

PI3USB3031

2-Channel, 1:3, USB 2.0 and MHL MUX/DeMUX

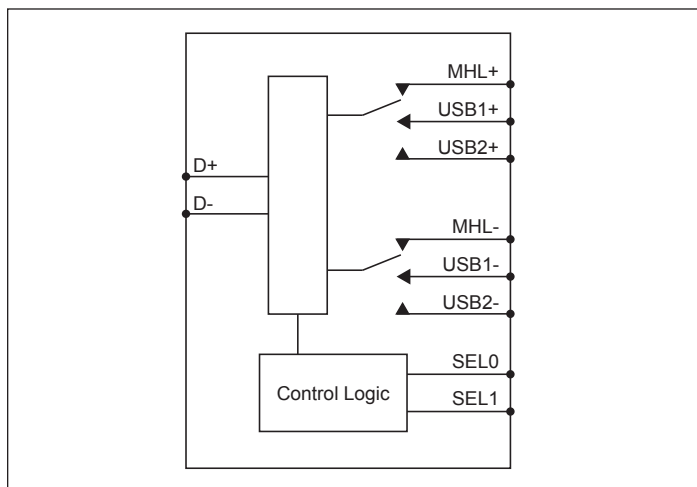
Description

The DIODES PI3USB3031 device is a 2-channel, 1:3 multiplexer that includes a high-speed Mobile High Definition Link (MHL), Mobility Display Port (MyDP) switch, and USB 2.0 High-Speed (480 Mbps) switches in the same package. These configurations allow the system designer to save board space and eliminate multiple connectors by using a common USB or Micro-USB connector for MHL/MyDP signals and two sets of USB data. The MHL/MyDP path supports the latest MHL Rev. 3.0 specification.

The PI3USB3031 has a VCC range of 1.8V to 5.5V and supports overvoltage tolerance (OVT) feature, which allows the I/O pins to withstand overvoltage conditions (up to 5.5 V). The power-off protection feature forces all I/O pins to be in high impedance mode when power is not present, allowing full isolation of the signals lines under such condition without excessive leakage current. The select pins of PI3USB3031 are compatible with 1.8V control voltage, allowing them to be directly interfaced with the General Purpose I/O (GPIO) from a mobile processor with out needing additional voltage level shifting circuitry.

The PI3USB3031 comes with a small 12-pin VQFN package with only 1.8mm x 1.8mm and QFN package with only 1.6mm x 1.6mm in size, which makes it a perfect candidate to be used in mobile applications.

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.

