

## Ultra-High Voltage Protection USB2 1:2 Mux/DeMux

### Features

- Differential Bi-Directional 2:1 Mux/DeMux
- Wide Input Voltage Range: 0-5.5V
- Wide bandwidth: 1GHz
  - ◆ Ultra-low Con: 7pF
  - ◆ Ultra-low Ron: 5Ω (typ)
- Low Propagation Delay, 0.25ns typ
- Low Off-Isolation, -30dB@240MHz
- Low Crosstalk: -35dB@240MHz,
- Low Power Consumption: 35μA typical
- Wide Supply Voltage 2.7-5.5V
- Support 1.8V Logic on Control Pins
- Protection Feature
  - ◆ Off-protection for current leakage in power-down mode
  - ◆ All I/O pins are high voltage tolerance
    - C0+/C0- tolerance to 24V
    - Lx+/- tolerance to 6V
    - V<sub>DD</sub> tolerance to 9V
  - ◆ Over-voltage protection when Vbus short to C0-/C0+ when device is power-on and enabled
- ESD Protection on (C0+/-)
  - ◆ IEC61000-4-2
- Wide Temperature Range: -40°C to 85°C
- Packaging (Pb-free & Green):
  - ◆ 10-contact, UQFN (ZUA10), 1.5x2mm, 0.5mm(H), 0.6mm pitch
  - ◆ 10-contact, UQFN (ZM10), 1.4x1.8mm, 0.55mm(H), 0.4mm pitch

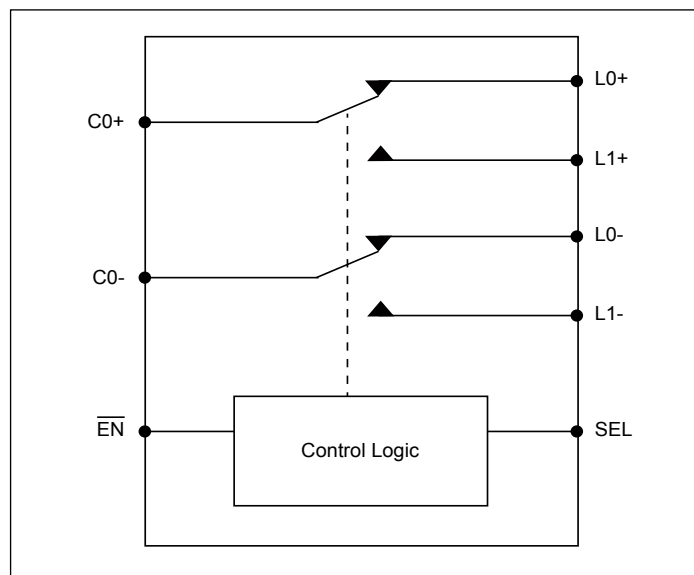
### Description

The PI3USB4000B is a 2-to-1 differential channel multiplexer/de-multiplexer switch. C0+/C0- pins can tolerate voltages up to 24V. Over-voltage protection (OVP) is implemented at 4.75V to immediately switch off the channels when over-voltage condition is detected. PI3USB4000B can pass USB2.0 signal with bandwidth 1GHz to maintain signal integrity and eye diagram open.

### Applications

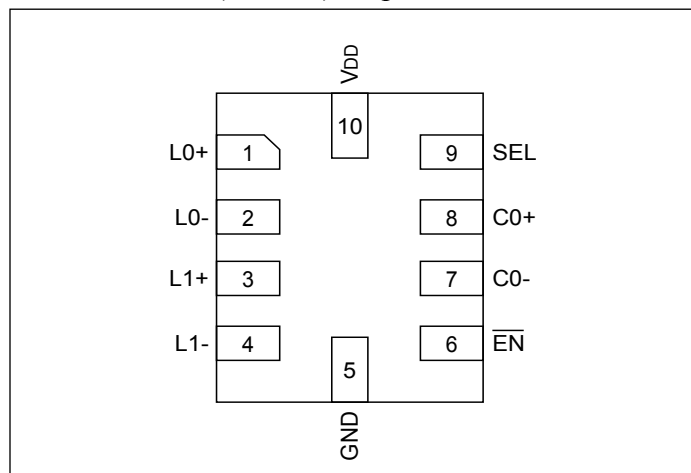
- Smart Phone, type-c application, Tablets, NB, PC

