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FAIRCHILD SEMICONDUCTOR®

March 2013

FSUSB40 — Low-Power, Two-Port, Hi-Speed, USB2.0 (480Mbps) Switch

Features

- Low On Capacitance: 5.9pF Typical
- Low On Resistance: 3.9Ω Typical
- Low Power Consumption: 1µA Maximum
  - 15µA Maximum I_{CCT} over an Expanded Voltage Range (V_{IN}=1.8V, V_{CC}=4.3V)
- Wide -3db Bandwidth: > 720MHz
- Packaged in:
  - 10-Lead MicroPak™ (1.6 x 2.1mm)
  - 10-Lead UMLP (1.4 x 1.8mm)
- 8kV ESD Rating, >16kV Power/GND ESD Rating
- Power-Off Protection on All Ports When V_{CC}=0V
  - D+/D- Pins Tolerate up to 5.25V
- Over-Voltage Tolerance (OVT) on all USB Ports Up to 5.25V without External Components

Applications

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

IMPORTANT NOTE:

For additional performance information, please contact analogswitch@fairchildsemi.com.

Description

The FSUSB40 is a bi-directional, low-power, two-port, Hi-Speed, USB2.0 switch. Configured as a double-pole, double-throw switch (DPDT) switch, it is optimized for switching between two Hi-Speed (480Mbps) sources or a Hi-Speed and Full-Speed (12Mbps) source.

The FSUSB40 is compatible with the requirements of USB2.0 and features an extremely low on capacitance (C_{ON}) of 5.9pF. 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 also minimizes interference.

The FSUSB40 contains special circuitry on the switch I/O pins for applications where the V_{CC} supply is powered-off (V_{CC}=0), which allows the device to withstand an over-voltage condition. This device is designed to minimize current consumption even when the control voltage applied to the SEL 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

Part Number	Top Mark	Operating Temperature Range	Eco Status	Package
FSUSB40L10X	HD	-40 to +85°C	RoHS	10-Lead MicroPak™ 1.6 x 2.1mm, JEDEC MO-255B
FSUSB40UMX	HC	-40 to +85°C	Green	10-Lead, Quad, Ultrathin Molded Leadless Package (UMLP), 1.4 x 1.8mm

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

For Fairchild's definition of Eco Status, please visit: http://www.fairchildsemi.com/company/green/rohs_green.html.

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Analog Symbol

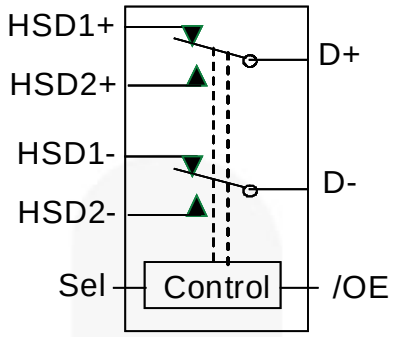


Figure 1. Analog Symbol

Pin Assignments

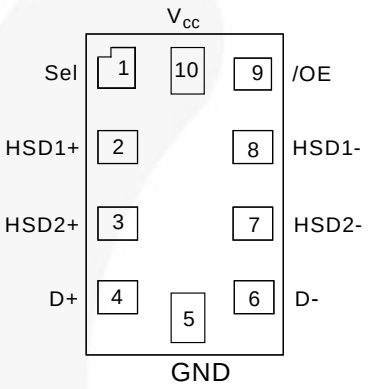


Figure 2. Pad Assignments for MicroPak™ (Top Through View)

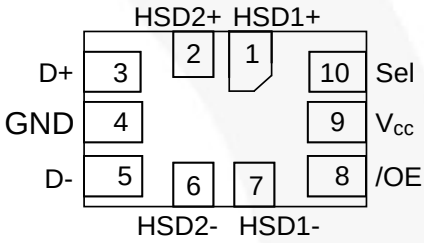


Figure 3. Pin Assignments for UMLP (Top Through View)

Pin Definitions

MicroPak™ Pin #	UMLP Pin #	Name	Description
9	8	/OE	Switch Enable
1	10	Sel	Switch Select
4, 6	3, 5	D+, D-	USB Data Bus
2, 3, 7, 8	1, 2, 6, 7	HSDn+, HSDn-	Multiplexed Source inputs
5	4	GND	Ground

