

**PI6CFGL402B**

**Low Power PCIe 3.0 Clock Generator with 4 HCSL Outputs**

**Features**

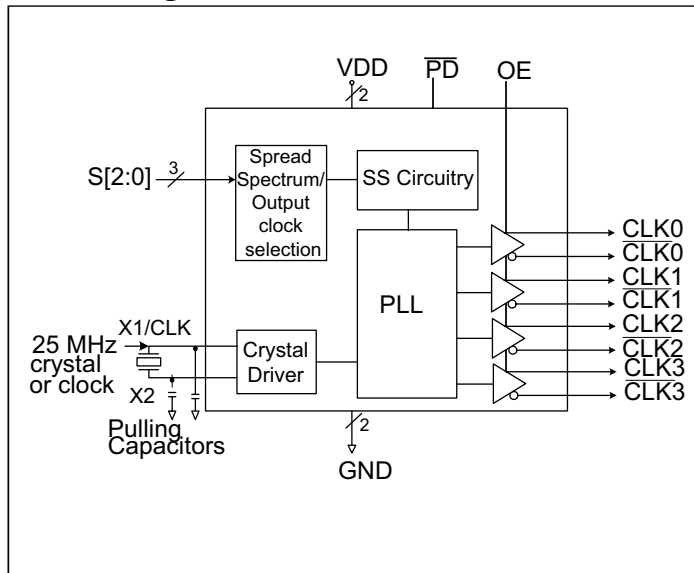
- PCIe® 3.0, 2.0 and 1.0 compliant
- LVDS compatible outputs
- Supply voltage of 3.3V ±5%
- 25MHz crystal or clock input frequency
- Low power consumption with independent output power supply 1.05V to 3.3V
- Jitter 40ps cycle-to-cycle (typ)
- Spread of -0.5%, -1.0%, -1.5%, and no spread
- Industrial temperature range
- Spread Bypass option available
- Spread and frequency selection via external pins
- Packaging: (Pb-free and Green)
  - 20-pin, 173-mil wide TSSOP

**Description**

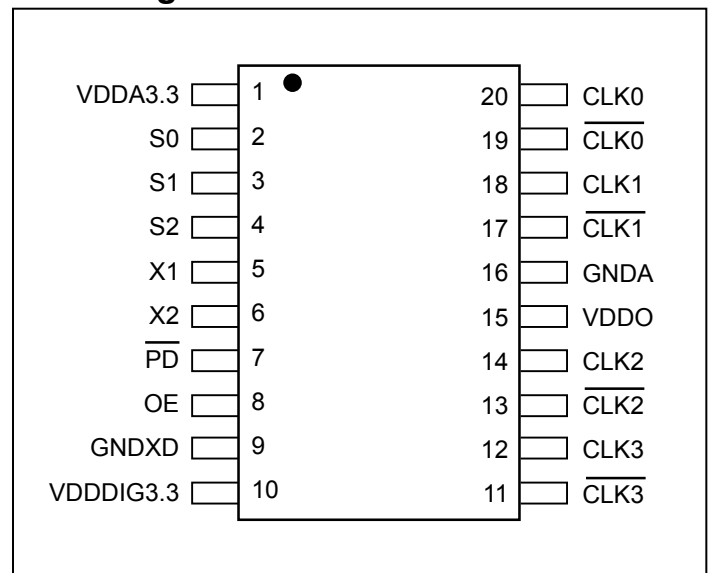
The PI6CFGL402B is a spread spectrum clock generator compliant to PCI Express® 3.0 and Ethernet requirements. The device is used for PC or embedded systems to substantially reduce Electromagnetic Interference (EMI).

The PI6CFGL402B provides four differential (HCSL) or LVDS spread spectrum outputs. The PI6CFGL402B is configured to select spread and clock selection. Using Diodes' patented Phase-Locked Loop (PLL) techniques, the device takes a 25MHz crystal input and produces four pairs of differential outputs (HCSL) at 100MHz and 200MHz clock frequencies. It also provides spread selection of -0.5%, -1.0%, -1.5%, and no spread.

