

# FSUSB20

## Low-Power 1-Port High-Speed USB (480Mbps) Switch

### 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 (1μA max)
- Control input: LVTTTL compatible
- Bi-directional operation
- USB high-speed and full-speed signaling capability
- Space-saving Pb-free packaging

### Applications

- Cell phone, PDA, digital camera, and notebook

### General Description

FSUSB20 is a low-power high-bandwidth switch specially designed for switching high-speed USB 2.0 signals in handset and consumer applications, such as cell phones, digital cameras, and notebooks with hubs or controllers with limited USB I/Os. 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 the high-speed USB 2.0 standard.

### Ordering Information

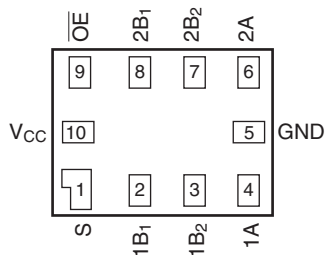
Order Number	Package Number	Pb-Free	Top Mark	Package Description
FSUSB20L10X	MAC010A	Yes	EY	10-Lead MicroPak™, 1.6 x 2.1mm
FSUSB20BQX	MLP014A	Yes	USB20	14-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.0mm
FSUSB20MUX	MUA10A	Yes	FSUSB20	10-Lead Molded Small Outline Package (MSOP), JEDEC MO-187, 3.0mm Wide

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

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

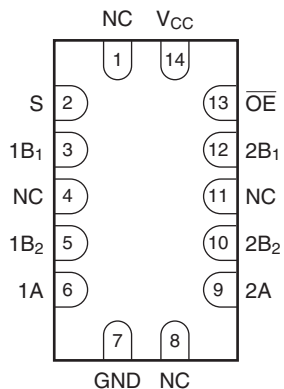
## Connection Diagrams

### Pad Assignments for MicroPak



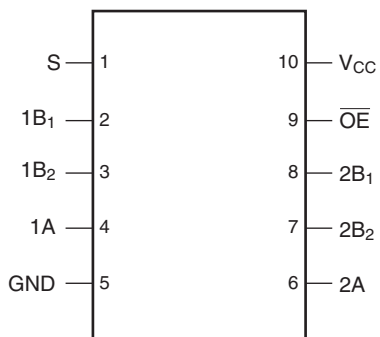
(Top View)

### Pad Assignments for DQFN



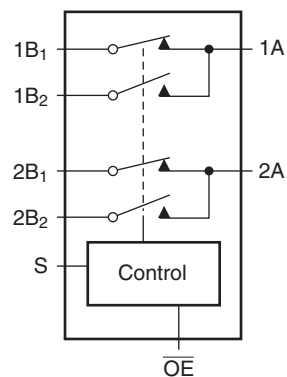
(Top Through View)

### Pin Assignment for MSOP



(Top Through View)

## Analog Symbol



## Truth Table

S	OE	Function
X	High	Disconnect
Low	Low	A = B <sub>1</sub>
High	Low	A = B <sub>2</sub>

## 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

## Absolute Maximum Ratings

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 ratings. The “Recommended Operating Conditions” table will define the conditions for actual device operation.

Symbol	Parameter	Min.	Max.	Unit
$V_{CC}$	Supply Voltage	-0.5	+4.6	V
$V_S$	DC Switch Voltage	-0.5V	$V_{CC}+0.05$	V
$V_{IN}$	DC Input Voltage <sup>(1)</sup>	-0.5	+4.6	
$I_{IK}$	DC Input Diode Current $V_{IN} < 0V$	-50		mA
$I_{OUT}$	DC Output Sink Current	50		mA
$I_{CC}/I_{GND}$	DC $V_{CC}/GND$ Current	$\pm 100$		mA
$T_{STG}$	Storage Temperature Range	-65	+150	°C
ESD	Human Body Model	All Pins	7000	V
		I/O to GND	7000	

### Notes:

- The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

## Recommended Operating Conditions<sup>(2)</sup>

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

### Notes:

- Unused control inputs must be held HIGH or LOW. They may not float.

## DC Electrical Characteristics

Typical values are at  $V_{CC} = 3.0V$  and  $T_A = +25^\circ C$ .

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = -40^\circ C$ to $+85^\circ C$			Units
				Min.	Typ.	Max.	
$V_{IK}$	Clamp Diode Voltage	$I_{IN} = -18mA$	3.0			-1.2	V
$V_{IH}$	HIGH Level Input Voltage		3.0 to 3.6	2.0			V
$V_{IL}$	LOW Level Input Voltage		3.0 to 3.6			0.8	V
$I_I$	Input Leakage Current	$0 \leq V_{IN} \leq 3.6V$	3.6			$\pm 1.0$	$\mu A$
$I_{OFF}$	OFF-STATE Leakage Current	$0 \leq A, B \leq V_{CC}$	3.6			$\pm 1.0$	$\mu A$
$R_{ON}$	Switch On Resistance <sup>(3)</sup>	$V_{IN} = 0.8V, I_{ON} = 8mA$	3.0		5.0	7.0	$\Omega$
		$V_{IN} = 3.0V, I_{ON} = 8mA$	3.0		4.5	6.5	$\Omega$
$\Delta R_{ON}$	Delta $R_{ON}$	$V_{IN} = 0.8V, V_{IN} = 0V-1.5V, I_{ON} = 8mA$	3.0		0.3		$\Omega$
$R_{FLAT(ON)}$	On Resistance Flatness <sup>(4)</sup>	$I_{OUT} = 8mA$	3.0		1.0		$\Omega$
$I_{CC}$	Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND, $I_{OUT} = 0$	3.6			1.0	$\mu A$

### Notes:

- 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.
- Flatness is defined as the difference between the maximum and minimum value on resistance over the specified range of conditions.

