19-1407; Rev 1; 1/99

SOT23, Rail-to-Rail, Fixed-Gain Gain-Amps/Open-Loop Op Amps

General Description

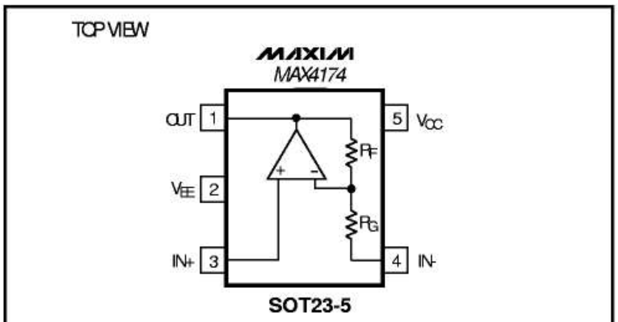
The MAX4174/MAX4175/MAX4274/MAX4275 Gain-Amp™ family combines a low-cost Rail-to-Rail® op amp with precision internal gain-setting resistors and V_{CC} / 2 biasing. Factory-trimmed on-chip resistors decrease design size, cost, and layout, and provide 0.1% gain accuracy. Fixed inverting gains from -0.25V/V to -100V/V or noninverting gains from +1.25V/V to +101V/V are available. These devices operate from a single +2.5V to +5.5V supply and consume only 300µA. Gain-Amp amplifiers are optimally compensated for each gain version, achieving exceptional GBW products up to 23MHz (A_V = +25V/V to +101V/V). High-voltage fault protection withstands ±17V at either input without excessive current draw.

Three versions are available in this amplifier family: single/dual/quad open-loop, unity-gain stable (MAX4281/MAX4282/MAX4284); single/dual fixed gain (MAX4174/MAX4274); and single/dual fixed gain plus internal V_{CC} / 2 bias at the noninverting input (MAX4175/MAX4275), which simplifies input biasing in single-supply designs. The input common-mode voltage range of the open-loop amplifiers extends from 150mV below the negative supply to within 1.2V of the positive supply. The outputs can swing rail-to-rail and drive a 1kΩ load while maintaining excellent DC accuracy. The amplifier is stable for capacitive loads up to 470pF.

Applications

- Portable Instruments
- Instruments, Terminals, and Bar-Code Readers
- Keyless Entry
- Photodiode Preamps
- Smart-Card Readers
- Infrared Receivers for Remote Controls
- Low-Side Current-Sense Amplifiers

Pin Configurations



Pin Configurations continued at end of data sheet.

Features

- ♦ Gain-Amp Family Provides Internal Precision Gain-Setting Resistors in SOT23 (MAX4174/5)
- ♦ 0.1% Gain Accuracy (R_F/R_G) (MAX4174/5, MAX4274/5)
- ♦ 54 Standard Gains Available (MAX4174/5, MAX4274/5)
- ♦ Open-Loop Unity-Gain-Stable Op Amps (MAX4281/2/4)
- ♦ Rail-to-Rail Outputs Drive 1kΩ Load
- ♦ Internal V_{CC} / 2 Biasing (MAX4175/MAX4275)
- ♦ +2.5V to +5.5V Single Supply
- ♦ 300µA Supply Current
- ♦ Up to 23MHz GBW Product
- ♦ Fault-Protected Inputs Withstand ±17V
- ♦ Stable with Capacitive Loads Up to 470pF with No Isolation Resistor

Ordering Information

PART*	TEMP. RANGE	PIN-PACKAGE	SOT TOP MARK
MAX4174_EUK-T	-40°C to +85°C	5 SOT23-5	††
MAX4175_EUK-T	-40°C to +85°C	5 SOT23-5	††

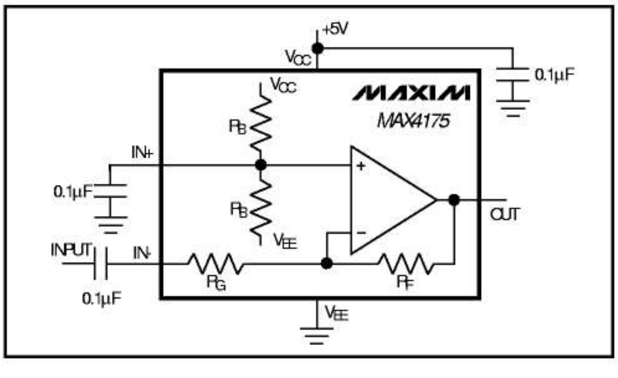
Ordering Information continued at end of data sheet.

* *Insert the desired gain code (from the Gain Selection Guide) in the blank to complete the part number.*

†† *Refer to the Gain Selection Guide for a list of preferred gains and SOT Top Marks.*

Selector Guide appears at end of data sheet.

Typical Operating Circuit



MAX4174/5, MAX4274/5, MAX4281/2/4†

† *Patent pending*

SOT23, Rail-to-Rail, Fixed-Gain Gain-Amps/Open-Loop Op Amps

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} to V_{EE}) ....-0.3V to +6V
Voltage Inputs (IN_)
MAX4281/4282/4284.....................(V_{EE} - 0.3V) to (V_{CC} + 0.3V)
MAX4174/4175/4274/4275 (with respect to GND) ....±17V
Output Short-Circuit Duration
(OUT_).....................................Continuous to Either V_{EE} or V_{CC}
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 4.1mW/°C above +70°C)............330mW
14-Pin SO (derate 8.3mW/°C above +70°C)...............667mW
16-Pin QSOP (derate 8.3mW/°C above +70°C)..........667mW
Operating Temperature Range ....-40°C to +85°C
Maximum Junction Temperature ....+150°C
Storage Temperature Range.............................-65°C to +150°C
Lead Temperature (soldering, 10sec) ....+300°C

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

ELECTRICAL CHARACTERISTICS—MAX4174/MAX4175/MAX4274/MAX4275 FIXED-GAIN AMPLIFIERS

(V_{CC} = +2.5V to +5.5V, V_{EE} = 0, V_{IN+} = V_{IN-} = V_{CC} / 2, R_L to V_{CC} / 2, R_L = open, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5V and T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{CC}	Guaranteed by PSRR tests		2.5		5.5	V
Supply Current (per Amplifier)	I_{CC}	MAX4174/MAX4274	V_{CC} = 3V		300	460	µA
			V_{CC} = 5V		330	510	
		MAX4175/MAX4275, includes V_{CC} / 2 bias resistors	V_{CC} = 3V		320	480	
			V_{CC} = 5V		355	530	
Input Offset Voltage	V_{OS}	R_L = 100kΩ			±0.5	±2.0	mV
Input Offset Voltage Drift					±5		µV/°C
Input Bias Current	I_{BIAS}	IN_+, MAX4174/MAX4274 (Note 2)			±0.05	±10	nA
Inverting Input Resistance		A_V < 25V/V			150		kΩ
		A_V > 25V/V			40		
Noninverting Input Resistance		MAX4174/MAX4274			1000		MΩ
		MAX4175/MAX4275			75		kΩ
IN_+ Bias Voltage		MAX4175/MAX4275, V_{IN+} = V_{IN-}		V_{CC} / 2 - 0.25		V_{CC} / 2 + 0.25	V
IN_+ Input Voltage Range		Guaranteed by functional test (Note 3)		V_{EE}		V_{CC} - 1.2	V
IN_- Input Voltage Range		Guaranteed by functional test		V_{EE}		V_{CC}	V
Power-Supply Rejection Ratio	PSRR	V_{CC} = 2.5V to 5.5V		70	90		dB
Closed-Loop Output Impedance	R_{OUT}				0.02		Ω
Short-Circuit Current		Shorted to V_{EE}			10		mA
		Shorted to V_{CC}			65		
Output Voltage Swing (Note 4)	V_{OH}/V_{OL}	R_L = 100kΩ	V_{CC} - V_{OH}		2	8	mV
			V_{OL} - V_{EE}		2	8	
		R_L = 1kΩ	V_{CC} - V_{OH}		150	250	
			V_{OL} - V_{EE}		60	150	

ELECTRICAL CHARACTERISTICS—MAX4174/MAX4175/MAX4274/MAX4275 (continued)

(V_{CC} = +2.5V to +5.5V, V_{EE} = 0, V_{IN+} = V_{IN-} = V_{CC} / 2, R_L to V_{CC} / 2, R_L = open, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5V and T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power-Up Time		Output settling to 1%		1		ms
Slew Rate	SR	V_{CC} = 5V, V_{OUT} = 4V step		0.7		V/µs
Settling Time to Within 0.01%		V_{CC} = 5V, V_{OUT} = 4V step		7		µs
Input Noise Voltage Density	e_n	f = 10kHz (Note 5)		90		nV/√Hz
Input Noise Current Density	i_n	f = 10kHz		4		fA/√Hz
Capacitive Load Stability	C_{LOAD}	No sustained oscillations		470		pF
DC Gain Accuracy		(V_{EE} + 25mV) < V_{OUT} < (V_{CC} - 25mV), R_L = 100kΩ (Note 6)		0.1	0.5	%
-3dB Bandwidth	BW_{-3dB}	Gain = +1.25V/V		1700		kHz
		Gain = +3V/V		970		
		Gain = +5V/V		970		
		Gain = +10V/V		640		
		Gain = +25V/V		590		
		Gain = +51V/V		330		

