PI3USB3000

High Speed USB 2.0 1:2 Mux/DeMux

Features

- Differential Bidirectional 2:1 Mux/DeMux
- Wide Input Voltage Range: 0 to 3.6V
- Mobile Hi-Definition Link (MHL) Switch:
  - Bandwidth (-3dB): 5.3GHz
  - R_{ON} (Typical): 5.7Ω
  - C_{ON} (Typical): 1.5pF @ 240MHz
- USB Switch:
  - Bandwidth (-3dB): 5.5GHz
  - R_{ON} (Typical): 4.6Ω
  - C_{ON} (Typical): 1.5pF @ 240MHz
- Low Propagation Delay, 0.1ns typ
- Low Off-Isolation: -34dB @ 240MHz
- Low Crosstalk: -37dB @ 240MHz
- Low Power Consumption: 35µA typical
- Wide Supply Voltage: 1.8V to 5.5V
- Supports 1.8V Logic on Control Pins
- Protection Feature
  - Power-off protection for minimizing current leakage in power-down mode
  - Connector pins are high voltage tolerated
    - D± tolerance to 9V
  - Overvoltage protection at D±
- Wide Temperature Range: -40°C to 85°C
- 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, UQFN (ZUA), 1.5x2mm, 0.5mm(H), 0.6mm pitch

Description

The PI3USB3000 is a 2-to-1 differential channel multiplexer/de-multiplexer switch. The D± pins can tolerate voltages up to 9V. Overvoltage protection (OVP) is implemented at 4.75V to immediately switch off the channels when an overvoltage condition is detected. The PI3USB3000 can pass USB 2.0 and MHL signals with a bandwidth of 5.5GHz to provide excellent signal integrity and eye diagram opening.

Applications

- Smart Phones
- USB-C® Applications
- Tablets
- NBs
- PCs

Block Diagram
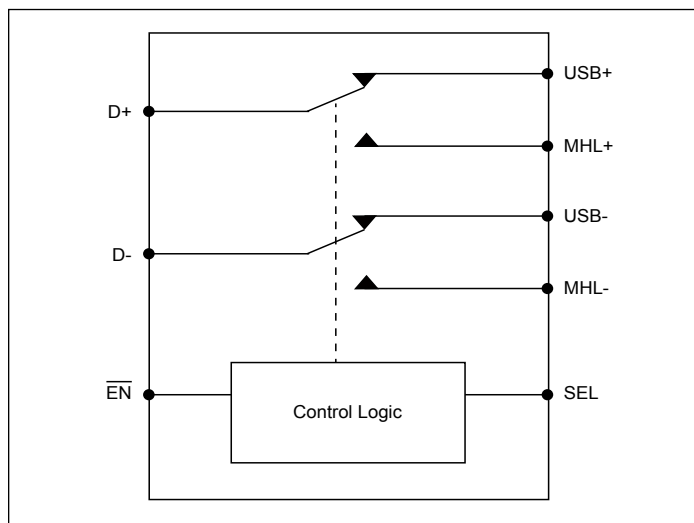
USB Type-C is a registered trademark of USB Implementers Forum.

