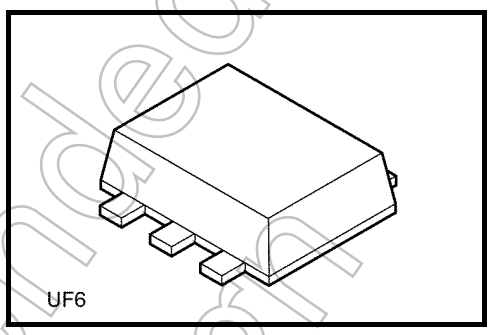
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7SP97TU, TC7SP98TU

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



Weight: 0.007 g(typ)

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.

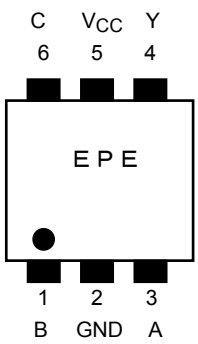
Features

- 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 : $|I_{OH}|/I_{OL}$ = ±8 mA (min) (V_{CC} = 3.0 V)
  : $|I_{OH}|/I_{OL}$ = ±4 mA (min) (V_{CC} = 2.3 V)
  : $|I_{OH}|/I_{OL}$ = ±1.5 mA (min) (V_{CC} = 1.65 V)
- Latch-up performance : −300 mA
- ESD performance : Machine model ≥ ±200 V
  Human body model ≥ ±2000 V
- Package : UF6
- Power-down protection is provided on all inputs and outputs

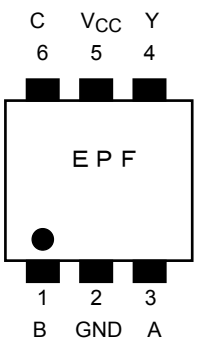
Start of commercial production
2007-06

Pin Assignment (top view)

TC7SP97TU



TC7SP98TU

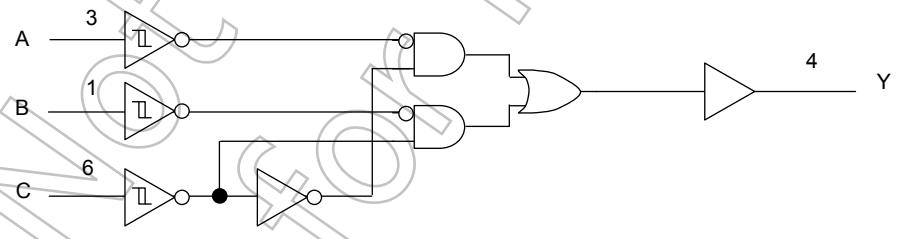


Truth Table

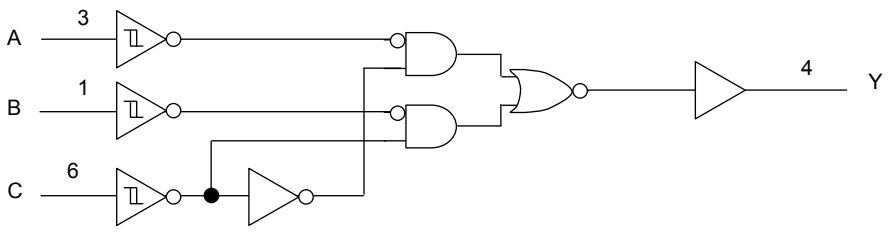
INPUTS			OUTPUT	
			TC7SP97	TC7SP98
A	B	C	Y	Y
L	L	L	L	H
L	L	H	L	H
L	H	L	H	L
L	H	H	L	H
H	L	L	L	H
H	L	H	H	L
H	H	L	H	L
H	H	H	H	L

System Diagram

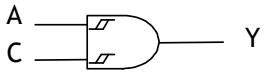
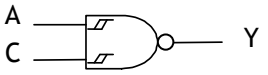
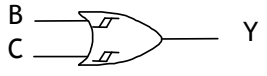
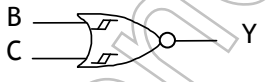
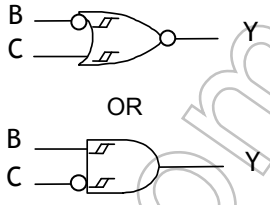
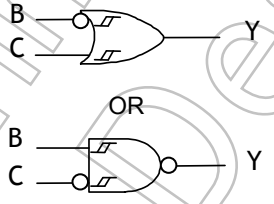
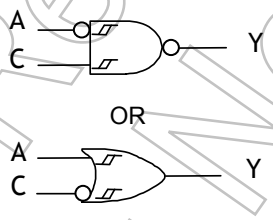
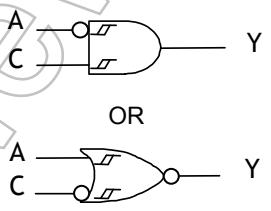
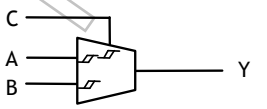
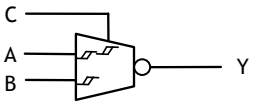
TC7SP97



