# HD151015

9 bit Level Shifter/Transceiver With 3 State Outputs

HITACHI

ADE-205-039C (Z)
3rd. Edition
Jun. 1993

## Description

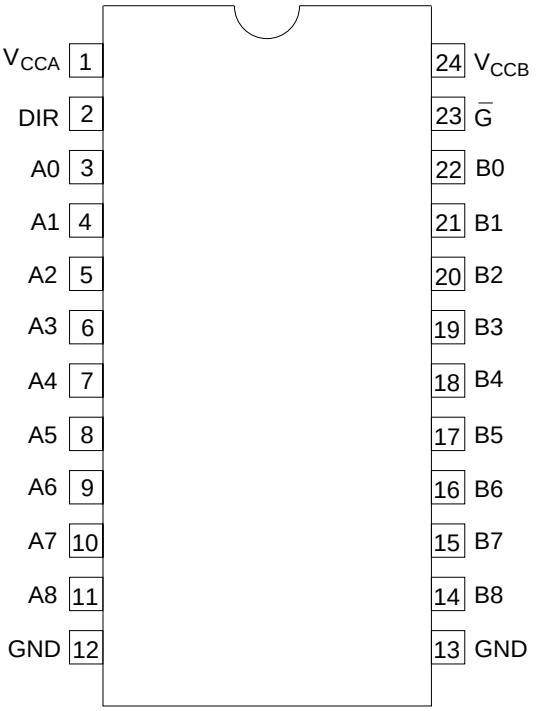
The HD151015 is an IC which consists of 9 bus transceivers (three state output) in a 24 pin package. Signals are transmitter from A to B when the direction control input (DiR) is at a high level, and from B to A when DiR is at a low level. When the enable input ($\overline{G}$) is high, A and B are isolated. And this product has two terminals ($V_{CCA}$, $V_{CCB}$), $V_{CCA}$ is connected with control input and A bus side, $V_{CCB}$ is connected with B bus side. $V_{CCA}$ and $V_{CCB}$ 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 $V_{CCA}$ input level to $V_{CCB}$ output level, $V_{CCB}$ input level to VCCA output level by providing different supply voltages to $V_{CCA}$ and $V_{CCB}$.
- This product is able to the power management : Turn on and off the supply on $V_{CCB}$ side with providing the supply of $V_{CCA}$.
  (Enable input ($\overline{G}$) : High level)
- Inputs and outputs are CMOS level, and the power dissipation is the same as CMOS standard logic.
- Wide operating supply voltage range:
  $V_{CCA} = V_{CCB}$ = 2 to 6 V ($V_{CCB}$ $V_{CCA}$ – 0.5 V)
- Wide operating temperature range: Ta = –40 to 85°C

Hitachi semiconductor

## Pin Arrangement




(Top view)

## Function Table

**Inputs**

| $\overline{G}$ | 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 | $V_{CCA}$, $V_{CCB}$ | –0.5 to +7.0 | V | |
| Input Diode Current | $I_{IK}$ | –20 | mA | $V_I$ = –0.5 |
| | | 20 | mA | $V_I = V_{CC} + 0.5$ |
| Input Voltage | $V_{IN}$ | –0.5 to $V_{CC}$ + 0.5 | V | |
| Output Diode Current | $I_{OK}$ | –50 | mA | $V_O$ = –0.5 |
| | | 50 | mA | $V_O = V_{CC} + 0.5$ |
| Output Voltage | $V_{OUT}$ | –0.5 to $V_{CC}$ + 0.5 | V | |
| Output Current | $I_O$ | ±50 | mA | |
| VCC or Ground Current | $I_{CC}$ or $I_{GND}$ | ±50 | mA | per output pin |
| Storage Temperature | Tstg | –65 to + 150 | °C | |

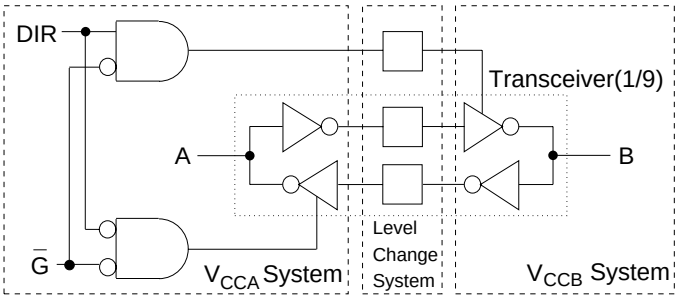
Note: 1. The absolute maximum ratings are values which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.

