A Product Line of
Diodes Incorporated

# PI3USB31

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

## Features

- $V_{DD}$ Operation at 2.8 V and 4.3 V
- 1.8 V Compatible Control-Pin Inputs
- $I_{OFF}$ Supports Full Power-Down Mode Operation
- $r_{on}$ = 6 Ω Typical
- $Dr_{on}$ <0.35 Ω Typical
- Cio(ON) = 5 pF Typical
- Low Power Consumption
- ESD Performance
  - 7 kV Human-Body Model, per JESD22 spec (A114-B, Class II)
  - 1000 V Charged-Device Model (C101)
  - ±4 kV 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 or your local Diodes representative.
  https://www.diodes.com/quality/product-definitions/
- Packaging (Pb-free & Green):
  - 8-pin, UQFN1515-8 (ZUA)

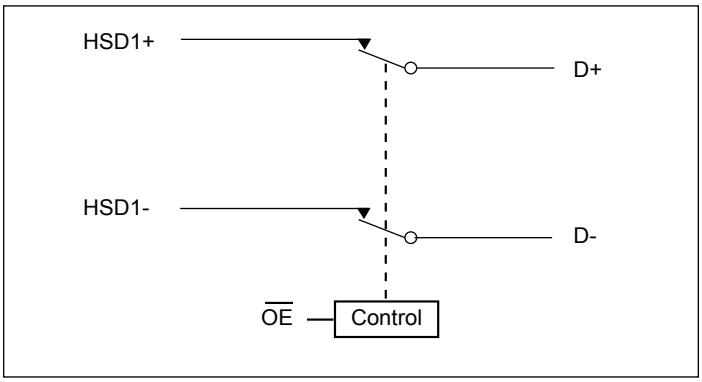
## Application

- Routes Signals for USB 1.0, 1.1, and 2.0

## Description

The PI3USB31 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).

## Block Diagram

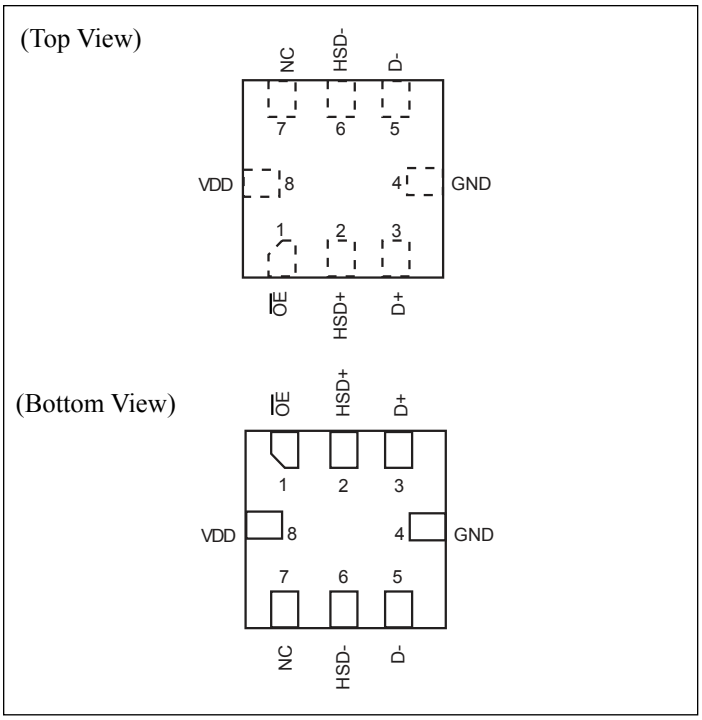



## Truth Table

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

**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(1)

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

Supply Voltage Range ($V_{DD}$).....–0.5V to +7V
Control Input Voltage Range ($V_{IN}$)(2)(3).....–0.5V to +7V
VI/O Switch I/O Voltage Range(2)(3)(4)
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(5).....±64mA
Continuous current through $V_{DD}$ or GND.....±100mA
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(1)

