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 and 6-pin µDFN.

_____Applications

Cellular Phones

Battery-Operated Equipment

Audio and Video Signal Routing

Communications Circuits

PCMCIA Cards

DSL Modems

_____Features

♦ **Available in 5-Pin SC70 and 6-Pin µDFN Packages**
♦ **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
MAX4594ELT-T	-40°C to +85°C	6 µDFN-6	AB
MAX4595EXK-T	-40°C to +85°C	5 SC70-5	AAI
MAX4595ELT-T	-40°C to +85°C	6 µDFN-6	AC
MAX4596EXK-T	-40°C to +85°C	5 SC70-5	AAJ
MAX4596ELT-T	-40°C to +85°C	6 µDFN-6	AD
MAX4597EXK-T	-40°C to +85°C	5 SC70-5	AAK
MAX4597ELT-T	-40°C to +85°C	6 µDFN-6	AE

_____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.

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

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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
    6-Pin μDFN (derate 2.1mW/°C above +70°C) 168mW
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

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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)

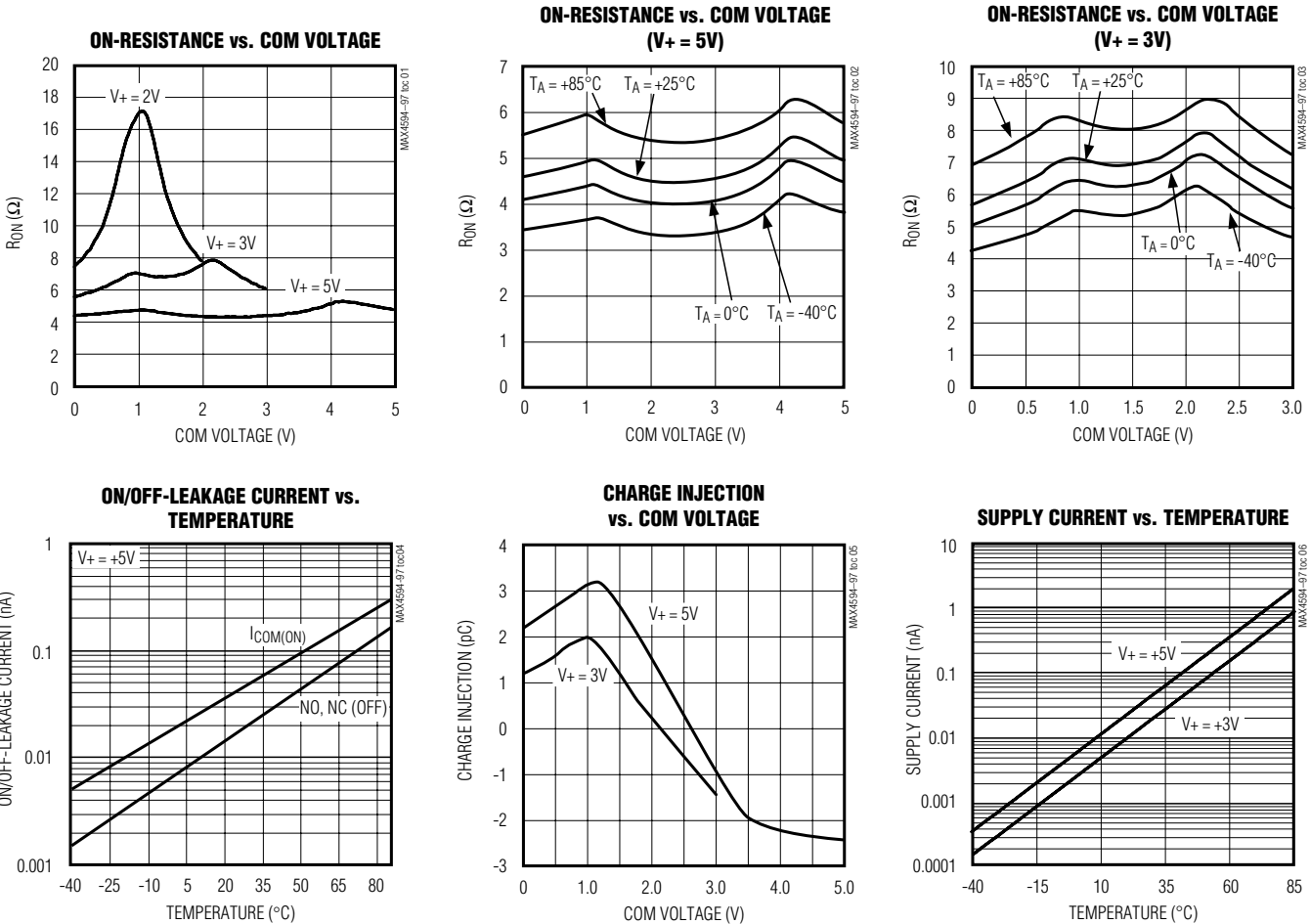| PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
Charge Injection (Note 5)	Q	V_{NO} or V_{NC} = 0, C_L = 1nF, Figure 2	T_A = +25°C			2	5	pC
Off-Isolation (Note 6)	V_{ISO}	V_{NO} or V_{NC} = 1V_{RMS}, R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 4	T_A = +25°C	MAX4594/ MAX4595		80		dB
				MAX4596/ MAX4597		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