## Recommended Operating Conditions

| Item | Symbol | Rating | Unit | Conditions |
|---|---|---|---|---|
| Supply voltage | $V_{CCA, B}$ | 2.0 to 6.0 | V | $V_{CCB} \geq V_{CCA}$ – 0.5 V |
| Input voltage | $V_{IN}$ | 0 to $V_{CC}$ | V | |
| Output voltage | $V_{OUT}$ | 0 to $V_{CC}$ | V | |
| Operating Temperature | $T_A$ | –40 to +85 | °C | |
| Input Rise and Fall Time*[1] | $t_r$, $t_f$ | 8 | ns/V | $V_{CC}$@3.0 V (Input DiR, $\overline{G}$, A) |
| | | | | $V_{CC}$@4.5 V (Input B) |
| | | | | $V_{CC}$@5.5 V (Input B) |

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

## Logick Diagram




## Electrical Characteristics

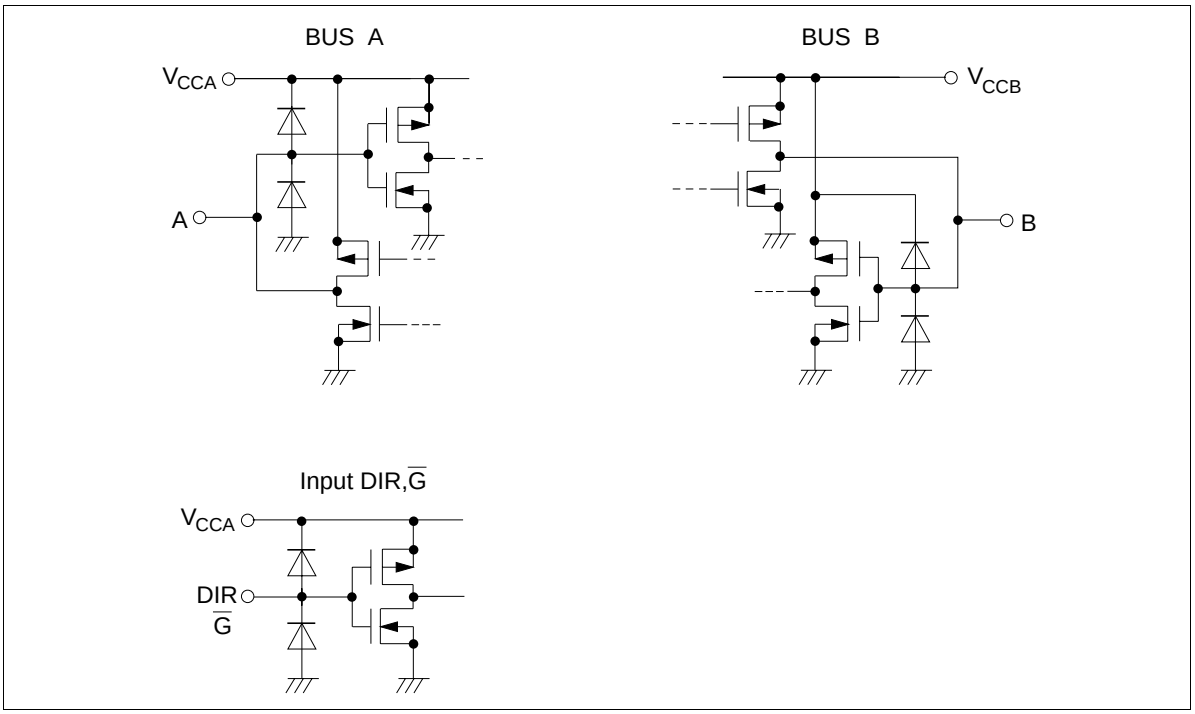
| Item | Sym-bol | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Ta = 25°C Min | Typ | Max | Ta = –40 to 85°C Min | Max | Unit | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| Input Voltage | $V_{IH}$ | 3.0 | 3.0 | 2.1 | 1.5 | — | 2.1 | — | V | $V_{OUT}$ = 0.1 V or $V_{CC}$ – 0.1 V |
| | | 4.5 | 4.5 | 3.15 | 2.25 | — | 3.15 | — | | |
| | | 5.5 | 5.5 | 3.85 | 2.75 | — | 3.85 | — | | |
| | $V_{IL}$ | 3.0 | 3.0 | — | 1.5 | 0.9 | — | 0.9 | V | $V_{OUT}$ = 0.1 V or $V_{CC}$ – 0.1 V |
| | | 4.5 | 4.5 | — | 2.25 | 1.35 | — | 1.35 | | |
| | | 5.5 | 5.5 | — | 2.75 | 1.65 | — | 1.65 | | |
| Output Voltage | $V_{OH}$ | 2.7 | 4.5 | 2.6 | 2.69 | — | 2.6 | — | V | $V_{IN}$ = $V_{IL}$ or $V_{IH}$, $I_{OH}$ = –50 µA A*[1] |
| | | 2.7 | 4.5 | 4.4 | 4.49 | — | 4.4 | — | | $V_{IN}$ = $V_{IL}$ or $V_{IH}$, $I_{OH}$ = –50 µA B |
| | | 2.7 | 4.5 | 2.3 | — | — | 2.2 | — | V | $V_{IN}$ = $I_{OH}$ = –4 mA A |
| | | 2.7 | 4.5 | 3.9 | — | — | 3.8 | — | | $V_{IL}$ or $V_{IH}$ $I_{OH}$ = –12 mA B |
| | $V_{OL}$ | 2.7 | 4.5 | — | 0.001 | 0.1 | — | 0.1 | V | $V_{IN}$ = $V_{IL}$ or $V_{IH}$, $I_{OL}$ = 50 µA A.B |
| | | 2.7 | 4.5 | — | — | 0.32 | — | 0.37 | V | $V_{IN}$ = $V_{IL}$ or $V_{IH}$, $I_{OL}$ = 12 mA A.B |
| Input Current | $I_{IN}$ | 3.3 | 5.5 | — | — | ±0.1 | — | ±1.0 | µA | $V_{IN}$ = $V_{CC}$ or GND |
| Off State Output Current | $I_{OZ}$ | 3.3 | 5.5 | — | — | ±0.5 | — | ±5.0 | µA | $V_{IN}(\overline{G})$ = $V_{IH}$, $V_{IN}$ = $V_{CC}$ or GND, $V_{OUT}$ = $V_{CC}$ or GND |
| Supply Current | $I_{CCA.B}$ | 3.3 | 5.5 | — | — | 8.0 | — | 80 | µA | $V_{IN}$ = $V_{CC}$ or GND |
| | $I_{CCA}$ | 5.5 | 0 | — | — | 8.0 | — | 80 | µA | $V_{IN}$ = $V_{CC}$ or GND, B Input OPEN |

