A Product Line of
Diodes Incorporated

PI3USB102J

USB 2.0 High-Speed (480Mbps) Switch with 5V Protection

Features

- USB 2.0 Compliant (High Speed, Full Speed, and Low Speed)
- R_{ON}: 2.0Ω typical @ V_{IN} < 0.5V
- Channel On Capacitance: 7.0pF (Max)
- Wide -3dB Bandwidth: 1600MHz
- Low Bit-to-Bit Skew
- Low Crosstalk: -29B @ 480Mbps
- Off Isolation: -28dB @ 480Mbps
- Near-Zero Propagation Delay: 250ps
- Support 1.8-V Logic on Control pins
- V_{DD} Operating Range: 3.0V to 3.6V
- Data pin I/O, ESD: 8kV HBM
- I/O Pins are Protected and can Tolerate a Short to VBUS
- Y+/Y- can Provide Overvoltage Protection to M/D Ports
- Low Supply Current: 30nA (Typ)
- Operating Temperature: -20°C to 100°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, X2QFN, 1.4mm × 1.2mm × 0.35mm (XUC)

Description

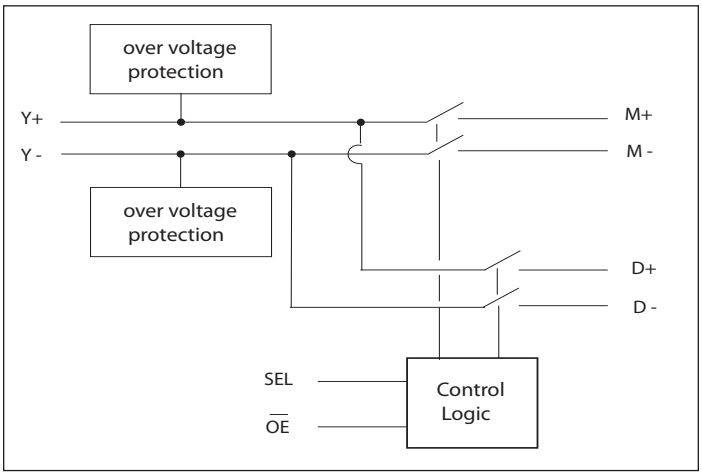
The PI3USB102J is a single differential channel 2:1 multiplexer/demultiplexer USB 2.0 switch. Industry leading advantages include a propagation delay of 250ps, which results from its low-channel resistance and I/O capacitance. PI3USB102J is bidirectional and offers very little attenuation of high-speed signals. It is designed for low bit-to-bit skew, high channel-to-channel noise isolation and is compatible with various standards, such as high-speed USB2.0 (480Mb/s).

The PI3USB102J offers overvoltage protection for the Y+/Y- pins as per the USB 2.0 specification. With the chip powered on or off and if Y+/Y- pins are shorted to VBUS (5V ±5%), a less than 3.6V signal transmits through M+/M- and D+/D- outputs after 300ns.

Applications

- Route Signals for USB2.0
- PC, Notebooks, and Handheld Devices

Block Diagram



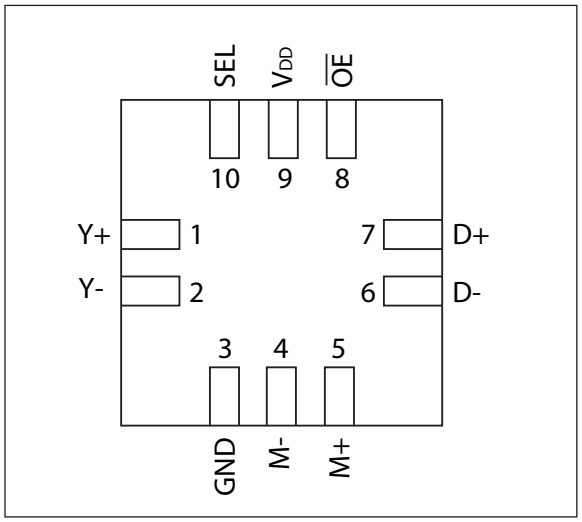
Notes:

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.

