

## High-Speed USB 2.0 (480 Mbps) 1-Port Switch with Full Power Down Feature

### Features

- V<sub>DD</sub> Operation at 2.8V and 4.3V
- 1.8V Compatible Control-Pin Inputs
- I<sub>OFF</sub> Supports Full Power-Down Mode Operation
- r<sub>on</sub> = 6Ω Typical
- D<sub>r<sub>on</sub></sub> < 0.35Ω Typical
- C<sub>io</sub>(ON) = 5pF Typical
- Low Power Consumption
- ESD Performance
  - 7kV Human-Body Model, per JESD22 spec (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)
  - ±4kV contact, per IEC61000-4-2
- Wide -3-dB Bandwidth = 2110 MHz 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](https://www.diodes.com/quality/product-definitions/) or your local Diodes representative.  
<https://www.diodes.com/quality/product-definitions/>
- Packaged in 8-Lead TLLGA (1.5 mm x 1.5 mm)

### Truth Table

$\overline{\text{OE}}$	Description
H	Disconnect
L	D+, D- = HSD+, HSD-

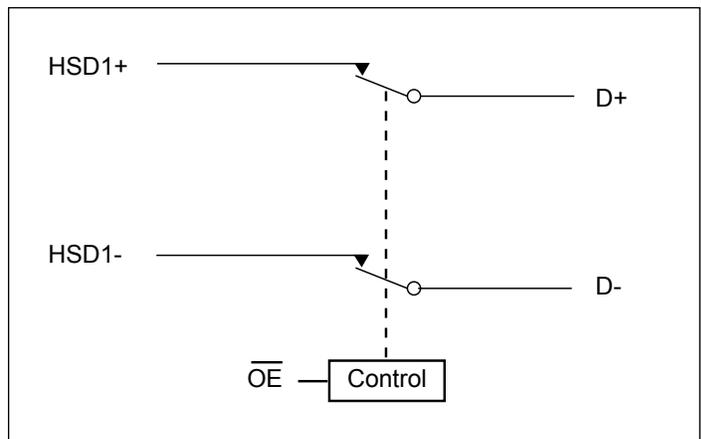
### Description

The PI3USB32 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 (750 MHz) of this switch allows signals to pass with minimum edge and phase distortion. 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).

### Application

- Routes Signals for USB 1.0, 1.1, and 2.0

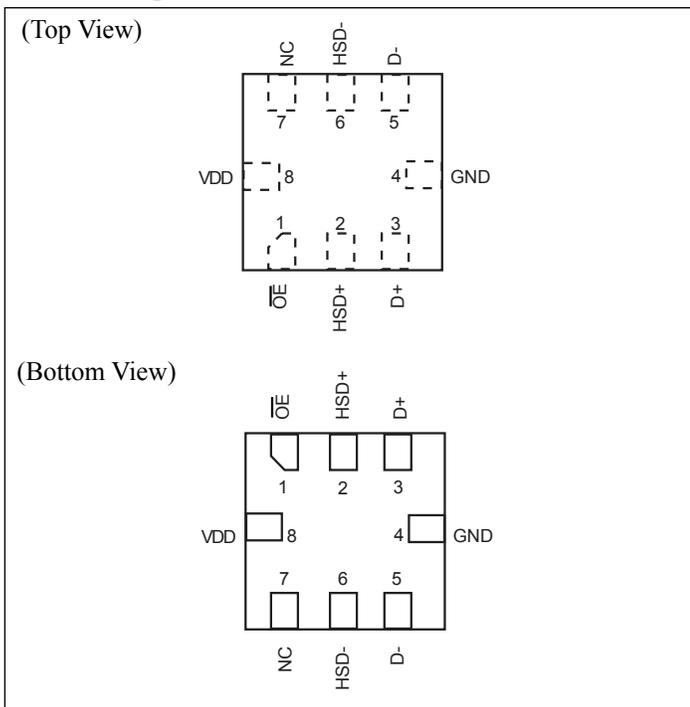
### Block Diagram



### 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**



NC = No Internal Connection

**Pin Description**

Name	Description
$\overline{OE}$	Bus-switch enable
D+, D-, HSD+, HSD-	Data ports
NC	No connect

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

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

Supply Voltage Range ( $V_{DD}$ ).....	-0.5V to +7V
Control Input Voltage Range ( $V_{IN}$ ) <sup>(2)(3)</sup> .....	-0.5V to +7V
VI/O Switch I/O Voltage Range <sup>(2)(3)(4)</sup>	
HSD+, HSD- .....	-0.5V to $V_{DD}+0.3$
D+, D- when $V_{DD} > 0$ .....	-0.5V to $V_{DD}+0.3$
D+, D- when $V_{DD} > 0$ .....	5.25V
Control Input Clamp Current .....	-50mA
I/O Port Clamp Current.....	-50mA
ON-state switch current <sup>(5)</sup> .....	$\pm 64$ mA
Continuous current through $V_{DD}$ or GND.....	$\pm 100$ mA
I/O Port Clamp Current.....	-50mA

**Note:**

- (1) 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.
- (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)  $V_I$  and  $V_O$  are used to denote specific conditions for  $V_{I/O}$ .
- (5)  $I_I$  and  $I_O$  are used to denote specific conditions for  $I_{I/O}$ .

