



## Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

### General Description

The MAX398/MAX399 precision, monolithic, CMOS analog multiplexers (muxes) offer low on-resistance (less than  $100\Omega$ ), which is matched to within  $6\Omega$  between channels and remains flat over the specified analog signal range ( $11\Omega$  max). They also offer low leakage over temperature (NO-off leakage current less than  $2.5\text{nA}$  at  $+85^\circ\text{C}$ ) and fast switching speeds (transition time less than  $250\text{ns}$ ). The MAX398 is an 8-channel device, and the MAX399 is a dual 4-channel device.

The MAX398/MAX399 are fabricated with Maxim's low-voltage silicon-gate process. Design improvements yield extremely low charge injection (less than  $5\text{pC}$ ) and guarantee electrostatic discharge protection greater than  $2000\text{V}$ .

These muxes operate with a single  $+3\text{V}$  to  $+15\text{V}$  supply or bipolar  $\pm 3\text{V}$  to  $\pm 8\text{V}$  supplies, while retaining CMOS-logic input compatibility and fast switching. CMOS inputs provide reduced input loading. The MAX398/MAX399 are pin compatible with the industry-standard DG408, DG409, DG508A, and DG509A.

### Applications

Sample-and-Hold Circuits  
Automatic Test Equipment  
Heads-Up Displays  
Guidance and Control Systems  
Military Radios  
Communications Systems  
Battery-Operated Systems  
PBX, PABX  
Audio Signal Routing  
Low-Voltage Data Acquisition Systems

### Features

- ♦ Pin Compatible with Industry-Standard DG408/DG409/DG508A/DG509A
- ♦ Guaranteed On-Resistance Match Between Channels ( $<6\Omega$ )
- ♦ Low On-Resistance ( $<100\Omega$ )
- ♦ Guaranteed Flat On-Resistance over Signal Range ( $<11\Omega$ )
- ♦ Guaranteed Low Charge Injection ( $<5\text{pC}$ )
- ♦ NO-Off Leakage Current  $<1\text{nA}$  at  $+85^\circ\text{C}$
- ♦ COM-Off Leakage Current  $<2.5\text{nA}$  at  $+85^\circ\text{C}$
- ♦ Electrostatic Discharge Protection  $>2000\text{V}$
- ♦ Single-Supply Operation ( $+3\text{V}$  to  $+15\text{V}$ )  
Bipolar-Supply Operation ( $\pm 3\text{V}$  to  $\pm 8\text{V}$ )
- ♦ Low Power Consumption ( $<300\mu\text{W}$ )
- ♦ Rail-to-Rail Signal Handling
- ♦ TTL/CMOS-Logic Compatible

### Ordering Information

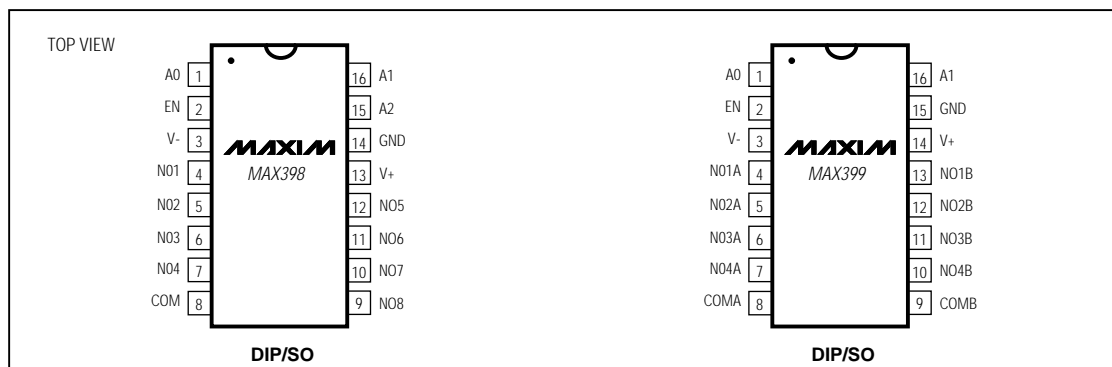
PART	TEMP. RANGE	PIN-PACKAGE
MAX398CPE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Plastic DIP
MAX398CSE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Narrow SO
MAX398C/D	$0^\circ\text{C}$ to $+70^\circ\text{C}$	Dice*
MAX398EPE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Plastic DIP
MAX398ESE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Narrow SO
MAX398EJE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 CERDIP**
MAX398MJE	$-55^\circ\text{C}$ to $+125^\circ\text{C}$	16 CERDIP**

Ordering Information continued at end of data sheet.

\* Contact factory for dice specifications.

\*\* Contact factory for package availability.

