A product Line of
Diodes Incorporated

PI3USB221E

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

Features

- V_{DD} Operation at 2.5V and 3.3V
- $V_{I/O}$ Accepts Signals up to 5.5V
- 1.8-V Compatible Control-Pin Inputs
- Low-Power Mode When $\overline{OE}$ Is Disabled (2 µA)
- r_{ON} = 6Ω Maximum
- Δ_{rON} = 0.2Ω Typical
- Cio(on) = 4pF Typical
- Support Over Voltage Protection
- Low Power Consumption (50 µA Maximum)
- ESD Performance
- IO Pins
  - 12KV HBM
  - 1KV CDM
  - +/-8KV contact Discharge (IEC61000-4-2)
  - VDD, GND, S, $\overline{OE}$ Pins
  - 4KV HBM
  - 1KV CDM
- High Bandwidth (1.6 GHz Typical)
- 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-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.
  https://www.diodes.com/quality/product-definitions/
- Packaging (Pb-free & Green):
  - 10-contact, UDFN (ZW10)
  - 10-contact, UQFN (ZUA10)

Description

The PI3USB221E 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.

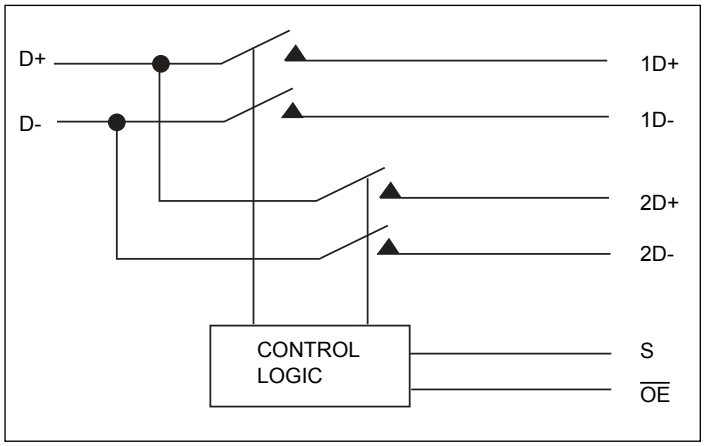
It is designed for low bit-to-bit skew and high channel-to-channel noise isolation, and is compatible with various standards, such as high-speed USB 2.0 (480 Mbps).

The PI3USB221E 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

Block Diagram



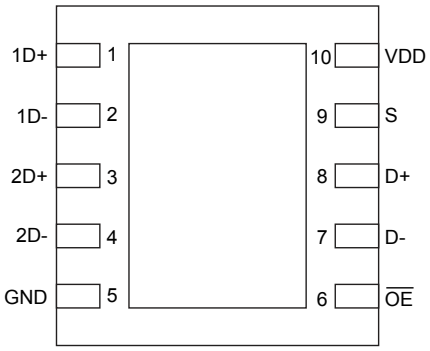
Truth Table

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

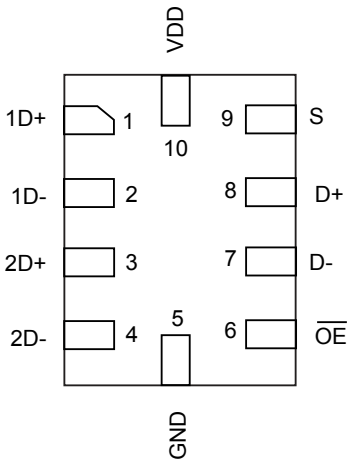
Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- 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

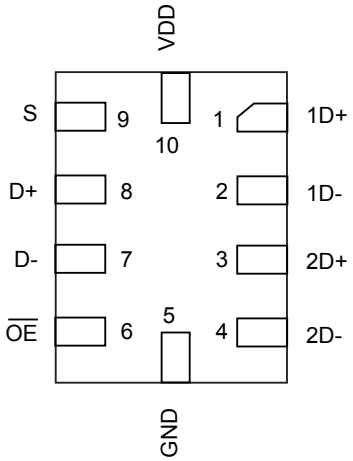
UDFN Package
(Top View)



UQFN Package
(Top View)



UQFN 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)

