

MAXIM

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

MAX4706/MAX4707

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 2 Ω on-resistance (R_{ON}) and 0.6 Ω R_{ON} flatness with a +2.7V supply. These devices typically consume only 0.02 μ A 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 μ DFN 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}**
2 Ω max (+2.7V Supply)
- ◆ **Guaranteed R_{ON} Flatness: 0.6 Ω (+2.7V Supply)**
- ◆ **Excellent AC Characteristics**
High Off-Isolation: -67dB at 1MHz
-3dB Bandwidth: 190MHz
- ◆ **0.013% Total Harmonic Distortion**
- ◆ **Low Supply Current: 0.02 μ A**
- ◆ **Tiny SC70 and μ DFN 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 μ DFN-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 μ DFN-6 | — |

*Future product—contact factory for availability.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

SC70-5

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

SC70-5

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

SC70-6

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

SC70-6

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.

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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) | $\pm 30\text{mA}$ |
| Continuous Current COM, NO, NC | $\pm 160\text{mA}$ |
| Peak Current COM, NO, NC (pulsed at 1ms, 10% duty cycle) | $\pm 300\text{mA}$ |

Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)

| | |
|---|---|
| 5-Pin SC70 (derate 3.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$) | 247mW |
| 6-Pin SC70 (derate 3.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$) | 245mW |
| 6-Pin μDFN (derate 2.1mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$) | 167.7mW |
| Operating Temperature Range | -40°C to $+85^\circ\text{C}$ |
| Storage Temperature Range | -65°C to $+150^\circ\text{C}$ |
| Lead Temperature (soldering, 10s) | $+300^\circ\text{C}$ |
| Junction Temperature | $+150^\circ\text{C}$ |

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, $V_{IH} = 2.0\text{V}$, $V_{IL} = 0.4\text{V}$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^\circ\text{C}$.) (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 |

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ELECTRICAL CHARACTERISTICS (continued)

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

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

Note 2: SC70 and μDFN packaged parts are 100% tested at $+25^\circ\text{C}$. Limits across the full temperature range are guaranteed by design and correlation.

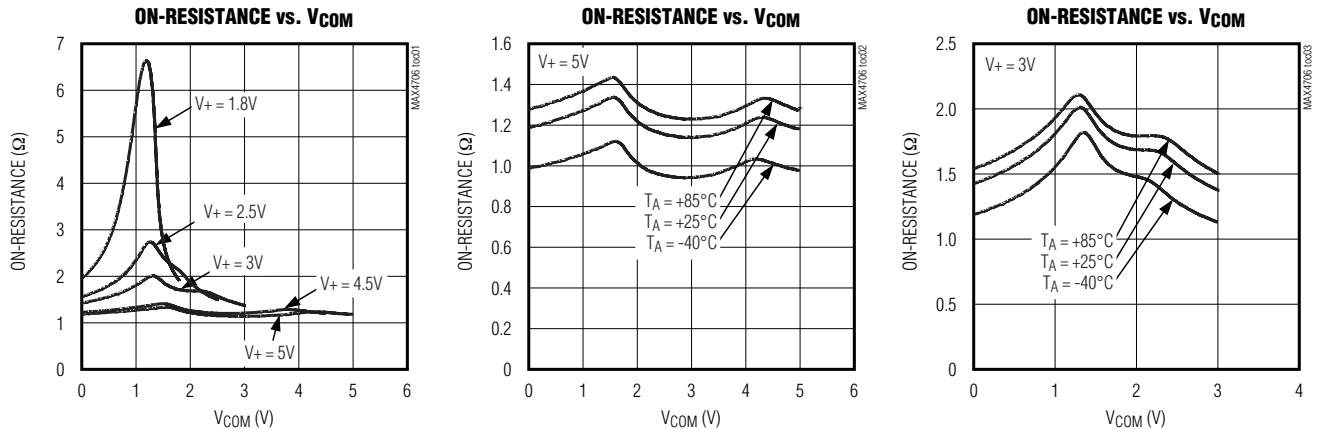
Note 3: R_{ON} flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

Note 4: Guaranteed by design.

Note 5: Off-isolation = $20\log_{10}(V_O / V_I)$, where V_O is V_{COM} and V_I is either V_{NC} or V_{NO} from the network analyzer.

