19-1709; Rev 0; 4/00

MAXIM

Fast, Low-Voltage, Dual 4Ω SPDT CMOS Analog Switch

General Description

The MAX4636 is a fast, dual 4Ω single-pole/double-throw (SPDT) analog switch that operates with supply voltages from +1.8V to +5.5V. High switching speeds, 1Ω on-resistance flatness, and low power consumption make this device ideal for audio/video, communications, and battery-operated devices. Containing two independently controllable SPDT switches in a single 10-pin µMAX package, the MAX4636 uses little board space, and its low power consumption ensures minimal impact on your power budget. The analog signal range extends to the supply rails.

Applications

Battery-Powered Equipment

Relay Replacement

Audio and Video Signal Routing

Low-Voltage Data-Acquisition Systems

Sample-and-Hold Circuits

Communications Circuits

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

Features

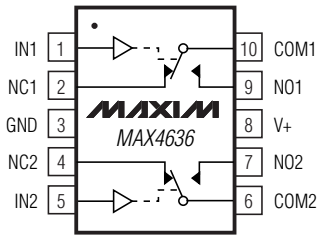
- **Guaranteed On-Resistance**
  4Ω (max) +5V Supply
  5.5Ω (max) +3V Supply
- **Guaranteed Match Between Channels**
  0.2Ω (max)
- **Guaranteed Flatness Over Signal Range**
  1Ω (max) with +5V Supply
- **Fast Switching Speeds**
  14ns (max) Turn-On Time
  6ns (max) Turn-Off Time
- **1.8V Operation**
  100Ω (typ) On-Resistance Over Temperature
  56ns (typ) Turn-On Time
  17ns (typ) Turn-Off Time
- **+1.8V to +5.5V Single-Supply Operation**
- **Rail-to-Rail® Signal Handling**
- **Low Crosstalk: -67dB at 1MHz**
- **High Off-Isolation: -65dB at 1MHz**
- **THD: 0.1%**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4636EUB	-40°C to +85°C	10 µMAX

Pin Configuration/Functional Diagram/Truth Table

TOP VIEW



µMAX

IN_	NO_ TO COM_	NC_ TO COM_
0	OFF	ON
1	ON	OFF

Fast, Low-Voltage, Dual 4Ω SPDT CMOS Analog Switch

ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)
V+, IN_ .....-0.3V to +6V
COM_, NC_, NO_ (Note 1) ..... -0.3V to (V+ + 0.3V)
Continuous Current into Any Terminal .....±30mA
Peak Current into COM_, NC_, NO_
(pulsed at 1ms, 10% duty cycle).....±100mA

Continuous Power Dissipation (T_A = +70°C)
10-Pin µMAX (derate 4.7mW/°C above +70°C).....330mW
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_, NC_, or COM_ 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 = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$			0		V+	V
On-Resistance	R_{ON}	V+ = 4.5V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 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 (Note 3)	ΔR_{ON}	V+ = 4.5V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		0.1	0.2	Ω
			T_A = T_{MIN} to T_{MAX}			0.4	
On-Resistance Flatness (Note 4)	$R_{FLAT(ON)}$	V+ = 4.5V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		0.5	1	Ω
			T_A = T_{MIN} to T_{MAX}			1.2	
NO_, NC_ Off-Leakage Current (Note 5)	$I_{NC\_(OFF)}$, $I_{NO\_(OFF)}$	V+ = 5.5V; $V_{COM\_}$ = 1V, 4.5V; $V_{NO\_}$ or $V_{NC\_}$ = 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; $V_{NO\_}$ or $V_{NC\_}$ = 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_ On-Leakage Current (Note 5)	$I_{COM\_(ON)}$	V+ = 5.5V; $V_{COM\_}$ = 4.5V, 1V; $V_{NO\_}$ or $V_{NC\_}$ = 4.5V, 1V or floating	T_A = +25°C	-0.1	±0.01	0.1	nA
			T_A = T_{MIN} to T_{MAX}	-0.3		0.3	
DIGITAL I/O (IN1, IN2)							
Input Logic High	V_{IH}			2.4			V
Input Logic Low	V_{IL}					0.8	V
Input Leakage Current	I_{IH}, I_{IL}	$V_{IN\_}$ = 0 or +5.5V		-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 = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DYNAMIC							
Turn-On Time (Note 5)	t_{ON}	$V_{NO\_}$, $V_{NC\_}$ = 3V; R_L = 300Ω, C_L = 35pF, Figure 1a	T_A = +25°C		12	14	ns
			T_A = T_{MIN} to T_{MAX}			16	
Turn-Off Time (Note 5)	t_{OFF}	$V_{NO\_}$, $V_{NC\_}$ = 3V; R_L = 300Ω, C_L = 35pF, Figure 1a	T_A = +25°C		5	6	ns
			T_A = T_{MIN} to T_{MAX}			8	
Break-Before-Make Time (Note 5)	t_{BBM}	$V_{NO\_}$, $V_{NC\_}$ = 3V; R_L = 300Ω, C_L = 35pF, Figure 1b	T_A = +25°C		7		ns
			T_A = T_{MIN} to T_{MAX}	1			
Charge Injection	Q	V_{GEN} = 2V, R_{GEN} = 0, C_L = 1.0nF, Figure 2			2		pC
NO_, NC_ Off-Capacitance	$C_{NO\_(OFF)}$, $C_{NC\_(OFF)}$	$V_{NO\_}$, $V_{NC\_}$ = GND, f = 1MHz, Figure 3			9		pF
COM_ On-Capacitance	$C_{COM\_(ON)}$	$V_{COM\_}$ = GND, f = 1MHz, Figure 3			32		pF
Off-Isolation (Note 6)	V_{ISO}	C_L = 5pF, R_L = 50Ω, f = 10MHz, Figure 4			-52		dB
		C_L = 5pF, R_L = 50Ω, f = 1MHz, Figure 4			-65		
Crosstalk (Note 7)	V_{CT}	C_L = 5pF, R_L = 50Ω, f = 10MHz, Figure 4			-66		dB
		C_L = 5pF, R_L = 50Ω, f = 1MHz, Figure 4			-67		
Total Harmonic Distortion	THD	R_L = 600Ω, $V_{NO\_}$ = 5Vp-p, f = 20Hz to 20kHz			0.1		%
SUPPLY							
Positive Supply Current	I+	V+ = 5.5V, $V_{IN\_}$ = 0 or V+			0.001	1.0	µA

