

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

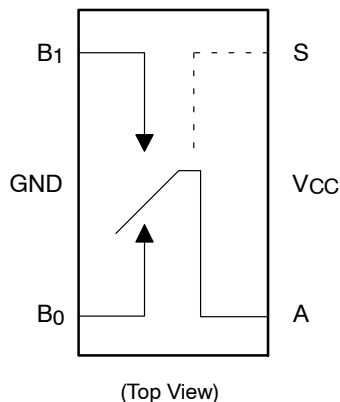
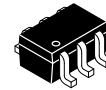


Figure 1. Analog Symbols

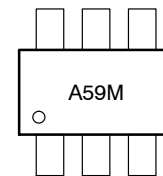


SC-88 (SC-70 6 Lead), 1.25x2
CASE 419AD

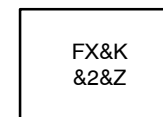


SIP6 1.45X1.0
CASE 127EB

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.

FSA4159

ORDERING INFORMATION

| Part Number | Operating Temperature Range | Top Mark | Package | Shipping [†] |
|-------------|-----------------------------|----------|--|-----------------------|
| 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 |

[†]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

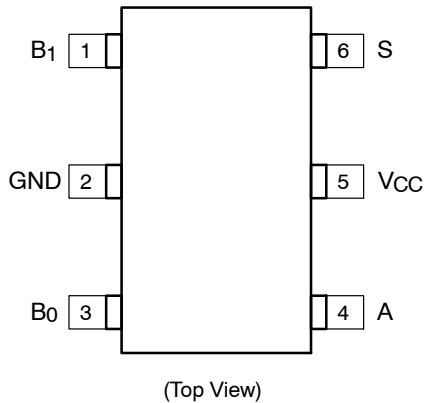


Figure 2. SC70 Pin Assignments

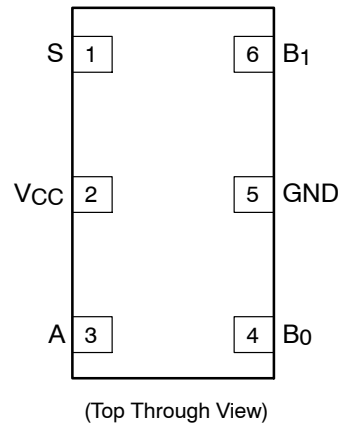


Figure 3. MicroPak™ Pin Assignments

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 _{CC} | 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 _{CC} | Supply Voltage | -0.5 | 6.5 | V |
| V _{SW} | Switch Voltage (Note 1) | -0.5 | V _{CC} + 0.5 | V |
| V _{IN} | Input Voltage (Note 1) | -0.5 | 6.5 | V |
| I _{IK} | Input Diode Current | | -50 | mA |
| I _{SW} | Switch Current (Continuous) | | 200 | mA |
| I _{SWPEAK} | Peak Switch Current (Pulsed at 1 ms Duration, < 10% Duty Cycle) | | 400 | mA |
| P _D | Power Dissipation at 85°C | | 180 | mW |
| T _{STG} | Storage Temperature Range | -65 | +150 | °C |
| T _J | Maximum Junction Temperature | | +150 | °C |
| T _L | 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 _{CC} | Supply Voltage | 1.65 | 5.50 | V |
| S | Control Input Voltage (Note 2) | 0 | V _{CC} | V |
| V _{SW} | Switch Input Voltage | 0 | V _{CC} | V |
| T _A | Operating Temperature | -40 | +85 | °C |
| θ _{JA} | 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 _{CC} (V) | Conditions | Ambient Temperature (T _A) | | | | | Unit |
|--|---|---------------------|---|---------------------------------------|-------|------|--------------|------|------|
| | | | | 25°C | | | -40 to +85°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| V _{IH} | 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 _{IL} | 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 _{IN} | Control Input Leakage | 5.50 | V _{IN} = 0 V or V _{CC} | -2 | | 2 | -100 | 100 | nA |
