

USB2.0 High-Speed (480Mbps) Signal Switch With Vbus Short Protection

Description

The PI3USB42 is a single differential channel 2:1 multiplexer/demultiplexer USB 2.0 Switch. Industry leading advantages include a propagation delay of less than 250ps, resulting from its low channel resistance and I/O capacitance. The device multiplexes differential outputs from a USB Host device to one of two corresponding outputs. The switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. It is designed for low bit-to-bit skew, high channel-to-channel noise isolation and is compatible with various standards, such as High Speed USB 2.0 (480Mb/s).

The PI3USB42 offers overvoltage protection per the USB2.0 specification. With the chip powered on or off, all I/O pins can withstand a short to Vbus (5V +/-10%). If VDD = 0V, the I/Os can still have signals present, and the signal will NOT leak through to VDD.

If the Vin (D+/-) is 0.6V greater than VDD, USB42 will turn off the switch between Input (D+/-) and output (D+A/B and D-A/B).

Application(s)

- Route Signals for USB 2.0
- Cell Phones, PDA, Digital Camera and Notebooks
- LCD Monitors, TVs, Set-top Boxes
- Portable Devices

Block Diagram

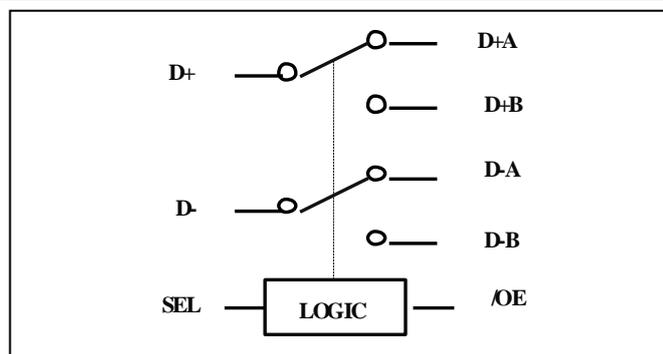


Table 1. Logic Function Table

/OE	SEL	Function
H	X	I/O's = Hi-Z
L	L	D(+/-) to D(+/-)A
L	H	D(+/-) to D(+/-)B

Notes:

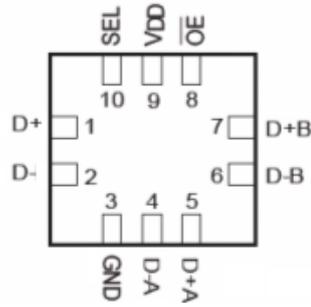
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Features

- USB 2.0 Compliant (High Speed and Full Speed)
- R_{ON} is 4.0Ω Typical @ V_{DD} = 3.0V
- Low Bit-to-Bit Skew
- Low Crosstalk: -41dB @ 240MHz
- Off Isolation: -37dB @ 240MHz
- Wide -3db Bandwidth: 770MHz
- Near-Zero Propagation Delay: 250ps
- Supports for 1.8V/2.5V/3.3V Logic on Control Pins
- Channel On Capacitance: 6.0pF
- VDD Operating Range: 1.8V to 4.5V
- Data Pin I/O ESD: >8kV HBM Protection per JESD22-A114D Specification
- I/O Pins Have Over-voltage Protection and Can Tolerate a Short to Vbus
- Packaging (Pb-free & Green): 10-pin, UQFN (ZM10)
- 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](#) or your local Diodes representative.

<https://www.diodes.com/quality/product-definitions/>

Pin Configuration



Pin Description

Pin Number	Pin Name	Description
1	D+	USB Data bus
2	D-	USB Data bus
3	GND	Ground
4	D-A	Multiplexed Source Inputs
5	D+A	Multiplexed Source Inputs
6	D-B	Multiplexed Source Inputs
7	D+B	Multiplexed Source Inputs
8	/OE	Switch Enable
9	V _{DD}	Positive Power Supply
10	SEL	Switch Select

Maximum Ratings

Storage Temperature	-65°C to +150°C
Junction Temperature	125°C
Supply Voltage to Ground Potential	-0.5V to +5V
Control Input Voltage.....	-0.5V to 4.6V
DC Switch Voltage (D+, D-, D+A, D-A, D+B and D-B)	-0.5V to 5.25V
DC Output Current	120mA
Power Dissipation	0.5W
ESD (HBM)	>8kV

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.

