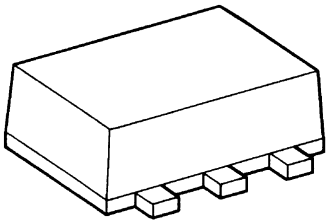
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7SG07AFS

Non-Inverter (Open Drain)

## Features

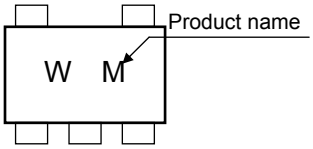
- High output current: 8 mA (min) at $V_{CC}$ = 3.0 V
- High-speed operation: $t_{pZL}$ = 2.5 ns (typ.) at $V_{CC}$ = 3.3 V, 15 pF
- Operating voltage range: $V_{CC}$ = 0.9 to 3.6 V
- 5.5-V tolerant input.
- 3.6-V power down protection output.



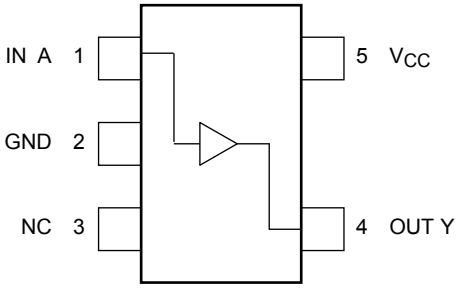
SON5-P-0.35 (fSV)

Weight: 0.001 g (typ.)

## Marking




## Pin Assignment (top view)




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

| Characteristics | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | $V_{CC}$ | −0.5 to 4.6 | V |
| DC input voltage | $V_{IN}$ | −0.5 to 7.0 | V |
| DC output voltage | $V_{OUT}$ | −0.5 to 4.6(Note 1) | V |
| Input diode current | $I_{IK}$ | −20 | mA |
| Output diode current | $I_{OK}$ | −20 (Note 2) | mA |
| DC output current | $I_{OUT}$ | 25 | mA |
| DC $V_{CC}$/ground current | $I_{CC}$ | ±50 | mA |
| Power dissipation | $P_D$ | 50 | mW |
| Storage temperature | $T_{stg}$ | −65 to 150 | °C |

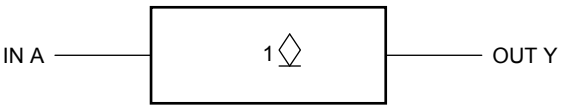
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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: Do not exceed $I_{OUT}$ of absolute maximum ratings.

Note 2: $V_{OUT} < GND$

Start of commercial production
2007-08

## IEC Logic Symbol




## Truth Table

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

Z: High impedance

## Operating Ranges

| Characteristics | Symbol | Rating | | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | 0.9 to 3.6 | | V |
| Input voltage | $V_{IN}$ | 0 to 5.5 | | V |
| Output voltage | $V_{OUT}$ | 0 to 3.6 | | V |
| Output Current | $I_{OL}$ | 8.0 | (Note 3) | mA |
| | | 4.0 | (Note 4) | |
| | | 3.0 | (Note 5) | |
| | | 1.7 | (Note 6) | |
| | | 0.3 | (Note 7) | |
| | | 0.02 | (Note 8) | |
| Operating temperature | $T_{opr}$ | −40 to 85 | | °C |
| Input rise and fall time | dt/dv | 0 to 10 | (Note 9) | ns/V |