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 5.5V
$V_{I/O}$ Switch I/O Voltage Range(2, 3, 4)	–0.5V to 5.5V
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
θ_{JA} Package Thermal Impedance	
TLLGA Package	48.7°C/W
TDFN Package	243°C/W
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	1.3	-	
		V_{DD} = 2.7 V to 3.6 V	1.4	-	
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	4.6	
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				–1.2	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			25	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)				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	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	3	
$C_{io(ON)}$		V_{DD} = 3.3V, 2.5V, V_{IN} = 3.3V or 0V, Switch ON			4	6	
r_{ON}[5]		V_{DD} = 3V, 2.3V	V_I = 0V, I_O = 30 mA			4	Ω
			V_I = 2.4V, I_O = –15 mA			6	
Dr_{ON}[6]		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		
V_{pass}		V_{DD} = 2.5 - 3.3V	V_{IN} > 3.8V, I_O = 10uA	2.8	3.8	4.2	V

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.
6. Dron is delta Ron between channels

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	1.6	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	
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

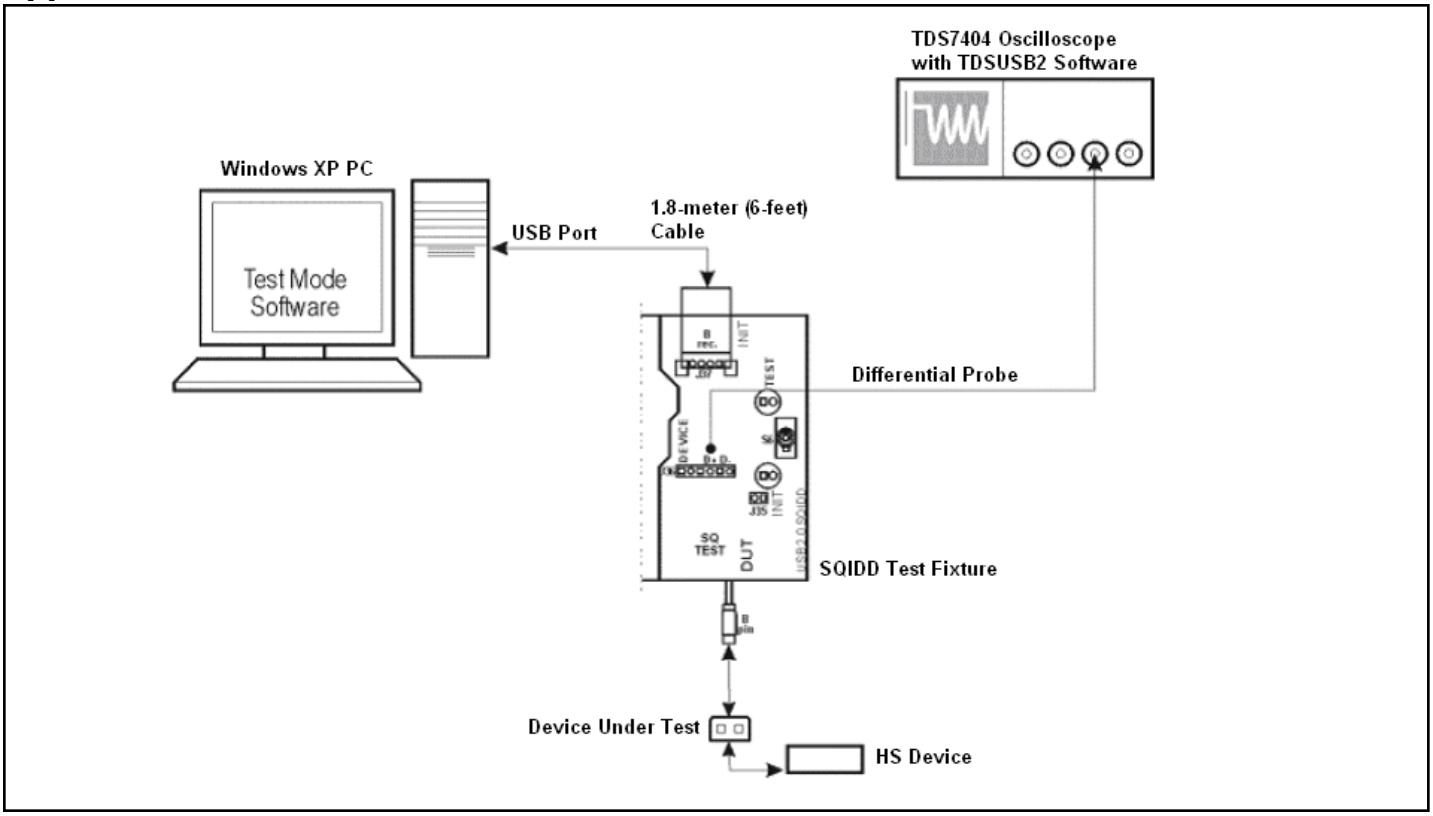
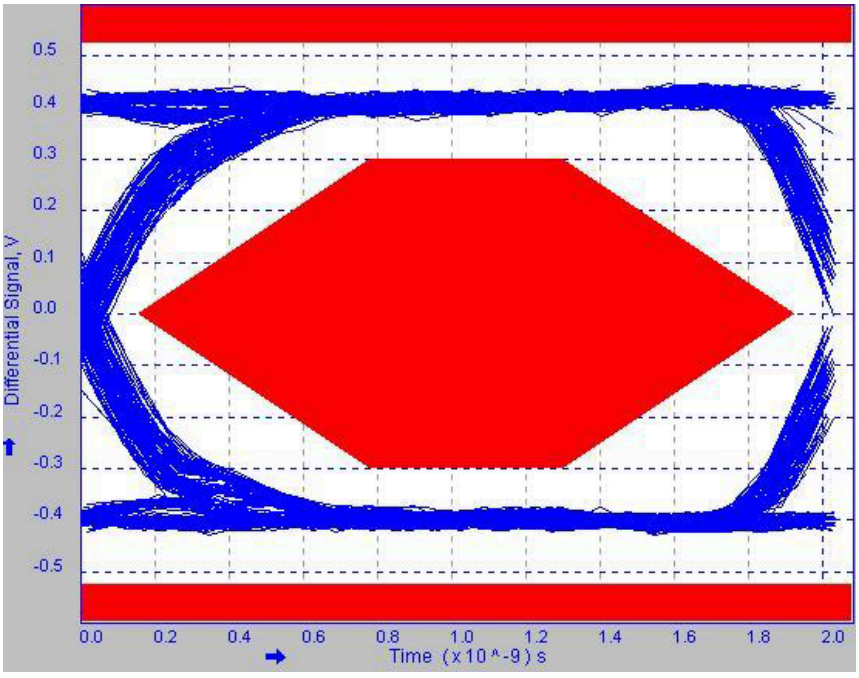