**Block Diagram**



**Pin Configuration**



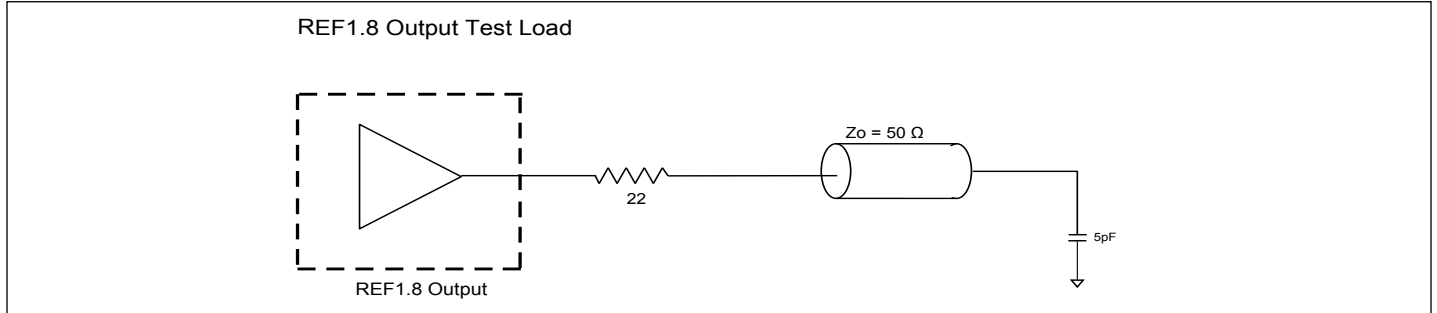
## Pin Description

Pin #	Pin Name	I/O Type	Description
1	VDDA3.3	Power	3.3V power for PLL core.
2	S0	Input	Spread Spectrum Select pin #0. See Spread Selection Table. Internal pull-up resistor.
3	S1	Input	Spread Spectrum Select pin #1. See Spread Selection Table. Internal pull-up resistor.
4	S2	Input	Spread Spectrum Select pin #2. See Spread Selection Table. Internal pull-up resistor.
5	X1	Input	Crystal connection.
6	X2	Output	Crystal connection.
7	$\overline{\text{PD}}$	Input	Power down. Internal pull-up resistor.
8	OE	Input	Output enable. Tri-states output (High=enable outputs); Low=disable outputs). Internal pull-up resistor.
9	GNDXD	Power	Connect to digital circuit ground.
10	VDDDIG3.3	Power	3.3V digital power.
11	$\overline{\text{CLK3}}$	Output	Selectable 100/200 MHz Spread Spectrum differential compliment output clock 3. LOW when output is disabled.
12	CLK3	Output	Selectable 100/200 MHz Spread Spectrum differential true output clock 3. LOW when output is disabled.
13	$\overline{\text{CLK2}}$	Output	Selectable 100/200 MHz Spread Spectrum differential compliment output clock 2. LOW when output is disabled.
14	CLK2	Output	Selectable 100/200 MHz Spread Spectrum differential true output clock 2. LOW when output is disabled.
15	VDDO	Power	Output power supply, nominal 1.8V, range 1.05V~3.3V.
16	GNDA	Power	Output and Analog circuit ground
17	$\overline{\text{CLK1}}$	Output	Selectable 100/200 MHz Spread Spectrum differential compliment output clock 1. LOW when output is disabled.
18	CLK1	Output	Selectable 100/200 MHz Spread Spectrum differential true output clock 1. LOW when output is disabled.
19	$\overline{\text{CLK0}}$	Output	Selectable 100/200 MHz Spread Spectrum differential compliment output clock 0. LOW when output is disabled.
20	CLK0	Output	Selectable 100/200 MHz Spread Spectrum differential true output clock 0. LOW when output is disabled.

