

# TC7SP332WBG

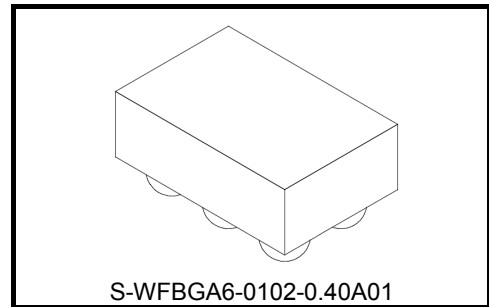
## Dual supply 2-Input OR Gate with Level Translator

The TC7SP332 is a dual supply, advanced high-speed CMOS 2-input dual supply voltage interface OR gate fabricated with silicon gate CMOS technology.

It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

Designed for use as an interface between a 1.2-V, 1.5-V, 1.8-V, or 2.5-V bus and a 1.8-V, 2.5-V or 3.3-V bus in mixed 1.2-V, 1.5-V, 1.8-V or 2.5-V/1.8-V, 2.5-V or 3.3-V supply systems.

All inputs are equipped with protection circuits against static discharge.

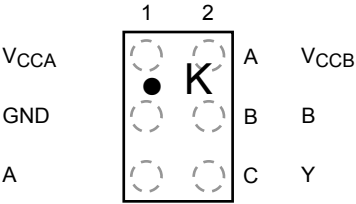


Weight: 1 mg (typ)

### Features

- Level converter for interfacing 1.2-V to 1.8-V, 1.2-V to 2.5-V, 1.2-V to 3.3-V, 1.5-V to 2.5-V, 1.5-V to 3.3-V, 1.8-V to 2.5-V, 1.8-V to 3.3-V or 2.5 V to 3.3-V system.
- High-speed operation :
  - $t_{pd} = 6.8 \text{ ns (max)}$  ( $V_{CCA} = 2.5 \pm 0.2 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )
  - $t_{pd} = 7.8 \text{ ns (max)}$  ( $V_{CCA} = 1.8 \pm 0.15 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )
  - $t_{pd} = 9.0 \text{ ns (max)}$  ( $V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )
  - $t_{pd} = 31 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 3.3 \pm 0.3 \text{ V}$ )
  - $t_{pd} = 9.5 \text{ ns (max)}$  ( $V_{CCA} = 1.8 \pm 0.15 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )
  - $t_{pd} = 10.5 \text{ ns (max)}$  ( $V_{CCA} = 1.5 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )
  - $t_{pd} = 32 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 2.5 \pm 0.2 \text{ V}$ )
  - $t_{pd} = 37 \text{ ns (max)}$  ( $V_{CCA} = 1.2 \pm 0.1 \text{ V}$ ,  $V_{CCB} = 1.8 \pm 0.15 \text{ V}$ )
- Output current :
  - $I_{OH}/I_{OL} = \pm 12 \text{ mA (min)}$  ( $V_{CC} = 3.0 \text{ V}$ )
  - $I_{OH}/I_{OL} = \pm 9 \text{ mA (min)}$  ( $V_{CC} = 2.3 \text{ V}$ )
  - $I_{OH}/I_{OL} = \pm 3 \text{ mA (min)}$  ( $V_{CC} = 1.65 \text{ V}$ )
- Latch-up performance:  $-300 \text{ mA}$
- ESD performance:
  - Machine model  $\geq \pm 200 \text{ V}$
  - Human body model  $\geq \pm 2000 \text{ V}$
- Ultra-small package: WCSP6
- Power-down protection is provided on all inputs and outputs

