A product Line of
Diodes Incorporated

PI3USB32212

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 Islation fo USB – HS: -30dB @ 480Mbps
- -3dB for USB – HS: 1.4 GHz
- V_{DD} Operating Range: 3.3V +/-10%
- ESD Tolerance: 2kV HBM
- Low channel-to-channel skew, 7ps typ
- 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.

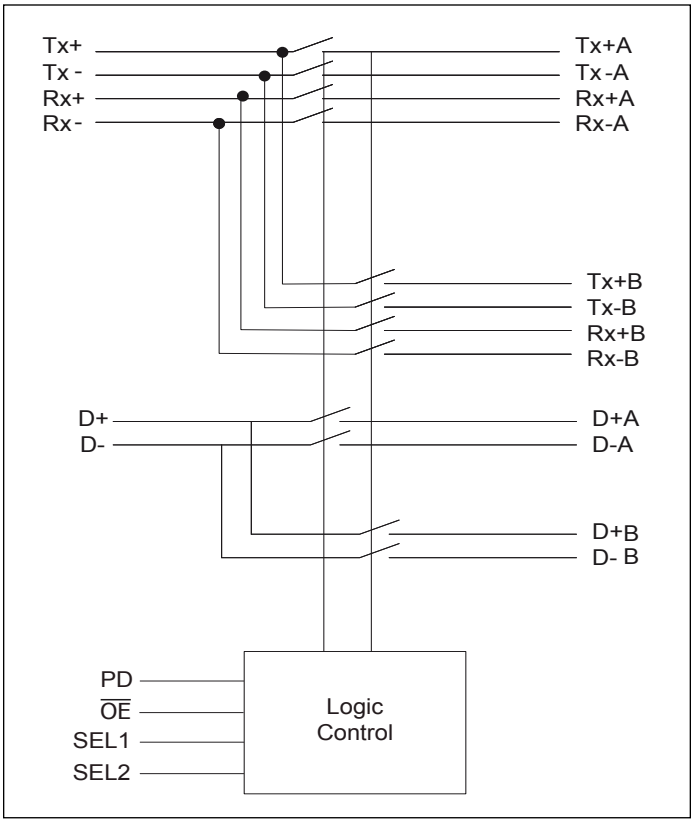
PI3USB32212 can be used to connect two hosts to a single device or a single host to two devices.

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).

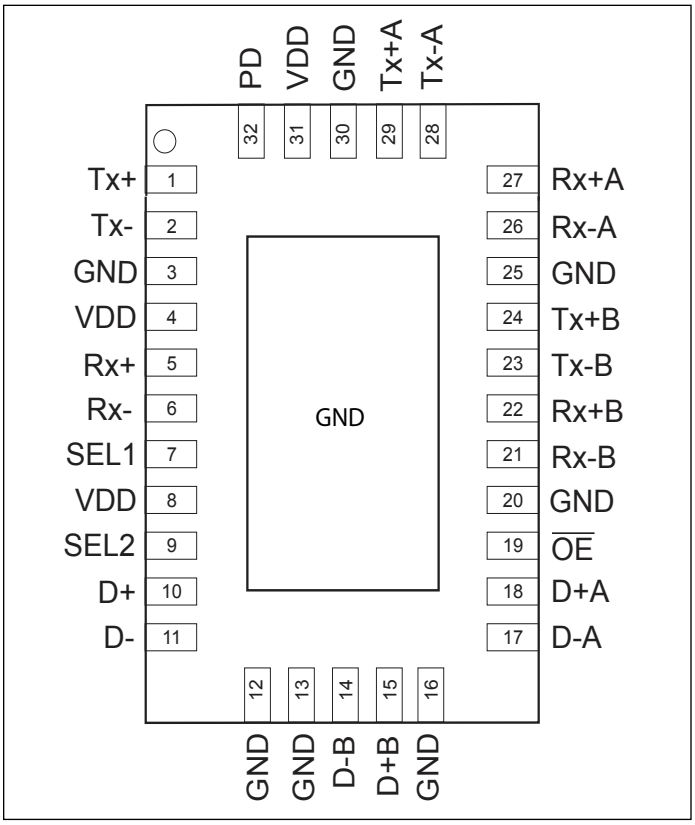
Application

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.

