# RD74VT1G02

## 2–input NOR Gate / Dual Supply Voltage Translator

REJ03D0513–0100
Rev.1.00
Jun. 01, 2005

## Description

The RD74VT1G02 has two–input NOR gate in a 6 pin package. The input is designed to track $V_{CC}$IN, which accepts voltages from 1.2V to 3.6V, and the output is designed to track $V_{CC}$OUT, which operates at 1.2V to 3.6V. Low voltage and high-speed operation is suitable for the battery powered products (e.g., notebook computers), and the low power consumption extends the battery life.

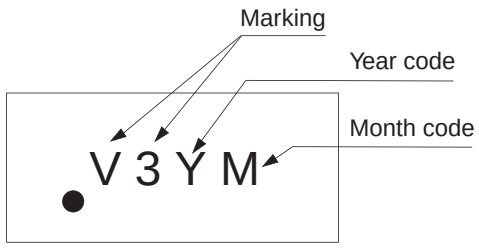
## Features

- This product function as level shift that change $V_{CC}$IN input level to $V_{CC}$OUT output level by providing different supply voltage to $V_{CC}$IN and $V_{CC}$OUT.
- The basic gate function is lined up as Renesas uni logic series.
- Supplied on emboss taping for high-speed automatic mounting.
- Supply voltage range: $V_{CC}$IN = 1.2 V to 3.6 V
  $V_{CC}$OUT = 1.2 V to 3.6 V
  Operating temperature range: –40 to +85°C
- All inputs $V_{IH}$ (Max.) = 3.6 V (@$V_{CC}$IN = 0 V to 3.6 V)
  Outputs $V_O$ (Max.) = 3.6 V (@$V_{CC}$OUT = 0 V)
- Output current ±2 mA (@$V_{CC}$OUT = 1.2 V)
  ±4 mA (@$V_{CC}$OUT = 1.4 V to 1.6 V)
  ±6 mA (@$V_{CC}$OUT = 1.65 V to 1.95 V)
  ±18 mA (@$V_{CC}$OUT = 2.3 V to 2.7 V)
  ±24 mA (@$V_{CC}$OUT = 3.0 V to 3.6 V)
- Ordering Information

| Part Name | Package Type | Package Code (Previous Code) | Package Abbreviation | Taping Abbreviation (Quantity) |
|---|---|---|---|---|
| RD74VT1G02CLE | WCSP-6 pin | SXBG0006KB–A (TBS-6AV) | CL | E (3,000 pcs/reel) |



