

### 3.3V Very-Low-Power 4-Output PCIe Clock Generator With On-Chip Termination

#### Features

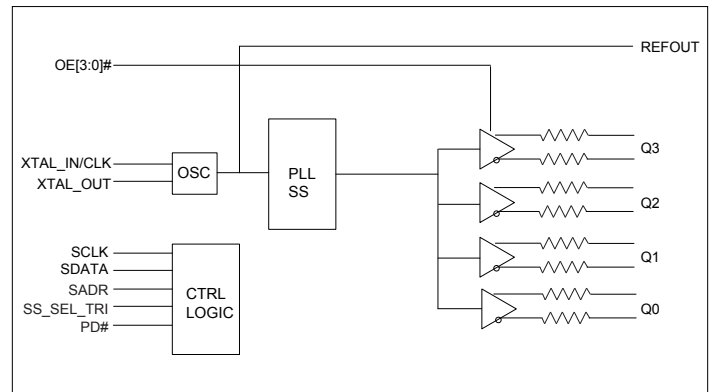
- 3.3V Supply Voltage
- Crystal/CMOS Input: 25MHz
- Four Differential Low Power HCSL Outputs with On-Chip Termination
- Default  $Z_{OUT} = 100\Omega$
- Individual Output Enable
- Reference CMOS Output
- Programmable Slew Rate and Output Amplitude for Each Output
- Differential Outputs Blocked until PLL is Locked
- Selectable 0%, -0.25%, or -0.5% Spread on Differential Outputs
- Strapping pins or SMBus for Configuration
- Differential Output-To-Output Skew <50ps
- Very-Low Jitter Outputs
  - Differential Cycle-To-Cycle Jitter <50ps
  - PCIe Gen1/Gen2/Gen3/Gen4/Gen5 Compliant
  - CMOS REFOUT Phase Jitter
    - < 0.3ps RMS, SSC off
    - <1.5ps RMS, SSC on
- 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](mailto:contact@diodes.com) or your local Diodes representative.  
<https://www.diodes.com/quality/product-definitions/>
- Packaging (Pb-free & Green): 32-lead 5mm × 5mm TQFN

#### Description

The PI6CG33401C is a 4-output very-low-power PCIe Gen1/Gen2/Gen3/Gen4/Gen5 clock generator. It uses 25MHz crystal or CMOS reference as an input to generate the 100MHz low-power differential HCSL outputs with on-chip terminations. The on-chip termination can save 16 external resistors and make layout easier. An additional buffered reference output is provided to serve as a low-noise reference for other circuitry.

It uses Diodes' proprietary PLL design to achieve very-low jitter that meets PCIe Gen1/Gen2/Gen3/Gen4/Gen5 requirements. It also provides various options such as different slew rate and amplitude through SMBUS, so users can configure the device easily to get the optimized performance for their individual boards. The device also supports selectable spread-spectrum options to reduce EMI for various applications.

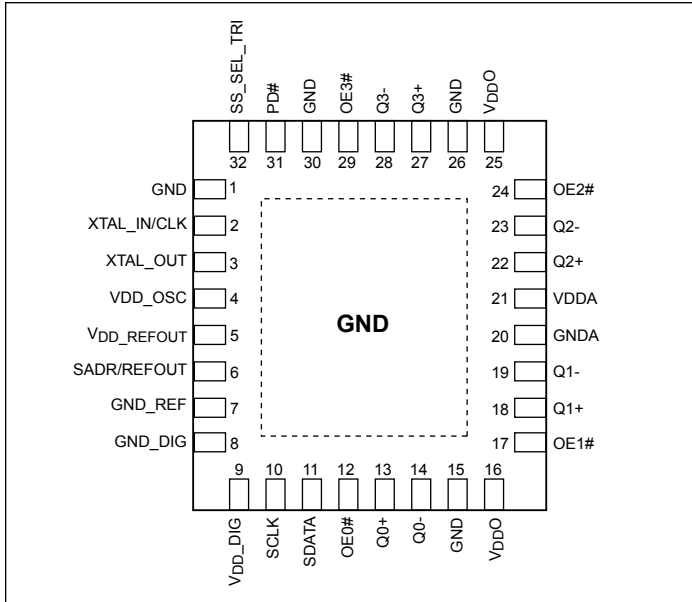
#### Block Diagram



#### 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	Type		Description
1, 15, 26, 30	GND	Power	—	Ground pin
2	XTAL_IN/CLK	Input	—	Crystal input or CMOS reference input
3	XTAL_OUT	Output	—	Crystal output
4	V <sub>DD</sub> _OSC	Power	—	Power supply for oscillator circuitry, nominal 3.3V
5	V <sub>DD</sub> _REFOUT	Power	—	Power supply for buffered CMOS output
6	SADR/REFOUT	Input/ Output	CMOS	Latch to select SMBus Address or LVC MOS REFOUT. This pin has an internal pulldown.
7	GND_REF	Power	—	Ground for REFOUT
8	GND_DIG	Power	—	Ground for digital circuitry
9	V <sub>DD</sub> _DIG	Power	—	Power supply for digital circuitry, nominal 3.3V
10	SCLK	Input	CMOS	SMBUS clock input, 3.3V tolerant
11	SDATA	Input/ Output	CMOS	SMBUS Data line, 3.3V tolerant
12	OE0#	Input	CMOS	Active low input for enabling Q0 pair. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
13	Q0+	Output	HCSL	Differential true clock output
14	Q0-	Output	HCSL	Differential complementary clock output
16, 25	V <sub>DDO</sub>	Power	—	Power supply for differential outputs

**Pin Description Cont.**

Pin #	Pin Name	Type		Description
17	OE1#	Input	CMOS	Active low input for enabling Q1 pair. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
18	Q1+	Output	HCSL	Differential true clock output
19	Q1-	Output	HCSL	Differential complementary clock output
20	GNDA	Power	—	Ground for analog circuitry
21	V <sub>DDA</sub>	Power	—	Power supply for analog circuitry
22	Q2+	Output	HCSL	Differential true clock output
23	Q2-	Output	HCSL	Differential complementary clock output
24	OE2#	Input	CMOS	Active low input for enabling Q2 pair. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
27	Q3+	Output	HCSL	Differential true clock output
28	Q3-	Output	HCSL	Differential complementary clock output
29	OE3#	Input	CMOS	Active low input for enabling Q3 pair. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
31	PD#	Input	CMOS	Input notifies device to sample latched inputs and start up on first high assertion. Low enters Power Down Mode, subsequent high assertions exit Power Down Mode. This pin has internal pullup resistor.
32	SS_SEL_TRI	Input	Tri-level	Latched select input to select spread-spectrum amount at initial power up. 1 = 0.5% spread, M = Spread off, 0 = Spread off. This pin has both internal pull-up and pull-down. Refer to SMBUS byte_1 bit 4, 3 = '01' to get -0.25% spread.
Epad	GND	Power	—	Connect to ground

### SMBus Address Selection Table

	SADR	Address	+Read/Write Bit
State of SADR on First Application of PD#	0	1101000	X
	1	1101010	X

### Power Management Table<sup>(3)</sup>

PD#	SMBus OE bit	OEn#	Qn+	Qn-	REFOUT
0	X	X	Low <sup>(1)</sup>	Low <sup>(1)</sup>	HiZ <sup>(2)</sup>
1	1	0	Running	Running	Running
1	1	1	Disabled <sup>(1)</sup>	Disabled <sup>(1)</sup>	Running
1	0	X	Disabled <sup>(1)</sup>	Disabled <sup>(1)</sup>	Disabled <sup>(4)</sup>

1. The output state is set by B11[1:0] (Low/Low default).

2. REF is Hi-Z until the 1st assertion of PD# high. After this, when PD# is low, REF is disabled. If Byte3, bit 5 = 1, then REF is running.

