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FAIRCHILD

SEMICONDUCTOR®

April 2013

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_{CCT} over an Expanded Control Voltage Range (V_{IN} = 2.6V, V_{CC} = 4.3V)
- Wide -3dB Bandwidth, >720MHz
- 8kV ESD Protection
- Power-Off Protection when V_{CC} = 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_{ON}) 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_{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

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
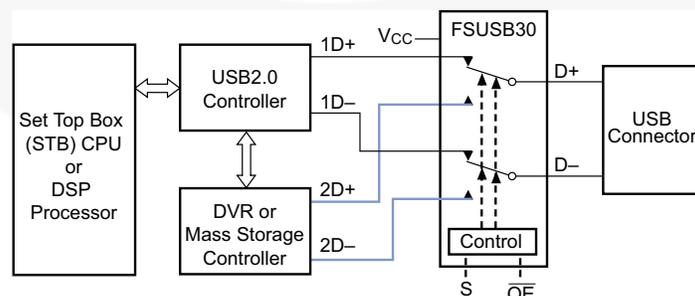
Figure 1. Typical Application

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

Connection Diagrams

Pad Assignments for MicroPak

(Top View)
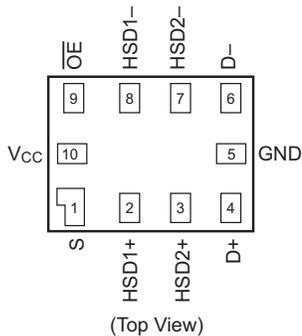
Pad Assignments for DQFN

(Top Through View)

Pin Assignment for MSOP

(Top Through View)

Pad Assignments for µMLP

(Top Through View)
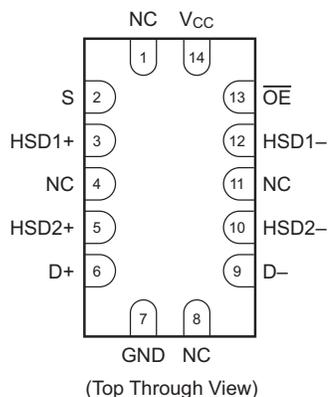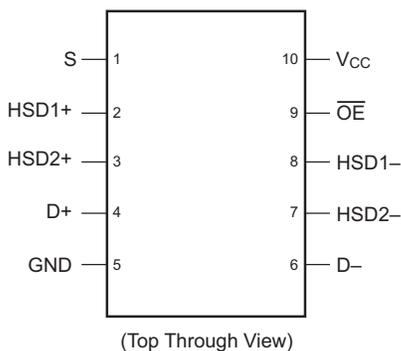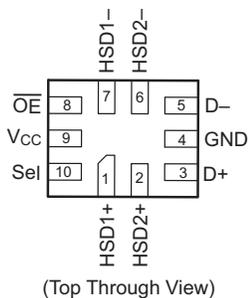
Analog Symbol
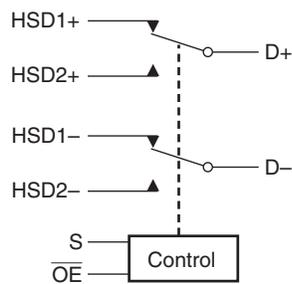
Pin Descriptions

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$_n$
HIGH	LOW	D+, D− = HSD2$_n$

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[1]		-0.5	V_{CC}	V
V_{SW}	DC Switch Voltage[1]	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.[2]

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
ΘJ_A	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_{CC} (V)	Min.	Typ.	Max.	Unit
V_{IK}	Clamp Diode Voltage	I_{IN} = -18mA	3.0			-1.2	V
V_{IH}	Input Voltage HIGH		3.0 to 3.6	1.3			V
			4.3	1.7			V
V_{IL}	Input Voltage LOW		3.0 to 3.6			0.5	V
			4.3			0.7	V
I_{IN}	Control Input Leakage	V_{SW} = 0.0V to V_{CC}	4.3	-1.0		1.0	µA
I_{OZ}	OFF State Leakage	$0 \leq Dn, HSD1_n, HSD2_n \leq V_{CC}$	4.3	-2.0		2.0	µA
I_{OFF}	Power OFF Leakage Current (D+, D−)	V_{SW} = 0V to 4.3V, V_{CC} = 0V	0	-2.0		2.0	µA
R_{ON}	Switch On Resistance[3]	V_{SW} = 0.4V, I_{ON} = -8mA	3.0		6.5	10.0	Ω
		V_{SW} = 0V, I_O = 30mA at 25°C	3.6			7.0	Ω
ΔR_{ON}	Delta R_{ON}[4]	V_{SW} = 0.4V, I_{ON} = -8mA	3.0		0.35		Ω
R_{ON} Flatness	R_{ON} Flatness[3]	V_{SW} = 0.0V - 1.0V, I_{ON} = -8mA	3.0		2.0		Ω
I_{CC}	Quiescent Supply Current	V_{CNTRL} = 0.0V or V_{CC}, I_{OUT} = 0	4.3			1.0	µA
I_{CCT}	Increase in I_{CC} Current per Control Voltage	V_{CNTRL} (control input) = 2.6V	4.3			10.0	µA

Notes:

3. Measured by the voltage drop between Dn, $HSD1_n$, $HSD2_n$ pins at the indicated current through the switch. On resistance is determined by the lower of the voltage on the two ports.
4. Guaranteed by characterization.

