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# FSUSB74

## 4:1 High-Speed USB Multiplexer/Switch

### Features

|                      |                                                                                                  |
|----------------------|--------------------------------------------------------------------------------------------------|
| Switch Type          | 4:1                                                                                              |
| USB                  | USB 2.0 High-Speed Compliant<br>USB 2.0 Full-Speed Compliant                                     |
| R <sub>ON</sub>      | 6.5Ω                                                                                             |
| C <sub>ON</sub>      | 7.5pF                                                                                            |
| ESD (IEC61000-4-2)   | 15kV (Air)<br>8kV (Contact)                                                                      |
| V <sub>CC</sub>      | 2.7 to 4.4V                                                                                      |
| I <sub>CCSLP</sub>   | <1μA                                                                                             |
| I <sub>CCACT</sub>   | 9μA                                                                                              |
| Package              | 16- Lead UMLP 1.80 x 2.60 x<br>0.55mm, 0.40mm Pitch<br>16-Lead MLP 3 x 3 x 0.7mm,<br>0.5mm Pitch |
| Ordering Information | FSUSB74UMX (UMLP)<br>FSUSB74MPX (MLP)                                                            |

### Description

The FSUSB74 is a bi-directional, low-power, high-speed USB 2.0 4:1 MUX. It is optimized for switching from four high-speed (480Mbps) sources or any combination of high-speed and full-/low-speed USB/UART sources to one USB 2.0 connector.

### Applications

- MP3 Portable Media Players
- Cellular Phones, Smart Phones
- Netbooks, Mobile Internet Devices (MID)

### Related Resources

- For samples and questions, please contact:  
[Analog.Switch@fairchildsemi.com](mailto:Analog.Switch@fairchildsemi.com).
- FSUSB74 Demonstration Board
- FSUSB74 Evaluation Board

