

## USB3.1, USB3.0 and USB2.0 Combo Switch

### Features

- 1:2 mux/demux for USB 3.1 Enhanced SS, USB 3.0 SS, 2.0HS, and 2.0FS signals
- Switches Tx, Rx, and Dx from USB3.0 connector
- Suitable for DisplayPort, PCIe Gen1/2/3, SATA 1.5/3/6G, SAS 1.5/3/6G and XAUI applications.
- -3dB bandwidth for enhanced superspeed channel: 10.6GHz
- Insertion Loss for enhanced superspeed channels @ 5.0 GHz: -1.5dB
- Insertion Loss for superspeed channels @ 2.5 GHz: -0.9dB
- Return loss for enhanced superspeed channels @ 5.0 GHz: -19.6dB
- Return Loss for superspeed channels @ 2.5 GHz: -26.4dB
- Low Bit-to-Bit Skew, 5ps typ(between '+' and '-' bits)
- Low Crosstalk for enhanced superspeed channels: -31.1dB @ 5.0 GHz
- Low Crosstalk for superspeed channels @2.5GHz: -33.3dB
- Low Off Isolation for enhanced superspeed channels: -17.4dB @ 5.0 GHz
- Low Off Isolation for superspeed channels @ 2.5GHz: -24.9dB
- Insertion Loss for USB – HS: -0.67dB @ 480Mbps
- Crosstalk for USB – HS: -33dB @ 480Mbps
- Off Isolation fo USB – HS: -30dB @ 480Mbps
- -3dB for USB – HS: 1.4 GHz
- V<sub>DD</sub> Operating Range: 3.3V +/-10%
- ESD Tolerance: 2kV HBM
- Low channel-to-channel skew, 7ps typ
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. “Green” Device (Note 3)
- For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](mailto:contact@diodes.com) or your local Diodes representative. <https://www.diodes.com/quality/product-definitions/>
- Packaging (Pb-free & Green):
  - 32 TQFN (ZL) 3mm x 6mm x 0.75mm, 0.4mm pitch

### Description

The PI3USB32212 USB3.1, USB3.0 and USB2.0 Combo Switch is a complete 1:2 switching solution for Enhanced SuperSpeed USB 3.1 signals. PI3USB32122 provides differential high-speed lanes for the USB3.1 10Gbps, USB3.0 5Gbps TX and RX lanes as well as a differential lane for 480 Mbps USB 2.0 signals.

PI3USB32212 can be used to connect two hosts to a single device or a single host to two devices.

PI3USB32212 offers excellent signal integrity for high-speed signals and low power dissipation. Insertion loss is -1.3dB and return loss is -19dB at 5 GHz (USB3.1). Insertion loss is -0.77dB and return loss is -27.8db at 2.5GHz (USB3.0).

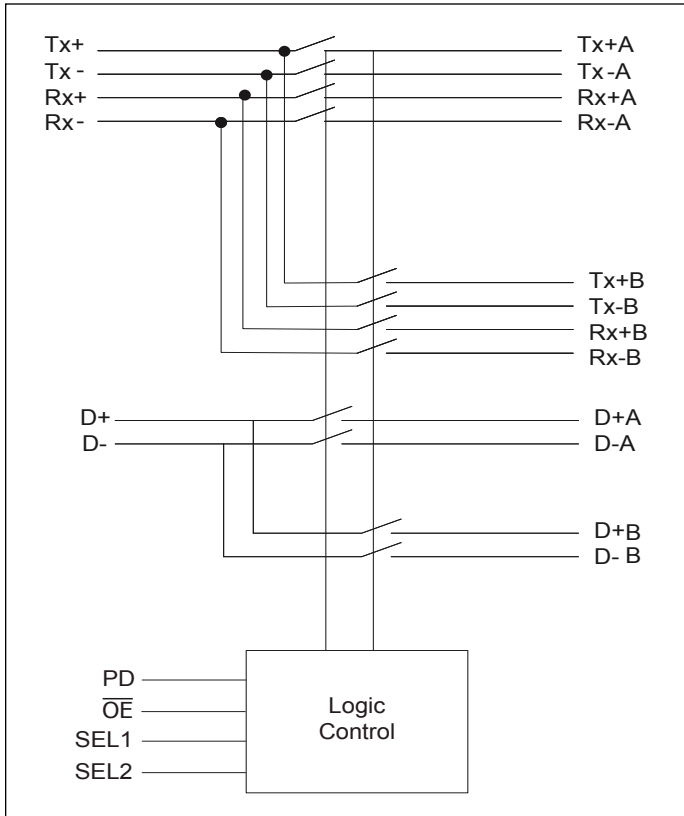
### Application

Routing of USB3.1/3.0/2.0 signals with low signal attenuation between source and sink. Applicable products include desktop PC, Notebook PC, Tablet, Docking, Telecom, DTV.

