

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

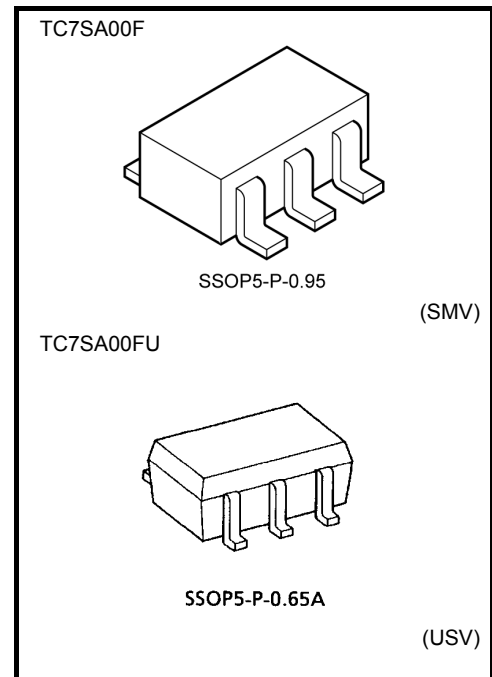
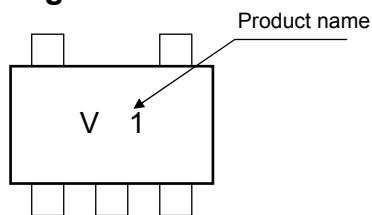
# TC7SA00F, TC7SA00FU

## 2-Input NAND Gate

### Features

- Low voltage operation :  $V_{CC} = 1.8$  to  $3.6$  V
- High speed operation :  $t_{pd} = 2.8$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)  
:  $t_{pd} = 3.7$  ns (max) ( $V_{CC} = 2.3$  to  $2.7$  V)  
:  $t_{pd} = 7.4$  ns (max) ( $V_{CC} = 1.8$  V)
- High output current :  $I_{OH}/I_{OL} = \pm 24$  mA (min) ( $V_{CC} = 3.0$  V)  
:  $I_{OH}/I_{OL} = \pm 18$  mA (min) ( $V_{CC} = 2.3$  V)  
:  $I_{OH}/I_{OL} = \pm 6$  mA (min) ( $V_{CC} = 1.8$  V)
- 3.6-V tolerant inputs.
- 3.6-V power down protection output.
- TC74VCX00FT equivalent.

### Marking

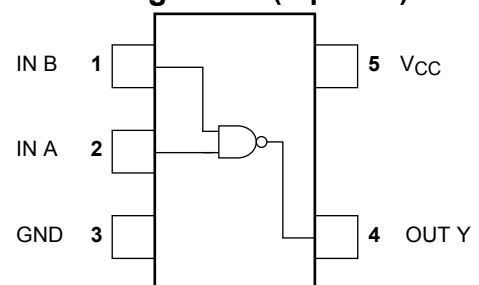


Weight  
SSOP5-P-0.95 : 0.016 g (typ.)  
SSOP5-P-0.65A : 0.006 g (typ.)

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

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

### Pin Assignment (top view)



Note: 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.

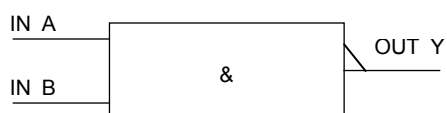
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

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

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

Note 3:  $V_{OUT} < GND$

## IEC Logic Symbol



## Truth Table

A	B	Y
L	L	H
L	H	H
H	L	H
H	H	L

## Operating Ranges

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

Note 4: Data retention only

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

Note 6: High or low state

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

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

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

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

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

Characteristics		Symbol	Test Condition		Min	Max	Unit	
			V <sub>CC</sub> (V)					
Input voltage	High level	V <sub>IH</sub>	—		2.7 to 3.6	2.0	—	V
	Low level	V <sub>IL</sub>	—		2.7 to 3.6	—	0.8	
Output voltage	High 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 to 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	—	
	Low level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	2.7 to 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 to 3.6 V	2.7 to 3.6	—	±5.0	μA	
Power off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 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 to 3.6	—	20.0	μA	
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	2.7 to 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 to 3.6	—	750		

