Not Recommended for New Design

A product Line of
Diodes Incorporated

**PI3USB221**

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

## Features

- $V_{DD}$ Operation at 2.5 V and 3.3 V
- $V_{I/O}$ Accepts Signals up to 5.5 V
- 1.8-V Compatible Control-Pin Inputs
- Low-Power Mode When $\overline{OE}$ Is Disabled (2 µA)
- $r_{ON}$ = 6Ω Maximum
- $\Delta r_{ON}$ = 0.2Ω Typical
- Cio(on) = 6 pF Maximum
- Low Power Consumption (50 µA Maximum)
- ESD > 8kV contact on USB signal path per IEC61000-4-2)
- High Bandwidth (1.1 GHz Typical)
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- Packaging (Pb-free & Green):
  - 10-contact, TDFN (ZE10)
  - 10-contact, TLLGA(XA10)

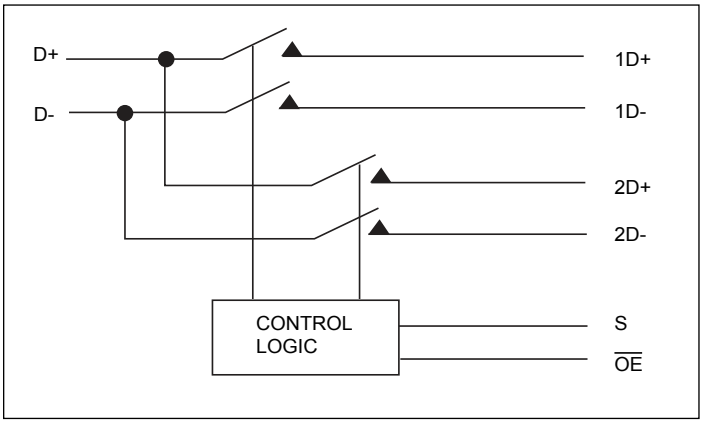
## Description

The PI3USB221 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).

## Applications

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

## Block Diagram

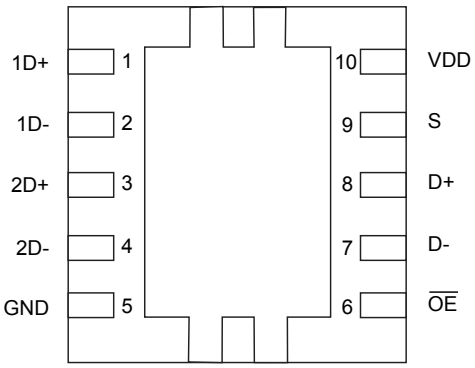



**Notes:**

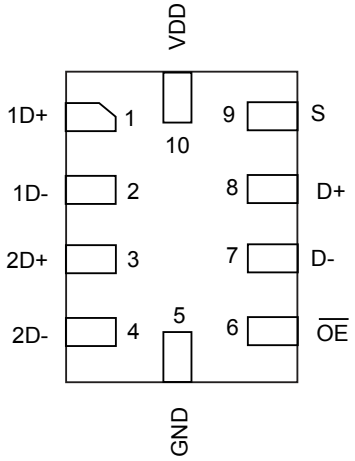
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free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

## Pin Configuration

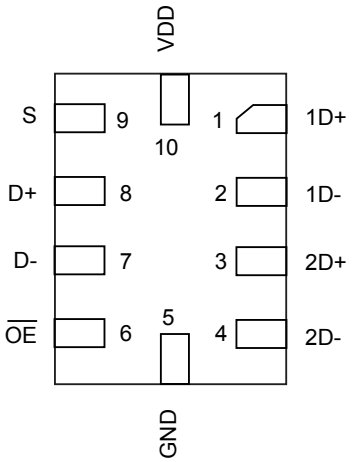
TDFN Package
(Top View)




TLLGA Package
(Top View)




TLLGA Package
(Bottom View)




## 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 |

## Absolute Maximum Ratings(1)

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

| | |
|---|---|
| $V_{DD}$ Supply Voltage Range | –0.5V to 4.6V |
| $V_{IN}$ Control Input Voltage Range[2, 3] | –0.5V to 7V |
| $V_{I/O}$ Switch I/O Voltage Range[2, 3, 4] | –0.5V to 7V |
| $I_{IK}$ Control Input Clamp Current ($V_{IN}$ < 0) | –50mA |
| $I_{I/OK}$ I/O Port Clamp Current ($V_{I/O}$ < 0) | –50mA |
| $I_{I/O}$ ON-state Switch Current[5] | ±120mA |
| Continuous Current Through $V_{DD}$ or GND | ±100mA |
| $T_{stg}$ Storage Temperature Range | –65 to 150°C |
| Tj 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 (1)

| Symbol | Description | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|---|
| $V_{DD}$ | Supply voltage | | 2.3 | 3.6 | V |
| $V_{IH}$ | High-level control input voltage | $V_{DD}$ = 2.3 V to 2.7 V | 1.4 | - | |
| | | $V_{DD}$ = 2.7 V to 3.6 V | 1.3 | - | |
| $V_{IL}$ | Low-level control input voltage | $V_{DD}$ = 2.3 V to 2.7 V | | 0.6 | |
| | | $V_{DD}$ = 2.7 V to 3.6 V | | 0.6 | |
| $V_{I/O}$ | Data input/output voltage | | 0 | 5.5 | |
| $T_A$ | Operating free-air temperature | | –40 | 85 | °C |