| | | 3.60 | | -2 | | 2 | -100 | 100 | |
| | | 2.70 | | -2 | | 2 | -20 | 20 | |
| | | 1.95 | | -2 | | 2 | -20 | 20 | |
| I _{NO(OFF)} , I _{NC(OFF)} | Off Leakage Current of Port B ₀ and B ₁ | 5.50 | A = 1 V, 4.5 V, B ₀ or B ₁ = 4.5 V, 1.0 V | -10 | | 10 | -50 | 50 | nA |
| | | 3.60 | A = 1 V, 3.0 V, B ₀ or B ₁ = 3.0 V, 1.0 V | -10 | | 10 | -50 | 50 | |
| | | 2.70 | A = 0.5 V, 2.3 V, B ₀ or B ₁ = 2.3 V, 0.5 V | -10 | | 10 | -50 | 50 | |
| | | 1.95 | A = 0.3 V, 1.65 V, B ₀ or B ₁ = 1.65 V, 0.3 V | -5 | | 5 | -20 | 20 | |
| I _{NO(ON)} , I _{NC(ON)} | On Leakage Current of Port B ₀ and B ₁ | 5.50 | A = Float, B ₀ or B ₁ = 4.5 V, 1.0 V | -20 | | 20 | -100 | 100 | nA |
| | | 3.60 | A = Float, B ₀ or B ₁ = 3.0 V, 1.0 V | -10 | | 10 | -20 | 20 | |
| | | 2.70 | A = Float, B ₀ or B ₁ = 2.3 V, 0.5 V | -10 | | 10 | -20 | 20 | |
| | | 1.95 | A = Float, B ₀ or B ₁ = 1.65 V, 0.3 V | -5 | | 5 | -20 | 20 | |
| I _{A(ON)} | On Leakage Current of Port A | 5.50 | A = 1 V, 4.5 V B ₀ or B ₁ = 1 V, 4.5 V, or Floating | -20 | | 20 | -100 | 100 | nA |
| | | 3.60 | A = 1 V, 3 V B ₀ or B ₁ = 1 V, 3 V, or Floating | -10 | | 10 | -20 | 20 | |
| | | 2.70 | A = 0.5 V, 2.3 V B ₀ or B ₁ = 0.5 V, 2.3 V, or Floating | -10 | | 10 | -20 | 20 | |
| | | 1.95 | A = 0.3 V, 1.65 V B ₀ or B ₁ = 0.3 V, 1.65 V, or Floating | -5 | | 5 | -20 | 20 | |
| I _{OFF} | Power Off Leakage Current of Port A & Port B | 0 | A = 0 to 5.5 V B ₀ or B ₁ = 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 _{CC} (V) | Conditions | Ambient Temperature (T _A) | | | | | Unit |
|---|--|---------------------|--|---------------------------------------|-------|-------|--------------|-------|------|
| | | | | 25°C | | | -40 to +85°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| R _{PEAK} | Peak On Resistance | 4.50 | I _{OUT} = -100 mA, B ₀ or B ₁ = 0 to V _{CC} | | 1.0 | 1.1 | | 1.3 | Ω |
| | | 3.00 | I _{OUT} = -100 mA, B ₀ or B ₁ = 0 to V _{CC} | | 1.2 | 1.5 | | 1.8 | |
| | | 2.30 | I _{OUT} = -8 mA, B ₀ or B ₁ = 0 to V _{CC} | | 1.5 | 2.0 | | 2.5 | |
| | | 1.65 | I _{OUT} = 2 mA, B ₀ or B ₁ = 0 to V _{CC} T _A = 25, 85°C | | 4.0 | 10.0 | | 15.0 | |
| I _{OUT} = 2 mA, B ₀ or B ₁ = 0 to V _{CC} T _A = -40°C | | | 10.0 | | | | | | |
