

# MAXIM

## Quad, SPST Analog Switch

MAX4613

### General Description

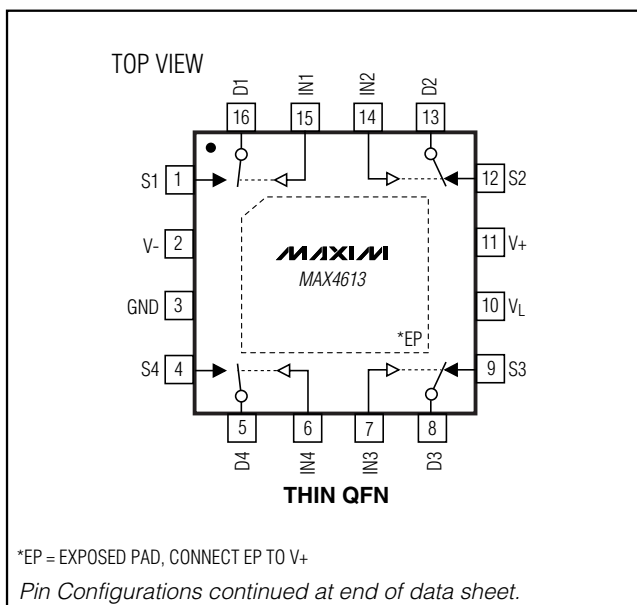
The MAX4613 quad analog switch features on-resistance matching ( $4\Omega$  max) between switches and guarantees on-resistance flatness over the signal range ( $9\Omega$  max). This low on-resistance switch conducts equally well in either direction. It guarantees low charge injection ( $10\text{pC}$  max), low power consumption ( $35\mu\text{W}$  max), and an electrostatic discharge (ESD) tolerance of 2000V minimum per Method 3015.7. The new design offers lower off-leakage current over temperature (less than  $5\text{nA}$  at  $+85^\circ\text{C}$ ).

The MAX4613 quad, single-pole/single-throw (SPST) analog switch has two normally closed switches and two normally open switches. Switching times are less than  $250\text{ns}$  for  $t_{\text{ON}}$  and less than  $70\text{ns}$  for  $t_{\text{OFF}}$ . Operation is from a single  $+4.5\text{V}$  to  $+40\text{V}$  supply or bipolar  $\pm 4.5\text{V}$  to  $\pm 20\text{V}$  supplies.

### Applications

Sample-and-Hold Circuits	Communication Systems
Test Equipment	Battery-Operated Systems
Heads-Up Displays	PBX, PABX
Guidance and Control Systems	Audio Signal Routing
Military Radios	Modems/Faxes

### Pin Configurations/ Functional Diagrams/Truth Table



### Features

- ◆ Pin Compatible with Industry-Standard DG213
- ◆ Guaranteed  $R_{\text{ON}}$  Match Between Channels ( $4\Omega$  max)
- ◆ Guaranteed  $R_{\text{FLAT(ON)}}$  Over Signal Range ( $9\Omega$  max)
- ◆ Guaranteed Charge Injection ( $10\text{pC}$  max)
- ◆ Low Off-Leakage Current Over Temperature ( $<5\text{nA}$  at  $+85^\circ\text{C}$ )
- ◆ Withstands 2000V min ESD, per Method 3015.7
- ◆ Low  $R_{\text{DS(ON)}}$  ( $85\Omega$  max)
- ◆ Single-Supply Operation  $+4.5\text{V}$  to  $+40\text{V}$   
Bipolar-Supply Operation  $\pm 4.5\text{V}$  to  $\pm 20\text{V}$
- ◆ Low Power Consumption ( $35\mu\text{W}$  max)
- ◆ Rail-to-Rail Signal Handling
- ◆ TTL/CMOS-Logic Compatible

### Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4613CPE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Plastic DIP
MAX4613CSE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Narrow SO
MAX4613CEE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 QSOP
MAX4613CUE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 TSSOP**
MAX4613CC/D	$0^\circ\text{C}$ to $+70^\circ\text{C}$	Dice*
MAX4613ETE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 TQFN-EP*** (5mm x 5mm)
MAX4613EPE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Plastic DIP
MAX4613ESE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Narrow SO
MAX4613EEE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 QSOP
MAX4613EUE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 TSSOP**

\*Contact factory for dice specifications.

