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# FSA839 — Low-Voltage, 0.8Ω SPDT Analog Switch with Power-Off Isolation

## Features

- Power-Off Isolation ($V_{CC}$=0 V)
- 0.8 Ω Maximum On Resistance ($R_{ON}$) for 4.5 V $V_{CC}$
- 0.25 Ω Maximum $R_{ON}$ Flatness for 4.5 V $V_{CC}$
- Broad $V_{CC}$ Operating Range: 1.65 V to 5.5 V
- Fast Turn-On and Turn-Off Times
- Control Input Switching Thresholds Independent of $V_{CC}$
- Break-Before-Make Enable Circuitry
- 0.4 mm WLCSP Packaging
- ESD Performance
  - HBM per JESD22-A114, I/O to GND: 8 kV
  - CDM per JESD22-C101: 500 V
  - IEC61000-4-2 Contact / Air: 8 kV / 15 kV

## Applications

- Cellular Phone
- Portable Media Player
- PDA

## Description

The FSA839 is a high-performance Single-Pole / Double-Throw (SPDT) analog switch for audio applications driven by low-voltage (1.8 V) baseband processors or ASICs. The device features ultra-low $R_{ON}$ of 0.8 Ω (maximum) at 4.5 V $V_{CC}$ and operates over the wide $V_{CC}$ range of 1.65 V to 5.5 V. The device is fabricated with sub-micron CMOS technology to achieve fast switching speeds and is designed for break-before-make operation.

The FSA839 interfaces between the low-voltage ASIC and regular audio amplifiers and CODECs operating up to a 5.5 V supply range. The control circuitry allows for 1.8 V (typical) signals on the control pin (Sel).

## Ordering Information

| Part Number | Operating Temperature Range | Top Mark | Package | Packing Method |
|---|---|---|---|---|
| FSA839UCX | -40°C to +85°C | N3 | 6-Ball WLCSP, 0.4 mm Pitch | Tape and Reel |

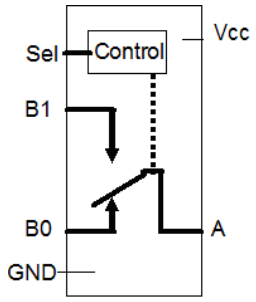
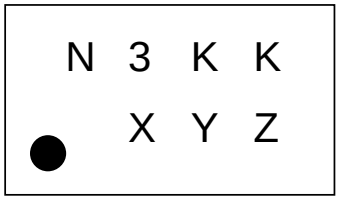



**Figure 1. Analog Symbol**


October-2017, Rev. 2
Publication Order Number:
FSA839/D

## Marking Information




KK = Lot Run Code
X = Year
Y = Work Week
Z = Assembly Site

**Figure 2. Top Mark with Pin 1 Orientation**

## Ball Configuration

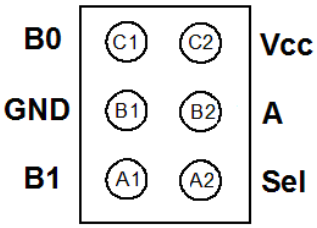



**Figure 3. Pin Assignments (Bottom View)**

## Ball Definitions

| Ball | Name | Description |
|---|---|---|
| A1 | B1 | Data Port (Normally Open) |
| B1 | GND | Ground |
| C1 | B0 | Data Ports (Normally Closed) |
| C2 | $V_{CC}$ | Supply Voltage |
| B2 | A | Common Data Port |
| A2 | Sel | Control Input |

## Truth Table

| Control Input (Sel) | Function |
|---|---|
| LOW | B0 connected to A |
| HIGH | B1 connected to A |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol | Parameter | | Min. | Max. | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | -0.5 | 6.5 | V |
| $V_{SW}$ | Switch Voltage[1] | | -0.5 | $V_{CC}$ + 0.5 | V |
| $V_{IN}$ | Input Voltage[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 | Human Body Model (JEDEC: JESD22-A114) | I/O to GND: A | | 8 | kV |
| | | All Pins | | 2 | |
| | Charged Device Model (JEDEC: JESD22-C101) | | | 500 | V |
| | Machine Model (JEDEC: JESD22-A115) | | | 100 | V |
| | IEC6100-4-2 Discharge System Test Performed on ON Semiconductor's FSA859 Applications Testing Board | Contact | | 8 | kV |
| | | Air | | 15 | |

