

**1.5V/1.8V/2.5V/3.3V, 160MHz, Low Skew 1:6 Crystal to LVCMOS Clock Buffer**

## Features

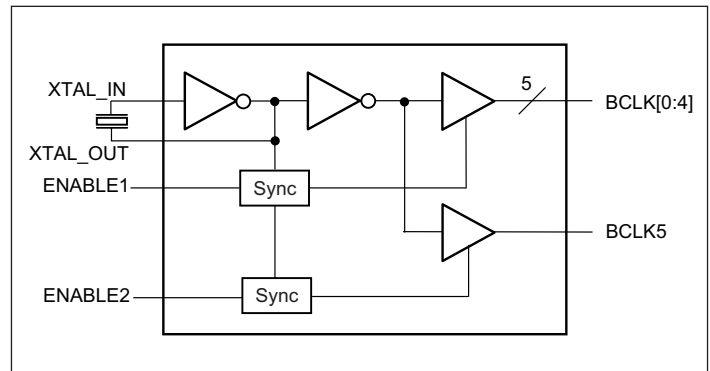
- Six low skew outputs: < 80ps
- Crystal oscillator input: 10MHz to 50MHz
- Switching frequency up to 160 MHz
- Fast output rise/fall time (down to 1.8V): < 800ps
- Synchronous output enables
- 1.5V, 1.8V, 2.5V, and 3.3V operation
- Industrial Temperature range: -40°C to +85°C
- Totally Lead-Free & Fully 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 available):
  - 16-pin, 173-mil wide TSSOP (L)

## Description

Diodes' PI6C10806B is a low skew, six output, crystal oscillator driver. The device's input range is from 10MHz to 50MHz. If the XTAL\_IN is driven with a signal source, then the input frequency can be as high as 160MHz. The outputs are configured into two groups: a five output and a single output, each with an independent output enable.

The PI6C10806B has a wide range of operating voltages: 1.5V, 1.8V, 2.5V, and 3.3V. This feature, paired with the low output-to-output and part-to-part skew, makes the device ideal for low voltage, low power, high frequency, single ended applications; such as in networking.

## Block Diagram



## Truth Table<sup>(1)</sup>

Inputs		Outputs	
ENABLE1	ENABLE2	BCLK[0:4]	BCLK5
L	L	L	L
L	H	L	Switching
H	L	Switching	L
H	H	Switching	Switching

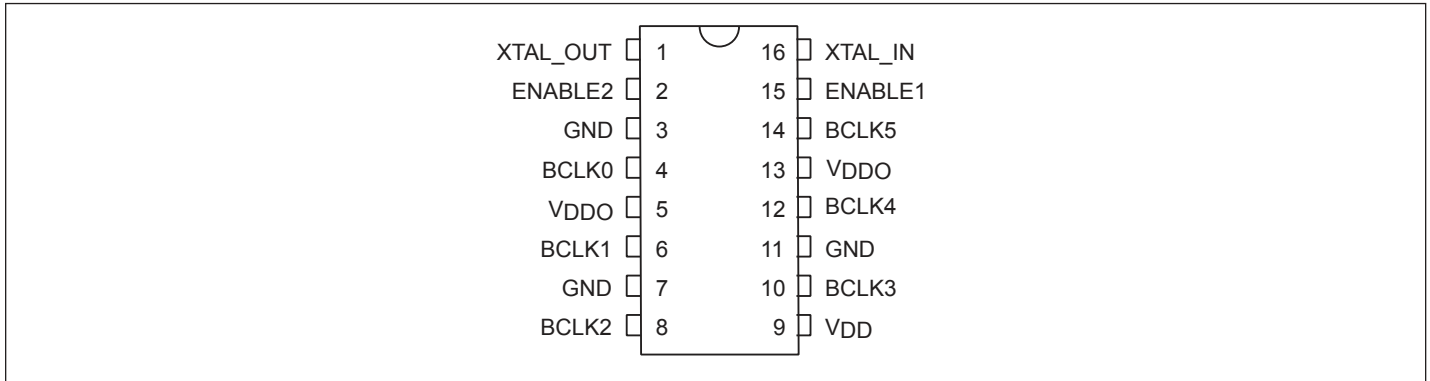
### Note:

1. H = High Voltage Level, L = Low Voltage Level

### 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	Description
15, 2	ENABLE1, ENABLE2	Active High Output Enable Inputs
16	XTAL_IN	Crystal interface
1	XTAL_OUT	Crystal interface
4, 6, 8, 10, 12, 14	BCLK[0:5]	Clock Outputs
3, 7, 11	GND	Ground
9	V <sub>DD</sub>	Core Power
5, 13	V <sub>DDO</sub>	Output Power

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

Storage Temperature.....	-65°C to +150°C
V <sub>DD</sub> , V <sub>DDO</sub> Voltage.....	-0.5V to +3.6V
Output Voltage (max. 4.6V).....	-0.5V to V <sub>DD</sub> +0.5V
Input Voltage (max 4.6V).....	-0.5V to V <sub>DD</sub> +0.5V
Junction Temperature.....	Max. 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.

