

## PI3CSW12

### High-Speed I3C 1:2 Multiplexer/DeMultiplexer Switch with Signal Enable

#### Features

- V<sub>DD</sub> Operation at 2.5V and 3.3V
- V<sub>I/O</sub> Accepts Signals up to 5.5V
- 1.8-V Compatible Control-Pin Inputs
- Low-Power Mode When  $\overline{\text{OE}}$  Is Disabled (2μA)
- r<sub>ON</sub> = 6Ω Maximum
- Δr<sub>ON</sub> = 0.2Ω Typical
- C<sub>io(on)</sub> = 4pF Typical
- Support Over Voltage Protection
- Low Power Consumption (50μA Maximum)
- ESD Performance
  - IO Pins
  - 12KV HBM
  - 1KV CDM
  - +/-8KV contact Discharge (IEC61000-4-2)
  - VDD, GND, S,  $\overline{\text{OE}}$  Pins
  - 4KV HBM
  - 1KV CDM
- High Bandwidth (1.6GHz 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.
- Packaging (Pb-free & Green):
  - 10-contact, UQFN (ZUA10)

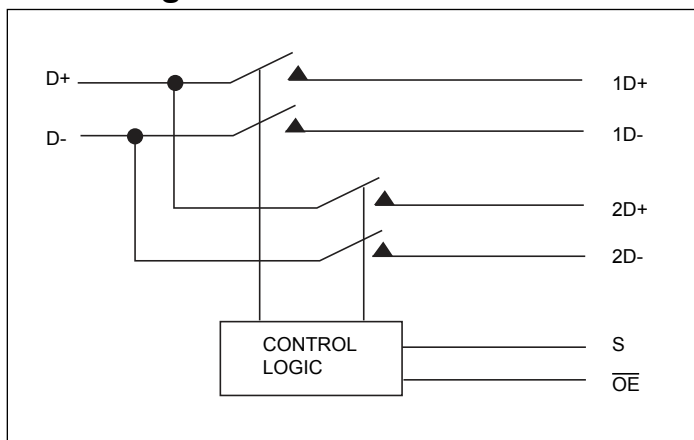
#### Applications

- Routes Signals for I3C
- Mobile Industry Processor Interface (MIPI) Signal Routing

#### Description

The PI3CSW12 is a high-bandwidth switch specially designed for the switching of high-speed I3C signals in communication and server applications, such as servers, workstations, and notebooks with hubs or controllers with limited I3C I/Os. The wide bandwidth (1.6GHz) of this switch allows signals to pass with minimum edge and phase distortion. The device multiplexes differential outputs from a I3C 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 I3C (up to 30Mbps).

#### Block Diagram



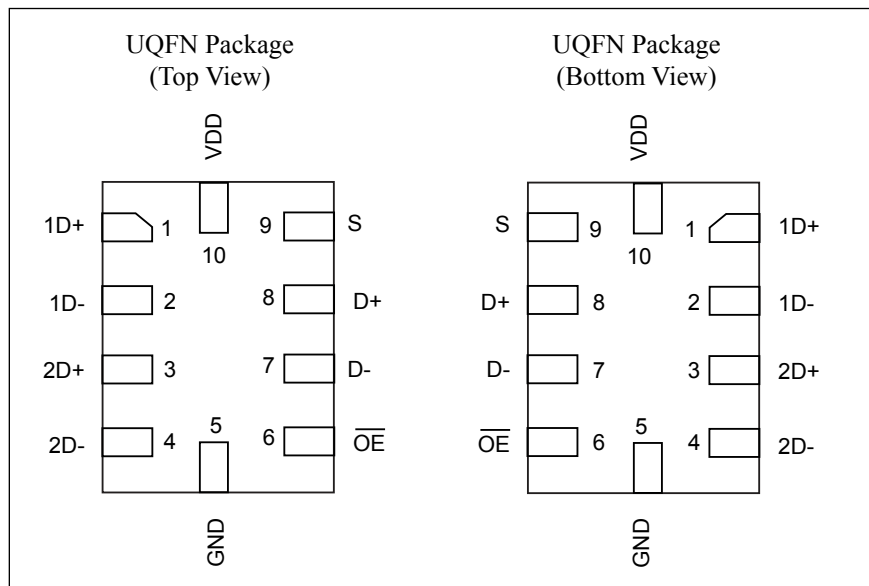
#### Truth Table

| S | $\overline{\text{OE}}$ | 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



## Pin Description

| Name            | Description                               |
|-----------------|-------------------------------------------|
| $\overline{OE}$ | Active LOW, Output enable                 |
| S               | Select input                              |
| D               | COM port                                  |
| nD              | I/O for I3C data path (port 1 and port 2) |

