

### **General Description**

The MAX4200-MAX4205 are ultra-high-speed, openloop buffers featuring high slew rate, high output current, low noise, and excellent capacitive-load-driving capability. The MAX4200/MAX4201/MAX4202 are single buffers, while the MAX4203/MAX4204/MAX4205 are dual buffers. The MAX4201/MAX4204 have integrated  $50\Omega$  termination resistors, making them ideal for driving  $50\Omega$  transmission lines. The MAX4202/MAX4205 include  $75\Omega$  back-termination resistors for driving  $75\Omega$  transmission lines. The MAX4200/MAX4203 have no internal termination resistors.

The MAX4200-MAX4205 use a proprietary architecture to achieve up to 780MHz -3dB bandwidth, 280MHz 0.1dB gain flatness, 4200V/µs slew rate, and ±90mA output current drive capability. They operate from ±5V supplies and draw only 2.2mA of quiescent current. These features, along with low-noise performance, make these buffers suitable for driving high-speed analog-todigital converter (ADC) inputs or for data-communications applications.

## **Applications**

High-Speed DAC Buffers

Wireless LANs

Digital-Transmission Line Drivers

High-Speed ADC Input Buffers

IF/Communications Systems

#### **Selector Guide**

PART	NO. OF BUFFERS	INTERNAL OUTPUT TERMINATION (Ω)	PIN-PACKAGE
MAX4200	1	_	8 SO, 5 SOT23
MAX4201	1	50	8 SO, 5 SOT23
MAX4202	1	75	8 SO, 5 SOT23
MAX4203	2	_	8 SO/µMAX
MAX4204	2	50	8 SO/µMAX
MAX4205	2	75	8 SO/µMAX

Pin Configurations appear at end of data sheet.

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### Features

- ♦ 2.2mA Supply Current
- ♦ High Speed

780MHz -3dB Bandwidth (MAX4201/MAX4202) 280MHz 0.1dB Gain Flatness (MAX4201/MAX4202) 4200V/µs Slew Rate

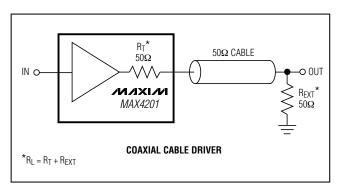
- ♦ Low 2.1nV/√Hz Voltage-Noise Density
- ♦ Low 0.8pA/√Hz Current-Noise Density
- ♦ High ±90mA Output Drive (MAX4200/MAX4203)
- **♦** Excellent Capacitive-Load-Driving Capability
- ♦ Available in Space-Saving SOT23 or µMAX® **Packages**

### **Ordering Information**

PIN-PACKAGE	TOP MARK	PKG CODE
8 SO	_	S8-2
5 SOT23-5	AABZ	U5-1
8 SO	_	S8-2
5 SOT23-5	ABAA	U5-1
8 SO	_	S8-2
5 SOT23-5	ABAB	U5-1
8 SO	_	S8-2
8 μMAX-8	_	U8-1
8 SO	_	S8-2
8 µMAX-8	_	U8-1
8 SO	_	S8-2
8 μMAX-8	_	U8-1
	8 SO 5 SOT23-5 8 SO 5 SOT23-5 8 SO 5 SOT23-5 8 SO 8 µMAX-8 8 SO 8 µMAX-8 8 SO	PIN-PACKAGE         MARK           8 SO         —           5 SOT23-5         AABZ           8 SO         —           5 SOT23-5         ABAA           8 SO         —           5 SOT23-5         ABAB           8 SO         —           8 μΜΑΧ-8         —           8 μΜΑΧ-8         —           8 SO         —           8 SO         —           8 SO         —

Note: All devices are specified over the -40°C to +85°C operating temperature range.