Truth Table

SEL	$\overline{OE}$	Y+	Y-
X	H	Hi-Z	Hi-Z
L	L	M+	M-
H	L	D+	D-

Pin Configuration



Pin Description

Pin #	Pin Name	Description
1	Y+	USB Data Bus
2	Y-	USB Data Bus
3	GND	Ground
4	M-	Multiplexed Source Inputs
5	M+	Multiplexed Source Inputs
6	D-	Multiplexed Source Inputs
7	D+	Multiplexed Source Inputs
8	$\overline{OE}$	Switch Enable
9	V_{DD}	Positive Power Supply
10	SEL	Switch Select

Maximum Ratings

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

Storage Temperature	–65°C to +150°C
Junction Temperature	125°C
Supply Voltage to Ground Potential	–0.5V to +4V
DC Input Voltage	–0.5V to +4V
DC Output Current	120mA
Power Dissipation	0.5W

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.

DC Electrical Characteristics for USB 2.0 Switching over Operating Range

(T_A = -20°C to 100°C, V_{DD} = 3.0V - 3.6V)

Parameter	Description	Test Conditions[1]	Min.	Typ.[2]	Max.	Units
V_{IH}	Input HIGH Voltage	Guaranteed HIGH level	1.4	—	—	V
V_{IL}	Input LOW Voltage	Guaranteed LOW level	—	—	0.6	
V_{IK}	Clamp Diode Voltage	V_{DD} = Max., I_{IK} = –18mA	—	-0.7	-1.2	
I_{IH}	Input HIGH Current for SEL and $\overline{OE}$	V_{DD} = Max., V_{IH} = VDD	-100	—	100	nA
I_{IL}	Input LOW Current for SEL and $\overline{OE}$	V_{DD} = Max., V_{IL} = GND	-100	—	100	
I_{IH}	Input HIGH Current for Y+/Y-	V_{DD} = 3.3V, $V_{Y+/Y-}$ = 5.25V, $V_{\overline{OE}}$ = V_{DD}, $V_{\overline{OE}}$ = GND	—	—	50	µA
		$V_{Y+/Y-}$ = V_{DD}, $V_{\overline{OE}}$ = V_{DD} or GND	—	—	1	
I_{IL}	Input LOW Current for Y+/Y-	V_{DD} = 3.3V, V_Y = 0V	—	—	1	
R_{ON}	Switch On-Resistance[3]	V_{DD} = 3V, 0V ≤ V_{input} ≤ 1.0V, I_{ON} = –40mA	—	2.0	5.0	Ω
$R_{FLAT(ON)}$	On-Resistance Flatness[3]	V_{DD} = 3V, 0V ≤ V_{input} ≤ 1.0V, I_{ON} = –40mA	—	1.5	—	
ΔR_{ON}	On-Resistance Match from Center Ports to any other Port[3]	V_{DD} = 3V, 0V ≤ V_{input} ≤ 1.0V, I_{ON} = –40mA	—	0.9	2.0	
		V_{DD} = 3V, 0V ≤ V_{input} ≤ 0.4V, I_{ON} = –40mA	—	0.5	—	
I_{OZ_M}	Output Leakage Current on Port M when D Path is on	$V_{Y+/Y-}$ = 5.25V, V_{DD} = 3.3V, SEL = High, $V_{M+/M-}$ = 0V	—	±2	—	µA
I_{OZ_D}	Output Leakage Current on Port D when M Path is on	$V_{Y+/Y-}$ = 5.25V, V_{DD} = 3.3V, SEL = Low, $V_{D+/D-}$ = 0V	—	±2	—	µA
I_{off_Y}	Y+/Y- Power-Off Leakage Current	V_{input} = 0V to 3.3V, V_{DD} = 0V, M+/M- = float, D+/D- = float	—	—	5	µA
I_{off_ctl}	SEL/$\overline{OE}$ Power-Off Leakage Current	V_{input} = 0V to 3.3V, V_{DD} = 0V, $V_{\overline{OE}}$ = 0 to 3.3V, V_{DD} = 0V	—	—	5	µA

Power Supply Characteristics

Parameters	Description	Test Conditions[1]	Min.	Typ.	Max.	Units
I_{DD}	Power Supply Current	V_{DD} = 3.3V, $\overline{OE}$ = GND, V_{SEL} = GND or 1.8V or V_{DD}	—	30	175	nA

Notes:
1. For max. or min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. V_{DD} = 3.0V - 3.6V, T_A = 25°C ambient.
3. Measured by the voltage drop between Y+/Y- and the lower of M+/M- and D+/D- at indicated current through the switch.

