



**PI3USB221A**

**High-Speed USB2.0 1:2 Multiplexer/DeMultiplexer Switch with Signal Enable**

**Features**

- V<sub>DD</sub> Operation at 2.5 V and 3.3 V
- V<sub>I/O</sub> Accepts Signals up to 5.5 V
- 1.8-V Compatible Control-Pin Inputs
- Low-Power Mode When  $\overline{OE}$  Is Disabled (2  $\mu$ A)
- r<sub>ON</sub> = 6 $\Omega$  Maximum
- $\Delta$ r<sub>ON</sub> = 0.2 $\Omega$  Typical
- C<sub>io(on)</sub> = 4pF Typical
- Support Over Voltage Protection
- Low Power Consumption (50  $\mu$ A Maximum)
- ESD Performance
  - IO Pins
  - 12KV HBM
  - 1KV CDM
  - VDD, GND, S,  $\overline{OE}$  Pins
  - 4KV HBM
  - 1KV CDM
- High Bandwidth (1.6 GHz Typical)
- Packaging (Pb-free & Green):
  - 10-contact, UDFN (ZW10)
  - 10-contact, UQFN (ZUA10)

**Description**

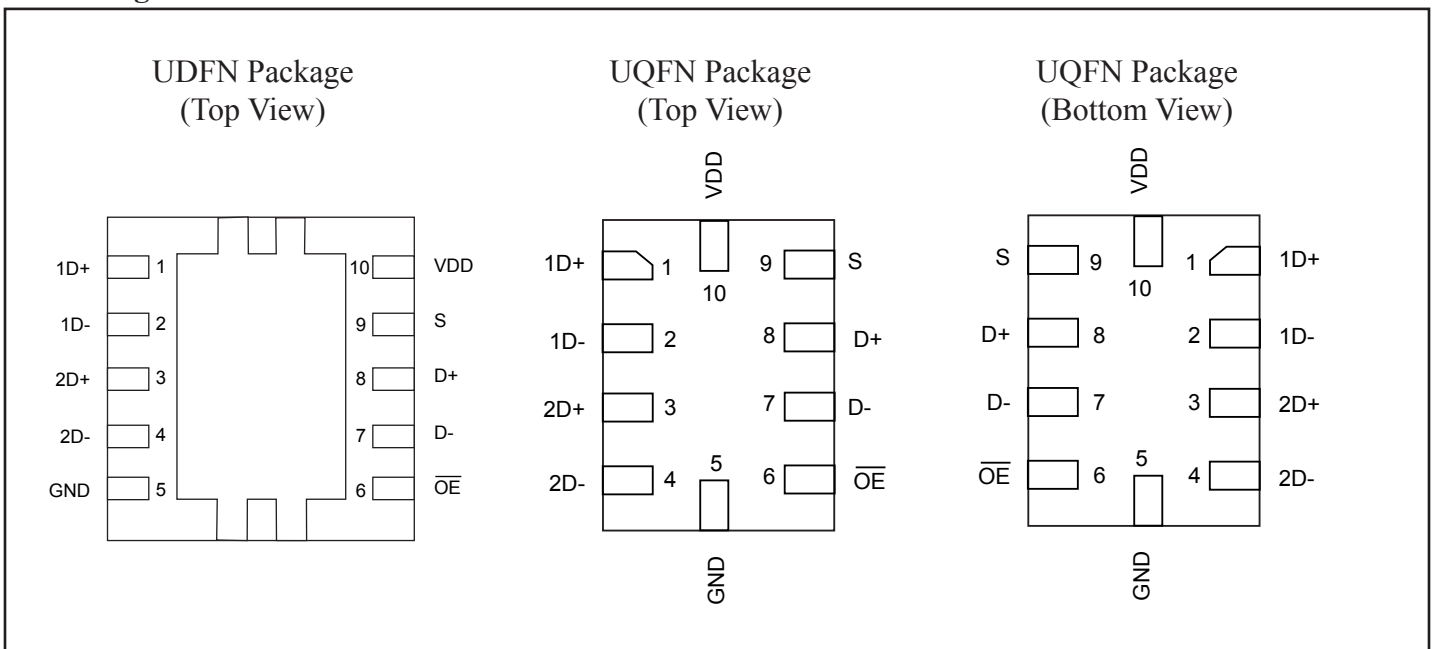
The PI3USB221A is a high-bandwidth switch specially designed for the switching of high-speed USB 2.0 signals in handset and consumer applications, such as cell phones, digital cameras, and notebooks with hubs or controllers with limited USB I/Os. The wide bandwidth (1.1 GHz) of this switch allows signals to pass with minimum edge and phase distortion. 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 and high channel-to-channel noise isolation, and is compatible with various standards, such as high-speed USB 2.0 (480 Mbps).

The PI3USB221A offer over voltage protection for the D+/D- pins as per the USB 2.0 specification. with the chip power on or off if D+/D- pins are shorted to VBus (5V+/-5%), a less than 3.8V (typical) signal will transmit through 1D+/1D- and 2D+/2D- output.

**Applications**

- Routes Signals for USB 1.0, 1.1, and 2.0
- Mobile Industry Processor Interface (MIPI) Signal Routing

**Pin Configuration**



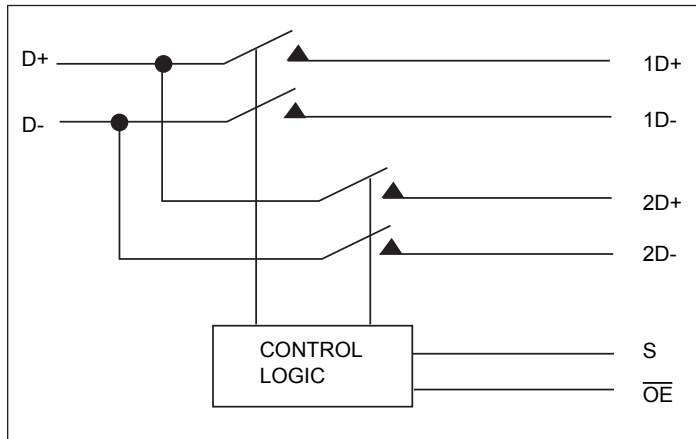


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**PI3USB221A**

### Block Diagram



### Pin Description

| Name            | Description                               |
|-----------------|---|
| $\overline{OE}$ | Active LOW, Output enable                 |
| S               | Select input                              |
| D               | COM port                                  |
| nD              | I/O for USB data path (port 1 and port 2) |

