

**PI3PCIE3415A**

**3.3V, PCI Express 3.0 2-Lane, 2:1 Mux/DeMux Switch**

**Features**

- Four Differential Channel, 2:1 Mux/DeMux
- PCI Express® 3.0 Performance, 8.0Gbps
- Pinout Optimized for Placement Between two PCIe Slots
- Bidirectional Operation
- Low Bit-to-Bit Skew, 10ps max
- Low Crosstalk: -48dB @ 4GHz
- High Off Isolation: -22dB @ 4GHz
- Low Insertion Loss: -1.2dB @ 4GHz
- Return Loss: -15dB @ 4GHz
- V<sub>DD</sub> Operating Range: +3.3V
- Industrial Temperature Range: -40°C to 85°C
- ESD Tolerance: 1.5kV HBM
- Low Channel-to-Channel Skew, 20ps max
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. “Green” Device (Note 3)
- Packaging (Pb-free & Green):
  - 42-contact, TQFN (ZH42), 3.5mm × 9mm

**Application**

Routing of PCI Express 3.0, DP1.2, USB3.0, SAS2.0, SATA3.0, XAUI, RXAUI signals with low signal attenuation.

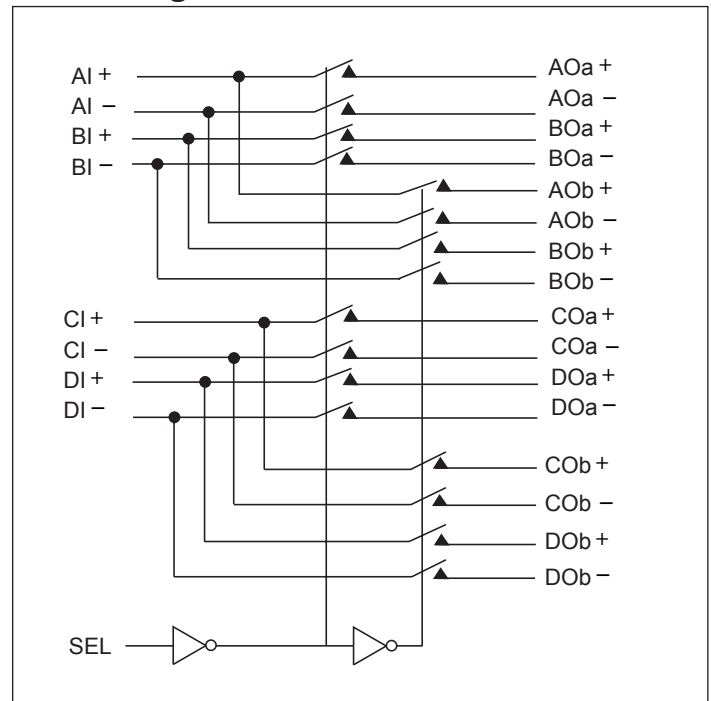
**Truth Table**

Function	SEL
xIy to xOay	L
xIy to xOby	H

**Description**

The PI3PCIE3415A is an 8-to-4 differential channel multiplexer/demultiplexer switch. This solution can switch two full PCI Express 3.0 lanes to one of two locations. Using a unique design technique, Diodes is able to minimize the impedance of the switch so that the attenuation observed through the switch is negligible. The unique design technique also offers a layout targeted for PCI Express signals, which minimizes the channel-to-channel skew as well as channel-to-channel crosstalk as required by the PCI Express specification.

**Block Diagram**



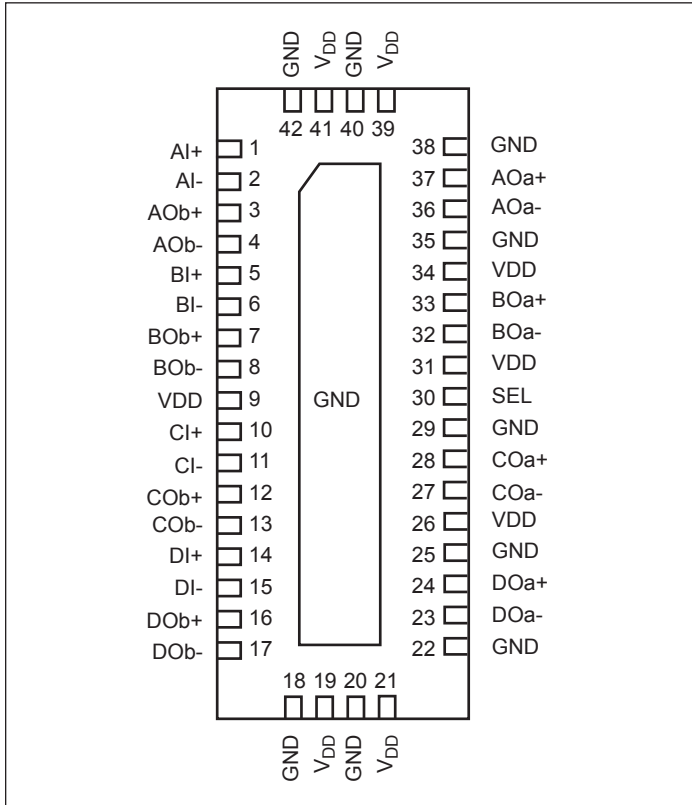
**Notes:**

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.

