

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

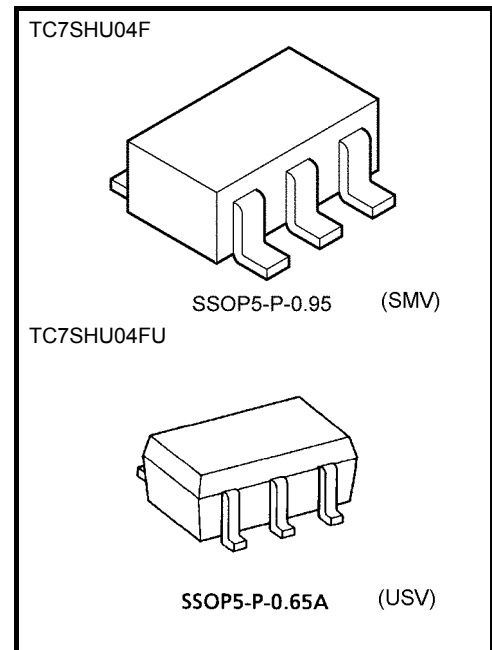
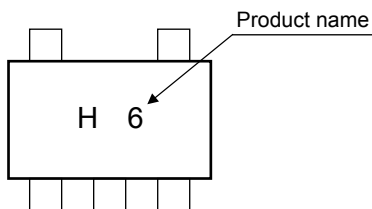
## TC7SHU04F, TC7SHU04FU

### INVERTER (Un-Buffer)

#### Features

- Super high speed operation :  $t_{pd} = 3.5 \text{ ns (typ.)}$   
@  $V_{CC} = 5V$ ,  $C_L = 15pF$
- Low power dissipation:  $I_{CC} = 2\mu A \text{ (max)}$   
@  $T_a = 25^\circ C$
- High noise immunity :  $V_{NIH} = V_{NIH} = 10\% V_{CC} \text{ (min)}$
- 5.5 V tolerant input.
- Wide operation voltage range :  $V_{CC} = 2 \text{ to } 5.5 V$

#### Marking

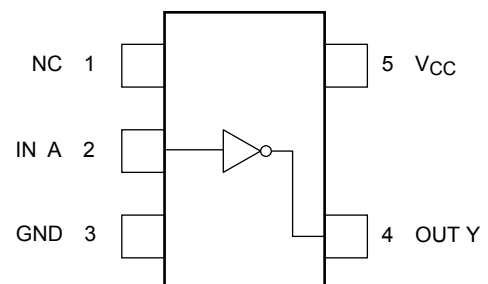


Weight  
SSOP5-P-0.95 : 0.016 g (Typ.)  
SSOP5-P-0.65A : 0.006 g (Typ.)

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

| Characteristics             | Symbol    | Rating                 | Unit       |
|-----------------------------|-----------|------------------------|------------|
| Supply voltage              | $V_{CC}$  | -0.5 to 7.0            | V          |
| DC input voltage            | $V_{IN}$  | -0.5 to 7.0            | V          |
| DC output voltage           | $V_{OUT}$ | -0.5 to $V_{CC} + 0.5$ | V          |
| Input diode current         | $I_{IK}$  | -20                    | mA         |
| Output diode current        | $I_{OK}$  | $\pm 20$ (Note 1)      | mA         |
| DC output current           | $I_{OUT}$ | $\pm 25$               | mA         |
| DC $V_{CC}$ /ground current | $I_{CC}$  | $\pm 50$               | mA         |
| Power dissipation           | $P_D$     | 200                    | mW         |
| Storage temperature         | $T_{stg}$ | -65 to 150             | $^\circ C$ |
| Lead temperature (10 s)     | $T_L$     | 260                    | $^\circ C$ |

#### Pin Assignment (top view)



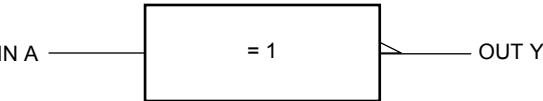
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.)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

Start of commercial production  
1993-09

IEC Logic Symbol



Truth Table

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

Operating Ranges

| Characteristics       | Symbol           | Rating               | Unit |
|-----------------------|------------------|----------------------|------|
| Supply voltage        | V <sub>CC</sub>  | 2 to 5.5             | V    |
| Input voltage         | V <sub>IN</sub>  | 0 to 5.5             | V    |
| Output voltage        | V <sub>OUT</sub> | 0 to V <sub>CC</sub> | V    |
| Operating temperature | T <sub>opr</sub> | −40 to 85            | °C   |

