



## Fault-Protected, Low-Voltage, Quad SPST Analog Switches

### General Description

The MAX4711/MAX4712/MAX4713 are fault-protected, Rail-to-Rail<sup>®</sup>, low-voltage analog switches featuring low on-resistance and guaranteed on-resistance flatness over the specified signal range. Due to the fault protection feature the analog switch input (NO<sub>\_</sub> or NC<sub>\_</sub>) and output (COM<sub>\_</sub>) pins are not symmetrical. The fault protection feature allows for the analog input to go beyond the plus or minus supplies without the device drawing excessive amounts of current from the analog inputs. When the analog inputs are driven beyond the supply rails when the switch is on, it will sense a fault and turn itself off and the analog switch output will be clamped to the same polarity supply as the input signal and will not go beyond the supply rails. This feature protects any electronic circuitry connected to the output from excessive voltages present on the analog inputs.

The MAX4711/MAX4712/MAX4713 are quad, single-pole/single-throw (SPST) analog switches. The MAX4711 has four normally closed switches (NC), the MAX4712 has four normally open switches (NO), and the MAX4713 has two NO and two NC switches. Switching times are less than 125ns for t<sub>ON</sub>, and less than 80ns for t<sub>OFF</sub>. These switches operate from a single +2.7V to +11V supply or from dual  $\pm$ 2.7V to  $\pm$ 5.5V supplies. All digital inputs have +0.8V to +2.4V logic thresholds, ensuring both TTL and CMOS logic compatibility when using  $\pm$ 4.5V to  $\pm$ 5.5V or single +4.5V to +11V supplies.

### Applications

Communication Systems  
Battery-Operated Systems  
Signal Routing  
Test Equipment  
Data-Acquisition  
Industrial and Process Control Systems  
Avionics  
Redundant/Backup Systems

**Pin Configurations/Functional Diagrams/Truth Tables**  
continued at end of data sheet.

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

### Features

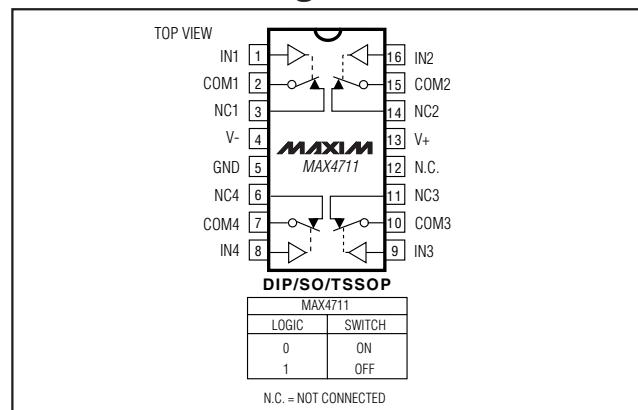
- ◆ Fault-Protected Analog Inputs
- ◆  $\pm$ 12V Fault Protection with Power Off
- ◆  $\pm$ 7V Fault Protection with  $\pm$ 5V Supplies
- ◆ +12V and -7V Fault Protection with +5V Supply
- ◆ +12V and -9V Fault Protection with +3V Supply
- ◆ Fault-Protected Digital Inputs May Exceed V+ Supply Rail
- ◆ All Switches Off with Power Off
- ◆ Rail-to-Rail Signal Handling
- ◆ Output Clamped to Appropriate Supply Voltages During Fault Condition
- ◆ 25 $\Omega$  (max) R<sub>ON</sub> at +25°C
- ◆ 1 $\Omega$  (max) On-Resistance Match Between Channels
- ◆ Single- and Dual-Supply Operation
- ◆ Pin-Compatible with Industry-Standard MAX391/MAX392/MAX393
- ◆ TTL- and CMOS-Compatible Logic Inputs

### Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX4711CUE	0°C to +70°C	16 TSSOP
MAX4711CSE	0°C to +70°C	16 Narrow SO
MAX4711CPE	0°C to +70°C	16 Plastic Dip
MAX4711EUE	-40°C to +85°C	16 TSSOP
MAX4711ESE	-40°C to +85°C	16 Narrow SO
MAX4711EPE	-40°C to +85°C	16 Plastic Dip

Ordering Information continued at end of data sheet.

### Pin Configurations/Functional Diagrams/Truth Tables



MAX4711/MAX4712/MAX4713

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## ABSOLUTE MAXIMUM RATINGS

V <sub>+</sub> .....	-0.3V to +13V
V <sub>-</sub> .....	-13V to +0.3V
V <sub>+</sub> to V <sub>-</sub> .....	-0.3V to +13V
IN .....	(V <sub>-</sub> + 12V) to (V <sub>-</sub> - 0.3V)
COM_ (Note 1) .....	(V <sub>-</sub> - 0.3V) to (V <sub>+</sub> + 0.3V)
NO_, NC_ (Note 2) .....	(V <sub>-</sub> - 12V) to (V <sub>-</sub> + 12V)
Continuous Current into Any Terminal .....	±40mA
Peak Current, into Any Terminal (pulsed at 1ms, 10% duty cycle) .....	±70mA

**Note 1:** COM\_ pin is not fault-protected. Signals on COM\_ exceeding V<sub>+</sub> or V<sub>-</sub> are clamped by internal diodes. Limit forward diode current to maximum current rating.

**Note 2:** NO\_ and NC\_ pins are fault-protected. Signals on NO\_ or NC\_ exceeding -12V to +12V may damage device. These limits apply with V<sub>+</sub> = V<sub>-</sub> = 0.

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<sub>+</sub> = +4.5V to +5.5V, V<sub>-</sub> = -4.5V to -5.5V, V<sub>IH</sub> = +2.4V, V<sub>IL</sub> = +0.8V, GND = 0, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Fault-Free Analog Signal Range	V <sub>COM_</sub> , V <sub>NO_</sub> , V <sub>NC_</sub>	Applies with power on	C, E	V-	V+	V	V
On-Resistance	R <sub>ON</sub>	V <sub>+</sub> = +4.5V, V <sub>-</sub> = -4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = ±3.5V, I <sub>OUT</sub> = 10mA	+25°C	16	25		Ω
			C, E		30		
On-Resistance Match Between Channels (Note 4)	ΔR <sub>ON</sub>	V <sub>+</sub> = +4.5V, V <sub>-</sub> = -4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = ±3.5V, I <sub>OUT</sub> = 10mA	+25°C	0.2	1		Ω
			C, E		2		
On-Resistance Flatness	R <sub>FLAT</sub>	V <sub>+</sub> = +4.5V, V <sub>-</sub> = -4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = ±3.5V, I <sub>OUT</sub> = 10mA	+25°C	1.3	4		Ω
			C, E		5		
NO_, NC_ Off-Leakage Current (Note 5)	I <sub>NO_(OFF)</sub> , I <sub>NC_(OFF)</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>COM_</sub> = ±4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = 4.5V	+25°C	-0.5	+0.5		nA
			C, E	-10	+10		
COM_ Off-Leakage Current (Note 5)	I <sub>COM_(OFF)</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>COM_</sub> = ±4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = 4.5V	+25°C	-0.5	+0.5		nA
			C, E	-10	+10		
COM_ On-Leakage Current (Note 5)	I <sub>COM_(ON)</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>COM_</sub> = ±4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = ±4.5V or floating	+25°C	-0.5	+0.5		nA
			C, E	-20	+20		
<b>FAULT</b>							
Fault-Protected Analog Signal Range	V <sub>NO_</sub> , V <sub>NC_</sub>	Applies with power on	C, E	-12 + V <sub>+</sub>	+12 + V <sub>-</sub>	V	V
Fault-Protected Analog Signal Range	V <sub>NO_</sub> , V <sub>NC_</sub>	Applies with power off	C, E	-12	+12	V	V
COM_ Output-Leakage Current, Supplies ON (Note 5)	I <sub>COM</sub>	All channels off, V <sub>+</sub> = +5V, V <sub>-</sub> = -5V, V <sub>NO_</sub> , V <sub>NC_</sub> = ±7V	+25°C	-50	+50		nA
			C, E	-500	+500		

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## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