| 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 | °C |

**Notes:**
1. All unused control inputs of the device must be held at VDD or GND to ensure proper device operation.

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

| Parameter | | Test Conditions(1) | Min | Typ.(2) | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{IK}$ | | $V_{DD}$ = 2.8V, $I_I$ = –18mA | | | -1.2 | V |
| $I_{IN}$ | Control inputs | $V_{DD}$ = 4.3V, $V_{IN}$ = 0 to 4.3V, $V_{DD}$ = 0V | | | ±1 | µA |
| $I_{OZ}$(3) | | $V_{DD}$ = 4.3V, $V_O$ = 0 to 3.6V, $V_I$ = 0, Switch OFF | | | ±1 | µA |
| $I_{OFF}$ | D+ and D- | $V_{DD}$ = 0V, $V_O$ = 0 to 4.3V, $V_I$ = 0, $V_{IN}$ = $V_{DD}$ or GND | | | ±2 | µA |
| $I_{CC}$ | | $V_{DD}$ = 4.3V, $I_{I/O}$ = 0 | | | 70 | µA |
| $DI_{CC}$(4) | Control inputs | $V_{DD}$ = 4.3V, $V_{IN}$ = 2.6V | | | 10 | µA |
| $C_{IN}$ | Control inputs | $V_{DD}$ = 0V, $V_{IN}$ = $V_{DD}$ or GND | | 1 | | pF |
| Cio(OFF) | | $V_{DD}$ = 3.3V, Switch OFF | | 2 | | pF |
| Cio(ON) | | $V_{DD}$ = 3.3V, Switch ON | | 5 | | pF |
| $R_{ON}$(5) | | $V_{DD}$ = 2.8V, $V_I$ = 0.4V, IO = –8mA | | 6 | 10 | W |
| $DR_{ON}$ | | $V_{DD}$ = 2.8V, $V_I$ = 0.4V, IO = –8mA | | 0.35 | | W |
| $DR_{ON(flat)}$ | | $V_{DD}$ = 2.8V, $V_I$ = 0V or 1 V, IO = –8mA | | 2 | | W |

**Notes:**

1. $V_{IN}$ and $I_{IN}$ refer to control input ($\overline{OE}$). $V_I$, $V_O$, $I_I$, and $I_O$ 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 $I_{OZ}$ 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 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, $T_A$ = –40°C TO 85°C, $V_{DD}$ = 3.3 V ± 10%, GND = 0 V)

| Parameter | Description | Test Conditions(1) | Typ.(1) | Units |
|---|---|---|---|---|
| $O_{IRR}$ | OFF isolation | $R_L$ = 50Ω, f = 240MHz | -30 | dB |
| BW | Bandwidth (-3 dB) | $R_L$ = 50Ω | 2110 | MHz |
| Xtalk | Crosstalk | $R_L$ =50Ω, f = 240MHz | -55 | dB |