### Typical Application

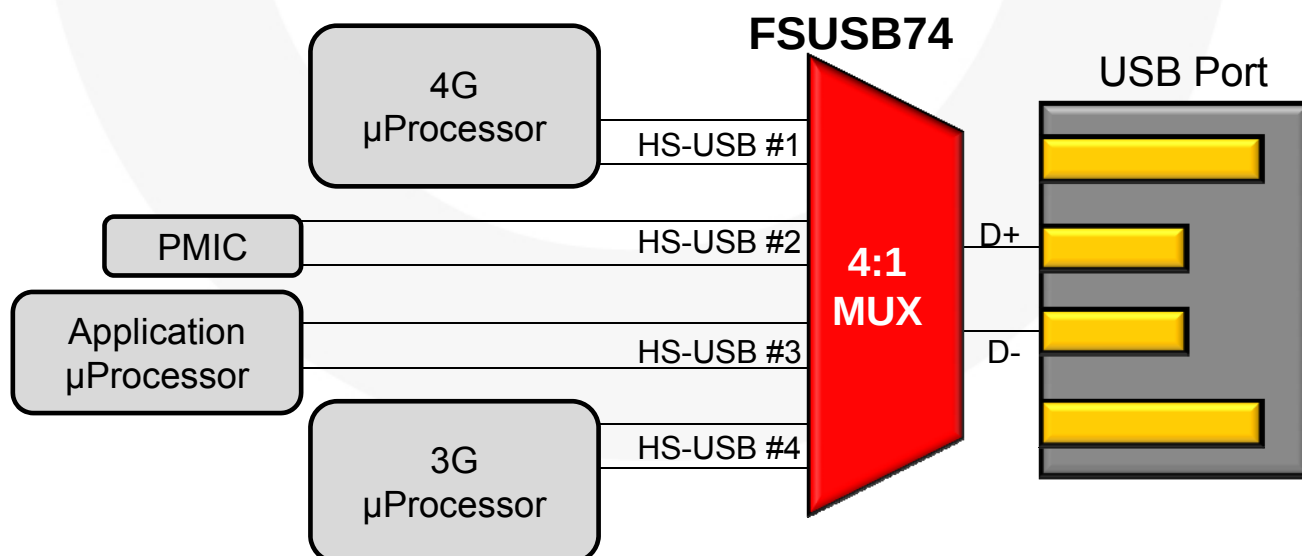


Figure 1. Mobile Phone Example

## Pin Configurations

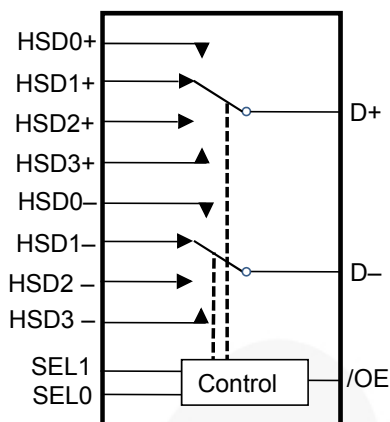


Figure 2. UMLP Analog Symbol

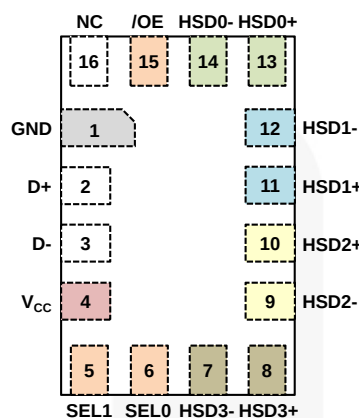


Figure 3. UMLP (Top View)

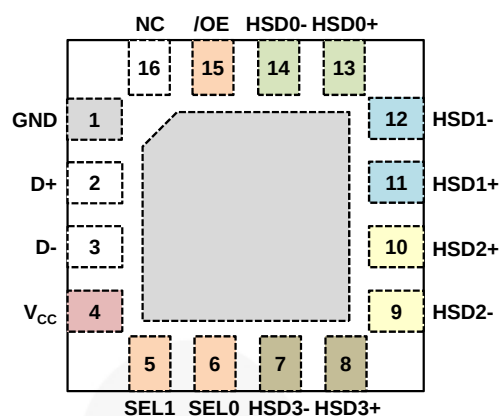


Figure 4. MLP (Top View)

## Pin Descriptions

| Pin # | Name            | Type         | Description                                          |
|-------|-----------------|--------------|------------------------------------------------------|
| 1     | GND             | Ground       | Ground                                               |
| 2     | D+              | I/O          | D+ common port (HS or FS USB)                        |
| 3     | D-              | I/O          | D- common port (HS or FS USB)                        |
| 4     | V <sub>CC</sub> | Power Supply | Supply Voltage                                       |
| 5     | SEL1            | Input        | Path Selection Control Input (see truth table below) |
| 6     | SEL0            | Input        | Path Selection Control Input (see truth table below) |
| 7     | HSD3-           | I/O          | D- from fourth source path (HS or FS USB)            |
| 8     | HSD3+           | I/O          | D+ from fourth source path (HS or FS USB)            |
| 9     | HSD2-           | I/O          | D- from third source path (HS or FS USB)             |
| 10    | HSD2+           | I/O          | D+ from third source path (HS or FS USB)             |
| 11    | HSD1+           | I/O          | D+ from second source path (HS or FS USB)            |
| 12    | HSD1-           | I/O          | D- from second source path (HS or FS USB)            |
| 13    | HSD0+           | I/O          | D+ from first source path (HS or FS USB)             |
| 14    | HSD0-           | I/O          | D- from first source path (HS or FS USB)             |
| 15    | /OE             | Input        | Enable Control Input (see truth table below)         |
| 16    | NC              |              | No Connect                                           |

## Truth Table

| /OE | SEL1 | SEL0 | Function                 |
|-----|------|------|--------------------------|
| 1   | X    | X    | D+, D- Switch Paths Open |
| 0   | 0    | 0    | D+=HSD0+, D-=HSD0-       |
| 0   | 0    | 1    | D+=HSD1+, D-=HSD1-       |
| 0   | 1    | 0    | D+=HSD2+, D-=HSD2-       |
| 0   | 1    | 1    | D+=HSD3+, D-=HSD3-       |