AC Electrical Characteristics

All typical values are for V_{CC} = 3.3V at 25°C unless otherwise specified.

Symbol	Parameter	Conditions	V_{CC} (V)	Min.	Typ.	Max.	Unit	Figure Number
t_{ON}	Turn-On Time S, $\overline{OE}$ to Output	$HD1_n, HD2_n$ = 0.8V, R_L = 50Ω, C_L = 5pF	3.0 to 3.6		13	30	ns	Figure 9
t_{OFF}	Turn-Off Time S, $\overline{OE}$ to Output	$HD1_n, HD2_n$ = 0.8V, R_L = 50Ω, C_L = 5pF	3.0 to 3.6		12	25	ns	Figure 9
t_{PD}	Propagation Delay[4]	R_L = 50Ω, C_L = 5pF	3.3		0.25		ns	Figure 7 Figure 8
t_{BBM}	Break-Before-Make	R_L = 50Ω, C_L = 5pF, V_{IN} = 0.8V	3.0 to 3.6	2.0		6.5	ns	Figure 10
O_{IRR}	Off Isolation (Non-Adjacent)	f = 240MHz, R_T = 50Ω	3.0 to 3.6		-30		dB	Figure 13
Xtalk	Non-Adjacent Channel Crosstalk	R_T = 50Ω, f = 240MHz	3.0 to 3.6		-45		dB	Figure 14
BW	−3dB Bandwidth	R_T = 50Ω, C_L = 0pF	3.0 to 3.6		720		MHz	Figure 12
		R_T = 50Ω, C_L = 5pF			550			

USB Hi-Speed Related AC Electrical Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	T_A = –40°C to +85°C			Units	Figure Number
				Min.	Typ.	Max.		
$t_{SK(O)}$	Channel-to-Channel Skew[5]	R_L = 50Ω, C_L = 5pF	3.0 to 3.6		50		ps	Figure 7 Figure 11
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output[5]	R_L = 50Ω, C_L = 5pF	3.0 to 3.6		20		ps	Figure 7 Figure 11
t_J	Total Jitter[5]	R_L = 50Ω, C_L = 5pF, t_R = t_F = 500ps at 480 Mbps (PRBS = 2^{15} – 1)	3.0 to 3.6		200		ps	

Note:

5. Guaranteed by characterization.

Capacitance

Symbol	Parameter	Conditions	T_A = –40°C to +85°C			Units	Figure Number
			Min.	Typ.	Max.		
C_{IN}	Control Pin Input Capacitance	V_{CC} = 0V		1.5		pF	Figure 16
C_{ON}	D1$_n$, D2$_n$, Dn On Capacitance	V_{CC} = 3.3, $\overline{OE}$ = 0V		3.7		pF	Figure 15
C_{OFF}	D1$_n$, D2$_n$ Off Capacitance	V_{CC} and $\overline{OE}$ = 3.3		2.5		pF	Figure 16

Typical Characteristics

Frequency Response

$C_L = 0pF, V_{CC} = 3.3V$
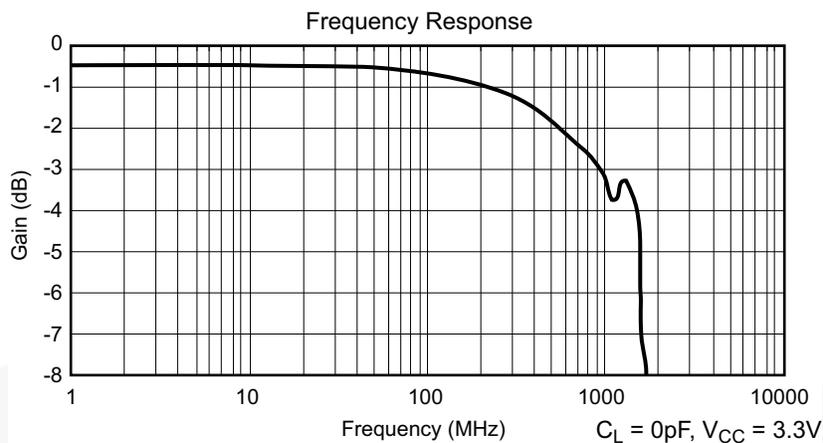
Figure 2. Gain vs. Frequency