3. Input High/ Low defined at default values for device.

4. See SMBUs Byte 3, bit 4 .

## Maximum Ratings

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

Storage Temperature.....	-65°C to +150°C
Supply Voltage to Ground Potential, $V_{DDxx}$ .....	-0.5V to +4.6V
Input Voltage .....	-0.5V to $V_{DD}+0.5V$ , not exceed 4.6V
SMBus, Input High Voltage .....	3.6V
ESD Protection (HBM) .....	2000V
Max Junction Temperature .....	+125°C

**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.

## Operating Conditions

Temperature =  $T_A$ ; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
$V_{DDO}$ , $V_{DDA}$ , $V_{DD\_OSC}$ , $V_{DD\_DIG}$ , $V_{DD\_RE-FOUT}$	Power Supply Voltage	—	3.135	3.3	3.465	V
$I_{DDA}$	Analog Power Supply Current	All outputs active @ 100MHz	—	22	25	mA
$I_{DD}$	Power Supply Current	All $V_{DD}$ , except $V_{DDA}$ and $V_{DDO}$ , All outputs active @ 100MHz	—	13	16	mA
$I_{DDO}$	IO Power Supply Current <sup>(3)</sup>	$V_{DDO}$ , All outputs active @ 100MHz	—	20	25	mA
$I_{DDA\_WL}$	Analog Power Supply Wake-on-LAN <sup>(1)</sup> Current	Q outputs off, REF output running	—	0.5	1	mA
$I_{DD\_WL}$	Power Supply Wake-on-LAN <sup>(1)</sup> Current	All $V_{DD}$ , except $V_{DDA}$ and $V_{DDO}$ , Q outputs off, REF output running	—	3	6	mA
$I_{DDO\_WL}$	Power Supply Wake-on-LAN <sup>(1)</sup> Current for Outputs	Q outputs off, REF output running	—	1	2	mA
$I_{DDA\_PD}$	Analog Power Supply Power Down <sup>(2)</sup> Current	All outputs off	—	0.5	1	mA
$I_{DDO\_PD}$	IO Power Down <sup>(2)</sup> Current	All outputs off	—	1	2	mA
$I_{DD\_PD}$	Power Supply Power Down <sup>(2)</sup> Current	All outputs off	—	1	2	mA
$T_A$	Ambient Temperature	Industrial grade	-40	—	85	°C

**Note:**

1. Wake-on-LAN mode: PD# = '0' Byte 3, bit 5 = '1'.
2. Power down mode: PD# = '0' Byte 3, bit 5 = '0'.
3. Outputs drive 5 inch trace.

## Input Electrical Characteristics

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
R <sub>pu</sub>	Internal Pullup Resistance	—	—	120	—	KΩ
R <sub>dn</sub>	Internal Pulldown Resistance	—	—	120	—	KΩ
C <sub>XTAL</sub>	Internal Capacitance on X_IN and X_OUT pins	—	—	8	—	pF
L <sub>PIN</sub>	Pin Inductance	—	—	—	7	nH

## Crystal Characteristic

Parameters	Description	Min.	Typ.	Max.	Units
OSCmode	Mode of Oscillation	Fundamental			
FREQ	Frequency	—	25	—	MHz
ESR <sup>(1)</sup>	Equivalent Series Resistance	—	—	50	Ω
C <sub>load</sub>	Load Capacitance	—	8	—	pF
C <sub>shunt</sub>	Shunt Capacitance	—	—	7	pF
—	Drive Level	—	—	200	μW

**Note:**

1. ESR value is dependent upon frequency of oscillation.

## SMBus Electrical Characteristics

Temperature = T<sub>A</sub>; Supply voltages per normal operation conditions; See test circuits for the load conditions.

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
V <sub>DDSMB</sub>	Nominal Bus Voltage	—	2.7	—	3.6	V
V <sub>IHSMB</sub>	SMBus Input High Voltage	SMBus, V <sub>DDSMB</sub> = 3.3V	2.1	—	3.6	V
		SMBus, V <sub>DDSMB</sub> < 3.3V	0.65 V <sub>DDSMB</sub>	—	—	
V <sub>ILSMB</sub>	SMBus Input Low Voltage	SMBus, V <sub>DDSMB</sub> = 3.3V	—	—	0.8	V
		SMBus, V <sub>DDSMB</sub> < 3.3V	—	—	0.8	
I <sub>SMBSINK</sub>	SMBus Sink Current	SMBus, at V <sub>OLSMB</sub>	4	—	—	mA
V <sub>OLSMB</sub>	SMBus Output Low Voltage	SMBus, at I <sub>SMBSINK</sub>	—	—	0.4	V
f <sub>MAXSMB</sub>	SMBus Operating Frequency	Maximum frequency	—	—	500	kHz
t <sub>RMSB</sub>	SMBus Rise Time	(Max V <sub>IL</sub> - 0.15) to (Min V <sub>IH</sub> + 0.15)	—	—	1000	ns
t <sub>FMSB</sub>	SMBus Fall Time	(Min V <sub>IH</sub> + 0.15) to (Max V <sub>IL</sub> - 0.15)	—	—	300	ns

## Spread Spectrum Characteristic

Temperature = T<sub>A</sub>; Supply voltages per normal operation conditions; See test circuits for the load conditions.

