19-1637; Rev 2; 2/04

MAXIM

Low-Voltage, Single-Supply, SPDT Analog Switch in SC70

General Description

The MAX4599 single-pole/double-throw (SPDT) switch operates from a +2.0V to +5.5V single supply. It offers 60Ω max on-resistance (R_{ON}) at +5V and fast switching times (t_{ON} = 30ns max, t_{OFF} = 25ns max).

The MAX4599 features excellent R_{ON} flatness (4Ω max) and matching (1Ω max) between channels. This device also offers 5pC max charge injection.

The MAX4599 is available in tiny 6-pin SC70, µDFN, and SOT23 packages.

Applications

Battery-Operated Equipment

Audio and Video Signal Routing

Cellular Phones

Low-Voltage Data-Acquisition Systems

Sample-and-Hold Circuits

Communications Circuits

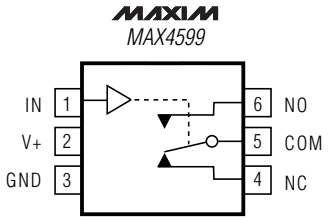
Features

- **Available in 6-Pin SC70 Package**
- **60Ω max (40Ω typ) On-Resistance**
- **1Ω max (0.2Ω typ) R_{ON} Matching Between Channels**
- **4Ω max (2.5Ω typ) R_{ON} Flatness**
- **Fast Switching: t_{ON} = 30ns (max)**
  t_{OFF} = 25ns (max)
- **Guaranteed 5pC max Charge Injection**
- **+2.0V to +5.5V Single-Supply Operation**
- **200MHz -3dB Bandwidth**
- **Low ±0.5nA Leakage Current at +25°C**
- **Break-Before-Make Switching**
- **TTL/CMOS-Logic Compatible**
- **-76dB Off-Isolation at 1MHz**
- **0.12% Total Harmonic Distortion**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX4599EXT-T	-40°C to +85°C	6 SC70-6	AAF
MAX4599EUT-T	-40°C to +85°C	6 SOT23-6	AAHC
MAX4599ELT-T	-40°C to +85°C	6 µDFN-6	AA

Pin Configuration/Functional Diagram/Truth Table



SC70-6/µDFN-6/SOT23-6

MAX4599		
IN	NC	NO
0	ON	OFF
1	OFF	ON

SWITCH IS SHOWN FOR "0" INPUT.

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.

Low-Voltage, Single-Supply, SPDT Analog Switch in SC70

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to GND
V+ .....-0.3V to +6V
IN, COM, NO, NC (Note 1) .....-0.3V to (V+ + 0.3V)
Continuous Current (any terminal).....±20mA
Peak Current, COM, NO, NC
(pulsed at 1ms, 10% duty cycle).....±40mA

Continuous Power Dissipation (T_A = +70°C)
6-Pin SC70-6 (derate 3.1mW/°C above +70°C).....245mW
6-Pin µDFN-6 (derate 2.1mW/°C above +70°C) 168mW
6-Pin SOT23-6 (derate 7.1mW/°C above +70°C) 571mW
Operating Temperature Range
MAX4599E_T .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C

Note 1: Signals on NO, NC, COM, or IN exceeding V+ or GND 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— Single +5V Supply

(V+ = +4.5V to +5.5V, V_{INH} = +2.4V, V_{INL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (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, I_{COM} = 1mA, V_{NO} or V_{NC} = 3.5V	T_A = +25°C		40	60	Ω
			T_A = T_{MIN} to T_{MAX}			65	
On-Resistance Match Between Channels (Note 4)	ΔRON	V+ = 4.5V, I_{COM} = 1A, V_{NO} or V_{NC} = 3.5V	T_A = +25°C		0.2	1	Ω
			T_A = T_{MIN} to T_{MAX}			2	
On-Resistance Flatness (Note 5)	$R_{FLAT(ON)}$	V+ = 4.5V; I_{COM} = 1mA; V_{NO} or V_{NC} = 1V, 2.0V, 3.5V	T_A = +25°C		2.5	4	Ω
			T_A = T_{MIN} to T_{MAX}			5	
NO, NC Off-Leakage Current (Note 6)	$I_{NO(OFF)}$, $I_{NC(OFF)}$	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 On-Leakage Current (Note 6)	$I_{COM(ON)}$	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
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO}, V_{NC} = 3V; R_L = 1kΩ; C_L = 35pF; Figure 2	T_A = +25°C		25	30	ns
			T_A = T_{MIN} to T_{MAX}			40	

ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ =+4.5V to +5.5V, V_{INH} = +2.4V, V_{INL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Turn-Off Time	t_{OFF}	V_{NO}, V_{NC} = 3V; R_L = 1kΩ; C_L = 35pF; Figure 2	T_A = +25°C		20	25	ns
			T_A = T_{MIN} to T_{MAX}			30	
Break-Before-Make	t_{BBM}	V_{NO}, V_{NC} = 3V; R_L = 1kΩ; C_L = 35pF; Figure 3	T_A = +25°C		10		ns
			T_A = T_{MIN} to T_{MAX}	1			
On-Channel -3dB Bandwidth	BW	Signal = 0dBm, 50Ω in and out, Figure 5	T_A = +25°C		200		MHz
Off-Isolation (Note 7)	V_{ISO}	C_L = 5pF; R_L = 50Ω; f = 1MHz; V_{NO}, V_{NC} = $1V_{RMS}$; Figure 5	T_A = +25°C		-76		dB
Charge Injection (Note 6)	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 1.0nF, Figure 4	T_A = +25°C		3	5	pC
NO, NC Off-Capacitance	$C_{NO(OFF)}$, $C_{NC(OFF)}$	V_{NO}, V_{NC} = GND; f = 1MHz; Figure 6	T_A = +25°C		8		pF
COM Off-Capacitance	$C_{COM(OFF)}$	V_{COM} = GND, f = 1MHz, Figure 6	T_A = +25°C		8		pF
Switch On-Capacitance	$C_{(ON)}$	V_{COM} = V_{NO}, V_{NC} = GND, f = 1MHz, Figure 6	T_A = +25°C		20		pF
Total Harmonic Distortion	THD	R_L = 600Ω, V_{IN} = 5Vp-p, f = 20Hz to 20kHz	T_A = +25°C		0.12		%
SUPPLY							
Power-Supply Range	V+			2.0		5.5	V
Positive Supply Current	I+	V+ = 5.5V, V_{IN} = 0 or V+		-1	0.001	1	µA

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +3.6V, V_{INH} = +2.0V, V_{INL} = +0.8V, T_A =T_{MIN} to T_{MAX}, unless otherwise noted.) (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+ = 2.7V, I_{COM} = 1mA, V_{NO} or V_{NC} = 1V	T_A = +25°C		60	95	Ω
			T_A = T_{MIN} to T_{MAX}			105	
DIGITAL I/O							
Input Logic High	V_{IH}			2.0			V
Input Logic Low	V_{IL}					0.8	V

Low-Voltage, Single-Supply, SPDT Analog Switch in SC70

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +3.6V, V_{INH} = +2.0V, V_{INL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO}, V_{NC} = 2V; R_L = 1kΩ; C_L = 35pF; Figure 2	T_A = +25°C		40	45	ns
			T_A = T_{MIN} to T_{MAX}			55	
Turn-Off Time	t_{OFF}	V_{NO}, V_{NC} = 2V; R_L = 1kΩ; C_L = 35pF; Figure 2	T_A = +25°C		30	35	ns
			T_A = T_{MIN} to T_{MAX}			40	
Break-Before-Make	t_{BBM}	V_{NO}, V_{NC} = 2V; R_L = 1kΩ; C_L = 35pF; Figure 3	T_A = +25°C		13		ns
			T_A = T_{MIN} to T_{MAX}	1			
Charge Injection (Note 6)	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 1.0nF, Figure 4	T_A = +25°C		2	5	pC
SUPPLY							
Positive Supply Current	I+	V+ = 3.6V, V_{IN} = 0 or V+		-1	0.001	1	µA

ELECTRICAL CHARACTERISTICS—Single +2.5V Supply

(V+ = +2.5V, V_{INH} = +2.0V, V_{INL} = +0.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.) (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+ = 2.5V, I_{COM} = 1mA, V_{NO} or V_{NC} = 1V	T_A = +25°C		65	110	Ω
			T_A = T_{MIN} to T_{MAX}			120	
Input Logic High	V_{IH}			2.0			V
Input Logic Low	V_{IL}					0.6	V
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO}, V_{NC} = 2V; R_L = 1kΩ; C_L = 35pF; Figure 3	T_A = +25°C		45	50	ns
			T_A = T_{MIN} to T_{MAX}			60	
Turn-Off Time	t_{OFF}	V_{NO}, V_{NC} = 2V; R_L = 1kΩ; C_L = 35pF; Figure 3	T_A = +25°C		30	35	ns
			T_A = T_{MIN} to T_{MAX}			45	

Note 2: Parameters are 100% tested at +25°C only and guaranteed by correlation at the full rated temperature.

