



# Low-Voltage, Quad, SPST CMOS Analog Switches

## General Description

The MAX4610/MAX4611/MAX4612 quad, low-voltage, single-pole/single-throw (SPST) analog switches are pin-compatible with the industry-standard 74HC4066 analog switch. On-resistance ( $100\Omega$  max) is matched between switches to  $4\Omega$  max and is flat ( $4\Omega$  max) over the specified signal range. Each switch handles  $V_+$  to GND analog signal levels. Maximum off-leakage current is only 1nA at  $T_A = +25^\circ\text{C}$  and 2nA at  $T_A = +85^\circ\text{C}$ .

The MAX4610 has four normally open (NO) switches, and the MAX4611 has four normally closed (NC) switches. The MAX4612 has two NO switches and two NC switches. These CMOS switches operate from a single +2V to +12V supply. All digital inputs have +0.8V and +2.4V logic thresholds, ensuring TTL/CMOS-logic compatibility when using a single +5V supply.

## Applications

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

## Features

- ◆ Pin-Compatible with Industry-Standard 74HC4066
- ◆ Guaranteed On-Resistance  
100 $\Omega$  max (5V Supply)  
46 $\Omega$  max (12V Supply)
- ◆ Guaranteed Match Between Channels (4 $\Omega$  max)
- ◆ Guaranteed Flatness Over Signal Range (18 $\Omega$  max)
- ◆ Off-Leakage Current Over Temperature  
<2nA at  $T_A = +85^\circ\text{C}$
- ◆ >2kV ESD Protection per Method 3015.7
- ◆ Rail-to-Rail<sup>®</sup> Signal Handling
- ◆ TTL/CMOS-Logic Compatible

## Ordering Information

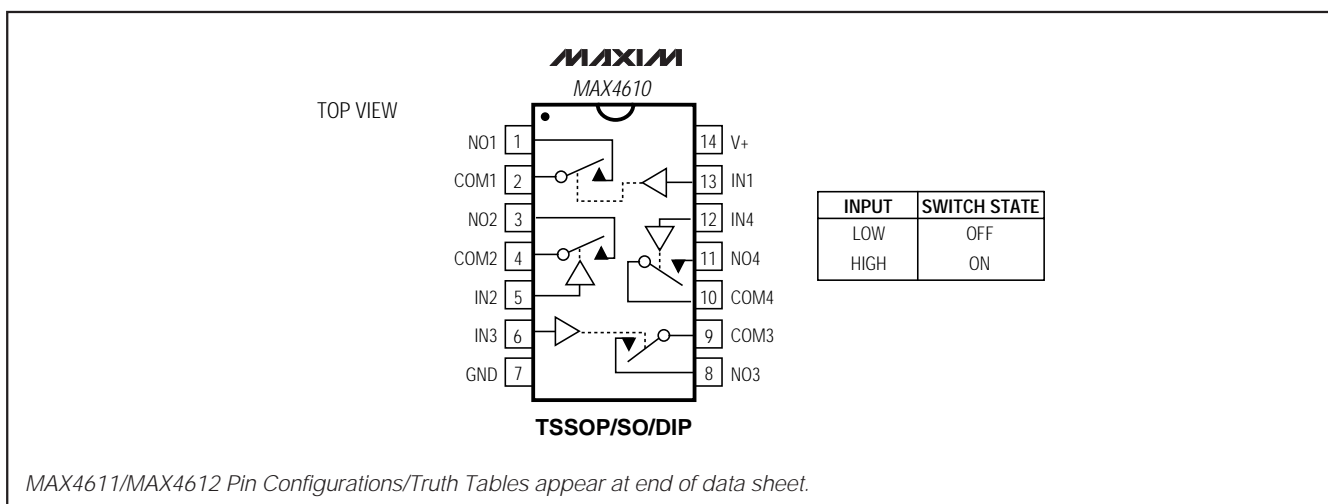
PART	TEMP. RANGE	PIN-PACKAGE
MAX4610CUD	0°C to +70°C	14 TSSOP**
MAX4610CSD	0°C to +70°C	14 Narrow SO
MAX4610CPD	0°C to +70°C	14 Plastic DIP
MAX4610C/D	0°C to +70°C	Dice*
MAX4610EUD	-40°C to +85°C	14 TSSOP**
MAX4610ESD	-40°C to +85°C	14 Narrow SO
MAX4610EPD	-40°C to +85°C	14 Plastic DIP

Ordering Information continued at end of data sheet.

\* Contact factory for dice specifications.

\*\* Contact factory for availability.

## Pin Configurations/Truth Tables



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



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MAX4610/MAX4611/MAX4612

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## ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND)

V+ .....	-0.3V to +13V
IN_, COM_, NO_, NC_ (Note 1) .....	-0.3V to (V + +0.3V)
Continuous Current (any terminal) (pulsed at 1ms, 10% duty cycle) .....	20mA
Peak Current (any terminal) (pulsed at 1ms, 10% duty cycle) .....	40mA
ESD per Method 3015.7 .....	>2kV

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

TSSOP (derate 6.3mW/°C above +70°C) .....	500mW
Narrow SO (derate 8.00mW/°C above +70°C) .....	640mW
Plastic DIP (derate 10.00mW/°C above +70°C) .....	800mW
Operating Temperature Ranges	
MAX461_C_ .....	0°C to +70°C
MAX461_E_ .....	-40°C to +85°C
Storage Temperature Range .....	-65°C to +160°C
Lead Temperature (soldering, 10sec) .....	+300°C