Typical Operating Characteristics

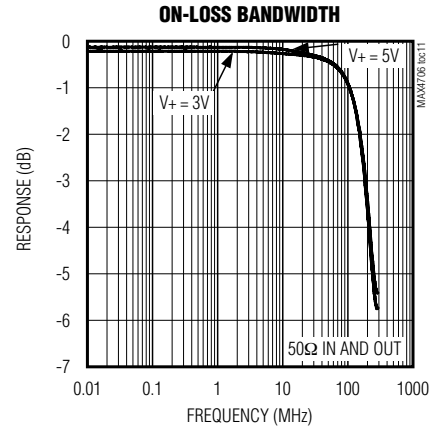
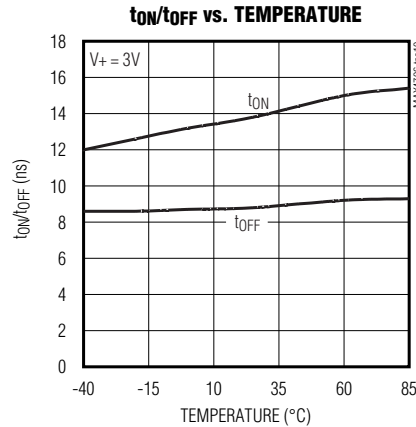
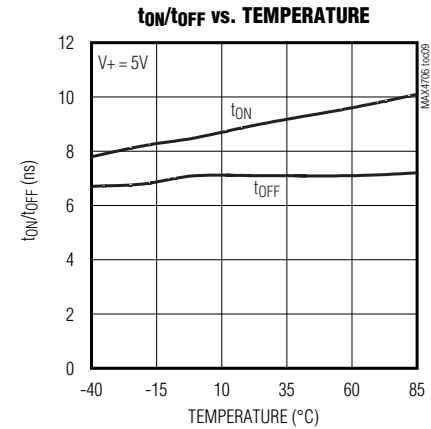
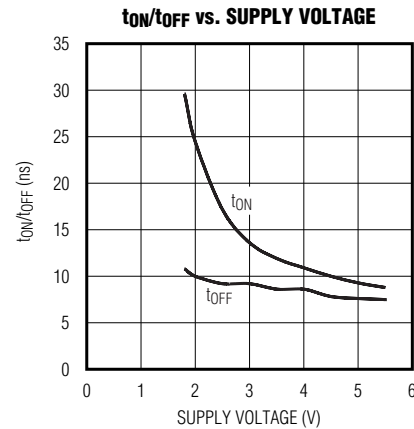
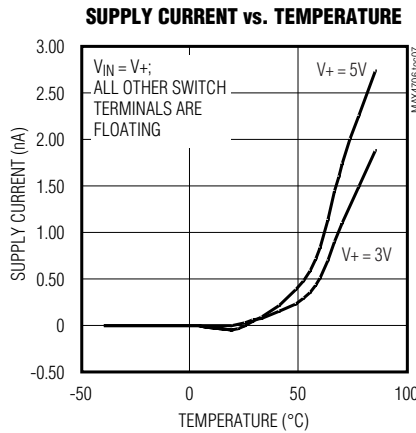
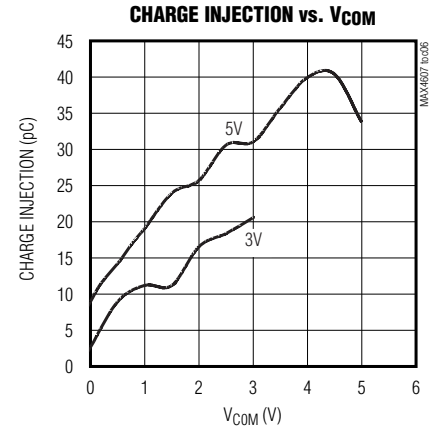
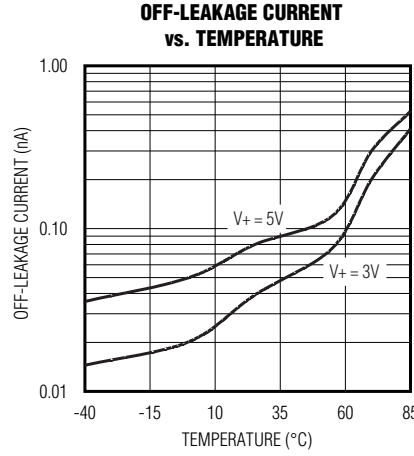
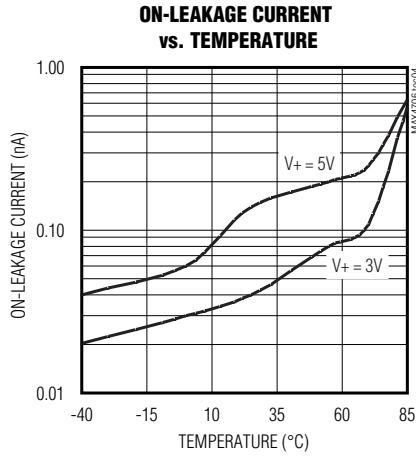
($T_A = +25^\circ\text{C}$, unless otherwise noted.)