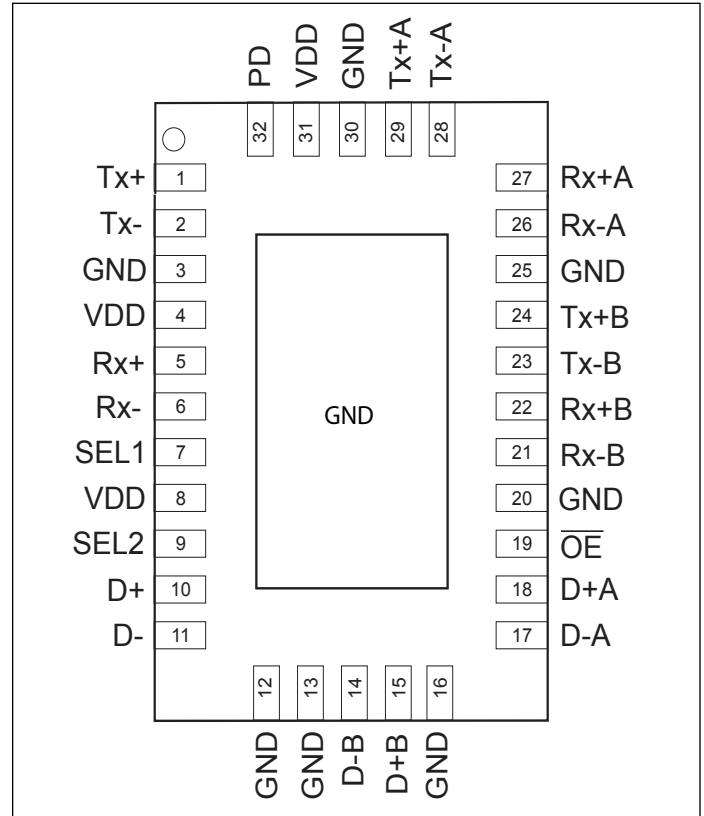
#### Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

**Block Diagram**



**Pin Assignment (TQFN-32)**



**Truth Table**

PD	$\overline{OE}$	SEL1	SEL2	Function
0	X	0	X	PortA is active for Tx & Rx
0	X	1	X	PortB is active for Tx & Rx
1	X	X	X	Both ports are Hi_Z for Tx & Rx
X	1	X	X	Both ports are High_Z for D+/D-
1	1	X	X	All channels are High_Z
X	0	X	0	PortB is active for D+/D-
X	0	X	1	PortA is active for D+/D-

**Note:**

1. PD & SEL1 are controls for the usb3.1 switch PD supports power down & output disable
2.  $\overline{OE}$  & SEL2 are controls for the usb2.0 switch
3. Bottom metal plate can be used as GND
4. VDD at pin8 provides power to both top and bottom die
5. All VDD need to connect to power

## Pin Description

Pin#	Pin Name	Signal Type	Description
1	Tx+	I/O	Positive differential USB3.x Tx signal for COM port
2	Tx-	I/O	Negative differential USB3.x Tx signal for COM port
3	GND	Ground	Ground
4	VDD	Power	3.3V +/-10% power supply
5	Rx+	I/O	Positive differential USB3.x Rx signal for COM port
6	Rx-	I/O	Negative differential USB3.x Rx signal for COM port
7	SEL1	I	Control for USB 3.x
8	VDD	Power	3.3V +/-10% power supply
9	SEL2	I	Control for USB 2.0
10	D+	I/O	Positive differential USB 2.0 COM port
11	D-	I/O	Negative differential USB2.0 COM port
12	GND	Ground	Ground
13	GND	Ground	Ground
14	D-B	I/O	Negative differential USB2.0 signal for port 1
15	D+B	I/O	Positive differential USB2.0 signal for port 1
16	GND	Ground	Ground
17	D-A	I/O	Negative differential USB2.0 signal for port 0
18	D+A	I/O	Positive differential USB2.0 signal for port 0
19	$\overline{OE}$	I	Control for USB 2.0
20	GND	Ground	Ground
21	Rx-B	I/O	Negative differential USB 3.x signal for port 0
22	Rx+B	I/O	Positive differential USB 3.x signal for port 0
23	Tx-B	I/O	Negative differential USB3.x Rx signal for port 0
24	Tx+B	I/O	Positive differential USB3.x Tx signal for port 0
25	GND	Ground	Ground
26	Rx-A	I/O	Negative differential USB3.xRx signal for port 1
27	Rx+A	I/O	Positive differential USB3.x Rx signal for port 1
28	Tx-A	I/O	Negative differential USB3.x Rx signal for port 1
29	Tx+A	I/O	Positive differential USB3.x Tx signal for port 1
30	GND	Ground	Ground
31	VDD	Power	3.3V +/-10% power supply
32	PD	I	Power down and disable USB3.x output

## 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 +4.0V
DC Input Voltage, USB3 .....	-0.5V to 1.5V
DC Input Voltage, USB2 .....	-0.5V to V <sub>DD</sub>
DC Output Current .....	120mA
Power Dissipation .....	0.5W
ESD.....	2KV HBM

**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 Switching over Operating Range

(T<sub>A</sub> = -40°C to +85°C, V<sub>DD</sub> = 3.3V ±10%)

Parameter	Description	Test Conditions <sup>(1)</sup>	Min.	Typ. <sup>(1)</sup>	Max.	Units
V <sub>IH</sub>	Input HIGH Voltage	Guaranteed HIGH level	0.65*V <sub>DD</sub>			V
V <sub>IL</sub>	Input LOW Voltage	Guaranteed LOW level			0.6	
V <sub>IK</sub>	Clamp Diode Voltage, Dx	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_SS</sub>	On resistance between input to output for SuperSpeed signals	V <sub>DD</sub> = 3.3V, V <sub>input</sub> = 0V to 1V, I <sub>INPUT</sub> = 20mA		10	13	Ohm
R <sub>ON_FS</sub>	On resistance between input to output for USB2.0 FS signals (D+/D-)	V <sub>DD</sub> = 3.3V, V <sub>input</sub> = 0 to 3.3V, I <sub>INPUT</sub> = 20mA		7	9	Ohm
R <sub>ON_HS</sub>	On resistance between input to output for USB2.0 HS signals (D+/D-)	V <sub>DD</sub> = 3.3V, V <sub>input</sub> = -0.4V to +0.4V, I <sub>INPUT</sub> = 20mA		4	6	Ohm