Note 3: 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 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.

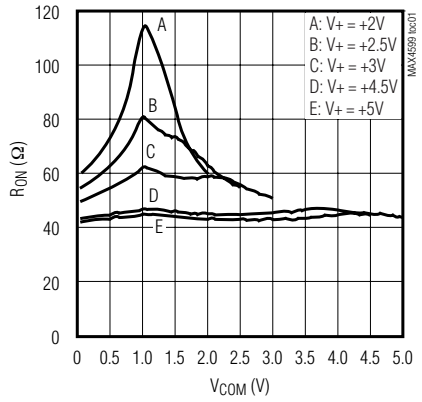
Note 7: Off-Isolation = $20\log_{10} (V_{COM} / V_{NO})$, V_{COM} = output, V_{NO} = input to off switch.

Low-Voltage, Single-Supply, SPDT Analog Switch in SC70

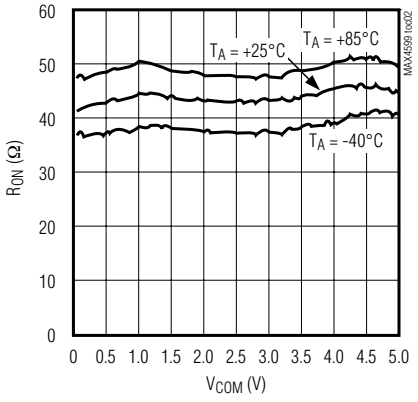
Typical Operating Characteristics

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

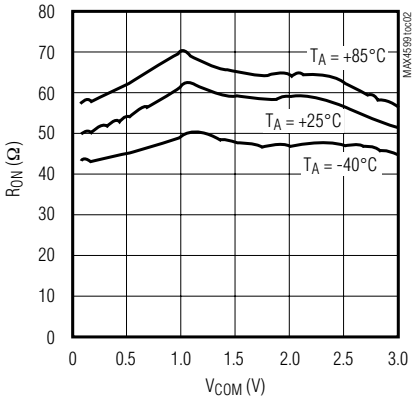
ON-RESISTANCE vs. COM VOLTAGE



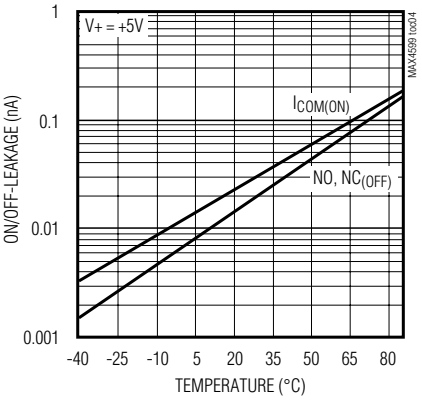
ON-RESISTANCE vs. COM VOLTAGE (V+ = +5V)



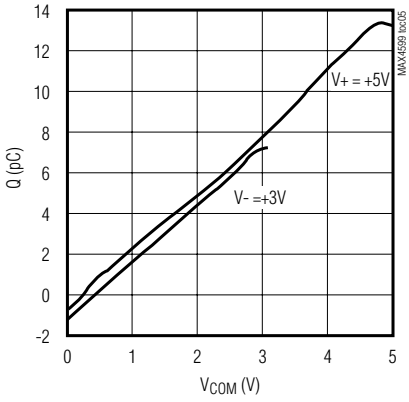
ON-RESISTANCE vs. COM VOLTAGE (V+ = +3V)