Truth Table

Sel	/OE	Function
X	H	Disconnect
L	L	D+, D-=HSD1+, HSD1-
H	L	D+, D-=HSD2+, HSD2-

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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		Min.	Max.	Unit
V_{CC}	Supply Voltage		-0.5	+5.5	V
V_{CNTRL}	DC Input Voltage (S, /OE)[1]		-0.5	V_{CC}	V
V_{SW}	DC Switch I/O Voltage[1]		-0.50	5.25	V
I_{IK}	DC Input Diode Current		-50		mA
I_{OUT}	DC Output Current			100	mA
T_{STG}	Storage Temperature		-65	+150	°C
ESD	Human Body Model, JEDEC: JESD22-A114	All Pins		7	kV
		I/O to GND		8	
		Power to GND		16	
	Charged Device Model, JEDEC: JESD22-C101			2	

Note:

1. The input and output negative 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.

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply Voltage	3.0	4.3	V
V_{CNTRL}	Control Input Voltage (S, /OE)[2]	0	V_{CC}	V
V_{SW}	Switch I/O Voltage	-0.5	4.5	V
T_A	Operating Temperature	-40	+85	°C

Note:

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

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DC Electrical Characteristics

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

Symbol	Parameter	Conditions	V_{CC} (V)	T_A=- 40ºC to +85ºC			Units
				Min.	Typ.	Max.	
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 to V_{CC}	4.3	-1		1	µA
I_{OZ}	Off State Leakage	0 ≤ Dn, HSD1n, HSD2n ≤ 3.6V	4.3	-2		2	µA
I_{OFF}	Power-Off Leakage Current (All I/O Ports)	V_{SW}=0V to 4.3V, V_{CC}=0V Figure 5	0	-2		2	µA
R_{ON}	HS Switch On Resistance(3)	V_{SW}=0.4V, I_{ON}=-8mA Figure 4	3.0		3.9	6.5	Ω
ΔR_{ON}	HS Delta Ron(4)	V_{SW}=0.4V, I_{ON}=-8mA	3.0		0.65		Ω
I_{CC}	Quiescent Supply Current	V_{CNTRL}=0 or Vcc, I_{OUT}=0	4.3			1.0	µA
I_{CCT}	Increase in I_{CC} Current Per Control Voltage and V_{CC}	V_{CNTRL}=2.6V V_{CC}=4.3V	4.3			10.0	µA
		V_{CNTRL}=1.8V V_{CC}=4.3V	4.3			15.0	µA

Notes:

3. Measured by the voltage drop between HSDn and Dn pins at the indicated current through the switch. On resistance is determined by the lower of the voltage on the two (HSDn or Dn ports).
4. Guaranteed by characterization.

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AC Electrical Characteristics

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

Symbol	Parameter	Conditions	V_{CC} (V)	T_A=- 40ºC to +85ºC			Units
				Min.	Typ.	Max.	
t_{ON}	Turn-On Time S, /OE to Output	R_L=50Ω, C_L=5pF V_{SW}=0.8V Figure 6, Figure 7	3.0 to 3.6		13	30	ns
t_{OFF}	Turn-Off Time S, /OE to Output	R_L=50Ω, C_L=5pF V_{SW}=0.8V Figure 6, Figure 7	3.0 to 3.6		12	25	ns
t_{PD}	Propagation Delay(5)	C_L=5 pF, R_L=50Ω Figure 6, Figure 8	3.3		0.25		ns
t_{BBM}	Break-Before-Make	R_L=50Ω, C_L=5pF V_{SW1}=V_{SW2}=0.8V Figure 12	3.0 to 3.6	2.0		6.5	ns
O_{IRR}	Off Isolation	R_L=50Ω, f=240MHz Figure 14	3.0 to 3.6		-30		dB
Xtalk	Non-Adjacent Channel Crosstalk	R_L=50Ω, f=240MHz Figure 15	3.0 to 3.6		-45		dB
BW	-3db Bandwidth	R_L=50Ω, C_L=0pF Figure 13	3.0 to 3.6		720		MHz
		R_L=50Ω, C_L=5pF Figure 13			550		MHz

Note:
5. Guaranteed by characterization.