ELECTRICAL CHARACTERISTICS—MAX4281/MAX4282/MAX4284 OPEN-LOOP OP AMPS

(V_{CC} = +2.5V to +5.5V, V_{EE} = 0, V_{IN+} = V_{IN-} = V_{CC} / 2, R_L to V_{CC} / 2, R_L = open, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5V and T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{CC}	Guaranteed by PSRR tests	2.5		5.5	V
Supply Current (per Amplifier)	I_{CC}	V_{CC} = 3V		290	450	µA
		V_{CC} = 5V		320	500	µA
Input Offset Voltage	V_{OS}	R_L = 100kΩ		±0.5	±2	mV
Input Offset Voltage Drift				±5		µV/°C
Input Bias Current	I_{BIAS}			±0.05	±10	nA
Input Offset Current	I_{OS}			±10	±1000	pA
Input Resistance	R_{IN}	Differential or common mode		1000		MΩ
Input Capacitance	C_{IN}			2.5		pF
Common-Mode Input Voltage Range	CMVR	Guaranteed by CMRR test	V_{EE} - 0.15		V_{CC} - 1.2	V
Common-Mode Rejection Ratio	CMRR	V_{EE} - 0.15V ≤ V_{CM} ≤ V_{CC} - 1.2V	60	90		dB
Power-Supply Rejection Ratio	PSRR	V_{CC} = 2.5V to 5.5V	70	90		dB
Closed-Loop Output Impedance	R_{OUT}	A_V = 1		0.02		Ω

SOT23, Rail-to-Rail, Fixed-Gain Gain-Amps/Open-Loop Op Amps

ELECTRICAL CHARACTERISTICS—MAX4281/MAX4282/MAX4284 OPEN-LOOP OP AMPS (continued)

(V_{CC} = +2.5V to +5.5V, V_{EE} = 0, V_{IN+} = V_{IN-} = V_{CC} / 2, R_L to V_{CC} / 2, R_L = open, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5V and T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Short-Circuit Current		Shorted to V_{EE}			10		mA
		Shorted to V_{CC}			65		mA
Large-Signal Voltage Gain	A_{VOL}	V_{EE} + 0.05V < V_{OUT} < V_{CC} - 0.1V, R_L = 100kΩ		90	120		dB
		V_{EE} + 0.25V < V_{OUT} < V_{CC} - 0.3V, R_L = 1kΩ		80	100		dB
Output Voltage Swing	V_{OH}/V_{OL}	R_L = 100kΩ	V_{CC} - V_{OH}		2	8	mV
			V_{OL} - V_{EE}		2	8	
		R_L = 1kΩ	V_{CC} - V_{OH}		160	250	
			V_{OL} - V_{EE}		60	100	
Gain Bandwidth Product	GBW				2		MHz
Slew Rate	SR	V_{CC} = 5V, V_{OUT} = 4V step			0.7		V/µs
Settling Time to within 0.01%		V_{CC} = 5V, V_{OUT} = 4V step			7		µs
Input Noise Voltage Density	e_n	f = 10kHz			60		nV/√Hz
Input Noise Current Density	i_n	f = 10kHz			1.8		fA/√Hz
Capacitive Load Stability	C_{LOAD}	No sustained oscillations, A_V = 1			470		pF
Power-Up Time		Output settling to 1%			1		ms

Note 1: MAX4174/MAX4175/MAX4281 and MAX4274/MAX4275/MAX4282 and MAX4284 are 100% production tested at T_A = +25°C. All temperature limits are guaranteed by design.

Note 2: Guaranteed by design.

Note 3: The input common-mode range for IN_+ is guaranteed by a functional test. A similar test is done on the IN_- input. See the *Applications Information* section for more information on the input voltage range of the Gain-Amp.

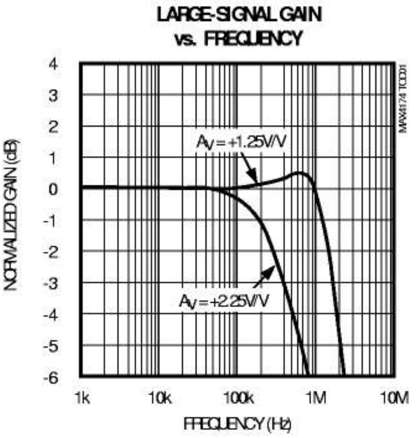
Note 4: For A_V = -0.5V/V and A_V = -0.25V/V, the output voltage swing is limited by the input voltage range.

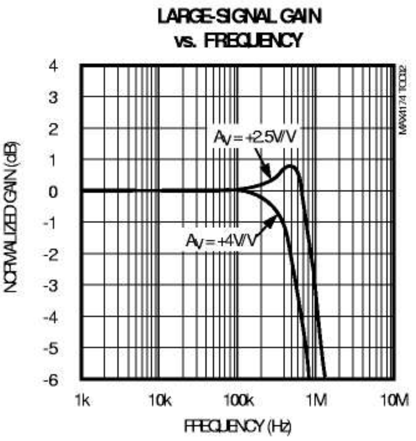
Note 5: Includes noise from on-chip resistors.

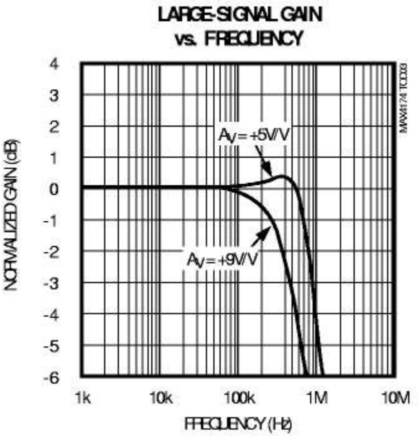
Note 6: The gain accuracy test is performed with the Gain-Amp in noninverting configuration. The output voltage swing is limited by the input voltage range for certain gains and supply voltage conditions. For situations where the output voltage swing is limited by the valid input range, the output limits are adjusted accordingly.

Typical Operating Characteristics

(V_{CC} = +5V, R_L = 100kΩ to V_{CC} / 2, small-signal V_{OUT} = 100mVp-p, large-signal V_{OUT} = 1Vp-p, T_A = +25°C, unless otherwise noted.)





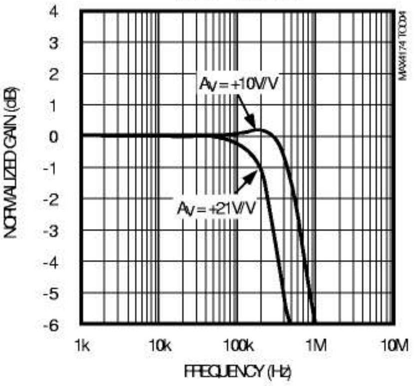


Typical Operating Characteristics (continued)

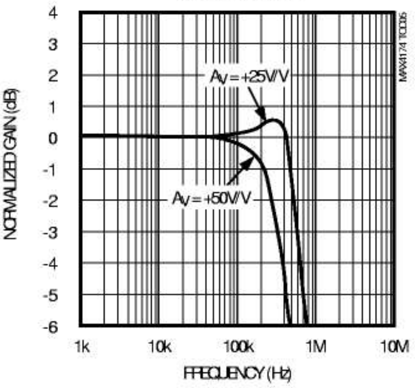
(V_{CC} = +5V, R_L = 100kΩ to V_{CC} / 2, small-signal V_{OUT} = 100mVp-p, large-signal V_{OUT} = 1Vp-p, T_A = +25°C, unless otherwise noted.)