| R _{ON} | Switch On Resistance (Note 3) | 4.50 | I _{OUT} = -100 mA, B ₀ or B ₁ = 2.5 V | | 0.8 | 0.9 | | 1.1 | Ω |
| | | 3.00 | I _{OUT} = -100 mA, B ₀ or B ₁ = 2.0 V | | 1.0 | 1.3 | | 1.6 | |
| | | 2.30 | I _{OUT} = -8 mA, B ₀ or B ₁ = 1.8 V | | 1.4 | 2.0 | | 2.4 | |
| | | 1.65 | I _{OUT} = -2 mA, B ₀ or B ₁ = 1.5 V | | 1.7 | 2.5 | | 3.5 | |
| ΔR _{ON} | On Resistance Matching Between Channels (Note 4) | 4.50 | I _{OUT} = -100 mA, B ₀ or B ₁ = 2.5 V | | 0.05 | 0.10 | | 0.10 | Ω |
| | | 3.00 | I _{OUT} = -100 mA, B ₀ or B ₁ = 2.0 V | | 0.10 | 0.15 | | 0.15 | |
| | | 2.30 | I _{OUT} = -8 mA, B ₀ or B ₁ = 1.8 V | | 0.15 | 0.20 | | 0.20 | |
| | | 1.65 | I _{OUT} = -2 mA, B ₀ or B ₁ = 1.5 V | | 0.15 | 0.40 | | 0.40 | |
| R _{FLAT(ON)} | On Resistance Flatness (Note 5) | 4.50 | I _{OUT} = -100 mA, B ₀ or B ₁ = 1.0 V, 1.5 V, 2.5 V | | 0.075 | 0.250 | | 0.250 | Ω |
| | | 3.00 | I _{OUT} = -100 mA, B ₀ or B ₁ = 0.8 V, 2.0 V | | 0.1 | 0.3 | | 0.3 | |
| | | 2.30 | I _{OUT} = -8 mA, B ₀ or B ₁ = 0.8 V, 1.8 V | | 0.2 | 1.0 | | 1.0 | |
| | | 1.65 | I _{OUT} = -2 mA, B ₀ or B ₁ = 0.6 V, 1.5 V | | 3.5 | | | | |
| I _{CC} | Quiescent Supply Current | 5.50 | V _{IN} = 0 or V _{CC} , I _{OUT} = 0 | | 10.0 | 50.0 | | 500.0 | nA |
| | | 3.60 | V _{IN} = 0 or V _{CC} , I _{OUT} = 0 | | 1.0 | 25.0 | | 100.0 | |
| | | 2.70 | V _{IN} = 0 or V _{CC} , I _{OUT} = 0 | | 0.5 | 20.0 | | 50.0 | |
| | | 1.95 | V _{IN} = 0 or V _{CC} , I _{OUT} = 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_{ON} = R_{ON max} - R_{ON min} measured at identical V_{CC}, 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°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 _{ON} | 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 _{OFF} | 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 _{BBM} | 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 | $R_L = 600\ \Omega$, $V_{IN} = 0.5\text{ V}_{PP}$, $f = 20\text{ Hz to }20\text{ kHz}$ | | 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 _{IN} | Control Pin Input Capacitance | 0 | $f = 1\text{ MHz}$ | | 3.5 | | pF | Figure 10 |
| C _{OFF} | B Port Off Capacitance | 1.65 to 5.50 | $f = 1\text{ MHz}$ | | 12.0 | | pF | Figure 10 |
| C _{ON} | 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