### Truth Table

| S | $\overline{OE}$ | Function   |
|---|-----------------|------------|
| X | H               | Disconnect |
| L | L               | D = 1D     |
| H | L               | D = 2D     |



PI3USB221A

**Absolute Maximum Ratings<sup>(1)</sup>**

Over operating free-air temperature range (unless otherwise noted)

|   |               |
|---|---------------|
| V <sub>DD</sub> Supply Voltage Range .....                              | -0.5V to 4.6V |
| V <sub>IN</sub> Control Input Voltage Range <sup>(2, 3)</sup> .....     | -0.5V to 5.5V |
| V <sub>I/O</sub> Switch I/O Voltage Range <sup>(2, 3, 4)</sup> .....    | -0.5V to 5.5V |
| I <sub>IK</sub> Control Input Clamp Current (V <sub>IN</sub> < 0) ..... | -50mA         |
| I <sub>I/O</sub> I/O Port Clamp Current (V <sub>I/O</sub> < 0) .....    | -50mA         |
| I <sub>I/O</sub> ON-state Switch Current <sup>(5)</sup> .....           | ±120mA        |
| Continuous Current through V <sub>DD</sub> or GND .....                 | ±100mA        |
| θ <sub>JA</sub> Package Thermal Impedance                               |               |
| TLLGA Package .....   | 48.7°C/W      |
| TDFN Package .....  | 243°C/W       |
| T <sub>stg</sub> Storage Temperature Range .....                        | -65 to 150°C  |
| T <sub>j</sub> Junction Temperature .....                               | 125°C         |

**Notes:**

1. Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. All voltages are with respect to ground, unless otherwise specified.
3. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
4. VI and VO are used to denote specific conditions for VI/O.
5. II and IO are used to denote specific conditions for II/O.
6. The package thermal impedance is calculated in accordance with JESD 51-7.

**Recommended Operating Conditions<sup>(1)</sup>**

| Symbol           | Description                      | Parameter                        | Min. | Max. | Unit |
|------------------|----------------------------------|----------------------------------|------|------|------|
| V <sub>DD</sub>  | Supply voltage                   |                                  | 2.3  | 3.6  | V    |
| V <sub>IH</sub>  | High-level control input voltage | V <sub>DD</sub> = 2.3 V to 2.7 V | 1.3  | -    |      |
|                  |                                  | V <sub>DD</sub> = 2.7 V to 3.6 V | 1.4  | -    |      |
| V <sub>IL</sub>  | Low-level control input voltage  | V <sub>DD</sub> = 2.3 V to 2.7 V |      | 0.6  |      |
|                  |                                  | V <sub>DD</sub> = 2.7 V to 3.6 V |      | 0.6  |      |
| V <sub>I/O</sub> | Data input/output voltage        |                                  | 0    | 4.6  |      |
| T <sub>A</sub>   | Operating free-air temperature   |                                  | -40  | 85   | °C   |

**Note:**

1. All unused control inputs of the device must be held at V<sub>DD</sub> or GND to ensure proper device operation.



PI3USB221A

## Electrical Characteristics

Over operating free-air temperature range (unless otherwise noted)

| Parameter                 | Testing Conditions   | Min.  | Typ. | Max.    | Unit    |   |
|---------------------------|--|---|------|---------|---------|---|
| $V_{IK}$                  | $V_{DD} = 3.6V, 2.7V, I_I = -18\text{ mA}$   |   |      | -1.2    | V       |   |
| $I_{IN}$                  | Control Inputs<br>$V_{DD} = 3.6V, 2.7V, 0V, V_{IN} = 0V\text{ to }3.6V$  |   |      | $\pm 1$ | $\mu A$ |   |
| $I_{OZ}^{(3)}$            | $V_{DD} = 3.6V, 2.7V, V_{IN} = V_{DD}\text{ or }GND,$<br>$V_O = 0V\text{ to }3.6V, V_I = 0V, \text{ Switch OFF}$ |   |      | $\pm 1$ |         |   |
| $I_{(OFF)}$               | $V_{DD} = 0V$  | $V_{I/O} = 0V\text{ to }3.6V$                         |      | $\pm 2$ |         |   |
|                           |  | $V_{I/O} = 0\text{ to }2.7V$                          |      | $\pm 1$ |         |   |
| $I_{CC}$                  | $V_{DD} = 3.6V, 2.7V, V_{IN} = V_{DD}\text{ or }GND,$<br>$I_{I/O} = 0V, \text{ Switch ON or OFF}$                |   | 25   | 50      |         |   |
| $I_{CC}$ (low power mode) | $V_{DD} = 3.6V, 2.7V, V_{IN} = V_{DD}\text{ or }GND,$<br>Switch disabled, (OE in high state)                     |   |      | 4       |         |   |
| $DI_{CC}^{(4)}$           | Control Inputs   | $V_{DD} = 2.7V, S$ sweeps from 1.4V to 3.3V, OE/ = 0V |      | 15      |         |   |
|                           |  | $V_{DD} = 2.7V, OE/$ sweeps from 1.4V to 3.3V, S = 0V |      | 0.75    |         |   |
| $C_{IN}$                  | Control Inputs<br>$V_{DD} = 3.3V, 2.5V, V_{IN} = 3.3V\text{ or }0V$  |   | 1    | 2       | pF      |   |
| $C_{io(OFF)}$             | $V_{DD} = 3.3V, 2.5V, V_{IN} = 3.3V\text{ or }0V, \text{ Switch OFF}$  |   | 2    | 3       |         |   |
| $C_{io(ON)}$              | $V_{DD} = 3.3V, 2.5V, V_{IN} = 3.3V\text{ or }0V, \text{ Switch ON}$   |   | 4    | 6       |         |   |
| $r_{ON}^{(5)}$            | $V_{DD} = 3V, 2.3V$  | $V_I = 0V, I_O = 30\text{ mA}$                        |      | 4       |         |   |
|                           |  | $V_I = 2.4V, I_O = -15\text{ mA}$                     |      | 6       |         |   |
| $Dr_{ON}^{(6)}$           | $V_{DD} = 3V, 2.3V$  | $V_I = 0V, I_O = 30\text{ mA}$                        |      | 0.2     |         |   |
|                           |  | $V_I = 1.7V, I_O = -15\text{ mA}$                     |      | 0.2     |         |   |
| $r_{ON(Flat)}$            | $V_{DD} = 3V, 2.3V$  | $V_I = 0V, I_O = 30\text{ mA}$                        |      | 1       |         |   |
|                           |  | $V_I = 1.7V, I_O = -15\text{ mA}$                     |      | 1       |         |   |
| $V_{pass}$                | $V_{DD} = 2.5 - 3.3V$  | $V_{IN} > 3.8V, I_O = 10\mu A$                        | 2.8  | 3.8     | 4.2     | V |

