TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7SP386WBG

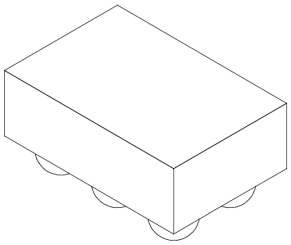
Dual supply 2-Input Exclusive-OR Gate with Level Translator

The TC7SP386 is a dual supply, advanced high-speed CMOS 2-input dual supply voltage interface Exclusive-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.



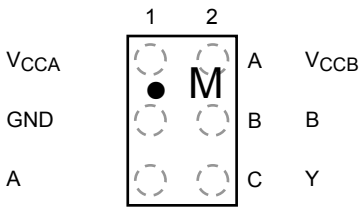
S-WFBGA6-0102-0.40A01

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 ns (max) (V_{CCA} = 2.5 ± 0.2 V, V_{CCB} = 3.3 ± 0.3 V)
  t_{pd} = 7.8 ns (max) (V_{CCA} = 1.8 ± 0.15 V, V_{CCB} = 3.3 ± 0.3 V)
  t_{pd} = 9.0 ns (max) (V_{CCA} = 1.5 ± 0.1 V, V_{CCB} = 3.3 ± 0.3 V)
  t_{pd} = 31 ns (max) (V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 3.3 ± 0.3 V)
  t_{pd} = 9.5 ns (max) (V_{CCA} = 1.8 ± 0.15 V, V_{CCB} = 2.5 ± 0.2 V)
  t_{pd} = 10.5 ns (max) (V_{CCA} = 1.5 ± 0.1 V, V_{CCB} = 2.5 ± 0.2 V)
  t_{pd} = 32 ns (max) (V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 2.5 ± 0.2 V)
  t_{pd} = 37 ns (max) (V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 1.8 ± 0.15 V)
- Output current : I_{OH}/I_{OL} = ±12 mA (min) (V_{CC} = 3.0 V)
  I_{OH}/I_{OL} = ±9mA (min) (V_{CC} = 2.3 V)
  I_{OH}/I_{OL} = ±3 mA (min) (V_{CC} = 1.65 V)
- Latch-up performance: −300 mA
- ESD performance: Machine model ≥ ±200 V
  Human body model ≥ ±2000 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	L

Block Diagram

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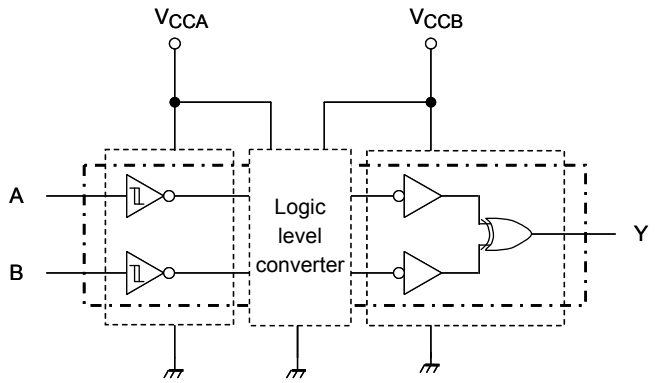


Absolute Maximum Ratings (Note 1)

