



# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

MAX4564

## General Description

The MAX4564 is a low-voltage, dual-supply, single-pole/double-throw (SPDT) analog switch designed to operate from dual  $\pm 1.8\text{V}$  to  $\pm 6\text{V}$  or single  $+1.8\text{V}$  to  $+12\text{V}$  supplies. The low on-resistance ( $R_{ON} = 40\Omega$  at  $\pm 5\text{V}$ ) and low power consumption ( $5\mu\text{W}$ ) make this part ideal for audio, video, and battery-powered applications. This switch offers low leakage currents ( $1\text{nA}$  max) and fast switching speeds ( $t_{ON} = 60\text{ns}$  and  $t_{OFF} = 40\text{ns}$  at  $\pm 5\text{V}$ , max).

The MAX4564 is available in 8-pin SOT23 and  $\mu\text{MAX}$  packages.

## Applications

- Battery-Operated Systems
- Audio and Video Switching
- Test Equipment
- Communications Circuits
- Sample-and-Hold Circuits
- Communications Systems

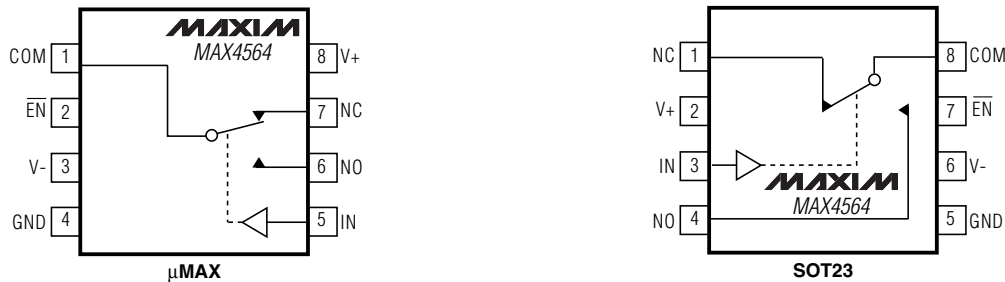
## Features

- ◆  $60\Omega$  max ( $40\Omega$ , typ) On-Resistance ( $R_{ON}$ )
- ◆  $3\Omega$  max ( $0.75\Omega$ , typ)  $R_{ON}$  Matching Between Channels
- ◆  $10\Omega$  (max)  $R_{ON}$  Flatness
- ◆ Low Charge Injection:  $3\text{pC}$  (typ)
- ◆ Low  $\pm 1\text{nA}$  Leakage Current at  $+25^\circ\text{C}$
- ◆ Fast Switching  
 $t_{ON} = 60\text{ns}$  (max)  
 $t_{OFF} = 40\text{ns}$  (max)
- ◆ Guaranteed Break-Before-Make Switching
- ◆ TTL/CMOS-Logic Compatible
- ◆ Low Crosstalk:  $-72\text{dB}$  (1MHz)
- ◆ High Off-Isolation:  $-77\text{dB}$  (1MHz)
- ◆ Bandwidth  $-3\text{dB}$ :  $>450\text{MHz}$  (typ)
- ◆ Available in an 8-Pin SOT23 Package

## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4564EKA-T	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	8 SOT23-8
MAX4564EUA	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	8 $\mu\text{MAX}$

## Functional Diagrams/Pin Configurations/Truth Table



$\overline{\text{EN}}$	IN	NC	NO
0	0	ON	OFF
0	1	OFF	ON
1	X	OFF	OFF

x = Don't care



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## ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)

V+	.....-0.3V to +13V
V-	.....-13V to +0.3V
V+ to V-	.....-0.3V to +13V
$\overline{EN}$ , IN, COM, NC, NO (Note 1)	..... (V- - 0.3V) to (V+ + 0.3V)
Continuous Current (any terminal)	..... $\pm 20$ mA
Peak Current, COM, NC, NO (pulsed at 1ms, 10% duty cycle)	..... $\pm 30$ mA
ESD per Method 3015.7	..... >2kV

Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )

8-Pin SOT23 (derate 7.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )	.....571mW
8-Pin $\mu\text{MAX}$ (derate 4.10mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$ )	.....330mW
Operating Temperature Range	
MAX4564E_A	..... $-40^\circ\text{C}$ to $+85^\circ\text{C}$
Junction Temperature	..... $+150^\circ\text{C}$
Storage Temperature Range	..... $-65^\circ\text{C}$ to $+150^\circ\text{C}$
Lead Temperature (soldering, 10s)	..... $+300^\circ\text{C}$

**Note 1:** Signals on NO, NC, COM, IN, or  $\overline{EN}$  exceeding V+ or V- 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— $\pm 5\text{V}$ Supply