**Note:**

1. All unused control inputs of the device must be held at $V_{DD}$ or GND to ensure proper device operation.

## 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 mA | | | | –1.8 | V |
| $I_{IN}$ | Control Inputs | $V_{DD}$ = 3.6V, 2.7V, 0V, $V_{IN}$ = 0V to 3.6V | | | | ±1 | µA |
| $I_{OZ}$[3] | | $V_{DD}$ = 3.6V, 2.7V, $V_{IN}$ = $V_{DD}$ or GND, $V_O$ = 0V to 3.6V, $V_I$ = 0V, Switch OFF | | | | ±1 | |
| $I_{(OFF)}$ | | $V_{DD}$ = 0V | $V_{I/O}$ = 0V to 3.6V | | | ±2 | |
| | | | $V_{I/O}$ = 0 to 2.7V | | | ±1 | |
| $I_{CC}$ | | $V_{DD}$ = 3.6V, 2.7V, $V_{IN}$ = $V_{DD}$ or GND, $I_{I/O}$ = 0 V, Switch ON or OFF | | | | 50 | |
| $I_{CC}$ (low power mode) | | $V_{DD}$ = 3.6V, 2.7V, $V_{IN}$ = $V_{DD}$ or GND, Switch disabled, ($\overline{OE}$ in high state) | | | | 2 | |
| $DI_{CC}$[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 | $V_{DD}$ = 3.3V, 2.5V, $V_{IN}$ = 3.3V or 0V | | | 1 | 2 | pF |
| $C_{io(OFF)}$ | | $V_{DD}$ = 3.3V, 2.5V, $V_{IN}$ = 3.3V or 0V, Switch OFF | | | 2 | 4 | |
| $C_{io(ON)}$ | | $V_{DD}$ = 3.3V, 2.5V, $V_{IN}$ = 3.3V or 0V, Switch ON | | | 5 | 6 | |
| $r_{ON}$[5] | | $V_{DD}$ = 3V, 2.3V | $V_I$ = 0V, $I_O$ = 30 mA | | | 6 | Ω |
| | | | $V_I$ = 2.4V, $I_O$ = –15 mA | | | 6 | |
| $Dr_{ON}$ | | $V_{DD}$ = 3V, 2.3V | $V_I$ = 0V, $I_O$ = 30 mA | | 0.2 | | |
| | | | $V_I$ = 1.7V, $I_O$ = –15 mA | | 0.2 | | |
| $r_{ON(flat)}$ | | $V_{DD}$ = 3V, 2.3V | $V_I$ = 0V, $I_O$ = 30 mA | | 1 | | |
| | | | $V_I$ = 1.7V, $I_O$ = –15 mA | | 1 | | |

**Notes:**

1. $V_{IN}$ and $I_{IN}$ refer to control inputs. VI, VO, II, and IO refer to data pins.
2. All typical values are at $V_{DD}$ = 3.3 V (unless otherwise noted), $T_A$ = 25°C.
3. For I/O ports, the parameter IOZ includes the input leakage current.
4. This is the increase in supply current for each input that is at the specified TTL voltage level, rather than $V_{DD}$ or GND.
5. 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.

## Dynamic Electrical Characteristics

over operating range, $T_A$ = –40°C to 85°C, $V_{DD}$ = 3.3 V ± 10%, GND = 0V

| Symbol | Parameter | Test Conditions | Typ.(1) | Unit |
|---|---|---|---|---|
| $X_{TALK}$ | Crosstalk | $R_L$ = 50Ω, $f$ = 250 MHz | –40 | dB |
| $O_{IRR}$ | OFF isolation | $R_L$ = 50Ω, $f$ = 250 MHz | –41 | |
| BW | Bandwidth (–3 dB) | $R_L$ = 50Ω | 1.1 | GHz |

**Note:**

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

## Switching Characteristics

over operating range, $T_A$ = –40°C to 85°C, $V_{DD}$ = 3.3 V ± 10%, GND = 0V

| Symbol | Parameter | | Min. | Typ.(1) | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{pd}$ | Propagation Delay[2,3] | | | 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[2] | | | 0.1 | 0.2 | |
| $t_{SK(P)}$ | Skew between opposite transitions of the same output (tPHL – tPLH)[2] | | | 0.1 | 0.2 | |

