

# RD74VT1G240

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

REJ03D0518-0100

Rev.1.00

Jun. 01, 2005

### Description

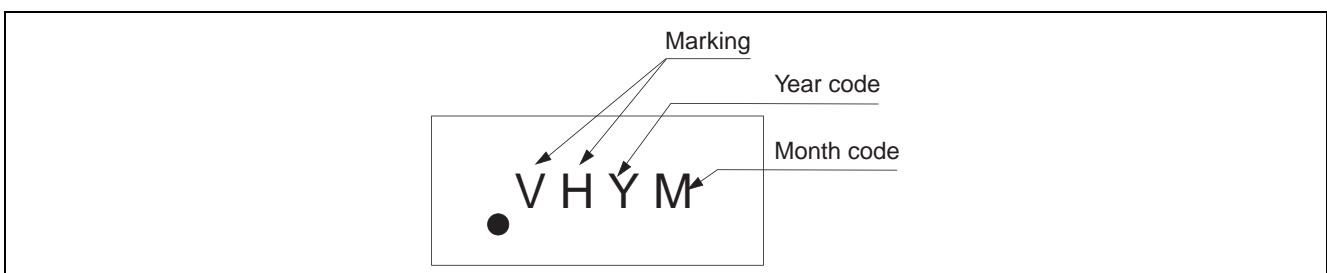
The RD74VT1G240 has a bus buffer inverted with 3-state output in a 6 pin package. Output is disabled when the associated output enable ( $\overline{OE}$ ) input is high. To ensure the high impedance state during power up or power down,  $\overline{OE}$  should be connected to  $V_{CC}$  through a pull-up resistor; the minimum value of the resistor is determined by the current sinking capability of the driver. The input is designed to track  $V_{CCIN}$ , which accepts voltages from 1.2V to 3.6V, and the output is designed to track  $V_{CCOUT}$ , 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  $V_{CCIN}$  input level to  $V_{CCOUT}$  output level by providing different supply voltage to  $V_{CCIN}$  and  $V_{CCOUT}$ .
- The basic gate function is lined up as Renesas uni logic series.
- Supplied on emboss taping for high-speed automatic mounting.
- Supply voltage range:  $V_{CCIN} = 1.2\text{ V to }3.6\text{ V}$   
 $V_{CCOUT} = 1.2\text{ V to }3.6\text{ V}$   
Operating temperature range:  $-40\text{ to }+85^{\circ}\text{C}$
- All inputs  $V_{IH}(\text{Max.}) = 3.6\text{ V} (@V_{CCIN} = 0\text{ V to }3.6\text{ V})$   
Outputs  $V_O(\text{Max.}) = 3.6\text{ V} (@V_{CCOUT} = 0\text{ V})$
- Output current  $\pm 2\text{ mA} (@V_{CCOUT} = 1.2\text{ V})$   
 $\pm 4\text{ mA} (@V_{CCOUT} = 1.4\text{ V to }1.6\text{ V})$   
 $\pm 6\text{ mA} (@V_{CCOUT} = 1.65\text{ V to }1.95\text{ V})$   
 $\pm 18\text{ mA} (@V_{CCOUT} = 2.3\text{ V to }2.7\text{ V})$   
 $\pm 24\text{ mA} (@V_{CCOUT} = 3.0\text{ V to }3.6\text{ V})$
- 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

