MAXIM

Low-Voltage, Single-Supply, 10Ω SPST CMOS Analog Switches

MAX4594–MAX4597

General Description

The MAX4594–MAX4597 single-pole/single-throw (SPST) analog switches operate from a single +2.0V to +5.5V supply. The MAX4594/MAX4596 switches are normally open (NO), and the MAX4595/MAX4597 are normally closed (NC). The MAX4596/MAX4597 pinouts are optimized for the highest SC70 package off-isolation available.

These switches have 10Ω max on-resistance (R_{ON}), with 1.5Ω max R_{ON} flatness over the analog signal range when powered from a +5V supply. The MAX4594–MAX4597 offer low 0.5nA leakage currents and fast switching times less than 40ns. They are packaged in an ultra-small 5-pin SC70.

Applications

Cellular Phones

Battery-Operated Equipment

Audio and Video Signal Routing

Communications Circuits

PCMCIA Cards

DSL Modems

Features

♦ **Available in SC70-5 Package**

♦ **10Ω max On-Resistance**

♦ **1.5Ω max On-Resistance Flatness**

♦ **Fast Switching**
  t_{ON} = 35ns max
  t_{OFF} = 40ns max

♦ **Guaranteed 5pC max Charge Injection**

♦ **+2.0V to +5.5V Single-Supply Operation**

♦ **300MHz -3dB Bandwidth at +25°C**

♦ **TTL/CMOS-Logic Compatible**

♦ **-80dB Off-Isolation at 1MHz**

♦ **0.5nA max Off-Leakage**

♦ **0.05% THD**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE	TOP MARK
MAX4594EXK-T	-40°C to +85°C	5 SC70-5	AAH
MAX4595EXK-T	-40°C to +85°C	5 SC70-5	AAI
MAX4596EXK-T	-40°C to +85°C	5 SC70-5	AAJ
MAX4597EXK-T	-40°C to +85°C	5 SC70-5	AAK

Pin Configurations/Functional Diagrams/Truth Table

INPUT	SWITCH STATE	
	MAX4594/MAX4596	MAX4595/MAX4597
LOW	OFF	ON
HIGH	ON	OFF

SWITCHES SHOWN FOR LOGIC "0" INPUT.

MAXIM

For price, delivery, and to place orders, please contact Maxim Distribution at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.
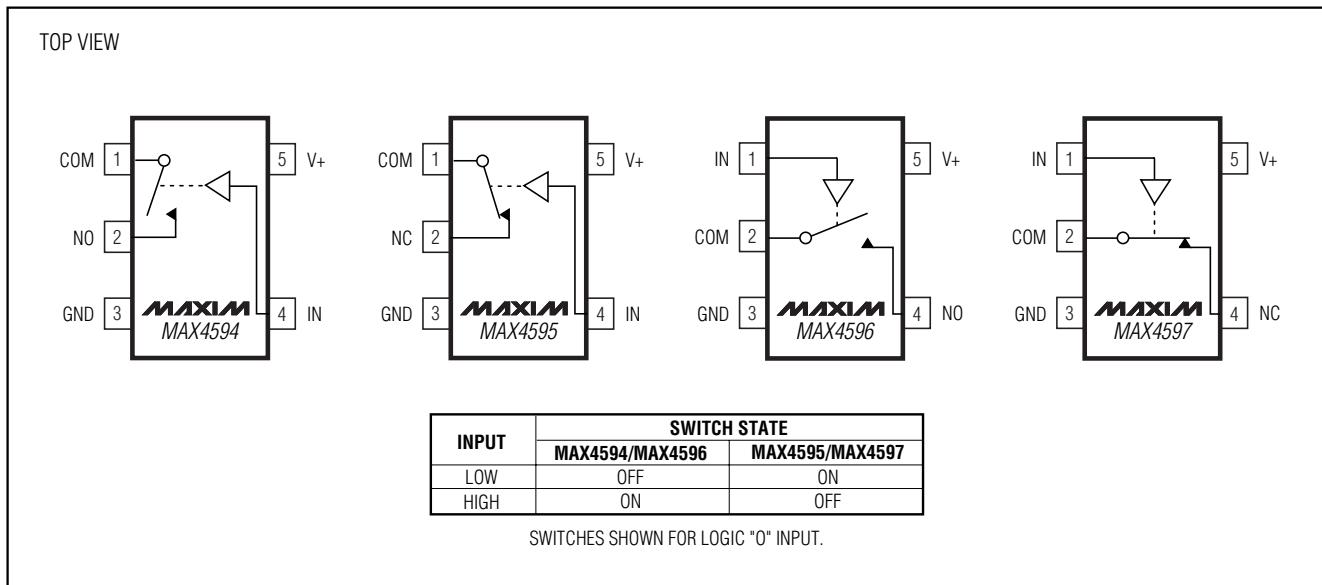
Low-Voltage, Single-Supply, 10Ω SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)