USB Hi-Speed-Related AC Electrical Characteristics

Symbol	Parameter	Conditions	V_{CC} (V)	T_A=- 40ºC to +85ºC			Units
				Min.	Typ.	Max.	
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output(6)	C_L=5pF, R_L=50Ω Figure 9	3.0 to 3.6		20		ps
t_J	Total Jitter(6)	R_L=50Ω, C_L=5pf, t_R=t_F=500ps (10-90%) at 480Mbps (PRBS=2^{15} – 1)	3.0 to 3.6		200		ps

Note:
6. Guaranteed by characterization.

Capacitance

Symbol	Parameter	Conditions	T_A=- 40ºC to +85ºC			Units
			Min.	Typ.	Max.	
C_{IN}	Control Pin Input Capacitance	V_{CC}=0V		1.5		pF
C_{ON}	D+/D- On Capacitance	V_{CC}=3.3V, /OE=0V, f=1MHz Figure 11		5.9	6.5	
C_{OFF}	D1n, D2n Off Capacitance	V_{CC} and /OE=3.3V Figure 10		2.0		

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Test Diagrams

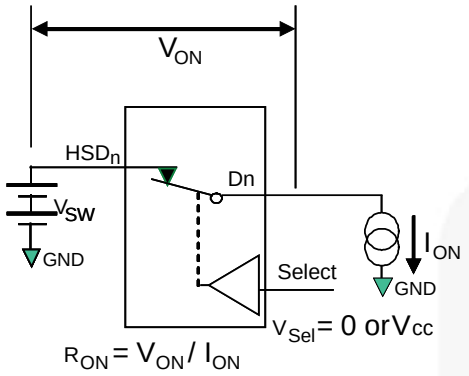
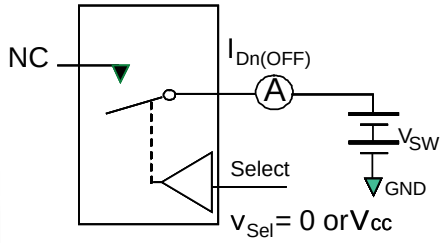
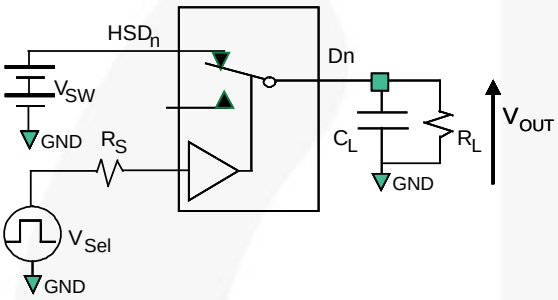


Figure 4. On Resistance



**Each switch port is tested separately

Figure 5. Off Leakage



R_L, R_S, and C_L are functions of the application environment (see AC Tables for specific values)
C_L includes test fixture and stray capacitance.

Figure 6. AC Test Circuit Load

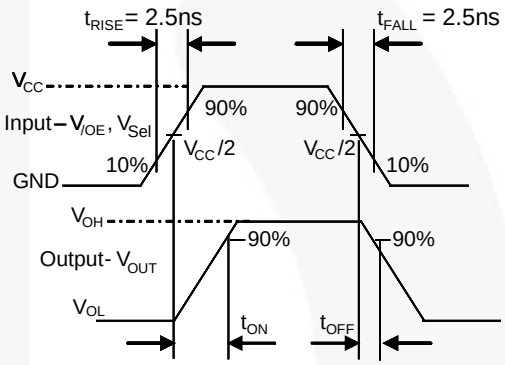


Figure 7. Turn-On / Turn-Off Waveforms

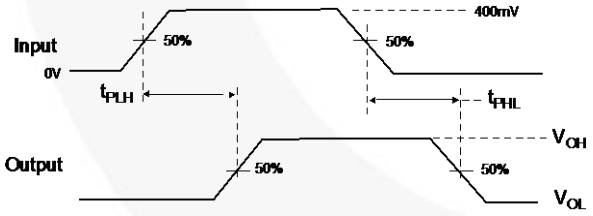


Figure 8. Propagation Delay ($t_R t_F$ – 500ps)