**Note 1:** Signals on NO\_, NC\_, COM\_, or IN\_ 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+ = +5V ±10%, V<sub>IN\_H</sub> = 2.4V, V<sub>IN\_L</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>ANALOG SWITCH</b>							
Analog Signal Range (Note 3)	V <sub>COM_</sub> , V <sub>NO_</sub> , V <sub>NC_</sub>			0		V+	V
On-Resistance	R <sub>ON</sub>	V+ = 4.5V, I <sub>COM_</sub> = 1mA, V <sub>NO_</sub> = V <sub>NC_</sub> = 3V	T <sub>A</sub> = +25°C	70	100		Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			150	
On-Resistance Match Between Channels (Note 4)	ΔR <sub>ON</sub>	V+ = 4.5V, I <sub>COM_</sub> = 1mA, V <sub>NO_</sub> = V <sub>NC_</sub> = 3V	T <sub>A</sub> = +25°C	1.0	4		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>	V+ = 4.5V; I <sub>COM_</sub> = 1mA; V <sub>NO_</sub> = V <sub>NC_</sub> = 3V, 2V, 1V	T <sub>A</sub> = +25°C	12	18		Ω
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			25	
NO or NC Off-Leakage Current (Note 6)	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				nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-2		2	
COM Off-Leakage Current (Note 6)	I <sub>COM(OFF)</sub>	V+ = 5.5V; V <sub>COM_</sub> = 1V, 4.5V; V <sub>NO_</sub> = V <sub>NC_</sub> = 4.5V, 1V	T <sub>A</sub> = +25°C	-0.1		0.1	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-2		2	
COM On-Leakage Current (Note 6)	I <sub>COM(ON)</sub>	V+ = 5.5V; V <sub>COM_</sub> = 1V, 4.5V; V <sub>NO_</sub> = V <sub>NC_</sub> = 1V, 4.5V, or floating	T <sub>A</sub> = +25°C	-0.2		0.2	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-4		4	

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

(V+ = +5V ±10%, V<sub>IN\_H</sub> = 2.4V, V<sub>IN\_L</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>LOGIC INPUT</b>							
Input Current with Input Voltage High	I <sub>IN_H</sub>	V <sub>IN_</sub> = 2.4V, all others = 0.8V	-0.1	0.001	0.1	μA	
Input Current with Input Voltage Low	I <sub>IN_L</sub>	V <sub>IN_</sub> = 0.8V, all others = 2.4V	-0.1	0.001	0.1	μA	
Input High Voltage	V <sub>IN_H</sub>		2.4	1.5		V	
Input Low Voltage	V <sub>IN_L</sub>			1.4	0.8	V	
<b>DYNAMIC</b> (Note 3)							
Turn-On Time	t <sub>ON</sub>	V <sub>COM_</sub> = 3V, Figure 2	T <sub>A</sub> = +25°C		35	60	ns
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			80	
Turn-Off Time	t <sub>OFF</sub>	V <sub>COM_</sub> = 3V, Figure 2	T <sub>A</sub> = +25°C		15	20	ns
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			30	
On-Channel Bandwidth	BW	Signal = 0dBm, Figure 4, 50Ω in and out	T <sub>A</sub> = +25°C		300		MHz
Charge Injection	V <sub>CTE</sub>	C <sub>L</sub> = 1.0nF, V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0, Figure 3	T <sub>A</sub> = +25°C		1	5	pC
Off-Isolation (Note 7)	V <sub>ISO</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 4	T <sub>A</sub> = +25°C		-60		dB
Crosstalk (Note 8)	V <sub>CT</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 5	T <sub>A</sub> = +25°C		-80		dB
NO_ or NC_ Capacitance	C <sub>(OFF)</sub>	f = 1MHz, Figure 6	T <sub>A</sub> = +25°C		16		pF
COM_ Off-Capacitance	C <sub>COM(OFF)</sub>	f = 1MHz, Figure 6	T <sub>A</sub> = +25°C		16		pF
COM_ On-Capacitance	C <sub>COM(ON)</sub>	f = 1MHz, Figure 6	T <sub>A</sub> = +25°C		23		pF
Total Harmonic Distortion	THD	600Ω IN and OUT, 20Hz to 20kHz, 2Vp-p	T <sub>A</sub> = +25°C		0.009		%
<b>SUPPLY</b>							
Power-Supply Range			2		12		V
Supply Current	I <sub>+</sub>	V <sub>IN</sub> = 0 or V <sub>+</sub> , all switches on or off	-1	0.001	1		μA

