FAIRCHILD SEMICONDUCTOR®

PRELIMINARY

January 2006

FSUSB31
Low Power Dual SPST Hi-Speed USB 2.0 (480Mbps) Switch

General Description

The FSUSB31 is Dual SPST isolation switch. This part is optimized for switching between two HS (480Mbps) sources or a HS and FS (12Mbps) source that meets USB2.0 specifications. The FSUSB31 also has special circuitry on the D+, D– pins that allows it to withstand an over voltage condition. This part also features very low quiescent current even when the control voltage is lower than the V_{CC} supply. This feature services mobile handset applications well allowing for direct interface with the baseband processor general purpose I/Os. Typical applications involve switching in portables and consumer applications such as cell phones, digital cameras and notebooks with hubs or controllers. The wide bandwidth (>720MHz) of this switch exceeds the bandwidth needed to pass the 3rd harmonic resulting in signals with minimum edge and phase distortion. Superior channel-to-channel crosstalk also results with minimal interference.

Features

- 10µA maximum I_{CCT} current over an expanded control voltage range (V_{IN} = 2.6V, V_{CC} = 4.3V)
- Lower Capacitance: Con = 6.5pF Typ
- 6.0Ω typical On Resistance (R_{ON})
- –3dB bandwidth: > 720MHz
- Low power consumption (1µA maximum)
- Packaged in:
  - Pb-Free 8-lead MicroPak™ (1.6mm by 2.1mm)
  - Pb-Free 8-lead US8
- 8kV ESD performance
- Power OFF protection when V_{CC} = 0V, D+, D– pins can tolerate up to 4.3V

Applications

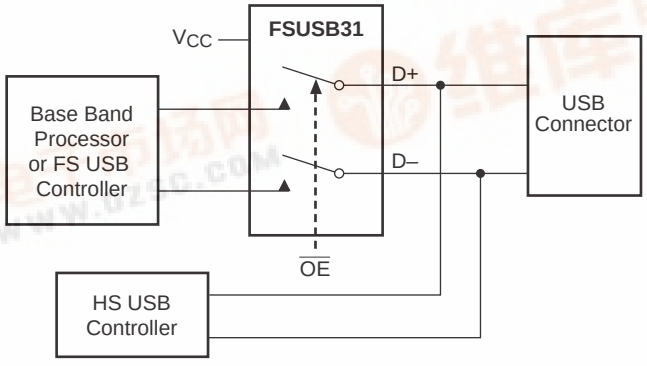
- Cell phone, PDA, Digital Camera, and Notebook
- LCD Monitor, TV, and Set-top Box

Ordering Information

Order Number	Package Number	Package Description
FSUSB31K8X	MAB08A	8-Lead US8, JEDEC MO-187, Variation CA 3.1mm Wide
FSUSB31L8X	MAC08A	Pb-Free 8-Lead MicroPak, 1.6 mm Wide

Pb-Free package per JEDEC J-STD-020B.

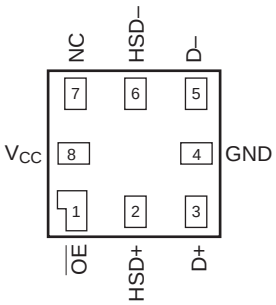
Application Diagram



MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

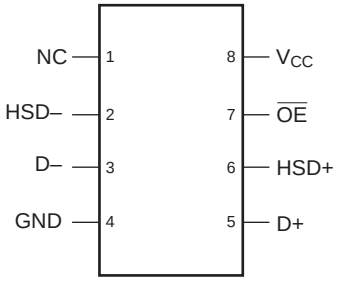
Connection Diagrams

Pad Assignments for MicroPak



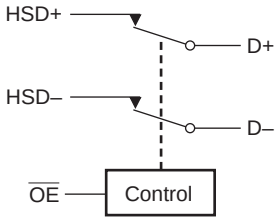
(Top View)

Pin Assignment for US8



(Top Through View)

Analog Symbol



Pin Descriptions

Pin Name	Description
$\overline{OE}$	Bus Switch Enable
D+, D–, HSD+, HSD–	Data Ports
NC	No Connect

Truth Table

$\overline{OE}$	Function
H	Disconnect
L	D+, D– = HSD

Absolute Maximum Ratings

(The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.)

