

**MAXIM****2Ω, Quad, SPST, CMOS Analog Switches****General Description**

The MAX4677/MAX4678/MAX4679 quad analog switches feature 1.6Ω max on-resistance ( $R_{ON}$ ) when operating from a dual ±5V supply.  $R_{ON}$  is matched between channels to 0.3Ω max and is flat (0.4Ω max) over the specified signal range. Each switch can handle Rail-to-Rail® analog signals. Off-leakage current is 0.1nA at +25°C. These switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automated test equipment. They have low power requirements, require less board space, and are more reliable than mechanical relays.

The MAX4677 has four normally closed (NC) switches, and the MAX4678 has four normally open (NO) switches. The MAX4679 has two NC and two NO switches and features guaranteed break-before-make switching.

The MAX4677/MAX4678/MAX4679 operate from either a single +2.7V to +11V or dual ±2.7V to ±5.5V supplies, making them ideal for use in digital card applications and single-ended 75Ω systems.

These devices feature a separate logic supply input that operates from +2.7V to V+, allowing independent logic and analog supplies.

**Applications**

Reed Relay Replacement	Avionics
Test Equipment	ADC Systems
Communications Systems	Data-Acquisition Systems
Audio Signal Routing	PBX/PABX Systems

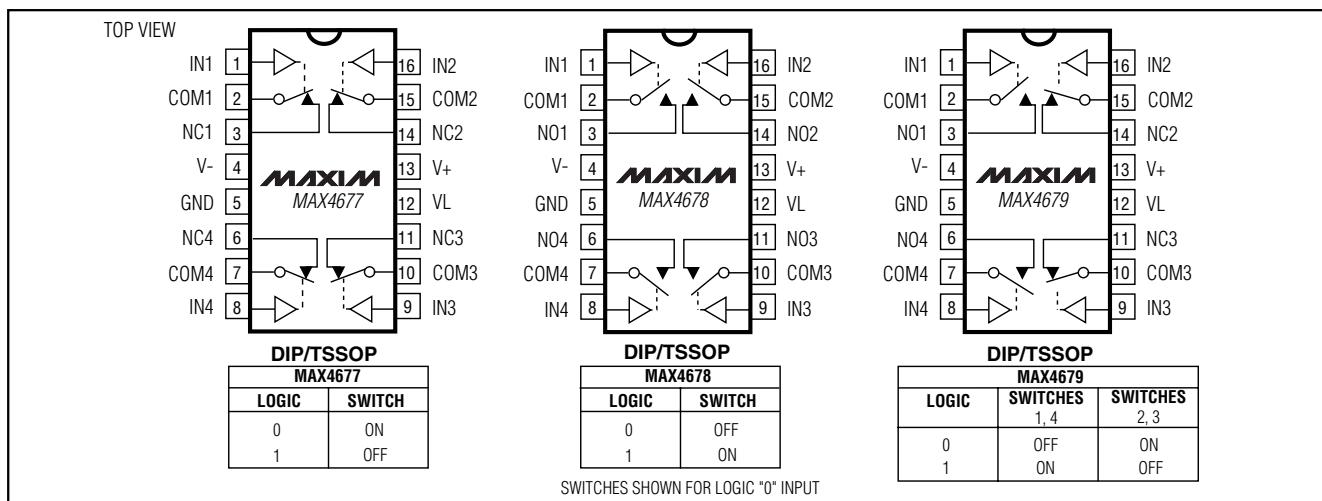
**Features**

- ◆ On-Resistance 1.6Ω max
- ◆ On-Resistance Flatness 0.4Ω max
- ◆ On-Resistance Matching 0.3Ω max
- ◆ Dual ±2.7V to ±5.5V or Single +2.7V to +11V Supply Range
- ◆ TTL/CMOS-Logic Compatible
- ◆ Crosstalk -84dB at 1MHz
- ◆ Off-Isolation -65dB at 1MHz
- ◆ -3dB Bandwidth: 66MHz
- ◆ Rail-to-Rail Signal Range

**Ordering Information**

PART	TEMP. RANGE	PIN-PACKAGE
<b>MAX4677EUE</b>	-40°C to +85°C	16 TSSOP
MAX4677EPE	-40°C to +85°C	16 DIP
<b>MAX4678EUE</b>	-40°C to +85°C	16 TSSOP
MAX4678EPE	-40°C to +85°C	16 DIP
<b>MAX4679EUE</b>	-40°C to +85°C	16 TSSOP
MAX4679EPE	-40°C to +85°C	16 DIP

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

**MAX4677/MAX4678/MAX4679****Pin Configurations/Functional Diagrams/Truth Tables****MAXIM**

Maxim Integrated Products 1

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For small orders, phone 1-800-835-8769.

# **2Ω, Quad, SPST, CMOS Analog Switches**

## **ABSOLUTE MAXIMUM RATINGS**

V+ to GND .....	-0.3V to +12V
V- to GND .....	+0.3V to -12V
V+ to V- .....	+12V
V <sub>L</sub> , IN <sub>_</sub> to GND (Note 1) .....	-0.3V to (V <sub>+</sub> + 0.3V)
V <sub>COM_</sub> , V <sub>NC_</sub> , V <sub>NO_</sub> (Note 1) .....	V- to V <sub>+</sub>
Current (any terminal) .....	±50mA
Continuous Current (COM <sub>_</sub> , NC <sub>_</sub> , NO <sub>_</sub> ) .....	±100mA
Peak Current (COM <sub>_</sub> , NC <sub>_</sub> , NO <sub>_</sub> pulsed at 1ms 10% duty cycle) .....	±200mA

Continuous Power Dissipation (T <sub>A</sub> = +70°C) 16-Pin Plastic DIP (derate 10.5mW/°C above +70°C) .....	842mW
16-Pin TSSOP (derate 5.7mW/°C above +70°C) .....	457mW
Operating Temperature Range .....	-40°C to +85°C
Storage Temperature Range .....	-65°C to +150°C
Junction Temperature .....	+150°C
Lead Temperature (soldering, 10s) .....	+300°C