Block Diagram



Pin Assignment (TQFN-32)



Truth Table

PD	$\overline{OE}$	SEL1	SEL2	Function
0	X	0	X	PortA is active fox Tx & Rx
0	X	1	X	PortB is active fox 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 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_{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

(TA = –40°C to +85°C, VDD = 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, Vinput = 0V to 1V, I_{INPUT} = 20mA		10	13	Ohm
R_{ON_FS}	On resistance between input to output for USB2.0 FS signals (D+/D-)	V_{DD} = 3.3V, Vinput = 0 to 3.3V, I_{INPUT} = 20mA		7	9	Ohm
R_{ON_HS}	On resistance between input to output for USB2.0 HS signals (D+/D-)	V_{DD} = 3.3V, Vinput = -0.4V to +0.4V, I_{INPUT} = 20mA		4	6	Ohm

Power Supply Characteristics (TA = –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 (TA = -40° to +85°C, VDD = 3.3V ±10%)

Parameter	Description	Test Conditions		Min.	Typ.	Max.	Units
DDXT	Differential Crosstalk on SuperSpeed Channels	See Fig. 1 for Measure-ment Setup	f= 2.5 GHz f= 4.0 GHz f= 5.0 GHz		-33.3 -31.9 -31.1		dB
DDOI	Differential OFF Isolation on SuperSpeed Channels	See Fig. 2 for Measure-ment Setup,	f= 2.5 GHz f= 4.0 GHz f= 5.0 GHz		-24.9 -18.9 -17.4		
DDIL	Differential Insertion Loss on SuperSpeed Channels	f= 2.5 GHz f= 4.0 GHz f= 5.0 GHz			-0.9 -1.3 -1.5		dB
R_{loss}	Differential Return Loss on SuperSpeed channels	f= 2.5 GHz f= 4.0 GHz f= 5.0 GHz			-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= 240 MHz f= 825 MHz	-35 -25	-39 -28		dB
$O_{IRR-USB2\ HS}$	OFF Isolation		f= 240 MHz f= 825 MHz	-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= 240 MHz f= 825 MHz f= 1.0 GHz f= 1.125 GHz			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 (T_A= -40° to +85°C, V_{DD} = 3.3V±10%)

