## HD151015

# 9 bit Level Shifter／Transceiver With 3 State Outputs <br> HITACHI 

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## Description

The HD151015 is an IC which consists of 9 bus transceivers（three state output）in a 24 pin package． Signals are transmitter from A to B when the direction control input（DiR）is at a high level，and from B to A when $\operatorname{DiR}$ is at a low level．When the enable input $(\overline{\mathrm{G}})$ is high，A and B are isolated．And this product has two terminals $\left(\mathrm{V}_{\mathrm{CCA}}, \mathrm{V}_{\mathrm{CCB}}\right), \mathrm{V}_{\mathrm{CCA}}$ is connected with control input and A bus side， $\mathrm{V}_{\mathrm{CCB}}$ is connected with B bus side． $\mathrm{V}_{\mathrm{CCA}}$ and $\mathrm{V}_{\mathrm{CCB}}$ are isolated．Consequently，it is best to change the level in case of two supply voltage coexist on one board and application of power management．

## Features

－This product function as level shift transceiver that change $\mathrm{V}_{\mathrm{CCA}}$ input level to $\mathrm{V}_{\mathrm{CCB}}$ output level， $\mathrm{V}_{\mathrm{CCB}}$ input level to VCCA output level by providing different supply voltages to $\mathrm{V}_{\mathrm{CCA}}$ and $\mathrm{V}_{\mathrm{CCB}}$ ．
－This product is able to the power management ：Turn on and off the supply on $\mathrm{V}_{\mathrm{CCB}}$ side with providing the supply of $\mathrm{V}_{\text {CCA }}$ ．
（Enable input $(\overline{\mathrm{G}})$ ：High level）
－Inputs and outputs are CMOS level，and the power dissipation is the same as CMOS standard logic．
－Wide operating supply voltage range：
$\mathrm{V}_{\mathrm{CCA}}=\mathrm{V}_{\mathrm{CCB}}=2$ to $6 \mathrm{~V}\left(\mathrm{~V}_{\mathrm{CCB}} \quad \mathrm{V}_{\mathrm{CCA}}-0.5 \mathrm{~V}\right)$
－Wide operating temperature range： $\mathrm{Ta}=-40$ to $85^{\circ} \mathrm{C}$

## HD151015

Pin Arrangement


Function Table
Inputs

| $\overline{\mathbf{G}}$ | DIR | Outputs |
| :--- | :--- | :--- |
| L | L | B data to A bus |
| L | H | A data to B bus |
| $H$ | $X$ | Z |

H: High level
L : Low level
Z : High Impedance
$X$ : Immaterial

## Absolute Maximum Ratings

| Item | Symbol | Rating | Unit | Conditions |
| :--- | :--- | :--- | :--- | :--- |
| Supply Voltage | $\mathrm{V}_{\mathrm{CCA}}, \mathrm{V}_{\mathrm{CCB}}$ | -0.5 to +7.0 | V |  |
| Input Diode Current | $\mathrm{I}_{\mathrm{IK}}$ | -20 | mA | $\mathrm{~V}_{1}=-0.5$ |
|  |  | 20 | mA | $\mathrm{~V}_{\mathrm{I}}=\mathrm{V}_{\mathrm{CC}}+0.5$ |
| Input Voltage | $\mathrm{V}_{\mathrm{IN}}$ | -0.5 to $\mathrm{V}_{\mathrm{CC}}+0.5$ | V |  |
| Output Diode Current | $\mathrm{I}_{\mathrm{OK}}$ | -50 | mA | $\mathrm{~V}_{\mathrm{O}}=-0.5$ |
|  |  | 50 | mA | $\mathrm{~V}_{\mathrm{O}}=\mathrm{V}_{\mathrm{CC}}+0.5$ |
| Output Voltage | $\mathrm{V}_{\mathrm{OUT}}$ | -0.5 to $\mathrm{V}_{\mathrm{CC}}+0.5$ | V |  |
| Output Current | $\mathrm{I}_{\mathrm{O}}$ | $\pm 50$ | mA |  |
| VCC or Ground Current | $\mathrm{I}_{\mathrm{CC}}$ or $\mathrm{I}_{\mathrm{GND}}$ | $\pm 50$ | mA | per output pin |
| Storage Temperature | Tstg | -65 to +150 | ${ }^{\circ} \mathrm{C}$ |  |

Note: 1. The absolute maximum ratings are values which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.