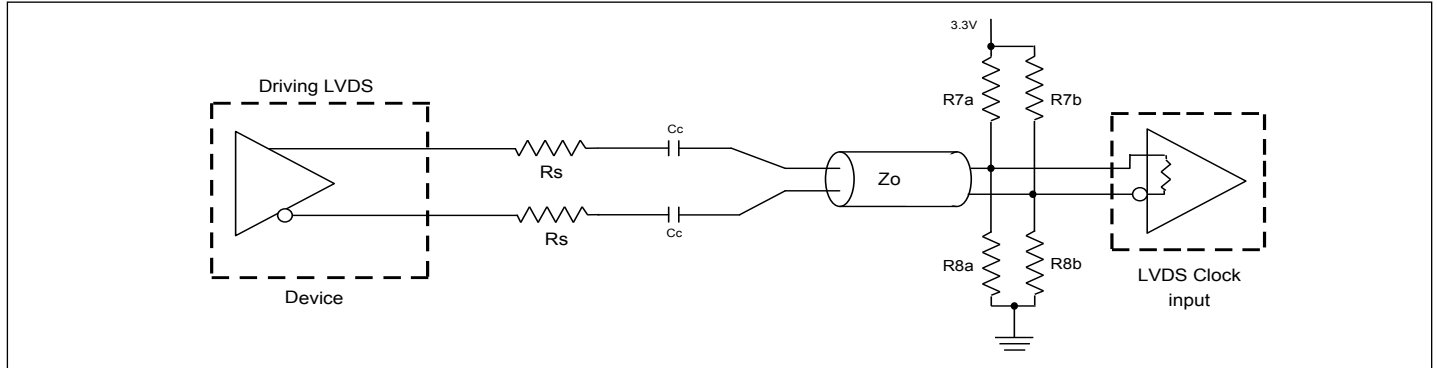
**Table 2: Spread Selection Table**

S2	S1	S0	Spread %	Spread Type	Output Frequency
0	0	0	-0.5	Down	100
0	0	1	-1.0	Down	100
0	1	0	-1.5	Down	100
0	1	1	No Spread	Not Applicable	100
1	0	0	-0.5	Down	200
1	0	1	-1.0	Down	200
1	1	0	-1.5	Down	200
1	1	1	No Spread	Not Applicable	200

## Test Loads



## Driving LVDS



## Driving LVDS inputs with the PI6CFGL402B

Component	Value	
	Receiver has termination	Receiver does not have termination
R7a, R7b	10K $\Omega$	140 $\Omega$
R8a, R8b	5.6K $\Omega$	75 $\Omega$
Cc	0.1 uF	0.1 uF
Vcm	1.2 volts	1.2 volts

## Maximum Ratings

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

Supply Voltage to Ground Potential.....	4.6V
All Inputs and Output.....	-0.5V to VDD+0.5V
Ambient Operating Temperature.....	-40 to +85°C
Storage Temperature.....	-65°C to +150°C
Junction Temperature .....	125°C
Soldering Temperature.....	260°C
ESD Protection (Input) .....	2000V(HBM)

**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.

## Electrical Characteristics–Current Consumption

(T<sub>A</sub> = -40~85°C; Supply Voltage VDD = 3.3V +/-10%; VDDO = 1.8V +/-10%, See Test Loads for Loading Conditions)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
I <sub>DDOP</sub>	Operating Supply Current <sup>1</sup>	Total power consumption, All outputs active @100MHz			60	mA

