

PI3DBS16412

3.3V, 1-20Gbps 2-Lane 2:1 Mux/De-Mux Switch

Features

- 4-Differential Channel, 2:1 Mux/DeMux
- Up to 20 Gbps for applications including USB3.0, USB3.1, 10GE, Thunderbolt 3, SAS3.0, and SATA3.0
- Bi-Directional Operation
- 3dB Bandwidth: 13 GHz
- Low Bit-to-Bit Skew, 3ps typ
- Low Channel-to-Channel skew, 10ps typ
- Low Insertion Loss: -1.2dB@5 GHz, -1.3dB@8 GHz, -2dB@10 GHz
- Return Loss: -21dB@5 GHz, -19dB@8 GHz, -9dB@10 GHz
- Low Power Consumption - 300µA typ
- Supply Voltage 3.3V
- Industrial Temperature Range: -40°C to 85°C
- 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):
 - 42-contact, TQFN (ZH42), 3.5x9mm
 - 40-contact, TQFN (ZLC40), 3x6mm

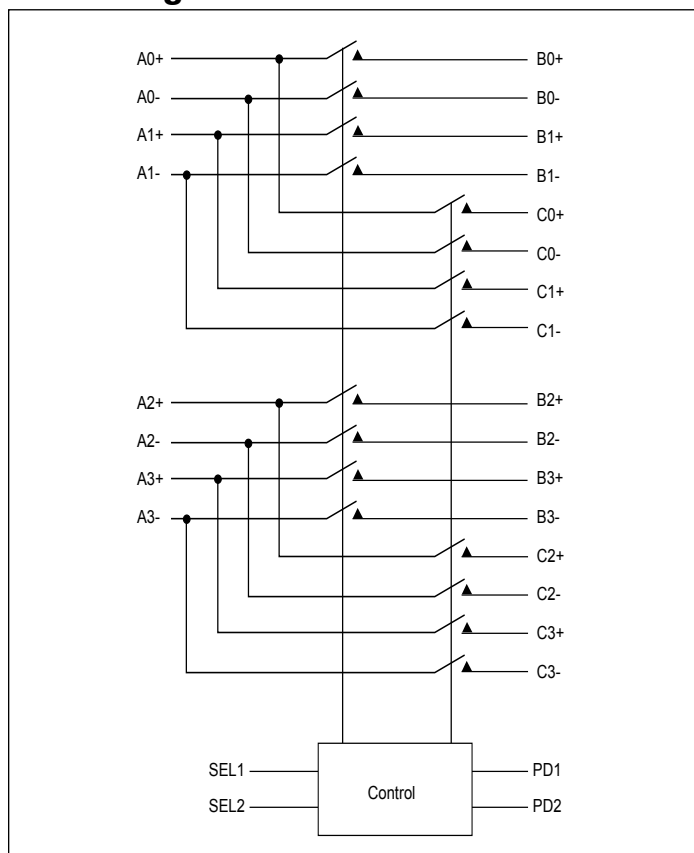
Application

- Routing high speed differential signals such as USB3.1 Gen 2, SAS3, PCIe4, TB3

Description

The PI3DBS16412 is an 8-to-4 differential channel multiplexer/demultiplexer switch. This solution can switch multiple signal types up to data rates of 20 Gbps. Using a unique design technique, Diodes has been able to minimize the impedance of the switch, such so that the attenuation observed through the switch is minimal. This unique design technique also offers a layout targeted for USB3.0, USB3.1, 10GE, Thunderbolt 3, SAS3.0, and SATA3.0 signals, which minimizes the channel-to-channel skew as well as channel-to-channel crosstalk, as required by high speed signals.