## Recommended Operating Conditions

| Item | Symbol | Rating | Unit | Conditions |
| :--- | :--- | :--- | :--- | :--- |
| Supply voltage | $\mathrm{V}_{\mathrm{CCA}, \mathrm{B}}$ | 2.0 to 6.0 | V | $\mathrm{~V}_{\mathrm{CCB}} \geq \mathrm{V}_{\mathrm{CCA}}-0.5 \mathrm{~V}$ |
| Input voltage | $\mathrm{V}_{\mathrm{IN}}$ | 0 to $\mathrm{V}_{\mathrm{CC}}$ | V |  |
| Output voltage | $\mathrm{V}_{\mathrm{OUT}}$ | 0 to $\mathrm{V}_{\mathrm{CC}}$ | V |  |
| Operating Temperature | $\mathrm{T}_{\mathrm{A}}$ | -40 to +85 | ${ }^{\circ} \mathrm{C}$ |  |
| Input Rise and Fall Time ${ }^{\star 1}$ | $\mathrm{t}_{\mathrm{r}}, \mathrm{t}_{\mathrm{f}}$ | 8 | $\mathrm{~ns} / \mathrm{V}$ | $\mathrm{V}_{\mathrm{CC}} @ 3.0 \mathrm{~V}$ (Input DiR, $\left.\overline{\mathrm{G}}, \mathrm{A}\right)$ |
|  |  |  |  | $\mathrm{V}_{\mathrm{CC}} @ 4.5 \mathrm{~V}$ (Input B) |
| $\mathrm{V}_{\mathrm{CC}} @ 5.5 \mathrm{~V}$ (Input B) |  |  |  |  |

Note: 1. The item guarantees maximum limit when one input switches. Waveform: Refer to test circuit of switching characteristics.