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

Parameter	Description	Min.	Max.	Units
$V_{DD}$	Supply voltage	2.8	4.3	V
$V_{IH}$	High-level control input voltage	$V_{DD} = 2.8V$ to $3.6V$	1.3	V
		$V_{DD} = 4.3V$	1.7	
$V_{IL}$	Input LOW Voltage	$V_{DD} = 2.8V$ to $3.6V$	0.5	V
		$V_{DD} = 4.3V$	0.6	
$V_{I/O}$	Data input/output voltage	0	$V_{DD}$	V
$T_A$	Operating free-air temperature	-40	85	$^{\circ}C$

**Notes:**

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

**PI3USB32**
**Electrical Characteristics** over operating free-air temperature range (unless otherwise noted)

Parameter	Test Conditions <sup>(1)</sup>	Min	Typ. <sup>(2)</sup>	Max	Unit
V <sub>IK</sub>	V <sub>DD</sub> = 2.8V, I <sub>I</sub> = -18mA			-1.2	V
I <sub>IN</sub>	Control inputs V <sub>DD</sub> = 4.3V, V <sub>IN</sub> = 0 to 4.3V, V <sub>DD</sub> = 0V			±1	μA
I <sub>OZ</sub> <sup>(3)</sup>	V <sub>DD</sub> = 4.3V, V <sub>O</sub> = 0 to 3.6V, V <sub>I</sub> = 0, Switch OFF			±1	μA
I <sub>OFF</sub>	D+ and D- V <sub>DD</sub> = 0V, V <sub>O</sub> = 0 to 4.3V, V <sub>I</sub> = 0, V <sub>IN</sub> = V <sub>DD</sub> or GND			±2	μA
I <sub>CC</sub>	V <sub>DD</sub> = 4.3V, I <sub>I/O</sub> = 0			70	μA
D I <sub>CC</sub> <sup>(4)</sup>	Control inputs V <sub>DD</sub> = 4.3V, V <sub>IN</sub> = 2.6V			10	μA
C <sub>IN</sub>	Control inputs V <sub>DD</sub> = 0V, V <sub>IN</sub> = V <sub>DD</sub> or GND		1		pF
C <sub>io</sub> (OFF)	V <sub>DD</sub> = 3.3V, Switch OFF		2		pF
C <sub>io</sub> (ON)	V <sub>DD</sub> = 3.3V, Switch ON		5		pF
R <sub>ON</sub> <sup>(5)</sup>	V <sub>DD</sub> = 2.8V, V <sub>I</sub> = 0.4V, I <sub>O</sub> = -8mA		6	10	W
DR <sub>ON</sub>	V <sub>DD</sub> = 2.8V, V <sub>I</sub> = 0.4V, I <sub>O</sub> = -8mA		0.35		W
DR <sub>ON</sub> (flat)	V <sub>DD</sub> = 2.8V, V <sub>I</sub> = 0V or 1V, I <sub>O</sub> = -8mA		2		W

**Notes:**

- V<sub>IN</sub> and I<sub>IN</sub> refer to control input ( $\overline{OE}$ ). V<sub>I</sub>, V<sub>O</sub>, I<sub>I</sub>, and I<sub>O</sub> refer to data pins.
- All typical values are at V<sub>DD</sub> = 3.3 V (unless otherwise noted), T<sub>A</sub> = 25°C.
- For I/O ports, the parameter I<sub>OZ</sub> 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<sub>DD</sub> or GND.
- Measured by the voltage drop between the D and HSD 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<sub>A</sub> = -40°C TO 85°C, V<sub>DD</sub> = 3.3 V ± 10%, GND = 0 V)

Parameter	Description	Test Conditions <sup>(1)</sup>	Typ. <sup>(1)</sup>	Units
O <sub>IRR</sub>	OFF isolation	R <sub>L</sub> = 50Ω, f = 240MHz	-30	dB
BW	Bandwidth (-3 dB)	R <sub>L</sub> = 50Ω	2110	MHz
Xtalk	Crosstalk	R <sub>L</sub> = 50Ω, f = 240MHz	-55	dB

**Notes:**

- 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  $85^{\circ}\text{C}$ ,  $V_{DD} = 3.3\text{ V} \pm 10\%$ ,  $GND = 0\text{ V}$ )

