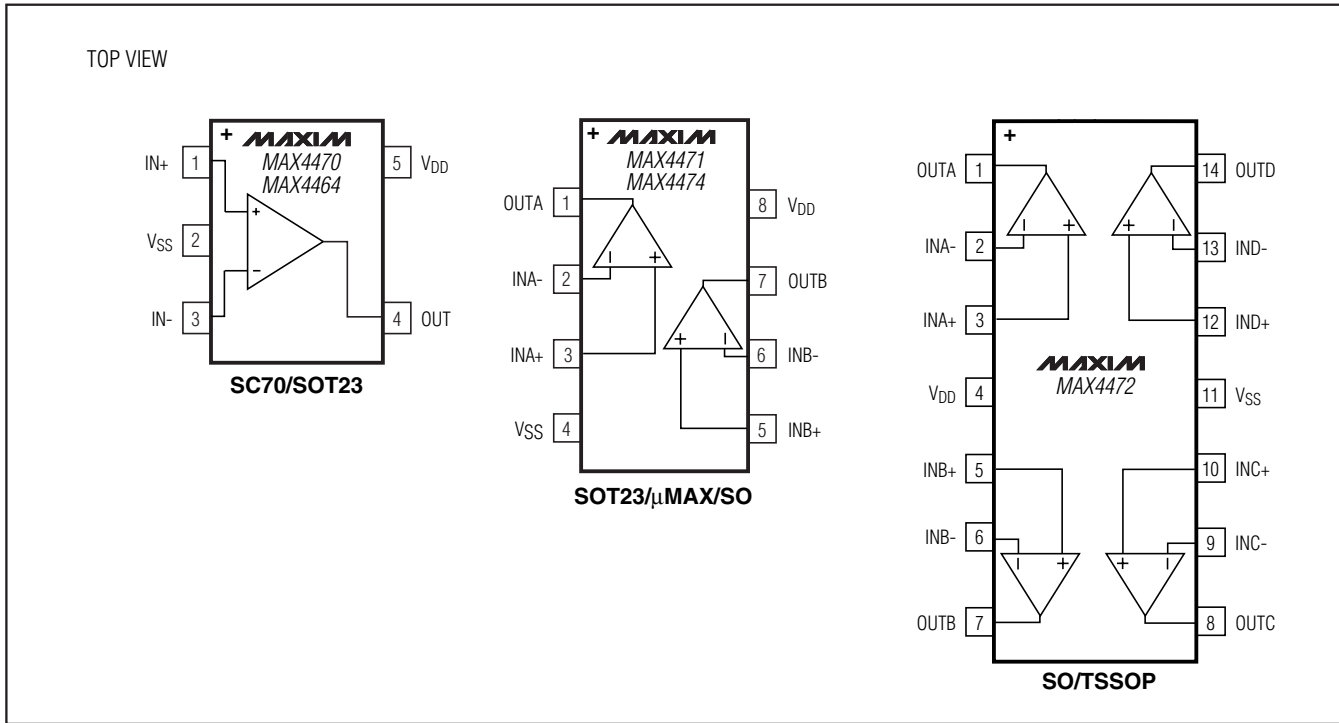


Figure 1. Compensation for Feedback Node Capacitance

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

Pin Configurations (continued)



