

# TC7SH02FU

## 1. Functional Description

- 2-Input NOR Gate

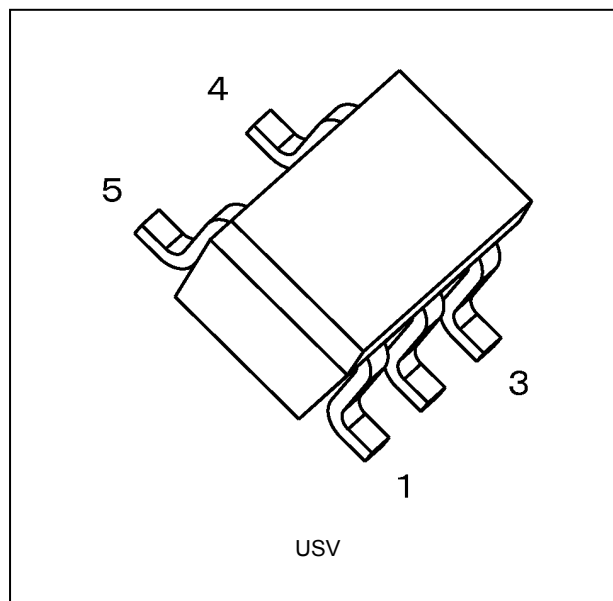
## 2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C (Note 2)
- (3) High speed operation:  $t_{pd} = 3.6$  ns (typ.) ( $V_{CC} = 5.0$  V,  $C_L = 15$  pF)
- (4) Low power dissipation:  $I_{CC} = 2.0$   $\mu$ A (max) ( $T_a = 25$  °C)
- (5) High noise immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (min)
- (6) 5.5 V tolerant inputs
- (7) Balanced Propagation Delay:  $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range:  $V_{CC} = 2.0$  to  $5.5$  V

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

Note 2: For devices with the ordering part number ending in J(CT).  $T_{opr} = -40$  to  $85$  °C for the other devices.

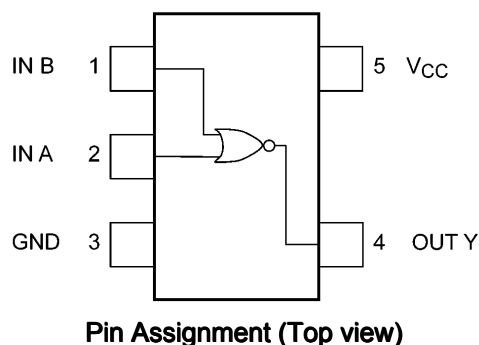
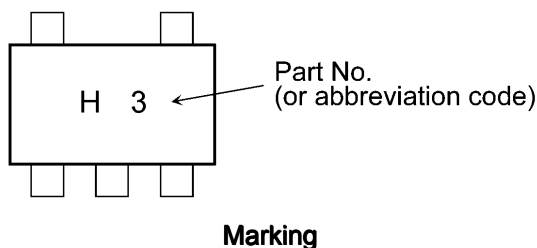
## 3. Packaging



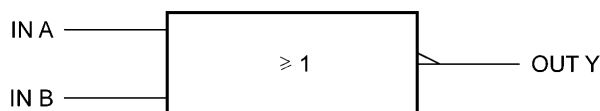
Start of commercial production

1995-03

**4. Marking and Pin Assignment**



**5. IEC Logic Symbol**



**6. Truth Table**

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

**7. Absolute Maximum Ratings (Note) (Unless otherwise specified, T<sub>a</sub> = 25 °C)**

| Characteristics                 | Symbol           | Note     | Rating                        | Unit |
|---------------------------------|------------------|----------|-------------------------------|------|
| Supply voltage                  | V <sub>CC</sub>  |          | -0.5 to 7.0                   | V    |
| Input voltage                   | V <sub>IN</sub>  |          | -0.5 to 7.0                   |      |
| DC output voltage               | V <sub>OUT</sub> |          | -0.5 to V <sub>CC</sub> + 0.5 |      |
| Input diode current             | I <sub>IK</sub>  |          | -20                           | mA   |
| Output diode current            | I <sub>OK</sub>  | (Note 1) | ±20                           |      |
| DC output current               | I <sub>OUT</sub> |          | ±25                           |      |
| V <sub>CC</sub> /ground current | I <sub>CC</sub>  |          | ±50                           |      |
| Power dissipation               | P <sub>D</sub>   |          | 200                           | mW   |
| Storage temperature             | T <sub>stg</sub> |          | -65 to 150                    | °C   |

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

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<sub>OUT</sub> < GND, V<sub>OUT</sub> > V<sub>CC</sub>

**8. Operating Ranges (Note)**

| Characteristics          | Symbol    | Note     | Test Condition                   | Rating        | Unit |
|--------------------------|-----------|----------|----------------------------------|---------------|------|
| Supply voltage           | $V_{CC}$  |          | —                                | 2.0 to 5.5    | V    |
| Input voltage            | $V_{IN}$  |          | —                                | 0 to 5.5      |      |
| Output voltage           | $V_{OUT}$ |          | —                                | 0 to $V_{CC}$ |      |
| Operating temperature    | $T_{opr}$ | (Note 1) | —                                | -40 to 125    | °C   |
|                          |           | (Note 2) | —                                | -40 to 85     |      |
| Input rise and fall time | dt/dv     |          | $V_{CC} = 3.3 \pm 0.3 \text{ V}$ | 0 to 100      | ns/V |
|                          |           |          | $V_{CC} = 5.0 \pm 0.5 \text{ V}$ | 0 to 20       |      |

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either  $V_{CC}$  or GND.

