



## PI6C2408

### Zero-Delay Clock Buffer

#### Features

- Maximum rated frequency: 140 MHz
- Low cycle-to-cycle jitter
- Input to output delay, less than 150ps
- External feedback pin allows outputs to be synchronized to the clock input
- 5V tolerant input\*
- Operates at 3.3V  $V_{DD}$
- Test mode allows bypass of the PLL for system testing purposes (e.g., IBIS measurements)
- Clock frequency multipliers  $\frac{1}{2}x$  to  $4x$  dependent on option
- Packaging (Pb-free and Green available):
  - 16-pin, 150-mil SOIC (W)
  - 16-pin 173-mil TSSOP (L)

\*  $FB\_IN$  and  $CLKIN$  must reference the same voltage thresholds for the PLL to deliver zero delay skewing

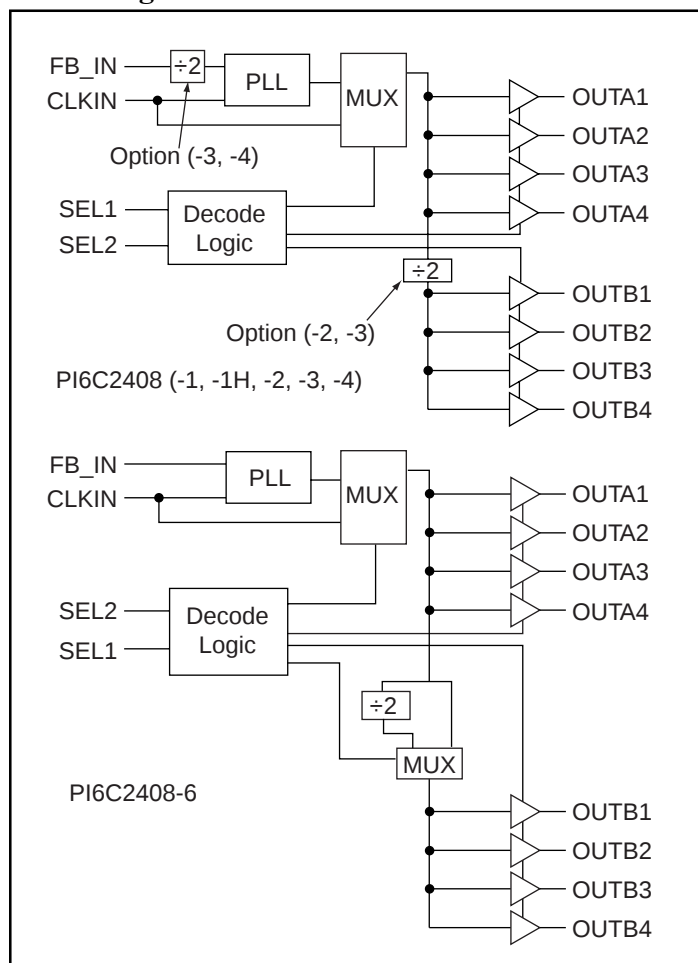
#### Description

The PI6C2408 is a PLL-based, zero-delay buffer, with the ability to distribute eight outputs of up to 140 MHz at 3.3 V. Two banks of four outputs exist, and, depending on product option ordered, can supply either reference frequency, prescaled half frequency, or multiplied 2x or 4x input clock frequencies. The PI6C2408 family has a power-sparing feature: when input SEL2 is 0, the component will 3-state one or both banks of outputs depending on the state of input SEL1. A PLL bypass test mode also exists. This product line is available in high-drive and industrial environment versions.

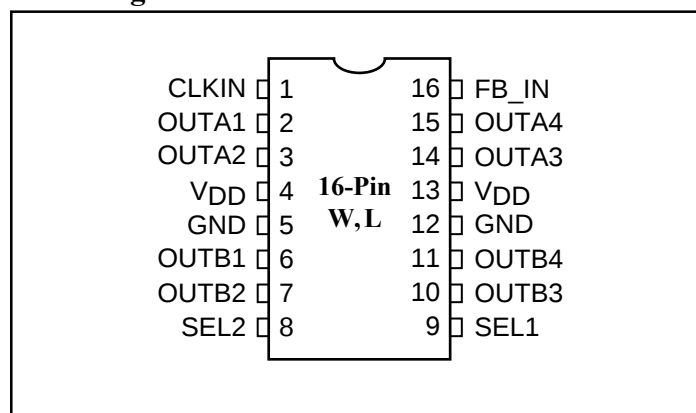
An external feedback pin is used to synchronize the outputs to the input; the relationship between loading of this signal and the other outputs determines the input-output delay.

The PI6C2408 is characterized for both commercial and industrial operation.