Chip Information

PROCESS: BiCMOS

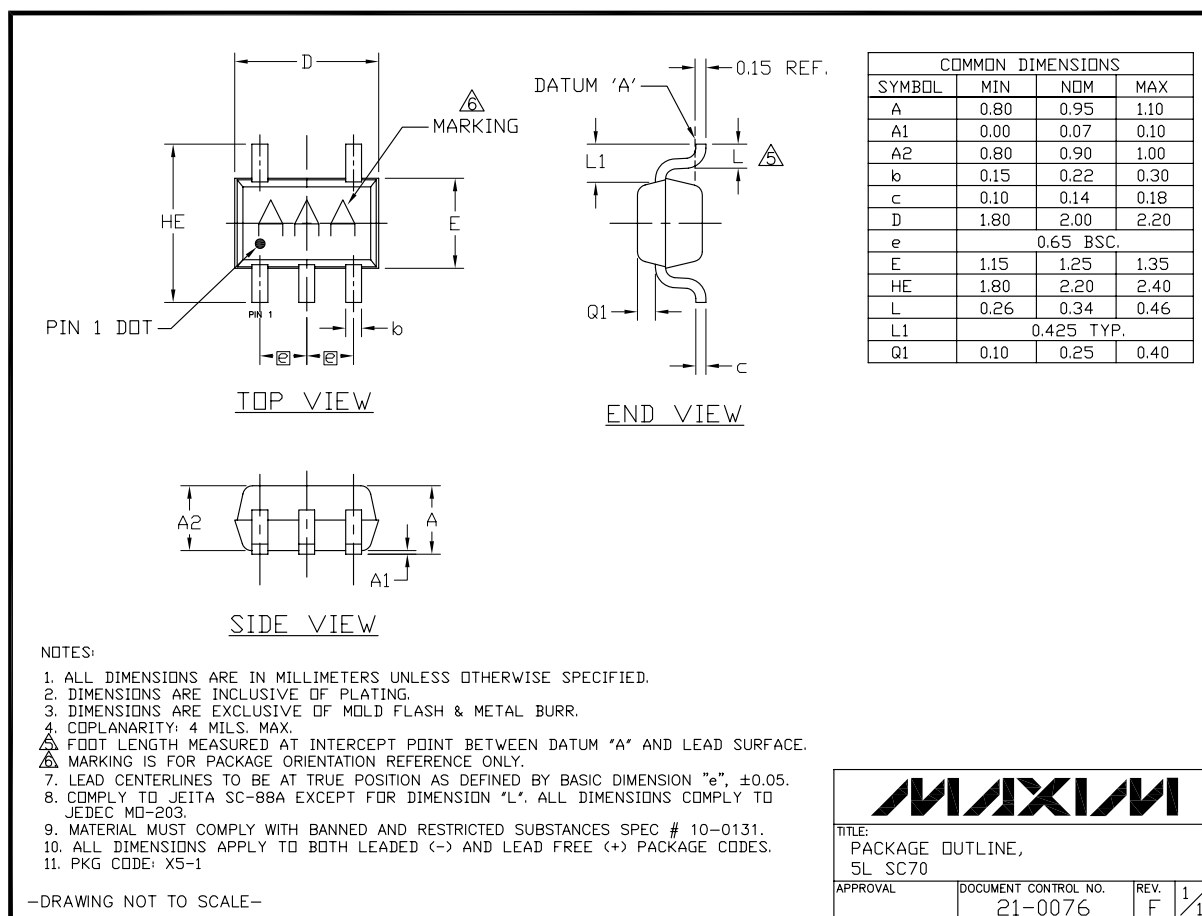
MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

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. 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.