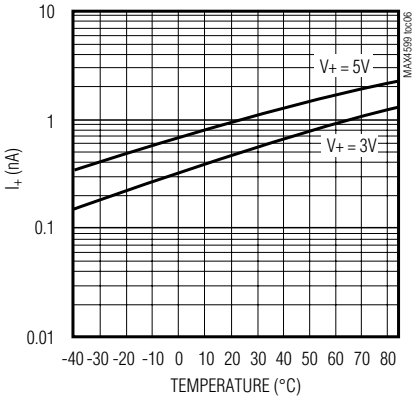
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE



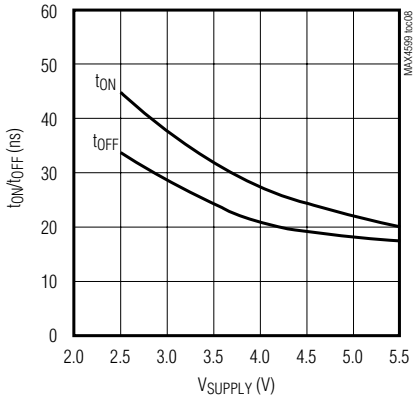
CHARGE INJECTION vs. COM VOLTAGE



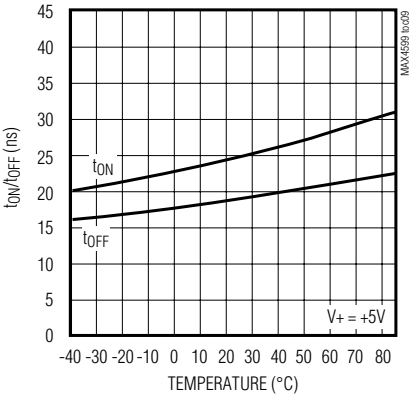
SUPPLY CURRENT vs. TEMPERATURE



TURN-ON/TURN-OFF TIME vs. SUPPLY VOLTAGE



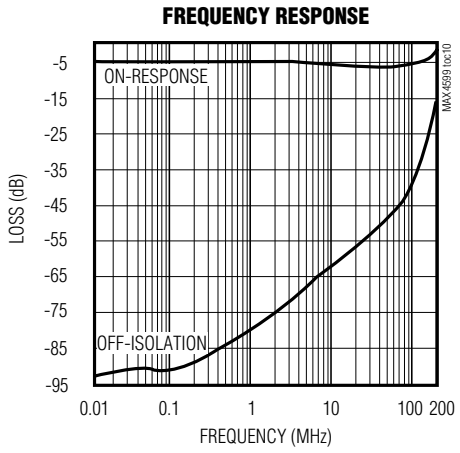
TURN-ON/TURN-OFF TIME vs. TEMPERATURE

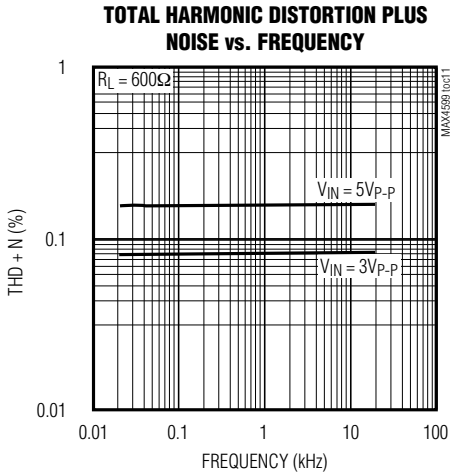


Low-Voltage, Single-Supply, SPDT Analog Switch in SC70

Typical Operating Characteristics (continued)

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





Pin Description

PIN	NAME	FUNCTION
1	IN	Digital Control Input
2	V+	Positive Supply Voltage
3	GND	Ground
4	NC	Analog Switch Normally Closed
5	COM	Analog Switch Common
6	NO	Analog Switch Normally Open

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 MAX4599 is 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.

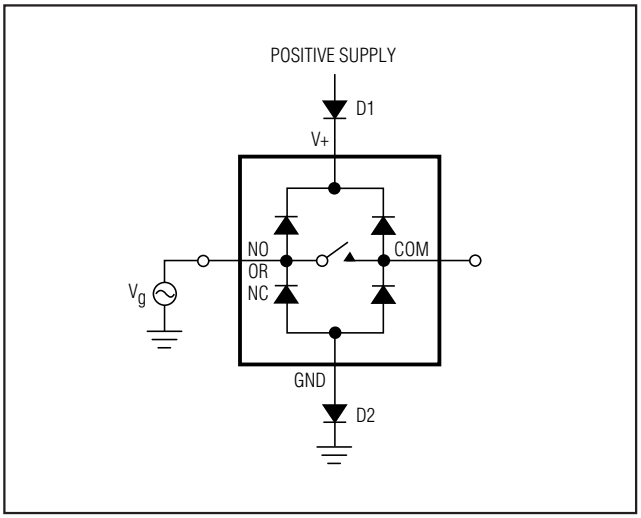


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

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.

