A product Line of
Diodes Incorporated

PI6CFGL601B

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

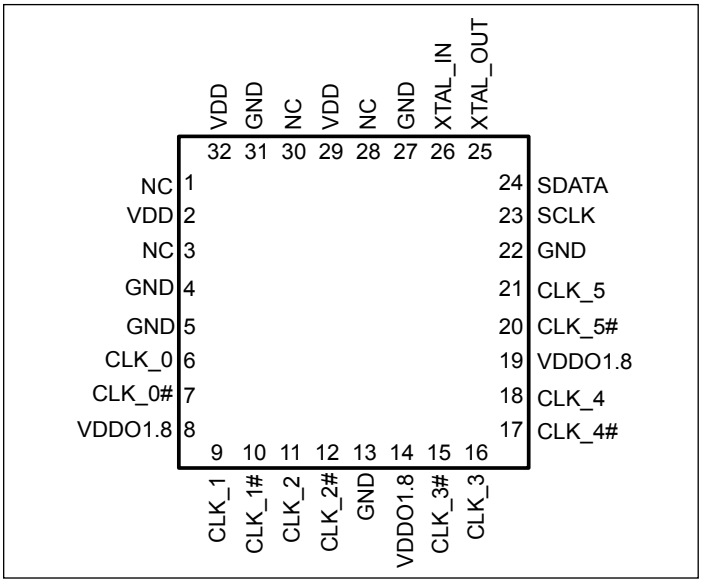
Application

- PCIe 3.0/2.0/1.0 clock generation

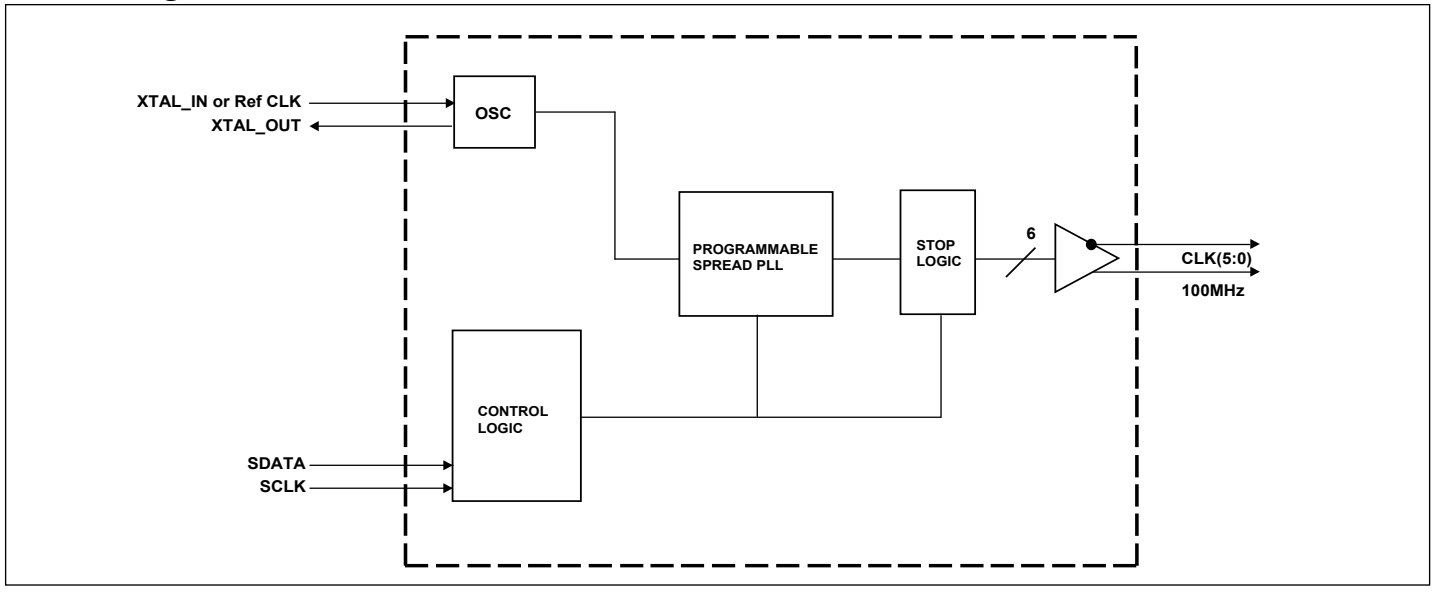
Description

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.