MAX4610/MAX4611/MAX4612

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MAX4610/MAX4611/MAX4612

## ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +3V, VIN\_H = 2.4V, VIN\_L = 0.5V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range (Note 3)	VCOM_, VNO_, VNC_			0		V+	V
On-Resistance	RON	V+ = 2.7V, ICOM_ = 1mA, VNO_ = VNC_ = 1V	TA = +25°C	175	360		Ω
			TA = TMIN to TMAX			450	
On-Resistance Match Between Channels (Note 4)	ΔRON	V+ = 2.7V, ICOM_ = 1mA, VNO_ = VNC_ = 1V	TA = +25°C	2	5		Ω
			TA = TMIN to TMAX			10	
NO_ or NC_ Off-Leakage Current (Notes 3, 6)	INO(OFF)	V+ = 3.6V; VCOM_ = 0.5V, 3V; VNO_ = VNC_ = 3V, 0.5V	TA = +25°C	-0.1		0.1	nA
			TA = TMIN to TMAX	-2		2	
COM_ Off-Leakage Current (Notes 3, 6)	ICOM(OFF)	V+ = 3.6V; VCOM_ = 0.5V, 3V; VNO_ = VNC_ = 3V, 0.5V	TA = +25°C	-0.1		0.1	nA
			TA = TMIN to TMAX	-2		2	
COM_ On-Leakage Current (Notes 3, 6)	ICOM(ON)	V+ = 3.6V; VCOM_ = 0.5V, 3V; VNO_ = VNC_ = 0.5V, 3V, or floating	TA = +25°C	-0.2		0.2	nA
			TA = TMIN to TMAX	-4		4	
<b>LOGIC INPUTS</b>							
Input High Voltage	VIN_H			2.4	1.0		V
Input Low Voltage	VIN_L				1.0	0.5	V
<b>DYNAMIC</b> (Note 3)							
Turn-On Time	tON	VCOM_ = 1.5V, Figure 2	TA = +25°C	50	90		ns
			TA = TMIN to TMAX			120	
Turn-Off Time	tOFF	VCOM_ = 1.5V, Figure 2	TA = +25°C	30	45		ns
			TA = TMIN to TMAX			60	

# Low-Voltage, Quad, SPST CMOS Analog Switches

MAX4610/MAX4611/MAX4612

## ELECTRICAL CHARACTERISTICS—Single +12V Supply

( $V_+ = +12V$ ,  $V_{IN\_H} = 4V$ ,  $V_{IN\_L} = 0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range (Note 3)	$V_{COM\_}$ , $V_{NO\_}$ , $V_{NC\_}$			0		$V_+$	V
On-Resistance	$R_{ON}$	$V_+ = 12V$ , $I_{COM} = 2mA$ , $V_{NO\_} = V_{NC\_} = 10V$	$T_A = +25^\circ C$		30	45	$\Omega$
			$T_A = T_{MIN}$ to $T_{MAX}$			60	
<b>LOGIC INPUTS</b>							
Input High Voltage	$V_{IN\_H}$			4.0	2.8		V
Input Low Voltage	$V_{IN\_L}$				2.5	0.8	V
<b>SUPPLY</b>							
Positive Supply Current	$I_+$	$V_{IN\_} = 0$ or $V_+$ , all switches on or off		-1	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:** Guaranteed by design.

**Note 4:**  $\Delta R_{ON} = R_{ON}(\text{max}) - R_{ON}(\text{min})$ .

**Note 5:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

**Note 6:** Leakage parameters are 100% tested at maximum-rated hot temperature and guaranteed by correlation at  $+25^\circ C$ .