MAX4174/MAX4175

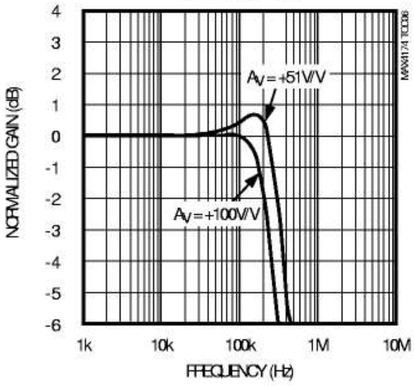
LARGE-SIGNAL GAIN vs. FREQUENCY



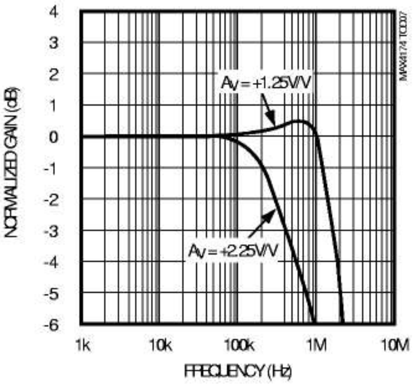
LARGE-SIGNAL GAIN vs. FREQUENCY



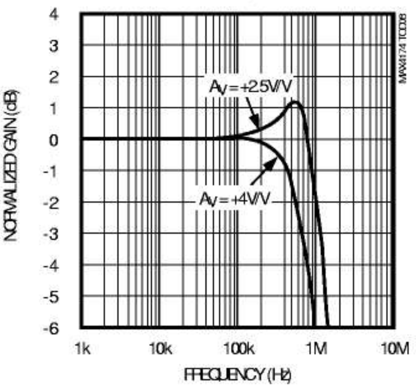
LARGE-SIGNAL GAIN vs. FREQUENCY



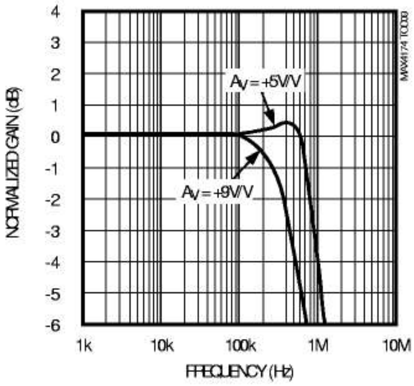
SMALL-SIGNAL GAIN vs. FREQUENCY



SMALL-SIGNAL GAIN vs. FREQUENCY



SMALL-SIGNAL GAIN vs. FREQUENCY



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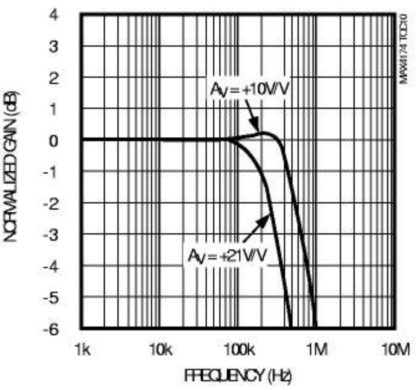
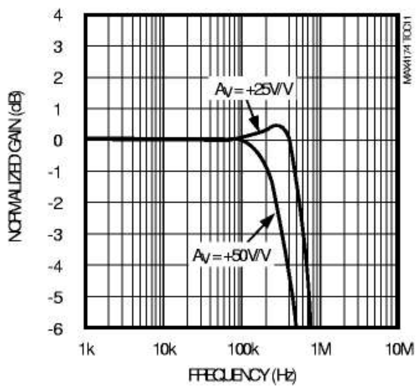
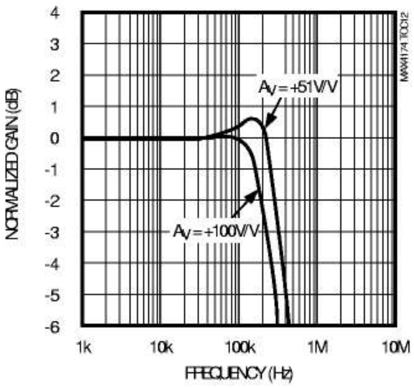


SMALL-SIGNAL GAIN vs. FREQUENCY



SMALL-SIGNAL GAIN vs. FREQUENCY



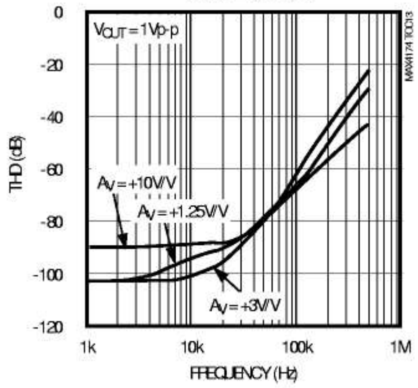
SOT23, Rail-to-Rail, Fixed-Gain Gain-Amps/Open-Loop Op Amps

Typical Operating Characteristics (continued)

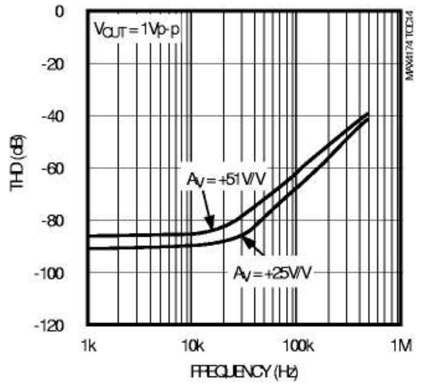
(V_{CC} = +5V, R_L = 100kΩ to V_{CC} / 2, small-signal V_{OUT} = 100mVp-p, large-signal V_{OUT} = 1Vp-p, T_A = +25°C, unless otherwise noted.)

MAX4174/MAX4175

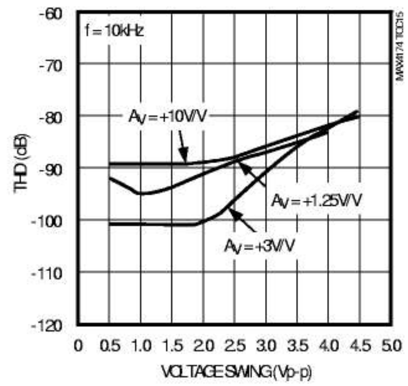
TOTAL HARMONIC DISTORTION vs. FREQUENCY



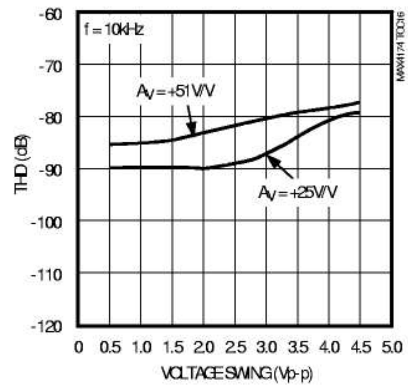
TOTAL HARMONIC DISTORTION vs. FREQUENCY



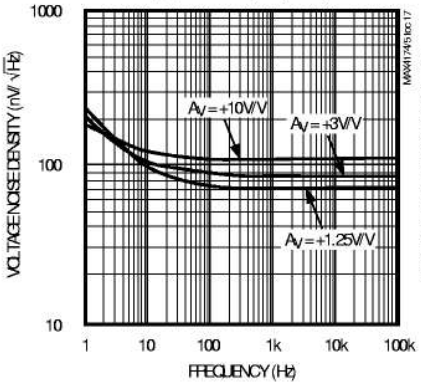
TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE SWING



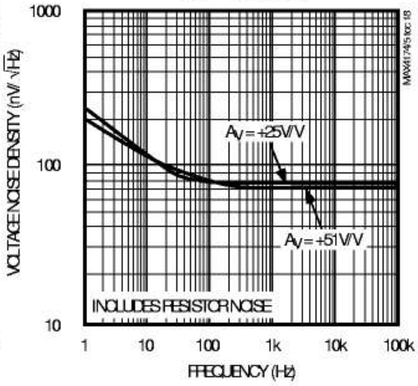
TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE SWING



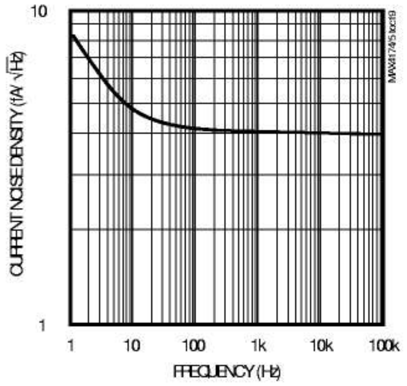
VOLTAGE NOISE DENSITY vs. FREQUENCY (A_V = +1.25, +3, +10)



VOLTAGE NOISE DENSITY vs. FREQUENCY (A_V = +25, +51)



CURRENT NOISE DENSITY vs. FREQUENCY

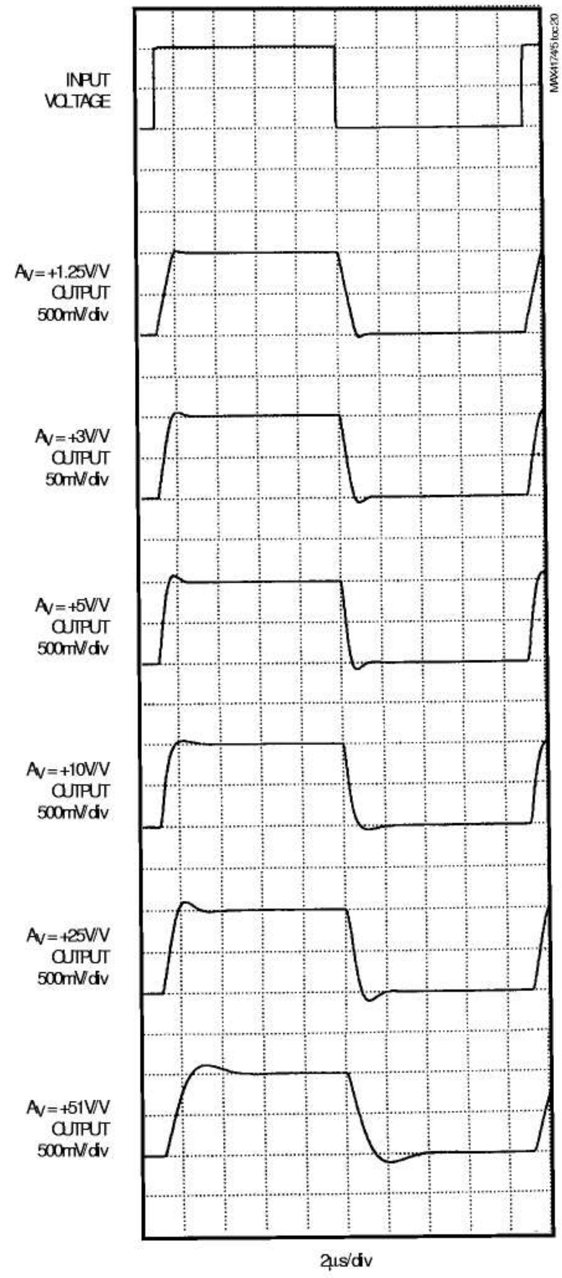


Typical Operating Characteristics (continued)

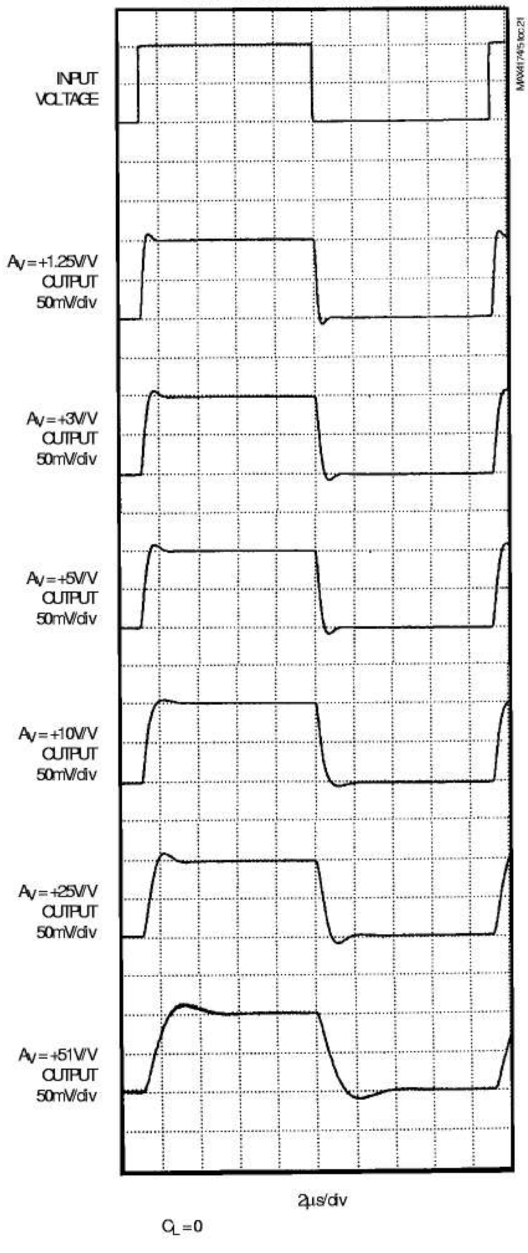
(V_{CC} = +5V, R_L = 100kΩ to V_{CC} / 2, small-signal V_{OUT} = 100mVp-p, large-signal V_{OUT} = 1Vp-p, T_A = +25°C, unless otherwise noted.)

