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# FSUSB40 — Low-Power, Two-Port, Hi-Speed, USB2.0 (480Mbps) Switch

## Features

- Low On Capacitance: 5.9pF 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:
  - 10-Lead MicroPak™ (1.6 x 2.1mm)
  - 10-Lead UMLP (1.4 x 1.8mm)
- 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
- Over-Voltage Tolerance (OVT) on all USB Ports Up to 5.25V without External Components

## 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 FSUSB40 is a bi-directional, low-power, two-port, Hi-Speed, USB2.0 switch. Configured as a double-pole, double-throw switch (DPDT) switch, it is optimized for switching between two Hi-Speed (480Mbps) sources or a Hi-Speed and Full-Speed (12Mbps) source.

The FSUSB40 is compatible with the requirements of USB2.0 and features an extremely low on capacitance ( $C_{ON}$ ) of 5.9pF. 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 FSUSB40 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 SEL 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. Other applications include switching and connector sharing in portable cell phones, PDAs, digital cameras, printers, and notebook computers.

## Ordering Information

| Part Number | Top Mark | Operating Temperature Range |  Eco Status | Package  |
|-------------|----------|-----------------------------|--|--|
| FSUSB40L10X | HD       | -40 to +85°C                | RoHS   | 10-Lead MicroPak™ 1.6 x 2.1mm, JEDEC MO-255B                         |
| FSUSB40UMX  | HC       | -40 to +85°C                | Green  | 10-Lead, Quad, Ultrathin Molded Leadless Package (UMLP), 1.4 x 1.8mm |

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

 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).

## Analog Symbol

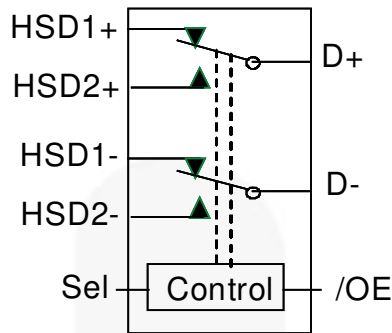


Figure 1. Analog Symbol

## Pin Assignments

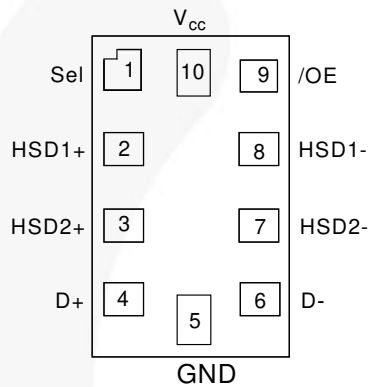


Figure 2. Pad Assignments for MicroPak™ (Top Through View)

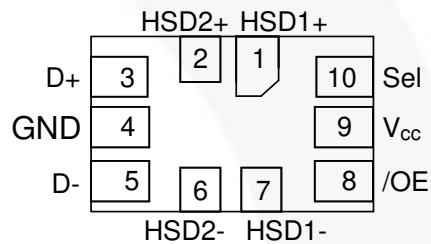


Figure 3. Pin Assignments for UMLP (Top Through View)

## Pin Definitions

| MicroPak™ Pin # | UMLP Pin # | Name         | Description               |
|-----------------|------------|--------------|---------------------------|
| 9               | 8          | /OE          | Switch Enable             |
| 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 | /OE | Function            |
|-----|-----|---------------------|
| X   | H   | Disconnect          |
| L   | L   | D+, D-=HSD1+, HSD1- |
| H   | L   | D+, D-=HSD2+, HSD2- |

## 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, /OE) <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                        |              | 100      | 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 (S, /OE) <sup>(2)</sup> | 0    | $V_{CC}$ | V    |
| $V_{SW}$    | Switch I/O Voltage                            | -0.5 | 4.5      | V    |
| $T_A$       | Operating Temperature                         | -40  | +85      | °C   |

