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# FSUSB46 — Hi-Speed USB2.0 (480Mbps) DPST Switch with Dedicated Charger Port Detection

## Features

- Low On Capacitance: 7.0pF Typical
- Low On Resistance: 3.9Ω Typical
- Low Power Consumption: 1μA Maximum
  - 15μA Maximum  $I_{OCT}$  over an Expanded Voltage Range ( $V_{IN}=1.8V$ ,  $V_{CC}=4.3V$ )
- Wide -3db Bandwidth: > 720MHz
- Packaged in Pb-free, 8-Lead MicroPak™ (1.6mm wide), US8 (3.1mm wide), and UMLP (1.4x1.4mm)
- 8kV ESD Rating, >16kV Power/GND ESD Rating
- Power-Off Protection on All Ports When  $V_{CC}=0V$ 
  - D+/D- Pins Tolerate up to 5.25V

## Applications

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

## IMPORTANT NOTE:

For additional performance information, please contact [analogswitch@fairchildsemi.com](mailto:analogswitch@fairchildsemi.com).

## Description

The FSUSB46 is a bi-directional, low-power, Hi-Speed, USB2.0 switch. Configured as a double-pole, single-throw switch (DPST) switch, it is optimized for switching a Hi-Speed (480Mbps) source.

The FSUSB46 is compatible with the requirements of USB2.0 and features an extremely low on capacitance ( $C_{ON}$ ) of 3.9pF. The wide bandwidth of this device (720MHz) exceeds the bandwidth needed to pass the third harmonic, resulting in signals with minimum edge and phase distortion. Superior channel-to-channel crosstalk also minimizes interference.

The FSUSB46 contains special circuitry on the switch I/O pins for applications where the  $V_{CC}$  supply is powered-off ( $V_{CC}=0$ ), which allows the device to withstand an over-voltage condition. This device is designed to minimize current consumption even when the control voltage applied to the /OE pin is lower than the supply voltage ( $V_{CC}$ ). This feature is especially valuable to ultra-portable applications, such as cell phones, allowing for direct interface with the general-purpose I/Os of the baseband processor. An additional feature is the detection of the 1-1 (high/high) state on D+/D- to signal an interrupt (INT) to the processor when entering a dedicated charging port mode of operation.

## Ordering Information

Part Number	Operating Temperature Range	Package	Eco Status
FSUSB46L8X	-40 to +85°C	8-Lead MicroPak™ 1.6mm Wide	RoHS
FSUSB46K8X	-40 to +85°C	8-Lead US8, JEDEC MO187, Variation CA 3.1mm	Green
FSUSB46UMX	-40 to +85°C	8-Lead Ultrathin Molded Leadless Package (UMLP), 1.2 x 1.4mm	Green

 For Fairchild's definition of Eco Status, please visit: [http://www.fairchildsemi.com/company/green/rohs\\_green.html](http://www.fairchildsemi.com/company/green/rohs_green.html).

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

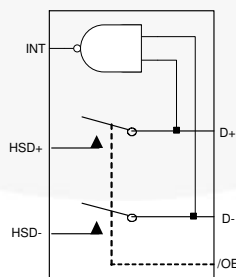
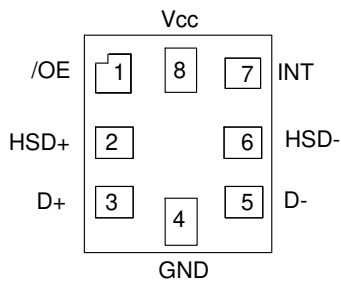
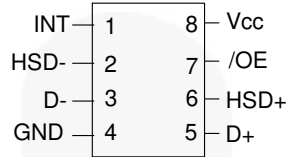


Figure 1. Analog Symbol

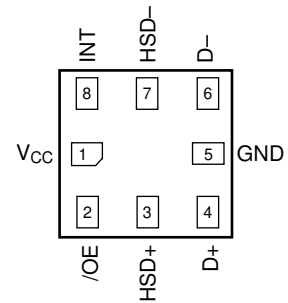
## Pin Configurations



**Figure 2. MicroPak™  
(Top Through View)**



**Figure 3. US8  
(Top Through View)**



**Figure 4. UMLP  
(Top Through View)**

## Pin Definitions

Pin Name	Description
INT	Interrupt Signaling Output Pin
/OE	Switch Enable
D+, D-	USB Data Bus Connector
HSD+, HSD-	USB Source Inputs
GND	Ground
V <sub>cc</sub>	Supply Voltage