**Notes:**

1. Guaranteed by design and characterization, not 100% tested in production.

## Electrical Characteristics–Input/Supply/Common Parameters–Normal Operating

**Conditions** (T<sub>A</sub> = -40~85°C; Supply Voltage VDD = 3.3V +/-10%; VDDO = 1.8V +/-10%, See Test Loads for Loading Conditions)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
V <sub>DDX</sub>	Supply Voltage <sup>1</sup>	Supply voltage for core, analog	3.0	3.3	3.6	V
V <sub>DDO</sub>	Supply Voltage <sup>1</sup>	Supply voltage outputs	1.65	1.8	2.0	V
V <sub>IH</sub>	Input High Voltage <sup>1</sup>	OE, S0, S1, S2	0.65 V <sub>DD</sub>		V <sub>DD</sub> + 0.3	V
V <sub>IL</sub>	Input Low Voltage <sup>1</sup>	OE, S0, S1, S2	-0.3		0.35 V <sub>DD</sub>	V
I <sub>IN</sub>	Input Current <sup>1</sup>	Single-ended inputs, V <sub>IN</sub> = GND, V <sub>IN</sub> = VDD (exclude XTAL pin)	-5		5	uA
I <sub>INP</sub>		Single-ended inputs V <sub>IN</sub> = 0 V; Inputs with internal pull-up resistors V <sub>IN</sub> = VDD; Inputs with internal pull-down resistors	-200		200	uA
f <sub>in</sub>	Input Frequency <sup>1</sup>	XTAL, or X1 input	23	25	27	MHz
L <sub>pin</sub>	Pin Inductance <sup>1</sup>				7	nH
C <sub>IN</sub>	Capacitance <sup>1,4</sup>	Logic Inputs, except DIF_IN	1.5		5	pF
C <sub>INDIF_IN</sub>		DIF_IN differential clock inputs	1.5		2.7	pF
C <sub>OUT</sub>		Output pin capacitance			6	pF

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
T <sub>STAB</sub>	Clk Stabilization <sup>1,2</sup>	From V <sub>DD</sub> Power-Up and after input clock stabilization or de-assertion of PD# to 1st clock		0.6	1	ms
f <sub>MODIN</sub>	Input SS Modulation Frequency <sup>1</sup>	Allowable Frequency (Triangular Modulation)	30	31.500	33	kHz
t <sub>OE</sub>	Output Enable Time <sup>1</sup>	All outputs			10	μs
t <sub>OT</sub>	Output Disable Time <sup>1</sup>	All outputs			10	μs
t <sub>STABLE</sub>	From power-up to V <sub>DD</sub> = 3.3V <sup>1</sup>	From Power-up V <sub>DD</sub> = 3.3V		3.0		ms
t <sub>SPREAD</sub>	Setting period after spread change <sup>1</sup>	Setting period after spread change		3.0		ms

**Note:**

1. Guaranteed by design and characterization, not 100% tested in production.
2. Control input must be monotonic from 20% to 80% of input swing. Input Frequency Capacitance
3. Time from deassertion until outputs are >200 mV
4. DIF\_IN input

**Electrical Characteristics—CLK 0.7V Low Power HCSL Outputs** (T<sub>A</sub> = -40~85°C; Supply Voltage V<sub>DD</sub> = 3.3V +/-10%; V<sub>DDO</sub> = 1.8V +/-10%; 100MHz output frequency, See Test Loads for Loading Conditions)