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +3.6V, V_{IH} = +2.0V, V_{IL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$			0		V+	V
On-Resistance	R_{ON}	V+ = 2.7V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		5	5.5	Ω
			T_A = T_{MIN} to T_{MAX}			8	
On-Resistance Match Between Channels (Note 3)	ΔR_{ON}	V+ = 2.7V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		0.1	0.2	Ω
			T_A = T_{MIN} to T_{MAX}			0.4	
On-Resistance Flatness (Note 4)	$R_{FLAT(ON)}$	V+ = 2.7V, $I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V+	T_A = +25°C		1.5	2	Ω
			T_A = T_{MIN} to T_{MAX}			2.5	
NO_, NC_ Off-Leakage Current (Note 5)	$I_{NO\_(OFF)}$, $I_{NC\_(OFF)}$	V+ = 3.3V; $V_{COM\_}$ = 1V, 3V; $V_{NO\_}$ or $V_{NC\_}$ = 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; $V_{NO\_}$ or $V_{NC\_}$ = 3V, 1V	T_A = +25°C	-0.1	±0.01	0.1	nA
			T_A = T_{MIN} to T_{MAX}	-0.3		0.3	

Fast, Low-Voltage, Dual 4Ω SPDT CMOS Analog Switch

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +3.6V, V_{IH} = +2.0V, V_{IL} = +0.8V, TA = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
COM_ On-Leakage Current (Note 5)	$I_{COM\_(ON)}$	V+ = 3.3V; $V_{COM\_}$ =1V, 3V; $V_{NO\_}$ or $V_{NC\_}$ = 1V, 3V, or floating	T_A = +25°C	-0.1	±0.01	0.1	nA
			T_A = T_{MIN} to T_{MAX}	-0.3		0.3	
DIGITAL I/O (IN1, IN2)							
Input Logic High	V_{IH}			2.0			V
Input Logic Low	V_{IL}					0.4	V
Input Leakage Current	I_{IH}, I_{IL}	$V_{IN\_}$ = 0 or +5.5V		-100	5	100	nA
DYNAMIC							
Turn-On Time (Note 5)	t_{ON}	$V_{NO\_}$, $V_{NC\_}$ = 2V; C_L = 35pF, R_L = 300Ω, Figure 1a	T_A = +25°C		14	18	ns
			T_A = T_{MIN} to T_{MAX}			20	