## **Typical Application Circuit**



Maxim Integrated Products 1

### **ABSOLUTE MAXIMUM RATINGS**

Supply Voltage (VCC to VEE)+12V	Operating Temperature Range40°C to +85°C
Voltage on Any Pin to GND(VEE - 0.3V) to (VCC + 0.3V)	Storage Temperature Range65°C to +150°C
Output Short-Circuit Duration to GNDContinuous	Lead Temperature (soldering, 10s)+300°C
Continuous Power Dissipation (TA = +70°C)	
5-Pin SOT23 (derate 7.1mW/°C above +70°C)571mW	
8-Pin µMAX (derate 4.1mW/°C above +70°C)330mW	
8-Pin SO (derate 5.9mW/°C above +70°C)471mW	

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

### DC ELECTRICAL CHARACTERISTICS

 $(V_{CC} = +5V, V_{EE} = -5V, R_L = \infty, T_A = T_{MIN} \text{ to } T_{MAX}, \text{ unless otherwise noted. Typical values are at } T_A = +25^{\circ}C.)$ 

PARAMETER	SYMBOL		MIN	TYP	MAX	UNITS			
Operating Supply Voltage	Vs	Guarantee	±4		±5.5	V			
Quiescent Supply Current	Is	Per buffer, V <sub>IN</sub> = 0V				2.2	4	mA	
Input Offset Voltage	Vos	V <sub>IN</sub> = 0V				1	15	mV	
Input Offset Voltage Drift	TCVos	VIN = 0V				20		μV/°C	
Input Offset Voltage Matching		MAX4203/I	MAX4204/MA	AX4205		0.4		mV	
Input Bias Current	IB					0.8	10	μΑ	
Input Resistance	RIN	(Note 1)				500		kΩ	
		-3.0V ≤ VOUT ≤ 3.0V	MAX4200/	$MAX4203$ , $R_{EXT} = 150Ω$	0.9	0.96	1.1		
Voltage Gain	Av		MAX4201/	MAX4201/MAX4204, $R_{EXT} = 50\Omega$		0.50	0.58	V/V	
			MAX4202/	$MAX4205$ , $R_{EXT} = 75Ω$	0.41	0.50	0.59		
Power-Supply Rejection	PSR	$V_S = \pm 4V$ to $\pm 5.5V$		55	72		dB		
		f = DC		MAX4200/MAX4203		8			
Output Resistance	Rout			MAX4201/MAX4204		50		Ω	
				MAX4202/MAX4205		75			
		R <sub>L</sub> = 30Ω		MAX4200/MAX4203		±90			
Output Current	lout			MAX4201/MAX4204		±52		mA	
				MAX4202/MAX4205		±44			
Short-Circuit Output Current		Sinking or sourcing N		MAX4200/MAX4203		150			
	Isc			MAX4201/MAX4204		90		mA	
				MAX4202/MAX4205		75			
Output-Voltage Swing	Vout	MAX4200/MAX4203		$R_L = 150\Omega$	±3.3	±3.8			
				$R_L = 100\Omega$	±3.2	±3.7			
				$RL = 37.5\Omega$ ±3		±3.3		V	
		MAX4201/MAX4204		$R_L = 50\Omega$	±1.9	±2.1			
		MAX4202/MAX4205		$R_L = 75\Omega$	±2.0	±2.3			