The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V _{DD}	Operating Voltage	1.8		4.5	V
V _{CNTRL} ⁽¹⁾	Control Input Voltage	0		4.3	
V _{INPUT}	Switch Input Voltage	-0.5		V _{DD} +0.5	
T _A	Operating Temperature	-40		105	°C

Notes:

1. The control input must be held high or low and it must not float.

DC Electrical Characteristics

T_A = -40°C to +105°C, V_{DD} = 3.0V - 4.5V

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Unit
V _{IH}	Input High Voltage	Guaranteed High Level	1.2			V
V _{IL}	Input Low Voltage	Guaranteed Low Level			0.60	
V _{IK}	Clamp Diode Voltage	V _{DD} = Max., I _{SEL} = -18mA		-0.7	-1.2	
I _{IH}	Input High Current	V _{DD} = Max., V _{SEL} = V _{DD}			±100	nA
I _{IL}	Input Low Current	V _{DD} = Max., V _{SEL} = GND			±100	
R _{ON}	Switch On-Resistance ⁽³⁾	V _{DD} = Min., 0 ≤ V _{INPUT} ≤ 0.4V, I _{INPUT} = -40mA		4.0	5.5	Ω
R _{FLAT(ON)}	On-Resistance Flatness ⁽³⁾	V _{DD} = Min., 0 ≤ V _{INPUT} ≤ 0.4V, I _{INPUT} = -40mA		0.25		
ΔR _{ON}	On-Resistance match from center ports to any other port ⁽³⁾	V _{DD} = Min., 0 ≤ V _{INPUT} ≤ 0.4V, I _{INPUT} = -40mA		0.1	1.0	
I _{OZ}	Output leakage current when port is off	V _{DD} = 4.5V, 0 ≤ V _{INPUT} ≤ 0.4V			±100	nA
I _{OFF}	Power-Off Leakage Current	V _{INPUT} = 0V~4.3V, V _{DD} = 0V			100	nA

Notes:

1. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

2. V_{DD} = 3.0 - 4.5V, T_A = 25°C ambient and maximum loading.

3. Measured by the voltage drop between D and Dn pin at indicated current through the Switch On-Resistance is determined by the lower of the voltages on the two (D, Dn) pins.

Power Supply Characteristics

T_A = -40°C to +105°C, V_{DD} = 3.0V - 4.5V

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ.	Max.	Unit.
I _{CC}	Quiescent Power Supply current	V _{DD} = Max., V _{SEL} = V _{DD} or GND			100	nA
I _{CCT}	Increase in I _{CC} Current per	V _{CNTRL} = 1.8V, V _{DD} = 4.5V		5.8	15	μA

PI3USB42

Parameter	Description	Test Conditions ⁽¹⁾	Min.	Typ.	Max.	Unit.
	Control Voltage and V_{DD}					

Notes:

1. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

Capacitance

$T_A = 25^\circ\text{C}$, $V_{DD} = 3.0\text{V}$, $f = 1\text{MHz}$

Parameters	Description	Test Conditions	Min.	Typ.	Max.	Units
C_{CNTRL}	Control logic pin Input Capacitance	$V_{SEL} = 0\text{V}$		6.0		pF
C_{OFF}	Switch Capacitance, Switch OFF			1.9		
C_{ON}	Switch Capacitance, Switch ON			6.0		

Dynamic Electrical Characteristics Over the Operating Range

$T_A = 25^\circ\text{C}$, $V_{DD} = 3.0\text{V}$

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ.	Max.	Units
XTALK	Crosstalk	$R_L = 50\Omega$, $f = 240\text{MHz}$		-41		dB
OIRR	OFF Isolation			-37		
BW	-3dB Bandwidth	$R_L = 50\Omega$		770		MHz

Switching Characteristics

$T_A = 25^\circ\text{C}$, $V_{DD} = 3.0\text{V}$

Parameters	Description	Test Conditions ⁽¹⁾	Min	Typ.	Max	Units
t_{PD}	Propagation Delay ^(2,3)	See Test Circuit for Electrical Characteristics		0.25		ns
t_{PZH} , t_{PZL}	Line Enable Time - SEL to D(+/-), D(+/-)n			25		
t_{PHZ} , t_{PLZ}	Line Disable Time - SEL to D(+/-), D(+/-)n			4		
t_{BBM}	Break-Before-Make			7		ns
t_{SKb-b}	Output skew, bit-to-bit (opposite transition of the same output ($t_{PHL} - t_{PLH}$)) ⁽²⁾	$V_{DD} = 3\text{V}$			35	ps
		$V_{DD} = 4\text{V}$			60	

