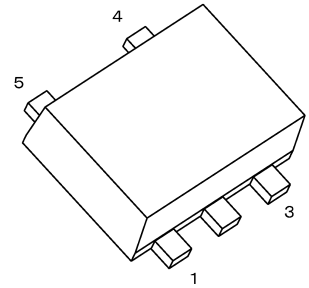
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7SZ05FE

Inverter (Open Drain)

## Features

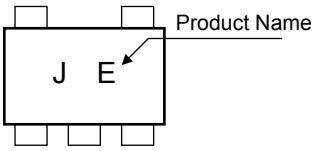
- High Output current : 24mA (min) at $V_{CC}$ = 3V
- Super high speed operation : $t_{pZL}$ = 2.3ns (typ.) at $V_{CC}$ = 5V, $C_L$ = 50pF
- Operation voltage range : $V_{CC}$ = 1.65 to 5.5V
- 5.5-V tolerant input
- 5.5-V power down protection output
- ESD performance : Machine model ≥ ±200 V
  Human body model ≥ ±2000 V
- Matches the performance of TC74LCX series when operated at 3.3- V $V_{CC}$



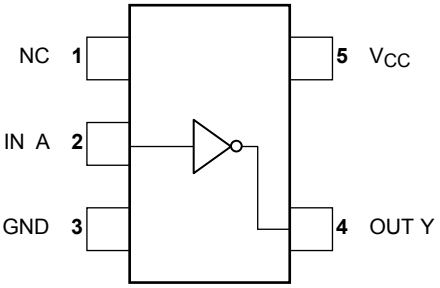

SON5-P-0.50S (ESV)

Weight : 0.003 g (typ.)

## Marking




## Pin Assignment (top view)




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

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | −0.5 to 6 | V |
| DC input voltage | $V_{IN}$ | −0.5 to 6 | V |
| DC output voltage | $V_{OUT}$ | −0.5 to 6 (Note 1) | V |
| Input diode current | $I_{IK}$ | −20 | mA |
| Output diode current | $I_{OK}$ | −20 (Note 2) | mA |
| DC output current | $I_{OUT}$ | 50 | mA |
| DC $V_{CC}$/ground current | $I_{CC}$ | ±50 | mA |
| Power dissipation | $P_D$ | 150 | mW |
| Storage temperature | $T_{stg}$ | −65 to 150 | °C |
| Lead temperature (10 s) | $T_L$ | 260 | °C |

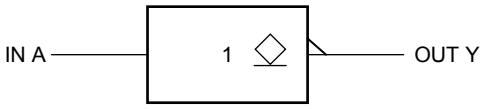
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.)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

Note 1: Do not exceed $I_{OUT}$ of absolute maximum ratings.

Note 2: $V_{OUT}$ < GND

Start of commercial production
2008-12

## IEC Logic Symbol




## Truth Table

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

Z: High Impedance

## Operating Ranges

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | 1.65 to 5.5 | V |
| | | 1.5 to 5.5 (Note 3) | |
| Input voltage | $V_{IN}$ | 0 to 5.5 | V |
| Output voltage | $V_{OUT}$ | 0 to 5.5 | V |
| Operating temperature | $T_{opr}$ | −40 to 85 | °C |
| Input rise and fall time | dt/dv | 0 to 20 ($V_{CC}$ = 1.80V± 0.15 V, 2.5 V ± 0.2 V) | ns/V |
| | | 0 to 10 ($V_{CC}$ = 3.3 V ± 0.3 V) | |
| | | 0 to 5 ($V_{CC}$ = 5.0 V ± 0.5 V) | |