### **AC ELECTRICAL CHARACTERISTICS**

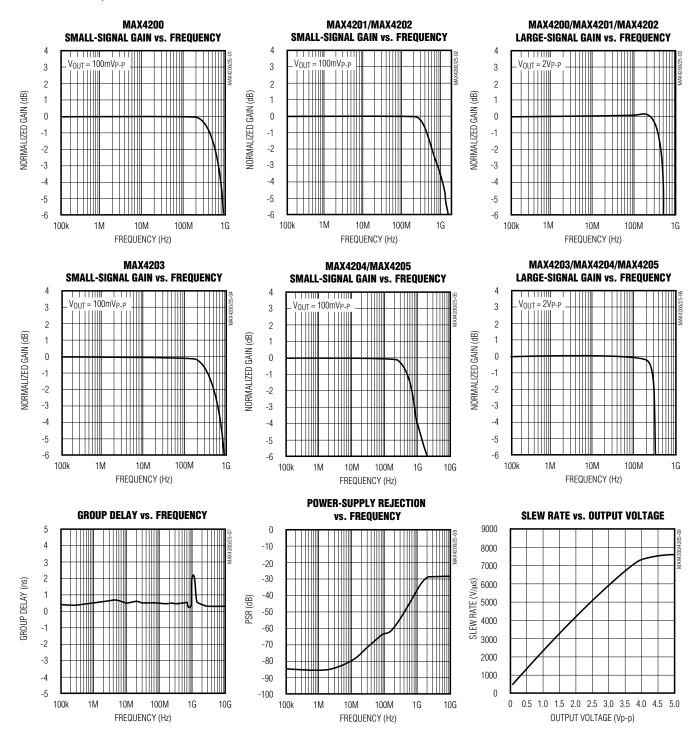
 $(V_{CC}=+5V,\ V_{EE}=-5V,\ R_L=100\Omega$  for MAX4200/MAX4201/MAX4203/MAX4204,  $R_L=150\Omega$  for MAX4202/MAX4205,  $T_A=T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A=+25^{\circ}C$ .)

PARAMETER	SYMBOL	CONDITIONS				MIN	TYP	MAX	UNITS		
		MAX			MAX420	00		660			
-3dB Bandwidth	BW <sub>(-3dB)</sub>	V <sub>OUT</sub> ≤ 100mV <sub>RMS</sub>		MAX4201/MAX4202			780		MHz		
				MAX4203			530				
				MAX4204/MAX4205			720				
		Vout ≤ 100mV <sub>RMS</sub>		MAX4200			220				
0.1dB Bandwidth	BW(0.1dB)			MAX4201/MAX4202			280		MHz		
0. Tab banawatii	DVV(0.10b)			MAX4203			130		IVII IZ		
				MAX420	MAX4204/MAX4205		230				
Full-Power Bandwidth	FPBW	VOUT ≤ 2VP-P		MAX	(4200/MAX	(4201/MAX4202		490		MHz	
Tail Tower Barlawidth	11 DW			MAX	X4203/MAX4204/MAX4205		310		]		
Slew Rate	SR	$V_{OUT} = 2V$	step					4200		V/µs	
Group Delay Time								405		ps	
Settling Time to 0.1%	ts	$V_{OUT} = 2V$	step					12		ns	
			MAX4200/MA MAX4202		1A Y 1201/	f = 5MHz		-48			
					//A//4201/	f = 20MHz		-45		- dBc	
Spurious-Free Dynamic	SFDR					f = 100MHz		-34			
Range			MAX4203/MAX MAX4205		10X1201/	f = 5MHz		-47			
						f = 20MHz		-44			
						f = 100MHz		-32			
	HD	MAX4200/MAX4201/ MAX4202, f = 500kHz, V <sub>OUT</sub> = 2V <sub>P-P</sub>			Second harmonic			-72			
				κHz,	Third harmonic			-48		- dBc	
Harmonic Distortion					Total harmonic			-48			
Tidimonio Biotorilon		MAX4203/MAX4204/I MAX4205, f = 500kHz, Vout = 2Vp-p			Second harmonic			-83			
				Third harmonic			-47				
				Total harmonic			-47				
Differential Gain Error	DG	NTSC, $R_L = 150\Omega$					1.3		%		
Differential Phase Error	DP	NTSC, $R_L = 150\Omega$					0.15		degrees		
Input Voltage-Noise Density	en	f = 1MHz				2.1		nV/√Hz			
Input Current-Noise Density	in	f = 1MHz				0.8		pA/√Hz			
Input Capacitance	CIN					2		рF			
Output Impedance	Zout	f = 10MHz					6		Ω		
Amplifier Crosstalk	XTALK	V <sub>OUT</sub> = 2V <sub>P-P</sub>		f = 10MHz			-87		dB		
7 mpilio Orossiaik	^IALK			f = 100MHz			-65		l GD		

Note 1: Tested with no load; increasing load will decrease input impedance.

