



# 0.4Ω, Low-Voltage, Single-Supply SPST Analog Switches in SC70

**MAX4715/MAX4716**

## General Description

The MAX4715/MAX4716 are low on-resistance, low-voltage, single-pole/single-throw (SPST) analog switches that operate from a +1.6V to +3.6V single supply. The MAX4715 is normally open (NO), and the MAX4716 is normally closed (NC). These devices also have fast switching speeds ( $t_{ON} = 18\text{ns}$  max,  $t_{OFF} = 12\text{ns}$  max).

When powered from a +3V supply, the MAX4715/MAX4716 offer 0.4Ω max on-resistance ( $R_{ON}$ ) with 0.1Ω max  $R_{ON}$  flatness. Their digital logic inputs are +1.8V CMOS compatible when using a single +3V supply.

The MAX4715 is pin compatible with the MAX4594, and the MAX4716 is pin compatible with the MAX4595. The MAX4715/MAX4716 are available in SC70-5 packages.

## Applications

Power Routing  
Battery-Operated Equipment  
Audio and Video Signal Routing  
Low-Voltage Data-Acquisition Systems  
Communications Circuits  
PCMCIA Cards  
Cellular Phones  
Modems  
Hard Drives

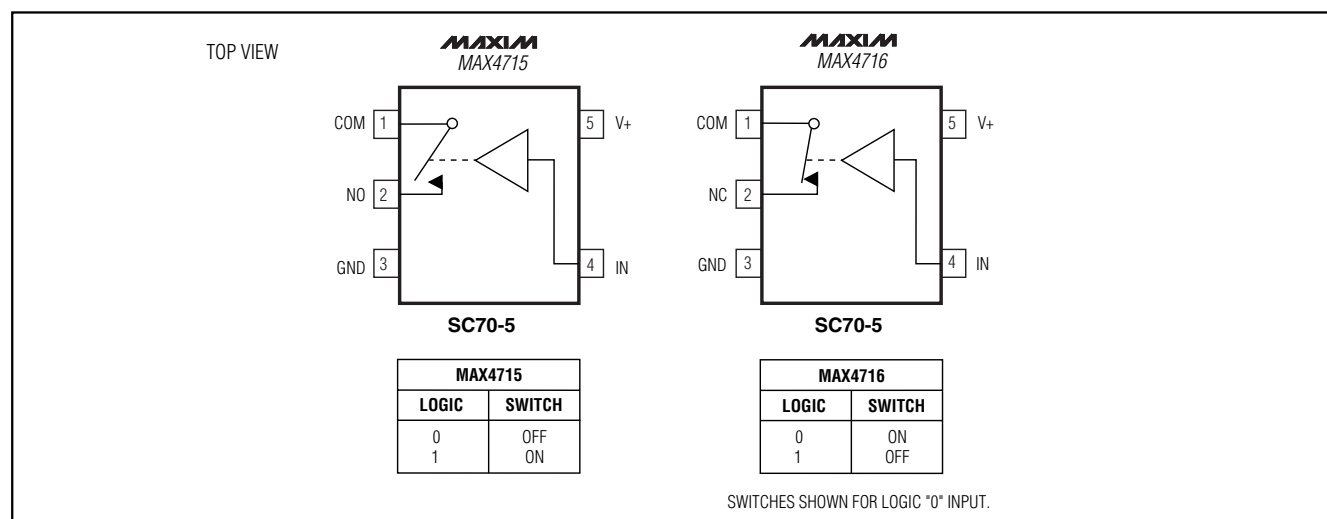
## Features

- ◆ Low  $R_{ON}$ 
  - 0.4Ω max (+3V Supply)
  - 1.2Ω max (+1.8V Supply)
- ◆ 0.1Ω max  $R_{ON}$  Flatness (+3V Supply)
- ◆ +1.6V to +3.6V Single-Supply Operation
- ◆ Available in 5-Pin SC70 Packages
- ◆ Fast Switching:  $t_{ON} = 18\text{ns}$  max,  $t_{OFF} = 12\text{ns}$  max
- ◆ +1.8V CMOS Logic Compatible (+3V Supply)
- ◆ Pin Compatible with MAX4594 (MAX4715)  
Pin Compatible with MAX4595 (MAX4716)

