

TC7SZ07AFS

1. Functional Description

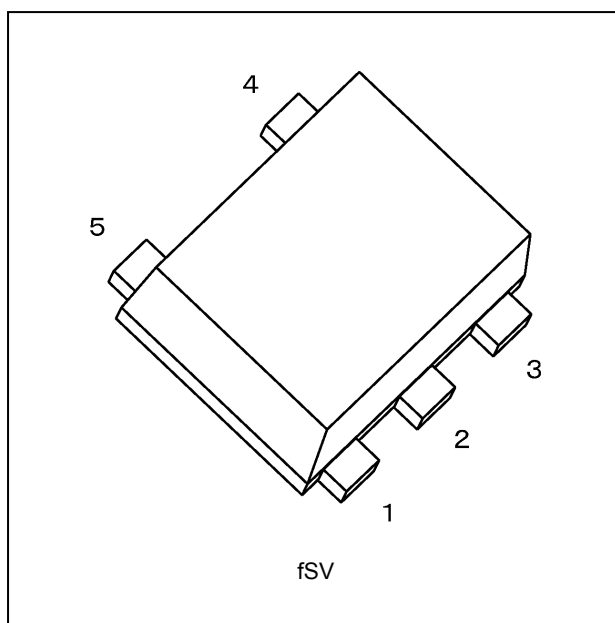
- Non-Inverter (Open Drain)

2. Features

- (1) Wide operating temperature range: $T_{opr} = -40$ to $125\text{ }^{\circ}\text{C}$ (Note 1)
- (2) High output current: $\pm 24\text{ mA}$ (min) at $V_{CC} = 3.0\text{ V}$
- (3) Super high speed operation: $t_{pZL} = 2.3\text{ ns}$ (typ.) at $V_{CC} = 5.0\text{ V}$, $C_L = 50\text{ pF}$
- (4) Operation voltage range: $V_{CC} = 1.65$ to 5.5 V
- (5) 5.5 V tolerant inputs
- (6) 5.5 V power down protection output

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

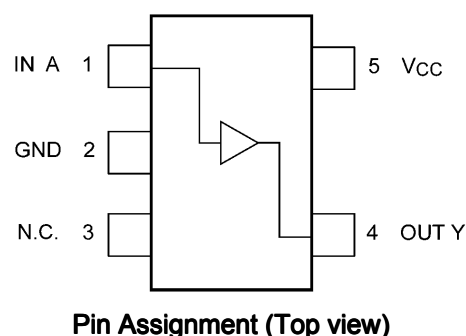
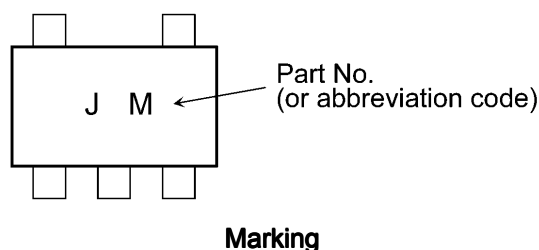
3. Packaging



Start of commercial production

2008-03

4. Marking and Pin Assignment



5. IEC Logic Symbol



6. Truth Table

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

Z: High impedance

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} | (Note 1) | -0.5 to 6.0 | V |
| Input diode current | I_{IK} | | -20 | mA |
| Output diode current | I_{OK} | (Note 2) | -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: I_{OUT} absolute maximum rating must be observed.

Note 2: $V_{OUT} < GND$

8. Operating Ranges (Note)

| Characteristics | Symbol | Note | Test Condition | 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 5.5 | V |
| Operating temperature | T_{opr} | (Note 2) | — | -40 to 125 | °C |
| | | (Note 3) | — | -40 to 85 | |
| Input rise and fall time | dt/dv | | $V_{CC} = 1.8 \pm 0.15 \text{ V}, 2.5 \pm 0.2 \text{ V}$ | 0 to 20 | ns/V |
| | | | $V_{CC} = 3.3 \pm 0.3 \text{ V}$ | 0 to 10 | |
| | | | $V_{CC} = 5.0 \pm 0.5 \text{ V}$ | 0 to 5 | |

