



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 ($R_{\text{ON}} = 40\Omega$ 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 (1nA max) and fast switching speeds ($t_{\text{ON}} = 60\text{ns}$ and $t_{\text{OFF}} = 40\text{ns}$ at $\pm 5\text{V}$, max).

The MAX4564 is available in 8-pin SOT23 and μMAX packages.

Applications

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

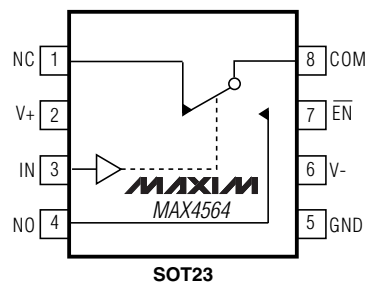
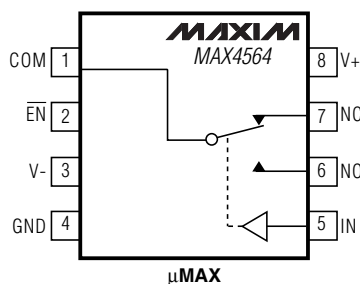
Features

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

Ordering Information

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

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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For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

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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)	 $\pm 20\text{mA}$
Peak Current, COM, NC, NO (pulsed at 1ms, 10% duty cycle)	 $\pm 30\text{mA}$
ESD per Method 3015.7	 $> 2\text{kV}$

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 μMAX (derate 4.10mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$)330mW

Operating Temperature Range

MAX4564E_A -40°C to $+85^\circ\text{C}$

Junction Temperature $+150^\circ\text{C}$

Storage Temperature Range -65°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
ANALOG SWITCH							
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	Ω
			E			100	
On-Resistance Match Between Channels (Note 4)	ΔR_{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	Ω
			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	Ω
			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_{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°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	T _A	MIN	TYP	MAX	UNITS
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t _{ON}	V _{NO} , V _{NC} = +3V, -3V, R _L = 1kΩ, C _L = 35pF	+25°C		40	60	ns
			E			75	
Turn-Off Time	t _{OFF}	V _{NO} , V _{NC} = +3V, -3V, R _L = 1kΩ, C _L = 35pF	+25°C		28	40	ns
			E			50	
Transition Time	t _{TRANS}	V _{NC} = +3V, V _{NO} = -3V, V _{NC} = -3V, V _{NO} = +3V, R _L = 1kΩ, C _L = 35pF	+25°C		50	70	ns
			E			85	
Break-Before-Make Time (Note 6)	t _{BBM}	V _{NO} , V _{NC} = +3V, -3V, R _L = 300Ω, C _L = 35pF	+25°C	5	15		ns
Charge Injection	Q	V _{GEN} = 0, R _{GEN} = 0, C _L = 100pF	+25°C		3		pC
-3dB Bandwidth	f _{-3dB}	R _L = 50Ω, C _L = 10pF, f _{0dB} = 1MHz	+25°C		450		MHz
Off-Isolation (Note 7)	V _{ISO}	R _L = 50Ω, C _L = 10pF, f _{IN} = 1MHz	+25°C		-77		dB
Crosstalk (Control Input to Signal Output)		R _L = 50Ω, C _L = 10pF, V ₊ = +4.5V, V ₋ = -4.5V, f _{IN} = 1MHz, V _{EN} = V _{IH}	+25°C		68		mV
Crosstalk (Between Switches)	V _{CT}	R _L = 50Ω, C _L = 10pF, f _{IN} = 1MHz	+25°C		-72		dB
Total Harmonic Distortion	THD	R _L = 600kΩ, C _L = 50pF, f _{IN} = 20kHz	+25°C		0.15		%
Control Input Capacitance	C _{IN}				3		pF
NO or NC Off-Capacitance	C _{OFF}	f _{IN} = 1MHz	+25°C		6		pF
COM Off-Capacitance	C _{COM(OFF)}	f _{IN} = 1MHz	+25°C		8		pF
COM On-Capacitance	C _{COM(ON)}	f _{IN} = 1MHz	+25°C		14		pF
LOGIC INPUT							
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 ₋ = -5.5V, V _{IN} = V _{EN} = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	
POWER SUPPLY							
Power-Supply Range	V ₊			2		6	V
	V ₋			-2		-6	
Positive Supply Current	I ₊	V ₊ = +5.5V, V ₋ = -5.5V, V _{IN} = V _{EN} = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	
Negative Supply Current	I ₋	V ₊ = +5.5V, V ₋ = -5.5V, V _{IN} = V _{EN} = 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
ANALOG SWITCH							
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} = +3.5 V	+25°C		72	100	Ω
			E			125	
On-Resistance Match Between Channels (Note 4)	ΔR _{ON}	V+ = +4.5V, V- = 0, I _{COM} = 1mA; V _{NO} , V _{NC} = +3.5 V	+25°C		0.75	5	Ω
			E			7	
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t _{ON}	V _{NO} , V _{NC} = +3V, R _L = 1kΩ, C _L = 35pF	+25°C		62	90	ns
			E			125	
Turn-Off Time	t _{OFF}	V _{NO} , V _{NC} = +3V, R _L = 1kΩ, 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 = 1kΩ, 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 = 300Ω, C _L = 35pF	E	10	35		ns
LOGIC INPUT							
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 _{EN} = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	
POWER SUPPLY							
Power-Supply Range	V+			1.8		12	V
Positive Supply Current	I+	V+ = +5.5V, V- = 0, V _{IN} = V _{EN} = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	
Negative Supply Current	I-	V+ = +5.5V, V- = 0, V _{IN} = V _{EN} = 0 or +5.5V	+25°C	-1	0.0001	1	μA
			E	-10		10	