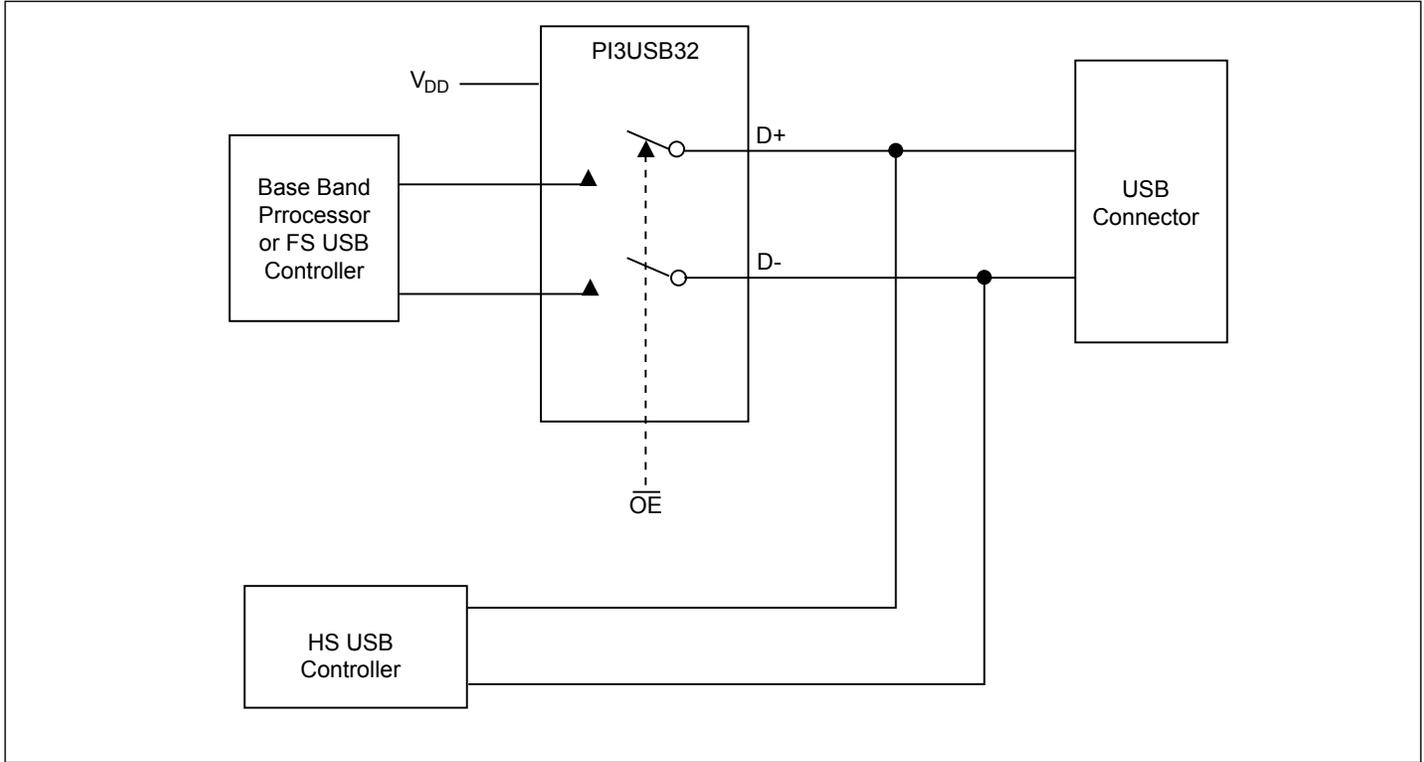
Parameters	Description	Test Conditions <sup>(1)</sup>	Min.	Typ.	Max.	Units
$t_{PD}$	Propagation Delay <sup>(2,3)</sup>	$R_L = 50\Omega, C_L = 5\text{ pF}$			0.35	ns
$t_{ON}$	Line Enable Time, $\overline{OE}$ to D+/D-	$R_L = 50\Omega, C_L = 5\text{ pF}$			55	ns
$t_{OFF}$	Line Disable Time - $\overline{OE}$ to D+/D-	$R_L = 50\Omega, C_L = 5\text{ pF}$			25	ns
$t_{SK(P)}$	Skew between opposite transitions of the same output ( $t_{PHL} - t_{PLH}$ ) <sup>(2)</sup>	$R_L = 50\Omega, C_L = 5\text{ pF}$		50		ps
$t_j$	Total Jitter <sup>(2)</sup>	$R_L = 50\Omega, C_L = 5\text{ pF}$ , $t_R = t_F = 500\text{ ps}$ at 480 Mbps (PBRs = $2^{15} - 1$ )		200		ps

**Notes:**

1. For Max or Min conditions, use the appropriate value specified under Electrical Characteristics for the applicable device type.
2. Guaranteed by design.
3. The bus 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 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.