Capacitance (T_A = 25°C, V_{DD} = 3.3V, f = 1MHz)

Parameters[3]	Description	Test Conditions[1]	Typ.[2]	Max.	Units
C_{IN}	Input Capacitance	—	2.2	3.2	pF
$C_{OFF\ (M/D)}$	Switch Off Capacitance for M and D Ports	$\overline{OE}$ = High	3.3	4.0	
$C_{OFF\ (Y)}$	Switch Off Capacitance for Y Port	$\overline{OE}$ = High	5.0	6.0	
C_{ON}	Switch Capacitance, Switch ON	V_{SEL} = 0V or V_{DD}	6.0	7.0	

Dynamic Electrical Characteristics Over the Operating Range

Parameters[3]	Description	Test Conditions	Min.	Typ.[2]	Max.	Units
X_{TALK}	Crosstalk	R_L = 50Ω, f = 240 MHz	—	-29	—	dB
O_{IRR}	OFF Isolation		—	-28	—	
-3dB BW	–3dB Bandwidth	R_L = 50Ω	—	1600	—	MHz
-0.5dB BW	–0.5dB Bandwidth	R_L = 50Ω	—	275	—	MHz
T_{OVP}	Over-Voltage Response Time[4]	R_L = 15kΩ C_L = 10 pF, $V_{Y+/Y-}$ = 5V, V_{DD} = 3.0 to 3.6V	100	200	300	ns
V_{DSW}	Dynamic Signal Output Swing[5]	C_L = 10 pF, $V_{Y+/Y-}$ = 5V, V_{DD} = 3.3V [6]	—	2.4	—	V

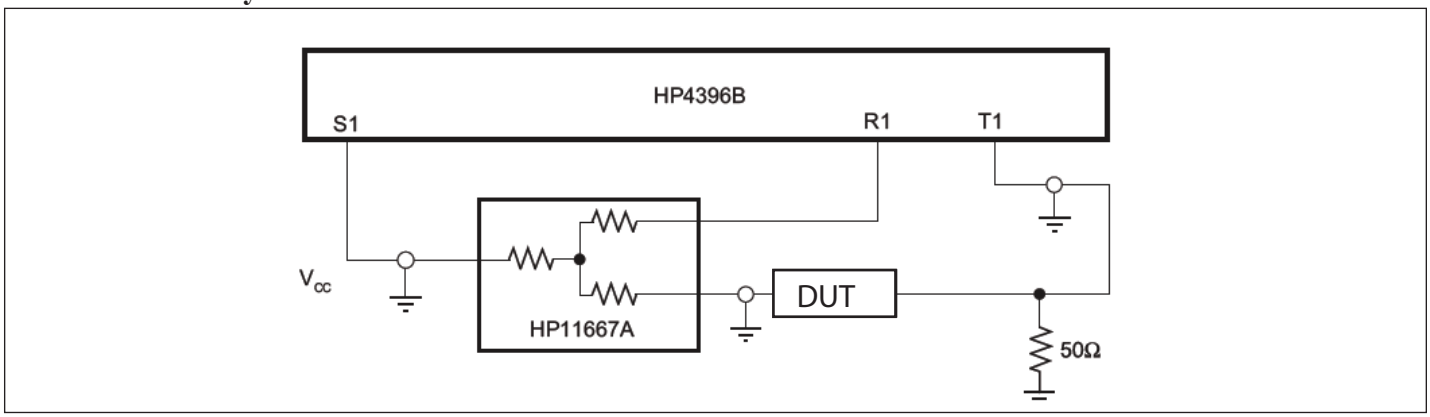
Notes:
1. For maximum or minimum conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at V_{DD} = 3.3V, T_A = 25°C ambient.
3. This parameter is determined by device characterization but is not production tested.
4. Time duration for output voltage higher than V_{DSW} when input is connected to 5V.
5. Output voltage at M+/M- and D+/D- are clamped to V_{DSW} (less than 3.0V) during overvoltage condition.
6. Tested using a 100kHz square wave with t_r = 75 ns and t_f = 75 ns.

