FAIRCHILD

SEMICONDUCTOR®

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FSUSB23 — High-Speed, USB2.0 (480Mbps) Switch

Features

- 10µA Maximum I_{CCT} Current over an Expanded Control

- Voltage Range: V_{IN} = 2.6V, V_{CC} = 3.6V)

- Lower Capacitance: C_{ON} = 9pF Typical

- 7Ω Typical On Resistance (R_{ON})

- -3dB Bandwidth: > 720MHz

- Low Power Consumption: 1mA Maximum

- Wide -3db Bandwidth: > 720MHz

- Packaged in:
  - 10-Lead MicroPak™ (1.6 x 2.1mm)
  - 16-Lead DQFN (2.5 x3.5mm)

- 7kV I/O to GND ESD Performance

Applications

- Cell phone, PDA, Digital Camera, and Notebook

- LCD Monitor, TV, and Set-Top Box

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, allowing 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 third harmonic, which results in signals with minimum edge and phase distortion. Superior channel-to-channel crosstalk results in minimal interference.

Ordering Information

Part Number	Top Mark	Operating Temperature Range	Package
FSUSB23L10X	EZ	-40 to +85°C	10-Lead MicroPak™ 1.6 x 2.1mm, JEDEC MO-255B
FSUSB23BQX	USB23	-40 to +85°C	16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN), JEDEC MO-241, 2.5 x 3.5mm

MicroPak™ is a trademark of Fairchild Semiconductor Corporation.

All packages are lead free per JEDEC: J-STD-020B standard.
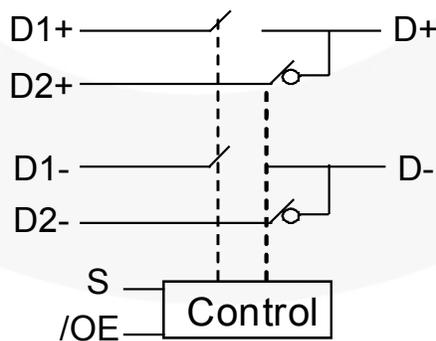
Figure 1. Analog Symbol

Pin Configurations
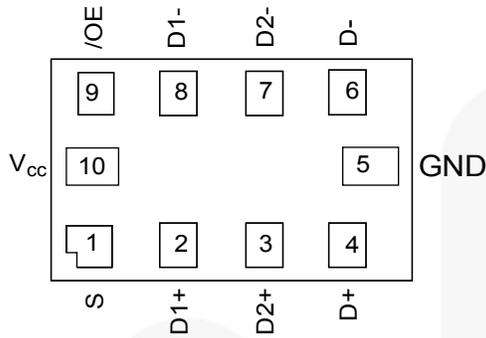


Figure 2.   Pad Assignments for MicroPak™
(Top Through View)
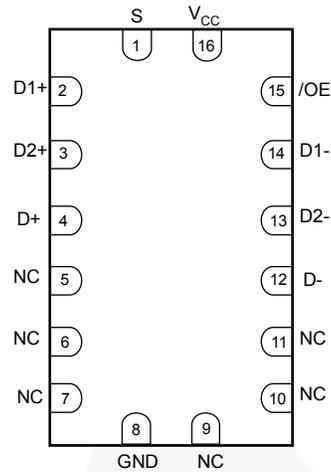
Figure 3.   Pin Assignments for DQFN
(Top Through View)

Pin Definitions

Pin # Micropak	Pin # DQFN	Pin Name	Pin Description
1	1	S	Switch Select
9	15	/OE	Bus Switch Enable
2, 3, 4 ,6, 7, 8	2, 3, 4, 12, 13, 14	D+, D-, Dn+, Dn-	Data Port
10	16	V_{CC}	Supply Voltage
5	8	GND	Ground
	5, 6, 7, 9, 10, 11	NC	No Connect

Truth Table

Sel	/OE	Function
X	HIGH	Disconnect
LOW	LOW	D+, D- = $D1_n$
HIGH	LOW	D+, D- = $D2_n$

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		Min.	Max.	Unit
V_{CC}	Supply Voltage		-0.5	4.6	V
V_{SW}	DC Switch Voltage[1]		-0.5	V_{CC} + 0.5	V
V_{IN}	DC Input Voltage[1]		-0.5	4.6	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, JEDEC: JESD22-A114	All Pins		7	kV
		I/O to GND		7	

Note:
1. The input and output negative ratings may be exceeded if the input and output diode current ratings are observed. DC switch voltage may never exceed 4.6V.

