19-3159; Rev 0; 1/04

MAXIM

Low-Voltage, 2Ω, SPST, CMOS Analog Switches

General Description

The MAX4706/MAX4707 single-pole/single-throw (SPST) switches operate from a single 1.8V to 5.5V supply. The MAX4706 is a normally closed (NC) switch and the MAX4707 is the normally open (NO) version. These switches provide 2Ω on-resistance (R_{ON}) and 0.6Ω R_{ON} flatness with a +2.7V supply. These devices typically consume only 0.02µA of quiescent current, making them suitable for use in low-power, portable applications. The MAX4706/MAX4707 feature low-leakage currents over the entire temperature range, TTL/CMOS-compatible digital logic, and excellent AC characteristics.

The MAX4706/MAX4707 are offered in small 5-pin and 6-pin SC70 and 6-pin µDFN packages.

Applications

Battery-Operated Equipment

Audio Signal Routing

Low-Voltage Data-Acquisition Systems

Sample-and-Hold Circuits

Communications Circuits

Relay Replacement

Features

- **Guaranteed R_{ON} 2Ω max (+2.7V Supply)**
- **Guaranteed R_{ON} Flatness: 0.6Ω (+2.7V Supply)**
- **Excellent AC Characteristics**
  High Off-Isolation: -67dB at 1MHz
  -3dB Bandwidth: 190MHz
- **0.013% Total Harmonic Distortion**
- **Low Supply Current: 0.02µA**
- **Tiny SC70 and µDFN Packages**
- **1.8V to 5.5V Single-Supply Operation**

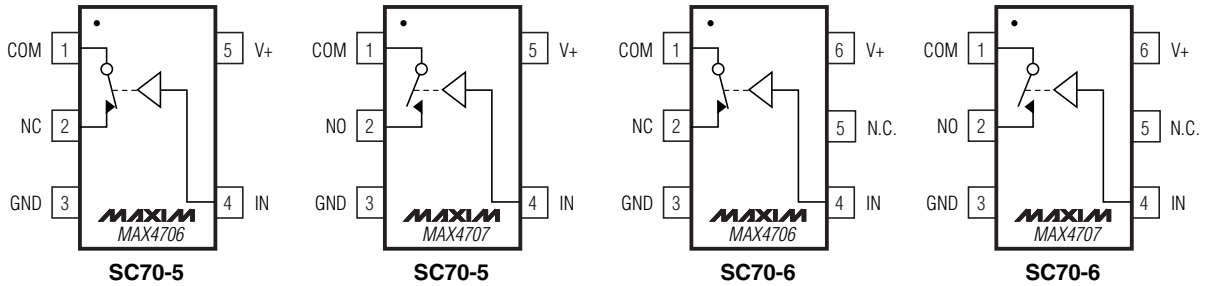
Ordering Information

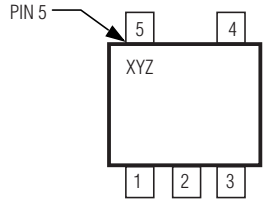
PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX4706EXK-T	-40°C to +85°C	5 SC70-5	AFO
MAX4706EXT-T	-40°C to +85°C	6 SC70-6	ABS
MAX4706ELT-T*	-40°C to +85°C	6 µDFN-6	—
MAX4707EXK-T	-40°C to +85°C	5 SC70-5	AFP
MAX4707EXT-T	-40°C to +85°C	6 SC70-6	ABT
MAX4707ELT-T*	-40°C to +85°C	6 µDFN-6	—

**Future product—contact factory for availability.*

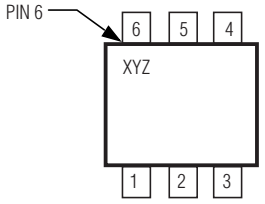
Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW





NOTE: SC70-5 PACKAGE HAS LETTERING NEAREST PIN 5.



NOTE: SC70-6 PACKAGE HAS LETTERING NEAREST PIN 6.

N.C. = NOT INTERNALLY CONNECTED.

INPUT	SWITCH STATE	
	MAX4706	MAX4707
0	ON	OFF
1	OFF	ON

SWITCHES SHOWN FOR LOGIC 0 INPUT.

