

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

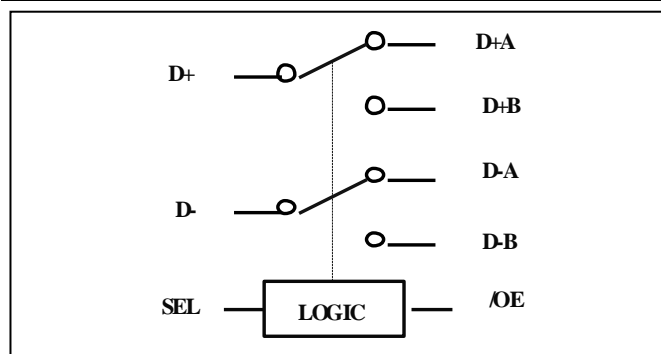


Table 1. Logic Function Table

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

Notes:

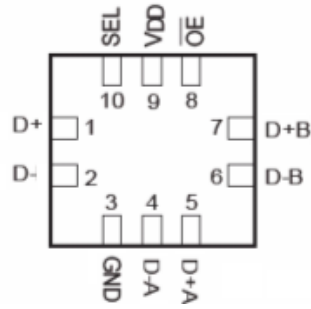
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and 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)
- RON is 4.0Ω Typical @ VDD = 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 _{CC1}	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:

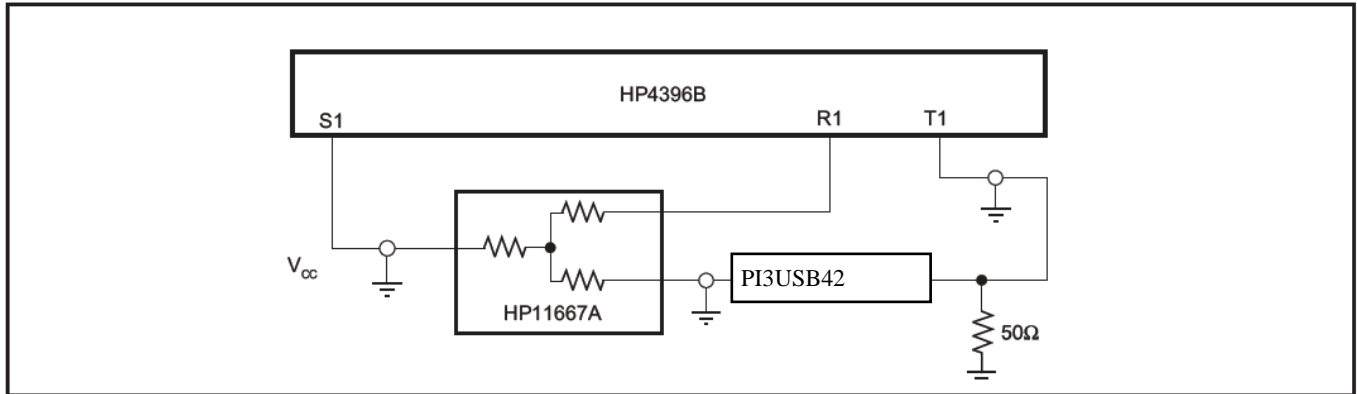
1. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

2. Guaranteed by design.

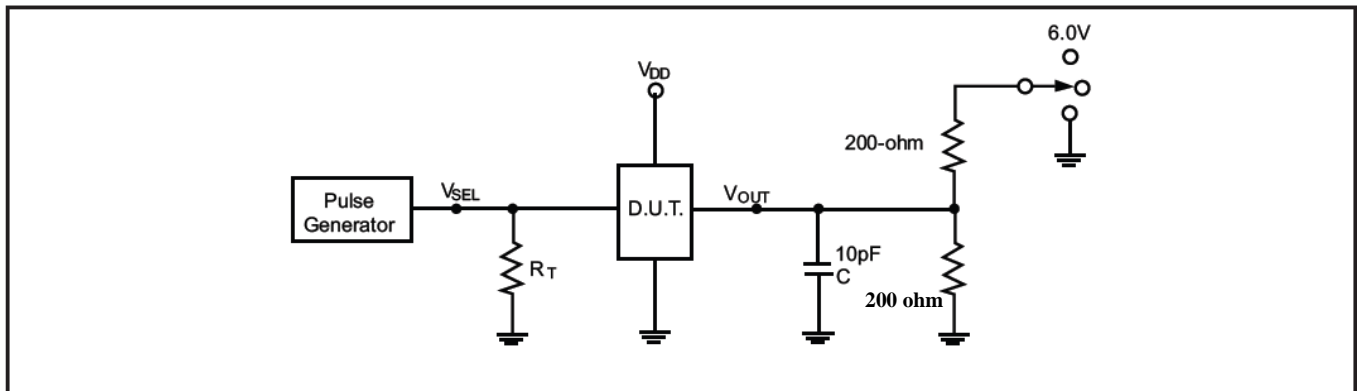
3. The switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25ns for 10pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, 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.

