19-1824; Rev 0; 2/01

Low-Cost, +3V/+5V, 620µA, 200MHz, Single-Supply Op Amps with Rail-to-Rail Outputs

MAX4452/MAX4453/MAX4454/MAX4352/MAX4353/MAX4354

General Description

The MAX4452/MAX4352 single, MAX4453/MAX4353 dual, and MAX4454/MAX4354 quad amplifiers combine high-speed performance with ultra-low power consumption. The MAX4452/MAX4453/MAX4454 are unity-gain stable and achieve a -3dB bandwidth of 200MHz, while the MAX4352/MAX4353/MAX4354 are compensated for a minimum closed-loop gain of +5V/V and achieve a 80MHz -3dB bandwidth. These devices consume only 620µA of supply current per amplifier.

These amplifiers operate from a +2.7V to +5.25V single supply and feature Rail-to-Rail® outputs. Along with an excellent speed/power ratio of 323MHz/mA, these devices feature a slew rate of 95V/µs and fast 20ns rise and fall times. These devices are ideal for low-power/low-voltage systems that require wide bandwidth such as cell phones and keyless entry systems.

The MAX4452/MAX4352 are available in miniature 5-pin SC70 and SOT23 packages, while the MAX4453/MAX4353 are available in tiny 8-pin SOT23 and SO packages. The MAX4454/MAX4354 are available in space-saving 14-pin TSSOP and SO packages.

Applications

Battery-Powered Instruments

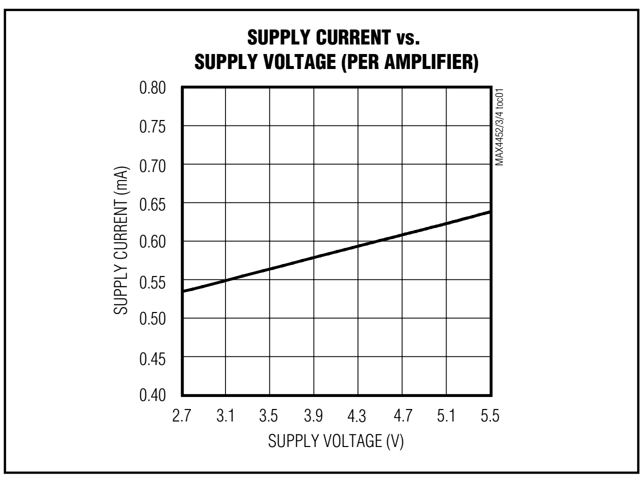
Cellular Telephones

Portable Communications

Keyless Entry

Baseband Applications

Typical Operating Characteristic



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

Features

- ♦ **Ultra-Low 620µA Supply Current**
- ♦ **High Speed (MAX4452/MAX4453/MAX4454)**
  200MHz -3dB Bandwidth
  30MHz 0.1dB Gain Flatness
  95V/µs Slew Rate
- ♦ **High Speed (MAX4352/MAX4353/MAX4354)**
  80MHz -3dB Bandwidth
  4MHz 0.1dB Gain Flatness
  240V/µs Slew Rate
- ♦ **Single +3V/+5V Operation**
- ♦ **Rail-to-Rail Outputs**
- ♦ **Input Common-Mode Range Extends Beyond V_{EE}**
- ♦ **Ultra-Small SC70-5, SOT23-5, and SOT23-8 Packages**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE	TOP MARK
MAX4452EXK-T	-40°C to +85°C	5 SC70-5	ABI
MAX4452EUK-T	-40°C to +85°C	5 SOT23-5	ADOV
MAX4453EKA-T	-40°C to +85°C	8 SOT23-8	AADS
MAX4453ESA	-40°C to +85°C	8 SO	—
MAX4454EUD	-40°C to +85°C	14 TSSOP	—
MAX4454ESD	-40°C to +85°C	14 SO	—
MAX4352EXK-T	-40°C to +85°C	5 SC70-5	ABJ
MAX4352EUK-T	-40°C to +85°C	5 SOT23-5	ADOW
MAX4353EKA-T	-40°C to +85°C	8 SOT23-8	AADT
MAX4353ESA	-40°C to +85°C	8 SO	—
MAX4354EUD	-40°C to +85°C	14 TSSOP	—
MAX4354ESD	-40°C to +85°C	14 SO	—

Pin Configurations appear at end of data sheet.

Selector Guide

PART	NO. OF AMPS	MIN GAIN	GAIN BANDWIDTH (MHz)	SLEW RATE (V/µs)
MAX4452	1	1	200	95
MAX4352	1	5	400	240
MAX4453	2	1	200	95
MAX4353	2	5	400	240
MAX4454	4	1	200	95
MAX4354	4	5	400	240

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} to V_{EE})....+6V
Differential Input Voltage 2.5V
IN_-, IN_+, OUT_....(V_{CC} + 0.3V) to (V_{EE} - 0.3V)
Current into Input Pins (IN_+, IN_-) ....±20mA
Output Short-Circuit Duration to V_{CC}, V_{EE} ....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
- 8-Pin SOT23 (derate 8.9mW/°C above +70°C)....741mW
- 8-Pin SO (derate 5.9mW/°C above +70°C)....471mW
- 14-Pin TSSOP (derate 6.3mW/°C above +70°C) 500mW
- 14-Pin SO (derate 8mW/°C above +70°C)....640mW

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

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_{CM} = V_{CC}/2 - 0.75V, V_{EE} = 0, R_L = ∞ to V_{CC}/2, V_{OUT} = V_{CC}/2, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Operating Supply Voltage Range	V_S	Guaranteed by PSRR test		2.7		5.25	V
Quiescent Supply Current (Per Amplifier)	I_S	V_{CC} = + 5V			620	1200	µA
		V_{CC} = +3V			530		
Input Common-Mode Voltage Range	V_{CM}	Guaranteed by CMRR test		V_{EE} - 0.1		V_{CC} - 1.5	V
Input Offset Voltage	V_{OS}				0.4	12	mV
Input Offset Voltage Temperature Coefficient	TC_{VOS}				7		µV/°C
Input Offset Voltage Matching		MAX4453/MAX4454/MAX4353/MAX4354			±1		mV
Input Bias Current	I_B				0.8	3	µA
Input Offset Current	I_{OS}				0.1		µA
Input Resistance	R_{IN}	Differential mode, -0.04V ≤ (V_{IN+} - V_{IN}) ≤ +0.04V			120		kΩ
		Common mode, V_{EE} - 0.1V ≤ V_{CM} ≤ V_{CC} - 1.5V			30		MΩ
Common-Mode Rejection Ratio	CMRR	V_{EE} - 0.1V ≤ V_{CM} ≤ V_{CC} - 1.5V		60	100		dB
Open-Loop Gain	A_{VOL}	+0.5V ≤ V_{OUT} ≤ +4.5V, R_L = 1kΩ		60	80		dB
Output Current	I_{OUT}	R_L = 20Ω connected to V_{CC} or V_{EE}	Sourcing		15		mA
			Sinking		22		
Output Voltage Swing	V_{OUT}	R_L = 1kΩ	V_{CC} - V_{OH}		180	400	mV
			V_{OL} - V_{EE}		75	350	
Output Short-Circuit Current	I_{SC}	Sourcing			17		mA
		Sinking			24		
Power-Supply Rejection Ratio	PSRR	V_{CC} = +2.7V to +5.25V, V_{CM} = 0, V_{OUT} = 2V		60	70		dB