**PI3USB32**

**Application Information**



**Application Diagram**

**PI3USB32**

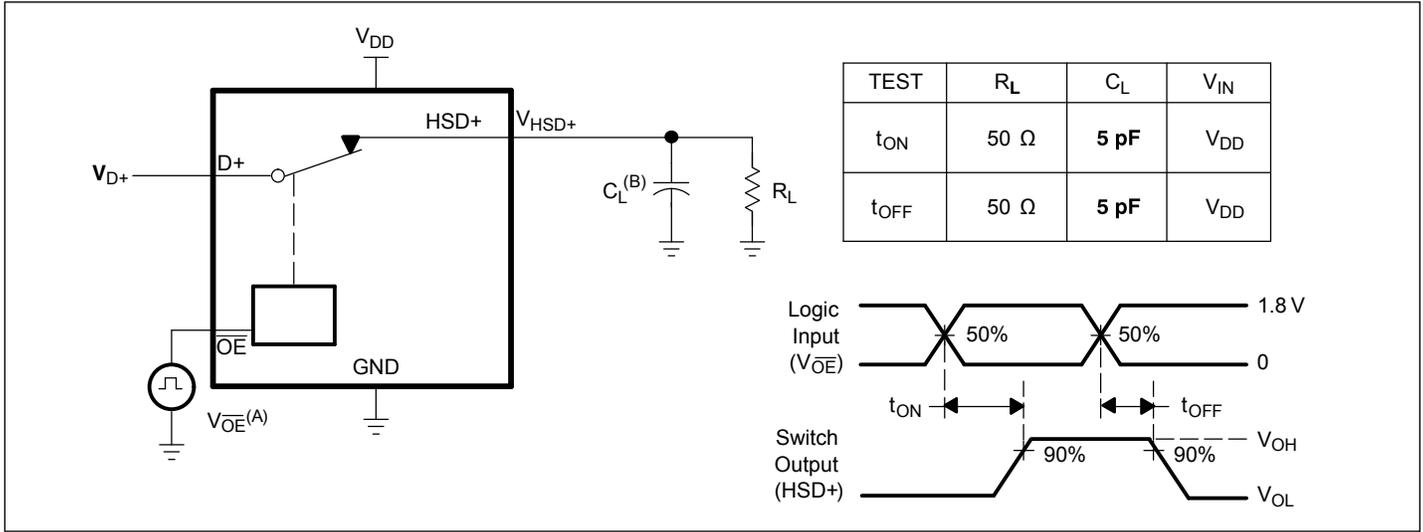


Figure 1. Turn-On (t<sub>ON</sub>) and Turn-Off Time (t<sub>OFF</sub>)

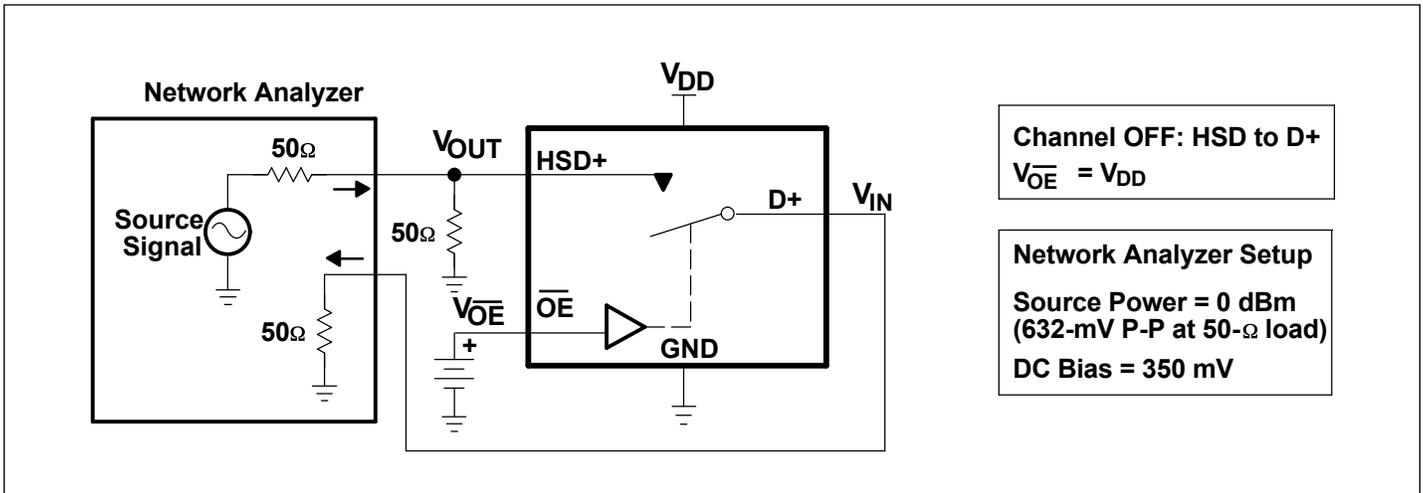


Figure 2. OFF Isolation (OIRR)