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ELECTRICAL CHARACTERISTICS—Single +3V Supply

($V_+ = +2.7V$ to $+3.3V$, $V_- = 0$, $V_{IH} = +2.4V$, $V_{IL} = +0.8V$, $GND = 0$, $T_A = T_{MIN}$ 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
ANALOG SWITCH							
Analog Signal Range	V _{COM} , V _{NO} , V _{NC}			0		V+	V
On-Resistance	R _{ON}	V+ = +2.7V, V- = 0, I _{COM} = 1mA; V _{NO} , V _{NC} = +1.5V	+25°C	160	275	Ω	
			E	300			
On-Resistance Match Between Channels (Note 4)	ΔR _{ON}	V+ = +2.7V, V- = 0, I _{COM} = 1mA; V _{NO} , V _{NC} = +1.5V	+25°C	1.5	10	Ω	
			E	12			
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t _{ON}	V _{NO} , V _{NC} = +1.5V, R _L = 2kΩ, C _L = 35pF	+25°C	120	250	ns	
			E	275			
Turn-Off Time	t _{OFF}	V _{NO} , V _{NC} = +1.5V, R _L = 2kΩ, C _L = 35pF	+25°C	40	110	ns	
			E	125			
Break-Before-Make Time (Note 6)	t _{BBM}	V _{NO} , V _{NC} = +1.5V, R _L = 2kΩ, C _L = 35pF	E	10		ns	
LOGIC INPUT							
Input Voltage Low	V _{IL}				0.8	V	
Input Voltage High	V _{IH}			2.4		V	
Input Leakage Current	I _L	V+ = +3.3V, V- = 0, V _{IN} = V _{EN} = 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 $+25^\circ C$ and guaranteed by design at the full-rated temperature.

Note 4: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.