Notes:

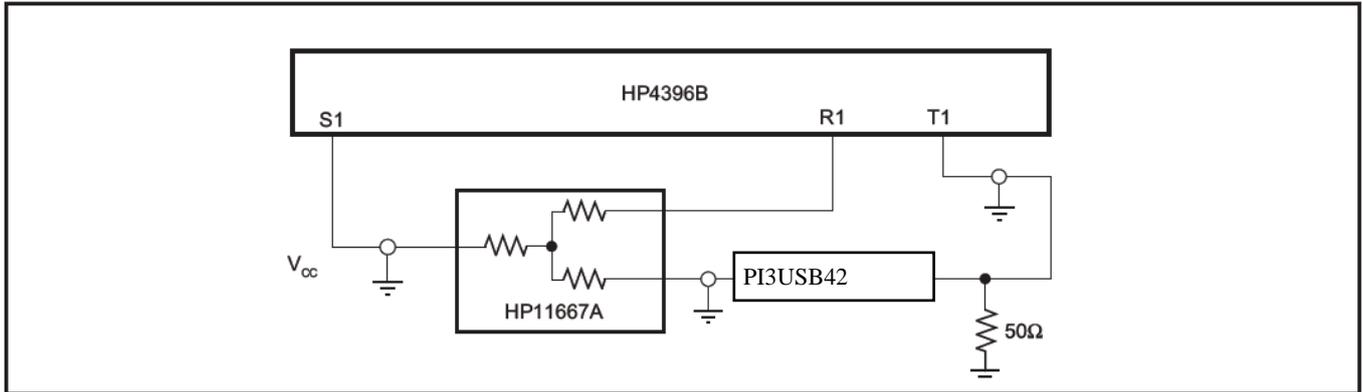
1. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

2. Guaranteed by design.

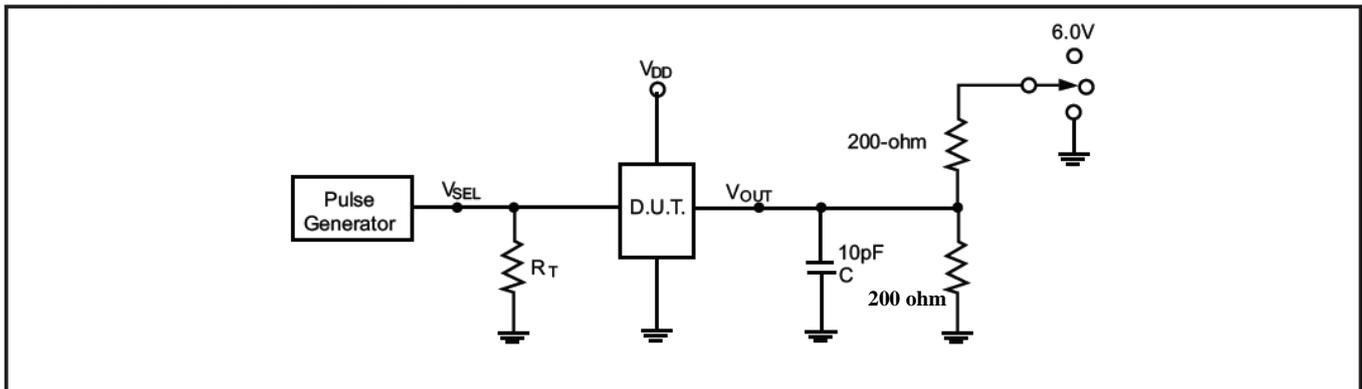
3. The switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25ns for 10pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, it adds very little propagational delay to the system. Propagational delay of the switch when used in a system is determined by the driving circuit on the driving side of the switch and its interactions with the load on the driven side.

Test Circuits and Test Diagramming

Test Circuit for Dynamic Electrical Characteristics



Test Circuit for Electrical Characteristics



Notes:

C_L = Load capacitance: includes jig and probe capacitance.

R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator

Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control.

Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.