V+ ....-0.3V to +6V
Voltage into Any Terminal (Note 1)...............-0.3V to (V+ + 0.3V)
Continuous Current into Any Terminal.............................±20mA
Peak Current, NO, NC, or COM
    (pulsed at 1ms, 10% duty cycle)................................±40mA

Continuous Power Dissipation (T_A = +70°C)
    5-Pin SC70 (derate 3.1mW/°C above +70°C)............247mW
Operating Temperature Range
    MAX459_EXK ....-40°C to +85°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

Note 1: Voltages exceeding V+ or GND on any signal terminal 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—+5V Supply

(V+ = +4.5V to +5.5V, V_{IH} = +2.4V, V_{IL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = +5V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		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_{NO}, or V_{NC} = 3.5V; I_{COM} = 10mA	T_A = +25°C		6.5	10	Ω
			T_A = T_{MIN} to T_{MAX}			12	
On-Resistance Flatness (Note 4)	$R_{FLAT(ON)}$	V_{NO} or V_{NC} = 1.5V, 2.5V, 3.5V; V+ = 4.5V; I_{COM} = 10mA	T_A = +25°C		0.5	1.5	Ω
			T_A = T_{MIN} to T_{MAX}			2	
NO or NC Off-Leakage Current	$I_{NO(OFF)}$ $I_{NC(OFF)}$	V+ = 5.5V; V_{COM} = 1V, 4.5V; V_{NO} or V_{NC} = 4.5V, 1V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-5		5	
COM Off-Leakage Current	$I_{COM(OFF)}$	V+ = 5.5V; V_{COM} = 1V, 4.5V; V_{NO} or V_{NC} = 4.5V, 1V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-5		5	
COM On-Leakage Current	$I_{COM(ON)}$	V+ = 5.5V; V_{COM} = 1V; 4.5V; V_{NO} or V_{NC} = 1V, 4.5V, or floating	T_A = +25°C	-1	0.01	1	nA
			T_A = T_{MIN} to T_{MAX}	-10		10	
DIGITAL I/O							
Input Logic High	V_{IH}			2.4			V
Input Logic Low	V_{IL}					0.8	V
Input Logic Current	I_{IH}, I_{IL}	V_{IN} = V+, 0		-1	0.03	1	µA
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO} or V_{NC} = 3V, R_L = 300Ω, C_L = 35pF, Figure 3	T_A = +25°C		20	35	ns
			T_A = T_{MIN} to T_{MAX}			45	
Turn-Off Time	t_{OFF}	V_{NO} or V_{NC} = 3V, R_L = 300Ω, C_L = 35pF, Figure 3	T_A = +25°C		25	40	ns
			T_A = T_{MIN} to T_{MAX}			50	
On-Channel -3dB Bandwidth	BW	Signal = 0dBm, 50Ω in and out, Figure 4	T_A = +25°C		300		MHz

ELECTRICAL CHARACTERISTICS—+5V Supply (continued)

