



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

**MAX4599**

## 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 ( $t_{ON} = 30\text{ns}$  max,  $t_{OFF} = 25\text{ns}$  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,  $\mu\text{DFN}$ , and SOT23 packages.

## 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:  $t_{ON} = 30\text{ns}$  (max)  
 $t_{OFF} = 25\text{ns}$  (max)
- ◆ Guaranteed 5pC max Charge Injection
- ◆ +2.0V to +5.5V Single-Supply Operation
- ◆ 200MHz -3dB Bandwidth
- ◆ Low  $\pm 0.5\text{nA}$  Leakage Current at +25°C
- ◆ Break-Before-Make Switching
- ◆ TTL/CMOS-Logic Compatible
- ◆ -76dB Off-Isolation at 1MHz
- ◆ 0.12% Total Harmonic Distortion

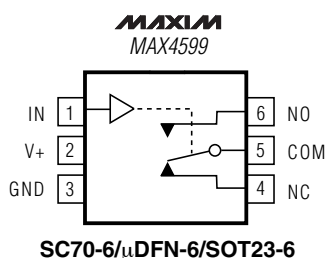
## Applications

Battery-Operated Equipment  
Audio and Video Signal Routing  
Cellular Phones  
Low-Voltage Data-Acquisition Systems  
Sample-and-Hold Circuits  
Communications Circuits

## 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 $\mu\text{DFN}$ -6 | AA       |

## Pin Configuration/Functional Diagram/Truth Table



| MAX4599 |     |     |
|---------|-----|-----|
| IN      | NC  | NO  |
| 0       | ON  | OFF |
| 1       | OFF | ON  |

SWITCH IS SHOWN FOR "0" INPUT.



# 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<br>(pulsed at 1ms, 10% duty cycle) | .....±40mA                |

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

|                                                 |                      |
|-------------------------------------------------|----------------------|
| 6-Pin SC70-6 (derate 3.1mW/°C above +70°C)      | .....245mW           |
| 6-Pin $\mu$ DFN-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<sub>INH</sub> = +2.4V, V<sub>INL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Notes 2, 3)

| PARAMETER                                     | SYMBOL                                                  | CONDITIONS                                                                                               |                                                       | MIN  | TYP  | MAX | UNITS |
|-----------------------------------------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------|------|-----|-------|
| ANALOG SWITCH                                 |                                                         |                                                                                                          |                                                       |      |      |     |       |
| Analog Signal Range                           | V <sub>COM</sub> ,<br>V <sub>NO</sub> , V <sub>NC</sub> |                                                                                                          |                                                       | 0    |      | V+  | V     |
| On-Resistance                                 | R <sub>ON</sub>                                         | V+ = 4.5V, I <sub>COM</sub> = 1mA,<br>V <sub>NO</sub> or V <sub>NC</sub> = 3.5V                          | T <sub>A</sub> = +25°C                                | 40   | 60   |     | Ω     |
|                                               |                                                         |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      | 65   |     |       |
| On-Resistance Match Between Channels (Note 4) | ΔRON                                                    | V+ = 4.5V, I <sub>COM</sub> = 1A,<br>V <sub>NO</sub> or V <sub>NC</sub> = 3.5V                           | T <sub>A</sub> = +25°C                                | 0.2  | 1    |     | Ω     |
|                                               |                                                         |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      | 2    |     |       |
| On-Resistance Flatness (Note 5)               | R <sub>FLAT(ON)</sub>                                   | V+ = 4.5V; I <sub>COM</sub> = 1mA;<br>V <sub>NO</sub> or V <sub>NC</sub> = 1V, 2.0V,<br>3.5V             | T <sub>A</sub> = +25°C                                | 2.5  | 4    |     | Ω     |
|                                               |                                                         |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      | 5    |     |       |
| NO, NC Off-Leakage Current (Note 6)           | I <sub>NO(OFF)</sub> ,<br>I <sub>NC(OFF)</sub>          | V+ = 5.5V; V <sub>COM</sub> = 1V,<br>4.5V; V <sub>NO</sub> or V <sub>NC</sub> = 4.5V,<br>1V              | T <sub>A</sub> = +25°C                                | -0.5 | 0.01 | 0.5 | nA    |
|                                               |                                                         |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -5   |      | 5   |       |
| COM On-Leakage Current (Note 6)               | I <sub>COM(ON)</sub>                                    | V+ = 5.5V; V <sub>COM</sub> = 1V,<br>4.5V; V <sub>NO</sub> or V <sub>NC</sub> = 1V,<br>4.5V, or floating | T <sub>A</sub> = +25°C                                | -1   | 0.01 | 1   | nA    |
|                                               |                                                         |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | -10  |      | 10  |       |
| DIGITAL I/O                                   |                                                         |                                                                                                          |                                                       |      |      |     |       |
| Input Logic High                              | V <sub>IH</sub>                                         |                                                                                                          |                                                       | 2.4  |      |     | V     |
| Input Logic Low                               | V <sub>IL</sub>                                         |                                                                                                          |                                                       |      |      | 0.8 | V     |
| DYNAMIC                                       |                                                         |                                                                                                          |                                                       |      |      |     |       |
| Turn-On Time                                  | t <sub>ON</sub>                                         | V <sub>NO</sub> , V <sub>NC</sub> = 3V;<br>R <sub>L</sub> = 1kΩ; C <sub>L</sub> = 35pF;<br>Figure 2      | T <sub>A</sub> = +25°C                                | 25   | 30   |     | ns    |
|                                               |                                                         |                                                                                                          | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      | 40   |     |       |