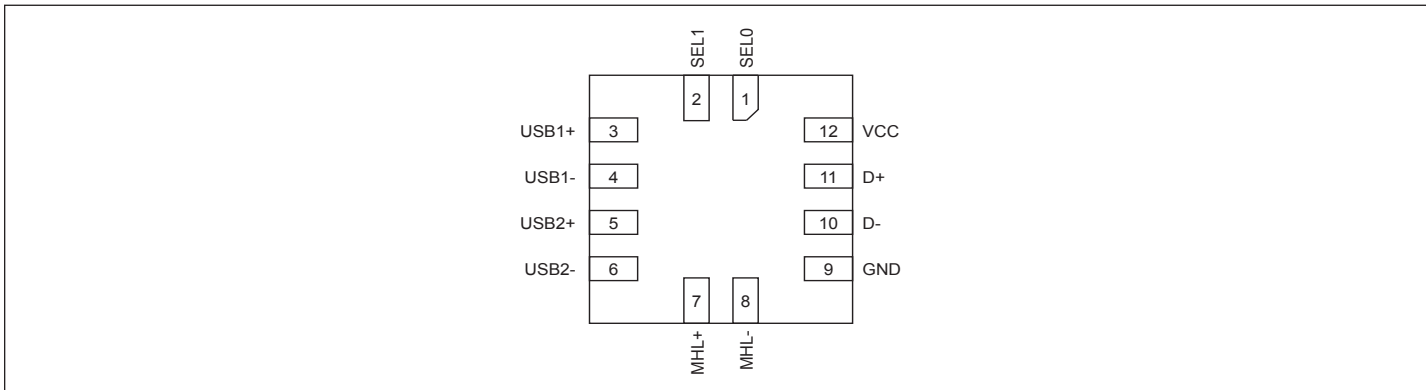
Features

- Wide VCC Range: 1.8V to 5.5V
- Mobile High-Definition Link (MHL) or Mobility Display Port (MyDP) Switch:
 - Bandwidth (-3dB): 6.5GHz
 - R_{ON} (Typical): 5.5Ω
 - C_{ON} (Typical): 1.3pF
- USB Switches (2 Sets):
 - Bandwidth (-3dB): 6.5GHz
 - R_{ON} (Typical): 4.5Ω
 - C_{ON} (Typical): 1pF
- Current Consumption: 28 μA (Typical)
- I_{OFF} Protection Prevents Current Leakage in Powered-Down State (VCC = 0V)
- 1.8V Compatible Control Inputs (SEL)
- Overvoltage Tolerance (OVT) on All I/O Pins Up to 5V Without External Components
- ESD Protection : 2kV(HBM), 1kV(CDM)
- 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-Q100/101/104/200, 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):
 - 12-Pin, 1.8mm x 1.8mm, 0.4mm pitch (WQFN)
 - 12-Pin, 1.6mm x 1.6mm, 0.4mm pitch (X2-QFN)

Application(s)

- PC Motherboards
- Notebooks
- Servers
- Smartphones
- Portable Instrumentation
- Digital Cameras USB 2.0 MHL

Pin Configuration



Pin Description

Pin#	Pin Name	Type	Description
1	SEL0	I	Digital Control Input 1
2	SEL1	I	Digital Control Input 2
3	USB1+	I/O	Differential Signal Path 1
4	USB1-	I/O	Differential Signal Path 1
5	USB2+	I/O	Differential Signal Path 2
6	USB2-	I/O	Differential Signal Path 2
7	MHL+	I/O	Differential Signal Path 3
8	MHL-	I/O	Differential Signal Path 3
9	GND	GND	Ground
10	D-	I/O	Common Differential Signal Path
11	D+	I/O	Common Differential Signal Path
12	VCC	POWER	Power Supply

Truth Table

SEL1	SEL0	Source Connected To Common Pin
Low	Low	USB1+/- connect to D+/-
Low	High	USB2+/- connect to D+/-
High	Low	MHL+/- connect to D+/-
High	High	USB and MHL switches in High-Z

Maximum Ratings

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

Storage Temperature	-65°C to +150°C
Ambient Temperature with Power Applied	-40°C to +125°C
Supply Voltage V_{CC}	-0.3V to +6.0V
DC Input Voltage for Control (SEL0 & SEL1)	-0.3V to +6.0V
DC Input Voltage for Switch I/O (Dx/USBx/MHLx)	-0.3V to +5.0V
Continuous DC Output Current (USB & MHL)	±15mA
ESD (HBM)	±2kV
ESD (CDM)	±1kV

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	Parameter	Min.	Typ.	Max.	Units
V_{CC}	Operating Voltage	1.8	3.3	5.5	V
$V_{I/O}$ (USB) $V_{I/O}$ (MHL)	Analog Voltage	0		3.6	V
V_{SEL}	Select Input Voltage (SEL0, SEL1)	0		V_{CC}	V
T_A	Operating Temperature	-40	25	85	°C

DC Electrical Characteristics

+3.3V Supply ($V_{CC} = 3.3V \pm 10\%$)