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

## Switching Characteristics

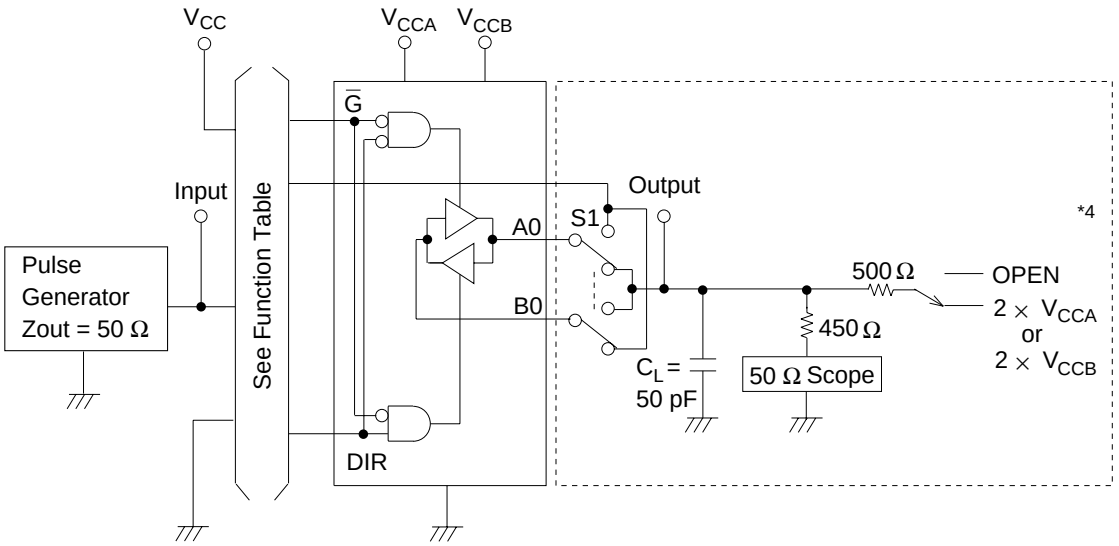
| | | Ta = 25°C<br>$V_{CCA}$ = 3.0 V, $V_{CCB}$ = 5.0 V | | | Ta = –40 to 85°C<br>$V_{CC}$ = 2.7 V, $V_{CCB}$ = 4.5 V | | | |
|---|---|---|---|---|---|---|---|---|
| **Item** | **Symbol** | **Min** | **Typ** | **Max** | **Min** | **Max** | **Unit** | **Conditions** |
| Propagation Delay Time | $t_{PLH}$ | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 | ns | B → A |
| | | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 | | A → B |
| | $t_{PHL}$ | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 | ns | B → A |
| | | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 | | A → B |
| Output Enable Time | $t_{ZH}$ | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{G}$ → A |
| | | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 | | $\overline{G}$ → B |
| | $t_{ZL}$ | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{G}$ → A |
| | | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 | | $\overline{G}$ → A |
| Output Disable Time | $t_{HZ}$ | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{G}$ → A |
| | | 1.0 | 9.0 | 16.0 | 1.0 | 20.0 | | $\overline{G}$ → B |
| | $t_{LZ}$ | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 | ns | $\overline{G}$ → A |
| | | 1.0 | 8.0 | 16.0 | 1.0 | 20.0 | | $\overline{G}$ → B |