Note 3 : Date retention only

## Electrical Characteristics

## DC Characteristics

| Characteristics | | Symbol | Test Condition | | $V_{CC}$ (V) | Ta = 25°C Min | Ta = 25°C Typ. | Ta = 25°C Max | Ta = −40 to 85°C Min | Ta = −40 to 85°C Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Input Voltage | High level | $V_{IH}$ | — | | 1.65 to 1.95 | $V_{CC}$ × 0.75 | — | — | $V_{CC}$ × 0.75 | — | V |
| | | | | | 2.3 to 5.5 | $V_{CC}$ × 0.7 | — | — | $V_{CC}$ × 0.7 | — | |
| | Low level | $V_{IL}$ | — | | 1.65 to 1.95 | — | — | $V_{CC}$ × 0.25 | — | $V_{CC}$ × 0.25 | |
| | | | | | 2.3 to 5.5 | — | — | $V_{CC}$ × 0.3 | — | $V_{CC}$ × 0.3 | |
| Z-state output leakage current | | $I_{LKG}$ | $V_{IN}$ = $V_{IL}$<br>$V_{OUT}$ = 0 to 5.5V | | 1.65 to 5.5 | — | — | ±5 | — | ±10 | μA |
| Output voltage | Low level | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ | $I_{OL}$ = 100 μA | 1.65 | — | 0 | 0.1 | — | 0.1 | V |
| | | | | | 2.3 | — | 0 | 0.1 | — | 0.1 | |
| | | | | | 3.0 | — | 0 | 0.1 | — | 0.1 | |
| | | | | | 4.5 | — | 0 | 0.1 | — | 0.1 | |
| | | | | $I_{OL}$ = 4 mA | 1.65 | — | 0.08 | 0.24 | — | 0.24 | |
| | | | | $I_{OL}$ = 8 mA | 2.3 | — | 0.1 | 0.3 | — | 0.3 | |
| | | | | $I_{OL}$ = 16 mA | 3.0 | — | 0.15 | 0.4 | — | 0.4 | |
| | | | | $I_{OL}$ = 24 mA | 3.0 | — | 0.22 | 0.55 | — | 0.55 | |
| | | | | $I_{OL}$ = 32 mA | 4.5 | — | 0.22 | 0.55 | — | 0.55 | |
| Input leakage current | | $I_{IN}$ | $V_{IN}$ = 5.5 V or GND | | 0 to 5.5 | — | — | ±1 | — | ±10 | μA |
| Power off leakage current | | $I_{OFF}$ | $V_{IN}$ or $V_{OUT}$ = 5.5V | | 0.0 | — | — | 1 | — | ±10 | μA |
| Quiescent supply current | | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 5.5 | — | — | 2 | — | 20 | μA |

## AC Characteristics (unless otherwise specified, Input: $t_r = t_f = 3$ ns)

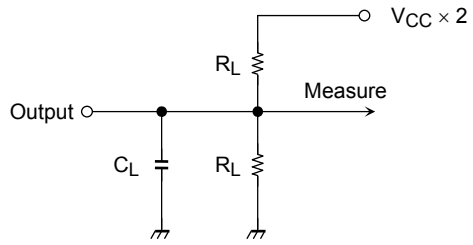
| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Propagation delay time | $t_{pZL}$ | $C_L$ = 50 pF, $R_L$ = 500 Ω | 1.80 ± 0.15 | 1.8 | 5.5 | 9.5 | 1.8 | 10.5 | ns |
| | | | 2.5 ± 0.2 | 1.2 | 3.7 | 5.8 | 1.2 | 6.4 | |
| | | | 3.3 ± 0.3 | 0.8 | 2.9 | 4.4 | 0.8 | 4.8 | |
| | | | 5.0 ± 0.5 | 0.5 | 2.3 | 3.5 | 0.5 | 3.9 | |
| | $t_{pLZ}$ | $C_L$ = 50 pF, $R_L$ = 500 Ω | 1.80 ± 0.15 | 1.8 | 4.3 | 9.5 | 1.8 | 10.5 | |
| | | | 2.5 ± 0.2 | 1.2 | 2.8 | 5.8 | 1.2 | 6.4 | |
| | | | 3.3 ± 0.3 | 0.8 | 2.1 | 4.4 | 0.8 | 4.8 | |
| | | | 5.0 ± 0.5 | 0.5 | 1.4 | 3.5 | 0.5 | 3.9 | |
| Input capacitance | $C_{IN}$ | — | 0 to 5.5 | — | 4 | — | — | — | pF |
| Output capacitance | $C_{OUT}$ | — | 0 to 5.5 | — | 8 | — | — | — | pF |
| Power dissipation capacitance | $C_{PD}$ | (Note 4) | 3.3 | — | 20 | — | — | — | pF |
| | | | 5.5 | — | 26 | — | — | — | |

Note 4: $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

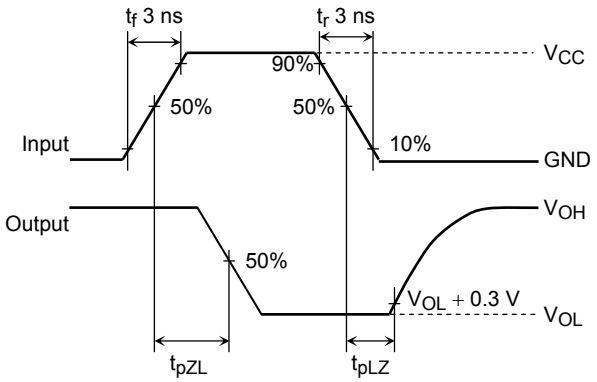
Average operating current can be obtained by the equation.

