19-2200; Rev 0; 10/01

Single-Supply, 150MHz, 16-Bit Accurate, Ultra-Low Distortion Op Amps

General Description

The MAX4434/MAX4435 single and MAX4436/MAX4437 dual operational amplifiers feature wide bandwidth, 16-bit settling time in 23ns, and low-noise/low-distortion operation. The MAX4434/MAX4436 are compensated for unity-gain stability and have a small-signal -3dB bandwidth of 150MHz. The MAX4435/MAX4437 are compensated for closed-loop gains of +5 or greater and have a small-signal, -3dB bandwidth of 150MHz.

The MAX4434–MAX4437 op amps require only 15mA of supply current per amplifier while achieving 115dB open-loop gain. Voltage noise density is a low 2.2nV/√Hz and provides 97dB spurious-free dynamic range (SFDR) at 1MHz. These characteristics make these op amps ideal for driving modern, high-speed 14- and 16-bit analog-to-digital converters (ADCs).

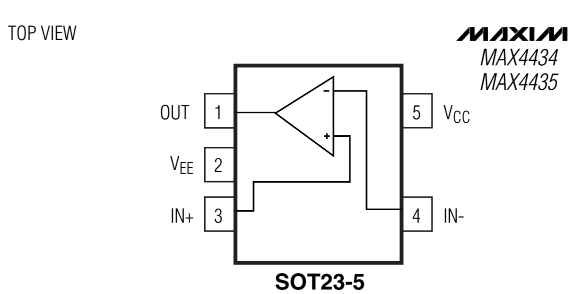
These high-speed op amps feature wide-output voltage swings and a high-current output drive up to 65mA. Using a voltage feedback architecture, the MAX4434–MAX4437 meet the requirements of many applications that previously depended on current feedback amplifiers.

The MAX4434/MAX4435 are available in space-saving 5-pin SOT23 packages and the MAX4436/MAX4437 are available in 8-pin µMAX packages.

Applications

High-Speed 14- and 16-Bit ADC Preamplifiers
Low-Noise Preamplifiers
IF/RF Amplifiers
Low-Distortion Active Filters
High-Performance Receivers
Precision Instrumentation

Pin Configurations



Pin Configurations continued at end of data sheet.

Features

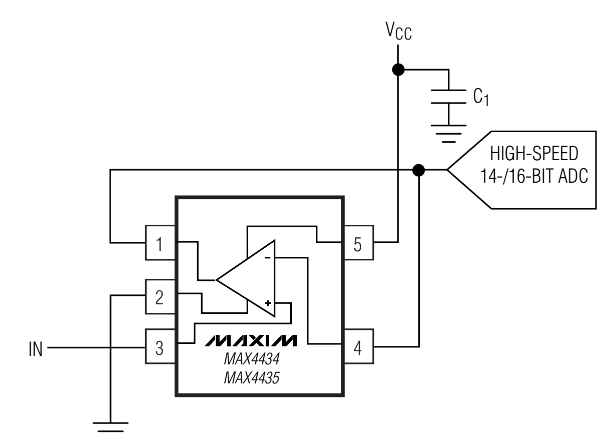
- ♦ **16-Bit Accurate Settling in 23ns (MAX4435/MAX4437)**
- ♦ **97dB SFDR at 1MHz, 4Vp-p Output**
- ♦ **2.2nV/√Hz Input Voltage Noise Density**
- ♦ **100dB (min) Open-Loop Gain**
- ♦ **388V/µs Slew Rate (MAX4435/MAX4437)**
- ♦ **65mA High Output Drive**
- ♦ **Available in Space-Saving Packages**
  - **5-Pin SOT23 (MAX4434/MAX4435)**
  - **8-Pin µMAX (MAX4436/MAX4437)**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4434EUK-T	-40°C to +85°C	5 SOT23-5
MAX4434ESA	-40°C to +85°C	8 SO
MAX4435EUK-T	-40°C to +85°C	5 SOT23-5
MAX4435ESA	-40°C to +85°C	8 SO
MAX4436EUA	-40°C to +85°C	8 µMAX
MAX4436ESA	-40°C to +85°C	8 SO
MAX4437EUA	-40°C to +85°C	8 µMAX
MAX4437ESA	-40°C to +85°C	8 SO

Selector Guide appears at end of data sheet.

Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Single-Supply, 150MHz, 16-Bit Accurate, Ultra-Low Distortion Op Amps

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} - V_{EE}) ....+6V
Differential Input Voltage ....+2V
Input Voltage Range ....(V_{CC} + 0.3V) to (V_{EE} - 0.3V)
Current into Any Input Pin....................±25mA
Output Short-Circuit Duration to V_{CC} or V_{EE} ....(Note 1)
Continuous Power Dissipation (T_A = +70°C)
5-Pin SOT23 (derate 7.1mW/°C above +70°C) 571mW
8-Pin SO (derate 5.88mW/°C above +70°C)..............471mW
8-Pin µMAX (derate 4.5mW/°C above +70°C) 330mW
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

Note 1: The MAX4434–MAX4437 are not protected for output short-circuit conditions.

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.