MAX4174/MAX4175

LARGE-SIGNAL PULSE RESPONSE



SMALL-SIGNAL PULSE RESPONSE

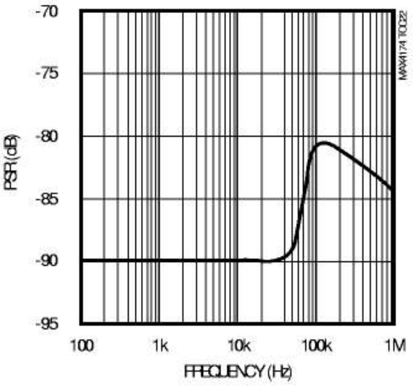


Typical Operating Characteristics (continued)

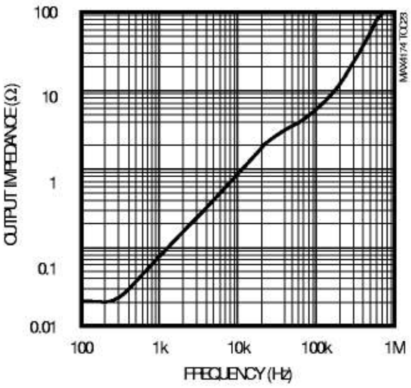
(V_{CC} = +5V, R_L = 100kΩ to V_{CC} / 2, small-signal V_{OUT} = 100mVp-p, large-signal V_{OUT} = 1Vp-p, T_A = +25°C, unless otherwise noted.)

MAX4174/MAX4175/MAX4281/MAX4282/MAX4284

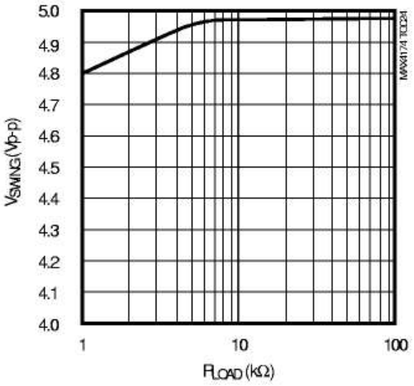
POWER-SUPPLY REJECTION vs. FREQUENCY



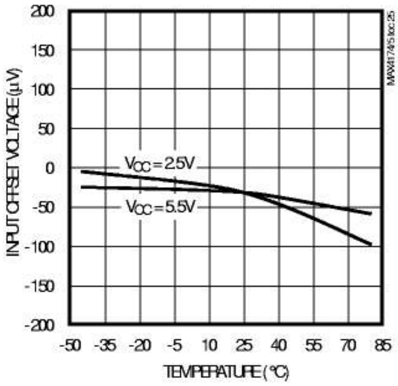
OUTPUT IMPEDANCE vs. FREQUENCY



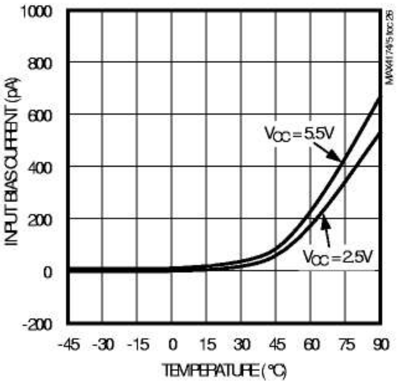
OUTPUT VOLTAGE SWING vs. R_{LOAD}



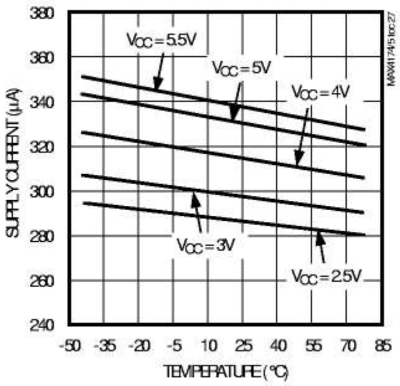
INPUT OFFSET VOLTAGE vs. TEMPERATURE



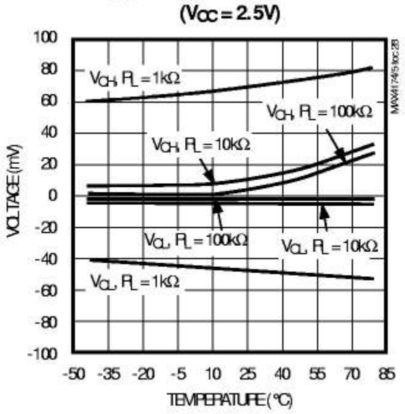
INPUT BIAS CURRENT vs. TEMPERATURE



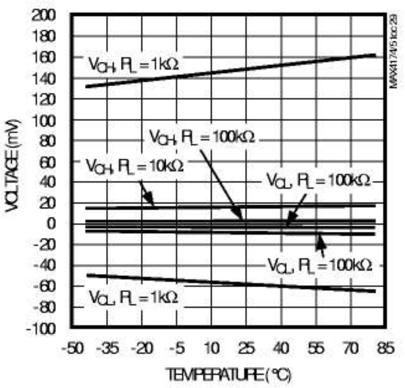
SUPPLY CURRENT vs. TEMPERATURE



V_{OH} AND V_{OL} vs. TEMPERATURE (V_{CC} = 2.5V)



V_{OH} AND V_{OL} vs. TEMPERATURE (V_{CC} = 5.5V)

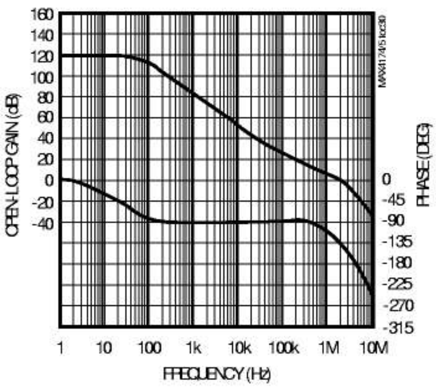


Typical Operating Characteristics

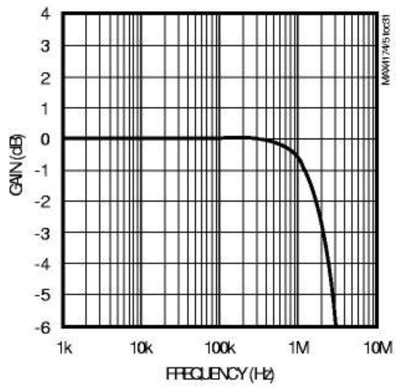
(V_{CC} = +5V, R_L = 100kΩ to V_{CC} / 2, small-signal V_{OUT} = 100mVp-p, large-signal V_{OUT} = 1Vp-p, T_A = +25°C, unless otherwise noted.)