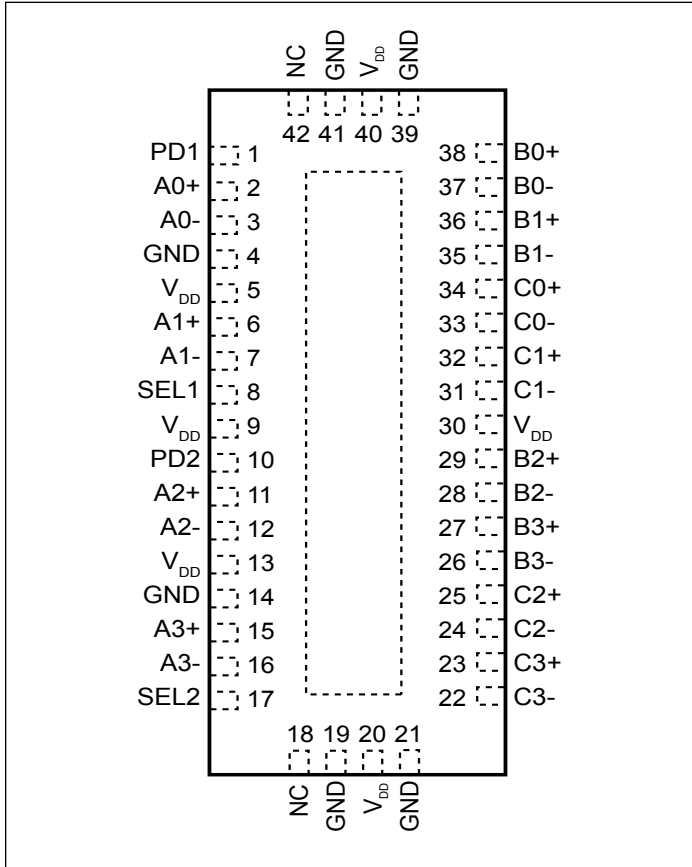
Block Diagram



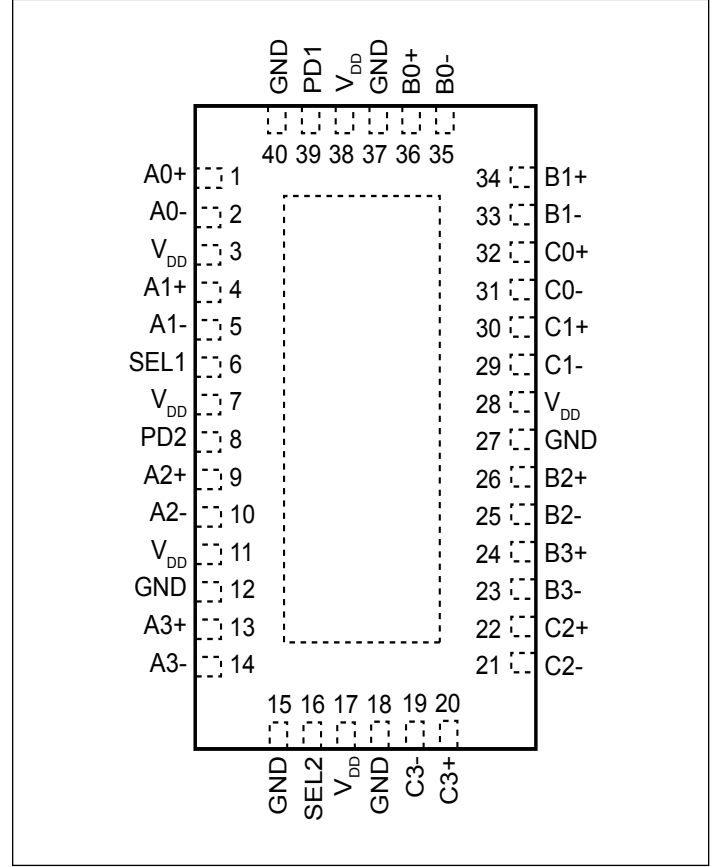
Notes:

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.

Pin Configuration: 42-TQFN (ZH)



Pin Configuration: 40-TQFN (ZLC)



Truth Table

Function	SEL1	PD1
Power down & hi_z switches A0 & A1	x	1
A0 → B0 A1 → B1	0	0
A0 → C0 A1 → C1	1	0

Function	SEL2	PD2
Power down & hi_z switches A2 & A3	x	1
A2 → B2 A3 → B3	0	0
A2 → C2 A3 → C3	1	0

Pin Description

Pin #		Pin Name	I/O	Description
42-TQFN	40-TQFN			
2	1	A0+	I/O	Signal I/O, Channel 0, Port A, 100K pull-down
3	2	A0-		
6	4	A1+	I/O	Signal I/O, Channel 1, Port A, 100K pull-down
7	5	A1-		
11	9	A2+	I/O	Signal I/O, Channel 2, Port A, 100K pull-down
12	10	A2-		
15	13	A3+	I/O	Signal I/O, Channel 3, Port A, 100K pull-down
16	14	A3-		
38	36	B0+	I/O	Signal I/O, Channel 0, Port B
37	35	B0-		
36	34	B1+	I/O	Signal I/O, Channel 1, Port B
35	33	B1-		
29	26	B2+	I/O	Signal I/O, Channel 2, Port B
28	25	B2-		
27	24	B3+	I/O	Signal I/O, Channel 3, Port B
26	23	B3-		
34	32	C0+	I/O	Signal I/O, Channel 0, Port C
33	31	C0-		
32	30	C1+	I/O	Signal I/O, Channel 1, Port C
31	29	C1-		
25	22	C2+	I/O	Signal I/O, Channel 2, Port C
24	21	C2-		
23	20	C3+	I/O	Signal I/O, Channel 3, Port C
22	19	C3-		
8, 17	6, 16	SEL_X	I	Operation mode Select (when SEL=0: A→B, when SEL=1: A→C)
5, 9, 13, 20, 30, 40	3, 7, 11, 17, 28, 38	V _{DD}	Pwr	3.3V ±10% Positive Supply Voltage
4, 14, 19, 21, 39, 41, Center Pad	12, 15, 18, 27, 37, 40, Center Pad	GND	Pwr	Power ground
1, 10	39, 8	PD_X	I	Power Down Selet PD_X = 0, Device enable, PD_X = 1, Device disable channel stay hi_z
18, 42		NC		No Connect