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

Characteristics		Symbol	Test Condition		Min	Max	Unit	
			V <sub>CC</sub> (V)					
Input voltage	High level	V <sub>IH</sub>	—		2.3 to 2.7	1.6	—	V
	Low level	V <sub>IL</sub>	—		2.3 to 2.7	—	0.7	
Output voltage	High 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 to 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	—	
	Low level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	2.3 to 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 to 3.6 V	2.3 to 2.7	—	±5.0	μA	
Power off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 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 to 2.7	—	20.0	μA	
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V	2.3 to 2.7	—	±20.0		

**DC Characteristics (Ta = -40 to 85°C, 1.8 V ≤ V<sub>CC</sub> < 2.3 V)**

Characteristics		Symbol	Test Condition			Min	Max	Unit
			V <sub>CC</sub> (V)					
Input voltage	High level	V <sub>IH</sub>	—		1.8 to 2.3	V <sub>CC</sub> × 0.7	—	V
	Low level	V <sub>IL</sub>	—		1.8 to 2.3	—	V <sub>CC</sub> × 0.2	
Output voltage	High 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	—	
	Low 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>IIN</sub>	V <sub>IN</sub> = 0 to 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 to 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 to 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)**

Characteristics		Symbol	Test Condition		V <sub>CC</sub> (V)	Min	Max	Unit
Propagation delay time		t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2		1.8	1.5	7.4	ns
					2.5 ± 0.2	1.0	3.7	
					3.3 ± 0.3	0.8	2.8	

For C<sub>L</sub> = 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	V <sub>CC</sub> (V)	Typ.	Unit
Quiet output maximum dynamic V <sub>OL</sub>	V <sub>OLP</sub>	V <sub>IN</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 11)	1.8	0.25	V
		V <sub>IN</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 11)	2.5	0.6	
		V <sub>IN</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>IN</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 11)	1.8	−0.25	V
		V <sub>IN</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 11)	2.5	−0.6	
		V <sub>IN</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>IN</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note 11)	1.8	1.5	V
		V <sub>IN</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note 11)	2.5	1.9	
		V <sub>IN</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)**

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
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.

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

AC Test Circuit

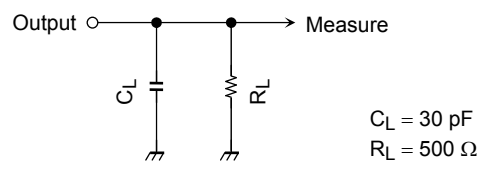
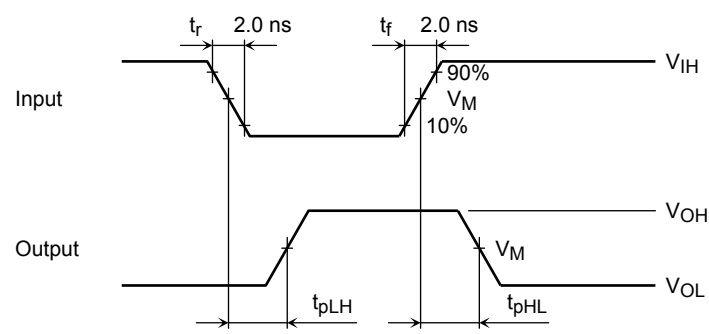