## 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 <sub>CC</sub>    | Supply Voltage                                          |                | -0.5  | 5.25            | V     |
| V <sub>CNTRL</sub> | DC Input Voltage (SEL1, SEL0, /OE, SELS) <sup>(1)</sup> |                | -0.50 | V <sub>CC</sub> | V     |
| V <sub>SW</sub>    | DC Switch I/O Voltage <sup>(1)</sup>                    |                | -0.50 | 5.25            | V     |
| I <sub>IK</sub>    | DC Input Diode Current                                  |                | -50   |                 | mA    |
| T <sub>STG</sub>   | Storage Temperature                                     |                | -65   | +150            | °C    |
| MSL                | Moisture Sensitivity Level (JEDEC J-STD-020A)           |                |       | 1               | Level |
| ESD                | IEC61000-4-2 System on USB connector pins D+ & D-       | Air Gap        | 15    |                 | kV    |
|                    |                                                         | Contact        | 8     |                 |       |
|                    | Human Body Model, JEDEC: JESD22-A114                    | D+,D- to GND   | 6     |                 |       |
|                    |                                                         | Power to GND   | 12    |                 |       |
|                    |                                                         | All Other Pins | 2     |                 |       |

**Note:**

1. 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 <sub>CC</sub>                   | Supply Voltage                                    | 2.5  | 4.4             | V    |
| V <sub>CNTRL</sub> <sup>(2)</sup> | Control Input Voltage (SEL1, SEL0, /OE, and SELS) | 0    | V <sub>CC</sub> | V    |
| V <sub>SW</sub>                   | Switch I/O Voltage                                | -0.5 | 4.4             | V    |
| T <sub>A</sub>                    | Operating Temperature                             | -40  | +85             | °C   |

**Note:**

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

## DC Electrical Characteristics

All typical values 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 $+85^{\circ}C$ |      |      | Unit     |
|-----------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------|--------------|----------------------------------------|------|------|----------|
|                       |                                                             |                                                                                 |              | Min.                                   | Typ. | Max. |          |
| $R_{ON}^{(3)}$        | HS Switch On Resistance                                     | $V_{SW}=0.4V$ , $I_{ON}=-8mA$ , Figure 5                                        | 3.3          |                                        | 6.5  | 9.0  | $\Omega$ |
| $\Delta R_{ON}^{(3)}$ | HS Delta Ron <sup>(4)</sup>                                 | $V_{SW}=0.4V$ , $I_{ON}=-8mA$                                                   | 3.3          |                                        | 0.5  |      | $\Omega$ |
| $I_{IN}$              | Control Input Leakage                                       | All Combinations of /OE, SEL1 & SEL0 in the Truth Table ( $1=V_{CC}$ , $0=0V$ ) | 4.4          | -1                                     |      | 1    | $\mu A$  |
| $I_{OZ}$              | Off State Leakage                                           | $0 \leq Dn$ , $HSD0n$ , $HSD1n$ , $HSD2n$ , $HSD3n \leq 4.4V$                   | 4.4          | -1                                     |      | 1    | $\mu A$  |
| $I_{OFF}$             | Power-Off Leakage Current (All I/O Ports)                   | $V_{SW}=0V$ to $4.4V$ , $V_{CC}=0V$ , Figure 6                                  | 0            | -1                                     |      | 1    | $\mu A$  |
| $I_{CCSLP}$           | Sleep Mode Supply Current                                   | /OE= $V_{CC}$                                                                   | 4.4          |                                        |      | 1    | $\mu A$  |
| $I_{CCACT}$           | Active Mode Supply Current                                  | All Active Modes in Truth Table                                                 | 4.4          |                                        | 9    | 18   | $\mu A$  |
| $I_{CCT}$             | Increase in $I_{CC}$ Current per Control Input and $V_{CC}$ | $V_{CNTRL}=1.8V$                                                                | 4.4          |                                        | 3.3  | 4.0  | $\mu A$  |
|                       |                                                             | $V_{CNTRL}=1.2V$                                                                | 4.4          |                                        | 4.9  | 6.0  | $\mu A$  |
| $V_{IK}$              | Clamp Diode Voltage                                         | $I_{IN}=-18mA$                                                                  | 2.5          |                                        |      | -1.2 | V        |
| $V_{IH}$              | Control Input Voltage High                                  | SEL1, SEL0, /OE                                                                 | 2.5 to 4.4   | 1.0                                    |      |      | V        |
| $V_{IL}$              | Control Input Voltage Low                                   | SEL1, SEL0, /OE                                                                 | 2.5 to 4.4   |                                        |      | 0.35 | V        |

### 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 values are for  $V_{CC}=3.3V$  at  $T_A=25^{\circ}C$  unless otherwise specified.

