

# Low-Voltage, 1 Ω SPDT Analog Switch with Power-Off Isolation

## FSA4159

### Description

The FSA4159 is a high-performance Single-Pole / Double-Throw (SPDT) analog switch. The device features ultra-low  $R_{ON}$  of 1 Ω at 4.5 V  $V_{CC}$  and operates over the wide  $V_{CC}$  range of 1.65 V to 5.50 V. The device is fabricated with sub-micron CMOS technology to achieve fast switching speeds and is designed for break-before-make operation.

The FSA4159 features very low quiescent current even when the control voltage is lower than the  $V_{CC}$  supply. This feature services mobile handset applications by allowing direct interface with baseband processor general-purpose I/Os.

### Features

- Low  $I_{CC}$  when the S Input is Lower than  $V_{CC}$
- Power-Off Isolation ( $V_{CC} = 0$  V)
- 1 Ω On Resistance ( $R_{ON}$ ) at 4.5 V  $V_{CC}$
- 0.25 Ω Maximum  $R_{ON}$  Flatness for 4.5 V  $V_{CC}$
- Space-Saving, Pb-Free, 6-Lead SC70 Surface Mount Package
- Broad  $V_{CC}$  Operating Range: 1.65 V to 5.50 V
- Fast Turn-On and Turn-Off Times
- Break-Before-Make Enable Circuitry
- These Devices are Pb-Free and are RoHS Compliant

### Applications

- Cellular Phone
- Portable Media Player
- PDA

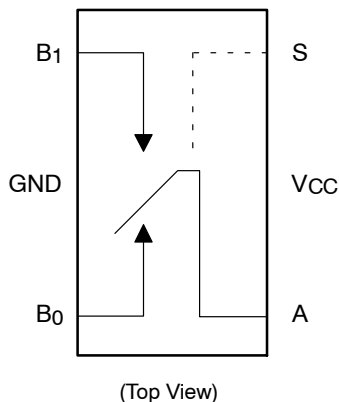
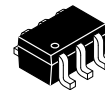


Figure 1. Analog Symbols

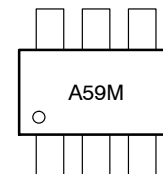


SC-88 (SC-70 6 Lead), 1.25x2  
CASE 419AD

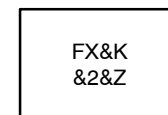


SIP6 1.45X1.0  
CASE 127EB

### MARKING DIAGRAMS



A59 = Specific Device Code  
M = Assembly Operationmonth



FX = Specific Device Code (S2)  
&K = 2-Digits Lot Run Traceability Code  
&2 = 2-Digit Date Code  
&Z = Assembly Plant Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

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## ORDERING INFORMATION

Part Number	Operating Temperature Range	Top Mark	Package	Shipping <sup>†</sup>
FSA4159P6X	-40°C to +85°C	A59	SC-88 (SC-70 6 Lead), 1.25x2 (Pb-Free)	3000 / Tape & Reel
FSA4159L6X	-40°C to +85°C	S2	SIP6 1.45X1.0 (Pb-Free)	5000 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## PIN CONFIGURATION

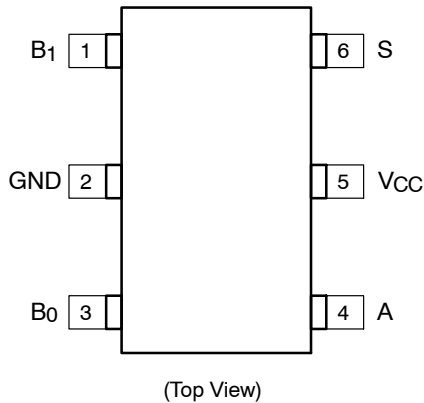


Figure 2. SC70 Pin Assignments

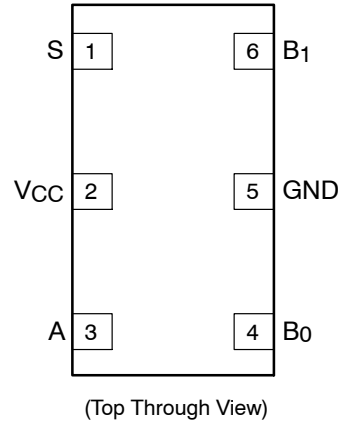


Figure 3. MicroPak™ Pin Assignments

## PIN DEFINITIONS

Pin# SC70	Pin# MicroPak	Name	Description
1	6	B1	Data Ports
2	5	GND	Ground
3	4	B0	Data Ports
4	3	A	Data Ports
5	2	V <sub>CC</sub>	Supply Voltage
6	1	S	Control Input

