

PI3WVR14412Q
20Gbps 1:2 Signal Switch For DP2.1, HDMI2.1, MIPI DPHY/CPHY, USB3.2

Description

The DIODES PI3WVR14412Q is a multi-standard video switch with wide voltage range capability. It supports DisplayPort 1.3/1.4/2.1, HDMI 1.4/2.0/2.1, MIPI DPHY/CPHY, USB3.2, and emerging and proprietary standards.

The PI3WVR14412Q can pass high-speed signals up to 1.2V peak-to-peak differential, with a common-mode voltage from 0 to VDD for TMDS signal.

The wide voltage range allows DC-coupled multi-standard operation. Eliminating AC coupling capacitors saves board space and improves signal integrity for dense PCB design.

In addition to four high-speed lanes, the PI3WVR14412Q also switches the DDC and HPD signals or AUX and HPD signals using the DDC/ AUX and HPD channel switch.

Application(s)

- Advanced Driver Assistance Systems (ADAS)
- Automotive Infotainment & Cluster
- Rear Seat Entertainment
- Automotive Head Units
- Aerospace & Defense

Features

- Supports DP2.1, HDMI2.1, MIPI DPHY/CPHY, USB3.2, LVDS Electrical Standard Compatible
- Data Rate Up to 20Gbps for 4-Lanes of High-Speed Channel
- Supports DDC and HPD Switch @ HDMI
- Supports Up to 720Mbps AUX Channel @ DP
- Insertion Loss: -2.0dB @10GHz
- Return Loss: -10dB @10GHz
- Low Channel-to-Channel Crosstalk: -30dB @10GHz
- Low Off-Isolation: -15dB @10GHz
- Low Bit-to-Bit Skew: 5ps @Typical
- Power Supply: 3.3V
- Supports AEC-Q100 Grade 2, -40°C to 105°C
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- The PI3WVR14412Q is suitable for automotive applications requiring specific change control; this part is AEC-Q100 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.
<https://www.diodes.com/quality/product-definitions/>
- Packaging (Pb-free & Green):
 - 40-Pin, TQFN (ZLC), 0.4mm pitch

Ordering Information

Ordering Code	Package Code	Package Description
PI3WVR14412Q2ZLCEX	ZLC	40-contact, 3 x 6mm (TQFN)

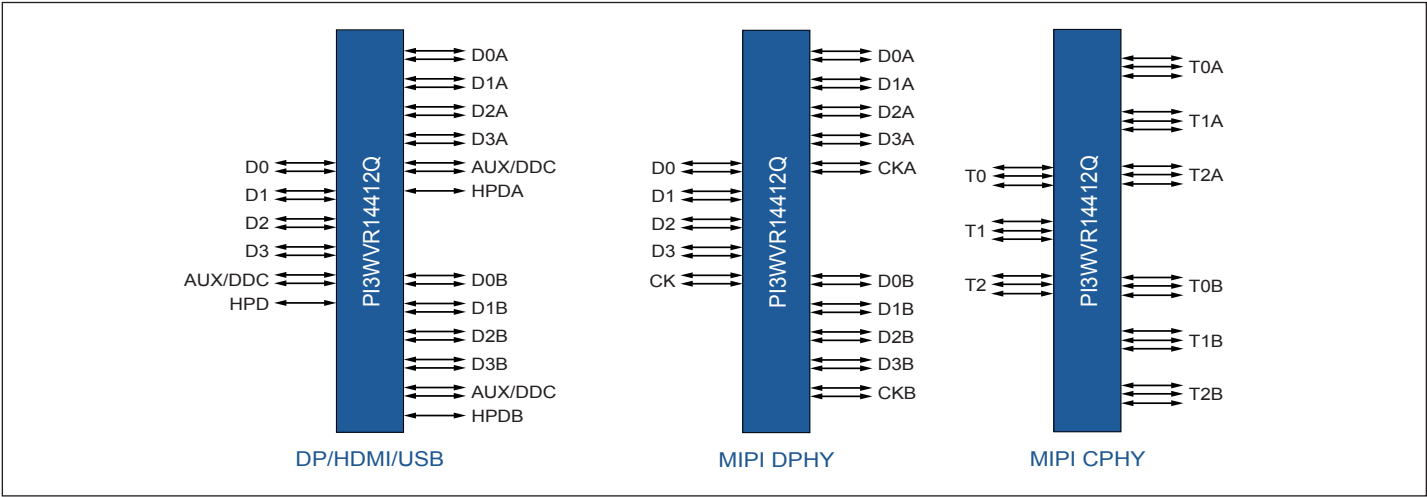
Notes:

- Q = Automotive Compliant
- 2 = AEC-Q100 Grade Level
- E = Pb-free and Green
- X suffix = Tape/Reel

