# PI6LC48H04

## PCIe® 3.0 and Ethernet Clock Generator with 4 HCSL Outputs

### Features

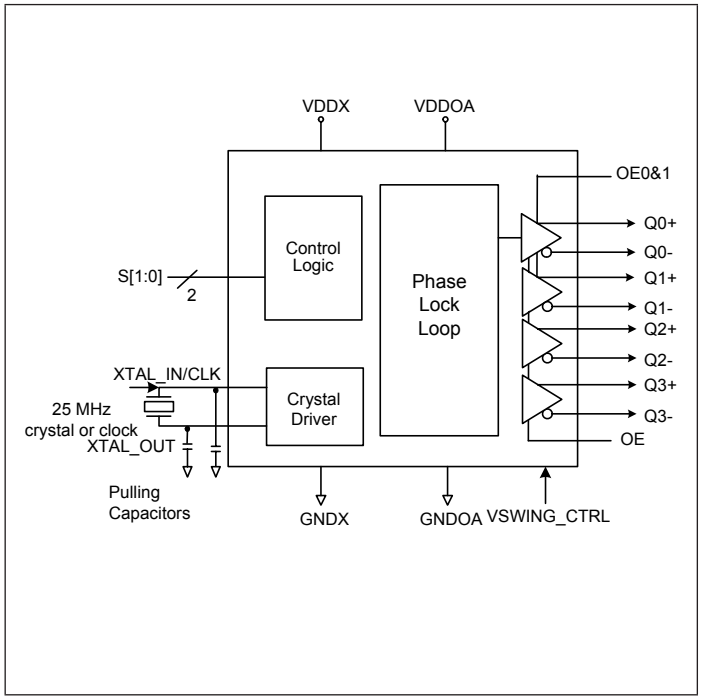
- PCIe® 3.0/2.0/1.0 compliant
  - PCIe 3.0 Phase jitter - 0.45ps RMS (High Freq. Typ.)
- LVDS compatible outputs
- Supply voltage of 3.3V±5% and 2.5V±5%
- 25MHz crystal or clock input frequency
- HCSL outputs, 0.7V low power differential pair
- Jitter 35ps cycle-to-cycle (typ)
- RMS phase jitter 12kHz ~ 20MHz @ 100MHz - 0.32ps (typ)
- RMS phase jitter 12kHz ~ 20MHz @ 125MHz, 156.25MHz, 200MHz - 0.3ps (typ)
- Industrial temperature range
- Packaging: (Pb-free and Green)
  - 20-pin TSSOP (L20)

### Description

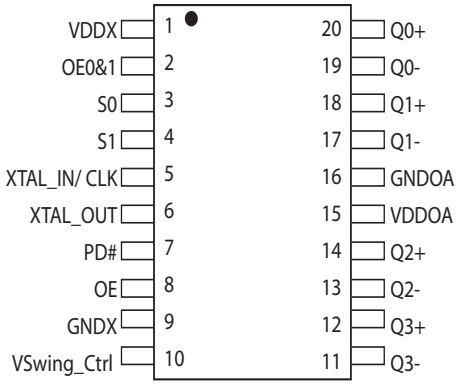
The PI6LC48H04 is a clock generator compliant to PCI Express® 3.0/2.0/1.0, Ethernet and other requirements. The device is used for networking or embedded systems.

The PI6LC48H04 provides four differential (Low Power HCSL) or LVDS outputs. Using Pericom's patented Phase Locked Loop (PLL) techniques, the device takes a 25MHz crystal input and produces four pairs of differential outputs (HCSL) at 156.25MHz, 100MHz, 125MHz, 133.33MHz and 200MHz clock frequencies.

