

### Features

- Ultra low jitter 156.25MHz clock generator <0.1ps max (12k to 20MHz) in LVPECL configuration
- 6 differential outputs with 2 banks
- User configurable output signaling standard for each bank: LVDS or LVPECL or HCSL
- Separate supply voltages for customizable output levels
- Low skew between outputs within banks (<40ps)
- 2.5V / 3.3V power supply
- Industrial temperature support
- LQFP-48 package

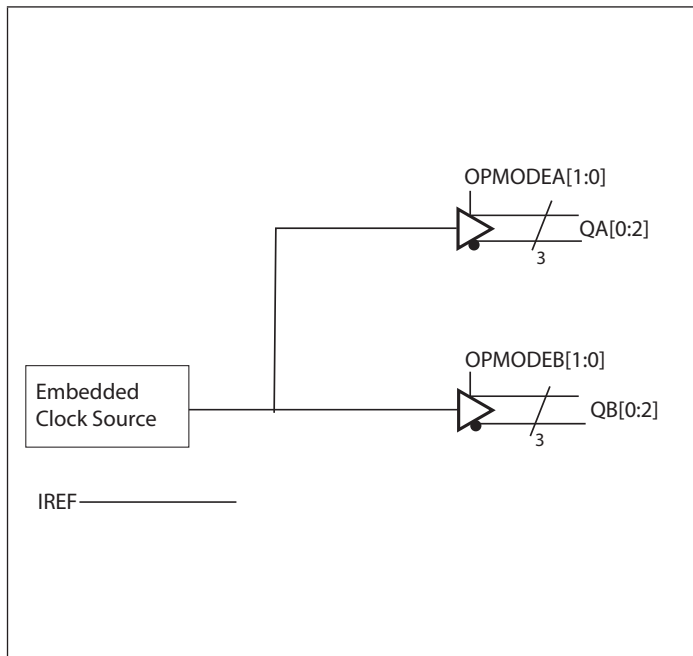
### Description

The PI6CXG06F62a is part of Pericom's FlexOut clock generator family. FlexOut generators combine a low jitter high performance clock generator along with fanout capabilities. It also integrates a unique feature with user configurable output signaling standards on per bank basis which provide great flexibility to users. This device is ideal for systems that need to distribute low jitter clock signals to multiple destinations.

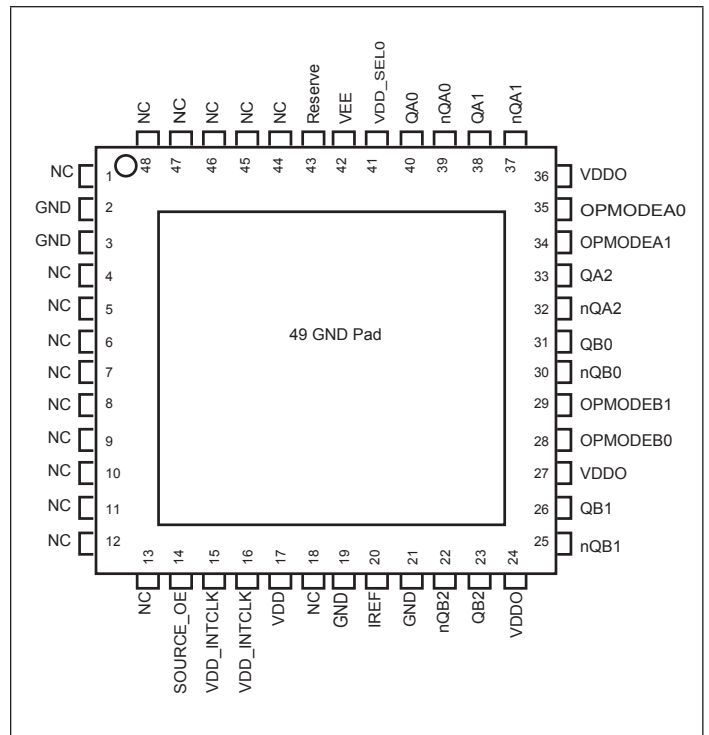
### Applications

- Networking systems including switches and routers
- High frequency backplane based computing and telecom platforms

### Block Diagram



### Pin Configuration (48-Pin LQFP)



## Pinout Table

Pin #	Pin Name	Type	Description
2, 3, 19, 21	GND	Power	Connect to Ground
14	SOURCE_OE	Input	Control of embedded clock source ON/ OFF
15, 16	VDD_INTCLK	Power	Voltage supply for embedded clock source
17	VDD	Power	Power supply for core
20	IREF	Output	Reference current for HCSL output tuning. Typically connected with external 475Ω resistor to GND
22, 23	nQB2 QB2	Output	Bank B differential output pair. Pin selectable LVPECL/LVDS/HCSL interface levels.
24, 27, 36	VDDO	Power	Power supply for output buffers
25, 26	nQB1 QB1	Output	Bank B differential output pair. Pin selectable LVPECL/LVDS/HCSL interface levels.
28	OPMODEB0	Input	Bank B output selection pin
29	OPMODEB1	Input	Bank B output selection pin
30, 31	nQB0 QB0	Output	Bank B differential output pair. Pin selectable LVPECL/LVDS/HCSL interface levels.
32, 33	nQA2 QA2	Output	Bank A differential output pair. Pin selectable LVPECL/LVDS/HCSL interface levels.
34	OPMODEA1	Input	Bank A output selection pin
35	OPMODEA0	Input	Bank A output selection pin
37, 38	nQA1 QA1	Output	Bank A differential output pair. Pin selectable LVPECL/LVDS/HCSL interface levels.
39, 40	nQA0 QA0	Output	Bank A differential output pair. Pin selectable LVPECL/LVDS/HCSL interface levels.
41	VDD_SEL0	Power	Connect to power supply, tie high
42	VEE	Power	Connect to Negative power supply
43	Reserve	Output (Do not connect)	Embedded source debug pin. To be left open and not connected in application.
49	GND Pad	Power	Exposed pad to be connected to Ground
1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 44, 45, 46, 47, 48	NC	-	No connect