### Notes:

- $V_{IN}$  and  $I_{IN}$  refer to control inputs.  $V_I, V_O, I_I,$  and  $I_O$  refer to data pins.
- All typical values are at  $V_{DD} = 3.3V$  (unless otherwise noted),  $T_A = 25^\circ C$ .
- For I/O ports, the parameter IOZ includes the input leakage current.
- This is the increase in supply current for each input that is at the specified TTL voltage level, rather than  $V_{DD}$  or GND.
- Measured by the voltage drop between the input and output terminals at the indicated current through the switch. ON-state resistance is determined by the lower of the voltages of the two terminals.
- Dron is delta Ron between channels

## Dynamic Electrical Characteristics

Over operating range,  $T_A = -40^\circ C$  to  $85^\circ C, V_{DD} = 3.3V \pm 10\%, GND = 0V$

| Symbol     | Parameter         | Test Conditions                      | Typ. <sup>(1)</sup> | Unit |
|------------|-------------------|--------------------------------------|---------------------|------|
| $X_{TALK}$ | Crosstalk         | $R_L = 50\Omega, f = 250\text{ MHz}$ | -40                 | dB   |
| $O_{IRR}$  | OFF isolation     | $R_L = 50\Omega, f = 250\text{ MHz}$ | -41                 |      |
| BW         | Bandwidth (-3 dB) | $R_L = 50\Omega$                     | 1.6                 | GHz  |

### Note:

- For Max or Min conditions, use the appropriate value specified under Electrical Characteristics for the applicable device type.



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### Switching Characteristics

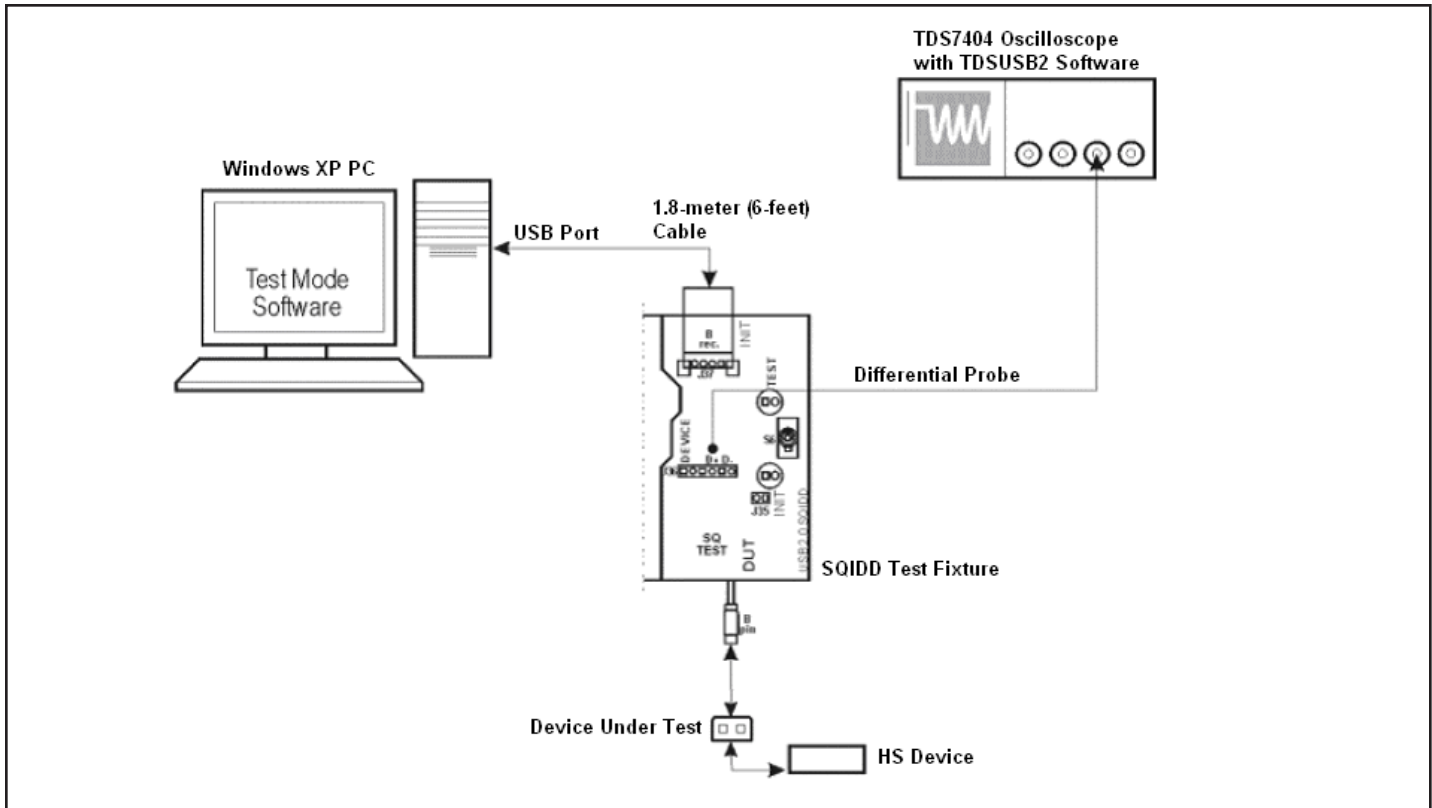
Over operating range,  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ ,  $V_{DD} = 3.3\text{ V} \pm 10\%$ ,  $GND = 0\text{V}$

