19-1717; Rev 1; 2/02

MAXIM

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

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 the tiny 10-pin µMAX and 12-pin QFN packages.

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

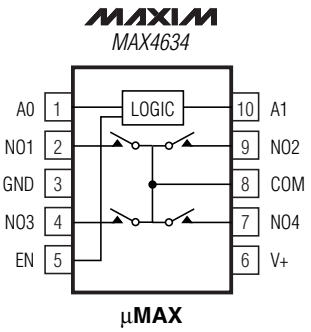
- **Guaranteed R_{ON}**
  2.5Ω typ (5V Supply)
  4.5Ω typ (3V Supply)
- **Guaranteed R_{ON} Match Between Channels**
  0.3Ω max
- **Guaranteed R_{ON} Flatness Over Signal Range**
  1Ω max
- **Guaranteed Low Leakage Currents**
  0.1nA (at +25°C)
- **+1.8V to +5.5V Single-Supply Operation**
- **+1.8V Operation**
  R_{ON} = 30Ω 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 µMAX
MAX4634EGC	-40°C to +85°C	12 QFN (4x4)

Pin Configuration/Functional Diagram/Truth Table

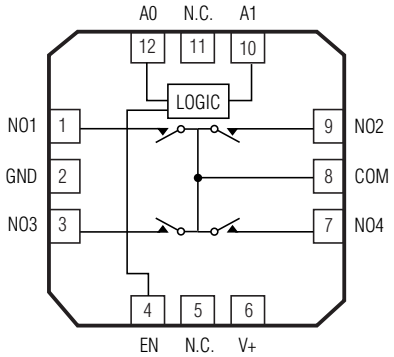
TOP VIEW



µMAX

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



QFN

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

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_A = +70°C)
10-Pin µMAX (derate 4.1mW/°C above +70°C) 330mW
12-Pin QFN (derate 16.9mW/°C above +70°C) 1349mW
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_{IH} = 2.4V, V_{IL} = 0.8V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +5V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V_{COM}, $V_{NO\_}$			0		V+	V
On-Resistance	R_{ON}	V+ = 4.5V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		2.5	4	Ω
			T_A = T_{MIN} to T_{MAX}			4.5	
On-Resistance Match Between Channels (Notes 3, 8)	ΔR_{ON}	V+ = 4.5V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		0.1	0.3	Ω
			T_A = T_{MIN} to T_{MAX}			0.4	
On-Resistance Flatness (Note 4)	$R_{FLAT(ON)}$	V+ = 4.5V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		0.75	1	Ω
			T_A = T_{MIN} to T_{MAX}			1.2	
NO_ Off-Leakage Current (Note 5)	$I_{NO\_(OFF)}$	V+ = 5.5V; V_{COM} = 1V, 4.5V; $V_{NO\_}$ = 4.5V, 1V	T_A = +25°C	-0.1	±0.01	0.1	nA
			T_A = T_{MIN} to T_{MAX}	-0.3		0.3	
COM Off-Leakage Current (Note 5)	$I_{COM(OFF)}$	V+ = 5.5V; V_{COM} = 1V, 4.5V; $V_{NO\_}$ = 4.5V, 1V	T_A = +25°C	-0.1	±0.01	0.1	nA
			T_A = T_{MIN} to T_{MAX}	-0.65		0.65	
COM On-Leakage Current (Note 5)	$I_{COM(ON)}$	V+ = 5.5V; V_{COM} = 1V, 4.5V; $V_{NO\_}$ = 1V, 4.5V, or floating	T_A = +25°C	-0.1	±0.01	0.1	nA
			T_A = T_{MIN} to T_{MAX}	-0.65		0.65	
DIGITAL I/O (A_, EN)							
Input Logic High	V_{IH}			2.4			V
Input Logic Low	V_{IL}					0.8	V
Input Logic Current				-100	5	100	nA

ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +4.5V to +5.5V, V_{IH} = 2.4V, V_{IL} = 0.8V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = +5V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DYNAMIC							
Turn-On Time (Note 5)	t_{ON}	$V_{NO\_}$ = 3V, R_L = 300Ω, C_L = 35pF, Figure 2	T_A = +25°C		14	18	ns
			T_A = T_{MIN} to T_{MAX}			20	
Turn-Off Time (Note 5)	t_{OFF}	$V_{NO\_}$ = 3V, R_L = 300Ω, C_L = 35pF, Figure 2	T_A = +25°C		6	11	ns
			T_A = T_{MIN} to T_{MAX}			13	
Break-Before-Make Time (Note 5)	t_{BBM}	$V_{NO\_}$ = 3V, R_L = 300Ω, C_L = 35pF, Figure 3	T_A = +25°C		8		ns
			T_A = T_{MIN} to T_{MAX}	1			
Charge Injection	Q	V_{GEN} = 2V, R_{GEN} = 0, C_L = 5pF, Figure 4			2		pC
Off-Isolation (Note 6)	V_{ISO}	C_L = 5pF, R_L = 50Ω, Figure 5	f = 10MHz		-57		dB
			f = 1MHz		-80		
Crosstalk (Note 7)	V_{CT}	C_L = 5pF, R_L = 50Ω, Figure 5	f = 10MHz		-52		dB
			f = 1MHz		-78		
NO_ Off-Capacitance	$C_{NO\_(OFF)}$	Figure 6			13		pF
COM Off-Capacitance	$C_{COM(OFF)}$	Figure 6			52		pF
COM On-Capacitance	$C_{COM(ON)}$	C_L = 5pF, Figure 6			68		pF
Total Harmonic Distortion	THD	R_L = 600Ω, f = 20Hz to 20kHz			0.018		%
POWER SUPPLY							
Power-Supply Range	V+			1.8		5.5	V
Positive Supply Current	I+	V+ = 5.5V, V_{IH} = V+, V_{IL} = 0			0.001	1.0	µA

ELECTRICAL CHARACTERISTICS—Single +3V Supply

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM\_}$, $V_{NO\_}$			0		V+	V
On-Resistance	R_{ON}	V+ = 2.7V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		4.5	7	Ω
			T_A = T_{MIN} to T_{MAX}			8	
On-Resistance Match Between Channels (Notes 3, 8)	ΔR_{ON}	V+ = 2.7V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		0.1	0.3	Ω
			T_A = T_{MIN} to T_{MAX}			0.4	

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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°C to +85°C, unless otherwise noted. Typical values are at V+ = +3V, T_A = +25°C.) (Note 2)

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

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

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

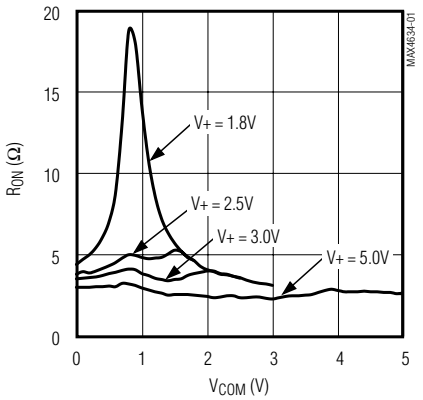
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NO_ Off-Capacitance	$C_{NO\_(OFF)}$	$V_{NO\_}$ = GND, f = 1MHz, Figure 6		13		pF
COM Off-Capacitance	$C_{COM(OFF)}$	V_{COM} = GND, f = 1MHz, Figure 6		52		pF
COM On-Capacitance	$C_{(ON)}$	V_{COM} = $V_{NO\_}$ = GND, f = 1MHz, Figure 6		68		pF
Total Harmonic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

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.
Note 8: R_{ON} and ΔR_{ON} matching specifications for QFN-packaged parts are guaranteed by design.

