A Product Line of
Diodes Incorporated

PI6CBE33123

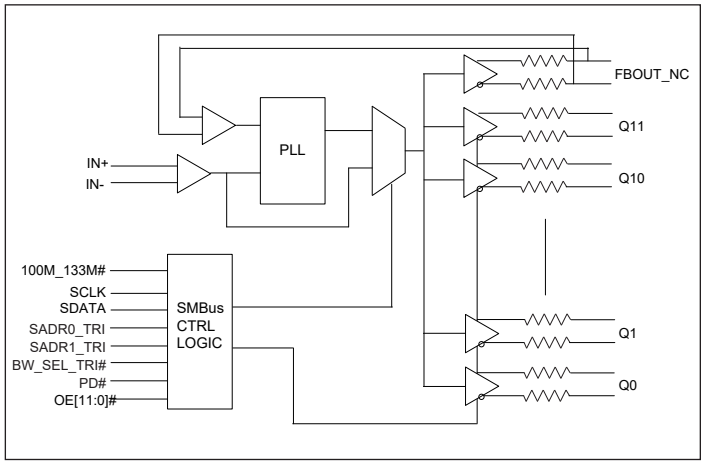
Low-Power 12-Output ZDB / Fanout Clock Buffer for PCIe 5.0/6.0 and UPI

Description

The DIODES PI6CBE33123 is a low-power PCIe® 1.0/2.0/3.0/4.0/5.0/6.0 clock buffer. It takes a reference input to fanout twelve 100MHz low-power differential HCSL outputs with on-chip terminations for 33Ω output impedance. It supports both zero-delay and fanout buffer functions for various applications. An individual OE pin for each output provides easier power management.

It uses Diodes proprietary PLL design to achieve very-low jitter that meets PCIe 1.0/2.0/3.0/4.0/5.0/6.0 requirements. Other than PCIe 100MHz support, this device also supports 133.33MHz via a pin.

