

PI3USB3102**USB3.0 and USB2.0 Combo Switch****Features**

- 1:2 mux/demux for USB 3.0SS, 2.0HS, and 2.0FS signals
- Switches Tx, Rx, Dx, and USB_ID from USB3.0 connector
- Insertion Loss for super-speed channels @ 2.5 GHz: -1.7dB
- -3dB Bandwidth for super-speed channels: 4.7GHz
- Return loss for super-speed channels @ 2.5GHz: -16dB
- Low Bit-to-Bit Skew, 7ps max (between '+' and '-' bits)
- Low Crosstalk for super-speed channels: -25dB@5.0 Gbps
- Low Off Isolation for super-speed channels: -25dB@5.0 Gbps
- V_{DD} Operating Range: 3.3V +/-10%
- ESD Tolerance: 2kV HBM
- Low channel-to-channel skew, 35ps max
- 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](https://www.diodes.com/quality/product-definitions/) or your local Diodes representative.
<https://www.diodes.com/quality/product-definitions/>
- Packaging (Pb-free & Green):
 - 32 TQFN (ZL)

Application

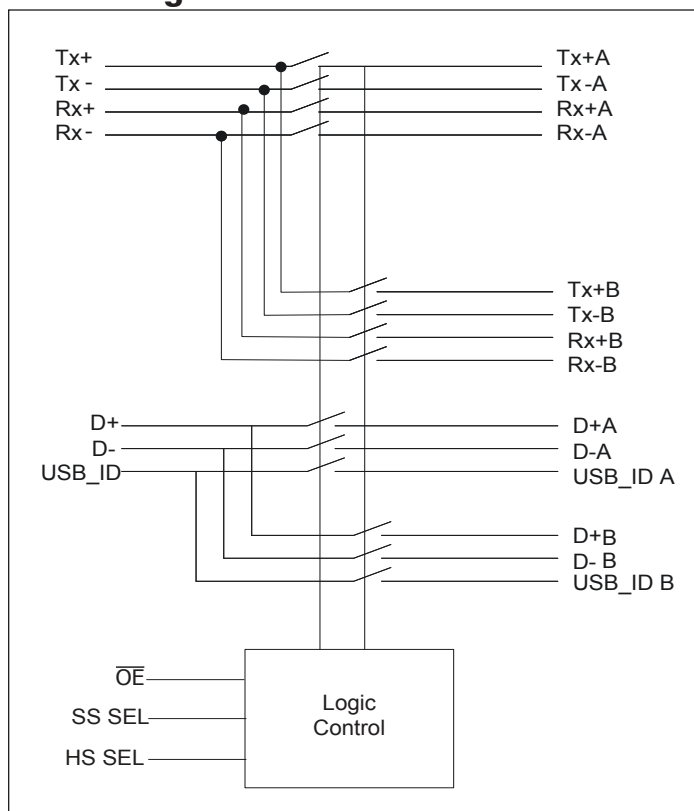
Routing of USB3.0 signals with low signal attenuation between source and sink.

Description

The DIODES PI3USB3102 USB3.0 and USB2.0 Combo Switch is a complete 1:2 switching solution for SuperSpeed USB 3.0 signals. PI3USB3102 provides differential high-speed lanes for the USB3.0 4.8 Gbps TX and RX lanes as well as a differential lane for 480 Mbps USB 2.0 signals and the USB_ID signal.

PI3USB3102 can be used to connect two hosts to a single device or a single host to two devices.

