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ON Semiconductor®

# FSUSB42 — Low-Power, Two-Port, High-Speed, USB2.0 (480Mbps) UART Switch

## Features

- Low On Capacitance: 3.7 pF Typical
- Low On Resistance: 3.9 Ω Typical
- Low Power Consumption: 1 μA Maximum
  - 15 μA Maximum  $I_{CCT}$  over an Expanded Voltage Range ( $V_{IN}=1.8$  V,  $V_{CC}=4.4$  V)
- Wide -3 db Bandwidth: > 720 MHz
- Packaged in:
  - 10-Lead UMLP (1.4 x 1.8 mm)
  - 10-Lead MSOP
- 8 kV ESD Rating, >16 kV Power / GND ESD Rating
- Over-Voltage Tolerance (OVT) on all USB Ports Up to 5.25 V without External Components

## Applications

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

## Description

The FSUSB42 is a bi-directional, low-power, two-port, high-speed, USB2.0 switch. Configured as a double-pole, double-throw switch (DPDT) switch, it is optimized for switching between any combination of high-speed (480 Mbps) or Full-Speed (12 Mbps) sources.

The FSUSB42 is compatible with the requirements of USB2.0 and features an extremely low on capacitance ( $C_{ON}$ ) of 3.7 pF. The wide bandwidth of this device (720 MHz) 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 FSUSB42 contains special circuitry on the switch I/O pins for applications where the  $V_{CC}$  supply is powered-off ( $V_{CC}=0$  V), 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	Package
FSUSB42UMX	HE	-40 to +85°C	10-Lead, Quad, Ultrathin Molded Leadless Package (UMLP), 1.4 x 1.8 mm
FSUSB42MUX	FSUSB42	-40 to +85°C	10-Lead, Molded Small-Outline Package (MSOP) JEDEC MO-187, 3.0 mm Wide

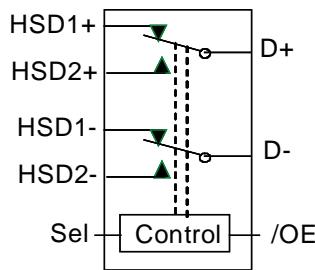


Figure 1. Analog Symbol

## Pin Assignments

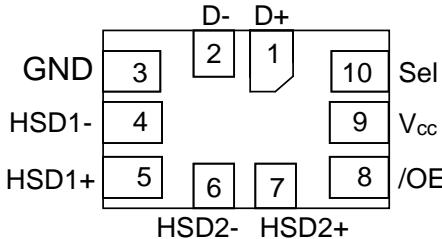


Figure 2. 10-Lead UMLP (Top-Through View)

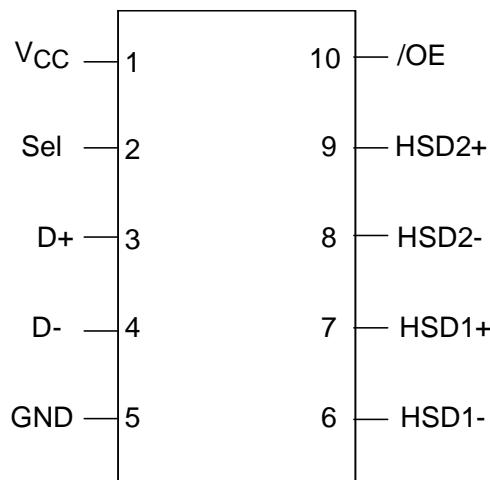


Figure 3. 10-Lead MSOP (Top-Through View)

## Pin Definitions

UMLP Pin#	MSOP Pin#	Name	Description
1	3	D+	Common USB Data Bus
2	4	D-	Common USB Data Bus
3	5	GND	Ground
4	6	HSD1-	Multiplexed Source Input 1
5	7	HSD1+	Multiplexed Source Input 1
6	8	HSD2-	Multiplexed Source Input 2
7	9	HSD2+	Multiplexed Source Input 2
8	10	/OE	Switch Enable
9	1	V <sub>cc</sub>	Supply Voltage
10	2	Sel	Switch Select

