

PI5USB212

USB 2.0 Signal Conditioner

Description

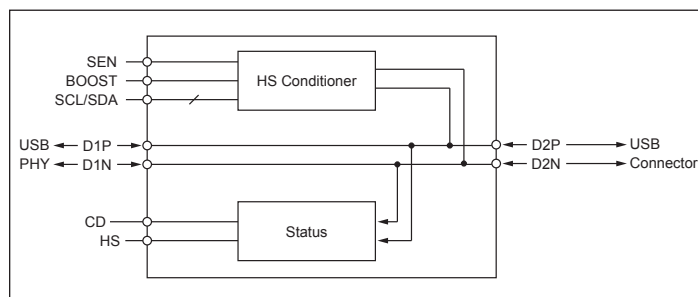
The DIODES PI5USB212 is an USB2.0 Signal conditioner to boost the signals and insert pre-emphasis to compensate the ISI signal loss in the channels before and after the conditioner. Patent-pending Design to maintain stable common mode with symmetrical Boost/Pre-emphasis on D+/D-.

The PI5USB212 can be used in USB Host or Device application, far from USB PHY or far from connector application. Boost/Pre-emphasis and Receiver Sensitivity levels can be configured through pin or I2C mode depending on the channel conditions. Device Attach and High-Speed handshake success are also detected and reported.

Application(s)

- Notebooks
- PCs
- Docking
- Cable Extenders
- TVs
- Monitors

Functional Block Diagram



Features

- Wide Supply Voltage Range: 2.3V to 5.5V
- USB Ports 5.5V Tolerance
- Low Power Consumption in Disconnect and Shutdown Mode
- Compatible with USB2.0, OTG 2.0 and BC 1.2
- Host or Device Agnostic
- Boost/Pre-Emphasis Level and Receiver Sensitivity Programming through Pin Mode or I2C Mode
- Symmetrical Boost/Pre-Emphasis on D+/D- to Maintain Stable Common Mode
- Device Attach and High-Speed Detections
- Supports Up to 5m Cable Length
- ESD Performance: 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-contact, X2QFN (XUA)

Ordering Information

Ordering Code	Package Code	Package Description	Pin 1 Location
PI5USB212XUAEX	XUA	X2-QFN1616-12	Top Left Corner
PI5USB212XUAEX-7R	XUA	X2-QFN1616-12	Top Right Corner

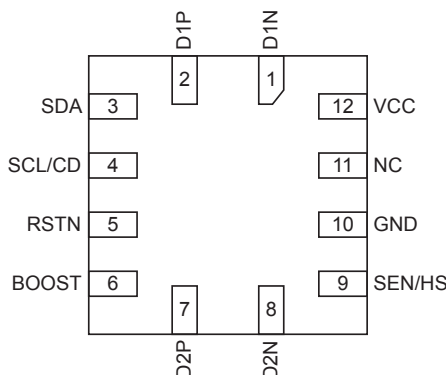
Notes:

- E = Pb-free and Green
- X suffix = Tape/Reel

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

Pin#	Pin Name	Type	Description
1, 2	D1N, D1P	I/O	USB High speed port
3	SDA	I/O	500k Ω internal pulled high and 1.8M Ω internal pulled down. <u>In I2C mode:</u> Bidirectional I2C data pin; Connected to a pull-up resistor During power up, pulled up SDA and SCL/CD with Rpu (<10k Ω) to enter I2C mode OR floating to enter Pin mode <u>In Pin mode:</u> Do not connect
4	SCL/CD	I/O	<u>In I2C mode:</u> I2C Clock pin During power up, pulled up SDA and SCL/CD with Rpu (<10k Ω) to enter I2C mode OR floating to enter Pin mode (500k Ω pull-down during RSTN rising) <u>In Pin mode:</u> Output CD, Flag indicating that a USB device is attached. Asserted from an unconnected state upon detection of DP or DM pull up resistor. De-asserted upon detection of disconnect.
5	RSTN	I	Device disable/enable. Low – Device is at RESET and in shutdown, and High – Normal operation. 500k Ω internal pulled high and 1.8M Ω internal pulled down. Recommend 0.1-uF external capacitor to GND to ensure clean power on reset if not driven. If the pin is driven, it must be held low until the supply voltage for the device reaches within specifications.
6	BOOST	I	USB High Speed Boost selection. Select via external pull down resistor. Sampled upon de-assertion of RSTN. Does not recognize real time adjustments.
7, 8	D2P, D2N	I/O	USB High speed port