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

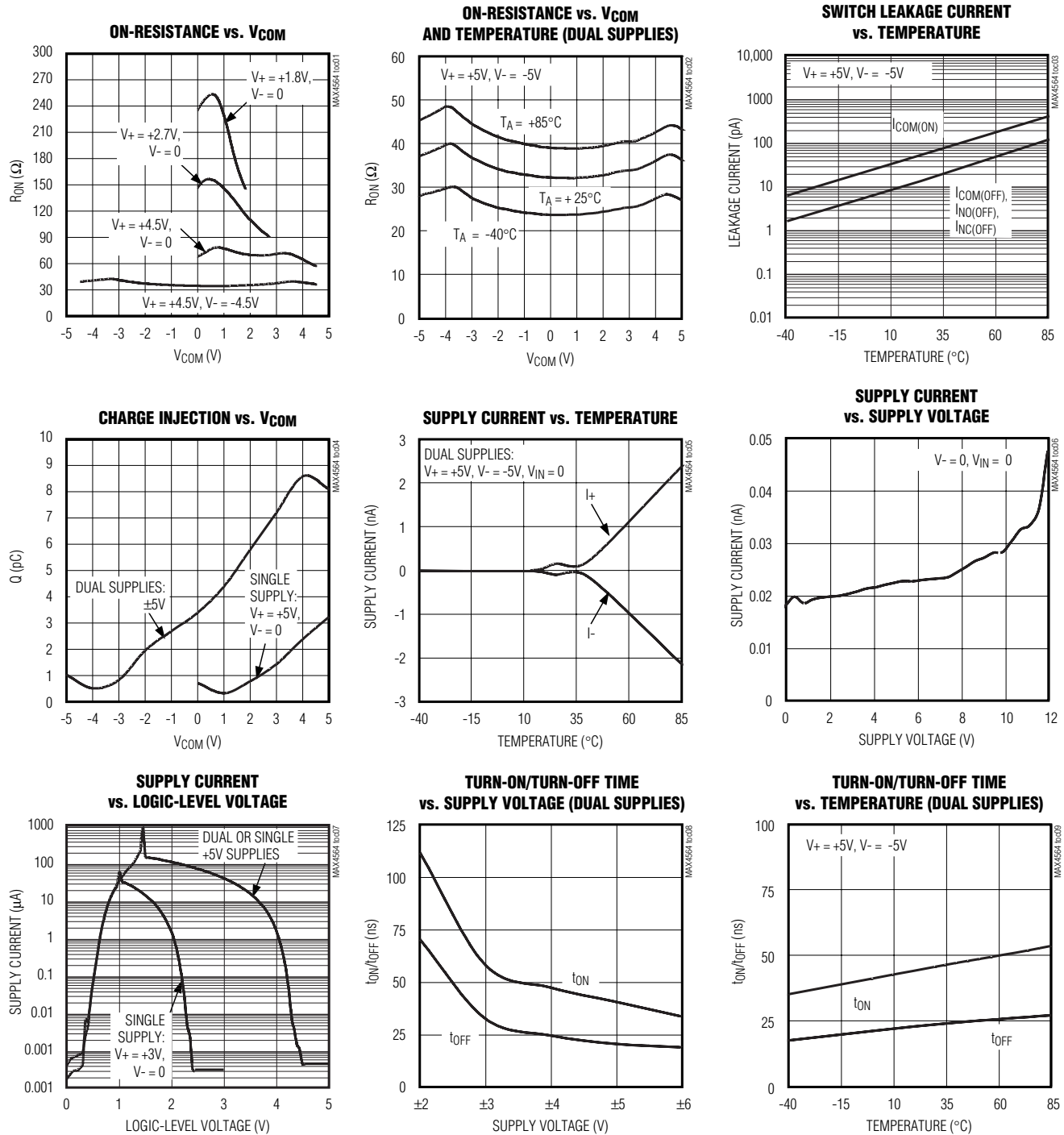
Note 6: Guaranteed by design.

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

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Typical Operating Characteristics