( $V_+ = +4.5V$  to  $+5.5V$ ,  $V_- = -4.5V$  to  $-5.5V$ ,  $V_{IH} = +2.4V$ ,  $V_{IL} = +0.8V$ ,  $GND = 0$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
NO_ or NC_ Off-Leakage Current, Supplies ON (Note 5)	I <sub>NO_</sub> , I <sub>NC_</sub>	$V_+ = +5V$ , $V_- = -5V$ , $V_{NO_}$ , $V_{NC_} = \pm 7V$	+25°C	-50	+50		nA
			C, E	-500	+500		
NO_ or NC_ Input-Leakage Current, Supplies OFF (Note 5)	I <sub>NO_</sub> , I <sub>NC_</sub>	$V_{NO_}$ , $V_{NC_} = \pm 12V$ , $V_\pm = 0$	+25°C	-0.5	+0.5		μA
			C, E	-5	+5		
Output Clamp Current	I <sub>COM_</sub>	$V_{NO_}$ , $V_{NC_} = +7V$ , $V_+ = +5V$ , $V_- = -5V$	C, E	9	20	33	mA
		$V_{NO_}$ , $V_{NC_} = -7V$ , $V_+ = +5V$ , $V_- = -5V$		-33	-16	-9	
Output Clamp Resistance	R <sub>CLAMP_</sub>	$V_{NO_}$ , $V_{NC_} = \pm 7V$	+25°C	200			Ω
Fault Trip Threshold			+25°C	V- -0.4V	V+ +0.4V		V
±Fault Output Turn-On Delay Time		$V_{NO_}$ , $V_{NC_} = \pm 7V$ , $R_{COM} = 1k\Omega$	+25°C	200			ns
±Fault Recovery Time		$V_{NO_}$ , $V_{NC_} = \pm 7V$ , $R_{COM} = 1k\Omega$	+25°C	700			ns
<b>LOGIC INPUT</b>							
Input Logic High	V <sub>IH</sub>		C, E	2.4			V
Input Logic Low	V <sub>IL</sub>		C, E		0.8		V
Input-Leakage Current (Note 5)	I <sub>IN</sub>	$V_{IN_} = 0$ or $V_+$	+25°C	-1	+1		μA
			C, E	-5	+5		
<b>SWITCH DYNAMICS</b>							
Turn-On Time	t <sub>ON</sub>	$V_{NO_}$ or $V_{NC_} = \pm 3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	80	125		ns
			C, E		150		
Turn-Off Time	t <sub>OFF</sub>	$V_{NO_}$ or $V_{NC_} = \pm 3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	50	80		ns
			C, E		100		
Break-Before-Make Time Delay (MAX4713 only)	t <sub>BBM</sub>	$V_{NO_}$ or $V_{NC_} = \pm 3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	15	30		ns
			C, E	5			
Charge Injection	Q	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1nF$ , Figure 4	+25°C	25			pC
NO_ or NC_ Off-Capacitance	C <sub>N(OFF)</sub>	f = 1MHz, Figure 5	+25°C	8			pF
COM_ Off-Capacitance	C <sub>COM(OFF)</sub>	f = 1MHz, Figure 5	+25°C	8			pF
COM_ On-Capacitance	C <sub>COM(ON)</sub>	f = 1MHz, Figure 5	+25°C	30			pF
Off-Isolation (Note 6)	V <sub>ISO</sub>	$R_L = 50\Omega$ , $C_L = 15pF$ , $P_{IN} = 0$ , f = 1MHz, Figure 6	+25°C		-59		dB
Channel-to-Channel Crosstalk (Note 7)	V <sub>CT</sub>	$R_L = 50\Omega$ , $C_L = 15pF$ , $P_{IN} = 0$ , f = 1MHz, Figure 6	+25°C		-87		dB

**MAX4711/MAX4712/MAX4713**

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## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V<sub>+</sub> = +4.5V to +5.5V, V<sub>-</sub> = -4.5V to -5.5V, 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.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>POWER SUPPLY</b>							
Power-Supply Range	V <sub>+</sub> , V <sub>-</sub>		C, E	±2.7	±5.5		V
V <sub>+</sub> Supply Current	I <sub>+</sub>	All V <sub>IN_</sub> = 0 or V <sub>+</sub>	+25°C	38	75		μA
			C, E		100		
V <sub>-</sub> Supply Current	I <sub>-</sub>	All V <sub>IN_</sub> = 0 or V <sub>+</sub>	+25°C	38	75		μA
			C, E		100		
GND Supply Current	I <sub>GND</sub>	All V <sub>IN_</sub> = 0 or V <sub>+</sub>	+25°C	0	1		μA
			C, E		10		

## ELECTRICAL CHARACTERISTICS—+5V Single Supply

(V<sub>+</sub> = +4.5V to +5.5V, V<sub>-</sub> = 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.) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Fault-Free Analog Signal Range	V <sub>COM_</sub> , V <sub>NO_</sub> , V <sub>NC_</sub>	Power on	C, E	V <sub>-</sub>	V <sub>+</sub>		V
On-Resistance	R <sub>ON</sub>	V <sub>+</sub> = +4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = +3.5V, I <sub>OUT</sub> = 10mA	+25°C	30	40		Ω
			C, E		50		
On-Resistance Match Between Channels (Note 4)	ΔR <sub>ON</sub>	V <sub>+</sub> = +4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = +3.5V, I <sub>OUT</sub> = 10mA	+25°C	0.3	2		Ω
			C, E		3		
On-Resistance Flatness	R <sub>FLAT</sub>	V <sub>+</sub> = +4.5V, V <sub>NO_</sub> , V <sub>NC_</sub> = +1.5V, +2.25V, +3.5V, I <sub>OUT</sub> = 10mA	+25°C	2	5		Ω
			C, E		6		
NO <sub>_</sub> , NC <sub>_</sub> Off-Leakage Current (Note 5)	I <sub>NO_(OFF)</sub> , I <sub>NC_(OFF)</sub>	V <sub>+</sub> = +5.5V, V <sub>COM_</sub> = +1V, +4.5V; V <sub>NO_</sub> , V <sub>NC_</sub> = +4.5V, +1V	+25°C	-0.5	+0.5		nA
			C, E	-10	+10		
COM <sub>_</sub> Off-Leakage Current (Note 5)	I <sub>COM_(OFF)</sub>	V <sub>+</sub> = +5.5V, V <sub>COM_</sub> = +1V, +4.5V; V <sub>NO_</sub> , V <sub>NC_</sub> = +4.5V, +1V	+25°C	-0.5	+0.5		nA
			C, E	-10	+10		
COM <sub>_</sub> On-Leakage Current (Note 5)	I <sub>COM_(ON)</sub>	V <sub>+</sub> = +5.5V, V <sub>COM_</sub> = +1V, +4.5V; V <sub>NO_</sub> , V <sub>NC_</sub> = +1V, +4.5V, or floating	+25°C	-0.5	+0.5		nA
			C, E	-20	+20		
<b>FAULT</b>							
Fault-Protected Analog Signal Range	V <sub>NO_</sub> , V <sub>NC_</sub>	Power on	C, E	-12 + V <sub>+</sub>	+12		V

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

( $V_+ = +4.5V$  to  $+5.5V$ ,  $V_- = 0$ ,  $V_{IH} = +2.4V$ ,  $V_{IL} = +0.8V$ ,  $GND = 0$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	$T_A$	MIN	TYP	MAX	UNITS
Fault-Protected Analog Signal Range	$V_{NO\_}, V_{NC\_}$	Power off	C, E	-12		+12	V
COM_ Output-Leakage Current, Supplies ON (Note 5)	$I_{COM\_}$	All channels off; $V_{NO\_}, V_{NC\_} = +12V$ or $-7V$ , $V_+ = +5V$	+25°C	-50	+50		nA
			C, E	-500		+500	
NO_ or NC_ Off-Leakage Current, Supplies ON (Note 5)	$I_{NO\_}, I_{NC\_}$	$V_{NO\_}, V_{NC\_} = +12V$ or $-7V$ , $V_+ = +5V$	+25°C	-50	+50		nA
			C, E	-500		+500	
NO_ or NC_ Input-Leakage Current, Supplies OFF (Note 5)	$I_{NO\_}, I_{NC\_}$	$V_{NO\_}, V_{NC\_} = \pm 12V$ , $V_\pm = 0$	+25°C	-0.5	+0.5		μA
			C, E	-5		+5	
Output Clamp Current	$I_{COM\_}$	$V_{NO\_}, V_{NC\_} = +12V$ , $V_+ = 5V$	C, E	2	6	11	mA
Output Clamp Resistance	$R_{CLAMP\_}$	Clamp on	+25°C		500		Ω
+Fault Output Turn-On Delay Time		$V_{NO\_}, V_{NC\_} = +12V$ , $R_L = 300\Omega$ , $V_+ = +5V$	+25°C		200		ns
+Fault Recovery Time		$V_{NO\_}, V_{NC\_} = +12V$ , $R_L = 300\Omega$ , $V_+ = +5V$	+25°C		500		μs
<b>LOGIC INPUT</b>							
Input Logic High	$V_{IH}$		C, E	2.4			V
Input Logic Low	$V_{IL}$		C, E		0.8		V
Input-Leakage Current (Note 5)	$I_{IN}$	$V_{IN\_} = 0$ or $V_+$	C, E	-1		+1	μA
<b>SWITCH DYNAMICS</b>							
Turn-On Time	$t_{ON}$	$V_{NO\_}$ or $V_{NC\_} = +3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	170	230		ns
			C, E		275		
Turn-Off Time	$t_{OFF}$	$V_{NO\_}$ or $V_{NC\_} = +3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	55	100		ns
			C, E		125		
Break-Before-Make Time Delay (MAX4713 only)	$t_{BBM}$	$V_{NO\_}$ or $V_{NC\_} = +3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	30	115		ns
			C, E	20			
Charge Injection	$Q$	$V_{GEN} = 0$ , $R_{GEN} = 0$ , $C_L = 1nF$ , Figure 4	+25°C		-1		pC
<b>POWER SUPPLY</b>							
Power-Supply Range	$V_+$		C, E	2.7	11		V
V+ Supply Current	$I_+$	All $V_{IN\_} = 0$ or $V_+$	+25°C	34	65		μA
			C, E		75		