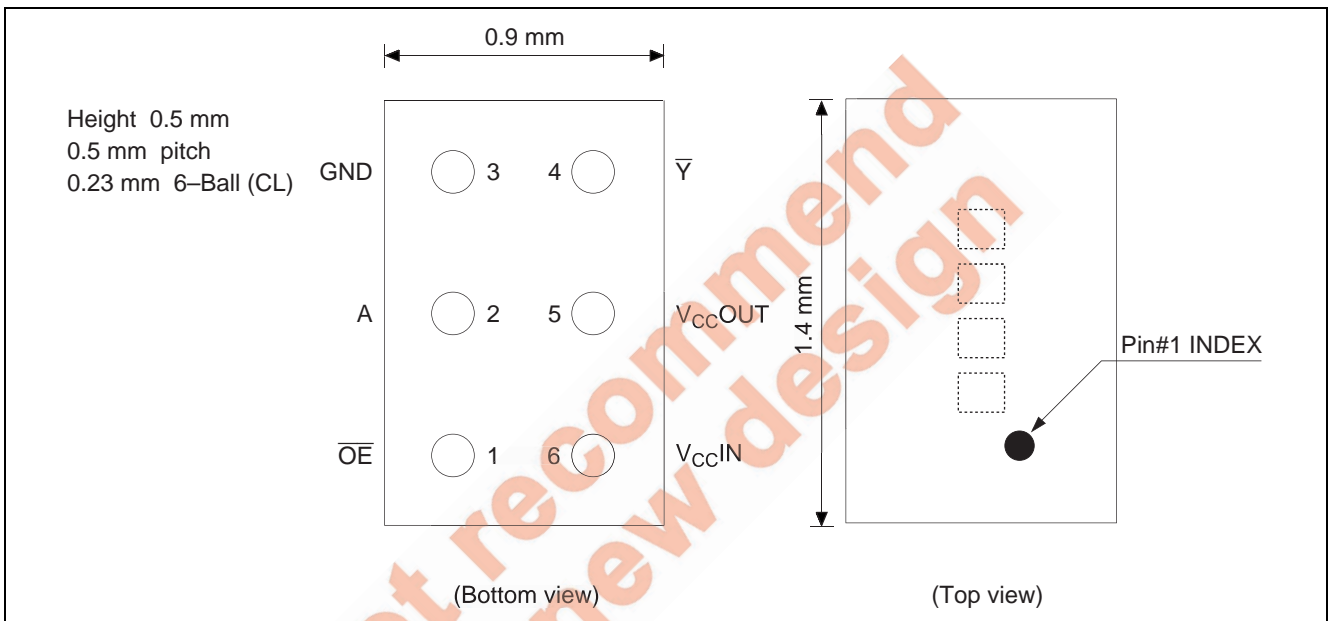


**Function Table**

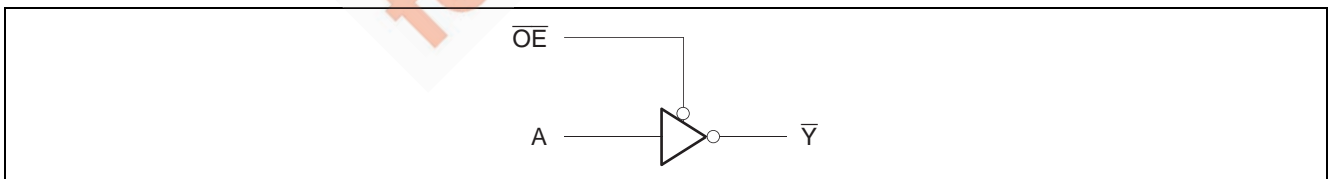
Inputs		Output $\bar{Y}$
$\bar{OE}$	A	
L	L	H
L	H	L
H	X	Z

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	$V_{CCIN}, V_{CCOUT}$	-0.5 to 4.6	V	
Input voltage range <sup>*1</sup>	$V_I$	-0.5 to 4.6	V	A port or $\overline{OE}$
Output voltage range <sup>*1, 2</sup>	$V_O$	-0.5 to $V_{CCOUT}+0.5$	V	Output: "H" or "L"
		-0.5 to 4.6		Output: "Z" or $V_{CCOUT}$ : 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	$I_O$	$\pm 50$	mA	
Continuous output current $V_{CC}$ or GND	$I_{CCIN}, I_{CCOUT}, I_{GND}$	$\pm 100$	mA	
Package Thermal impedance	$\theta_{ja}$	123	$^{\circ}C/W$	
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}C$	

