RENESAS

# HD151015

## 9 bit Level Shifter/Transceiver With 3 State Outputs

REJ03D0300-0500
Rev.5.00
May 10, 2006

## Description

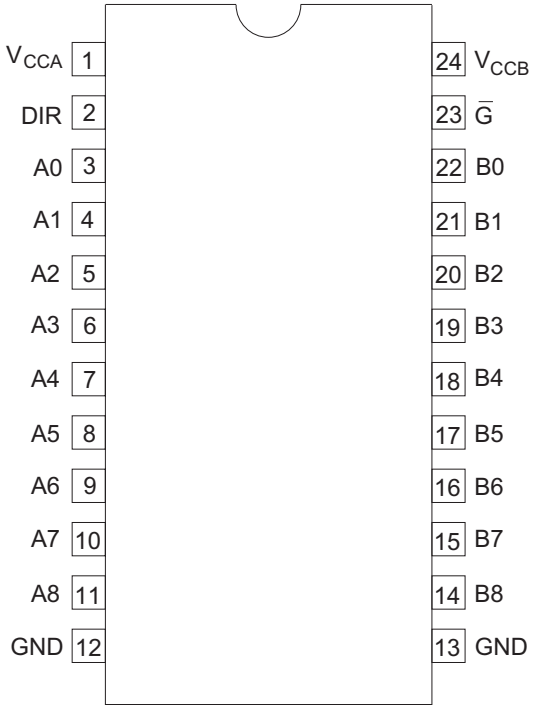
The HD151015 is an IC which consists of 9 bus transceivers (three state output) in a 24 pin package. Signals are transmitter from A to B when the direction control input (DiR) is at a high level, and from B to A when DiR is at a low level. When the enable input ($\overline{G}$) is high, A and B are isolated. 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 $V_{CCA}$ 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 ($V_{CCB} \geq V_{CCA} - 0.5$ V)
- Wide operating temperature range: Ta = –40 to 85°C
- Ordering Information

| Part Name | Package Type | Package Code (Previous Code) | Package Abbreviation | Taping Abbreviation (Quantity) |
|---|---|---|---|---|
| HD151015TEL | TSSOP-24 pin | PTSP0024JB-A (TTP-24DBV) | T | EL (1,000 pcs/reel) |

## Pin Arrangement




(Top view)

## Function Table

| Inputs | | Outputs |
|---|---|---|
| $\overline{G}$ | DIR | |
| 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 | |

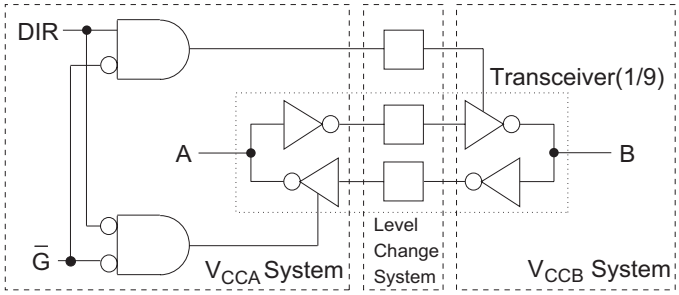
Note: 1. The absolute maximum ratings are values which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.