Block Diagram



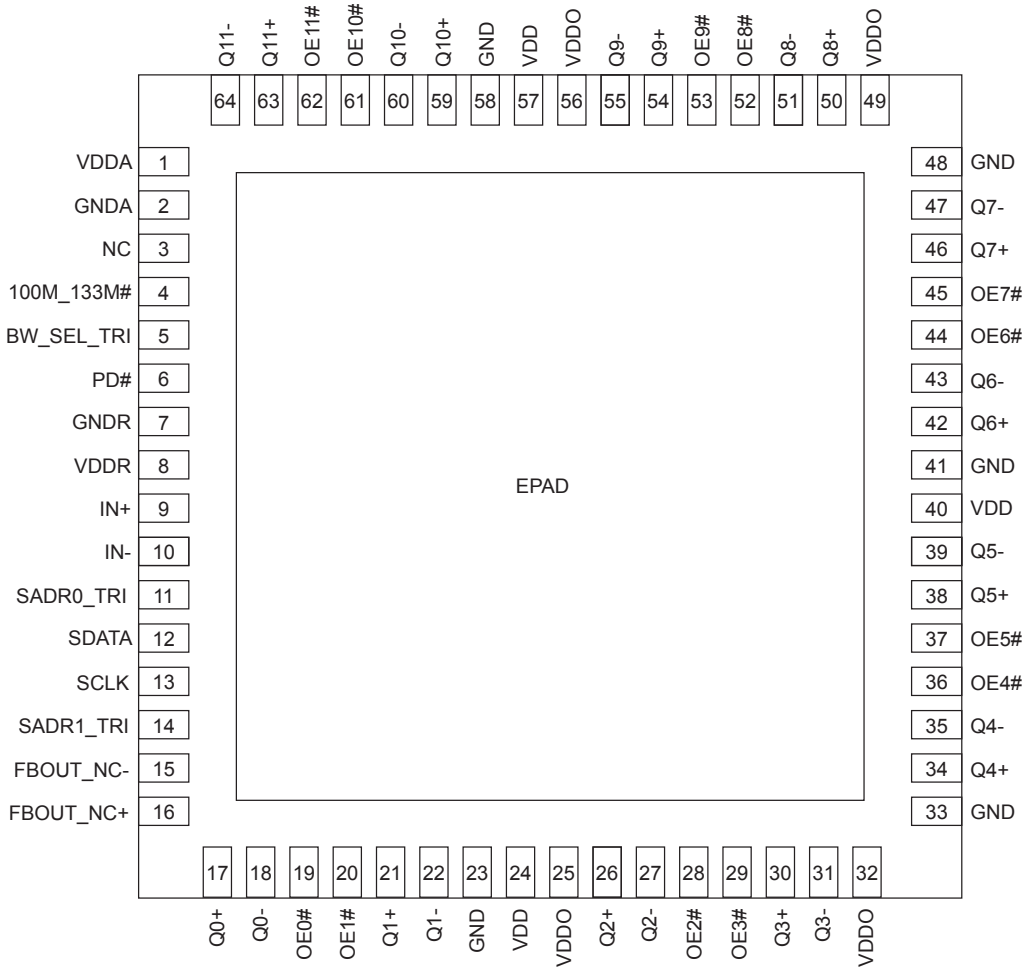
Features

- Twelve Differential Low-Power HCSL Outputs with On-Chip Termination
- Default Z_{OUT} = 33Ω
- Spread Spectrum Tolerant
- Individual Output Enable
- Selectable PLL Bandwidths
- Hardware/SMBus Control of ZDB and Fanout Buffer Modes
- Up to 9 Selectable SMBus Addresses
- 1 to 400MHz Fanout Buffer Operation
- 100MHz and 133.33MHz ZDB Mode
- Differential Output-to-output Skew <50ps
- Very Low Jitter Outputs
  - Differential Cycle-to-Cycle Jitter <50ps
  - Fanout Buffer Mode Additive Phase Jitter
    - PCIe 6.0 CC: 0.012ps
    - DB2000Q Additive Jitter: 0.02ps
  - ZDB Mode Phase Jitter
    - PCIe 6.0 CC: RMS 0.01ps
    - QPI/UPI 11.4GB/s: 0.14ps RMS
    - IF-UPI: RMS 0.15 ps
- 3.3V Core Supply Voltage
- 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 or your local Diodes representative. https://www.diodes.com/quality/product-definitions/
- Packaging (Pb-free & Green):
  - 64-lead, 9mm × 9mm TQFN (ZD)

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	VDDA	Power	—	Analog VDD
2	GNDA	Power	—	Analog ground
3	NC	—	—	Internal connected for feedback loop. Do not connect this pin.
4	100M_133M#	Input	CMOS	Latch to select frequency. This pin has internal pullup resistor. See Frequency Select Table
5	BW_SEL_TRI	Input	Tri-level	Latch to select low-loop bandwidth, bypass PLL, and high-loop bandwidth. This pin has internal pullup resistor
6	PD#	Input	CMOS	Input notifies device to sample latched inputs and start up on first high assertion. Low enters Power Down Mode; subsequent high assertions exit Power Down Mode. This pin has internal pullup resistor.
7	GNDR	Power	—	Analog ground for receiver

Pin Number	Pin Name	Type		Description
8	VDDR	Power	—	Analog VDD for receiver
9	IN+	Input	HCSL	Differential true clock input
10	IN-	Input	HCSL	Differential complementary clock input
11	SADR0_TRI	Input	Tri-level	Latch to select SMBus Address. This pin has an internal pulldown.
12	SDATA	Input/ Output	CMOS	SMBUS Data line, 3.3V tolerant
13	SCLK	Input	CMOS	SMBUS clock input, 3.3V tolerant
14	SADR1_TRI	Input	Tri-level	Latch to select SMBus Address. This pin has an internal pulldown.
15	FBOUT_NC-	—	—	Complementary differential feedback output. This pin should NOT be connected to anything outside the chip. It exists to provide delay path matching to get zero propagation delay.
16	FBOUT_NC+	—	—	True differential feedback output. This pin should NOT be connected to anything outside the chip. It exists to provide delay path matching to get zero propagation delay.
17	Q0+	Output	HCSL	Differential true clock output
18	Q0-	Output	HCSL	Differential complementary clock output
19	OE0#	Input	CMOS	Active low input for enabling Q0 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
20	OE1#	Input	CMOS	Active low input for enabling Q1 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
21	Q1+	Output	HCSL	Differential true clock output
22	Q1-	Output	HCSL	Differential complementary clock output
23, 33, 41, 48, 58	GND	Power	—	Ground
24, 40, 57	V_{DD}	Power	—	Power supply, nominal 3.3V
25, 32, 49, 56	VDDO	Power	—	Power supply for differential outputs
26	Q2+	Output	HCSL	Differential true clock output
27	Q2-	Output	HCSL	Differential complementary clock output
28	OE2#	Input	CMOS	Active low input for enabling Q2 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
29	OE3#	Input	CMOS	Active low input for enabling Q3 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
30	Q3+	Output	HCSL	Differential true clock output
31	Q3-	Output	HCSL	Differential complementary clock output
34	Q4+	Output	HCSL	Differential true clock output
35	Q4-	Output	HCSL	Differential complementary clock output
36	OE4#	Input	CMOS	Active low input for enabling Q4 pair. This pin has an internal pulldown. 1 = disable outputs, 0 = enable outputs
37	OE5#	Input	CMOS	Active low input for enabling Q5 pair. This pin has an internal pulldown. 1 = disable outputs, 0 = enable outputs

Pin Number	Pin Name	Type		Description
38	Q5+	Output	HCSL	Differential true clock output
39	Q5-	Output	HCSL	Differential complementary clock output
42	Q6+	Output	HCSL	Differential true clock output
43	Q6-	Output	HCSL	Differential complementary clock output
44	OE6#	Input	CMOS	Active low input for enabling Q6 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
45	OE7#	Input	CMOS	Active low input for enabling Q7 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
46	Q7+	Output	HCSL	Differential true clock output
47	Q7-	Output	HCSL	Differential complementary clock output
50	Q8+	Output	HCSL	Differential true clock output
51	Q8-	Output	HCSL	Differential complementary clock output
52	OE8#	Input	CMOS	Active low input for enabling Q8 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
53	OE9#	Input	CMOS	Active low input for enabling Q9 pair. This pin has an internal pulldown. 1 =disable outputs, 0 = enable outputs
54	Q9+	Output	HCSL	Differential true clock output
55	Q9-	Output	HCSL	Differential complementary clock output
59	Q10+	Output	HCSL	Differential true clock output
60	Q10-	Output	HCSL	Differential complementary clock output
61	OE10#	Input	CMOS	Active low input for enabling Q10 pair. This pin has an internal pull-down. 1 = disable outputs, 0 = enable outputs
62	OE11#	Input	CMOS	Active low input for enabling Q11 pair. This pin has an internal pull-down. 1 = disable outputs, 0 = enable outputs
63	Q11+	Output	HCSL	Differential true clock output
64	Q11-	Output	HCSL	Differential complementary clock output
EPAD	EPAD	Power	—	Connect to ground