\*\*Contact factory for availability.

\*\*\*EP = Exposed Pad

# Quad, SPST Analog Switch

## ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to GND

V+	+44V
V-	-44V
V+ to V-	+44V
V <sub>L</sub>	(GND - 0.3V) to (V+ + 0.3V)
Digital Inputs V <sub>S</sub> , V <sub>D</sub> (Note 1)	(V- - 2V) to (V+ + 2V) or 30mA (whichever occurs first)
Continuous Current (any terminal)	30mA
Peak Current, S <sub>-</sub> or D <sub>-</sub> (pulsed at 1ms, 10% duty cycle max)	100mA

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

Plastic DIP (derate 10.53mW/°C above +70°C)	842mW
Narrow SO (derate 8.70mW/°C above +70°C)	696mW
QSOP (derate 8.3mW/°C above +70°C)	667mW
Thin QFN (derate 33.3mW/°C above +70°C)	2667mW
TSSOP (derate 6.7mW/°C above +70°C)	457mW
Operating Temperature Ranges	
MAX4613C_ _	0°C to +70°C
MAX4613E_ _	-40°C to +85°C
Storage Temperature Range	-65°C to +165°C
Lead Temperature (soldering, 10sec)	+300°C

**Note 1:** Signals on S<sub>-</sub>, D<sub>-</sub>, or IN<sub>-</sub> exceeding V+ or V- are clamped by internal diodes. Limit forward 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—Dual Supplies

(V+ = 15V, V- = -15V, V<sub>L</sub> = 5V, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</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>SWITCH</b>						
Analog Signal Range	V <sub>ANALOG</sub>	(Note 3)	-15		15	V
Drain-Source On-Resistance	R <sub>DS(ON)</sub>	V <sub>D</sub> = ±10V, I <sub>S</sub> = 1mA	T <sub>A</sub> = +25°C		55	70
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			85
On-Resistance Match Between Channels (Note 4)	ΔR <sub>DS(ON)</sub>	V <sub>D</sub> = ±10V, I <sub>S</sub> = 1mA	T <sub>A</sub> = +25°C			4
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			5
On-Resistance Flatness (Note 4)	R <sub>FLAT(ON)</sub>	V <sub>D</sub> = ±5V, I <sub>S</sub> = 1mA	T <sub>A</sub> = +25°C			9
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>			15
Source Leakage Current (Note 5)	I <sub>S(OFF)</sub>	V <sub>D</sub> = ±14V, V <sub>S</sub> = ∓14V	T <sub>A</sub> = +25°C		-0.50	0.01
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-5	5
Drain-Off Leakage Current (Note 5)	I <sub>D(OFF)</sub>	V <sub>D</sub> = ±14V, V <sub>S</sub> = ∓14V	T <sub>A</sub> = +25°C		-0.50	0.01
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-5	5
Drain-On Leakage Current (Note 5)	I <sub>D(ON)</sub> or I <sub>S(ON)</sub>	V <sub>D</sub> = ±14V, V <sub>S</sub> = ±14V	T <sub>A</sub> = +25°C		-0.50	0.08
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-10	10
<b>INPUT</b>						
Input Current with Input Voltage High	I <sub>INH</sub>	V <sub>IN</sub> = 2.4V, all others = 0.8V	-0.5	-0.00001	0.5	μA
Input Current with Input Voltage Low	I <sub>INL</sub>	V <sub>IN</sub> = 0.8V, all others = 2.4V	-0.5	-0.00001	0.5	μA
<b>SUPPLY</b>						
Power-Supply Range	V+, V-		±4.5		±20.0	V
Positive Supply Current	I+	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C		-1	0.001
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-5	5
Negative Supply Current	I-	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C		-1	0.001
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		-5	5