## AC Electrical Characteristics

Typical values are at  $V_{CC} = 3.3V$  and  $T_A = +25^\circ C$ .

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = -40^\circ C$ to $+85^\circ C$			Units	Figure Number
				Min.	Typ.	Max.		
$t_{ON}$	Turn ON Time S-to-Bus B	$V_B = 0.8V$	3.0 to 3.6		4.8	7.0	ns	Figure 5 Figure 6
$t_{OFF}$	Turn OFF Time S-to-Bus B	$V_B = 0.8V$	3.0 to 3.6		2.2	4.0	ns	Figure 5 Figure 6
$t_{PD}$	Propagation Delay	$C_L = 10pF$	3.0 to 3.6		0.25		ns	Figure 10
$O_{IRR}$	Non-Adjacent OFF-Isolation	$f = 250MHz,$ $R_L = 50\Omega$	3.0 to 3.6		-26.0		dB	Figure 7
$X_{TALK}$	Non-Adjacent Channel Crosstalk	$f = 250MHz,$ $R_L = 50\Omega,$	3.0 to 3.6		-45.0		dB	Figure 8
BW	-3dB Bandwidth	$R_L = 50\Omega, C_L = 0pF$	3.0 to 3.6		750		MHz	Figure 9
		$R_L = 50\Omega, C_L = 5pF$			435			

## USB Related AC Electrical Characteristics

Typical values are at  $V_{CC} = 3.3V$  and  $T_A = +25^\circ C$ .

Symbol	Parameter	Conditions	$V_{CC}$ (V)	$T_A = -40^\circ C$ to $+85^\circ C$			Units	Figure Number
				Min.	Typ.	Max.		
$t_{SK(O)}$	Channel-to-Channel Skew	$C_L = 10pF$	3.0 to 3.6		0.051		ns	Figure 10 Figure 11
$t_{SK(P)}$	Skew of Opposite Transition of the Same Output	$C_L = 10pF$	3.0 to 3.6		0.020		ns	Figure 10 Figure 11
$T_J$	Total Jitter	$R_L = 50\Omega$ , $C_L = 10pF$ $t_R = t_F = 750ps$ at 480Mbps	3.0 to 3.6		0.170		ns	

## Capacitance

Typical values are at  $V_{CC} = 3.3V$  and  $T_A = +25^\circ C$ .

Symbol	Parameter	Conditions	$T_A = -40^\circ C$ to $+85^\circ C$		Units
			Typ.		
$C_{IN}$	Control Pin Input Capacitance	$V_{CC} = 0V$	2.5		pF
$C_{ON}$	A/B ON Capacitance	$V_{CC} = 3.3V$ , $\overline{OE} = 0V$	12.0		pF
$C_{OFF}$	Port B OFF Capacitance	$V_{CC}$ and $\overline{OE} = 3.3V$	4.0		pF