### Block Diagram




### Pin Configuration (20-Pin TSSOP)



## Pin Description

| Pin # | Pin Name | I/O Type | | Description |
|---|---|---|---|---|
| 1 | VDDX | Power | | Crystal supply pin. |
| 2 | OE0&1 | Input | Pull-up | Output enable pin for Q0+/- and Q1+/-. When HIGH, output is enabled and active. When LOW, output is disabled and in high impedance state. Don't care if OE is LOW. Internal 343kΩpull-up resistor. |
| 3 | S0 | Input | Pull-up | Frequency select pin. Internal 343kΩ pull-up resistor. |
| 4 | S1 | Input | Pull-up | Frequency select pin. Internal 343kΩ pull-up resistor. |
| 5 | XTAL_IN/CLK | Input | | Crystal or clock input. Connect to a 25MHz crystal or single ended clock. |
| 6 | XTAL_OUT | Output | | Crystal output. Leave unconnected for clock input. |
| 7 | PD# | Input | Pull-up | Power down pin. When HIGH, the device is in normal operation. When LOW, the device is in power down mode and all outputs are in high impedance state. Internal 343kΩ pull-up resistor. |
| 8 | OE | Input | Pull-up | Output enable pin for all outputs. When HIGH, Q2+/- and Q3+/- are enabled and active and Q0+/- and Q1+/- depends on OE0&1. When LOW, all outputs are disabled and in high impedance state and not dependent on OE0&1. Internal 343kΩ pull-up resistor. |
| 9 | GNDX | Power | | Crystal ground. |
| 10 | VSWING_ CTRL | Input | Pull-up and pull down | VOH selection pin for all outputs. Tri-level selction for different voltage swings. |
| 11,12 | Q3-, Q3+ | Output | | Low power HCSL clock output 3. |
| 13,14 | Q2-, Q2+ | Output | | Low power HCSL clock output 2. |
| 15 | VDDOA | Power | | Analog and output supply pin. |
| 16 | GNDOA | Power | | Analog and output ground. |
| 17,18 | Q1-, Q1+ | Output | | Low power HCSL clock output 1. |
| 19,20 | Q0-, Q0+ | Output | | Low power HCSL clock output 0. |

**Table 1: Output Select Table (25MHz Xtal Input)**

| S1 | S0 | CLK(MHz) |
|---|---|---|
| 0 | 0 | 156.25 |
| 0 | 1 | 100 |
| 1 | 0 | 125 |
| 1 | 1 | 200 (Default) |

**Table 1a: Output Select Table (Generating other frequencies)**

| Xtal Input Freq. | S1 | S0 | CLK(MHz) |
|---|---|---|---|
| 21.33MHz | 0 | 0 | 133.3MHz |
| 26.66MHz | 1 | 0 | 133.3MHz |

Note: Above frequencies are only for the provided settings. Do not deviate from provided S1, S0 settings. For any other output frequencies, please contact Pericom

**Table 2: Output Enable Table**

| OE | OE0&1 | Q0+/- | Q1+/- | Q2+/- | Q3+/- |
|---|---|---|---|---|---|
| 0 | 0 | HiZ | HiZ | HiZ | HiZ |
| 0 | 1 | HiZ | HiZ | HiZ | HiZ |
| 1 | 0 | HiZ | HiZ | Active | Active |
| 1 (Default) | 1 (Default) | Active | Active | Active | Active |

**Table 3: VSWING_CTRL Select Table**

| VSWING_CTRL | **Output Amplitude (V)** |
|---|---|
| 0 | 0.63 |
| Open (default) | 0.75 |
| 1 | 0.87 |

## Maximum Ratings

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

Supply Voltage to Ground Potential . . . . . 4.6V
All Inputs . . . . . .-0.5V to $V_{DD}$+0.5V
Ambient Operating Temperature . . . . . -40 to +85°C
Storage Temperature . . . . . -65 to +150°C
Junction Temperature . . . . . 150°C
Soldering Temperature . . . . . 260°C
ESD Protection (HBM) . . . . . 2000 V

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 Specifications

### Recommended Operation Conditions

| Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Ambient Operating Temperature | -40 | | +85 | °C |
| Power Supply Voltage (measured with respect to GND) | 3.135 | 3.3 | 3.465 | V |
| | 2.375 | 2.5 | 2.625 | V |

