

**PI3PCIE2215**

**3.3V, PCI Express<sup>®</sup> 1-lane, 2:1 Mux/DeMux Switch**

**Features**

- 2 Differential Channel, 2:1 Mux/DeMux
- PCI Express<sup>®</sup> 2.0 Performance, 5.0Gbps
- Pinout optimized for placement between two PCIe slots
- Bi-directional operation
- Low Bit-to-Bit Skew, 5ps max
- Low Crosstalk: -26dB@5 GHz
- Low Off Isolation: -20dB@5 GHz
- VDD Operating Range: +3.3V
- ESD Tolerance: 2kV HBM
- 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):
  - 28 contact TQFN (ZH)

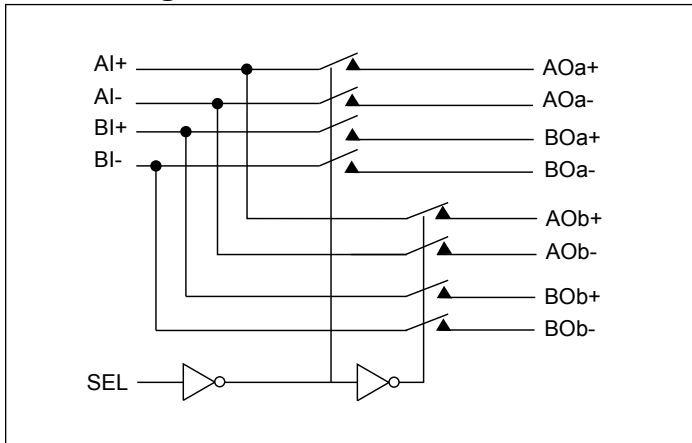
**Description**

Diodes' PI3PCIE2215 is a 4 to 2 differential channel multiplexer/demultiplexer switch. The PI3PCIE family of switch solutions is fully compliant with PCIe<sup>®</sup> signals at 5.0Gbps. Due to its low bit-to-bit skew, high channel-to-channel noise isolation and high bandwidth, this product is ideal for PCI Express switching.

**Application**

Switch a PCI Express<sup>®</sup> lane output between two PCI Express lane inputs

**Block Diagram**



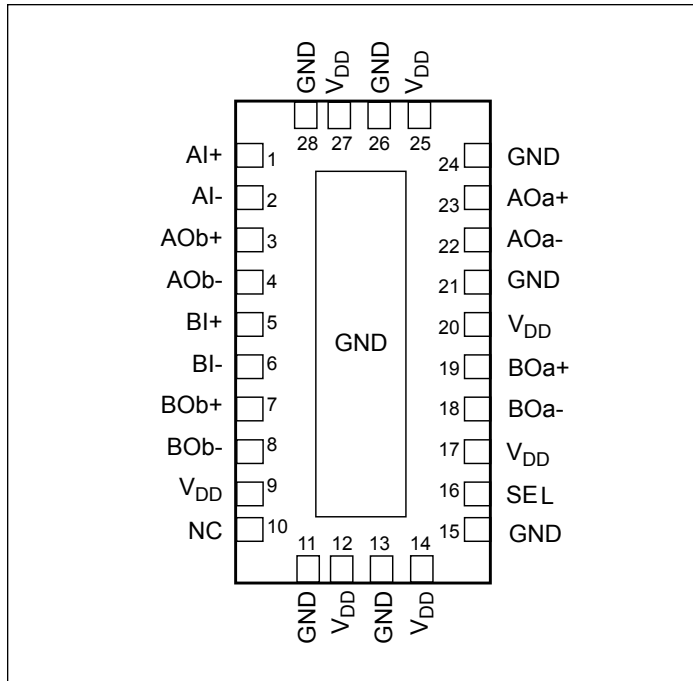
**Truth Table**

| Function    | SEL |
|-------------|-----|
| xIy to xOay | L   |
| xIy to xOby | H   |