Note 1: For devices with the ordering part number ending in J(CT).

Note 2: For devices except those with the ordering part number ending in J(CT).

**9. Electrical Characteristics**

**9.1. DC Characteristics (Unless otherwise specified,  $T_a = 25 \text{ }^\circ\text{C}$ )**

| Characteristics           | Symbol   | Test Condition                       |                                     | $V_{CC}$ (V)             | Min                 | Typ. | Max                 | Unit          |      |
|---------------------------|----------|--------------------------------------|-------------------------------------|--------------------------|---------------------|------|---------------------|---------------|------|
| High-level input voltage  | $V_{IH}$ | —                                    |                                     | 2.0                      | 1.5                 | —    | —                   | V             |      |
|                           |          |                                      |                                     | 3.0 to 5.5               | $V_{CC} \times 0.7$ | —    | —                   |               |      |
| Low-level input voltage   | $V_{IL}$ | —                                    |                                     | 2.0                      | —                   | —    | 0.5                 | V             |      |
|                           |          |                                      |                                     | 3.0 to 5.5               | —                   | —    | $V_{CC} \times 0.3$ |               |      |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IL}$                    | $I_{OH} = -50 \text{ } \mu\text{A}$ | 2.0                      | 1.9                 | 2.0  | —                   | V             |      |
|                           |          |                                      |                                     | 3.0                      | 2.9                 | 3.0  | —                   |               |      |
|                           |          |                                      |                                     | 4.5                      | 4.4                 | 4.5  | —                   |               |      |
|                           |          |                                      |                                     | $I_{OH} = -4 \text{ mA}$ | 3.0                 | 2.58 | —                   |               | —    |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH} \text{ or } V_{IL}$ | $I_{OL} = 50 \text{ } \mu\text{A}$  | 2.0                      | —                   | 0.0  | 0.1                 | V             |      |
|                           |          |                                      |                                     | 3.0                      | —                   | 0.0  | 0.1                 |               |      |
|                           |          |                                      |                                     | 4.5                      | —                   | 0.0  | 0.1                 |               |      |
|                           |          |                                      |                                     | $I_{OL} = 4 \text{ mA}$  | 3.0                 | —    | —                   |               | 0.36 |
|                           |          |                                      |                                     | $I_{OL} = 8 \text{ mA}$  | 4.5                 | —    | —                   |               | 0.36 |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5 \text{ V or GND}$      |                                     | 0 to 5.5                 | —                   | —    | $\pm 0.1$           | $\mu\text{A}$ |      |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC} \text{ or GND}$     |                                     | 5.5                      | —                   | —    | 2.0                 | $\mu\text{A}$ |      |

**9.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85$  °C)**

| Characteristics           | Symbol   | Test Condition                |                      | $V_{CC}$ (V) | Min                 | Max                 | Unit    |
|---------------------------|----------|-------------------------------|----------------------|--------------|---------------------|---------------------|---------|
| High-level input voltage  | $V_{IH}$ | —                             |                      | 2.0          | 1.5                 | —                   | V       |
|                           |          |                               |                      | 3.0 to 5.5   | $V_{CC} \times 0.7$ | —                   |         |
| Low-level input voltage   | $V_{IL}$ | —                             |                      | 2.0          | —                   | 0.5                 | V       |
|                           |          |                               |                      | 3.0 to 5.5   | —                   | $V_{CC} \times 0.3$ |         |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IL}$             | $I_{OH} = -50 \mu A$ | 2.0          | 1.9                 | —                   | V       |
|                           |          |                               |                      | 3.0          | 2.9                 | —                   |         |
|                           |          |                               |                      | 4.5          | 4.4                 | —                   |         |
|                           |          |                               | $I_{OH} = -4$ mA     | 3.0          | 2.48                | —                   |         |
|                           |          |                               | $I_{OH} = -8$ mA     | 4.5          | 3.80                | —                   |         |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OL} = 50 \mu A$  | 2.0          | —                   | 0.1                 | V       |
|                           |          |                               |                      | 3.0          | —                   | 0.1                 |         |
|                           |          |                               |                      | 4.5          | —                   | 0.1                 |         |
|                           |          |                               | $I_{OL} = 4$ mA      | 3.0          | —                   | 0.44                |         |
|                           |          |                               | $I_{OL} = 8$ mA      | 4.5          | —                   | 0.44                |         |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5$ V or GND       |                      | 0 to 5.5     | —                   | $\pm 1.0$           | $\mu A$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND      |                      | 5.5          | —                   | 20.0                | $\mu A$ |