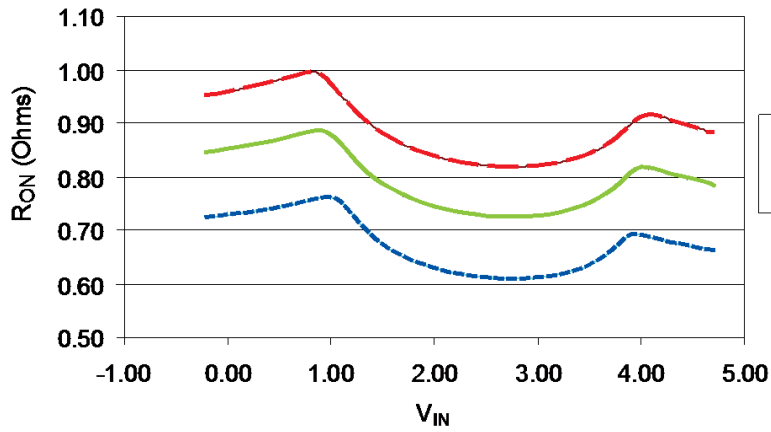


Figure 4. Switch R_{ON} (V_{CC} = 4.5 V)

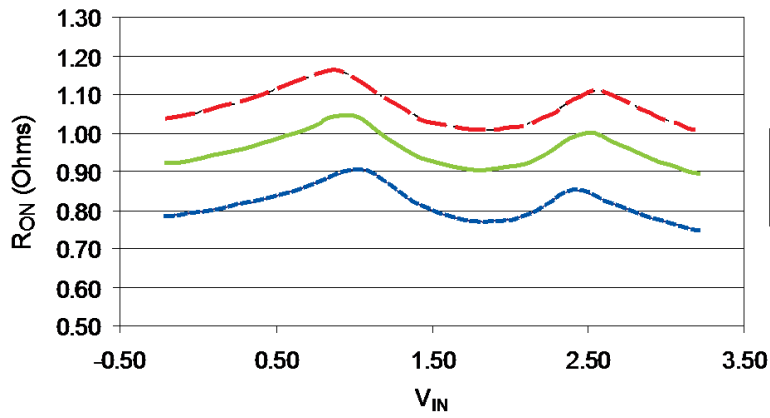


Figure 5. Switch R_{ON} (V_{CC} = 3.0 V)

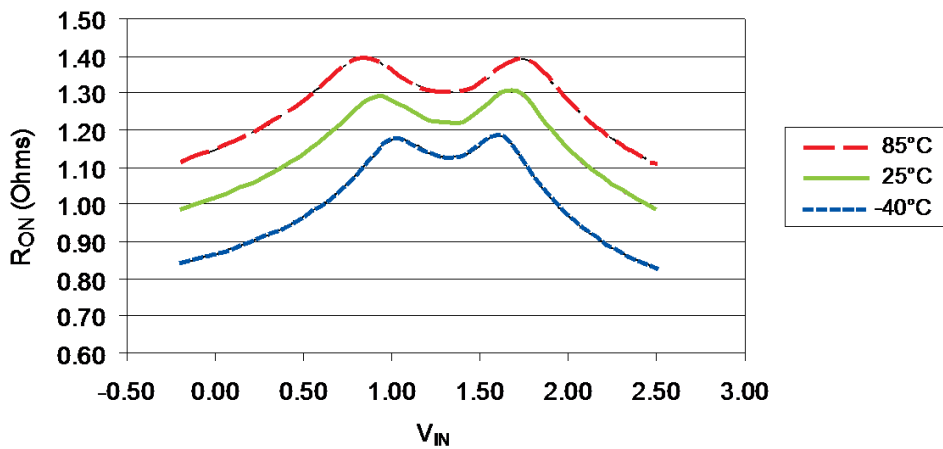


Figure 6. Switch R_{ON} (V_{CC} = 2.3 V)