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
f <sub>MOD</sub>	SS Modulation Frequency	Triangular modulation	30	31.8	33	kHz

## LVC MOS DC Electrical Characteristics

Temperature = T<sub>A</sub>; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
V <sub>IH</sub>	Input High Voltage	Single-ended inputs, except SMBus	0.75 V <sub>DD</sub>	—	V <sub>DD</sub> +0.3	V
V <sub>IM</sub>	Input Mid Voltage	SS_SEL_TRI	0.4V <sub>DD</sub>	0.5V <sub>DD</sub>	0.6V <sub>DD</sub>	V
V <sub>IL</sub>	Input Low Voltage	Single-ended inputs, except SMBus	-0.3	—	0.25 V <sub>DD</sub>	V
I <sub>IH</sub>	Input High Current	Single-ended inputs, V <sub>IN</sub> = V <sub>DD</sub>	—	—	5	μA
I <sub>IL</sub>	Input Low Current	Single-ended inputs, V <sub>IN</sub> = 0V	-5	—	—	μA
I <sub>IH</sub>	Input High Current	Single-ended inputs with pullup/pulldown resistor, V <sub>IN</sub> = V <sub>DD</sub>	—	—	50	μA
I <sub>IL</sub>	Input Low Current	Single-ended inputs with pullup/pulldown resistor, V <sub>IN</sub> = 0V	-50	—	—	μA
V <sub>OH</sub>	Output High Voltage	REFOUT, except SMBus; I <sub>OH</sub> = -2mA	0.8 × V <sub>DD_</sub> REFOUT	—	—	V
V <sub>OL</sub>	Output Low Voltage	REFOUT, except SMBus; I <sub>OL</sub> = 2mA	—	—	0.2 × V <sub>DD_</sub> REFOUT	V
R <sub>OUT</sub>	CMOS Output Impedance	—	—	20	—	Ω
C <sub>IN</sub>	Input Capacitance	—	1.5	—	5	pF

## LVCMOS AC Characteristics

Temperature =  $T_A$ ; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Units
$f_{\text{INPUT}}$	Input Frequency	XTAL_IN/CLK	—	25	—	MHz
$t_{\text{RIN}}$	Input Rise Time	Single-ended inputs	—	—	5	ns
$t_{\text{FIN}}$	Input Fall Time	Single-ended inputs	—	—	5	ns
$t_{\text{STAB}}$	Clock Stabilization	From power up and after input clock stabilization or deassertion of PD# to first clock	—	0.75	1	ms
$t_{\text{OELAT}}$	Output Enable Latency	Q start after OE# assertion Q stop after OE# deassertion	1	—	3	clocks
$t_{\text{PDLAT}}$	PD# Deassertion	Differential outputs enable after PD# deassertion	—	20	300	$\mu\text{s}$
$t_{\text{PERIOD}}$	REFOUT Clock Period	REFOUT, assume input is at 25MHz	—	40	—	ns
$f_{\text{ACC}}$	REFOUT Frequency Accuracy <sup>(1)</sup>	REFOUT, long term accuracy to input	—	0	—	ppm
$t_{\text{SLEW}}$	REFOUT Slew Rate <sup>(1)</sup>	Byte 3 = 1F, 20% to 80% of $V_{\text{DDREF}}$	0.9	1.4	2	V/ns
		Byte 3 = 5F, 20% to 80% of $V_{\text{DDREF}}$	1.5	2.4	3.2	V/ns
		Byte 3 = 9F, 20% to 80% of $V_{\text{DDREF}}$	2.0	3.0	3.8	V/ns
		Byte 3 = DF, 20% to 80% of $V_{\text{DDREF}}$	2.3	3.2	4	V/ns
$t_{\text{DC}}$	REFOUT Duty Cycle <sup>(1)</sup>	$V_T = V_{\text{DD}} / 2V$ , driven by a Xtal	45	50	55	%
$t_{\text{DCDIS}}$	REFOUT Duty Cycle Distortion	$V_T = V_{\text{DD}} / 2V$ , driven by an external source	-2	0	+2	%
$t_{\text{JITCC}}$	REFOUT Cycle-Cycle Jitter	$V_T = V_{\text{DD}} / 2V$ , driven by a Xtal	—	70	150	ps
$t_{\text{JITPH}}$	REFOUT Phase Jitter, RMS	12kHz to 5MHz, SSC off, driven by a Xtal	—	0.16	0.3	ps
		12kHz to 5MHz, SSC on, driven by a Xtal	—	0.9	1.5	ps
$t_{\text{JITN}}$	Noise Floor	1kHz offset, driven by a Xtal	—	-149	-135	dBc/Hz
		10kHz offset to Nyquist, driven by a Xtal	—	-158	-140	dBc/Hz

**Note:**

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



## HCSL Output Characteristics

Temperature =  $T_A$ ; Supply voltages per normal operation conditions; See test circuits for the load conditions

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
$V_{OH}$	Output Voltage High <sup>(1)</sup>	Statistical measurement on single-ended signal using oscilloscope math function	660	784	850	mV
$V_{OL}$	Output Voltage Low <sup>(1)</sup>		-150	—	150	mV
$V_{OMAX}$	Output Voltage Maximum <sup>(1)</sup>	Measurement on single ended signal using absolute value	—	816	1150	mV
$V_{OMIN}$	Output Voltage Minimum <sup>(1)</sup>		-300	-42	—	mV
$V_{OC}$	Output Cross Voltage <sup>(1,2,4)</sup>	—	250	430	550	mV
$DV_{OC}$	$V_{OC}$ Magnitude Change <sup>(1,2,5)</sup>	—	—	12	140	mV

**Note:**

1. At default SMBUS amplitude settings.
2. Guaranteed by design and characterization—not 100% tested in production.
3. Measured from differential waveform.
4. This one is defined as voltage where  $Q+ = Q-$  measured on a component test board and only applied to the differential rising edge.
5. The total variation of all  $V_{cross}$  measurements in any particular system. This is a subset of  $V_{cross\_min/max}$  allowed.

## HCSL Output AC Characteristics

Temperature =  $T_A$ ; Supply voltages per normal operation conditions; See test circuits for the load conditions.

Symbol	Parameters	Condition	Min.	Typ.	Max.	Units
$f_{OUT}$	Output Frequency	—	—	100	—	MHz
$t_{RF}$	Slew Rate <sup>(1,2,3)</sup>	Scope averaging on fast setting	2.5	3.2	4	V/ns
		Scope averaging on slow setting	2.2	3	3.7	V/ns
$D_{tRF}$	Slew Rate Matching <sup>(1,2,4)</sup>	Scope averaging on	—	7	15	%
$t_{DC}$	Duty Cycle <sup>(1,2)</sup>	Measured differentially, PLL Mode	45	50	55	%
$t_{SKEW}$	Output Skew <sup>(1,2)</sup>	Averaging on, $V_T = 50\%$	—	20	50	ps
$t_{jC-C}$	Cycle-to-Cycle Jitter <sup>(1,2)</sup>	—	—	20	50	ps

