

CMOS Digital Integrated Circuits Silicon Monolithic

TC7SZU04AFS

1. Functional Description

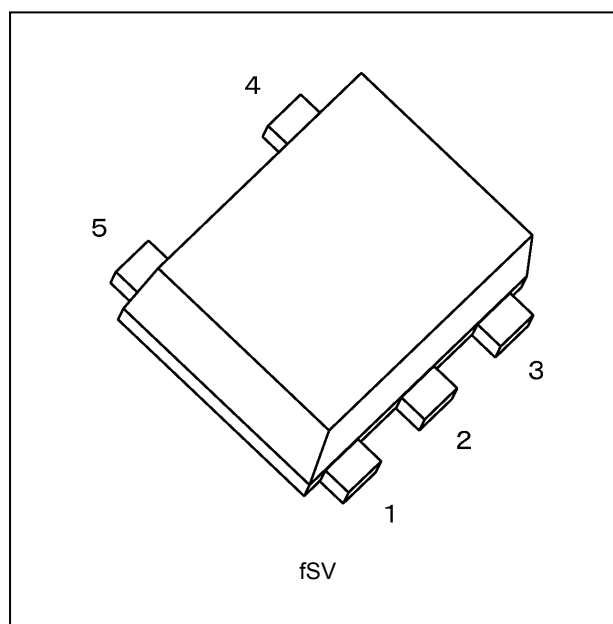
- Inverter (Unbuffer)

2. Features

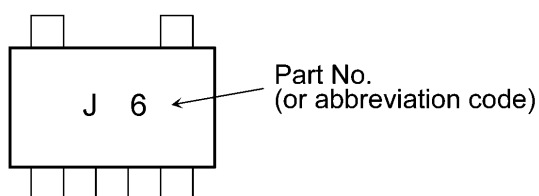
- (1) Wide operating temperature range: $T_{opr} = -40$ to 125 °C (Note 1)
- (2) High output current: ± 32 mA (min) at $V_{CC} = 4.5$ V
- (3) Operation voltage range: $V_{CC} = 1.65$ to 5.5 V
- (4) 5.5 V tolerant inputs

Note 1: For devices with the ordering part number ending in J(T). $T_{opr} = -40$ to 85 °C for the other devices.

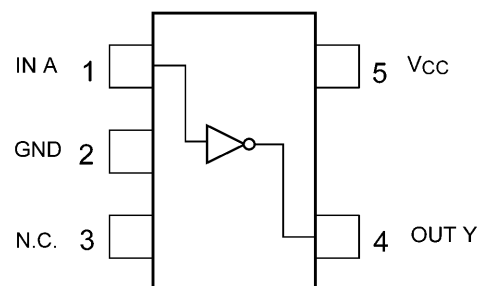
3. Packaging



4. Marking and Pin Assignment



Marking

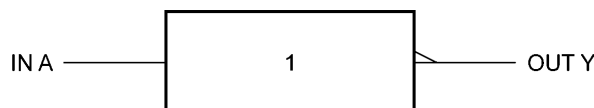


Pin Assignment (Top view)

Start of commercial production

2008-05

5. IEC Logic Symbol



6. Truth Table

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

7. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

| Characteristics | Symbol | Note | Rating | Unit |
|--------------------------|-----------|----------|------------------------|------------------|
| Supply voltage | V_{CC} | | -0.5 to 6.0 | V |
| Input voltage | V_{IN} | | -0.5 to 6.0 | V |
| DC output voltage | V_{OUT} | | -0.5 to $V_{CC} + 0.5$ | V |
| Input diode current | I_{IK} | | -20 | mA |
| Output diode current | I_{OK} | (Note 1) | ± 20 | mA |
| DC output current | I_{OUT} | | ± 50 | mA |
| V_{CC} /ground current | I_{CC} | | ± 50 | mA |
| Power dissipation | P_D | | 50 | mW |
| Storage temperature | T_{stg} | | -65 to 150 | $^\circ\text{C}$ |