**Note 1:** Signals on NC<sub>\_</sub>, NO<sub>\_</sub>, COM<sub>\_</sub>, or IN<sub>\_</sub> exceeding V<sub>+</sub> or V<sub>-</sub> 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—Dual Supplies**

(V<sub>+</sub> = +5V ±10%, V<sub>-</sub> = -5V ±10%, V<sub>L</sub> = +2.7V to V<sub>+</sub>, GND = 0, V<sub>IH</sub> = +2.4V, V<sub>IL</sub> = +0.8V, 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 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
<b>ANALOG SWITCH</b>							
Input Voltage Range	V <sub>COM_</sub> , V <sub>NO_</sub> , V <sub>NC_</sub>		V-		V+	V	
On-Resistance	R <sub>ON</sub>	V <sub>+</sub> = 4.5V, V <sub>-</sub> = -4.5V, I <sub>COM_</sub> = 50mA, V <sub>NO_</sub> or V <sub>NC_</sub> = ±3.3V	TA = +25°C	1.2	1.6	Ω	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>		2		
On-Resistance Match Between Channels (Note 3)	ΔR <sub>ON</sub>	V <sub>+</sub> = 4.5V, V <sub>-</sub> = -4.5V, I <sub>COM_</sub> = 50mA, V <sub>NO_</sub> or V <sub>NC_</sub> = ±3.3V	TA = +25°C	0.2	0.3	Ω	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>		0.5		
On-Resistance Flatness (Note 4)	R <sub>FLAT</sub>	V <sub>+</sub> = 4.5V, V <sub>-</sub> = -4.5V, I <sub>COM_</sub> = 50mA, V <sub>NO_</sub> or V <sub>NC_</sub> = ±3.3V, 0	TA = +25°C	0.2	0.4	Ω	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>		0.5		
NC <sub>_</sub> or NO <sub>_</sub> Off-Leakage Current (Note 5)	I <sub>N_(OFF)</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>NO_</sub> or V <sub>NC_</sub> = ±4.5V, V <sub>COM_</sub> = ±4.5V	TA = +25°C	-1	0.1	1	nA
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	-10		10	
COM <sub>_</sub> Off-Leakage Current (Note 5)	I <sub>COM_(OFF)</sub>	V <sub>+</sub> = +5.5V, V <sub>-</sub> = -5.5V, V <sub>NO_</sub> or V <sub>NC_</sub> = ±4.5V, V <sub>COM_</sub> = ±4.5V	TA = +25°C	-1	0.1	1	nA
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	-10		10	
COM <sub>_</sub> 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> or V <sub>NC_</sub> = ±4.5V or floating	TA = +25°C	-2	0.2	2	nA
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	-25		25	
<b>LOGIC INPUT</b>							
Input Logic High	V <sub>IH</sub>	V <sub>L</sub> = V <sub>+</sub>		2.4		V	
Input Logic Low	V <sub>IL</sub>	V <sub>L</sub> = V <sub>+</sub>			0.8	V	
Input Leakage Current	I <sub>IN</sub>	V <sub>L</sub> = V <sub>+</sub>	-1	0.005	1	µA	

# **2Ω, Quad, SPST, CMOS Analog Switches**

## **ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)**

( $V_+ = +5V \pm 10\%$ ,  $V_- = -5V \pm 10\%$ ,  $V_L = +2.7V$  to  $V_+$ ,  $GND = 0$ ,  $V_{IH} = +2.4V$ ,  $V_{IL} = +0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>POWER SUPPLY</b>						
Positive Supply Voltage	$V_+$		+2.7	+5.5		V
Negative Supply Voltage	$V_-$		-2.7	-5.5		V
Logic Supply Voltage	$V_L$		2.7	$V_+$		V
Positive Supply Current	$I_+$	$IN_- = GND$ or $V_L$	0.001	1		$\mu A$
Negative Supply Current	$I_-$	$IN_- = GND$ or $V_L$		-1		$\mu A$
Logic Supply Current	$I_L$	$IN_- = GND$ or $V_L$		1		$\mu A$
Ground Current	$I_{GND}$	$IN_- = 0$ or $V_+$ , $V_+ = 5.5V$ , $V_- = -5.5V$		1		$\mu A$
<b>DYNAMIC</b>						
Turn-On Time	$t_{ON}$	$V_+ = +4.5V$ , $V_- = -4.5V$ , $V_{NC\_}$ or $V_{NO\_} = \pm 3.3V$ , $V_L = V_+$ , Figure 2	$T_A = +25^\circ C$	200	350	ns
			$T_A = T_{MIN}$ to $T_{MAX}$		500	
Turn-Off Time	$t_{OFF}$	$V_+ = +4.5V$ , $V_- = -4.5V$ , $V_{NC\_}$ or $V_{NO\_} = \pm 3.3V$ , $V_L = V_+$ , Figure 2	$T_A = +25^\circ C$	110	150	ns
			$T_A = T_{MIN}$ to $T_{MAX}$		350	
Break-Before-Make Delay	$t_{BBM}$	Figure 3, MAX4679 only, $R_L = 300\Omega$ , $C_L = 35pF$		5		ns
Charge Injection	$Q$	$R_{GEN} = 0$ , $C_L = 1nF$ , $V_{GEN} = 0$ , Figure 4		85		pC
Off-Isolation	$V_{ISO}$	$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 5a		-65		dB
Crosstalk		$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 6a		-84		dB
-3dB Bandwidth	$BW$	$R_S = 50\Omega$ , $R_L = 50\Omega$ , Figure 7a		66		MHz
NC or NO Off-Capacitance	$C_{(N\_OFF)}$	$f = 1MHz$ , Figure 8		85		pF
COM Off-Capacitance	$C_{(COMOFF)}$	$f = 1MHz$ , Figure 8		85		pF
On-Capacitance	$C_{(ON)}$	$f = 1MHz$ , Figure 8		350		pF