Symbol	Parameter	Test Conditions	T_A	Min.	Typ.	Max.	Units
MHL SWITCH							
R_{ON}	On-Resistance	$V_{CC} = 2.5V, V_{I/O} = 1.5V, I_{ON} = -8mA$, Test Circuit 1	25°C		5.5	7	Ω
ΔR_{ON}	On-resistance matching between channels	$V_{CC} = 2.5V, V_{I/O} = 1.5V, I_{ON} = -8mA$	25°C		0.1		Ω
R_{ONF}	On-Resistance Flatness	$V_{CC} = 2.5V, V_{I/O} = 1.5V$ to 3.3V, $I_{ON} = -8mA$	25°C		1		Ω
I_{OZ}	Off Leakage Current	$V_{CC} = 4.3V$, Switch OFF. $V_{MHL+}/MHL- = 1.5V$ to 3.3V; $V_{D+}/D- = 0V$	25°C	-2		2	μA
I_{ON}	ON Leakage Current	$V_{CC} = 4.3V$, Power OFF. $V_{MHL+}/MHL- = 1.5V$ to 3.3V; $V_{D+}/D- = NC$	-40°C to 85°C	-2		2	μA
I_{OFF}	Power Off leakage Current	$V_{CC} = 0V$, Power OFF. $V_{MHL+}/MHL- = 1.5V$ to 3.3V; $V_{D+}/D- = NC$	-40°C to 85°C	-10		10	μA

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Symbol	Parameter	Test Conditions	T _A	Min.	Typ.	Max.	Units
USB SWITCH (USB1 & USB2)							
R _{ON}	On-Resistance	V _{CC} = 2.5V, V _{I/O} = 0.4V, I _{ON} = -8mA, Test Circuit 1	25°C		4.5	6	Ω
ΔR _{ON}	On-resistance matching between channels	V _{CC} = 2.5V, V _{I/O} = 0.4V, I _{ON} = -8mA	25°C		0.1		Ω
R _{ONF}	On-Resistance Flatness	V _{CC} = 2.5V, V _{I/O} = 0V to 0.4V, I _{ON} = -8mA	25°C		1		Ω
I _{OZ}	Off Leakage Current	V _{CC} = 4.3V, Switch OFF. V _{USB+/ USB-} = 0V to 0.4V; V _{D+/D-} = 0V	25°C	-2		2	μA
I _{ON}	ON Leakage Current	V _{CC} = 4.3V, Switch ON. V _{USBHL+/ USB-} = 0V to 0.4V; V _{D+/D-} = NC	25°C	-2		2	μA
I _{OFF}	Power Off leakage Current	V _{CC} = 0V, Power ON or OFF. V _{USBHL+/ USB-} = 0V to 0.4V; V _{D+/D-} = NC	25°C	-10		10	μA
Select INPUTS (SEL0, SEL1)							
V _{IH}	Input Logic High	V _{CC} = 2.5V to 4.3V	25°C	1.3			V
V _{IL}	Input Logic Low	V _{CC} = 2.5V to 4.3V	25°C	0		0.6	V
I _{IN}	Input Leakage Current	V _{CC} = 2.5V, V _{I/O} = 0V to 0.4V, I _{ON} = -8mA	25°C	-10		10	μA

Dynamic Characteristics

 +3.3V Supply (V_{CC} = 3.3V ±10%)

Symbol	Parameter	Test Conditions	T _A	Min.	Typ.	Max.	Units
t _{pd}	Propagation delay Time	R _L = 50Ω, C _L = 5pF, V _{CC} = 2.5V to 4.3V, V _{I/O(USB)} = 0.4V, V _{I/O(MHL)} = 3.3V	25°C		50		ps
t _{switch}	Switching time between USB/MHL channels in active modes	R _L = 50Ω, C _L = 5pF, V _{CC} = 2.5V to 4.3V, V _{I/O(USB)} = 0.4V, V _{I/O(MHL)} = 3.3V	25°C			400	ns
t _{ON}	Turn-On Time	R _L = 50Ω, C _L = 5pF, V _{CC} = 2.5V to 4.3V, V _{I/O(USB)} = 0.4V, V _{I/O(MHL)} = 3.3V	25°C			100	μs
t _{OFF}	Turn-Off Time	R _L = 50Ω, C _L = 5pF, V _{CC} = 2.5V to 4.3V, V _{I/O(USB)} = 0.4V, V _{I/O(MHL)} = 3.3V	25°C			100	μs
C _{ON(MHL)}	MHL Channels On Capacitance	V _{CC} = 3.3V, V _{I/O} = 0V or 3.3V, f = 240MHz, Switch ON	25°C		1.3		pF
C _{ON(USB)}	USB Channel On Capacitance	V _{CC} = 3.3V, V _{I/O} = 0V or 3.3V, f = 240MHz, Switch ON	25°C		1		pF

