



# Fast, Low-Voltage, 4Ω, 4-Channel CMOS Analog Multiplexer

MAX4634

## General Description

The MAX4634 fast, low-voltage, 4-channel CMOS analog multiplexer features 4Ω max on-resistance ( $R_{ON}$ ). It offers  $R_{ON}$  matching between switches to 0.3Ω max and  $R_{ON}$  flatness of 1Ω max over the specified signal range. Each switch can handle  $V+$  to GND analog signals. Off-leakage current is only 0.1nA max at +25°C. The MAX4634 features fast turn-on ( $t_{ON}$ ) and turn-off ( $t_{OFF}$ ) times of 18ns and 11ns, respectively. All this comes in a tiny 10-pin  $\mu$ MAX package.

This low-voltage multiplexer operates from a +1.8V to +5.5V single supply. All digital inputs have +0.8V and +2.4V logic thresholds, ensuring TTL/CMOS-logic compatibility with +5V operation.

## Applications

- Battery-Operated Equipment
- Audio and Video Signal Routing
- Low-Voltage Data-Acquisition Systems
- Sample-and-Hold Circuits
- Communications Circuits

## Features

- ◆ **Guaranteed  $R_{ON}$**   
2.5Ω typ (5V Supply)  
4.5Ω typ (3V Supply)
- ◆ **Guaranteed  $R_{ON}$  Match Between Channels**  
0.3Ω max
- ◆ **Guaranteed  $R_{ON}$  Flatness Over Signal Range**  
1Ω max
- ◆ **Guaranteed Low Leakage Currents**  
0.1nA (at +25°C)
- ◆ **+1.8V to +5.5V Single-Supply Operation**
- ◆ **+1.8V Operation**  
 $R_{ON} = 30\Omega$  typ Over Temperature  
 $t_{ON} = 30ns$  typ,  $t_{OFF} = 13ns$  typ
- ◆  **$V+$  to GND Signal Handling**
- ◆ **TTL/CMOS-Logic Compatible**
- ◆ **-78dB Crosstalk (at 1MHz)**
- ◆ **-80dB Off-Isolation (at 1MHz)**
- ◆ **0.018% Total Harmonic Distortion**

## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4634EUB	-40°C to +85°C	10 $\mu$ MAX

## Pin Configuration/Functional Diagram/Truth Table

TOP VIEW

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

X = DON'T CARE



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## ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND)

V+ .....	-0.3V to +6V
A_, EN, COM, NO_ (Note 1) .....	-0.3V to (V+ + 0.3V)
Continuous Current (all other pins) .....	±20mA
Continuous Current (COM, NO_) .....	±50mA
Peak Current (COM, NO_ pulsed at 1ms, 10% duty cycle) .....	±100mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

10-Pin μMAX (derate 4.1mW/°C above +70°C) .....330mW

Operating Temperature Range

MAX4634EUB .....-40°C to +85°C

Storage Temperature Range .....-65°C to +150°C

Lead Temperature (soldering, 10s) .....+300°C

**Note 1:** Signals on NO\_, COM, EN, or A\_ exceeding V+ or GND are clamped by internal diodes. Limit forward diode current to maximum current rating.

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—Single +5V Supply

(V+ = +4.5V to +5.5V, V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +5V, T<sub>A</sub> = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>COM</sub> , V <sub>NO_</sub>		0		V+	V	
On-Resistance	R <sub>ON</sub>	V+ = 4.5V, I <sub>COM</sub> = 10mA, V <sub>NO_</sub> = 0 to V+	T <sub>A</sub> = +25°C		2.5	4	Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			4.5	
On-Resistance Match Between Channels (Note 3)	ΔR <sub>ON</sub>	V+ = 4.5V, I <sub>COM</sub> = 10mA, V <sub>NO_</sub> = 0 to V+	T <sub>A</sub> = +25°C		0.1	0.3	Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			0.4	
On-Resistance Flatness (Note 4)	R <sub>FLAT(ON)</sub>	V+ = 4.5V, I <sub>COM</sub> = 10mA, V <sub>NO_</sub> = 0 to V+	T <sub>A</sub> = +25°C		0.75	1	Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			1.2	
NO_ Off-Leakage Current (Note 5)	I <sub>NO_(OFF)</sub>	V+ = 5.5V; V <sub>COM</sub> = 1V, 4.5V; V <sub>NO_</sub> = 4.5V, 1V	T <sub>A</sub> = +25°C		-0.1	±0.01	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-0.3	0.3	
COM Off-Leakage Current (Note 5)	I <sub>COM(OFF)</sub>	V+ = 5.5V; V <sub>COM</sub> = 1V, 4.5V; V <sub>NO_</sub> = 4.5V, 1V	T <sub>A</sub> = +25°C		-0.1	±0.01	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-0.65	0.65	
COM On-Leakage Current (Note 5)	I <sub>COM(ON)</sub>	V+ = 5.5V; V <sub>COM</sub> = 1V, 4.5V; V <sub>NO_</sub> = 1V, 4.5V, or floating	T <sub>A</sub> = +25°C		-0.1	±0.01	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-0.65	0.65	
<b>DIGITAL I/O (A_, EN)</b>							
Input Logic High	V <sub>IH</sub>		2.4			V	
Input Logic Low	V <sub>IL</sub>				0.8	V	
Input Logic Current			-100	5	100	nA	