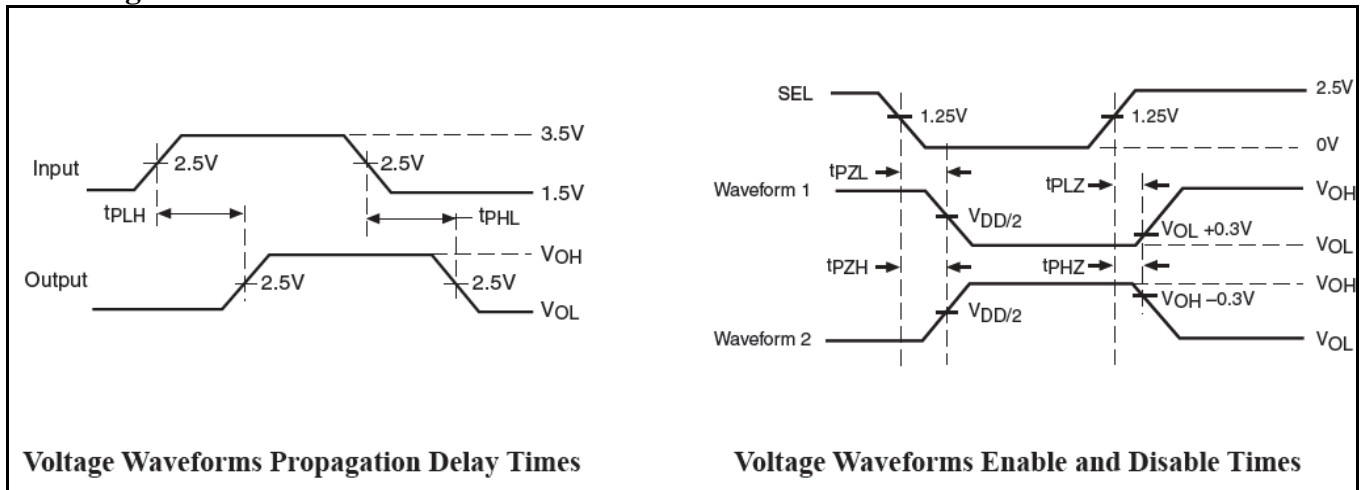
All input impulses are supplied by generators having the following characteristics: $PRR \leq \text{MHz}$, $Z_O = 50\Omega$, $t_R \leq 2.5\text{ns}$, $t_F \leq 2.5\text{ns}$.

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

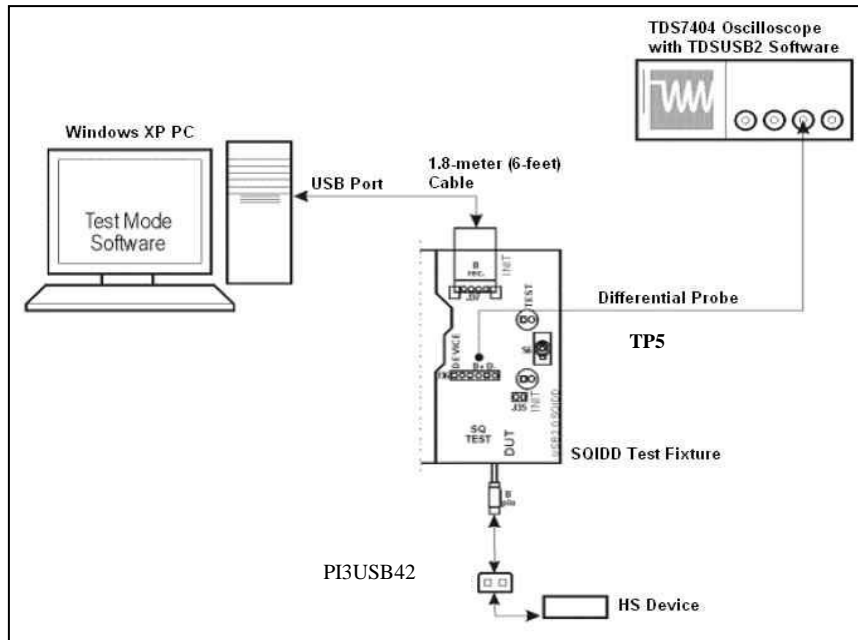
Logic Inputs

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.

