



March 2005  
Revised April 2005

# FSUSB20

## Low Voltage Ultra Low Power USB High Speed (480 Mbps) Dual DPDT Switch (Preliminary)

### General Description

FSUSB20 is a low power high bandwidth analog switch specially designed for applications of the switching of high speed USB 2.0 signals in handset and consumer applications such as cell phone, digital camera, and notebook with hubs or controllers of limited USB I/O. The wide bandwidth (>720MHz) of this switch allows signals to pass with minimum edge and phase distortion. Superior channel-to-channel crosstalk results in minimal interference. It is compatible with high speed USB2.0 standard.

### Features

- -30dB OFF Isolation at 250MHz
- -30dB non-adjacent channel crosstalk at 250MHz
- 4.5Ω typical On Resistance (R<sub>ON</sub>)
- -3dB bandwidth: >720MHz
- Low power consumption (1uA max)
- Control input: LVTTTL compatible
- Bidirectional operation
- USB high speed and full speed signaling capability

### Applications

- Cell phone, PDA, digital camera, and notebook

### Ordering Code:

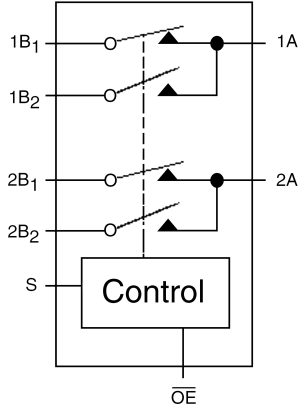
Order Number	Package Number	Package Description
FSUSB20L10X (Preliminary)	MAC010A	Pb-Free 10-Lead MicroPak, 1.6 mm x 2.1mm
FSUSB20BQX	MLP014A	Pb-Free 14-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.0mm

Pb-Free package per JEDEC J-STD-020B.

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

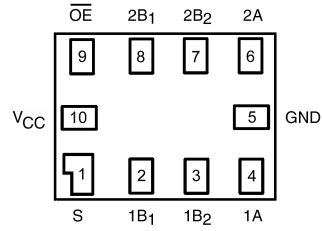
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**Analog Symbol**



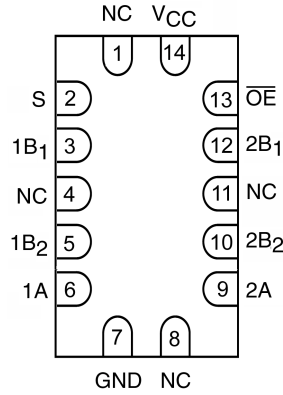
**Connection Diagrams**

**Pad Assignments for MicroPak**



(Top View)

**Pad Assignments for DQFN**



(Top Through View)

**Pin Descriptions**

Pin Name	Description
OE	Bus Switch Enable
S	Select Input
A	Bus A
B <sub>1</sub> -B <sub>2</sub>	Bus B

**Truth Table**

S	OE	Function
X	H	Disconnect
L	L	A = B <sub>1</sub>
H	L	A = B <sub>2</sub>

**Absolute Maximum Ratings**(Note 1)

Supply Voltage ( $V_{CC}$ )	-0.5V to +4.6V
DC Switch Voltage ( $V_S$ )	-0.5V to $V_{CC} + 0.05V$
DC Input Voltage ( $V_{IN}$ ) (Note 2)	-0.5V to +4.6V
DC Input Diode Current ( $I_{IK}$ ) $V_{IN} < 0V$	-50 mA
DC Output ( $I_{OUT}$ ) Sink Current	50 mA
DC $V_{CC}/GND$ Current ( $I_{CC}/I_{GND}$ )	$\pm 100$ mA
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150 °C
<b>ESD</b>	
Human Body Model	
All Pins	4kV
I/O to GND	5kV

**Recommended Operating Conditions** (Note 3)

Power Supply Operating ( $V_{CC}$ )	3.0V to 3.6V
Input Voltage ( $V_{IN}$ )	0V to $V_{CC}$
Output Voltage ( $V_{OUT}$ )	0V to $V_{CC}$
Input Rise and Fall Time ( $t_r, t_f$ )	
Switch Control Input	0 ns/V to 5 ns/V
Switch I/O	0 ns/V to DC
Free Air Operating Temperature ( $T_A$ )	-40 °C to +85 °C

**Note 1:** The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum rating. The Recommended Operating Conditions tables will define the conditions for actual device operation.

