

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7S04F, TC7S04FU

## Inverter

The TC7S04 is a high speed C<sup>2</sup>MOS Inverter fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves high speed operation similar to equivalent LSTTL while maintaining the C<sup>2</sup>MOS low power dissipation.

The internal circuit is composed of 3 stages including buffer output, which enables high noise immunity and stable output.

The input is equipped with protection circuits against static discharge or transient excess voltage.

Output currents are 1/2 compared to TC74HC series models.

## Features

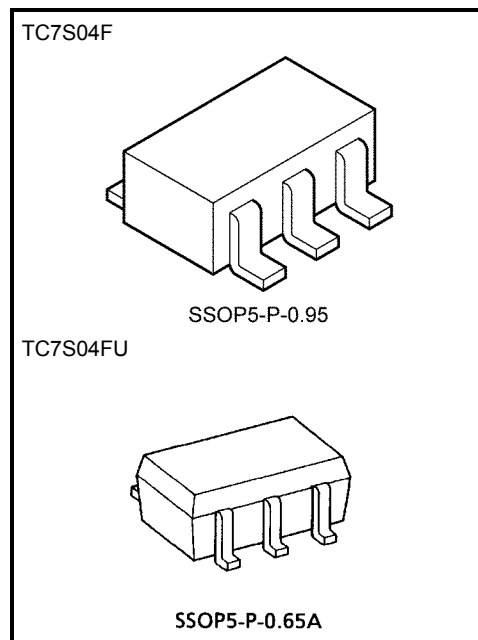
- High speed:  $t_{pd} = 7 \text{ ns (typ.)}$  at  $V_{CC} = 5 \text{ V}$
- Low power dissipation:  $I_{CC} = 1 \text{ } \mu\text{A (max)}$  at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (min)}$
- Output drive capability: 5 LSTTL loads
- Symmetrical output impedance:  $|I_{OH}| = I_{OL} = 2 \text{ mA (min)}$
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range:  $V_{CC} \text{ (opr)} = 2 \text{ to } 6 \text{ V}$

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

| Characteristics             | Symbol    | Rating                 | Unit             |
|-----------------------------|-----------|------------------------|------------------|
| Supply voltage range        | $V_{CC}$  | -0.5 to 7              | V                |
| DC input voltage            | $V_{IN}$  | -0.5 to $V_{CC} + 0.5$ | V                |
| DC output voltage           | $V_{OUT}$ | -0.5 to $V_{CC} + 0.5$ | V                |
| Input diode current         | $I_{IK}$  | $\pm 20$               | mA               |
| Output diode current        | $I_{OK}$  | $\pm 20$               | mA               |
| DC output current           | $I_{OUT}$ | $\pm 12.5$             | mA               |
| DC $V_{CC}$ /ground current | $I_{CC}$  | $\pm 25$               | mA               |
| Power dissipation           | $P_D$     | 200                    | mW               |
| Storage temperature range   | $T_{stg}$ | -65 to 150             | $^\circ\text{C}$ |
| Lead temperature (10 s)     | $T_L$     | 260                    | $^\circ\text{C}$ |

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).



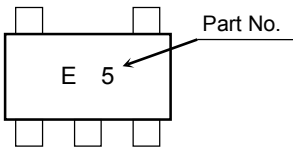
Weight

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

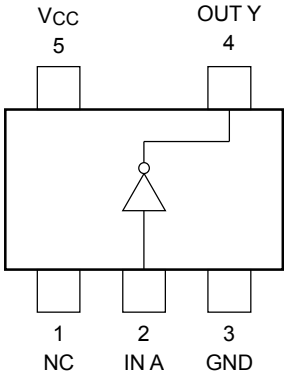
SSOP5-P-0.65A: 0.006 g (typ.)

Start of commercial production  
1987-08

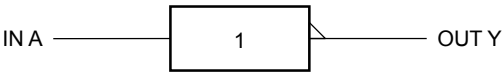
Marking



Pin Configuration (top view)



Logic Diagram



Truth Table

| A | Y |
|---|---|
| L | H |
| H | L |

Operating Ranges

| Characteristics             | Symbol | Rating                  | Unit |
|-----------------------------|--------|-------------------------|------|
| Supply voltage              | VCC    | 2 to 6                  | V    |
| Input voltage               | VIN    | 0 to VCC                | V    |
| Output voltage              | VOUT   | 0 to VCC                | V    |
| Operating temperature range | Topr   | -40 to 85               | °C   |
| Input rise and fall time    | tr, tf | 0 to 1000 (VCC = 2.0 V) | ns   |
|                             |        | 0 to 500 (VCC = 4.5 V)  |      |
|                             |        | 0 to 400 (VCC = 6.0 V)  |      |

