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2.5Gbps x2 Lane Serial PCI Express Repeater/Equalizer

Features

- Two High Speed PCI Express lanes
- Supports PCI Express data rates (2.5 Gbps) on each lane
- Adjustable Transmiter De-Emphasis & Amplitude
- Adjustable Receiver Equalization
- Two Spread Spectrum Reference Clock Buffer Outputs
- 100Ω Differential CML I/O's
- Low Power (100mW per Channel)
- Standby Mode – Power Down State
- V_{DD} Operating Range: 1.8V +/-0.1V
- Packaging (Pb-free & Green):
  - 84-ball LFBGA

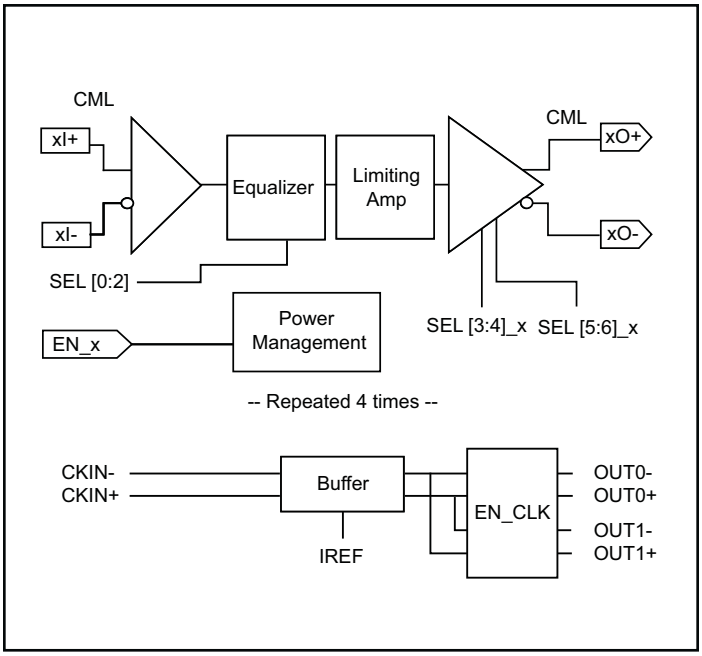
Description

Pericom Semiconductor's PI2EQX4402 is a low power, PCI Express compliant signal re-driver. The device provides programmable equalization, amplification, and de-emphasis by using 7 select bits, SEL[0:6], to optimize performance over a variety of physical mediums by reducing Inter-symbol interference. PI2EQX4402 supports four 100 Differential CML data I/O's between the Protocol ASIC to a switch fabric, across a backplane, or extends the signals across other distant data pathways on the user's platform.

The integrated equalization circuitry provides flexibility with signal integrity of the PCI Express signal before the re-driver. Whereas the integrated de-emphasis circuitry provides flexibility with signal integrity of the PCI Express signal after the re-driver.

In addition to providing signal re-conditioning, Pericom's PI2EQX4402 also provides power management Stand-by mode operated by a Bus Enable pin.

Block Diagram



Pin Description (Top View)

	1	2	3	4	5	6	7	8	9	10
A	NC	NC	SEL0_A	SEL0_B	SEL4_A	SEL4_B	SEL6_A	SEL6_B	EN_A	EN_B
B	V_{DD}	NC	V_{DD}	SEL1_A	SEL2_A	SEL3_A	SEL5_A	V_{DD}	EN_C	V_{DD}
C	BO+	NC	AI+	SEL1_B	SEL2_B	SEL3_B	SEL5_B	BI+	EN_D	AO+
D	BO–	V_{DD}	AI–					BI–	GND	AO–
E	GND	V_{DD}	GND					GND	GND	GND
F	V_{DD}	GND	V_{DD}					V_{DD}	GND	V_{DD}
G	DO+	SEL0_C	CI+					DI+	SEL6_C	CO+
H	DO–	SEL0_D	CI–	V_{DD}	CKIN+	CKIN–	GND	DI–	SEL6_D	CO–
J	GND	SEL1_C	GND	SEL2_C	SEL2_D	SEL3_D	IREF	GND	SEL4_D	GND
K	EN_CLK	SEL1_D	SEL3_C	SEL4_C	OUT0+	OUT0–	OUT1+	OUT1–	SEL5_C	SEL5_D

