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# FSUSB45 — High-Speed USB2.0 (480Mbps) Switch with Dedicated Charger Port Detect

## Features

- Low On Capacitance: 7.0 pF Typical
- Low On Resistance: 3.9 Ω Typical
- Low Power Consumption: 1 μA Maximum
  - 15 μA Maximum I<sub>CC</sub>T over an Expanded Voltage Range (V<sub>IN</sub>=1.8 V, V<sub>CC</sub>=4.3 V)
- Wide -3 db Bandwidth: > 720 MHz
- Packaged in:
  - 10-Lead MicroPak™ (1.6 x 2.1 mm)
  - 10-Lead UMLP (1.4 x 1.8 mm)
- 8 kV ESD Rating, >16 kV Power/GND ESD Rating
- Power-Off Protection on All Ports When V<sub>CC</sub>=0 V
  - D+/D- Pins Tolerate up to 5.25 V

## 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 FSUSB45 is a bi-directional, low-power, two-port, High-Speed, USB2.0 switch. Configured as a double-pole, double-throw (DPDT) switch, it is optimized for switching between two HS (480 Mbps) sources or an HS source and a Full-Speed (12 Mbps) source.

The FSUSB45 is compatible with the requirements of USB2.0 and features an extremely low on capacitance (C<sub>ON</sub>) of 7.0 pF. The wide bandwidth of this device (720 MHz) 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 FSUSB45 contains special circuitry on the switch I/O pins for applications where the V<sub>CC</sub> supply is powered-off (V<sub>CC</sub>=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 SEL pin is lower than the supply voltage (V<sub>CC</sub>). This feature is especially valuable to mobile 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 state on D+/D- to signal an interrupt (INT) to the processor when entering a dedicated charging port mode of operation.

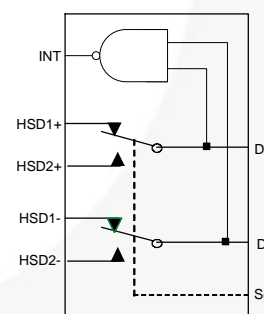


Figure 1. Analog Symbol

## Ordering Information

| Part Number | Top Mark | Operating Temperature Range | Package   |
|-------------|----------|-----------------------------|---|
| FSUSB45L10X | JA       | -40 to +85°C                | 10-Lead, MicroPak™ 1.6 x 2.1 mm, JEDEC MO-255B                        |
| FSUSB45UMX  | JB       | -40 to +85°C                | 10-Lead, Quad, Ultrathin Molded Leadless Package (UMLP), 1.4 x 1.8 mm |

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

## Pin Assignments

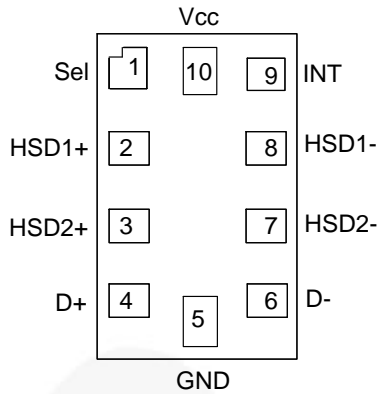


Figure 2. Pad Assignments for MicroPak (Top Through View)

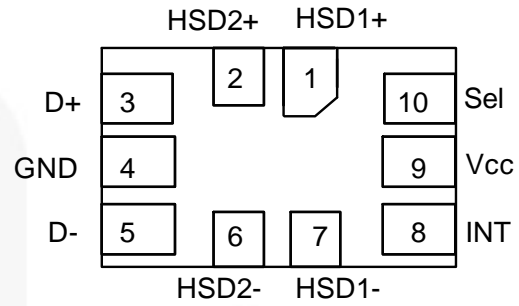


Figure 3. Pin Assignments for UMLP (Top Through View)

## Pin Definitions

| MicroPak™ Pin # | UMLP Pin # | Name         | Description                    |
|-----------------|------------|--------------|--------------------------------|
| 9               | 8          | INT          | Interrupt Signaling Output Pin |
| 1               | 10         | Sel          | Switch Select                  |
| 4, 6            | 3, 5       | D+, D-       | USB Data Bus                   |
| 2, 3, 7, 8      | 1, 2, 6, 7 | HSDn+, HSDn- | Multiplexed Source Inputs      |
| 5               | 4          | GND          | Ground                         |