**DC Characteristics ($T_A$ = -40°C to +85°C)**

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| | | | 2.375 | 2.5 | 2.625 | V |
| $V_{IH}$ | Input High Voltage(1) | OE, S0, S1, OE0&1, PD# @ VDD=3.3V | 2.0 | | $V_{DD}$ +0.3 | V |
| | | OE, S0, S1, OE0&1, PD# @ VDD=2.5V | 1.7 | | $V_{DD}$ +0.3 | V |
| | | VSWING_CTRL @ VDD = 3.3V and 2.5V | $V_{DD}$ x 0.7 | | $V_{DD}$ +0.3 | V |
| $V_{IL}$ | Input Low Voltage(1) | OE, S0, S1, OE0&1, PD# @ VDD=3.3V | GND -0.3 | | 0.8 | V |
| | | OE, S0, S1, OE0&1, PD# @ VDD=2.5V | GND -0.3 | | 0.7 | V |
| | | VSWING_CTRL @ VDD = 3.3V and 2.5V | GND -0.3 | | $V_{DD}$ x 0.3 | V |
| $I_{IH}$ | Input High Current | OE, S0, S1, OE0&1, PD# with Vin = $V_{DD}$ | -5 | | 5 | µA |
| | | VSWING_CTRL with Vin = $V_{DD}$ | | | 150 | |
| $I_{IL}$ | Input Low Current | OE, S0, S1, OE0&1, PD# with Vin = 0 | -20 | | 20 | |
| | | VSWING_CTRL with Vin = 0 | -150 | | | |
| $I_{DD}$(2) | Operating Supply Current | $C_L$ = 2pF | | | 120 | mA |
| $I_{DDOE}$ | | OE = LOW | | | 65 | mA |
| $I_{DDPD}$ | Power Down Supply Current | | | | 50 | µA |
| $C_{IN}$ | Input Capacitance | @ 25MHz | | | 7 | pF |
| $C_{OUT}$ | Output Capacitance | @ 25MHz | | | 6 | pF |

**Notes:**

**1. Single edge is monotonic when transitioning through region.**

**2. Total current consumption of device, inclusive of $I_{DDOE}$**

**HCSL Output AC Characteristics ($V_{DD}$ = 3.3V ±5%, $T_A$ = -40°C to +85°C)**

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $F_{IN}$ | Input Frequency | | | 25 | | MHz |
| $F_{OUT}$ | Output Frequency | | 100 | | 200 | MHz |
| $V_{OH}$ | Output High Voltage (1,2) | 100 MHz HCSL output @ $V_{DD}$ = 3.3V | 660 | 800 | 900 | mV |
| $V_{OL}$ | Output Low Voltage(1,2) | 100 MHz HCSL output @ $V_{DD}$ = 3.3V | -150 | 0 | | mV |
| $V_{CPA}$ | Crossing Point Voltage(1,2) | Absolute @100MHz | 250 | 350 | 550 | mV |
| $V_{CN}$ | Crossing Point Voltage(1,2,4) | Variation over all edges@100MHz | | | 140 | mV |
| $J_{CC}$ | Jitter, Cycle-to-Cycle(1,3) | | | 35 | 60 | ps |
| $J_{Period}$ | Period jitter | | | 26 | 40 | ps |
| $J_{Phase}$ | RMS Phase Jitter, (Random) | 100MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.32 | 0.5 | ps |
| | | 125MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.3 | 0.5 | ps |
| | | 156.25MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.3 | 0.5 | ps |
| | | 200MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.3 | 0.5 | ps |
| $J_{RMS2.0}$ | PCIe 2.0 RMS Jitter | PCIe 2.0 Test Method @ 100MHz Output | | | 3.1 | ps |
| $J_{RMS3.0}$ | PCIe 3.0 RMS Jitter | PLL L-BW @ 2M & 5M 1st H3 | | 1.42 | 3 | ps |
| | | PLL L-BW @ 2M & 4M 1st H3 | | 2.05 | 3 | ps |
| | | PLL H-BW @ 2M & 5M 1st H3 | | 0.45 | 1 | ps |
| | | PLL H-BW @ 2M & 4M 1st H3 | | 0.45 | 1 | ps |
| $t_{OR}$ | Rise Time(1,2) | From 0.175V to 0.525V | 175 | | 700 | ps |
| $t_{OF}$ | Fall Time(1,2) | From 0.525V to 0.175V | 175 | | 700 | ps |
| $t_{RF}$ | Slew Rate | Differential Slew Rate +150mV / -150mV | 1.1 | 2.7 | 5.5 | V/ns |
| $T_{SKEW}$ | Skew between outputs | At Crossing Point Voltage | | | 25 | ps |
| $T_{DUTY-CYCLE}$ | Duty Cycle(1,3) | | 45 | | 55 | % |
| $T_{OE}$ | Output Enable Time(5) | All outputs | | | 10 | µs |
| $T_{OT}$ | Output Disable Time(5) | All outputs | | | 10 | µs |
| $t_{STABLE}$ | Stabilization Time | From Power-up $V_{DD}$=3.3V | | 20 | | ms |

**Notes:**
1. $C_L$ = 2 pF
2. Single-ended waveform
3. Differential waveform
4. Measured at the crossing point
5. CLK pins are tri-stated when OE is LOW