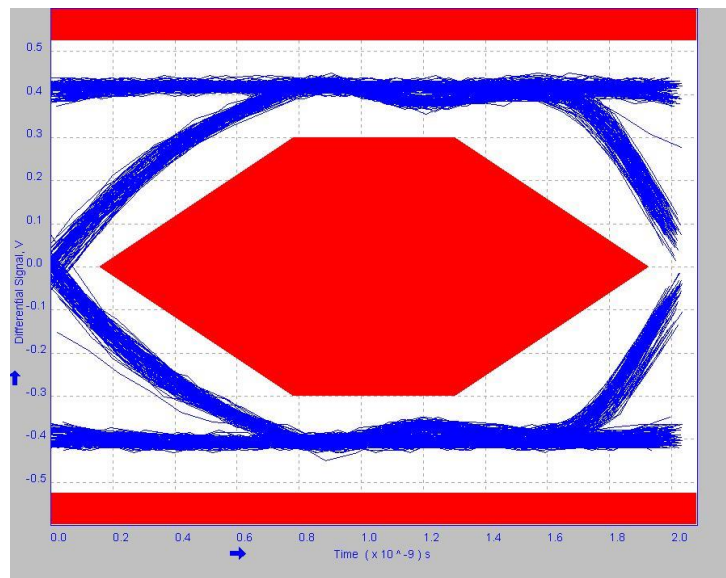
Power Supply Sequencing

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

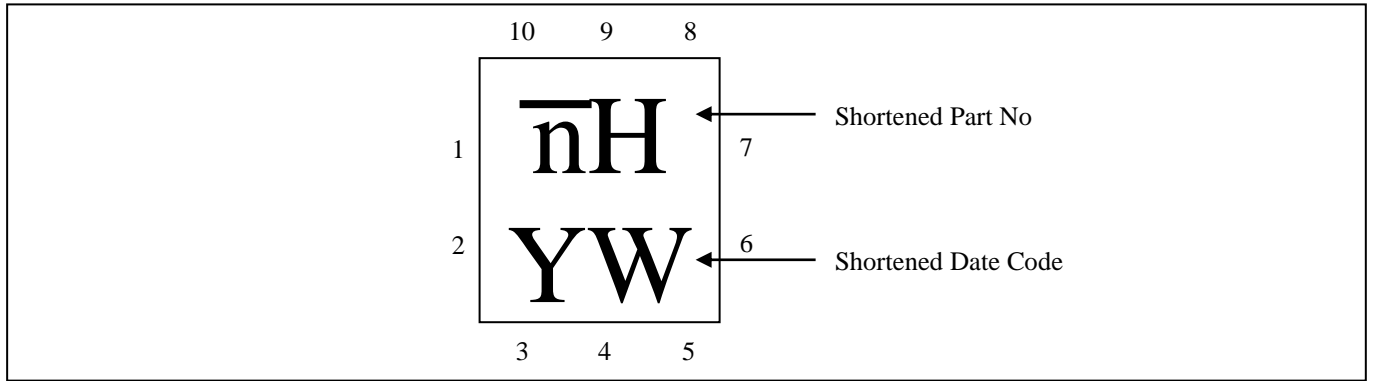


USB2.0 High-speed (480Mbps) Signal Integrity Test Setup



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

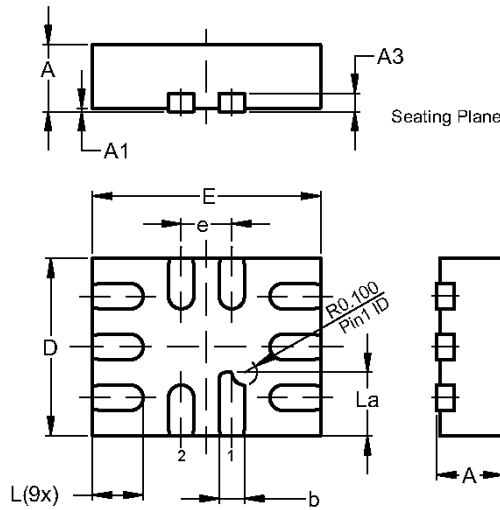
Part Marking



Packaging Mechanical

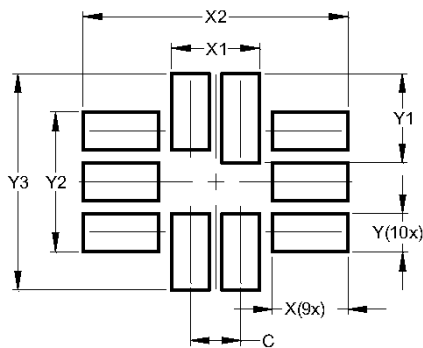
10-UQFN (ZM)

Package Outline



U-QFN1418-10			
Dim	Min	Max	Typ
A	0.45	0.55	0.50
A1	0.00	0.05	0.02
A3	--	--	0.13
b	0.15	0.25	0.20
D	1.35	1.45	1.40
E	1.75	1.85	1.80
e	--	--	0.40
L	0.35	0.45	0.40
La	0.45	0.55	0.50
All Dimensions in mm			

Suggested Pad Layout



Dimensions	Value (in mm)
C	0.400
X	0.600
X1	0.700
X2	2.100
Y	0.300
Y1	0.700
Y2	1.100
Y3	1.700

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.
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- 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

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