### Pin Configurations



Maxim Integrated Products 1

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## ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to GND		Continuous Power Dissipation (T <sub>A</sub> = +70°C)
V+ .....	-0.3V to +17V	Plastic DIP (derate 7.5mW/°C above +70°C) .....
V- .....	+0.3V to -17V	Narrow SO (derate 8.7mW/°C above +70°C) .....
V+ to V- .....	-0.3V to +17V	CERDIP (derate 10.0mW/°C above +70°C) .....
Voltage into Any Terminal (Note 1).....(V- - 2V) to (V+ + 2V) or		Operating Temperature Ranges
30mA (whichever occurs first)		MAX39_C_ _ .....
Current into Any Terminal .....	30mA	MAX39_E_ _ .....
Peak Current, Any Terminal .....	30mA	MAX39_MJE .....
(pulsed at 1ms, 10% duty cycle max) .....	40mA	Storage Temperature Range .....
		Lead Temperature (soldering, 10sec) .....

**Note 1:** Signals on any terminal exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current ratings.

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—Dual Supplies

(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = +2.4V, V<sub>AL</sub> = V<sub>ENL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS		
<b>SWITCH</b>									
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub>	(Note 3)		V-		V+	V		
Channel On-Resistance	R <sub>ON</sub>	I <sub>NO</sub> = 1mA, V <sub>COM</sub> = ±3.5V	T <sub>A</sub> = +25°C	60	100		Ω		
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		125				
R <sub>ON</sub> Matching Between Channels (Note 4)	ΔR <sub>ON</sub>	I <sub>NO</sub> = 1mA, V <sub>COM</sub> = ±3.5V, V+ = 5V, V- = -5V	T <sub>A</sub> = +25°C		6		Ω		
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		8				
On-Resistance Flatness (Note 5)	R <sub>FLAT(ON)</sub>	I <sub>NO</sub> = 1mA, V <sub>COM</sub> = ±3V, V+ = 5V, V- = -5V	T <sub>A</sub> = +25°C		11		Ω		
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		14				
NO-Off Leakage Current (Note 6)	I <sub>NO(OFF)</sub>	V <sub>NO</sub> = ±4.5V, V <sub>COM</sub> = ±4.5V, V+ = 5.5V, V- = -5.5V	T <sub>A</sub> = +25°C	-0.1	0.1		nA		
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-1.0	1.0			
				M	-10	10			
COM-Off Leakage Current (Note 6)	I <sub>COM(OFF)</sub>	V <sub>COM</sub> = ±4.5V, V <sub>NO</sub> = ±4.5V, V+ = 5.5V, V- = -5.5V	MAX398	T <sub>A</sub> = +25°C	-0.2	0.2	nA		
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5		2.5	
					M	-20		20	
			MAX399	T <sub>A</sub> = +25°C	-0.1	0.1			
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-1.5			1.5
					M	-10			10
COM-On Leakage Current (Note 6)	I <sub>COM(ON)</sub>	V <sub>COM</sub> = ±4.5V, V <sub>NO</sub> = 4.5V,	MAX398	T <sub>A</sub> = +25°C	-0.4	0.4	nA		
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-5		5	
					M	-40		40	
			MAX399	T <sub>A</sub> = +25°C	-0.2	0.2			
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5			2.5
					M	-20			20