#### Block Diagram



#### Pin Configuration



**Input Select Decoding for PI6C2408 (-1, -1H, -4)**

| SEL2 | SEL1 | OUTA [1-4] | OUTB [1-4] | Output Source | PLL |
|------|------|------------|------------|---------------|-----|
| 0    | 0    | 3-State    | 3-State    | PLL           | OFF |
| 0    | 1    | PLL        | 3-State    | PLL           | ON  |
| 1    | 0    | CLKIN      | CLKIN      | CLKIN         | OFF |
| 1    | 1    | PLL        | PLL        | PLL           | ON  |

**Input Select Decoding for PI6C2408 (-2, -3)**

| SEL2 | SEL1 | OUTA [1-4] | OUTB [1-4] | Output Source | PLL |
|------|------|------------|------------|---------------|-----|
| 0    | 0    | 3-State    | 3-State    | PLL           | OFF |
| 0    | 1    | PLL        | 3-State    | PLL           | ON  |
| 1    | 0    | CLKIN      | CLKIN/2    | CLKIN         | OFF |
| 1    | 1    | PLL        | PLL        | PLL           | ON  |

**Input Select Decoding for PI6C2408-6**

| SEL2 | SEL1 | OUTA [1-4] | OUTB [1-4] | Output Source | PLL |
|------|------|------------|------------|---------------|-----|
| 0    | 0    | 3-State    | 3-State    | PLL           | OFF |
| 0    | 1    | CLKIN      | CLKIN/2    | CLKIN         | OFF |
| 1    | 0    | PLL        | PLL        | PLL           | ON  |
| 1    | 1    | PLL        | PLL/2      | PLL           | ON  |

**PI6C2408 Configurations**

| Device      | Feedback From | OUTA [1-4] Frequency | OUTB [1-4] Frequency                              |
|-------------|---------------|----------------------|---------------------------------------------------|
| PI6C2408-1  | OUTA or OUTB  | CLKIN                | CLKIN                                             |
| PI6C2408-1H | OUTA or OUTB  | CLKIN                | CLKIN                                             |
| PI6C2408-2  | OUTA          | CLKIN                | CLKIN/2                                           |
| PI6C2408-2  | OUTB          | 2X CLKIN             | CLKIN                                             |
| PI6C2408-3  | OUTA          | 2X CLKIN             | CLKIN or $\overline{\text{CLKIN}}$ <sup>(1)</sup> |
| PI6C2408-3  | OUTB          | 4X CLKIN             | 2X CLKIN                                          |
| PI6C2408-4  | OUTA or OUTB  | 2X CLKIN             | 2X CLKIN                                          |
| PI6C2408-6  | OUTA          | CLKIN                | CLKIN or CLKIN/2                                  |
| PI6C2408-6  | OUTB          | CLKIN or 2X CLKIN    | CLKIN                                             |

**Note:**

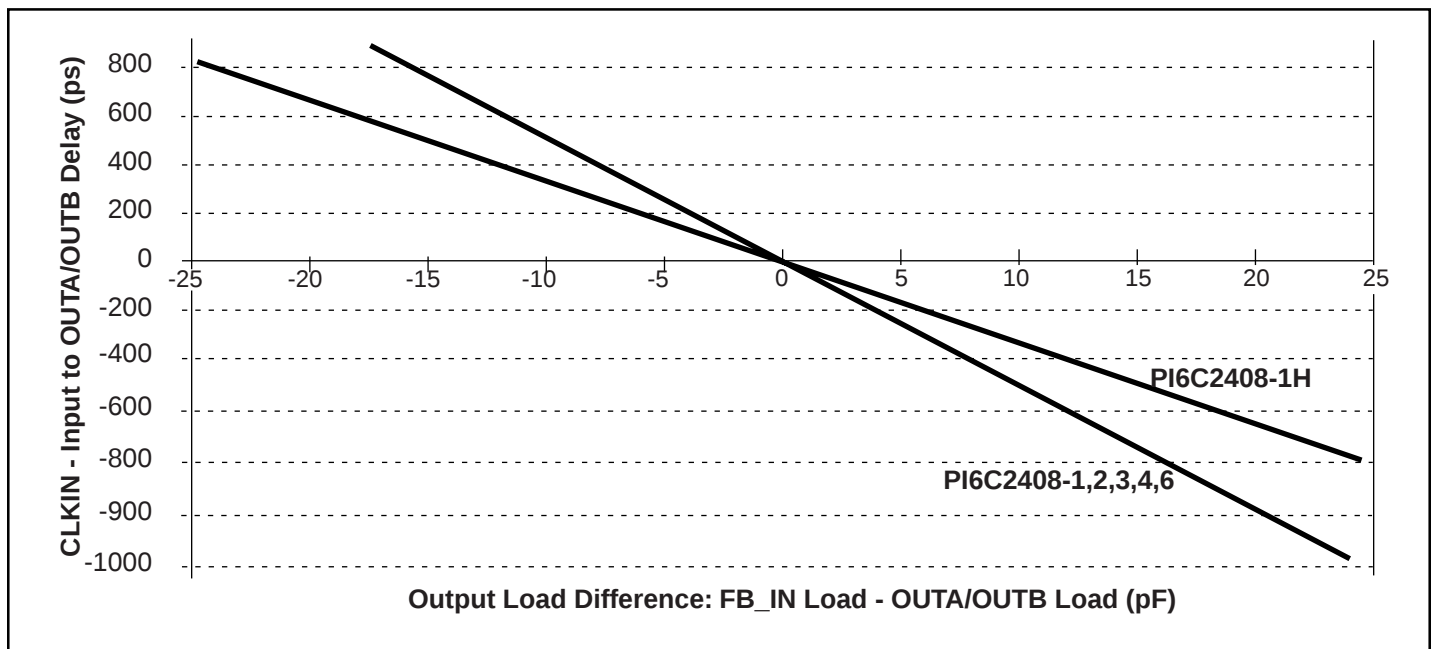
1. Output phase is indeterminant (0° or 180° from CLKIN)