**Note 2:** The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

**Note 3:** Unused control inputs must be held HIGH or LOW. They may not float.

**DC Electrical Characteristics**

Symbol	Parameter	$V_{CC}$ (V)	$T_A = -40\text{ °C to }+85\text{ °C}$			Units	Conditions
			Min	Typ (Note 4)	Max		
$V_{IK}$	Clamp Diode Voltage	3.0			-1.2	V	$I_{IN} = -18\text{ mA}$
$V_{IH}$	HIGH Level Input Voltage	3.0 - 3.6	2.0			V	
$V_{IL}$	LOW Level Input Voltage	3.0 - 3.6			0.8	V	
$I_I$	Input Leakage Current	3.6			$\pm 1.0$	$\mu A$	$0 \leq V_{IN} \leq 3.6V$
$I_{OFF}$	OFF-STATE Leakage Current	3.6			$\pm 1.0$	$\mu A$	$0 \leq A, B \leq V_{CC}$
$R_{ON}$	Switch On Resistance (Note 5)	3.0		5.0	7.0	$\Omega$	$V_{IN} = 0.8V$ $I_{ON} = 8\text{ mA}$
		3.0		4.5	6.5	$\Omega$	$V_{IN} = 3.0V$ $I_{ON} = 8\text{ mA}$
$\Delta R_{ON}$	Delta $R_{ON}$	3.0		0.3		$\Omega$	$V_{IN} = 0.8V, V_{IN} = 0V - 1.5V, I_{ON} = 8\text{ mA}$
$R_{FLAT(ON)}$	On Resistance Flatness (Note 6)	3.0		1.0	1.3	$\Omega$	$I_{OUT} = 8\text{ mA}$
$I_{CC}$	Quiescent Supply Current	3.6			1.0	$\mu A$	$V_{IN} = V_{CC}$ or GND, $I_{OUT} = 0$

**Note 4:** Typical values are at  $V_{CC} = 3.0V$  and  $T_A = +25\text{ °C}$

**Note 5:** Measured by the voltage drop between A and B pins at the indicated current through the switch. On Resistance is determined by the lower of the voltages on the two (A or B) pins.

**Note 6:** Flatness is defined as the difference between the maximum and minimum value On Resistance over the specified range of conditions.

**AC Electrical Characteristics**

Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C			Units	Conditions	Figure Number
			Min	Typ (Note 7)	Max			
t <sub>ON</sub>	Turn ON Time S-to-Bus B	3.0 to 3.6		4.8	7.0	ns	V <sub>B</sub> = 0.8V	Figures 5, 6
t <sub>OFF</sub>	Turn OFF Time S-to-Bus B	3.0 to 3.6		2.2	4.0	ns	V <sub>B</sub> = 0.8V	Figures 5, 6
t <sub>PD</sub>	Propagation Delay	3.0 to 3.6		0.25		ns	C <sub>L</sub> = 10 pF	Figure 10
O <sub>IRR</sub>	Non-Adjacent OFF-Isolation	3.0 to 3.6		-28.0		dB	f = 250MHz, R <sub>L</sub> = 50Ω	Figure 7
X <sub>TALK</sub>	Non-Adjacent Channel Crosstalk	3.0 to 3.6		-30.0		dB	R <sub>L</sub> = 50Ω, f = 250MHz	Figure 8
BW	-3dB Bandwidth	3.0 to 3.6		750		MHz	R <sub>L</sub> = 50Ω	Figure 9

