RD74VT1G240

Bus Buffer Inverted with 3-state Output / Dual Supply Voltage Translator

REJ03D0518–0100
Rev.1.00
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Description

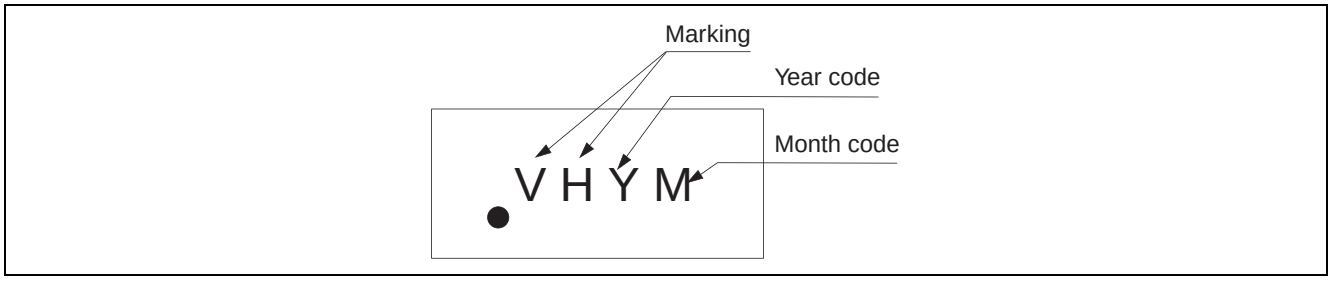
The RD74VT1G240 has a bus buffer inverted with 3-state output in a 6 pin package. Output is disabled when the associated output enable ($\overline{OE}$) input is high. To ensure the high impedance state during power up or power down, $\overline{OE}$ should be connected to V_{CC} through a pull-up resistor; the minimum value of the resistor is determined by the current sinking capability of the driver. 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)
RD74VT1G240CLE	WCSP-6 pin	SXBG0006KB–A (TBS-6AV)	CL	E (3,000 pcs/reel)