SMBus Address Selection Table

	SADR1_tri	SADR0_tri	Address
State of SADR on first application of PD#	0	0	D8
	0	M	DA
	0	1	DE
	M	0	C2
	M	M	C4
	M	1	C6
	1	0	CA
	1	M	CC
	1	1	CE

Power Management Table

PD#	IN	SMBus OE bit	OEn#	Qn+	Qn-	PLL Status
0	X	X	X	Low	Low	Off
1	Running	0	X	Low	Low	On(1)
1	Running	1	0	Running	Running	On(1)
1	Running	1	1	Low	Low	On(1)

Note:
1. If PLL Bypass mode is selected, the PLL will be off and outputs will be running.

PLL Operating Mode Select Table

BW_SEL_TRI	Operating Mode	PLL
0	PLL with Low Bandwidth	Running
M	PLL Bypass	Off
1	PLL with High Bandwidth	Running

Frequency Select Table

100M_133M#	IN (MHz)	Qn (MHz)
0	133.33	133.33
1 (default)	100	100

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 +4.6V
Input Voltage ..... –0.5V to V_{DD} +0.5V, not exceed 4.6V
SMBus, Input High Voltage 3.6V
ESD Protection (HBM) 2000V
Junction Temperature .....125°C max

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_{DD}, V_{DDA}, V_{DDR}	Power Supply Voltage	—	3.135	3.3	3.465	V
V_{DDO}	Output Power Supply Voltage	—	0.95	1.05-3.3	3.465	V
I_{DDA}	Analog Power Supply Current	V_{DDA}, PLL mode, All outputs active @ 100MHz	—	20	25	mA
I_{DD}	Power Supply Current	V_{DD} + V_{DD_R}, All outputs active @ 100MHz	—	46	55	mA
I_{DDO}	Power Supply Current for Outputs(2)	V_{DDO}, PLL mode, All outputs active @ 100MHz	—	100	115	mA
I_{DDA_PD}	Analog Power Supply Power Down(1) Current	V_{DDA}, PLL mode, All outputs LOW/LOW	—	0.55	1	mA
I_{DD_PD}	Power Supply Power Down(1) Current	V_{DD} + V_{DD_R}, All outputs LOW/LOW	—	0.9	1.1	mA
I_{DDO_PD}	Power Supply Current Power Down(1) for Outputs	V_{DDO}, All outputs LOW/LOW	—	1.75	2.5	mA
T_A	Ambient Temperature	Industrial grade	–40	—	85	°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 Pullup Resistance	—	—	120	—	KW
R_{dn}	Internal Pulldown Resistance	—	—	120	—	KW
L_{PIN}	Pin Inductance	—	—	—	7	nH

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* 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	—	—	500	kHz
t_{RMSB}	SMBus Rise Time	(Max V_{IL} - 0.15) to (Min V_{IH} + 0.15)	—	—	1000	ns
t_{FMSB}	SMBus Fall Time	(Min V_{IH} + 0.15) to (Max V_{IL} - 0.15)	—	—	300	ns

LVCMOS DC 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_{IH}	Input High Voltage	Single-ended inputs, except SMBus	0.75* V_{DD}	—	V_{DD} +0.3	V
V_{IM}	Input Mid Voltage	SADR0_TRI, SADR1_TRI, BW_SEL_TRI	0.4V_{DD}	0.5V_{DD}	0.6V_{DD}	V
V_{IL}	Input Low Voltage	Single-ended inputs, except SMBus	-0.3	—	0.25 V_{DD}	V
I_{IH}	Input High Current	Single-ended inputs, V_{IN} = V_{DD}	—	—	5	µA
I_{IL}	Input Low Current	Single-ended inputs, V_{IN} = 0V	-5	—	—	µA
I_{IH}	Input High Current	Single-ended inputs with pullup/pulldown resistor, V_{IN} = V_{DD}	—	—	50	µA
I_{IL}	Input Low Current	Single-ended inputs with pullup/pulldown resistor, V_{IN} = 0V	-50	—	—	µA
C_{IN}	Input Capacitance	—	1.5	—	5	pF

LVCMOS AC 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
t_{OELAT}	Output Enable Latency	Q start after OE# assertion Q stop after OE# deassertion	4	5	10	clocks
t_{PDLAT}	PD# Deassertion	Differential outputs enable after PD# deassertion	—	20	300	µs

HCSL Input Characteristics(1)