Note 7: Typical values are at V<sub>CC</sub> = 3.3V and T<sub>A</sub> = +25°C

**USB Related AC Electrical Characteristics** (Note 8)

Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = -40°C to +85°C			Units	Conditions	Figure Number
			Min	Typ	Max			
t <sub>SK(O)</sub>	Channel-to-Channel Skew	3.0 to 3.6		0.051		ns	C <sub>L</sub> = 10 pF	Figures 10, 11
t <sub>SK(P)</sub>	Skew of Opposite Transition of the Same Output	3.0 to 3.6		0.020		ns	C <sub>L</sub> = 10 pF	Figures 10, 11
T <sub>J</sub>	Total Jitter	3.0 to 3.6		0.210		ns	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10 pF t <sub>R</sub> = t <sub>F</sub> = 750ps at 480 Mbps	

Note 8: Typical values are at V<sub>CC</sub> = 3.3V and T<sub>A</sub> = +25°C

**Capacitance** (Note 9)

Symbol	Parameter	T <sub>A</sub> = -40°C to +85°C		Units	Conditions
		Typ			
C <sub>IN</sub>	Control Pin Input Capacitance	2.5		pF	V <sub>CC</sub> = 0V
C <sub>ON</sub>	A/B ON Capacitance	12.0		pF	V <sub>CC</sub> = 3.3V, OE = 0V
C <sub>OFF</sub>	Port B OFF Capacitance	4.0		pF	V <sub>CC</sub> and OE = 3.3V