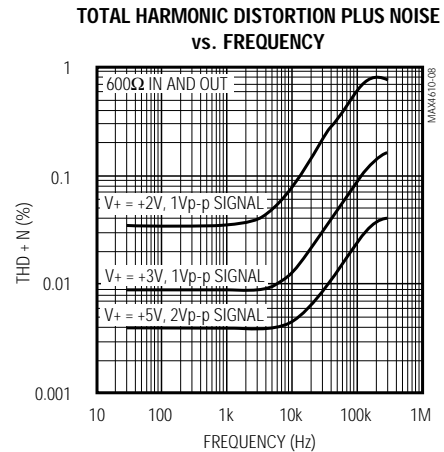
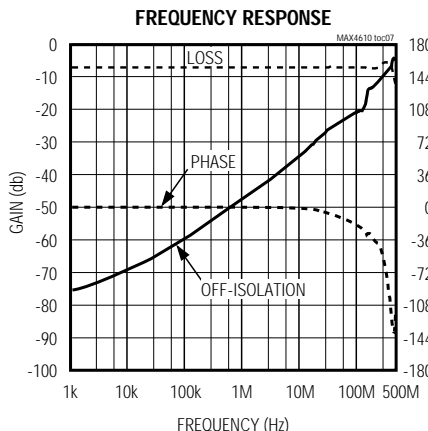
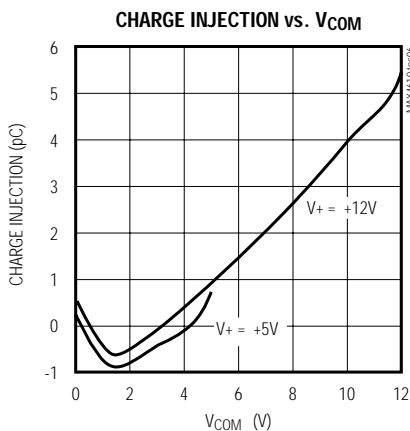
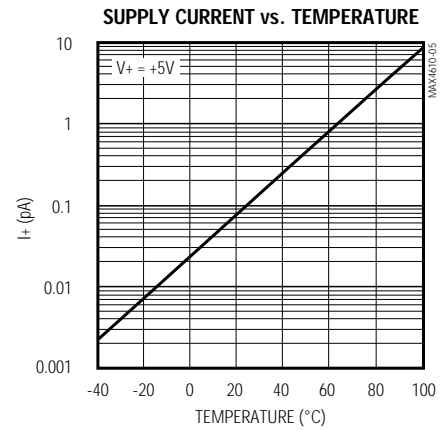
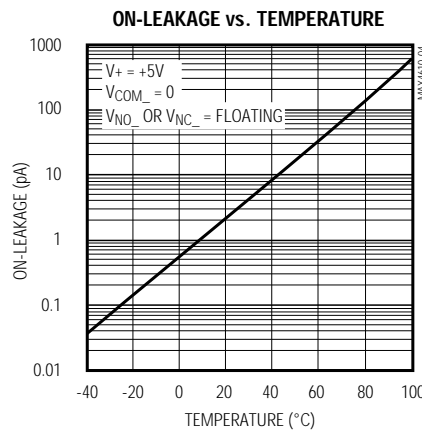
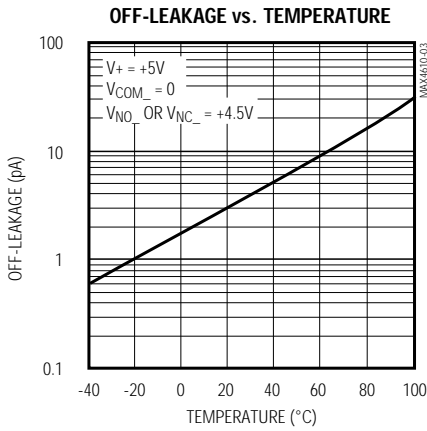
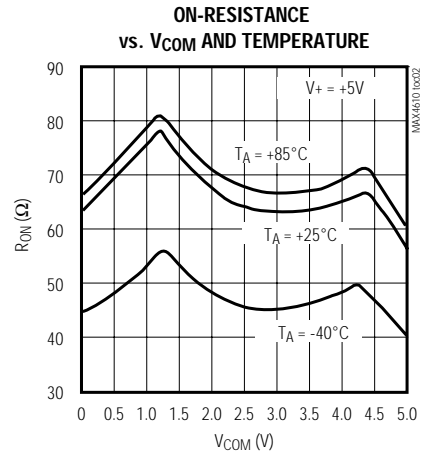
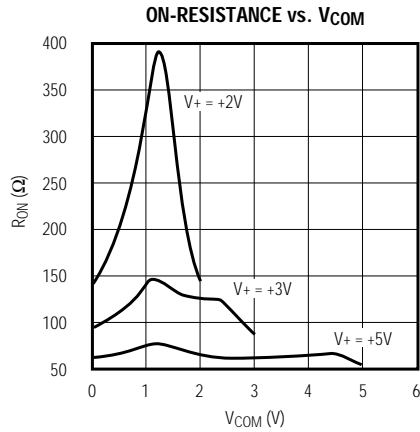
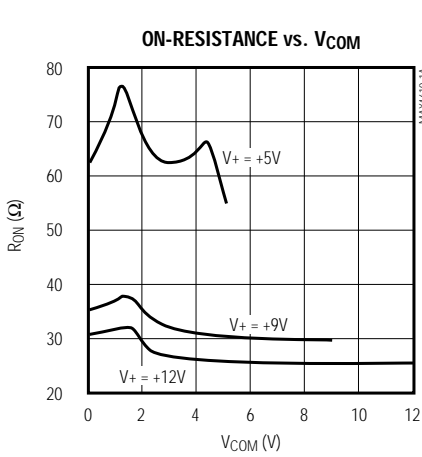
**Note 7:** Off-Isolation =  $20\log_{10}(V_{COM\_} / V_{NO\_})$ ,  $V_{COM\_}$  = output,  $V_{NO\_}$  = input to off switch.

**Note 8:** Between any two switches.

# Low-Voltage, Quad, SPST CMOS Analog Switches

## Typical Operating Characteristics

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



# Low-Voltage, Quad, SPST CMOS Analog Switches

## Pin Description

PIN			NAME	FUNCTION
MAX4610	MAX4611	MAX4612		
1, 3, 8, 11	—	—	NO1, NO2, NO3, NO4	Analog Switch Normally Open Terminals
—	1, 3, 8, 11	—	NC1, NC2, NC3, NC4	Analog Switch Normally Closed Terminals
2, 4, 9, 10	2, 4, 9, 10	2, 4, 9, 10	COM1, COM2, COM3, COM4	Analog Switch Common Terminals
13, 5, 6, 12	13, 5, 6, 12	13, 5, 6, 12	IN1, IN2, IN3, IN4	Logic-Control Digital Inputs
—	—	1, 3	NO1, NO2	Analog Switch Normally Open Terminals
—	—	8, 11	NC3, NC4	Analog Switch Normally Closed Terminals
7	7	7	GND	Ground
14	14	14	V+	Positive Analog Supply Input
—	—	—	N.C.	No Connection. Not internally connected.

MAX4610/MAX4611/MAX4612

## Applications Information

### Power-Supply Sequencing and Overvoltage Protection

Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings may cause permanent damage to the devices.

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), and to a diode drop above ground (for D2). Leakage is unaffected by adding the diodes. On-resistance increases by a small amount at low supply voltages. Maximum supply voltage (V+) must not exceed 13V.

