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# FSA4159

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

### Features

- Low  $I_{CC}$  When the S Input is Lower Than  $V_{CC}$
- Power-Off Isolation ( $V_{CC}=0$  V)
- 1 Ω On Resistance ( $R_{ON}$ ) for 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
- Pb-Free “Green” Packaging

### 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 4.5V  $V_{CC}$  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.

### Applications

- Cellular Phone
- Portable Media Player
- PDA

### Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method
FSA4159P6X	-40°C to +85°C	6-Lead SC70, EIAJ SC88, 1.25 mm Wide	3000 Units on Tape and Reel
FSA4159L6X	-40°C to +85°C	6-Lead MicroPak™, 1.00 mm Wide	5000 Units on Tape and Reel

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

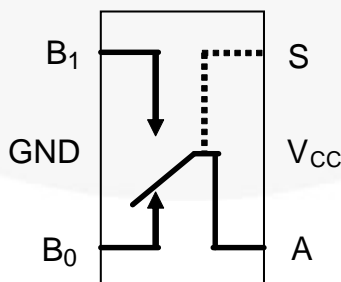


Figure 1. Analog Symbols

## Pin Configuration

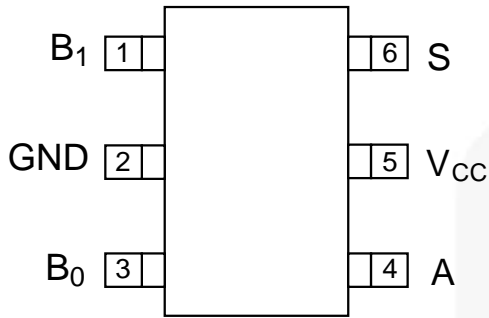


Figure 2. SC70 Pin Assignments (Top View)

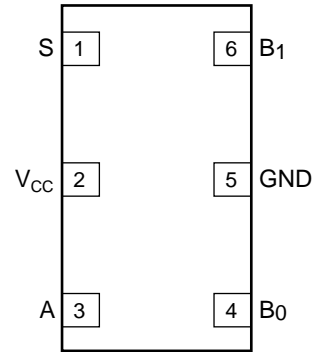


Figure 3. MicroPak™ Pin Assignment (Top View)

## 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

## 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 1ms Duration, <10% Duty Cycle)		400	mA
$P_D$	Power Dissipation at 85°C		180	mW
$T_{STG}$	Storage Temperature Range	-65	+150	°C
$T_J$	Max Junction Temperature		+150	°C
$T_L$	Lead Temperature (Soldering, 10 Seconds)		+260	°C
ESD	Human Body Model (JEDEC: JESD22-A114)		4000	V
	Charged Device Model (JEDEC: JESD22-C101)		1500	
	Machine Model (JEDEC: JESD22-A115)		200	

**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. 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
S	Control Input Voltage <sup>(2)</sup>	0	$V_{CC}$	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:**

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

## 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	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 or V <sub>CC</sub>	-2		2	-100	100	nA
		3.60	V <sub>IN</sub> =0 or V <sub>CC</sub>	-2		2	-100	100	
		2.70	V <sub>IN</sub> =0 or V <sub>CC</sub>	-2		2	-20	20	
		1.95	V <sub>IN</sub> =0 or V <sub>CC</sub>	-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

Continued on following page...

### 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.	
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 T <sub>A</sub> =-40°C		4.0	10.0		
R <sub>ON</sub>	Switch On Resistance <sup>(3)</sup>	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	
Δ R <sub>ON</sub>	On Resistance Matching Between Channels <sup>(4)</sup>	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 <sup>(5)</sup>	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	

**Notes:**

3. On resistance is determined by the voltage drop between A and B pins at the indicated current through the switch.
4. Δ R<sub>ON</sub>=R<sub>ON</sub> maximum – R<sub>ON</sub> minimum 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.

## AC Electrical Characteristics

All typical value 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	$T_A=+25^\circ\text{C}$			$T_A=-40\text{to}+85^\circ\text{C}$		Unit	Figure
				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	$R_L=600\ \Omega$ , $V_{IN}=0.5\ V_{PP}$ , $f=20\ \text{Hz}$ to $20\ \text{kHz}$		.006				%	Figure 10 Figure 17
		5.00			.002					

## Capacitance

Symbol	Parameter	$V_{CC}$ (V)	Conditions	$T_A=+25^\circ\text{C}$			Unit
				Min.	Typ.	Max.	
$C_{IN}$	Control Pin Input Capacitance	0	$f=1\ \text{MHz}$ , See Figure 10		1.5		pF
$C_{OFF}$	B Port Off Capacitance	1.65 to 5.50	$f=1\ \text{MHz}$ , See Figure 10		12		pF
$C_{ON}$	A Port On Capacitance	1.65 to 5.50	$f=1\ \text{MHz}$ , See Figure 10		41		pF