## Truth Table

SEL	/OE	Function
X	HIGH	Disconnect
LOW	LOW	D+= HSD1+, D-= HSD1-
HIGH	LOW	D+= HSD2+, D-= HSD2-

### Notes:

1. LOW  $\leq V_{IL}$ .
2. HIGH  $\geq V_{IH}$ .
3. X=Don't Care.

## 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 <sub>CC</sub>	Supply Voltage	-0.5	5.6	V
V <sub>CNTRL</sub>	DC Input Voltage (S, /OE) <sup>(4)</sup>	-0.5	V <sub>CC</sub>	V
V <sub>SW</sub>	DC Switch I/O Voltage <sup>(4)</sup> (V <sub>CC</sub> =0V)	-0.50	5.25	V
I <sub>IK</sub>	DC Input Diode Current	-50		mA
I <sub>OUT</sub>	DC Output Current		100	mA
T <sub>STG</sub>	Storage Temperature	-65	+150	°C
MSL	Moisture Sensitivity Level (JEDEC J-STD-020A)		1	Level
ESD	Human Body Model, JEDEC: JESD22-A114	All Pins	7	kV
		I/O to GND	8	
		Power to GND	16	
		D+/D-	9	
	IEC 61000-4-2 System on USB Connector Pins D+ & D-	Air Discharge	15	
		Contact	8	
	Charged Device Model, JEDEC: JESD22-C101		2	

**Note:**

- 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. ON Semiconductor does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	2.4	4.4	V
V <sub>CNTRL</sub>	Control Input Voltage (S, /OE) <sup>(5)</sup>	0	V <sub>CC</sub>	V
V <sub>SW</sub>	Switch I/O Voltage	-0.5	4.5	V
T <sub>A</sub>	Operating Temperature	-40	+85	°C

**Note:**

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

## DC Electrical Characteristics

All typical value are at  $T_A=25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Condition	$V_{cc}$ (V)	$T_A=-40^\circ\text{C}$ to $+85^\circ\text{C}$			Unit
				Min.	Typ.	Max.	
$V_{IK}$	Clamp Diode Voltage	$I_{IN}=-18\text{mA}$	3.0			-1.2	V
$V_{IH}$	Input Voltage High		2.4 to 3.6	1.3			V
			4.3	1.7			
$V_{IL}$	Input Voltage Low		2.4 to 3.6			0.5	V
			4.3			0.7	
$I_{IN}$	Control Input Leakage	$V_{SW}=0$ to $V_{CC}$	0 to 4.3	-1		1	$\mu\text{A}$
$I_{OZ}$	Off State Leakage	$0 \leq D_n, HSD1n, HSD2n \leq 3.6 \text{ V}$	4.3	-2		2	$\mu\text{A}$
$I_{OFF}$	Power-Off Leakage Current (All I/O Ports)	$V_{SW}=0 \text{ V}$ to 4.3 V, $V_{CC}=0 \text{ V}$ Figure 5	0	-2		2	$\mu\text{A}$
$R_{ON}$	HS Switch On Resistance <sup>(6)</sup>	$V_{SW}=0.4 \text{ V}, I_{ON}=-8 \text{ mA}$ Figure 4	2.4		4.5	7.5	$\Omega$
			3.0		3.9	6.5	
$\Delta R_{ON}$	HS Delta $R_{ON}$ <sup>(7)</sup>	$V_{SW}=0.4 \text{ V}, I_{ON}=-8 \text{ mA}$	3.0		0.65		$\Omega$
$I_{CC}$	Quiescent Supply Current	$V_{CNTRL}=0$ or $V_{CC}, I_{OUT}=0$	4.3			1	$\mu\text{A}$
$I_{CCT}$	Increase in $I_{CC}$ Current per Control Voltage and $V_{CC}$	$V_{CNTRL}=2.6 \text{ V}, V_{CC}=4.3 \text{ V}$	4.3			10	$\mu\text{A}$
		$V_{CNTRL}=1.8 \text{ V}, V_{CC}=4.3 \text{ V}$	4.3			15	$\mu\text{A}$

**Notes:**

6. 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).
7. Guaranteed by characterization.