(V+ = +4.5V to +5.5V, V_{IH} = +2.4V, V_{IL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = +5V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
Charge Injection (Note 5)	Q	V_{NO} or V_{NC} = 0, C_L = 1nF, Figure 2	T_A = +25°C			2	5	pC
Off-Isolation (Note 6)	V_{ISO}	V_{NO} or V_{NC} = 1V_{RMS}, R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 4	T_A = +25°C	MAX4594/ MAX4595		80		dB
				MAX4596/ MAX4597		83		
NO or NC Off-Capacitance	$C_{NO(OFF)}$, $C_{NC(OFF)}$	V_{NO} or V_{NC} = 0, f = 1MHz, Figure 5	T_A = +25°C			8		pF
COM Off-Capacitance	$C_{COM(OFF)}$	V_{COM} = 0, f = 1MHz, Figure 5	T_A = +25°C			8		pF
COM On-Capacitance	$C_{COM(ON)}$	V_{COM} = 0, f = 1MHz, Figure 5	T_A = +25°C			20		pF
Total Harmonic Distortion Plus Noise	THD	V = 5Vp-p, R_L = 600Ω, f = 20Hz to 20kHz	T_A = +25°C			0.05		%
POWER SUPPLY								
Power-Supply Range	V+				2.0		5.5	V
V+ Supply Current	I+	V+ = 5.5V, V_{IN} = 0 or V+	T_A = T_{MIN} to T_{MAX}		-1		1	µA

ELECTRICAL CHARACTERISTICS—+3V Supply

(V+ = +2.7V to +3.6V, V_{IH} = +2.0V, V_{IL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = +3.0V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V_{COM}, V_{NO}, V_{NC}			0		V+	V
On-Resistance	R_{ON}	V_{NO} or V_{NC} = 1.5V, I_{COM} = 10mA, V+ = 2.7V	T_A = +25°C		10	20	Ω
			T_A = T_{MIN} to T_{MAX}			25	
DIGITAL I/O							
Input Logic High	V_{IH}			2.0			V
Input Logic Low	V_{IL}					0.8	V
Input Logic Current	I_{IH}, I_{IL}	V_{IN} = V+, 0		-1	0.03	1	µA
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO} or V_{NC} = 2V, R_L = 300Ω, C_L = 35pF, Figure 3	T_A = +25°C		25	45	ns
			T_A = T_{MIN} to T_{MAX}			55	
Turn-Off Time	t_{OFF}	V_{NO} or V_{NC} = 2V, R_L = 300Ω, C_L = 35pF, Figure 3	T_A = +25°C		30	50	ns
			T_A = T_{MIN} to T_{MAX}			60	
Charge Injection (Note 5)	Q	V_{NO} or V_{NC} = 0, C_L = 1nF, Figure 2	T_A = +25°C		2	4	pC

MAX4594–MAX4597

ELECTRICAL CHARACTERISTICS—+3V Supply (continued)

(V+ = +2.7V to +3.6V, V_{IH} = +2.0V, V_{IL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = +3.0V, T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY							
V+ Supply Current	I+	V+ = 3.6V, V_{IN} = 0 or V+	T_A = T_{MIN} to T_{MAX}	-1		1	µA

Note 2: Parameters are 100% tested at +25°C only, and guaranteed by correlation at the full-rated temperature.
Note 3: Algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.
Note 4: Flatness is defined as the difference between the maximum and minimum values of on-resistance as measured over the specified analog signal ranges.
Note 5: Guaranteed by design.
Note 6: Off-Isolation = $20\log_{10} (V_{COM} / V_{NO})$, V_{COM} = output, V_{NO} = input to off switch.