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Symbol	Parameter	Test Conditions	T _A	Min.	Typ.	Max.	Units
C _{OFF(MHL)}	MHL Channels Off Capacitance	V _{CC} = 3.3V, V _{I/O} = 0V or 3.3V, f = 240MHz, Switch OFF	25°C		1.3		pF
C _{OFF(USB)}	USB Channel Off Capacitance	V _{CC} = 3.3V, V _{I/O} = 0V or 3.3V, f = 240 MHz, Switch OFF	25°C		1		pF
C _I	Digital Input Capacitance	V _{CC} = 3.3V, V _{I/O} = 0V or 2V	25°C		2.2		pF
O _{ISO(MHL)}	MHL path Off Isolations	V _S = -10dBm, V _{DC_BIAS} = 2.4V, RT = 50Ω, f = 240MHz, Switch OFF	25°C		-38		dB
O _{ISO(USB)}	USB path Off Isolations	V _S = -10dBm, V _{DC_BIAS} = 0.2V, RT = 50Ω, f = 240MHz, Switch OFF	25°C		-38		dB
X _{TALK(MHL)}	MHL Channel Crosstalk	V _S = -10dBm, V _{DC_BIAS} = 2.4V, RT = 50Ω, f = 240MHz, Switch ON	25°C		-65		dB
X _{TALK(USB)}	USB Channel Crosstalk	V _S = -10dBm, V _{DC_BIAS} = 0.2V, RT = 50Ω, f = 240MHz, Switch ON	25°C		-45		dB
f _{3dB(MHL)}	-3dB Bandwidth	V _{CC} = 2.5V to 4.3V, R _L = 50Ω, Switch ON	25°C		6.5		GHz
f _{3dB(USB)}	-3dB Bandwidth	V _{CC} = 2.5V to 4.3V, R _L = 50Ω, Switch ON	25°C		6.5		GHz
SUPPLY							
I _{CC}	Power Supply Current	V _{CC} = 4.3V, V _{IN} = V _{CC} or GND, V _{I/O} = 0V, Switch ON or OFF	25°C		28	40	μA

