

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

Description

The DIODES PI3USB32212 USB3.1, USB3.0 and USB2.0 Combo Switch is a complete 1:2 switching solution for Enhanced Super-Speed 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 480Mbps 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 5GHz (USB3.1). Insertion loss is -0.77dB and return loss is -27.8db at 2.5GHz (USB3.0).

Application(s)

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.

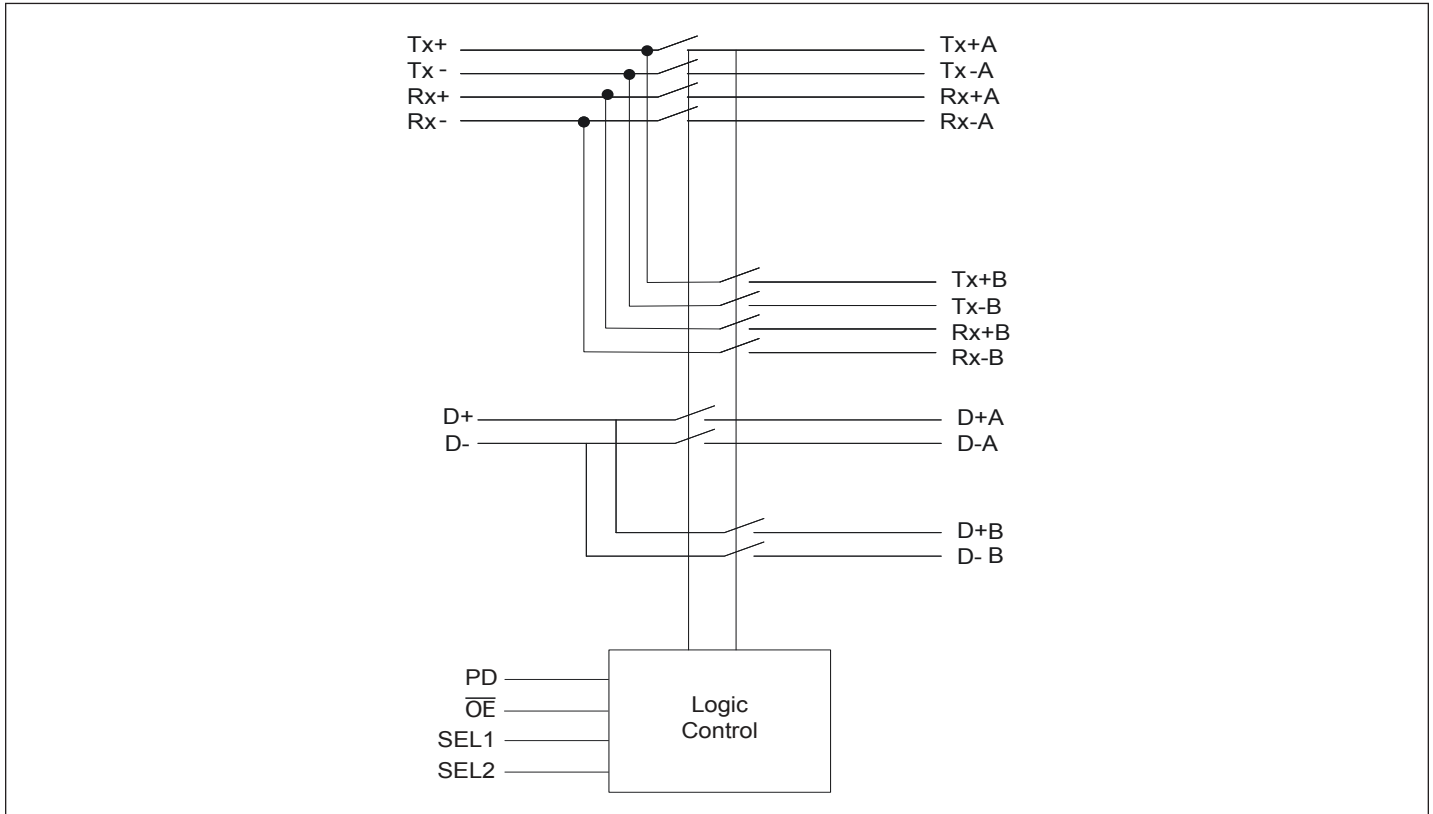
Features

- 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 @5.0GHz: -1.5dB
- Insertion Loss for superspeed channels @ 2.5 GHz: -0.9dB
- Return loss for enhanced superspeed channels @5.0GHz: -19.6dB
- Return Loss for superspeed channels @ 2.5 GHz: -26.4dB
- Low Bit-to-Bit Skew, 5ps typical (between '+' and '-' bits)
- Low Crosstalk for enhanced superspeed channels: -31.1dB @5.0GHz
- Low Crosstalk for superspeed channels @2.5GHz: -33.3dB
- Low Off Isolation for enhanced superspeed channels: -17.4dB @5.0GHz
- 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: 1.4GHz
- V_{DD} Operating Range: 3.3V +/-10%
- ESD Tolerance: 2kV HBM
- Low channel-to-channel skew, 7ps typical
- 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-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](#) 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