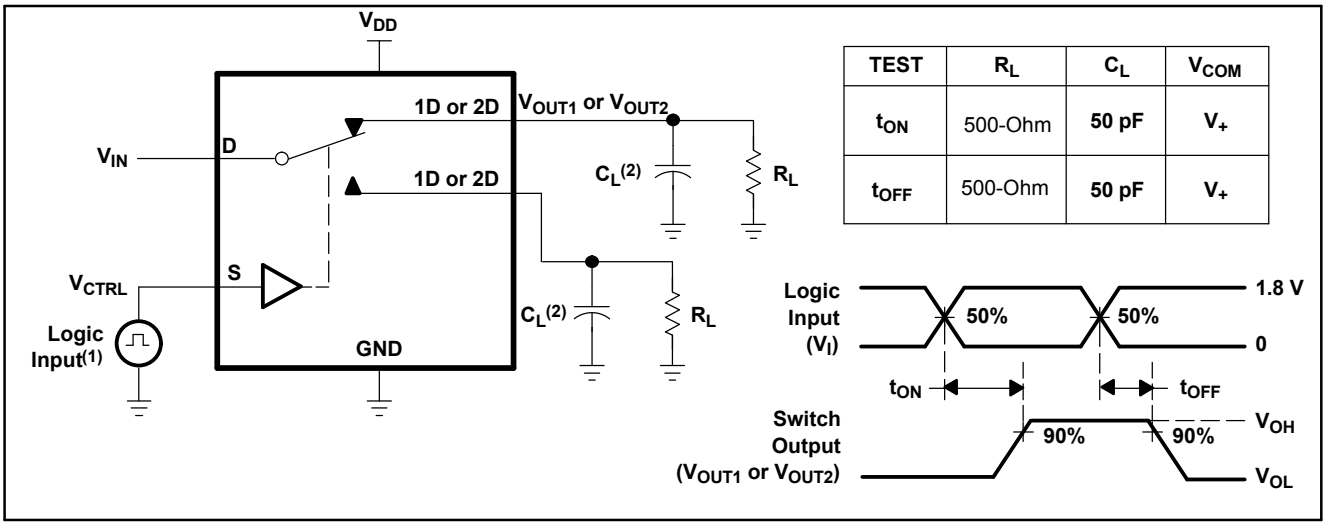
Figure 1: HS Eye Test Setup

Test Result



Test Result: High-speed, Up-stream, Near-end Eye of PI3USB221E

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})