### Block Diagram

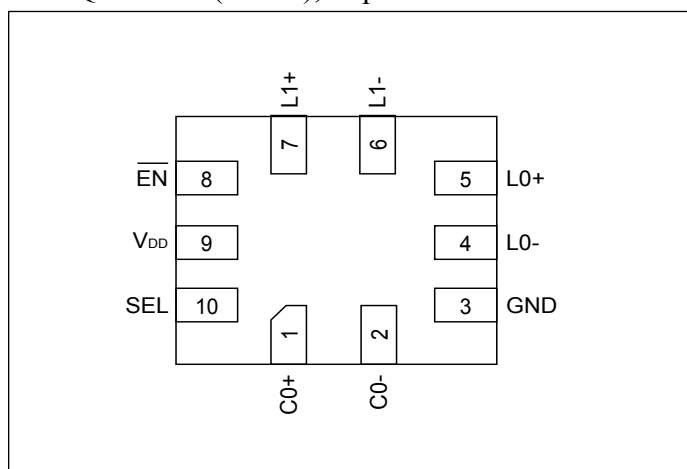


## Pin Configuration

10-UQFN Pin# (ZUA10), Top View



10-UQFN Pin# (ZM10), Top View



## Pin Description

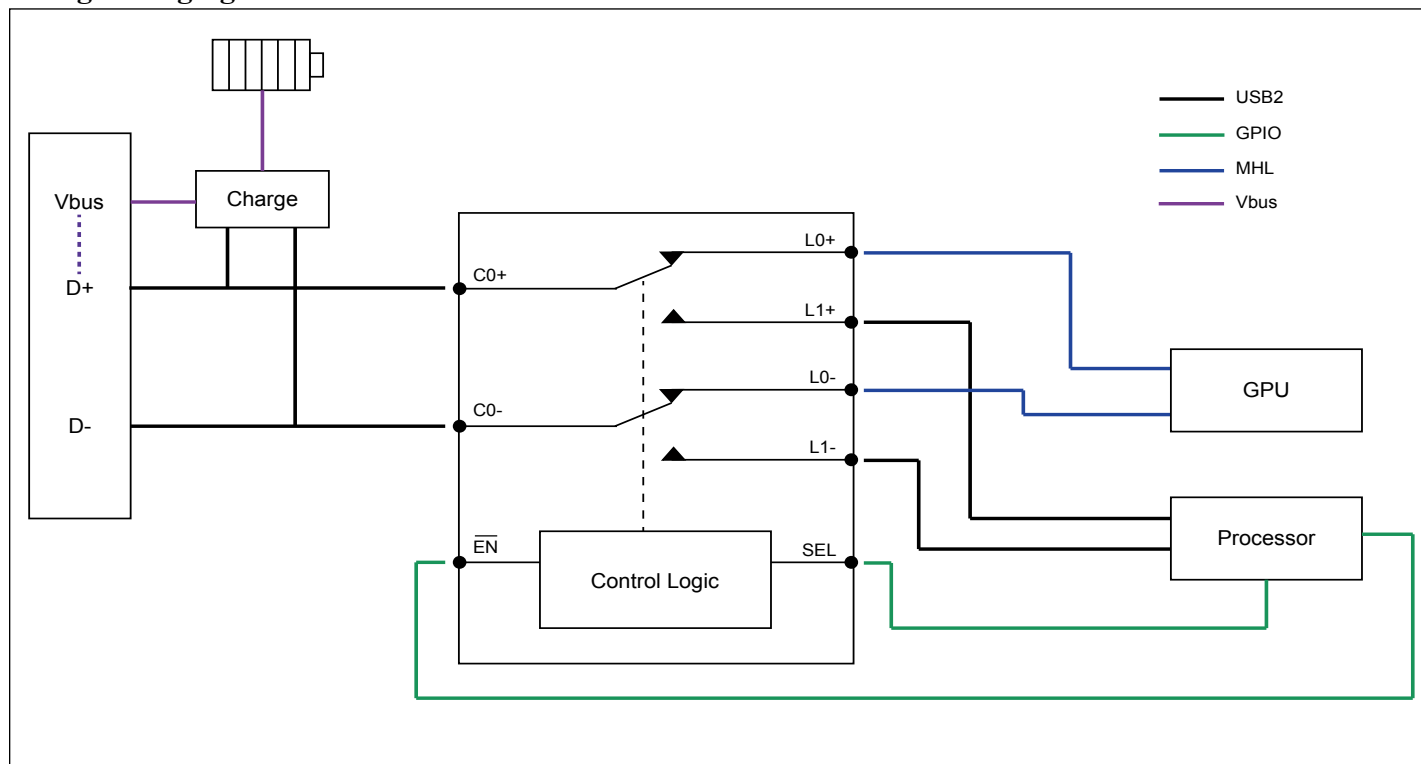
10-UQFN Pin# (ZUA10)	10-UQFN Pin# (ZM10)	Pin Name	Signal Type	Description
8, 7	1, 2	C0+, C0-	I/O	Signal I/O, Common Port
3, 4	7, 8	L1+, L1-	I/O	Signal I/O, Channel 1
1, 2	5, 4	L0+, L0-	I/O	Signal I/O, Channel 0
9	10	SEL	I	Operation mode Select (when SEL=0: C0→L0, when SEL=1: C0→L1)
6	8	$\overline{\text{EN}}$	I	$\overline{\text{EN}} = 1$ , Power down is enabled. Please see Truth Table.
10	9	VDD	Pwr	Positive Supply Voltage
5	3	GND	Pwr	Power ground