**Power Supply DC Characteristics** (V<sub>DD</sub>/V<sub>DDO</sub> = 3.3V ± 5%, T<sub>A</sub> = -40°C to 85°C)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V <sub>DD</sub>	Core Supply Voltage		3.135	3.3	3.465	V
V <sub>DDO</sub>	Output Supply Voltage		3.135	3.3	3.465	V
I <sub>DD</sub>	Power Supply Current	ENABLE1:2 = '00'			10	mA
I <sub>DDO</sub>	Output Supply Current	ENABLE1:2 = '00'			5	mA

**Power Supply DC Characteristics** (V<sub>DD</sub>/V<sub>DDO</sub> = 2.5V ± 5%, T<sub>A</sub> = -40°C to 85°C)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V <sub>DD</sub>	Core Supply Voltage		2.375	2.5	2.625	V
V <sub>DDO</sub>	Output Supply Voltage		2.375	2.5	2.625	V
I <sub>DD</sub>	Power Supply Current	ENABLE1:2 = '00'			8	mA
I <sub>DDO</sub>	Output Supply Current	ENABLE1:2 = '00'			4	mA

**Power Supply DC Characteristics** (V<sub>DD</sub>/V<sub>DDO</sub> = 1.8V ± 0.2V, T<sub>A</sub> = -40°C to 85°C)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V <sub>DD</sub>	Core Supply Voltage		1.6	1.8	2.0	V
V <sub>DDO</sub>	Output Supply Voltage		1.6	1.8	2.0	V
I <sub>DD</sub>	Power Supply Current	ENABLE1:2 = '00'			5	mA
I <sub>DDO</sub>	Output Supply Current	ENABLE1:2 = '00'			3	mA

**Power Supply DC Characteristics** (V<sub>DD</sub>/V<sub>DDO</sub> = 1.5V ± 5%, T<sub>A</sub> = -40°C to 85°C)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V <sub>DD</sub>	Core Supply Voltage		1.425	1.5	1.575	V
V <sub>DDO</sub>	Output Supply Voltage		1.425	1.5	1.575	V
I <sub>DD</sub>	Power Supply Current	ENABLE1:2 = '00'			5	mA
I <sub>DDO</sub>	Output Supply Current	ENABLE1:2 = '00'			3	mA

**Power Supply DC Characteristics** (V<sub>DD</sub> = 3.3V ± 5%, T<sub>A</sub> = -40°C to 85°C)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
I <sub>DD</sub>	Power Supply Current	ENABLE1:2 = '00'			10	mA
		V <sub>DDO</sub> = 2.5V ± 5%				
		V <sub>DDO</sub> = 1.5V ± 5%				

**Power Supply DC Characteristics Cont.**

Symbols	Parameters		Test Conditions	Min.	Typ	Max.	Units
I <sub>DDO</sub>	Output Supply Current	ENABLE1:2 = '00'	V <sub>DDO</sub> = 2.5V ± 5%			4	mA
			V <sub>DDO</sub> = 1.8V ± 0.2V			3	
			V <sub>DDO</sub> = 1.5V ± 5%			3	

**Power Supply DC Characteristics (V<sub>DD</sub> = 2.5V ± 5%, T<sub>A</sub> = -40°C to 85°C)**

Symbols	Parameters		Test Conditions	Min.	Typ	Max.	Units
I <sub>DD</sub>	Power Supply Current	ENABLE1:2 = '00'	V <sub>DDO</sub> = 1.8V ± 0.2V			8	mA
			V <sub>DDO</sub> = 1.5V ± 5%				
I <sub>DDO</sub>	Output Supply Current	ENABLE1:2 = '00'	V <sub>DDO</sub> = 1.8V ± 0.2V			3	
			V <sub>DDO</sub> = 1.5V ± 5%				

**Power Supply DC Characteristics (V<sub>DD</sub> = 1.8V ± 0.2V, T<sub>A</sub> = -40°C to 85°C)**

Symbols	Parameters		Test Conditions	Min.	Typ	Max.	Units
I <sub>DD</sub>	Power Supply Current	ENABLE1:2 = '00'	V <sub>DDO</sub> = 1.5V ± 5%			5	mA
I <sub>DDO</sub>	Output Supply Current	ENABLE1:2 = '00'	V <sub>DDO</sub> = 1.5V ± 5%			3	