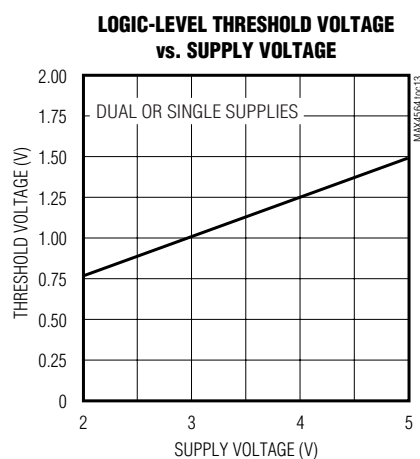
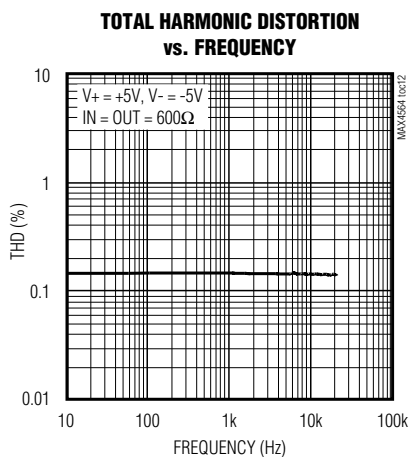
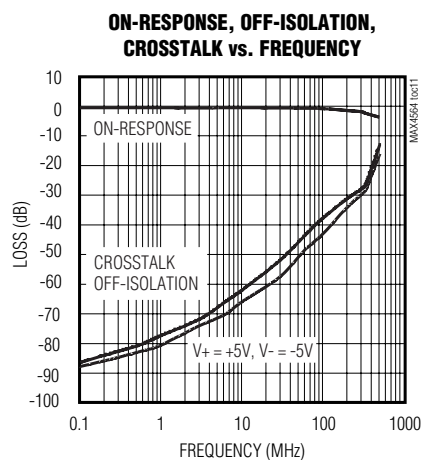
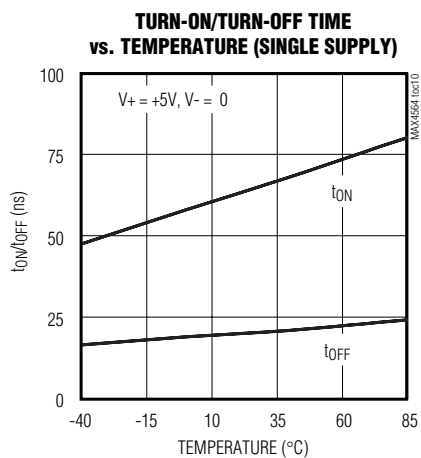
($T_A = +25^\circ\text{C}$, unless otherwise noted.)



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

Typical Operating Characteristics (continued)

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



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

Pin Description

μMAX	SOT23	NAME	FUNCTION
1	8	COM	Analog Switch Common
2	7	EN	Device Enable. Drive EN low for normal SPDT switch operation. If 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® 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

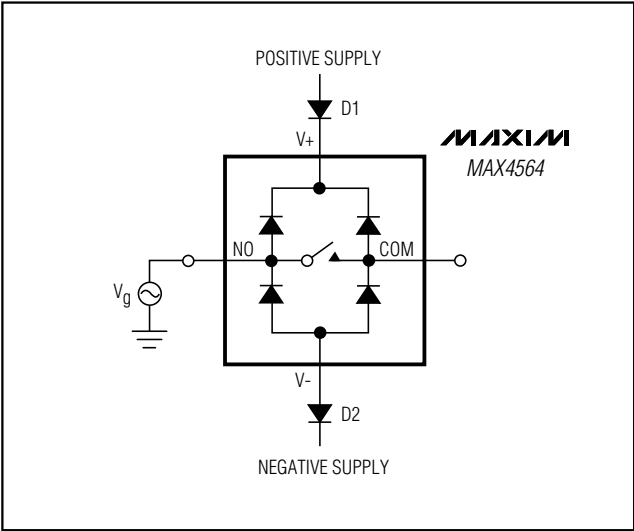


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

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

MAX 4564

The diagram shows the MAX4564 circuit and its timing characteristics. The circuit diagram on the left illustrates the MAX4564 package with pins V-, V+, V+, and COM. The input is labeled V_{IN} and the output is V_{OUT}. The input is connected to the NO or NC pin, and the output is connected to the COM pin. The input is also connected to the IN pin, which is connected to the GND pin. The output is connected to the V_{OUT} pin, which is connected to the V_{OUT} pin. The output is connected to a load resistor R_L and a load capacitor C_L (35pF). The input is connected to a logic input source. The output is connected to a logic output source. The timing diagram on the right shows the logic input waveforms V_{INH} and V_{INL} and the switch output V_{OUT}. The logic input waveforms are inverted for switches that have the opposite logic sense. The timing parameters shown are t_r < 5ns, t_f < 5ns, t_{ON}, and t_{OFF}. The output voltage is 0.9 × V_{OUT}.