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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.
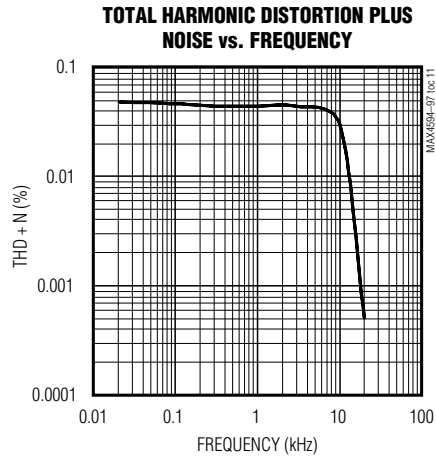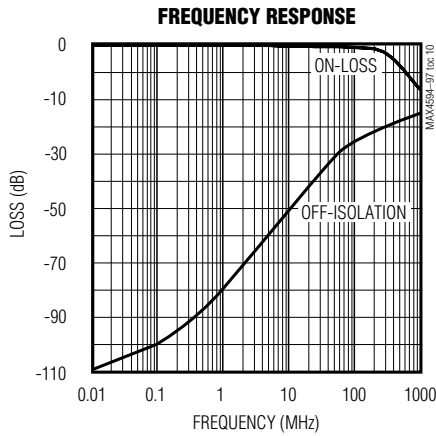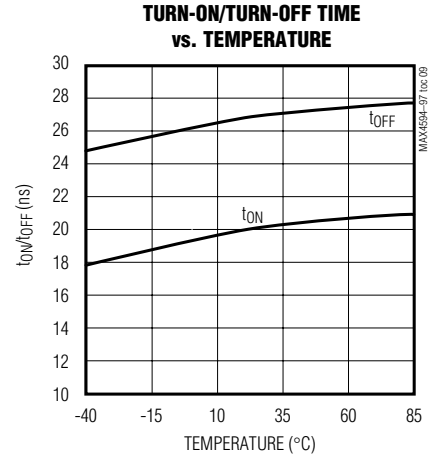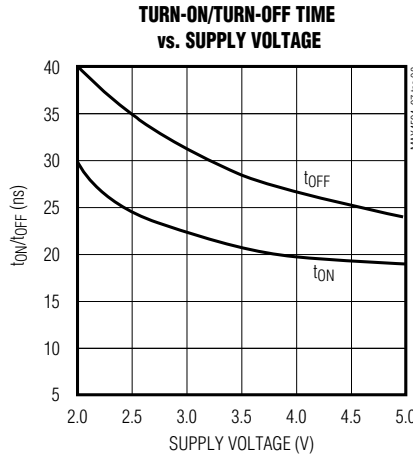
Typical Operating Characteristics

(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

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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			
SC70	µDFN	SC70	µDFN	SC70	µDFN	SC70	µDFN		
1	1	1	1	2	2	2	2	COM	Analog Switch, Common
2	2	—	—	4	4	—	—	NO	Analog Switch, Normally Open
3	3	3	3	3	3	3	3	GND	Ground
4	4	4	4	1	1	1	1	IN	Digital Control Input
5	6	5	6	5	6	5	6	V+	Positive Supply Voltage
—	—	2	2	—	—	4	4	NC	Analog Switch, Normally Closed
—	5	—	5	—	5	—	5	N.C.	No Connection. Not internally connected.
EP	EP	EP	EP	EP	EP	EP	EP	PAD	Exposed Pad. Connect to GND (µDFN only.)