## TRUTH TABLE

Control Input (S)	Function
Low	B0 connected to A
High	B1 connected to A

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## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	Supply Voltage	-0.5	6.5	V
V <sub>SW</sub>	Switch Voltage (Note 1)	-0.5	V <sub>CC</sub> + 0.5	V
V <sub>IN</sub>	Input Voltage (Note 1)	-0.5	6.5	V
I <sub>IK</sub>	Input Diode Current		-50	mA
I <sub>SW</sub>	Switch Current (Continuous)		200	mA
I <sub>SWPEAK</sub>	Peak Switch Current (Pulsed at 1 ms Duration, < 10% Duty Cycle)		400	mA
P <sub>D</sub>	Power Dissipation at 85°C		180	mW
T <sub>STG</sub>	Storage Temperature Range	-65	+150	°C
T <sub>J</sub>	Maximum Junction Temperature		+150	°C
T <sub>L</sub>	Lead Temperature (Soldering, 10 seconds)		+260	°C
ESD	Electrostatic Discharge Capability	Human Body Model (JEDEC: JESD22-A114)	4000	V
		Charged Device Model (JEDEC: JESD22-C101)	1500	
		Machine Model (JEDEC: JESD22-A115)	200	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. The input and output negative ratings may be exceeded if the input and output diode current ratings are observed.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	Supply Voltage	1.65	5.50	V
S	Control Input Voltage (Note 2)	0	V <sub>CC</sub>	V
V <sub>SW</sub>	Switch Input Voltage	0	V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature	-40	+85	°C
θ <sub>JA</sub>	Thermal Resistance, Still Air		350	°C/W

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

2. Control Input must be held HIGH or LOW; it must not float.

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## DC ELECTRICAL CHARACTERISTICS

(All typical values are at 25°C unless otherwise specified.)

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	Ambient Temperature (T <sub>A</sub> )					Unit
				25°C			-40 to +85°C		
				Min.	Typ.	Max.	Min.	Max.	
V <sub>IH</sub>	Input Voltage High	4.50 to 5.50					2.4		V
		3.00 to 3.60					2.4		
		2.30 to 2.70					1.8		
		1.65 to 1.95					1.5		
V <sub>IL</sub>	Input Voltage Low	4.50 to 5.50						0.8	V
		3.00 to 3.60						0.8	
		2.30 to 2.70						0.6	
		1.65 to 1.95						0.6	
I <sub>IN</sub>	Control Input Leakage	5.50	V <sub>IN</sub> = 0 V or V <sub>CC</sub>	-2		2	-100	100	nA
		3.60		-2		2	-100	100	
		2.70		-2		2	-20	20	
		1.95		-2		2	-20	20	
I <sub>NO(OFF)</sub> , I <sub>NC(OFF)</sub>	Off Leakage Current of Port B <sub>0</sub> and B <sub>1</sub>	5.50	A = 1 V, 4.5 V, B <sub>0</sub> or B <sub>1</sub> = 4.5 V, 1.0 V	-10		10	-50	50	nA
		3.60	A = 1 V, 3.0 V, B <sub>0</sub> or B <sub>1</sub> = 3.0 V, 1.0 V	-10		10	-50	50	
		2.70	A = 0.5 V, 2.3 V, B <sub>0</sub> or B <sub>1</sub> = 2.3 V, 0.5 V	-10		10	-50	50	
		1.95	A = 0.3 V, 1.65 V, B <sub>0</sub> or B <sub>1</sub> = 1.65 V, 0.3 V	-5		5	-20	20	
I <sub>NO(ON)</sub> , I <sub>NC(ON)</sub>	On Leakage Current of Port B <sub>0</sub> and B <sub>1</sub>	5.50	A = Float, B <sub>0</sub> or B <sub>1</sub> = 4.5 V, 1.0 V	-20		20	-100	100	nA
		3.60	A = Float, B <sub>0</sub> or B <sub>1</sub> = 3.0 V, 1.0 V	-10		10	-20	20	
		2.70	A = Float, B <sub>0</sub> or B <sub>1</sub> = 2.3 V, 0.5 V	-10		10	-20	20	
		1.95	A = Float, B <sub>0</sub> or B <sub>1</sub> = 1.65 V, 0.3 V	-5		5	-20	20	
I <sub>A(ON)</sub>	On Leakage Current of Port A	5.50	A = 1 V, 4.5 V B <sub>0</sub> or B <sub>1</sub> = 1 V, 4.5 V, or Floating	-20		20	-100	100	nA
		3.60	A = 1 V, 3 V B <sub>0</sub> or B <sub>1</sub> = 1 V, 3 V, or Floating	-10		10	-20	20	
		2.70	A = 0.5 V, 2.3 V B <sub>0</sub> or B <sub>1</sub> = 0.5 V, 2.3 V, or Floating	-10		10	-20	20	
		1.95	A = 0.3 V, 1.65 V B <sub>0</sub> or B <sub>1</sub> = 0.3 V, 1.65 V, or Floating	-5		5	-20	20	
I <sub>OFF</sub>	Power Off Leakage Current of Port A & Port B	0	A = 0 to 5.5 V B <sub>0</sub> or B <sub>1</sub> = 0 to 5.5 V		±1.00		-5.00	5.00	μA

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## DC ELECTRICAL CHARACTERISTICS (continued)

(All typical values are at 25°C unless otherwise specified.)