# Quad, SPST Analog Switch

MAX4613

## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V<sub>+</sub> = 15V, V<sub>-</sub> = -15V, V<sub>L</sub> = 5V, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</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	
Logic Supply Current	I <sub>L</sub>	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C	-1	0.001	1	μA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-5		5	
Ground Current	I <sub>GND</sub>	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C	-1	-0.0001	1	μA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-5		5	
<b>DYNAMIC</b>							
Turn-On Time (Note 3)	t <sub>ON</sub>	V <sub>S</sub> = ±10V, Figure 2	T <sub>A</sub> = +25°C	150	250	ns	
Turn-Off Time (Note 3)	t <sub>OFF</sub>	V <sub>S</sub> = ±10V, Figure 2	T <sub>A</sub> = +25°C	90	120	ns	
Break-Before-Make Time Delay (Note 3)	t <sub>D</sub>	Figure 3	T <sub>A</sub> = +25°C	5	20	ns	
Charge Injection (Note 3)	Q	C <sub>L</sub> = 1nF, V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0, Figure 4	T <sub>A</sub> = +25°C	5	10	pC	
Off-Isolation Rejection Ratio (Note 6)	OIRR	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 5	T <sub>A</sub> = +25°C	60		dB	
Crosstalk (Note 7)		R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 6	T <sub>A</sub> = +25°C	100		dB	
Source-Off Capacitance	C <sub>S(OFF)</sub>	f = 1MHz, Figure 7	T <sub>A</sub> = +25°C	4		pF	
Drain-Off Capacitance	C <sub>D(OFF)</sub>	f = 1MHz, Figure 7	T <sub>A</sub> = +25°C	4		pF	
Source-On Capacitance	C <sub>S(ON)</sub>	f = 1MHz, Figure 8	T <sub>A</sub> = +25°C	16		pF	
Drain-On Capacitance	C <sub>D(ON)</sub>	f = 1MHz, Figure 8	T <sub>A</sub> = +25°C	16		pF	

## ELECTRICAL CHARACTERISTICS—Single Supply

(V<sub>+</sub> = 12V, V<sub>-</sub> = 0V, V<sub>L</sub> = 5V, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</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>SWITCH</b>							
Analog Signal Range	V <sub>ANALOG</sub>		0		12	V	
Drain-Source On-Resistance	R <sub>DS(ON)</sub>	V <sub>L</sub> = 5V; V <sub>D</sub> = 3V, 8V; I <sub>S</sub> = 1mA	T <sub>A</sub> = +25°C	100	160	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>		200		
<b>SUPPLY</b>							
Power-Supply Range	V <sub>+</sub> , V <sub>-</sub>		4.5		40	V	
Power-Supply Current	I <sub>+</sub>	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C	-1	0.001	1	μA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-5		5	
Negative Supply Current	I <sub>-</sub>	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C	-1	-0.0001	1	μA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-5		5	
Logic Supply Current	I <sub>L</sub>	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C	-1	0.001	1	μA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-5		5	
Ground Current	I <sub>GND</sub>	All channels on or off, V <sub>IN</sub> = 0 or 5V	T <sub>A</sub> = +25°C	-1	-0.0001	1	μA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-5		5	

# Quad, SPST Analog Switch

## ELECTRICAL CHARACTERISTICS—Single Supply (continued)

( $V_+ = 12V$ ,  $V_- = 0$ ,  $V_L = 5V$ ,  $GND = 0V$ ,  $V_{INH} = 2.4V$ ,  $V_{INL} = 0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS
<b>DYNAMIC</b>						
Turn-On Time (Note 3)	$t_{ON}$	$V_S = 8V$ , Figure 2		300	400	ns
Turn-Off Time (Note 3)	$t_{OFF}$	$V_S = 8V$ , Figure 2		60	200	ns
Charge Injection (Note 3)	Q	$C_L = 1nF$ , $V_{GEN} = 0$ , $R_{GEN} = 0$ , Figure 4		5	10	pC

**Note 2:** Typical values are for **design aid only**, are not guaranteed and are not subject to production testing. 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:** On-resistance match between channels and flatness are guaranteed only with bipolar-supply operation. Flatness is defined as the difference between the maximum and the minimum value of on-resistance as measured at the extremes of the specified analog signal range.

