

6-Output Low Power PCIe Gen 1-2-3 Clock Generator

Features

- 25MHz crystal or reference clock input
- 100MHz low power HCSL or LVDS compatible outputs
- PCIe 3.0, 2.0 and 1.0 compliant
- Selectable spread spectrum of -0.5% and no spread
- Programmable output amplitude
- Cycle-to-cycle jitter (typ.) ~ 30ps
- Supply voltage of 3.3V+/-10%
- Output supply voltage of 1.8V
- Industrial ambient operating temperature
- Available in lead-free package: 32-TQFN

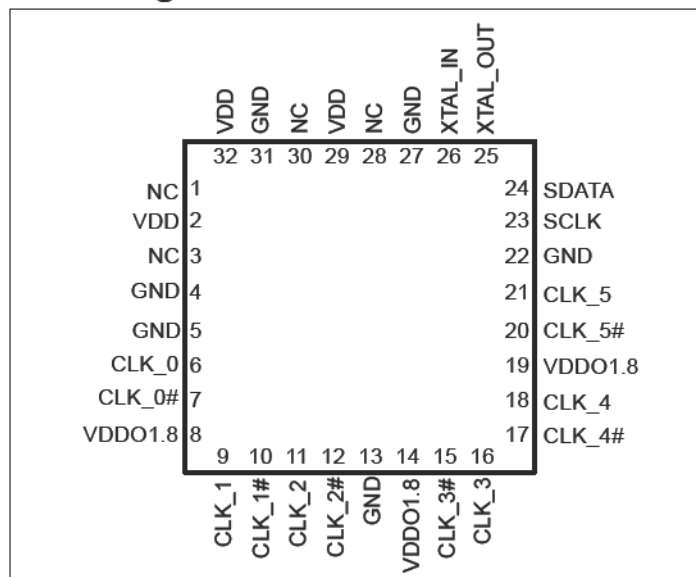
Description

The PI6CFGL601B is a 6-output low-power 100MHz clock synthesizer for PCIe Gen 1-2-3. It runs from a 25MHz XTAL, provides spread spectrum capability, and has an SMBus for software control of the device.