## 2Ω, Quad, SPST, CMOS Analog Switches

### ELECTRICAL CHARACTERISTICS—Single Supply

( $V_+ = +5V \pm 10\%$ ,  $V_- = 0$ ,  $V_L = +2.7V$  to  $V_+$ ,  $GND = 0$ ,  $V_{IH} = +2.4V$ ,  $V_{IL} = +0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Input Voltage Range	$V_{COM\_}$ , $V_{NO\_}$ , $V_{NC\_}$			0	$V_+$		V
On-Resistance	$R_{ON}$	$V_+ = +4.5V$ , $I_{COM\_} = 50mA$ , $V_{NO\_}$ or $V_{NC\_} = 3.3V$		$T_A = +25^\circ C$	1.8	2.7	$\Omega$
				$T_A = T_{MIN}$ to $T_{MAX}$	3.5		
On-Resistance Match Between Channels (Note 3)	$\Delta R_{ON}$	$V_+ = +4.5V$ , $I_{COM\_} = 50mA$ , $V_{NO\_}$ or $V_{NC\_} = 3.3V$		$T_A = +25^\circ C$	0.05	0.15	$\Omega$
				$T_A = T_{MIN}$ to $T_{MAX}$	0.3		
On-Resistance Flatness (Note 4)	$R_{FLAT}$	$V_+ = +4.5V$ , $I_{COM\_} = 50mA$ , $V_{NO\_}$ or $V_{NC\_} = 3.3V$ , 1.5V		$T_A = +25^\circ C$	0.15	0.25	$\Omega$
				$T_A = T_{MIN}$ to $T_{MAX}$	0.4		
NC_ or NO_ Off- Leakage Current (Note 5)	$I_{N(OFF)}$	$V_+ = +5.5V$ ; $V_{NO\_}$ or $V_{NC\_} = 4.5V$ , 1V; $V_{COM\_} = 1V$ , 4.5V		$T_A = +25^\circ C$	-1	0.1	nA
				$T_A = T_{MIN}$ to $T_{MAX}$	-10	10	
COM_ Off-Leakage Current (Note 5)	$I_{COM(OFF)}$	$V_+ = +5.5V$ ; $V_{NO\_}$ or $V_{NC\_} = 4.5V$ , 1V; $V_{COM\_} = 1V$ , 4.5V		$T_A = +25^\circ C$	-1	0.1	nA
				$T_A = T_{MIN}$ to $T_{MAX}$	-10	10	
COM_ On-Leakage Current (Note 5)	$I_{COM(ON)}$	$V_+ = +5.5V$ ; $V_{COM\_} = 1V$ , 4.5V; $V_{NO\_}$ or $V_{NC\_} = 1V$ , 4.5V, or floating		$T_A = +25^\circ C$	-2	0.2	nA
				$T_A = T_{MIN}$ to $T_{MAX}$	-25	25	
<b>LOGIC INPUT</b>							
Input Low Voltage	$V_{IL}$	$V_L = V_+$		0.8		V	
Input High Voltage	$V_{IH}$	$V_L = V_+$		2.4		V	
Input Leakage Current	$I_{IN}$	$V_L = V_+$		-1	0.005	1	$\mu A$
<b>POWER SUPPLY</b>							
Positive Supply Voltage	$V_+$			2.7	6	V	
Logic Supply Voltage	$V_L$			2.7	$V_+$	V	
Positive Supply Current	$I_+$	$V_{IN\_} = 0$ or $V_L$ , $V_L = V_+$		1	1	$\mu A$	
Logic Supply Current	$I_L$	$V_{IN\_} = 0$ or $V_L$ , $V_+ = 5.5V$		1		$\mu A$	
Ground Current	$I_{GND}$	$V_{IN\_} = 0$ or $V_L$ , $V_+ = 5.5V$		1	10	$\mu A$	
<b>DYNAMIC</b>							
Turn-On Time	$t_{ON}$	$V_L = V_+$ , $V_+ = +4.5V$ ; $V_{NC\_}$ or $V_{NO\_} = 3.3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2		$T_A = +25^\circ C$	600	1000	ns
				$T_A = T_{MIN}$ to $T_{MAX}$	1400		
Turn-Off Time	$t_{OFF}$	$V_L = V_+$ , $V_+ = +4.5V$ ; $V_{NC\_}$ or $V_{NO\_} = 3.3V$ , $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 2		$T_A = +25^\circ C$	120	165	ns
				$T_A = T_{MIN}$ to $T_{MAX}$	400		

# **2Ω, Quad, SPST, CMOS Analog Switches**

## **ELECTRICAL CHARACTERISTICS—Single Supply (continued)**

( $V_+ = +5V \pm 10\%$ ,  $V_- = 0$ ,  $V_L = +2.7V$  to  $V_+$ ,  $GND = 0$ ,  $V_{IH} = +2.4V$ ,  $V_{IL} = +0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Break-Before-Make Delay	$t_{BBM}$	MAX4679 only, $R_L = 300\Omega$ , $C_L = 35pF$ , Figure 3	5			ns
Charge Injection	$Q$	$R_{GEN} = 0$ , $C_L = 1nF$ , $V_{GEN} = 0$ , Figure 4		9		pC
Off-Isolation	$V_{ISO}$	$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 5b		-65		dB
Crosstalk		$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 6b		-84		dB
-3dB Bandwidth	$BW$	$R_S = 50\Omega$ , $R_L = 50\Omega$ , Figure 7b		63		MHz
NC or NO Off-Capacitance	$C_{(N\_OFF)}$	$f = 1MHz$ , Figure 8		85		pF
COM Off-Capacitance	$C_{(COMOFF)}$	$f = 1MHz$ , Figure 8		85		pF
On-Capacitance	$C_{(ON)}$	$f = 1MHz$ , Figure 8		350		pF