**Note:**

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

## DC Electrical Characteristics

All typical value are at 25°C 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     |
| 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  | 0 ≤ Dn, HSD1n,<br>HSD2n ≤ 3.6V                                 | 4.3                 | -2                              |      | 2    | μA    |
| I <sub>OFF</sub> | Power-Off Leakage Current<br>(All I/O Ports)                                   | V <sub>SW</sub> =0V to 4.3V, V <sub>CC</sub> =0V<br>Figure 5   | 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 4       | 3.0                 |                                 | 3.9  | 6.5  | Ω     |
| ΔR <sub>ON</sub> | HS Delta Ron <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                 |                                 |      | 1.0  | μA    |
| I <sub>CCT</sub> | Increase in I <sub>CC</sub> Current Per<br>Control Voltage and V <sub>CC</sub> | V <sub>CNTRL</sub> =2.6V V <sub>CC</sub> =4.3V                 | 4.3                 |                                 |      | 10.0 | μA    |
|                  |  | V <sub>CNTRL</sub> =1.8V V <sub>CC</sub> =4.3V                 | 4.3                 |                                 |      | 15.0 | μA    |

### Notes:

3. 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).
4. 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<br>S, /OE to Output  | $R_L=50\Omega$ , $C_L=5pF$<br>$V_{SW}=0.8V$<br>Figure 6, Figure 7 | 3.0 to 3.6   |                                      | 13   | 30   | ns    |
| $t_{OFF}$ | Turn-Off Time<br>S, /OE to Output | $R_L=50\Omega$ , $C_L=5pF$<br>$V_{SW}=0.8V$<br>Figure 6, Figure 7 | 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 6, Figure 8                 | 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 12 | 3.0 to 3.6   | 2.0                                  |      | 6.5  | ns    |
| $O_{IRR}$ | Off Isolation                     | $R_L=50\Omega$ , $f=240MHz$<br>Figure 14                          | 3.0 to 3.6   |                                      | -30  |      | dB    |
| Xtalk     | Non-Adjacent Channel Crosstalk    | $R_L=50\Omega$ , $f=240MHz$<br>Figure 15                          | 3.0 to 3.6   |                                      | -45  |      | dB    |
| BW        | -3db Bandwidth                    | $R_L=50\Omega$ , $C_L=0pF$<br>Figure 13                           | 3.0 to 3.6   |                                      | 720  |      | MHz   |
|           |                                   | $R_L=50\Omega$ , $C_L=5pF$<br>Figure 13                           |              |                                      | 550  |      | MHz   |

**Note:**

5. Guaranteed by characterization.

## USB Hi-Speed-Related AC Electrical Characteristics

| Symbol      | Parameter  | Conditions  | $V_{CC}$ (V) | $T_A=-40^{\circ}C$ 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 9  | 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<br>(PRBS= $2^{15} - 1$ ) | 3.0 to 3.6   |                                      | 200  |      | ps    |

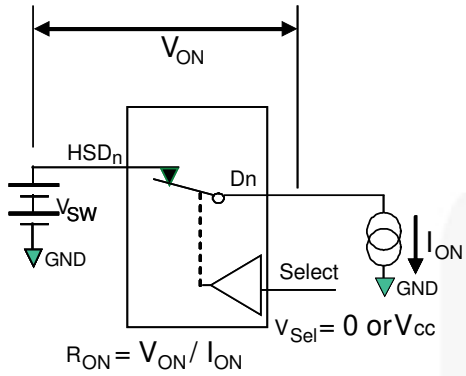
**Note:**

6. Guaranteed by characterization.

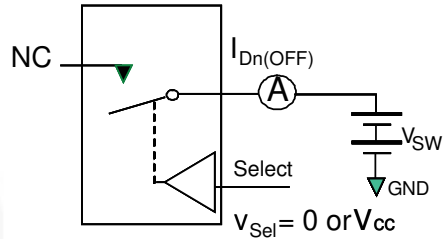
## Capacitance

| 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    |
| $C_{ON}$  | D+/D- On Capacitance          | $V_{CC}=3.3V$ , /OE=0V, $f=1MHz$<br>Figure 11 |                                      | 5.9  | 6.5  |       |
| $C_{OFF}$ | D1n, D2n Off Capacitance      | $V_{CC}$ and /OE=3.3V<br>Figure 10            |                                      | 2.0  |      |       |