Maximum Ratings

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

Storage Temperature	-65°C to +150°C
Junction Temperature (T _j).....	125°C
Supply Voltage to Ground Potential	-0.5V to +3.7V
Channel DC Input Voltage	-0.5V to 1.5V
DC Output Current	120mA
Power Dissipation	0.5W
Control Logic DC Input Voltage	-0.5V
ESD (HBM).....	1KV

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 _{DD}	3.3V Power Supply		3.0	3.3	3.6	V
I _{DD}	Current consumption in normal operation	SEL = GND or V _{DD} , PD = Low		200	350	µA
I _{DDQ}	Current consumption when all switches are disabled	V _{DD} = 3.3V, PD = High		65	90	µA
P _{DD}	Total Power from VDD 3.3V supply	Control pins = GND or V _{DD}		2		mW
P _{DDQ}	Power consumption when all switches are disabled	V _{DD} = 3.3V, PD = High		1.1		mW
T _A	Operating temperature range		-40		85	°C

DC Electrical Characteristics for Switching over Operating Range

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽¹⁾	Max.	Units
V _{IH} - cntrl signals	Input HIGH Voltage for SEL and PD	V _{DD} = 3.3V	1.4			V
V _{IL} - cntrl signals	Input LOW Voltage for SEL and PD	V _{DD} = 3.3V			0.4	
V _{IK}	Clamp Diode Voltage	V _{DD} = Max., I _{input} = -18mA		-0.7	-1.2	
I _{IH_ctrl}	Input HIGH Current for SEL and PD	V _{DD} = Max., V _{input} = 3.3V	-50		+50	µA
I _{IL_ctrl}	Input LOW Current for SEL and PD	V _{DD} = Max., V _{input} = 0V	-10		+10	
I _{OZH}	HighZ HIGH Current, switch I/O pins	V _{DD} = 3.3V., V _{input} = 1.0V	-10		+10	µA
I _{OZL}	HighZ LOW Current, switch I/O pins	V _{DD} = Max., V _{input} = 0V	-10		+10	µA
I _{IH}	Input HIGH Current for A _N	V _{DD} = Max., V _{input} = 1.2V	-20		+20	µA
	Input HIGH Current for B _N , C _N	V _{DD} = Max., V _{input} = 1.2V	-10		+10	µA
I _{IL}	Input LOW Current for A _N , B _N & C _N	V _{DD} = Max., V _{input} = 0V	-10		+10	µA
V _p	Max voltage pass through tolerance analog switches (See Test Circuit)	V _{DD} = 3.3V, I _{PASS} = 10mA		1		V
V _{IN}	Analog Signal to input of switch			1.1	1.2	V

Note: 1. Typical values are at V_{DD} = 3.3V, T_A = 25°C ambient and maximum loading.

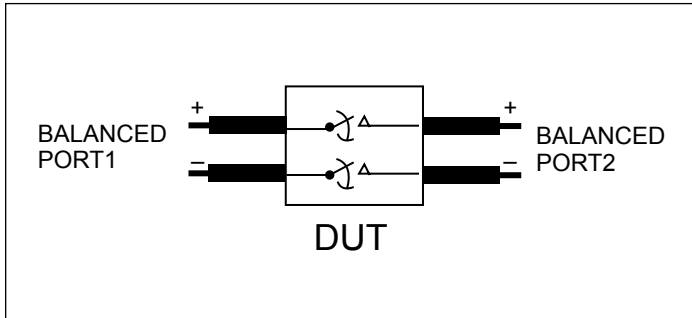
Dynamic Electrical Characteristics

Parameter	Description	Test Conditions	Min.	Typ. ⁽¹⁾	Max.	Units
DDIL	Differential Insertion Loss	f=2.5GHz f=4.0GHz f=5.0GHz f=8.0GHz f=10.0GHz		-0.8 -0.9 -1.2 -1.3 -2.0		dB
DDRL	Differential Return Loss	f= 2.5GHz f= 4.0GHz f= 5.0GHz f= 8.0GHz f=10.0GHz		-25.0 -24.0 -21.0 -19.0 -14.0		dB
DDOI	Differential OFF Isolation	f= 2.5GHz f= 4.0GHz f= 5.0GHz f= 8.0GHz f=10.0GHz		-27.0 -21.0 -19.0 -18.0 -19.0		dB
DDXT	Differential Crosstalk	f= 2.5GHz f= 4.0GHz f= 5.0GHz f=8.0GHz f=10.0GHz		-30.0 -29.0 -29.0 -30.0 -33.0		dB
BW	3dB Bandwidth			13		GHz

