August 2005
Revised August 2005

FSUSB23

Low Power Hi-Speed USB 2.0 (480Mbps) Switch

General Description

The FSUSB23 is a low power high bandwidth analog switch specifically designed for high speed USB 2.0 applications. The FSUSB23 features very low quiescent current even when the control voltage is lower than the V_{CC} supply. This feature services mobile handset applications well allowing for direct interface with the baseband processor general purpose I/Os. Typical applications involve switching in portables and consumer applications such as cell phones, digital cameras, and notebooks with hubs or controllers. The wide bandwidth (>720MHz) of this switch exceeds the bandwidth needed to pass the 3rd harmonic which results in signals with minimum edge and phase distortion. Superior channel-to-channel crosstalk results in minimal interference.

Features

- 10μA maximum I_{CCT} current over an expanded control voltage range (V_{IN} = 2.6V, V_{CC} = 3.6V)
- Lower Capacitance: Con = 9pF Typ
- 7Ω typical On Resistance (R_{ON})
- −3dB bandwidth: > 720MHz
- Low power consumption (1μA maximum)
- Packaged in:
  - Pb-Free 10-lead MicroPak™ (1.6mm by 2.1mm)
  - Pb-Free 16-lead DQFN
- 7kV I/O to GND ESD performance

Applications

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

Ordering Code:

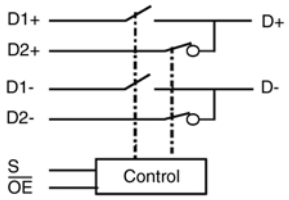
Order Number	Package Number	Package Description
FSUSB23L10X	MAC010A	Pb-Free 10-Lead MicroPak, 1.6 mm x 2.1mm
FSUSB23BQX	MLP016E	Pb-Free 16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm

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

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

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Analog Symbol



Pin Descriptions

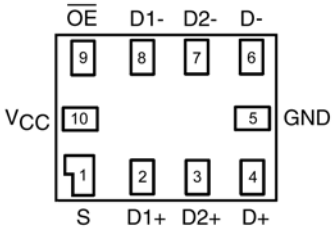
Pin Name	Description
$\overline{OE}$	Bus Switch Enable
S	Select Input
D+, D–, Dn+, Dn–	Data Ports

Truth Table

S	$\overline{OE}$	Function
X	H	Disconnect
L	L	D+, D– = $D1_n$
H	L	D+, D– = $D2_n$

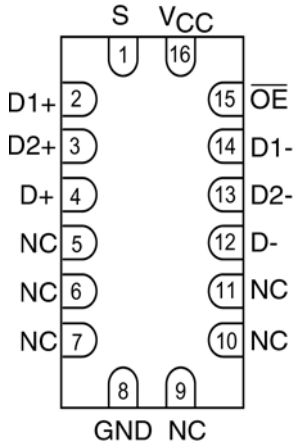
Connection Diagrams

Pad Assignments for MicroPak



(Top View)

Pad Assignments for DQFN



(Top Through View)

Absolute Maximum Ratings(Note 1)

Supply Voltage (V_{CC})	−0.5V to +4.6V
DC Switch Voltage (Note 2)	−0.5V to V_{CC} + 0.5V
DC Input Voltage (V_{IN}) (Note 2)	−0.5v to +4.6V
DC Input Diode Current	−50mA
DC Output Current	50mA
Storage Temperature	−65°C to +150°C
ESD (Human Body Model)	
All Pins	7 KV
I/O to GND	7 KV

Recommended Operating Conditions
(Note 3)

Supply Voltage V_{CC}	3.0V to 3.6V
Control Input Voltage	0V to V_{CC}
Switch Input Voltage	0V to V_{CC}
Operating Temperature	−40°C to +85°C
Thermal Resistance	
10 MicroPak	250°C/w

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. DC switch voltage may never exceed 4.6V.

Note 3: Control input must be held HIGH or LOW and it must not float.

DC Electrical Characteristics (All typical values are @ 25°C unless otherwise specified.)

