

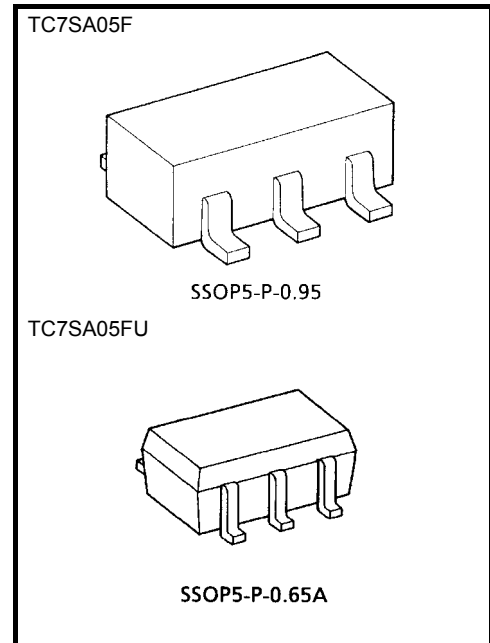
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7SA05F, TC7SA05FU

Inverter (Open Drain)

## Features

- Low voltage operation :  $V_{CC} = 1.8\sim 3.6\text{ V}$
- High speed operation :  $t_{pZ} = 3.5\text{ ns (max)} (V_{CC} = 3.0\sim 3.6\text{ V})$   
 :  $t_{pZ} = 4.1\text{ ns (max)} (V_{CC} = 2.3\sim 2.7\text{ V})$   
 :  $t_{pZ} = 8.2\text{ ns (max)} (V_{CC} = 1.8\text{ V})$
- High Output current :  $I_{OL} = 24\text{ mA (min)} (V_{CC} = 3.0\text{ V})$   
 :  $I_{OL} = 18\text{ mA (min)} (V_{CC} = 2.3\text{ V})$   
 :  $I_{OL} = 6\text{ mA (min)} (V_{CC} = 1.8\text{ V})$
- 3.6-V tolerant input.
- 3.6-V power down protection output.



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

## Absolute Maximum Ratings (Ta = 25°C)

Characteristics	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
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	-50 (Note 2)	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	$T_{stg}$	-65~150	°C

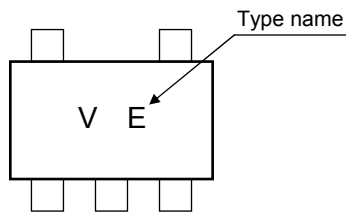
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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).

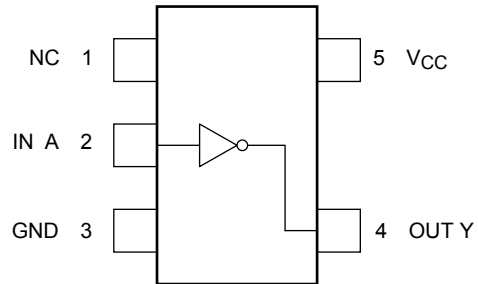
Note 1:  $I_{OUT}$  absolute maximum rating must be observed.

Note 2:  $V_{OUT} < GND$

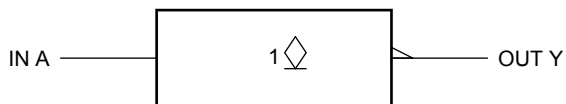
## Marking



## Pin Assignment (top view)



## Logic Diagram



## Truth Table

A	Y
L	Z
H	L

Z: High impedance

## Operating Ranges

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	1.8~3.6	V
		1.2~3.6 (Note 3)	
Input voltage	$V_{IN}$	-0.3~3.6	V
Output voltage	$V_{OUT}$	0~ $V_{CC}$	V
Output current	$I_{OH}/I_{OL}$	24 (Note 4)	mA
		18 (Note 5)	
		6 (Note 6)	
Operating temperature range	$T_{opr}$	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note 7)	ns/V