### Typical Performance Characteristics

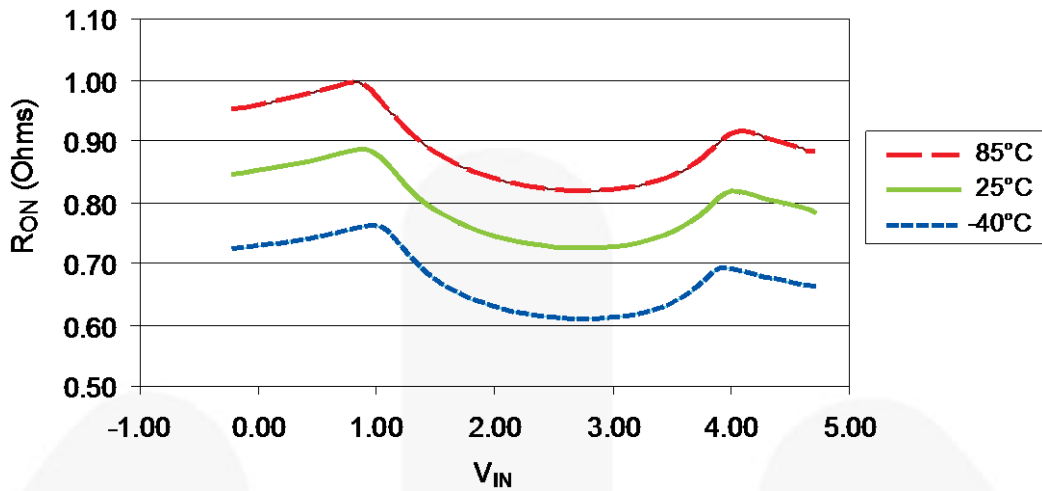


Figure 4. Switch R<sub>ON</sub> (V<sub>CC</sub>=4.5 V)

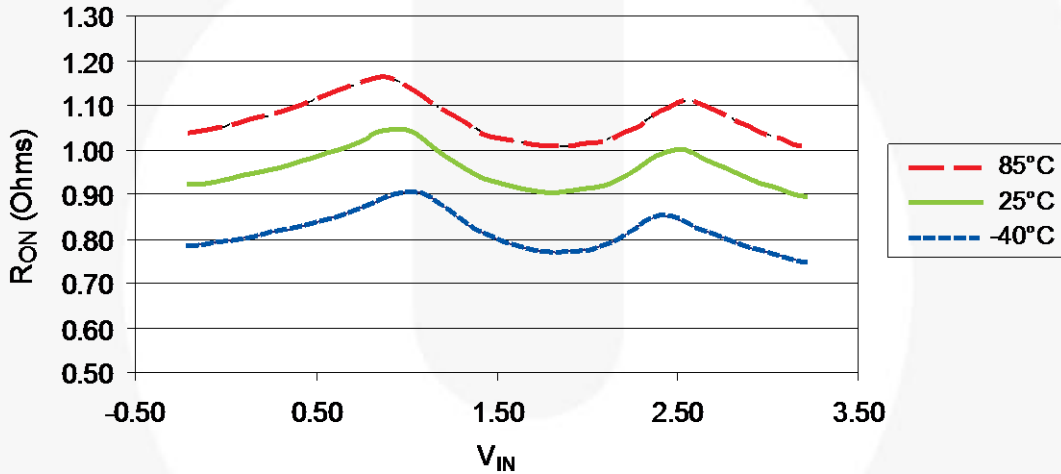


Figure 5. Switch R<sub>ON</sub> (V<sub>CC</sub>=3.0 V)