PI5USB212

Pin#	Pin Name	Type	Description
9	SEN/HS	I/O	<p><u>In I2C mode:</u> No function</p> <p><u>In Pin mode:</u> At reset: 3-level input signal SEN. Receiver Sensitivity selection. High Sensitivity (pin is pulled high) Medium Sensitivity (pin is left floating) Low Sensitivity (pin is pulled low)</p> <p>After Reset: Output signal HS. Flag indicating that channel is in High Speed mode.</p> <p>Asserted upon: 1. Detection of USB-IF High Speed test fixture from an unconnected state followed by transmission of USB TEST_PACKET pattern. 2. Detection of High Speed a successful High Speed handshake</p>
10	GND	Power	Ground
11	NC	—	No Connection
12	VCC	Power	Supply Power

Maximum Ratings

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

Storage Temperature	–55°C to +125°C
Supply Voltage	–0.5V to +6.0V
USB IO Voltage	–0.5V to +6.0V
Control Input Voltage	–0.5V to +6.0V
Output Current	10mA
ESD: HBM Mode	2000V

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 _{CC}	Supply Voltage		2.3		5.5	V
T _A	Ambient Temperature		–40		85	°C

DC Electrical Characteristics

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
Power						
I _{ACTIVE}	High-speed (HS) active current	USB channel in HS mode with traffic		22	30	mA
I _{IDLE}	High-speed idle current	USB channel in HS mode without traffic		14	22	mA
I _{SUSPE}	High-speed suspend current	USB channel in HS Suspend mode		0.55	1.5	mA
I _{FS_LS}	Full/Low speed current	USB channel in FS/LS mode		0.6	1.5	mA
I _{DISC}	Disconnect current	No USB attachment		0.7	1.5	mA
I _{RSTN}	Disable current	RSTB = 0V		13	80	μA
I _{LKG_FS}	Pin fail-safe leakage current for SDA, SCL/CD, DxP/N, RSTN, SEN/HS	V _{CC} = 0V, Tested Pin = 5.5V			40	μA
RSTN						
V _{IH}	High-level input voltage		1.05		5.5	V
V _{IL}	Low-level input voltage		0		0.4	V
I _{IH}	High-level input current	VRSTN = V _{CC}	–15		15	μA
I _{IL}	Low-level input current	VRSTN = 0V	–20		20	μA
SEN						
V _{IH}	High-level input voltage		1.6			V
V _{IF}	Floating-level input voltage		1.0		1.5	V
V _{IL}	Low-level input voltage				0.8	V
I _{IH}	High-level input current	VSEN = V _{CC}	–5		5	uA
I _{IL}	Low-level input current	VSEN = 0V	–5		5	uA

PI5USB212

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
BOOST						
R _{BOOST}	Setting 0				160	Ω
	Setting 1		1.5		2	kΩ
	Setting 2		3.4		3.96	kΩ
	Setting 3		7.5			kΩ
CD, HS						
V _{OH}	High-level output voltage	I _{out} = 50uA, VCC > 3.0V	2.5			V
		I _{out} = 25 uA, VCC = 2.3V	1.8			
V _{OL}	Low-level output voltage	I _{out} = 50uA			0.4	V
SCL, SDA						
C _{I2CBUS}	I2C Bus capacitance		4		150	pF
V _{IH}	SDA and SCL input high level voltage		1.05		5.5	V
V _{IL}	SDA and SCL input low level voltage		0		0.3	V
I _{SDAO}	SDA low level output current	SDA = 0.4V	1.5			mA
f _{SCL}	SCL clock frequency				1000	KHz
DxP, DxM						
C _{IO}	Capacitance to GND	240MHz, Device off		2.4		pF

Switching Characteristics

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
F _{BR}	DxP/M bit rate				480.24	Mbps
t _{RISE}	DxP/M rise time	10% - 90%; VCC = 5.5V; Max BOOST	100			ps
t _{FALL}	DxP/M fall time	90% - 10%; VCC = 5.5V; Max BOOST	100			ps
t _{RSTN_PW}	Minimum width to detect a valid RSTN signal assert when the pin is actively driven		20			μs
t _{STABLE}	VCC stable before RSTN de-assertion		100			μs
t _{VCC_RAMP}	VCC ramp time		0.2		100	ms

Detail Description

Overview

The PI5USB212 is an USB2.0 High-Speed (HS) Signal conditioner to boost the signals and insert pre-emphasis to compensate the ISI signal loss in the channels before and after. PI5USB212 will not alter the signals of USB Low Speed (LS), Full Speed (FS), On-The-Go (OTG) and Battery Charging (BC), while HS signals are compensated. Boost/Pre-emphasis level and Receiver Sensitivity can be programmed by I2C or pin mode.