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

Top View
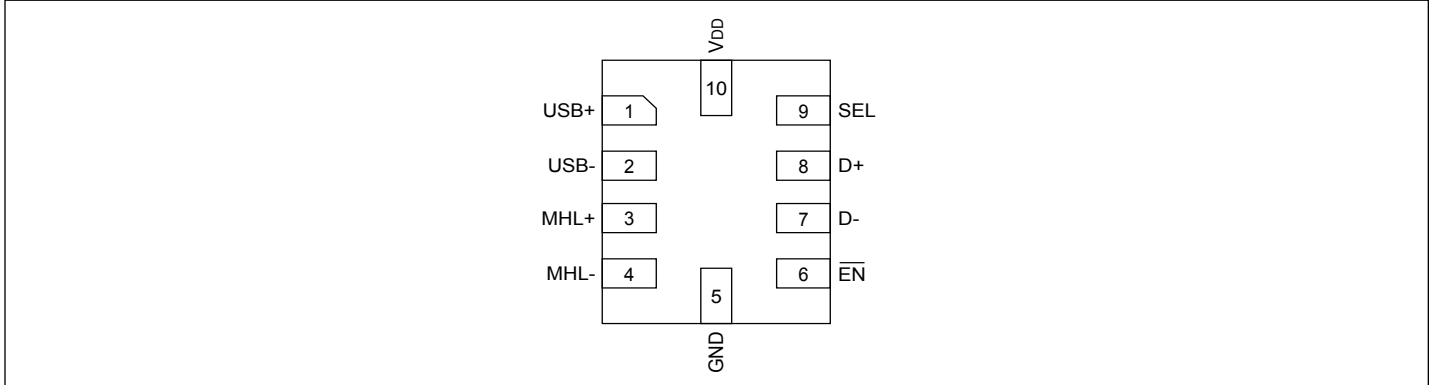
Pin Description

Pin#	Pin Name	Signal Type	Description
8, 7	D+, D−	I/O	Signal I/O, Common Port
3, 4	MHL+, MHL−	I/O	Signal I/O, MHL Channel
1, 2	USB+, USB−	I/O	Signal I/O, USB Channel
9	SEL	I	Operation Mode Select (when SEL = L: D± → USB±, when SEL = H: D± → MHL±)
10	V_{DD}	PWR	Positive Supply Voltage
5	GND	PWR	Power Ground
6	$\overline{EN}$	I	$\overline{EN}$ = 1, Chip is Power Down. $\overline{EN}$ = 0, Chip is Enabled, Please refer to Truth Table.

Truth Table

Function	SEL
D+/- to USB+/-	L
D+/- to MHL+/-	H

PI3USB3000 Application in MHL Switching and provide overvoltage protection for D+/- when high voltage charging
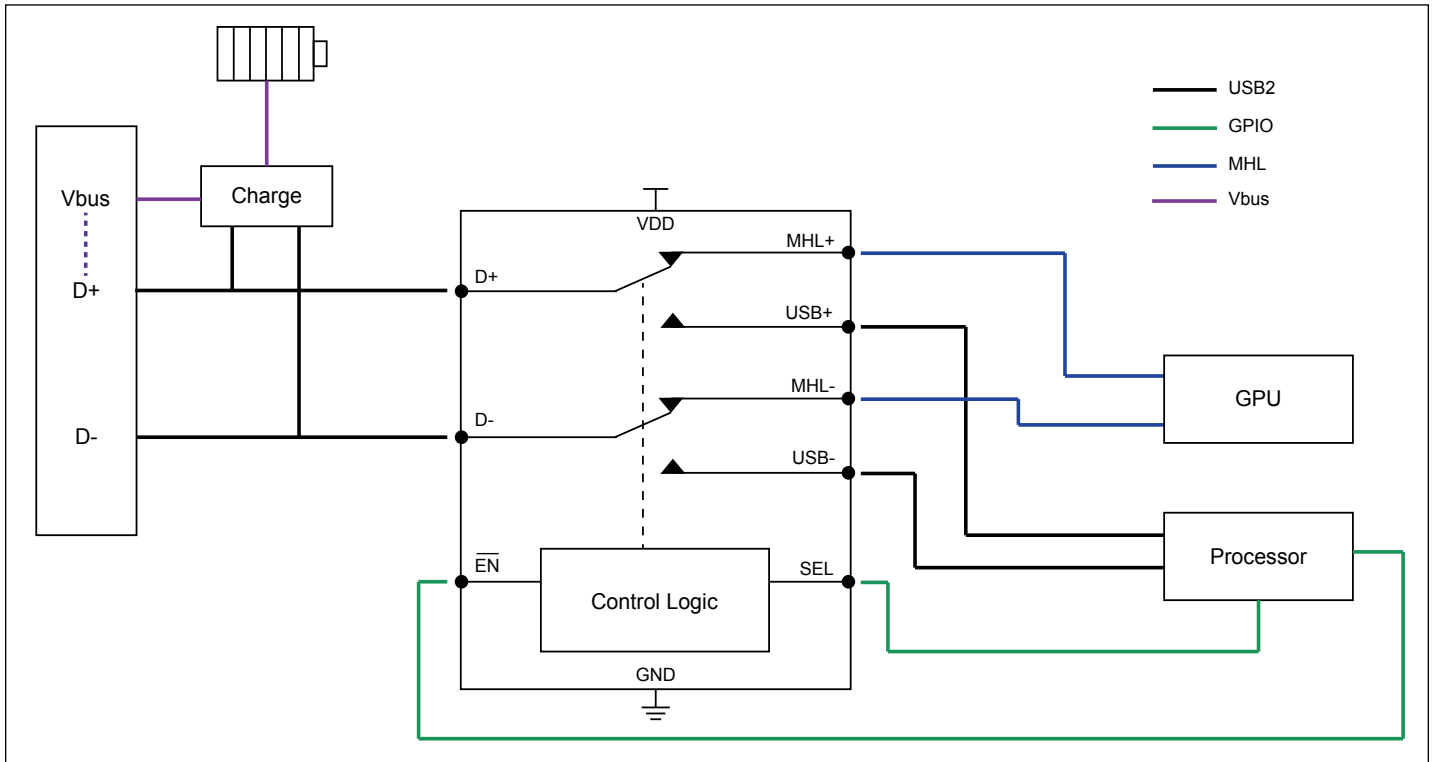
Maximum Ratings