MAX4711/MAX4712/MAX4713

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## ELECTRICAL CHARACTERISTICS—+3V Single Supply

( $V_+ = +2.7V$  to  $+3.6V$ ,  $V_- = 0$ ,  $V_{IH} = +2.0V$ ,  $V_{IL} = +0.6V$ ,  $GND = 0$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	$T_A$	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Fault-Free Analog Signal Range	$V_{COM\_}$ , $V_{NO\_}$ , $V_{NC\_}$	Power-on	C, E	$V_-$	$V_+$		V
On-Resistance	$R_{ON}$	$V_+ = +2.7V$ , $V_{NO\_}$ , $V_{NC\_} = +1V$ , $I_{OUT} = 1mA$	+25°C	54	75		$\Omega$
			C, E		100		
On-Resistance Match Between Channels (Note 4)	$\Delta R_{ON}$	$V_+ = +2.7V$ , $V_{NO\_}$ , $V_{NC\_} = +1V$ , $I_{OUT} = 1mA$	+25°C	1	7		$\Omega$
			C, E		9		
NO_, NC_ Off-Leakage Current (Note 5)	$I_{NO\_OFF}$ , $I_{NC\_OFF}$	$V_+ = +3.6V$ , $V_{COM\_} = +0.7V$ , $+3V$ ; $V_{NO\_}$ , $V_{NC\_} = +3V$ , $+0.7V$	+25°C	-0.5	+0.5		nA
			C, E	-10	+10		
COM_ Off-Leakage Current (Note 5)	$I_{COM\_OFF}$	$V_+ = +3.6V$ , $V_{COM\_} = +0.7V$ , $+3V$ ; $V_{NO\_}$ , $V_{NC\_} = +3V$ , $+0.7V$	+25°C	-0.5	+0.5		nA
			C, E	-10	+10		
COM_ On-Leakage Current (Note 5)	$I_{COM\_ON}$	$V_+ = +3.6V$ , $V_{COM\_} = +0.7$ , $+3V$ ; $V_{NO\_}$ , $V_{NC\_} = +0.7V$ , $+3V$ , or floating	+25°C	-0.5	+0.5		nA
			C, E	-20	+20		
<b>FAULT</b>							
Fault-Protected Analog Signal Range	$V_{NO\_}$ , $V_{NC\_}$	Power-on	C, E	$-12 + V_+$	$+12$		V
Fault-Protected Analog Signal Range	$V_{NO\_}$ , $V_{NC\_}$	Power-off	C, E	-12	+12		V
COM_ Output-Leakage Current, Supplies ON (Note 5)	$I_{COM}$	All channels off; $V_{NO\_}$ , $V_{NC\_} = +12V$ or $-9V$ , $V_+ = +3V$	+25°C	-50	+50		nA
			C, E	-500	+500		
NO_ or NC_ Off-Leakage Current, Supplies ON (Note 5)	$I_{NO\_}$ , $I_{NC\_}$	$V_{NO\_}$ , $V_{NC\_} = +12V$ or $-9V$ , $V_+ = +3V$	+25°C	-50	+50		nA
			C, E	-500	+500		
NO_ or NC_ Input-Leakage Current, Supplies OFF (Note 5)	$I_{NO\_}$ , $I_{NC\_}$	$V_{NO\_}$ , $V_{NC\_} = \pm 12V$ , $V_{\pm} = 0$	+25°C	-0.5	+0.5		$\mu A$
			C, E	-5	+5		
Output Clamp Current	$I_{COM\_}$	$V_{NO\_}$ , $V_{NC\_} = +12V$ , $V_+ = +3V$	C, E	0.5	3.0		mA
Output Clamp Resistance	$R_{CLAMP\_}$	$V_+ = +3V$ , $V_{NO\_}$ , $V_{NC\_} = +12V$ ; clamp on	+25°C		600		k $\Omega$
+Fault Output Turn-On Delay Time		$V_{NO\_}$ , $V_{NC\_} = +12V$ , $R_L = 300\Omega$ , $V_+ = +3V$	+25°C		200		ns
+Fault Recovery Time		$V_{NO\_}$ , $V_{NC\_} = +12V$ , $R_L = 300\Omega$ , $V_+ = +3V$	+25°C		2.2		$\mu s$

# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

## ELECTRICAL CHARACTERISTICS—+3V Single Supply (continued)

( $V_+ = +2.7V$  to  $+3.6V$ ,  $V_- = 0$ ,  $V_{IH} = +2.0V$ ,  $V_{IL} = +0.6V$ ,  $GND = 0$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 3)

PARAMETER	SYMBOL	CONDITIONS	$T_A$	MIN	TYP	MAX	UNITS
<b>LOGIC INPUT</b>							
Input Logic High	$V_{IH}$		C, E	2			V
Input Logic Low	$V_{IL}$		C, E		0.6		V
Input-Leakage Current (Note 5)	$I_{IN_-}$	$V_{IN_-} = 0$ or $V_+$	C, E	-5		+5	$\mu A$
<b>SWITCH DYNAMICS</b>							
Turn-On Time	$t_{ON}$	$V_+ = +2.7V$ , $V_{NO_-}$ or $V_{NC_-} = +1.5V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	340	500		ns
			C, E		600		
Turn-Off Time	$t_{OFF}$	$V_+ = +2.7V$ , $V_{NO_-}$ or $V_{NC_-} = +1.5V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	100	175		ns
			C, E		225		
Break-Before-Make Time Delay (MAX4713 only)	$t_{BBM}$	$V_+ = +2.7V$ , $V_{NO_-}$ or $V_{NC_-} = +1.5V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2	+25°C	60	240		ns
			C, E	50			
<b>POWER SUPPLY</b>							
Power-Supply Range	$V_+$		C, E	2.7	11		V
V <sub>+</sub> Supply Current	$I_+$	All $V_{IN_-} = 0$ or $V_+$	+25°C	8	15		$\mu A$
			C, E		20		

**Note 3:** Algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.

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

**Note 5:** Leakage parameters are 100% tested at maximum-rated temperature and with dual supplies. Leakage parameters are guaranteed by correlation at  $+25^\circ C$ .

**Note 6:** Off-isolation =  $20 \log_{10} [V_{COM_-}/(V_{NO_-} \text{ or } V_{NC_-})]$ ,  $V_{COM_-}$  = output,  $V_{NO_-}$  or  $V_{NC_-}$  = input to off switch.

