19-2008; Rev 0; 4/01

MAXIM

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

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} = 18ns max, t_{OFF} = 12ns 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} = 18ns max, t_{OFF} = 12ns max**
- **+1.8V CMOS Logic Compatible (+3V Supply)**
- **Pin Compatible with MAX4594 (MAX4715)**
  Pin Compatible with MAX4595 (MAX4716)

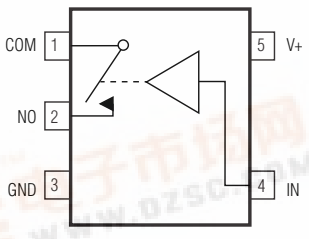
Ordering Information

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

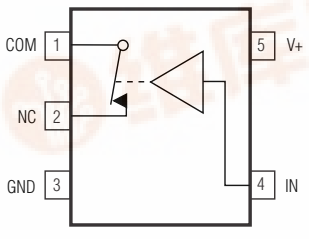
MAXIM
MAX4715



SC70-5

MAX4715	
LOGIC	SWITCH
0	OFF
1	ON

MAXIM
MAX4716



SC70-5

MAX4716	
LOGIC	SWITCH
0	ON
1	OFF

SWITCHES SHOWN FOR LOGIC "0" INPUT.

0.4Ω, 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 .....±300mA
Peak Switch Current NO, NC to COM
(pulsed at 1ms, 10% duty cycle max)..... ±600mA
Continuous Power Dissipation (T_A = +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_{IH} = +1.4V, V_{IL} = +0.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = +3.0V and T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V_{COM}, V_{NO}, V_{NC}			0		V+	V
On-Resistance (Note 6)	R_{ON}	V+ = 2.7V, I_{COM} = 100mA, V_{NO} or V_{NC} = 1.5V	+25°C		0.3	0.4	Ω
			T_{MIN} to T_{MAX}			0.45	
On-Resistance Flatness (Note 4)	$R_{FLAT(ON)}$	V+ = 2.7V, I_{COM} = 100mA, V_{NO} or V_{NC} = 0.6, 1.5V, 2.1V	+25°C		0.05	0.09	Ω
			T_{MIN} to T_{MAX}			0.1	
NO, NC Off-Leakage Current	$I_{NO(OFF)}$ or $I_{NC(OFF)}$ or	V+ = 3.3V, V_{COM} = 0.3V, 3V V_{NO} or V_{NC} = 3V, 0.3V	+25°C	-1	0.01	1	nA
			T_{MIN} to T_{MAX}	-10		10	
COM Off-Leakage Current	$I_{COM(OFF)}$	V+ = 3.3V, V_{COM} = 0.3V, 3V V_{NO} or V_{NC} = 3V, 0.3V	+25°C	-1	0.01	1	nA
			T_{MIN} to T_{MAX}	-10		10	
COM On-Leakage Current	$I_{COM(ON)}$	V+ = 3.3V, V_{COM} = 0.3V, 3V, V_{NO} or V_{NC} = 0.3V, 3V or floating	+25°C	-2		2	nA
			T_{MIN} to T_{MAX}	-10		10	
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO} or V_{NC} = 1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		12	18	ns
			T_{MIN} to T_{MAX}			20	
Turn-Off Time	t_{OFF}	V_{NO} or V_{NC} = 1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		6	12	ns
			T_{MIN} to T_{MAX}			15	
Charge Injection	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 1.0nF, Figure 2	+25°C		20		pC
Off-Isolation (Note 5)	V_{ISO}	f = 1MHz, V_{COM} = $1V_{RMS}$, R_L = 50Ω, C_L = 5pF, Figure 3	+25°C		-54		dB
Total Harmonic Distortion	THD	f = 20Hz to 20kHz, V_{COM} = $2V_{P-P}$, R_L = 32Ω	+25°C		0.01		%
NC or NO Off-Capacitance	$C_{NO(OFF)}$ $C_{NC(OFF)}$	f = 1MHz, Figure 4	+25°C		55		pF
COM Off-Capacitance	$C_{COM(OFF)}$	f = 1MHz, Figure 4	+25°C		55		pF
COM On-Capacitance	$C_{COM(ON)}$	f = 1MHz, Figure 4	+25°C		80		pF