**Test Diagrams**

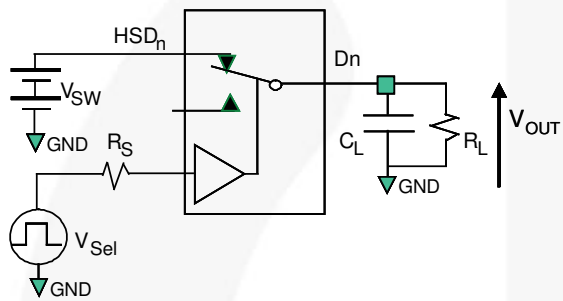


**Figure 4. On Resistance**



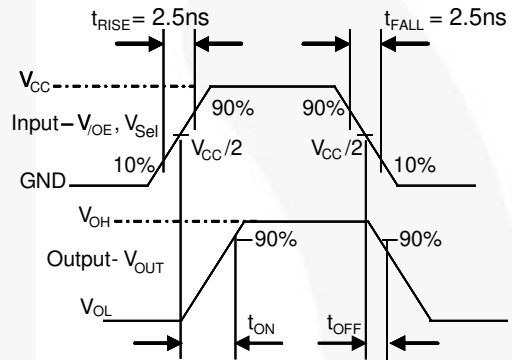
\*\*Each switch port is tested separately

**Figure 5. Off Leakage**

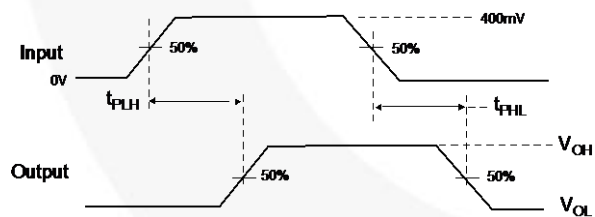


$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance.

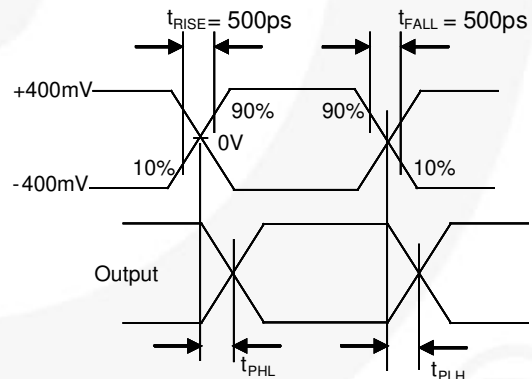
**Figure 6. AC Test Circuit Load**



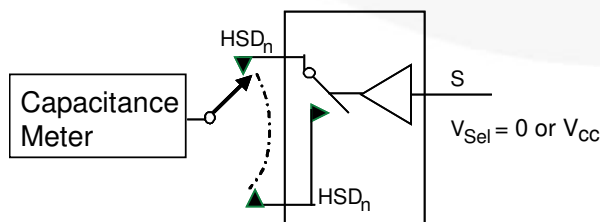
**Figure 7. Turn-On / Turn-Off Waveforms**



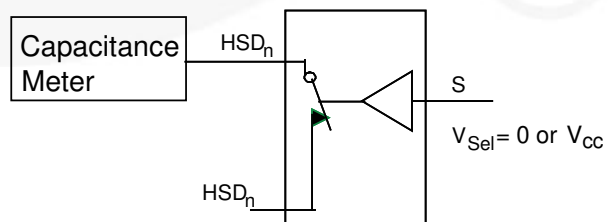
**Figure 8. Propagation Delay ( $t_R, t_F - 500ps$ )**



