## Features

- Near-Zero propagation delay
- 5-ohm switches connect inputs to outputs
- High signal passing bandwidth ( 500 MHz )
- Beyond Rail-to-Rail switching
- 5 V I/O tolerant with 3.3 V supply
- 2.5 V and 3.3 V supply voltage operation
- Hot insertion capable
- Capable of Hot-Swapping
- Industrial operating temperature: $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$
- 2 kV ESD Protection (human body model)
- Latch-up performance: $>250 \mathrm{~mA}$ per JESD17
- Packaging ( Pb -free \& Green available):
- 16-pin 150-mil wide plastic QSOP (Q)
- 16-pin 173-mil wide plastic TSSOP (L)


## Block Diagram



## Truth Table ${ }^{(1)}$

| $\overline{\mathbf{E N}}$ | $\mathbf{S}$ | $\mathbf{Y}_{\mathbf{A}}$ | $\mathbf{Y}_{\mathbf{B}}$ | $\mathbf{Y}_{\mathbf{C}}$ | $\mathbf{Y}_{\mathbf{D}}$ | Function |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| H | X | $\mathrm{Hi}-\mathrm{Z}$ | $\mathrm{Hi}-\mathrm{Z}$ | $\mathrm{Hi}-\mathrm{Z}$ | $\mathrm{Hi}-\mathrm{Z}$ | Disable |
| L | L | $\mathrm{I}_{4}$ | ${ }_{\mathrm{I}} \mathrm{B}_{0}$ | ${ }_{\mathrm{I}} \mathrm{C}_{0}$ | ${ }_{\mathrm{I}} \mathrm{D}_{0}$ | $\mathrm{~S}=0$ |
| L | H | ${ }_{\mathrm{I}} \mathrm{A}_{1}$ | ${ }_{\mathrm{I}} \mathrm{B}_{1}$ | ${ }_{\mathrm{I}} \mathrm{C}_{1}$ | ${ }_{\mathrm{I}} \mathrm{D}_{1}$ | $\mathrm{~S}=1$ |

Notes:

1. $\mathrm{H}=$ High Voltage Level

L = Low Voltage Level

## Description

The PI3CH480 is a 4-channel, 2:1 Multiplexer/Demultiplexer with 3 -state outputs. The switch introduces no additional ground bounce noise or propagation delay.
The PI3CH480 device is very useful in switching signals that have high bandwidth ( 500 MHz ).

## Pin Configuration



Pin Description

| Pin Name | Description |
| :---: | :--- |
| ${ }_{\mathrm{I}} \mathrm{A}_{\mathrm{N}}$ to ${ }_{\mathrm{I}} \mathrm{D}_{\mathrm{N}}$ | Data Inputs |
| S | Select Inputs |
| $\overline{\mathrm{EN}}$ | Enable |
| $\mathrm{Y}_{\mathrm{A}}$ to $\mathrm{Y}_{\mathrm{D}}$ | Data Outputs |
| GND | Ground |
| $\mathrm{V}_{\mathrm{CC}}$ | Power |

## Maximum Ratings

(Above which the useful life may be impaired. For user guidelines, not tested.)
Storage Temperature ............................................. $-65^{\circ} \mathrm{C}$ to $+150^{\circ} \mathrm{C}$
Ambient Temperature with Power Applied ............... $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$
Supply Voltage to Ground Potential ............................ -0.5 V to +4.6 V
DC Input Voltage ........................................................ -0.5 V to +6.0 V
DC Output Current................................................................... 120 mA
Power Dissipation ........................................................................................

## 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.

DC Electrical Characteristics, 3.3V Supply (Over Operating Range, $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V} \pm 10 \%$ )