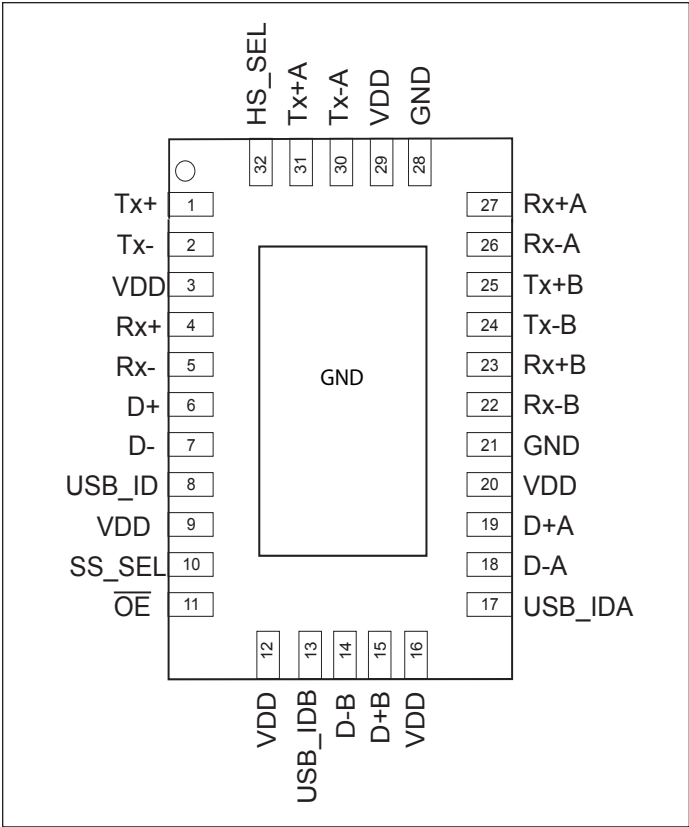
PI3USB3102 offers excellent signal integrity for high-speed signals and low power dissipation. Insertion loss is 1.7 dB and return loss is -16 dB at 2.5 GHz. Power dissipation is 6.6 mW maximum.

Block Diagram**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.

PI3USB3102

Pin Configuration



Truth Table

| OE | SS_SEL | HS_SEL | Function |
|------|--------|--------|-------------------------------------|
| Low | Low | Low | Port A active for all channels |
| Low | Low | High | Port A for SS, port B for HS and ID |
| Low | High | Low | Port B for SS, port A for HS and ID |
| Low | High | High | Port B active for all channels |
| High | x | x | I/O's are hi-z and IC is power down |

Pin Description

| Pin# | Pin Name | Signal Type | Description |
|------|------------------------|-------------|---|
| 1 | Tx+ | I/O | Positive differential USB3.0 Tx signal for COM port |
| 2 | Tx- | I/O | Negative differential USB3.0 Tx signal for COM port |
| 3 | VDD | Power | 3.3V +/-10% power supply |
| 4 | Rx+ | I/O | Positive differential USB3.0 Rx signal for COM port |
| 5 | Rx- | I/O | Negative differential USB3.0 Rx signal for COM port |
| 6 | D+ | I/O | Positive differential USB2.0 signal for COM port |
| 7 | D- | I/O | Negative differential USB2.0 signal for COM port |
| 8 | USB_ID | I/O | USB_ID for COM port |
| 9 | VDD | Power | 3.3V +/-10% power supply |
| 10 | SS_SEL | I | Switch logic control for SuperSpeed Path If HIGH, then path B is selected for SuperSpeed channels only If LOW, then path A is selected for SuperSpeed channels only |
| 11 | $\overline{\text{OE}}$ | I | Output enable. if $\overline{\text{OE}}$ is low, IC is enabled. If $\overline{\text{OE}}$ is high, then IC is power down and all I/Os are Hi-Z |
| 12 | VDD | Power | 3.3V +/-10% power supply |
| 13 | USB_IDB | I/O | USB_ID for port B |
| 14 | D-B | I/O | Negative differential USB2.0 signal for port B |
| 15 | D+B | I/O | Positive differential USB2.0 signal for port B |
| 16 | VDD | Power | 3.3V +/-10% power supply |
| 17 | USB_IDA | I/O | USB_ID for port A |
| 18 | D-A | I/O | Negative differential USB2.0 signal for port A |
| 19 | D+A | I/O | Positive differential USB2.0 signal for port A |
| 20 | VDD | Power | 3.3V +/-10% power supply |
| 21 | GND | Ground | Ground |
| 22 | Rx-B | I/O | Negative differential USB3.0 Rx signal for port B |
| 23 | Rx+B | I/O | Positive differential USB3.0 Rx signal for port B |
| 24 | Tx-B | I/O | Negative differential USB3.0 Tx signal for port B |
| 25 | Tx+B | I/O | Positive differential USB3.0 Tx signal for port B |
| 26 | Rx-A | I/O | Negative differential USB3.0 Rx signal for port A |
| 27 | Rx+A | I/O | Positive differential USB3.0 Rx signal for port A |
| 28 | GND | Ground | Ground |
| 29 | VDD | Power | 3.3V +/-10% power supply |
| 30 | Tx-A | I/O | Negative differential USB3.0 Tx signal for port A |
| 31 | Tx+A | I/O | Positive differential USB3.0 Tx signal for port A |
| 32 | HS_SEL | I | Switch logic control for USB2.0 (D+/-) and USB_ID path If High, path B is selected If LOW, path A is selected |