**9.3. DC Characteristics (Note) (Unless otherwise specified,  $T_a = -40$  to  $125$  °C)**

| Characteristics           | Symbol   | Test Condition                |                      | $V_{CC}$ (V) | Min                 | Max                 | Unit    |
|---------------------------|----------|-------------------------------|----------------------|--------------|---------------------|---------------------|---------|
| High-level input voltage  | $V_{IH}$ | —                             |                      | 2.0          | 1.5                 | —                   | V       |
|                           |          |                               |                      | 3.0 to 5.5   | $V_{CC} \times 0.7$ | —                   |         |
| Low-level input voltage   | $V_{IL}$ | —                             |                      | 2.0          | —                   | 0.5                 | V       |
|                           |          |                               |                      | 3.0 to 5.5   | —                   | $V_{CC} \times 0.3$ |         |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IL}$             | $I_{OH} = -50 \mu A$ | 2.0          | 1.9                 | —                   | V       |
|                           |          |                               |                      | 3.0          | 2.9                 | —                   |         |
|                           |          |                               |                      | 4.5          | 4.4                 | —                   |         |
|                           |          |                               | $I_{OH} = -4$ mA     | 3.0          | 2.40                | —                   |         |
|                           |          |                               | $I_{OH} = -8$ mA     | 4.5          | 3.70                | —                   |         |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OL} = 50 \mu A$  | 2.0          | —                   | 0.1                 | V       |
|                           |          |                               |                      | 3.0          | —                   | 0.1                 |         |
|                           |          |                               |                      | 4.5          | —                   | 0.1                 |         |
|                           |          |                               | $I_{OL} = 4$ mA      | 3.0          | —                   | 0.55                |         |
|                           |          |                               | $I_{OL} = 8$ mA      | 4.5          | —                   | 0.55                |         |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5$ V or GND       |                      | 0 to 5.5     | —                   | $\pm 2.0$           | $\mu A$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND      |                      | 5.5          | —                   | 40.0                | $\mu A$ |

Note: For devices with the ordering part number ending in J(CT).

**9.4. AC Characteristics (Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )**

| Characteristics               | Symbol             | Note     | Test Condition | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Typ. | Max  | Unit |
|-------------------------------|--------------------|----------|----------------|---------------|------------|-----|------|------|------|
| Propagation delay time        | $t_{PLH}, t_{PHL}$ |          | —              | $3.3 \pm 0.3$ | 15         | —   | 5.6  | 7.9  | ns   |
|                               |                    |          |                |               | 50         | —   | 8.1  | 11.4 |      |
|                               |                    |          |                | $5.0 \pm 0.5$ | 15         | —   | 3.6  | 5.5  |      |
|                               |                    |          |                |               | 50         | —   | 5.1  | 7.5  |      |
| Input capacitance             | $C_{IN}$           |          | —              |               |            | —   | 4    | 10   | pF   |
| Power dissipation capacitance | $C_{PD}$           | (Note 1) | —              |               |            | —   | 15   | —    | pF   |

Note 1:  $C_{PD}$  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.

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

**9.5. AC Characteristics (Unless otherwise specified,  $T_a = -40\text{ to }85\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )**

| Characteristics        | Symbol             | Test Condition | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|------------------------|--------------------|----------------|---------------|------------|-----|------|------|
| Propagation delay time | $t_{PLH}, t_{PHL}$ | —              | $3.3 \pm 0.3$ | 15         | 1.0 | 9.5  | ns   |
|                        |                    |                |               | 50         | 1.0 | 13.0 |      |
|                        |                    |                | $5.0 \pm 0.5$ | 15         | 1.0 | 6.5  |      |
|                        |                    |                |               | 50         | 1.0 | 8.5  |      |
| Input capacitance      | $C_{IN}$           | —              |               |            | —   | 10   | pF   |

**9.6. AC Characteristics (Note) (Unless otherwise specified,  $T_a = -40\text{ to }125\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )**

| Characteristics        | Symbol             | Test Condition | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|------------------------|--------------------|----------------|---------------|------------|-----|------|------|
| Propagation delay time | $t_{PLH}, t_{PHL}$ | —              | $3.3 \pm 0.3$ | 15         | 1.0 | 11.0 | ns   |
|                        |                    |                |               | 50         | 1.0 | 14.5 |      |
|                        |                    |                | $5.0 \pm 0.5$ | 15         | 1.0 | 7.5  |      |
|                        |                    |                |               | 50         | 1.0 | 9.5  |      |
| Input capacitance      | $C_{IN}$           | —              |               |            | —   | 10   | pF   |

Note: For devices with the ordering part number ending in J(CT).

Package Dimensions

Unit: mm



Weight: 0.006 g (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-353  |
| Nickname: USV   |

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