



# 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

TOP VIEW

MAX4715

LOGIC	SWITCH
0	OFF
1	ON

MAX4716

LOGIC	SWITCH
0	ON
1	OFF

SWITCHES SHOWN FOR LOGIC "0" INPUT.



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## 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	±300mA
Peak Switch Current NO, NC to COM (pulsed at 1ms, 10% duty cycle max)	±600mA
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
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>COM</sub> , 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, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V	+25°C T <sub>MIN</sub> to T <sub>MAX</sub>		0.3	0.4 0.45	Ω
On-Resistance Flatness (Note 4)	R <sub>FLAT(ON)</sub>	V+ = 2.7V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 0.6, 1.5V, 2.1V	+25°C T <sub>MIN</sub> to T <sub>MAX</sub>		0.05	0.09 0.1	Ω
NO, NC Off-Leakage Current	I <sub>NO(OFF)</sub> or I <sub>NC(OFF)</sub> or	V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V V <sub>NO</sub> or V <sub>NC</sub> = 3V, 0.3V	+25°C T <sub>MIN</sub> to T <sub>MAX</sub>	-1 -10	0.01	1 10	nA
COM Off-Leakage Current	I <sub>COM(OFF)</sub>	V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V V <sub>NO</sub> or V <sub>NC</sub> = 3V, 0.3V	+25°C T <sub>MIN</sub> to T <sub>MAX</sub>	-1 -10	0.01	1 10	nA
COM On-Leakage Current	I <sub>COM(ON)</sub>	V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V, V <sub>NO</sub> or V <sub>NC</sub> = 0.3V, 3V or floating	+25°C T <sub>MIN</sub> to T <sub>MAX</sub>	-2 -10		2 10	nA
<b>DYNAMIC</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF, Figure 1	+25°C T <sub>MIN</sub> to T <sub>MAX</sub>		12	18 20	ns
Turn-Off Time	t <sub>OFF</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF, Figure 1	+25°C T <sub>MIN</sub> to T <sub>MAX</sub>		6	12 15	ns
Charge Injection	Q	V <sub>GEN</sub> = 0, R <sub>GEN</sub> = 0, 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> , R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 3	+25°C		-54		dB
Total Harmonic Distortion	THD	f = 20Hz to 20kHz, 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> 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

## 0.4Ω, 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	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>			0		V <sub>+</sub>	V
On-Resistance	R <sub>ON</sub>	I <sub>COM</sub> = 10mA, 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 I <sub>NC(OFF)</sub>	V <sub>COM</sub> = 0.3V, 1.5V, V <sub>NO</sub> or 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 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 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	
<b>DYNAMIC</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, 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, 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, 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)

( $V_+ = +1.8V$ ,  $V_{IH} = +1V$ ,  $V_{IL} = +0.4V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
<b>LOGIC INPUT</b>							
Input Voltage Low	$V_{IL}$					0.4	V
Input Voltage High	$V_{IH}$			1			V
Input Leakage Current	$I_{IN}$	$V_{IN} = 0$ or $V_+$				1	$\mu A$
<b>SUPPLY</b>							
Positive Supply Current	$I_+$	$V_{IN} = 0$ or $V_+$	+25°C		0.04	0.2	$\mu A$
			$T_{MIN}$ to $T_{MAX}$			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.