| Symbol      | Parameter                                                                                  | Conditions                                                                  | $V_{CC}$ (V) | $T_A=-40^{\circ}C$ to $+85^{\circ}C$ |      |      | Unit    |
|-------------|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------|--------------------------------------|------|------|---------|
|             |                                                                                            |                                                                             |              | Min.                                 | Typ. | Max. |         |
| $t_{ON}$    | Turn-On Time when Switching from One USB Path (or Disabled i.e. /OE=1) to Another USB Path | $R_L=50\Omega$ , $C_L=35pF$ , $V_{SW}=0.8V$ , Figure 7, Figure 8            | 2.5 to 4.4   | 126                                  |      | 400  | $\mu s$ |
| $t_{OFF}$   | Turn-Off Time, Turning Off Any of the USB Paths                                            | $R_L=50\Omega$ , $C_L=35pF$ , $V_{SW}=0.8V$ , Figure 7, Figure 8            | 2.5 to 4.4   |                                      |      | 80   | ns      |
| $t_{PD}$    | Propagation Delay <sup>(5)</sup>                                                           | $C_L=5pF$ , $R_L=50\Omega$ , Figure 7, Figure 9                             | 3.3          |                                      | 0.25 |      | ns      |
| $t_{RF}$    | Slow Turn-On/Off Switch Paths <sup>(5)</sup>                                               | $C_L=5pF$ , Dn at 0V or 3.6V, $40.5\Omega$ in series with switch 10% to 90% | 3.3          |                                      | 4.5  |      | ns      |
| $t_{BBM}$   | Break-Before-Make Time <sup>(5)</sup>                                                      | $R_L=50\Omega$ , $C_L=35pF$ , $V_{SW1}=V_{SW2}=0.8V$ , Figure 11            | 2.5 to 4.4   | 126                                  |      | 400  | $\mu s$ |
| $O_{IRR}$   | Off Isolation <sup>(5)</sup>                                                               | $R_L=50\Omega$ , $f=240MHz$ , Figure 13                                     | 2.5 to 4.4   |                                      | -40  |      | dB      |
| Xtalk       | Channel-to-Channel Crosstalk <sup>(5)</sup>                                                | $R_L=50\Omega$ , $f=240MHz$ , Figure 14                                     | 2.5 to 4.4   |                                      | -40  |      | dB      |
| $t_{SK(P)}$ | Pulse Skew <sup>(5)</sup>                                                                  | $V_{SW}=0.2V_{diffPP}$ , Figure 10, $C_L=5pF$                               | 2.5 to 4.4   |                                      | 25   |      | ps      |
| $t_{SK(I)}$ | Skew Between Differential Signals Within a Pair <sup>(5)</sup>                             | $V_{SW}=0.2V_{diffPP}$ , Figure 10, $C_L=5pF$                               | 2.5 to 4.4   |                                      | 25   |      | ps      |

### Note:

5. Guaranteed by characterization.

## Capacitance Characteristics

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

| Symbol    | Parameter                                                 | Conditions                                             | $V_{CC}$ (V) | Typical | Unit |
|-----------|-----------------------------------------------------------|--------------------------------------------------------|--------------|---------|------|
| $C_{IN}$  | Input Capacitance <sup>(6)</sup>                          |                                                        | 0            | 3       | pF   |
| $C_{ON}$  | D+/D- On Capacitance <sup>(6)</sup>                       | Any Switch Path Enabled, $f=1MHz$ , Figure 16          | 3.3          | 7.5     |      |
| $C_{OFF}$ | HSD0n, HSD1n, HSD2n, HSD3n Off Capacitance <sup>(6)</sup> | If $V_{CC}=3.3V$ , then /OE=3.3V; $f=1MHz$ , Figure 15 | 0 or 3.3     | 2.2     |      |