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

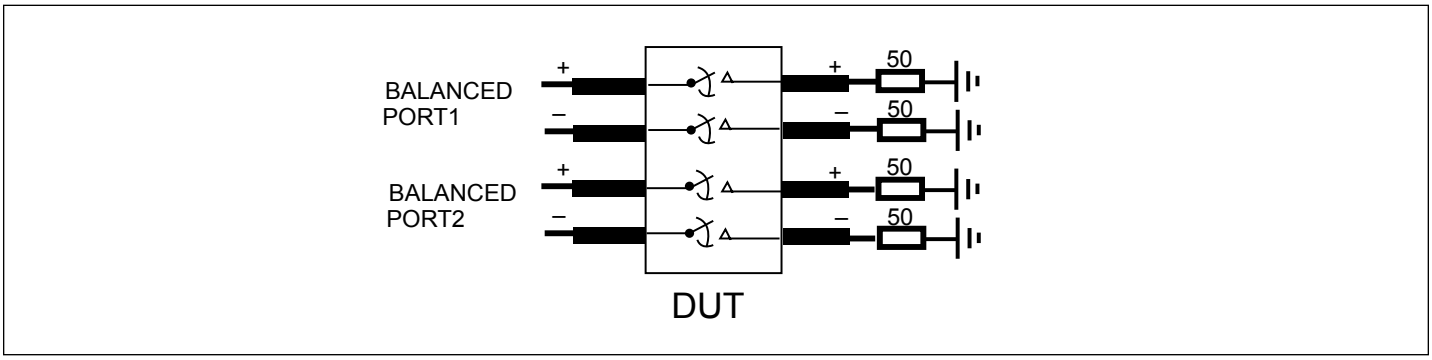


Fig 1. Crosstalk Setup

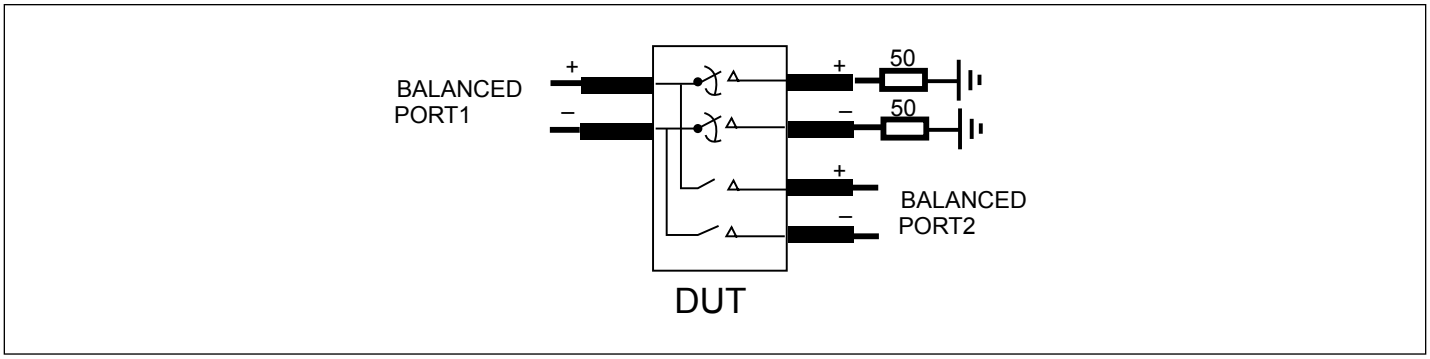


Fig 2. Off-isolation setup

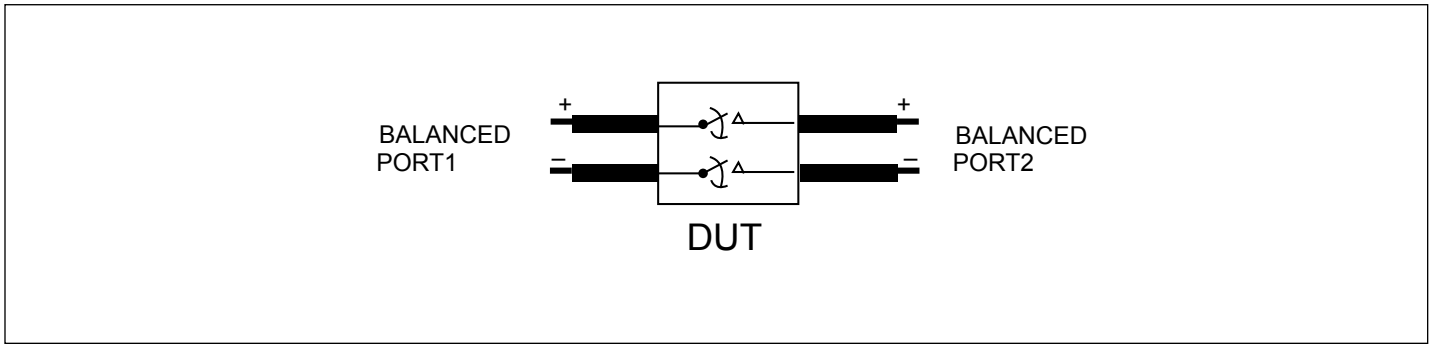


