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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  $I_{CCT}$  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).

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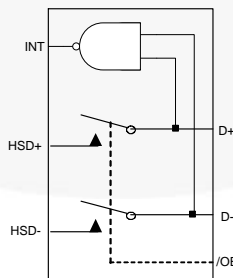
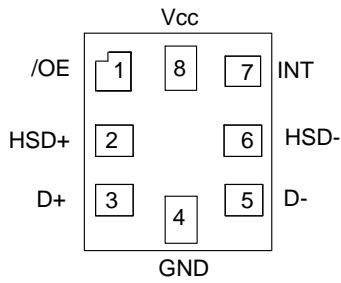
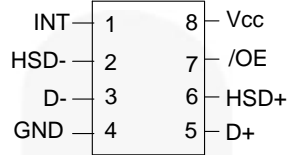


Figure 1. Analog Symbol

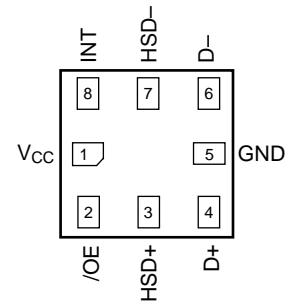
## Pin Configurations



**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<sub>CC</sub>=3.3V unless otherwise specified.

| Symbol           | Parameter   | Conditions   | V <sub>CC</sub> (V) | T <sub>A</sub> =- 40°C to +85°C |      |      | Units |
|------------------|---|--|---------------------|---------------------------------|------|------|-------|
|                  |   |  |                     | Min.                            | Typ. | Max. |       |
| V <sub>IK</sub>  | Clamp Diode Voltage   | I <sub>IN</sub> =-18mA   | 3.0                 |                                 |      | -1.2 | V     |
| V <sub>IH</sub>  | Input Voltage High  |  | 3.0 to 3.6          | 1.3                             |      |      | V     |
|                  |   |  | 4.3                 | 1.7                             |      |      | V     |
| V <sub>IL</sub>  | Input Voltage Low   |  | 3.0 to 3.6          |                                 |      | 0.5  | V     |
|                  |   |  | 4.3                 |                                 |      | 0.7  | V     |
| V <sub>OH</sub>  | Output Voltage High   | I <sub>OH</sub> =-2mA  | 3.0 to 3.6          | 2.4                             |      |      | V     |
|                  |   |  | 4.3                 | 2.4                             |      |      | V     |
| V <sub>OL</sub>  | Output Voltage Low  | I <sub>OL</sub> =2mA   | 3.0 to 3.6          |                                 |      | 0.25 | V     |
|                  |   |  | 4.3                 |                                 |      | 0.25 | V     |
| I <sub>IN</sub>  | Control Input Leakage   | V <sub>SW</sub> =0 to V <sub>CC</sub>                          | 4.3                 | -1                              |      | 1    | μA    |
| I <sub>OZ</sub>  | Off State Leakage   | HSD+ or HSD-=0V, 3.6V or floating                              | 4.3                 | -2                              |      | 2    | μA    |
| I <sub>OFF</sub> | Power-Off Leakage Current (All I/O Ports)                                   | V <sub>SW</sub> =0V to 4.3V, V <sub>CC</sub> =0V<br>Figure 6   | 0                   | -2                              |      | 2    | μA    |
| R <sub>ON</sub>  | HS Switch On Resistance <sup>(3)</sup>                                      | V <sub>SW</sub> =0.4V, I <sub>ON</sub> =-8mA<br>Figure 5       | 3.0                 |                                 | 3.9  | 6.5  | Ω     |
| ΔR <sub>ON</sub> | HS Delta R <sub>ON</sub> <sup>(4)</sup>                                     | V <sub>SW</sub> =0.4V, I <sub>ON</sub> =-8mA                   | 3.0                 |                                 | 0.65 |      | Ω     |
| I <sub>CC</sub>  | Quiescent Supply Current  | V <sub>CNTRL</sub> =0 or V <sub>CC</sub> , I <sub>OUT</sub> =0 | 4.3                 |                                 |      | 1    | μA    |
| I <sub>CCT</sub> | Increase in I <sub>CC</sub> Current Per Control Voltage and V <sub>CC</sub> | V <sub>CNTRL</sub> =2.6V V <sub>CC</sub> =4.3V                 | 4.3                 |                                 |      | 10   | μA    |
|                  |   | V <sub>CNTRL</sub> =1.8V V <sub>CC</sub> =4.3V                 | 4.3                 |                                 |      | 20   | μA    |