84-Ball LFBGA

Pin Description

Pin #	Pin Name	I/O	Description
B1, F1, D2, E2, B3, F3, H4, B8, F8, B10, F10	V_{DD}	PWR	1.8V Supply Voltage
C3	AI+	I	Positive CML Input Channel A with internal 50Ω pull down
D3	AI-	I	Negative CML Input Channel A with internal 50Ω pull down
E1, J1, F2, E3, J3, H7, E8, J8, D9, E9, F9, E10, J10	GND	PWR	Supply Ground
C8	BI+	I	Positive CML Input Channel B with internal 50Ω pull down
D8	BI-	I	Negative CML Input Channel B with internal 50Ω pull down
G3	CI+	I	Positive CML Input Channel C with internal 50Ω pull down
H3	CI-	I	Negative CML Input Channel C with internal 50Ω pull down
G8	DI+	I	Positive CML Input Channel D with internal 50Ω pull down
H8	DI-	I	Negative CML Input Channel D with internal 50Ω pull down
A3, B4, B5	SEL[0:2]_A	I	Selection pins for equalizer (see Amplifier Configuration Table) w/ 50KΩ internal pull up
A4, C4, C5	SEL[0:2]_B	I	
G2, J2, J4	SEL[0:2]_C	I	
H2, K2, J5	SEL[0:2]_D	I	
B6, A5	SEL[3:4]_A	I	Selection pins for amplifier (see Amplifier Configuration Table) w/ 50KΩ internal pull up
C6, A6	SEL[3:4]_B	I	
K3, K4	SEL[3:4]_C	I	
J6, J9	SEL[3:4]_D	I	
B7, A7	SEL[5:6]_A	I	Selection pins for De-Emphasis (See De-Emphasis Configuration Table) w/ 50KΩ internal pull up
C7, A8	SEL[5:6]_B	I	
K9, G9	SEL[5:6]_C	I	
K10, H9	SEL[5:6]_D	I	
C10	AO+	O	Positive CML Output Channel A internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
D10	AO-	O	Negative CML Output Channel A with internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
C1	BO+	O	Positive CML Output Channel B with internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
D1	BO-	O	Negative CMLOutput Channel B with internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
G10	CO+	O	Positive CMLOutput Channel C with internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
H10	CO-	O	Negative CMLOutput Channel C with internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
G1	DO+	O	Positive CMLOutput Channel D with internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
H1	DO-	O	Negative CMLOutput Channel D with internal 50Ω pull up during normal operation and 2KΩ pull up otherwise.
A9, A10, B9, C9	EN_ [A,B,C,D]	I	EN_[A:D] is the enable pin with internal 50KΩ pull up resistor. A LVCMOS high provides normal operation. A LVCMOS low selects a low power down mode.

Pin Description (Continued)

Pin #	Pin Name	I/O	Description
H6	CKIN-	I	Differential Input Reference Clock
H5	CKIN+	I	
K5, K6	OUT0+, OUT0-	O	Differential Reference Clock Output
K7, K8	OUT1+, OUT1-	O	
J7	IREF	O	External 475Ω resistor connection to set the differential output current
K1	EN_CLK	I	Enable output clock pin with internal 50KΩ pull up resistor
A1, A2, B2, C2	NC	N/A	No connect pins. For normal operation, leave pins floating

Inputs	Outputs
EN_[A, B, C, D]	O+ / O-
High	Normal output
Low	No output

Inputs	Clock Outputs
EN_CLK	
High	Clock output
Low	No clock output

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 ..... –0.5V to +2.5V
DC SIG Voltage ..... –0.5V to V_{DD} +0.5V
Current Output ..... -25mA to +25mA
Power Dissipation Continous 800mW
Operating Temperature ..... 0 to +70°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.

Output Swing Control

SEL3_[A:D]	SEL4_[A:D]	Swing
0	0	1x
0	1	0.8x
1	0	1.2x
1	1	1.4x

Output De-emphasis Adjustment

SEL5_[A:D]	SEL6_[A:D]	De-emphasis
0	0	0dB
0	1	-2.5dB
1	0	-3.5dB
1	1	-4.5dB

Equalizer Selection

SEL0_[A:D]	SEL1_[A:D]	SEL2_[A:D]	Compliance Channel
0	0	0	No Equalization
0	0	1	[0:1.5dB] @ 1.25 GHz
0	1	0	[0:2.5dB] @ 1.25 GHz
0	1	1	[0:3.5dB] @ 1.25 GHz
1	0	0	[0:4.5dB] @ 1.25 GHz
1	0	1	[0:5.5dB] @ 1.25 GHz
1	1	0	[0:6.5dB] @ 1.25 GHz
1	1	1	[0:7.5dB] @ 1.25 GHz