## Truth Table

Data Path		Charger Detect Path	
/OE	Switch Connection	D+ D-	INT Output
HIGH	D+, D- = Open	1-1	LOW
LOW	D+, D- = HSD+, HSD-	0X, X0	HIGH

## 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	+5.5	V
$V_{CNTRL}$	DC Input Voltage (S) <sup>(1)</sup>	-0.5	$V_{CC}$	V
$V_{SW}$	DC Switch I/O Voltage <sup>(1)</sup>	-0.50	5.25	V
$I_{IK}$	DC Input Diode Current	-50		mA
$I_{OUT}$	DC Output Current		50	mA
$T_{STG}$	Storage Temperature	-65	+150	°C
ESD	Human Body Model, JEDEC: JESD22-A114	All Pins	7	kV
		I/O to GND	8	
		Power to GND	16	
	Charged Device Model, JEDEC: JESD22-C101	2		

**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	3.0	4.3	V
$V_{CNTRL}$	Control Input Voltage (/OE) <sup>(2)</sup>	0	$V_{CC}$	V
$V_{SW}$	Switch I/O Voltage	-0.5	$V_{CC}$	V
$T_A$	Operating Temperature	-40	+85	°C

**Note:**

- The control input must be held HIGH or LOW; it must not float.

## DC Electrical Characteristics

All typical value are at 25°C,  $V_{CC}=3.3V$  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
$V_{IL}$	Input Voltage Low		3.0 to 3.6			0.5	V
			4.3			0.7	V
$V_{OH}$	Output Voltage High	$I_{OH}=-2mA$	3.0 to 3.6	2.4			V
			4.3	2.4			V
$V_{OL}$	Output Voltage Low	$I_{OL}=2mA$	3.0 to 3.6			0.25	V
			4.3			0.25	V
$I_{IN}$	Control Input Leakage	$V_{SW}=0$ to $V_{CC}$	4.3	-1		1	$\mu A$
$I_{OZ}$	Off State Leakage	HSD+ or HSD-=0V, 3.6V or floating	4.3	-2		2	$\mu A$
$I_{OFF}$	Power-Off Leakage Current (All I/O Ports)	$V_{SW}=0V$ to 4.3V, $V_{CC}=0V$ Figure 6	0	-2		2	$\mu A$
$R_{ON}$	HS Switch On Resistance <sup>(3)</sup>	$V_{SW}=0.4V$ , $I_{ON}=-8mA$ Figure 5	3.0		3.9	6.5	$\Omega$
$\Delta R_{ON}$	HS Delta $R_{ON}$ <sup>(4)</sup>	$V_{SW}=0.4V$ , $I_{ON}=-8mA$	3.0		0.65		$\Omega$
$I_{CC}$	Quiescent Supply Current	$V_{CNTRL}=0$ or $V_{CC}$ , $I_{OUT}=0$	4.3			1	$\mu A$
$I_{CCT}$	Increase in $I_{CC}$ Current Per Control Voltage and $V_{CC}$	$V_{CNTRL}=2.6V$ $V_{CC}=4.3V$	4.3			10	$\mu A$
		$V_{CNTRL}=1.8V$ $V_{CC}=4.3V$	4.3			20	$\mu A$

### Notes:

- Measured by the voltage drop between HSDn and Dn pins at the indicated current through the switch. On resistance is determined by the lower of the voltage on the two (HSDn or Dn ports).
- Guaranteed by characterization.

## AC Electrical Characteristics

All typical value are for  $V_{CC}=3.3V$  at  $25^{\circ}C$  unless otherwise specified.