## 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

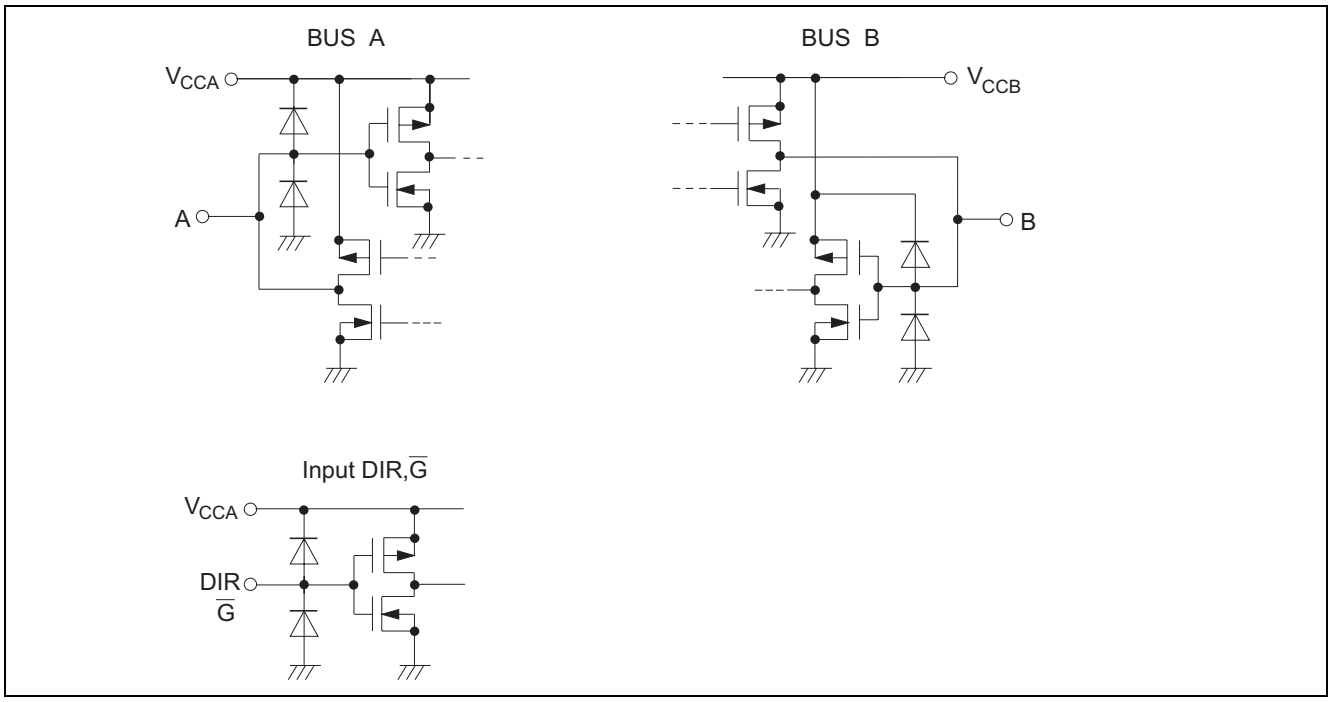
| Item | Sym-bol | $V_{CCA}$ (V) | $V_{CCB}$ (V) | Ta = 25°C Min | Ta = 25°C Typ | Ta = 25°C Max | Ta = –40 to 85°C Min | Ta = –40 to 85°C Max | Unit | Conditions | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Input Voltage | $V_{IH}$ | 3.0 | 3.0 | 2.1 | 1.5 | — | 2.1 | — | V | $V_{OUT}$ = 0.1 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 | $V_{IN}$ = $V_{IL}$ or $V_{IH}$, $I_{OH}$ = –4 mA | A |
| | | 2.7 | 4.5 | 3.9 | — | — | 3.8 | — | | $V_{IN}$ = $V_{IL}$ 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

