

# RD74VT1G86

## 2-input Exclusive-OR Gate / Dual Supply Voltage Translator

REJ03D0516-0100

Rev.1.00

Apr. 15, 2005

### Description

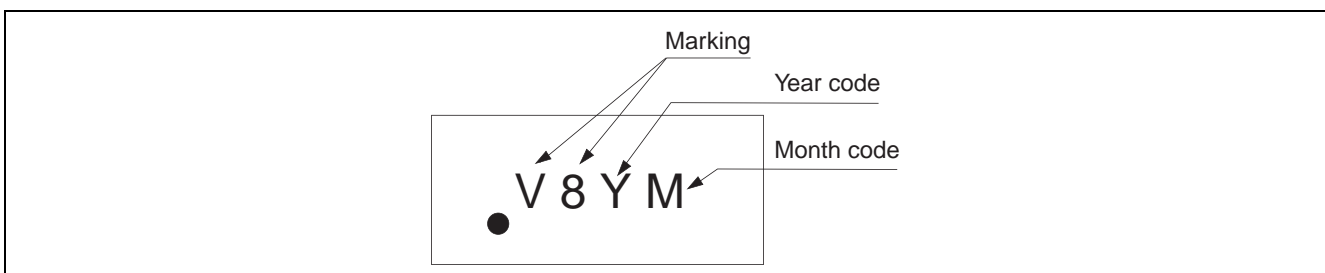
The RD74VT1G86 performs the Boolean functions  $Y = A \oplus B$  or  $Y = \overline{A}B + A\overline{B}$  in positive logic. A common application is as a true / complement element. If one of the inputs is low, the other input will be reproduced in true form at the output. If one of the inputs is high, the signal on the other input will be reproduced inverted form at the output. The input is designed to track  $V_{CCIN}$ , which accepts voltage 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)
RD74VT1G86CLE	WCSP-6 pin	SXBG0006KB-A (TBS-6AV)	CL	E (3,000 pcs/reel)