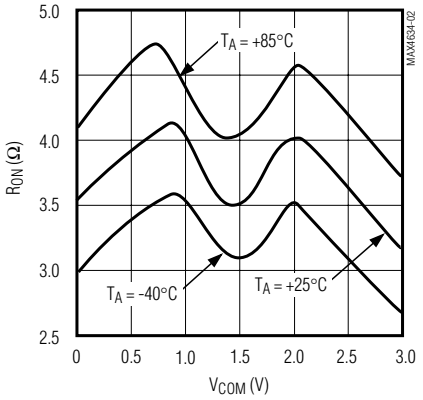
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

ON-RESISTANCE vs. V_{COM}



ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (V+ = +3V)

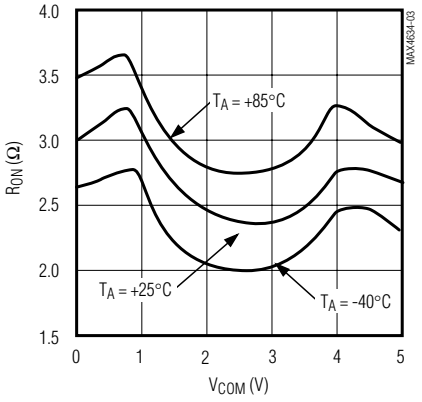


Fast, Low-Voltage, 4Ω, 4-Channel CMOS Analog Multiplexer

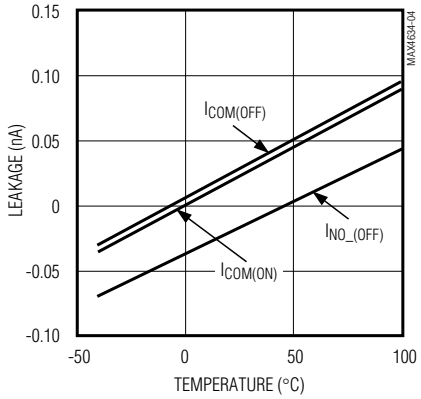
Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

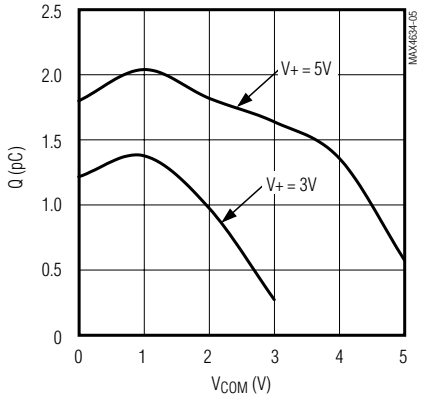
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (V+ = +5V)



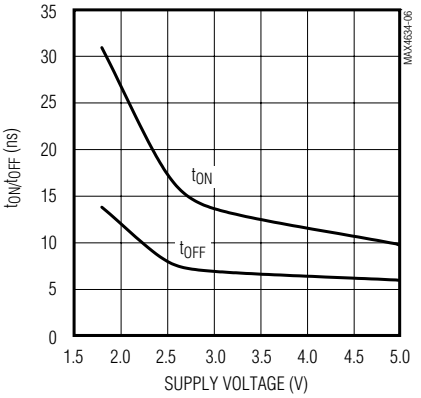
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE



