

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

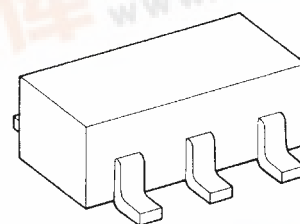
TC7SAU04F, TC7SAU04FU

Inverter (unbuffer) with 3.6 V Tolerant Input

Features

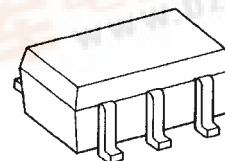
- Low voltage operation : $V_{CC} = 1.8 \sim 3.6 \text{ V}$
- Low power dissipation : $I_{CC} < 20 \mu\text{A}$ (max)
($V_{CC} = 3.6 \text{ V}$, $T_a = -40 \sim 85^\circ\text{C}$)
- High speed operation : $t_{pd} = 3.5 \text{ ns}$ (max) ($V_{CC} = 3.0 \sim 3.6 \text{ V}$)
: $t_{pd} = 4.2 \text{ ns}$ (max) ($V_{CC} = 2.3 \sim 2.7 \text{ V}$)
: $t_{pd} = 8.4 \text{ ns}$ (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.

TC7SAU04F



SSOP5-P-0.95

TC7SAU04FU



SSOP5-P-0.65A

Weight

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

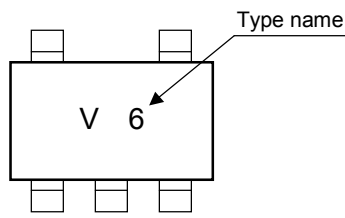
SSOP5-P-0.65A : 0.006 g (typ.)

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

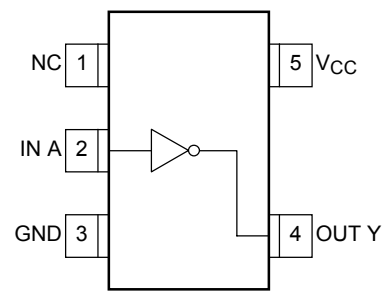
| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-----------|-----------------------------------|------------------|
| Power supply voltage | V_{CC} | $-0.5 \sim 4.6$ | V |
| DC input voltage | V_{IN} | $-0.5 \sim 4.6$ | V |
| DC output voltage | V_{OUT} | $-0.5 \sim V_{CC} + 0.5$ (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} | $-65 \sim 150$ | $^\circ\text{C}$ |

Note 1: High or low state. I_{OUT} absolute maximum rating be observed.Note 2: $V_{OUT} < \text{GND}$, $V_{OUT} > V_{CC}$

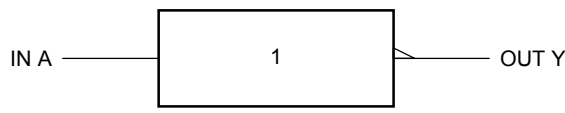
Marking



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

Note 6: $V_{CC} = 2.3 \sim 2.7$ V

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

Note 8: $V_{IN} = 0.8 \sim 2.0$ V, $V_{CC} = 3.0$ V

Electrical Characteristics

DC Characteristics (Ta = -40~85°C)

| Characteristics | | Symbol | Test Condition | | Min | Max | Unit | |
|--------------------------|------------|-----------------|---|---------------------------|---------------------|------------------------|------------------------|---|
| | | | | | V _{CC} (V) | | | |
| Input voltage | High level | V _{IH} | — | | 1.8 | 0.85 × V _{CC} | — | V |
| | | | | | 2.3~3.6 | 0.8 × V _{CC} | — | |
| | Low level | V _{IL} | — | | 1.8 | — | 0.15 × V _{CC} | |
| | | | | | 2.3~3.6 | — | 0.2 × V _{CC} | |
| Output voltage | High level | V _{OH} | V _{IN} = V _{IL} | I _{OH} = −100 μA | 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 μA | 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} = 0~3.6 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} ≦ (V _{IN} , V _{OUT}) ≦ 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.

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

AC Test Circuit

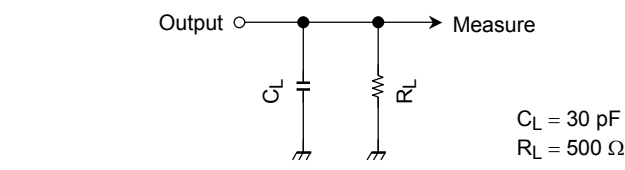
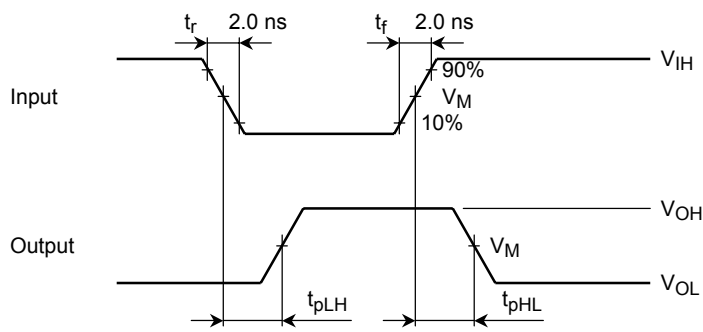


