

# TC7SZU04F

## 1. Functional Description

- Inverter (Unbuffer)

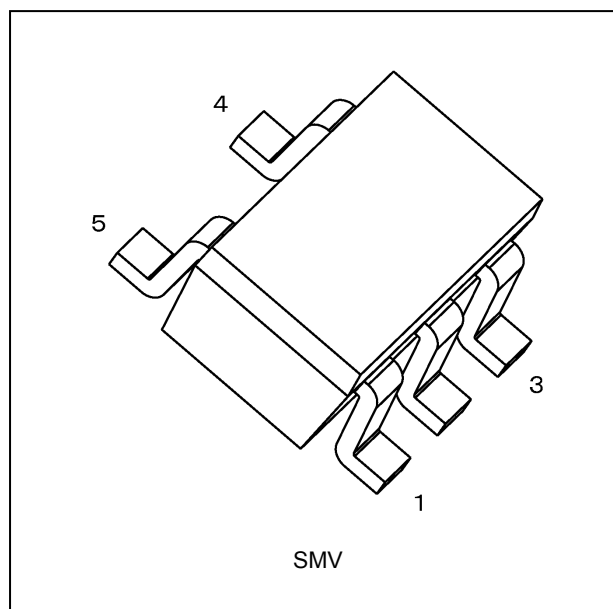
## 2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125\text{ }^{\circ}\text{C}$  (Note 2)
- (3) High output current:  $\pm 16\text{ mA}$  (min) at  $V_{CC} = 4.5\text{ V}$
- (4) Low power dissipation:  $I_{CC} = 2\text{ }\mu\text{A}$  (max) at  $V_{CC} = 5.5\text{ V}$ ,  $T_a = 25\text{ }^{\circ}\text{C}$
- (5) Operation voltage range:  $V_{CC} = 1.65$  to  $5.5\text{ V}$
- (6)  $5.5\text{ V}$  tolerant inputs

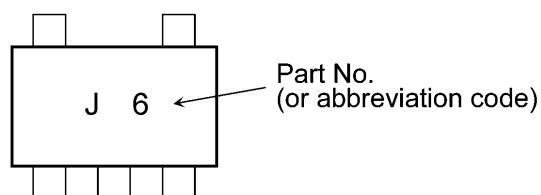
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

Note 2: For devices with the ordering part number ending in J(CT).  $T_{opr} = -40$  to  $85\text{ }^{\circ}\text{C}$  for the other devices.

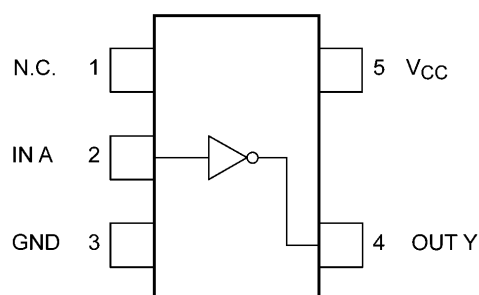
## 3. Packaging



## 4. Marking and Pin Assignment



Marking

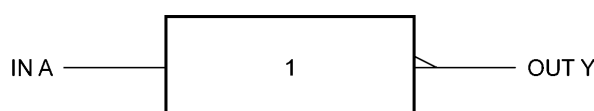


Pin Assignment (Top view)

Start of commercial production

1998-08

### 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) | $\pm 20$               | mA                 |
| DC output current        | $I_{OUT}$ |          | $\pm 50$               | mA                 |
| $V_{CC}$ /ground current | $I_{CC}$  |          | $\pm 50$               | mA                 |
| Power dissipation        | $P_D$     |          | 200                    | 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:  $V_{OUT} < \text{GND}$ ,  $V_{OUT} > V_{CC}$