### HC SL Output AC Characteristics Cont.

Symbol	Parameters	Condition	Min.	Typ.	Max	Spec Limit	Units
t <sub>JPHASE</sub>	Integrated Phase Jitter (RMS) <sup>(1,5)</sup>	PCIe Gen 1 <sup>(6)</sup>		20	30	86	ps(p-p)
		PCIe Gen 2 Low Band, 10kHz < f < 1.5MHz		0.08	0.1	3.0	ps
		PCIe Gen 2 High Band, 1.5MHz < f < Nyquist (50MHz)		0.99	1.3	3.1	ps
		PCIe Gen3 Common Clock Architecture (PLL BW of 2-4 or 2-5MHz, CDR = 10MHz)		0.32	0.42	1.0	ps
		PCIe Gen3 Separate Reference No Spread (PLL BW of 2-4 or 2-5MHz, CDR =10 MHz)		0.16	0.21	0.7	ps
		PCIe Gen 4 (PLL BW of 2-4 or 2-5MHz, CDR = 10MHz)		0.32	0.4	0.5	ps
		PCIe Gen 5 <sup>(7)</sup> (PLL BW of 500k to 1.8MHz. CDR = 20MHz)		0.02	0.05	0.15	ps
t <sub>JPH-SRISG2</sub>	Integrated Phase Jitter (RMS), -0.25% Spread	PCIe Gen 2, Separate Reference Independent Spread (PLL BW of 16MHz, CDR=5MHz)		0.6	0.92	2	ps
t <sub>JPH-SRISG3</sub>	Integrated Phase Jitter (RMS), -0.25% Spread	PCIe Gen 3, Separate Reference Independent Spread (PLL BW of 2-4MHz or 2-5MHz, CDR=10MHz)		0.32	0.4	0.7	ps
t <sub>JPH-SRISG2</sub>	Integrated Phase Jitter (RMS), -0.5% Spread	PCIe Gen 2, Separate Reference Independent Spread (PLL BW of 16MHz, CDR=5MHz)		0.8	1.1	2	ps
t <sub>JPH-SRISG3</sub>	Integrated Phase Jitter (RMS), -0.5% Spread	PCIe Gen 3, Separate Reference Independent Spread (PLL BW of 2-4MHz or 2-5MHz, CDR=10MHz)		0.35	0.6	0.7	ps

**Note:**

1. Guaranteed by design and characterization—not 100% tested in production.
2. Measured from differential waveform.
3. Slew rate is measured through the V<sub>swing</sub> voltage range centered around differential 0V, within ±150mV window.
4. It is measured using a ±75mV window centered on the average cross point.
5. See <http://www.pcisig.com> for complete specs.
6. Sample size of at least 100k cycles. This can be extrapolated to 108ps pk-pk @ 1M cycles for a BER of 10<sup>-12</sup>.
7. PCIe Gen 5 v0.9 specification.

### Differential Output Clock Periods - Spread Spectrum Disabled

Center Freq. MHz	Measurement Window							Units
	1 clock	1 $\mu$ s	0.1 s	0.1 s	0.1 s	1 $\mu$ s	1 clock	
	-c2c jitter AbsPer Min	- SSC Short-term Avg. Min	-ppm Long-term Avg. min	0 ppm Period Nominal	+ppm Long-term Avg. max	+ SSC Short-term Avg. Max	-c2c jitter AbsPer Max	
100.00	9.94900		9.99900	10.00000	10.00100		10.05100	ns

### Differential Output Clock Periods - Spread Spectrum Enabled

Center Freq. MHz	Measurement Window							Units
	1 clock	1 $\mu$ s	0.1 s	0.1 s	0.1 s	1 $\mu$ s	1 clock	
	-c2c jitter AbsPer Min	- SSC Short-term Avg. Min	-ppm Long-term Avg. min	0 ppm Period Nominal	+ppm Long-term Avg. max	+ SSC Short-term Avg. Max	-c2c jitter AbsPer Max	
99.75	9.94906	9.99906	10.02406	10.02506	10.02607	10.05107	10.10107	ns

**Note:**

1. Guaranteed by design and characterization—not 100% tested in production.
2. All long term accuracy and clock period specifications are guaranteed assuming REF is trimmed to 25.00MHz.

## SMBus Serial Data Interface

PI6CG33401C is a slave-only device that supports block 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.

### Address Assignment

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

**Note:**

- SMBus address is latched on SADR pin.

### How to Write

1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	8 bits	1 bit	8 bits	1 bit		8 bits	1 bit	1 bit
Start bit	Add.	W(0)	Ack	Beginning Byte location = N	Ack	Data Byte count = X	Ack	Beginning Data Byte (N)	Ack	.....	Data Byte (N+X-1)	Ack	Stop bit

### How to Read

1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	1 bit	7 bits	1 bit	1 bit	8 bits	1 bit	8 bits	1 bit
Start bit	Address	W(0)	Ack	Beginning Byte location = N	Ack	Repeat Start bit	Address	R(1)	Ack	Data Byte count = X	Ack	Beginning Data Byte (N)	Ack

.....										8 bits	1 bit	1 bit
										Data Byte (N+X-1)	NAck	Stop bit

## Byte 0: Output Enable Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—	—	0	See B11[1:0]	—
6	Reserved	—	—	0		—
5	Reserved	—	—	0		—
4	Reserved	—	—	0		—
3	Q3_OE	Q3 output enable	RW	1		Pin Control
2	Q2_OE	Q2 output enable	RW	1		Pin Control
1	Q1_OE	Q1 output enable	RW	1		Pin Control
0	Q0_OE	Q0 output enable	RW	1		Pin Control

**Note:**

- A low on these bits will override the OE# pins and force the differential outputs to the state indicated by B11[1:0] (Low/ Low default).

### Byte 1: SS Spread Spectrum and Control Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	SSENRB1	SS Enable Readback Bit1	R	Latch	'00' for SS_SEL_TRI = '0', '10' for SS_SEL_TRI = 'M', '11' for SS_SEL_TRI = '1'	
6	SSENRB0	SS Enable Readback Bit0	R	Latch		
5	SSEN_SWCTR	Enable SW control of SS	RW	0	Values in B1[7:6] control SS amount	Values in B1[4:3] control SS amount
4	SSENSW1	SS enable SW control Bit1	RW <sup>(1)</sup>	0	'00' = SS off, '01' = -0.25% SS, '10' = SS off, '11' = -0.5% SS	
3	SSENSW0	SS enable SW control Bit0	RW <sup>(1)</sup>	0		
2	Reserved	—	—	1	—	—
1	Amplitude1	Control output amplitude	RW	1	'00' = 0.6V, '01' = 0.68V, '10' = 0.75V, '11' = 0.85V	
0	Amplitude0		RW	0		

**Note:**

1. Spread must be selected OFF or ON with the hardware latch pin. These bits must not be used to turn spread ON or OFF after power up. These bits can be used to change the spread amount, and B1[5] must be set to a 1 for these bits to have any effect on the part. If these bits are used to turn spread OFF or ON, the system must be reset.