DC ELECTRICAL CHARACTERISTICS

(V_{CC} = +5V, V_{EE} = 0, R_L = ∞ to V_{CC}/2, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Common-Mode Voltage Range	V_{CM}	Guaranteed by CMRR test		V_{EE}		V_{CC} - 1	V
Input Offset Voltage	V_{OS}				1	3.5	mV
Input Offset Voltage Temperature Coefficient	TCV_{OS}				4		µV/°C
Input Offset Voltage Matching		MAX4436/MAX4437			0.25		mV
Input Bias Current	I_B				14	22	µA
Input Offset Current	I_{OS}				1	5	µA
Input Resistance	R_{IN}	Differential Mode -10mV ≤ V_{IN} ≤ +10mV			1		kΩ
		Common Mode 0 ≤ V_{CM} ≤ (V_{CC} - 1V)			1.7		MΩ
Common-Mode Rejection Ratio	CMRR	V_{EE} ≤ V_{CM} ≤ (V_{CC} - 1V)		75	100		dB
Open-Loop Gain	A_{VOL}	(V_{EE} + 0.25) ≤ V_{OUT} ≤ (V_{CC} - 0.25), R_L = 10kΩ		100	115		dB
		(V_{EE} + 0.5) ≤ V_{OUT} ≤ (V_{CC} - 0.5), R_L = 500Ω		96	110		
Output Voltage Swing	V_{OUT}	R_L = 10kΩ	V_{CC} - V_{OH}		65	200	mV
			V_{OL} - V_{EE}		15	70	
Output Current	I_{OUT}	R_L = 20Ω to Ground	Sinking	40	65		mA
			Sourcing	35	60		
Output Short-Circuit Current	I_{SC}	Sinking or sourcing			±70		mA
DC Power-Supply Rejection Ratio	PSRR	V_{CC} = +4.5V to +5.5V		85	110		dB
Operating Supply Voltage	V_S	Guaranteed by PSRR test		+4.5		+5.5	V
Quiescent Supply Current (Per Amplifier)	I_S				15	18	mA

Note 2: All devices are 100% production tested at +25°C. Specifications over temperature limits are guaranteed by design.

AC ELECTRICAL CHARACTERISTICS

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = V_{CC}/2, R_L = 500Ω, A_{VCL} = +1, and T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small-Signal -3dB Bandwidth	BW_{SS}	V_{OUT} = 20mVp-p MAX4434/MAX4436		150		MHz
		V_{OUT} = 20mVp-p MAX4435/MAX4437 (A_{VCL} = +5)		150		
Large-Signal -3dB Bandwidth	BW_{LS}	V_{OUT} = 2Vp-p MAX4434/MAX4436		28		MHz
		V_{OUT} = 4Vp-p MAX4435/MAX4437 (A_{VCL} = +5)		25		
Small-Signal 0.1dB Gain Flatness	$BW_{0.1dBSS}$	V_{OUT} = 20mVp-p MAX4434/MAX4436		80		MHz
		V_{OUT} = 20mVp-p MAX4435/MAX4437 (A_{VCL} = +5)		80		
Large-Signal 0.1dB Gain Flatness	$BW_{0.1dBLS}$	V_{OUT} = 2Vp-p MAX4434/MAX4436		15		MHz
		V_{OUT} = 4Vp-p MAX4435/MAX4437 (A_{VCL} = +5)		20		
Slew Rate	SR	V_{OUT} = 2V step MAX4434/MAX4436		133		V/µs
		V_{OUT} = 4V step MAX4435/MAX4437 (A_{VCL} = +5)		388		
Rise/Fall Time	t_R, t_F	V_{OUT} = 2V step MAX4434/MAX4436		17		ns
		V_{OUT} = 4V step MAX4435/MAX4437 (A_{VCL} = +5)		10		
Settling Time to 16-Bit (0.0015%)	$t_{S\ 0.0015\%}$	V_{OUT} = 1.5V to 3.5V step MAX4434/MAX4436		35		ns
		V_{OUT} = 1.5V to 3.5V step MAX4435/MAX4437 (A_{VCL} = +5)		23		
		V_{OUT} = 1V to 4V step MAX4434/MAX4436		42		
Output "Glitch" Settling to 16-Bit (0.0015%)		5pF load, C_L charged from 1V to 4V		41		ns
Output Overload Recovery Time		50% overdrive, settling to 10% accuracy		100		ns
AC Common-Mode Rejection Ratio	CMRR	f_C = 100kHz		-92		dB

Single-Supply, 150MHz, 16-Bit Accurate, Ultra-Low Distortion Op Amps

AC ELECTRICAL CHARACTERISTICS (continued)

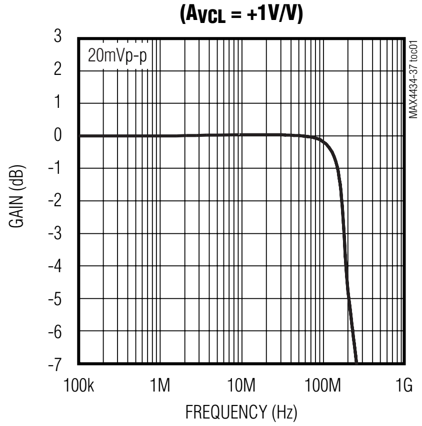
(V_{CC} = +5V, V_{EE} = 0, V_{CM} = V_{CC}/2, R_L = 500Ω, A_{VCL} = +1, and T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
AC Power-Supply Rejection Ratio	PSRR	f_C = 100kHz			-101		dB
Spurious-Free Dynamic Range	SFDR	V_{OUT} = 2Vp-p centered at V_{CC}/2	f_C = 100kHz		-97		dBc
			f_C = 1MHz		-98		
		V_{OUT} = 3Vp-p centered at V_{CC}/2	f_C = 100kHz		-130		
			f_C = 1MHz		-99		
		V_{OUT} = 4Vp-p centered at V_{CC}/2	f_C = 100kHz		-112		
			f_C = 1MHz		-97		
Input Noise Voltage Density	e_n	f_C = 100kHz			2.2		nV/√Hz
Input Noise Current Density	i_n	f_C = 100kHz			2.0		pA/√Hz
Input Capacitance	C_{IN}				2.3		pF
Maximum Capacitive Load Without Sustained Oscillations					30		pF
Output Impedance	Z_{OUT}	f_C = 1MHz			0.05		Ω
Crosstalk		f_C = 1MHz, MAX4436/MAX4437			-80		dB

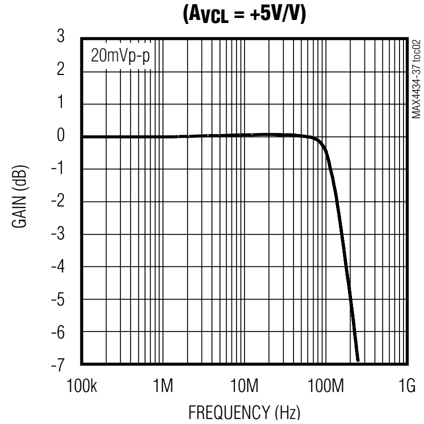
Typical Operating Characteristics

(V_{CC} = +5V, V_{EE} = 0, R_L = 500Ω, C_L = 0, T_A = +25°C, unless otherwise noted.)