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = +2.7V to +3.6V, V_{IH} = +1.4V, V_{IL} = +0.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V+ = +3.0V and T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
LOGIC INPUT							
Input Voltage Low	V_{IL}					0.5	V
Input Voltage High	V_{IH}			1.4			V
Input Leakage Current	I_{IN}	V_{IN} = 0 or V+		-1		1	µA
SUPPLY							
Power-Supply Range	V+			1.6		3.6	V
Positive Supply Current	I+	V+ = +3.6V, V_{IN} = 0 or V+	+25°C		0.04	0.2	µA
			T_{MIN} to T_{MAX}			2	

ELECTRICAL CHARACTERISTICS—Single +1.8V Supply

(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°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V_{COM}, V_{NO}, V_{NC}			0		V+	V
On-Resistance	R_{ON}	I_{COM} = 10mA, V_{NO} or V_{NC} = 0.9V	+25°C		0.6	1.2	Ω
			T_{MIN} to T_{MAX}			2.5	
NO or NC Off-Leakage Current	$I_{NO(OFF)}$ or $I_{NC(OFF)}$	V_{COM} = 0.3V, 1.5V, V_{NO} or V_{NC} = 1.5V, 0.3V	+25°C	-1		1	nA
			T_{MIN} to T_{MAX}	-10		10	
COM Off-Leakage Current	$I_{COM(OFF)}$	V_{COM} = 0.3V, 1.5V, V_{NO} or V_{NC} = 1.5V, 0.3V	+25°C	-1		1	nA
			T_{MIN} to T_{MAX}	-10		10	
COM On-Leakage Current	$I_{COM(ON)}$	V_{COM} = 1.5V, 0.3V, V_{NO} or V_{NC} = 1.5V, 0.3V, or floating	+25°C	-2		2	nA
			T_{MIN} to T_{MAX}	-10		10	
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO} or V_{NC} = 1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		18	25	ns
			T_{MIN} to T_{MAX}			30	
Turn-Off Time	t_{OFF}	V_{NO} or V_{NC} = 1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	+25°C		9	20	ns
			T_{MIN} to T_{MAX}			25	
Charge Injection	Q	V_{GEN} = 0, R_{GEN} = 0, C_L = 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°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
LOGIC INPUT							
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	µA
SUPPLY							
Positive Supply Current	I+	V_{IN} = 0 or V+	+25°C		0.04	0.2	µA
			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.

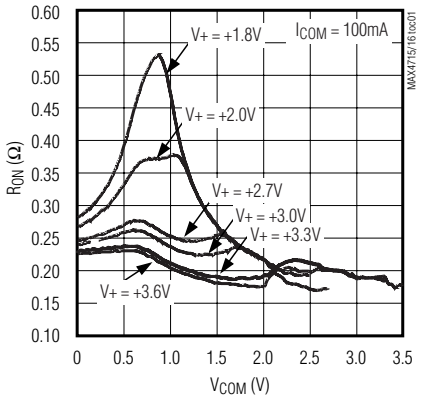
Note 5: Off-Isolation = $20\log_{10}$ [V_{COM} / (V_{NC} or V_{NO})], V_{COM} = output, V_{NC} or V_{NO} = input to off switch.

Note 6: Guaranteed by design.