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## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = +2.4V, V<sub>AL</sub> = V<sub>ENL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS	
<b>DIGITAL LOGIC INPUT</b>							
Logic High Input Voltage	V <sub>AH</sub> , V <sub>ENH</sub>		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		2.4	V	
Logic Low Input Voltage	V <sub>AL</sub> , V <sub>ENL</sub>		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		0.8	V	
Input Current with Input Voltage High	I <sub>AH</sub> , I <sub>ENH</sub>	V <sub>A</sub> = V <sub>EN</sub> = 2.4V	-0.1		0.1	μA	
Input Current with Input Voltage Low	I <sub>AL</sub> , I <sub>ENL</sub>	V <sub>A</sub> = V <sub>EN</sub> = 0.8V	-0.1		0.1	μA	
<b>SUPPLY</b>							
Power-Supply Range			±3		±8	V	
Positive Supply Current	I <sub>+</sub>	V <sub>EN</sub> = V <sub>A</sub> = 0V/V+, V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V	T <sub>A</sub> = +25°C		-1	1	μA
Negative Supply Current	I <sub>-</sub>	V <sub>EN</sub> = V <sub>A</sub> = 0V/V+, V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V	T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-1	1	μA
Ground Current	I <sub>GND</sub>	V <sub>EN</sub> = V <sub>A</sub> = 0V/V+, V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V	T <sub>A</sub> = +25°C		-1	1	μA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-1	1	
<b>DYNAMIC</b>							
Transition Time	t <sub>TRANS</sub>	Figure 1			150	ns	
Break-Before-Make Interval	t <sub>OPEN</sub>	Figure 2	T <sub>A</sub> = +25°C		0	40	ns
Enable Turn-On Time	t <sub>ON(EN)</sub>	Figure 3	T <sub>A</sub> = +25°C		60	150	ns
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			250	
Enable Turn-Off Time	t <sub>OFF(EN)</sub>	Figure 3	T <sub>A</sub> = +25°C		40	150	ns
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			200	
Charge Injection (Note 3)	Q	C <sub>L</sub> = 10nF, V <sub>S</sub> = 0V, R <sub>S</sub> = 0Ω	T <sub>A</sub> = +25°C		2	5	pC
Off Isolation (Note 7)		V <sub>EN</sub> = 0V, R <sub>L</sub> = 1kΩ, f = 100kHz	T <sub>A</sub> = +25°C		-75		dB
Crosstalk Between Channels	V <sub>CT</sub>	V <sub>EN</sub> = 2.4V, f = 100kHz, V <sub>GEN</sub> = 1V <sub>p-p</sub> , R <sub>L</sub> = 1kΩ	T <sub>A</sub> = +25°C		-92		dB
Logic Input Capacitance	C <sub>IN</sub>	f = 1MHz	T <sub>A</sub> = +25°C		8		pF
NO-Off Capacitance	C <sub>NO(OFF)</sub>	f = 1MHz, V <sub>EN</sub> = V <sub>D</sub> = 0V	T <sub>A</sub> = +25°C		11		pF
COM-Off Capacitance	C <sub>COM(OFF)</sub>	f = 1MHz, V <sub>EN</sub> = V <sub>D</sub> = 0V	MAX398	T <sub>A</sub> = +25°C	40		pF
			MAX399		20		
COM-On Capacitance	C <sub>COM(ON)</sub>	f = 1MHz, V <sub>EN</sub> = V <sub>D</sub> = 0V	MAX398	T <sub>A</sub> = +25°C	54		pF
			MAX399		34		

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## ELECTRICAL CHARACTERISTICS—Single 5V

(V+ = 5V ±10%, V- = 0V, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = +2.4V, V<sub>AL</sub> = V<sub>ENL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS	
<b>SWITCH</b>								
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub>	(Note 3)		V-		V+	V	
On-Resistance	R <sub>ON</sub>	I <sub>NO</sub> = 1mA, V <sub>COM</sub> = 3.5V, V+ = 4.5V		T <sub>A</sub> = +25°C		150	225	Ω
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			280	
R <sub>ON</sub> Matching Between Channels (Note 4)	ΔR <sub>ON</sub>	I <sub>NO</sub> = 1mA, V <sub>COM</sub> = 3.5V, V+ = 4.5V		T <sub>A</sub> = +25°C			11	Ω
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			13	
On-Resistance Flatness	R <sub>FLAT</sub>	I <sub>NO</sub> = 1mA; V <sub>COM</sub> = 3V, 2V, 1V; V+ = 5V		T <sub>A</sub> = +25°C		10	18	Ω
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		15	22	
NO-Off Leakage Current (Note 8)	I <sub>NO(OFF)</sub>	V <sub>NO</sub> = 4.5V, V <sub>COM</sub> = 0V, V+ = 5.5V		T <sub>A</sub> = +25°C		-0.1	0.1	nA
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-1.0	1.0	
					M	-10	10	
COM-Off Leakage Current (Note 8)	I <sub>COM(OFF)</sub>	V <sub>COM</sub> = 4.5V, V <sub>NO</sub> = 0V, V+ = 5.5V	MAX398	T <sub>A</sub> = +25°C		-0.2	0.2	nA
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5	2.5	
		M	-20		20			
		V <sub>COM</sub> = 4.5V, V <sub>NO</sub> = 0V, V+ = 5.5V	MAX399	T <sub>A</sub> = +25°C		-0.2	0.2	
T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E			-1.5	1.5			
	M	-10	10					
COM-On Leakage Current (Note 8)	I <sub>COM(ON)</sub>	V <sub>COM</sub> = 4.5V, V <sub>NO</sub> = 4.5V, V+ = 5.5V	MAX398	T <sub>A</sub> = +25°C		-0.4	0.4	nA
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-5	5	
					M	-40	40	
		T <sub>A</sub> = +25°C	T <sub>A</sub> = +25°C		-0.2	0.2		
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5	2.5		
				M	-20	20		
<b>DIGITAL LOGIC INPUT</b>								
Logic High Input Voltage	V <sub>AH</sub> , V <sub>ENH</sub>			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		2.4		V
Logic Low Input Voltage	V <sub>AL</sub> , V <sub>ENL</sub>			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			0.8	V
Input Current with Input Voltage High	I <sub>AH</sub> , I <sub>ENH</sub>	V <sub>A</sub> = V <sub>EN</sub> = 2.4V				-0.1	0.1	μA
Input Current with Input Voltage Low	I <sub>AL</sub> , I <sub>ENL</sub>	V <sub>A</sub> = 0V V <sub>EN</sub> = 0.8V				-0.1	0.1	μA
<b>SUPPLY</b>								
Power-Supply Range						3	15	V
Positive Supply Current	I+	V <sub>EN</sub> = V <sub>A</sub> = 0V, V+; V+ = 5.5V; V- = 0V				-1.0	1.0	μA
Negative Supply Current	I-	V <sub>EN</sub> = V <sub>A</sub> = 0V, V+; V+ = 5.5V; V- = 0V				-1.0	1.0	μA
I <sub>GND</sub> Supply Current	I <sub>GND</sub>	V <sub>EN</sub> = V+, 0V; V <sub>A</sub> = 0V; V+ = 5.5V; V- = 0V		T <sub>A</sub> = +25°C		-1.0	1.0	μA
				T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-1.0	1.0	

# Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

MAX398/MAX399

## ELECTRICAL CHARACTERISTICS—Single 5V (continued)

(V+ = 5V ±10%, V- = 0V, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = +2.4V, V<sub>AL</sub> = V<sub>ENL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS
<b>DYNAMIC</b>						
Transition Time	t <sub>TRANS</sub>	V <sub>NO</sub> = 3V		90	245	ns
Break-Before-Make Interval	t <sub>OPEN</sub>		10	40		ns
Enable Turn-On Time	t <sub>ON(EN)</sub>		T <sub>A</sub> = +25°C		90	200
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		275	
Enable Turn-Off Time	t <sub>OFF(EN)</sub>		T <sub>A</sub> = +25°C		50	125
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		200	
Charge Injection (Note 3)	Q	C <sub>L</sub> = 10nF, V <sub>S</sub> = 0V, R <sub>S</sub> = 0Ω	T <sub>A</sub> = +25°C		1.5	5

## ELECTRICAL CHARACTERISTICS—Single 3V

(V+ = 3V ±10%, V- = 0V, GND = 0V, V<sub>AH</sub> = V<sub>ENH</sub> = +2.4V, V<sub>AL</sub> = V<sub>ENL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS
<b>SWITCH</b>						
Analog Signal Range	V <sub>ANALOG</sub>	(Note 3)	V-		V+	V
On-Resistance	R <sub>ON</sub>	I <sub>NO</sub> = 1mA, V <sub>COM</sub> = 1.5V, V+ = 3V	T <sub>A</sub> = +25°C		230	375
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		425	
<b>DYNAMIC</b>						
Transition Time (Note 3)	t <sub>TRANS</sub>	Figure 1, V <sub>IN</sub> = 2.4V, V <sub>NO1</sub> = 1.5V, V <sub>NO8</sub> = 0V	T <sub>A</sub> = +25°C		230	575
Enable Turn-On Time (Note 3)	t <sub>ON(EN)</sub>	Figure 3, V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0V, V <sub>NO1</sub> = 1.5V	T <sub>A</sub> = +25°C		200	500
Enable Turn-Off Time (Note 3)	t <sub>OFF(EN)</sub>	Figure 3, V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0V, V <sub>NO1</sub> = 1.5V	T <sub>A</sub> = +25°C		75	400
Charge Injection (Note 3)	Q	C <sub>L</sub> = 10nF, V <sub>S</sub> = 0V, R <sub>S</sub> = 0Ω	T <sub>A</sub> = +25°C		1	5

**Note 2:** The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.

**Note 3:** Guaranteed by design.

**Note 4:** ΔR<sub>ON</sub> = R<sub>ONMAX</sub> - R<sub>ONMIN</sub>.

**Note 5:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges, i.e., V<sub>NO</sub> = 3V to 0V and 0V to -3V.

**Note 6:** Leakage parameters are 100% tested at maximum rated hot operating temperature, and guaranteed by correlation at +25°C.

