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March 2013

# FSA859 — Dual-Voltage, 0.8Ω SPDT Analog Switch with Power-Off Isolation

## Features

- Power-Off Isolation ($V_{CC}$=0V)
- 0.8Ω Maximum On Resistance ($R_{ON}$) for 4.5V $V_{CC}$
- 0.25Ω Maximum $R_{ON}$ Flatness for 4.5V $V_{CC}$
- Broad $V_{CC}$ Operating Range: 1.65V to 5.5V
- Fast Turn-On and Turn-Off Times
- Control Input Referenced to $V_{IO}$
- Break-Before-Make Enable Circuitry
- 0.5mm WLCSP packaging
- ESD Performance
  - HBM: JESD22-A114, I/O to GND 8kV
  - CDM: JESD22-C101 500V
  - IEC61000-4-2 Contact / Air 8kV / 15kV

## Applications

- Cellular Phone
- Portable Media Player
- PDA

## Description

The FSA859 is a high-performance Single-Pole / Double-Throw (SPDT) analog switch for audio applications driven by low voltage (1.8V) baseband processors or ASICs. The device features ultra-low $R_{ON}$ of 0.8Ω (maximum) at 4.5V $V_{CC}$ and operates over the wide $V_{CC}$ range of 1.65V to 5.5V. The device is fabricated with sub-micron CMOS technology to achieve fast switching speeds and is designed for break-before-make operation.

The FSA859 interfaces between the low-voltage ASIC and regular audio amplifiers and CODECs operating up to the supply range of 5.5V through the dual-voltage supplies of $V_{IO}$ and $V_{CC}$. The $V_{IO}$ supply operates the control circuitry, allowing for 1.8V (typical) signals on the control pin (Sel).

## IMPORTANT NOTE:

For additional performance information, please contact analogswitch@fairchildsemi.com.

## Ordering Information

| Part Number | Operating Temperature Range | Top Mark | Eco Status | Package | Packing Method |
|---|---|---|---|---|---|
| FSA859UCX | -40°C to +85°C | N2 | Green | 8-Ball WLCSP, 0.5mm pitch | Tape and Reel |

*For Fairchild's definition of "green" Eco Status, please visit: http://www.fairchildsemi.com/company/green/rohs_green.html.*

## Analog Symbols

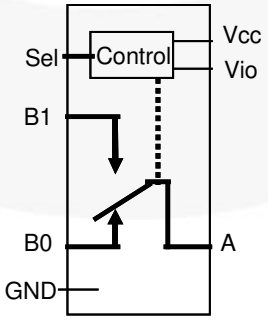
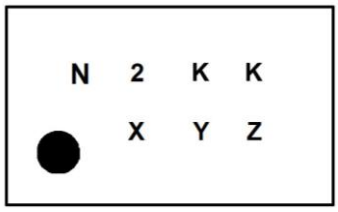



**Figure 1. Analog Symbol**

## Marking Information




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

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

## Pin Configuration

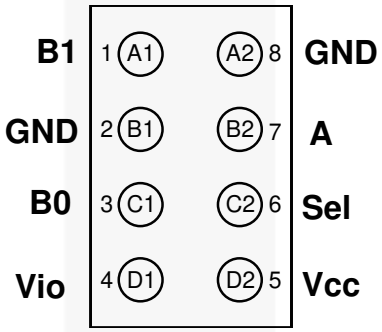



**Figure 3. Pin Assignments (Top Through View)**

## Pin Definitions

| Pin | Ball | Name | Description |
|---|---|---|---|
| 1 | A1 | B1 | Data Port (Normally Open) |
| 2 | B1 | GND | Ground |
| 3 | C1 | B0 | Data Ports (Normally Closed) |
| 4 | D1 | $V_{IO}$ | Digital Control Supply |
| 5 | D2 | $V_{CC}$ | Supply Voltage |
| 6 | C2 | Sel | Control Input |
| 7 | B2 | A | Common Data Port |
| 8 | A2 | GND | Ground |

## 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 |
| $V_{IO}$ | Digital Control 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 1ms 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 Fairchild'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. Fairchild 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 |
| $V_{IO}$ | Digital Control Supply | 1.65 | 1.95 | V |
| Sel | Control Input Voltage[2] | 0 | $V_{IO}$ | 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 |