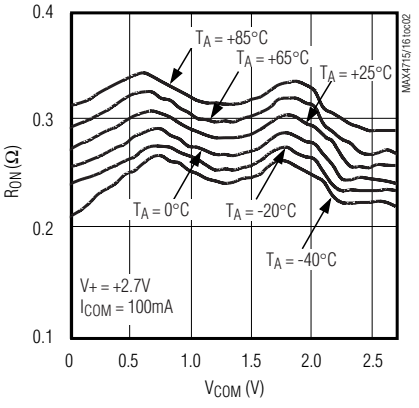
Typical Operating Characteristics

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

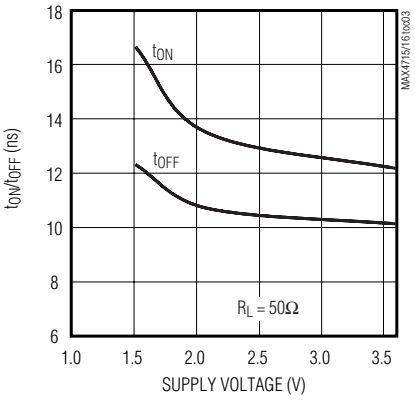
ON-RESISTANCE vs. COM VOLTAGE



ON-RESISTANCE vs. COM VOLTAGE OVER TEMPERATURE



TURN-ON/OFF TIMES vs. SUPPLY VOLTAGE

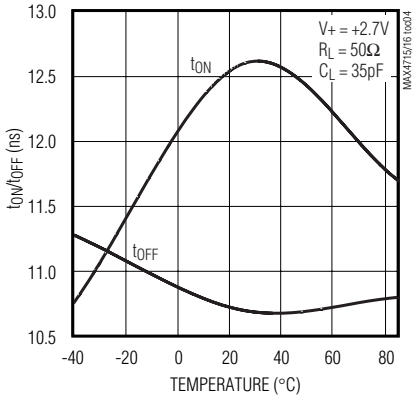


0.4Ω, Low-Voltage, Single-Supply SPST Analog Switches in SC70

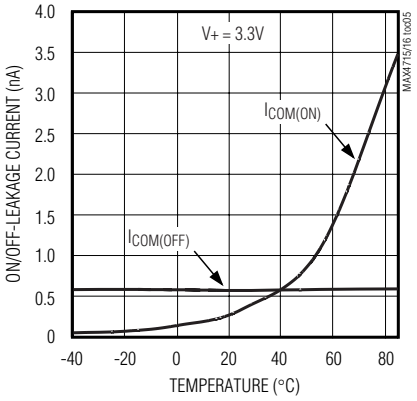
Typical Operating Characteristics (continued)

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

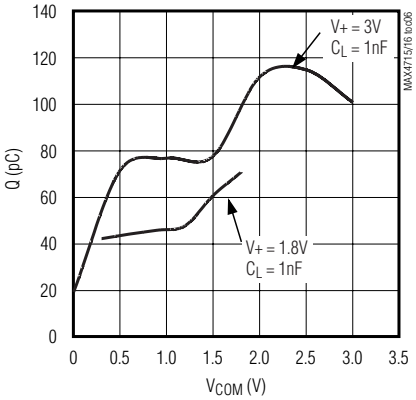
TURN-ON/OFF TIMES vs. TEMPERATURE



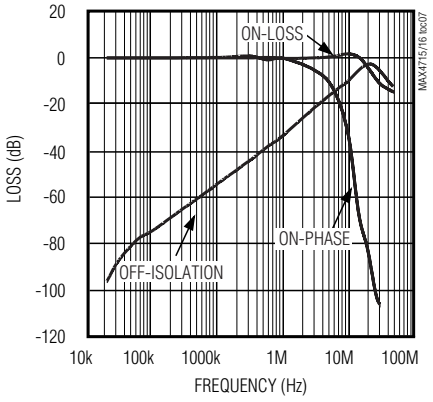
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE



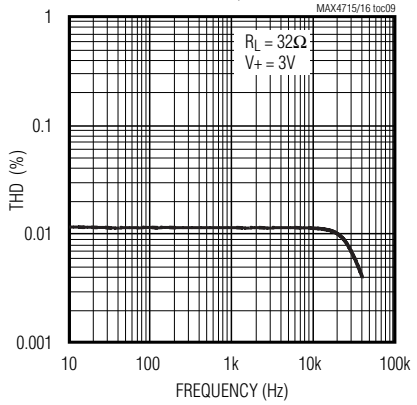
CHARGE INJECTION vs. COM VOLTAGE



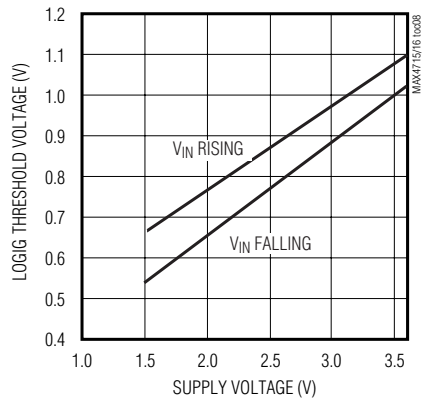
FREQUENCY RESPONSE



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

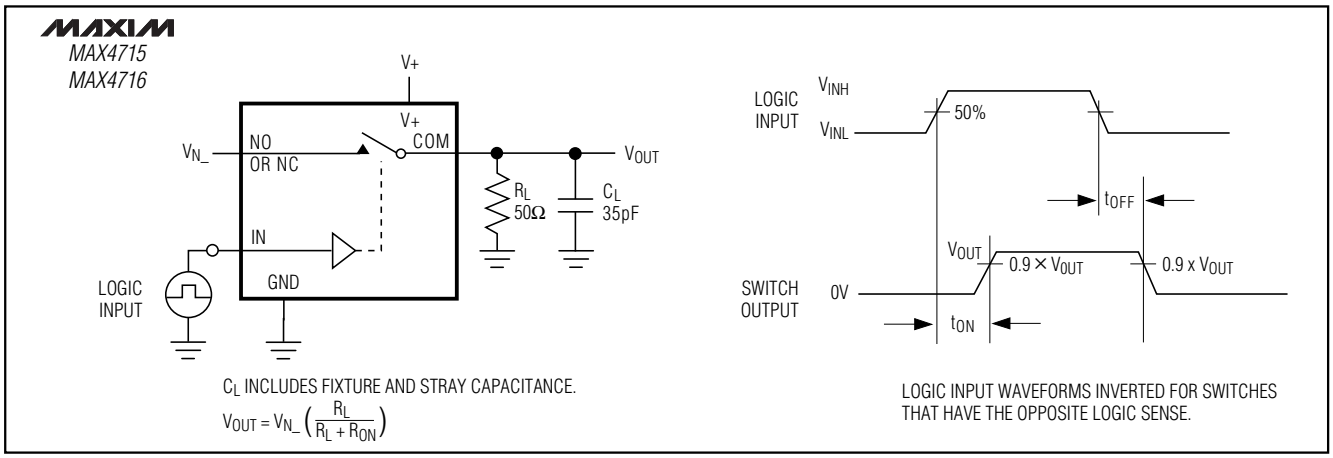


Figure 1. Switching Time

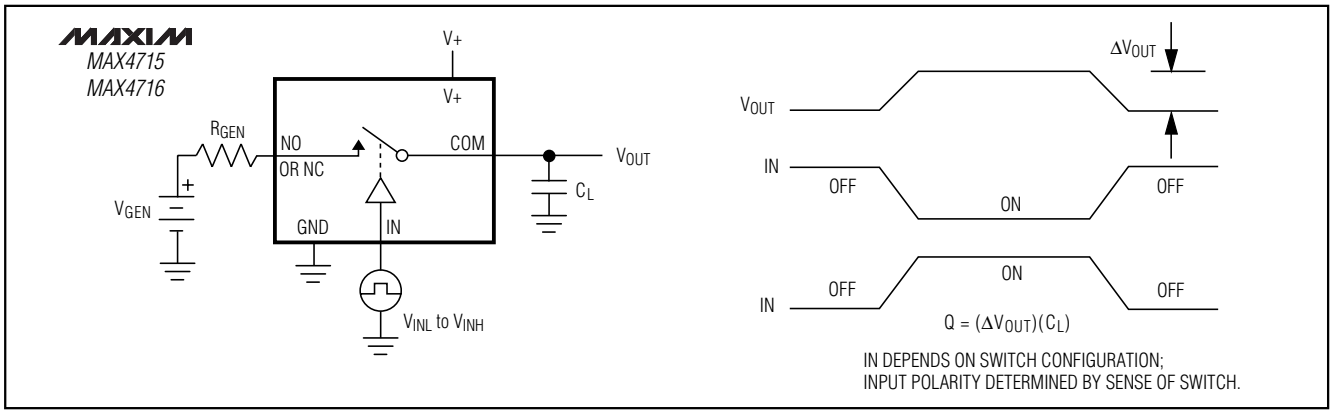


Figure 2. Charge Injection

Test Circuits/Timing Diagrams (continued)