**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.

## Pin Configuration



## Pin Descriptions

| Pin Number                                | Pin Name        | Type   | Description  |
|---|-----------------|--|--|
| 1<br>2                                    | AI+<br>AI-      | Differential input                           | Differential input pair from PCIE signal source. Signal is passed through to the AOa+, AOa- pin respectively when SEL=0. Signal is passed through to the AOb+, AOb- pin respectively when SEL = 1. |
| 23<br>22                                  | AOa+<br>AOa-    | Differential pass-through input              | Differential analog pass-through output. Signal from AI+ and AI- is passed through AOa+ and AOa- respectively when SEL=0.  |
| 3<br>4                                    | AOb+<br>AOb-    | Differential pass-through input              | Differential analog pass-through output. Signal from AI+ and AI- is passed through AOa+ and AOa- respectively when SEL=1.  |
| 5<br>6                                    | BI+<br>BI-      | Differential input                           | Differential input pair from PCIE signal source. Signal is passed through to the BOa+, BOa- pin respectively when SEL=0. Signal is passed through to the BOb+, BOb- pin respectively when SEL = 1. |
| 19<br>18                                  | BOa+<br>BOa-    | Differential pass-through input              | Differential analog pass-through output. Signal from BI+ and BI- is passed through BOa+ and BOa- respectively when SEL=0.  |
| 7<br>8                                    | BOb+<br>BOb-    | Differential pass-through input              | Differential analog pass-through output. Signal from BI+ and BI- is passed through BOb+ and BOb- respectively when SEL=1.  |
| 11, 13, 15, 21, 24,<br>26, 28, Center pad | GND             | Ground input                                 | Ground   |
| 10  | NC              | -  | No Connect - Reserved, do not connect  |
| 16  | SEL             | 3.6V tolerant low-voltage single-ended input | SEL controls the mux through a flow-through latch.   |
| 9, 12, 14, 17, 20,<br>25, 27              | V <sub>DD</sub> | Power supply                                 | Power, 3.3V ±10%   |

## 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 +4.6V  |
| DC Input Voltage .....                   | -0.5V to 1.5V   |
| 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.

## Electrical Characteristics

### Recommended Operating Conditions

| Symbol            | Parameter   | Conditions | Min | Typ. | Max | Units |
|-------------------|---|------------|-----|------|-----|-------|
| V <sub>DD</sub>   | 3.3V Power Supply                                 |            | 3.0 | 3.3  | 3.6 | V     |
| I <sub>DD</sub>   | Total current from V <sub>DD</sub> 3.3V supply    |            | 0   |      | 2.5 | mA    |
| T <sub>CASE</sub> | Case temperature range for operation within spec. |            | -40 |      | 85  | °C    |

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

| Parameter           | Description                      | Test Conditions  | Min | Typ. <sup>(1)</sup> | Max | Units |
|---------------------|----------------------------------|--|-----|---------------------|-----|-------|
| V <sub>IH-SEL</sub> | Input high level, SEL input      |  | 2.0 |                     | 3.6 | V     |
| V <sub>IL-SEL</sub> | Input Low Level, SEL input       |  | 0   |                     | 0.8 | V     |
| I <sub>IN_SEL</sub> | Input Leakage Current, SEL input | Measured with input at V <sub>IH-SEL</sub> max and V <sub>IL-SEL</sub> min | -10 |                     | 10  | µA    |
| R <sub>ON</sub>     | On Resistance                    | V <sub>DD</sub> = Min., V <sub>IN</sub> = 1.3V, I <sub>IN</sub> = 40mA     |     |                     | 12  | Ω     |
| C <sub>ON</sub>     | On Channel Capacitance           | V <sub>IN</sub> = 0, V <sub>DD</sub> = 3.3V                                |     | 2.0                 |     | pF    |