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



Truth Table 1

PD	$\overline{\text{OE}}$	SEL1	SEL2	Function
0	X	0	X	Port A is active for Tx & Rx
0	X	1	X	Port B is active for Tx & Rx
1	X	X	X	Both ports are Hi_Z for Tx & Rx

Note:

1. PD & SEL1 are the controls only for the USB3.1 switch.

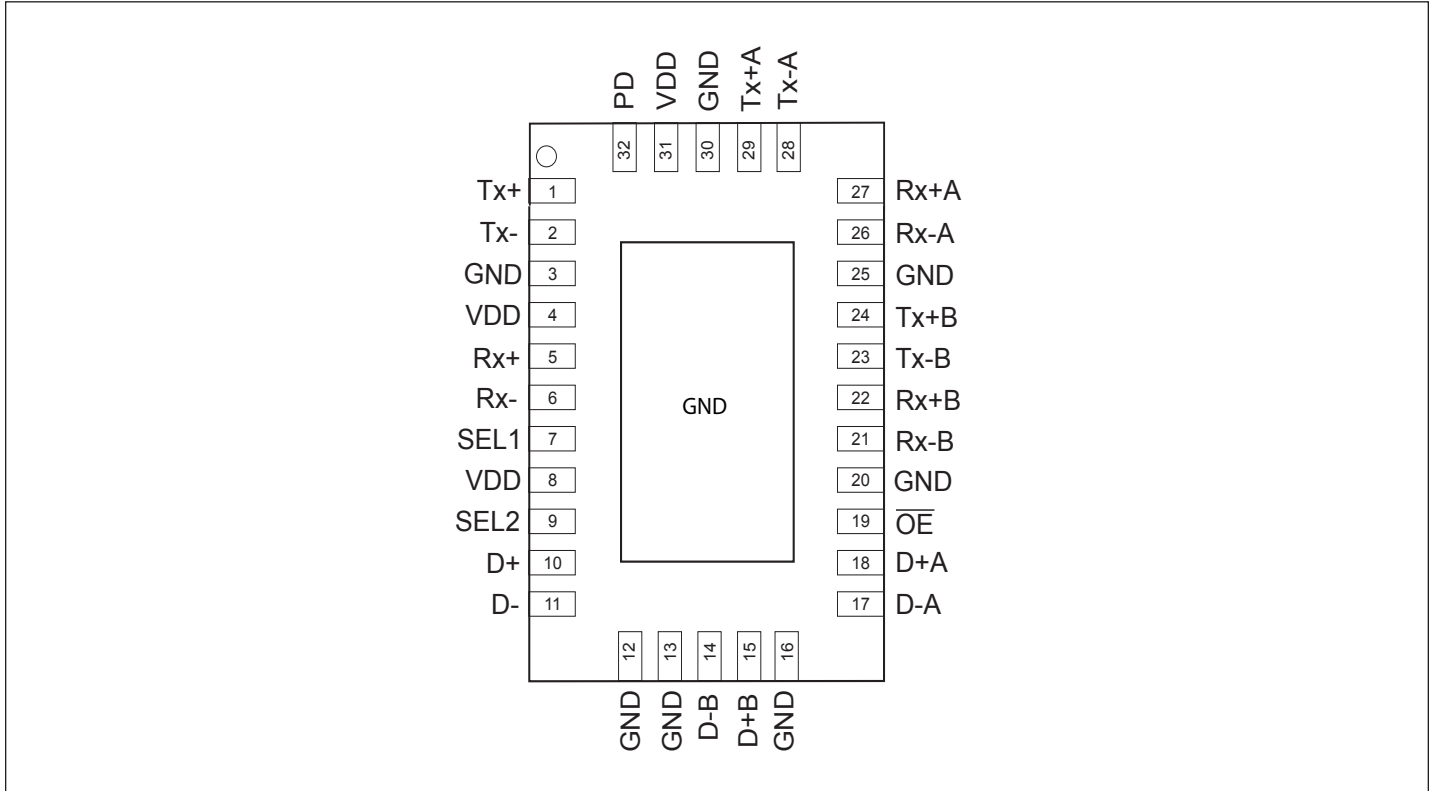
Truth Table 2

PD	$\overline{\text{OE}}$	SEL1	SEL2	Function
X	1	X	X	Both ports are High_Z for D+/D-
X	0	X	0	Port A USB2.0
X	0	X	1	Port B USB2.0

Note:

1. $\overline{\text{OE}}$ & SEL2 are the controls only for USB2.0 switch.
2. Connect to GND for the thermal pad underneath.
3. All the VDD pins shall connect to VDD power.