### Article Indication

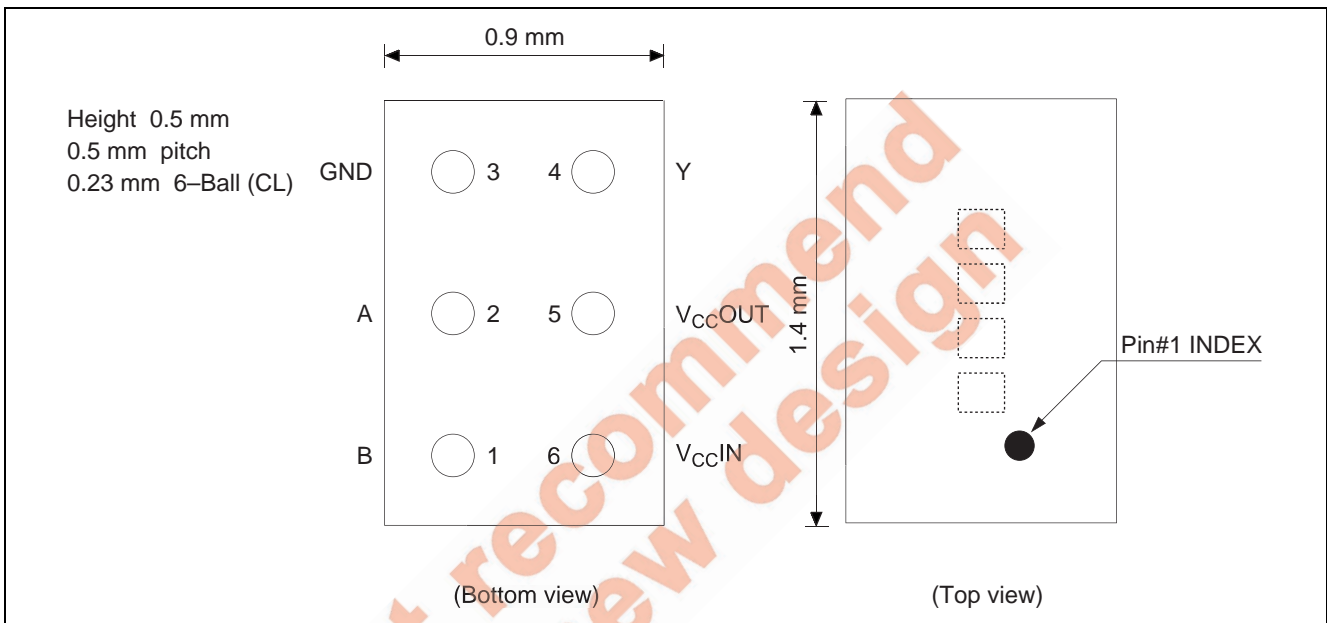


**Function Table**

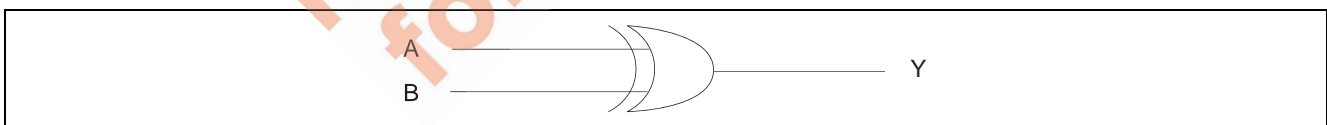
Inputs		Output Y
A	B	
L	L	L
L	H	H
H	L	H
H	H	L

H: High level  
L: Low level

**Pin Arrangement**



**Logic Diagram**



## Absolute Maximum Ratings

Item	Symbol	Ratings	Unit	Conditions
Supply voltage range	$V_{CCIN}, V_{CCOUT}$	-0.5 to 4.6	V	
Input voltage range <sup>*1</sup>	$V_I$	-0.5 to 4.6	V	
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		$V_{CCOUT}$ : 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.

- The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- 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	
	$V_O$	0 to $V_{CCOUT}$	V	Output: "H" or "L"
0 to 3.6		$V_{CCOUT}$ : 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	
		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	
		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	V	I <sub>OL</sub> = 100 μA
			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	μA	V <sub>IN</sub> = GND or V <sub>CCIN</sub>
Output leakage current	I <sub>OFF</sub>	0	0	—	—	1.5	μA	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V
Quiescent supply current	I <sub>CCIN</sub>	1.2 to 3.6	1.2 to 3.6	-3.0	—	3.0	μA	I <sub>O(Y port)</sub> = 0 V <sub>IN</sub> = V <sub>CCIN</sub> or GND
	I <sub>CCOUT</sub>	1.2 to 3.6	1.2 to 3.6	-3.0	—	3.0		I <sub>O(Y 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	3.6	—	—	250	μA	A or B port V <sub>CCIN</sub> -0.6 (1 input)
Input capacitance	C <sub>IN</sub>	3.3	3.3	—	3.5	—	pF	V <sub>IN</sub> = V <sub>CC</sub> or GND

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

## Switching Characteristics

$V_{CCIN} = 3.3 \pm 0.3 \text{ V}$

Item	Symbol	FROM (Input)	TO (Output)	Ta = -40 to 85°C								Unit	Test Conditions		
				V <sub>CC</sub> OUT= 1.2V		V <sub>CC</sub> OUT= 1.5±0.1V		V <sub>CC</sub> OUT= 1.8±0.15V		V <sub>CC</sub> OUT= 2.5±0.2V				V <sub>CC</sub> OUT= 3.3±0.3V	
				Typ	Min	Max	Min	Max	Min	Max	Min			Max	Min
Propagation delay time	t <sub>PLH</sub>	A or B	Y	8.6	2.0	8.4	1.5	5.8	1.0	4.4	1.0	3.9	ns	C <sub>L</sub> = 15 pF R <sub>L</sub> = 2.0 kΩ	
	t <sub>PHL</sub>			8.6	2.0	8.4	1.5	5.8	1.0	4.4	1.0	3.9			

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

Item	Symbol	FROM (Input)	TO (Output)	Ta = -40 to 85°C								Unit	Test Conditions		
				V <sub>CC</sub> OUT= 1.2V		V <sub>CC</sub> OUT= 1.5±0.1V		V <sub>CC</sub> OUT= 1.8±0.15V		V <sub>CC</sub> OUT= 2.5±0.2V				V <sub>CC</sub> OUT= 3.3±0.3V	
				Typ	Min	Max	Min	Max	Min	Max	Min			Max	Min
Propagation delay time	t <sub>PLH</sub>	A or B	Y	8.7	2.0	8.8	1.5	6.2	1.0	4.7	1.0	4.5	ns	C <sub>L</sub> = 15 pF R <sub>L</sub> = 2.0 kΩ	
	t <sub>PHL</sub>			8.7	2.0	8.8	1.5	6.2	1.0	4.7	1.0	4.5			