Figure 1

AC Waveform



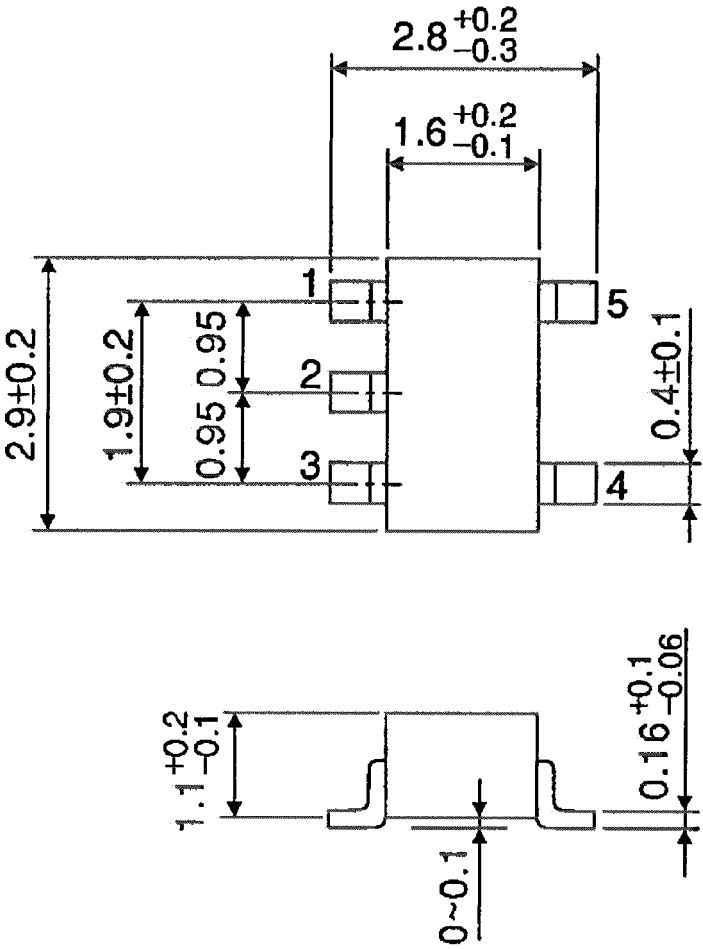
| Symbol | V_{CC} | | |
|----------|-------------------------|-------------------------|-----------------|
| | $3.3 \pm 0.3 \text{ V}$ | $2.5 \pm 0.2 \text{ V}$ | 1.8 V |
| V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| V_M | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |

Figure 2 t_{pLH} , t_{pHL}

Package Dimensions

SSOP5-P-0.95

Unit : mm

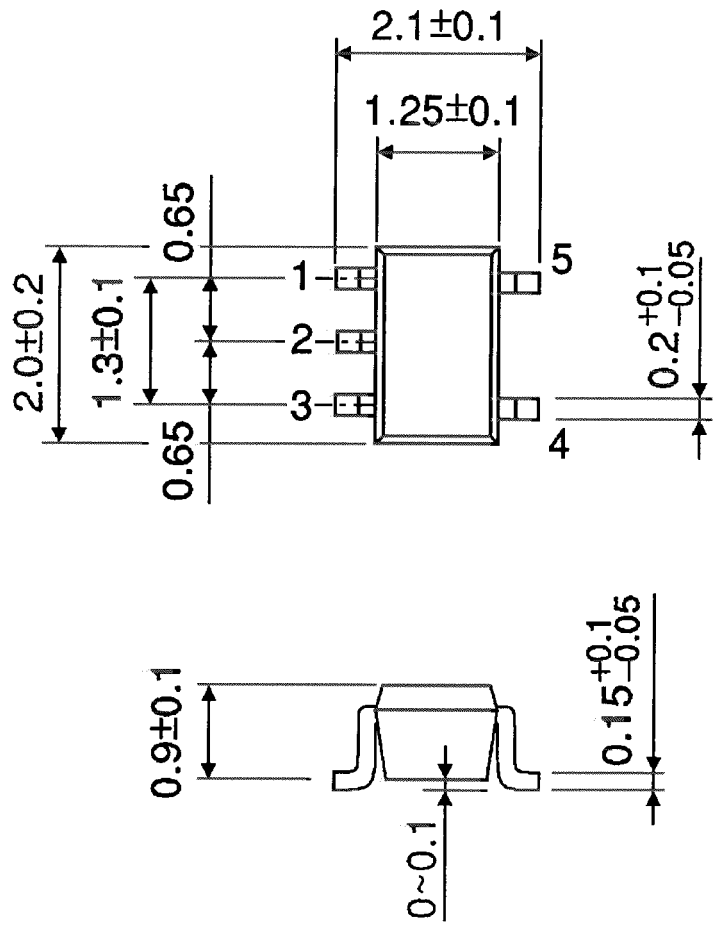


Weight: 0.016 g (typ.)

Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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