### Typical Characteristics

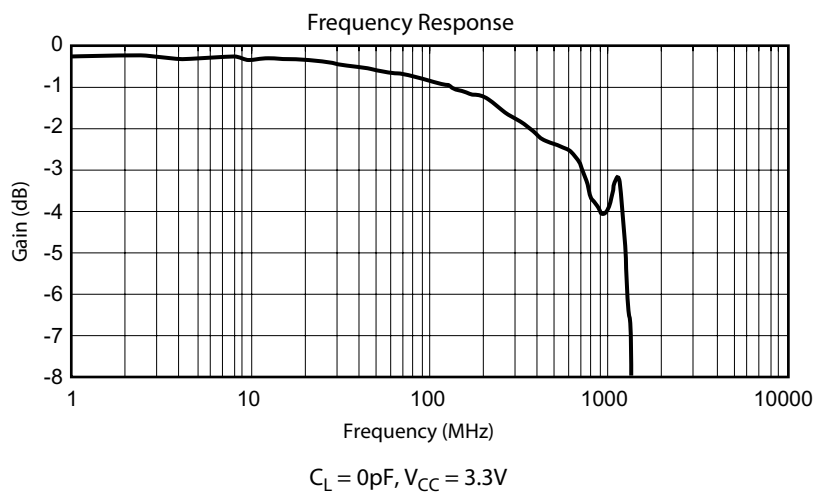


Figure 1. Gain vs. Frequency

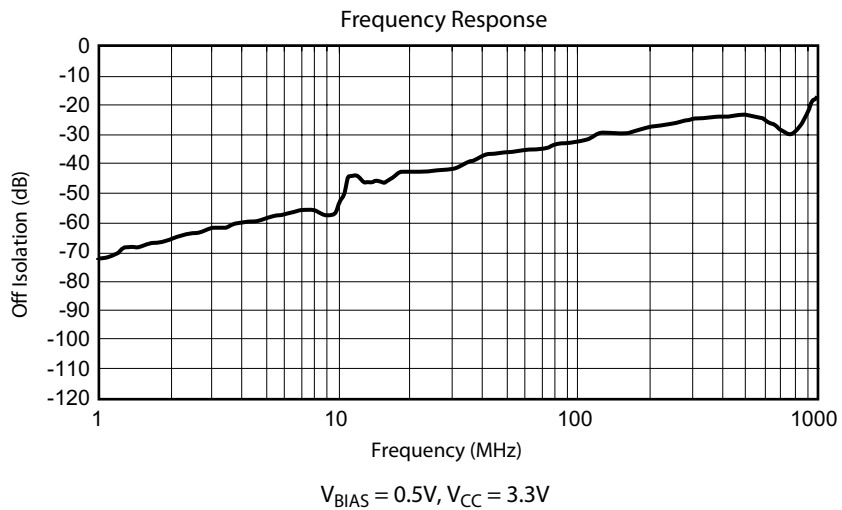
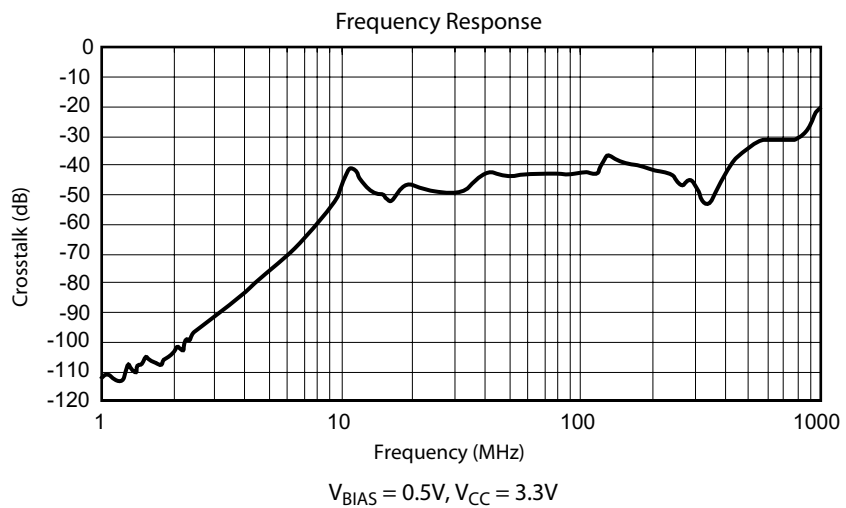
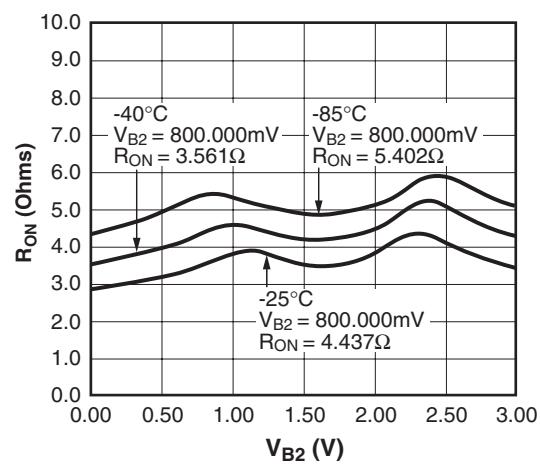


Figure 2. OFF Isolation

**Typical Characteristics (Continued)**

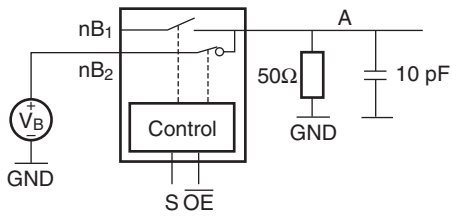


**Figure 3. Crosstalk**



**Figure 4.  $R_{ON}$**

## AC Loading and Waveforms

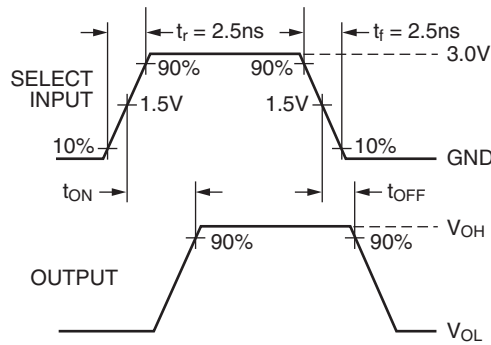


**Note:** Input driven by 50Ω source terminated in 50Ω

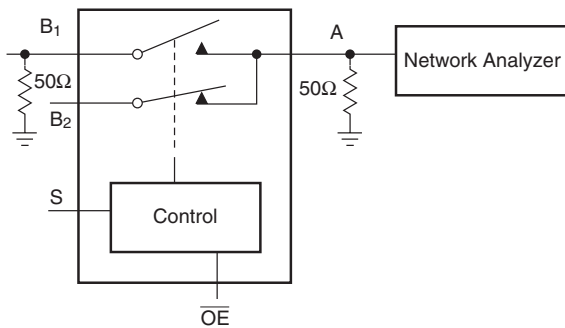
**Note:**  $C_L$  includes load and stray capacitance