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

Item	Symbol	FROM (Input)	TO (Output)	Ta = -40 to 85°C								Unit	Test Conditions		
				V <sub>CC</sub> OUT= 1.2V		V <sub>CC</sub> OUT= 1.5±0.1V		V <sub>CC</sub> OUT= 1.8±0.15V		V <sub>CC</sub> OUT= 2.5±0.2V				V <sub>CC</sub> OUT= 3.3±0.3V	
				Typ	Min	Max	Min	Max	Min	Max	Min			Max	Min
Propagation delay time	t <sub>PLH</sub>	A or B	Y	9.8	2.0	9.8	1.5	7.4	1.0	6.4	1.0	6.2	ns	C <sub>L</sub> = 15 pF R <sub>L</sub> = 2.0 kΩ	
	t <sub>PHL</sub>			9.8	2.0	9.8	1.5	7.4	1.0	6.4	1.0	6.2			

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

Item	Symbol	FROM (Input)	TO (Output)	Ta = -40 to 85°C								Unit	Test Conditions		
				V <sub>CC</sub> OUT= 1.2V		V <sub>CC</sub> OUT= 1.5±0.1V		V <sub>CC</sub> OUT= 1.8±0.15V		V <sub>CC</sub> OUT= 2.5±0.2V				V <sub>CC</sub> OUT= 3.3±0.3V	
				Typ	Min	Max	Min	Max	Min	Max	Min			Max	Min
Propagation delay time	t <sub>PLH</sub>	A or B	Y	10.5	2.0	11.2	1.5	10.0	1.0	9.0	1.0	8.8	ns	C <sub>L</sub> = 15 pF R <sub>L</sub> = 2.0 kΩ	
	t <sub>PHL</sub>			10.5	2.0	11.2	1.5	10.0	1.0	9.0	1.0	8.8			

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

Item	Symbol	FROM (Input)	TO (Output)	Ta = -40 to 85°C					Unit	Test Conditions
				V <sub>CC</sub> OUT= 1.2V	V <sub>CC</sub> OUT= 1.5±0.1V	V <sub>CC</sub> OUT= 1.8±0.15V	V <sub>CC</sub> OUT= 2.5±0.2V	V <sub>CC</sub> OUT= 3.3±0.3V		
				Typ	Typ	Typ	Typ	Typ		
Propagation delay time	t <sub>PLH</sub>	A or B	Y	12.0	10.5	9.5	9.5	9.5	ns	C <sub>L</sub> = 15 pF R <sub>L</sub> = 2.0 kΩ
	t <sub>PHL</sub>			12.0	10.5	9.5	9.5	9.5		

## Operating Characteristics

Item	Symbol	V <sub>CC</sub> IN (V)	V <sub>CC</sub> OUT (V)	Ta = 25°C			Unit	Test Conditions
				Min	Typ	Max		
Power dissipation capacitance	C <sub>PD</sub>	3.3	3.3	—	12	—	pF	f = 10 MHz C <sub>L</sub> = 0

## Power-up Considerations

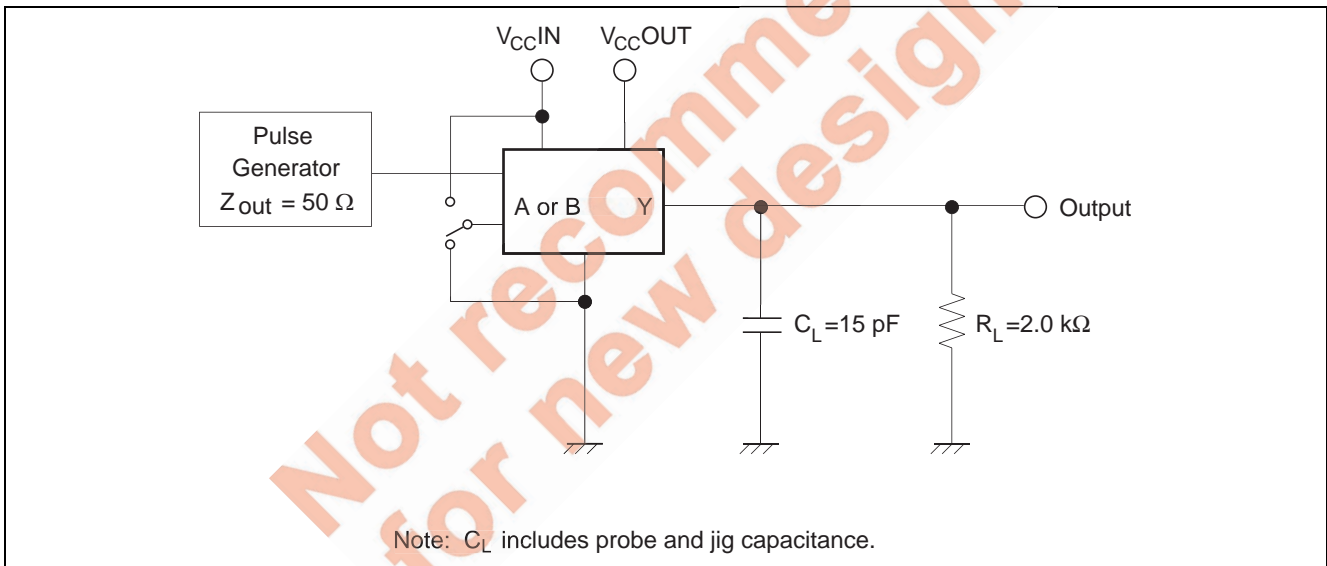
Level-translation devices offer an opportunity for successful mixed-voltage signal design.