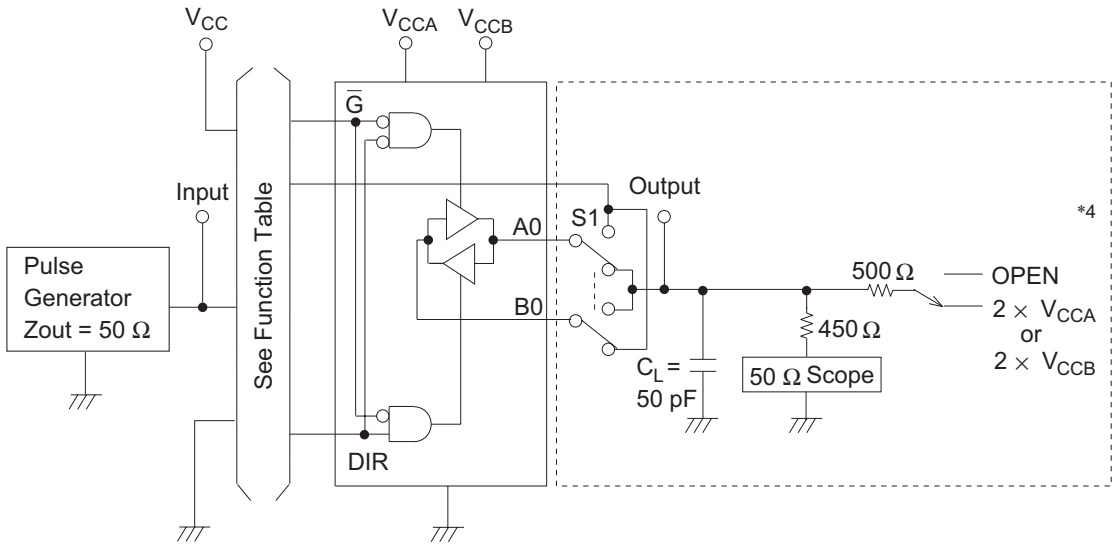
| Item | Symbol | Ta = 25°C $V_{CCA}$ = 3.0 V, $V_{CCB}$ = 5.0 V | | | Ta = –40 to 85°C $V_{CC}$ = 2.7 V, $V_{CCB}$ = 4.5 V | | Unit | Conditions |
|---|---|---|---|---|---|---|---|---|
| | | Min | Typ | Max | Min | Max | | |
| Propagation Delay Time | $t_{PLH}$ | 1.0 | 5.0 | 10.0 | 1.0 | 12.0 | ns | 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