**Note:** Input PRR = 1.0 MHz,  $t_W$  = 500ns

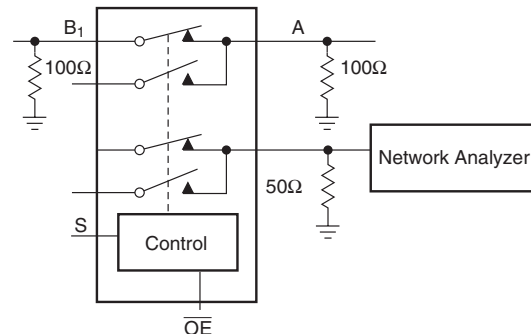
**Figure 5. AC Test Circuit**



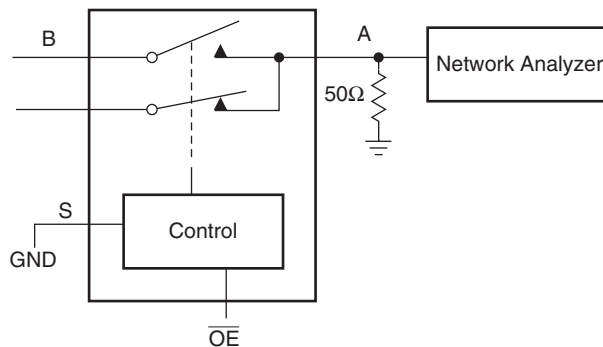
**Figure 6. AC Waveforms**



**Figure 7. OFF Isolation Test**



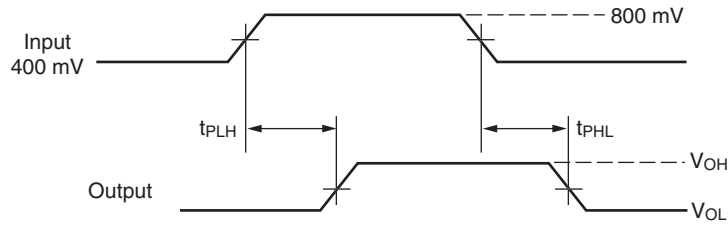
**Figure 8. Crosstalk Test**



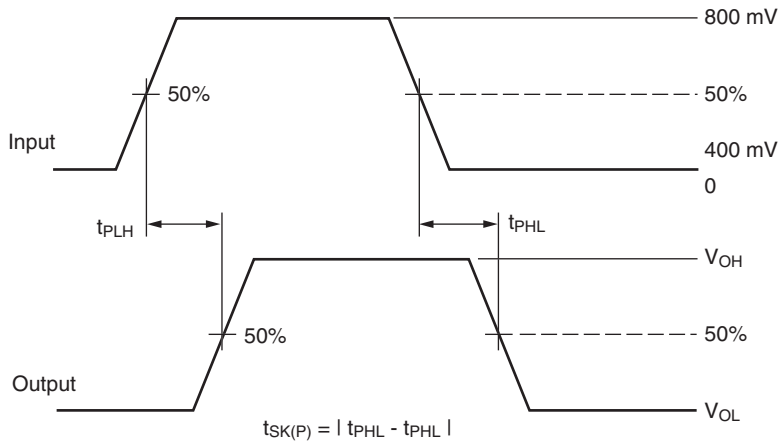
**Figure 9. Bandwidth Test**



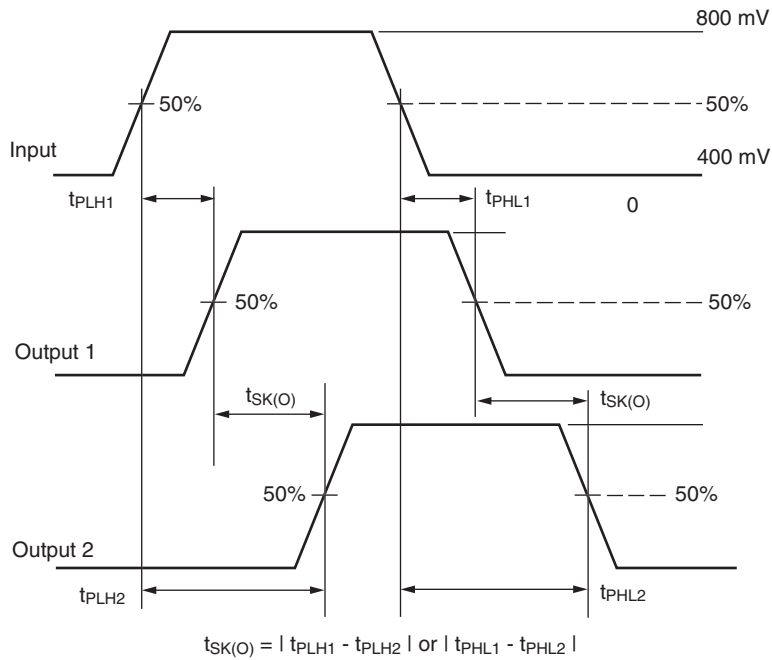
**AC Loading and Waveforms (Continued)**



**Figure 10. Propagation Delay**



**Figure 11. Pulse Skew  $t_{SK(P)}$**



**Figure 12. Output Skew  $t_{SK(O)}$**

## Tape and Reel Specifications

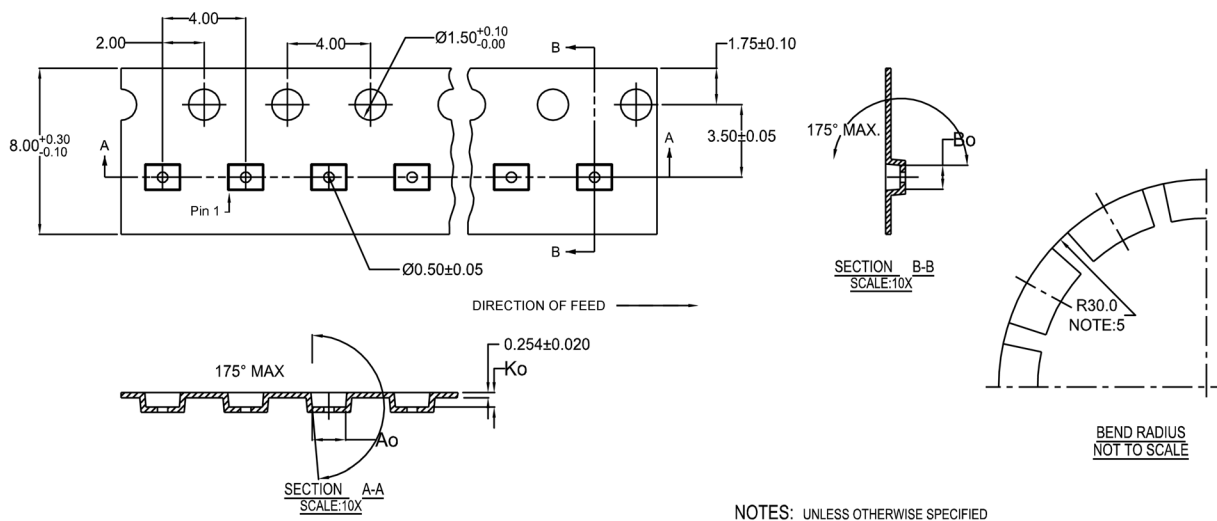
### Tape Format for MicroPak

Dimensions are in millimeters unless otherwise noted.

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

### Tape Dimension

Dimensions are in millimeters unless otherwise noted.