_____*Typical Operating Characteristics*

(V+ = +5V, T_A = +25°C, unless otherwise noted.)
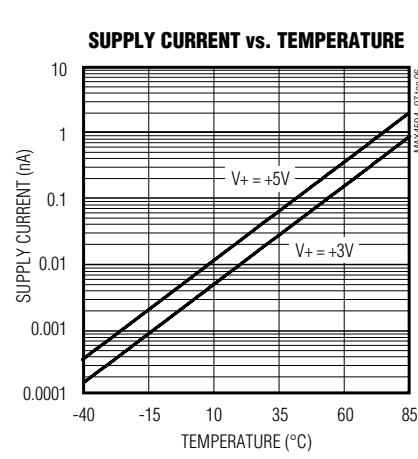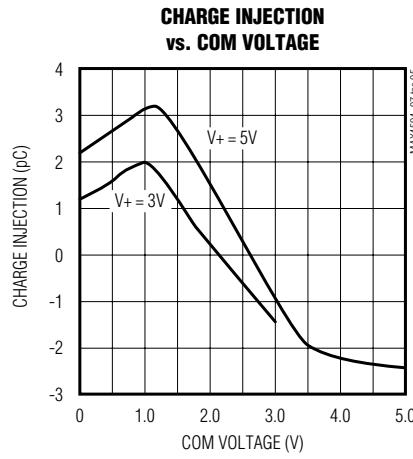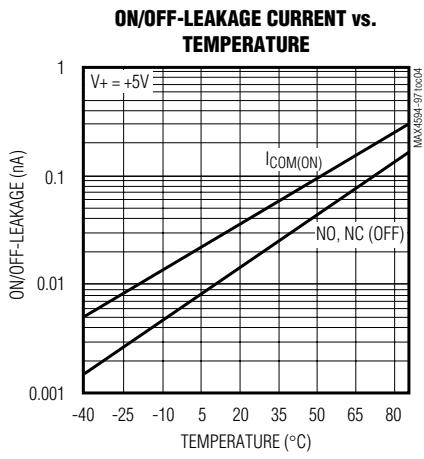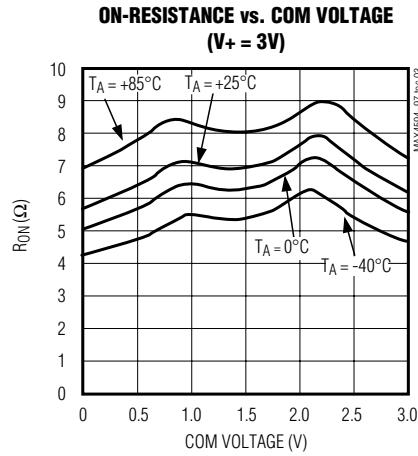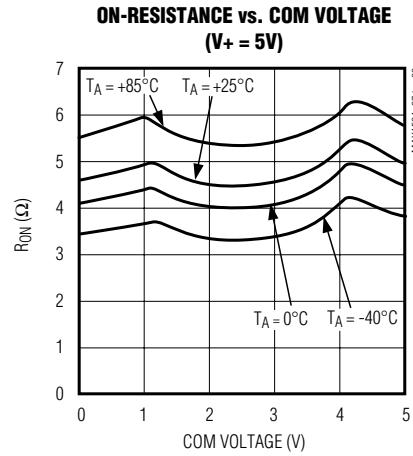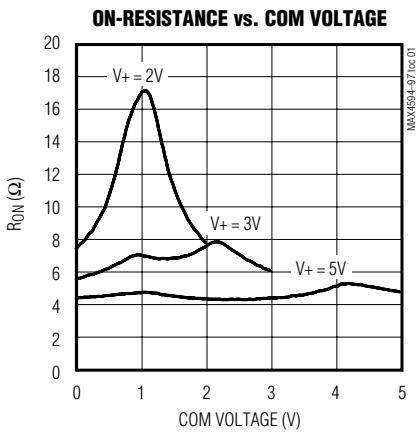
ON-RESISTANCE vs. COM VOLTAGE

ON-RESISTANCE vs. COM VOLTAGE (V+ = 5V)

ON-RESISTANCE vs. COM VOLTAGE (V+ = 3V)

ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE

CHARGE INJECTION vs. COM VOLTAGE

SUPPLY CURRENT vs. TEMPERATURE

MAXIM

MAX4594–MAX4597

Typical Operating Characteristics (continued)

(V+ = +5V, T_A = +25°C, unless otherwise noted.)