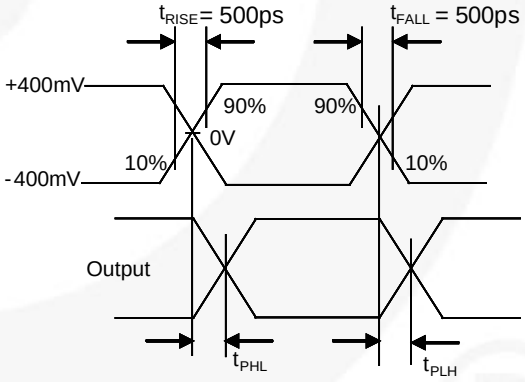


Figure 9. Intra-Pair Skew Test $t_{SK(P)}$

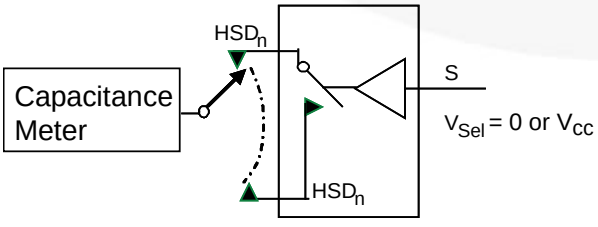


Figure 10. Channel Off Capacitance

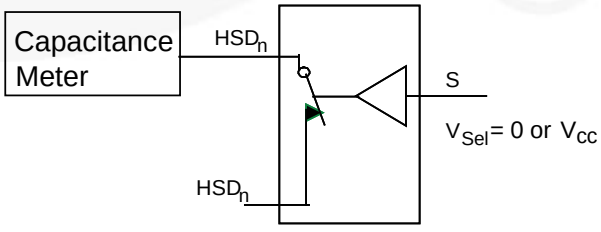
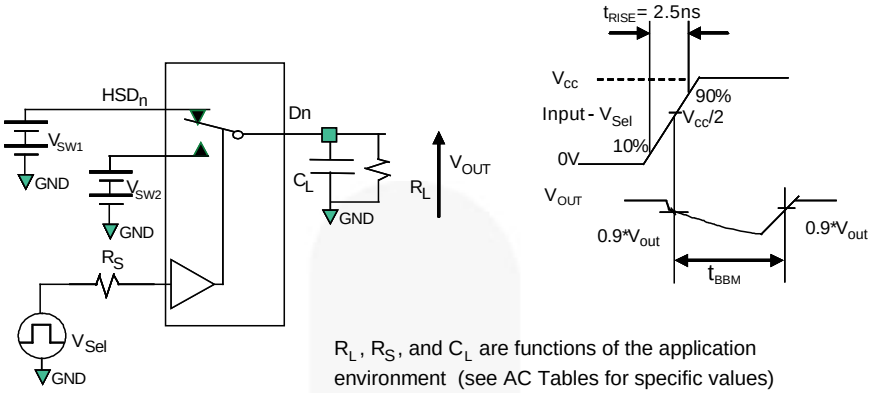


Figure 11. Channel On Capacitance

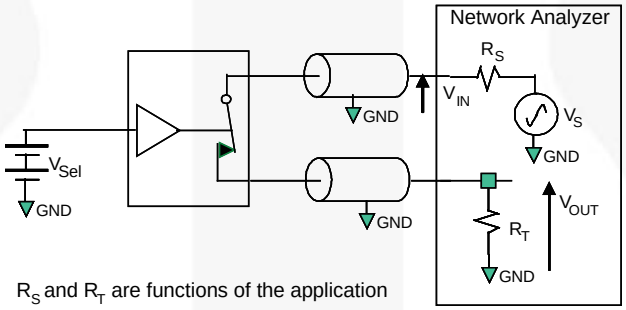
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Test Diagrams (Continued)



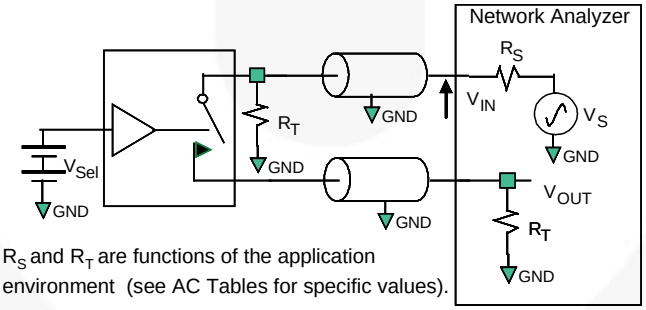
R_L, R_S, and C_L are functions of the application environment (see AC Tables for specific values)
C_L includes test fixture and stray capacitance.