PCI Express is a registered trademark of PCI-SIG.

**Pin Configuration**

42-TQFN (ZH) Top-Side View



**Pin Descriptions**

Pin#	Pin Name	Type	Description
1, 2	AI+, AI-	Differential I/O	Differential I/O pair from PCIe signal source. Signal is routed to the AOa+, AOa- pin respectively when SEL=0. Signal is routed to the AOb+, AOb- pin respectively when SEL = 1.
37, 36	AOa+, AOa-	Differential I/O	Differential analog pass-through I/O. Signal from AI+ and AI- is routed to AOa+ and AOa- respectively when SEL=0.
3, 4	AOb+, AOb-	Differential I/O	Differential analog pass-through I/O. Signal from AI+ and AI- is routed to AOb+ and AOb- respectively when SEL=1.
5, 6	BI+, BI-	Differential I/O	Differential I/O pair from PCIe signal source. Signal is routed to the BOa+, BOa- pin respectively when SEL=0. Signal is routed to the BOb+, BOb- pin respectively when SEL = 1.
33, 32	BOa+, BOa-	Differential I/O	Differential analog pass-through I/O. Signal from BI+ and BI- is routed to BOa+ and BOa- respectively when SEL=0.
7, 8	BOb+, BOb-	Differential I/O	Differential analog pass-through I/O. Signal from BI+ and BI- is routed to BOb+ and BOb- respectively when SEL=1.
10, 11	CI+, CI-	Differential I/O	Differential I/O pair from PCIe signal source. Signal is routed to the COa+, COa- pin respectively When SEL=0. Signal is routed to the COb+, COb- pin respectively when SEL = 1.

### Pin Descriptions Cont.

Pin#	Pin Name	Type	Description
28, 27	COa+, COa-	Differential I/O	Differential analog pass-through I/O. Signal from CI+ and CI- is routed to COa+, COa- pin respectively when SEL = 0.
12, 13	COb+, COb-	Differential I/O	Differential analog pass-through I/O. Signal from CI+ and CI- is routed to COb+, COb- pin respectively when SEL = 1.
14, 15	DI+, DI-	Differential I/O	Differential I/O pair from PCIE signal source. Signal is routed to the DOa+, DOa- pin respectively when SEL=0. Signal is routed to the DOb+, DOb- pin respectively when SEL = 1.
24, 23	DOa+, DOa-	Differential I/O	Differential analog pass-through I/O. Signal from DI+ and DI- is routed to DOa+, DOa- pin respectively when SEL = 0.
16, 17	DOb+, DOb-	Differential I/O	Differential analog pass-through I/O. Signal from DI+ and DI- is routed to DOb+, DOb- pin respectively when SEL = 1.
30	SEL	3.6V Tolerant Low-voltage Single-ended Input	SEL controls the mux through a flow-through latch.
9, 19, 21, 26, 31, 34, 39, 41	VDD	Power Supply	Power, 3.3V ±10%
18, 20, 22, 25, 29, 35, 38, 40, 42	GND	Power Supply	Power ground

## 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 +3.7V
Channel DC Input Voltage .....	-0.5V to 1.5V
DC Output Current .....	120mA
SEL DC Input Voltage .....	-0.5V to 3.7V
Junction Temperature .....	125°C

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	SEL = 0V or V <sub>DD</sub>	0	0.15	1	mA
T <sub>A</sub>	Operating Temperature Range	—	-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
I <sub>IH</sub>	Input High Current, xI, xO	V <sub>DD</sub> = Max, V <sub>IN</sub> = 1.5V	-10	—	10	μA
I <sub>IL</sub>	Input Low Current, xI, xO	V <sub>DD</sub> = Max, V <sub>IN</sub> = 0V	-10	—	10	μA
I <sub>IH</sub>	Input High Current, SEL	V <sub>DD</sub> = Max, V <sub>IN</sub> = V <sub>DD</sub>	-5	—	5	μA
I <sub>IL</sub>	Input Low Current, SEL	V <sub>DD</sub> = Max, V <sub>IN</sub> = 0V	-5	—	5	μA
I <sub>OZH</sub>	HighZ High Current xOa, xOb	V <sub>DD</sub> = Max, V <sub>IN</sub> = 1.5V	-10	—	10	μA
I <sub>OZL</sub>	HighZ Low Current xOa, xOb	V <sub>DD</sub> = Max, V <sub>IN</sub> = 0V	-10	—	10	μA