## Truth Table

| Sel | Switch Connection   | INT Output |
|-----|---------------------|------------|
| L   | D+, D-=HSD1+, HSD1- | LOW        |
| H   | D+, D-=HSD2+, HSD2- | 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    |
| $V_{CNTRL}^{(2)}$ | Control Input Voltage (Sel) | 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>=3.3 V 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> =-18 mA  | 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> =-2 mA   | 3.0 to 3.6          | 2.4                             |      |      | V     |
|  |  |  | 4.3                 | 2.4                             |      |      | V     |
| V <sub>OL</sub>                                | Output Voltage Low   | I <sub>OL</sub> =2 mA  | 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>NC(OFF)</sub> ,<br>I <sub>NO(OFF)</sub> | Off State Leakage  | HSD1n or HSD2n=0 V,<br>3.6 V or floating,<br>D+/-=0 or 3.6 V     | 4.3                 | -2                              |      | 2    | μA    |
| I <sub>Dn(ON)</sub>                            | ON State Leakage   | HSD1n or HSD2n=0 V,<br>3.6 V or floating,<br>D+/-=0 or 3.6 V     | 4.3                 | -2                              |      | 2    | μA    |
| I <sub>OFF</sub>                               | Power-Off Leakage Current<br>(All I/O Ports)                                   | V <sub>SW</sub> =0 V to 4.3 V, V <sub>CC</sub> =0 V,<br>Figure 5 | 0                   | -2                              |      | 2    | μA    |
| R <sub>ON</sub>                                | HS Switch On Resistance <sup>(3)</sup>   | V <sub>SW</sub> =0.4 V, I <sub>ON</sub> =-8 mA,<br>Figure 4      | 3.0                 |                                 | 3.9  | 6.5  | Ω     |
| ΔR <sub>ON</sub>                               | HS Delta R <sub>ON</sub> <sup>(4)</sup>  | V <sub>SW</sub> =0.4 V, I <sub>ON</sub> =-8 mA                   | 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                 |                                 |      | 1.0  | μA    |
| I <sub>CCCT</sub>                              | Increase in I <sub>CC</sub> Current per<br>Control Voltage and V <sub>CC</sub> | V <sub>CNTRL</sub> =2.6 V, V <sub>CC</sub> =4.3 V                | 4.3                 |                                 |      | 10.0 | μA    |
|  |  | V <sub>CNTRL</sub> =1.8 V, V <sub>CC</sub> =4.3 V                | 4.3                 |                                 |      | 20.0 | 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  $V_{CC}=3.3$  V at  $25^{\circ}\text{C}$  unless otherwise specified.

| Symbol       | Parameter                            | Conditions  | $V_{CC}$ (V) | $T_A=-40$ to $+85^{\circ}\text{C}$ |      |      | Units |
|--------------|--------------------------------------|---|--------------|------------------------------------|------|------|-------|
|              |                                      |   |              | Min.                               | Typ. | Max. |       |
| $t_{ON}$     | Turn-On Time, S to Output            | $R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , $V_{SW}=0.8\ \text{V}$ , Figure 6, Figure 7 | 3.0 to 3.6   |                                    | 13   | 30   | ns    |
| $t_{OFF}$    | Turn-Off Time, S to Output           | $R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , $V_{SW}=0.8\ \text{V}$ , Figure 6, Figure 7 | 3.0 to 3.6   |                                    | 12   | 25   | ns    |
| $t_{PD}$     | Propagation Delay <sup>(5)</sup>     | $C_L=5\ \text{pF}$ , $R_L=50\ \Omega$ , Figure 6, Figure 8                          | 3.3          |                                    | 0.25 |      | ns    |
| $t_{BBM}$    | Break-Before-Make                    | $R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , $V_{SW1}=V_{SW2}=0.8\ \text{V}$ , Figure 12 | 3.0 to 3.6   | 2.0                                |      | 6.5  | ns    |
| $t_{PLH/HL}$ | INT Propagation Delay <sup>(5)</sup> | $R_L=50\ \Omega$ , $C_L=5\ \text{pF}$   | 3.0 to 3.6   |                                    |      | 10   | ns    |
| $O_{IRR}$    | Off Isolation                        | $R_L=50\ \Omega$ , $f=24\ \text{MHz}$ , Figure 14                                   | 3.0 to 3.6   |                                    | -30  |      | dB    |
| Xtalk        | Non-Adjacent Channel Crosstalk       | $R_L=50\ \Omega$ , $f=240\ \text{MHz}$ , Figure 15                                  | 3.0 to 3.6   |                                    | -45  |      | dB    |
| BW           | -3 db Bandwidth                      | $R_L=50\ \Omega$ , $C_L=0\ \text{pF}$ , Figure 13                                   | 3.0 to 3.6   |                                    | 720  |      | MHz   |
|              |                                      | $R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , Figure 13                                   |              |                                    | 550  |      | MHz   |

