

MAXIM

High-Speed, Micropower Op Amps

General Description

The MAX402/MAX403 high-speed, micropower op amps are fabricated with Maxim's high-frequency complementary bipolar process. These devices feature a combination of high-speed performance and low-power operation that offers significant improvement over other available op amps.

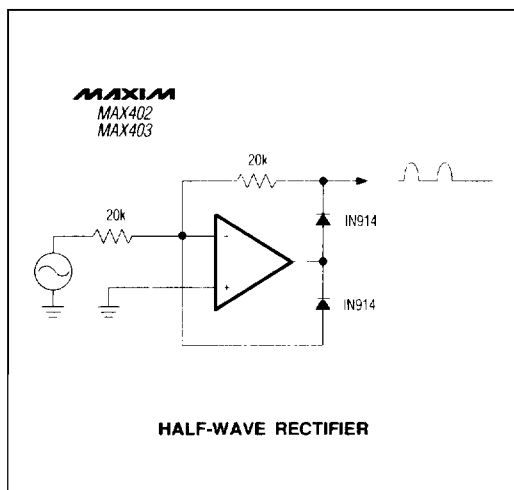
The MAX402 guarantees a 5V/ μ s slew rate and 1.4MHz bandwidth while drawing only 75 μ A of supply current. For applications requiring increased speed, the MAX403 guarantees a 25V/ μ s slew rate and 7MHz bandwidth while drawing a maximum supply current of 375 μ A. These micropower op amps have excellent load-driving capability: ± 3.6 V into a 10k Ω load for both amplifiers, and ± 3.3 V into a 2k Ω load for the MAX403. Both op amps are unity-gain stable and operate from ± 3 V to ± 5 V supplies, or a single supply from +6V to +10V.

The combination of high speed and low power makes the MAX402/MAX403 ideal for high-speed, battery-powered applications.

Applications

Low-Power Signal Processing
Portable Instruments
Remote Sensors

Typical Application Circuit



Features

MAX402

- ◆ 1.4MHz Min Unity Gain Bandwidth
- ◆ 5V/ μ s Min Slew Rate
- ◆ 75 μ A Max Supply Current

MAX403

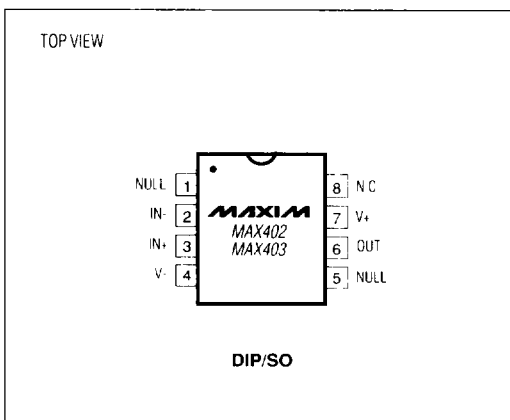
- ◆ 7MHz Min Unity Gain Bandwidth
- ◆ 25V/ μ s Min Slew Rate
- ◆ 375 μ A Max Supply Current

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX402CPA	0°C to +70°C	8 Plastic DIP
MAX402CSA	0°C to +70°C	8 SO
MAX402C/D	0°C to +70°C	Dice*
MAX402EPA	-40°C to +85°C	8 Plastic DIP
MAX402ESA	-40°C to +85°C	8 SO
MAX403CPA	0°C to +70°C	8 Plastic DIP
MAX403CSA	0°C to +70°C	8 SO
MAX403C/D	0°C to +70°C	Dice*
MAX403EPA	-40°C to +85°C	8 Plastic DIP
MAX403ESA	-40°C to +85°C	8 SO
MAX403MJA	-55°C to +125°C	8 CERDIP

* Contact factory for dice specifications and military temperature range availability

Pin Configuration



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ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V+ to V-)	12V
Input Voltage Range	(V+ +0.3V) to (V- -0.3V)
Differential Input Voltage	V+ to V-
Short-Circuit Current Duration	Indefinite
Maximum Current into Any Pin	50mA
Continuous Power Dissipation (TA = +25°C)	
8-Pin Plastic DIP	375mW
8-Pin CERDIP	500mW
8-Pin SO	471mW

Operating Temperature Ranges:

MAX40 _ C	0°C to +70°C
MAX40 _ E	-40°C to +85°C
MAX403MJA	-55°C to +125°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10 sec)	+300°C

Note 1: Absolute maximum ratings apply to packaged parts only, unless otherwise noted.