## AC Electrical Characteristics

All typical value are for  $V_{CC}=3.3$  V at  $T_A=25^\circ C$  unless otherwise specified.

<b>Symbol</b>	<b>Parameter</b>	<b>Condition</b>	$V_{CC}$ (V)	$T_A=-40^\circ C$ to $+85^\circ C$			<b>Unit</b>
				<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
$t_{ON}$	Turn-On Time S, /OE to Output	$R_L=50\ \Omega$ , $C_L=5\ pF$ , $V_{SW}=0.8\ V$ , Figure 6, Figure 7	2.4		24	40	ns
			3.0 to 3.6		13	30	
$t_{OFF}$	Turn-Off Time S, /OE to Output	$R_L=50\ \Omega$ , $C_L=5\ pF$ , $V_{SW}=0.8\ V$ , Figure 6, Figure 7	2.4		15	35	ns
			3.0 to 3.6		12	25	
$t_{PD}$	Propagation Delay <sup>8</sup>	$C_L=5\ pF$ , $R_L=50\ \Omega$ , Figure 6, Figure 8	3.3		0.25		ns
$t_{BBM}$	Break-Before-Make	$R_L=50\ \Omega$ , $C_L=5\ pF$ , $V_{SW1}=V_{SW2}=0.8\ V$ , Figure 10	2.4	2.0		10	ns
			3.0 to 3.6	2.0		6.5	
$O_{IRR}$	Off Isolation	$R_L=50\ \Omega$ , $f=240\ MHz$ , Figure 12	3.0 to 3.6		-30		dB
Xtalk	Non-Adjacent Channel Crosstalk	$R_L=50\ \Omega$ , $f=240\ MHz$ , Figure 13	3.0 to 3.6		-45		dB
BW	-3db Bandwidth	$R_L=50\ \Omega$ , $C_L=0\ pF$ , Figure 11	3.0 to 3.6		720		MHz
		$R_L=50\ \Omega$ , $C_L=5\ pF$ , Figure 11			550		MHz

**Note:**

8. Guaranteed by characterization.

## USB High-Speed-Related AC Electrical Characteristics

All typical value are for  $V_{CC}=3.3$  V at  $T_A=25^\circ C$  unless otherwise specified.

<b>Symbol</b>	<b>Parameter</b>	<b>Condition</b>	$V_{CC}$ (V)	$T_A=-40^\circ C$ to $+85^\circ C$			<b>Unit</b>
				<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output <sup>(9)</sup>	$C_L=5\ pF$ , $R_L=50\ \Omega$ , Figure 9			20		ps
$t_J$	Total Jitter <sup>(9)</sup>	$R_L=50\ \Omega$ , $C_L=5\ pF$ , $t_R=t_F=500\ ps$ (10-90%) at 480 Mbps (PRBS= $2^{15}-1$ )			200		ps

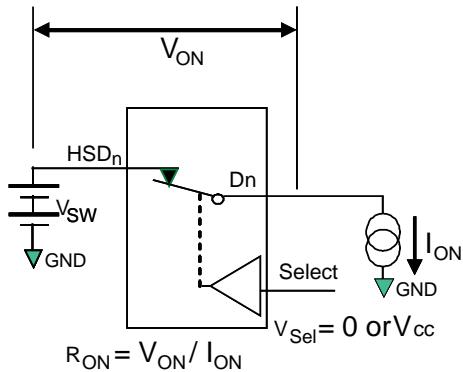
**Note:**

9. Guaranteed by characterization.

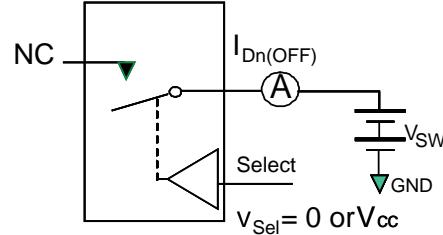
## Capacitance

<b>Symbol</b>	<b>Parameter</b>	<b>Condition</b>	$T_A=-40^\circ C$ to $+85^\circ C$			<b>Unit</b>
			<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	
$C_{IN}$	Control Pin Input Capacitance	$V_{CC}=0\ V$		1.5		pF
$C_{ON}$	D+/D- On Capacitance	$V_{CC}=3.3\ V$ , /OE=0 V, $f=240\ MHz$ , Figure 15		3.7		
$C_{OFF}$	D1n, D2n Off Capacitance	$V_{CC}$ and /OE=3.3 V, Figure 14		2.0		