## Truth Table

Function	SEL	$\overline{\text{EN}}$
C0+/- to L0+/-	L	L
C0+/- to L1+/-	H	L
All Switches Hi-z	x	H

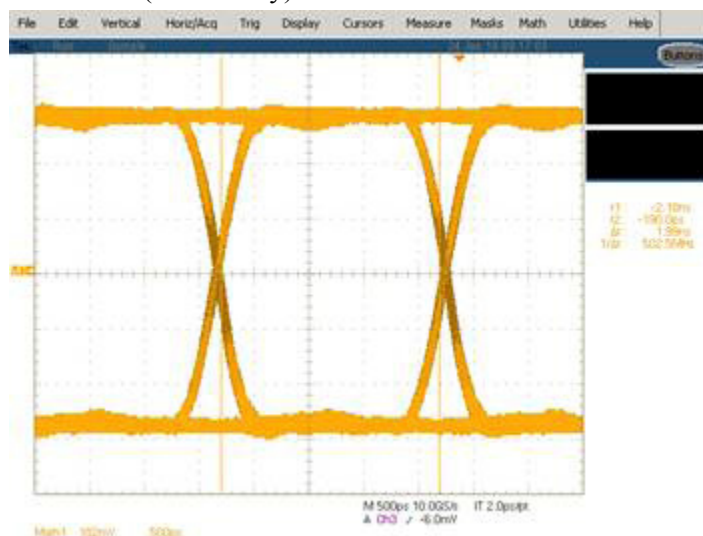
# PI3USB4000B

## PI3USB4000B application in MHL Switching and provide overvoltage protection for D+/- when high voltage charging

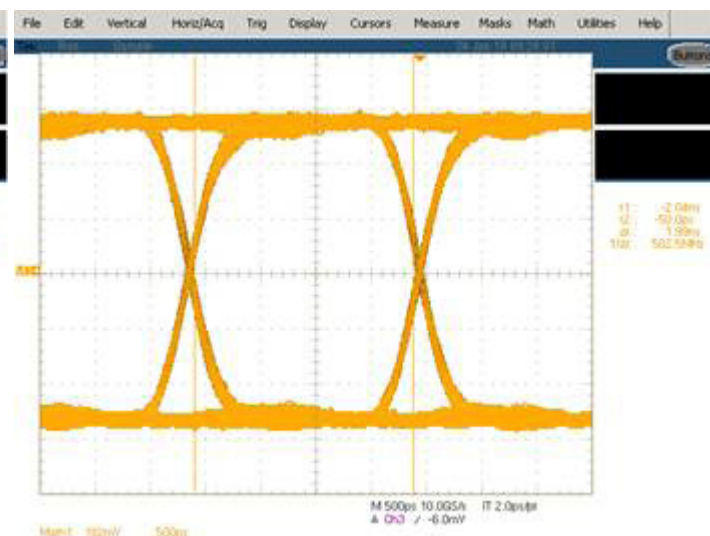


### USB2.0 High Speed (480Mbps) Eye Diagram

No Device (Trace Only)



With USB4000B



## Maximum Ratings

(Above which useful life may be impaired. For user guidelines, not tested.)