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

ELECTRICAL CHARACTERISTICS

(V+ = 5V, V- = -5V, TA = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MAX402			MAX403			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V _{OS}			0.5	2		0.5	2	mV
Offset Voltage Tempco $\Delta V_{OS}/\Delta T$	TCV _{OS}	TA = T _{MIN} to T _{MAX}		25			25		$\mu V/^{\circ}C$
Input Bias Current	I _B			± 2	± 5		± 10	± 25	nA
Input Voltage Range	IVR		± 3.5	± 3.8		± 3.5	± 3.8		V
Differential Input Resistance	R _{IN} (DIFF)			90			18		M Ω
Common-Mode Input Resistance	R _{IN} (CM)			1			1		G Ω
Input Noise Voltage Density	e _n	f _O = 10Hz		43			33		nV/ \sqrt{Hz}
		f _O = 1000Hz		26			14		
Input Noise Current Density	i _n	f _O = 10Hz		0.06			0.25		pA/ \sqrt{Hz}
		f _O = 1000Hz		0.03			0.07		
Common-Mode Rejection Ratio	CMRR	V _{CM} = $\pm 3.5V$	75	95		66	80		dB
Power-Supply Rejection Ratio	PSRR	V _S = $\pm 4.5V$ to $\pm 5.5V$	56	65		60	70		dB
Large-Signal Gain	A _{VOL}	R _L = 10k Ω	68	75			80		dB
		R _L = 2k Ω				68	75		
Output Voltage Swing	V _{OUT}	R _L = 10k Ω	± 3.6	± 3.9		± 3.6	± 3.9		V
		R _L = 2k Ω				± 3.3	± 3.6		
Short-Circuit Output Current	I _{SC}			3			5		mA
Slew Rate	SR	10k Ω 20pF load	5	7		25	40		V/ μs
Gain Bandwidth	GBW	10k Ω 20pF load	1.4	2		7	10		MHz
Quiescent Current	I _Q		40	50	75	200	250	375	μA

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MAX402/MAX403

ELECTRICAL CHARACTERISTICS

($V_+ = 5V$, $V_- = -5V$, $T_A = 0^\circ C$ to $+70^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MAX402C _ A			MAX403C _ A			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			4			4		mV
Input Bias Current	I_B			± 10			± 50		nA
Input Voltage Range	IVR		± 3.5			± 3.5			V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = \pm 3.5V$	70			66			dB
Power-Supply Rejection Ratio	PSRR	$V_S = \pm 4.5V$ to $\pm 5.5V$	54			60			dB
Large-Signal Gain	A_{VOL}	$R_L = 10k\Omega$	66						dB
		$R_L = 2k\Omega$				66			
Output Voltage Swing	V_{OUT}	$R_L = 10k\Omega$	± 3.5			± 3.5			V
		$R_L = 2k\Omega$				± 3.2			
Slew Rate	SR	$10k\Omega$ $20pF$ load	4.5			22.5			V/ μs
Gain Bandwidth	GBW	$10k\Omega$ $20pF$ load	1.3			7			MHz
Quiescent Current	I_Q		35	90		175	450		μA

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ELECTRICAL CHARACTERISTICS

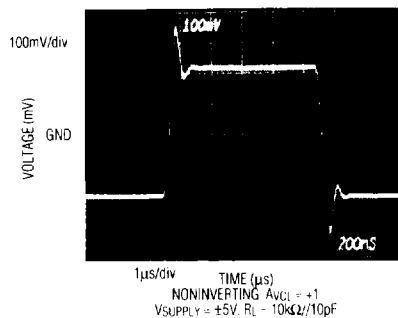
($V_+ = 5V$, $V_- = -5V$, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MAX402E _ A			MAX403E _ A			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			5			5		mV
Input Bias Current	I_B			± 20			± 100		nA
Input Voltage Range	IVR		± 3.5			± 3.5			V
Common-Mode Rejection Ratio	CMRR	$V_{CM} = \pm 3.5V$	68			66			dB
Power-Supply Rejection Ratio	PSRR	$V_S = \pm 4.5V$ to $\pm 5.5V$	52			58			dB
Large-Signal Gain	A_{VOL}	$R_L = 10k\Omega$	63						dB
		$R_L = 2k\Omega$				63			
Output Voltage Swing	V_{OUT}	$R_L = 10k\Omega$	± 3.4			± 3.4			V
		$R_L = 2k\Omega$				± 3.0			
Slew Rate	SR	$10k\Omega$ $20pF$ load	4.0			20			V/ μs
Gain Bandwidth	GBW	$10k\Omega$ $20pF$ load	1.2			6			MHz
Quiescent Current	I_Q		30	95		150	475		μA