**Note:**

5. Guaranteed by characterization.

## USB Hi-Speed-Related AC Electrical Characteristics

| Symbol      | Parameter  | Conditions  | $V_{CC}$ (V) | $T_A=-40$ to $+85^{\circ}\text{C}$ |      |      | Units |
|-------------|--|---|--------------|------------------------------------|------|------|-------|
|             |  |   |              | Min.                               | Typ. | Max. |       |
| $t_{SK(P)}$ | Skew of Opposite Transitions of the Same Output <sup>(6)</sup> | $C_L=5\ \text{pF}$ , $R_L=50\ \Omega$ , Figure 9  | 3.0 to 3.6   |                                    | 20   |      | ps    |
| $t_J$       | Total Jitter <sup>(6)</sup>                                    | $R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , $t_R=t_F=500\ \text{ps}$ (10-90%) at 480 Mbps (PRBS= $2^{15}-1$ ) | 3.0 to 3.6   |                                    | 200  |      | ps    |

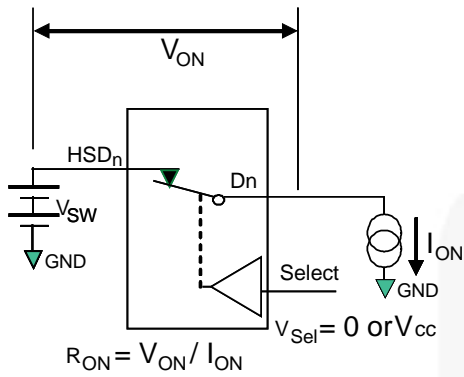
**Note:**

6. Guaranteed by characterization.

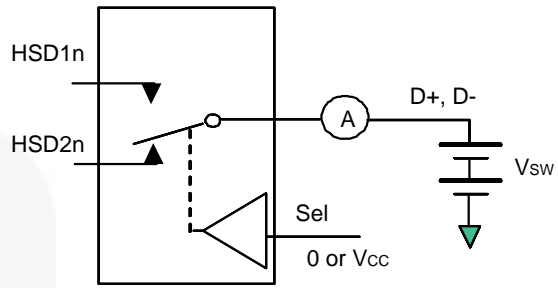
## Capacitance

| Symbol    | Parameter                     | Conditions   | $T_A=-40$ to $+85^{\circ}\text{C}$ |      |      | Units |
|-----------|-------------------------------|--|------------------------------------|------|------|-------|
|           |                               |  | Min.                               | Typ. | Max. |       |
| $C_{IN}$  | Control Pin Input Capacitance | $V_{CC}=0$   |                                    | 1.5  |      | pF    |
| $C_{OUT}$ | INT Pin Output Capacitance    | $V_{CC}=0$   |                                    | 2.5  |      | pF    |
| $C_{ON}$  | D+/D- On Capacitance          | $V_{CC}=3.3\ \text{V}$ , $f=1\ \text{MHz}$ , Figure 11 |                                    | 7.0  | 7.9  | pF    |
| $C_{OFF}$ | D1n, D2n Off Capacitance      | $V_{CC}=3.3\ \text{V}$ , Figure 10                     |                                    | 2.0  |      | pF    |