Article Indication



Function Table

Inputs		Output $\overline{Y}$
$\overline{OE}$	A	
L	L	H
L	H	L
H	X	Z

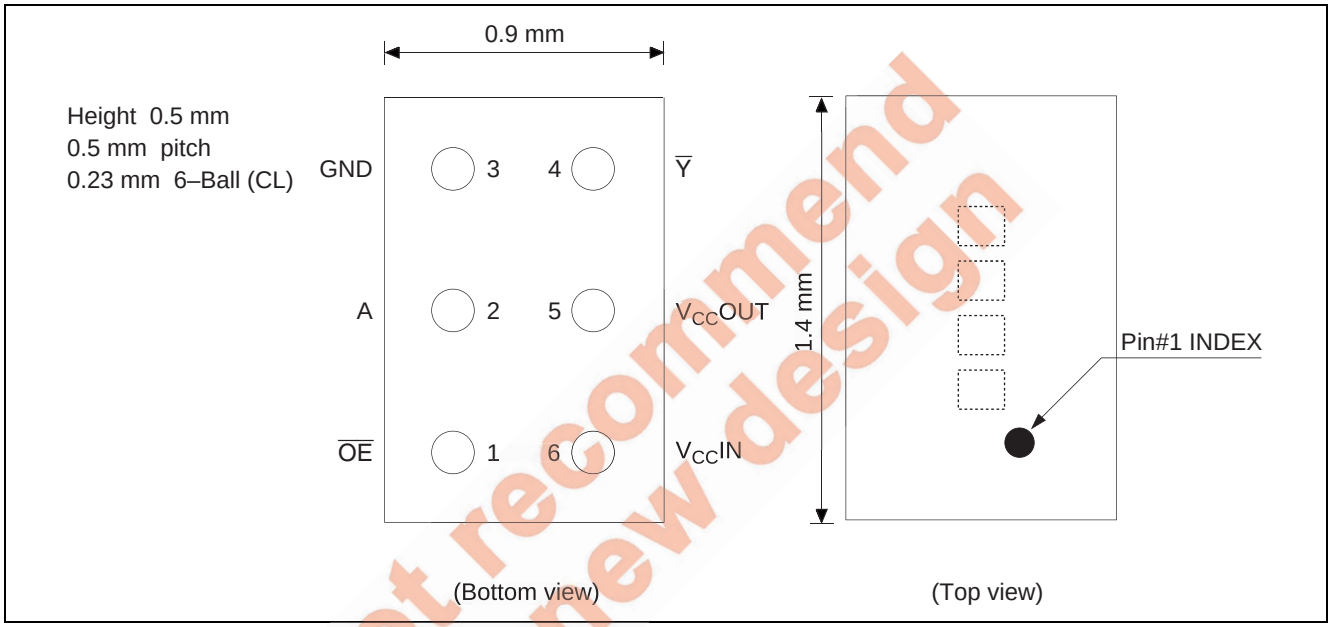
H: High level

L: Low level

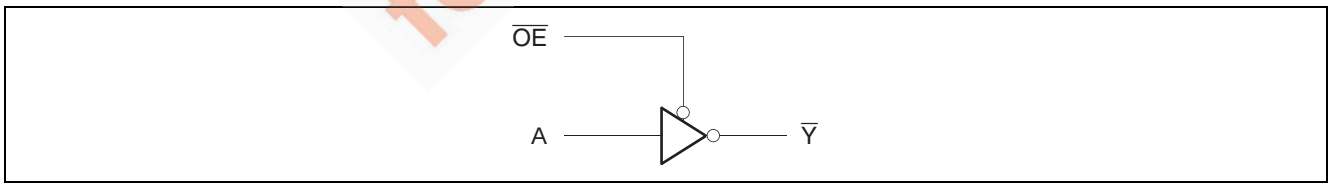
X: Immaterial

Z: High impedance

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	A port or $\overline{OE}$
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		Output: “Z” or 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	θ_{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	A port or $\overline{OE}$
	V_O	0 to V_{CC}OUT	V	Output: “H” or “L”
		0 to 3.6		Output: “Z” or 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	A port Control input
		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	A port Control input
		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 $V_{CC}IN$ control input
Off state output current	I_{OZ}	3.6	3.6	–1.5	—	1.5	µA	V_{IN} = V_{IH} or V_{IL}
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	$I_{O(\overline{Y}\ port)}$ = 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		$I_{O(\overline{Y}\ port)}$ = 0 V_{IN} = $V_{CC}IN$ or GND
Increase in I_{CC} per input	ΔI_{CC}	3.6	3.6	—	—	250	µA	A port or control $V_{CC}IN$–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	$\overline{Y}$	9.6	2.0	9.4	1.0	6.0	1.0	4.0	1.0	3.4	ns	C_L = 15pF R_L = 2.0kΩ
	t_{PHL}			9.6	2.0	9.4	1.0	6.0	1.0	4.0	1.0	3.4		
Output enable time	t_{ZH}	$\overline{OE}$	$\overline{Y}$	11.2	2.0	10.6	1.5	6.8	1.0	4.2	1.0	3.8	ns	C_L = 15pF R_L = 2.0kΩ
	t_{ZL}			11.2	2.0	10.6	1.5	6.8	1.0	4.2	1.0	3.8		
Output disable time	t_{HZ}	$\overline{OE}$	$\overline{Y}$	5.0	2.0	5.4	1.5	4.7	1.0	4.0	1.0	3.8	ns	C_L = 15pF R_L = 2.0kΩ
	t_{LZ}			5.0	2.0	5.4	1.5	4.7	1.0	4.0	1.0	3.8		