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## ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +4.5V to +5.5V, V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +5V, T<sub>A</sub> = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>DYNAMIC</b>						
Turn-On Time (Note 5)	t <sub>ON</sub>	V <sub>NO_</sub> = 3V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Figure 2	T <sub>A</sub> = +25°C	14	18	ns
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		20	
Turn-Off Time (Note 5)	t <sub>OFF</sub>	V <sub>NO_</sub> = 3V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Figure 2	T <sub>A</sub> = +25°C	6	11	ns
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		13	
Break-Before-Make Time (Note 5)	t <sub>BBM</sub>	V <sub>NO_</sub> = 3V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Figure 3	T <sub>A</sub> = +25°C	8		ns
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	1		
Charge Injection	Q	V <sub>GEN</sub> = 2V, R <sub>GEN</sub> = 0, C <sub>L</sub> = 5pF, Figure 4		2		pC
Off-Isolation (Note 6)	V <sub>ISO</sub>	C <sub>L</sub> = 5pF, R <sub>L</sub> = 50Ω, Figure 5	f = 10MHz	-57		dB
			f = 1MHz	-80		
Crosstalk (Note 7)	V <sub>CT</sub>	C <sub>L</sub> = 5pF, R <sub>L</sub> = 50Ω, Figure 5	f = 10MHz	-52		dB
			f = 1MHz	-78		
NO_ Off-Capacitance	C <sub>NO_(OFF)</sub>	Figure 6		13		pF
COM Off-Capacitance	C <sub>COM(OFF)</sub>	Figure 6		52		pF
COM On-Capacitance	C <sub>COM(ON)</sub>	C <sub>L</sub> = 5pF, Figure 6		68		pF
Total Harmonic Distortion	THD	R <sub>L</sub> = 600Ω, f = 20Hz to 20kHz		0.018		%
<b>POWER SUPPLY</b>						
Power-Supply Range	V+		1.8		5.5	V
Positive Supply Current	I+	V+ = 5.5V, V <sub>IH</sub> = V+, V <sub>IL</sub> = 0		0.001	1.0	μA

## ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +3.3V, V<sub>IH</sub> = 2.0V, V<sub>IL</sub> = 0.4V, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +3V, T<sub>A</sub> = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>						
Analog Signal Range	V <sub>COM_</sub> , V <sub>NO_</sub>		0		V+	V
On-Resistance	R <sub>ON</sub>	V+ = 2.7V, I <sub>COM</sub> = 10mA, V <sub>NO_</sub> = 0 to V+	T <sub>A</sub> = +25°C	4.5	7	Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		8	
On-Resistance Match Between Channels (Note 3)	ΔR <sub>ON</sub>	V+ = 2.7V, I <sub>COM</sub> = 10mA, V <sub>NO_</sub> = 0 to V+	T <sub>A</sub> = +25°C	0.1	0.3	Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		0.4	