**Note:**

1. Typical values are at V<sub>DD</sub> = 3.3V, T<sub>A</sub> = 25°C ambient and maximum loading.

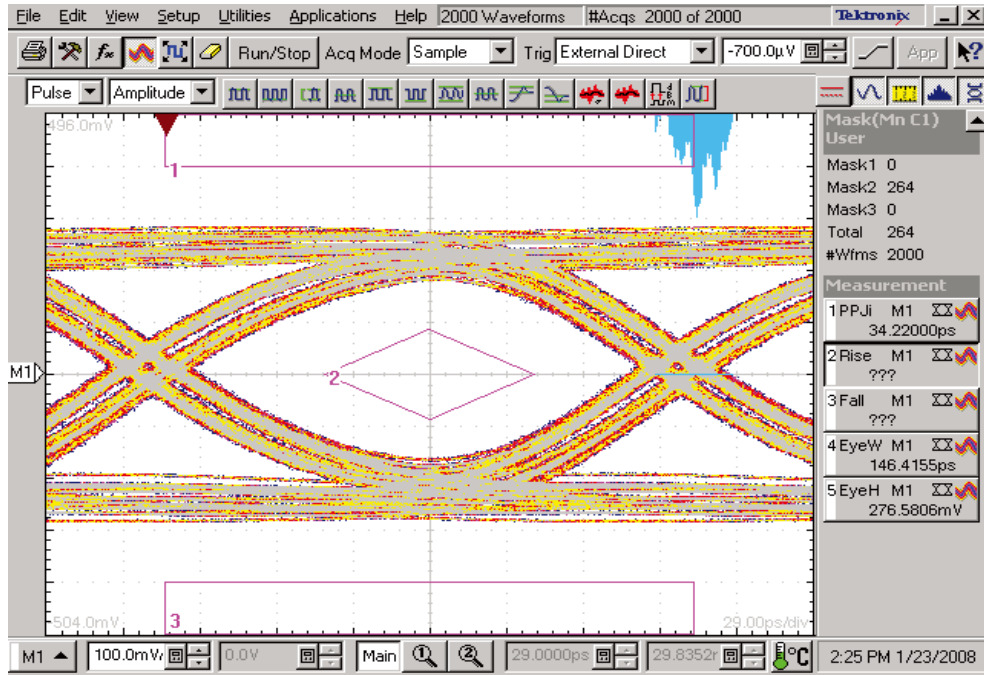
### Dynamic Electrical Characteristics for xI±, xOy±

| Parameter           | Description                 | Test Conditions  | Min. | Typ. <sup>(1)</sup> | Max.  | Units |
|---------------------|-----------------------------|------------------|------|---------------------|-------|-------|
| DDIL                | Differential Insertion Loss | f=1.2GHz         | -1.5 |                     |       | dB    |
|                     |                             | f=2.5GHz         | -2.0 |                     |       |       |
|                     |                             | f=5.0GHz         | -5.0 |                     |       |       |
|                     |                             | f=7.5GHz         | -9.0 |                     |       |       |
| DDIL <sub>OFF</sub> | Differential Off Isolation  | f= 0 to 3.0GHz   |      |                     | -20.0 |       |
| DDRL                | Differential Return Loss    | f= 0 to 2.8GHz   |      | -14.0               |       |       |
|                     |                             | f= 2.8 to 5.0GHz |      | -8.0                |       |       |
|                     |                             | f= 5.0 to 7.5GHz |      | -4.0                |       |       |
| DDNEXT              | Near End Crosstalk          | f= 0 to 2.5GHz   |      |                     | -32.0 |       |
|                     |                             | f= 2.5 to 5.0GHz |      |                     | -26.0 |       |
|                     |                             | f= 5.0 to 7.5GHz |      |                     | -20.0 |       |

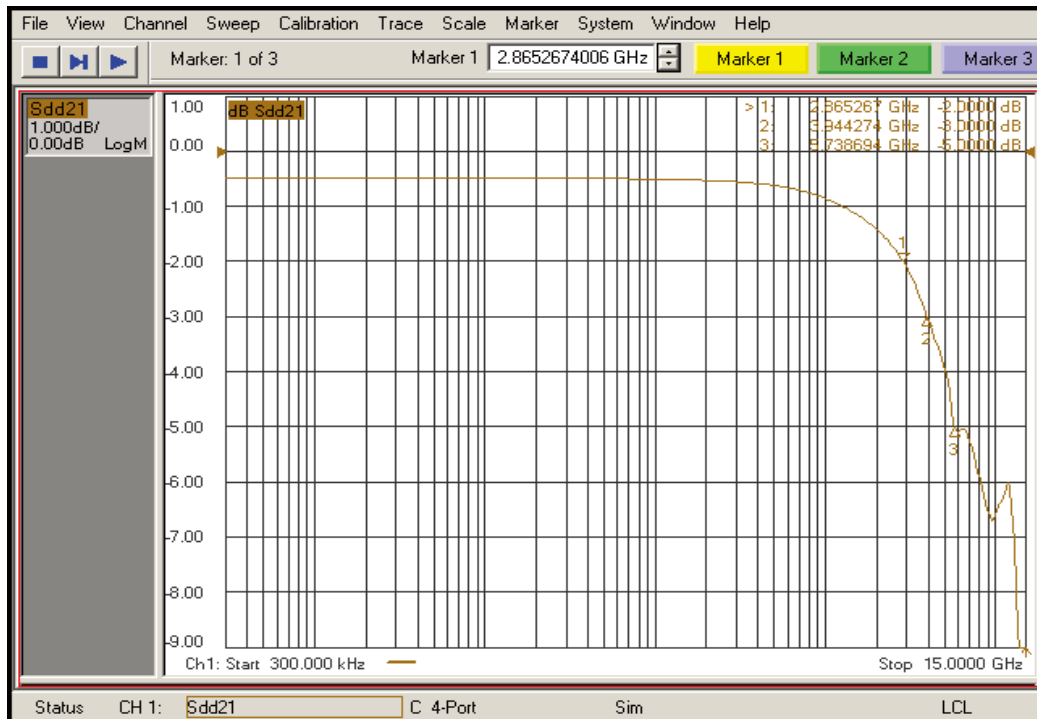
**Switching Characteristics** ( $T_A = -40^\circ$  to  $+85^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V} \pm 10\%$ )