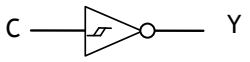
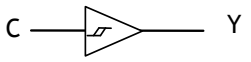
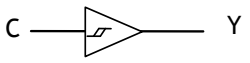
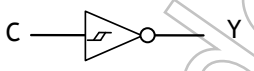
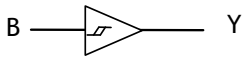
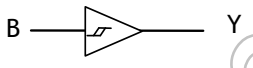
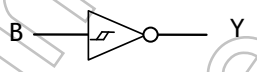
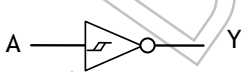
TC7SP98



Logic configrations(1/2)

Function	Input Condition	TC7SP97 Logic symbol	TC7SP98 Logic symbol	FUNCTION TABLE
SP97 AND SP98 NAND	A=INPUT B=L-Level C=INPUT Y=OUTPUT			A B C Y(97) Y(98) L L L L H L L H L H H L L L H H L H H L
SP97 OR SP98 NOR	A=H-Level B=INPUT C=INPUT Y=OUTPUT			A B C Y(97) Y(98) H L L L H H L H H L H H L H L H H H H L
SP97 Schmitt INV+NOR or Schmitt INV+AND SP98 Schmitt INV+OR or Schmitt INV+NAND	A=L-Level B=INPUT C=INPUT Y=OUTPUT			A B C Y(97) Y(98) L L L L H L L H L H L H L H L L H H L H
SP97 Schmitt INV+NAND or Schmitt INV+OR SP98 Schmitt INV+AND or Schmitt INV+NOR	A=INPUT B=H-Level C=INPUT Y=OUTPUT			A B C Y(97) Y(98) L H L H L L H H L H H H L H L H H H H L
SP97 2 to 1 Selector SP98 2 to 1 Selector+INV	A=INPUT B=INPUT C=Select Y=OUTPUT			A B C Y(97) Y(98) L L L L H L H L H L H L L L H H H L H L L L H L H L H H L H H L H H L H H H H L

Logic configrations(2/2)

Function	Input Condition	TC7SP97 Logic symbol	TC7SP98 Logic symbol	FUNCTION TABLE
SP97 Schmitt INV SP98 Schmitt Buffer	A=L-Level B=H-Level C=INPUT Y=OUTPUT			A B C | Y (97 98) L H L | H L L H H | L H
SP97 Schmitt Buffer SP98 Schmitt INV	A=H-Level B=L-Level C=INPUT Y=OUTPUT			A B C | Y (97 98) H L L | L H H L H | H L
SP97 Schmitt Buffer SP98 Schmitt INV	A=L-Level B=INPUT C=L-Level Y=OUTPUT			A B C | Y (97 98) L L L | L H L H L | H L
SP97 Schmitt Buffer SP98 Schmitt INV	A=H-Level B=INPUT C=L-Level Y=OUTPUT			A B C | Y (97 98) H L L | L H H H L | H L
SP97 Schmitt Buffer SP98 Schmitt INV	A=INPUT B=L-Level C=H-Level Y=OUTPUT			A B C | Y (97 98) L L H | L H H L H | H L

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 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: V_{CC} = 0 V

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

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

Operating Range (Note1)

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

Note 2: V_{CC} = 0 V

Note 3: High or low state

Note 4: V_{CC} = 3.0 to 3.6 V

Note 5: V_{CC} = 2.3 to 2.7 V

Note 6: V_{CC} = 1.65 to 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 to 1.3	V_{CC} - 0.1	—	V
				I_{OH} = –500 μA	1.4 to 1.6	V_{CC} - 0.2	—	
				I_{OH} = –1.5 mA	1.65 to 1.95	V_{CC} - 0.3	—	
				I_{OH} = –4.0 mA	2.3 to 2.7	V_{CC} - 0.4	—	
				I_{OH} = –8.0 mA	3.0 to 3.6	2.40	—	
	L-level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.2 to 1.3	—	0.10	
				I_{OL} = 500 μA	1.4 to 1.6	—	0.20	
				I_{OL} = 3.0 mA	1.65 to 1.95	—	0.25	
				I_{OL} = 4.0 mA	2.3 to 2.7	—	0.40	
				I_{OL} = 8.0 mA	3.0 to 3.6	—	0.40	
Input leakage current		I_{IN}	V_{IN} = 0 to 3.6 V		1.2 to 3.6	—	±1.5	μA
Power-off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	—	1.5	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		1.2 to 3.6	—	3.0	μA
			V_{CC} ≤ V_{IN} ≤ 3.6 V		1.2 to 3.6	—	±3.0	
Increase in I_{CC} per input		ΔI_{CC}	V_{IH} = V_{CC} – 0.6 V		2.7 to 3.6	—	100	