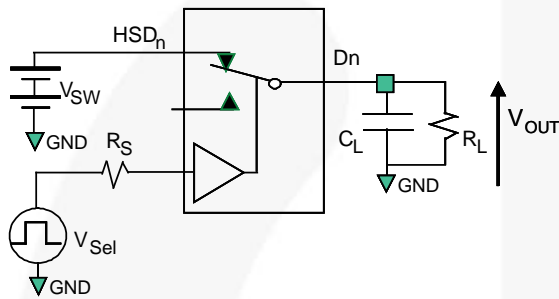
### Test Diagrams



**Figure 4. On Resistance**

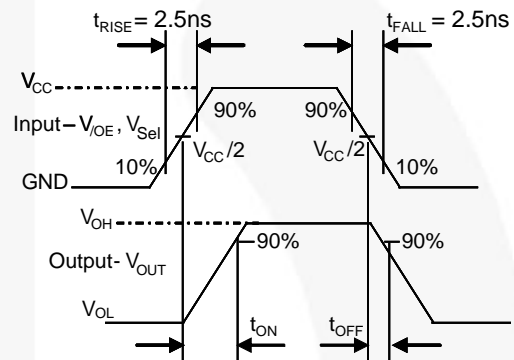


**Figure 5. Off/On Leakage**

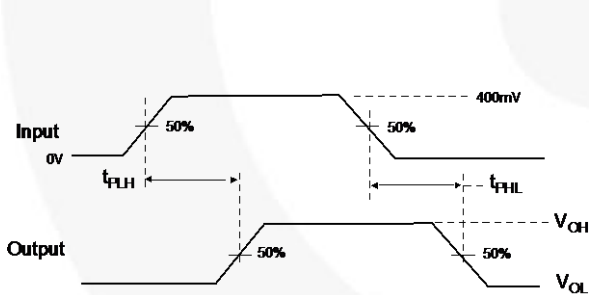


$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance.

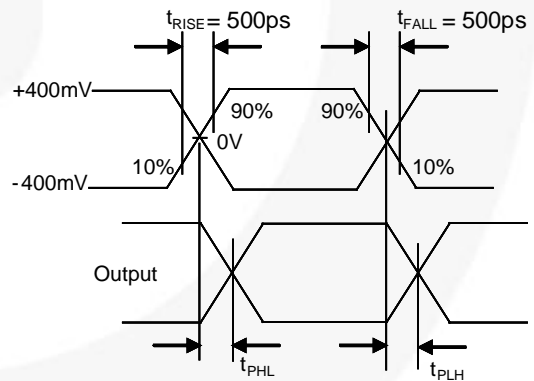
**Figure 6. AC Test Circuit Load**



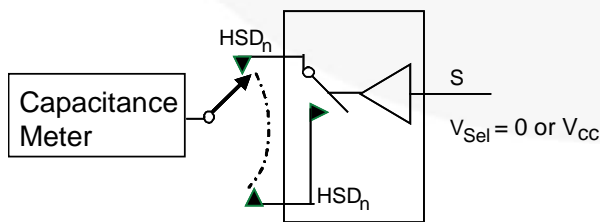
**Figure 7. Turn-On / Turn-Off Waveforms**



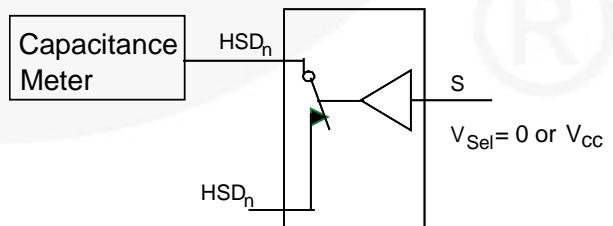
**Figure 8. Propagation Delay ( $t_{RTF} = 500ps$ )**