(V+ = +4.5V to +6V, V- = -4.5V to -6V,  $V_{IH} = +2.4\text{V}$ ,  $V_{IL} = +0.8\text{V}$ , GND = 0,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	$T_A$	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	$V_{COM}$ , $V_{NO}$ , $V_{NC}$			V-		V+	V
On-Resistance	$R_{ON}$	V+ = +4.5V, V- = -4.5V, $I_{COM} = 1\text{mA}$ ; $V_{NO}$ , $V_{NC} = \pm 3.5\text{V}$	$+25^\circ\text{C}$		40	60	$\Omega$
			E			100	
On-Resistance Match Between Channels (Note 4)	$\Delta R_{ON}$	V+ = +4.5V, V- = -4.5V, $I_{COM} = 1\text{mA}$ ; $V_{NO}$ , $V_{NC} = \pm 3.5\text{V}$	$+25^\circ\text{C}$		0.75	3	$\Omega$
			E			4	
On-Resistance Flatness (Note 5)	$R_{FLAT(ON)}$	V+ = +4.5V, V- = -4.5V, $I_{COM} = 1\text{mA}$ ; $V_{NO}$ , $V_{NC} = -3.5\text{V}$ , 0, +3.5V	$+25^\circ\text{C}$		6.5	10	$\Omega$
			E			13	
NO or NC Off-Leakage Current	$I_{NC(OFF)}$ or $I_{NO(OFF)}$	V+ = +5.5V, V- = -5.5V; $V_{COM} = +4.5\text{V}$ , -4.5V; $V_{NO}$ , $V_{NC} = -4.5$ , +4.5V	$+25^\circ\text{C}$	-1	0.05	1	nA
			E	-5		5	
COM Off-Leakage Current	$I_{COM(OFF)}$	V+ = +5.5V, V- = -5.5V; $V_{COM} = +4.5\text{V}$ , -4.5V; $V_{NO}$ , $V_{NC} = -4.5$ , +4.5V	$+25^\circ\text{C}$	-1	0.05	1	nA
			E	-5		5	
COM On-Leakage Current	$I_{COM(ON)}$	V+ = +5.5V, V- = -5.5V, $V_{COM} = +4.5\text{V}$ , -4.5V; $V_{NO}$ , $V_{NC} = +4.5\text{V}$ , -4.5V, or floating	$+25^\circ\text{C}$	-2	0.05	2	nA
			E	-10		10	

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## ELECTRICAL CHARACTERISTICS—±5V Supply (continued)

(V+ = +4.5V to +6V, V- = -4.5V to -6V, V<sub>IH</sub> = +2.4V, V<sub>IL</sub> = +0.8V, GND = 0, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>SWITCH DYNAMIC CHARACTERISTICS</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> , V <sub>NC</sub> = +3V, -3V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF	+25°C	40	60	75	ns
			E				
Turn-Off Time	t <sub>OFF</sub>	V <sub>NO</sub> , V <sub>NC</sub> = +3V, -3V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF	+25°C	28	40	50	ns
			E				
Transition Time	t <sub>TRANS</sub>	V <sub>NC</sub> = +3V, V <sub>NO</sub> = -3V, V <sub>NC</sub> = -3V, V <sub>NO</sub> = +3V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF	+25°C	50	70	85	ns
			E				
Break-Before-Make Time (Note 6)	t <sub>BBM</sub>	V <sub>NO</sub> , V <sub>NC</sub> = +3V, -3V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF	+25°C	5	15		ns
Charge Injection	Q	V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0, C <sub>L</sub> = 100pF	+25°C		3		pC
-3dB Bandwidth	f <sub>-3dB</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF, f <sub>0dB</sub> = 1MHz	+25°C		450		MHz
Off-Isolation (Note 7)	V <sub>ISO</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF, f <sub>IN</sub> = 1MHz	+25°C		-77		dB
Crosstalk (Control Input to Signal Output)		R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF, V <sub>+</sub> = +4.5V, V <sub>-</sub> = -4.5V, f <sub>IN</sub> = 1MHz, V <sub>EN</sub> = V <sub>IH</sub>	+25°C		68		mV
Crosstalk (Between Switches)	V <sub>CT</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF, f <sub>IN</sub> = 1MHz	+25°C		-72		dB
Total Harmonic Distortion	THD	R <sub>L</sub> = 600kΩ, C <sub>L</sub> = 50pF, f <sub>IN</sub> = 20kHz	+25°C		0.15		%
Control Input Capacitance	C <sub>IN</sub>				3		pF
NO or NC Off-Capacitance	C <sub>OFF</sub>	f <sub>IN</sub> = 1MHz	+25°C		6		pF
COM Off-Capacitance	C <sub>COM(OFF)</sub>	f <sub>IN</sub> = 1MHz	+25°C		8		pF
COM On-Capacitance	C <sub>COM(ON)</sub>	f <sub>IN</sub> = 1MHz	+25°C		14		pF
<b>LOGIC INPUT</b>							
Input Voltage Low	V <sub>IL</sub>					0.8	V
Input Voltage High	V <sub>IH</sub>			2.4			V
Input Leakage Current	I <sub>L</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>IN</sub> = V <sub>EN</sub> = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	
<b>POWER SUPPLY</b>							
Power-Supply Range	V <sub>+</sub>			2		6	V
	V <sub>-</sub>			-2		-6	
Positive Supply Current	I <sub>+</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>IN</sub> = V <sub>EN</sub> = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	
Negative Supply Current	I <sub>-</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>IN</sub> = V <sub>EN</sub> = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	