Frequency Response

Figure 3. Off Isolation

Frequency Response

$V_{CC} = 3.3V$

Figure 4. Crosstalk

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Test Diagrams

R$_{ON}$ = V$_{ON}$ / I$_{ON}$
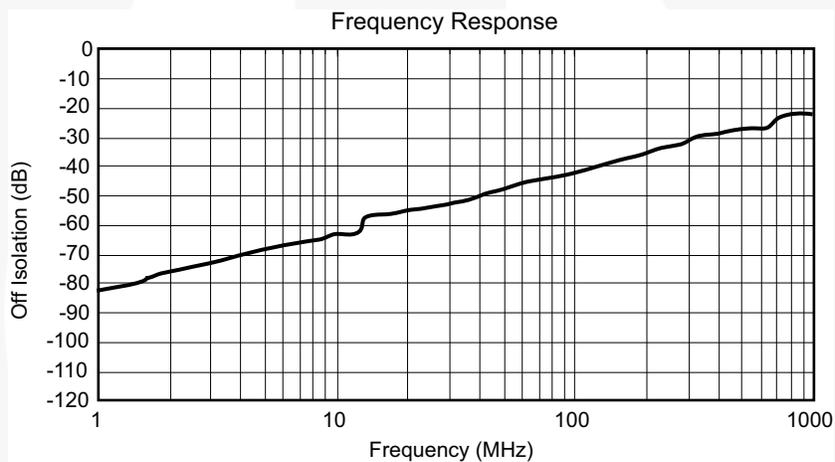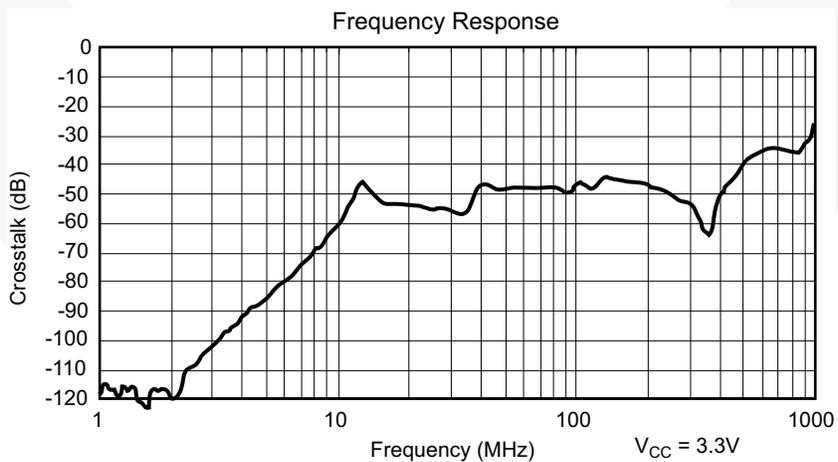
Figure 5. On Resistance

Each switch port is tested separately.

Figure 6. Off Leakage
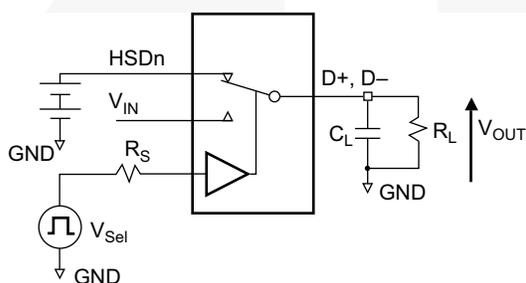
R$_L$, R$_S$, and C$_L$ are functions of the application environment (see AC Electrical tables for specific values).

C$_L$ includes test fixture and stray capacitance.

Figure 7. AC Test Circuit Load
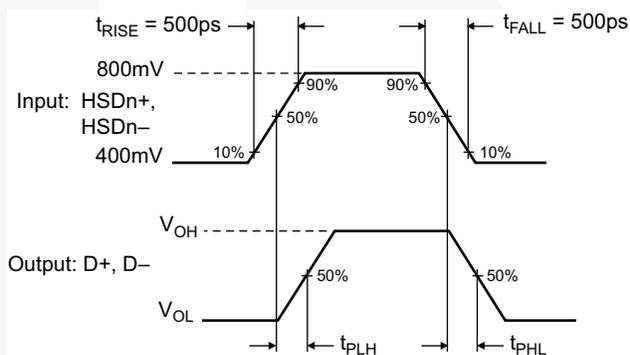
Figure 8. Switch Propagation Delay Waveforms
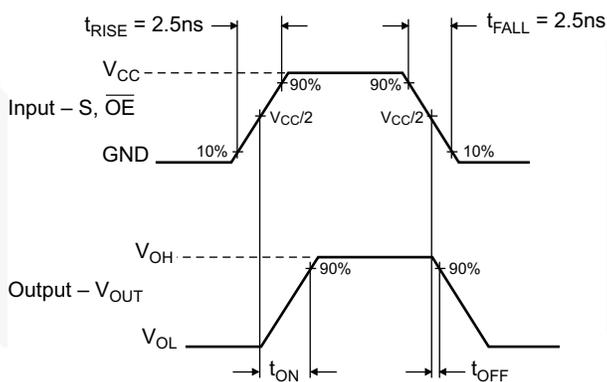
Figure 9. Turn-On / Turn-Off Waveform

V_CC

V_CC

V_O — HSDn

HSDn

D+, D− — V_OUT

R_L

C_L*

S

Control Input

GND

*C_L includes test fixture and stray capacitance.

Control Input

V_CC

0V

50%

$t_R = t_F = 2.5ns$ (10–90%)

V_OUT

$0.9 \times V_{OUT}$

t_D

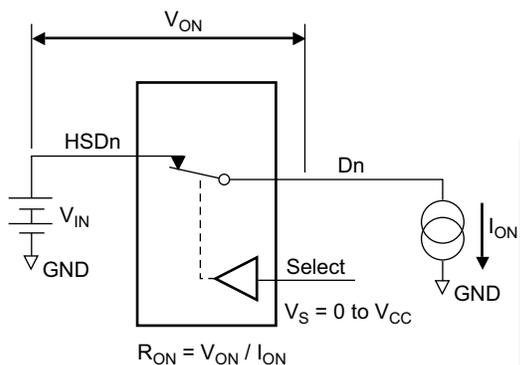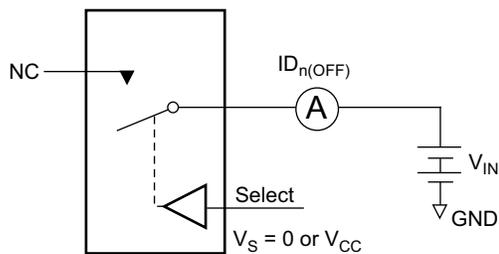**Figure 10. Break-Before-Make (t_BBM)**