(Above which useful life may be impaired. For user guidelines, not tested.)

Storage Temperature	−65°C to +150°C
Supply Voltage (VDD) to Ground Potential	−0.3V to +6V
Channel Input/Output Voltage (USB±/MHL±)	−0.3V to +5V
Channel Input/Output Voltage (D±)	−0.3V to +9V
Control Pins Input Voltage ($\overline{\text{EN}}$/SEL)	−0.3V to +6V
ESD (All Pins)...	2KV (HBM) and 1KV (CDM)
Channel Input/Output Current (D±→USB±, D±→MHL±)..........	±20mA
Junction Temperature	125°C

Note:
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.

Recommended Operating Conditions

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
V_{DD}	Power Supply		1.8	3.3	5.5	V
$V_{I/O}$	Analog Voltage Range		0		3.6	V
V_I	Voltage Range for Control Pins		0		5.5	V
I_{DD}	Current Consumption in Normal Operation	V_{IO} =0V, SEL = GND or V_{DD}, chip enabled		35	55	μA
I_{DD_OVP}	Current Consumption in OVP	$V_{D\pm}$ = 5.5V, SEL = GND or V_{DD}, chip enabled		35		μA
I_{DDQ}	Chip Disabled Current Consumption	V_{IO} = 0V, SEL = GND or V_{DD}, $\overline{\text{EN}}$ = High		1	2	μA
T_A	Operating Temperature Range		-40		85	°C

DC Electrical Characteristics for Switching over Operating Range

(T_A = -40°C to 85°C, Typical values are at V_{DD} = 3.3V, T_A = 25°C, $\overline{\text{EN}}$=0V (unless otherwise noted))

Parameter	Description	Test Conditions		Min.	Typ.	Max.	Units
Control Pins – $\overline{\text{EN}}$/SEL							
V_{IH} - cntrl signals	Input HIGH Voltage for SEL and $\overline{\text{EN}}$	V_{DD} = 1.8 - 5.5V		1.3			V
V_{IL} - cntrl signals	Input LOW Voltage for SEL and $\overline{\text{EN}}$	V_{DD} = 1.8 - 5.5V				0.6	V
I_{IH}	Input HIGH Current for SEL and $\overline{\text{EN}}$	V_I = 5.5V		-1		1	μA
I_{IL}	Input LOW Current for SEL and $\overline{\text{EN}}$	V_I = 0V		-1		1	μA
Over Voltage Protection							
$V_{OVP\_D\pm}$	D± OVP Trigger Voltage			4.6	4.75	5.0	V
MHL Switch							
R_{ON}	ON-state Resistance	V_{DD} = 2.7V	$V_{I/O}$ = 1.65V, I_{ON} = -8mA		5.7	9	Ω
		V_{DD} = 1.8V	$V_{I/O}$ = 1.65V, I_{ON} = -8mA		5.7	9.5	

DC Electrical Characteristics for Switching over Operating Range Cont.

