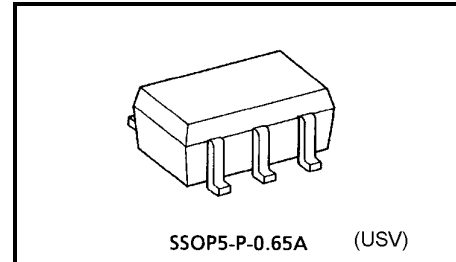TOSHIBA CMOS Digital Integrated Circuit    Silicon Monolithic
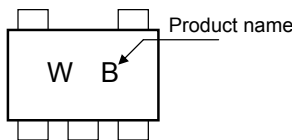
# TC7SG125FU

Bus Buffer with 3-STATE Output

## Features

- High-level output current:    $I_{OH}/I_{OL}$ = ±8 mA (min)
  at $V_{CC}$ = 3.0 V
- High-speed operation:  $t_{pd}$ = 2.4 ns (typ.)
  at $V_{CC}$ = 3.3 V,15pF
- Operating voltage range: $V_{CC}$ = 0.9~3.6 V
- 5.5-V tolerant inputs.
- 3.6-V power down protection output.



SSOP5-P-0.65A    (USV)

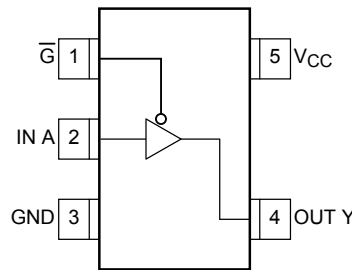Weight: 0.006 g (typ.)

## Marking



W  B

Product name

## Pin Assignment (top view)



| | |
|---|---|
| $\overline{G}$ 1 | 5 $V_{CC}$ |
| IN A 2 | |
| GND 3 | 4 OUT Y |

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

| Characteristics | Symbol | Value | Unit |
|---|---|---|---|
| Power supply voltage | $V_{CC}$ | −0.5~4.6 | V |
| DC input voltage | $V_{IN}$ | −0.5~7.0 | V |
| DC output voltage | $V_{OUT}$ | −0.5~ 4.6 (Note 1) | V |
| Input diode current | | −0.5~ $V_{CC}$ + 0.5 (Note 2) | |
| Output diode current | $I_{IK}$ | −20 | mA |
| DC output current | $I_{OK}$ | −20 (Note 3) | mA |
| DC $V_{CC}$/ground current | $I_{OUT}$ | ±25 | mA |
| Power dissipation | $I_{CC}$ | ±50 | mA |
| Storage temperature | $P_D$ | 200 | mW |
| Power supply voltage | $T_{stg}$ | −65~150 | °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:   $V_{CC}$ = 0V
Note 2:   High or Low State. IOUT abusolute maximum rating must be observed.
Note 3:   VOUT < GND

## IEC Logic Symbol

$\overline{G}$ — EN ▷

IN A —

OUT Y
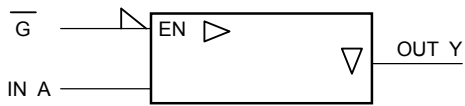
## Truth Table

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

## Operating Ranges

| Characteristics | Symbol | Value | | Unit |
|---|---|---|---|---|
| Power supply voltage | $V_{CC}$ | 0.9~3.6 | | V |
| Input voltage | $V_{IN}$ | 0~5.5 | | V |
| Output voltage | $V_{OUT}$ | 0~3.6 | (Note 4) | V |
| | | 0~$V_{CC}$ | (Note 5) | |
| Output Current | $I_{OH}/I_{OL}$ | ±8.0 | (Note 6) | mA |
| | | ±4.0 | (Note 7) | |
| | | ±3.0 | (Note 8) | |
| | | ±1.7 | (Note 9) | |
| | | ±0.3 | (Note 10) | |
| | | ±0.02 | (Note 11) | |
| Operating temperature | $T_{opr}$ | −40~85 | | °C |
| Input rise and fall time | dt/dV | 0~10 | (Note 12) | ns/V |

Note 4: $V_{CC}$ = 0V

Note 5: High or Low state.