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	$V_{CCIN}$	1.2 to 3.6	V	
	$V_{CCOUT}$	1.2 to 3.6		
Input/Output voltage	$V_I$	0 to 3.6	V	A port or $\overline{OE}$
	$V_O$	0 to $V_{CCOUT}$	V	Output: "H" or "L"
0 to 3.6		Output: "Z" or $V_{CCOUT}$ : OFF		
Output current	$I_{OH}$	-2	mA	$V_{CCOUT} = 1.2$ V
		-4		$V_{CCOUT} = 1.5 \pm 0.1$ V
		-6		$V_{CCOUT} = 1.8 \pm 0.15$ V
		-18		$V_{CCOUT} = 2.5 \pm 0.2$ V
		-24		$V_{CCOUT} = 3.3 \pm 0.3$ V
	$I_{OL}$	2	mA	$V_{CCOUT} = 1.2$ V
		4		$V_{CCOUT} = 1.5 \pm 0.1$ V
		6		$V_{CCOUT} = 1.8 \pm 0.15$ V
		18		$V_{CCOUT} = 2.5 \pm 0.2$ V
		24		$V_{CCOUT} = 3.3 \pm 0.3$ V
Input transition rise or fall time	$\Delta t / \Delta v$	10	ns / V	
Operation free-air temperature	$T_a$	-40 to 85	$^{\circ}C$	

## Electrical Characteristics

(Ta = -40 to 85°C)

Item	Symbol	V <sub>CCIN</sub> (V)*	V <sub>CCOUT</sub> (V)*	Min	Typ	Max	Unit	Test conditions	
Input voltage	V <sub>IH</sub>	1.2	1.2 to 3.6	V <sub>CCIN</sub> ×0.75	—	—	V	A port Control input	
		1.5±0.1		V <sub>CCIN</sub> ×0.70	—	—			
		1.8±0.15		V <sub>CCIN</sub> ×0.65	—	—			
		2.5±0.2		1.6	—	—			
		3.3±0.3		2.0	—	—			
	V <sub>IL</sub>	1.2	1.2 to 3.6	—	—	V <sub>CCIN</sub> ×0.25	V	A port Control input	
		1.5±0.1		—	—	V <sub>CCIN</sub> ×0.30			
		1.8±0.15		—	—	V <sub>CCIN</sub> ×0.35			
		2.5±0.2		—	—	0.7			
		3.3±0.3		—	—	0.8			
Output voltage	V <sub>OH</sub>	1.2 to 3.6	1.2 to 3.6	V <sub>CCOUT</sub> -0.2	—	—	V	I <sub>OH</sub> = -100 μA	
			1.2	0.9	—	—		I <sub>OH</sub> = -2 mA	
			1.5±0.1	1.1	—	—		I <sub>OH</sub> = -4 mA	
			1.8±0.15	1.25	—	—		I <sub>OH</sub> = -6 mA	
			2.5±0.2	1.7	—	—		I <sub>OH</sub> = -18 mA	
			3.3±0.3	2.2	—	—		I <sub>OH</sub> = -24 mA	
			V <sub>OL</sub>	1.2 to 3.6	1.2 to 3.6	—		—	0.2
	1.2	—			—	0.3	I <sub>OL</sub> = 2 mA		
	1.5±0.1	—			—	0.3	I <sub>OL</sub> = 4 mA		
	1.8±0.15	—			—	0.3	I <sub>OL</sub> = 6 mA		
	2.5±0.2	—			—	0.6	I <sub>OL</sub> = 18 mA		
	3.3±0.3	—			—	0.55	I <sub>OL</sub> = 24 mA		
	Input current	I <sub>IN</sub>			3.6	3.6	-1.0	—	1.0
			I <sub>OZ</sub>	3.6					
Output leakage current	I <sub>OFF</sub>	0			0	—	—	1.5	μA
			Quiescent supply current	I <sub>CCIN</sub>					
I <sub>CCOUT</sub>	1.2 to 3.6	1.2 to 3.6			-3.0	—	3.0	μA	I <sub>O(̄port)</sub> = 0 V <sub>IN</sub> = V <sub>CCIN</sub> or GND
			Increase in I <sub>CC</sub> per input	ΔI <sub>CC</sub>					3.6
Input capacitance	C <sub>IN</sub>	3.3			3.3	—	3.5	—	