Symbol	Parameter	V_{CC}	T_A = −40°C to +85°C			Units	Conditions
		(V)	Min	Typ	Max		
V_{IK}	Clamp Diode Voltage	3.0			−1.2	V	I_{IN} = −18mA
V_{IH}	Input Voltage HIGH	3.0 to 3.6	1.2			V	
V_{IL}	Input Voltage LOW	3.0 to 3.6			0.50	V	
I_{IN}	Control Input Leakage	3.6			±1.0	µA	V_{IN} = 0V to V_{CC}
I_{OZ}	OFF State Leakage				±1.0	µA	0 ≤ Dn, $D1_n$, $D2_n$ ≤ V_{CC}
R_{ON}	Switch On Resistance	3.0		6.0	9.0	Ω	V_{IN} = 0.4V, I_{ON} = −8mA
	(Note 4)			7.0	10.0		V_{IN} = 0.8V, I_{ON} = −8mA
ΔR_{ON}	Delta R_{ON} (Note 5)	3.0		0.3		Ω	V_{IN} = 0.8V, I_{ON} = −8mA
R_{ON} Flatness	R_{ON} Flatness (Note 4)	3.0		2.0		Ω	V_{IN} = 0.0V − 1.0V, I_{ON} = −8mA
I_{CC}	Quiescent Supply Current	3.6			1.0	µA	V_{IN} = 0.0V or V_{CC}, I_{OUT} = 0
I_{CCT}	Increase in I_{CC} Current per Control Voltage and V_{CC} Levels	3.6			10.0	µA	V_{IN} = 2.6V V_{CC} = 3.6V

Note 4: Measured by the voltage drop between Dn, $D1_n$, $D2_n$ pins at the indicated current through the switch. On Resistance is determined by the lower of the voltage on the two ports.

Note 5: Guaranteed by characterization.

AC Electrical Characteristics (All typical values are for V_{CC} = 3.3v @ 25°C unless otherwise specified.)

Symbol	Parameter	V_{CC}	T_A = −40°C to +85°C			Units	Conditions	Figure
		(V)	Min	Typ	Max			Number
t_{ON}	Turn On Time S, $\overline{OE}$ to Output	3.0 to 3.6		10.0	13.0	ns	$V_{D1n, D2n}$ = 0.8V, R_L = 50Ω, C_L = 10Ω	Figure 5
t_{OFF}	Turn OFF Time S, $\overline{OE}$ to Output	3.0 to 3.6		8.0	11.0	ns	$V_{D1n, D2n}$ = 0.8V, R_L = 50Ω, C_L = 10Ω	Figure 5
t_{PD}	Propagation Delay (Note 6)	3.3		0.25		ns	C_L = 10 pF	Figures 3, 4
O_{IRR}	OFF Isolation (Non-Adjacent)	3.0 to 3.6		−30.0		dB	f = 250MHz, R_L = 50Ω	Figure 8
Xtalk	Non-Adjacent Channel Crosstalk	3.0 to 3.6		−43.0		dB	R_L = 50Ω, f = 250MHz	Figure 9
BW	−3dB Bandwidth	3.0 to 3.6		720		MHz	R_L = 50Ω	Figure 7

Note 6: Guaranteed by characterization

USB Related AC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	$T_A = -40°C$ to $+85°C$			Units	Conditions	Figure Number
			Min	Typ	Max			
$t_{SK(O)}$	Channel-to-Channel Skew (Note 7)	3.0 to 3.6		40.0		ps	C_L = 10pF	Figures 3, 6
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output (Note 7)	3.0 to 3.6		20.0		ps	C_L = 10pF	Figures 3, 6
t_J	Total Jitter (Note 7)	3.0 to 3.6		150		ps	R_L = 50Ω, C_L = 10pF, $t_R = t_F$ = 750ps at 480 Mbps (PRBS = $2^{15} - 1$)	

Note 7: Guaranteed by design.

Capacitance

Symbol	Parameter	$T_A = -40°C$ to $+85°C$			Units	Conditions	Figure Number
		Min	Typ	Max			
C_{IN}	Control Pin Input Capacitance		2.0		pF	V_{CC} = 0V	Figure 11
C_{ON}	$D1_n$, $D2_n$, Dn ON Capacitance		9.0		pF	V_{CC} = 3.3, $\overline{OE}$ = 0V	Figure 10
C_{OFF}	$D1_n$, $D2_n$ OFF Capacitance		4.0		pF	V_{CC} and $\overline{OE}$ = 3.3	Figure 11