**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.

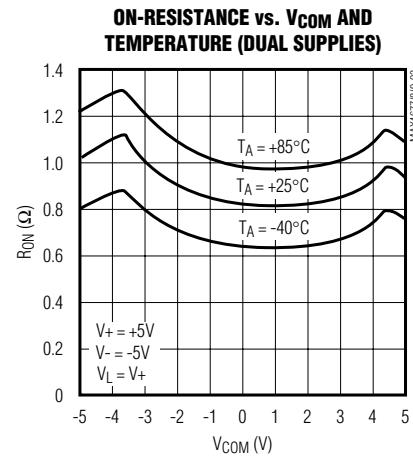
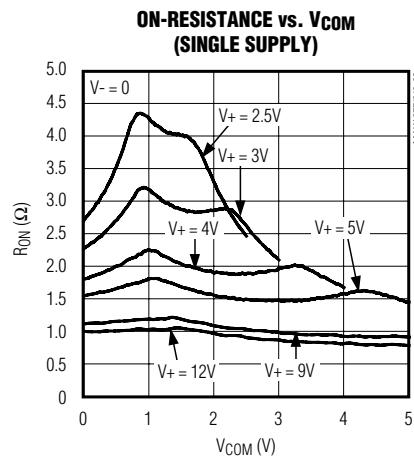
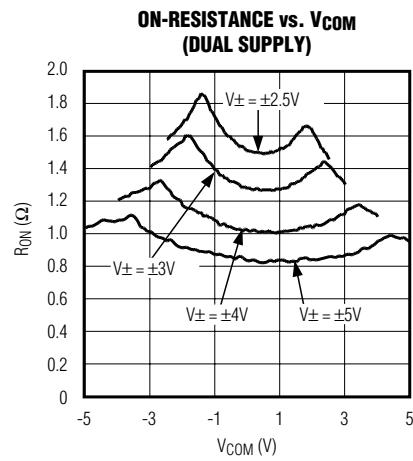
**Note 3:**  $\Delta R_{ON} = R_{ON}(MAX) - R_{ON}(MIN)$ .

**Note 4:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

**Note 5:** Leakage parameters are 100% tested at maximum-rated hot operating temperature and the highest supply voltage, and guaranteed by correlation at  $+25^\circ C$ .

## **Typical Operating Characteristics**

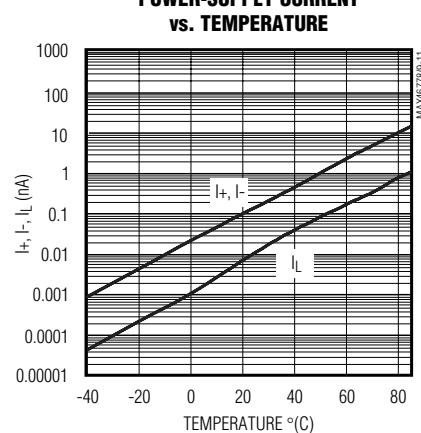
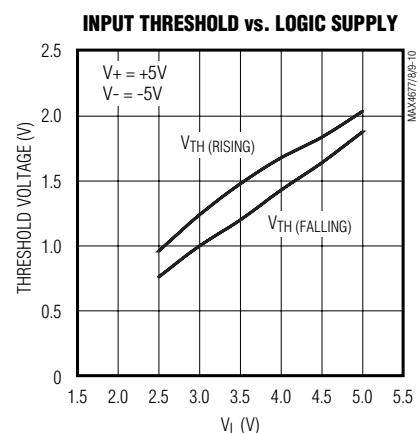
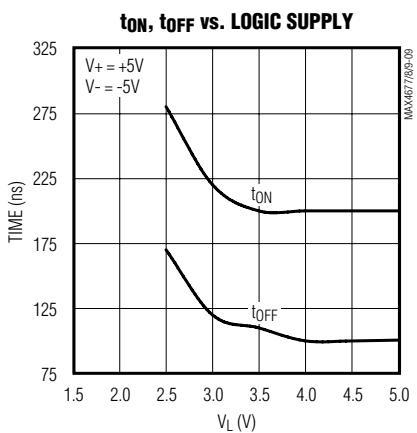
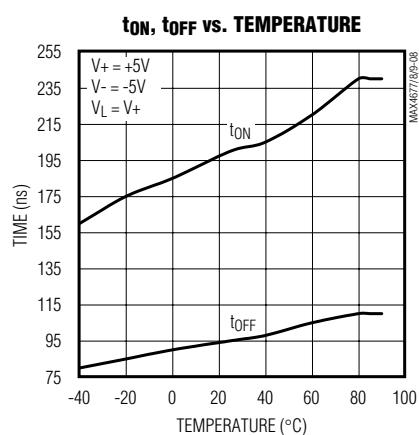
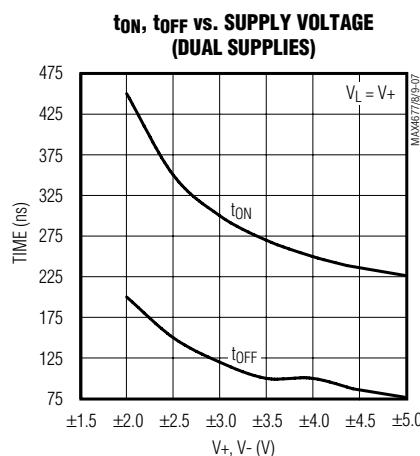
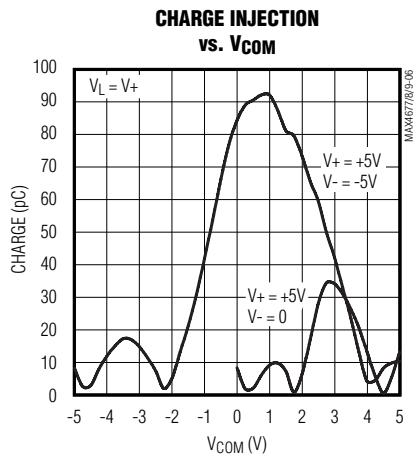
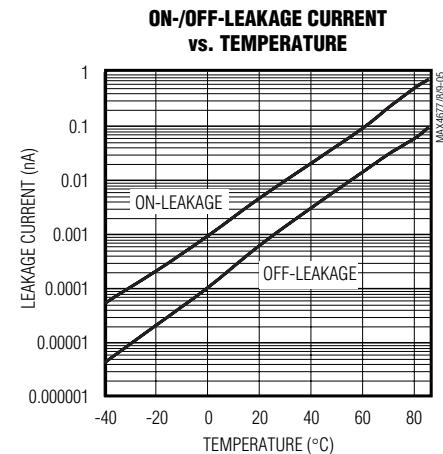
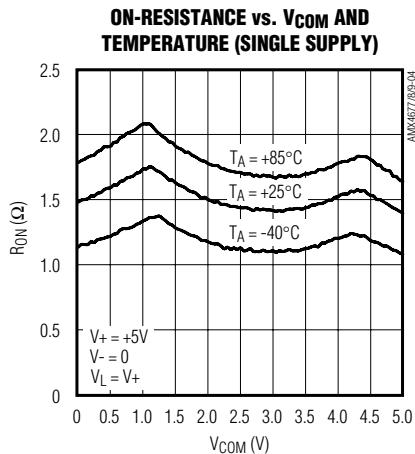
( $T_A = +25^\circ C$ , unless otherwise noted.)