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_{CCA} (V)	V_{CCB} (V)	Ta = −40 to 85°C		Unit
							Min	Max	
Input voltage	H-level	V_P	—		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_N	—		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_H	—		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_{OHB}	V_{IN} = V_{IH} or V_{IL}	I_{OHB} = −100 μA	1.1 to 2.7	1.65 to 3.6	V_{CCB} − 0.2	—	V
				I_{OHB} = −3 mA	1.1 to 2.7	1.65	1.25	—	
				I_{OHB} = −9 mA	1.1 to 2.7	2.3	1.7	—	
				I_{OHB} = −12 mA	1.1 to 2.7	3.0	2.2	—	
	L-level	V_{OLB}	V_{IN} = V_{IH} or V_{IL}	I_{OLB} = 100 μA	1.1 to 2.7	1.65 to 3.6	—	0.2	V
				I_{OLB} = 3 mA	1.1 to 2.7	1.65	—	0.3	
				I_{OLB} = 9 mA	1.1 to 2.7	2.3	—	0.6	
				I_{OLB} = 12 mA	1.1 to 2.7	3.0	—	0.55	
Input leakage current		I_{IN}	V_{IN} = 0 to 3.6 V		1.1 to 2.7	1.65 to 3.6	—	±1.0	μA
Power-off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	0	—	2.0	μA
Quiescent supply current		I_{CCA}	V_{IN} = V_{CCA} or GND		1.1 to 2.7	1.65 to 3.6	—	2.0	μA
		I_{CCB}	V_{IN} = V_{CCA} or GND		1.1 to 2.7	1.65 to 3.6	—	2.0	
		I_{CCA}	V_{CCA} < V_{IN} ≤ 3.6 V		1.1 to 2.7	1.65 to 3.6	—	±2.0	
		I_{CCB}	V_{IN} = V_{CCA} V_{CCB} ≤ Y ≤ 3.6 V		1.1 to 2.7	1.65 to 3.6	—	±2.0	

AC Characteristics (Ta = −40 to 85°C, Input: $t_r = t_f = 2.0$ ns)

V_{CCA} = 2.5 ± 0.2 V, V_{CCB}= 3.3 ± 0.3 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	6.8	ns

V_{CCA} = 1.8 ± 0.15 V, V_{CCB} = 3.3 ± 0.3 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	7.8	ns

V_{CCA} = 1.5 ± 0.1 V, V_{CCB} = 3.3 ± 0.3 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	9.0	ns

V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 3.3 ± 0.3 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	31	ns

V_{CCA} = 1.8 ± 0.15 V, V_{CCB} = 2.5 ± 0.2 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	9.5	ns

V_{CCA} = 1.5 ± 0.1 V, V_{CCB} = 2.5 ± 0.2 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	10.5	ns

V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 2.5 ± 0.2 V

Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	32	ns

V_{CCA} = 1.2 ± 0.1 V, V_{CCB} = 1.8 ± 0.15 V

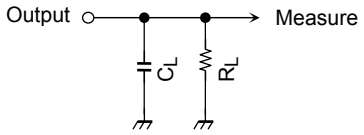
Characteristics	Symbol	Test Condition	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	1.0	37	ns

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Circuit	V_{CCA} (V)	V_{CCB} (V)	Typ.	Unit
Input capacitance	C_{IN}	A, B	2.5	3.3	5	pF
Power dissipation capacitance (Note)	C_{PDA}	f_{IN} = 10 MHz	2.5	3.3	5	pF
	C_{PDB}	f_{IN} = 10 MHz	2.5	3.3	10	

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

AC Test Circuit



Symbol	V_{CC} (output)	
	3.3 ± 0.3 V 2.5 ± 0.2 V	1.8 ± 0.15 V
R_L	500 Ω	1 kΩ
C_L	30 pF	30 pF