Pin Configuration



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

Pin#	Pin Name	Signal Type	Description
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	$\overline{\text{OE}}$	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 _{DD}
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_A = -40°C to +85°C, V_{DD} = 3.3V ±10%

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽¹⁾	Max.	Units
V _{IH}	Input HIGH Voltage	Guaranteed HIGH level	0.65*V _{DD}			V
V _{IL}	Input LOW Voltage	Guaranteed LOW level			0.6	
V _{IK}	Clamp Diode Voltage, Dx	V _{DD} = Max., I _{IN} = -18mA		-0.7	-1.2	
I _{IH}	Input HIGH Current	V _{DD} = Max., V _{IN} = V _{DD}			±5	µA
I _{IL}	Input LOW Current	V _{DD} = Max., V _{IN} = GND			±5	
R _{ON_SS}	On resistance between input to output for SuperSpeed signals	V _{DD} = 3.3V, V _{input} = 0V to 1V, I _{INPUT} = 20mA		10	13	Ω
R _{ON_FS}	On resistance between input to output for USB2.0 FS signals (D+/D-)	V _{DD} = 3.3V, V _{input} = 0 to 3.3V, I _{INPUT} = 20mA		7	9	Ω
R _{ON_HS}	On resistance between input to output for USB2.0 HS signals (D+/D-)	V _{DD} = 3.3V, V _{input} = -0.4V to +0.4V, I _{INPUT} = 20mA		4	6	Ω

Power Supply Characteristics

T_A = -40°C to +85°C

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽¹⁾	Max.	Units
I _{CC}	Quiescent Power Supply Current	V _{DD} = Max., V _{IN} = GND or V _{DD}			500	µA

Dynamic Electrical Characteristics over Operating Range

T_A = -40°C to +85°C, V_{DD} = 3.3V ±10%

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
DDXT	Differential Crosstalk on Super-Speed Channels	See Fig. 1 for Measurement Setup		-33.3 -31.9 -31.1		dB
		f = 2.5GHz				
		f = 4.0GHz				
		f = 5.0GHz				

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
DDOI	Differential OFF Isolation on SuperSpeed Channels	See Fig. 2 for Measurement Setup, f = 2.5GHz f = 4.0GHz f = 5.0GHz		-24.9 -18.9 -17.4		dB
DDIL	Differential Insertion Loss on SuperSpeed Channels	f = 2.5GHz f = 4.0GHz f = 5.0GHz		-0.9 -1.3 -1.5		dB
R _{loss}	Differential Return Loss on SuperSpeed channels	f = 2.5GHz f = 4.0GHz f = 5.0GHz		-26.4 -22.4 -19.6		dB
BW	3db Bandwidth on SuperSpeed channels			10.6		GHz
X _{TALK-USB2 HS}	Crosstalk	R _L = 50Ω	f = 240MHz f = 825MHz	-35 -25	-39 -28	dB
O _{IRR-USB2 HS}	OFF Isolation		f = 240MHz f = 825MHz	-29 -20	-32 -23	
BW-USB2 HS	-3dB Bandwidth	R _L = 50Ω	1100	1400		MHz
BW-USB2 HS	-0.5dB Bandwidth	R _L = 50Ω	150	400		MHz
IN-USB2 HS	Insertion Loss	f = 240MHz f = 825MHz f = 1.0GHz f = 1.125GHz		0.47 1.8 2.2 2.4	0.67 2.4 2.6 3.0	dB

Note:

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

Switching Characteristics

TA = -40°C to +85°C, VDD = 3.3V ±10%

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

PI3USB32212

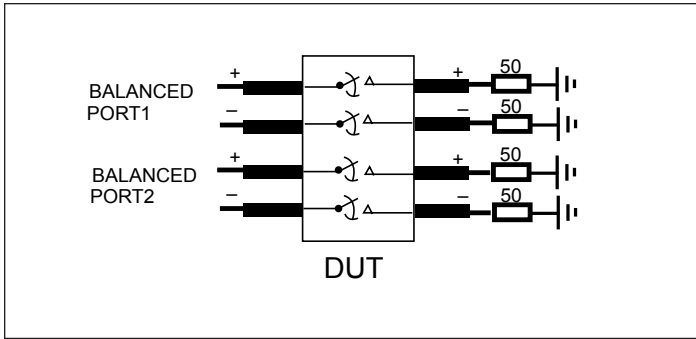


Figure 1. Crosstalk Setup

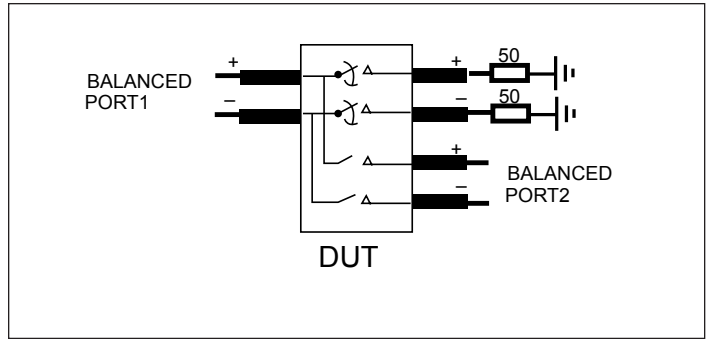