$t_{RISE} = 500ps$ $t_{FALL} = 500ps$

800mV

90%   90%

Input: D+, D−

50%   50%

10%   10%

400mV

Output1: HSD1+ HSD1−

V_OH

50%   50%

V_OL

t_{PLH1} t_{PHL1}

$t_{RISE} = 500ps$ $t_{FALL} = 500ps$

800mV

90%   90%

Input: HSDn+ HSDn−

50%   50%

10%   10%

400mV

Output: D+, D−

V_OH

50%   50%

V_OL

t_{PLH} t_{PHL}

$T_{SK(P)} = |\, t_{PHL} - t_{PLH}\, |$
Pulse Skew, $T_{SK(P)}$

Output1: D2+, D2−

V_OH

50%   50%

V_OL

t_{PLH2} t_{PHL2}

$T_{SK(O)} = |\, t_{PLH1} - t_{PLH2}\, |$ or $|\, t_{PHL1} - t_{PHL2}\, |$
Output Skew, $T_{SK(OUT)}$

Figure 11. Switch Skew Tests

Network Analyzer

FSUSB30

R_S

V_IN

V_S

GND

V_Sel

GND

GND

GND

V_OUT

R_T

GND

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

Figure 12. Bandwidth

OFF-Isolation = 20 Log (V_{OUT}/V_{IN})

Figure 13. Channel Off Isolation

R_S and R_T are functions of the application environment (50, 75 or 100Ω)

Crosstalk = 20 Log (V_{OUT}/V_{IN})
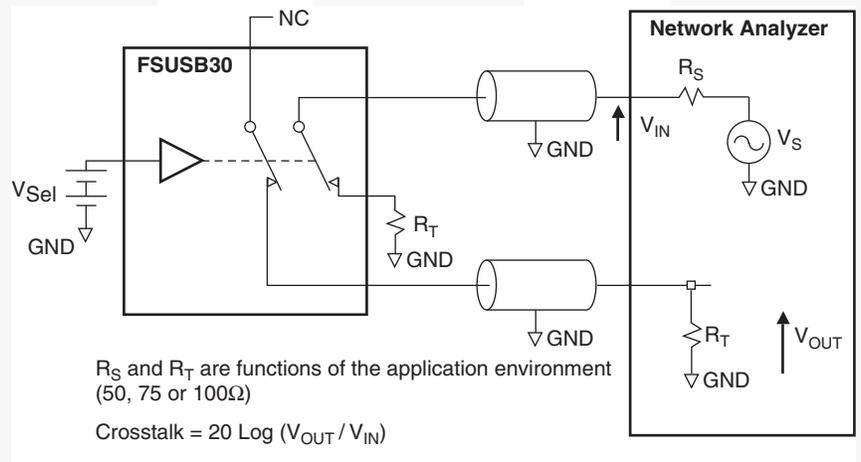
Figure 14. Non-Adjacent Channel-to-Channel Crosstalk

f = 240MHz

V_{Sel} = 0 or V_{CC}

f = 240MHz

V_{Sel} = 0 or V_{CC}

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 uni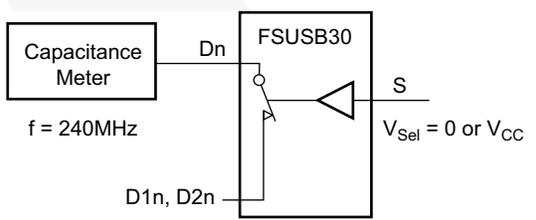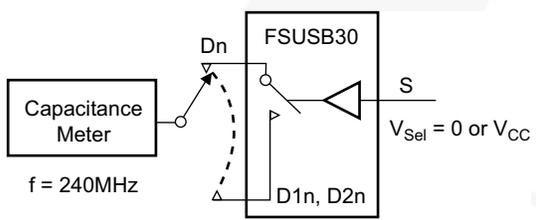ntended signal bleed through as well as guaranteed system reliability during a power-down, overvoltage condition. The protection has been added to the common pins (D+, D-).

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 100Ω series resister 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.
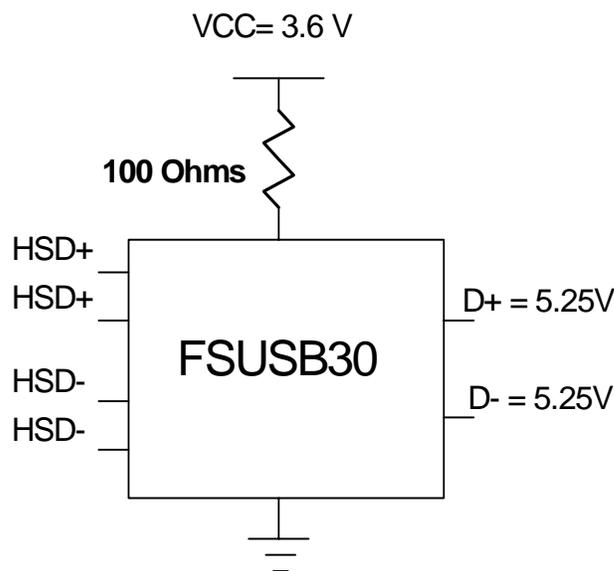

Figure 17. Adding 100Ω resistor in series with the V_{CC} supply allows the FSUSB30 to withstand a Vbus short when powered up

