19-3786; Rev 0; 6/91

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

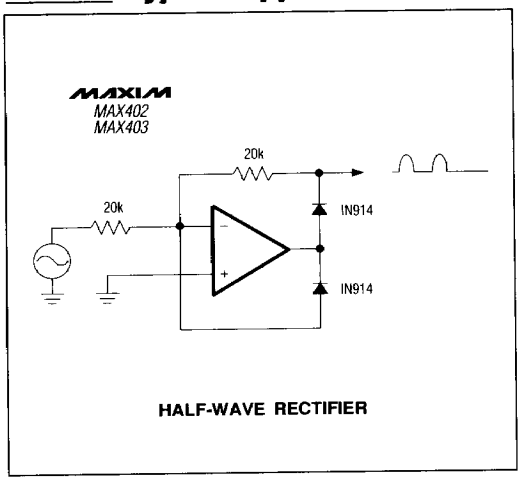
Applications

Low-Power Signal Processing

Portable Instruments

Remote Sensors

Typical Application Circuit



HALF-WAVE RECTIFIER

Features

MAX402

- **1.4MHz Min Unity Gain Bandwidth**
- **5V/µs Min Slew Rate**
- **75µA Max Supply Current**

MAX403

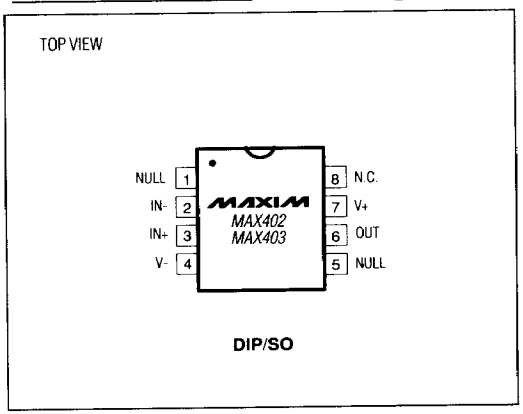
- **7MHz Min Unity Gain Bandwidth**
- **25V/µs Min Slew Rate**
- **375µA Max Supply Current**

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



DIP/SO

High-Speed, Micropower Op Amps

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 (T_A = +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, T_A = +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}	$T_A = T_{MIN}$ to T_{MAX}		25			25		µV/°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		MΩ
Common-Mode Input Resisitance	R_{IN} (CM)			1			1		GΩ
Input Noise Voltage Density	e_n	f_O = 10Hz		43			33		nV/√Hz
		f_O = 1000Hz		26			14		
Input Noise Current Density	i_n	f_O = 10Hz		0.06			0.25		pA/√Hz
		f_O = 1000Hz		0.03			0.07		
Common-Mode Rejection Ratio	CMRR	V_{CM} = ±3.5V	75	95		66	80		dB
Power-Supply Rejection Ratio	PSRR	V_S = ±4.5V to ±5.5V	56	65		60	70		dB
Large-Signal Gain	A_{VOL}	R_L = 10kΩ	68	75			80		dB
		R_L = 2kΩ				68	75		
Output Voltage Swing	V_{OUT}	R_L = 10kΩ	±3.6	±3.9		±3.6	±3.9		V
		R_L = 2kΩ				±3.3	±3.6		
Short-Circuit Output Current	I_{SC}			3			5		mA
Slew Rate	SR	10kΩ | | 20pF load	5	7		25	40		V/µs
Gain Bandwidth	GBW	10kΩ | | 20pF load	1.4	2		7	10		MHz
Quiescent Current	I_Q		40	50	75	200	250	375	µA

ELECTRICAL CHARACTERISTICS

(V+ = 5V, V- = -5V, T_A = 0°C to +70°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} = ±3.5V	70			66			dB
Power-Supply Rejection Ratio	PSRR	V_S = ±4.5V to ±5.5V	54			60			dB
Large-Signal Gain	A_{VOL}	R_L = 10kΩ	66						dB
		R_L = 2kΩ				66			
Output Voltage Swing	V_{OUT}	R_L = 10kΩ	±3.5			±3.5			V
		R_L = 2kΩ				±3.2			
Slew Rate	SR	10kΩ | | 20pF load	4.5			22.5			V/µs
Gain Bandwidth	GBW	10kΩ | | 20pF load	1.3			7			MHz
Quiescent Current	I_Q		35		90	175		450	µA

ELECTRICAL CHARACTERISTICS

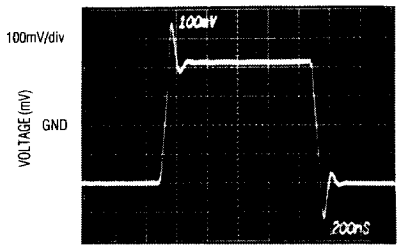
(V+ = 5V, V- = -5V, T_A = -40°C to +85°C, unless otherwise noted.)

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} = ±3.5V	68			66			dB
Power-Supply Rejection Ratio	PSRR	V_S = ±4.5V to ±5.5V	52			58			dB
Large-Signal Gain	A_{VOL}	R_L = 10kΩ	63						dB
		R_L = 2kΩ				63			
Output Voltage Swing	V_{OUT}	R_L = 10kΩ	±3.4			±3.4			V
		R_L = 2kΩ				±3.0			
Slew Rate	SR	10kΩ | | 20pF load	4.0			20			V/µs
Gain Bandwidth	GBW	10kΩ | | 20pF load	1.2			6			MHz
Quiescent Current	I_Q		30		95	150		475	µA