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	Ambient Temperature (T <sub>A</sub> )					Unit
				25°C			-40 to +85°C		
				Min.	Typ.	Max.	Min.	Max.	
R <sub>PEAK</sub>	Peak On Resistance	4.50	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 0 to V <sub>CC</sub>		1.0	1.1		1.3	Ω
		3.00	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 0 to V <sub>CC</sub>		1.2	1.5		1.8	
		2.30	I <sub>OUT</sub> = -8 mA, B <sub>0</sub> or B <sub>1</sub> = 0 to V <sub>CC</sub>		1.5	2.0		2.5	
		1.65	I <sub>OUT</sub> = 2 mA, B <sub>0</sub> or B <sub>1</sub> = 0 to V <sub>CC</sub> T <sub>A</sub> = 25, 85°C		4.0	10.0		15.0	
I <sub>OUT</sub> = 2 mA, B <sub>0</sub> or B <sub>1</sub> = 0 to V <sub>CC</sub> T <sub>A</sub> = -40°C			10.0						
R <sub>ON</sub>	Switch On Resistance (Note 3)	4.50	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 2.5 V		0.8	0.9		1.1	Ω
		3.00	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 2.0 V		1.0	1.3		1.6	
		2.30	I <sub>OUT</sub> = -8 mA, B <sub>0</sub> or B <sub>1</sub> = 1.8 V		1.4	2.0		2.4	
		1.65	I <sub>OUT</sub> = -2 mA, B <sub>0</sub> or B <sub>1</sub> = 1.5 V		1.7	2.5		3.5	
ΔR <sub>ON</sub>	On Resistance Matching Between Channels (Note 4)	4.50	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 2.5 V		0.05	0.10		0.10	Ω
		3.00	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 2.0 V		0.10	0.15		0.15	
		2.30	I <sub>OUT</sub> = -8 mA, B <sub>0</sub> or B <sub>1</sub> = 1.8 V		0.15	0.20		0.20	
		1.65	I <sub>OUT</sub> = -2 mA, B <sub>0</sub> or B <sub>1</sub> = 1.5 V		0.15	0.40		0.40	
R <sub>FLAT(ON)</sub>	On Resistance Flatness (Note 5)	4.50	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 1.0 V, 1.5 V, 2.5 V		0.075	0.250		0.250	Ω
		3.00	I <sub>OUT</sub> = -100 mA, B <sub>0</sub> or B <sub>1</sub> = 0.8 V, 2.0 V		0.1	0.3		0.3	
		2.30	I <sub>OUT</sub> = -8 mA, B <sub>0</sub> or B <sub>1</sub> = 0.8 V, 1.8 V		0.2	1.0		1.0	
		1.65	I <sub>OUT</sub> = -2 mA, B <sub>0</sub> or B <sub>1</sub> = 0.6 V, 1.5 V		3.5				
I <sub>CC</sub>	Quiescent Supply Current	5.50	V <sub>IN</sub> = 0 or V <sub>CC</sub> , I <sub>OUT</sub> = 0		10.0	50.0		500.0	nA
		3.60	V <sub>IN</sub> = 0 or V <sub>CC</sub> , I <sub>OUT</sub> = 0		1.0	25.0		100.0	
		2.70	V <sub>IN</sub> = 0 or V <sub>CC</sub> , I <sub>OUT</sub> = 0		0.5	20.0		50.0	
		1.95	V <sub>IN</sub> = 0 or V <sub>CC</sub> , I <sub>OUT</sub> = 0		0.5	15.0		50.0	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. On resistance is determined by the voltage drop between A and B pins at the indicated current through the switch.

4. ΔR<sub>ON</sub> = R<sub>ON max</sub> - R<sub>ON min</sub> measured at identical V<sub>CC</sub>, temperature and voltage.

5. Flatness is defined as the difference between the maximum and minimum value of on resistance over the specified range of conditions.

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## AC ELECTRICAL CHARACTERISTICS

(All typical values are at  $V_{CC} = 1.8\text{ V}, 2.5\text{ V}, 3.0\text{ V}, 5.0\text{ V}$  at  $25^\circ\text{C}$  unless otherwise specified.)

