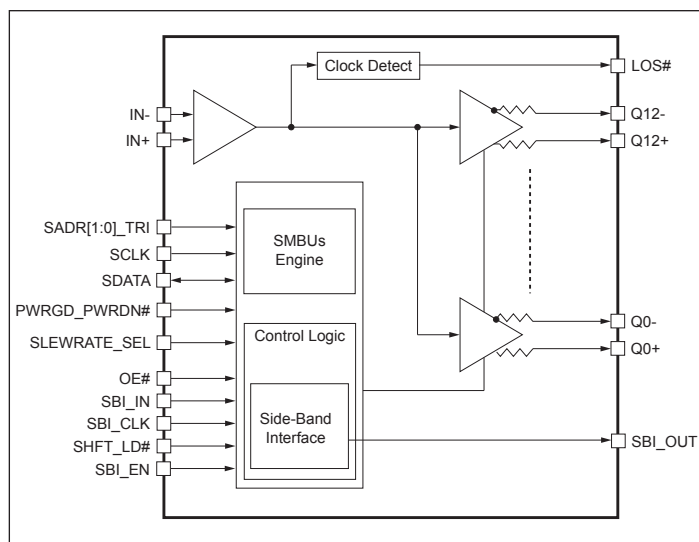


## 13-Output Low-Power Fanout Clock Buffer for PCIe 6.0 Application

### Description

The PI6CB332013A is a low-power PCIe® 5.0/6.0 clock buffer. It takes a reference input to fanout 13 low-power differential HCSL outputs up to 400MHz, with on-chip terminations for 85Ω or 100Ω output impedance. An individual OE pin for each output provides easier power management. The device also supports Power Down Tolerant (PDT), automatic output clock parking upon loss of input clock, and Flexible Startup Sequencing features.

### Block Diagram



### Features

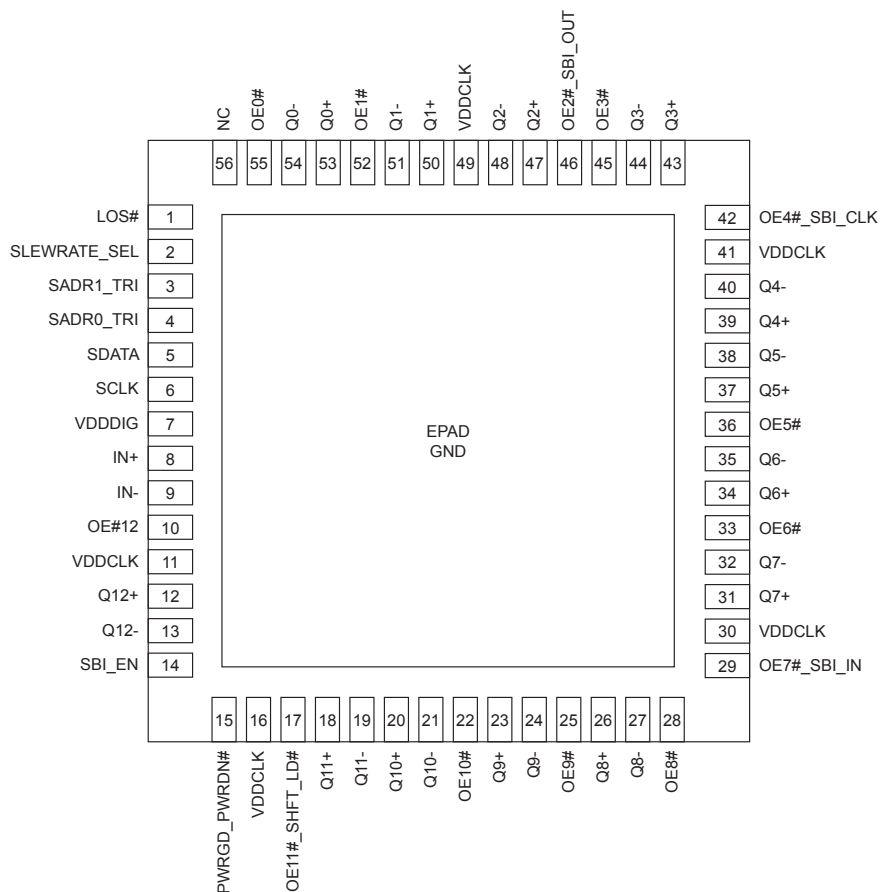
- 13 Low-Power HCSL Outputs with On-Chip Termination
- 85Ω or 100Ω Output Impedance
- Individual Output Enable
- Supports I/O Power Down Tolerant
- Flexible Startup Power Sequencing
- Automatic Output Clock Parking Upon Loss of Input Clock
- Up to 9 Selectable SMBus Addresses
- Supports SBI OE# Interface
- Differential Output-to-Output Skew <50ps
- Additive Phase Jitter
  - PCIe 5.0: Typical 5fs RMS
  - PCIe 6.0: Typical 3fs RMS
  - DB2000QL: Typical 10fs RMS
- 3.3V Supply Voltage
- Temperature Range: -40°C to 105°C
- Packaging (Pb-free & Green):
  - 56-VQFN, 7mm × 7mm (ZLF)
- 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.

<https://www.diodes.com/quality/product-definitions/>

#### 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 Number	Pin Name	Type		Description
1	LOS#	Output	Open Drain	Open drain output, needs external pull up, Low output indicates loss of input clock signal, PDT
2	SLEWRATE_SEL	Input	CMOS	Input to select default slew rate of the outputs. 0 = Slow Slew Rate, 1 = Fast Slew Rate. Internal pull up.
3	SADR1_tri	Input	Tri-level	SMBus address bit. This is a tri-level input that works in conjunction with SADR0_tri pin, to decode SMBus addresses. It has internal pull-up/down resistors to bias to VDD/2. See the SMBus Address Selection table.
4	SADR0_tri	Input	Tri-level	SMBus address bit. This is a tri-level input that works in conjunction with SADR1_tri pin, to decode SMBus addresses. It has internal pull-up/down resistors to bias to VDD/2. See the SMBus Address Selection table.
5	SDATA	I/O	CMOS	Data pin for SMBus interface.
6	SCLK	Input	CMOS	Clock pin of SMBus interface.

Pin Number	Pin Name	Type		Description
7	VDDDIG	Power		Digital power.
8	IN+	Input	Diff.	True clock input. PDT. Internal pull down.
9	IN-	Input	Diff.	Complementary clock input. Internal pull up.
10	OE12#	Input	CMOS	Active low input for enabling output 12. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
11	VDDCLK	Power		Clock power supply.
12	Q12+	Output	Diff.	True clock output.
13	Q12-	Output	Diff.	Complementary clock output.
14	SBI_EN	Input	CMOS	0 = SBI is disabled. 1 = SBI is enabled. Internal pull down, PDT.
15	PWRGD_PWRDN#	Input	CMOS	1 = power good mode, I2C address is latched. 0 = power down mode. Internal pull up, PDT.
16	VDDCLK	Power		Clock Power supply.
17	OE11#_SHFT_LD#	Input	CMOS	SBI_EN=0: OE mode 0 = Enable output, 1 = Disable Output SBI_EN=1: SBI mode This pin becomes SHFT_LD pin. For both OE mode and SBI mode, Internal pull up, PDT.
18	Q11+	Output	Diff.	True clock output.
19	Q11-	Output	Diff.	Complementary clock output.
20	Q10+	Output	Diff.	True clock output.
21	Q10-	Output	Diff.	Complementary clock output.
22	OE10#	Input	CMOS	Active low input for enabling output 10. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
23	Q9+	Output	Diff.	True clock output.
24	Q9-	Output	Diff.	Complementary clock output.
25	OE9#	Input	CMOS	Active low input for enabling output 9. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
26	Q8+	Output	Diff.	True clock output.
27	Q8-	Output	Diff.	Complementary clock output.
28	OE8#	Input	CMOS	Active low input for enabling output 8. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
29	OE7#_SBI_IN	Input	CMOS	SBI_EN=0: OE mode 0 = Enable output 7, 1 = Disable output 7 SBI_EN=1: SBI mode This pin becomes SBI_IN pin For both OE mode and SBI mode, Internal pull up, PDT.
30	VDDCLK	Power		Clock power supply.

