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# FSUSB30

## Low-Power, Two-Port, High-Speed USB 2.0 (480Mbps) Switch

### Features

- ? Low On Capacitance: 3.7pF (Typical)
- ? Low On Resistance: 6.5Ω (Typical)
- ? Low Power Consumption: 1μA (Maximum)
  - 10μA Maximum I<sub>CC</sub>T over an Expanded Control Voltage Range (V<sub>IN</sub> = 2.6V, V<sub>CC</sub> = 4.3V)
- ? Wide -3dB Bandwidth, >720MHz
- ? 8kV ESD Protection
- ? Power-Off Protection when V<sub>CC</sub> = 0V; D+/D- Pins can Tolerate up to 5.5V
- ? Packaged in:
  - 10-lead MicroPak™ (1.6 x 2.1mm)
  - 10-lead MSOP
  - 10-lead UMLP (1.4 x 1.8mm)

### Applications

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

### Related Application Notes

- ? AN-6022 Using the FSUSB30 / FSUSB31 to Comply with USB 2.0 Fault Condition Requirements

### Description

The FSUSB30 is a low-power, two-port, high-speed USB 2.0 switch. Configured as a double-pole double-throw (DPDT) switch, it is optimized for switching between two high-speed (480Mbps) sources or a Hi-Speed and Full-Speed (12Mbps) source. The FSUSB30 is compatible with the requirements of USB2.0 and features an extremely low on capacitance (C<sub>ON</sub>) of 3.7pF. 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 minimizes interference.

The FSUSB30 contains special circuitry on the D+/D- pins which allows the device to withstand an overvoltage condition when powered off. This device is also designed to minimize current consumption even when the control voltage applied to the S pin, is lower than the supply voltage (V<sub>CC</sub>). 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

Order Number	Package Number	Product Code Top Mark	Package Description
FSUSB30L10X	MAC010A	FJ	10-Lead MicroPak, 1.6 x 2.1mm
FSUSB30MUX	MUA10A	FSUSB30	10-Lead Molded Small Outline Package (MSOP), JEDEC MO-187, 3.0mm Wide
FSUSB30UMX	MLP010A	GJ	10-Lead, Quad, Ultrathin, MLP (UMLP) 1.4 x 1.8mm

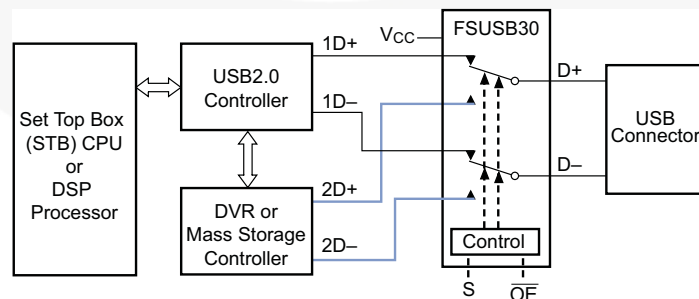
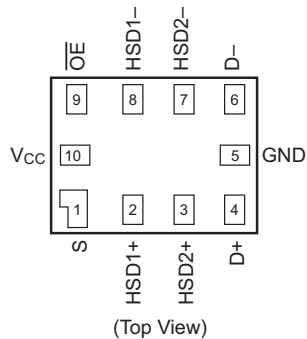


Figure 1. Typical Application

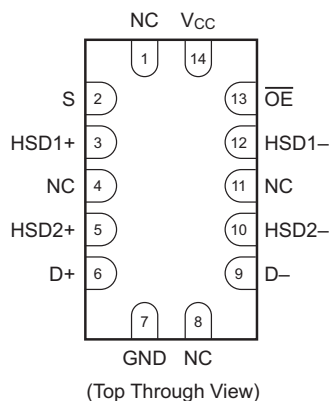
MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

## Connection Diagrams

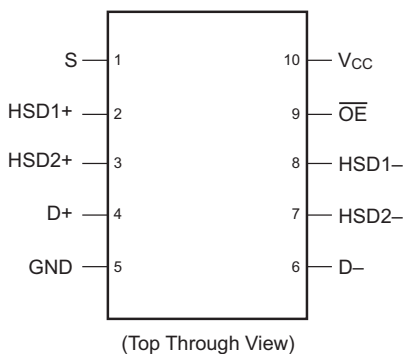
Pad Assignments for MicroPak



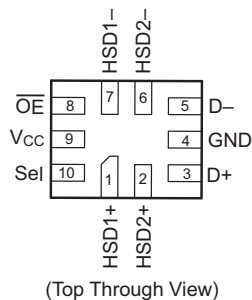
Pad Assignments for DQFN



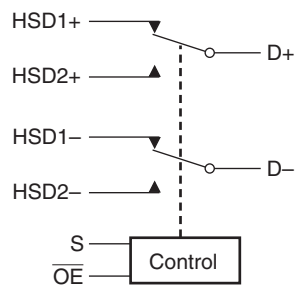
Pin Assignment for MSOP



Pad Assignments for  $\mu$ MLP



## Analog Symbol



## Pin Descriptions

Pin Name	Description
$\overline{OE}$	Bus Switch Enable
S	Select Input
D+, D-, HSDn+, HSDn-	Data Ports
NC	No Connect

## Truth Table

S	$\overline{OE}$	Function
X	HIGH	Disconnect
LOW	LOW	D+, D- = HSD1 <sub>n</sub>
HIGH	LOW	D+, D- = HSD2 <sub>n</sub>

## 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	Minimum	Maximum	Unit	
$V_{CC}$	Supply Voltage	-0.5	+5.5	V	
$V_{CNTRL}$	DC Input Voltage <sup>(1)</sup>	-0.5	$V_{CC}$	V	
$V_{SW}$	DC Switch Voltage <sup>(1)</sup>	HSDnX	0.5	$V_{CC}$	V
		D+,D- when $V_{CC} > 0$	0.5	$V_{CC}$	V
		D+,D- when $V_{CC} = 0$	-0.50	$V_{CC}$	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	All Pins		8	kV
		I/O to GND		8	kV