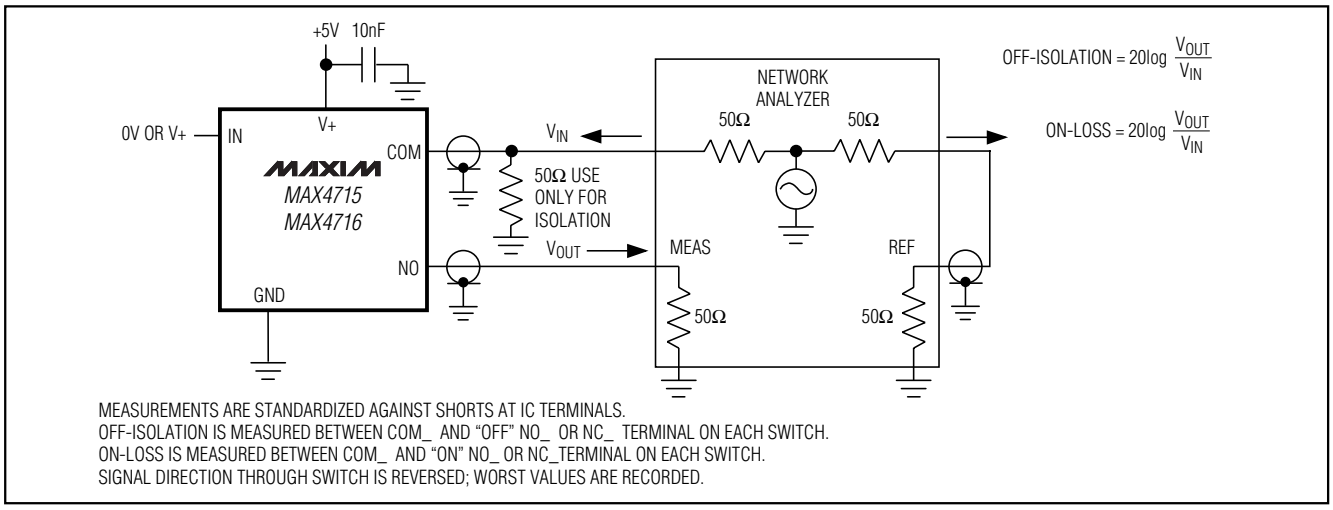


Figure 3. On-Loss and Off-Isolation

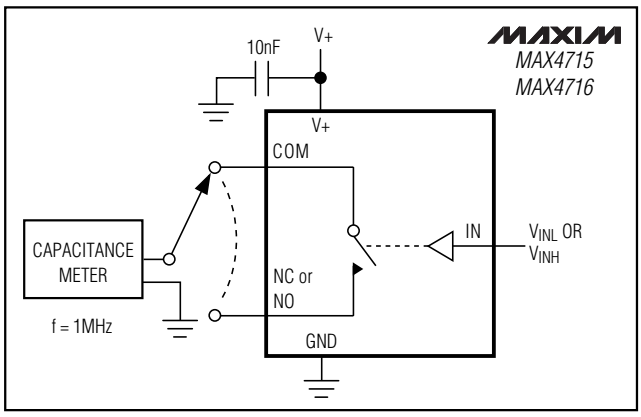


