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ON Semiconductor®

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

## Features

- Power-Off Isolation ( $V_{CC}=0\text{ V}$ )
- 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

## 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).

## Applications

- Cellular Phone
- Portable Media Player
- PDA

## 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

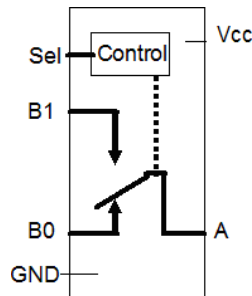
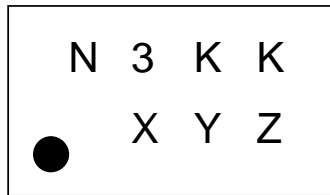


Figure 1. Analog Symbol

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

## Marking Information



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

Figure 2. Top Mark with Pin 1 Orientation

## Ball Configuration

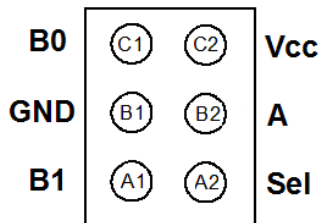


Figure 3. Pin Assignments (Bottom View)

## Ball Definitions

Ball	Name	Description
A1	B1	Data Port (Normally Open)
B1	GND	Ground
C1	B0	Data Ports (Normally Closed)
C2	V <sub>CC</sub>	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 <sup>(1)</sup>		-0.5	$V_{CC} + 0.5$	V
$V_{IN}$	Input Voltage <sup>(1)</sup>		-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:

- 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 <sub>CC</sub> (V)	Conditions	T <sub>A</sub> =+25°C			T <sub>A</sub> =-40 to +85°C		Unit
				Min.	Typ.	Max.	Min.	Max.	
V <sub>IH</sub>	Input Voltage High	1.65 to 5.50					1.0		V
V <sub>IL</sub>	Input Voltage Low	1.65 to 5.50						0.57	V
I <sub>IN</sub>	Control Input Leakage	1.95 to 5.50	V <sub>SEL</sub> =0	-2		2	-20	20	nA
I <sub>NO(OFF)</sub> , I <sub>NC(OFF)</sub>	Off-Leakage Current of Port B0 and B1 <sup>(5)</sup>	5.50	A=1 V, 4.5 V B0 or B1=4.5, 1 V	-10		10	-50	50	nA
		3.60	A=1 V, 3.0V B0 or B1=3.0, 1V	-10		10	-50	50	
		2.70	A=0.5 V, 2.3 V B0 or B1=2.3, 0.5V	-10		10	-50	50	
		1.95	A=0.3 V, 1.65 V B0 or B1=1.65, 0.3 V	-5		5	-20	20	
I <sub>NO(ON)</sub> , I <sub>NC(ON)</sub>	On-Leakage Current of Port B0 and B1 <sup>(5)</sup>	5.50	A=Floating B0 or B1=4.5, 1V	-20		20	-100	100	nA
		3.60	A=Floating B0 or B1=3.0, 1 V	-10		10	-20	20	
		2.70	A=Floating B0 or B1=2.3, 0.5 V	-10		10	-20	20	
		1.95	A=Floating B0 or B1=1.65, 0.3 V	-5		5	-20	20	
I <sub>A(ON)</sub>	On Leakage Current of Port A <sup>(5)</sup>	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 <sub>OFF</sub>	Power Off Leakage Current of Port A & Port B <sup>(5)</sup>	0	A=0 to 5.5 V B0 or B1=0 to 5.5 V	-1.00	0.01	1.00	-5.00	5.00	μA
R <sub>PD</sub>	Internal Pull-Down Resistor	1.65 to 1.95			2.0				MΩ
I <sub>CC</sub>	Quiescent Supply Current	5.50	V <sub>IN</sub> , V <sub>SEL</sub> =0 or V <sub>CC</sub> , I <sub>OUT</sub> =0			100		500	nA