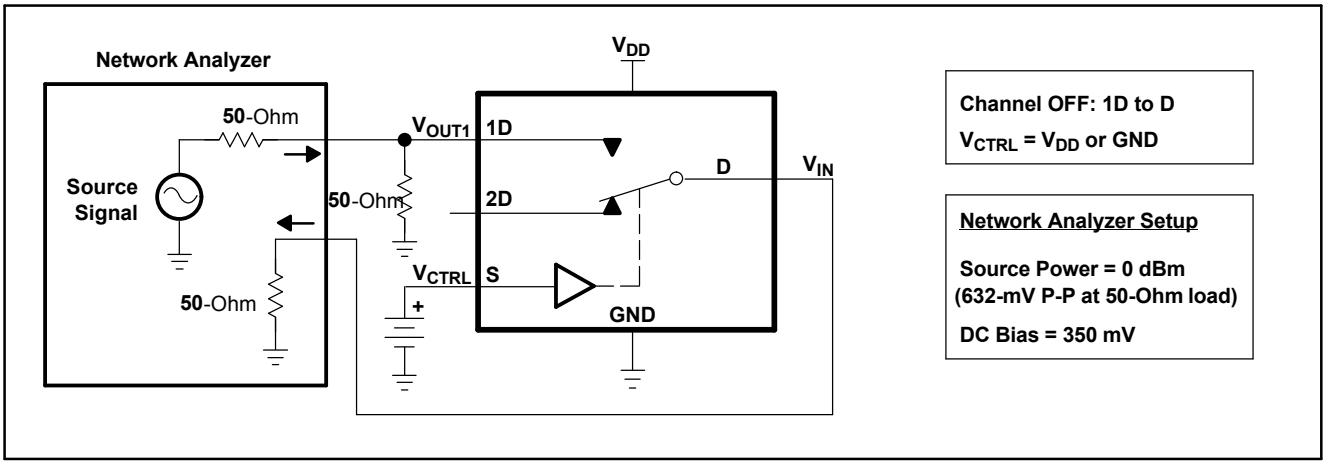


Figure 3. OFF Isolation (O_{ISO})

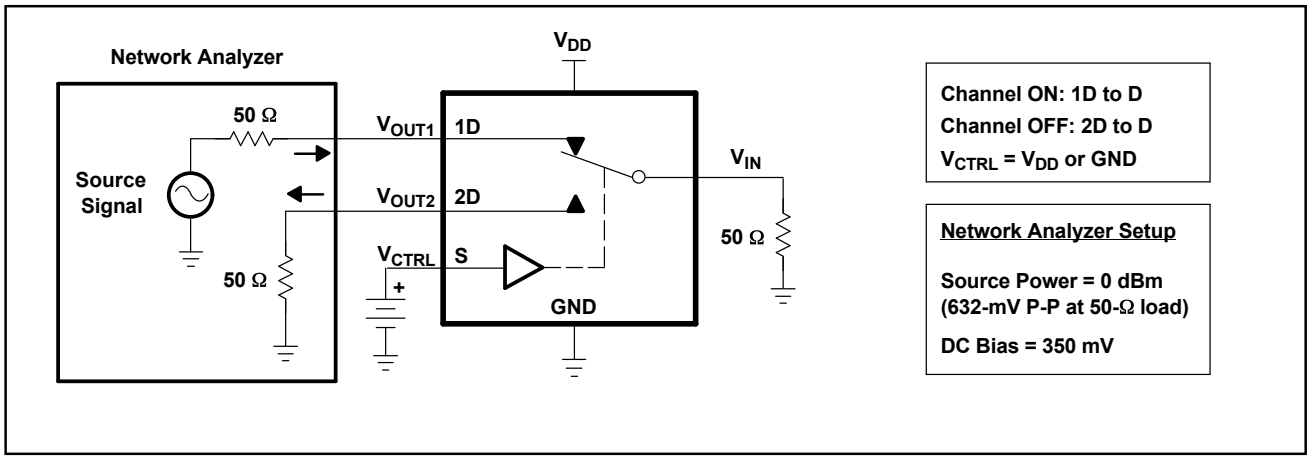


Figure 4. Crosstalk (X_{TALK})