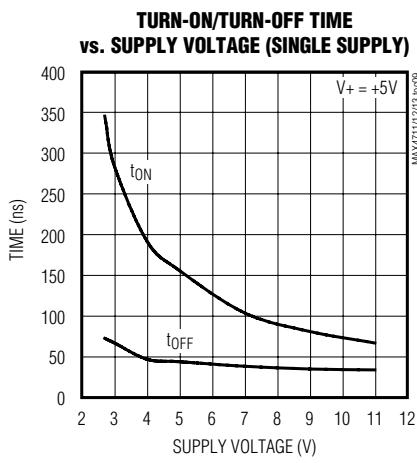
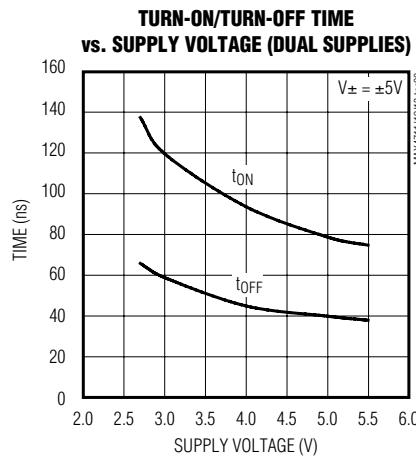
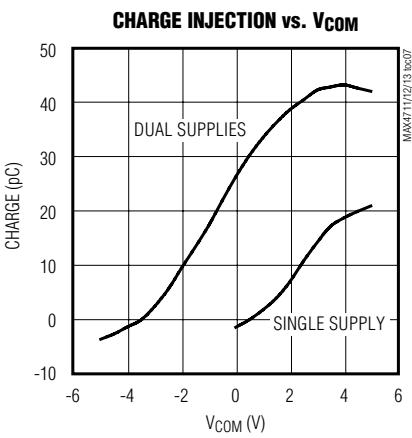
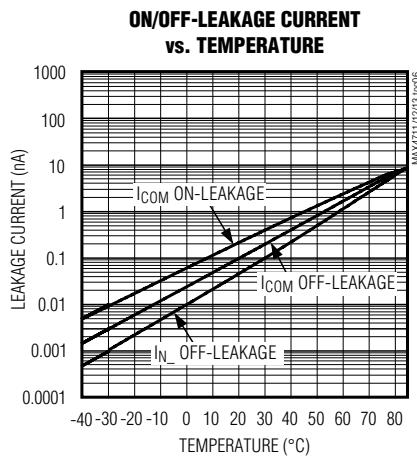
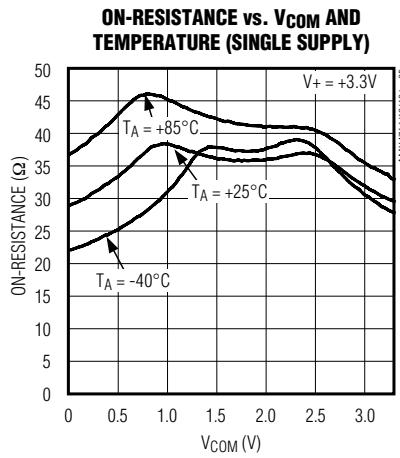
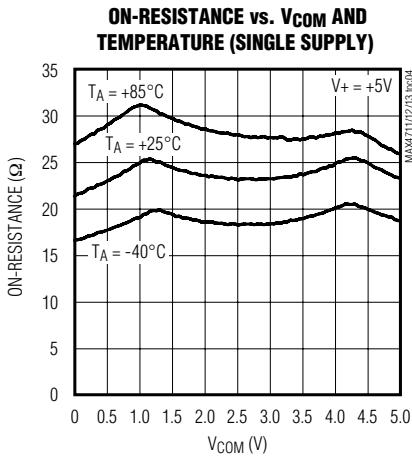
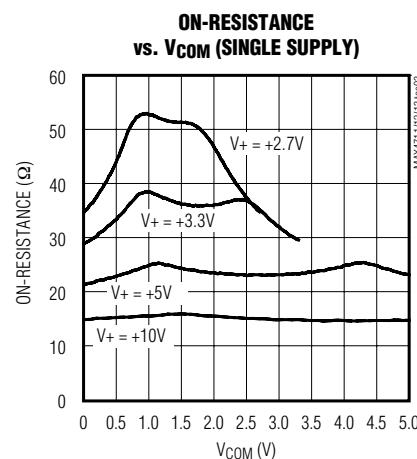
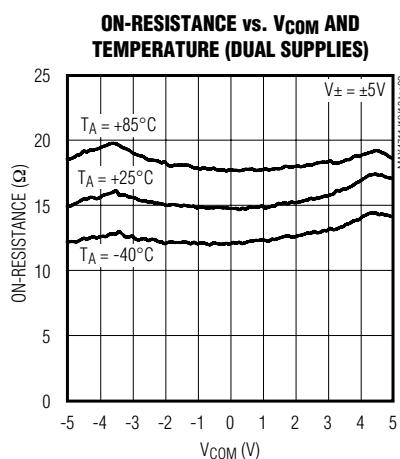
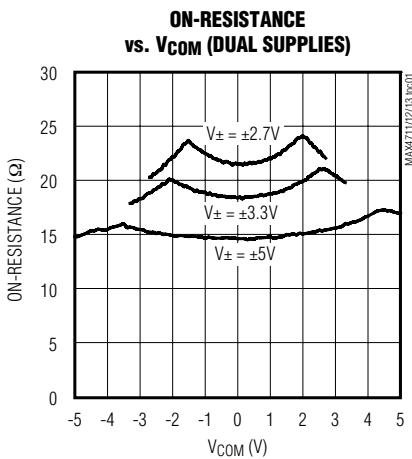
**Note 7:** Between any two switches.

MAX4711/MAX4712/MAX4713

# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

## Typical Operating Characteristics

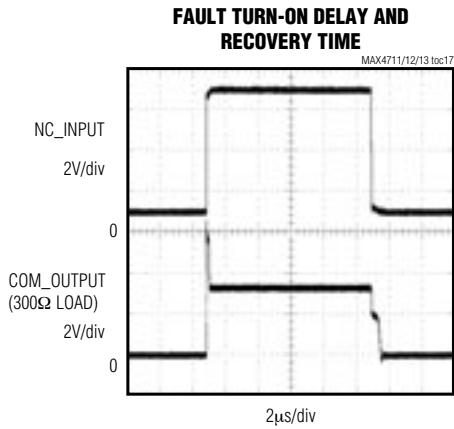
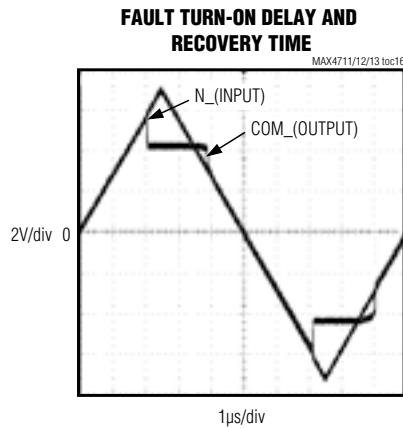
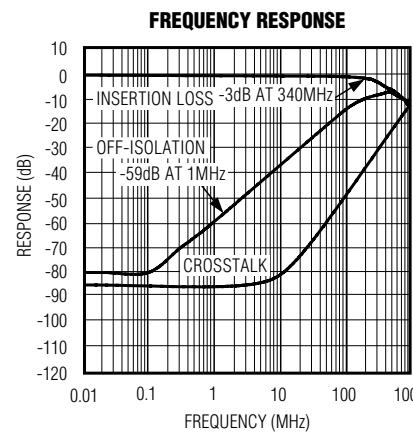
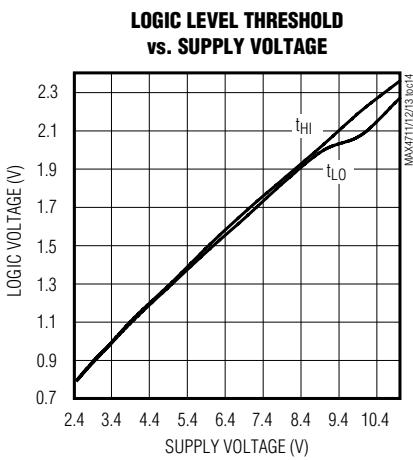
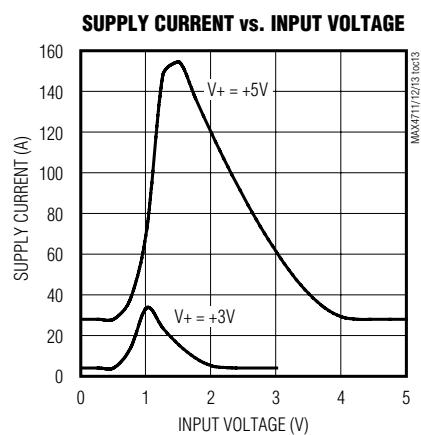
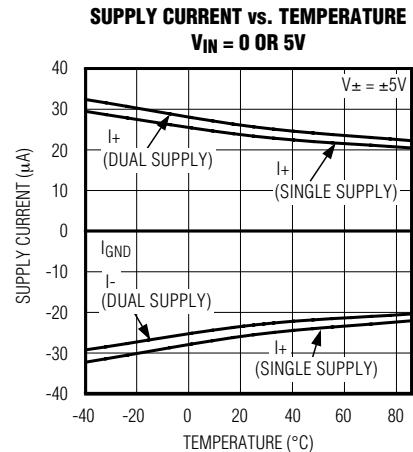
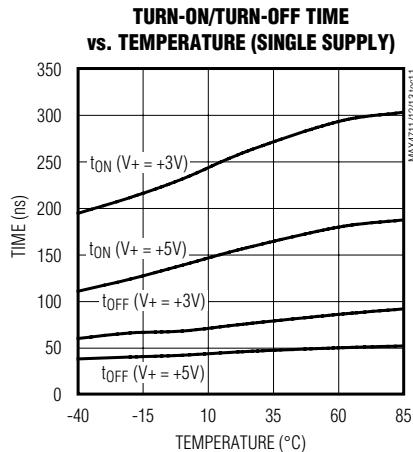
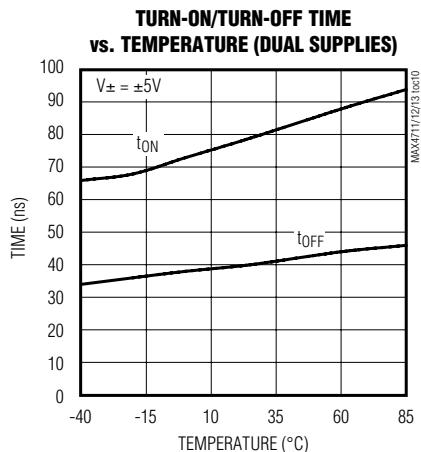
( $V_+ = +5V$ ,  $V_- = -5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