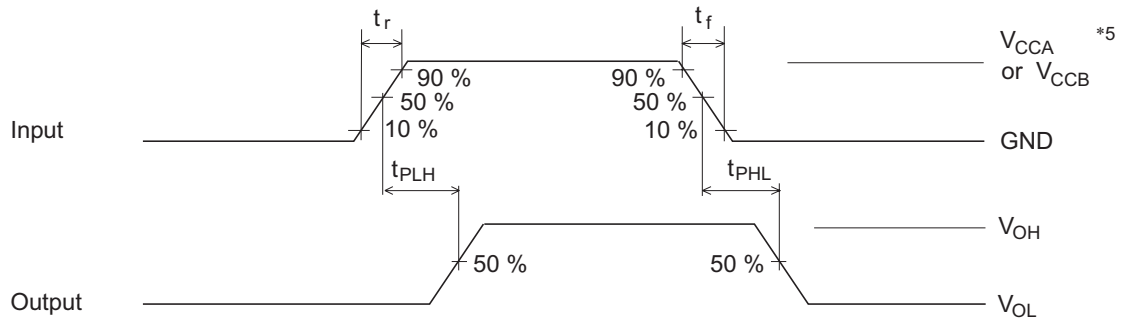
## Switching Time Test Method

### Test Circuit

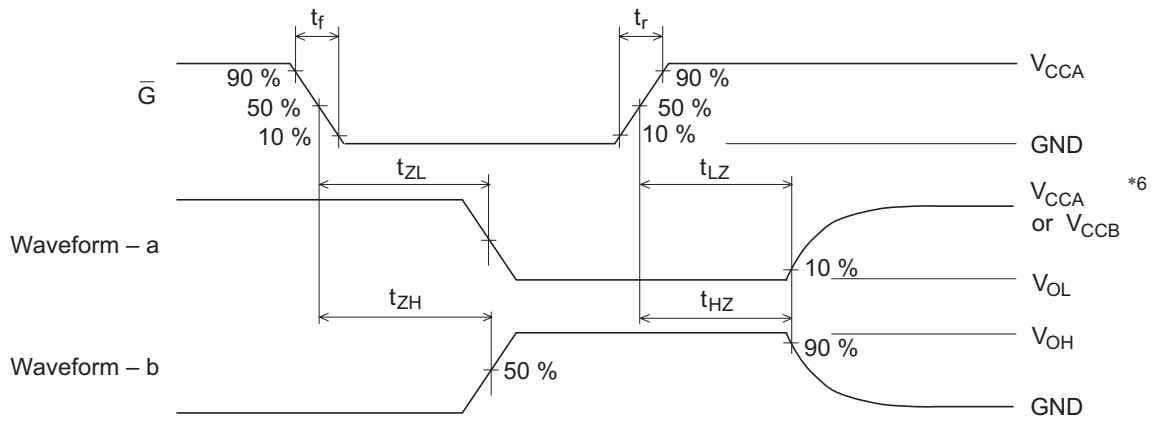



Notes:
1. $C_L$ includes probe and jig capacitance.
2. A1-B1, A2-B2, A3-B3, A4-B4, A5-B5, A6-B6, A7-B7, A8-B8 are identical to above circuit.
3. S1 is a input/output switch.
4. When A → B: $2 \times V_{CCB}$, B → A: $2 \times V_{CCA}$