Note 3: $V_{CC}$ = 3.0 to 3.6 V

Note 4: $V_{CC}$ = 2.3 to 2.7 V

Note 5: $V_{CC}$ = 1.65 to 1.95 V

Note 6: $V_{CC}$ = 1.4 to 1.6 V

Note 7: $V_{CC}$ = 1.1 to 1.3 V

Note 8: $V_{CC}$ = 0.9 V

Note 9: $V_{IN}$ = 0.8 to 2.0 V, $V_{CC}$ = 3.0 V

## Electrical Characteristics

### DC Characteristics

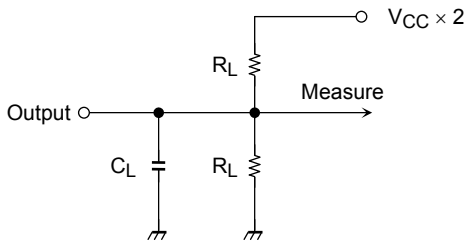
| Characteristics | Symbol | Test Condition | | $V_{CC}$ (V) | Ta = 25°C Min | Ta = 25°C Typ. | Ta = 25°C Max | Ta = −40 to 85°C Min | Ta = −40 to 85°C Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| High-level input voltage | $V_{IH}$ | — | | 0.9 | $V_{CC}$ | — | — | $V_{CC}$ | — | V |
| | | | | 1.1 to 1.3 | $V_{CC}$ × 0.7 | — | — | $V_{CC}$ × 0.7 | — | |
| | | | | 1.4 to 1.6 | $V_{CC}$ × 0.65 | — | — | $V_{CC}$ × 0.65 | — | |
| | | | | 1.65 to 1.95 | $V_{CC}$ × 0.65 | — | — | $V_{CC}$ × 0.65 | — | |
| | | | | 2.3 to 2.7 | 1.7 | — | — | 1.7 | — | |
| | | | | 3.0 to 3.6 | 2.0 | — | — | 2.0 | — | |
| Low-level input voltage | $V_{IL}$ | — | | 0.9 | — | — | GND | — | GND | V |
| | | | | 1.1 to 1.3 | — | — | $V_{CC}$ × 0.3 | — | $V_{CC}$ × 0.3 | |
| | | | | 1.4 to 1.6 | — | — | $V_{CC}$ × 0.35 | — | $V_{CC}$ × 0.35 | |
| | | | | 1.65 to 1.95 | — | — | $V_{CC}$ × 0.35 | — | $V_{CC}$ × 0.35 | |
| | | | | 2.3 to 2.7 | — | — | 0.7 | | 0.7 | |
| | | | | 3.0 to 3.6 | — | — | 0.8 | | 0.8 | |
| High-level output voltage | $V_{OL}$ | $V_{IN}$ = $V_{IL}$ | $I_{OL}$ = 0.02 mA | 0.9 | — | — | 0.1 | — | 0.1 | V |
| | | | $I_{OL}$ = 0.3 mA | 1.1 to 1.3 | — | — | $V_{CC}$ × 0.25 | — | $V_{CC}$ × 0.25 | |
| | | | $I_{OL}$ = 1.7 mA | 1.4 to 1.6 | — | — | $V_{CC}$ × 0.25 | — | $V_{CC}$ × 0.25 | |
| | | | $I_{OL}$ = 3.0 mA | 1.65 to 1.95 | — | — | 0.45 | — | 0.45 | |
| | | | $I_{OL}$ = 4.0 mA | 2.3 to 2.7 | — | — | 0.4 | — | 0.4 | |
| | | | $I_{OL}$ = 8.0 mA | 3.0 to 3.6 | — | — | 0.4 | — | 0.4 | |
| Input leakage current | $I_{IN}$ | $V_{IN}$ = 0 to 5.5 V | | 0 to 3.6 | — | — | ±0.1 | — | ±1.0 | μA |
| Output OFF state current | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$<br>$V_{OUT}$ = 0 to 3.6 V | | 0.9 to 3.6 | — | — | ±1.0 | — | ±10.0 | μA |
| Power-off leakage current | $I_{OFF}$ | $V_{IN}$ = 5.5 V<br>or $V_{OUT}$ = 3.6 V | | 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 (Unless otherwise specified, input $t_r = t_f = 3$ ns)