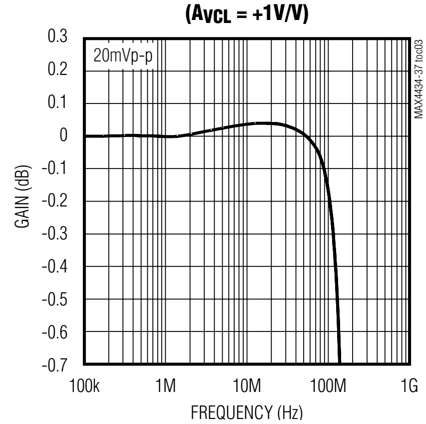
MAX4434/MAX4436
SMALL-SIGNAL GAIN vs. FREQUENCY
(A_{VCL} = +1V/V)



MAX4435/MAX4437
SMALL-SIGNAL GAIN vs. FREQUENCY
(A_{VCL} = +5V/V)



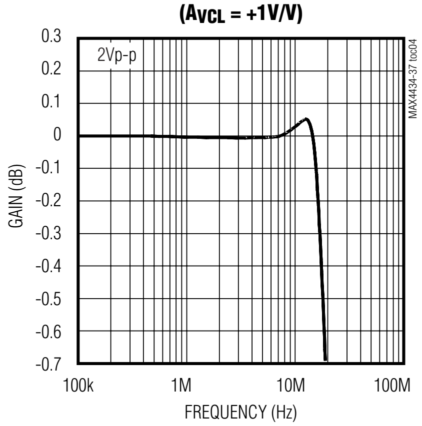
MAX4434/MAX4436
GAIN FLATNESS vs. FREQUENCY
(A_{VCL} = +1V/V)



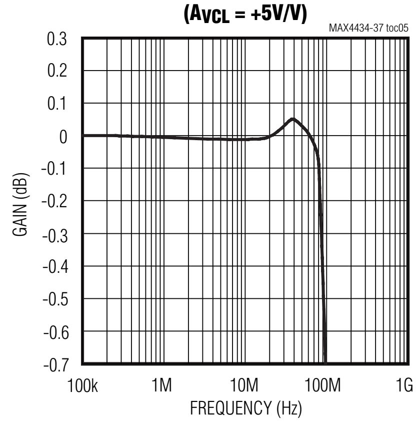
Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, R_L = 500Ω, C_L = 0, T_A = +25°C, unless otherwise noted.)

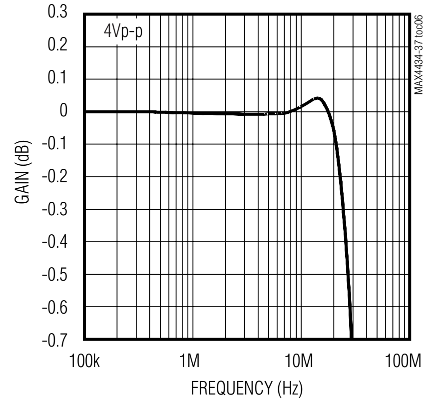
MAX4434/MAX4436 GAIN FLATNESS vs. FREQUENCY (A_{VCL} = +1V/V)



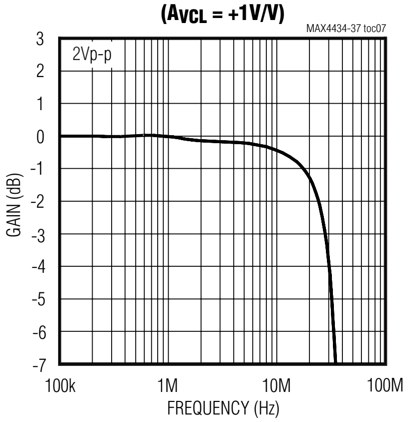
MAX4435/MAX4437 GAIN FLATNESS vs. FREQUENCY (A_{VCL} = +5V/V)



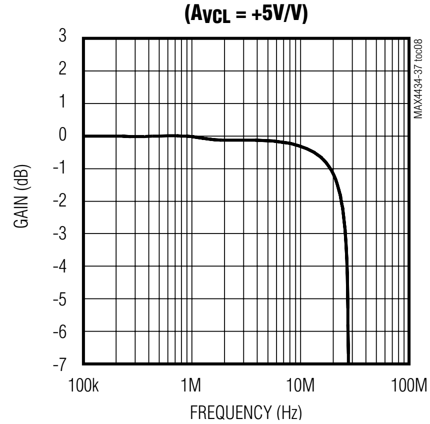
MAX4435/MAX4437 GAIN FLATNESS vs. FREQUENCY (A_{VCL} = +5V/V)



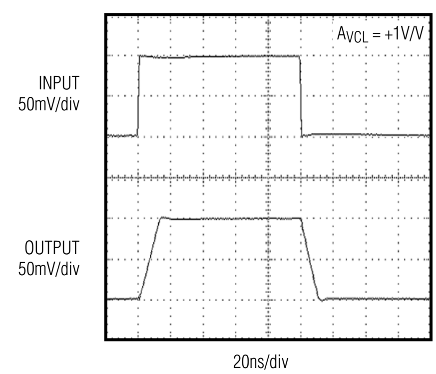
MAX4434/MAX4436 LARGE-SIGNAL GAIN vs. FREQUENCY (A_{VCL} = +1V/V)