## Article Indication



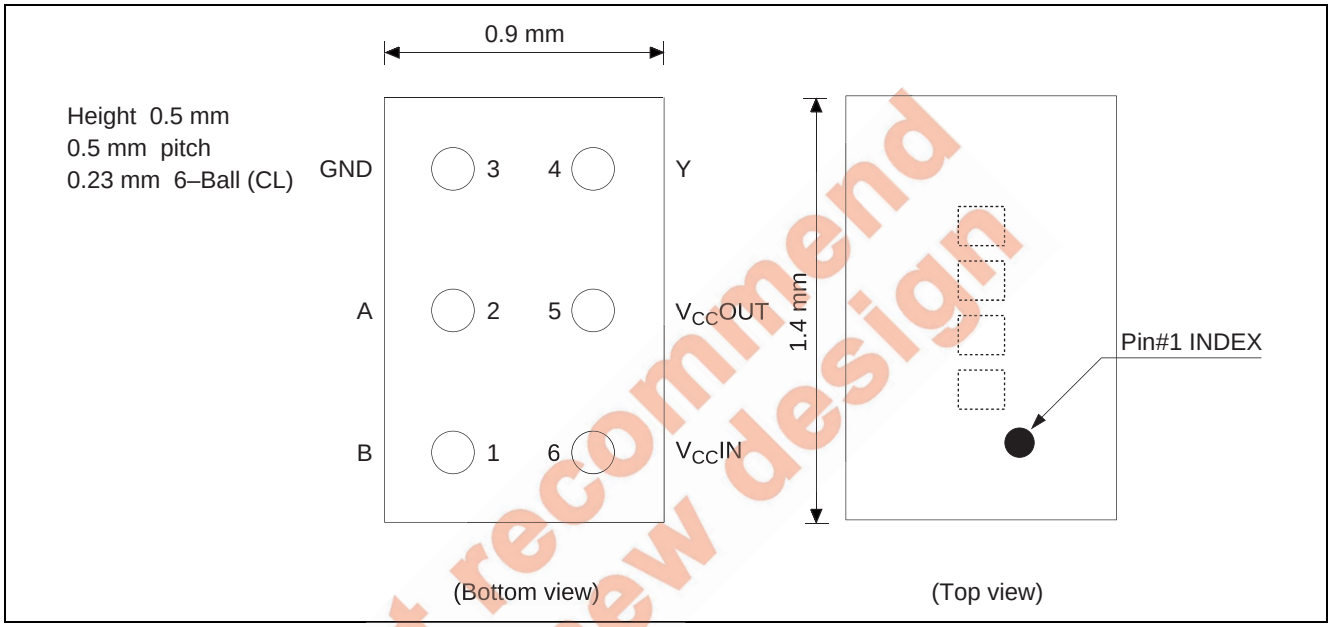
## Function Table

| Inputs | | Output Y |
|---|---|---|
| A | B | |
| L | L | H |
| L | H | L |
| H | L | L |
| H | H | L |

H: High level

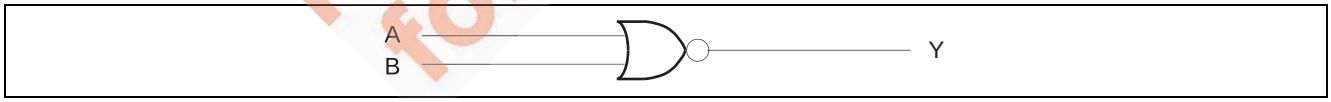
L: Low level

## Pin Arrangement






## Logic Diagram



## Absolute Maximum Ratings

| Item | Symbol | Ratings | Unit | Conditions |
|---|---|---|---|---|
| Supply voltage range | $V_{CC}$IN, $V_{CC}$OUT | –0.5 to 4.6 | V | |
| Input voltage range [*1] | $V_I$ | –0.5 to 4.6 | V | |
| Output voltage range [*1, 2] | $V_O$ | –0.5 to $V_{CC}$OUT+0.5 | V | Output: “H” or “L” |
| | | –0.5 to 4.6 | | $V_{CC}$OUT: OFF |
| Input clamp current | $I_{IK}$ | –50 | mA | $V_I$ < 0 |
| Output clamp current | $I_{OK}$ | –50 | mA | $V_O$ < 0 |
| | | 50 | | $V_O$ > $V_{CC}$+0.5 |
| Continuous output current | $I_O$ | ±50 | mA | |
| Continuous output current $V_{CC}$ or GND | $I_{CC}$IN, $I_{CC}$OUT, $I_{GND}$ | ±100 | mA | |
| Package Thermal impedance | $\theta_{ja}$ | 123 | °C/W | |
| Storage temperature | Tstg | –65 to 150 | °C | |

Notes: 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.

1. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. This value is limited to 4.6 V maximum.



## Recommended Operating Conditions

| Item | Symbol | Ratings | Unit | Conditions |
|---|---|---|---|---|
| Supply voltage range | $V_{CC}$IN | 1.2 to 3.6 | V | |
| | $V_{CC}$OUT | 1.2 to 3.6 | | |
| Input/Output voltage | $V_I$ | 0 to 3.6 | V | |
| | $V_O$ | 0 to $V_{CC}$OUT | V | Output: “H” or “L” |
| | | 0 to 3.6 | | $V_{CC}$OUT: OFF |
| Output current | $I_{OH}$ | –2 | mA | $V_{CC}$OUT = 1.2 V |
| | | –4 | | $V_{CC}$OUT = 1.5±0.1 V |
| | | –6 | | $V_{CC}$OUT = 1.8±0.15 V |
| | | –18 | | $V_{CC}$OUT = 2.5±0.2 V |
| | | –24 | | $V_{CC}$OUT = 3.3±0.3 V |
| | $I_{OL}$ | 2 | mA | $V_{CC}$OUT = 1.2 V |
| | | 4 | | $V_{CC}$OUT = 1.5±0.1 V |
| | | 6 | | $V_{CC}$OUT = 1.8±0.15 V |
| | | 18 | | $V_{CC}$OUT = 2.5±0.2 V |
| | | 24 | | $V_{CC}$OUT = 3.3±0.3 V |
| Input transition rise or fall time | $\Delta t / \Delta v$ | 10 | ns / V | |
| Operation free-air temperature | Ta | –40 to 85 | °C | |