AC ELECTRICAL CHARACTERISTICS

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, R_L = 1kΩ to $V_{CC}/2$, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Small Signal -3dB Bandwidth	BW_{SS}	V_{OUT} = 100mV_{p-p}	MAX4452/MAX4453/ MAX4454		200		MHz
			MAX4352/MAX4353/ MAX4354		80		
Large Signal -3dB Bandwidth	BW_{LS}	V_{OUT} = 2V_{p-p}	MAX4452/MAX4453/ MAX4454		15		MHz
			MAX4352/MAX4353/ MAX4354		38		
Bandwidth for 0.1dB Flatness	$BW_{0.1dB}$	V_{OUT} = 100mV_{p-p}	MAX4452/MAX4453/ MAX4454		30		MHz
			MAX4352/MAX4353/ MAX4354		4		
Slew Rate	SR	V_{OUT} = 2V step	MAX4452/MAX4453/ MAX4454		95		V/µs
			MAX4352/MAX4353/ MAX4354		240		
Rise/Fall Time	t_R, t_F	V_{OUT} = 2V step 10% to 90%	MAX4452/MAX4453/ MAX4454		20		ns
			MAX4352/MAX4353/ MAX4354		8		
Settling Time	$t_{S\ 1\%}$	V_{OUT} = 2V step	MAX4452/MAX4453/ MAX4454		40		ns
			MAX4352/MAX4353/ MAX4354		50		
	$t_{S\ 0.1\%}$	V_{OUT} = 2V step	MAX4452/MAX4453/ MAX4454		50		
			MAX4352/MAX4353/ MAX4354		60		

AC ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, R_L = 1kΩ to V_{CC}/2, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Spurious-Free Dynamic Range	SFDR	V_{CC} = 5V, V_{OUT} = 2Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-83		dBc
			MAX4352/MAX4353/MAX4354		-74		
		V_{CC} = 3V, V_{OUT} = 2Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-79		
			MAX4352/MAX4353/MAX4354		-70		
2nd-Harmonic Distortion		V_{CC} = 5V, V_{OUT} = 2Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-83		dBc
			MAX4352/MAX4353/MAX4354		-74		
		V_{CC} = 3V, V_{OUT} = 1Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-79		
			MAX4352/MAX4353/MAX4354		-70		
3rd-Harmonic Distortion		V_{CC} = 5V, V_{OUT} = 2Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-87		dBc
			MAX4352/MAX4353/MAX4354		-74		
		V_{CC} = 3V, V_{OUT} = 1Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-80		
			MAX4352/MAX4353/MAX4354		-72		
Total Harmonic Distortion	THD	V_{CC} = 5V, V_{OUT} = 2Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-82		dB
			MAX4352/MAX4353/MAX4354		-71		
		V_{CC} = 3V, V_{OUT} = 1Vp-p, f_C = 1MHz	MAX4452/MAX4453/MAX4454		-77		
			MAX4352/MAX4353/MAX4354		-68		

AC ELECTRICAL CHARACTERISTICS (continued)

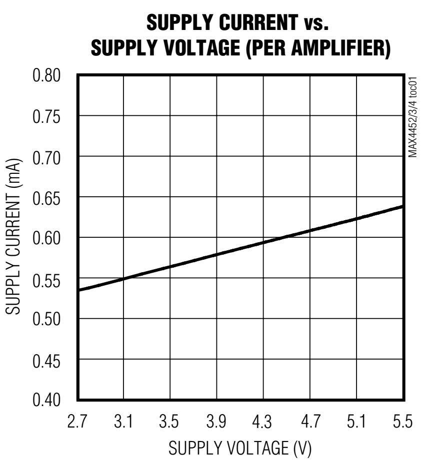
(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, R_L = 1kΩ to V_{CC}/2, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), T_A = +25°C, unless otherwise noted.)

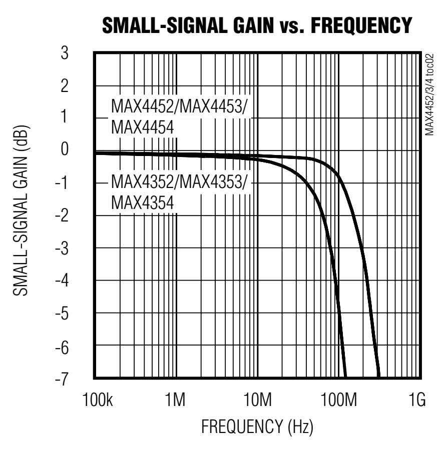
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Two-Tone, Third-Order Intermodulation Distortion		f_1 = 2MHz, f_2 = 2.1MHz		-65		dBc
Input Noise-Voltage Density	e_n	f = 10kHz		15		nV/√Hz
Input Noise-Current Density	i_n	f = 10kHz		0.5		pA/√Hz
Input Capacitance	C_{IN}			2		pF
Output Impedance	Z_{OUT}	f = 1MHz		0.8		Ω
Capacitive Load Drive				22		pF
Crosstalk	X_{TALK}	MAX4453/MAX4454/MAX4353/MAX4354 V_{OUT} = 100mVp-p, f = 1MHz		-74		dB
Power-Up 1% Settling Time (Note 2)				1	100	µs

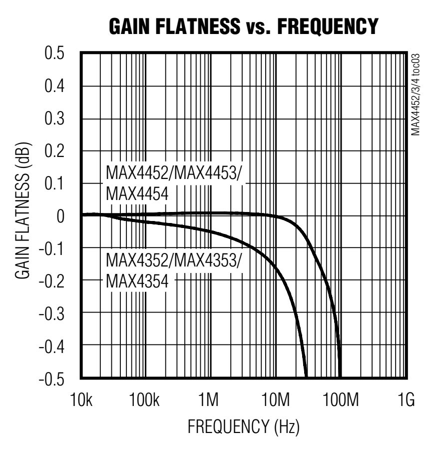
Note 1: Units are 100% production tested at T_A = +25°C. Specifications over temperature limits are guaranteed by design.
Note 2: Guaranteed by design.

Typical Operating Characteristics

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), R_L = 1kΩ to V_{CC}/2, C_L = 5pF, T_A = +25°C, unless otherwise noted.)



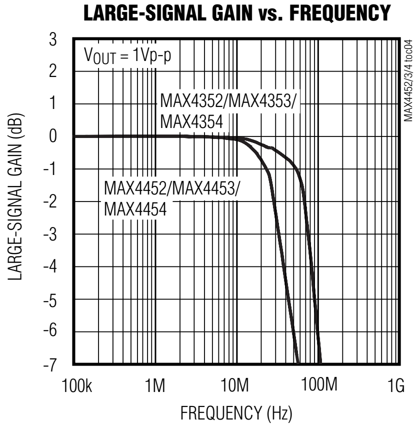




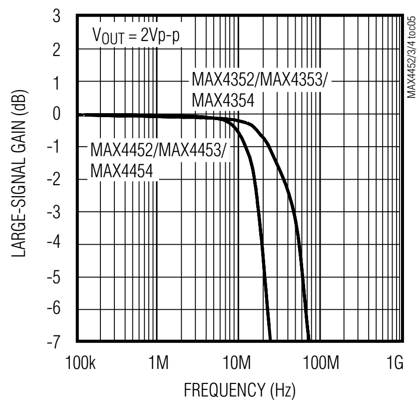
Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), R_L = 1kΩ to V_{CC}/2, C_L = 5pF, T_A = +25°C, unless otherwise noted.)