**Note:**

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

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. ON Semiconductor does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 1.65 | 5.50 | V |
| SEL | Control Input Voltage | 0 | 1.95 | V |
| $V_{SW}$ | Switch Input Voltage | 0 | $V_{CC}$ | V |
| $T_A$ | Operating Temperature | -40 | +85 | °C |
| $\theta_{JA}$ | Thermal Resistance, Still Air | | 350 | °C/W |

## DC Electrical Characteristics

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

| Symbol | Parameter | $V_{CC}$ (V) | Conditions | $T_A$=+25°C | | | $T_A$=-40 to +85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| $V_{IH}$ | Input Voltage High | 1.65 to 5.50 | | | | | 1.0 | | V |
| $V_{IL}$ | Input Voltage Low | 1.65 to 5.50 | | | | | | 0.57 | V |
| $I_{IN}$ | Control Input Leakage | 1.95 to 5.50 | $V_{Sel}$=0 | -2 | | 2 | -20 | 20 | nA |
| $I_{NO(0FF)}$, $I_{NC(OFF)}$, | Off-Leakage Current of Port B0 and B1[5] | 5.50 | A=1 V, 4.5 V<br>B0 or B1=4.5, 1 V | -10 | | 10 | -50 | 50 | nA |
| | | 3.60 | A=1 V, 3.0V<br>B0 or B1=3.0, 1V | -10 | | 10 | -50 | 50 | |
| | | 2.70 | A=0.5 V, 2.3 V<br>B0 or B1=2.3, 0.5V | -10 | | 10 | -50 | 50 | |
| | | 1.95 | A=0.3 V, 1.65 V<br>B0 or B1=1.65 ,0.3 V | -5 | | 5 | -20 | 20 | |
| $I_{NO(On)}$, $I_{NC(On)}$ | On-Leakage Current of Port B0 and B1[5] | 5.50 | A=Floating<br>B0 or B1=4.5, 1V | -20 | | 20 | -100 | 100 | nA |
| | | 3.60 | A=Floating<br>B0 or B1=3.0, 1 V | -10 | | 10 | -20 | 20 | |
| | | 2.70 | A=Floating<br>B0 or B1=2.3, 0.5 V | -10 | | 10 | -20 | 20 | |
| | | 1.95 | A=Floating<br>B0 or B1=1.65, 0.3 V | -5 | | 5 | -20 | 20 | |
| $I_{A(ON)}$ | On Leakage Current of Port A[5] | 5.50 | A=1 V, 4.5 V; B0 or B1=1 V, 4.5 V, or Floating | -20 | | 20 | -100 | 100 | nA |
| | | 3.60 | A=1V, 3.0VB0 or B1=1V, 3.0V, or Floating | -10 | | 10 | -20 | 20 | |
| | | 2.70 | A=0.5 V, 2.3 V, B0 or B1=0.5 V, 2.3 V, or Floating | -10 | | 10 | -20 | 20 | |
| | | 1.95 | A=0.3 V, 1.65 V; B0 or B1=0.3 V, 1.65 V, or Floating | -5 | | 5 | -20 | 20 | |
| $I_{OFF}$ | Power Off Leakage Current of Port A & Port B[5] | 0 | A=0 to 5.5 V<br>B0 or B1=0 to 5.5 V | -1.00 | 0.01 | 1.00 | -5.00 | 5.00 | µA |
| $R_{PD}$ | Sel Internal Pull-Down Resistor | 1.65 to 1.95 | | | 2.0 | | | | MΩ |
| $I_{CC}$ | Quiescent Supply Current | 5.50 | $V_{IN}$, $V_{SEL}$ =0 or $V_{CC}$, $I_{OUT}$=0 | | | 100 | | 500 | nA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 3.60 | $V_{IN}$, $V_{SEL}$ =0 or $V_{CC}$, $I_{OUT}$=0 | | | 75 | | 300 | |
| | | 2.70 | $V_{IN}$, $V_{SEL}$ =0 or $V_{CC}$, $I_{OUT}$=0 | | | 50 | | 250 | |
| | | 1.95 | $V_{IN}$, $V_{SEL}$ =0 or $V_{CC}$, $I_{OUT}$=0 | | | 25 | | 150 | |