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

Typical Operating Characteristics (continued)

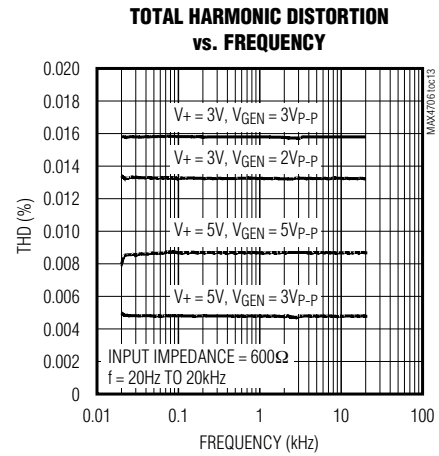
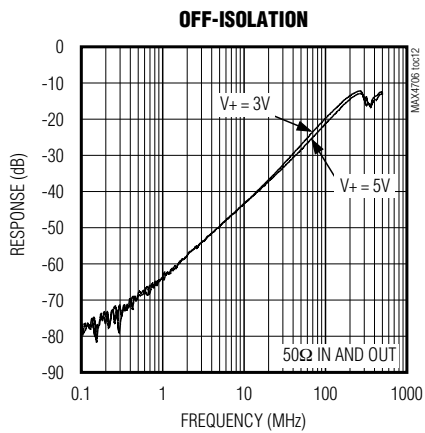
(T_A = +25°C, unless otherwise noted.)



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

Typical Operating Characteristics (continued)

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



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.

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.