| Symbol      | Parameter  | Min.                     | Typ. <sup>(1)</sup> | Max. | Unit |
|-------------|--|--------------------------|---------------------|------|------|
| $t_{pd}$    | Propagation Delay <sup>(2,3)</sup>   |                          | 0.25                |      | ns   |
| $t_{ON}$    | Line enable time   | S to D, nD               |                     | 125  |      |
|             |  | $\overline{OE}$ to D, nD |                     | 100  |      |
| $t_{OFF}$   | Line disable time  | S to D, nD               |                     | 12   |      |
|             |  | $\overline{OE}$ to D, nD |                     | 12   |      |
| $t_{SK(O)}$ | Output skew between center port to any other port <sup>(2)</sup>                               |                          | 0.1                 | 0.2  |      |
| $t_{SK(P)}$ | Skew between opposite transitions of the same output<br>( $t_{PHL} - t_{PLH}$ ) <sup>(2)</sup> |                          | 0.1                 | 0.2  |      |
| $t_{VPASS}$ | OVP response time  |                          | 53                  |      | ns   |

#### Notes:

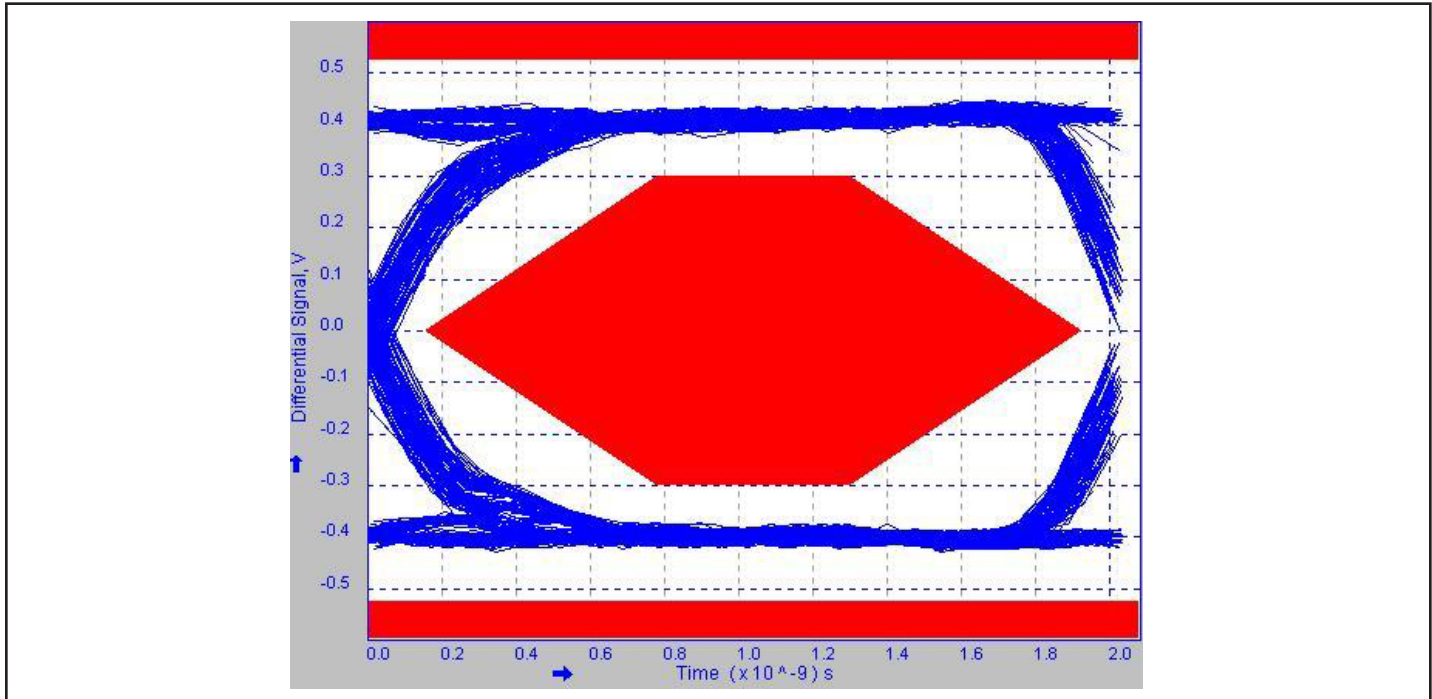
1. For Max or Min conditions, use the appropriate value specified under Electrical Characteristics for the applicable device type.
2. Specified by design
3. The switch contributes no propagational delay other than the RC delay of the on resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.25 ns for 10-pF 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 bus 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.