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

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: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

8. Operating Ranges (Note)

| Characteristics | Symbol | Note | Rating | Unit |
|-----------------------|-----------|----------|---------------|------------------|
| Supply voltage | V_{CC} | | 1.65 to 5.5 | V |
| | | (Note 1) | 1.5 to 5.5 | |
| Input voltage | V_{IN} | | 0 to 5.5 | V |
| Output voltage | V_{OUT} | | 0 to V_{CC} | V |
| Operating temperature | T_{opr} | (Note 2) | -40 to 125 | $^\circ\text{C}$ |
| | | (Note 3) | -40 to 85 | |

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either V_{CC} or GND.

Note 1: Data retention only

Note 2: For devices with the ordering part number ending in J(T).

Note 3: For devices except those with the ordering part number ending in J(T).

9. Electrical Characteristics

9.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Typ. | Max | Unit | |
|---------------------------|----------|---------------------------------|------------------------------------|--------------------------|----------------------|------|----------------------|---------------|------|
| High-level input voltage | V_{IH} | — | | 1.65 to 1.95 | $V_{CC} \times 0.85$ | — | — | V | |
| | | | | 2.3 to 5.5 | $V_{CC} \times 0.8$ | — | — | | |
| Low-level input voltage | V_{IL} | — | | 1.65 to 1.95 | — | — | $V_{CC} \times 0.15$ | V | |
| | | | | 2.3 to 5.5 | — | — | $V_{CC} \times 0.2$ | | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL}$ | $I_{OH} = -100\text{ }\mu\text{A}$ | 1.65 | 1.45 | 1.64 | — | V | |
| | | | | 2.3 | 2.1 | 2.3 | — | | |
| | | | | 3.0 | 2.7 | 3.0 | — | | |
| | | | | 4.5 | 4.0 | 4.4 | — | | |
| | | $V_{IN} = \text{GND}$ | $I_{OH} = -4\text{ mA}$ | 1.65 | 1.29 | 1.52 | — | | |
| | | | | $I_{OH} = -8\text{ mA}$ | 2.3 | 1.9 | 2.14 | | — |
| | | | | $I_{OH} = -16\text{ mA}$ | 3.0 | 2.4 | 2.75 | | — |
| | | | | $I_{OH} = -24\text{ mA}$ | 3.0 | 2.3 | 2.61 | | — |
| | | | | $I_{OH} = -32\text{ mA}$ | 4.5 | 3.8 | 4.13 | | — |
| | | | | | | | | | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ | $I_{OL} = 100\text{ }\mu\text{A}$ | 1.65 | — | 0.0 | 0.2 | V | |
| | | | | 2.3 | — | 0.0 | 0.2 | | |
| | | | | 3.0 | — | 0.0 | 0.3 | | |
| | | | | 4.5 | — | 0.0 | 0.5 | | |
| | | $V_{IN} = V_{CC}$ | $I_{OL} = 4\text{ mA}$ | 1.65 | — | 0.08 | 0.24 | | |
| | | | | $I_{OL} = 8\text{ mA}$ | 2.3 | — | 0.1 | | 0.3 |
| | | | | $I_{OL} = 16\text{ mA}$ | 3.0 | — | 0.17 | | 0.4 |
| | | | | $I_{OL} = 24\text{ mA}$ | 3.0 | — | 0.25 | | 0.55 |
| | | | | $I_{OL} = 32\text{ mA}$ | 4.5 | — | 0.26 | | 0.55 |
| | | | | | | | | | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V or GND}$ | | 0 to 5.5 | — | — | ± 1 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}\text{ or GND}$ | | 5.5 | — | — | 2 | μA | |