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

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## ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +4.5V to +5.5V, VINH = +2.4V, VINL = +0.8V, TA = TMIN to TMAX, unless otherwise noted.) (Notes 2, 3)

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

## ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +3.6V, VINH = +2.0V, VINL = +0.8V, TA = TMIN to TMAX, unless otherwise noted.) (Notes 2, 3)

| PARAMETER           | SYMBOL                                                  | CONDITIONS                                                                    |                                                       | MIN | TYP | MAX | UNITS |
|---------------------|---------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------|-----|-----|-----|-------|
| ANALOG SWITCH       |                                                         |                                                                               |                                                       |     |     |     |       |
| Analog Signal Range | V <sub>COM</sub> ,<br>V <sub>NO</sub> , V <sub>NC</sub> |                                                                               |                                                       | 0   |     | V+  | V     |
| On-Resistance       | R <sub>ON</sub>                                         | V+ = 2.7V, I <sub>COM</sub> = 1mA,<br>V <sub>NO</sub> or V <sub>NC</sub> = 1V | T <sub>A</sub> = +25°C                                | 60  | 95  | Ω   |       |
|                     |                                                         |                                                                               | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 105 |     |     |       |
| DIGITAL I/O         |                                                         |                                                                               |                                                       |     |     |     |       |
| Input Logic High    | V <sub>IH</sub>                                         |                                                                               |                                                       | 2.0 |     |     | V     |
| Input Logic Low     | V <sub>IL</sub>                                         |                                                                               |                                                       |     |     | 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<sub>INH</sub> = +2.0V, V<sub>INL</sub> = +0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Notes 2, 3)

| PARAMETER                 | SYMBOL           | CONDITIONS                                                                                                   | MIN                                                   | TYP   | MAX | UNITS   |
|---------------------------|------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------|-----|---------|
| <b>DYNAMIC</b>            |                  |                                                                                                              |                                                       |       |     |         |
| Turn-On Time              | t <sub>ON</sub>  | V <sub>NO</sub> , V <sub>NC</sub> = 2V;<br>R <sub>L</sub> = 1k $\Omega$ ; C <sub>L</sub> = 35pF;<br>Figure 2 | T <sub>A</sub> = +25°C                                | 40    | 45  | ns      |
|                           |                  |                                                                                                              | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |       | 55  |         |
| Turn-Off Time             | t <sub>OFF</sub> | V <sub>NO</sub> , V <sub>NC</sub> = 2V;<br>R <sub>L</sub> = 1k $\Omega$ ; C <sub>L</sub> = 35pF;<br>Figure 2 | T <sub>A</sub> = +25°C                                | 30    | 35  | ns      |
|                           |                  |                                                                                                              | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |       | 40  |         |
| Break-Before-Make         | t <sub>BBM</sub> | V <sub>NO</sub> , V <sub>NC</sub> = 2V;<br>R <sub>L</sub> = 1k $\Omega$ ; C <sub>L</sub> = 35pF;<br>Figure 3 | T <sub>A</sub> = +25°C                                | 13    |     | ns      |
|                           |                  |                                                                                                              | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 1     |     |         |
| Charge Injection (Note 6) | Q                | V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,<br>C <sub>L</sub> = 1.0nF, Figure 4                              | T <sub>A</sub> = +25°C                                | 2     | 5   | pC      |
| <b>SUPPLY</b>             |                  |                                                                                                              |                                                       |       |     |         |
| Positive Supply Current   | I+               | V+ = 3.6V, V <sub>IN</sub> = 0 or V+                                                                         | -1                                                    | 0.001 | 1   | $\mu$ A |