## **Fault-Protected, Low-Voltage, Quad SPST Analog Switches**

### **Typical Operating Characteristics (continued)**

( $V_+ = +5V$ ,  $V_- = -5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

## Pin Description

PIN			NAME	FUNCTION
MAX4711	MAX4712	MAX4713		
1, 16, 9, 8	1, 16, 9, 8	1, 16, 9, 8	IN1, IN2, IN3, IN4	Logic Inputs. Fault-protected to (V- + 12V).
2, 15, 10, 7	2, 15, 10, 7	2, 15, 10, 7	COM1, COM2, COM3, COM4	Analog Switch Common Terminals
3, 14, 11, 6	—	—	NC1, NC2, NC3, NC4	Fault-Protected Analog Switch Normally Closed Terminals
—	3, 14, 11, 6	—	NO1, NO2, NO3, NO4	Fault-Protected Analog Switch Normally Open Terminals
—	—	3, 6	NO1, NO4	Fault-Protected Analog Switch Normally Open Terminals
—	—	14, 11	NC2, NC3	Fault-Protected Analog Switch Normally Closed Terminals
4	4	4	V-	Negative Supply Voltage Input. Connect to GND for single-supply operation.
5	5	5	GND	Ground
12	12	12	N.C.	No Connection. Not internally connected.
13	13	13	V+	Positive Supply Input

## Detailed Description

The MAX4711/MAX4712/MAX4713 differ considerably from traditional fault-protection switches, with several advantages. First, they are constructed with two parallel FET's allowing very low on-resistance. Second, they allow signals on the NC<sub>\_</sub> or NO<sub>\_</sub> pins that are within or slightly beyond the supply rails to be passed through the switch to the COM terminal, allowing rail-to-rail signal operation. Third, when a signal on NC<sub>\_</sub> or NO<sub>\_</sub> exceeds the supply rails by about 150mV (a fault condition) the voltage on COM<sub>\_</sub> is limited to the same polarity supply voltage. Operation is identical for both fault polarities.

During a fault condition, the NO<sub>\_</sub> or NC<sub>\_</sub> input becomes high impedance regardless of the switch state or load resistance. If the switch is on, the COM<sub>\_</sub> output current is supplied from V<sub>+</sub> or V<sub>-</sub> by the clamp FET's that are connected from COM to each supply. These FET's can typically source or sink up to 15mA. When power is removed, the fault protection is still in effect. In this case, the NO<sub>\_</sub> or NC<sub>\_</sub> terminals are a virtual open circuit. The fault can be up to  $\pm 12V$ .

The COM<sub>\_</sub> pins are not fault-protected, they act as normal CMOS switch terminals. If a voltage source is connected to any COM<sub>\_</sub> pin, it should be limited to the supply voltages. Exceeding the supply voltage will

cause high currents to flow through the ESD-protected diodes, possibly damaging the device (see *Absolute Maximum Ratings*).

## Pin Compatibility

These switches have identical pinouts to common non-fault-protected CMOS switches. Care should be exercised while considering them for direct replacements in existing printed circuit boards since only the NO<sub>\_</sub> and NC<sub>\_</sub> pins of each switch are fault-protected.

## Internal Construction

Internal construction is shown in Figure 1, with the analog signal paths shown in bold. A single NO switch is shown; the NC configuration is identical except the logic-level translator is inverting. The analog switch is formed by the parallel combination of N-channel FET (N1) and P-channel FET (P1), which are driven on and off simultaneously according to the input fault condition and the logic-level state.

## Normal Operation

Two comparators continuously compare the voltage on the NO<sub>\_</sub> (or NC<sub>\_</sub>) pin with V<sub>+</sub> and V<sub>-</sub>. When the signal on NO<sub>\_</sub> or NC<sub>\_</sub> is between V<sub>+</sub> and V<sub>-</sub> the switch acts normally, with FETs N1 and P1 turning on and off in response to IN<sub>\_</sub> signals. The parallel combination of N1 and P1 forms a low-value resistor between NO<sub>\_</sub> (or

# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

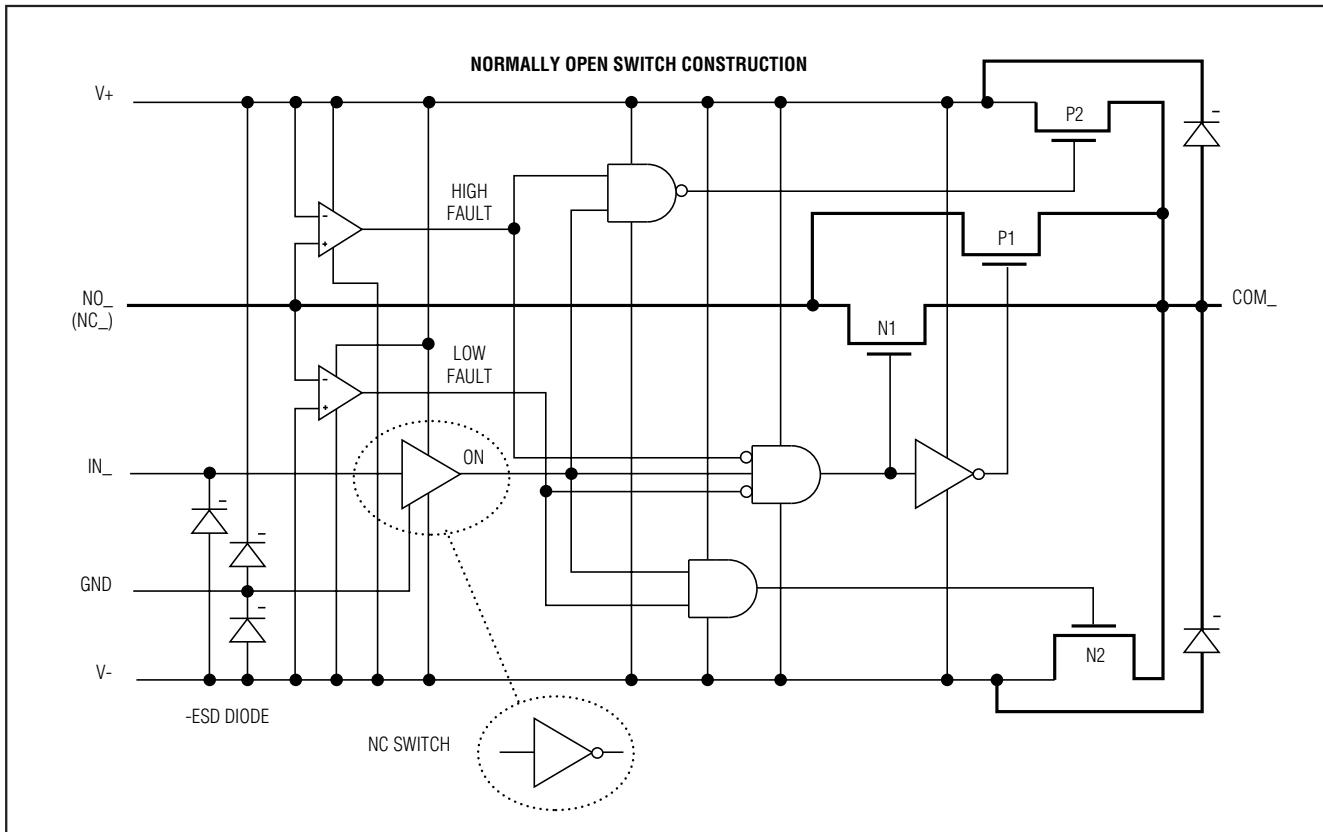


Figure 1. Block Diagram

NC\_) and COM\_ so that signals pass equally well in either direction.

### Positive Fault Condition

When the signal on NO\_ (or NC\_) exceeds V+ by about 150mV, the high-fault comparator output is high, turning off FETs N1 and P1. This makes the NO\_ (or NC\_) input high impedance regardless of the switch state. If the switch state is “off”, all FETs are turned off and both NO\_ (or NC\_) and COM\_ are high impedance. If the switch state is “on”, clamp FET P2 is turned on, sourcing current from V+ to COM\_.

### Negative Fault Condition

When the signal on NO\_ (or NC\_) exceeds V- by about 150mV, the low-fault comparator output is high, turning off FETs N1 and P1. This makes the NO\_ (or NC\_) input high impedance regardless of the switch state. If the switch state is “off”, all FETs are turned off and both NO\_ (or NC\_) and COM\_ are high impedance. If the switch state is “on”, clamp FET N2 is turned on, sinking current from COM\_ to V-.

### Transient Fault Response and Recovery

When a fast rise-time or fall-time transient on NC\_ or NO\_ exceeds V+ or V-, the output (COM\_) follows the input to the supply rail with only a few nanoseconds delay. This delay is due to the switch on-resistance and circuit capacitance to ground. When the input transient returns to within the supply rails, however, there is a 700ns output recovery delay time. These values depend on the COM\_ output resistance and capacitance, and are not production tested or guaranteed. The delays are not dependent on the fault amplitude. Higher COM\_ output resistance and capacitance increase recovery times.

### COM\_ and IN\_ Pins

FETs N2 and P2 can source about  $\pm 15\text{mA}$  from V+ or V- to COM\_ in the fault condition. Ensure that if the COM\_ pin is connected to a low-resistance load, the absolute maximum current rating of 40mA is never exceeded both in normal and fault conditions.