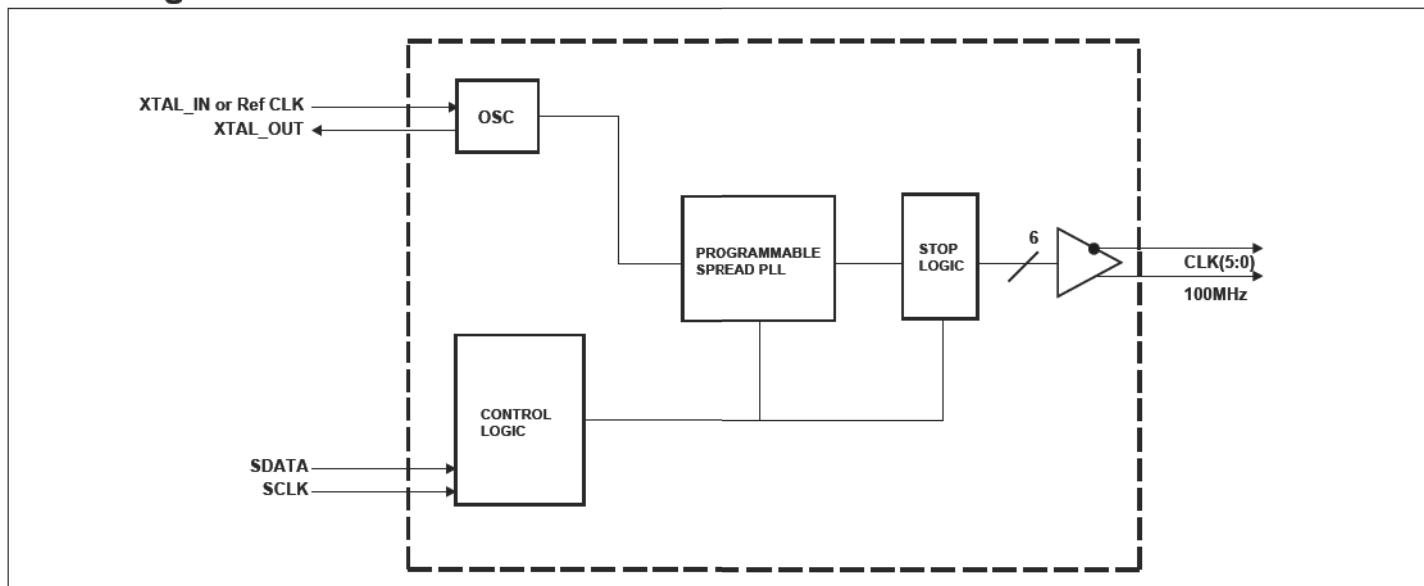
Application

- PCIe 3.0/2.0/1.0 clock generation

Pin Configuration



Block Diagram



Pin Description

| Pin # | Pin Name | Type | Description |
|-------|----------|--------------|--|
| 1 | NC | N/A | No Connection. |
| 2 | VDD | Power | Power supply, nominal 3.3V |
| 3 | NC | N/A | No Connection. |
| 4 | GND | Power | Ground pin. |
| 5 | GND | Power | Ground pin. |
| 6 | CLK_0 | Output | 0.7V differential true clock output, LOW when output is disabled. |
| 7 | CLK_0# | Output | 0.7V differential Complementary clock output, LOW when output is disabled. |
| 8 | VDDO1.8 | Power | Power supply for outputs, nominally 1.8V, range 1.05 to 3.3V |
| 9 | CLK_1 | Output | 0.7V differential true clock output, LOW when output is disabled. |
| 10 | CLK_1# | Output | 0.7V differential Complementary clock output, LOW when output is disabled. |
| 11 | CLK_2 | Output | 0.7V differential true clock output, LOW when output is disabled. |
| 12 | CLK_2# | Output | 0.7V differential Complementary clock output, LOW when output is disabled. |
| 13 | GND | Power | Ground pin. |
| 14 | VDDO1.8 | Power | Power supply for outputs, nominally 1.8V, range 1.05 to 3.3V |
| 15 | CLK_3# | Output | 0.7V differential Complementary clock output, LOW when output is disabled. |
| 16 | CLK_3 | Output | 0.7V differential true clock output, LOW when output is disabled. |
| 17 | CLK_4# | Output | 0.7V differential Complementary clock output, LOW when output is disabled. |
| 18 | CLK_4 | Output | 0.7V differential true clock output, LOW when output is disabled. |
| 19 | VDDO1.8 | Power | Power supply for outputs, nominally 1.8V, range 1.05 to 3.3V |
| 20 | CLK_5# | Output | 0.7V differential Complementary clock output, LOW when output is disabled. |
| 21 | CLK_5 | Output | 0.7V differential true clock output, LOW when output is disabled. |
| 22 | GND | Power | Ground pin. |
| 23 | SCLK | Input | Clock pin of SMBUS circuitry, 5V tolerant |
| 24 | SDATA | Input/output | Data pin of SMBUS circuitry, 5V tolerant |
| 25 | XTAL_OUT | Output | Crystal output, Nominally 25.00MHz. |
| 26 | XTAL_IN | Input | Crystal input or reference input clock, Nominally 25.00MHz. |
| 27 | GND | Power | Ground pin. |
| 28 | NC | N/A | No Connection. |
| 29 | VDD | Power | Power supply, nominal 3.3V |
| 30 | NC | N/A | No Connection. |
| 31 | GND | Power | Ground pin. |
| 32 | VDD | Power | Power supply, nominal 3.3V |

Serial Data Interface (SMBus)

This part is a slave only device that supports blocks 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 by issuing STOP.

Address Assignment

| A6 | A5 | A4 | A3 | A2 | A1 | A0 | W/R |
|----|----|----|----|----|----|----|-----|
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0/1 |

Data Protocol

(Write)

| 1 bit | 8 bits | 1 | 8 bits | 1 | 8 bits | 1 | 8 bits | 1 | | 8 bits | 1 | 1 bit |
|-----------|----------------|-----|-----------------|-----|--------------|-----|-------------|-----|-----|---------------|-----|----------|
| Start bit | Slave Addr: D2 | Ack | Register offset | Ack | Byte Count=N | Ack | Data Byte 0 | Ack | ... | Data Byte N-1 | Ack | Stop bit |

(Read)

| 1 bit | 8 bits | 1 | 8 bits | 1 | 1 | 8 bits | 1 | 8 bits | 1 | 8 bits | 1 | | 8 bits | 1 | 1 bit |
|-----------|----------------|-----|-----------------|-----|--------------|----------------|-----|--------------|-----|-------------|-----|-----|---------------|---------|----------|
| Start bit | Slave Addr: D2 | Ack | Register offset | Ack | Repeat start | Slave Addr: D3 | Ack | Byte Count=N | Ack | Data Byte 0 | Ack | ... | Data Byte N-1 | NOT Ack | Stop bit |

Note:

1. Register offset for indicating the starting register for indexed block write and indexed block read. Byte Count in write mode cannot be 0.

