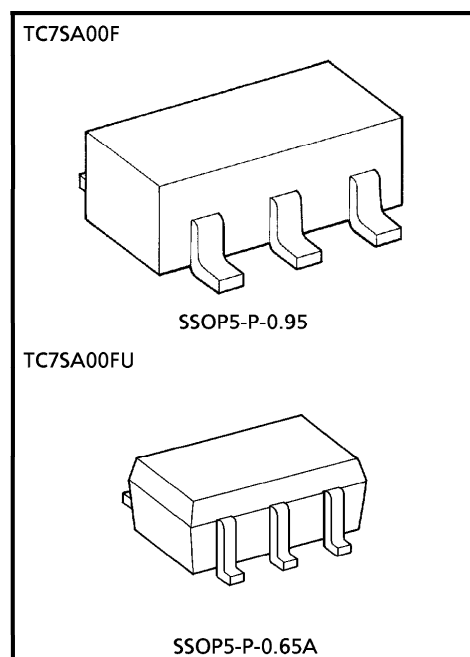


# TC7SA00F, TC7SA00FU

## LOW-VOLTAGE 2-INPUT NAND GATE WITH 3.6 V TOLERANT INPUTS AND OUTPUTS

### FEATURES

- Low Voltage Operation :  $V_{CC} = 1.8\sim 3.6\text{ V}$
- High Speed Operation :  $t_{pd} = 2.8\text{ ns (max.)}$   
at  $V_{CC} = 3.0\sim 3.6\text{ V}$   
 $t_{pd} = 3.7\text{ ns (max.)}$   
at  $V_{CC} = 2.3\sim 2.7\text{ V}$   
 $t_{pd} = 7.4\text{ ns (max.)}$   
at  $V_{CC} = 1.8\text{ V}$
- 3.6 V Tolerant inputs and outputs.
- Output Current :  $I_{OH}/I_{OL} = \pm 24\text{ mA (min.)}$   
at  $V_{CC} = 3.0\text{ V}$   
 $I_{OH}/I_{OL} = \pm 18\text{ mA (min.)}$  at  
 $V_{CC} = 2.3\text{ V}$   
 $I_{OH}/I_{OL} = \pm 6\text{ mA (min.)}$  at  
 $V_{CC} = 1.8\text{ V}$
- Latch-up Performance :  $\pm 300\text{ mA}$
- ESD Performance : Human Body Model  $> \pm 2000\text{ V}$   
: Machine Model  $> \pm 200\text{ V}$
- Power Down Protection is provided on all inputs and outputs.
- TC74VCX00FT Equivalent



Weight  
 SSOP5-P-0.95 : 0.016g (Typ.)  
 SSOP5-P-0.65A : 0.006g (Typ.)

# PRELIMINARY

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## MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Power Supply Voltage	$V_{CC}$	-0.5~4.6	V
DC Input Voltage	$V_{IN}$	-0.5~4.6	V
DC Output Voltage	$V_{OUT}$	-0.5~4.6 (Note 1)	V
		-0.5~ $V_{CC}$ + 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	$I_{CC}/I_{GND}$	±100	mA
Storage Temperature	$T_{stg}$	-65~150	°C

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

(Note 2) High or Low State.  $I_{OUT}$  absolute maximum rating must be observed.

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

# PRELIMINARY

## RECOMMENDED OPERATING RANGE

PARAMETER	SYMBOL	RATING	UNIT
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	$T_{opr}$	-40~85	°C
Input Rise And Fall Time	$dt/dv$	0~10 (Note 10)	ns/V

(Note 4) Data Retention Only

(Note 5)  $V_{CC} = 0\text{ V}$

(Note 6) High or Low State

(Note 7)  $V_{CC} = 3.0\sim 3.6\text{ V}$

(Note 8)  $V_{CC} = 2.3\sim 2.7\text{ V}$

(Note 9)  $V_{CC} = 1.8\text{ V}$

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

**ELECTRICAL CHARACTERISTICS**

DC characteristics (Ta = -40~85°C, 2.7 V < VCC ≤ 3.6 V)