### Electrical Characteristics

#### DC Electrical Characteristics

| Characteristics          |            | Symbol | Test Condition   |              | Ta = 25°C     |      |      | Ta = -40 to 85°C |      | Unit |      |
|--------------------------|------------|--------|------------------|--------------|---------------|------|------|------------------|------|------|------|
|                          |            |        |                  |              | VCC (V)       | Min  | Typ. | Max              | Min  |      | Max  |
| Input voltage            | High level | VIH    | —                |              | 2.0           | 1.5  | —    | —                | 1.5  | V    |      |
|                          |            |        |                  |              | 4.5           | 3.15 | —    | —                | 3.15 |      | —    |
|                          |            |        |                  |              | 6.0           | 4.2  | —    | —                | 4.2  |      | —    |
|                          | Low level  | VIL    | —                |              | 2.0           | —    | —    | 0.5              | —    |      | 0.5  |
|                          |            |        |                  |              | 4.5           | —    | —    | 1.35             | —    |      | 1.35 |
|                          |            |        |                  |              | 6.0           | —    | —    | 1.8              | —    |      | 1.8  |
| Output voltage           | High level | VOH    | VIN = VIL        | IOH = -20 µA | 2.0           | 1.9  | 2.0  | —                | 1.9  | —    | V    |
|                          |            |        |                  |              | 4.5           | 4.4  | 4.5  | —                | 4.4  | —    |      |
|                          |            |        |                  |              | 6.0           | 5.9  | 6.0  | —                | 5.9  | —    |      |
|                          |            |        |                  | IOH = -2 mA  | 4.5           | 4.18 | 4.31 | —                | 4.13 | —    |      |
|                          |            |        |                  |              | IOH = -2.6 mA | 6.0  | 5.68 | 5.80             | —    | 5.63 |      |
|                          | Low level  | VOL    | VIN = VIH        | IOL = 20 µA  | 2.0           | —    | 0    | 0.1              | —    | 0.1  |      |
|                          |            |        |                  |              | 4.5           | —    | 0    | 0.1              | —    | 0.1  |      |
|                          |            |        |                  |              | 6.0           | —    | 0    | 0.1              | —    | 0.1  |      |
|                          |            |        |                  | IOL = 2 mA   | 4.5           | —    | 0.17 | 0.26             | —    | 0.33 |      |
|                          |            |        |                  |              | IOL = 2.6 mA  | 6.0  | —    | 0.18             | 0.26 | —    |      |
| Input leakage current    |            | IIN    | VIN = VCC or GND |              | 6.0           | —    | —    | ±0.1             | —    | ±1.0 | µA   |
| Quiescent supply current |            | ICC    | VIN = VCC or GND |              | 6.0           | —    | —    | 1.0              | —    | 10.0 | µA   |

Note: Output currents are 1/2 compared to TC74HC series models.

#### AC Electrical Characteristics (C<sub>L</sub> = 15 pF, input t<sub>r</sub> = t<sub>f</sub> = 6 ns, V<sub>CC</sub> = 5 V)

| Characteristics        | Symbol                               | Test Condition | Ta = 25°C |      |     | Unit |
|------------------------|--------------------------------------|----------------|-----------|------|-----|------|
|                        |                                      |                | Min       | Typ. | Max |      |
| Output transition time | t <sub>TLH</sub><br>t <sub>THL</sub> | —              | —         | 5    | 10  | ns   |
| Propagation delay time | t <sub>pLH</sub><br>t <sub>pHL</sub> | —              | —         | 7    | 15  | ns   |