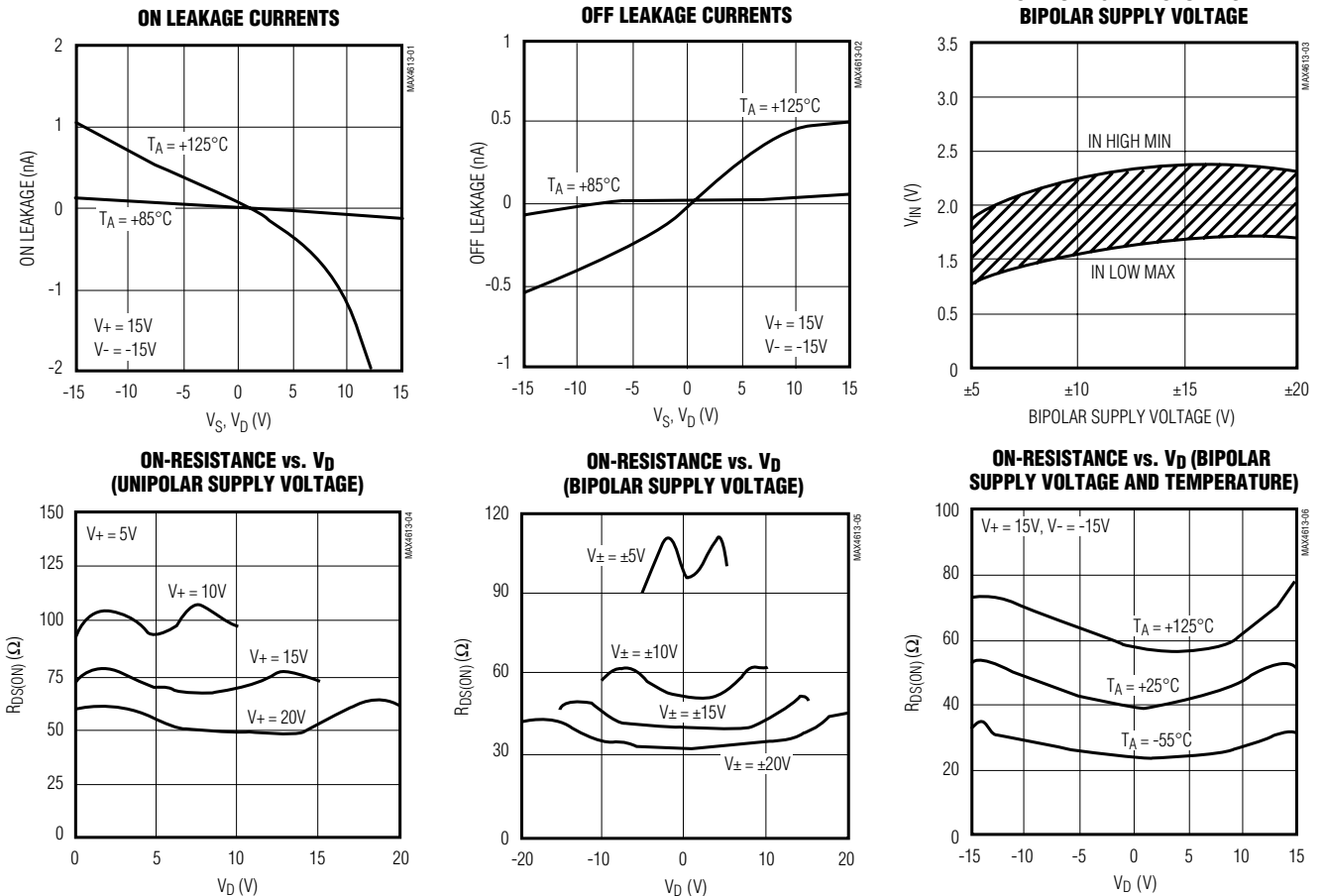
**Note 5:** Leakage parameters  $I_{S(OFF)}$ ,  $I_{D(OFF)}$ ,  $I_{D(ON)}$ , and  $I_{S(ON)}$  are 100% tested at the maximum rated hot temperature and guaranteed at  $+25^\circ C$ .

