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 the tiny 10-pin µMAX® and 10-pin, 3mm x 3mm, TDFN 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

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Features

- Guaranteed R_{ON}
  - 2.35Ω (typ) with 5V Supply
  - 4.5Ω (typ) with 3V Supply
- 0.3Ω (max) Guaranteed R_{ON} Match Between Channels
- 1Ω (max) Guaranteed R_{ON} Flatness Over Signal Range
- 0.1nA (at +25°C) Guaranteed Low Leakage Currents
- +1.8V to +5.5V Single-Supply Operation
- +1.8V Operation
  - R_{ON} = 30Ω (typ) Overtemperature
  - 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

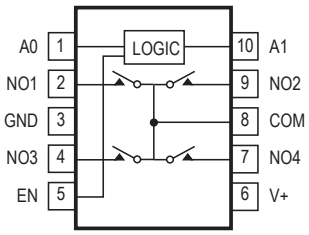
PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX4634EUB	-40°C to +85°C	10 µMAX	—
MAX4634ETB	-40°C to +85°C	10 TDFN-EP* (3mm x 3mm)	AAU

**EP = Exposed pad.*

Pin Configurations/Functional Diagrams/Truth Table

TOP VIEW

MAX4634EUB

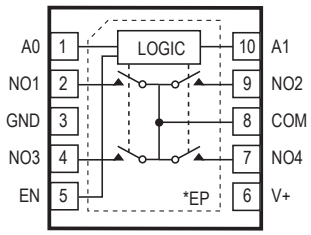


µMAX

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

MAX4634ETB



TDFN

*EP = EXPOSED PAD

19-1717; Rev 4; 3/22

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
10-Pin TDFN (derate 24.4mW/°C
above +70°C) 1951mW
Operating Temperature Range..... -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.) (Notes 2, 3)

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 4, 5)	ΔR_{ON}	V+ = 4.5V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		0.1	0.4	Ω
			T_A = T_{MIN} to T_{MAX}			0.4	
On-Resistance Flatness (Note 6)	$R_{FLAT(ON)}$	V+ = 4.5V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		0.75	1.2	Ω
			T_A = T_{MIN} to T_{MAX}			1.2	
NO_ Off-Leakage Current (Note 7)	$I_{NO\_(OFF)}$	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 7)	$I_{COM(OFF)}$	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 7)	$I_{COM(ON)}$	V+ = 5.5V; V_{COM} = 1V, 4.5V; $V_{NO\_}$ = 1V, 4.5V, or unconnected	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.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DYNAMIC							
Turn-On Time (Note 7)	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 7)	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 7)	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 8)	V_{ISO}	C_L = 5pF, R_L = 50Ω, Figure 5	f = 10MHz		-57		dB
			f = 1MHz		-80		
Crosstalk (Note 9)	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.) (Notes 2, 3)

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	8	Ω
			T_A = T_{MIN} to T_{MAX}			8	
On-Resistance Match Between Channels (Notes 4, 5)	ΔR_{ON}	V+ = 2.7V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		0.1	0.4	Ω
			T_A = T_{MIN} to T_{MAX}			0.4	

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.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
On-Resistance Flatness (Note 6)	$R_{FLAT(ON)}$	V+ = 2.7V, I_{COM} = 10mA, $V_{NO\_}$ = 0 to V+	T_A = +25°C		1.2	5	Ω
			T_A = T_{MIN} to T_{MAX}			5	
NO_ Off-Leakage Current (Note 7)	$I_{NO\_(OFF)}$	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 7)	$I_{COM(OFF)}$	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 7)	$I_{COM(ON)}$	V+ = 3.3V; V_{COM} = 1V, 3V; $V_{NO\_}$ = 1V, 3V, or unconnected	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 7)	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 7)	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 7)	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 8)	V_{ISO}	C_L = 5pF, R_L = 50Ω, Figure 5	f = 10MHz		-57		dB
			f = 1MHz		-80		
Crosstalk (Note 9)	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.) (Notes 2, 3)