Turn-Off Time (Note 5)	t_{OFF}	$V_{NO\_}$, $V_{NC\_}$ = 2V; C_L = 35pF, R_L = 300Ω, Figure 1a	T_A = +25°C		6	8	ns
			T_A = T_{MIN} to T_{MAX}			10	
Break-Before-Make Time (Note 5)		$V_{NO\_}$, $V_{NC\_}$ = 2V; C_L = 35pF, R_L = 300Ω, Figure 1b	T_A = +25°C		7		ns
			T_A = T_{MIN} to T_{MAX}	1			
Charge Injection	Q	V_{GEN} = 1.5V, R_{GEN} = 0, C_L = 1.0nF, Figure 2			11		pC
NO_, NC_ Off-Capacitance	$C_{NO\_(OFF)}$, $C_{NC\_(OFF)}$	$V_{NO\_}$, $V_{NC\_}$ = GND, f = 1MHz, Figure 3			9		pF
COM On-Capacitance	C_{COM} (ON)	V_{COM} = GND, f = 1MHz, Figure 3			32		pF
Off-Isolation (Note 6)	V_{ISO}	C_L = 5pF, R_L = 50Ω, f = 10MHz, Figure 4			-52		dB
		C_L = 5pF, R_L = 50Ω, f = 1MHz, Figure 4			-65		
Crosstalk (Note 7)	V_{CT}	C_L = 5pF, R_L = 50Ω, f = 10MHz, Figure 4			-66		dB
		C_L = 5pF, R_L = 50Ω, f = 1MHz, Figure 4			-67		
SUPPLY							
Positive Supply Current	I+	V+ = 3.6V, V_{IN} = 0 or +3.6V			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 values of on-resistance as measured over the specified analog signal ranges.

Note 5: Guaranteed by design.

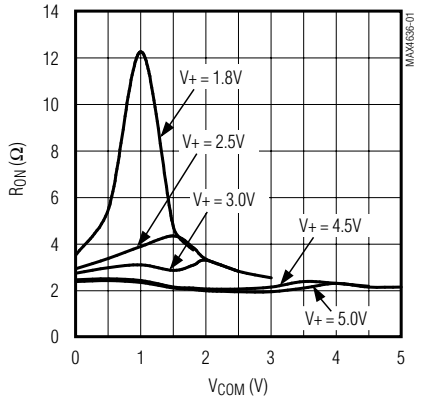
Note 6: Off-Isolation = $20\log_{10}$ (V_{COM} / V_{NO}), V_{COM} = output, V_{NO} = input to off switch.

Note 7: Between any two switches.

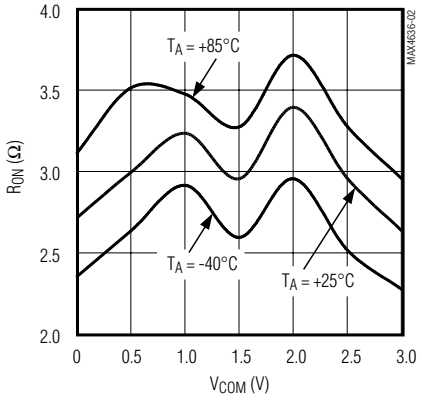
Typical Operating Characteristics

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

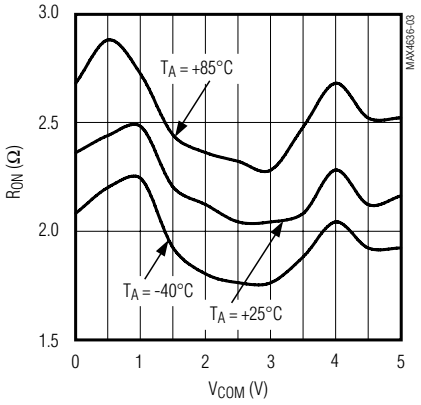
ON-RESISTANCE vs. V_{COM}



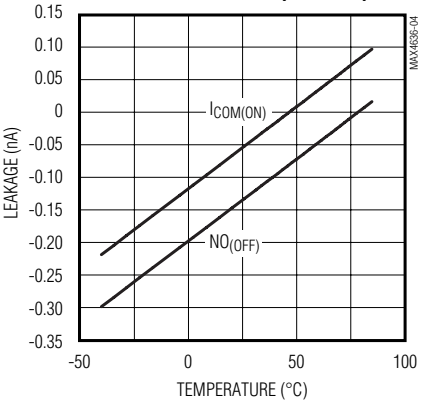
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (V+ = +3V)



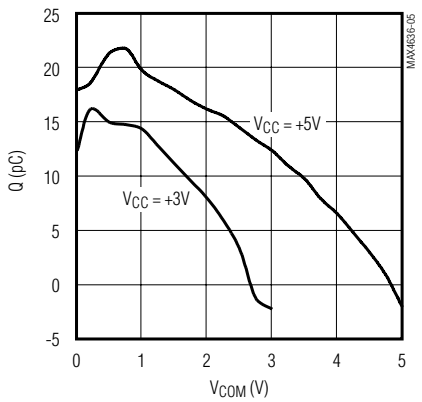
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (V+ = +5V)