Note 3: Data retention only

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

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

Note 6:  $V_{CC} = 1.8$  V

Note 7:  $V_{IN} = 0.8\sim 2.0$  V,  $V_{CC} = 3.0$  V

## Electrical Characteristics

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

Characteristics		Symbol	Test Condition	VCC (V)	Min	Max	Unit	
Input voltage	High level	V <sub>IH</sub>	—	2.7~3.6	2.0	—	V	
	Low level	V <sub>IL</sub>	—	2.7~3.6	—	0.8		
Output voltage	Low 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	V
				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		

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

Characteristics		Symbol	Test Condition	VCC (V)	Min	Max	Unit	
Input voltage	High level	V <sub>IH</sub>	—	2.3~2.7	1.6	—	V	
	Low level	V <sub>IL</sub>	—	2.3~2.7	—	0.7		
Output voltage	Low 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	V
				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	2.3~2.7	—	±20.0		

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

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V <sub>IH</sub>	—		1.8~2.3	0.7 × V <sub>CC</sub>	—	V
	Low level	V <sub>IL</sub>	—		1.8~2.3	—	0.2 × V <sub>CC</sub>	
Output voltage	Low level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	1.8	—	0.2	V
				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)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Propagation delay time	t <sub>pZL</sub>	Figure 1, Figure 2			1.8	1.0	8.2	ns
					2.5 ± 0.2	0.8	4.1	
					3.3 ± 0.3	0.6	3.5	
	t <sub>pLZ</sub>	Figure 1, Figure 2			1.8	1.0	6.8	ns
					2.5 ± 0.2	0.8	3.8	
					3.3 ± 0.3	0.6	3.5	

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

## Capacitive Characteristics (Ta = 25°C)

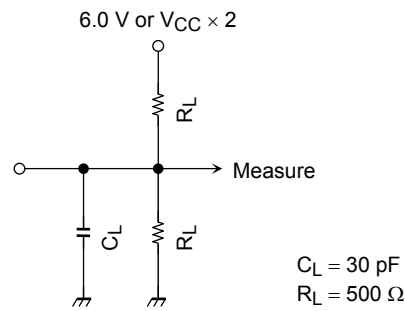
Characteristics	Symbol	Test Condition		VCC (V)	Typ.	Unit
Input capacitance	C <sub>IN</sub>	—		1.8, 2.5, 3.3	4	pF
Output capacitance	C <sub>OUT</sub>	—			3	pF
Power dissipation capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz	(Note 8)	1.8, 2.5, 3.3	4	pF

Note 8: 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.

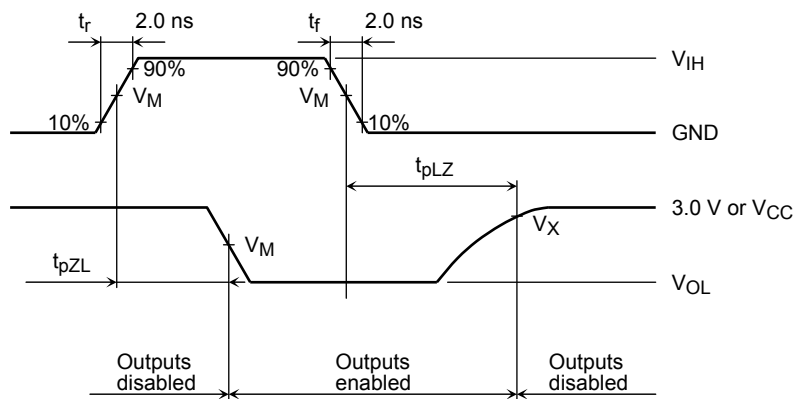
$$I_{CC (opr.)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

