

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7W04FU, TC7W04FK

## 3 Inverters

The TC7W04 is a high speed C<sup>2</sup>MOS Buffer fabricated with silicon gate C<sup>2</sup>MOS technology.

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

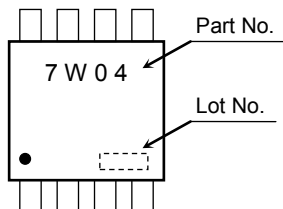
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## Features

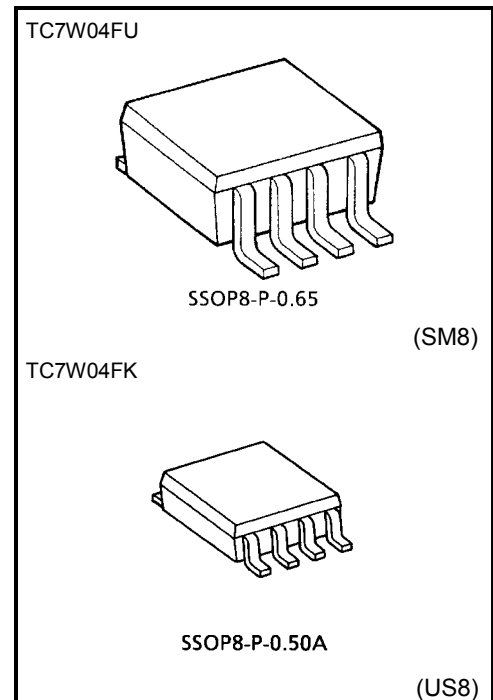
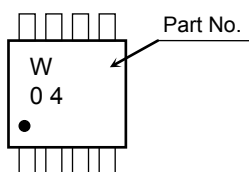
- High speed:  $t_{pd} = 6 \text{ ns (typ.)}$  at  $V_{CC} = 5V$
- Low power dissipation:  $I_{CC} = 1\mu A \text{ (max)}$  at  $T_a = 25^\circ C$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (min)}$
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance:  $|I_{OH}| = I_{OL} = 4 \text{ mA (min)}$
- Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- Wide operating voltage range:  $V_{CC} \text{ (opr)} = 2 \text{ to } 6V$

## Marking

TC7W04FU



TC7W04FK



## Weight

SSOP8-P-0.65: 0.02 g (typ.)  
SSOP8-P-0.50A: 0.01 g (typ.)

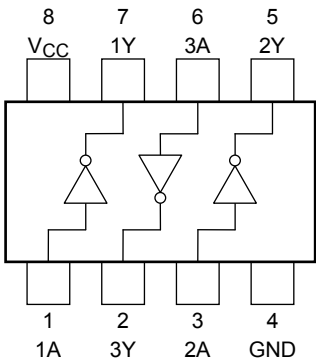
Start of commercial production  
1991-09

Absolute Maximum Ratings (Ta = 25°C)

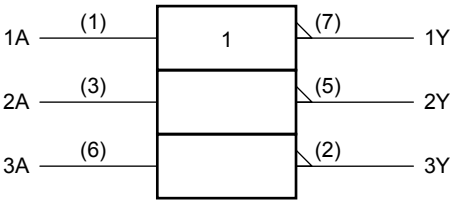
| Characteristics                    | Symbol           | Rating                        | Unit |
|------------------------------------|------------------|-------------------------------|------|
| Supply voltage range               | V <sub>CC</sub>  | −0.5 to 7                     | V    |
| DC input voltage                   | V <sub>IN</sub>  | −0.5 to V <sub>CC</sub> + 0.5 | V    |
| DC output voltage                  | V <sub>OUT</sub> | −0.5 to V <sub>CC</sub> + 0.5 | V    |
| Input diode current                | I <sub>IK</sub>  | ±20                           | mA   |
| Output diode current               | I <sub>OK</sub>  | ±20                           | mA   |
| DC output current                  | I <sub>OUT</sub> | ±25                           | mA   |
| DC V <sub>CC</sub> /ground current | I <sub>CC</sub>  | ±25                           | mA   |
| Power dissipation                  | P <sub>D</sub>   | 300 (SM8)                     | mW   |
|                                    |                  | 200 (US8)                     |      |
| Storage temperature range          | T <sub>stg</sub> | −65 to 150                    | °C   |
| Lead temperature (10 s)            | T <sub>L</sub>   | 260                           | °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).