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A=-40^{\circ}C$ to $+85^{\circ}C$			Units
				Min.	Typ.	Max.	
$t_{ON}$	Turn-On Time /OE to Output	$R_L=50\Omega$ , $C_L=5pF$ $V_{SW}=0.8V$ Figure 7, Figure 8	3.0 to 3.6		13	30	ns
$t_{OFF}$	Turn-Off Time /OE to Output	$R_L=50\Omega$ , $C_L=5pF$ $V_{SW}=0.8V$ Figure 7, Figure 8	3.0 to 3.6		12	25	ns
$t_{PD}$	Propagation Delay <sup>(5)</sup>	$C_L=5 pF$ , $R_L=50\Omega$ Figure 7, Figure 9	3.3		0.25		ns
$t_{BBM}$	Break-Before-Make	$R_L=50\Omega$ , $C_L=5pF$ $V_{SW1}=V_{SW2}=0.8V$ Figure 13	3.0 to 3.6	2.0		6.5	ns
$t_{PLH/HL}$	INT Propagation Delay <sup>(5)</sup>	$R_L=500\Omega$ , $C_L=5pF$	3.0 to 3.6		10		ns
$O_{IRR}$	Off Isolation	$R_L=50\Omega$ , $f=240MHz$ Figure 15	3.0 to 3.6		-30		dB
Xtalk	Non-Adjacent Channel Crosstalk	$R_L=50\Omega$ , $f=240MHz$ Figure 16	3.0 to 3.6		-45		dB
BW	-3db Bandwidth	$R_L=50\Omega$ , $C_L=0pF$ Figure 14	3.0 to 3.6		720		MHz
		$R_L=50\Omega$ , $C_L=5pF$ Figure 14			550		MHz

**Note:**

5. Guaranteed by characterization.

## USB Hi-Speed-Related AC Electrical Characteristics

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A=-40^{\circ}C$ to $+85^{\circ}C$			Units
				Min.	Typ.	Max.	
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output <sup>(6)</sup>	$C_L=5pF$ , $R_L=50\Omega$ Figure 10	3.0 to 3.6		20		ps
$t_J$	Total Jitter <sup>(6)</sup>	$R_L=50\Omega$ , $C_L=5pf$ , $t_R=t_F=500ps$ (10-90%) at 480Mbps (PRBS= $2^{15}-1$ )	3.0 to 3.6		200		ps

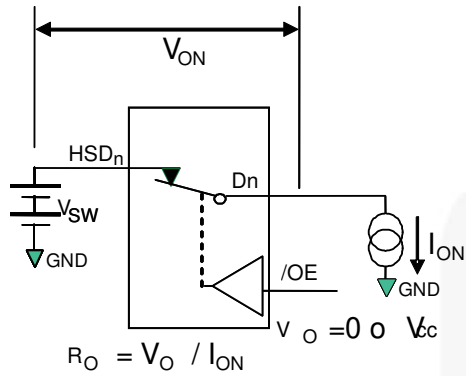
**Note:**

6. Guaranteed by characterization.

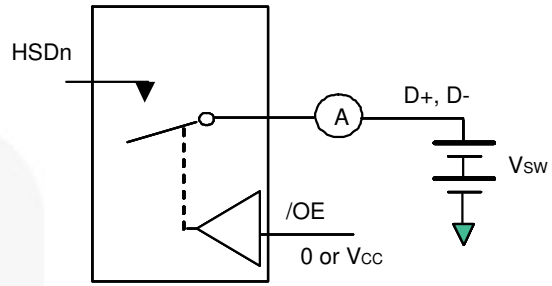
## Capacitance

Symbol	Parameter	Conditions	$T_A=-40^{\circ}C$ to $+85^{\circ}C$			Units
			Min.	Typ.	Max.	
$C_{IN}$	Control Pin Input Capacitance	$V_{CC}=0V$		1.5		pF
$C_{OUT}$	INT Pin Output Capacitance	$V_{CC}=0V$		2.5		pF
$C_{ON}$	D+, D- On Capacitance	$V_{CC}=3.3V$ , $f=1MHz$ Figure 12		7.0	7.9	pF
$C_{OFF}$	D+, D- Off Capacitance	$V_{CC}=3.3V$ Figure 11		2.0		pF