Maximum Ratings

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

| | |
|--|-------------------|
| Storage Temperature | -65°C to +150°C |
| Junction Temperature | 125°C |
| Supply Voltage to Ground Potential | -0.5V to +4.2V |
| DC Input Voltage | -0.5V to V_{DD} |
| 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 Switching over Operating Range

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

| Parameter | Description | Test Conditions ⁽¹⁾ | Min. | Typ. ⁽¹⁾ | Max. | Units |
|------------------|---|---|------|---------------------|---------|---------------|
| V_{IH} | Input HIGH Voltage | Guaranteed HIGH level | 1.5 | | | V |
| V_{IL} | Input LOW Voltage | Guaranteed LOW level | | | 0.75 | |
| V_{IK} | Clamp Diode Voltage, Dx | $V_{DD} = \text{Max.}$, $I_{IN} = -18\text{mA}$ | | -0.8 | -1.1 | |
| I_{IH} | Input HIGH Current | $V_{DD} = \text{Max.}$, $V_{IN} = V_{DD}$ | | | ± 5 | μA |
| I_{IL} | Input LOW Current | $V_{DD} = \text{Max.}$, $V_{IN} = \text{GND}$ | | | ± 5 | |
| $I_{OFF_HS/ID}$ | I/O leakage when part is off for D+, D- and USB_ID signals only | $V_{DD} = 0\text{V}$, $V_{INPUT} = 0\text{V}$ to 3.6V | | | 20 | |
| R_{ON_SS} | On resistance between input to output for SuperSpeed signals | $V_{DD} = 3.3\text{V}$, $V_{input} = 0\text{V}$ to 1V , $I_{INPUT} = 20\text{mA}$ | | 10 | 13 | Ohm |
| R_{ON_FS} | On resistance between input to output for USB2.0 FS signals (D+/D-) | $V_{DD} = 3.3\text{V}$, $V_{input} = 0$ to 3.3V , $I_{INPUT} = 20\text{mA}$ | | 7 | 9 | Ohm |
| R_{ON_HS} | On resistance between input to output for USB2.0 HS signals (D+/D-) | $V_{DD} = 3.3\text{V}$, $V_{input} = -0.4\text{V}$ to $+0.4\text{V}$, $I_{INPUT} = 20\text{mA}$ | | 4 | 6 | Ohm |
| USB_ID_I | Input voltage tolerance on USB_ID path | | | | 5.5 | V |
| USB_ID_O | Output voltage on USB_ID path | USB_ID input from 0V to 5.25V | | | 3.6 | V |

Power Supply Characteristics ($T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$)

| Parameter | Description | Test Conditions ⁽¹⁾ | Min. | Typ. ⁽¹⁾ | Max. | Units |
|-----------|--------------------------------|--|------|---------------------|------|-------|
| I_{CC} | Quiescent Power Supply Current | $V_{DD} = \text{Max.}$, $V_{IN} = \text{GND}$ or V_{DD} | | | 2 | mA |