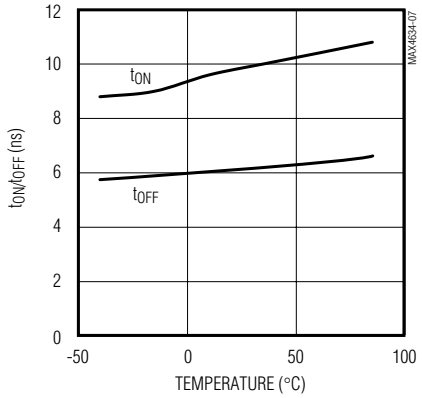
CHARGE INJECTION vs. V_{COM}



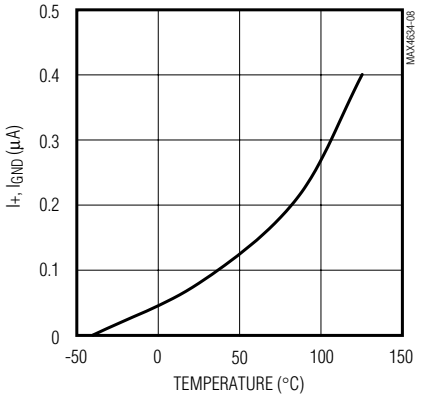
ON/OFF-ENABLE TIME vs. SUPPLY VOLTAGE



ON/OFF-ENABLE TIME vs. TEMPERATURE



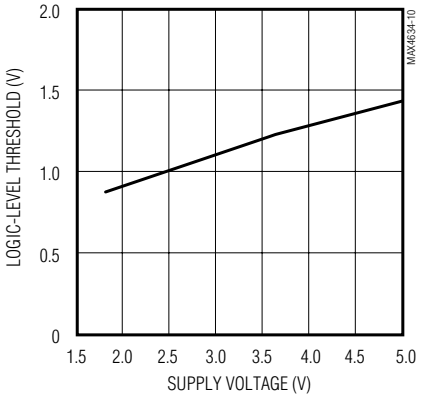
POWER-SUPPLY CURRENT vs. TEMPERATURE



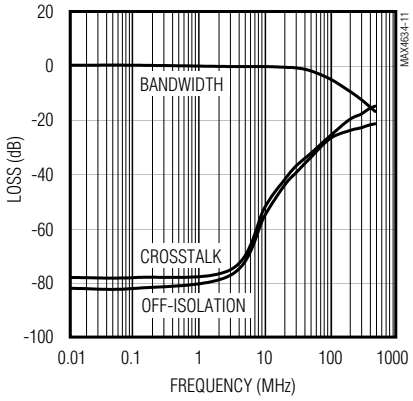
Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

LOGIC-LEVEL THRESHOLD vs. SUPPLY VOLTAGE



FREQUENCY RESPONSE



Pin Description

PIN		NAME	FUNCTION
μMAX	QFN		
1	12	A0	Address Input
2	1	NO1	Normally Open Switch 1
3	2	GND	Ground
4	3	NO3	Normally Open Switch 3
5	4	EN	Enable Logic Input
6	6	V+	Positive Supply Voltage
7	7	NO4	Normally Open Switch 4
8	8	COM	Analog Switch Common Terminal
9	9	NO2	Normally Open Switch 2
10	10	A1	Address Input
—	5, 11	N.C.	No Connection

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.