## Ordering Information

| PART         | TEMP. RANGE    | PIN-PACKAGE | TOP MARK |
|--------------|----------------|-------------|----------|
| MAX4715EXK-T | -40°C to +85°C | 5 SC70-5    | ACJ      |
| MAX4716EXK-T | -40°C to +85°C | 5 SC70-5    | ACK      |

## Pin Configurations/Functional Diagrams/Truth Tables



# 0.4 $\Omega$ , Low-Voltage, Single-Supply SPST Analog Switches in SC70

## ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to GND

V+, IN ..... -0.3V to +4V  
 COM, NO, NC (Note 1) ..... -0.3V to (V+ + 0.3V)  
 Continuous Current NO, NC to COM .....  $\pm 300$ mA  
 Peak Switch Current NO, NC to COM  
 (pulsed at 1ms, 10% duty cycle max) .....  $\pm 600$ mA  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
 5-Pin SC70 (derate 3.1mW/°C above +70°C) ..... 247mW

Operating Temperature Range

MAX471\_EXK ..... -40°C to +85°C  
 Junction Temperature ..... +150°C  
 Storage Temperature Range ..... -65°C to +150°C  
 Lead Temperature (soldering, 10s) ..... +300°C

**Note 1:** Signals on NO, NC, or COM exceeding V+ or GND are clamped by internal diodes.

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 +3V Supply

(V+ = +2.7V to +3.6V, V<sub>IH</sub> = +1.4V, V<sub>IL</sub> = +0.5V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V+ = +3.0V and T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER                       | SYMBOL                                                  | CONDITIONS                                                                                               | TA                                   | 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 (Note 6)          | R <sub>ON</sub>                                         | V+ = 2.7V, I <sub>COM</sub> = 100mA,<br>V <sub>NO</sub> or V <sub>NC</sub> = 1.5V                        | +25°C                                | 0.3  | 0.4  |     | Ω     |
|                                 |                                                         |                                                                                                          | T <sub>MIN</sub> to T <sub>MAX</sub> |      | 0.45 |     |       |
| On-Resistance Flatness (Note 4) | R <sub>FLAT(ON)</sub>                                   | V+ = 2.7V, I <sub>COM</sub> = 100mA,<br>V <sub>NO</sub> or V <sub>NC</sub> = 0.6, 1.5V, 2.1V             | +25°C                                | 0.05 | 0.09 |     | Ω     |
|                                 |                                                         |                                                                                                          | T <sub>MIN</sub> to T <sub>MAX</sub> |      | 0.1  |     |       |
| NO, NC Off-Leakage Current      | I <sub>NO(OFF)</sub> or<br>I <sub>NC(OFF)</sub> or      | V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V<br>V <sub>NO</sub> or V <sub>NC</sub> = 3V, 0.3V                  | +25°C                                | -1   | 0.01 | 1   | nA    |
|                                 |                                                         |                                                                                                          | T <sub>MIN</sub> to T <sub>MAX</sub> | -10  |      | 10  |       |
| COM Off-Leakage Current         | I <sub>COM(OFF)</sub>                                   | V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V<br>V <sub>NO</sub> or V <sub>NC</sub> = 3V, 0.3V                  | +25°C                                | -1   | 0.01 | 1   | nA    |
|                                 |                                                         |                                                                                                          | T <sub>MIN</sub> to T <sub>MAX</sub> | -10  |      | 10  |       |
| COM On-Leakage Current          | I <sub>COM(ON)</sub>                                    | V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V, V <sub>NO</sub> or<br>V <sub>NC</sub> = 0.3V, 3V or floating     | +25°C                                | -2   |      | 2   | nA    |
|                                 |                                                         |                                                                                                          | T <sub>MIN</sub> to T <sub>MAX</sub> | -10  |      | 10  |       |
| DYNAMIC                         |                                                         |                                                                                                          |                                      |      |      |     |       |
| Turn-On Time                    | t <sub>ON</sub>                                         | V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω,<br>C <sub>L</sub> = 35pF, Figure 1      | +25°C                                | 12   | 18   |     | ns    |
|                                 |                                                         |                                                                                                          | T <sub>MIN</sub> to T <sub>MAX</sub> |      | 20   |     |       |
| Turn-Off Time                   | t <sub>OFF</sub>                                        | V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω,<br>C <sub>L</sub> = 35pF, Figure 1      | +25°C                                | 6    | 12   |     | ns    |
|                                 |                                                         |                                                                                                          | T <sub>MIN</sub> to T <sub>MAX</sub> |      | 15   |     |       |
| Charge Injection                | Q                                                       | V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,<br>C <sub>L</sub> = 1.0nF, Figure 2                          | +25°C                                | 20   |      |     | pC    |
| Off-Isolation (Note 5)          | V <sub>ISO</sub>                                        | f = 1MHz, V <sub>COM</sub> = 1V <sub>RMS</sub> ,<br>R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 3 | +25°C                                | -54  |      |     | dB    |
| Total Harmonic Distortion       | THD                                                     | f = 20Hz to 20kHz,<br>V <sub>COM</sub> = 2V <sub>P-P</sub> , R <sub>L</sub> = 32Ω                        | +25°C                                | 0.01 |      |     | %     |
| NC or NO Off-Capacitance        | C <sub>NO(OFF)</sub><br>C <sub>NC(OFF)</sub>            | f = 1MHz, Figure 4                                                                                       | +25°C                                | 55   |      |     | pF    |
| COM Off-Capacitance             | C <sub>COM(OFF)</sub>                                   | f = 1MHz, Figure 4                                                                                       | +25°C                                | 55   |      |     | pF    |
| COM On-Capacitance              | C <sub>COM(ON)</sub>                                    | f = 1MHz, Figure 4                                                                                       | +25°C                                | 80   |      |     | pF    |