**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

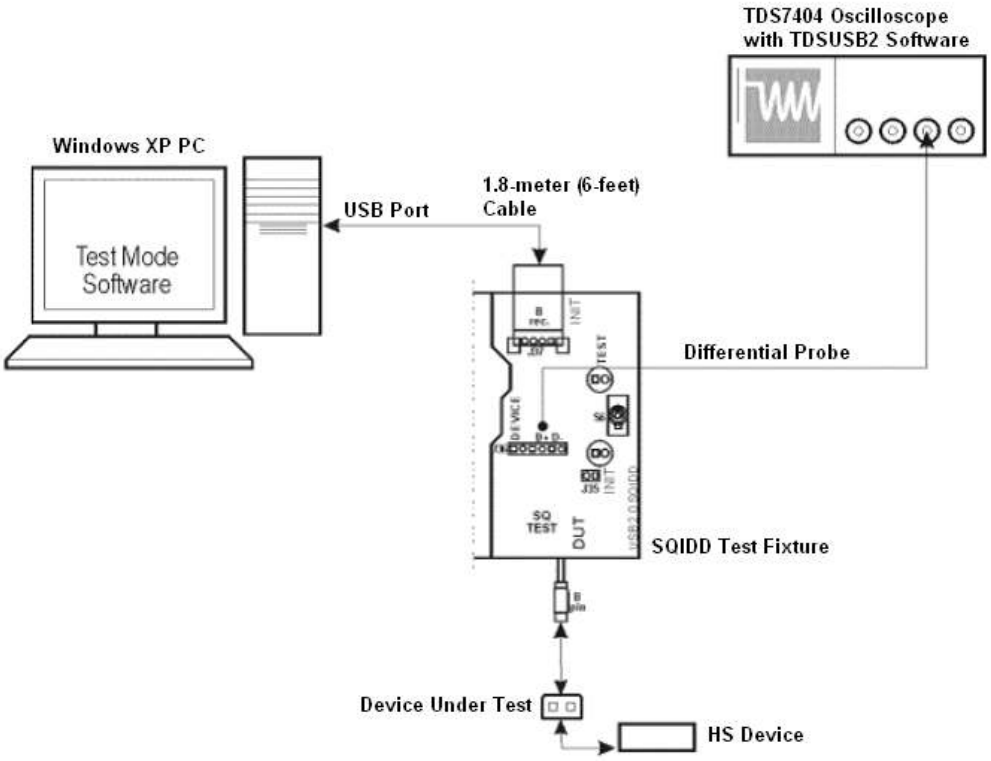
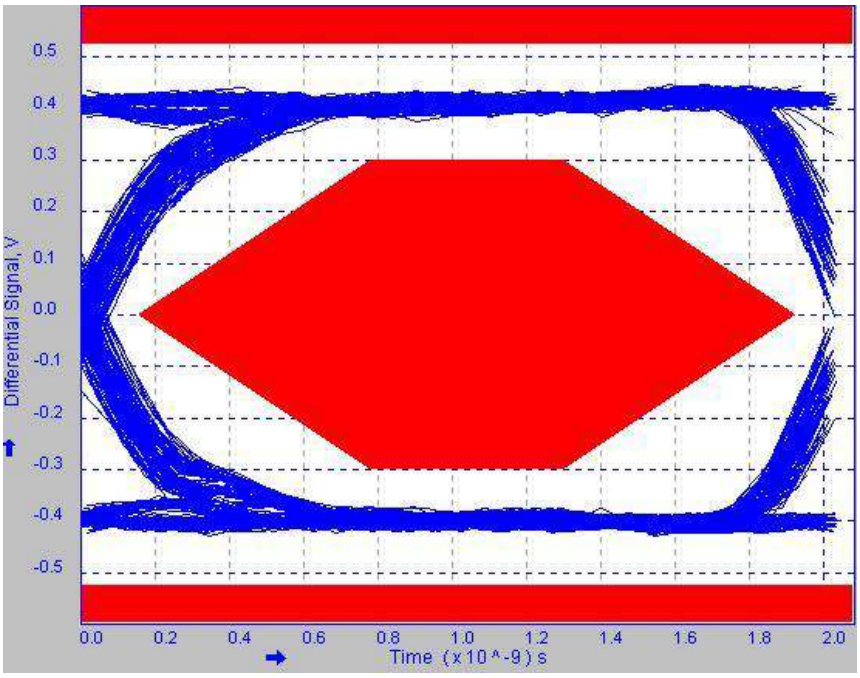


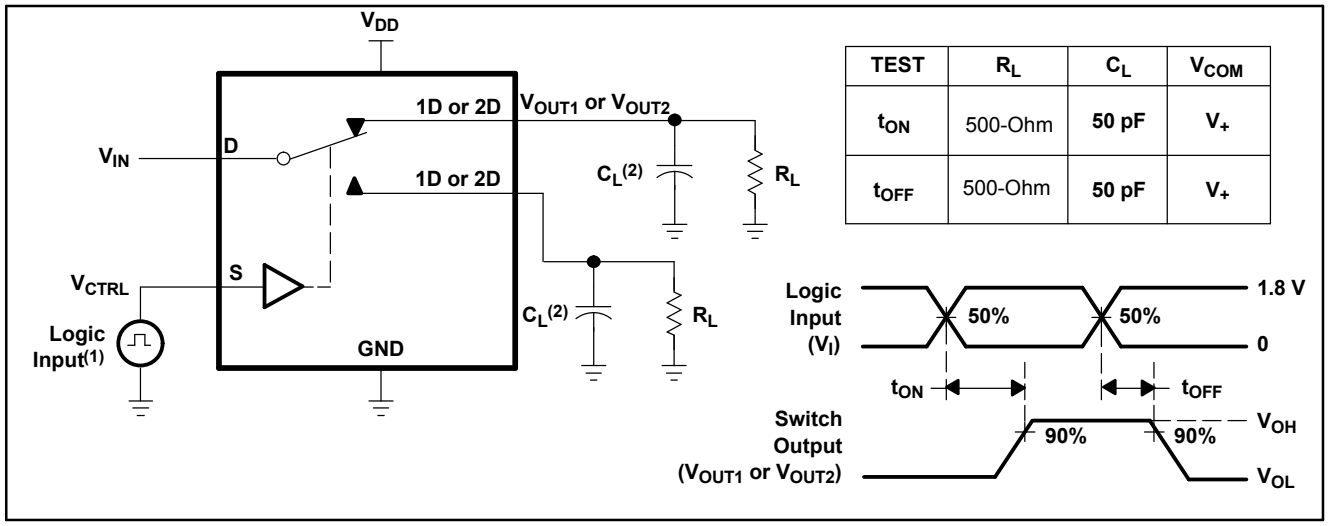

**Figure 1: HS Eye Test Setup**

## Test Result




**Test Result 1: High-speed, Up-stream, Near-end Eye of PI3USB221**

## Parameter Measurement Information




| TEST | $R_L$ | $C_L$ | $V_{COM}$ |
|---|---|---|---|
| $t_{ON}$ | 500-Ohm | 50 pF | $V_+$ |
| $t_{OFF}$ | 500-Ohm | 50 pF | $V_+$ |

(1) All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, $Z_O$ = 50-Ohm, $t_r$ < 5 ns, $t_f$ < 5 ns.
(2) $C_L$ includes probe and jig capacitance.