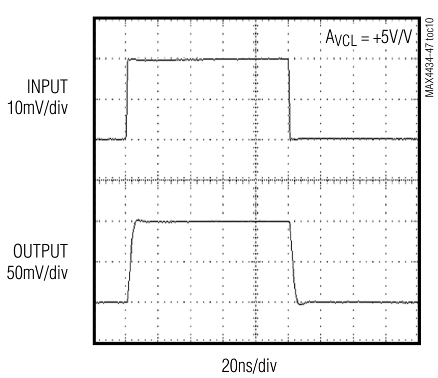
MAX4435/MAX4437 LARGE-SIGNAL GAIN vs. FREQUENCY (A_{VCL} = +5V/V)



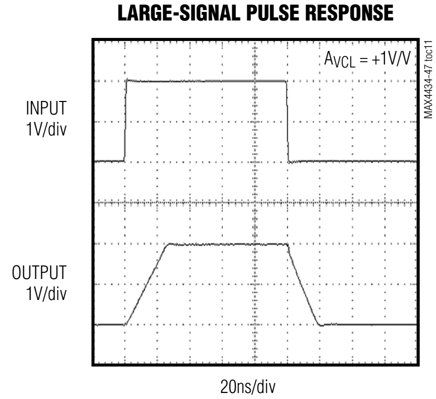
MAX4434/MAX4436 SMALL-SIGNAL PULSE RESPONSE



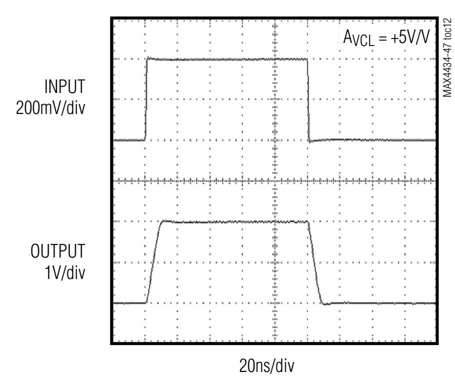
MAX4435/MAX4437 SMALL-SIGNAL PULSE RESPONSE



MAX4434/MAX4436 LARGE-SIGNAL PULSE RESPONSE



MAX4435/MAX4437 LARGE-SIGNAL PULSE RESPONSE

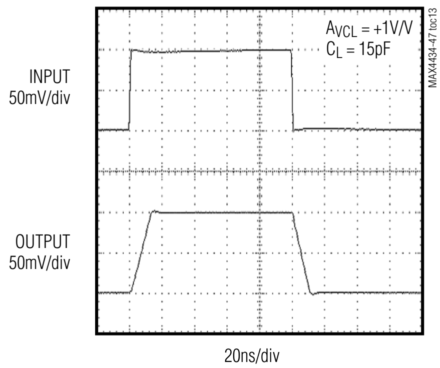


Single-Supply, 150MHz, 16-Bit Accurate, Ultra-Low Distortion Op Amps

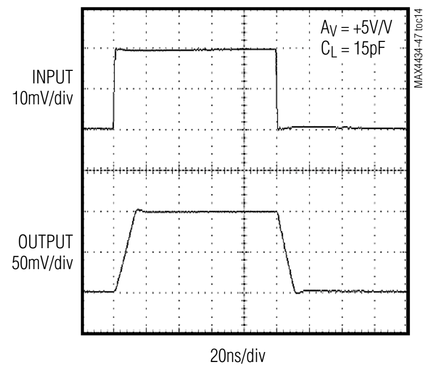
Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, R_L = 500Ω, C_L = 0, T_A = +25°C, unless otherwise noted.)

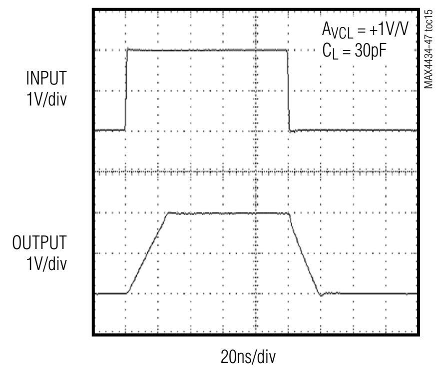
MAX4434/MAX4436 SMALL-SIGNAL PULSE RESPONSE



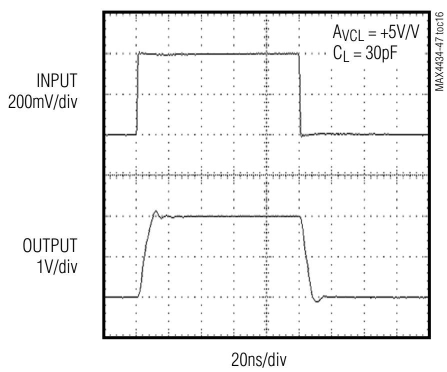
MAX4435/MAX4437 SMALL-SIGNAL PULSE RESPONSE



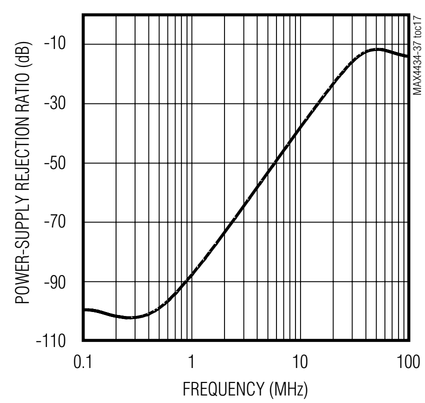
MAX4434/MAX4436 LARGE-SIGNAL PULSE RESPONSE



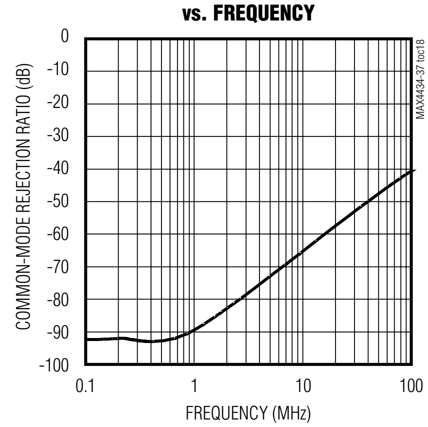
MAX4435/MAX4437 LARGE-SIGNAL PULSE RESPONSE