Test Diagrams

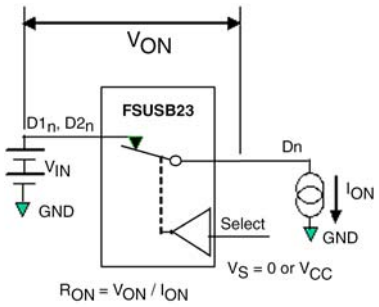
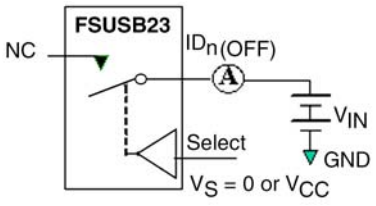
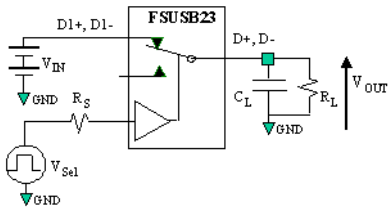


FIGURE 1. On Resistance



Note: Each switch port is tested separately.

FIGURE 2. OFF Leakage



Note: R_L, R_S, and C_L are functions of application environment (See AC Electrical table for specific values).

Note: C_L includes test fixture and stray capacitance.

FIGURE 3. AC Test Circuit Load

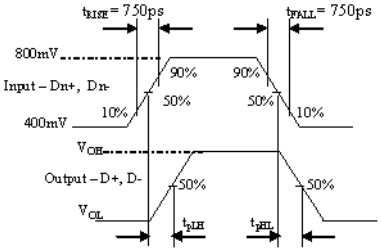


FIGURE 4. Switch Propagation Delay Waveforms

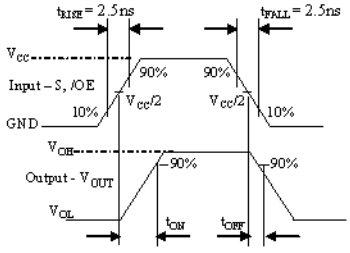


FIGURE 5. Turn ON/ Turn OFF Waveform

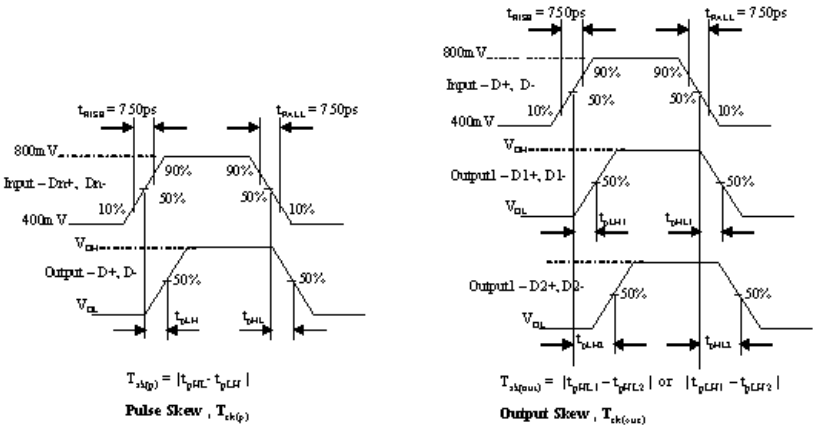
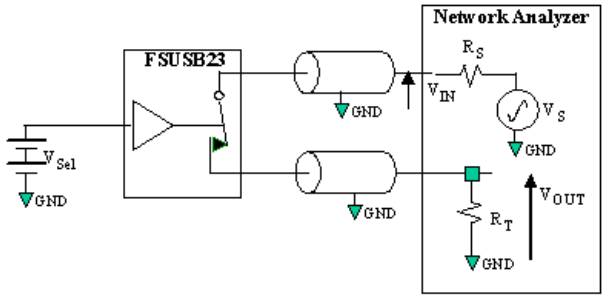
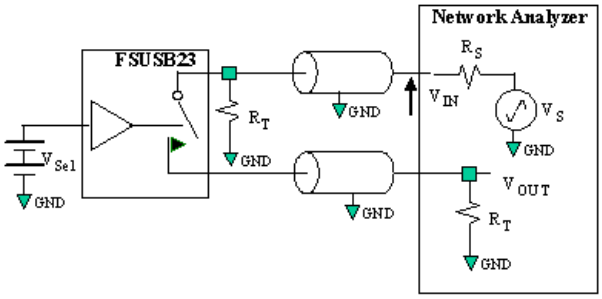