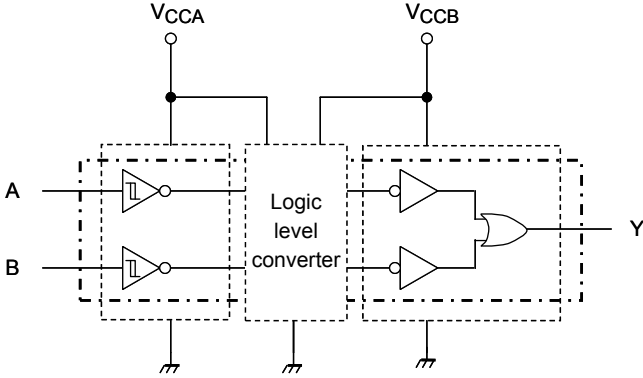
**Pin Assignment (top view)**



**Truth Table**

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

**Block Diagram**



## Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage (Note 2)	$V_{CCA}$	-0.5 to 4.6	V
	$V_{CCB}$	-0.5 to 4.6	
DC input voltage (A, B)	$V_{IN}$	-0.5 to 4.6	V
DC output voltage (Y)	$V_{OUTB}$	-0.5 to 4.6 (Note 3)	V
		-0.5 to $V_{CCB} + 0.5$ (Note 4)	
Input diode current	$I_{IK}$	-25	mA
Output diode current	$I_{OK}$	±50 (Note 5)	mA
DC output current	$I_{OUTB}$	±25	mA
DC $V_{CC}$ /ground current per supply pin	$I_{CCA}$	±25	mA
	$I_{CCB}$	±50	
Power dissipation	$P_D$	100	mW
Storage temperature	$T_{stg}$	-65 to 150	°C

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: Don't supply a voltage to  $V_{CCB}$  pin when  $V_{CCA}$  is in the OFF state.

Note 3: Output in OFF state

Note 4: High or Low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 5:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

## Operating Ranges (Note 6)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CCA}$	1.1 to 2.7	V
	$V_{CCB}$	1.65 to 3.6	
Input voltage (A, B)	$V_{IN}$	0 to 3.6	V
Output voltage (Y)	$V_{OUTB}$	0 to 3.6 (Note 7)	V
		0 to $V_{CCB}$ (Note 8)	
Output current (Y)	$I_{OUTB}$	±12 (Note 9)	mA
		±9 (Note 10)	
		±3 (Note 11)	
Operating temperature	$T_{opr}$	-40 to 85	°C
Input rise and fall time	$dt/dv$	0 to 10 (Note 12)	ns/V

Note 6: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either  $V_{CC}$  or GND.

Note 7: Output in OFF state

Note 8: High or Low state

Note 9:  $V_{CCB} = 3.0$  to 3.6 V

Note 10:  $V_{CCB} = 2.3$  to 2.7 V

Note 11:  $V_{CCB} = 1.65$  to 1.95 V

Note 12:  $V_{IN} = 0.8$  to 2.0 V,  $V_{CCA} = 2.5$  V,  $V_{CCB} = 3.0$  V

## Electrical Characteristics

### DC Characteristics (Ta = -40 to 85°C)

Characteristics		Symbol	Test Condition	V <sub>CCA</sub> (V)	V <sub>CCB</sub> (V)	Ta = -40 to 85°C		Unit	
						Min	Max		
Input voltage	H-level	V <sub>P</sub>	—	1.2	1.65 to 3.6	—	1.10	V	
				1.4	1.65 to 3.6	—	1.20		
				1.65	1.65 to 3.6	—	1.35		
				2.3	1.65 to 3.6	—	1.70		
				2.7	1.65 to 3.6	—	2.00		
	L-level	V <sub>N</sub>	—	1.2	1.65 to 3.6	0.10	—	V	
				1.4	1.65 to 3.6	0.20	—		
				1.65	1.65 to 3.6	0.30	—		
				2.3	1.65 to 3.6	0.50	—		
				2.7	1.65 to 3.6	0.70	—		
Hysteresis voltage		V <sub>H</sub>	—	1.2	1.65 to 3.6	0.20	0.90	V	
				1.4	1.65 to 3.6	0.20	0.90		
				1.65	1.65 to 3.6	0.20	0.95		
				2.3	1.65 to 3.6	0.30	1.00		
				2.7	1.65 to 3.6	0.30	1.20		
Output voltage	H-level	V <sub>OHB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OHB</sub> = -100 μA	1.1 to 2.7	1.65 to 3.6	V <sub>CCB</sub> - 0.2	—	V
				I <sub>OHB</sub> = -3 mA	1.1 to 2.7	1.65	1.25	—	
				I <sub>OHB</sub> = -9 mA	1.1 to 2.7	2.3	1.7	—	
				I <sub>OHB</sub> = -12 mA	1.1 to 2.7	3.0	2.2	—	
	L-level	V <sub>OLB</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OLB</sub> = 100 μA	1.1 to 2.7	1.65 to 3.6	—	0.2	V
				I <sub>OLB</sub> = 3 mA	1.1 to 2.7	1.65	—	0.3	
				I <sub>OLB</sub> = 9 mA	1.1 to 2.7	2.3	—	0.6	
				I <sub>OLB</sub> = 12 mA	1.1 to 2.7	3.0	—	0.55	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V	1.1 to 2.7	1.65 to 3.6	—	±1.0	μA	
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V	0	0	—	2.0	μA	
Quiescent supply current		I <sub>CCA</sub>	V <sub>IN</sub> = V <sub>CCA</sub> or GND	1.1 to 2.7	1.65 to 3.6	—	2.0	μA	
		I <sub>CCB</sub>	V <sub>IN</sub> = V <sub>CCA</sub> or GND	1.1 to 2.7	1.65 to 3.6	—	2.0		
		I <sub>CCA</sub>	V <sub>CCA</sub> < V <sub>IN</sub> ≤ 3.6 V	1.1 to 2.7	1.65 to 3.6	—	±2.0		
		I <sub>CCB</sub>	V <sub>IN</sub> = V <sub>CCA</sub> V <sub>CCB</sub> ≤ Y ≤ 3.6 V	1.1 to 2.7	1.65 to 3.6	—	±2.0		