| Parameters | Description | Test Conditions ${ }^{(1)}$ | Min. | Typ. ${ }^{(2)}$ | Max. | Units |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{IH}}$ | Input HIGH Voltage | Guaranteed Logic HIGH Level | 2.0 |  |  | V |
| $\mathrm{V}_{\text {IL }}$ | Input LOW Voltage | Guaranteed Logic LOW Level | -0.5 |  | 0.8 |  |
| $\mathrm{V}_{\text {IK }}$ | Clamp Diode Voltage | $\mathrm{V}_{\mathrm{CC}}=$ Min., $\mathrm{I}_{\mathrm{IN}}=-18 \mathrm{~mA}$ |  | -1.3 | -1.8 |  |
| $\mathrm{I}_{\text {IH }}$ | Input HIGH Current | $\mathrm{V}_{\mathrm{CC}}=$ Max., $\mathrm{V}_{\text {IN }}=\mathrm{V}_{\mathrm{CC}}$ |  |  | $\pm 1$ | $\mu \mathrm{A}$ |
| IIL | Input LOW Current | $\mathrm{V}_{\mathrm{CC}}=$ Max., $\mathrm{V}_{\text {IN }}=$ GND |  |  | $\pm 1$ |  |
| IOZH | High Impedance Output Current | $0 \leq \mathrm{Y}, \mathrm{IN} \leq \mathrm{V}_{\mathrm{CC}}$ |  |  | $\pm 1$ |  |
| $\mathrm{R}_{\text {ON }}$ | Switch On-Resistance ${ }^{(3)}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=\mathrm{Min} ., \mathrm{V}_{\mathrm{IN}}=0 \mathrm{~V}, \\ & \mathrm{I}_{\mathrm{ON}}=48 \mathrm{~mA} \text { or }-64 \mathrm{~mA} \end{aligned}$ |  | 4 | 6 | $\Omega$ |
|  |  | $\mathrm{V}_{\mathrm{CC}}=$ Min., $\mathrm{V}_{\mathrm{IN}}=3.6 \mathrm{~V}, \mathrm{I}_{\mathrm{ON}}=-15 \mathrm{~mA}$ |  | 5 | 8 |  |

## Notes:

1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at $\mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ ambient and maximum loading.
3. Measured by the voltage drop between $Y$ and In pin at indicated current through the switch. On-Resistance is determined by the lower of the voltages on the two ( $\mathrm{Y}, \mathrm{In}$ ) pins.

DC Electrical Characteristics, 2.5V Supply (Over Operating Range, $\mathrm{T}_{\mathrm{A}}=-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}, \mathrm{V}_{\mathrm{CC}}=2.5 \mathrm{~V} \pm 10 \%$ )

| Parameters | Description | Test Conditions ${ }^{(1)}$ | Min. | Typ. ${ }^{(2)}$ | Max. | Units |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{V}_{\mathrm{IH}}$ | Input HIGH Voltage | Guaranteed Logic HIGH Level | 1.8 |  | $\mathrm{V}_{\mathrm{CC}}+0.3$ | V |
| $\mathrm{V}_{\text {IL }}$ | Inout LOW Voltage | Guaranteed Logic LOW Level | -0.3 |  | 0.8 |  |
| $\mathrm{V}_{\text {IK }}$ | Clamp Diode Voltage | $\mathrm{V}_{\mathrm{CC}}=$ Max., $\mathrm{I}_{\text {IN }}=-6 \mathrm{~mA}$ |  | -0.7 | -1.8 |  |
| $\mathrm{I}_{\mathrm{IH}}$ | Input HIGH Current | $\mathrm{V}_{\mathrm{CC}}=$ Max., $\mathrm{V}_{\text {IN }}=\mathrm{V}_{\mathrm{CC}}$ |  |  | $\pm 1$ | $\mu \mathrm{A}$ |
| $\mathrm{I}_{\text {IL }}$ | Input LOW Current | $\mathrm{V}_{\mathrm{CC}}=$ Max., $\mathrm{V}_{\text {IN }}=\mathrm{GND}$ |  |  | $\pm 1$ |  |
| IOZH | High Impedance Current | $0 \leq \mathrm{Y}, \mathrm{In} \leq \mathrm{V}_{\mathrm{CC}}$ |  |  | $\pm 1$ |  |
| $\mathrm{R}_{\mathrm{ON}}$ | Switch On-Resistance ${ }^{(3)}$ | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=\text { Min., } \mathrm{V}_{\mathrm{IN}}=0 \mathrm{~V}, \\ & \mathrm{I}_{\mathrm{ON}}=-48 \mathrm{~mA} \end{aligned}$ |  | 4 | 8 | $\Omega$ |
|  |  | $\begin{aligned} & \mathrm{V}_{\mathrm{CC}}=\mathrm{Min} ., \mathrm{V}_{\mathrm{IN}}=2.25 \mathrm{~V}, \\ & \mathrm{I}_{\mathrm{ON}}=-15 \mathrm{~mA} \end{aligned}$ |  | 7 | 14 |  |

## Notes:

1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at $\mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V}, \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}$ ambient and maximum loading.
3. Measured by the voltage drop between $Y$ and In pin at indicated current through the switch. On-Resistance is determined by the lower of the voltages on the two (Y, In) pins.