Figure 2. Off-Isolation Setup

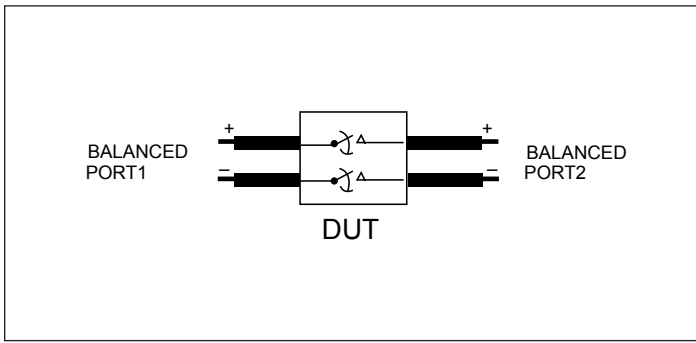


Figure 3. Differential Insertion Loss Setup

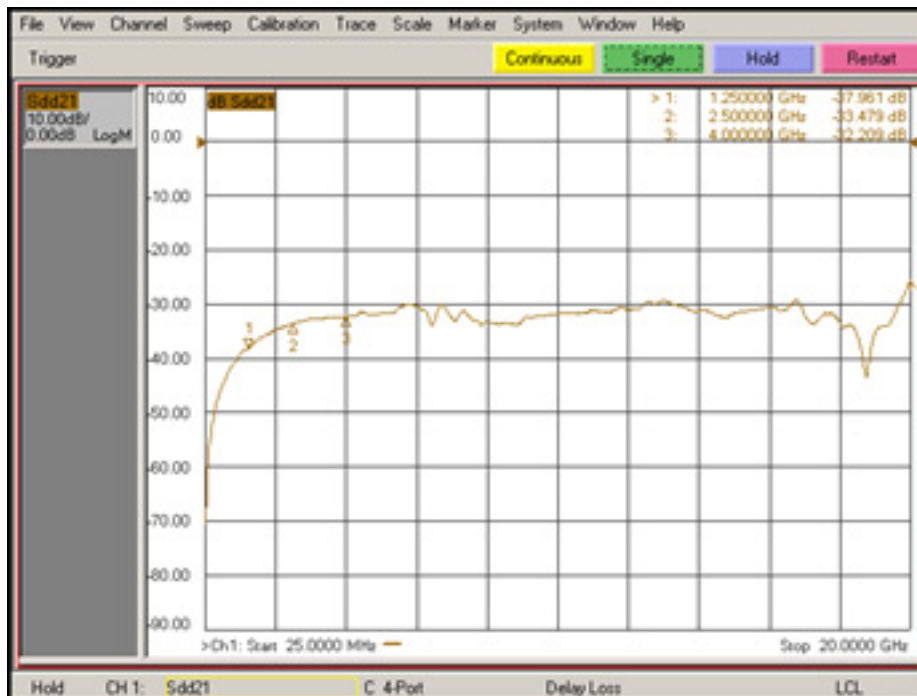


Figure 4. Differential Crosstalk – Super Speed



Figure 5. Differential Off Isolation – Super Speed