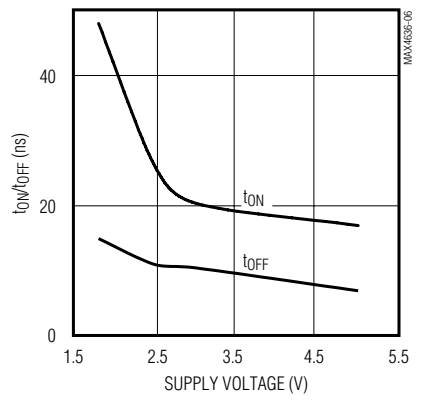
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE (V+ = +5V)



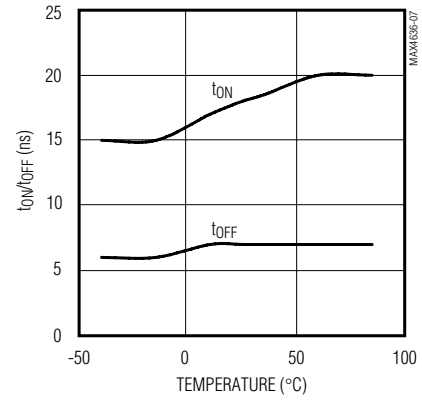
CHARGE INJECTION vs. V_{COM}



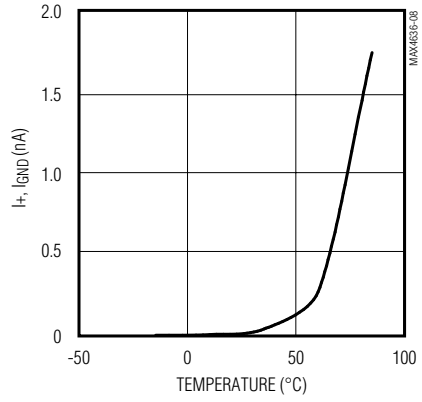
TURN-ON/OFF TIME vs. SUPPLY VOLTAGE



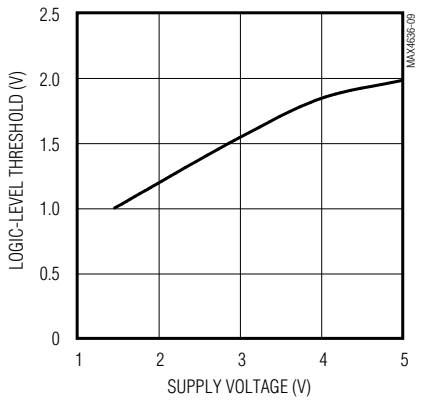
TURN-ON/OFF TIME vs. TEMPERATURE (V+ = +5V)



POWER-SUPPLY CURRENT vs. TEMPERATURE (V+ = +5V)



LOGIC-LEVEL THRESHOLD vs. SUPPLY VOLTAGE

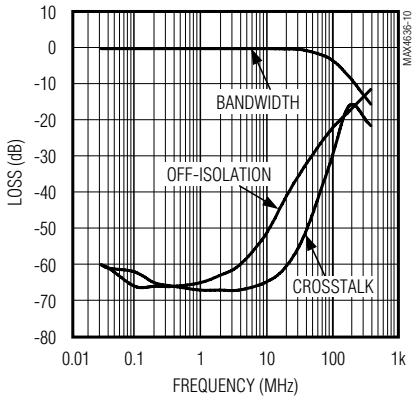


Fast, Low-Voltage, Dual 4Ω SPDT CMOS Analog Switch

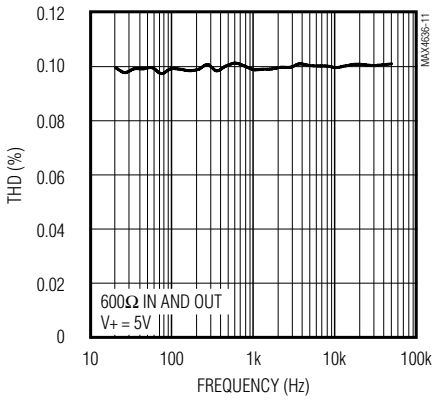
Typical Operating Characteristics (continued)