*Continued on the following page…*

## DC Electrical Characteristics (Continued)

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

| Symbol | Parameter | $V_{CC}$ (V) | Conditions | $T_A$=+25°C | | | $T_A$=-40 to +85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| $I_{CCT}$ | Increase in $I_{CC}$ per Control Input | 5.50 | $V_{Sel}$ = 1.8 V | | 26 | 40 | | 50 | µA |
| | | 3.60 | $V_{Sel}$ = 1.8 V | | 5 | 15 | | 20 | |
| | | 2.70 | $V_{Sel}$ = 1.8 V | | 1 | 5 | | 10 | |
| | | 1.95 | $V_{Sel}$ = 1.8 V | | 0.01 | 1.00 | | 3.00 | |
| $I_{CCZ}$ | Supply Current Sleep | 5.50 | $V_{IN}$, $V_{Sel}$ = Floating | | | 0.5 | | 1.0 | µA |
| $R_{ON}$ | Switch On Resistance(2,5) | 4.50 | $I_{OUT}$=-100 mA, B0 or B1=2.5 V | | 0.50 | 0.75 | | 0.80 | Ω |
| | | 3.00 | $I_{OUT}$=-100 mA, B0 or B1=2.0 V | | 0.75 | 0.90 | | 1.20 | |
| | | 2.25 | $I_{OUT}$=-100 mA, B0 or B1=1.8 V | | 1.0 | 1.3 | | 1.6 | |
| | | 1.65 | $I_{OUT}$=-100 mA, B0 or B1=1.2 V | | 2.5 | 5.0 | | 7.0 | |
| $\Delta R_{ON}$ | On Resistance Matching Between Channels(3,5) | 4.50 | $I_{OUT}$=-100 mA, B0 or B1=2.5 V | | 0.05 | 0.10 | | 0.10 | Ω |
| | | 3.00 | $I_{OUT}$=-100 mA, B0 or B1=2.0 V | | 0.10 | 0.15 | | 0.15 | |
| | | 2.25 | $I_{OUT}$=-100 mA, B0 or B1=1.8 V | | 0.15 | 0.20 | | 0.20 | |
| | | 1.65 | $I_{OUT}$=-100 mA, B0 or B1=1.2 V | | 0.15 | 0.40 | | 0.40 | |
| $R_{FLAT(ON)}$ | On Resistance Flatness(4,5) | 4.50 | $I_{OUT}$=-100 mA, B0 or B1=1.0V, 1.5 V, 2.5 V | | 0.075 | 0.250 | | 0.250 | Ω |
| | | 3.00 | $I_{OUT}$=-100 mA, B0 or B1=0.8 V, 2.0 V | | 0.1 | 0.3 | | 0.3 | |
| | | 2.25 | $I_{OUT}$=-100 mA, B0 or B1=0.8 V, 1.8 V | | 0.25 | 0.50 | | 0.60 | |
| | | 1.65 | $I_{OUT}$=-100mA, B0 or B1=0.6 V, 1.2 V | | 3.5 | | | | |

**Notes**:

2. On resistance is determined by the voltage drop between A and B pins at the indicated current through the switch.
3. $\Delta R_{ON}=R_{ON}$ maximum – $R_{ON}$ minimum; measured at identical $V_{CC}$, temperature, and voltage.
4. Flatness is defined as the difference between the maximum and minimum value of on resistance over the specified range of conditions.
5. Guaranteed by characterization, not production tested for $V_{CC}$=1.65 – 1.95 V.