SMBus Table: Device Control Register, READ/WRITE ADDRESS (D2/D3)

| BYTE 0 | | | | | | | |
|--------|------|---------------|------------------|------|-----|--------|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | Reserved | | | | | 0 |
| 5 | | Spread Enable | | R/W | Off | -0.50% | 1 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 0 |
| 2 | | Reserved | | | | | 0 |
| 1 | | Reserved | | | | | 0 |
| 0 | | Reserved | | | | | 0 |

SMBus Table: Output Enable Register

| BYTE 1 | | | | | | | |
|--------|------|----------|------------------|------|---------|--------|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | CLK_0 OE | Output Enable | R/W | Disable | Enable | 1 |
| 5 | | Reserved | | | | | 0 |
| 4 | | Reserved | | | | | 0 |
| 3 | | CLK_1 OE | Output Enable | R/W | Disable | Enable | 1 |
| 2 | | Reserved | | | | | 0 |
| 1 | | Reserved | | | | | 0 |
| 0 | | Reserved | | | | | 0 |

SMBus Table: Reserved Register

| BYTE 2 | | | | | | | |
|--------|------|----------|------------------|------|---|---|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | Reserved | | | | | 0 |
| 5 | | Reserved | | | | | 0 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 0 |
| 2 | | Reserved | | | | | 0 |
| 1 | | Reserved | | | | | 0 |
| 0 | | Reserved | | | | | 0 |

SMBus Table: Output Enable Register

| BYTE 3 | | | | | | | |
|--------|------|----------|------------------|------|---------|--------|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | CLK_5 OE | Output Enable | R/W | Disable | Enable | 1 |
| 6 | | CLK_4 OE | Output Enable | R/W | Disable | Enable | 1 |
| 5 | | Reserved | | | | | 0 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 0 |
| 2 | | Reserved | | | | | 0 |
| 1 | | Reserved | | | | | 0 |
| 0 | | Reserved | | | | | 0 |

SMBus Table: Reserved Register

| BYTE 4 | | | | | | | |
|--------|------|----------|------------------|------|---|---|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | Reserved | | | | | 0 |
| 5 | | Reserved | | | | | 0 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 0 |
| 2 | | Reserved | | | | | 0 |
| 1 | | Reserved | | | | | 0 |
| 0 | | Reserved | | | | | 0 |

SMBus Table: Output amplitude adjustment

| BYTE 5 | | | | | | | |
|--------|------|------------------------|----------------------|-----------------------|----------------------|---|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | Reserved | | | | | 0 |
| 5 | | Reserved | | | | | 0 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 0 |
| 2 | | Reserved | | | | | 0 |
| 1 | | CLK_0/1/2/3/4/5 AMP | Amplitude adjustment | R/W | 00=700mV 01=800mV | | 0 |
| 0 | R/W | | | 10=900mV 11=1000mV | | 1 | |

SMBus Table: Reserved Register

| BYTE 6 | | | | | | | |
|--------|------|----------|------------------|------|---|---|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | Reserved | | | | | 0 |
| 5 | | Reserved | | | | | 0 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 0 |
| 2 | | Reserved | | | | | 0 |
| 1 | | Reserved | | | | | 0 |
| 0 | | Reserved | | | | | 0 |

SMBus Table: Vendor & Revision ID Register

| BYTE 7 | | | | | | | |
|--------|------|------|------------------|------|---|---|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | RID3 | REVISION ID | R | | | 0 |
| 6 | | RID2 | | R | | | 0 |
| 5 | | RID1 | | R | | | 0 |
| 4 | | RID0 | | R | | | 0 |
| 3 | | VID3 | VENDOR ID | R | | | 0 |
| 2 | | VID2 | | R | | | 0 |
| 1 | | VID1 | | R | | | 0 |
| 0 | | VID0 | | R | | | 0 |

SMBus Table: Reserved Register

| BYTE 8 | | | | | | | |
|--------|------|----------|------------------|------|---|---|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | Reserved | | | | | 0 |
| 5 | | Reserved | | | | | 0 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 1 |
| 2 | | Reserved | | | | | 1 |
| 1 | | Reserved | | | | | 1 |
| 0 | | Reserved | | | | | 1 |

SMBus Table: Output Enable Register

| BYTE 9 | | | | | | | |
|--------|------|----------|------------------|------|---------|--------|---------|
| Bit | Pin# | Name | Control Function | Type | 0 | 1 | Default |
| 7 | | Reserved | | | | | 0 |
| 6 | | CLK_3 OE | Output Enable | R/W | Disable | Enable | 1 |
| 5 | | CLK_2 OE | Output Enable | R/W | Disable | Enable | 1 |
| 4 | | Reserved | | | | | 0 |
| 3 | | Reserved | | | | | 0 |
| 2 | | Reserved | | | | | 0 |
| 1 | | Reserved | | | | | 0 |
| 0 | | Reserved | | | | | 0 |