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

## Switching Characteristics

V<sub>CCIN</sub> = 3.3±0.3 V

Item	Symbol	From (input)	To (output)	Ta = -40 to 85°C										Unit	Test conditions
				V <sub>CCOUT</sub> = 1.2 V		V <sub>CCOUT</sub> = 1.5±0.1 V		V <sub>CCOUT</sub> = 1.8±0.15 V		V <sub>CCOUT</sub> = 2.5±0.2 V		V <sub>CCOUT</sub> = 3.3±0.3 V			
				Typ	Min	Max	Min	Max	Min	Max	Min	Max	Min		
Propagation delay time	t <sub>PLH</sub>	A	ȳ	9.6	2.0	9.4	1.0	6.0	1.0	4.0	1.0	3.4	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>PHL</sub>			9.6	2.0	9.4	1.0	6.0	1.0	4.0	1.0	3.4			
Output enable time	t <sub>ZH</sub>	OE	ȳ	11.2	2.0	10.6	1.5	6.8	1.0	4.2	1.0	3.8	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>ZL</sub>			11.2	2.0	10.6	1.5	6.8	1.0	4.2	1.0	3.8			
Output disable time	t <sub>HZ</sub>	OE	ȳ	5.0	2.0	5.4	1.5	4.7	1.0	4.0	1.0	3.8	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>LZ</sub>			5.0	2.0	5.4	1.5	4.7	1.0	4.0	1.0	3.8			

## Switching Characteristics (Cont)

$V_{CCIN} = 2.5 \pm 0.2 \text{ V}$

Item	Symbol	From (input)	To (output)	Ta = -40 to 85°C								Unit	Test conditions		
				V <sub>CC</sub> OUT= 1.2 V		V <sub>CC</sub> OUT= 1.5±0.1 V		V <sub>CC</sub> OUT= 1.8±0.15 V		V <sub>CC</sub> OUT= 2.5±0.2 V				V <sub>CC</sub> OUT= 3.3±0.3 V	
				Typ	Min	Max	Min	Max	Min	Max	Min			Max	Min
Propagation delay time	t <sub>PLH</sub>	A	Y̅	10.0	2.0	9.4	1.5	6.0	1.0	4.0	1.0	3.5	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>PHL</sub>			10.0	2.0	9.4	1.5	6.0	1.0	4.0	1.0	3.5			
Output enable time	t <sub>ZH</sub>	OE̅	Y̅	11.6	2.0	11.4	1.5	7.2	1.0	4.8	1.0	3.8	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>ZL</sub>			11.6	2.0	11.4	1.5	7.2	1.0	4.8	1.0	3.8			
Output disable time	t <sub>HZ</sub>	OE̅	Y̅	5.2	2.0	5.0	1.5	4.7	1.0	4.0	1.0	4.0	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>LZ</sub>			5.2	2.0	5.0	1.5	4.7	1.0	4.0	1.0	4.0			

$V_{CCIN} = 1.8 \pm 0.15 \text{ V}$

Item	Symbol	From (input)	To (output)	Ta = -40 to 85°C								Unit	Test conditions		
				V <sub>CC</sub> OUT= 1.2 V		V <sub>CC</sub> OUT= 1.5±0.1 V		V <sub>CC</sub> OUT= 1.8±0.15 V		V <sub>CC</sub> OUT= 2.5±0.2 V				V <sub>CC</sub> OUT= 3.3±0.3 V	
				Typ	Min	Max	Min	Max	Min	Max	Min			Max	Min
Propagation delay time	t <sub>PLH</sub>	A	Y̅	10.2	2.0	9.8	1.5	6.5	1.0	4.4	1.0	4.1	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>PHL</sub>			10.2	2.0	9.8	1.5	6.5	1.0	4.4	1.0	4.1			
Output enable time	t <sub>ZH</sub>	OE̅	Y̅	11.6	2.0	11.8	1.5	7.6	1.0	5.2	1.0	4.4	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>ZL</sub>			11.6	2.0	11.8	1.5	7.6	1.0	5.2	1.0	4.4			
Output disable time	t <sub>HZ</sub>	OE̅	Y̅	5.8	2.0	5.6	1.5	5.4	1.0	4.8	1.0	5.0	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>LZ</sub>			5.8	2.0	5.6	1.5	5.4	1.0	4.8	1.0	5.0			