## Power Supply Characteristics (T<sub>A</sub> = -40°C to +85°C)

Parameter	Description	Test Conditions <sup>(1)</sup>	Min.	Typ. <sup>(1)</sup>	Max.	Units
I <sub>CC</sub>	Quiescent Power Supply Current	V <sub>DD</sub> = Max., V <sub>IN</sub> = GND or V <sub>DD</sub>			500	µA

**Dynamic Electrical Characteristics over Operating Range** ( $T_A = -40^\circ$  to  $+85^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V} \pm 10\%$ )

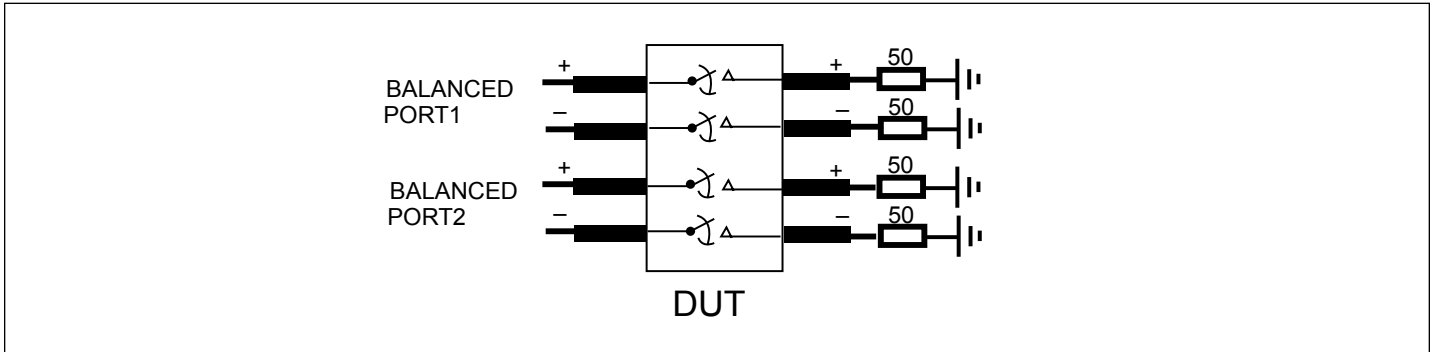
Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
DDXT	Differential Crosstalk on SuperSpeed Channels	See Fig. 1 for Measurement Setup	$f = 2.5\text{ GHz}$ $f = 4.0\text{ GHz}$ $f = 5.0\text{ GHz}$	-33.3 -31.9 -31.1		dB
DDOI	Differential OFF Isolation on SuperSpeed Channels	See Fig. 2 for Measurement Setup,	$f = 2.5\text{ GHz}$ $f = 4.0\text{ GHz}$ $f = 5.0\text{ GHz}$	-24.9 -18.9 -17.4		
DDIL	Differential Insertion Loss on SuperSpeed Channels		$f = 2.5\text{ GHz}$ $f = 4.0\text{ GHz}$ $f = 5.0\text{ GHz}$	-0.9 -1.3 -1.5		dB
$R_{\text{loss}}$	Differential Return Loss on SuperSpeed channels		$f = 2.5\text{ GHz}$ $f = 4.0\text{ GHz}$ $f = 5.0\text{ GHz}$	-26.4 -22.4 -19.6		dB
BW	3db Bandwidth on SuperSpeed channels			10.6		GHz
$X_{\text{TALK-USB2 HS}}$	Crosstalk	$R_L = 50\Omega$	$f = 240\text{ MHz}$ $f = 825\text{ MHz}$	-35 -25	-39 -28	dB
$O_{\text{IRR-USB2 HS}}$	OFF Isolation		$f = 240\text{ MHz}$ $f = 825\text{ MHz}$	-29 -20	-32 -23	
$BW_{\text{-USB2 HS}}$	-3dB Bandwidth	$R_L = 50\Omega$		1100	1400	MHz
$BW_{\text{-USB2 HS}}$	-0.5dB Bandwidth	$R_L = 50\Omega$		150	400	MHz
$IN_{\text{-USB2 HS}}$	Insertion Loss		$f = 240\text{ MHz}$ $f = 825\text{ MHz}$ $f = 1.0\text{ GHz}$ $f = 1.125\text{ GHz}$	0.47 1.8 2.2 2.4	0.67 2.4 2.6 3.0	dB