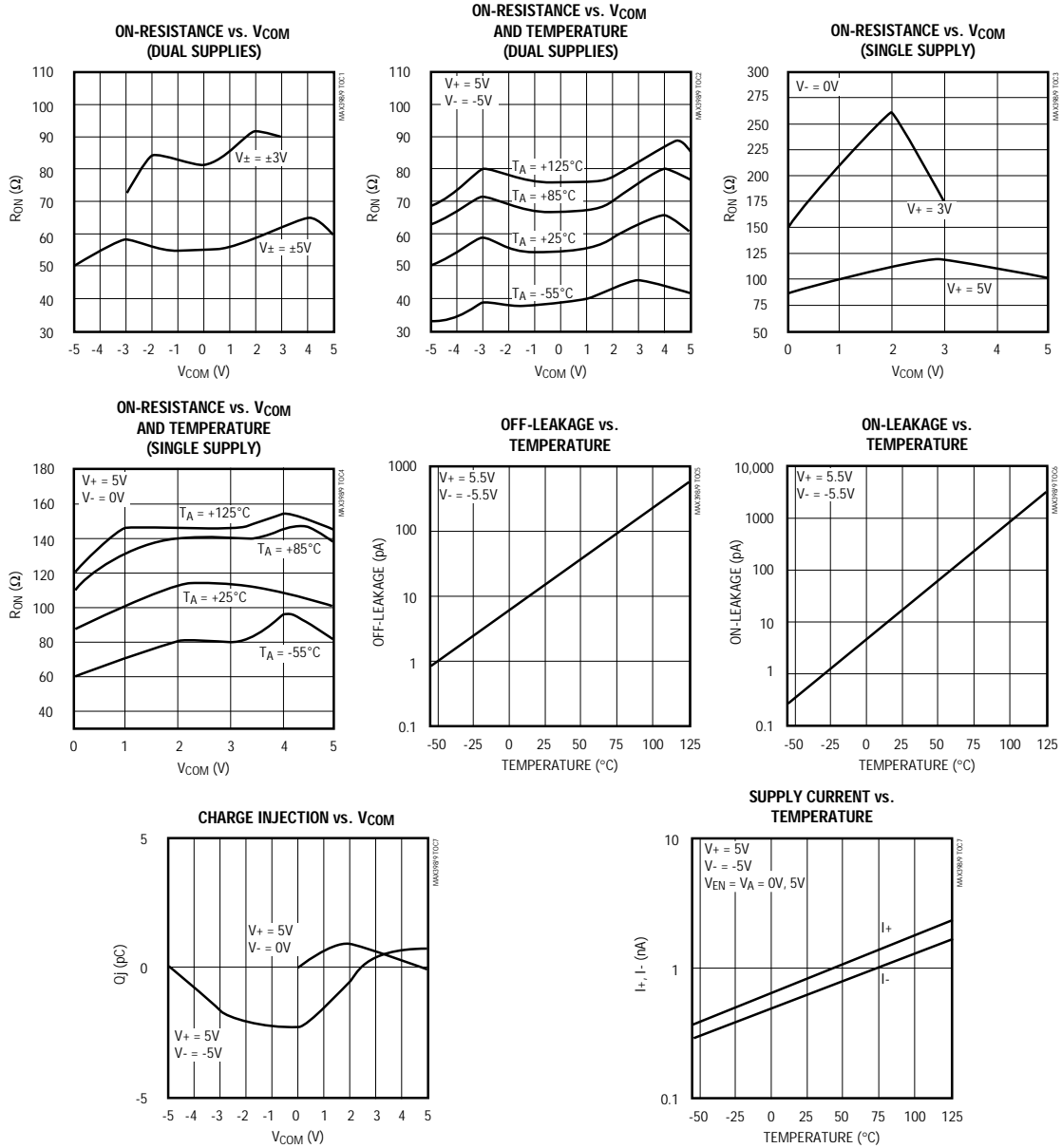
**Note 7:** Worst-case isolation is on channel 4 because of its proximity to the COM pin. Off isolation = 20log V<sub>COM</sub>/V<sub>NO</sub>, V<sub>COM</sub> = output, V<sub>NO</sub> = input to off switch.

**Note 8:** Leakage testing at single supply is guaranteed by correlation testing with dual supplies.

# Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

## Typical Operating Characteristics

( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



## Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

### Pin Description

MAX398/MAX399

PIN		NAME	FUNCTION
MAX398	MAX399		
1, 15, 16	—	A0, A2, A1	Address Inputs
—	1, 16	A0, A1	Address Inputs
2	2	EN	Enable Input, connect to V+ if not used
3	3	V-	Negative Supply Voltage Input
4–7	—	NO1–NO4	Analog Inputs—bidirectional
—	4–7	NO1A–NO4A	Analog Inputs—bidirectional
8	—	COM	Analog Output—bidirectional
—	8, 9	COMA, COMB	Analog Outputs—bidirectional
9–12	—	NO8–NO5	Analog Inputs—bidirectional
—	10–13	NO4B–NO1B	Analog Inputs—bidirectional
13	14	V+	Positive Supply Voltage Input
14	15	GND	Ground

# Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

## Applications Information

### Operation with Supply Voltages Other than $\pm 5V$

Using supply voltages less than  $\pm 5V$  reduces the analog signal range. The MAX398/MAX399 muxes operate with  $\pm 3V$  to  $\pm 8V$  bipolar supplies or with a  $+3V$  to  $+15V$  single supply. Connect  $V^-$  to GND when operating with a single supply. Both device types can also operate with unbalanced supplies, such as  $+10V$  and  $-5V$ . The *Typical Operating Characteristics* graphs show typical on-resistance with  $\pm 3V$ ,  $\pm 5V$ ,  $+3V$  and  $+5V$  supplies. (Switching times increase by a factor of two or more for operation at  $5V$ .)

### Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence  $V^+$  on first, then  $V^-$ , followed by the logic inputs, NO, or COM. If power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below  $V^+$  and one diode drop

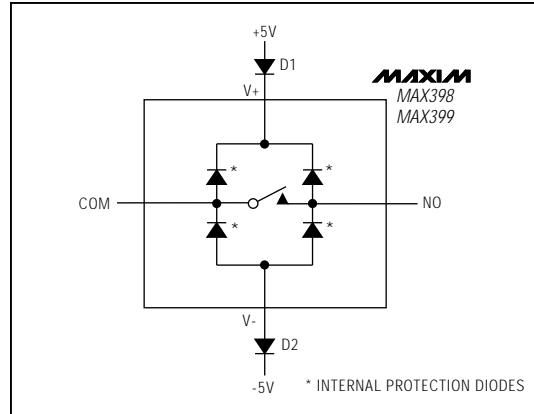


Figure 1. Overvoltage Protection Using External Blocking Diodes

above  $V^-$ , but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between  $V^+$  and  $V^-$  should not exceed  $17V$ . These protection diodes are not recommended when using a single supply.

## Test Circuits/Timing Diagrams

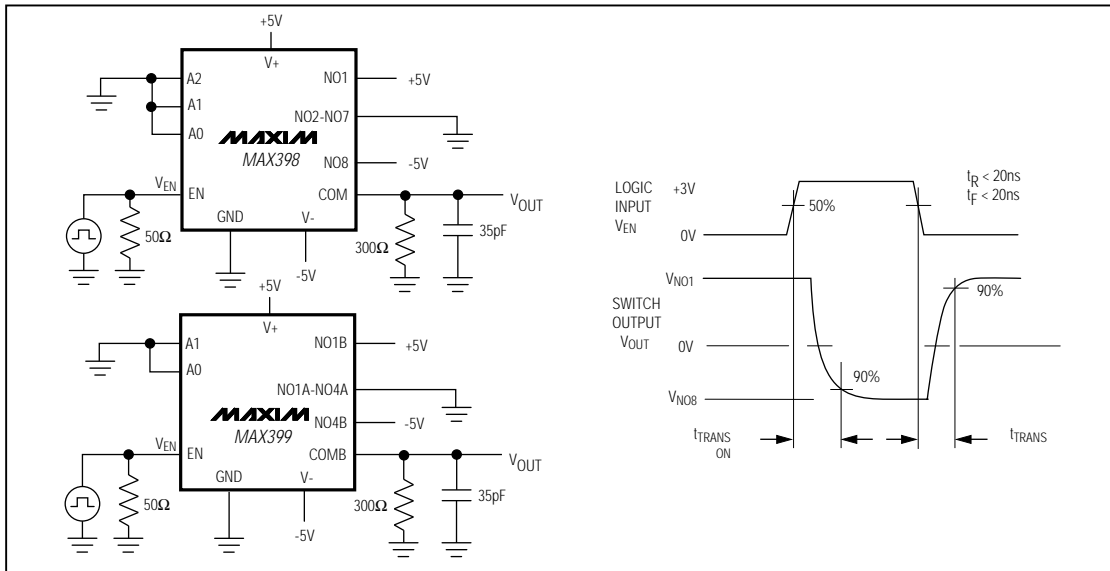


Figure 2. Transition Time



# Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

Test Circuits/Timing Diagrams (continued)