Storage Temperature .....	-65°C to +150°C
Supply Voltage (VDD) to Ground Potential .....	-0.3V to +9V
Channel Input/Output Voltage (Lx+/-) .....	-0.3V to +6V
Channel Input/Output Voltage (C0+/-) .....	-0.3V to +24V
Control Pins Input Voltage ( $\overline{\text{EN}}/\text{SEL}$ ) .....	-0.3V to +6V
ESD (All Pins).....	2KV (HBM) and 1KV (CDM)
Channel Input/Output Current (Lx/C0) .....	±50mA

### Note:

Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## Recommended Operating Conditions

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
V <sub>DD</sub>	Power Supply		2.7	3.3	6.0	V
V <sub>IO</sub>	Analog Voltage Range		0		5.5	V
V <sub>I</sub>	Voltage Range for Control Pins		0		5.5	V
I <sub>DD</sub>	Current Consumption in Normal Operation	V <sub>DD</sub> = 3.3V, V <sub>IO</sub> = 0V, SEL = GND or V <sub>DD</sub> , $\overline{\text{EN}}$ = Low		35	45	μA
I <sub>DD_OVP</sub>	Current Consumption in OVP	V <sub>DD</sub> = 3.3V, V <sub>C0+</sub> /V <sub>C0-</sub> = 5.5V, SEL = GND or V <sub>DD</sub> , $\overline{\text{EN}}$ = Low		35		μA
I <sub>DDQ</sub>	Chip Disabled Current Consumption	V <sub>DD</sub> = 3.3V, V <sub>IO</sub> = 0V, SEL = GND or V <sub>DD</sub> , $\overline{\text{EN}}$ = High		1	2	μA
T <sub>A</sub>	Operating Temperature Range		-40		85	°C

## DC Electrical Characteristics for Switching over Operating Range

(T<sub>A</sub> = -40°C to 85°C, Typical values are at V<sub>DD</sub> = 3.3V, T<sub>A</sub> = 25°C, (unless otherwise noted))

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
<b>Control Pins – <math>\overline{\text{EN}}/\text{SEL}</math></b>						
V <sub>IH</sub> - cntrl signals	Input HIGH Voltage for SEL and $\overline{\text{EN}}$	V <sub>DD</sub> = 2.7-5.5V	1.2			V
V <sub>IL</sub> - cntrl signals	Input LOW Voltage for SEL and $\overline{\text{EN}}$	V <sub>DD</sub> = 2.7-5.5V			0.6	V
I <sub>IH</sub>	Input HIGH Current for SEL and $\overline{\text{EN}}$	V <sub>I</sub> = 0-5.5V	-1		1	μA
I <sub>IL</sub>	Input LOW Current for SEL and $\overline{\text{EN}}$	V <sub>I</sub> = 0-5.5V	-1		1	μA
<b>High Speed IO – L0/L1/C0</b>						
V <sub>OVP</sub>	OVP trigger voltage		4.6	4.75	5.0	V
R <sub>on</sub>	ON resistance	V <sub>I/O</sub> = 0V, 0.4V, I <sub>on</sub> = -8 mA		5	8	Ω
Δ R <sub>on</sub>	On resistance between + and - channel	V <sub>I/O</sub> = 0V, 0.4V, I <sub>on</sub> = -8 mA		0.5	1	Ω
R <sub>on_Flat</sub>	ON resistance flatness	V <sub>I/O</sub> = 0V, 0.4V, I <sub>on</sub> = -8 mA		0.2	0.5	Ω
I <sub>off</sub>	Power-off leakage	V <sub>DD</sub> = 0V, V <sub>I/O</sub> = 0 - 3.6V	-1		1	μA
I <sub>OC</sub>	Channel off leakage current	$\overline{\text{EN}}$ = V <sub>DD</sub> = 3.3V, V <sub>I/O</sub> = 0-3.6V	-1		1	μA
I <sub>ON</sub>	Channel on leakage current	$\overline{\text{EN}}$ = 0V, V <sub>DD</sub> = 3.3V, V <sub>I/O</sub> = 0-3.6V	-1		1	μA
I <sub>OVP</sub>	Leakage current on C0+/C0- in OVP mode	$\overline{\text{EN}}$ = 0V, V <sub>DD</sub> = 3.3V, V <sub>C0+</sub> or V <sub>C0-</sub> = 20V		3	15	μA
Z <sub>ON_GND</sub>	On-State impedance to GND	$\overline{\text{EN}}$ = low, SEL = H or L V <sub>I/O</sub> = 0-18V	5	7		MΩ

## Dynamic Electrical Characteristics

( $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Typical values are at  $V_{DD} = 3.3\text{V}$ ,  $T_A = 25^{\circ}\text{C}$ , (unless otherwise noted))