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, $T_a = 25^\circ\text{C}$)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Typ. | Max | Unit |
|--|-----------|--|----------------------------|--------------|----------------------|------|----------------------|---------------|
| High-level input voltage | V_{IH} | — | | 1.65 to 1.95 | $V_{CC} \times 0.75$ | — | — | V |
| | | | | 2.3 to 5.5 | $V_{CC} \times 0.7$ | — | — | |
| Low-level input voltage | V_{IL} | — | | 1.65 to 1.95 | — | — | $V_{CC} \times 0.25$ | V |
| | | | | 2.3 to 5.5 | — | — | $V_{CC} \times 0.3$ | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL}$ | $I_{OL} = 100 \mu\text{A}$ | 1.65 | — | 0.0 | 0.1 | V |
| | | | | 2.3 | — | 0.0 | 0.1 | |
| | | | | 3.0 | — | 0.0 | 0.1 | |
| | | | | 4.5 | — | 0.0 | 0.1 | |
| | | | $I_{OL} = 4 \text{ mA}$ | 1.65 | — | 0.08 | 0.24 | |
| | | | $I_{OL} = 8 \text{ mA}$ | 2.3 | — | 0.1 | 0.3 | |
| | | | $I_{OL} = 16 \text{ mA}$ | 3.0 | — | 0.15 | 0.4 | |
| | | | $I_{OL} = 24 \text{ mA}$ | 3.0 | — | 0.22 | 0.55 | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ $V_{OUT} = 0 \text{ to } 5.5 \text{ V}$ | | 1.65 to 5.5 | — | — | ± 5 | μA |
| | | | | — | — | — | — | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5 \text{ V or GND}$ | | 0 to 5.5 | — | — | ± 1 | μA |
| Power-OFF leakage current | I_{OFF} | $V_{IN} \text{ or } V_{OUT} = 5.5 \text{ V}$ | | 0 | — | — | 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 $85\text{ }^{\circ}\text{C}$)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Max | Unit |
|--|-----------|--|-----------------------------------|--------------|----------------------|----------------------|---------------|
| High-level input voltage | V_{IH} | — | | 1.65 to 1.95 | $V_{CC} \times 0.75$ | — | V |
| | | | | 2.3 to 5.5 | $V_{CC} \times 0.7$ | — | |
| Low-level input voltage | V_{IL} | — | | 1.65 to 1.95 | — | $V_{CC} \times 0.25$ | V |
| | | | | 2.3 to 5.5 | — | $V_{CC} \times 0.3$ | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL}$ | $I_{OL} = 100\text{ }\mu\text{A}$ | 1.65 | — | 0.1 | V |
| | | | | 2.3 | — | 0.1 | |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 1.65 | — | 0.24 | |
| | | | $I_{OL} = 8\text{ mA}$ | 2.3 | — | 0.3 | |
| | | | $I_{OL} = 16\text{ mA}$ | 3.0 | — | 0.4 | |
| | | | $I_{OL} = 24\text{ mA}$ | 3.0 | — | 0.55 | |
| | | | $I_{OL} = 32\text{ mA}$ | 4.5 | — | 0.55 | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ $V_{OUT} = 0$ to 5.5 V | | 1.65 to 5.5 | — | ± 10 | μA |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V}$ or GND | | 0 to 5.5 | — | ± 10 | μA |
| Power-OFF leakage current | I_{OFF} | V_{IN} or $V_{OUT} = 5.5\text{ V}$ | | 0 | — | 10 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 5.5 | — | 20 | μA |