## AC Electrical Characteristics

All typical value are at $V_{CC}$=1.8 V, 2.5 V, 3.0 V, and 5.0 V at 25°C unless otherwise specified.

| Symbol | Parameter | $V_{CC}$ (V) | Conditions | $T_A$=+25°C | | | $T_A$=-40 to +85°C | | Unit | Figure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | | |
| $t_{ON}$ | Turn-On Time[6] | 4.50 to 5.50 | B0 or B1=$V_{CC}$, $R_L$=50 Ω, $C_L$=35 pF | 1.0 | 12.0 | 25.0 | 1.0 | 30.0 | ns | Figure 4 |
| | | 3.00 to 3.60 | | 5.0 | 15.0 | 30.0 | 3.0 | 35.0 | | |
| | | 2.30 to 2.70 | | 5.0 | 20.0 | 35.0 | 5.0 | 40.0 | | |
| | | 1.65 to 1.95 | | 10.0 | 50.0 | 70.0 | 10.0 | 75.0 | | |
| $t_{OFF}$ | Turn-Off Time[6] | 4.50 to 5.50 | B0 or B1=$V_{CC}$, $R_L$=50 Ω, $C_L$=35 pF | 1.0 | 9.5 | 20.0 | 1.0 | 25.0 | ns | Figure 4 |
| | | 3.00 to 3.60 | | 1.0 | 9.0 | 20.0 | 1.0 | 25.0 | | |
| | | 2.30 to 2.70 | | 2.0 | 10.0 | 20.0 | 2.0 | 25.0 | | |
| | | 1.65 to 1.95 | | 2.0 | 28.0 | 40.0 | 2.0 | 50.0 | | |
| $t_{BBM}$ | Break-Before-Make Time[7] | 4.50 to 5.50 | B0 or B1=$V_{CC}$/2, $R_L$=50 Ω, $C_L$=35 pF | 1.0 | 10.0 | 12.0 | 0.1 | 14.0 | ns | Figure 5 |
| | | 3.00 to 3.60 | | 1.0 | 14.0 | 16.0 | 1.0 | 17.0 | | |
| | | 2.30 to 2.70 | | 1.0 | 21.0 | 25.0 | 1.0 | 27.0 | | |
| | | 1.65 to 1.95 | | | 35.0 | | 2.0 | 50.0 | | |
| Q | Charge Injection | 5.50 | $C_L$=1.0 nF, $V_{GEN}$=0 V, $R_{GEN}$=0 Ω | | 70 | | | | pC | Figure 7 |
| | | 3.30 | | | 40 | | | | | |
| | | 2.50 | | | 30 | | | | | |
| | | 1.65 | | | 10 | | | | | |
| OIRR | Off Isolation | 1.8 to 5.0 | f=1 MHz, $R_L$=50 Ω | | -55 | | | | dB | Figure 6 |
| Xtalk | Crosstalk | 1.8 to 5.0 | f=1 MHz, $R_L$=50 Ω | | 55 | | | | dB | Figure 6 |
| BW | -3 db Bandwidth | 5.50 | $R_L$=50 Ω | | 60 | | | | MHz | Figure 9 |
| | | 3.30 | | | 60 | | | | | |
| | | 2.50 | | | 55 | | | | | |
| | | 1.65 | | | 50 | | | | | |
| THD | Total Harmonic Distortion | 1.80 | $R_L$=600 Ω, $V_{IN}$=0.5 $V_{PP}$, f=20 Hz to 20 kHz | | .02 | | | | % | Figure 10 |
| | | 5.00 | | | .001 | | | | | |
| PSRR | Power Supply Rejection Ratio | 3.3 | f=217 Hz on $V_{CC}$ at 500 mvpp | | -23 | | | | dB | Figure 11 |