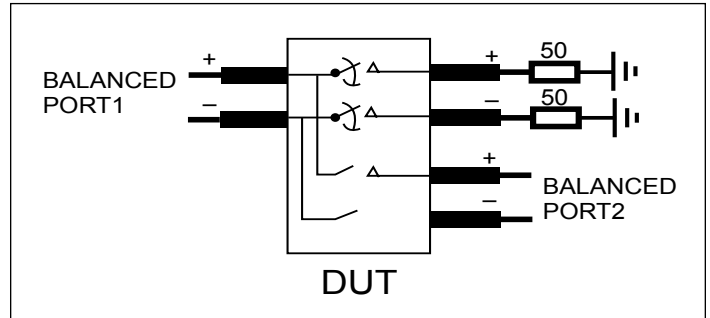
Switching Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
tPZH, tPZL	Line Enable Time - SEL to A _N , B _N , C _N			200	350	ns
tPHZ, tPLZ	Line Disable Time - SEL to A _N , B _N , C _N			200	350	ns
tPLH	Propagation Delay, LOW to HIGH				50	ps
tPHL	Propagation Delay, HIGH to LOW				50	ps
t _{b-b}	Bit-to-bit skew within the same differential pair			3	10	ps
t _{ch-ch}	Channel-to-channel skew			10	20	ps

