

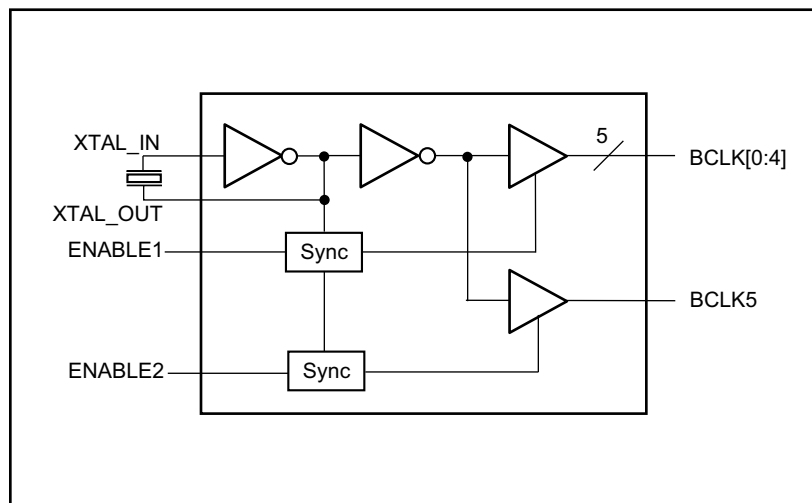
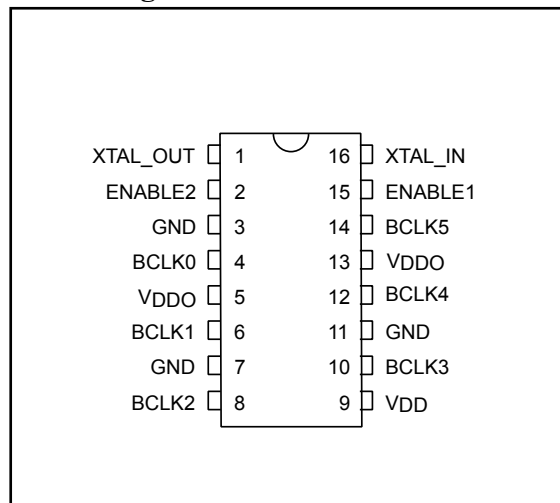
1.8V/2.5V/3.3V, 100MHz, Low Skew 1:6 Crystal to LVC MOS Clock Buffer
Features

- Six low skew outputs: < 80ps
- Crystal oscillator input: 10MHz to 50MHz
- Switching frequency up to 100 MHz
- Fast output rise/fall time: < 800ps
- Synchronous output enables
- Industrial Temperature range: -40°C to +85°C
- 1.8V, 2.5V and 3.3V operation
 - Mixed 3.3V core/2.5V output, 3.3V core/1.8V output, and 2.5V core/1.8V output operating voltages
- Packaging (Pb-free & Green available):
 - 16-pin 173-mil wide TSSOP (L)

Description

Pericom Semiconductor's PI6C10806B is a low skew six output crystal oscillator driver. Crystal oscillator input range is from 10MHz to 50MHz. If XTAL_IN is driven with a signal source, then the input frequency can be as high as 100MHz. PI6C10806B, the outputs are configured into 2 groups: a five output and a single output; each with independent output enable.

PI6C10806B has a wide range of operating voltages: 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 networking

Block Diagram

Pin Configuration

Pin Description

Pin Name	Description
ENABLE1, ENABLE2	Active High Output Enable Inputs
XTAL_IN	Crystal interface
XTAL_OUT	Crystal interface
BCLK[0:5]	Clock Outputs
GND	Ground
V _{DD}	Core Power
V _{DDO}	Output Power

Truth Table⁽¹⁾

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

Power Supply DC Characteristics ($V_{DD}/V_{DDO} = 3.3V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		3.135	3.3	3.465	V
I_{DD}	Power Supply Current	ENABLE1:2 = '00'			10	mA
I_{DDO}	Output Supply Current	ENABLE1:2 = '00'			5	mA

Power Supply DC Characteristics ($V_{DD}/V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V_{DD}	Core Supply Voltage		2.375	2.5	2.625	V
V_{DDO}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Power Supply Current	ENABLE1:2 = '00'			8	mA
I_{DDO}	Output Supply Current	ENABLE1:2 = '00'			4	mA