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
<b>Control Pins – <math>\overline{\text{EN}}/\text{SEL}</math></b>						
$C_I$	Input capacitance	$f=1\text{MHz}$		5		pF
<b>High Speed IO – L0/L1/C0</b>						
Con	ON Capacitance	$f=1\text{MHz}$		7		pF
Coff	OFF Capacitance	$f=1\text{MHz}$		9		pF
DDIL	Insertion Loss	$f=240\text{MHz}$		-0.5		dB
DDRL	Differential Return Loss	$f=240\text{MHz}$		-15		dB
DDOI	Differential OFF Isolation	$f=240\text{MHz}$		-30		dB
		$f=100\text{kHz}$		-80		dB
DDXT	Differential Crosstalk	$f=240\text{MHz}$		-35		dB
BW	-3dB Bandwidth			1		GHz

## Switching Characteristics<sup>(1)</sup>

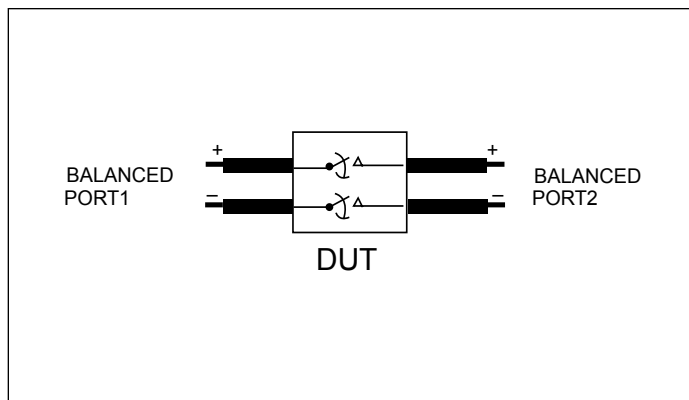
( $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Typical values are at  $V_{DD} = 3.3\text{V}$ ,  $T_A = 25^{\circ}\text{C}$ , (unless otherwise noted))

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
$t_{OVP}$	OVP Response Time <sup>(1)</sup>	$R_{LX} = 600\Omega$ , time from the voltage on $C0\pm = 4\sim 6\text{V}$ to the voltage on $LX\pm = 4.75$		0.5	1	$\mu\text{s}$
$t_{PZH}, t_{PZL}$	Line Enable Time	See Test Circuit for Electrical Characteristics		20		$\mu\text{s}$
$t_{PHZ}, t_{PLZ}$	Line Disable Time			50		ns
$t_{pd}$	Propagation Delay			250		ps
$t_{b-b}$	Bit-to-bit Skew Within the Same Differential Pair <sup>(1)</sup>			8	20	ps
$T_{on}$	Device Enable Time			100		$\mu\text{s}$
$T_{off}$	Device Disable Time			50		ns

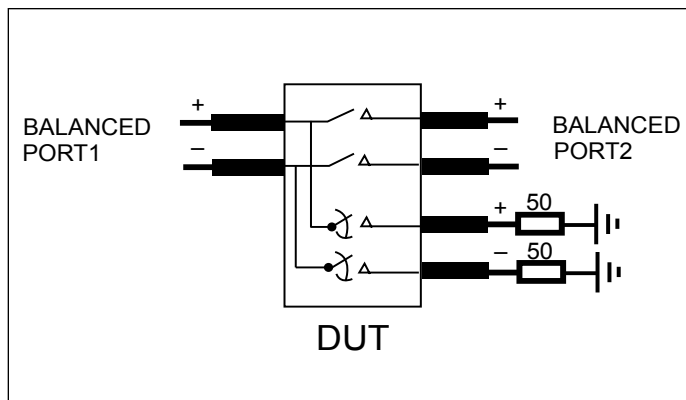
### Note:

1. Guaranteed by design.

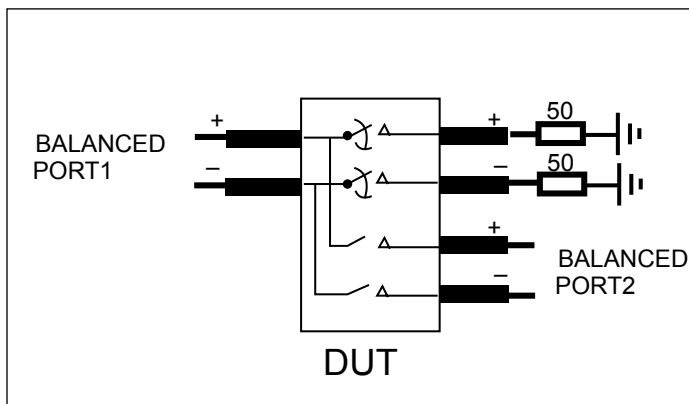
**PI3USB4000B**



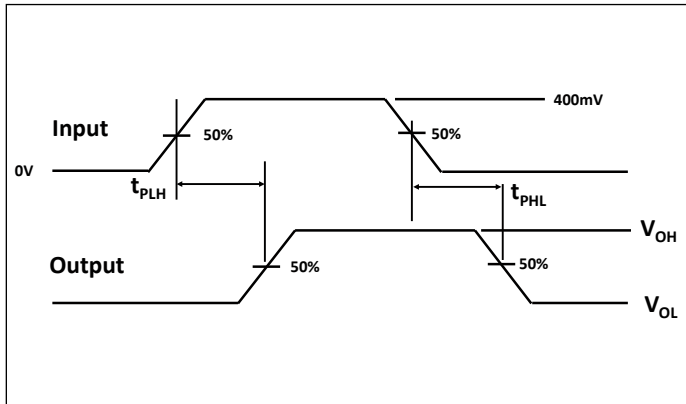
**Fig 1. Differential Insertion Loss Setup**