Symbol	Parameter	$V_{CC}(V)$	Conditions	Ambient Temperature ( $T_A$ )					Unit	Figure
				25°C			-40 to +85°C			
				Min.	Typ.	Max.	Min.	Max.		
t <sub>ON</sub>	Turn-On Time	4.50 to 5.50	$B_0$ or $B_1 = V_{CC}$ , $R_L = 50\ \Omega$ , $C_L = 35\ \text{pF}$	1	16	30	1	35	ns	Figure 11
		3.00 to 3.60		5	21	35	3	50		
		2.30 to 2.70		5	28	40	5	50		
		1.65 to 1.95		10	50	70	10	75		
t <sub>OFF</sub>	Turn-Off Time	4.50 to 5.50	$B_0$ or $B_1 = V_{CC}$ , $R_L = 50\ \Omega$ , $C_L = 35\ \text{pF}$	1	13	20	1	30	ns	Figure 11
		3.00 to 3.60		1	15	20	1	30		
		2.30 to 2.70		2	20	35	2	50		
		1.65 to 1.95		2.0	28	40	2	50		
t <sub>BBM</sub>	Break-Before-Make Time	4.50 to 5.50	$B_0$ or $B_1 = V_{CC}$ , $R_L = 50\ \Omega$ , $C_L = 35\ \text{pF}$		3.0		0.1	20.0	ns	Figure 12
		3.00 to 3.60			6.0		1.0	40.0		
		2.30 to 2.70		2.0	10.0	35.0	2.0	45.0		
		1.65 to 1.95			22.0		2.0	70.0		
Q	Charge Injection	5.50	$C_L = 1.0\ \text{nF}$ , $V_{GEN} = 0\ \text{V}$ , $R_{GEN} = 0\ \Omega$		15				pC	Figure 14
		3.30			11					
		2.50			8					
		1.65			6					
OIRR	Off Isolation	1.80 to 5.00	$f = 1\ \text{MHz}, R_L = 50\ \Omega$		-60				dB	Figure 13
Xtalk	Crosstalk	1.80 to 5.00	$f = 1\ \text{MHz}, R_L = 50\ \Omega$		-60				dB	Figure 13
BW	-3db Bandwidth	5.50	$R_L = 50\ \Omega$		180				MHz	Figure 7 Figure 8 Figure 16
		3.30			180					
		2.50			180					
		1.65			180					
THD	Total Harmonic Distortion	1.80	$R_L = 600\ \Omega$ , $V_{IN} = 0.5\ V_{PP}$ , $f = 20\ \text{Hz to } 20\ \text{kHz}$		0.006				%	Figure 10 Figure 17
		5.00			0.002					

## CAPACITANCE

Symbol	Parameter	$V_{CC}(V)$	Conditions	$T_A = 25^\circ\text{C}$			Unit	Figure
				Min.	Typ.	Max.		
C <sub>IN</sub>	Control Pin Input Capacitance	0	$f = 1\ \text{MHz}$		3.5		pF	Figure 10
C <sub>OFF</sub>	B Port Off Capacitance	1.65 to 5.50	$f = 1\ \text{MHz}$		12.0		pF	Figure 10
C <sub>ON</sub>	A Port On Capacitance	1.65 to 5.50	$f = 1\ \text{MHz}$		40.0		pF	Figure 10

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## TYPICAL PERFORMANCE CHARACTERISTICS

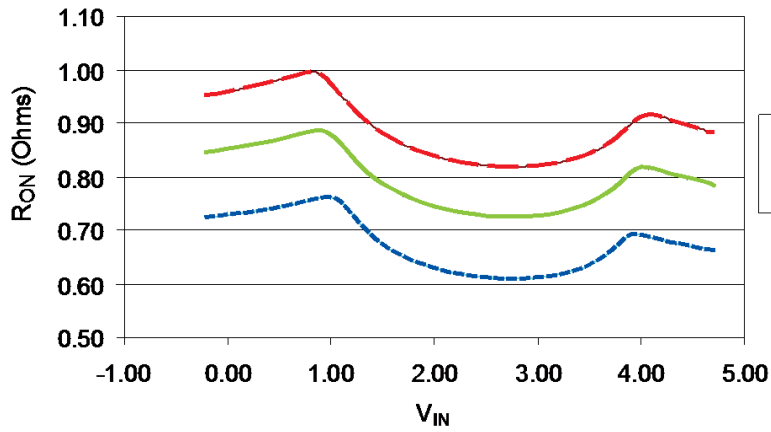


Figure 4. Switch R<sub>ON</sub> (V<sub>CC</sub> = 4.5 V)

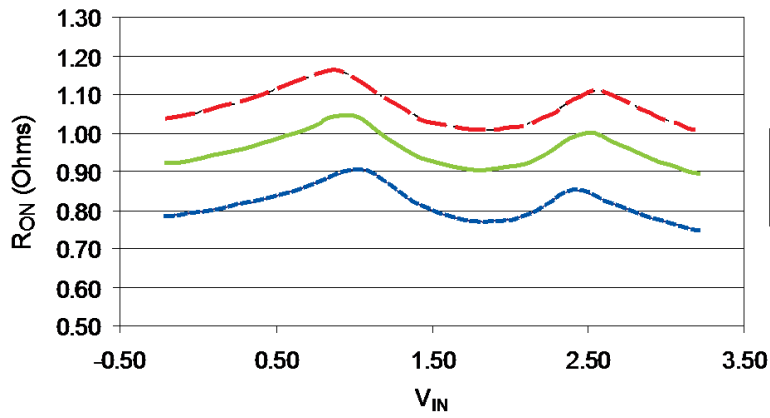


Figure 5. Switch R<sub>ON</sub> (V<sub>CC</sub> = 3.0 V)

