

## 4.2V, Wide Bandwidth, 2-Channel, 2:1 Mux/DeMux USB 2.0 Switch w/ Single Select

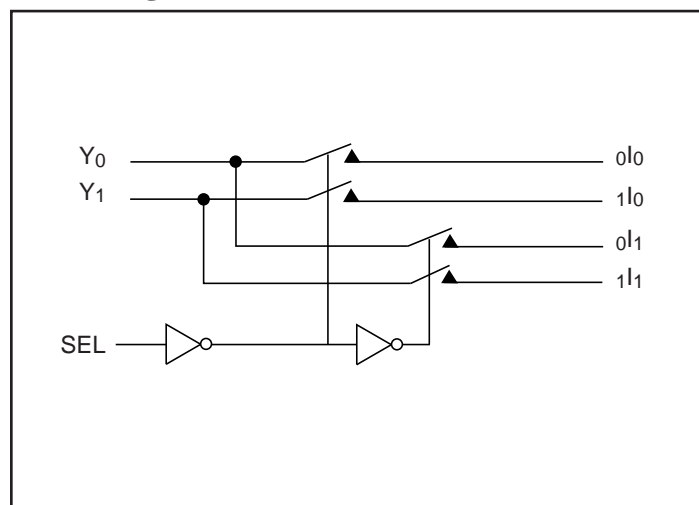
### Features

- USB 2.0 compliant
- $R_{ON}$  is  $4\Omega$  typical
- Low bit-to-bit skew
- Low Crosstalk:  $-31\text{dB}$  @ 250 MHz
- Near-Zero propagation delay: 250ps
- Switching speed: 9ns
- Channel On Capacitance: 6pF (typical)
- $V_{DD}$  Operating Range: 2.7V to 5.0V
- ESD  $>2000\text{V}$  . . . Human Body Model
- $>700$  MHz bandwidth (or data frequency)
- Packaging (Pb-free & Green):
  - 12-contact, 1.6mm x 2.2mm, TQFN (ZK12)
  - 12-contact, 3mm x 3.5mm, TDFN (ZE12)