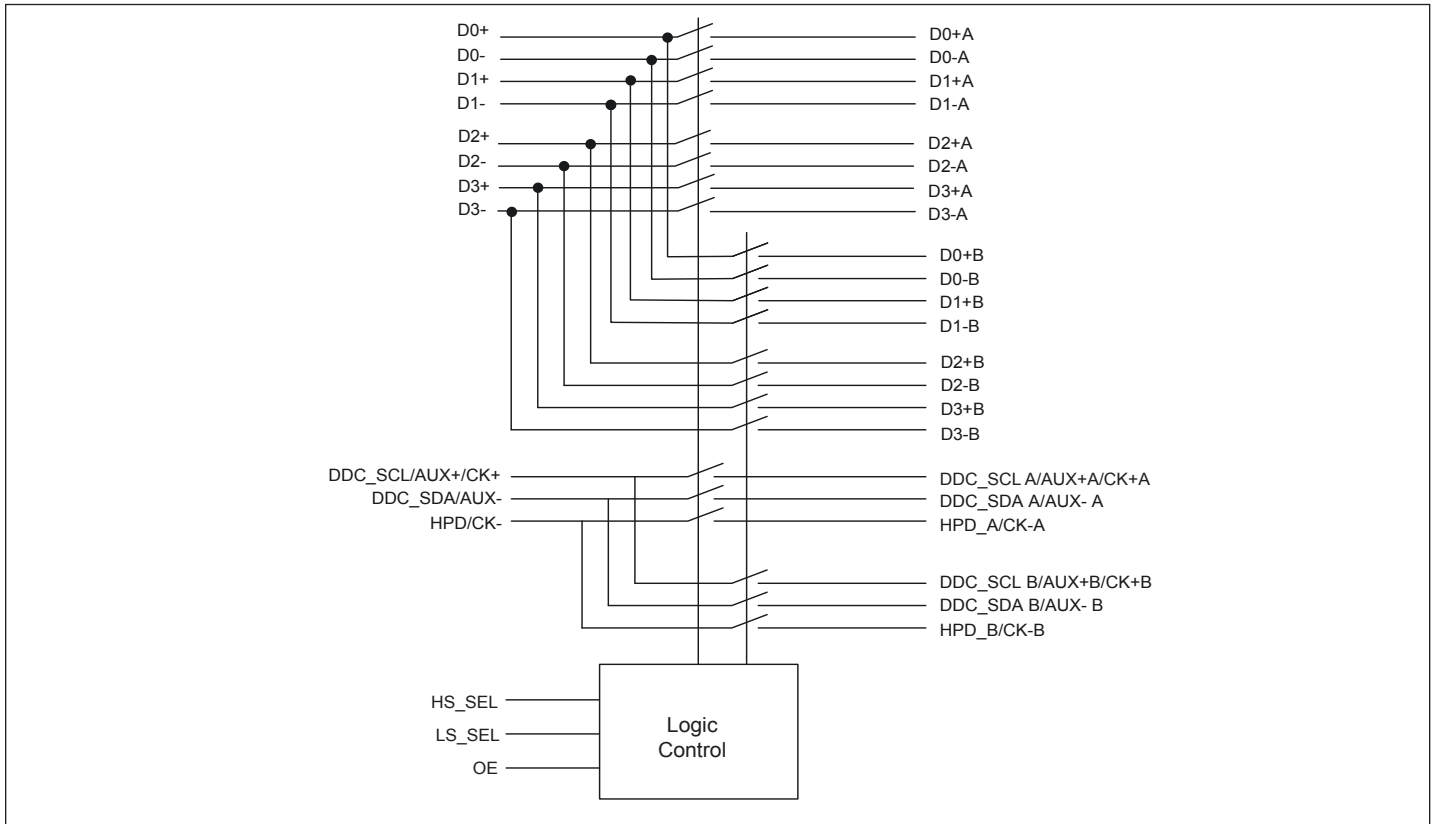
Notes:

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. Automotive products are AEC-Q100 qualified and are PPAP capable. Refer to <https://www.diodes.com/quality/>.

