

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7SP97TU, TC7SP98TU

Low Voltage Single Configurable Multiple Function Gate with 3.6 V Tolerant Inputs and Outputs

The TC7SP97,98 is a high performance CMOS multiple Function Gate which is guaranteed to operate from 1.2-V to 3.6-V. Designed for use in 1.5 V, 1.8 V, 2.5 V or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

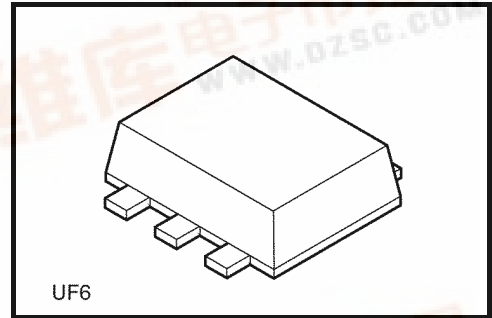
It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

It independently consists of three circuits for Multiple Function Gate.

The output state is determined by seven patterns of 3-inputs.

The user can choose the functions of Multiplexer, AND, OR, NAND, Schmitt Inverter, and Schmitt Buffer.

All inputs are equipped with protection circuits against static discharge.

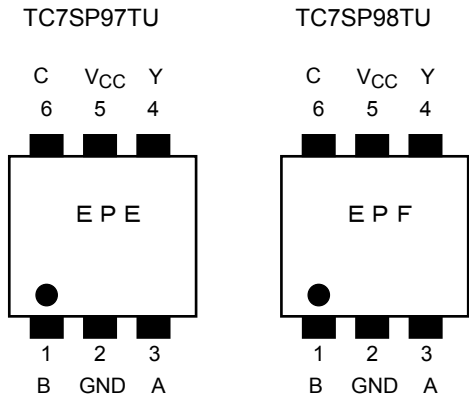


Weight: 0.007 g(typ)

Features

- Low-voltage operation : $V_{CC} = 1.2$ to 3.6 V
- High-speed operation : $t_{pd} = 8.5$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
: $t_{pd} = 12.0$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
- Output current : $|I_{OH}|/|I_{OL}| = \pm 8$ mA (min) ($V_{CC} = 3.0$ V)
: $|I_{OH}|/|I_{OL}| = \pm 4$ mA (min) ($V_{CC} = 2.3$ V)
: $|I_{OH}|/|I_{OL}| = \pm 1.5$ mA (min) ($V_{CC} = 1.65$ V)
- Latch-up performance : -300 mA
- ESD performance : Machine model $\geq \pm 200$ V
Human body model $\geq \pm 2000$ V
- Package : UF6
- Power-down protection is provided on all inputs and outputs

Pin Assignment (top view)

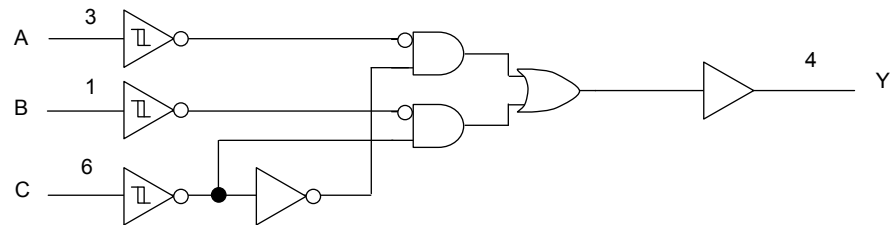


Truth Table

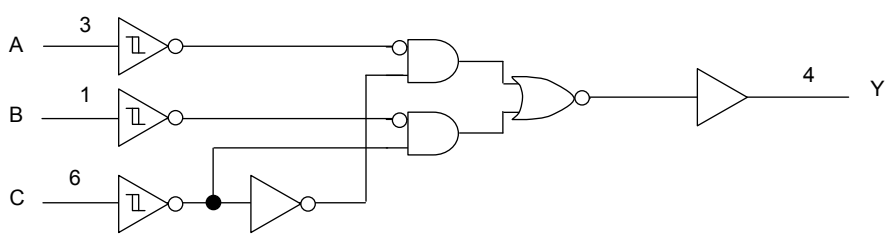
INPUTS			OUTPUT	
			TC7SP97	TC7SP98
A	B	C	Y	Y
L	L	L	L	H
L	L	H	L	H
L	H	L	H	L
L	H	H	L	H
H	L	L	L	H
H	L	H	H	L
H	H	L	H	L
H	H	H	H	L

System Diagram

TC7SP97



TC7SP98



Logic configurations(1/2)