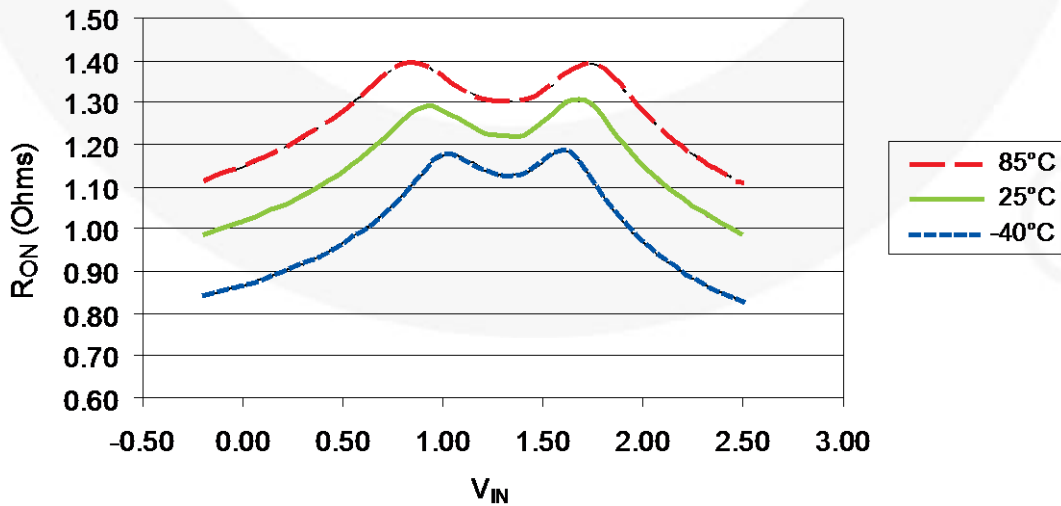


Figure 6. Switch R<sub>ON</sub> (V<sub>CC</sub>=2.3 V)



**Typical Performance Characteristics** (Continued)

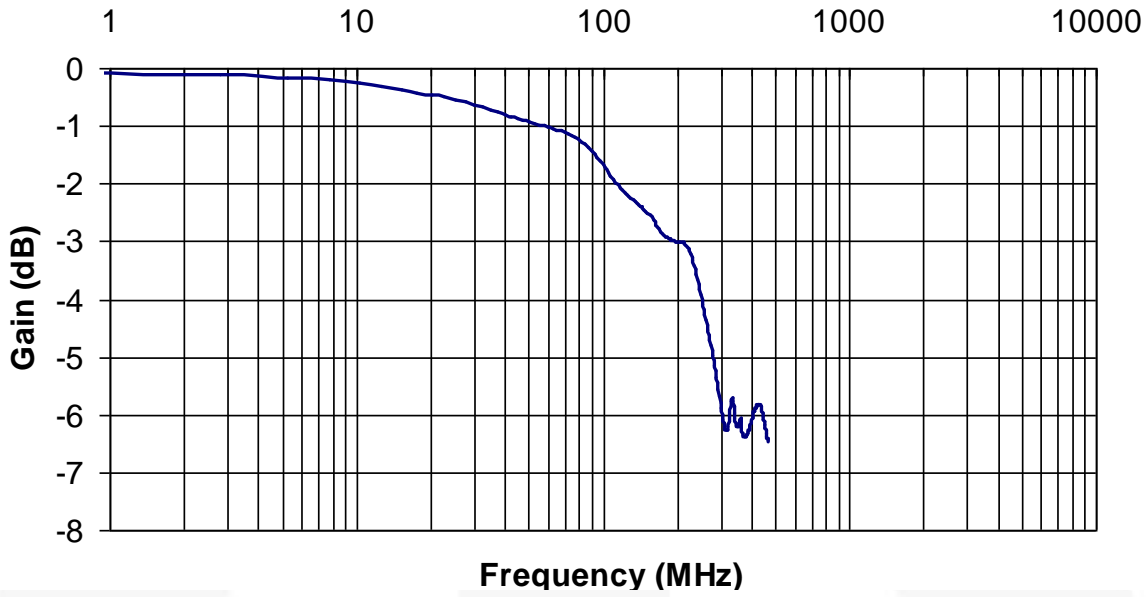


Figure 7. Frequency Response ( $C_L=0\text{ pF}$ ,  $V_{CC}=5.5\text{ V}$ )