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MAX4564

V- V+ V+ COM

V_{IN} NO OR NC

IN GND

LOGIC INPUT

V_{OUT} R_L C_L 35pF

C_L INCLUDES FIXTURE AND STRAY CAPACITANCE.

LOGIC INPUT V_{INH} V_{INL}

50%

t_r < 5ns t_f < 5ns

SWITCH OUTPUT

0 V_{OUT} 0.9 × V_{OUT} 0.9 × V_{OUT}

t_{ON} t_{OFF}

LOGIC INPUT WAVEFORMS INVERTED FOR SWITCHES THAT HAVE THE OPPOSITE LOGIC SENSE.

The diagram shows the MAX4564 circuit and its timing characteristics. The circuit diagram includes a MAXIM MAX4564 component with pins V-, V+, NC, NO, IN, COM, and GND. A logic input is connected to the IN pin, and a logic input signal is shown as a square wave. The output of the device is connected to the COM pin, which is also connected to a load resistor R_L and a load capacitor C_L (35pF). The output voltage is V_{OUT} . The timing diagram shows the output voltage V_{OUT} as a function of time. It illustrates the output voltage rising from a low level to a high level, with the rise time t_D defined as the time interval from the start of the rise to the point where the output voltage reaches $0.9 \times V_{OUT}$.

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Test Circuits/Timing Diagrams (continued)