## 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/OK</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:

- 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.
- All voltages are with respect to ground, unless otherwise specified.
- The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- VI and VO are used to denote specific conditions for VI/O.
- II and IO are used to denote specific conditions for II/O.
- 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> = 2.3V to 2.7V | 1.3  | -    |      |
|                  |                                  | V <sub>DD</sub> = 2.7V to 3.6V | 1.4  | -    |      |
| V <sub>IL</sub>  | Low-level control input voltage  | V <sub>DD</sub> = 2.3V to 2.7V |      | 0.6  |      |
|                  |                                  | V <sub>DD</sub> = 2.7V to 3.6V |      | 0.6  |      |
| V <sub>I/O</sub> | Data input/output voltage        |                                | 0    | 4.6  | °C   |
| T <sub>A</sub>   | Operating free-air temperature   |                                | –40  | 85   |      |

### Note:

- All unused control inputs of the device must be held at V<sub>DD</sub> 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 <sub>IK</sub>                  |                | V <sub>DD</sub> = 3.6V, 2.7V, I <sub>I</sub> = -18 mA                                                                                |                                                              |      |      | -1.2 | V    |
| I <sub>IN</sub>                  | Control Inputs | V <sub>DD</sub> = 3.6V, 2.7V, 0V, V <sub>IN</sub> = 0V to 3.6V                                                                       |                                                              |      |      | ±1   | μA   |
| I <sub>OZ</sub> <sup>(3)</sup>   |                | V <sub>DD</sub> = 3.6V, 2.7V, V <sub>IN</sub> = V <sub>DD</sub> or GND, V <sub>O</sub> = 0V to 3.6V, V <sub>I</sub> = 0V, Switch OFF |                                                              |      |      | ±1   |      |
| I <sub>(OFF)</sub>               |                | V <sub>DD</sub> = 0V                                                                                                                 | V <sub>I/O</sub> = 0V to 3.6V                                |      |      | ±2   |      |
|                                  |                |                                                                                                                                      | V <sub>I/O</sub> = 0 to 2.7V                                 |      |      | ±1   |      |
| I <sub>CC</sub>                  |                | V <sub>DD</sub> = 3.6V, 2.7V, V <sub>IN</sub> = V <sub>DD</sub> or GND, I <sub>I/O</sub> = 0 V, Switch ON or OFF                     |                                                              |      | 25   | 50   |      |
| I <sub>CC</sub> (low power mode) |                | V <sub>DD</sub> = 3.6V, 2.7V, V <sub>IN</sub> = V <sub>DD</sub> or GND, Switch disabled, (OE in high state)                          |                                                              |      |      | 4    |      |
| DI <sub>CC</sub> <sup>(4)</sup>  | Control Inputs |                                                                                                                                      | V <sub>DD</sub> = 2.7V, S sweeps from 1.4V to 3.3V, OE/ = 0V |      |      | 15   |      |
|                                  |                |                                                                                                                                      | V <sub>DD</sub> = 2.7V, OE/ sweeps from 1.4V to 3.3V, S = 0V |      |      | 0.75 |      |
| C <sub>IN</sub>                  | Control Inputs | V <sub>DD</sub> = 3.3V, 2.5V, V <sub>IN</sub> = 3.3V or 0V                                                                           |                                                              |      | 1    | 2    | pF   |
| C <sub>io(OFF)</sub>             |                | V <sub>DD</sub> = 3.3V, 2.5V, V <sub>IN</sub> = 3.3V or 0V, Switch OFF                                                               |                                                              |      | 2    | 3    |      |
| C <sub>io(ON)</sub>              |                | V <sub>DD</sub> = 3.3V, 2.5V, V <sub>IN</sub> = 3.3V or 0V, Switch ON                                                                |                                                              |      | 4    |      |      |
| r <sub>ON</sub> <sup>(5)</sup>   |                | V <sub>DD</sub> = 3V, 2.3V                                                                                                           | V <sub>I</sub> = 0V, I <sub>O</sub> = 30mA                   |      |      | 4    | Ω    |
|                                  |                |                                                                                                                                      | V <sub>I</sub> = 2.4V, I <sub>O</sub> = -15mA                |      |      | 6    |      |
| Dr <sub>ON</sub> <sup>(6)</sup>  |                | V <sub>DD</sub> = 3V, 2.3V                                                                                                           | V <sub>I</sub> = 0V, I <sub>O</sub> = 30mA                   |      | 0.2  |      |      |
|                                  |                |                                                                                                                                      | V <sub>I</sub> = 1.7V, I <sub>O</sub> = -15mA                |      | 0.2  |      |      |
| r <sub>ON(flat)</sub>            |                | V <sub>DD</sub> = 3V, 2.3V                                                                                                           | V <sub>I</sub> = 0V, I <sub>O</sub> = 30mA                   |      | 1    |      |      |
|                                  |                |                                                                                                                                      | V <sub>I</sub> = 1.7V, I <sub>O</sub> = -15mA                |      | 1    |      |      |
| V <sub>pass</sub>                |                | V <sub>DD</sub> = 2.5 - 3.3V                                                                                                         | V <sub>IN</sub> > 3.8V, I <sub>O</sub> = 10uA                | 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  $V_{DD} = 3.3\text{ V}$  (unless otherwise noted),  $T_A = 25^\circ C$ .
- For I/O ports, the parameter  $I_{OZ}$  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.
- $Dr_{ON}$  is delta  $R_{ON}$  between channels

