

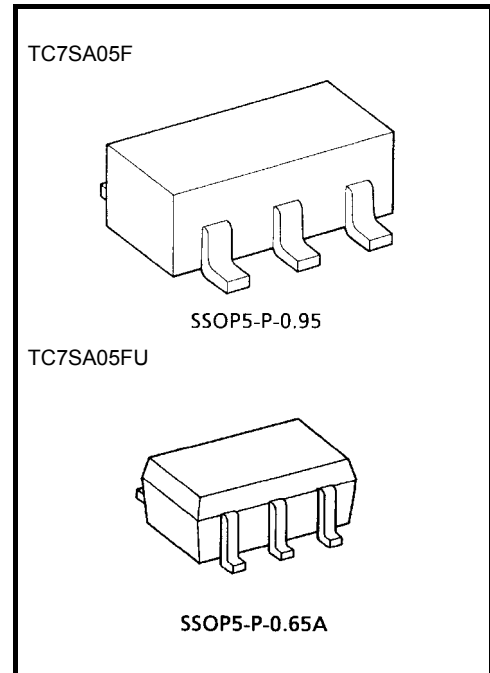
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7SA05F, TC7SA05FU

Inverter (Open Drain)

Features

- Low voltage operation : $V_{CC} = 1.8\sim 3.6\text{ V}$
- High speed operation : $t_{pZ} = 3.5\text{ ns (max)} (V_{CC} = 3.0\sim 3.6\text{ V})$
 : $t_{pZ} = 4.1\text{ ns (max)} (V_{CC} = 2.3\sim 2.7\text{ V})$
 : $t_{pZ} = 8.2\text{ ns (max)} (V_{CC} = 1.8\text{ V})$
- High Output current : $I_{OH}/I_{OL} = \pm 24\text{ mA (min)} (V_{CC} = 3.0\text{ V})$
 : $I_{OH}/I_{OL} = \pm 18\text{ mA (min)} (V_{CC} = 2.3\text{ V})$
 : $I_{OH}/I_{OL} = \pm 6\text{ mA (min)} (V_{CC} = 1.8\text{ V})$
- 3.6-V tolerant input.
- 3.6-V power down protection output.



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 |
|-----------------------------|-----------|-------------------|------|
| Power supply voltage | V_{CC} | -0.5~4.6 | V |
| DC input voltage | V_{IN} | -0.5~4.6 | V |
| DC output voltage | V_{OUT} | -0.5~4.6 (Note 1) | V |
| Input diode current | I_{IK} | -50 | mA |
| Output diode current | I_{OK} | -50 (Note 2) | mA |
| DC output current | I_{OUT} | ± 50 | mA |
| Power dissipation | P_D | 200 | mW |
| DC V_{CC} /ground current | I_{CC} | ± 100 | mA |
| Storage temperature range | T_{stg} | -65~150 | °C |

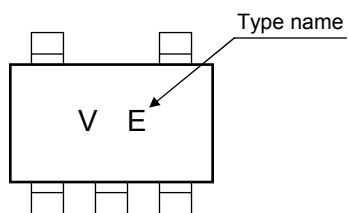
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.)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

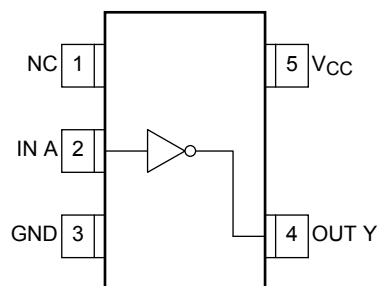
Note 1: I_{OUT} absolute maximum rating must be observed.

Note 2: $V_{OUT} < GND$

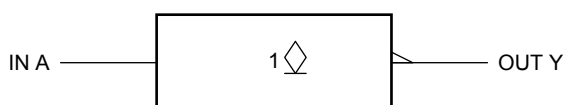
Marking



Pin Assignment (top view)



Logic Diagram



Truth Table

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

Z: High impedance

Operating Ranges

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-----------------|------------------|------|
| Power supply voltage | V_{CC} | 1.8~3.6 | V |
| | | 1.2~3.6 (Note 3) | |
| Input voltage | V_{IN} | -0.3~3.6 | V |
| Output voltage | V_{OUT} | 0~ V_{CC} | V |
| Output current | I_{OH}/I_{OL} | 24 (Note 4) | mA |
| | | 18 (Note 5) | |
| | | 6 (Note 6) | |
| Operating temperature range | T_{opr} | -40~85 | °C |
| Input rise and fall time | dt/dv | 0~10 (Note 7) | ns/V |