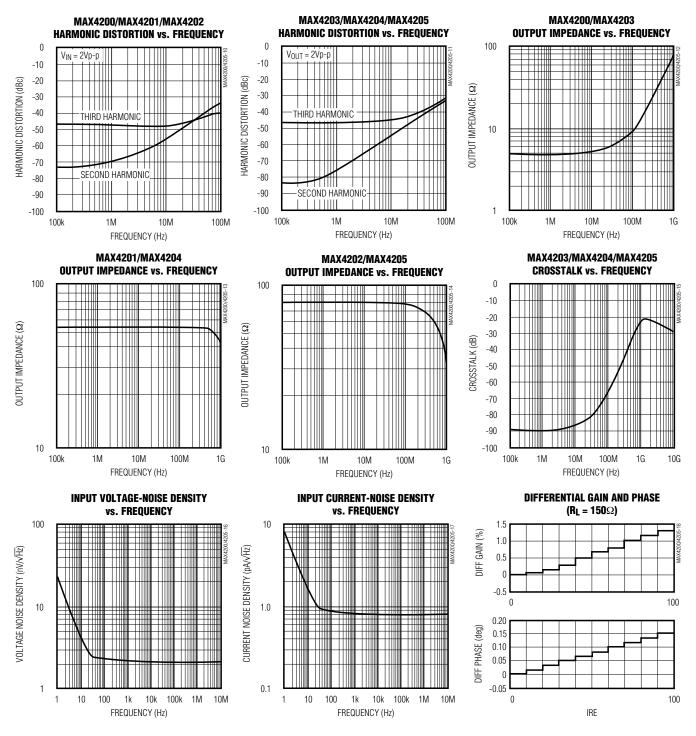
## **Typical Operating Characteristics**

 $(V_{CC} = +5V, V_{EE} = -5V, R_L = 100\Omega$  for MAX4200/MAX4201/MAX4203/MAX4204,  $R_L = 150\Omega$  for MAX4202/MAX4205, unless otherwise noted.)



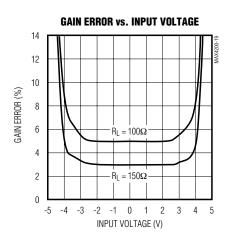
## Typical Operating Characteristics (continued)

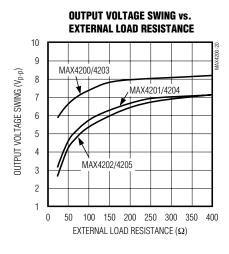
 $(V_{CC}=+5V,\,V_{EE}=-5V,\,R_L=100\Omega$  for MAX4200/MAX4201/MAX4203/MAX4204,  $R_L=150\Omega$  for MAX4202/MAX4205, unless otherwise noted.)

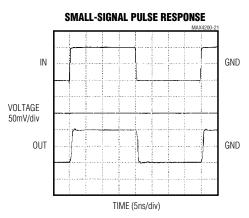


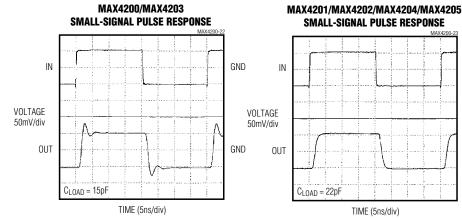
## Typical Operating Characteristics (continued)

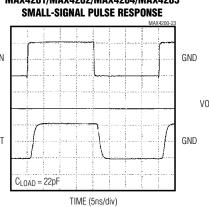
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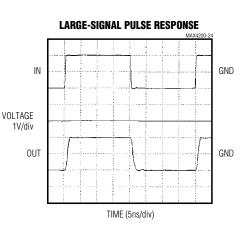