**I/O DC Characteristics (T<sub>A</sub> = -40°C to 85°C)**

Symbols	Parameters		Test Conditions	Min.	Typ	Max.	Units
V <sub>IH</sub>	Input High Voltage	ENABLE 1, ENABLE 2	V <sub>DD</sub> = 3.3V ± 5%	2		V <sub>DDO</sub> + 0.3	V
			V <sub>DD</sub> = 2.5V ± 5%	1.7		V <sub>DDO</sub> + 0.3	V
			V <sub>DD</sub> = 1.8V ± 0.2V	0.65* V <sub>DDO</sub>		V <sub>DDO</sub> + 0.3	V
			V <sub>DD</sub> = 1.5V ± 5%	0.65* V <sub>DDO</sub>		V <sub>DDO</sub> + 0.3	V
V <sub>IL</sub>	Input Low Voltage	ENABLE 1, ENABLE 2	V <sub>DD</sub> = 3.3V ± 5%	-0.3		0.8	V
			V <sub>DD</sub> = 2.5V ± 5%	-0.3		0.7	V
			V <sub>DD</sub> = 1.8V ± 0.2V	-0.3		0.35* V <sub>DDO</sub>	V
			V <sub>DD</sub> = 1.5V ± 5%	-0.3		0.35* V <sub>DDO</sub>	V
V <sub>OH</sub>	Output High Voltage		V <sub>DDO</sub> = 3.3V ± 5% <sup>(1)</sup>	2.6			V
			V <sub>DDO</sub> = 2.5V ± 5%; I <sub>OH</sub> = -1mA	2			V
			V <sub>DDO</sub> = 2.5V ± 5% <sup>(1)</sup>	1.8			V
			V <sub>DDO</sub> = 1.8V ± 0.2V <sup>(1)</sup>	V <sub>DDO</sub> - 0.3			V
			V <sub>DDO</sub> = 1.5V ± 5% <sup>(1)</sup>	V <sub>DDO</sub> - 0.3			V

**I/O DC Characteristics Cont.**

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V <sub>OL</sub>	Output Low Voltage	V <sub>DD</sub> = 3.3V ± 5% <sup>(1)</sup>			0.5	V
		V <sub>DDO</sub> = 2.5V ± 5%; I <sub>OL</sub> = 1mA			0.4	V
		V <sub>DDO</sub> = 2.5V ± 5% <sup>(1)</sup>			0.45	V
		V <sub>DDO</sub> = 1.8V ± 0.2V <sup>(1)</sup>			0.35	V
		V <sub>DDO</sub> = 1.5V ± 5% <sup>(1)</sup>			0.3	V
R <sub>OUT</sub>	Output Impedance	V <sub>DDO</sub> = 3.3 V		7		Ω
		V <sub>DDO</sub> = 2.5 V		8		Ω
		V <sub>DDO</sub> = 1.8 V		13		Ω
		V <sub>DDO</sub> = 1.5 V		20		Ω

 Notes: 1. I<sub>OH</sub> = -8mA, I<sub>OL</sub> = 8mA.

**AC Characteristics (Over Operating Range: V<sub>DD</sub> = 3.3V ± 5%, T<sub>A</sub> = -40° to 85°C)**

Parameters	Description	Test Conditions <sup>(1)</sup>	Min.	Typ	Max.	Units
f <sub>OUT</sub>	Output Frequency	Using Crystal	10		50	MHz
		External Clock <sup>(2)</sup>	V <sub>DDO</sub> = 3.3V±5%	0	160	
			V <sub>DDO</sub> = 2.5V±5%			
			V <sub>DDO</sub> = 1.8V±0.2V	0	100	
t <sub>DC</sub>	Output Duty Cycle	@ V <sub>DDO</sub> /2	V <sub>DDO</sub> = 3.3V±5%	47	53	%
			V <sub>DDO</sub> = 2.5V±5%			
			V <sub>DDO</sub> = 1.8V±0.2V	45	55	
			V <sub>DDO</sub> = 1.5V±5%			
t <sub>r</sub> /t <sub>f</sub>	CLKn Rise/Fall Time	20% to 80%	V <sub>DDO</sub> = 3.3V±5%	150	800	ps
			V <sub>DDO</sub> = 2.5V±5%	200	800	
			V <sub>DDO</sub> = 1.8V±0.2V	200	800	
			V <sub>DDO</sub> = 1.5V±5%	600	1300	
RMS	Random RMS Phase Jitter	25MHz @ Integra- tion Range 100Hz - 1MHz	V <sub>DDO</sub> = 3.3V±5%		0.098	ps
			V <sub>DDO</sub> = 2.5V±5%		0.112	
			V <sub>DDO</sub> = 1.8V±0.2V		0.233	
			V <sub>DDO</sub> = 1.5V±5%		0.277	
t <sub>SK(O)</sub> <sup>(3)</sup>	Output to Output Skew between any two outputs of the same device @ same transition	@V <sub>DDO</sub> /2			80	ps
t <sub>DIS,t<sub>EN</sub></sub> <sup>(4)</sup>	Output Enable/Disable	@V <sub>DDO</sub> /2			4	cycles

**Notes:**

- Unless noted otherwise, all parameters are tested with xtal @ f ≤ Fxtal\_max,; outputs are terminated @ 50Ω to V<sub>DDO</sub>/2, see waveforms.
- External clock source is driving XTAL\_IN input
- Identical conditions: loading, transitions, supply voltage, temperature, package type and speed grade.
- These parameters are guaranteed, but not tested. Max delay is 4 cycles. Min. setup time = 3ns.