**Note:**

1. The input and output negative voltage 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.<sup>(2)</sup>

Symbol	Parameter	Minimum	Maximum	Unit
$V_{CC}$	Supply Voltage	3.0	4.3	V
$V_{IN}$	Control Input Voltage	0	$V_{CC}$	V
$V_{SW}$	Switch Input Voltage	0	$V_{CC}$	V
$T_A$	Operating Temperature	-40	+85	°C
$\Theta_{JA}$	Thermal Resistance, 10 MicroPak		250	°C/W

**Note:**

2. Control input must be held HIGH or LOW and it must not float.

## DC Electrical Characteristics

All typical values are at 25°C unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C			Unit
				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> = 0.0V to V <sub>CC</sub>	4.3	-1.0		1.0	μA
I <sub>OZ</sub>	OFF State Leakage	0 ≤ D <sub>n</sub> , HSD1 <sub>n</sub> , HSD2 <sub>n</sub> ≤ V <sub>CC</sub>	4.3	-2.0		2.0	μA
I <sub>OFF</sub>	Power OFF Leakage Current (D+, D-)	V <sub>SW</sub> = 0V to 4.3V, V <sub>CC</sub> = 0V	0	-2.0		2.0	μA
R <sub>ON</sub>	Switch On Resistance <sup>(3)</sup>	V <sub>SW</sub> = 0.4V, I <sub>ON</sub> = -8mA	3.0		6.5	10.0	Ω
			3.6			7.0	Ω
ΔR <sub>ON</sub>	Delta R <sub>ON</sub> <sup>(4)</sup>	V <sub>SW</sub> = 0.4V, I <sub>ON</sub> = -8mA	3.0		0.35		Ω
R <sub>ON</sub> Flatness	R <sub>ON</sub> Flatness <sup>(3)</sup>	V <sub>SW</sub> = 0.0V - 1.0V, I <sub>ON</sub> = -8mA	3.0		2.0		Ω
I <sub>CC</sub>	Quiescent Supply Current	V <sub>CNTRL</sub> = 0.0V 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 Control Voltage	V <sub>CNTRL</sub> (control input) = 2.6V	4.3			10.0	μA

### Notes:

- Measured by the voltage drop between D<sub>n</sub>, HSD1<sub>n</sub>, HSD2<sub>n</sub> pins at the indicated current through the switch. On resistance is determined by the lower of the voltage on the two ports.
- Guaranteed by characterization.

## AC Electrical Characteristics

All typical values are for V<sub>CC</sub> = 3.3V at 25°C unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C			Unit	Figure Number
				Min.	Typ.	Max.		
t <sub>ON</sub>	Turn-On Time S, OE to Output	HD1 <sub>n</sub> , HD2 <sub>n</sub> = 0.8V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF	3.0 to 3.6		13	30	ns	Figure 9
t <sub>OFF</sub>	Turn-Off Time S, OE to Output	HD1 <sub>n</sub> , HD2 <sub>n</sub> = 0.8V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF	3.0 to 3.6		12	25	ns	Figure 9
t <sub>PD</sub>	Propagation Delay <sup>(4)</sup>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF	3.3		0.25		ns	Figure 7 Figure 8
t <sub>BMM</sub>	Break-Before-Make	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, V <sub>IN</sub> = 0.8V	3.0 to 3.6	2.0		6.5	ns	Figure 10
O <sub>IRR</sub>	Off Isolation (Non-Adjacent)	f = 240MHz, R <sub>T</sub> = 50Ω	3.0 to 3.6		-30		dB	Figure 13
Xtalk	Non-Adjacent Channel Crosstalk	R <sub>T</sub> = 50Ω, f = 240MHz	3.0 to 3.6		-45		dB	Figure 14
BW	-3dB Bandwidth	R <sub>T</sub> = 50Ω, C <sub>L</sub> = 0pF	3.0 to 3.6		720		MHz	Figure 12
		R <sub>T</sub> = 50Ω, C <sub>L</sub> = 5pF			550			

### USB Hi-Speed Related AC Electrical Characteristics

Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C			Units	Figure Number
				Min.	Typ.	Max.		
t <sub>SK(O)</sub>	Channel-to-Channel Skew <sup>(5)</sup>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF	3.0 to 3.6		50		ps	Figure 7 Figure 11
t <sub>SK(P)</sub>	Skew of Opposite Transitions of the Same Output <sup>(5)</sup>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF	3.0 to 3.6		20		ps	Figure 7 Figure 11
t <sub>J</sub>	Total Jitter <sup>(5)</sup>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, t <sub>R</sub> = t <sub>F</sub> = 500ps at 480 Mbps (PRBS = 2 <sup>15</sup> - 1)	3.0 to 3.6		200		ps	

**Note:**

5. Guaranteed by characterization.

### Capacitance

Symbol	Parameter	Conditions	T <sub>A</sub> = -40°C to +85°C			Units	Figure Number
			Min.	Typ.	Max.		
C <sub>IN</sub>	Control Pin Input Capacitance	V <sub>CC</sub> = 0V		1.5		pF	Figure 16
C <sub>ON</sub>	D1 <sub>n</sub> , D2 <sub>n</sub> , Dn On Capacitance	V <sub>CC</sub> = 3.3, $\overline{OE}$ = 0V		3.7		pF	Figure 15
C <sub>OFF</sub>	D1 <sub>n</sub> , D2 <sub>n</sub> Off Capacitance	V <sub>CC</sub> and $\overline{OE}$ = 3.3		2.5		pF	Figure 16