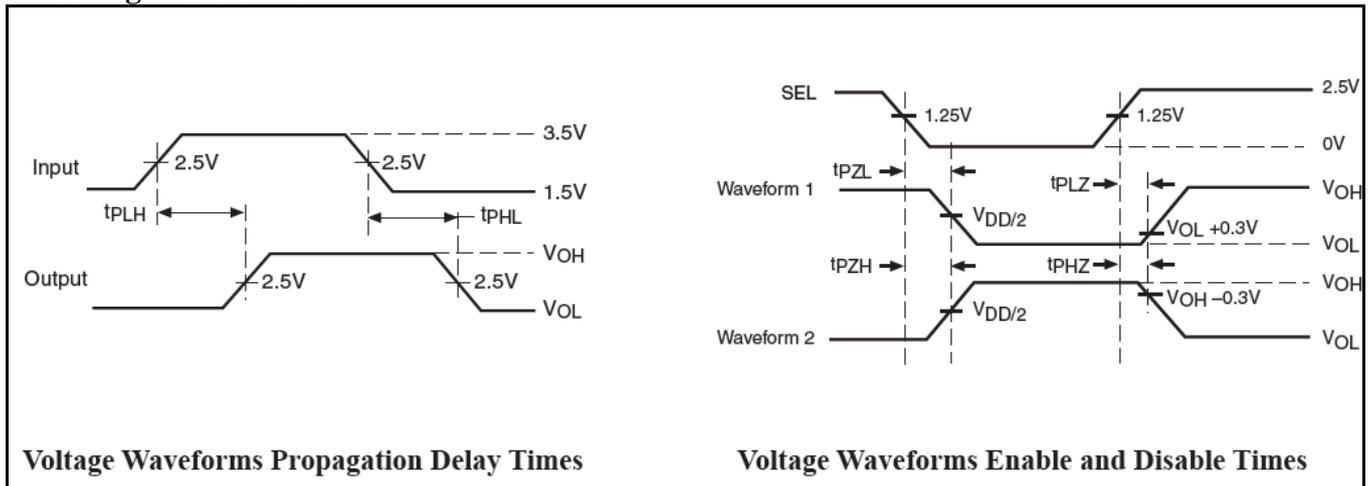
All input impulses are supplied by generators having the following characteristics: $PRR \leq \text{MHz}$, $Z_O = 50\Omega$, $t_R \leq 2.5\text{ns}$, $t_F \leq 2.5\text{ns}$.

The outputs are measured one at a time with on transition per measurement.

Table 2. Switch Positions

Test	Switch
t_{PLZ} , t_{PZL} (output on I-side)	6.0V
t_{PHZ} , t_{PZH} (output on I-side)	GND
Prop Delay	Open

Switching Waveforms



Applications Information

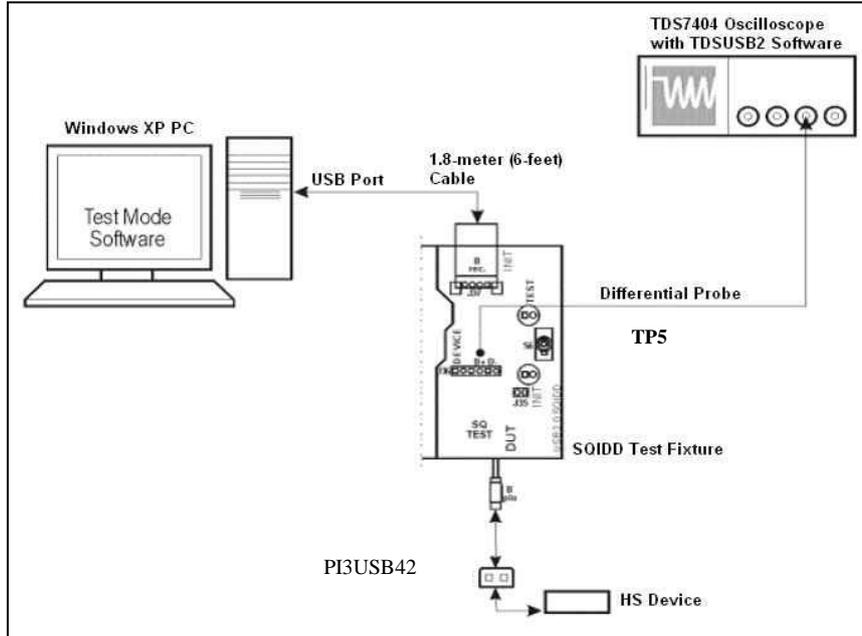
Logic Inputs

The logic control inputs can be driven up to +4.3V regardless of the supply voltage. For example, given a +3.3V supply, the output enables or select pins may be driven to low to 0V and high to 4.3V.