AC/DC Electrical Characteristics for 2.5 Gbps Quad Repeater/Equalizer (V_{DD} = 1.8 ±0.1V)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
Ps	Supply Power	EN = LVCMOS Low			0.1	W
		EN = LVCMOS High			0.6	
	Latency	From input to output		2.0		ns
CML Receiver Input						
RL_{RX}	Return Loss	50 MHz to 1.25 GHz		12		dB
$V_{RX-DIFFP-P}$	Differential Input Peak-to-peak Voltage		0.175		1.200	V
$V_{RX-CM-ACP}$	AC Peak Common Mode Input Voltage				150	mV
$Z_{RX-DIFF-DC}$	DC Differential Input Impedance		80	100	120	Ω
Z_{RX-DC}	DC Input Impedance		40	50	60	
Equalization						
J_{RS}	Residual Jitter(1,2)	Total Jitter			0.3	Ulp-p
		Deterministic jitter			0.2	
J_{RM}	Random Jitter(1,2)			1.5		psrms

Notes

1. K28.7 pattern is applied differentially at point A as shown in Figure 1.
2. Total jitter does not include the signal source jitter. Total jitter (TJ) = (14.1 × RJ + DJ) where RJ is random RMS jitter and DJ is maximum deterministic jitter. Signal source is a K28.5 ± pattern (00 1111 1010 11 0000 0101) for the deterministic jitter test and K28.7 (0011111000) or equivalent for random jitter test. Residual jitter is that which remains after equalizing media-induced losses of the environment of Figure 1 or its equivalent. The deterministic jitter at point B must be from media-induced loss, and not from clock source modulation. Jitter is measured at 0V at point C of Figure 1.