| Parameter          | Description                                       | Test Conditions                                   | Min. | Typ. | Max. | Units |
|--------------------|---|---|------|------|------|-------|
| tPZH, tPZL         | Line Enable Time - SEL to xI+/-, xOy+/-           | See "Test Circuit for Electrical Characteristics" | 0.5  |      | 12.0 | ns    |
| tPHZ, tPLZ         | Line Disable Time - SEL to xI+/-, xOy+/-          | See "Test Circuit for Electrical Characteristics" | 0.5  |      | 12.0 | ns    |
| t <sub>b-b</sub>   | Bit-to-bit skew within the same differential pair | See "Test Circuit for Electrical Characteristics" |      |      | 7    | ps    |
| t <sub>ch-ch</sub> | Channel-to-channel skew                           | See "Test Circuit for Electrical Characteristics" |      |      | 35   | ps    |

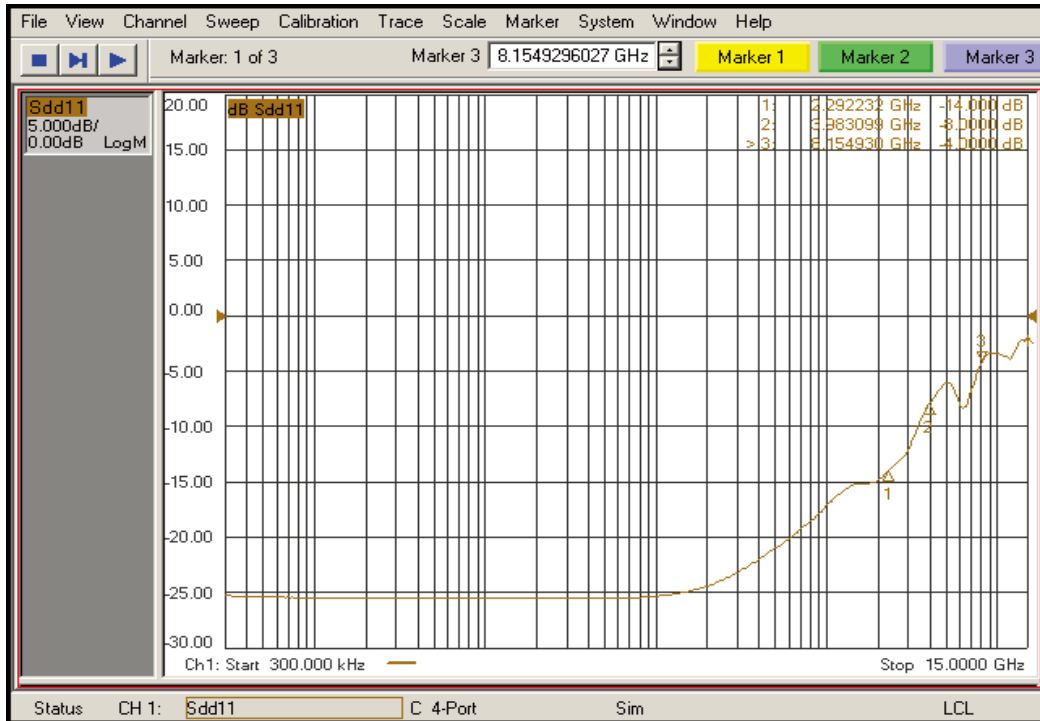
**PI3PCIE2215**



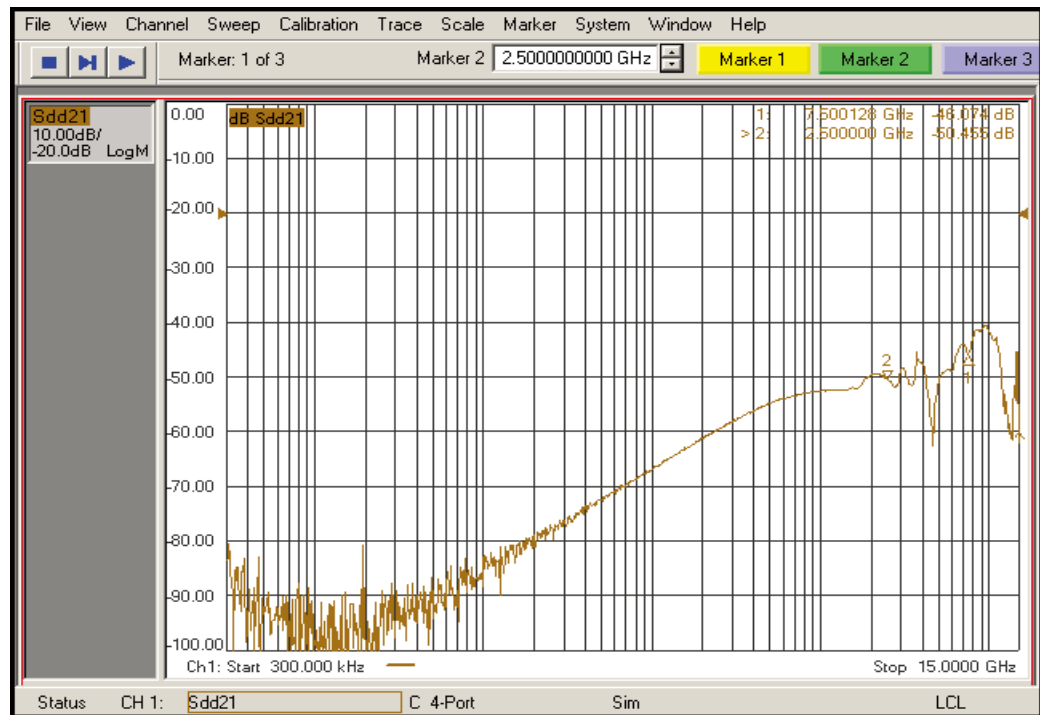