## Pin Description

| Pin          | Signal          | Description                                      |
|--------------|-----------------|--------------------------------------------------|
| 1            | CLKIN           | Input clock reference frequency (weak pull-down) |
| 2, 3, 14, 15 | OUTA[1-4]       | Clock output, Bank A (weak pull-down)            |
| 4, 13        | V <sub>DD</sub> | 3.3V supply                                      |
| 5, 12        | GND             | Ground                                           |
| 6, 7, 10, 11 | OUTB[1-4]       | Clock output, Bank B (weak pull-down)            |
| 8            | SEL2            | Select input, bit 2 (weak pull-up)               |
| 9            | SEL1            | Select input, bit 1 (weak pull-up)               |
| 16           | FB_IN           | PLL feedback input                               |

## Zero Delay and Skew Control

**CLKIN Input to Output Bank Delay vs. Difference in Loading between FB\_IN pin and OUTA/OUTB pins**



The relationship between loading of the FB\_IN signal and other outputs determines the input-output delay. Zero delay is achieved when all outputs, including feedback, are loaded equally.

## Maximum Ratings

|                                                               |                                 |
|---------------------------------------------------------------|---------------------------------|
| Supply Voltage to Ground Potential .....                      | -0.5V to +7.0V                  |
| DC Input Voltage (Except CLKIN) .....                         | -0.5V to V <sub>DD</sub> + 0.5V |
| DC Input Voltage CLKIN .....                                  | -0.5 to 7V                      |
| Storage Temperature .....                                     | -65°C to +150°C                 |
| Maximum Soldering Temperature (10 seconds) .....              | 260°C                           |
| Junction Temperature .....                                    | 150°C                           |
| Static Discharge Voltage (per MIL-STD-883, Method 3015) ..... | >2000V                          |

**Operating Conditions** ( $V_{CC}=3.3V \pm 0.3V$ )

| Parameter | Description                              | Min. | Max. | Units |
|-----------|------------------------------------------|------|------|-------|
| $V_{DD}$  | Supply Voltage                           | 3.0  | 3.6  | V     |
| $T_A$     | Commerical Operating Temperature         | 0    | 70   | °C    |
|           | Industrial Operating Temperature         | -40  | 85   |       |
| $C_L$     | Load Capacitance, below 100 MHz          | —    | 30   | pF    |
|           | Load Capacitance, from 100 MHz to 140MHz | —    | 15   |       |
| $C_{IN}$  | Input Capacitance                        | —    | 7    |       |

**DC Electrical Characteristics for Industrial Temperature Devices**

| Parameter          | Description            | Test Conditions                                               | Min. | Max.       | Units   |
|--------------------|------------------------|---------------------------------------------------------------|------|------------|---------|
| $V_{IL}$           | Input LOW Voltage      |                                                               |      | 0.8        | V       |
| $V_{IH}$           | Input HIGH Voltage     |                                                               | 2.0  |            |         |
| $I_{IL}$           | Input LOW Current      | $V_{IN} = 0V$                                                 |      | 50.0       | $\mu A$ |
| $I_{IH}$           | Input HIGH Current     | $V_{IN} = V_{DD}$                                             |      | 100.0      |         |
| $V_{OL}$           | Output LOW Voltage     | $I_{OL} = 8mA (-1, -2, -3, -4, -6); I_{OL} = 12mA (-1H)$      |      | 0.4        | V       |
| $V_{OH}$           | Output HIGH Voltage    | $I_{OH} = -8mA (-1, -2, -3, -4, -6); I_{OH} = -12mA (-1H)$    | 2.4  |            |         |
| $I_{DD}$ (PD mode) | Pwr Dwn Supply Current | SEL1 = 0 (-1, -2, -3, -4, -1H); SEL2 = 0 (-6)                 |      | 25.0       | $\mu A$ |
| $I_{DD}$           | Supply Current         | Unloaded outputs 100 MHz,<br>Select inputs at $V_{DD}$ or GND |      | 54.0       | mA      |
|                    |                        |                                                               |      | 70.0 (-1H) |         |
|                    |                        | Unloaded outputs 66 MHz, CLKIN, except (-1H)                  |      | 39.0       |         |
|                    |                        | Unloaded outputs 33MHz, CLKIN, except (-1H)                   |      | 20.0       |         |