**Notes:**

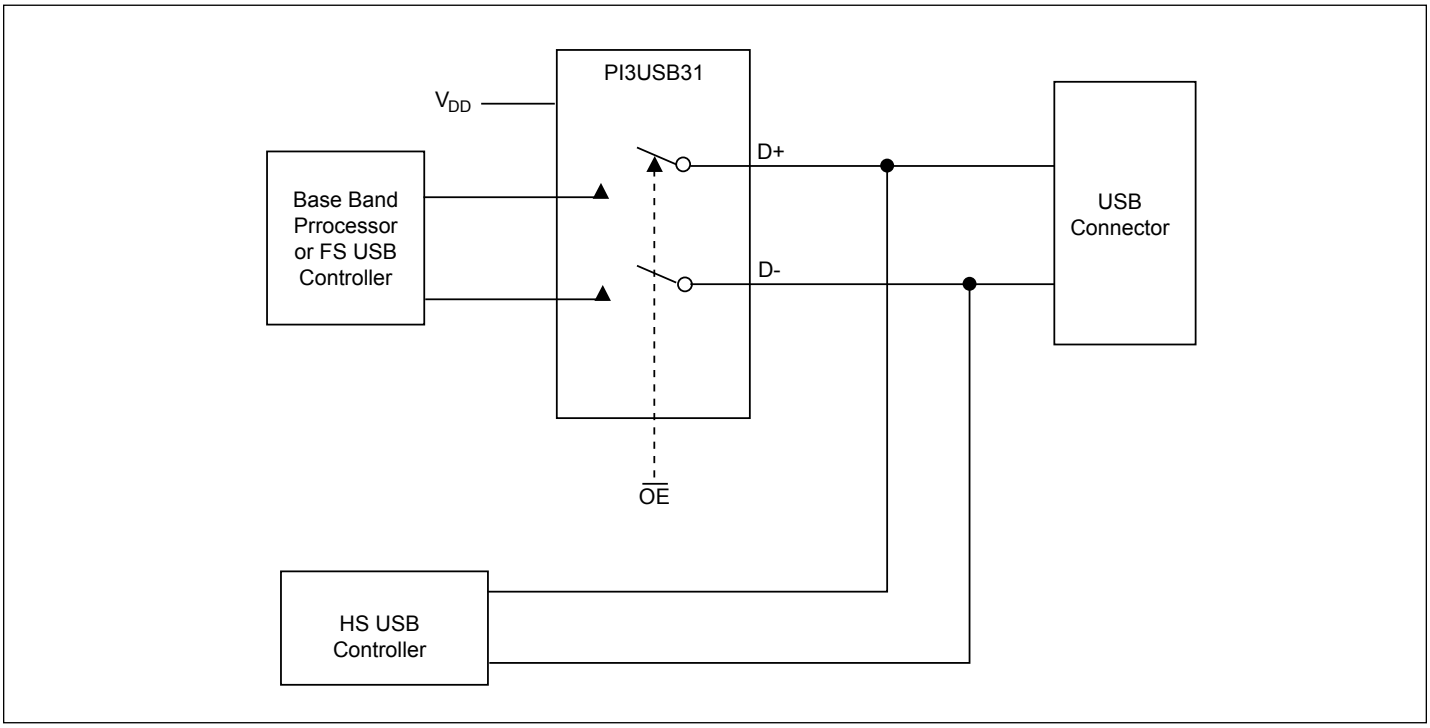
1. For Max or Min conditions, use the appropriate value specified under Electrical Characteristics for the applicable device type.

## Switching Characteristics (over operating range, $T_A$ = –40°C TO 85°C, $V_{DD}$ = 3.3 V ± 10%, GND = 0 V)

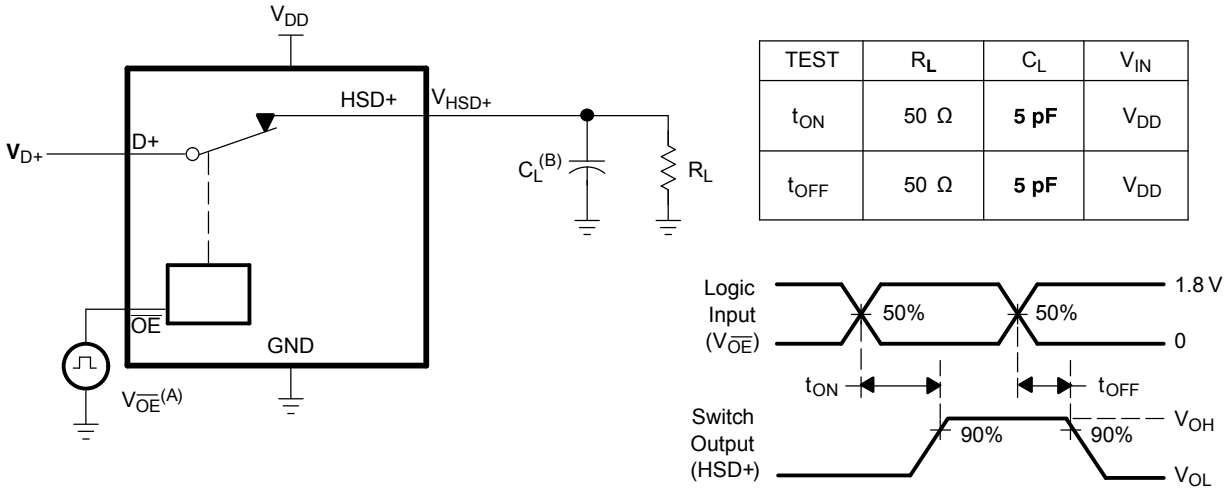
| Parameters | Description | Test Conditions (1) | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $t_{PD}$ | Propagation Delay(2,3) | $R_L$ = 50W, $C_L$ = 5pF | | | 0.35 | ns |
| $t_{ON}$ | Line Enable Time, $\overline{OE}$ to D+/D- | $R_L$ = 50W, $C_L$ = 5pF | | | 55 | ns |
| $t_{OFF}$ | Line Disable Time - $\overline{OE}$ to D+/D- | $R_L$ = 50W, $C_L$ = 5pF | | | 25 | ns |
| $t_{SK(P)}$ | Skew between opposite transitions of the same output ($t_{PHL}$ - $t_{PLH}$)(2) | $R_L$ = 50W, $C_L$ = 5pF | | 50 | | ps |
| $t_J$ | Total Jitter(2) | $R_L$ = 50W, $C_L$ = 5pF, tR = $t_F$ = 500ps at 480Mbps (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 0.25 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