10	300056	$2.30 \pm 0.05$	$1.78 \pm 0.05$	$0.68 \pm 0.05$
8	300038	$1.78 \pm 0.05$	$1.78 \pm 0.05$	$0.68 \pm 0.05$
6	300033	$1.60 \pm 0.05$	$1.15 \pm 0.05$	$0.70 \pm 0.05$



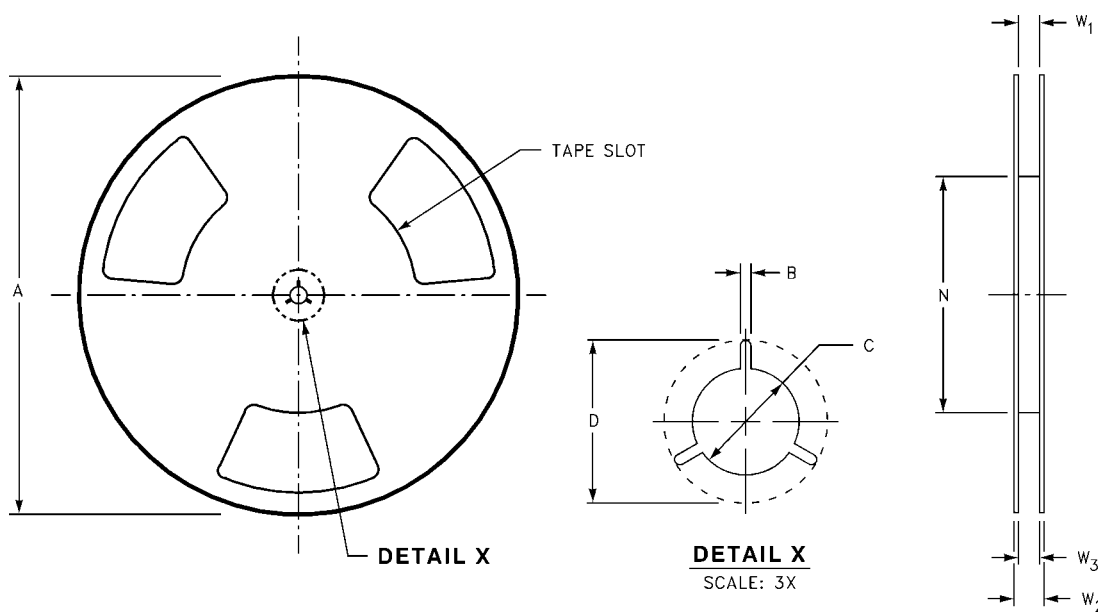
SCALE: 6X

NOTES: UNLESS OTHERWISE SPECIFIED

- ACCUMULATED 50 SPROCKETS, SPROCKET HOLE PITCH IS  $200.00 \pm 0.30\text{MM}$
- NO INDICATED CORNER RADIUS IS  $0.127\text{MM}$
- CAMBER NOT TO EXCEED  $1\text{MM}$  IN  $100\text{MM}$
- SMALLEST ALLOWABLE BENDING RADIUS
- POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

### Reel Dimension for MicroPak

Dimensions are in inches (millimeters) unless otherwise noted.



Tape Size	A	B	C	D	N	W1	W2	W3
(8mm)	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)

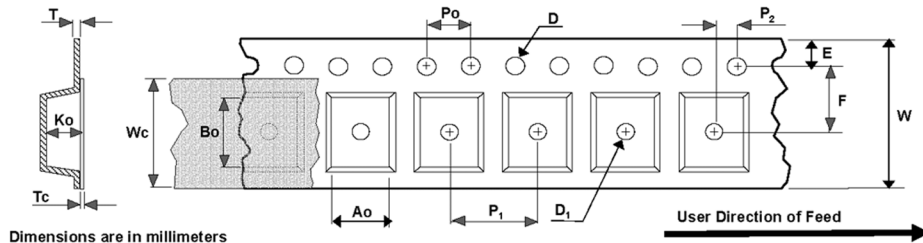
### Tape Format for DQFN

Dimensions are in millimeters unless otherwise notes.

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

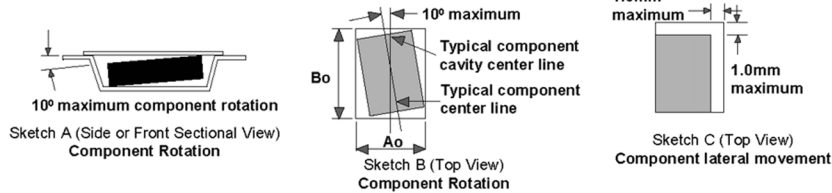
Dimensions are in millimeters unless otherwise noted.



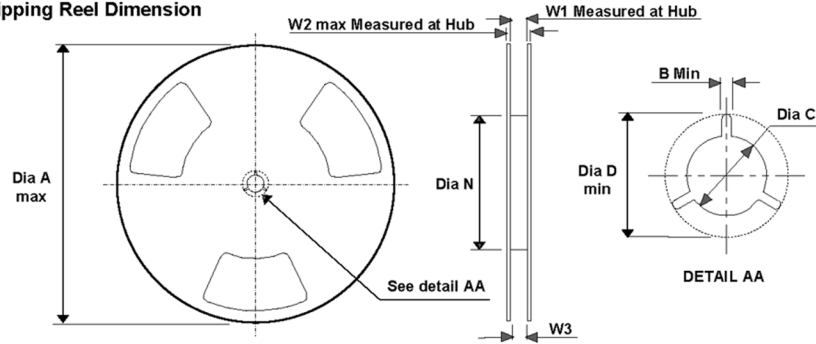
Dimensions are in millimeters

Package	Ao +/-0.10	Bo +/-0.10	D +/-0.05	D1 min.	E +/-0.1	F +/-0.1	Ko +/-0.1	P1 TYP	Po TYP	P2 +/-0.05	T TYP	Tc +/-0.005	W +/-0.3	Wc TYP
2 x 2	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
4 x 4	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
5 x 5	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
6 x 6	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: Ao, Bo, and Ko dimensions are determined with respect to the EIA /Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).