Power Supply DC Characteristics ($V_{DD}/V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V_{DD}	Core Supply Voltage		1.6	1.8	2.0	V
V_{DDO}	Output Supply Voltage		1.6	1.8	2.0	V
I_{DD}	Power Supply Current	ENABLE1:2 = '00'			5	mA
I_{DDO}	Output Supply Current	ENABLE1:2 = '00'			3	mA

Power Supply DC Characteristics ($V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Power Supply Current	ENABLE1:2 = '00'			10	mA
I_{DDO}	Output Supply Current	ENABLE1:2 = '00'			4	mA

Power Supply DC Characteristics ($V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		1.6	1.8	2.0	V
I_{DD}	Power Supply Current	ENABLE1:2 = '00'			10	mA
I_{DDO}	Output Supply Current	ENABLE1:2 = '00'			3	mA

Power Supply DC Characteristics ($V_{DD} = 2.5V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
V_{DD}	Core Supply Voltage		2.375	2.5	2.625	V
V_{DDO}	Output Supply Voltage		1.6	1.8	2.0	V
I_{DD}	Power Supply Current	ENABLE1:2 = '00'			8	mA
I_{DDO}	Output Supply Current	ENABLE1:2 = '00'			3	mA

I/O DC Characteristics ($T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units	
V_{IH}	Input High Voltage	ENABLE 1, ENABLE 2	$V_{DD} = 3.3V \pm 5\%$	2		$V_{DDO} + 0.3$	V
			$V_{DD} = 2.5V \pm 5\%$	1.7		$V_{DDO} + 0.3$	V
			$V_{DD} = 1.8V \pm 0.2V$	$1.65 * V_{DDO}$		$V_{DDO} + 0.3$	V
V_{IL}	Input Low Voltage	ENABLE 1, ENABLE 2	$V_{DD} = 3.3V \pm 5\%$	-0.3		0.8	V
			$V_{DD} = 2.5V \pm 5\%$	-0.3		0.7	V
			$V_{DD} = 1.8V \pm 0.2V$	-0.3		$0.35 * V_{DDO}$	V
V_{OH}	Output High Voltage		$V_{DDO} = 3.3V \pm 5\%$ ⁽¹⁾	2.6			V
			$V_{DDO} = 2.5V \pm 5\%$; $I_{OH} = -1mA$	2			V
			$V_{DDO} = 2.5V \pm 5\%$ ⁽¹⁾	1.8			V
			$V_{DDO} = 1.8V \pm 0.2V$ ⁽¹⁾	$V_{DDO} - 0.3$			V
V_{OL}	Output Low Voltage		$V_{DD} = 3.3V \pm 5\%$ ⁽¹⁾			0.5	V
			$V_{DDO} = 2.5V \pm 5\%$; $I_{OH} = -1mA$			0.4	V
			$V_{DDO} = 2.5V \pm 5\%$ ⁽¹⁾			0.45	V
			$V_{DDO} = 1.8V \pm 0.2V$ ⁽¹⁾			0.35	V

Notes:

1. For Max. or Min. conditions, use appropriate operating V_{DD} and T_A values.

3.3V 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 _{DD} , V _{DDO} Voltage.....	-0.5V to +3.6V
Output Voltage (max. 4.6V).....	-0.5V to V _{DD} +0.5V
Input Voltage (max 4.6V).....	-0.5V to V _{DD} +0.5V

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.

3.3V I/O DC Characteristics (Over Operating Range: V_{DD} = 3.3V ± 5%, T_A = -40° to 85°C)

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units
V _{DDO}	I/O Supply Voltage		3.135	3.3	3.465	
V _{IH}	Input HIGH Voltage	Logic HIGH level	2		V _{DD} +0.3	V
V _{IL}	Input LOW Voltage	Logic LOW level	-0.3		1.3	
V _{OH}	Output High Voltage	V _{DDO} = Min., V _{IN} = V _{IH} or V _{IL}	I _{OH} = -1mA	2		V
			I _{OH} = -8mA	2		
V _{OL}	Output LOW Voltage	V _{DDO} = Min., V _{IN} = V _{IH} or V _{IL}	I _{OL} = 1mA		0.4	V
			I _{OL} = 8mA		0.4	

Notes:

- For Max. or Min. conditions, use appropriate operating range values.
- Typical values are at V_{DD} = 3.3V, +25°C ambient and maximum loading.