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

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
V_{IHDIF}	Diff. Input High Voltage(3)	IN+, IN-, single-end measurement	600	800	1150	mV
V_{ILDIF}	Diff. Input Low Voltage(3)	IN+, IN-, single-end measurement	-300	0	300	mV
V_{COM}	Diff. Input Common Mode Voltage		150	—	900	mV
V_{SWING}	Diff. Input Swing Voltage	Peak to peak value (V_{IHDIF} - V_{ILDIF})	300	—	2900	mV
f_{INBP}	Input Frequency	PLL Bypass mode	1	—	400	MHz
f_{IN100}	Input Frequency	100MHz PLL	98.5	100	102.5	MHz
f_{IN133}	Input Frequency	133MHz PLL	132	133.33	135	MHz
$f_{MODI-PCIe}$	Input SS Modulation Freq. PCIe	Allowable frequency for PCIe applications (Triangular Modulation)	30	—	33	kHz
t_{STAB}	Clock stabilization	From V_{DD} Power-Up and after input clock stabilization or de-assertion of PD# to 1st clock	—	0.75	1.0	ms
t_{RF}	Diff. Input Slew Rate(2)	Measured differentially with 10 inch trace. Please refer to test load Figure 1	0.4	—	—	V/ns
I_{IN}	Diff. Input Leakage Current	$V_{IN} = V_{DD}$, V_{IN} = GND	-5	0.01	5	uA
t_{DC}	Diff. Input Duty Cycle	Measured differentially	45	—	55	%
tj_{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 +/-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 Vbias, where Vbias is (V_{IH}-V_{IL})/2

HCSL Output DC 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(1)	Statistical measurement on single-ended signal using oscilloscope math function	660	—	850	mV
V_{OL}	Output Voltage Low(1)		-150	—	150	mV
V_{OMAX}	Output Voltage Maximum(1)	Measurement on single ended signal using absolute value	—	—	1150	mV
V_{OMIN}	Output Voltage Minimum(1)		-300	—	—	mV
V_{OC}	Output Cross Voltage(1,2,4)	—	250	—	550	mV
DV_{OC}	V_{OC} Magnitude Change(1,2,5)	—	—	—	140	mV

Note:

1. At default SMBUS amplitude settings.
2. Guaranteed by design and characterization—not 100% tested in production.
3. Measured from differential waveform.
4. This one is defined as voltage where Q+ = Q- measured on a component test board and only applied to the differential rising edge.
5. The total variation of all Vcross measurements in any particular system. This is a subset of Vcross_min/max allowed.

HCSL Output AC Characteristics

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

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
f_{OUT}	Output Frequency	PLL mode 100MHz	98.5	100	102.5	MHz
		PLL bypass mode	1	—	400	MHz
BW	PLL Bandwidth(1,8)	-3dB point in High Bandwidth Mode	2	2.65	4	MHz
		-3dB point in Low Bandwidth Mode	0.7	1.1	1.4	MHz
tj_{peak}	PLL Jitter Peaking	Peak pass band gain, low bandwidth	0	1.2	2	dB
		Peak pass band gain, high bandwidth	0	1.2	2.5	dB
t_{RF}	Slew Rate(1,2,3)	Scope averaging on fast setting with 10 inch trace. Please refer to test load Figure 1	2.2	3	4.0	V/ns
Dt_{RF}	Slew Rate Matching(1,2,4)	Scope averaging on	—	8	20	%
t_{SKEW}	Output Skew(1,2)	Averaging on, V_T = 50%	—	30	50	ps
t_{DC}	Duty Cycle(1,2)	Measured differentially, PLL Mode	45	50	55	%
t_{DCD}	Duty Cycle Distortion(1,7)	Measured differentially, PLL Bypass Mode at 100MHz	-3.5	0	3.5	%
tj_{c-c}	Cycle-to-Cycle Jitter(1,2)	PLL mode	—	14	60	ps
		Additive jitter, Bypass mode	—	0.1	1	ps
t_{pd_PLL}	Propagation delay	Input to output propagation delay in PLL mode at 100MHz with nominal temperature and voltage	-100	15	100	ps
t_{pd_BYP}	Propagation delay	Input to output propagation delay in ByPass mode at 100MHz with nominal temperature and voltage	1650	2150	2650	ps