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	3.6	V
V_{CNTRL}	Control Input Voltage[2][3]		0	V_{CC}	V
V_{SW}	Switch Input Voltage		0	V_{CC}	V
T_A	Operating Temperature		-40	+85	°C
Θ_{JA}	Thermal Resistance	Micropak		250	°C/W

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.
3. The control input must be held HIGH or LOW; it must not float.

DC Electrical Characteristics

All typical values 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	1.2			V
V_{IL}	Input Voltage Low		3.0 to 3.6			.50	V
I_{IN}	Control Input Leakage	V_{IN}=0V to V_{CC}	3.6			1	µA
I_{OZ}	Off State Leakage	$0 \leq D_n, D1_n, D2_n \leq V_{CC}$				1	µA
R_{ON}	Switch On Resistance[4]	V_{SW}=0.4V, I_{ON}=-8mA	3.0		6	9	Ω
		V_{SW}=0.8V, I_{ON}=-8mA			7	10	
ΔR_{ON}	Delta R_{ON}[5]	V_{IN}=0.4V, I_{ON}=-8mA	3.0		0.3		Ω
$R_{ON\ Flat}$	R_{ON} Flatness[4]	V_{IN}=0V-1.0V, I_{ON}=-8mA	3.0		2.0		Ω
I_{CC}	Quiescent Supply Current	V_{IN}=0 or V_{CC}, I_{OUT}=0	3.6			1	µA
I_{CCT}	Increase in I_{CC} Current Per Control Voltage and V_{CC}	V_{IN}=2.6V V_{CC}=3.6V	3.6			10	µA

Notes:
4. Measured by the voltage drop across the D_n, $D1_n$, $D2_n$ pins at the indicated current through the switch.
   On resistance is determined by the lower of the voltage on the two (HSDn or Dn ports).
5. 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)	T_A=- 40ºC to +85ºC			Units
				Min.	Typ.	Max.	
t_{ON}	Turn-On Time S, /OE to Output	V_{D1n}, D_{2n}=0.8V, R_L=50Ω, C_L=10pF Figure 8	3.0 to 3.6		10	13	ns
t_{OFF}	Turn-Off Time S, /OE to Output	V_{D1n}, D_{2n}=0.8V, R_L=50Ω, C_L=10pF Figure 8	3.0 to 3.6		8	11	ns
t_{PD}	Propagation Delay[6]	R_L=50Ω, C_L=10pF Figure 6, Figure 7	3.3		0.25		ns
O_{IRR}	Off Isolation, Non-Adjacent	f=250MHz, R_T=50Ω Figure 14	3.0 to 3.6		-30		dB
Xtalk	Non-Adjacent Channel Crosstalk	f=250MHz, R_T=50Ω Figure 9	3.0 to 3.6		-43		dB
BW	-3db Bandwidth	R_T=50Ω Figure 13	3.0 to 3.6		720		MHz

Note:
6. 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.	
$t_{SK(O)}$	Channel-to-Channel Skew[7]	R_L=50Ω, C_L=10pF Figure 6, Figure 12	3.0 to 3.6		40		ps
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output[7]	R_L=50Ω, C_L=10pF Figure 6, Figure 12	3.0 to 3.6		20		ps
t_J	Total Jitter[7]	R_L=50Ω, C_L=10pf, t_R=t_F=750ps at 480Mbps (PRBS=2^{15} – 1)	3.0 to 3.6		150		ps

Note:
7. 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 Figure 11		2		pF
C_{ON}	$D1_n$, $D2_n$, D_n On Capacitance	V_{CC}=3.3V, /OE=0V Figure 10		9		pF
C_{OFF}	$D1_n$, $D2_n$ Off Capacitance	V_{CC} and /OE=3.3V Figure 11		4		pF