## ELECTRICAL CHARACTERISTICS—Single +2.5V Supply

(V+ = +2.5V, V<sub>INH</sub> = +2.0V, V<sub>INL</sub> = +0.6V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Notes 2, 3)

| PARAMETER            | SYMBOL                                                  | CONDITIONS                                                                                                   | MIN                                                   | TYP | MAX | UNITS    |
|----------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-----|-----|----------|
| <b>ANALOG SWITCH</b> |                                                         |                                                                                                              |                                                       |     |     |          |
| Analog Signal Range  | V <sub>COM</sub> ,<br>V <sub>NO</sub> , V <sub>NC</sub> |                                                                                                              | 0                                                     |     | V+  | V        |
| On-Resistance        | R <sub>ON</sub>                                         | V+ = 2.5V, I <sub>COM</sub> = 1mA,<br>V <sub>NO</sub> or V <sub>NC</sub> = 1V                                | T <sub>A</sub> = +25°C                                | 65  | 110 | $\Omega$ |
|                      |                                                         |                                                                                                              | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |     | 120 |          |
| Input Logic High     | V <sub>IH</sub>                                         |                                                                                                              | 2.0                                                   |     |     | V        |
| Input Logic Low      | V <sub>IL</sub>                                         |                                                                                                              |                                                       |     | 0.6 | V        |
| <b>DYNAMIC</b>       |                                                         |                                                                                                              |                                                       |     |     |          |
| Turn-On Time         | t <sub>ON</sub>                                         | V <sub>NO</sub> , V <sub>NC</sub> = 2V;<br>R <sub>L</sub> = 1k $\Omega$ ; C <sub>L</sub> = 35pF;<br>Figure 3 | T <sub>A</sub> = +25°C                                | 45  | 50  | ns       |
|                      |                                                         |                                                                                                              | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |     | 60  |          |
| Turn-Off Time        | t <sub>OFF</sub>                                        | V <sub>NO</sub> , V <sub>NC</sub> = 2V;<br>R <sub>L</sub> = 1k $\Omega$ ; C <sub>L</sub> = 35pF;<br>Figure 3 | T <sub>A</sub> = +25°C                                | 30  | 35  | ns       |
|                      |                                                         |                                                                                                              | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |     | 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.