## Test Diagrams

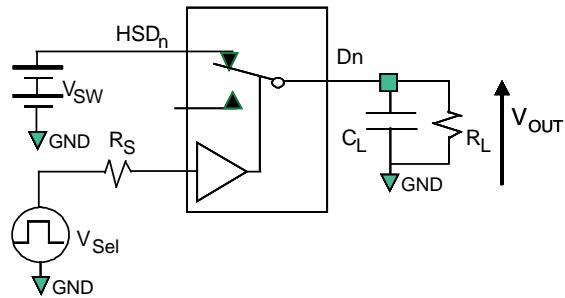


**Figure 4. On Resistance**



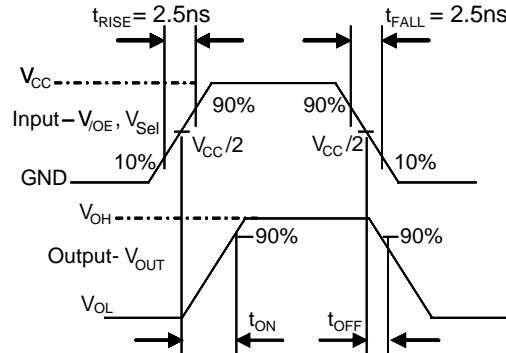
\*\*Each switch port is tested separately

**Figure 5. Off Leakage**

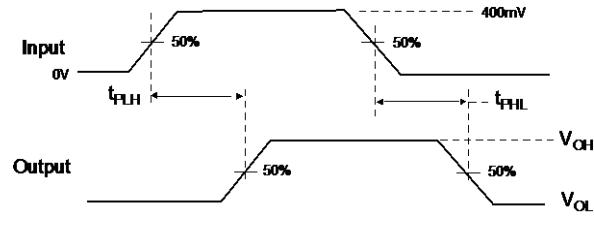


$R_L$ ,  $R_S$ , and  $C_L$  are functions of the application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance.