Fig 3. Differential Insertion Loss set up

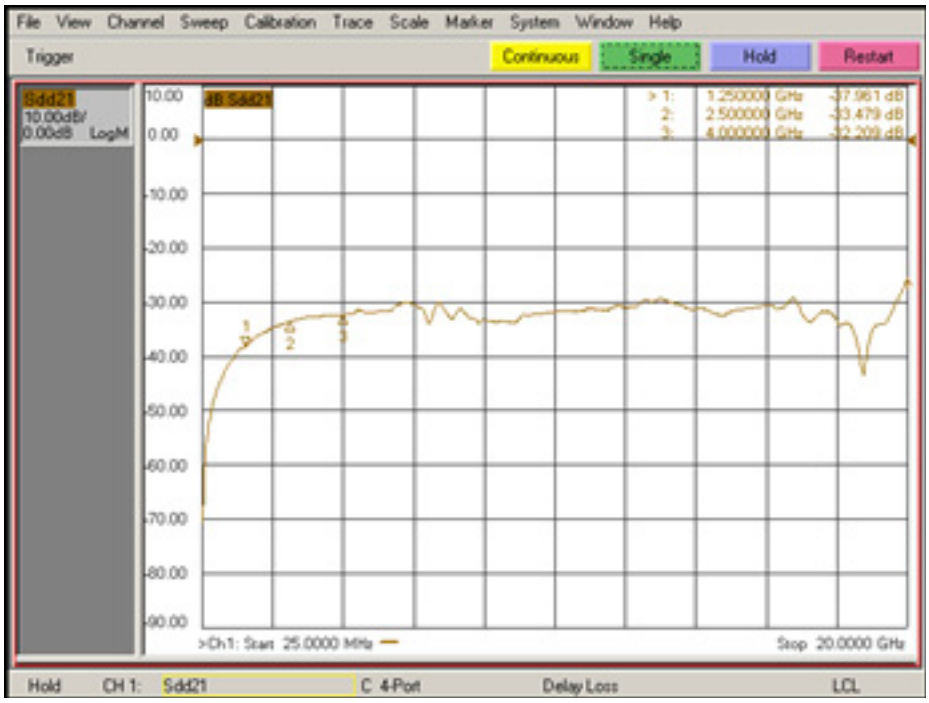


Fig 4. Differential Crosstalk – Super Speed

Fig 5. Differential Off Isolation – Super Speed

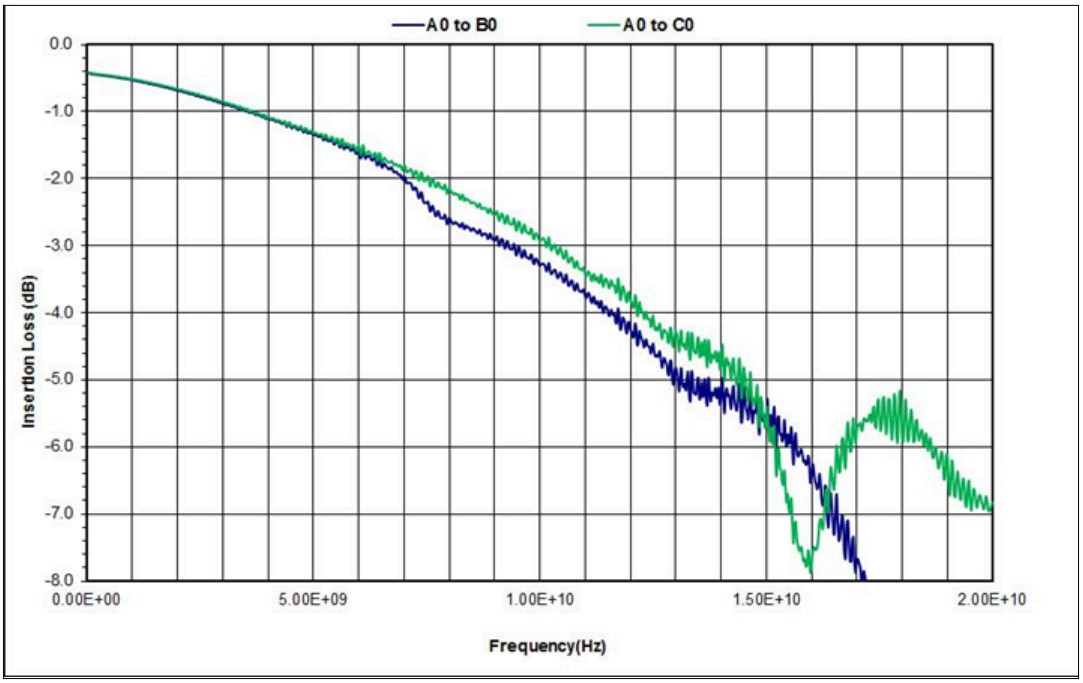