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	$\overline{Y}$	10.0	2.0	9.4	1.5	6.0	1.0	4.0	1.0	3.5	ns	C_L = 15pF
	t_{PHL}			10.0	2.0	9.4	1.5	6.0	1.0	4.0	1.0	3.5		R_L = 2.0kΩ
Output enable time	t_{ZH}	$\overline{OE}$	$\overline{Y}$	11.6	2.0	11.4	1.5	7.2	1.0	4.8	1.0	3.8	ns	C_L = 15pF
	t_{ZL}			11.6	2.0	11.4	1.5	7.2	1.0	4.8	1.0	3.8		R_L = 2.0kΩ
Output disable time	t_{HZ}	$\overline{OE}$	$\overline{Y}$	5.2	2.0	5.0	1.5	4.7	1.0	4.0	1.0	4.0	ns	C_L = 15pF
	t_{LZ}			5.2	2.0	5.0	1.5	4.7	1.0	4.0	1.0	4.0		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	$\overline{Y}$	10.2	2.0	9.8	1.5	6.5	1.0	4.4	1.0	4.1	ns	C_L = 15pF
	t_{PHL}			10.2	2.0	9.8	1.5	6.5	1.0	4.4	1.0	4.1		R_L = 2.0kΩ
Output enable time	t_{ZH}	$\overline{OE}$	$\overline{Y}$	11.6	2.0	11.8	1.5	7.6	1.0	5.2	1.0	4.4	ns	C_L = 15pF
	t_{ZL}			11.6	2.0	11.8	1.5	7.6	1.0	5.2	1.0	4.4		R_L = 2.0kΩ
Output disable time	t_{HZ}	$\overline{OE}$	$\overline{Y}$	5.8	2.0	5.6	1.5	5.4	1.0	4.8	1.0	5.0	ns	C_L = 15pF
	t_{LZ}			5.8	2.0	5.6	1.5	5.4	1.0	4.8	1.0	5.0		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	$\overline{Y}$	11.4	2.0	10.5	1.5	7.2	1.0	4.8	1.0	4.7	ns	C_L = 15pF
	t_{PHL}			11.4	2.0	10.5	1.5	7.2	1.0	4.8	1.0	4.7		R_L = 2.0kΩ
Output enable time	t_{ZH}	$\overline{OE}$	$\overline{Y}$	12.2	2.0	12.6	1.5	8.6	1.0	5.4	1.0	4.8	ns	C_L = 15pF
	t_{ZL}			12.2	2.0	12.6	1.5	8.6	1.0	5.4	1.0	4.8		R_L = 2.0kΩ
Output disable time	t_{HZ}	$\overline{OE}$	$\overline{Y}$	6.2	2.0	7.0	1.5	6.0	1.0	5.4	1.0	5.2	ns	C_L = 15pF
	t_{LZ}			6.2	2.0	7.0	1.5	6.0	1.0	5.4	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	$\overline{Y}$	11.0	7.5	6.0	4.5	4.0	ns	C_L = 15pF
	t_{PHL}			11.0	7.5	6.0	4.5	4.0		R_L = 2.0kΩ
Output enable time	t_{ZH}	$\overline{OE}$	$\overline{Y}$	12.8	9.5	7.2	5.2	4.5	ns	C_L = 15pF
	t_{ZL}			12.8	9.5	7.2	5.2	4.5		R_L = 2.0kΩ
Output disable time	t_{HZ}	$\overline{OE}$	$\overline{Y}$	7.0	6.0	5.7	5.5	5.5	ns	C_L = 15pF
	t_{LZ}			7.0	6.0	5.7	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 C_L = 0

Power-up Considerations

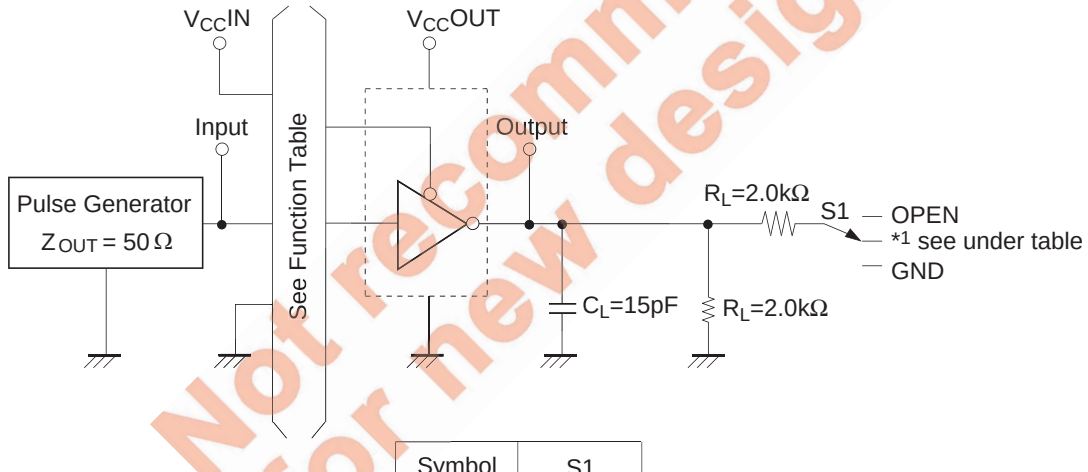
Level-translation devices offer an opportunity for successful mixed-voltage signal design.