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## ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +3.3V, V<sub>IH</sub> = 2.0V, V<sub>IL</sub> = 0.4V, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +3V, T<sub>A</sub> = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
On-Resistance Flatness (Note 4)	R <sub>FLAT(ON)</sub>	V+ = 2.7V, I <sub>COM</sub> = 10mA, V <sub>NO-</sub> = 0 to V+	T <sub>A</sub> = +25°C	1.2	2.5	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		3		
NO <sub>-</sub> Off-Leakage Current (Note 5)	I <sub>NO-(OFF)</sub>	V+ = 3.3V; V <sub>COM</sub> = 1V, 3V; V <sub>NO-</sub> = 3V, 1V	T <sub>A</sub> = +25°C	-0.1	±0.01	0.1	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-0.3		0.3	
COM Off-Leakage Current (Note 5)	I <sub>COM-(OFF)</sub>	V+ = 3.3V; V <sub>COM</sub> = 1V, 3V; V <sub>NO-</sub> = 3V, 1V	T <sub>A</sub> = +25°C	-0.1	±0.01	0.1	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-0.65		0.65	
COM On-Leakage Current (Note 5)	I <sub>COM-(ON)</sub>	V+ = 3.3V; V <sub>COM</sub> = 1V, 3V; V <sub>NO-</sub> = 1V, 3V, or floating	T <sub>A</sub> = +25°C	-0.1	±0.01	0.1	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-0.65		0.65	
<b>DIGITAL I/O (A<sub>-</sub>, EN)</b>							
Input High	V <sub>IH</sub>			2.0			V
Input Low	V <sub>IL</sub>					0.4	V
Input Logic Current				-100	5	100	nA
<b>DYNAMIC</b>							
Turn-On Time (Note 5)	t <sub>ON</sub>	V <sub>NO-</sub> = 2V, C <sub>L</sub> = 35pF, R <sub>L</sub> = 300Ω, Figure 2	T <sub>A</sub> = +25°C	16	22	ns	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		24		
Turn-Off Time (Note 5)	t <sub>OFF</sub>	V <sub>NO-</sub> = 2V, C <sub>L</sub> = 35pF, R <sub>L</sub> = 300Ω, Figure 2	T <sub>A</sub> = +25°C	8	14	ns	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		16		
Break-Before-Make Time (Note 5)	t <sub>BBM</sub>	V <sub>NO-</sub> = 2V, C <sub>L</sub> = 35pF, R <sub>L</sub> = 300Ω, Figure 3	T <sub>A</sub> = +25°C	9		ns	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	1			
Charge Injection	Q	V <sub>GEN</sub> = 1.5V, R <sub>GEN</sub> = 0, C <sub>L</sub> = 5pF, Figure 4		2		pC	
Off-Isolation (Note 6)	V <sub>ISO</sub>	C <sub>L</sub> = 5pF, R <sub>L</sub> = 50Ω, Figure 5	f = 10MHz	-57		dB	
			f = 1MHz	-80			
Crosstalk (Note 7)	V <sub>CT</sub>	C <sub>L</sub> = 5pF, R <sub>L</sub> = 50Ω, Figure 5	f = 10MHz	-52		dB	
			f = 1MHz	-78			

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## ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

( $V_+ = +2.7V$  to  $+3.3V$ ,  $V_{IH} = 2.0V$ ,  $V_{IL} = 0.4V$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise noted. Typical values are at  $V_+ = +3V$ ,  $T_A = +25^\circ C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NO_ Off-Capacitance	$C_{NO(OFF)}$	$V_{NO} = GND$ , $f = 1MHz$ , Figure 6		13		pF
COM Off-Capacitance	$C_{COM(OFF)}$	$V_{COM} = GND$ , $f = 1MHz$ , Figure 6		52		pF
COM On-Capacitance	$C_{(ON)}$	$V_{COM} = V_{NO} = GND$ , $f = 1MHz$ , Figure 6		68		pF
Total Harmonic Distortion	THD	$R_L = 600\Omega$ , $f = 20Hz$ to $20kHz$		0.018		%
<b>POWER SUPPLY</b>						
Positive Supply Current	$I_+$	$V_+ = 3.3V$ , $V_{IH} = V_+$ , $V_{IL} = 0$		0.001	1	$\mu A$

**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:**  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$ .

**Note 4:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

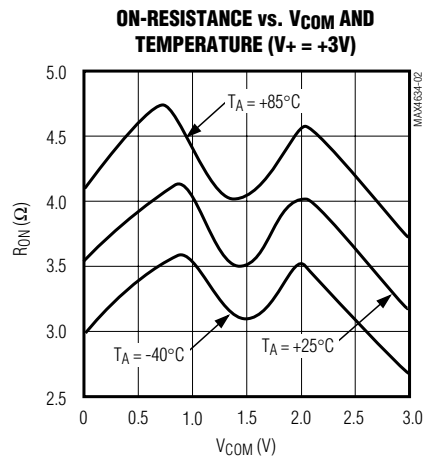
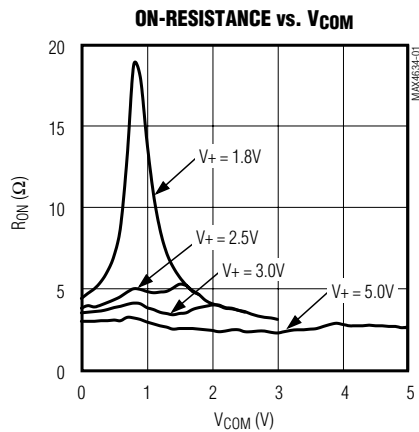
**Note 5:** Guaranteed by design.

**Note 6:** Off-Isolation =  $20\log_{10}(V_{COM} / V_{NO})$ , where  $V_{COM}$  = output and  $V_{NO}$  = input to off switch.