# 0.4 $\Omega$ , Low-Voltage, Single-Supply SPST Analog Switches in SC70

## ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V<sub>+</sub> = +2.7V to +3.6V, V<sub>IH</sub> = +1.4V, V<sub>IL</sub> = +0.5V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at V<sub>+</sub> = +3.0V and T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER               | SYMBOL          | CONDITIONS                                                    | T <sub>A</sub>                       | MIN | TYP  | MAX | UNITS |
|-------------------------|-----------------|---------------------------------------------------------------|--------------------------------------|-----|------|-----|-------|
| <b>LOGIC INPUT</b>      |                 |                                                               |                                      |     |      |     |       |
| Input Voltage Low       | V <sub>IL</sub> |                                                               |                                      |     |      | 0.5 | V     |
| Input Voltage High      | V <sub>IH</sub> |                                                               |                                      | 1.4 |      |     | V     |
| Input Leakage Current   | I <sub>IN</sub> | V <sub>IN</sub> = 0 or V <sub>+</sub>                         |                                      | -1  |      | 1   | μA    |
| <b>SUPPLY</b>           |                 |                                                               |                                      |     |      |     |       |
| Power-Supply Range      | V <sub>+</sub>  |                                                               |                                      | 1.6 |      | 3.6 | V     |
| Positive Supply Current | I <sub>+</sub>  | V <sub>+</sub> = +3.6V, V <sub>IN</sub> = 0 or V <sub>+</sub> | +25°C                                |     | 0.04 | 0.2 | μA    |
|                         |                 |                                                               | T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | 2   |       |

