TOSHIBA

TOSHIBA CMOS Digital Integrated Circuit   Silicon Monolithic
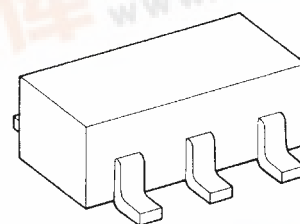
TC7SAU04F,TC7SAU04FU

Inverter (unbuffer) with 3.6 V Tolerant Input

Features

- Low voltage operation : $V_{CC} = 1.8 \sim 3.6$ V
- Low power disipation : $I_{CC} < 20$ µA (max)
-      ($V_{CC} = 3.6$ V, Ta = $-40 \sim 85°C$)
- High speed operation : $t_{pd} = 3.5$ ns (max) ($V_{CC} = 3.0 \sim 3.6$ V)
  : $t_{pd} = 4.2$ ns (max) ($V_{CC} = 2.3 \sim 2.7$ V)
  : $t_{pd} = 8.4$ 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)
- Latch-up performance : ± 300 mA or more
- ESD performance : Human body model > ± 200 V
  : Machine model > ± 2000 V
- Power down protection is provided on all inputs and outputs.

TC7SAU04F

SSOP5-P-0.95

TC7SAU04FU
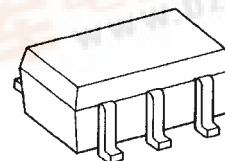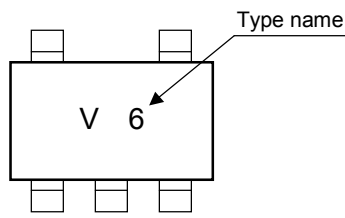
SSOP5-P-0.65A

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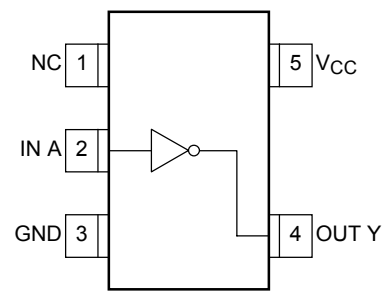SSOP5-P-0.65A : 0.006 g (typ.)

Maximum Ratings (Ta = 25°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}	$-0.5 \sim V_{CC} + 0.5$ (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}	$-65 \sim 150$	°C

Note 1: High or low state. I_{OUT} absolute maximum rating be observed.

Note 2: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$
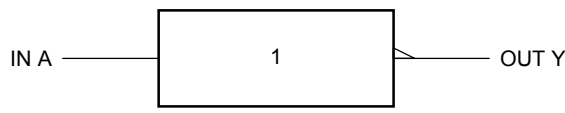
Marking

Type name

V 6

Pin Assignment (top view)

NC 1   5 V$_{CC}$

IN A 2

GND 3   4 OUT Y

Logic Diagram

IN A ———[1]——— OUT Y

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 3)	
Input voltage	V$_{IN}$	−0.3~3.6		V
Output voltage	V$_{OUT}$	0~V$_{CC}$	(Note 4)	V
Output current	I$_{OH}$/I$_{OL}$	±24	(Note 5)	mA
		±18	(Note 6)	
		±6	(Note 7)	
Operating temperature range	T$_{opr}$	−40~85		°C
Input rise and fall time	dt/dv	0~10	(Note 8)	ns/V