Typical Characteristics

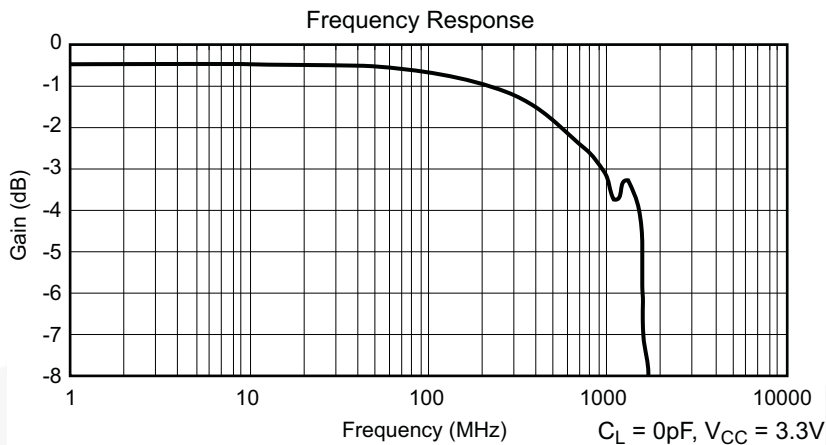


Figure 2. Gain vs. Frequency

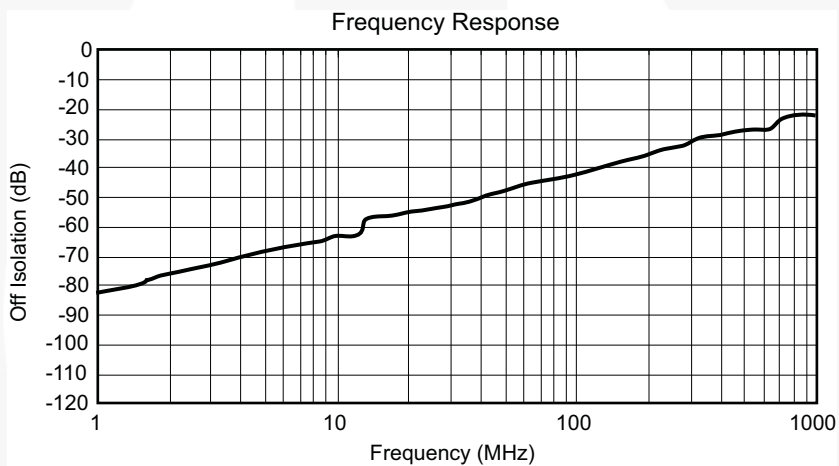


Figure 3. Off Isolation

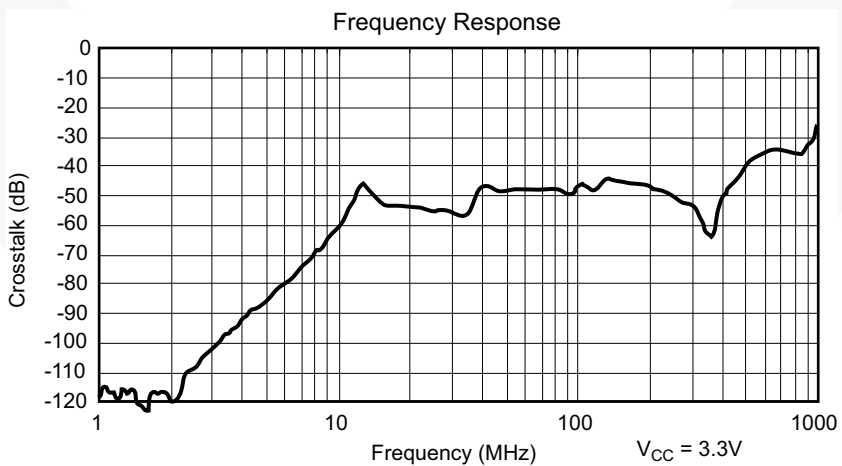
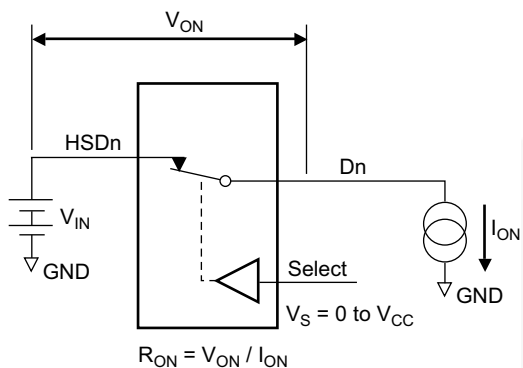
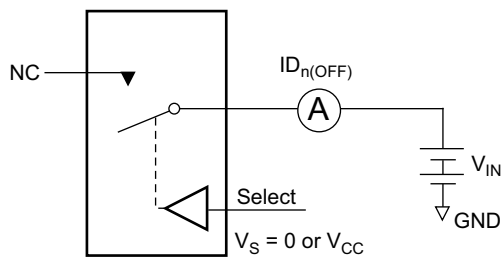


Figure 4. Crosstalk

## Test Diagrams

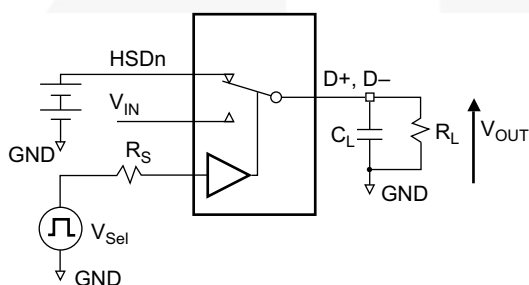


**Figure 5. On Resistance**



Each switch port is tested separately.

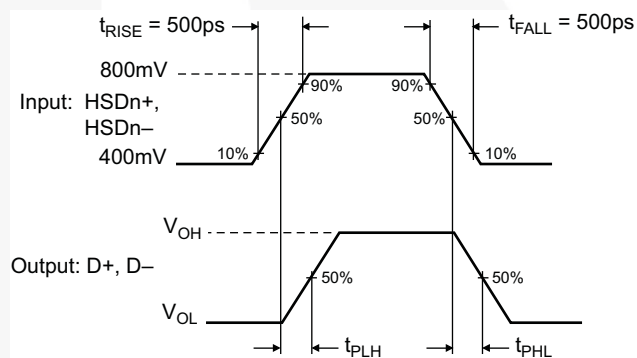
**Figure 6. Off Leakage**



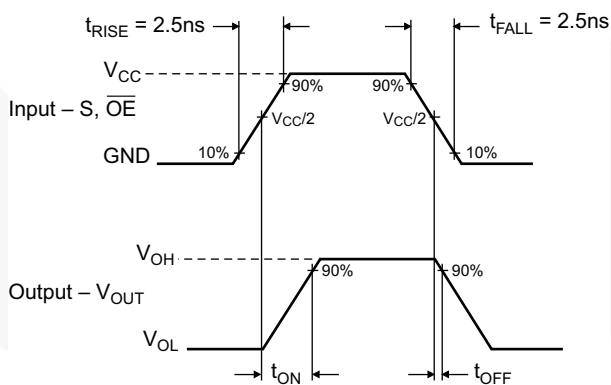
$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Electrical tables for specific values).