## ELECTRICAL CHARACTERISTICS—Single +1.8V Supply

(V<sub>+</sub> = +1.8V, V<sub>IH</sub> = +1V, V<sub>IL</sub> = +0.4V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER                    | SYMBOL                                                  | CONDITIONS                                                                                          | TA                                   | MIN | TYP | MAX | UNITS |
|------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------|-----|-----|-----|-------|
| ANALOG SWITCH                |                                                         |                                                                                                     |                                      |     |     |     |       |
| Analog Signal Range          | V <sub>COM</sub> , V <sub>NO</sub> ,<br>V <sub>NC</sub> |                                                                                                     |                                      | 0   |     | V+  | V     |
| On-Resistance                | R <sub>ON</sub>                                         | I <sub>COM</sub> = 10mA,<br>V <sub>NO</sub> or V <sub>NC</sub> = 0.9V                               | +25°C                                |     | 0.6 | 1.2 | Ω     |
|                              |                                                         |                                                                                                     | T <sub>MIN</sub> to T <sub>MAX</sub> |     |     | 2.5 |       |
| NO or NC Off-Leakage Current | I <sub>NO(OFF)</sub> or<br>I <sub>NC(OFF)</sub>         | V <sub>COM</sub> = 0.3V, 1.5V, V <sub>NO</sub> or<br>V <sub>NC</sub> = 1.5V, 0.3V                   | +25°C                                | -1  |     | 1   | nA    |
|                              |                                                         |                                                                                                     | T <sub>MIN</sub> to T <sub>MAX</sub> | -10 |     | 10  |       |
| COM Off-Leakage Current      | I <sub>COM(OFF)</sub>                                   | V <sub>COM</sub> = 0.3V, 1.5V, V <sub>NO</sub> or<br>V <sub>NC</sub> = 1.5V, 0.3V                   | +25°C                                | -1  |     | 1   | nA    |
|                              |                                                         |                                                                                                     | T <sub>MIN</sub> to T <sub>MAX</sub> | -10 |     | 10  |       |
| COM On-Leakage Current       | I <sub>COM(ON)</sub>                                    | V <sub>COM</sub> = 1.5V, 0.3V, V <sub>NO</sub> or<br>V <sub>NC</sub> = 1.5V, 0.3V, or floating      | +25°C                                | -2  |     | 2   | nA    |
|                              |                                                         |                                                                                                     | T <sub>MIN</sub> to T <sub>MAX</sub> | -10 |     | 10  |       |
| DYNAMIC                      |                                                         |                                                                                                     |                                      |     |     |     |       |
| Turn-On Time                 | t <sub>ON</sub>                                         | V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω,<br>C <sub>L</sub> = 35pF, Figure 1 | +25°C                                |     | 18  | 25  | ns    |
|                              |                                                         |                                                                                                     | T <sub>MIN</sub> to T <sub>MAX</sub> |     |     | 30  |       |
| Turn-Off Time                | t <sub>OFF</sub>                                        | V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω,<br>C <sub>L</sub> = 35pF, Figure 1 | +25°C                                |     | 9   | 20  | ns    |
|                              |                                                         |                                                                                                     | T <sub>MIN</sub> to T <sub>MAX</sub> |     |     | 25  |       |
| Charge Injection             | Q                                                       | V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0,<br>C <sub>L</sub> = 1nF, Figure 2                       | +25°C                                |     | 40  |     | pC    |

# 0.4Ω, Low-Voltage, Single-Supply SPST Analog Switches in SC70

## ELECTRICAL CHARACTERISTICS—Single +1.8V Supply (continued)

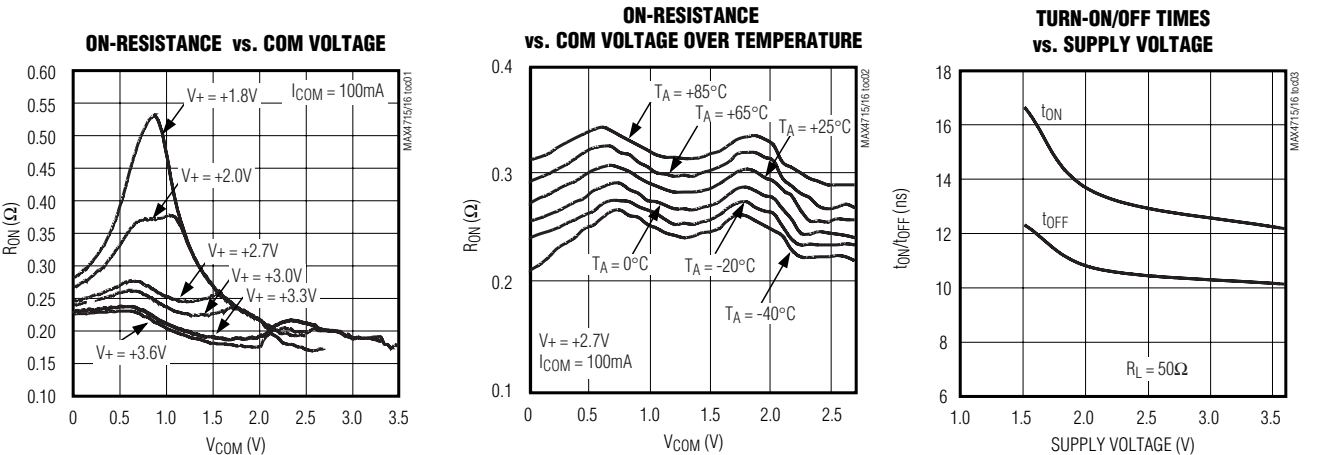
(V+ = +1.8V, VIH = +1V, VIL = +0.4V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Notes 2, 3)