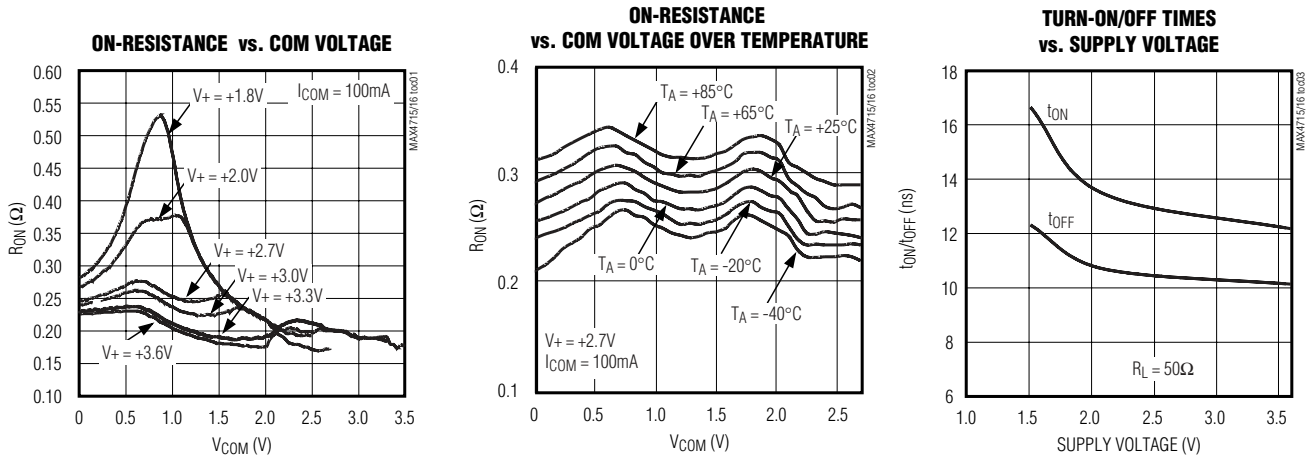
**Note 4:** Flatness is defined as the difference between the maximum and minimum values of on-resistance as measured over the specified analog signal range.

**Note 5:** Off-Isolation =  $20 \log_{10} [V_{COM} / (V_{NC}$  or  $V_{NO})]$ ,  $V_{COM}$  = output,  $V_{NC}$  or  $V_{NO}$  = input to off switch.

**Note 6:** Guaranteed by design.

## Typical Operating Characteristics

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



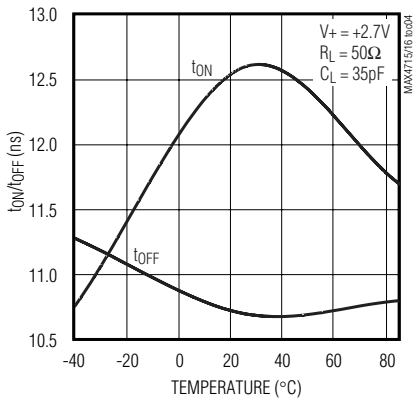
# 0.4Ω, Low-Voltage, Single-Supply SPST Analog Switches in SC70

MAX4715/MAX4716

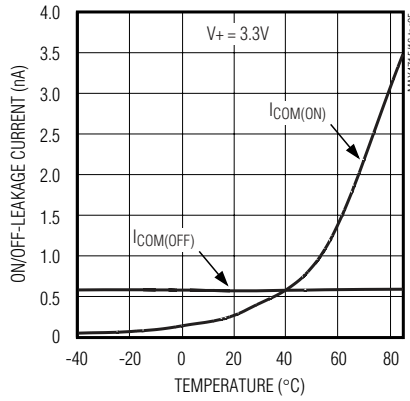
## Typical Operating Characteristics (continued)

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

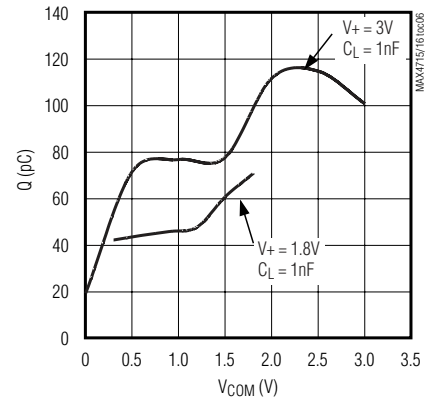
**TURN-ON/OFF TIMES vs. TEMPERATURE**



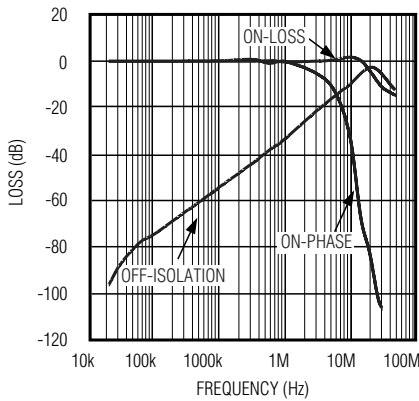
**ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE**