Switching Characteristics

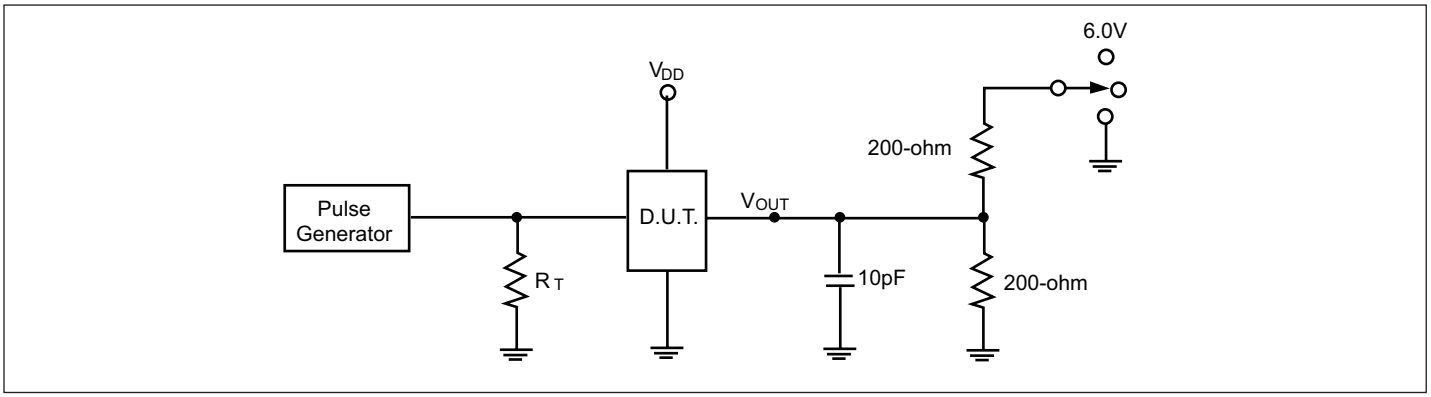
Parameters	Description	Test Conditions [1]	Min.	Typ.	Max.	Units
t_{PD}	Propagation Delay[2,3]	See Test Circuit for Electrical Characteristics	—	0.25	—	ns
t_{PZH}, t_{PZL}	Line Enable Time - SEL, $\overline{OE}$ to D(+/-), M(+/-)		0.5	—	50	
t_{PHZ}, t_{PLZ}	Line Disable Time - SEL, $\overline{OE}$ to D(+/-), M(+/-)		0.5	—	50	
t_{SKb-b}	Output Skew, Bit-to-Bit (Opposite Transition of the Same Output (t_{PHL}-t_{PLH})[2]		—	8	20	ps

Notes:
1. For maximum or minimum conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Guaranteed by design.
3. 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 0.25ns for 10pF load. Because 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 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.

Test Circuit for Dynamic Electrical Characteristics



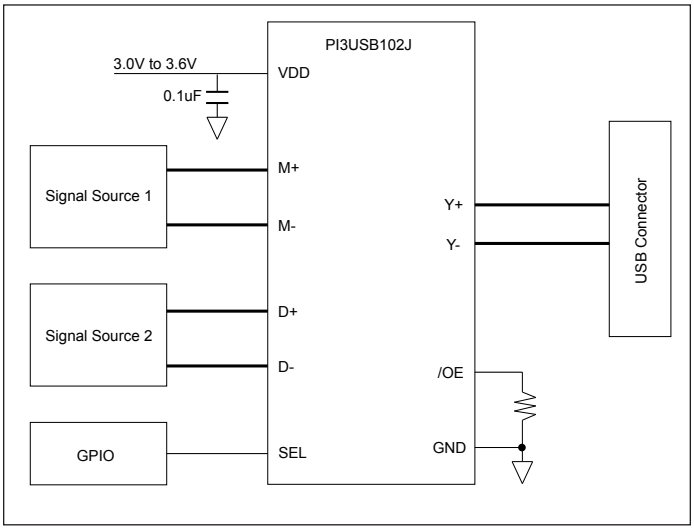
Test Circuit for Electrical Characteristics



Notes:

1. C_L = Load capacitance; includes jig and probe capacitance.
2. R_T = Termination resistance; should be equal to Z_{OUT} of the Pulse Generator.
3. All input impulses are supplied by generators having the following characteristics: $Z_O = 50\Omega$, $t_R \leq 2.5$ns, $t_F \leq 2.5$ns.
4. The outputs are measured one at a time with on transition per measurement.