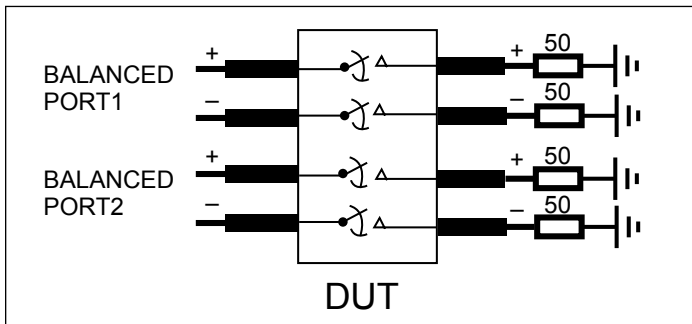
PI3DBS16412



Diff. Insertion Loss and Return Loss Test Circuit

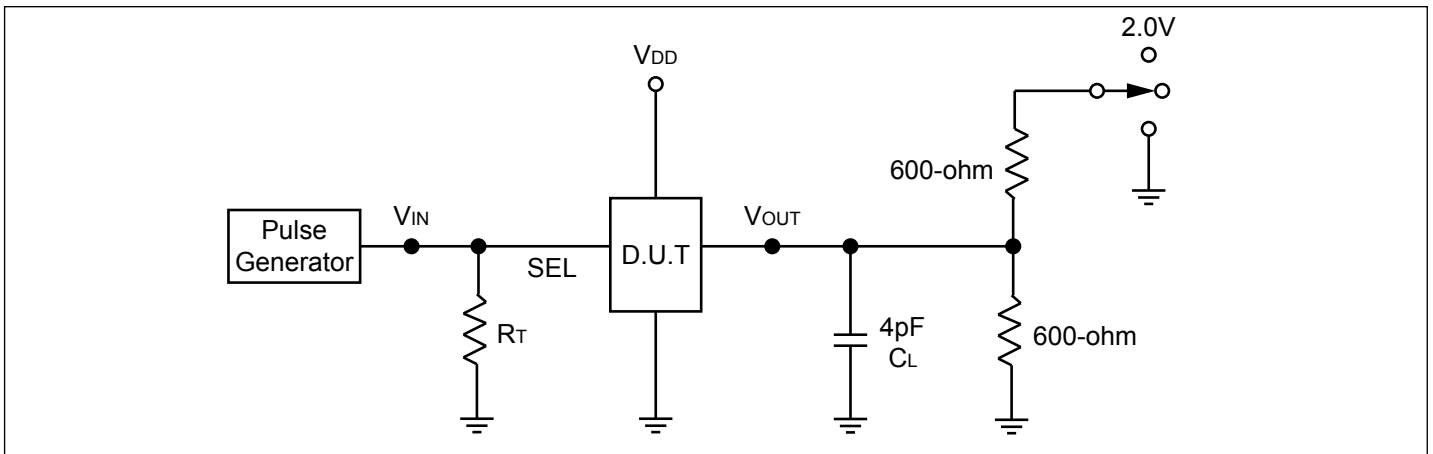


Diff. Off Isolation Test Circuit



Diff. Near End Xtalk Test Circuit

Test Circuit for Electrical Characteristics



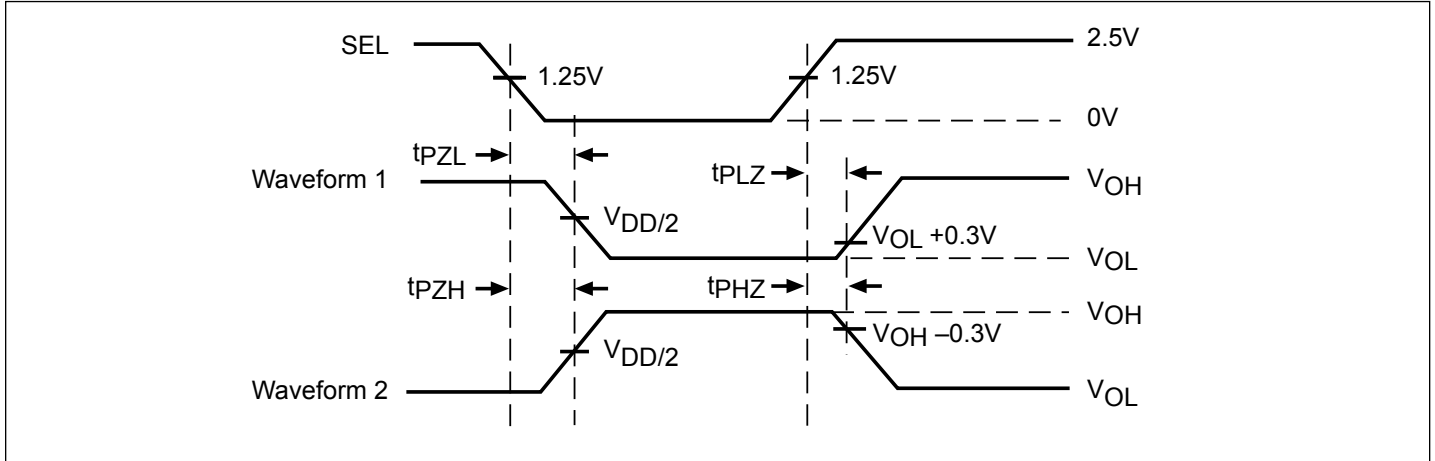
Notes:

1. CL = Load capacitance: includes jig and probe capacitance.
2. RT = Termination resistance: should be equal to ZOUT 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, ZO = 50Ω, tR ≤ 2.5ns, tF ≤ 2.5ns.
5. The outputs are measured one at a time with one transition per measurement.

Switch Position

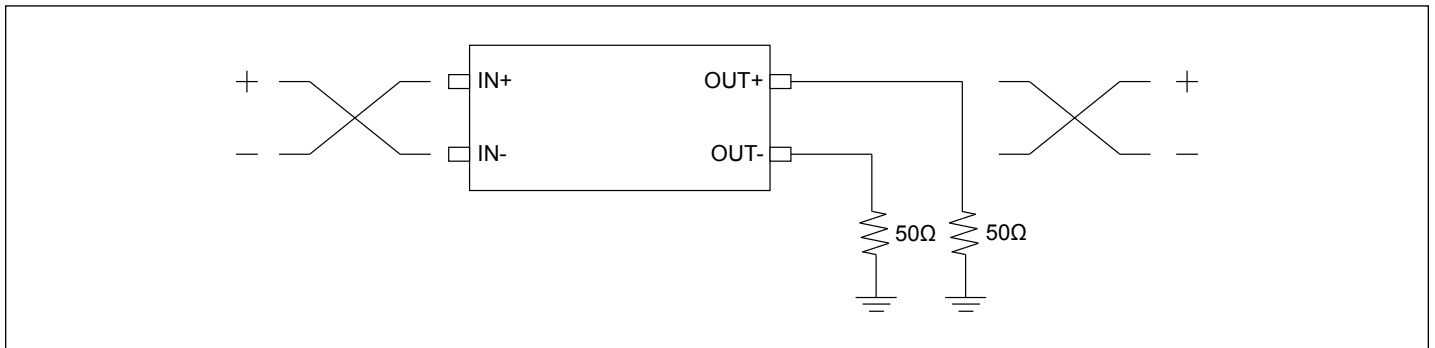
Test	Switch
t _{PLZ} , t _{PZL}	2.0V
t _{PHZ} , t _{PZH}	GND