## Waveforms-1



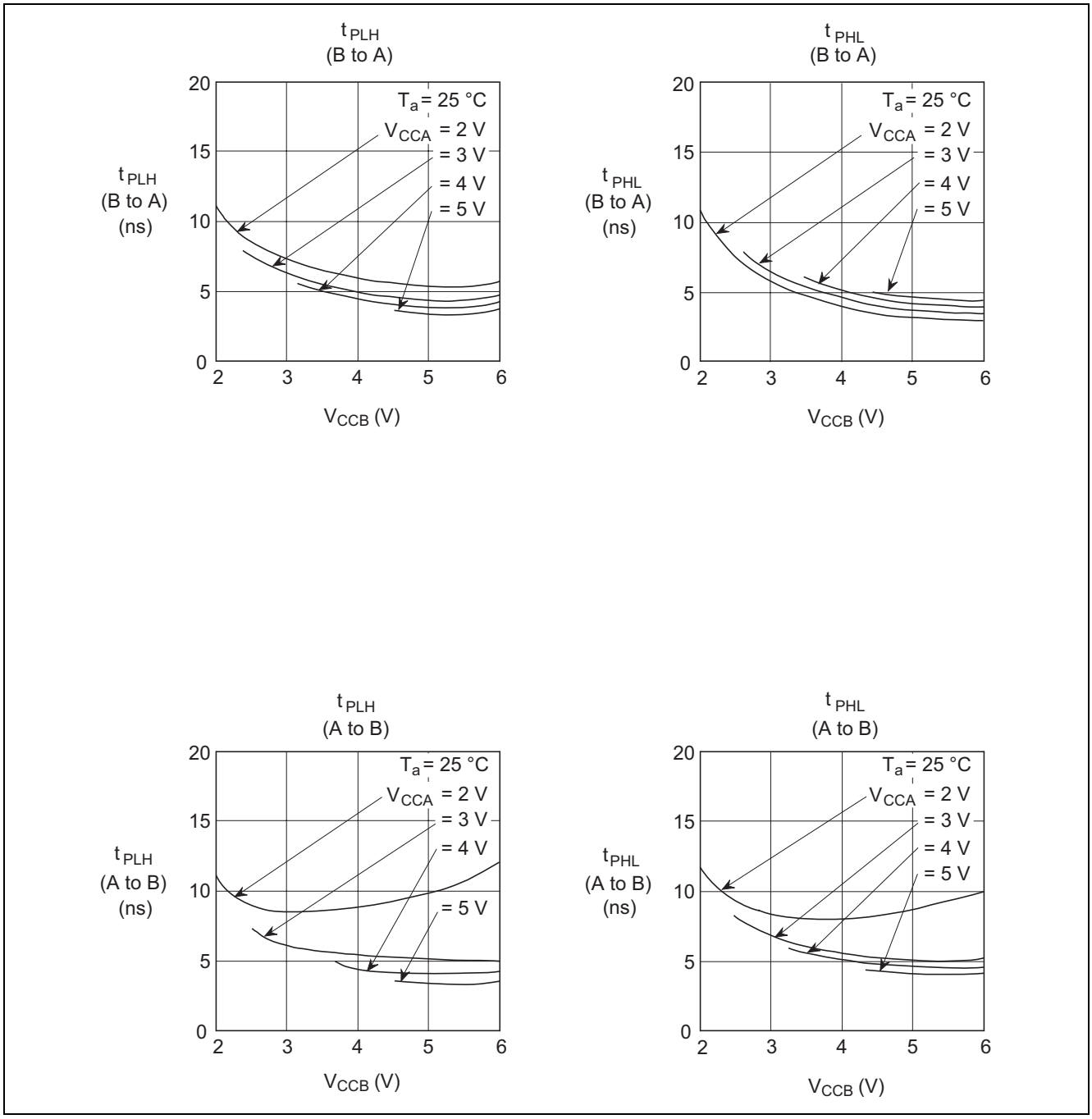

## Waveforms-2



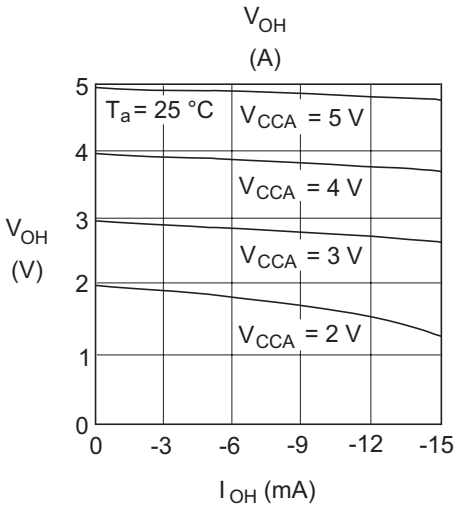

Notes:
1. $t_r = t_f = 2.5$ ns.
2. Input Waveform: PRR = 1 MHz, duty cycle 50%
3. Waveform-a is set as outputs are “Low” when enable input is “Low”.
4. Waveform-b is set as outputs are “High” when enable input is “Low”.
5. When A → B: $V_{CCA}$, B → A : $V_{CCB}$
6. When $\overline{G}$ → A: $V_{CCA}$,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