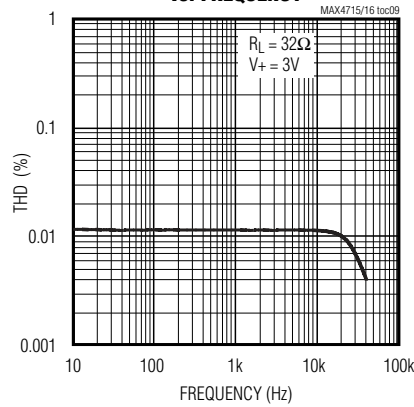
**CHARGE INJECTION vs. COM VOLTAGE**



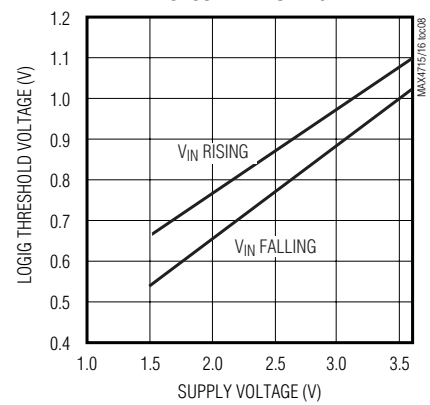
**FREQUENCY RESPONSE**



**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

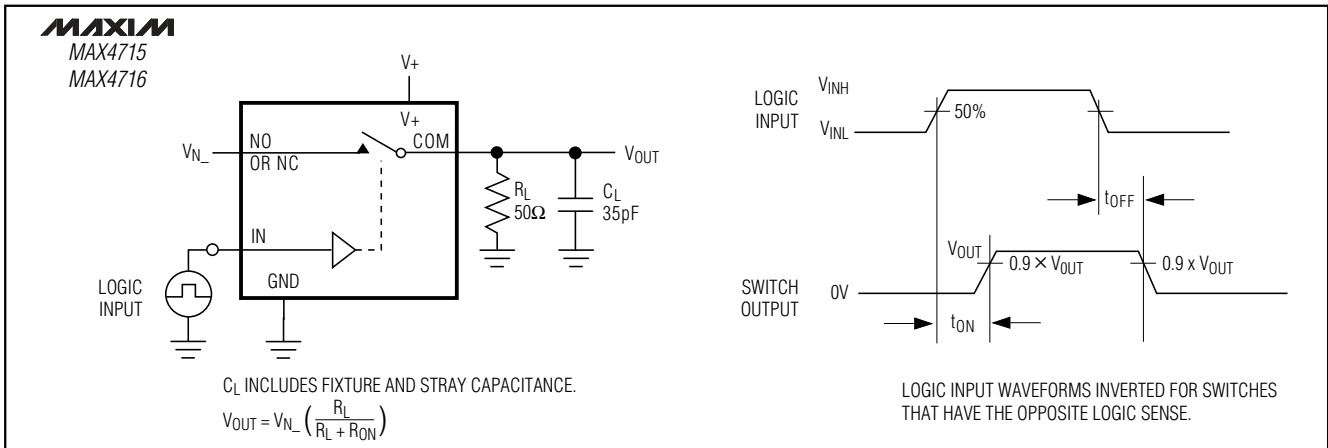


Figure 1. Switching Time

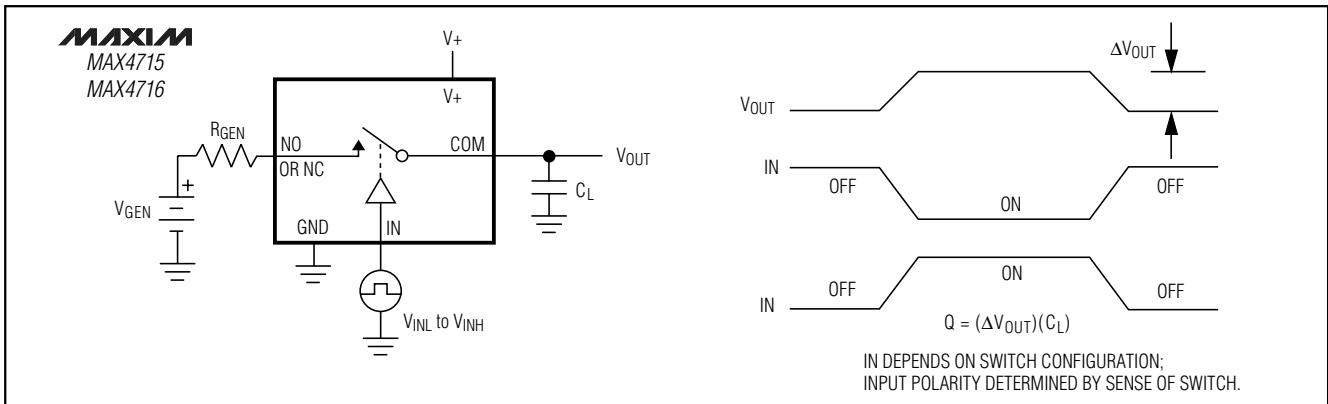


Figure 2. Charge Injection

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

## Test Circuits/Timing Diagrams (continued)

MAX4715/MAX4716

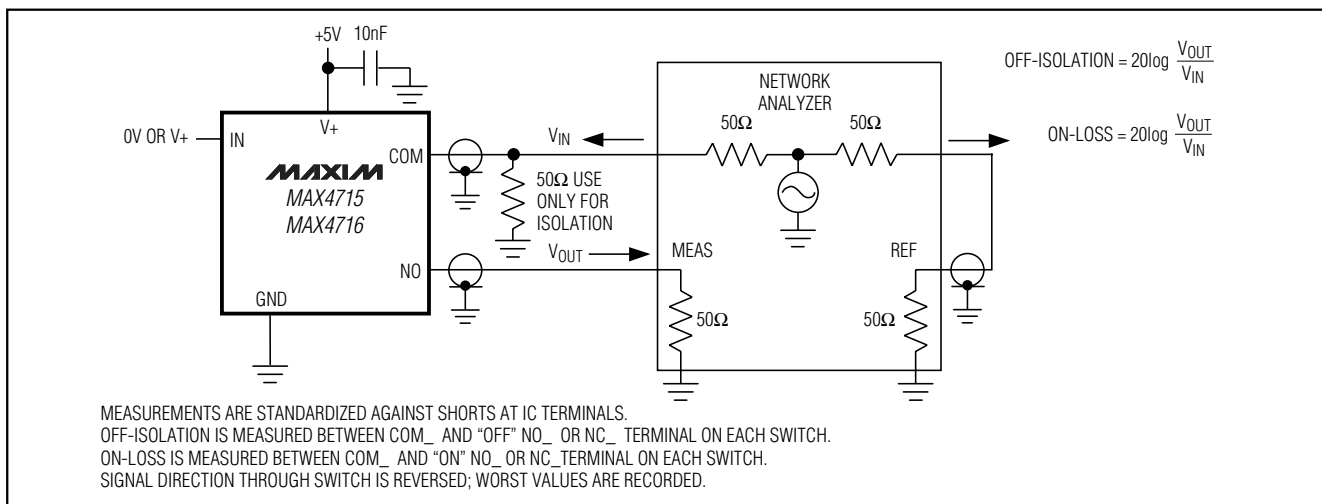


Figure 3. On-Loss and Off-Isolation

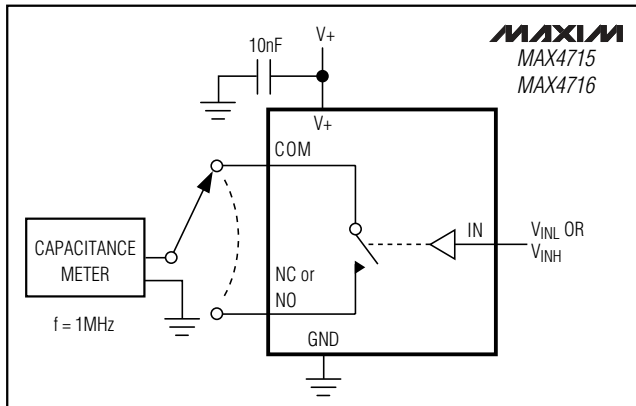


Figure 4. Channel Off/On-Capacitance

## Chip Information

TRANSISTOR COUNT: 135  
 PROCESS: CMOS

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

## Package Information

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.

<b>MAXIM</b>			
<small>PROPRIETARY INFORMATION</small>			
<small>TITLE:</small>			
PACKAGE OUTLINE, SC70, 5L			
<small>APPROVAL</small>	<small>DOCUMENT CONTROL NO.</small>	<small>REV</small>	<small>1/1</small>