Simplified Use Cases



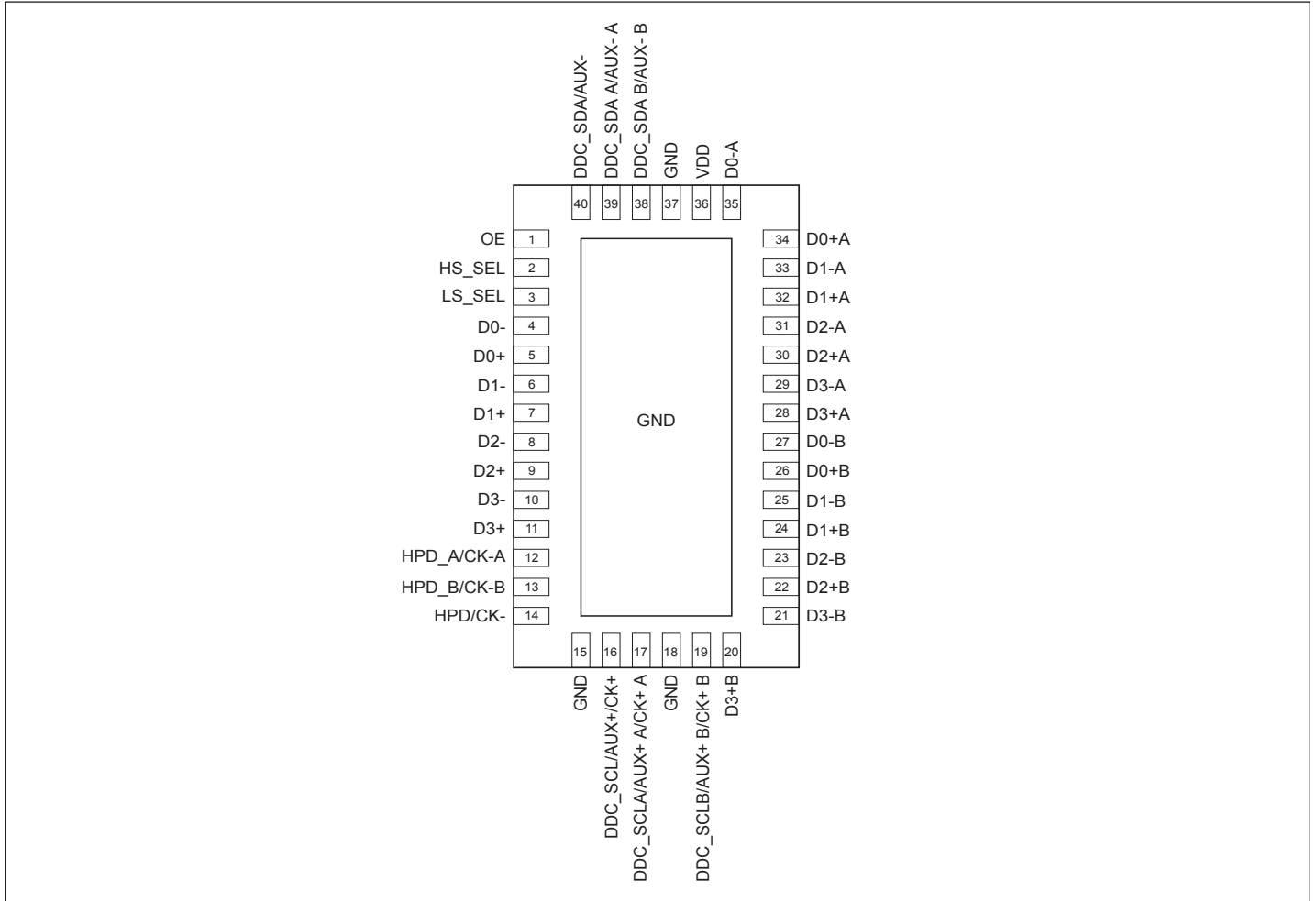
Block Diagram



Truth Table

Control			Switch Function		
OE	HS_SEL	LS_SEL	D0-D3	DDC/ AUX	HPD
High	Low	Low	A	DDC_SCL A/AUX+A/CK+A DDC_SDA A/AUX-A	HPD_A/CK-A
High	Low	High	A	DDC_SCL B/AUX+B/CK+B DDC_SDA B/AUX-B	HPD_B/CK-B
High	High	Low	B	DDC_SCL A/AUX+A/CK+A DDC_SDA A/AUX-A	HPD_A/CK-A
High	High	High	B	DDC_SCL B/AUX+B/CK+B DDC_SDA B/AUX-B	HPD_B/CK-B
Low	x	x	Hi-Z	Hi-Z	Hi-Z

Pin Configuration



Pin Description

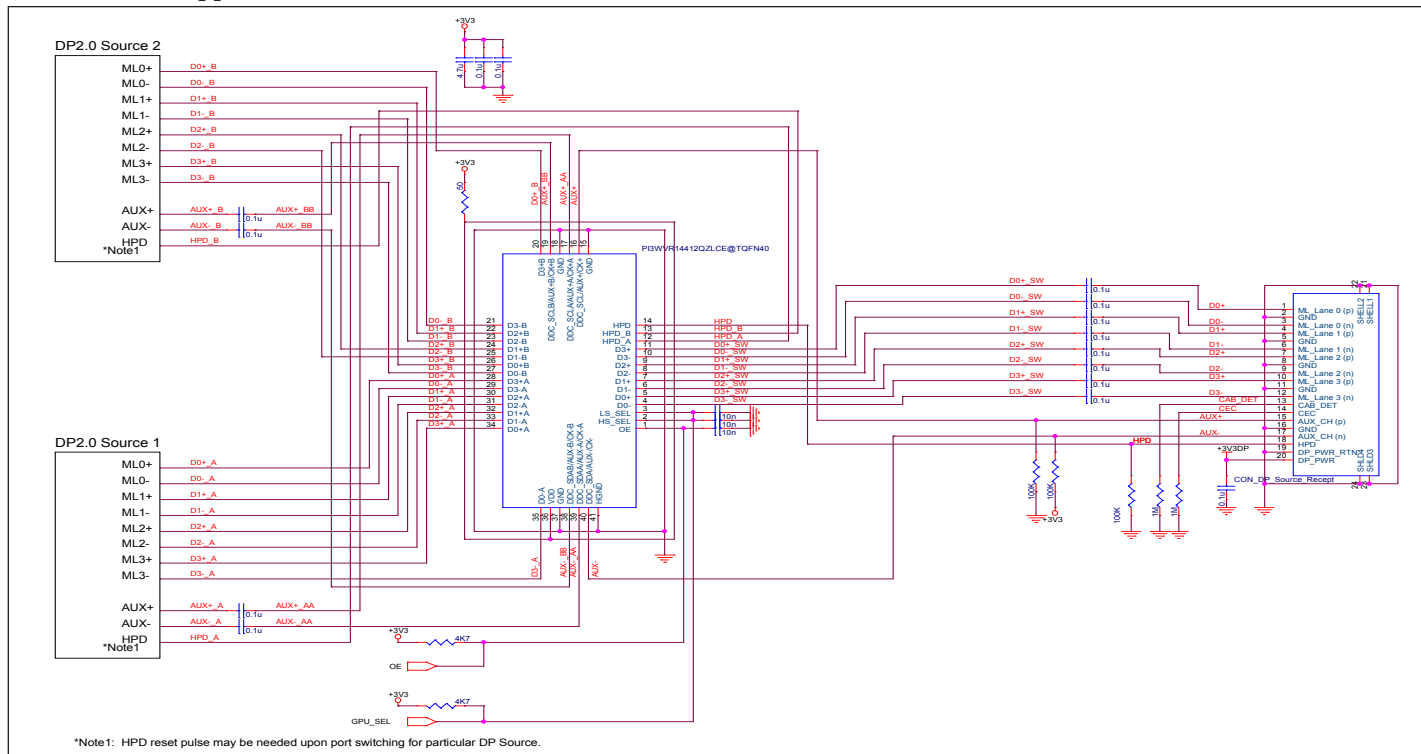
Pin#	Pin Name	Signal Type	Description
1	OE	I	Output enable. If OE is high, IC is enabled. If OE is low, IC is power down and all I/Os are Hi-Z
2	HS_SEL	I	Switch logic control for High Speed Channels
3	LS_SEL	I	Switch logic control for Low Speed Signals, DDC, AUX, HPD, CK
4	D0-	I/O	Negative differential signal 0 for COM port
5	D0+	I/O	Positive differential signal 0 for COM port
6	D1-	I/O	Negative differential signal 1 for COM port
7	D1+	I/O	Positive differential signal 1 for COM port
8	D2-	I/O	Negative differential signal 2 for COM port
9	D2+	I/O	Positive differential signal 2 for COM port
10	D3-	I/O	Negative differential signal 3 for COM port