For more information, see Applications Note *AN-6022 Using the FSUSB30 to Comply with USB 2.0 Fault Condition Requirements* at www.fairchildsemi.com
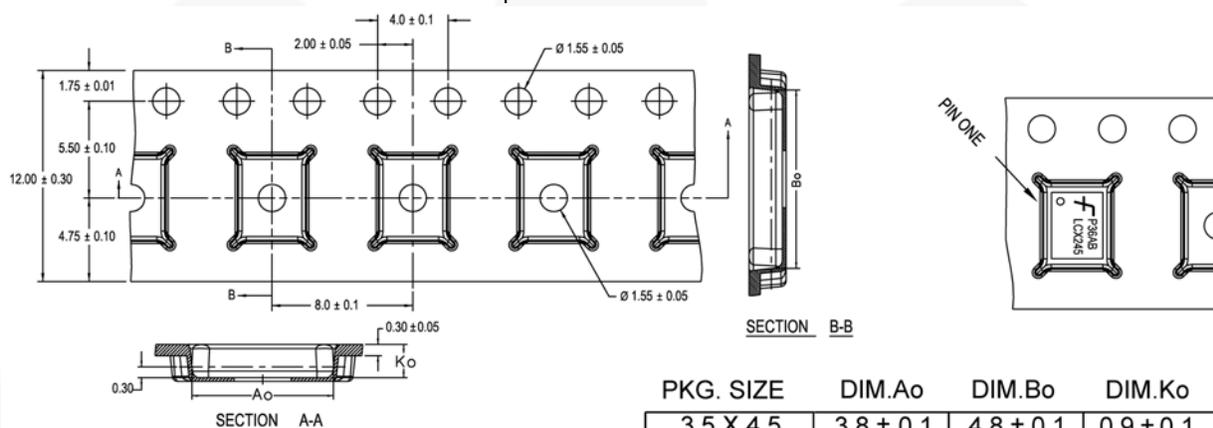
Tape and Reel Specifications

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

Dimenions are in millimeters unless otherwise specified.

PKG. SIZE	DIM.Ao	DIM.Bo	DIM.Ko
3.5 X 4.5	3.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
3.0 X 3.0	3.3 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 4.5	2.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
2.5 X 3.5	2.8 ± 0.1	3.8 ± 0.1	0.9 ± 0.1
2.5 X 3.0	2.8 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 2.5	2.8 ± 0.1	2.8 ± 0.1	0.9 ± 0.1

DIMENSIONS ARE IN MILLIMETERS

NOTES: unless otherwise specified

1. Cummulative 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 ±0.002[0.05] for these dimensions on all 12mm tapes.
5. Ao and Bo measured on a plane 0.120[0.30] above the bottom of the pocket.
6. Ko 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. Diemension in inches rounded.

Reel Dimensions for DQFN

Dimensions are in inches (millimeters) unless otherwise specified.
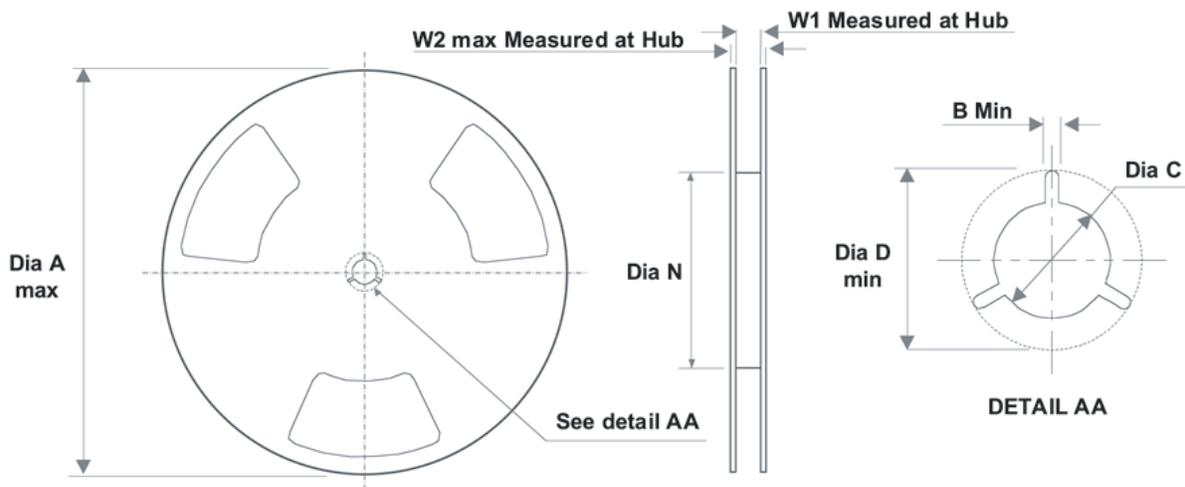
Tape Size	A	B	C	D	N	W1	W2
(12mm)	13.0 (330)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	7.008 (178)	0.488 (12.4)	0.724 (18.4)