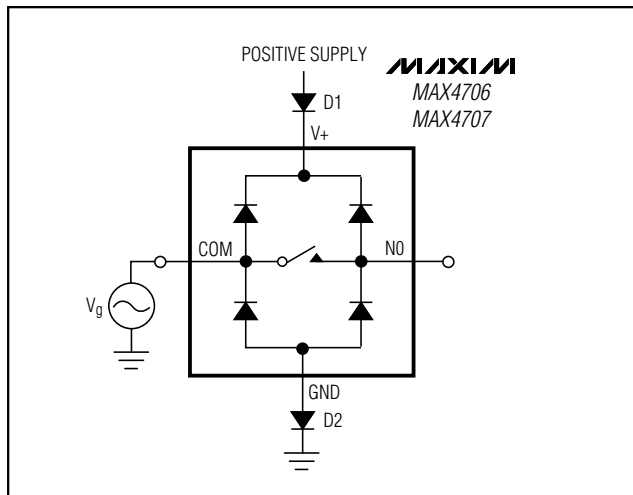


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

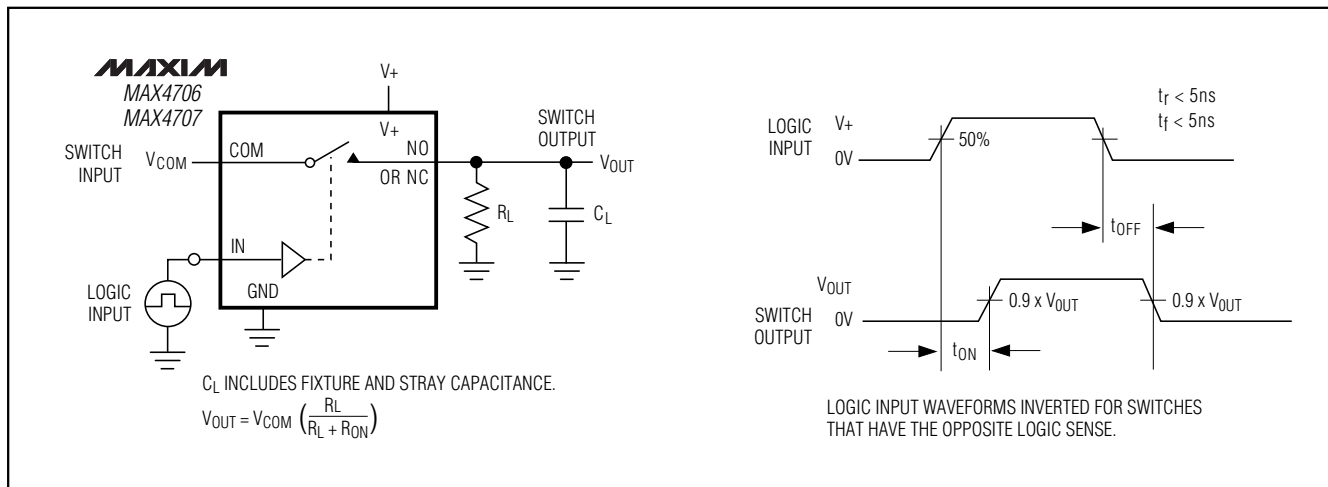


Figure 2. Switching Time

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MAX4706/MAX4707

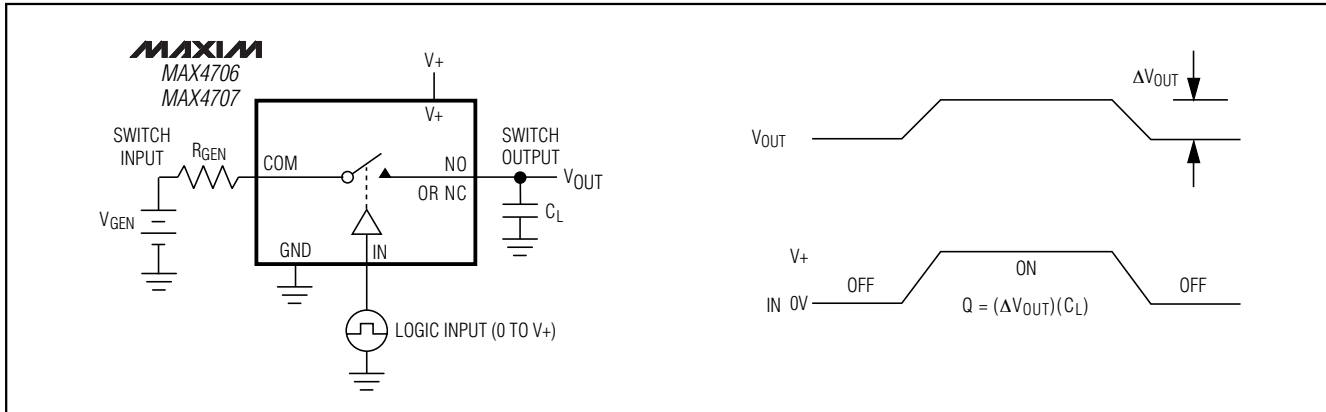


Figure 3. Charge Injection

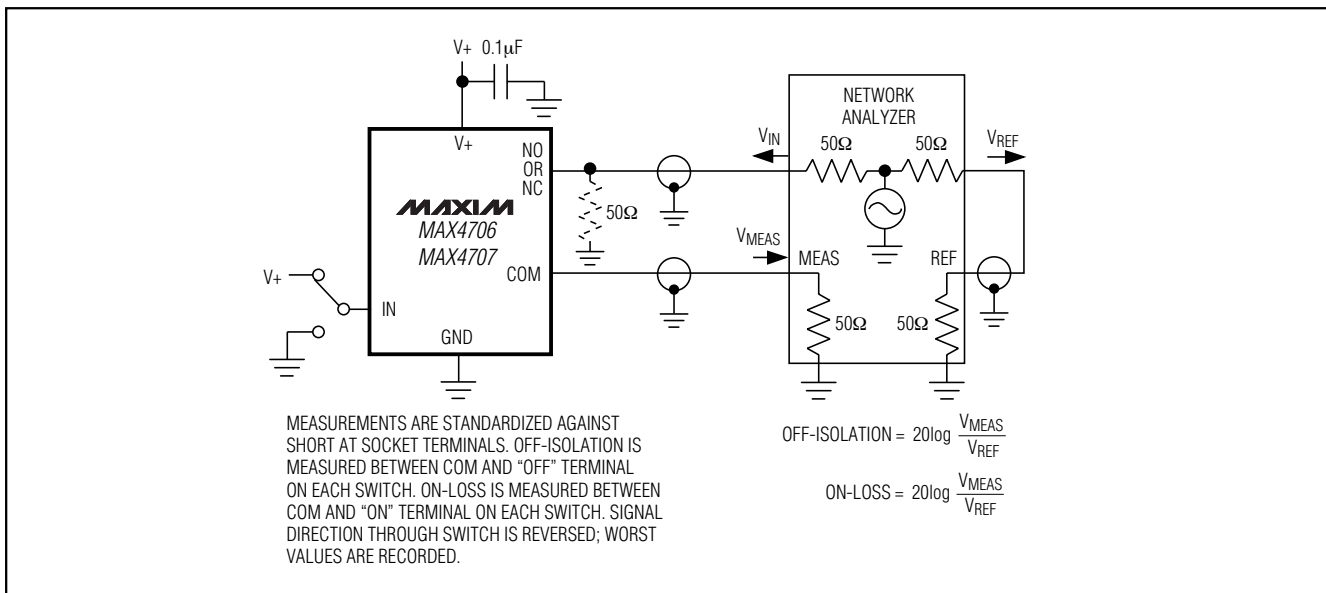


Figure 4. Off-Isolation and On-Loss Bandwidth

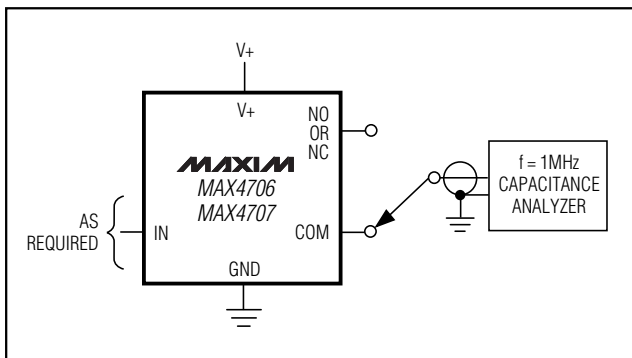


Figure 5. Channel Off/On-Capacitance

Chip Information

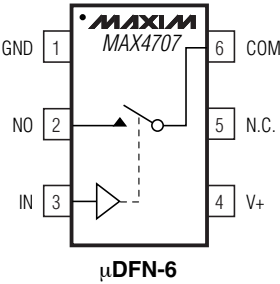