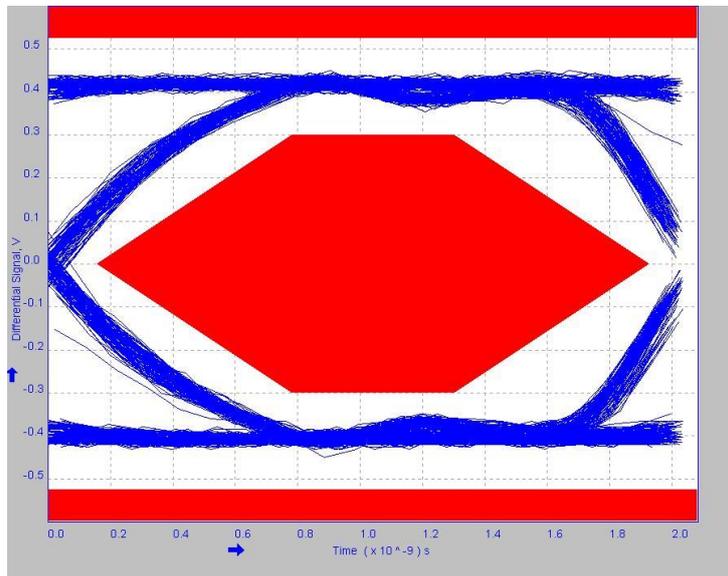
Power Supply Sequencing

Proper power supply sequencing is recommended for all CMOS devices. Always apply VDD and GND before applying signals to input/output or control pin.

Eye Diagram Measurement

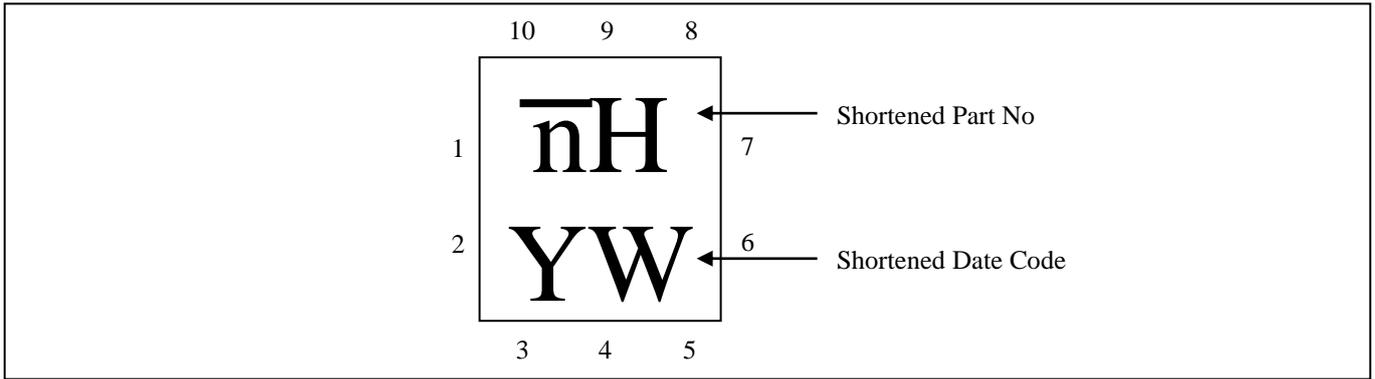


USB2.0 High-speed (480Mbps) Signal Integrity Test Setup



High Speed Signal Quality Eye Diagram Test ($V_{DD} = 3.3V$)