Note 6: $V_{CC}$ = 3.0~3.6 V

Note 7: $V_{CC}$ = 2.3~2.7 V

Note 8: $V_{CC}$ = 1.65~1.95 V

Note 9: $V_{CC}$ = 1.4~1.6 V

Note 10: $V_{CC}$ = 1.1~1.3 V

Note 11: $V_{CC}$ = 0.9 V

Note 12: $V_{IN}$ = 0.8~2.0 V, $V_{CC}$ = 3.0 V

## Electrical Characteristics

### DC Characteristics

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Ta = 25°C Min | Typ. | Max | Ta = −40~85°C Min | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Input voltage | High level | $V_{IH}$ | — | | 0.9 | $V_{CC}$ | — | — | $V_{CC}$ | — | V |
| | | | | | 1.1~1.3 | $V_{CC} \times 0.7$ | — | — | $V_{CC} \times 0.7$ | — | |
| | | | | | 1.4~1.6 | $V_{CC} \times 0.65$ | — | — | $V_{CC} \times 0.65$ | — | |
| | | | | | 1.65~1.95 | $V_{CC} \times 0.65$ | — | — | $V_{CC} \times 0.65$ | — | |
| | | | | | 2.3~2.7 | 1.7 | — | — | 1.7 | — | |
| | | | | | 3.0~3.6 | 2.0 | — | — | 2.0 | — | |
| | Low level | $V_{IL}$ | — | | 0.9 | — | — | GND | — | GND | |
| | | | | | 1.1~1.3 | — | — | $V_{CC} \times 0.3$ | — | $V_{CC} \times 0.3$ | |
| | | | | | 1.4~1.6 | — | — | $V_{CC} \times 0.35$ | — | $V_{CC} \times 0.35$ | |
| | | | | | 1.65~1.95 | — | — | $V_{CC} \times 0.35$ | — | $V_{CC} \times 0.35$ | |
| | | | | | 2.3~2.7 | — | — | 0.7 | — | 0.7 | |
| | | | | | 3.0~3.6 | — | — | 0.8 | — | 0.8 | |
| Output voltage | High level | $V_{OH}$ | $V_{IN} = V_{IL}$ or $V_{IH}$ | $I_{OH} = -0.02$ mA | 0.9 | 0.75 | — | — | 0.75 | — | V |
| | | | | $I_{OH} = -0.3$ mA | 1.1~1.3 | $V_{CC} \times 0.75$ | — | — | $V_{CC} \times 0.75$ | — | |
| | | | | $I_{OH} = -1.7$ mA | 1.4~1.6 | $V_{CC} \times 0.75$ | — | — | $V_{CC} \times 0.75$ | — | |
| | | | | $I_{OH} = -3.0$ mA | 1.65~1.95 | $V_{CC} -0.45$ | — | — | $V_{CC} -0.45$ | — | |
| | | | | $I_{OH} = -4.0$ mA | 2.3~2.7 | 2.0 | — | — | 2.0 | — | |
| | | | | $I_{OH} = -8.0$ mA | 3.0~3.6 | 2.48 | — | — | 2.48 | — | |
| | Low level | $V_{OL}$ | $V_{IN} = V_{IL}$ | $I_{OL} = 0.02$ mA | 0.9 | — | — | 0.1 | — | 0.1 | |
| | | | | $I_{OL} = 0.3$ mA | 1.1~1.3 | — | — | $V_{CC} \times 0.25$ | — | $V_{CC} \times 0.25$ | |
| | | | | $I_{OL} = 1.7$ mA | 1.4~1.6 | — | — | $V_{CC} \times 0.25$ | — | $V_{CC} \times 0.25$ | |
| | | | | $I_{OL} = 3.0$ mA | 1.65~1.95 | — | — | 0.45 | — | 0.45 | |
| | | | | $I_{OL} = 4.0$ mA | 2.3~2.7 | — | — | 0.4 | — | 0.4 | |
| | | | | $I_{OL} = 8.0$ mA | 3.0~3.6 | — | — | 0.4 | — | 0.4 | |
| Input leakage current | | $I_{IN}$ | $V_{IN} = 0$~5.5V | | 0~3.6 | — | — | ±0.1 | — | ±1.0 | μA |
| 3-state output off-state current | | $I_{OZ}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ $V_{IN} = 0$~3.6V | | 0.9~3.6 | — | — | 1.0 | — | 10.0 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN} = 5.5V$ or $V_{OUT} = 3.6V$ | | 0.0 | — | — | 1.0 | — | 10.0 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND | | 3.6 | — | — | 1.0 | — | 10.0 | μA |