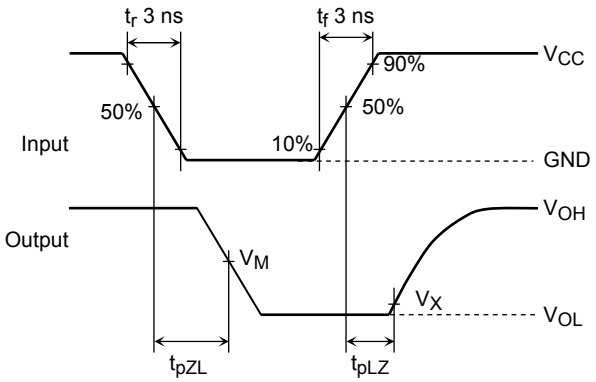
| Characteristics | Symbol | Test Condition | | Ta = 25°C | | | Ta = −40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (V) | Min | Typ. | Max | Min | Max | |
| Propagation delay time | $t_{pZL}$ | $C_L$ = 10 pF, $R_L$ = 100 kΩ | 0.9 | — | 11.9 | — | — | — | ns |
| | | $C_L$ = 10 pF, $R_L$ = 5 kΩ | 1.1 to 1.3 | — | 6.3 | 11.5 | 1.0 | 15.0 | |
| | | | 1.4 to 1.6 | — | 4.2 | 6.5 | 1.0 | 9.5 | |
| | | | 1.65 to 1.95 | — | 3.4 | 5.5 | 1.0 | 7.1 | |
| | | | 2.3 to 2.7 | — | 2.7 | 3.9 | 1.0 | 4.5 | |
| | | | 3.0 to 3.6 | — | 2.3 | 3.4 | 1.0 | 3.9 | |
| | | $C_L$ = 15 pF, $R_L$ = 100 kΩ | 0.9 | — | 12.8 | — | — | — | |
| | | $C_L$ = 15 pF, $R_L$ = 5 kΩ | 1.1 to 1.3 | — | 7.2 | 12.8 | 1.0 | 17.5 | |
| | | | 1.4 to 1.6 | — | 4.6 | 7.7 | 1.0 | 10.5 | |
| | | | 1.65 to 1.95 | — | 3.9 | 6.6 | 1.0 | 7.9 | |
| | | | 2.3 to 2.7 | — | 3.2 | 4.5 | 1.0 | 5.5 | |
| | | | 3.0 to 3.6 | — | 2.5 | 3.7 | 1.0 | 4.6 | |
| | | $C_L$ = 30 pF, $R_L$ = 100 kΩ | 0.9 | — | 16.4 | — | — | — | |
| | | $C_L$ = 30 pF, $R_L$ = 5 kΩ | 1.1 to 1.3 | — | 9.4 | 17.8 | 1.0 | 21.5 | |
| | | | 1.4 to 1.6 | — | 5.7 | 9.8 | 1.0 | 12.1 | |
| | | | 1.65 to 1.95 | — | 4.4 | 7.5 | 1.0 | 10.3 | |
| | | | 2.3 to 2.7 | — | 3.6 | 5.3 | 1.0 | 6.5 | |
| | | | 3.0 to 3.6 | — | 2.8 | 4.1 | 1.0 | 5.1 | |
| Propagation delay time | $t_{pLZ}$ | $C_L$ = 10 pF, $R_L$ = 100 kΩ | 0.9 | — | 112.5 | — | — | — | ns |
| | | $C_L$ = 10 pF, $R_L$ = 5 kΩ | 1.1 to 1.3 | — | 8.6 | 15.7 | 1.0 | 22.7 | |
| | | | 1.4 to 1.6 | — | 7.5 | 9.5 | 1.0 | 10.6 | |
| | | | 1.65 to 1.95 | — | 7.1 | 8.7 | 1.0 | 9.6 | |
| | | | 2.3 to 2.7 | — | 6.8 | 7.9 | 1.0 | 8.8 | |
| | | | 3.0 to 3.6 | — | 6.5 | 7.5 | 1.0 | 8.4 | |
| | | $C_L$ = 15 pF, $R_L$ = 100 kΩ | 0.9 | — | 134.9 | — | — | — | |
| | | $C_L$ = 15 pF, $R_L$ = 5 kΩ | 1.1 to 1.3 | — | 10.5 | 16.8 | 1.0 | 24.7 | |
| | | | 1.4 to 1.6 | — | 9.0 | 10.4 | 1.0 | 11.3 | |
| | | | 1.65 to 1.95 | — | 8.5 | 9.7 | 1.0 | 10.5 | |
| | | | 2.3 to 2.7 | — | 7.9 | 8.8 | 1.0 | 10.1 | |
| | | | 3.0 to 3.6 | — | 7.6 | 8.3 | 1.0 | 9.5 | |
| | | $C_L$ = 30 pF, $R_L$ = 100 kΩ | 0.9 | — | 214.5 | — | — | — | |
| | | $C_L$ = 30 pF, $R_L$ = 5 kΩ | 1.1 to 1.3 | — | 14.1 | 18.6 | 1.0 | 26.7 | |
| | | | 1.4 to 1.6 | — | 13.5 | 14.5 | 1.0 | 16.0 | |
| | | | 1.65 to 1.95 | — | 12.7 | 13.8 | 1.0 | 15.0 | |
| | | | 2.3 to 2.7 | — | 12.2 | 13.5 | 1.0 | 14.7 | |
| | | | 3.0 to 3.6 | — | 11.9 | 12.8 | 1.0 | 14.4 | |
| Input capacitance | $C_{IN}$ | — | 3.6 | — | 3 | — | — | — | pF |
| Power dissipation capacitance | $C_{PD}$ | (Note 10) | 0.9 to 3.6 | — | 6 | — | — | — | pF |