9.2. DC Characteristics (Unless otherwise specified, $T_a = -40$ to 85 °C)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Max | Unit | |
|---------------------------|----------|----------------------------------|--------------------------|---------------------------|---------------------------|----------------------|---------|------|
| High-level input voltage | V_{IH} | — | | 1.65 to 1.95 | $V_{CC} \times 0.85$ | — | V | |
| | | | | 2.3 to 5.5 | $V_{CC} \times 0.8$ | — | | |
| Low-level input voltage | V_{IL} | — | | 1.65 to 1.95 | — | $V_{CC} \times 0.15$ | V | |
| | | | | 2.3 to 5.5 | — | $V_{CC} \times 0.2$ | | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL}$ | $I_{OH} = -100 \mu A$ | 1.65 | 1.45 | — | V | |
| | | | | 2.3 | 2.1 | — | | |
| | | | | 3.0 | 2.7 | — | | |
| | | | | 4.5 | 4.0 | — | | |
| | | $V_{IN} = GND$ | $I_{OH} = -4 \text{ mA}$ | 1.65 | 1.29 | — | | |
| | | | | $I_{OH} = -8 \text{ mA}$ | 2.3 | 1.9 | | — |
| | | | | | 3.0 | 2.4 | | — |
| | | | | $I_{OH} = -16 \text{ mA}$ | 3.0 | 2.3 | | — |
| | | | | | $I_{OH} = -32 \text{ mA}$ | 3.0 | | 2.3 |
| | | | | 4.5 | | 3.8 | | — |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ | $I_{OL} = 100 \mu A$ | 1.65 | — | 0.2 | V | |
| | | | | 2.3 | — | 0.2 | | |
| | | | | 3.0 | — | 0.3 | | |
| | | | | 4.5 | — | 0.5 | | |
| | | $V_{IN} = V_{CC}$ | $I_{OL} = 4 \text{ mA}$ | 1.65 | — | 0.24 | | |
| | | | | $I_{OL} = 8 \text{ mA}$ | 2.3 | — | | 0.3 |
| | | | | | 3.0 | — | | 0.4 |
| | | | | $I_{OL} = 16 \text{ mA}$ | 3.0 | — | | 0.55 |
| | | | | | $I_{OL} = 24 \text{ mA}$ | 3.0 | | — |
| | | | | 4.5 | | — | | 0.55 |
| Input leakage current | I_{IN} | $V_{IN} = 5.5 \text{ V or GND}$ | | 0 to 5.5 | — | ± 10 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC} \text{ or GND}$ | | 5.5 | — | 20 | μA | |

9.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to 125 °C)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Max | Unit | |
|---------------------------|----------|----------------------------------|--------------------------|---------------------------|---------------------------|----------------------|---------|------|
| High-level input voltage | V_{IH} | — | | 1.65 to 1.95 | $V_{CC} \times 0.85$ | — | V | |
| | | | | 2.3 to 5.5 | $V_{CC} \times 0.8$ | — | | |
| Low-level input voltage | V_{IL} | — | | 1.65 to 1.95 | — | $V_{CC} \times 0.15$ | V | |
| | | | | 2.3 to 5.5 | — | $V_{CC} \times 0.2$ | | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL}$ | $I_{OH} = -100 \mu A$ | 1.65 | 1.45 | — | V | |
| | | | | 2.3 | 2.1 | — | | |
| | | | | 3.0 | 2.7 | — | | |
| | | | | 4.5 | 4.0 | — | | |
| | | $V_{IN} = GND$ | $I_{OH} = -4 \text{ mA}$ | 1.65 | 0.95 | — | | |
| | | | | $I_{OH} = -8 \text{ mA}$ | 2.3 | 1.7 | | — |
| | | | | | 3.0 | 2.2 | | — |
| | | | | $I_{OH} = -16 \text{ mA}$ | 3.0 | 2.0 | | — |
| | | | | | $I_{OH} = -32 \text{ mA}$ | 3.0 | | 2.0 |
| | | | | 4.5 | | 3.4 | | — |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IH}$ | $I_{OL} = 100 \mu A$ | 1.65 | — | 0.2 | V | |
| | | | | 2.3 | — | 0.2 | | |
| | | | | 3.0 | — | 0.3 | | |
| | | | | 4.5 | — | 0.5 | | |
| | | $V_{IN} = V_{CC}$ | $I_{OL} = 4 \text{ mA}$ | 1.65 | — | 0.7 | | |
| | | | | $I_{OL} = 8 \text{ mA}$ | 2.3 | — | | 0.45 |
| | | | | | 3.0 | — | | 0.6 |
| | | | | $I_{OL} = 16 \text{ mA}$ | 3.0 | — | | 0.8 |
| | | | | | $I_{OL} = 24 \text{ mA}$ | 3.0 | | — |
| | | | | 4.5 | | — | | 0.8 |
| Input leakage current | I_{IN} | $V_{IN} = 5.5 \text{ V or GND}$ | | 0 to 5.5 | — | ± 20 | μA | |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC} \text{ or GND}$ | | 5.5 | — | 200 | μA | |