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 control side of the device.
   (Power up of V_{CC}IN is first. Next power up is V_{CC}OUT)
3. Tie $\overline{OE}$ to V_{CC}IN with a pull-up resistor so that it ramps with V_{CC}IN.

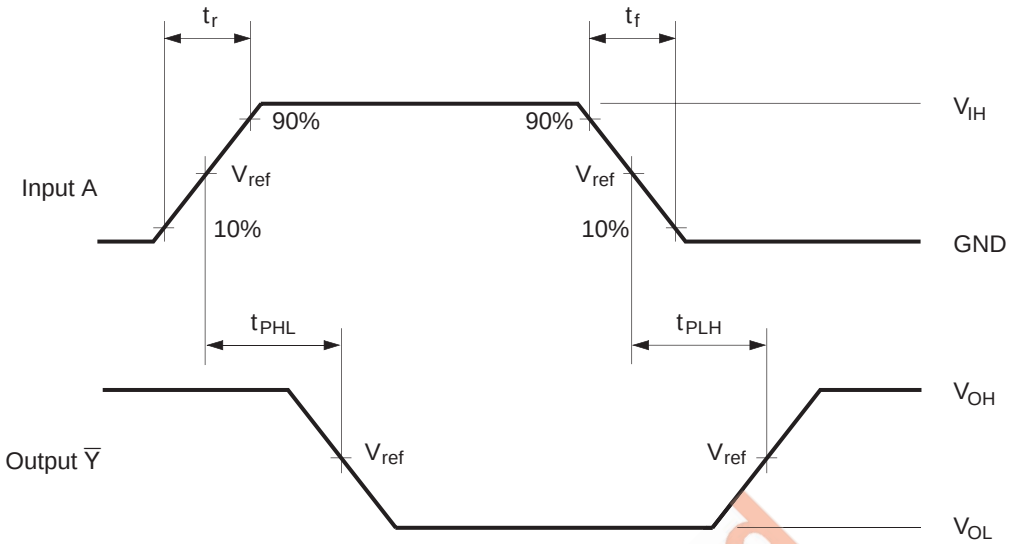
Test Circuit



Symbol	S1
t_{PLH}/ t_{PHL}	OPEN
t_{HZ} / t_{ZH}	GND
t_{LZ} / t_{ZL}	2 × V_{CC}

Note: C_L includes probe and jig capacitance.