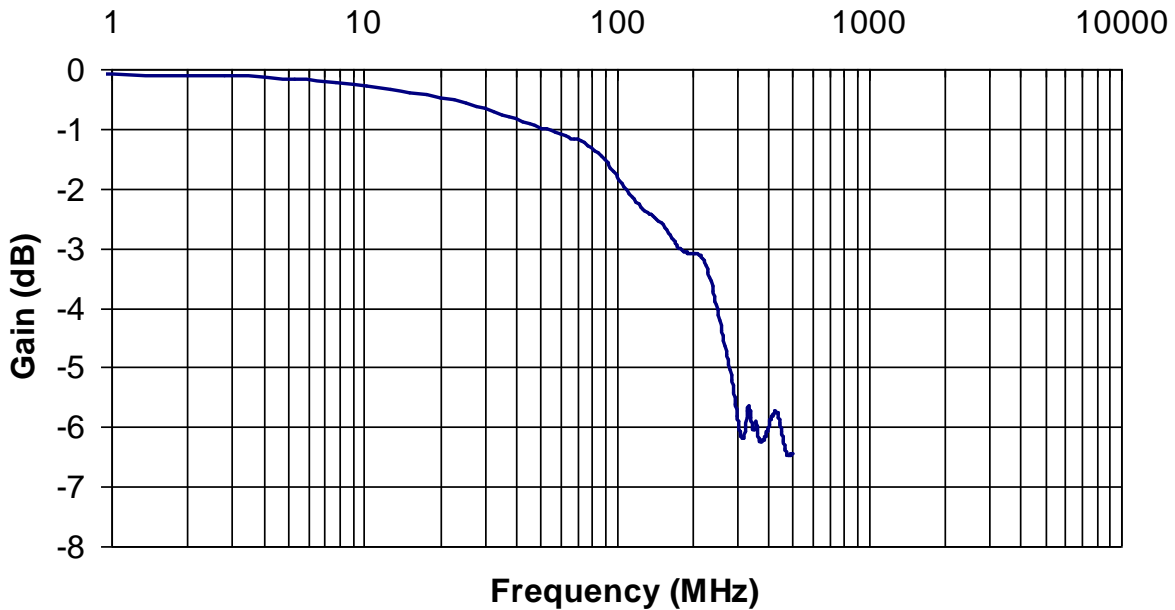


Figure 8. Frequency Response ( $C_L=0\text{ pF}$ ,  $V_{CC}=3.3\text{ V}$ )

Typical Performance Characteristics (Continued)

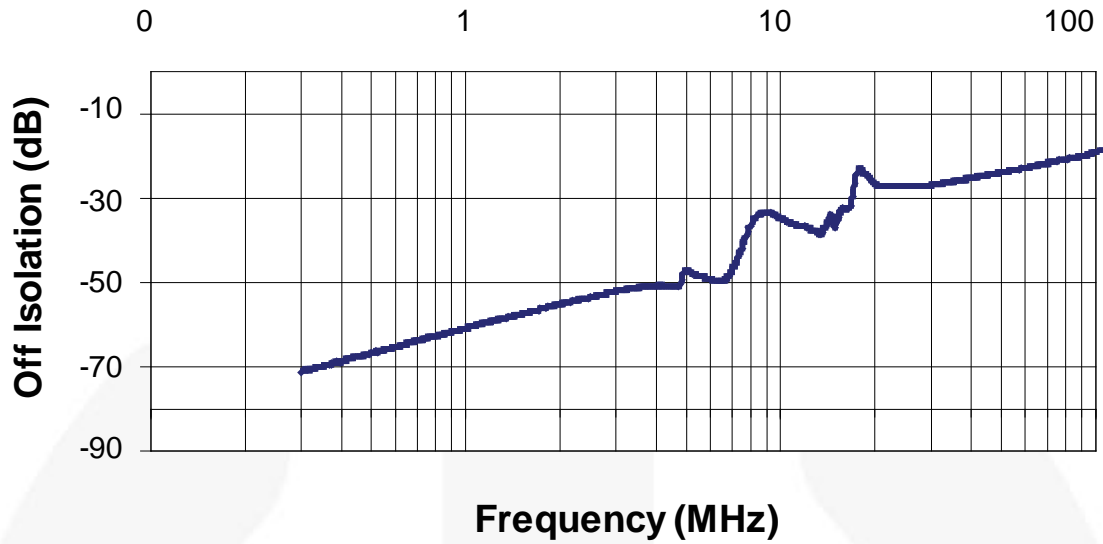


Figure 9. Off Isolation ( $V_{CC}=5.0\text{ V}$ )