BOOST/PRE-EMPHASIS

The BOOST pin of PI5USB212 is used to configure the level of BOOST/PRE-EMPHASIS in pin mode and initialize the corresponding register in I2C mode. Amplitude boost compensates the amplitude loss due to the long channel before PI5USB212, and pre-emphasis compensates the high frequency loss due to the low-pass long channel after PI5USB212. The four settings can be selected by an external pulldown resistor at this pin and it will be sampled a short moment after RSTN rising.

BOOST Pin Connection	Register Default Value	Boost/Pre-Emphasis Level
Setting 0 (<160 Ω)	0000	Lowest
Setting 1 (~1.8 k Ω)	0101	Lower Mid
Setting 2 (~3.6 k Ω)	1010	Higher Mid
Setting 3 (>7.5 k Ω)	1111	Highest

Receiver Sensitivity

The SEN pin of PI5USB212 is used to configure the level of Receiver Sensitivity in pin mode and initialize the corresponding register in I2C mode. The three settings can be selected by connecting the pin to VCC/Floating/GND during RSTN and it will be sampled a short moment after RSTN rising. After RSTN, the pin will function as an output for HS detection.

SEN Pin Connection	Register Default Value	Receiver Sensitivity Level
VCC	11	Highest
Floating	10	Higher Mid
GND	01	Lower Mid

PI5USB212

I2C Mode

PI5USB212 supports 1MHz down-to-1.2V I2C for device configuration and status readback. This controller is enabled after SCL and SDA pins are sampled high shortly after de-assertion of RSTN. Otherwise, pin mode is enabled. In I2C mode, the registers can be accessed by I2C read/write transaction to 7-bit slave address 0x2C.

Address	Register	Type	Reset Value	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
00h	Reserved	RW	00000000b	Reserved							
01h	Control	RW	0000xxxxb	Receiver Equalization Level 00 (Lowest) 01 10 11 (Highest)	Boost/Pre-emphasis Level				Receiver Sensitivity Level		
					Coarse 00 (Lowest) 01 10 11 (Highest)		Fine 00 (Lowest) 01 10 11 (Highest)		00 (Lowest) 01 10 11 (Highest)		
					Default value set by BOOST pin sampling during startup				Default value set by SEN pin sampling during startup		
02h	Device ID	R	10110000b	Device ID: 10110					Revision: 000		

Device Functional Modes

Low Speed (LS) Mode/Full Speed (FS) Mode

PI5USB212 automatically detects a LS/FS connection and does not enable signal compensation. In pin mode, CD pin is asserted high.

High Speed (HS) Mode

PI5USB212 automatically detects a HS connection and will enable signal compensation. In pin mode, CD and HS pins are asserted high.