**Note:**

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

## Electrical Characteristics

All typical values are at 25°C unless otherwise specified. $V_{IO}$=1.65 to 1.95V.

| Symbol | Parameter | $V_{CC}$ (V) | Conditions | $T_A$=+25°C | | | $T_A$=-40 to +85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| $V_{IHIO}$ | Input Voltage High - $V_{IO}$ | 1.95 to 5.50 | | | | | 0.65•$V_{IO}$ | $V_{IO}$ | V |
| $V_{ILIO}$ | Input Voltage Low - $V_{IO}$ | 1.95 to 5.50 | | | | | 0 | 0.35•$V_{IO}$ | V |
| $I_{IN}$ | Control Input Leakage | 1.95 to 5.50 | $V_{Sel}$=0 or $V_{IO}$ | -2 | | 2 | -20 | 20 | nA |
| $I_{NO(0FF)}$, $I_{NC(OFF)}$, | Off-Leakage Current of Port B0 and B1 (6) | 5.50 | A=1V,4.5V<br>B0 or B1=4.5, 1V | -10 | | 10 | -50 | 50 | nA |
| | | 3.60 | A=1V,3.0V<br>B0 or B1=3.0, 1V | -10 | | 10 | -50 | 50 | |
| | | 2.70 | A=0.5V,2.3V<br>B0 or B1=2.3, 0.5V | -10 | | 10 | -50 | 50 | |
| | | 1.95 | A=0.3V,1.65V<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 (6) | 5.50 | A=float<br>B0 or B1=4.5, 1V | -20 | | 20 | -100 | 100 | nA |
| | | 3.60 | A=float<br>B0 or B1=3.0, 1V | -10 | | 10 | -20 | 20 | |
| | | 2.70 | A=float<br>B0 or B1=2.3, 0.5V | -10 | | 10 | -20 | 20 | |
| | | 1.95 | A=float<br>B0 or B1=1.65, 0.3V | -5 | | 5 | -20 | 20 | |
| $I_{A(ON)}$ | On Leakage Current of Port A (6) | 5.50 | A=1V,4.5V; B0 or B1=1V, 4.5V 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=0.5V, 2.3V, B0 or B1=0.5V, 2.3V, or floating | -10 | | 10 | -20 | 20 | |
| | | 1.95 | A=0.3V, 1.65V; B0 or B1=0.3V, 1.65V, or floating | -5 | | 5 | -20 | 20 | |
| $I_{OFF}$ | Power Off Leakage Current of Port A & Port B(6) | 0 | A=0 to 5.5V<br>B0 or B1=0 to 5.5V | -1.00 | 0.01 | 1.00 | -5.00 | 5.00 | µA |
| $I_{CC}$ | Quiescent Supply Current | 5.50 | $V_{IN}$=0 or $V_{CC}$, $I_{OUT}$=0 | | 10 | 50 | | 500 | 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 | |

*Continued on the following page…*

## Electrical Characteristics (Continued)

All typical values are at 25°C unless otherwise specified. $V_{IO}$=1.65 to 1.95V.

| Symbol | Parameter | $V_{CC}$ (V) | Conditions | $T_A$=+25°C | | | $T_A$=-40 to +85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| $R_{ON}$ | Switch On Resistance(3,6) | 4.50 | $I_{OUT}$=-100mA, B0 or B1=2.5V | | 0.50 | 0.75 | | 0.80 | Ω |
| | | 3.00 | $I_{OUT}$=-100mA, B0 or B1=2.0V | | 0.75 | 0.90 | | 1.2 | |
| | | 2.25 | $I_{OUT}$=-100mA, B0 or B1=1.8V | | 1.0 | 1.3 | | 1.6 | |
| | | 1.65 | $I_{OUT}$=-100mA, B0 or B1=1.2V | | 2.5 | 5.0 | | 7.0 | |
| $\Delta R_{ON}$ | On Resistance Matching Between Channels(4,6) | 4.50 | $I_{OUT}$=-100mA, B0 or B1=2.5V | | 0.05 | 0.10 | | 0.10 | Ω |
| | | 3.00 | $I_{OUT}$=-100mA, B0 or B1=2.0V | | 0.10 | 0.15 | | 0.15 | |
| | | 2.25 | $I_{OUT}$=-100mA, B0 or B1=1.8V | | 0.15 | 0.20 | | 0.20 | |
| | | 1.65 | $I_{OUT}$=-100mA, B0 or B1=1.2V | | 0.15 | 0.40 | | 0.40 | |
| $R_{FLAT(ON)}$ | On Resistance Flatness(5,6) | 4.50 | $I_{OUT}$=-100mA, B0 or B1=1.0V, 1.5V, 2.5V | | 0.075 | 0.250 | | 0.250 | Ω |
| | | 3.00 | $I_{OUT}$=-100mA, B0 or B1=0.8V, 2.0V | | 0.1 | 0.3 | | 0.3 | |
| | | 2.25 | $I_{OUT}$=-100mA, B0 or B1=0.8V, 1.8V | | 0.25 | 0.50 | | 0.6 | |
| | | 1.65 | $I_{OUT}$=-100mA, B0 or B1=0.6V, 1.2V | | 3.5 | | | | |