$C_L$  includes test fixture and stray capacitance.

**Figure 7. AC Test Circuit Load**

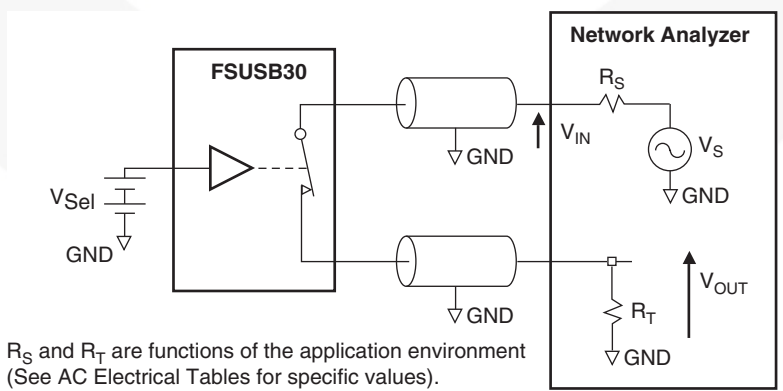
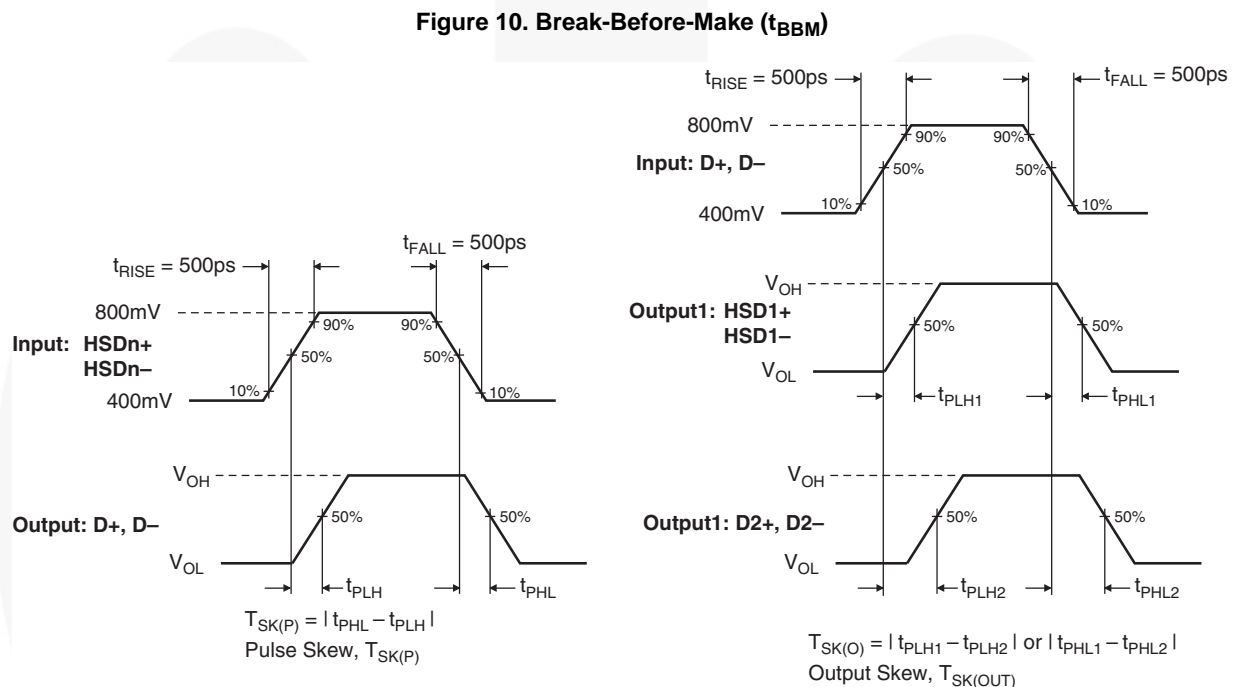
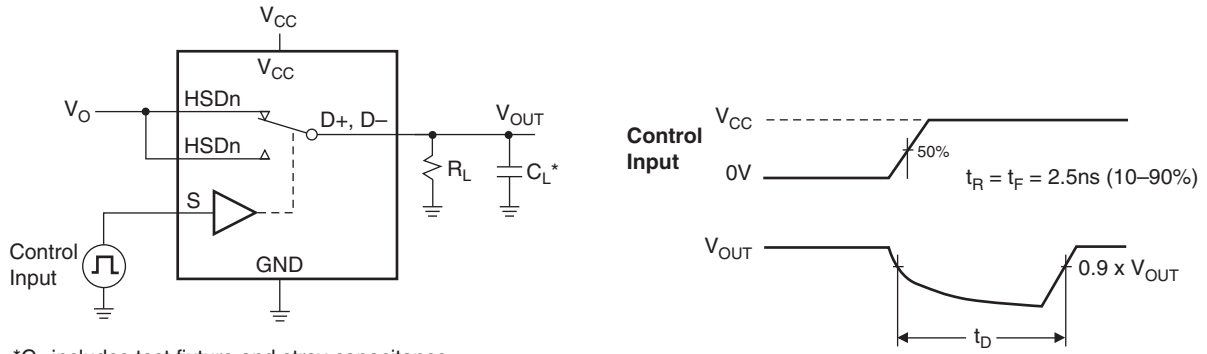