### 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           | $R_L=50\Omega$ , $C_L=5pF$<br>$V_{SW}=0.8V$<br>Figure 7, Figure 8 | 3.0 to 3.6   |                                      | 13   | 30   | ns    |
| $t_{OFF}$    | Turn-Off Time /OE to Output          | $R_L=50\Omega$ , $C_L=5pF$<br>$V_{SW}=0.8V$<br>Figure 7, Figure 8 | 3.0 to 3.6   |                                      | 12   | 25   | ns    |
| $t_{PD}$     | Propagation Delay <sup>(5)</sup>     | $C_L=5 pF$ , $R_L=50\Omega$<br>Figure 7, Figure 9                 | 3.3          |                                      | 0.25 |      | ns    |
| $t_{BBM}$    | Break-Before-Make                    | $R_L=50\Omega$ , $C_L=5pF$<br>$V_{SW1}=V_{SW2}=0.8V$<br>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                        | $R_L=50\Omega$ , $f=240MHz$<br>Figure 15                          | 3.0 to 3.6   |                                      | -30  |      | dB    |
| Xtalk        | Non-Adjacent Channel Crosstalk       | $R_L=50\Omega$ , $f=240MHz$<br>Figure 16                          | 3.0 to 3.6   |                                      | -45  |      | dB    |
| BW           | -3db Bandwidth                       | $R_L=50\Omega$ , $C_L=0pF$<br>Figure 14                           | 3.0 to 3.6   |                                      | 720  |      | MHz   |
|              |                                      | $R_L=50\Omega$ , $C_L=5pF$<br>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> | $C_L=5pF$ , $R_L=50\Omega$<br>Figure 10  | 3.0 to 3.6   |                                      | 20   |      | ps    |
| $t_J$       | Total Jitter <sup>(6)</sup>                                    | $R_L=50\Omega$ , $C_L=5pf$ ,<br>$t_R=t_F=500ps$ (10-90%) at<br>480Mbps (PRBS= $2^{15}-1$ ) | 3.0 to 3.6   |                                      | 200  |      | ps    |

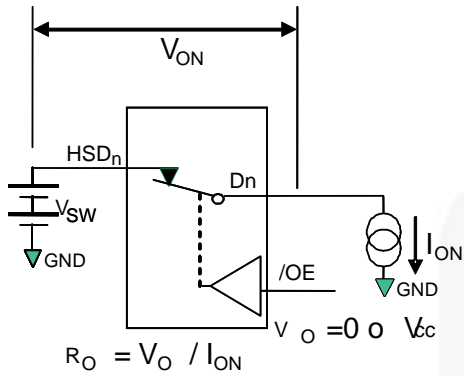
**Note:**

6. Guaranteed by characterization.

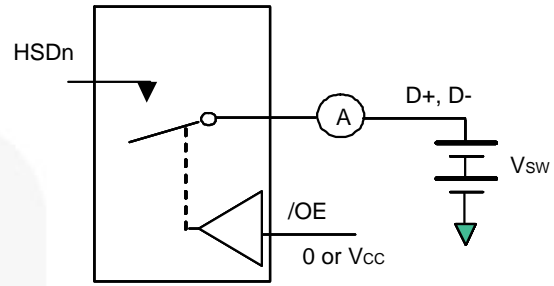
## Capacitance

| 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         | $V_{CC}=3.3V$ , $f=1MHz$<br>Figure 12 |                                      | 7.0  | 7.9  | pF    |
| $C_{OFF}$ | D+, D- Off Capacitance        | $V_{CC}=3.3V$<br>Figure 11            |                                      | 2.0  |      | pF    |