## Input and Output Equivalent Circuit



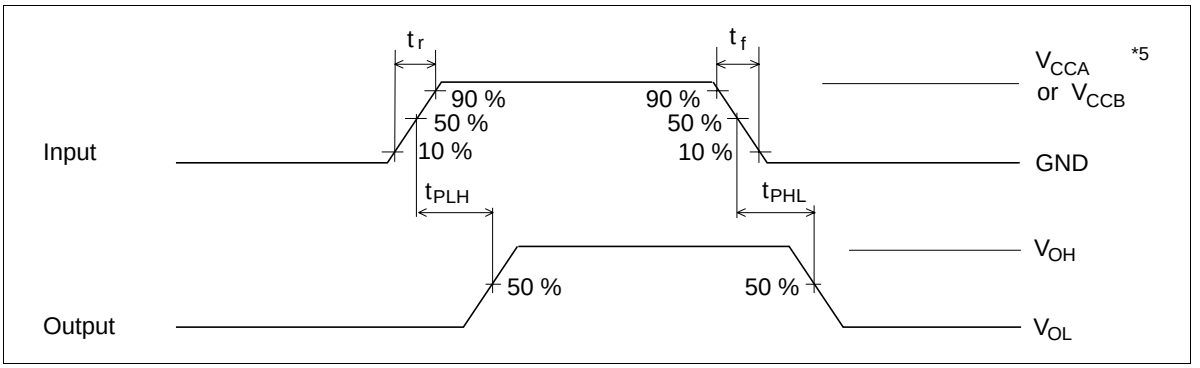
## Switching Time Test Method

### Test Circuit

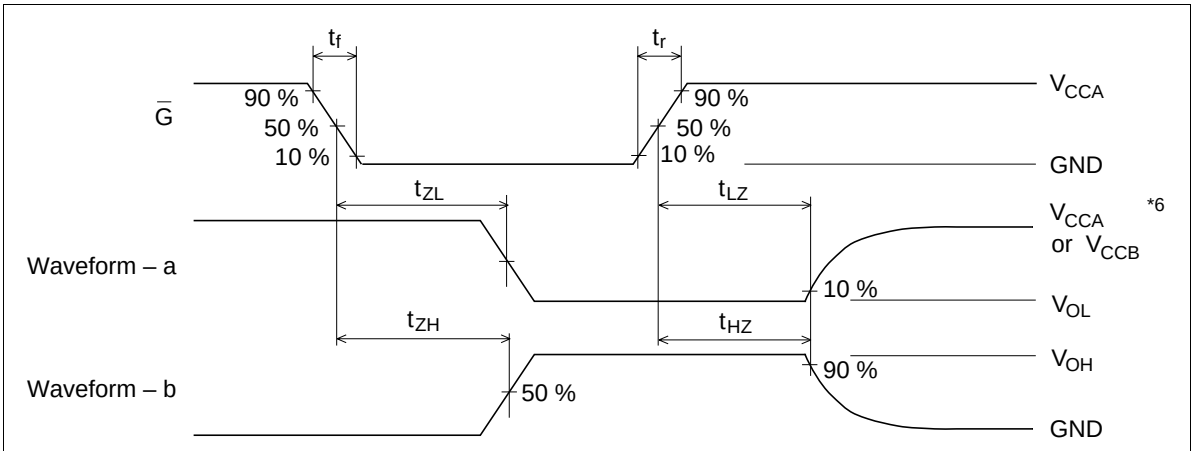



Notes:
1. $C_L$ includes probe and jig capacitance.
2. A1-B1, A2-B2, A3-B3, A4-B4, A5-B5, A6-B6, A7-B7, A8-B8 are identical to above circuit.
3. S1 is a input/output switch.
4. When A → B: 2 × $V_{CCB}$, B → A: 2 ¥ $V_{CCA}$

**Waveforms-1**



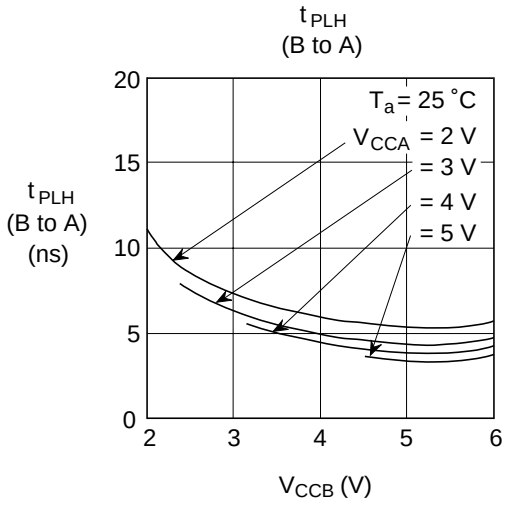