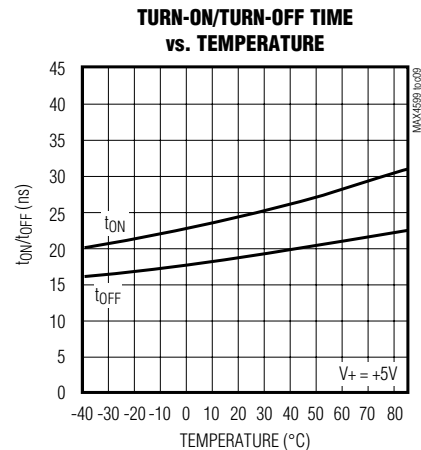
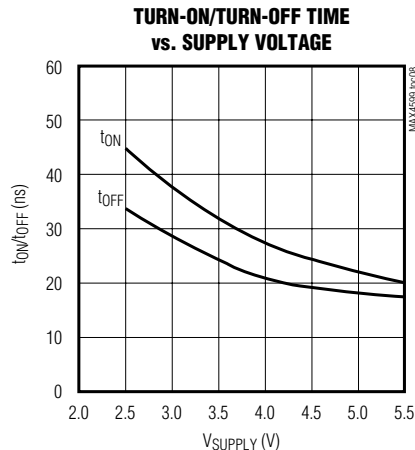
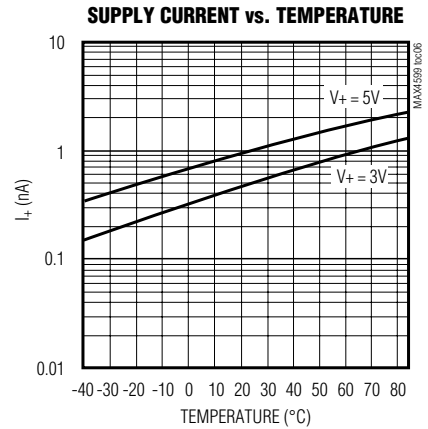
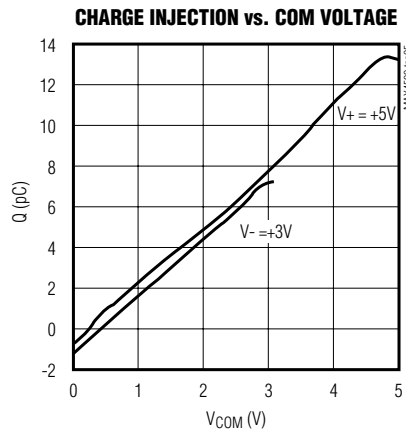
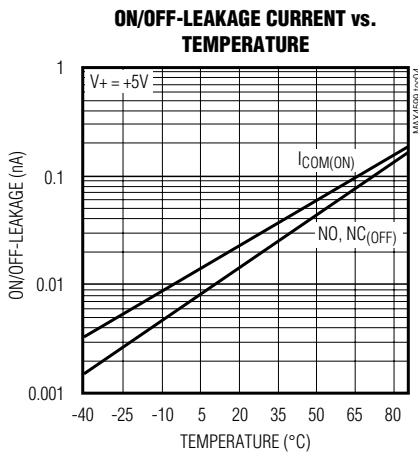
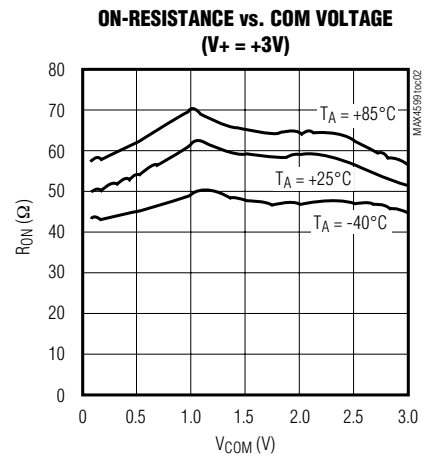
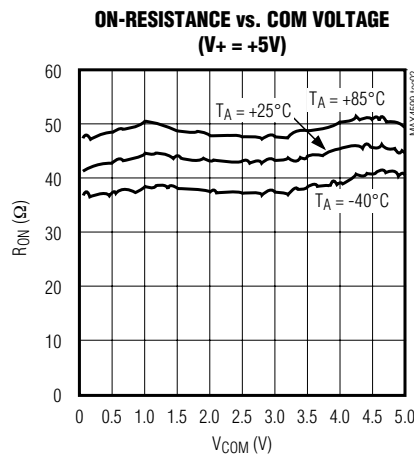
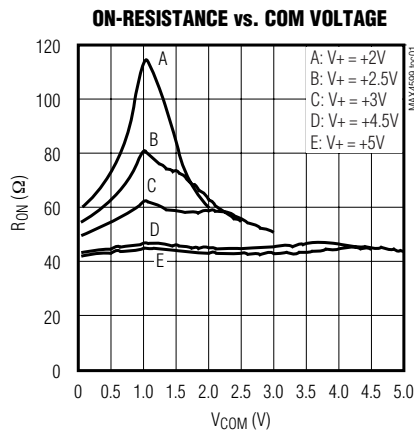
**Note 7:** Off-Isolation =  $20\log_{10}(V_{COM}/V_{NO})$ , V<sub>COM</sub> = output, V<sub>NO</sub> = input to off switch.