LOGIC THRESHOLD vs. SUPPLY VOLTAGE
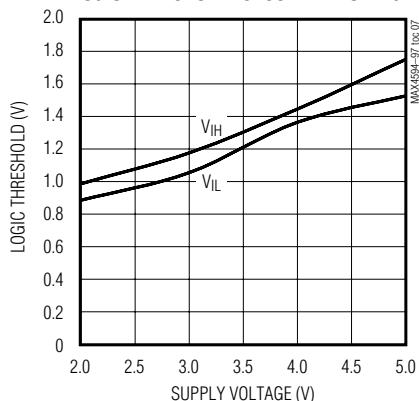
TURN-ON/TURN-OFF TIME vs. SUPPLY VOLTAGE
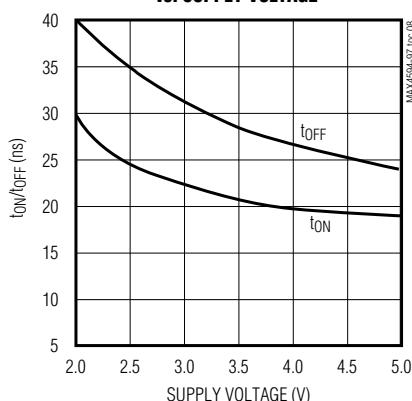
TURN-ON/TURN-OFF TIME vs. TEMPERATURE
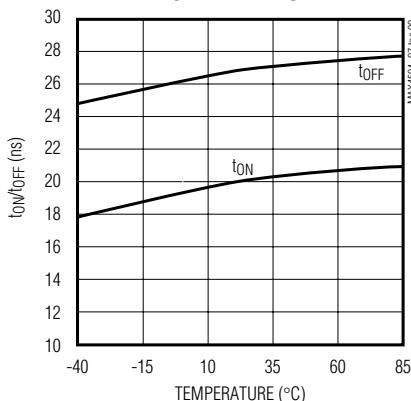
FREQUENCY RESPONSE
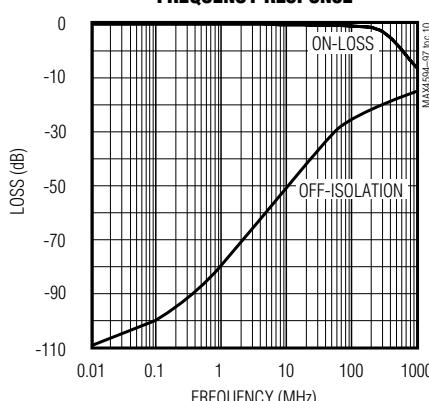
TOTAL HARMONIC DISTORTION PLUS NOISE vs. FREQUENCY
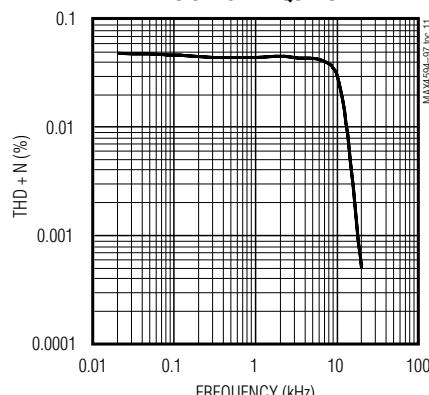
Pin Description

PIN				NAME	FUNCTION
MAX4594	MAX4595	MAX4596	MAX4597		
1	1	2	2	COM	Analog Switch, Common
2	—	4	—	NO	Analog Switch, Normally Open
3	3	3	3	GND	Ground
4	4	1	1	IN	Digital Control Input
5	5	5	5	V+	Positive Supply-Voltage
—	2	—	4	NC	Analog Switch, Normally Closed

Note: NO, NC, and COM pins are identical and interchangeable. Any pin may be considered as an input or an output; signals pass equally well in both directions.