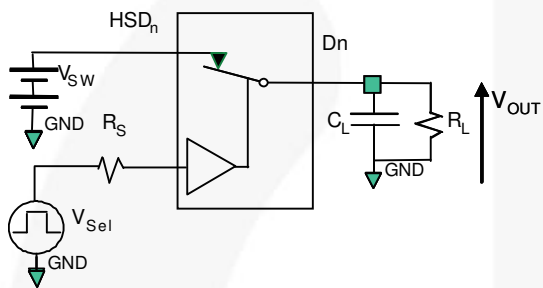
### Test Diagrams



**Figure 5. On Resistance**

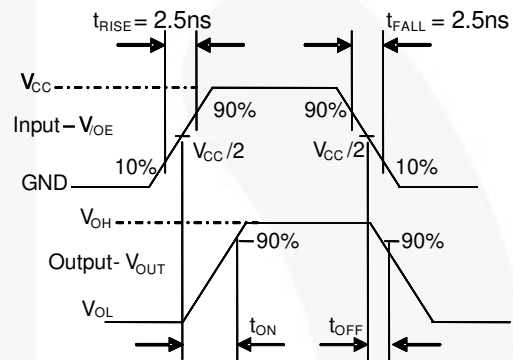


**Figure 6. Off/On Leakage**

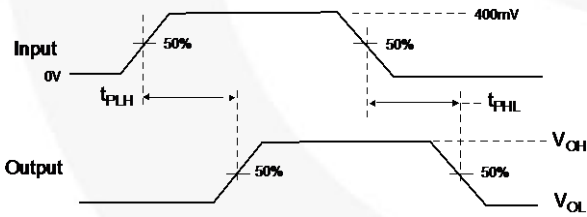


$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance.

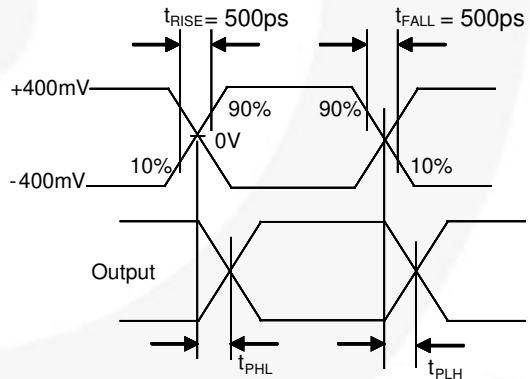
**Figure 7. AC Test Circuit Load**



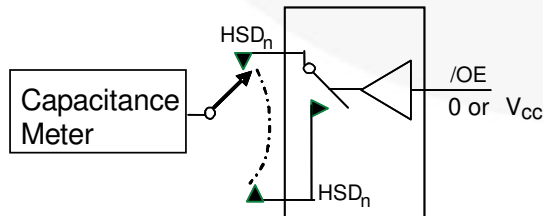
**Figure 8. Turn-On / Turn-Off Waveforms**



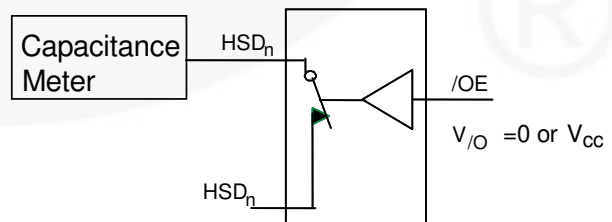
**Figure 9. Propagation Delay ( $t_{r,t_f} = 500ps$ )**