**Figure 8. Switch Propagation Delay Waveforms**



**Figure 9. Turn-On / Turn-Off Waveform**





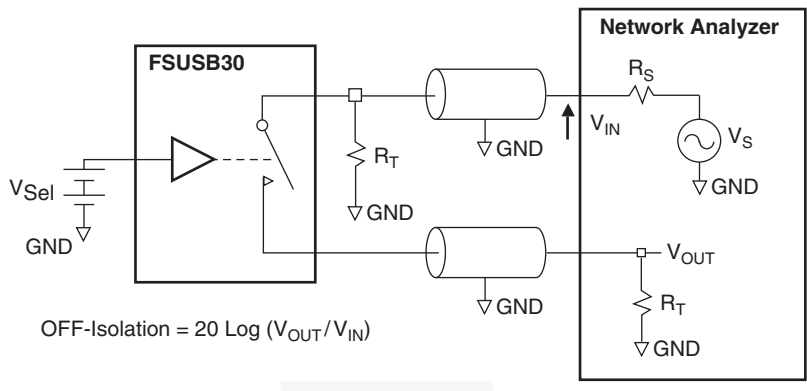


Figure 13. Channel Off Isolation

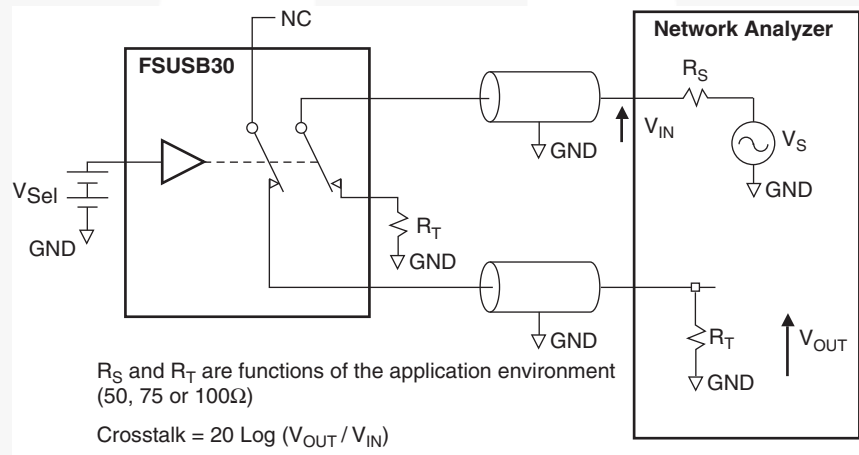


Figure 14. Non-Adjacent Channel-to-Channel Crosstalk

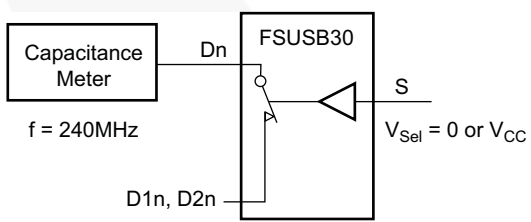


Figure 15. Channel On Capacitance

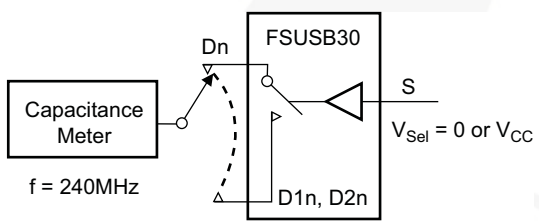


Figure 16. Channel Off Capacitance

## Application Guidance: Meeting USB 2.0 Vbus Short Requirements

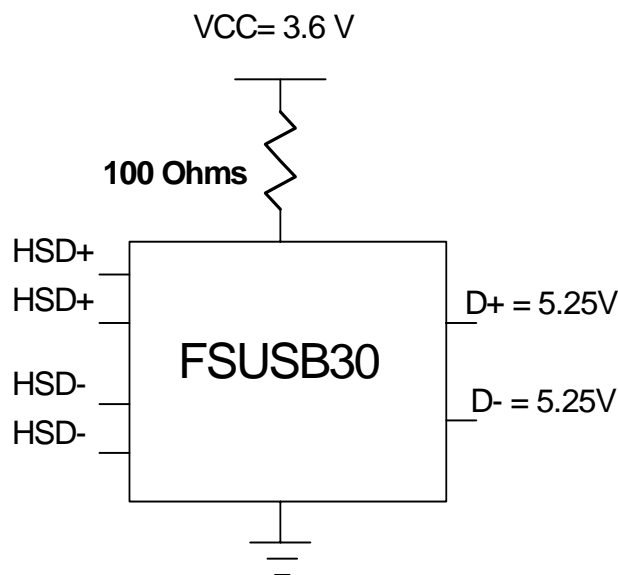
In section 7.1.1 of the USB 2.0 specification, it notes that USB devices must be able to withstand a Vbus short to D+ or D- when the USB devices is either powered off or powered on. The FSUSB30 can be successfully configured to meet both these requirements.

### Power-Off Protection

For a Vbus short circuit, the switch is expected to withstand such a condition for at least 24 hours. The FSUSB30 has specially designed circuitry which prevents unintended signal bleed through as well as guaranteed system reliability during a power-down, over-voltage condition. The protection has been added to the common pins (D+, D-).

### Power-On Protection

The USB 2.0 specification also notes that the USB device should be capable of withstanding a Vbus short during transmission of data. Fairchild recommends adding a  $100\Omega$  series resistor between the switch VCC pin and supply rail to protect against this case. This modification works by limiting current flow back into the  $V_{CC}$  rail during the over-voltage event so current remains within the safe operating range. In this application, the switch passes the full 5.25V input signal through to the selected output, while maintaining specified off isolation on the un-selected pins.