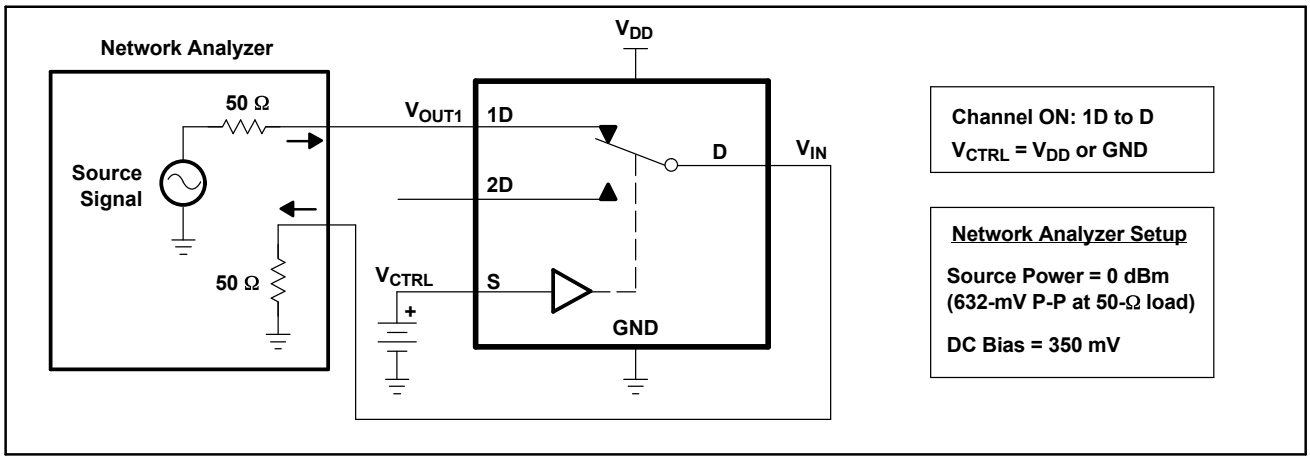


Figure 5. Bandwidth (BW)