PI3WVR14412Q

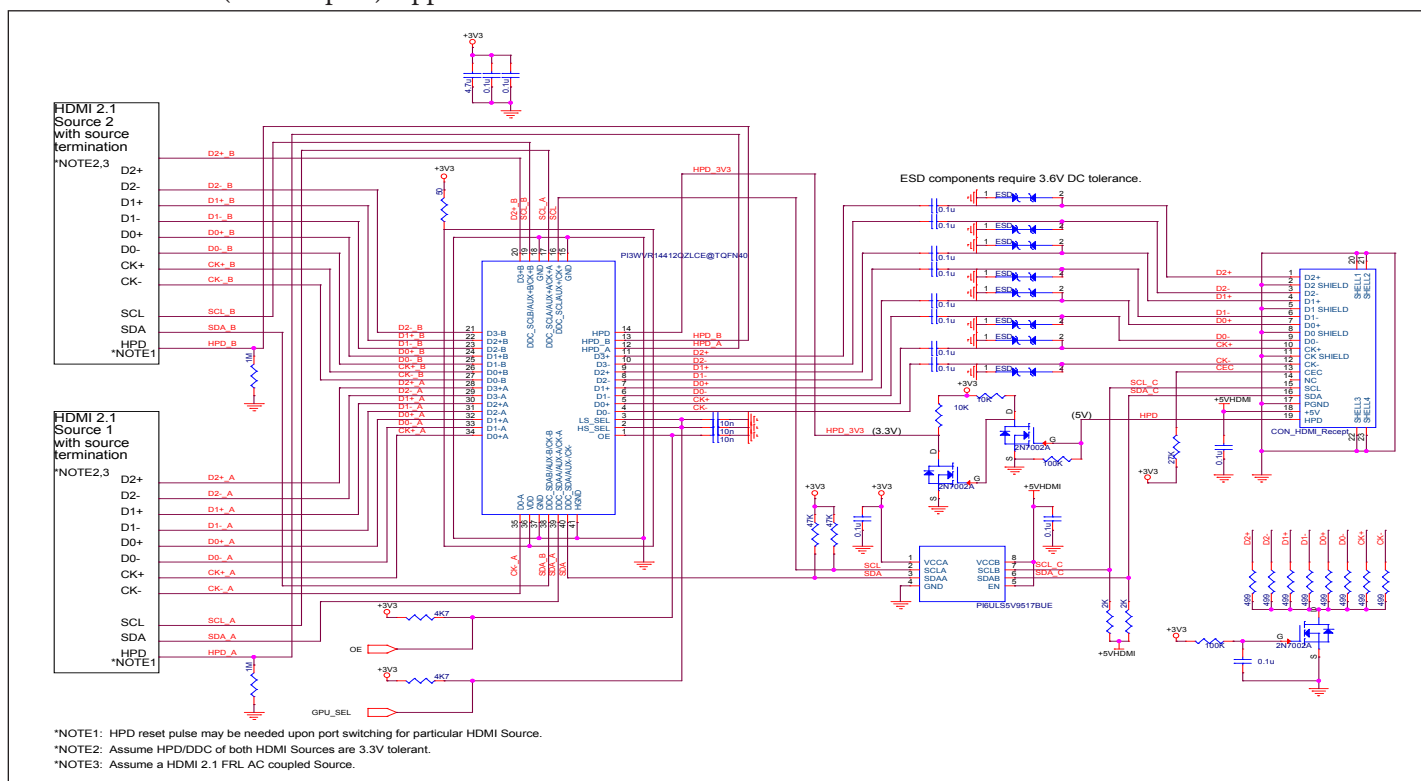
Pin#	Pin Name	Signal Type	Description
11	D3+	I/O	Positive differential signal 3 for COM port
12	HPD_A/CK-A	I/O	HPD/CK for port A
13	HPD_B/CK-B	I/O	HPD/CK for port B
14	HPD/CK-	I/O	HPD/CK for COM port
16	DDC_SCL/AUX+/CK+	I/O	Positive differential signal for DDC_SCL/AUX/CK COM port
17	DDC_SCLA/AUX+A/CK+A	I/O	Positive differential signal for DDC_SCL/AUX/CK port A
19	DDC_SCLB/AUX+B/CK+B	I/O	Positive differential signal for DDC_SCL/AUX/CK port B
20	D3+B	I/O	Positive differential signal 3 for port B
21	D3-B	I/O	Negative differential signal 3 for port B
22	D2+B	I/O	Positive differential signal 2 for port B
23	D2-B	I/O	Negative differential signal 2 for port B
24	D1+B	I/O	Positive differential signal 1 for port B
25	D1-B	I/O	Negative differential signal 1 for port B
26	D0+B	I/O	Positive differential signal 0 for port B
27	D0-B	I/O	Negative differential signal 0 for port B
28	D3+A	I/O	Positive differential signal 3 for port A
29	D3-A	I/O	Negative differential signal 3 for port A
30	D2+A	I/O	Positive differential signal 2 for port A
31	D2-A	I/O	Negative differential signal 2 for port A
32	D1+A	I/O	Positive differential signal 1 for port A
33	D1-A	I/O	Negative differential signal 1 for port A
34	D0+A	I/O	Positive differential signal 0 for port A
35	D0-A	I/O	Negative differential signal 0 for port A
36	VDD	Power	3.3V +/-10% power supply
38	DDC_SDA B/AUX-B	I/O	Negative differential signal for DDC_SCL/AUX port B
39	DDC_SDA A/AUX-A	I/O	Negative differential signal for DDC_SCL/AUX port A
40	DDC_SDA/AUX-	I/O	Negative differential signal for DDC_SCL/AUX COM port
15, 18, 37, Center pad	GND	Ground	Ground