**Figure 17. Adding  $100\Omega$  resistor in series with the  $V_{CC}$  supply allows the FSUSB30 to withstand a Vbus short when powered up**

For more information, see Applications Note *AN-6022 Using the FSUSB30 to Comply with USB 2.0 Fault Condition Requirements* at [www.fairchildsemi.com](http://www.fairchildsemi.com)

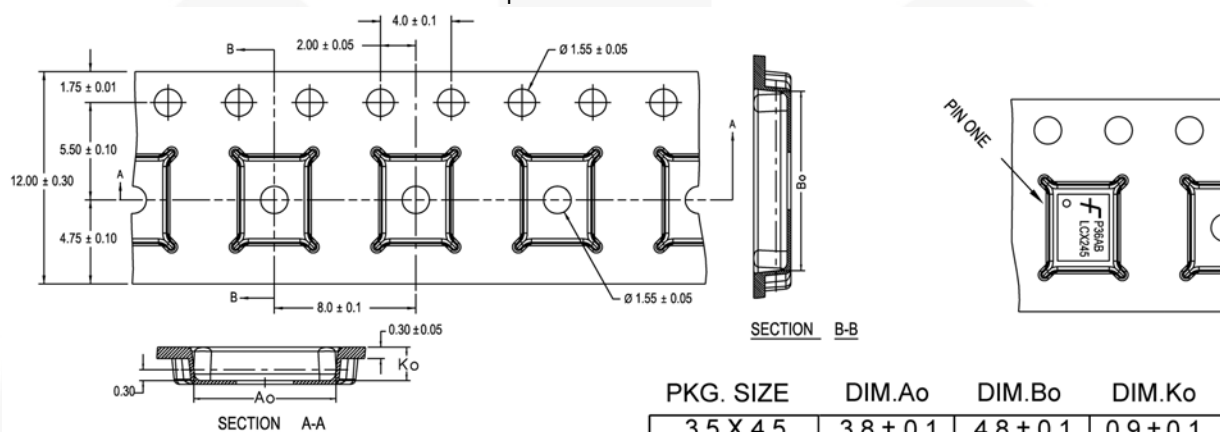
## Tape and Reel Specifications

### Tape Format for DQFN

Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
BQX	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	2500/3000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed

### Tape Dimensions

Dimensions are in millimeters unless otherwise specified.



DIMENSIONS ARE IN MILLIMETERS

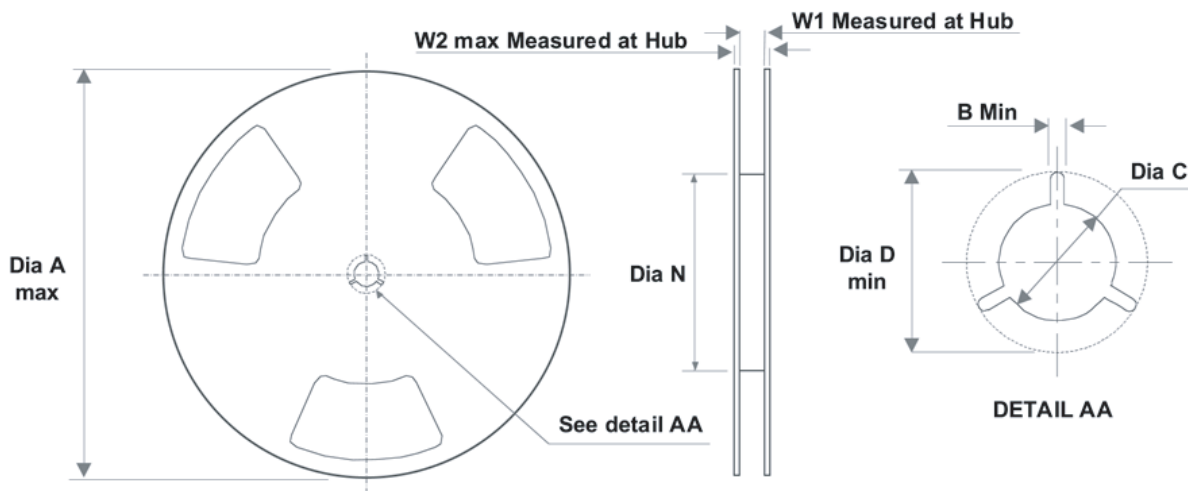
NOTES: unless otherwise specified

1. Cumulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is  $\pm 0.002[0.05]$  for these dimensions on all 12mm tapes.
5.  $A_o$  and  $B_o$  measured on a plane 0.120[0.30] above the bottom of the pocket.
6.  $K_o$  measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
7. Pocket position relative to sprocket hole measured as true position of pocket. Not pocket hole.
8. Controlling dimension is millimeter. Dimension in inches rounded.



### Reel Dimensions for DQFN

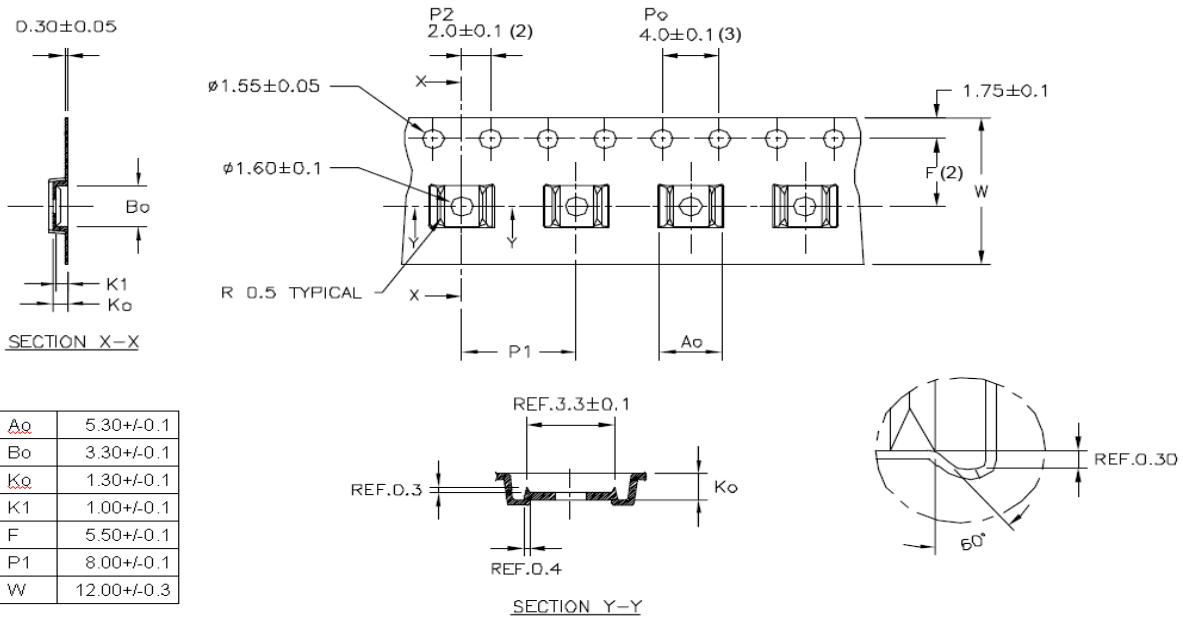
Dimensions are in inches (millimeters) unless otherwise specified.