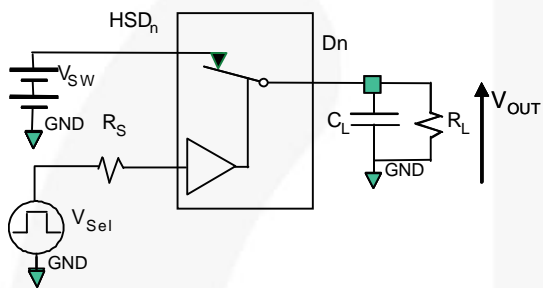
### Test Diagrams



**Figure 5. On Resistance**

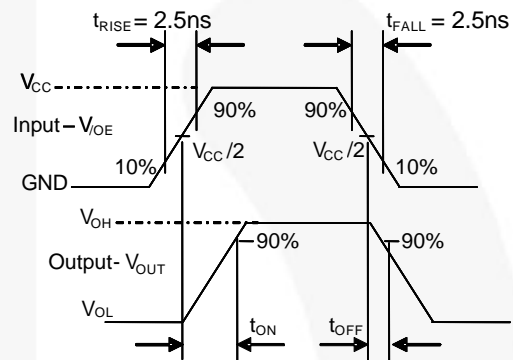


**Figure 6. Off/On Leakage**

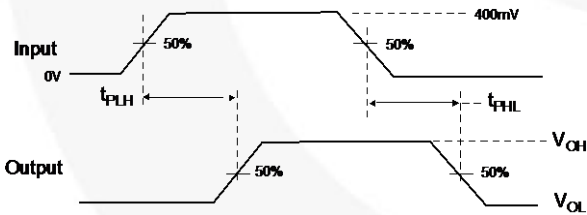


$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance.

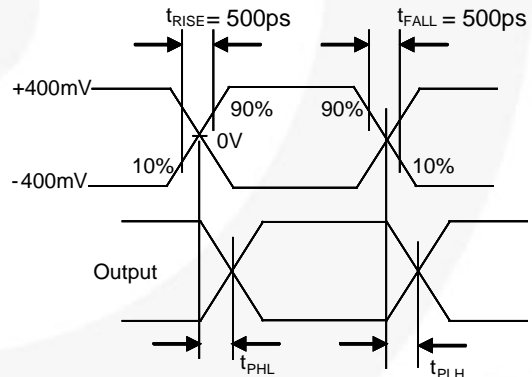
**Figure 7. AC Test Circuit Load**



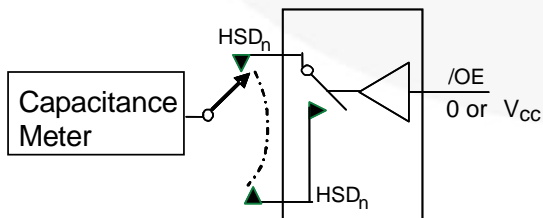
**Figure 8. Turn-On / Turn-Off Waveforms**



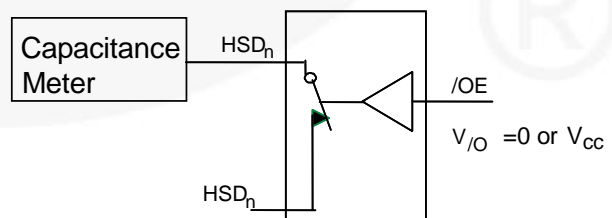
**Figure 9. Propagation Delay ( $t_{r,t_f} = 500ps$ )**