Tape Dimensions for MSOP

Dimensions are in inches (millimeters) unless otherwise specified.
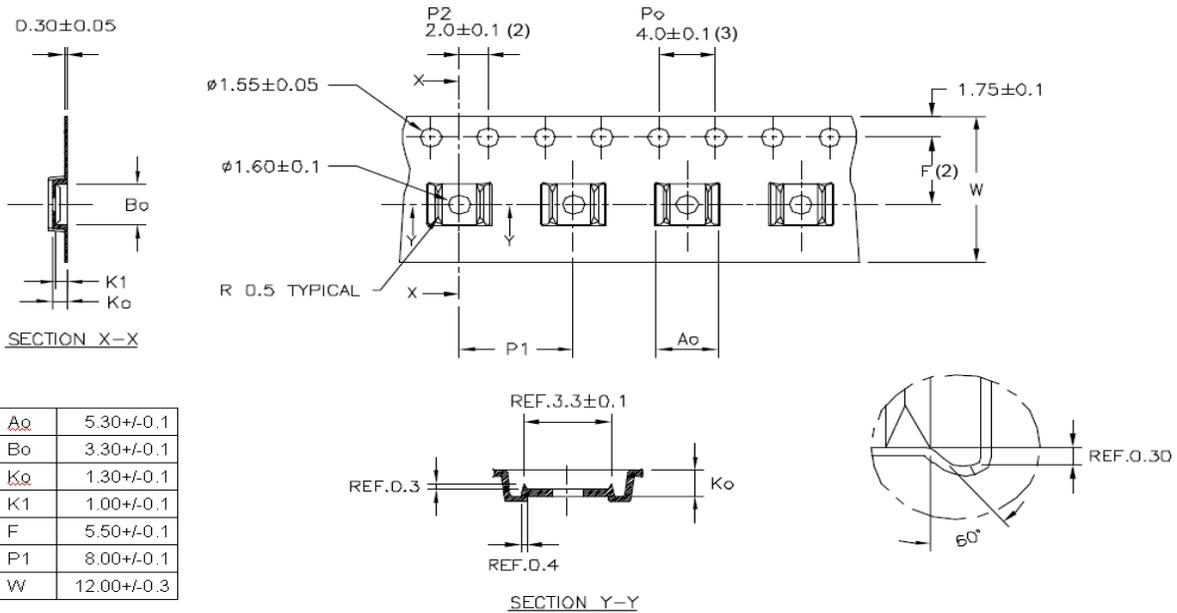
Ao	5.30+/-0.1
Bo	3.30+/-0.1
Ko	1.30+/-0.1
K1	1.00+/-0.1
F	5.50+/-0.1
P1	8.00+/-0.1
W	12.00+/-0.3

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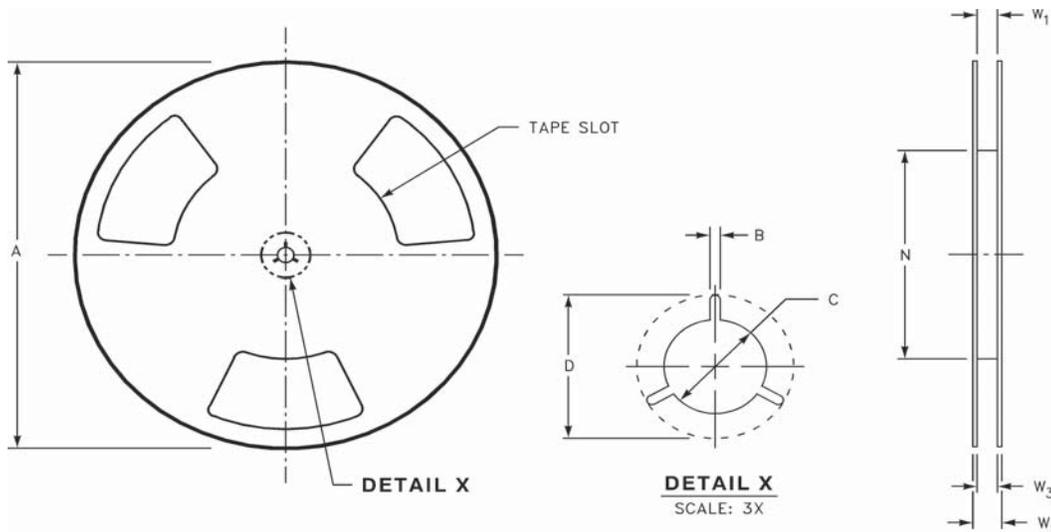
Tape Size	A	B	C	D	N	W1	W2	W3
(12mm)	13 (330)	0.059 (1.5)	0.512 (13)	0.795 (20.2)	7.008 (178)	0.448 (12.4)	0.724 (18.4)	0.468-0.606 (11.9 -15.4)

Physical Dimensions

2X   △ 0.10 C

2.10 → ▶ A

B

1.60

PIN1 IDENT IS
2X LONGER THAN
OTHER LINES

TOP VIEW

2X   △ 0.10 C

1.62

(0.11)

0.56

1.12

KEEPOUT ZONE, NO TRACES
OR VIAS ALLOWED

0.50

(0.35) 10X

(0.25) 10X

RECOMMENDED LAND PATTERN

0.55 MAX

// 0.05 C

△ 0.05 C

0.05
0.00

C

SIDE VIEW

(0.20)

0.35
0.25

(0.15)

0.35
0.25

DETAIL A 2X SCALE

DETAIL A

D
0.65
0.55

(0.36)

0.35
0.25

1

4

0.56

10

5

(0.29)