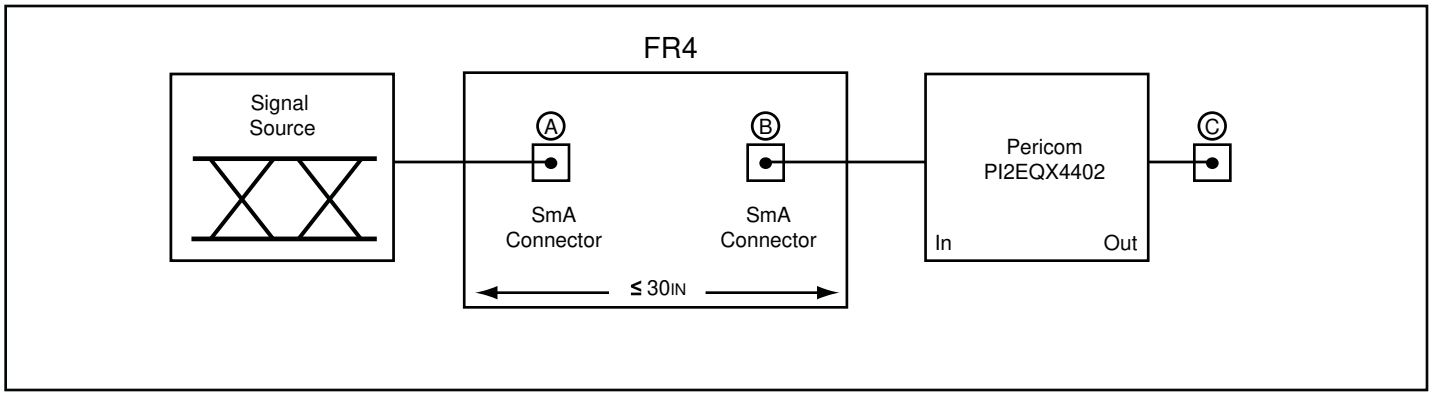


Figure 1. Test Condition Referenced in the Electrical Characteristic Table

AC/DC Electrical Characteristics for 2.5 Gbps x2 Lane Repeater/Equalizer (TA = 0 to 70˚C)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
CML Transmitter Output (100Ω differential)						
V_{DIFFP}	Output Voltage Swing	Differential Swing $\lvert V_{TX-D+} - V_{TX-D-} \rvert$	400		900	mVp-p
V_{TX-C}	Common-Mode Voltage	$\lvert V_{TX-D+} + V_{TX-D-} \rvert / 2$		V_{DD}-0.3		
t_F, t_R	Transition Time	20% to 80% (1)			150	ps
Z_{OUT}	Output resistance	Single ended	40	50	60	Ω
$Z_{TX-DIFF-DC}$	DC Differential TX Impedance		80	100	120	Ω
C_{TX}	AC Coupling Capacitor		75		200	nF
$V_{TX-DIFFP-P}$	Differential Peak-to-peak Ouput Voltage	$V_{TX-DIFFP-P} = 2 * \lvert V_{TX-D+} - V_{TX-D-} \rvert$	0.8		1.8	V
LVCMOS Control Pins						
V_{IH}	Input High Voltage		0.65 × V_{DD}		V_{DD}	V
V_{IL}	Input Low Voltage				0.35 × V_{DD}	
I_{IH}	Input High Current				250	µA
I_{IL}	Input Low Current				500	

Note:
1. Using K28.7 (0011111000) pattern)

AC Switching Characteristics for Clock Buffer (V_{DD} = 1.8 ±0.1V, AV_{DD} = 1.8 ±0.1V) (3)

Symbol	Parameters	Min	Max.	Units	Notes
T_{rise} / T_{fall}	Rise and Fall Time (measured between 0.175V to 0.525V) (1)	125	525	ps	1
ΔT_{rise} / ΔT_{fall}	Rise and Fall Time Variation		75	ps	1
V_{HIGH}	Voltage High including overshoot	660	900	mV	1
V_{LOW}	Voltage Low including undershoot	-200		mV	1
V_{CROSS}	Absolute crossing point voltages	200	550	mV	1
ΔV_{CROSS}	Total Variation of Vcross over all edges		250	mV	1
T_{DC}	Duty Cycle (input duty cycle = 50%) (2)	45	55	%	2

Notes:
1. Measurement taken from Single Ended waveform.
2. Measurement taken from Differential waveform.
3. Test configuration is R_S = 33.2Ω, Rp = 49.9Ω, and 2pF.