## AC Electrical Characteristics ( $C_L = 50 \text{ pF}$ , input $t_r = t_f = 6 \text{ ns}$ )

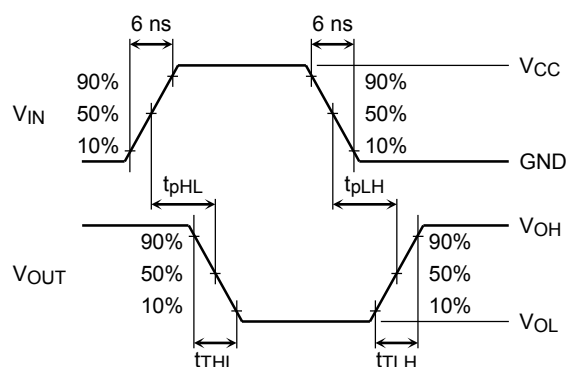
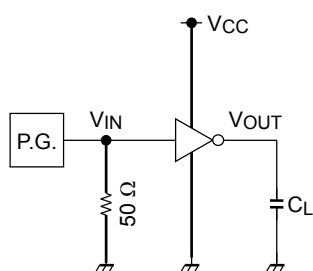
| Characteristics               | Symbol                 | Test Condition | $V_{CC}$<br>(V) | $T_a = 25^\circ\text{C}$ |      |     | $T_a = -40$<br>to $85^\circ\text{C}$ |     | Unit |
|-------------------------------|------------------------|----------------|-----------------|--------------------------|------|-----|--------------------------------------|-----|------|
|                               |                        |                |                 | Min                      | Typ. | Max | Min                                  | Max |      |
| Output transition time        | $t_{TLH}$<br>$t_{THL}$ | —              | 2.0             | —                        | 50   | 125 | —                                    | 155 | ns   |
|                               |                        |                | 4.5             | —                        | 14   | 25  | —                                    | 31  |      |
|                               |                        |                | 6.0             | —                        | 12   | 21  | —                                    | 26  |      |
| Propagation delay time        | $t_{pLH}$<br>$t_{pHL}$ | —              | 2.0             | —                        | 48   | 100 | —                                    | 125 | ns   |
|                               |                        |                | 4.5             | —                        | 12   | 20  | —                                    | 25  |      |
|                               |                        |                | 6.0             | —                        | 9    | 17  | —                                    | 21  |      |
| Input capacitance             | $C_{IN}$               | —              | —               | —                        | 5    | 10  | —                                    | 10  | pF   |
| Power dissipation capacitance | $CPD$                  | (Note 1)       | —               | —                        | 10   | —   | —                                    | —   | pF   |

Note 1: CPD defined as the value of internal equivalent capacitance of IC which is calculated from the operating current consumption without load (refer to test circuit).

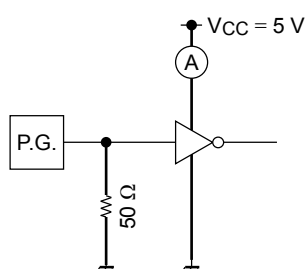
Average operating current can be obtained by the equation hereunder.

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

## Switching Characteristics Test Circuit



## $I_{CC(\text{opr})}$ Test Circuit



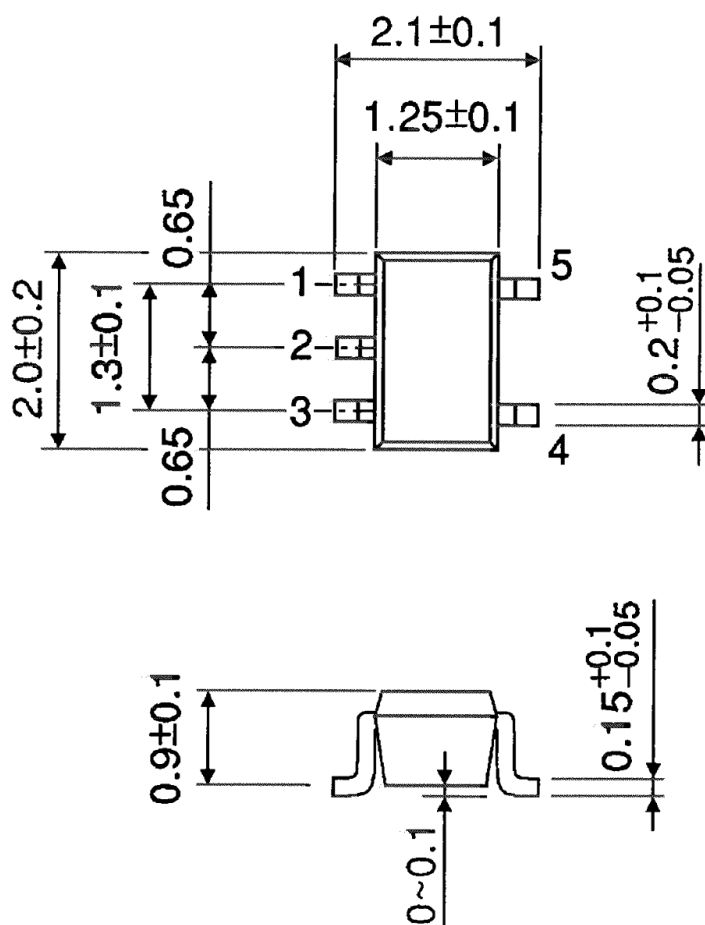
Input waveform is the same as that in case of switching characteristics test.



### Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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