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

Low-Voltage, 2Ω, SPST, CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to ground.)
V+, IN .....-0.3V to +6V
COM, NO, NC (Note 1).....-0.3V to (V+ + 0.3V)
Continuous Current (IN, V+, GND) .....±30mA
Continuous Current COM, NO, NC .....±160mA
Peak Current COM, NO, NC
(pulsed at 1ms, 10% duty cycle) .....±300mA

Continuous Power Dissipation (T_A = +70°C)
5-Pin SC70 (derate 3.1mW/°C above +70°C) 247mW
6-Pin SC70 (derate 3.1mW/°C above +70°C) 245mW
6-Pin µDFN (derate 2.1mW/°C above +70°C).....167.7mW
Operating Temperature Range .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C
Junction Temperature.....+150°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

(V+ = 2.7V to 3.6V, V_{IH} = 2.0V, V_{IL} = 0.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

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} = 10mA, V_{NO} or V_{NC} = 0V to V+	T_A = +25°C		2.0	3.0	Ω
			T_A = T_{MIN} to T_{MAX}			3.5	
On-Resistance Flatness (Note 3)	$R_{FLAT (ON)}$	V+ = 2.7V, I_{COM} = 10mA, V_{NO} or V_{NC} = 0V to V+	T_A = +25°C		0.6	0.85	Ω
			T_A = T_{MIN} to T_{MAX}			0.97	
NO, NC Off-Leakage Current	$I_{NO(OFF)}$, $I_{NC(OFF)}$	V+ = 3.3V, V_{COM} = 1V, 3V; V_{NO} or V_{NC} = 3V, 1V	T_A = +25°C	-1	0.1	+1	nA
			T_A = T_{MIN} to T_{MAX}	-2		+2	
COM On-Leakage Current	$I_{COM(ON)}$	V+ = 3.3V, V_{COM} = 1V or 3V; V_{NO} or V_{NC} = 1V, 3V, or floating	T_A = +25°C	-1	0.1	+1	nA
			T_A = T_{MIN} to T_{MAX}	-2		+2	
COM Off-Leakage Current	$I_{COM(OFF)}$	V+ = 3.3V, V_{COM} = 1V or 3V; V_{NO} or V_{NC} = 3V, 1V	T_A = +25°C	-1	0.1	+1	nA
			T_A = T_{MIN} to T_{MAX}	-2		+2	
DIGITAL INPUTS							
Input Logic High	V_{IH}			2.0			V
Input Logic Low	V_{IL}					0.4	V
Input Current	I_{IN}	V_{IN} = 0V or V+		-1	0.05	+1	µA
DYNAMIC							
Turn-On Time (Note 4)	t_{ON}	V_{COM} = 2V, R_L = 300Ω, C_L = 35pF, Figure 2	T_A = +25°C		12	20	ns
			T_A = T_{MIN} to T_{MAX}			20	
Turn-Off Time (Note 4)	t_{OFF}	V_{COM} = 2V, R_L = 300Ω, C_L = 35pF, Figure 2	T_A = +25°C		8	15	ns
			T_A = T_{MIN} to T_{MAX}			15	
Charge Injection	Q	V_{GEN} = 0V, R_{GEN} = 0, C_L = 1.0nF, Figure 3			5		pC
NO, NC Off-Capacitance	$C_{NO(OFF)}$, $C_{NC(OFF)}$	V_{NO}, V_{NC} = GND, f = 1MHz, Figure 5			17		pF
Switch On-Capacitance	C_{ON}	V_{COM} = $V_{NO/NC}$, f = 1MHz, Figure 5			35		pF

ELECTRICAL CHARACTERISTICS (continued)

(V+ = 2.7V to 3.6V, V_{IH} = 2.0V, V_{IL} = 0.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Off-Isolation (Note 5)	V_{ISO}	V_{NO} = V_{NC} = 1V_{RMS}, R_L = 50Ω, C_L = 5pF, Figure 4	f = 10MHz		-62		dB
			f = 1MHz		-82		
On-Channel Bandwidth -3dB	BW	R_L = 50Ω, C_L = 5pF, Figure 4			190		MHz
Total Harmonic Distortion	THD	R_L = 600Ω, 2V_{P-P}, f = 20Hz to 20kHz	T_A = +25°C		0.013		%
SUPPLY							
Positive Supply Current	I+	V+ = 5.5V, V_{IN} = 0V or V+	T_A = +25°C		0.02		µA
			T_A = T_{MIN} to T_{MAX}			1	

Note 2: SC70 and µDFN packaged parts are 100% tested at +25°C. Limits across the full temperature range are guaranteed by design and correlation.