Pin Configuration (top view)



Logic Diagram



Truth Table

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

## Operating Ranges

| Characteristics             | Symbol     | Rating                        | Unit |
|-----------------------------|------------|-------------------------------|------|
| Supply voltage              | $V_{CC}$   | 2 to 6                        | V    |
| Input voltage               | $V_{IN}$   | 0 to $V_{CC}$                 | V    |
| Output voltage              | $V_{OUT}$  | 0 to $V_{CC}$                 | V    |
| Operating temperature range | $T_{opr}$  | -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 Electrical Characteristics

| Characteristics |                          | Symbol                   | Test Condition                    |                                          | Ta = 25°C                 |           |                 | Ta = -40 to 85°C                  |                                          | Unit |     |      |    |     |
|-----------------|--------------------------|--------------------------|-----------------------------------|------------------------------------------|---------------------------|-----------|-----------------|-----------------------------------|------------------------------------------|------|-----|------|----|-----|
|                 |                          |                          |                                   |                                          | V <sub>CC</sub> (V)       | Min       | Typ.            | Max                               | Min                                      |      | Max |      |    |     |
| Input voltage   | High level               | 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                | V <sub>IL</sub>          | —                                 |                                          | 2.0                       | —         | —               | 0.5                               | —                                        | 0.5  |     |      |    |     |
|                 |                          |                          |                                   |                                          | 4.5                       | —         | —               | 1.35                              | —                                        | 1.35 |     |      |    |     |
|                 |                          |                          |                                   |                                          | 6.0                       | —         | —               | 1.8                               | —                                        | 1.8  |     |      |    |     |
| Output voltage  | High level               | 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> = -4 mA                  | 4.5                       | 4.18      | 4.31            | —                                 | 4.13                                     | —    |     |      |    |     |
|                 |                          |                          |                                   |                                          | I <sub>OH</sub> = -5.2 mA | 6.0       | 5.68            | 5.80                              | —                                        | 5.63 |     | —    |    |     |
|                 |                          |                          |                                   |                                          |                           | Low level | V <sub>OL</sub> | V <sub>IN</sub> = V <sub>IH</sub> | I <sub>OL</sub> = 20 μA                  | 2.0  |     | —    | 0  | 0.1 |
|                 | 4.5                      | —                        | 0                                 | 0.1                                      |                           |           |                 |                                   |                                          | —    |     | 0.1  |    |     |
|                 | 6.0                      | —                        | 0                                 | 0.1                                      | —                         |           |                 |                                   |                                          | 0.1  |     |      |    |     |
|                 | I <sub>OL</sub> = 4 mA   | 4.5                      | —                                 | 0.17                                     | 0.26                      |           |                 |                                   | —                                        | 0.33 |     |      |    |     |
|                 |                          | I <sub>OL</sub> = 5.2 mA | 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  | —  | —   |
|                 | Quiescent supply current |                          | I <sub>CC</sub>                   | V <sub>IN</sub> = V <sub>CC</sub> or GND |                           | 6.0       | —               | —                                 | 1.0                                      | —    |     | 10.0 | μA |     |

AC Electrical Characteristics ( $C_L = 15 \text{ pF}$ ,  $V_{CC} = 5 \text{ V}$ ,  $T_a = 25^\circ\text{C}$ )

| Characteristics        | Symbol                 | Test Condition | Ta = 25°C |      |     | Unit |
|------------------------|------------------------|----------------|-----------|------|-----|------|
|                        |                        |                | Min       | Typ. | Max |      |
| Output transition time | $t_{TLH}$<br>$t_{THL}$ | —              | —         | 4    | 8   | ns   |
| Propagation delay time | $t_{PLH}$<br>$t_{PHL}$ | —              | —         | 6    | 12  | ns   |

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

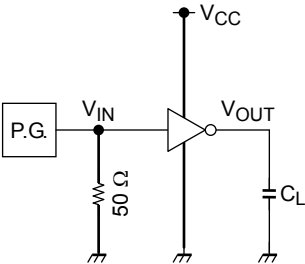
| Characteristics               | Symbol                 | Test Condition | $V_{CC} \text{ (V)}$ | $T_a = 25^\circ\text{C}$ |      |     | $T_a = -40 \text{ to } 85^\circ\text{C}$ |     | Unit |
|-------------------------------|------------------------|----------------|----------------------|--------------------------|------|-----|------------------------------------------|-----|------|
|                               |                        |                |                      | Min                      | Typ. | Max | Min                                      | Max |      |
| Output transition time        | $t_{TLH}$<br>$t_{THL}$ | —              | 2.0                  | —                        | 30   | 75  | —                                        | 95  | ns   |
|                               |                        |                | 4.5                  | —                        | 8    | 15  | —                                        | 19  |      |
|                               |                        |                | 6.0                  | —                        | 7    | 13  | —                                        | 16  |      |
| Propagation delay time        | $t_{pLH}$<br>$t_{pHL}$ | —              | 2.0                  | —                        | 27   | 75  | —                                        | 95  | ns   |
|                               |                        |                | 4.5                  | —                        | 9    | 15  | —                                        | 19  |      |
|                               |                        |                | 6.0                  | —                        | 8    | 13  | —                                        | 16  |      |
| Input capacitance             | $C_{IN}$               | —              | —                    | —                        | 5    | 10  | —                                        | 10  | pF   |
| Power dissipation capacitance | $C_{PD}$               | (Note)         | —                    | —                        | 20   | —   | —                                        | —   | pF   |

Note:  $C_{PD}$  is defined as the value of internal equivalent capacitance of IC which is calculated from the operating current consumption without load (refer to test circuit).