Note 9: Typical values are at V<sub>CC</sub> = 3.3V and T<sub>A</sub> = +25°C

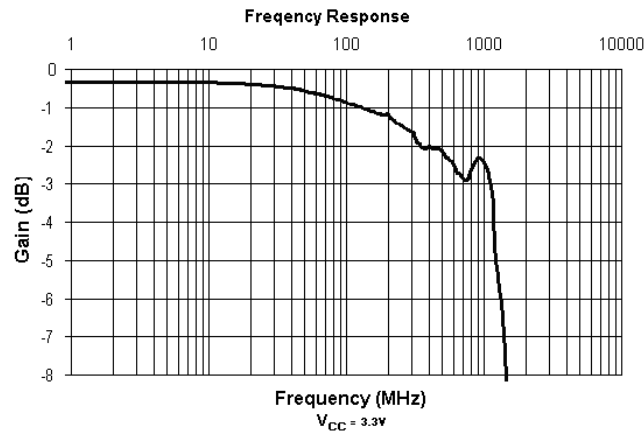


FIGURE 1. Gain vs. Frequency

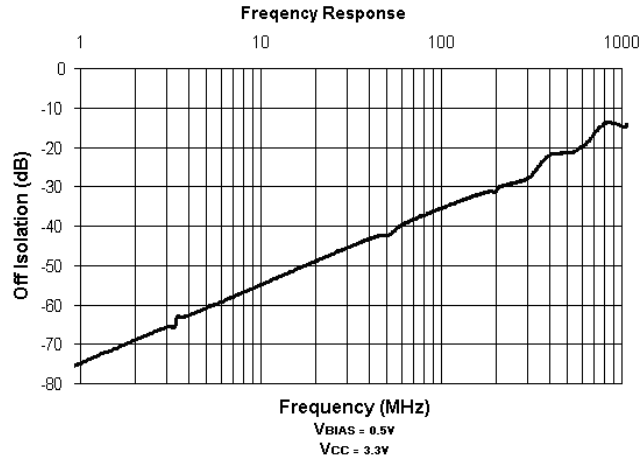


FIGURE 2. OFF Isolation

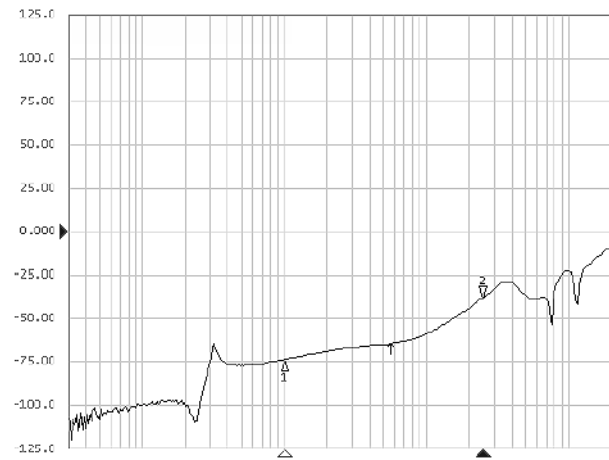


FIGURE 3. Crosstalk

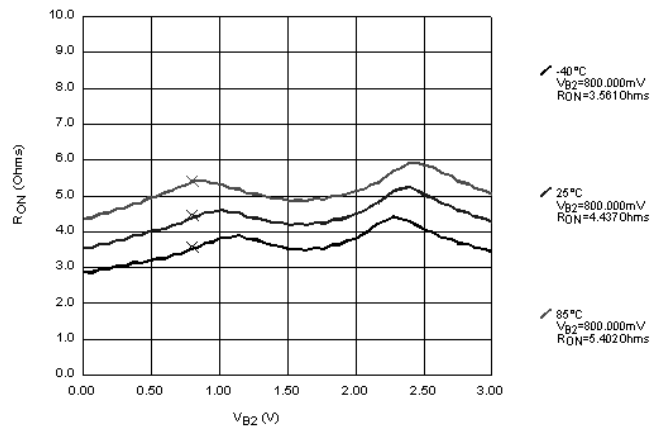
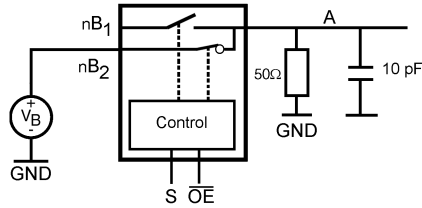


FIGURE 4. R<sub>ON</sub>

AC Loading and Waveforms



Note: Input driven by 50Ω source terminated in 50Ω  
 Note: C<sub>L</sub> includes load and stray capacitance  
 Note: Input PRR = 1.0 MHz, t<sub>W</sub> = 500 ns

FIGURE 5. AC Test Circuit

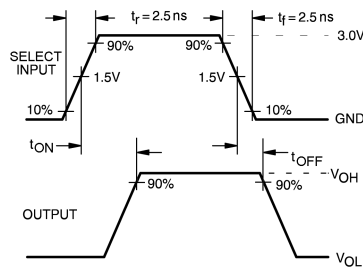


FIGURE 6. AC Waveforms

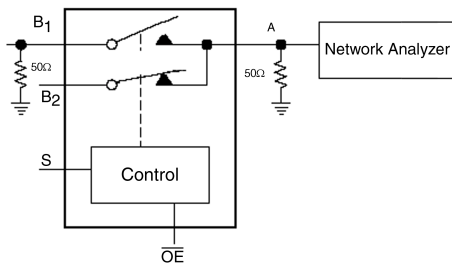


FIGURE 7. OFF Isolation Test

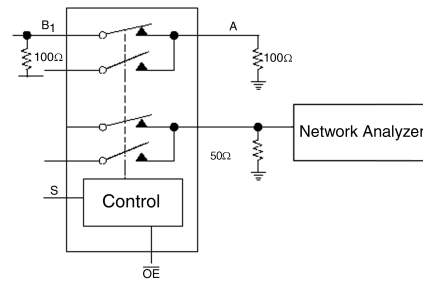


FIGURE 8. Crosstalk Test

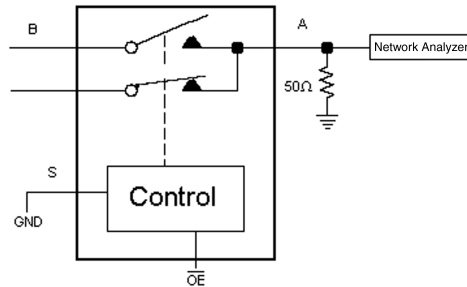


FIGURE 9. Bandwidth Test

AC Loading and Waveforms (Continued)