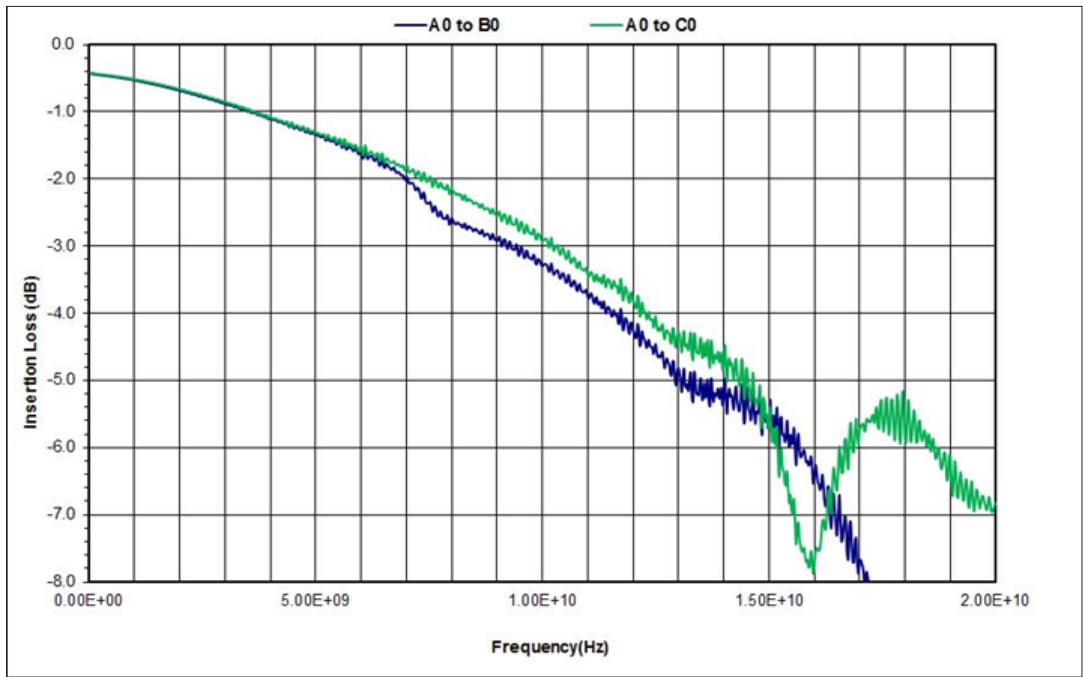


Figure 6. Differential Insertion Loss – Super Speed

PI3USB32212

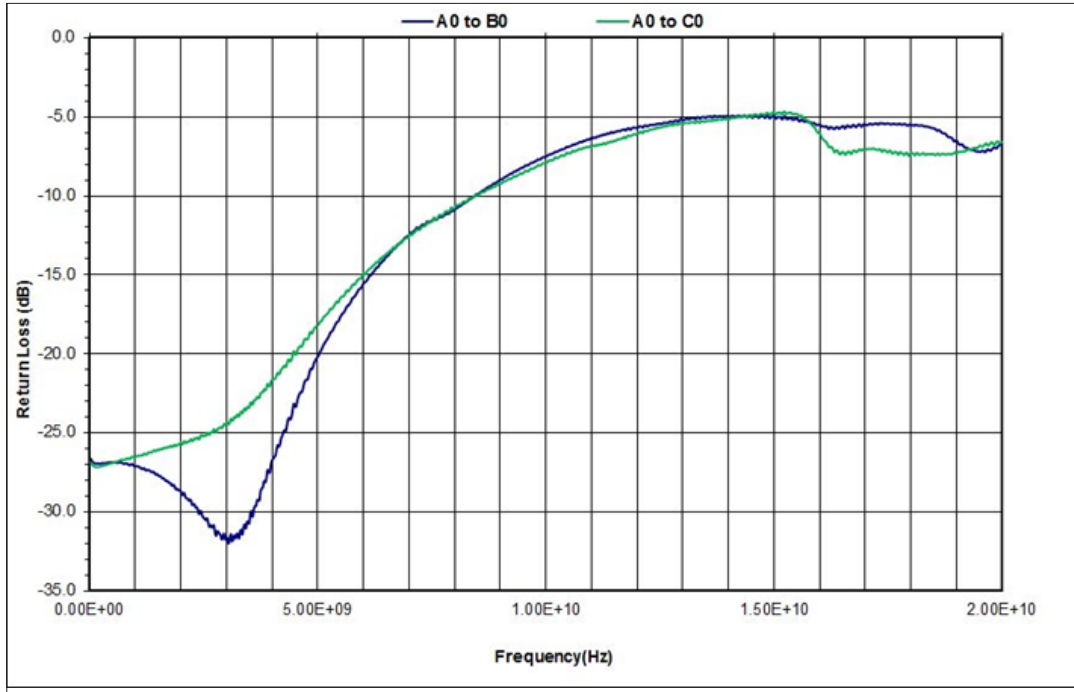


Figure 7. Differential Return Loss – Super Speed

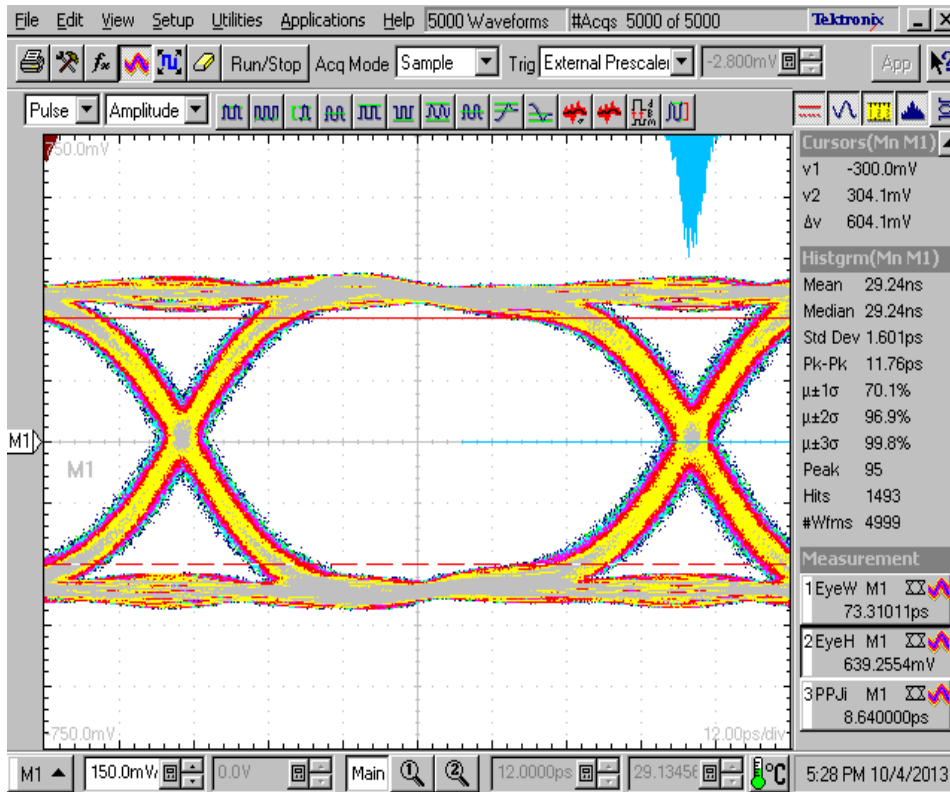


Figure 8. 12Gbps Eye without PI3USB32212

PI3USB32212