Symbol	Parameter	Rating
V_{CC}	Supply Voltage	–0.5V to +4.6V
V_S	DC Input Voltage[1]	–0.5V to +4.6V
V_{IN}	DC Switch Voltage[1]	
	HSD	–0.5V to V_{CC} + 0.3V
	D+, D–	–0.5V to +4.6V
	DC Input Diode Current	–50mA
	DC Output Current	50mA
	Storage Temperature	–65°C to +150°C
	ESD (Human Body Model)	
	All Pins	8 KV
	I/O to GND	8 KV

Recommended Operating Conditions[2]

Symbol	Parameter	Rating
V_{CC}	Supply Voltage	3.0V to 4.3V
V_{IN}	Control Input Voltage	0V to V_{CC}
	Switch Input Voltage	0V to V_{CC}
	Operating Temperature	–40°C to +85°C

Notes:

1. The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed. DC switch voltage may never exceed 4.6V.
2. Control input must be held HIGH or LOW and it must not float.

DC Electrical Characteristics

(All typical values are @ 25°C unless otherwise specified.)

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = -40^{\circ}C$ to $+85^{\circ}C$			Units
				Min	Typ	Max	
V_{IK}	Clamp Diode Voltage	I_{IN} = –18mA	3.0			–1.2	V
V_{IH}	Input Voltage HIGH		3.0 to 3.6	1.3			V
			4.3	1.7			
V_{IL}	Input Voltage LOW		3.0 to 3.6			0.5	V
			4.3			0.7	
I_{IN}	Control Input Leakage	V_{IN} = 0V to V_{CC}	4.3	–1.0		1.0	µA
I_{OZ}	OFF State Leakage	0 ≤ HSD ≤ V_{CC}	4.3	–2.0		2.0	µA
I_{OFF}	Power OFF Leakage Current (D+, D–)	V_{IN} = 0.0V to 4.3V, V_{CC} = 0V	0	-2.0		2.0	µA
R_{ON}	Switch On Resistance[3]	V_{IN} = 0.8V, I_{ON} = –8mA	3.0		6.5	9.0	Ω
ΔR_{ON}	Delta R_{ON}[4]	V_{IN} = 0.8V, I_{ON} = –8mA	3.0		0.35		Ω
R_{ON} Flatness	R_{ON} Flatness [3]	V_{IN} = 0.0V – 1.0V, I_{ON} = –8mA	3.0		2.0		Ω
I_{CC}	Quiescent Supply Current	V_{IN} = 0.0V or V_{CC}, I_{OUT} = 0	4.3			1.0	µA
I_{CCT}	Increase in I_{CC} Current per Control Voltage and V_{CC} Levels	V_{IN} = 2.6V, V_{CC} = 4.3V	4.3			10.0	µA

AC Electrical Characteristics

(All typical values are for V_{CC} = 3.3V @ 25°C unless otherwise specified.)

Symbol	Parameter	Conditions	V_{CC} (V)	$T_A = -40^{\circ}C$ to $+85^{\circ}C$			Units	Figure Number
				Min	Typ	Max		
t_{ON}	Turn On Time, $\overline{OE}$ to Output	V_{IN} = 0.8V, R_L = 50Ω, C_L = 5pF	3.0 to 3.6		15.0	30.0	ns	Figure 5
t_{OFF}	Turn OFF Time. $\overline{OE}$ to Output	V_{IN} = 0.8V, R_L = 50Ω, C_L = 5pF	3.0 to 3.6		12.0	25.0	ns	Figure 5
t_{PD}	Propagation Delay[4]	R_L = 50Ω, C_L = 5pF	3.3		0.25		ns	Figure 3 Figure 4
T_{BBM}	Break-Before-Make	R_L = 50Ω, C_L = 5pF, V_{IN} = 0.8V	3.0 to 3.6	2.0		6.5	ns	Figure 6
O_{IRR}	OFF Isolation (Non-Adjacent)	f = 240MHz, R_T = 50Ω	3.0 to 3.6		–30.0		dB	Figure 9
Xtalk	Non-Adjacent Channel Crosstalk	R_T = 50Ω, f = 240MHz	3.0 to 3.6		–45.0		dB	Figure 10
BW	–3dB Bandwidth	R_T = 50Ω, C_L = 0pF	3.0 to 3.6		720		MHz	Figure 8
		R_T = 50Ω, C_L = 5pF			550			

Notes:

3. Measured by the voltage drop between Dn, HSD, Dn pins at the indicated current through the switch. On Resistance is determined by the lower of the voltage on the two ports.
4. Guaranteed by characterization.