PI3USB3102
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 | | Typ. | Max. | Units |
|---------------|--|-----------------------------------|----------------------|-------|------|-------|
| X_{TALK} | Crosstalk on SuperSpeed Channels | See Fig. 1 for Measurement Setup | $f = 2.5\text{ GHz}$ | -25dB | | dB |
| O_{IRR} | OFF Isolation on SuperSpeed Channels | See Fig. 2 for Measurement Setup, | $f = 2.5\text{ GHz}$ | -22dB | | |
| I_{LOSS} | Differential Insertion Loss on SuperSpeed Channels | @5.0Gbps (see figure 3) | | -1.7 | | dB |
| R_{loss} | Differential Return Loss on SuperSpeed channels | @ 2.5GHz | | -16 | | dB |
| BW_{SS} | Bandwidth -3dB for SuperSpeed path ($Tx\pm/ Rx\pm$) | See figure 3 | | 4.7 | | GHz |
| BW_{HS} | -3dB BW for USB high speed path (D+/-) | See figure 3 | | 1.5 | | GHz |
| $T_{sw\ a-b}$ | Time it takes to switch from port A to port B | | | | 1 | us |
| $T_{sw\ b-a}$ | Time it takes to switch from port B to port A | | | | 1 | us |
| $T_{startup}$ | Vdd valid to channel enable | | | | 10 | us |
| T_{wakeup} | Enabling output by changing \overline{OE} from low to High | | | | 10 | us |

Note:

1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at $V_{DD} = 3.3\text{V}$, $T_A = 25^\circ\text{C}$ 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_{pd} | Propagation delay (input pin to output pin) | | 80 | | ps |
| t_{b-b} | Bit-to-bit skew within the same differential pair | | 5 | | ps |
| t_{ch-ch} | Channel-to-channel skew | | | 35 | ps |