Parameter	Description	Test Conditions		Min.	Typ.	Max.	Units
ΔR_{ON}	ON-state Resistance match between + and - paths	$V_{DD} = 1.8V$	$V_{I/O} = 1.65V$, $I_{ON} = -8mA$		0.1		Ω
$R_{ON(FLAT)}$	ON-state Resistance Flatness	$V_{DD} = 1.8V$	$V_{I/O} = 1.65V$ to 3.45V, $I_{ON} = -8mA$		1		Ω
I_{OZ}	OFF Leakage Current	$V_{DD} = 4.8V$	Switch OFF, $V_{MHL\pm} = 1.65V$ to 3.45V, $V_{D\pm} = 0V$	-2		2	μA
I_{OFF}	Power-off Leakage Current	$V_{DD} = 0V$	Switch ON or OFF, $V_{MHL\pm} = 1.65V$ to 3.45V, $V_{D\pm} = NC$	-10		10	μA
I_{ON}	ON Leakage Current	$V_{DD} = 4.8V$	Switch ON, $V_{MHL\pm} = 1.65V$ to 3.45V, $V_{D\pm} = NC$	-2		2	μA
		$V_{DD} = 1.8V$	Switch ON, $V_{MHL\pm} = 1.65V$ to 3.45V, $V_{D\pm} = NC$	-125		125	

USB Switch

Parameter	Description	Test Conditions		Min.	Typ.	Max.	Units
R_{ON}	ON-state Resistance	$V_{DD} = 1.8V$	$V_{I/O} = 0.4V$, $I_{ON} = -8mA$		4.6	7.5	Ω
ΔR_{ON}	ON-state Resistance match between + and - paths	$V_{DD} = 1.8V$	$V_{I/O} = 0.4V$, $I_{ON} = -8mA$		0.1		Ω
$R_{ON(FLAT)}$	ON-state Resistance Flatness	$V_{DD} = 1.8V$	$V_{I/O} = 0V$ or 0.4V, $I_{ON} = -8mA$		1		Ω
I_{OZ}	OFF Leakage Current	$V_{DD} = 4.8V$	Switch OFF, $V_{USB\pm} = 0V$ to 3.6V, $V_{D\pm} = 0V$	-2		2	μA
I_{OFF}	Power-off Leakage Current	$V_{DD} = 0V$	Switch ON or OFF, $V_{USB\pm} = 0V$ to 3.6V, $V_{D\pm} = NC$	-10		10	μA
I_{ON}	ON Leakage Current	$V_{DD} = 4.8V$	Switch ON, $V_{USB\pm} = 0V$ to 3.6V, $V_{D\pm} = NC$	-2		2	μA
		$V_{DD} = 1.8V$	Switch ON, $V_{USB\pm} = 0V$ to 3.6V, $V_{D\pm} = NC$	-125		125	

Dynamic Electrical Characteristics

($T_A = -40°C$ to $85°C$, Typical values are at $V_{DD} = 3.3V$, $T_A = 25°C$, (unless otherwise noted))

Parameter	Description	Test Conditions		Min.	Typ.	Max.	Units
$C_{ON(MHL)}$	MHL path ON Capacitance	Switch ON	$V_{DD} = 3.3V$, $V_{I/O} = 0$ or 3.3V, $f = 240MHz$		1.5	2	pF
$C_{ON(USB)}$	USB path ON Capacitance	Switch ON	$V_{DD} = 3.3V$, $V_{I/O} = 0$ or 3.3V, $f = 240MHz$		1.5	2	pF
$C_{OFF(MHL)}$	MHL path OFF Capacitance	Switch OFF	$V_{DD} = 3.3V$, $V_{I/O} = 0$ or 3.3V, $f = 240MHz$		1.5	2	pF
$C_{OFF(USB)}$	USB path OFF Capacitance	Switch OFF	$V_{DD} = 3.3V$, $V_{I/O} = 0$ or 3.3V, $f = 240MHz$		1.5	2	pF
C_I	Digital Input Capacitance		$V_{DD} = 3.3V$, $V_I = 0$ or 2V		2.2		pF

Dynamic Electrical Characteristics Cont.

