

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

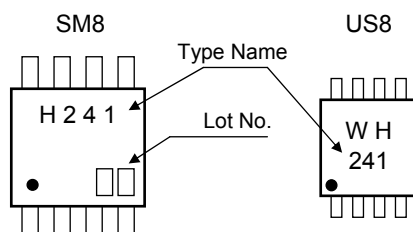
# TC7WH241FU, TC7WH241FK

Dual Bus Buffer Non Inverted, 3-State Outputs

## Features

- High speed:  $t_{pd} = 3.6 \text{ ns}$  (typ.) at  $V_{CC} = 5 \text{ V}$
- Low power dissipation:  $I_{CC} = 2 \mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- 5.5-V Tolerant inputs.
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range:  $V_{CC} = 2 \text{ to } 5.5 \text{ V}$
- Low Noise :  $V_{OLP} = 0.8 \text{ V}$  (max.)

## Marking



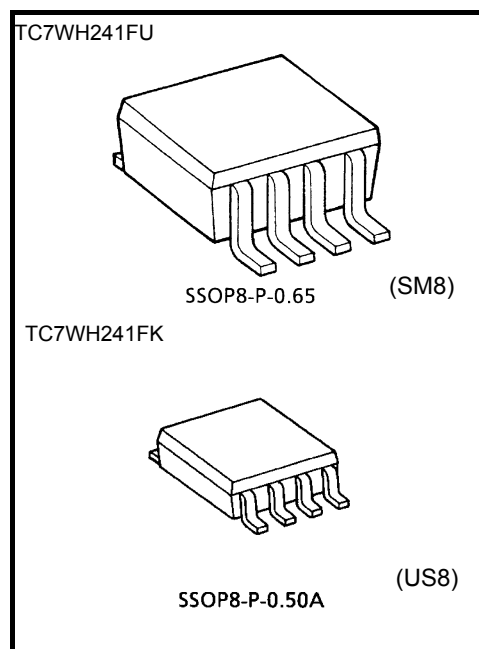
## Absolute Maximum Ratings ( $T_a = 25^\circ\text{C}$ )

| 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           | $P_D$     | 300 (SM8)              | mW               |
|                             |           | 200 (US8)              |                  |
| Storage temperature         | $T_{stg}$ | -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.).

Note 1:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

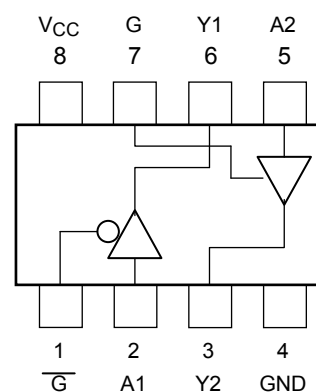


Weight

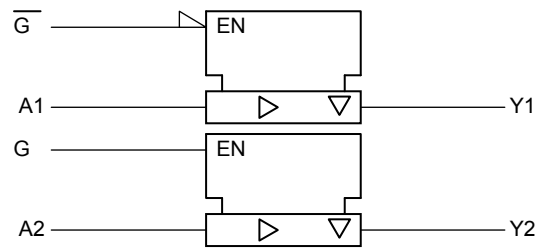
SSOP8-P-0.65: 0.02 g (typ.)

SSOP8-P-0.50A: 0.01 g (typ.)

## Pin Assignment (top view)



IEC Logic Symbol



Truth Table

| INPUTS         |   |   | OUTPUTS        |
|----------------|---|---|----------------|
| $\overline{G}$ | G | A | $\overline{Y}$ |
| L              | H | L | L              |
| L              | H | H | H              |
| H              | L | X | Z              |