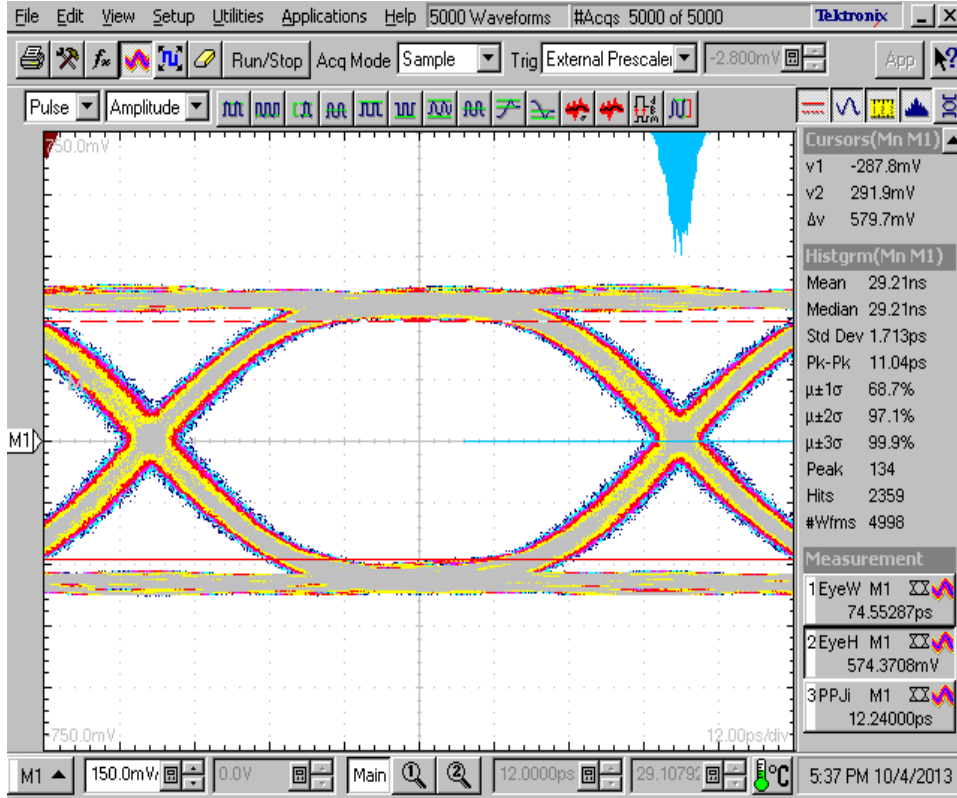


Figure 9. 12Gbps Eye with PI3USB32212

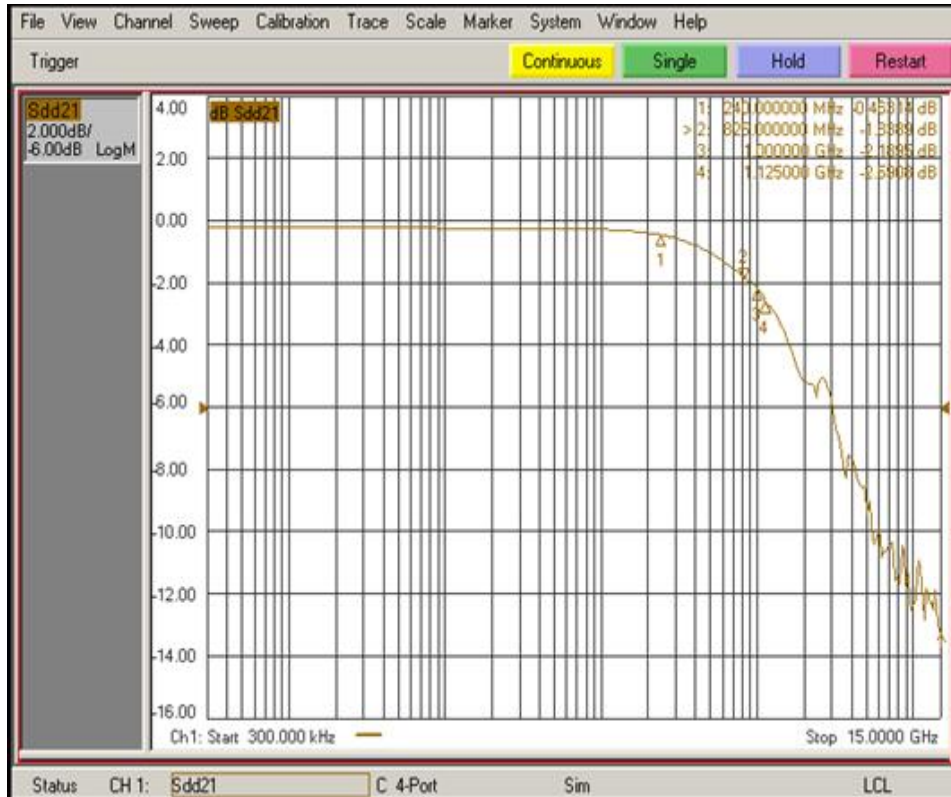
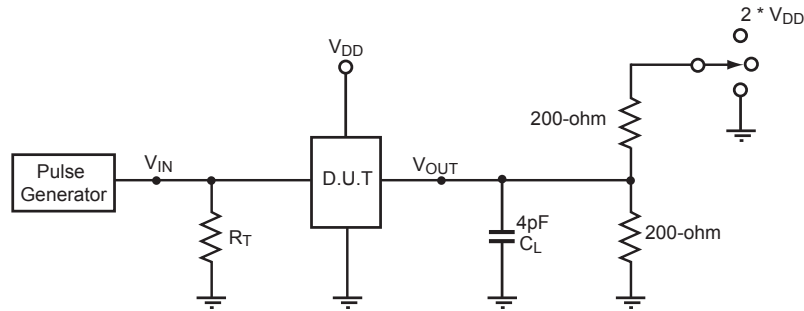


Figure 10. Differential Insertion loss, $V_{DD} = 3.3V$ – USB2 HS



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.