**Note:**

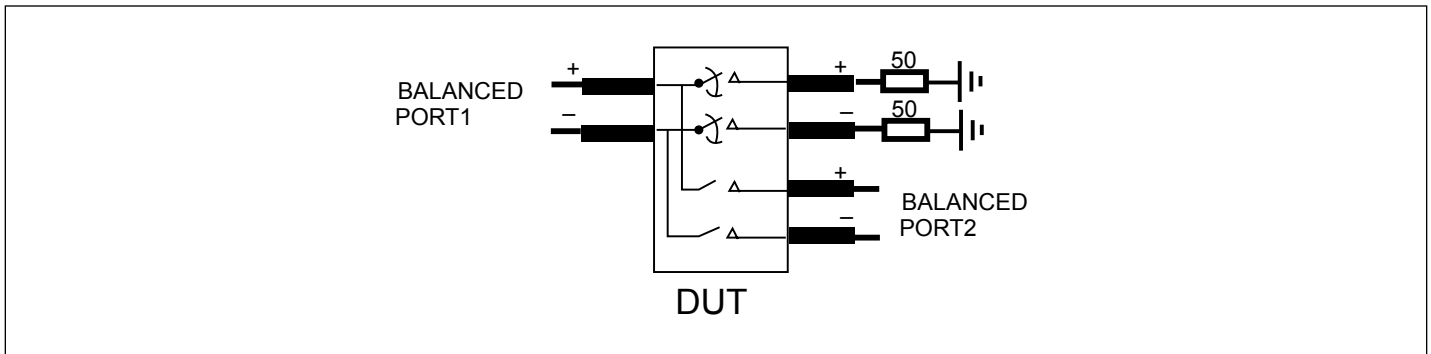
- For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at  $V_{DD} = 3.3\text{V}$ ,  $T_A = 25^\circ\text{C}$  ambient and maximum loading.

**Switching Characteristics** ( $T_A = -40^\circ$  to  $+85^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V} \pm 10\%$ )

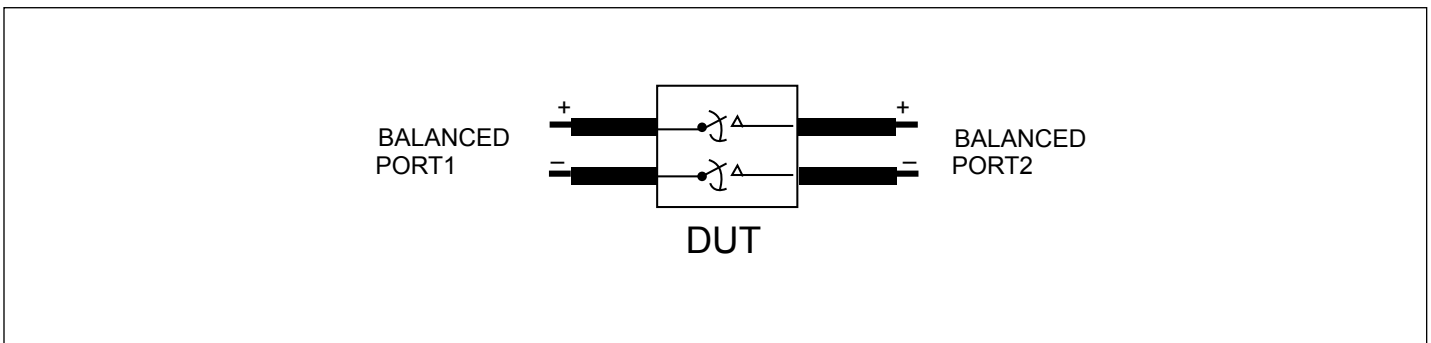
Parameter	Description	Min.	Typ.	Max.	Units
$T_{\text{pd}}$	Propagation delay (input pin to output pin)	USB3		80	ps
		USB-HS		250	
$t_{\text{b-b}}$	Bit-to-bit skew within the same differential pair			10	ps
$t_{\text{ch-ch}}$	Channel-to-channel skew			20	ps
$T_{\text{sw}}$	Switching time between paths (toggling SEL1, SEL2)	2		100	ns