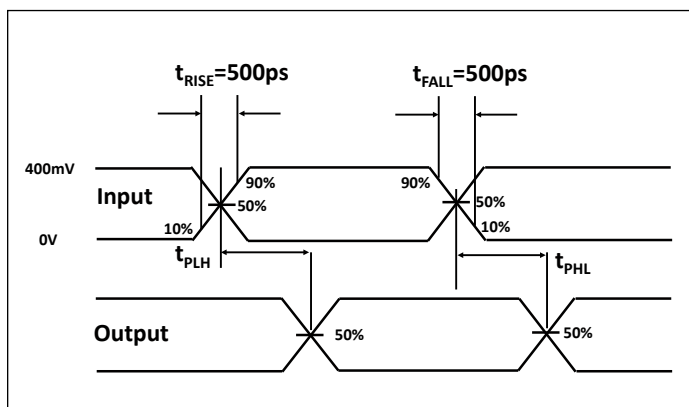
**Fig 2. Off-isolation Setup**



**Fig 3. Crosstalk Setup**

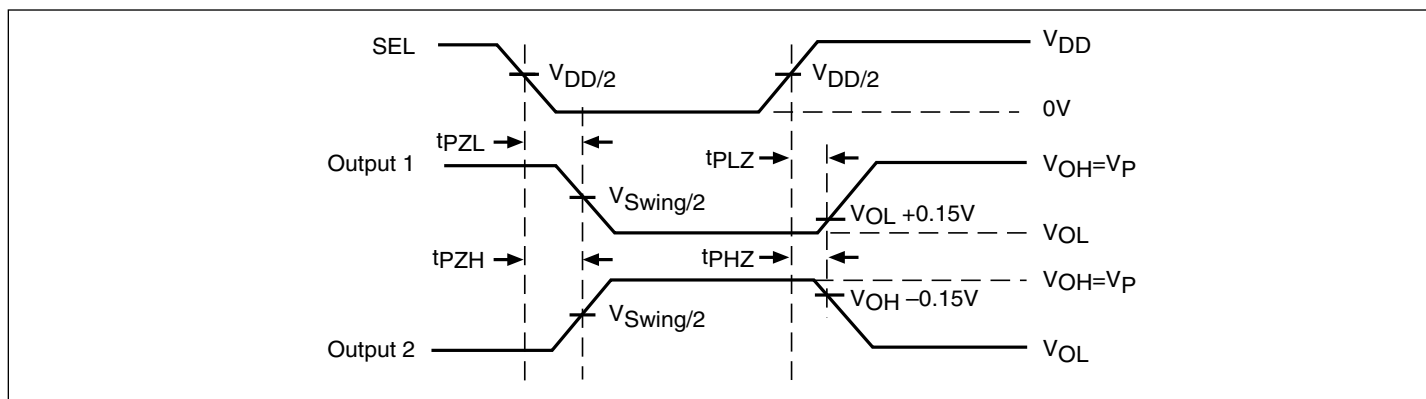


**Fig 4. Propagation Delay**



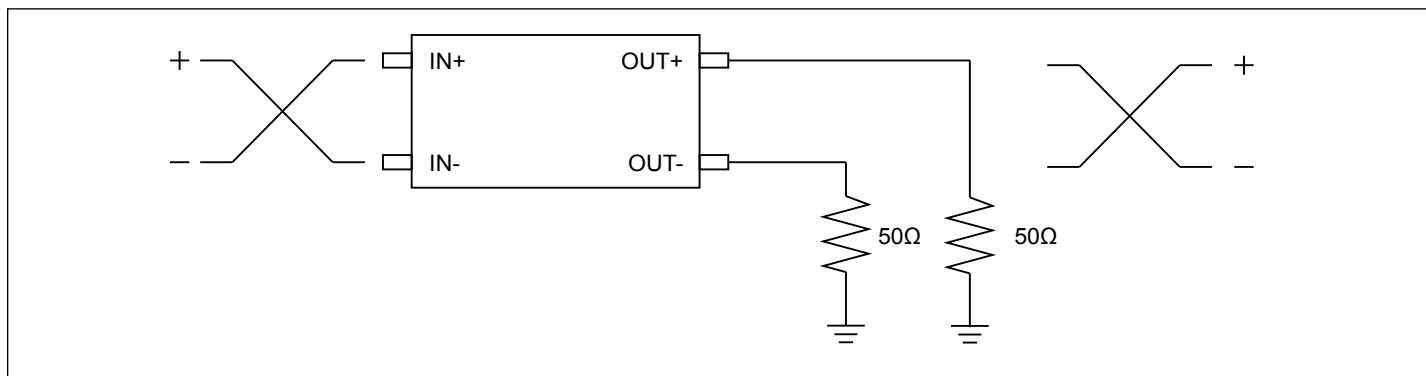
**Fig 5. Skew Test**

## Switching Waveforms



Voltage Waveforms Enable and Disable Times

## Test Circuit for Propagation Delay



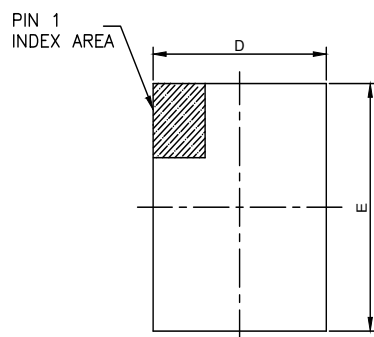
## Part Marking

ZUA Package and ZM Package

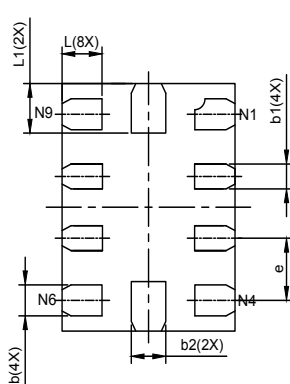
Top mark not available at this time. To obtain advance information regarding the top mark, please contact your local sales representative.

**PI3USB4000B**

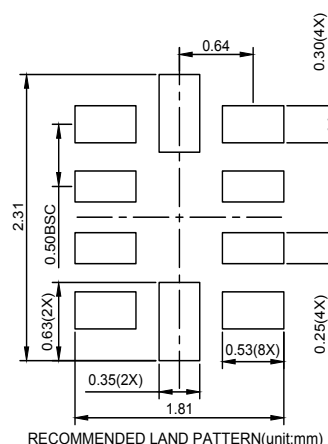
## Packaging Mechanical: 10-UQFN (ZUA)



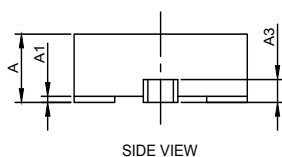
TOP VIEW



BOTTOM VIEW



RECOMMENDED LAND PATTERN(unit:mm)



SIDE VIEW

PKG. DIMENSIONS(MM)			
SYMBOL	Min	NOM	Max
A	0.50	0.60	0.65
A1	0.00	0.02	0.05
A3	0.15 REF		
D	1.45	1.50	1.55
E	1.95	2.00	2.05
b	0.20	0.25	0.30
b1	0.15	0.20	0.25
b2	0.25	0.30	0.35
e	0.50 BSC		
L	0.25	0.35	0.45
L1	0.30	0.40	0.50