**AC Electrical Characteristics for Industrial Temperature Devices**

| Parameters         | Name                                                                   | Test Conditions                                                      | Min. | Typ. | Max. | Units |
|--------------------|------------------------------------------------------------------------|----------------------------------------------------------------------|------|------|------|-------|
| F <sub>O</sub>     | Output Frequency                                                       | 30pF load                                                            | 10.0 |      | 100  | MHz   |
|                    |                                                                        | 15pF load                                                            |      |      | 140  |       |
| t <sub>DC</sub>    | Duty Cycle <sup>(1)</sup><br>(-1, -2, -3, -4, -6)                      | Measured at V <sub>DD</sub> /2, F <sub>OUT</sub> <66.67MHz 30pF load | 40.0 | 50   | 60.0 | %     |
|                    |                                                                        | Measured at V <sub>DD</sub> /2, F <sub>OUT</sub> <140 MHz 15pF load  |      |      |      |       |
|                    |                                                                        | Measured at V <sub>DD</sub> /2, F <sub>OUT</sub> <45 MHz 30pF load   | 45.0 |      | 55.0 |       |
|                    | Duty Cycle <sup>(1)</sup> (-1H)                                        | Measured at V <sub>DD</sub> /2, F <sub>OUT</sub> <66.67MHz 30pF load | 45.0 |      | 60.0 |       |
|                    |                                                                        | Measured at V <sub>DD</sub> /2, F <sub>OUT</sub> <140 MHz 15pF load  | 40.0 |      | 55.0 |       |
|                    |                                                                        | Measured at V <sub>DD</sub> /2, F <sub>OUT</sub> <45MHz 30pF load    | 45.0 |      |      |       |
| t <sub>R</sub>     | Rise Time <sup>(1)</sup> (-1, -2, -3, -4,)                             | Measured between 0.8V and 2.0V, 30pF load                            |      |      | 2.2  | ns    |
|                    |                                                                        | Measured between 0.8V and 2.0V, 15pF load                            |      |      | 1.50 |       |
|                    | Rise Time <sup>(1)</sup> (-1H)                                         | Measured between 0.8V and 2.0V, 30pF load                            |      |      | 1.50 |       |
| t <sub>F</sub>     | Fall Time <sup>(1)</sup> (-1, -2, -3, -4,)                             | Measured between 0.8V and 2.0V, 30pF load                            |      |      | 2.50 |       |
|                    |                                                                        | Measured between 0.8V and 2.0V, 15pF load                            |      |      | 1.50 |       |
|                    | Fall Time <sup>(1)</sup> (-1H)                                         | Measured between 0.8V and 2.0V, 30pF load                            |      |      | 1.25 |       |
| t <sub>SK(O)</sub> | Output to Output Skew within same Bank (-1,-2,-3,-4,-6) <sup>(1)</sup> | All outputs equally loaded                                           |      |      | 200  | ps    |
|                    | OUTA to OUTB Skew <sup>(1)</sup><br>(-1,-1H,-4)                        |                                                                      |      |      |      |       |
|                    | OUTA to OUTB Skew <sup>(1)</sup><br>(-2,-3,-6)                         |                                                                      |      |      | 400  |       |
| t <sub>0</sub>     | Delay, CLKIN Rising Edge to FB_IN Rising Edge <sup>(1)</sup>           | Measured at V <sub>DD</sub> /2                                       |      | 0    | ±150 |       |
| t <sub>SK(D)</sub> | Device-to-Device Skew <sup>(1)</sup>                                   | Measured at V <sub>DD</sub> /2 on FB_IN pins of devices              |      | 0    | 500  |       |
| t <sub>SLEW</sub>  | Output Slew Rate <sup>(1)</sup>                                        | Measured between 0.8V & 2.0V on -1H device using Test Crt #2         | 1    |      |      | V/ns  |
| t <sub>JIT</sub>   | Cycle-to-Cycle Jitter <sup>(1)</sup><br>(-1,-1H,-4)                    | Measured at 66.67 MHz, loaded 30pF load                              |      |      | 200  | ps    |
|                    |                                                                        | Measured at 140 MHz, loaded 15pF load                                |      |      | 100  |       |
|                    | Cycle-to-Cycle Jitter <sup>(1)</sup><br>(-2,-3,-6)                     | Measured at 66.67 MHz, loaded 30pF load                              |      |      | 400  |       |
| t <sub>LOCK</sub>  | PLL Lock Time <sup>(1)</sup>                                           | Stable power supply, valid clocks presented on CLKIN and FB_IN pins  |      |      | 1.0  | ms    |