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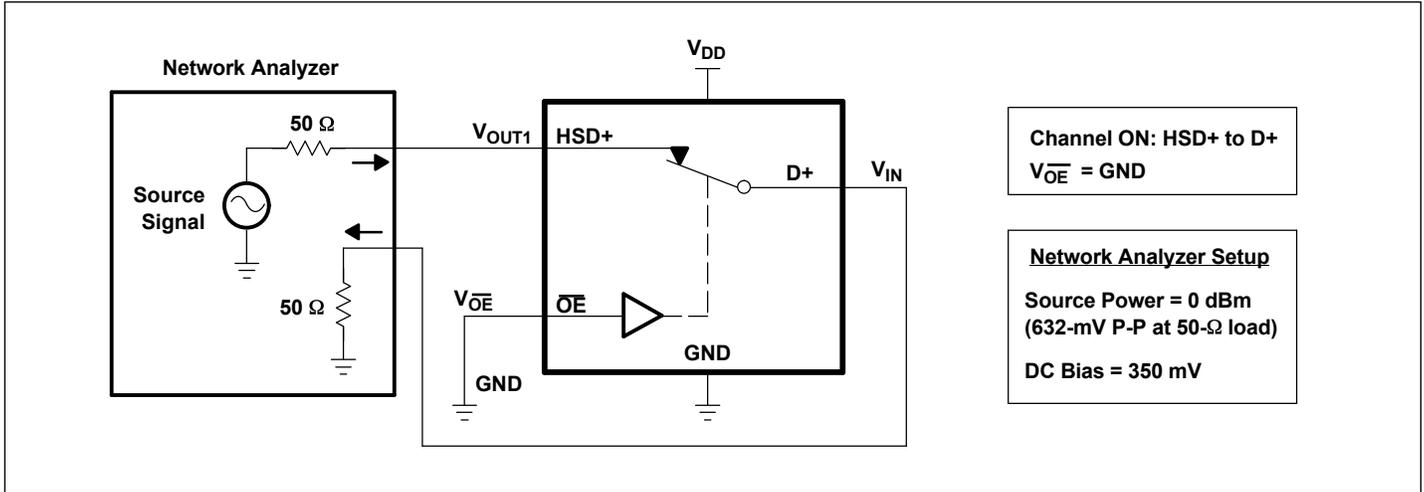


Figure 3. Bandwidth (BW)