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

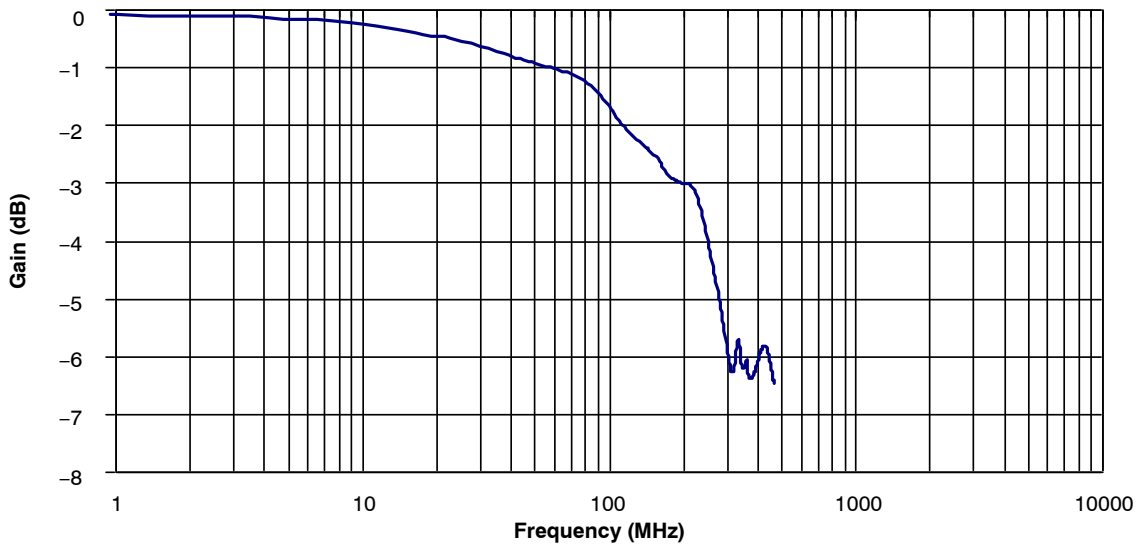


Figure 7. Frequency Response ($C_L = 0\text{ pF}$, $V_{CC} = 5.5\text{ V}$)

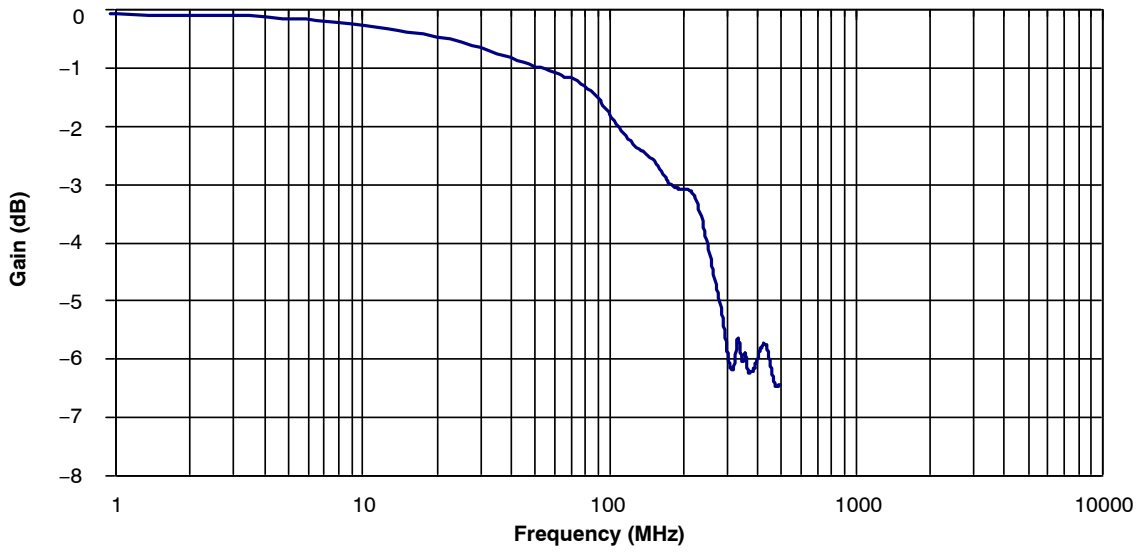


Figure 8. Frequency Response ($C_L = 0\text{ pF}$, $V_{CC} = 3.3\text{ V}$)

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TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

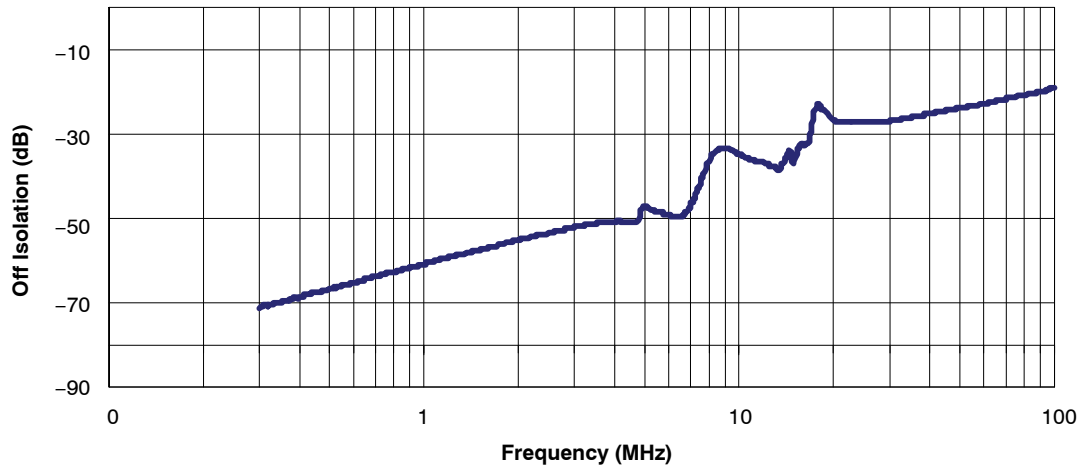


Figure 9. Off Isolation ($V_{CC} = 5.0\text{ V}$)