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## ELECTRICAL CHARACTERISTICS—Single +5V Supply

( $V_+ = +4.5V$  to  $+6V$ ,  $V_- = 0$ ,  $V_{IH} = +2.4V$ ,  $V_{IL} = +0.8V$ ,  $GND = 0$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	$T_A$	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	$V_{COM}$ , $V_{NO}$ , $V_{NC}$			0		$V_+$	V
On-Resistance	$R_{ON}$	$V_+ = +4.5V$ , $V_- = 0$ , $I_{COM} = 1mA$ ; $V_{NO}$ , $V_{NC} = +3.5V$	+25°C		72	100	$\Omega$
			E			125	
On-Resistance Match Between Channels (Note 4)	$\Delta R_{ON}$	$V_+ = +4.5V$ , $V_- = 0$ , $I_{COM} = 1mA$ ; $V_{NO}$ , $V_{NC} = +3.5V$	+25°C		0.75	5	$\Omega$
			E			7	
<b>SWITCH DYNAMIC CHARACTERISTICS</b>							
Turn-On Time	$t_{ON}$	$V_{NO}$ , $V_{NC} = +3V$ , $R_L = 1k\Omega$ , $C_L = 35pF$	+25°C		62	90	ns
			E			125	
Turn-Off Time	$t_{OFF}$	$V_{NO}$ , $V_{NC} = +3V$ , $R_L = 1k\Omega$ , $C_L = 35pF$	+25°C		22	60	ns
			E			75	
Transition Time	$t_{TRANS}$	$V_{NC} = +3V$ , $V_{NO} = 0$ , $V_{NC} = 0$ , $V_{NO} = +3V$ , $R_L = 1k\Omega$ , $C_L = 35pF$	+25°C		68	100	ns
			E			130	
Break-Before-Make Time (Note 6)	$t_{BBM}$	$V_{NO}$ , $V_{NC} = +3V$ , $R_L = 300\Omega$ , $C_L = 35pF$	E	10	35		ns
<b>LOGIC INPUT</b>							
Input Voltage Low	$V_{IL}$					0.8	V
Input Voltage High	$V_{IH}$			2.4			V
Input Leakage Current	$I_L$	$V_+ = +5.5V$ , $V_- = 0$ , $V_{IN} = V_{\overline{EN}} = 0$ or $+5.5V$	+25°C	-1	0.0001	1	$\mu A$
			E	-10		10	
<b>POWER SUPPLY</b>							
Power-Supply Range	$V_+$			1.8		12	V
Positive Supply Current	$I_+$	$V_+ = +5.5V$ , $V_- = 0$ , $V_{IN} = V_{\overline{EN}} = 0$ or $+5.5V$	+25°C	-1	0.0001	1	$\mu A$
			E	-10		10	
Negative Supply Current	$I_-$	$V_+ = +5.5V$ , $V_- = 0$ , $V_{IN} = V_{\overline{EN}} = 0$ or $+5.5V$	+25°C	-1	0.0001	1	$\mu A$
			E	-10		10	

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## ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +3.3V, V- = 0, V<sub>IH</sub> = +2.4V, V<sub>IL</sub> = +0.8V, GND = 0, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>			0		V+	V
On-Resistance	R <sub>ON</sub>	V+ = +2.7V, V- = 0, I <sub>COM</sub> = 1mA; V <sub>NO</sub> , V <sub>NC</sub> = +1.5V	+25°C		160	275	Ω
			E			300	
On-Resistance Match Between Channels (Note 4)	ΔR <sub>ON</sub>	V+ = +2.7V, V- = 0, I <sub>COM</sub> = 1mA; V <sub>NO</sub> , V <sub>NC</sub> = +1.5V	+25°C		1.5	10	Ω
			E			12	
<b>SWITCH DYNAMIC CHARACTERISTICS</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> , V <sub>NC</sub> = +1.5V, R <sub>L</sub> = 2kΩ, C <sub>L</sub> = 35pF	+25°C		120	250	ns
			E			275	
Turn-Off Time	t <sub>OFF</sub>	V <sub>NO</sub> , V <sub>NC</sub> = +1.5V, R <sub>L</sub> = 2kΩ, C <sub>L</sub> = 35pF	+25°C		40	110	ns
			E			125	
Break-Before-Make Time (Note 6)	t <sub>BBM</sub>	V <sub>NO</sub> , V <sub>NC</sub> = +1.5V, R <sub>L</sub> = 2kΩ, C <sub>L</sub> = 35pF	E	10			ns
<b>LOGIC INPUT</b>							
Input Voltage Low	V <sub>IL</sub>					0.8	V
Input Voltage High	V <sub>IH</sub>			2.4			V
Input Leakage Current	I <sub>L</sub>	V+ = +3.3V, V- = 0, V <sub>IN</sub> = V <sub>EN</sub> = 0 or +3.3V	+25°C	-1	0.0001	1	μA
			E	-10		10	