**Notes:**

1. See Switching Waveforms on page 7.

**DC Electrical Characteristics for Commercial Temperature Devices**

| Parameter                 | Description               | Test Conditions                                                            | Min. | Max. | Units |
|---------------------------|---------------------------|----------------------------------------------------------------------------|------|------|-------|
| V <sub>IL</sub>           | Input LOW Voltage         | —                                                                          | —    | 0.8  | V     |
| V <sub>IH</sub>           | Input HIGH Voltage        | —                                                                          | 2.0  | —    |       |
| I <sub>IL</sub>           | Input LOW Current         | V <sub>IN</sub> = 0V                                                       | —    | 50   | μA    |
| I <sub>IH</sub>           | Input HIGH Current        | V <sub>IN</sub> = V <sub>DD</sub>                                          | —    | 100  |       |
| V <sub>OL</sub>           | Output LOW Voltage        | I <sub>OL</sub> = 8mA (–1, –2, –3, –4, –6); I <sub>OL</sub> = 12mA (–1H)   | —    | 0.4  | V     |
| V <sub>OH</sub>           | Output HIGH Voltage       | I <sub>OH</sub> = –8mA (–1, –2, –3, –4, –6); I <sub>OH</sub> = –12mA (–1H) | 2.4  | —    |       |
| I <sub>DD</sub> (PD mode) | Power Down Supply Current | SEL1 = 0 (–1, –2, –3, –4, –1H); SEL2 = 0 (–6)                              | —    | 12   | μA    |
| I <sub>DD</sub>           | Supply Current            | Unloaded outputs, 66.67 MHz, Select inputs at V <sub>DD</sub> or GND       | —    | 39   | mA    |
| I <sub>DD</sub>           | Supply Current            | Unloaded outputs 100 MHz Select Inputs @ V <sub>DD</sub> or GND            | —    | 54   |       |

**AC Electrical Characteristics for Commercial Temperature Device**

| Parameters         | Name                                                                            | Test Conditions                                                     | Min. | Typ. | Max. | Units |
|--------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------|------|------|------|-------|
| F <sub>O</sub>     | Output Frequency                                                                | 30pF load                                                           | 10   |      | 100  | MHz   |
|                    |                                                                                 | 15pF load                                                           |      |      | 140  |       |
| t <sub>DC</sub>    | Duty Cycle <sup>(1)</sup> (–1H)                                                 | Measured at V <sub>DD</sub> /2, for high drive output               | 45   | 50   | 55   | %     |
|                    | Duty Cycle (–1, –2, –3, –4, –6)                                                 | Measured at V <sub>DD</sub> /2, for normal drive output             | 40   | 50   | 60   |       |
| t <sub>R</sub>     | Rise Time <sup>(1)</sup> @30pF                                                  | Measured between 0.8V and 2.0V                                      |      |      | 2.2  | ns    |
|                    | Rise Time <sup>(1)</sup> @15pF                                                  |                                                                     |      |      | 1.5  |       |
|                    | Rise Time <sup>(1)</sup> @30pF (–1H)                                            |                                                                     |      |      | 1.5  |       |
| t <sub>F</sub>     | Fall Time <sup>(1)</sup> @30pF                                                  |                                                                     |      |      | 2.2  |       |
|                    | Fall Time <sup>(1)</sup> @15pF                                                  |                                                                     |      |      | 1.5  |       |
|                    | Fall Time <sup>(1)</sup> @30pF (–1H)                                            |                                                                     |      |      | 1.25 |       |
| t <sub>SK(O)</sub> | Output to Output Skew <sup>(1)</sup> within same bank (–1, –1H, –2, –3, –4, –6) | All outputs equally loaded, V <sub>DD</sub> /2                      |      |      | 200  | ps    |
|                    | OUTA to OUTB Skew <sup>(1)</sup> (–1, –1H, –4)                                  | All outputs equally loaded, V <sub>DD</sub> /2                      |      |      | 200  |       |
|                    | OUTA to OUTB Skew <sup>(1)</sup> (–2, –3, –6)                                   | All outputs equally loaded, V <sub>DD</sub> /2                      |      |      | 400  |       |
| t <sub>0</sub>     | Input to Output Delay, CLKIN Rising Edge to FB_IN Rising Edge <sup>(1)</sup>    | Measured at V <sub>DD</sub> /2                                      |      | 0    | ±150 |       |
| t <sub>SK(D)</sub> | Device to Device Skew <sup>(1)</sup>                                            | Measured at V <sub>DD</sub> /2 on FB_IN pins of devices             |      | 0    | 500  |       |
| t <sub>SLEW</sub>  | Output Slew Rate <sup>(1)</sup>                                                 | Measured between 0.8V and 2.0V on –1H device using Test Circuit #2  | 1    |      |      | V/ns  |
| t <sub>JIT</sub>   | Cycle-to-Cycle Jitter <sup>(1)</sup> (–1, –1H, –4)                              | Measured at 66.67 MHz, loaded 30pF outputs                          |      |      | 200  | ps    |
|                    |                                                                                 | Measured at 140 MHz, loaded 15pF outputs                            |      |      | 100  |       |
|                    | Cycle-to-Cycle Jitter <sup>(1)</sup> (–2, –3, –6)                               | Measured at 66.7 MHz, loaded 30pF outputs                           |      |      | 400  |       |
| t <sub>LOCK</sub>  | PLL Lock Time <sup>(1)</sup>                                                    | Stable power supply, valid clocks presented on CLKIN and FB_IN pins |      |      | 1.0  | ms    |

**Notes:**

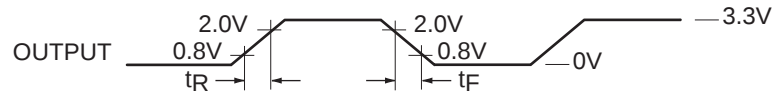
1. See Switching Waveforms on page 7.