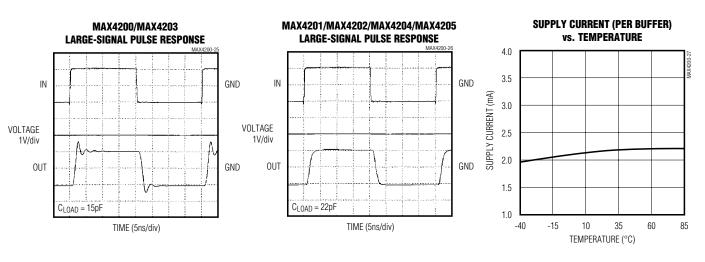


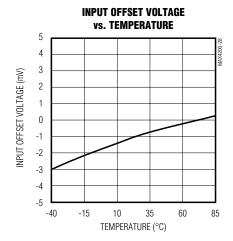


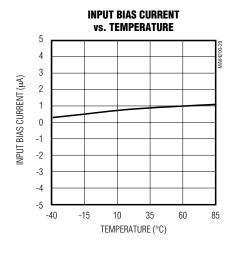


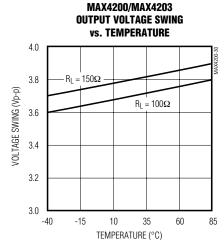
## Typical Operating Characteristics (continued)

 $(V_{CC} = +5V, V_{EE} = -5V, R_L = 100\Omega$  for MAX4200/MAX4201/MAX4203/MAX4204,  $R_L = 150\Omega$  for MAX4202/MAX4205, unless otherwise noted.)









**Pin Description** 

PIN						
MAX4200/MAX4201/MAX4202		MAX4203 MAX4204	NAME	FUNCTION		
SOT23-5	so	MAX4205				
		SO/μMAX				
1	1, 2, 5, 8	_	N.C.	No Connection. Not Internally Connected		
3	3	_	IN	Buffer Input		
_	_	1	IN1	Buffer 1 Input		
_	_	2	OUT1	Buffer 1 Output		
2	4	_	VEE	Negative Power Supply		
_	_	3	V <sub>EE1</sub>	Negative Power Supply for Buffer 1		
_	_	4	V <sub>EE2</sub>	Negative Power Supply for Buffer 2		
_	_	5	IN2	Buffer 2 Input		
_	_	6	OUT2	Buffer 2 Output		
5	6	_	OUT	Buffer Output		
4	7	_	Vcc	Positive Power Supply		
_	_	7	VCC2	Positive Power Supply for Buffer 2		
_	_	8	V <sub>CC1</sub>	Positive Power Supply for Buffer 1		

## **Detailed Description**

The MAX4200–MAX4205 wide-band, open-loop buffers feature high slew rates, high output current, low 2.1nV $\sqrt{\text{Hz}}$  voltage-noise density, and excellent capacitive-load-driving capability. The MAX4200/MAX4203 are single/dual buffers with up to 660MHz bandwidth, 230MHz 0.1dB gain flatness, and a 4200V/µs slew rate. The MAX4201/MAX4204 single/dual buffers with integrated 50 $\Omega$  output termination resistors, up to 780MHz bandwidth, 280MHz gain flatness, and a 4200V/µs slew rate, are ideally suited for driving high-speed signals over 50 $\Omega$  cables. The MAX4202/MAX4205 provide bandwidths up to 720MHz, 230MHz gain flatness, 4200V/µs slew rate, and integrated 75 $\Omega$  output termination resistors for driving 75 $\Omega$  cables.

With an open-loop gain that is slightly less than +1V/V, these devices do not have to be compensated with the internal dominant pole (and its associated phase shift) that is present in voltage-feedback devices. This feature allows the MAX4200–MAX4205 to achieve a nearly constant group delay time of 405ps over their full frequency range, making them well suited for a variety of RF and IF signal-processing applications.