PARAMETER		SYMBOL	TEST CONDITION		MIN.	MAX.	UNIT	
				VCC (V)				
Input Voltage	"H" Level	V <sub>IH</sub>		2.7~3.6	2.0	—	V	
	"L" Level	V <sub>IL</sub>		2.7~3.6	—	0.8		
Output Voltage	"H" Level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.7~3.6	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -12 mA	2.7	2.2	—	
				I <sub>OH</sub> = -18 mA	3.0	2.4	—	
				I <sub>OH</sub> = -24 mA	3.0	2.2	—	
	"L" Level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	2.7~3.6	—	0.2	
				I <sub>OL</sub> = 12 mA	2.7	—	0.4	
				I <sub>OL</sub> = 18 mA	3.0	—	0.4	
			I <sub>OL</sub> = 24 mA	3.0	—	0.55		
Input Leakage Current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V	2.7~3.6	—	± 5.0	μA	
Power Off Leakage Current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V	0	—	10.0	μA	
Quiescent Supply Current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	2.7~3.6	—	20.0	μA	
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	2.7~3.6	—	± 20.0		
Increase In I <sub>CC</sub> Per Input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V	2.7~3.6	—	750	μA	

**PRELIMINARY**

**ELECTRICAL CHARACTERISTICS**

DC characteristics (Ta = -40~85°C, 2.3 V ≤ VCC ≤ 2.7 V)

PARAMETER		SYMBOL	TEST CONDITION		MIN.	MAX.	UNIT	
				VCC (V)				
Input Voltage	"H" Level	V <sub>IH</sub>		2.3~2.7	1.6	—	V	
	"L" Level	V <sub>IL</sub>		2.3~2.7	—	0.7		
Output Voltage	"H" Level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.3~2.7	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	2.3	2.0	—	
				I <sub>OH</sub> = -12 mA	2.3	1.8	—	
				I <sub>OH</sub> = -18 mA	2.3	1.7	—	
	"L" Level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	2.3~2.7	—	0.2	
				I <sub>OL</sub> = 12 mA	2.3	—	0.4	
				I <sub>OL</sub> = 18 mA	2.3	—	0.6	
Input Leakage Current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V	2.3~2.7	—	± 5.0	μA	
Power Off Leakage Current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V	0	—	10.0	μA	
Quiescent Supply Current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	2.3~2.7	—	20.0	μA	
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V <sub>CC</sub>	2.3~2.7	—	± 20.0		

**ELECTRICAL CHARACTERISTICS**

DC characteristics (Ta = -40~85°C, 1.8 V ≤ VCC < 2.3 V)

PARAMETER		SYMBOL	TEST CONDITION		VCC (V)	MIN.	MAX.	UNIT
Input Voltage	"H" Level	V <sub>IH</sub>			1.8~2.3	0.7 × V <sub>CC</sub>	—	V
	"L" Level	V <sub>IL</sub>			1.8~2.3	—	0.2 × V <sub>CC</sub>	
Output Voltage	"H" Level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	1.8	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	1.8	1.4	—	
	"L" Level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	1.8	—	0.2	
				I <sub>OL</sub> = 6 mA	1.8	—	0.3	
Input Leakage Current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		1.8	—	± 5.0	μA
Power Off Leakage Current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent Supply Current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		1.8	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		1.8	—	± 20.0	

AC characteristics (Ta = -40~85°C, Input t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF, R<sub>L</sub> = 500 Ω)

PARAMETER	SYMBOL	TEST CONDITION	VCC (V)	MIN.	MAX.	UNIT
			1.8	1.5	7.4	
Propagation Delay Time	t <sub>pLH</sub> t <sub>pHL</sub>	(Fig.1, 2)	2.5 ± 0.2	1.0	3.7	ns
			3.3 ± 0.3	0.8	2.8	

For C<sub>L</sub> = 50 pF, add approximately 300 ps to the AC maximum specification.