## Switching Waveforms

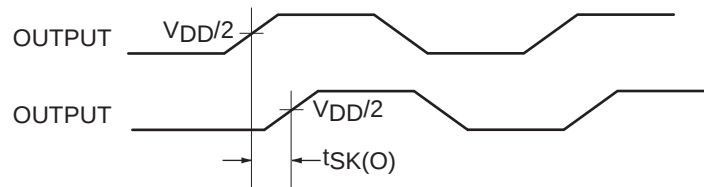
Duty Cycle Timing



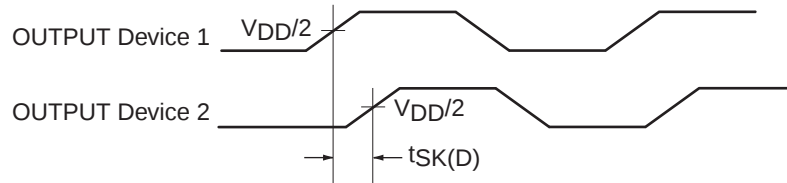
All Outputs Rise/Fall Time



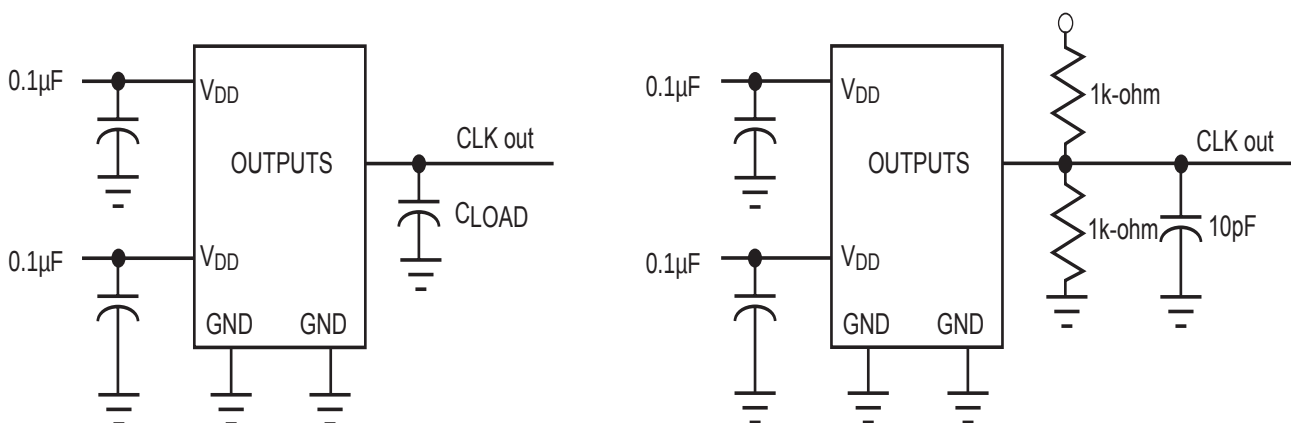
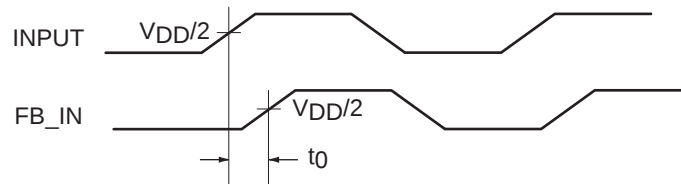
Output-Output Skew