## Output Mode select function

OPMODEA/B [1]	OPMODEA/B [0]	Output Bank A / Bank B Mode
0	0	LVPECL
0	1	LVDS
1	0	HCSL
1	1	Hi-Z

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

Storage temperature.....	-55 to +150°C
Supply Voltage to Ground Potential (All VDD, VDDO) .....	-0.5 to +4.6V
Inputs (Referenced to GND) .....	-0.5 to VDD+0.5V
Clock Output (Referenced to GND).....	-0.5 to VDD+0.5V
V <sub>EE</sub> .....	-0.5V
Latch up .....	±200mA
ESD Protection .....	2000 V min (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.

**Power Supply Characteristics and Operating Conditions**

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
V <sub>DD</sub> , V <sub>DD_X</sub>	Supply Voltage		3.135		3.465	V
			2.375		2.625	V
V <sub>DDO</sub>	Output Supply Voltage		3.135		3.465	V
			2.375		2.625	V
V <sub>EE</sub>	Negative Supply Voltage		-0.5		0	V
I <sub>DD</sub>	Core Power Supply Current	All outputs unloaded		85	110	mA
I <sub>DDO</sub>	Output Power Supply Current	All LVPECL outputs unloaded		69	100	
		All LVDS outputs loaded		82	100	
		All HCSL outputs unloaded		51	70	
I <sub>DDTOTAL</sub>	Total Power Supply Current	All outputs unloaded			210	
T <sub>A</sub>	Ambient Operating Temperature		-40		85	°C

### DC Electrical Specifications - LVCMOS Inputs

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
I <sub>IH</sub>	Input High current	Input = V <sub>DD</sub>			150	uA
I <sub>IL</sub>	Input Low current	Input = GND	-150			uA
V <sub>IH</sub>	Input high voltage	V <sub>DD</sub> =3.3V	2.0		V <sub>DD</sub> +0.3	V
V <sub>IL</sub>	Input low voltage	V <sub>DD</sub> =3.3V	-0.3		0.8	V
V <sub>IH</sub>	Input high voltage	V <sub>DD</sub> =2.5V	1.7		V <sub>DD</sub> +0.3	V
V <sub>IL</sub>	Input low voltage	V <sub>DD</sub> =2.5V	-0.3		0.7	V

### DC Electrical Specifications- LVPECL Outputs

Parameter	Description	Conditions	Min.	Typ.	Max.	Units
V <sub>OH</sub>	Output High voltage	V <sub>DD</sub> =3.3V	2.1		2.6	V
		V <sub>DD</sub> =2.5V	1.3		1.6	
V <sub>OL</sub>	Output Low voltage	V <sub>DD</sub> =3.3V	1.3		1.8	V
		V <sub>DD</sub> =2.5V	0.5		0.8	

### DC Electrical Specifications- LVDS Outputs

Parameter	Description	Conditions	Min.	Typ.	Max.	Units
V <sub>OH</sub>	Output High voltage			1.433		V
V <sub>OL</sub>	Output Low voltage			1.064		V
V <sub>ocm</sub>	Output common mode voltage			1.25		V
DV <sub>ocm</sub>	Change in V <sub>ocm</sub> between output states				55	mV
R <sub>o</sub>	Output impedance		85		140	Ω

### DC Electrical Specifications- HCSL Outputs

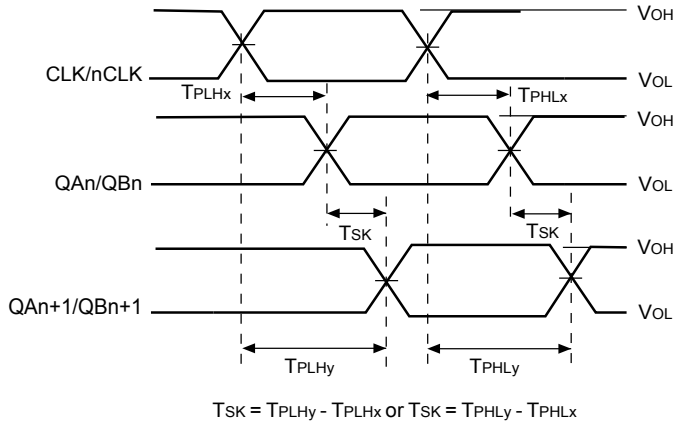
Parameter	Description	Conditions	Min.	Typ.	Max.	Units
V <sub>OH</sub>	Output High voltage		520	800		mV
V <sub>OL</sub>	Output Low voltage			0	150	mV