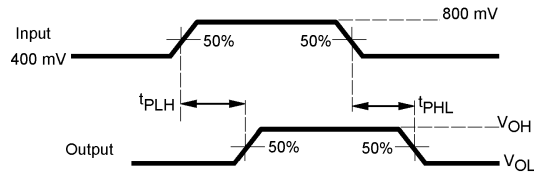
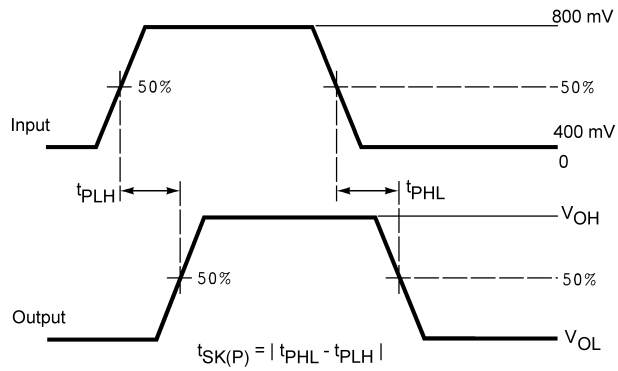
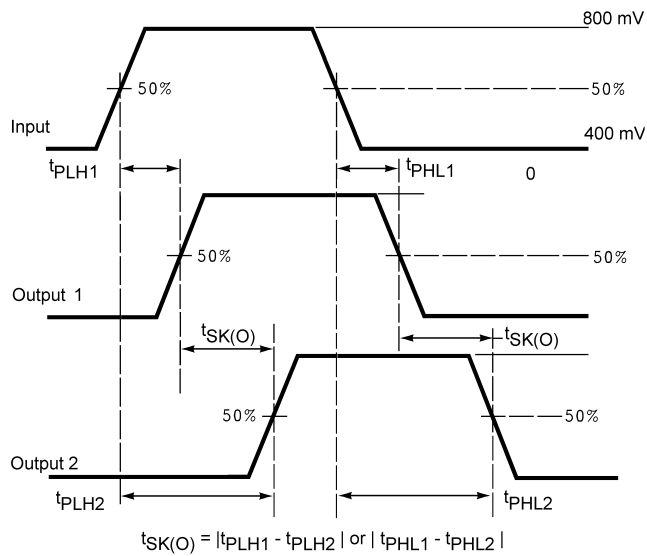


FIGURE 10. Propagation Delay



Pulse Skew  $t_{SK(P)}$



Output Skew  $t_{SK(O)}$

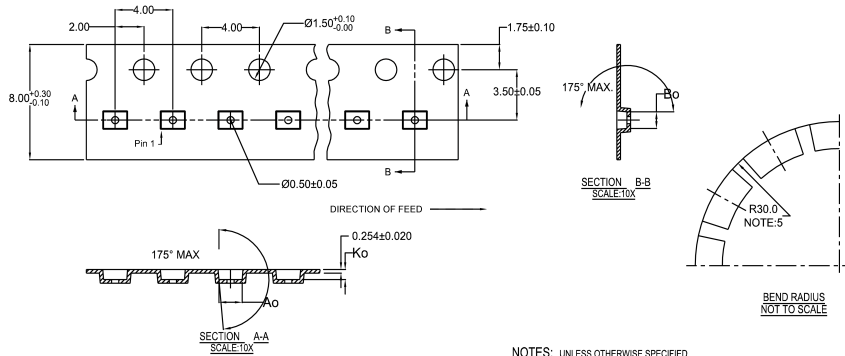
FIGURE 11. Skew Test

FSUSB20

### Tape and Reel Specification

Tape Format For Micropak

Package Designator	Tape Section	Number Cavities	Cavity Status	Cover Tape Status
L10X	Leader (Start End)	125 (typ)	Empty	Sealed
	Carrier	5000	Filled	Sealed
	Trailer (Hub End)	75 (typ)	Empty	Sealed