**PRELIMINARY**

Dynamic switching characteristics (Ta = 25°C, Input t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF)

PARAMETER	SYMBOL	TEST CONDITION	VCC (V)	TYP.	UNIT
			1.8	0.25	
Quiet Output Maximum Dynamic V <sub>OL</sub>	V <sub>OLP</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 11)	1.8	0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 11)	2.5	0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note 11)	3.3	0.8	
Quiet Output Minimum Dynamic V <sub>OL</sub>	V <sub>OLV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 11)	1.8	-0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 11)	2.5	-0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note 11)	3.3	-0.8	
Quiet Output Minimum Dynamic V <sub>OH</sub>	V <sub>OHV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 11)	1.8	1.5	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 11)	2.5	1.9	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note 11)	3.3	2.2	

(Note 11) Parameter guaranteed by design.

Capacitive characteristics (Ta = 25°C)

PARAMETER	SYMBOL	TEST CONDITION	V <sub>CC</sub> (V)	TYP.	UNIT
			1.8, 2.5, 3.3		
Input Capacitance	C <sub>IN</sub>	—	1.8, 2.5, 3.3	6	pF
Power Dissipation Capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz (Note 12)	1.8, 2.5, 3.3	20	pF

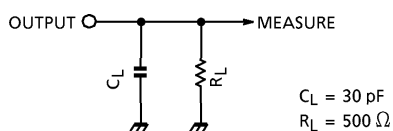
(Note 12) C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

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

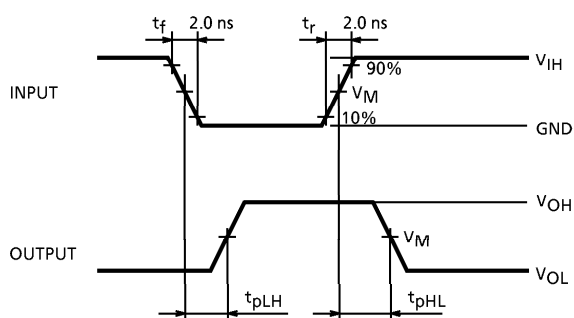
**TEST CIRCUIT**

Fig.1



**AC WAVEFORM**

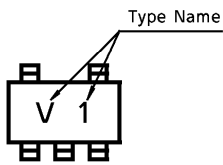
Fig.2 t<sub>pLH</sub>, t<sub>pHL</sub>



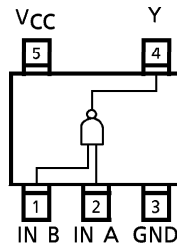
SYMBOL	V <sub>CC</sub>		
	3.3 ± 0.3 V	2.5 ± 0.2 V	1.8 V
V <sub>IH</sub>	2.7 V	V <sub>CC</sub>	V <sub>CC</sub>
V <sub>M</sub>	1.5 V	V <sub>CC</sub> /2	V <sub>CC</sub> /2