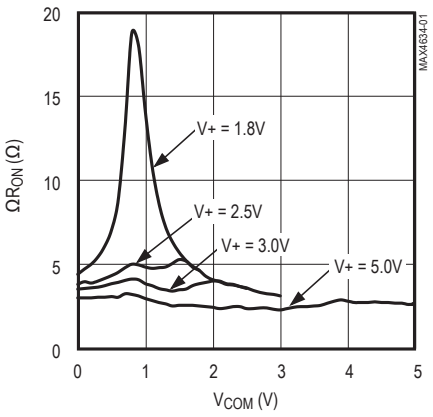
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NO_ Off-Capacitance	$C_{NO\_(OFF)}$	$V_{NO\_}$ = GND, f = 1MHz, Figure 6		13		pF
COM Off-Capacitance	$C_{COM(OFF)}$	V_{COM} = GND, f = 1MHz, Figure 6		52		pF
COM On-Capacitance	$C_{(ON)}$	V_{COM} = $V_{NO\_}$ = GND, f = 1MHz, Figure 6		68		pF
Total Harmonic 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: TDFN parts are tested at +25°C and guaranteed by design and correlation over the entire temperature range.
Note 4: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 5: R_{ON} and ΔR_{ON} matching specifications for TDFN-packaged parts are guaranteed by design.
Note 6: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.
Note 7: Guaranteed by design.
Note 8: Off-isolation = $20\log_{10}$ (V_{COM} / V_{NO}), where V_{COM} = output and V_{NO} = input to off switch.
Note 9: Between any two switches.

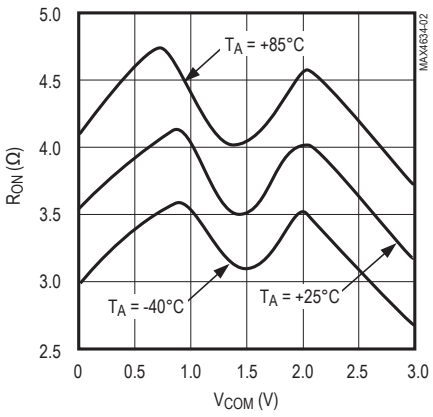
Typical Operating Characteristics

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

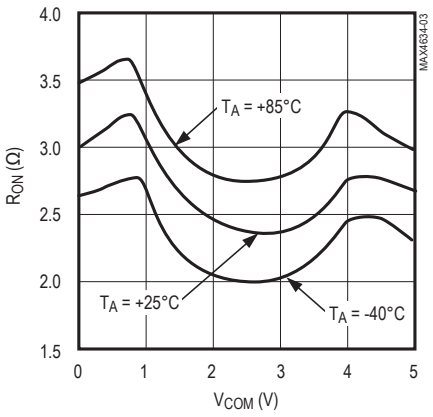
ON-RESISTANCE vs. V_{COM}



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



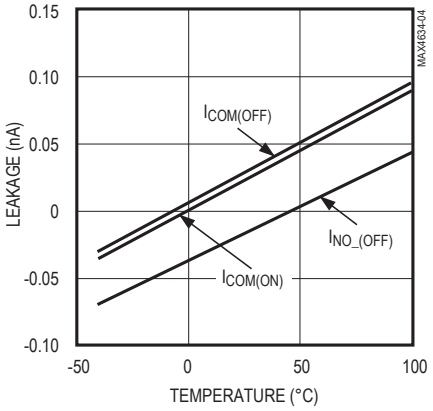
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (V+ = +5V)



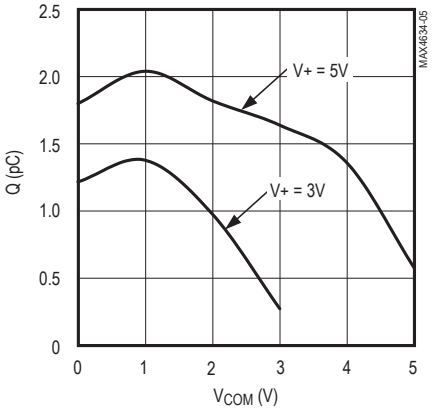
Typical Operating Characteristics (continued)