9

6

0.35 9X
0.25

0.50

0.25 9X
0.15

1.62

⊕ | 0.10 Ⓜ | C A B
  | 0.05 Ⓜ | C

ALL FEATURES

BOTTOM VIEW

NOTES:
A. PACKAGE CONFORMS TO JEDEC
    REGISTRATION MO-255, VARIATION UABD .
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCES PER
    ASME Y14.5M, 1994.
D. PRESENCE OF CENTER PAD IS PACKAGE
    SUPPLIER DEPENDENT. IF PRESENT IT
    IS NOT INTENDED TO BE SOLDERED AND
    HAS A BLACK OXIDE FINISH.
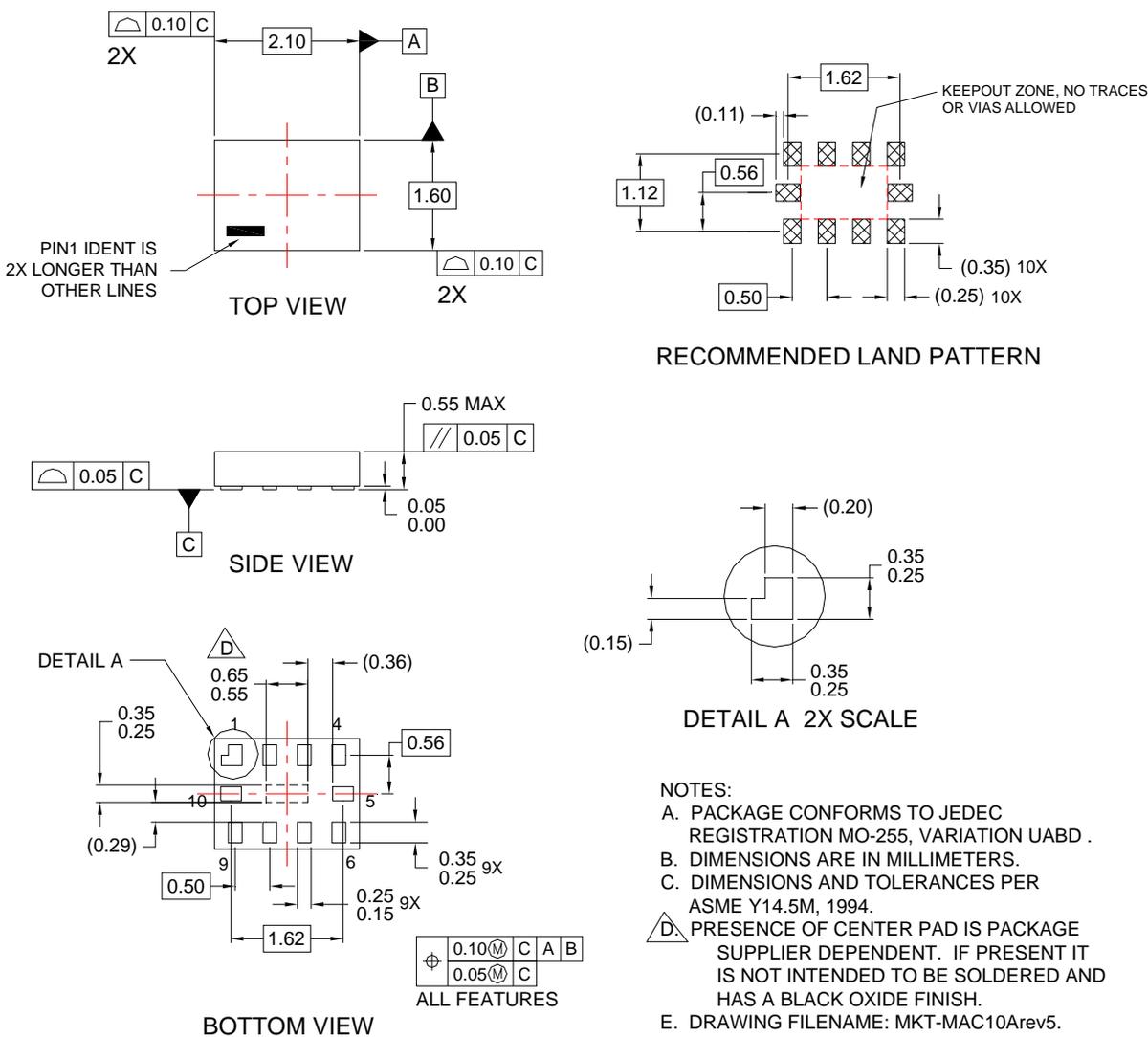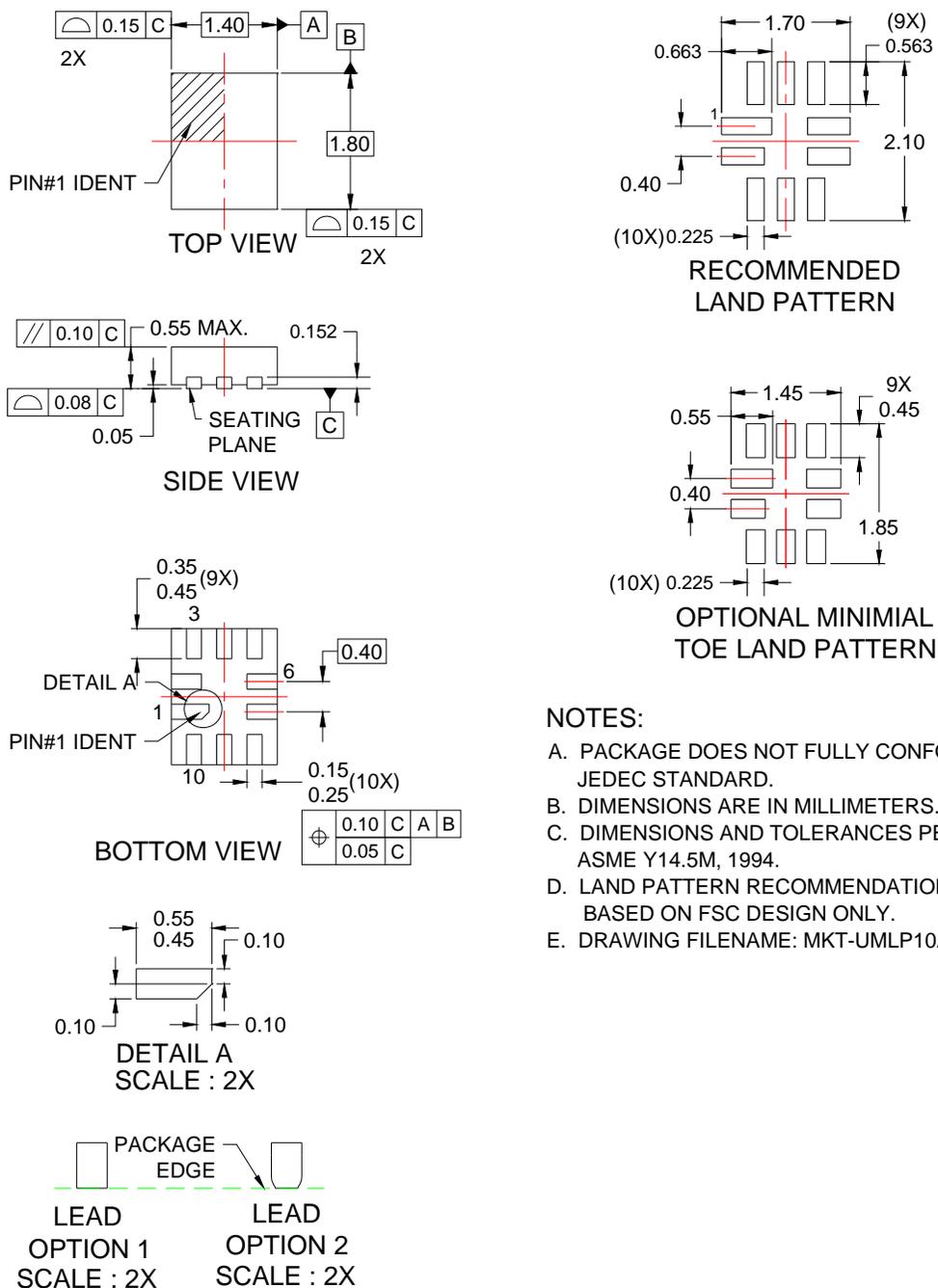E. DRAWING FILENAME: MKT-MAC10Arev5.