## Dynamic Electrical Characteristics

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

| Symbol            | Parameter         | Test Conditions                      | Typ. <sup>(1)</sup> | Unit |
|-------------------|-------------------|--------------------------------------|---------------------|------|
| X <sub>TALK</sub> | Crosstalk         | $R_L = 50\Omega, f = 250\text{ MHz}$ | -40                 | dB   |
|                   |                   | $R_L = 50\Omega, f = 50\text{ MHz}$  | -55                 |      |
| O <sub>IRR</sub>  | OFF isolation     | $R_L = 50\Omega, f = 250\text{ MHz}$ | -41                 |      |
| BW                | Bandwidth (-3 dB) | $R_L = 50\Omega$                     | 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,  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ ,  $V_{DD} = 3.3\text{ V} \pm 10\%$ ,  $\text{GND} = 0\text{V}$

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

### Notes:

- For Max or Min conditions, use the appropriate value specified under Electrical Characteristics for the applicable device type.
- Specified by design
- The switch contributes no propagation 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 propagation delay to the system. Propagation 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

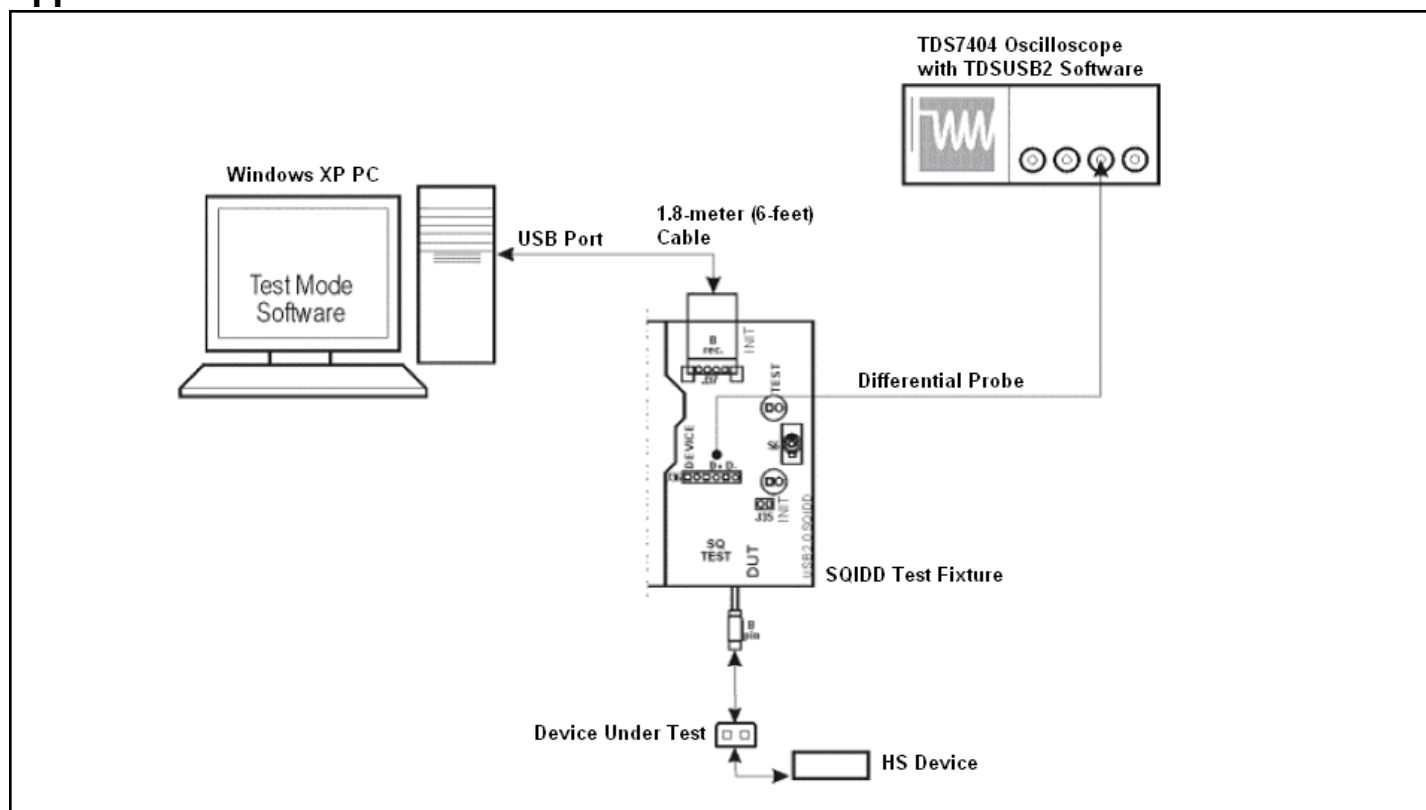
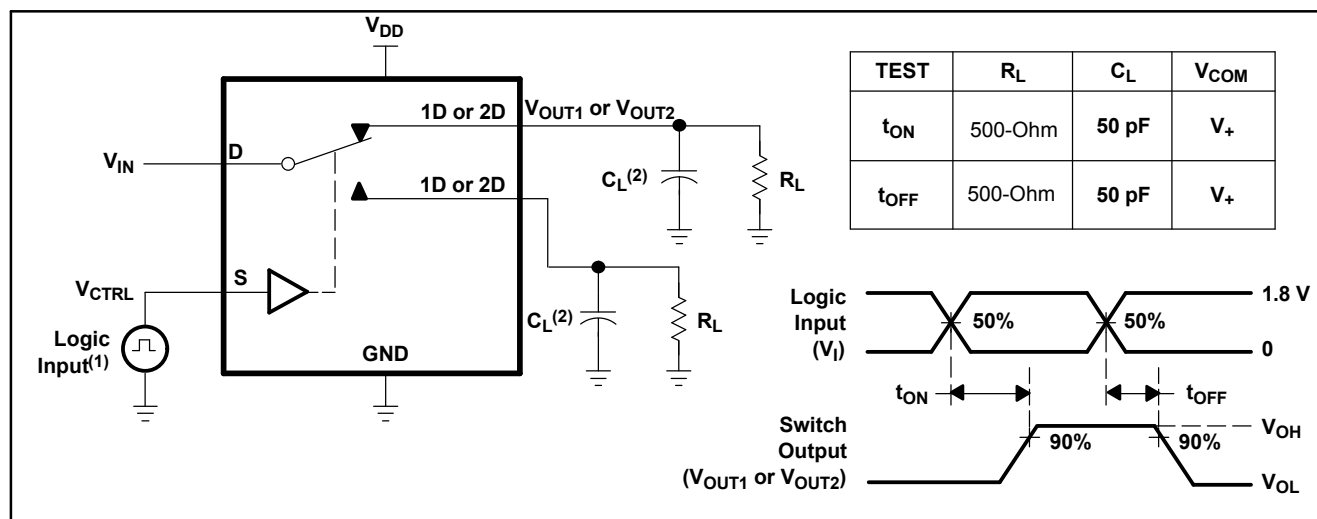