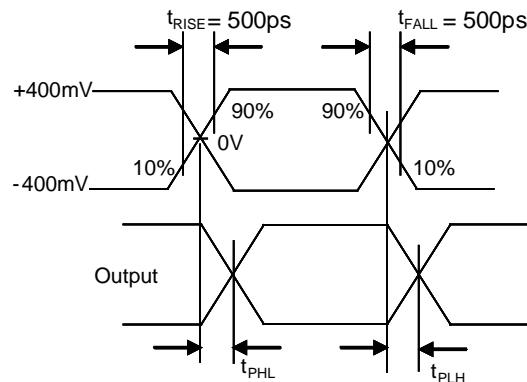
**Figure 6. AC Test Circuit Load**



**Figure 7. Turn-On / Turn-Off Waveforms**

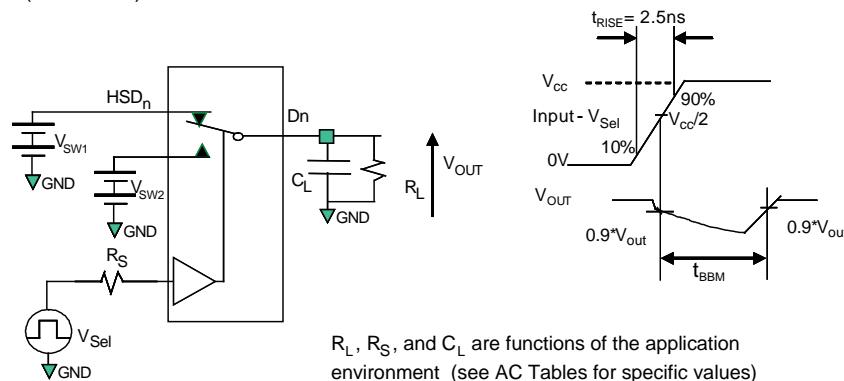


**Figure 8. Propagation Delay ( $t_{RTF} = 500$  ps)**

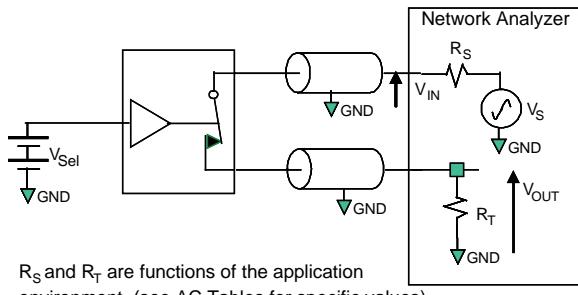


**Figure 9. Intra-Pair Skew Test  $t_{SK(P)}$**

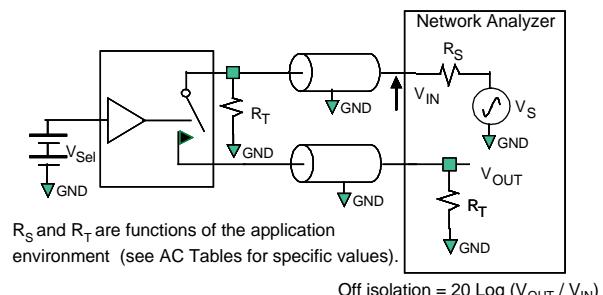
## Test Diagrams (Continued)



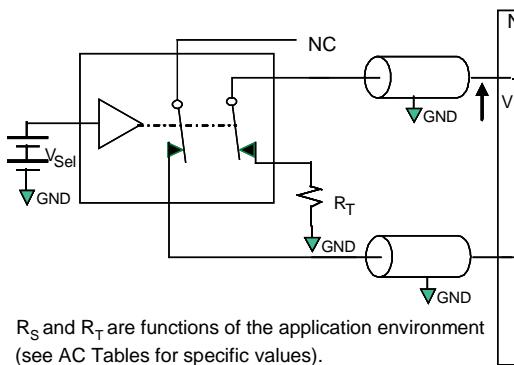
**Figure 10. Break-Before-Make Interval Timing**