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

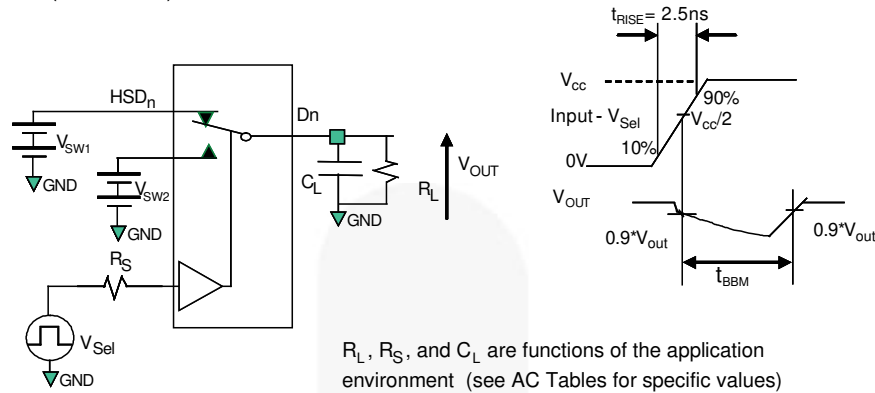


**Figure 10. Channel Off Capacitance**



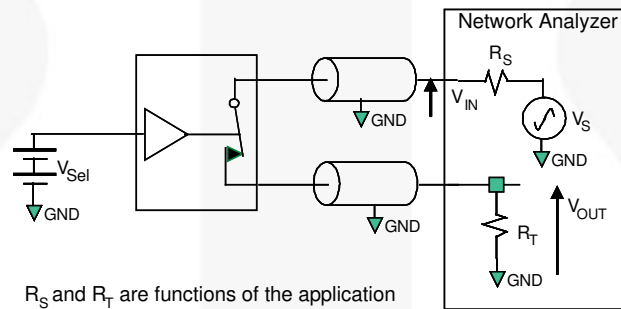
**Figure 11. Channel On Capacitance**

**Test Diagrams (Continued)**



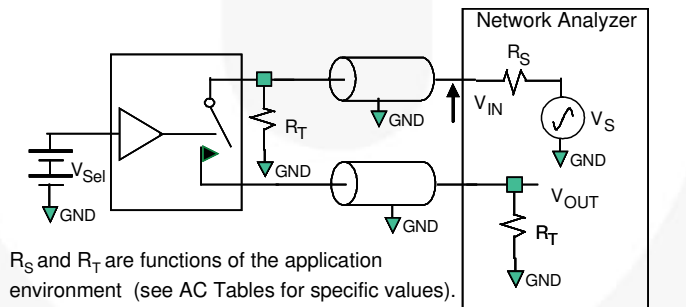
$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance.