Pin Number	Pin Name	Type		Description
31	Q7+	Output	Diff.	True clock output.
32	Q7-	Output	Diff.	Complementary clock output.
33	OE6#	Input	CMOS	Active low input for enabling output 6. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
34	Q6+	Output	Diff.	True clock output.
35	Q6-	Output	Diff.	Complementary clock output.
36	OE5#	Input	CMOS	Active low input for enabling output 5. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
37	Q5+	Output	Diff.	True clock output.
38	Q5-	Output	Diff.	Complementary clock output.
39	Q4+	Output	Diff.	True clock output.
40	Q4-	Output	Diff.	Complementary clock output.
41	VDDCLK	Power		Clock power supply.
42	OE4#_SBI_CLK	Input	CMOS	SBI_EN=0: OE mode 0 = Enable output 4, 1 = Disable output 4 SBI_EN=1: SBI mode This pin becomes SBI_CLK pin For both OE mode and SBI mode, Internal pull up, PDT.
43	Q3+	Output	Diff.	True clock output.
44	Q3-	Output	Diff.	Complementary clock output.
45	OE3#	Input	CMOS	Active low input for enabling output 3. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
46	OE2#_SBI_OUT	I/O	CMOS	SBI_EN=0: OE mode 0 = Enable output 2, 1 = Disable output 2 SBI_EN=1: SBI mode This pin becomes SBI_OUT pin For both OE mode and SBI mode, Internal pull up, PDT.
47	Q2+	Output	Diff.	True clock output.
48	Q2-	Output	Diff.	Complementary clock output.
49	VDDCLK	PWR		Clock power supply.
50	Q1+	Output	Diff.	True clock output.
51	Q1-	Output	Diff.	Complementary clock output.
52	OE1#	Input	CMOS	Active low input for enabling output 1. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.
53	Q0+	Output	Diff.	True clock output.
54	Q0-	Output	Diff.	Complementary clock output.
55	OE0#	Input	CMOS	Active low input for enabling output 0. 0 = Enable output, 1 = Disable output. Internal pull up, PDT.

PI6CB332013A

Pin Number	Pin Name	Type	Description
56	NC	NC	Not connected.
EPAD	GND	Power	Connect epad to ground.

## Maximum Ratings

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

Storage Temperature.....	–65°C to +150°C
Supply Voltage to Ground Potential, $V_{DDXX}$ .....	–0.5V to +3.9V
Input Voltage .....	–0.5V to $V_{DD} + 0.3V$ , not exceed 3.9V
Input Voltage (PDT Pin) .....	–0.5V to +3.9V
ESD Protection (HBM) .....	2000V
Iout (Output Current Continuous) .....	30mA
Iout (Output Current Surge).....	60mA
Junction Temperature .....	150°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.

## Operating Conditions

Temperature =  $T_A$ ; Supply voltages per normal operation conditions; See test circuits for the load conditions

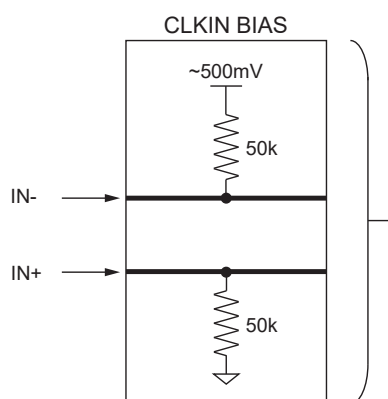
Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
$V_{DDDIG}$	Power Supply Voltage		2.97	3.3	3.63	V
$V_{DDCLK}$	Output Power Supply Voltage		2.97	3.3	3.63	V
$I_{DD}$	Power Supply Current	$V_{DDDIG} + V_{DDCLK}$ , All outputs active @100MHz		140	165	mA
$I_{DD\_PD}$	Power Supply Power Down <sup>(1)</sup> Current	$V_{DDDIG} + V_{DDCLK}$ , All outputs LOW/LOW		6	7.5	mA
$I_{DDVDDCLK\_PD}$	Power Supply Current Power Down <sup>(1)</sup> for Outputs	$V_{DDCLK}$ , All outputs LOW/LOW		0.65	1.21	mA
$T_A$	Ambient Temperature	Industrial grade	–40		105	°C

### Note:

1. Input clock is not running.
2. Outputs drive 10 inch trace.

## Input Electrical Characteristics

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
$R_{pu}$	Internal Pull up Resistance			120		K $\Omega$
$R_{dn}$	Internal Pull down Resistance			120		K $\Omega$
$L_{PIN}$	Pin Inductance				7	nH


**Figure 1. Input Clock Bias Network**

## SMBus Electrical Characteristics

 Temperature =  $T_A$ ; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
$V_{DDSMB}$	Nominal Bus Voltage		2.7		3.6	V
$V_{IHSMB}$	SMBus Input High Voltage	SMBus, $V_{DDSMB} = 3.3V$	2.1		3.6	V
		SMBus, $V_{DDSMB} < 3.3V$	$0.65 \cdot V_{DDSMB}$			
$V_{ILSMB}$	SMBus Input Low Voltage	SMBus, $V_{DDSMB} = 3.3V$			0.8	V
		SMBus, $V_{DDSMB} < 3.3V$			0.8	
$I_{SMBSINK}$	SMBus Sink Current	SMBus, at $V_{OLSMB}$	4			mA
$V_{OLSMB}$	SMBus Output Low Voltage	SMBus, at $I_{SMBSINK}$			0.4	V
$f_{MAXSMB}$	SMBus Operating Frequency	Maximum frequency			400	kHz
$t_{RMSB}$	SMBus Rise Time	(Max $V_{IL} - 0.15$ ) to (Min $V_{IH} + 0.15$ )			300	ns
$t_{FMSB}$	SMBus Fall Time	(Min $V_{IH} + 0.15$ ) to (Max $V_{IL} - 0.15$ )			300	ns

## Side-Band Interface Electrical Characteristics

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
$t_{PERIOD}$	Clock Period	Clock period	40			ns
$t_{SETUP}$	SHFT Setup Time to Clock	SHFT_LDB high to SBI_CLK rising edge	10			ns
$t_{DSU}$	SBI_IN Setup Time	SBI_IN setup to SBI_CLK rising edge	5			ns
$t_{DHOLD}$	SBI_IN Hold Time	SBI_IN hold after SBI_CLK rising edge	2			ns

**PI6CB332013A**

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
t <sub>CO</sub>	SBI_CLK to SBI_OUT	SBI_CLK rising edge to SBI_OUT valid	2			ns
t <sub>SHOLD</sub>	SHFT Hold Time	SHFT_LDB hold (high) after SBI_CLK rising edge (SBI_CLK to SHFT_LDB falling edge)	10			ns
t <sub>EN/DIS</sub>	Enable/Disable Time	Delay from SHFT_LDB falling edge to next output configuration taking effect	4		12	clocks
t <sub>SLEW</sub>	Slew Rate	SBI_CLK (between 20% and 80%)	0.7		4	V/ns
		SBI_out impedance		50		Ω

## LVCMOS DC Electrical Characteristics

Temperature = T<sub>A</sub>; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
V <sub>IH</sub>	Input High Voltage	Single-ended inputs, except SMBus	0.75 x V <sub>DD</sub>		0.3 + V <sub>DD</sub>	V
V <sub>IM</sub>	Input Mid Voltage	SADRO_TRI, SADR1_TRI, BW_SEL_TRI	0.4 x V <sub>DD</sub>	0.5 x V <sub>DD</sub>	0.6 x V <sub>DD</sub>	V
V <sub>IL</sub>	Input Low Voltage	Single-ended inputs, except SMBus	-0.3		0.25 x V <sub>DD</sub>	V
I <sub>IH</sub>	Input High Current	Single-ended inputs with pullup/pulldown resistor, V <sub>IN</sub> = V <sub>DD</sub>			50	uA
I <sub>IL</sub>	Input Low Current	Single-ended inputs with pullup/pulldown resistor, V <sub>IN</sub> = 0V	-50			μA
C <sub>IN</sub>	Input Capacitance		1.5		5	pF