Low-Voltage, Single-Supply, 10Ω SPST CMOS Analog Switches

Applications Information

Analog Signal Levels

Analog signals can range over the supply voltage (V+ to GND) with on-resistance changing very little over the entire range (see *Typical Operating Characteristics*). The MAX4594–MAX4597 are bidirectional, so the NO, NC, and COM pins can be used either as inputs or outputs.

Power-Supply Sequencing and Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V+ before applying analog signals or logic inputs, especially if the analog or logic signals are not current limited. If this sequencing is not possible, and if the analog or logic inputs are not current limited to <20mA, add a small-signal diode (D1) as shown in Figure 1. If the analog signal can dip below GND, add D2. Adding protection diodes reduces the analog signal range to a diode drop (about 0.7V) below V+ for D1 or to a diode drop above ground for D2. The addition of diodes does not affect leakage. On-resistance increases by a small amount at low supply voltages. Maximum supply voltage (V+) must not exceed 6V.

Protection diodes D1 and D2 also protect against some overvoltage situations. A fault voltage up to the absolute maximum rating at an analog signal input does not damage the device, even if the supply voltage is below the signal voltage.
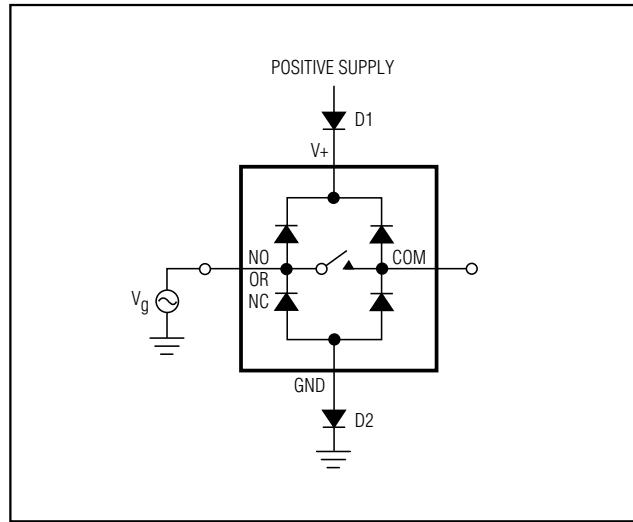

Figure 1. Overvoltage Protection Using Two External Blocking Diodes

Chip Information

TRANSISTOR COUNT: 50

Test Circuits/Timing Diagrams

$$Q = \Delta V_{OUT} \times C_L$$
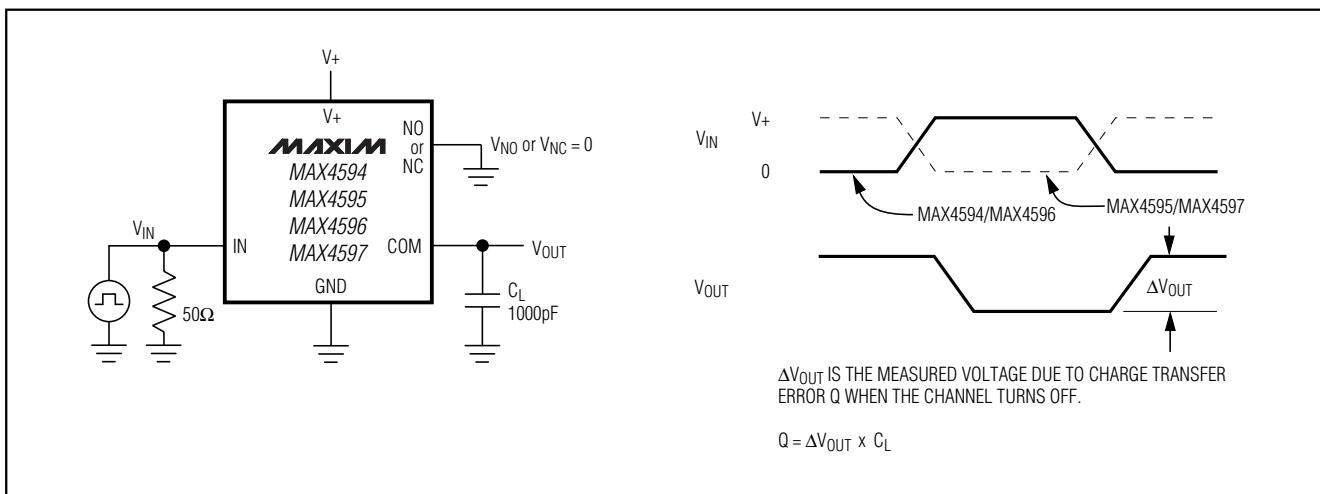
Figure 2. Charge Injection