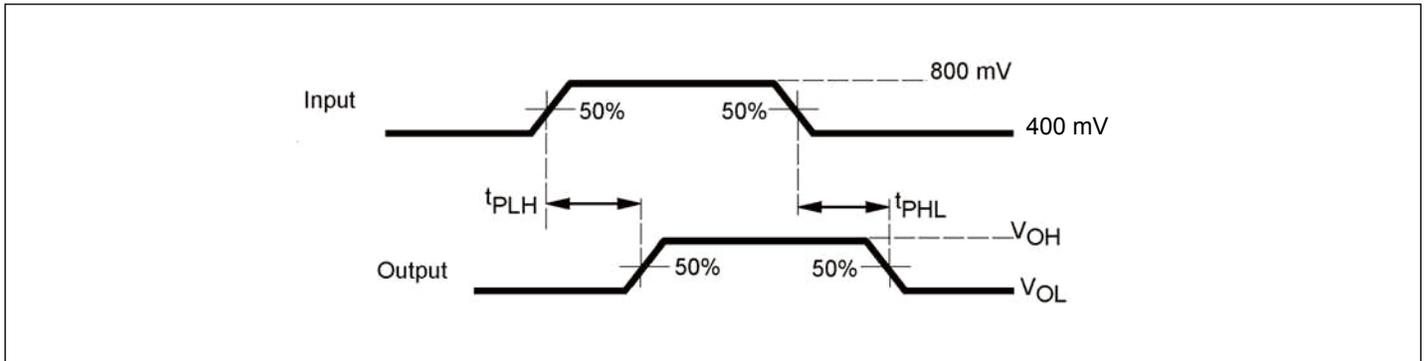
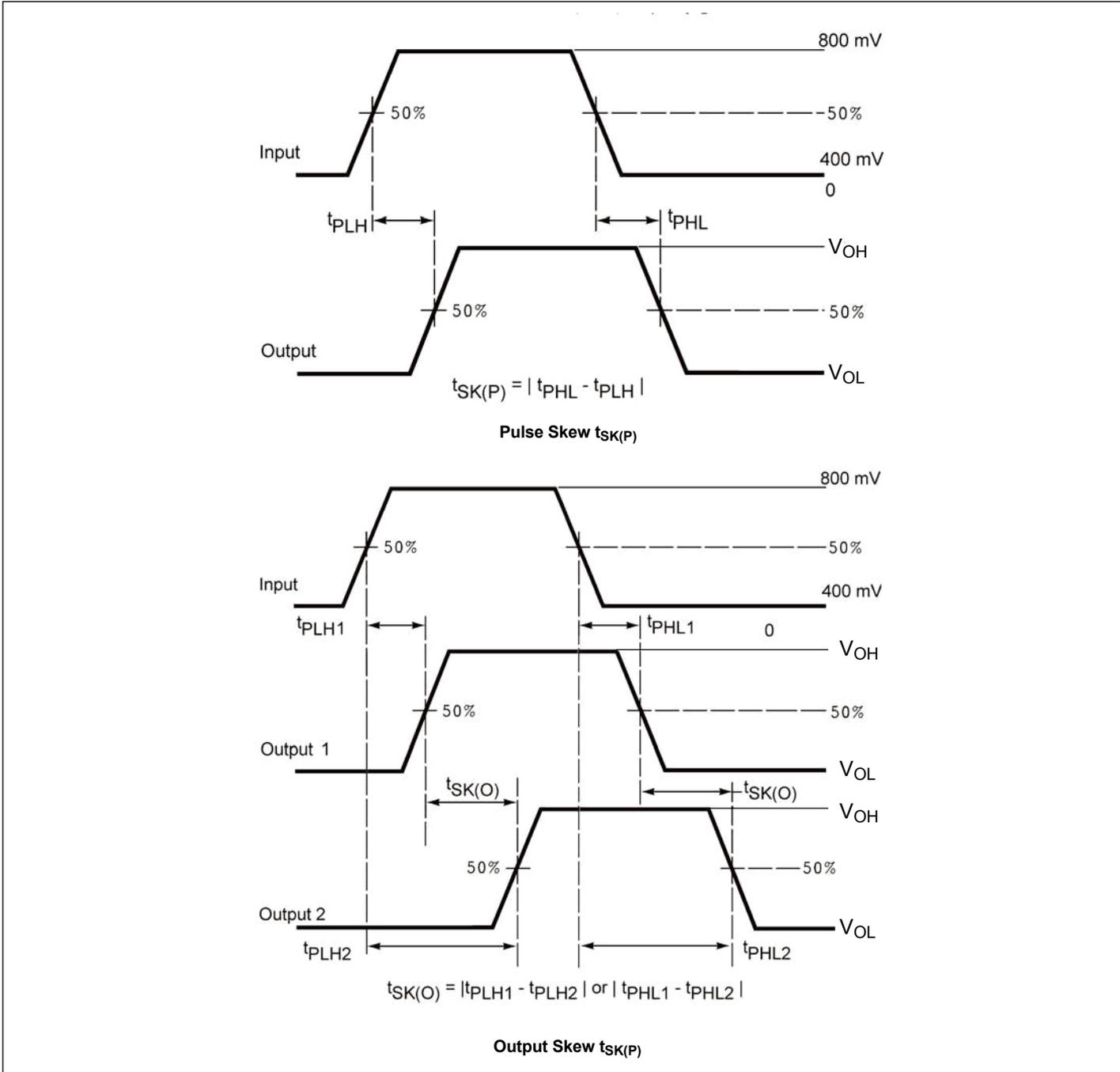
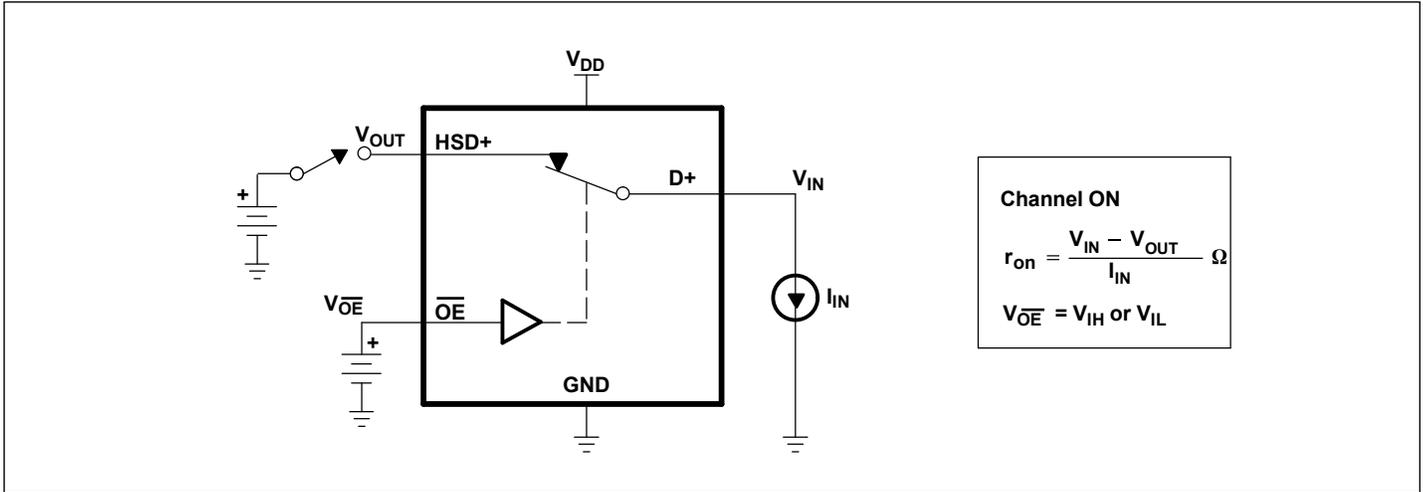