MAX4281/MAX4282/MAX4284

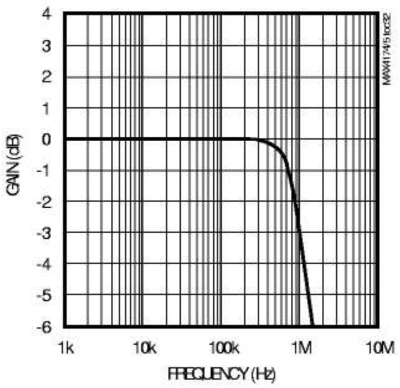
OPEN-LOOP GAIN AND PHASE vs. FREQUENCY



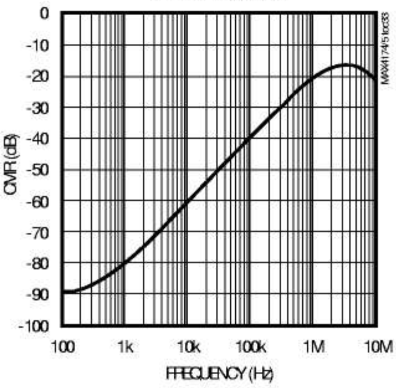
SMALL-SIGNAL GAIN vs. FREQUENCY



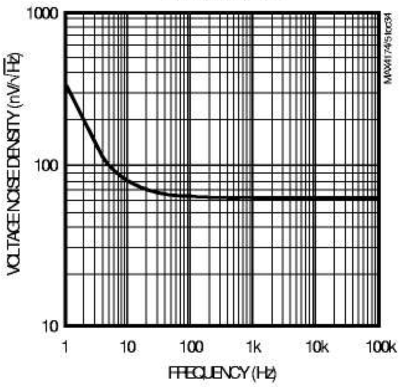
LARGE-SIGNAL GAIN vs. FREQUENCY



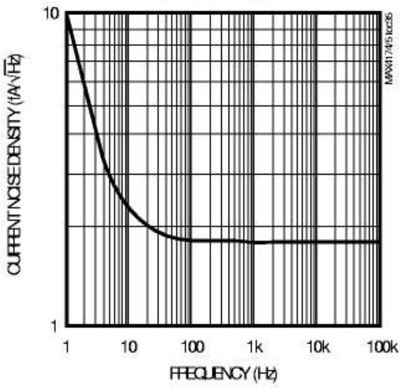
COMMON-MODE REJECTION vs. FREQUENCY



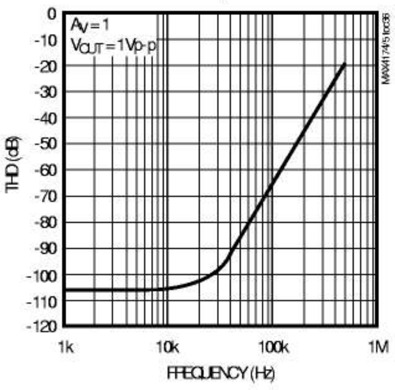
VOLTAGE NOISE DENSITY vs. FREQUENCY



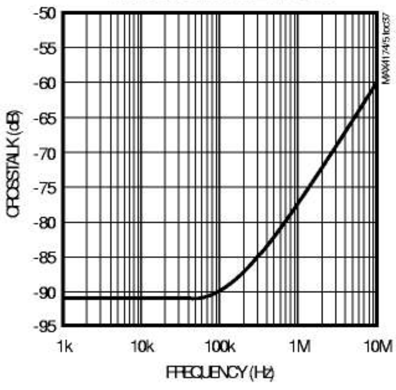
CURRENT NOISE DENSITY vs. FREQUENCY



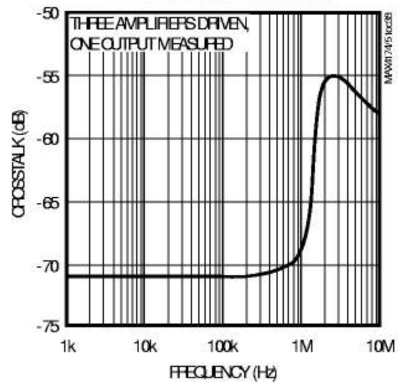
TOTAL HARMONIC DISTORTION vs. FREQUENCY



MAX4282 CROSSTALK vs. FREQUENCY



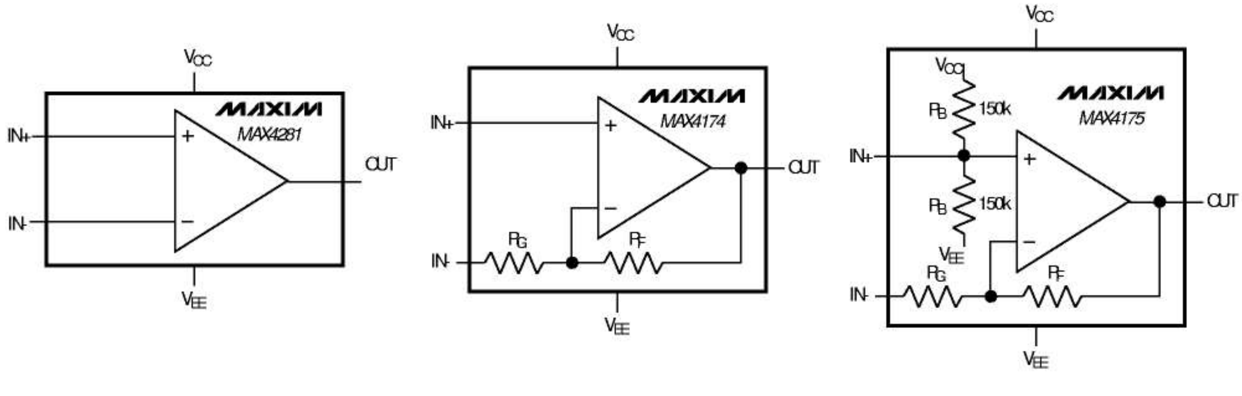
MAX4284 CROSSTALK vs. FREQUENCY



Pin Description

PIN							NAME	FUNCTION
MAX4281		MAX4174/ MAX4175	MAX4282	MAX4274/ MAX4275	MAX4284			
5 SOT23	8 SO	5 SOT23	8 SO/µMAX	8 SO/µMAX	14 SO	16 QSOP		
1	6	1	1, 7	1, 7	1, 7, 8, 14	1, 7, 10, 16	OUT, OUTA, OUTB, OUTC, OUTD	Amplifier Output
2	4	2	4	4	11	13	V_{EE}	Negative Supply or Ground
3	3	3	3, 5	3, 5	3, 5, 10, 12	3, 5, 12, 14	IN+, INA+, INB+, INC+, IND+	Noninverting Amplifier Input. Internally biased to V_{CC} / 2 for MAX4175/MAX4275.
4	2	4	2, 6	2, 6	2, 6, 9, 13	2, 6, 11, 15	IN-, INA-, INB-, INC-, IND-	Inverting Amplifier Input. Connects to R_G for MAX4174/ 4175/4274/4275.
5	7	5	8	8	4	4	V_{CC}	Positive Supply
—	1, 5, 8	—	—	—	—	8, 9	N.C.	No Connection. Not internally connected.

Functional Diagrams



Detailed Description

Maxim's Gain-Amp fixed-gain amplifiers combine a low-cost rail-to-rail op amp with internal gain-setting resistors. Factory-trimmed on-chip resistors provide 0.1% gain accuracy while decreasing design size, cost, and layout. Three versions are available in this amplifier family: single/dual/quad open-loop, unity-gain-stable devices (MAX4281/MAX4282/MAX4284); single/dual fixed-gain devices (MAX4174/MAX4274); and single/dual devices with fixed gain plus internal V_{CC} / 2 bias at the noninverting input (MAX4175/MAX4275). All amplifiers feature rail-to-rail outputs and drive a 1kΩ load while maintaining excellent DC accuracy.

Open-Loop Op Amps

The single/dual/quad MAX4281/MAX4282/MAX4284 are high-performance, open-loop op amps with rail-to-rail outputs. These devices are compensated for unity-gain stability, and feature a gain bandwidth (GBW) of 2MHz. The op amps in these ICs feature an input common-mode range that extends from 150mV below the negative rail to within 1.2V of the positive rail. These high performance op amps serve as the core for this family of Gain-Amp fixed-gain amplifiers. Although the -3dB bandwidth will not correspond to that of a fixed-gain amplifier in higher gain configurations, these open-loop op-amps can be used to prototype designs.

Internal Gain-Setting Resistors

Maxim's proprietary laser trimming techniques produce the necessary R_F/R_G values (Figure 1), so many gain offerings are easily available. These Gain-Amp fixed-gain amplifiers feature a negative-feedback resistor network that is laser trimmed to provide a gain-setting feedback ratio (R_F/R_G) with 0.1% typical accuracy. The standard op amp pinouts allow the Gain-Amp fixed-gain amplifiers to drop in directly to existing board designs, easily replacing op-amp-plus-resistor gain blocks.

Gain-Amp Bandwidth

Gain-Amp fixed-gain amplifiers feature factory-trimmed precision resistors to provide fixed inverting gains from -0.25V/V to -100V/V or noninverting gains from +1.25V/V to +101V/V. The op-amp core is decompensated strategically over the gain-set options to maximize bandwidth. Open-loop decompensation increases GBW product, ensuring that usable bandwidth is maintained with increasing closed-loop gains. A Gain-Amp with a fixed gain of A_V = 100V/V has a -3dB bandwidth of 230kHz. By comparison, a unity-gain-stable op amp configured for A_V = 100V/V would yield a -3dB bandwidth of only 20kHz (Figure 2). Decompensation is performed at five intermediate gain sets, as shown in the *Gain Selection Guide*. Low gain decompensation greatly increases usable bandwidth, while decompensation above gains of +25V/V offers diminished returns.

V_{CC} / 2 Internal Bias

The MAX4175/MAX4275 Gain-Amp fixed-gain amplifiers with the V_{CC} / 2 bias option are identical to standard Gain-Amp fixed-gain amplifiers, with the added feature of V_{CC} / 2 internal bias at the noninverting inputs. Two 150kΩ resistors form a voltage-divider for self-biasing the noninverting input, eliminating external bias resistors for AC-coupled applications, and allowing maximum signal swing at the op amp's rail-to-rail output for single-supply systems (see *Typical Operating Circuit*). For DC-coupled applications, use the MAX4174/MAX4274.