**Application Information**



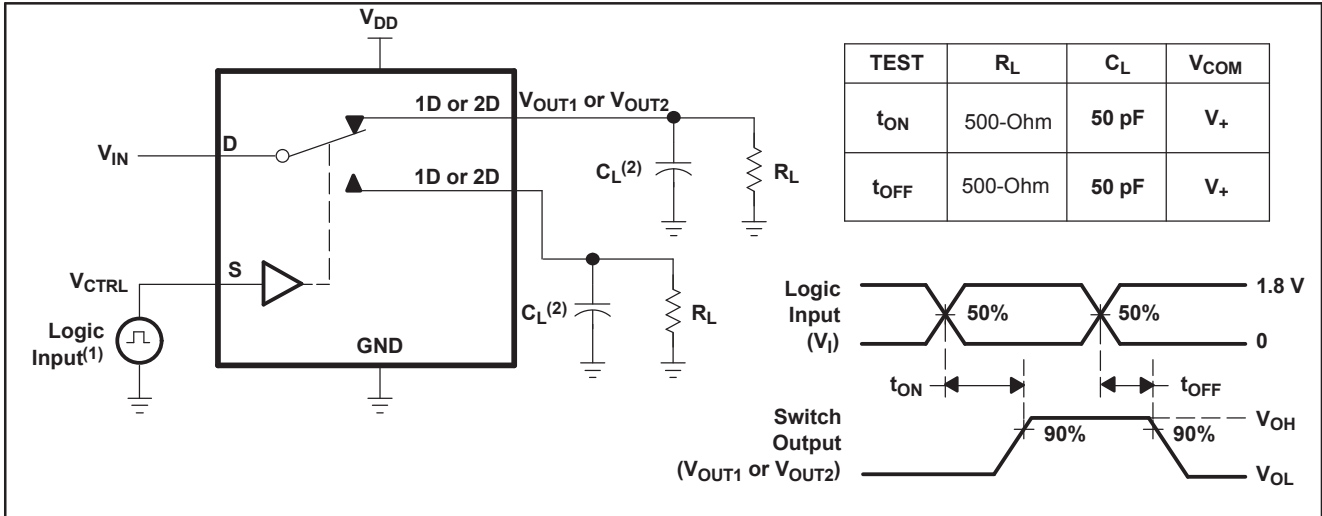
**Figure 1: HS Eye Test Setup**

**Test Result**



**Test Result: High-speed, Up-stream, Near-end Eye of PI3USB221A**

PARAMETER MEASUREMENT INFORMATION



- (1) All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z<sub>O</sub> = 50-Ohm, t<sub>r</sub> < 5 ns, t<sub>f</sub> < 5 ns.
- (2) C<sub>L</sub> includes probe and jig capacitance.

Figure 2. Turn-On (t<sub>ON</sub>) and Turn-Off Time (t<sub>OFF</sub>)

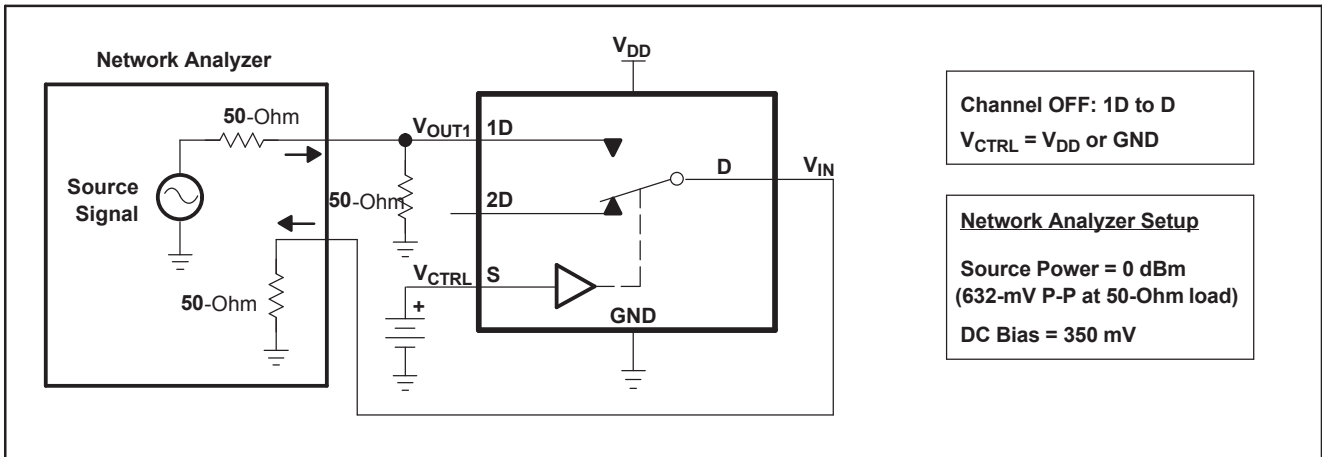
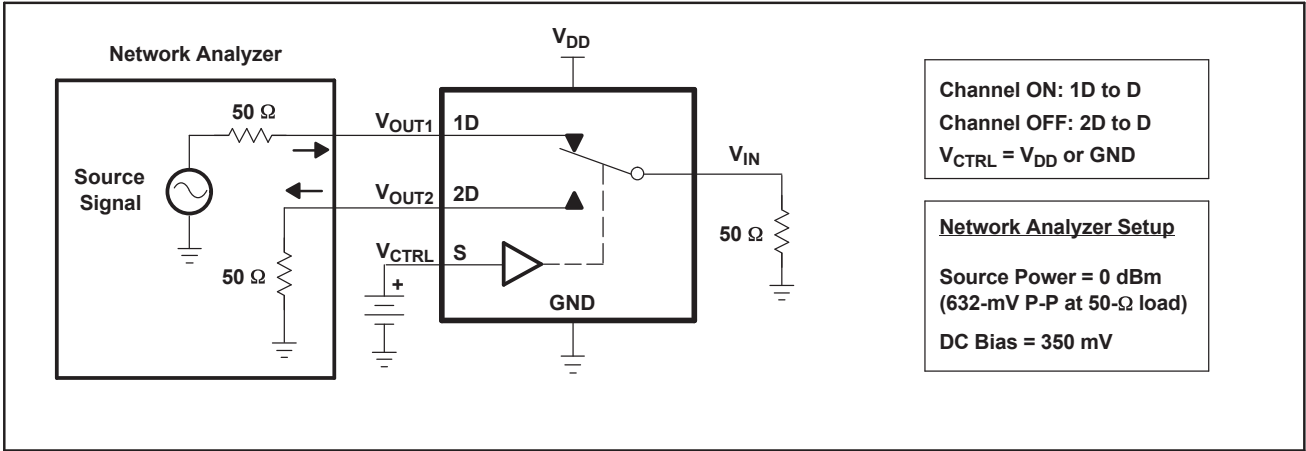
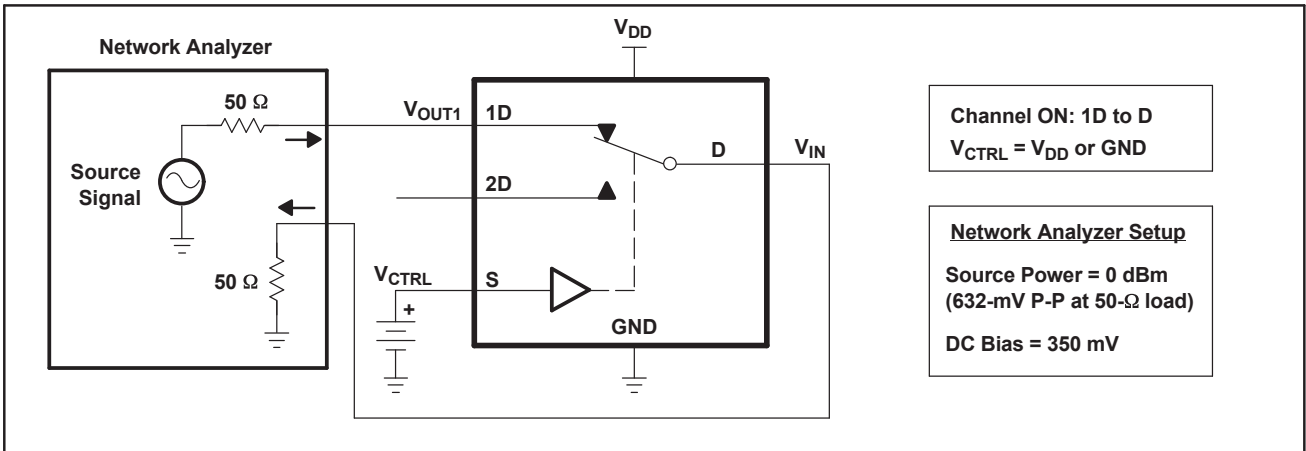