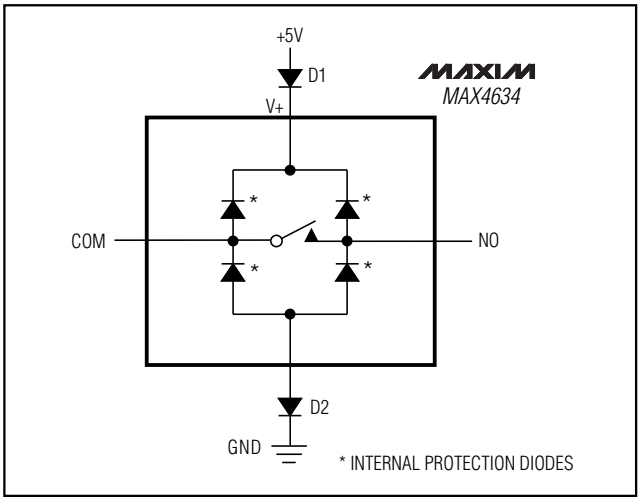


Figure 1. Overvoltage Protection Using External Blocking Diodes

Test Circuits/Timing Diagrams

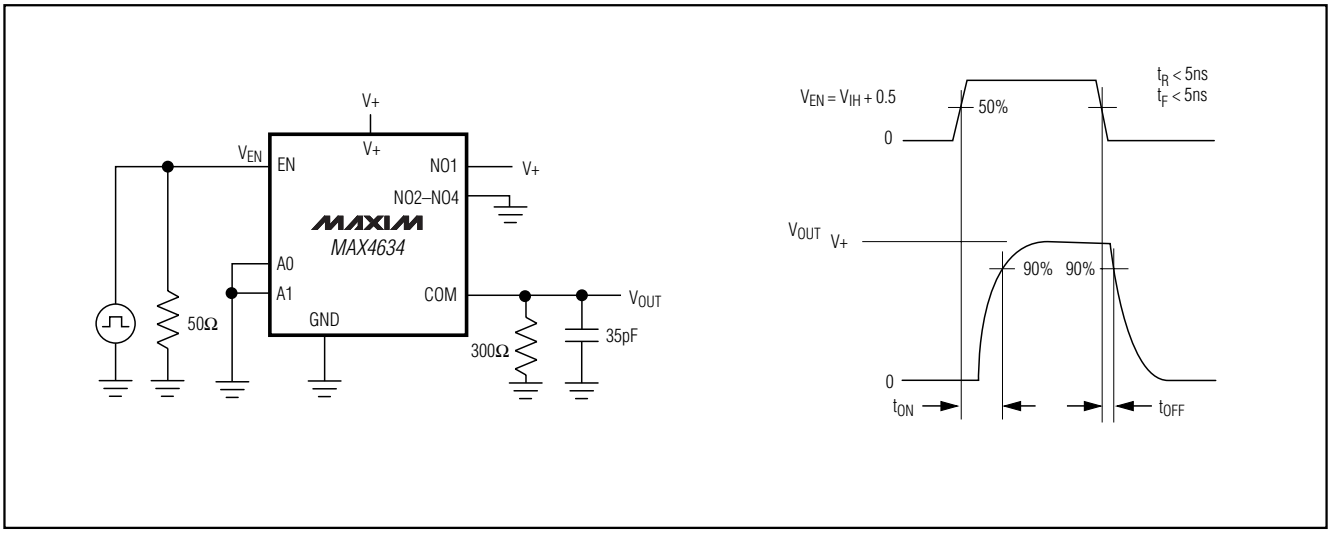


Figure 2. Switching Time

Test Circuits/Timing Diagrams (continued)