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

## Typical Operating Characteristics

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

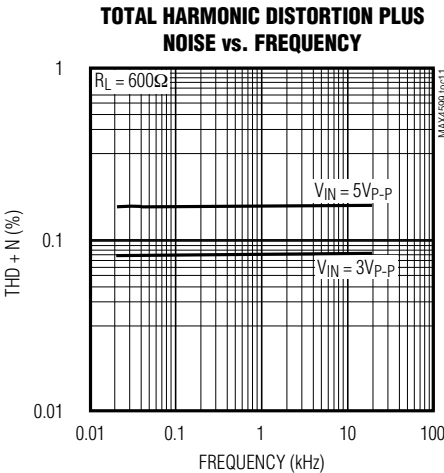
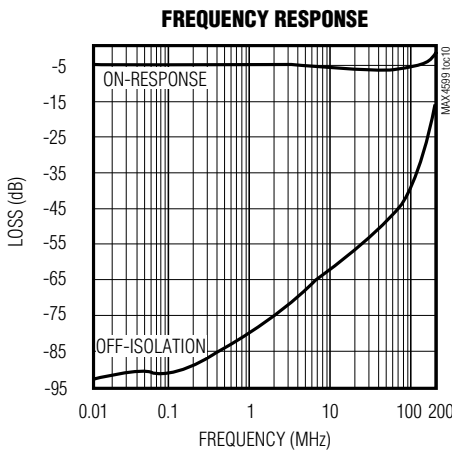
MAX4599



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

## Typical Operating Characteristics (continued)

(T<sub>A</sub> = +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<sub>+</sub> 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<sub>+</sub> 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

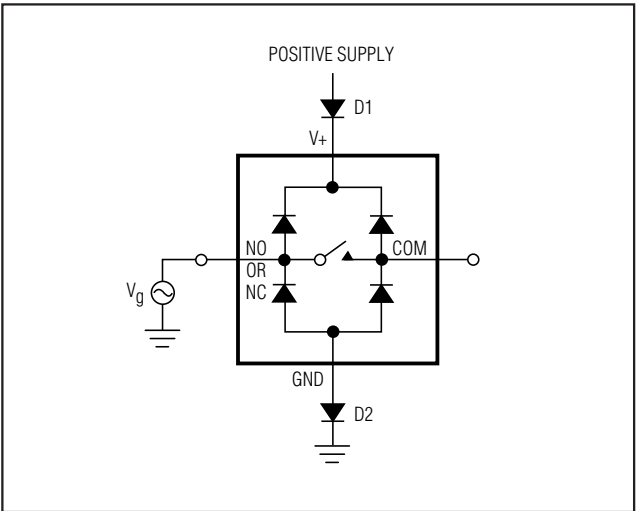


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

reduces the analog signal range to a diode drop (about 0.7V) below V<sub>+</sub> 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<sub>+</sub>) 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.