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

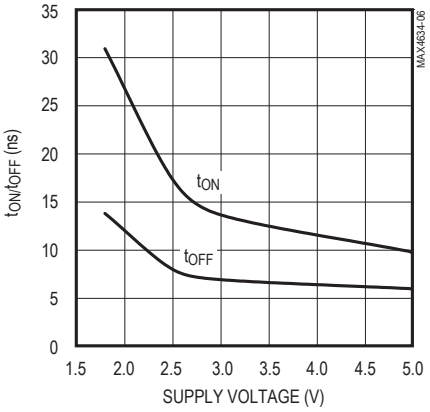
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE



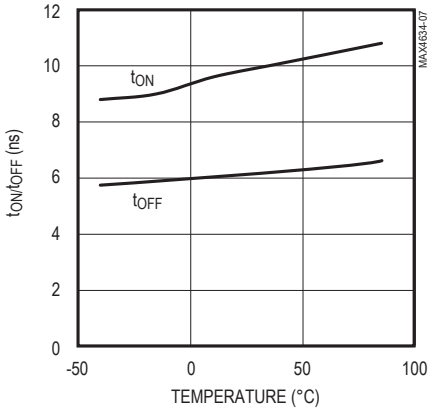
CHARGE INJECTION vs. V_{COM}



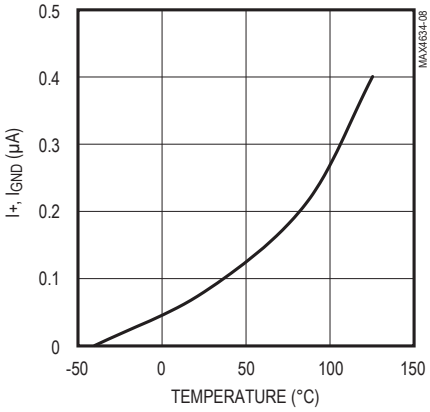
ON/OFF-ENABLE TIME vs. SUPPLY VOLTAGE



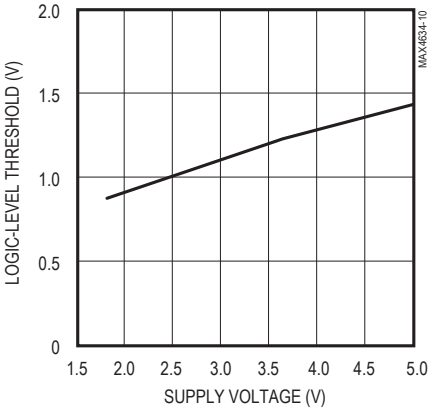
ON/OFF-ENABLE TIME vs. TEMPERATURE



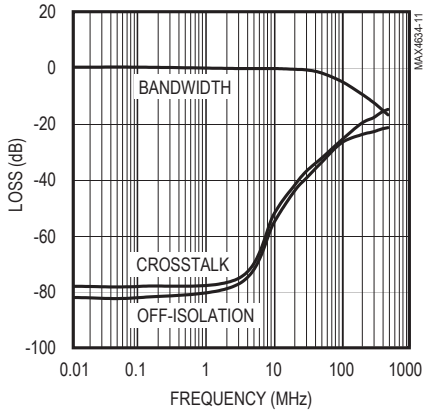
POWER-SUPPLY CURRENT vs. TEMPERATURE



LOGIC-LEVEL THRESHOLD vs. SUPPLY VOLTAGE



FREQUENCY RESPONSE



Pin Description

PIN	NAME	FUNCTION
μMAX/ TDFN		
1	A0	Address Input. See the *Truth Table* for details.
2	NO1	Normally Open Switch 1
3	GND	Ground
4	NO3	Normally Open Switch 3
5	EN	Enable Logic Input. See the *Truth Table* for details.
6	V+	Positive Supply Voltage. Connect to an external power supply. Bypass to GND with a 10μF capacitor placed as close to the pin as possible.
7	NO4	Normally Open Switch 4
8	COM	Analog Switch Common Terminal
9	NO2	Normally Open Switch 2
10	A1	Address Input. See the *Truth Table* for details.
—	EP	Exposed Pad. Internally connected to GND. Connect to a large PCB ground plane for proper operation. Not intended as an electrical connection point (TDFN package only).