**PI6C10806B**

**AC Characteristics** ( $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$ )

Parameters	Description	Test Conditions <sup>(1)</sup>	Min.	Typ	Max.	Units
f <sub>OUT</sub>	Output Frequency	Using Crystal	10		50	MHz
		External Clock <sup>(2)</sup>	V <sub>DDO</sub> = 2.5V±5%	0	160	
			V <sub>DDO</sub> = 1.8V±0.2V	0	160	
		V <sub>DDO</sub> = 1.5V±5%	0	100		
t <sub>DC</sub>	Output Duty Cycle	@ V <sub>DDO</sub> /2	V <sub>DDO</sub> = 2.5V±5%	47	53	%
			V <sub>DDO</sub> = 1.8V±0.2V			
			V <sub>DDO</sub> = 1.5V±5%	45	55	
t <sub>R</sub> /t <sub>F</sub>	CLKn Rise/Fall Time	20% to 80%	V <sub>DDO</sub> = 2.5V±5%	150	800	ps
			V <sub>DDO</sub> = 1.8V±0.2V	200	900	
			V <sub>DDO</sub> = 1.5V±5%	700	1400	
RMS	Random RMS Phase Jitter	25MHz @ Integra- tion Range	V <sub>DDO</sub> = 2.5V±5%		0.112	ps
			V <sub>DDO</sub> = 1.8V±0.2V		0.233	
		100Hz - 1MHz	V <sub>DDO</sub> = 1.5V±5%		0.277	
t <sub>SK(O)</sub> <sup>(3)</sup>	Output to Output Skew be- tween any two outputs of the same device @ same transition	@V <sub>DDO</sub> /2			80	ps
t <sub>DIS</sub> ,t <sub>EN</sub> <sup>(4)</sup>	Output Enable/Disable	@V <sub>DDO</sub> /2			4	cycles

**Notes:**

1. Unless noted otherwise, all parameters are tested with xtal @ f <= Fxtal\_max,; outputs are terminated @ 50Ω to V<sub>DDO</sub>/2, see waveforms.
2. External clock source is driving XTAL\_IN input
3. Identical conditions: loading, transitions, supply voltage, temperature, package type and speed grade.
4. These parameters are guaranteed, but not tested. Max delay is 4 cycles. Min. setup time = 3ns.

**AC Characteristics** ( $V_{DD} = 1.8V \pm 0.2V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$ )

Parameters	Description	Test Conditions <sup>(1)</sup>	Min.	Typ	Max.	Units
f <sub>OUT</sub>	Output Frequency	Using Crystal	10		50	MHz
		External Clock <sup>(2)</sup>	V <sub>DDO</sub> = 1.8V ± 0.2V	0	160	
			V <sub>DDO</sub> = 1.5V ± 5%	0	100	
t <sub>DC</sub>	Output Duty Cycle	@ V <sub>DDO</sub> /2	V <sub>DDO</sub> = 1.8V ± 0.2V	47	53	%
			V <sub>DDO</sub> = 1.5V ± 5%	45	55	
t <sub>R</sub> /t <sub>F</sub>	CLKn Rise/Fall Time	20% to 80%	V <sub>DDO</sub> = 1.8V ± 0.2V	150	800	ps
			V <sub>DDO</sub> = 1.5V ± 5%	800	1500	
RMS	Random RMS Phase Jitter	25MHz @ Integra- tion Range 100Hz - 1MHz	V <sub>DDO</sub> = 1.8V ± 0.2V		0.233	ps
			V <sub>DDO</sub> = 1.5V ± 5%		0.277	
t <sub>SK(O)</sub> <sup>(3)</sup>	Output to Output Skew between any two outputs of the same device @ same transition	@V <sub>DDO</sub> /2			80	ps
t <sub>DIS</sub> , t <sub>EN</sub> <sup>(4)</sup>	Output Enable/Disable	@V <sub>DDO</sub> /2			4	cycles

**Notes:**

 All parameters measured at  $f = f_{MAX}$  using a crystal input unless noted otherwise.

 Outputs are terminated at 50Ω to V<sub>DDO</sub>/2.

1. XTAL\_IN can be overdriven relatively to a signal a crystal provides.
2. Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at V<sub>DDO</sub>/2.
3. These parameters are guaranteed, but not tested.
4. This parameter is defined in accordance with JEDEC Standard 65.