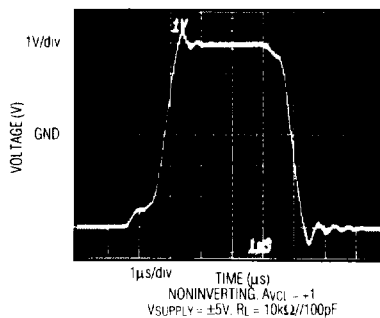
High-Speed, Micropower Op Amps

Typical Operating Characteristics

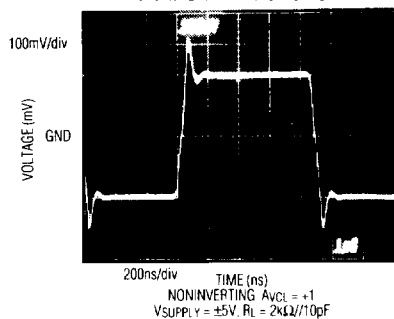
**MAX402 SMALL-SIGNAL
TRANSIENT RESPONSE**



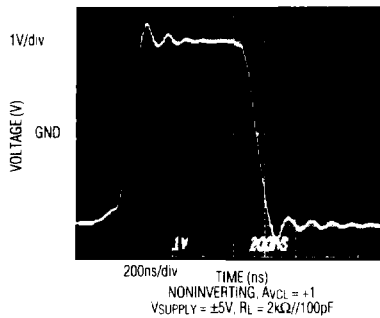
**MAX402 LARGE-SIGNAL
TRANSIENT RESPONSE**



**MAX403 SMALL-SIGNAL
TRANSIENT RESPONSE**



**MAX403 LARGE-SIGNAL
TRANSIENT RESPONSE**



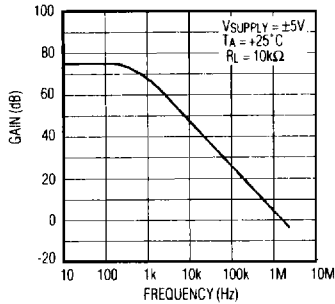
High-Speed, Micropower Op Amps

Typical Operating Characteristics (continued)

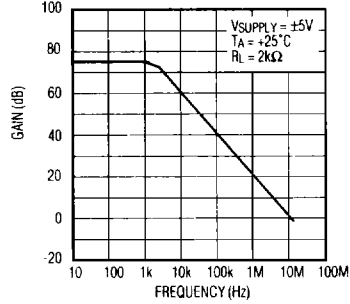
MAX402/MAX403

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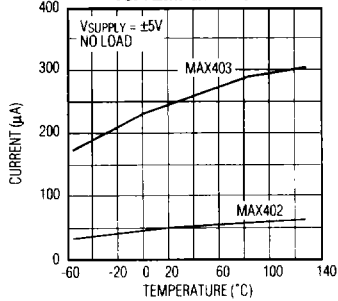
MAX402 OPEN-LOOP GAIN vs. FREQUENCY



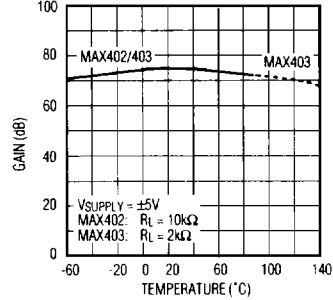
MAX403 OPEN-LOOP GAIN vs. FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE

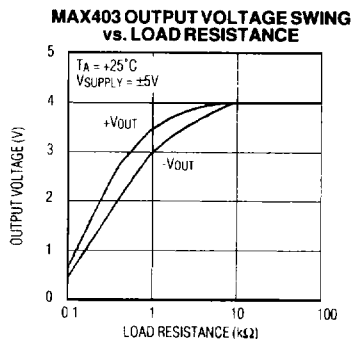
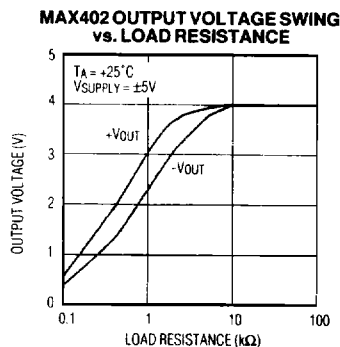
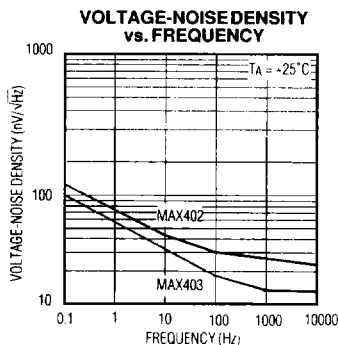
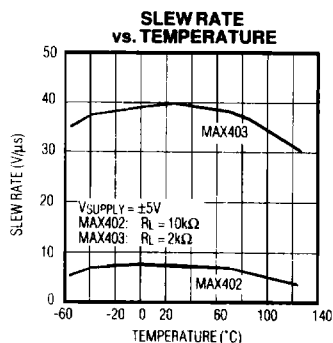
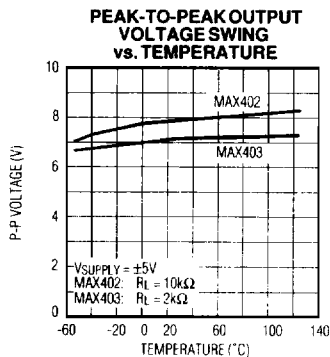