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

FREQUENCY RESPONSE



TOTAL HARMONIC DISTORTION vs. FREQUENCY



Pin Description

PIN	NAME	FUNCTION
1	IN1	Logic Control for Switch 1
2	NC1	Normally Closed Terminal of Switch 1
3	GND	Ground
4	NC2	Normally Closed Terminal of Switch 2
5	IN2	Logic Control Input for Switch 2
6	COM2	Common Terminal of Switch 2
7	NO2	Normally Open Terminal of Switch 2
8	V+	Input Supply Voltage, +1.8V to +5.5V
9	NO1	Normally Open Terminal of Switch 1
10	COM1	Common Terminal of Switch 1

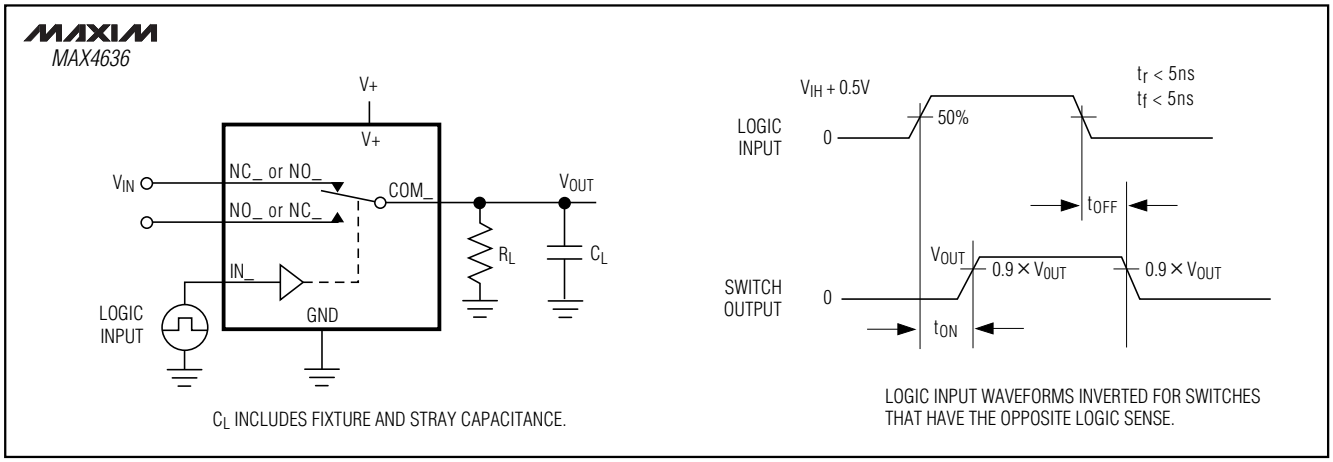


Figure 1a. Switching Time

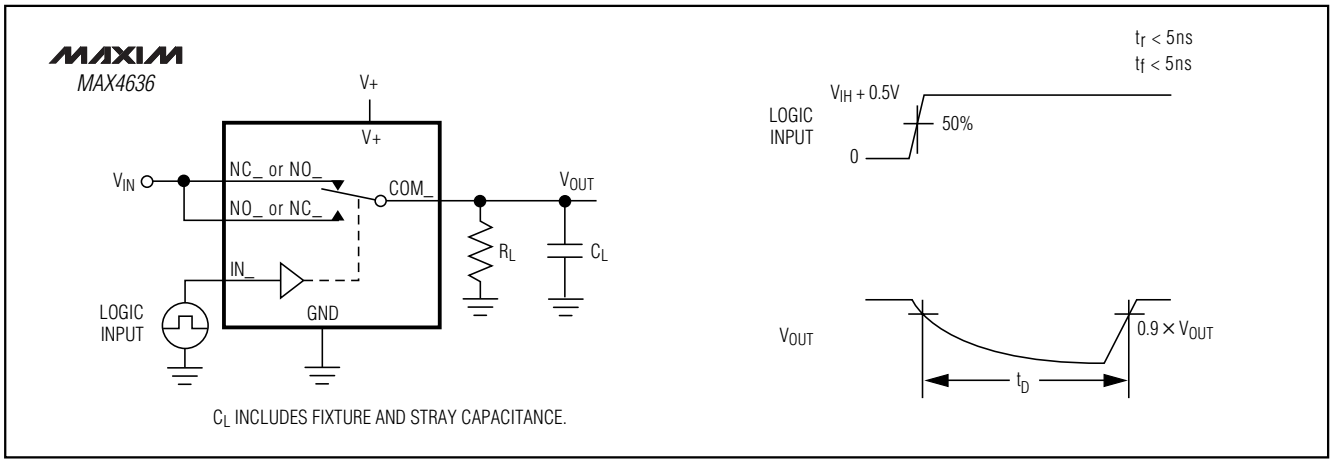


Figure 1b. Break-Before-Make Interval

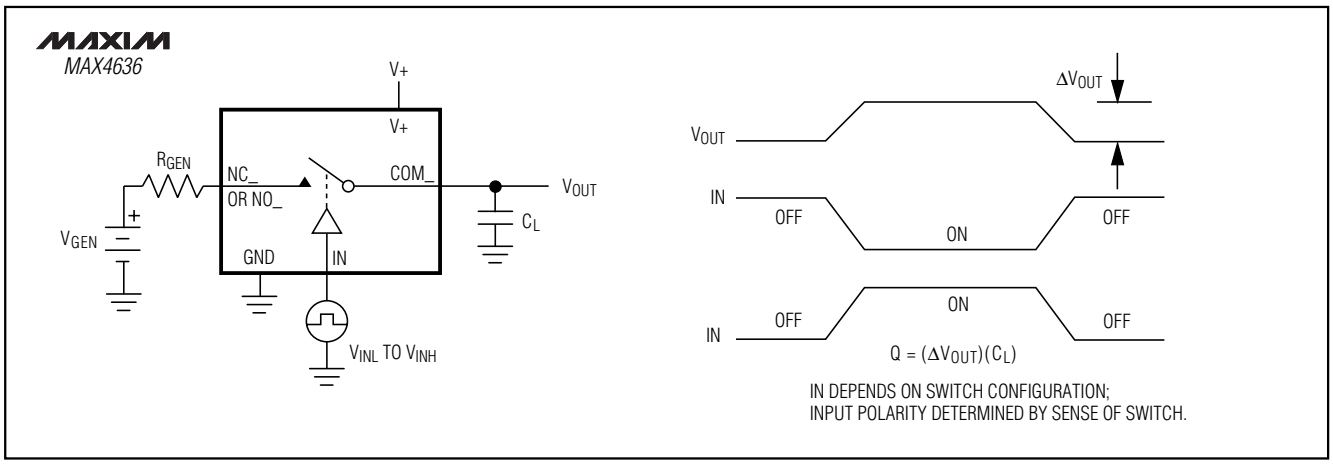


Figure 2. Charge Injection

Fast, Low-Voltage, Dual 4Ω SPDT CMOS Analog Switch

Detailed Description

The MAX4636 is a low-on-resistance (R_{ON}), low-voltage, dual SPDT analog switch that operates from a +1.8V to +5.5V supply. The MAX4636 features very fast switching speed (t_{ON} = 14ns max, t_{OFF} = 6ns max) and guaranteed break-before-make switching. Its low maximum R_{ON} allows high continuous currents to be switched in a variety of applications.

Applications Information

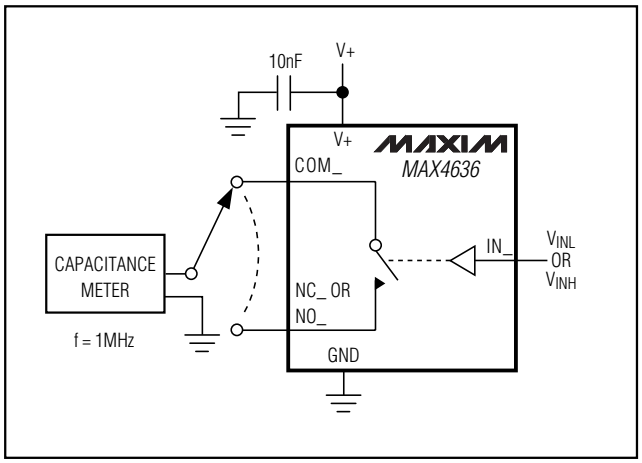


Figure 3. Channel Off/On-Capacitance

Logic Inputs

The MAX4636 logic inputs (IN1, IN2) can be driven up to +5.5V, regardless of the voltage on V+. This allows interfacing to 5V logic signals while operating with a +3.3V supply voltage without external level translation.

Analog Signal Levels

Analog signals ranging over the entire supply voltage (V+ to GND) can be passed with very little change in on-resistance (see *Typical Operating Characteristics*). The switches are bidirectional, so the NO_, NC_, and COM_ pins may be used as either inputs or outputs.

Power-Supply Sequencing and Overvoltage Protection

Caution: Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the device. Proper power-supply sequencing is recommended for all CMOS devices. Always apply V+ before applying analog signals, especially if the analog signal is not current limited. If this sequencing is not possible, and if the analog inputs are not current limited to less than 30mA, add a small-signal diode (D1) as shown in Figure 5. If the analog signal can dip below GND, add D2. Adding protection diodes reduces the analog range to a diode drop (about 0.7V) below V+ (for D1), and a diode drop above ground (for D2).