Test Circuits and Timing Diagrams

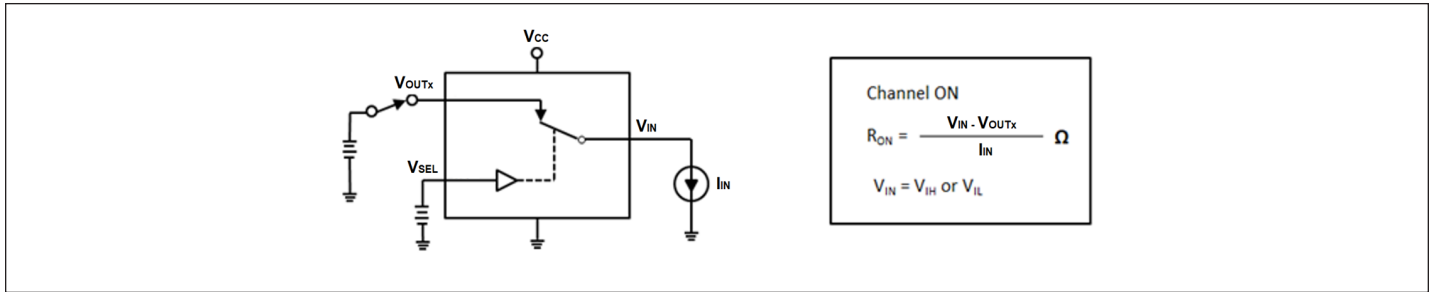


Figure 1. On Resistance

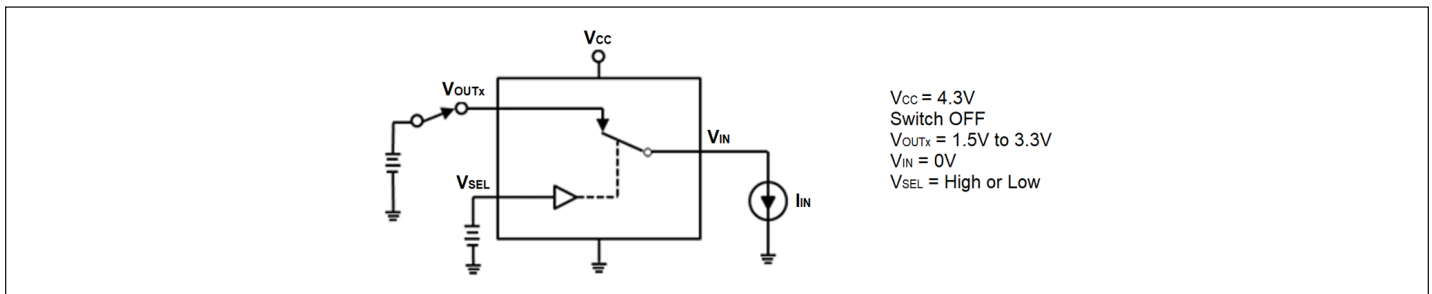


Figure 2. OFF Leakage Current IOZ

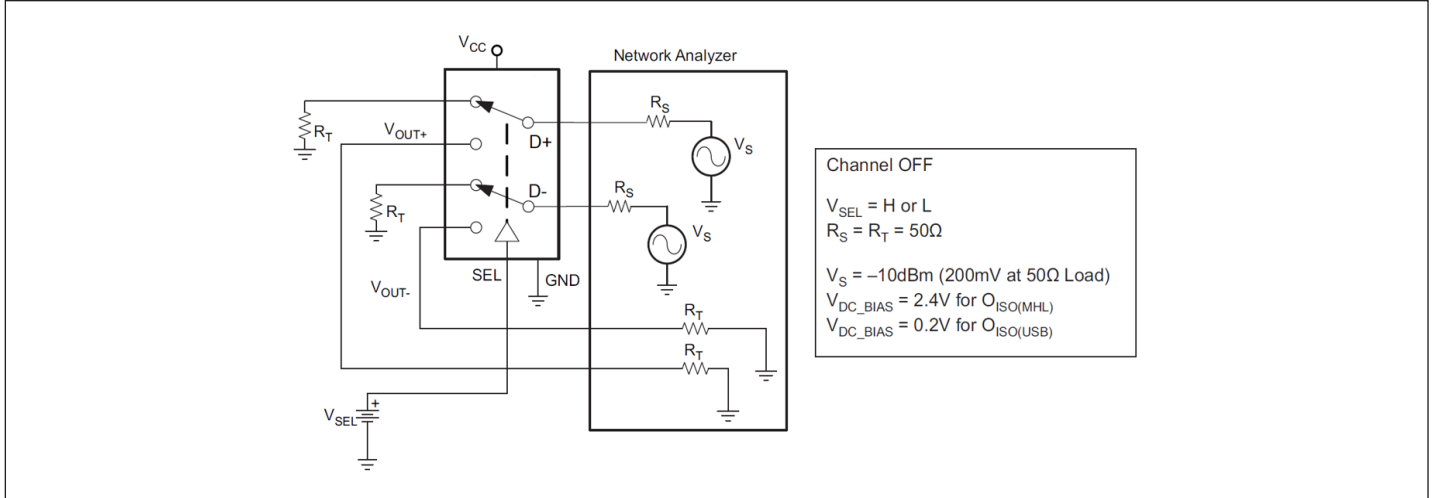


Figure 3. Differential OFF Isolation (OISO)