**Figure 2. Turn-On ($t_{ON}$) and Turn-Off Time ($t_{OFF}$)**

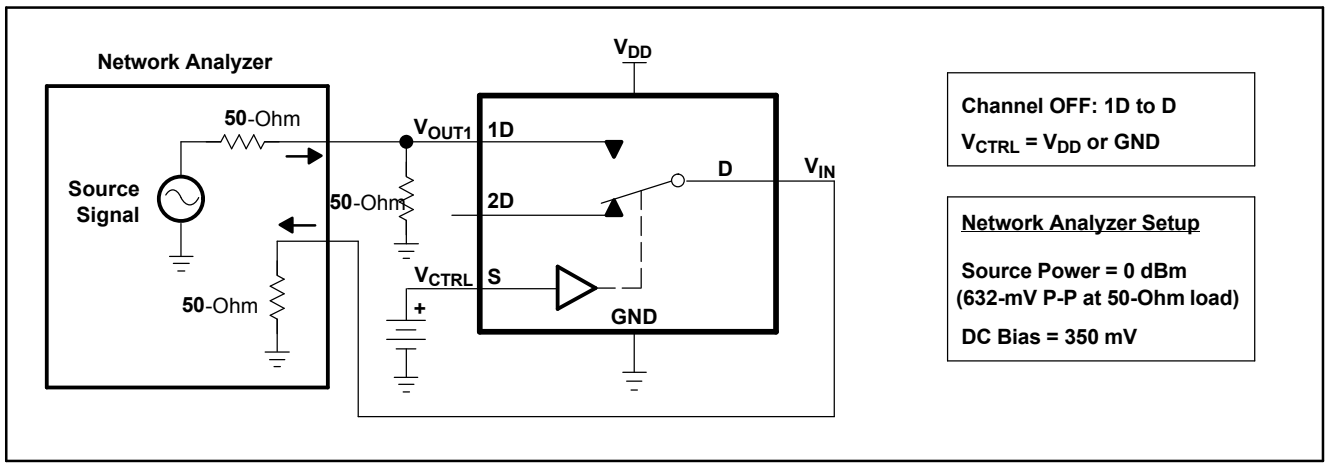



**Figure 3. OFF Isolation ($O_{ISO}$)**

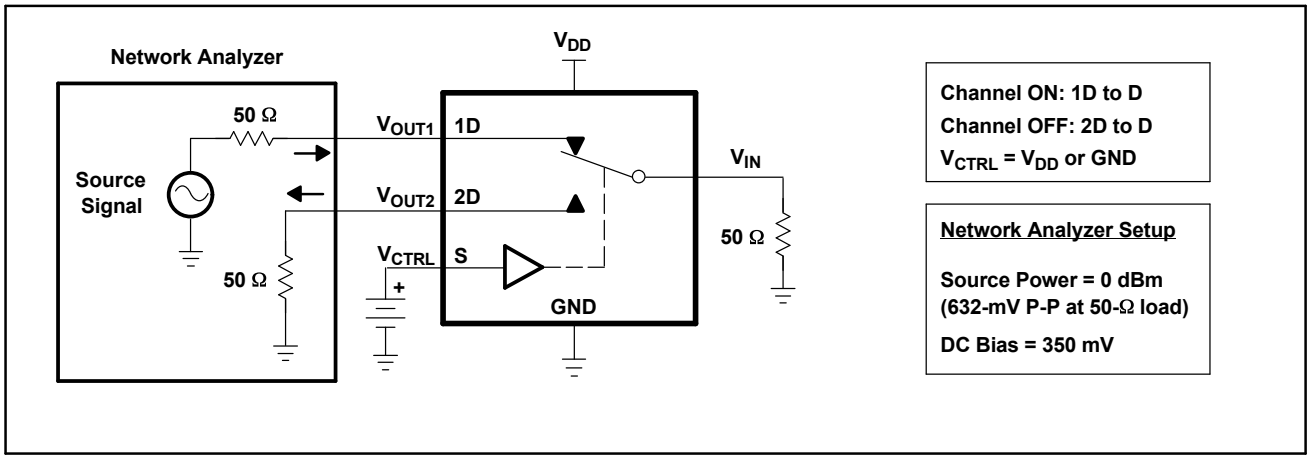



**Figure 4. Crosstalk ($X_{TALK}$)**

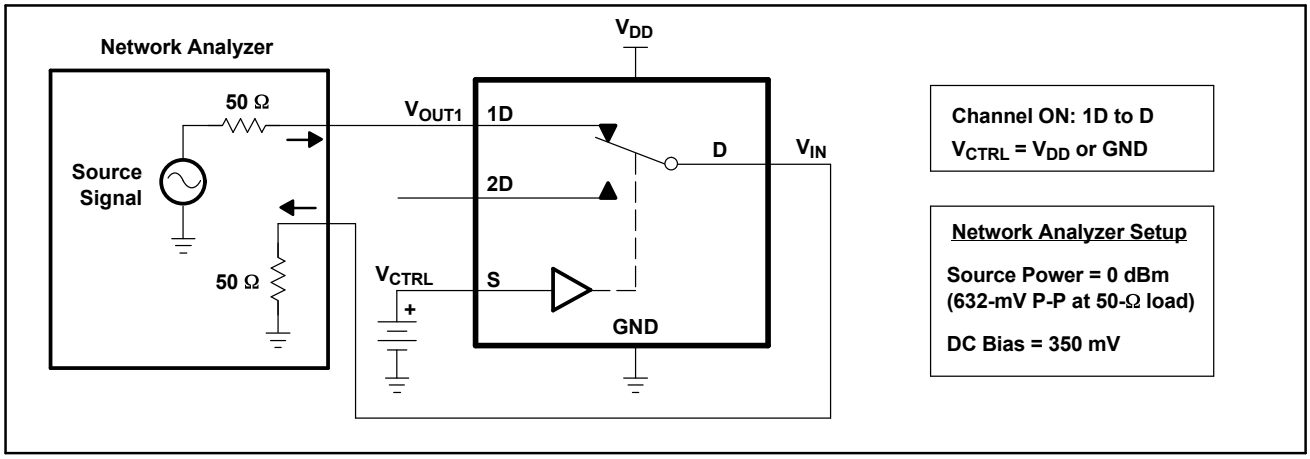



