

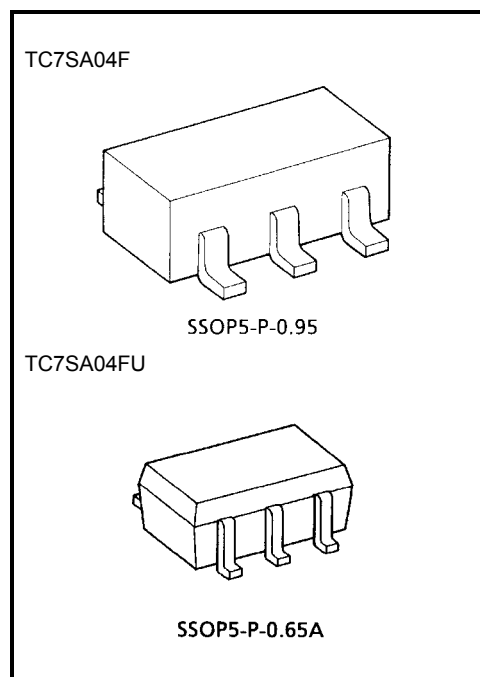
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7SA04F,TC7SA04FU

Inverter with 3.6 V Tolerant Input and Output

Features

- Low voltage operation : $V_{CC} = 1.8 \sim 3.6 \text{ V}$
- High speed operation : $t_{pd} = 2.8 \text{ ns (max)} (V_{CC} = 3.0 \sim 3.6 \text{ V})$
 $t_{pd} = 3.7 \text{ ns (max)} (V_{CC} = 2.3 \sim 2.7 \text{ V})$
 $t_{pd} = 7.4 \text{ ns (max)} (V_{CC} = 1.8 \text{ V})$
- High Output current : $I_{OH}/I_{OL} = \pm 24 \text{ mA (min)} (V_{CC} = 3.0 \text{ V})$
 $I_{OH}/I_{OL} = \pm 18 \text{ mA (min)} (V_{CC} = 2.3 \text{ V})$
 $I_{OH}/I_{OL} = \pm 6 \text{ mA (min)} (V_{CC} = 1.8 \text{ V})$
- Latch-up performance : $\pm 300 \text{ mA}$ or more
- ESD performance : Human body model $> \pm 200 \text{ V}$
Machine model $> \pm 2000 \text{ V}$
- Power down protection is provided on all inputs and outputs.
- TC74VCX04FT equivalent.



Weight

SSOP5-P-0.95 : 0.016 g (typ.)

SSOP5-P-0.65A : 0.006 g (typ.)

Maximum Ratings ($T_a = 25^\circ\text{C}$)

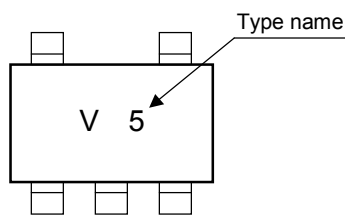
Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	$-0.5 \sim 4.6$	V
DC input voltage	V_{IN}	$-0.5 \sim 4.6$	V
DC output voltage	V_{OUT}	$-0.5 \sim 4.6$ (Note 1)	V
		$-0.5 \sim V_{CC} + 0.5$ (Note 2)	
Input diode current	I_{IK}	-50	mA
Output diode current	I_{OK}	± 50 (Note 3)	mA
DC output current	I_{OUT}	± 50	mA
Power dissipation	P_D	200	mW
DC V_{CC} /ground current	I_{CC}	± 100	mA
Storage temperature range	T_{stg}	$-65 \sim 150$	$^\circ\text{C}$

Note 1: $V_{CC} = 0 \text{ V}$

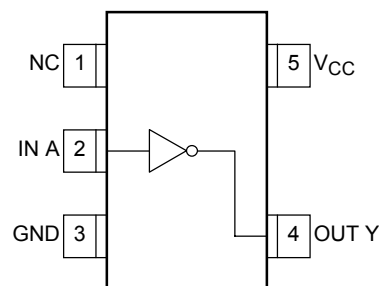
Note 2: High or low state. I_{OUT} absolute maximum rating be observed.