**Note 7:** Between any two switches.

## Typical Operating Characteristics

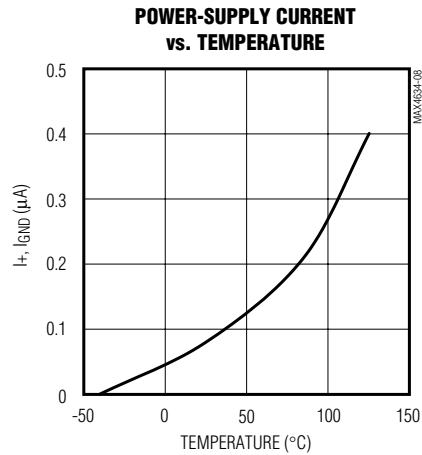
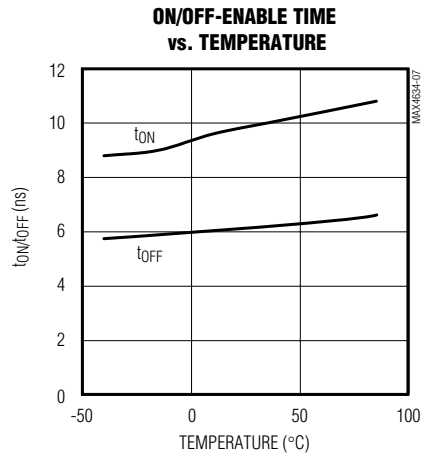
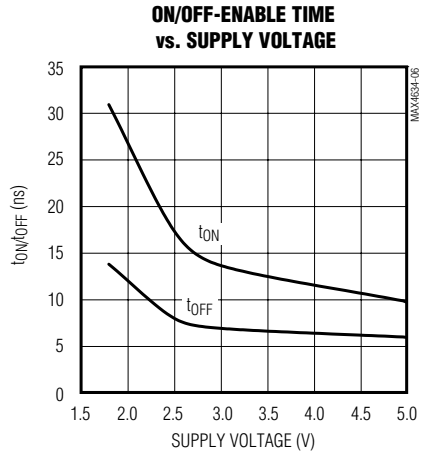
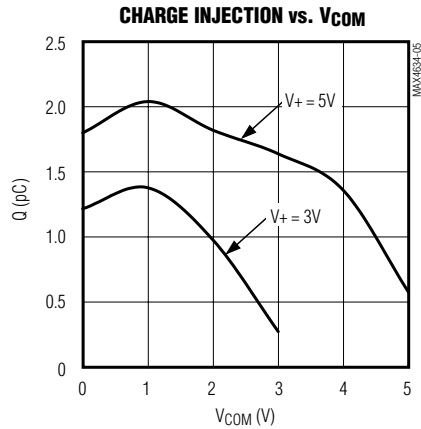
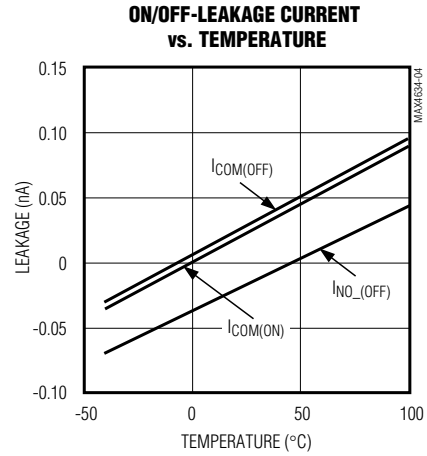
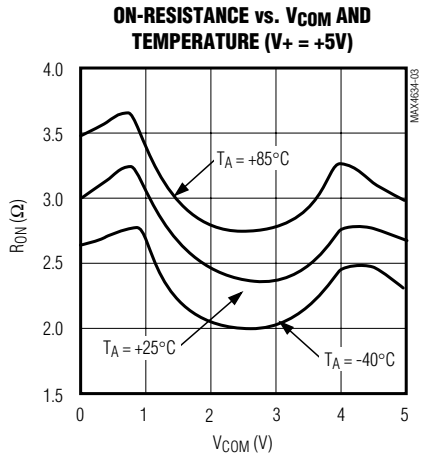
( $T_A = +25^\circ C$ , unless otherwise noted.)



# Fast, Low-Voltage, 4Ω, 4-Channel CMOS Analog Multiplexer

## Typical Operating Characteristics (continued)

(T<sub>A</sub> = +25°C, unless otherwise noted.)