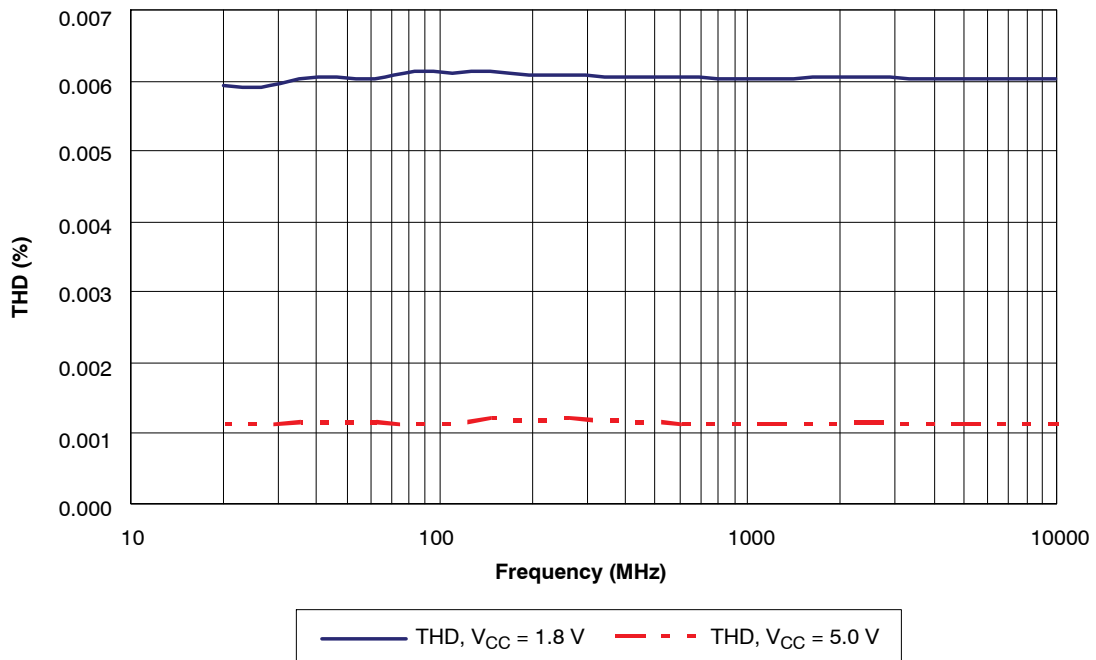


Figure 10. Total Harmonic Distortion, Frequency Response ($C_L = 0\text{ pF}$)