Test Diagrams
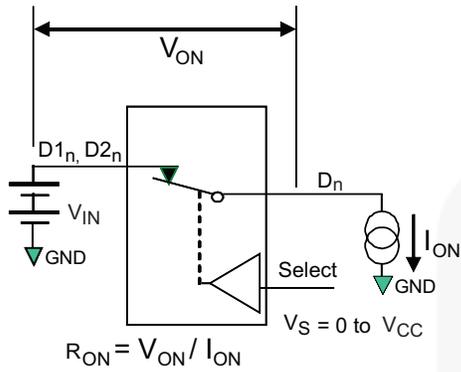
Figure 4.   On Resistance

$R_{ON} = V_{ON} / I_{ON}$

$V_S = 0$ to V_{CC}

Figure 5.   Off Leakage
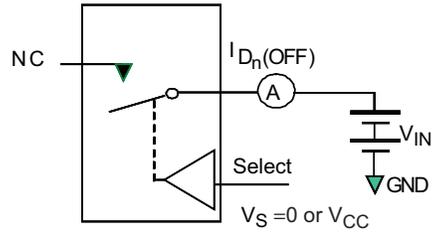
**Each switch port is tested separately
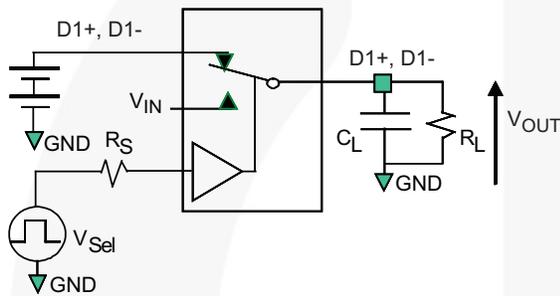

R_L, R_S, and C_L are functions of the application environment (see AC Tables for specific values)
C_L includes test fixture and stray capacitance.

Figure 6.   AC Test Circuit Load
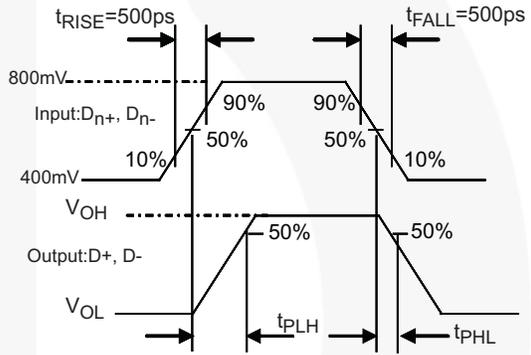
Figure 7.   Switch Propagation Delay Waveforms
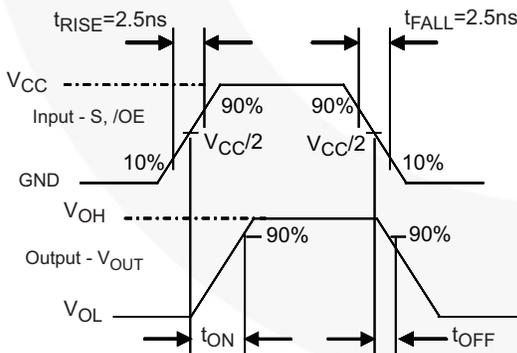
Figure 8.   Turn On / Turn Off Waveform
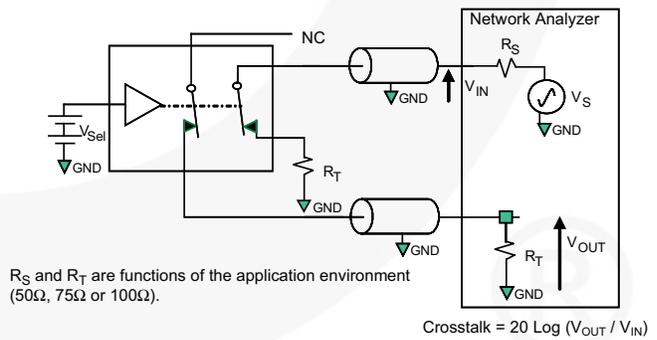
R_S and R_T are functions of the application environment
(50Ω, 75Ω or 100Ω).