3.3V I/O AC Characteristics (Over Operating Range: V_{DD}/V_{DDO} = 3.3V ± 5%, T_A = -40° to 85°C)

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ	Max.	Units
f _{OUT}	Output Frequency	Using Crystal	10		50	MHz
		External Clock ⁽²⁾	0		100	
t _{DC}	Output Duty Cycle	@ V _{DDO} /2	47		53	%
t _R /t _F	CLKn Rise/Fall Time	20% to 80%	150		800	ps
RMS	Random RMS Phase Jitter	25MHz @ Integration Range 100Hz - 1MHz		0.098		ps
t _{SK(O)} ⁽³⁾	Output to Output Skew between any two outputs of the same device @ same transition	@V _{DDO} /2			80	ps
t _{DIS} , t _{EN} ⁽⁴⁾	Output Enable/Disable	@V _{DDO} /2			4	cycles

Notes:

- Unless noted otherwise, all parameters are tested with xtal @ f ≤ Fxtal_max,; outputs are terminated @ 50Ω to V_{DDO}/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.

2.5V 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 _{DD} , V _{DDO} Voltage.....	-0.5V to +3.6V
Output Voltage (max. 3.6V).....	-0.5V to V _{DD} +0.5V
Input Voltage (max 3.6V).....	-0.5V to V _{DD} +0.5V

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.

2.5V I/O DC Characteristics (Over Operating Range: V_{DD} = 2.5V ± 5%, T_A = -40° to 85°C)

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units
V _{DDO}	I/O Supply Voltage		2.375	2.5	2.625	
V _{IH}	Input HIGH Voltage	Logic HIGH level	1.7		V _{DD} +0.3	V
V _{IL}	Input LOW Voltage	Logic LOW level	-0.3		0.7	
V _{OH}	Output High Voltage	V _{DDO} = Min., V _{IN} = V _{IH} or V _{IL}	I _{OH} = -1mA	2		V
			I _{OH} = -8mA	2		
V _{OL}	Output LOW Voltage	V _{DDO} = Min., V _{IN} = V _{IH} or V _{IL}	I _{OL} = 1mA		0.4	V
			I _{OL} = 8mA		0.4	

Notes:

- For Max. or Min. conditions, use appropriate operating range values.
- Typical values are at V_{DD} = 3.3V, +25°C ambient and maximum loading.

2.5V I/O AC Characteristics (Over Operating Range: V_{DD}/V_{DDO} = 2.5V ± 5%, T_A = -40° to 85°C)

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ	Max.	Units
f _{OUT}	Output Frequency	Using Crystal	10		50	MHz
		External Clock ⁽²⁾	0		100	
t _{DC}	Output Duty Cycle	@ V _{DDO} /2	47		55	%
t _R /t _F	CLKn Rise/Fall Time	20% to 80%	150		800	ps
RMS	Random RMS Phase Jitter	25MHz @ Integration Range 100Hz - 1MHz		0.112		ps
t _{SK(O)} ⁽³⁾	Output to Output Skew between any two outputs of the same device @ same transition	@V _{DDO} /2			80	ps
t _{DIS} , t _{EN} ⁽⁴⁾	Output Enable/Disable	@V _{DDO} /2			4	cycles

Notes:

- Unless noted otherwise, all parameters are tested with xtal @ f <= Fxtal_max,; outputs are terminated @ 50Ω to V_{DDO}/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.

1.8V 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 _{DDO} , V _{DD} Voltage.....	-0.5V to +2.5V
Output Voltage (max 2.5V)	-0.5V to V _{DD} +0.5V
Input Voltage (max 2.5V)	-0.5V to V _{DD} +0.5V

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.