PI3USB3102

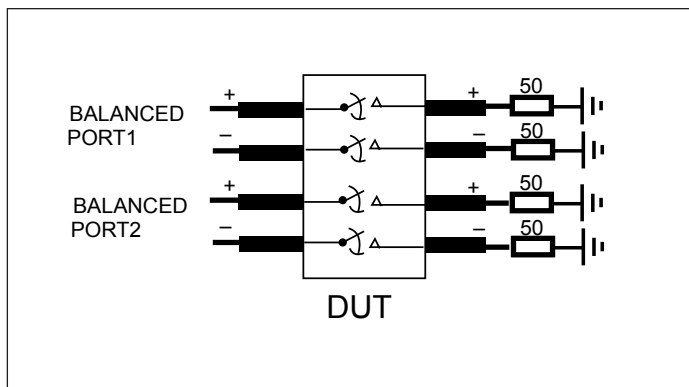


Fig 1. Crosstalk Setup

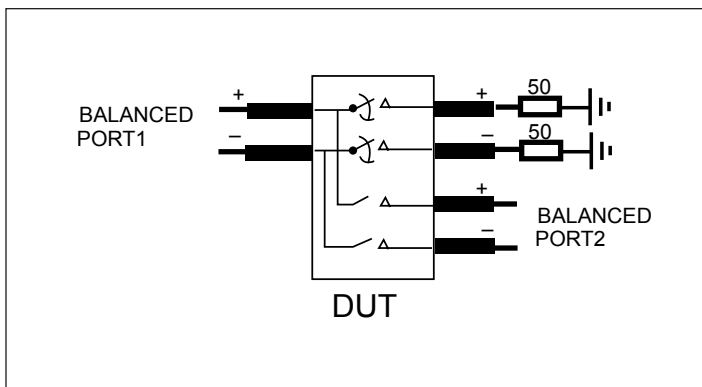


Fig 2. Off-Isolation Setup

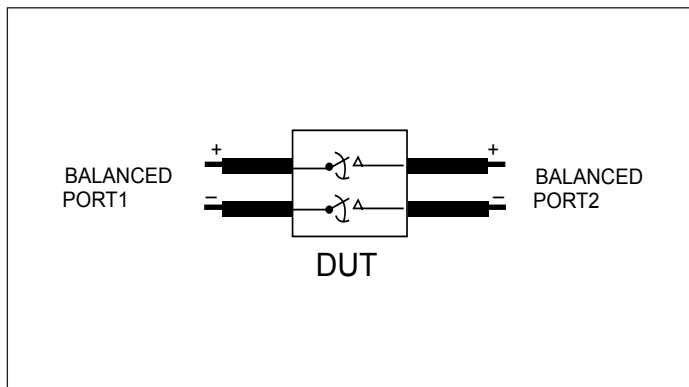


Fig 3. Differential Insertion Loss Setup

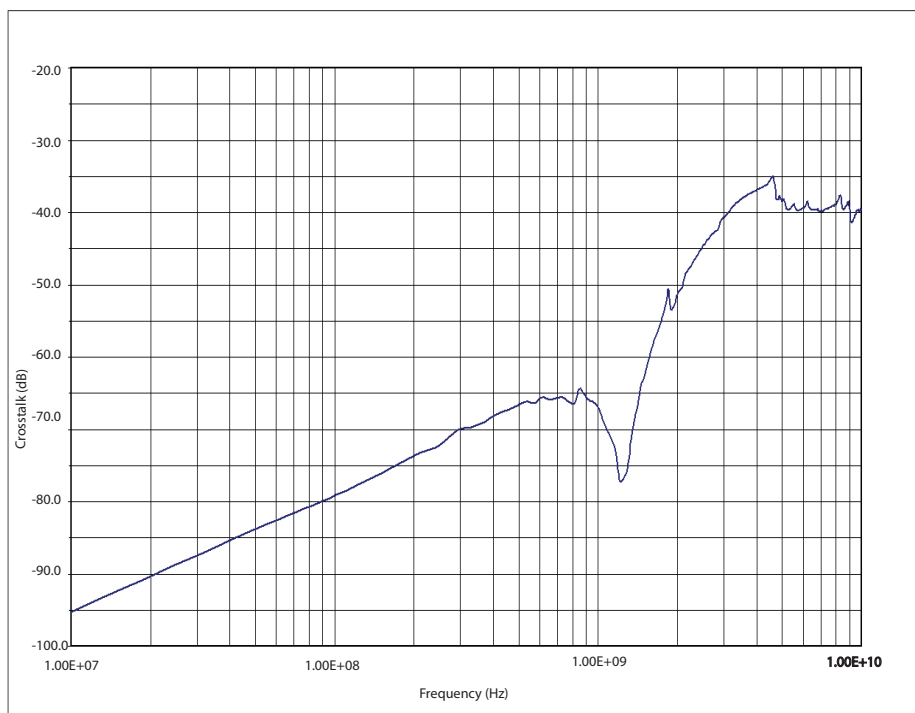


Fig 4. Xtalk for SuperSpeed Channels (Tx/Rx)