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 10=900mV 11=1000mV		0
0				R/W			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
Juction 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–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}	Outputt Low Voltage[1]	Single-ended outputs, except SMBus. I_{OL} = -2mA			0.45	V
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
Tind	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

Electrical Characteristics–Input/Supply/Common Output Parameters Cont.

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
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 VIL - 0.15) to (Min VIH + 0.15)			1000	ns
t_{FSMB}	SCLK/SDATA Fall Time[1]	(Min VIH + 0.15) to (Max VIL - 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
t_{DC}	Duty Cycle[1]	Measured differentially, PLL Mode	45		55	%
tskew	Skew, Output to Output[1]	VT = 50%			50	ps
$t_{jcyc-cyc}$	Jitter, Cycle to cycle[1,2]	PLL mode			50	ps

Notes:

1. Guaranteed by design and characterization, not 100% tested in production. CL = 2pF with RS = 33Ω for Zo = 50Ω (100Ω differential trace impedance).
2. Measured from differential waveform.
3. Slew rate is measured through the Vswing voltage range centered around differential 0V. This results in a +/-150mV window around differential 0V.
4. 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.
5. 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).
6. 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

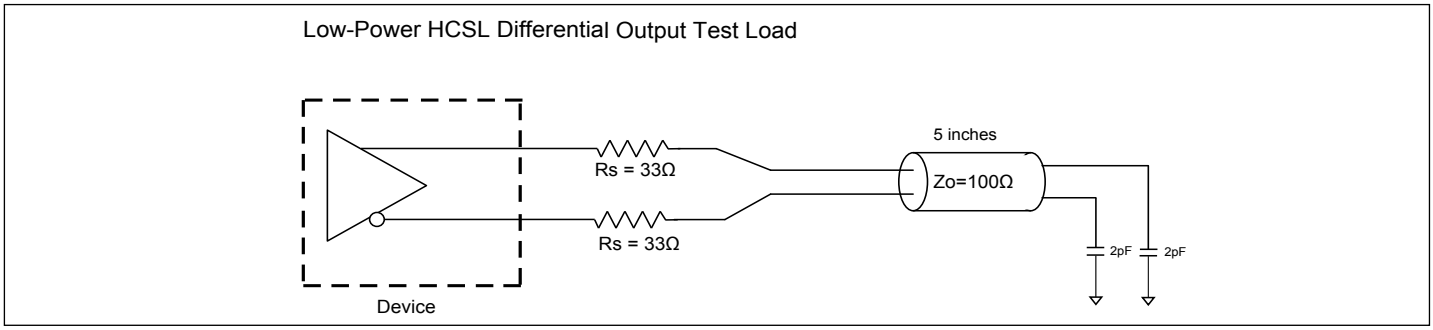
T_A = -40~85°C; Supply Voltage VDD = 3.3 V +/-10%; VDDO = 1.8V +/-10%, See Test Loads for Loading Conditions

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)

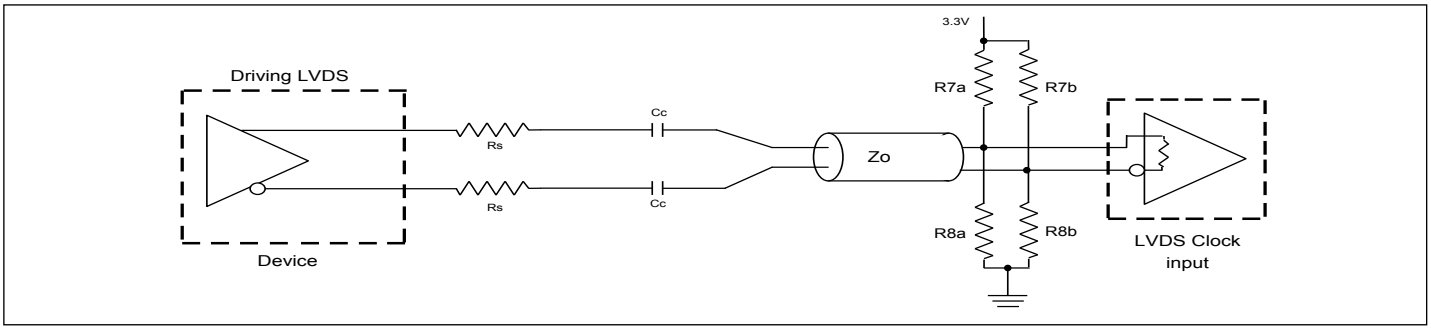
Notes:

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.

Test Loads



Driving LVDS



Driving LVDS inputs with the PI6CFGL601B

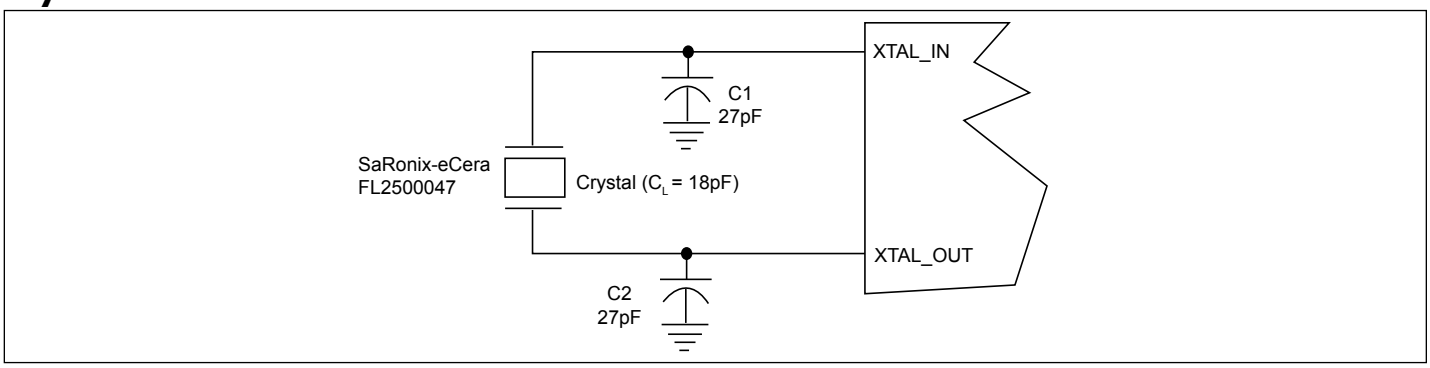
Component	Value	
	Receiver has termination	Receiver does not have termination
R7a, R7b	10K Ω	140 Ω
R8a, R8b	5.6K Ω	75 Ω
Cc	0.1 uF	0.1 uF
Vcm	1.2 V	1.2 V

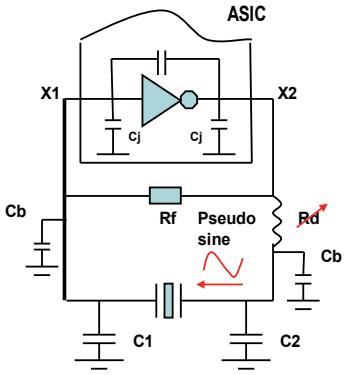
Application Notes

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





CL= crystal spec. loading cap.

Cj = chip in/output cap. (3~5pF)

Cb = PCB trace/via cap. (2~4pF)

C1,2 = load cap. components

Rd = drive level res. (100Ω)

Final choose/trim C1=C2=2 *CL - (Cb +Cj) for the target +/-ppm
Example: C1=C2=2*(18pF) – (4pF+5pF)=27pF