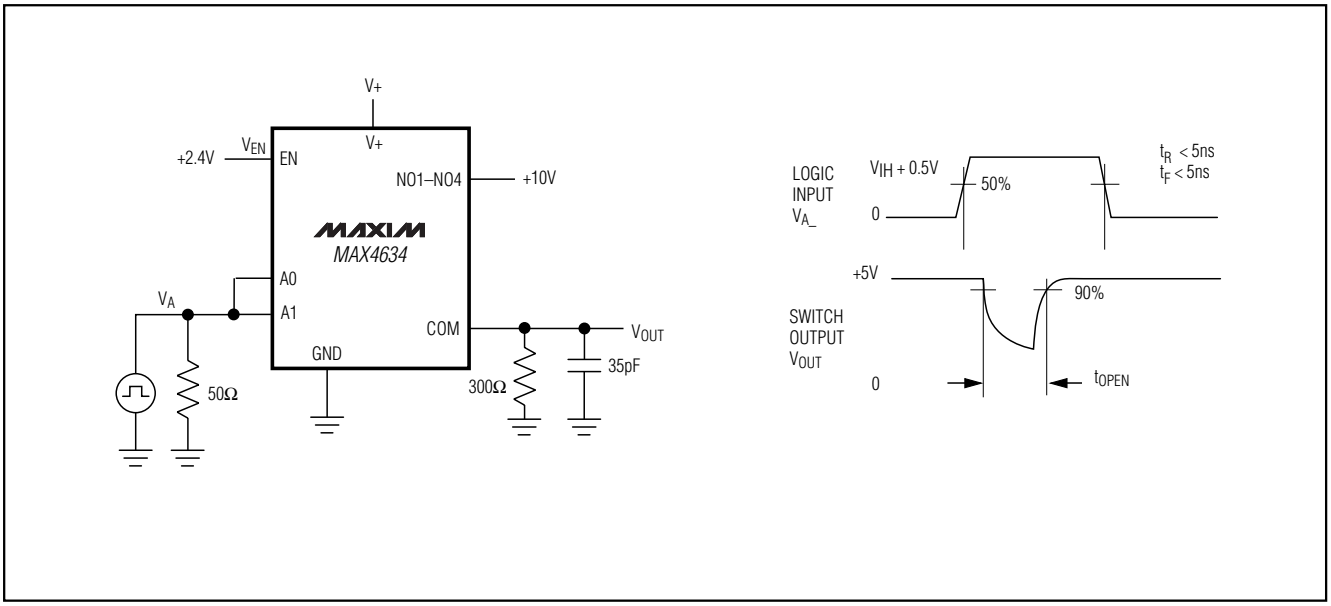


Figure 3. Break-Before-Make Interval

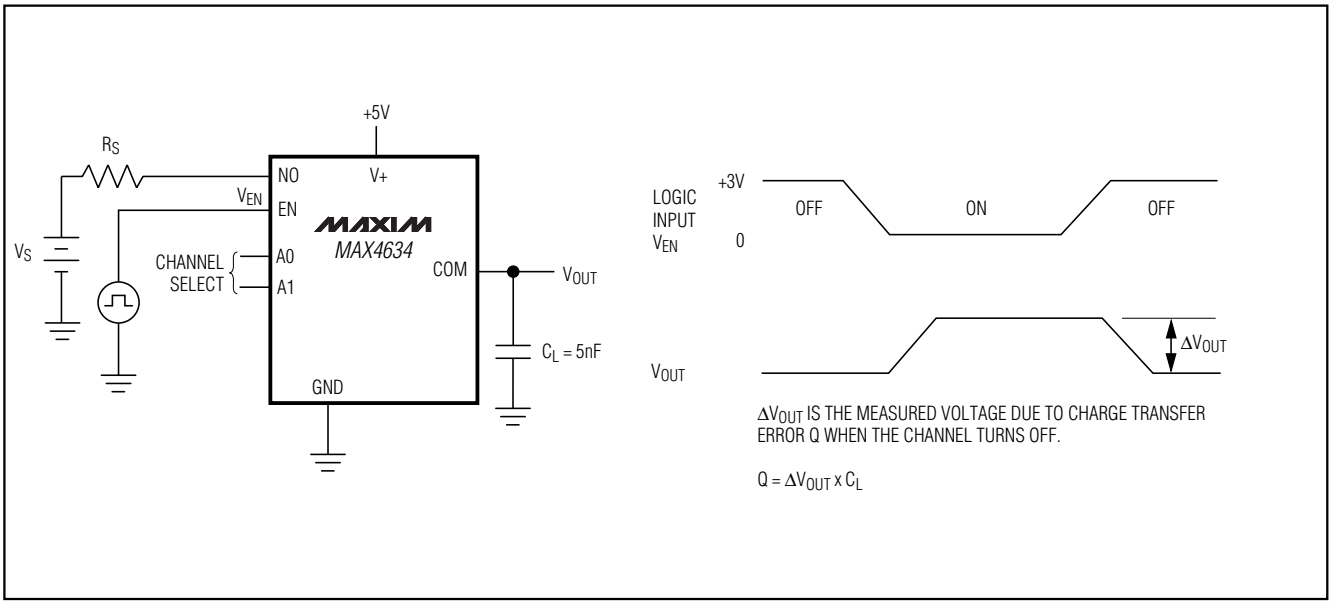


Figure 4. Charge Injection

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

Test Circuits/Timing Diagrams (continued)