10	300056	2.30±0.05	1.78±0.05	0.68±0.05
8	300038	1.78±0.05	1.78±0.05	0.68±0.05
6	300033	1.60±0.05	1.15±0.05	0.70±0.05

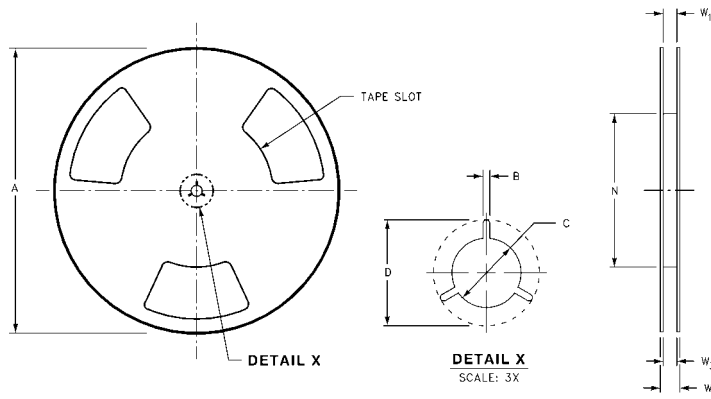
NOTES: UNLESS OTHERWISE SPECIFIED

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



SCALE: 6X

#### REEL DIMENSIONS inches (millimeters)



Tape Size	A	B	C	D	N	W1	W2	W3
8 mm	7.0 (177.8)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	2.165 (55.00)	0.331 + 0.059/-0.000 (8.40 + 1.50/-0.00)	0.567 (14.40)	W1 + 0.078/-0.039 (W1 + 2.00/-1.00)

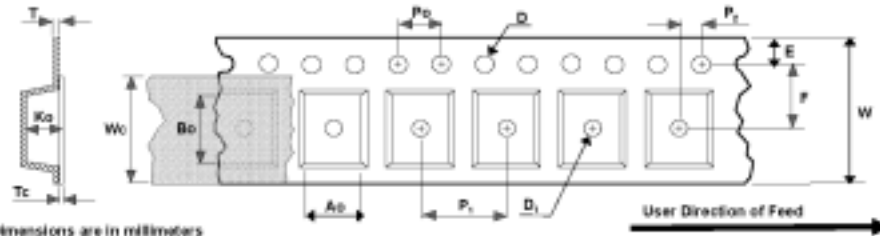


**Tape and Reel Specification** (Continued)

**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

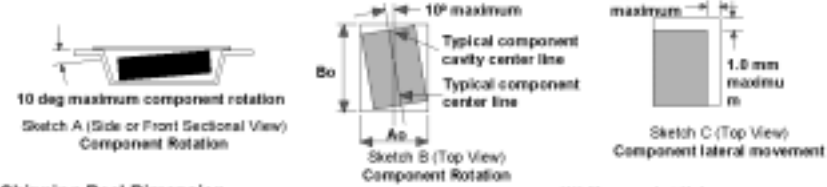
**TAPE DIMENSIONS** inches (millimeters)