MAXIM

Test Circuits/Timing Diagrams (continued)
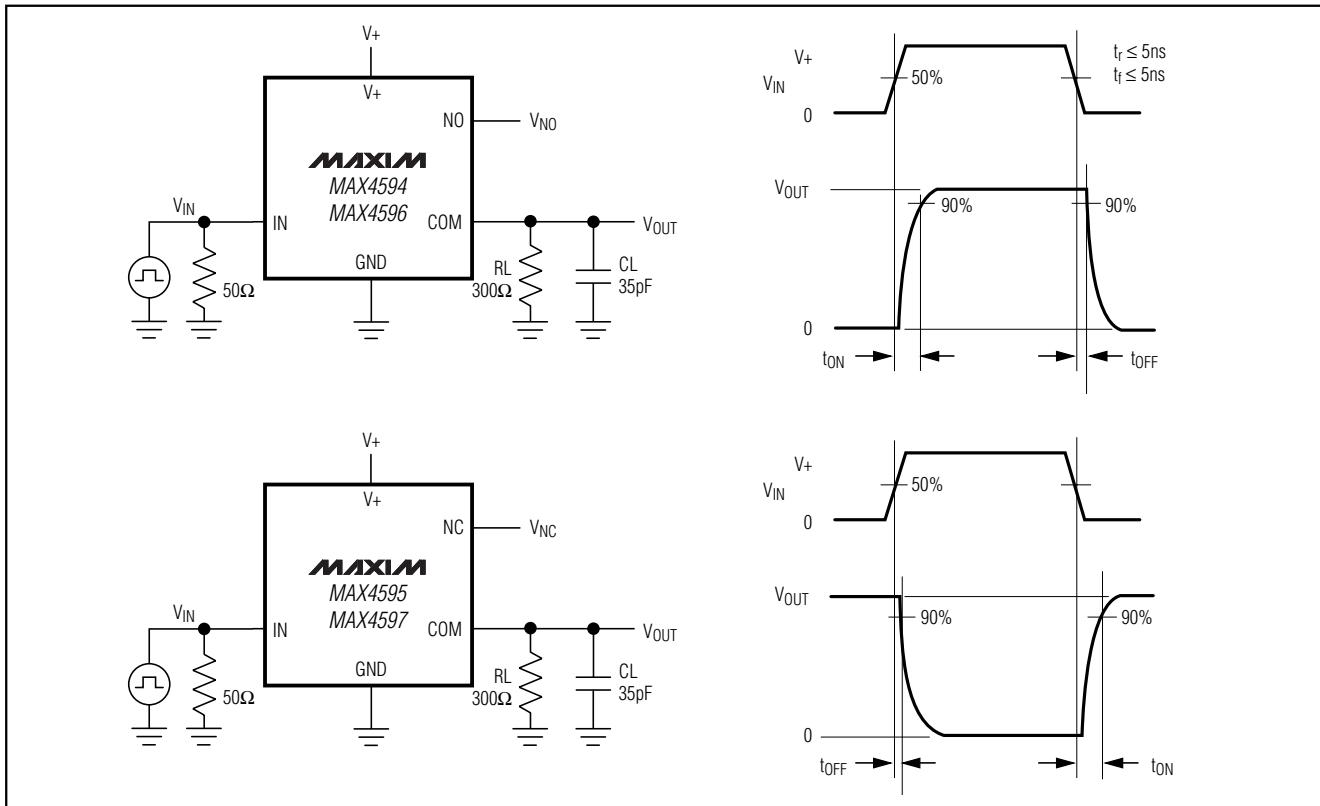
Figure 3. Switching Times
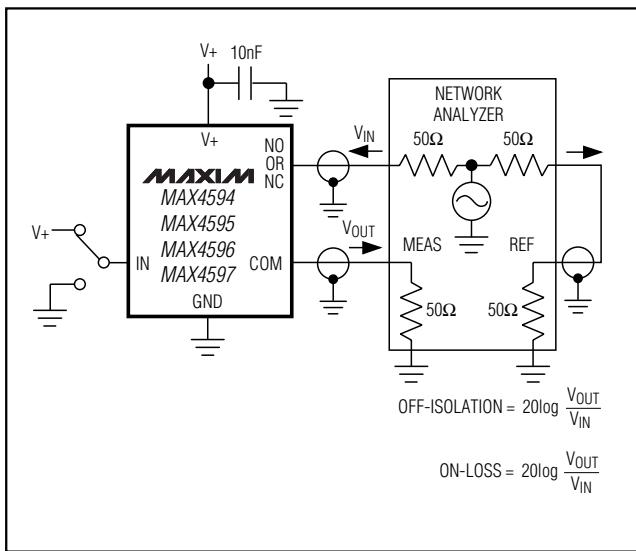
Figure 4. Off-Isolation and On-Channel Bandwidth