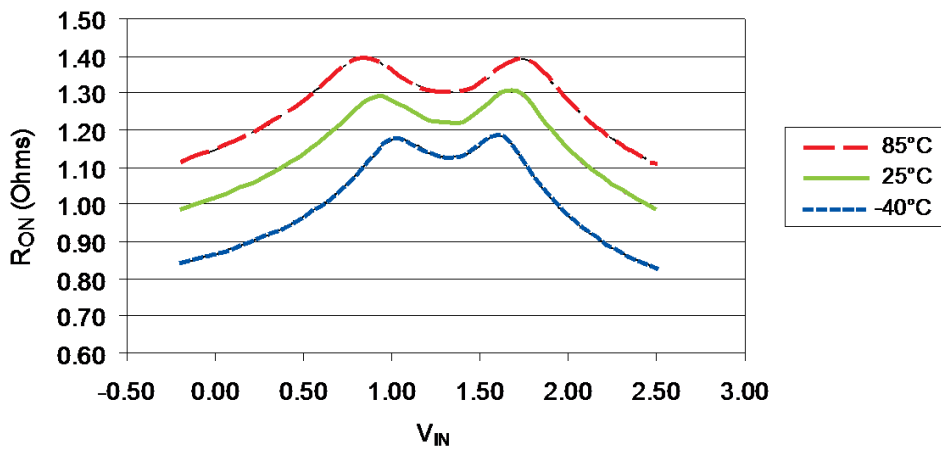


Figure 6. Switch R<sub>ON</sub> (V<sub>CC</sub> = 2.3 V)

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

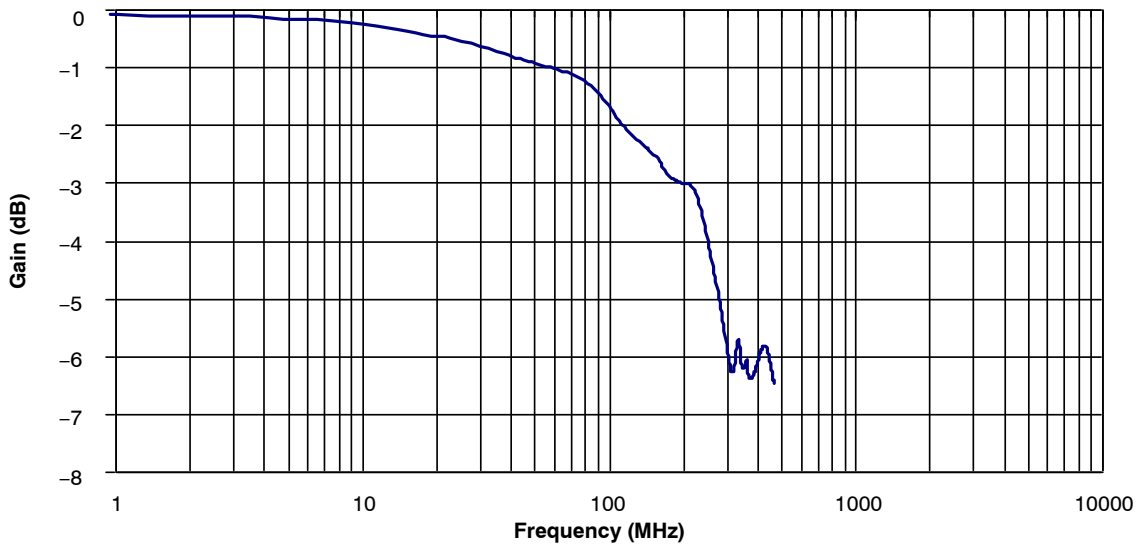


Figure 7. Frequency Response ( $C_L = 0\text{ pF}$ ,  $V_{CC} = 5.5\text{ V}$ )

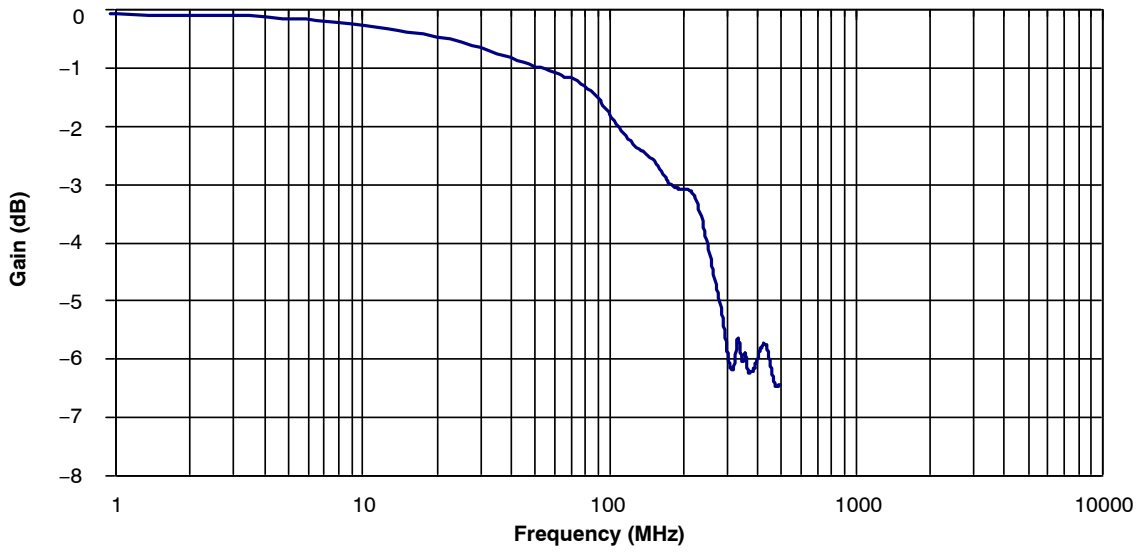


Figure 8. Frequency Response ( $C_L = 0\text{ pF}$ ,  $V_{CC} = 3.3\text{ V}$ )