## Fault-Protected, Low-Voltage, Quad SPST Analog Switches

The COM\_ pins do not have fault protection. Reverse ESD-protection diodes are internally connected between COM\_ and V+ and V-. If a signal on COM\_ exceeds V+ or V- by more than a diode drop, one of these diodes will conduct. The IN\_ pin can exceed the positive supply voltage, but they can go below the negative supply by only a diode drop. The maximum voltage on these pins is 12V if operating from a single supply, regardless of the supply voltage (including 0 volts), and if operating from dual supplies, the maximum voltage is (V- + 12V).

### Fault-Protection Voltage and Power Off

The maximum fault voltage on the NC\_ or NO\_ pins is  $\pm 12V$  with power off.

### IN\_ Logic-Level Thresholds

The logic-level thresholds are CMOS and TTL compatible when using  $\pm 4.5V$  to  $\pm 5.5V$  or single  $+4.5V$  to  $+11V$  supplies. When using a  $+2.7V$  supply, the logic thresholds are  $V_{IH} = 2.0V$  and  $V_{IL} = 0.6V$ .

### Dual Supplies

The MAX4711/MAX4712/MAX4713 operate with bipolar supplies between  $\pm 2.7V$  and  $\pm 5.5V$ . The V+ and V- supplies need not be symmetrical, but their difference should not exceed 11V.

### Single Supply

The MAX4711/MAX4712/MAX4713 operate from a single supply between  $+2.7V$  and  $+11V$  when V- is connected to GND.

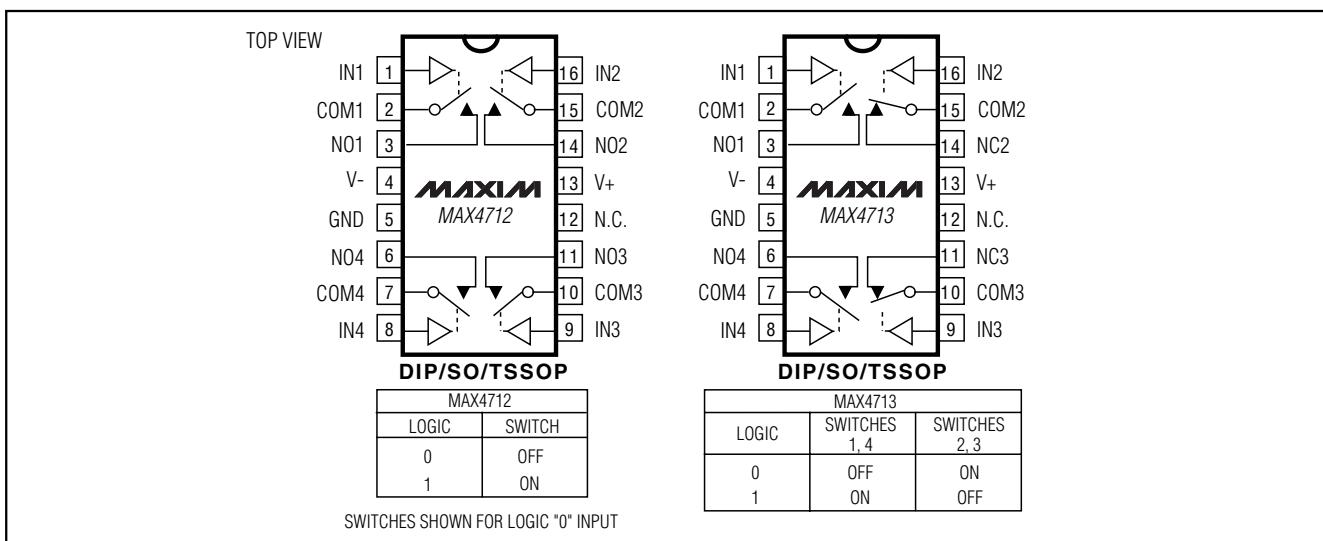
### Chip Information

TRANSISTOR COUNT: 463

### Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE
MAX4712CUE	0°C to +70°C	16 TSSOP
MAX4712CSE	0°C to +70°C	16 Narrow SO
MAX4712CPE	0°C to +70°C	16 Plastic Dip
MAX4712EUE	-40°C to +85°C	16 TSSOP
MAX4712ESE	-40°C to +85°C	16 Narrow SO
MAX4712EPE	-40°C to +85°C	16 Plastic Dip
MAX4713CUE	0°C to +70°C	16 TSSOP
MAX4713CSE	0°C to +70°C	16 Narrow SO
MAX4713CPE	0°C to +70°C	16 Plastic Dip
MAX4713EUE	-40°C to +85°C	16 TSSOP
MAX4713ESE	-40°C to +85°C	16 Narrow SO
MAX4713EPE	-40°C to +85°C	16 Plastic Dip