**Notes:**

1. Ref: JEDEC MO-288B.

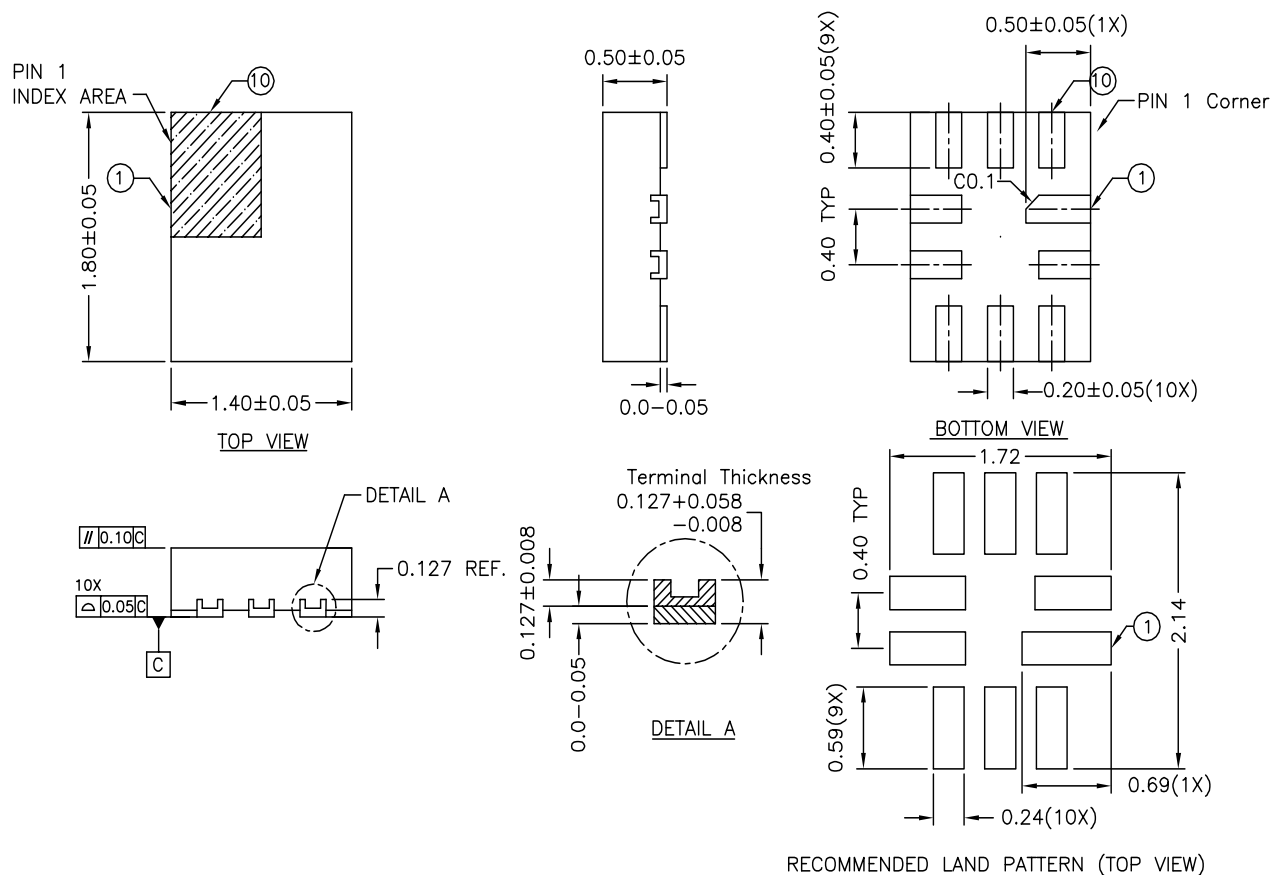
DESCRIPTION: 10-Pin, UQFN, 1.5X2.0

PACKAGE CODE: ZUA(ZUA10)

DOCUMENT CONTROL#: PD-2220

REVISION: --



**PI3USB4000B**
**Packaging Mechanical: 10-UQFN (ZM)**

**NOTE :**

1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
3. REFER JEDEC MO-236/MO-248
4. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.



DATE: 01/29/09

**DESCRIPTION: 10-contact, Ultra-thin Quad Flat No-Lead (UQFN)**
**PACKAGE CODE: ZM10**
**DOCUMENT CONTROL #: PD-2066**
**REVISION: A**

09-0072

**For latest package info.**

 please check: <http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/>
**Ordering Information**

Ordering Code	Package Code	Package Description
PI3USB4000BZUAEX	ZUA	10-Pin, 1.5x2.0 (UQFN)
PI3USB4000BZMEX	ZM	10-contact, Ultra-thin Quad Flat No-Lead (UQFN)

**Notes:**

1. EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant. All applicable RoHS exemptions applied.
2. See <http://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free. Thermal characteristics can be found on the company web site at [www.diodes.com/design/support/packaging/](http://www.diodes.com/design/support/packaging/)
3. E = Pb-free and Green
4. X suffix = Tape/Reel

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