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

## Test Circuits/Timing Diagrams

MAX4599

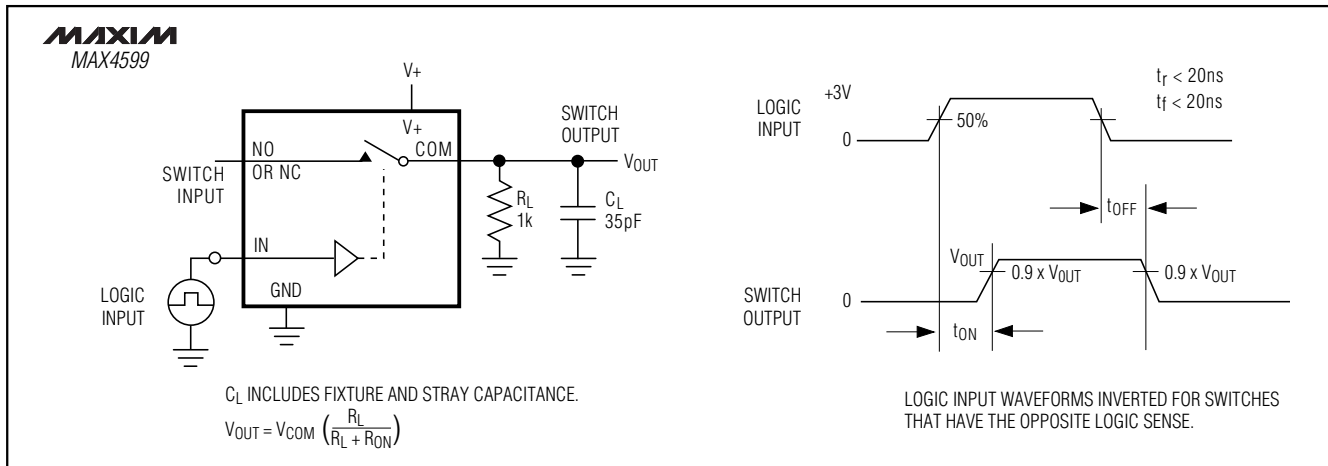


Figure 2. Switching Time

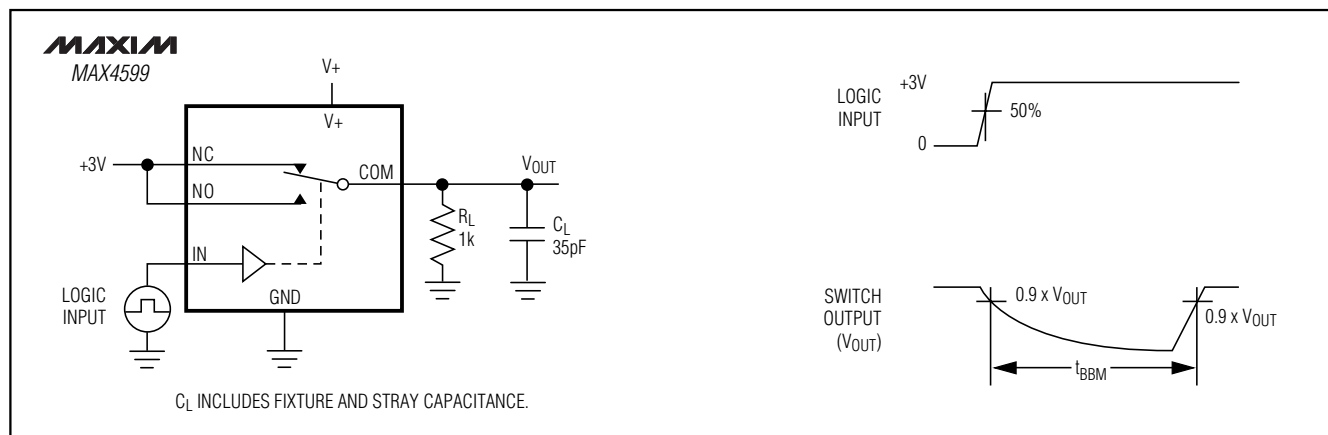


Figure 3. Break-Before-Make Interval

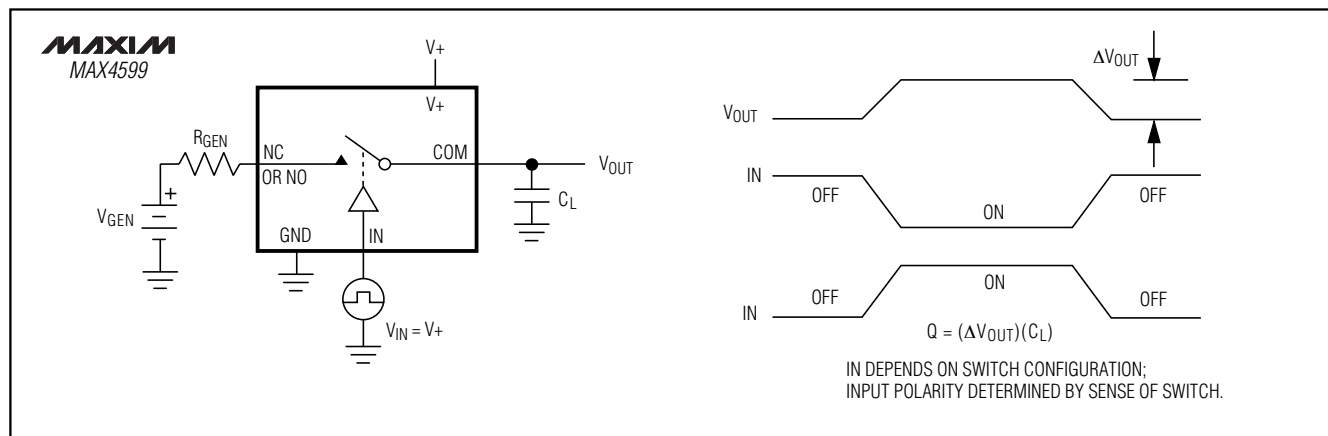


Figure 4. Charge Injection