### Application

- Routes signals for USB 2.0
- Hand held devices

### Block Diagram



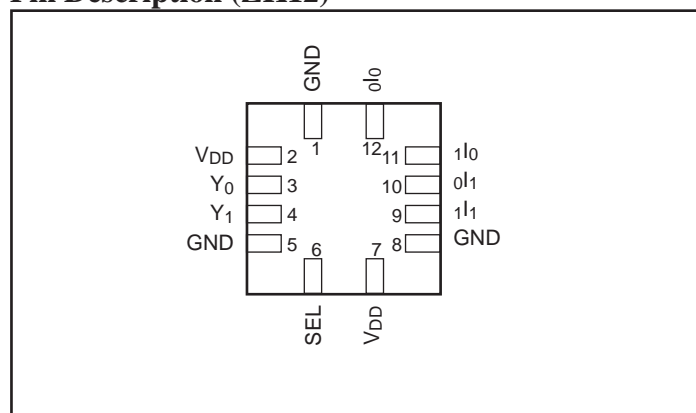
### Truth Table

Function	SEL
$Y_n$ to $nI_o$	L
$Y_n$ to $nI_1$	H

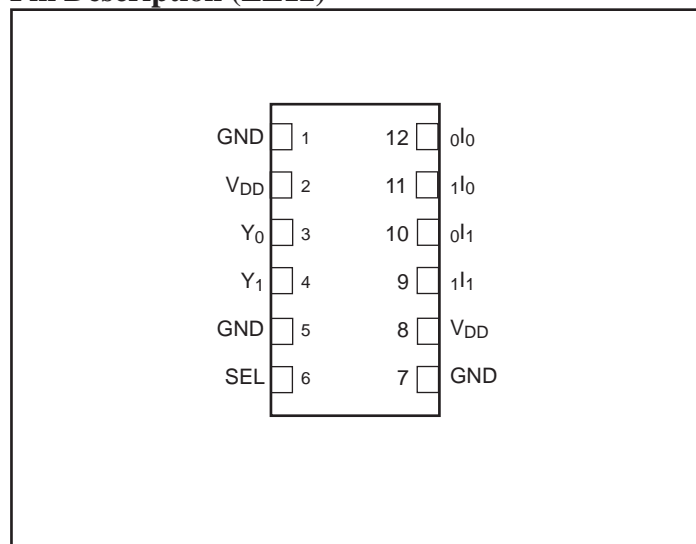
### Description

The PI3USB10M is a single differential channel 2:1 multiplexer/demultiplexer USB 2.0 Switch. Industry leading advantages include a propagation delay of less than 250ps, resulting from its low channel resistance and I/O capacitance. The device multiplexes differential outputs from a USB Host device to one of two corresponding outputs. The switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. It is designed for low bit-to-bit skew, high channel-to-channel noise isolation and is compatible with various standards, such as High Speed USB 2.0 (480 Mb/s).

### Pin Description (ZK12)



### Pin Description (ZE12)



### Maximum Ratings

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

Storage Temperature .....	-65°C to +150°C
Supply Voltage to Ground Potential .....	-0.5V to +5.25V
DC Input Voltage .....	-0.5V to +5.5V
DC Output Current .....	120mA
Power Dissipation .....	0.5W

**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.

### DC Electrical Characteristics for USB 2.0 Switching over Operating Range

(T<sub>A</sub> = -40°C to +85°C, V<sub>DD</sub> = 3.0V – 4.4V)

Parameter	Description	Test Conditions <sup>(1)</sup>		Min.	Typ. <sup>(2)</sup>	Max.	Units
V <sub>IH</sub>	Input HIGH Voltage	Guaranteed HIGH level	V <sub>DD</sub> = 4.2V	2.0			V
			V <sub>DD</sub> = 3.3V	1.6			
V <sub>IL</sub>	Input LOW Voltage	Guaranteed HIGH level				0.8	
V <sub>IK</sub>	Clamp Diode Voltage	V <sub>DD</sub> = Max., I <sub>IN</sub> = -18mA			-0.7	-1.2	
I <sub>IH</sub>	Input HIGH Current	V <sub>DD</sub> = Max., V <sub>IN</sub> = V <sub>DD</sub>				±5	µA
I <sub>IL</sub>	Input LOW Current	V <sub>DD</sub> = Max., V <sub>IN</sub> = GND				±5	
R <sub>ON</sub>	Switch On-Resistance <sup>(3)</sup>	V <sub>DD</sub> = Min., 1.25V ≤ V <sub>IN</sub> ≤ V <sub>DD</sub> , I <sub>IN</sub> = -40mA			4.0	6.5	Ω
R <sub>FLAT(ON)</sub>	On-Resistance Flatness <sup>(3)</sup>	V <sub>DD</sub> = Min., V <sub>IN</sub> @ 1.5V and V <sub>DD</sub> I <sub>IN</sub> = -40mA			1.0		
ΔR <sub>ON</sub>	On-Resistance match from center ports to any other port <sup>(3)</sup>	V <sub>DD</sub> = Min., 1.5V ≤ V <sub>IN</sub> ≤ V <sub>DD</sub> , I <sub>IN</sub> = -40mA			0.9	2.0	

#### Notes:

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- V<sub>DD</sub> = 3.0 - 4.4V, T<sub>A</sub> = 25°C ambient and maximum loading.
- Measured by the voltage drop between Y and In pin at indicated current through the Switch-On-Resistance is determined by the lower of the voltages on the two (Y, In) pins.

### Power Supply Characteristics (V<sub>DD</sub> = 3.0 - 4.4V)

Parameters	Description	Test Conditions <sup>(1)</sup>	Min.	Typ.	Max.	Units
I <sub>DD</sub>	Quiescent Power Supply Current	V <sub>DD</sub> = Max., V <sub>IN</sub> = GND or V <sub>DD</sub>			800	µA

#### Notes:

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

**DC Electrical Characteristics for USB 2.0 Switching over Operating Range**
 $(T_A = -40^{\circ}\text{C to } +85^{\circ}\text{C}, V_{DD} = 5.0\text{V})$ 