Adding protection diodes causes the logic thresholds to be shifted relative to the power-supply rails. This can be significant when low supply voltages (+5V or less) are used. With a +5V supply, TTL compatibility is not guaranteed when protection diodes are added. Driving IN1 and IN2 all the way to the supply rails (i.e., to a

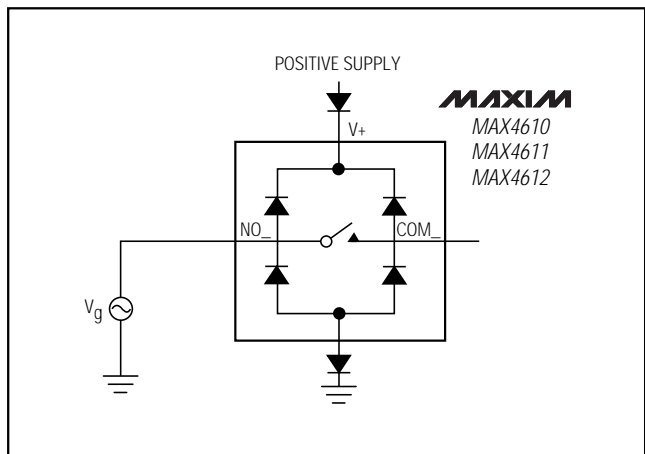


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

diode drop higher than the V+ pin, or to a diode drop lower than the GND pin) is always acceptable.

Protection diodes D1 and D2 also protect against some overvoltage situations. With Figure 1'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 will result.

# Low-Voltage, Quad, SPST CMOS Analog Switches

## Operating Considerations for High-Voltage Supply

The MAX4610/MAX4611/MAX4612 are pin-compatible with the industry-standard 74HC4066 and the MAX4066, and are optimized for +5V single-supply operation. The MAX4610 family is capable of +12V single-supply operation with some precautions. The absolute maximum rating for V+ is +13.2V (referenced to GND). When operating near this region, bypass V+

with a minimum 0.1µF capacitor to ground as close to the IC as possible.

**Caution: The absolute maximum V+ to V- differential voltage is 13.0V. Typical ±6V or 12V supplies with ±10% tolerances can be as high as 13.2V. This voltage can damage the MAX4610/MAX4611/MAX4612. Even ±5% tolerance supplies may have overshoot or noise spikes that exceed 13.0V.**