Switching Waveforms



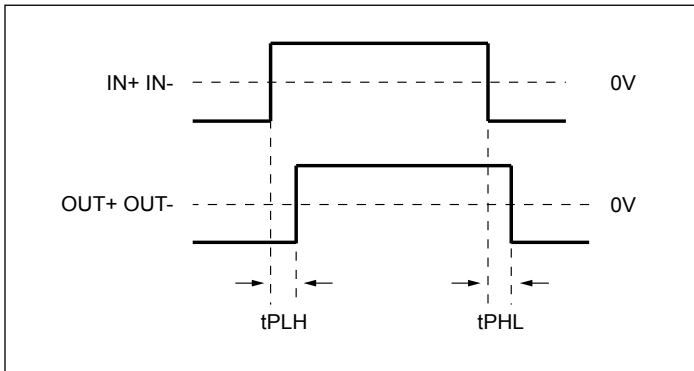
Voltage Waveforms Enable and Disable Times

Test Circuit for Propagation Delay

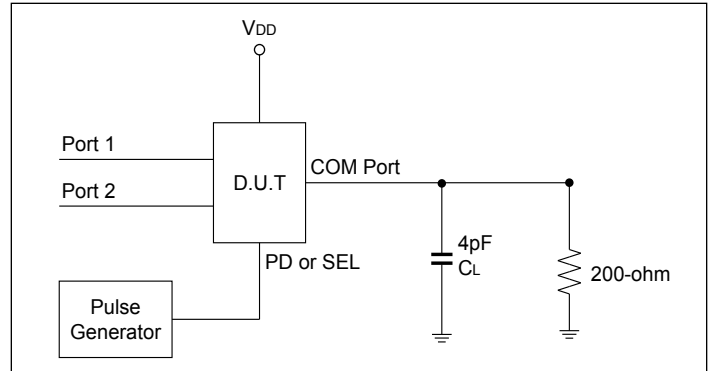


PI3DBS16412

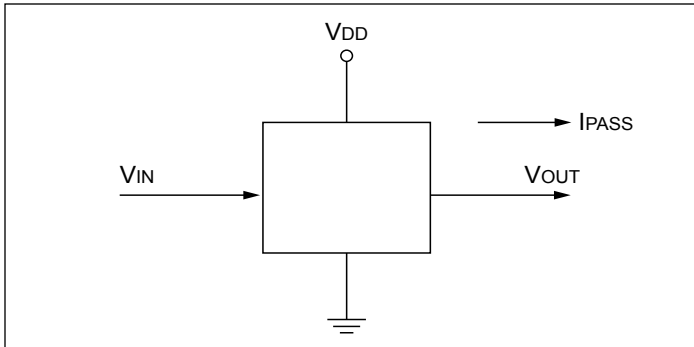
Differential Input/Output Signal Waveform