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

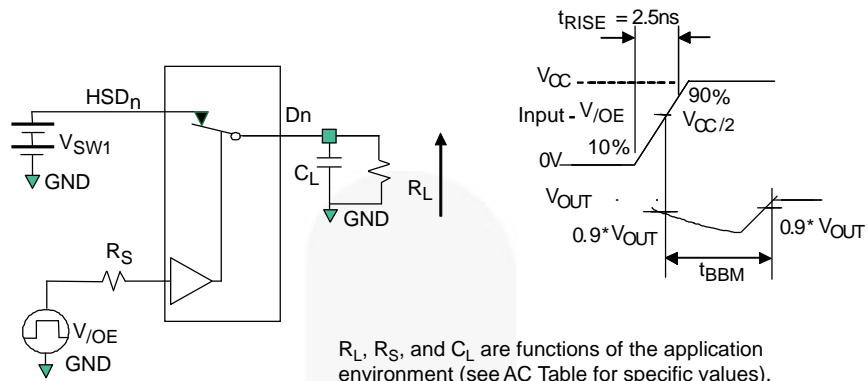


**Figure 11. Channel Off Capacitance**



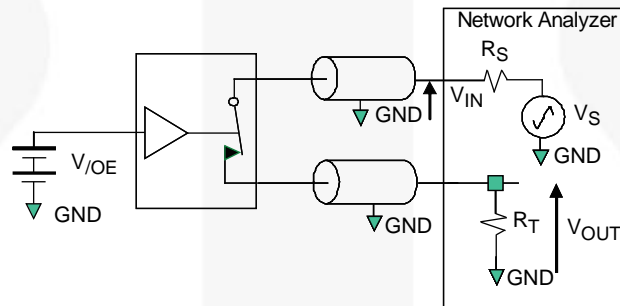
**Figure 12. Channel On Capacitance**

**Test Diagrams (Continued)**



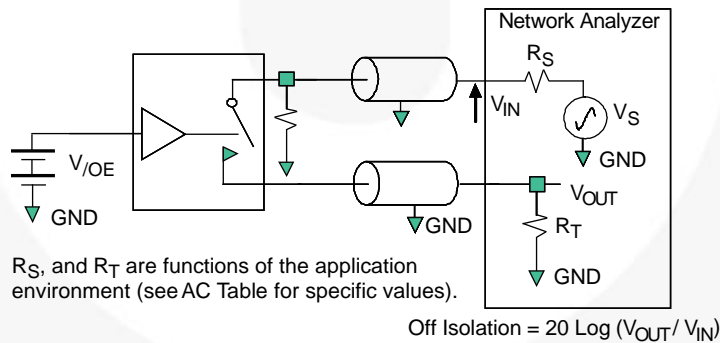
$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Table for specific values).  $C_L$  includes text figure and stray capacitance.

**Figure 13. Break-Before-Make Interval Timing**



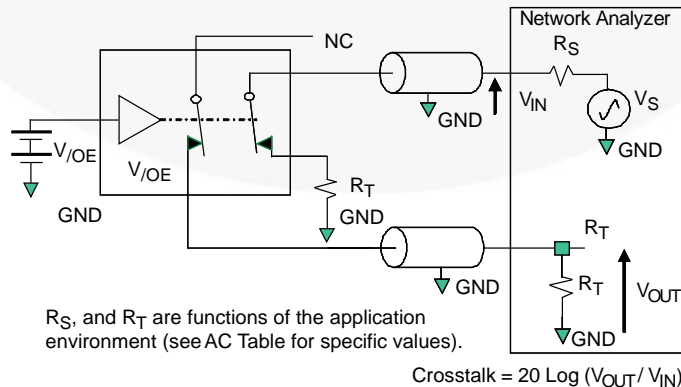
$R_S$ , and  $R_T$  are functions of the application environment (see AC Table for specific values).