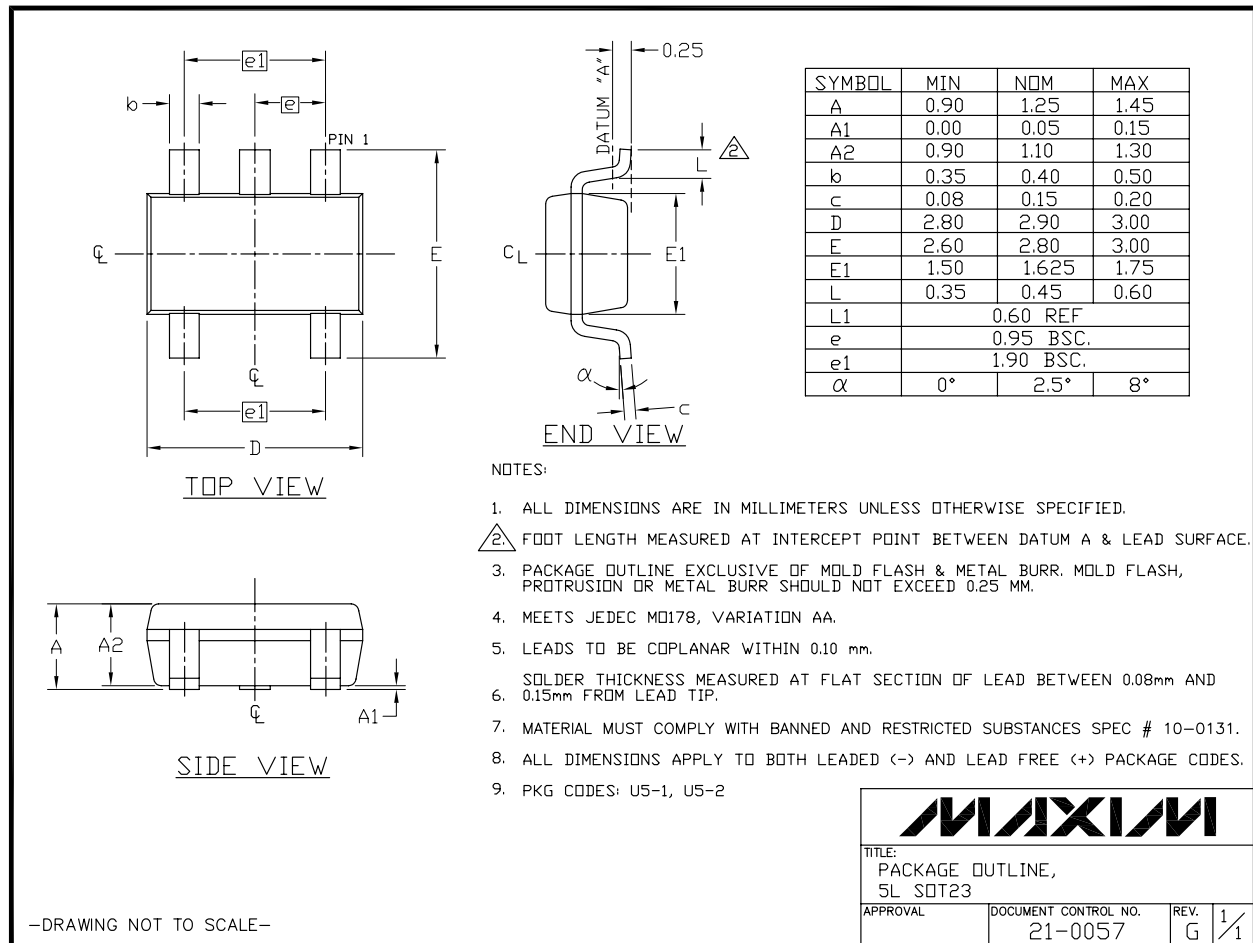
PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.	LAND PATTERN NO.
5 SC70	X5+1	21-0076	90-0188
5 SOT23	U5+1	21-0057	90-0174
6 WLP	W61B1+1	21-0217	Refer to Application Note 1891
8 μ MAX	U8+1	21-0036	90-0092
8 SOT23	K8+5	21-0078	90-0176
8 SOIC	S8+2	21-0041	90-0096
14 SOIC	S14+1	21-0041	90-0096
14 TSSOP	U14+1	21-0066	90-0117



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

Package Information (continued)

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MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

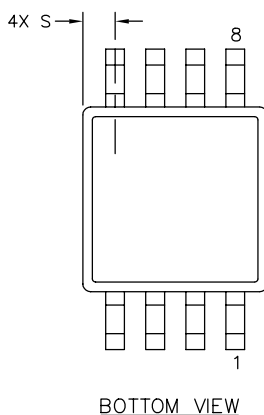
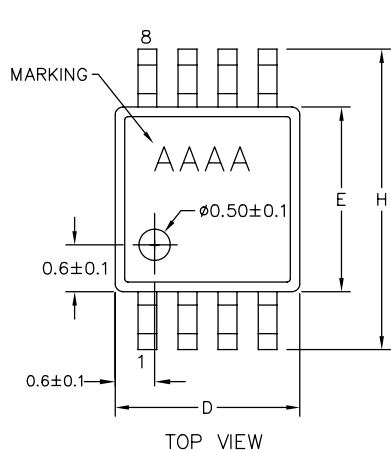
For the latest package outline information and land patterns (footprints), go to www.maxim-ic.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



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

Package Information (continued)

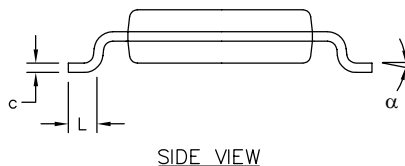
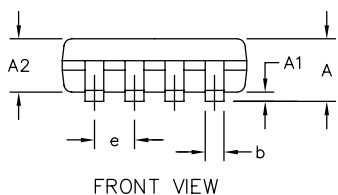
For the latest package outline information and land patterns (footprints), go to www.maxim-ic.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.