Figure 11. Test Circuit for Electrical Characteristics

Switching Waveforms

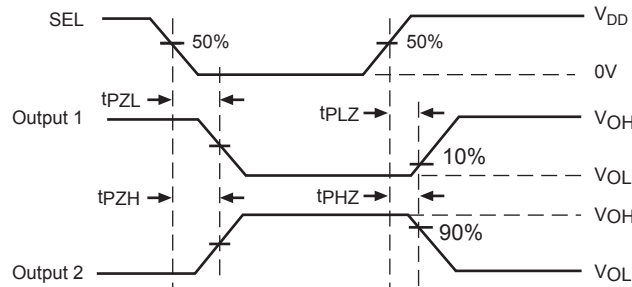


Figure 12. Voltage Waveforms Enable and Disable Times

Switch Positions

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

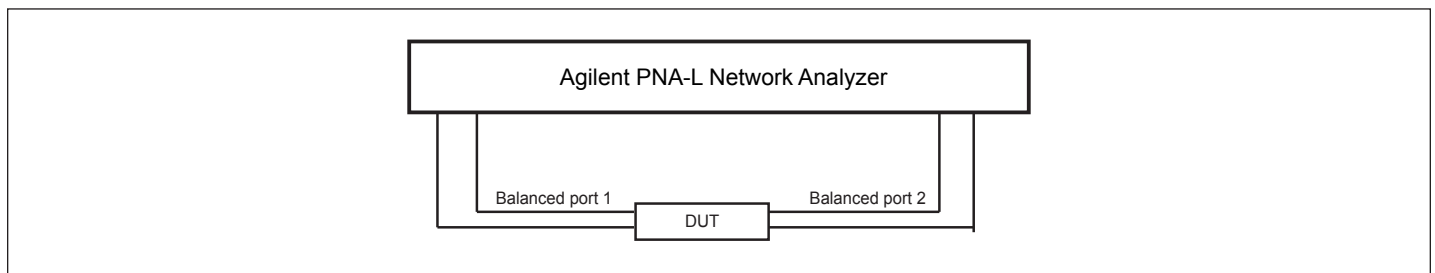


Figure 13. Test Circuit for Dynamic Electrical Characteristics

PI3USB32212

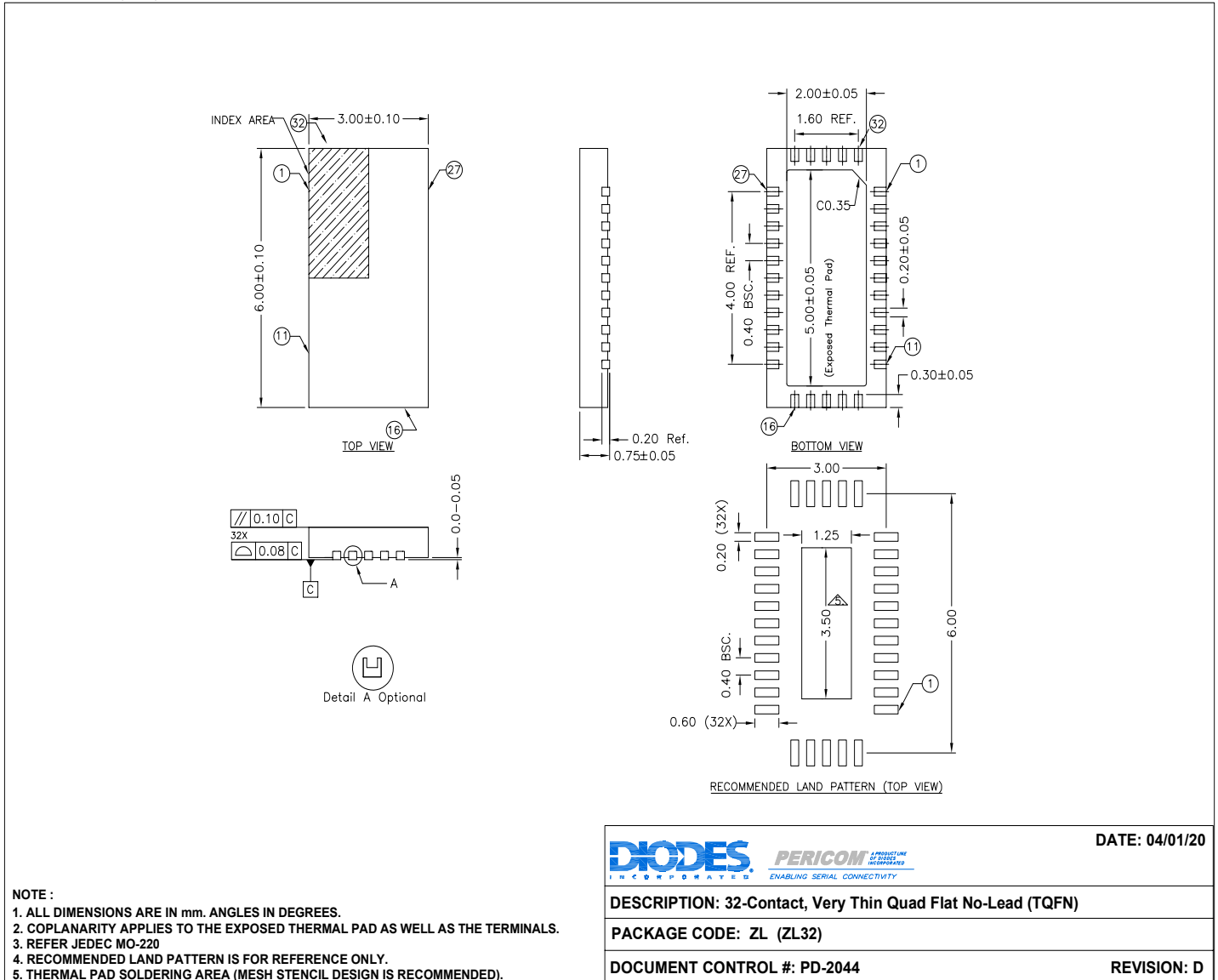
Part Marking

PI3USB
32212ZLE
○ YYWWXX

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

Packaging Mechanical

32-TQFN (ZL)



DIODES PERICOM A PRODUCT LINE OF DIODES INCORPORATED ENABLING SERIAL CONNECTIVITY	DATE: 04/01/20
DESCRIPTION: 32-Contact, Very Thin Quad Flat No-Lead (TQFN)	
PACKAGE CODE: ZL (ZL32)	
DOCUMENT CONTROL #: PD-2044	REVISION: D

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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