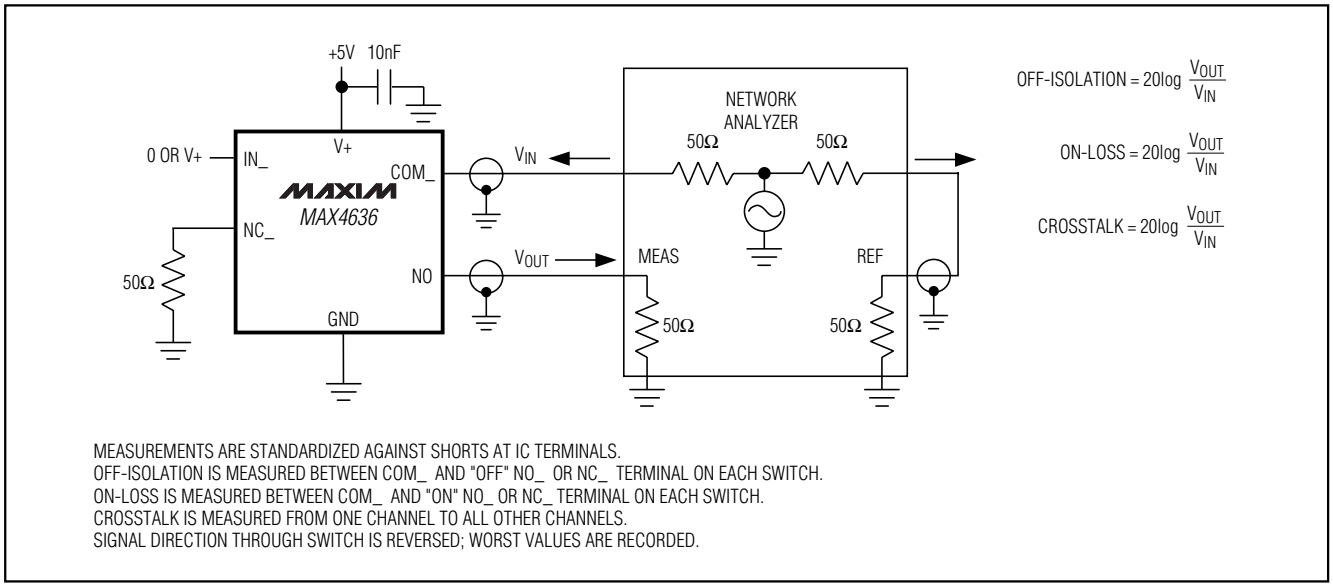


Figure 4. On-Loss, Off-Isolation, and Crosstalk

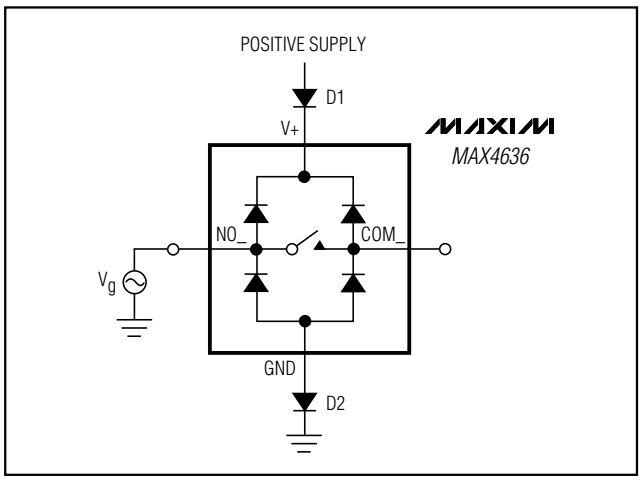


Figure 5. Overvoltage Protection Using Two External Blocking Diodes

On-resistance increases slightly at low supply voltages. Maximum supply voltage (V+) must not exceed +6V. Adding protection diode D2 causes the logic threshold to be shifted relative to GND. Protection diodes D1 and D2 also protect against some overvoltage situations. With Figure 5's circuit, if the supply voltage is below the absolute maximum rating, and if a fault voltage up to the absolute maximum rating is applied to an analog signal pin, no damage results.