Note 3: Data retention only

Note 4: $V_{CC} = 3.0\sim 3.6$ V

Note 5: $V_{CC} = 2.3\sim 2.7$ V

Note 6: $V_{CC} = 1.8$ V

Note 7: $V_{IN} = 0.8\sim 2.0$ V, $V_{CC} = 3.0$ V

Electrical Characteristics

DC Characteristics (Ta = -40~85°C, 2.7 V < VCC ≤ 3.6 V)

| Characteristics | | Symbol | Test Condition | VCC (V) | Min | Max | Unit | |
|---------------------------------------|------------|------------------|---|--------------------------|---------|-------|------|---|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | 2.7~3.6 | 2.0 | — | V | |
| | Low level | V _{IL} | — | 2.7~3.6 | — | 0.8 | | |
| Output voltage | Low level | V _{OL} | V _{IN} = V _{IH} | I _{OL} = 100 μA | 2.7~3.6 | — | 0.2 | V |
| | | | | I _{OL} = 12 mA | 2.7 | — | 0.4 | |
| | | | | I _{OL} = 18 mA | 3.0 | — | 0.4 | |
| | | | | I _{OL} = 24 mA | 3.0 | — | 0.55 | |
| Input leakage current | | I _{IN} | V _{IN} = 0~3.6 V | 2.7~3.6 | — | ±5.0 | μA | |
| Power off leakage current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | 0 | — | 10.0 | μA | |
| Quiescent supply current | | I _{CC} | V _{IN} = V _{CC} or GND | 2.7~3.6 | — | 20.0 | μA | |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | 2.7~3.6 | — | ±20.0 | | |
| Increase in I _{CC} per input | | ΔI _{CC} | V _{IH} = V _{CC} - 0.6 V | 2.7~3.6 | — | 750 | | |

DC Characteristics (Ta = -40~85°C, 2.3 V ≤ VCC ≤ 2.7 V)

| Characteristics | | Symbol | Test Condition | VCC (V) | Min | Max | Unit | |
|---------------------------|------------|------------------|---|--------------------------|---------|-------|------|---|
| | | | | | | | | |
| Input voltage | High level | V _{IH} | — | 2.3~2.7 | 1.6 | — | V | |
| | Low level | V _{IL} | — | 2.3~2.7 | — | 0.7 | | |
| Output voltage | Low level | V _{OL} | V _{IN} = V _{IH} | I _{OL} = 100 μA | 2.3~2.7 | — | 0.2 | V |
| | | | | I _{OL} = 12 mA | 2.3 | — | 0.4 | |
| | | | | I _{OL} = 18 mA | 2.3 | — | 0.6 | |
| Input leakage current | | I _{IN} | V _{IN} = 0~3.6 V | 2.3~2.7 | — | ±5.0 | μA | |
| Power off leakage current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | 0 | — | 10.0 | μA | |
| Quiescent supply current | | I _{CC} | V _{IN} = V _{CC} or GND | 2.3~2.7 | — | 20.0 | μA | |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | 2.3~2.7 | — | ±20.0 | | |

DC Characteristics (Ta = -40~85°C, 1.8 V ≤ VCC < 2.3 V)

| Characteristics | | Symbol | Test Condition | | VCC (V) | | Min | Max | Unit |
|---------------------------|------------|------------------|---|--------------------------|---------|-----|-----------------------|-----------------------|------|
| | | | | | 1.8 | 2.3 | | | |
| Input voltage | High level | V _{IH} | — | | 1.8 | 2.3 | 0.7 × V _{CC} | — | V |
| | Low level | V _{IL} | — | | 1.8 | 2.3 | — | 0.2 × V _{CC} | |
| Output voltage | Low level | V _{OL} | V _{IN} = V _{IH} | I _{OL} = 100 μA | 1.8 | 2.3 | — | 0.2 | V |
| | | | | I _{OL} = 6 mA | 1.8 | 2.3 | — | 0.3 | |
| Input leakage current | | I _{IN} | V _{IN} = 0~3.6 V | | 1.8 | 2.3 | — | ±5.0 | μA |
| Power off leakage current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | | 0 | 2.3 | — | 10.0 | μA |
| Quiescent supply current | | I _{CC} | V _{IN} = V _{CC} or GND | | 1.8 | 2.3 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 1.8 | 2.3 | — | ±20.0 | |