Parameter	Description	Test Conditions		Min.	Typ.	Max.	Units
O_{IOS}	OFF Isolation	Switch OFF	$R_L = 50\Omega$, f = 240MHz		-34		dB
X_{TALK}	Crosstalk	Switch ON	$R_L = 50\Omega$, f = 240MHz		-37		dB
$B_{W(MHL)}$	MHL path -3dB Bandwidth	Switch ON	$R_L = 50\Omega$		5.3		GHz
$B_{W(USB)}$	USB path -3dB Bandwidth	Switch ON	$R_L = 50\Omega$		5.5		GHz

Switching Characteristics[1]

(T_A = -40°C to 85°C, Typical values are at V_{DD} = 3.3V, T_A = 25°C, (unless otherwise noted))

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
t_{OVP}	OVP Response Time[1]	$R_{USB/MHL} = 600\Omega$, time from the voltage on D± = 4~6V to the voltage on USB/MHL± = 4.75V		0.5	1	µs
t_{PZH}, t_{PZL}	Line Enable Time (SEL to Output)	See Test Circuit for Electrical Characteristics			600	ns
t_{PHZ}, t_{PLZ}	Line Disable Time			50		ns
t_{Pd}	Propagation Delay			100		ps
t_{b-b}	Bit-to-bit Skew Within the Same Differential Pair[1]			8	20	ps
T_{on}	Device Enable Time			100		µs
T_{off}	Device Disable Time			50		ns

Note:
1. Guaranteed by design.
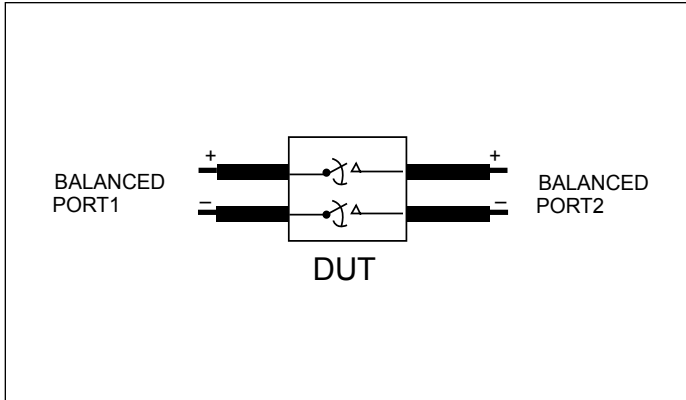
Figure 1. Differential Insertion Loss Setup
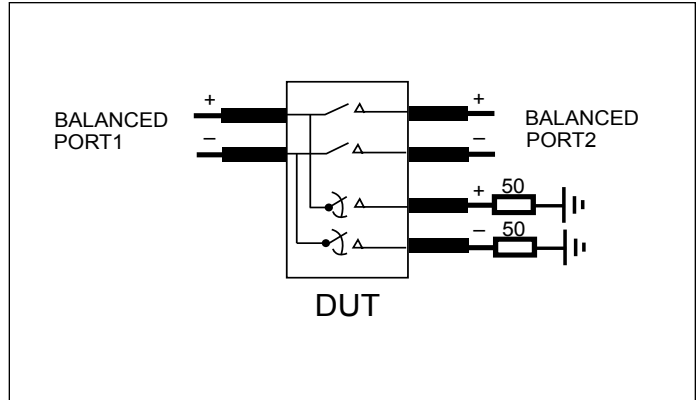
Figure 2. Off-isolation Setup
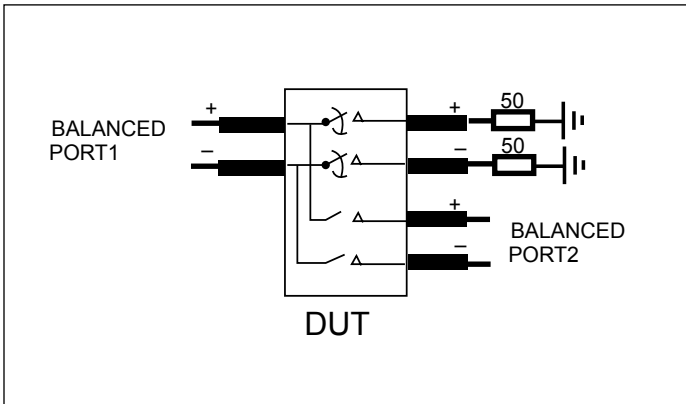
Figure 3. Crosstalk Setup
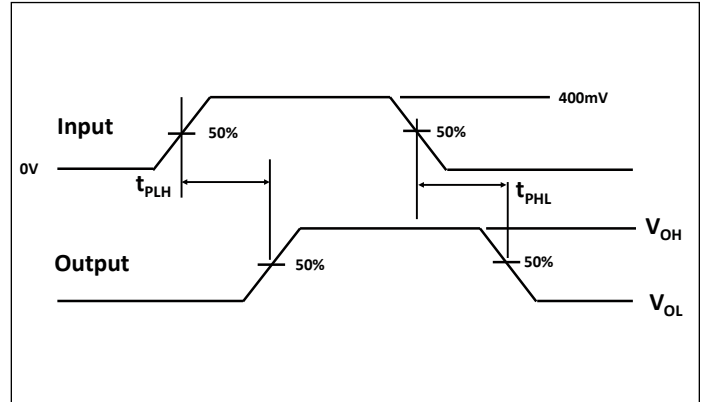
Figure 4. Propagation Delay
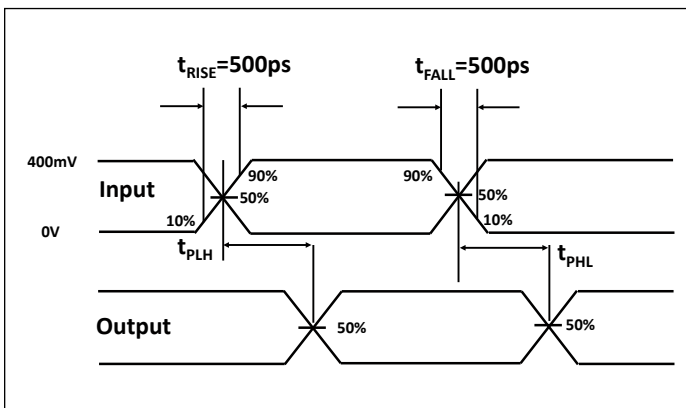
Figure 5. Skew Test