HCSL Output AC Characteristics (PLL Mode PCIe Phase Jitter)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Spec Limit	Units
$tj_{PH\_PLL\_CC}$	Integrated Phase Jitter PLL Mode (RMS)(1,5) Low Bandwidth (Common Clocked Architecture)	PCIe 1.0(6)	—	2.5	5	86	ps (p-p)
		PCIe 2.0 Low Band	—	0.025	0.05	3.1	ps
		PCIe 2.0 High Band	—	0.161	0.18	3	ps
		PCIe 3.0	—	0.051	0.071	1	ps
		PCIe 4.0	—	0.051	0.071	0.5	ps
		PCIe 5.0(11)	—	0.013	0.022	0.15	ps
		PCIe 6.0	—	0.01	0.016	0.1	ps
$tj_{PH\_PLL\_SRIS}$	Integrated Phase Jitter PLL Mode (RMS)(1,5) Low Bandwidth (SRIS Architecture)	PCIe 1.0	—	7.8	8.7	—	ps (p-p)
		PCIe 2.0	—	0.139	0.208	—	ps
		PCIe 3.0	—	0.061	0.12	—	ps
		PCIe 4.0	—	0.062	0.12	—	ps
		PCIe 5.0(11)	—	0.062	0.105	—	ps
		PCIe 6.0	—	0.05	0.085	—	ps
$tj_{PH\_PLL\_CC}$	Integrated Phase Jitter PLL Mode (RMS)(1,5) High Bandwidth (Common Clocked Architecture)	PCIe 1.0(6)	—	5.1	6.5	86	ps (p-p)
		PCIe 2.0 Low Band	—	0.026	0.052	3.1	ps
		PCIe 2.0 High Band	—	0.18	0.24	3	ps
		PCIe 3.0	—	0.053	0.063	1	ps
		PCIe 4.0	—	0.053	0.063	0.5	ps
		PCIe 5.0(11)	—	0.016	0.027	0.15	ps
		PCIe 6.0	—	0.012	0.02	—	ps
$tj_{PH\_PLL\_SRIS}$	Integrated Phase Jitter PLL Mode (RMS)(1,5) High Bandwidth (SRIS Architecture)	PCIe 1.0	—	7.51	8.12	—	ps (p-p)
		PCIe 2.0	—	0.153	0.198	—	ps
		PCIe 3.0	—	0.067	0.087	—	ps
		PCIe 4.0	—	0.07	0.09	—	ps
		PCIe 5.0(11)	—	0.065	0.111	—	ps
		PCIe 6.0	—	0.056	0.095	—	ps

Note:

1. Guaranteed by design and characterization—not 100% tested in production.
2. Measured from differential waveform.
3. Slew rate is measured through the Vswing voltage range centered around differential 0V, within ±150mV window.
4. Slew rate matching is measured through ±75mV window centered around differential zero.
5. See http://www.pcisig.com for complete specs.
6. Sample size of at least 100k cycles. This can be extrapolated to 108ps pk-pk @ 1M cycles for a BER of 10^{-12}.
7. Duty cycle distortion is the difference in duty cycle between the output and input clock when the device is operated in the PLL bypass mode.
8. The Min and Max values of each BW setting track each other, low BW max will never occur with high BW min.
9. Applies to all differential outputs.
10. For additive jitter RMS value is calculated by the following equation = SQRT [(total jitter)*2 - (input jitter)*2].
11. PCIe 5.0 v0.9 specification.

HCSL Output AC Characteristics (Fanout Buffer Mode Additive Phase Jitter)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Output Limit	Units
$tj_{PH\_A\_CC}$	Additive Integrated Phase Jitter (RMS)(1,5) (Common Clocked Architecture)	PCIe 1.0(6)	—	1.2	1.8	86	ps (p-p)
		PCIe 2.0 Low Band	—	0.004	0.015	3	ps
		PCIe 2.0 High Band	—	0.058	0.087	3.1	ps
		PCIe 3.0	—	0.019	0.0228	1	ps
		PCIe 4.0	—	0.019	0.0228	0.5	ps
		PCIe 5.0(11)	—	0.014	0.024	0.15	ps
		PCIe 6.0	—	0.012	0.020	0.1	ps
$tj_{PH\_A\_SRIS}$	Additive Integrated Phase Jitter (RMS)(1,5,10) (SRIS Architecture)	PCIe 1.0	—	0.111	0.154	—	ps (p-p)
		PCIe 2.0	—	0.051	0.09	—	ps
		PCIe 3.0	—	0.022	0.042	—	ps
		PCIe 4.0	—	0.023	0.043	—	ps
		PCIe 5.0(11)	—	0.024	0.041	—	ps
		PCIe 6.0	—	0.022	0.037	—	ps
$tj_{PH\_A\_12k-20M}$	Additive Integrated Phase Jitter (RMS)(1,5,10) 12kHz ~ 20MHz	100MHz, SSC off	—	0.086	0.111	—	ps

Note:

1. Guaranteed by design and characterization—not 100% tested in production.
2. Measured from differential waveform.
3. Slew rate is measured through the Vswing voltage range centered around differential 0V, within ±150mV window.
4. Slew rate matching is measured through ±75mV window centered around differential zero.
5. See http://www.pcisig.com for complete specs.
6. Sample size of at least 100k cycles. This can be extrapolated to 108ps pk-pk @ 1M cycles for a BER of 10-12.
7. Duty cycle distortion is the difference in duty cycle between the output and input clock when the device is operated in the PLL bypass mode.
8. The Min and Max values of each BW setting track each other, low BW max will never occur with high BW min.
9. Applies to all differential outputs.
10. For additive jitter RMS value is calculated by the following equation = SQRT [(total jitter)*2 - (input jitter)*2].
11. PCIe 5.0 v0.9 specification.