Figure 1

AC Waveform

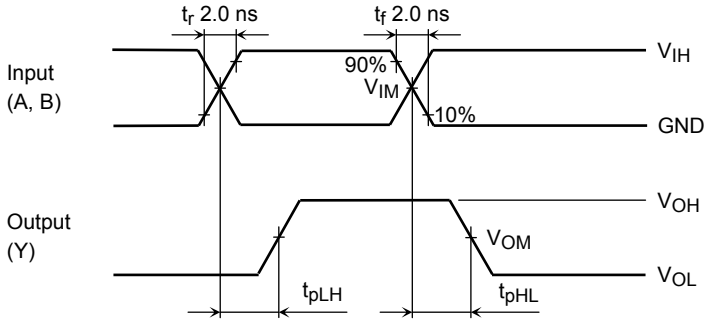
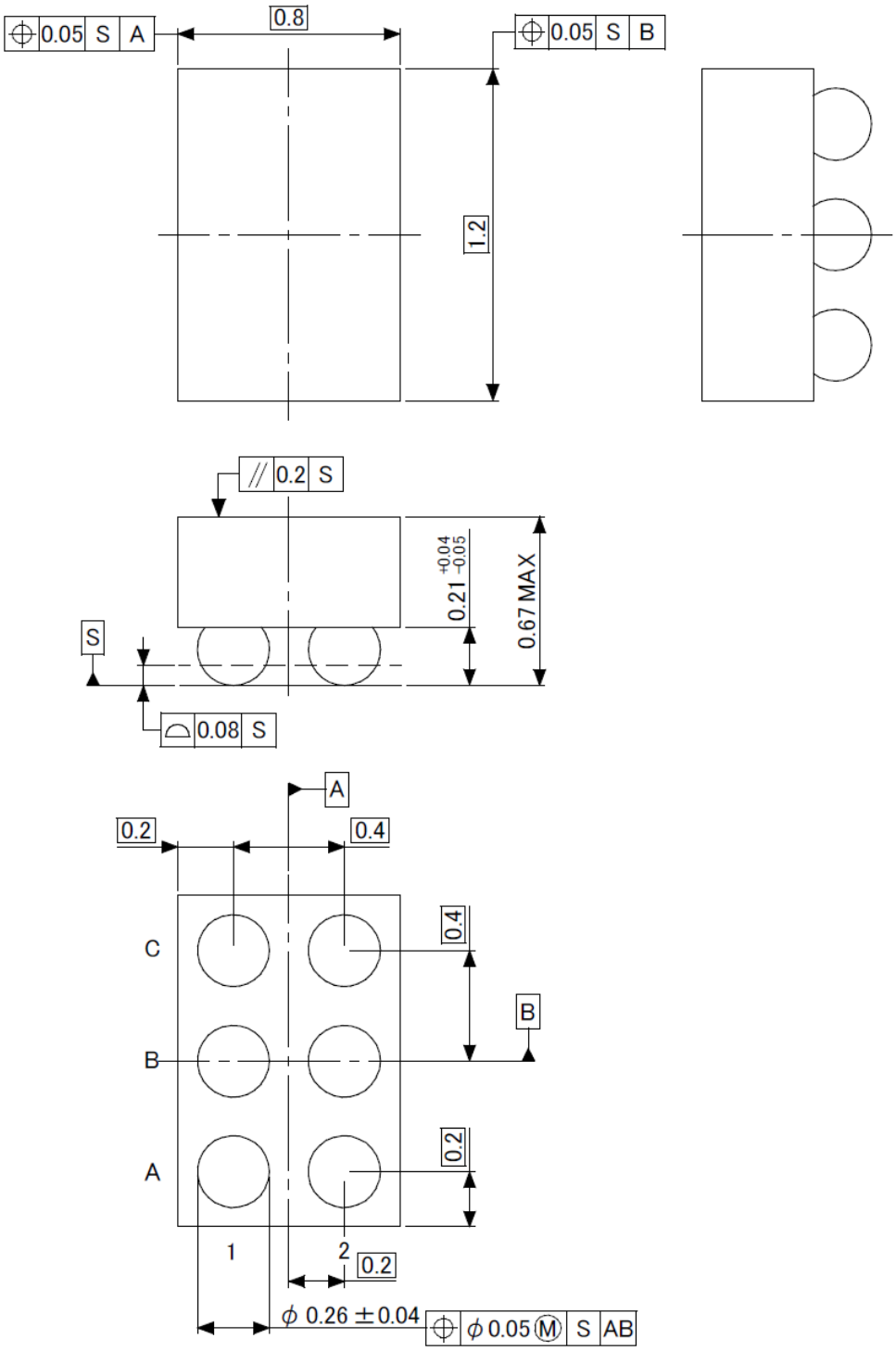


Figure 2 t_{pLH}, t_{pHL}

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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