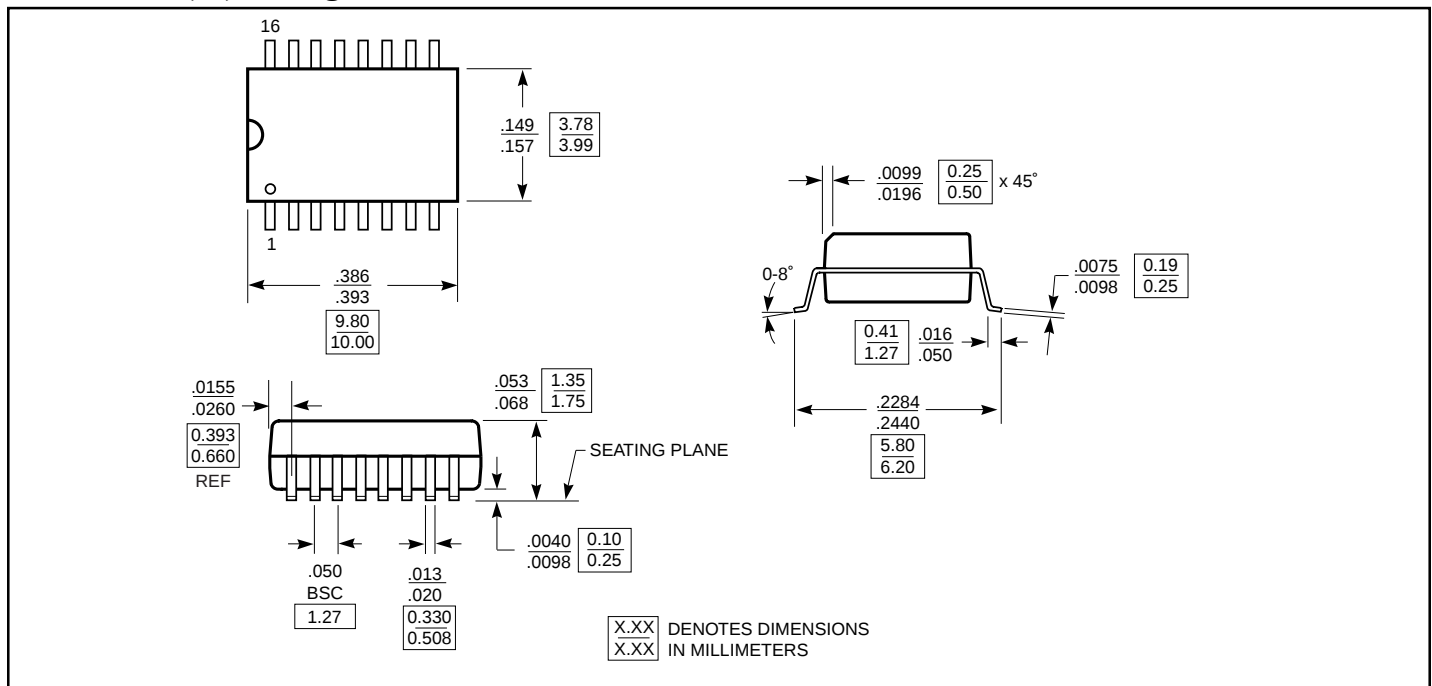
Device-Device Skew



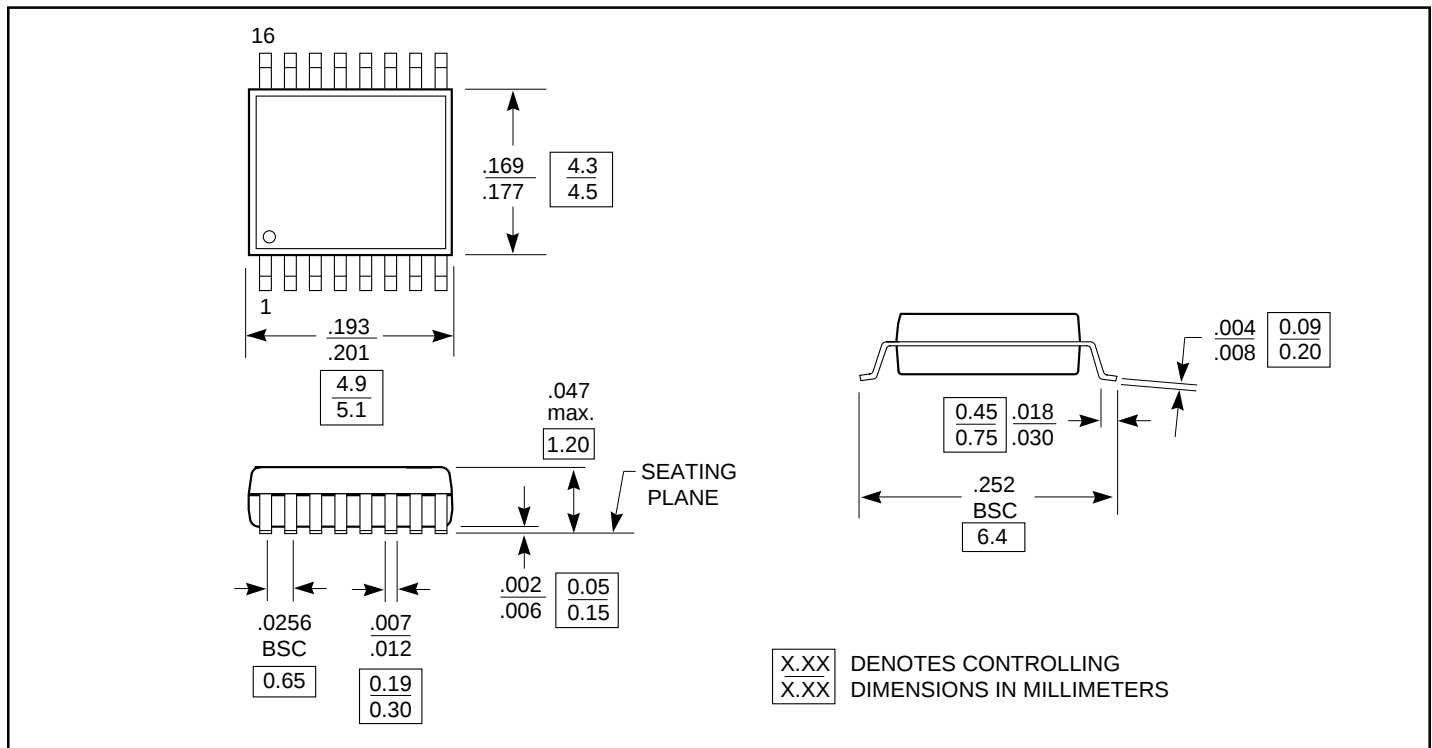
Input-Output Propagation Delay



### 16-Pin SOIC (W) Package



### 16-Pin TSSOP (L) Package



**Note:** Controlling dimensions in millimeters. Ref: JEDEC MS-012 AC

**Ordering Information (Commercial Temperature Device)**

| Ordering Code | Package | Description                           | Operating Range |
|---------------|---------|---------------------------------------|-----------------|
| PI6C2408-1W   | W       | 16-pin 150-mil SOIC                   | Commercial      |
| PI6C2408-1WE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Commercial      |
| PI6C2408-1HW  | W       | 16-pin 150-mil SOIC                   | Commercial      |
| PI6C2408-1HWE | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Commercial      |
| PI6C2408-2W   | W       | 16-pin 150-mil SOIC                   | Commercial      |
| PI6C2408-2WE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Commercial      |
| PI6C2408-3W   | W       | 16-pin 150-mil SOIC                   | Commercial      |
| PI6C2408-3WE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Commercial      |
| PI6C2408-4W   | W       | 16-pin 150-mil SOIC                   | Commercial      |
| PI6C2408-4WE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Commercial      |
| PI6C2408-6W   | W       | 16-pin 150-mil SOIC                   | Commercial      |
| PI6C2408-6WE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Commercial      |
| PI6C2408-1WE  | W       | Pb-free & Green 16-pin 150-mil SOIC   | Commercial      |
| PI6C2408-1HWE | W       | Pb-free & Green 16-pin 150-mil SOIC   | Commercial      |
| PI6C2408-1L   | L       | 16-pin 173-mil TSSOP                  | Commercial      |
| PI6C2408-1LE  | L       | Pb-free & Green, 16-pin 173-mil TSSOP | Commercial      |
| PI6C2408-1HL  | L       | 16-pin 173-mil TSSOP                  | Commercial      |
| PI6C2408-1HLE | L       | Pb-free & Green, 16-pin 173-mil TSSOP | Commercial      |