## HD151015

## Logick Diagram



## Electrical Characteristics

| Item | $\begin{aligned} & \text { Sym- } \\ & \text { bol } \end{aligned}$ | $\begin{aligned} & V_{\text {cCA }} \\ & (\mathrm{V}) \end{aligned}$ | $V_{\text {cСB }}$ <br> (V) | $\mathrm{Ta}=25^{\circ} \mathrm{C}$ |  | Max | $\begin{aligned} & \mathrm{Ta}=-40 \text { to } \\ & 85^{\circ} \mathrm{C} \end{aligned}$ |  | Unit | Conditions |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Min | Typ |  | Min | Max |  |  |
| Input Voltage | $\mathrm{V}_{\mathrm{IH}}$ | 3.0 | 3.0 | 2.1 | 1.5 | - | 2.1 | - | V | $\mathrm{V}_{\text {OUT }}=0.1 \mathrm{~V}$ or $\mathrm{V}_{\text {CC }}-0.1 \mathrm{~V}$ |
|  |  | 4.5 | 4.5 | 3.15 | 2.25 | - | 3.15 | - |  |  |
|  |  | 5.5 | 5.5 | 3.85 | 2.75 | - | 3.85 | - |  |  |
|  | $\mathrm{V}_{1 \mathrm{~L}}$ | 3.0 | 3.0 | - | 1.5 | 0.9 | - | 0.9 | V | $\mathrm{V}_{\text {OUT }}=0.1 \mathrm{~V}$ or $\mathrm{V}_{\text {cC }}-0.1 \mathrm{~V}$ |
|  |  | 4.5 | 4.5 | - | 2.25 | 1.35 | - | 1.35 |  |  |
|  |  | 5.5 | 5.5 | - | 2.75 | 1.65 | - | 1.65 |  |  |
| Output | $\mathrm{V}_{\text {OH }}$ | 2.7 | 4.5 | 2.6 | 2.69 | - | 2.6 | - | V | $\mathrm{V}_{\mathrm{IN}}=\mathrm{V}_{\mathrm{IL}}$ or $\mathrm{V}_{\mathrm{IH}}, \mathrm{I}_{\mathrm{OH}}=-50 \mu \mathrm{AA}{ }^{* 1}$ |
| Voltage |  | 2.7 | 4.5 | 4.4 | 4.49 | - | 4.4 | - |  | $\mathrm{V}_{\text {IN }}=\mathrm{V}_{\text {IL }}$ or $\mathrm{V}_{\text {IH }}, \mathrm{I}_{\text {OH }}=-50 \mu \mathrm{AB}$ |
|  |  | 2.7 | 4.5 | 2.3 | - | - | 2.2 | - | V | $\mathrm{V}_{\text {IN }}=\quad \mathrm{I}_{\text {OH }}=-4 \mathrm{~mA} \mathrm{~A}$ |
|  |  | 2.7 | 4.5 | 3.9 | - | - | 3.8 | - |  | $\mathrm{V}_{\mathrm{IL}}$ or $\mathrm{V}_{\mathrm{IH}} \quad \mathrm{I}_{\text {OH }}=-12 \mathrm{~mA} \mathrm{~B}$ |
|  | $\mathrm{V}_{\mathrm{oL}}$ | 2.7 | 4.5 | - | 0.001 | 0.1 | - | 0.1 | V | $\mathrm{V}_{\text {IN }}=\mathrm{V}_{\mathrm{IL}}$ or $\mathrm{V}_{\mathrm{IH}}, \mathrm{I}_{\mathrm{OL}}=50 \mu \mathrm{~A}$ A.B |
|  |  | 2.7 | 4.5 | - | - | 0.32 | - | 0.37 | V | $\mathrm{V}_{\mathrm{IN}}=\mathrm{V}_{\text {IL }}$ or $\mathrm{V}_{\text {IH }}, \mathrm{I}_{\mathrm{OL}}=12 \mathrm{~mA} \mathrm{A.B}$ |
| Input Current | $\mathrm{I}_{\text {IN }}$ | 3.3 | 5.5 | - | - | $\pm 0.1$ | - | $\pm 1.0$ | $\mu \mathrm{A}$ | $\mathrm{V}_{\mathrm{IN}}=\mathrm{V}_{\mathrm{CC}}$ or GND |
| Off State Output Current | $\mathrm{I}_{\text {OZ }}$ | 3.3 | 5.5 | - | - | $\pm 0.5$ | - | $\pm 5.0$ | $\mu \mathrm{A}$ | $\begin{aligned} & \mathrm{V}_{\text {IN }}(\overline{\mathrm{G}})=\mathrm{V}_{\mathrm{IH}}, \mathrm{~V}_{\text {IN }}=\mathrm{V}_{\mathrm{CC}} \text { or GND, } \\ & \mathrm{V}_{\text {OUT }}=\mathrm{V}_{\mathrm{CC}} \text { or } G N D \end{aligned}$ |
| Supply | $\underline{I_{\text {cCA.B }}}$ | 3.3 | 5.5 | - | - | 8.0 | - | 80 | $\mu \mathrm{A}$ | $\mathrm{V}_{\mathrm{IN}}=\mathrm{V}_{\mathrm{CC}}$ or GND |
| Current | $\mathrm{I}_{\text {CCA }}$ | 5.5 | 0 | - | - | 8.0 | - | 80 | $\mu \mathrm{A}$ | $\mathrm{V}_{\text {IN }}=\mathrm{V}_{\mathrm{CC}}$ or GND, B Input OPEN |