Test Circuit for SEL Switching Time

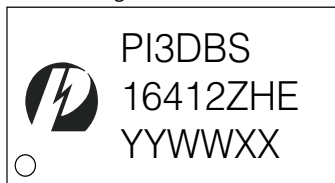


Test Circuit for Max Voltage Pass through



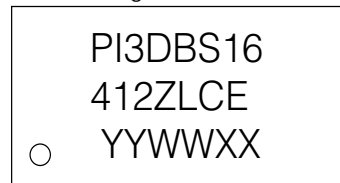
Part Marking

ZH Package



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

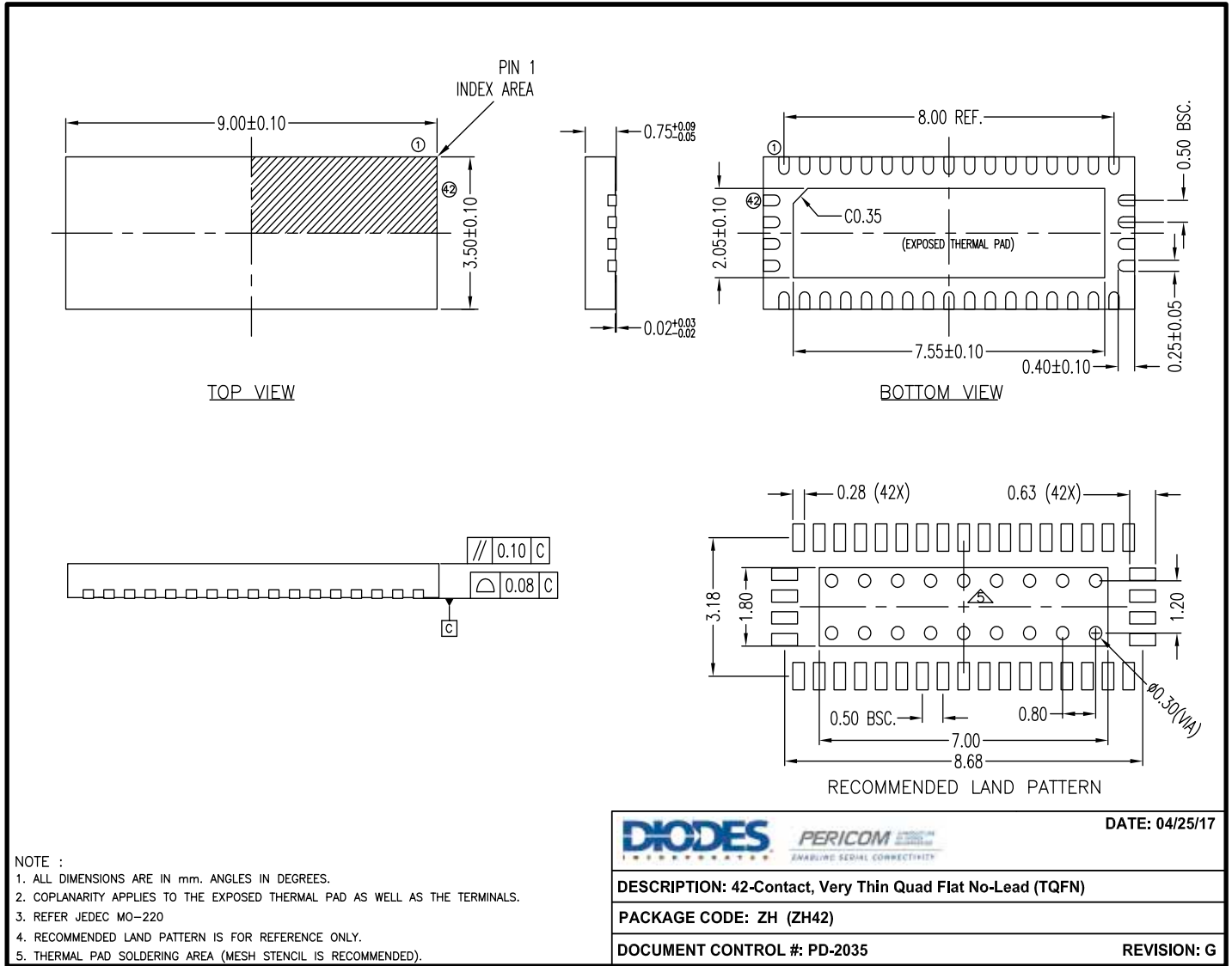
ZLC Package



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

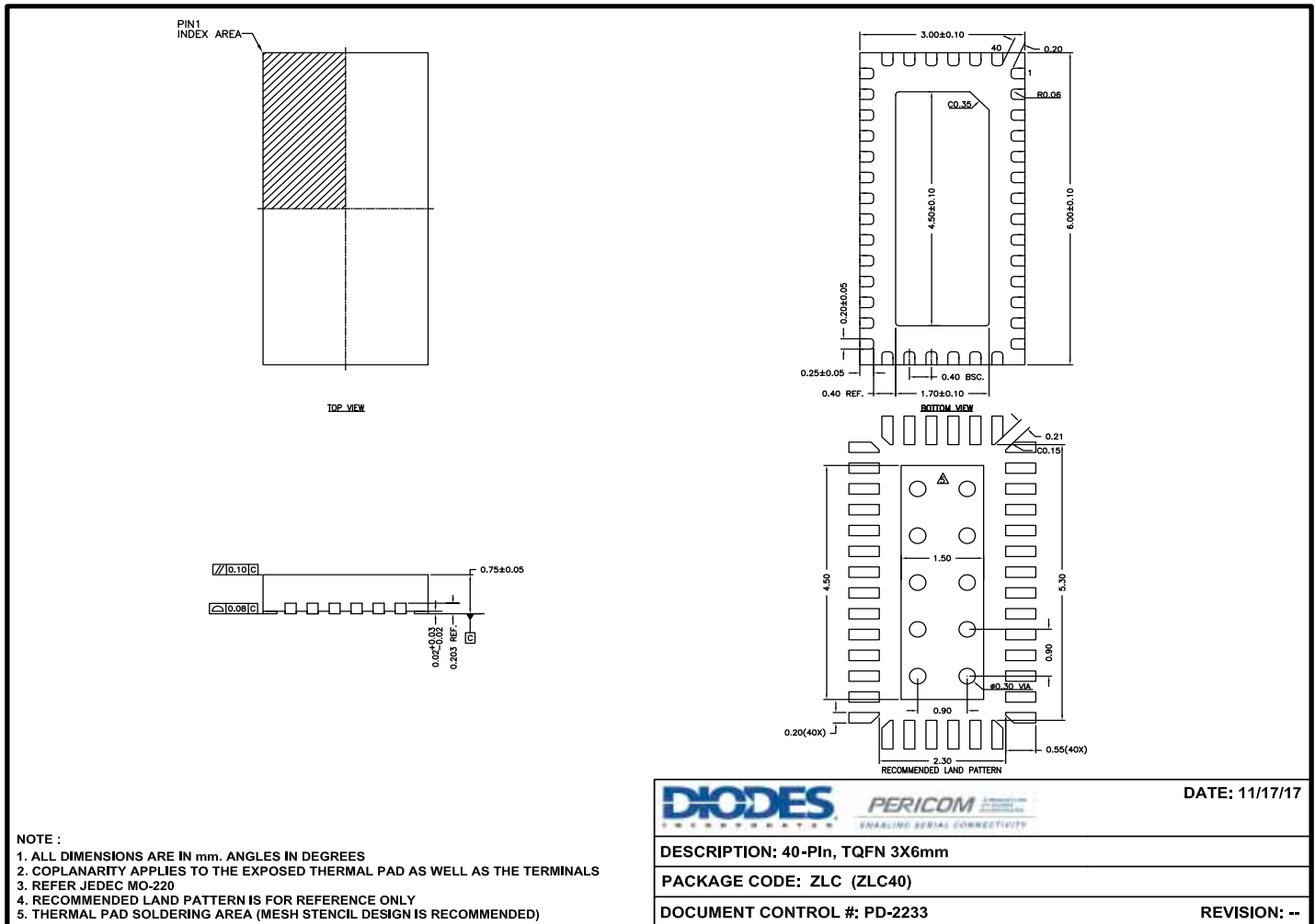
PI3DBS16412

Packaging Mechanical: 42-TQFN (ZH)



17-0266

Packaging Mechanical: 40-TQFN (ZLC)



For latest package info.

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

Ordering Information

Ordering Number	Package Code	Package Description
PI3DBS16412ZHXX	ZH	42-Contact, Very Thin Quad Flat No-Lead (TQFN)
PI3DBS16412ZLCEX	ZLC	40-Pin, 3x6mm (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

1. DIODES INCORPORATED AND ITS SUBSIDIARIES (“DIODES”) MAKE NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO ANY INFORMATION CONTAINED IN THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

2. The Information contained herein is for informational purpose only and is provided only to illustrate the operation of Diodes products described herein and application examples. Diodes does not assume any liability arising out of the application or use of this document or any product described herein. This document is intended for skilled and technically trained engineering customers and users who design with Diodes products. Diodes products may be used to facilitate safety-related applications; however, in all instances customers and users are responsible for (a) selecting the appropriate Diodes products for their applications, (b) evaluating the suitability of the Diodes products for their intended applications, (c) ensuring their applications, which incorporate Diodes products, comply the applicable legal and regulatory requirements as well as safety and functional-safety related standards, and (d) ensuring they design with appropriate safeguards (including testing, validation, quality control techniques, redundancy, malfunction prevention, and appropriate treatment for aging degradation) to minimize the risks associated with their applications.

3. Diodes assumes no liability for any application-related information, support, assistance or feedback that may be provided by Diodes from time to time. Any customer or user of this document or products described herein will assume all risks and liabilities associated with such use, and will hold Diodes and all companies whose products are represented herein or on Diodes' websites, harmless against all damages and liabilities.