Note 3: Data retention only

Note 4: High or low state

Note 5: V$_{CC}$ = 3.0~3.6 V

Note 6: V$_{CC}$ = 2.3~2.7 V

Note 7: V$_{CC}$ = 1.8 V

Note 8: V$_{IN}$ = 0.8~2.0 V, V$_{CC}$ = 3.0 V

Electrical Characteristics

DC Characteristics (Ta = −40~85°C)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		1.8	$0.85 \times V_{CC}$	—	V
					2.3~3.6	$0.8 \times V_{CC}$	—	
	Low level	V_{IL}	—		1.8	—	$0.15 \times V_{CC}$	
					2.3~3.6	—	$0.2 \times V_{CC}$	
Output voltage	High level	V_{OH}	$V_{IN} = V_{IL}$	$I_{OH} = -100\ \mu A$	1.8~3.6	$V_{CC} - 0.2$	—	V
				$I_{OH} = -6\ mA$	1.8	1.4	—	
				$I_{OH} = -12\ mA$	2.3	1.8	—	
				$I_{OH} = -18\ mA$	2.3	1.7	—	
				$I_{OH} = -12\ mA$	2.7	2.2	—	
				$I_{OH} = -18\ mA$	3.0	2.4	—	
				$I_{OH} = -24\ mA$	3.0	2.2	—	
	Low level	V_{OL}	$V_{IN} = V_{IH}$	$I_{OL} = 100\ \mu A$	1.8~3.6	—	0.2	
				$I_{OL} = 6\ mA$	1.8	—	0.3	
				$I_{OL} = 12\ mA$	2.3	—	0.4	
				$I_{OL} = 18\ mA$	2.3	—	0.6	
				$I_{OL} = 12\ mA$	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}	$V_{IN} = 0{\sim}3.6\ V$		2.7~3.6	—	±5.0	μA
Quiescent supply current		I_{CC}	$V_{IN} = V_{CC}$ or GND		2.7~3.6	—	20.0	μA
			$V_{CC} \leqq (V_{IN}, V_{OUT}) \leqq 3.6\ V$		2.7~3.6	—	±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	8.4	ns
			2.5 ± 0.2	0.8	4.2	
			3.3 ± 0.3	0.6	3.5	

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	V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	V_{IN} = 1.8 V, V_{IL} = 0 V (Note 9)	1.8	0.25	ns
		V_{IN} = 2.5 V, V_{IL} = 0 V (Note 9)	2.5	0.6	
		V_{IN} = 3.3 V, V_{IL} = 0 V (Note 9)	3.3	0.8	
Quiet output minimum dynamic V_{OL}	V_{OLV}	V_{IN} = 1.8 V, V_{IL} = 0 V (Note 9)	1.8	−0.25	ns
		V_{IN} = 2.5 V, V_{IL} = 0 V (Note 9)	2.5	−0.6	
		V_{IN} = 3.3 V, V_{IL} = 0 V (Note 9)	3.3	−0.8	
Quiet output minimum dynamic V_{OH}	V_{OLP}	V_{IN} = 1.8 V, V_{IL} = 0 V (Note 9)	1.8	1.5	ns
		V_{IN} = 2.5 V, V_{IL} = 0 V (Note 9)	2.5	1.9	
		V_{IN} = 3.3 V, V_{IL} = 0 V (Note 9)	3.3	2.2	

Note 9:   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	4	pF
Power dissipation capacitance	C_{PD}	f_{IN} = 10 MHz (Note 10)	1.8, 2.5, 3.3	7	pF

Note 10: 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.

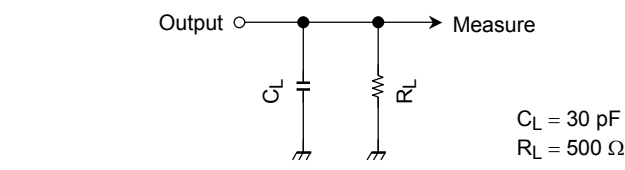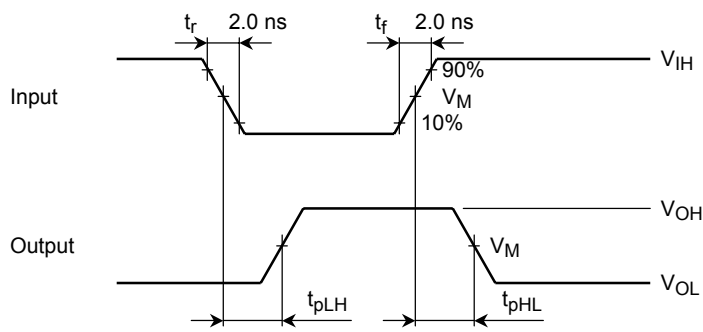$$I_{CC\ (opr.)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