MAX398/MAX399

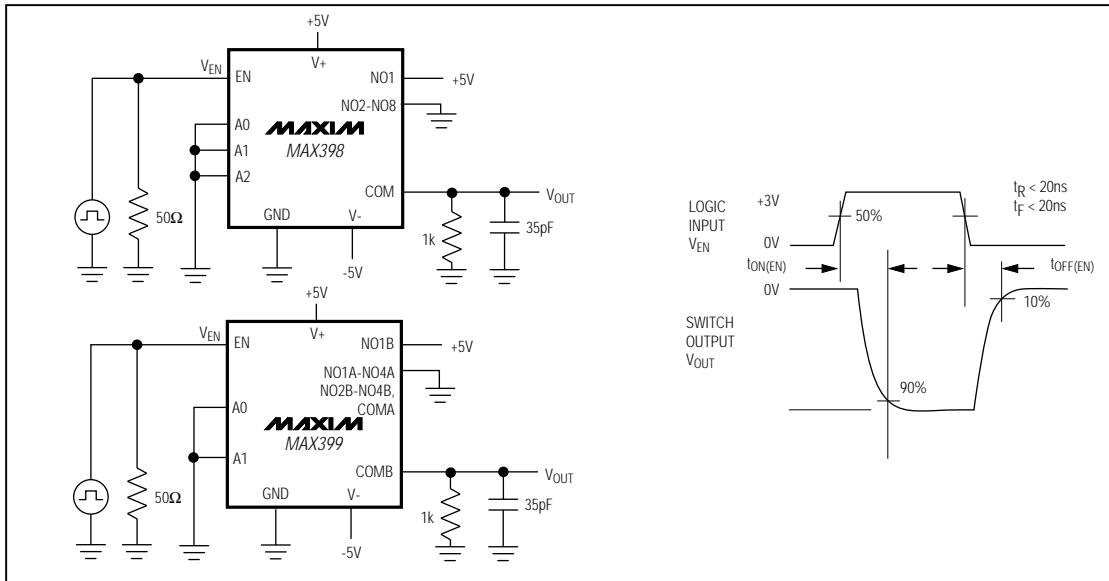


Figure 3. Enable Switching Time

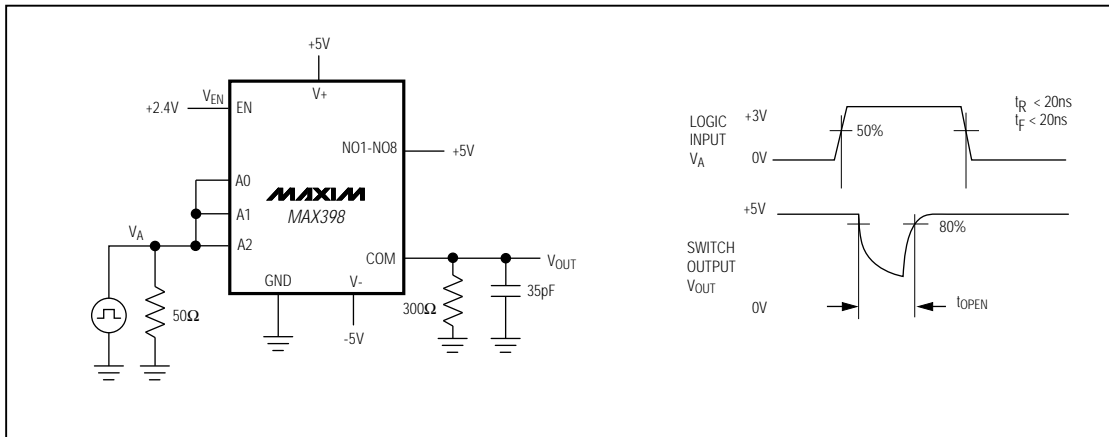


Figure 4. Break-Before-Make Interval

# Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

## Test Circuits/Timing Diagrams (continued)

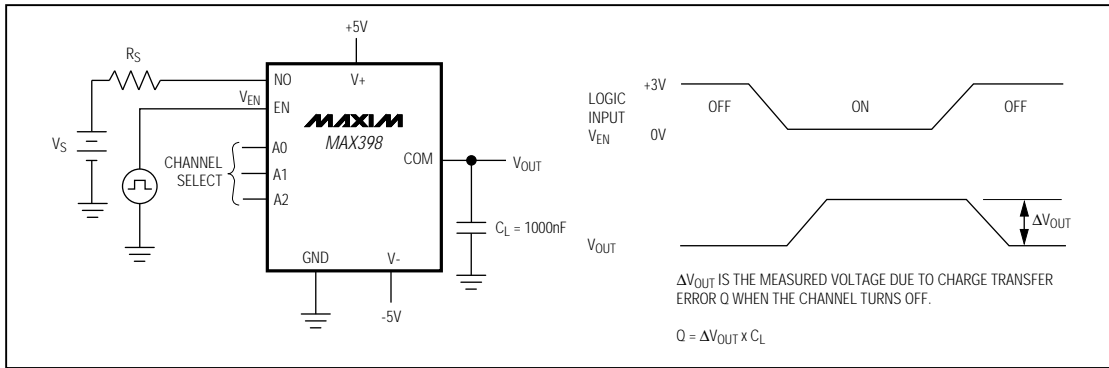


Figure 5. Charge Injection

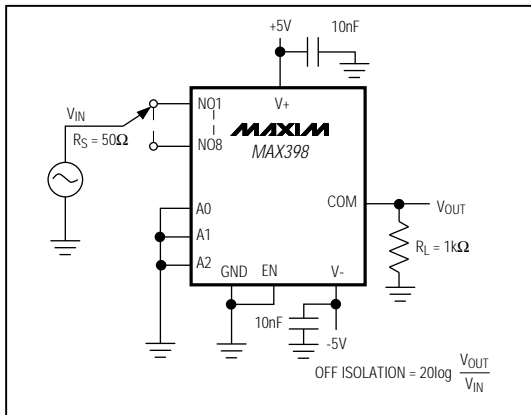


Figure 6. Off Isolation

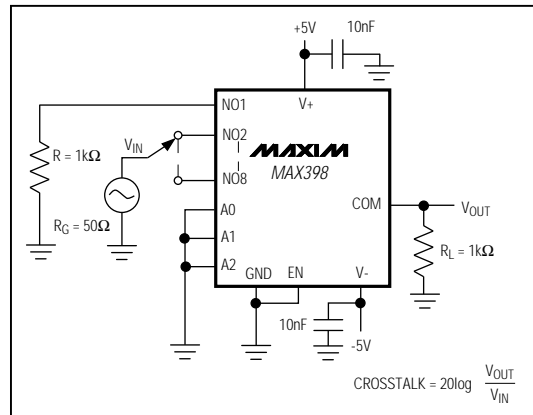


Figure 7. Crosstalk

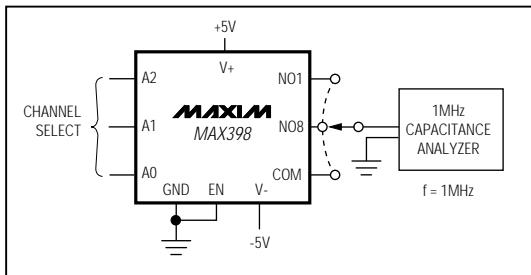


Figure 8. NO/COM Capacitance

# Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

## Functional Diagrams/Truth Tables

MAX398/MAX399

**MAX398**

MAX398				
A2	A1	A0	EN	ON SWITCH
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

**MAX399**

MAX399			
A1	A0	EN	ON SWITCH
X	X	0	NONE