**HCSL Output AC Characteristics ($V_{DD}$ = 2.5V ±5%, $T_A$ = -40°C to +85°C)**

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $F_{IN}$ | Input Frequency | | | 25 | | MHz |
| $F_{OUT}$ | Output Frequency | | 100 | | 200 | MHz |
| $V_{OH}$ | Output High Voltage (1,2) | 100 MHz HCSL output @ $V_{DD}$ = 2.5V | 660 | 800 | 900 | mV |
| $V_{OL}$ | Output Low Voltage(1,2) | 100 MHz HCSL output @ $V_{DD}$ = 2.5V | -150 | 0 | | mV |
| $V_{CPA}$ | Crossing Point Voltage(1,2) | Absolute @100MHz | 250 | 350 | 550 | mV |
| $V_{CN}$ | Crossing Point Voltage(1,2,4) | Variation over all edges@100MHz | | | 140 | mV |
| $J_{CC}$ | Jitter, Cycle-to-Cycle(1,3) | | | 35 | 60 | ps |
| $J_{Period}$ | Period jitter | | | 26 | 40 | ps |
| $J_{Phase}$ | RMS Phase Jitter, (Random) | 100MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.32 | 0.5 | ps |
| | | 125MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.3 | 0.5 | ps |
| | | 156.25MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.3 | 0.5 | ps |
| | | 200MHz 25MHz Xtal input, 12kHz - 20MHz | | 0.3 | 0.5 | ps |
| $J_{RMS2.0}$ | PCIe 2.0 RMS Jitter | PCIe 2.0 Test Method @ 100MHz Output | | | 3.1 | ps |
| $J_{RMS3.0}$ | PCIe 3.0 RMS Jitter | PLL L-BW @ 2M & 5M 1st H3 | | 1.42 | 3 | ps |
| | | PLL L-BW @ 2M & 4M 1st H3 | | 2.05 | 3 | ps |
| | | PLL H-BW @ 2M & 5M 1st H3 | | 0.45 | 1 | ps |
| | | PLL H-BW @ 2M & 4M 1st H3 | | 0.45 | 1 | ps |
| $t_{OR}$ | Rise Time(1,2) | From 0.175V to 0.525V | 175 | | 700 | ps |
| $t_{OF}$ | Fall Time(1,2) | From 0.525V to 0.175V | 175 | | 700 | ps |
| $t_{RF}$ | Slew Rate | Differential Slew Rate +150mV / -150mV | 1.1 | 2.7 | 5.5 | V/ns |
| $T_{SKEW}$ | Skew between outputs | At Crossing Point Voltage | | | 25 | ps |
| $T_{DUTY-CYCLE}$ | Duty Cycle(1,3) | | 45 | | 55 | % |
| $T_{OE}$ | Output Enable Time(5) | All outputs | | | 10 | µs |
| $T_{OT}$ | Output Disable Time(5) | All outputs | | | 10 | µs |
| $t_{STABLE}$ | Stabilization Time | From Power-up $V_{DD}$=2.5V | | 20 | | ms |

**Notes:**
1. $C_L$ = 2 pF
2. Single-ended waveform
3. Differential waveform
4. Measured at the crossing point
5. CLK pins are tri-stated when OE is LOW