Figure 3. OFF Isolation (O<sub>ISO</sub>)

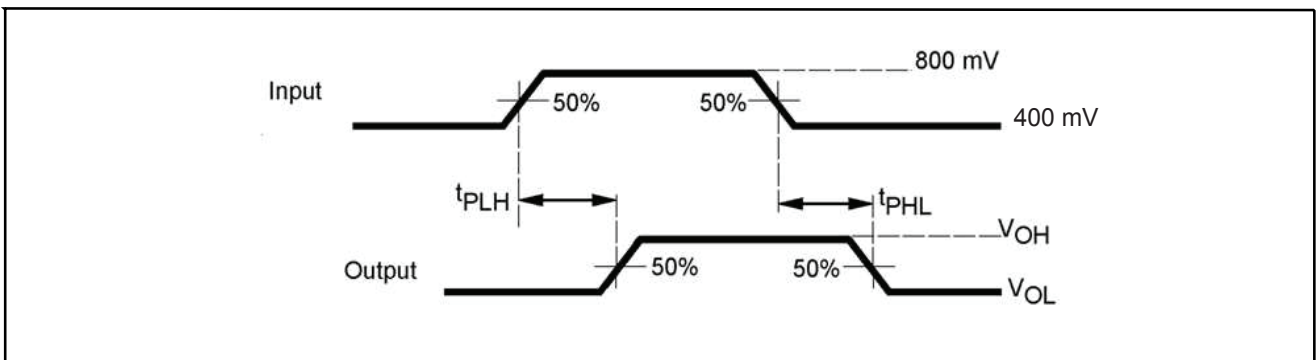
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**Figure 4. Crosstalk ( $X_{TALK}$ )**