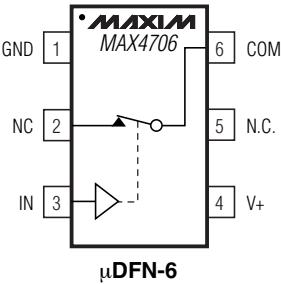
TRANSISTOR COUNT: 190

PROCESS: CMOS

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

Pin Configurations/Functional Diagrams/Truth Tables (continued)

TOP VIEW



| INPUT | SWITCH STATE | |
|-------|--------------|---------|
| | MAX4706 | MAX4707 |
| 0 | ON | OFF |
| 1 | OFF | ON |

SWITCHES SHOWN FOR LOGIC 0 INPUT.

N.C. = NOT INTERNALLY CONNECTED.

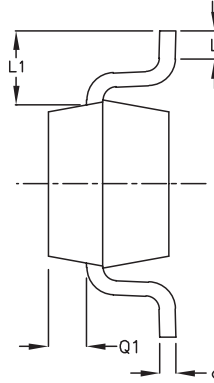
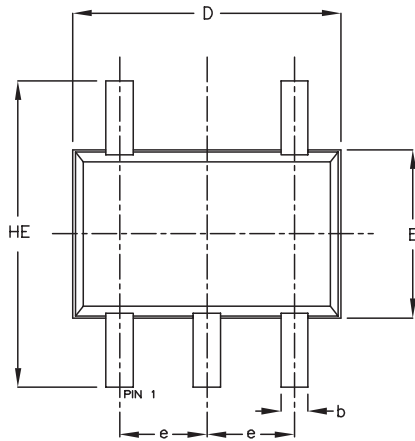
Low-Voltage, 2Ω, SPST, CMOS Analog Switches