High-Voltage (±17V) Input Fault Protection

The MAX4174/MAX4175/MAX4274/MAX4275 include ±17V input fault protection. For normal operation, see the input voltage range specification in the *Electrical Characteristics*. Overdriven inputs up to ±17V will not

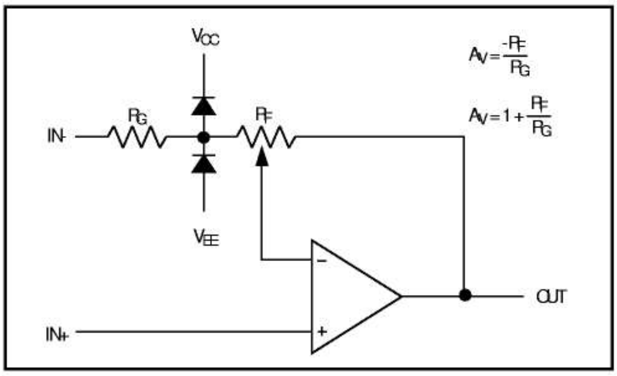


Figure 1. Internal Gain-Setting Resistors

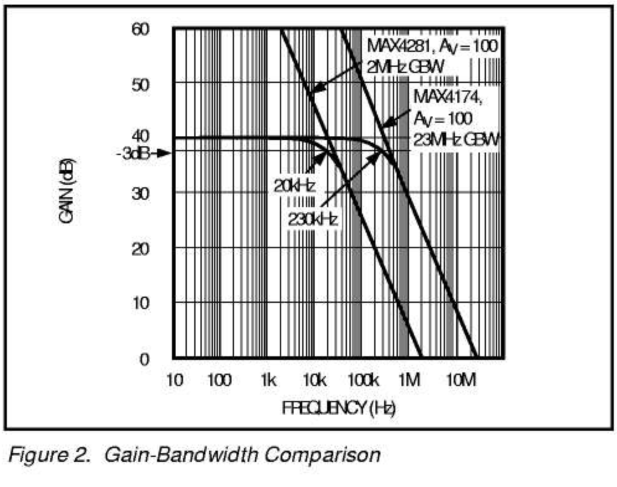


Figure 2. Gain-Bandwidth Comparison

SOT23, Rail-to-Rail, Fixed-Gain Gain-Amps/Open-Loop Op Amps

cause output phase reversal. A back-to-back SCR structure at the input pins allows either input to safely swing ±17V relative to V_{EE} (Figure 3). Additionally, the internal op-amp inputs are diode clamped to either supply rail for the protection of sensitive input stage circuitry. Current through the clamp diodes is limited by a 5kΩ resistor at the noninverting input, and by R_G at the inverting input. An IN+ or IN- fault voltage as high as ±17V will cause less than 3.5mA of current to flow through the input pin, protecting both the Gain-Amp and the signal source from damage.

Applications Information

Gain-Amp fixed-gain amplifiers offer a precision, fixed gain amplifier in a small package that can be used in a variety of circuit board designs. Gain-Amp fixed-gain amplifiers can be used in many op amp circuits that use resistive negative feedback to set gain, and that do not require other connections to the op-amp inverting input. Both inverting and noninverting op-amp configurations can be implemented easily using a Gain-Amp.

Gain-Amp Input Voltage Range

The MAX4174/MAX4175/MAX4274/MAX4275 combine both an op amp and gain-setting feedback resistors on the same chip. Because the inverting input pin is actually tied to the R_G input series resistor, the inverting input voltage range is different from the noninverting input voltage range. Just as with a discrete design, care must be taken not to saturate the inputs/output of the core op amp, to avoid signal distortions or clipping.

The inverting inputs (IN_-) of the MAX4174/MAX4175/MAX4274/MAX4275 must be within the supply rails or signal distortion may result. The Gain-Amp's inverting input structure includes diodes to both supplies, such that driving the inverting input beyond the rails may cause signal distortions (Figure 1). For applications that require sensing voltages beyond the rails, use the MAX4281/MAX4282/MAX4284 open-loop op amps (Figure 4).

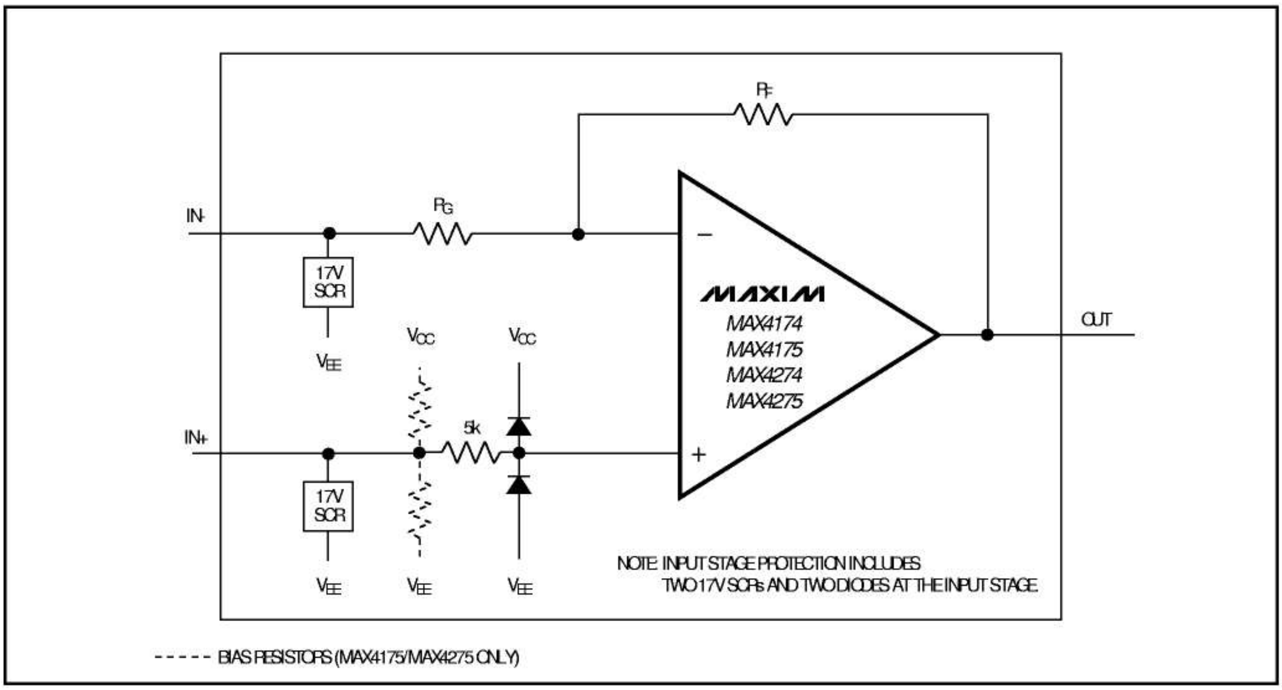


Figure 3. Input Protection

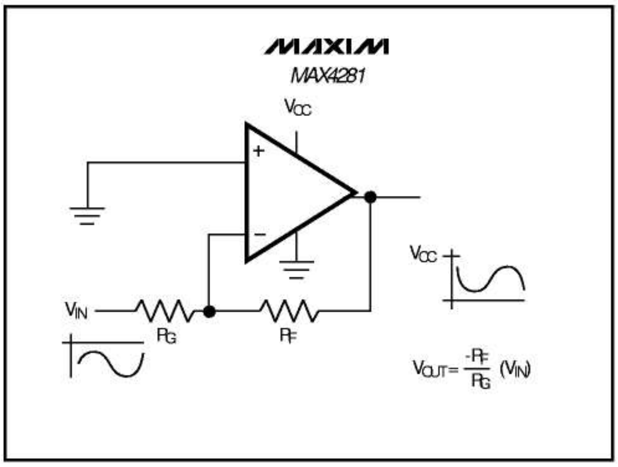


Figure 4. Single-Supply, DC-Coupled Inverting Amplifier with Negative Input Voltage

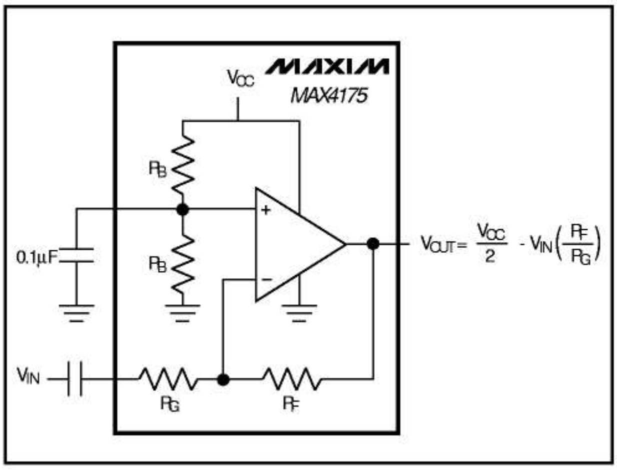


Figure 6. Single-Supply, AC-Coupled Inverting Amplifier

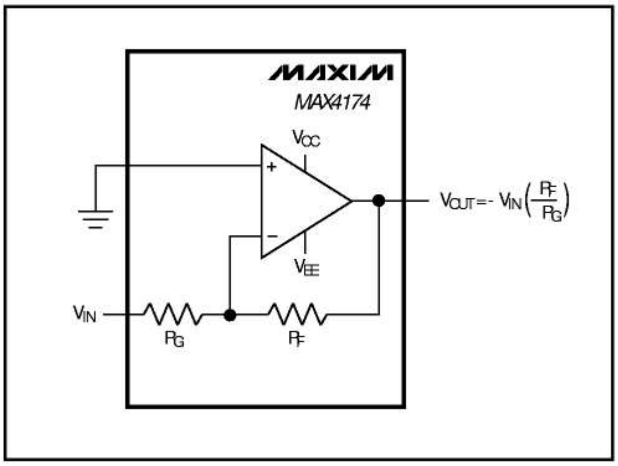


Figure 5. Dual-Supply, DC-Coupled Inverting Amplifier

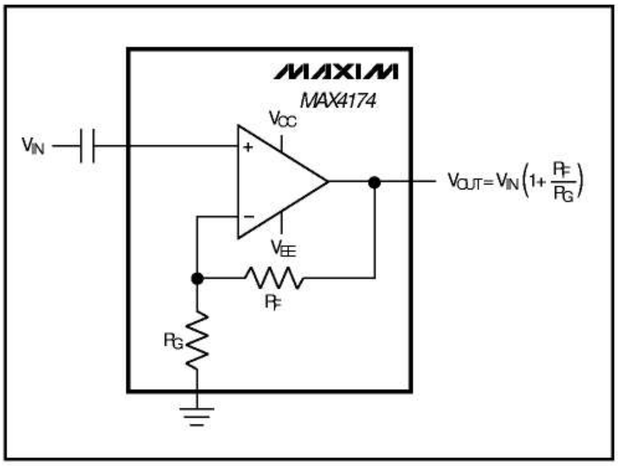


Figure 7. Dual-Supply, AC-Coupled Noninverting Amplifier

Gain-Amp Signal Coupling and Configurations

Common op-amp configurations include both noninverting and inverting amplifiers. Figures 5–8 show various single and dual-supply circuit configurations. Single-supply systems benefit from a midsupply bias on the noninverting input (provided internally on MAX4175/MAX4275), as this produces a quiescent DC level at the center of the rail-to-rail output stage signal swing. For dual-supply systems, ground-referenced signals may be DC-coupled into the inverting or noninverting inputs.