Tape Size	A	B	C	D	N	W1	W2
(12mm)	13.0 (330)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	7.008 (178)	0.488 (12.4)	0.724 (18.4)

### Tape Dimensions for MSOP

Dimensions are in inches (millimeters) unless otherwise specified.

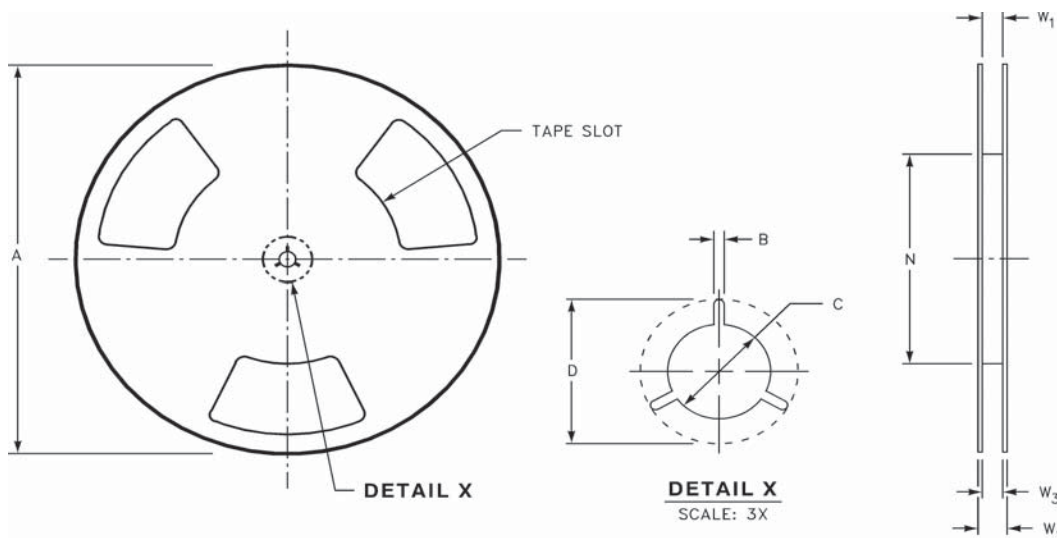


**Notes:**

1. All dimensions are in millimeters.
2. Measured from centerline of sprocket hole to centerline of pocket.
3. Cumulative tolerance of ten sprocket holes is ±0.20mm.
4. Other material available.