Note 3: R_{ON} flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

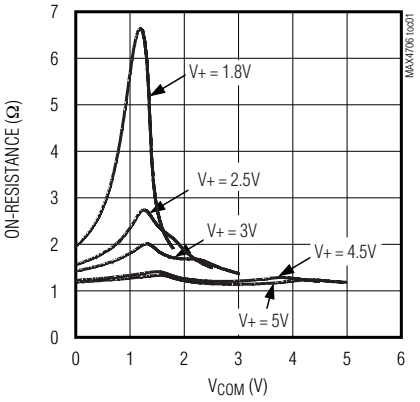
Note 4: Guaranteed by design.

Note 5: Off-isolation = 20log10 (VO / VI), where VO is V_{COM} and VI is either V_{NC} or V_{NO} from the network analyzer.

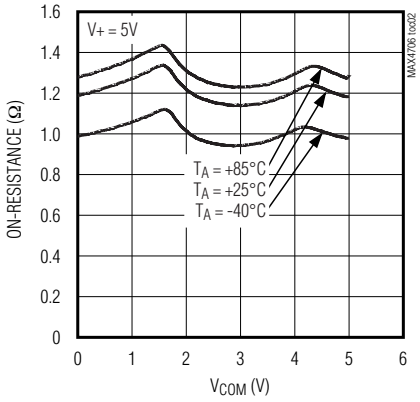
Typical Operating Characteristics

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

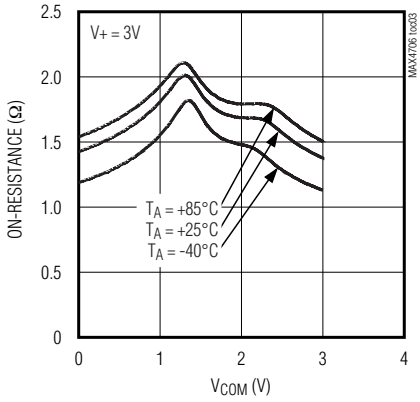
ON-RESISTANCE vs. V_{COM}



ON-RESISTANCE vs. V_{COM}



ON-RESISTANCE vs. V_{COM}

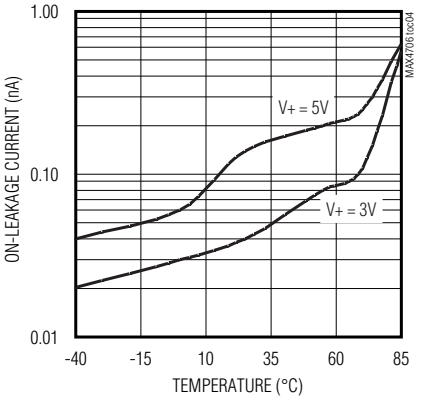


Low-Voltage, 2Ω, SPST, CMOS Analog Switches

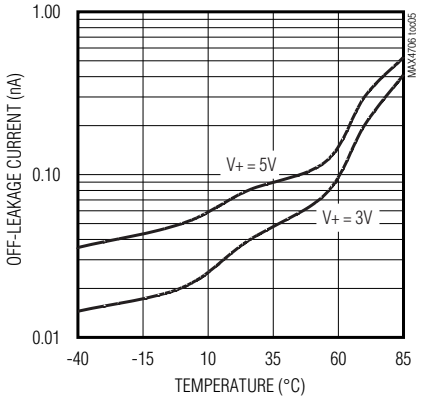
Typical Operating Characteristics (continued)