$V_{CCIN} = 1.5 \pm 0.1 \text{ V}$

Item	Symbol	From (input)	To (output)	Ta = -40 to 85°C								Unit	Test conditions		
				V <sub>CC</sub> OUT= 1.2 V		V <sub>CC</sub> OUT= 1.5±0.1 V		V <sub>CC</sub> OUT= 1.8±0.15 V		V <sub>CC</sub> OUT= 2.5±0.2 V				V <sub>CC</sub> OUT= 3.3±0.3 V	
				Typ	Min	Max	Min	Max	Min	Max	Min			Max	Min
Propagation delay time	t <sub>PLH</sub>	A	Y̅	11.4	2.0	10.5	1.5	7.2	1.0	4.8	1.0	4.7	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>PHL</sub>			11.4	2.0	10.5	1.5	7.2	1.0	4.8	1.0	4.7			
Output enable time	t <sub>ZH</sub>	OE̅	Y̅	12.2	2.0	12.6	1.5	8.6	1.0	5.4	1.0	4.8	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>ZL</sub>			12.2	2.0	12.6	1.5	8.6	1.0	5.4	1.0	4.8			
Output disable time	t <sub>HZ</sub>	OE̅	Y̅	6.2	2.0	7.0	1.5	6.0	1.0	5.4	1.0	5.2	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ	
	t <sub>LZ</sub>			6.2	2.0	7.0	1.5	6.0	1.0	5.4	1.0	5.2			

$V_{CCIN} = 1.2 \text{ V}$

Item	Symbol	From (input)	To (output)	Ta = -40 to 85°C					Unit	Test conditions
				V <sub>CC</sub> OUT= 1.2 V	V <sub>CC</sub> OUT= 1.5±0.1 V	V <sub>CC</sub> OUT= 1.8±0.15 V	V <sub>CC</sub> OUT= 2.5±0.2 V	V <sub>CC</sub> OUT= 3.3±0.3 V		
				Typ	Typ	Typ	Typ	Typ		
Propagation delay time	t <sub>PLH</sub>	A	Y̅	11.0	7.5	6.0	4.5	4.0	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ
	t <sub>PHL</sub>			11.0	7.5	6.0	4.5	4.0		
Output enable time	t <sub>ZH</sub>	OE̅	Y̅	12.8	9.5	7.2	5.2	4.5	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ
	t <sub>ZL</sub>			12.8	9.5	7.2	5.2	4.5		
Output disable time	t <sub>HZ</sub>	OE̅	Y̅	7.0	6.0	5.7	5.5	5.5	ns	C <sub>L</sub> = 15pF R <sub>L</sub> = 2.0kΩ
	t <sub>LZ</sub>			7.0	6.0	5.7	5.5	5.5		

## Operating Characteristics

$T_a = 25^\circ\text{C}$

Item	Symbol	V <sub>CCIN</sub> (V)	V <sub>CCOUT</sub> (V)	Min	Typ	Max	Unit	Test conditions
Power dissipation capacitance	C <sub>PD</sub>	3.3	3.3	—	12	—	pF	f = 10 MHz C <sub>L</sub> = 0