9.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125\text{ }^{\circ}\text{C}$)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Max | Unit |
|--|-----------|--|-----------------------------------|--------------|----------------------|----------------------|---------------|
| High-level input voltage | V_{IH} | — | | 1.65 to 1.95 | $V_{CC} \times 0.75$ | — | V |
| | | | | 2.3 to 5.5 | $V_{CC} \times 0.7$ | — | |
| Low-level input voltage | V_{IL} | — | | 1.65 to 1.95 | — | $V_{CC} \times 0.25$ | V |
| | | | | 2.3 to 5.5 | — | $V_{CC} \times 0.3$ | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL}$ | $I_{OL} = 100\text{ }\mu\text{A}$ | 1.65 | — | 0.1 | V |
| | | | | 2.3 | — | 0.1 | |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 1.65 | — | 0.7 | |
| | | | $I_{OL} = 8\text{ mA}$ | 2.3 | — | 0.45 | |
| | | | $I_{OL} = 16\text{ mA}$ | 3.0 | — | 0.6 | |
| | | | $I_{OL} = 24\text{ mA}$ | 3.0 | — | 0.8 | |
| | | | $I_{OL} = 32\text{ mA}$ | 4.5 | — | 0.8 | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ $V_{OUT} = 0$ to 5.5 V | | 1.65 to 5.5 | — | ± 20 | μA |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V}$ or GND | | 0 to 5.5 | — | ± 20 | μA |
| Power-OFF leakage current | I_{OFF} | V_{IN} or $V_{OUT} = 5.5\text{ V}$ | | 0 | — | 100 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ 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_{PZL} | | $R_L = 500\text{ }\Omega$ | 1.8 ± 0.15 | 50 | 1.8 | 5.5 | 9.5 | ns |
| | | | | 2.5 ± 0.2 | | 1.2 | 3.7 | 5.8 | |
| | | | | 3.3 ± 0.3 | | 0.8 | 2.9 | 4.4 | |
| | | | | 5.0 ± 0.5 | | 0.5 | 2.3 | 3.5 | |
| | t_{PLZ} | | $R_L = 500\text{ }\Omega$ | 1.8 ± 0.15 | 50 | 1.8 | 4.3 | 9.5 | ns |
| | | | | 2.5 ± 0.2 | | 1.2 | 2.8 | 5.8 | |
| | | | | 3.3 ± 0.3 | | 0.8 | 2.1 | 4.4 | |
| | | | | 5.0 ± 0.5 | | 0.5 | 1.4 | 3.5 | |
| Input capacitance | C_{IN} | | — | 0 to 5.5 | — | — | 4 | — | pF |
| Output capacitance | C_{OUT} | | — | 0 to 5.5 | — | — | 4 | — | pF |
| Power dissipation capacitance | C_{PD} | (Note 1) | — | 3.3 | — | — | 4 | — | pF |
| | | | | 5.5 | | — | 10 | — | |

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: $t_r = t_f = 3\text{ ns}$)

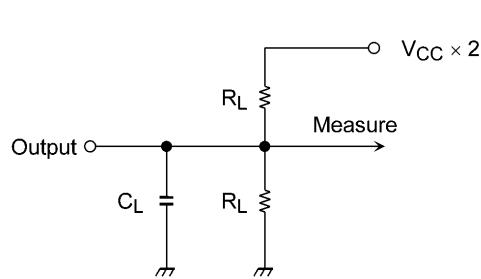
| Characteristics | Symbol | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|-----------|---------------------------|----------------|------------|-----|------|------|
| Propagation delay time | t_{PZL} | $R_L = 500\text{ }\Omega$ | 1.8 ± 0.15 | 50 | 1.8 | 10.5 | ns |
| | | | 2.5 ± 0.2 | | 1.2 | 6.4 | |
| | | | 3.3 ± 0.3 | | 0.8 | 4.8 | |
| | | | 5.0 ± 0.5 | | 0.5 | 3.9 | |
| | t_{PLZ} | $R_L = 500\text{ }\Omega$ | 1.8 ± 0.15 | 50 | 1.8 | 10.5 | ns |
| | | | 2.5 ± 0.2 | | 1.2 | 6.4 | |
| | | | 3.3 ± 0.3 | | 0.8 | 4.8 | |
| | | | 5.0 ± 0.5 | | 0.5 | 3.9 | |

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

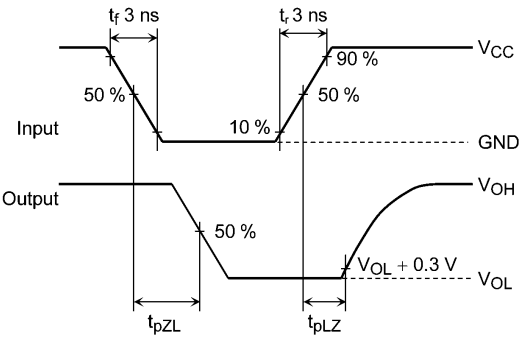
| Characteristics | Symbol | Test Condition | V_{CC} (V) | C_L (pF) | Min | Max | Unit |
|------------------------|-----------|---------------------------|----------------|------------|-----|------|------|
| Propagation delay time | t_{PZL} | $R_L = 500\text{ }\Omega$ | 1.8 ± 0.15 | 50 | 1.8 | 12.0 | ns |
| | | | 2.5 ± 0.2 | | 1.2 | 7.5 | |
| | | | 3.3 ± 0.3 | | 0.8 | 5.5 | |
| | | | 5.0 ± 0.5 | | 0.5 | 4.5 | |
| | t_{PLZ} | $R_L = 500\text{ }\Omega$ | 1.8 ± 0.15 | 50 | 1.8 | 12.0 | ns |
| | | | 2.5 ± 0.2 | | 1.2 | 7.5 | |
| | | | 3.3 ± 0.3 | | 0.8 | 5.5 | |
| | | | 5.0 ± 0.5 | | 0.5 | 4.5 | |