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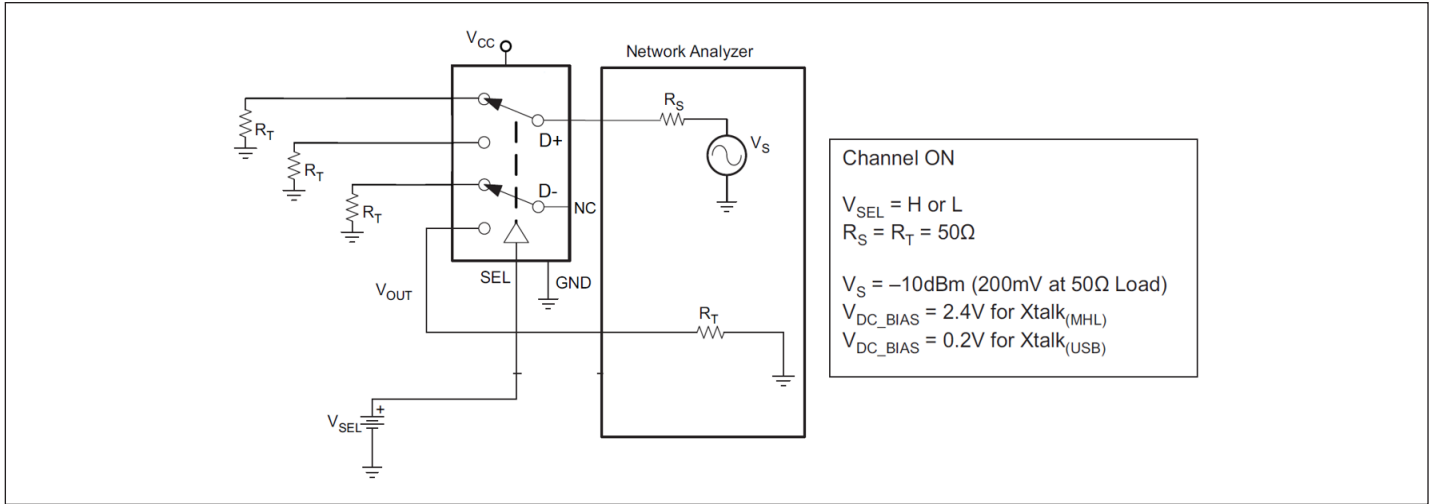


Figure 4. Crosstalk

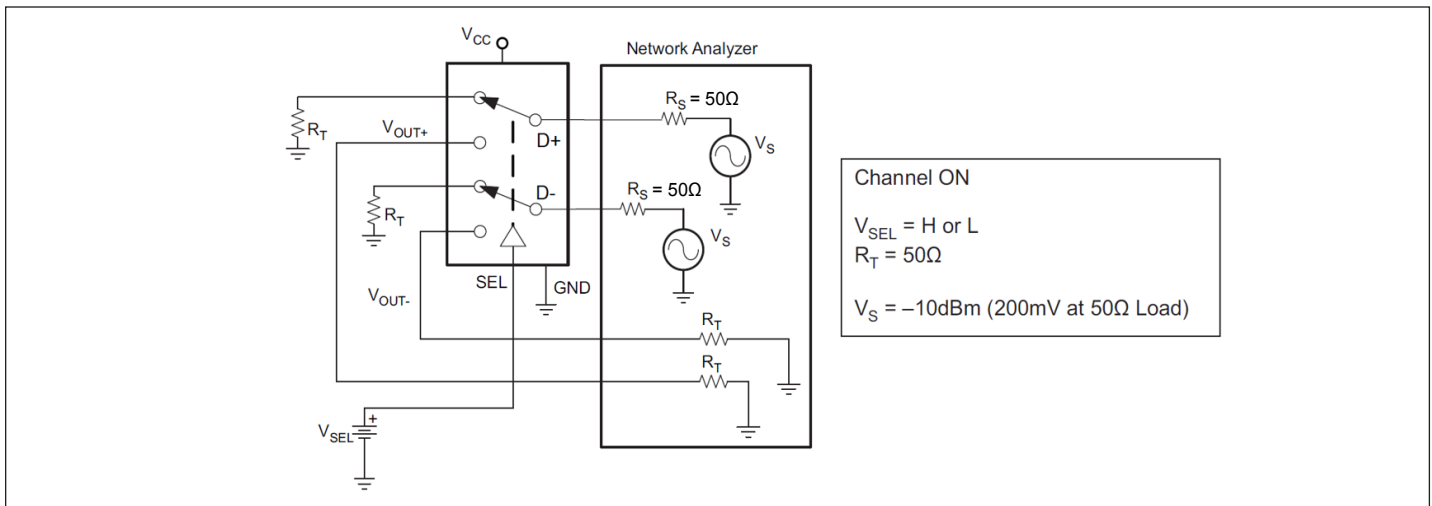


Figure 5. Differential Bandwidth

Part Marking

ZN Package

○

HB

YW

HB = PI3USB3031ZNE
 Y: Date Code (Year)
 W: Date Code (Workweek)
 Line above "H" denotes for Lead-free and Green