## Power-up Considerations

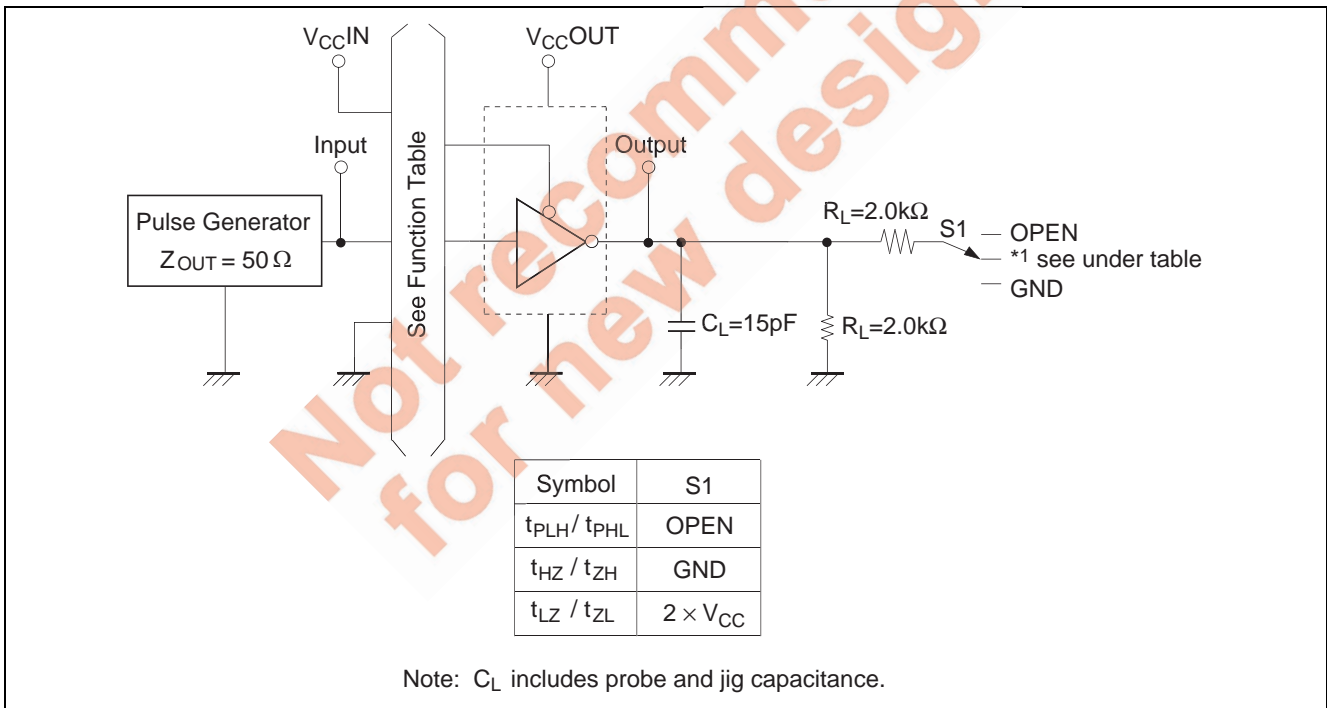
Level-translation devices offer an opportunity for successful mixed-voltage signal design.

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.

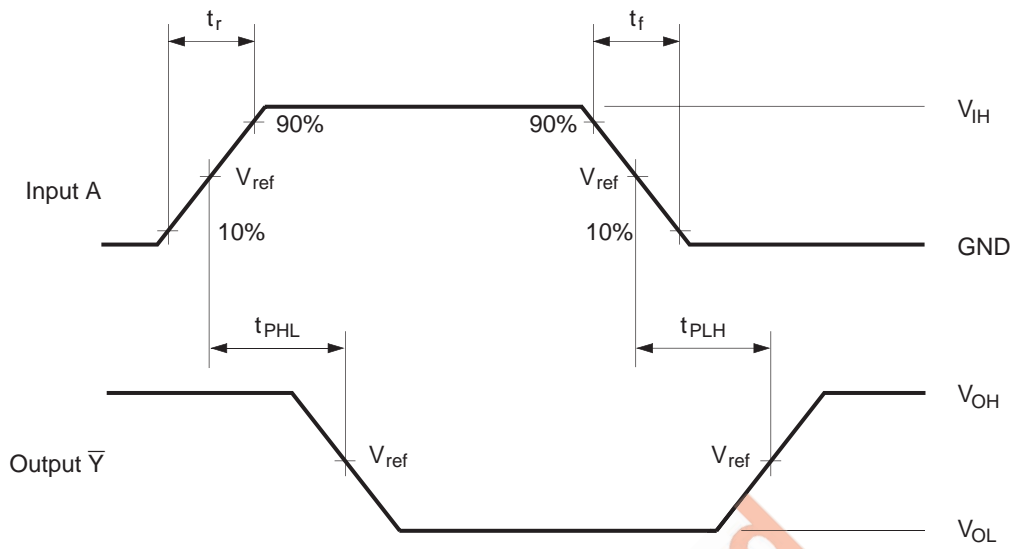
Take these precautions to guard against such power-up problems.