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

## AC Characteristics Measurement Circuit

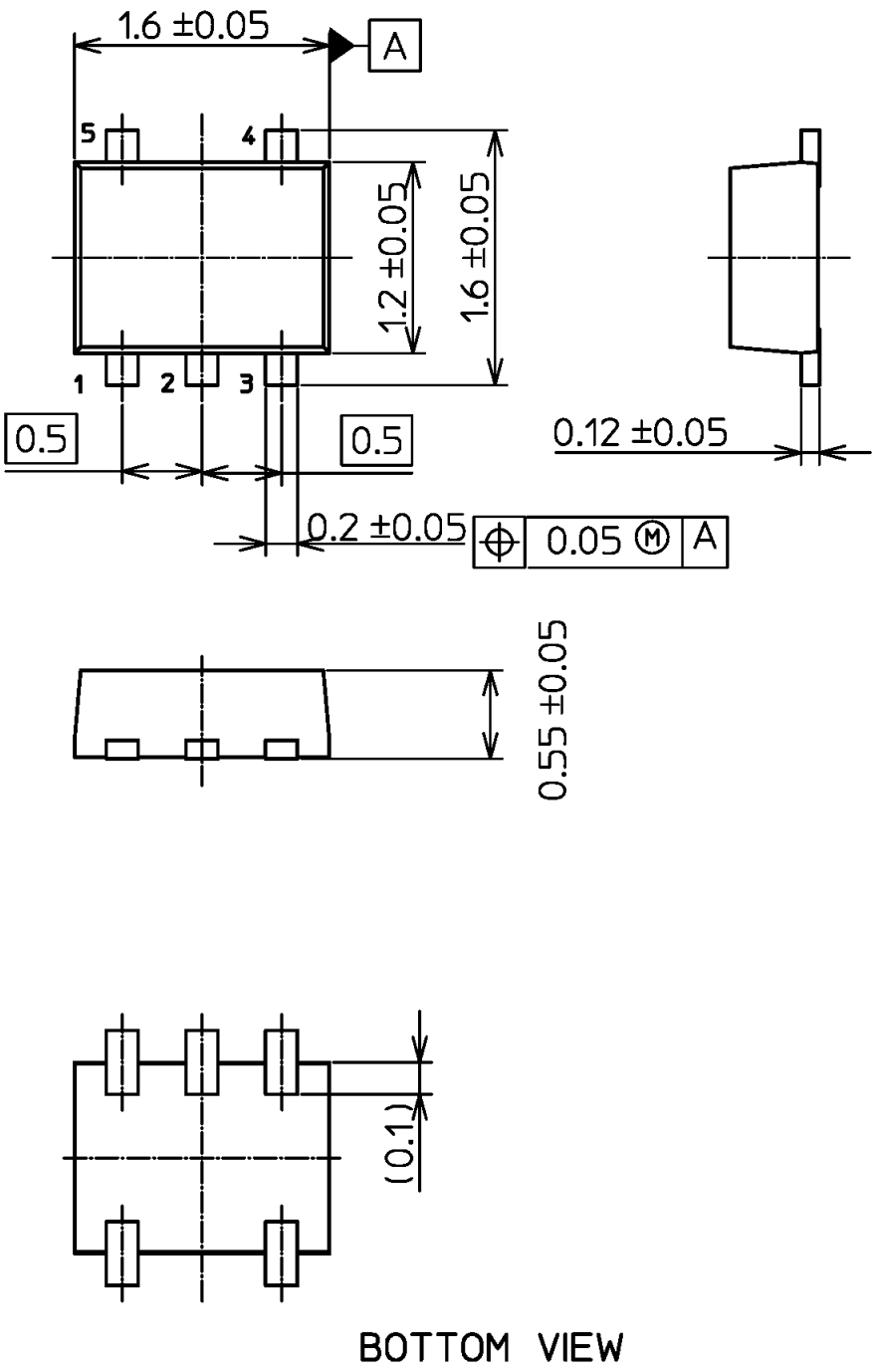



## AC Waveforms



## Package Dimensions

SON5-P-0.50S Unit: mm




Weight: 0.003 g (typ.)

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