OPEN-LOOP GAIN vs. TEMPERATURE



High-Speed, Micropower Op Amps

Typical Operating Characteristics (continued)



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Pin Description

PIN	NAME	FUNCTION
1, 5	NULL	Offset-Voltage Adjustment
2	IN-	Inverting Input
3	IN+	Noninverting Input
4	V-	Negative Power Supply
6	OUT	Amplifier Signal Output
7	V+	Positive Power Supply
8	N.C.	No Connect

Applications Information

Input Offset-Voltage Adjustment

Pins 1 and 5 (NULL) null the input offset voltage. To adjust amplifier offset, connect a potentiometer between the two NULL pins with the wiper connected to V-, as shown in Figure 1. A 10kΩ potentiometer should be used with the MAX402, while a 2kΩ potentiometer is recommended with the MAX403. The offset voltage can be adjusted approximately ±6mV with these trim potentiometers.

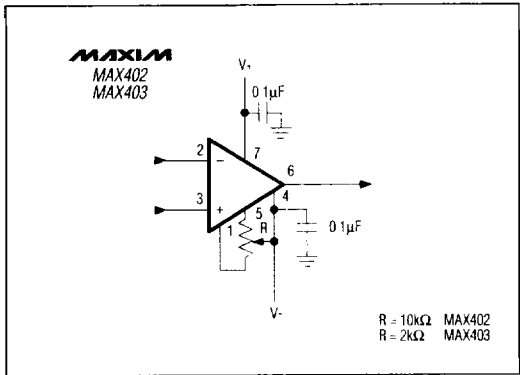


Figure 1. Offset-Voltage Adjustment

Operating Supply Voltage

The MAX402/MAX403 are specified with ±5V power supplies, but also operate with dual supplies down to ±3V or single supplies ranging from +6V to +10V. The input voltage range for normal amplifier operation is between V- + 1.5V and V+ - 1.5V. For example, with a single +6V supply, the common-mode input voltage ranges between +1.5V and +4.5V.

Layout and Bypassing

The MAX402/MAX403 power-supply inputs should be bypassed with 0.1μF ceramic capacitors positioned as close to the power-supply pins as possible. To obtain maximum performance, a ground plane should be used. This is especially important for high-frequency applications. Minimize lead lengths in connections from the power-supply bypass capacitors to ground to further reduce inductance. Connections to the amplifier's input terminals should be as short and direct as possible, with a minimum of inductance.

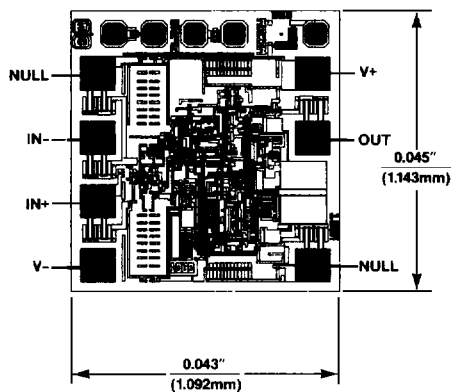
Overload Conditions

The MAX402/MAX403 inputs withstand differential voltages equal to the power-supply rails, without requiring external clamp diodes or input current-limiting resistors. Schottky diodes, used internally throughout the devices, prevent saturation of the internal transistors and allow the amplifiers to recover quickly from overload conditions.

The output stages of the MAX402/MAX403 employ a current-limit circuit that prevents damage to the amplifier in the event of a fault condition. The output may be shorted to either power supply or ground for an indefinite time without damage.

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Chip Topography



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.