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.
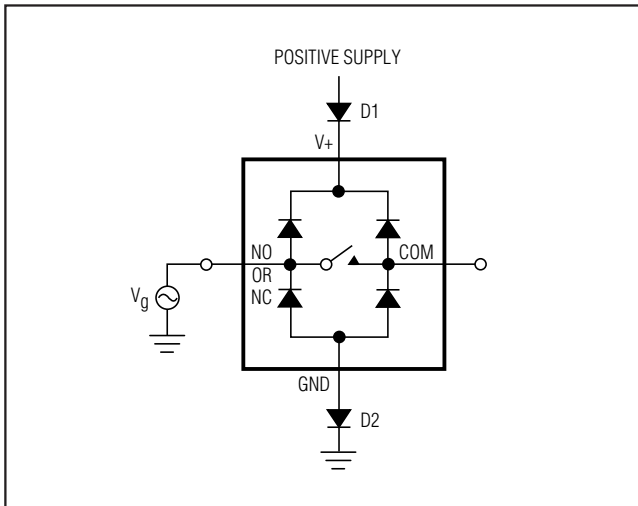
Power-Supply Sequencing and Overvoltage Protection

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.

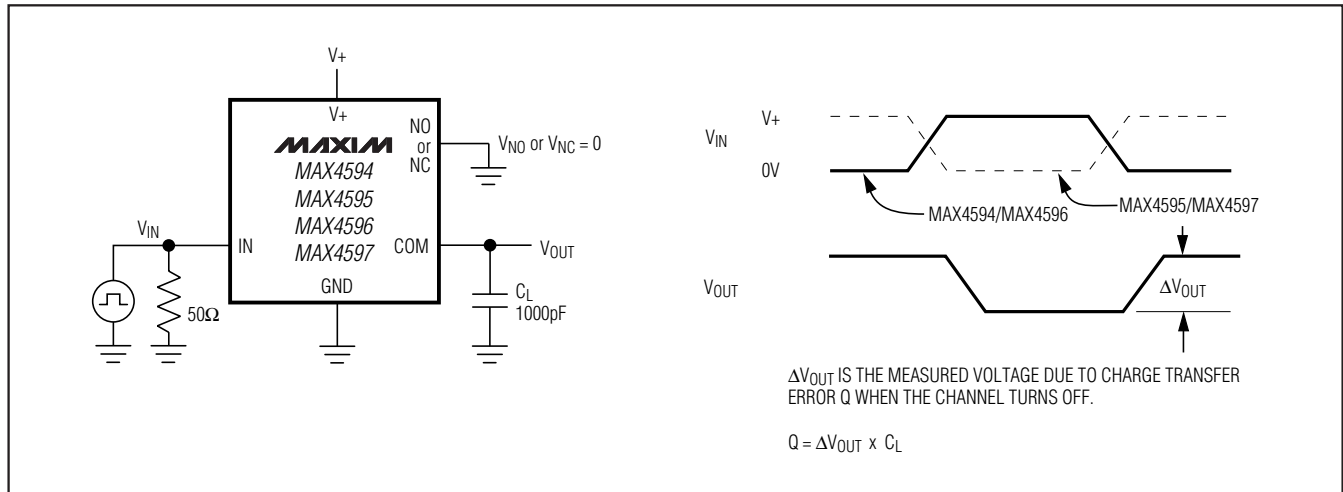Figure 1. Overvoltage Protection Using Two External Blocking Diodes

Test Circuits/Timing Diagrams

ΔV_{OUT} IS THE MEASURED VOLTAGE DUE TO CHARGE TRANSFER ERROR Q WHEN THE CHANNEL TURNS OFF.