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

**Figure 9.   Non-Adjacent Channel-to-Channel Crosstalk**

Test Diagrams (Continued)
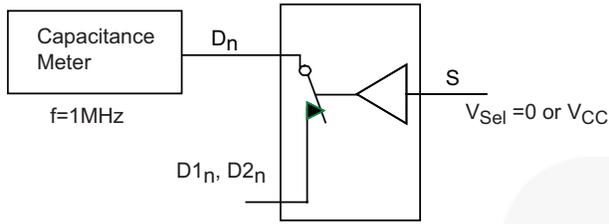
Figure 10. Channel On Capacitance
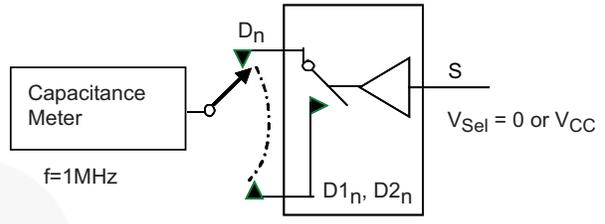
Figure 11. Channel Off Capacitance

$$T_{SK(P)}= |t_{PHL}-t_{PLH}|$$
Pulse Skew, $T_{SK(P)}$
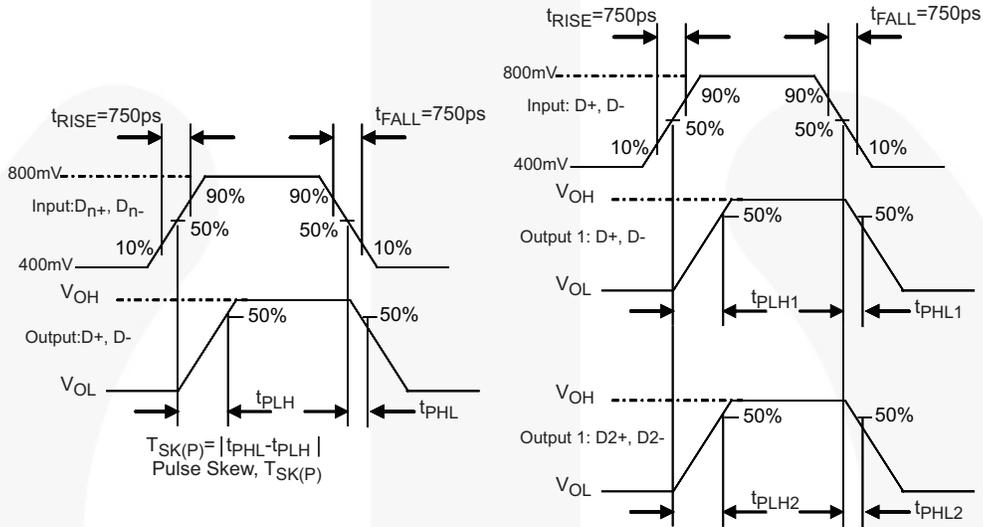
Figure 12. Switch Skew Tests

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

Figure 13. Bandwidth

Off Isolation $=20Log(V_{OUT}/V_{IN})$
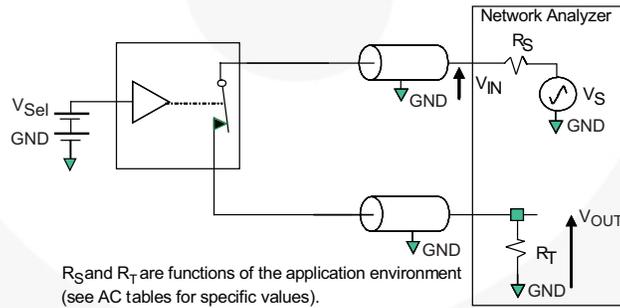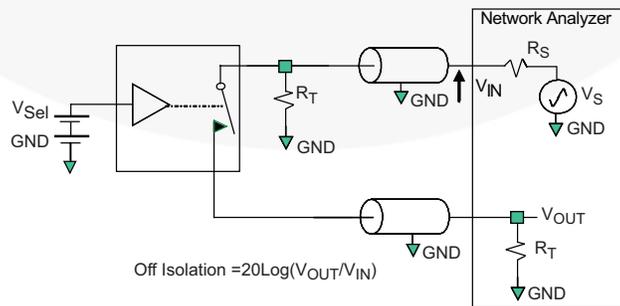
Figure 14. Channel Off Isolation

Physical Dimensions

2X ⌒ 0.10 C

B

2.10

9   6

A

PIN#1 IDENT

1

4

1.60

2X ⌒ 0.10 C

TOP VIEW

1.75
1.50
1.25
1.00
0.75
0.50
0.25

1.47
1.12
0.86
0.61

0.11
0.24
0.86

1.86
1.51
1.12

0.35 (10X)
0.25 (10X)