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+.

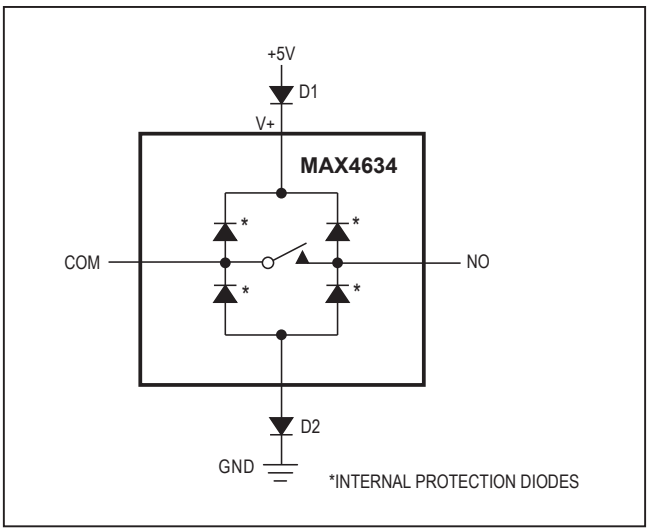


Figure 1. Overvoltage Protection Using External Blocking Diodes

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.

Test Circuits/Timing Diagrams

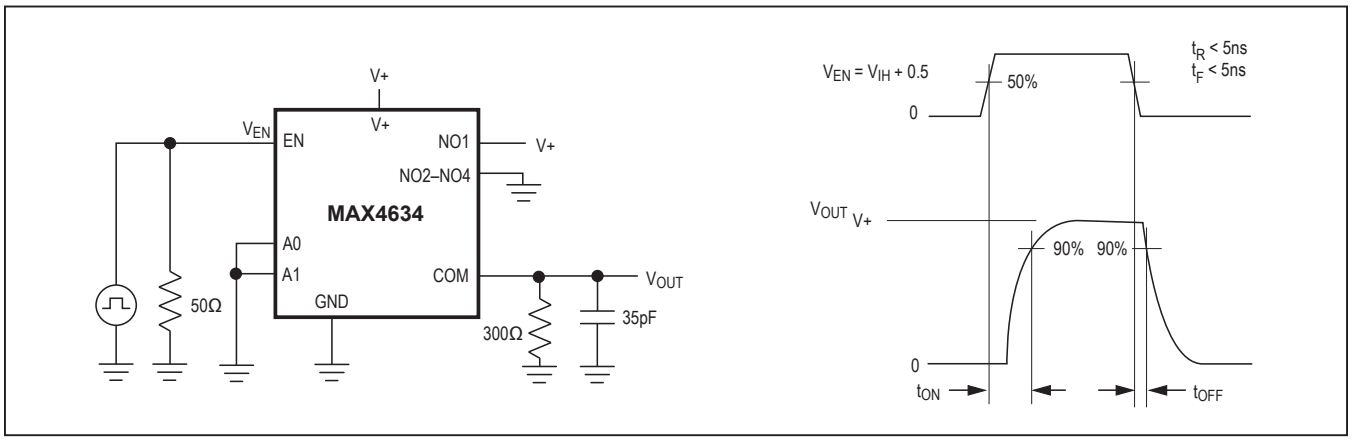


Figure 2. Switching Time

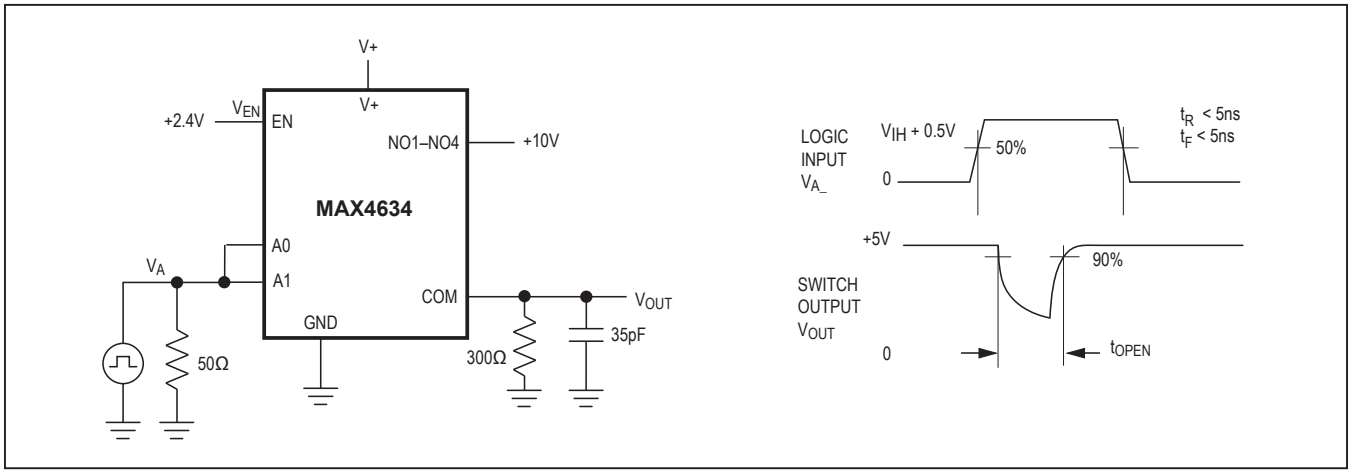


Figure 3. Break-Before-Make Interval

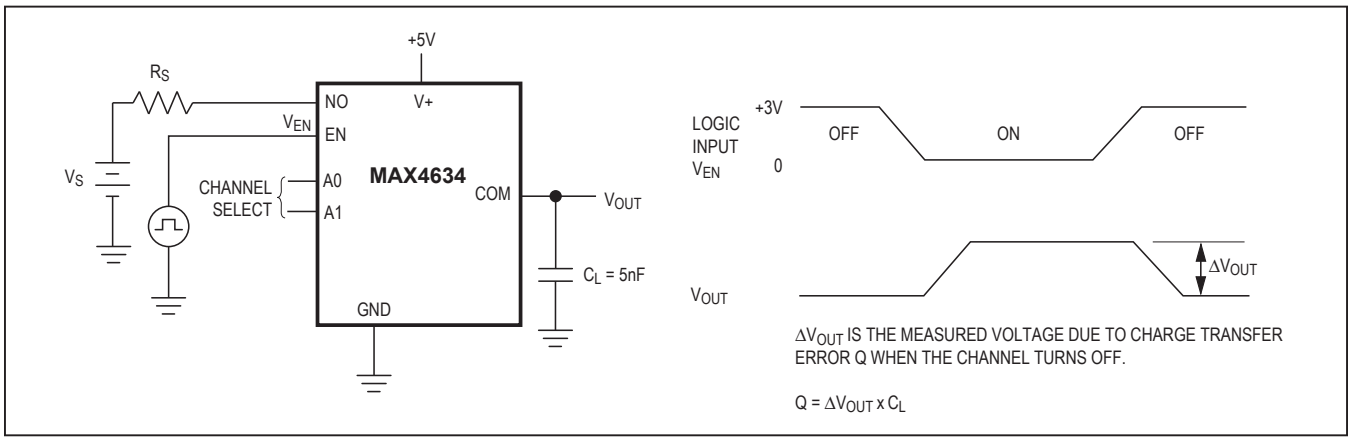
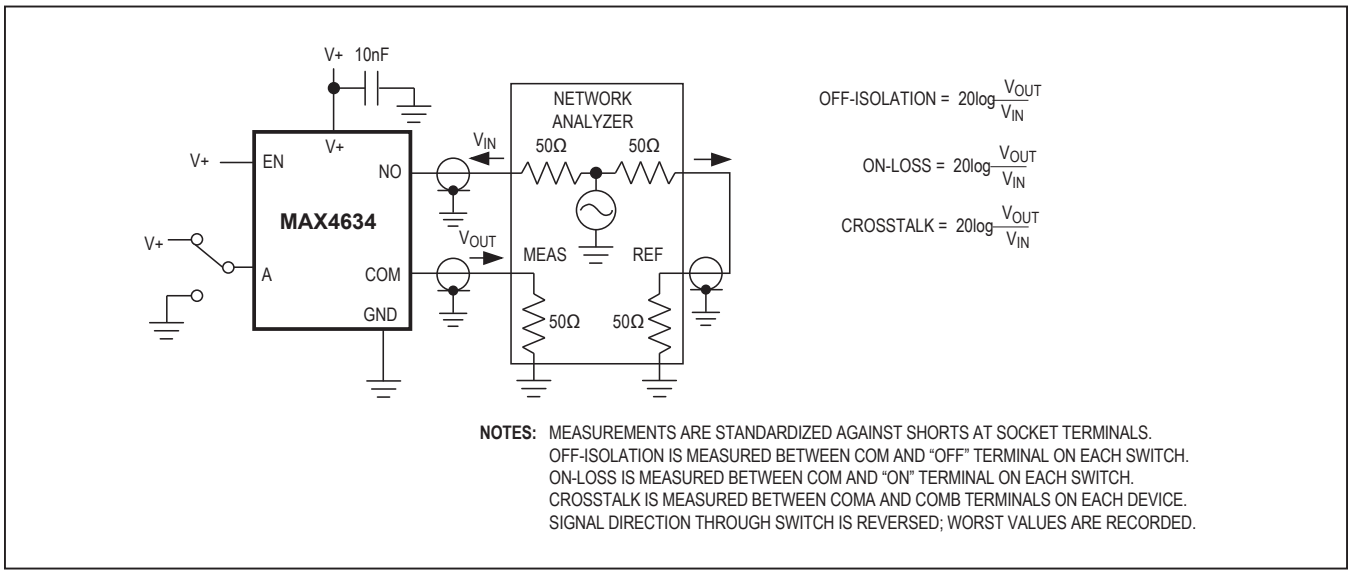