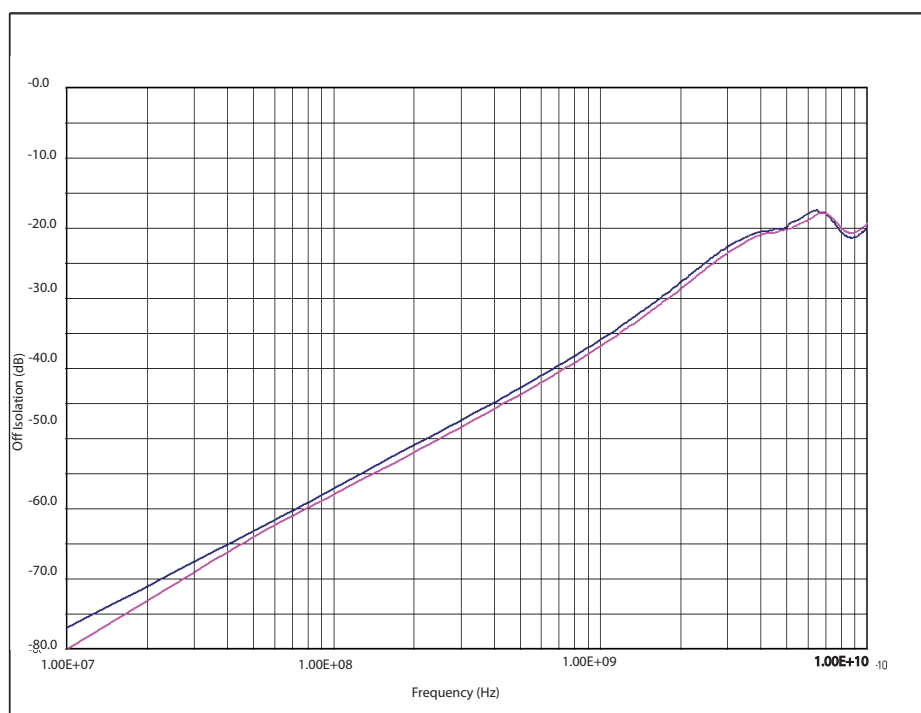


Fig 5. Off Isolation for SuperSpeed Channels (Tx/Rx). Red is for path B and Blue is for path A

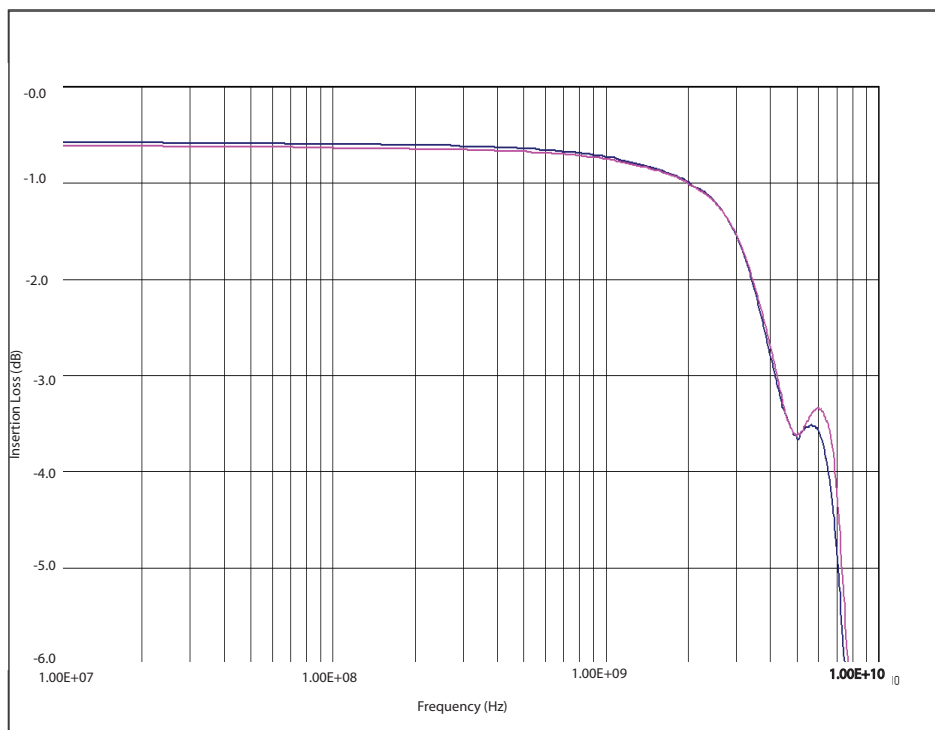
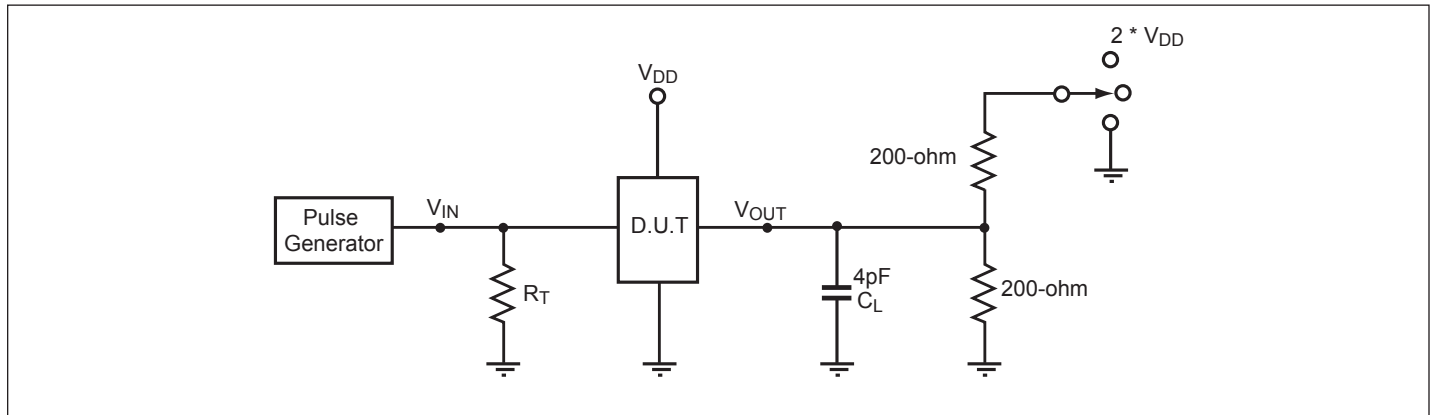