LAND PATTERN RECOMENDATION

0.55 MAX
∥ 0.05 C

0.05
0.00

C

⌒ 0.05 C

0.75
0.50

(0.09)
0.25

(0.10)

10X 0.35
     0.25

(0.20)

1.50

0.15
0.25 10X

⊕ 0.10 Ⓜ C A B
⊕ 0.05 Ⓜ C

BOTTOM VIEW
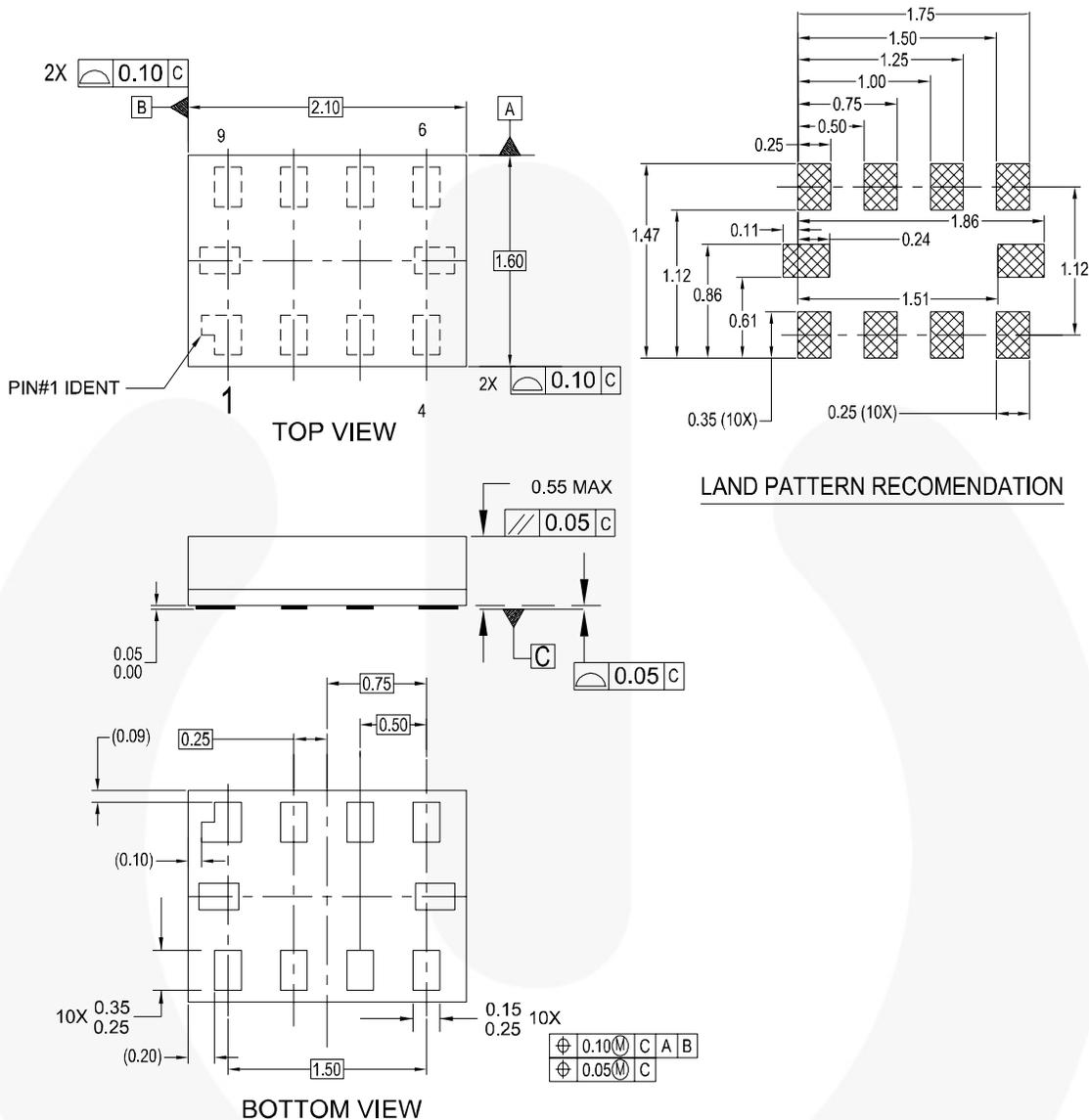
NOTES:

A. PACKAGE CONFORMS TO JEDEC MO255, VARIATION UABD

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES CONFORMS TO ASME Y14.5M, 1994.