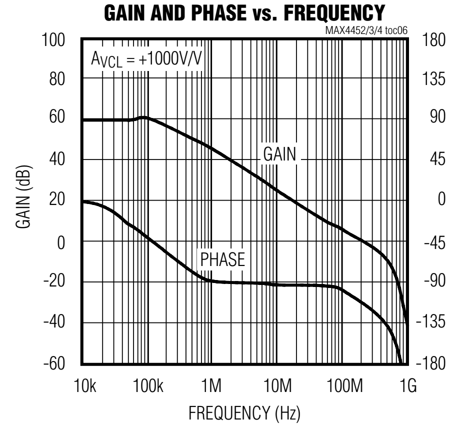
LARGE-SIGNAL GAIN vs. FREQUENCY



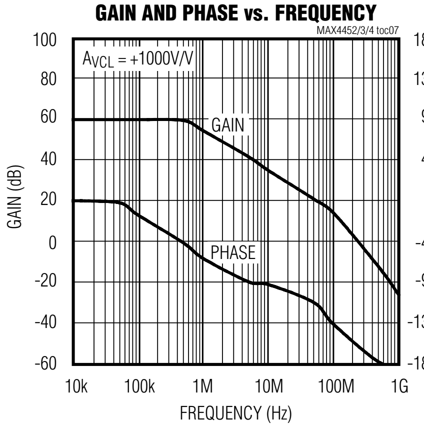
LARGE-SIGNAL GAIN vs. FREQUENCY



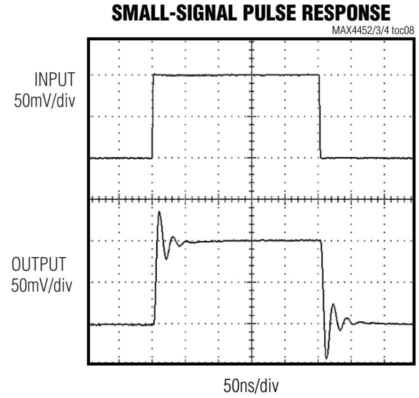
MAX4452/MAX4453/MAX4454
GAIN AND PHASE vs. FREQUENCY



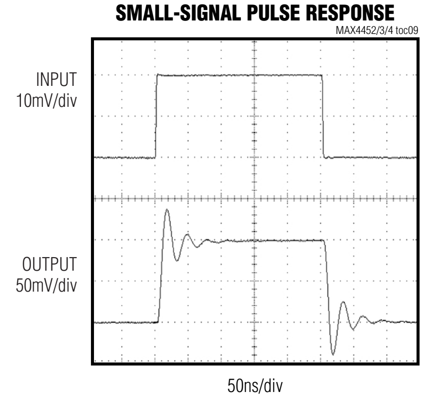
MAX4352/MAX4353/MAX4354
GAIN AND PHASE vs. FREQUENCY



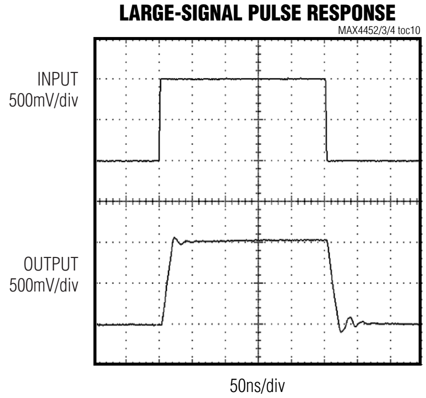
MAX4452/MAX4453/MAX4454
SMALL-SIGNAL PULSE RESPONSE



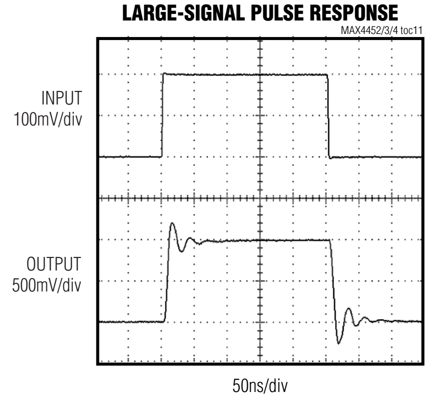
MAX4352/MAX4353/MAX4354
SMALL-SIGNAL PULSE RESPONSE



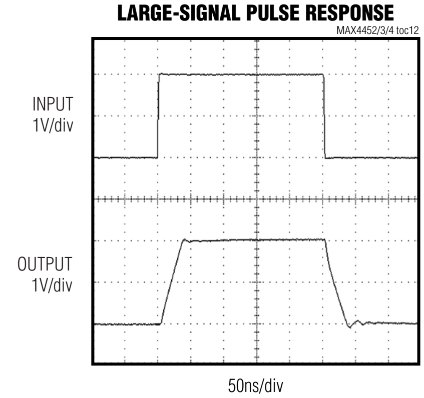
MAX4452/MAX4453/MAX4454
LARGE-SIGNAL PULSE RESPONSE



MAX4352/MAX4353/MAX4354
LARGE-SIGNAL PULSE RESPONSE



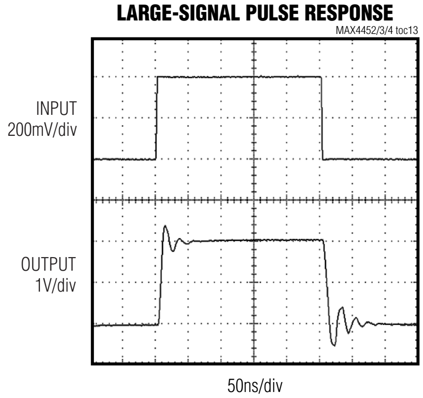
MAX4452/MAX4453/MAX4454
LARGE-SIGNAL PULSE RESPONSE



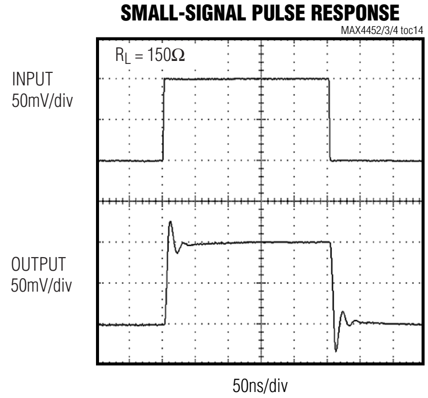
Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), R_L = 1kΩ to V_{CC}/2, C_L = 5pF, T_A = +25°C, unless otherwise noted.)

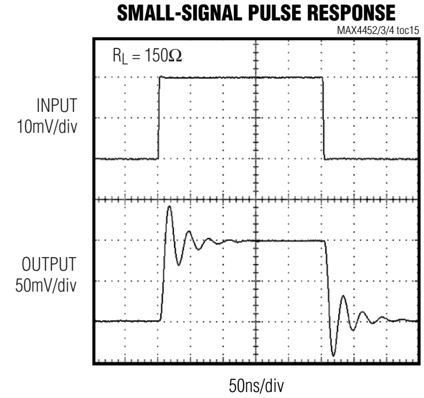
MAX4352/MAX4353/MAX4354 LARGE-SIGNAL PULSE RESPONSE



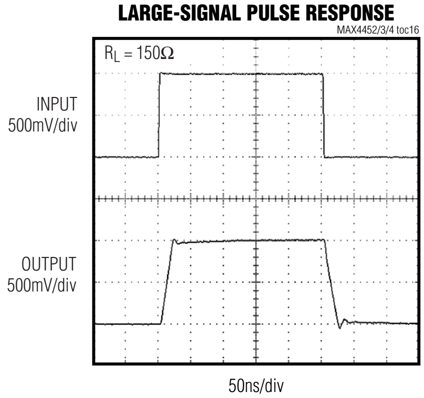
MAX4452/MAX4453/MAX4454 SMALL-SIGNAL PULSE RESPONSE