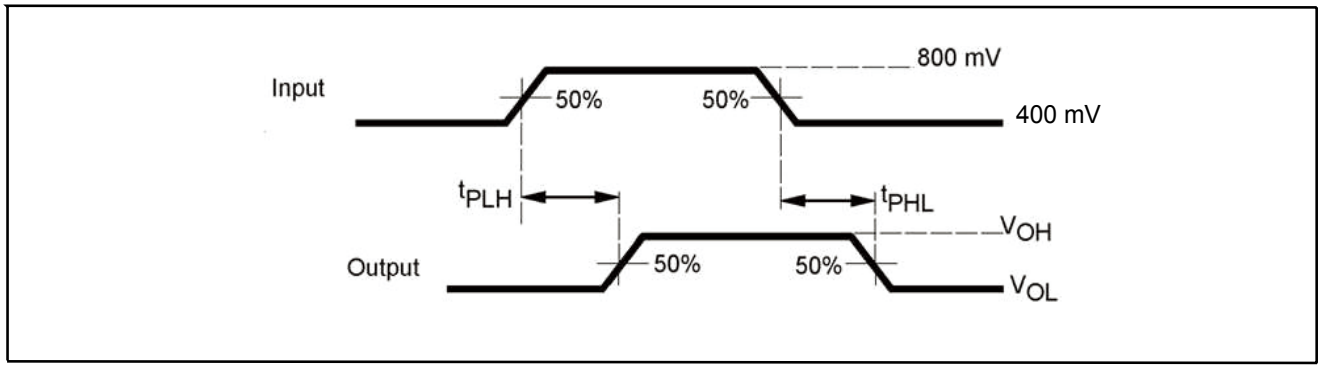


Figure 6. Propagation Delay

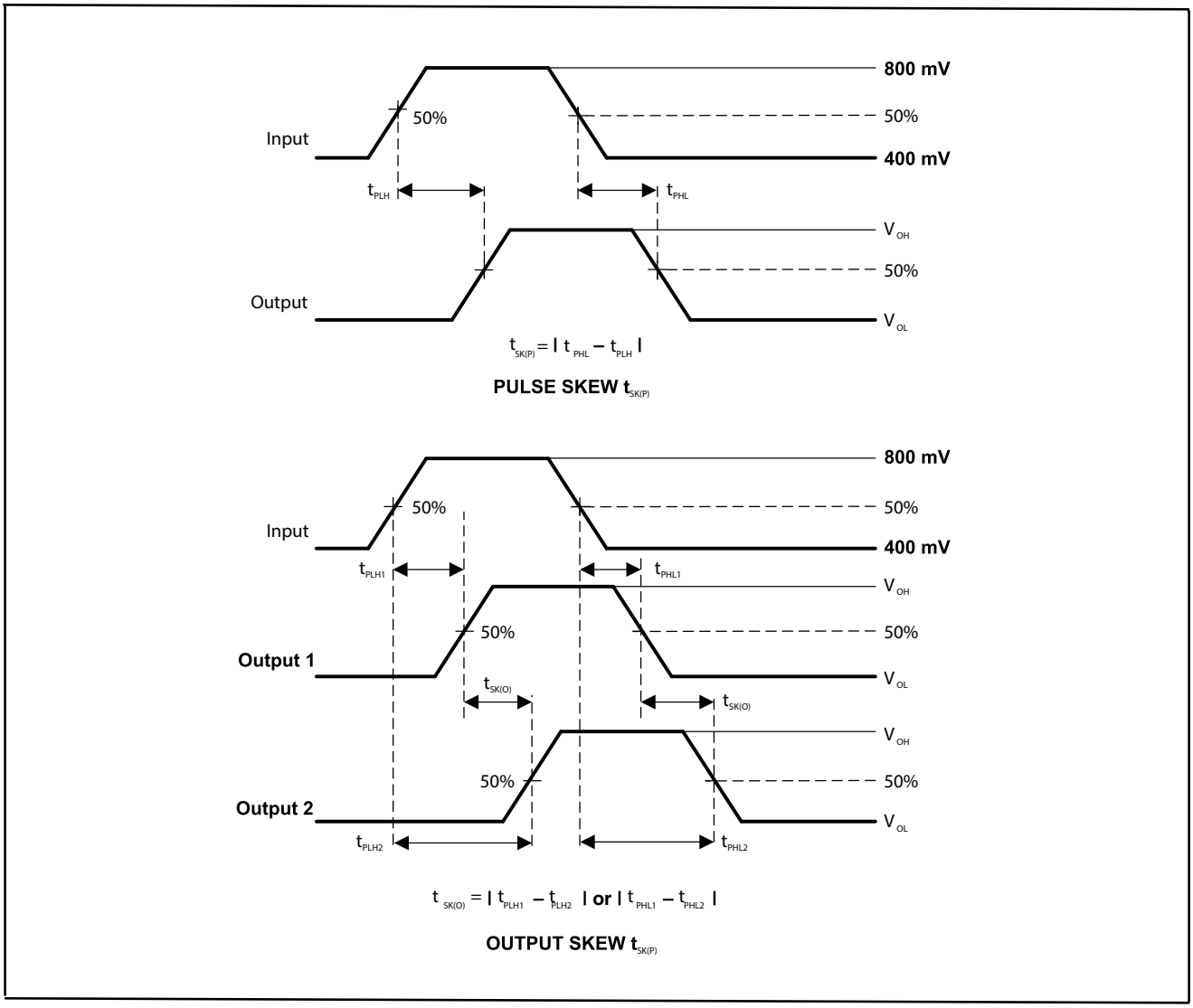


Figure 7. Skew Test

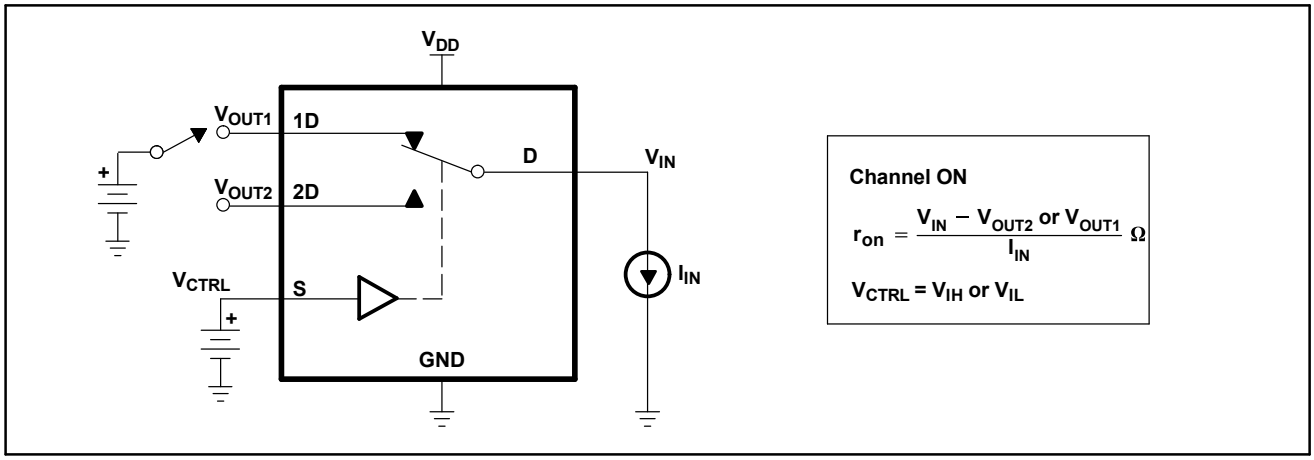


Figure 8. ON-State Resistance (r_{on})