**Figure 10. Intra-Pair Skew Test  $t_{SK(P)}$**



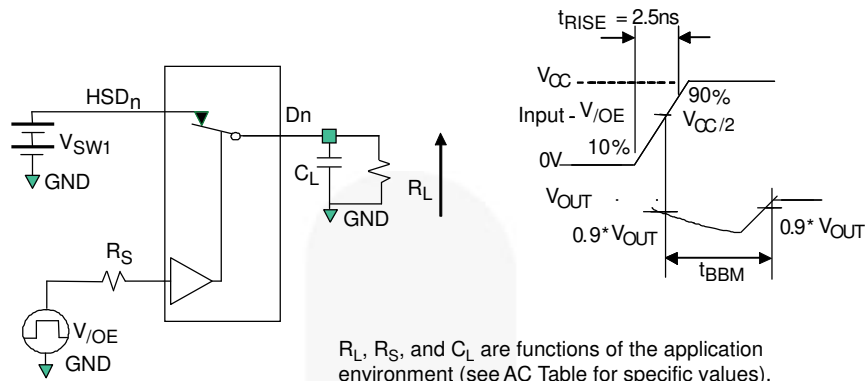
**Figure 11. Channel Off Capacitance**



**Figure 12. Channel On Capacitance**

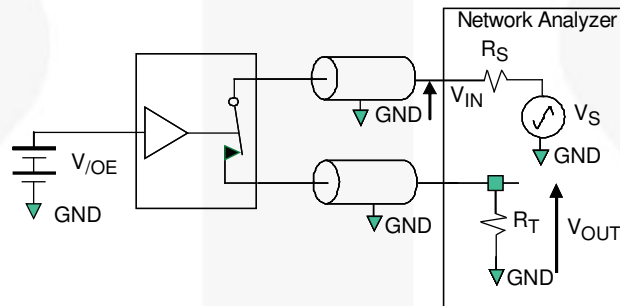


Test Diagrams (Continued)



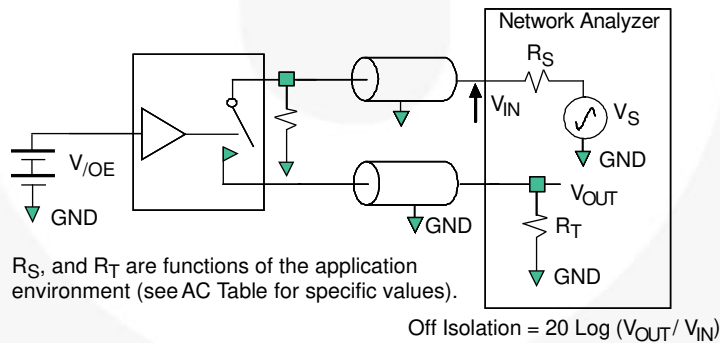
$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Table for specific values).  $C_L$  includes text figure and stray capacitance.

Figure 13. Break-Before-Make Interval Timing



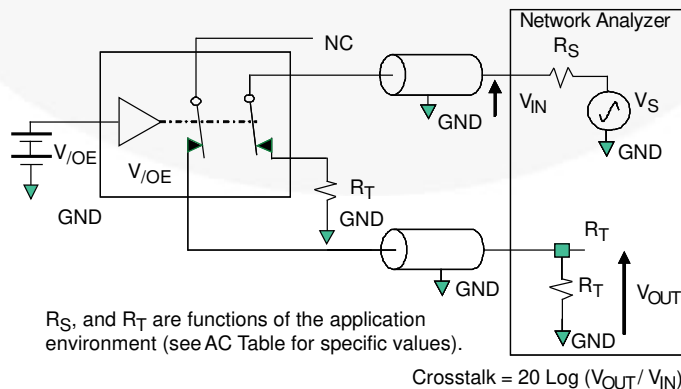
$R_S$ , and  $R_T$  are functions of the application environment (see AC Table for specific values).

Figure 14. Bandwidth



$R_S$ , and  $R_T$  are functions of the application environment (see AC Table for specific values).