USB Hi-Speed Related AC Electrical Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	T_A = –40°C to +85°C			Units	Figure Number
				Min	Typ	Max		
$t_{SK(O)}$	Channel-to-Channel Skew[5]	C_L = 5pF	3.0 to 3.6		50.0		ps	Figure 3 Figure 7
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output[5]	C_L = 5pF	3.0 to 3.6		20.0		ps	Figure 3 Figure 7
t_J	Total Jitter[5]	R_L = 50Ω, C_L = 5pF, $t_R = t_F$ = 500ps at 480 Mbps (PRBS = $2^{15} - 1$)	3.0 to 3.6		200		ps	

Notes:

5. Guaranteed by design.

Capacitance

Symbol	Parameter	Conditions	T_A = –40°C to +85°C			Units	Figure Number
			Min	Typ	Max		
C_{IN}	Control Pin Input Capacitance	V_{CC} = 0V		1.5		pF	Figure 12
C_{ON}	$D1_n$, $D2_n$, Dn ON Capacitance	V_{CC} = 3.3, $\overline{OE}$ = 0V		6.5		pF	Figure 11
C_{OFF}	$D1_n$, $D2_n$ OFF Capacitance	V_{CC} and $\overline{OE}$ = 3.3		2.5		pF	Figure 12

Test Diagrams

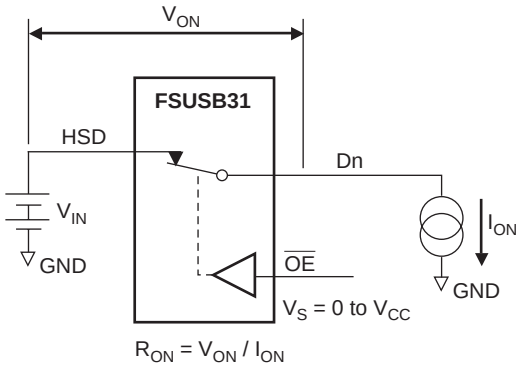
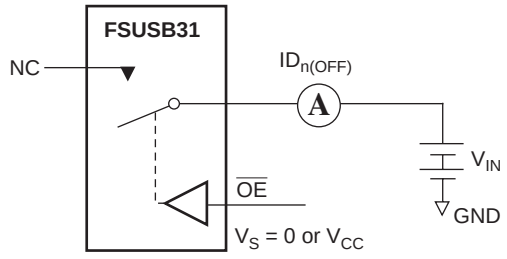
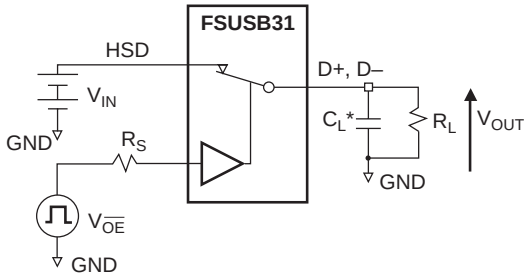


Figure 1. On Resistance



Each switch port is tested separately.

Figure 2. OFF Leakage



R_L, R_S, and C_L are functions of the application environment (see AC Electrical tables for specific values).

*C_L includes test fixture and stray capacitance.

Figure 3. AC Test Circuit Load

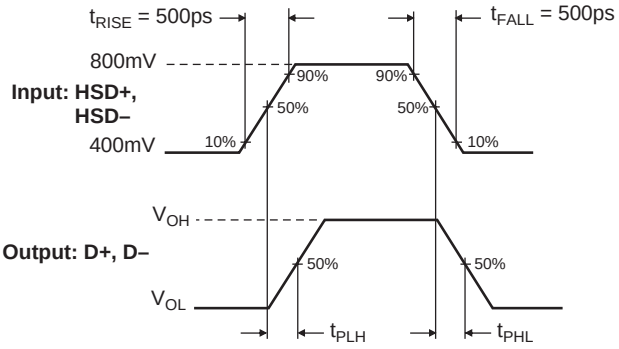


Figure 4. Switch Propagation Delay Waveforms (T_{PD})