**Note:**

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

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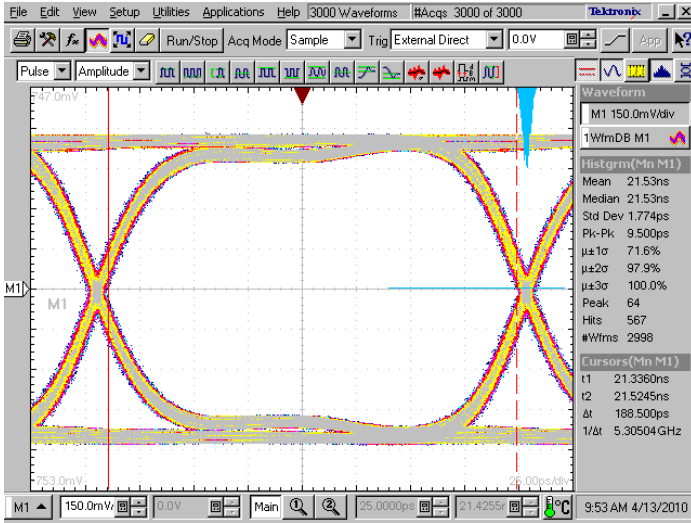
### Dynamic Electrical Characteristics for xI+/-, xOy+/-

Parameter	Description	Test Conditions	Min.	Typ. <sup>(1)</sup>	Max.	Units
DDIL	Differential Insertion Loss	f = 50MHz -1.25GHz f = 1.25GHz - 2.5GHz f = 2.5GHz - 4GHz f = 5.0GHz	—	-0.8 -1.1 -1.2 -1.7	-1.0 -1.3 -1.5 -2.0	dB
DDIL <sub>OFF</sub>	Differential Off Isolation	f = 0 to 4.0GHz	-25.8 -20.6 -17.6 -15.4	-32.2 -25.8 -22.0 -19.3	—	
DDRL	Differential Return Loss	f = 50MHz - 1.25GHz f = 1.25GHz - 2.5GHz f = 2.5GHz - 4GHz f = 5.0GHz	-18.2 -16.8 -12 -8	-22.7 -21.0 -15.0 -10.0	—	
DDNEXT	Near End Crosstalk	f = 50MHz -1.25GHz f = 1.25GHz - 2.5GHz f = 2.5GHz - 4GHz f = 5.0GHz	-44.8 -41.6 -38.4 -36	-56 -52 -48 -45	—	
BW	Bandwidth -3dB	—	—	8.4	—	

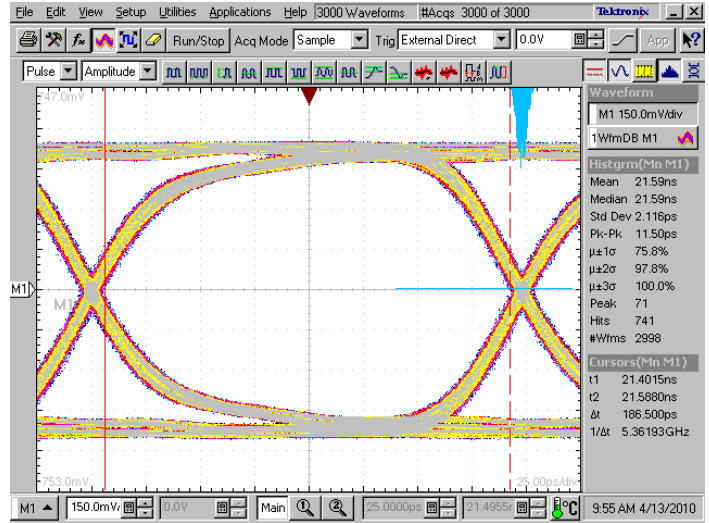
### Switching Characteristics

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
t <sub>PZH</sub> , t <sub>PZL</sub>	Line Enable Time - SEL to xI+/-, xOy+/-	See "Test Circuit for Electrical Characteristics"	0.5	15	25	ns
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Line Disable Time - SEL to xI+/-, xOy+/-	See "Test Circuit for Electrical Characteristics"	0.5	5	25	ns
t <sub>PLH</sub>	Propagation Delay, LOW to HIGH	—	17	—	36	ps
t <sub>PHL</sub>	Propagation Delay, HIGH to LOW	—	21	—	39	ps
t <sub>b-b</sub>	Bit-to-Bit Skew Within Same Differential Pair	See "Test Circuit for Electrical Characteristics"	—	4	10	ps
t <sub>ch-ch</sub>	Channel-to-Channel Skew	See "Test Circuit for Electrical Characteristics"	—	—	20	ps