### Byte 2: Differential Output Slew Rate Control Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—	—	1	—	—
6	Reserved	—	—	1	—	—
5	Reserved	—	—	1	—	—
4	Reserved	—	—	1	—	—
3	SLEWRATECTR_Q3	Control slew rate of Q3	RW	1	Slow setting	Fast setting
2	SLEWRATECTR_Q2	Control slew rate of Q2	RW	1	Slow setting	Fast setting
1	SLEWRATECTR_Q1	Control slew rate of Q1	RW	1	Slow setting	Fast setting
0	SLEWRATECTR_Q0	Control slew rate of Q0	RW	1	Slow setting	Fast setting

### Byte 3: REF Control Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	REFSLEWRATE	Slew rate control for REF	RW	0	'00' = 1.4V/ns '01' = 2.4V/ns, '10' = 3V/ns, '11' = 3.2V/ns	
6			RW	1		
5	REF_PDSTATE	Wake-on-Lan enable for REF	RW	0	REF = Disabled in PD state <sup>(1)</sup>	REF = running in PD state
4	REF_OE	Output enable for REF	RW	1	REF = Disabled <sup>(1)</sup>	REF = running
3	Reserved	—	—	1	—	—
2	Reserved	—	—	1	—	—
1	Reserved	—	—	1	—	—
0	Reserved	—	—	1	—	—

**Note:**

1. The disabled state depends on Byte11[1:0]. '00' = Low, '01'=HiZ, '10'=Low, '11'=High.

### Byte 4: Reserved

Bit	Control Function	Description	Type	Power-up Condition	0	1
7:0	Reserved	—	—	0x40	—	—

### Byte 5: Revision and Vendor ID Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	RID3	Revision ID	R	0	rev = 0000	
6	RID2		R	0		
5	RID1		R	0		
4	RID0		R	0		
3	PVID3	Vendor ID	R	0	Diodes = 0011	
2	PVID2		R	0		
1	PVID1		R	1		
0	PVID0		R	1		

### Byte 6: Device Type/Device ID Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	DTYPE1	Device type	R	0	'00' = CG, '01' = ZDB, '10' = Reserve, '11' = NZDB	
6	DTYPE0		R	0		
5	DID5	Device ID	R	0	000100 binary, 04Hex	
4	DID4		R	0		
3	DID3		R	0		
2	DID2		R	1		
1	DID1		R	0		
0	DID0		R	0		

### Byte 7: Byte Count Register

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—	—	0	—	—
6	Reserved	—	—	0	—	—
5	Reserved	—	—	0	—	—
4	BC4	Byte count programming	RW	0	Writing to this register will configure how many bytes will be read back, default is 8 bytes	
3	BC3		RW	1		
2	BC2		RW	0		
1	BC1		RW	0		
0	BC0		RW	0		

### Byte 8 and 9: Reserved

Bit	Control Function	Description	Type	Power-up Condition	0	1
7:0	Reserved	—	—	B8: 0x36 B9: 0x00	—	—

### Byte 10: PD Restore

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—	—	0	—	—
6	PD Restore	PD Restore to default configuration	RW	1	Clear PD Config	Keep PD Config
5:0	Reserved	—	—	0	—	—

### Byte 11: Stop Control

Bit	Control Function	Description	Type	Power-up Condition	0	1
7:2	Reserved	—	—	0	—	—
1	STP1	True/ Compliment DIF Output Disable Sate	RW	0	00= Low/Low	10= High/Low
0	STP0		RW	0	01= HiZ/HiZ	11= Low/High

### Byte 12: Impedance Control

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Q1_Zout1	Q1 Zout	RW	10	00 = Reserved 01 = 85Ω 10 = 100Ω 11 = Reserved	
6	Q1_Zout0	Q1 Zout	RW			
5	Reserved					
4	Reserved					
3	Q0_Zout1	Q0 Zout	RW			
2	Q0_Zout0	Q0 Zout	RW			
1	Reserved					
0	Reserved					

### Byte 13: Impedance Control

Bit	Control Function	Description	Type	Power Up Condition	0	1
7	Reserved			10	00 = Reserved 01 = 85Ω 10 = 100Ω 11 = Reserved	
6	Reserved					
5	Q3_Zout1	Q3 Zout	RW			
4	Q3_Zout0	Q3 Zout	RW			
3	Q2_Zout1	Q2 Zout	RW			
2	Q2_Zout0	Q2 Zout	RW			
1	Reserved					
0	Reserved					



### Byte 14: OE Termination Control

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	OE1_term1	OE1 pullup or down	RW	0	00=None	10= Pullup
6	OE1_term0	OE1 pullup or down	RW	1	01= Pulldown	11=Pullup and Down
5	Reserved	—	—	0	—	—
4	Reserved	—	—	1	—	—
3	OE0_term1	OE0 pullup or down	RW	0	00=None	10= Pullup
2	OE0_term0	OE0 pullup or down	RW	1	01= Pulldown	11=Pullup and Down
1	Reserved	—	—	0	—	—
0	Reserved	—	—	1	—	—

### Byte 15: OE Termination Control

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—	—	0	—	—
6	Reserved	—	—	1	—	—
5	OE3_term1	OE3 pullup or down	RW	0	00=None	10= Pullup
4	OE3_term0	OE3 pullup or down	RW	1	01= Pulldown	11=Pullup and Down
3	OE2_term1	OE2 pullup or down	RW	0	00=None	10= Pullup
2	OE2_term0	OE2 pullup or down	RW	1	01= Pulldown	11=Pullup and Down
1	Reserved	—	—	0	—	—
0	Reserved	—	—	1	—	—

### Byte 16: Power Good Termination Control

Bit	Control Function	Description	Type	Power-up Condition	0	1
7:2	Reserved	—	—	0x09	—	—
1	PWRGD_PD1	Clock power good and power-down pullup or pulldown	RW	1	00=None	10= Pullup
0	PWRGD_PD0		RW	0	01= Pulldown	11=Pullup and Down