## AC Characteristics (Ta = -40 to 85°C, Input: tr = tf = 2.0 ns)

**VCCA = 2.5 ± 0.2 V, VCCB = 3.3 ± 0.3 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	6.8	ns

**VCCA = 1.8 ± 0.15 V, VCCB = 3.3 ± 0.3 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	7.8	ns

**VCCA = 1.5 ± 0.1 V, VCCB = 3.3 ± 0.3 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	9.0	ns

**VCCA = 1.2 ± 0.1 V, VCCB = 3.3 ± 0.3 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	31	ns

**VCCA = 1.8 ± 0.15 V, VCCB = 2.5 ± 0.2 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	9.5	ns

**VCCA = 1.5 ± 0.1 V, VCCB = 2.5 ± 0.2 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	10.5	ns

**VCCA = 1.2 ± 0.1 V, VCCB = 2.5 ± 0.2 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	32	ns

**VCCA = 1.2 ± 0.1 V, VCCB = 1.8 ± 0.15 V**

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.0	37	ns

## Capacitive Characteristics (Ta=25°C)

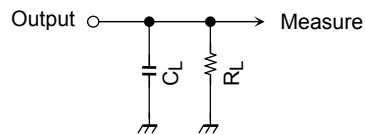
Characteristics	Symbol	Test Circuit	VCC (V)		Typ.	Unit
			VCCA (V)	VCCB (V)		
Input capacitance	C <sub>IN</sub>	A, B	2.5	3.3	5	pF
Power dissipation capacitance (Note)	C <sub>PD(A)</sub>	f <sub>IN</sub> = 10 MHz	2.5	3.3	5	pF
	C <sub>PD(B)</sub>	f <sub>IN</sub> = 10 MHz	2.5	3.3	10	

Note: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC} / 2 \text{ (per bit)}$$

## AC Test Circuit



Symbol	V <sub>CC</sub> (output)	
		3.3 ± 0.3 V 2.5 ± 0.2 V
R <sub>L</sub>	500 Ω	1 kΩ
C <sub>L</sub>	30 pF	30 pF