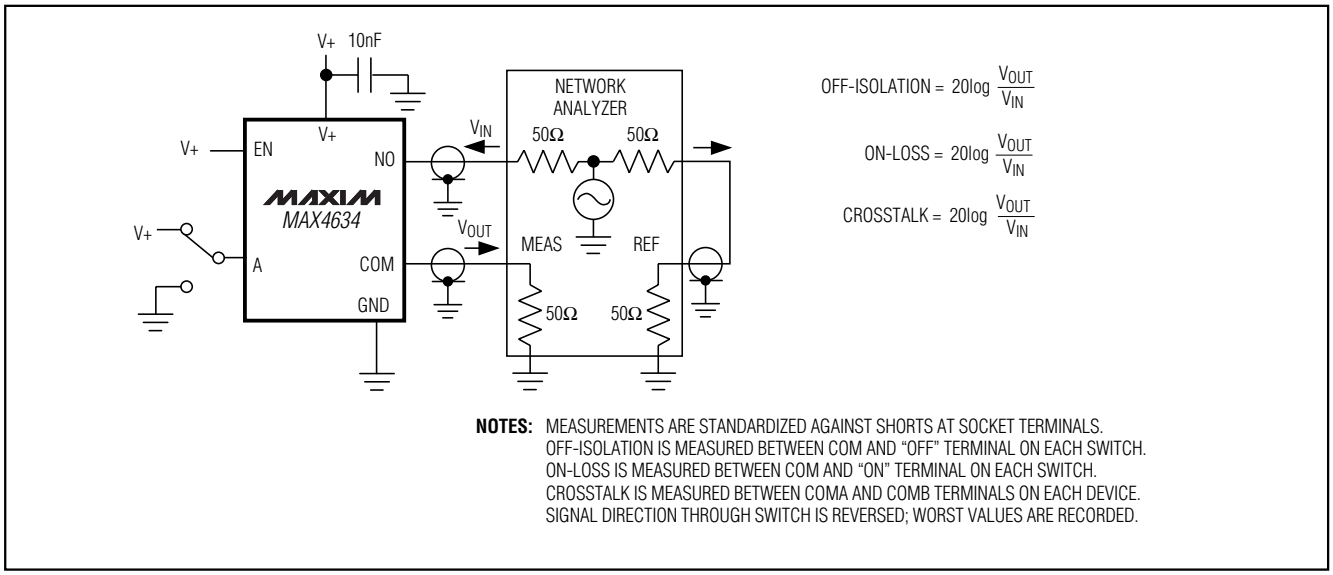


Figure 5. Off-Isolation/On-Channel Bandwidth

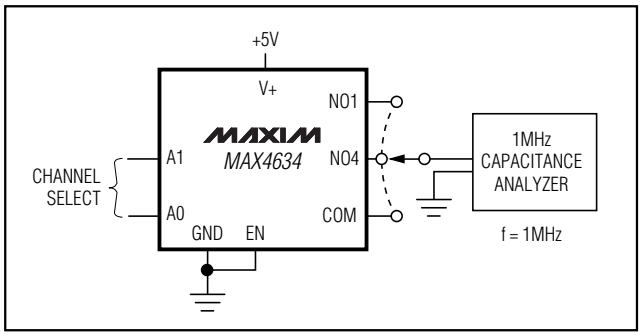


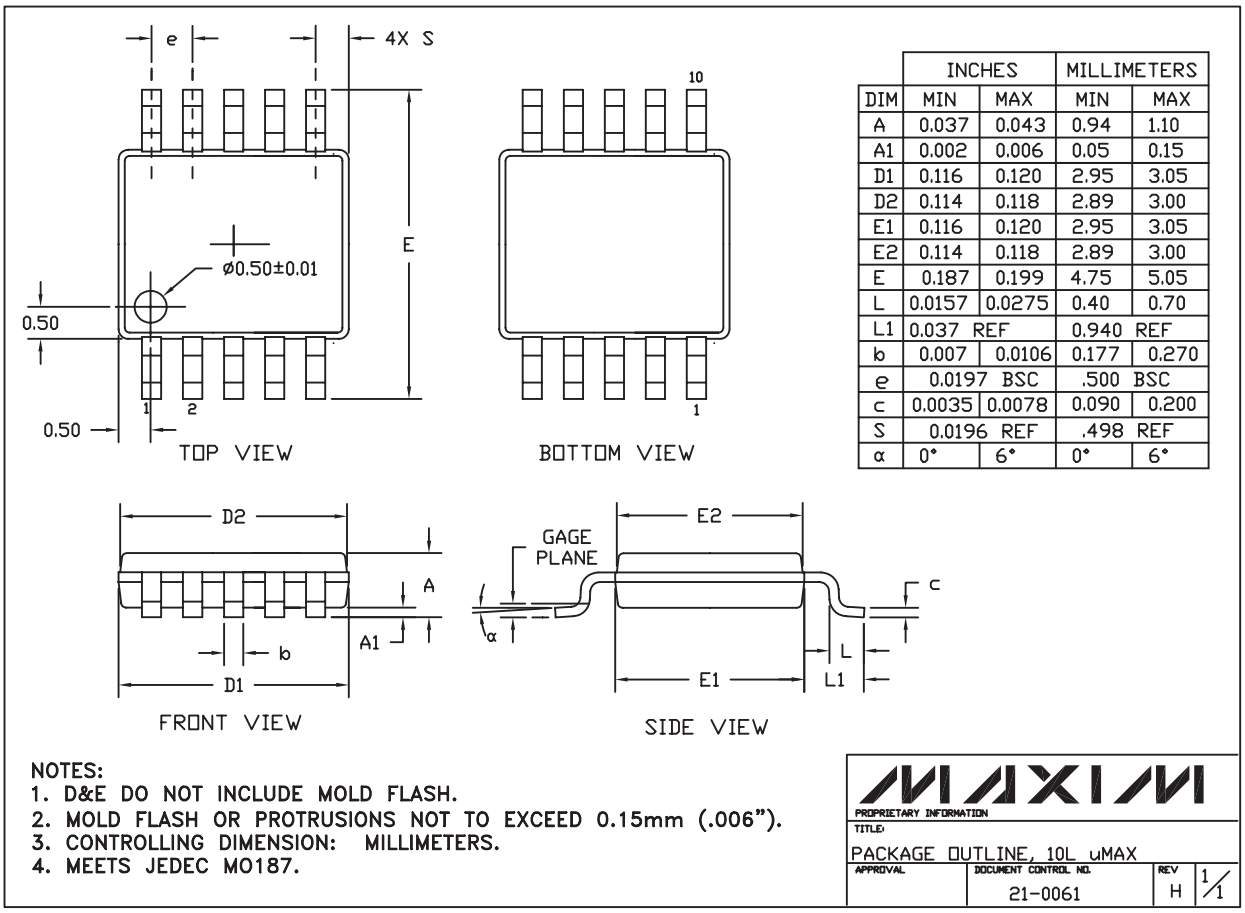
Figure 6. Channel Off/On-Capacitance

Chip Information

TRANSISTOR COUNT: 231

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

Package Information



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10
A1	0.002	0.006	0.05	0.15
D1	0.116	0.120	2.95	3.05
D2	0.114	0.118	2.89	3.00
E1	0.116	0.120	2.95	3.05
E2	0.114	0.118	2.89	3.00
E	0.187	0.199	4.75	5.05
L	0.0157	0.0275	0.40	0.70
L1	0.037 REF		0.940 REF	
b	0.007	0.0106	0.177	0.270
e	0.0197 BSC		.500 BSC	
c	0.0035	0.0078	0.090	0.200
S	0.0196 REF		.498 REF	
α	0°	6°	0°	6°

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