**AC Test Circuit**



**Figure 1**

**AC Waveforms**



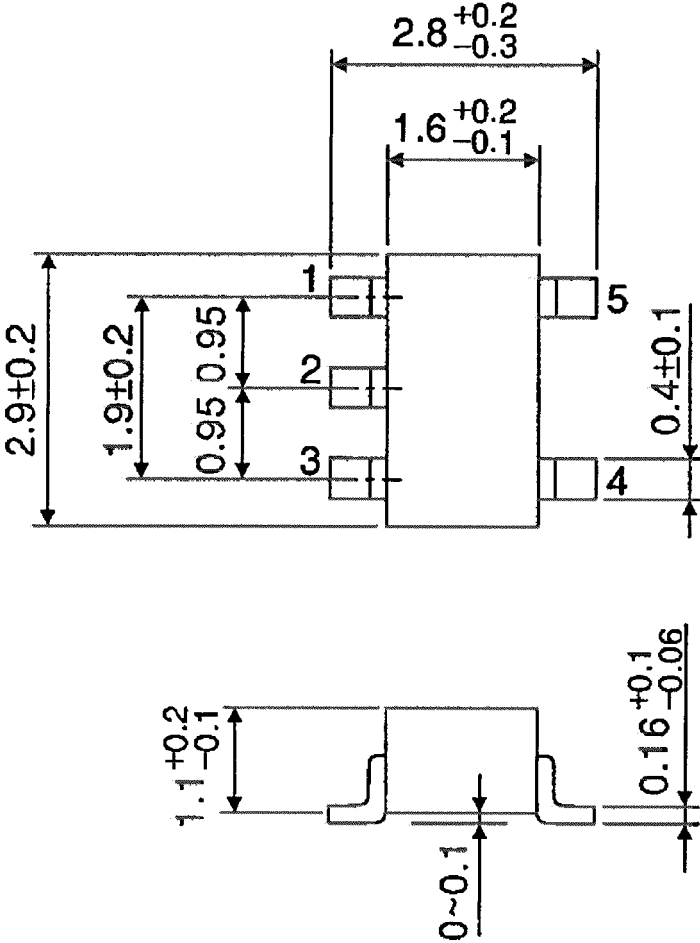
Symbol	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$

**Figure 2  $t_{pZL}$ ,  $t_{pLZ}$**

Package Dimensions

SSOP5-P-0.95

Unit : mm

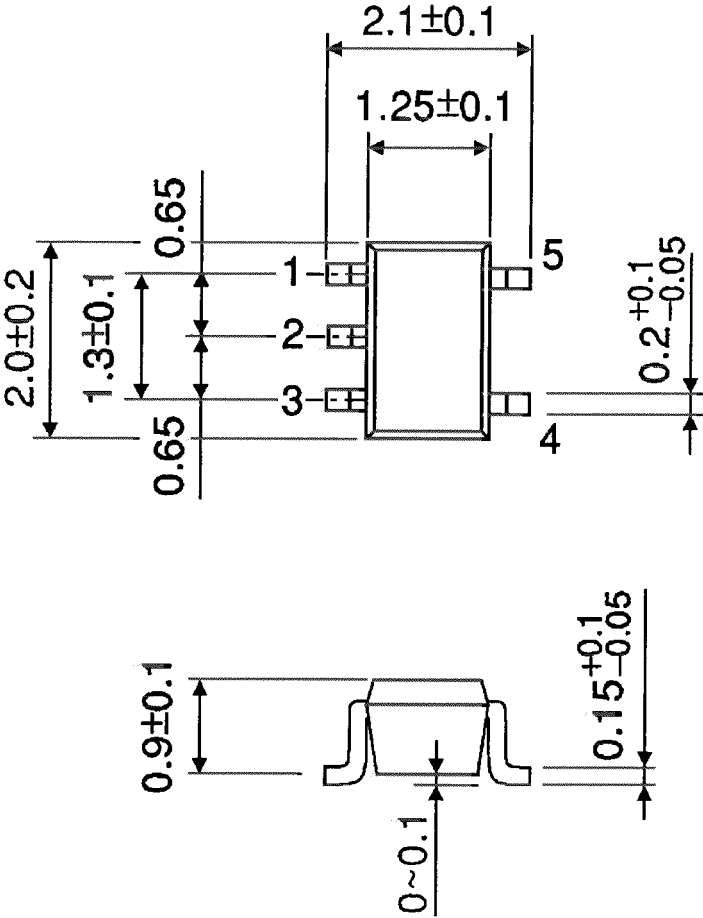


Weight: 0.016 g (typ.)

Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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