Parameter	Description	Test Conditions <sup>(1)</sup>		Min.	Typ. <sup>(2)</sup>	Max.	Units
$V_{IH}$	Input HIGH Voltage	Guaranteed HIGH level	$V_{DD} = 4.2\text{V}$	2.0			V
			$V_{DD} = 3.3\text{V}$	1.6			
$V_{IL}$	Input LOW Voltage	Guaranteed HIGH level				0.8	
$V_{IK}$	Clamp Diode Voltage	$V_{DD} = \text{Max.}, I_{IN} = -18\text{mA}$			-0.7	-1.2	
$I_{IH}$	Input HIGH Current	$V_{DD} = \text{Max.}, V_{IN} = V_{DD}$				$\pm 5$	$\mu\text{A}$
$I_{IL}$	Input LOW Current	$V_{DD} = \text{Max.}, V_{IN} = \text{GND}$				$\pm 5$	
$R_{ON}$	Switch On-Resistance <sup>(3)</sup>	$V_{DD} = \text{Min.}, 1.25\text{V} \leq V_{IN} \leq V_{DD}, I_{IN} = -40\text{mA}$			4.0	6.5	$\Omega$
$R_{FLAT(ON)}$	On-Resistance Flatness <sup>(3)</sup>	$V_{DD} = \text{Min.}, V_{IN} @ 1.5\text{V and } V_{DD} I_{IN} = -40\text{mA}$			1.0		
$\Delta R_{ON}$	On-Resistance match from center ports to any other port <sup>(3)</sup>	$V_{DD} = \text{Min.}, 1.5\text{V} \leq V_{IN} \leq V_{DD}, I_{IN} = -40\text{mA}$			0.9	2.0	

**Notes:**

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- $V_{DD} = 3.0 - 4.4\text{V}$ ,  $T_A = 25^{\circ}\text{C}$  ambient and maximum loading.
- Measured by the voltage drop between Y and In pin at indicated current through the Switch-On-Resistance is determined by the lower of the voltages on the two (Y, In) pins.

**Power Supply Characteristics ( $V_{DD} = 5.0\text{V}$ )**

Parameters	Description	Test Conditions <sup>(1)</sup>	Min.	Typ.	Max.	Units
$I_{DD}$	Quiescent Power Supply Current	$V_{DD} = \text{Max.}, V_{IN} = \text{GND or } V_{DD}$			800	$\mu\text{A}$

**Notes:**

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

**Capacitance** ( $T_A = 25^\circ\text{C}$ ,  $f = 1\text{MHz}$ )

Parameters <sup>(3)</sup>	Description	Test Conditions <sup>(1)</sup>	Typ. <sup>(2)</sup>	Max.	Units
$C_{IN}$	Input Capacitance	$V_{IN} = 0\text{V}$	2	3	pF
$C_{OFF}$	Port I Capacitance, Switch OFF		4	6	
$C_{ON}$	Switch Capacitance, Switch ON		7.5	9.5	

**Dynamic Electrical Characteristics Over the Operating Range**

Parameters	Description	Test Conditions	Min.	Typ. <sup>(2)</sup>	Max.	Units
$X_{TALK}$	Crosstalk	$R_L = 50\Omega$ , $f = 250\text{MHz}$		-31		dB
$O_{IRR}$	OFF Isolation			-39		
BW	Bandwidth -3dB	$R_L = 50\Omega$		700		MHz

**Notes:**

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at  $V_{DD} = 3.3\text{V}$ ,  $T_A = 25^\circ\text{C}$  ambient and maximum loading.
- This parameter is determined by device characterization but is not production tested.