Note 3: $V_{OUT} < \text{GND}$, $V_{OUT} > V_{CC}$

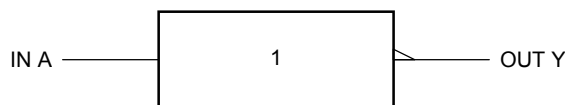
Marking



Pin Assignment (top view)



Logic Diagram



Truth Table

A	Y
L	H
H	L

Recommended Operating Range

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	1.8~3.6	V
		1.2~3.6 (Note 4)	
Input voltage	V_{IN}	-0.3~3.6	V
Output voltage	V_{OUT}	0~3.6 (Note 5)	V
		0~ V_{CC} (Note 6)	
Output current	I_{OH}/I_{OL}	± 24 (Note 7)	mA
		± 18 (Note 8)	
		± 6 (Note 9)	
Operating temperature range	T_{opr}	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note 10)	ns/V

Note 4: Data retention only

Note 5: $V_{CC} = 0$ V

Note 6: High or low state

Note 7: $V_{CC} = 3.0 \sim 3.6$ V

Note 8: $V_{CC} = 2.3 \sim 2.7$ V

Note 9: $V_{CC} = 1.8$ V

Note 10: $V_{IN} = 0.8 \sim 2.0$ V, $V_{CC} = 3.0$ V

Electrical Characteristics
DC Characteristics ($T_a = -40 \sim 85^\circ\text{C}$, $2.7\text{ V} < V_{CC} \leq 3.6\text{ V}$)

Characteristics		Symbol	Test Condition		Min	Max	Unit	
			V _{CC} (V)					
Input voltage	High level	V _{IH}	—		2.7~3.6	2.0	—	V
	Low level	V _{IL}	—		2.7~3.6	—	0.8	
Output voltage	High level	V _{OH}	V _{IN} = V _{IL}	I _{OH} = -100 μA	2.7~3.6	V _{CC} - 0.2	—	V
				I _{OH} = -12 mA	2.7	2.2	—	
				I _{OH} = -18 mA	3.0	2.4	—	
				I _{OH} = -24 mA	3.0	2.2	—	
	Low level	V _{OL}	V _{IN} = V _{IH}	I _{OL} = 100 μA	2.7~3.6	—	0.2	
				I _{OL} = 12 mA	2.7	—	0.4	
				I _{OL} = 18 mA	3.0	—	0.4	
				I _{OL} = 24 mA	3.0	—	0.55	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V	2.7~3.6	—	±5.0	μA	
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V	0	—	10.0	μA	
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND	2.7~3.6	—	20.0	μA	
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V	2.7~3.6	—	±20.0		
Increase in I _{CC} per input		ΔI _{CC}	V _{IH} = V _{CC} - 0.6 V	2.7~3.6	—	750		

DC Characteristics ($T_a = -40 \sim 85^\circ\text{C}$, $2.3\text{ V} \leq V_{CC} \leq 2.7\text{ V}$)

Characteristics		Symbol	Test Condition		Min	Max	Unit	
				V _{CC} (V)				
Input voltage	High level	V _{IH}	—		2.3~2.7	1.6	—	V
	Low level	V _{IL}	—		2.3~2.7	—	0.7	
Output voltage	High level	V _{OH}	V _{IN} = V _{IL}	I _{OH} = -100 μA	2.3~2.7	V _{CC} - 0.2	—	V
				I _{OH} = -6 mA	2.3	2.0	—	
				I _{OH} = -12 mA	2.3	1.8	—	
				I _{OH} = -18 mA	2.3	1.7	—	
	Low level	V _{OL}	V _{IN} = V _{IH}	I _{OL} = 100 μA	2.3~2.7	—	0.2	
				I _{OL} = 12 mA	2.3	—	0.4	
				I _{OL} = 18 mA	2.3	—	0.6	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		2.3~2.7	—	±5.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.3~2.7	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.3~2.7	—	±20.0	

DC Characteristics (Ta = -40~85°C, 1.8 V ≤ V_{CC} < 2.3 V)