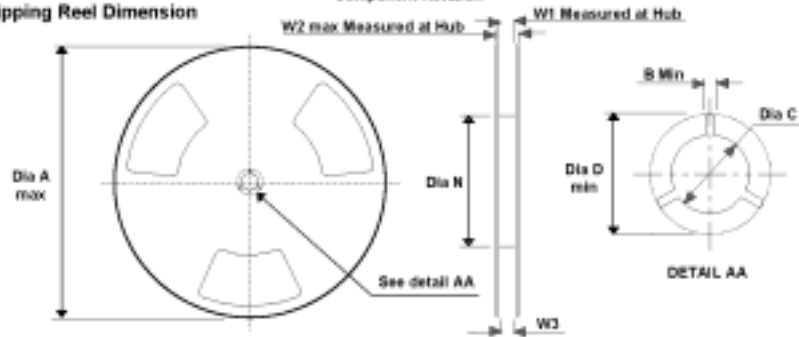
Dimensions are in millimeters

Package	A <sub>0</sub> +/-0.10	B <sub>0</sub> +/-0.10	D +/-0.05	D <sub>1</sub> min	E +/-0.1	F +/-0.1	K <sub>0</sub> +/-0.1	P <sub>1</sub> TYP	P <sub>0</sub> TYP	P <sub>i</sub> +/-0.05	T TYP	T <sub>c</sub> +/-0.025	W +/-0.3	W <sub>c</sub> TYP
2x2	2.30	2.30	1.55	1.0	1.75	3.5	1.0	8	4	2.0	0.3	0.07	8	5.3
2.5x2.5	2.80	2.80	1.55	1.5	1.75	5.5	0.9	8	4	2.0	0.3	0.07	12	9.3
2.5x3.0	2.80	3.30	1.55	1.5	1.75	5.5	0.9	8	4	2.0	0.3	0.07	12	9.3
2.5x3.5	2.80	3.80	1.55	1.5	1.75	5.5	0.9	8	4	2.0	0.3	0.07	12	9.3
2.5x4.5	2.80	4.80	1.55	1.5	1.75	5.5	0.9	8	4	2.0	0.3	0.07	12	9.3
3.5x4.5	3.80	4.80	1.55	1.5	1.75	5.5	0.9	8	4	2.0	0.3	0.07	12	9.3
2.5x3.0	2.80	3.30	1.55	1.5	1.75	5.5	0.9	8	4	2.0	0.3	0.07	12	9.3
4x4	4.35	4.35	1.55	1.5	1.75	5.5	1.1	8	4	2.0	0.3	0.07	12	9.3
5x5	5.35	5.35	1.55	1.5	1.75	5.5	1.1	8	4	2.0	0.3	0.07	12	9.3
6x6	6.30	6.30	1.55	1.5	1.75	7.5	1.1	12	4	2.0	0.3	0.07	16	13.3

Notes: A<sub>0</sub>, B<sub>0</sub>, and K<sub>0</sub> dimensions are determined with respect to the EIA/Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).