**Figure 5. Bandwidth (BW)**

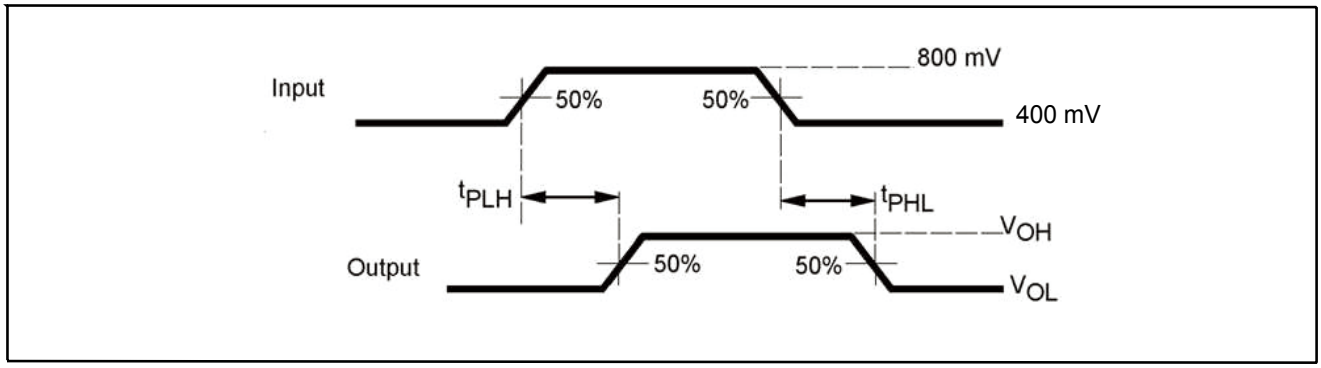



**Figure 6. Propagation Delay**

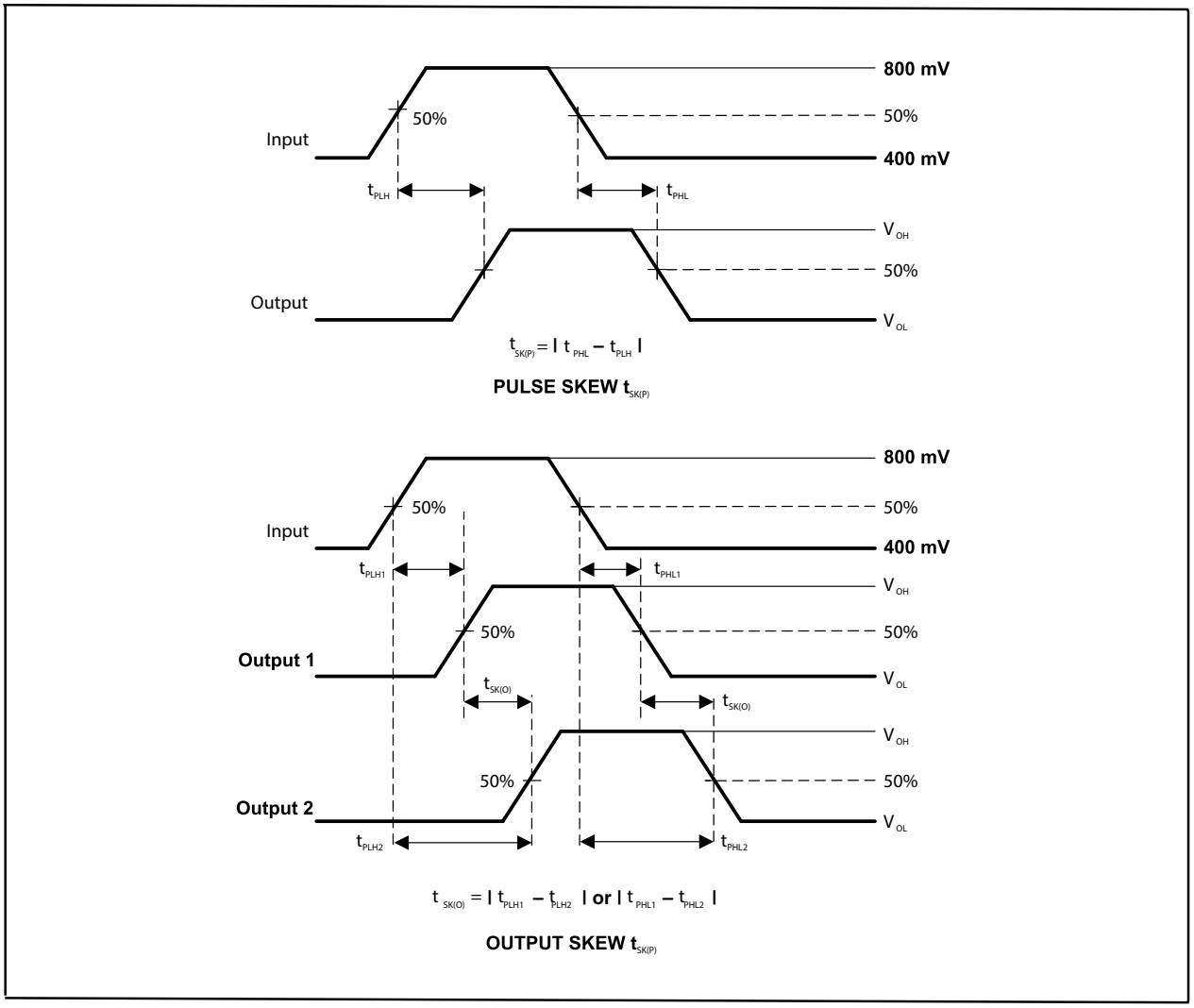



**Figure 7. Skew Test**

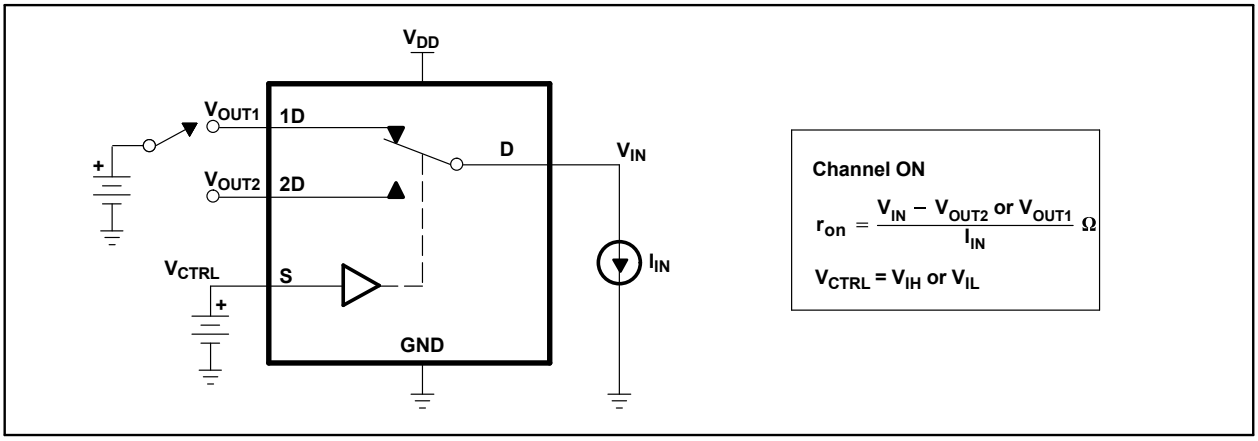



**Figure 8. ON-State Resistance ($r_{on}$)**

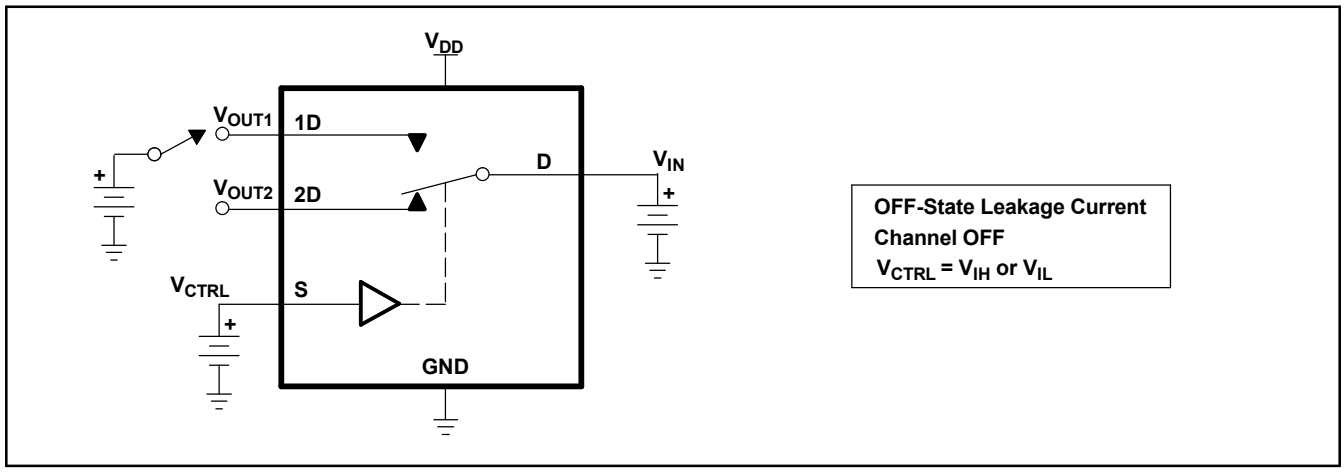