### Pin Configurations/Functional Diagrams/Truth Tables (continued)



# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

## Test Circuits/Timing Diagrams

**MAX4711/MAX4712/MAX4713**

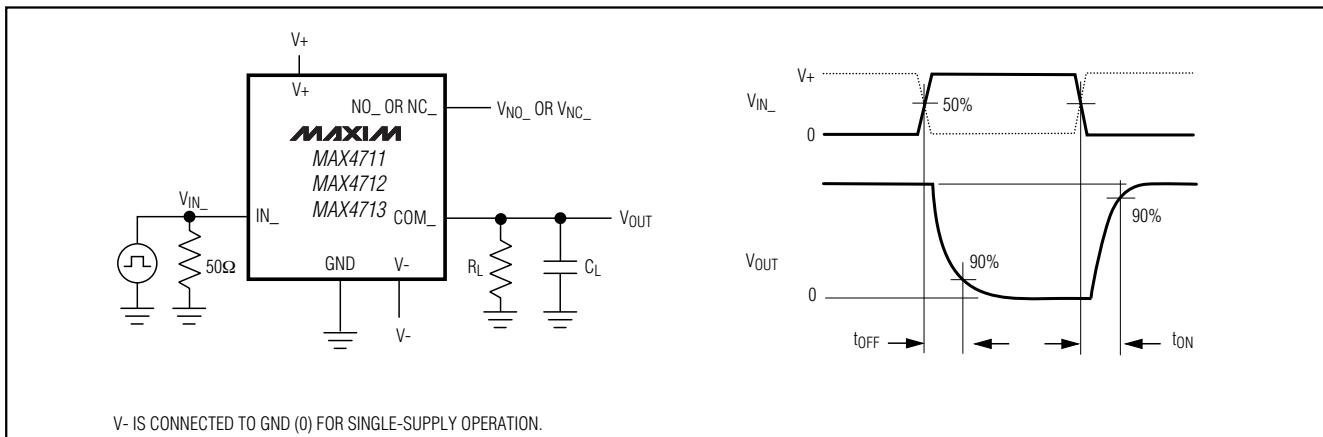


Figure 2. Switch Turn-On/Turn-Off Times

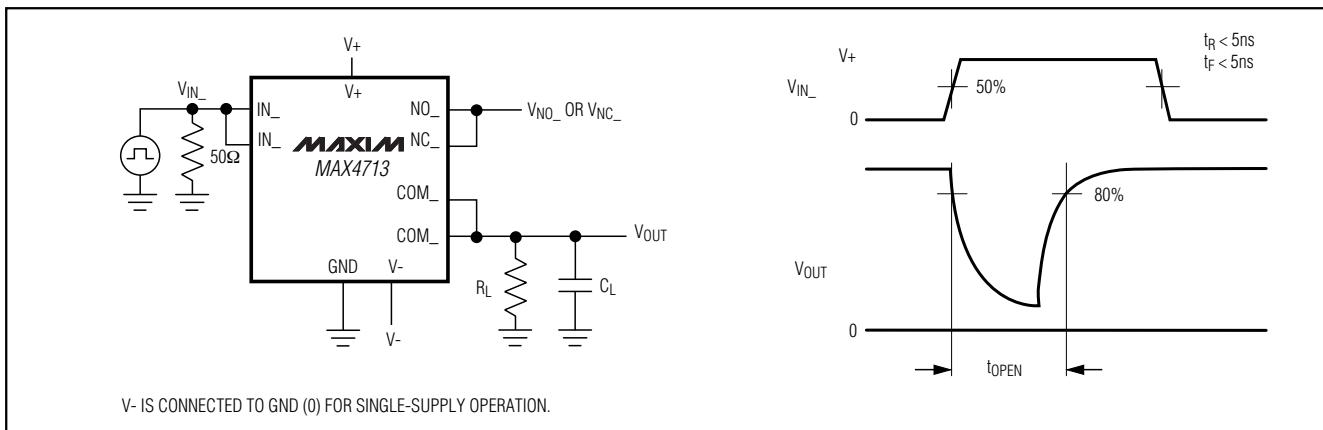


Figure 3. MAX4713 Break-Before-Make Interval

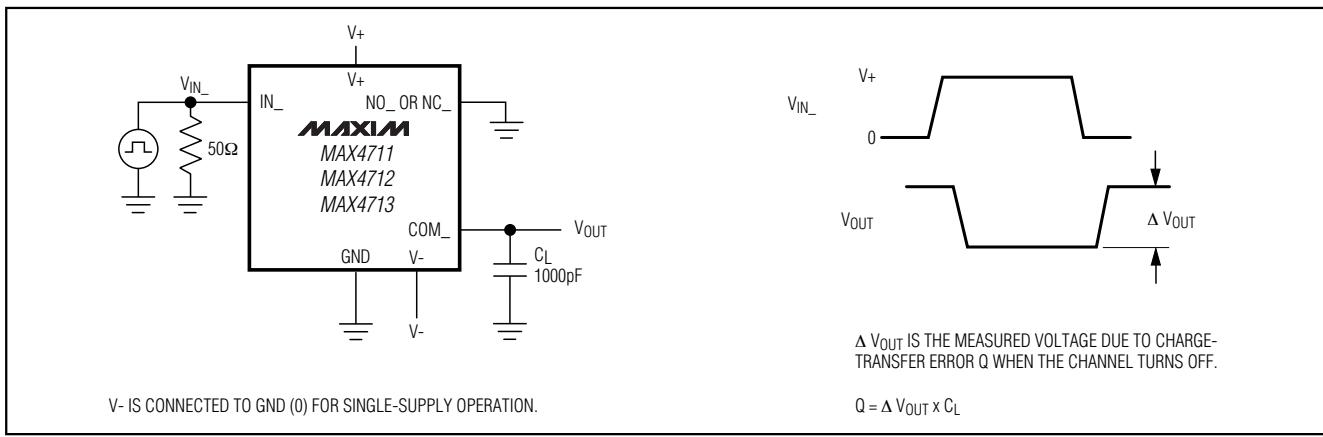


Figure 4. Charge Injection

## Fault-Protected, Low-Voltage, Quad SPST Analog Switches

### Test Circuits/Timing Diagrams (continued)

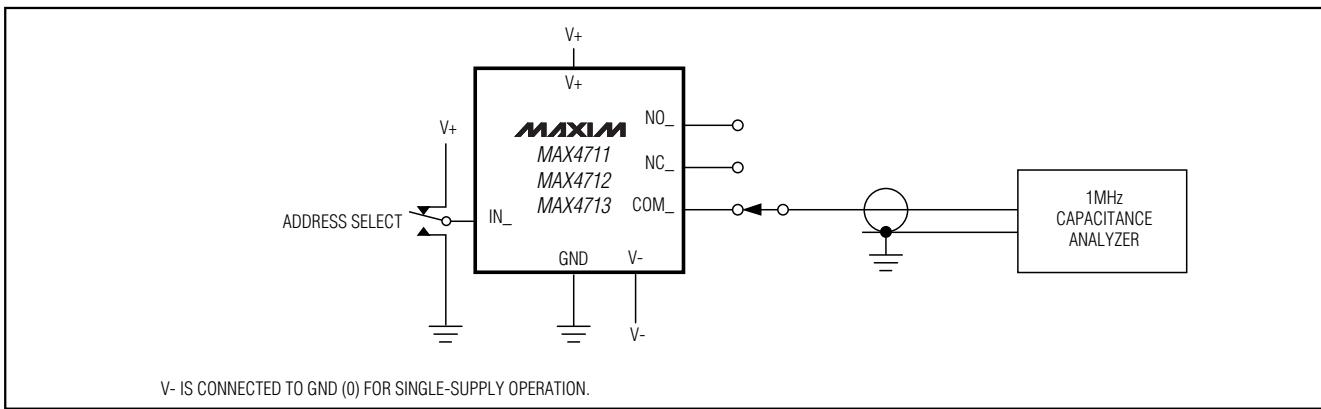


Figure 5. *COM<sub>l</sub>, NO<sub>l</sub>, NC<sub>l</sub> Capacitance*

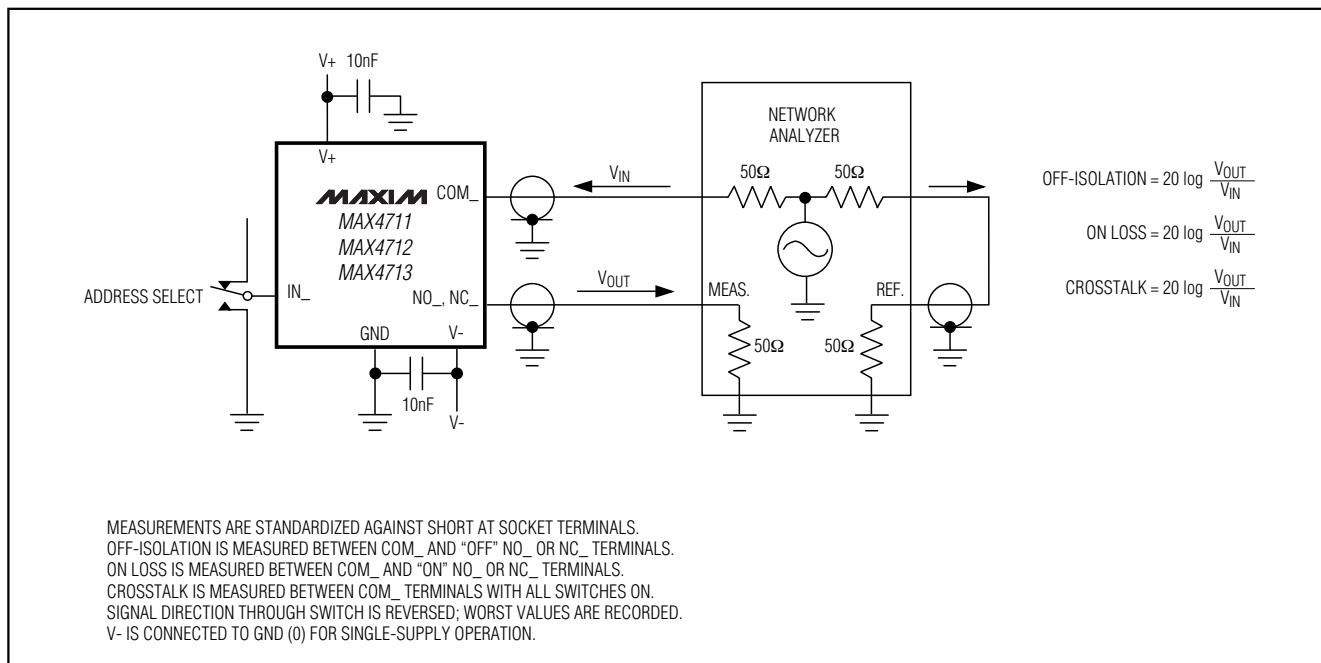
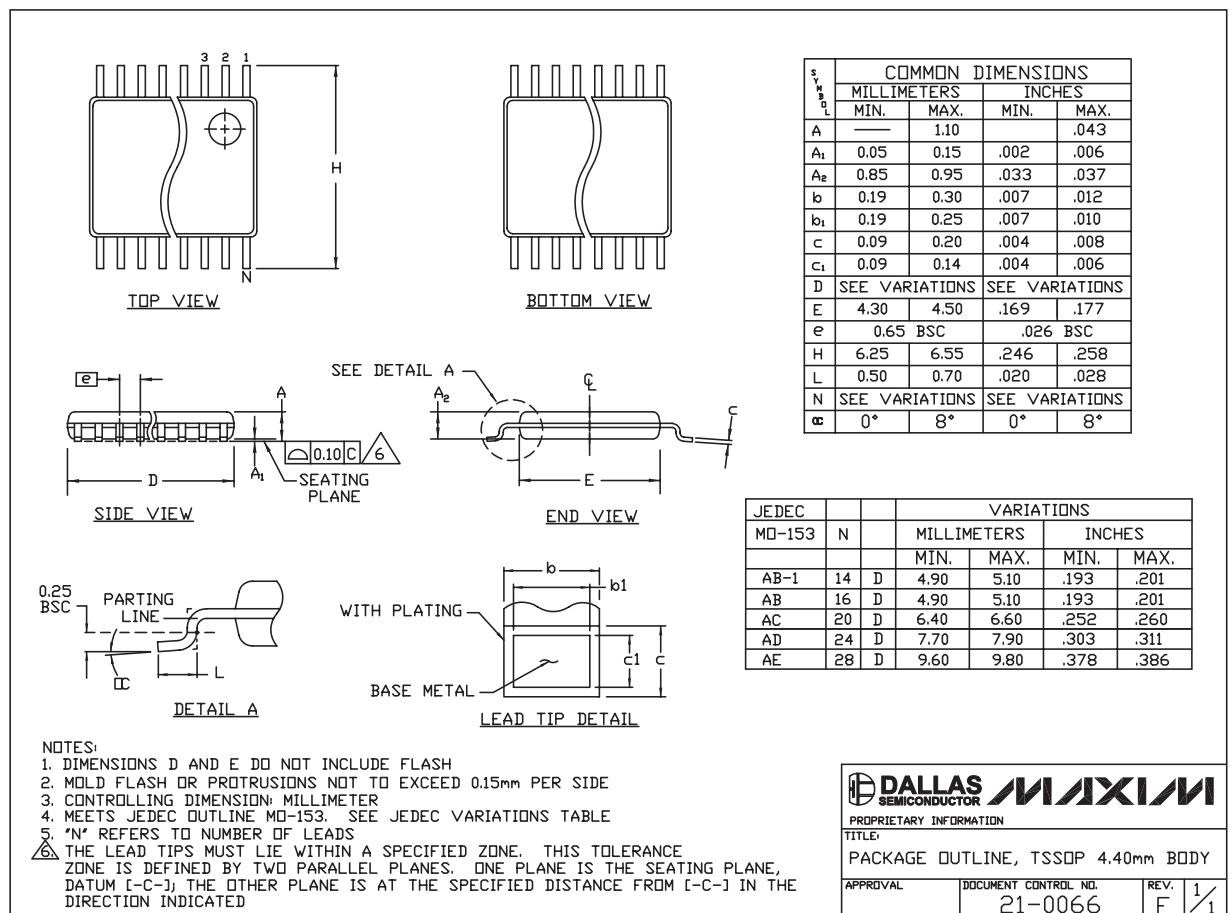