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—

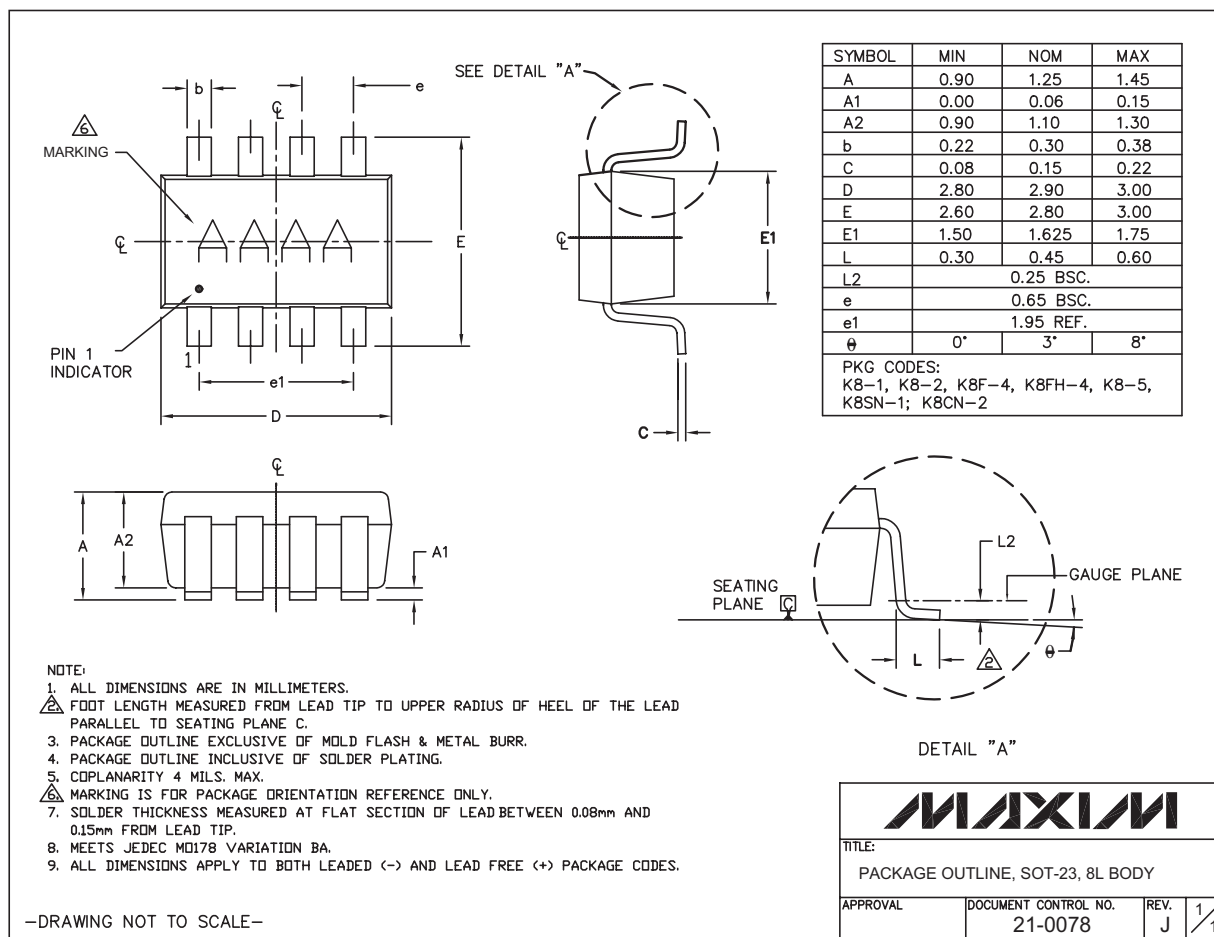
MAXIM			
TITLE:			
PACKAGE OUTLINE, 8L uMAX/uSOP			
APPROVAL	DOCUMENT CONTROL NO.	REV.	1/1
	21-0036	L	

MAX4464/MAX4470/MAX4471/MAX4472/MAX4474

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

Package Information (continued)