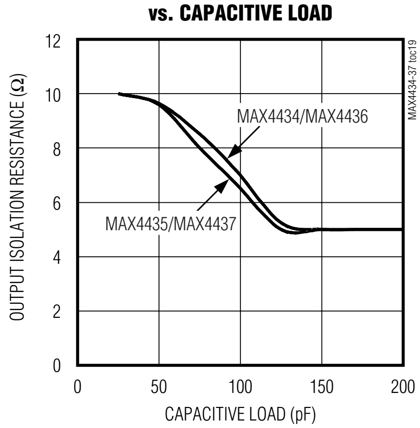
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



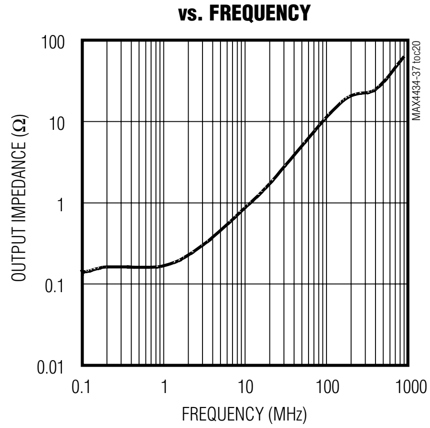
COMMON-MODE REJECTION RATIO vs. FREQUENCY



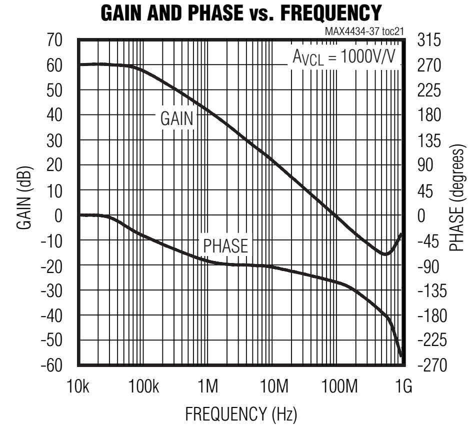
OUTPUT ISOLATION RESISTANCE vs. CAPACITIVE LOAD



CLOSED-LOOP OUTPUT IMPEDANCE vs. FREQUENCY



GAIN AND PHASE vs. FREQUENCY

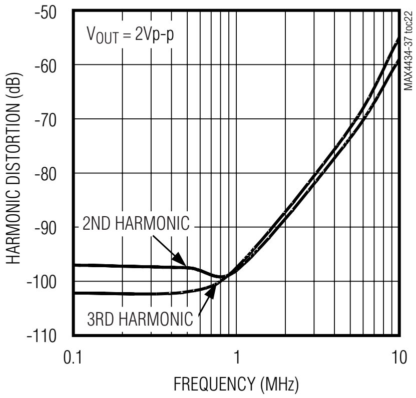


Single-Supply, 150MHz, 16-Bit Accurate, Ultra-Low Distortion Op Amps

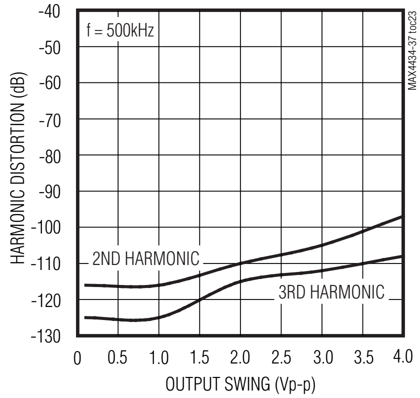
Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, R_L = 500Ω, C_L = 0, T_A = +25°C, unless otherwise noted.)