Fig 6. Differential Insertion Loss – Super Speed

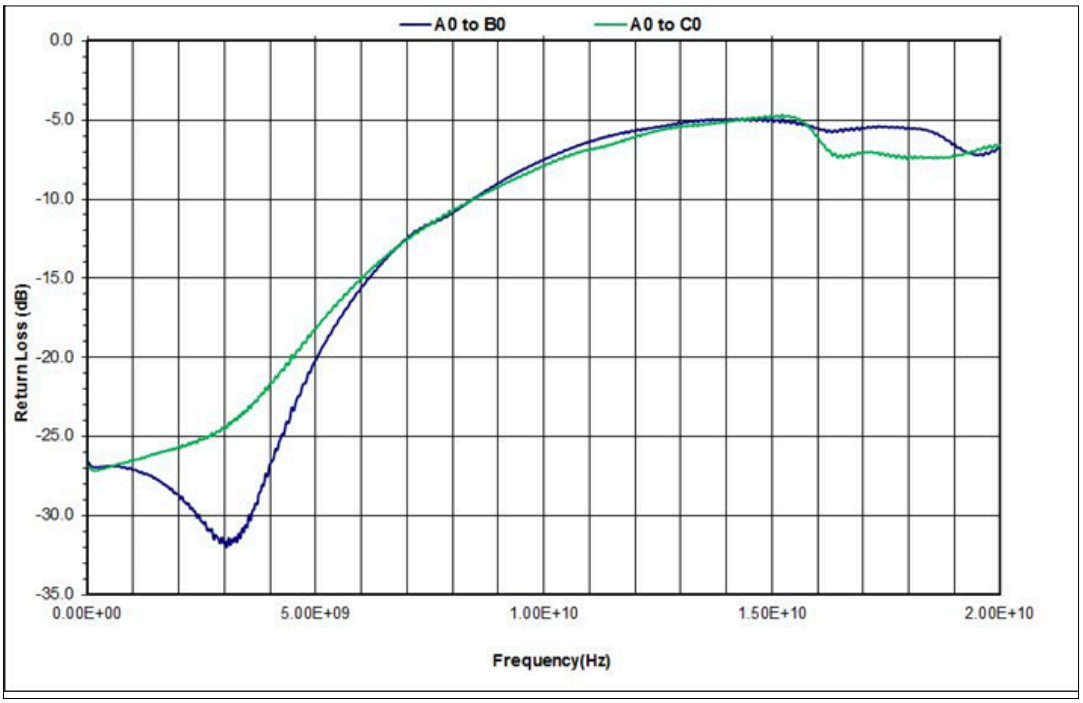


Fig 7. Differential Return Loss – Super Speed

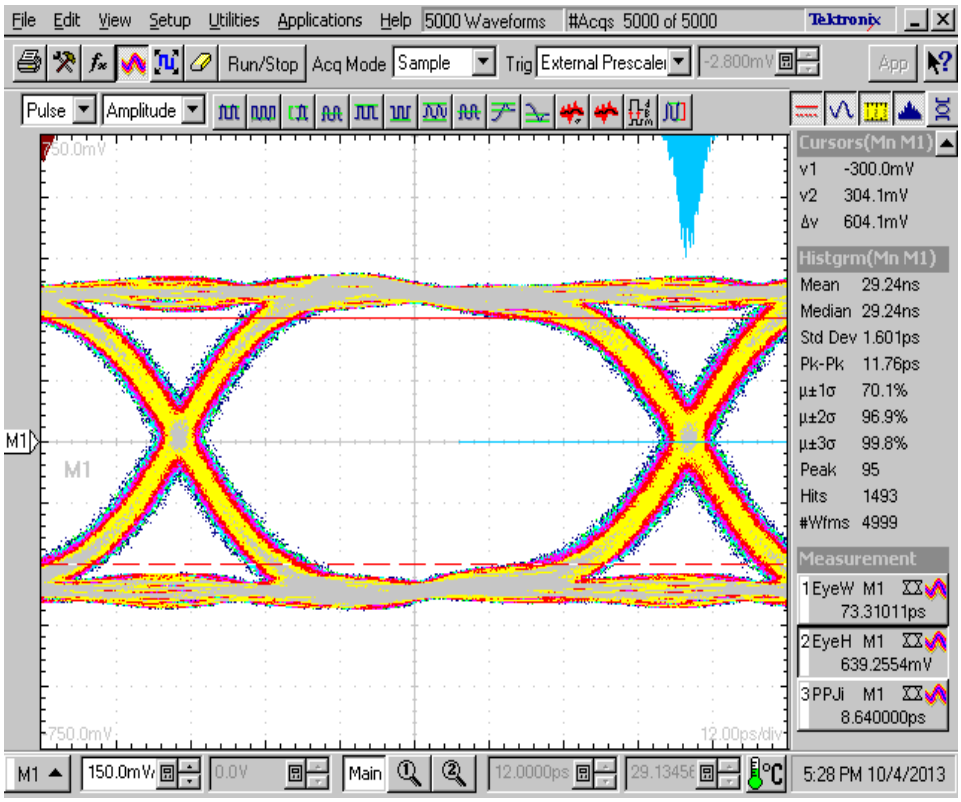


Fig 8. 12Gbps Eye without PI3USB32212

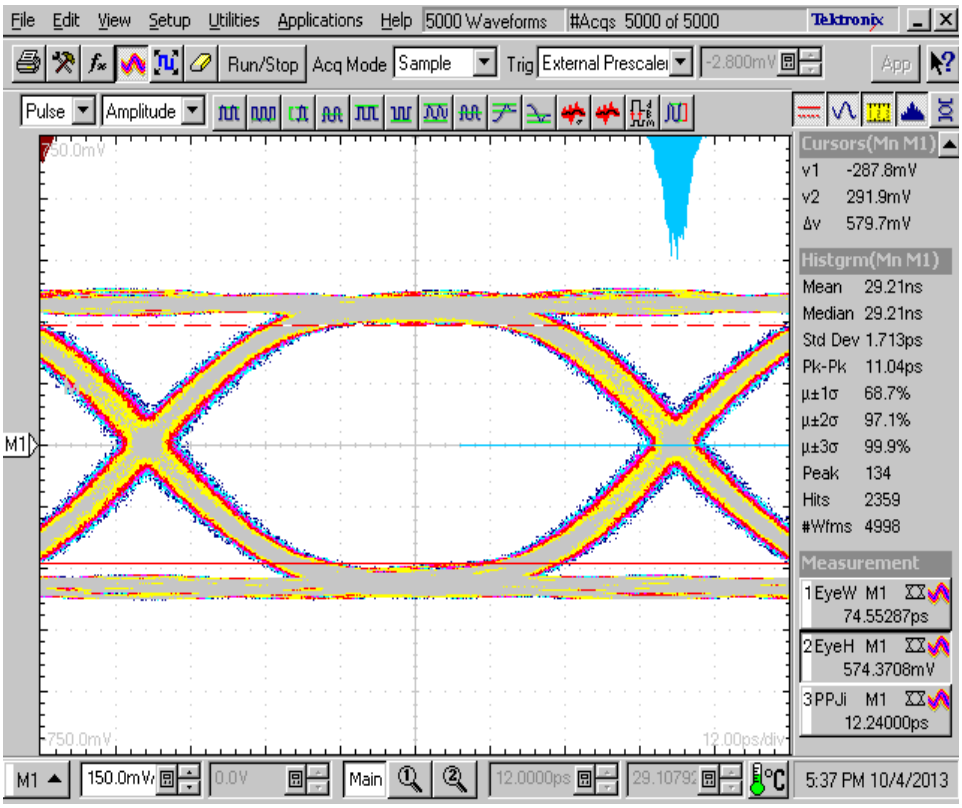