AC Characteristics (Ta = -40~85°C, input: t_r = t_f = 2.0 ns, C_L = 30 pF, R_L = 500 Ω)

| Characteristics | | Symbol | Test Condition | | VCC (V) | | Min | Max | Unit |
|------------------------|------------------|--------------------|----------------|-----|---------|-----|-----|-----|------|
| | | | | | 1.8 | 2.3 | | | |
| Propagation delay time | t _{pZL} | Figure 1, Figure 2 | 1.8 | 2.3 | 1.0 | 8.2 | ns | | |
| | | | 2.5 ± 0.2 | 2.3 | 0.8 | 4.1 | | | |
| | | | 3.3 ± 0.3 | 2.3 | 0.6 | 3.5 | | | |
| | t _{pLZ} | Figure 1, Figure 2 | 1.8 | 2.3 | 1.0 | 6.8 | ns | | |
| | | | 2.5 ± 0.2 | 2.3 | 0.8 | 3.8 | | | |
| | | | 3.3 ± 0.3 | 2.3 | 0.6 | 3.5 | | | |

For C_L = 50 pF, add approximately 300 ps to the AC maximum specification.

Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | | VCC (V) | | Typ. | Unit |
|-------------------------------|------------------|--------------------------|----------|---------|-----|------|------|
| | | | | 1.8 | 2.3 | | |
| Input capacitance | C _{IN} | — | | 1.8 | 2.3 | 4 | pF |
| Output capacitance | C _{OUT} | — | | 1.8 | 2.3 | 3 | pF |
| Power dissipation capacitance | C _{PD} | f _{IN} = 10 MHz | (Note 8) | 1.8 | 2.3 | 4 | pF |

Note 8: 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 Test Circuit

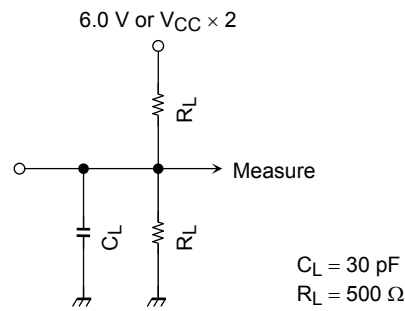
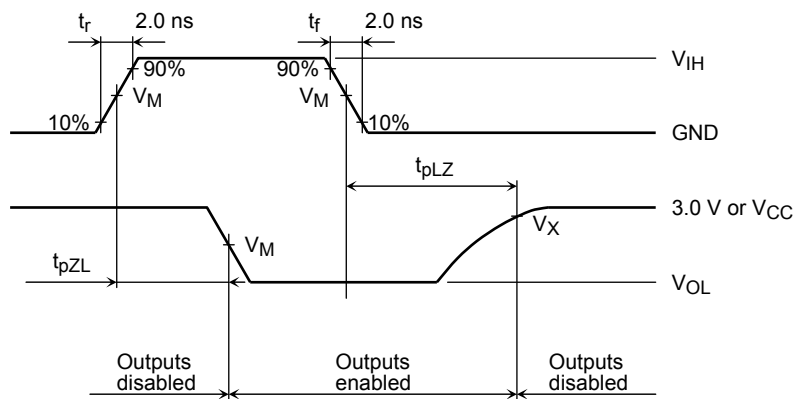