OTG Mode/B.C.1.2 Mode

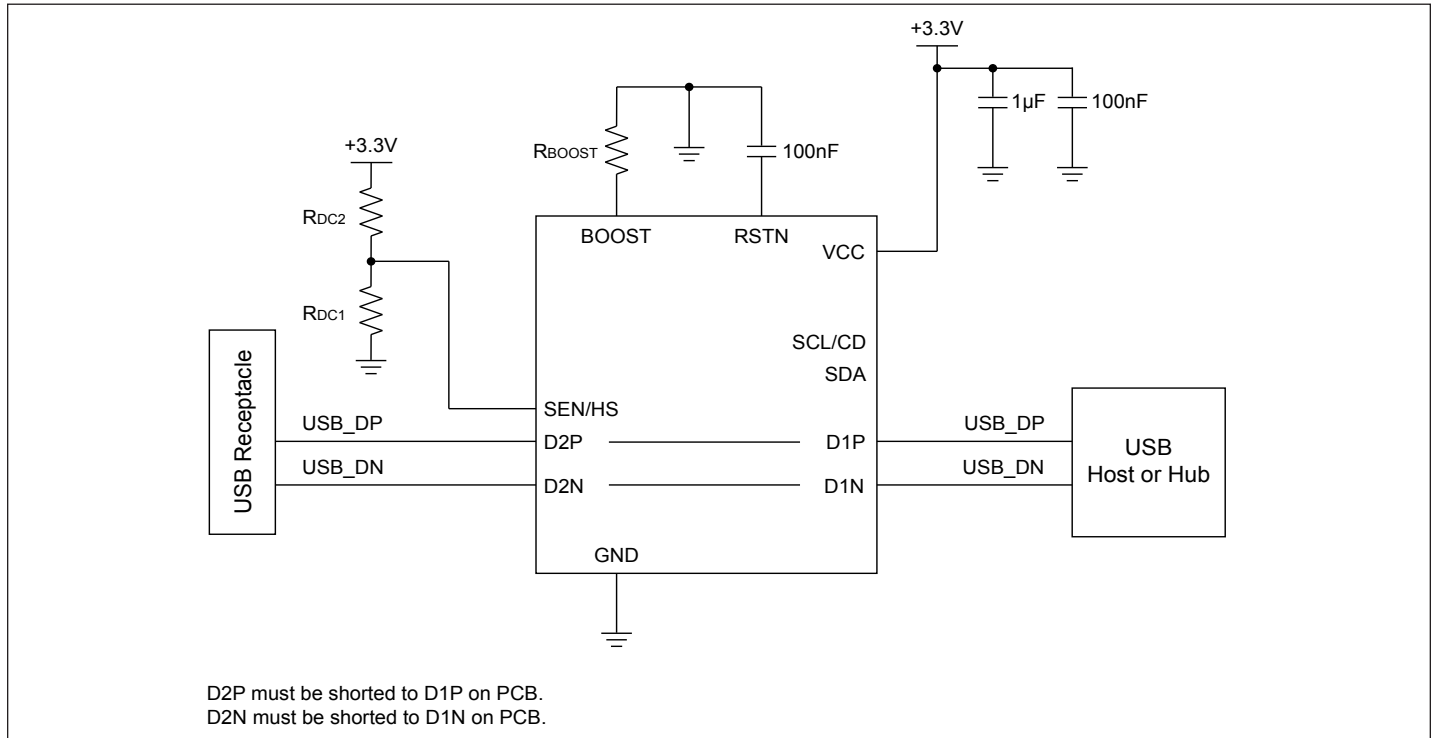
PI5USB212 does not enable signal compensation for OTG or B.C.1.2 signals. In pin mode, CD pin is asserted low.

Shutdown Mode

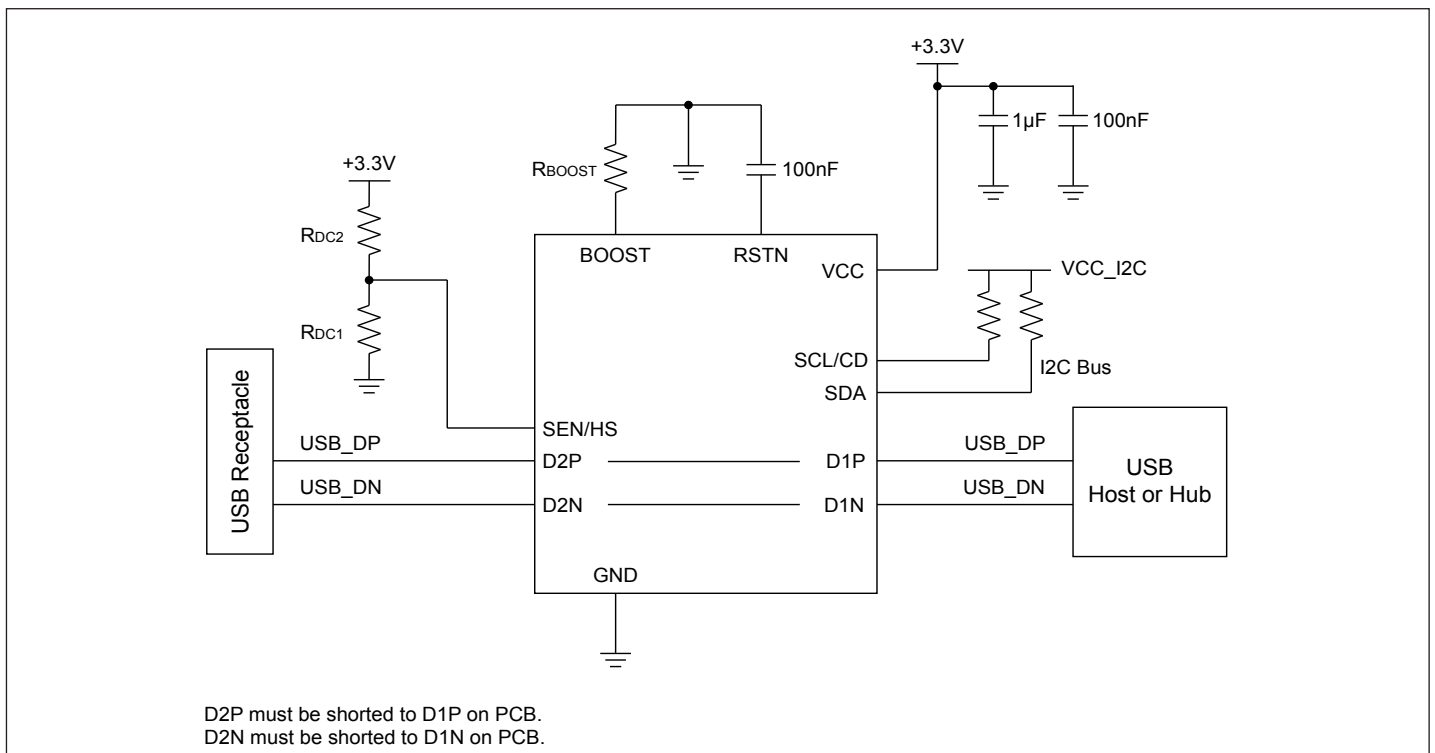
PI5USB212 is disabled when its RSTN pin is asserted low. In shutdown mode the USB channel is still fully operational, but there is neither signal compensation nor any indication from the CD or HS pin as to the status of the channel.