Package Information

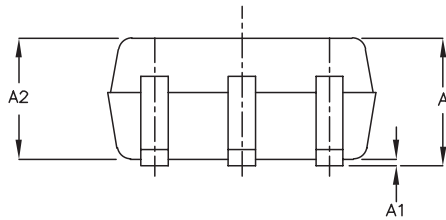
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to www.maxim-ic.com/packages.)

SC70, 5LEPS

MAX4706/MAX4707



| 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.

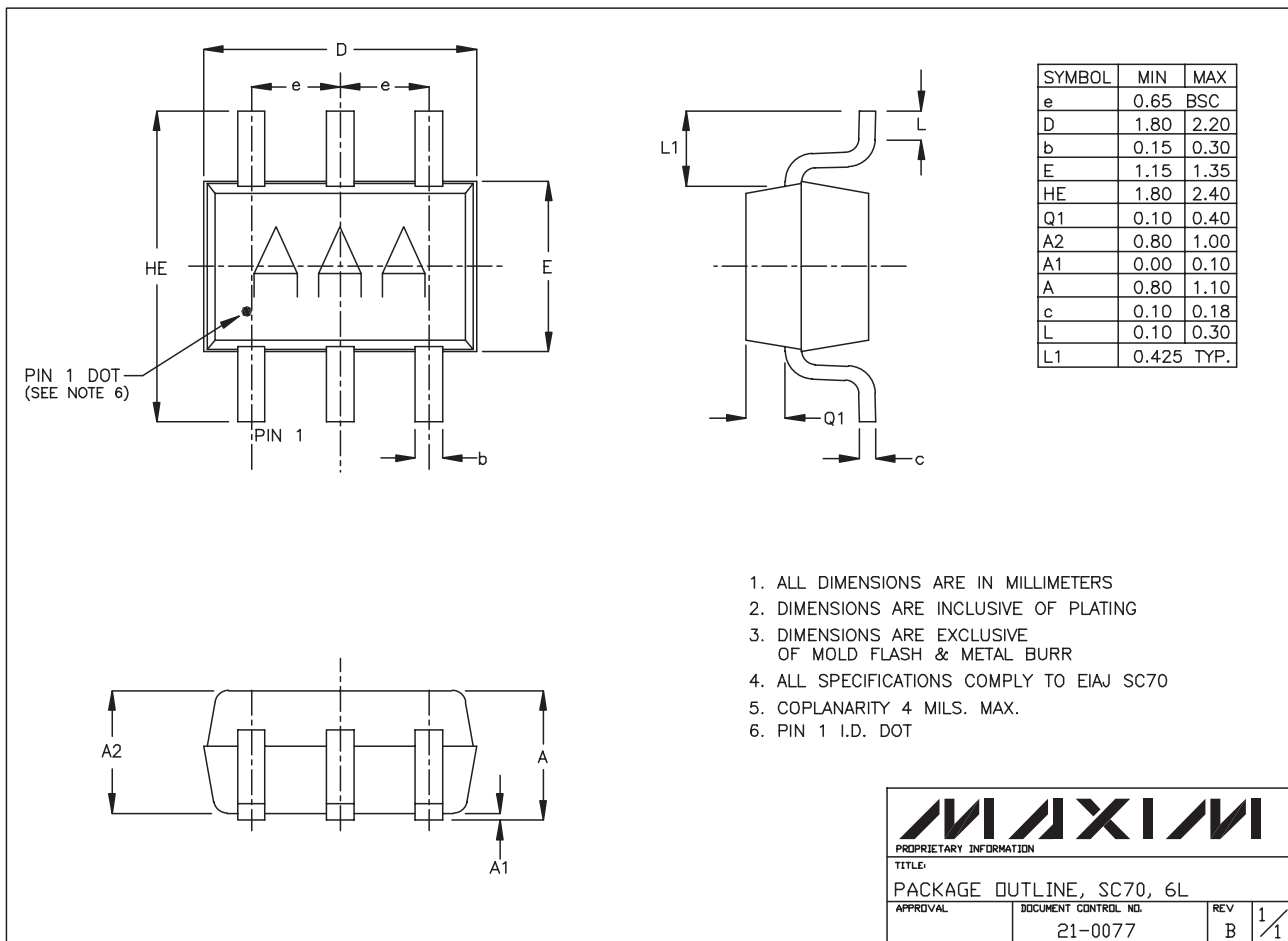
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|---------------------------|----------------------|-------|
| MAXIM | | |
| PROPRIETARY INFORMATION | | |
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| PACKAGE OUTLINE, SC70, 5L | | |
| APPROVAL | DOCUMENT CONTROL NO. | REV |
| | 21-0076 | B 1/1 |