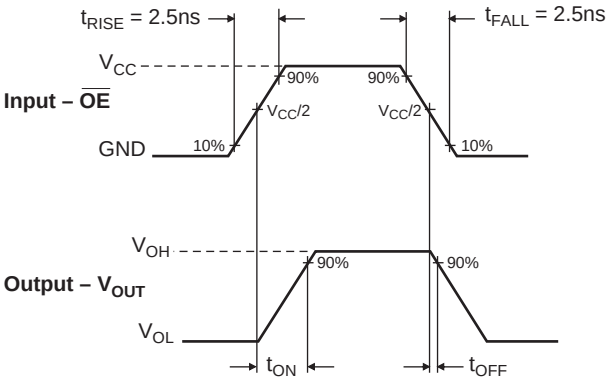
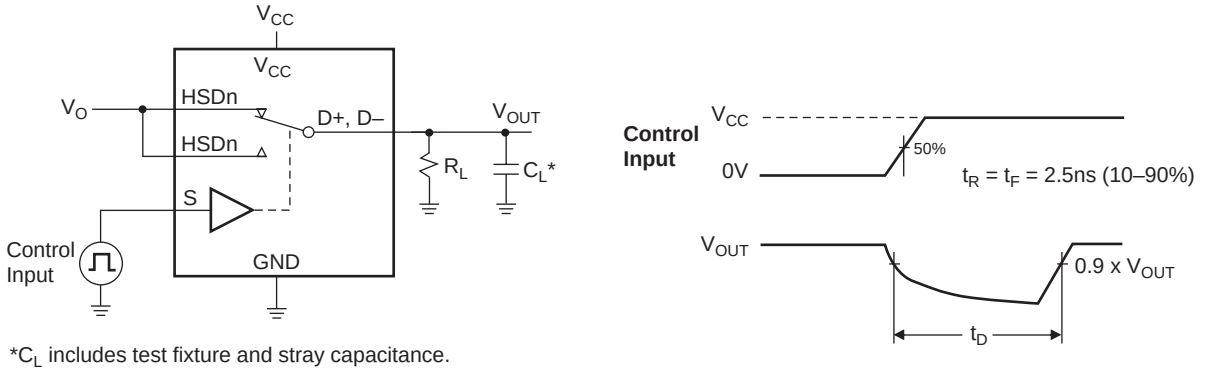


Figure 5. Turn ON / Turn OFF Waveform (T_{ON} / T_{OFF})



*C_L includes test fixture and stray capacitance.

Figure 6. Break-before-Make (T_{BBM})

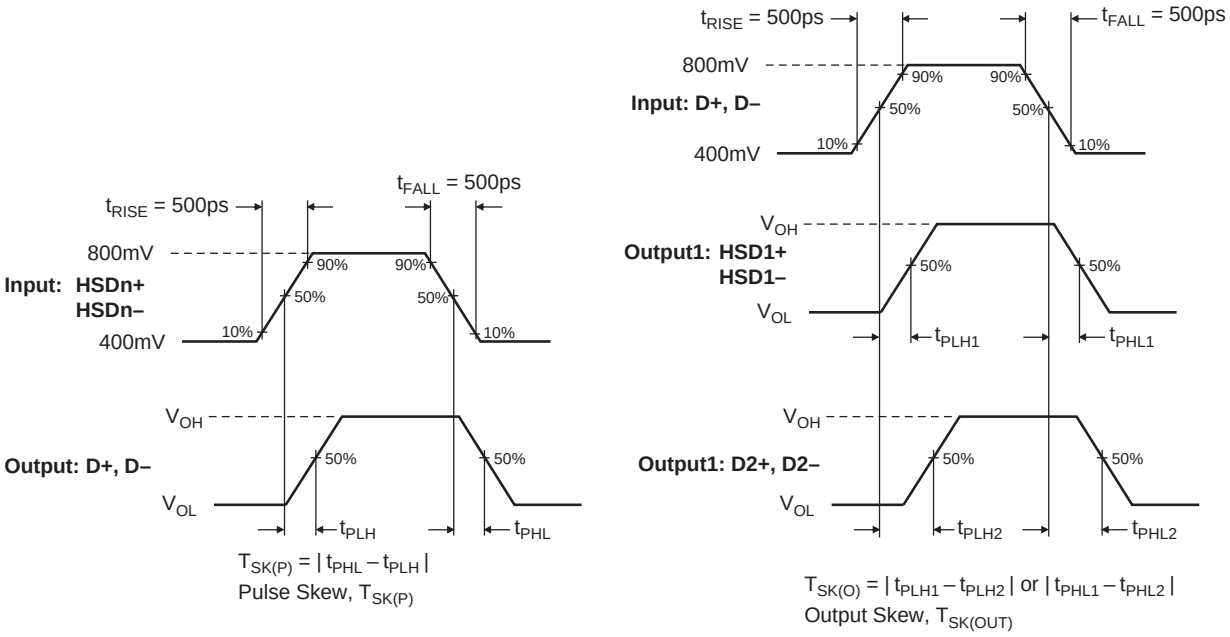
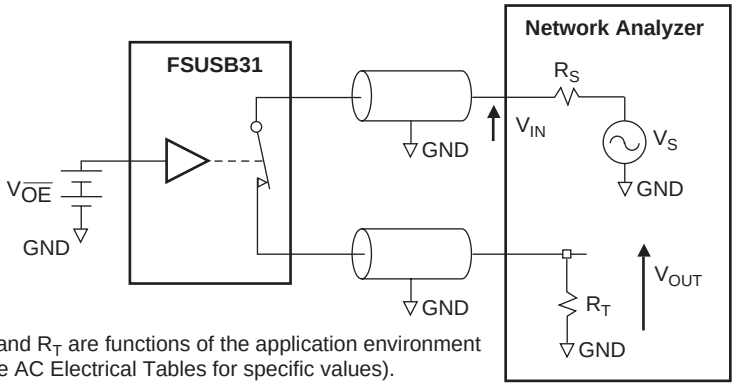