Figure 12. Break-Before-Make Interval Timing



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

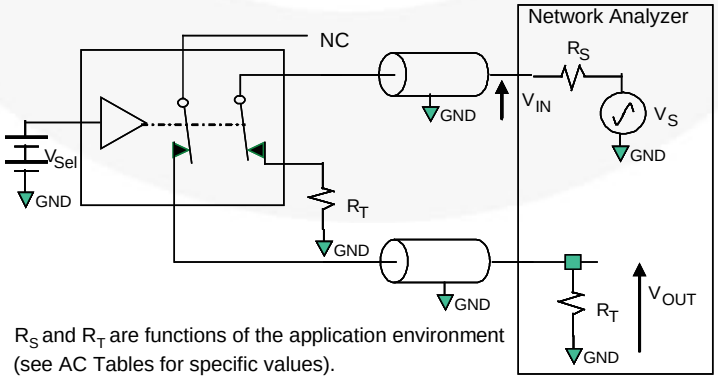
Figure 13. Bandwidth



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

Off isolation = 20 Log (V_{OUT} / V_{IN})

Figure 14. Channel Off Isolation



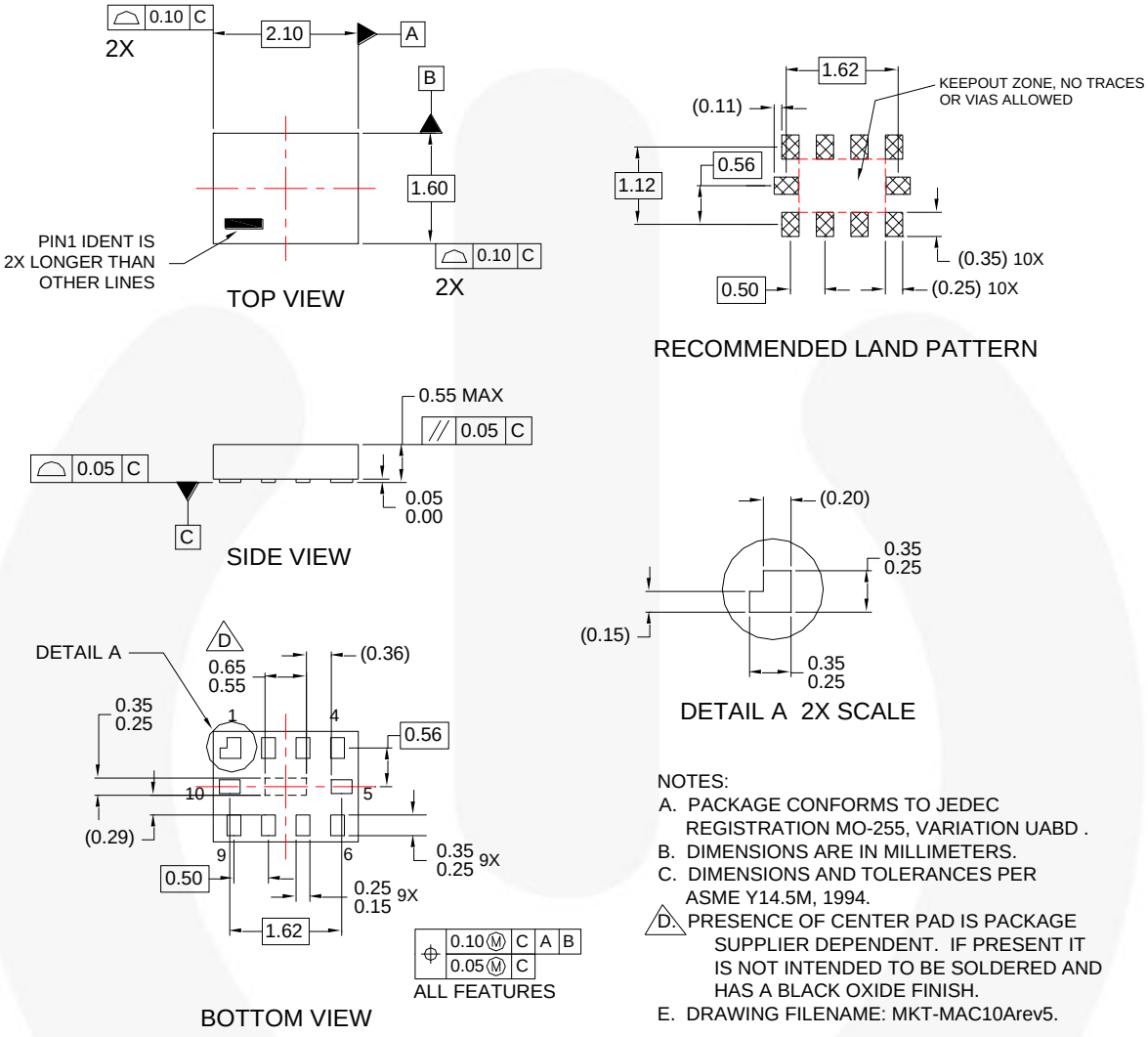
R_S and R_T are functions of the application environment (see AC Tables for specific values).