High-Speed, Micropower Op Amps

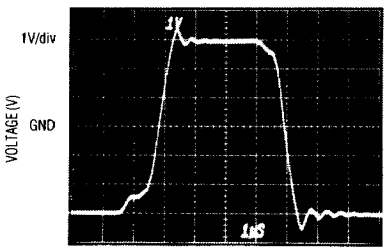
Typical Operating Characteristics

MAX402 SMALL-SIGNAL TRANSIENT RESPONSE



NONINVERTING, A_{VCL} = +1
V_{SUPPLY} = ±5V, R_L = 10kΩ//10pF

MAX402 LARGE-SIGNAL TRANSIENT RESPONSE

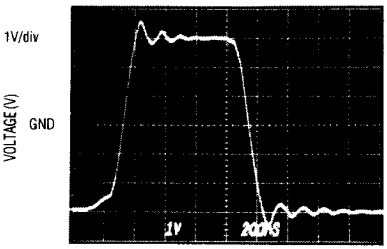


NONINVERTING, A_{VCL} = +1
V_{SUPPLY} = ±5V, R_L = 10kΩ//100pF

MAX403 SMALL-SIGNAL TRANSIENT RESPONSE

NONINVERTING, A_{VCL} = +1
V_{SUPPLY} = ±5V, R_L = 2kΩ//10pF

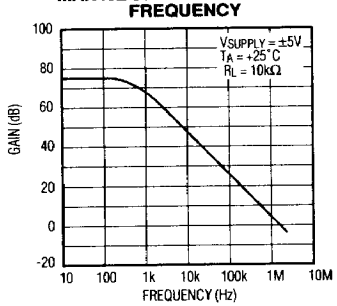
MAX403 LARGE-SIGNAL TRANSIENT RESPONSE



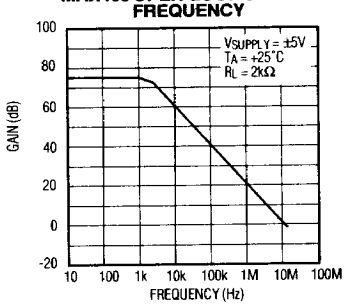
NONINVERTING, A_{VCL} = +1
V_{SUPPLY} = ±5V, R_L = 2kΩ//100pF

Typical Operating Characteristics (continued)

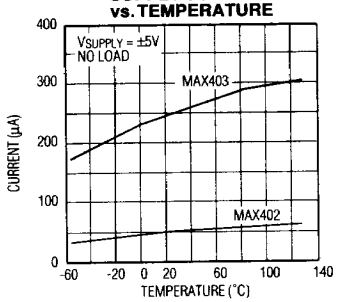
MAX402 OPEN-LOOP GAIN vs. FREQUENCY



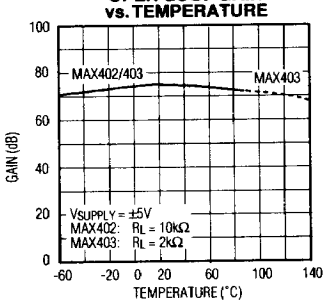
MAX403 OPEN-LOOP GAIN vs. FREQUENCY



SUPPLY CURRENT vs. TEMPERATURE

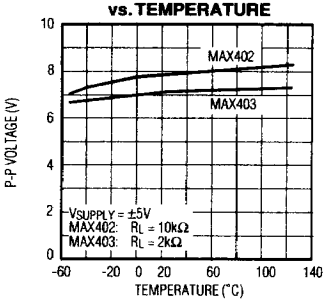


OPEN-LOOP GAIN vs. TEMPERATURE

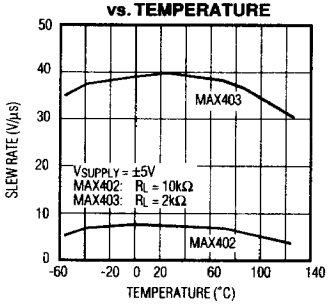


Typical Operating Characteristics (continued)

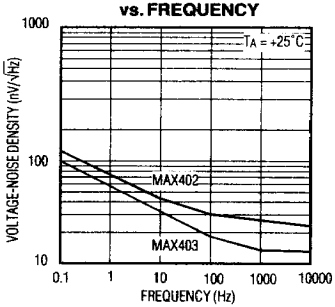
PEAK-TO-PEAK OUTPUT VOLTAGE SWING vs. TEMPERATURE



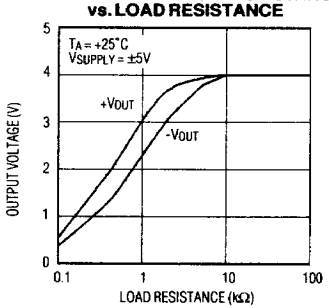
SLEW RATE vs. TEMPERATURE



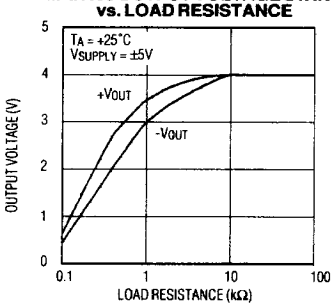
VOLTAGE-NOISE DENSITY vs. FREQUENCY



MAX402 OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE



MAX403 OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE



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.

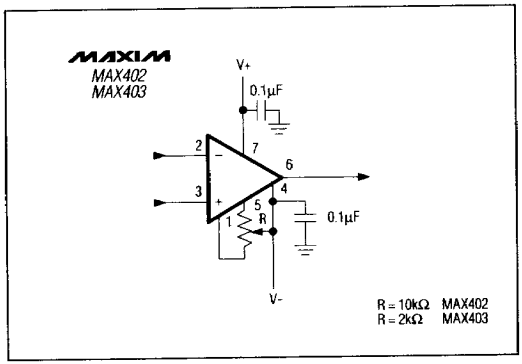


Figure 1. Offset-Voltage Adjustment

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.

High-Speed, Micropower Op Amps

Chip Topography