**Figure 9. Intra-Pair Skew Test  $t_{SK(P)}$**

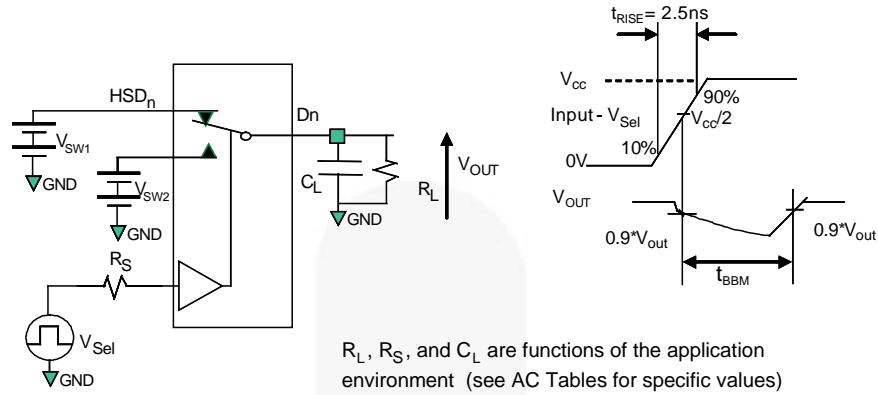


**Figure 10. Channel Off Capacitance**



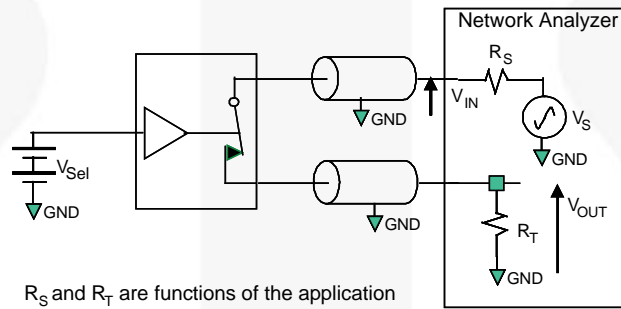
**Figure 11. Channel On Capacitance**

**Test Diagrams (Continued)**



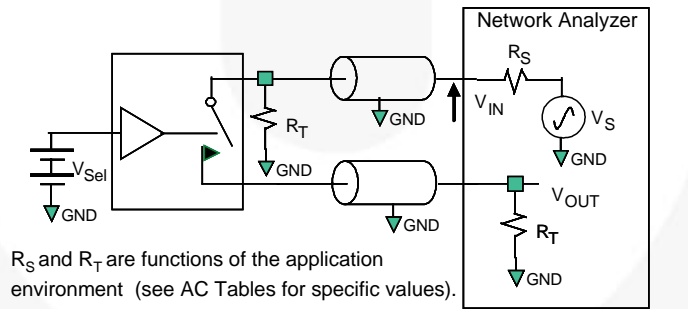
$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance.