Crosstalk = 20 Log (V_{OUT} / V_{IN})

Figure 15. Non-Adjacent Channel-to-Channel Crosstalk

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Physical Dimensions



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.

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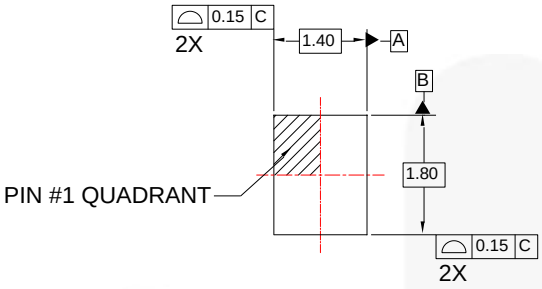
Figure 16. 10-Lead MicroPak™

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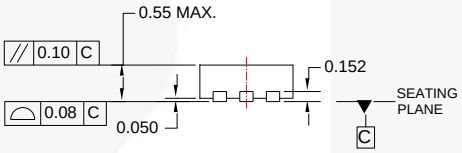
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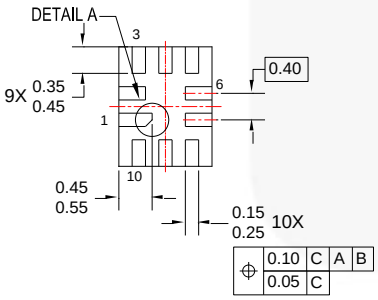
Physical Dimensions



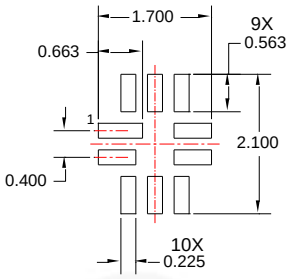
TOP VIEW



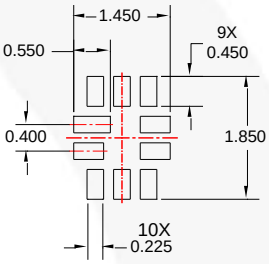
SIDE VIEW



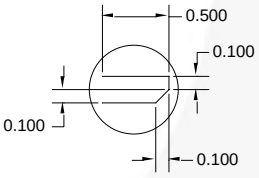
BOTTOM VIEW



RECOMMENDED LAND PATTERN



OPTIONAL MINIMIAL TOE LAND PATTERN



DETAIL A
PIN #1 TERMINAL
SCALE: 2X

NOTES:

A. DIMENSIONS ARE IN MILLIMETERS.

B. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

C. DRAWING FILENAME: UMLP10Arev2

Figure 17. 10-Lead, Ultrathin Molded Leadless Package (UMLP)

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