TEST DIAGRAMS

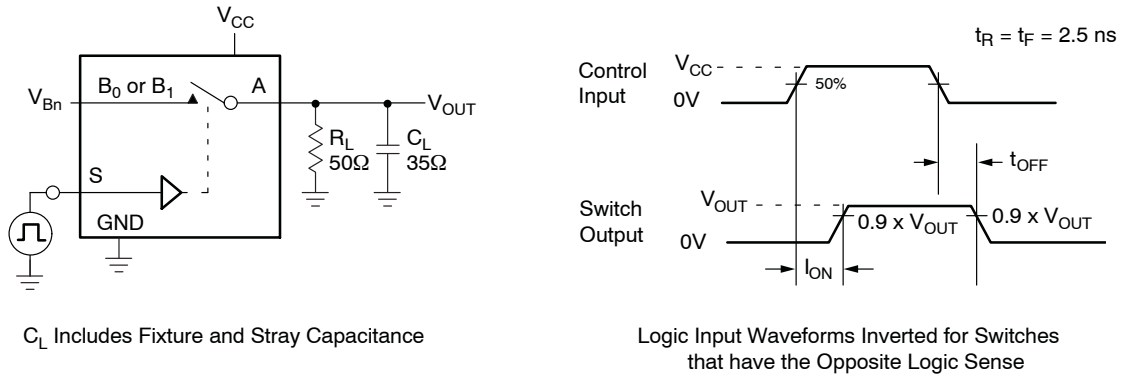


Figure 11. Turn On / Off Timing

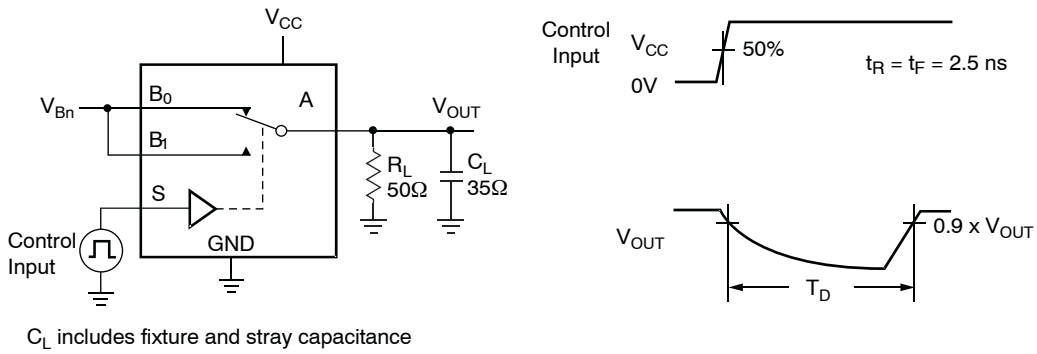


Figure 12. Break-Before-Make Timing

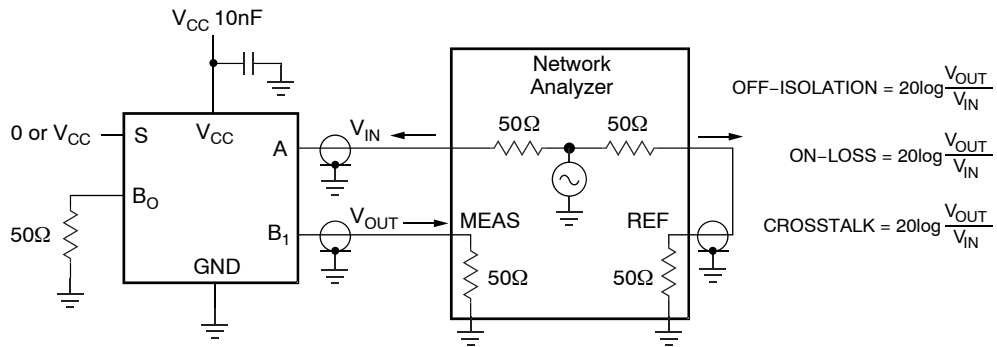


Figure 13. Off Isolation and Crosstalk

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TEST DIAGRAMS (Continued)