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

## Test Circuits/Timing Diagrams (continued)

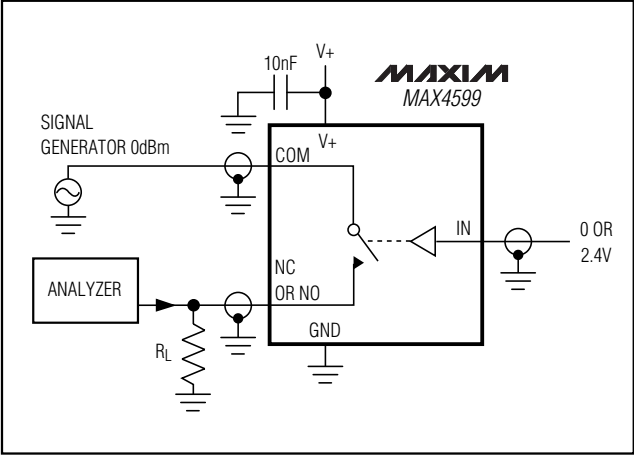


Figure 5. Off-Isolation/On-Channel Bandwidth

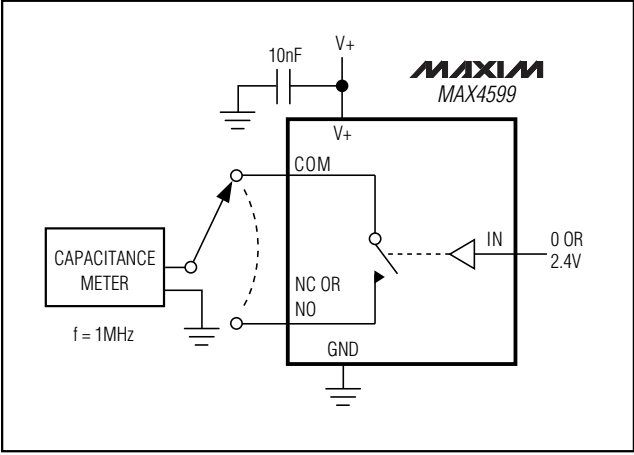


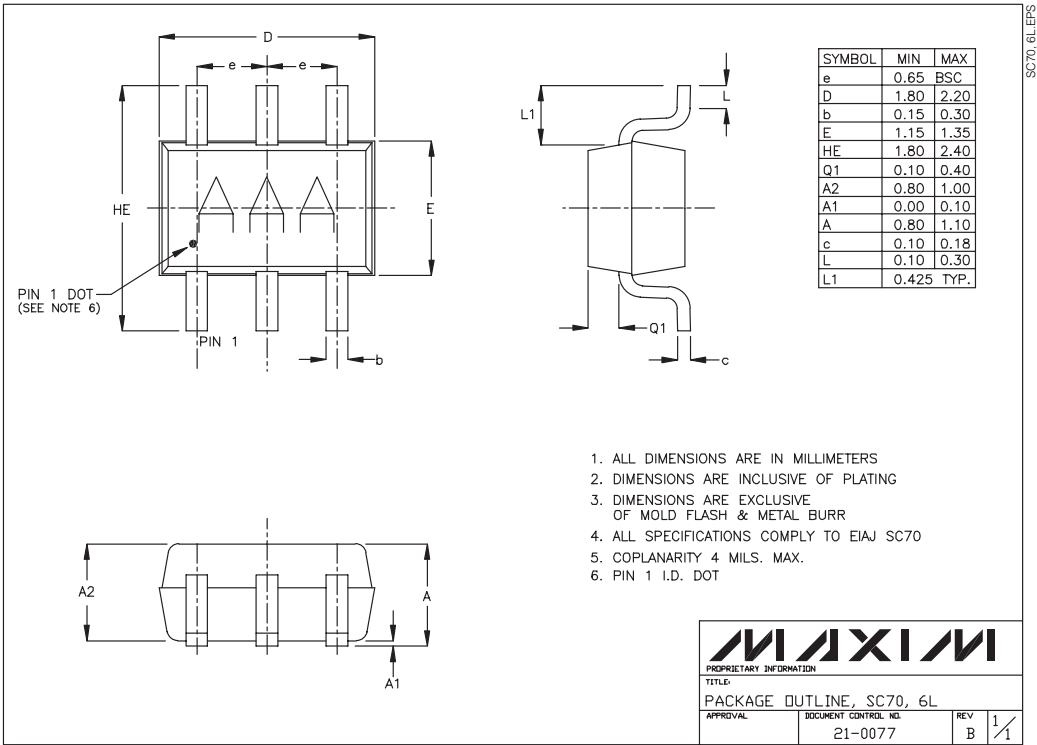
Figure 6. Channel On/Off-Capacitance