Function	Input Condition	TC7SP97 Logic symbol	TC7SP98 Logic symbol	FUNCTION TABLE																																															
SP97 AND	A=INPUT B=L-Level C=INPUT			<table border="1"> <thead> <tr> <th rowspan="2">A</th> <th rowspan="2">B</th> <th rowspan="2">C</th> <th colspan="2">Y</th> </tr> <tr> <th>97</th> <th>98</th> </tr> </thead> <tbody> <tr> <td>L</td> <td>L</td> <td>L</td> <td>L</td> <td>H</td> </tr> <tr> <td>L</td> <td>L</td> <td>H</td> <td>L</td> <td>H</td> </tr> <tr> <td>H</td> <td>L</td> <td>L</td> <td>L</td> <td>H</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> <td>H</td> <td>L</td> </tr> </tbody> </table>	A	B	C	Y		97	98	L	L	L	L	H	L	L	H	L	H	H	L	L	L	H	H	L	H	H	L																				
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SP97 OR	A=H-Level B=INPUT C=INPUT			<table border="1"> <thead> <tr> <th rowspan="2">A</th> <th rowspan="2">B</th> <th rowspan="2">C</th> <th colspan="2">Y</th> </tr> <tr> <th>97</th> <th>98</th> </tr> </thead> <tbody> <tr> <td>H</td> <td>L</td> <td>L</td> <td>L</td> <td>H</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> <td>H</td> <td>L</td> </tr> <tr> <td>H</td> <td>H</td> <td>L</td> <td>H</td> <td>L</td> </tr> <tr> <td>H</td> <td>H</td> <td>H</td> <td>H</td> <td>L</td> </tr> </tbody> </table>	A	B	C	Y		97	98	H	L	L	L	H	H	L	H	H	L	H	H	L	H	L	H	H	H	H	L																				
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Logic configurations(2/2)

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L	L	H	L	H																	
H	L	H	H	L																	
SP98 Schmitt INV																					

Absolute Maximum Rating (Note1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	-0.5 to 4.6	V
DC input voltage	V_{IN}	-0.5 to 4.6	V
DC output voltage	V_{OUT}	-0.5 to 4.6 (Note2)	V
		-0.5 to $V_{CC} + 0.5$ (Note3)	
Input diode current	I_{IK}	-20	mA
Output diode current	I_{OK}	± 20 (Note4)	mA
DC output current	I_{OUT}	± 25	mA
Power dissipation	P_D	180	mW
DC V_{CC} /ground current	I_{CC}/I_{GND}	± 25	mA
Storage temperature	T_{stg}	-65~150	°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: $V_{CC} = 0$ V

Note 3: High or Low state. I_{OUT} absolute rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Operating Range (Note1)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	1.2~3.6	V
Input voltage	V_{IN}	-0.3~3.6	V
Output voltage	V_{OUT}	0~3.6 (Note2)	V
		0~ V_{CC} (Note3)	
Output current	I_{OH}/I_{OL}	± 8.0 (Note4)	mA
		± 4.0 (Note5)	
		± 1.5 (Note6)	
Operating temperature	T_{opr}	-40~85	°C

Note 1: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either VCC or GND.

Note 2: $V_{CC} = 0$ V

Note 3: High or low state

Note 4: $V_{CC} = 3.0\sim 3.6$ V

Note 5: $V_{CC} = 2.3\sim 2.7$ V

Note 6: $V_{CC} = 1.65\sim 1.8$ V

Electrical Characteristics

DC Characteristics (Ta = -40 to 85°C)

Characteristics		Symbol	Test Condition	V _{CC} (V)	Min	Max	Unit	
Input voltage	H-level	V _P	—	1.2		1.10	V	
				1.4		1.20		
				1.65		1.35		
				2.3		1.70		
				3.0		2.00		
				3.6		2.20		
	L-level	V _N	—	1.2	0.10		V	
				1.4	0.20			
				1.65	0.30			
				2.3	0.50			
				3.0	0.70			
				3.6	0.80			
Hysteresis voltage		V _H	—	1.2	0.2	0.9	V	
				1.4	0.2	0.9		
				1.65	0.2	0.95		
				2.3	0.3	1.0		
				3.0	0.3	1.2		
				3.6	0.3	1.2		
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.2~1.3	V _{CC} - 0.1	—	V
				I _{OH} = -500 μA	1.4~1.6	V _{CC} - 0.2	—	
				I _{OH} = -1.5 mA	1.65~1.95	V _{CC} - 0.3	—	
				I _{OH} = -4.0 mA	2.3~2.7	V _{CC} - 0.4	—	
				I _{OH} = -8.0 mA	3.0~3.6	2.40	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.2~1.3	—	0.10	
				I _{OL} = 500 μA	1.4~1.6	—	0.20	
				I _{OL} = 3.0 mA	1.65~1.95	—	0.25	
				I _{OL} = 4.0 mA	2.3~2.7	—	0.40	
				I _{OL} = 8.0 mA	3.0~3.6	—	0.40	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V	1.2~3.6	—	±1.5	μA	
Power-off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V	0	—	1.5	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND	1.2~3.6	—	3.0	μA	
			V _{CC} ≦ V _{IN} ≦ 3.6 V	1.2~3.6	—	±3.0		
Increase in I _{CC} per input		ΔI _{CC}	V _{IH} = V _{CC} - 0.6 V	2.7~3.6	—	100		

AC Characteristics (Ta = -40 to 85°C, Input: tr = tf = 3.0 ns)