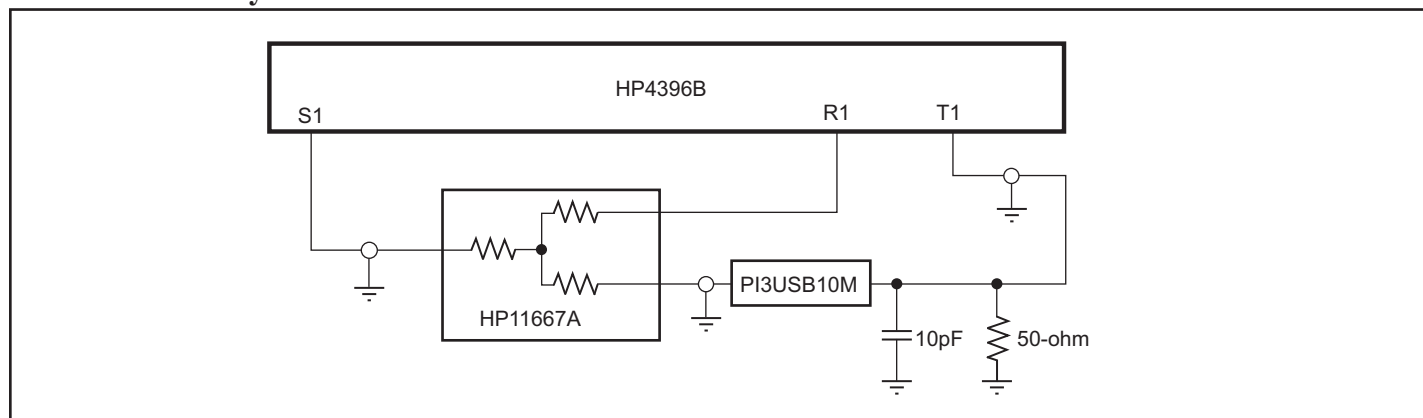
**Switching Characteristics** ( $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $V_{DD} = 3.0\text{V}$  to  $4.4\text{V}$ )

Parameters	Description	Test <sup>(1)</sup> Conditions	Min.	Typ.	Max.	Units
$t_{PD}$	Propagation Delay <sup>(2,3)</sup>	See Test Circuit for Electrical Characteristics		0.15		ns
$t_{PZH}$ , $t_{PZL}$	Line Enable Time - SEL to $Y_N$ , $NI_0$ , $I_N$		0.5		15.0	
$t_{PHZ}$ , $t_{PLZ}$	Line Disable Time - SEL to $Y_N$ , $NI_0$ , $I_N$		0.5		9.0	
$t_{SKC-C}$	Output skew, channel-to-channel <sup>(2)</sup>			3.5	14	ps
$t_{SKb-b}$	Output skew, bit-to-bit (opposite transition of the same output ( $t_{PHL}$ - $t_{PLH}$ ) <sup>(2)</sup> )			7.5	20	

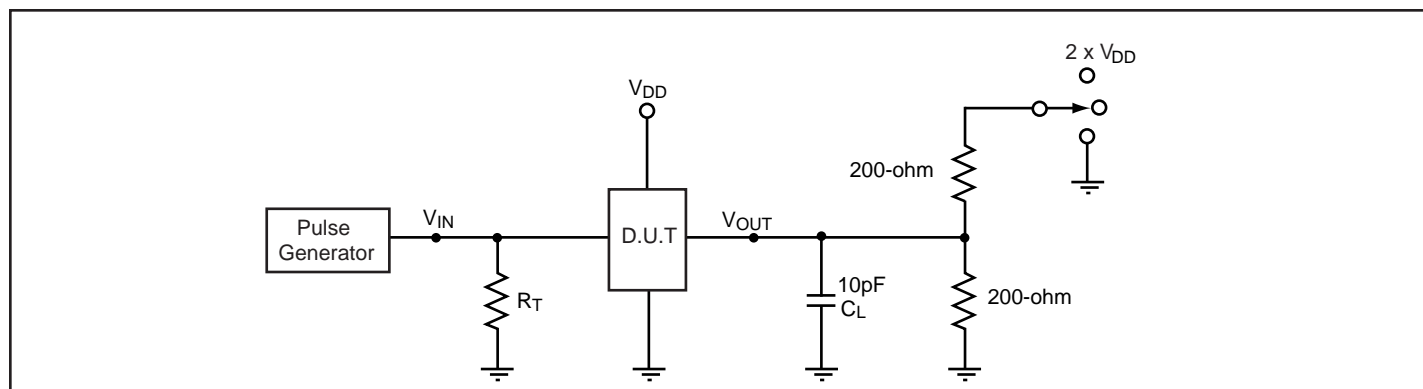
**Notes:**

- For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Guaranteed by design.
- The switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25ns for 10pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, it adds very little propagational delay to the system. Propagational delay of the USB switch when used in a system is determined by the driving circuit on the driving side of the switch and its interactions with the load on the driven side.