## Test Circuits/Timing Diagrams

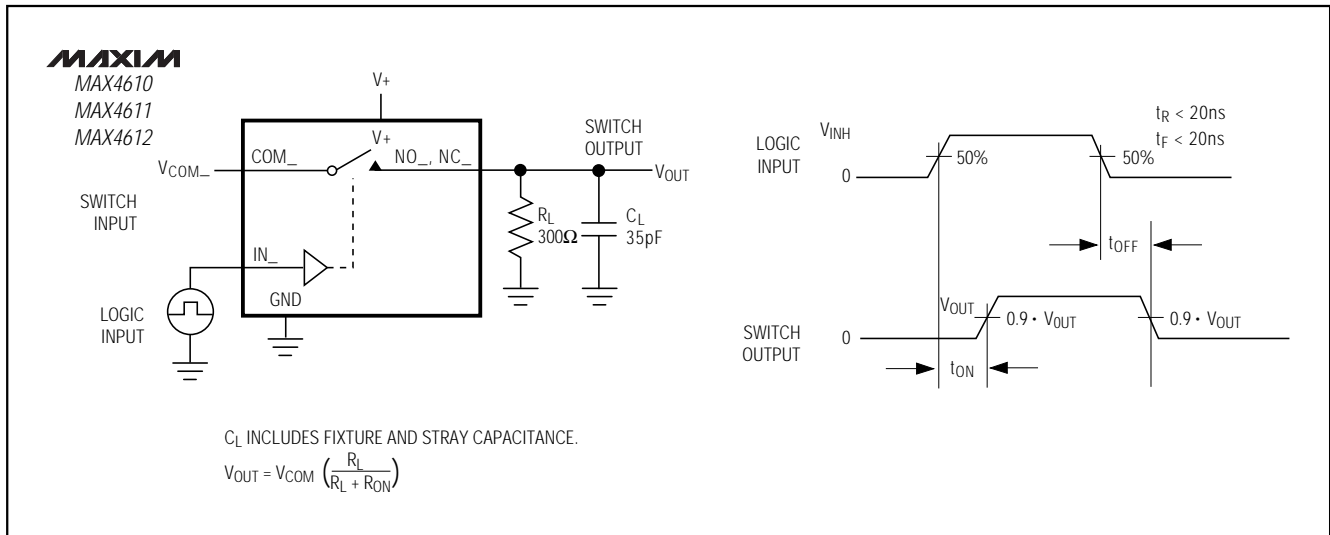


Figure 2. Switching Time

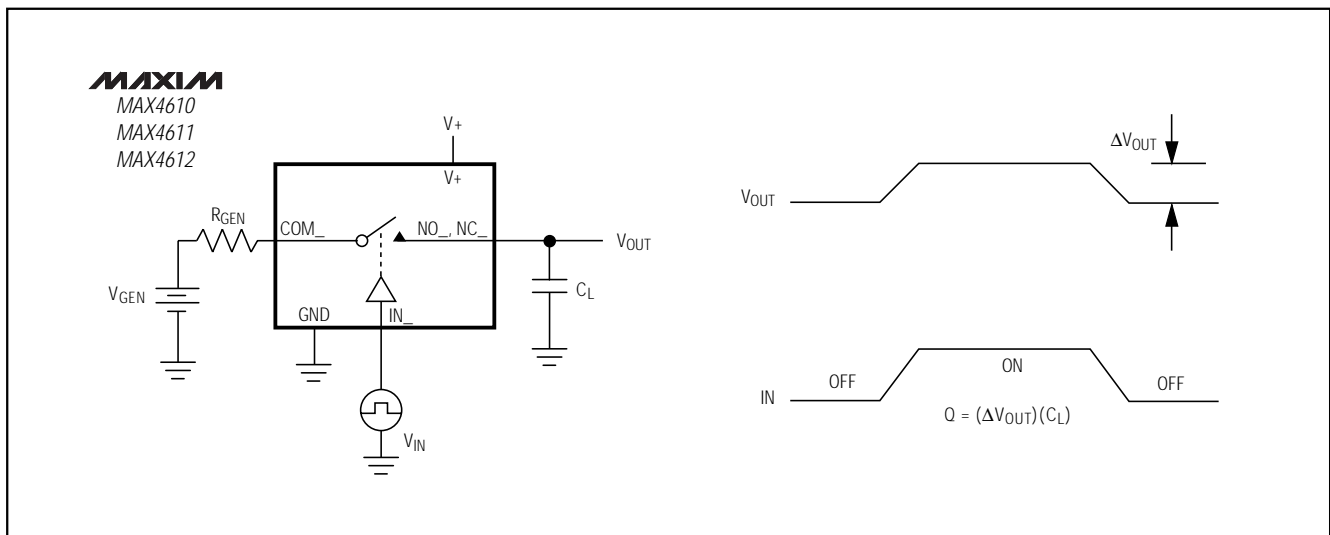


Figure 3. Charge Injection



# Low-Voltage, Quad, SPST CMOS Analog Switches

## Test Circuits/Timing Diagrams (continued)

MAX4610/MAX4611/MAX4612

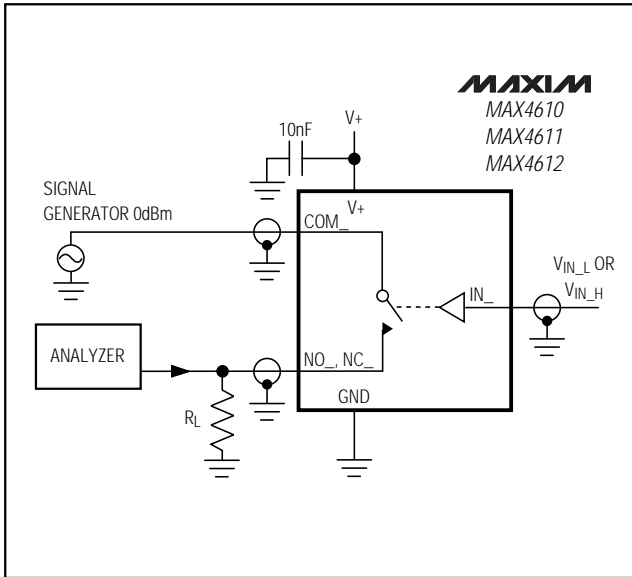


Figure 4. Off-Isolation/On-Channel Bandwidth

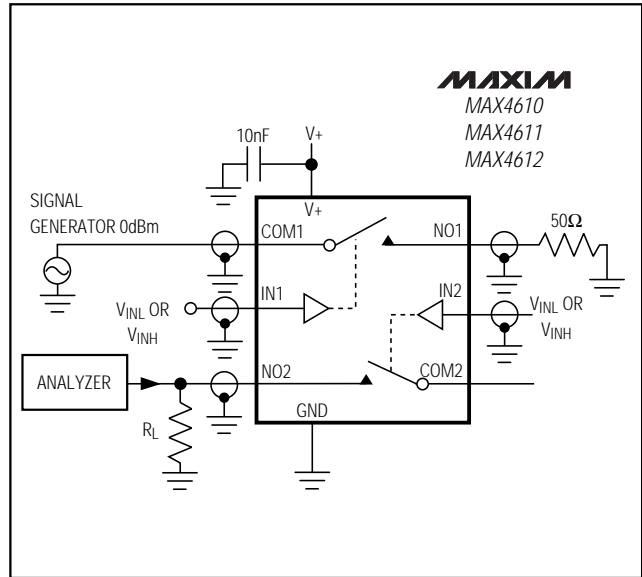


Figure 5. Crosstalk

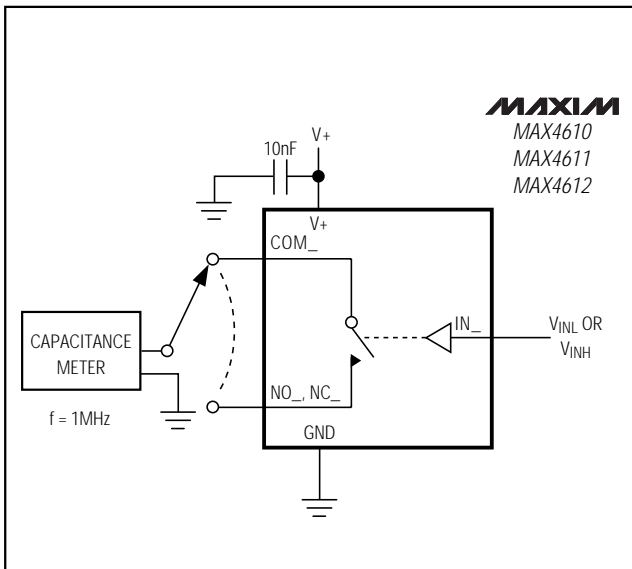


Figure 6. Channel Off/On-Capacitance

## Ordering Information (continued)

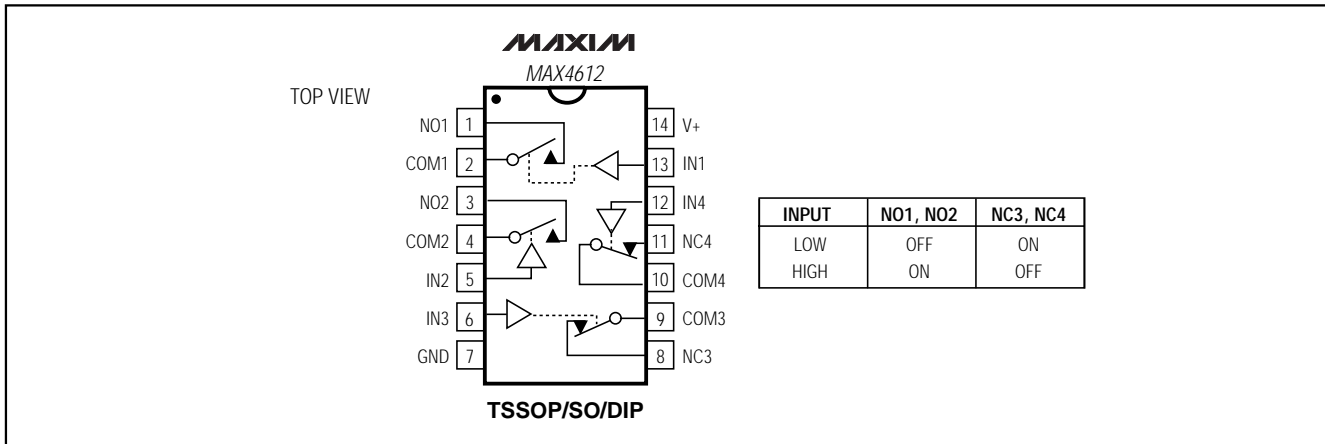
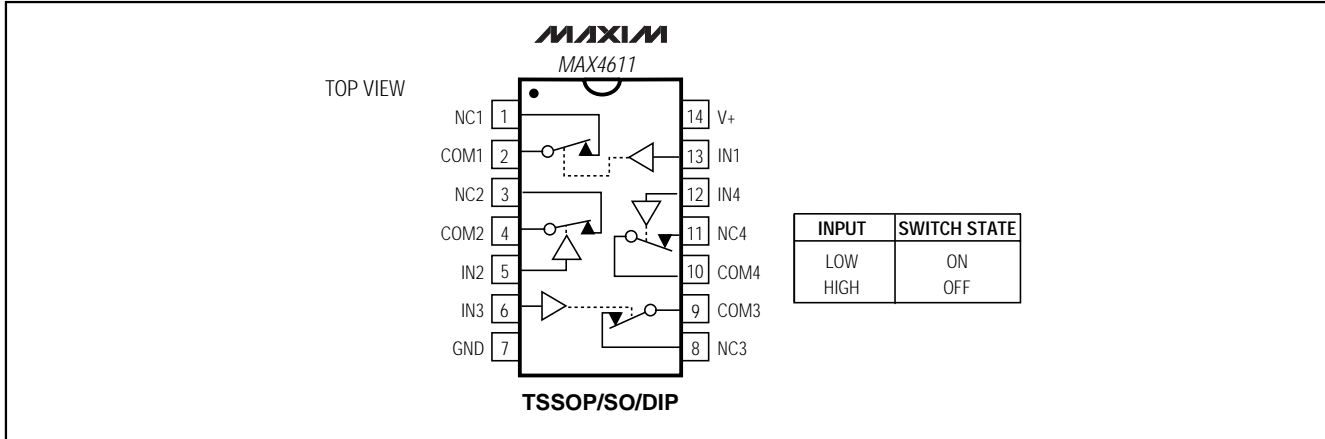
PART	TEMP. RANGE	PIN-PACKAGE
<b>MAX4611</b> CUD	0°C to +70°C	14 TSSOP**
MAX4611CSD	0°C to +70°C	14 Narrow SO
MAX4611CPD	0°C to +70°C	14 Plastic DIP
MAX4611C/D	0°C to +70°C	Dice*
MAX4611EUD	-40°C to +85°C	14 TSSOP**
MAX4611ESD	-40°C to +85°C	14 Narrow SO
MAX4611EPD	-40°C to +85°C	14 Plastic DIP
<b>MAX4612</b> CUD	0°C to +70°C	14 TSSOP**
MAX4612CSD	0°C to +70°C	14 Narrow SO
MAX4612CPD	0°C to +70°C	14 Plastic DIP
MAX4612C/D	0°C to +70°C	Dice*
MAX4612EUD	-40°C to +85°C	14 TSSOP**
MAX4612ESD	-40°C to +85°C	14 Narrow SO
MAX4612EPD	-40°C to +85°C	14 Plastic DIP

\* Contact factory for dice specifications.

\*\* Contact factory for availability.