Figure 7. Switch Skew Tests



R_S and R_T are functions of the application environment (See AC Electrical Tables for specific values).

Figure 8. Bandwidth

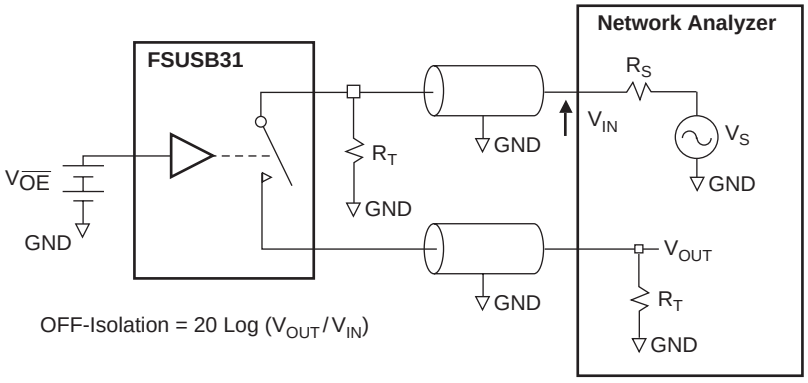


Figure 9. Channel OFF Isolation

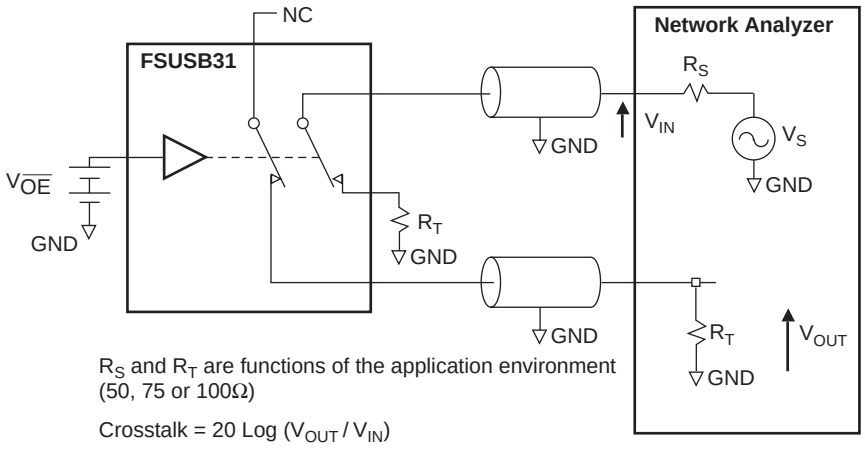


Figure 10. Non-Adjacent Channel-to-Channel Crosstalk

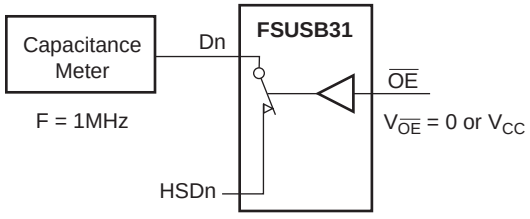


Figure 11. Channel ON Capacitance

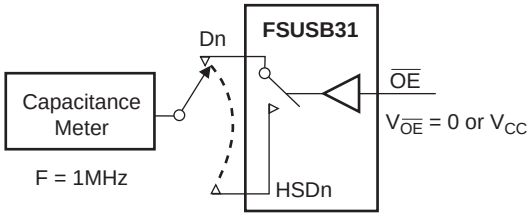


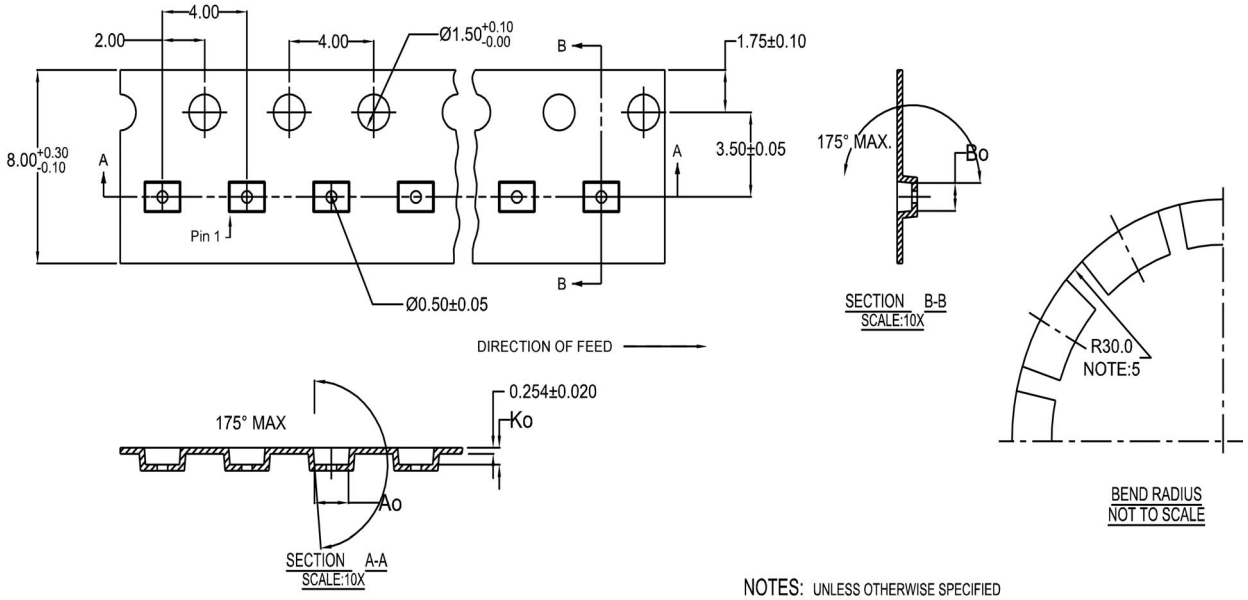
Figure 12. Channel OFF Capacitance

Tape and Reel Specification

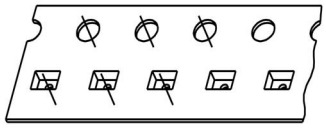
Tape Format for MircoPak

Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
L8X	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	5000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

Tape Dimension inches (millimeters)



10	300056	2.30±0.05	1.78±0.05	0.68±0.05
8	300038	1.78±0.05	1.78±0.05	0.68±0.05
6	300033	1.60±0.05	1.15±0.05	0.70±0.05