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## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

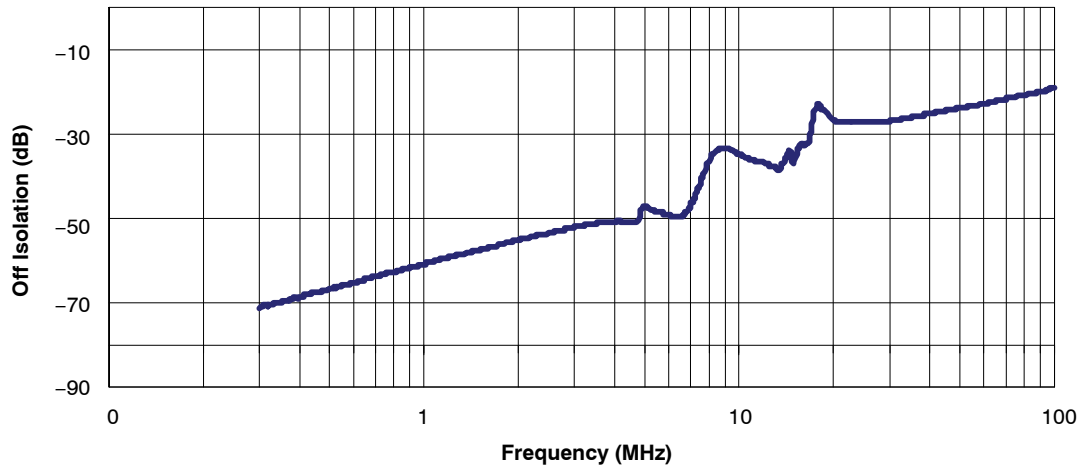


Figure 9. Off Isolation ( $V_{CC} = 5.0$  V)

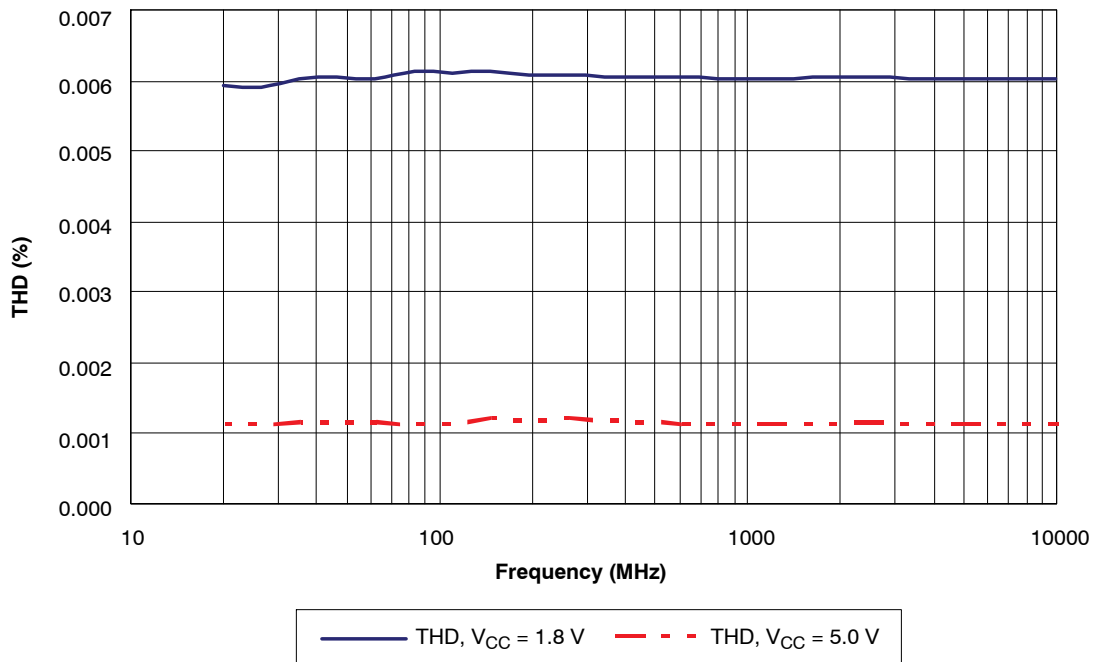


Figure 10. Total Harmonic Distortion, Frequency Response ( $C_L = 0$  pF)