**AC Characteristics** ( $V_{DD} = 1.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $85^\circ C$ )

Parameters	Description	Test Conditions <sup>(1)</sup>	Min.	Typ	Max.	Units
f <sub>OUT</sub>	Output Frequency	Using Crystal	10		50	MHz
		External Clock <sup>(2)</sup>	0		100	
t <sub>DC</sub>	Output Duty Cycle	@ V <sub>DDO</sub> /2	45		55	%
t <sub>R</sub> /t <sub>F</sub>	CLKn Rise/Fall Time	20% to 80% V <sub>DDO</sub> = 1.5V ± 5%	800		1500	ps
RMS	Random RMS Phase Jitter	25MHz @ Integra- tion Range 100Hz - 1MHz V <sub>DDO</sub> = 1.5V ± 5%		0.277		ps
t <sub>SK(O)</sub> <sup>(3)</sup>	Output to Output Skew between any two outputs of the same device @ same transition	@V <sub>DDO</sub> /2			80	ps
t <sub>DIS</sub> , t <sub>EN</sub> <sup>(4)</sup>	Output Enable/Disable	@V <sub>DDO</sub> /2			4	cycles

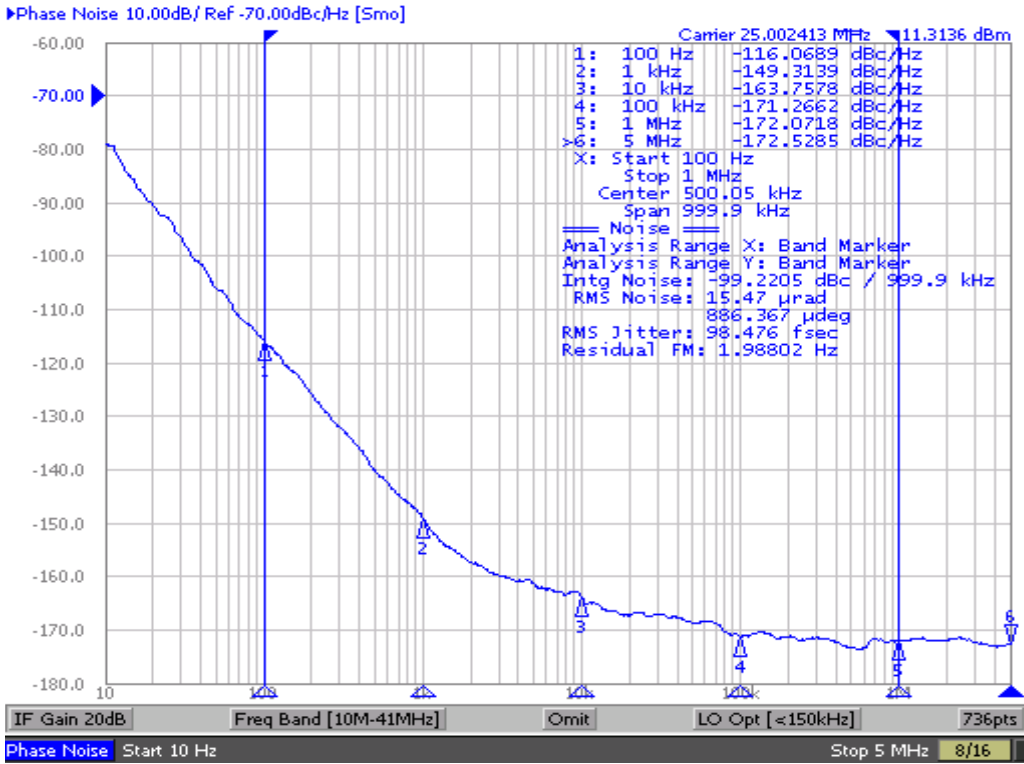
**Notes:**

 All parameters measured at  $f = f_{MAX}$  using a crystal input unless noted otherwise.

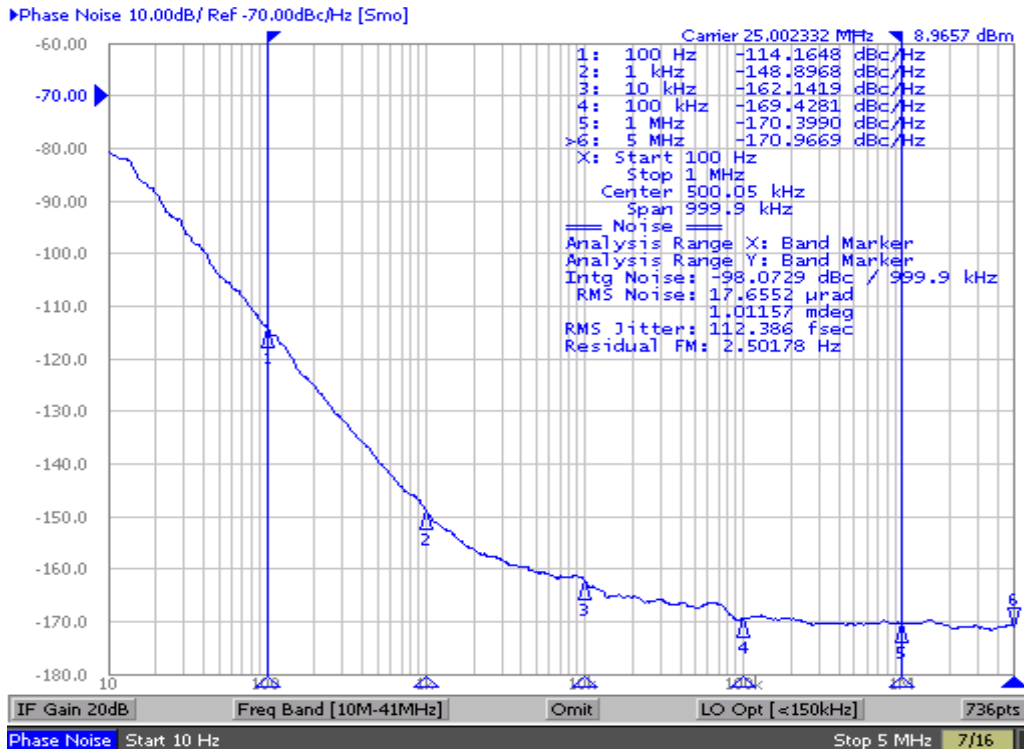
 Outputs are terminated at 50Ω to V<sub>DDO</sub>/2.