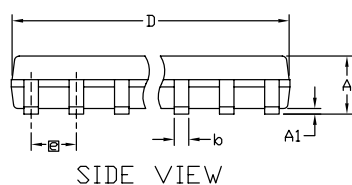
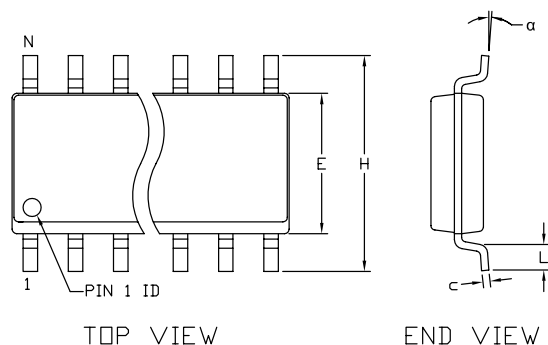
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Single/Dual/Quad, +1.8V/750nA, SC70, Rail-to-Rail Op Amps

Package Information (continued)

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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:

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

-DRAWING NOT TO SCALE-

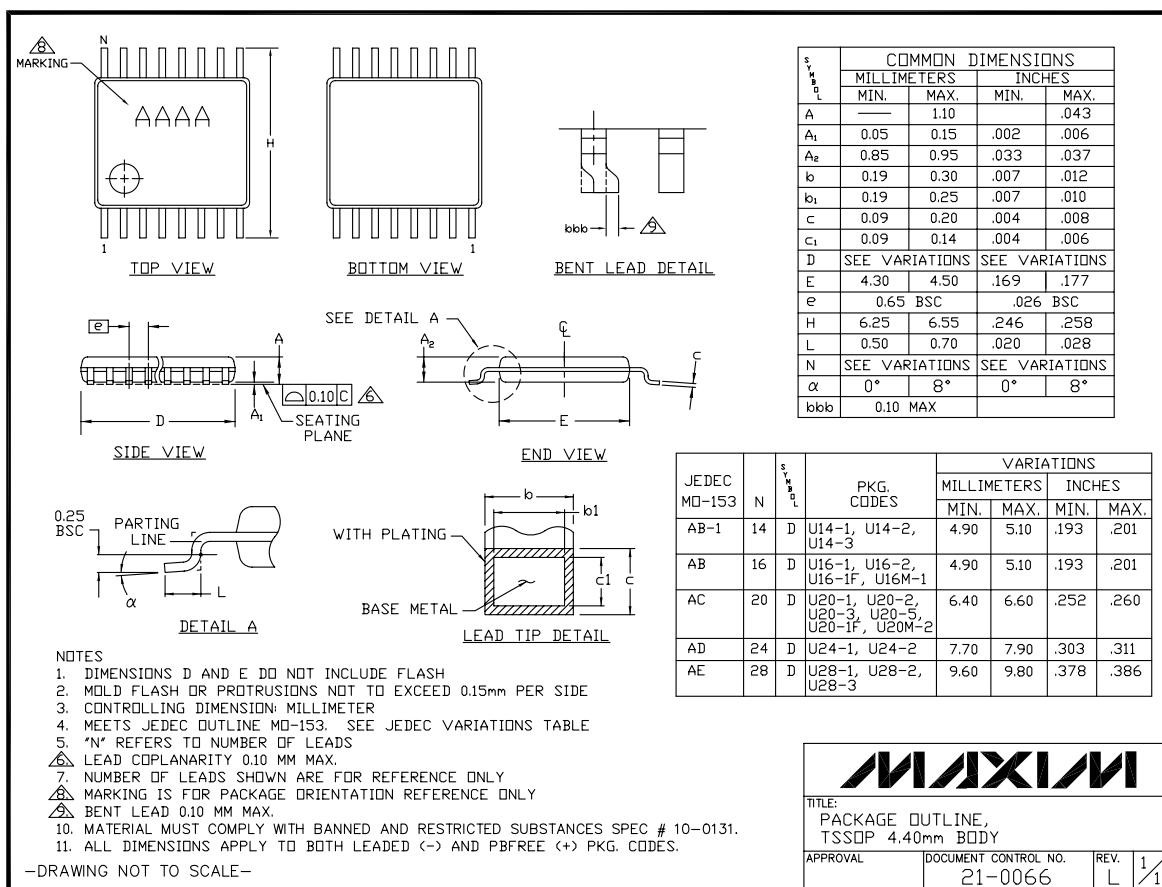
TITLE: PACKAGE OUTLINE, 8L, 14L, 16L SDIC .150 INCH		
APPROVAL	DOCUMENT CONTROL NO. 21-0041	REV. C 1/1

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 NUMBER	REVISION DATE	DESCRIPTION	PAGES 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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