## Application Information

### Decoupling Capacitors

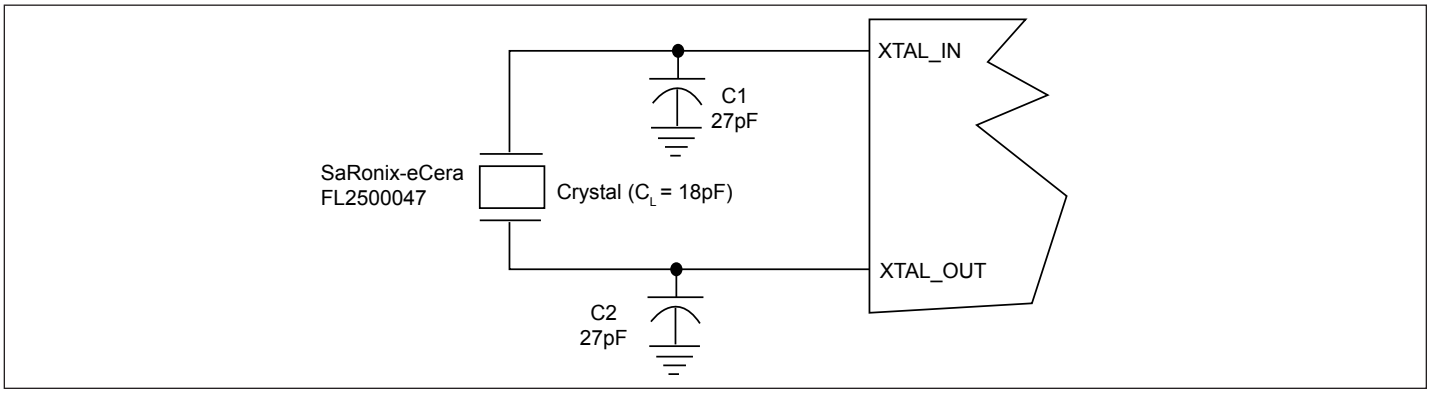
Decoupling capacitors of 0.01µF should be connected between each $V_{DD}$ pin and the ground plane and placed as close to the $V_{DD}$ pin as possible.

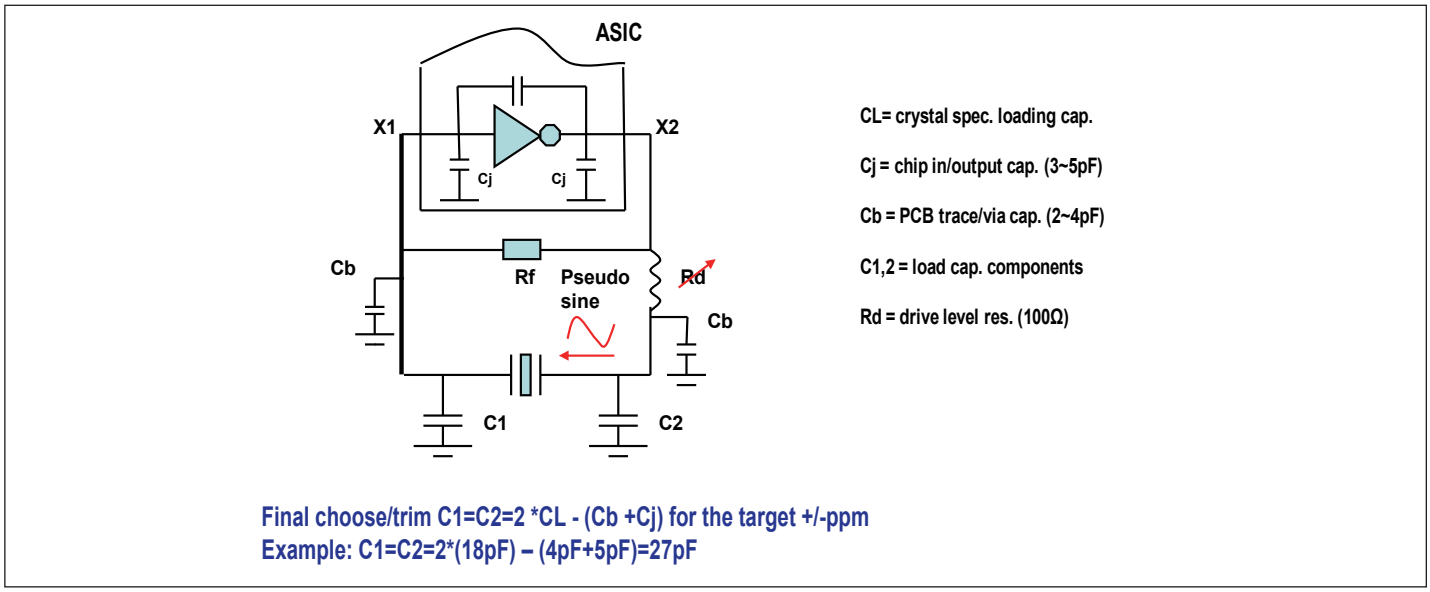
### Crystal

Use a 25MHz fundamental mode parallel resonant crystal with less than 300PPM of error across temperature.