1. XTAL\_IN can be overdriven relatively to a signal a crystal provides.
2. Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at V<sub>DDO</sub>/2.
3. These parameters are guaranteed, but not tested.
4. This parameter is defined in accordance with JEDEC Standard 65.

**Jitter** (typical phase noise at 25MHz)



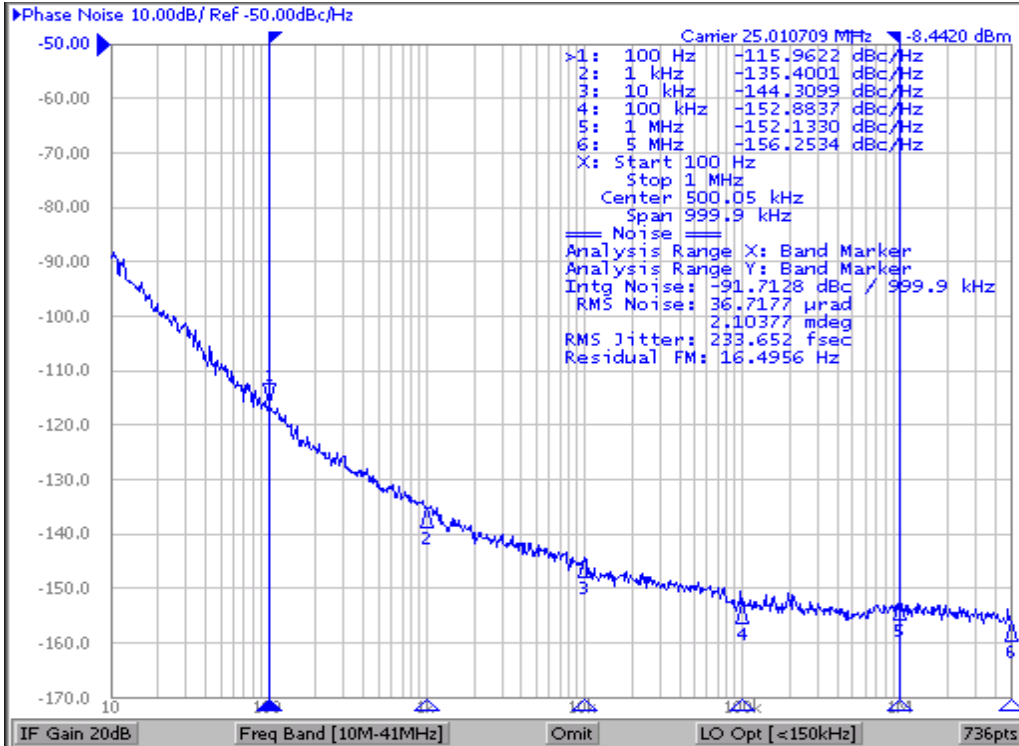
**3.3V Core/3.3V Output**  
RMS phase jitter (Random)  
100Hz to 1MHz =0.098ps (typical)