Characteristics	Symbol	Test Condition	VCC (V)	Min	Max	Unit
Propagation delay time (A, B,C-Y)	tpLH tpHL	Figure 1, Figure 2 CL = 10pF, RL = 1MΩ	1.8 ± 0.15	1.0	21.0	ns
			2.5 ± 0.2	0.8	10.0	
			3.3 ± 0.3	0.6	7.0	
	tpLH tpHL	Figure 1, Figure 2 CL = 15pF, RL = 1MΩ	1.8 ± 0.15	1.0	23.0	ns
			2.5 ± 0.2	0.8	11.0	
			3.3 ± 0.3	0.6	7.7	
	tpLH tpHL	Figure 1, Figure 2 CL = 30pF, RL = 1MΩ	1.8 ± 0.15	1.0	27.0	ns
			2.5 ± 0.2	0.8	12.0	
			3.3 ± 0.3	0.6	8.5	

Dynamic Switching Characteristics (Ta = 25°C, Input: tr = tf = 3.0 ns, CL = 30 pF)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V (Note)	1.8	0.25	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	0.6	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	0.8	
Quiet output minimum dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V (Note)	1.8	-0.25	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	-0.6	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	-0.8	
Quiet output minimum dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V (Note)	1.8	1.5	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	1.9	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	2.2	

Note : Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	1.8, 2.5, 3.3	6	pF
Power dissipation capacitance	CPD	fIN = 10 MHz (Note)	1.8, 2.5, 3.3	30	pF

Note : CPD 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:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

AC Test Circuit

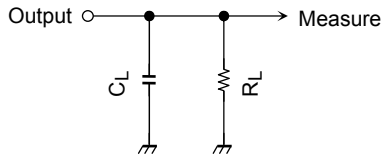
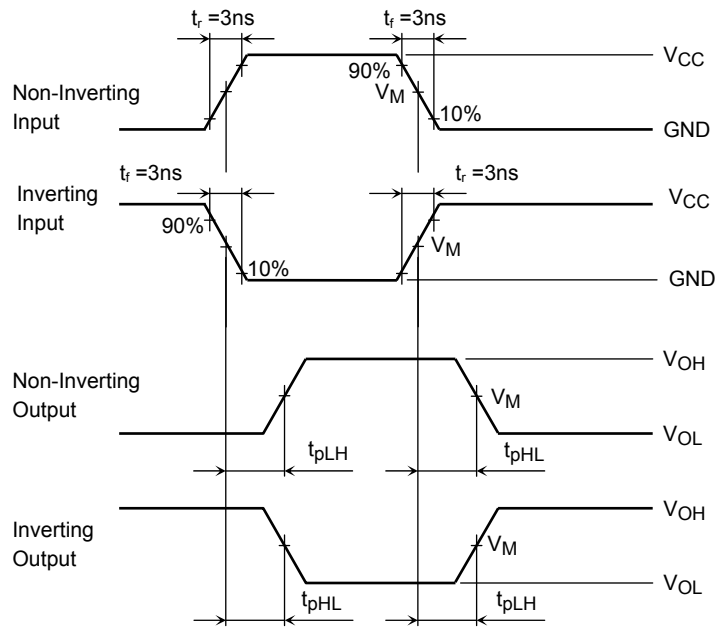


Figure 1

AC Waveform



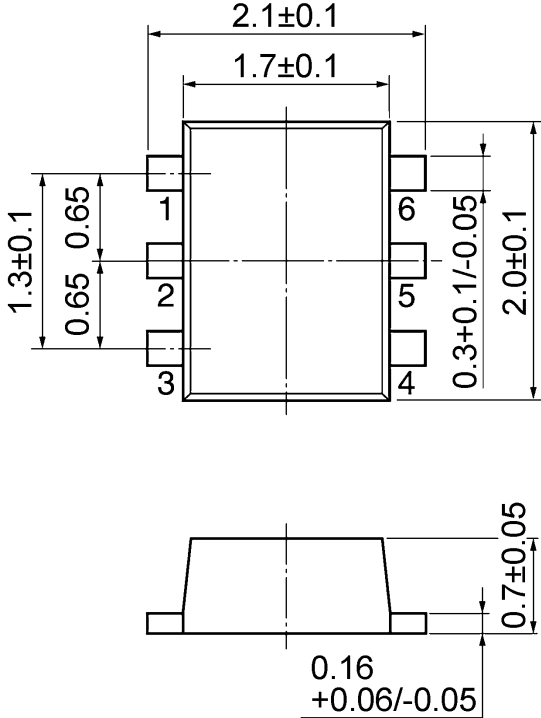
Symbol	V_{CC}		
	$3.3 \pm 0.3\text{ V}$	$2.5 \pm 0.2\text{ V}$	$1.8\text{ V} \pm 0.15\text{ V}$
V_{IN}	V_{CC}	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$

Figure 2 t_{pLH} , t_{pHL}

Package Dimensions

UF6

Unit: mm



Weight: 0.06 g (typ.)

RESTRICTIONS ON PRODUCT USE

20070701-EN

- The information contained herein is subject to change without notice.
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc.
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