**Note 6:** Off-Isolation Rejection Ratio =  $20\log(V_D/V_S)$ .

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

## Typical Operating Characteristics

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

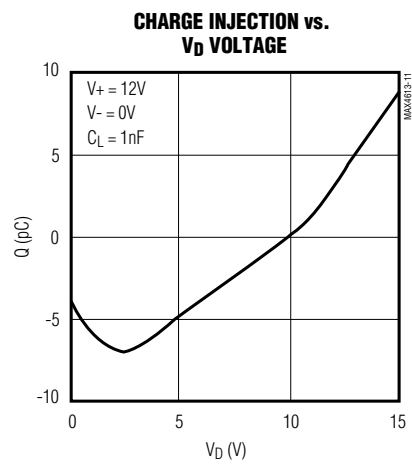
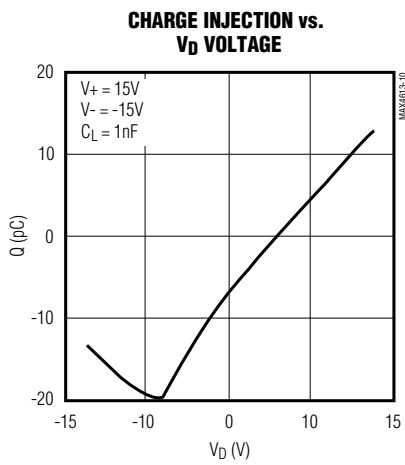
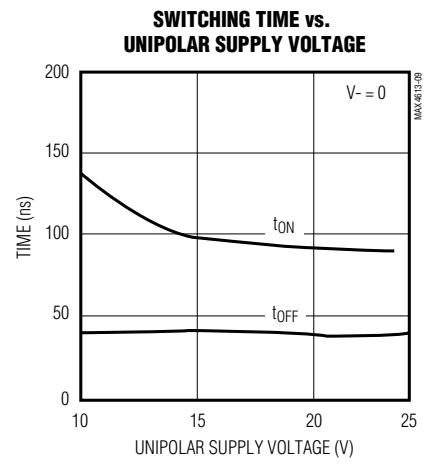
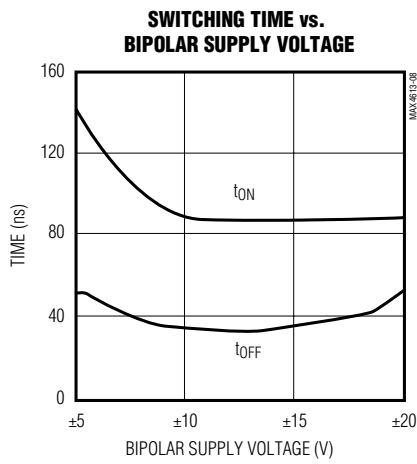
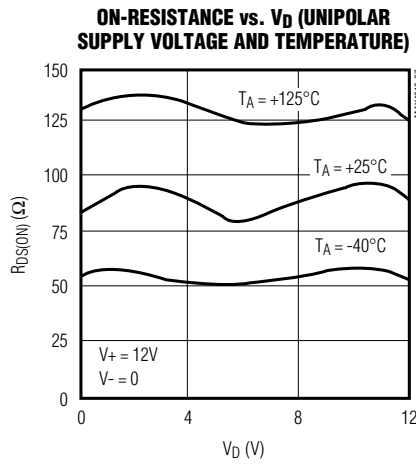


# Quad, SPST Analog Switch

MAX4613

## Typical Operating Characteristics (continued)

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



# Quad, SPST Analog Switch

## Pin Description

PIN		NAME	FUNCTION
DIP/SO/TSSOP	THIN QFN		
1, 8, 9, 16	6, 7, 14, 15	IN1–IN4	Logic Control Input
2, 7, 10, 15	5, 8, 13, 16	D1–D4	Analog-Switch Drain Output
3, 6, 11, 14	1, 4, 9, 12	S1–S4	Analog-Switch Source Output
4	2	V-	Negative-Supply Voltage Input
5	3	GND	Ground
12	10	V <sub>L</sub>	Logic-Supply Voltage Input
13	11	V+	Positive-Supply Voltage Input—Connected to Substrate
—	EP	PAD	Exposed Pad. Connect PAD to V+.

## Applications Information

### General Operation

- 1) Switches are open when power is off.
- 2) IN<sub>-</sub>, D<sub>-</sub>, and S<sub>-</sub> should not exceed V<sub>+</sub> or V<sub>-</sub>, even with the power off.
- 3) Switch leakage is from each analog switch terminal to V<sub>+</sub> or V<sub>-</sub>, not to other switch terminals.