Note: For devices with the ordering part number ending in J(T).

9.4. AC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

| Characteristics | Symbol | Note | Test Condition | V_{CC} (V) | C_L (pF) | Min | Typ. | Max | Unit |
|-------------------------------|--------------------|----------|--------------------------|----------------|------------|-----|------|-----|------|
| Propagation delay time | t_{PLH}, t_{PHL} | | $R_L = 1\text{ M}\Omega$ | 1.8 ± 0.15 | 15 | 1.0 | — | 8.5 | ns |
| | | | | 2.5 ± 0.2 | | 0.8 | — | 6.2 | |
| | | | | 3.3 ± 0.3 | | 0.5 | — | 4.5 | |
| | | | | 5.0 ± 0.5 | | 0.5 | — | 3.9 | |
| | | | $R_L = 500\ \Omega$ | 3.3 ± 0.3 | 50 | 1.0 | — | 6.0 | ns |
| | | | | 5.0 ± 0.5 | | 0.8 | — | 5.0 | |
| Input capacitance | C_{IN} | | — | 0 to 5.5 | — | — | 5 | — | pF |
| Power dissipation capacitance | C_{PD} | (Note 1) | — | 3.3 | — | — | 10 | — | pF |
| | | | | 5.5 | | — | 25 | — | |

Note 1: 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.

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

9.5. AC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|--------------------|--------------------------|----------------|------------|-----|-----|------|
| Propagation delay time | t_{PLH}, t_{PHL} | $R_L = 1\text{ M}\Omega$ | 1.8 ± 0.15 | 15 | 1.0 | 9.0 | ns |
| | | | 2.5 ± 0.2 | | 0.8 | 6.5 | |
| | | | 3.3 ± 0.3 | | 0.5 | 4.8 | |
| | | | 5.0 ± 0.5 | | 0.5 | 4.1 | |
| | | $R_L = 500\ \Omega$ | 3.3 ± 0.3 | 50 | 1.0 | 6.5 | ns |
| | | | 5.0 ± 0.5 | | 0.8 | 5.5 | |