Figure 1

AC Waveforms



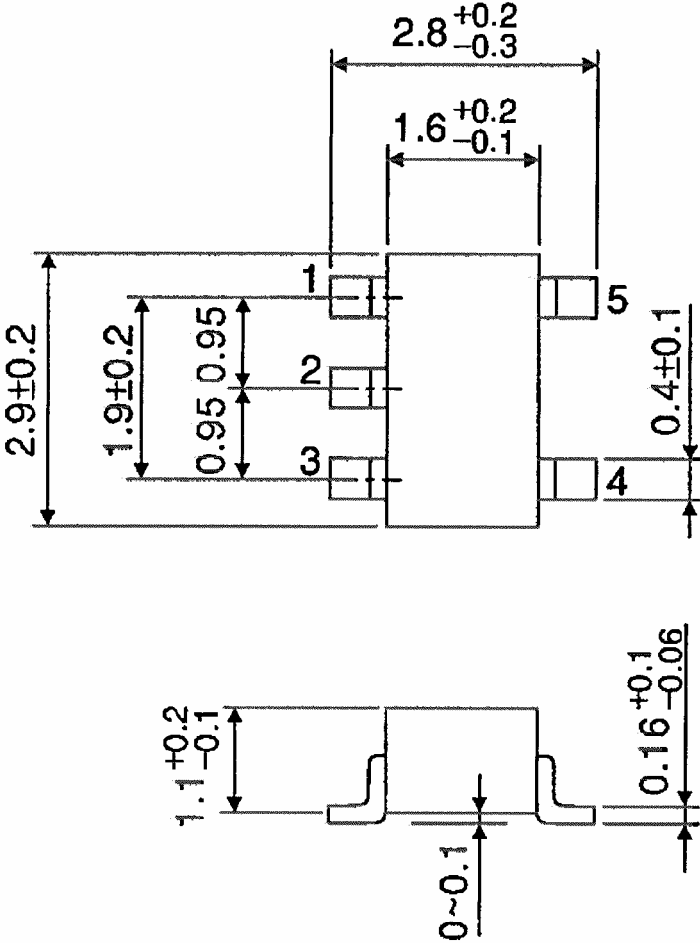
| Symbol | V_{CC} | | |
|----------|--------------------------|---------------------------|---------------------------|
| | $3.3 \pm 0.3 \text{ V}$ | $2.5 \pm 0.2 \text{ V}$ | 1.8 V |
| V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| V_M | 1.5 V | $V_{CC}/2$ | $V_{CC}/2$ |
| V_X | $V_{OH} - 0.3 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ |

Figure 2 t_{pZL} , t_{PLZ}

Package Dimensions

SSOP5-P-0.95

Unit : mm

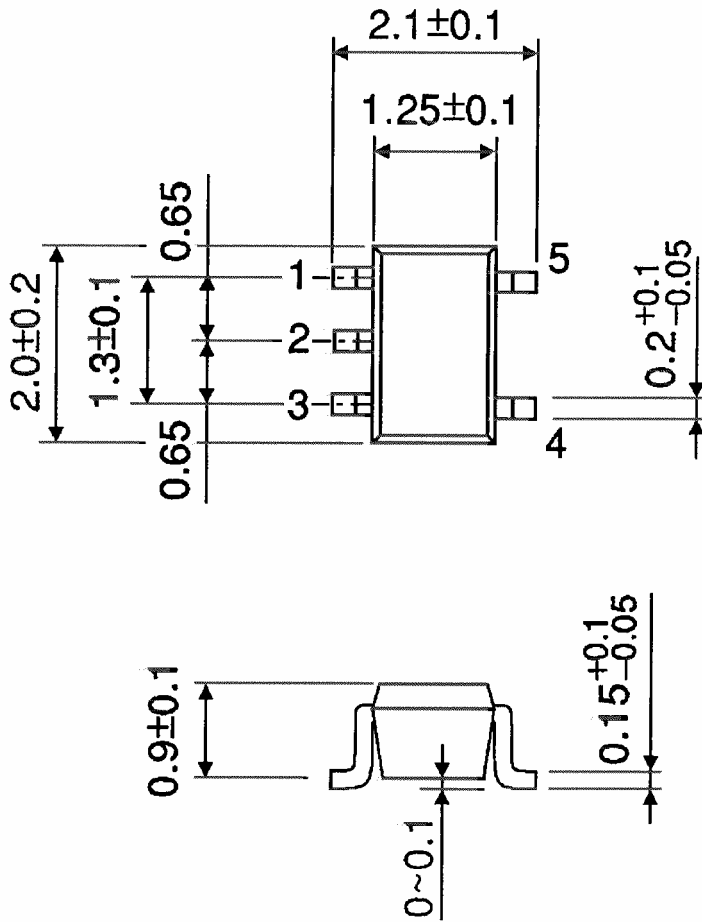


Weight: 0.016 g (typ.)

Package Dimensions

SSOP5-P-0.65A

Unit : mm



Weight: 0.006 g (typ.)

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20070701-EN GENERAL

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