## AC Characteristics (Input: $t_r = t_f$ = 3 ns)

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = −40~85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Propagation delay time | $t_{pLH}$ $t_{pHL}$ | $C_L$ = 10 pF, $R_L$ = 1 MΩ | 0.9 | — | 15.3 | — | — | — | ns |
| | | | 1.1~1.3 | — | 8.3 | 18.4 | 1.0 | 34.2 | |
| | | | 1.4~1.6 | — | 5.0 | 8.5 | 1.0 | 10.0 | |
| | | | 1.65~ 1.95 | — | 4.0 | 6.2 | 1.0 | 6.7 | |
| | | | 2.3~2.7 | — | 2.6 | 3.9 | 1.0 | 4.4 | |
| | | | 3.0~3.6 | — | 2.1 | 3.1 | 1.0 | 3.7 | |
| | | $C_L$ = 15 pF, $R_L$ = 1 MΩ | 0.9 | — | 17.7 | — | — | — | |
| | | | 1.1~1.3 | — | 9.6 | 21.5 | 1.0 | 37.2 | |
| | | | 1.4~1.6 | — | 5.6 | 9.3 | 1.0 | 11.2 | |
| | | | 1.65~ 1.95 | — | 4.5 | 6.9 | 1.0 | 7.1 | |
| | | | 2.3~2.7 | — | 2.9 | 4.4 | 1.0 | 5.0 | |
| | | | 3.0~3.6 | — | 2.4 | 3.4 | 1.0 | 3.9 | |
| | | $C_L$ = 30 pF, $R_L$ = 1 MΩ | 0.9 | — | 29.0 | — | — | — | |
| | | | 1.1~1.3 | — | 14.5 | 29.6 | 1.0 | 56.0 | |
| | | | 1.4~1.6 | — | 8.2 | 13.1 | 1.0 | 15.9 | |
| | | | 1.65~ 1.95 | — | 6.0 | 9.2 | 1.0 | 9.6 | |
| | | | 2.3~2.7 | — | 4.0 | 5.7 | 1.0 | 6.1 | |
| | | | 3.0~3.6 | — | 3.3 | 4.4 | 1.0 | 4.8 | |
| Output enable time | $t_{pZL}$ $t_{pZH}$ | $C_L$ = 10 pF, $R_L$ = 100 kΩ | 0.9 | — | 22.7 | — | — | — | ns |
| | | $C_L$ = 10 pF, $R_L$ = 5 kΩ | 1.1~1.3 | — | 10.9 | 18.7 | 1.0 | 29.8 | |
| | | | 1.4~1.6 | — | 5.9 | 8.7 | 1.0 | 9.8 | |
| | | | 1.65~ 1.95 | — | 4.5 | 6.3 | 1.0 | 6.8 | |
| | | | 2.3~2.7 | — | 3.1 | 4.2 | 1.0 | 4.5 | |
| | | | 3.0~3.6 | — | 2.4 | 3.2 | 1.0 | 3.5 | |
| | | $C_L$ = 15 pF, $R_L$ = 100 kΩ | 0.9 | — | 25.3 | — | — | — | |
| | | $C_L$ = 15 pF, $R_L$ = 5 kΩ | 1.1~1.3 | — | 11.9 | 20.7 | 1.0 | 34.7 | |
| | | | 1.4~1.6 | — | 6.5 | 9.5 | 1.0 | 11.1 | |
| | | | 1.65~ 1.95 | — | 4.9 | 6.8 | 1.0 | 7.2 | |
| | | | 2.3~2.7 | — | 3.3 | 4.4 | 1.0 | 4.8 | |
| | | | 3.0~3.6 | — | 2.5 | 3.4 | 1.0 | 3.7 | |
| | | $C_L$ = 30 pF, $R_L$ = 100 kΩ | 0.9 | — | 37.7 | — | — | — | |
| | | $C_L$ = 30 pF, $R_L$ = 5 kΩ | 1.1~1.3 | — | 17.1 | 30.7 | 1.0 | 50.5 | |
| | | | 1.4~1.6 | — | 8.8 | 13.1 | 1.0 | 15.1 | |
| | | | 1.65~ 1.95 | — | 6.6 | 9.2 | 1.0 | 9.9 | |
| | | | 2.3~2.7 | — | 4.1 | 5.4 | 1.0 | 5.8 | |
| | | | 3.0~3.6 | — | 3.1 | 4.1 | 1.0 | 4.5 | |

| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = −40~85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Output disable time | $t_{pLZ}$ $t_{pHZ}$ | $C_L$ = 10 pF, $R_L$ = 100 kΩ | 0.9 | — | 117.6 | — | — | — | ns |
| | | $C_L$ = 10 pF, $R_L$ = 5 kΩ | 1.1~1.3 | — | 9.2 | 16.0 | 1.0 | 22.4 | |
| | | | 1.4~1.6 | — | 7.1 | 9.1 | 1.0 | 10.4 | |
| | | | 1.65~1.95 | — | 6.7 | 8.3 | 1.0 | 9.0 | |
| | | | 2.3~2.7 | — | 6.2 | 7.3 | 1.0 | 8.8 | |
| | | | 3.0~3.6 | — | 5.8 | 6.9 | 1.0 | 7.6 | |
| | | $C_L$ = 15 pF, $R_L$ = 100 kΩ | 0.9 | — | 139.2 | — | — | — | |
| | | $C_L$ = 15 pF, $R_L$ = 5 kΩ | 1.1~1.3 | — | 10.0 | 16.9 | 1.0 | 25.1 | |
| | | | 1.4~1.6 | — | 7.8 | 9.8 | 1.0 | 11.3 | |
| | | | 1.65~1.95 | — | 7.4 | 9.2 | 1.0 | 10.6 | |
| | | | 2.3~2.7 | — | 7.0 | 8.2 | 1.0 | 10.3 | |
| | | | 3.0~3.6 | — | 6.8 | 7.7 | 1.0 | 9.5 | |
| | | $C_L$ = 30 pF, $R_L$ = 100 kΩ | 0.9 | — | 230.8 | — | — | — | |
| | | $C_L$ = 30 pF, $R_L$ = 5 kΩ | 1.1~1.3 | — | 14.0 | 20.8 | 1.0 | 31.9 | |
| | | | 1.4~1.6 | — | 12.2 | 13.5 | 1.0 | 14.9 | |
| | | | 1.65~1.95 | — | 11.5 | 13.0 | 1.0 | 13.9 | |
| | | | 2.3~2.7 | — | 11.3 | 12.2 | 1.0 | 13.5 | |
| | | | 3.0~3.6 | — | 10.9 | 11.8 | 1.0 | 12.9 | |
| Input capacitance | $C_{IN}$ | — | 3.6 | — | 3 | — | — | — | pF |
| Power dissipation capacitance | $C_{PD}$ | (Note13) | 0.9 ~ 3.6 | — | 8 | — | — | — | pF |

Note 13: $C_{PD}$ 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:

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

## AC Characteristics Measurement Circuit
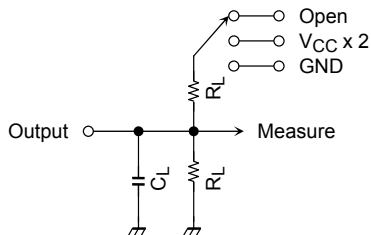


| Characteristics | Switch |
|---|---|
| $t_{pLH}$, $t_{pHL}$ | Open |
| $t_{pLZ}$, $t_{pZL}$ | $V_{CC}$ x 2 |
| $t_{pHZ}$, $t_{pZH}$ | GND |