Configuration Test Load Board Termination

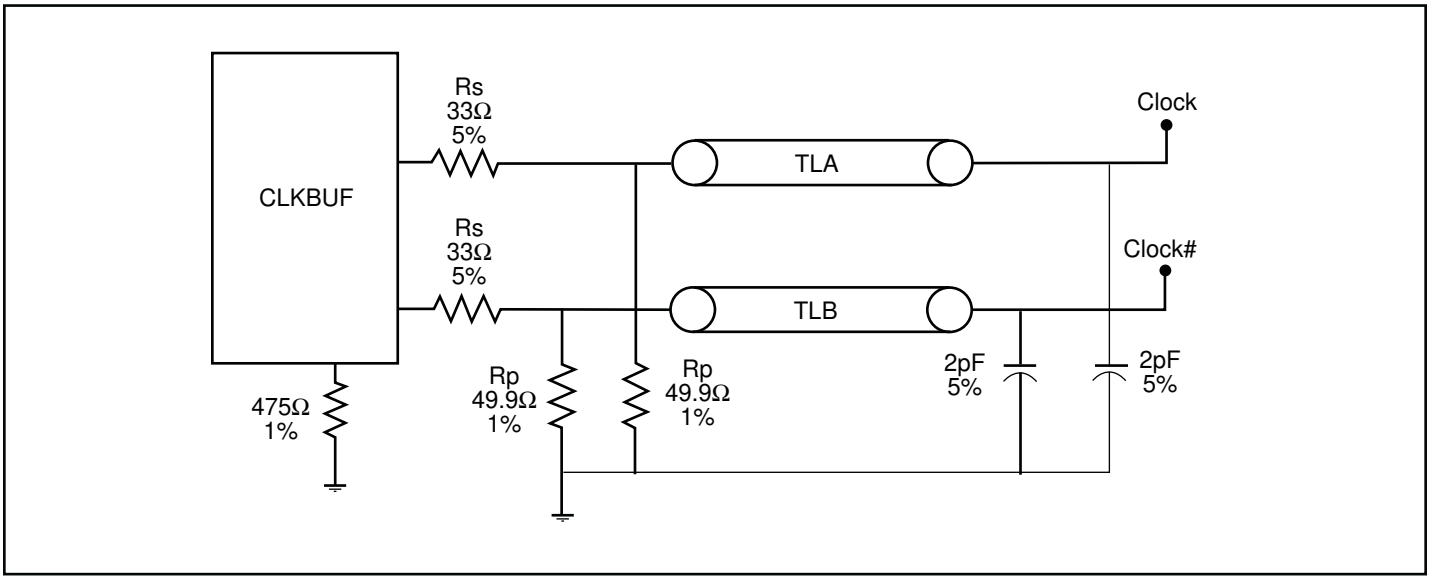
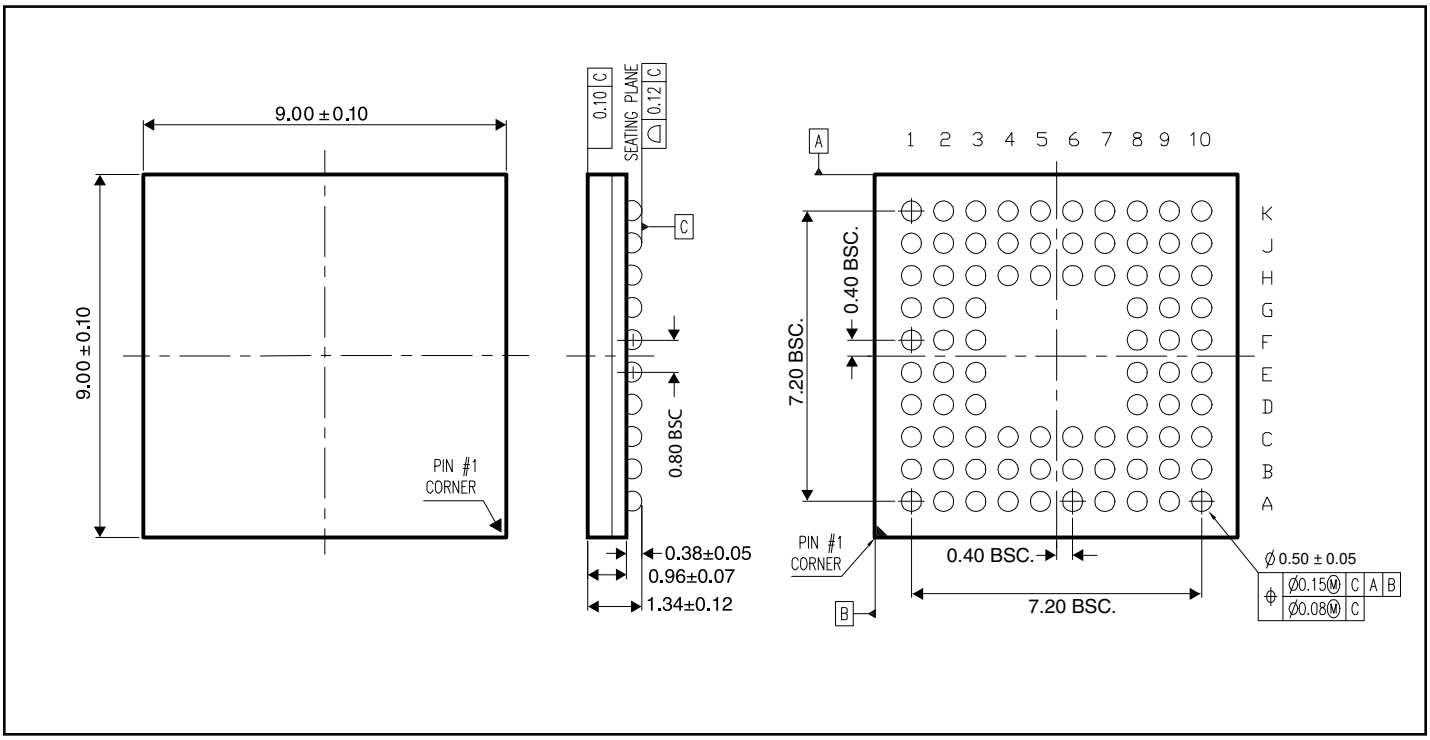


Figure 2. Configuration test load board termination

Note:
• TLA and TLB are 3” transmission lines.

Packaging Mechanical: 84-Ball LFBGA (NB)



Ordering Information

Ordering Number	Package Code	Package Description
PI2EQX4402NB	NB	84-Ball LFBGA
PI2EQX4402NBE	NB	Pb-free & Green 84-Ball LFBGA

Notes:

- Thermal characteristics can be found on the company web site at www.pericom.com/packaging/
- E = Pb-free & Green
- X suffix = Tape/Reel