### Test Circuit for Dynamic Electrical Characteristics



### Test Circuit for Electrical Characteristics



#### Notes:

$C_L$  = Load capacitance: includes jig and probe capacitance.

$R_T$  = Termination resistance: should be equal to  $Z_{OUT}$  of the Pulse Generator

Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control.

Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.

All input impulses are supplied by generators having the following characteristics:  $PRR \leq \text{MHz}$ ,  $Z_O = 50\Omega$ ,  $t_R \leq 2.5\text{ns}$ ,  $t_F \leq 2.5\text{ns}$ .

The outputs are measured one at a time with on transition per measurement.

### Switch Positions

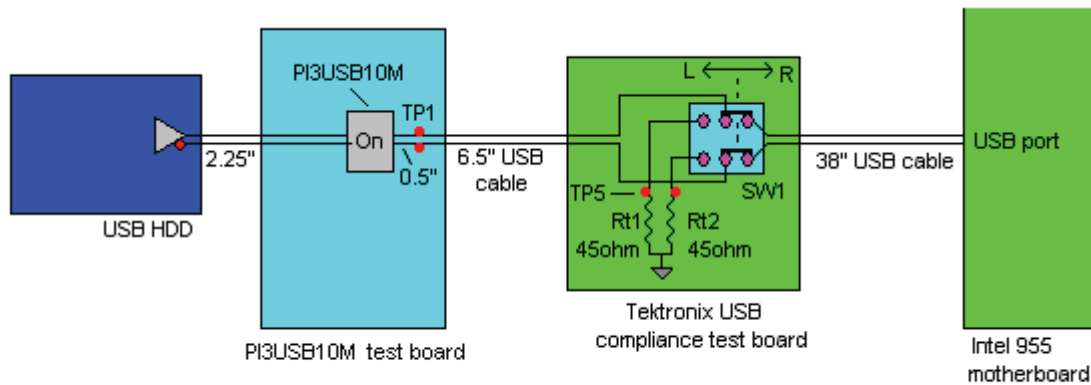
Test	Switch
$t_{PLZ}$ , $t_{PZL}$ (output on I-side)	$2 \times V_{DD}$
$t_{PHZ}$ , $t_{PZH}$ (output on I-side)	GND
Prop Delay	Open