### AC Electrical Specifications – Differential Outputs

Parameter	Description	Conditions	Min.	Typ.	Max.	Units
F <sub>OUT</sub>	Clock output frequency			156.25		MHz
F <sub>STAB</sub>	Frequency stability				±25	ppm
T <sub>r</sub>	Output rise time	From 20% to 80%		150		ps
T <sub>f</sub>	Output fall time	From 80% to 20%		150		ps
T <sub>ODC</sub>	Output duty cycle	Generator mode	48		52	%
V <sub>PP</sub>	Output swing Single-ended	LVPECL outputs	400			mV
		LVDS outputs	250			
		HCSL outputs	520			
T <sub>PHASEJ</sub>	Phase jitter RMS	LVPECL		0.07	0.1	ps
		LVDS		0.09	0.12	
		HCSL		0.09	0.15	
V <sub>CROSS</sub>	Absolute crossing voltage	HCSL	160		460	mV
DV <sub>CROSS</sub>	Total variation of crossing voltage	HCSL			140	mV
T <sub>SK</sub>	Output Skew	6 outputs devices, outputs in same bank, with same load, at DUT.		40		ps
T <sub>OD</sub>	Valid to HiZ		200			ns
T <sub>OE</sub>	HiZ to valid		200			ns

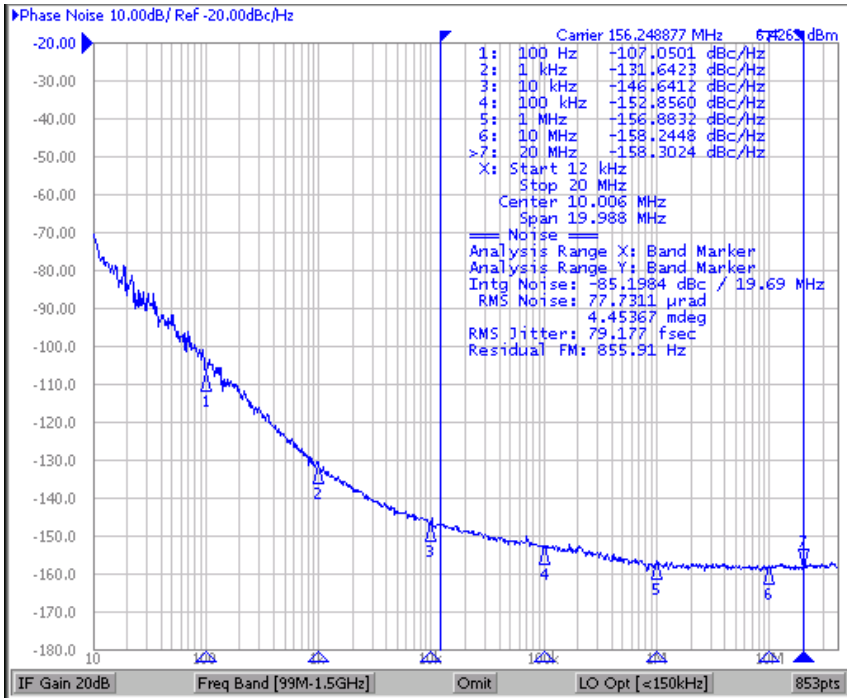
**Output Skew**

Output Skew  $T_{SK}$

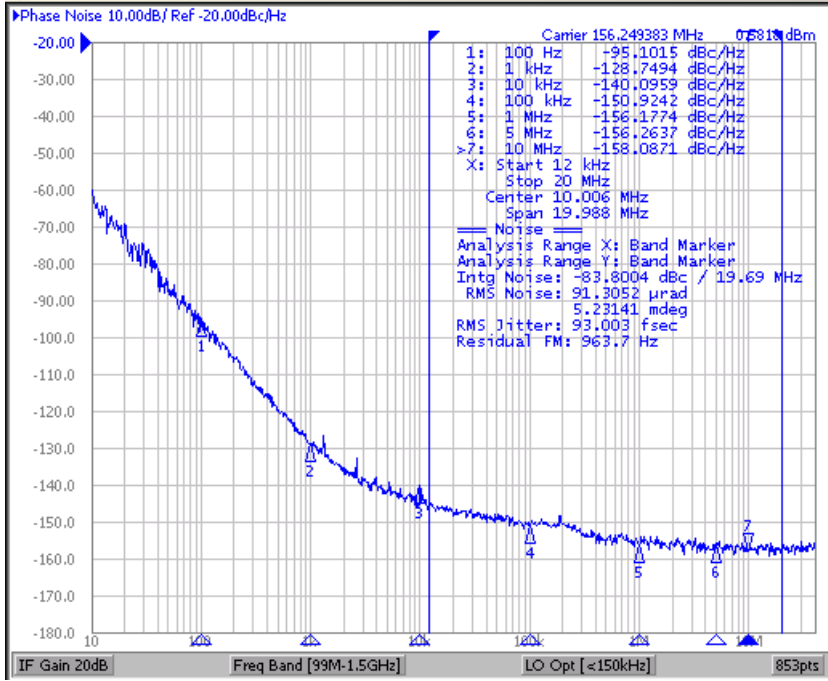


**Phase Noise Plots**

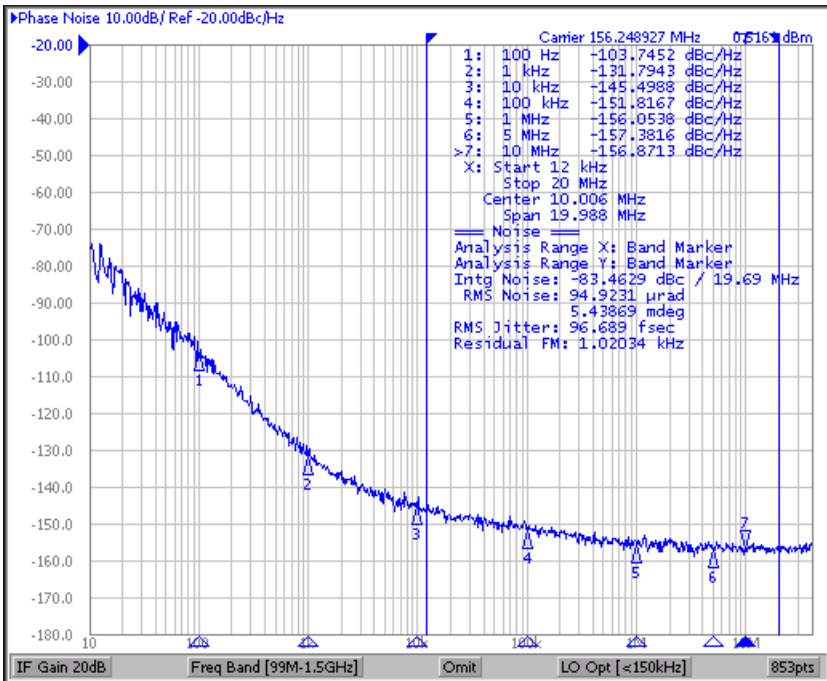
LVPECL



**LVDS**

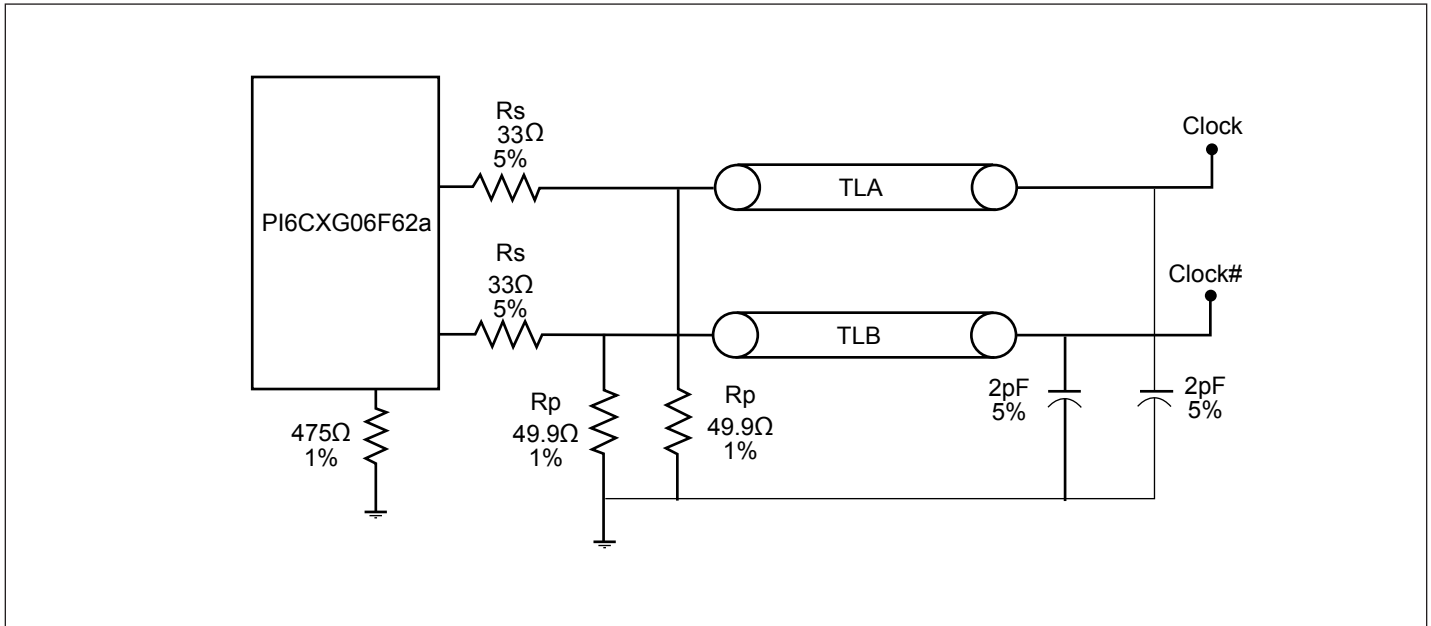


**HCSL**

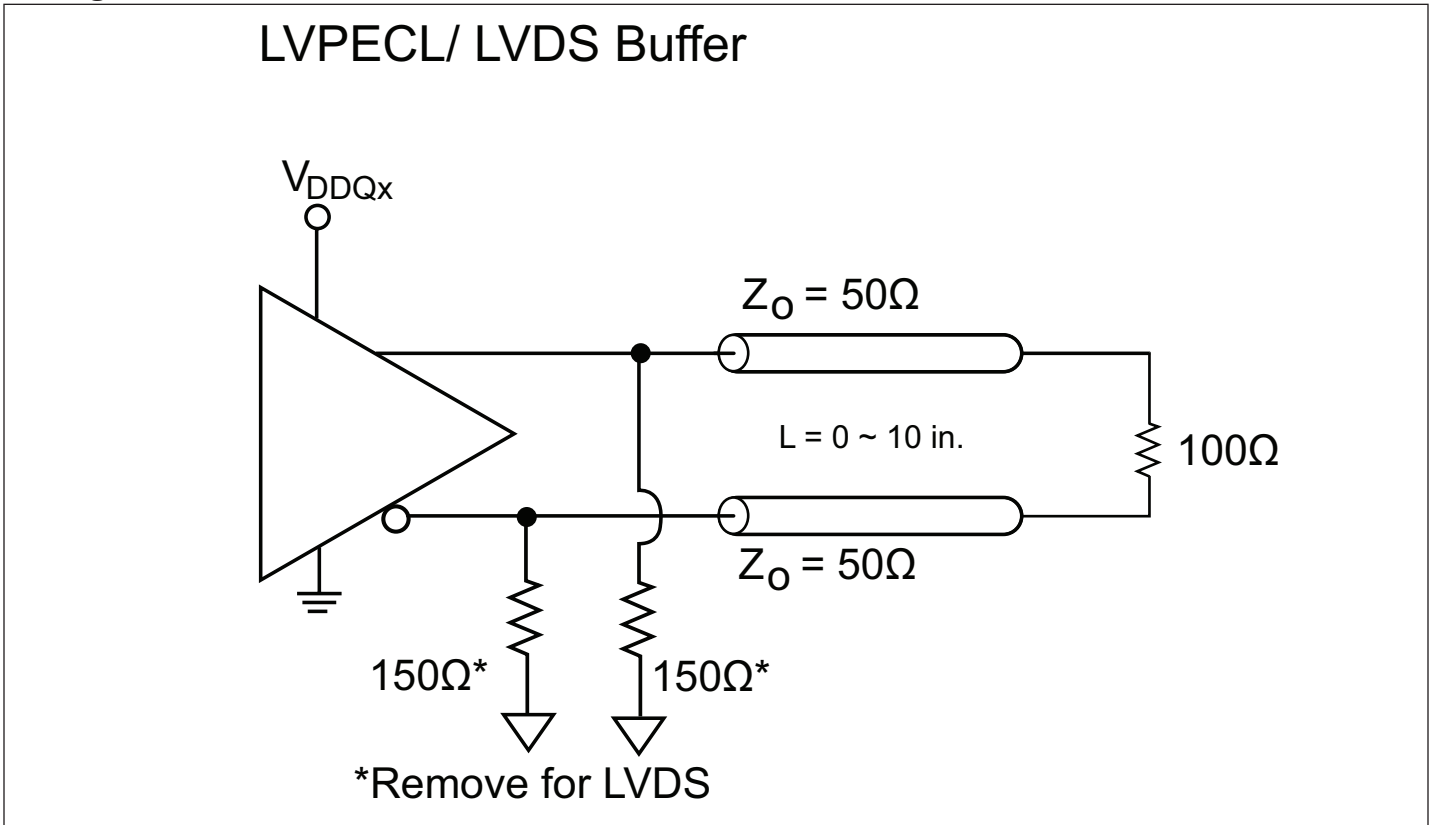




**Configuration Test Load Board Termination for HCSL outputs**



**Configuration Test Load Board Termination for LVPECL/ LVDS**



**Application information**

**Suggest for Unused Inputs and Outputs**

**LVC MOS Input Control Pins**

It is suggested to add pull-up=4.7k and pull-down=1k for LVC-MOS pins even though they have internal pull-up/down but with much higher value (>=50k) for higher design reliability.

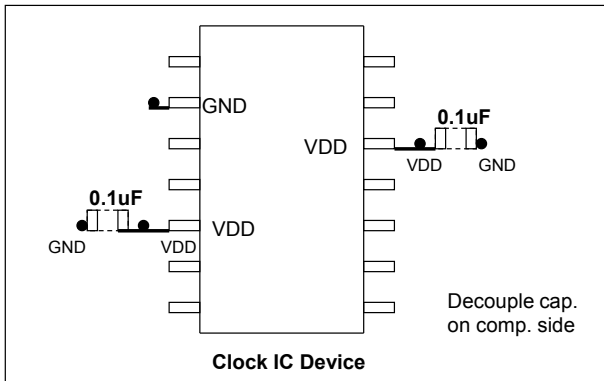
**Outputs**

All unused outputs are suggested to be left open and not connected to any trace. This can lower the IC power supply power.