### 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(CT).

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

## 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                 | 1.65 | —                    | V             |
|                           |          |                                  |                                    | 2.3          | 2.1                  | 2.3  | —                    |               |
|                           |          |                                  |                                    | 3.0          | 2.7                  | 3.0  | —                    |               |
|                           |          |                                  |                                    | 4.5          | 4.0                  | 4.4  | —                    |               |
|                           |          | $V_{IN} = \text{GND}$            | $I_{OH} = -4\text{ mA}$            | 2.3          | 1.9                  | 2.14 | —                    |               |
|                           |          |                                  | $I_{OH} = -8\text{ mA}$            | 3.0          | 2.4                  | 2.75 | —                    |               |
|                           |          |                                  | $I_{OH} = -12\text{ mA}$           | 3.0          | 2.3                  | 2.61 | —                    |               |
|                           |          |                                  | $I_{OH} = -16\text{ mA}$           | 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                  |               |
|                           |          | $V_{IN} = V_{CC}$                | $I_{OL} = 4\text{ mA}$             | 2.3          | —                    | 0.1  | 0.3                  |               |
|                           |          |                                  | $I_{OL} = 8\text{ mA}$             | 3.0          | —                    | 0.17 | 0.4                  |               |
|                           |          |                                  | $I_{OL} = 12\text{ mA}$            | 3.0          | —                    | 0.25 | 0.55                 |               |
|                           |          |                                  | $I_{OL} = 16\text{ mA}$            | 4.5          | —                    | 0.26 | 0.55                 |               |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5\text{ V or GND}$   |                                    | 0 to 5.5     | —                    | —    | $\pm 1$              | $\mu\text{A}$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC} \text{ or GND}$ |                                    | 5.5          | —                    | —    | 2                    | $\mu\text{A}$ |

## 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 | $V_{CC} \times 0.85$ | —                    | 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                 | —                    | V             |
|                           |          |                                  |                                    | 2.3          | 2.1                  | —                    |               |
|                           |          |                                  |                                    | 3.0          | 2.7                  | —                    |               |
|                           |          |                                  |                                    | 4.5          | 4.0                  | —                    |               |
|                           |          | $V_{IN} = \text{GND}$            | $I_{OH} = -4\text{ mA}$            | 2.3          | 1.9                  | —                    |               |
|                           |          |                                  | $I_{OH} = -8\text{ mA}$            | 3.0          | 2.4                  | —                    |               |
|                           |          |                                  | $I_{OH} = -12\text{ mA}$           | 3.0          | 2.3                  | —                    |               |
|                           |          |                                  | $I_{OH} = -16\text{ mA}$           | 4.5          | 3.8                  | —                    |               |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$                | $I_{OL} = 100\text{ }\mu\text{A}$  | 1.65         | —                    | 0.2                  | V             |
|                           |          |                                  |                                    | 2.3          | —                    | 0.2                  |               |
|                           |          |                                  |                                    | 3.0          | —                    | 0.3                  |               |
|                           |          |                                  |                                    | 4.5          | —                    | 0.5                  |               |
|                           |          | $V_{IN} = V_{CC}$                | $I_{OL} = 4\text{ mA}$             | 2.3          | —                    | 0.3                  |               |
|                           |          |                                  | $I_{OL} = 8\text{ mA}$             | 3.0          | —                    | 0.4                  |               |
|                           |          |                                  | $I_{OL} = 12\text{ mA}$            | 3.0          | —                    | 0.55                 |               |
|                           |          |                                  | $I_{OL} = 16\text{ mA}$            | 4.5          | —                    | 0.55                 |               |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5\text{ V or GND}$   |                                    | 0 to 5.5     | —                    | $\pm 10$             | $\mu\text{A}$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC} \text{ or GND}$ |                                    | 5.5          | —                    | 20                   | $\mu\text{A}$ |