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

*Continued on the following page...*

## DC Electrical Characteristics (Continued)

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

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> =+25°C			T <sub>A</sub> =-40 to +85°C		Unit
				Min.	Typ.	Max.	Min.	Max.	
I <sub>CC</sub> T	Increase in I <sub>CC</sub> per Control Input	5.50	V <sub>SEL</sub> = 1.8 V		26	40		50	μA
		3.60	V <sub>SEL</sub> = 1.8 V		5	15		20	
		2.70	V <sub>SEL</sub> = 1.8 V		1	5		10	
		1.95	V <sub>SEL</sub> = 1.8 V		0.01	1.00		3.00	
I <sub>CC</sub> Z	Supply Current Sleep	5.50	V <sub>IN</sub> , V <sub>SEL</sub> = Floating			0.5		1.0	μA
R <sub>ON</sub>	Switch On Resistance <sup>(2,5)</sup>	4.50	I <sub>OUT</sub> =-100 mA, B0 or B1=2.5 V		0.50	0.75		0.80	Ω
		3.00	I <sub>OUT</sub> =-100 mA, B0 or B1=2.0 V		0.75	0.90		1.20	
		2.25	I <sub>OUT</sub> =-100 mA, B0 or B1=1.8 V		1.0	1.3		1.6	
		1.65	I <sub>OUT</sub> =-100 mA, B0 or B1=1.2 V		2.5	5.0		7.0	
ΔR <sub>ON</sub>	On Resistance Matching Between Channels <sup>(3,5)</sup>	4.50	I <sub>OUT</sub> =-100 mA, B0 or B1=2.5 V		0.05	0.10		0.10	Ω
		3.00	I <sub>OUT</sub> =-100 mA, B0 or B1=2.0 V		0.10	0.15		0.15	
		2.25	I <sub>OUT</sub> =-100 mA, B0 or B1=1.8 V		0.15	0.20		0.20	
		1.65	I <sub>OUT</sub> =-100 mA, B0 or B1=1.2 V		0.15	0.40		0.40	
R <sub>FLAT(ON)</sub>	On Resistance Flatness <sup>(4,5)</sup>	4.50	I <sub>OUT</sub> =-100 mA, B0 or B1=1.0V, 1.5 V, 2.5 V		0.075	0.250		0.250	Ω
		3.00	I <sub>OUT</sub> =-100 mA, B0 or B1=0.8 V, 2.0 V		0.1	0.3		0.3	
		2.25	I <sub>OUT</sub> =-100 mA, B0 or B1=0.8 V, 1.8 V		0.25	0.50		0.60	
		1.65	I <sub>OUT</sub> =-100mA, B0 or B1=0.6 V, 1.2 V		3.5				

### Notes:

- On resistance is determined by the voltage drop between A and B pins at the indicated current through the switch.
- ΔR<sub>ON</sub>=R<sub>ON</sub> maximum – R<sub>ON</sub> minimum; measured at identical V<sub>CC</sub>, temperature, and voltage.
- Flatness is defined as the difference between the maximum and minimum value of on resistance over the specified range of conditions.
- Guaranteed by characterization, not production tested for V<sub>CC</sub>=1.65 – 1.95 V.

## AC Electrical Characteristics

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

Symbol	Parameter	$V_{CC}$ (V)	Conditions	$T_A=+25^\circ\text{C}$			$T_A=-40$ to $+85^\circ\text{C}$		Unit	Figure
				Min.	Typ.	Max.	Min.	Max.		
$t_{ON}$	Turn-On Time <sup>(6)</sup>	4.50 to 5.50	$B0$ or $B1=V_{CC}$ , $R_L=50\ \Omega$ , $C_L=35\text{ pF}$	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 <sup>(6)</sup>	4.50 to 5.50	$B0$ or $B1=V_{CC}$ , $R_L=50\ \Omega$ , $C_L=35\text{ pF}$	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 <sup>(7)</sup>	4.50 to 5.50	$B0$ or $B1=V_{CC}/2$ , $R_L=50\ \Omega$ , $C_L=35\text{ pF}$	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	$C_L=1.0\text{ nF}$ , $V_{GEN}=0\text{ V}$ , $R_{GEN}=0\ \Omega$		70				pC	Figure 7
		3.30			40					
		2.50			30					
		1.65			10					
OIRR	Off Isolation	1.8 to 5.0	$f=1\text{ MHz}$ , $R_L=50\ \Omega$		-55				dB	Figure 6
Xtalk	Crosstalk	1.8 to 5.0	$f=1\text{ MHz}$ , $R_L=50\ \Omega$		55				dB	Figure 6
BW	-3 db Bandwidth	5.50	$R_L=50\ \Omega$		60				MHz	Figure 9
		3.30			60					
		2.50			55					
		1.65			50					
THD	Total Harmonic Distortion	1.80	$R_L=600\ \Omega$ , $V_{IN}=0.5\text{ V}_{PP}$ , $f=20\text{ Hz}$ to $20\text{ kHz}$		.02				%	Figure 10
		5.00			.001					
PSRR	Power Supply Rejection Ratio	3.3	$f=217\text{ Hz}$ on $V_{CC}$ at $500\text{ mV}_{pp}$		-23				dB	Figure 11