Figure 4. Propagation Delay

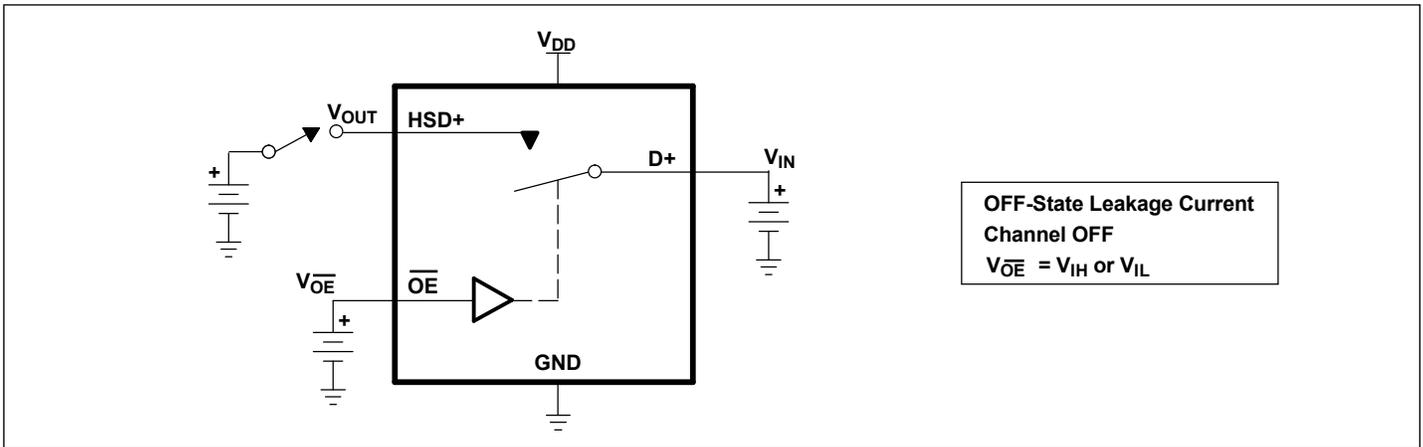


**Figure 5. Skew Test**

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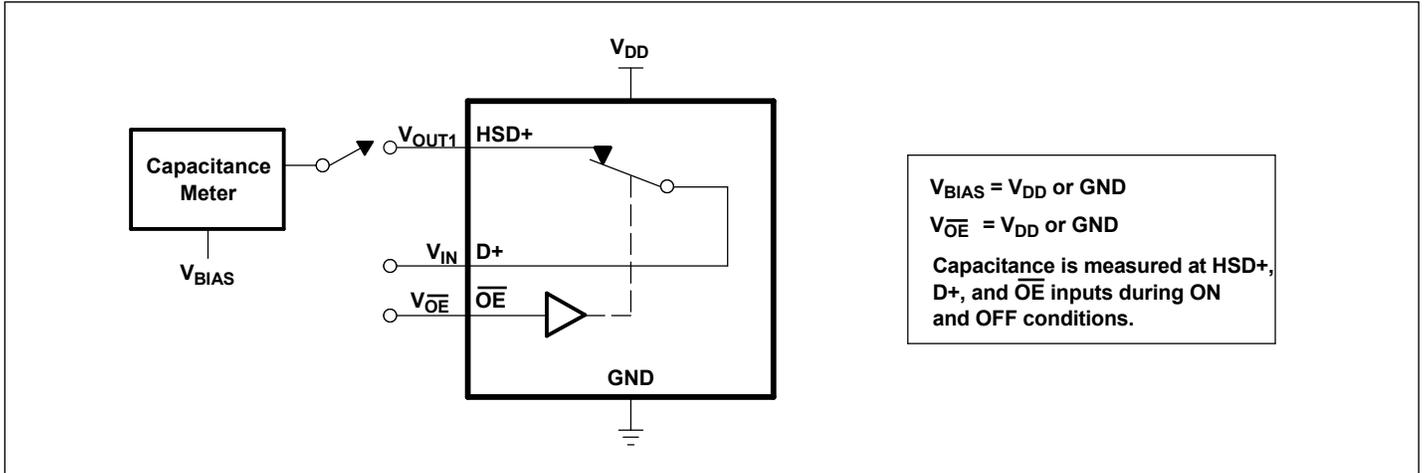