**Waveforms-2**

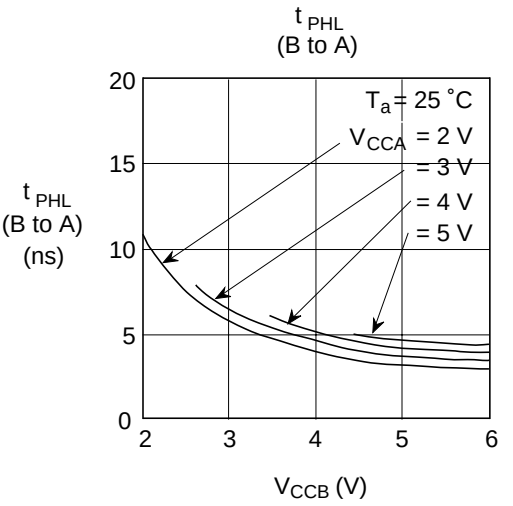


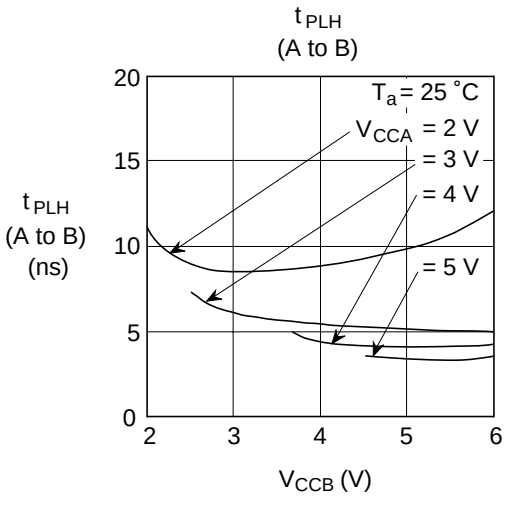

Notes:
1. $t_r = t_f = 2.5$ ns.
2. Input Waveform: PRR = 1 MHz, duty cycle 50%
3. Waveform-a is set as outputs are “Low” when enable input is “Low”.
4. Waveform-b is set as outputs are “High” when enable input is “Low”.
5. When A $\rightarrow$ B: $V_{CCA}$, B $\rightarrow$ A : $V_{CCB}$
6. When $\overline{G}$ $\rightarrow$ A: $V_{CCA}$, $\overline{G}$ $\rightarrow$ B : $V_{CCB}$