## Application Information

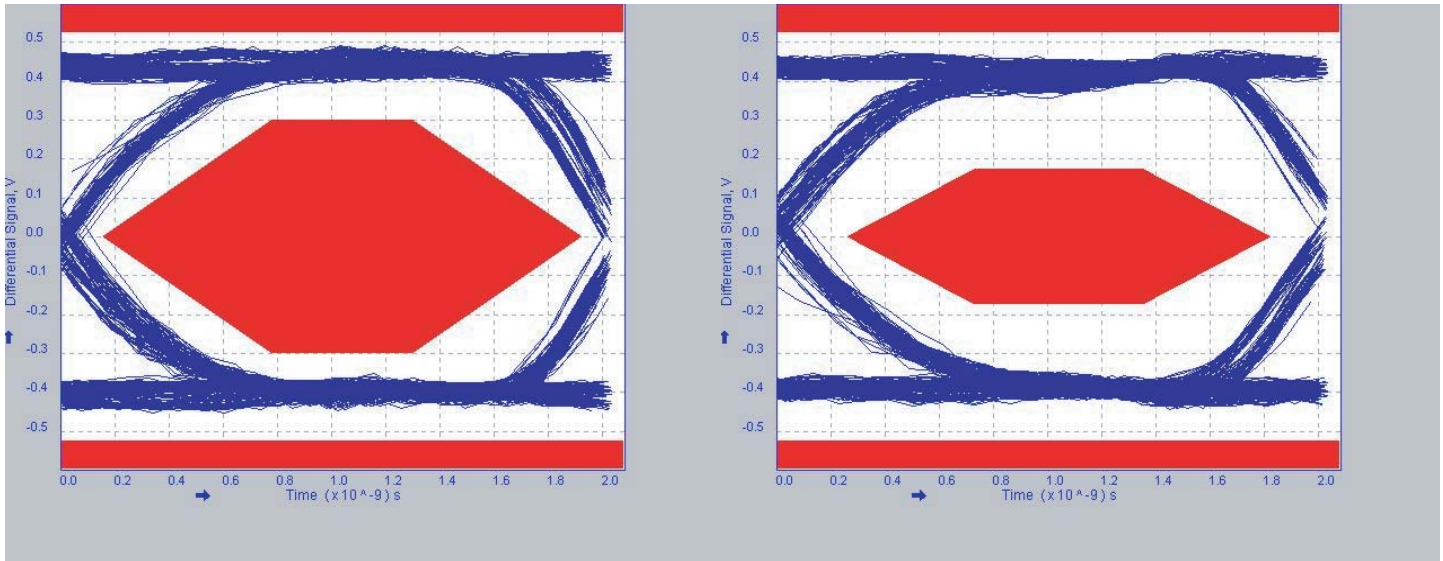
### Logic Inputs

The logic control inputs can be driven up to +3.6V regardless of the supply voltage. For example, given a +3.3V supply, the output enables or select pins may be driven low to 0V and high to 3.6V. Driving IN Rail-to-Rail® minimizes power consumption.

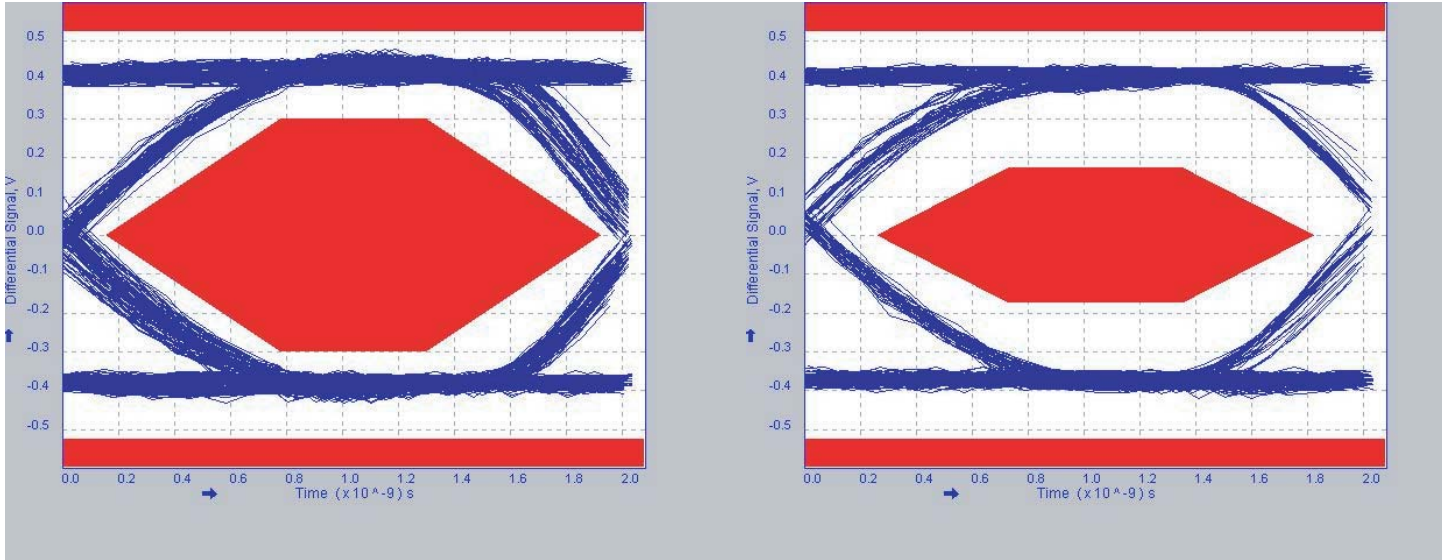
*Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd*