These buffers operate with ±5V supplies and consume only 2.2mA of quiescent supply current per buffer while providing up to ±90mA of output current drive capability.

## **Applications Information**

#### **Power Supplies**

The MAX4200–MAX4205 operate with dual supplies from ±4V to ±5.5V. Both VCC and VEE should be bypassed to the ground plane with a 0.1µF capacitor located as close to the device pin as possible.

#### **Layout Techniques**

Maxim recommends using microstrip and stripline techniques to obtain full bandwidth. To ensure that the PC board does not degrade the amplifier's performance, design it for a frequency greater than 6GHz. Pay careful attention to inputs and outputs to avoid large parasitic capacitance. Whether or not you use a constant-impedance board, observe the following guidelines when designing the board:

- Do not use wire-wrap boards, because they are too inductive.
- Do not use IC sockets, because they increase parasitic capacitance and inductance.

- 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.

### Input Impedance

The MAX4200–MAX4205 input impedance looks like a 500k $\Omega$  resistor in parallel with a 2pF capacitor. Since these devices operate without negative feedback, there is no loop gain to transform the input impedance upward, as in closed-loop buffers. As a consequence, the input impedance is directly related to the output impedance. If the output load impedance decreases, the input impedance also decreases. Inductive input sources (such as an unterminated cable) may react with the input capacitance and produce some peaking in the buffer's frequency response. This effect can usually be minimized by using a properly terminated transmission line at the buffer input, as shown in Figure 1.

### **Output Current and Gain Sensitivity**

The absence of negative feedback means that open-loop buffers have no loop gain to reduce their effective output impedance. As a result, open-loop devices usually suffer from decreasing gain as the output current is decreased. The MAX4200–MAX4205 include local feedback around the buffer's class-AB output stage to ensure low output impedance and reduce gain sensitivity to load variations. This feedback also produces demand-driven current bias to the output transistors for ±90mA (MAX4200/MAX4203) drive capability that is relatively independent of the output voltage (see *Typical Operating Characteristics*).

### **Output Capacitive Loading and Stability**

The MAX4200–MAX4205 provide maximum AC performance with no load capacitance. This is the case when the load is a properly terminated transmission line. However, these devices are designed to drive any load capacitance without oscillating, but with reduced AC performance.

Since the MAX4200–MAX4205 operate in an open-loop configuration, there is no negative feedback to be transformed into positive feedback through phase shift introduced by a capacitive load. Therefore, these devices will not oscillate with capacitive loading, unlike similar buffers operating in a closed-loop configuration. However, a capacitive load reacting with the buffer's output impedance can still affect circuit performance. A capacitive load will form a lowpass filter with the buffer's output resistance, thereby limiting system

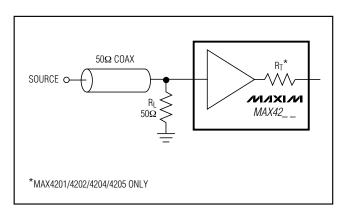


Figure 1. Using a Properly Terminated Input Source

bandwidth. With higher capacitive loads, bandwidth is dominated by the RC network formed by RT and  $C_L$ ; the bandwidth of the buffer itself is much higher. Also note that the isolation resistor forms a divider that decreases the voltage delivered to the load.

Another concern when driving capacitive loads results from the amplifier's output impedance, which looks inductive at high frequency. This inductance forms an L-C resonant circuit with the capacitive load and causes peaking in the buffer's frequency response.

Figure 2 shows the frequency response of the MAX4200/MAX4203 under different capacitive loads. To settle out some of the peaking, the output requires an isolation resistor like the one shown in Figure 3. Figure 4 is a plot of the MAX4200/MAX4203 frequency response with capacitive loading and a  $10\Omega$  isolation resistor. In many applications, the output termination resistors included in the MAX4201/MAX4202/ MAX4204/MAX4205 will serve this purpose, reducing component count and board space. Figure 5 shows the MAX4201/MAX4202/ MAX4204/MAX4205 frequency response with capacitive loads of 47pF, 68pF, and 120pF.