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

LOGIC "0"  $V_{AL} \leq +0.8V$ , LOGIC "1"  $V_{AH} \geq +2.4V$

# Precision, 8-Channel/Dual 4-Channel, Low-Voltage, CMOS Analog Multiplexers

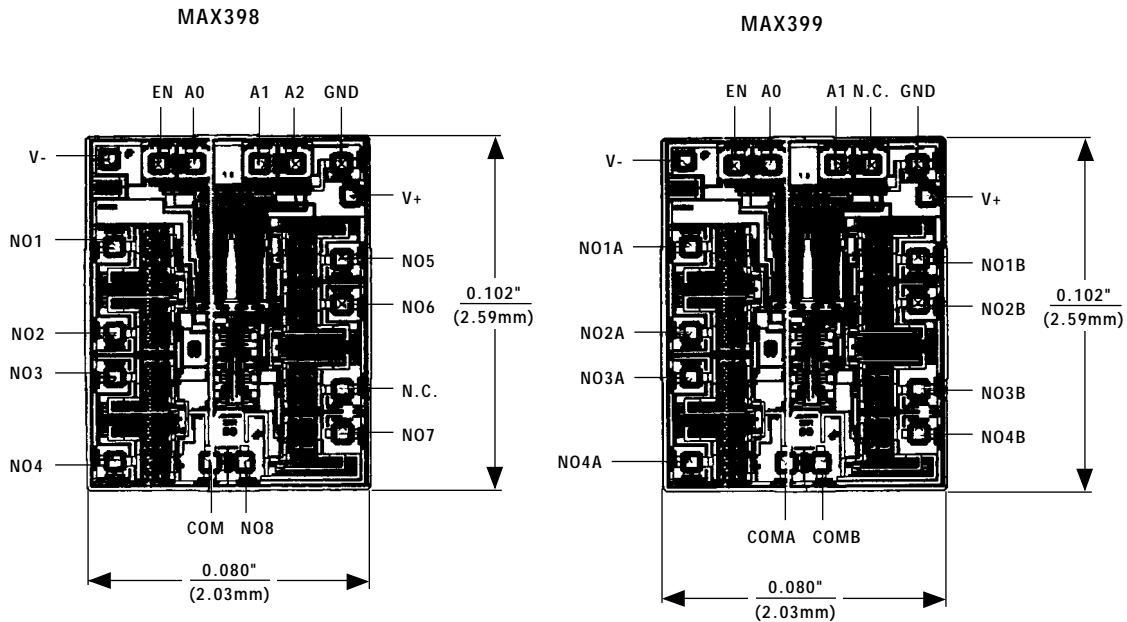
## \_Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
MAX399CPE	0°C to +70°C	16 Plastic DIP
MAX399CSE	0°C to +70°C	16 Narrow SO
MAX399C/D	0°C to +70°C	Dice*
MAX399EPE	-40°C to +85°C	16 Plastic DIP
MAX399ESE	-40°C to +85°C	16 Narrow SO
MAX399EJE	-40°C to +85°C	16 CERDIP**
MAX399MJE	-55°C to +125°C	16 CERDIP**

\* Contact factory for dice specifications.

\*\* Contact factory for package availability.

## Chip Topographies



TRANSISTOR COUNT: 161  
SUBSTRATE CONNECTED TO V+

TRANSISTOR COUNT: 161  
SUBSTRATE CONNECTED TO V+

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