FIGURE 6. Switch Skew Tests



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

FIGURE 7. Bandwidth



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

FIGURE 8. Channel OFF Isolation

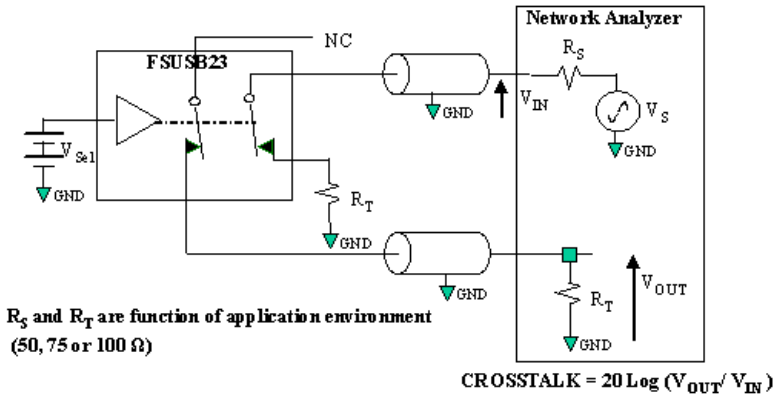


FIGURE 9. Non-Adjacent Channel-to-Channel Crosstalk

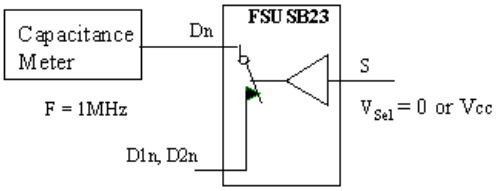


FIGURE 10. Channel ON Capacitance

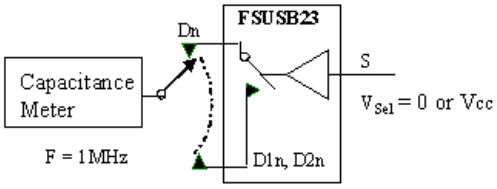


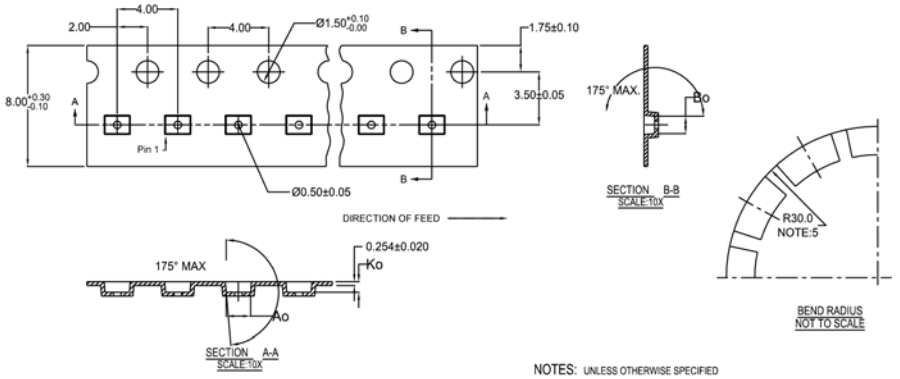
FIGURE 11. Channel OFF Capacitance

Tape and Reel Specification

TAPE FORMAT for MircoPak

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 DIMENSIONS inches (millimeters)



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

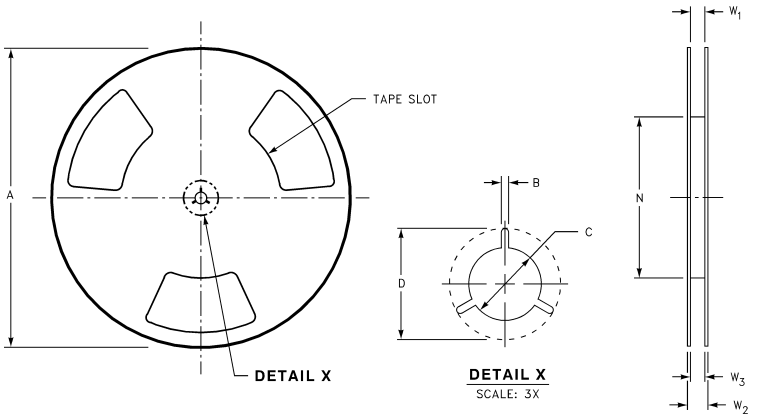
NOTES: UNLESS OTHERWISE SPECIFIED

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)