Application Schematic

DP 2:1 Source Application Schematic

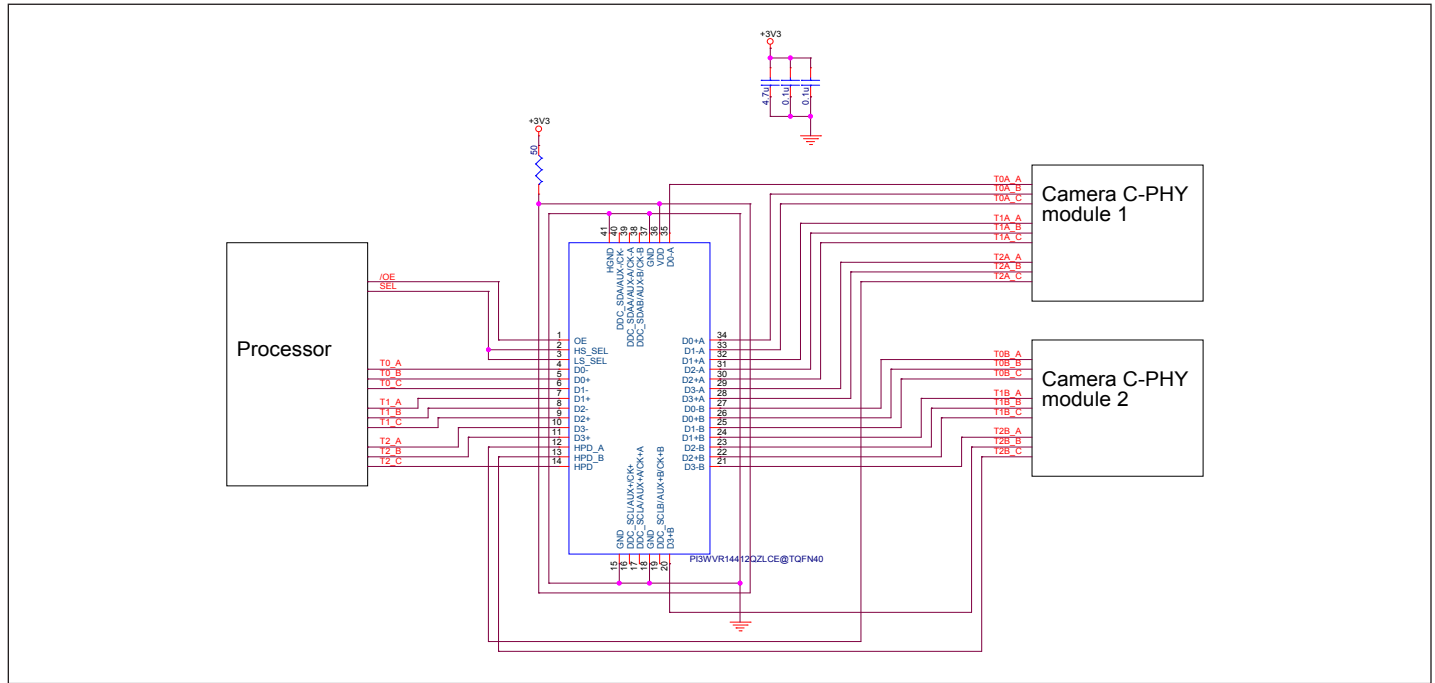


HDMI 2:1 Source (AC Coupled) Application Schematic

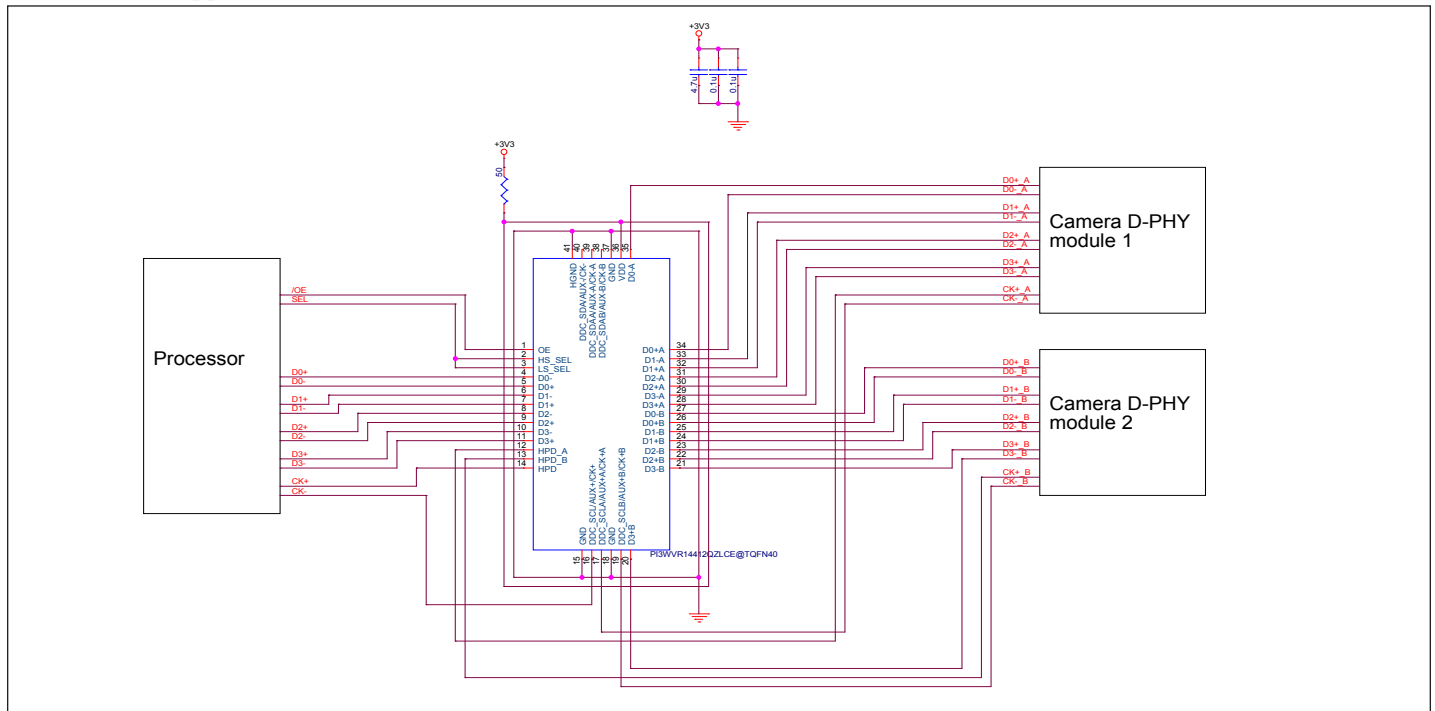


PI3WVR14412Q

MIPI C-PHY Application Schematic



MIPI D-PHY Application Schematic



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 +3.8V
DC Input Voltage.....	-0.5V to VDD
High-Speed Channel.....	-0.5V to VDD+0.4V
HPD_x, SCL_x, SDA_x	-0.5V to VDD+0.4V
ESD:	
HBM.....	±1500V
CDM.....	±1000V

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.