Figure 1

AC Waveforms



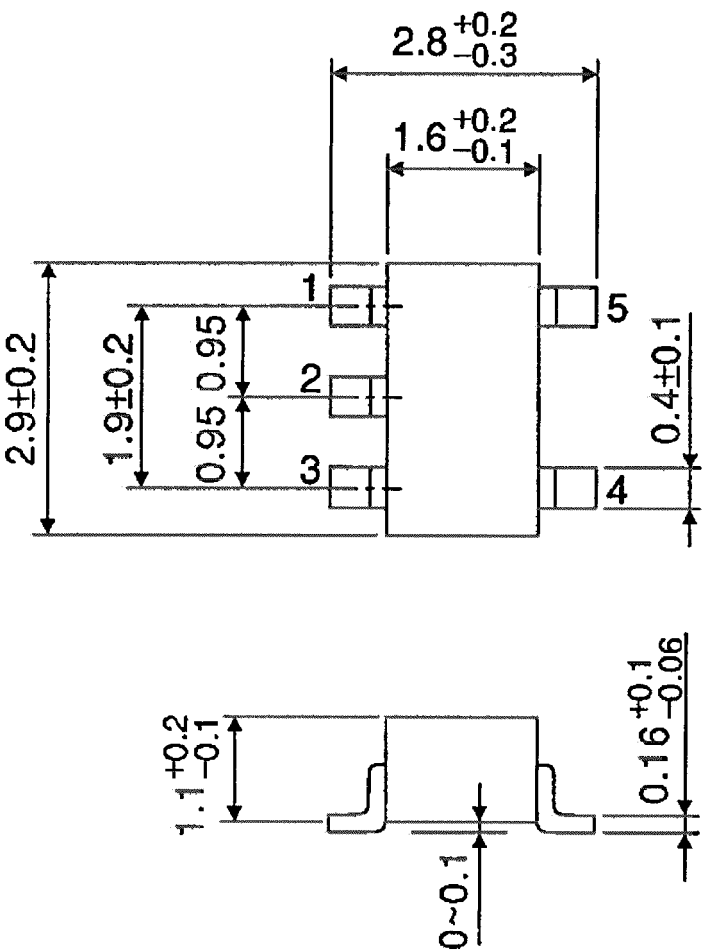
Symbol	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$

Figure 2  $t_{pLH}$ ,  $t_{pHL}$

Package Dimensions

SSOP5-P-0.95

Unit : mm

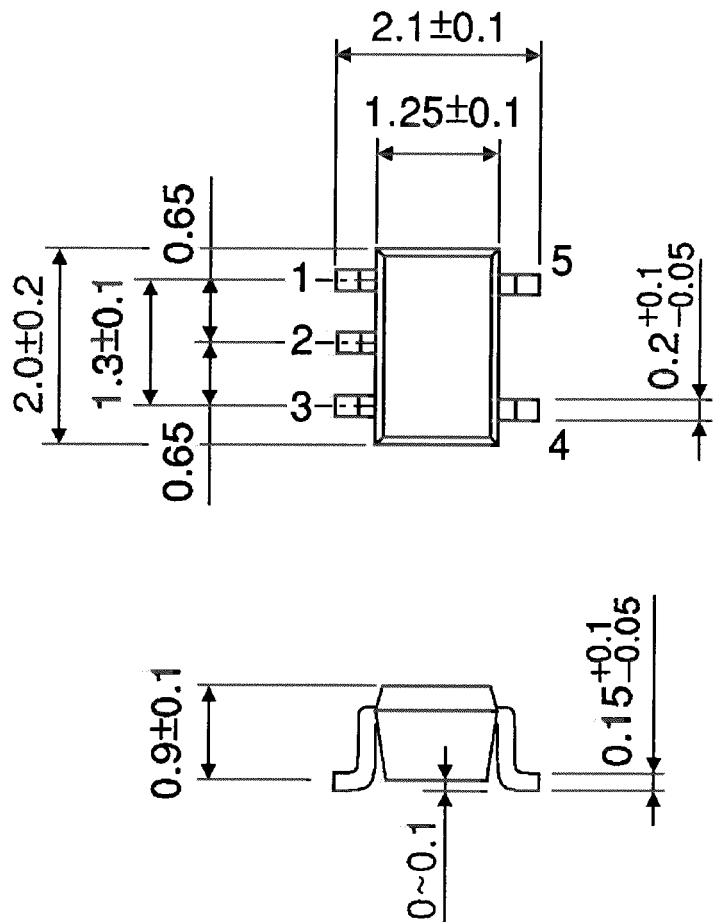


Weight: 0.016 g (typ.)

Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)



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