AC Characteristics (Ta = –40 to 85°C, Input: $t_r = t_f = 3.0$ ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time (A, B,C-Y)	t_{pLH} t_{pHL}	Figure 1, Figure 2 CL = 10pF、R_L = 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	
	t_{pLH} t_{pHL}	Figure 1, Figure 2 CL = 15pF、R_L = 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	
	t_{pLH} t_{pHL}	Figure 1, Figure 2 CL = 30pF、R_L = 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: $t_r = t_f = 3.0$ ns, $C_L = 30$ pF)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	V_{IH} = 1.8 V, V_{IL} = 0 V (Note)	1.8	0.25	V
		V_{IH} = 2.5 V, V_{IL} = 0 V (Note)	2.5	0.6	
		V_{IH} = 3.3 V, V_{IL} = 0 V (Note)	3.3	0.8	
Quiet output minimum dynamic V_{OL}	V_{OLV}	V_{IH} = 1.8 V, V_{IL} = 0 V (Note)	1.8	–0.25	V
		V_{IH} = 2.5 V, V_{IL} = 0 V (Note)	2.5	–0.6	
		V_{IH} = 3.3 V, V_{IL} = 0 V (Note)	3.3	–0.8	
Quiet output minimum dynamic V_{OH}	V_{OHV}	V_{IH} = 1.8 V, V_{IL} = 0 V (Note)	1.8	1.5	V
		V_{IH} = 2.5 V, V_{IL} = 0 V (Note)	2.5	1.9	
		V_{IH} = 3.3 V, V_{IL} = 0 V (Note)	3.3	2.2	

Note : Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	—	1.8, 2.5, 3.3	6	pF
Power dissipation capacitance	C_{PD}	f_{IN} = 10 MHz (Note)	1.8, 2.5, 3.3	30	pF

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:

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

AC Test Circuit

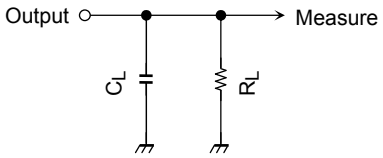
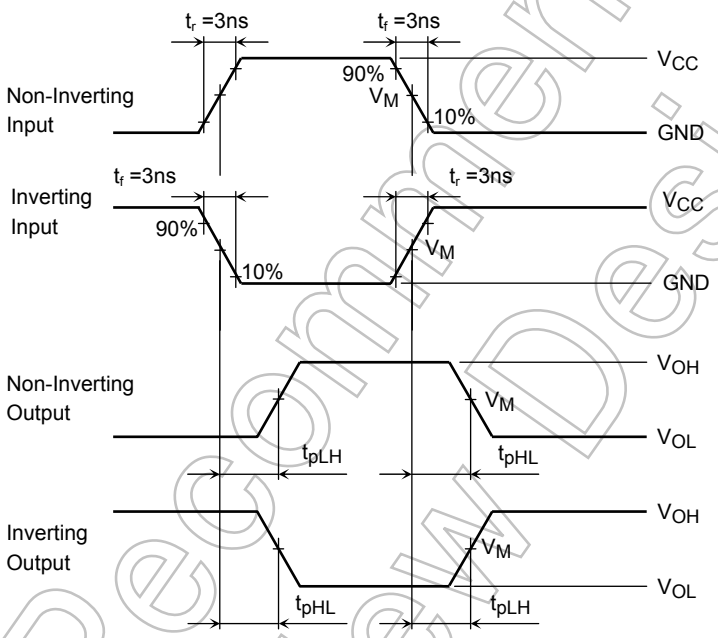


Figure 1

AC Waveform



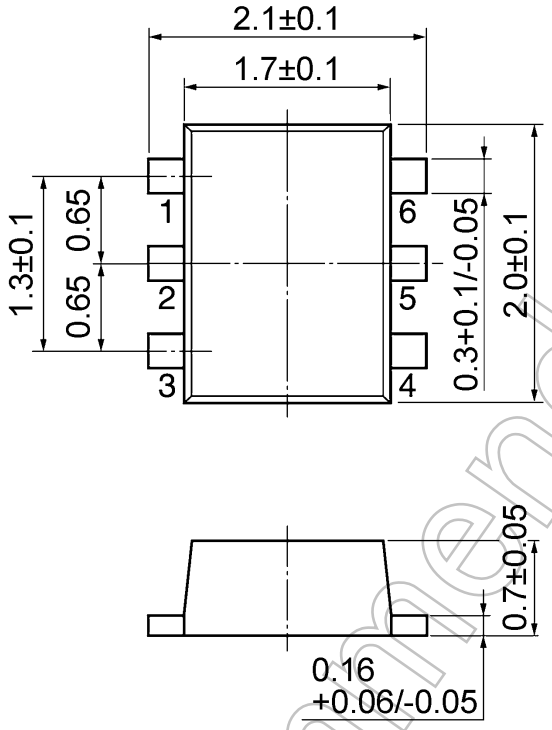
Symbol	V_{CC}		
	3.3 ± 0.3 V	2.5 ± 0.2 V	1.8 V± 0.15 V
V_{IN}	V_{CC}	V_{CC}	V_{CC}
V_M	1.5 V	V_{CC}/2	V_{CC}/2

Figure 2 t_{pLH}, t_{pHL}

Package Dimensions

UF6

Unit: mm



Weight: 0.06 g (typ.)

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