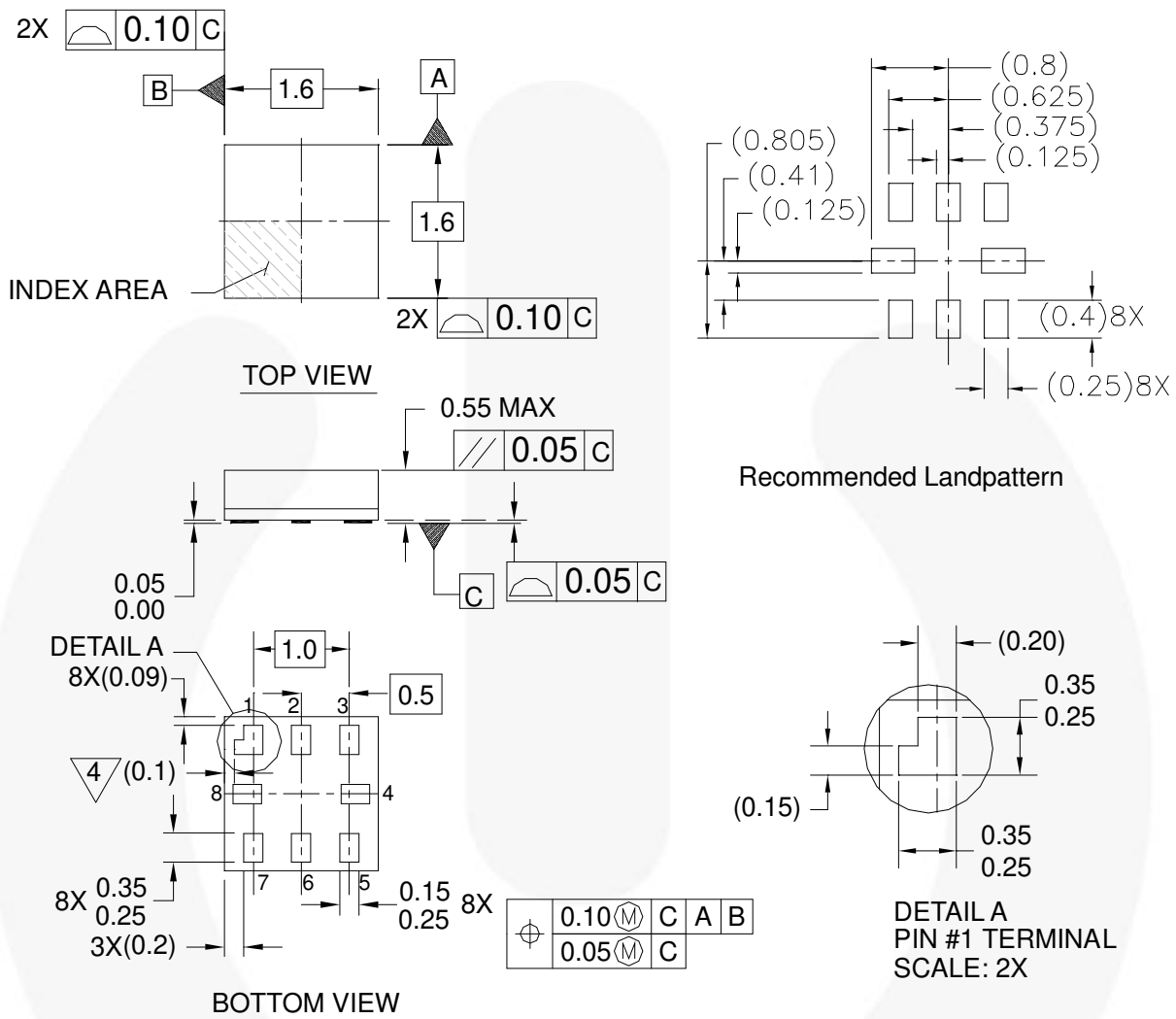
Figure 15. Channel Off Isolation



$R_S$ , and  $R_T$  are functions of the application environment (see AC Table for specific values).

Figure 16. Non-Adjacent Channel-to-Channel Crosstalk

## Physical Dimensions



**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
5. DRAWING FILE NAME: MKT-MAC08AREV4

MAC08AREV4

**Figure 17. 8-Lead MicroPak™**

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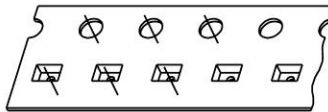
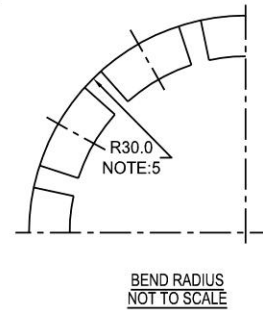
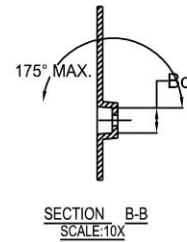
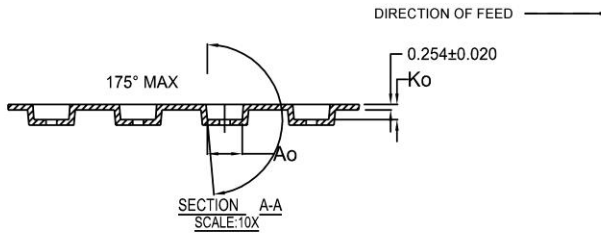
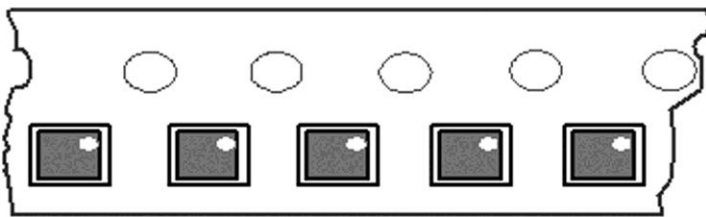
### Tape and Reel Specifications