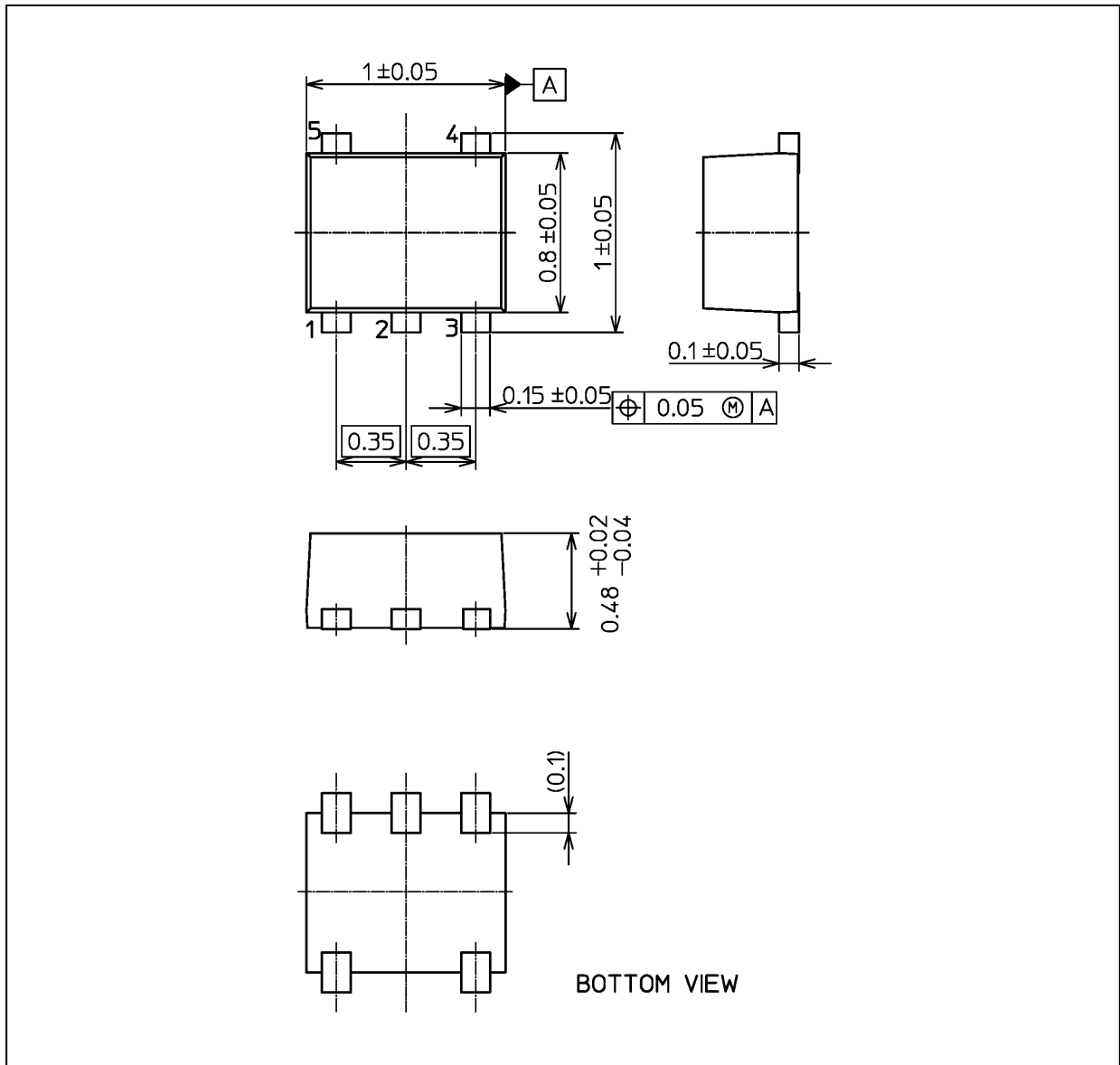
9.6. AC Characteristics (Note) (Unless otherwise specified, $T_a = -40\text{ to }125\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

| Characteristics | Symbol | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|--------------------|--------------------------|----------------|------------|-----|------|------|
| Propagation delay time | t_{PLH}, t_{PHL} | $R_L = 1\text{ M}\Omega$ | 1.8 ± 0.15 | 15 | 1.0 | 10.0 | ns |
| | | | 2.5 ± 0.2 | | 0.8 | 7.5 | |
| | | | 3.3 ± 0.3 | | 0.5 | 5.5 | |
| | | | 5.0 ± 0.5 | | 0.5 | 5.0 | |
| | | $R_L = 500\ \Omega$ | 3.3 ± 0.3 | 50 | 1.0 | 7.5 | ns |
| | | | 5.0 ± 0.5 | | 0.8 | 6.5 | |

Note: For devices with the ordering part number ending in J(T).

Package Dimensions

Unit: mm



Weight: 1.0 mg (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-953 |
| Nickname: fSV |

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