**Fig 1. Crosstalk Setup**



**Fig 2. Off-isolation Setup**



**Fig 3. Differential Insertion Loss Setup**

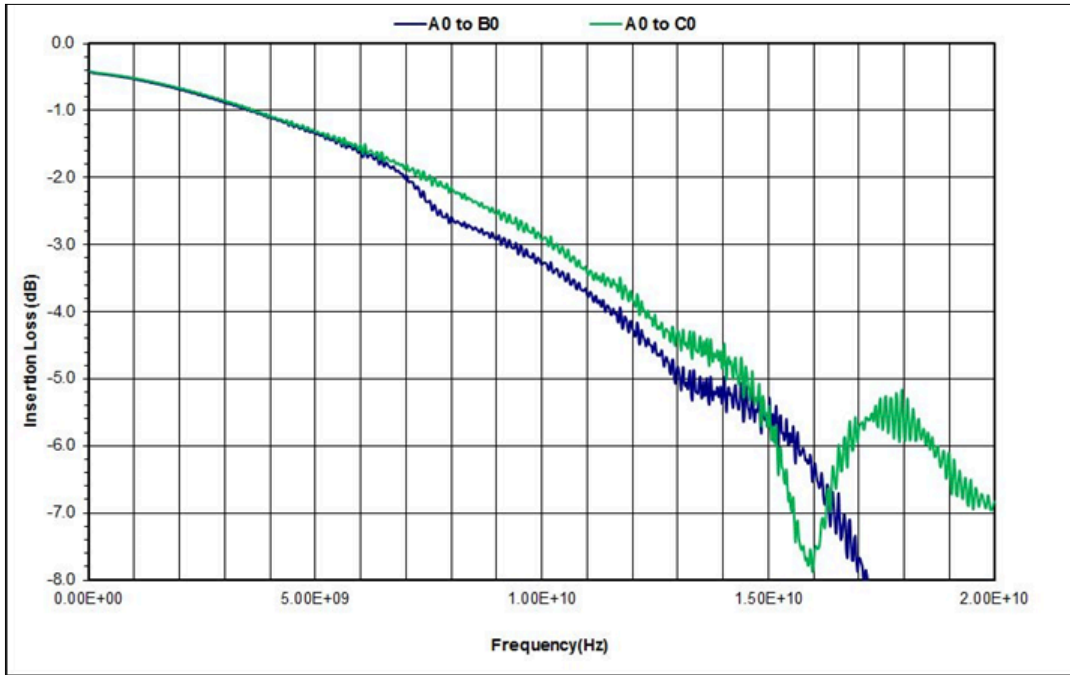
**PI3USB32212**



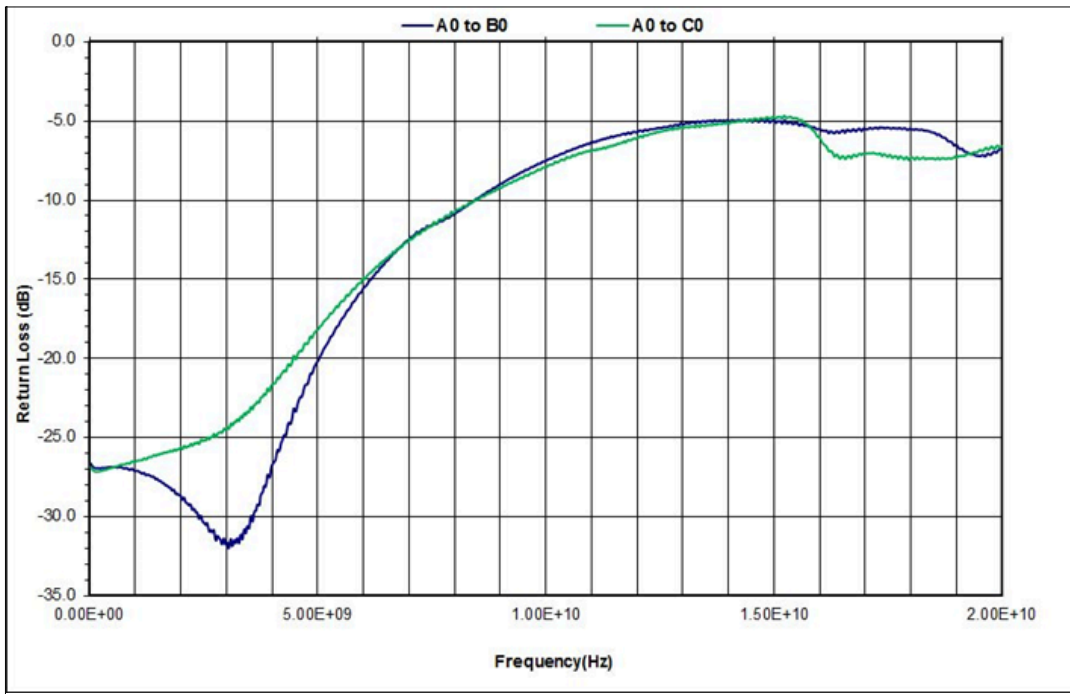
**Fig 4. Differential Crosstalk – Super Speed**



**Fig 5. Differential Off Isolation – Super Speed**



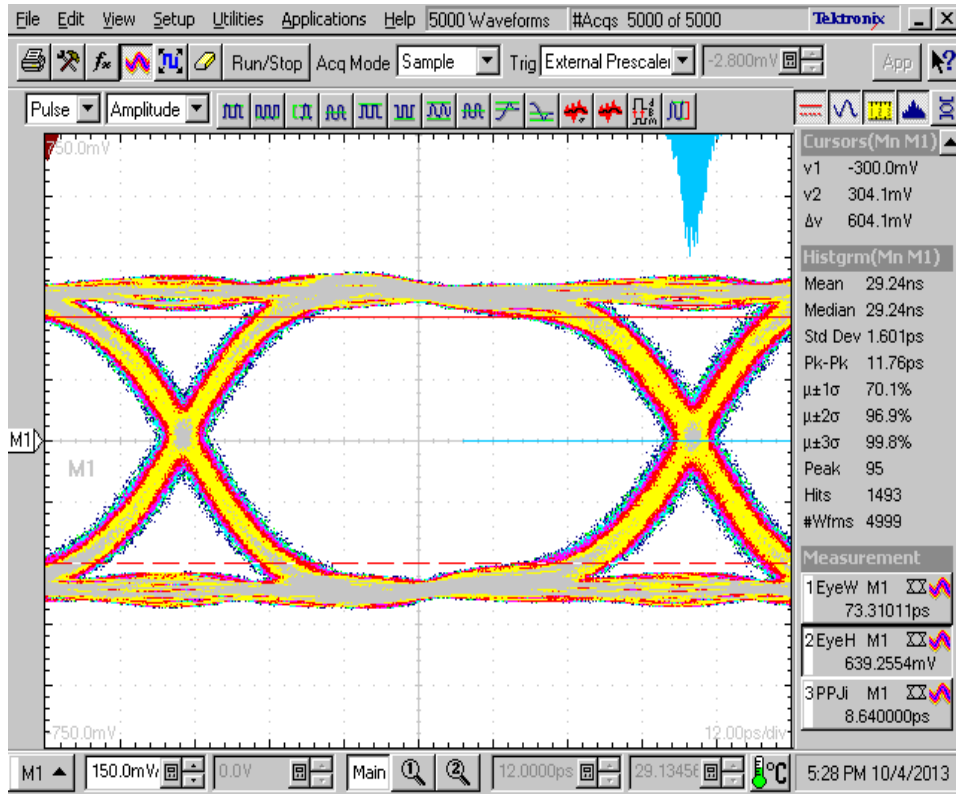
**Fig 6. Differential Insertion Loss – Super Speed**