**Figure 1: USB 2.0 High-Speed (480Mbps) Signal Integrity Test Setup**

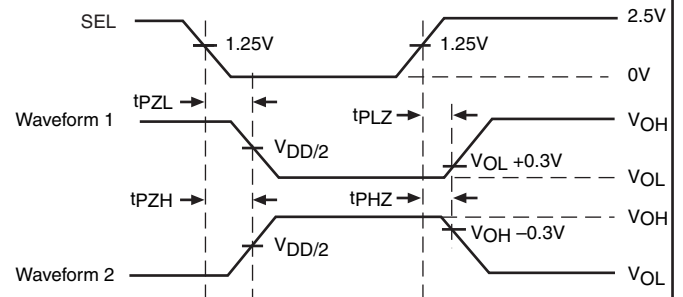
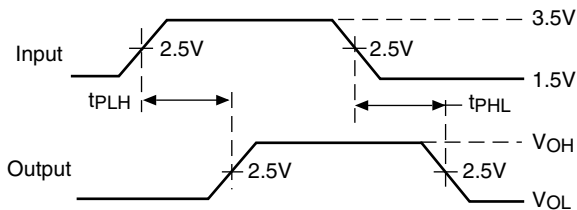


**Figure 2: USB 2.0 High-Speed (480Mbps) TP1, left eye, and TP5, right eye, tested with no PI3USB10M in the signal path**

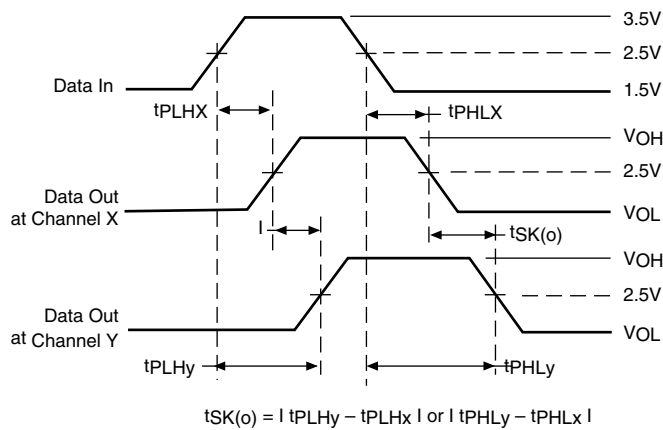


**Figure 3: USB 2.0 High-Speed (480Mbps) TP1, left eye, and TP5, right eye, tested with PI3USB10M data signals connected**