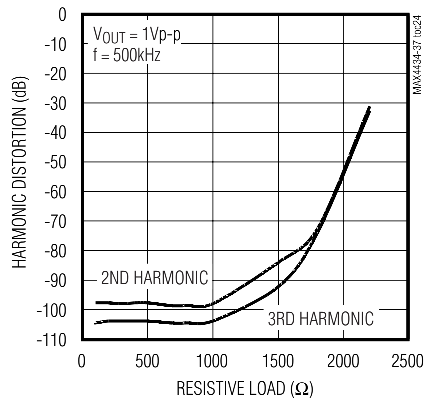
HARMONIC DISTORTION vs. FREQUENCY



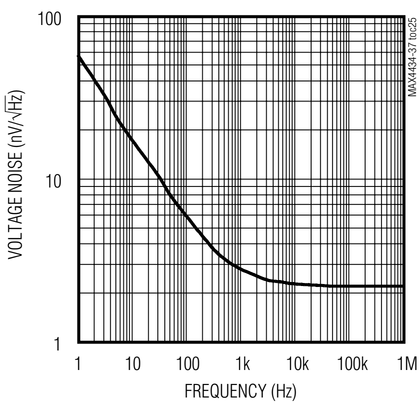
HARMONIC DISTORTION vs. OUTPUT SWING



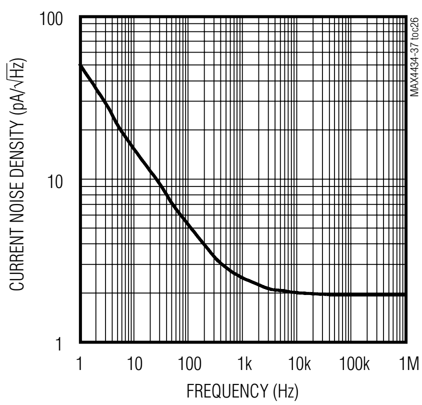
HARMONIC DISTORTION vs. RESISTIVE LOAD



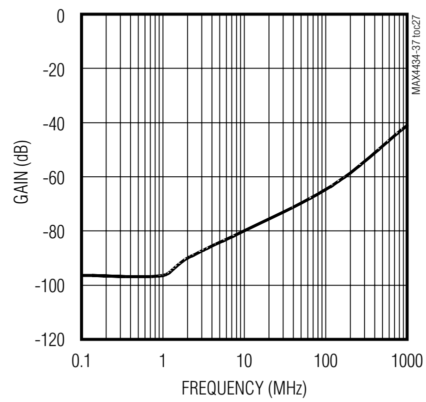
INPUT VOLTAGE NOISE vs. FREQUENCY



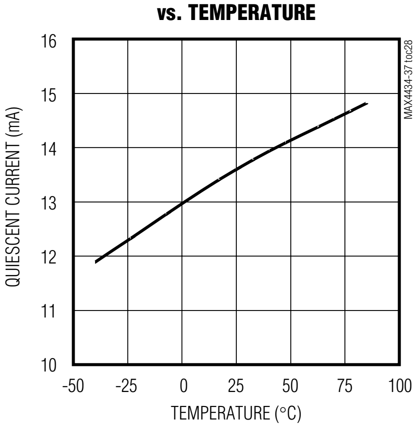
INPUT CURRENT NOISE DENSITY vs. FREQUENCY



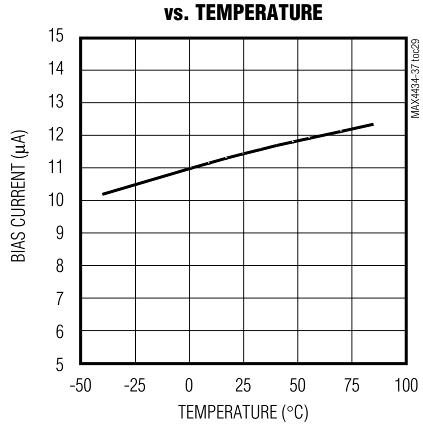
MAX4436/MAX4437 CROSSTALK vs. FREQUENCY



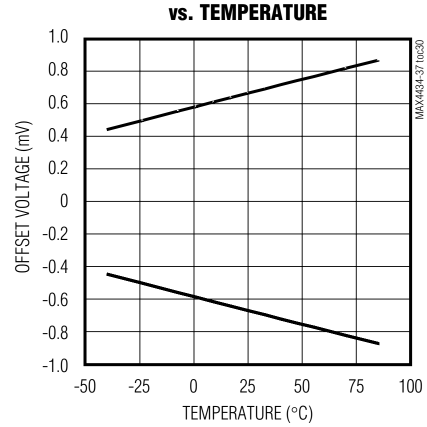
QUIESCENT CURRENT PER AMPLIFIER vs. TEMPERATURE



BIAS CURRENT vs. TEMPERATURE



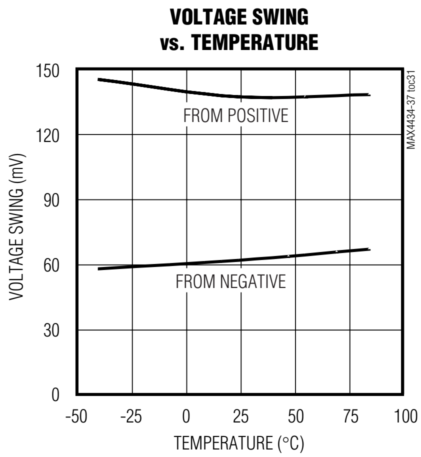
OFFSET VOLTAGE vs. TEMPERATURE

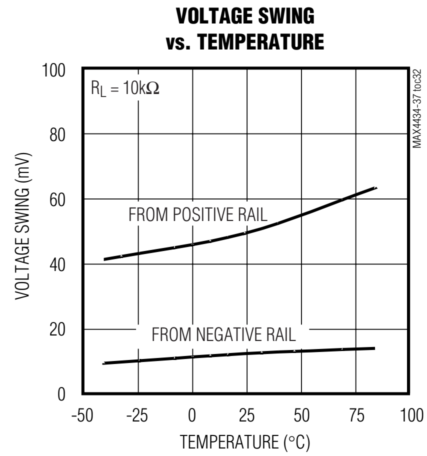


Single-Supply, 150MHz, 16-Bit Accurate, Ultra-Low Distortion Op Amps

Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, R_L = 500Ω, C_L = 0, T_A = +25°C, unless otherwise noted.)





Pin Description

PIN		NAME	FUNCTION
MAX4434/MAX4435			
SOT23	SO		
1	6	OUT	Output
2	4	V_{EE}	Ground
3	3	IN+	Noninverting Input
4	2	IN-	Inverting Input
5	7	V_{CC}	Positive Power Supply
—	1, 5, 8	N.C.	No Connection. Not internally connected.

PIN	NAME	FUNCTION
MAX4436/MAX4437		
SO/μMAX		
1	OUTA	Amplifier A Output
2	INA-	Amplifier A Inverting Input
3	INA+	Amplifier A Noninverting Input
4	V_{EE}	Ground
5	INB+	Amplifier A Noninverting Input
6	INB-	Amplifier A Inverting Input
7	OUTB	Amplifier A Output
8	V_{CC}	Positive Power Supply

Detailed Description

The MAX4434–MAX4437 are wide-bandwidth, ultra-low-distortion, voltage-feedback amplifiers. The MAX4434/MAX4436 are internally compensated for unity gain. The MAX4435/MAX4437 are internally compensated for gains of +5V/V or greater.

These amplifiers have ultra-fast 35ns (MAX4434/MAX4436) 16-bit settling times, -97dB SFDR at 1MHz, and 4Vp-p output swing with minimum 115dB open-loop gain.

High-Speed ADC Input Driver Application

The MAX4434–MAX4437 op amps are ideal for driving high-speed 14- to 16-bit ADCs. In most cases, these ADCs operate with a charge balance scheme, with capacitive loads internally switched on and off from the input. The driver used must withstand these changing capacitive loads while holding the signal amplitude stability consistent with the ADC's resolution and, at the same time, have a frequency response compatible with the sampling speed of the ADC (Figure 1).