HCSL Output Filtered Phase Jitter (QPI_UPI/DB2000Q)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Spec Limit	Units
$tj_{PHPLL\_QPI\_UPI}$	Integrated Phase Jitter PLL Mode (RMS)(1,5)	QPI and UPI, 100M or 133.33MHz, 4.8Gbps, 6.4Gbps 12UI	—	0.18	0.38	0.5	ps
		QPI and UPI, 100MHz, 8.0Gbps, 12UI	—	0.17	0.2	0.3	ps
		QPI and UPI, 100MHz, <11.4Gbps, 12UI	—	0.14	0.16	0.2	ps
$tj_{PH\_QPI\_UPI}$	Fanout Buffer Mode Additive Integrated Phase Jitter (RMS)(1,5,10)	QPI and UPI, 100M or 133.33MHz, 4.8Gbps, 6.4Gbps 12UI	—	0.06	0.08	—	ps (p-p)
		QPI and UPI, 100MHz, 8.0Gbps, 12UI	—	0.06	0.08	—	ps
		QPI and UPI, 100MHz, <11.4Gbps, 12UI	—	0.03	0.06	—	ps
tj_{PH_IFUPI}	PLL Mode IF-UPI phase jitter	Low bandwidth	—	0.15	0.18	1	ps
		High bandwidth	—	0.18	0.22	1	ps
	Fanout Buffer Mode IF-UPI phase jitter		—	0.08	0.1	1	ps
$tj_{PH\_DB2000Q}$	Fanout Buffer Mode DB2000Q phase jitter		—	0.02	0.03	0.08	ps

Note:

1. Guaranteed by design and characterization—not 100% tested in production.
2. Measured from differential waveform.
3. Slew rate is measured through the Vswing voltage range centered around differential 0V, within ±150mV window.
4. Slew rate matching is measured through ±75mV window centered around differential zero.
5. See http://www.pcisig.com for complete specs.
6. Sample size of at least 100k cycles. This can be extrapolated to 108ps pk-pk @ 1M cycles for a BER of 10-12.
7. Duty cycle distortion is the difference in duty cycle between the output and input clock when the device is operated in the PLL bypass mode.
8. The Min and Max values of each BW setting track each other, low BW max will never occur with high BW min.
9. Applies to all differential outputs.
10. For additive jitter RMS value is calculated by the following equation = SQRT [(total jitter)*2 - (input jitter)*2].
11. PCIe 5.0 v0.9 specification.

SMBus Serial Data Interface

PI6CBE33123 is a slave-only device that supports block read and block write protocol using a single 7-bit address and read/write bit as shown below.
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

How to 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	Add.	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

How to 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

Byte 0: PLL Operating Mode and Frequency Select Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	PLLMODERB1	PLL Mode Readback Bit1	R	Latch	00 = Low BW ZDB 01= Fanout mode 10 = Reserved 11 = High BW ZDB	
6	PLLMODERB0	PLL Mode Readback Bit0	R	Latch		
5	Reserved	—		0	—	—
4	Reserved	—		0	—	—
3	PLL SW Control	PLL Mode control Bit0	RW(1)	0	Hardware Latch	SMBus Control
2	PLL mode	PLL Mode 1	RW	1	00 = Low BW ZDB 01= Fanout mode 10 = Reserved 11 = High BW ZDB	
1	PLL mode	PLL Mode 0	RW	1		
0	Frequency Select RB	Frequency select readback	R	Latch	133MHz	100MHz

Byte 1: Output Enable Register 1

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Q7_OE	Q7 output enable	RW	1	Output Low/ Low	OE Pin Control
6	Q6_OE	Q6 output enable	RW	1	Output Low/ Low	OE Pin Control
5	Q5_OE	Q5 output enable	RW	1	Output Low/ Low	OE Pin Control
4	Q4_OE	Q4 output enable	RW	1	Output Low/ Low	OE Pin Control
3	Q3_OE	Q3 output enable	RW	1	Output Low/ Low	OE Pin Control
2	Q2_OE	Q2 output enable	RW	1	Output Low/ Low	OE Pin Control
1	Q1_OE	Q1 output enable	RW	1	Output Low/ Low	OE Pin Control
0	Q0_OE	Q0 output enable	RW	1	Output Low/ Low	OE Pin Control

Byte 2: Output Enable Register 2

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—	RW	0	—	—
6	Reserved	—	RW	0	—	—
5	Reserved	—	RW	0	—	—
4	Reserved	—	RW	0	—	—
3	Q11_OE	Q11 output enable	RW	1	Output Low/ Low	OE Pin Control
2	Q10_OE	Q10 output enable	RW	1	Output Low/ Low	OE Pin Control
1	Q9_OE	Q9 output enable	RW	1	Output Low/ Low	OE Pin Control
0	Q8_OE	Q8 output enable	RW	1	Output Low/ Low	OE Pin Control

Byte 3 and Byte 4: Reserved

Byte 5: Revision and Vendor ID Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	RID3	Revision ID	R	0	rev = 0000	
6	RID2		R	0		
5	RID1		R	0		
4	RID0		R	0		
3	PVID3	Vendor ID	R	0	Diodes = 0011	
2	PVID2		R	0		
1	PVID1		R	1		
0	PVID0		R	1		

Byte 6: Device ID Register

Bit	Control Function	Description	Type	Power-up Condition
7	NA	DID7	R	0hA7 for PI6CBE33123
6		DID6	R	
5		DID5	R	
4		DID4	R	
3		DID3	R	
2		DID2	R	
1		DID1	R	
0		DID0	R	