## Electrical Characteristics

(Ta = –40 to 85°C)

| Item | Symbol | $V_{CC}IN$ (V) * | $V_{CC}OUT$ (V) * | Min | Typ | Max | Unit | Test conditions |
|---|---|---|---|---|---|---|---|---|
| Input voltage | $V_{IH}$ | 1.2 | 1.2 to 3.6 | $V_{CC}IN \times 0.75$ | — | — | V | |
| | | 1.5±0.1 | | $V_{CC}IN \times 0.70$ | — | — | | |
| | | 1.8±0.15 | | $V_{CC}IN \times 0.65$ | — | — | | |
| | | 2.5±0.2 | | 1.6 | — | — | | |
| | | 3.3±0.3 | | 2.0 | — | — | | |
| | $V_{IL}$ | 1.2 | 1.2 to 3.6 | — | — | $V_{CC}IN \times 0.25$ | V | |
| | | 1.5±0.1 | | — | — | $V_{CC}IN \times 0.30$ | | |
| | | 1.8±0.15 | | — | — | $V_{CC}IN \times 0.35$ | | |
| | | 2.5±0.2 | | — | — | 0.7 | | |
| | | 3.3±0.3 | | — | — | 0.8 | | |
| Output voltage | $V_{OH}$ | 1.2 to 3.6 | 1.2 to 3.6 | $V_{CC}OUT$–0.2 | — | — | V | $I_{OH}$ = –100 µA |
| | | | 1.2 | 0.9 | — | — | | $I_{OH}$ = –2 mA |
| | | | 1.5±0.1 | 1.1 | — | — | | $I_{OH}$ = –4 mA |
| | | | 1.8±0.15 | 1.25 | — | — | | $I_{OH}$ = –6 mA |
| | | | 2.5±0.2 | 1.7 | — | — | | $I_{OH}$ = –18 mA |
| | | | 3.3±0.3 | 2.2 | — | — | | $I_{OH}$ = –24 mA |
| | $V_{OL}$ | 1.2 to 3.6 | 1.2 to 3.6 | — | — | 0.2 | V | $I_{OL}$ = 100 µA |
| | | | 1.2 | — | — | 0.3 | | $I_{OL}$ = 2 mA |
| | | | 1.5±0.1 | — | — | 0.3 | | $I_{OL}$ = 4 mA |
| | | | 1.8±0.15 | — | — | 0.3 | | $I_{OL}$ = 6 mA |
| | | | 2.5±0.2 | — | — | 0.6 | | $I_{OL}$ = 18 mA |
| | | | 3.3±0.3 | — | — | 0.55 | | $I_{OL}$ = 24 mA |
| Input current | $I_{IN}$ | 3.6 | 3.6 | –1.0 | — | 1.0 | µA | $V_{IN}$ = GND or $V_{CC}IN$ |
| Output leakage current | $I_{OFF}$ | 0 | 0 | — | — | 1.5 | µA | $V_{IN}$, $V_{OUT}$ = 0 to 3.6 V |
| Quiescent supply current | $I_{CC}IN$ | 1.2 to 3.6 | 1.2 to 3.6 | –3.0 | — | 3.0 | µA | $I_{O(Y\ port)}$ = 0 $V_{IN}$ = $V_{CC}IN$ or GND |
| | $I_{CC}OUT$ | 1.2 to 3.6 | 1.2 to 3.6 | –3.0 | — | 3.0 | | $I_{O(Y\ port)}$ = 0 $V_{IN}$ = $V_{CC}IN$ or GND |
| Increase in $I_{CC}$ per input | $\Delta I_{CC}$ | 3.6 | 3.6 | — | — | 250 | µA | A or B port $V_{CC}IN$–0.6 (1 input) |
| Input capacitance | $C_{IN}$ | 3.3 | 3.3 | — | 3.5 | — | pF | $V_{IN}$ = $V_{CC}$ or GND |

Note: For conditions shown as Min or Max, use the appropriate values under recommended operating conditions.