**Figure 11. Bandwidth**

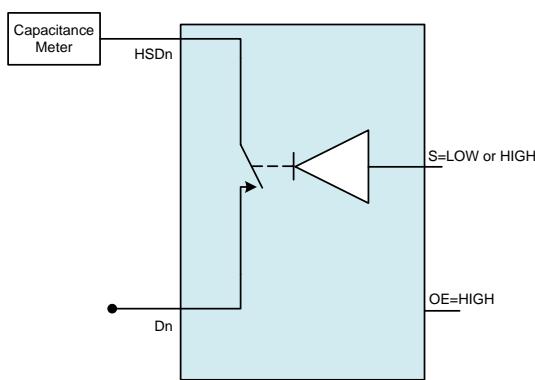


**Figure 12. Channel Off Isolation**

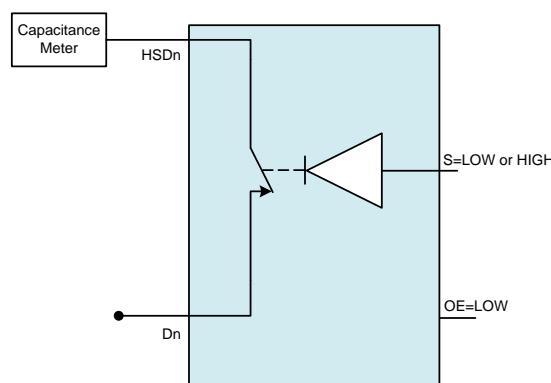


$$\text{Crosstalk} = 20 \log (V_{OUT} / V_{IN})$$

**Figure 13. Non-Adjacent Channel-to-Channel Crosstalk**

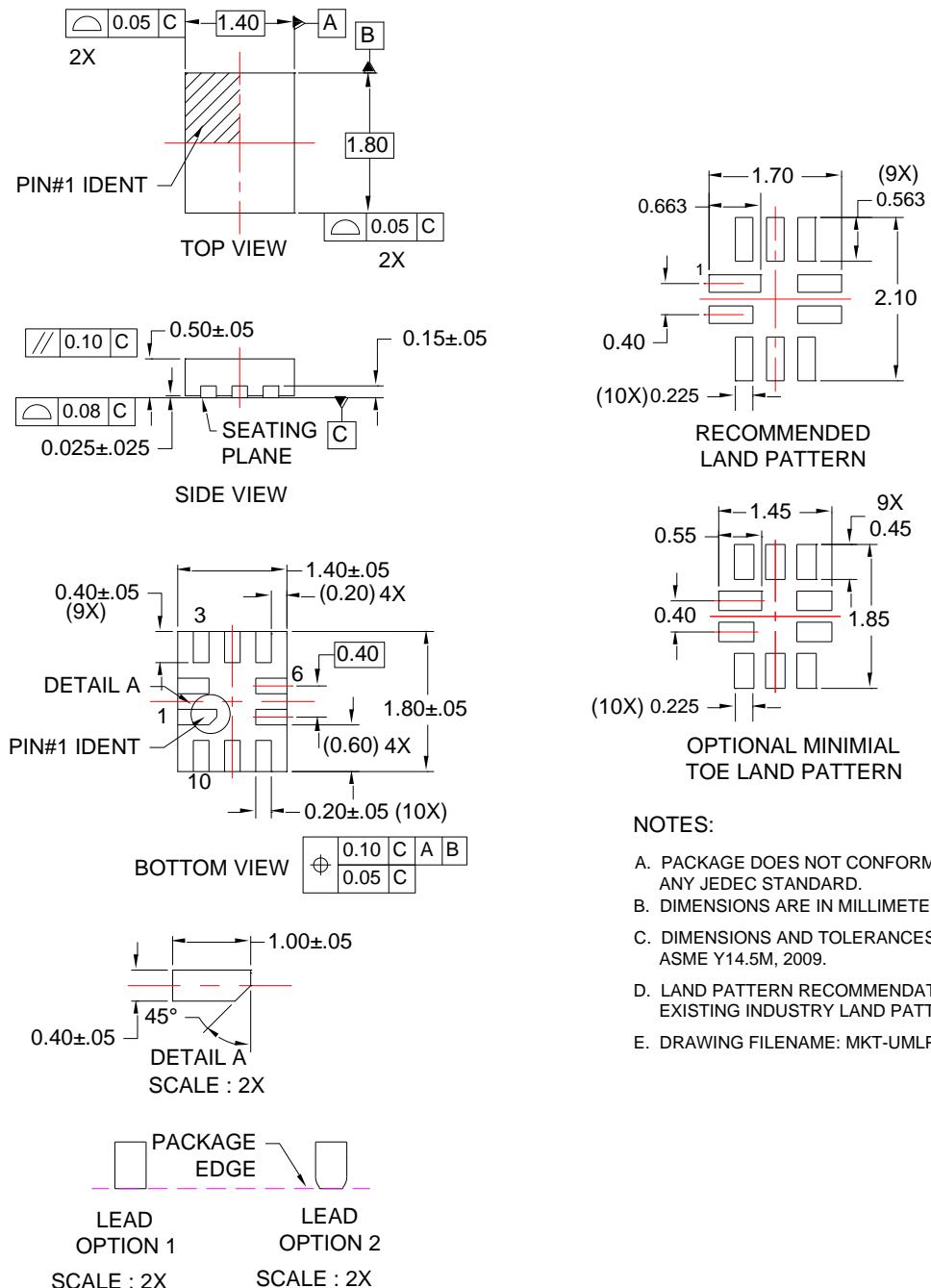


**Figure 14. Channel Off Capacitance**



**Figure 15. Channel