Recommended Operating Conditions

Parameter	Description	Min.	Typ. ⁽²⁾	Max.	Units
V _{DD}	Power Supply	3	3.3	3.6	V
V _{DX}	High-speed Channels Voltage Range	0		VDD	V
V _{OTHER}	DDC/AUX/HPD/CK Channels Voltage Range	0		VDD	V

DC Electrical Characteristics for Switching over Operating Range

T_A = -40°C to +105°C, V_{DD} = 3.3V ±10%

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units
V _{IH}	Input HIGH Voltage (OE, GPU_SEL and DDC/AUX/CK_HPDP_SEL)	Guaranteed HIGH level	1.5			V
V _{IL}	Input LOW Voltage (OE, GPU_SEL and DDC/AUX/CK_HPDP_SEL)	Guaranteed LOW level			0.75	
I _{IH}	Input HIGH Current (OE, GPU_SEL and DDC/AUX/CK_HPDP_SEL)	V _{DD} = Max., V _{IN} = V _{DD}			±1	μA
I _{IL}	Input LOW Current (OE, GPU_SEL and DDC/AUX/CK_HPDP_SEL)	V _{DD} = Max., V _{IN} = GND			±1	
I _{OFF_SB}	I/O leakage when part is off for sideband signals only (DDC/AUX/CK, HPD)	V _{DD} = 0V, V _{INPUT} = 0V to 3.6V			5	
R _{ON_HS}	On resistance between input to output for high speed signals	V _{DD} = 3.3V, V _{INPUT} = 0V to V _{DD} , I _{INPUT} = 10mA		8	12.5	Ω
		T _A = -40°C to 85°C			14.5	
R _{ON_DDC/ AUX}	On resistance between input to output for side-band signals (DDC/AUX/CK)	V _{DD} = 3.3V, V _{INPUT} = 0V to V _{DD} , I _{INPUT} = 10mA		8	12.5	Ω
R _{ON_HPDP}	On resistance between input to output for HPD channel	V _{DD} = 3.3V, V _{INPUT} = 0V to V _{DD} , I _{INPUT} = 10mA		8	12.5	Ω
I _{OZ_SB}	I/O leakage for sideband signals only (DDC, AUX, CK, HPD)	V _{DD} = 3.6V, V _{INPUT} = 0 to V _{DD}			5	uA

Power Supply Characteristics

 $T_A = -40^{\circ}\text{C to } +105^{\circ}\text{C}$

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units
I_{DD}	Power Supply Current	$V_{DD} = 3.3\text{V}$, $V_{IN} = \text{GND or } V_{DD}$		0.1	0.5	mA
$I_{DD,Off}$	Power Supply Current, Disabled	$V_{DD} = 3.3\text{V}$, $V_{IN} = \text{GND or } V_{DD}$, $V_{OE} < V_{IL}$		1	150	μA

Note:

- For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at $V_{DD} = 3.3\text{V}$, $T_A = 25^{\circ}\text{C}$ ambient and maximum loading.

Dynamic Electrical Characteristics over Operating Range

 $T_A = -40^{\circ}\text{ to } +105^{\circ}\text{C}$, $V_{DD} = 3.3\text{V} \pm 10\%$

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units
X_{TALK}	Channel-to-Channel Crosstalk on High-Speed Channels	$f = 10\text{GHz}$		-30		dB
O_{IRR}	OFF Isolation on High-Speed Channels	$f = 10\text{GHz}$		-15		
I_{LOSS}	Differential Insertion Loss on High-Speed Channels	$f = 10\text{GHz}$		-2.0		dB
R_{loss}	Differential Return Loss on high-speed channels	$f = 10\text{GHz}$		-10		dB
$BW_{Dx\pm}$	Bandwidth -3dB for Main high-speed path ($Dx\pm$)			12		GHz
$BW_{DDC/AUX/CK}$ and HPD	-3dB BW for DDC/AUX/CK and HPD signals			3		GHz

Note:

- For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at $V_{DD} = 3.3\text{V}$, $T_A = 25^{\circ}\text{C}$ ambient and maximum loading.

Switching Characteristics

 $T_A = -40^{\circ}\text{ to } +105^{\circ}\text{C}$, $V_{DD} = 3.3\text{V} \pm 10\%$

Parameter	Description	Min.	Typ.	Max.	Units
T_{pd}	Propagation delay (input pin to output pin) on all channels		110		ps
tb-b	Bit-to-bit skew within the same differential pair of $Dx\pm$ channels		5	7	ps
tch-ch	Channel-to-channel skew of $Dx\pm$ channels			35	ps
Tsw a-b	Time it takes to switch from port A to port B			20	us
Tsw b-a	Time it takes to switch from port B to port A			20	us
Tstartup	V_{DD} valid to channel enable			200	us
Twakeup	Enabling output by changing OE from low to High			200	us