$Q = \Delta V_{OUT} \times C_L$

Figure 2. Charge Injection
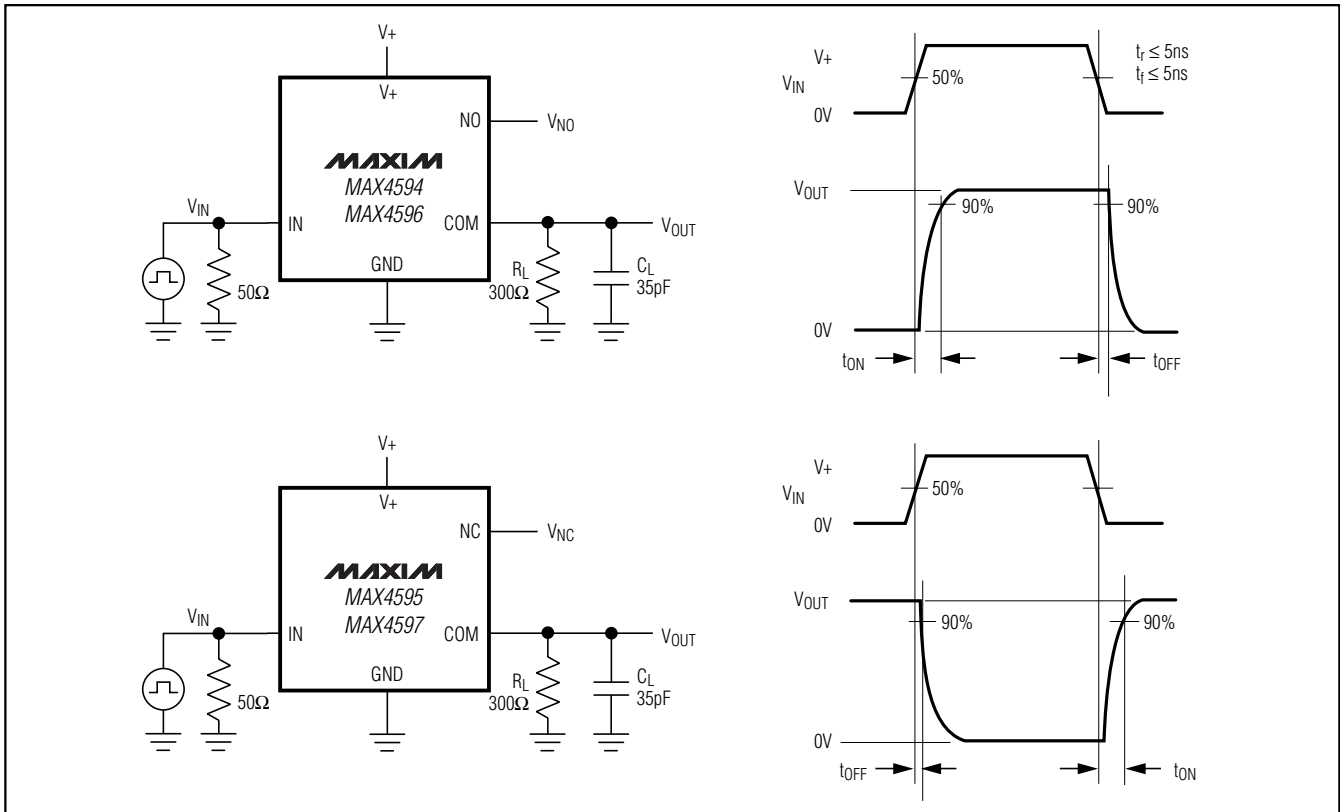
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Test Circuits/Timing Diagrams (continued)