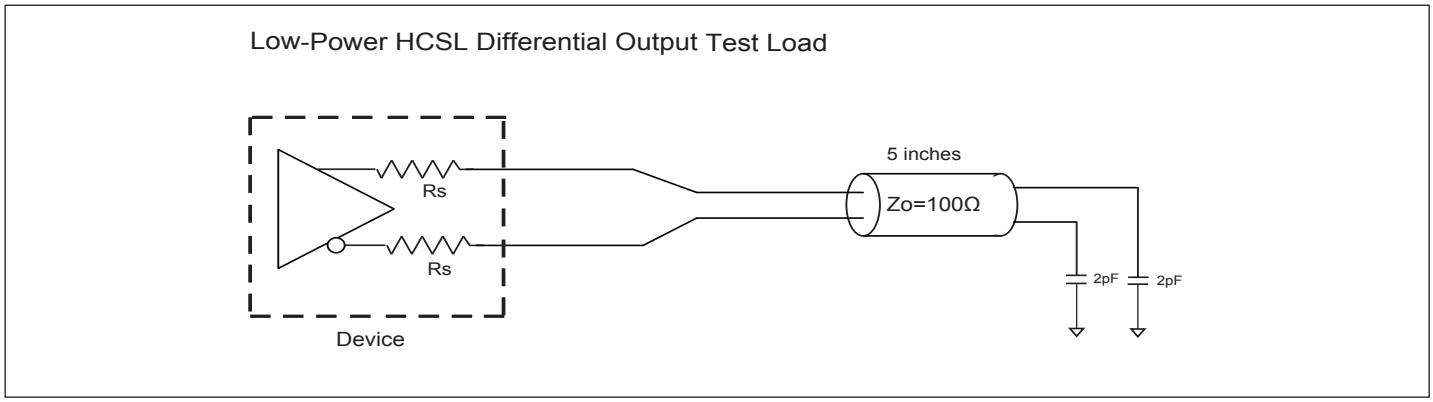
## Crystal circuit connection

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.