Switching Waveforms
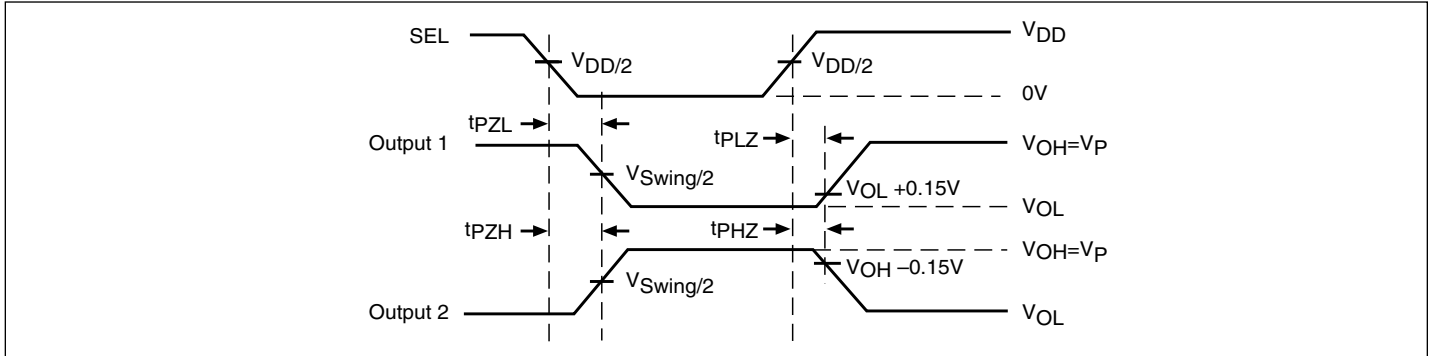
Voltage Waveforms Enable and Disable Times