1.8V I/O DC Characteristics (Over Operating Range: V_{DDO} = 1.8V ± 0.2V, T_A = -40° to 85°C)

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ. ⁽²⁾	Max.	Units
V _{DDO}	I/O Supply Voltage		1.6	1.8	2.0	V
V _{IH}	Input HIGH Voltage	Logic HIGH level	0.65*V _{DD}		V _{DD} +0.3	
V _{IL}	Input LOW Voltage	Logic LOW level	-0.3		0.35*V _{DD}	
I _L	Input Current	V _{DD} = Max, V _{IN} = V _{DD} or GND I pin			15	μA
V _{OH}	Output High Voltage	V _{DD} = Min., V _{IN} = V _{IH} or V _{IL}	I _{OH} = -2mA	1.2		V
			I _{OH} = -8mA	1.2		
V _{OL}	Output Low Voltage	V _{DD} = Min., V _{IN} = V _{IH} or V _{IL}	I _{OL} = 2mA		0.35	
			I _{OL} = 8mA		0.35	

Notes:

- For Max. or Min. conditions, use appropriate operating V_{DD} and T_a values.
- Typical values are at V_{DD} = 1.8V, +25°C ambient and maximum loading.

1.8V I/O AC Characteristics (Over Operating Range: V_{DD} / V_{DDO} = 1.8V ± 0.2V, T_A = -40° to 85°C)

Parameters	Description	Test Conditions ⁽¹⁾	Min.	Typ	Max.	Units
f _{OUT}	Output Frequency	Using Crystal	10		50	MHz
		External Clock ⁽²⁾	0		100	
t _{DC}	Output Duty Cycle	@ V _{DDO} /2	47		55	%
RMS	Random RMS Phase Jitter	25MHz @ Integration Range 100Hz - 1MHz		0.096 @1.8V		ps
t _R /t _F	CLK _n Rise/Fall Time	20% to 80%	150		800	ps
t _{SK(O)} ⁽³⁾	Output to Output Skew between any two outputs of the same device @ same transition	@V _{DDO} /2			80	ps
t _{DIS} , t _{EN} ⁽⁴⁾	Output Enable/Disable	@V _{DDO} /2			4	cycles

Notes:

- Unless noted otherwise, all parameters are tested with xtal @ f ≤ F_{xtal_max}; outputs are terminated @ 50Ω to V_{DDO}/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.

AC Characteristics ($V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions ⁽¹⁾	Min.	Typ	Max.	Units
f_{MAX}	Output Frequency	Using External Crystal	10		50	MHz
		Using External Clock Source ⁽²⁾	DC		100	MHz
odc	Output Duty Cycle		48		52	%
$t_{SK(O)}$ ⁽³⁾	Output Skew ⁽²⁾ ⁽⁴⁾				80	ps
$t_{jit(\emptyset)}$	RMS Phase Jitter (Random)	25MHz @ Integration Range: 100Hz-1MHz		0.091		ps
t_R/t_F	Output Rise/Fall Time	20% to 80%	200		800	ps
t_{EN} ⁽⁴⁾	Output Enable Time ⁽³⁾	ENABLE1			4	cycles
		ENABLE2			4	cycles
t_{DIS}	Output Disable Time ⁽³⁾	ENABLE1			4	cycles
		ENABLE2			4	cycles

Notes:

1. Unless noted otherwise, all parameters are tested with xtal @ $f \leq F_{xtal_max}$; outputs are terminated @ 50Ω to $V_{DDO}/2$, 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 ($V_{DD} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ C$ to $85^\circ C$)

Symbols	Parameters	Test Conditions ⁽¹⁾	Min.	Typ	Max.	Units
f _{MAX}	Output Frequency	Using External Crystal	10		50	MHz
		Using External Clock Source ⁽²⁾	DC		100	MHz
odc	Output Duty Cycle		48		52	%
t _{SK(O)} ⁽³⁾	Output Skew ⁽²⁾ ⁽⁴⁾				80	ps
t _{jit(Ø)}	RMS Phase Jitter (Random)	25MHz @ Integration Range: 100Hz-1MHz		0.122		ps
t _R /t _F	Output Rise/Fall Time	20% to 80%	200		900	ps
t _{EN} ⁽⁴⁾	Output Enable Time ⁽³⁾	ENABLE1			4	cycles
		ENABLE2			4	cycles
t _{DIS}	Output Disable Time ⁽³⁾	ENABLE1			4	cycles
		ENABLE2			4	cycles