## HCSL Input Characteristics<sup>(1)</sup>

Temperature = T<sub>A</sub>; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
f <sub>IN</sub>	Input Frequency	V <sub>DD</sub> = 3.3V	1	100	400	MHz
	Autoparking on		25			MHz
	Autoparking off		1			MHz
V <sub>IHDIF</sub>	Diff. Input High Voltage <sup>(3)</sup>	IN+, IN-, single-end measurement	330		1150	mV
V <sub>ILDIF</sub>	Diff. Input Low Voltage <sup>(3)</sup>	IN+, IN-, single-end measurement	-300	0	300	mV
V <sub>SWING</sub>	Diff. Input Swing Voltage	Peak to peak value (V <sub>IHDIF</sub> - V <sub>ILDIF</sub> )	200			mV
V <sub>COM</sub>	Common mode voltage		100		1200	mV
t <sub>RF</sub>	Diff. Input Slew Rate <sup>(2)</sup>		0.7			V/ns



**PI6CB332013A**

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
$I_{IN}$	Diff. Input Leakage Current	$V_{IN+} = V_{DD}$ , $V_{IN-} = 0.8V$	-40		100	$\mu A$
$t_{DC}$	Diff. Input Duty Cycle	Measured differentially	45		55	%
$t_{j-c-c}$	Diff. Input Cycle to cycle jitter	Measured differentially			125	ps

**Note:**

1. Guaranteed by design and characterization, not 100% tested in production
2. Slew rate measured through  $\pm 75mV$  window centered around differential zero
3. The device can be driven by a single-ended clock by driving the true clock and biasing the complement clock input to the  $V_{bias}$ , where  $V_{bias}$  is  $(V_{IH} - V_{IL})/2$

## **HCSL Output Characteristics**

Temperature =  $T_A$ ; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
$V_{OH}$	Output Voltage High		660	780	900	mV
$V_{OL}$	Output Voltage Low		-150	20	150	mV
$V_{cross\ absolute}$	Absolute Crossing point Voltage		250		550	mV
$V_{cross\_var}$	Crossing point voltage variation				140	mV
$f_{OUT}$	Output Frequency			100	400	MHz
$t_{RF}$	Fast Slew Rate <sup>(1,2,3)</sup>	Scope averaging on, 10 inch trace	2.3	3.0	4	V/ns
	Slow Slew Rate		2	2.8	3.8	
$Dt_{RF}$	Slew rate matching <sup>(1,2,4)</sup>	Scope averaging on, 10 inch trace			20	%
$t_{SKEW}$	Output Skew <sup>(1,2)</sup>	Averaging on, $V_T = 50\%$			50	ps
$t_{DC}$	Diff. Output Duty Cycle	Measured differentially	45		55	%
$T_{pd}$	Propagation Delay			2.0	3	ns
$t_{OELAT}$	Output Enable Latency	Q start after OE# assertion Q stop after OE# deassertion	4	5	10	clocks
$t_{PDLAT}$	PD# De-assertion	Differential outputs enable after PD# de-assertion		20	300	$\mu s$
$t_{LOSAAssert}$	LOS Assert Time	Time from disappearance of input clock to LOS assert		200	300	ns
$t_{LOSDeassert}$	LOS De-assert Time	Time from appearance of input clock to LOS de-assert		6	9	clocks

**Note:**

1. Guaranteed by design and characterization, not 100% tested in production
2. Measured from differential waveform
3. Slew rate is measured through the  $V_{swing}$  voltage range centered around differential 0V, within  $\pm 150mV$  window
4. Slew rate matching is measured through  $\pm 75mV$  window centered around differential zero
5. Duty cycle distortion is the difference in duty cycle between the out and input clock

## HCSSL Output AC Characteristics - Phase Jitter

Temperature = T<sub>A</sub>; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Condition	Typ.	Max.	Specification Limit	Units
t <sub>jph</sub> PCIeG1-CC	Additive PCIe Phase Jitter (Common Clocked Architecture) SSC ≤ -0.5%	PCIe Gen 1 (2.5 GT/s)	1300		8,600	fs p-p
t <sub>jph</sub> PCIeG2-CC		PCIe Gen 2 Hi Band (5.0 GT/s)	58		3,100	fs RMS
		PCIe Gen 2 Lo Band (5.0 GT/s)	4		3,000	
t <sub>jph</sub> PCIeG3-CC		PCIe Gen 3 (8.0 GT/s)	19		1,000	
t <sub>jph</sub> PCIeG4-CC		PCIe Gen 4 (16.0 GT/s)	19		500	
t <sub>jph</sub> PCIeG5-CC		PCIe Gen 5 (32.0 GT/s)	5	7.5	150	
t <sub>jph</sub> PCIeG6-CC		PCIe Gen 6 (64.0 GT/s)	3	5.8	100	
t <sub>jph</sub> PCIeG1-IR	Additive PCIe Phase Jitter (IR Architectures - SRIS, SRNS) SSC ≤ -0.3%	PCIe Gen 1 (2.5 GT/s)	111			fs RMS
t <sub>jph</sub> PCIeG2-IR		PCIe Gen 2 (5.0 GT/s)	51			
t <sub>jph</sub> PCIeG3-IR		PCIe Gen 3 (8.0 GT/s)	23			
t <sub>jph</sub> PCIeG4-IR		PCIe Gen 4 (16.0 GT/s)	22			
t <sub>jph</sub> PCIeG5-IR		PCIe Gen 5 (32.0 GT/s)	6	8.1		
t <sub>jph</sub> PCIeG6-IR		PCIe Gen 6 (64.0 GT/s)	4	7		

Note: The Refclk jitter is measured after applying the filter functions found in the PCI Express Base Specification 6.0, Revision 1.0. For the exact measurements

## SMBus Serial Data Interface

PI6CB332013A is a slave only device that supports block and byte protocol using a single 7-bit address and read/write bit as shown below. The highest bit of register address is to distinguish block write/read and byte write/read. when the highest bit is "1", it's the byte operation, the highest bit is "0", it's the block operation.

Read and write block transfers can be stopped after any complete byte transfer.

### Address Assignment

A6	A5	A4	A3	A2	A1	A0	R/W
1	1	0	See SMBus Address Selection Table				1/0

Note: SMBus address is latched on SADR pin

### Byte Write

1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	8 bits	1 bit	1 bit
Start bit	Address	W(0)	Ack	Beginning Byte location = N	Ack	data	Ack	Stop bit

### Byte Read

1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	1 bit	7 bits	1 bit	8 bits	1 bit	1 bit
Start bit	Address	W(0)	Ack	Beginning Byte location = N	Ack	Repeat Start bit	Address	R(1)	data	NAck	Stop bit

### Block Write

1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	8 bits	1 bit	8 bits	1 bit		8 bits	1 bit	1 bit
Start bit	Address	W(0)	Ack	Beginning Byte Location = N	Ack	Data Byte count = X	Ack	Beginning Data Byte (N)	Ack	.....	Data Byte (N+X-1)	Ack	Stop bit

### Block Read

1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	8 bits	1 bit
Start bit	Address	W(0)	Ack	Beginning Byte Location = N	Ack	Repeat Start bit	Address	R(1)	Ack	Data Byte count = X	Ack	Beginning Data Byte (N)	Ack
										8 bits	1 bit	1 bit	
.....										Data Byte (N+X-1)	NAck	Stop bit	

## SMBus Address Decode

Address Selection		Binary Value								Hex Value
SADR_tri1	SADR_tri0	7	6	5	4	3	2	1	Read/Write	
0	0	1	1	0	1	1	0	0	0	D8
	M	1	1	0	1	1	0	1	0	DA
	1	1	1	0	1	1	1	1	0	DE
M	0	1	1	0	0	0	0	1	0	C2
	M	1	1	0	0	0	1	0	0	C4
	1	1	1	0	0	0	1	1	0	C6
1	0	1	1	0	0	1	0	1	0	CA
	M	1	1	0	0	1	1	0	0	CC
	1	1	1	0	0	1	1	1	0	CE