#### **Coaxial Cable Drivers**

Coaxial cable and other transmission lines are easily driven when properly terminated at both ends with their characteristic impedance. Driving back-terminated transmission lines essentially eliminates the line's capacitance. The MAX4201/MAX4204, with their integrated  $50\Omega$  output termination resistors, are ideal for driving  $50\Omega$  cables. The MAX4202/MAX4205 include integrated  $75\Omega$  termination resistors for driving  $75\Omega$  cables. Note that the output termination resistor forms a voltage divider with the load resistance, thereby decreasing the amplitude of the signal at the receiving end of the cable by one half (see the *Typical Application Circuit*).

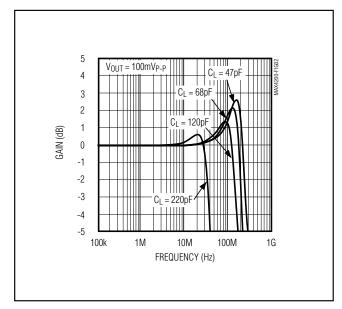


Figure 2. MAX4200/MAX4203 Small-Signal Gain vs. Frequency with Load Capacitance and No Isolation Resistor

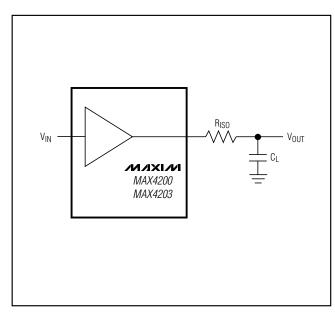


Figure 3. Driving a Capacitive Load Through an Isolation Resistor

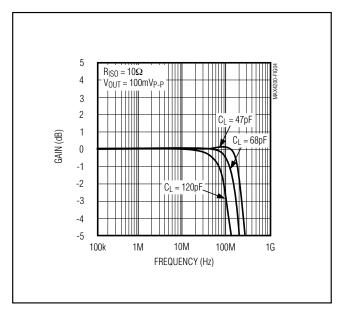


Figure 4. MAX4200/MAX4203 Small-Signal Gain vs. Frequency with Load Capacitance and  $10\Omega$  Isolation Resistor

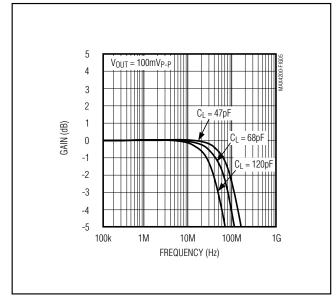
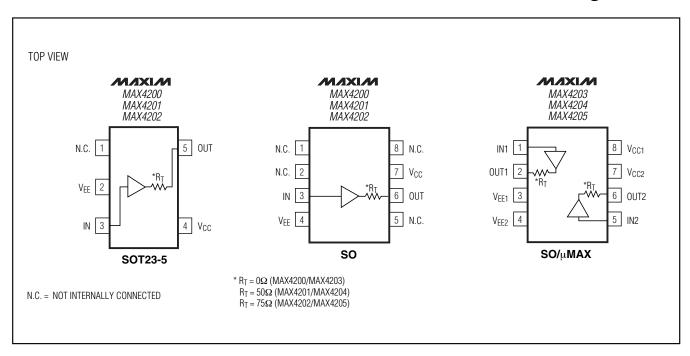


Figure 5. MAX4201/MAX4202/MAX4204/MAX4205 Small-Signal Gain vs. Frequency with Capacitive Load and No External Isolation Resistor