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

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Always visit Fairchild Semiconductor's online packaging area for the most recent package drawings:
http://www.fairchildsemi.com/packaging/.

Physical Dimensions

3.00±0.10

2.45

4.90

3.00±0.10

PIN #1 ID
QUADRANT

1   5

(0.381)

TOP VIEW

1.40 MIN

10   6

(0.30)

4.40

1   5

0.50

0.85±0.10

1.10 MAX

0.15
0.00

0.50

0.10 C
ALL LEAD TIPS

0.27
0.17

.08 (M) A B C

SIDE VIEW

0.23
0.08

END VIEW

A

12°
TOP & BOTTOM

GAUGE
PLANE

R0.13 TYP

SEATING
PLANE

4°-8°

0.22

0.80
0.40

(0.95)

DETAIL A
SCALE 20 : 1

NOTES: UNLESS OTHERWISE SPECIFIED

A. THIS PACKAGE CONFORMS TO JEDEC MO-187
   VARIATION BA.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS ARE EXCLUSIVE OF BURRS,
   MOLD FLASH AND TIE BAR EXTRUSIONS.
D. DIMENSIONS AND TOLERANCES AS PER ASME
   Y14.5-1994.
E. LAND PATTERN AS PER IPC7351#SOP50P490X110-10AN
F. FILE NAME: MKT-MUA10AREV3

Figure 18. 10-Lead Molded Small Outline Package (MSOP), JEDEC MO-187, 3.0mm Wide

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Physical Dimensions

0.15 C   1.40   A   B
2X

PIN#1 IDENT

1.80

TOP VIEW

0.15 C
2X

// 0.10 C   0.55 MAX.   0.152

0.08 C

0.05   SEATING PLANE   C

SIDE VIEW

0.35 (9X)
0.45
3

DETAIL A

PIN#1 IDENT

1

0.40

6

10

0.15 (10X)
0.25

BOTTOM VIEW

⊕ 0.10 C A B
0.05 C

0.55
0.45   0.10

0.10   0.10

DETAIL A
SCALE : 2X

PACKAGE EDGE

LEAD
OPTION 1
SCALE : 2X

LEAD
OPTION 2
SCALE : 2X

1.70   (9X)
0.663   0.563

1

0.40   2.10

(10X) 0.225

RECOMMENDED
LAND PATTERN

1.45   9X
0.55   0.45

0.40

1.85

(10X) 0.225

OPTIONAL MINIMIAL
TOE LAND PATTERN

NOTES:

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

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

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

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FACT Quiet Series™	MotionMax™	SuperSOT™-3	UniFET™
FACT®	mWSaver™	SuperSOT™-6	VCX™
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Definition of Terms

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