## Switching Waveforms

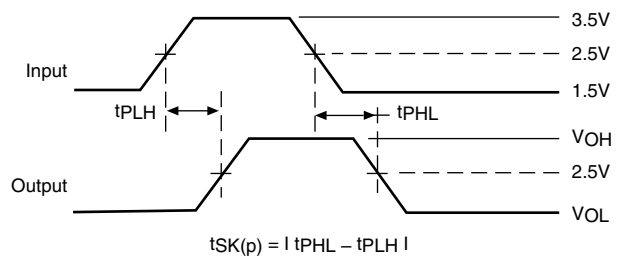


## Voltage Waveforms Propagation Delay Times



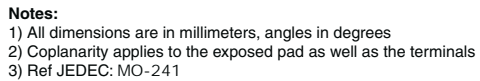
### Output Skew - $t_{SK(o)}$

## Voltage Waveforms Enable and Disable Times



### Pulse Skew - $t_{SK(p)}$





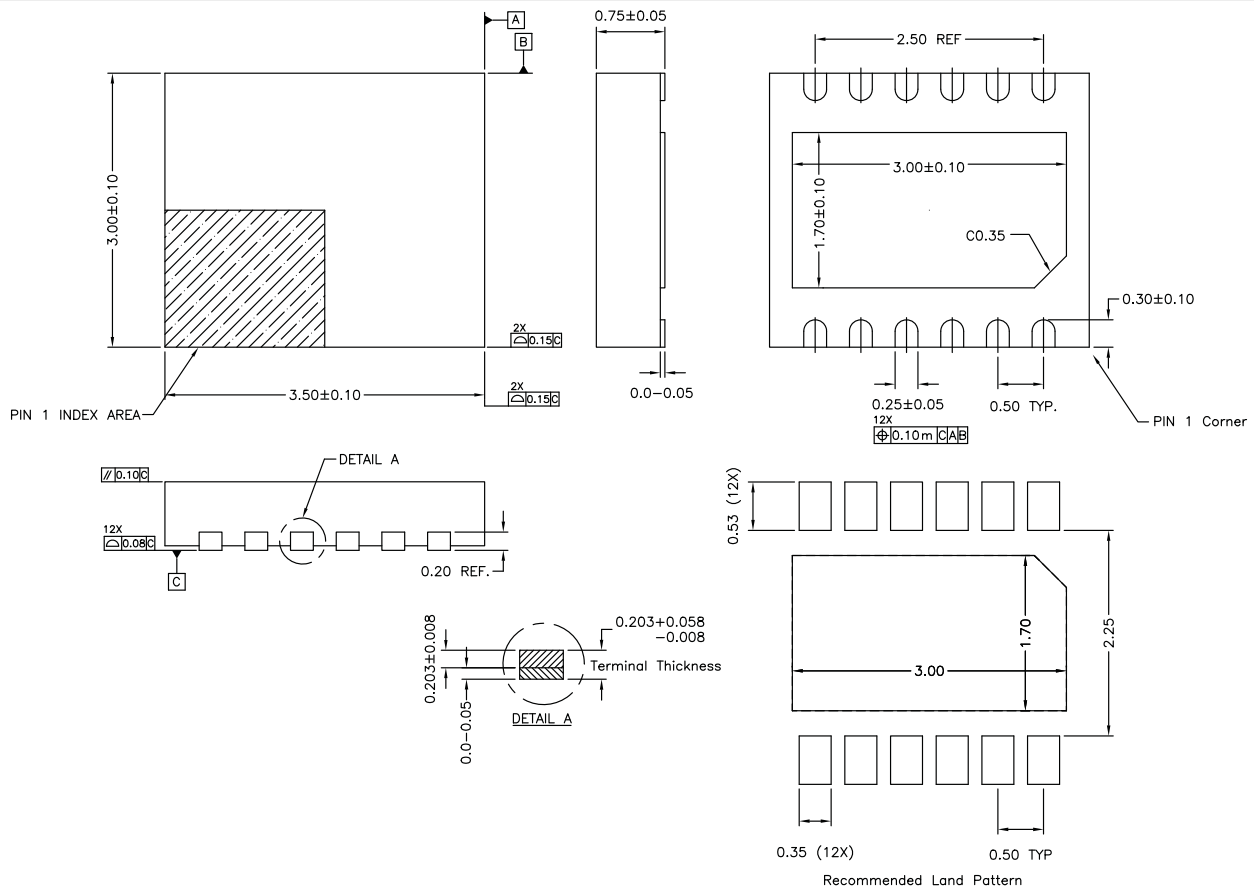
DATE: 04/19/06

**DESCRIPTION:** 12-contact, Thin Quad Flat No Lead (TQFN)

**PACKAGE CODE: ZK12**

DOCUMENT CONTROL #: PD-2059

**REVISION: -**


**Notes:**

- 1) All dimensions are in millimeters, angles in degrees
- 2) Coplanarity applies to the exposed pad as well as the terminals
- 3) Ref JEDEC: MO-229C/WFED-2


**DATE: 04/18/06**
**DESCRIPTION: 12-contact, Very Thin Fine Pitch Dual Flat No Lead (TDFN)**
**PACKAGE CODE: ZE12**
**DOCUMENT CONTROL #: PD-2022**
**REVISION: B**
**Ordering Information**

Ordering Code	Package Code	Package Description	Top Marking
PI3USB10MZKE	ZK	Pb-free & Green, 12-contact TQFN	UM
PI3USB10MZEE	ZE	Pb-free & Green, 12-contact TDFN	YK

**Notes:**

- Thermal characteristics can be found on the company web site at [www.pericom.com/packaging/](http://www.pericom.com/packaging/)
- E = Pb-free and Green
- Adding an X suffix = Tape/Reel