Inverting and Noninverting Configurations

The circuits typically used for the inverting and noninverting configurations of the MAX4434–MAX4437 are shown in Figures 2a and 2b. The minimum unconditionally stable gain values are 1 for the MAX4434/MAX4436 and 5 for the MAX4435/MAX4437. Use care in selecting the value for the resistor marked R_S in both circuits. From dynamic stability considerations (based on the part's frequency response and the input capacitance of the MAX4434–MAX4437), the maximum recommended value for R_S is 500Ω. In general, lower R_S values will yield a higher bandwidth and better dynamic stability, at the cost of higher power consumption, higher power dissipation in the IC, and reduced output drive availability. For a minimum R_S value, take into consideration that the current indicated as I_F is supplied by the output stage and must be discounted from the maximum output current to calculate the maximum current available to the load. I_F can be found using the following equation:

$$I_F = V_{IN(MAX)} / R_S$$

If DC thermal stability is an important design concern, the Thevenin resistance seen by both inputs at DC must be balanced. This includes the resistance of the signal source and termination resistors if the amplifier signal input is fed from a transmission line. The capacitance associated with the feedback resistors must also be considered as a possible limitation to the available bandwidth or to the dynamic stability. Only resistors with small parallel capacitance specifications should be considered.

Applications Information

Layout and Power-Supply Bypassing

The MAX4434–MAX4437 have wide bandwidth and consequently require careful board layout. To realize the full AC performance of these high-speed amplifiers, pay careful attention to power-supply bypassing and board layout. The PC board should have a large low-impedance ground plane that is as free of voids as possible. Do not use commercial breadboards. Keep signal lines as short and straight as possible. Observe high-frequency bypassing techniques to maintain the amplifier's accuracy and stability. In general, use sur-

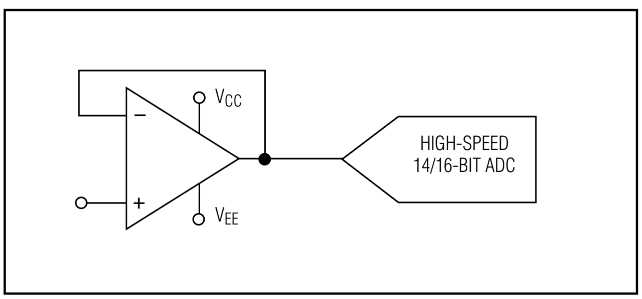


Figure 1. Typical Application Circuit

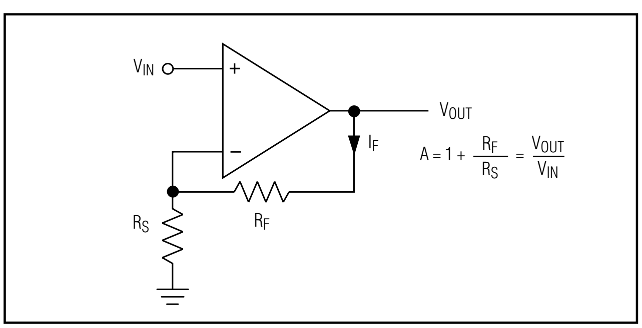


Figure 2a. Noninverting Configuration

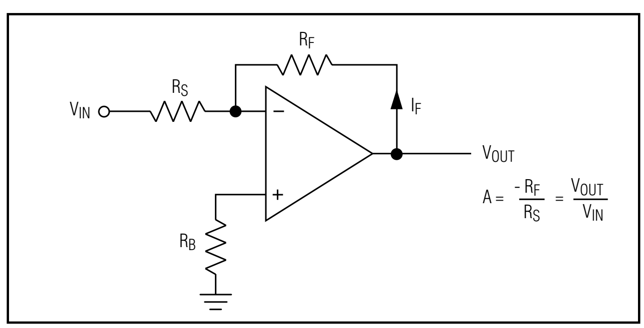


Figure 2b. Inverting Configuration

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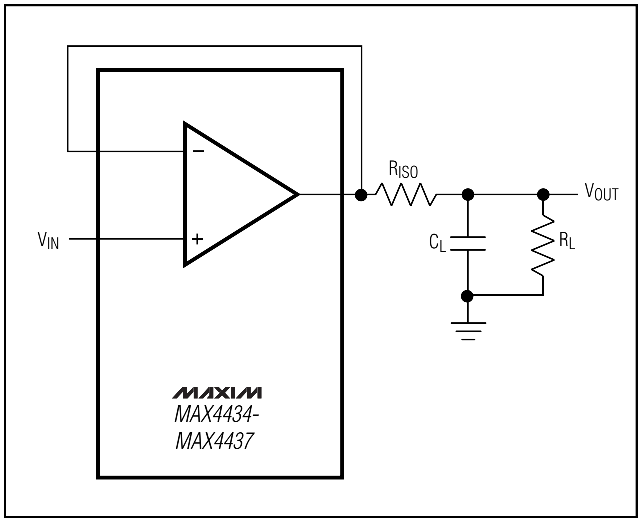


Figure 3. Capacitive-Load Driving Circuit

face-mount components since they have shorter bodies and lower parasitic reactance. This will result in improved performance over through-hole components. The bypass capacitors should include 1nF and/or 0.1µF surface-mount ceramic capacitors between V_{CC} and the ground plane, located as close to the package as possible. Place a 10µF tantalum capacitor at the power supply's point of entry to the PC board to ensure the integrity of the incoming supplies. Input termination resistors and output back-termination resistors, if used, should be surface-mount types and should be placed as close to the IC pins as possible.