Application Diagram

Pin Mode



I2C Mode



PI5USB212

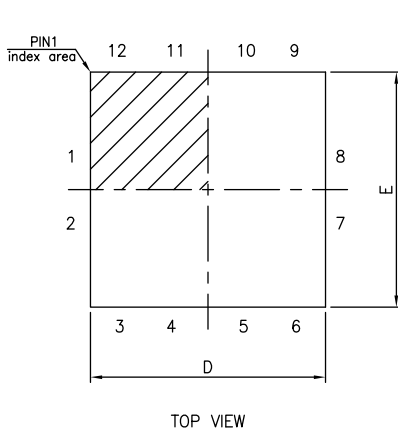
Part Marking

DD
YW

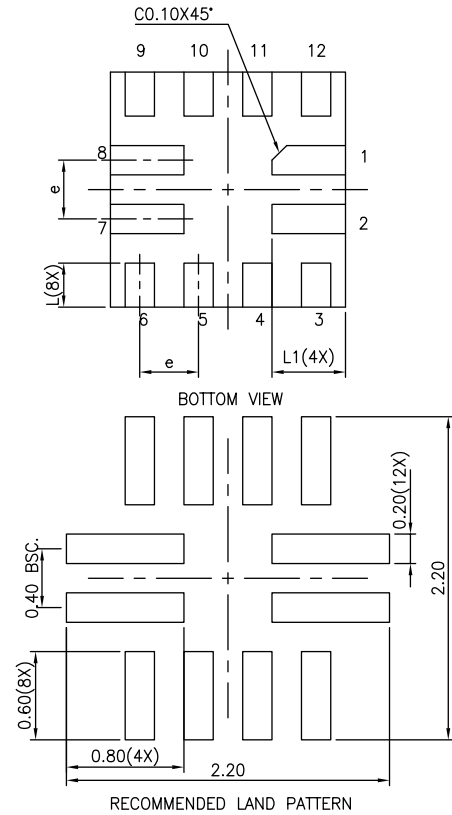
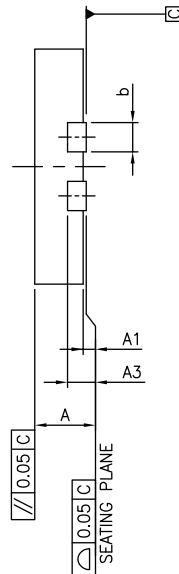
DD: PI5USB212XUAE
Y: Date Code (Year)
W: Date Code (Workweek)

Packaging Mechanical

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.

For latest package info.

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