X: Don't Care  
Z: High Impedance

Operating Ranges

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

**Electrical Characteristics**
**DC Characteristics**

| Characteristics                  | Symbol          | Test Condition  |                          | Ta = 25°C              |                       |      | Ta = -40 to 85°C      |                       | Unit                  |     |
|----------------------------------|-----------------|---|--------------------------|------------------------|-----------------------|------|-----------------------|-----------------------|-----------------------|-----|
|                                  |                 |   |                          | V <sub>CC</sub><br>(V) | Min                   | Typ. | Max                   | Min                   |                       | Max |
| High-level input voltage         | V <sub>IH</sub> | —   |                          | 2.0                    | 1.50                  | —    | —                     | 1.50                  | —                     | V   |
|                                  |                 |   |                          | 3.0 to 5.5             | V <sub>CC</sub> × 0.7 | —    | —                     | V <sub>CC</sub> × 0.7 | —                     |     |
| Low-level input voltage          | V <sub>IL</sub> | —   |                          | 2.0                    | —                     | —    | 0.50                  | —                     | 0.50                  | V   |
|                                  |                 |   |                          | 3.0 to 5.5             | —                     | —    | V <sub>CC</sub> × 0.3 | —                     | V <sub>CC</sub> × 0.3 |     |
| High-level output voltage        | V <sub>OH</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>  | I <sub>OH</sub> = -50 μA | 2.0                    | 1.9                   | 2.0  | —                     | 1.9                   | —                     | V   |
|                                  |                 |   |                          | 3.0                    | 2.9                   | 3.0  | —                     | 2.9                   | —                     |     |
|                                  |                 |   |                          | 4.5                    | 4.4                   | 4.5  | —                     | 4.4                   | —                     |     |
|                                  |                 |   | 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> or V <sub>IL</sub>  | I <sub>OL</sub> = 50 μA  | 2.0                    | —                     | 0.0  | 0.1                   | —                     | 0.1                   | V   |
|                                  |                 |   |                          | 3.0                    | —                     | 0.0  | 0.1                   | —                     | 0.1                   |     |
|                                  |                 |   |                          | 4.5                    | —                     | 0.0  | 0.1                   | —                     | 0.1                   |     |
|                                  |                 |   | I <sub>OL</sub> = 4 mA   | 3.0                    | —                     | —    | 0.36                  | —                     | 0.44                  |     |
|                                  |                 |   | I <sub>OL</sub> = 8 mA   | 4.5                    | —                     | —    | 0.36                  | —                     | 0.44                  |     |
| 3-State Output Off-State Current | I <sub>OZ</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>OUT</sub> = V <sub>CC</sub> or GND |                          | 5.5                    | —                     | —    | 0.25                  | —                     | 2.50                  | μA  |
| 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: $t_r = t_f = 3$ 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        | $t_{pLH}$<br>$t_{pHL}$   |                      | $3.3 \pm 0.3$       | 15                  | —         | 5.3  | 7.5  | 1.0              | 9.0  | ns   |
|                               |                          |                      |                     | 50                  | —         | 7.8  | 11.0 | 1.0              | 12.5 |      |
|                               |                          |                      | $5.0 \pm 0.5$       | 15                  | —         | 3.6  | 5.5  | 1.0              | 6.5  |      |
|                               |                          |                      |                     | 50                  | —         | 5.1  | 7.5  | 1.0              | 8.5  |      |
| 3-State Output Enable Time    | $t_{pZL}$<br>$t_{pZH}$   | R <sub>L</sub> = 1kΩ | $3.3 \pm 0.3$       | 15                  | —         | 6.6  | 10.6 | 1.0              | 12.5 | ns   |
|                               |                          |                      |                     | 50                  | —         | 9.1  | 14.1 | 1.0              | 16.0 |      |
|                               |                          |                      | $5.0 \pm 0.5$       | 15                  | —         | 4.7  | 7.3  | 1.0              | 8.5  |      |
|                               |                          |                      |                     | 50                  | —         | 6.2  | 9.3  | 1.0              | 10.5 |      |
| 3-State Output Disable Time   | $t_{pLZ}$<br>$t_{pHZ}$   | R <sub>L</sub> = 1kΩ | $3.3 \pm 0.3$       | 50                  | —         | 10.3 | 14.0 | 1.0              | 16.0 | ns   |
|                               |                          |                      | $5.0 \pm 0.5$       | 50                  | —         | 6.7  | 9.2  | 1.0              | 10.5 |      |
| Output to Output Skew         | $t_{osLH}$<br>$t_{osHL}$ | (Note 2)             | $3.3 \pm 0.3$       | 50                  | —         | —    | 1.5  | —                | 1.5  | ns   |
|                               |                          |                      | $5.0 \pm 0.5$       | 50                  | —         | —    | 1.0  | —                | 1.0  |      |
| Input Capacitance             | C <sub>IN</sub>          |                      |                     |                     | —         | 4    | 10   | —                | 10   | pF   |
| Output Capacitance            | C <sub>I/O</sub>         |                      |                     |                     | —         | 6    | —    | —                | —    | pF   |
| Power Dissipation Capacitance | C <sub>PD</sub>          | (Note 3)             |                     |                     | —         | 17   | —    | —                | —    | pF   |

Note 2: Parameter guaranteed by design.

$$t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|$$

Note 3: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

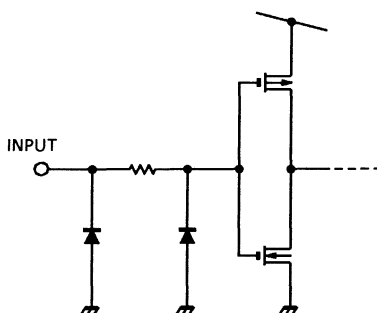
Average operating current can be obtained by the equation :