Figure 4. Charge Injection

Test Circuits/Timing Diagrams (continued)



NOTES: MEASUREMENTS ARE STANDARDIZED AGAINST SHORTS AT SOCKET TERMINALS.
OFF-ISOLATION IS MEASURED BETWEEN COM AND "OFF" TERMINAL ON EACH SWITCH.
ON-LOSS IS MEASURED BETWEEN COM AND "ON" TERMINAL ON EACH SWITCH.
CROSSTALK IS MEASURED BETWEEN COMA AND COMB TERMINALS ON EACH DEVICE.
SIGNAL DIRECTION THROUGH SWITCH IS REVERSED; WORST VALUES ARE RECORDED.

Figure 5. Off-Isolation/On-Channel Bandwidth

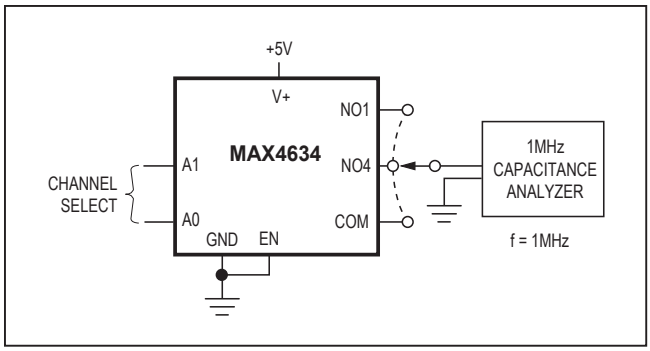


Figure 6. Channel Off/On-Capacitance

Chip Information

PROCESS: CMOS

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
10 µMAX	—	21-0061
10 TDFN	T1033-1	21-0137

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	4/00	Initial release	—
1	2/02	Added QFN package	—
2	5/03	Added QFN packaging information	—
3	2/09	Added TDFN package information (replaced QFN), style edits	1, 7
4	3/22	Updated *Electrical Characteristics* tables	2, 3, 4