Figure 3. Switching Times

Figure 4. Off-Isolation and On-Channel Bandwidth

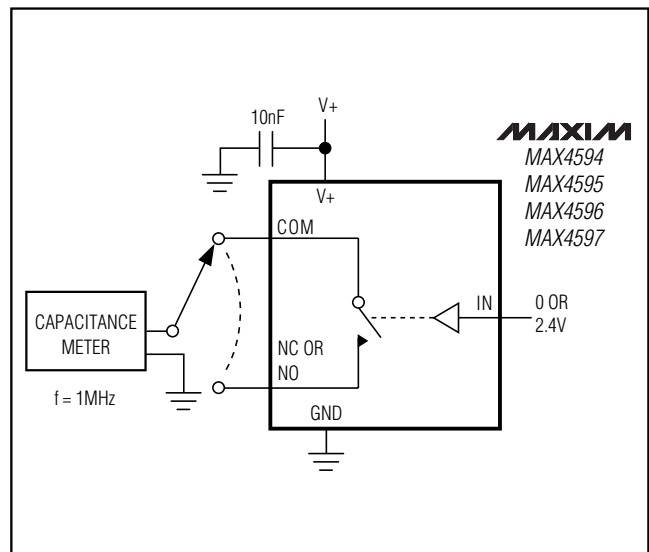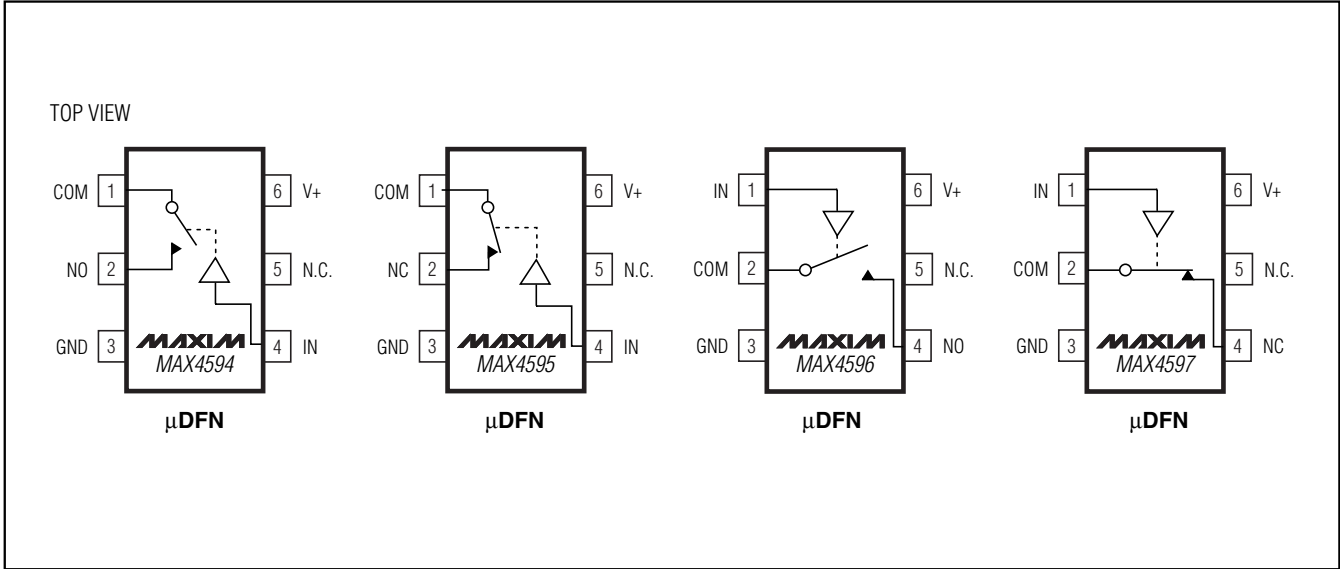$$\text{OFF-ISOLATION} = 20\log \frac{V_{OUT}}{V_{IN}}$$

$$\text{ON-LOSS} = 20\log \frac{V_{OUT}}{V_{IN}}$$

Figure 5. Channel On-/Off-Capacitance

_____Pin Configurations/Functional Diagrams/Truth Table (continued)

MAX4594–MAX4597

TOP VIEW

_____Chip Information

TRANSISTOR COUNT: 50

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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**.)

6L UDFN.EPS

TOP VIEW

TOPMARK

PIN 1
INDEX AREA

AAA

A

E

D

1

SIDE VIEW

A

A1

BOTTOM VIEW

e

b

4   5   6

PIN 1
0.075x45°

L

L2

L1

3   2   1

A   A

SECTION A-A

b

NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
3. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC
   DIMENSION "e", ±0.05.

-DRAWING NOT TO SCALE-

SYMBOL	COMMON DIMENSIONS		
	MIN.	NOM.	MAX.
A	0.64	0.72	0.80
A1	--	0.20	--
D	1.45	1.50	1.55
E	0.95	1.00	1.05
L	0.30	0.35	0.40
L1	--	--	0.08
L2	--	--	0.05
b	0.17	0.20	0.23
e	0.50 BSC.		