XUA Package

○

HA

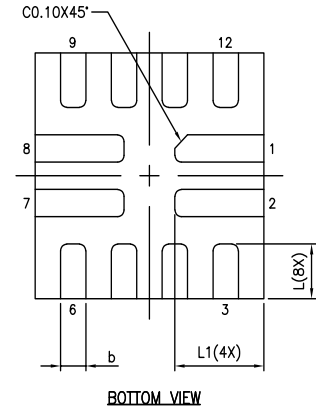
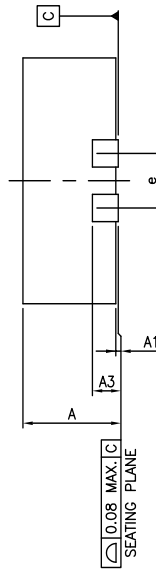
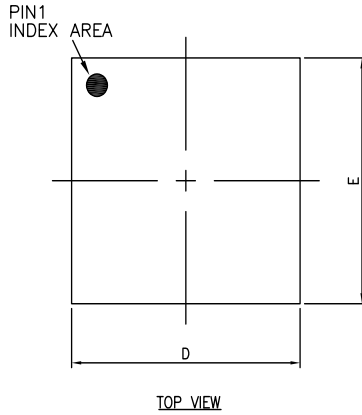
YW

HA = PI3USB3031XUAE
 Y: Date Code (Year)
 W: Date Code (Workweek)
 Line above "H" denotes Pin 1 indicator, Lead-free and Green

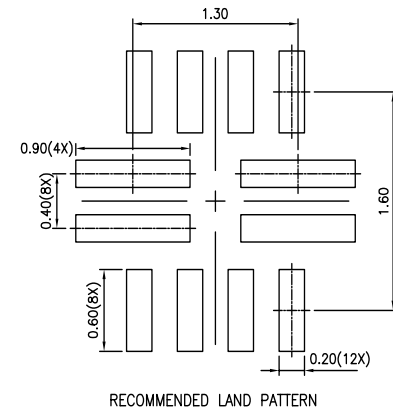
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Packaging Mechanical

12-WQFN (ZN)



SYMBOLS	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.203 REF.		
b	0.15	0.20	0.25
D	1.70	1.80	1.90
E	1.70	1.80	1.90
e	0.40 BSC		
L	0.35	0.40	0.45
L1	0.65	0.70	0.75



- NOTE :
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES
 2. COPLANARITY APPLIES TO THE EXPOSED THERMAL PAD AS WELL AS THE TERMINALS
 3. REFER JEDEC MO-220
 4. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY
 5. THERMAL PAD SOLDERING AREA (MESH STENCIL DESIGN IS RECOMMENDED)

		DATE: 01/13/23
DESCRIPTION: W-QFN1818-12		
PACKAGE CODE: ZN (ZN12)		
DOCUMENT CONTROL #: PD-2282		REVISION: --

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12-X2QFN (XUA)

SYMBOLS	MIN.	NOM.	MAX.
A	0.30	0.35	0.40
A1	0.00	0.02	0.05
A3	0.127 REF.		
b	0.15	0.20	0.25
D	1.55	1.60	1.65
E	1.55	1.60	1.65
e	0.40 BSC		
L	0.25	0.30	0.35
L1	0.45	0.50	0.55

NOTE :

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

DATE: 04/21/22

DESCRIPTION: X2-QFN1616-12

PACKAGE CODE: XUA (XUA12)

DOCUMENT CONTROL #: PD-2167

REVISION: B

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
PI3USB3031ZNEX	ZN	12-Pin, W-QFN1818-12 (WQFN)
PI3USB3031XUAEX	XUA	12-Pin, X2-QFN1616-12 (X2QFN)

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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