

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

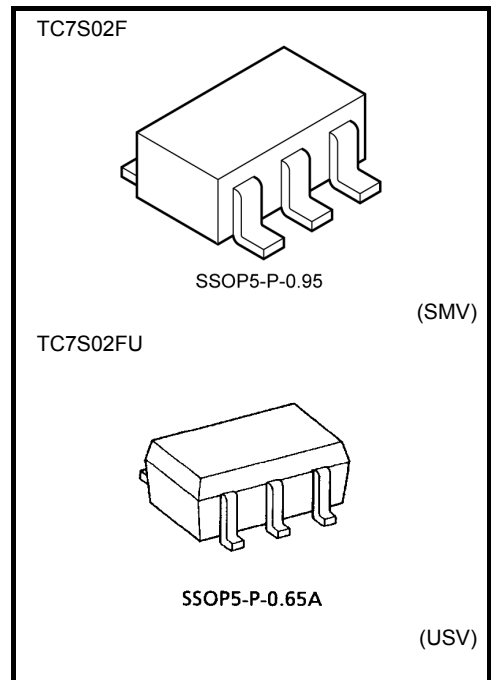
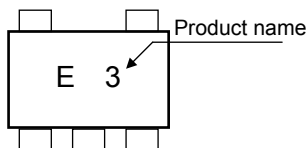
# TC7S02F, TC7S02FU

## 2-Input NOR Gate

### Features

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

### Marking

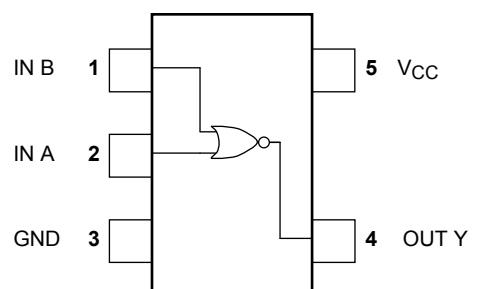


Weight  
 SSOP5-P-0.95 : 0.016 g (typ.)  
 SSOP5-P-0.65A : 0.006 g (typ.)

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

| Characteristics             | Symbol    | Rating                 | Unit |
|-----------------------------|-----------|------------------------|------|
| Supply voltage              | $V_{CC}$  | -0.5 to 7.0            | 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         | $T_{stg}$ | -65 to 150             | °C   |
| Lead temperature (10 s)     | $T_L$     | 260                    | °C   |

### Pin Assignment (top view)

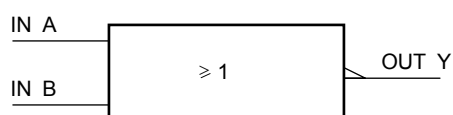


Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.)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

Start of commercial production  
 1987-08

## IEC Logic Symbol



## Truth Table

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

## Operating Ranges

| Characteristics          | Symbol     | Rating                        | Unit |
|--------------------------|------------|-------------------------------|------|
| Supply voltage           | $V_{CC}$   | 2.0 to 6.0                    | V    |
| Input voltage            | $V_{IN}$   | 0 to $V_{CC}$                 | V    |
| Output voltage           | $V_{OUT}$  | 0 to $V_{CC}$                 | V    |
| Operating temperature    | $T_{opr}$  | -40 to 85                     | °C   |
| Input rise and fall time | $t_r, t_f$ | 0 to 1000 ( $V_{CC} = 2.0$ V) | ns   |
|                          |            | 0 to 500 ( $V_{CC} = 4.5$ V)  |      |
|                          |            | 0 to 400 ( $V_{CC} = 6.0$ V)  |      |