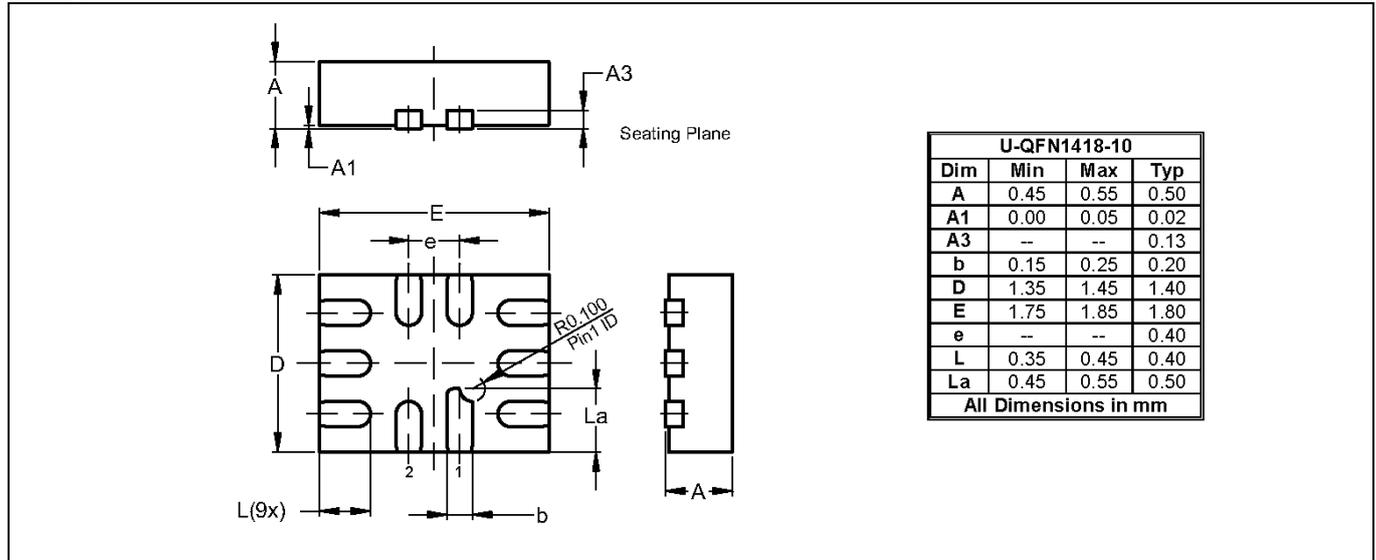
Part Marking



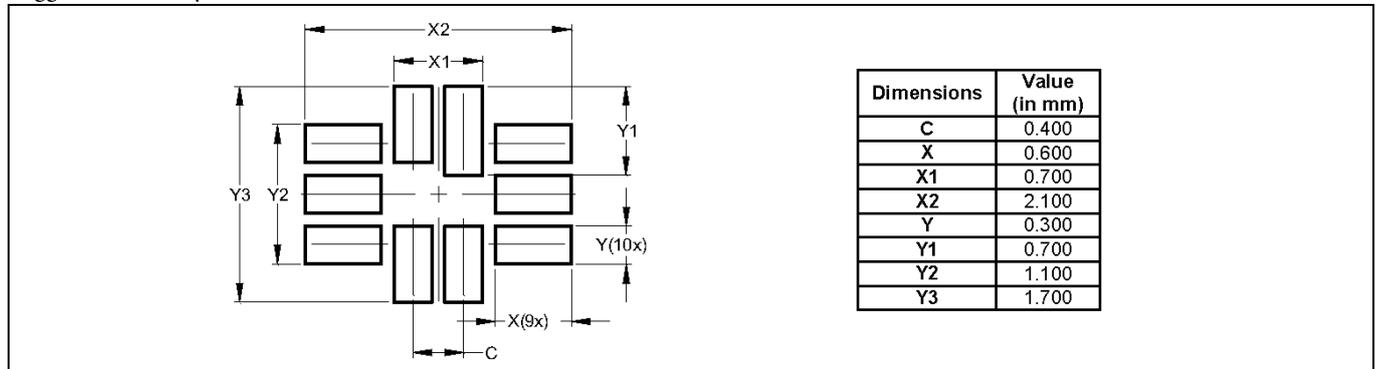
Packaging Mechanical

10-UQFN (ZM)

Package Outline



Suggested Pad Layout



ALL DIMENSIONS ARE NOMINAL VALUES SHOWN IN MILLIMETERS

Note: The suggested land pattern dimensions have been provided for reference only, as actual pad layouts may vary depending on application. These numbers may be modified based on user equipment capability or fabrication criteria. A more robust pattern may be desired for wave soldering and is calculated by adding 0.2 mm to the 'Z' dimension. For further information, please reference document IPC-7351A, Naming Convention for Standard SMT Land Patterns, and for international grid details, please see document IEC, Publication 97.

For latest package info.

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

Ordering Information

Orderable Part Number	Package Code	Package Description
PI3USB42ZMEX	ZM	10-contact, Ultra-thin Quad Flat No-Lead (UQFN)

Notes:

- No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
- 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.
- Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
- E = Pb-free and Green
- X suffix = Tape/Reel

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.
© 2025 Diodes Incorporated. All Rights Reserved.

www.diodes.com