**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**

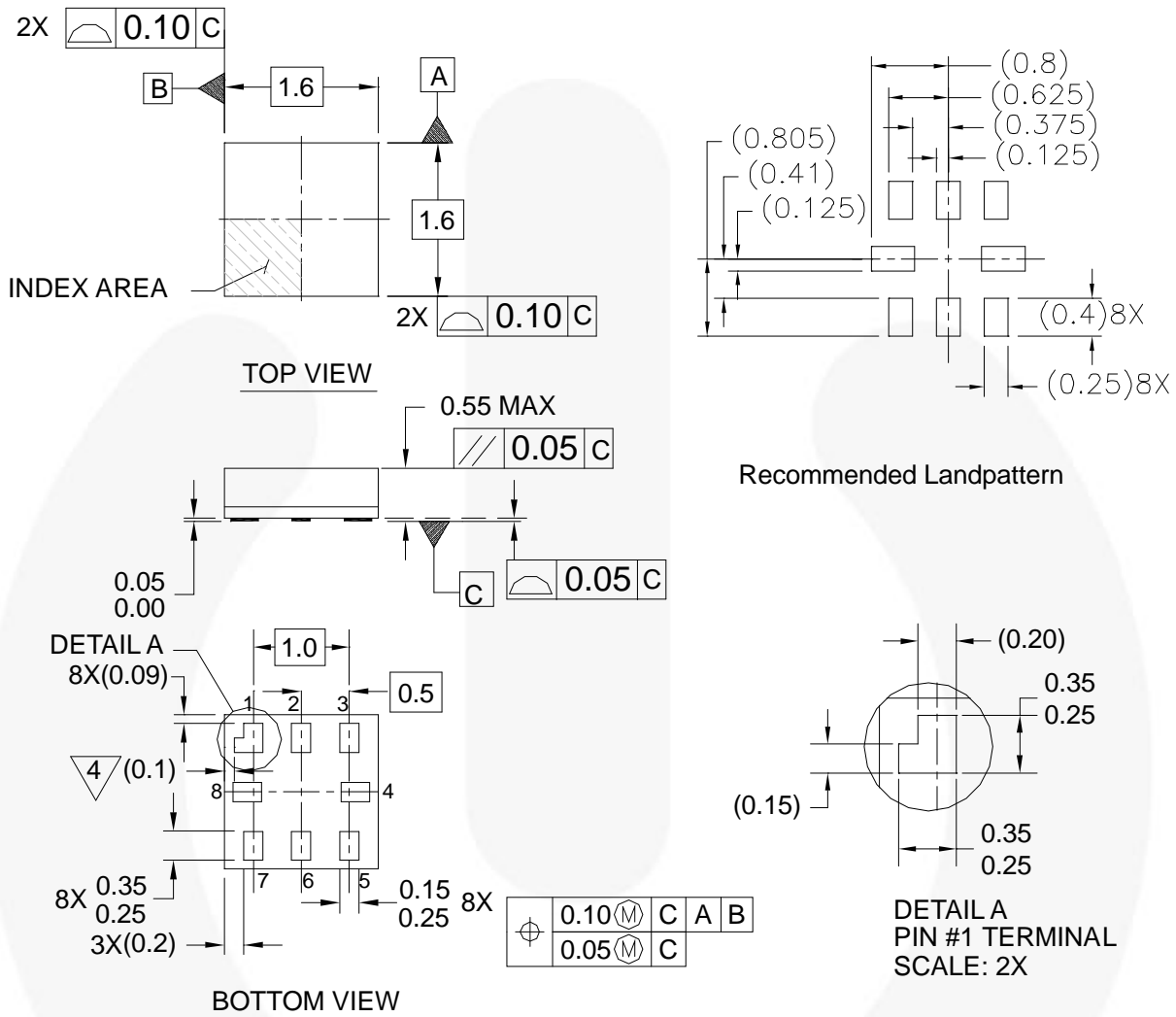


$R_S$ , and  $R_T$  are functions of the application environment (see AC Table for specific values).

**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™**

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.