Byte 7: Byte Count Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—		0	—	—
6	Reserved	—		0	—	—
5	Reserved	—		0	—	—
4	BC4	Wring to the register configures how many bytes will be read back on a block read	RW	0	—	—
3	BC3		RW	1	—	—
2	BC2		RW	0	—	—
1	BC1		RW	0	—	—
0	BC0		RW	0	—	—

Test Loads

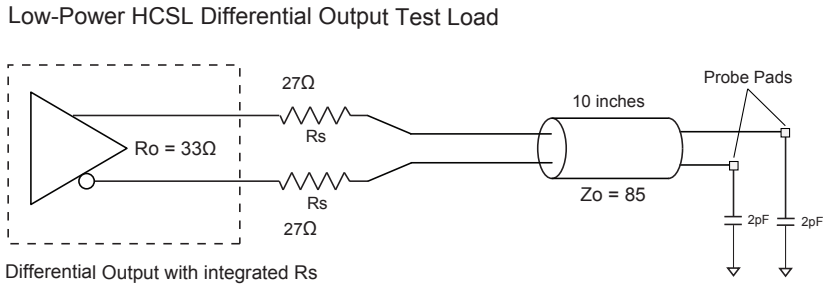


Figure 1. Low-Power HCSL Test Circuit

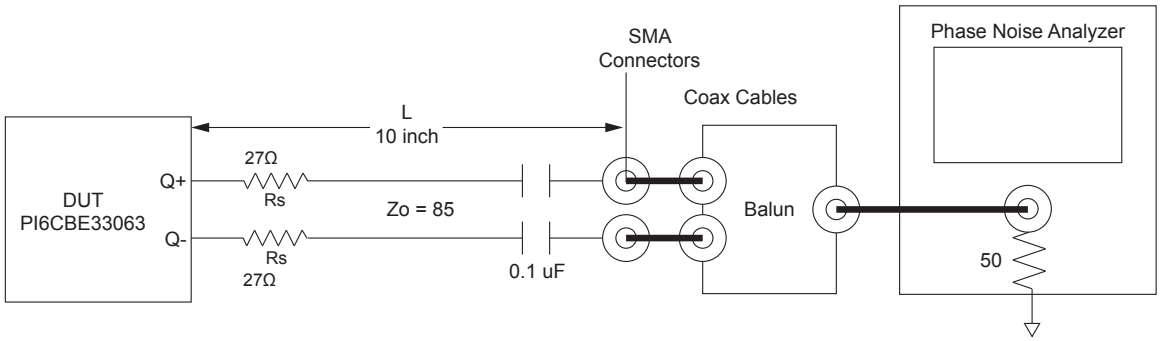


Figure 2. Test Set Up for Phase Jitter Measurement

LVDS Output Termination

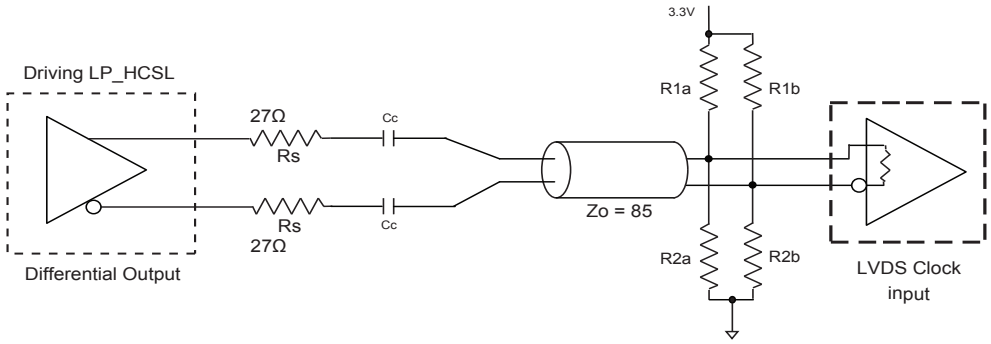


Figure 3. Differential Output Driving LVDS

Power Supply

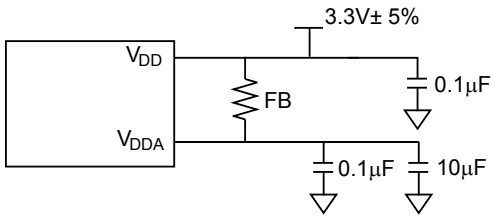


Figure 4. Power Supply Filter

Thermal Characteristics Table

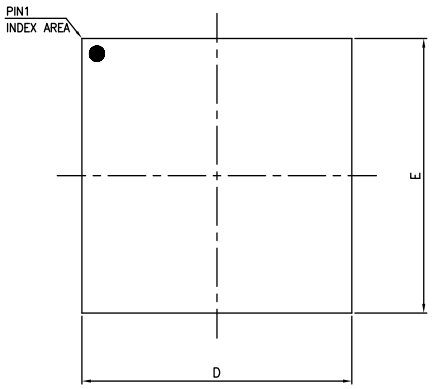
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
θ_{JA}	Thermal Resistance Junction to Ambient	Still air		19.8		°C/W
θ_{JC}	Thermal Resistance Junction to Case			8.3		°C/W