**5.0 Gbps Receive Eye Mask (-3.5dB)**



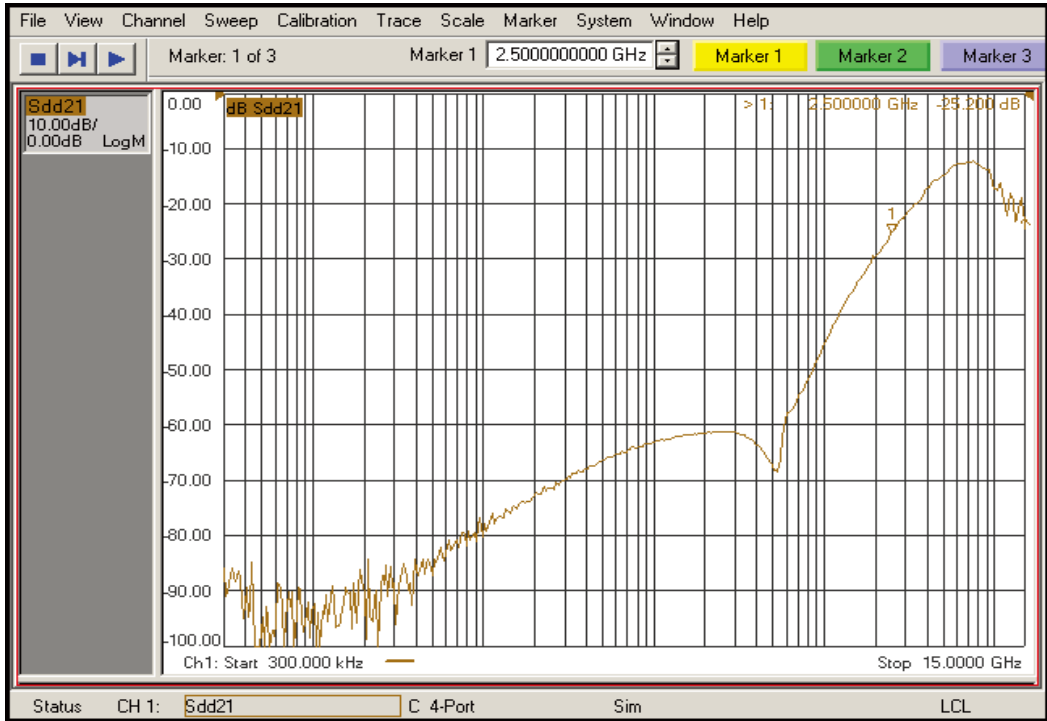
**Differential Insertion Loss**



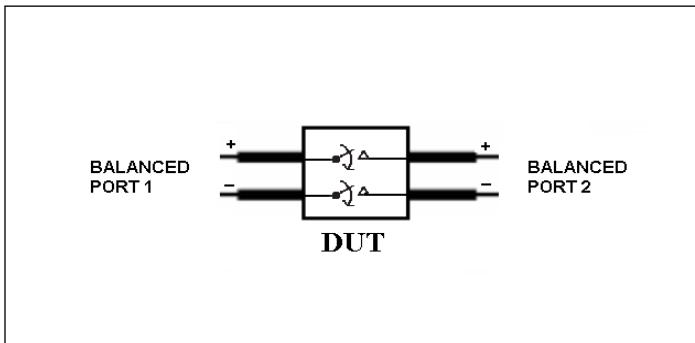
**Differential Return Loss**



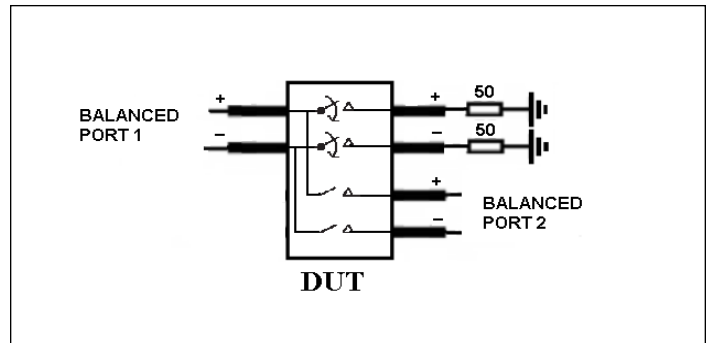
**Differential Off Isolation**



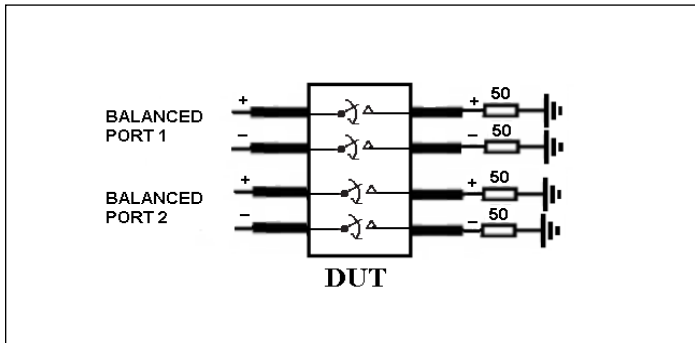
**Differential Crosstalk**



**Differential Insertion Loss/Return Loss Test Circuit**

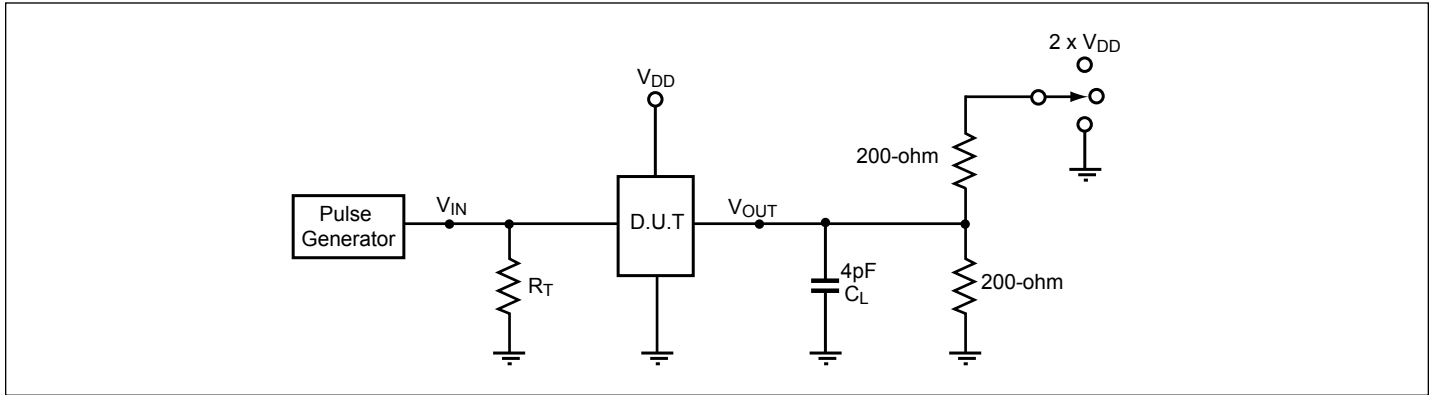


**Differential Off Isolation Test Circuit**



**Differential Near End Crosstalk Test Circuit**

**Test Circuit for Electrical Characteristics<sup>(1-5)</sup>**



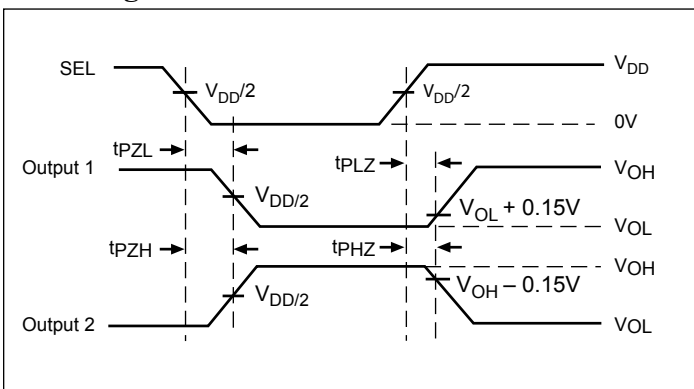
**Notes:**

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.  
output 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
4. All input impulses are supplied by generators having the following characteristics:  $PRR \leq \text{MHz}$ ,  $Z_O = 50\Omega$ ,  $t_R \leq 2.5\text{ns}$ ,  $t_F \leq 2.5\text{ns}$ .