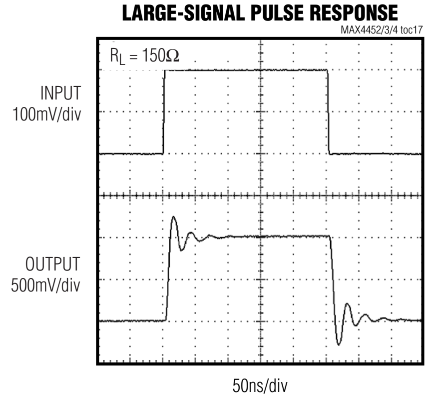
MAX4352/MAX4353/MAX4354 SMALL-SIGNAL PULSE RESPONSE



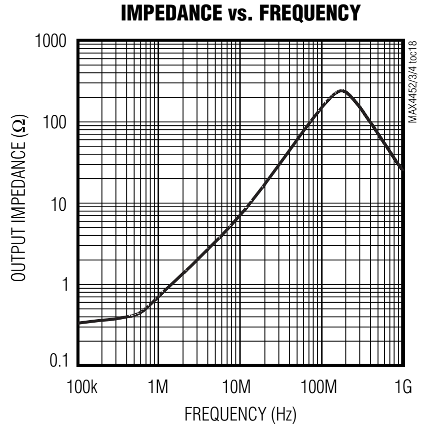
MAX4452/MAX4453/MAX4454 LARGE-SIGNAL PULSE RESPONSE



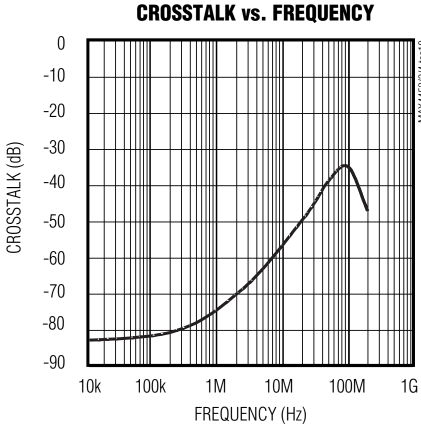
MAX4352/MAX4353/MAX4354 LARGE-SIGNAL PULSE RESPONSE



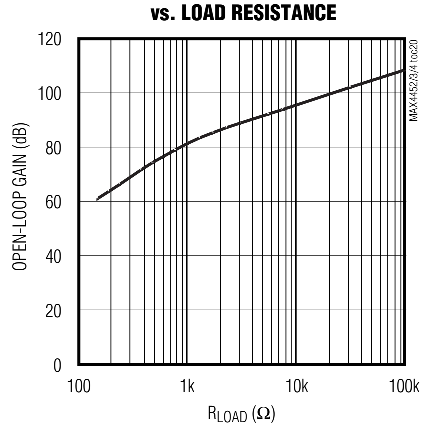
CLOSED-LOOP OUTPUT IMPEDANCE vs. FREQUENCY



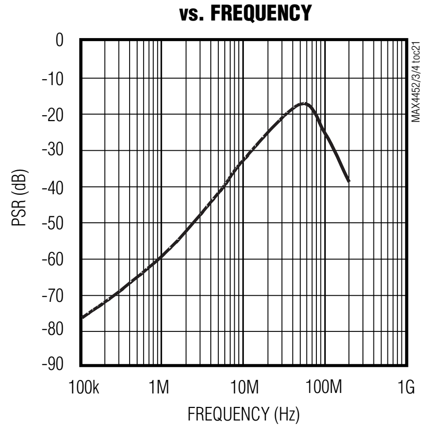
CROSSTALK vs. FREQUENCY



OPEN-LOOP GAIN vs. LOAD RESISTANCE



POWER-SUPPLY REJECTION vs. FREQUENCY

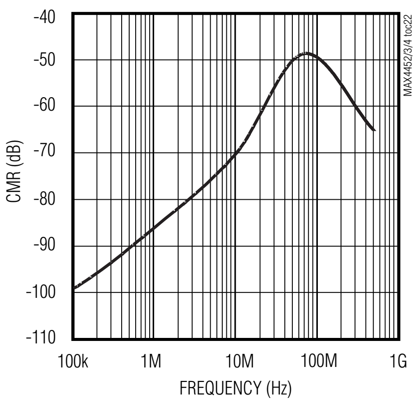


Low-Cost, +3V/+5V, 620µA, 200MHz, Single-Supply Op Amps with Rail-to-Rail Outputs

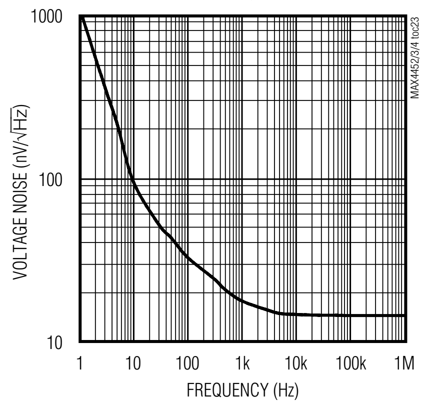
Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), R_L = 1kΩ to V_{CC}/2, C_L = 5pF, T_A = +25°C, unless otherwise noted.)

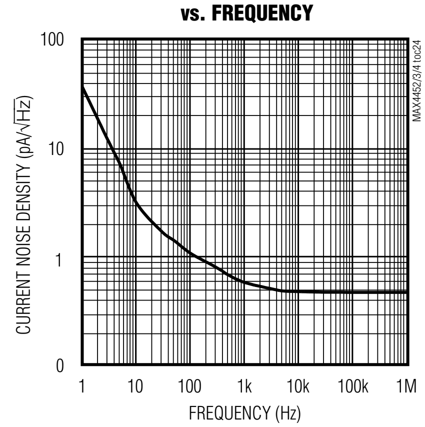
COMMON-MODE REJECTION vs. FREQUENCY



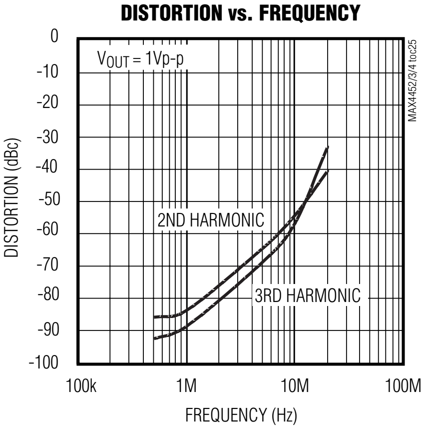
VOLTAGE NOISE DENSITY vs. FREQUENCY



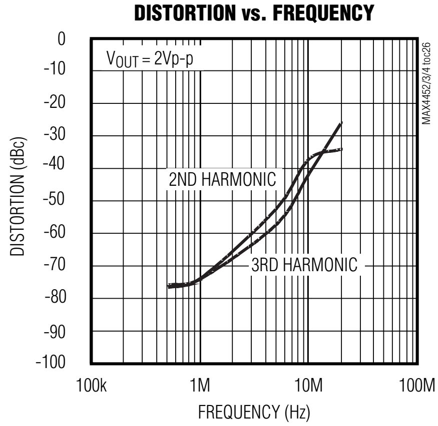
CURRENT NOISE DENSITY vs. FREQUENCY



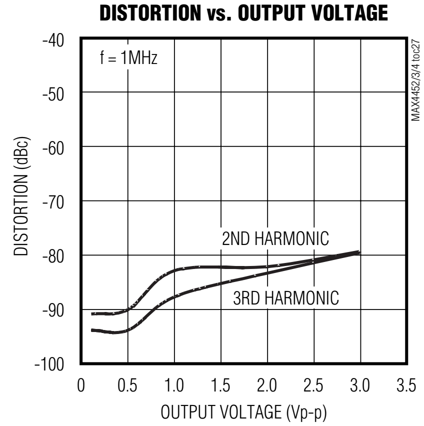
MAX4452/MAX4453/MAX4454 DISTORTION vs. FREQUENCY