Electrical Characteristics

DC Characteristics

| Characteristics           | Symbol          | Test Condition                           |                          | Ta = 25°C           |                       |      | Ta = −40 to 85°C      |                       | Unit                  |     |
|---------------------------|-----------------|------------------------------------------|--------------------------|---------------------|-----------------------|------|-----------------------|-----------------------|-----------------------|-----|
|                           |                 |                                          |                          | V <sub>CC</sub> (V) | Min                   | Typ. | Max                   | Min                   |                       | Max |
| High-level input voltage  | V <sub>IH</sub> | —                                        |                          | 2.0                 | 1.7                   | —    | —                     | 1.7                   | —                     | V   |
|                           |                 |                                          |                          | 3.0 to 5.5          | V <sub>CC</sub> × 0.8 | —    | —                     | V <sub>CC</sub> × 0.8 | —                     |     |
| Low-level input voltage   | V <sub>IL</sub> | —                                        |                          | 2.0                 | —                     | —    | 0.3                   | —                     | 0.3                   | V   |
|                           |                 |                                          |                          | 3.0 to 5.5          | —                     | —    | V <sub>CC</sub> × 0.2 | —                     | V <sub>CC</sub> × 0.2 |     |
| High-level output voltage | V <sub>OH</sub> | V <sub>IN</sub> = V <sub>IL</sub>        | I <sub>OH</sub> = −50 μA | 2.0                 | 1.8                   | 2.0  | —                     | 1.8                   | —                     | V   |
|                           |                 |                                          |                          | 3.0                 | 2.7                   | 3.0  | —                     | 2.7                   | —                     |     |
|                           |                 |                                          |                          | 4.5                 | 4.0                   | 4.5  | —                     | 4.0                   | —                     |     |
|                           |                 | V <sub>IN</sub> =GND                     | I <sub>OH</sub> = −4 mA  | 3.0                 | 2.58                  | —    | —                     | 2.48                  | —                     |     |
|                           |                 |                                          | I <sub>OH</sub> = −8 mA  | 4.5                 | 3.94                  | —    | —                     | 3.80                  | —                     |     |
| Low-level output voltage  | V <sub>OL</sub> | V <sub>IN</sub> = V <sub>IH</sub>        | I <sub>OL</sub> = 50 μA  | 2.0                 | —                     | 0    | 0.2                   | —                     | 0.2                   | V   |
|                           |                 |                                          |                          | 3.0                 | —                     | 0    | 0.3                   | —                     | 0.3                   |     |
|                           |                 |                                          |                          | 4.5                 | —                     | 0    | 0.5                   | —                     | 0.5                   |     |
|                           |                 | V <sub>IN</sub> =V <sub>CC</sub>         | I <sub>OL</sub> = 4 mA   | 3.0                 | —                     | —    | 0.36                  | —                     | 0.44                  |     |
|                           |                 |                                          | I <sub>OL</sub> = 8 mA   | 4.5                 | —                     | —    | 0.36                  | —                     | 0.44                  |     |
| Input leakage current     | I <sub>IN</sub> | V <sub>IN</sub> = 5.5 V or GND           |                          | 0 to 5.5            | —                     | —    | ±0.1                  | —                     | ±1.0                  | μA  |
| Quiescent supply current  | I <sub>CC</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND |                          | 5.5                 | —                     | —    | 2.0                   | —                     | 20.0                  | μA  |

**AC Characteristics (unless otherwise specified, input:  $t_r = t_f = 3 \text{ ns}$ )**

| Characteristics               | Symbol                               | Test Condition      |                     | Ta = 25°C |      |      | Ta = -40 to 85°C |      | Unit |
|-------------------------------|--------------------------------------|---------------------|---------------------|-----------|------|------|------------------|------|------|
|                               |                                      | V <sub>CC</sub> (V) | C <sub>L</sub> (pF) | Min       | Typ. | Max  | Min              | Max  |      |
| Propagation delay time        | t <sub>pLH</sub><br>t <sub>pHL</sub> | 3.3 ± 0.3           | 15                  | —         | 5.0  | 8.9  | 1.0              | 10.5 | ns   |
|                               |                                      |                     | 50                  | —         | 7.5  | 11.4 | 1.0              | 13.0 |      |
|                               |                                      | 5.0 ± 0.5           | 15                  | —         | 3.5  | 5.5  | 1.0              | 6.5  |      |
|                               |                                      |                     | 50                  | —         | 5.0  | 7.0  | 1.0              | 8.0  |      |
| Input capacitance             | C <sub>IN</sub>                      |                     |                     | —         | 5    | 10   | —                | 10   | pF   |
| Power dissipation capacitance | C <sub>PD</sub>                      | (Note 2)            |                     | —         | 6    | —    | —                | —    | pF   |