Notes:

1. Unless noted otherwise, all parameters are tested with xtal @ $f \leq F_{xtal_max}$; outputs are terminated @ 50Ω to $V_{DDO}/2$, 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 ($V_{DD} = 2.5V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ\text{C}$ to 85°C)

Symbols	Parameters	Test Conditions	Min.	Typ	Max.	Units
f_{MAX}	Output Frequency	Using External Crystal	10		50	MHz
		Using External Clock Source ⁽¹⁾	DC		100	MHz
odc	Output Duty Cycle		47		53	%
$t_{SK(O)}$	Output Skew ^{(2) (4)}				80	ps
$t_{jit(\emptyset)}$	RMS Phase Jitter (Random)	25MHz @ Integration Range: 100Hz-1MHz		0.131		ps
t_R/t_F	Output Rise/Fall Time	20% to 80%	200		900	ps
t_{EN}	Output Enable Time ⁽³⁾	ENABLE1			4	cycles
		ENABLE2			4	cycles
t_{DIS}	Output Disable Time ⁽³⁾	ENABLE1			4	cycles
		ENABLE2			4	cycles

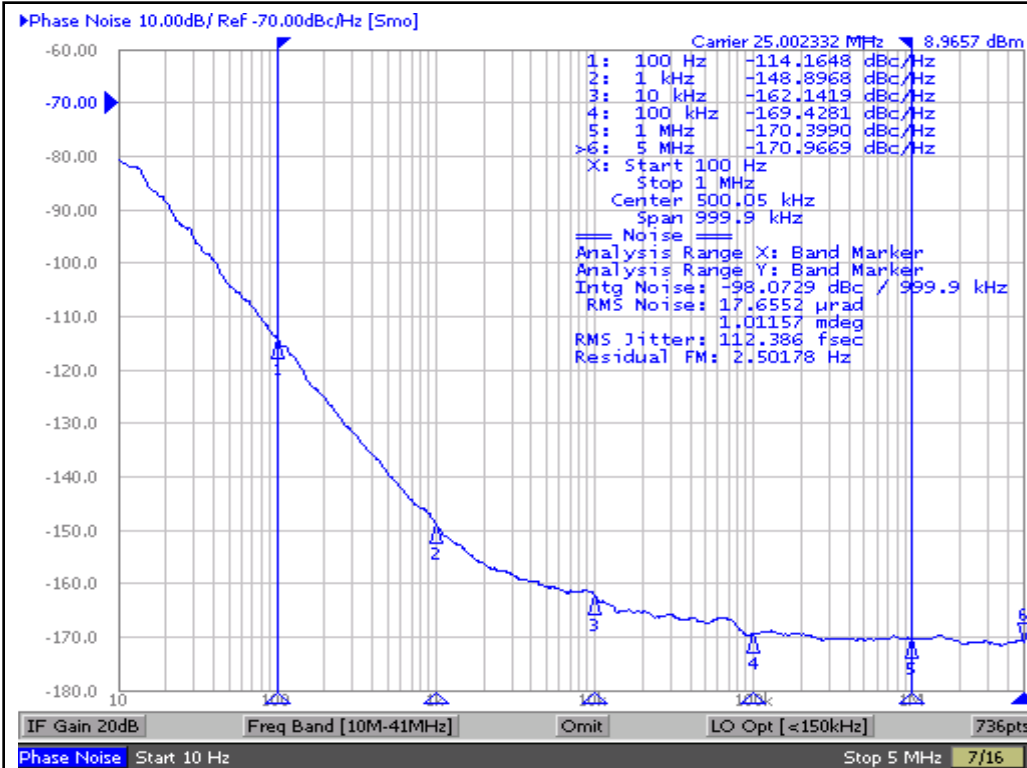
Notes:

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

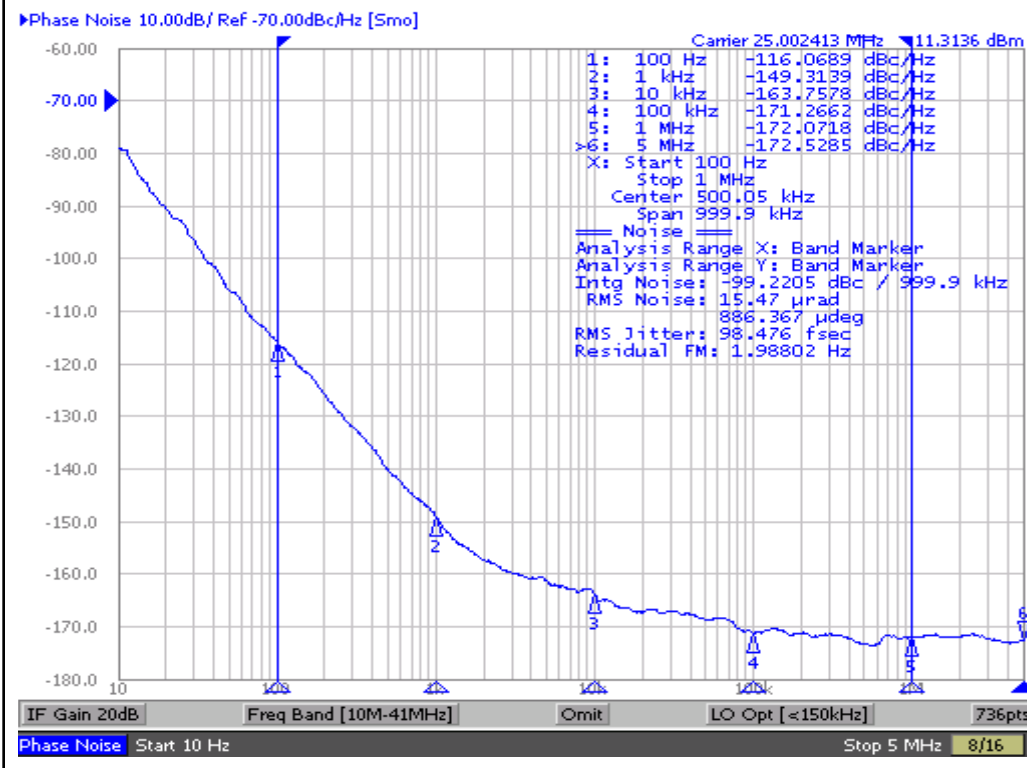
Outputs are terminated at 50Ω to $V_{DDO}/2$.

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 $V_{DDO}/2$.
3. These parameters are guaranteed, but not tested.
4. This parameter is defined in accordance with JEDEC Standard 65.