$$\text{OFF-ISOLATION} = 20\log \frac{V_{OUT}}{V_{IN}}$$

$$\text{ON-LOSS} = 20\log \frac{V_{OUT}}{V_{IN}}$$
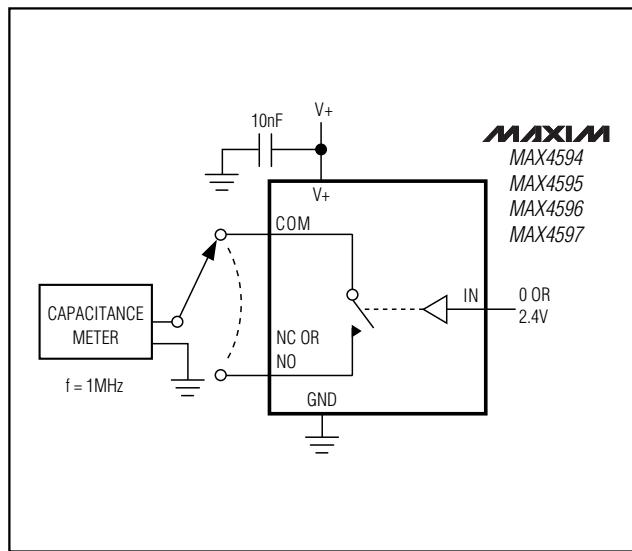
Figure 5. Channel On-/Off-Capacitance

Low-Voltage, Single-Supply, 10Ω SPST CMOS Analog Switches

_____**Package Information**

SC70, 5L.EPS

SYMBOL	MIN	MAX
e	0.65	BSC
D	1.80	2.20
b	0.15	0.30
E	1.15	1.35
HE	1.80	2.40
Q1	0.10	0.40
A2	0.80	1.00
A1	0.00	0.10
A	0.80	1.10
c	0.10	0.18
L	0.10	0.30
L1	0.425	TYP.

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS
2. DIMENSIONS ARE INCLUSIVE OF PLATING
3. DIMENSIONS ARE EXCLUSIVE
   OF MOLD FLASH & METAL BURR
4. ALL SPECIFICATIONS COMPLY TO EIAJ SC70
5. COPLANARITY 4 MILS. MAX.

MAXIM
PROPRIETARY INFORMATION
TITLE:
PACKAGE OUTLINE, SC70, 5L

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0076	B	1/1