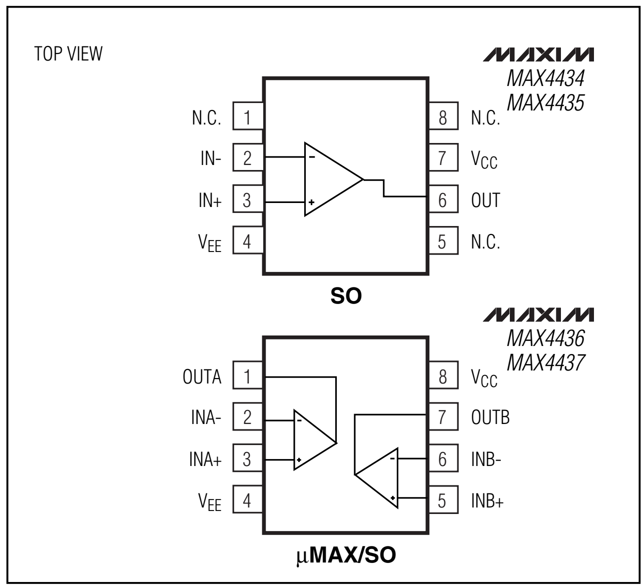
Driving Capacitive Loads

The MAX4434–MAX4437 can drive capacitive loads. However, excessive capacitive loads may cause ringing or instability at the output as phase margin is reduced. Adding a small isolation resistor in series with the output capacitive load helps reduce the ringing but slightly increases gain error (see *Typical Operating Characteristics* and Figure 3).

Selector Guide

PART	AMPS	MIN GAIN STABLE (V/V)	BW (MHz)	SETTLING TIME TO 0.0015% (ns)
MAX4434	1	+1	150	35
MAX4435	1	+5	150	23
MAX4436	2	+1	150	35
MAX4437	2	+5	150	23

Pin Configurations (continued)



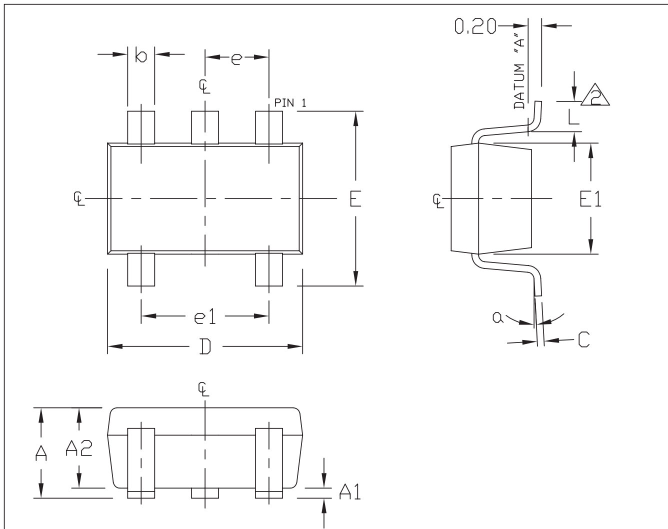
Chip Information

MAX4434/MAX4435 TRANSISTOR COUNT: 141

MAX4436/MAX4437 TRANSISTOR COUNT: 318

Package Information

SOT5L.EPS



SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95 REF	
e1	1.90 REF	
α	0°	10°

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. MEETS JEDEC MO178.

MAXIM
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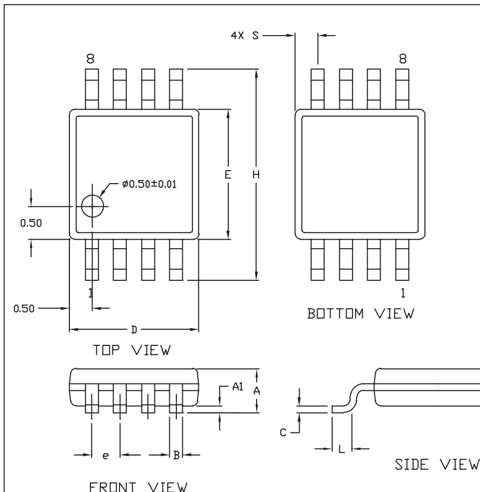
8LUMAXD.EPS



	INCHES		MILLIMETERS		JEDEC INCHES		JEDEC MILLIMETERS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
α	0°	6°	0°	6°	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC					

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. MEETS JEDEC MO-187.

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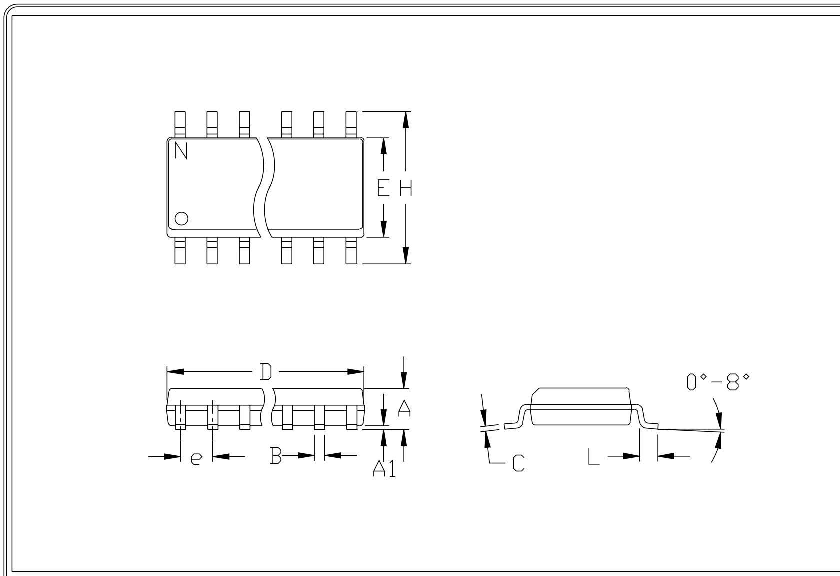
Single-Supply, 150MHz, 16-Bit Accurate, Ultra-Low Distortion Op Amps

Package Information (continued)



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR. SUNNYVALE CA 94086 FAX (408) 737 7194 PROPRIETARY INFORMATION | TITLE: PACKAGE FAMILY OUTLINE: SOIC .150" | 1/1 | DOCUMENT CONTROL NUMBER 21-0041 REV A

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