

**PI6LC48H04**

**PCIe® 4.0 and Ethernet Clock Generator with 4 HCSL Outputs**

**Features**

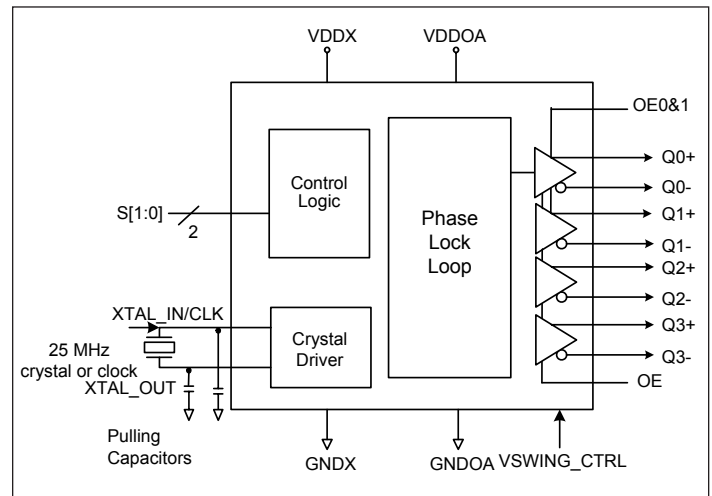
- PCIe® 4.0/3.0/2.0/1.0 compliant
  - PCIe 4.0 Phase jitter - 0.45ps RMS
- LVDS compatible outputs
- Supply voltage of 3.3V±5% and 2.5V±5%
- 25MHz crystal or clock input frequency
- HCSL outputs, 0.7V low power differential pair
- Jitter 35ps cycle-to-cycle (typ)
- RMS phase jitter 12kHz ~ 20MHz @ 100MHz - 0.32ps (typ)
- RMS phase jitter 12kHz ~ 20MHz @ 125MHz, 156.25MHz, 200MHz - 0.3ps (typ)
- Industrial temperature range
- 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-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](https://www.diodes.com/contact-us) or your local Diodes representative.  
<https://www.diodes.com/quality/product-definitions/>
- Packaging: (Pb-free and Green)
  - 20-pin TSSOP (L20)

**Description**

The PI6LC48H04 is a clock generator compliant to PCI Express® 4.0/3.0/2.0/1.0, 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 Diodes' 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.

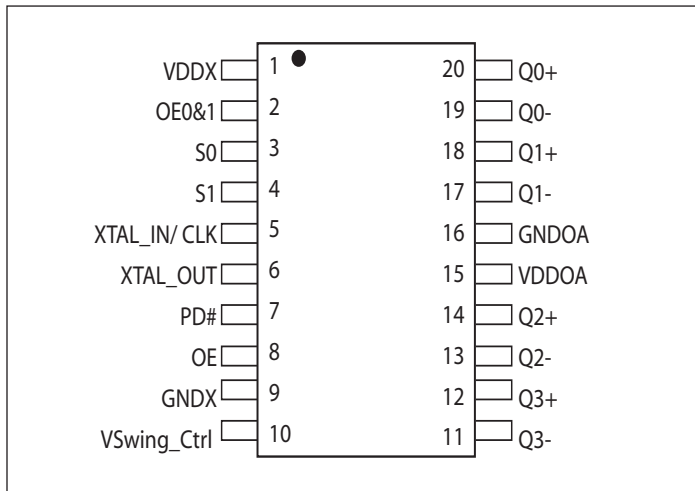
**Block Diagram**



**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 #	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 343kΩ pull-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/ pull down	VOH selection pin for all outputs. Tri-level selection 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.

**PI6LC48H04**

**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 Diodes.

**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

**PI6LC48H04**

**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 <sub>DD</sub> +0.5V
Storage Temperature .....	-65 to +150°C
Junction Temperature .....	125°C
ESD Protection (HBM).....	2000V

**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<sub>A</sub> = -40°C to +85°C)**

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

**Notes:**

1. Single edge is monotonic when transition through region.
2. Total current consumption of device, inclusive of I<sub>DDOE</sub>.