Package Designator	Tape Section	Cavity Number	Cavity Status	Cover Tape Status
L6X, L8X, L10X	Leader (Start End)	125 (Typical)	Empty	Sealed
	Carrier	5000	Filled	Sealed
	Trailer (Hub End)	75 (Typical)	Empty	Sealed

#### Standard Tape and Reel Specifications

Standard tape and reel specifications for MicroPak are available at Fairchild Semiconductor's website:  
[http://www.fairchildsemi.com/products/logic/pdf/micropak\\_tr.pdf](http://www.fairchildsemi.com/products/logic/pdf/micropak_tr.pdf)

#### FSUSB46L8X\_F130 Tape and Reel Specifications



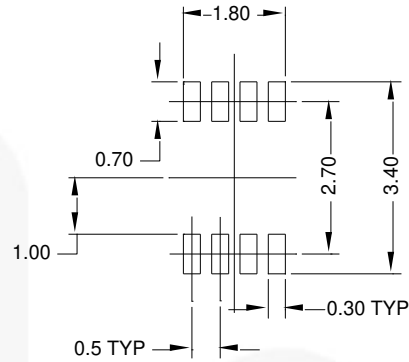
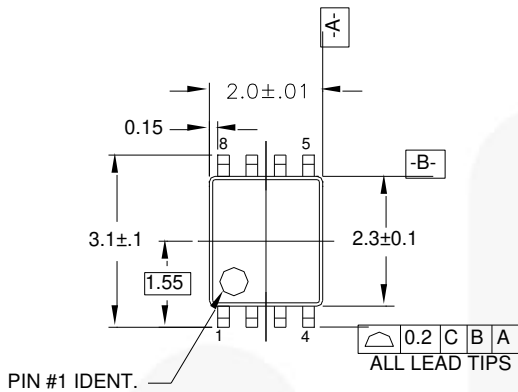
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NOTES: UNLESS OTHERWISE SPECIFIED

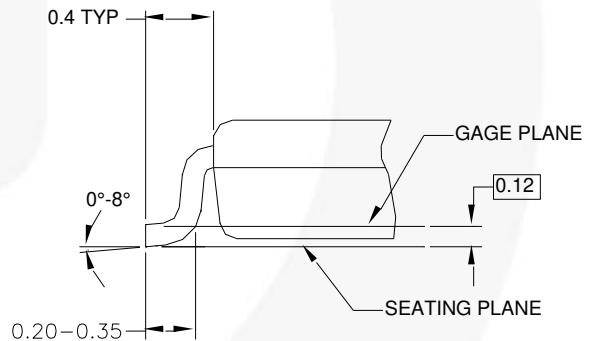
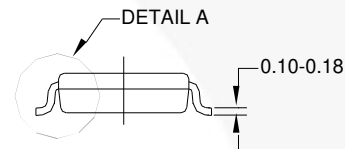
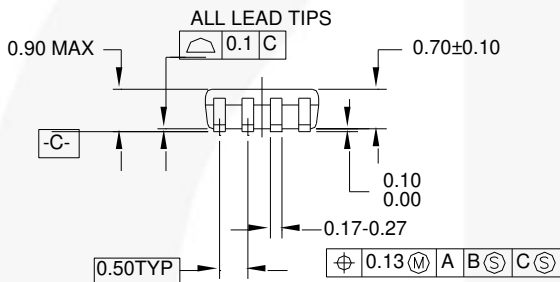
1. ACCUMULATED 50 SPROCKETS, SPROCKET HOLE PITCH IS 200.00 ±0.30MM
2. NO INDICATED CORNER RADIUS IS 0.127MM
3. CAMBER NOT TO EXCEED 1MM IN 100MM
4. SMALLEST ALLOWABLE BENDING RADIUS
5. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

10	30056	2.30 ± 0.1mm	1.78 ± 0.1mm	0.68 ± 0.1mm
8	30038	1.78 ± 0.1mm	1.78 ± 0.1mm	0.68 ± 0.1mm
6	30033	1.60 ± 0.1mm	1.15 ± 0.1mm	0.70 ± 0.1mm