**Figure 5. Bandwidth (BW)**



**Figure 6. Propagation Delay**



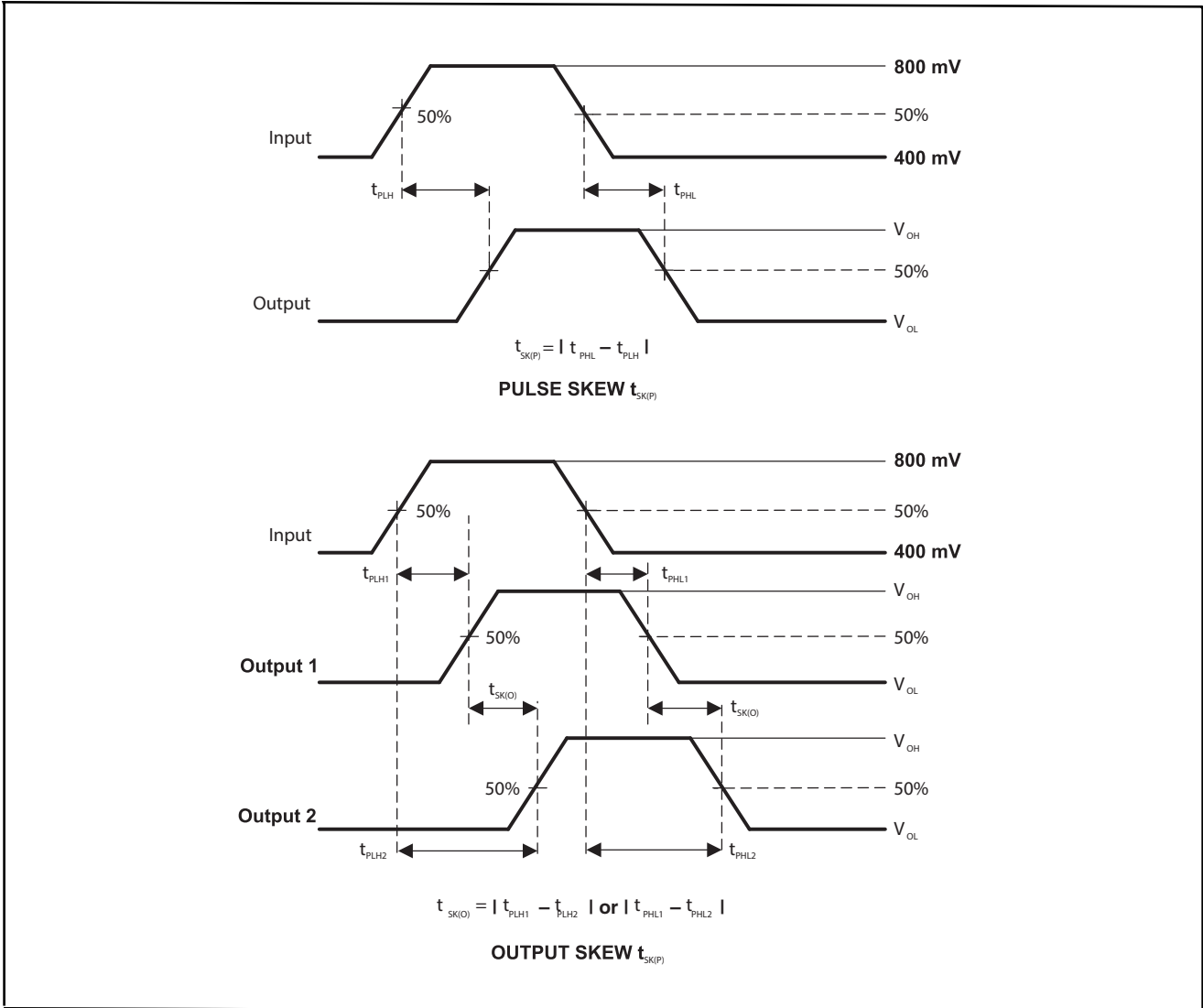


Figure 7. Skew Test

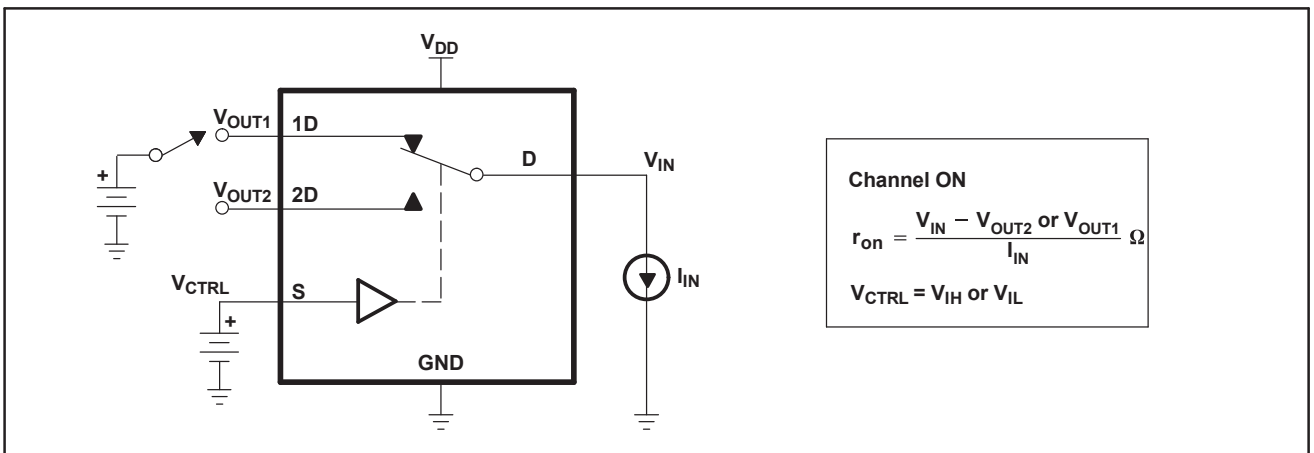
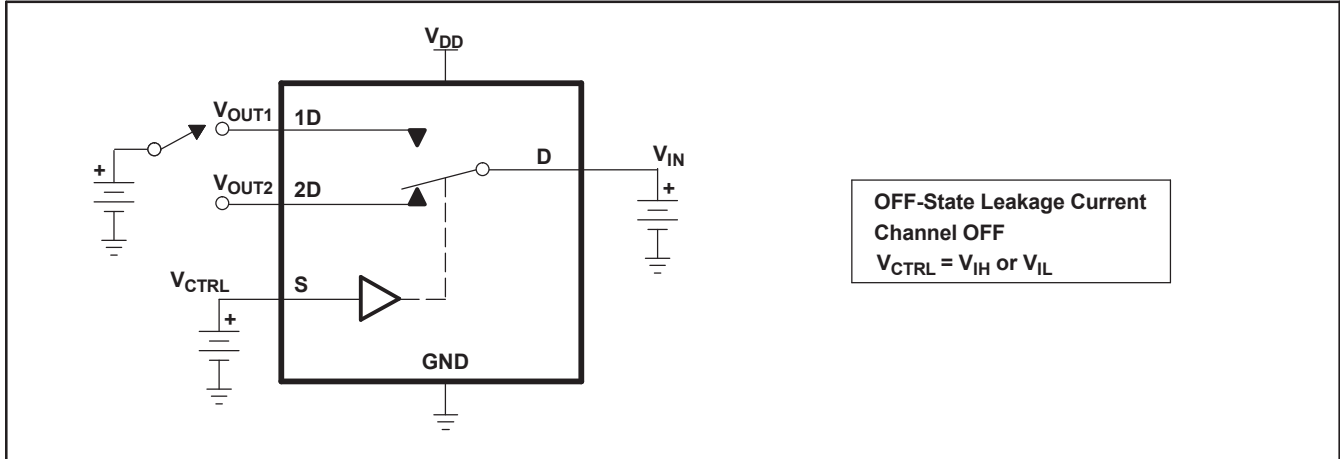
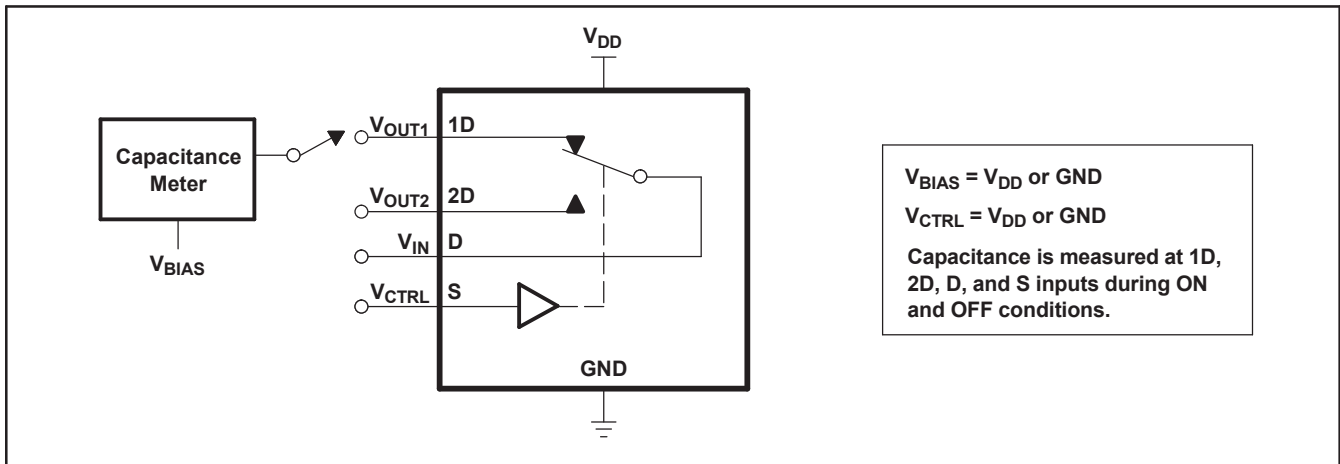