## Side-Band Interface

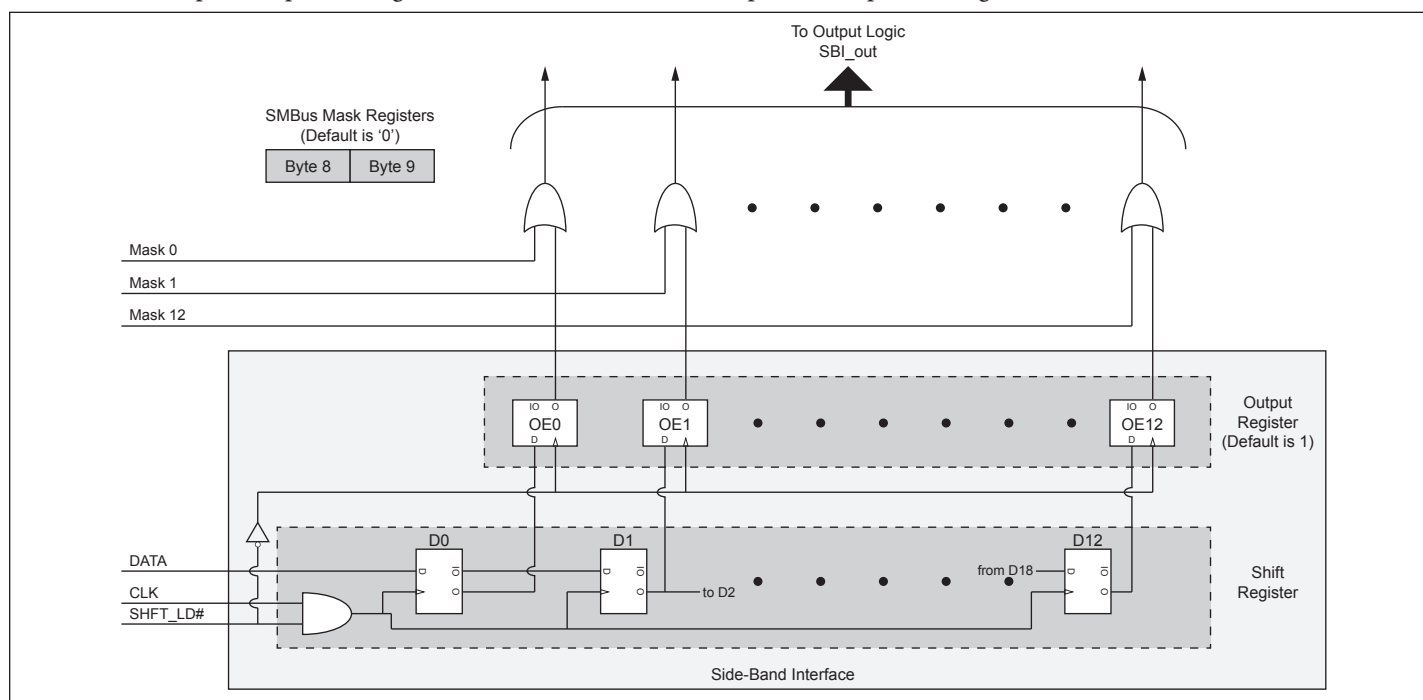
This interface consists of DATA, CLK and SHFT\_LD# pins. When the SHFT\_LD# pin is high, the rising edge of CLK can shift DATA into the shift register. After shifting data, the falling edge of SHFT\_LD# clocks the shift register contents to the Output register.

When the SBI is enabled, DATA, CLK, and SHFT\_LD# are enabled on OE7#, OE4# and OE11# respectively. Additionally, SMBus registers for masking off the disable function of the shift register (0 value of a bit) become active. When set to a one, the mask register forces its respective output to 'enabled.' This prevents accidentally disabling critical outputs when using the SBI.

An SMBus read back bit in Byte 4 indicates which output enable control interface is enabled.

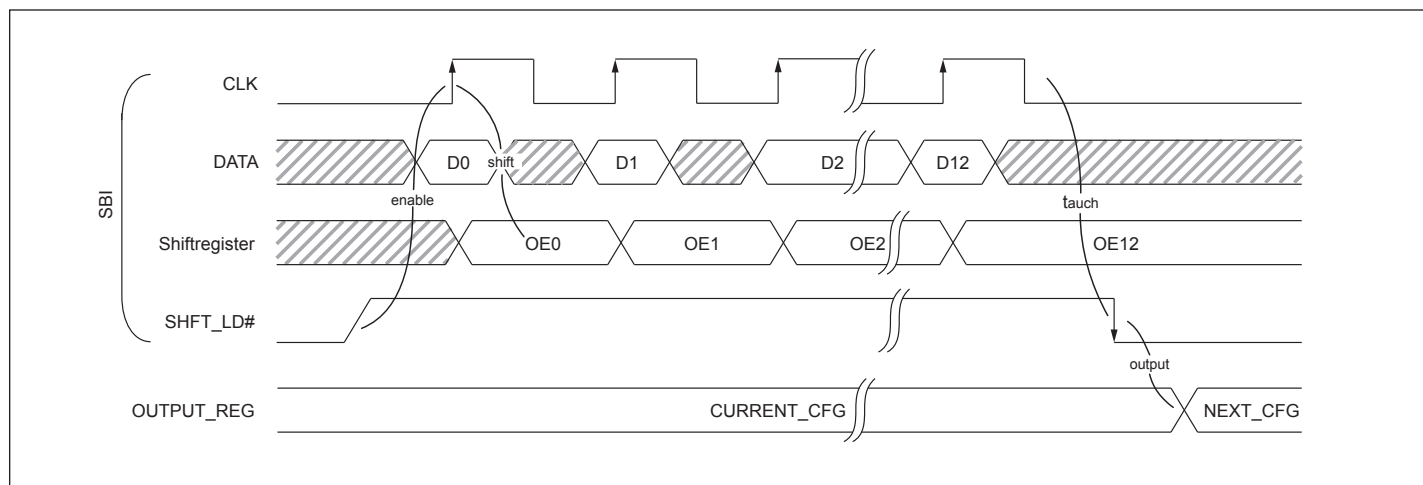
When the SBI is enabled, and power has been applied, the SBI is active, even if the PWRGD/PWRDN# pin indicates the part is in power down. This allows loading the shift register and transferring the contents to the output register before the assertion of PWRGD. Note that the mask registers are part of the normal SMBus interface and cannot be accessed when the PWRGD/PWRDN# is low. Figure 2 provides a functional description of the SBI.

The SBI and the traditional SMBus output enable registers both default to the 'output enabled' state at power-up. The mask registers default to zero at power-up, allowing the shift bits to disable their respective output. See Figure 2.



**Figure 2. Side Band Interface Control Logic Description**

Figure 3 shows the basic timing of the side-band interface. The SHFT\_LD# pin goes high to enable the CLK input. Next, the rising edge of CLK clocks enable DATA into the shift register. After the 13th clock for output 13, stop the clock low and drive the SHFT\_LD# pin low. The falling edge of SHFT\_LD# clocks the shift register contents to the output register, enabling or disabling the outputs. Always shift 13 bits of data into the shift register to control the outputs.



**Figure 3. Side Band Interface Functional Timing**

The SBI interface supports clock rates up to 10MHz. Multiple devices may share CLK and DATA pins. Dedicating a SHFT\_LD# pin to each device allows its use as a chip-select pin. When the SHFT\_LD# pin is low, the PI6CB3320xx ignores any activity on the CLK and DATA pins.