Fig 9. 12Gbps Eye with PI3USB32212

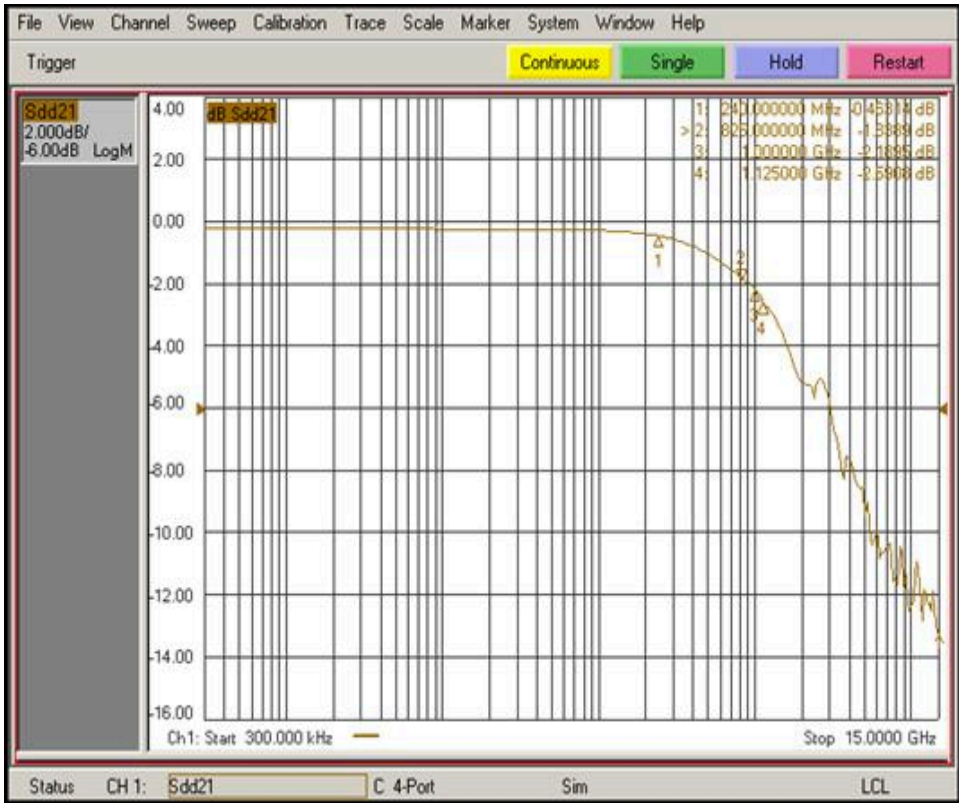
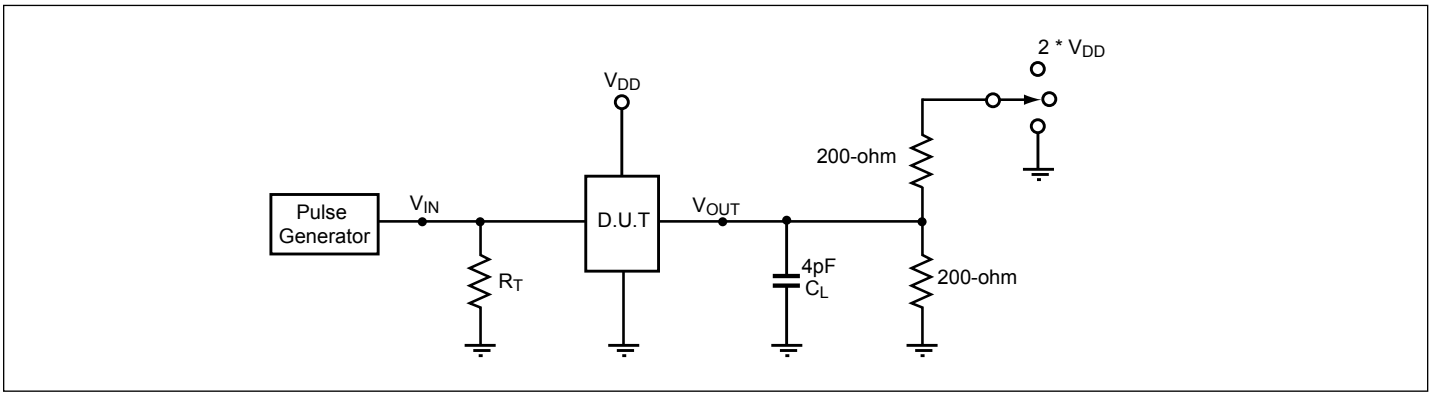


Fig 10. Differential Insertion loss, V_{DD} = 3.3V – USB2 HS

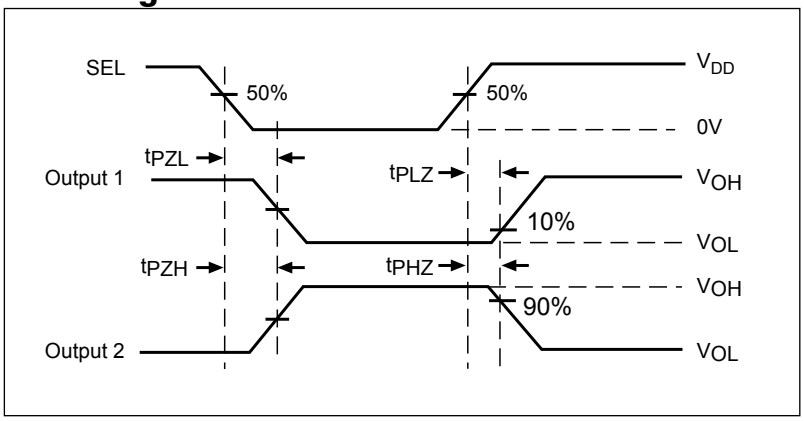
Test Circuit for Electrical Characteristics(1-5)



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 ≤ MHz, Z_O = 50Ω, t_R ≤ 2.5ns, t_F ≤ 2.5ns.
6. The outputs are measured one at a time with one transition per measurement.