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
Trf	Slew rate <sup>1,2,3</sup>		1.1	2	4.5	V/ns
V <sub>HIGH</sub>	Voltage High <sup>1</sup>	Statistical measurement on single-ended signal using oscilloscope math function. (Scope averaging on)	660		950	mV
V <sub>LOW</sub>	Voltage Low <sup>1</sup>		-150		150	mV
V <sub>max</sub>	Max Voltage <sup>1</sup>	Measurement on single ended signal using absolute value. (Scope averaging off)			1150	mV
V <sub>min</sub>	Min Voltage <sup>1</sup>		-300			mV
V <sub>swing</sub>	V <sub>swing</sub> <sup>1,2</sup>	Scope averaging off	300			mV
V <sub>cross_abs</sub>	Crossing Voltage (abs) <sup>1,5</sup>	Scope averaging off	250		550	mV
Δ-V <sub>cross</sub>	Crossing Voltage (var) <sup>1,6</sup>	Scope averaging off			140	mV
t <sub>DC</sub>	Duty Cycle <sup>1</sup>	Measured differentially, PLL Mode	45		55	%
t <sub>skew</sub>	Skew, Output to Output <sup>1</sup>	V <sub>T</sub> = 50%			50	ps
t <sub>jcyc-cyc</sub>	Jitter, Cycle to cycle <sup>1,2</sup>	PLL mode			50	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 V<sub>swing</sub> voltage range centered around differential 0V. This results in a +/-150mV window around differential 0V.
4. Matching applies to rising edge rate for Clock and falling edge rate for Clock#. It is measured using a +/-75mV window centered on the average cross point where Clock rising meets Clock# falling. The median cross point is used to calculate the voltage thresholds the oscilloscope is to use for the edge rate calculations.
5. V<sub>cross</sub> is defined as voltage where Clock = Clock# measured on a component test board and only applies to the differential rising edge (i.e. Clock rising and Clock# falling).
6. The total variation of all V<sub>cross</sub> measurements in any particular system. Note that this is a subset of V<sub>cross\_min/max</sub> (V<sub>cross</sub> absolute) allowed. The intent is to limit V<sub>cross</sub> induced modulation by setting Δ-V<sub>cross</sub> to be smaller than V<sub>cross</sub> absolute.

## Electrical Characteristics–Phase Jitter Parameters

( $T_A = -40\sim 85^\circ\text{C}$ ; Supply Voltage  $V_{DD} = 3.3\text{V} \pm 10\%$ ;  $V_{DDO} = 1.8\text{V} \pm 10\%$ ; 100MHz output frequency, See Test Loads for Loading Conditions)

Symbol	Parameters	Condition	Min.	Typ.	Industry Limit	Units
$t_{jphPCIeG1}$	Phase Jitter, PCI Express	PCIe Gen 1 <sup>1,2,3,5</sup>		25	86	ps (p-p)
$t_{jphPCIeG2}$		PCIe Gen 2 Low Band $10\text{kHz} < f < 1.5\text{MHz}$ <sup>1,2,5</sup>		0.9	3	ps (rms)
		PCIe Gen 2 High Band $1.5\text{MHz} < f < \text{Nyquist}$ (50MHz) <sup>1,2,5</sup>		1.6	3.1	ps (rms)
$t_{jphPCIeG3}$		PCIe Gen 3 (PLL BW of 2-4MHz, CDR = 10MHz) <sup>1,2,4,5</sup>		0.36	1	ps (rms)