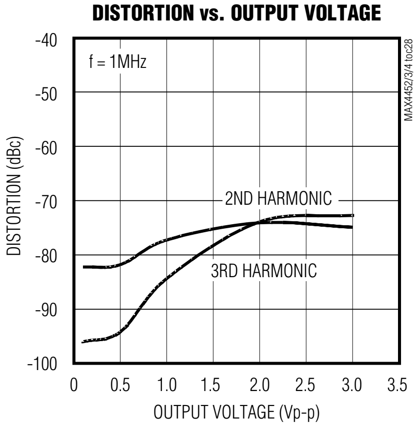
MAX4352/MAX4353/MAX4354 DISTORTION vs. FREQUENCY



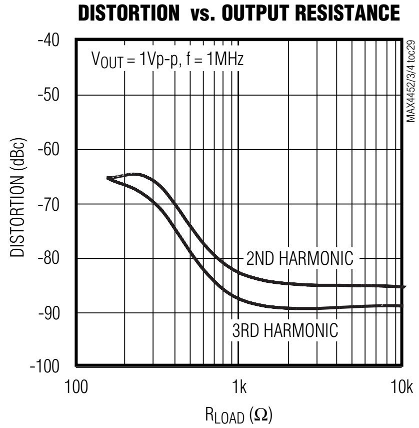
MAX4452/MAX4453/MAX4454 DISTORTION vs. OUTPUT VOLTAGE



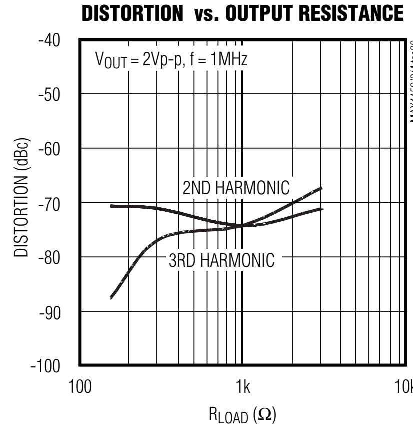
MAX4352/MAX4353/MAX4354 DISTORTION vs. OUTPUT VOLTAGE



MAX4452/MAX4453/MAX4454 DISTORTION vs. OUTPUT RESISTANCE



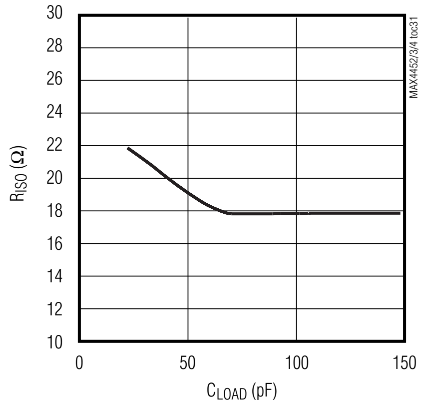
MAX4352/MAX4353/MAX4354 DISTORTION vs. OUTPUT RESISTANCE



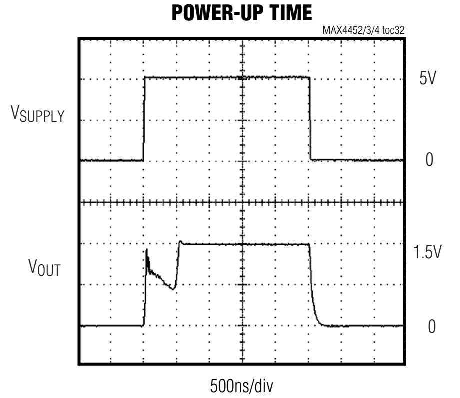
Typical Operating Characteristics (continued)

(V_{CC} = +5V, V_{EE} = 0, V_{CM} = +1.75V, A_{VCL} = +1V/V (MAX4452/MAX4453/MAX4454), A_{VCL} = +5V/V (MAX4352/MAX4353/MAX4354), R_L = 1kΩ to V_{CC}/2, C_L = 5pF, T_A = +25°C, unless otherwise noted.)

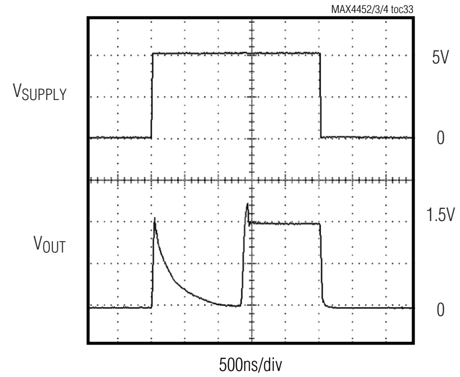
ISOLATION RESISTANCE vs. CAPACITIVE LOAD



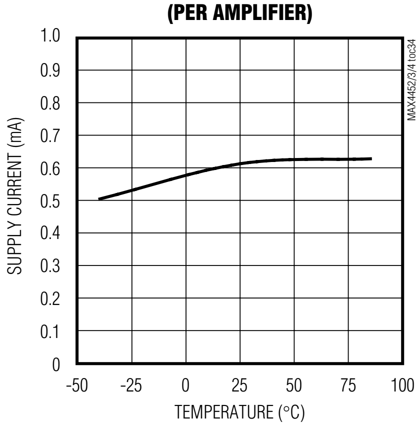
MAX4452/MAX4453/MAX4454 POWER-UP TIME



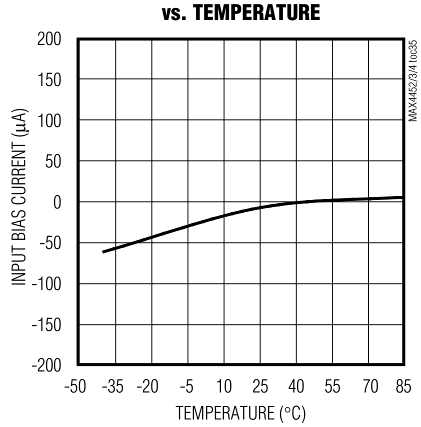
MAX4352/MAX4353/MAX4354 POWER-UP TIME



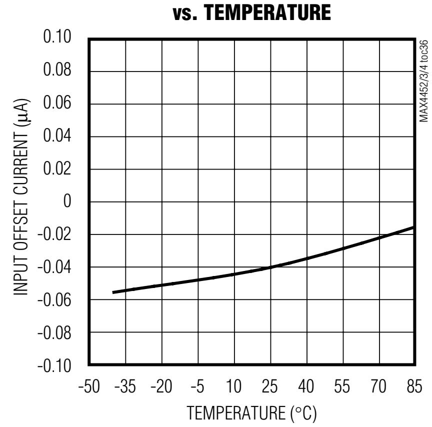
SUPPLY CURRENT vs. TEMPERATURE (PER AMPLIFIER)