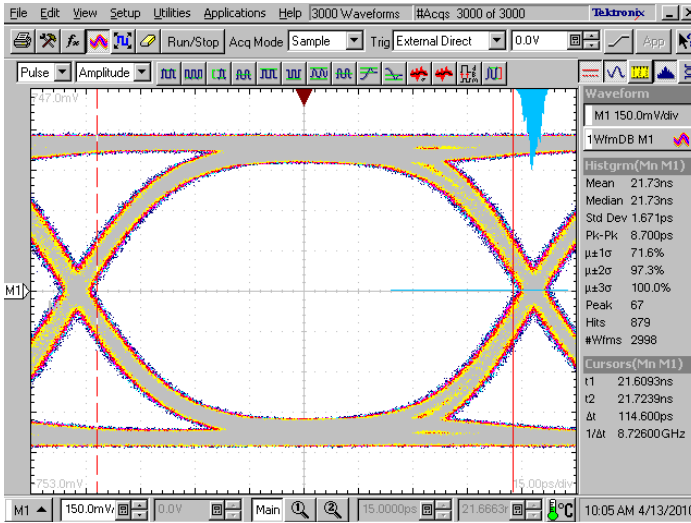
**PI3PCIE3415A**



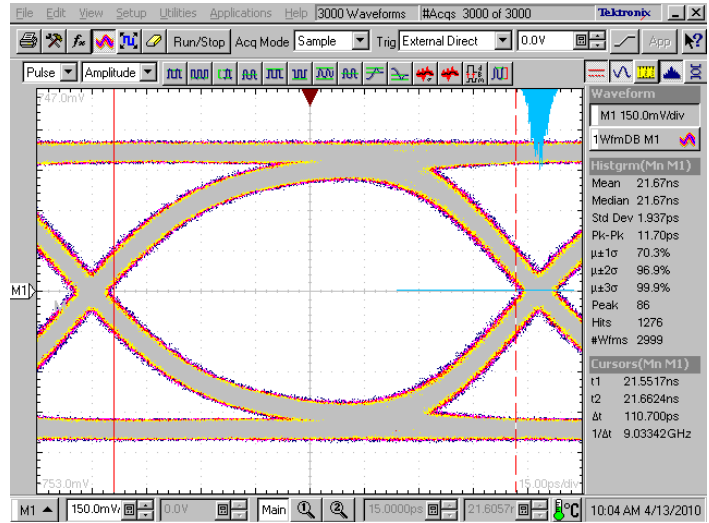
5.0Gbps RX Signal Eye Without PI3PCIE3415A