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

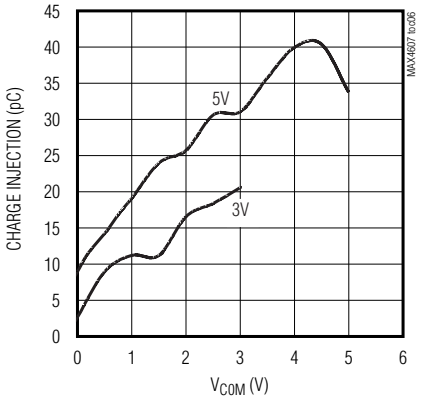
ON-LEAKAGE CURRENT vs. TEMPERATURE



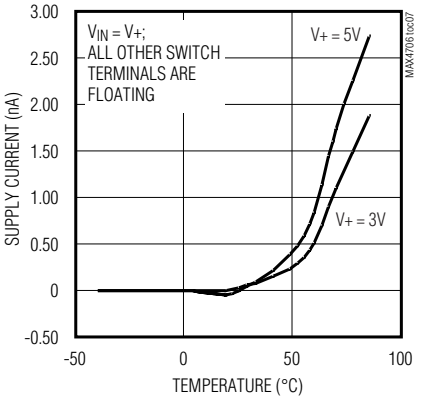
OFF-LEAKAGE CURRENT vs. TEMPERATURE



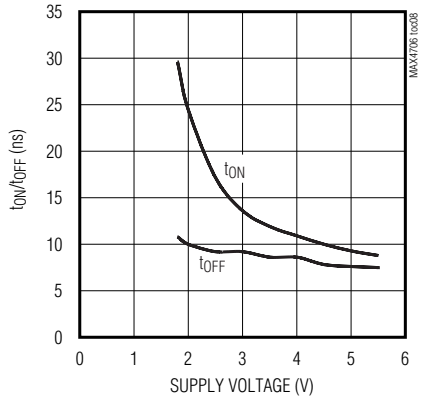
CHARGE INJECTION vs. V_{COM}



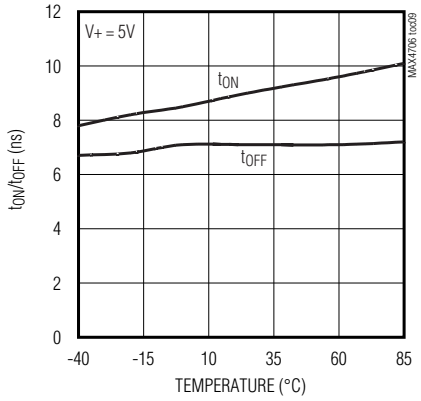
SUPPLY CURRENT vs. TEMPERATURE



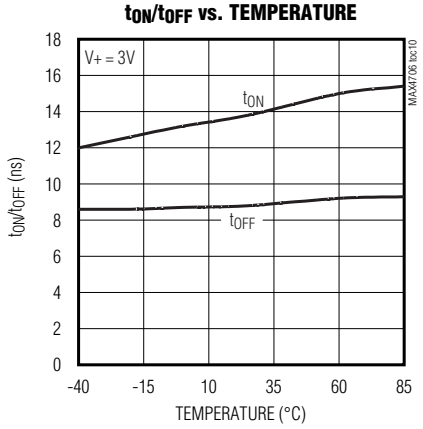
t_{ON}/t_{OFF} vs. SUPPLY VOLTAGE



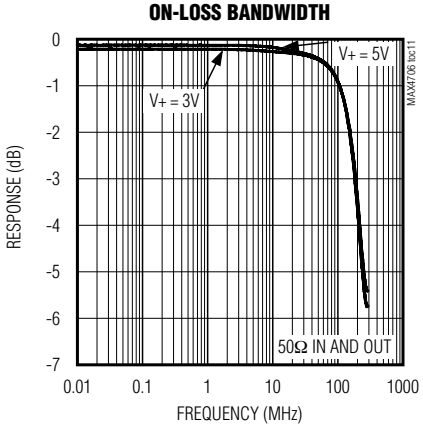
t_{ON}/t_{OFF} vs. TEMPERATURE



t_{ON}/t_{OFF} vs. TEMPERATURE



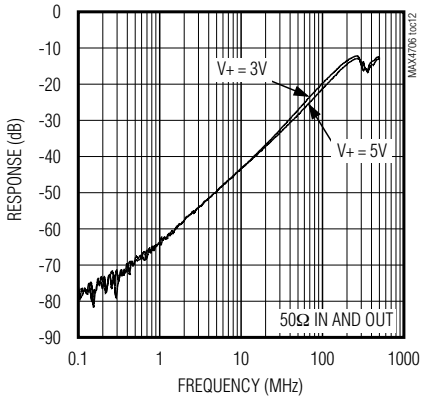
ON-LOSS BANDWIDTH



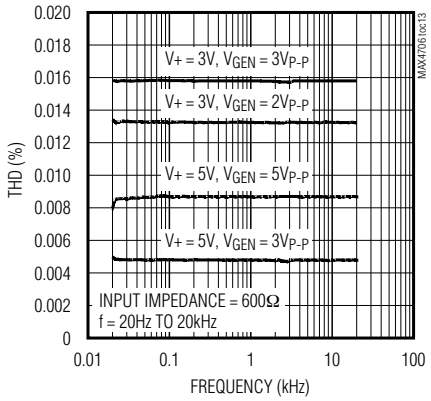
Typical Operating Characteristics (continued)