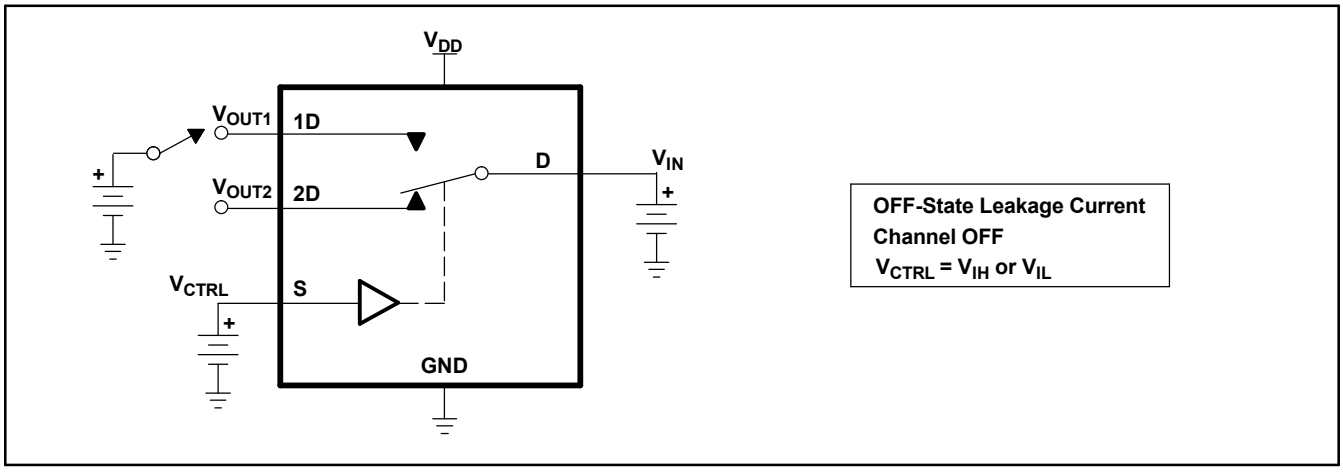


Figure 9. OFF-State Leakage Current

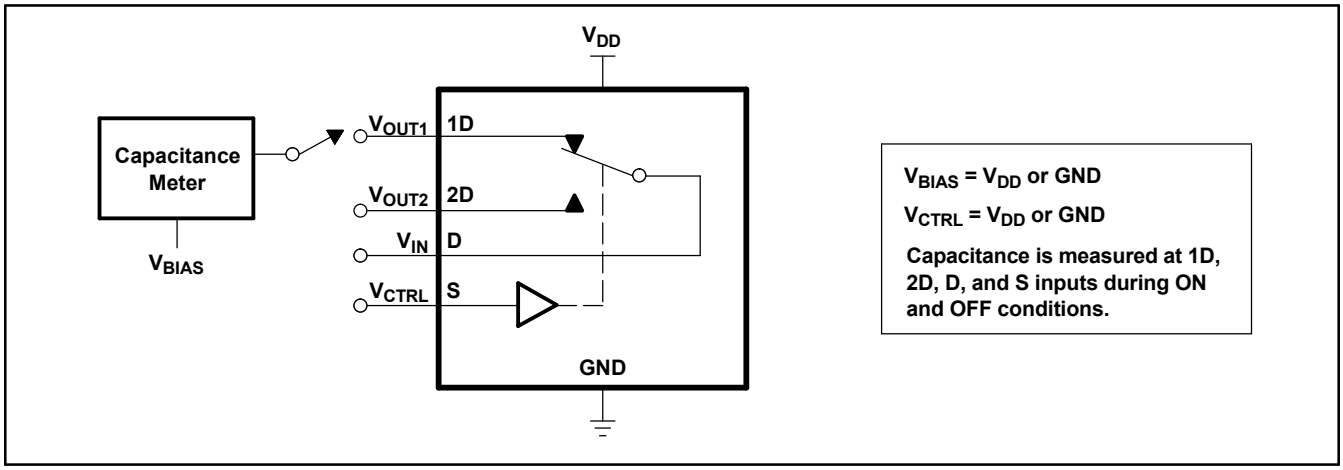
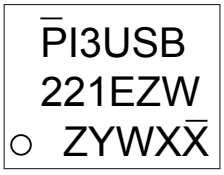