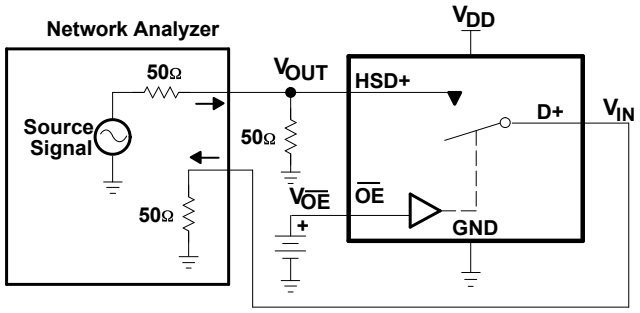



**Application Diagram**




| TEST | $R_L$ | $C_L$ | $V_{IN}$ |
|---|---|---|---|
| $t_{ON}$ | 50 Ω | **5 pF** | $V_{DD}$ |
| $t_{OFF}$ | 50 Ω | **5 pF** | $V_{DD}$ |

**Figure 1. Turn-On ($t_{ON}$) and Turn-Off Time ($t_{OFF}$)**




**Channel OFF: HSD to D+**
**$V_{\overline{OE}}$ = $V_{DD}$**

**Network Analyzer Setup**
**Source Power = 0 dBm (632-mV P-P