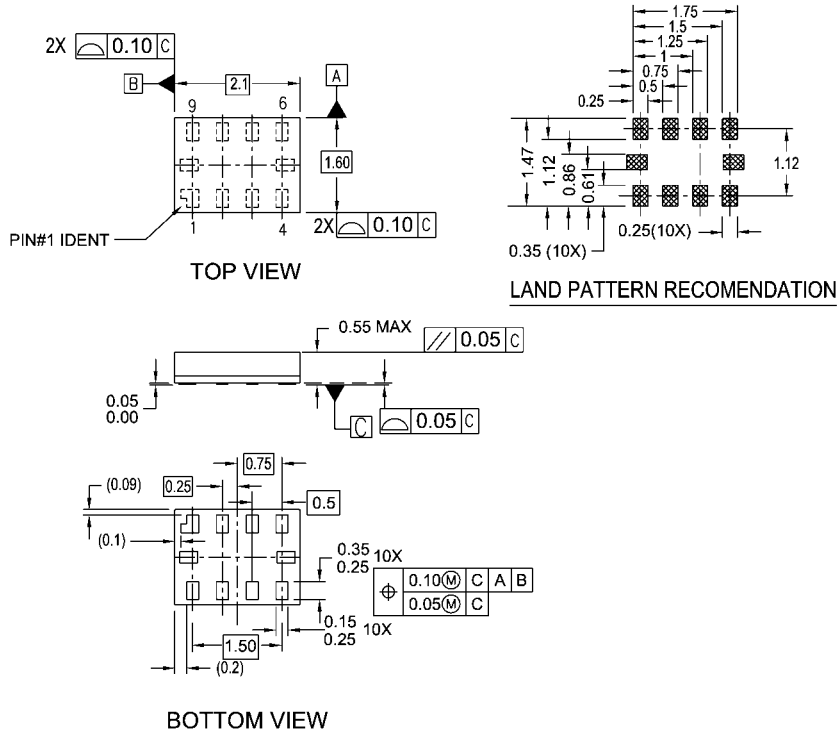
**Shipping Reel Dimension**



Dimensions are in millimeters

Tape Width	Dia A max	Dim B min	Dia C +5/-2	Dia D min	Dia N min	Dim W1 +2/-0	Dim W2 max	Dim W3 (L8L - USB)
8	330	1.5	13	20.2	178	8.4	14.4	7.9-10.4
12	330	1.5	13	20.2	178	12.4	18.4	11.9-15.4
16	330	1.5	13	20.2	178	16.4	22.4	15.9-19.4

**Physical Dimensions** inches (millimeters) unless otherwise noted



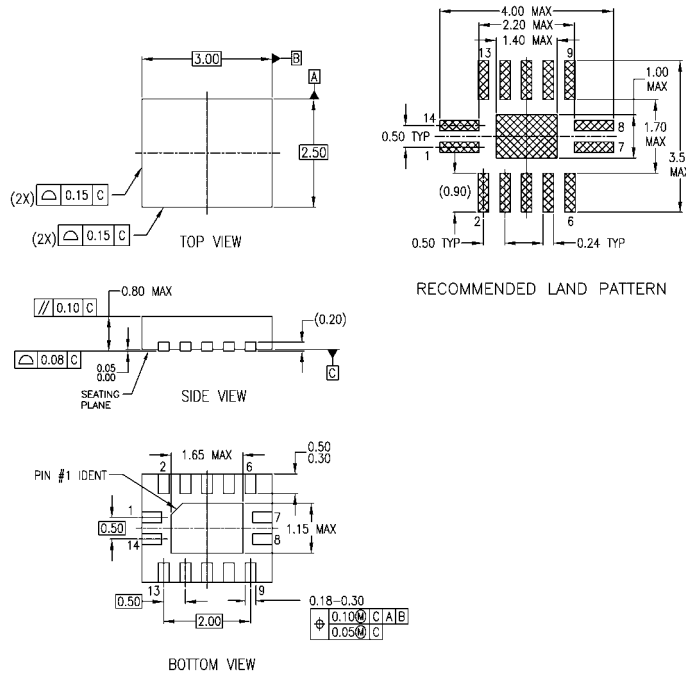
NOTES:

- A. PACKAGE CONFORMS TO JEDEC MO255, VARIATION UABD
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES CONFORMS TO ASME Y14.5M, 1994.

MAC010ARevB

**Pb-Free 10-Lead MicroPak, 1.6 mm x 2.1mm**  
**Package Number MAC010A**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



- NOTES:
- A. CONFORMS TO JEDEC REGISTRATION MO-241, VARIATION AA
  - B. DIMENSIONS ARE IN MILLIMETERS.
  - C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP014ArevA

**Pb-Free 14-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.0mm Package Number MLP014A**

**Technology Description**

The Fairchild Switch family derives from and embodies Fairchild's proven switch technology used for several years in its 74LVX3L384 (FST3384) bus switch product.

Fairchild does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and Fairchild reserves the right at any time without notice to change said circuitry and specifications.

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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