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.

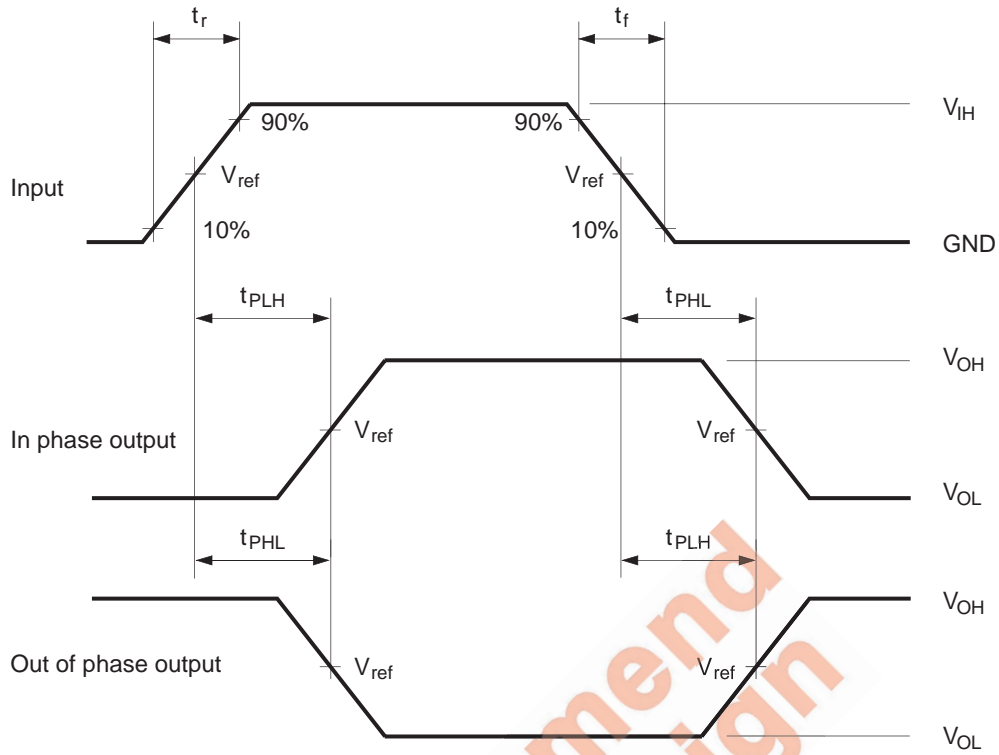
Take these precautions to guard against such power-up problems.

1. Connect ground before any supply voltage is applied.
2. Next, power up the input side of the device.  
(Power up of V<sub>CC</sub>IN is first. Next power up is V<sub>CC</sub>OUT)