**Power Decoupling & Routing**

**VDD Pin Decoupling**

As general design rule, each VDD pin must have a 0.1uF decoupling capacitor. For better decoupling, 1uF can be used. Locating the decoupling capacitor on the component side has better decoupling filter result as below.

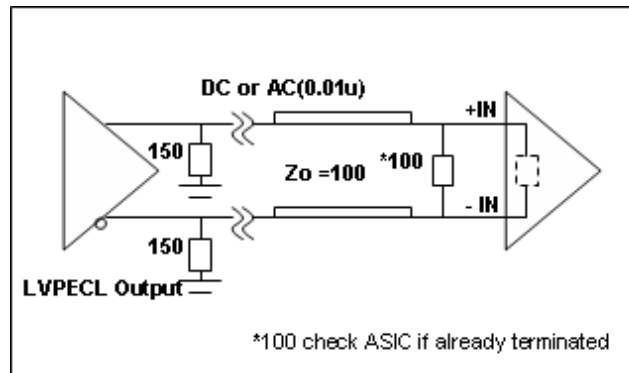


Placement of Decoupling caps

**Device LVPECL Output Terminations**

**LVPECL Output Popular Termination**

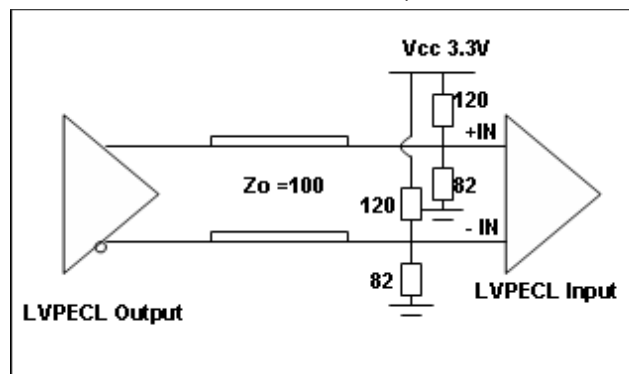
The most popular LVPECL termination is 150ohm pull-down bias and 100ohm across at RX side. Please consult ASIC data-sheet if it already has 100ohm or equivalent internal termination. If so, do not connect external 100ohm across. This popular termination's advantage is that it does not allow any bias through from V<sub>DD</sub>. This prevents V<sub>DD</sub> system noise coupling onto clock trace.