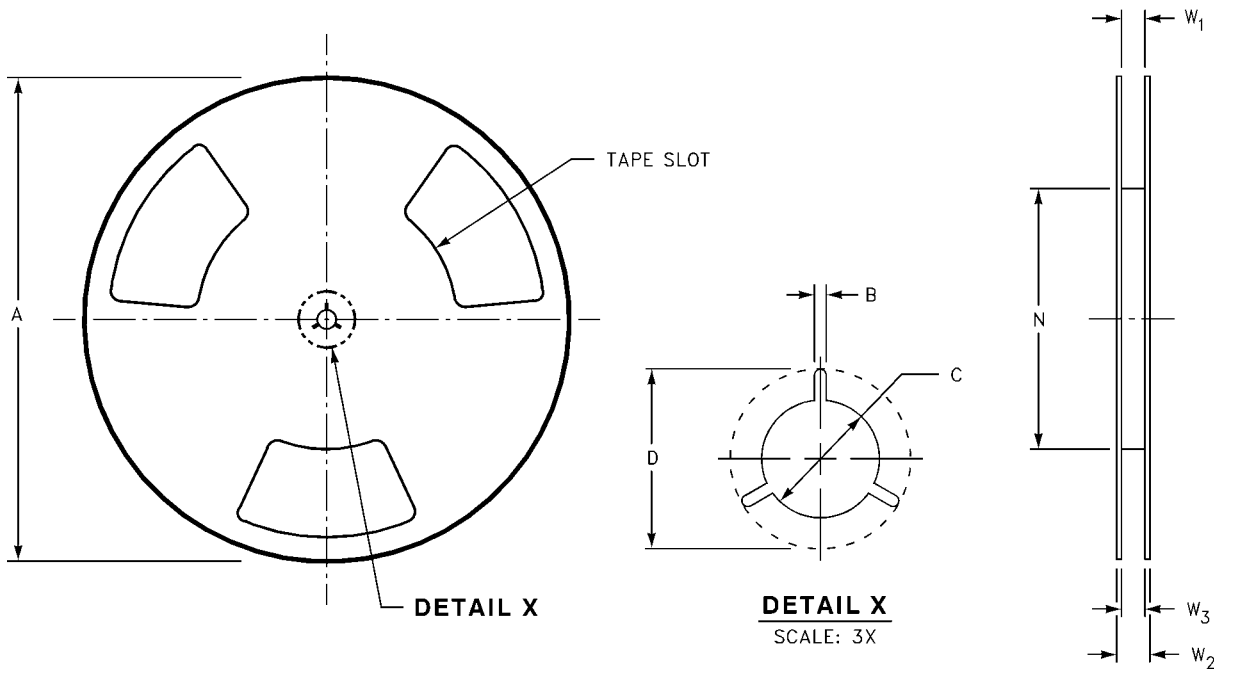


SCALE: 6X

NOTES: UNLESS OTHERWISE SPECIFIED

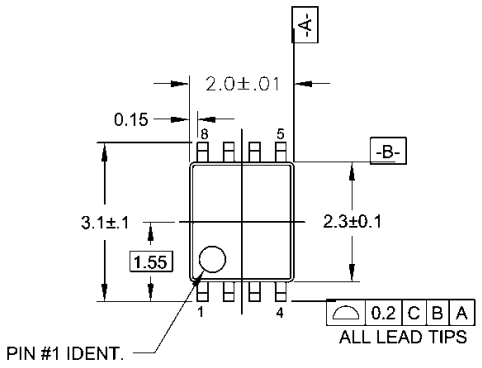
1. ACCUMULATED 50 SPROCKETS, SPROCKET HOLE PITCH IS 200.00 ±0.30MM
2. NO INDICATED CORNER RADIUS IS 0.127MM
3. CAMBER NOT TO EXCEED 1MM IN 100MM
4. SMALLEST ALLOWABLE BENDING RADIUS
5. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

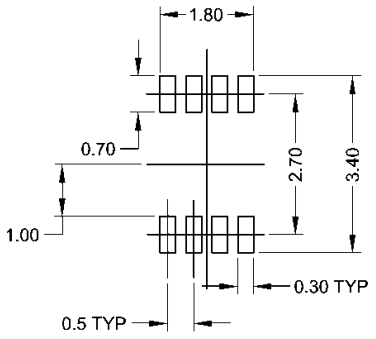
Reel Dimension for MircoPak inches (millimeters)



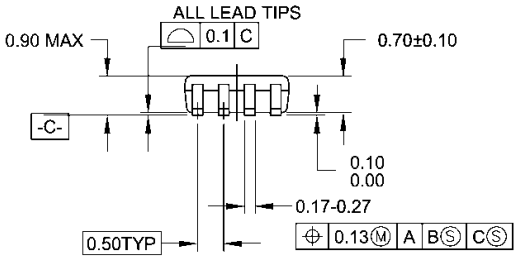
Tape Size	A	B	C	D	N	W1	W2	W3
8 mm	7.0 (177.8)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	2.165 (55.00)	0.331 + 0.059/–0.000 (8.40 + 1.50/–0.00)	0.567 (14.40)	W1 + 0.078/–0.039 (W1 + 2.00/–1.00)

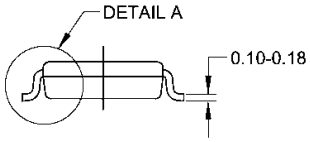
Physical Dimensions inches (millimeters) unless otherwise noted