Test Circuits/Timing Diagrams

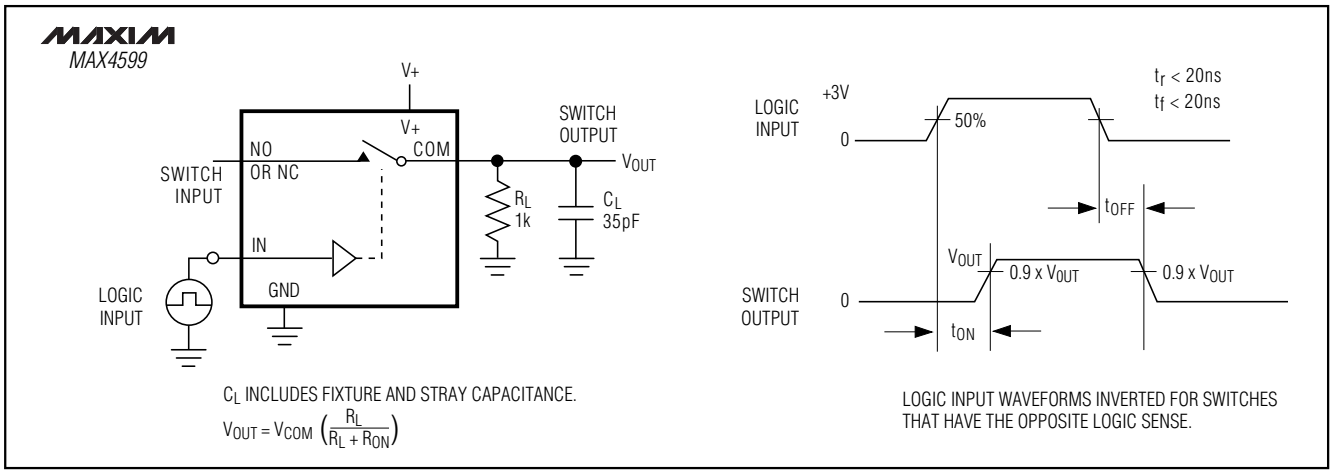


Figure 2. Switching Time

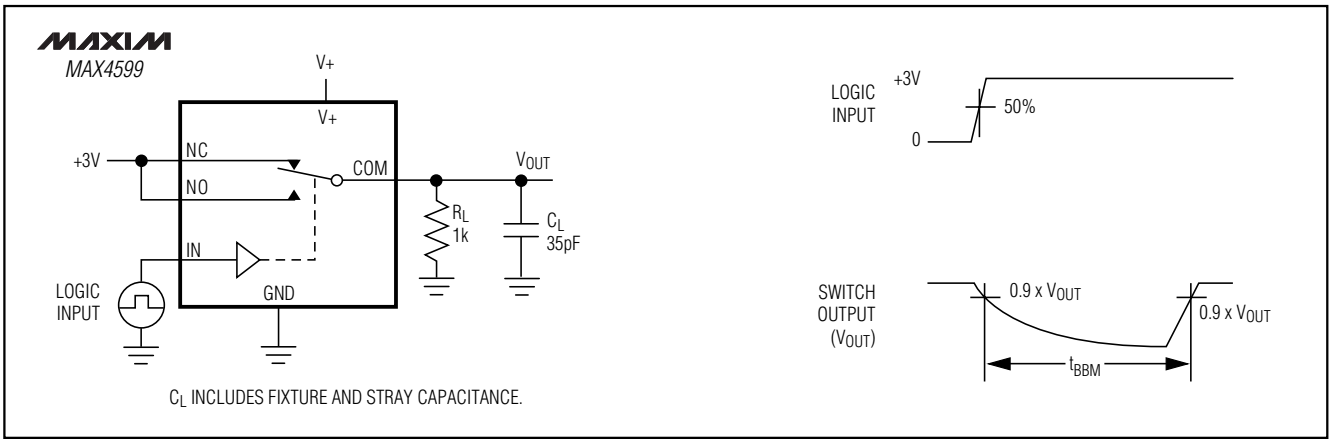


Figure 3. Break-Before-Make Interval