**Notes**:

3. On resistance is determined by the voltage drop between A and B pins at the indicated current through the switch.
4. $\Delta R_{ON}=R_{ON}$ maximum – $R_{ON}$ minimum 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.
6. Guaranteed by characterization, not production tested for $V_{CC}$=1.65 – 1.95V.

## AC Electrical Characteristics

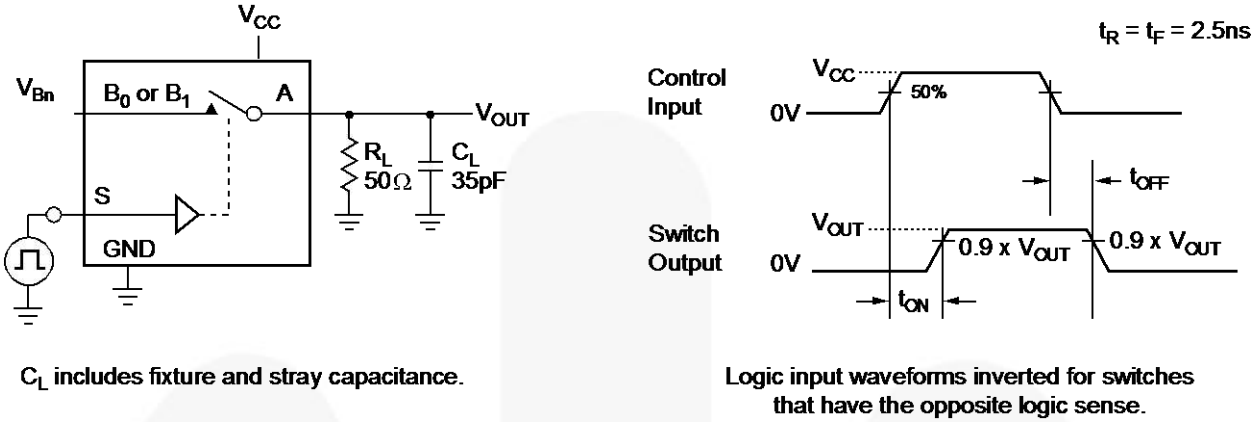
All typical value are at $V_{IO}$=1.8V and $V_{CC}$=1.8V, 2.5V, 3.0V, and 5.0V at 25°C unless otherwise specified.

| Symbol | Parameter | $V_{CC}$ (V) | Conditions | $T_A$=+25ºC | | | $T_A$=-40 to +85ºC | | Unit | Figure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | | |
| $t_{ON}$ | Turn-On Time[6] | 4.50 to 5.50 | B0 or B1=$V_{CC}$, $R_L$=50Ω, $C_L$=35pF | 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=$V_{CC}$, $R_L$=50Ω, $C_L$=35pF | 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[6] | 4.50 to 5.50 | B0 or B1=$V_{CC}$, $R_L$=50Ω, $C_L$=35pF | 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 | $C_L$=1.0nF, $V_{GEN}$=0V, $R_{GEN}$=0Ω | | 47 | | | | pC | Figure 7 |
| | | 3.30 | | | 33 | | | | | |
| | | 2.50 | | | 23 | | | | | |
| | | 1.65 | | | 10 | | | | | |
| OIRR | Off Isolation | 1.8 to 5.0 | f=1MHz, $R_L$=50Ω | | -60 | | | | dB | Figure 6 |
| Xtalk | Crosstalk | 1.8 to 5.0 | f=1MHz, $R_L$=50Ω | | 55 | | | | dB | Figure 6 |
| BW | -3db Bandwidth | 5.50 | $R_L$=50Ω | | 60 | | | | MHz | Figure 9 |
| | | 3.30 | | | 60 | | | | | |
| | | 2.50 | | | 55 | | | | | |
| | | 1.65 | | | 50 | | | | | |
| THD | Total Harmonic Distortion | 1.80 | $R_L$=600Ω, $V_{IN}$=0.5$V_{PP}$, f=20Hz to 20kHz | | .015 | | | | % | Figure 10 |
| | | 5.00 | | | .002 | | | | | |