4. Products described herein may be covered by one or more United States, international or foreign patents and pending patent applications. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks and trademark applications. Diodes does not convey any license under any of its intellectual property rights or the rights of any third parties (including third parties whose products and services may be described in this document or on Diodes' website) under this document.

5. Diodes products are provided subject to Diodes' Standard Terms and Conditions of Sale (<https://www.diodes.com/about/company/terms-and-conditions/terms-and-conditions-of-sales/>) or other applicable terms. This document does not alter or expand the applicable warranties provided by Diodes. Diodes does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

6. Diodes products and technology may not be used for or incorporated into any products or systems whose manufacture, use or sale is prohibited under any applicable laws and regulations. Should customers or users use Diodes products in contravention of any applicable laws or regulations, or for any unintended or unauthorized application, customers and users will (a) be solely responsible for any damages, losses or penalties arising in connection therewith or as a result thereof, and (b) indemnify and hold Diodes and its representatives and agents harmless against any and all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim relating to any noncompliance with the applicable laws and regulations, as well as any unintended or unauthorized application.

7. While efforts have been made to ensure the information contained in this document is accurate, complete and current, it may contain technical inaccuracies, omissions and typographical errors. Diodes does not warrant that information contained in this document is error-free and Diodes is under no obligation to update or otherwise correct this information. Notwithstanding the foregoing, Diodes reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. 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 determinative format released by Diodes.

8. Any unauthorized copying, modification, distribution, transmission, display or other use of this document (or any portion hereof) is prohibited. Diodes assumes no responsibility for any losses incurred by the customers or users or any third parties arising from any such unauthorized use.

Copyright © 2020 Diodes Incorporated

www.diodes.com