## 2Ω, Quad, SPST, CMOS Analog Switches

### Typical Operating Characteristics (continued)

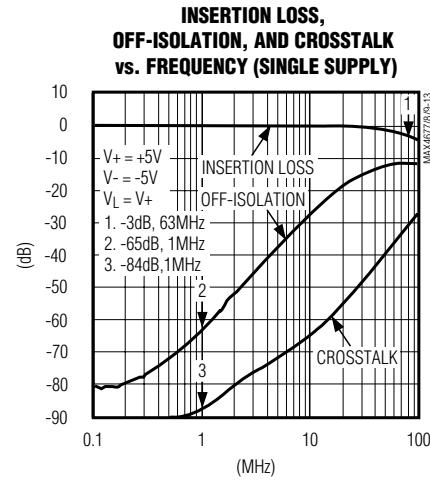
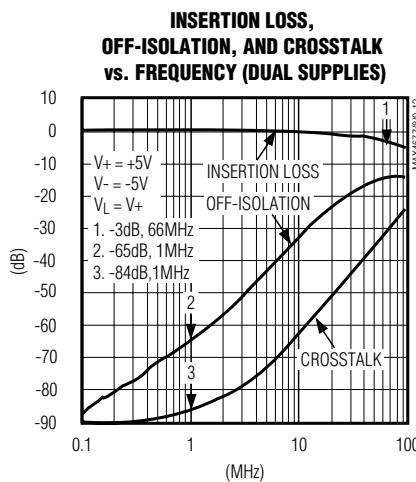
( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



# **$2\Omega$ , Quad, SPST, CMOS Analog Switches**

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

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



## **Pin Description**

<b>PIN</b>			<b>NAME</b>	<b>FUNCTION</b>
<b>MAX4677</b>	<b>MAX4678</b>	<b>MAX4679</b>		
1, 8, 9, 16	1, 8, 9, 16	1, 8, 9, 16	IN1, IN2, IN3, IN4	Logic Inputs
2, 7, 10, 15	2, 7, 10, 15	2, 7, 10, 15	COM1, COM2, COM3, COM4	Analog Switch Common Terminals
3, 6, 11, 14	—	—	NC1, NC2, NC3, NC4	Analog Switch Normally Closed Terminals
—	3, 6, 11, 14	—	NO1, NO2, NO3, NO4	Analog Switch Normally Open Terminals
—	—	3, 6	NO1, NO4	Analog Switch Normally Open Terminals
—	—	11, 14	NC2, NC3	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	VL	Logic Supply Input
13	13	13	V+	Positive Supply Input

## 2Ω, Quad, SPST, CMOS Analog Switches

### Applications Information

#### 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 can cause permanent damage to the devices. Always sequence V+ on first, then V-, then V<sub>L</sub> followed by the logic inputs, NO<sub>-</sub>, NC<sub>-</sub>, or COM. If proper power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with the supply pins, and a Schottky diode between V+ and V<sub>L</sub> for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 11V.

Power-supply bypassing improves noise margin and prevents switching noise from propagating from the V+ supply to other components. A 0.1µF capacitor connected from V+ to GND is adequate for most applications.