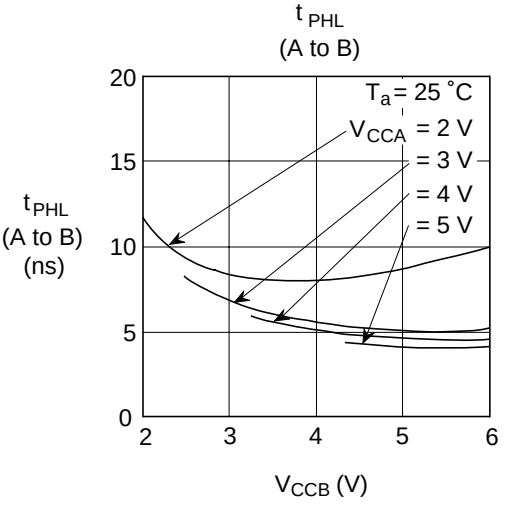
## Typical Characteristic Curves

**Propagation Delay Times vs Power Supply** ($V_{CCA}$, $V_{CCB}$)

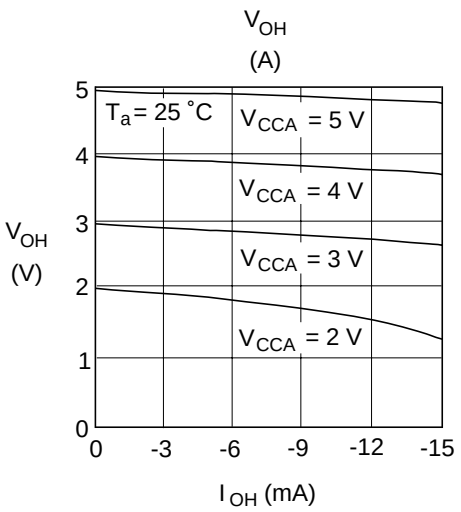


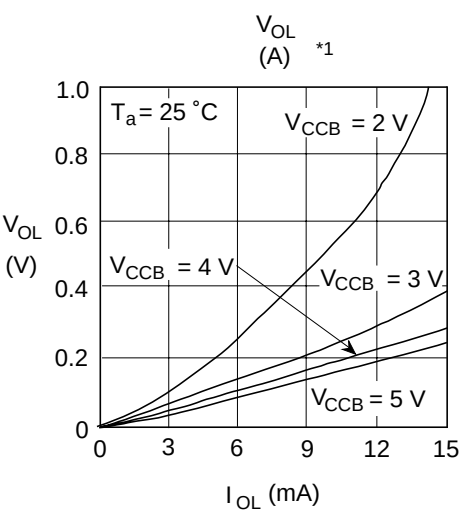



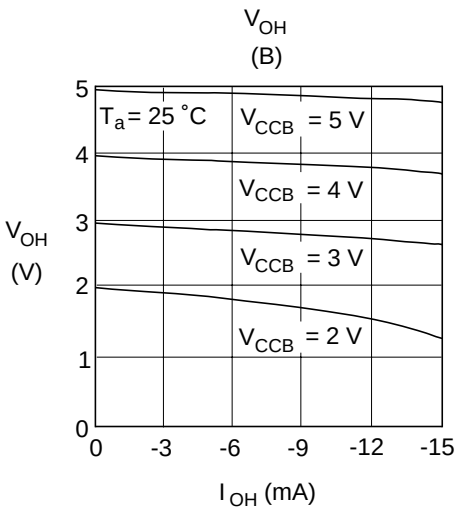



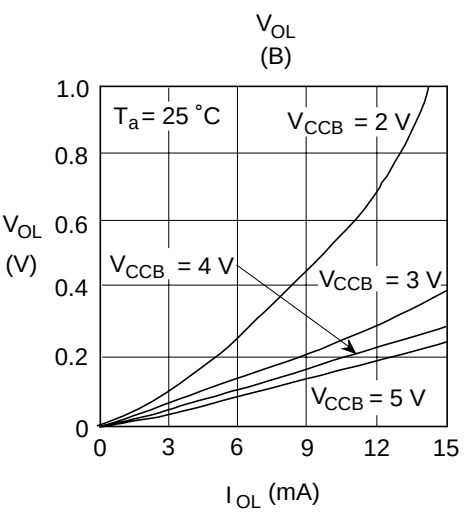



**Output Voltage vs Output Current**



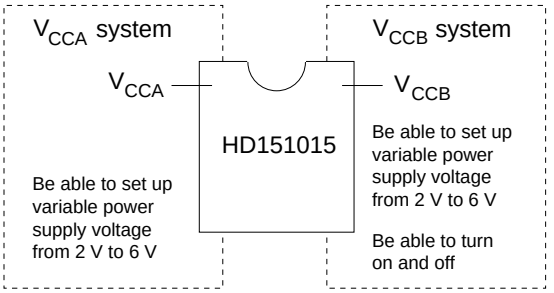



## Application

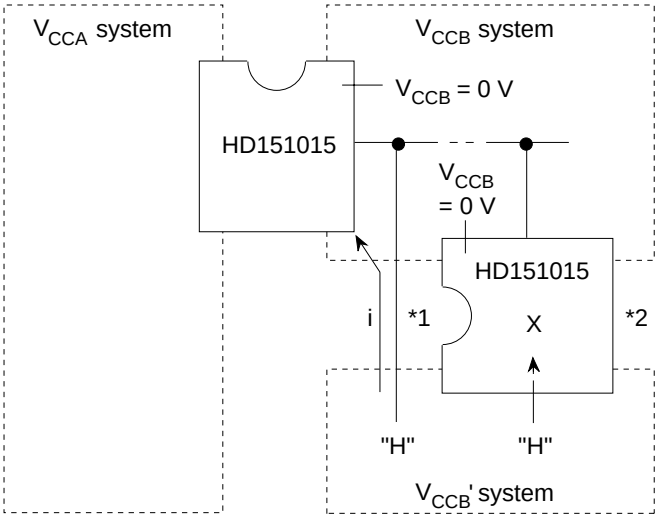
**For power management system (1)**




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

1. For $V_{CCA}$ side
   Be able to switch fast mode ($V_{CCA}$ = 5 V) and power save mode ($V_{CCA}$ = 3 V)
2. For $V_{CCB}$ side
   Be able to switch normal mode ($V_{CCB}$ = 5 V) and suspend mode ($V_{CCB}$ = 0 V)
3. For both side