5.0Gbps RX Signal Eye With PI3PCIE3415A

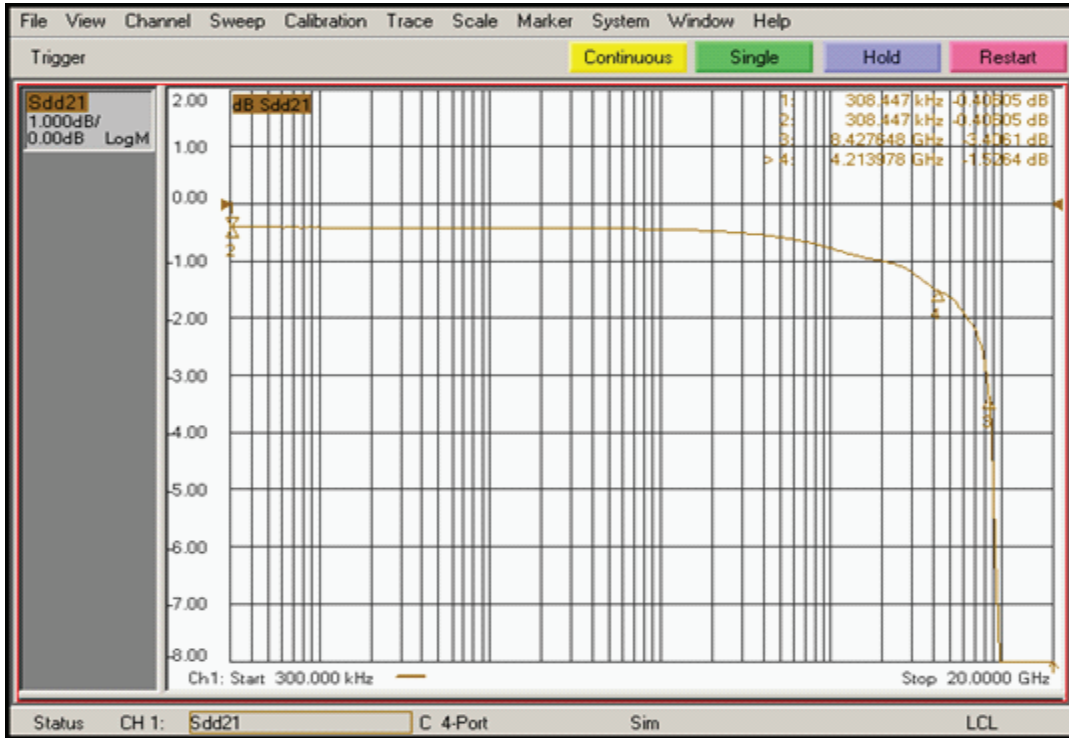


8.0Gbps RX Signal Eye Without PI3PCIE3415A

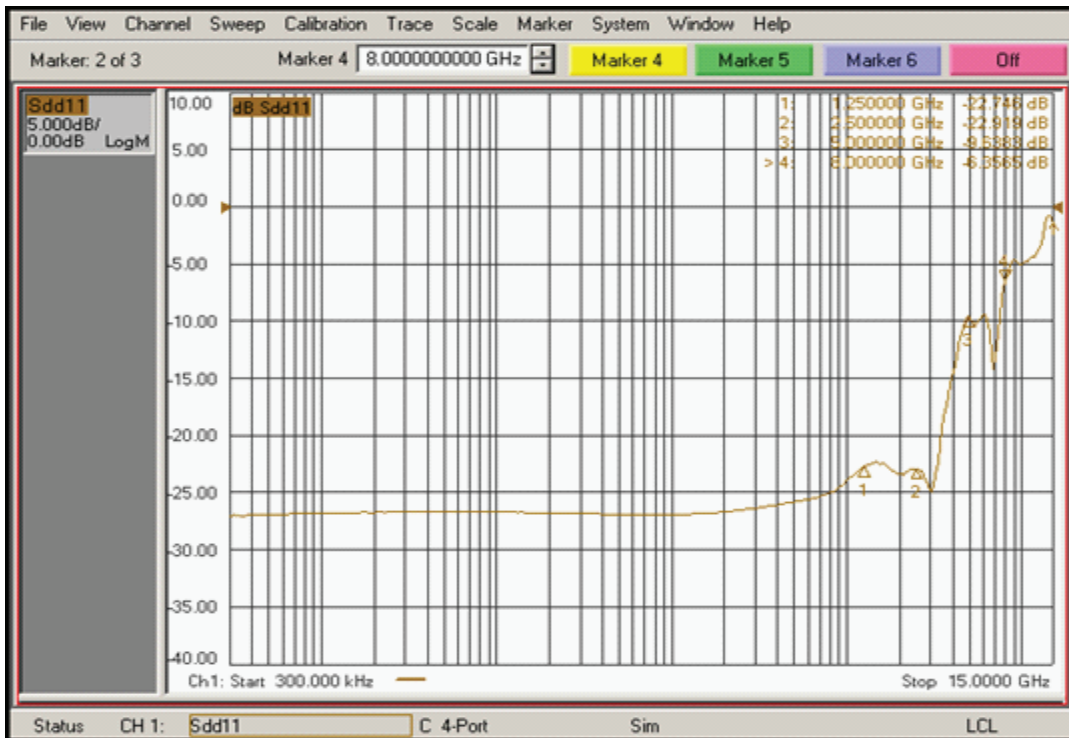


8.0Gbps RX Signal Eye With PI3PCIE3415A

**PI3PCIE3415A**

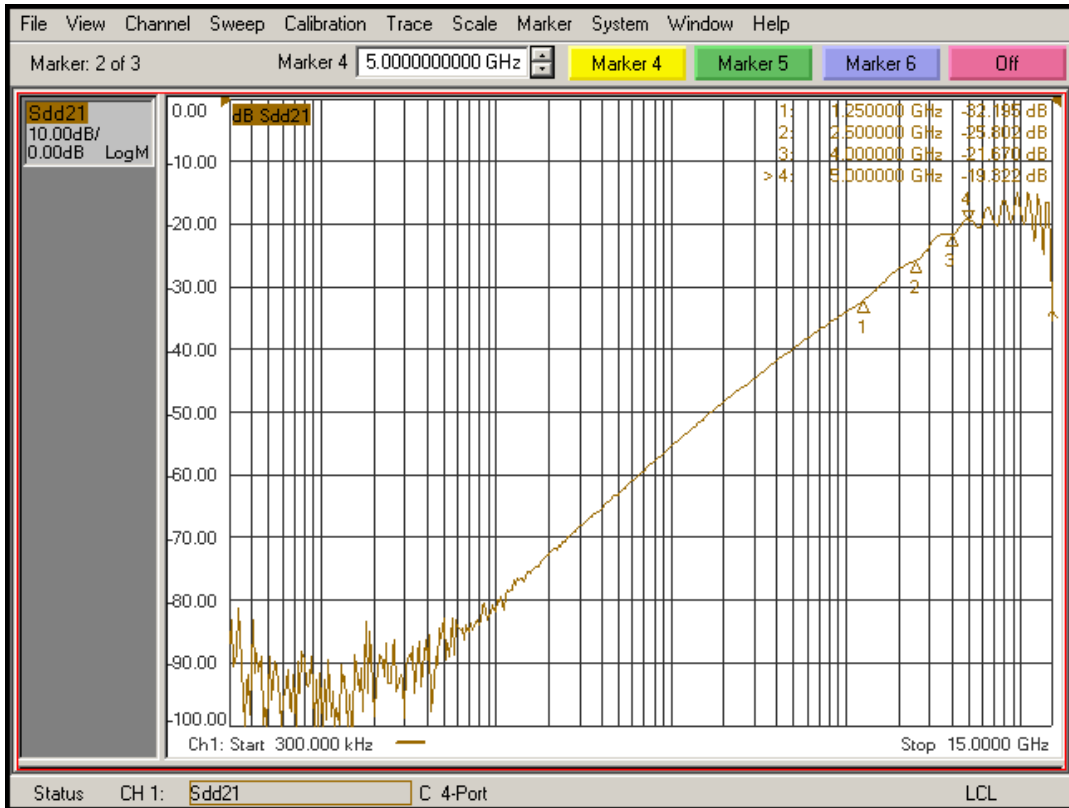


Differential Insertion Loss

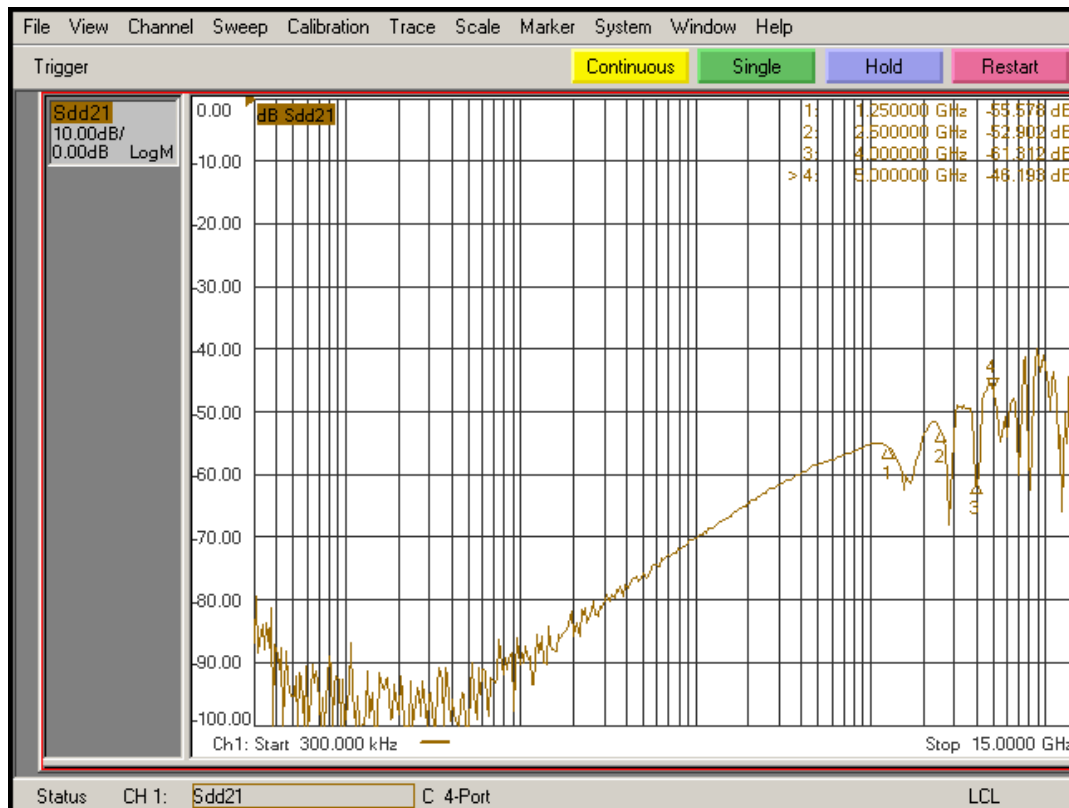


Differential Return Loss

**PI3PCIE3415A**



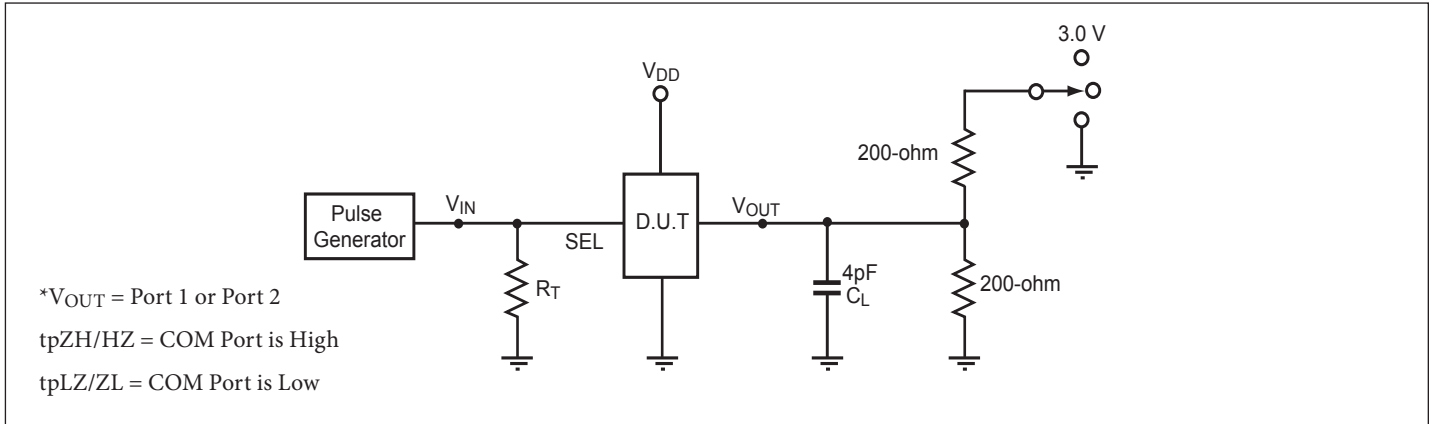