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

OFF-ISOLATION



TOTAL HARMONIC DISTORTION vs. FREQUENCY



Pin Description

PIN						NAME	FUNCTION
MAX4706			MAX4707				
SC70-5	SC70-6	µDFN-6	SC70-5	SC70-6	µDFN-6		
1	1	6	1	1	6	COM	Analog Switch Common Terminal
2	2	2	—	—	—	NC	Analog Switch Normally Closed Terminal
3	3	1	3	3	1	GND	Ground
4	4	3	4	4	3	IN	Logic Input Control
5	6	4	5	6	4	V+	Positive Supply Voltage
—	—	—	2	2	2	NO	Analog Switch Normally Open Terminal
—	5	5	—	5	5	N.C.	No Connection. Not internally connected.

Low-Voltage, 2Ω, SPST, CMOS Analog Switches

Detailed Description

The MAX4706/MAX4707 SPST switches operate from a single supply ranging from 1.8V to 5.5V. The MAX4706 is a normally closed (NC) switch and the MAX4707 is the normally open (NO) version. These switches provide 3.5Ω on-resistance (R_{ON}) and 0.9Ω R_{ON} flatness with a +2.7V supply. These devices typically consume only 0.02µA of quiescent current, making them suitable for use in low-power, portable applications. The MAX4706/MAX4707 feature low-leakage currents over the entire temperature range, TTL/CMOS-compatible digital logic, and excellent AC characteristics.

The MAX4706/MAX4707 are offered in small 5-pin and 6-pin SC70 and 6-pin µDFN packages.

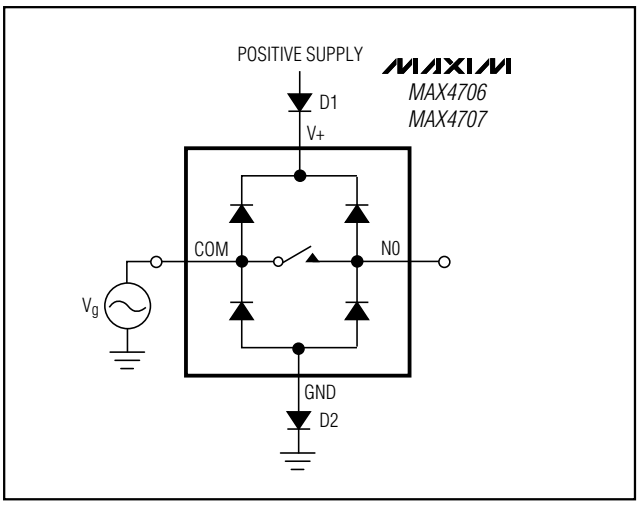


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

Applications Information

The MAX4706/MAX4707 operate from a single +1.8V to +5.5V supply. The MAX4706/MAX4707 accept bipolar input signals when V+ and GND are biased from bipolar supplies. For example, the switch accepts a $1V_{P-P}$ input when V+ = 2V and GND = -2V. ESD-protection diodes are internally connected between each analog switch terminal and both V+ and GND. One of these diodes conducts if any analog signal is greater than V+ or less than GND (Figure 1). Virtually all analog leakage current is attributed to the ESD diodes. Each diode is biased by the analog signal and either V+ or GND. The ESD diodes' leakage currents vary as the signal changes.

Power-Supply Sequencing and Overvoltage Protection

Caution: Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the device.

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V+ before applying analog signals, especially if the analog signal is not current-limited.