IN_+ Filter on MAX4175/MAX4275

Internal resistor biasing of the V_{CC} / 2 bias options couples power-supply noise directly to the op amp's noninverting input. To minimize high-frequency power-supply noise coupling, add a 1µF to 0.1µF capacitor from IN+ to ground to create a lowpass filter (Figure 6). The lowpass filter resulting from the internal bias resistors and added capacitor can help eliminate higher frequency power-supply noise coupling through the noninverting input.

Supply Bypassing and Board Layout

All devices in the Gain-Amp family operate from a +2.5V to +5.5V single supply or from ±1.25V to ±2.75V dual supplies. For single-supply operation, bypass the power supply with a 0.1µF capacitor to ground. For dual supplies, bypass each supply to ground. Bypass with capacitors as close to the device as possible, to minimize lead inductance and noise. A printed circuit board with a low-inductance ground plane is recommended.

Capacitive-Load Stability

Driving large capacitive loads can cause instability in most low-power, rail-to-rail output amplifiers. The fixed-gain amplifiers of this Gain-Amp family are stable with capacitive loads up to 470pF. Stability with higher capacitive loads can be improved by adding an isolation resistor in series with the op-amp output, as shown in Figure 9. This resistor improves the circuit's phase margin by isolating the load capacitor from the amplifier's output. In Figure 10, a 1000pF capacitor is driven with a 100Ω isolation resistor exhibiting some overshoot but no oscillation. Figures 11 and 12 show the typical small-signal pulse responses of Gain-Amp fixed-gain amplifiers with 250pF and 470pF capacitive loads and no isolation resistor.

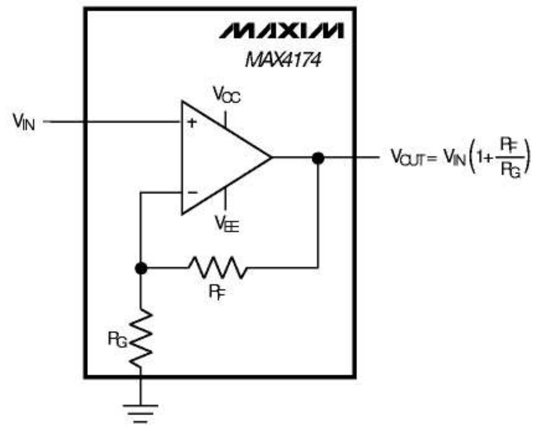


Figure 8. Dual-Supply, DC-Coupled Noninverting Amplifier

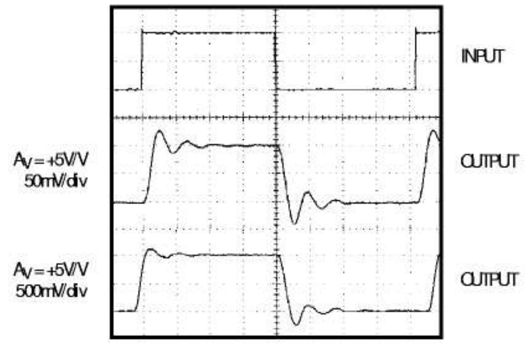


Figure 10. Small-Signal/Large-Signal Transient Response with Excessive Capacitive Load with Isolation Resistor

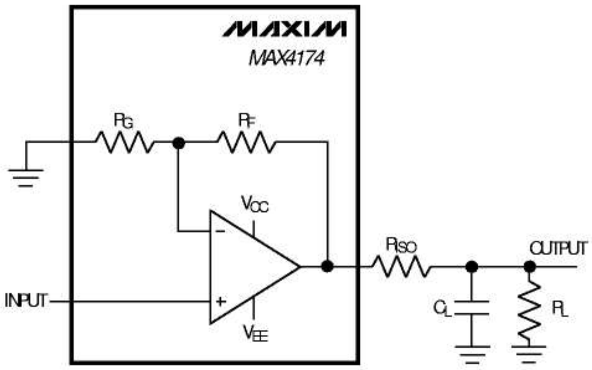


Figure 9. Dual-Supply, Capacitive-Load Driving Circuit

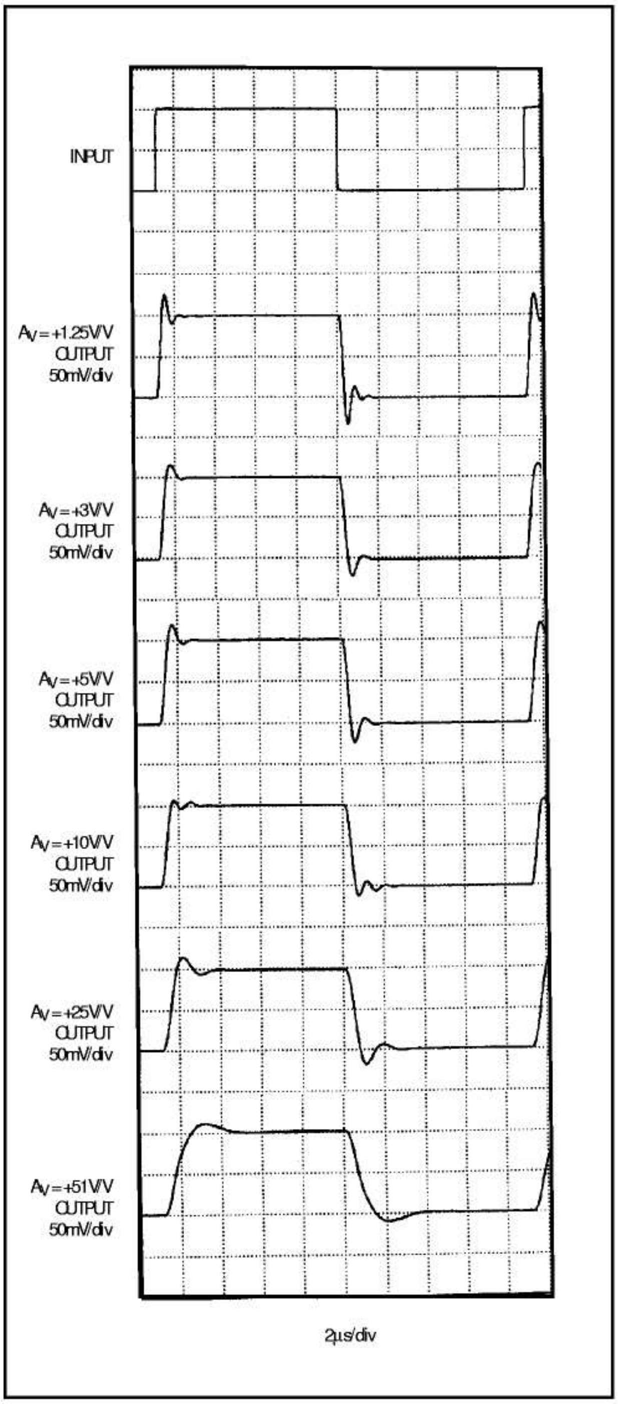


Figure 11. MAX4174/MAX4175 Small-Signal Pulse Response (C_L = 250pF, R_L = 100kΩ)

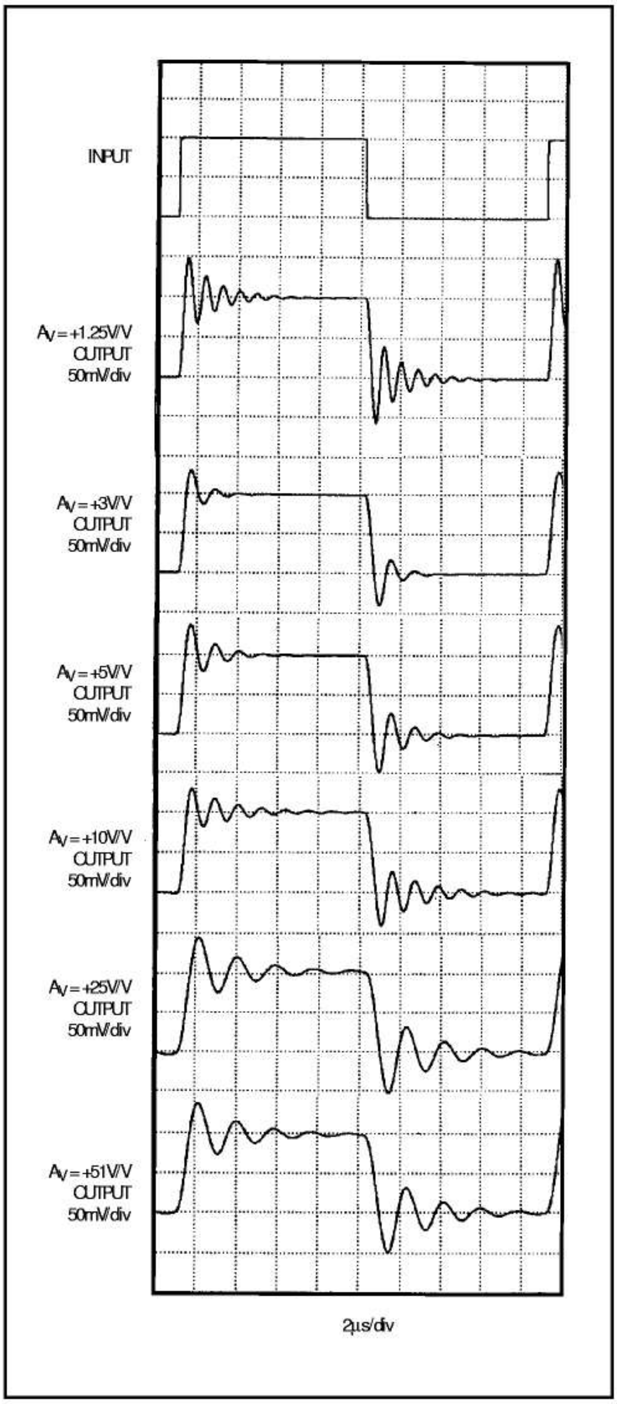


Figure 12. MAX4174/MAX4175 Small-Signal Pulse Response (C_L = 470pF, R_L = 100kΩ)