### Note:

6. Guaranteed by characterization.

## Test Diagrams

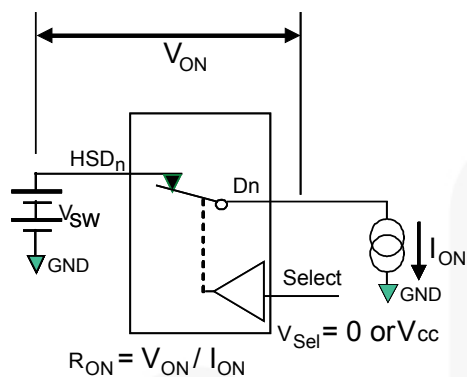
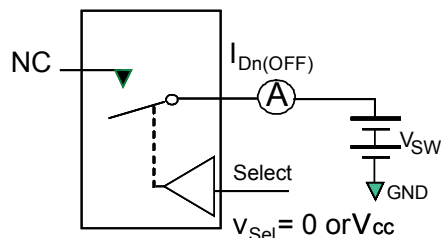
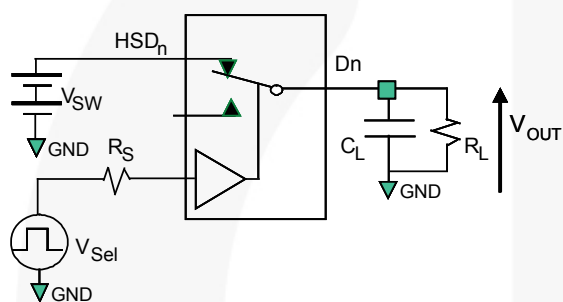


Figure 5. On Resistance



\*\*Each switch port is tested separately

Figure 6. Off 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

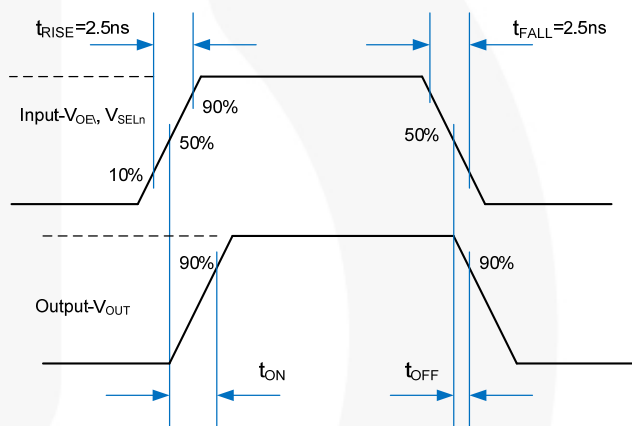


Figure 8. Turn-On / Turn-Off Waveforms

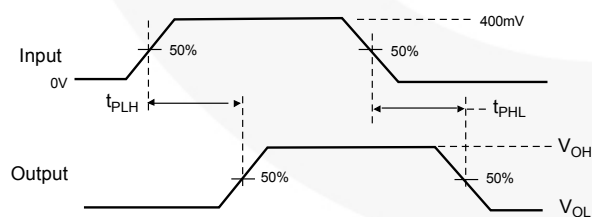


Figure 9. Propagation Delay ( $t_{RtF}$  – 500ps)