**Note 2:** The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.

**Note 3:** SOT-packaged products are 100% tested at +25°C and guaranteed by design at the full-rated temperature.

**Note 4:** ΔR<sub>ON</sub> = R<sub>ON(MAX)</sub> - R<sub>ON(MIN)</sub>.

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

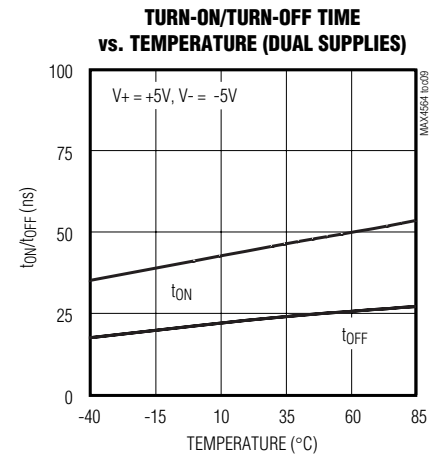
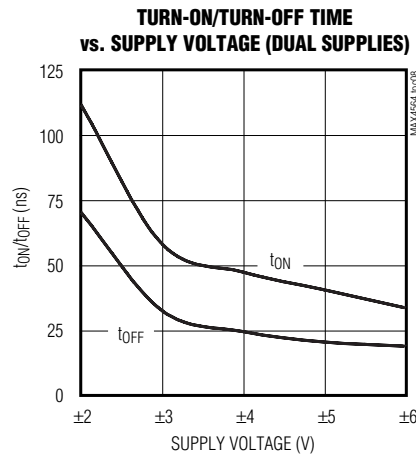
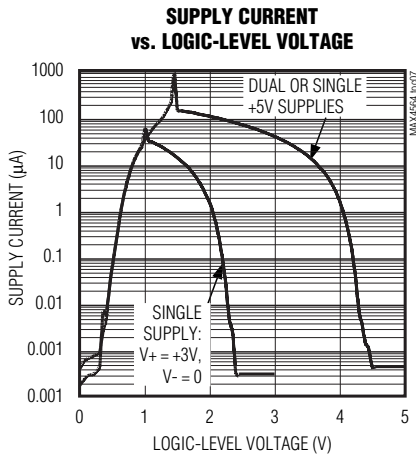
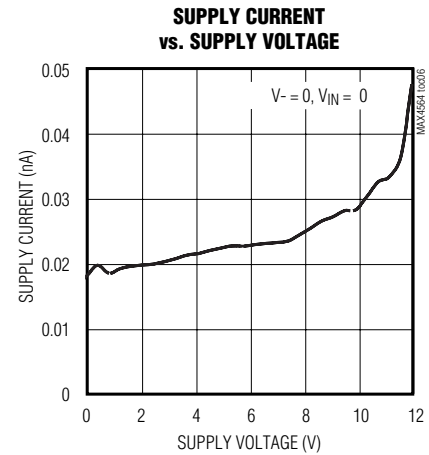
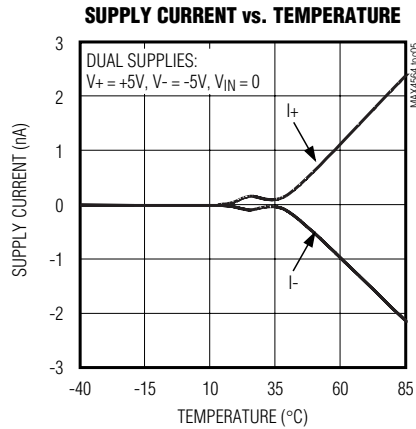
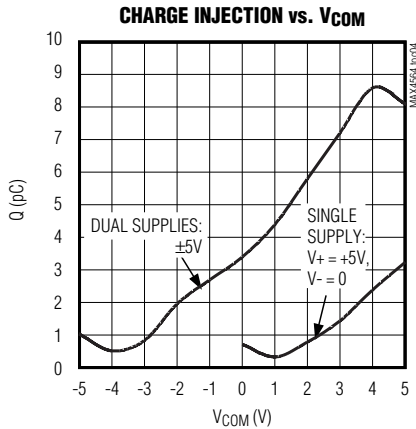
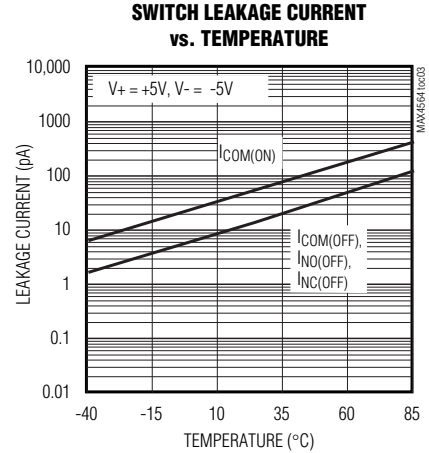
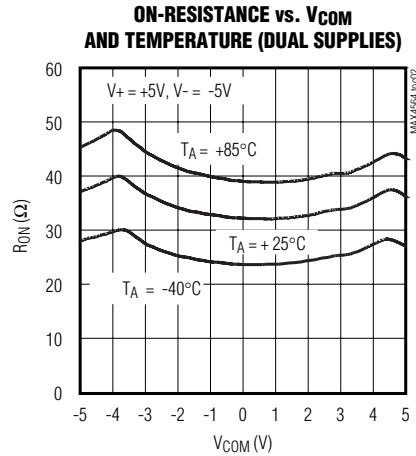
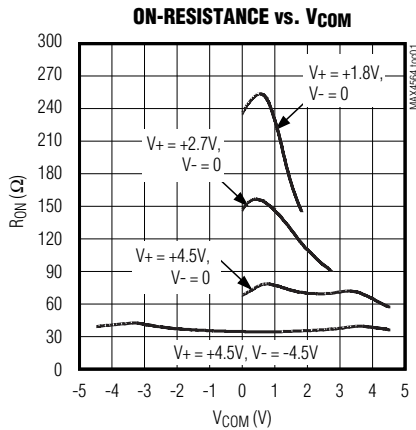
**Note 6:** Guaranteed by design.