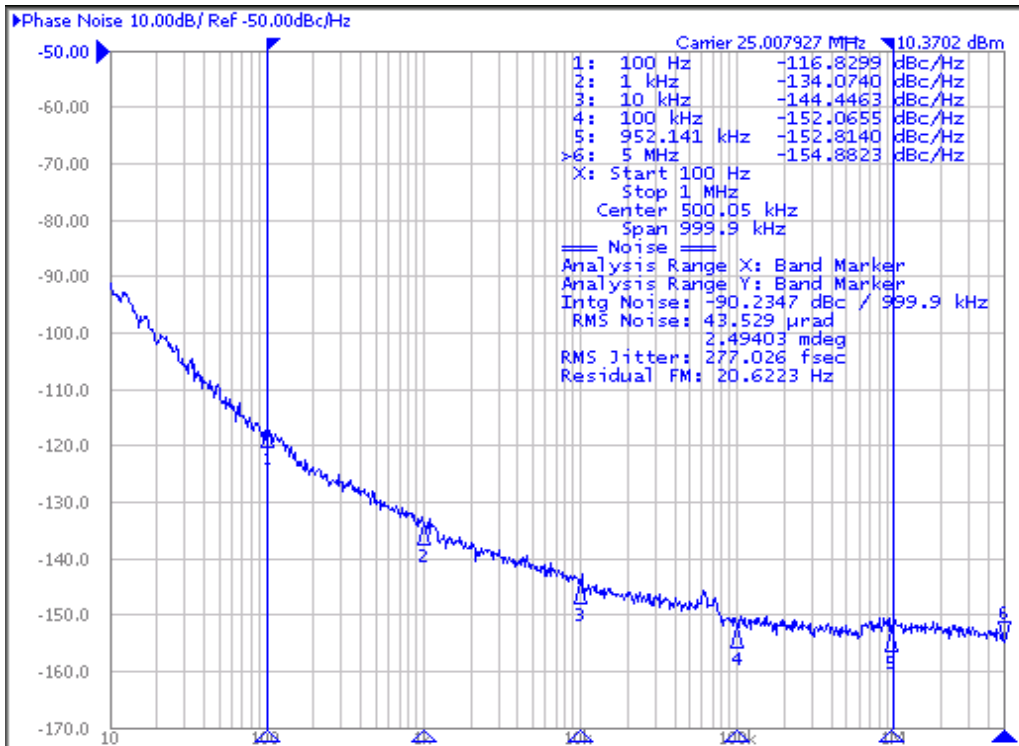
**2.5V Core/2.5V Output**  
RMS phase jitter (Random)  
100Hz to 1MHz =0.112ps (typical)