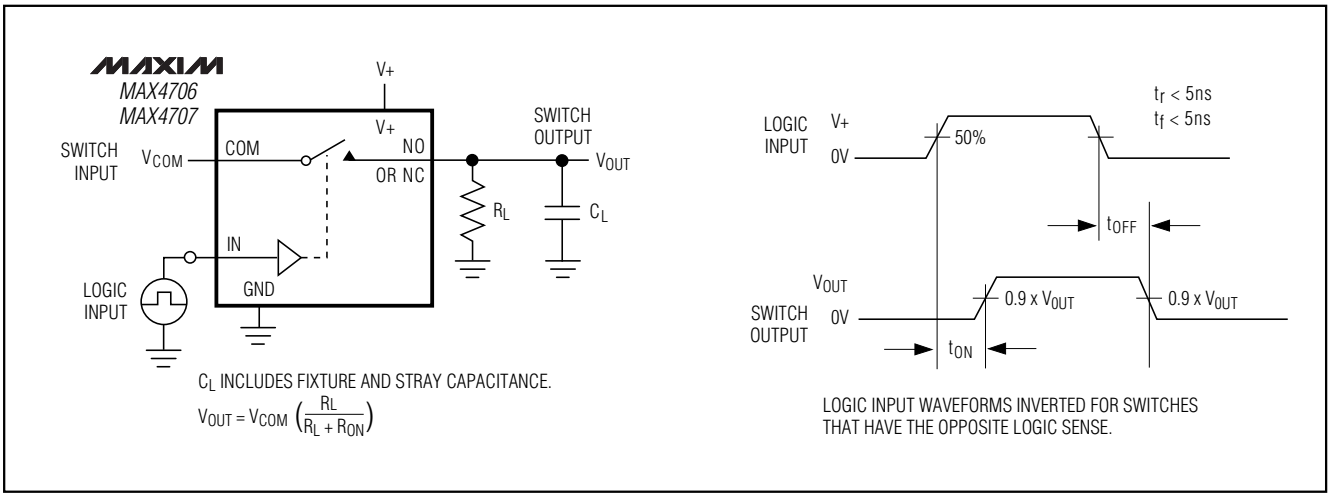


Figure 2. Switching Time

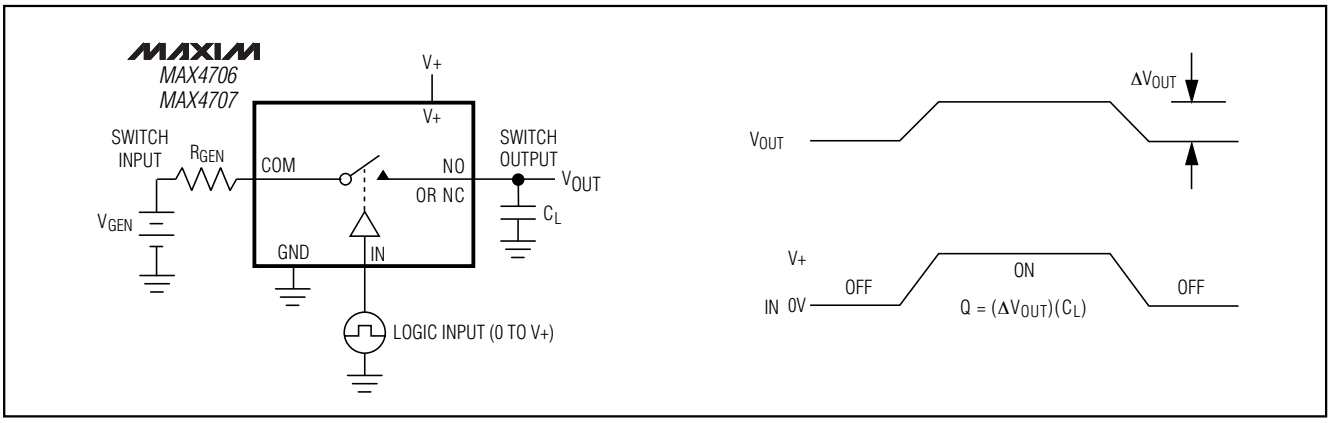


Figure 3. Charge Injection

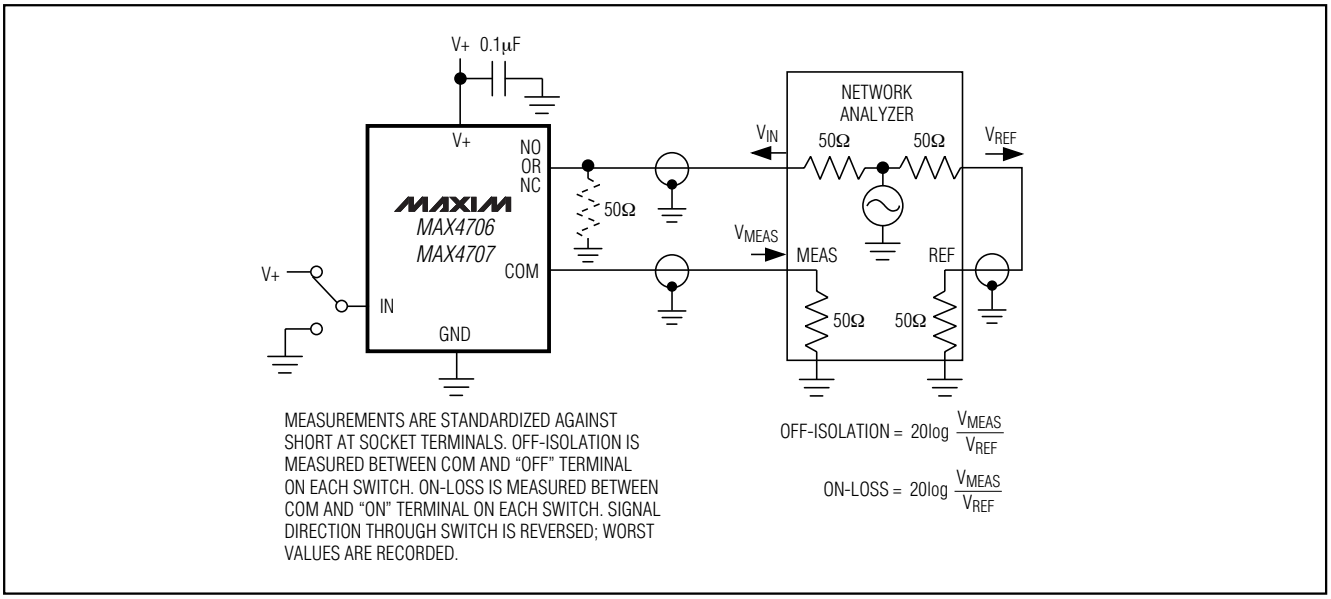


Figure 4. Off-Isolation and On-Loss Bandwidth

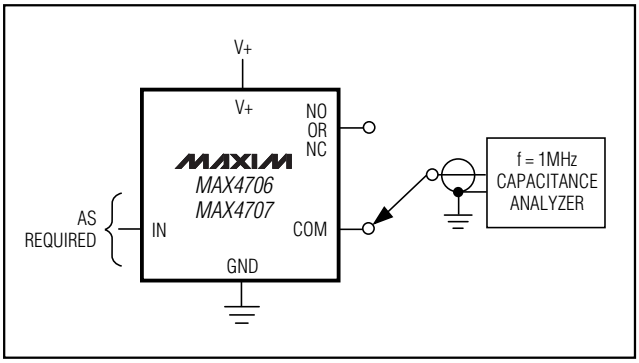


Figure 5. Channel Off/On-Capacitance

Chip Information

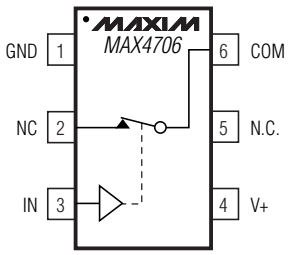
TRANSISTOR COUNT: 190

PROCESS: CMOS

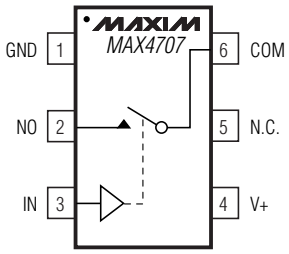
Low-Voltage, 2Ω, SPST, CMOS Analog Switches

Pin Configurations/Functional Diagrams/Truth Tables (continued)