**Byte 17: Reserved**

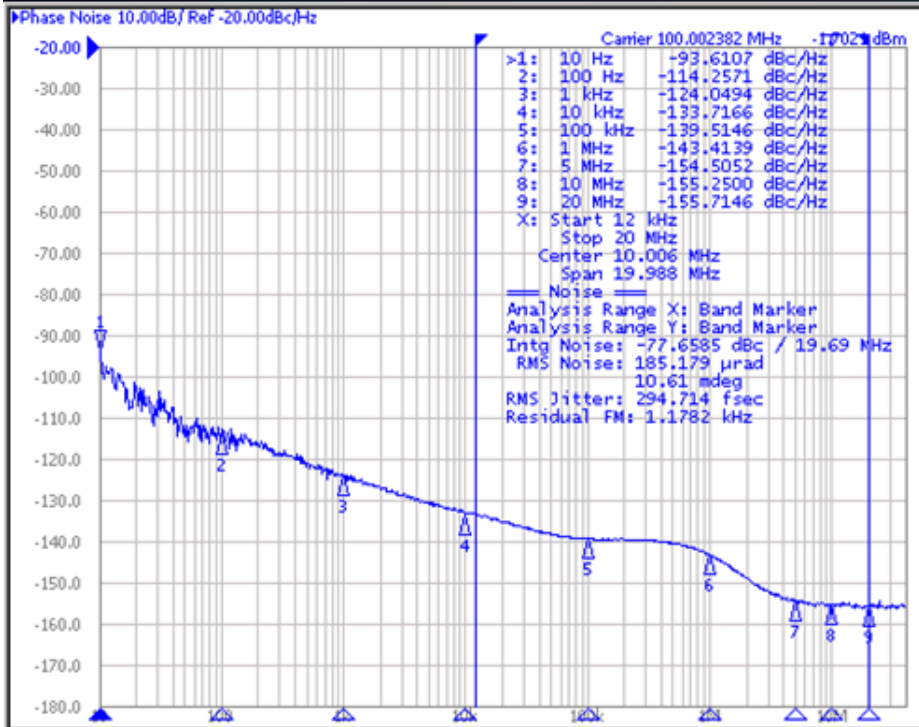
**Byte 18: Enable Pin Control**

Bit	Control Function	Description	Type	Power-up Condition	0	1
7	Reserved	—	—	0	—	—
6	OE3_Enable	Sets Enable High or Low	RW	0	Enable = Low	Enable = High
5	OE2_Enable	Sets Enable High or Low	RW	0	Enable = Low	Enable = High
4	Reserved	—	—	0	—	—
3	OE1_Enable	Sets Enable High or Low	RW	0	Enable = Low	Enable = High
2	Reserved	—	—	0	—	—
1	OE0_Enable	Sets Enable High or Low	RW	0	Enable = Low	Enable = High
0	Reserved	—	—	0	—	—

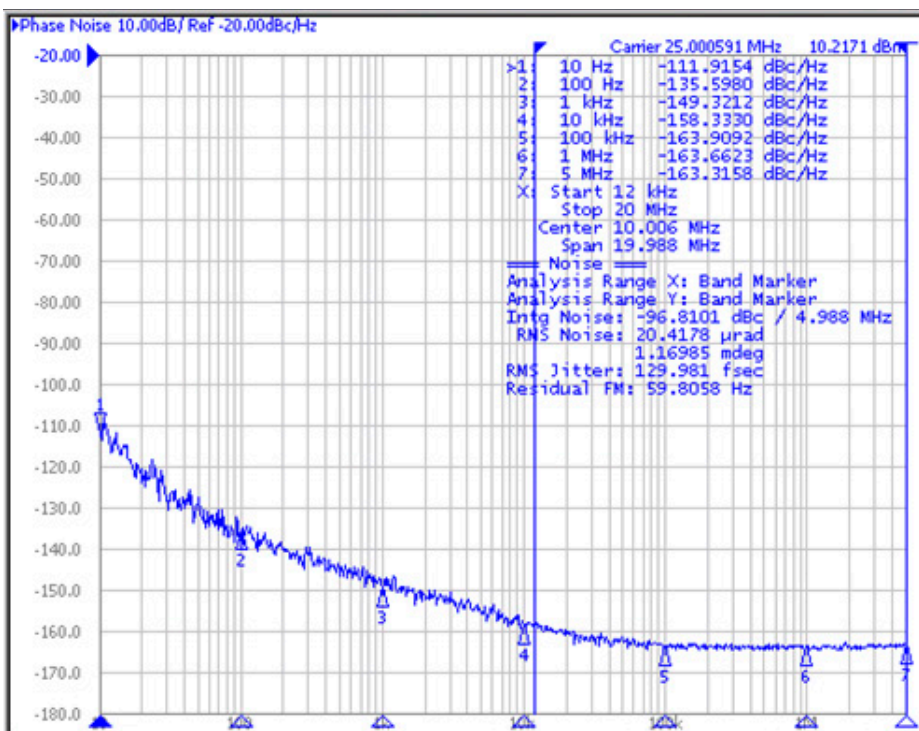
**Byte 19: Power Down Pin Control**

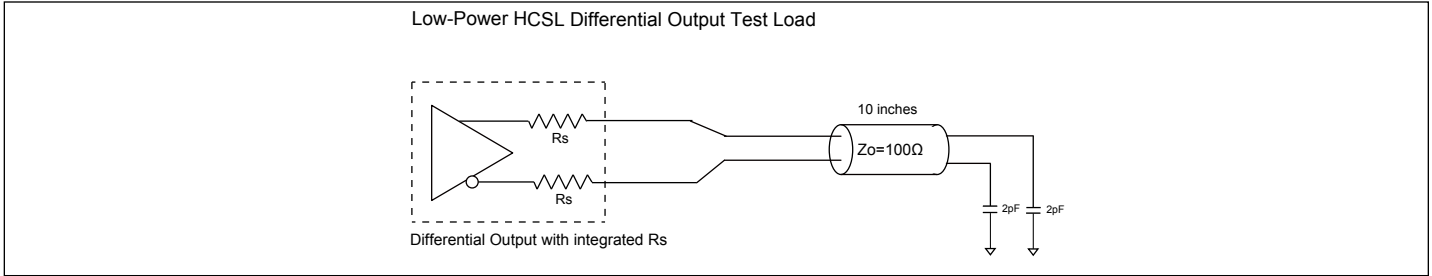
Bit	Control Function	Description	Type	Power-up Condition	0	1
7:1	Reserved	—	—	0	—	—
0	PWRGD_PD	PWRGD_PD Active via Pullup or Pulldown	RW	0	Power Down = Low	Power Down = High