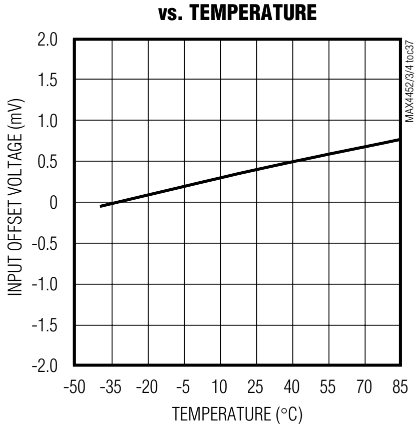
INPUT BIAS CURRENT vs. TEMPERATURE



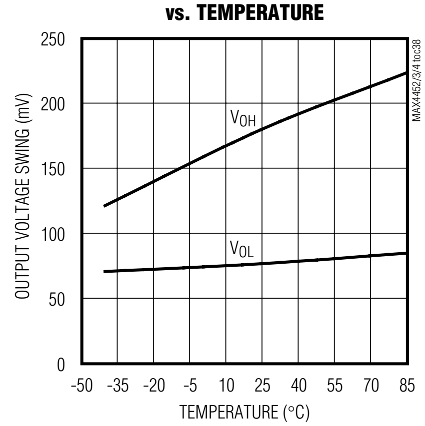
INPUT OFFSET CURRENT vs. TEMPERATURE



INPUT OFFSET VOLTAGE vs. TEMPERATURE



OUTPUT VOLTAGE SWING vs. TEMPERATURE



Pin Description

PIN			NAME	FUNCTION
MAX4452 MAX4352	MAX4453 MAX4353	MAX4454 MAX4354		
1	—	—	OUT	Amplifier Output
2	4	11	V_{EE}	Negative Power Supply
3	—	—	IN+	Noninverting Amplifier Input
4	—	—	IN-	Inverting Amplifier Input
5	8	4	V_{CC}	Positive Power Supply
—	1	1	OUTA	Amplifier A Output
—	2	2	INA-	Amplifier A Inverting Input
—	3	3	INA+	Amplifier A Noninverting Input
—	7	7	OUTB	Amplifier B Output
—	6	6	INB-	Amplifier B Inverting Input
—	5	5	INB+	Amplifier B Noninverting Input
—	—	8	OUTC	Amplifier C Output
—	—	9	INC-	Amplifier C Inverting Input
—	—	10	INC+	Amplifier C Noninverting Input
—	—	14	OUTD	Amplifier D Output
—	—	13	IND-	Amplifier D Inverting Input
—	—	12	IND+	Amplifier D Noninverting Input

Detailed Description

The MAX4452/MAX4352 single, MAX4453/MAX4353 dual, and MAX4454/MAX4354 quad, single-supply, rail-to-rail, voltage-feedback amplifiers achieve high slew rates and wide bandwidths while consuming only 620µA per amplifier. Excellent speed/power ratio makes them ideal for portable devices and high-frequency signal applications.

Internal feedback around the output stage ensures low open-loop output impedance, reducing gain sensitivity to load variations. This feedback also produces demand-driven current bias to the output transistors.

Rail-to-Rail Outputs, Ground-Sensing Input

The input common-mode range extends from (V_{EE} - 0.1V) to (V_{CC} - 1.5V) with excellent common-mode rejection. Beyond this range, the amplifier output is a nonlinear function of the input, but does not undergo phase reversal or latchup.

The output swings to within 180mV of either power-supply rail with a 1kΩ load. The input ground-sensing and the rail-to-rail output substantially increase the dynamic range.

Output Capacitive Loading and Stability

The MAX4452/MAX4453/MAX4454/MAX4352/MAX4353/MAX4354 are optimized for AC performance. They are not designed to drive highly reactive loads. Such loads decrease phase margin and may produce excessive ringing and oscillation. The use of an isolation resistor eliminates this problem (Figure 1). Figure 2 is a graph of the Optimal Isolation Resistor (R_{ISO}) vs. Capacitive Load.

Applications Information

Choosing Resistor Values

Unity-Gain Configuration

The MAX4452/MAX4453/MAX4454 are internally compensated for unity gain. When configured for unity gain, a 24Ω feedback resistor (R_F) is recommended. This resistor improves AC response by reducing the Q of the parallel LC circuit formed by the parasitic feedback capacitance and inductance.

Inverting and Noninverting Configurations

Select the gain-setting feedback (R_F) and input (R_G) resistor values that best fit the application. Large resistor values increase voltage noise and interact with the amplifier's input and PC board capacitance. This can generate undesirable poles and zeros and decrease bandwidth or cause oscillations. For example, a noninverting gain-of-two configuration (R_F = R_G) using 1kΩ resistors, combined with 2pF of amplifier input capacitance and 1pF of PC board capacitance, causes a pole at 106MHz. Since this pole is within the amplifier bandwidth, it jeopardizes stability. Reducing the 1kΩ resistors to 100Ω extends the pole frequency to 1.06GHz, but could limit output swing by adding 200Ω in parallel with the amplifier's load resistor.

Note: For high-gain applications where output offset voltage is a consideration, choose RS to be equal to the parallel combination of RF and RG (Figures 3a and 3b).