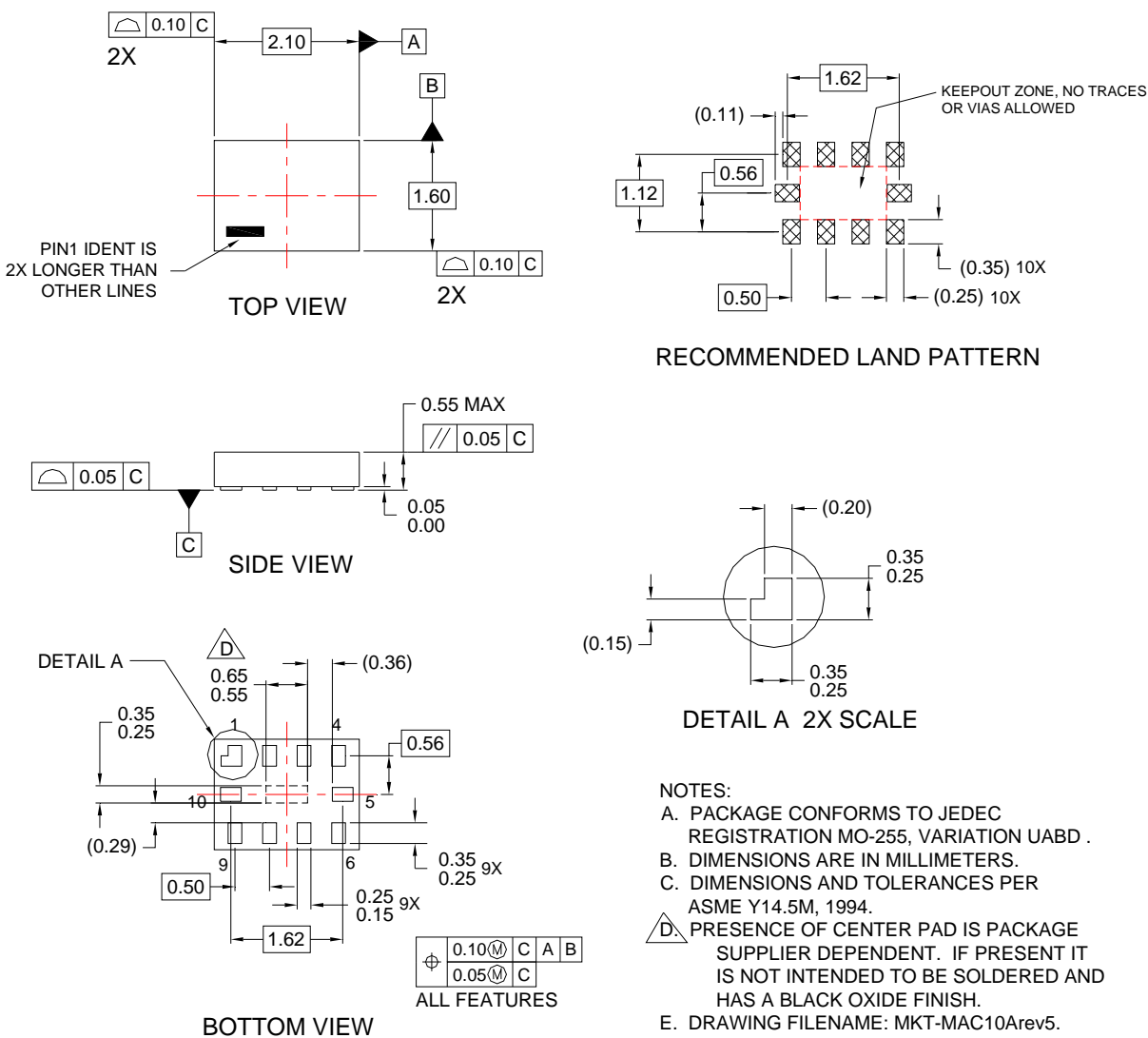
### Reel Dimensions for MSOP

Dimensions are in inches (millimeters) unless otherwise specified.



Tape Size	A	B	C	D	N	W1	W2	W3
(12mm)	13 (330)	0.059 (1.5)	0.512 (13)	0.795 (20.2)	7.008 (178)	0.448 (12.4)	0.724 (18.4)	0.468-0.606 (11.9 -15.4)

## Physical Dimensions



**Figure 17. 10-Lead MicroPak, 1.6 x 2.1mm**

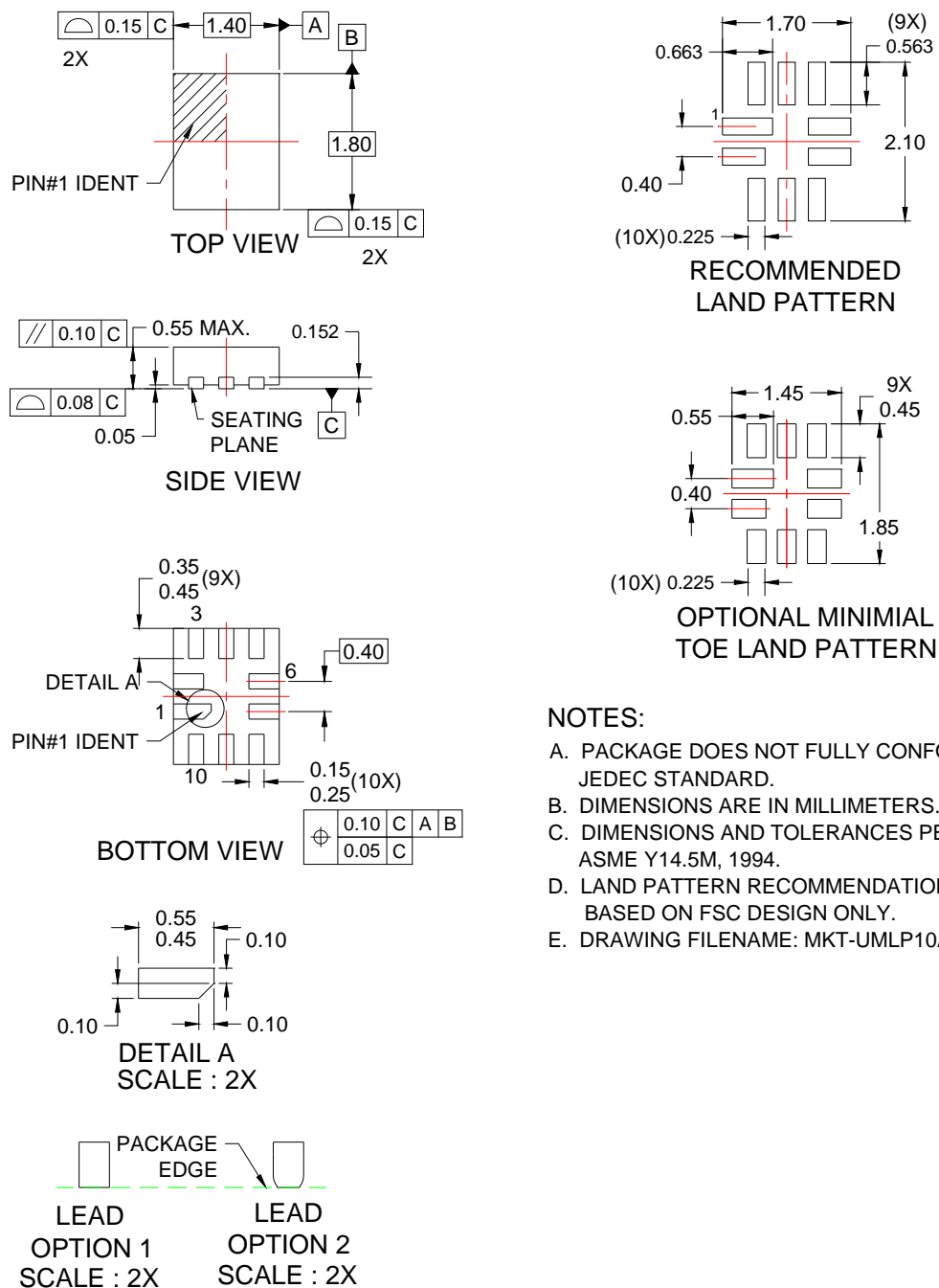
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## Physical Dimensions



### NOTES:

- PACKAGE DOES NOT FULLY CONFORM TO JEDEC STANDARD.
- DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
- LAND PATTERN RECOMMENDATION IS BASED ON FSC DESIGN ONLY.
- DRAWING FILENAME: MKT-UMLP10Arev3.

**Figure 19. 10-Lead, Quad, Ultrathin Molded Leadless Package (UMLP), 1.4 x 1.8mm**

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