at 50-Ω load)**
**DC Bias = 350 mV**

**Figure 2. OFF Isolation (OIRR)**

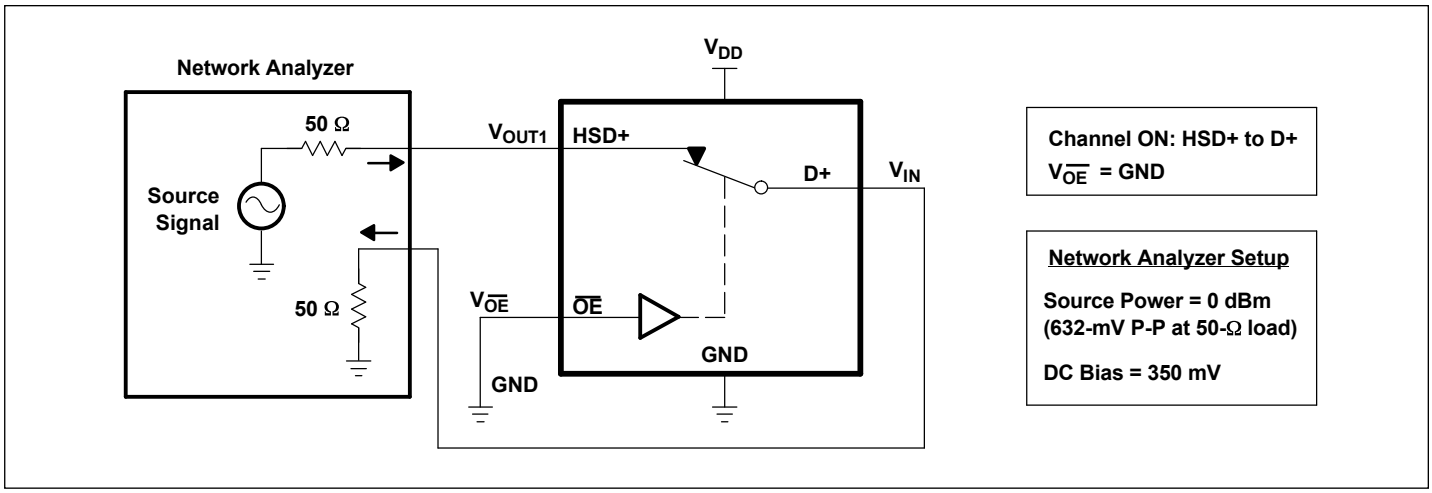



**Figure 3. Bandwidth (BW)**

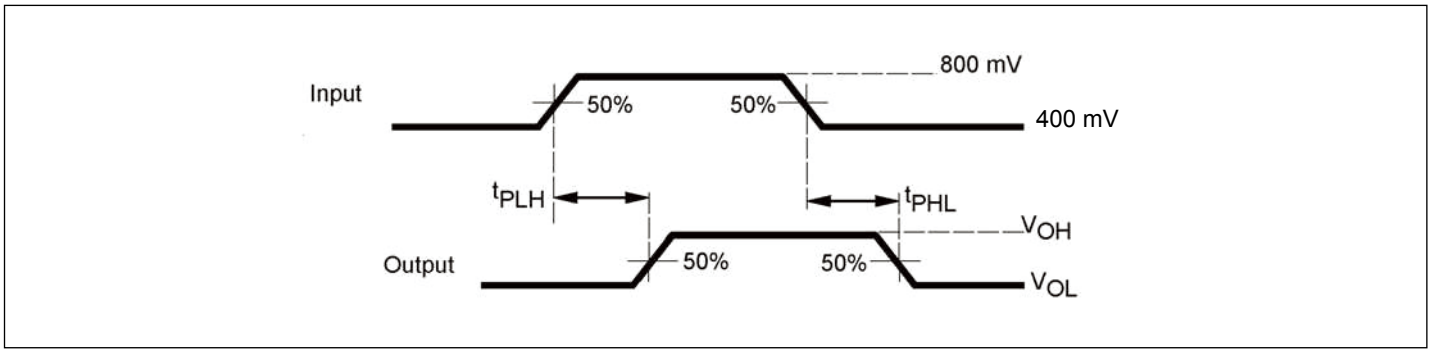



**Figure 4. Propagation Delay**

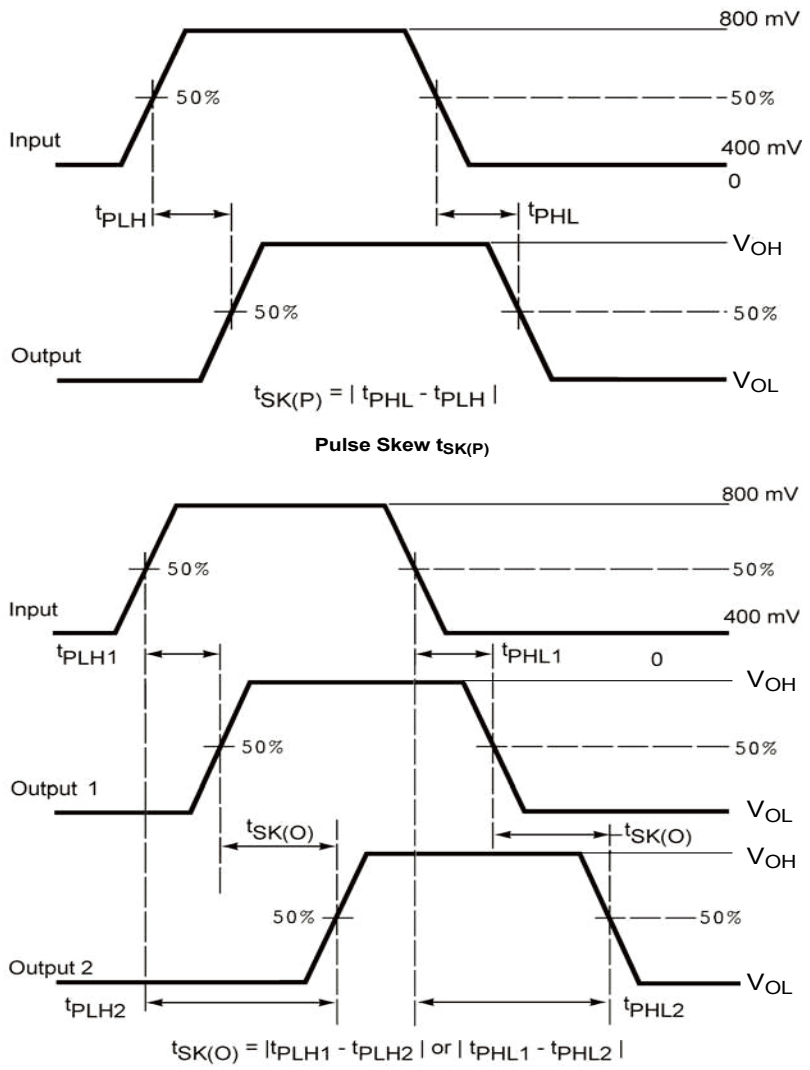



**Figure 5. Skew Test**

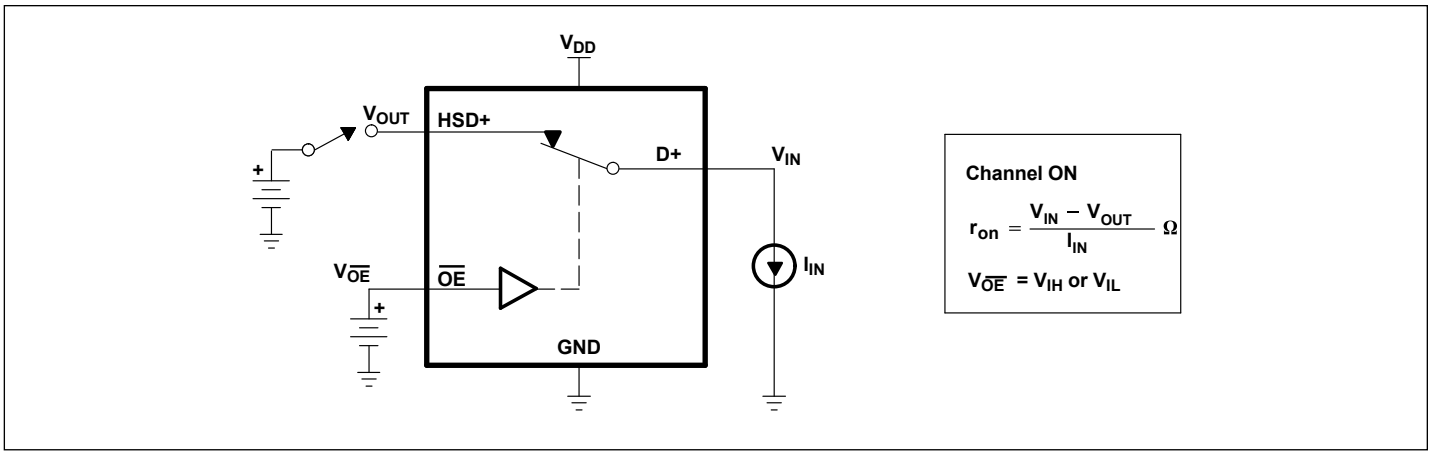



**Figure 6. ON-State Resistance ($r_{on}$)**

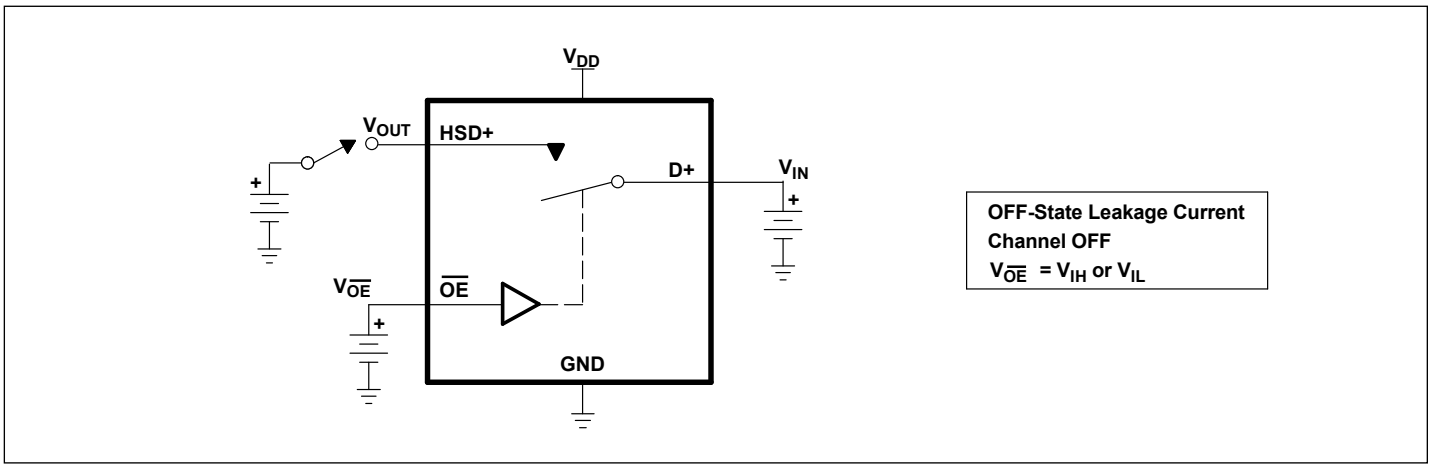