Test Circuit for Propagation Delay

Part Marking

Y: Date Code (Year)
W: Date Code (Workweek)
Note: Date Code per MA-1251
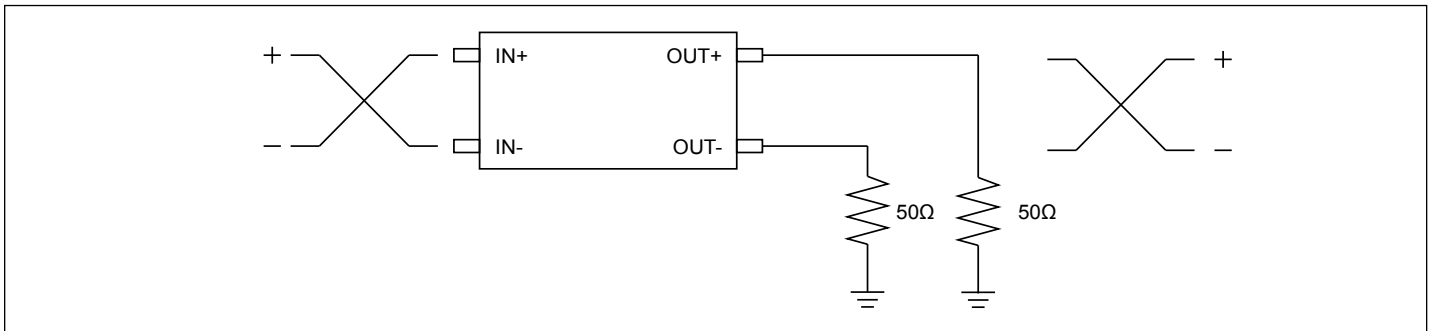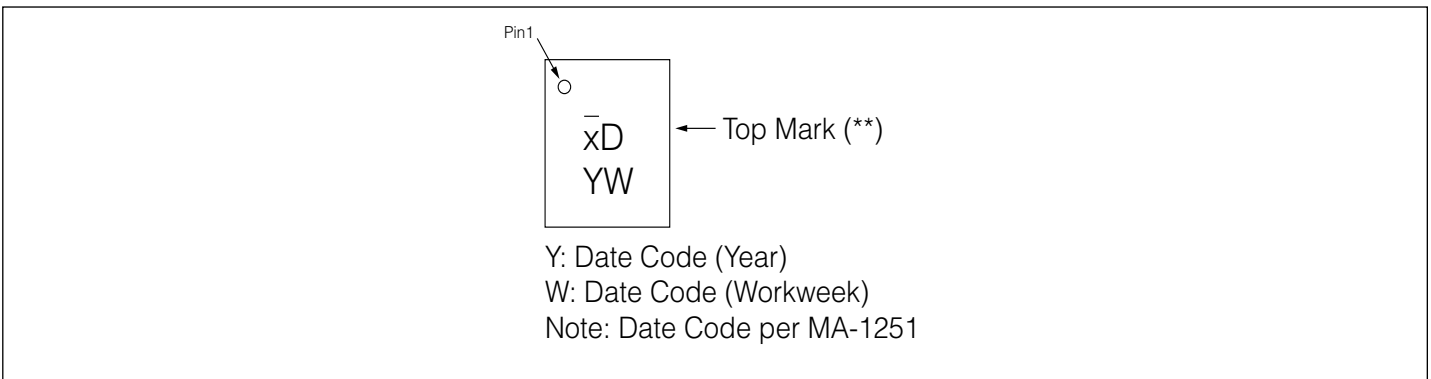
Packaging Mechanical

10-UQFN (ZUA)

PIN 1
INDEX AREA

D

E

TOP VIEW

L1(2X)   L(8X)

N9   N1   b1(4X)

N6   N4

b(4X)   b2(2X)   e

BOTTOM VIEW

0.64   0.30(4X)

2.31   0.50BSC

0.63(2X)   0.25(4X)

0.35(2X)   0.53(8X)

1.81

RECOMMENDED LAND PATTERN(unit:mm)

A1   A3

A

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

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
PI3USB3000ZUAEX	ZUA	10-Pin, 1.5x2.0 (UQFN)

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

IMPORTANT NOTICE