Switching Waveforms

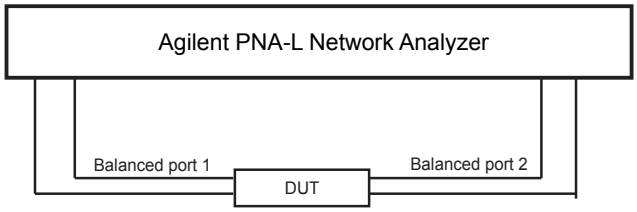


Voltage Waveforms Enable and Disable Times

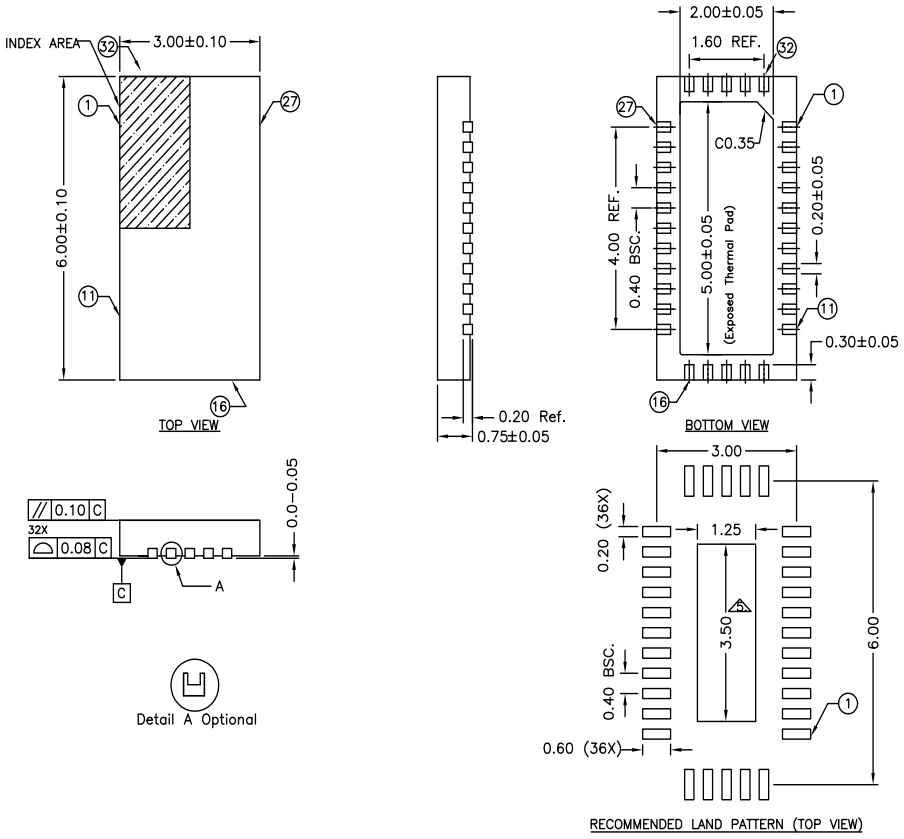
Switch Positions

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

Test Circuit for Dynamic Electrical Characteristics



Packaging Mechanical: 32-TQFN (ZL)



NOTE :
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY APPLIES TO THE EXPOSED THERMAL PAD AS WELL AS THE TERMINALS.
3. REFER JEDEC MO-220
4. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.
5. THERMAL PAD SOLDERING AREA (MESH STENCIL DESIGN IS RECOMMENDED).

DATE: 07/05/16

DESCRIPTION: 32-Contact, Very Thin Quad Flat No-Lead (TQFN)

PACKAGE CODE: ZL (ZL32)

DOCUMENT CONTROL #: PD-2044 REVISION: C

16-0142

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:

- Thermal characteristics can be found on the company web site at www.diodes.com/design/support/packaging/
- E = Pb-free and Green
- X suffix = Tape/Reel

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