1. Connect ground before any supply voltage is applied.
2. Next, power up the control side of the device.  
(Power up of V<sub>CCIN</sub> is first. Next power up is V<sub>CCOUT</sub>)
3. Tie  $\overline{\text{OE}}$  to V<sub>CCIN</sub> with a pull-up resistor so that it ramps with V<sub>CCIN</sub>.

## Test Circuit



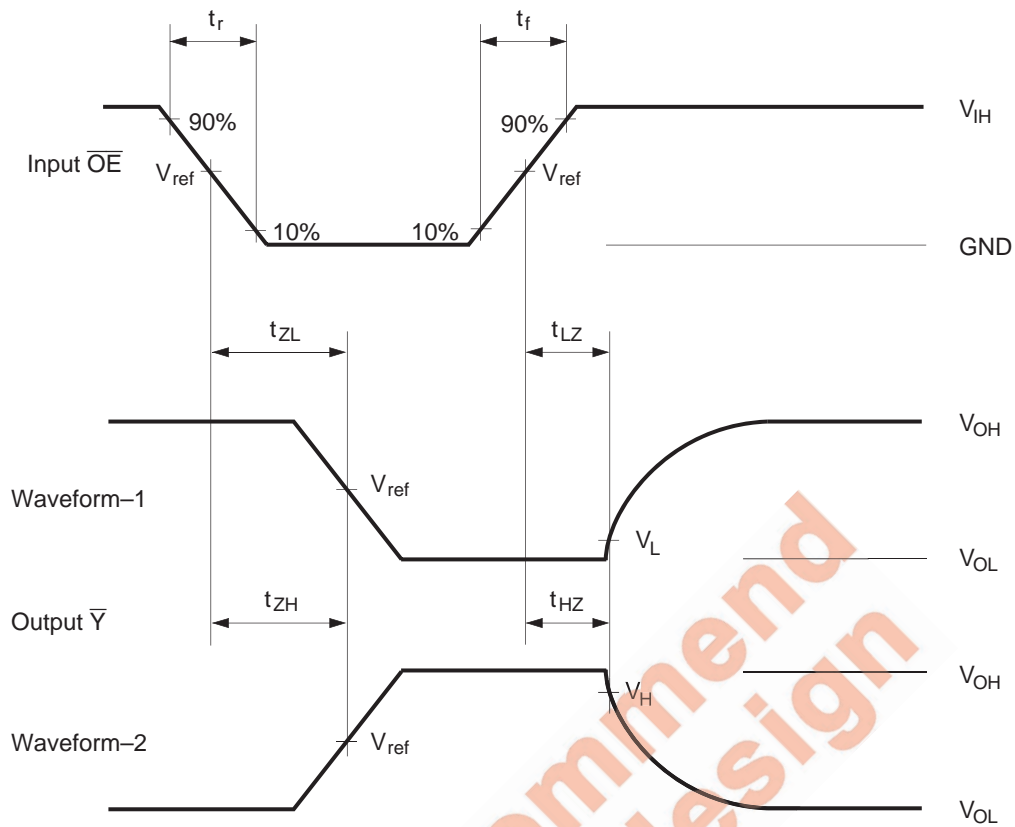
## Waveforms-1



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

Note: 1. Input waveform : PRR  $\leq$  10 MHz,  $Z_o = 50 \Omega$ , duty cycle 50%.