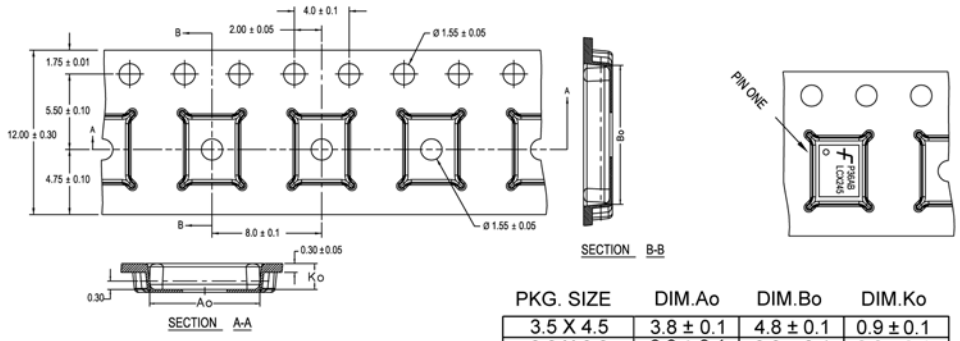


Tape Size	A	B	C	D	N	W1	W2	W3
8 mm	7.0 (177.8)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	2.165 (55.00)	0.331 + 0.059/−0.000 (8.40 + 1.50/−0.00)	0.567 (14.40)	W1 + 0.078/−0.039 (W1 + 2.00/−1.00)

Tape 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)



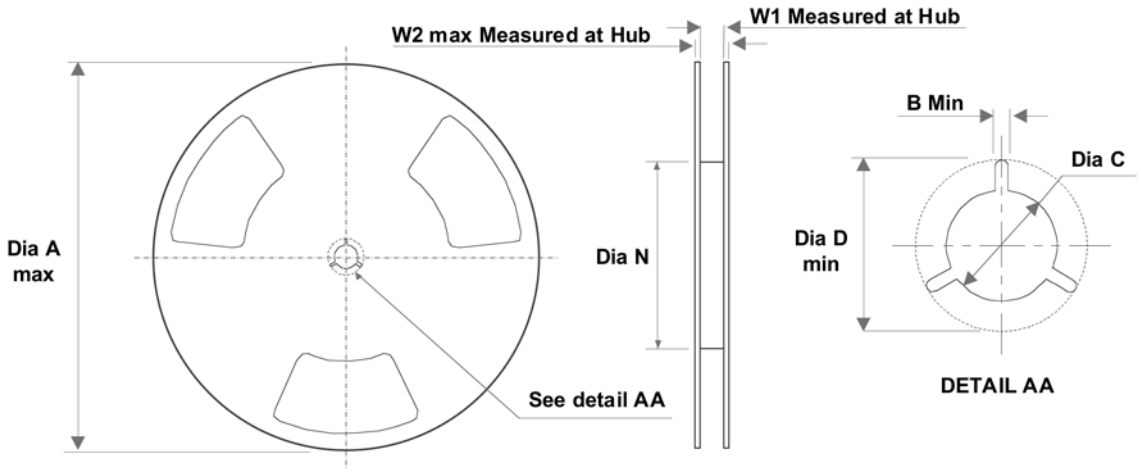
PKG. SIZE	DIM.Ao	DIM.Bo	DIM.Ko
3.5 X 4.5	3.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
3.0 X 3.0	3.3 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 4.5	2.8 ± 0.1	4.8 ± 0.1	0.9 ± 0.1
2.5 X 3.5	2.8 ± 0.1	3.8 ± 0.1	0.9 ± 0.1
2.5 X 3.0	2.8 ± 0.1	3.3 ± 0.1	0.9 ± 0.1
2.5 X 2.5	2.8 ± 0.1	2.8 ± 0.1	0.9 ± 0.1

DIMENSIONS ARE IN MILLIMETERS

NOTES: unless otherwise specified

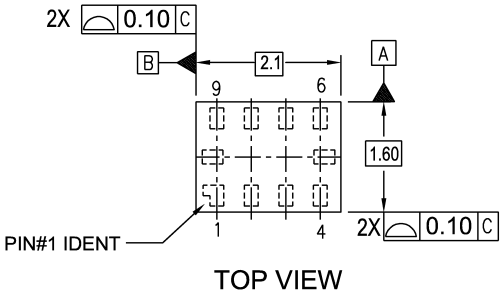
1. Cummulative pitch for feeding holes and cavities (chip pockets) not to exceed 0.008[0.20] over 10 pitch span.
2. Smallest allowable bending radius.
3. Thru hole inside cavity is centered within cavity.
4. Tolerance is ±0.002[0.05] for these dimensions on all 12mm tapes.
5. Ao and Bo measured on a 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 inches (millimeters)