## SMBus Registers

Byte 0: OUTPUT_ENABLE_0					
Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Q5_EN	Output Enable for Q5	RW	1	1 = output is enabled 0 = output is disabled (low low)
6	Q4_EN	Output Enable for Q4	RW	1	
5	Reserved		RW	1	
4	Reserved		RW	1	
3	Q3_EN	Output Enable for Q3	RW	1	
2	Q2_EN	Output Enable for Q2	RW	1	
1	Q1_EN	Output Enable for Q1	RW	1	
0	Q0_EN	Output Enable for Q0	RW	1	
Byte 1: OUTPUT_ENABLE_1					
Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RW	1	0 = output is disabled (low/low) 1 = output is enabled
6	Q12_EN	Output Enable for Q12	RW	1	
5	Q11_EN	Output Enable for Q11	RW	1	
4	Q10_EN	Output Enable for Q10	RW	1	
3	Q9_EN	Output Enable for Q9	RW	1	
2	Q8_EN	Output Enable for Q8	RW	1	
1	Q7_EN	Output Enable for Q7	RW	1	
0	Q6_EN	Output Enable for Q6	RW	1	
Byte 2: OE#_PIN_READBACK_0					
Bit	Control Function	Description	Type	Power Up Condition	Definition
7	RB_OE#_5	Status of OE#5	RO	Pin	0 = OE# pin low 1 = OE# pin high
6	RB_OE#_4	Status of OE#4	RO	Pin	
5	Reserved		RO	1	
4	Reserved		RO	1	
3	RB_OE#_3	Status of OE#3	RO	Pin	
2	RB_OE#_2	Status of OE#2	RO	Pin	
1	RB_OE#_1	Status of OE#1	RO	Pin	
0	RB_OE#_0	Status of OE#0	RO	Pin	

**Byte 3: OE#\_PIN\_READBACK\_1**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RO	1	0 = OE# pin low 1 = OE# pin high
6	RB_OE#_12	Status of OE#12	RO	Pin	
5	RB_OE#_11	Status of OE#11	RO	Pin	
4	RB_OE#_10	Status of OE#10	RO	Pin	
3	RB_OE#_9	Status of OE#9	RO	Pin	
2	RB_OE#_8	Status of OE#8	RO	Pin	
1	RB_OE#_7	Status of OE#7	RO	Pin	
0	RB_OE#_6	Status of OE#6	RO	Pin	

**Byte 4: SBEN\_RDBK\_ACP\_CONFIG**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RW	1'b111	
6			RW		
5			RW		
4	ACP_ENABLE	Enable Automatic Clock Parking to low/low when LOS event is detected	RW	1	0 = disable ACP 1 = enable ACP
3	Reserved		RW	1'b110	
2			RW		
1			RW		
0	RB_SBI_ENQ	Status of SBI_ENQ	RO	1'bX	0 = pin low 1 = pin high

**Byte 5: VENDOR\_REVISION\_ID**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	RID	REVISION ID, A rev is 0000	RO	0000	
6			RO		
5			RO		
4			RO		
3	VID	VENDOR ID, Diodes	RO	0011	
2			RO		
1			RO		
0			RO		



**PI6CB332013A**
**Byte 6: DEVICE\_ID**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	DEVICE_ID	Device ID	RO	PI6CB332013A (0H4D) PI6CB332013A100 (0H6D)	
6			RO		
5			RO		
4			RO		
3			RO		
2			RO		
1			RO		
0			RO		

**Byte 7: BYTE\_COUNT**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RW	0x0	
6			RW		
5			RW		
4	BC	Writing to this register configures how many bytes will be read back in a block read.	RW	0x7	
3			RW		
2			RW		
1			RW		
0			RW		

**Byte 8: SBI\_MASK\_0**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	MASK5	Masks off Side-band Disable for Q5	RW	0	0 = SBI may disable the output 1 = SBI cannot disable the output
6	MASK4	Masks off Side-band Disable for Q4	RW	0	
5	Reserved		RW	0	
4	Reserved		RW	0	
3	MASK3	Masks off Side-band Disable for Q3	RW	0	
2	MASK2	Masks off Side-band Disable for Q2	RW	0	
1	MASK1	Masks off Side-band Disable for Q1	RW	0	
0	MASK0	Masks off Side-band Disable for Q0	RW	0	

**PI6CB332013A**
**Byte 9: SBI\_MASK\_1**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RW	0	0 = SBI may disable the output 1 = SBI cannot disable the output
6	MASK12	Masks off Side-band Disable for Q12	RW	0	
5	MASK11	Masks off Side-band Disable for Q11	RW	0	
4	MASK10	Masks off Side-band Disable for Q10	RW	0	
3	MASK9	Masks off Side-band Disable for Q9	RW	0	
2	MASK8	Masks off Side-band Disable for Q8	RW	0	
1	MASK7	Masks off Side-band Disable for Q7	RW	0	
0	MASK6	Masks off Side-band Disable for Q6	RW	0	

**Byte 10: RESERVED**
**Byte 11: SBI\_READBACK\_0**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	SBI_Q5	Readback of Sideband_Disable for Q5	RO	X	0 = bit low 1 = bit high
6	SBI_Q4	Readback of Sideband_Disable for Q4	RO	X	
5	Reserved		RO	0	
4	Reserved		RO	0	
3	SBI_Q3	Readback of Sideband_Disable for Q3	RO	X	
2	SBI_Q2	Readback of Sideband_Disable for Q2	RO	X	
1	SBI_Q1	Readback of Sideband_Disable for Q1	RO	X	
0	SBI_Q0	Readback of Sideband_Disable for Q0	RO	X	

**Byte 12: SBI\_READBACK\_1**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RO	0	0 = bit low 1 = bit high
6	SBI_Q12	Readback of Sideband_Disable for Q12	RO	X	
5	SBI_Q11	Readback of Sideband_Disable for Q11	RO	X	
4	SBI_Q10	Readback of Sideband_Disable for Q10	RO	X	
3	SBI_Q9	Readback of Sideband_Disable for Q9	RO	X	
2	SBI_Q8	Readback of Sideband_Disable for Q8	RO	X	
1	SBI_Q7	Readback of Sideband_Disable for Q7	RO	X	
0	SBI_Q6	Readback of Sideband_Disable for Q6	RO	X	

**Byte 13-16: RESERVED**

**PI6CB332013A**
**Byte 17: LPHCSL\_AMP\_CTRL**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	AMP	Global Differential output Control 0.625V~1V 25mV/step Default = 0.8V	RW	0x70	
6			RW		
5			RW		
4			RW		
3	Reserved			0x0	
2					
1					
0					

**Byte 18: POWERDOWN\_RESTORE\_LOS#**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	AC_IN	Enable receiver bias when IN is AC coupled	RW	0	0 = DC coupled input 1 = AC coupled input
6	Rx_TERM	Enable termination resistors on IN	RW	0	0 = input termination R is disabled 1 = input termination R is enabled
5	Reserved		RW	0	
4			RW	0	
3	PD_RESTORE#	Save Configuration in Power Down	RW	1	0 = Config Cleared 1 = Config Saved
2	SDATA_TIMEOUT_EN	Enable SMB SDATA time out monitoring	RW	1	0 = disable SDATA time out 1 = enable SDATA time out
1	Reserved		RW	0	
0	LOS#_RB	Real time read back of loss detect block output	RO	1'bX	0 = LOS event detected 1 = NO LOS event detected.