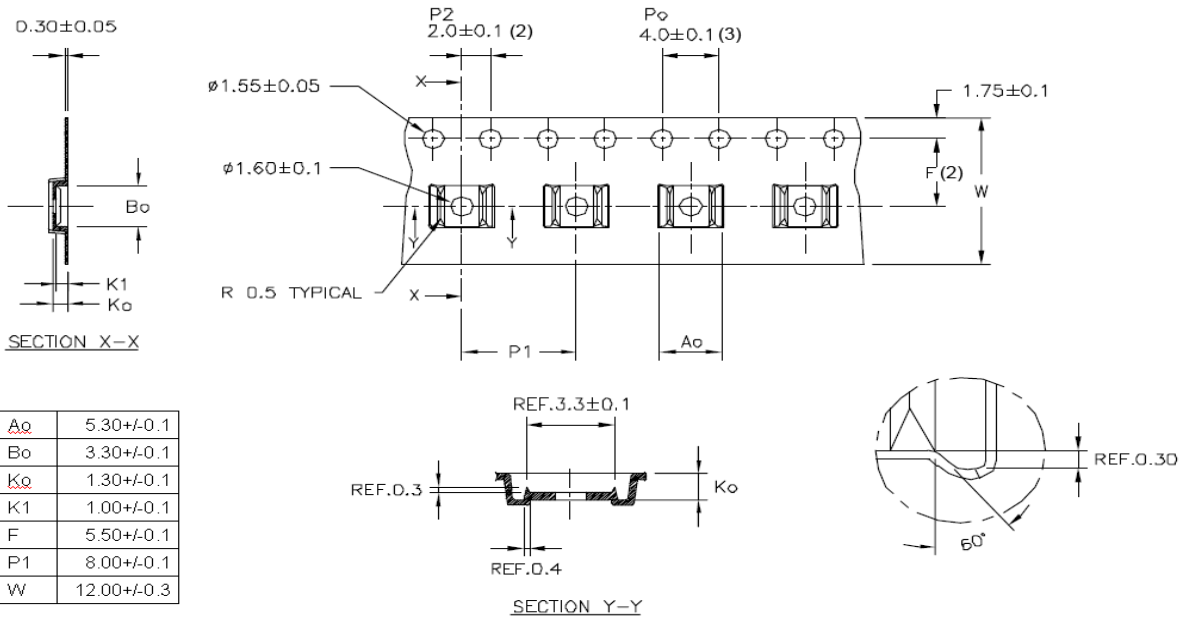
### Shipping Reel Dimension



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 (LSL - USL)
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

### Tape Dimensions for MSOP

Dimensions are in inches (millimeters) unless otherwise specified.



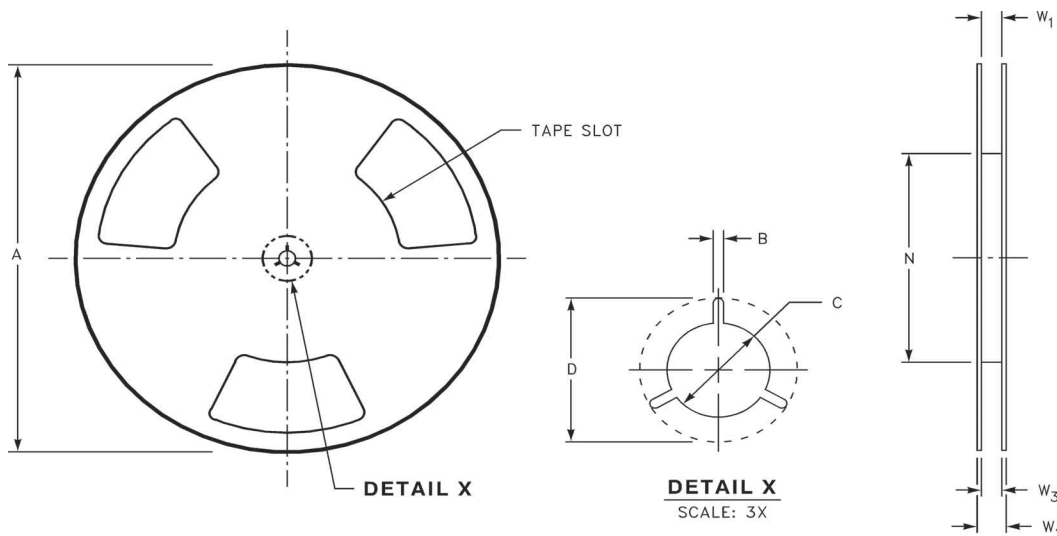
A <sub>0</sub>	5.30±0.1
B <sub>0</sub>	3.30±0.1
K <sub>0</sub>	1.30±0.1
K <sub>1</sub>	1.00±0.1
F	5.50±0.1
P <sub>1</sub>	8.00±0.1
W	12.00±0.3