**Figure1   $t_{pLH}$, $t_{pHL}$**

## AC Characteristics Measurement Circuit
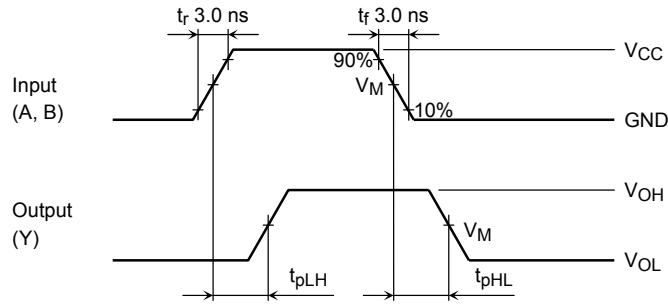


**Figure2** $t_{pLH}$, $t_{pHL}$
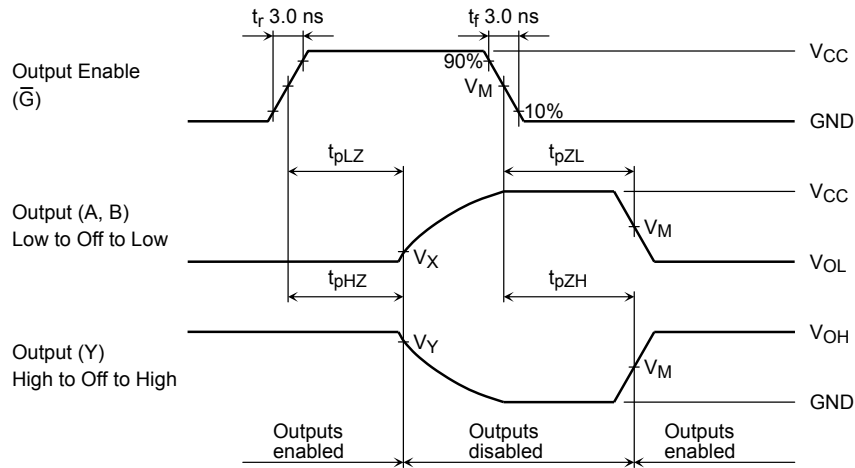


**Figure3** $t_{pLZ}$, $t_{pHZ}$, $t_{pZL}$, $t_{pZH}$

| UNIT | $V_{CC}$ | | | | | |
|------|----------|----------|----------|----------|----------|----------|
| | 3.3±0.3 V | 2.5±0.2 V | 1.8±0.15 V | 1.5±0.1 V | 1.2±0.1 V | 0.9 V |
| $V_M$ | $V_{CC}$ / 2 | $V_{CC}$ / 2 | $V_{CC}$ / 2 | $V_{CC}$ / 2 | $V_{CC}$ / 2 | $V_{CC}$ / 2 |
| $V_X$ | $V_{OL}$ + 0.3 V | $V_{OL}$ + 0.15 V | $V_{OL}$ + 0.15 V | $V_{OL}$ + 0.1 V | $V_{OL}$ + 0.1 V | $V_{OL}$ + 0.1 V |
| $V_Y$ | $V_{OH}$ - 0.3 V | $V_{OH}$ - 0.15 V | $V_{OH}$ - 0.15 V | $V_{OH}$ - 0.1 V | $V_{OH}$ - 0.1 V | $V_{OH}$ - 0.1 V |

## Package Dimensions

SSOP5-P-0.65A

Unit : mm
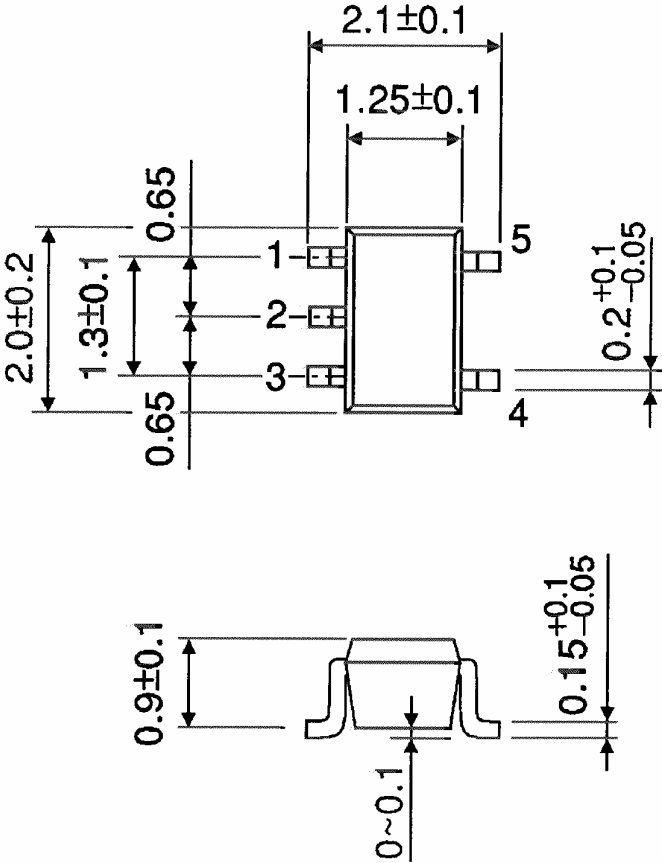


Weight: 0.006 g (typ.)

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