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

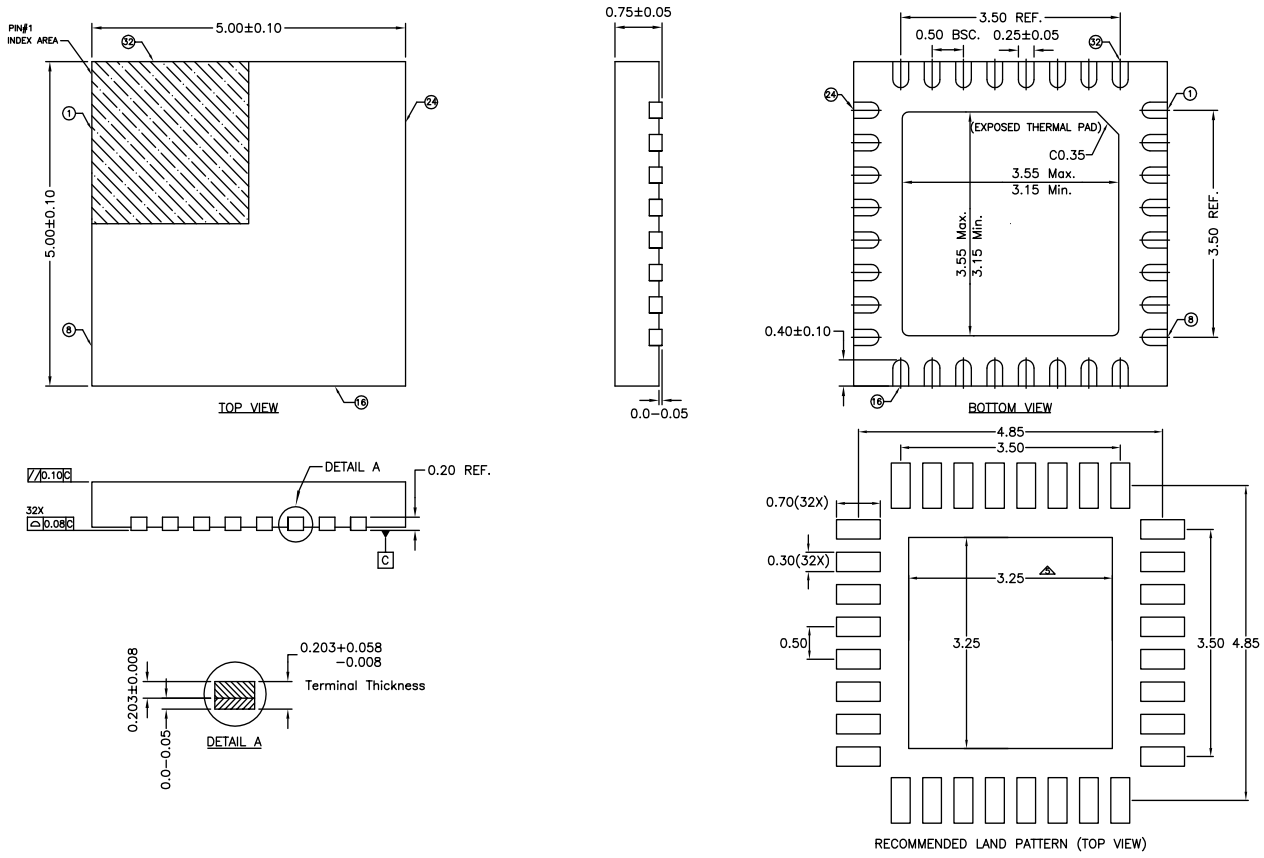
Part Marking

ZH package

PI6CFGL
601BZHIE
*YYWWXX
○

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

Packaging Mechanical: 32-TQFN (ZH)



NOTE :
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
3. REFER JEDEC MO–220.
4. RECOMMENDED LAND PATTERN IS FOR REFERENCE ONLY.
5. THERMAL PAD SOLDERING AREA (MESH STENCIL DESIGN IS RECOMMENDED)

DATE: 12/06/16

DESCRIPTION: 32-Contact, Thin Quad Flat No-Lead (TQFN)

PACKAGE CODE: ZH (ZH32)

DOCUMENT CONTROL #: PD-2070 REVISION: C

17-0570

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
PI6CFGL601BZHIEX	ZH	32-contact, Thin Quad Flat No-Lead (TQFN)

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

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or

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.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

www.diodes.com