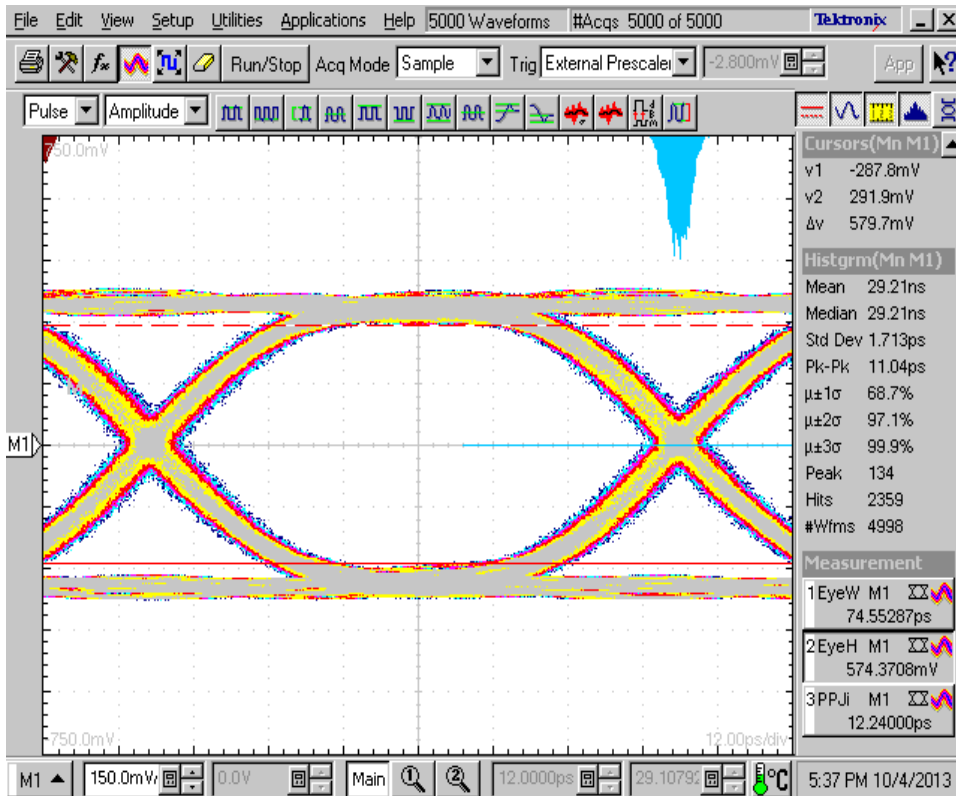
**Fig 7. Differential Return Loss – Super Speed**