   Be able to switch fast mode ($V_{CCA}$ = 5 V) and power save mode ($V_{CCA}$ = 3 V)
   (When $V_{CCA}$ = $V_{CCB}$, in this case, please switch $V_{CCA}$ and $V_{CCB}$ simulteneously.)

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




HD151015 uses conventional CMOS input circuit. So, you have to care of designing in case of common bus line in different power block. We show one example.

In this case, if $V_{CCB}$ become turn off, current flows from bus line to $V_{CCB}$. (refer to *[1])

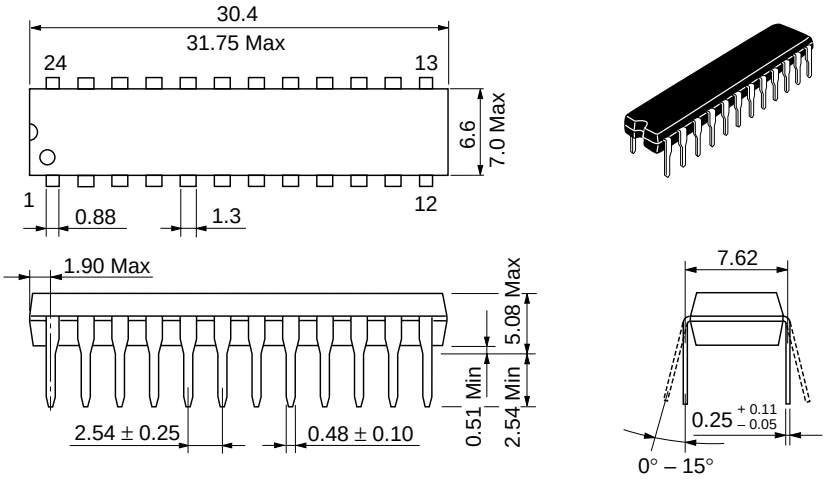
This is cause of malfunction. In order to prevent this problem, I recommend using this device for interface to each power block. (refer to *[2])

[Cautions on using]

Please use this IC on condition of $V_{CCA}$ usually ON, because if you use it on condition of $V_{CCA}$ being OFF, $V_{CCB}$ being ON, it will be troubled.