**Byte 19: RESERVED**

**Byte 20: OUTPUT\_SLEW\_RATE\_0**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Q5_SLEWRATE	Q5 Slewrate Control	RW	pin status	0 = low slew rate 1 = high slew rate
6	Q4_SLEWRATE	Q4 Slewrate Control	RW	pin status	
5	Reserved		RW	pin status	
4	Reserved		RW	pin status	
3	Q3_SLEWRATE	Q3 Slewrate Control	RW	pin status	
2	Q2_SLEWRATE	Q2 Slewrate Control	RW	pin status	
1	Q1_SLEWRATE	Q1 Slewrate Control	RW	pin status	
0	Q0_SLEWRATE	Q0 Slewrate Control	RW	pin status	

**Byte 21: OUTPUT\_SLEW\_RATE\_1**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RW	pin status	0 = low slew rate 1 = high slew rate
6	Q12_SLEWRATE	Q12 Slewrate Control	RW	pin status	
5	Q11_SLEWRATE	Q11 Slewrate Control	RW	pin status	
4	Q10_SLEWRATE	Q10 Slewrate Control	RW	pin status	
3	Q9_SLEWRATE	Q9 Slewrate Control	RW	pin status	
2	Q8_SLEWRATE	Q8 Slewrate Control	RW	pin status	
1	Q7_SLEWRATE	Q7 Slewrate Control	RW	pin status	
0	Q6_SLEWRATE	Q6 Slewrate Control	RW	pin status	

**Byte 22-37: RESERVED**
**Byte 38: WRITE\_LOCK\_NCLEAR**

Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RW	1'b00000000	
6			RW		
5			RW		
4			RW		
3			RW		
2			RW		
1			RW		
0	WRITE_LOCK	Non-clearable SMBus Write Lock bit. When written to one, the SMBus control registers cannot be written to. This bit can only be cleared by cycling power.	RW	0	0 = SMBus not locked for writing by this bit. See WRITE_LOCK_RW1C bit. 1 = SMBus locked for writing

Byte 39: WRITE_LOCK_CLEAR_LOS_EVENT					
Bit	Control Function	Description	Type	Power Up Condition	Definition
7	Reserved		RW1C	1'b000000	
6			RW1C		
5			RW1C		
4			RW1C		
3			RW1C		
2			RW1C		
1	LOS_EVT	<p>LOS Event Status</p> <p>When high, indicates that a LOS event was detected. Can be cleared by writing a 1 to it.</p>	RW1C	0	<p>0 = No LOS event detected</p> <p>1 = LOS event detected.</p>
0	WRITE_LOCK_RW1C	<p>Clearable SMBus Write Lock bit.</p> <p>When written to one, the SMBus control registers cannot be written to. This bit can be cleared by writing a 1 to it.</p>	RW1C	0	<p>0 = SMBus not locked for writing by this bit. See WRITE_LOCK bit.</p> <p>1 = SMBus locked for writing</p>

## Applications Information

### Power Down Tolerant Pins

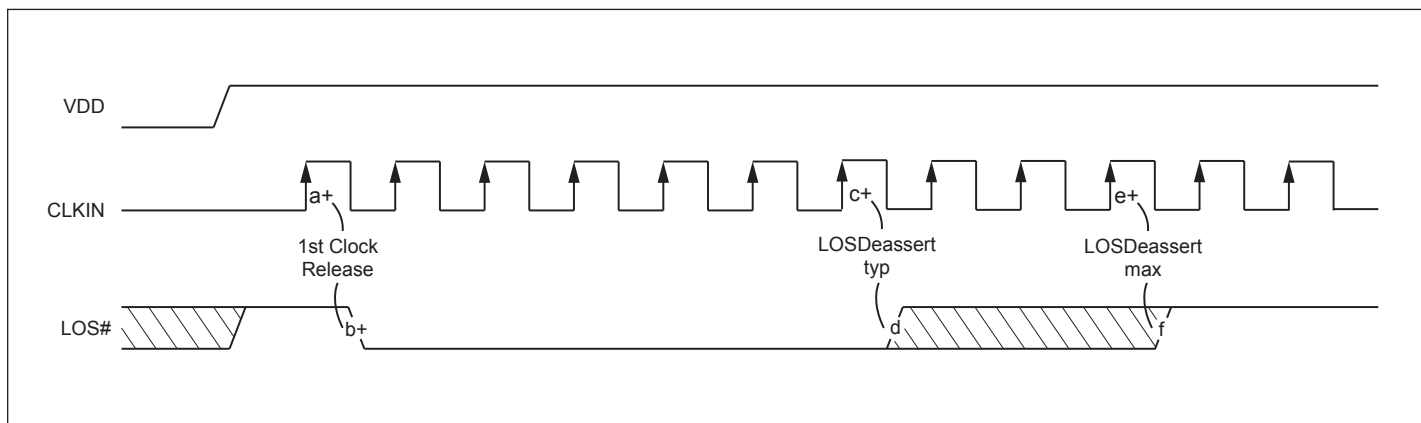
Pins that are Power Down Tolerant (PDT) can be driven by voltages as high as the normal VDD of the chip, even though VDD is not present (the device is not powered). There will be no ill effects to the device and it will power up normally. This feature supports disaggregation, where the PI6CB3320xx may be on one circuit board and devices that interface with it are on other boards. These boards may power up at different times, driving pins on the PI6CB3320xx before it has received power.

### Flexible Startup Sequencing

PI6CB3320xx devices support Flexible Startup Sequencing (FSS), IN+/- pins are PDT. FSS allows application of CLKIN at different times in the device/system startup sequence. FSS is an additional feature that helps the system designer manage the impact of disaggregation. Table shows the supported sequences; that is, the PI6CB3320xx devices can have CLKIN running before VDD is applied, and can have VDD applied and sit for extended periods with no input clock.

### Loss of Signal and Automatic Clock Parking

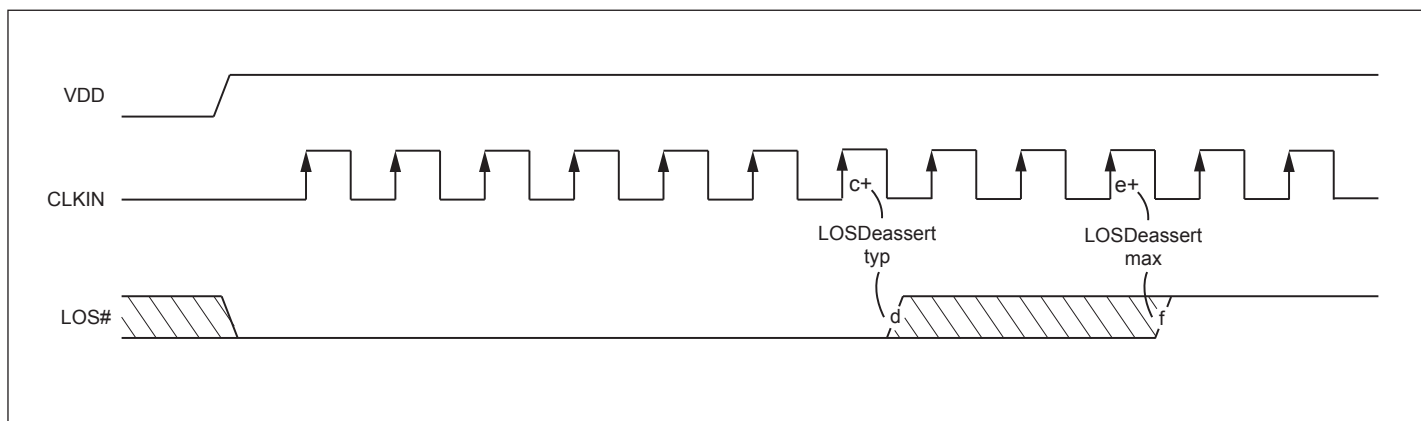
The PI6CB3320xx buffers have a Loss of Signal (LOS) circuit to detect the presence or absence of an input clock. The LOS circuit drives the open-drain LOS# pin (the “#” suffix indicates “bar”, or active-low) and sets the LOS\_EVT bit in the SMBus register space. There are two slightly different LOS# pin behaviors at power up. Figure 4 and Figure 5 show the LOS# de-assertion timing for the 4, 8, 13, 16 and 20-output buffers. CLKIN is represented differentially in Figure 4 and Figure 5.