## 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](http://www.maxim-ic.com/packages).)



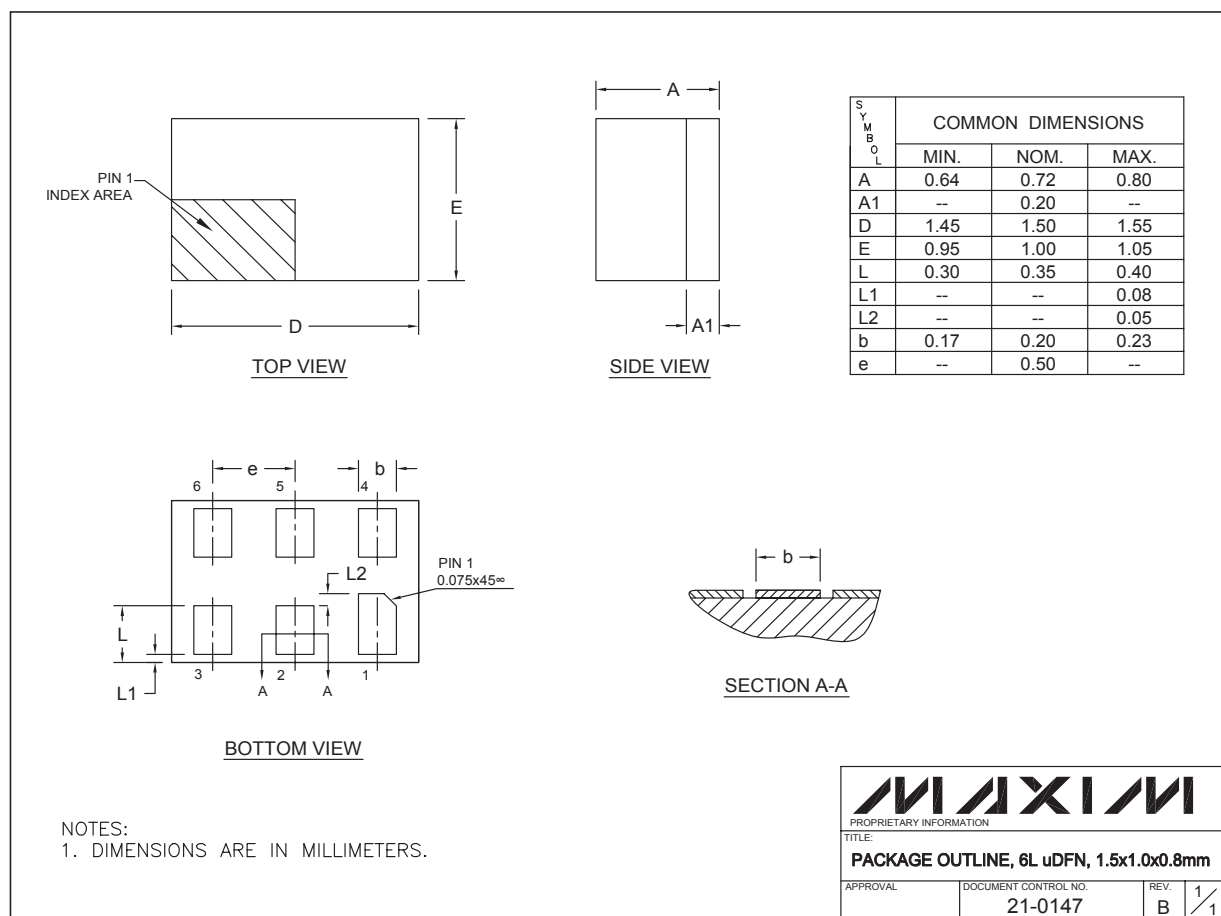


# Low-Voltage, Single-Supply, SPDT Analog Switch in SC70

## 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](http://www.maxim-ic.com/packages).)

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