**Figure 9. OFF-State Leakage Current**

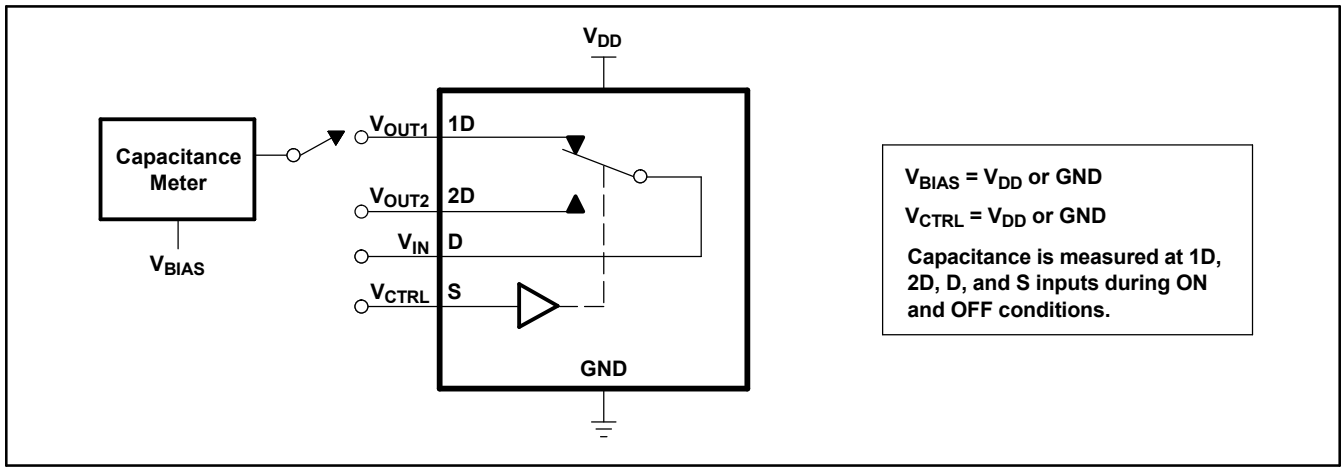



**Figure 10. Capacitance**

## Part Marking

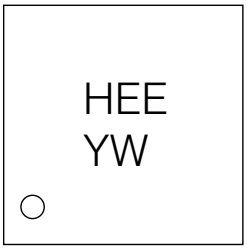
XA Package

HE = PI3USB221XAE


X: Shorten Year Code
Y: Shorten Workeek Code

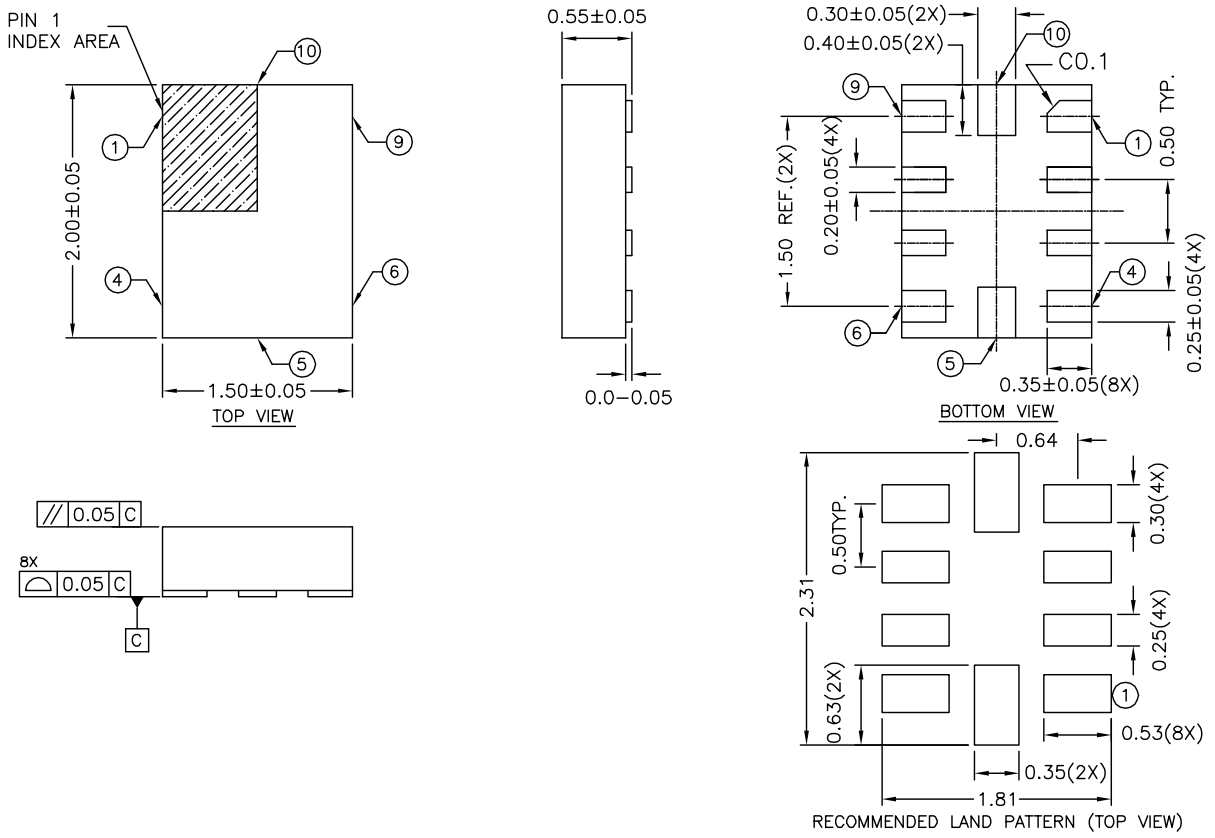
ZE Package

HE = PI3USB221ZEE




Y: Shorten Year Code
W: Shorten Workweek Code

## Packaging Mechanical: 10-TLLGA (XA)




NOTE :
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS
3. REFER JEDEC MO−288
4. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.