5. The outputs are measured one at a time with one transition per measurement.

**Switch Positions**

| Test                  | Switch            |
|-----------------------|-------------------|
| $t_{PLZ}$ , $t_{PZL}$ | $2 \times V_{DD}$ |
| $t_{PHZ}$ , $t_{PZH}$ | GND               |
| Prop Delay            | Open              |

**Switching Waveforms**



**Voltage Waveforms Enable and Disable Times**



## Applications Information

### Differential Inputs/Output Characteristics for Gen2 speeds

| Symbol                  | Parameter                               | Min    | Nom    | Max    | Units | Comments   |
|-------------------------|---|--------|--------|--------|-------|--|
| Tbit                    | Unit Interval                           | 199.94 | 200.00 | 200.06 | ps    | Defined by Gen2 spec.  |
| V <sub>RX-DIFFp-p</sub> | Differential Input Peak to Peak Voltage | TBD    |        | 1.200  | V     | $V_{RX-DIFFp-p} = 2 *  V_{RX-D+} - V_{RX-D-} $ . Applies to IN_S and RX_IN signals.  |
| T <sub>RX-EYE</sub>     | Minimum Eye Width at IN_D input pair.   | TBD    |        |        | Tbit  |  |
| V <sub>CM-AC-pp</sub>   | AC Peak Common-Mode Input Voltage       |        |        | 100    | mV    | $V_{CM-AC-pp} =  V_{RX-D+} + V_{RX-D-} /2 - V_{RX-CM-DC}$ .<br><br>$V_{RX-CM-DC} = DC(avg) \text{ of }  V_{RX-D+} + V_{RX-D-} /2$<br><br>VCM-AC-pp includes all frequencies above 30kHz. |
| Z <sub>RX-DIFF-DC</sub> | DC Differential Input Impedance         | 80     | 100    | 120    | W     | Rx DC Differential Mode impedance  |
| Z <sub>RX-DC</sub>      | DC Input Impedance                      | 40     | 50     | 60     | W     | Required IN_D+ as well as IN_D-DC impedance (50 W +/- 20% tolerance). Includes mux resistance.   |
| V <sub>RX-Bias</sub>    | Rx input termination voltage            | 0      |        | 2.0    | V     | Intended to limit power-up stress on PCIE output buffers.  |