**PRELIMINARY**

**MARKING**



**PIN ASSIGNMENT (TOP VIEW)**



**TRUTH TABLE**

INPUTS		OUTPUTS
A	B	Y
L	L	H
L	H	H
H	L	H
H	H	L

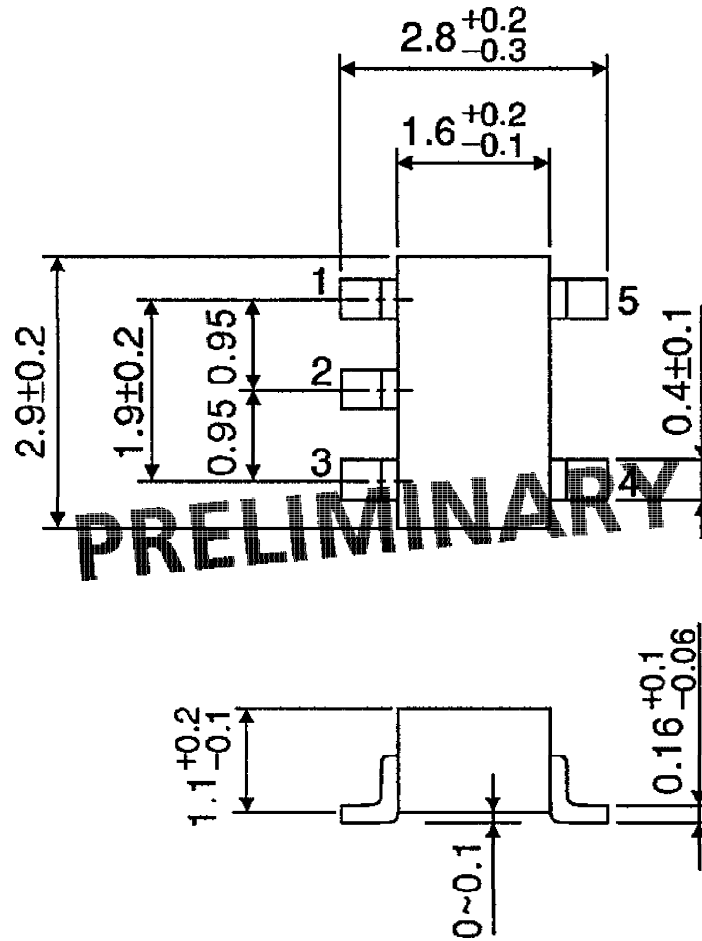
**LOGIC DIAGRAM**



**PRELIMINARY**

OUTLINE DRAWING  
SSOP5-P-0.95

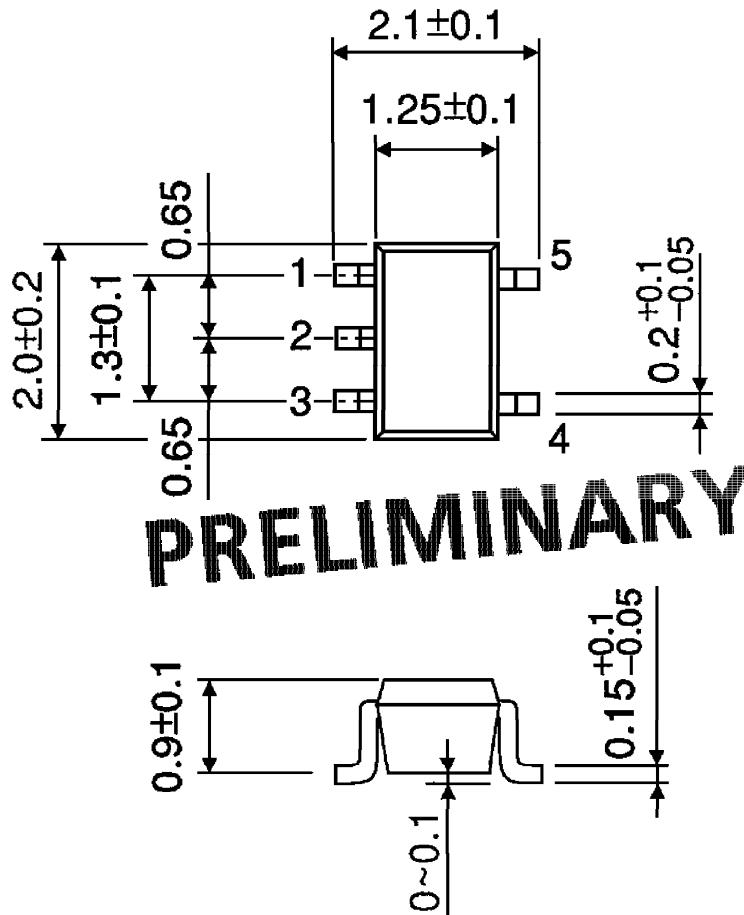
Unit : mm



Weight : 0.016 g (Typ.)

OUTLINE DRAWING  
SSOP5-P-0.65A

Unit : mm



Weight : 0.006 g (Typ.)