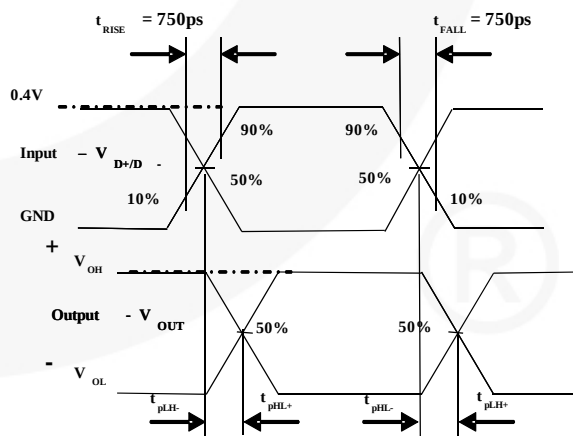


Figure 10. Skew Test Waveforms

$$t_{SK(P)} = |t_{PLH-} - t_{PHL-}| \text{ or } |t_{PLH+} - t_{PHL+}|$$

$$t_{SK(I)} = |t_{PLH-} - t_{PHL+}| \text{ or } |t_{PLH+} - t_{PHL-}|$$

# Test Diagrams (Continued)

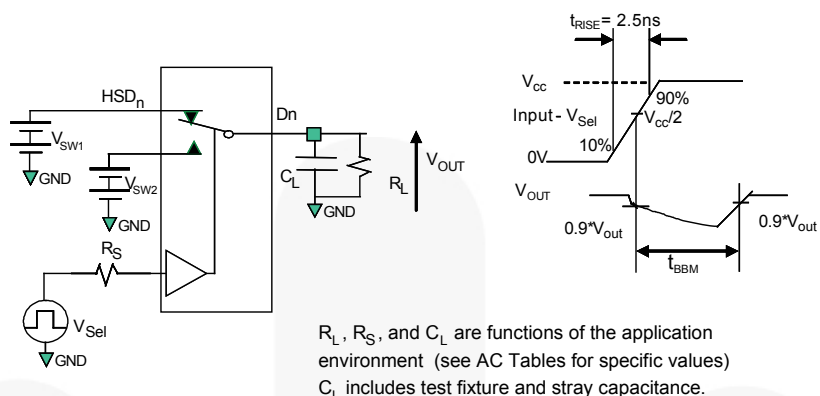


Figure 11. Break-Before-Make Interval Timing

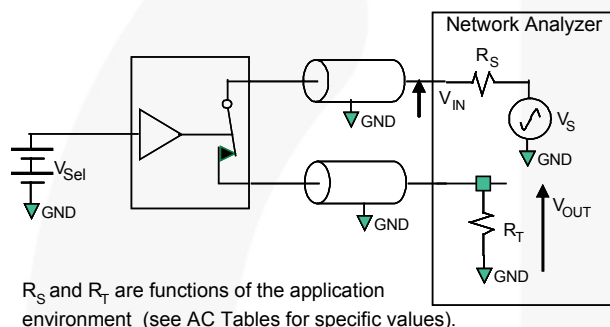


Figure 12. Bandwidth

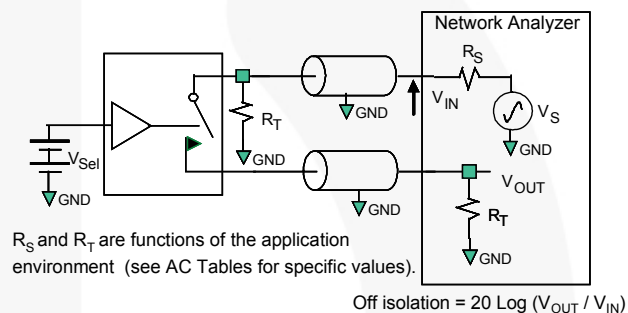


Figure 13. Channel Off Isolation

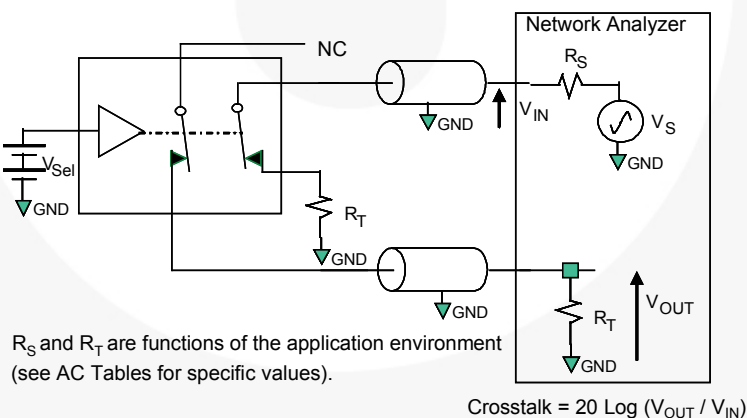


Figure 14. Non-Adjacent Channel-to-Channel Crosstalk

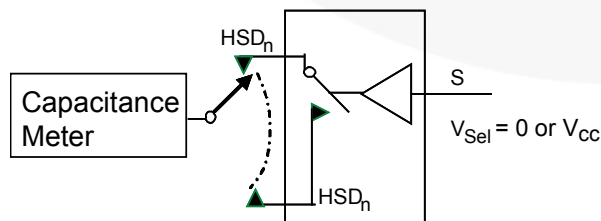


Figure 15. Channel Off Capacitance

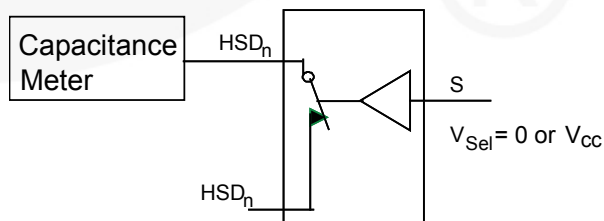


Figure 16. Channel On Capacitance



## Physical Dimensions

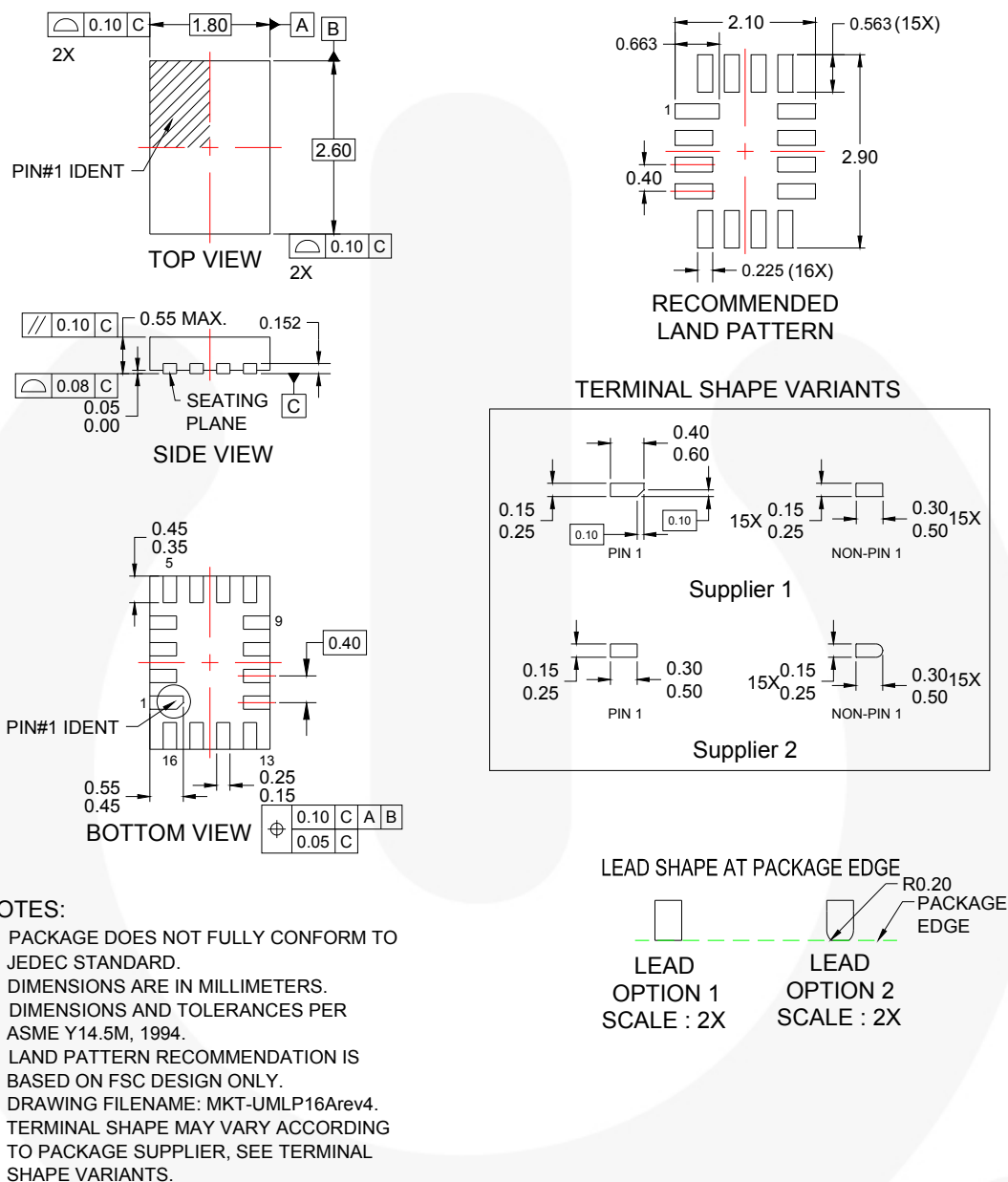


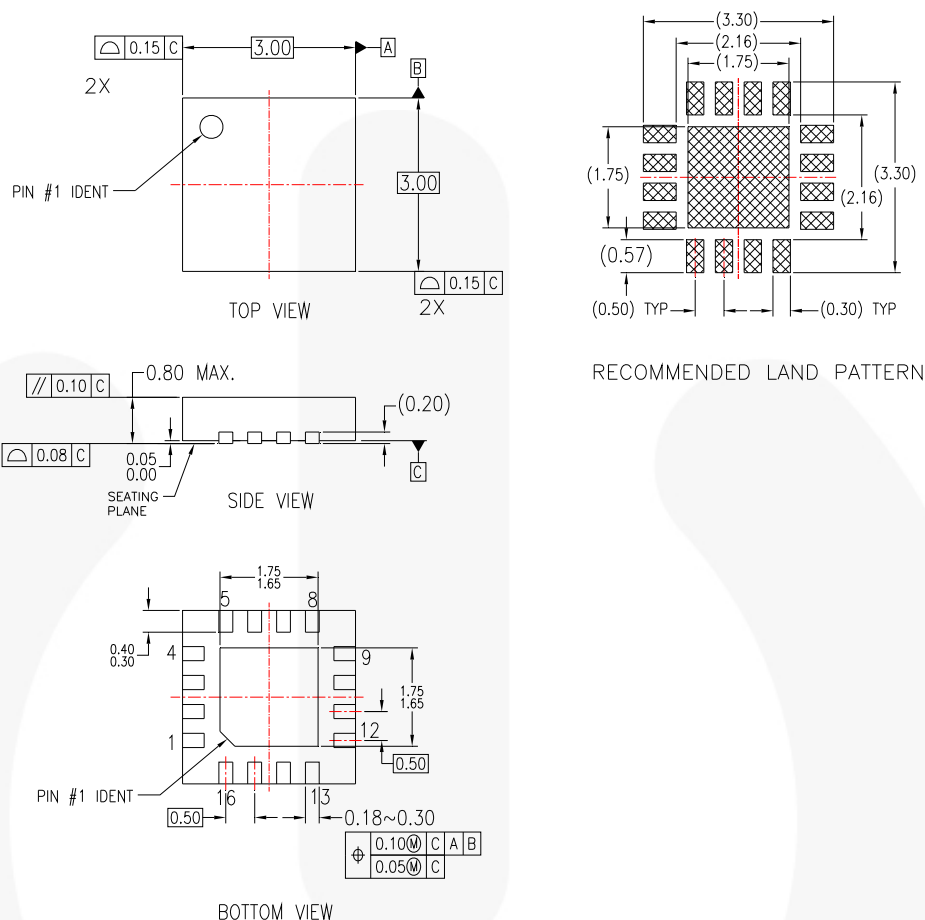
Figure 17. 16-Pin, Ultrathin Molded Leadless Package (UMLP)

| Order Number | Operating Temperature Range | Package Description                                   | Packing Method |
|--------------|-----------------------------|-------------------------------------------------------|----------------|
| FSUSB74UMX   | -40 to 85°C                 | 16-Terminal, Ultrathin Molded Leadless Package (UMLP) | Tape & Reel    |

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## Physical Dimensions



### NOTES:

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- DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994
- DIMENSIONS ARE EXCLUSIVE OF BURS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

MLP16BrevB

**Figure 18. 16-Lead, Quad Molded Leadless Package (MLP)**

| Order Number | Operating Temperature Range | Package Description                                     | Packing Method |
|--------------|-----------------------------|---------------------------------------------------------|----------------|
| FSUSB74MPX   | -40 to 85°C                 | 16-Lead, Quad, Molded Leadless Package (MLP), 3mm x 3mm | Tape & Reel    |

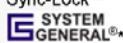
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|  Fairchild® | MicroPak2™                                     | SuperFET®                                                                                          | UHC™                                                                                        |
| Fairchild Semiconductor®                                                                     | MillerDrive™                                   | SuperSOT™-3                                                                                        | Ultra FRFET™                                                                                |
| FACT Quiet Series™                                                                           | MotionMax™                                     | SuperSOT™-6                                                                                        | UniFET™                                                                                     |
| FACT®                                                                                        | Motion-SPM™                                    | SuperSOT™-8                                                                                        | VCM™                                                                                        |
| FAST®                                                                                        | mWSaver™                                       | SupreMOS®                                                                                          | VisualMax™                                                                                  |
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