## Switching Characteristics

$V_{CC}IN$ = 3.3±0.3 V

| Item | Symbol | From (input) | To (output) | Ta = –40 to 85°C | | | | | | | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{CC}OUT$= 1.2 V | $V_{CC}OUT$= 1.5±0.1 V | | $V_{CC}OUT$= 1.8±0.15 V | | $V_{CC}OUT$= 2.5±0.2 V | | $V_{CC}OUT$= 3.3±0.3 V | | | |
| | | | | Typ | Min | Max | Min | Max | Min | Max | Min | Max | | |
| Propagation delay time | $t_{PLH}$ | A or B | Y | 7.8 | 2.0 | 7.4 | 1.5 | 4.8 | 1.0 | 3.4 | 1.0 | 3.2 | ns | $C_L$ = 15pF $R_L$ = 2.0kΩ |
| | $t_{PHL}$ | | | 7.8 | 2.0 | 7.4 | 1.5 | 4.8 | 1.0 | 3.4 | 1.0 | 3.2 | | |

## Switching Characteristics (Cont)

$V_{CC}IN$ = 2.5±0.2 V

| Item | Symbol | From (input) | To (output) | Ta = –40 to 85°C | | | | | | | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{CC}OUT$= 1.2 V | $V_{CC}OUT$= 1.5±0.1 V | | $V_{CC}OUT$= 1.8±0.15 V | | $V_{CC}OUT$= 2.5±0.2 V | | $V_{CC}OUT$= 3.3±0.3 V | | | |
| | | | | Typ | Min | Max | Min | Max | Min | Max | Min | Max | | |
| Propagation delay time | $t_{PLH}$ | A or B | Y | 7.8 | 2.0 | 7.6 | 1.5 | 5.0 | 1.0 | 3.7 | 1.0 | 3.5 | ns | $C_L$ = 15pF |
| | $t_{PHL}$ | | | 7.8 | 2.0 | 7.6 | 1.5 | 5.0 | 1.0 | 3.7 | 1.0 | 3.5 | | $R_L$ = 2.0kΩ |

$V_{CC}IN$ = 1.8±0.15 V

| Item | Symbol | From (input) | To (output) | Ta = –40 to 85°C | | | | | | | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{CC}OUT$= 1.2 V | $V_{CC}OUT$= 1.5±0.1 V | | $V_{CC}OUT$= 1.8±0.15 V | | $V_{CC}OUT$= 2.5±0.2 V | | $V_{CC}OUT$= 3.3±0.3 V | | | |
| | | | | Typ | Min | Max | Min | Max | Min | Max | Min | Max | | |
| Propagation delay time | $t_{PLH}$ | A or B | Y | 8.0 | 2.0 | 8.0 | 1.5 | 5.5 | 1.0 | 4.4 | 1.0 | 4.0 | ns | $C_L$ = 15pF |
| | $t_{PHL}$ | | | 8.0 | 2.0 | 8.0 | 1.5 | 5.5 | 1.0 | 4.4 | 1.0 | 4.0 | | $R_L$ = 2.0kΩ |

$V_{CC}IN$ = 1.5±0.1 V

| Item | Symbol | From (input) | To (output) | Ta = –40 to 85°C | | | | | | | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{CC}OUT$= 1.2 V | $V_{CC}OUT$= 1.5±0.1 V | | $V_{CC}OUT$= 1.8±0.15 V | | $V_{CC}OUT$= 2.5±0.2 V | | $V_{CC}OUT$= 3.3±0.3 V | | | |
| | | | | Typ | Min | Max | Min | Max | Min | Max | Min | Max | | |
| Propagation delay time | $t_{PLH}$ | A or B | Y | 8.2 | 2.0 | 8.5 | 1.5 | 6.4 | 1.0 | 5.5 | 1.0 | 5.2 | ns | $C_L$ = 15pF |
| | $t_{PHL}$ | | | 8.2 | 2.0 | 8.5 | 1.5 | 6.4 | 1.0 | 5.5 | 1.0 | 5.2 | | $R_L$ = 2.0kΩ |