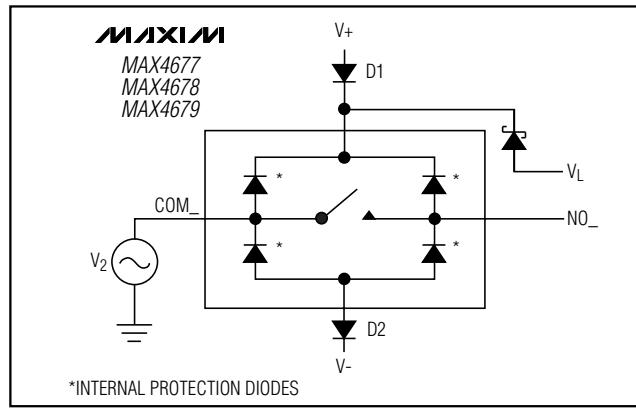


Figure 1. Overvoltage Protection Using External Blocking Diodes

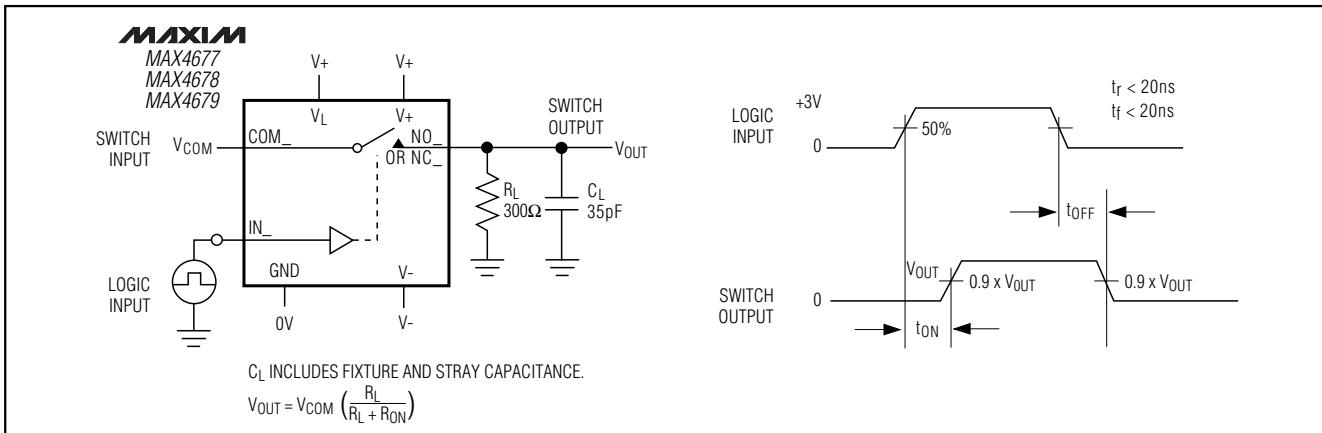


Figure 2. Switching Time

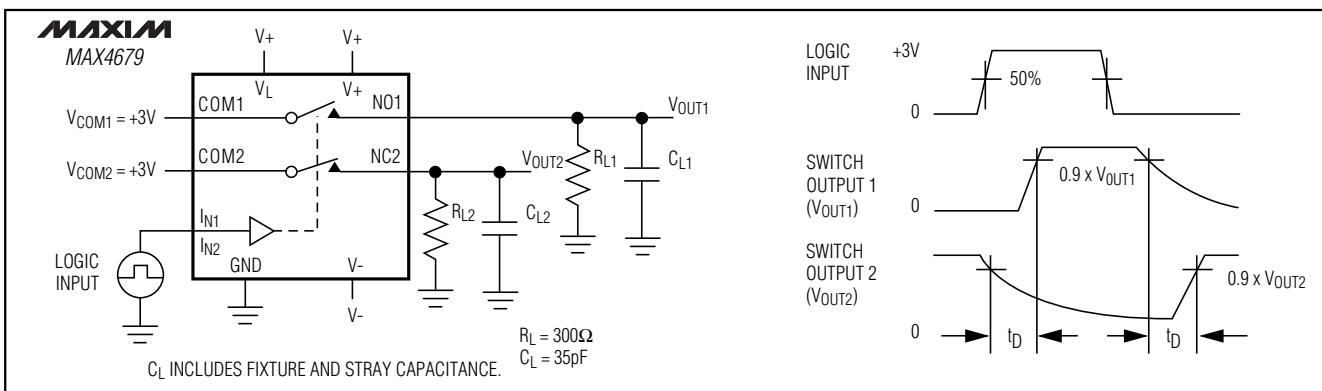


Figure 3. Break-Before-Make Interval (MAX4679 Only)