TEST DIAGRAMS

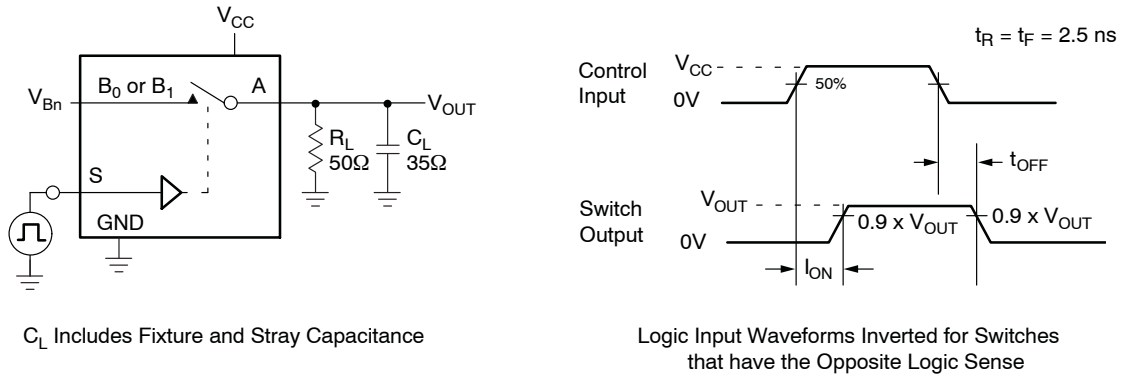


Figure 11. Turn On / Off Timing

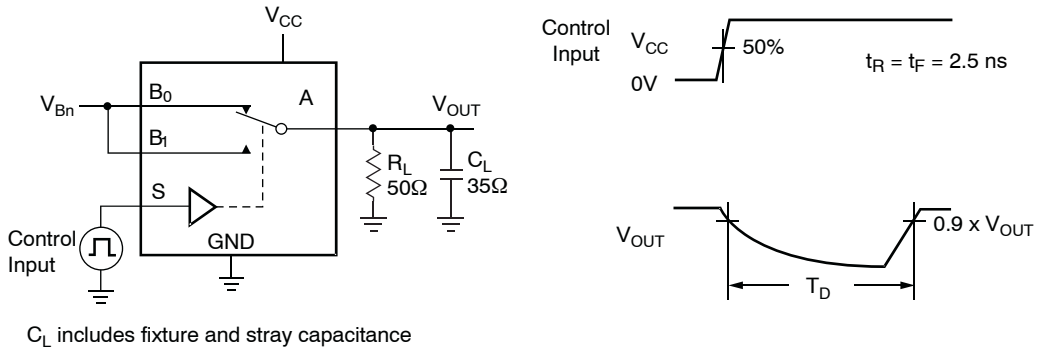


Figure 12. Break-Before-Make Timing

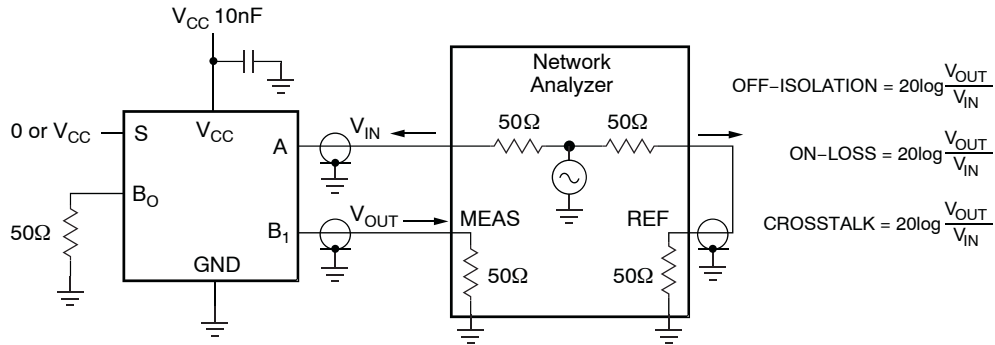


Figure 13. Off Isolation and Crosstalk

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## TEST DIAGRAMS (Continued)