Fig 6. Insertion Loss for SuperSpeed Channels (Tx/Rx). Red is for path B and Blue is for path A

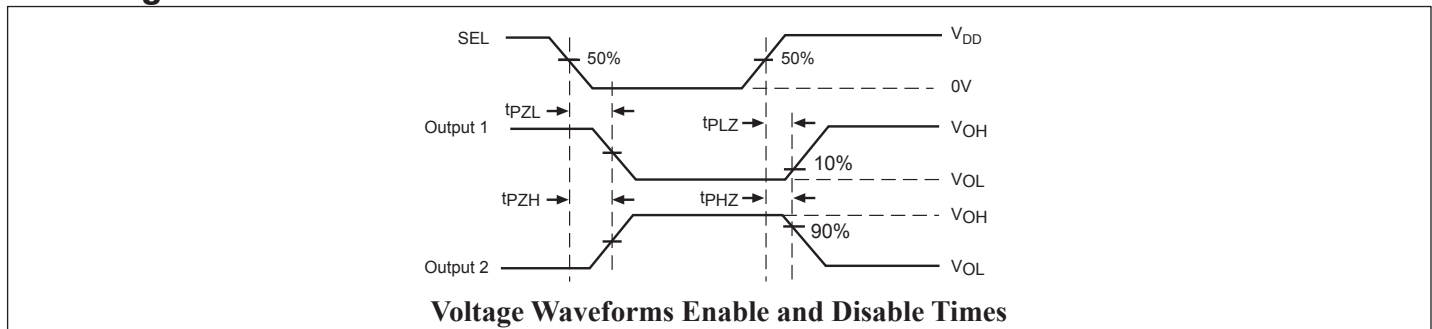
Test Circuit for Electrical Characteristics⁽¹⁻⁵⁾



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.