**Phase Noise Plots**  
**100MHz HCSL Clock (12k to 20MHz)**

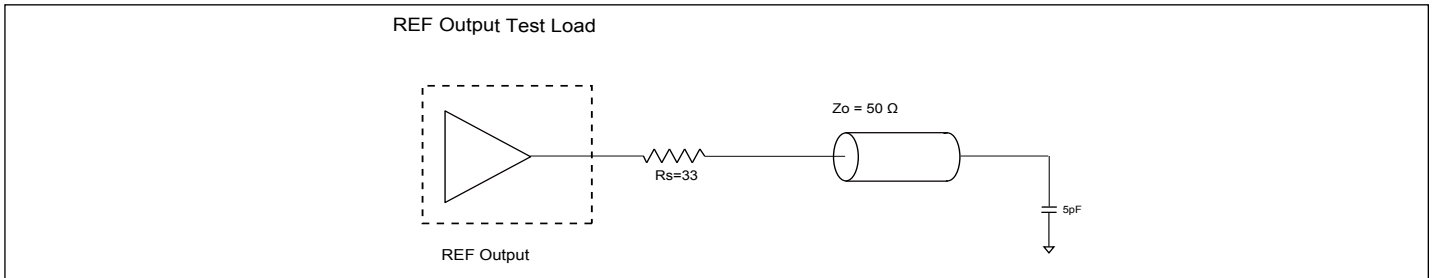


**25MHz CMOS Clock**

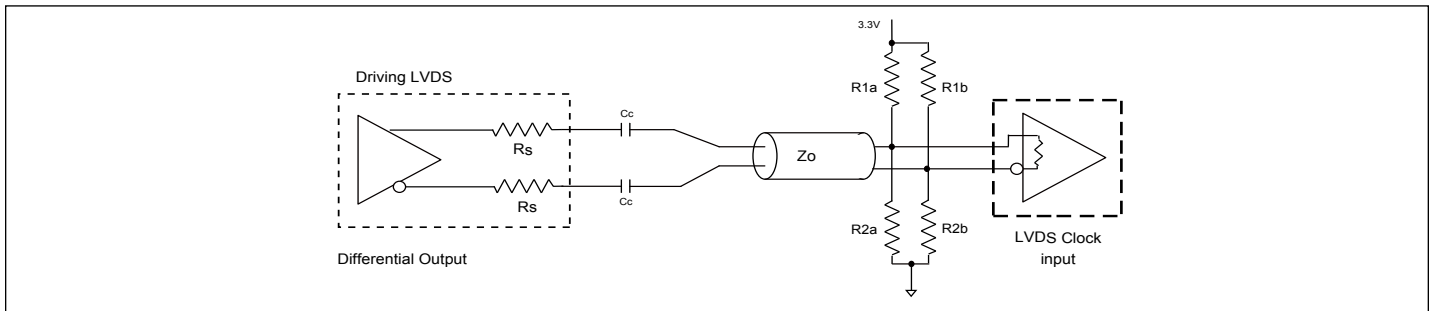




**Figure 1. Low Power HCSL Test Circuit**



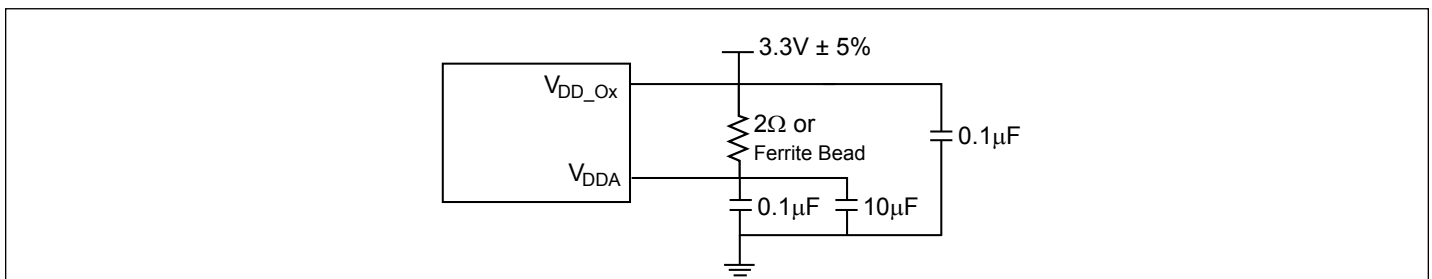
**Figure 2. CMOS REF Test Circuit**



**Figure 3. Differential Output driving LVDS**

**Alternate Differential Output Terminations**

Component	Receiver with Termination	Receiver without Termination	Unit
R <sub>1a</sub> , R <sub>1b</sub>	10,000	140	Ω
R <sub>2a</sub> , R <sub>2b</sub>	5600	75	Ω
C <sub>C</sub>	0.1	0.1	μF
V <sub>CM</sub>	1.2	1.2	V