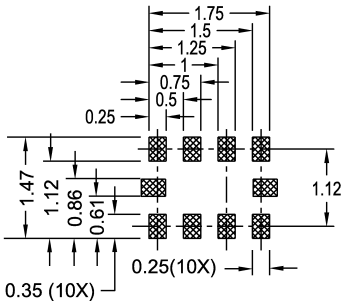


Tape Size	A	B	C	D	N	W1	W2
12 mm	13.0 (330)	0.059 (1.50)	0.512 (13.00)	0.795 (20.20)	7.008 (178)	0.488 (12.4)	0.724 (18.4)

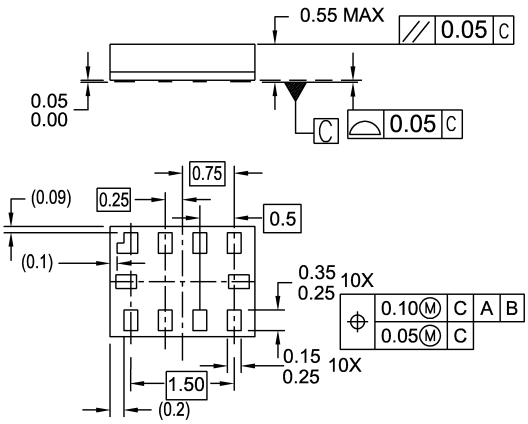
Physical Dimensions inches (millimeters) unless otherwise noted



TOP VIEW



LAND PATTERN RECOMENDATION



BOTTOM VIEW

NOTES:

A. PACKAGE CONFORMS TO JEDEC MO255, VARIATION UABD

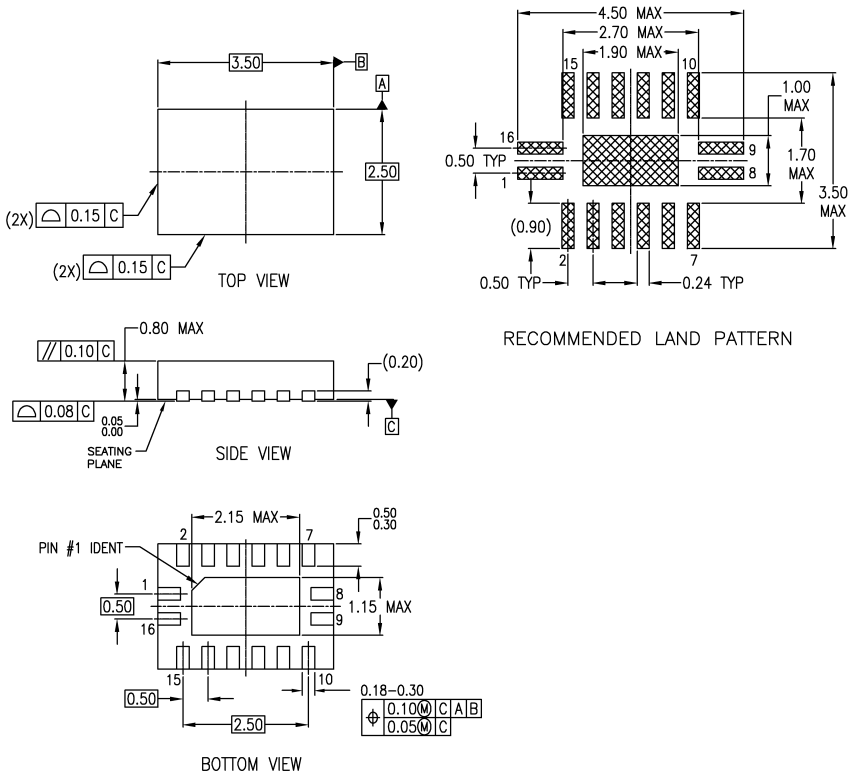
B. DIMENSIONS ARE IN MILLIMETERS.

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 AB
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP016ErevA

Pb-Free 16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm
Package Number MLP016E

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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 in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
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.