**Figure 4. LOS# De-assert Timing for 4/8/13/16 Outputs**

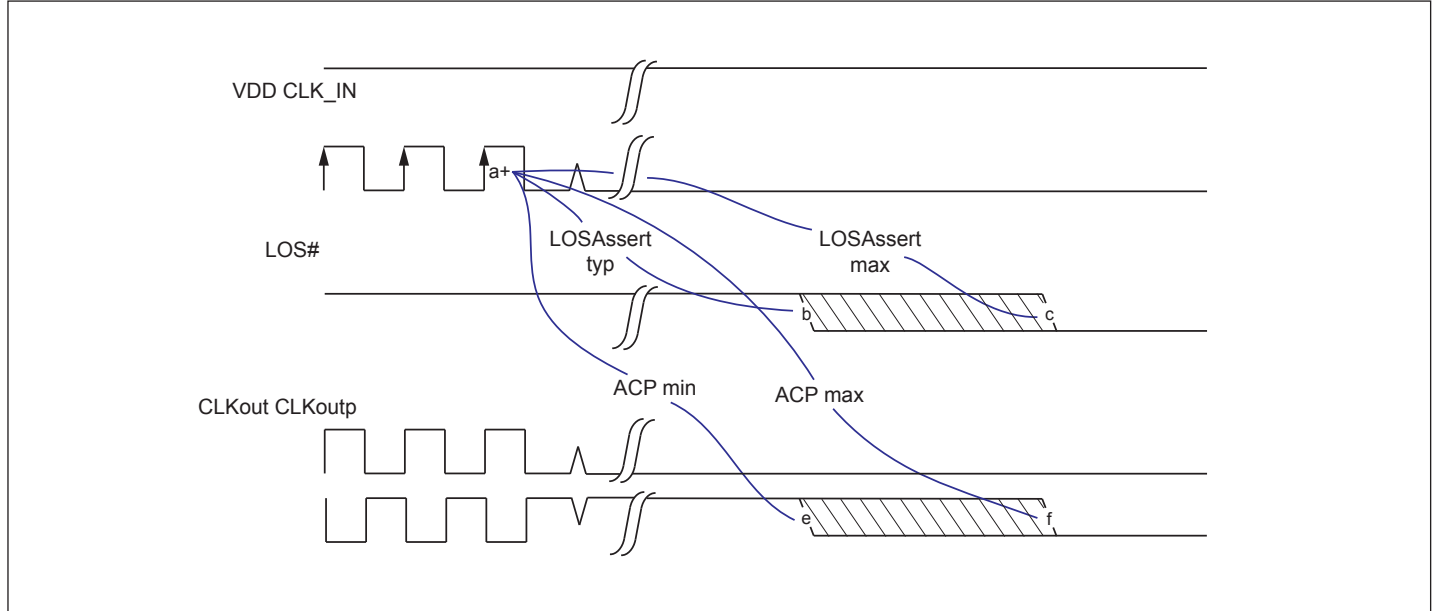
Note: The LOS circuit on the 13-output buffer requires a CLKIN edge to release the LOS# pin after power up. So, the LOS# pin will be high until the first clock edge after power up.

Figure 5 shows the LOS# de-assertion timing for the 20-output buffers. LOS# on the 20-output buffers defaults to low at power up.



**Figure 5. LOS# De-assert Timing for 20 Outputs**

The following diagram shows the LOS# assertion sequence when the CLKIN is lost. It also shows the Automatic Clock Parking (ACP) circuit bring the inputs to a Low/Low state after an LOS event. For exact timing, see Electrical Characteristics.