$$R_S = \frac{R_F \times R_G}{R_F + R_G}$$

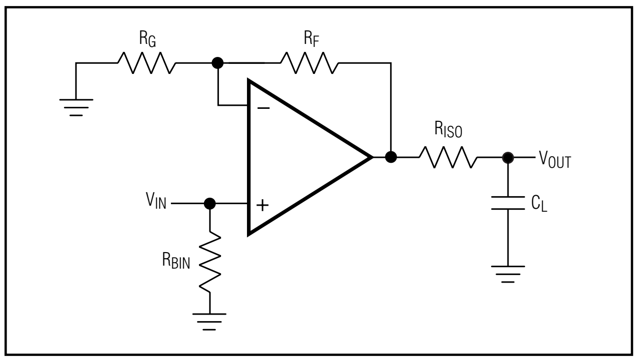


Figure 1. Driving a Capacitive Load Through an Isolation Resistor

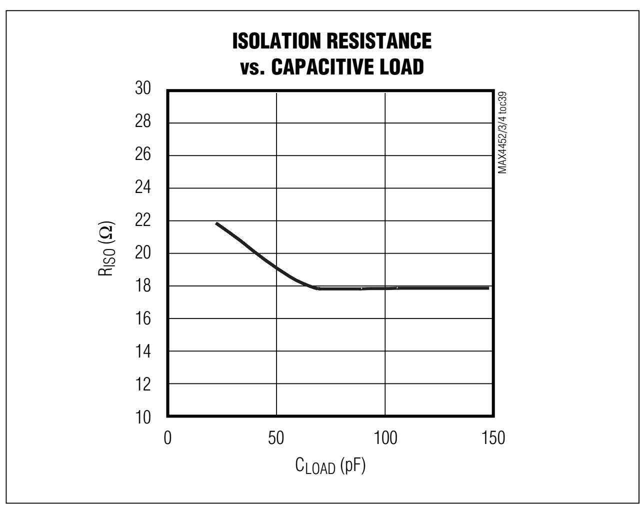


Figure 2. Optimal Isolation Resistor vs. Capacitive Load

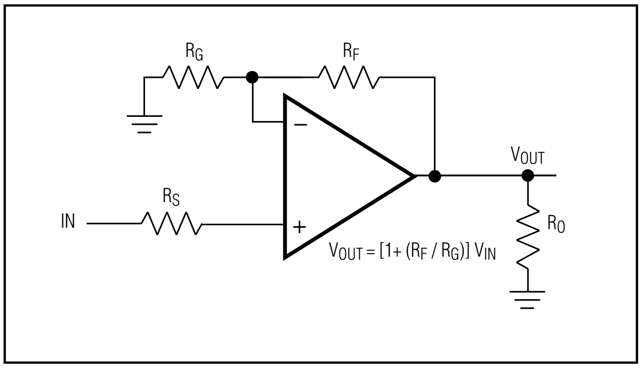


Figure 3a. Noninverting Gain Configuration

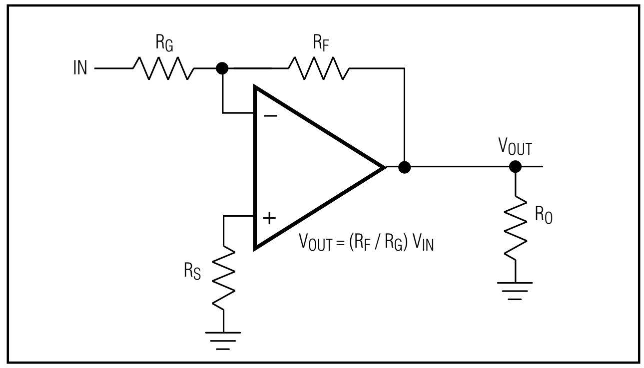


Figure 3b. Inverting Gain Configuration

Active Filters

The low distortion and high bandwidth of the MAX4452/MAX4453/MAX4454 and MAX4352/ MAX4353/MAX4354 make them ideal for use in active filter circuits. Figure 4 is a 15MHz lowpass multiple feedback active filter using the MAX4452.

$$\text{Gain} = \frac{-R2}{R1}$$

$$f_0 = \frac{1}{2p}\sqrt{\frac{1}{R2 \times R3 \times C1 \times C2}}$$

$$Q = \frac{\dfrac{C2}{\sqrt{C1 \times C2 \times R2 \times R3}}}{\dfrac{1}{R1} + \dfrac{1}{R2} + \dfrac{1}{R3}}$$

ADC Input Buffer

Input buffer amplifiers can be a source of significant errors in high-speed ADC applications. The input buffer is usually required to rapidly charge and discharge the ADC's input, which is often capacitive. See *Output Capacitive Loading and Stability*. In addition, since a high-speed ADC's input impedance often changes very rapidly during the conversion cycle, measurement accuracy must be maintained using an amplifier with very low output impedance at high frequencies. The combination of high speed, fast slew rate, low noise, and a low and stable distortion over load makes the MAX4452/MAX4453/MAX4454/MAX4352/MAX4353/ MAX4354 ideally suited for use as buffer amplifiers in high-speed ADC applications.

Layout and Power-Supply Bypassing

These amplifiers operate from a single +2.7V to +5.25V power supply. Bypass V_{CC} to ground with a 0.1µF capacitor as close to the pin as possible.

Maxim recommends using microstrip and stripline techniques to obtain full bandwidth. Design the PC board for a frequency greater than 1GHz to prevent amplifier performance degradation due to board parasitics. Avoid large parasitic capacitance at inputs and outputs. Whether or not a constant-impedance board is used, observe the following guidelines:

- Do not use wirewrap boards due to their high inductance.
- Do not use IC sockets because of the increased parasitic capacitance and inductance.

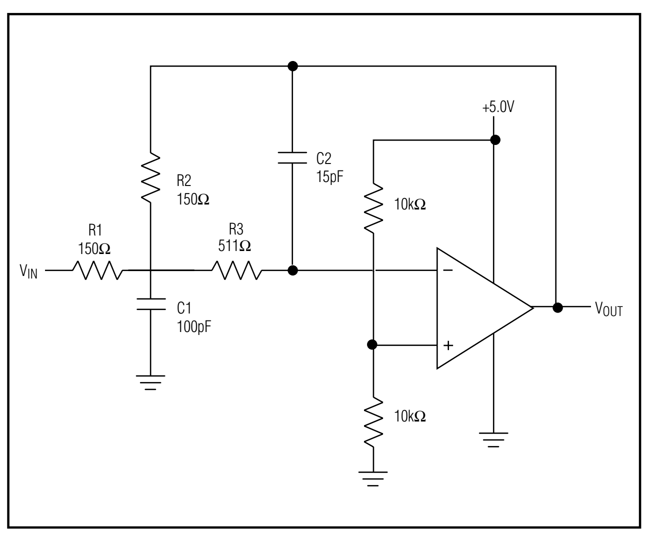


Figure 4. Multiple-Feedback Lowpass Filter

- Use surface-mount instead of through-hole components for better high-frequency performance.
- Use a PC board with at least two layers; it should be as free from voids as possible.
- Keep signal lines as short and as straight as possible. Do not make 90° turns; round all corners.