**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

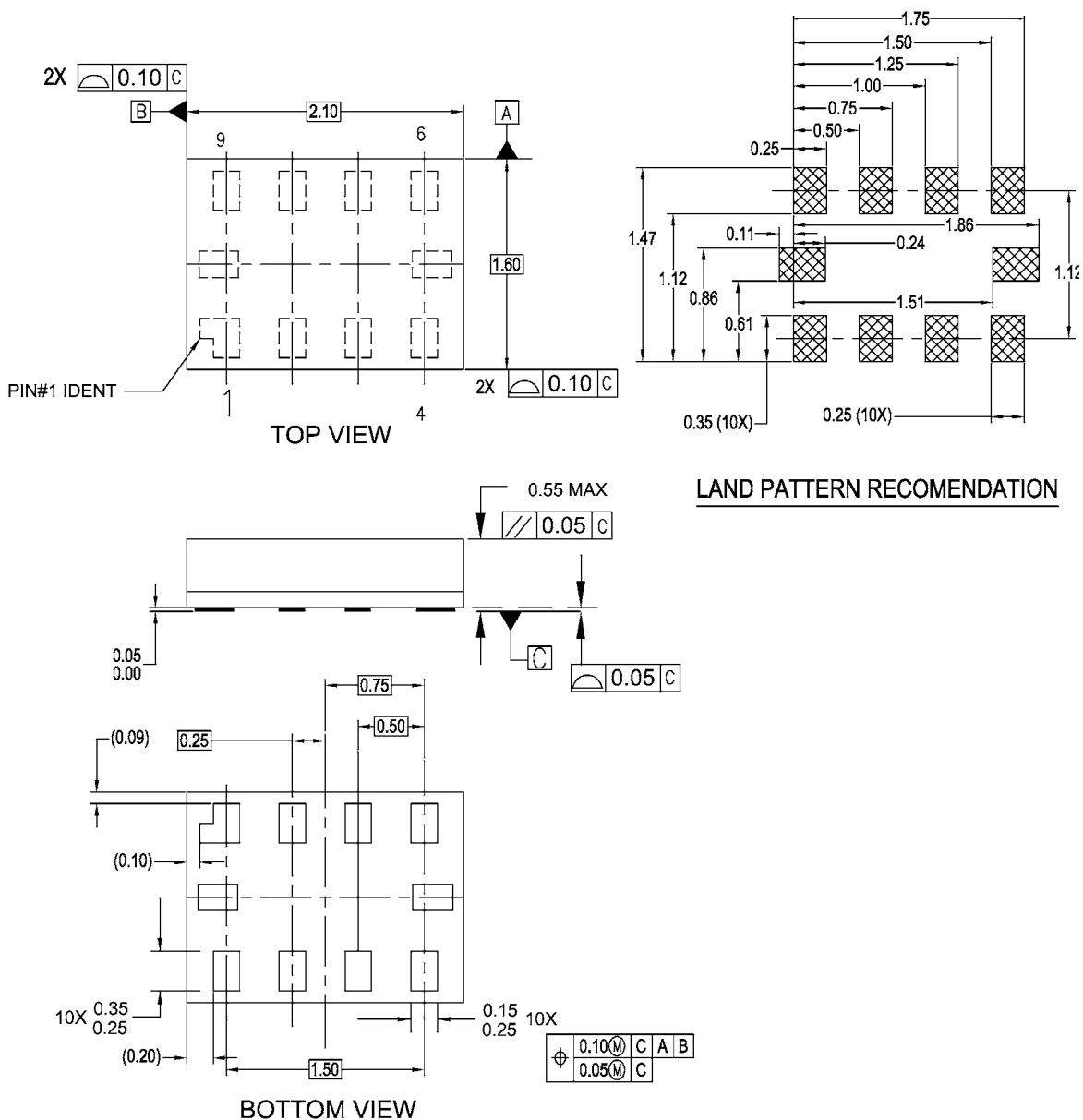
Dimensions are in inches (millimeters) unless otherwise specified.



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 (Continued)

Dimensions are in millimeters unless otherwise noted.



**NOTES:**

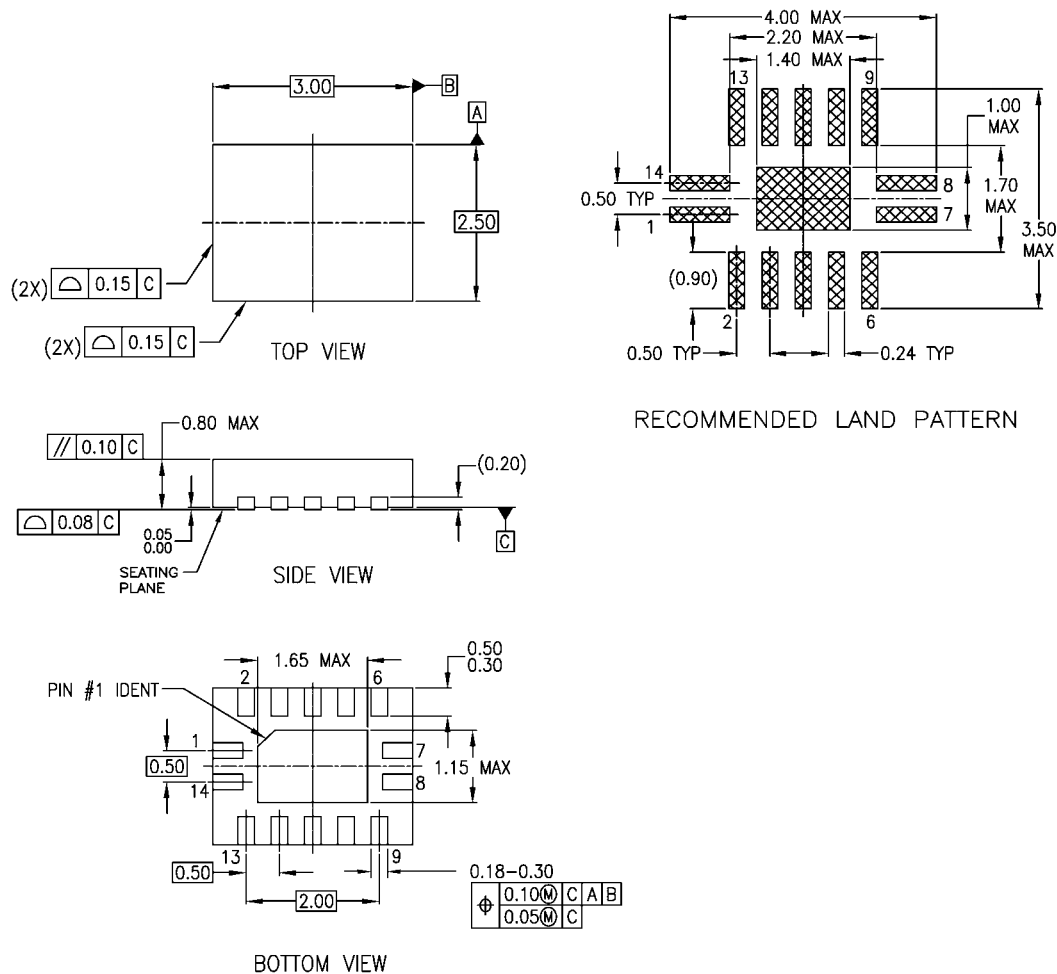
- A. PACKAGE CONFORMS TO JEDEC MO255, VARIATION UABD
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES CONFORMS TO ASME Y14.5M, 1994.