Figure 1: HS Eye Test Setup

## Parameter Measurement Information



(1) All input pulses are supplied by generators having the following characteristics: PRR  $\leq$  10 MHz,  $Z_O = 50\text{-}\Omega$ ,  $t_r < 5\text{ ns}$ ,  $t_f < 5\text{ ns}$ .

(2)  $C_L$  includes probe and jig capacitance.

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

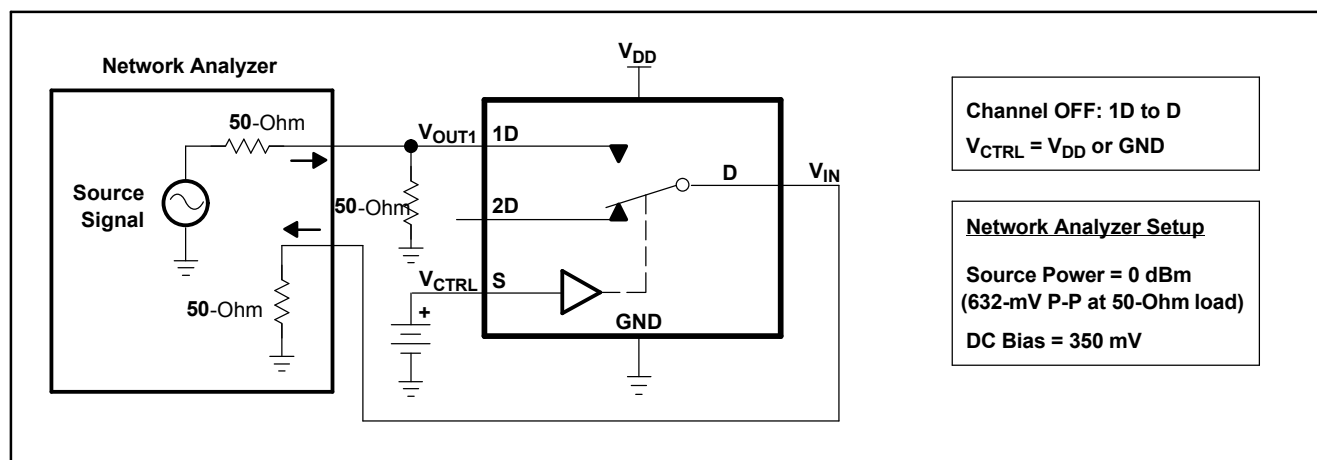
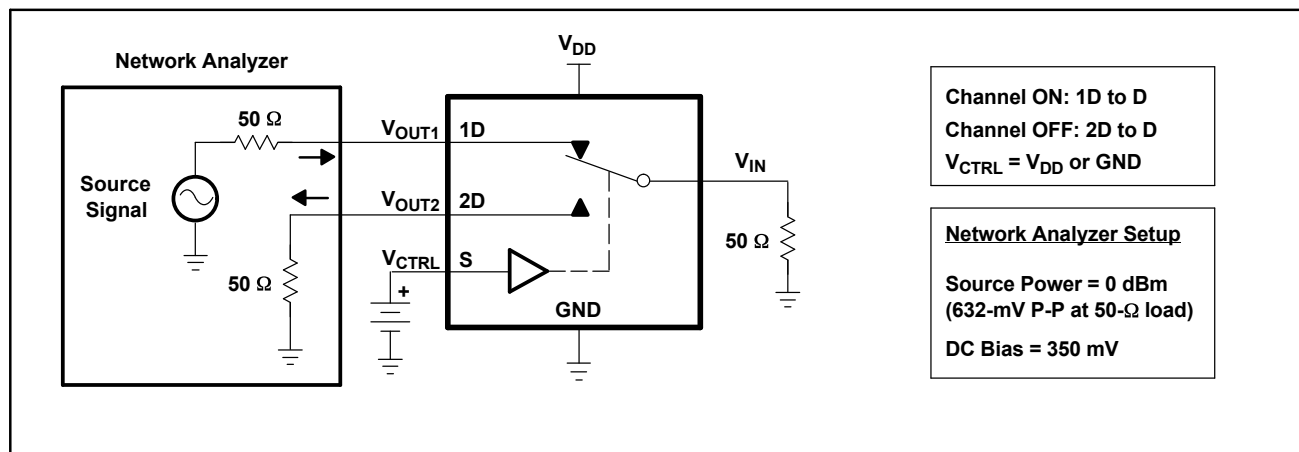
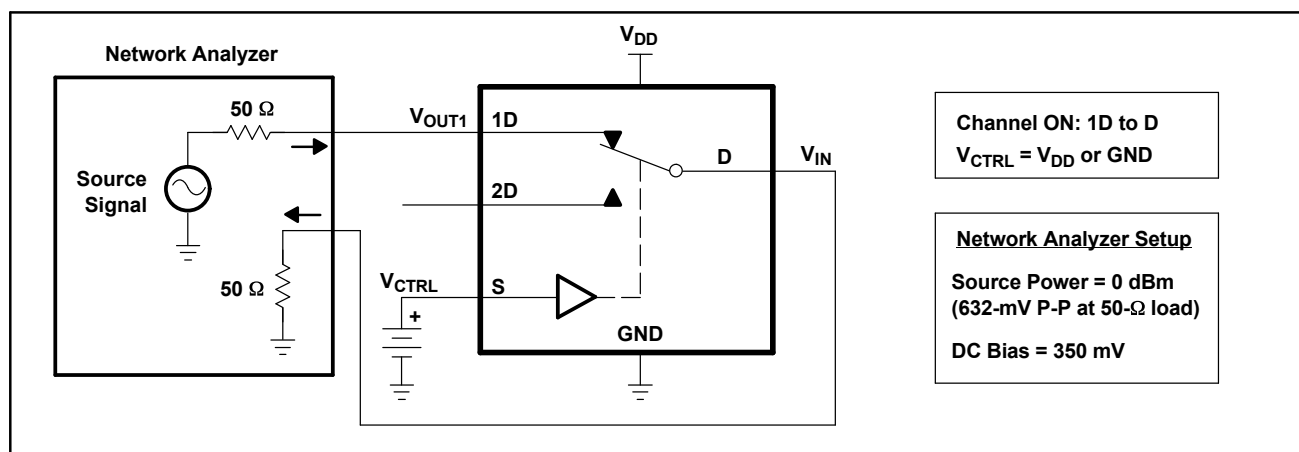


Figure 3. OFF Isolation ( $O_{ISO}$ )