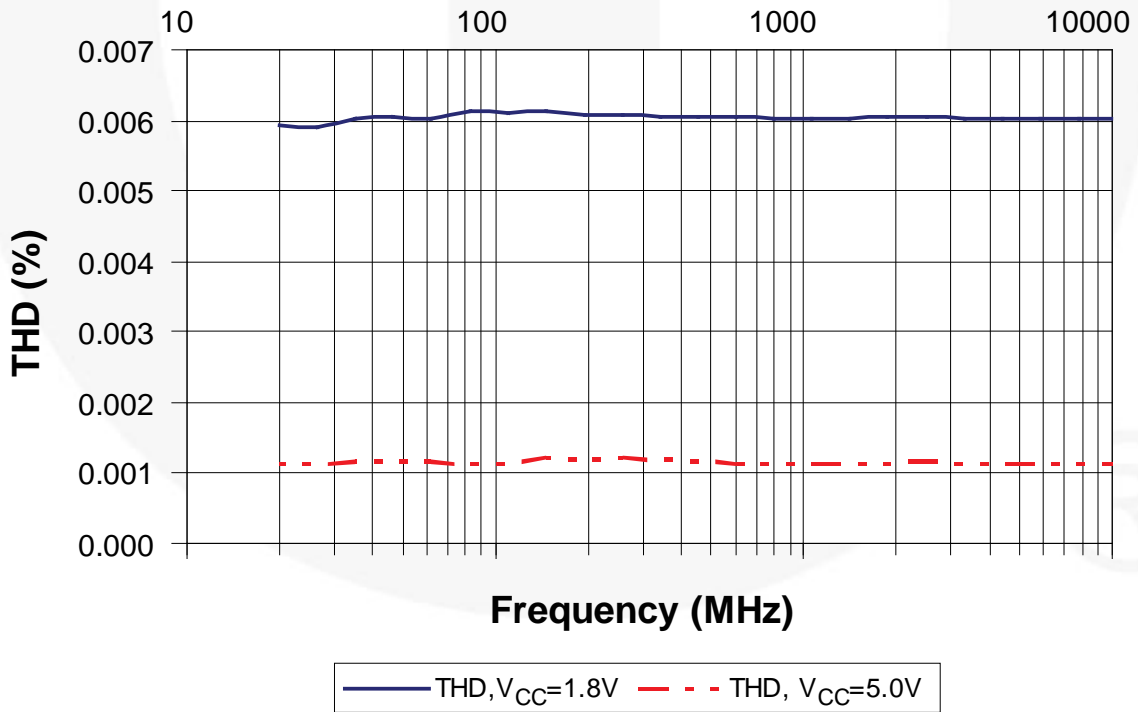
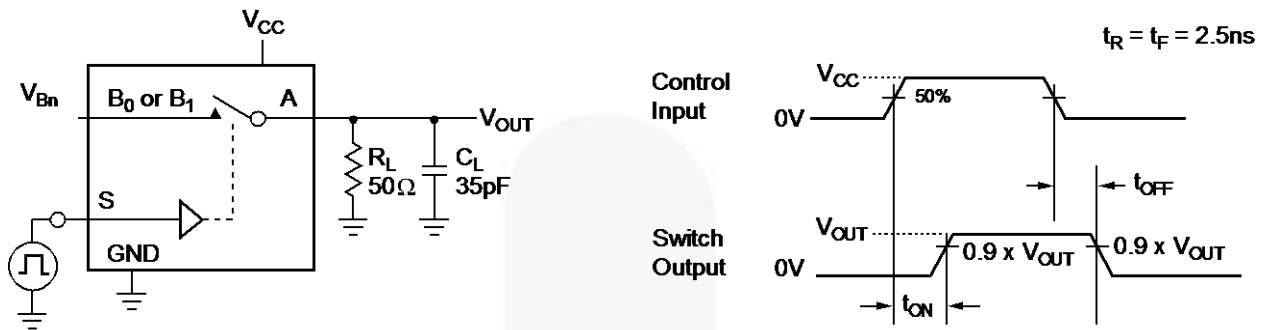


Figure 10. Total Harmonic Distortion, Frequency Response ( $C_L=0\text{ pF}$ )

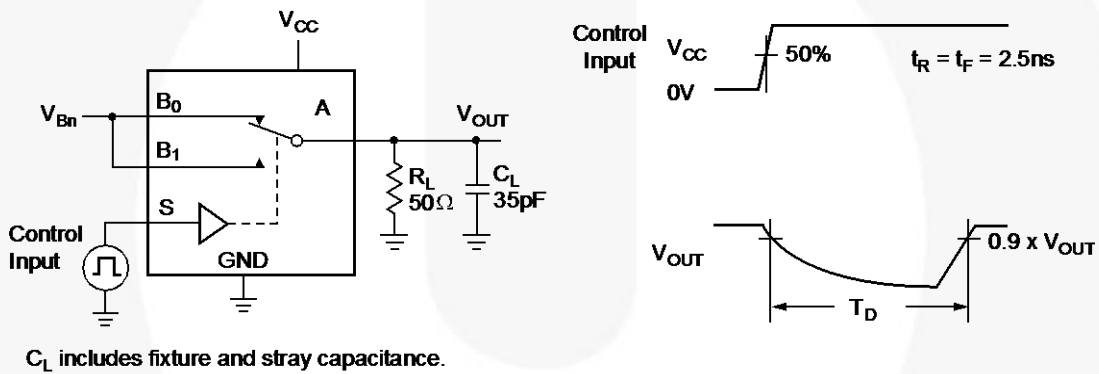
### Test Diagrams



$C_L$  includes fixture and stray capacitance.