| PARAMETER               | SYMBOL | CONDITIONS    | TA           | MIN | TYP  | MAX | UNITS |
|-------------------------|--------|---------------|--------------|-----|------|-----|-------|
| <b>LOGIC INPUT</b>      |        |               |              |     |      |     |       |
| Input Voltage Low       | VIL    |               |              |     |      | 0.4 | V     |
| Input Voltage High      | VIH    |               |              | 1   |      |     | V     |
| Input Leakage Current   | IIN    | VIN = 0 or V+ |              |     |      | 1   | μA    |
| <b>SUPPLY</b>           |        |               |              |     |      |     |       |
| Positive Supply Current | I+     | VIN = 0 or V+ | +25°C        |     | 0.04 | 0.2 | μA    |
|                         |        |               | TMIN to TMAX |     |      | 2   |       |

- Note 2:** 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 3:** SC70-packaged parts are 100% tested at +25°C. Limits across the full temperature range are guaranteed by design and correlation.
- Note 4:** Flatness is defined as the difference between the maximum and minimum values of on-resistance as measured over the specified analog signal range.
- Note 5:** Off-Isolation = 20log10 [VCOM / (VNC or VNO)], VCOM = output, VNC or VNO = input to off switch.
- Note 6:** Guaranteed by design.

## Typical Operating Characteristics

(TA = +25°C, unless otherwise noted.)

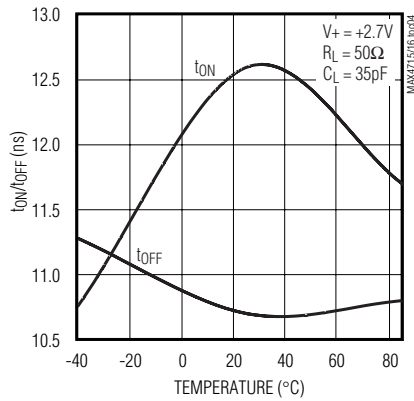


# 0.4 $\Omega$ , Low-Voltage, Single-Supply SPST Analog Switches in SC70

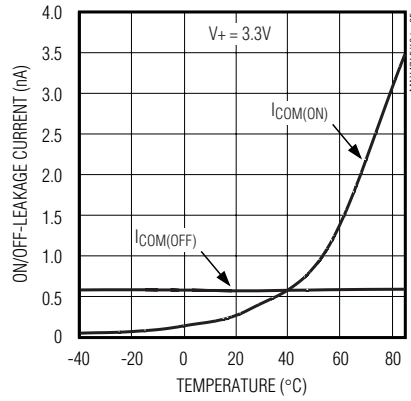
## Typical Operating Characteristics (continued)