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 V _{DD} +0.5V |
| Ambient Operating Temperature..... | -40°C 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_A = -40~85°C; Supply Voltage VDD = 3.3 V +/-10%; VDDO = 1.8V +/-10%, See Test Loads for loading conditions

| Symbol | Parameters | Condition | Min. | Typ. | Max. | Units |
|--------------------|---------------------------------------|---------------------------------|------|------|------|-------|
| I _{DD3,3} | Operating Supply Current ¹ | VDD, All outputs active @100MHz | | 50 | 65 | mA |

Notes:

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

Electrical Characteristics–Output Duty Cycle, Jitter, and Skew Characteristics

T_A = -40~85°C; Supply Voltage VDD = 3.3 V +/-10%; VDDO = 1.8V +/-10%, See Test Loads for Loading Conditions

| Symbol | Parameters | Condition | Min. | Typ. | Max. | Units |
|----------------------|---------------------------------------|-----------------------------------|------|------|------|-------|
| t _{DC} | Duty Cycle ¹ | Measured differentially, PLL Mode | 45 | | 55 | % |
| tskew | Skew, Output to Output ¹ | VT = 50% | | | 50 | ps |
| t _{cyc-cyc} | Jitter, Cycle to cycle ^{1,2} | PLL mode | | | 50 | ps |

Notes:

1. Guaranteed by design and characterization, not 100% tested in production.
2. Measured from differential waveform

Electrical Characteristics–Input/Supply/Common Output Parameters

T_A = -40~85°C; Supply Voltage VDD = 3.3 V +/-10%; VDDO = 1.8V +/-10%

| Symbol | Parameters | Condition | Min. | Typ. | Max. | Units |
|------------------|----------------------------------|--|-----------------------|------|----------------------|-------|
| V _{DD} | Supply Voltage ¹ | Supply voltage for core, analog | 3.0 | 3.3 | 3.6 | V |
| V _{DDO} | Supply Voltage ¹ | Supply voltage outputs | 1.65 | 1.8 | 2.0 | V |
| V _{IH} | Input High Voltage ¹ | Single-ended inputs, except SMBus | 0.65 V _{DD} | | V _{DD} +0.3 | V |
| V _{IL} | Input Low Voltage ¹ | Single-ended inputs, except SMBus | -0.3 | | 0.35 V _{DD} | V |
| V _{OH} | Output High Voltage ¹ | Single-ended outputs, except SMBus. I _{OH} = -2mA | V _{DD} -0.45 | | | V |
| V _{OL} | Output Low Voltage ¹ | Single-ended outputs, except SMBus. I _{OL} = -2mA | | | 0.45 | V |

| Symbol | Parameters | Condition | Min. | Typ. | Max. | Units |
|--------------|--|---|------|--------|-------------|-------|
| I_{IN} | Input Current ¹ | Single-ended inputs, $V_{IN} = GND$, $V_{IN} = VDD$ (exclude XTAL_IN pin) | -5 | | 5 | uA |
| I_{INP} | | Single-ended inputs $V_{IN} = 0 V$; Inputs with internal pull-up resistors $V_{IN} = VDD$; Inputs with internal pull-down resistors | -200 | | 200 | uA |
| T_{ind} | Ambient Operating Temperature ¹ | Industrial range | -40 | | 85 | °C |
| F_{in} | Input Frequency ¹ | XTAL_IN | | 25.000 | | MHz |
| L_{pin} | Pin Inductance ¹ | | | | 7 | nH |
| C_{IN} | Capacitance ¹ | Logic Inputs | 1.5 | | 5 | pF |
| C_{INXTAL} | | Crystal inputs | | | 6 | pF |
| C_{OUT} | | Output pin capacitance | | | 6 | pF |
| T_{STAB} | Clk Stabilization ^{1,2} | From V_{DD} Power-Up and after input clock stabilization to 1st clock | | | 1.8 | ms |
| f_{MODIN} | SS Modulation Frequency ¹ | Allowable Frequency (Triangular Modulation) | 30 | 31.500 | 33 | kHz |
| t_F | Tfall ^{1,2} | Fall time of control inputs | | | 5 | ns |
| t_R | Trise ^{1,2} | Rise time of control inputs | | | 5 | ns |
| V_{ILSMB} | SMBus Input Low Voltage ¹ | | | | 0.8 | V |
| V_{IHSMB} | SMBus Input High Voltage ¹ | | 2.1 | | V_{DDSMB} | V |
| V_{OLSMB} | SMBus Output Low Voltage ¹ | @ I_{PULLUP} | | | 0.4 | V |
| I_{PULLUP} | SMBus Sink Current ¹ | @ V_{OL} | 4 | | | mA |
| V_{DDSMB} | Nominal Bus Voltage ¹ | 3V to 5V +/- 10% | 2.7 | | 5.5 | V |
| t_{RSMB} | SCLK/SDATA Rise Time ¹ | (Max $V_{IL} - 0.15$) to (Min $V_{IH} + 0.15$) | | | 1000 | ns |
| t_{FSMB} | SCLK/SDATA Fall Time ¹ | (Min $V_{IH} + 0.15$) to (Max $V_{IL} - 0.15$) | | | 300 | ns |
| f_{MAXSMB} | SMBus Operating Frequency ¹ | Delay from assertion of first output enable register to first clock Maximum SMBus operating frequency | | | 100 | kHz |