Capacitance $\left(\mathrm{T}_{\mathrm{A}}=25^{\circ} \mathrm{C}, \mathrm{f}=1 \mathrm{MHz}\right.$ )

| Parameters ${ }^{(1)}$ | Description | Test Conditions | Typ. | Max. | Units |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{C}_{\text {IN }}$ | Input Capacitance | $\mathrm{V}_{\mathrm{IN}}=0 \mathrm{~V}$ | 1.6 | 2.5 | pF |
| CoFF(IN) | In Capacitance, Switch Off |  | 2.2 | 3.5 |  |
| $\mathrm{C}_{\mathrm{OFF}(\mathrm{Y})}$ | Y Capacitance, Switch Off |  | 4.9 | 6.5 |  |
| CON | Y/In Capacitance, Switch On |  | 8.4 | 10 |  |

Notes:

1. This parameter is determined by device characterization but is not production tested.

## Power Supply Characteristics

| Parameters | Description | Test Conditions ${ }^{(\mathbf{1 )}}$ | Min. | Typ. ${ }^{(\mathbf{2})}$ | Max. | Units |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{I}_{\mathrm{CC}}$ | Quiescent Power Supply Current | $\mathrm{V}_{\mathrm{CC}}=3.6 \mathrm{~V}, \mathrm{~V}_{\mathrm{IN}}=$ GND or $\mathrm{V}_{\mathrm{CC}}$ |  |  | 0.8 | mA |

## Notes:

1. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device.
2. Typical values are at $\mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V},+25^{\circ} \mathrm{C}$ ambient.

Dynamic Electrical Characteristics Over the Operating Range ( $\mathrm{T}_{\mathrm{A}}=-40^{\circ}$ to $+85^{\circ}, \mathrm{V}_{\mathrm{CC}}=3.3 \mathrm{~V} \pm 10 \%$ )

| Parameter | Description | Test Condition | Min. | Typ. | Max. | Units |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{X}_{\text {TALK }}$ | Crosstalk | 10 MHz |  | -60 |  | dB |
| $\mathrm{O}_{\text {IRR }}$ | Off-Isolation | 10 MHz |  | -60 |  |  |
| BW | -3 dB Bandwidth | See Test Diagram | 200 | 500 |  | MHz |

## Switching Characteristics over 3.3V Operating Range

| Parameters | Description | Conditions ${ }^{(1)}$ | Com. |  |  | Units |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Min. | Typ. | Max. |  |
| $\mathrm{t}_{\mathrm{PLH}}$ $\mathrm{t}_{\mathrm{PHL}}$ | Propogation Delay ${ }^{(2,3)} \mathrm{Y}$ to In, In to Y | See Test Diagram |  |  | 0.3 | ns |
| tpZH <br> tpZL | Enable Time S or $\overline{\mathrm{EN}}$ to Y or In | See Test Diagram | 1.5 |  | 9.0 |  |
| tPHZ <br> tPLZ | Disable Time S or $\overline{\mathrm{EN}}$ to Y or In |  | 1.5 |  | 9.0 |  |

## Notes:

1. See test circuit and waveforms.
2. This parameter is guaranteed but not tested on Propagation Delays.
3. The switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.30 ns for 10 pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, it adds very little propagational delay to the system. Propagational delay of the switch when used in a system is determined by the driving circuit on the driving side of the switch and its interaction with the load on the driven side.