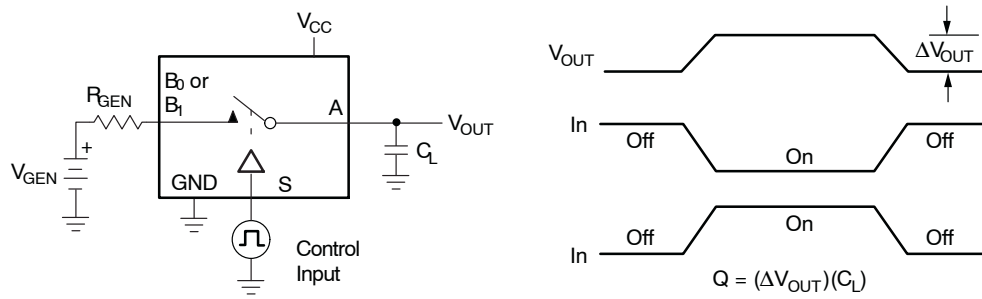


Figure 14. Charge Injection

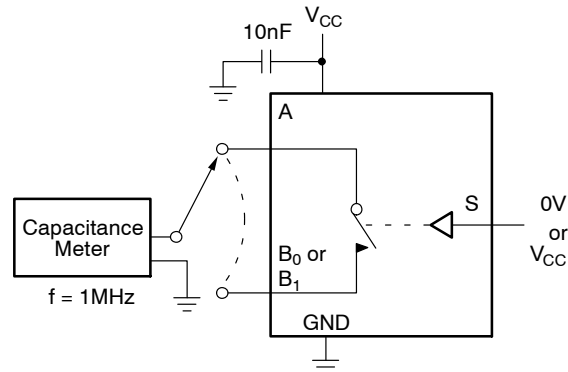


Figure 15. On / Off Capacitance Measurement Setup

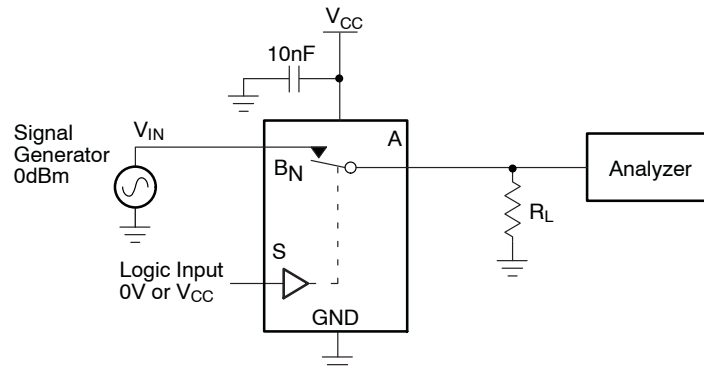


Figure 16. Bandwidth

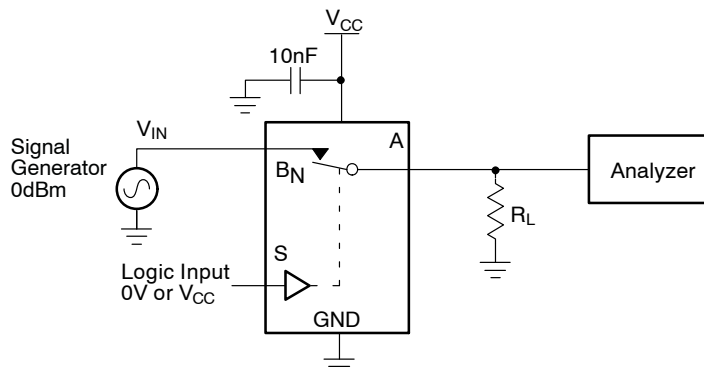
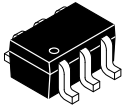


Figure 17. Harmonic Distortion

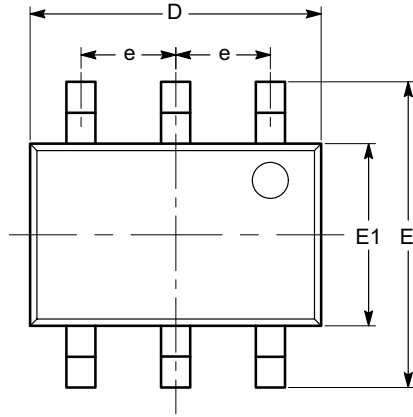
MicroPak is a trademark of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries.



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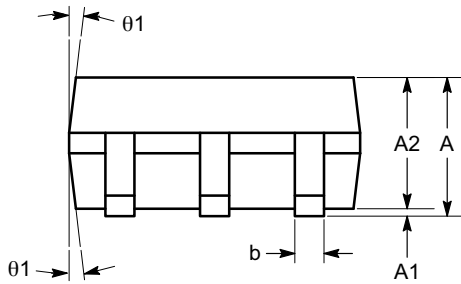
**SC-88 (SC-70 6 Lead), 1.25x2**  
**CASE 419AD**  
**ISSUE A**

DATE 07 JUL 2010

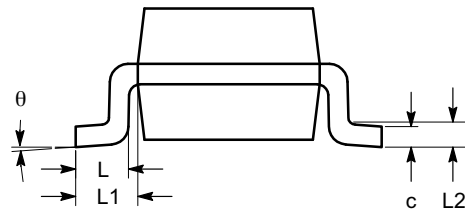


TOP VIEW

SYMBOL	MIN	NOM	MAX
A	0.80		1.10
A1	0.00		0.10
A2	0.80		1.00
b	0.15		0.30
c	0.10		0.18
D	1.80	2.00	2.20
E	1.80	2.10	2.40
E1	1.15	1.25	1.35
e	0.65 BSC		
L	0.26	0.36	0.46
L1	0.42 REF		
L2	0.15 BSC		
$\theta$	0°		8°
$\theta_1$	4°		10°



SIDE VIEW



END VIEW

**Notes:**

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC MO-203.

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