Notes:

1. Guaranteed by design and characterization, not 100% tested in production.
2. Control input must be monotonic from 20% to 80% of input swing.

Electrical Characteristics–CLK 0.7V Low Power Differential Outputs

T_A = -40~85°C; Supply Voltage VDD = 3.3 V +/-10%; VDDO = 1.8V +/-10%, See Test Loads for loading conditions

| Symbol | Parameters | Condition | Min. | Typ. | Max. | Units |
|------------|---------------------------------------|---|------|------|------|-------|
| Trf | Slew rate ^{1,2,3} | Scope averaging on | 1 | | 4 | V/ns |
| ΔTrf | Slew rate matching ^{1,2,4} | Slew rate matching, Scope averaging on | | | 20 | % |
| VHigh | Voltage High ¹ | Statistical measurement on single-ended signal using oscilloscope math function. (Scope averaging on) | 660 | | 850 | mV |
| VLow | Voltage Low ¹ | | -150 | | 150 | |
| Vmax | Max Voltage ¹ | Measurement on single ended signal using absolute value. (Scope averaging off) | | | 1150 | mV |
| Vmin | Min Voltage ¹ | | -300 | | | |
| Vswing | Vswing ^{1,2} | Scope averaging off | 300 | | | mV |
| Vcross_abs | Crossing Voltage (abs) ^{1,5} | Scope averaging off | 300 | | 550 | mV |
| Δ-Vcross | Crossing Voltage (var) ^{1,6} | Scope averaging off | | | 140 | mV |

Notes:

- Guaranteed by design and characterization, not 100% tested in production. CL = 2pF with RS = 33Ω for Zo = 50Ω (100Ω differential trace impedance).
- Measured from differential waveform.
- Slew rate is measured through the Vswing voltage range centered around differential 0V. This results in a +/-150mV window around differential 0V.
- Matching applies to rising edge rate of Clock / falling edge rate of Clock#. It is measured in 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 uses for the edge rate calculations.
- Vcross 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).
- The total variation of all Vcross measurements in any particular system. Note that this is a subset of V_cross_min/max (V_cross absolute) allowed. The intent is to limit Vcross induced modulation by setting V_cross_delta to be smaller than V_cross abs.

Electrical Characteristics–Phase Jitter Parameters

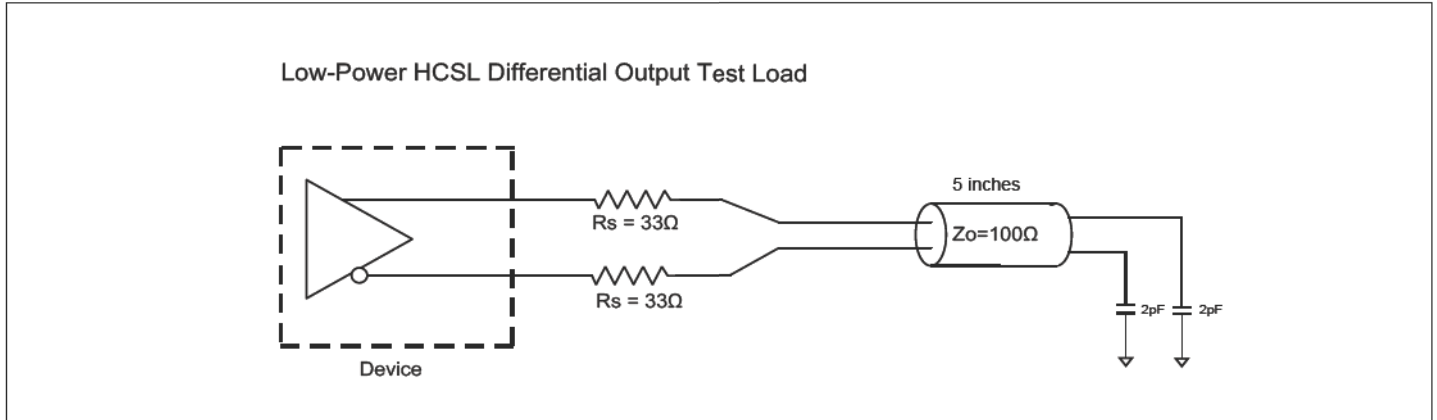
T_A = -40~85°C; Supply Voltage VDD = 3.3 V +/-10%; VDDO = 1.8V +/-10%, See Test Loads for Loading Conditions