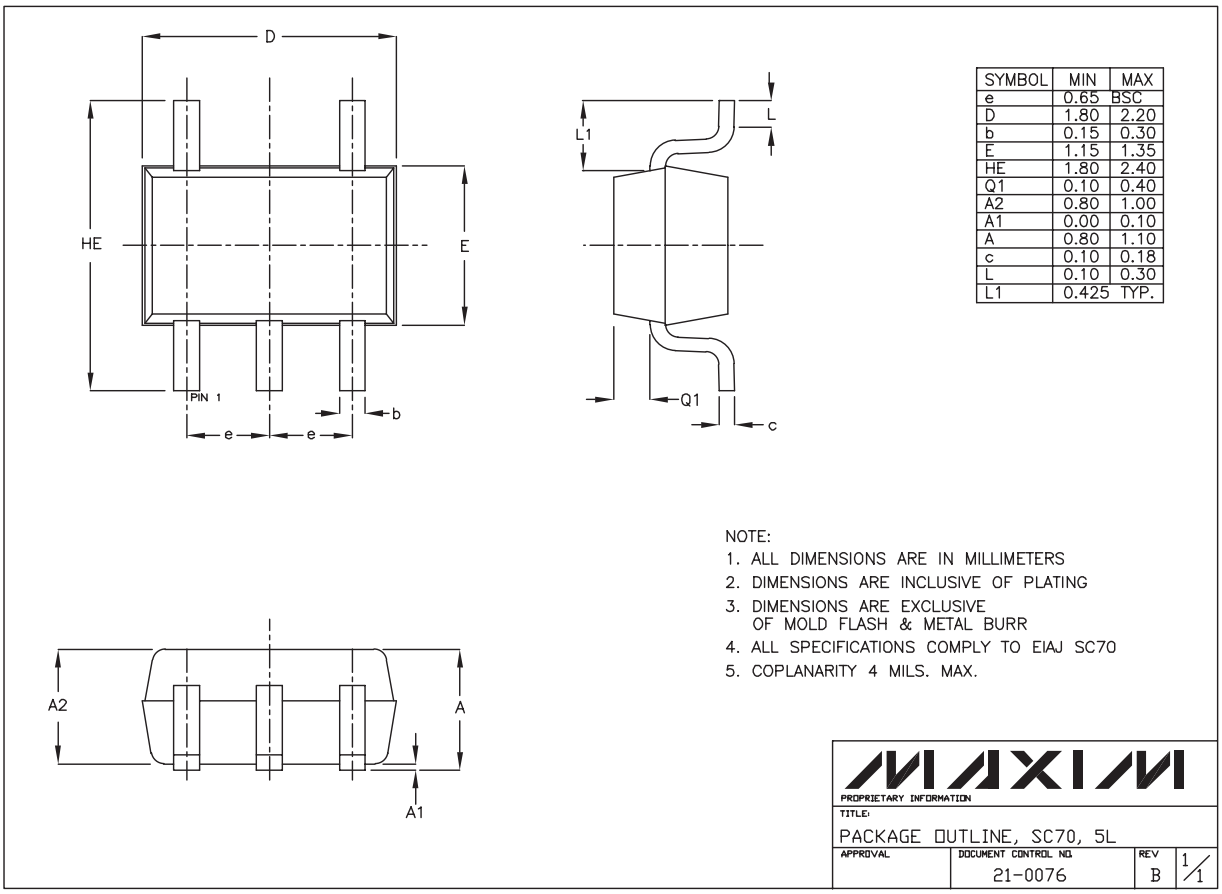
Figure 4. Channel Off/On-Capacitance

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.	