PI3WVR14412Q

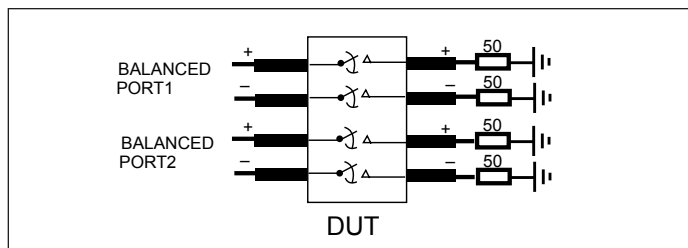


Figure 1. Crosstalk Setup

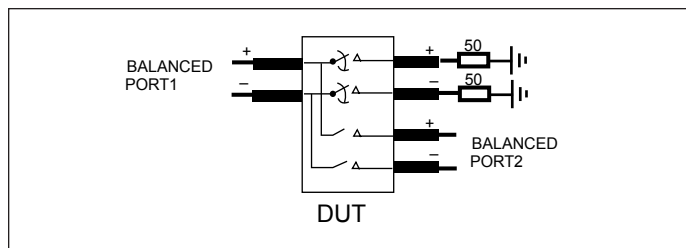


Figure 2. Off-isolation Setup

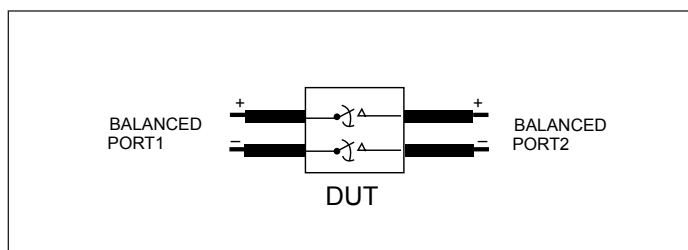
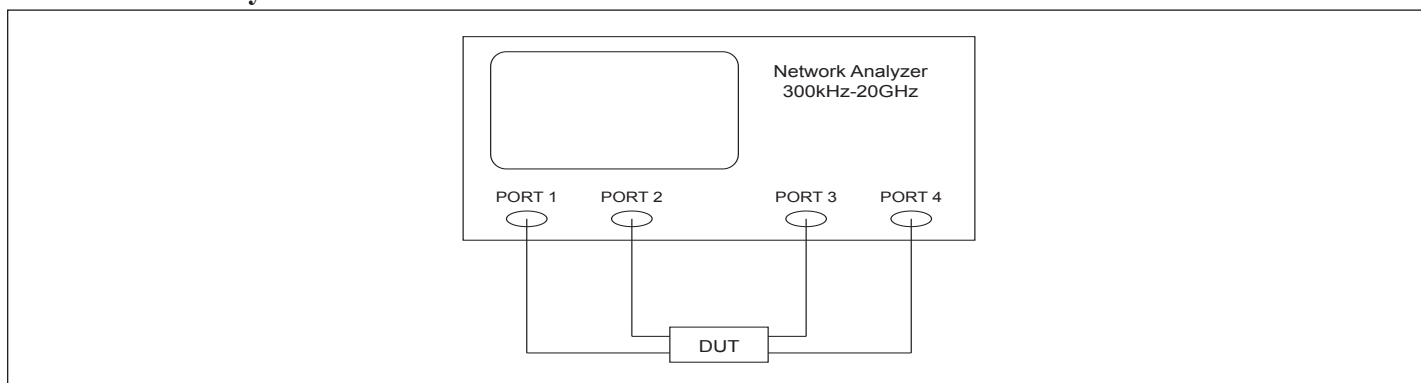
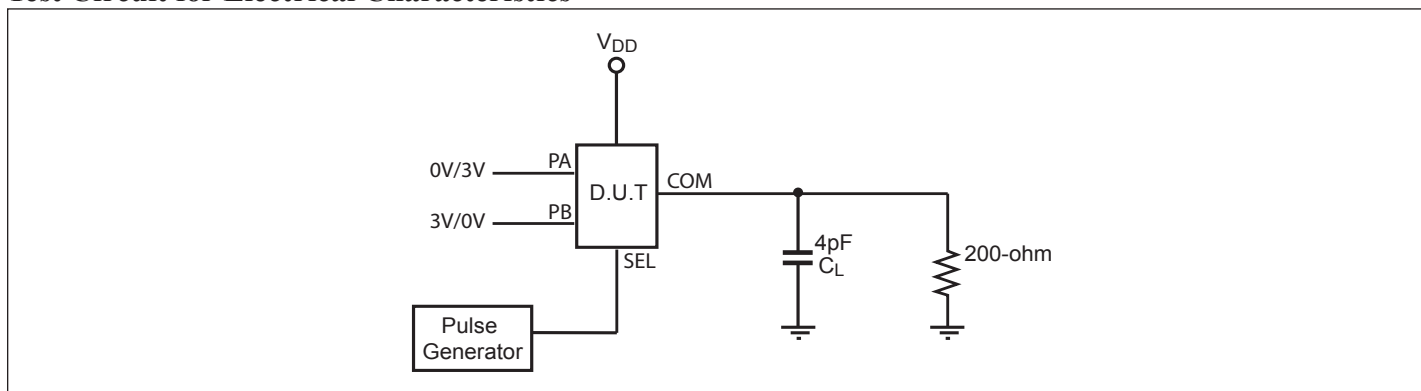


Figure 3. Differential Insertion Loss

Test Circuit for Dynamic Electrical Characteristics



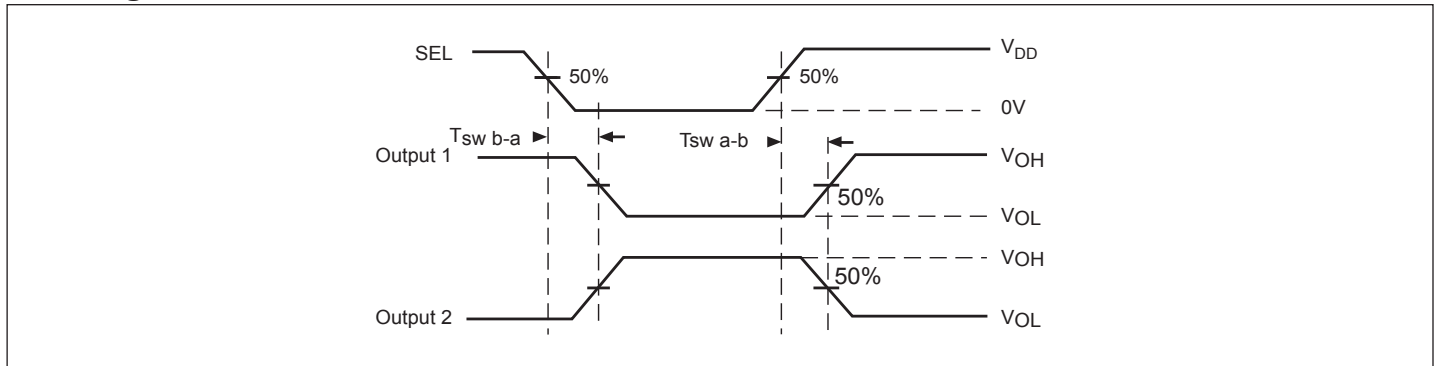
Test Circuit for Electrical Characteristics



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. All input impulses are supplied by generators having the following characteristics: $PRR \leq \text{MHz}$, $Z_O = 50\Omega$, $t_R \leq 2.5\text{ns}$, $t_F \leq 2.5\text{ns}$.
4. The outputs are measured one at a time with one transition per measurement.