**Differential Off Isolation**



**Differential Crosstalk**



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



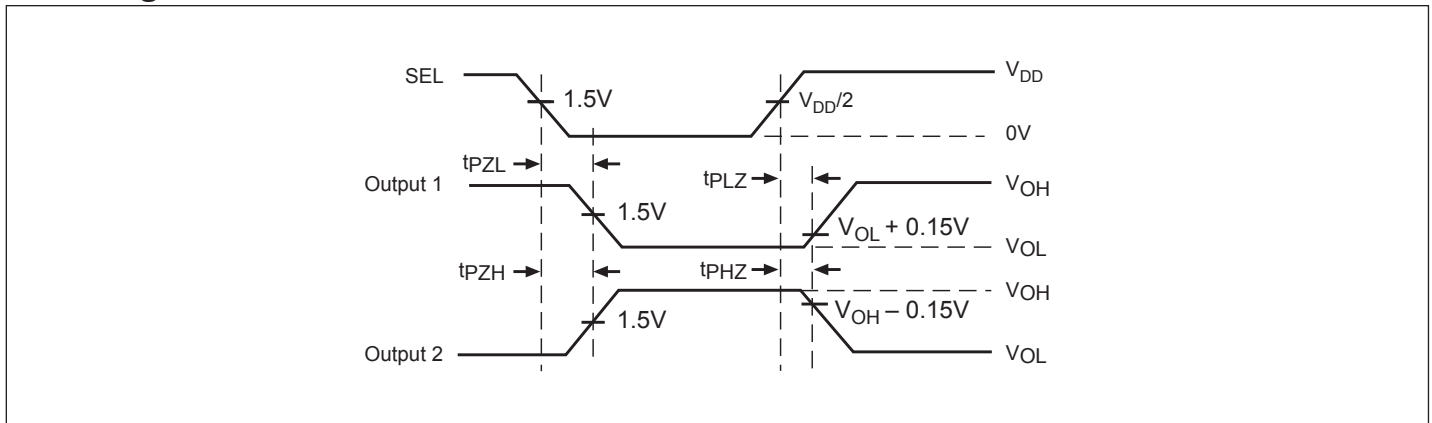
**Notes:**

1. C<sub>L</sub> = Load capacitance: includes jig and probe capacitance.
2. R<sub>T</sub> = Termination resistance: should be equal to Z<sub>OUT</sub> 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 ≤ MHz, Z<sub>O</sub> = 50Ω, t<sub>R</sub> ≤ 2.5ns, t<sub>F</sub> ≤ 2.5ns.
5. The outputs are measured one at a time with one transition per measurement.