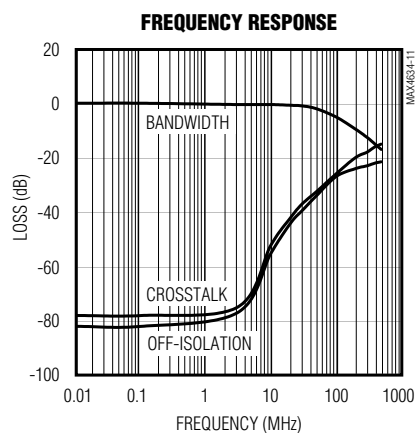
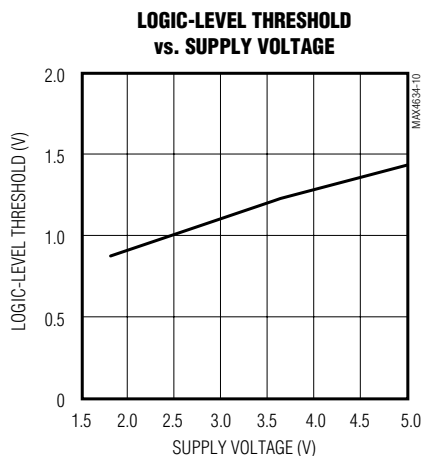


# Fast, Low-Voltage, 4Ω, 4-Channel CMOS Analog Multiplexer

**MAX4634**

## Typical Operating Characteristics (continued)

(T<sub>A</sub> = +25°C, unless otherwise noted.)



## Pin Description

PIN	NAME	FUNCTION
1	A0	Address Input
2	NO1	Normally Open Switch 1
3	GND	Ground
4	NO3	Normally Open Switch 3
5	EN	Enable Logic Input
6	V+	Positive Supply Voltage
7	NO4	Normally Open Switch 4
8	COM	Analog Switch Common Terminal
9	NO2	Normally Open Switch 2
10	A1	Address Input

# Fast, Low-Voltage, 4Ω, 4-Channel CMOS Analog Multiplexer

## Detailed Description

The MAX4634 is a low-on-resistance, low-voltage analog multiplexer that operates from a +1.8V to +5.5V single supply. CMOS switch construction allows processing of analog signals that are within the supply voltage range (GND to V+).

To disable all switch channels, drive EN low. All four inputs and COM become high impedance during this state. If the disable feature is not needed, connect EN to V+.

## Applications Information

### Power-Supply Sequencing and Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V+ before applying analog signals or logic inputs, especially if the analog or logic signals are not current limited. If this sequencing is not possible, and if the analog or logic inputs are not current limited to < 20mA, add a small-signal diode (D1) as shown in Figure 1. If the analog signal can dip below GND, add D2. Adding protection diodes reduces the analog signal range to a diode drop (about 0.7V) below V+ for D1 or to a diode drop above ground for D2. The addition of diodes does not affect leakage. On-resistance increases by a small amount at low supply voltages. Maximum supply voltage (V+) must not exceed 6V.

Protection diodes D1 and D2 also protect against some overvoltage situations. A fault voltage up to the absolute maximum rating at an analog signal input does not damage the device, even if the supply voltage is below the signal voltage.