Characteristics		Symbol	Test Condition			Min	Max	Unit	
					V _{CC} (V)				
Input voltage	High level	V _{IH}	—		1.8~2.3	0.7 × V _{CC}	—	V	
	Low level	V _{IL}	—		1.8~2.3	—	0.2 × V _{CC}		
Output voltage	High level	V _{OH}	V _{IN} = V _{IL}	I _{OH} = -100 μA	1.8	V _{CC} - 0.2	—	V	
				I _{OH} = -6 mA	1.8	1.4	—		
	Low level	V _{OL}	V _{IN} = V _{IH}	I _{OL} = 100 μA	1.8	—	0.2		
				I _{OL} = 6 mA	1.8	—	0.3		
Input leakage current		I _{IIN}	V _{IN} = 0~3.6 V			1.8	—	±5.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V			0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND			1.8	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V			1.8	—	±20.0	

AC Characteristics (Ta = -40~85°C, input: t_r = t_f = 2.0 ns, C_L = 30 pF, R_L = 500 Ω)

Characteristics		Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Propagation delay time		t _{pLH} t _{pHL}	Figure 1, Figure 2		1.8	1.0	7.4	ns
					2.5 ± 0.2	0.8	3.7	
					3.3 ± 0.3	0.6	2.8	

For C_L = 50 pF, add approximately 300 ps to the AC maximum specification.

Dynamic Switching Characteristics (Ta = 25°C, input: t_r = t_f = 2.0 ns, C_L = 30 pF)

Characteristics	Symbol	Test Condition		Typ.	Unit
			V _{CC} (V)		
Quiet output maximum dynamic V _{OL}	V _{OLP}	V _{IN} = 1.8 V, V _{IL} = 0 V (Note 11)	1.8	0.25	ns
		V _{IN} = 2.5 V, V _{IL} = 0 V (Note 11)	2.5	0.6	
		V _{IN} = 3.3 V, V _{IL} = 0 V (Note 11)	3.3	0.8	
Quiet output minimum dynamic V _{OL}	V _{OLV}	V _{IN} = 1.8 V, V _{IL} = 0 V (Note 11)	1.8	−0.25	ns
		V _{IN} = 2.5 V, V _{IL} = 0 V (Note 11)	2.5	−0.6	
		V _{IN} = 3.3 V, V _{IL} = 0 V (Note 11)	3.3	−0.8	
Quiet output minimum dynamic V _{OH}	V _{OLP}	V _{IN} = 1.8 V, V _{IL} = 0 V (Note 11)	1.8	1.5	ns
		V _{IN} = 2.5 V, V _{IL} = 0 V (Note 11)	2.5	1.9	
		V _{IN} = 3.3 V, V _{IL} = 0 V (Note 11)	3.3	2.2	

Note 11: Parameter guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition		Typ.	Unit
			V _{CC} (V)		
Input capacitance	C _{IN}	—	1.8, 2.5, 3.3	5	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note 12)	1.8, 2.5, 3.3	18	pF

Note 12: 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

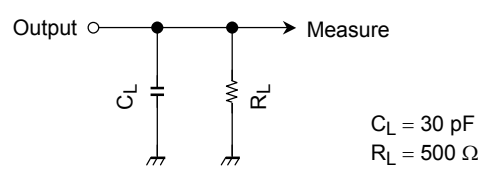
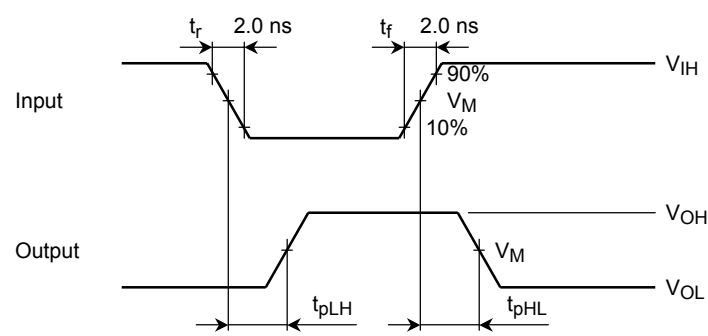