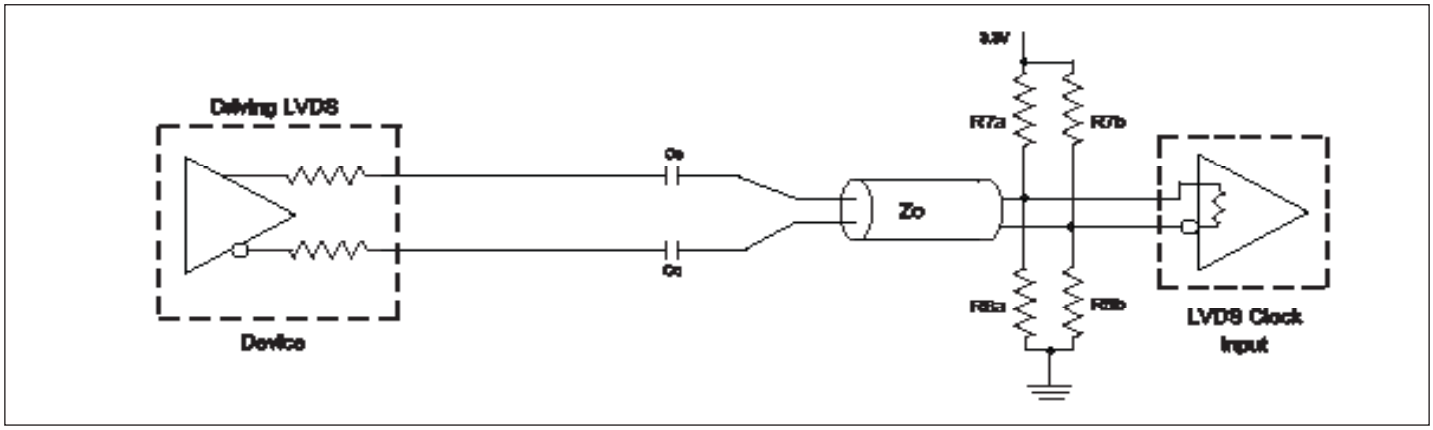


## Test Loads




## Driving LVDS




## Driving LVDS inputs

| 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 volts | 1.2 volts |

## Thermal Characteristics

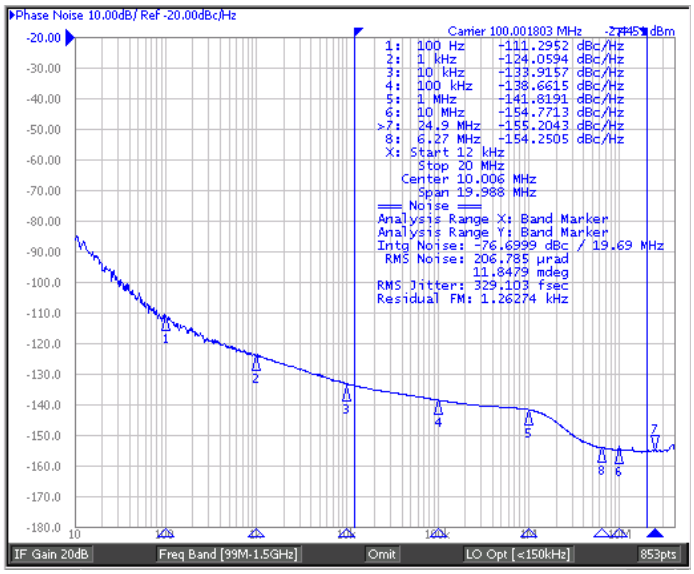
| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $\theta_{JA}$ | Thermal Resistance Junction to Ambient | Still air | | | 84 | °C/W |
| $\theta_{JC}$ | Thermal Resistance Junction to Case | | | | 17 | °C/W |

**Recomended Crystal Specification**

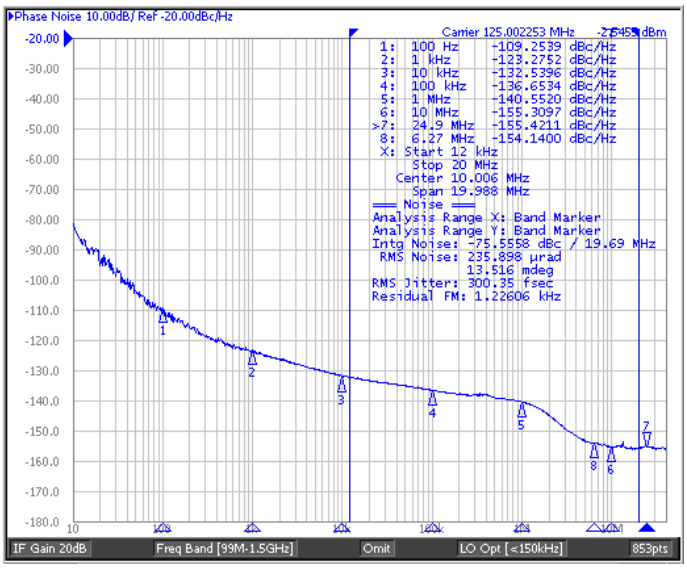
Pericom recommends:
a) GC2500003 XTAL 49S/SMD(4.0 mm), 25M, CL=18pF, +/-30ppm
http://www.pericom.com/pdf/datasheets/se/GC_GF.pdf
b) FY2500107, SMD 5x3.2(4P), 25M, CL=18pF, +/-30ppm
http://www.pericom.com/pdf/datasheets/se/FY_F9.pdf
c) FL2500038, SMD 3.2x2.5(4P), 25M, CL=18pF, +/-20ppm
http://www.pericom.com/pdf/datasheets/se/FL.pdf