Physical Dimensions



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

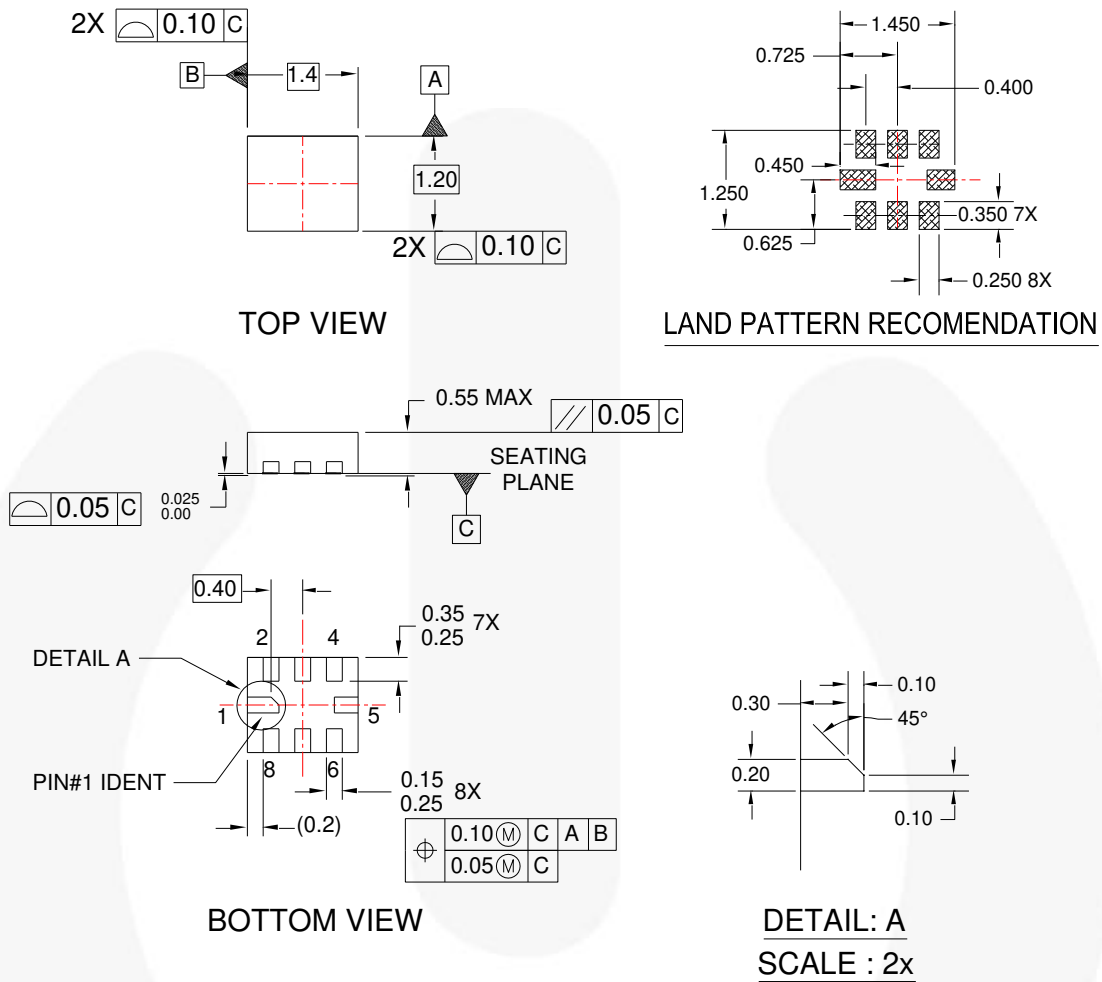
Figure 18. 8-Lead US8, JEDEC MO-187

For current tape and reel specifications, visit Fairchild Semiconductor's online packaging area:  
<http://www.fairchildsemi.com/ms/MS/MS-522.pdf>

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Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:  
<http://www.fairchildsemi.com/packaging/>.

## Physical Dimensions



### NOTES:

- A. DOES NOT CONFORMS TO JEDEC STANDARD.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES CONFORMS TO ASME Y14.5M, 1994.
- D. DRAWING FILE NAME : UMLP08Arev1

**Figure 19. 8-Lead, Ultrathin Molded Leadless Package (UMLP), 1.2 x 1.4mm**


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