## Part Marking



YY: Year

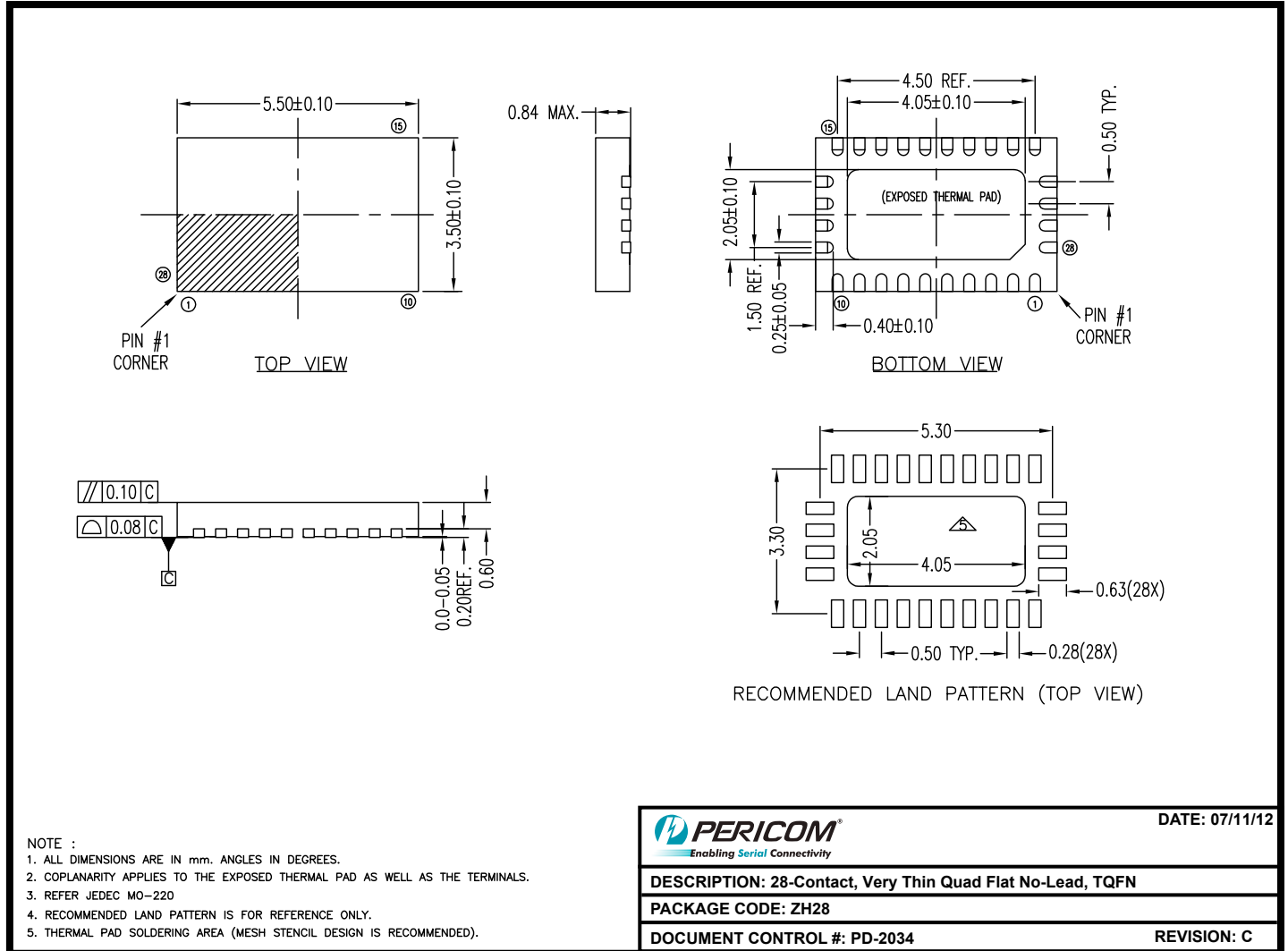
WW: Workweek

1st X: Assembly Code

2nd X: Fab Code

Bar above fab code means Cu wire

**Packaging Mechanical: 28-TQFN (ZH)**



12-0419

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                            |
|-----------------|--------------|--|
| PI3PCIE2215ZHEX | ZH           | 28-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

**IMPORTANT NOTICE**

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and definitive format released by Diodes Incorporated.

**LIFE SUPPORT**

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
  2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.
- B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2016, Diodes Incorporated  
[www.diodes.com](http://www.diodes.com)