DALLAS SEMICONDUCTOR **MAXIM**

TITLE:
PACKAGE OUTLINE, 6L uDFN, 1.5x1.0x0.8mm

APPROVAL

DOCUMENT CONTROL NO.
21-0147

REV.
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MAX4594–MAX4597
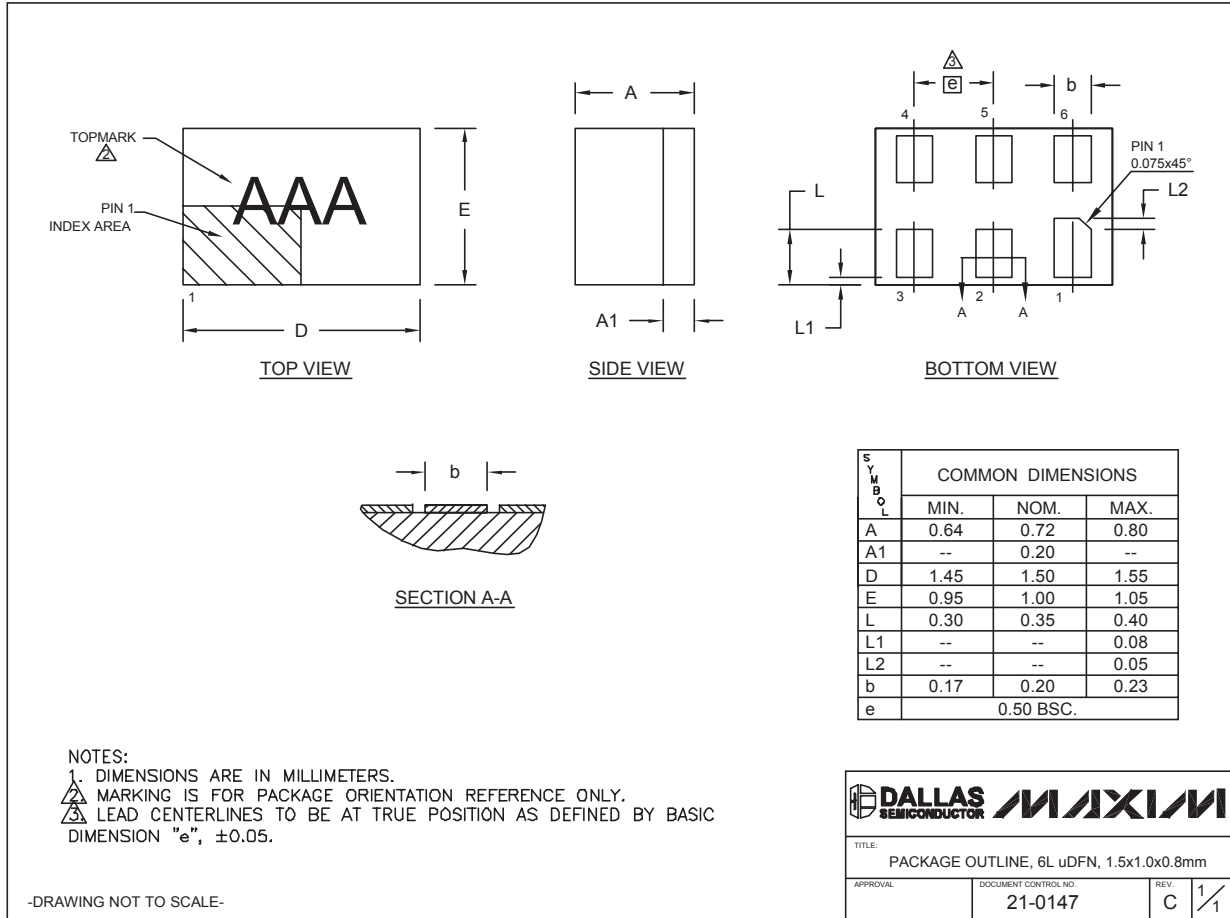
Low-Voltage, Single-Supply, 10Ω SPST CMOS Analog Switches

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**.)

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

SC70, 5L.EPS

0.15 REF.

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. COMPLY TO EIAJ SC70 EXCEPT FOR PIN COUNT AND DIMENSION "b".
5. COPLANARITY 4 MILS. MAX.
6. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM "A" AND LEAD SURFACE.
7. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
8. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e", ±0.05.

DALLAS SEMICONDUCTOR /VI/IXI/VI

TITLE: PACKAGE OUTLINE, 5L SC70			
APPROVAL	DOCUMENT CONTROL NO. 21-0076	REV. C	1/1

−DRAWING NOT TO SCALE−