**Note 7:** Off-Isolation = 20log<sub>10</sub> (V<sub>COM</sub> / V<sub>NO</sub>), V<sub>NO</sub> = input to off switch.

# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

## Typical Operating Characteristics

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

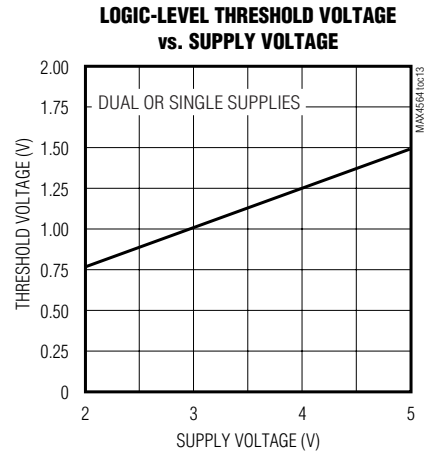
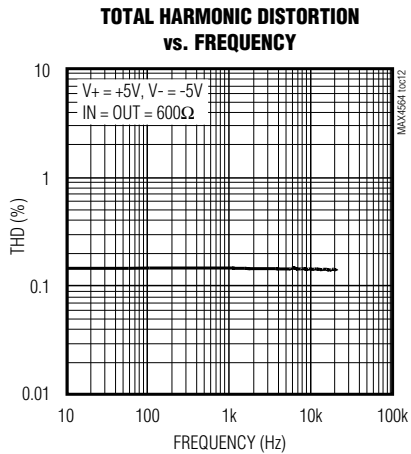
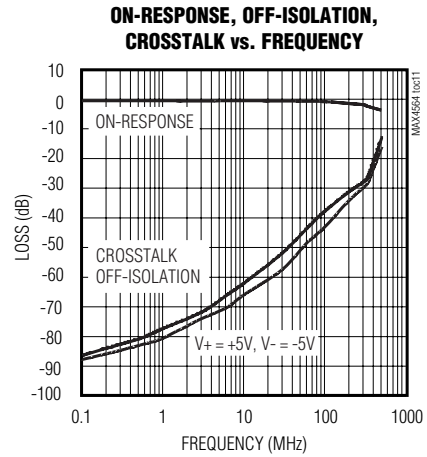
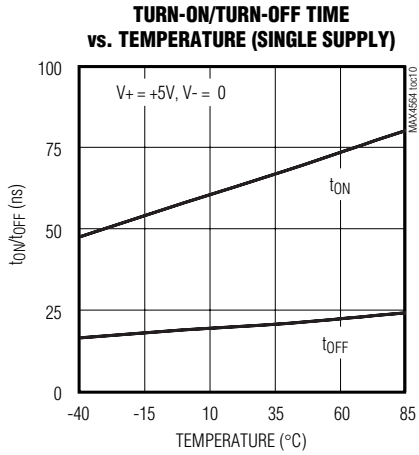


# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

## Typical Operating Characteristics (continued)

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

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# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

## Pin Description

$\mu$ MAX	SOT23	NAME	FUNCTION
1	8	COM	Analog Switch Common
2	7	$\overline{\text{EN}}$	Device Enable. Drive $\overline{\text{EN}}$ low for normal SPDT switch operation. If $\overline{\text{EN}}$ is high, both NO and NC are disconnected.
3	6	V-	Negative Supply Voltage
4	5	GND	Ground
5	3	IN	Digital Control Input
6	4	NO	Analog Switch Normally Open
7	1	NC	Analog Switch Normally Closed
8	2	V+	Positive Supply Voltage

## Detailed Description

The MAX4564 is a dual-supply SPDT CMOS analog switch. The MAX4564 has break-before-make switching. The CMOS switch construction provides Rail-to-Rail<sup>®</sup> signal handling while consuming virtually no power. Each of the two switches is independently controlled by a TTL/CMOS-level-compatible digital input.