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

Figure 11. Turn On / Off Timing



$C_L$  includes fixture and stray capacitance.

Figure 12. Break-Before-Make Timing

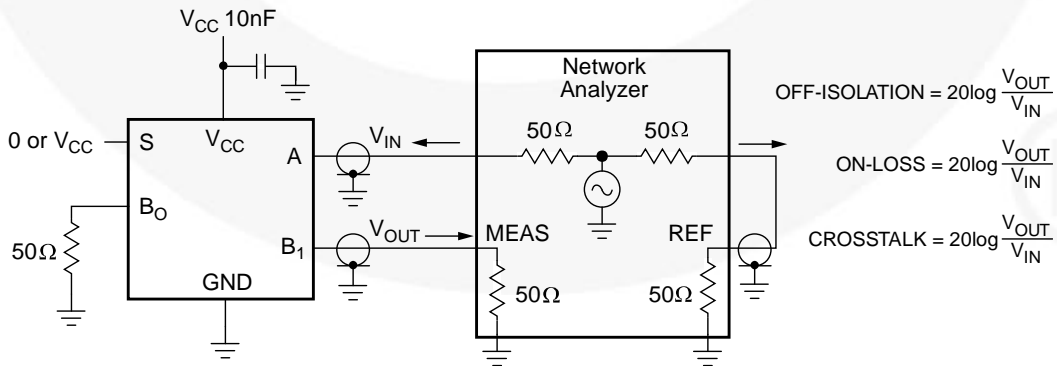
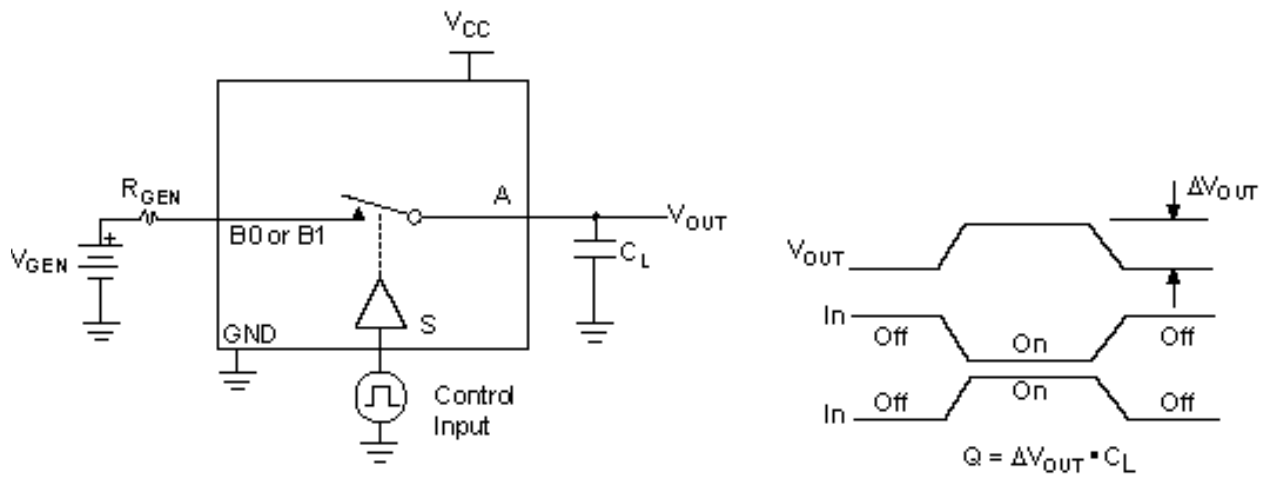
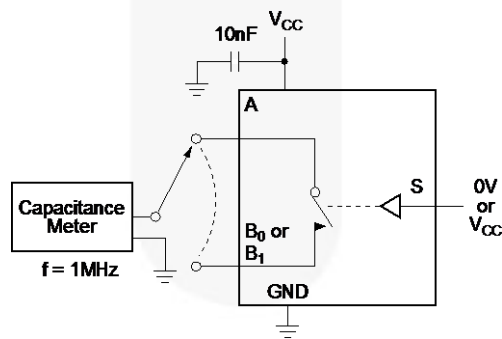