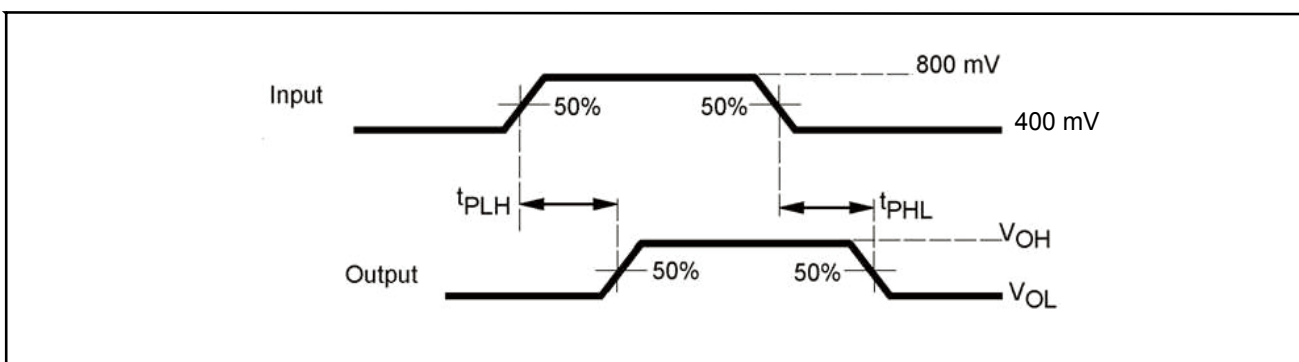
**PI3CSW12**



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



**Figure 5. Bandwidth (BW)**



**Figure 6. Propagation