## Applications Information

### Overvoltage Protection

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 sequence V+ on first, then V-, followed by the logic inputs NO, NC, or COM. If power-supply sequencing is not possible, add two small-signal diodes (D1, D2) in series with supply pins. Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the device's low switch resistance and low leakage characteristics.

## Test Circuits/ Timing Diagrams

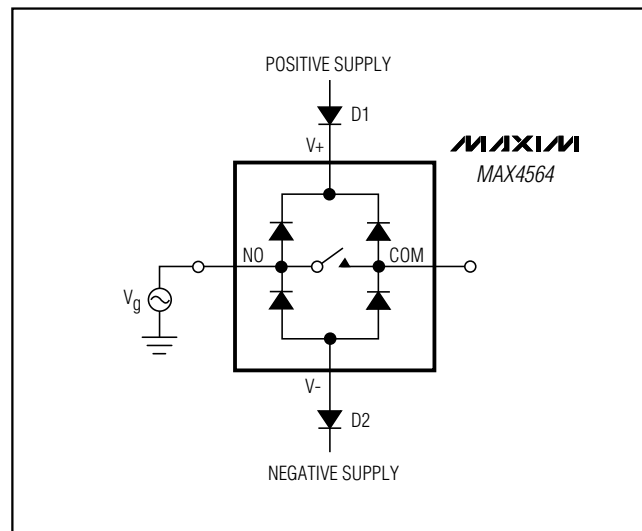


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

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



# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

## Test Circuits/Timing Diagrams (continued)

**MAX4564**

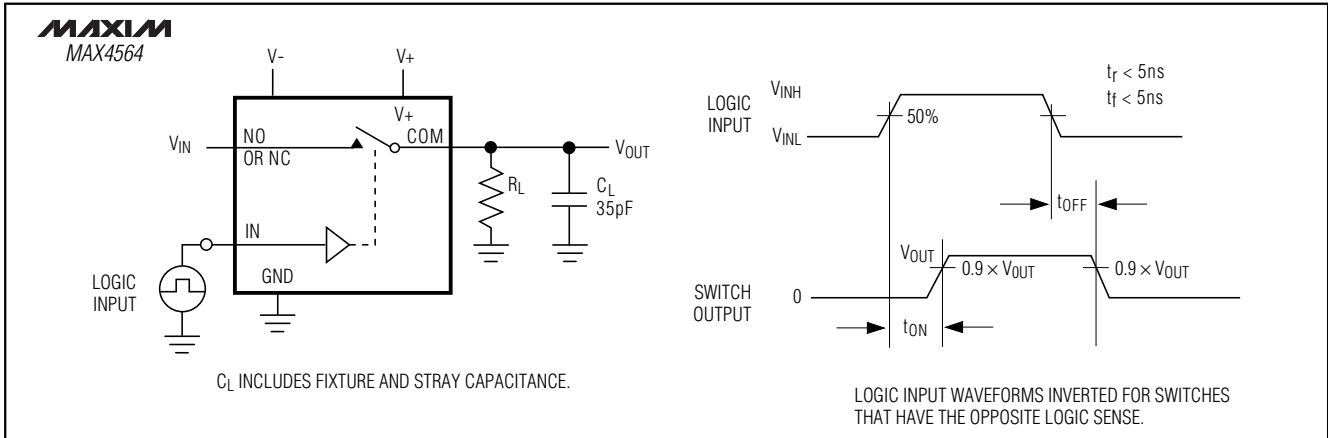


Figure 2. Switching Time