PERICOM Enabling Serial Connectivity

**DATE: 01/26/09**

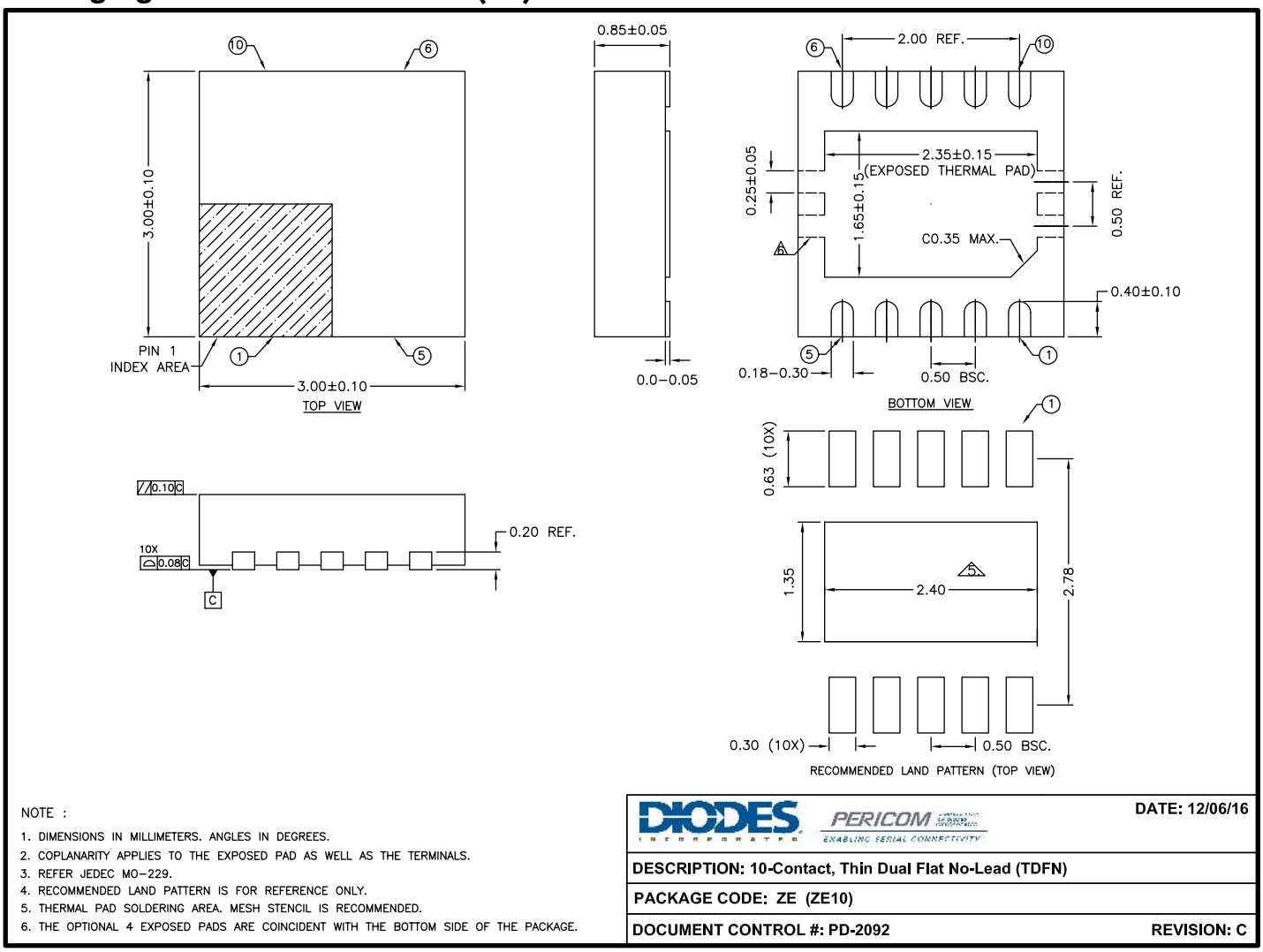
**DESCRIPTION: 10-Lead, Thin Leadframe Land Grid Array (TLLGA)**

**PACKAGE CODE: XA10**

**DOCUMENT CONTROL #: PD-2095** **REVISION: --**

09-0064

## Packaging Mechanical: 10-TDFN (ZE)




NOTE :

1. DIMENSIONS IN MILLIMETERS. ANGLES IN DEGREES.
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
3. REFER JEDEC MO–229.
4. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.
5. THERMAL PAD SOLDERING AREA. MESH STENCIL IS RECOMMENDED.
6. THE OPTIONAL 4 EXPOSED PADS ARE COINCIDENT WITH THE BOTTOM SIDE OF THE PACKAGE.

| | |
|---|---|
| | DATE: 12/06/16 |
| DESCRIPTION: 10-Contact, Thin Dual Flat No-Lead (TDFN) | |
| PACKAGE CODE: ZE (ZE10) | |
| DOCUMENT CONTROL #: PD-2092 | REVISION: C |

16-0275

**For latest package info.**

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

## Ordering Information

| Ordering Code | Package Code | Package Description |
|---|---|---|
| PI3USB221XAEX | XA | 10-Lead, Thin Leadframe Land Grid Array (TLLGA) |
| PI3USB221ZEEX | ZE | 10-Contact, Thin Dual Flat No Lead (TDFN) |

**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

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