| Symbol | Parameters | Condition | Min. | Typ. | INDUSTRY LIMIT | Units |
|------------------------|--|--|------|------|----------------|----------|
| t _{jphPCIeG1} | Phase Jitter, PCI Express ^{1,2,3,5} | PCIe Gen 1 | | 27 | 86 | ps (p-p) |
| t _{jphPCIeG2} | Phase Jitter, PCI Express ^{1,2,5} | PCIe Gen 2 Low Band 10kHz < f < 1.5MHz | | 0.5 | 3 | ps (rms) |
| | | PCIe Gen 2 High Band 1.5MHz < f < Nyquist (50MHz) | | 2.1 | 3.1 | ps (rms) |
| t _{jphPCIeG3} | Phase Jitter, PCI Express ^{1,2,4,5} | PCIe Gen 3 (PLL BW of 2-4MHz, CDR = 10MHz) | | 0.5 | 1 | ps (rms) |

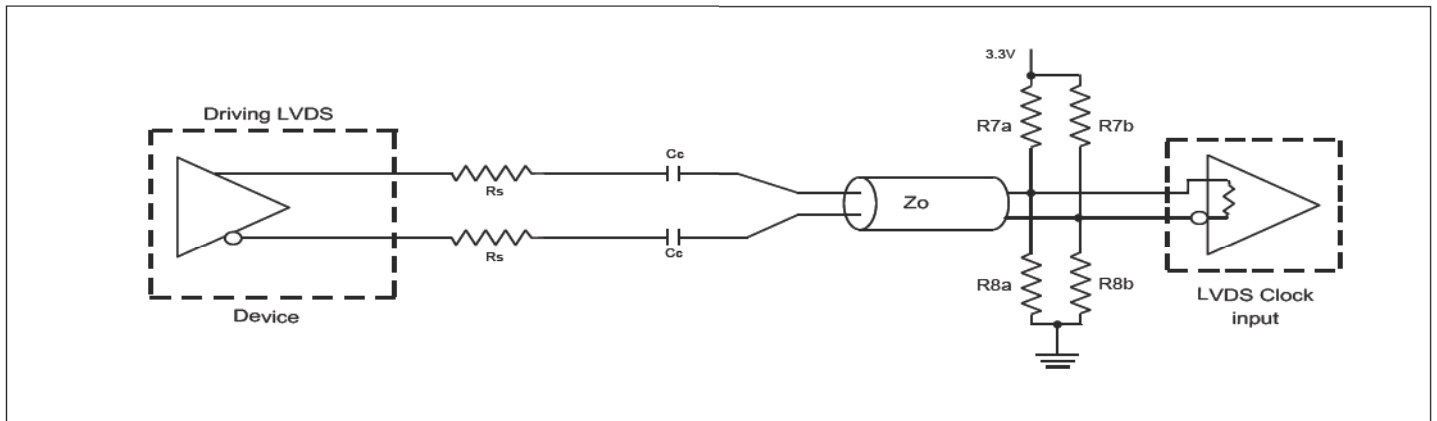
Notes:

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

Test Loads



Driving LVDS



Driving LVDS inputs with the PI6CFGL601B

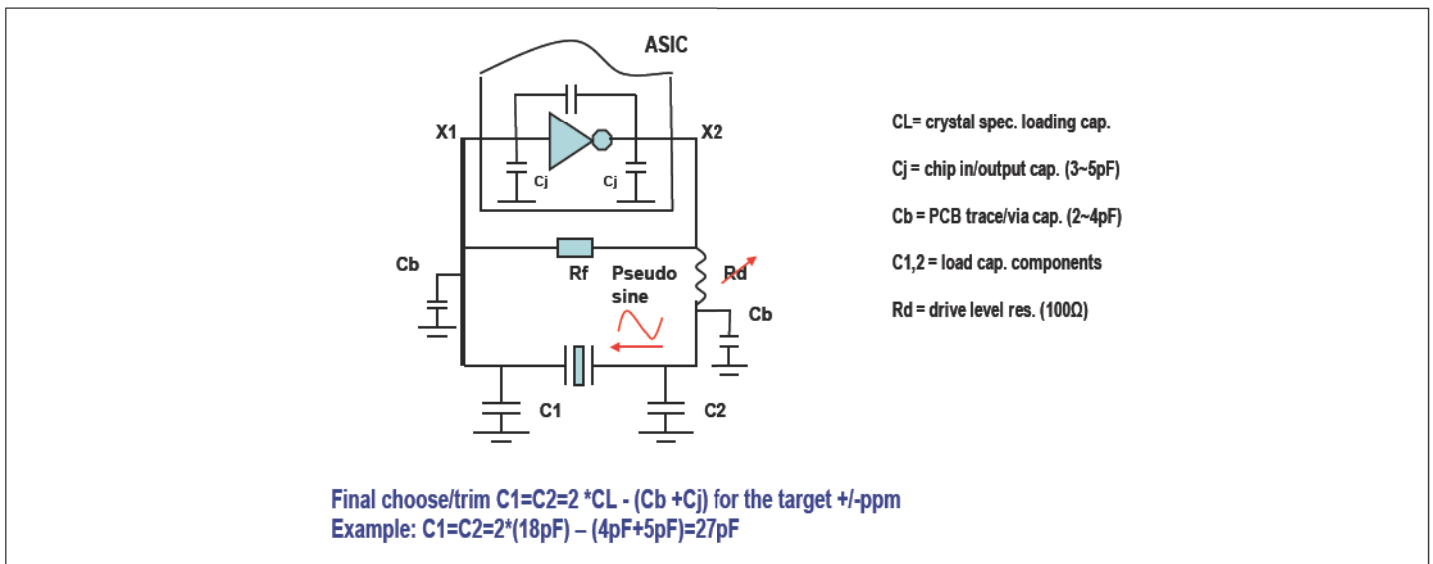
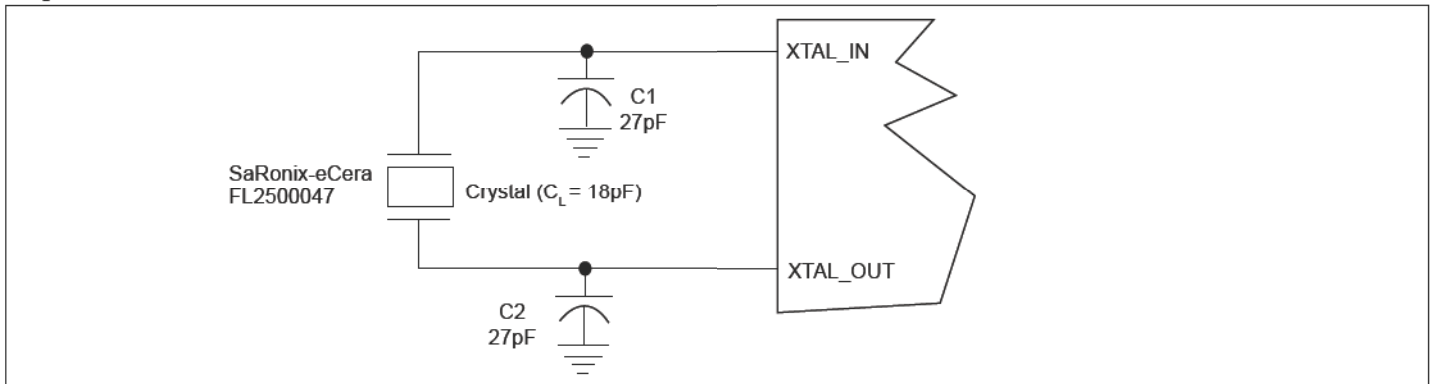
| Component | Value | |
|-----------|--------------------------|------------------------------------|
| | Receiver has termination | Receiver does not have termination |
| R7a, R7b | 10K Ω | 140 Ω |
| R8a, R8b | 5.6K Ω | 75 Ω |
| Cc | 0.1 uF | 0.1 uF |
| Vcm | 1.2 V | 1.2 V |