Switching Waveforms



Voltage Waveforms for Select Timing

Test Condition

Output 1 Test Condition	Output 2 Test Condition
PA = Low	PA = High
PB = High	PB = Low

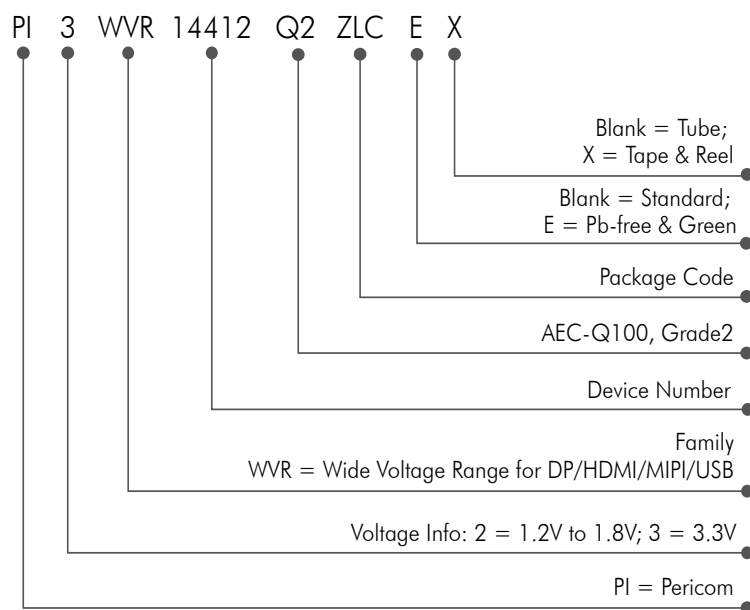
PI3WVR14412Q

Part Marking

PI3WVR144
12Q2ZLCE
○ YYWWXX

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

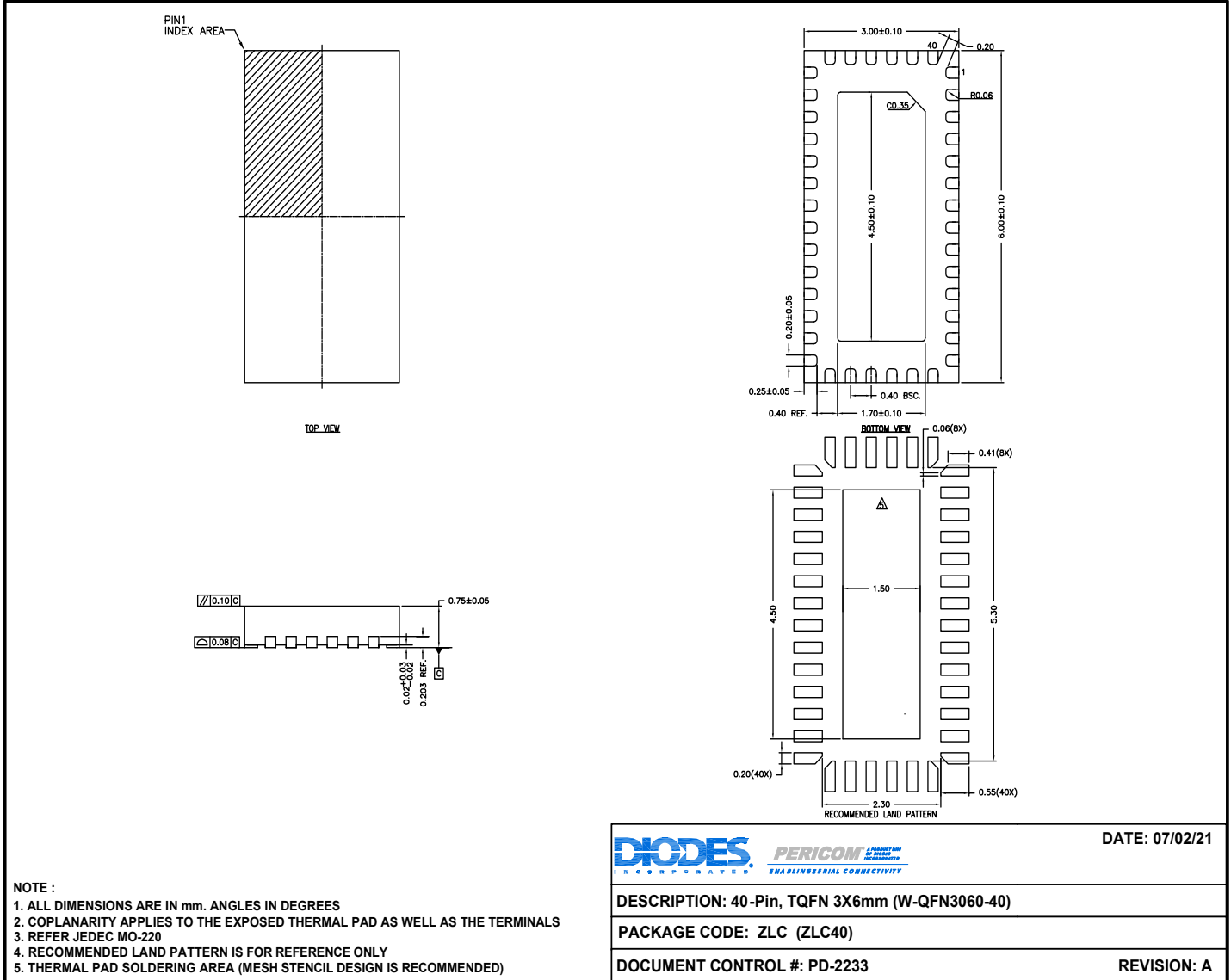
Device Naming Information



PI3WVR14412Q

Packaging Mechanical

40-TQFN (ZLC)



21-1406

For latest package info.

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

IMPORTANT NOTICE

1. DIODES INCORPORATED (Diodes) AND ITS SUBSIDIARIES 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 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.

9. This Notice may be periodically updated with the most recent version available at <https://www.diodes.com/about/company/terms-and-conditions/important-notice>

The Diodes logo is a registered trademark of Diodes Incorporated in the United States and other countries.

All other trademarks are the property of their respective owners.

© 2023 Diodes Incorporated. All Rights Reserved.

www.diodes.com