### Operation with Supply Voltages Other than ±15V

Using supply voltages less than ±15V will reduce the analog signal range. The MAX4613 operates with ±4.5V to ±20V bipolar supplies or with a +4.5V to +40V single supply; connect V<sub>-</sub> to GND when operating with a single supply. Also, all device types can operate with unbalanced supplies such as +24V and -5V. V<sub>L</sub> must be connected to +5V to be TTL compatible, or to V<sub>+</sub> for CMOS-logic level inputs. The *Typical Operating Characteristics* graphs show typical on-resistance with ±20V, ±15V, ±10V, and ±5V supplies. (Switching times increase by a factor of two or more for operation at ±5V.)

### Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V<sub>+</sub> on first, followed by

V<sub>L</sub>, V<sub>-</sub>, and logic inputs. If power-supply sequencing is not possible, add two small, external signal diodes in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to 1V below V<sub>+</sub> and 1V above V<sub>-</sub>, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V<sub>+</sub> and V<sub>-</sub> should not exceed +44V.

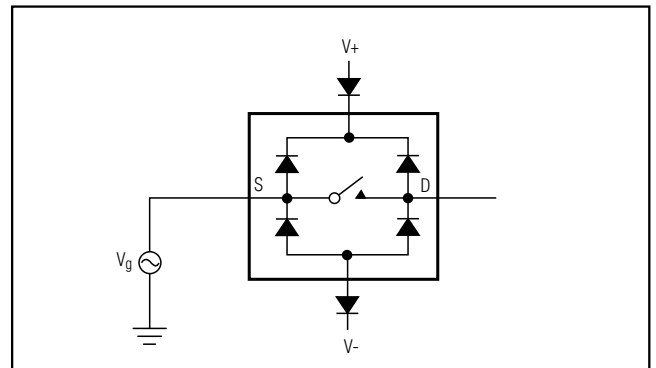


Figure 1. Overvoltage Protection Using External Blocking Diodes

# Quad, SPST Analog Switch

## Timing Diagrams/Test Circuits

**MAX4613**

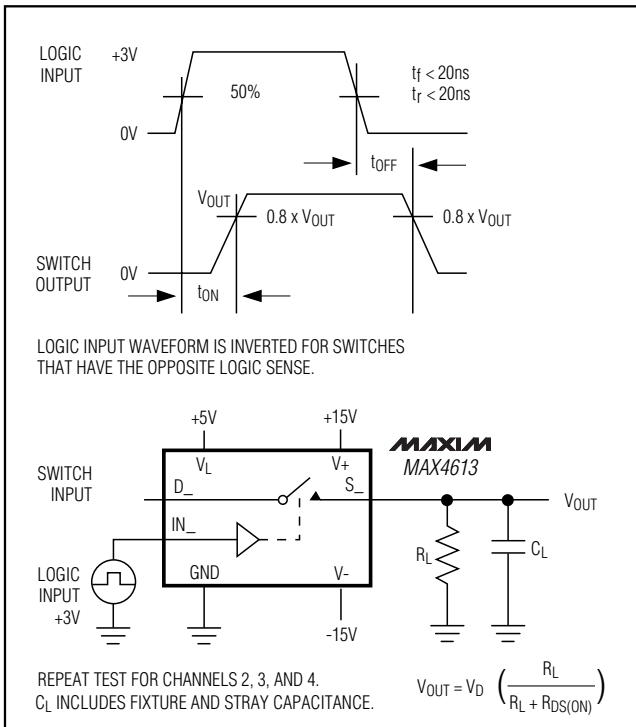


Figure 2. Switching Time

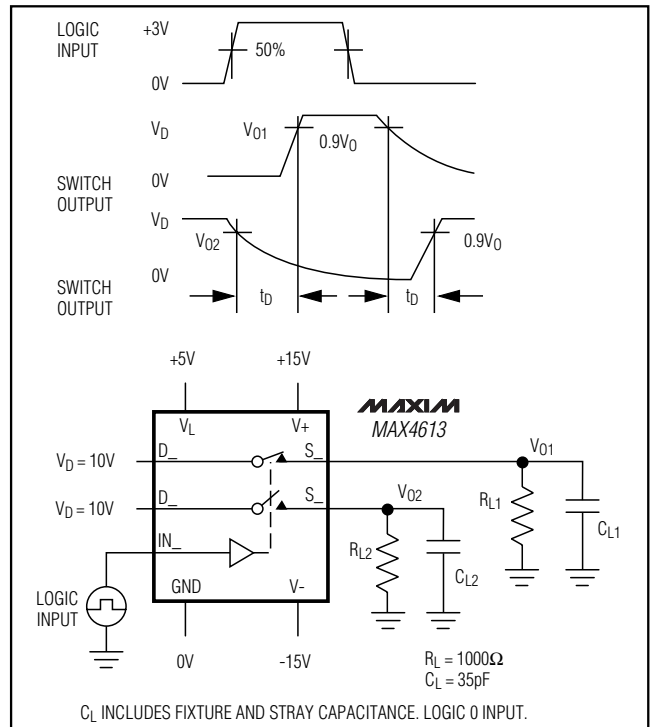