Part Marking

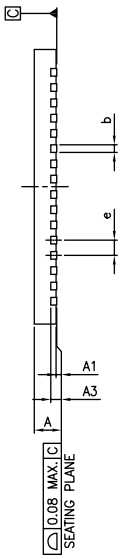
Z: Die Rev
YY: Date Code (Year)
WW: Date Code (Workweek)
1st X: Assembly Site Code
2nd X: Wafer Fab Site Code
Bar above fab code means Cu wire

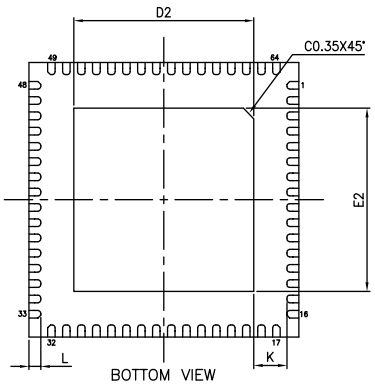
Packaging Mechanical

64-TQFN (ZD)

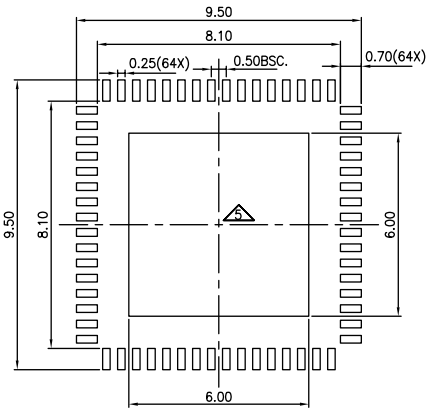


TOP VIEW





BOTTOM VIEW



RECOMMENDED LAND PATTERN

SYMBOLS	MIN.	NOM.	MAX.
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
A3		0.203 REF.	
b	0.18	0.25	0.30
D	8.90	9.00	9.10
E	8.90	9.00	9.10
e		0.50 BSC.	
K		1.10 REF.	
D2	5.95	6.00	6.05
E2	5.95	6.00	6.05
L	0.35	0.40	0.45

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: 05/18/18

DESCRIPTION: 64-Contact, Very Thin Quad Flat No-Lead (TQFN)

PACKAGE CODE: ZD (ZD64)

DOCUMENT CONTROL #: PD-2036 REVISION: D

For latest package information:

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

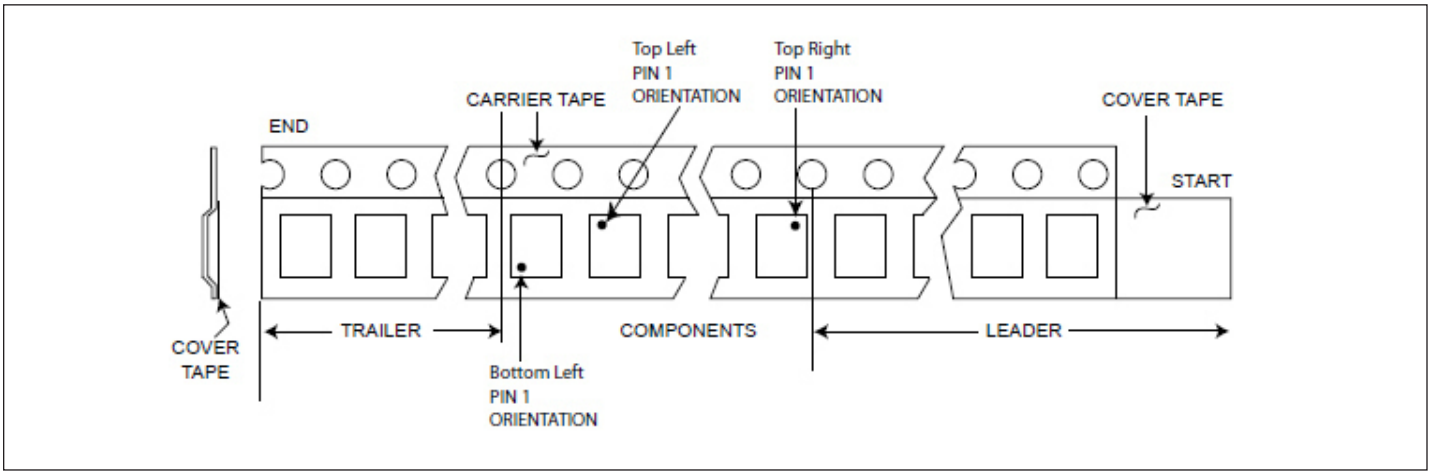
Ordering Information

Ordering Code	Package Code	Package Description	Temperature	Pin 1 Orientation
PI6CBE33123ZDIEX	ZD	64-Contact, Very Thin Quad Flat No-Lead (TQFN)	-40~85°C	Top Right Corner
PI6CBE33123ZDIEX-13R	ZD	64-Contact, Very Thin Quad Flat No-Lead (TQFN)	-40~85°C	Top Left Corner

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. I = Industrial
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

Pin 1 Orientation



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