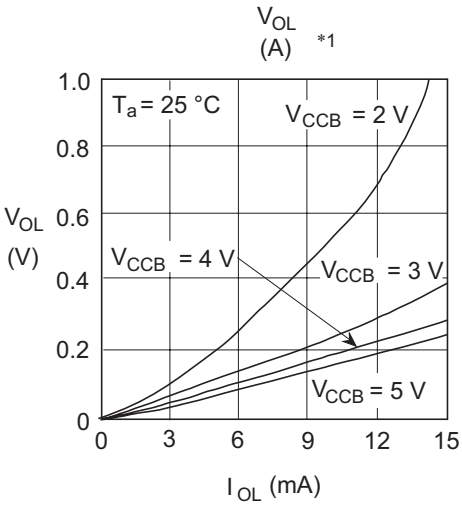
## Typical Characteristic Curves

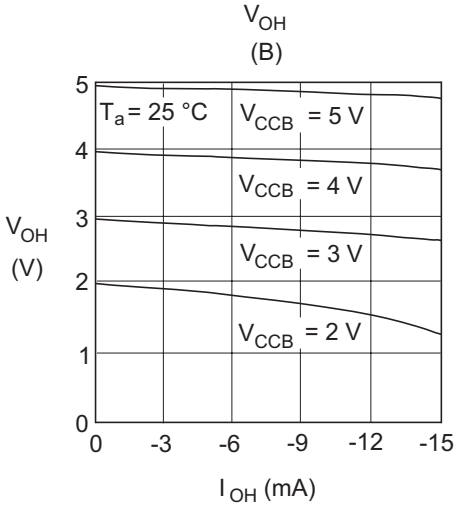
### Propagation Delay Times vs Power Supply ($V_{CCA}$, $V_{CCB}$)

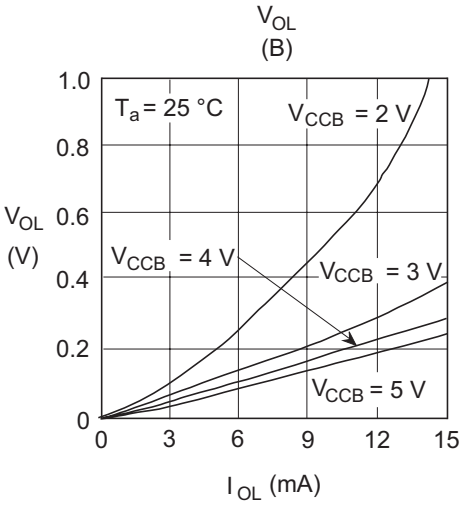


## Output Voltage vs Output Current



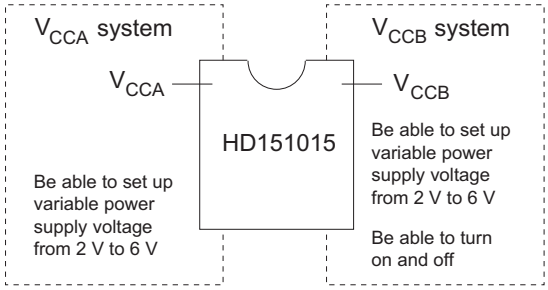




Note: 1. $V_{OL}$ (A) does not depend on $V_{CCA}$

## Application

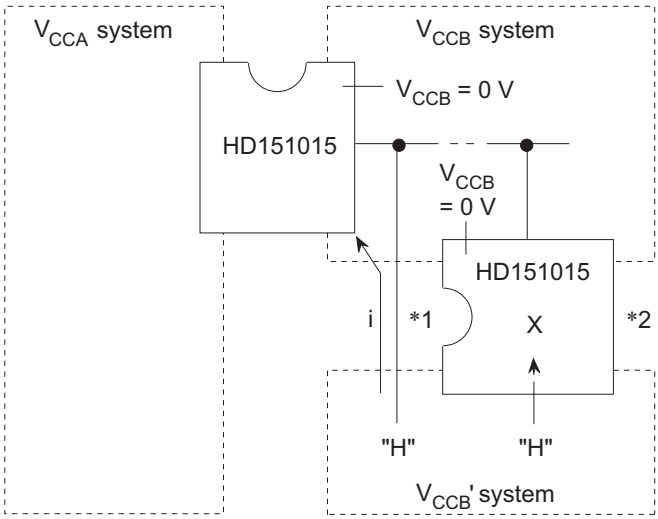
**For power management system (1)**




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)