**Figure 12. Break-Before-Make Interval Timing**



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

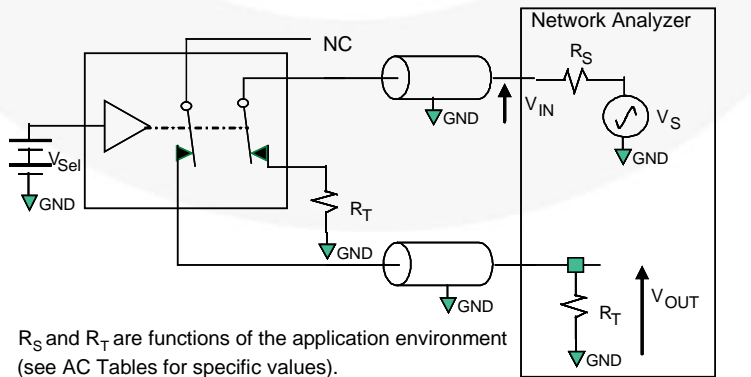
**Figure 13. Bandwidth**



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

$$\text{Off isolation} = 20 \text{ Log} (V_{OUT} / V_{IN})$$

**Figure 14. Channel Off Isolation**



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

$$\text{Crosstalk} = 20 \text{ Log} (V_{OUT} / V_{IN})$$

**Figure 15. Non-Adjacent Channel-to-Channel Crosstalk**



Physical Dimensions

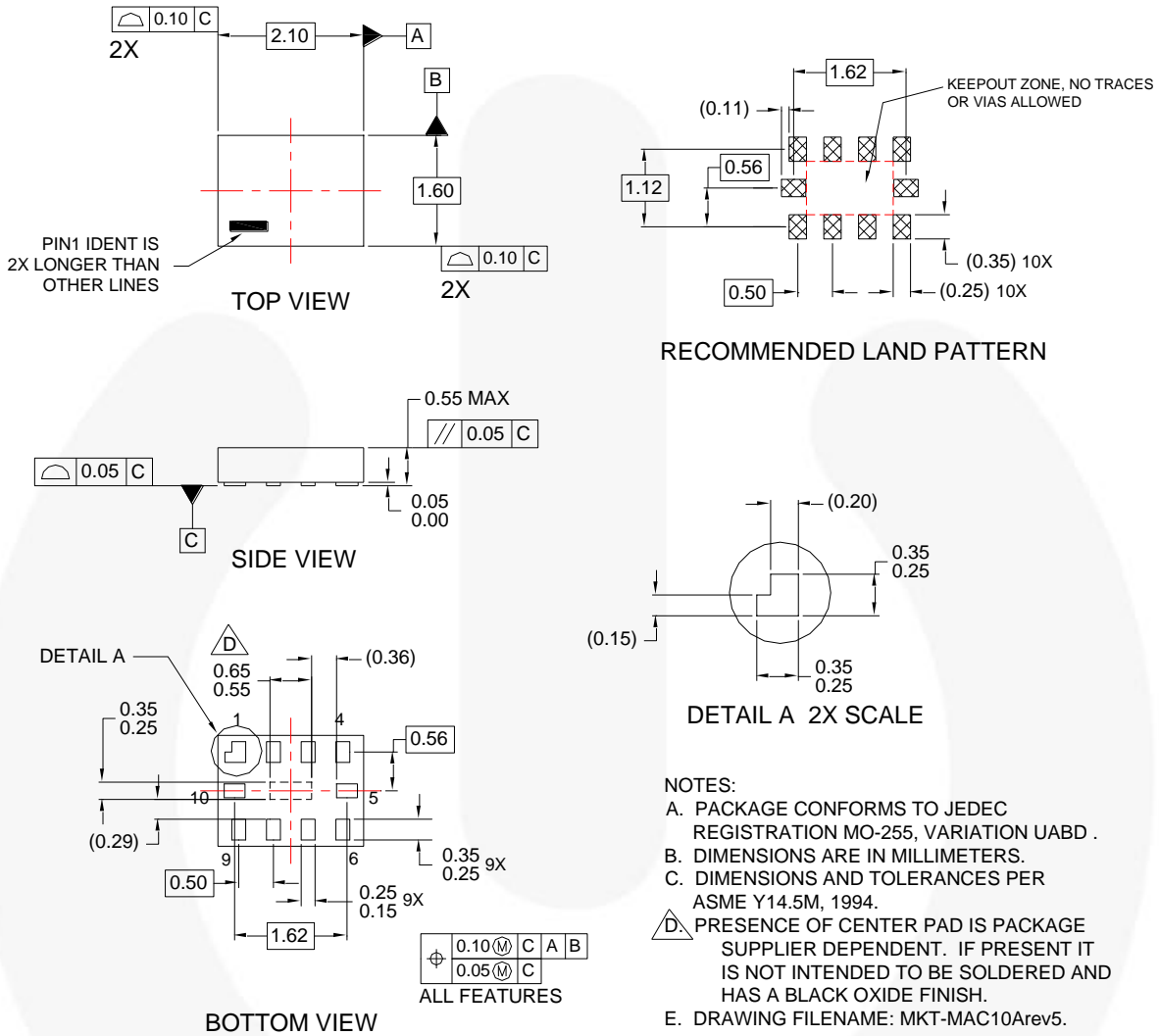
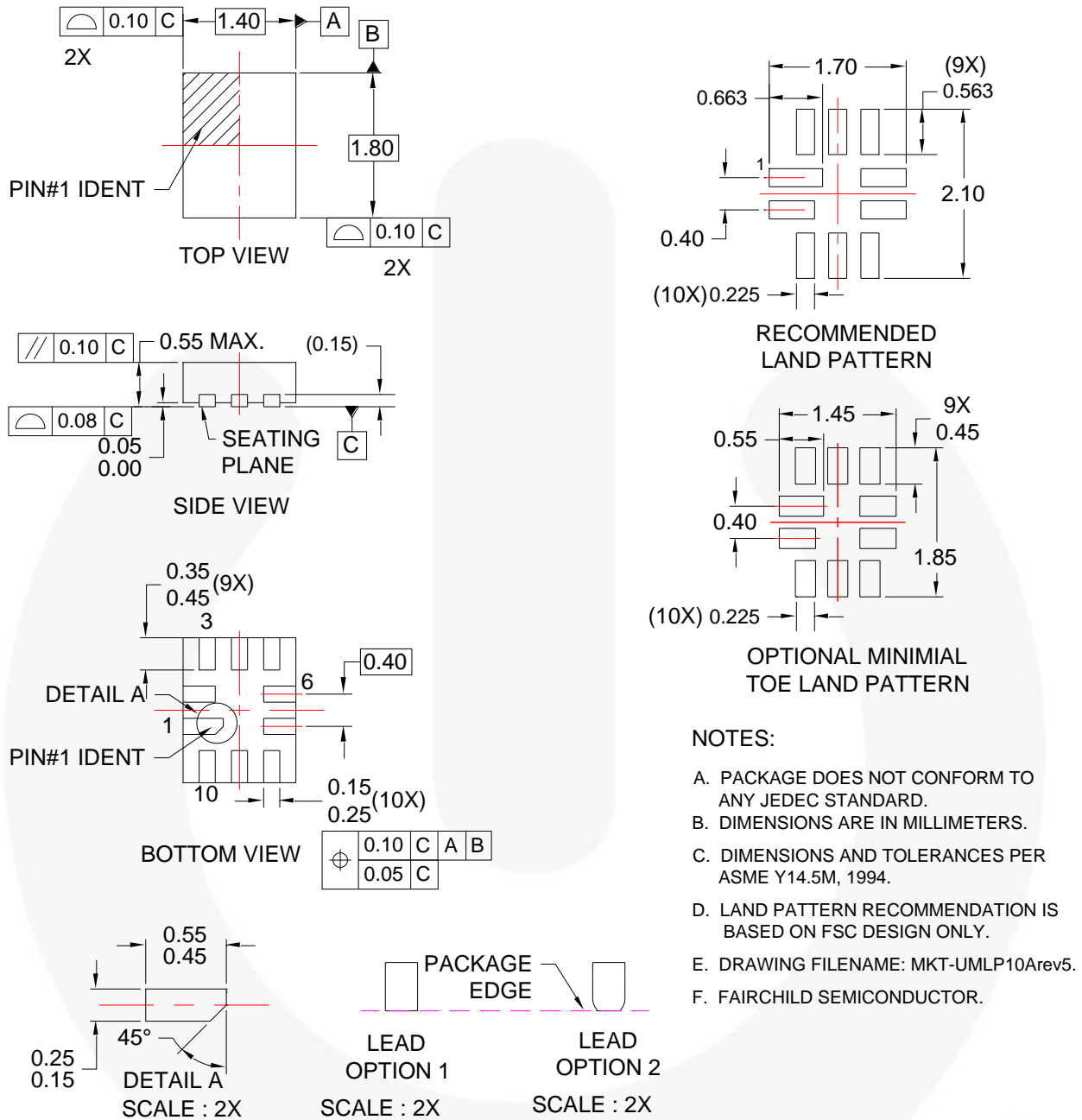


Figure 16. 10-Lead MicroPak™

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## Physical Dimensions




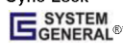



**Figure 17. 10-Lead Ultrathin Molded Leadless Package (UMLP)**

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| BitSiC™  | Global Power Resource™                         | Programmable Active Droop™  | TinyBuck®   |
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| FAST®  | mWSaver®                                       | SuperSOT™-8   | VisualMax™  |
| FastvCore™   | OptoHiT™                                       | SupreMOS®   | VoltagePlus™  |
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