Application Notes

Crystal circuit connection

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

Crystal Oscillator Circuit

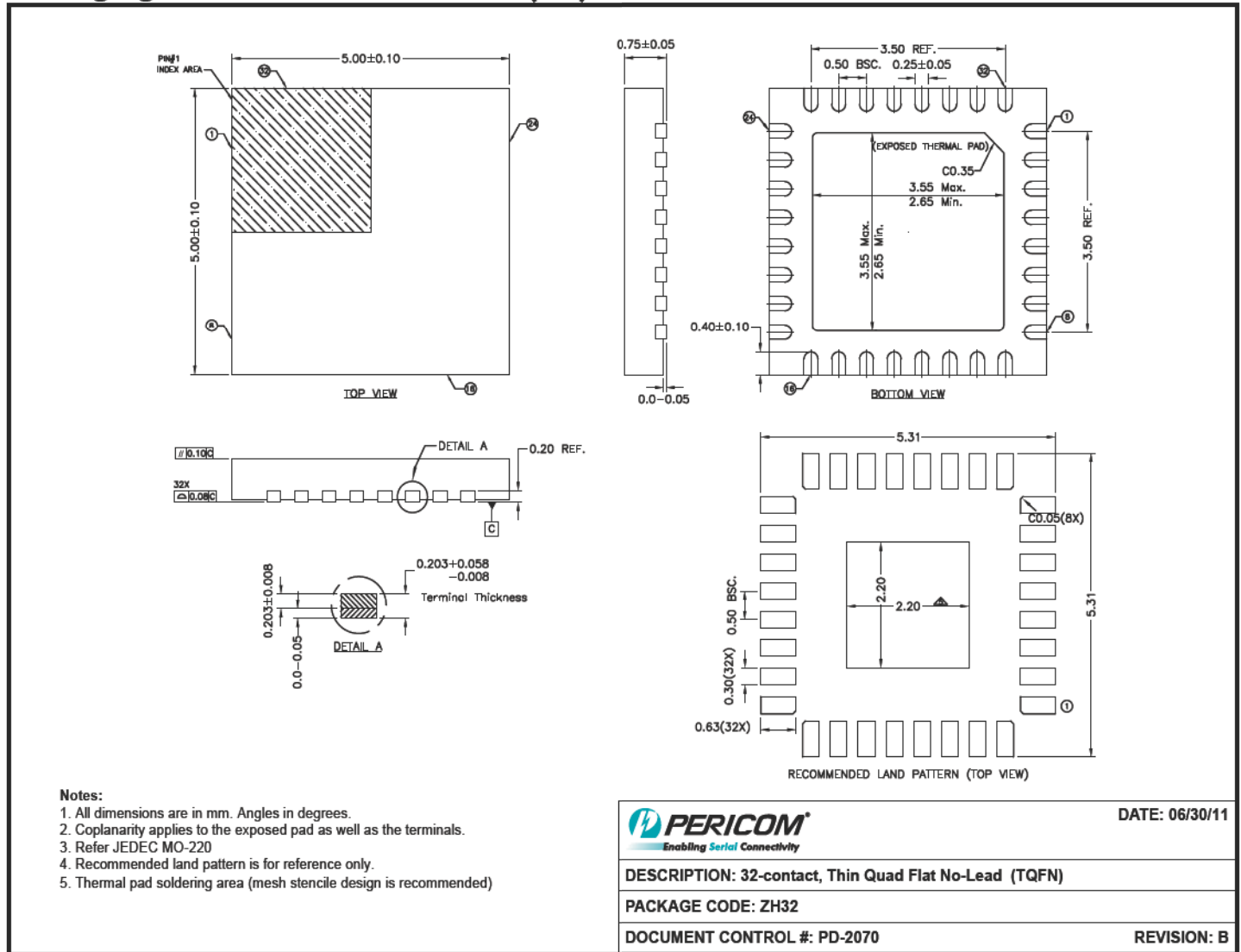


Recommended Crystal Specification

Pericom recommends:

- a) FL2500047, SMD 3.2x2.5(4P), 25M, CL=18pF, +/-20ppm, <http://www.pericom.com/pdf/datasheets/se/FL.pdf>
- b) FY2500081, SMD 5x3.2(4P), 25M, CL=18pF, +/-30ppm, http://www.pericom.com/pdf/datasheets/se/FY_F9.pdf

Packaging Mechanical: 32-Pin TQFN (ZH)



11-0147

Note: For latest package info, please check: <http://www.pericom.com/products/packaging/mechanicals.php>

Ordering Information⁽¹⁻³⁾

| Ordering Code | Package Code | Package Description |
|-----------------|--------------|---|
| PI6CFGL601BZHIE | ZH | 32-contact, Thin Quad Flat No-Lead (TQFN) |

Notes:

1. Thermal characteristics can be found on the company web site at www.pericom.com/packaging/
2. E = Pb-free and Green
3. Adding an X suffix = Tape/Reel