MAC010ARevC

**Figure 13. 10-Lead MicroPak, 1.6 x 2.1mm**

### Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.



**NOTES:**

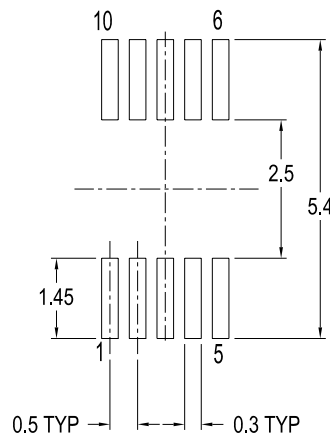
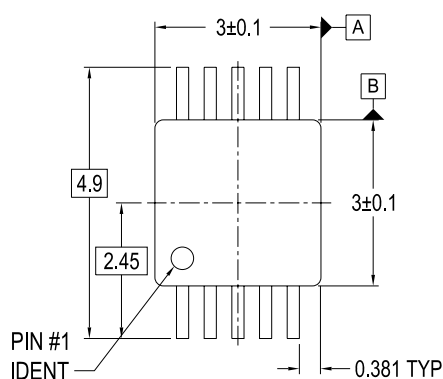
- A. CONFORMS TO JEDEC REGISTRATION MO-241, VARIATION AA
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP014ArevA

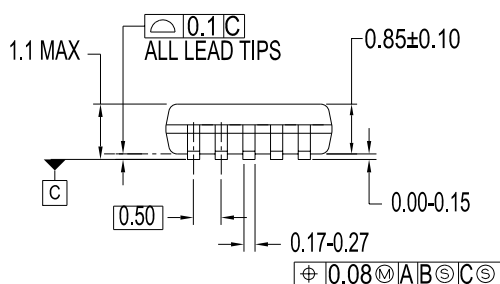
**Figure 14. 14-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.0mm**

### Physical Dimensions (Continued)

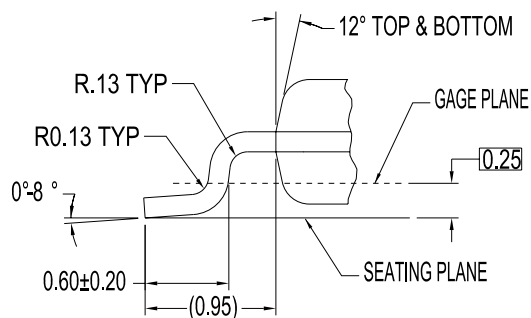
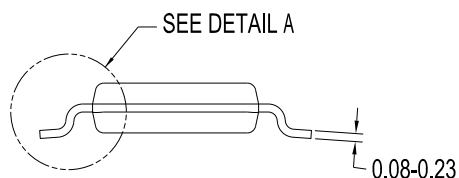
Dimensions are in millimeters unless otherwise noted.



LAND PATTERN RECOMENDATION



DIMENSIONS ARE IN MILLIMETERS



DETAIL A

**NOTES:**

- A. CONFORMS TO JEDEC REGISTRATION MO-187, VARIATION BA, REF NOTE 6, DATE 11/00.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- D. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.

MUA10AREVA

**Figure 15. 10-Lead Molded Small Outline Package (MSOP), JEDEC MO-187, 3.0mm Wide**



## TRADEMARKS

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ACEx™	FACT Quiet Series™	OCX™	SILENT SWITCHER®	UniFET™
ActiveArray™	GlobalOptoisolator™	OCXPro™	SMART START™	UltraFET®
Bottomless™	GTO™	OPTOLOGIC®	SPM™	VCX™
Build it Now™	HiSeC™	OPTOPLANAR™	Stealth™	Wire™
CoolFET™	I <sup>2</sup> C™	PACMAN™	SuperFET™	
CROSSVOLT™	i-Lo™	POP™	SuperSOT™_3	
DOME™	ImpliedDisconnect™	Power247™	SuperSOT™_6	
EcoSPARK™	IntelliMAX™	PowerEdge™	SuperSOT™_8	
E <sup>2</sup> CMOS™	ISOPLANAR™	PowerSaver™	SyncFET™	
EnSigna™	LittleFET™	PowerTrench®	TCM™	
FACT™	MICROCOUPLER™	QFET®	TinyBoost™	
FAST®	MicroFET™	QS™	TinyBuck™	
FAST <sub>r</sub> ™	MicroPak™	QT Optoelectronics™	TinyPWM™	
FPS™	MICROWIRE™	Quiet Series™	TinyPower™	
FRFET™	MSX™	RapidConfigure™	TinyLogic®	
	MSXPro™	RapidConnect™	TINYOPTO™	
Across the board. Around the world.™		µSerDes™	TruTranslation™	
The Power Franchise®		ScalarPump™	UHC™	
Programmable Active Droop™				

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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is 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.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
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Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

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