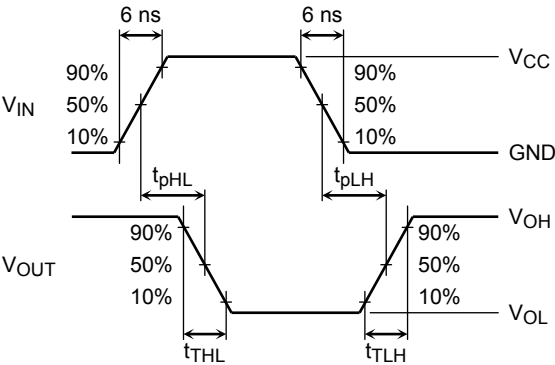
Average operating current can be obtained by the equation hereunder.

$$I_{CC \text{ (opr)}} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/3 \text{ (per gate)}$$

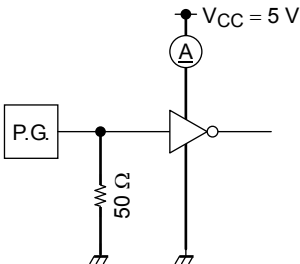
**AC Electrical Characteristics Test Circuit**



**AC Electrical Characteristics Test Waveform**



**Operating Current Consumption Test Circuit**

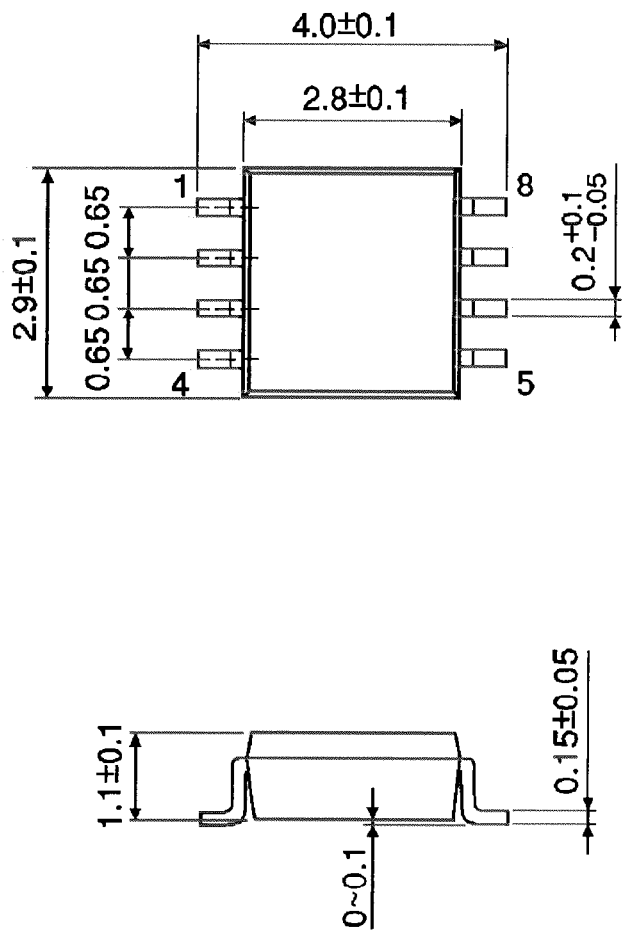


This input waveform is equal to the AC electrical characteristics test waveform.

Package Dimensions

SSOP8-P-0.65

Unit : mm

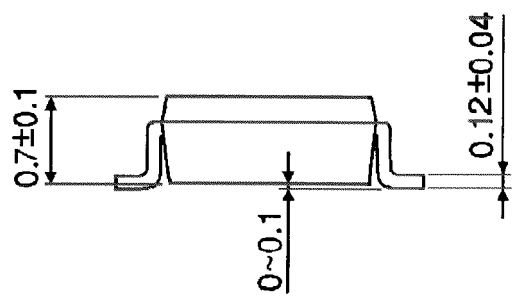
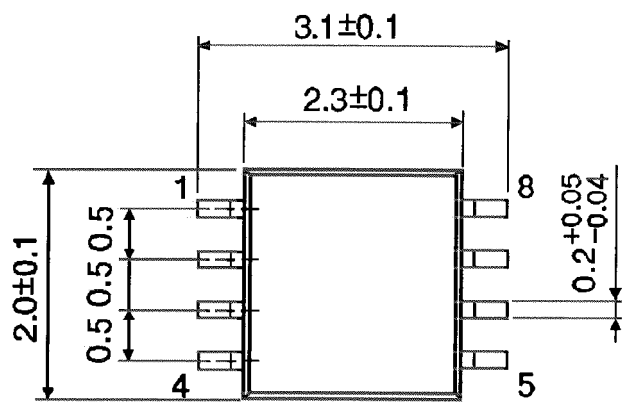


Weight: 0.02 g (typ.)

Package Dimensions

SSOP8-P-0.50A

Unit : mm



Weight: 0.01 g (typ.)

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