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

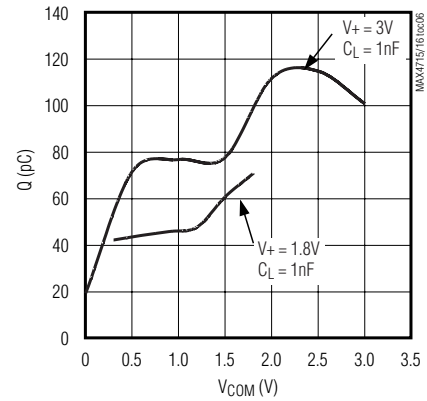
**TURN-ON/OFF TIMES  
vs. TEMPERATURE**



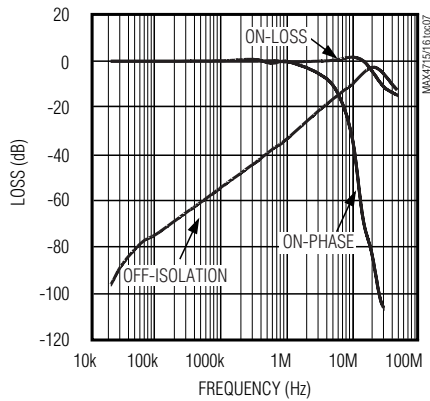
**ON/OFF-LEAKAGE CURRENT  
vs. TEMPERATURE**



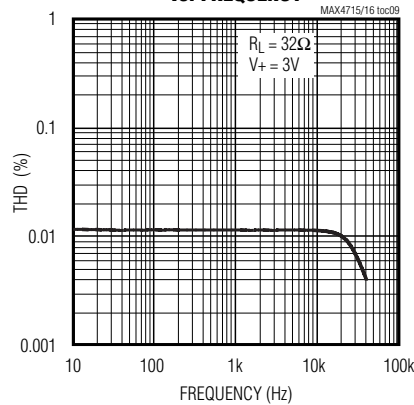
**CHARGE INJECTION vs. COM VOLTAGE**



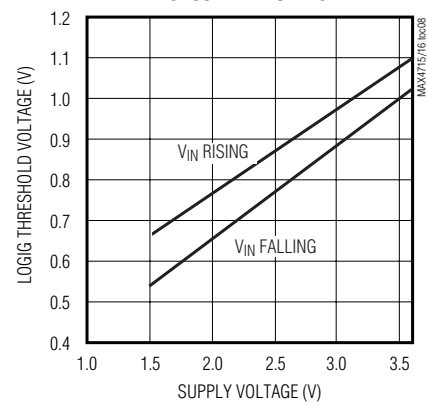
**FREQUENCY RESPONSE**



**TOTAL HARMONIC DISTORTION  
vs. FREQUENCY**



**LOGIC THRESHOLD VOLTAGE  
vs. SUPPLY VOLTAGE**



## Pin Description

| PIN     |         | NAME | FUNCTION                      |
|---------|---------|------|-------------------------------|
| MAX4715 | MAX4716 |      |                               |
| 1       | 1       | COM  | Analog Switch—Common          |
| 2       | —       | NO   | Analog Switch—Normally Open   |
| —       | 2       | NC   | Analog Switch—Normally Closed |
| 3       | 3       | GND  | Ground                        |
| 4       | 4       | IN   | Digital Control Input         |
| 5       | 5       | V+   | Positive Supply Input         |

# 0.4Ω, Low-Voltage, Single-Supply SPST Analog Switches in SC70

## Detailed Description

The MAX4715/MAX4716 are low on-resistance ( $R_{ON}$ ), low-voltage, single-pole/single-throw (SPST) analog switches that operate from a +1.6V to +3.6V single supply. The MAX4715 is normally open (NO), and the MAX4716 is normally closed (NC).

When powered from a +3V supply, their 0.4Ω  $R_{ON}$  allows high continuous currents to be switched in a variety of applications.

## Applications Information

### Logic Inputs

The MAX4715/MAX4716 logic inputs can be driven up to +3.6V regardless of the supply voltage. For example,

with a +3.3V supply, IN may be driven low to GND and high to +3.6V. Driving IN Rail-to-Rail® minimizes power consumption.

### Analog Signal Levels

Analog signals that range over the entire supply voltage ( $V_+$  to GND) can be passed with very little change in on-resistance (see *Typical Operating Characteristics*). The switches are bidirectional, so the NO, NC, and COM pins can be used as either inputs or outputs.