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

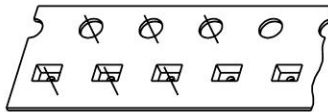
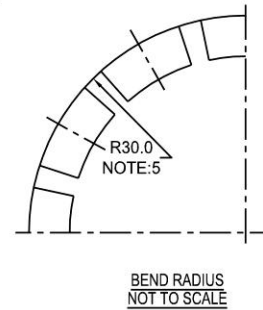
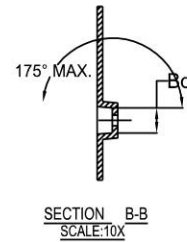
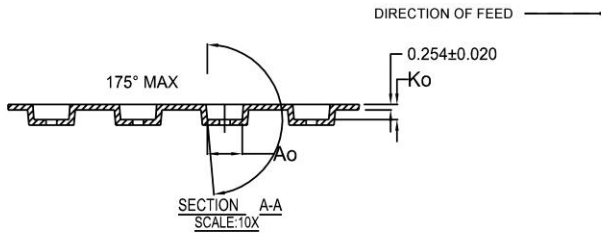
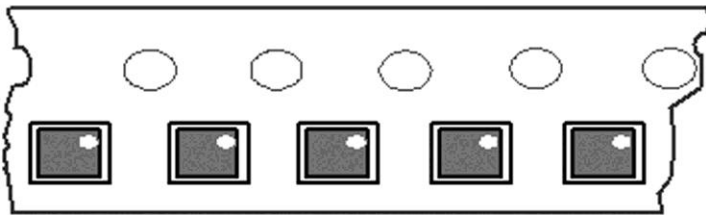
### Tape and Reel Specifications

| 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



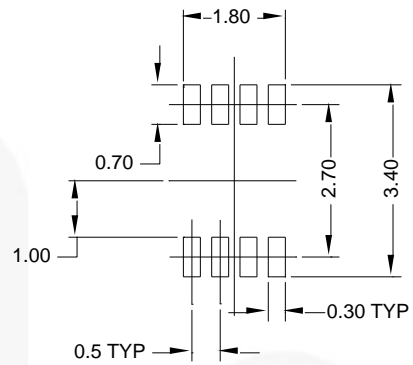
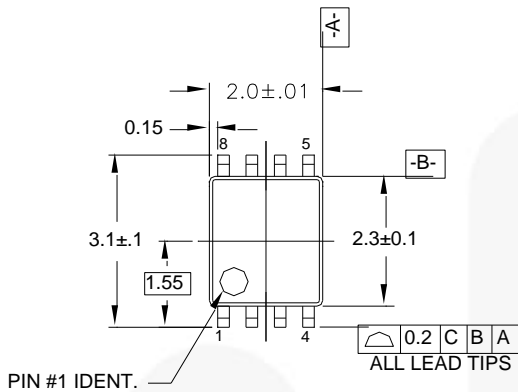
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NOTES: UNLESS OTHERWISE SPECIFIED

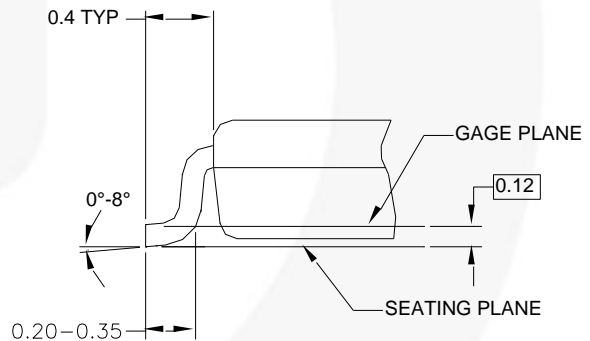
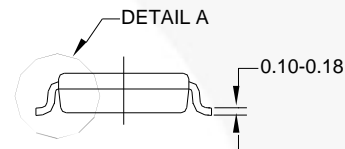
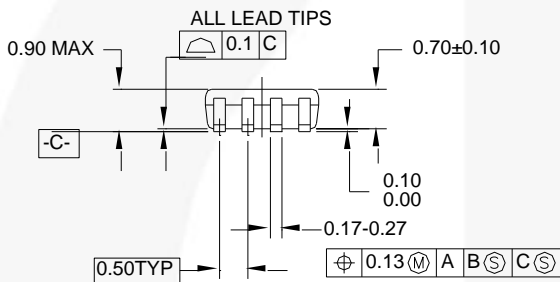
1. ACCUMULATED 50 SPROCKETS, SPROCKET HOLE PITCH IS 200.00 ±0.30MM
2. NO INDICATED CORNER RADIUS IS 0.127MM
3. CAMBER NOT TO EXCEED 1MM IN 100MM
4. SMALLEST ALLOWABLE BENDING RADIUS
5. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

|    |       |              |              |              |
|----|-------|--------------|--------------|--------------|
| 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