**Figure 6. LOS# Assert Timing**

## Test Load

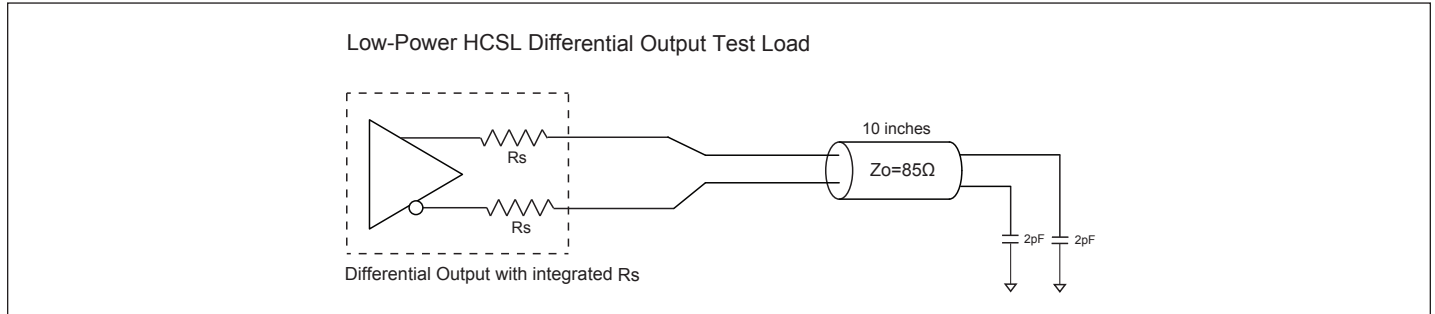


Figure 7. Low Power HCSL Test Circuit

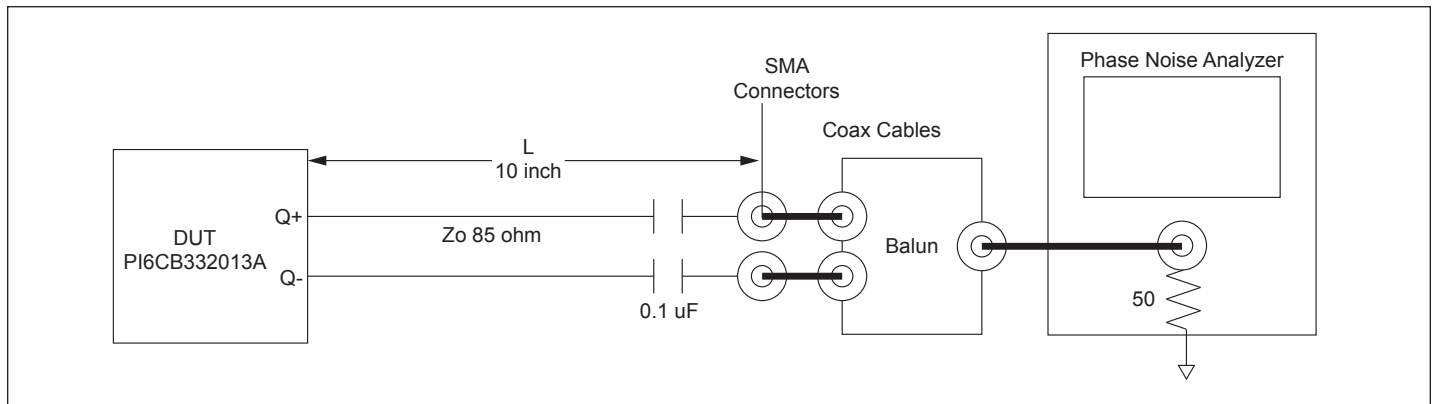


Figure 8. Test Set Up for Phase Jitter Measurement

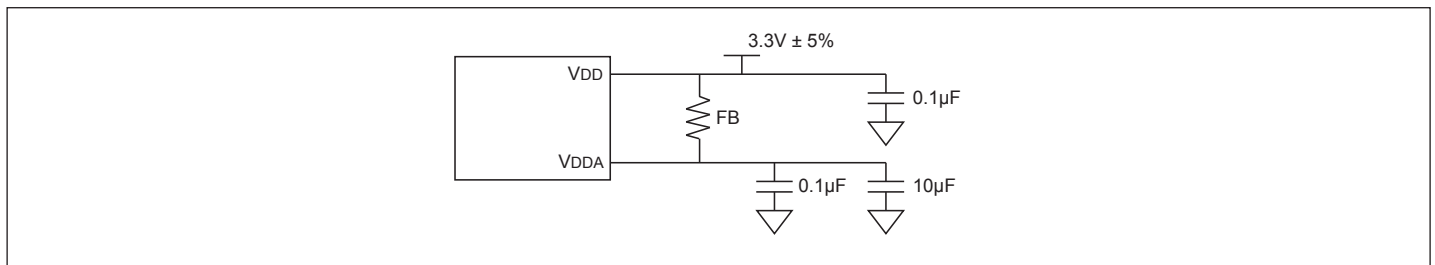


Figure 9. Power Supply Filter



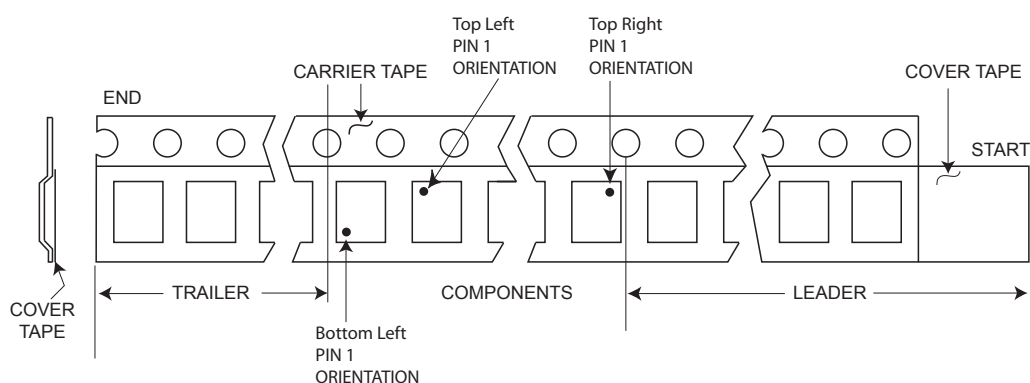
**PI6CB332013A**

## Part Marking



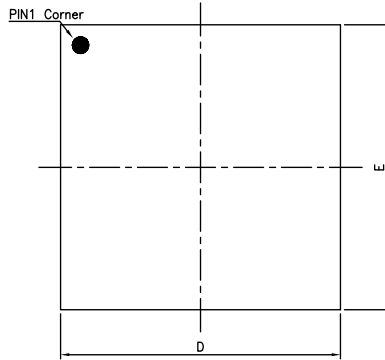
\*: Die Rev  
YY: Date Code (Year)  
WW: Date Code (Workweek)  
1st X: Assembly Site Code  
2nd X: Fab Site Code

## Package Information



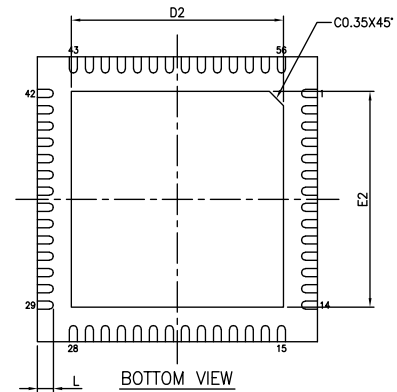
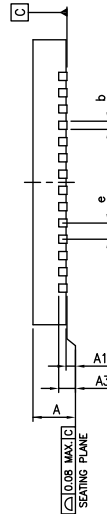
## Packaging Mechanical

### 56-VQFN (ZLF)

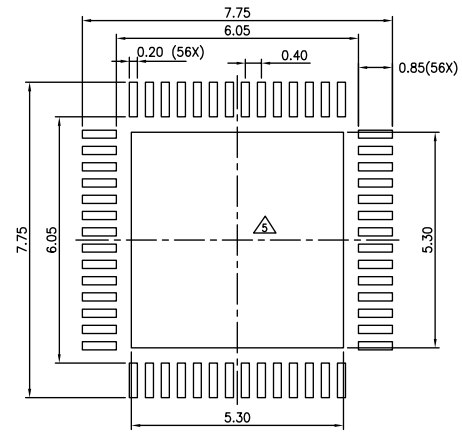


TOP VIEW

SYMBOLS	MIN.	NOM.	MAX.
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
A3	0.203 REF.		
b	0.15	0.20	0.25
D	6.90	7.00	7.10
E	6.90	7.00	7.10
e	0.40 BSC		
L	0.35	0.40	0.45
D2	5.25	5.30	5.35
E2	5.25	5.30	5.35



BOTTOM VIEW



RECOMMENDED LAND PATTERN

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: 07/17/23

DESCRIPTION: V-QFN7070-56

PACKAGE CODE: ZLF (ZLF56)

DOCUMENT CONTROL #: PD-2285

REVISION: -

For latest package info.

please check: <http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/>

## Ordering Information

Orderable Part Number	Package Code	Package Description	Pin 1 Orientation	Temperature
PI6CB332013AZLFEX	ZLF	56-Pin, VQFN7070-56	Top Right Corner	-40~105°C
PI6CB332013A100ZLFEX	ZLF	56-Pin, VQFN7070-56	Top Right Corner	-40~105°C
PI6CB332013AZLFEX-13R	ZLF	56-Pin, VQFN7070-56	Top Left Corner	-40~105°C
PI6CB332013A100ZLFEX-13R	ZLF	56-Pin, VQFN7070-56	Top Left Corner	-40~105°C

### 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. A = For 85Ω output impedance, A100 = For 100Ω output impedance
5. E = Pb-free and Green
6. X suffix = Tape/Reel
7. For packaging detail, go to our website at: <https://www.diodes.com/assets/MediaList-Attachments/Diodes-Package-Information.pdf>

**IMPORTANT NOTICE**

1. DIODES INCORPORATED (Diodes) AND ITS SUBSIDIARIES MAKE NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO ANY INFORMATION CONTAINED IN THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

2. The Information contained herein is for informational purpose only and is provided only to illustrate the operation of Diodes' products described herein and application examples. Diodes does not assume any liability arising out of the application or use of this document or any product described herein. This document is intended for skilled and technically trained engineering customers and users who design with Diodes' products. Diodes' products may be used to facilitate safety-related applications; however, in all instances customers and users are responsible for (a) selecting the appropriate Diodes products for their applications, (b) evaluating the suitability of Diodes' products for their intended applications, (c) ensuring their applications, which incorporate Diodes' products, comply the applicable legal and regulatory requirements as well as safety and functional-safety related standards, and (d) ensuring they design with appropriate safeguards (including testing, validation, quality control techniques, redundancy, malfunction prevention, and appropriate treatment for aging degradation) to minimize the risks associated with their applications.

3. Diodes assumes no liability for any application-related information, support, assistance or feedback that may be provided by Diodes from time to time. Any customer or user of this document or products described herein will assume all risks and liabilities associated with such use, and will hold Diodes and all companies whose products are represented herein or on Diodes' websites, harmless against all damages and liabilities.

4. Products described herein may be covered by one or more United States, international or foreign patents and pending patent applications. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks and trademark applications. Diodes does not convey any license under any of its intellectual property rights or the rights of any third parties (including third parties whose products and services may be described in this document or on Diodes' website) under this document.

5. Diodes' products are provided subject to Diodes' Standard Terms and Conditions of Sale (<https://www.diodes.com/about/company/terms-and-conditions/terms-and-conditions-of-sales/>) or other applicable terms. This document does not alter or expand the applicable warranties provided by Diodes. Diodes does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

6. Diodes' products and technology may not be used for or incorporated into any products or systems whose manufacture, use or sale is prohibited under any applicable laws and regulations. Should customers or users use Diodes' products in contravention of any applicable laws or regulations, or for any unintended or unauthorized application, customers and users will (a) be solely responsible for any damages, losses or penalties arising in connection therewith or as a result thereof, and (b) indemnify and hold Diodes and its representatives and agents harmless against any and all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim relating to any noncompliance with the applicable laws and regulations, as well as any unintended or unauthorized application.

7. While efforts have been made to ensure the information contained in this document is accurate, complete and current, it may contain technical inaccuracies, omissions and typographical errors. Diodes does not warrant that information contained in this document is error-free and Diodes is under no obligation to update or otherwise correct this information. Notwithstanding the foregoing, Diodes reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes.

8. Any unauthorized copying, modification, distribution, transmission, display or other use of this document (or any portion hereof) is prohibited. Diodes assumes no responsibility for any losses incurred by the customers or users or any third parties arising from any such unauthorized use.

9. This Notice may be periodically updated with the most recent version available at <https://www.diodes.com/about/company/terms-and-conditions/important-notice>

The Diodes logo is a registered trademark of Diodes Incorporated in the United States and other countries.

All other trademarks are the property of their respective owners.

© 2025 Diodes Incorporated. All Rights Reserved.

[www.diodes.com](http://www.diodes.com)