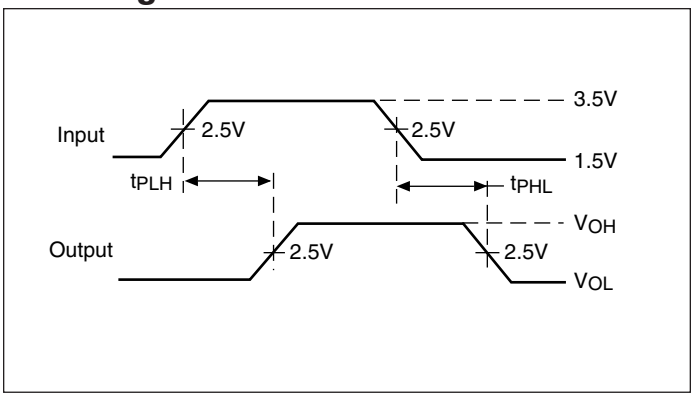
Application Example Diagram



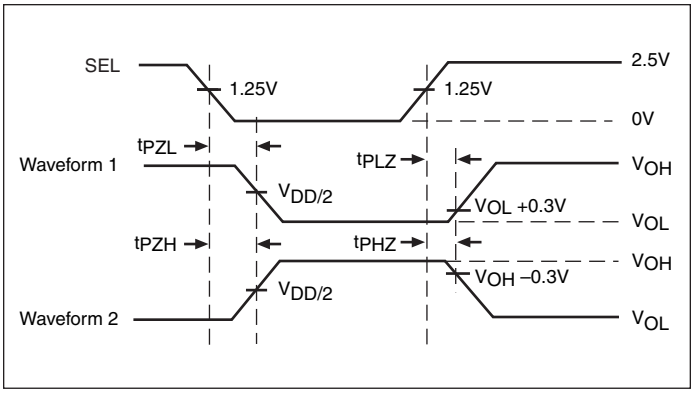
Switch Positions

Test	Switch
t_{PLZ}, t_{PZL}	6.0V
t_{PHZ}, t_{PZH}	GND
Prop Delay	Open

Switching Waveforms

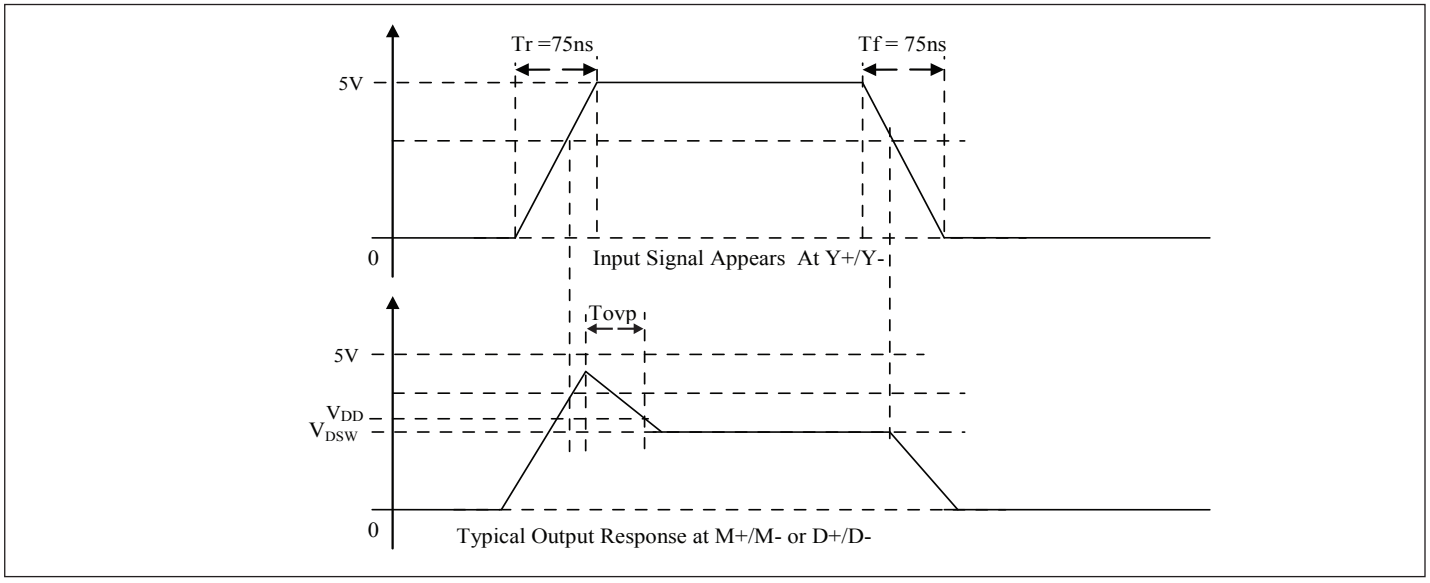


Voltage Waveforms Propagation Delay Times



Voltage Waveforms Enable and Disable Times

Overvoltage Protection Waveforms

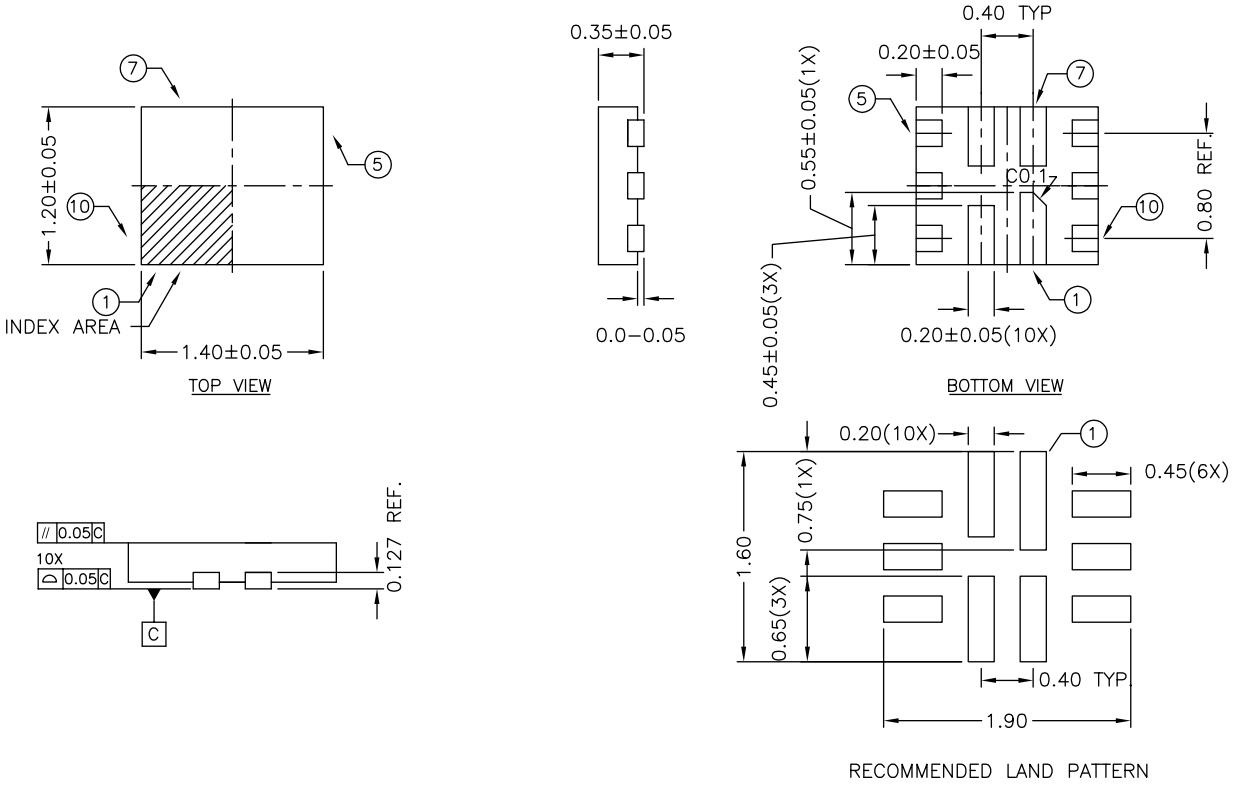


The PI3USB102J offers overvoltage protection for the I/O pins to protect from shorts to VBUS (5V). When a 5V is applied to Y+/Y-, the voltage at M+/M-, and D+/D- falls to 3.6V within the time T_{OVP} then clamps to V_{DSW}.

Part Marking

Z = Die Rev
* = One letter datecode

Packaging Mechanical: 10-X2QFN (XUC)



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

DATE: 06/28/16

DESCRIPTION: 10-contact, Super Thin QFN, X2QFN

PACKAGE CODE: XUC (XUC10)

DOCUMENT CONTROL #: PD-2208 REVISION: --

16-0055

For latest package information:

See http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/.

Ordering Information

Ordering Code	Package Code	Package Description	Top Mark
PI3USB102JXUCEX	XUC	10-contact, Super-Thin QFN (X2QFN)	BN

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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