## 2Ω, Quad, SPST, CMOS Analog Switches

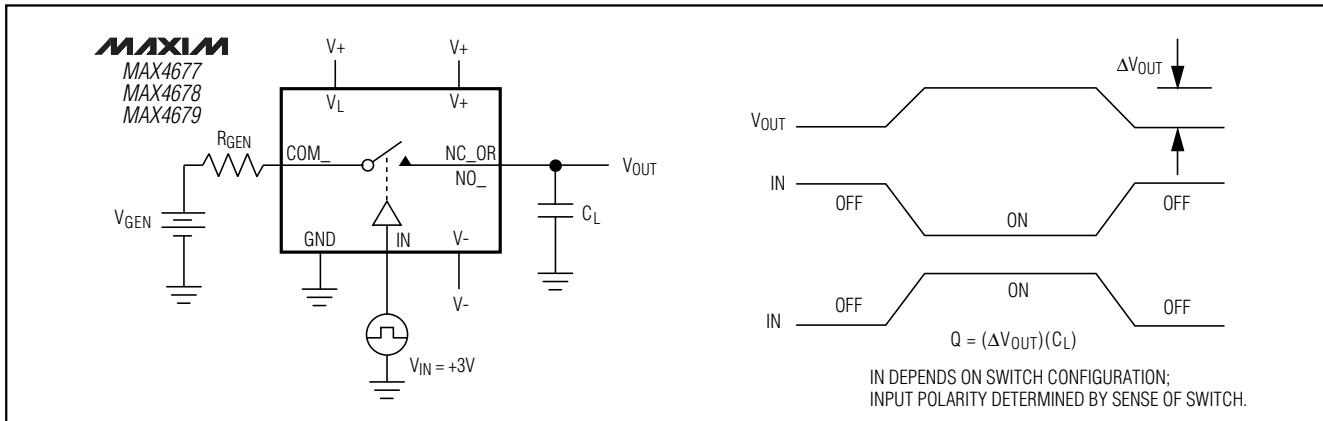


Figure 4. Charge Injection

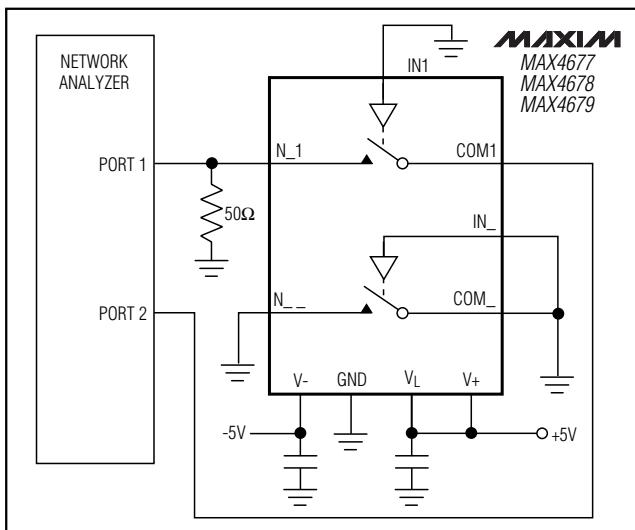


Figure 5a. Off-Isolation Test Circuit, Dual Supplies

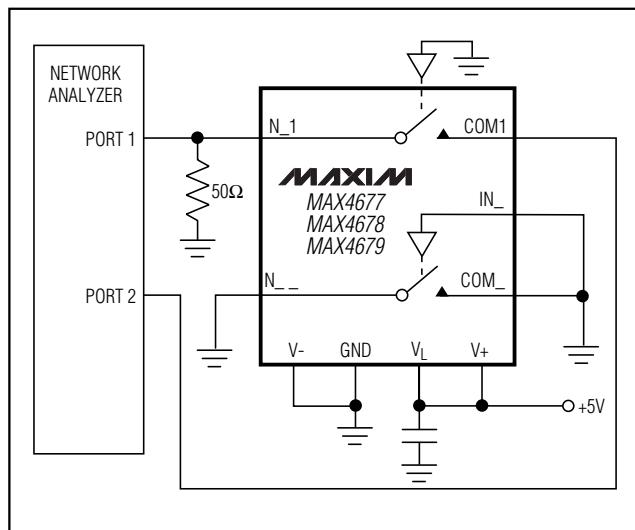


Figure 5b. Off-Isolation Test Circuit, Single Supply

## **2Ω, Quad, SPST, CMOS Analog Switches**

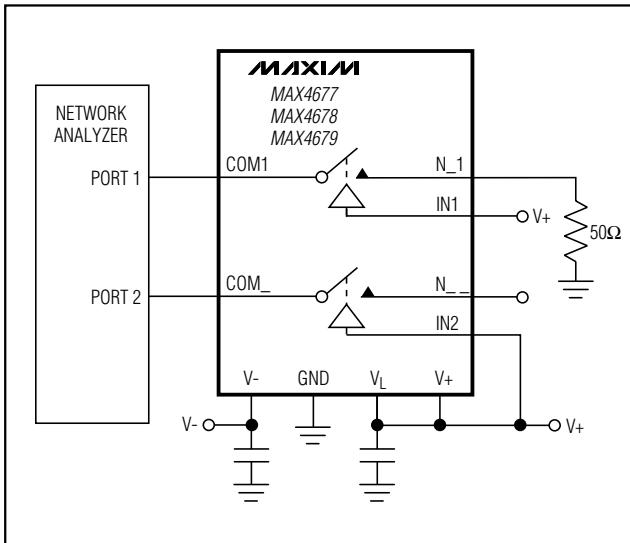


Figure 6a. Crosstalk Test Circuit, Dual Supplies

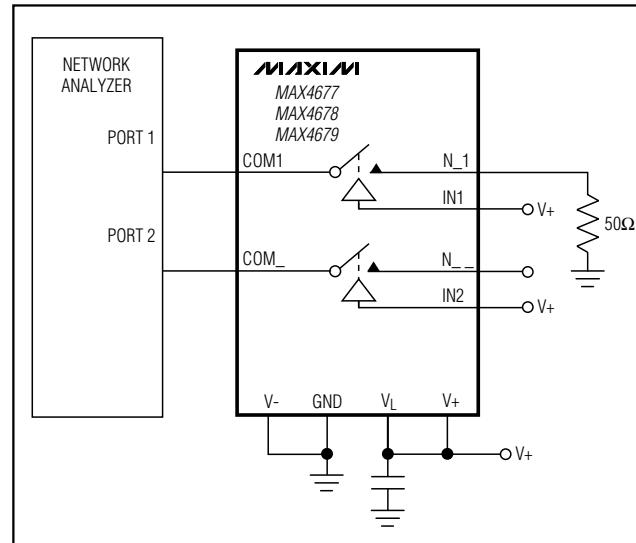


Figure 6b. Crosstalk Test Circuit, Single Supply