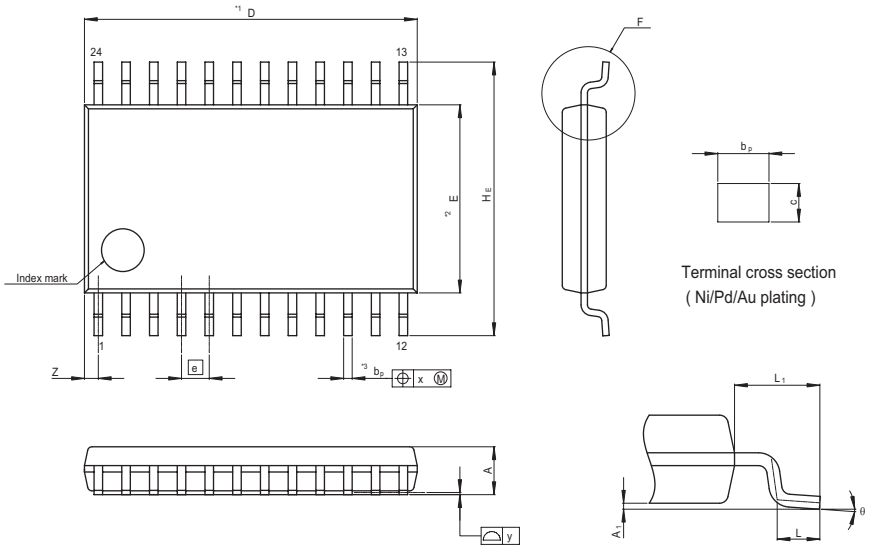
This is cause of malfunction. In order to prevent this problem, I recommend using this device for interface to each power block. (refer to *2)

[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

| JEITA Package Code | RENESAS Code | Previous Code | MASS[Typ.] |
|---|---|---|---|
| P-TSSOP24-4.4x7.8-0.65 | PTSP0024JB-A | TTP-24DBV | 0.08g |




NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

| Reference Symbol | Dimension in Millimeters | | |
|---|---|---|---|
| | Min | Nom | Max |
| D | — | 7.80 | 8.10 |
| E | — | 4.40 | — |
| $A_2$ | — | — | — |
| $A_1$ | 0.03 | 0.07 | 0.10 |
| A | — | — | 1.10 |
| $b_p$ | 0.15 | 0.20 | 0.25 |
| $b_1$ | — | — | — |
| c | 0.10 | 0.15 | 0.20 |
| $c_1$ | — | — | — |
| θ | 0° | — | 8° |
| $H_E$ | 6.20 | 6.40 | 6.60 |
| e | — | 0.65 | — |
| x | — | — | 0.13 |
| y | — | — | 0.10 |
| Z | — | — | 0.65 |
| L | 0.4 | 0.5 | 0.6 |
| $L_1$ | — | 1.0 | — |

Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan



## RENESAS SALES OFFICES

http://www.renesas.com

Refer to "**http://www.renesas.com/en/network**" for the latest and detailed information.

**Renesas Technology America, Inc.**
450 Holger Way, San Jose, CA 95134-1368, U.S.A
Tel: <1> (408) 382-7500, Fax: <1> (408) 382-7501

**Renesas Technology Europe Limited**
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.
Tel: <44> (1628) 585-100, Fax: <44> (1628) 585-900

**Renesas Technology (Shanghai) Co., Ltd.**
Unit 204, 205, AZIACenter, No.1233 Lujiazui Ring Rd, Pudong District, Shanghai, China 200120
Tel: <86> (21) 5877-1818, Fax: <86> (21) 6887-7898

**Renesas Technology Hong Kong Ltd.**
7th Floor, North Tower, World Finance Centre, Harbour City, 1 Canton Road, Tsimshatsui, Kowloon, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2730-6071

**Renesas Technology Taiwan Co., Ltd.**
10th Floor, No.99, Fushing North Road, Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

**Renesas Technology Singapore Pte. Ltd.**
1 Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001

**Renesas Technology Korea Co., Ltd.**
Kukje Center Bldg. 18th Fl., 191, 2-ka, Hangang-ro, Yongsan-ku, Seoul 140-702, Korea
Tel: <82> (2) 796-3115, Fax: <82> (2) 796-2145

**Renesas Technology Malaysia Sdn. Bhd**
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No.18, Jalan Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: <603> 7955-9390, Fax: <603> 7955-9510



Colophon .6.0