AC Test Circuit

Output ○────●────●───→ Measure
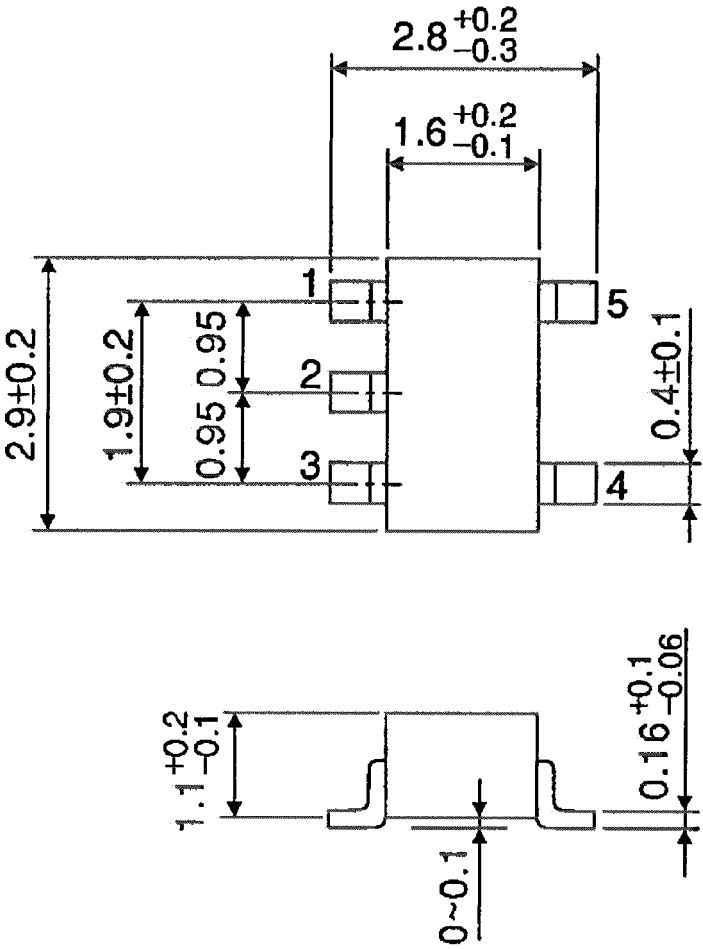
C_L R_L

$C_L = 30$ pF
$R_L = 500\ \Omega$

Figure 1

AC Wareform

t_r 2.0 ns t_f 2.0 ns

Input — 90% / V_M / 10% — V_{IH}

Output — V_M — V_{OH} / V_{OL}

t_{pLH} t_{pHL}

Symbol	V_{CC}		
	3.3 ± 0.3 V	2.5 ± 0.2 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
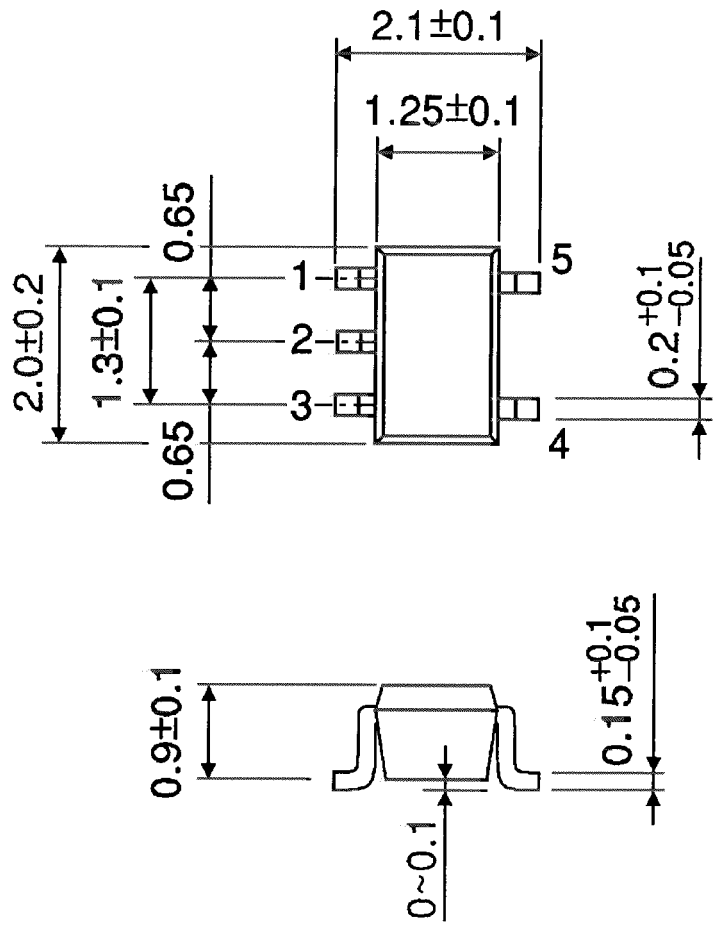
Weight: 0.006 g (typ.)

RESTRICTIONS ON PRODUCT USE

2002-12-13