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

9.7. AC Characteristics Measurement Circuit and AC Waveform



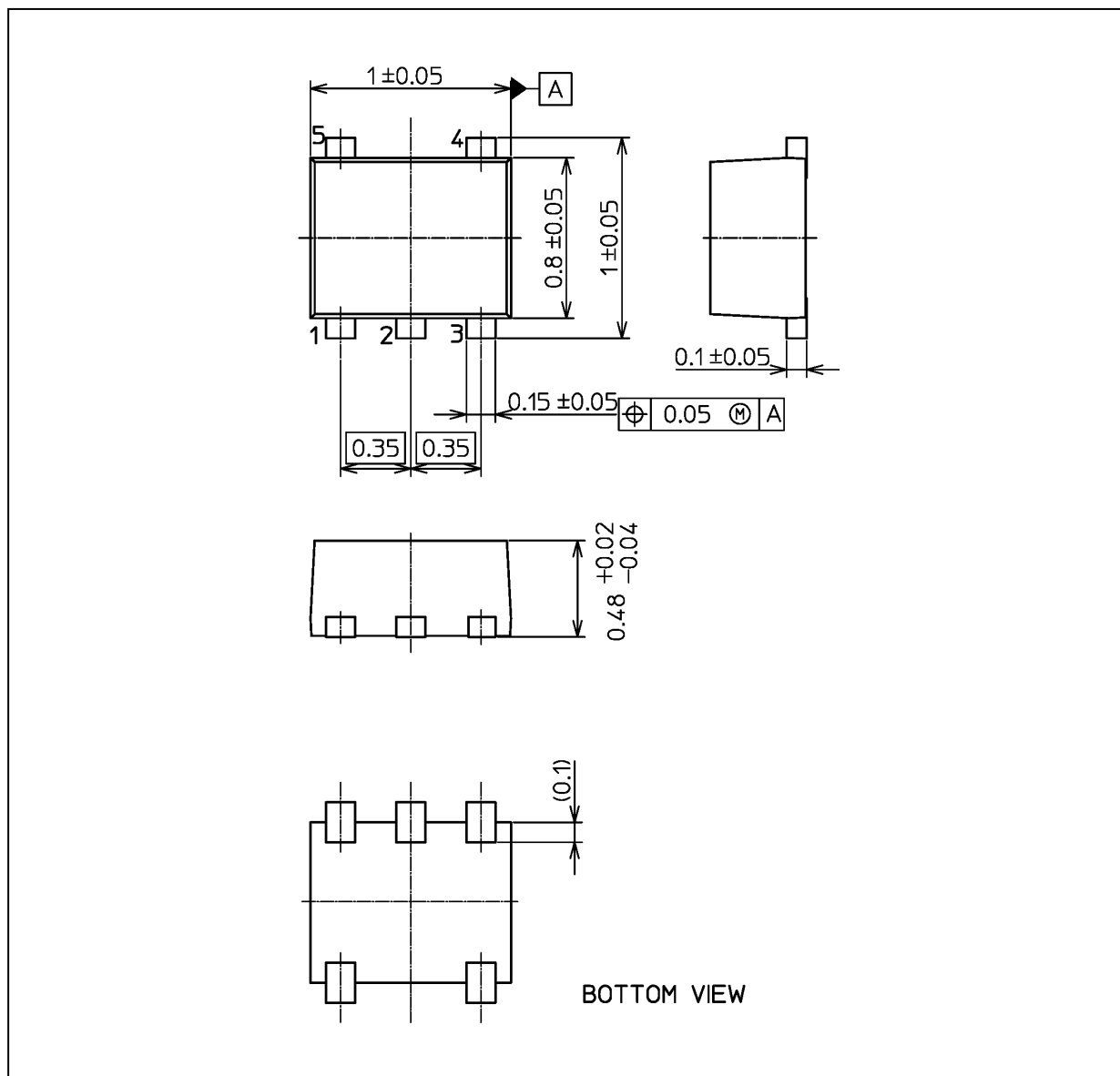
AC Characteristics Measurement Circuit



AC Waveform

Package Dimensions

Unit: mm



Weight: 1.0 mg (typ.)

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

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