*Rail-to-Rail is a registered trademark of Nippon Motorola Ltd.*

## Test Circuits/Timing Diagrams

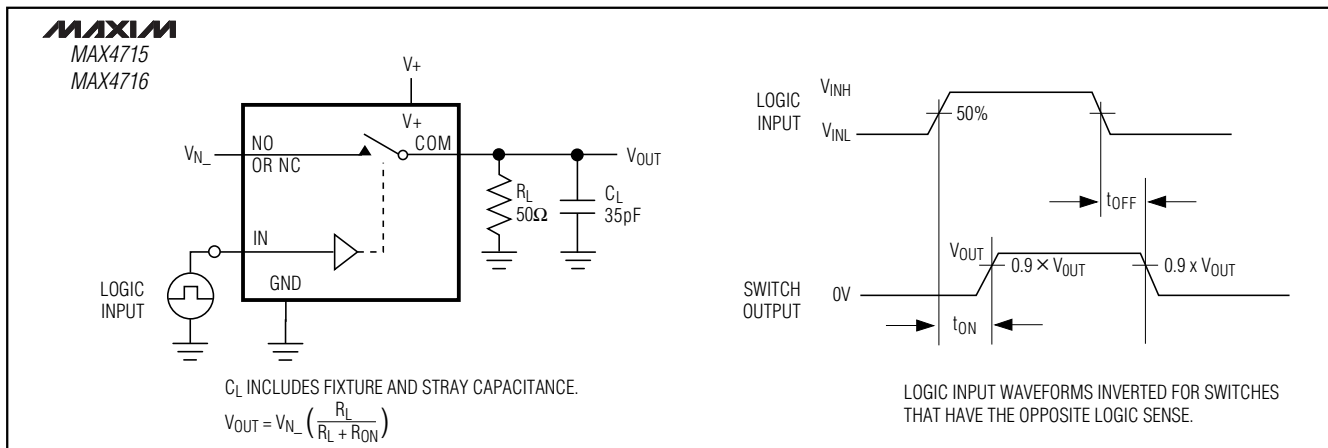


Figure 1. Switching Time

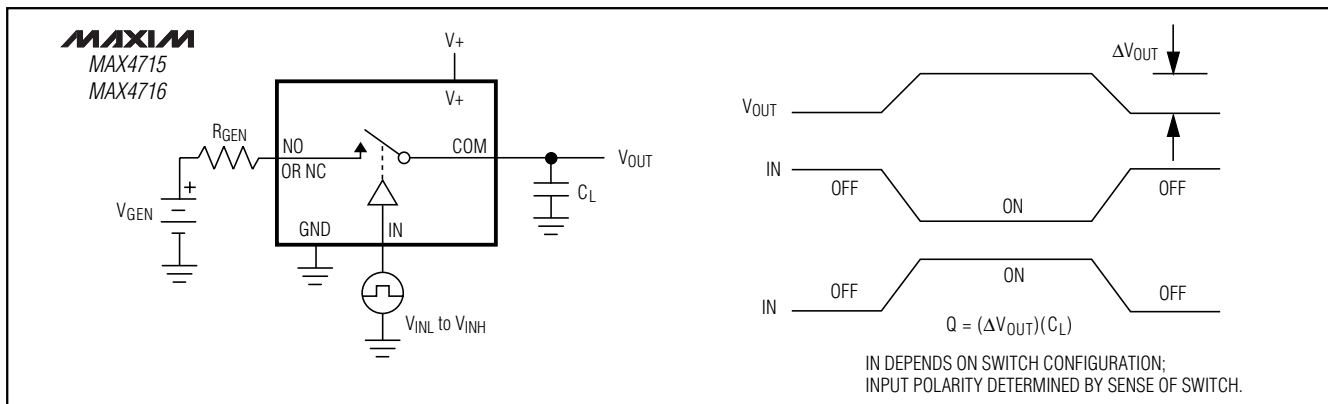


Figure 2. Charge Injection

**MAX4715/MAX4716**

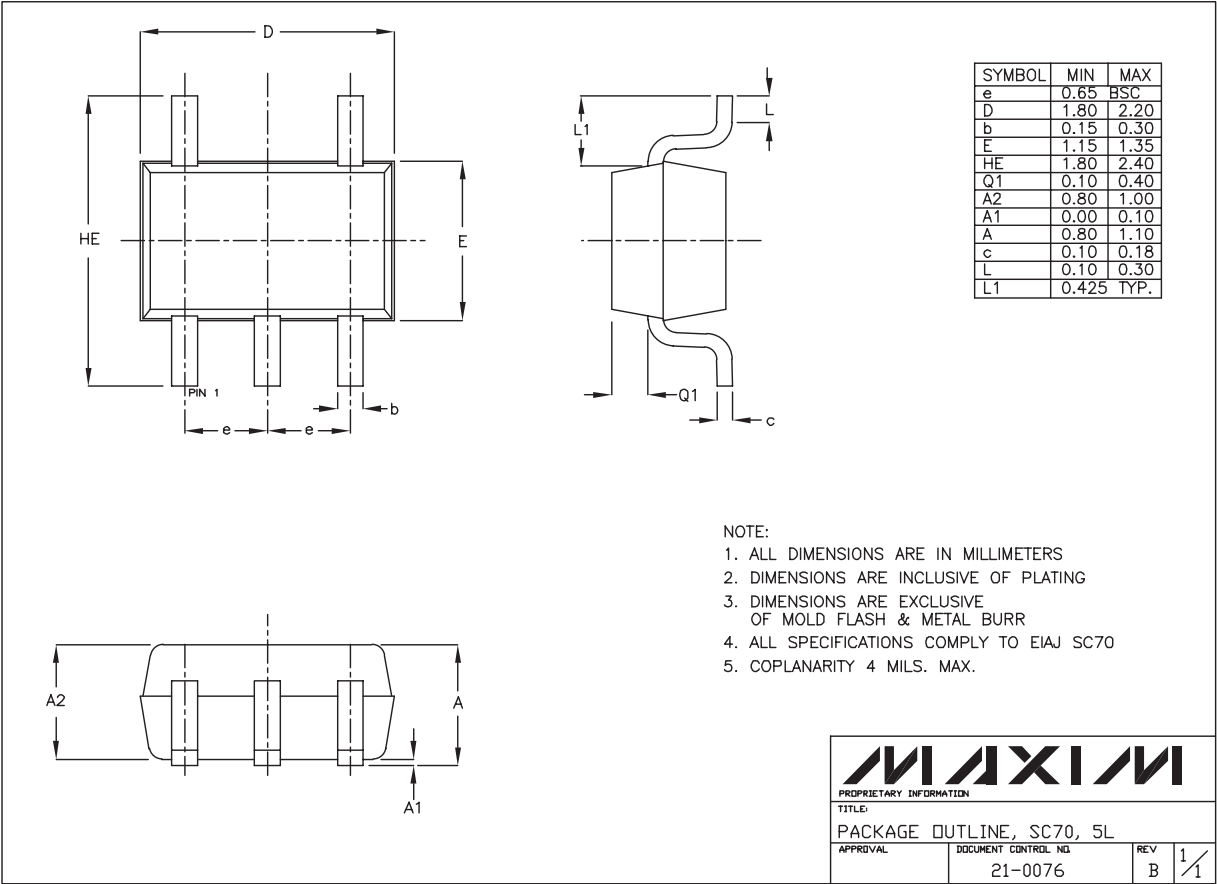
MEASUREMENTS ARE STANDARDIZED AGAINST SHORTS AT IC TERMINALS.  
 OFF-ISOLATION IS MEASURED BETWEEN COM\_ AND "OFF" NO\_ OR NC\_ TERMINAL ON EACH SWITCH.  
 ON-LOSS IS MEASURED BETWEEN COM\_ AND "ON" NO\_ OR NC\_ TERMINAL ON EACH SWITCH.  
 SIGNAL DIRECTION THROUGH SWITCH IS REVERSED; WORST VALUES ARE RECORDED.

[illegible]

TRANSISTOR COUNT: 135  
PROCESS: CMOS

# 0.4Ω, Low-Voltage, Single-Supply SPST Analog Switches in SC70

## Package Information



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

8 Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600