Figure 1

## AC Waveform

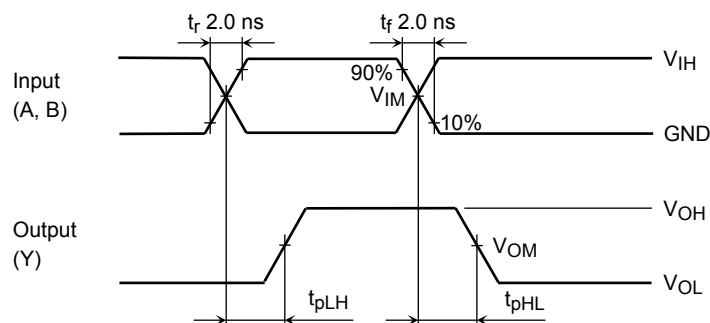
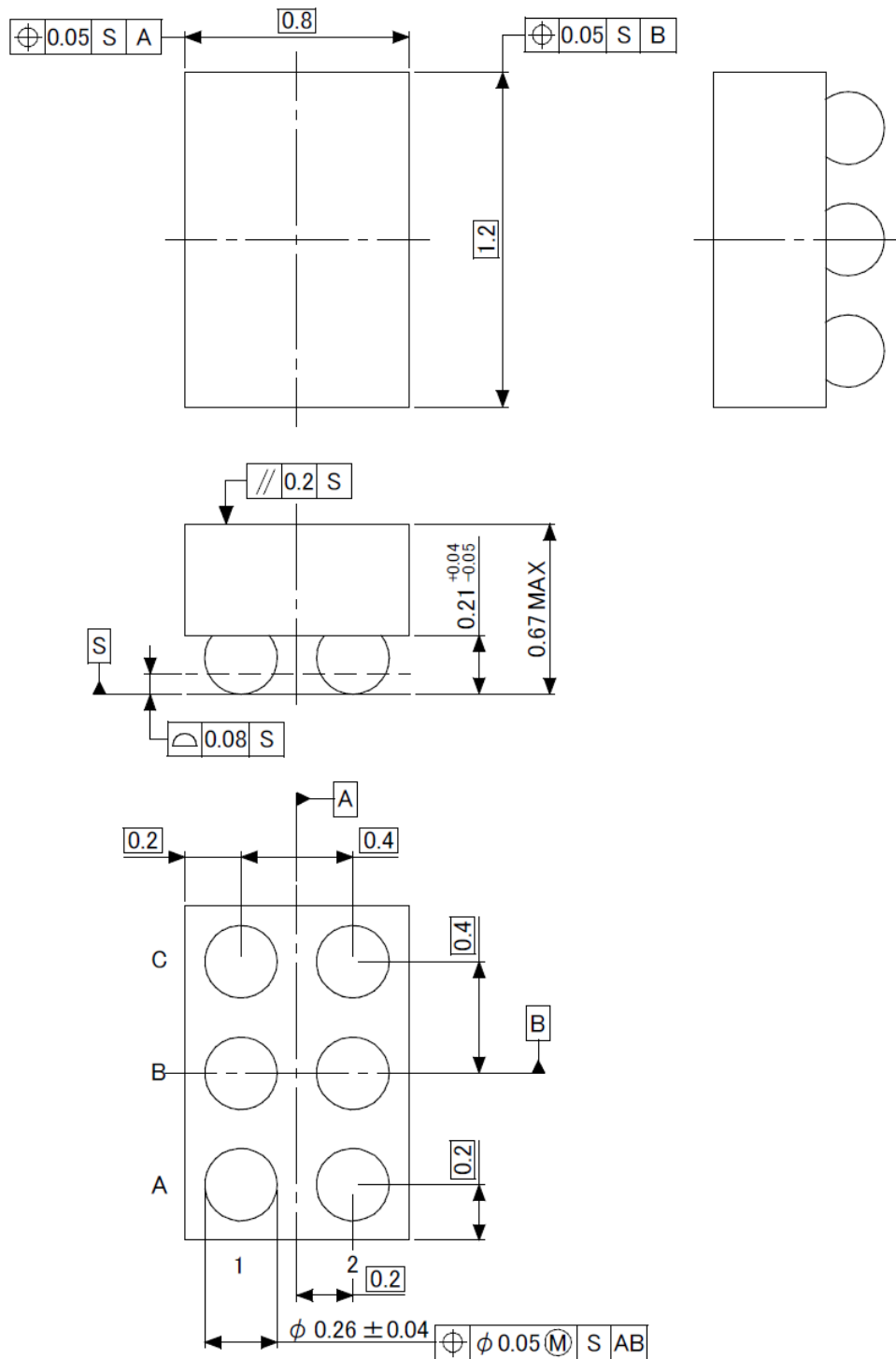


Figure 2 t<sub>pLH</sub>, t<sub>pHL</sub>

**Package Dimensions**

S-WFBGA6-0102-0.40A01

Unit: mm



Weight: 1 mg (typ.)

The resins used in this product include no flame retardants.

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