### Notes:

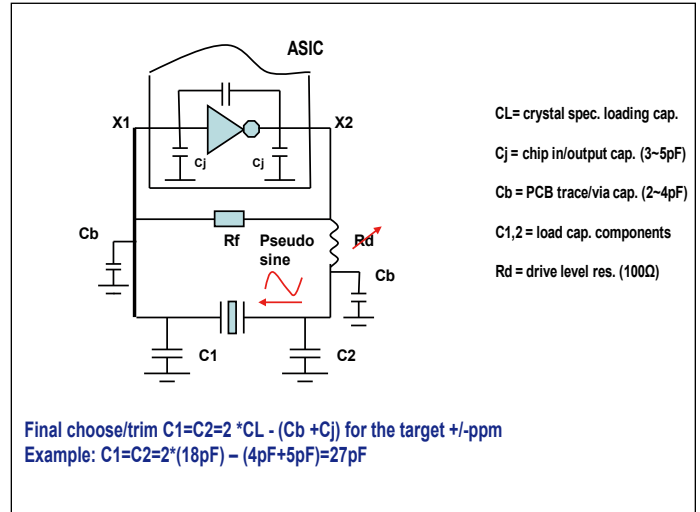
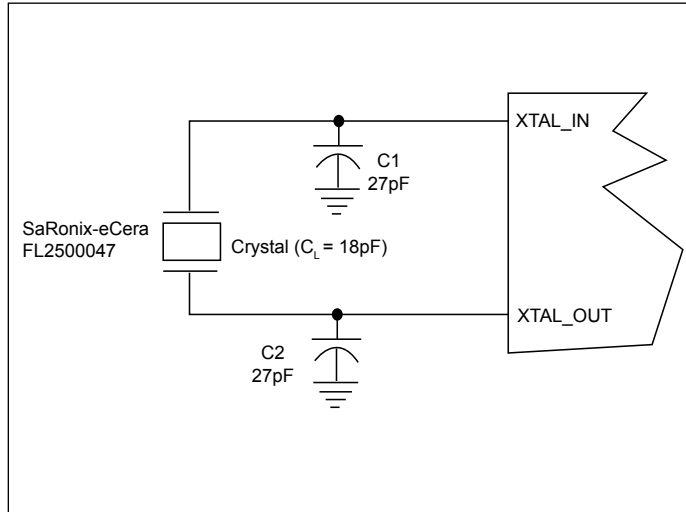
1. Guaranteed by design and characterization, not 100% tested in production.
2. See <http://www.pcisig.com> for complete specs.
3. Sample size of at least 100k cycles. This figures extrapolates to 108ps pk-pk @ 1M cycles for a BER of 1-12.
4. Calculated from Intel-supplied Clock Jitter Tool.
5. Applies to all different outputs.

## Application Notes

### Crystal circuit connection

The following diagram shows crystal circuit connection with a parallel crystal. For the  $C_L=18\text{pF}$  crystal, it is suggested to use  $C1=27\text{pF}$ ,  $C2=27\text{pF}$ .  $C1$  and  $C2$  can be adjusted to fine tune to the target ppm of crystal oscillator according to different board layouts.

### Crystal Oscillator Circuit



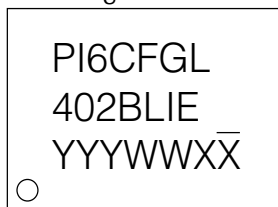
## Recommended Crystal Specification

### Diodes Recommends:

- a) FY2500081, SMD 5x3.2(4P), 25M,  $C_L=18\text{pF}$ , +/-30ppm, <https://www.diodes.com/assets/Datasheets/FYF9.pdf>
- b) FL2500047, SMD 3.2x2.5(4P), 25M,  $C_L=18\text{pF}$ , +/-20ppm, <https://www.diodes.com/assets/Datasheets/FL.pdf>

## Part Marking

L Package



- 1st Y: Die Rev
- YY: Year
- WW: Workweek
- 1st X: Assembly Code
- 2nd X: Fab Code

**Packaging Mechanical: 20-TSSOP (L)**

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1	0.05	–	0.15
A2	0.80	1.00	1.05
b	0.19	–	0.30
C	0.09	–	0.20
D	6.40	6.50	6.60
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65 BSC		
L1	1.00 REF		
L	0.45	0.60	0.75
S	0.20	–	–
$\theta$	0°	–	8°

**NOTES:**  
 1. ALL DIMENSIONS IN MILLIMETERS. ANGLES IN DEGREES.  
 2. JEDEC MO-153F  
 3. DIMENSIONS DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

16-0074

		DATE: 03/31/16
DESCRIPTION: 20-Pin, 173mil Wide TSSOP		
PACKAGE CODE: L (L20)		
DOCUMENT CONTROL #: PD-1311	REVISION: G	

For latest package info.

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

**Ordering Information(1-3)**

Ordering Code	Package Code	Description
PI6CFGL402BLIEX	L	20-Pin, 173mil Wide (TSSOP)

Notes:

1. EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant. All applicable RoHS exemptions applied.
2. See <http://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free. Thermal characteristics can be found on the company web site at [www.diodes.com/design/support/packaging/](http://www.diodes.com/design/support/packaging/)
3. E = Pb-free and Green
4. X suffix = Tape/Reel



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