Delay**

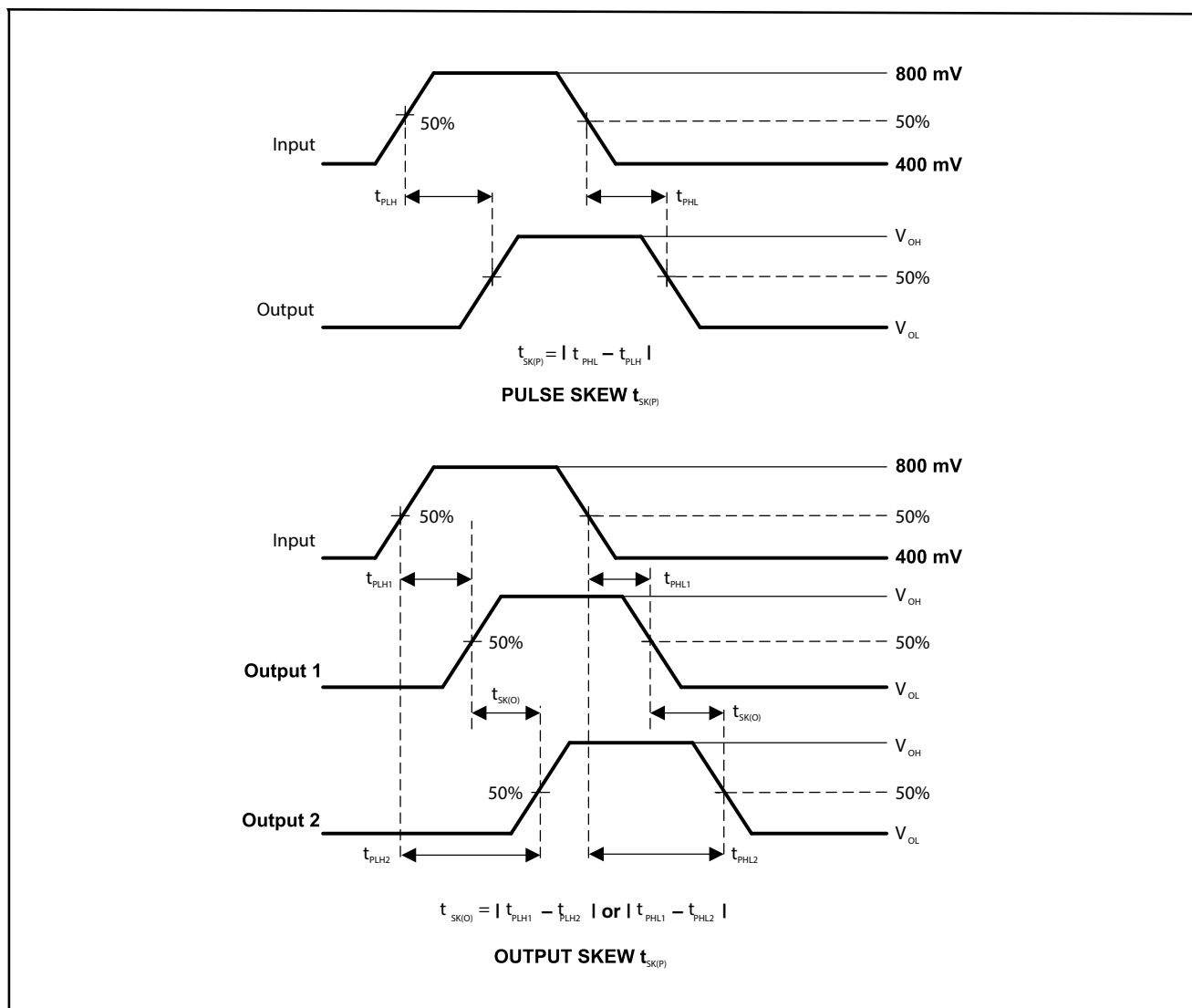


Figure 7. Skew Test

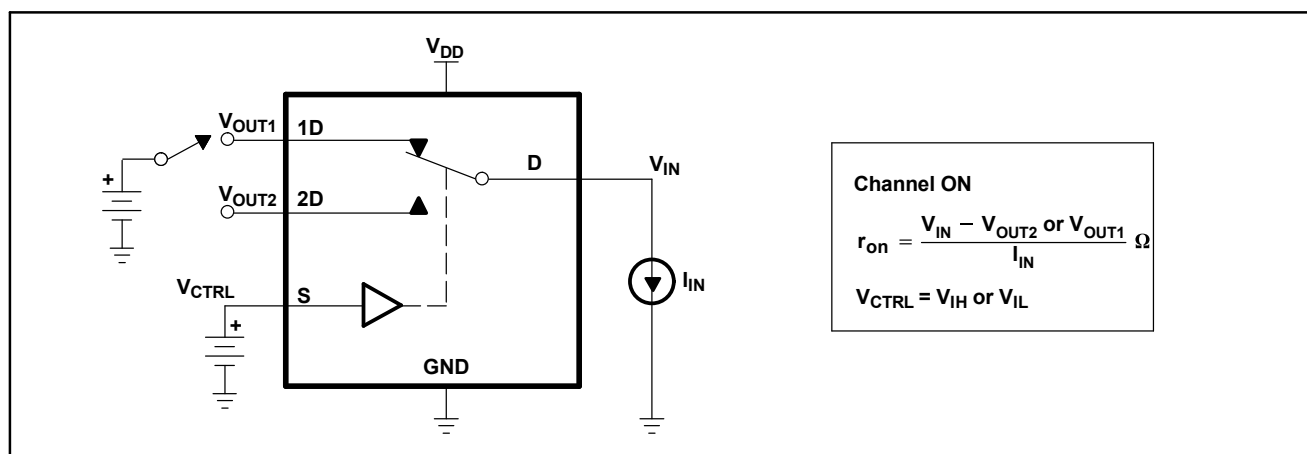


Figure 8. ON-State Resistance ( $r_{on}$ )