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} \quad I_{CC}/2$$

## Noise Characteristics (Ta = 25°C, input: $t_r = t_f = 3$ ns)

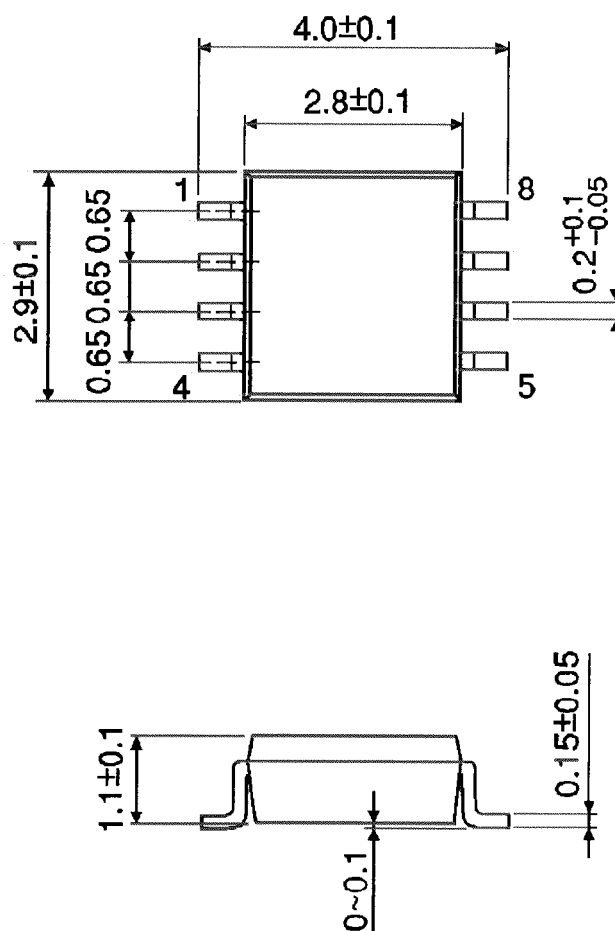
| Characteristics                              | Symbol           | Test Condition         |                     | Typ. | Limit | Unit |
|--|------------------|------------------------|---------------------|------|-------|------|
|  |                  |                        | V <sub>CC</sub> (V) |      |       |      |
| Quiet output maximum dynamic V <sub>OL</sub> | V <sub>OLP</sub> | C <sub>L</sub> = 50 pF | 5.0                 | 0.5  | 0.8   | V    |
| Quiet output minimum dynamic V <sub>OL</sub> | V <sub>OLV</sub> | C <sub>L</sub> = 50 pF | 5.0                 | -0.5 | -0.8  | V    |
| Minimum high level dynamic input voltage     | V <sub>IHD</sub> | C <sub>L</sub> = 50 pF | 5.0                 | —    | 3.5   | V    |
| Maximum low level dynamic input voltage      | V <sub>ILD</sub> | C <sub>L</sub> = 50 pF | 5.0                 | —    | 1.5   | V    |

## Input Equivalent Circuit



## SSOP8-P-0.65

Unit : mm

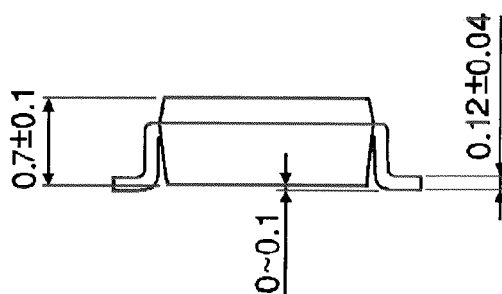
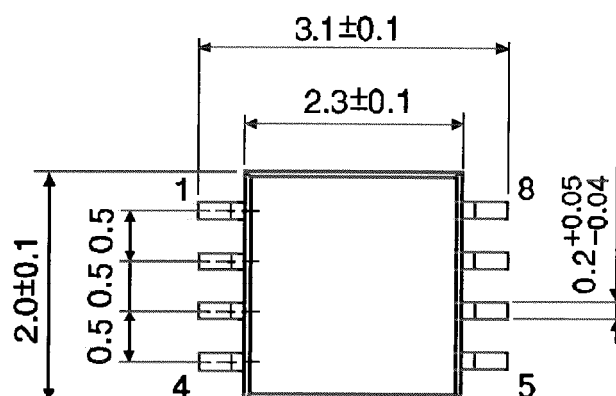


Weight: 0.02 g (typ.)

## Package Dimensions

SSOP8-P-0.50A

Unit : mm



Weight: 0.01 g (typ.)

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