## 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                 | 1.5  | —    | —                | 1.5  | —    | V   |
|                           |                 |   |                          | 4.5                 | 3.15 | —    | —                | 3.15 | —    |     |
|                           |                 |   |                          | 6.0                 | 4.2  | —    | —                | 4.2  | —    |     |
| Low-level input voltage   | V <sub>IL</sub> | —   |                          | 2.0                 | —    | —    | 0.5              | —    | 0.5  |     |
|                           |                 |   |                          | 4.5                 | —    | —    | 1.35             | —    | 1.35 |     |
|                           |                 |   |                          | 6.0                 | —    | —    | 1.8              | —    | 1.8  |     |
| High-level output voltage | V <sub>OH</sub> | V <sub>IN</sub> = V <sub>IL</sub>                       | I <sub>OH</sub> = -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              | —    |      |     |
|                           |                 |   | I <sub>OH</sub> = -2 mA  | 4.5                 | 4.18 | 4.31 | —                | 4.13 | —    |     |
| 6.0                       | 5.68            | 5.80  |                          | —                   | 5.63 | —    |                  |      |      |     |
| Low-level output voltage  | V <sub>OL</sub> | V <sub>IN</sub> = V <sub>IH</sub><br>or V <sub>IL</sub> | I <sub>OL</sub> = 20 μA  | 2.0                 | —    | 0.0  | 0.1              | —    | 0.1  |     |
|                           |                 |   |                          | 4.5                 | —    | 0.0  | 0.1              | —    | 0.1  |     |
|                           |                 |   | 6.0                      | —                   | 0.0  | 0.1  | —                | 0.1  |      |     |
|                           |                 |   | I <sub>OL</sub> = 2 mA   | 4.5                 | —    | 0.17 | 0.26             | —    | 0.33 |     |
| 6.0                       | —               | 0.18  |                          | 0.26                | —    | 0.33 |                  |      |      |     |
| Input leakage current     | I <sub>IN</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                |                          | 6.0                 | —    | —    | ±0.1             | —    | ±1.0 | μA  |
| Quiescent supply current  | I <sub>CC</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                |                          | 6.0                 | —    | —    | 1.0              | —    | 10.0 | μA  |

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

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

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

## AC Characteristics (C<sub>L</sub> = 50pF, Input: t<sub>r</sub> = t<sub>f</sub> = 6 ns)

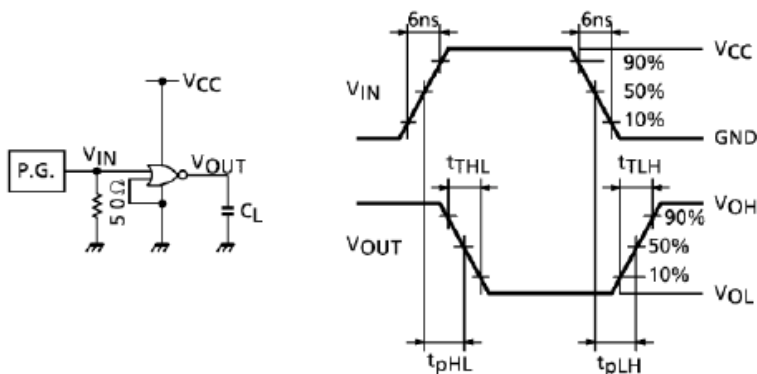
| Characteristics               | Symbol                               | Test Condition | V <sub>CC</sub> (V) | Ta = 25°C |      |     | Ta = -40 to 85°C |     | Unit |
|-------------------------------|--------------------------------------|----------------|---------------------|-----------|------|-----|------------------|-----|------|
|                               |                                      |                |                     | Min       | Typ. | Max | Min              | Max |      |
| Output transition time        | t <sub>TLH</sub><br>t <sub>THL</sub> | —              | 2.0                 | —         | 50   | 125 | —                | 155 | ns   |
|                               |                                      |                | 4.5                 | —         | 14   | 25  | —                | 31  |      |
|                               |                                      |                | 6.0                 | —         | 12   | 21  | —                | 26  |      |
| Propagation delay time        | t <sub>pLH</sub><br>t <sub>pHL</sub> | —              | 2.0                 | —         | 48   | 100 | —                | 125 | ns   |
|                               |                                      |                | 4.5                 | —         | 12   | 20  | —                | 25  |      |
|                               |                                      |                | 6.0                 | —         | 9    | 17  | —                | 21  |      |
| Input capacitance             | C <sub>IN</sub>                      | —              | —                   | 5         | 10   | —   | 10               | pF  |      |
| Power dissipation capacitance | C <sub>PD</sub>                      | (Note 1)       | —                   | 10        | —    | —   | —                | pF  |      |

Note 1: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

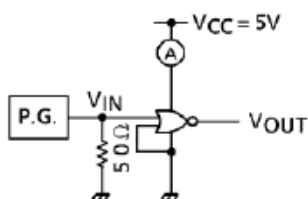
Average operating current can be obtained by the equation:

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

## Switching Characteristics Test Circuit



## I<sub>CC (opr.)</sub> Test Circuit

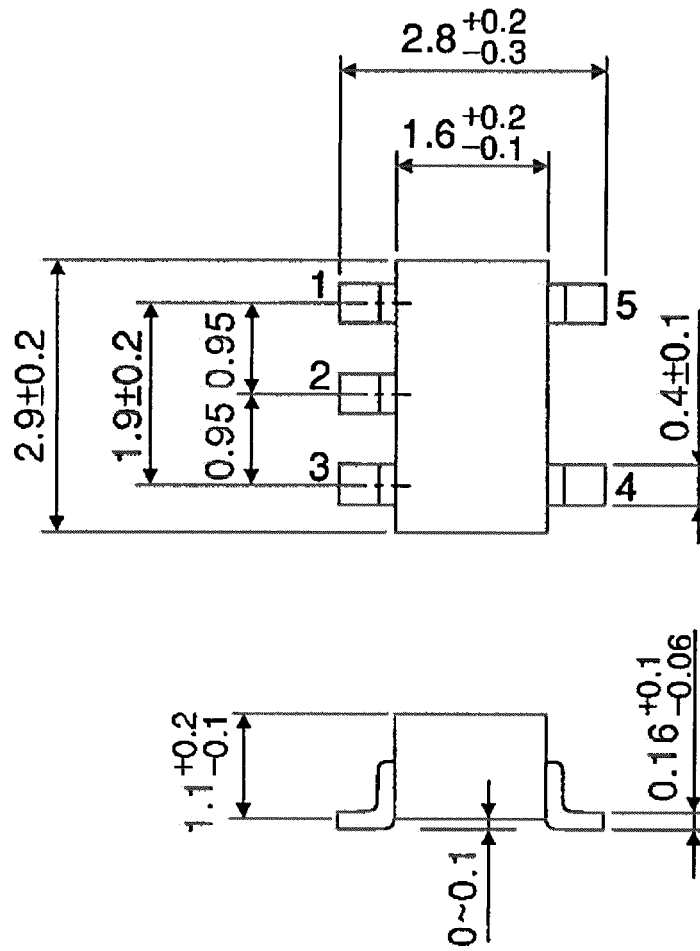


Input waveform is the same as that in case of switching characteristics test.

## Package Dimensions

SSOP5-P-0.95

Unit : mm

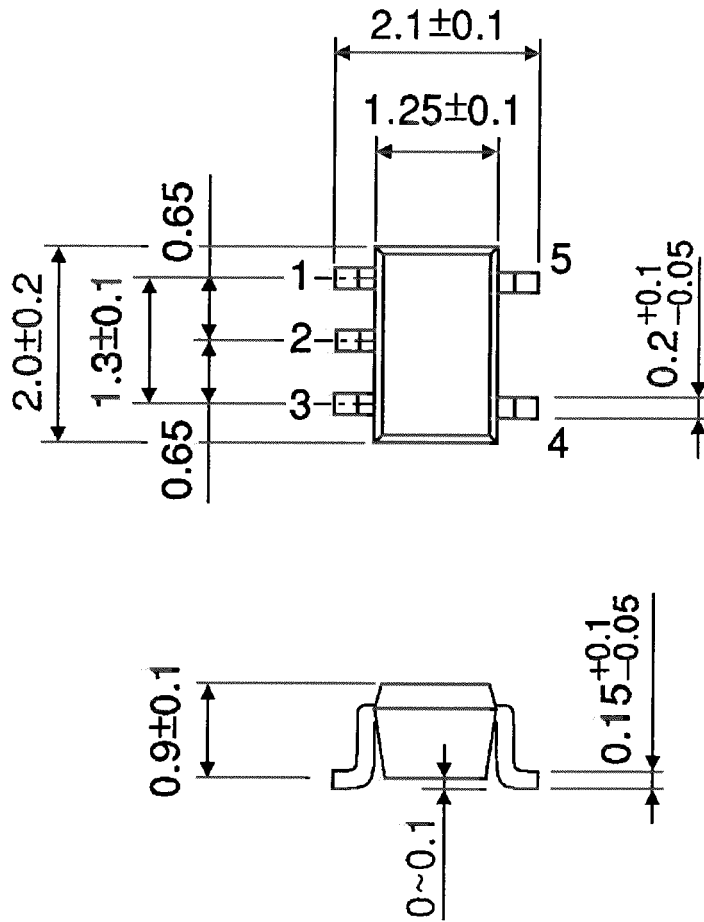


Weight: 0.016 g (typ.)

## Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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