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

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 <sup>(1,2)</sup>	100 MHz HCSL output @ $V_{DD} = 3.3V$	660	800	900	mV
$V_{OL}$	Output Low Voltage <sup>(1,2)</sup>	100 MHz HCSL output @ $V_{DD} = 3.3V$	-150	0		mV
$V_{CPA}$	Crossing Point Voltage <sup>(1,2)</sup>	Absolute @100MHz	250	350	550	mV
$V_{CN}$	Crossing Point Voltage <sup>(1,2,4)</sup>	Variation over all edges@100MHz			140	mV
$J_{CC}$	Jitter, Cycle-to-Cycle <sup>(1,3)</sup>			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
$J_{RMS4.0}$	PCIe 4.0 RMS Jitter	PCIe Gen 4 (PLL BW of 2-4 or 2-5MHz, CDR =10MHz)		0.37	0.45	ps
$t_{OR}$	Rise Time <sup>(1,2)</sup>	From 0.175V to 0.525V	175		700	ps
$t_{OF}$	Fall Time <sup>(1,2)</sup>	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 <sup>(1,3)</sup>		45		55	%
$T_{OE}$	Output Enable Time <sup>(5)</sup>	All outputs			10	$\mu s$
$T_{OT}$	Output Disable Time <sup>(5)</sup>	All outputs			10	$\mu s$
$t_{STABLE}$	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** ( $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ )

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 <sup>(1,2)</sup>	100 MHz HCSL output @ $V_{DD} = 2.5V$	660	800	900	mV
$V_{OL}$	Output Low Voltage <sup>(1,2)</sup>	100 MHz HCSL output @ $V_{DD} = 2.5V$	-150	0		mV
$V_{CPA}$	Crossing Point Voltage <sup>(1,2)</sup>	Absolute @100MHz	250	350	550	mV
$V_{CN}$	Crossing Point Voltage <sup>(1,2,4)</sup>	Variation over all edges@100MHz			140	mV
$J_{CC}$	Jitter, Cycle-to-Cycle <sup>(1,3)</sup>			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
$J_{RMS4.0}$	PCIe 4.0 RMS Jitter	PCIe Gen 4 (PLL BW of 2-4 or 2-5MHz, CDR =10MHz)		0.37	0.45	ps
$t_{OR}$	Rise Time <sup>(1,2)</sup>	From 0.175V to 0.525V	175		700	ps
$t_{OF}$	Fall Time <sup>(1,2)</sup>	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 <sup>(1,3)</sup>		45		55	%
$T_{OE}$	Output Enable Time <sup>(5)</sup>	All outputs			10	$\mu$ s
$T_{OT}$	Output Disable Time <sup>(5)</sup>	All outputs			10	$\mu$ s
$t_{STABLE}$	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