## Test Circuit



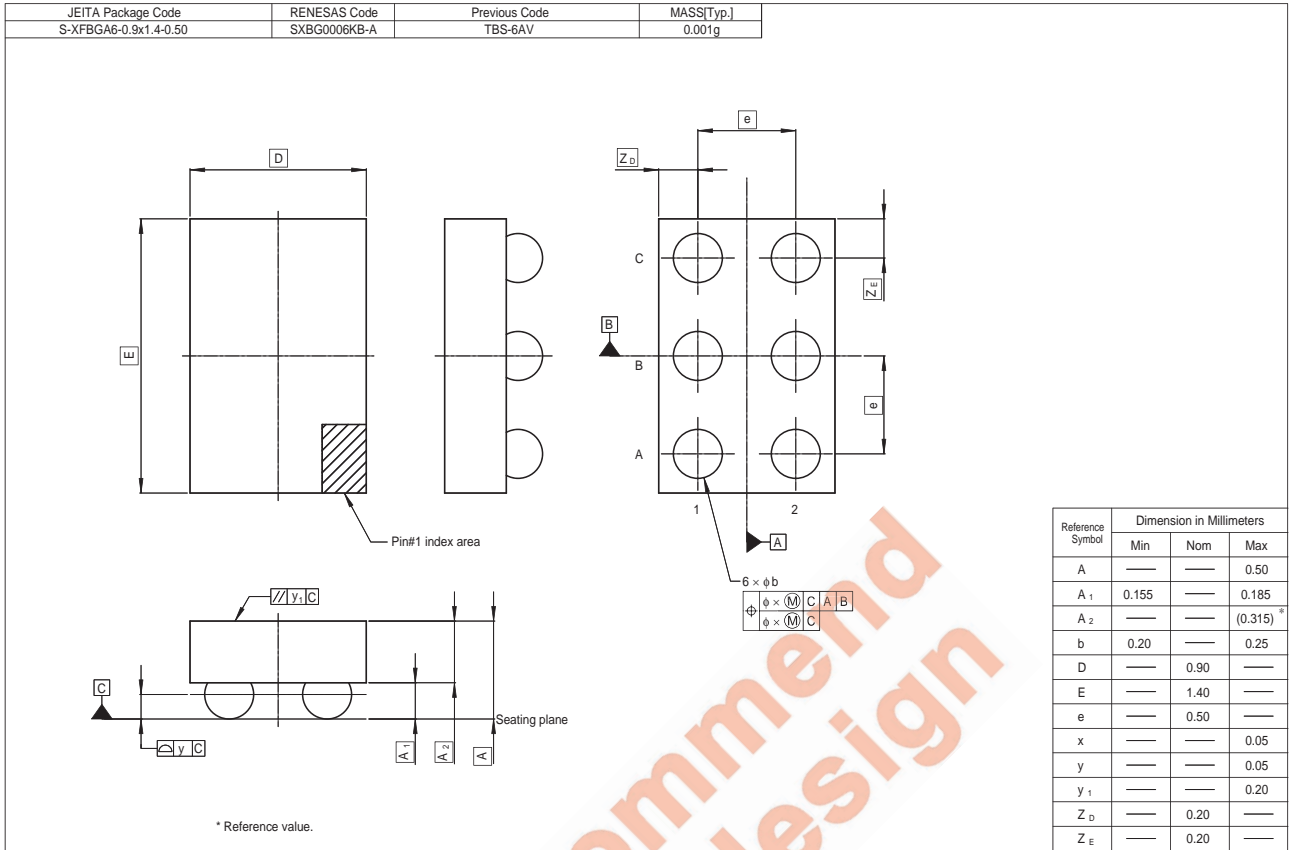
• Waveforms



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  $\leq$  10 MHz,  $Z_O = 50 \Omega$ , duty cycle 50%

Package Dimensions



Not recommended for new design



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

Keep safety first in your circuit designs!

1. Renesas Technology Corp. puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage.  
Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corp. product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corp. or a third party.
2. Renesas Technology Corp. assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corp. without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corp. or an authorized Renesas Technology Corp. product distributor for the latest product information before purchasing a product listed herein.  
The information described here may contain technical inaccuracies or typographical errors.  
Renesas Technology Corp. assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.  
Please also pay attention to information published by Renesas Technology Corp. by various means, including the Renesas Technology Corp. Semiconductor home page (<http://www.renesas.com>).
4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corp. assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corp. semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corp. or an authorized Renesas Technology Corp. product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
6. The prior written approval of Renesas Technology Corp. is necessary to reprint or reproduce in whole or in part these materials.
7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.  
Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
8. Please contact Renesas Technology Corp. for further details on these materials or the products contained therein.



### 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 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 (Shanghai) Co., Ltd.**  
Unit2607 Ruijing Building, No.205 Maoming Road (S), Shanghai 200020, China  
Tel: <86> (21) 6472-1001, Fax: <86> (21) 6415-2952

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