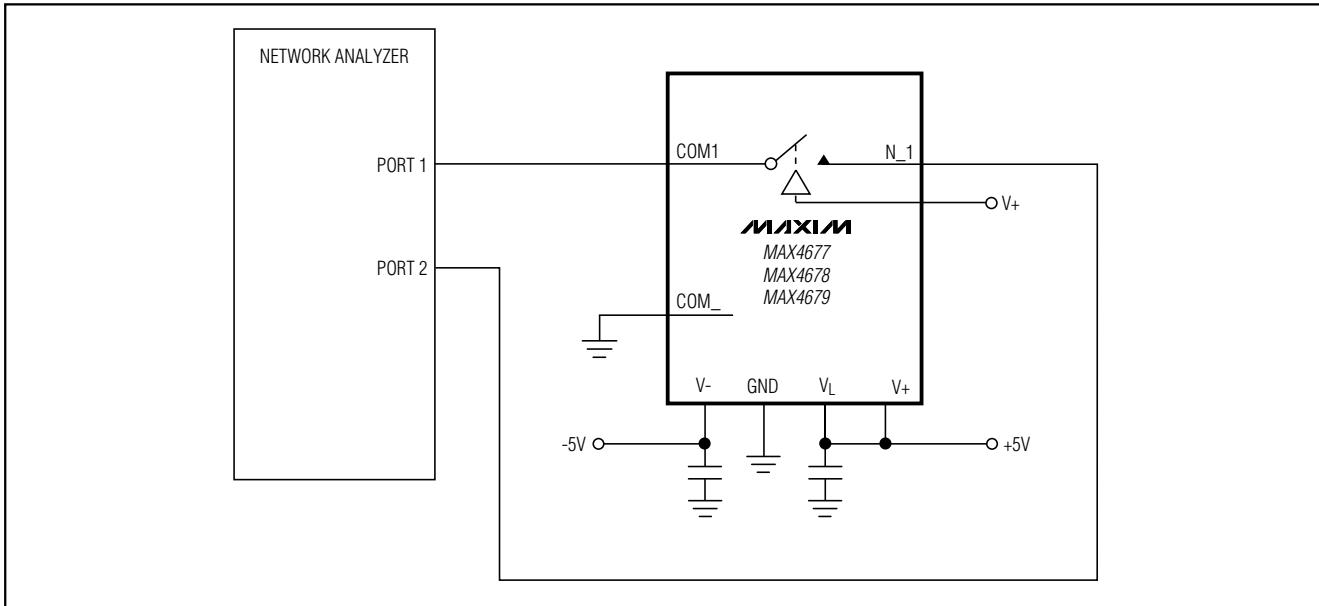


Figure 7a. Insertion Loss Test Circuit, Dual Supplies

## **2Ω, Quad, SPST, CMOS Analog Switches**

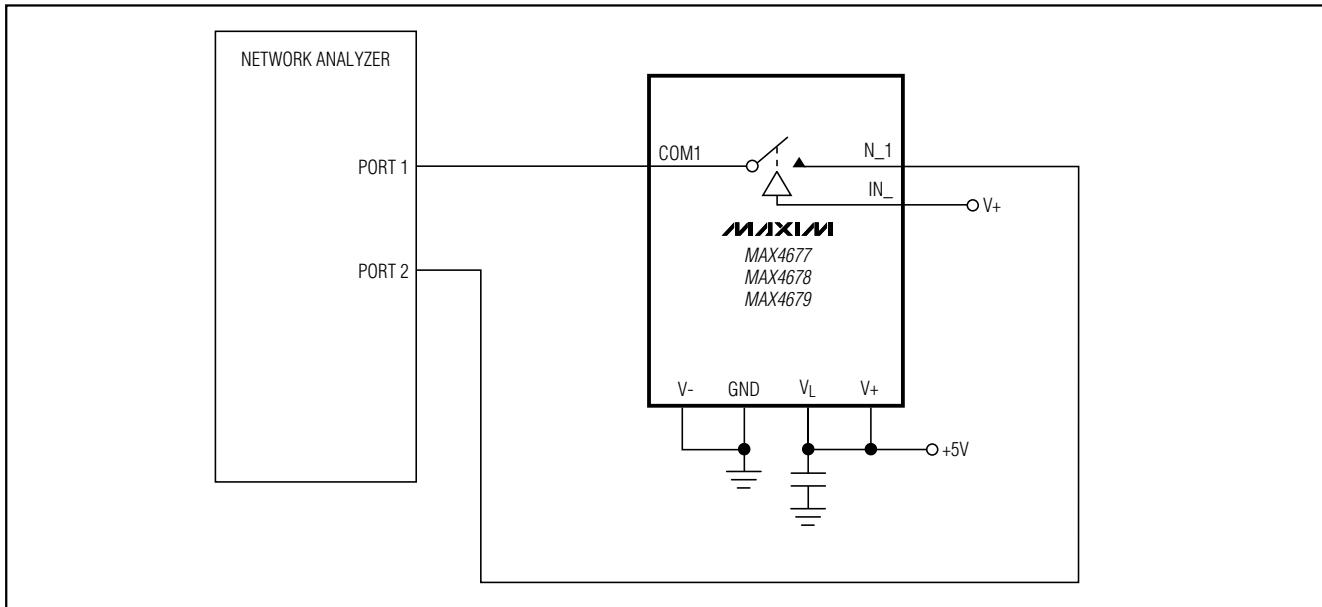


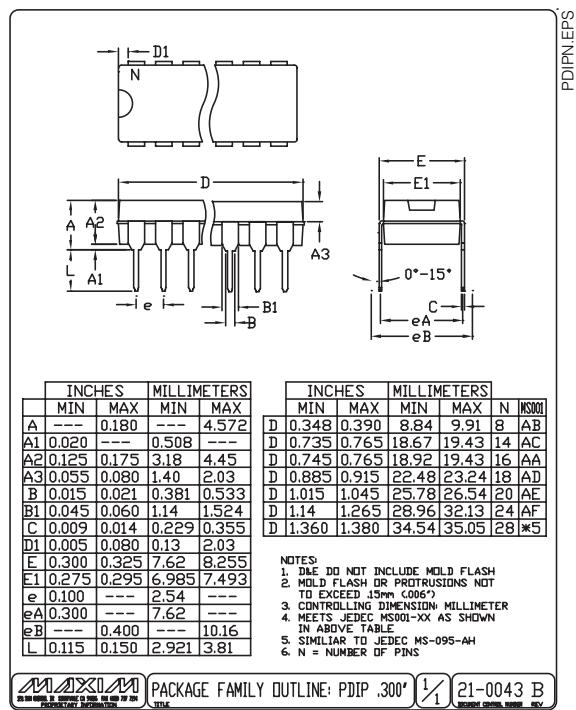
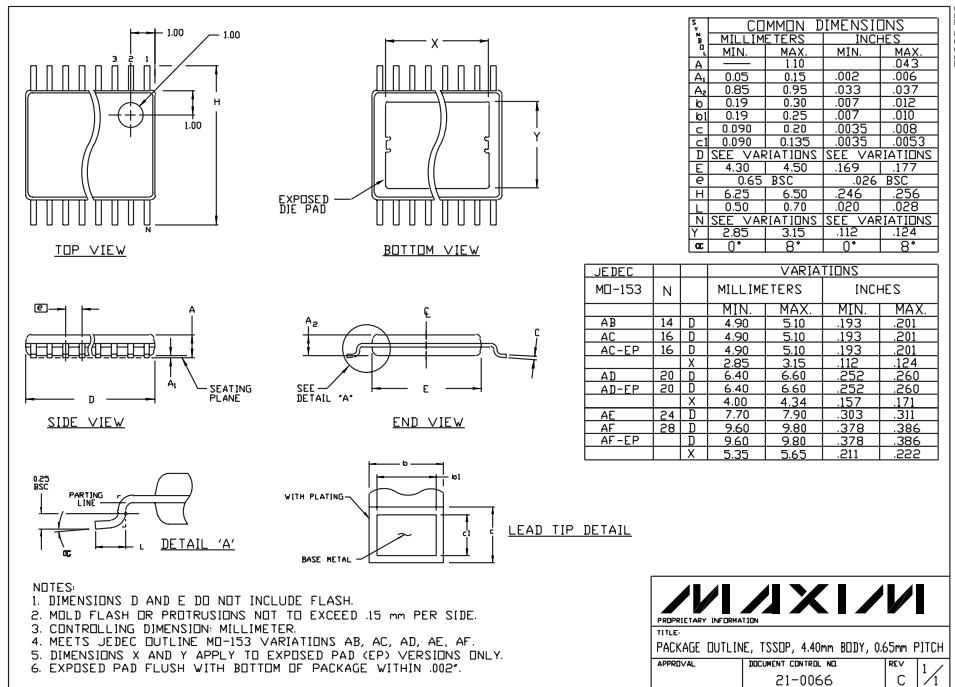
Figure 7b. Insertion Loss Test Circuit, Single Supply

### **Chip Information**

TRANSISTOR COUNT: 240  
PROCESS: CMOS

# 2Ω, Quad, SPST, CMOS Analog Switches

## Package Information



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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