Figure 8. ON-State Resistance ( $r_{on}$ )

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**Figure 9. OFF-State Leakage Current**



**Figure 10. Capacitance**

**Part Marking Information**

**ZW Package**

PI3USB  
221AZW  
ZYWX

Z : Die Rev  
Y : Year  
W : Workweek  
1st X: Assembly Code  
2nd X: Fab Code

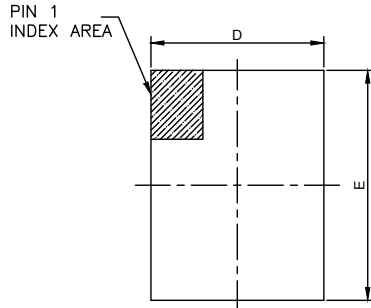
**ZUA Package**

YU  
YW

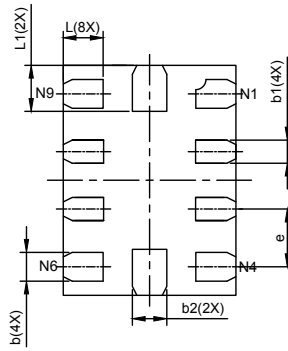
Y : Shorten Year Code  
W : Shorten Workweek Code

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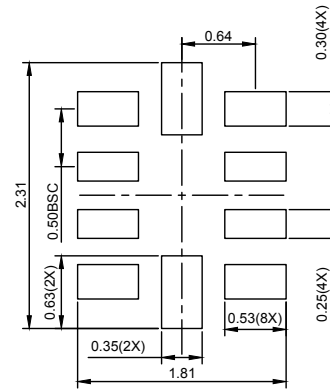
**Packaging Mechanical: 10-contact UQFN (ZUA)**



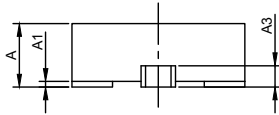
TOP VIEW



BOTTOM VIEW



RECOMMENDED LAND PATTERN(unit:mm)



SIDE VIEW

| PKG. DIMENSIONS(MM) |          |      |      |
|---------------------|----------|------|------|
| SYMBOL              | Min      | NOM  | Max  |
| A                   | 0.50     | 0.60 | 0.65 |
| A1                  | 0.00     | 0.02 | 0.05 |
| A3                  | 0.15 REF |      |      |
| D                   | 1.45     | 1.50 | 1.55 |
| E                   | 1.95     | 2.00 | 2.05 |
| b                   | 0.20     | 0.25 | 0.30 |
| b1                  | 0.15     | 0.20 | 0.25 |
| b2                  | 0.25     | 0.30 | 0.35 |
| e                   | 0.50 BSC |      |      |
| L                   | 0.25     | 0.35 | 0.45 |
| L1                  | 0.30     | 0.40 | 0.50 |

Notes:  
1. Ref: JEDEC MO-288B.

|                                    |  |                |
|------------------------------------|--|----------------|
|                                    |  | DATE: 01/06/17 |
| DESCRIPTION: 10-Pin, UQFN, 1.5X2.0 |  |                |
| PACKAGE CODE: ZUA(ZUA10)           |  |                |
| DOCUMENT CONTROL#: PD-2220         |  | REVISION: --   |

17-0002

**PI3USB221A**

**Packaging Mechanical: 10-contact UDFN (ZW)**

| PKG. DIMENSIONS(MM) |          |      |      |
|---------------------|----------|------|------|
| SYMBOL              | Min      | NOM  | Max  |
| A                   | 0.50     | 0.60 | 0.65 |
| A1                  | 0.00     | 0.02 | 0.05 |
| A3                  | 0.15 REF |      |      |
| D                   | 2.90     | 3.00 | 3.10 |
| E                   | 2.90     | 3.00 | 3.10 |
| D1                  | 2.30     | 2.40 | 2.50 |
| E1                  | 1.50     | 1.60 | 1.70 |
| b                   | 0.18     | 0.25 | 0.30 |
| e                   | 0.50 BSC |      |      |
| L                   | 0.25     | 0.40 | 0.55 |

**Notes:**  
1. Comply with JEDEC MO-229F, except 'L' Max and 'L' Min.

|                                |              |                |
|--------------------------------|--------------|----------------|
|                                |              | DATE: 01/06/17 |
| DESCRIPTION: 10-Pin, UDFN, 3X3 |              |                |
| PACKAGE CODE: ZW(ZW10)         |              |                |
| DOCUMENT CONTROL#: PD-2219     | REVISION: -- |                |

17-0001

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                 |
|-----------------|--------------|-------------------------------------|
| PI3USB221AZUAEX | ZUA          | 10-Pin, 1.5x2.0 (UQFN), Tape & Reel |
| PI3USB221AZWEX  | ZW           | 10-Pin, 3x3 (UDFN), Tape & Reel     |

Notes:

- Thermal characteristics can be found on the company web site at [www.diodes.com/design/support/packaging/](http://www.diodes.com/design/support/packaging/)
- E = Pb-free and Green
- X suffix = Tape/Reel



PI3USB221A

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