## Waveforms-2

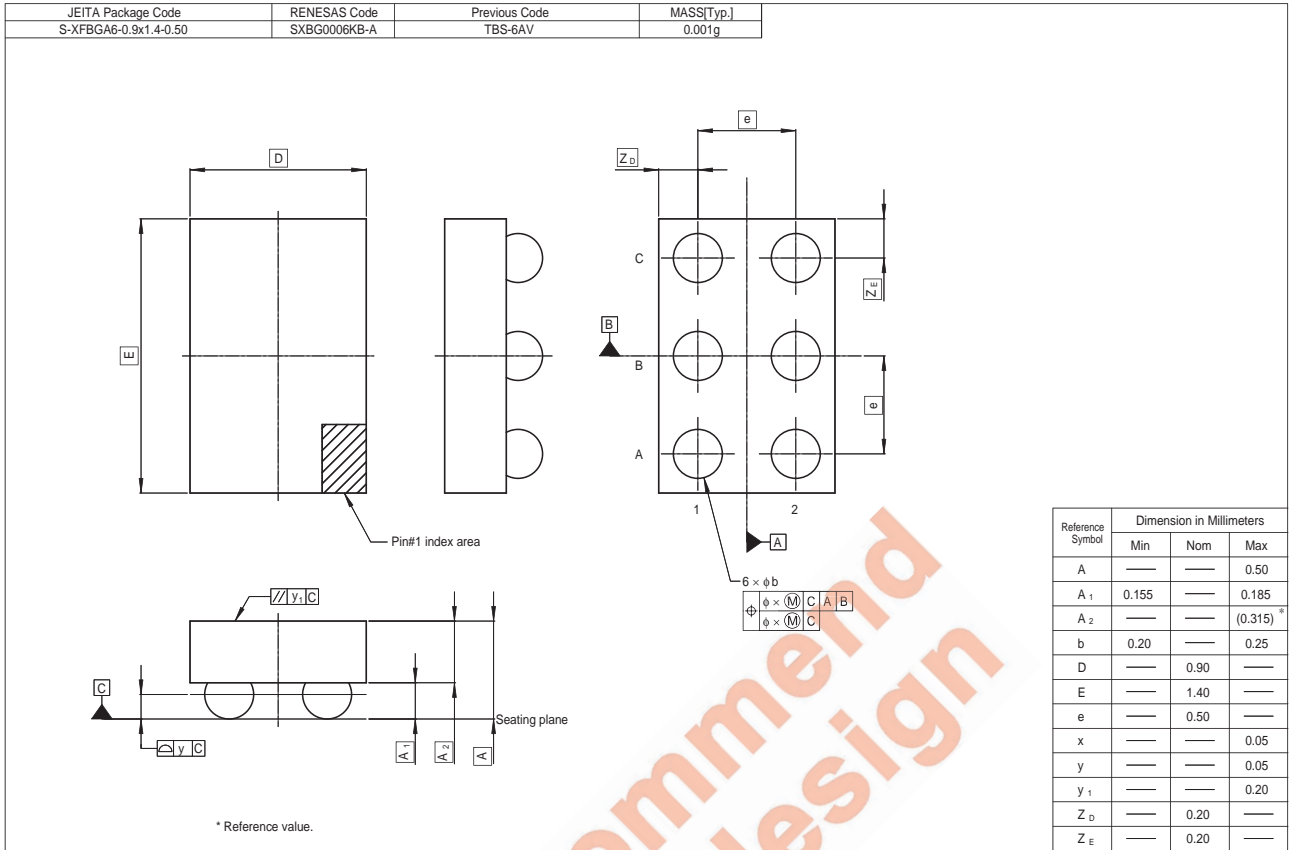


Symbol	$V_{CC} = 1.2 V, 1.5 \pm 0.1 V$	$V_{CC} = 1.8 \pm 0.15 V$	$V_{CC} = 2.5 \pm 0.2 V$	$V_{CC} = 3.3 \pm 0.3 V$
$t_r / t_f$	2.0 ns	2.0 ns	2.0 ns	2.0 ns
$V_{IH}$	$V_{CC}$	$V_{CC}$	$V_{CC}$	$V_{CC}$
$V_{ref}$	$1/2 V_{CC}$	$1/2 V_{CC}$	$1/2 V_{CC}$	$1/2 V_{CC}$
$V_H / V_L$	$V_H = V_{OH} - 0.1 V$ $V_L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

- Notes:
1. Input waveform : PRR  $\leq 10$  MHz,  $Z_O = 50 \Omega$ , 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



Not recommended for new design

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