## **Pin Configurations**



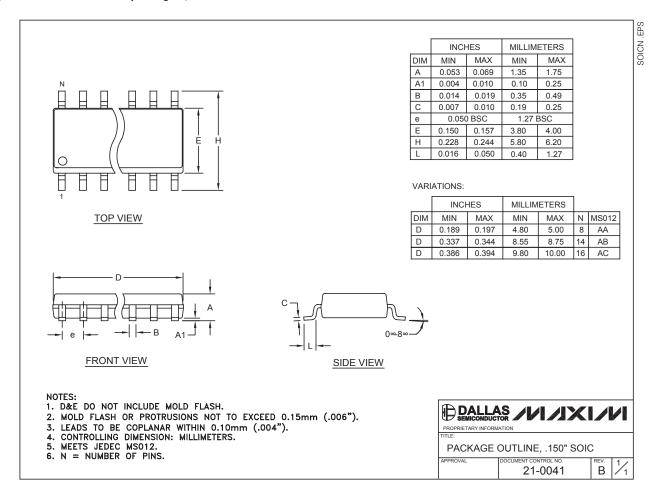
## **Chip Information**

TRANSISTOR COUNTS:

MAX4200/MAX4201/MAX4202: 33 MAX4203/MAX4204/MAX4205: 67 SUBSTRATE CONNECTED TO VEE

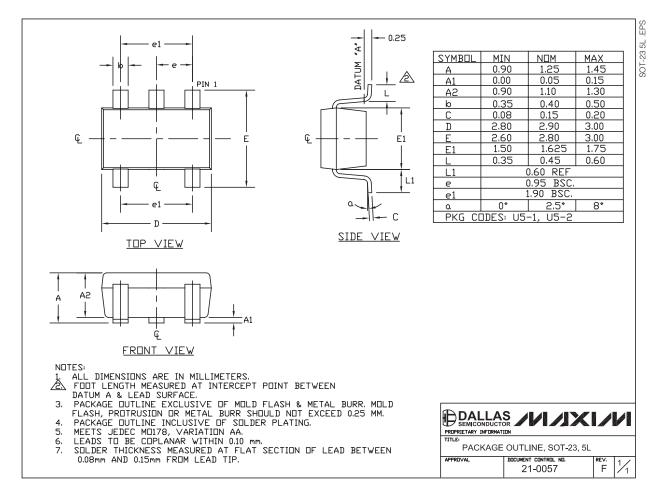
### **Package Information**

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to <a href="https://www.maxim-ic.com/packages">www.maxim-ic.com/packages</a>.)



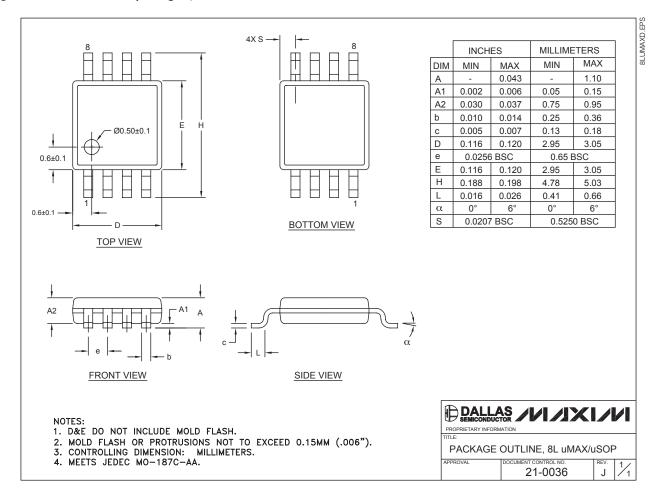
## **Package Information (continued)**

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### Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to <a href="https://www.maxim-ic.com/packages">www.maxim-ic.com/packages</a>.)



## \_Revision History

Pages changed at Rev 3: 1-5, 8, 10-14

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.

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- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов:
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- Поставка сложных, дефицитных, либо снятых с производства позиций;
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- Экспресс доставка в любую точку России;
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- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001:
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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