## Switching Characteristics over 2.5V Operating Range

| Parameters | Description | Conditions ${ }^{(1)}$ | Com. |  | Units |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Min. | Max. |  |
| $\mathrm{t}_{\mathrm{tLH}}$ $\mathrm{t}_{\mathrm{tPHL}}$ | Propogation Delay ${ }^{(2,3)} \mathrm{Y}$ to In, In to Y | See Test Diagram |  | 0.3 | ns |
| $\begin{aligned} & \mathrm{t}_{\mathrm{PZH}} \\ & \mathrm{t}_{\mathrm{PZL}} \end{aligned}$ | Enable Time S or $\overline{\mathrm{EN}}$ to Y or In | See Test Diagram | 1.5 | 15.0 |  |
| $\begin{aligned} & \mathrm{t}_{\mathrm{PHZ}} \\ & \mathrm{t}_{\mathrm{PLZ}} \end{aligned}$ | Disable Time S or $\overline{\mathrm{EN}}$ to Y or In |  | 1.5 | 12.0 |  |

## Notes:

1. See test circuit and waveforms.
2. This parameter is guaranteed but not tested on Propagation Delays.
3. The switch contributes no propagational delay other than the RC delay of the On-Resistance of the switch and the load capacitance. The time constant for the switch alone is of the order of 0.30 ns for 10 pF load. Since this time constant is much smaller than the rise/fall times of typical driving signals, it adds very little propagational delay to the system. Propagational delay of the switch when used in a system is determined by the driving circuit on the driving side of the switch and its interaction with the load on the driven side.

## Test Circuit for Electrical Characteristics ${ }^{(1)}$



Notes:

- $\mathrm{C}_{\mathrm{L}}=$ Load capacitance: includes jig and probe capacitance.
- $\mathrm{R}_{\mathrm{T}}=$ Termination resistance: should be equal to ZOUT of the Pulse Generator
- All input impulses are supplied by generators having the following characteristics: $\mathrm{PRR} \leq 10 \mathrm{MHz}, \mathrm{Z}_{\mathrm{O}}=50-\mathrm{ohm}, \mathrm{t}_{\mathrm{R}} \leq 2.5 \mathrm{~ns}, \mathrm{t}_{\mathrm{F}} \leq 2.5 \mathrm{~ns}$.
- The outputs are measured one at a time with one transition per measurement.


## Switch Positions

| Test | Switch |
| :---: | :---: |
| $\mathrm{t}_{\text {PLZ }}, \mathrm{t}_{\text {PZL }}$ | 6.0 V |
| $\mathrm{t}_{\text {PHZ }}, \mathrm{t}_{\text {PZH }}$ | GND |
| Prop Delay | Open |

## Test Circuit for Dynamic Electrical Characteristics



## Switching Waveforms



Voltage Waveforms Enable and Disable Times

## Applications Information

## Logic Inputs

The logic control inputs can be driven upto 3.6 V regardless of the supply voltage. For example, given a +3.3 V supply, $\overline{\text { EN }}$ may be driven LOW to 0 V and HIGH to 3.6 V . Driving $\overline{\mathrm{EN}}$ Rail-to-Rail ${ }^{\mathbb{B}}$ minimizes power consumption.

## Power Supply-Sequencing

Proper power supply sequencing is recommended for all CMOS devices. Always apply $\mathrm{V}_{\mathrm{CC}}$ before applying signals to the input/ output or control pins.

## Hot Insertion

For Datacom and Telecom applications that have ten or more volts passing through the backplane, a high voltage from the power supply may be seen at the device input pins during hot insertion. The PI3CHxx devices have maximum limits of 6 V and 120 mA for 20 ns . If the power is higher or applied for a longer time or repeatedly reaches the maximum limits, the devices can be damaged.

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

## Packaging Mechanical: 16-pin QSOP (Q)



## Packaging Mechanical: 16-pin TSSOP (L)



## Ordering Information

| Ordering Code | Package Code | Package Description |
| :---: | :---: | :---: |
| PI3CH480QE | Q | Pb-free \& Green, 150-mil, 16-pin QSOP |
| PI3CH480LE | L | Pb-free \& Green, 173-mil, 16-pin TSSOP |

## Notes:

- Thermal characteristics can be found on the company web site at www.pericom.com/packaging/
- $\mathrm{E}=\mathrm{Pb}$-free \& Green
- Adding an X suffix $=$ Tape/Reel