Figure 6. *Frequency Response, Off-Isolation, and Crosstalk*

# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

## 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).)

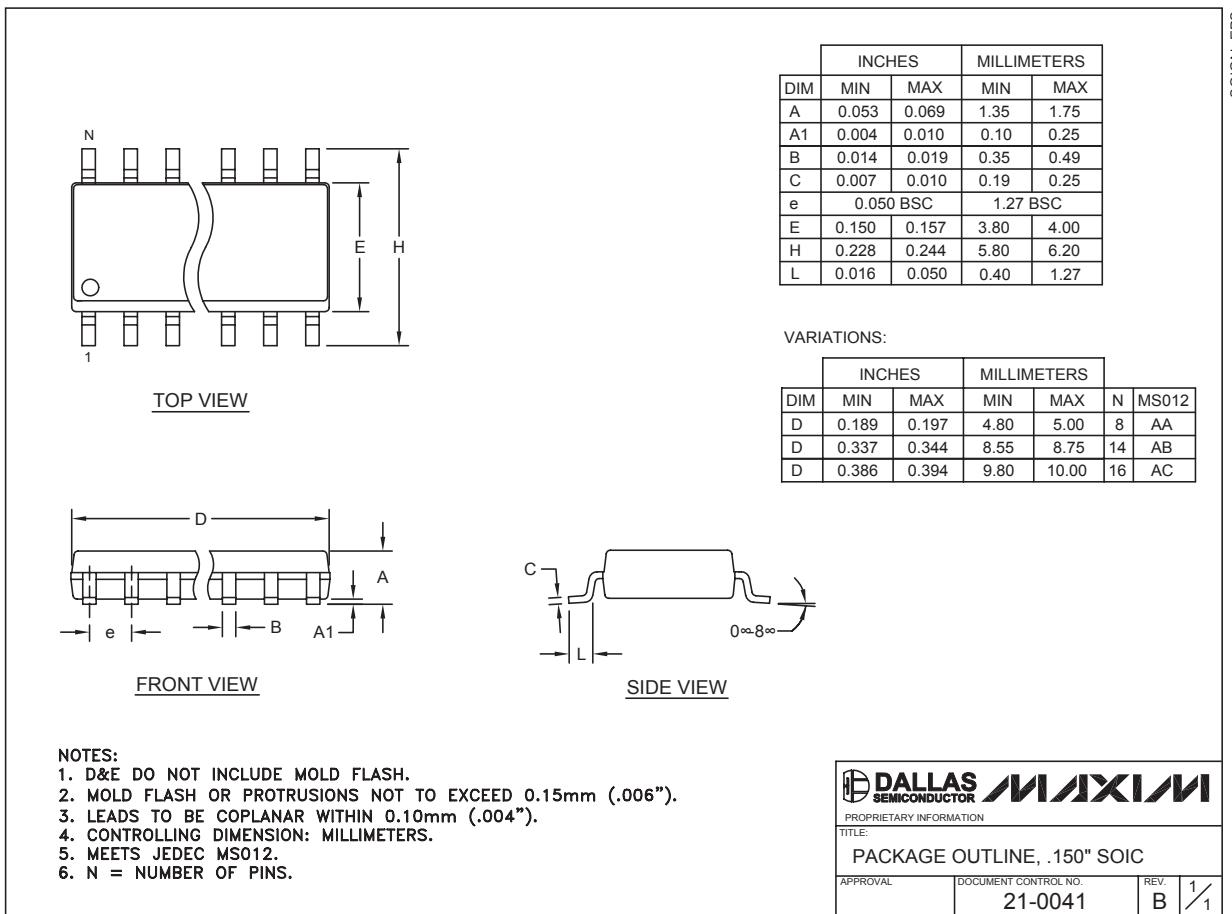


**MAX4711/MAX4712/MAX4713**

# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

## Package Information (continued)

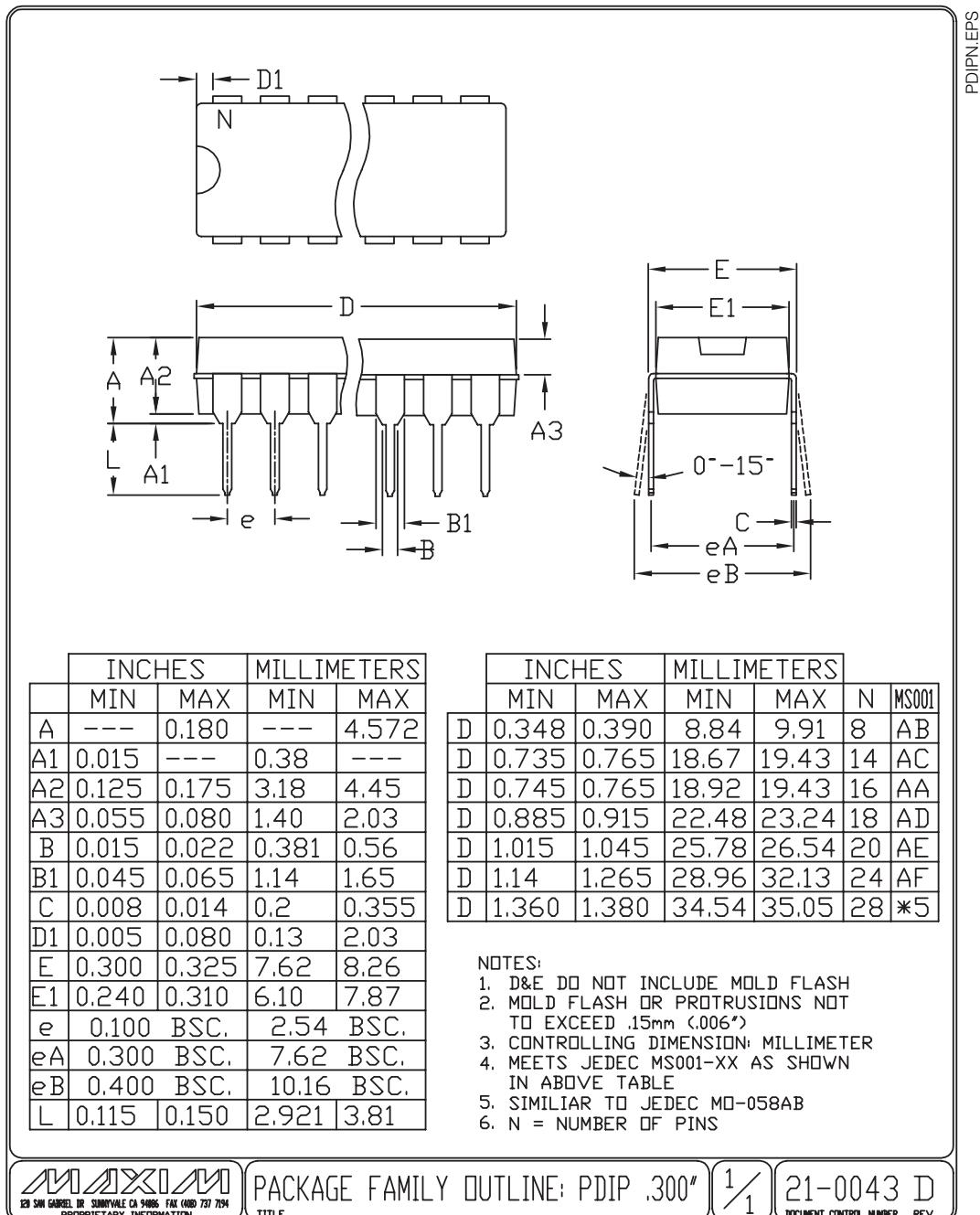
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



# Fault-Protected, Low-Voltage, Quad SPST Analog Switches

## 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).)



**MAXIM**  
120 SAN GABRIEL IR, SUNNYVALE CA 94086 FAX (408) 737-7104  
PROPRIETARY INFORMATION

PACKAGE FAMILY OUTLINE: PDIP .300"

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21-0043 D  
DOCUMENT CONTROL NUMBER REV

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