**PI6C10806B**

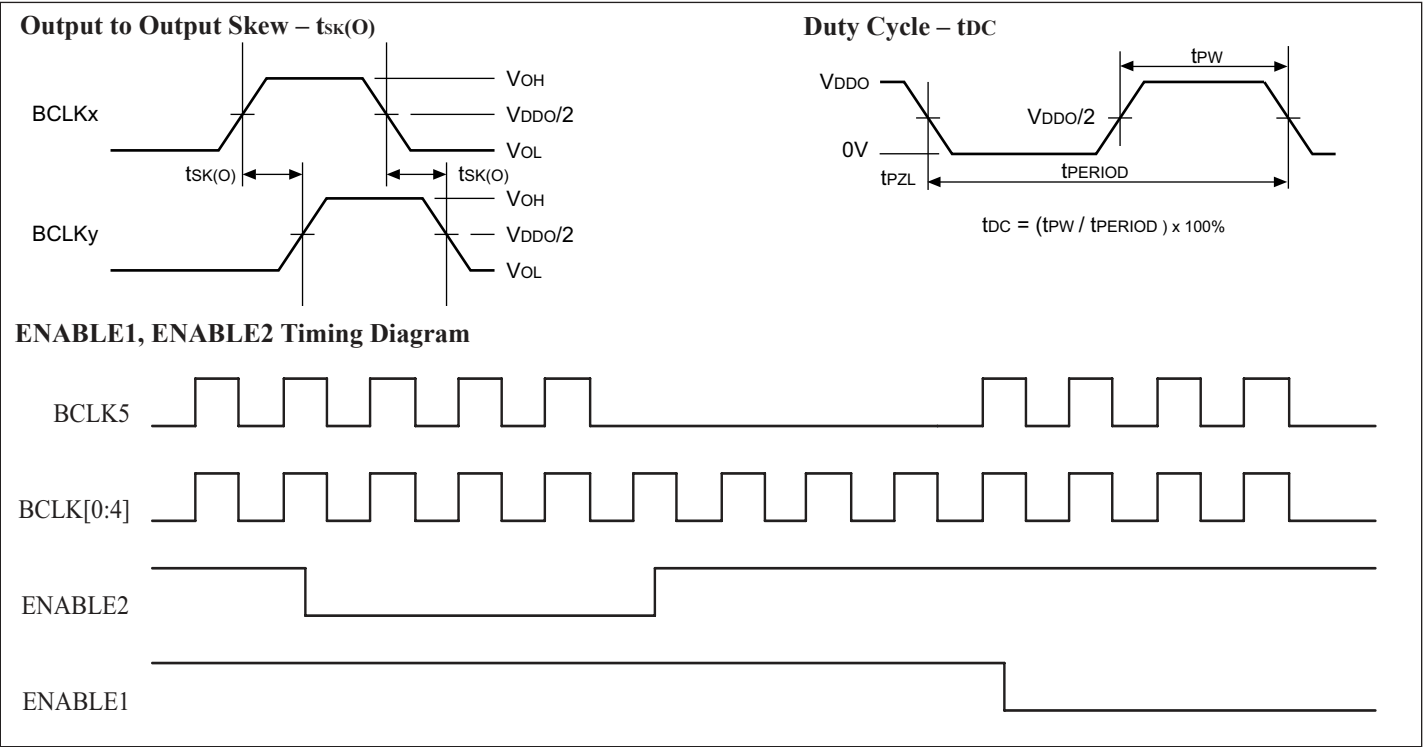


**1.8V Core/1.8V Output**  
**RS phase jitter (Random)**  
**100Hz to 1MHz =0.233ps (typical)**

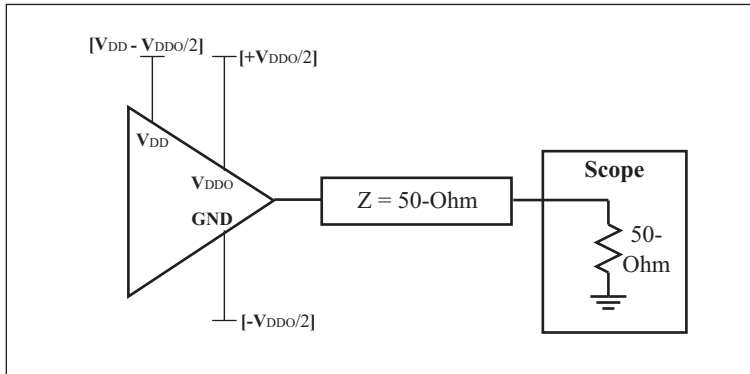


**1.5V Core/1.5V Output**  
**RMS phase jitter (Random)**  
**100Hz to 1MHz =0.277ps (typical)**

**Waveforms**



**AC Test Circuit Load**



**Note:**  
V<sub>DD</sub>/V<sub>DDO</sub> = 1.5V ± 5%,  
1.8V ± 0.2V,  
2.5V ± 5%,  
3.3V ± 5%

**Crystal Characteristic**

Parameters	Description	Min	Typ	Max.	Units
OSCMODE	Mode of Oscillation	Fundamental			
FREQ	Frequency	10	25	50	MHz
ESR <sup>(1)</sup>	Equivalent Series Resistance	30		50	Ohm
CLOAD	Load Capacitance		18		pF
CSHUNT	Shunt Capacitance			7	pF
DRIVE level				1	mW

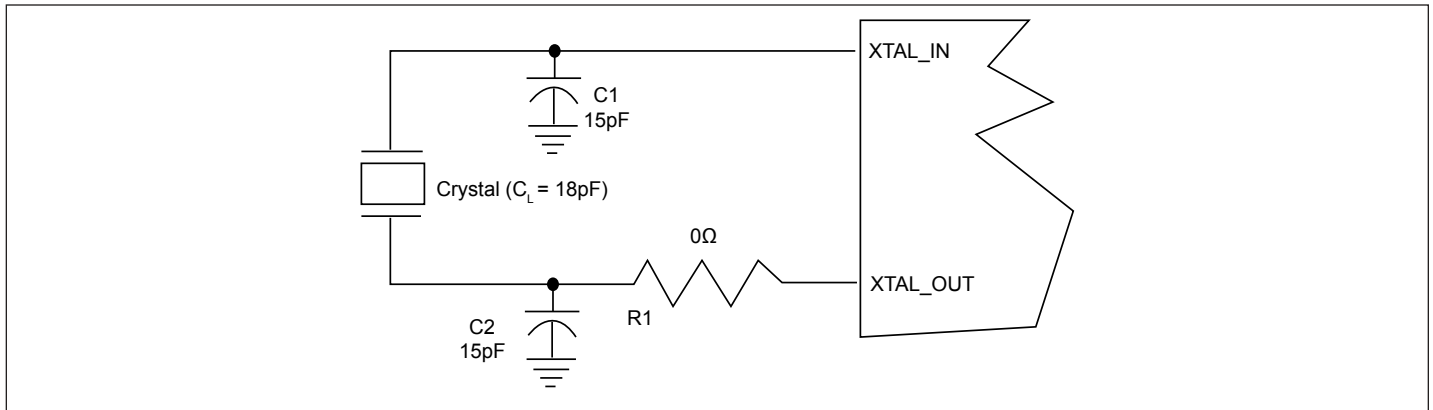
**Note:** 1. ESR value is dependent upon frequency of oscillation

## Application Notes

### Crystal Circuit Connection

The following diagram shows PI6C10806B crystal circuit connection with a parallel crystal. For the  $C_L=18\text{pF}$  crystal, it is suggested to use  $C1=15\text{pF}$ ,  $C2=15\text{pF}$ .  $C1$  and  $C2$  can be adjusted to fine tune to the target ppm of crystal oscillator according to different board layouts.  $R1$  is not recommended.

### Crystal Oscillator Circuit



## Part Marking

PI6C  
10806BLE  
ZYWX̄

Z: Die Rev  
Y: Year  
W: Workweek  
1st X: Assembly Code  
2nd X: Fab Code

**Packaging Mechanical: 16-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	4.90	5.00	5.10
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.

		DATE: 03/24/16
DESCRIPTION: 16-Pin, 173mil Wide TSSOP		
PACKAGE CODE: L (L16)		
DOCUMENT CONTROL #: PD-1310	REVISION: G	

16-0061

**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
PI6C10806BLEX	L	16-Pin, 173mil Wide (TSSOP)

**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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