	21-0076	B	

SC70, 5L EFS

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## MAX4716

### Part Number Table

#### Notes:

1. See the [MAX4716 QuickView Data Sheet](#) for further information on this product family or download the [MAX4716 full data sheet](#) (PDF, 208kB).
2. Other options and links for purchasing parts are listed at: <http://www.maxim-ic.com/sales>.
3. [Didn't Find What You Need?](#) Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
4. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: See [full data sheet](#) or [Part Naming Conventions](#).
5. \* Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses.

Part Number	Free Sample	Buy Direct	Package: TYPE PINS SIZE DRAWING CODE/VAR *	Temp	RoHS/Lead-Free? Materials Analysis
MAX4716EXK+	<input type="checkbox"/>	<input type="checkbox"/>	SC-70;5 pin; Dwg: <a href="#">21-0076E</a> (PDF) Use pkgcode/variation: X5+1*	-40C to +85C	RoHS/Lead-Free: <a href="#">Yes</a> <a href="#">Materials Analysis</a>
MAX4716EXK+T	<input type="checkbox"/>	<input type="checkbox"/>	SC-70;5 pin; Dwg: <a href="#">21-0076E</a> (PDF) Use pkgcode/variation: X5+1*	-40C to +85C	RoHS/Lead-Free: <a href="#">Yes</a> <a href="#">Materials Analysis</a>
MAX4716EXK+TG104	<input type="checkbox"/>	<input type="checkbox"/>	SC-70;5 pin; Dwg: <a href="#">21-0076E</a> (PDF) Use pkgcode/variation: X5+1*	-40C to +85C	RoHS/Lead-Free: <a href="#">Yes</a> <a href="#">Materials Analysis</a>
MAX4716EXK	<input type="checkbox"/>	<input type="checkbox"/>	SC-70;5 pin; Dwg: <a href="#">21-0076E</a> (PDF) Use pkgcode/variation: X5-1*	-40C to +85C	RoHS/Lead-Free: <a href="#">No</a> <a href="#">Materials Analysis</a>
MAX4716EXK-T	<input type="checkbox"/>	<input type="checkbox"/>	SC-70;5 pin; Dwg: <a href="#">21-0076E</a> (PDF) Use pkgcode/variation: X5-1*	-40C to +85C	RoHS/Lead-Free: <a href="#">No</a> <a href="#">Materials Analysis</a>

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