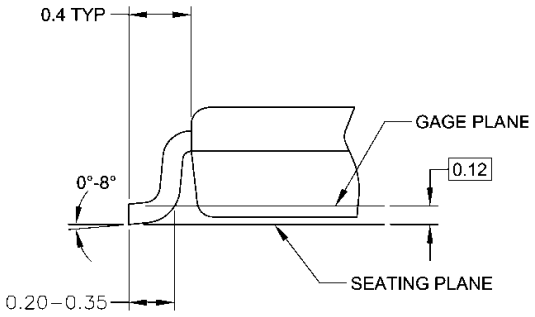




LAND PATTERN RECOMMENDATION







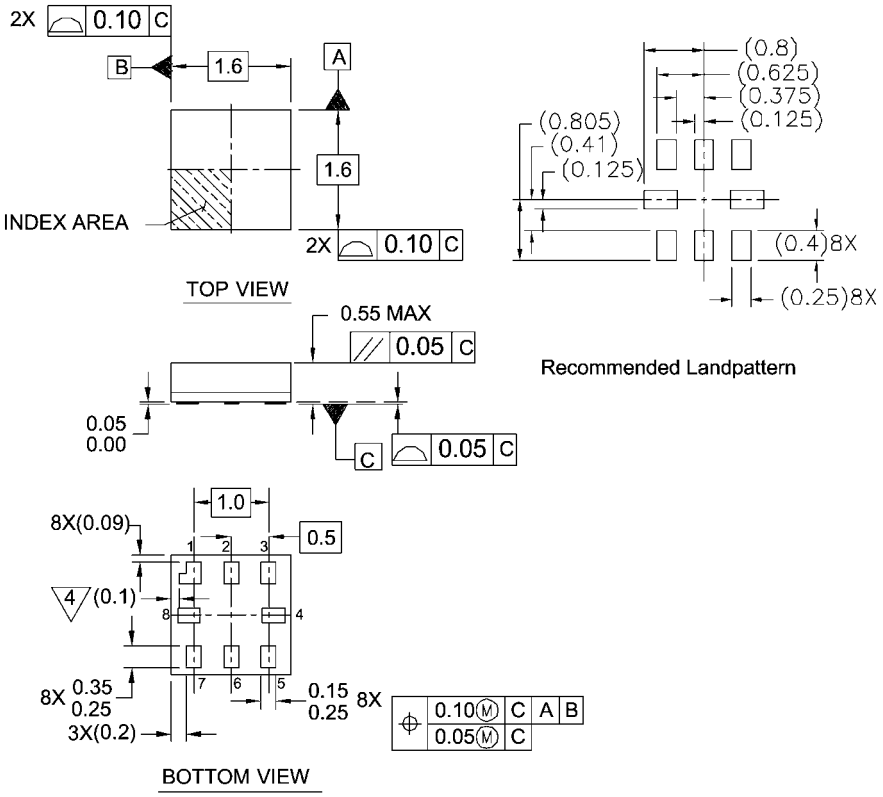
DETAIL A

NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-187
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MAB08AREVC

8-Lead US8, JEDEC MO-187, Variation CA 3.1mm Wide
Package Number MAB08A



Notes:

1. PACKAGE CONFORMS TO JEDEC MO-255 VARIATION UAAD
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y.14M-1994
4. PIN 1 FLAG, END OF PACKAGE OFFSET.

MAC08AREVC

Pb-Free 8-Lead MicroPak, 1.6 mm Wide
Package Number MAC08A

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Build it Now™	FRFET™	MicroFET™	QS™	TinyLogic®
CoolFET™	GlobalOptoisolator™	MicroPak™	QT Optoelectronics™	TINYOPTO™
CROSSVOLT™	GTO™	MICROWIRE™	Quiet Series™	TruTranslation™
DOME™	HiSeC™	MSX™	RapidConfigure™	UHC™
EcoSPARK™	I^2C™	MSXPro™	RapidConnect™	UltraFET®
E^2CMOS™	*i-Lo*™	OCX™	µSerDes™	UniFET™
EnSigna™	ImpliedDisconnect™	OCXPro™	ScalarPump™	VCX™
FACT™	IntelliMAX™	OPTOLOGIC®	SILENT SWITCHER®	Wire™
FACT Quiet Series™		OPTOPLANAR™	SMART START™	
Across the board. Around the world.™		PACMAN™	SPM™	
The Power Franchise®		POP™	Stealth™	
Programmable Active Droop™		Power247™	SuperFET™	
		PowerEdge™	SuperSOT™-3	

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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, or (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 significant injury to the user.

2. A critical component is 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.

PRODUCT STATUS DEFINITIONS

Definition of Terms

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

Rev. I17