**Switch Positions**

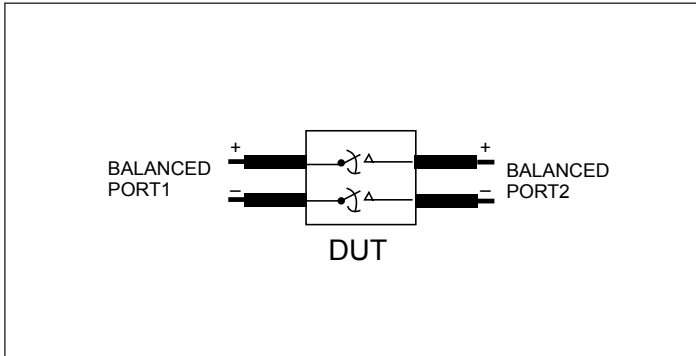
Test	Switch
t <sub>PLZ</sub> , t <sub>PZL</sub>	3.0V
t <sub>PHZ</sub> , t <sub>PZH</sub>	GND

**Switching Waveforms**

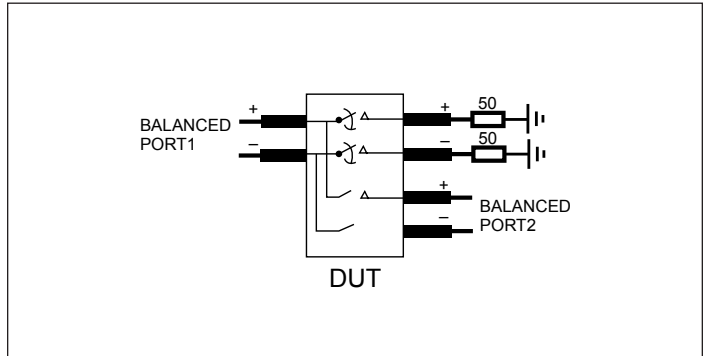


**Voltage Waveforms Enable and Disable Times**

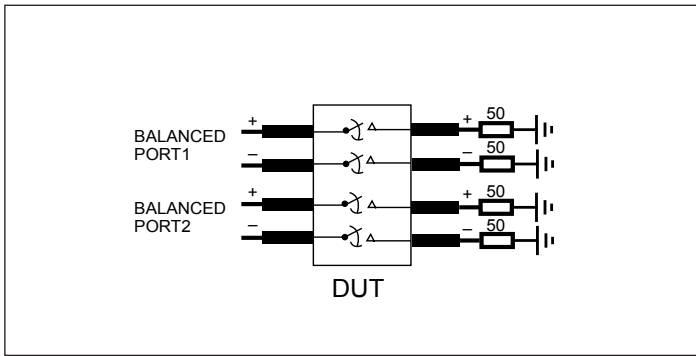
**PI3PCIE3415A**



**Differential Insertion Loss and Return Test Circuit**



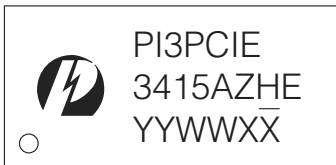
**Differential Off Isolation Test Circuit**