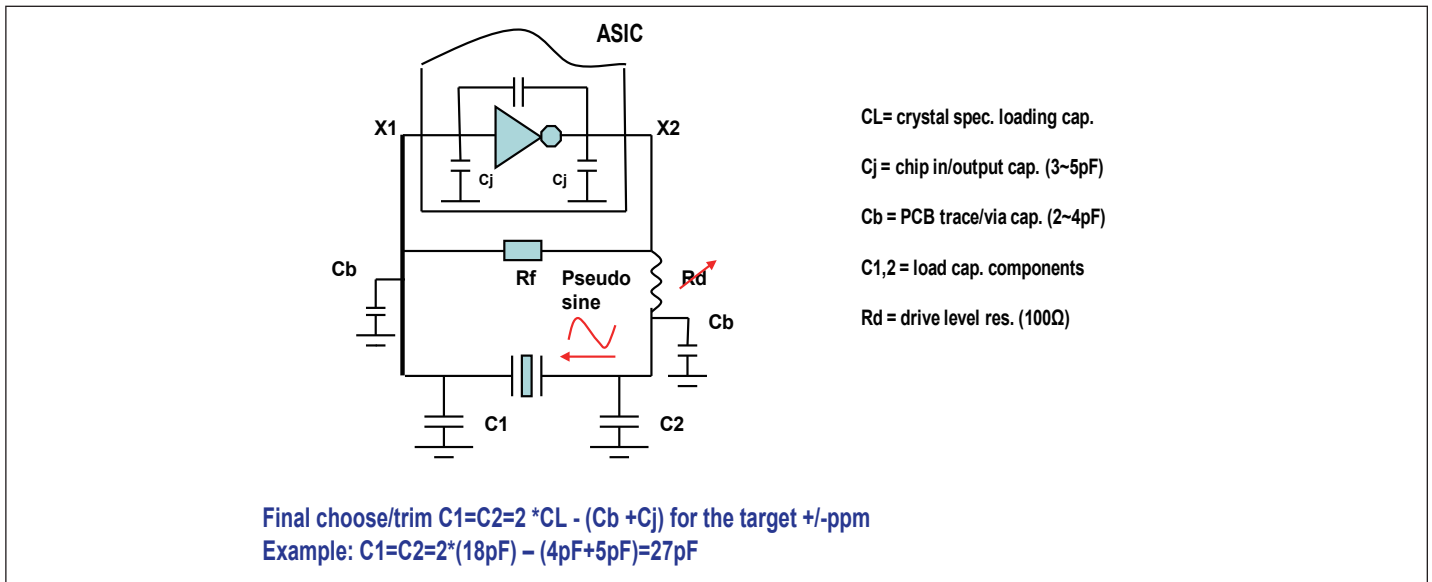
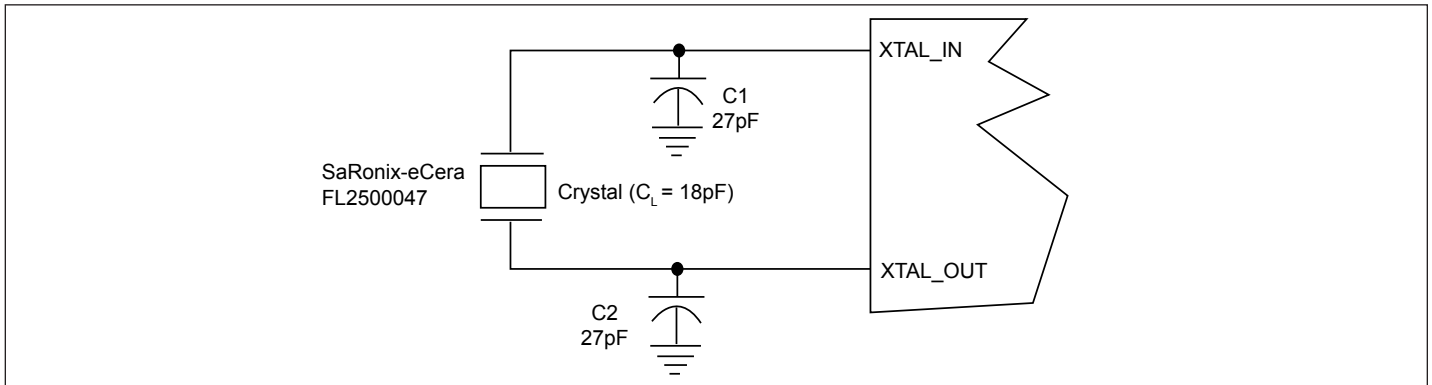
Decoupling capacitors of 0.01μF should be connected between each V<sub>DD</sub> pin and the ground plane and placed as close to the V<sub>DD</sub> pin as possible.

### Crystal

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

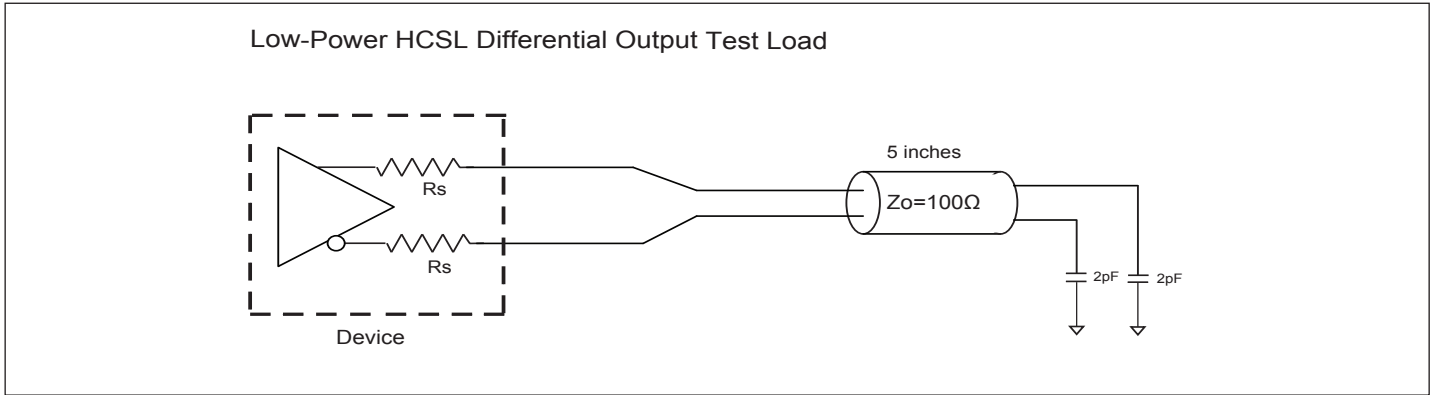
## Crystal Circuit Connection

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.