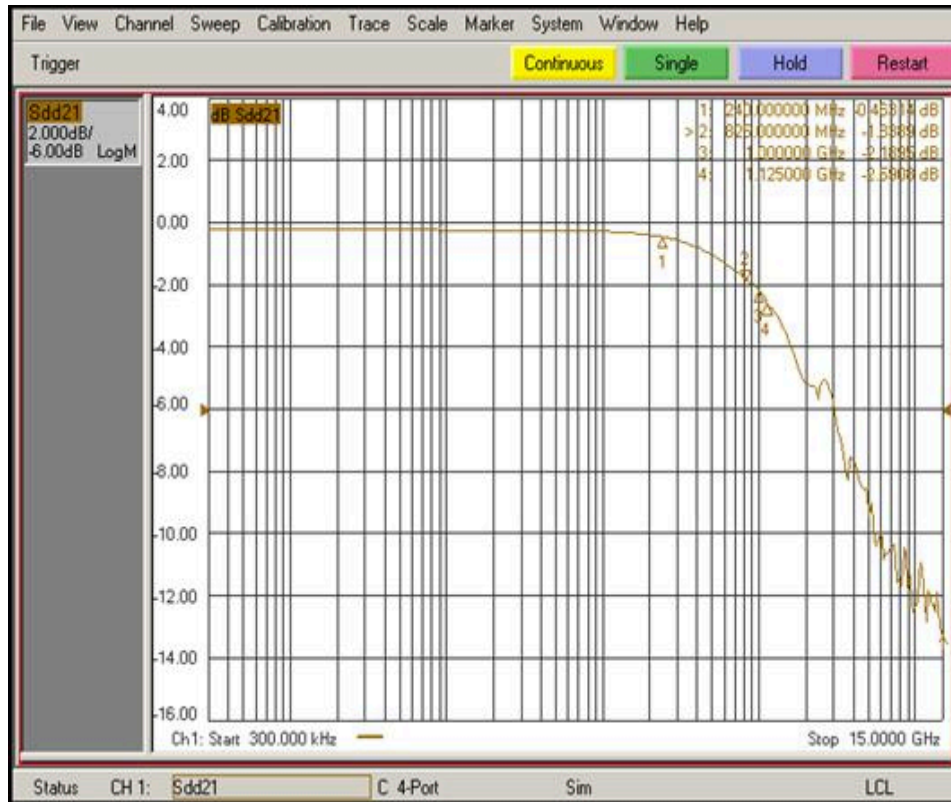
**PI3USB32212**



**Fig 8. 12Gbps Eye without PI3USB32212**

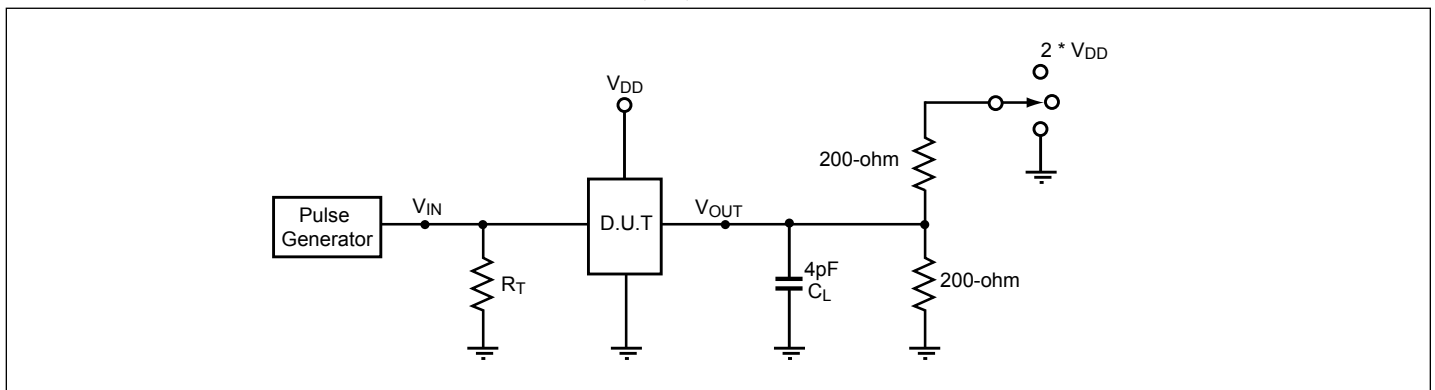


**Fig 9. 12Gbps Eye with PI3USB32212**



**Fig 10. Differential Insertion loss,  $V_{DD} = 3.3V$  – USB2 HS**

**Test Circuit for Electrical Characteristics(1-5)**

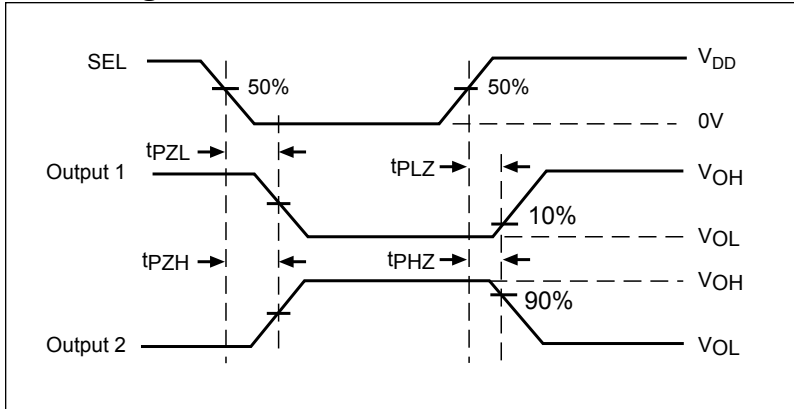


**Notes:**

1.  $C_L$  = Load capacitance: includes jig and probe capacitance.
2.  $R_T$  = Termination resistance: should be equal to  $Z_{OUT}$  of the Pulse Generator
3. Output 1 is for an output with internal conditions such that the output is low except when disabled by the output control.
4. Output 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
5. All input impulses are supplied by generators having the following characteristics:  $PRR \leq \text{MHz}$ ,  $Z_O = 50\Omega$ ,  $t_R \leq 2.5\text{ns}$ ,  $t_F \leq 2.5\text{ns}$ .
6. The outputs are measured one at a time with one transition per measurement.