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



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

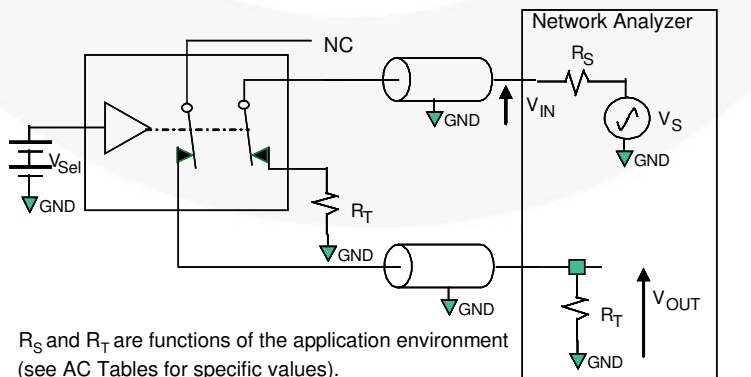
**Figure 13. Bandwidth**



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

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

**Figure 14. Channel Off Isolation**



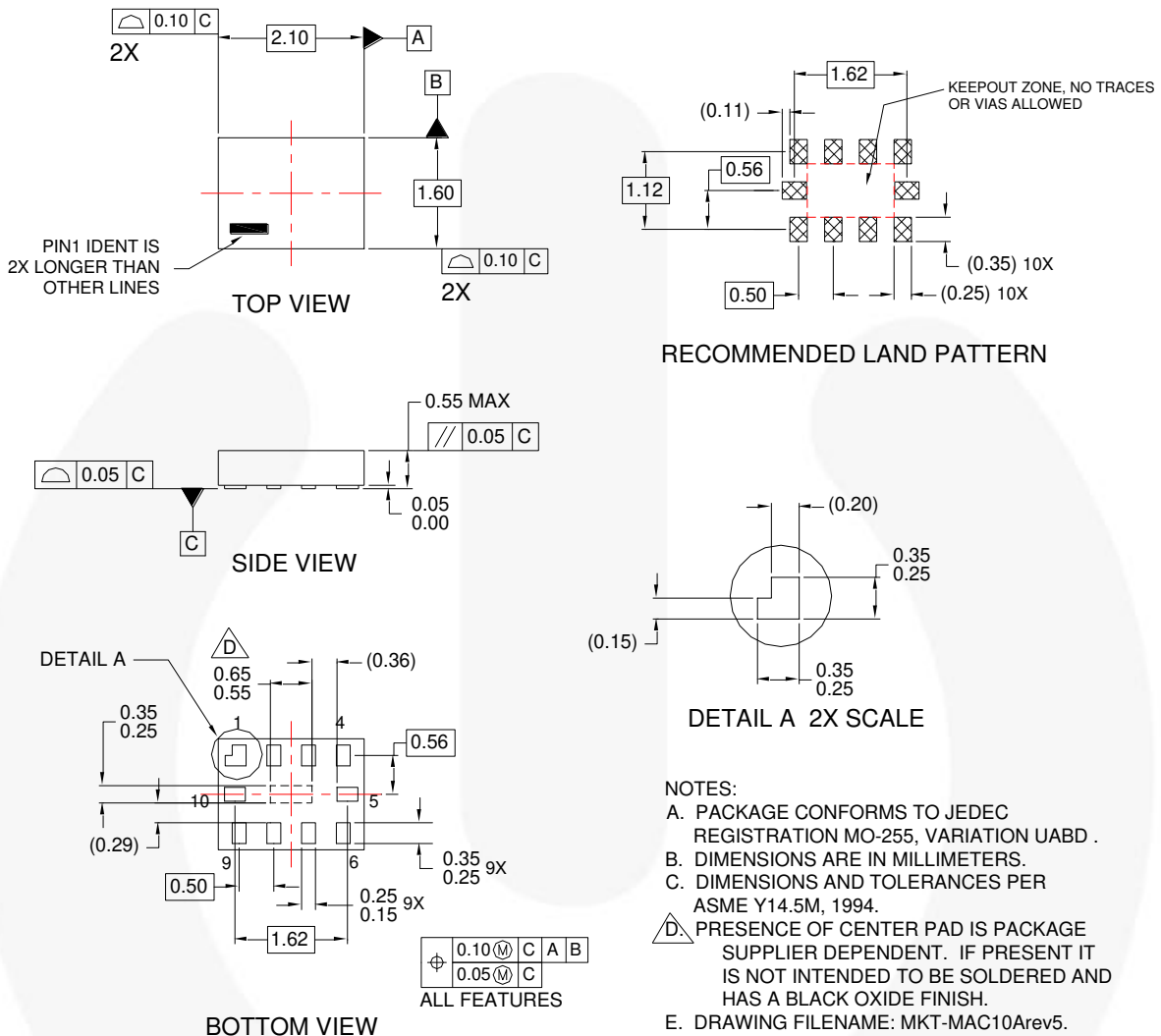
$R_S$  and  $R_T$  are functions of the application environment (see AC Tables for specific values).