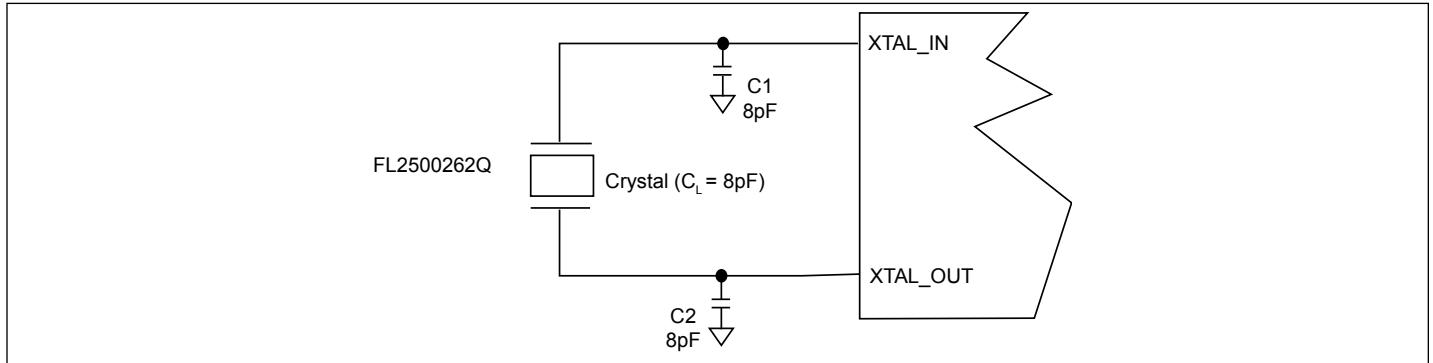


**Figure 4. Power Supply Filter**

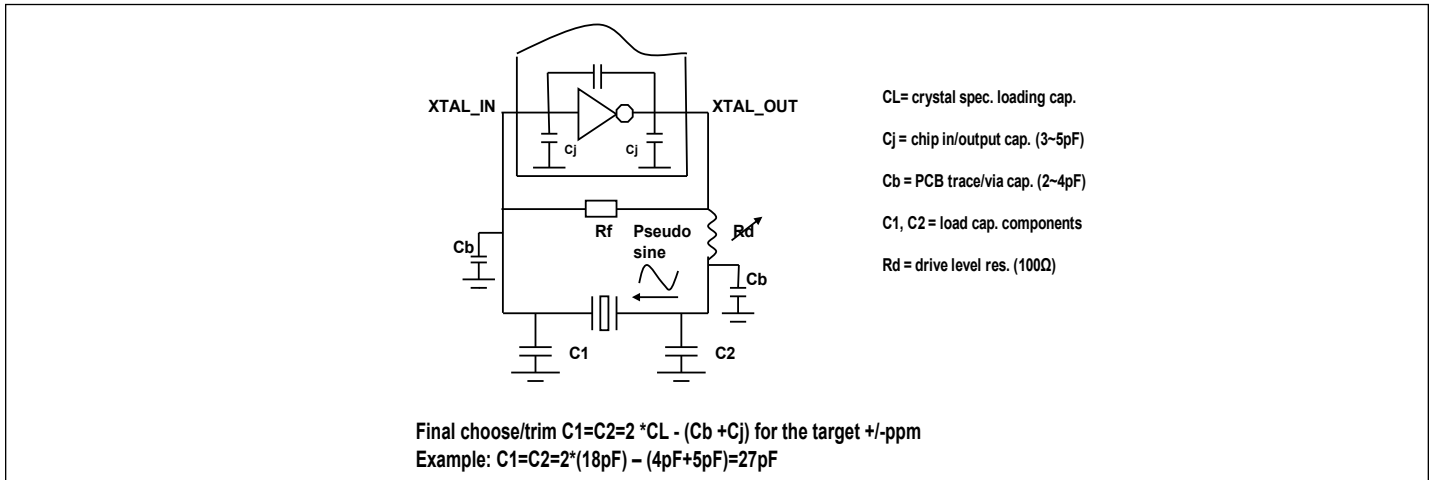
## Crystal Circuit Connection

The following diagram shows PI6CG33401C crystal circuit connection with a parallel crystal. For the  $CL = 8\text{pF}$  crystal, it is suggested to use  $C1 = 8\text{pF}$  and  $C2 = 8\text{pF}$ .  $C1$  and  $C2$  can be adjusted to fine tune to the target ppm of crystal oscillator according to different board layouts based on the following formula in the Crystal Capacitor Calculation diagram.

## Crystal Oscillator Circuit



## Crystal Capacitor Calculation



## Recommended Crystal Specification

### Diodes recommends:

- FL2500217, SMD 3.2x2.5(4P), 25MHz,  $CL=8\text{pF}$ , +/-20ppm, <https://www.diodes.com/assets/Datasheets/FL.pdf>
- FH2500016, SMD 2.5x2.0(4P), 25MHz,  $CL=8\text{pF}$ , +/-30ppm, <https://www.diodes.com/assets/Datasheets/FH.pdf>
- FW2500031, SMD 2.0x1.6(4P), 25MHz,  $CL=8\text{pF}$ , +/-30ppm, <https://www.diodes.com/assets/Datasheets/FW.pdf>
- US2500003, SMD 1.6x1.2(4P), 25MHz,  $CL=12\text{pF}$ , +/-30ppm, <https://www.diodes.com/assets/Datasheets/US.pdf>

**PI6CG33401C**

### Thermal Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$\theta_{JA}$	Thermal Resistance Junction to Ambient	Still air			44.7	°C/W
$\theta_{JC}$	Thermal Resistance Junction to Case				21.7	°C/W

### Part Marking



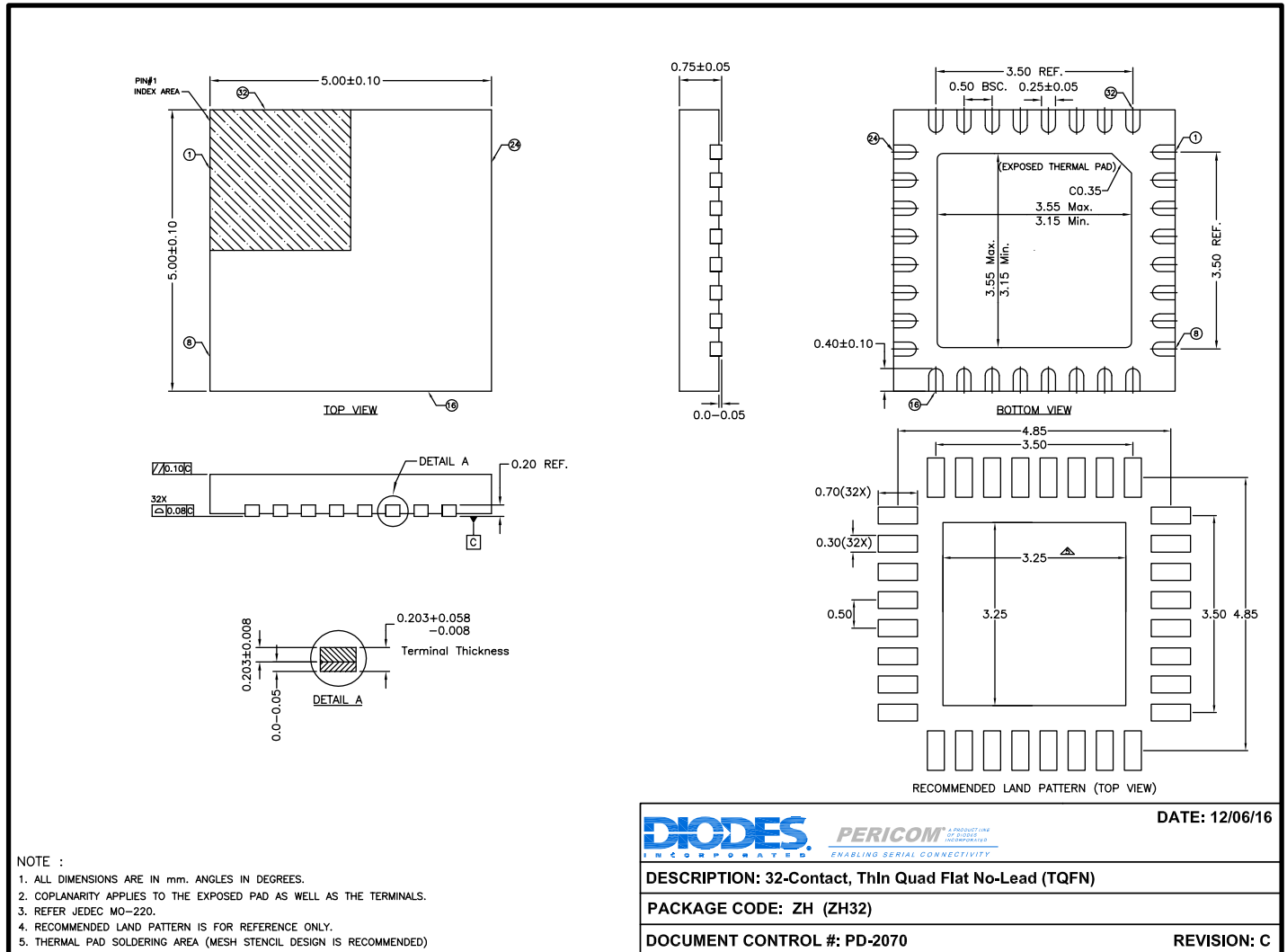
YY: Year

WW: Workweek

1st X: Assembly Code

2nd X: Fab Code

**Packaging Mechanical: 32-TQFN (ZH)**



17-0570

**For latest package information:**

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

**Ordering Information**

Ordering Code	Package Code	Package Description	Pin 1 Location
PI6CG33401CZHIEX	ZH	32-Contact, Thin Quad Flat No-Lead (TQFN)	Top Right Corner
PI6CG33401CZHIEX-13R	ZH	32-Contact, Thin Quad Flat No-Lead (TQFN)	Top Left Corner

**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
6. For packaging details, go to our website at: <https://www.diodes.com/assets/MediaList-Attachments/Diodes-Package-Information.pdf>

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