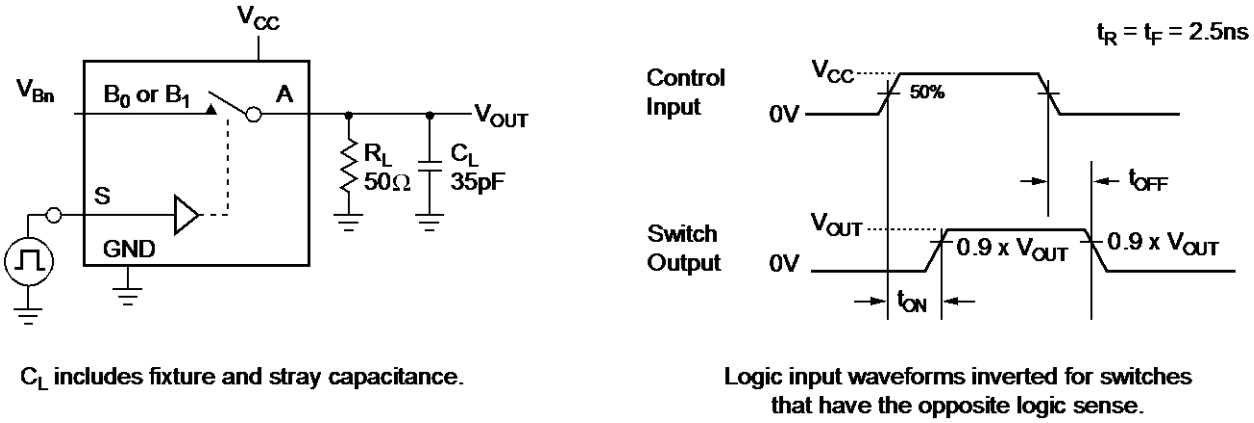
**Notes:**

6. Guaranteed by characterization, not production tested for $V_{CC}$=1.65 – 1.95 V.
7. Guaranteed by characterization, not production tested.

## Capacitance

| Symbol | Parameter | $V_{CC}$ (V) | Conditions | $T_A$=+25°C | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $C_{IN}$ | Control Pin Input Capacitance | 0 | f=1 MHz | | 3.2 | | pF |
| $C_{OFF}$ | B Port Off Capacitance | 1.65 to 5.50 | f=1 MHz | | 50 | | pF |
| $C_{ON}$ | A Port On Capacitance | 1.65 to 5.50 | f=1 MHz | | 150 | | pF |

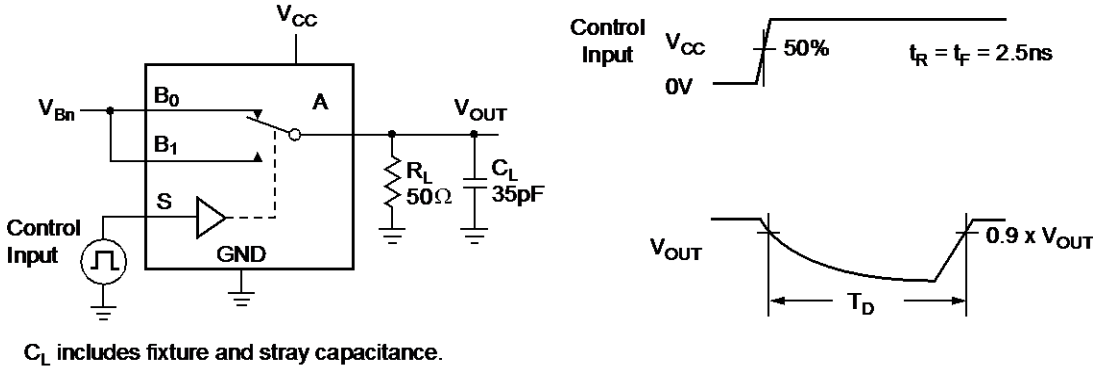
## Test Diagrams




$C_L$ includes fixture and stray capacitance.

Logic input waveforms inverted for switches that have the opposite logic sense.

**Figure 4. Turn On / Off Timing**




$C_L$ includes fixture and stray capacitance.