TOP VIEW



μDFN-6



μDFN-6

INPUT	SWITCH STATE	
	MAX4706	MAX4707
0	ON	OFF
1	OFF	ON

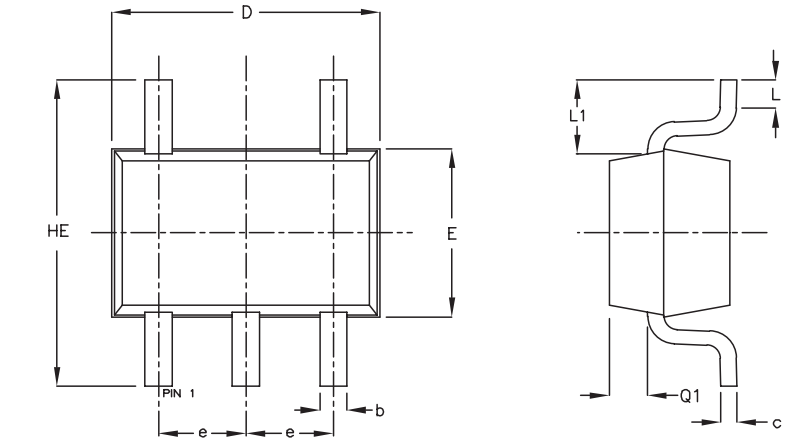
SWITCHES SHOWN FOR LOGIC 0 INPUT.

N.C. = NOT INTERNALLY CONNECTED.

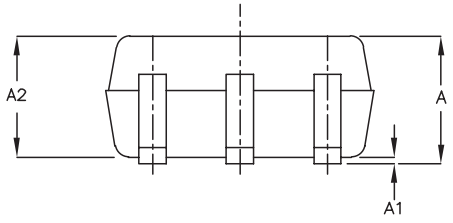
Package Information

(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**.)

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

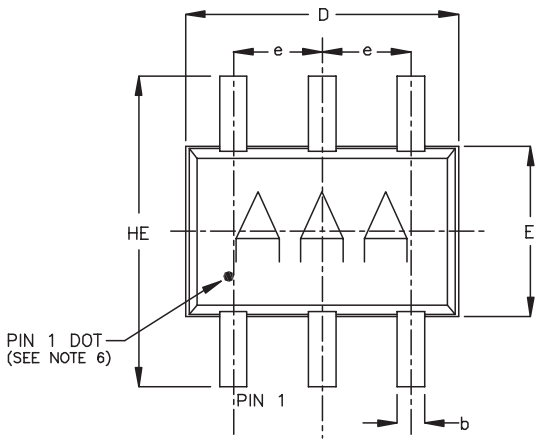
APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0076	B	1/1

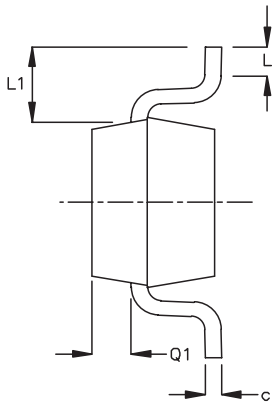
Low-Voltage, 2Ω, SPST, CMOS Analog Switches

Package Information (continued)

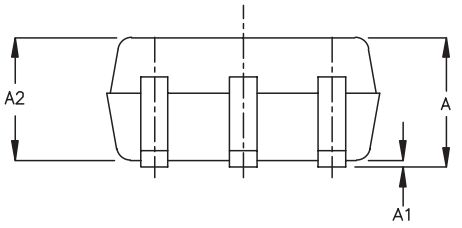
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

SC70, 6L 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.	



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.
6. PIN 1 I.D. DOT

MAXIM
PROPRIETARY INFORMATION

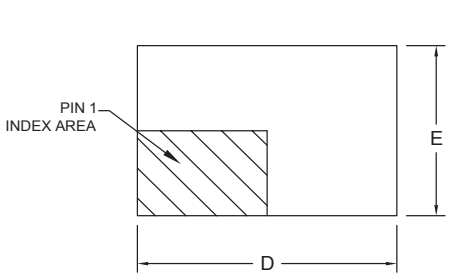
TITLE:
PACKAGE OUTLINE, SC70, 6L

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0077	B	1/1

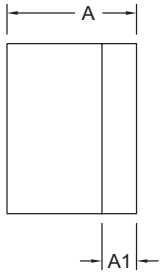
Package Information (continued)

(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

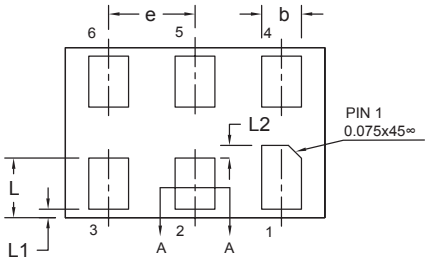


TOP VIEW

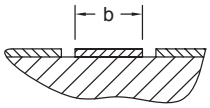


SIDE VIEW

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