LVPECL Output Popular Termination

**LVPECL Output Thevenin Termination**

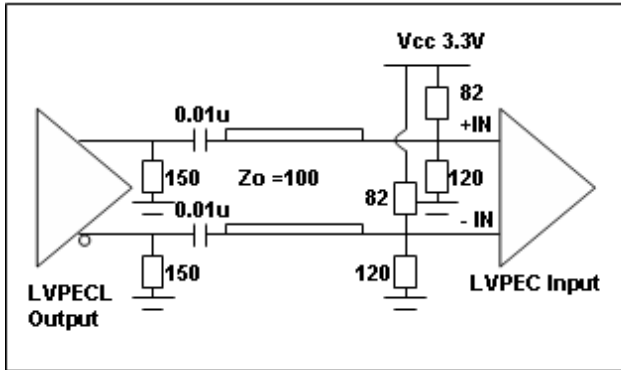
Below is an LVPECL output Thevenin termination which is used for shorter trace drive (<5in.), but it takes V<sub>DD</sub> bias current and V<sub>DD</sub> noise can get onto clock trace. It also requires more component count. So it is seldom used today.



LVPECL Thevenin Output Termination

**LVPECL Output AC Thevenin Termination**

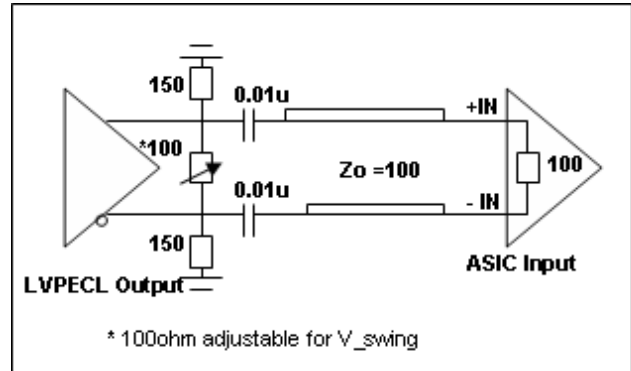
LVPECL AC Thevenin terminations require a 150ohm pull-down before the AC coupling capacitor at the source as shown below. Note that pull-up/down resistor value is swapped compared to the previous example. This circuit is good for short trace (<5in.) application only.



LVPECL Output AC Thenvenin Termination

**LVPECL Output V<sub>swing</sub> Adjustment**

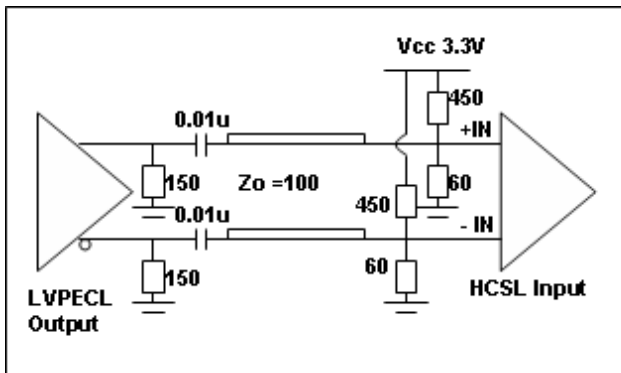
It is suggested to add another cross 100ohm at TX side to tune the LVPECL output V<sub>swing</sub> without changing the optimal 150ohm pull-down bias in Fig. 12. This form of double termination can reduce the V<sub>swing</sub> in 1/2 of the original at the RX side. By fine tuning the 100ohm resistor at the TX side with larger values like 150 to 200ohm, one can increase the V<sub>swing</sub> by > 1/2 ratio.



LVPECL Output V<sub>swing</sub> Adjustment

**LVPECL Output Drive HCSL Input**

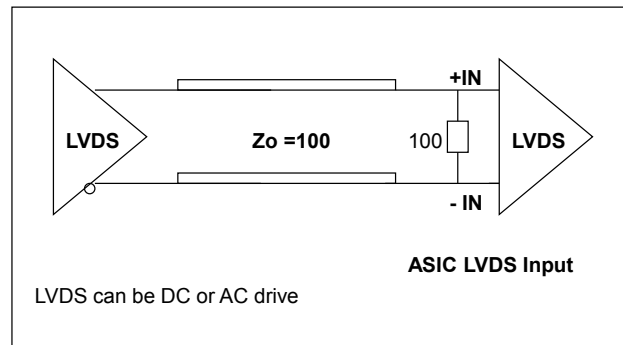
Using the LVPECL output to drive a HCSL input can be done using a typical LVPECL AC Thenvenin termination scheme. Use pull-up/down 450/60ohm to generate V<sub>cm</sub>=0.4V for the HCSL input clock. This termination is equivalent to 50Ohm load as shown below.