Chip Information

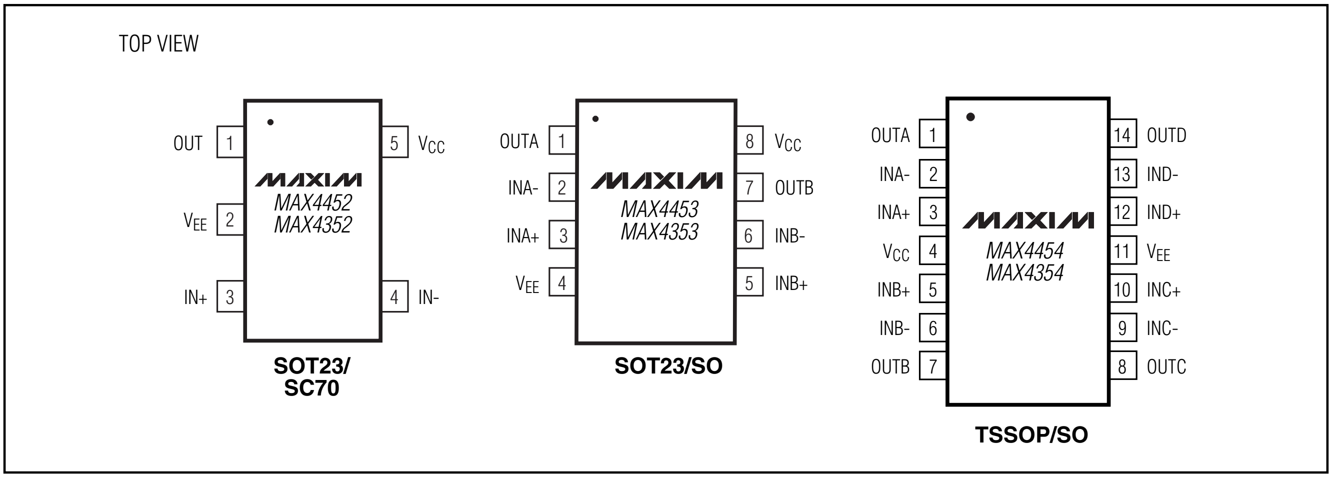
MAX4452/MAX4352 TRANSISTOR COUNT: 97

MAX4453/MAX4353 TRANSISTOR COUNT: 192

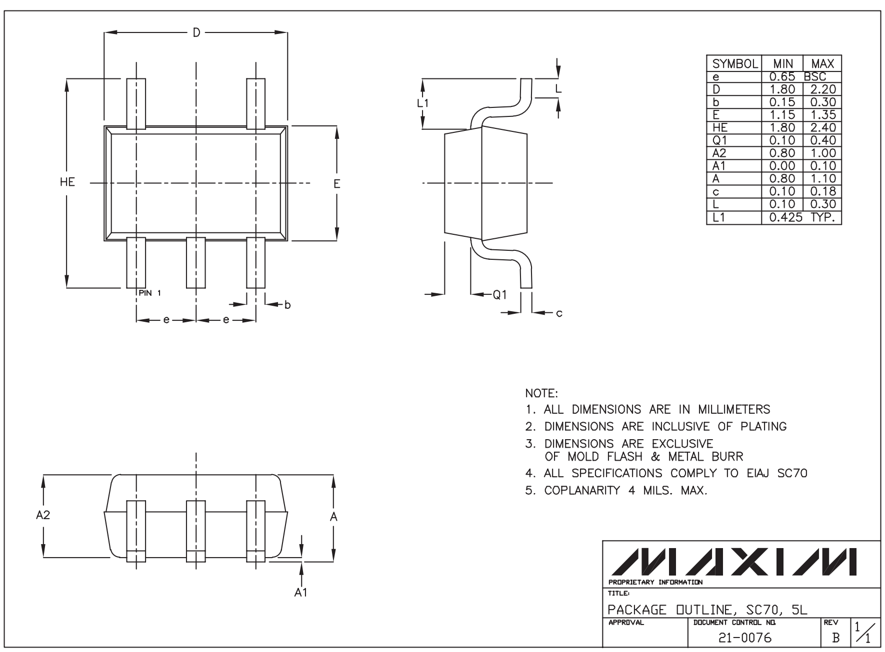
MAX4454/MAX4354 TRANSISTOR COUNT: 378

PROCESS: Bipolar

Pin Configurations



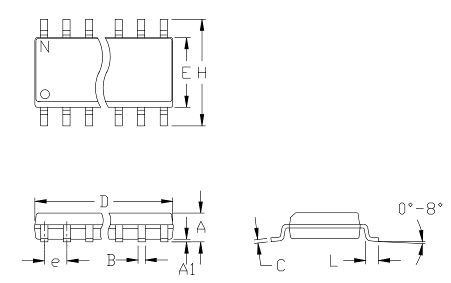
Package Information



SYMBOL	MIN	MAX
e	0.65 BSC	
D	1.80	2.20
b	0.15	0.30
E	1.15	1.35
HE	1.80	2.40
Q1	0.10	0.40
A2	0.80	1.00
A1	0.00	0.10
A	0.80	1.10
c	0.10	0.18
L	0.10	0.30
L1	0.425 TYP.	

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

Package Information (continued)

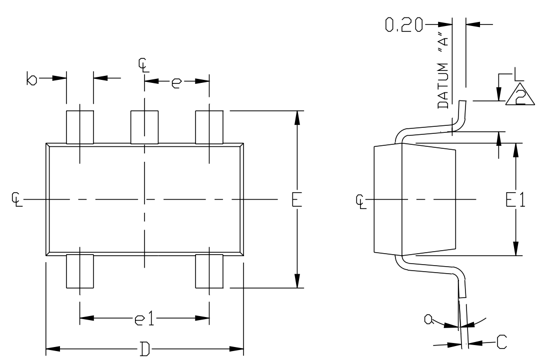


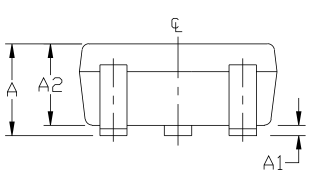
	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

	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 | 21-0041 A | DOCUMENT CONTROL NUMBER | REV





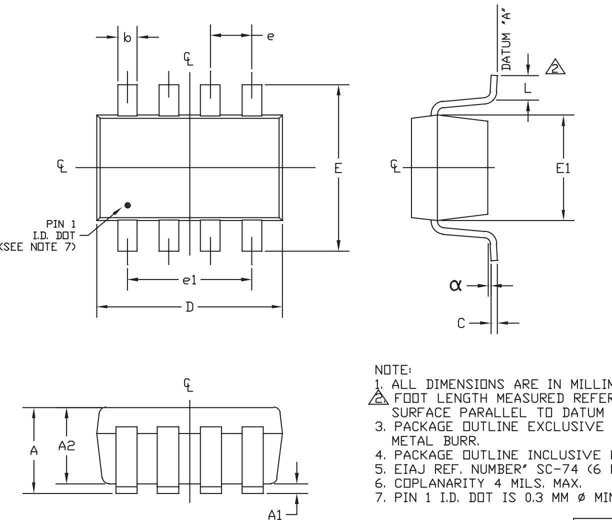
SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95 REF	
e1	1.90 REF	
α	0°	10°

NOTE:
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.

MAXIM | PROPRIETARY INFORMATION | TITLE: PACKAGE OUTLINE, SOT23, 5L | APPROVAL | DOCUMENT CONTROL NO. 21-0057 | REV B | 1/1

Package Information (continued)

SOT23, 8L.EPS

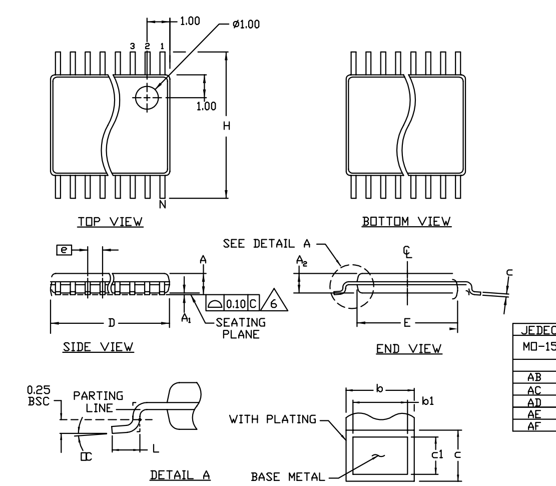


SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.28	0.45
C	0.09	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.10	0.60
e	0.65 ref	
e1	1.95 ref	
α	0°	10°

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED REFERENCE TO FLAT FOOT SURFACE PARALLEL TO DATUM 'A'.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. EIAJ REF. NUMBER' SC-74 (6 LEAD VERSION)
6. COPLANARITY 4 MILS. MAX.
7. PIN 1 I.D. DOT IS 0.3 MM ø MIN. LOCATED ABOVE PIN 1.

MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, SOT 23, 8L
APPROVAL | DOCUMENT CONTROL NO. 21-0078 | REV B | 1/1

TSSOP,NO PADS.EPS



SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	—	1.10		.043
A_1	0.05	0.15	.002	.006
A_2	0.85	0.95	.033	.037
b	0.19	0.30	.007	.012
b1	0.19	0.25	.007	.010
c	0.090	0.20	.0035	.008
c1	0.090	0.135	.0035	.0053
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	.169	.177
e	0.65 BSC		.026 BSC	
H	6.25	6.50	.246	.256
L	0.50	0.70	.020	.028
N	SEE VARIATIONS		SEE VARIATIONS	
α	0°	8°	0°	8°

JEDEC MO-153	N		VARIATIONS			
			MILLIMETERS		INCHES	
			MIN.	MAX.	MIN.	MAX.
AB	14	D	4.90	5.10	.193	.201
AC	16	D	4.90	5.10	.193	.201
AD	20	D	6.40	6.60	.252	.260
AE	24	D	7.70	7.90	.303	.311
AF	28	D	9.60	9.80	.378	.386

NOTES:
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC OUTLINE MO-153 VARIATIONS- AB, AC, AD, AE, AF
5. 'N' REFERS TO NUMBER OF LEADS
6. THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED.

MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, TSSOP, 4.40 MM BODY
APPROVAL | DOCUMENT CONTROL NO. 21-0066 | REV D | 1/1

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