**Differential Near End Xtalk Test Circuit**

**Part Marking**

ZH Package



YY: Year

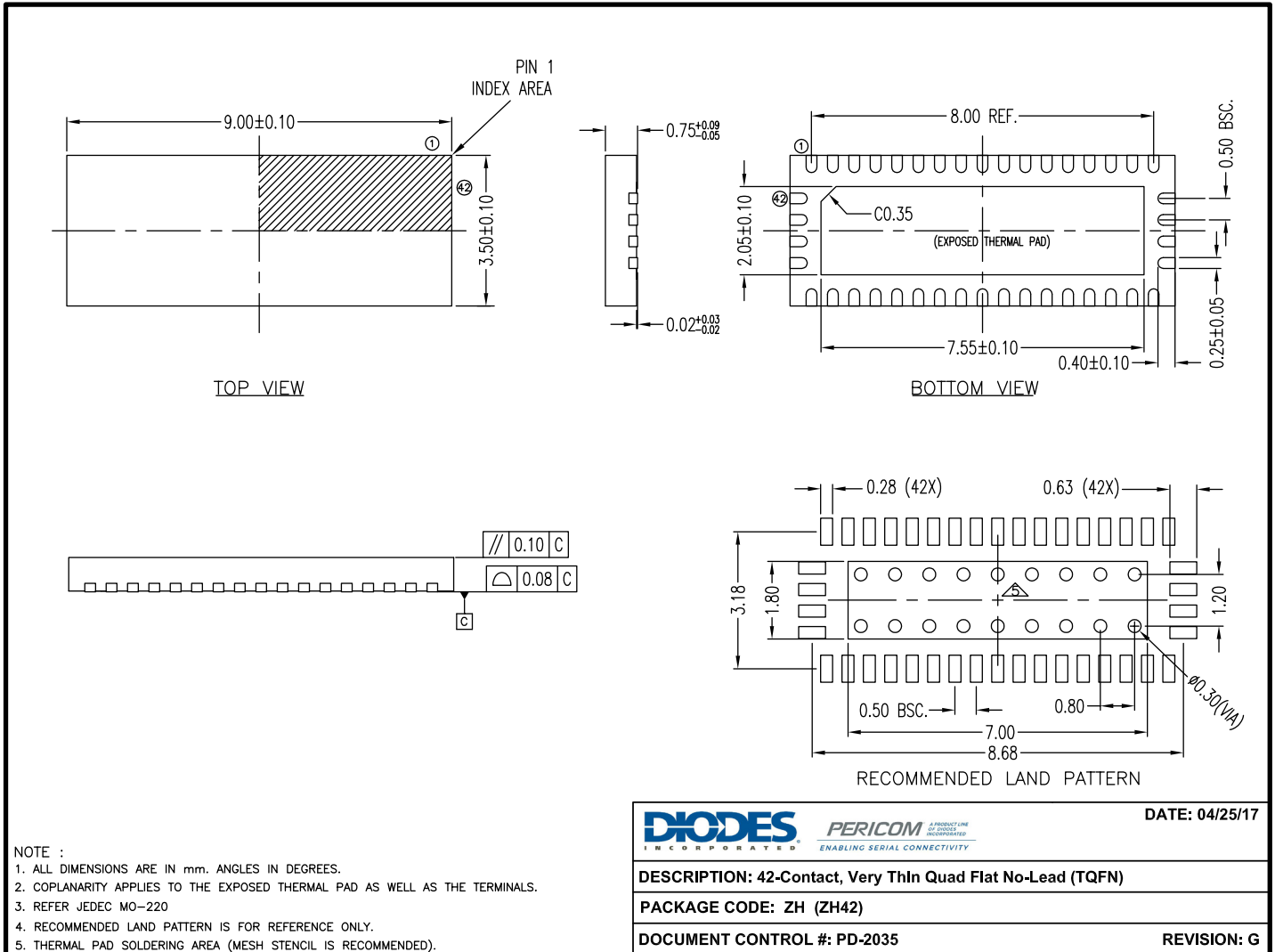
WW: Workweek

1st X: Assembly Code

2nd X: Fab Code

**PI3PCIE3415A**

**Packaging Mechanical: 42-TQFN (ZH)**



17-0266

**For latest package information:**

See <http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/>.

**Ordering Information**

Ordering Code	Package Code	Package Description
PI3PCIE3415AZHEX	ZH	42-contact, Very Thin Quad Flat No-Lead (TQFN), (width 24mm)
PI3PCIE3415AZHE+DRX	ZH	42-contact, Very Thin Quad Flat No-Lead (TQFN), (width 16mm)

**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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