LVPECL Output Drive HCSL Termination

**LVDS Output Termination**

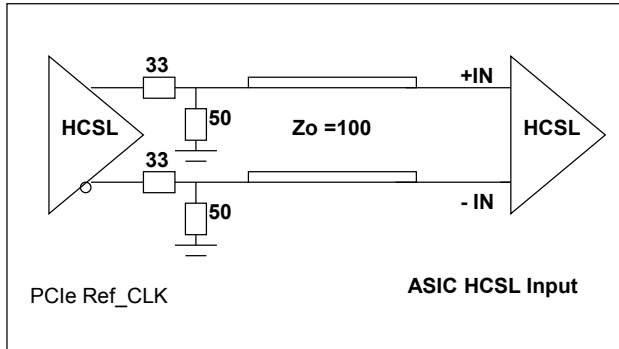
LVDS termination is different from LVPECL by removing the 150ohm pull-down bias. LVDS requires an RX termination equivalent of 100ohm across at the RX side. LVDS can be implemented via AC coupling if the ASIC has an internal termination with DC bias.



LVDS Ouput Driving LVDS Input

**HCSL Output Termination**

HCSL output is mostly used in PCIe reference clocking. It needs DC coupling to drive HCSL input with TX a 33/50ohm termination. To get better SI, it is better to put 33/50 termination on the component side. HCSL can AC drive LVPECL, LVDS and CML inputs too, but the V<sub>swing</sub> will be ½ of the HCSL V<sub>swing</sub> due to the TX and RX side double 50ohm termination.



HCSL Output Termination

**PCIe Ref\_CLK Jitter**

PCIe reference clock jitter specification requires testing via the PCI-SIG jitter tool, which is regulated by US PCI-SIG organization. The jitter tool has PCIe Serdes embedded filter to calculate the equivalent jitter that relates to data link eye closure. Direct peak-peak jitter or phase jitter test data, normally is higher than jitter measure using PCI-SIG jitter tool. It has high-frequency jitter and low-frequency jitter spec. limit. For more information, please refer to the PCI-SIG website: <http://www.pcisig.com/specifications/pciexpress/>

**Clock Jitter Definitions**

**Total jitter= RJ + DJ**

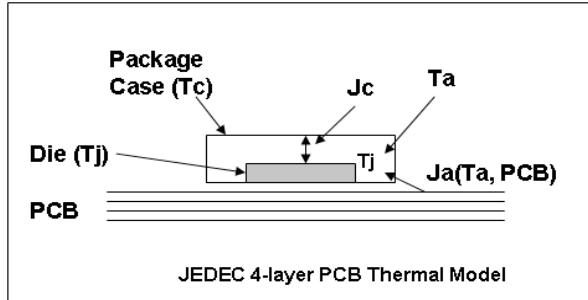
Random Jitter (RJ) is unpredictable and unbounded timing noise that can fit in a Gaussian math distribution in RMS. RJ test values are directly related with how long or how many test samples are available. Deterministic Jitter (DJ) is timing jitter that is predictable and periodic in fixed interference frequency. Total Jitter (TJ) is the combination of random jitter and deterministic jitter: , where is a factor based on total test sample count. JEDEC std. specifies digital clock TJ in 10k random samples.

**Phase Jitter**

Phase noise is short-term random noise attached on the clock carrier and it is a function of the clock offset from the carrier, for example dBc/Hz@10kHz which is phase noise power in 1-Hz normalized bandwidth vs. the carrier power @10kHz offset. Integration of phase noise in plot over a given frequency band yields RMS phase jitter, for example, to specify phase jitter <=1ps at 12k to 20MHz offset band as SONET standard specification.

**Device Thermal Calculation**

Figure below shows the JEDEC thermal model in a 4-layer PCB.



**JEDEC IC Thermal Model**

Important factors to influence device operating temperature are:

- 1) The power dissipation from the chip ( $P_{chip}$ ) is after subtracting power dissipation from external loads. Generally it can be the no-load device  $I_{dd}$
- 2) Package type and PCB stack-up structure, for example, 1oz 4 layer board. PCB with more layers and are thicker has better heat dissipation
- 3) Chassis air flow and cooling mechanism. More air flow M/s and adding heat sink on device can reduce device final junction temperature  $T_j$

The individual device thermal calculation formula:

$$T_j = T_a + P_{chip} \times J_a$$

$$T_c = T_j - P_{chip} \times J_c$$

$J_a$  \_\_\_ Package thermal resistance from die to the ambient air in C/W unit; This data is provided in JEDEC model simulation. An air flow of 1m/s will reduce  $J_a$  (still air) by 20~30%

$J_c$  \_\_\_ Package thermal resistance from die to the package case in C/W unit

$T_j$  \_\_\_ Die junction temperature in C (industry limit <125C max.)

$T_a$  \_\_\_ Ambient air temperature in C

$T_c$  \_\_\_ Package case temperature in C

$P_{chip}$  \_\_\_ IC actually consumes power through  $I_{ee}$ /GND current

device  $I_{ee}$  or GND current to calculate  $T_j$ , especially for LVPECL buffer ICs that have a 150ohm pull-down and equivalent 100ohm differential RX load.

**Thermal calculation example**

To calculate  $T_j$  and  $T_c$  of PI6CV304 in an SOIC-8 package:  
Step 1: Go to Pericom web to find  $J_a=157$  C/W,  $J_c=42$  C/W  
<http://www.pericom.com/support/packaging/packaging-mechanicals-and-thermal-characteristics/>

Step 2: Go to device datasheet to find  $I_{dd}=40$ mA max.