MAC010ARevC

**Figure 15. 10-Lead MicroPak™ 1.6 x 2.1mm**

Note: click here for tape and reel specifcations, available at:
http://www.fairchildsemi.com/products/analog/pdf//micropak_tr.pdf

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Physical Dimensions

TOP VIEW

SIDE VIEW

RECOMMENDED LAND PATTERN

BOTTOM VIEW
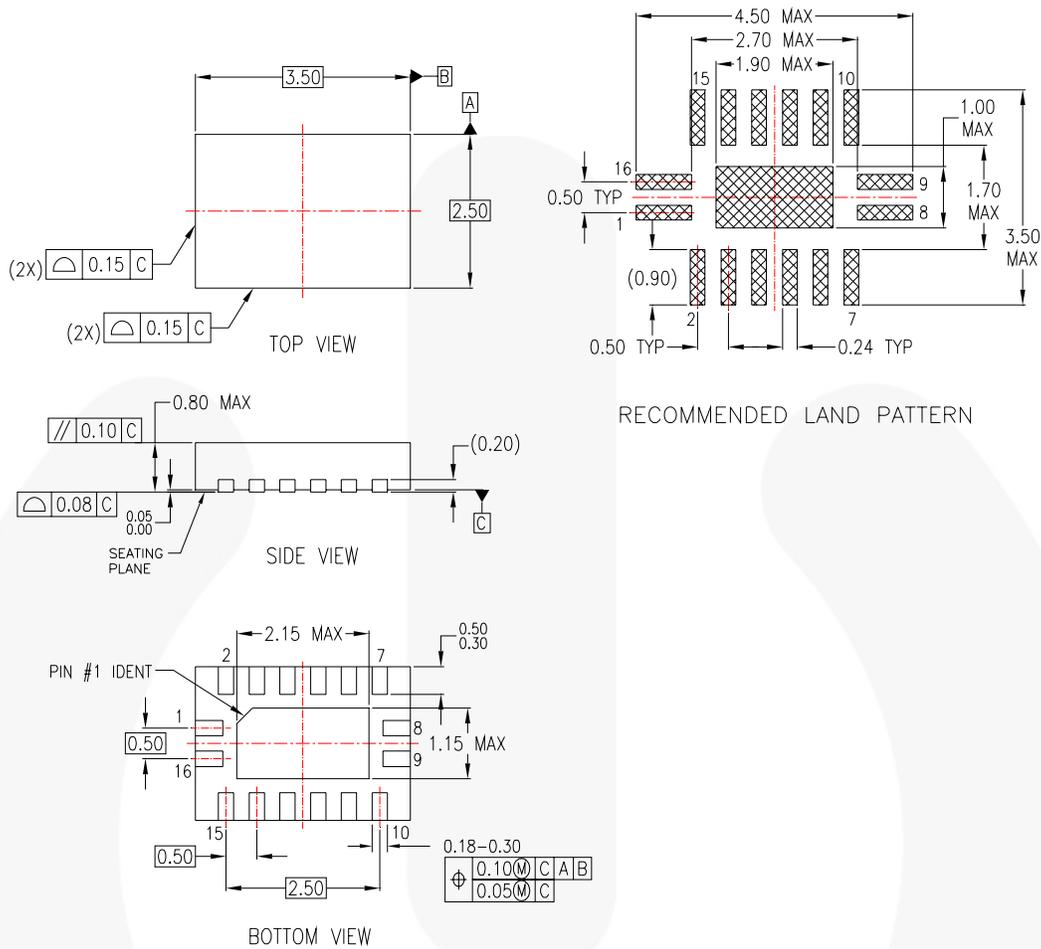
NOTES:

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

MLP16ErevA

Figure 16. 16-Terminal Depopulated Quad Very-Thin Flat Pack No Leads (DQFN) Package

Note: click here for tape and reel specifcations, available at:
http://www.fairchildsemi.com/products/analog/packaging/MLP16_25x35.html

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