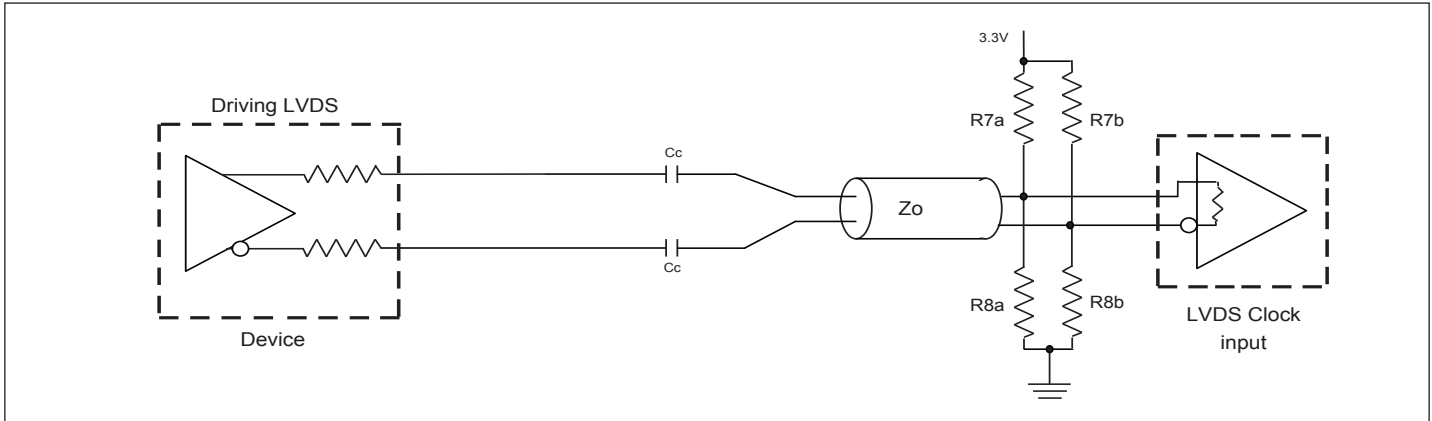


**PI6LC48H04**

**Test Loads**



**Driving LVDS**



**Driving LVDS Inputs**

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 $\mu$ F	0.1 $\mu$ F
Vcm	1.2 volts	1.2 volts



**PI6LC48H04**

**Thermal Characteristics**

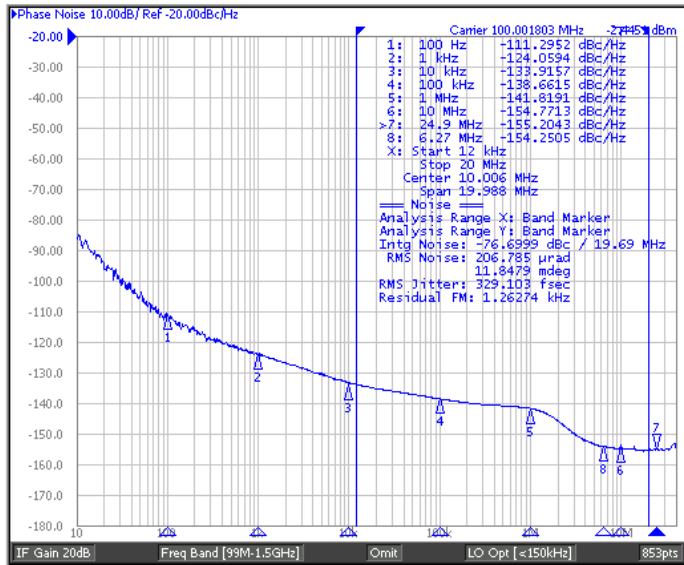
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$\theta_{JA}$	Thermal Resistance Junction to Ambient	Still air			84	°C/W
$\theta_{JC}$	Thermal Resistance Junction to Case				17	°C/W