**Figure 7. OFF-State Leakage Current**

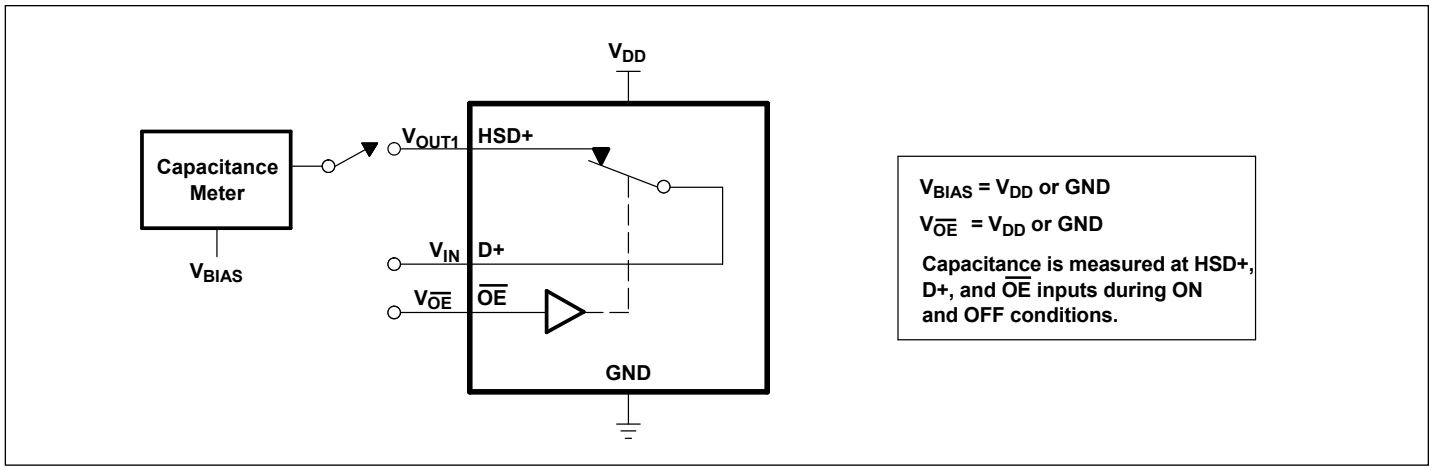



**Figure 8. Capacitance**

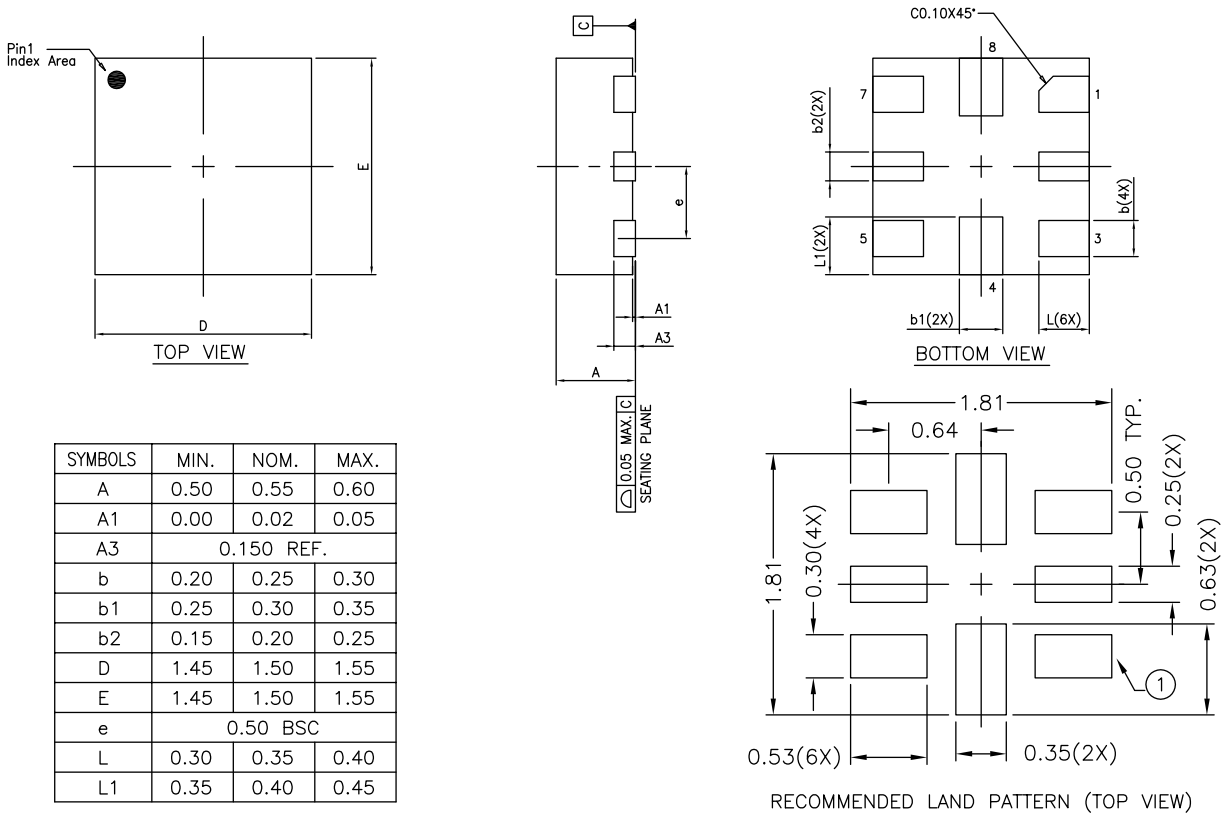
## Part Marking

$\overline{D}$G
XY

DG: Top Mark
XY: Date Code per MA-1251

## Packaging Mechanical:

8-UQFN1515-8 (ZUA)




| SYMBOLS | MIN. | NOM. | MAX. |
|---|---|---|---|
| A | 0.50 | 0.55 | 0.60 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | | 0.150 REF. | |
| b | 0.20 | 0.25 | 0.30 |
| b1 | 0.25 | 0.30 | 0.35 |
| b2 | 0.15 | 0.20 | 0.25 |
| D | 1.45 | 1.50 | 1.55 |
| E | 1.45 | 1.50 | 1.55 |
| e | | 0.50 BSC | |
| L | 0.30 | 0.35 | 0.40 |
| L1 | 0.35 | 0.40 | 0.45 |

**NOTE :**
**1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES**
**2. REFER JEDEC MO-288**
**3. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.**

**DATE: 07/23/20**

**DESCRIPTION: 8-contact, U-QFN1515-8**

**PACKAGE CODE: ZUA (ZUA8)**

**DOCUMENT CONTROL #: PD-2260** **REVISION: –**

**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 |
|---|---|---|---|
| PI3USB31ZUAEX | ZUA | 8-contact (U-QFN1515-8) | DG |

**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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