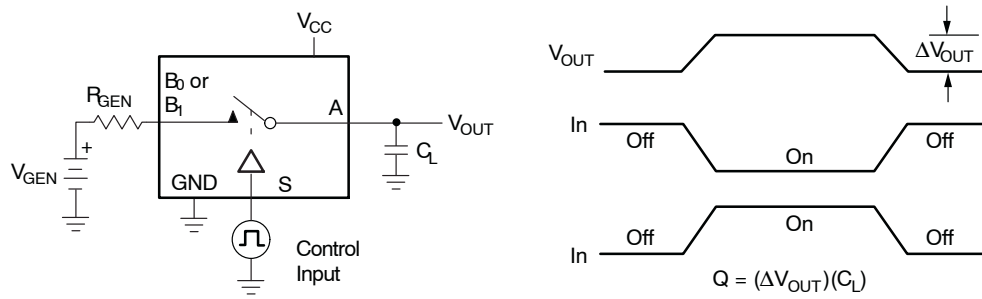


Figure 14. Charge Injection

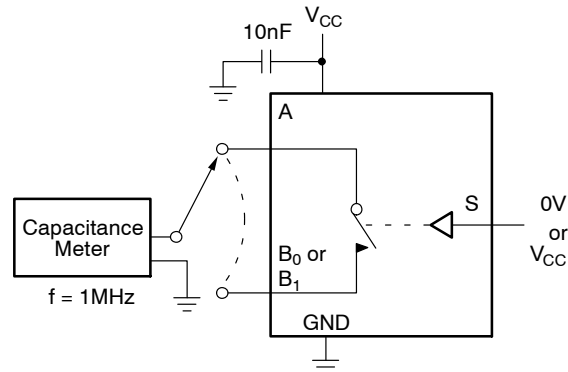


Figure 15. On / Off Capacitance Measurement Setup

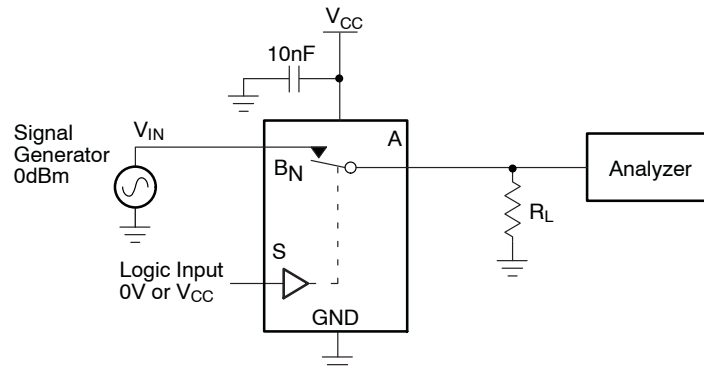


Figure 16. Bandwidth

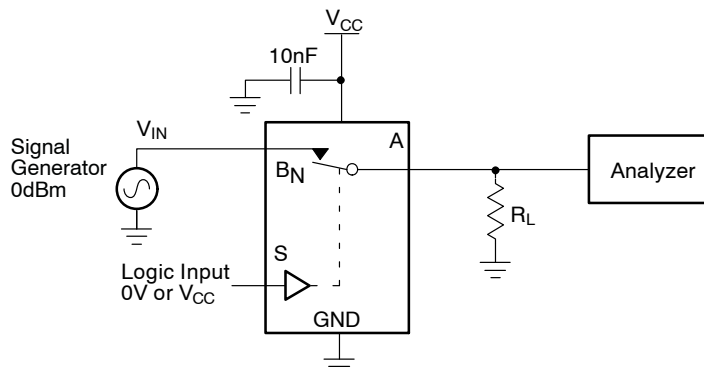
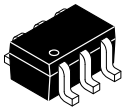


Figure 17. Harmonic Distortion

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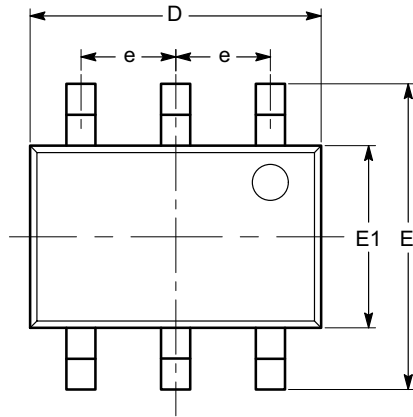
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS



1

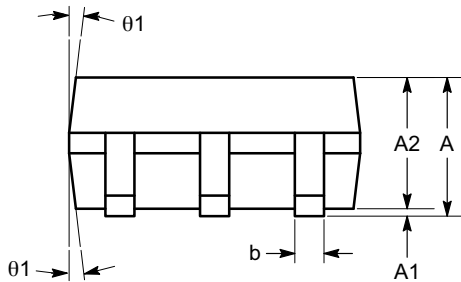
SC-88 (SC-70 6 Lead), 1.25x2
CASE 419AD
ISSUE A

DATE 07 JUL 2010

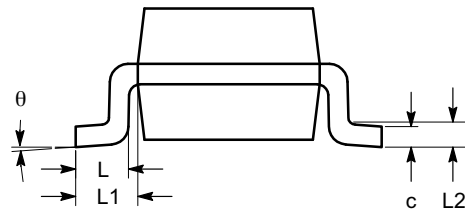


TOP VIEW

| 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 | | |
| θ | 0° | | 8° |
| θ_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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