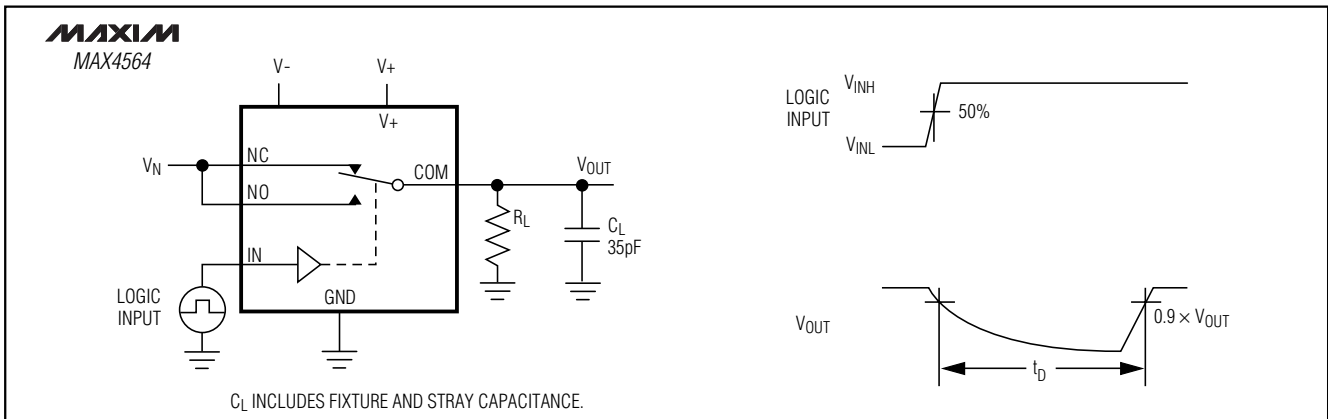


Figure 3. Break-Before-Make Interval

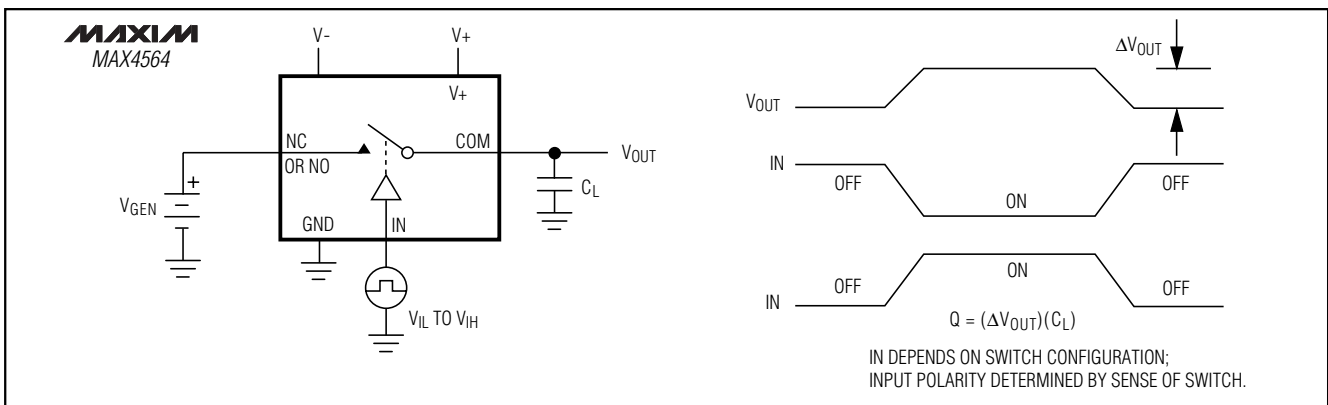


Figure 4. Charge Injection

# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

## Test Circuits/Timing Diagrams (continued)

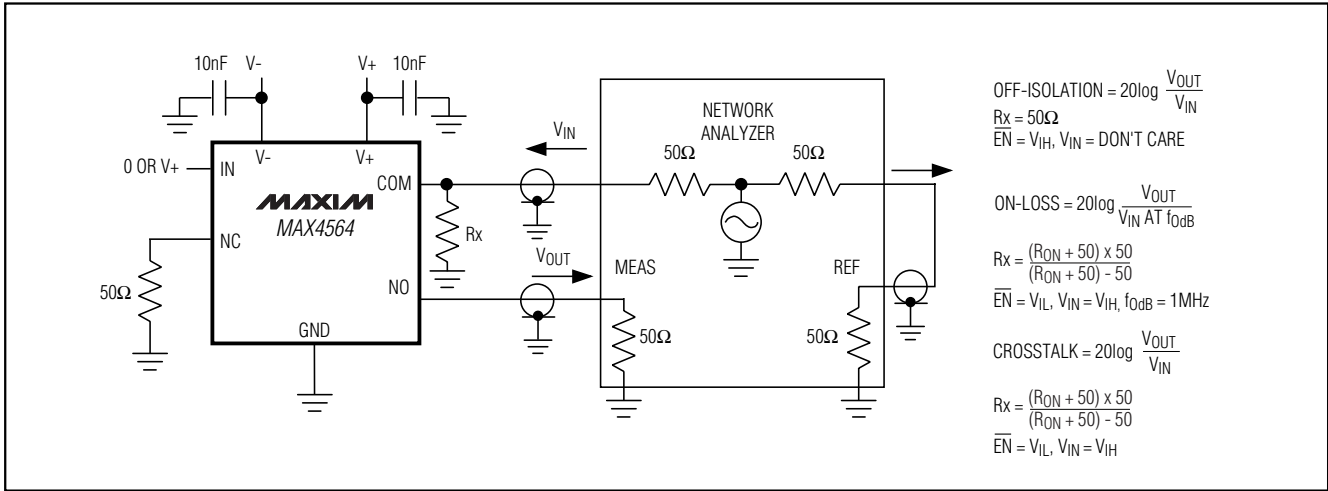


Figure 5. On-Loss, Off-Isolation, and Crosstalk

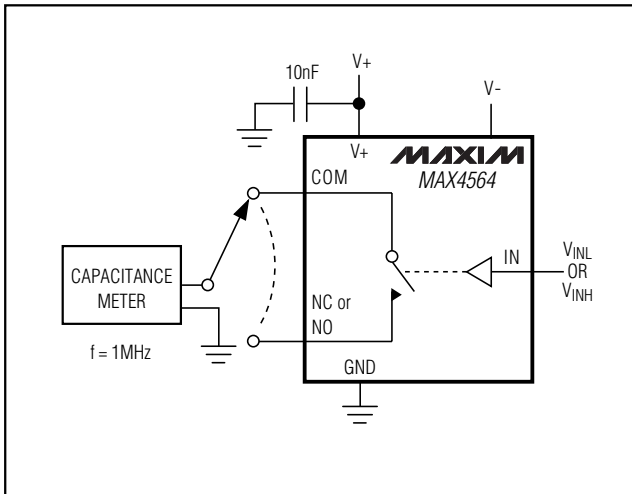


Figure 6. Channel Off/On-Capacitance

## Chip Information

TRANSISTOR COUNT: 116

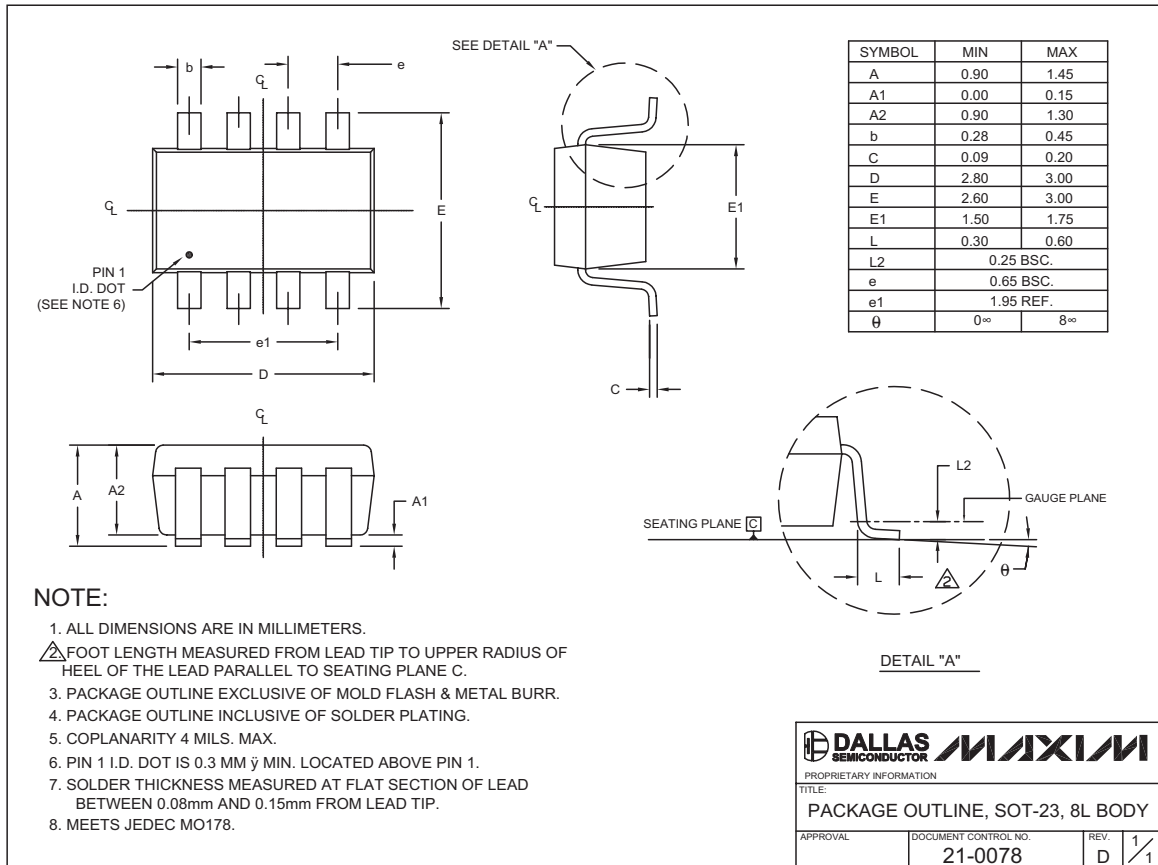
PROCESS : CMOS

# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

## 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).)

**MAX4564**



SOT23, 8L-EFS

# Low-Voltage, Dual-Supply, SPDT Analog Switch with Enable

## Package Information (continued)

(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).)

8LUMAXD.EPS

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	-	0.043	-	1.10
A1	0.002	0.006	0.05	0.15
A2	0.030	0.037	0.75	0.95
b	0.010	0.014	0.25	0.36
c	0.005	0.007	0.13	0.18
D	0.116	0.120	2.95	3.05
e	0.0256 BSC		0.65 BSC	
E	0.116	0.120	2.95	3.05
H	0.188	0.198	4.78	5.03
L	0.016	0.026	0.41	0.66
α	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC	

**NOTES:**  
 1. D&E DO NOT INCLUDE MOLD FLASH.  
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").  
 3. CONTROLLING DIMENSION: MILLIMETERS.  
 4. MEETS JEDEC MO-187C-AA.

**DALLAS SEMICONDUCTOR** **MAXIM**  
 PROPRIETARY INFORMATION  
 TITLE: PACKAGE OUTLINE, 8L uMAX/uSOP  
 APPROVAL: DOCUMENT CONTROL NO. 21-0036 REV. J 1/1

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