## Capacitance

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

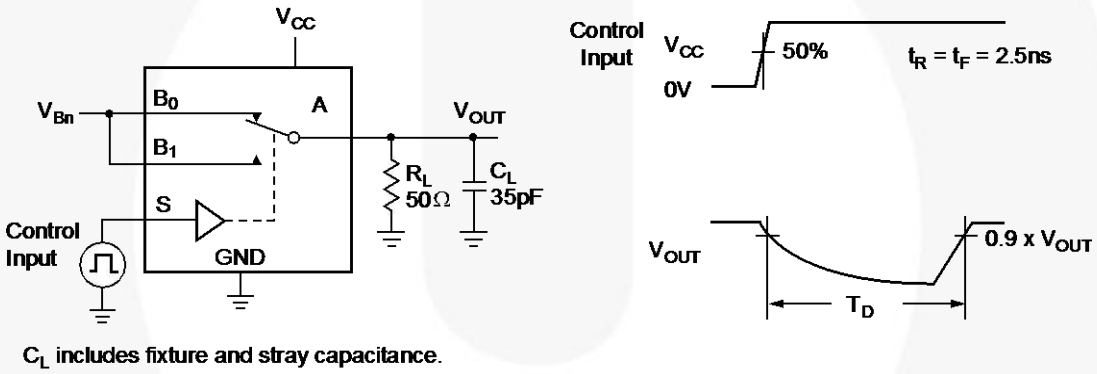
## Test Diagrams




$C_L$ 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**

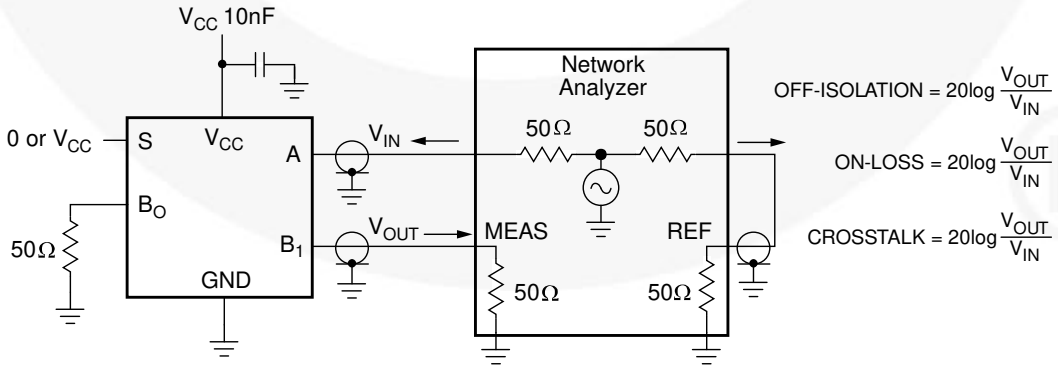



**Figure 6. Off Isolation and Crosstalk**

## Test Diagrams (Continued)

**Figure 7. Charge Injection**

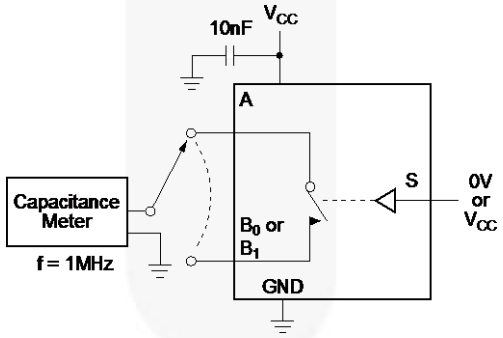



**Figure 8. On / Off Capacitance Measurement Setup**

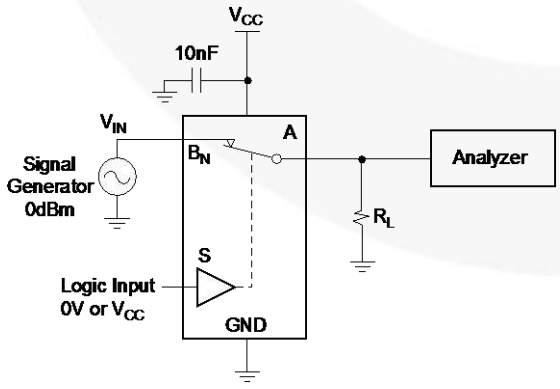



**Figure 9. Bandwidth**

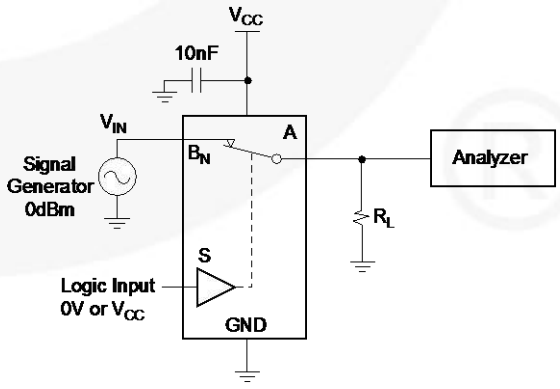
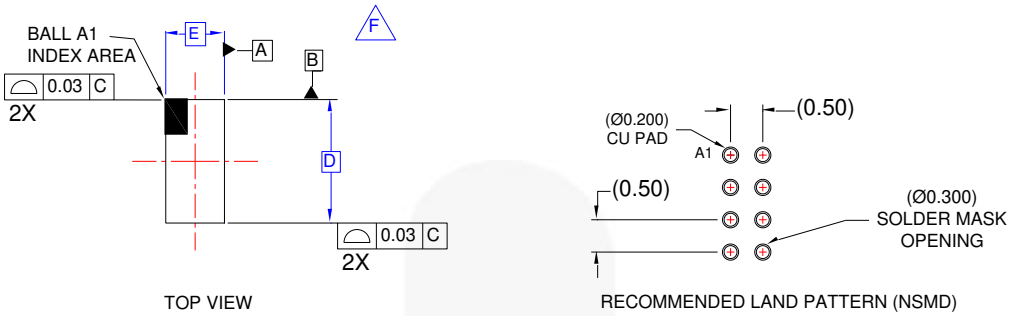
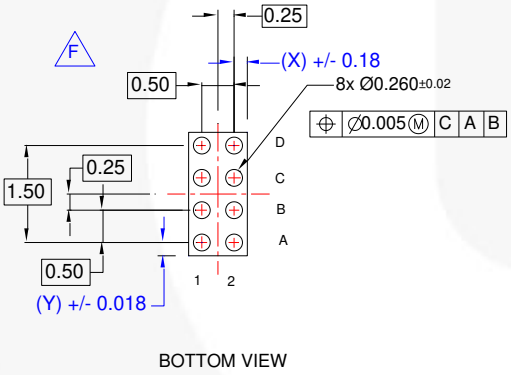



**Figure 10. Harmonic Distortion**

## Physical Dimensions








NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

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

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

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

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

G. BALL COMPOSITION: Sn95.5Ag3.9Cu0.6

H. DRAWING FILNAME: MKT-UC008ADrev2

**Figure 11. 8-Ball, WLCSP 0.5mm Pitch**

**Table 1. Product Specific Dimensions**

| Product | D | E | X | Y |
|---|---|---|---|---|
| FSA859UCX | 1.910 | 0.910 | 0.205 | 0.205 |

*Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.*

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SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SupreMOS™
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the power franchise
TinyBoost™
TinyBuck™
TinyLogic®
TINYOPTO™
TinyPower™
TinyPWM™
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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

## PRODUCT STATUS DEFINITIONS

**Definition of Terms**

| Datasheet Identification | Product Status | Definition |
|---|---|---|
| Advance Information | Formative / In Design | Datasheet contains the design specifications for product development. Specifications may change in any manner without notice. |
| Preliminary | First Production | Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |
| No Identification Needed | Full Production | Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design. |
| Obsolete | Not In Production | Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only. |

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