Figure 3. Break-Before-Make Test Circuit

## Revision History

Pages changed at Rev 3: 1, 9, 10

# Quad, SPST Analog Switch

## Timing Diagrams/Test Circuits (continued)

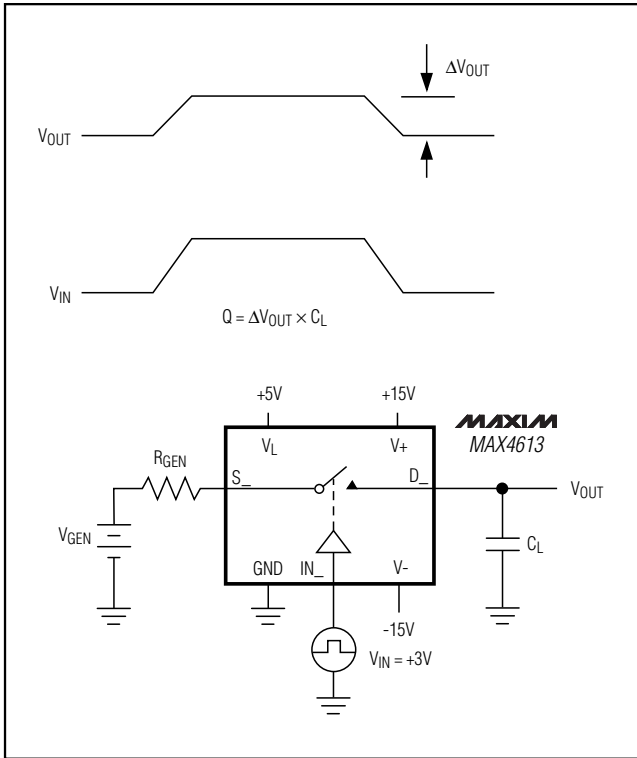


Figure 4. Charge Injection

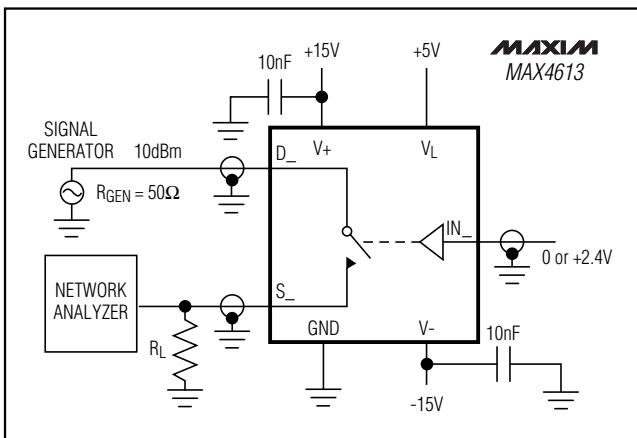


Figure 5. Off-Isolation Rejection Ratio

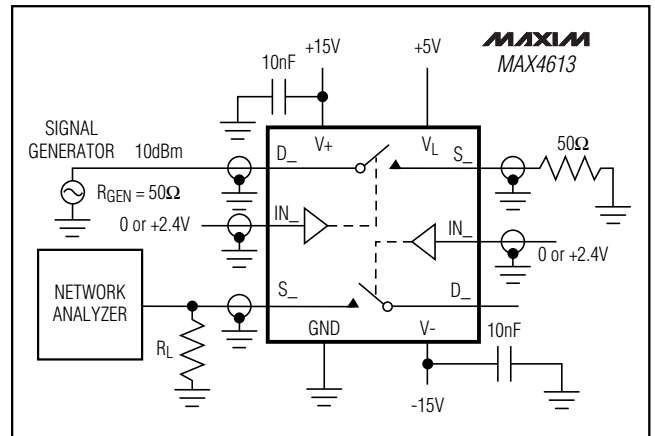


Figure 6. Crosstalk

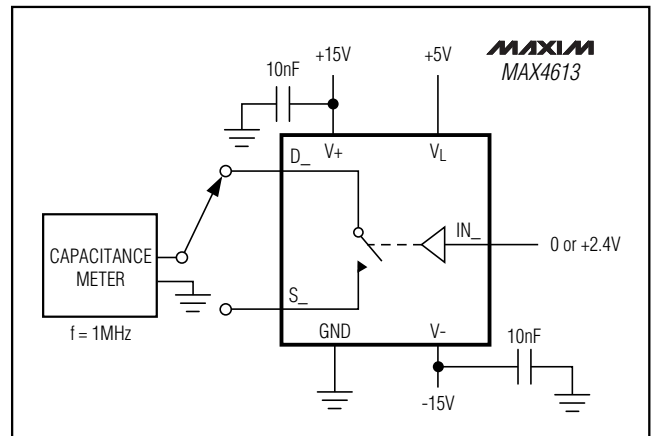


Figure 7. Source/Drain-Off Capacitance

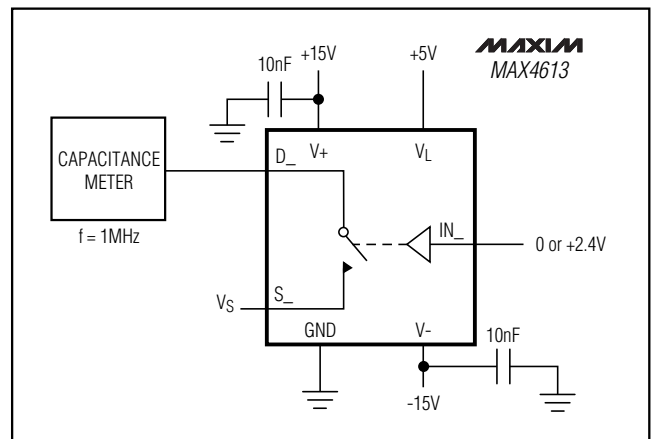


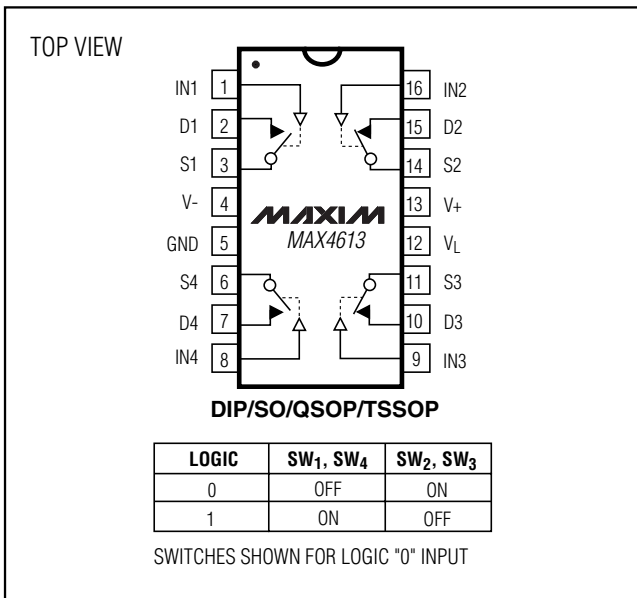
Figure 8. Source/Drain-On Capacitance



# Quad, SPST Analog Switch

MAX4613

## Pin Configurations (continued)



## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