### Notes:

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



### Capacitance

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> =+25°C			Unit
				Min.	Typ.	Max.	
C <sub>IN</sub>	Control Pin Input Capacitance	0	f=1 MHz		3.2		pF
C <sub>OFF</sub>	B Port Off Capacitance	1.65 to 5.50	f=1 MHz		50		pF
C <sub>ON</sub>	A Port On Capacitance	1.65 to 5.50	f=1 MHz		150		pF

### Test Diagrams

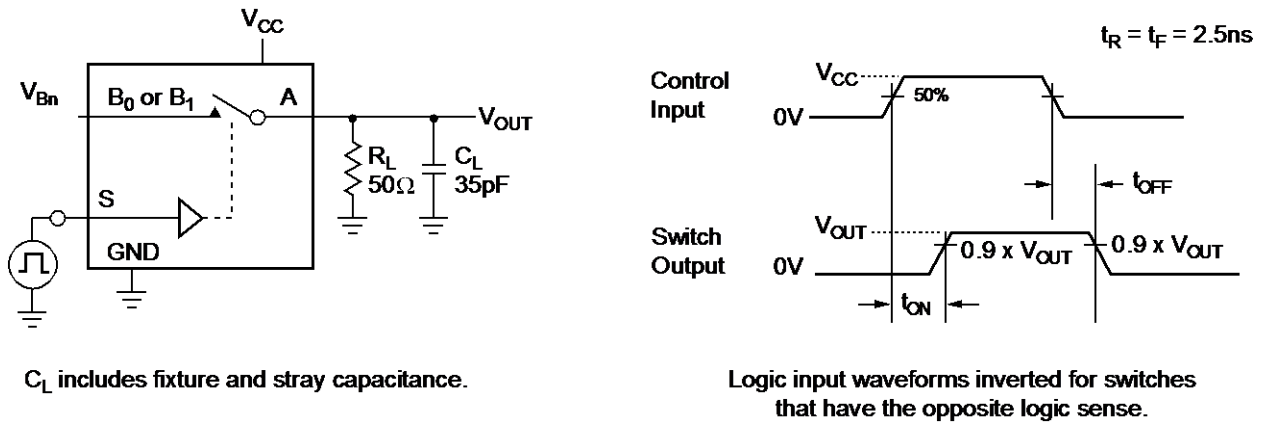


Figure 4. Turn On / Off Timing

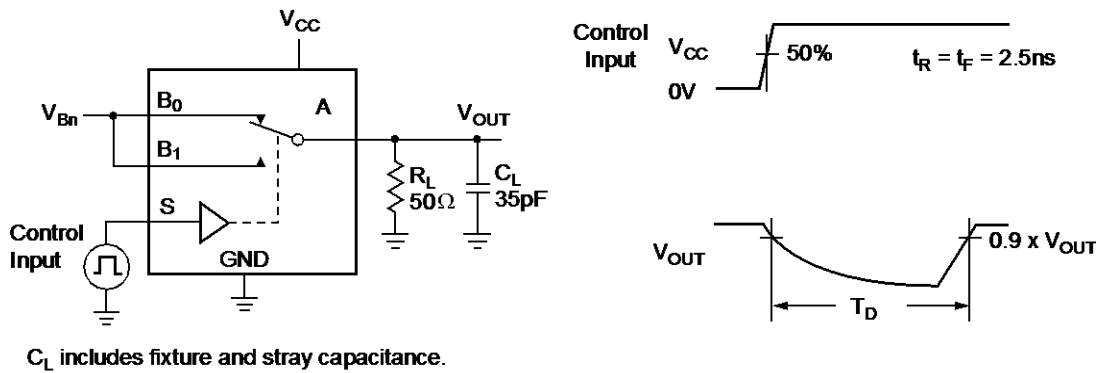


Figure 5. Break-Before-Make Timing

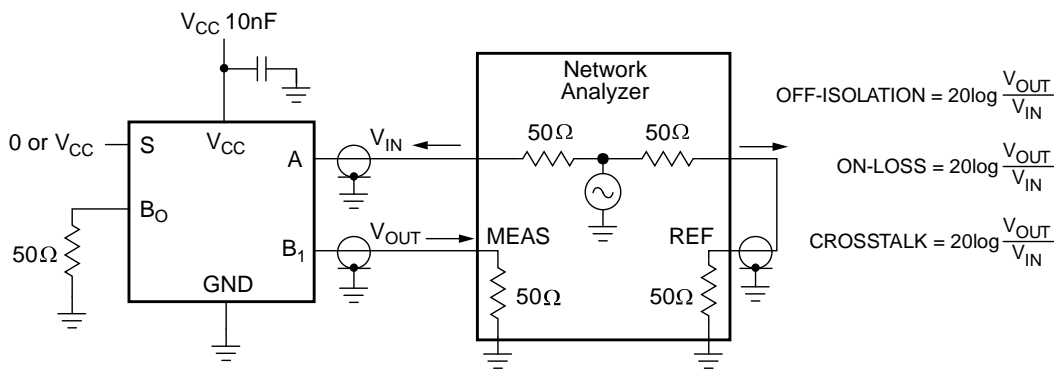


Figure 6. Off Isolation and Crosstalk

Test Diagrams (Continued)