## Phase Noise Plot

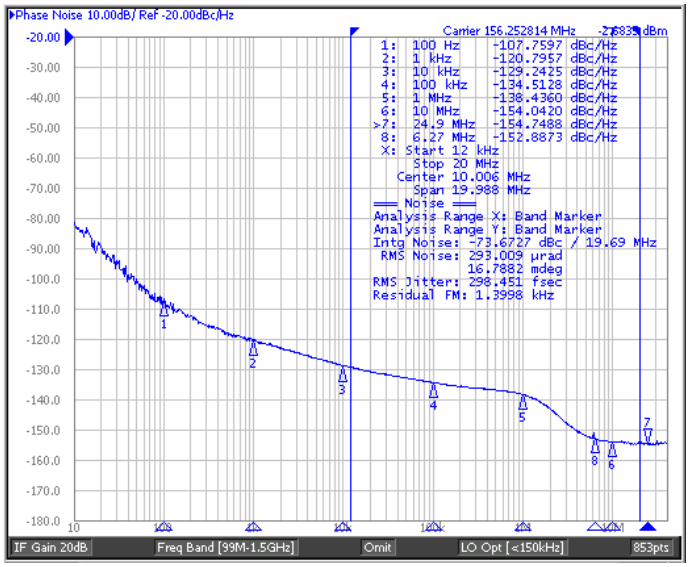
### 100MHz



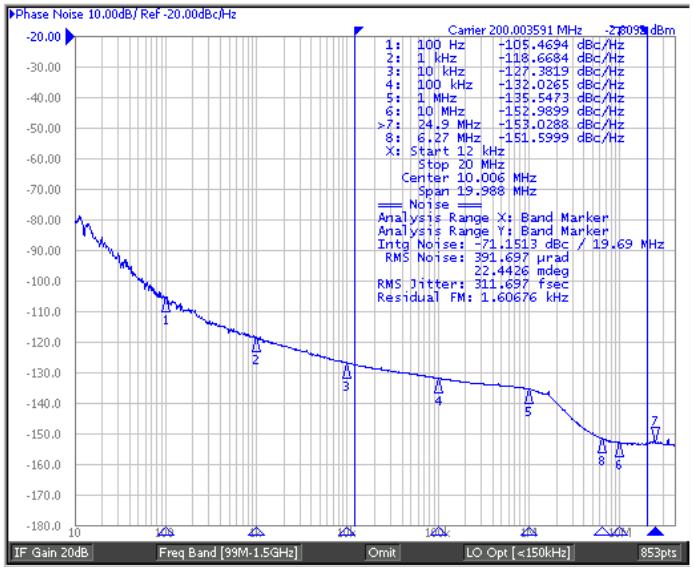

### 125MHz



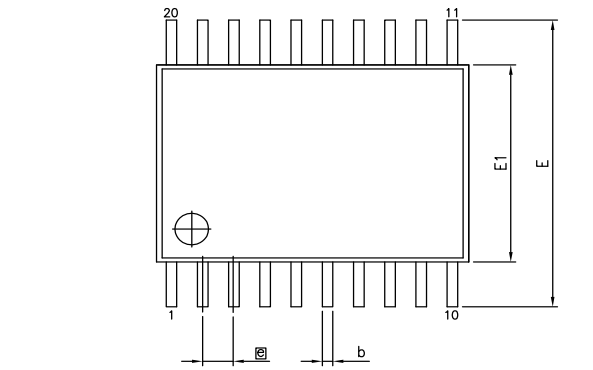

### 156.25MHz

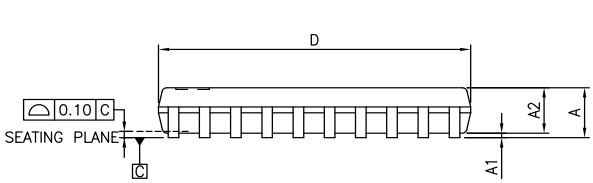


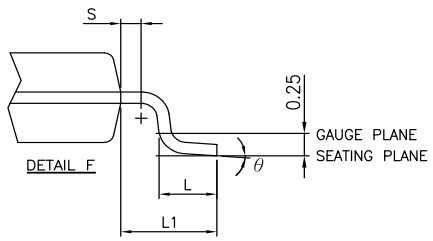

### 200MHz



## Packaging Mechanical: 20-Pin TSSOP (L)




VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

| SYMBOLS | MIN. | NOM. | MAX. |
|---|---|---|---|
| A | – | – | 1.20 |
| A1 | 0.05 | – | 0.15 |
| A2 | 0.80 | – | 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 | | 6.40 BSC | |
| e | | 0.65 BSC | |
| L1 | | 1.00 REF | |
| L | 0.45 | 0.60 | 0.75 |
| S | 0.20 | – | – |
| θ | 0° | – | 8° |

**Notes:**
1. Refer JEDEC MO-153F/AC
2. Controlling dimensions in millimeters
3. Package outline exclusive of mold flash and metal burr

PERICOM Enabling Serial Connectivity — **DATE: 05/03/12**

**DESCRIPTION: 20-pin, 173mil Wide TSSOP**

**PACKAGE CODE: L**

**DOCUMENT CONTROL #: PD-1311** **REVISION: F**

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

## Ordering Information

| Ordering Code | Package Code | Package Type | Operating Temperature |
|---|---|---|---|
| PI6LC48H04LIE | L | Pb-free & Green, 20-pin TSSOP | Industrial |
| PI6LC48H04LIEX | L | Pb-free & Green, 20-pin TSSOP, Tape & Reel | |

**Notes:**

- **Thermal characteristics can be found on the company web site at www.pericom.com/packaging/**
- **"E" denotes Pb-free and Green packaging**
- **X = Suffix for tape and reel packaging**