Figure 10. Capacitance

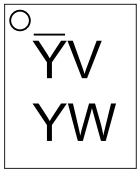
Part Marking

ZW Package



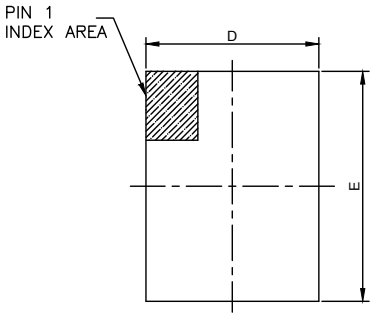
Z : Die Rev
Y : Year
W : Workweek
1st X: Assembly Code
2nd X: Fab Code

ZUA Package

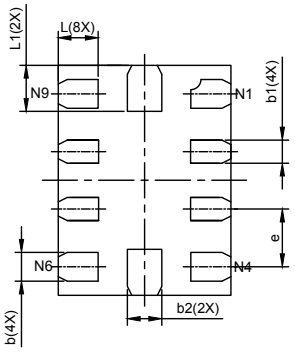


Y : Shorten Year Code
W : Shorten Workweek Code

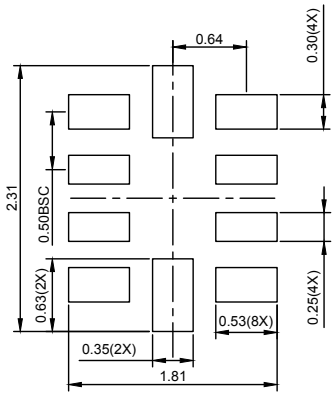
Packaging Mechanical: 10-UQFN (ZUA)



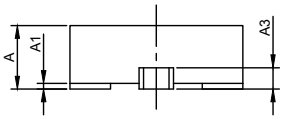
TOP VIEW



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

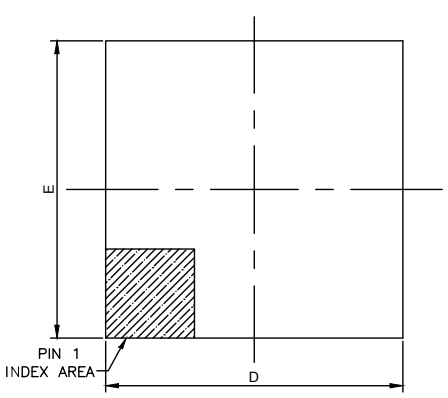
DESCRIPTION: 10-Pin, UQFN, 1.5X2.0

PACKAGE CODE: ZUA(ZUA10)

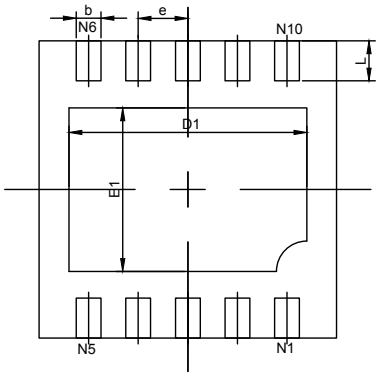
DOCUMENT CONTROL#: PD-2220 **REVISION: --**

17-0002

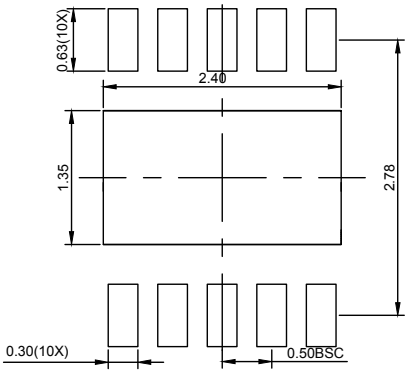
Packaging Mechanical: 10-UDFN (ZW)



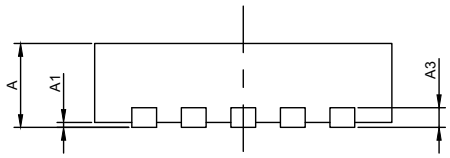
TOP VIEW



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	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	Pin 1 Orientation
PI3USB221EZUAEX	ZUA	10-Pin, 1.5x2.0 (UQFN)	Top Left Corner
PI3USB221EZWEX	ZW	10-Pin, 3x3 (UDFN)	Top Left Corner
PI3USB221EZWEX-13R	ZW	10-Pin, 3x3 (UDFN)	Top Right Corner

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
6. For packaging details, go to our website at: https://www.diodes.com/assets/MediaList-Attachments/Diodes-Package-Information.pdf

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A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or

2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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