$V_{CC}IN$ = 1.2 V

| Item | Symbol | From (input) | To (output) | Ta = –40 to 85°C | | | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $V_{CC}OUT$= 1.2 V | $V_{CC}OUT$= 1.5±0.1 V | $V_{CC}OUT$= 1.8±0.15 V | $V_{CC}OUT$= 2.5±0.2 V | $V_{CC}OUT$= 3.3±0.3 V | | |
| | | | | Typ | Typ | Typ | Typ | Typ | | |
| Propagation delay time | $t_{PLH}$ | A or B | Y | 8.7 | 7.0 | 6.0 | 5.5 | 5.5 | ns | $C_L$ = 15pF |
| | $t_{PHL}$ | | | 8.7 | 7.0 | 6.0 | 5.5 | 5.5 | | $R_L$ = 2.0kΩ |

## Operating Characteristics

Ta = 25°C

| Item | Symbol | $V_{CC}IN$ (V) | $V_{CC}OUT$ (V) | Min | Typ | Max | Unit | Test conditions |
|---|---|---|---|---|---|---|---|---|
| Power dissipation capacitance | $C_{PD}$ | 3.3 | 3.3 | — | 12 | — | pF | f = 10 MHz<br>$C_L$ = 0 |



## Power-up Considerations

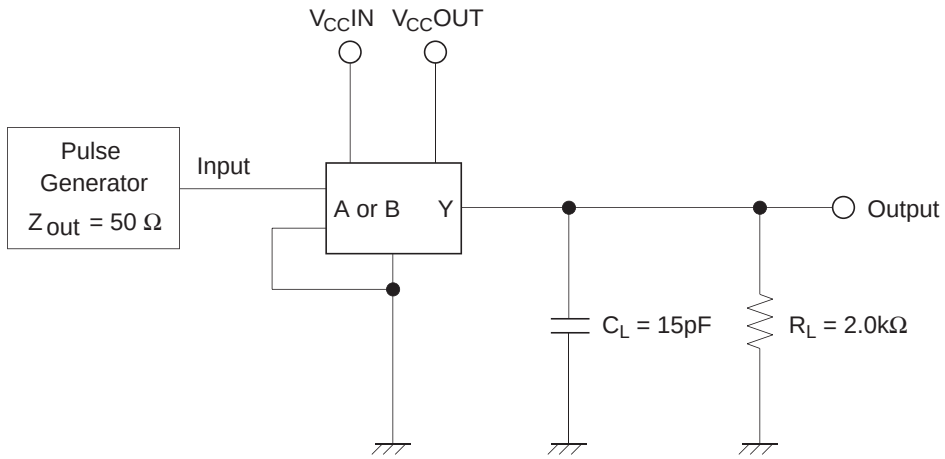
Level-translation devices offer an opportunity for successful mixed-voltage signal design.

A proper power-up sequence always should be followed to avoid excessive supply current, bus contention, oscillations, or other anomalies caused by improperly biased device pins.

Take these precautions to guard against such power-up problems.

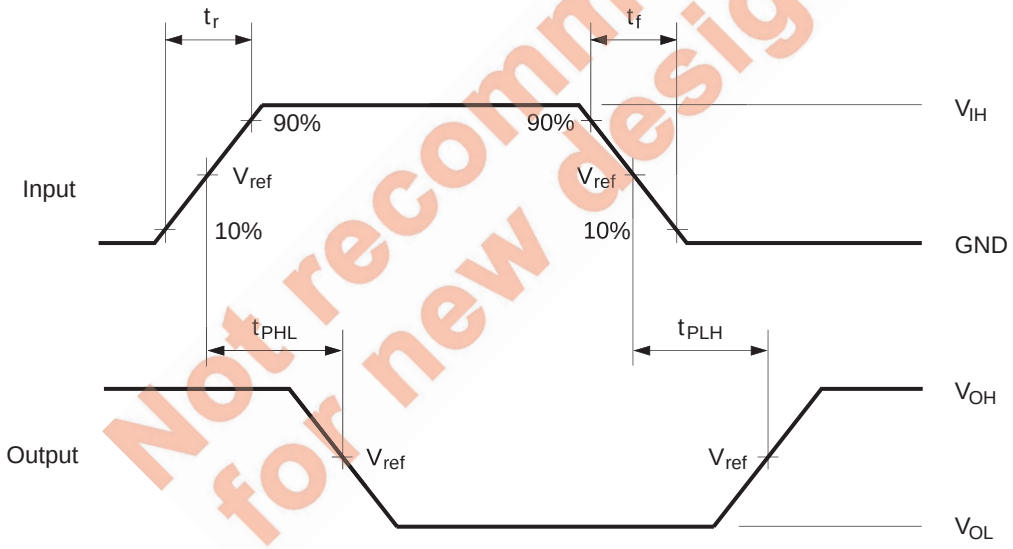
1. Connect ground before any supply voltage is applied.
2. Next, power up the input side of the device.
   (Power up of $V_{CC}IN$ is first. Next power up is $V_{CC}OUT$)