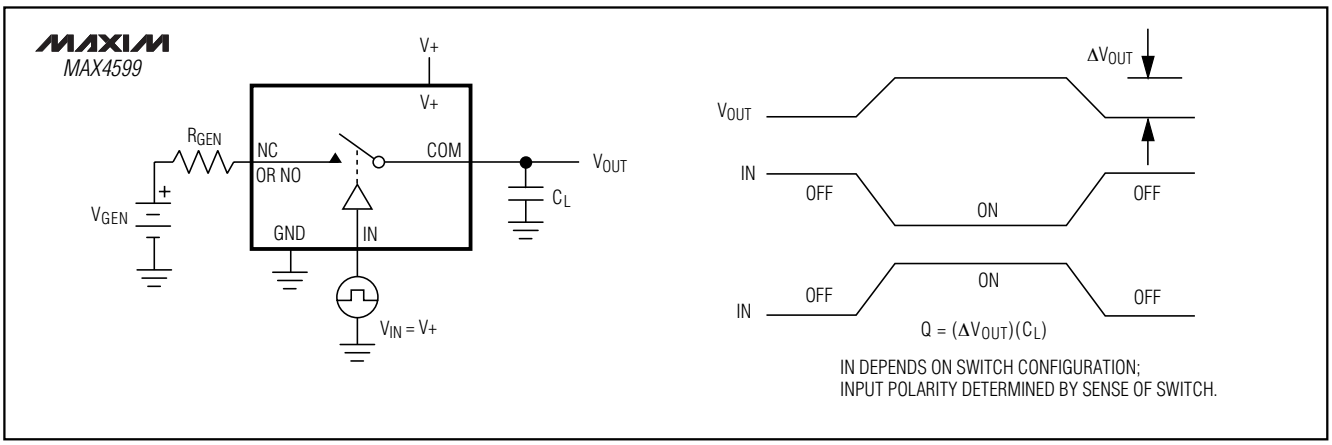


Figure 4. Charge Injection

Low-Voltage, Single-Supply, SPDT Analog Switch in SC70

Test Circuits/Timing Diagrams (continued)