**Recommended Crystal Specification**

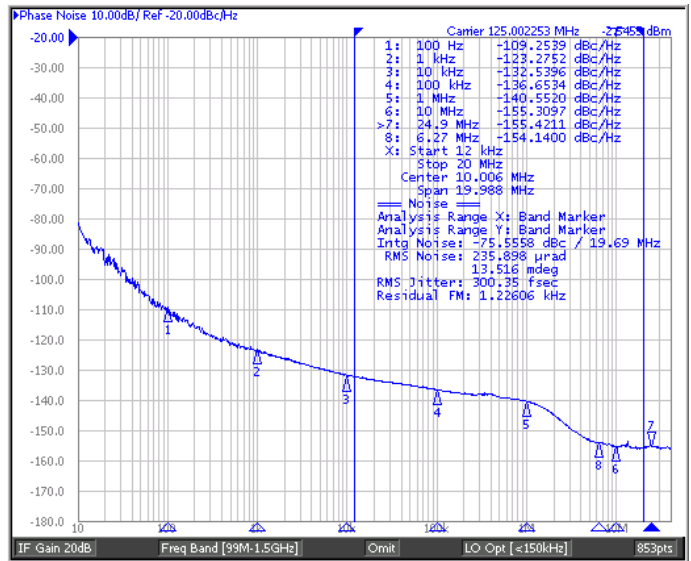
Pericom recommends:

- a) GC2500003 XTAL 49S/SMD(4.0 mm), 25M, CL=18pF, +/-30ppm
- b) FY2500107, SMD 5x3.2(4P), 25M, CL=18pF, +/-30ppm
- c) FL2500038, SMD 3.2x2.5(4P), 25M, CL=18pF, +/-20ppm

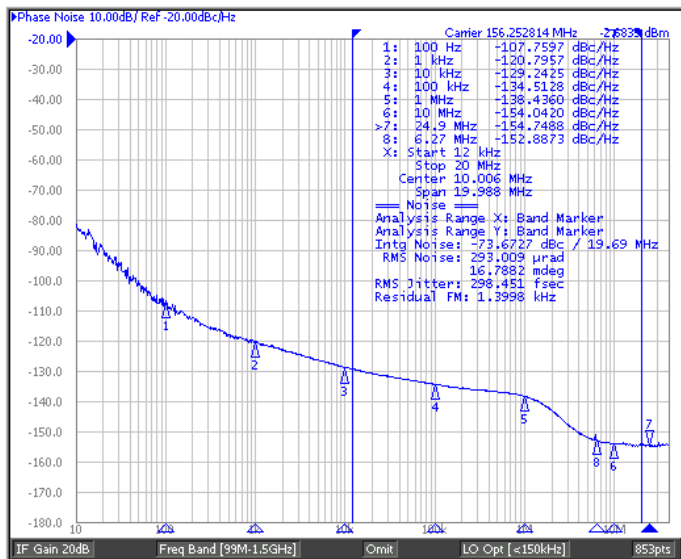
**Phase Noise Plot  
100MHz**



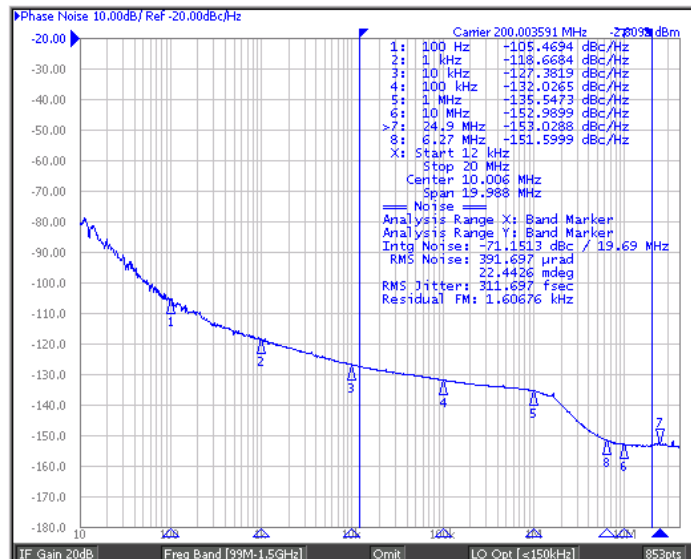
**125MHz**



**156.25MHz**



**200MHz**



**PI6LC48H04**

### Part Marking

L Package

PI6C  
48H04LIE  
A2YYWWX<sup>̄</sup>  
○

A2: BD Option

YY: Year

WW: Workweek

1st X: Assembly Code

2nd X: Fab Site Code

**PI6LC48H04**

**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.

**PERICOM**  
Enabling Serial Connectivity

DATE: 03/31/16

DESCRIPTION: 20-Pin, 173mil Wide TSSOP

PACKAGE CODE: L (L20)

DOCUMENT CONTROL #: PD-1311

REVISION: G

16-0074

For latest package info.

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

**Ordering Information**

Ordering Code	Package Code	Package Description	Operating Temperature
PI6LC48H04LIEX	L	20-Pin, 173mil Wide (TSSOP)	Industrial

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. E = Pb-free and Green
5. X suffix = Tape/Reel

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2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

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