**Figure 5. Break-Before-Make Timing**

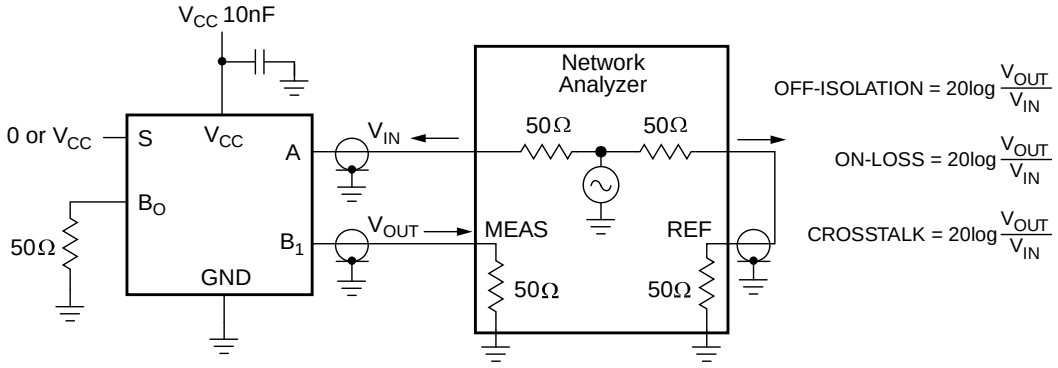



**Figure 6. Off Isolation and Crosstalk**

## Test Diagrams (Continued)

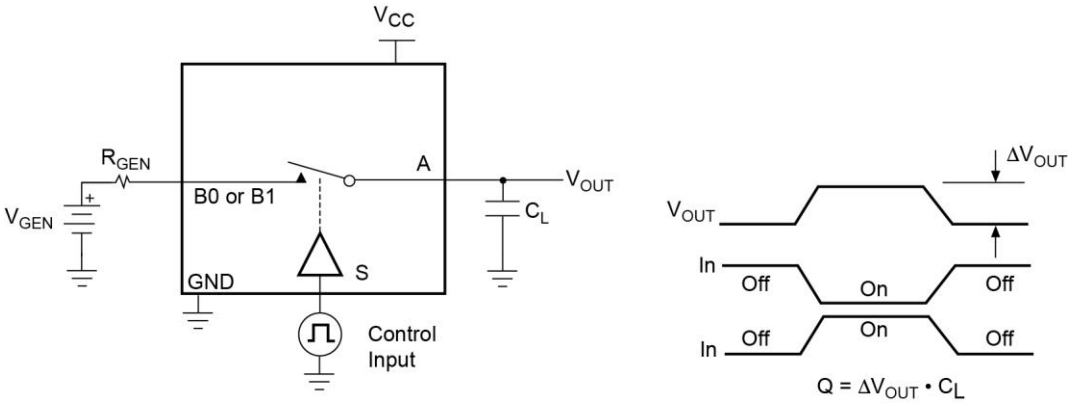



**Figure 7. Charge Injection**

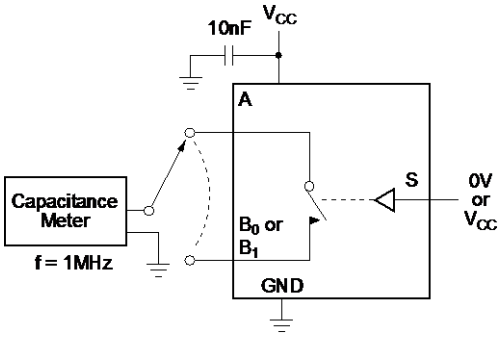



**Figure 8. On / Off Capacitance Measurement Setup**

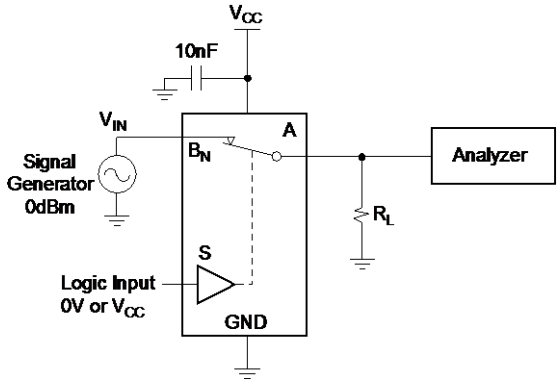



**Figure 9. Bandwidth**

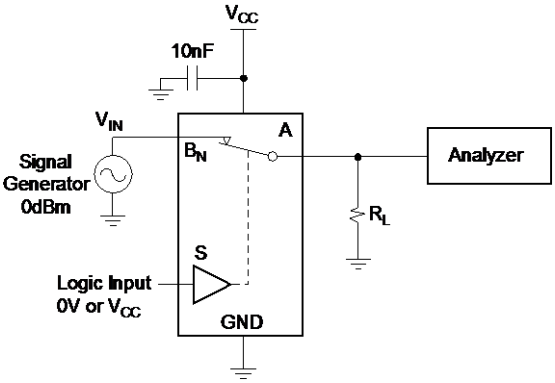



**Figure 10. Harmonic Distortion**

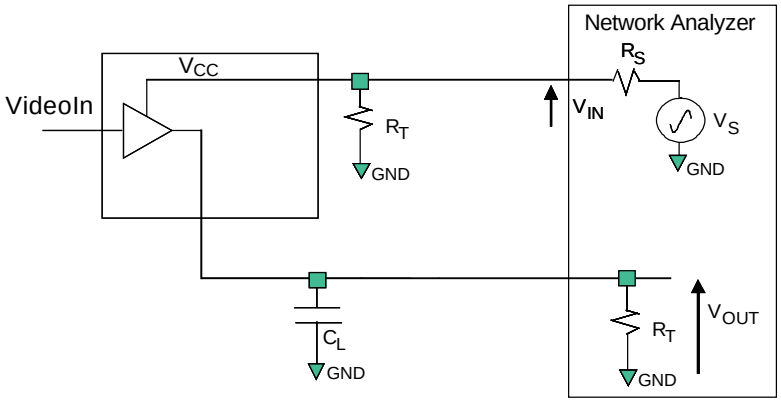
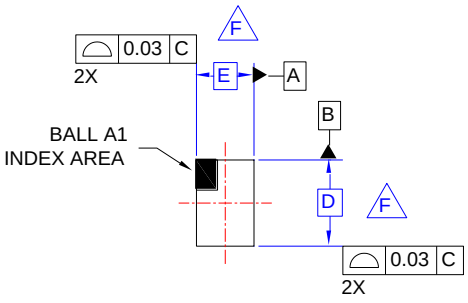



**Figure 11. PSRR**

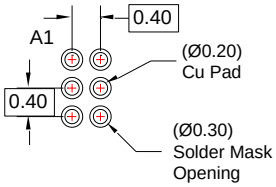
## Product Specific Dimensions

| Product | D | E | X | Y |
|---|---|---|---|---|
| FSA839UCX | 1.160 ±.030 | 0.760 ±.030 | 0.180 | 0.180 |