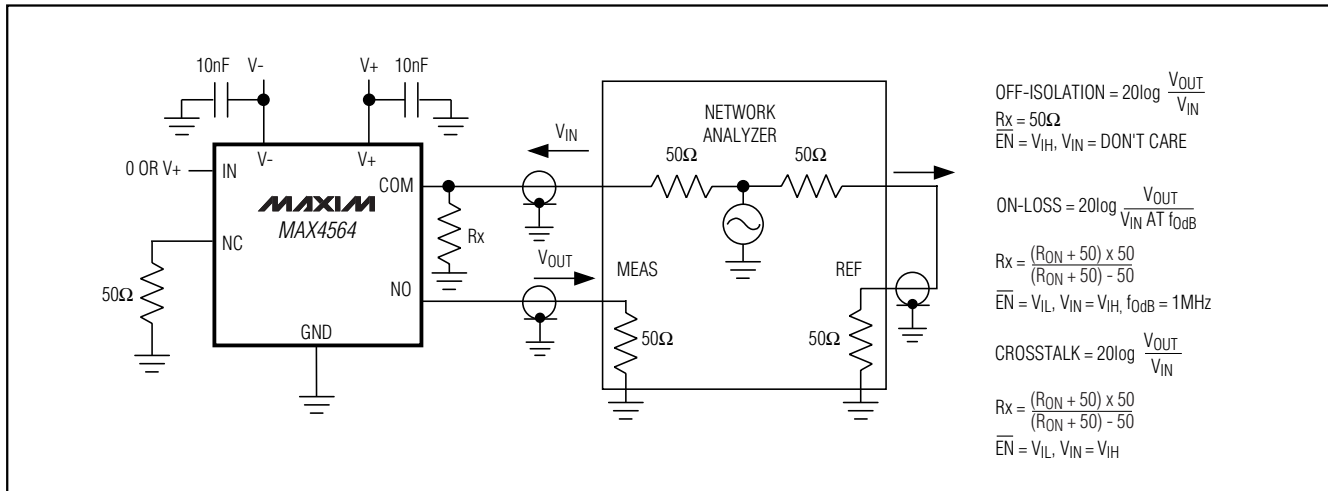


Figure 5. On-Loss, Off-Isolation, and Crosstalk

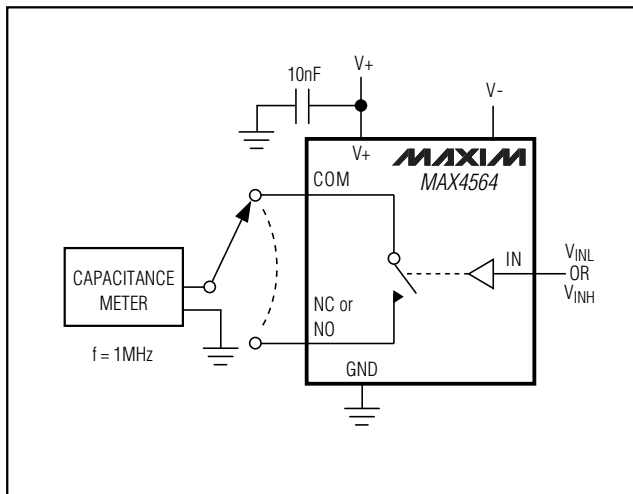


Figure 6. Channel Off/On-Capacitance

Chip Information

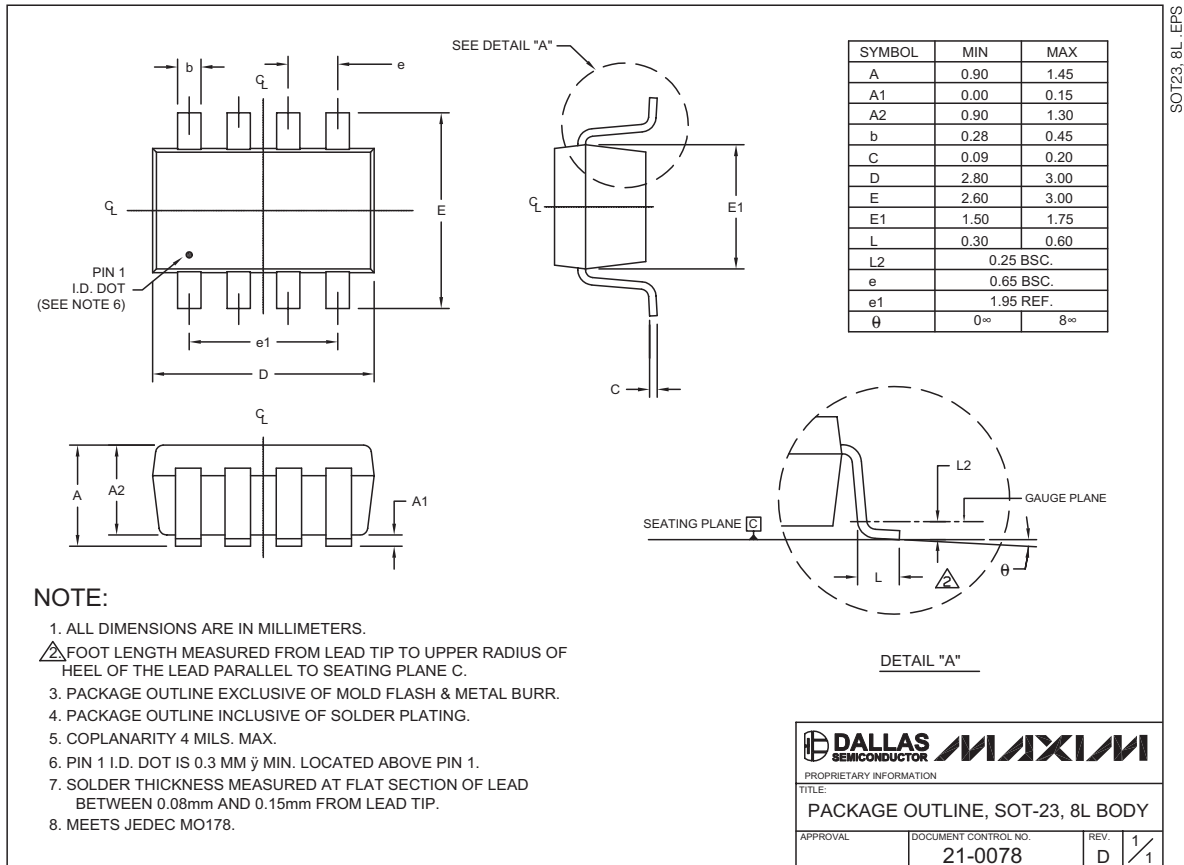
TRANSISTOR COUNT: 116

PROCESS : CMOS

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