### 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

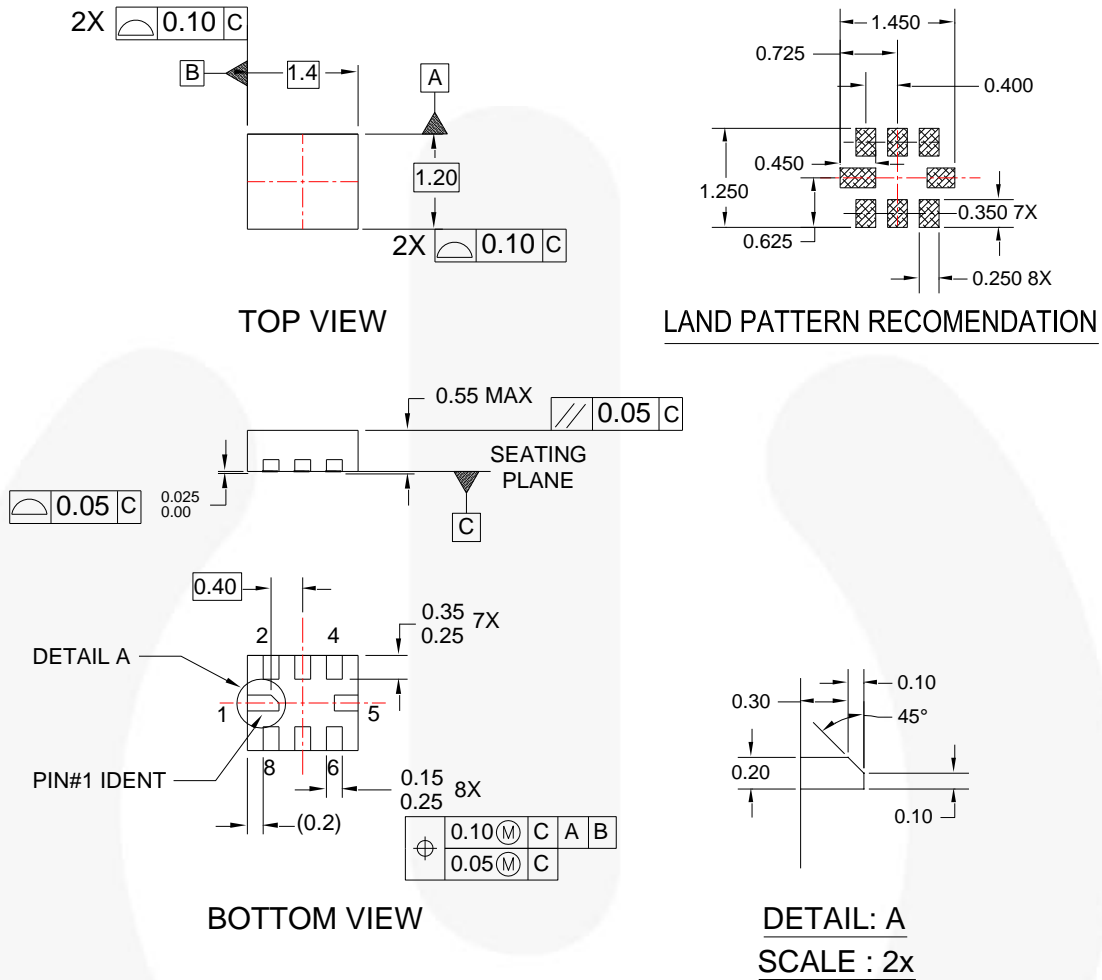
Figure 18. 8-Lead US8, JEDEC MO-187

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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## 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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