Low-Voltage, 2 Ω , 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, 6LEPS



| | | | |
|---------------------------|----------------------|-----|-----|
| | | | |
| PROPRIETARY INFORMATION | | | |
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| PACKAGE OUTLINE, SC70, 6L | | | |
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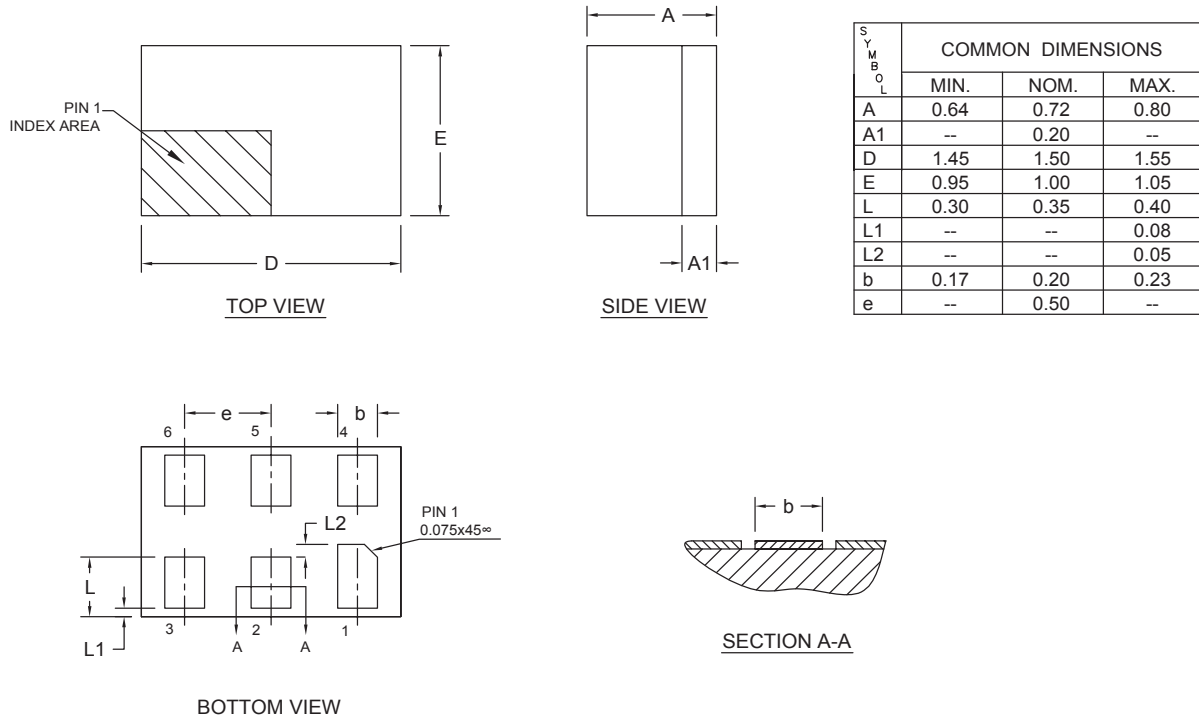
Low-Voltage, 2Ω, SPST, CMOS Analog Switches

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.)

MAX4706/MAX4707

6L uDFN/EPSS



NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.

| | | | |
|---|----------------------|------|-----|
| | | | |
| PROPRIETARY INFORMATION | | | |
| TITLE: | | | |
| PACKAGE OUTLINE, 6L uDFN, 1.5x1.0x0.8mm | | | |
| APPROVAL | DOCUMENT CONTROL NO. | REV. | 1/1 |
| | 21-0147 | B | |

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