## Test Circuit




Note: $C_L$ includes probe and jig capacitance.

• **Waveforms**

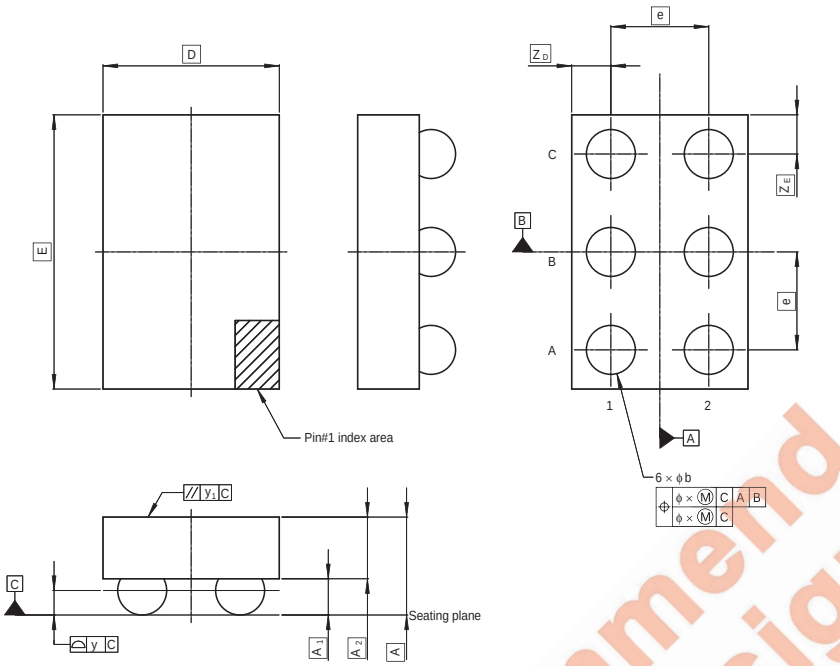



| Symbol | $V_{CC}$ = 1.2V to 3.6V |
|---|---|
| $t_r$ / $t_f$ | 2.0 ns |
| $V_{IH}$ | $V_{CC}$ |
| $V_{ref}$ | 1/2 $V_{CC}$ |

Note: Input waveform : PRR ≤ 10 MHz, $Z_O$ = 50 Ω, duty cycle 50%

# Package Dimensions

| JEITA Package Code | RENESAS Code | Previous Code | MASS[Typ.] |
|---|---|---|---|
| S-XFBGA6-0.9x1.4-0.50 | SXBG0006KB-A | TBS-6AV | 0.001g |




* Reference value.

| Reference Symbol | Dimension in Millimeters | | |
|---|---|---|---|
| | Min | Nom | Max |
| A | — | — | 0.50 |
| $A_1$ | 0.155 | — | 0.185 |
| $A_2$ | — | — | (0.315) * |
| b | 0.20 | — | 0.25 |
| D | — | 0.90 | — |
| E | — | 1.40 | — |
| e | — | 0.50 | — |
| x | — | — | 0.05 |
| y | — | — | 0.05 |
| $y_1$ | — | — | 0.20 |
| $Z_D$ | — | 0.20 | — |
| $Z_E$ | — | 0.20 | — |

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