Note: 1. A: Output A, B: Output B, A.B: Output A.B

## Switching Characteristics

|  |  | $\begin{aligned} & \mathrm{Ta}=25^{\circ} \mathrm{C} \\ & \mathrm{~V}_{\mathrm{CCA}}=3.0 \mathrm{~V}, \mathrm{~V}_{\mathrm{CCB}}=5.0 \mathrm{~V} \end{aligned}$ |  |  | $\begin{aligned} & \mathrm{Ta}=-40 \text { to } 85^{\circ} \mathrm{C} \\ & \mathrm{~V}_{\mathrm{CC}}=2.7 \mathrm{~V}, \mathrm{~V}_{\mathrm{CCB}}=4.5 \mathrm{~V} \end{aligned}$ |  |  | Conditions |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Item | Symbol | Min | Typ | Max | Min | Max | Unit |  |
| Propagation Delay Time | $\mathrm{t}_{\text {PLH }}$ | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 | ns | $B \rightarrow A$ |
|  |  | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 |  | $A \rightarrow B$ |
|  | $\mathrm{t}_{\text {PHL }}$ | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 | ns | $B \rightarrow A$ |
|  |  | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 |  | $A \rightarrow B$ |
| Output Enable Time | $\mathrm{t}_{\mathrm{zH}}$ | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{\mathrm{G}} \rightarrow \mathrm{A}$ |
|  |  | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 |  | $\overline{\mathrm{G}} \rightarrow \mathrm{B}$ |
|  | $\mathrm{t}_{\mathrm{zL}}$ | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{\mathrm{G}} \rightarrow \mathrm{A}$ |
|  |  | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 |  | $\overline{\mathrm{G}} \rightarrow \mathrm{A}$ |
| Output Disable Time | $\mathrm{t}_{\mathrm{Hz}}$ | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{\mathrm{G}} \rightarrow \mathrm{A}$ |
|  |  | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 |  | $\overline{\mathrm{G}} \rightarrow \mathrm{B}$ |
|  | $t_{\text {Lz }}$ | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{\mathrm{G}} \rightarrow \mathrm{A}$ |
|  |  | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 |  | $\overline{\mathrm{G}} \rightarrow \mathrm{B}$ |

## Input and Output Equivalent Circuit



## HD151015

## Switching Time Test Method

## Test Circuit



## Waveforms-1



Waveforms-2


## HD151015

## Typical Characteristic Curves

Propagation Delay Times vs Power Supply $\left(\mathrm{V}_{\mathrm{CCA}}, \mathrm{V}_{\mathrm{CCB}}\right)$


## HD151015

## Output Voltage vs Output Current



## HD151015

## Application

## For power management system (1)



Note: HD151015 is also used for power management system. We show some Examples.

1. For $\mathrm{V}_{\mathrm{CCA}}$ side

Be able to switch fast mode ( $\mathrm{V}_{\mathrm{CCA}}=5 \mathrm{~V}$ ) and power save mode $\left(\mathrm{V}_{\mathrm{CCA}}=3 \mathrm{~V}\right)$
2. For $\mathrm{V}_{\mathrm{CCB}}$ side

Be able to switch normal mode $\left(\mathrm{V}_{\mathrm{CCB}}=5 \mathrm{~V}\right)$ and suspend mode $\left(\mathrm{V}_{\mathrm{CCB}}=0 \mathrm{~V}\right)$
3. For both side

Be able to switch fast mode ( $\mathrm{V}_{\mathrm{CCA}}=5 \mathrm{~V}$ ) and power save mode $\left(\mathrm{V}_{\mathrm{CCA}}=3 \mathrm{~V}\right)$
(When $\mathrm{V}_{\text {CCA }}=\mathrm{V}_{\mathrm{CCB}}$, in this case, please switch $\mathrm{V}_{\mathrm{CCA}}$ and $\mathrm{V}_{\mathrm{CCB}}$ simulteneously.)

For power management system (2) (Common bus line in different power system)

[Cautions on using]
Please use this IC on condition of $\mathrm{V}_{\mathrm{CCA}}$ usually ON , because if you use it on condition of $\mathrm{V}_{\mathrm{CCA}}$ being OFF , $\mathrm{V}_{\mathrm{CCB}}$ being ON , it will be troubled.

## HD151015

## Package Dimensions




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