| PI6C2408-3L   | L       | 16-pin 173-mil TSSOP                  | Commercial      |
| PI6C2408-3LE  | L       | Pb-free & Green, 16-pin 173-mil TSSOP | Commercial      |
| PI6C2408-4L   | L       | 16-pin 173-mil TSSOP                  | Commercial      |
| PI6C2408-4LE  | L       | Pb-free & Green, 16-pin 173-mil TSSOP | Commercial      |
| PI6C2408-1LE  | L       | Pb-free & Green 16-pin 173-mil TSSOP  | Commercial      |
| PI6C2408-1HLE | L       | Pb-free & Green 16-pin 173-mil TSSOP  | Commercial      |

**Ordering Information (Industrial Temperature Device)**

| Ordering Code  | Package | Description                           | Operating Range |
|----------------|---------|---------------------------------------|-----------------|
| PI6C2408-1WI   | W       | 16-pin 150-mil SOIC                   | Industrial      |
| PI6C2408-1WIE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Industrial      |
| PI6C2408-1HWI  | W       | 16-pin 150-mil SOIC                   | Industrial      |
| PI6C2408-1HWIE | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Industrial      |
| PI6C2408-2WI   | W       | 16-pin 150-mil SOIC                   | Industrial      |
| PI6C2408-2WIE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Industrial      |
| PI6C2408-4WI   | W       | 16-pin 150-mil SOIC                   | Industrial      |
| PI6C2408-4WIE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Industrial      |
| PI6C2408-6WI   | W       | 16-pin 150-mil SOIC                   | Industrial      |
| PI6C2408-6WIE  | W       | Pb-free & Green, 16-pin 150-mil SOIC  | Industrial      |
| PI6C2408-1LI   | L       | 16-pin 173-mil TSSOP                  | Industrial      |
| PI6C2408-1LIE  | L       | Pb-free & Green, 16-pin 173-mil TSSOP | Industrial      |
| PI6C2408-6LI   | L       | 16-pin 173-mil TSSOP                  | Industrial      |
| PI6C2408-6LIE  | L       | Pb-free & Green, 16-pin 173-mil TSSOP | Industrial      |

**Notes:**

1. Thermal characteristics can be found on the company web site at [www.pericom.com/packaging/](http://www.pericom.com/packaging/)