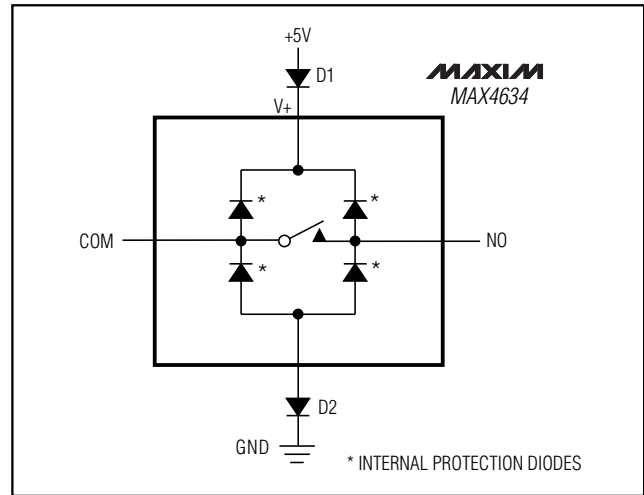


Figure 1. Overvoltage Protection Using External Blocking Diodes

## Test Circuits/Timing Diagrams

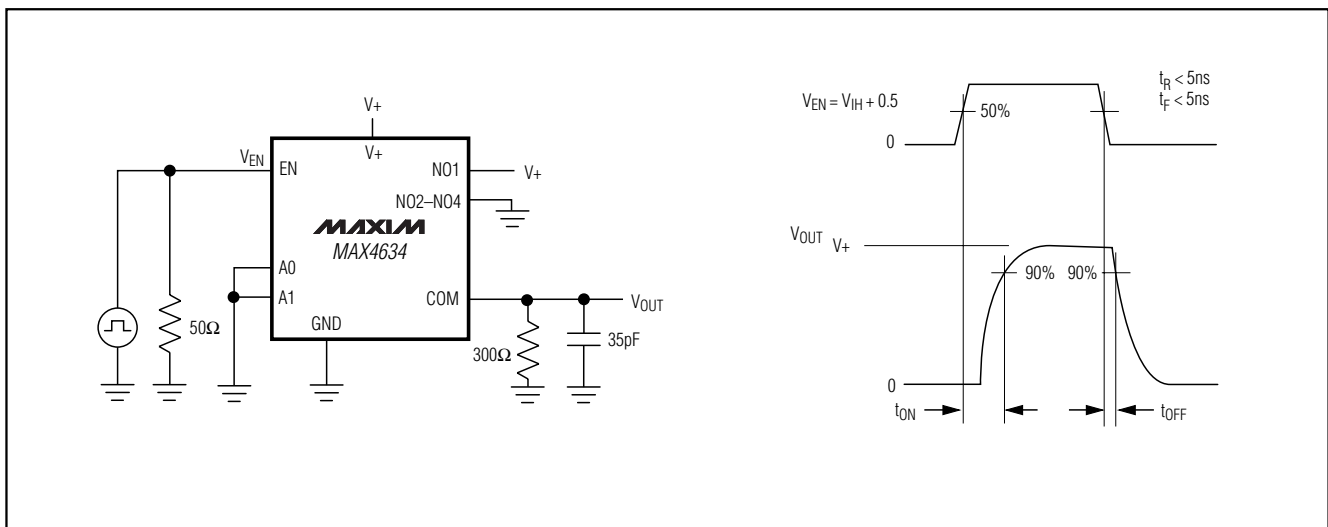


Figure 2. Switching Time



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## Test Circuits/Timing Diagrams (continued)

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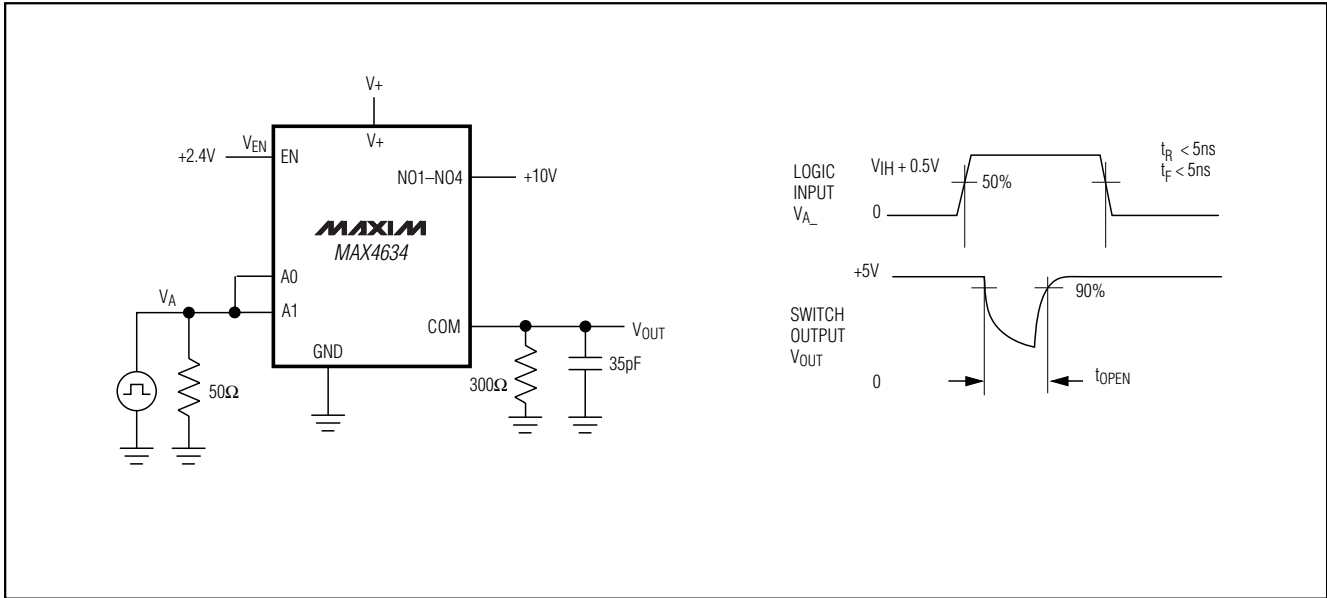