SOT23, Rail-to-Rail, Fixed-Gain Gain-Amps/Open-Loop Op Amps

Gain Selection Guide

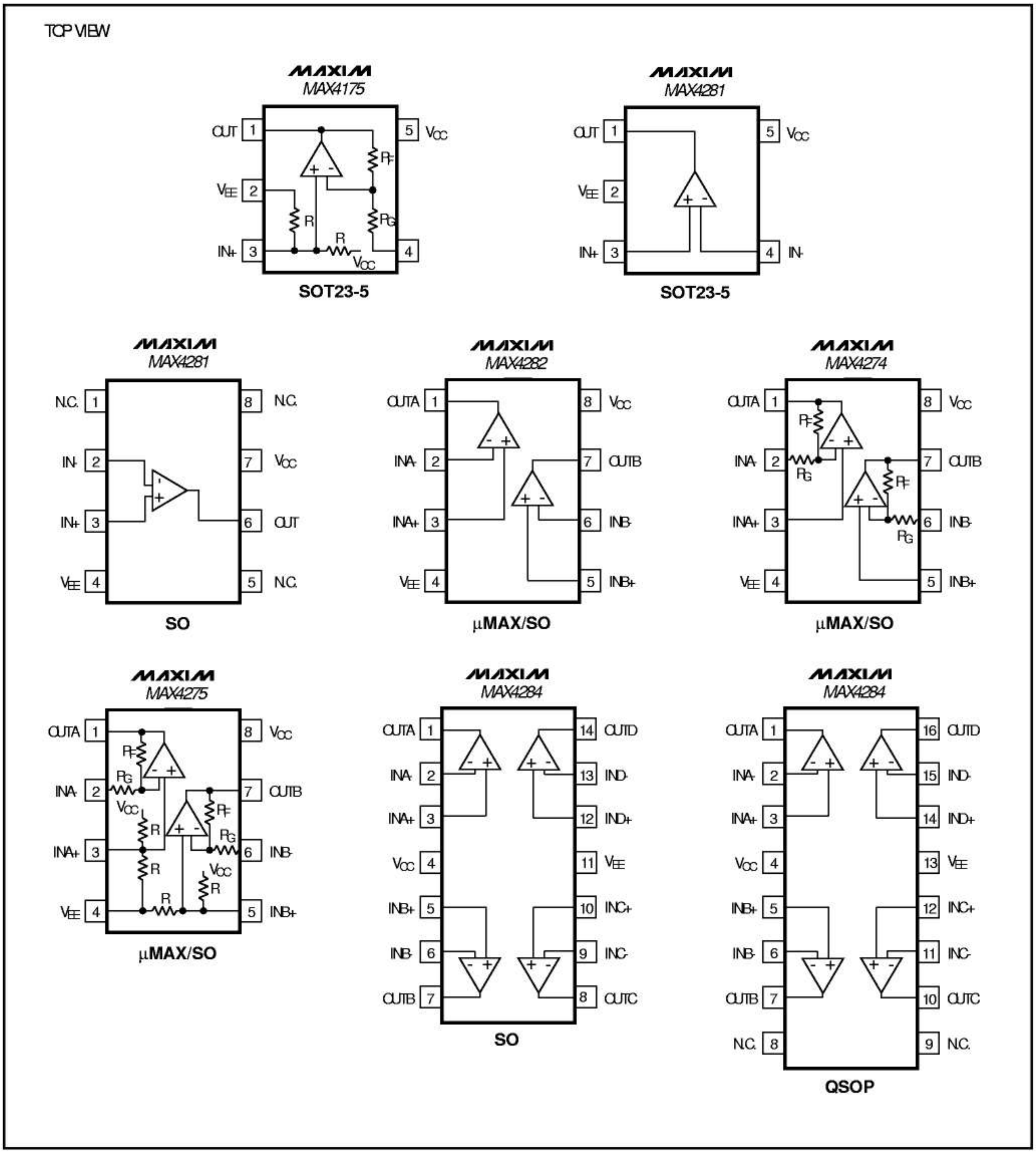
GAIN CODE	R_F/R_G INVERTING GAIN	1+ (R_F/R_G) NONINVERTING GAIN	-3dB BW (kHz)†	SOT TOP MARK	
				MAX4174	MAX4175
AB*	0.25	1.25	1700	ACDS	ACET
AC	0.5	1.5	1280	ACDT	ACEU
AD*	1	2	590	ACDU	ACEV
AE	1.25	2.25	450	ACDV	ACEW
AF	1.5	2.5	1180	ACDW	ACEX
AG*	2	3	970	ACDX	ACEY
AH	2.5	3.5	820	ACDY	ACEZ
AJ	3	4	690	ACDZ	ACFA
AK*	4	5	970	ACEA	ACFB
AL	5	6	790	ACEB	ACFC
AM	6	7	640	ACEC	ACFD
AN	8	9	480	ACED	ACFE
AO*	9	10	640	ACEE	ACFF
BA*	10	11	560	ACEF	ACFG
BB	12.5	13.5	460	ACEG	ACFH
BC	15	16	390	ACEH	ACFI
BD	20	21	300	ACEI	ACFJ
BE*	24	25	590	ACEJ	ACFK
BF	25	26	580	ACEK	ACFL
BG	30	31	510	ACEL	ACFM
BH	40	41	390	ACEM	ACFN
BJ*	49	50	310	ACEN	ACFO
BK*	50	51	330	ACEO	ACFP
BL	60	61	310	ACEP	ACFQ
BM	80	81	260	ACEQ	ACFR
BN*	99	100	230	ACER	ACFS
CA*	100	101	230	ACES	ACFT

Note: *Gains in the noninverting configuration are 1+ (R_F/R_G) and range from +1.25V/V to +101V/V. For a +1V/V gain, use the MAX4281/MAX4282/MAX4284.*

* *Preferred Gains. These gain versions are available as samples and in small quantities.*

† *The -3dB bandwidth is the same for inverting and noninverting configurations.*

Pin Configurations (continued)



SOT23, Rail-to-Rail, Fixed-Gain Gain-Amps/Open-Loop Op Amps

Ordering Information (continued)

PART*	TEMP. RANGE	PIN-PACKAGE	SOT TOP MARK
MAX4274_EUA**	-40°C to +85°C	8 µMAX	
MAX4274_ESA**	-40°C to +85°C	8 SO	
MAX4275_EUA**	-40°C to +85°C	8 µMAX	
MAX4275_ESA**	-40°C to +85°C	8 SO	
MAX4281EUK-T	-40°C to +85°C	5 SOT23-5	ACDR
MAX4281ESA	-40°C to +85°C	8 SO	
MAX4282EUA	-40°C to +85°C	8 µMAX	
MAX4282ESA	-40°C to +85°C	8 SO	
MAX4284ESD	-40°C to +85°C	14 SO	
MAX4284EEE	-40°C to +85°C	16 QSOP	

Note: *Refer to Gain Selection Guide for SOT top marks.*
* *Insert the desired gain code (from the Gain Selection Guide) in the blank to complete the part number. Refer to Gain Selection Guide for a list of preferred gains.*
** *Future product—contact factory for availability.*

Chip Information

TRANSISTOR COUNTS:
MAX4174: 178
MAX4175: 178
MAX4274: 332
MAX4275: 332
MAX4281: 178
MAX4282: 332
MAX4284: 328
SUBSTRATE CONNECTED TO V_{EE}

Selector Guide

PART*	INVERTING GAINS AVAILABLE (V/V) (INVERTING, R_F/R_G)	NONINVERTING GAIN (V/V)	INTERNAL RESISTORS	INTERNAL V_{CC} / 2 BIAS	NO. OF AMPS PER PACKAGE	PIN-PACKAGE
MAX4174_	-0.25 to -100	+1.25 to +101	Yes	No	1	5-pin SOT23
MAX4175_	-0.25 to -100	+1.25 to +101	Yes	Yes	1	5-pin SOT23
MAX4274_**	-0.25 to -100	+1.25 to +101	Yes	No	2	8-pin µMAX/SO
MAX4275_**	-0.25 to -100	+1.25 to +101	Yes	Yes	2	8-pin µMAX/SO
MAX4281	Open Loop, Unity-Gain Stable		No	No	1	5-pin SOT23, 8-pin SO
MAX4282	Open Loop, Unity-Gain Stable		No	No	2	8-pin µMAX/SO
MAX4284	Open Loop, Unity-Gain Stable		No	No	4	14-pin SO, 16-pin QSOP

* *Insert the desired gain code (from the Gain Selection Guide) in the blank to complete the part number.*
** *Future product—contact factory for availability.*