Figure 1

AC Waveform



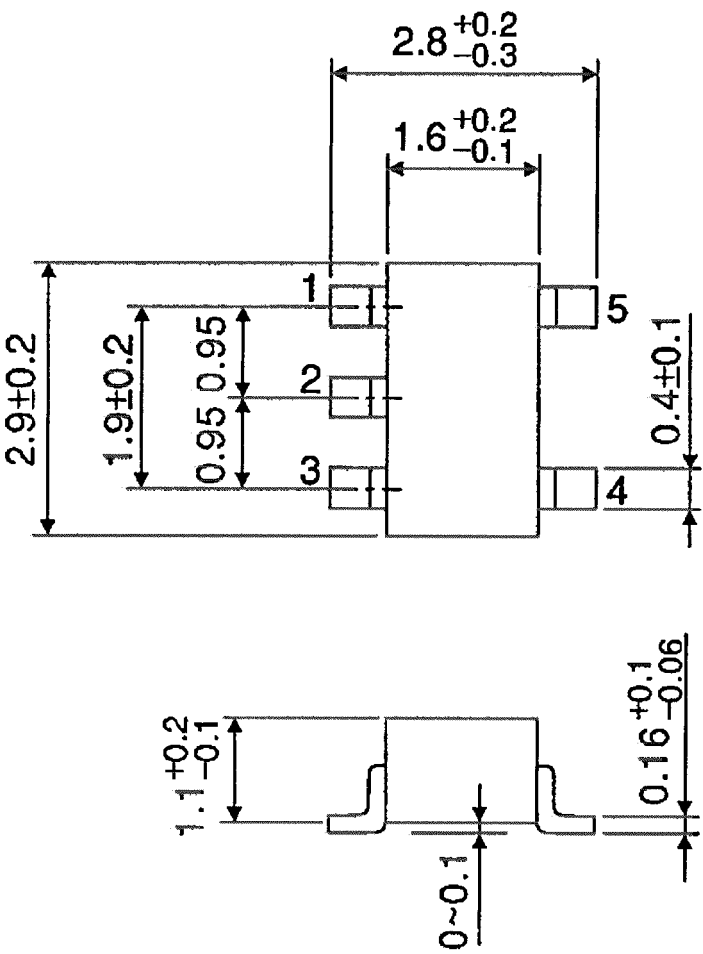
Symbol	V_{CC}		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$

Figure 2 t_{pLH} , t_{pHL}

Package Dimensions

SSOP5-P-0.95

Unit : mm

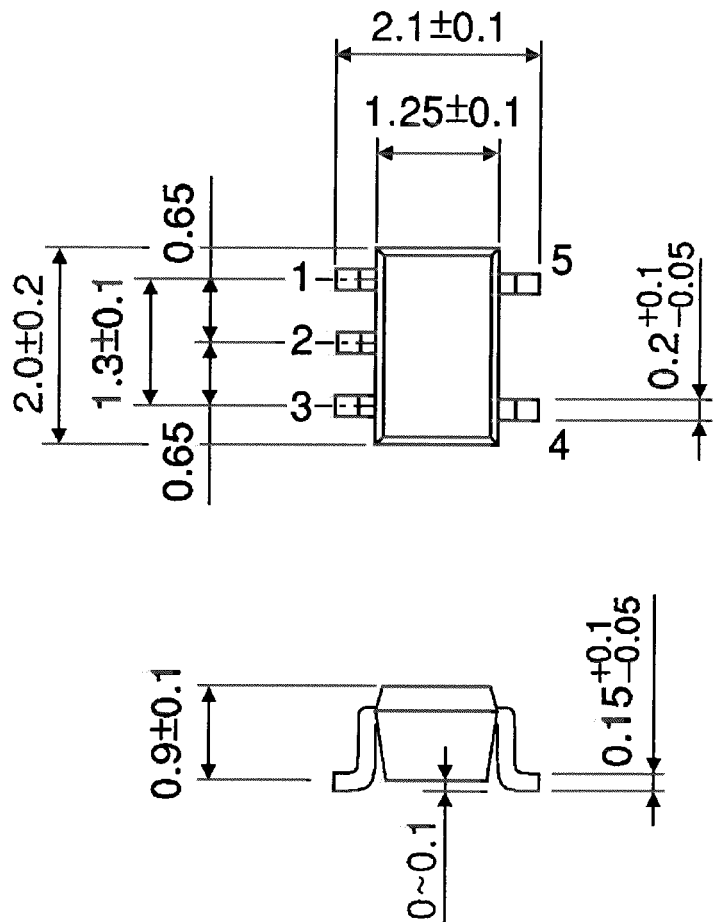


Weight: 0.016 g (typ.)

Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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