On Capacitance**

## Physical Dimensions

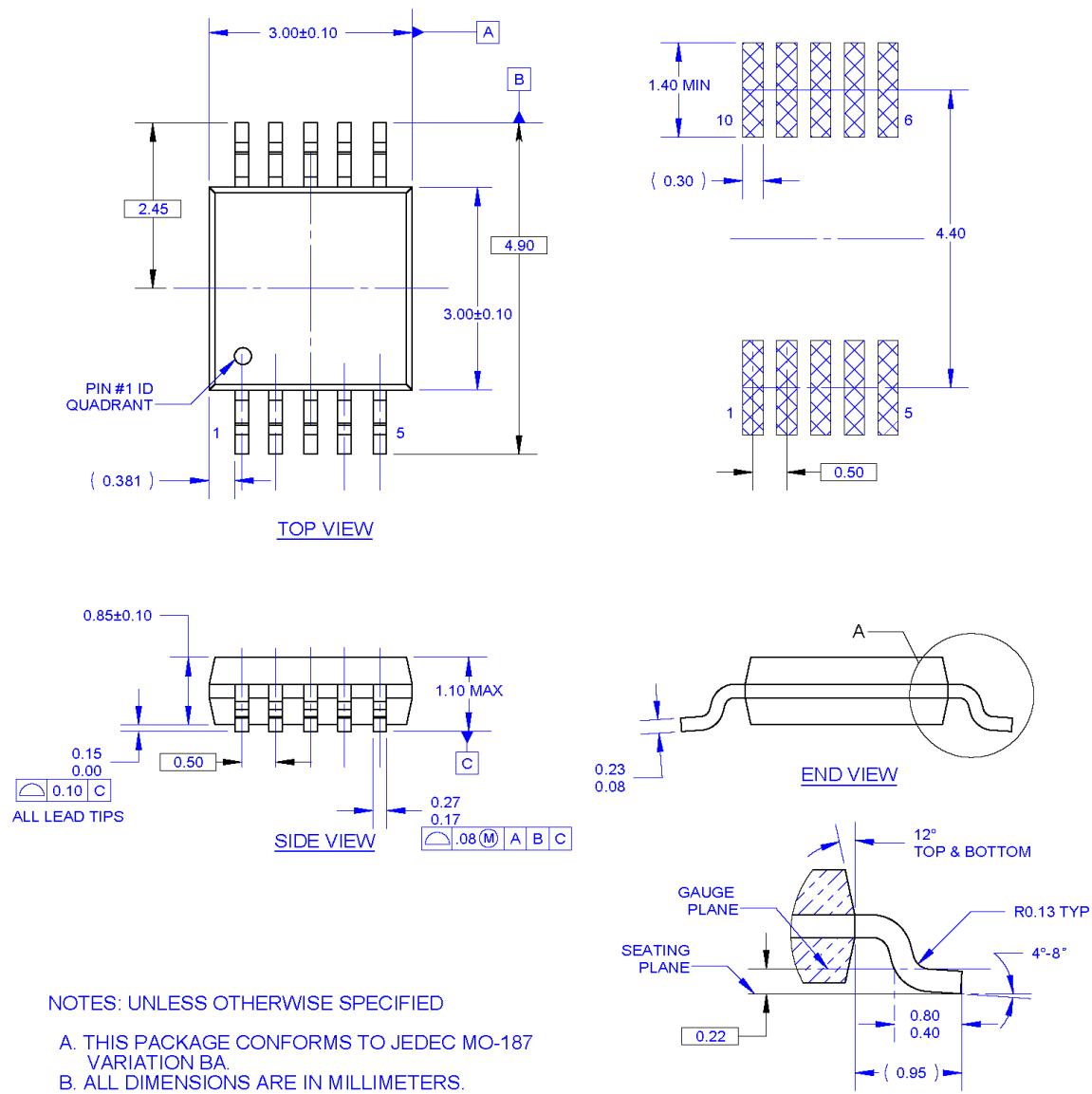


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**Figure 16. 10-Lead, Ultrathin Molded Leadless Package (UMLP)**

**Physical Dimensions (Continued)**



**Figure 17. 10-Lead, Molded Small Outline Package (MSOP)**

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