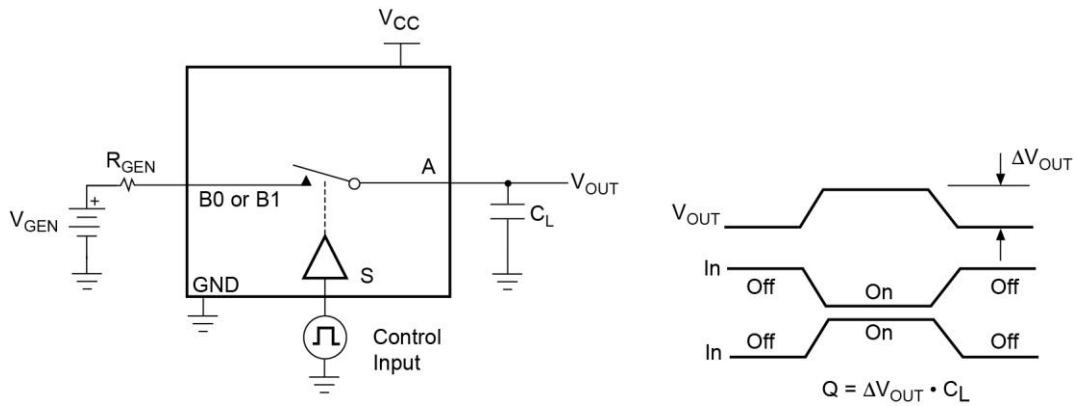


Figure 7. Charge Injection

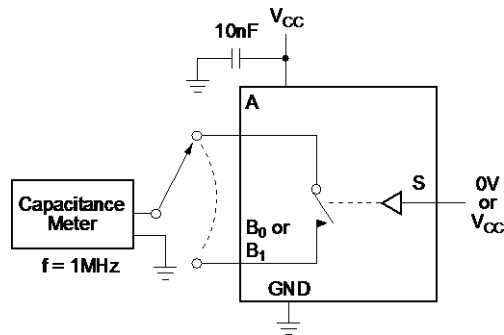


Figure 8. On / Off Capacitance Measurement Setup

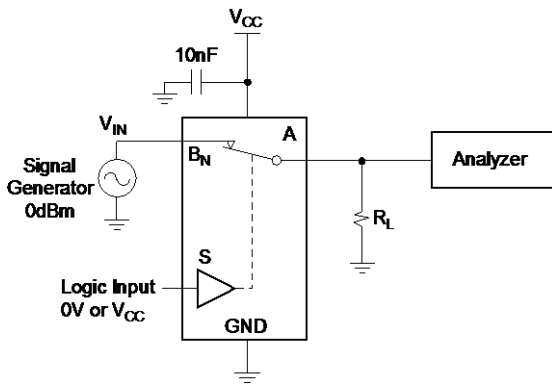


Figure 9. Bandwidth

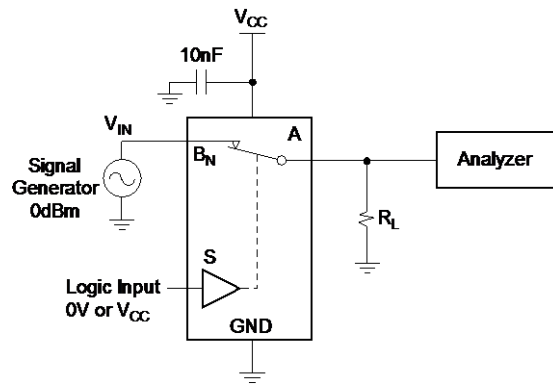


Figure 10. Harmonic Distortion

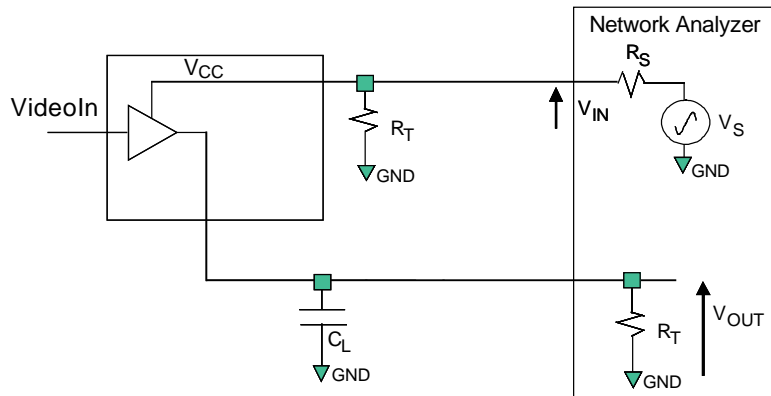
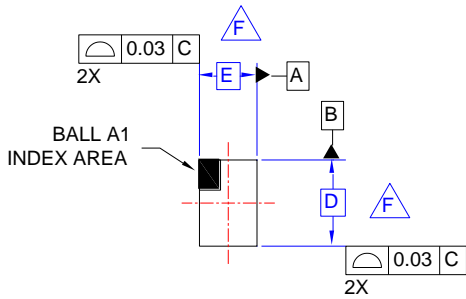


Figure 11. PSRR

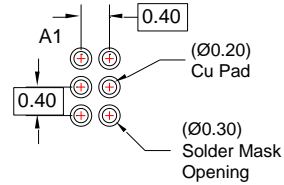
### Product Specific Dimensions

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

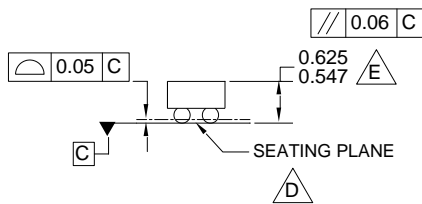
### Physical Dimensions



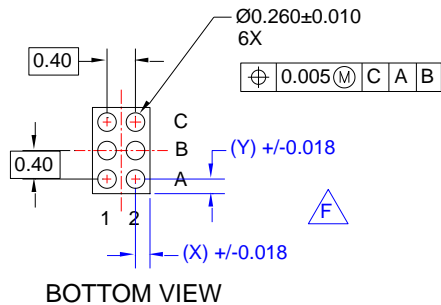
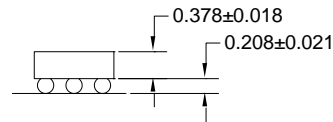
TOP VIEW



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

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