$I_{DD}$	Supply Current	$C_L = 33$ pF/33MHz	20	mA
		$C_L = 33$ pF/66MHz	40	
		$C_L = 22$ pF/80MHz	35	
		$C_L = 15$ pF/100MHz	32	
		$C_L = 10$ pF/125MHz	28	
		$C_L = 10$ pF/155MHz	41	

Step 3:  $P_{total} = 3.3V \times 40mA = 0.132W$

Step 4: If  $T_a=85C$

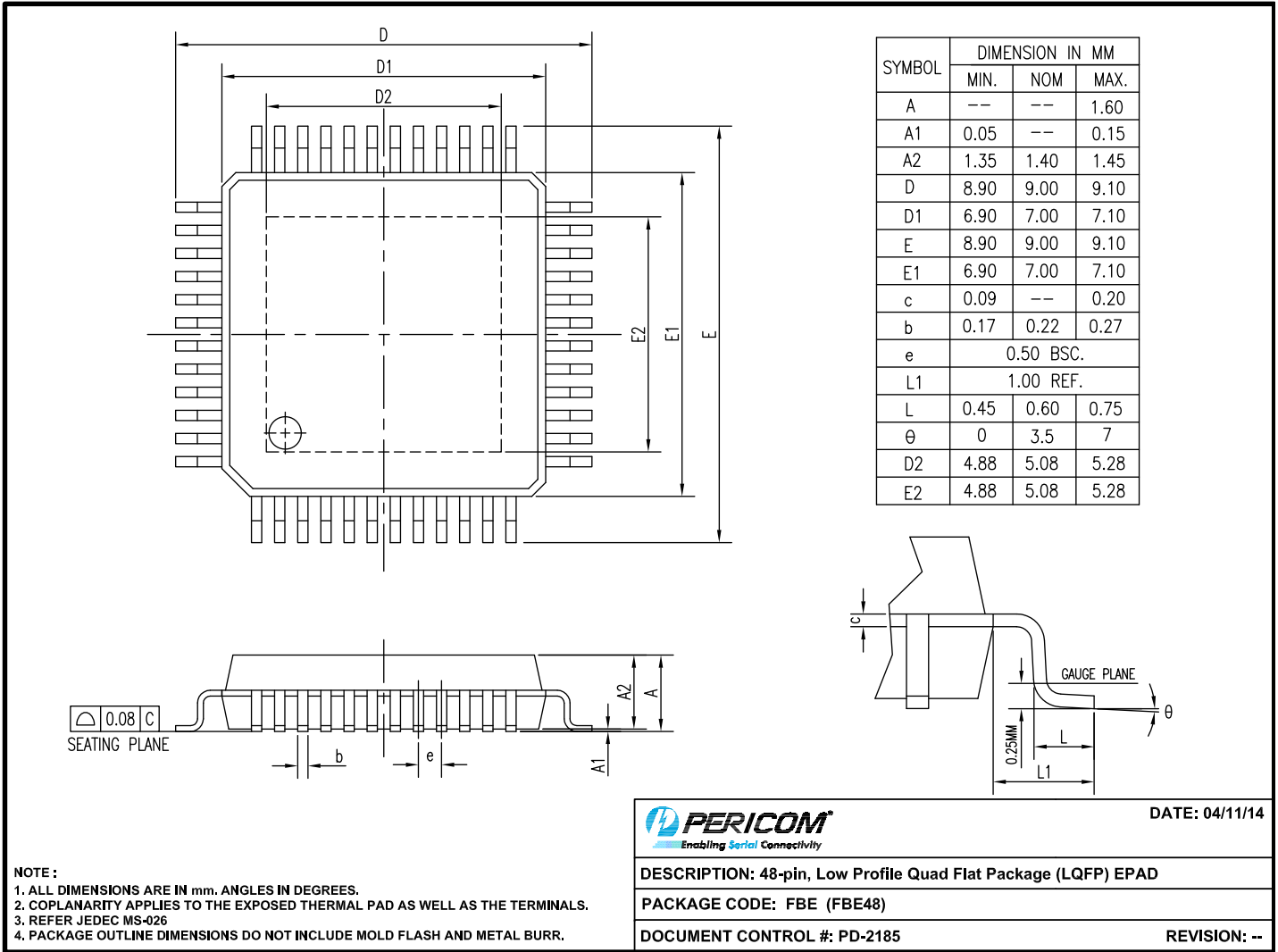
$$T_j = 85 + J_a \times P_{total} = 85 + 25.9 = 105.7C$$

$$T_c = T_j + J_c \times P_{total} = 105.7 - 5.54 = 100.1C$$

Note:

The above calculation is directly using  $I_{dd}$  current without subtracting the load power, so it is a conservative estimation. For more precise thermal calculation, use  $P_{unload}$  or  $P_{chip}$  from device lcc or GND current to calculate  $T_j$ , especially for LVPECL buffer ICs that have a 150ohm pull-down and equivalent 100ohm differential RX load.

**Packaging Mechanical:**



Ordering Code	Package Code	Package Type	Operating Temperature
PI6CXG06F62aFBEIE	FBE	Pb-free & Green, 48-pin LQFP	-40 °C to 85 °C

- Notes:**
1. Thermal characteristics can be found on the company web site at [www.pericom.com/packaging/](http://www.pericom.com/packaging/)
  2. "E" denotes Pb-free and Green
  3. Adding an "X" at the end of the ordering code denotes tape and Reel packaging