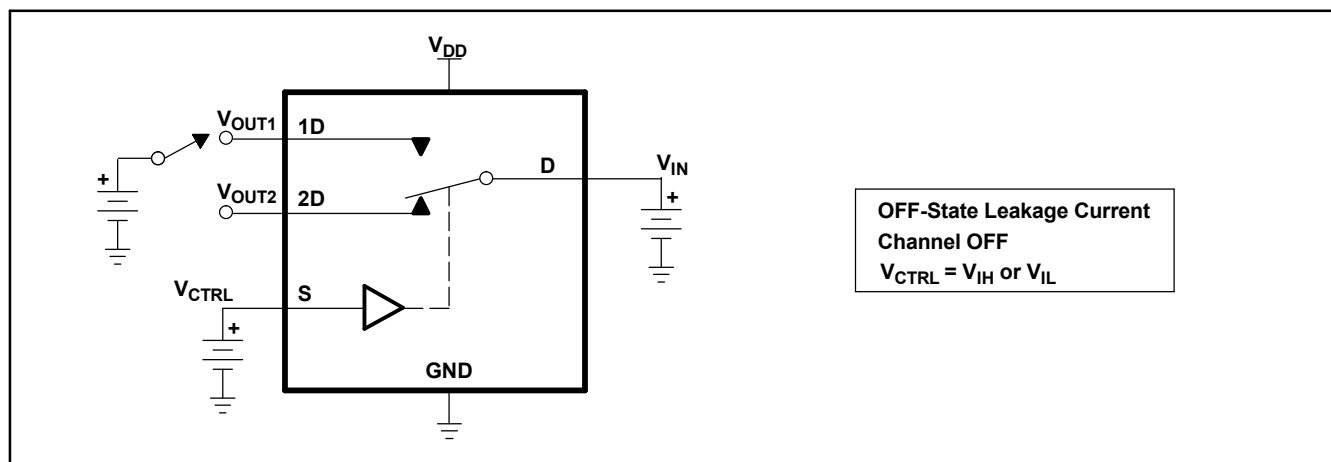


Figure 9. OFF-State Leakage Current

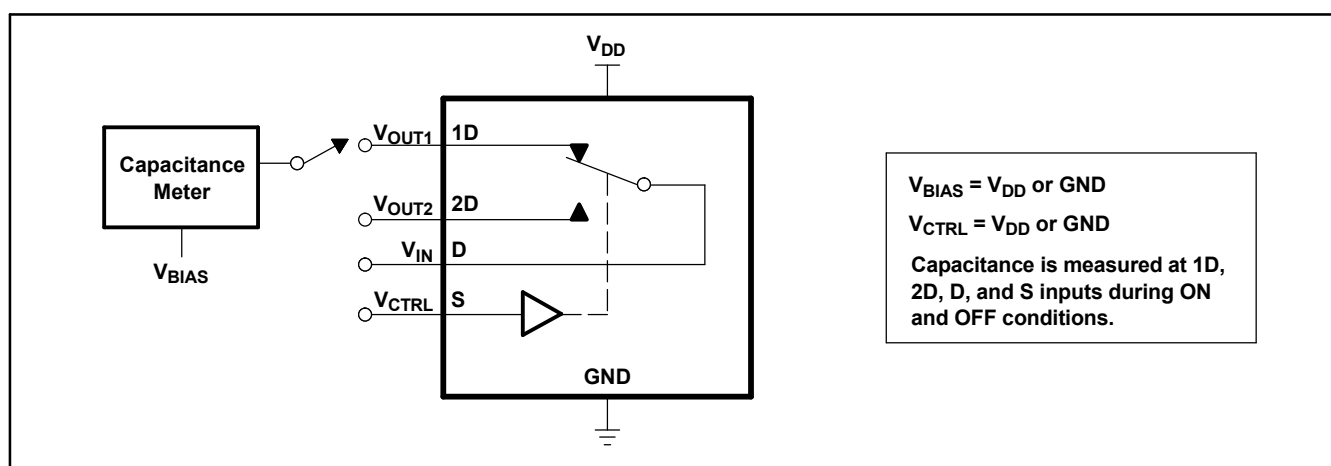
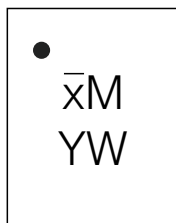


Figure 10. Capacitance

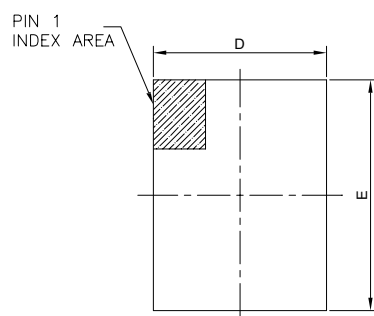
## Part Marking



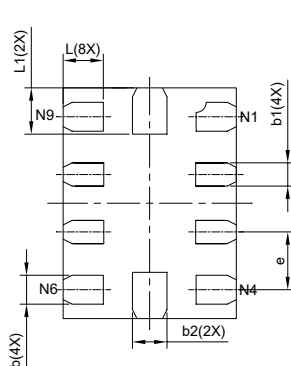
xM: PI3CSW12ZUAE

Y: Date Code (Year)

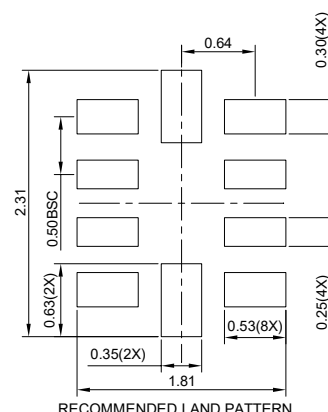
W: Date Code (Workweek)

**PI3CSW12**
**Packaging Mechanical: 10-UQFN (ZUA)**


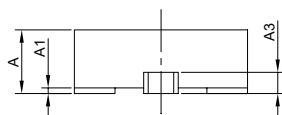
TOP VIEW



BOTTOM VIEW



| PKG DIMENSIONS |          |      |      |
|----------------|----------|------|------|
| SYMBOL         | MIM      | NOM  | MAX  |
| A              | 0.50     | ---  | 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 |



SIDE VIEW

**Notes:**

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

DATE: 07/13/20

**DESCRIPTION: 10-Pin, UQFN, 1.5X2.0 (U-QFN1520-10)**
**PACKAGE CODE: ZUA(ZUA10)**
**DOCUMENT CONTROL#: PD-2220**
**REVISION: A**
**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                    |
|-----------------|--------------|----------------------------------------|
| PI3CSW12ZUAEX   | ZUA          | 10-Pin, 1.5x2.0 (UQFN) (U-QFN 1520-10) |

**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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