Package Information

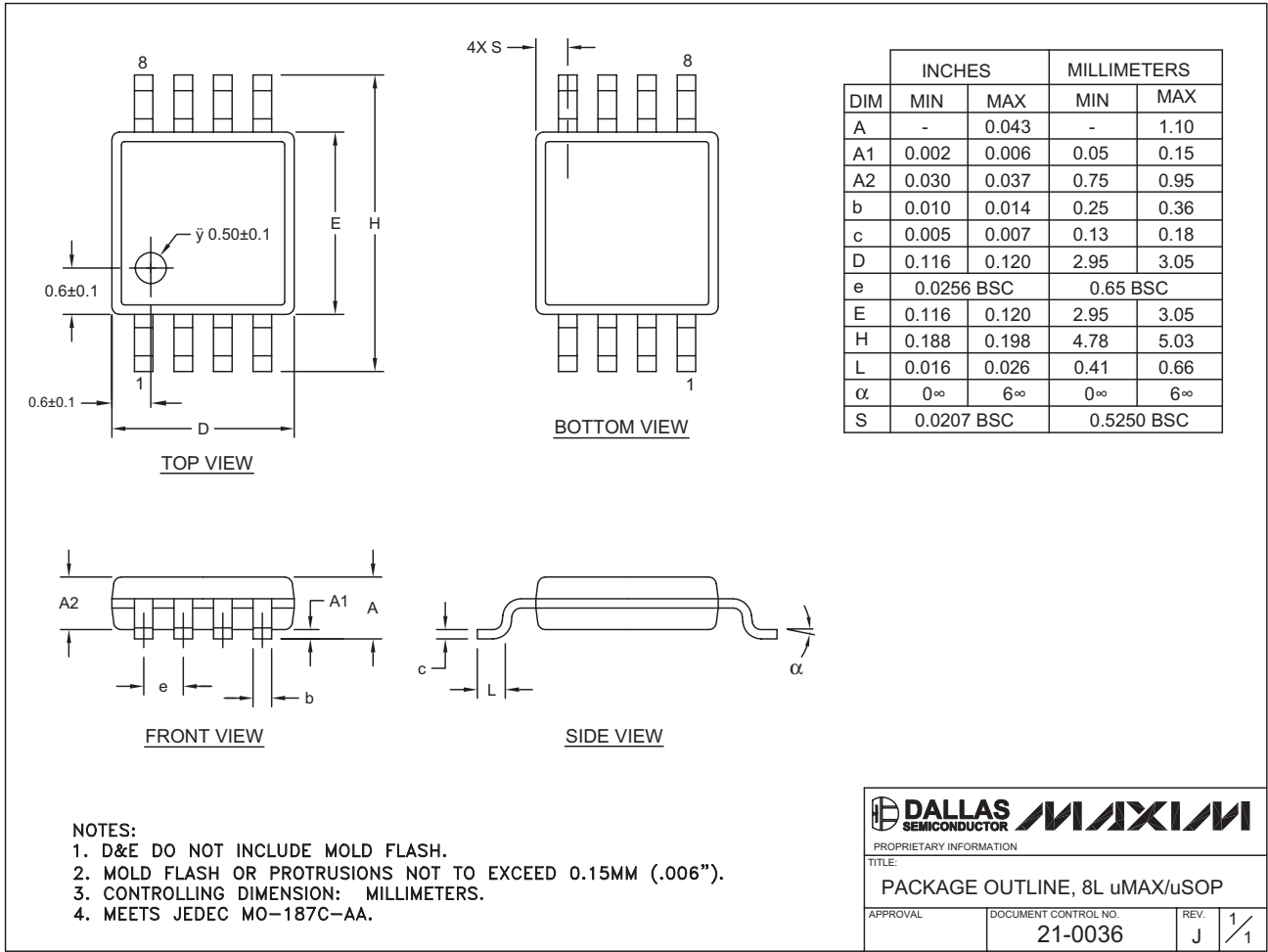
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to www.maxim-ic.com/packages.)



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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.)



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