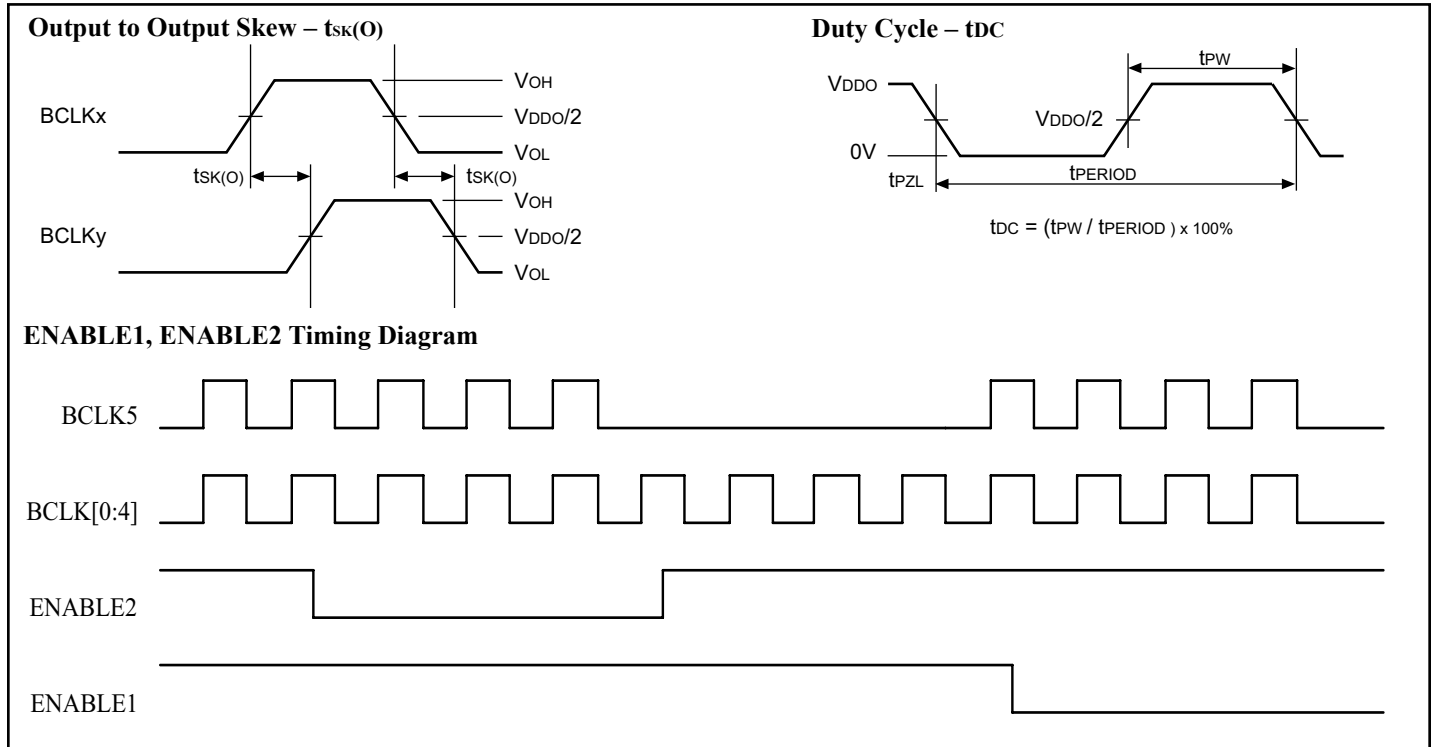
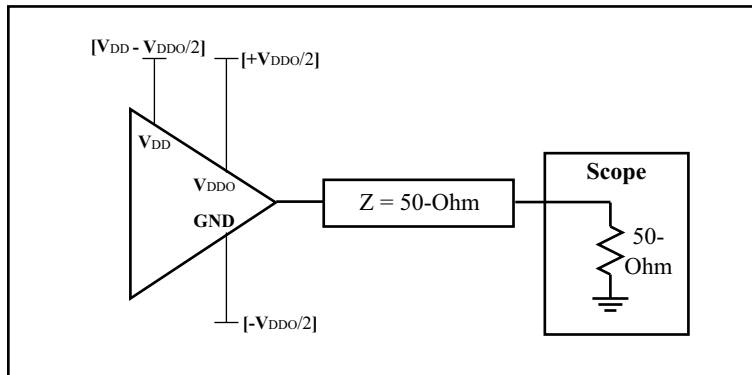
Jitter (typical phase noise at 25MHz)



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



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

Waveforms

AC Test Circuit Load

Note:
 $V_{DD}/V_{DDO} = 1.8V \pm 0.2V,$
 $2.5V \pm 5\%,$
 $3.3V \pm 5\%$
Crystal Characteristic (link to "<http://www.pericom.com/saronix>" for more detailed crystal specifications)