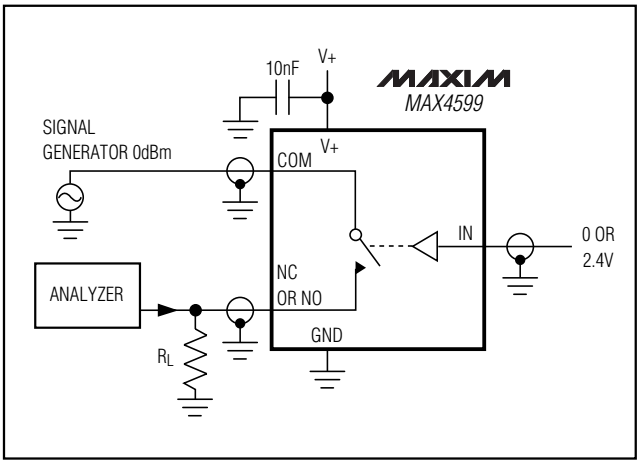


Figure 5. Off-Isolation/On-Channel Bandwidth

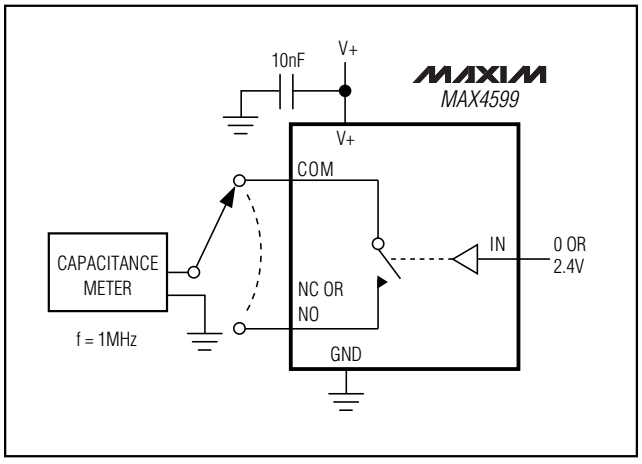


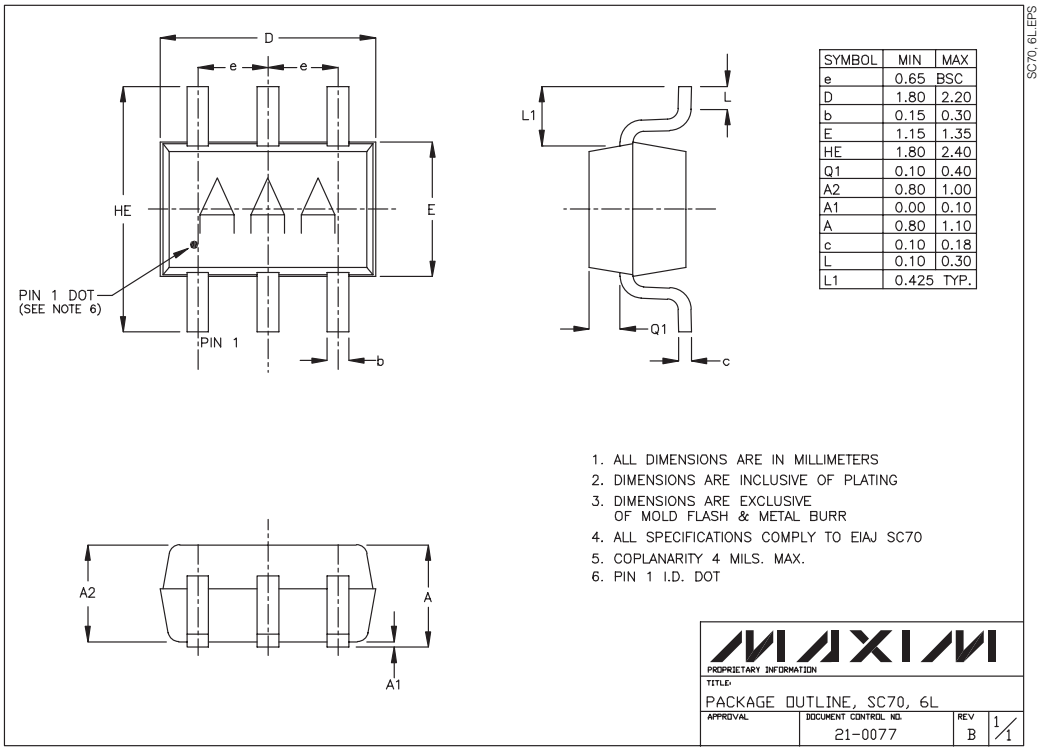
Figure 6. Channel On/Off-Capacitance

Chip Information

TRANSISTOR COUNT: 89

Package Information

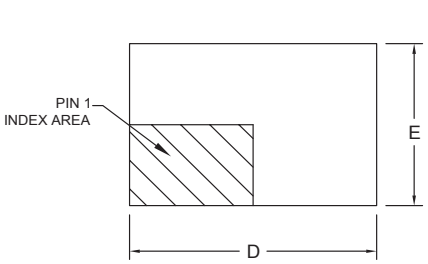
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)



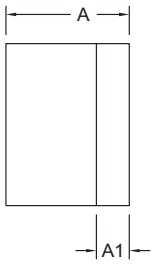
Package Information (continued)

(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**.)

6L UDFN.EPS

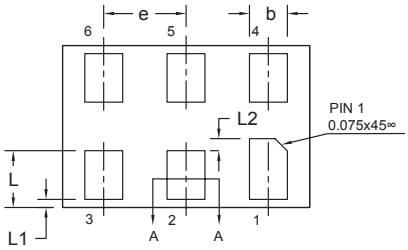


TOP VIEW

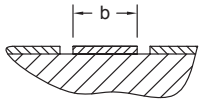


SIDE VIEW

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	--



BOTTOM VIEW



SECTION A-A

NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.

MAXIM
PROPRIETARY INFORMATION

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

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0147	B	1/1

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