Note 2: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

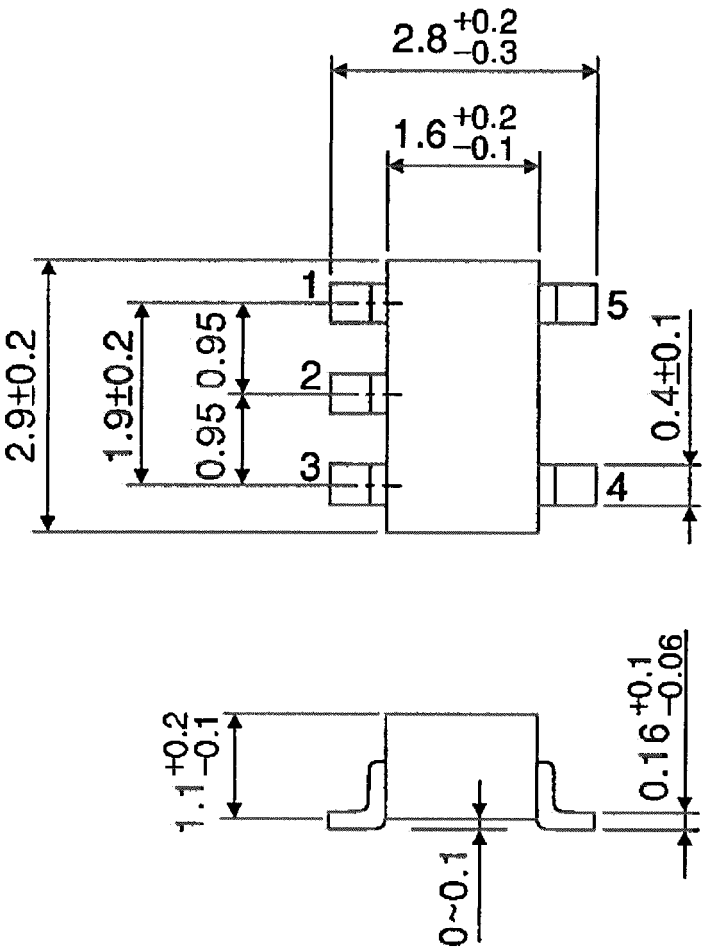
Average operating current can be obtained by the equation:

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

Package Dimensions

SSOP5-P-0.95

Unit : mm

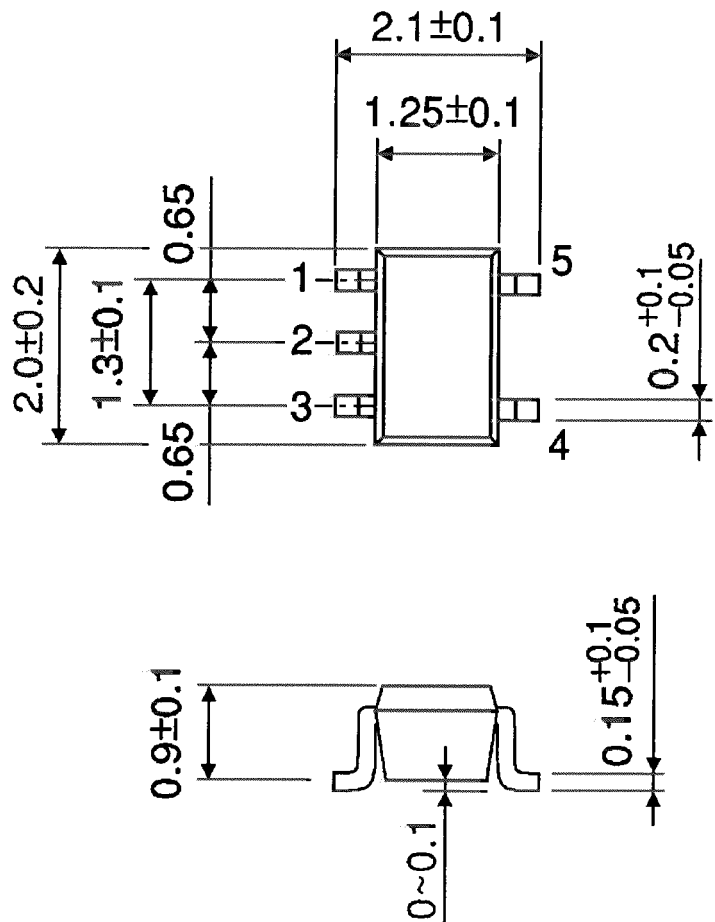


Weight: 0.016 g (typ.)

Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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