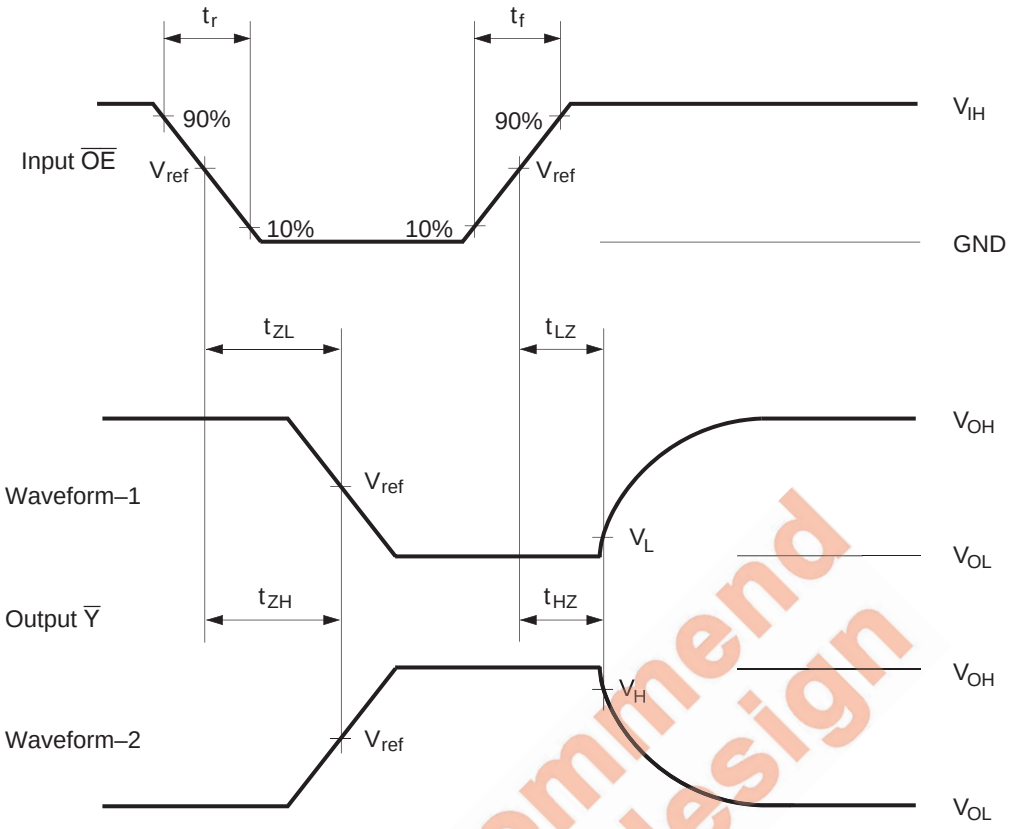
Waveforms–1



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

Note: 1. Input waveform : PRR ≤ 10 MHz, Zo = 50 Ω, duty cycle 50%.

Waveforms–2

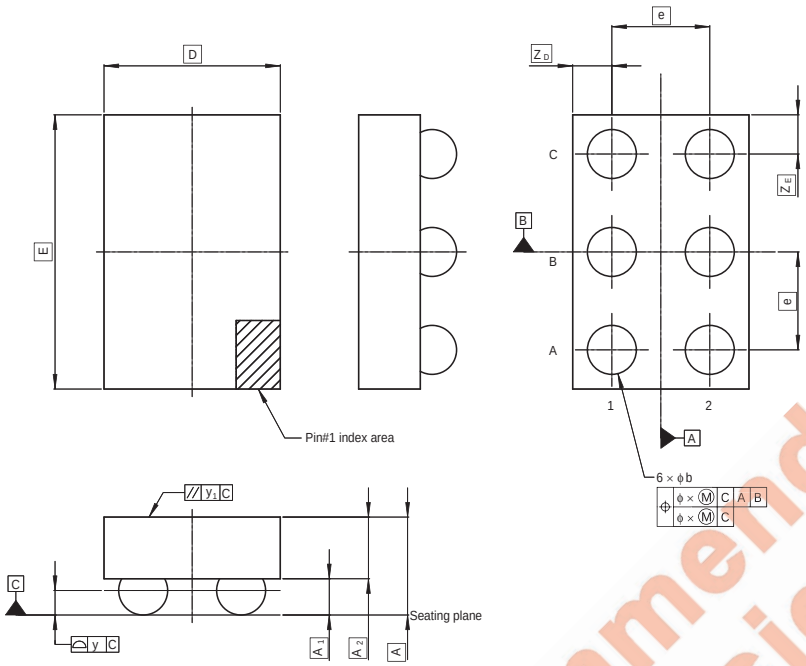


Symbol	V_{CC} = 1.2 V, 1.5±0.1 V	V_{CC} = 1.8±0.15 V	V_{CC} = 2.5±0.2 V	V_{CC} = 3.3±0.3 V
t_r / t_f	2.0 ns	2.0 ns	2.0 ns	2.0 ns
V_{IH}	V_{CC}	V_{CC}	V_{CC}	V_{CC}
V_{ref}	1/2V_{CC}	1/2V_{CC}	1/2V_{CC}	1/2V_{CC}
V_H / V_L	V_H = V_{OH}-0.1 V V_L = V_{OL}+0.1 V	V_H = V_{OH}-0.15 V V_L = V_{OL}+0.15 V	V_H = V_{OH}-0.15 V V_L = V_{OL}+0.15 V	V_H = V_{OH}-0.3 V V_L = V_{OL}+0.3 V

Notes: 1. Input waveform : PRR ≤ 10 MHz, Z_O = 50 Ω, duty cycle 50%
2. Waveform – 1 is for an output with internal conditions such that the output is low except when disabled by the output control.
3. Waveform – 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
4. The output are measured one at a time with one transition per measurement.

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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