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

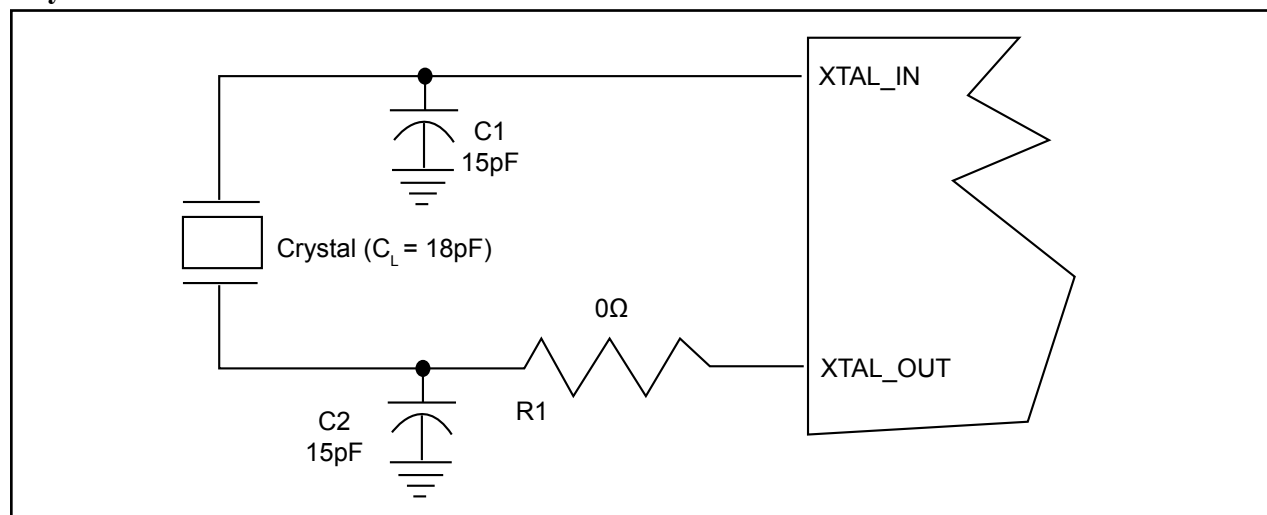
Note: 1. ESR value is dependent upon frequency of oscillation

Application Notes

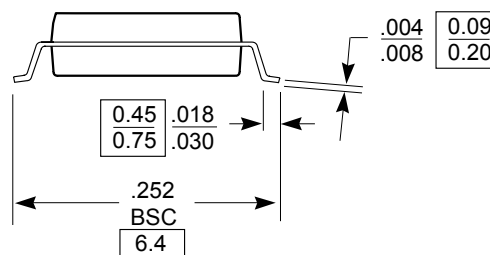
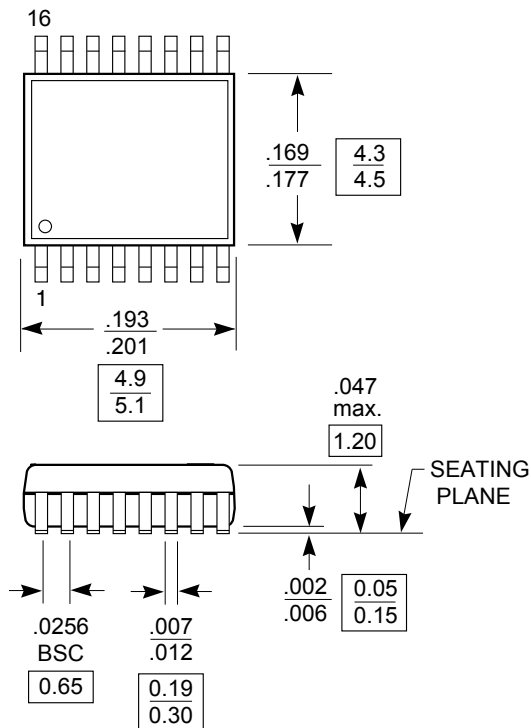
Crystal circuit connection

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



DOCUMENT CONTROL NO.
 PD - 1310

 REVISION: E
 DATE: 03/09/05

Note:

1. Package Outline Exclusive of Mold Flash and Metal Burr
2. Controlling dimensions in millimeters
3. Ref: JEDEC MO-153F/AB


 Pericom Semiconductor Corporation
 3545 N. 1st Street, San Jose, CA 95134
 1-800-435-2335 • www.pericom.com

DESCRIPTION: 16-Pin, 173-Mil Wide, TSSOP

PACKAGE CODE: L

Note:

- For latest package info, please check: <http://www.pericom.com/products/packaging/mechanicals.php>

PI6C10806B Ordering Information(1,2,3)

Ordering Code	Package Code	Package Description
PI6C10806BLE	L	Pb-Free and Green 16-pin 173-mil TSSOP

Notes:

1. Thermal characteristics can be found on the company web site at www.pericom.com/packaging/
2. E = Pb-free and Green
3. X suffix = Tape/Reel

Mouser Electronics

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- Специальные условия для постоянных клиентов.
- Подбор аналогов.
- Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.
- Приемлемые сроки поставки, возможна ускоренная поставка.
- Доставку товара в любую точку России и стран СНГ.
- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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