Figure 3. Break-Before-Make Interval

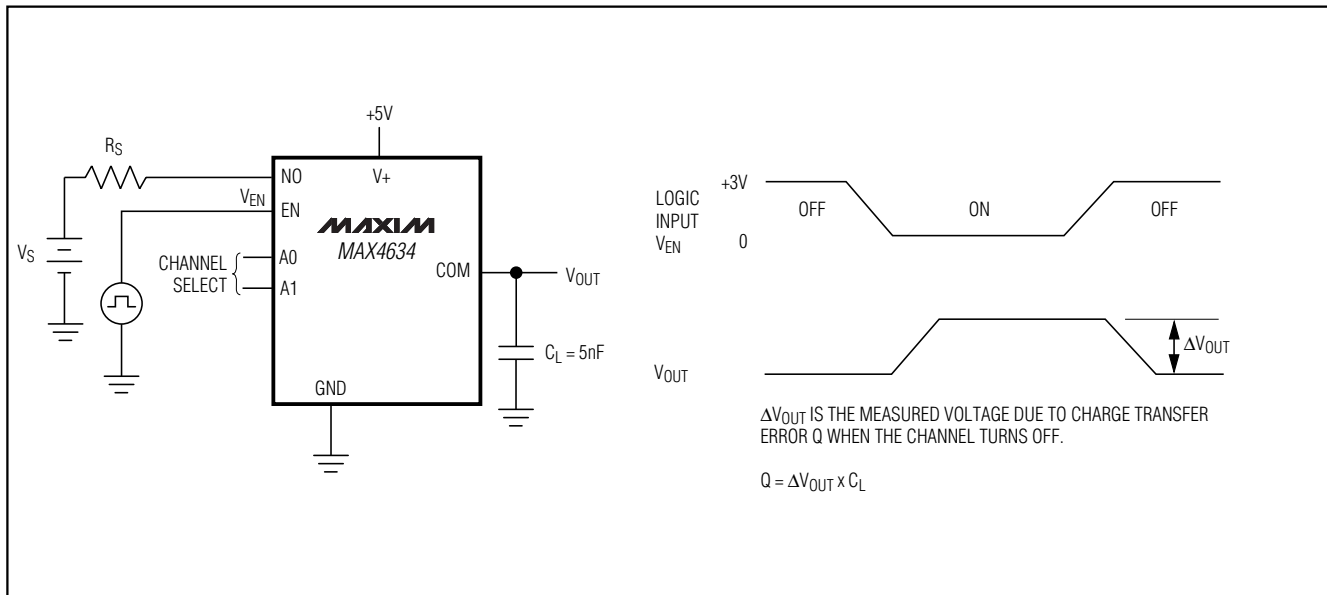


Figure 4. Charge Injection

# Fast, Low-Voltage, 4Ω, 4-Channel CMOS Analog Multiplexer

## Test Circuits/Timing Diagrams (continued)

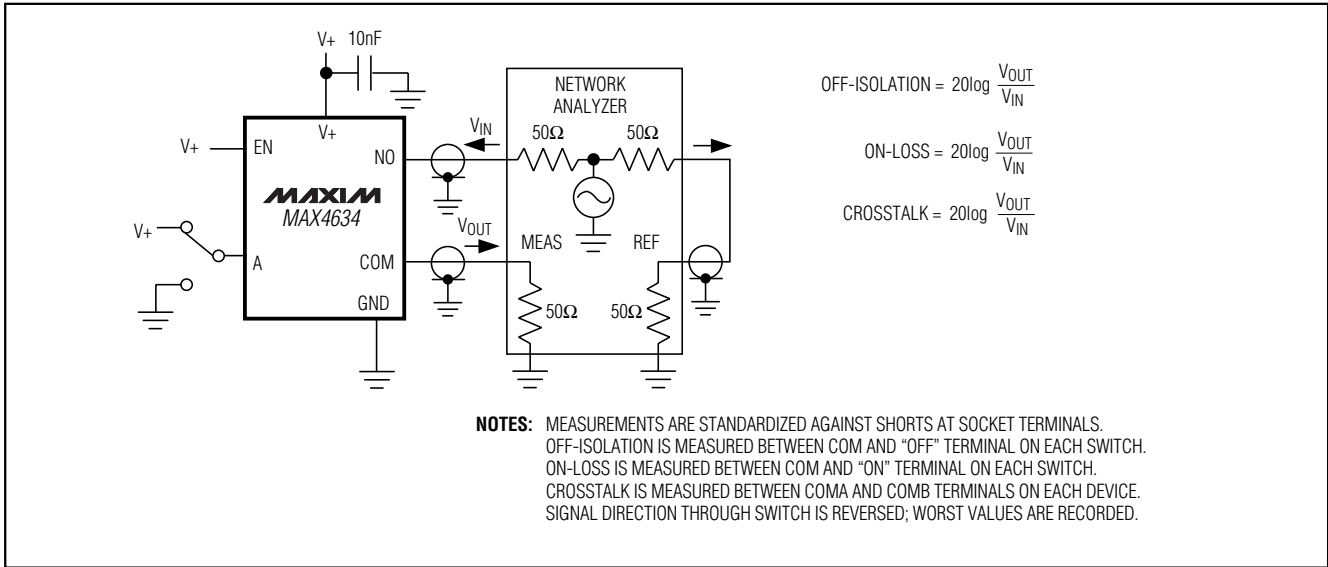


Figure 5. Off-Isolation/On-Channel Bandwidth

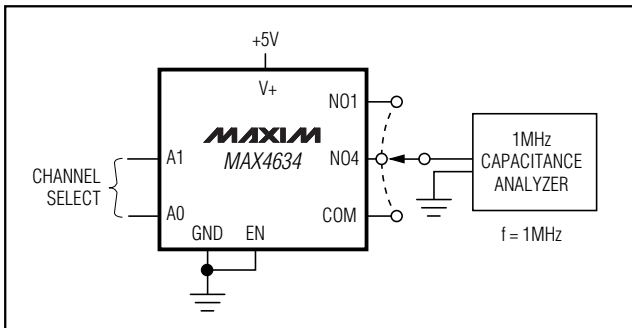


Figure 6. Channel Off/On-Capacitance

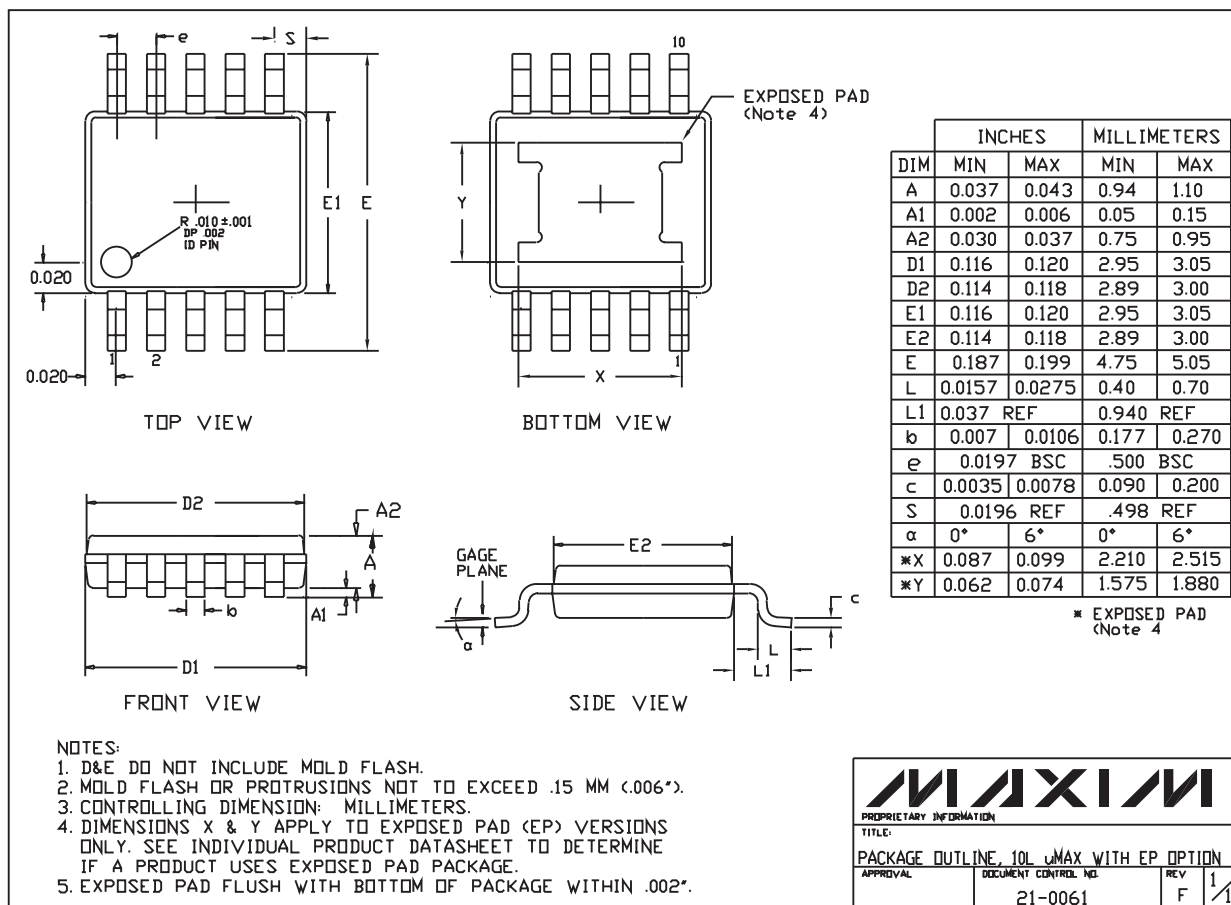
## Chip Information

TRANSISTOR COUNT: 231

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## Package Information

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**Note:** The MAX4634 package does not have an exposed pad.

# **Fast, Low-Voltage, 4Ω, 4-Channel CMOS Analog Multiplexer**

## **NOTES**

*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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