Figure 13. Off Isolation and Crosstalk

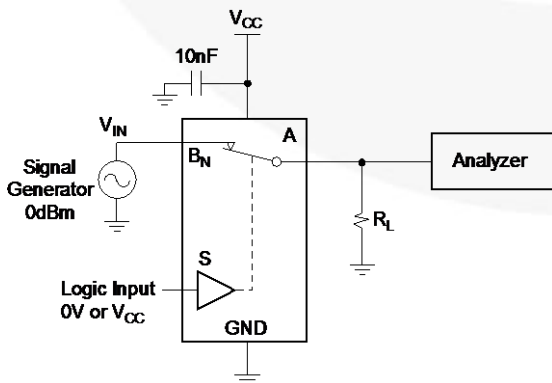
**Test Diagrams (Continued)**



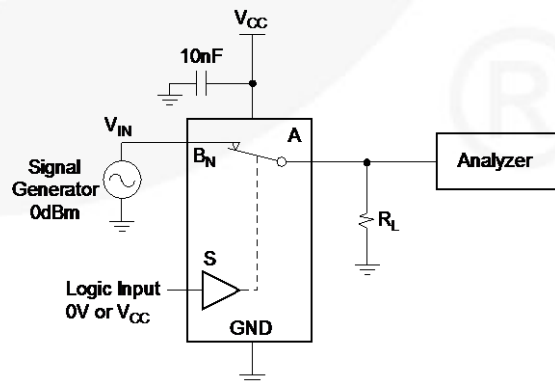
**Figure 14. Charge Injection**



**Figure 15. On / Off Capacitance Measurement Setup**

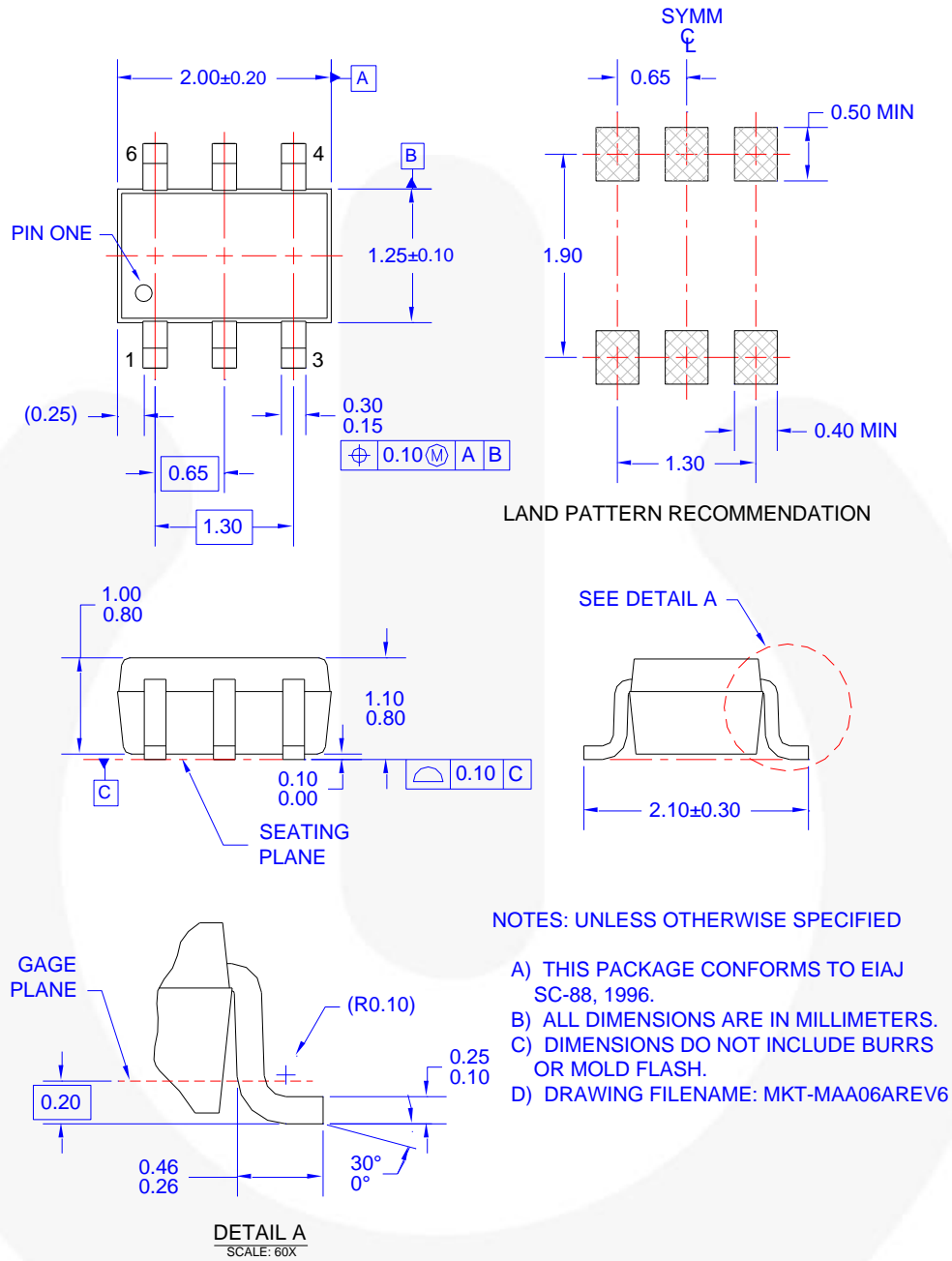


**Figure 16. Bandwidth**



**Figure 17. Harmonic Distortion**

## Physical Dimensions



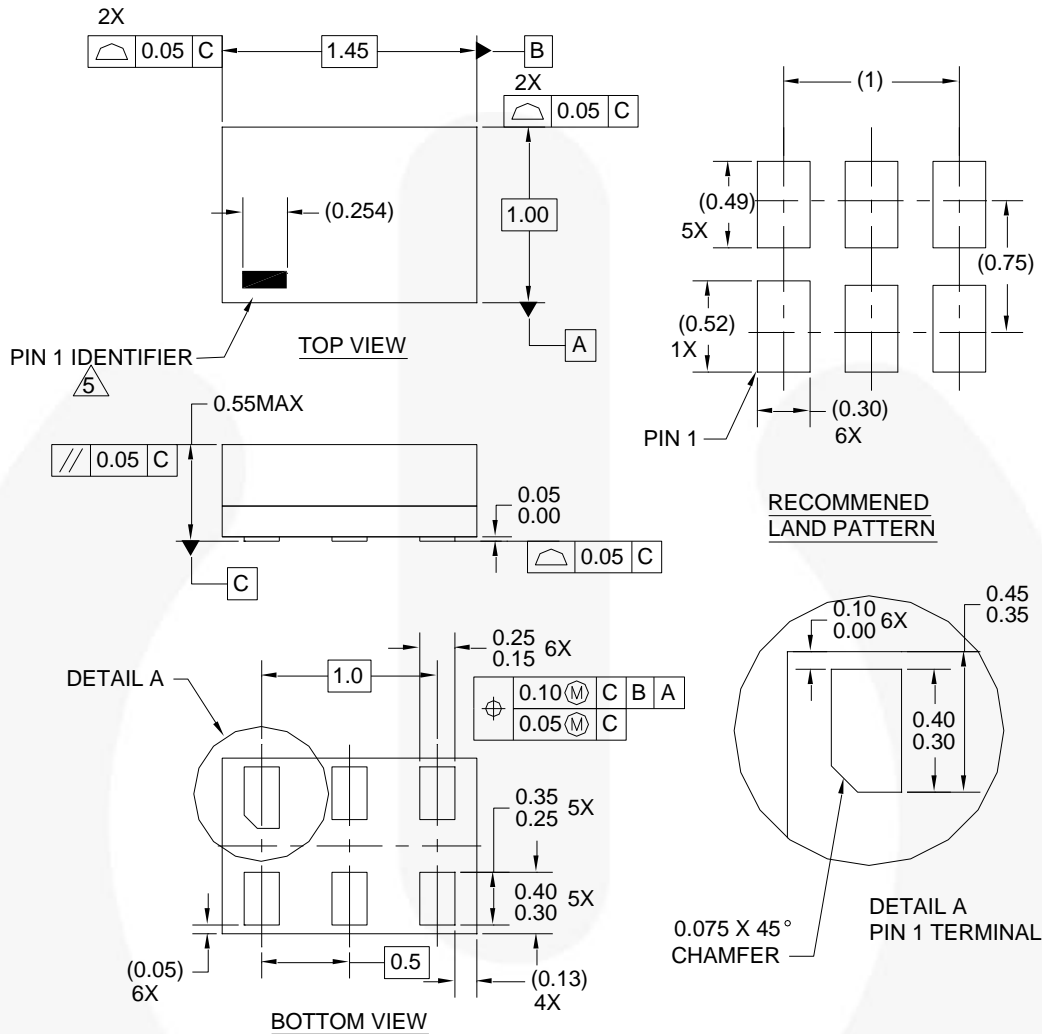
**Figure 18. 6-Lead SC70, EIAJ SC88, 1.25mm Wide Package:**

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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**Physical Dimensions** (Continued)



**Notes:**

1. CONFORMS TO JEDEC STANDARD M0-252 VARIATION UAAD
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-1994
4. FILENAME AND REVISION: MAC06AREV4
5. PIN ONE IDENTIFIER IS 2X LENGTH OF ANY OTHER LINE IN THE MARK CODE LAYOUT.

**Figure 19. 6-Lead, MicroPak™ 1.0mm Wide Package**

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