**PI3USB32212**

**Switching Waveforms**

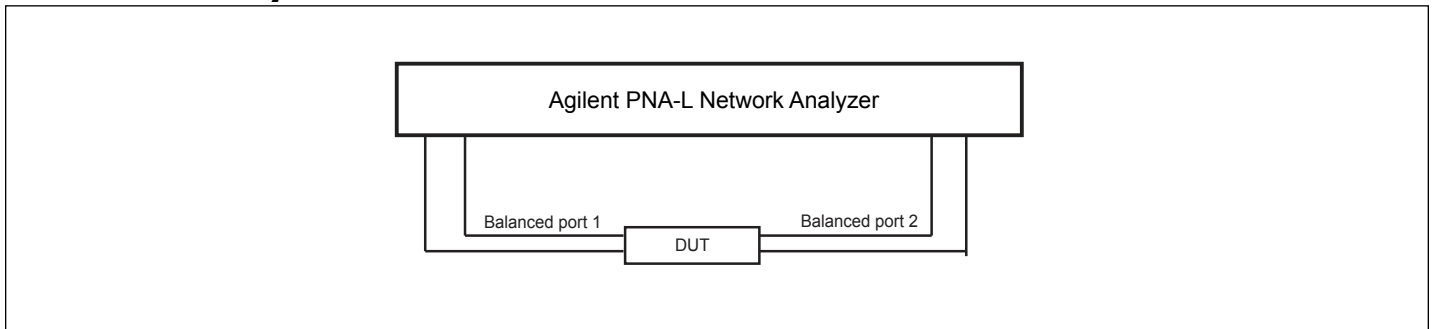


**Voltage Waveforms Enable and Disable Times**

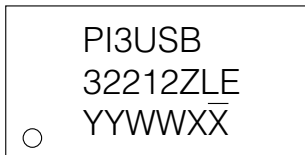
**Switch Positions**

Test	Switch
t <sub>PLZ</sub> , t <sub>PZL</sub> (output on B-side)	2 * V <sub>dd</sub>
t <sub>PHZ</sub> , t <sub>PZH</sub> (output on B-side)	GND
Prop Delay	Open

**Test Circuit for Dynamic Electrical Characteristics**

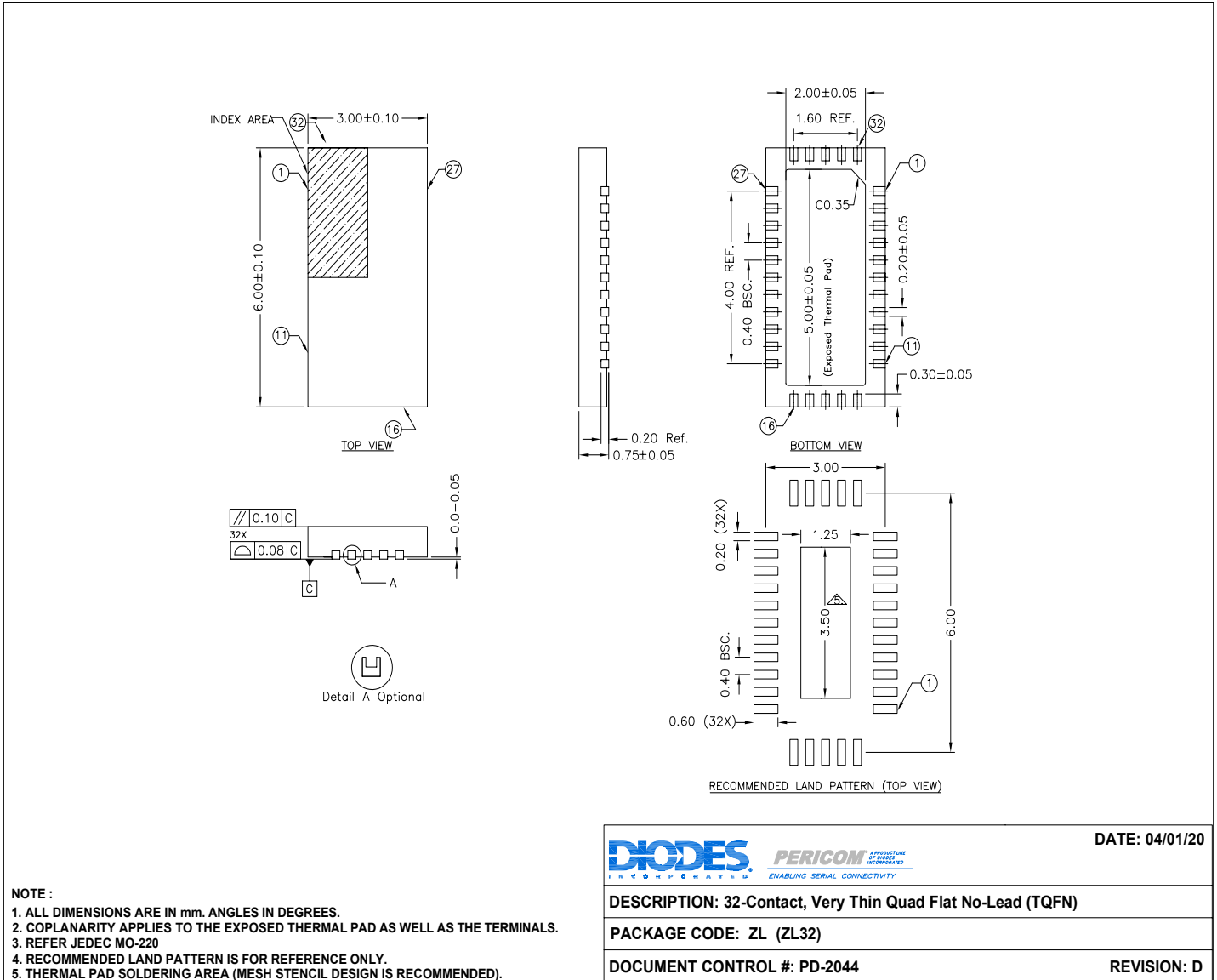


**Part Marking**



YY: Year  
WW: Workweek  
1st X: Assembly Code  
2nd X: Fab Code

**Packaging Mechanical: 32-TQFN (ZL)**



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
PI3USB32212ZLEX	ZL	32-contact, Very Thin Quad Flat No-Lead (TQFN) Copper Wire
PI3USB32212ZLEX+DA	ZL	32-contact, Very Thin Quad Flat No-Lead (TQFN) Gold Wire

**Notes:**

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. E = Pb-free and Green
5. X suffix = Tape/Reel

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