**Figure 6. ON-State Resistance ( $r_{on}$ )**



**Figure 7. OFF-State Leakage Current**

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**Figure 8. Capacitance**

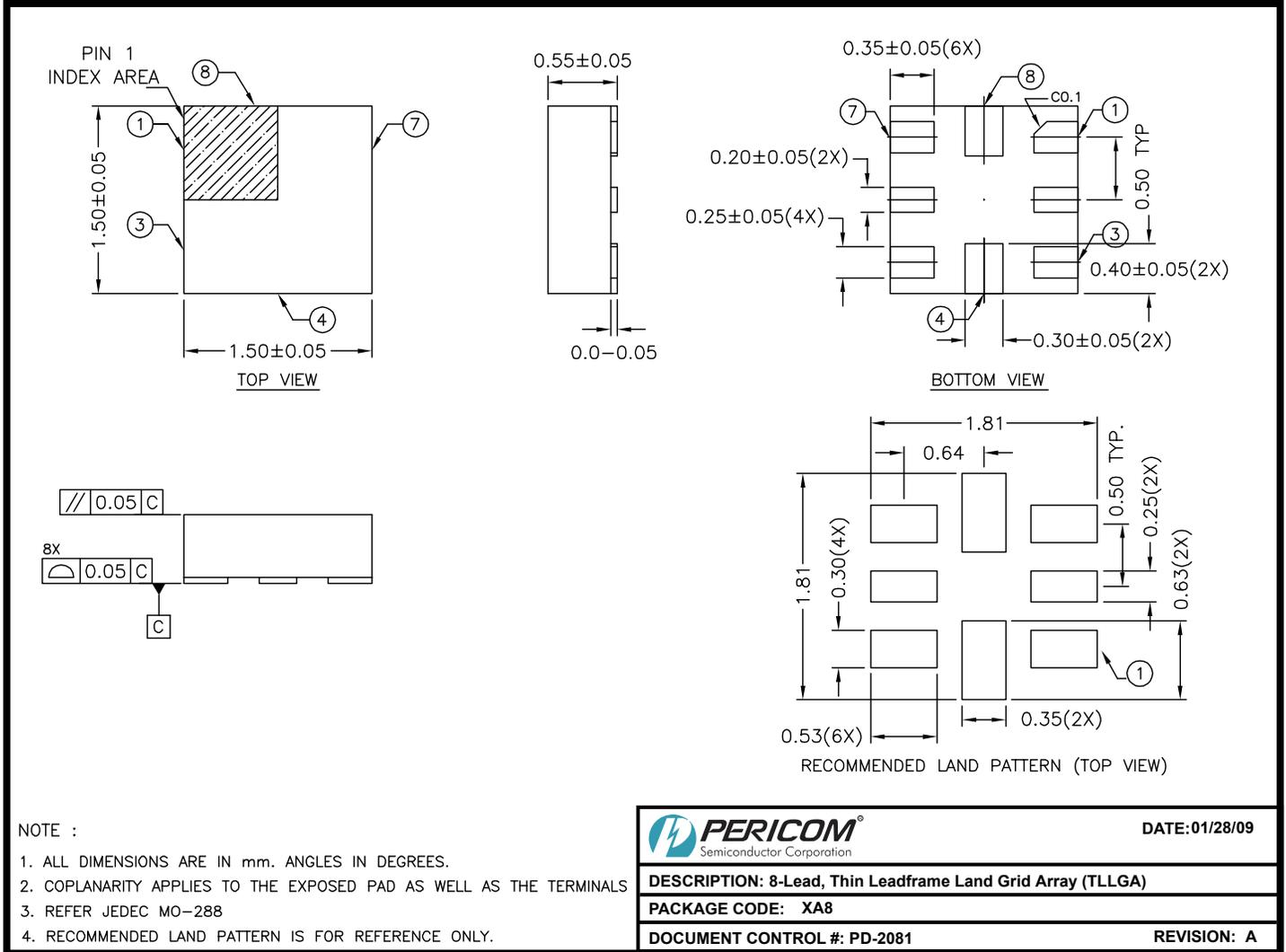
**Part Marking**

Top mark not available at this time. To obtain advance information regarding the top mark, please contact your local sales representative.

**PI3USB32**

**Packaging Mechanical**

8-TLLGA (XA)



09-0065

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	Description	Top Mark
PI3USB32XAEX	XA	8-Lead, Thin Leadframe Land Grid Array (TLLGA)	EK

Notes:

1. 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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4. E = Pb-free and Green
5. X suffix = Tape/Reel

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