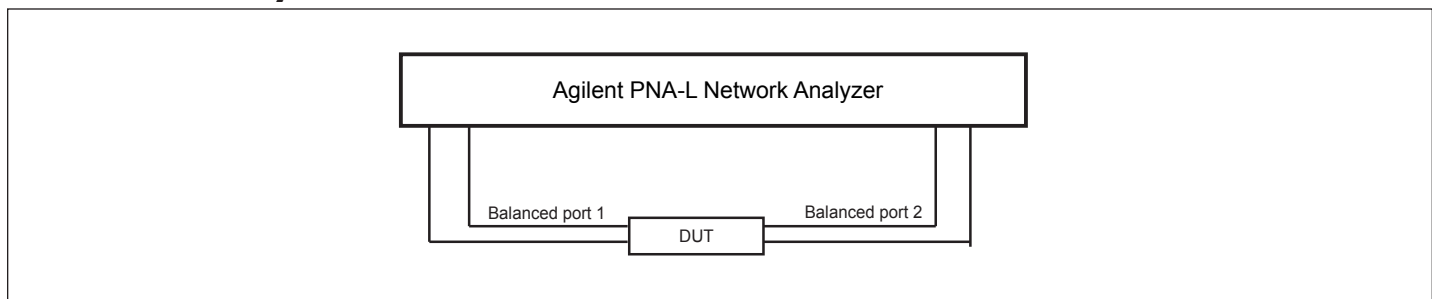
Switching Waveforms



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 |

Test Circuit for Dynamic Electrical Characteristics



PI3USB3102

Part Marking



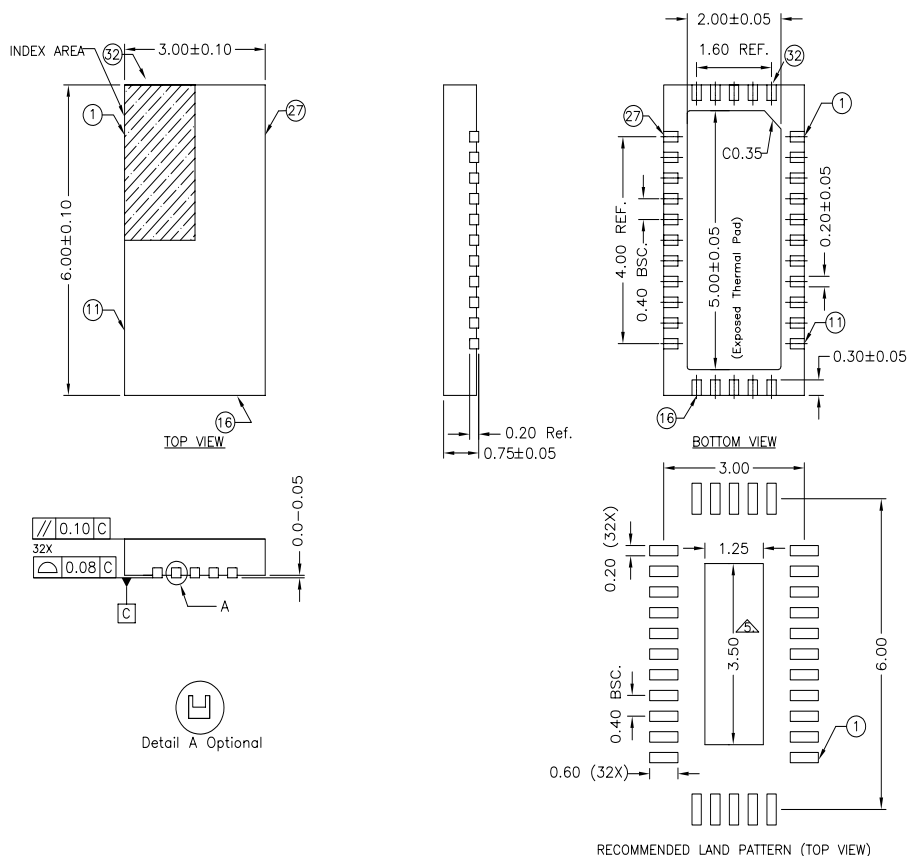
YY: Year

WW: Workweek

1st X: Assembly Code

2nd X: Fab Code

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).

20-1240

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 |
|----------------|--------------|--|
| PI3USB3102ZLEX | ZL | 32-contact, Very Thin Quad Flat No-Lead (TQFN) |

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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