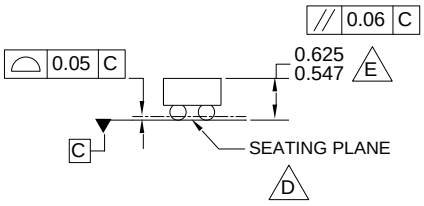
## Physical Dimensions

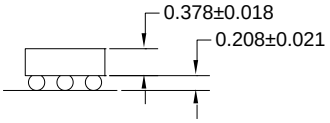



TOP VIEW

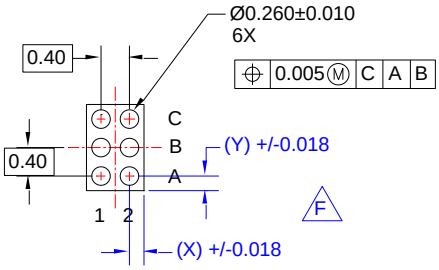



RECOMMENDED LAND PATTERN
(NSMD PAD TYPE)




SIDE VIEWS




BOTTOM VIEW

NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES PER ASMEY14.5M, 1994.

D. DATUM C, THE SEATING PLANE IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.

E. PACKAGE TYPICAL HEIGHT IS 586 MICRONS ±39 MICRONS (547-625 MICRONS).

F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.

G. DRAWING FILENAME: UC006ACrev4.

**Figure 12. 6-Ball, WLCSP 0.4 mm Pitch**

## PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT:**

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