Note 10: $C_{PD}$ 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:
$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

## Measurement Circuit for AC Characteristics



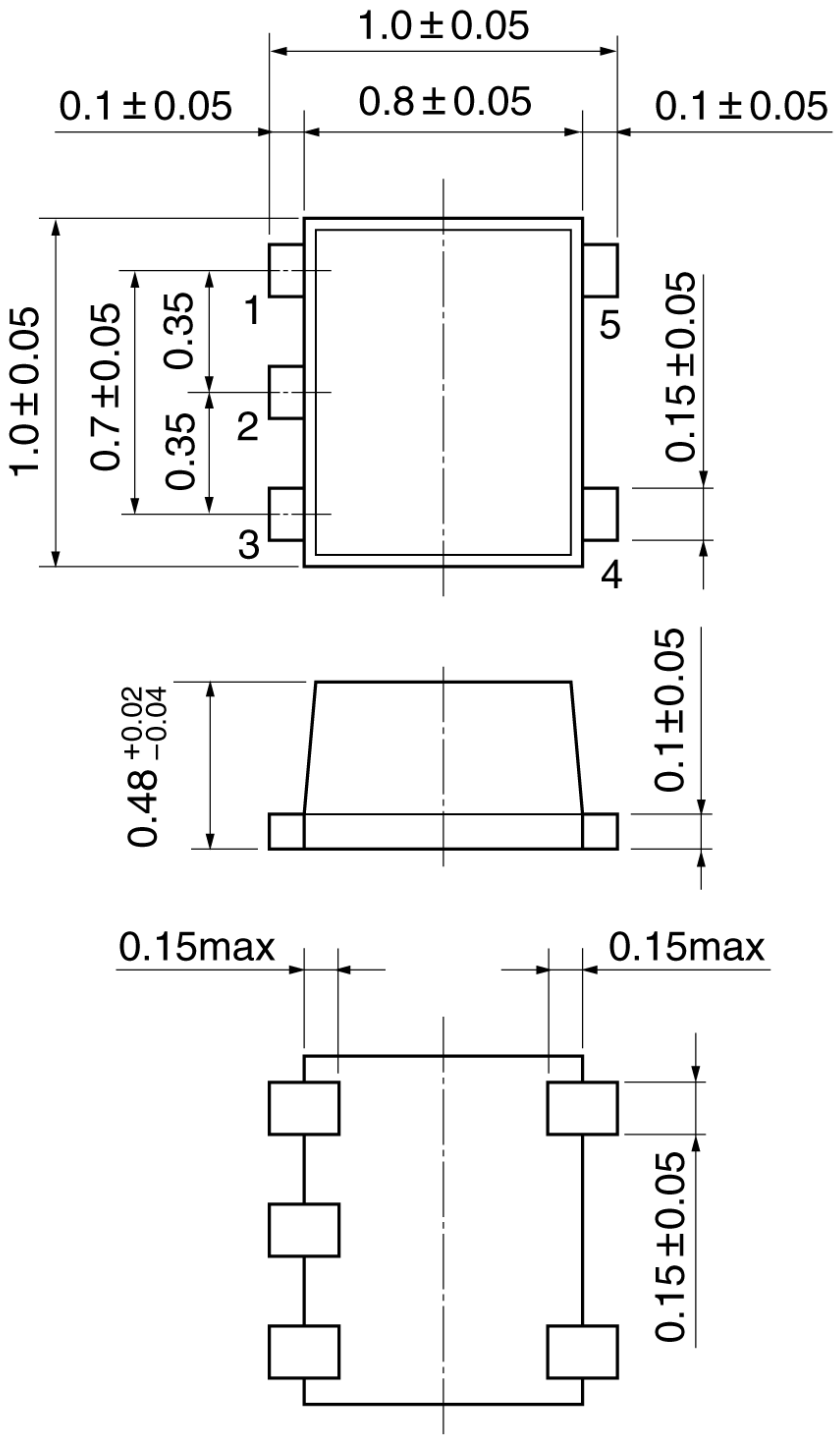

## Measurement Waveform




| Symbol | $V_{CC}$ | | | | | |
|---|---|---|---|---|---|---|
| | 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 |

**Package Dimensions**

**SON5-P-0.35** **Unit:mm**




Weight: 0.001 g (typ.)

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