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

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



## Physical Dimensions

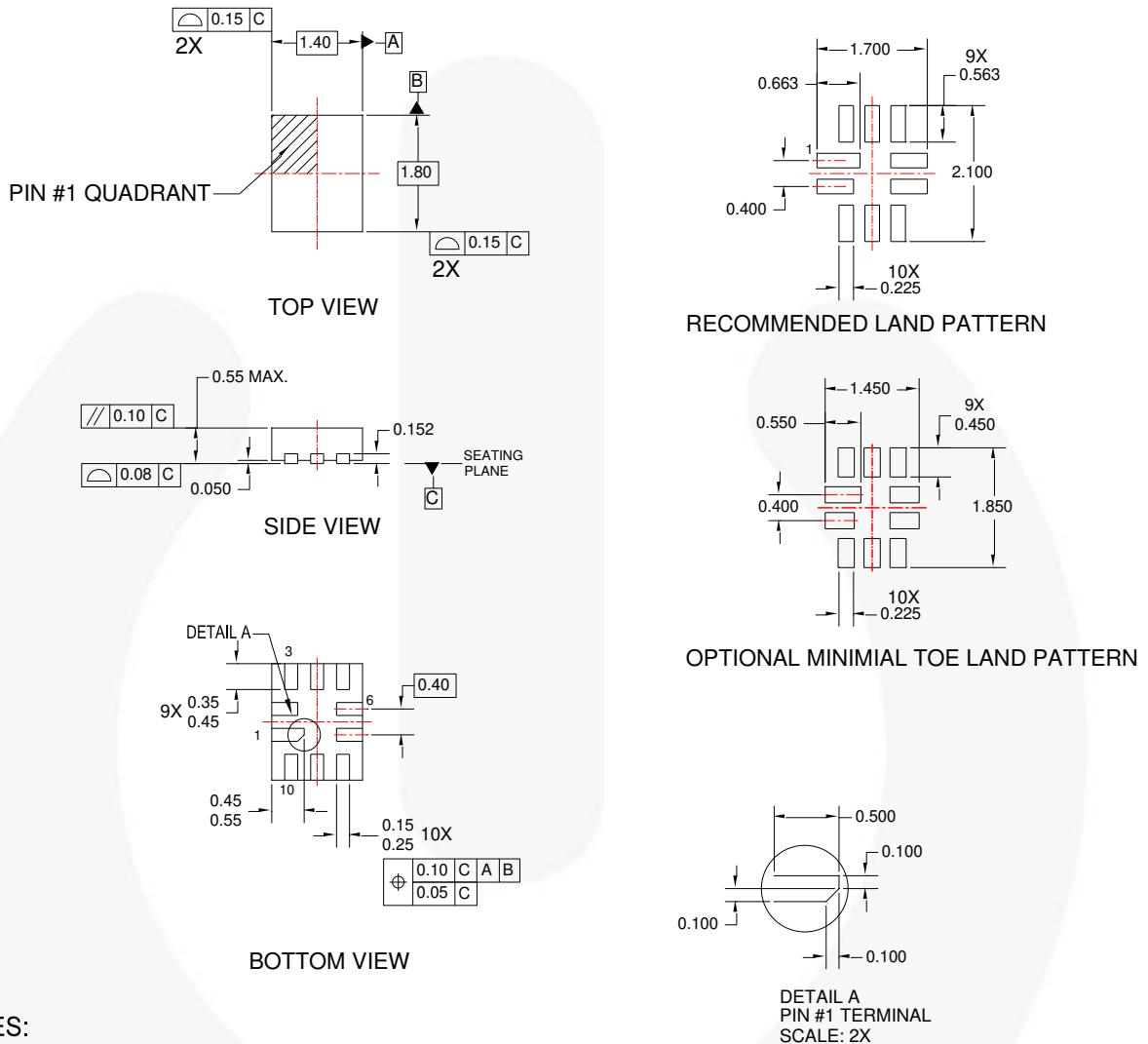


**Figure 16. 10-Lead MicroPak™**

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## Physical Dimensions



### NOTES:

- A. DIMENSIONS ARE IN MILLIMETERS.
- B. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994
- C. DRAWING FILENAME: UMLP10Arev2

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

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| Auto-SPM™                | FPS™                     | PowerTrench®                          |   |
| Build it Now™            | F-PFS™                   | PowerXS™                              |   |
| CorePLUS™                | FRFET®                   | Programmable Active Droop™            |   |
| CorePOWER™               | Global Power Resource SM | QFET®                                 |   |
| CROSSVOLT™               | Green FPST™              | QST™                                  |   |
| CTL™                     | Green FPST™ e-Series™    | Quiet Series™                         |   |
| Current Transfer Logic™  | Gmax™                    | RapidConfigure™                       |   |
| DEUXPEED®                | GTO™                     | ™                                     |   |
| EcoSPARK®                | IntelliMAX™              | Saving our world, 1mV/W/kW at a time™ |   |
| EfficientMax™            | ISOPLANAR™               | SignalWise™                           |   |
| EZSWITCH™**              | MegaBuck™                | SmartMax™                             |   |
| ™**                      | MICROCOUPLER™            | SMART START™                          |   |
| ™                        | MicroFET™                | SPM®                                  |   |
| Fairchild®               | MicroPak™                | STEALTH™                              |   |
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| FAST®                    | OPTOLOGIC®               | SuperSOT™-8                           |   |
| FastvCore™               | OPTOPLANAR®              | SupreMOS™                             |   |
| FETBench™                | ™                        | SyncFET™                              |   |
|                          | PDP SPM™                 | Sync-Lock™                            |   |

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