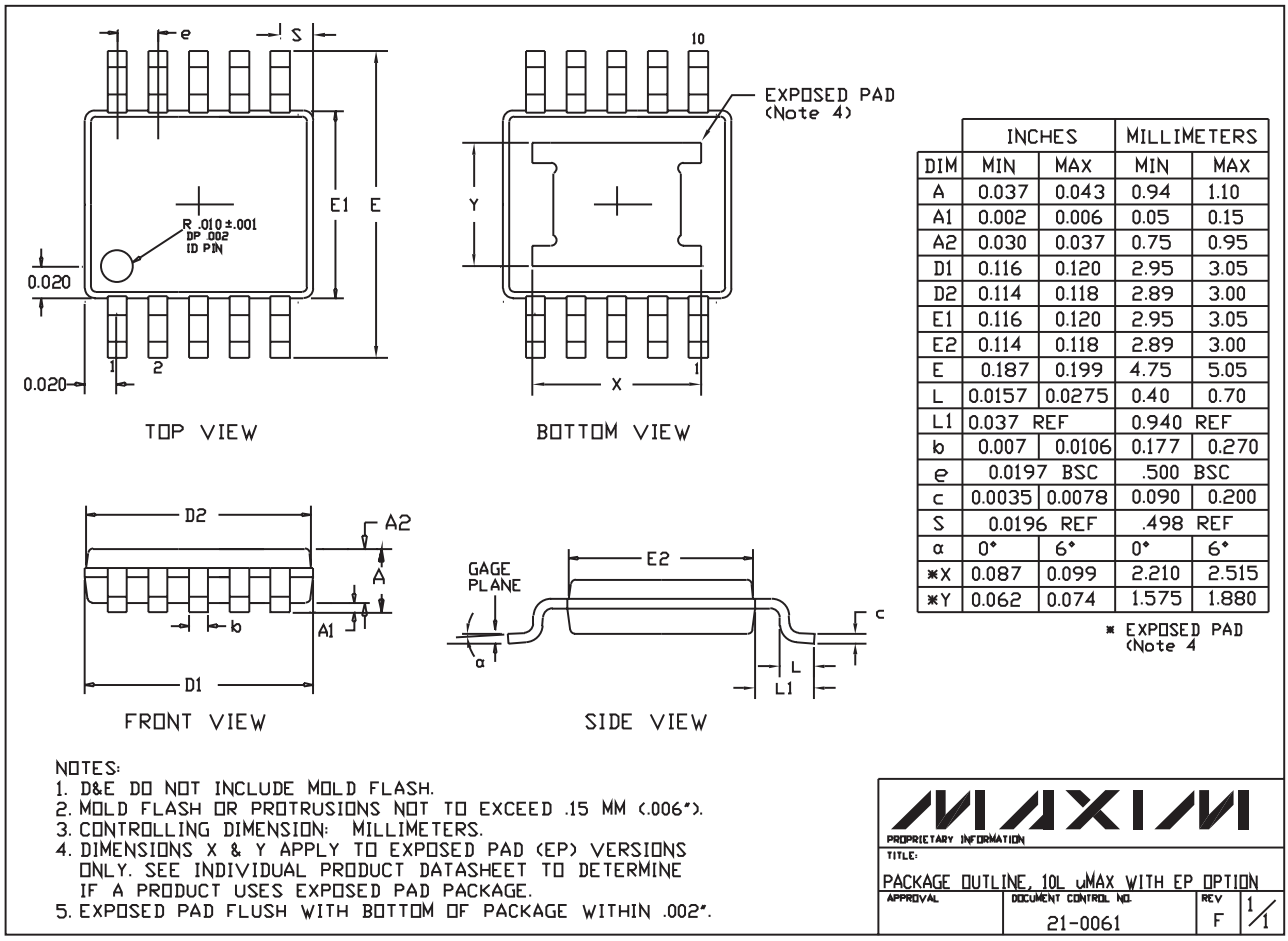
Chip Information

TRANSISTOR COUNT: 239

PROCESS: CMOS

Fast, Low-Voltage, Dual 4Ω SPDT CMOS Analog Switch

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
A2	0.030	0.037	0.75	0.95
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°
*X	0.087	0.099	2.210	2.515
*Y	0.062	0.074	1.575	1.880

* EXPOSED PAD
(Note 4

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15 MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. DIMENSIONS X & Y APPLY TO EXPOSED PAD (EP) VERSIONS ONLY. SEE INDIVIDUAL PRODUCT DATASHEET TO DETERMINE IF A PRODUCT USES EXPOSED PAD PACKAGE.
5. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".

MAXIM
PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, 10L uMAX WITH EP OPTION

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0061	F	1/1

Note: *The MAX4636 does not have an exposed pad.*

NOTES

NOTES