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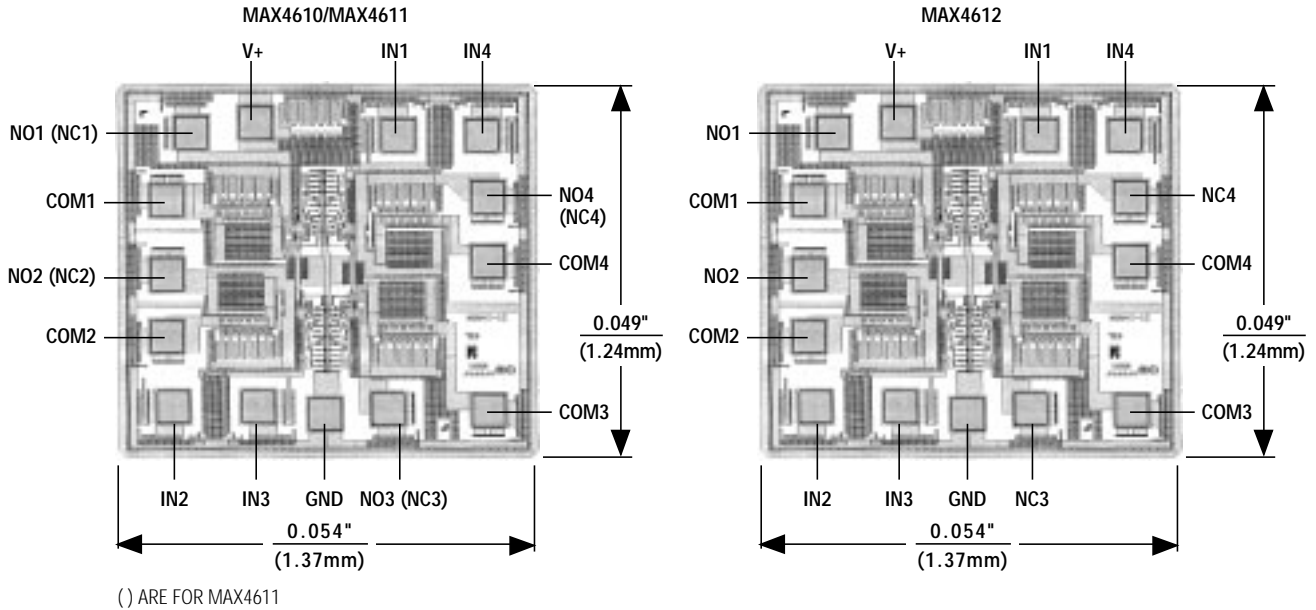
Pin Configurations/Truth Tables (continued)



# Low-Voltage, Quad, SPST CMOS Analog Switches

Chip Topographies

MAX4610/MAX4611/MAX4612



TRANSISTOR COUNT: 132  
SUBSTRATE CONNECTED TO V+

## Package Information

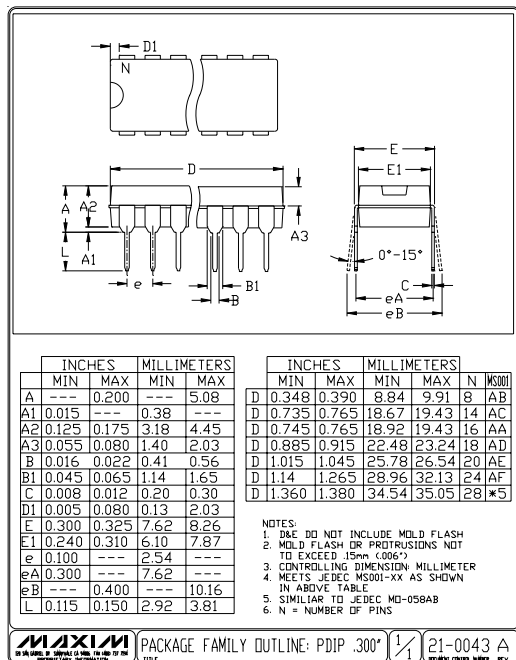
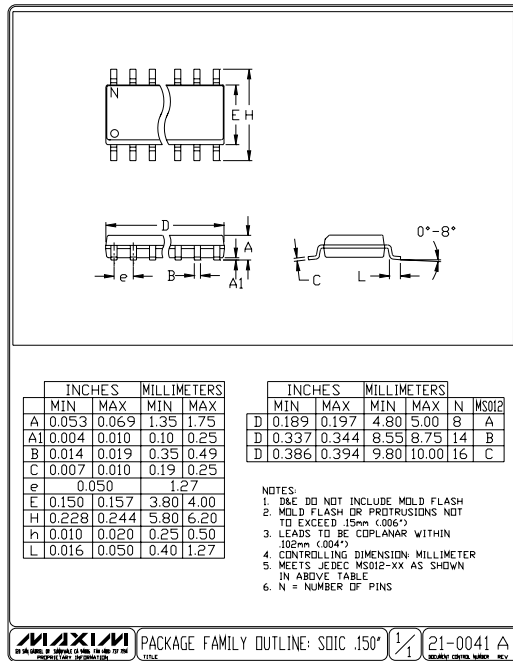
COMMON DIMENSIONS	
MILLIMETERS	INCHES
A	1.10
A <sub>1</sub>	0.05
A <sub>2</sub>	0.85
b	0.19
b <sub>1</sub>	0.19
c	0.090
c <sub>1</sub>	0.090
D	SEE VARIATIONS
E	4.30
e	0.65
H	6.25
L	0.50
N	SEE VARIATIONS
Y	2.85
φ	0*

VARIATIONS	
JEDEC	N
MO-153	N
AB	14
AC	16
AC-FP	16
AD	20
AD-FP	20
AE	24
AF	28
AF-FP	28

NOTES:  
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH.  
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15 mm PER SIDE.  
3. CONTROLLING DIMENSION: MILLIMETER.  
4. MEETS JEDEC OUTLINE MO-153 VARIATIONS AB, AC, AD, AE, AF.  
5. DIMENSIONS X AND Y APPLY TO EXPOSED PAD (EP) VERSIONS ONLY.  
6. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".

# Low-Voltage, Quad, SPST CMOS Analog Switches

## Package Information (continued)



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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