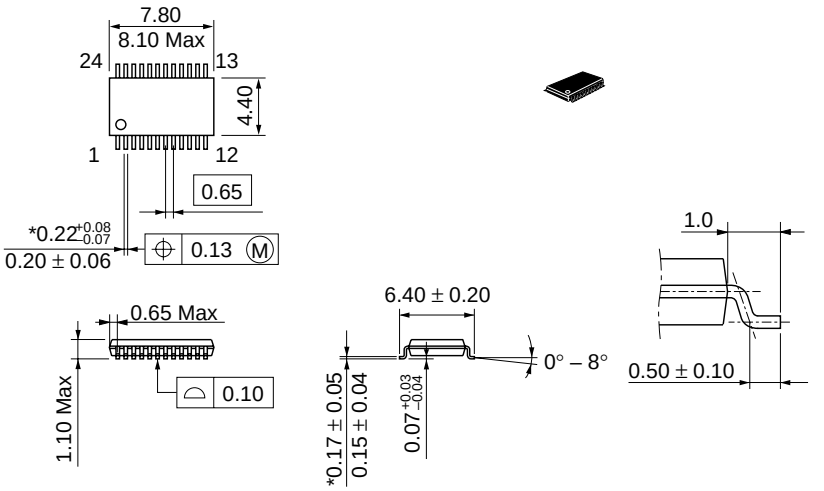
## Package Dimensions

Unit: mm




| | |
|---|---|
| Hitachi Code | DP-24N |
| JEDEC | — |
| EIAJ | Conforms |
| Mass (reference value) | 1.84 g |

Unit: mm




*Dimension including the plating thickness
Base material dimension

| | |
|---|---|
| Hitachi Code | TTP-24DB |
| JEDEC | — |
| EIAJ | — |
| Mass (reference value) | 0.08 g |

## Cautions

1. Hitachi neither warrants nor grants licenses of any rights of Hitachi's or any third party's patent, copyright, trademark, or other intellectual property rights for information contained in this document. Hitachi bears no responsibility for problems that may arise with third party's rights, including intellectual property rights, in connection with use of the information contained in this document.
2. Products and product specifications may be subject to change without notice. Confirm that you have received the latest product standards or specifications before final design, purchase or use.
3. Hitachi makes every attempt to ensure that its products are of high quality and reliability. However, contact Hitachi's sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten human life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
4. Design your application so that the product is used within the ranges guaranteed by Hitachi particularly for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. Hitachi bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail-safes, so that the equipment incorporating Hitachi product does not cause bodily injury, fire or other consequential damage due to operation of the Hitachi product.
5. This product is not designed to be radiation resistant.
6. No one is permitted to reproduce or duplicate, in any form, the whole or part of this document without written approval from Hitachi.
7. Contact Hitachi's sales office for any questions regarding this document or Hitachi semiconductor products.

HITACHI

**Hitachi, Ltd.**
Semiconductor & Integrated Circuits.
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan
Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

URL
NorthAmerica : http://semiconductor.hitachi.com/
Europe : http://www.hitachi-eu.com/hel/ecg
Asia : http://sicapac.hitachi-asia.com
Japan : http://www.hitachi.co.jp/Sicd/indx.htm

**For further information write to:**

Hitachi Semiconductor (America) Inc.
179 East Tasman Drive,
San Jose,CA 95134
Tel: <1> (408) 433-1990
Fax: <1>(408) 433-0223

Hitachi Europe GmbH
Electronic Components Group
Dornacher Straβe 3
D-85622 Feldkirchen, Munich
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.
Electronic Components Group.
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 585160

Hitachi Asia Ltd.
Hitachi Tower
16 Collyer Quay #20-00,
Singapore 049318
Tel : <65>-538-6533/538-8577
Fax : <65>-538-6933/538-3877
URL : http://www.hitachi.com.sg

Hitachi Asia Ltd.
(Taipei Branch Office)
4/F, No. 167, Tun Hwa North Road,
Hung-Kuo Building,
Taipei (105), Taiwan
Tel : <886>-(2)-2718-3666
Fax : <886>-(2)-2718-8180
Telex : 23222 HAS-TP
URL : http://www.hitachi.com.tw

Hitachi Asia (Hong Kong) Ltd.
Group III (Electronic Components)
7/F., North Tower,
World Finance Centre,
Harbour City, Canton Road
Tsim Sha Tsui, Kowloon,
Hong Kong
Tel : <852>-(2)-735-9218
Fax : <852>-(2)-730-0281
URL : http://www.hitachi.com.hk


Colophon 2.0