## 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 | $V_{CC} \times 0.85$ | —                    | 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                 | —                    | V             |
|                           |          |                                  |                                    | 2.3          | 2.1                  | —                    |               |
|                           |          |                                  |                                    | 3.0          | 2.7                  | —                    |               |
|                           |          |                                  |                                    | 4.5          | 4.0                  | —                    |               |
|                           |          | $V_{IN} = \text{GND}$            | $I_{OH} = -4\text{ mA}$            | 2.3          | 1.7                  | —                    |               |
|                           |          |                                  | $I_{OH} = -8\text{ mA}$            | 3.0          | 2.2                  | —                    |               |
|                           |          |                                  | $I_{OH} = -12\text{ mA}$           | 3.0          | 2.0                  | —                    |               |
|                           |          |                                  | $I_{OH} = -16\text{ mA}$           | 4.5          | 3.4                  | —                    |               |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$                | $I_{OL} = 100\text{ }\mu\text{A}$  | 1.65         | —                    | 0.2                  | V             |
|                           |          |                                  |                                    | 2.3          | —                    | 0.2                  |               |
|                           |          |                                  |                                    | 3.0          | —                    | 0.3                  |               |
|                           |          |                                  |                                    | 4.5          | —                    | 0.5                  |               |
|                           |          | $V_{IN} = V_{CC}$                | $I_{OL} = 4\text{ mA}$             | 2.3          | —                    | 0.45                 |               |
|                           |          |                                  | $I_{OL} = 8\text{ mA}$             | 3.0          | —                    | 0.6                  |               |
|                           |          |                                  | $I_{OL} = 12\text{ mA}$            | 3.0          | —                    | 0.8                  |               |
|                           |          |                                  | $I_{OL} = 16\text{ mA}$            | 4.5          | —                    | 0.8                  |               |
| Input leakage current     | $I_{IN}$ | $V_{IN} = 5.5\text{ V or GND}$   |                                    | 0 to 5.5     | —                    | $\pm 20$             | $\mu\text{A}$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC} \text{ or GND}$ |                                    | 5.5          | —                    | 200                  | $\mu\text{A}$ |

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

### 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        | $t_{PLH}, t_{PHL}$ |          | $R_L = 1\text{ M}\Omega$  | $1.8 \pm 0.15$ | 15         | 1.0 | —    | 8.5 | ns   |
|                               |                    |          |                           | $2.5 \pm 0.2$  |            | 0.8 | —    | 6.2 |      |
|                               |                    |          |                           | $3.3 \pm 0.3$  |            | 0.5 | —    | 4.5 |      |
|                               |                    |          |                           | $5.0 \pm 0.5$  |            | 0.5 | —    | 3.9 |      |
|                               |                    |          | $R_L = 500\text{ }\Omega$ | $3.3 \pm 0.3$  | 50         | 1.0 | —    | 6.0 | ns   |
|                               |                    |          |                           | $5.0 \pm 0.5$  |            | 0.8 | —    | 5.0 |      |
| Input capacitance             | $C_{IN}$           |          | —                         | 0 to 5.5       | —          | —   | 4.5  | —   | pF   |
| Power dissipation capacitance | $C_{PD}$           | (Note 1) | —                         | 3.3            | —          | —   | 6.3  | —   | pF   |
|                               |                    |          |                           | 5.5            |            | —   | 9.5  | —   |      |

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             | Note | Test Condition            | $V_{CC}$ (V)   | $C_L$ (pF) | Min | Max | Unit |
|------------------------|--------------------|------|---------------------------|----------------|------------|-----|-----|------|
| Propagation delay time | $t_{PLH}, t_{PHL}$ |      | $R_L = 1\text{ M}\Omega$  | $1.8 \pm 0.15$ | 15         | 1.0 | 9.0 | ns   |
|                        |                    |      |                           | $2.5 \pm 0.2$  |            | 0.8 | 6.5 |      |
|                        |                    |      |                           | $3.3 \pm 0.3$  |            | 0.5 | 4.8 |      |
|                        |                    |      |                           | $5.0 \pm 0.5$  |            | 0.5 | 4.1 |      |
|                        |                    |      | $R_L = 500\text{ }\Omega$ | $3.3 \pm 0.3$  | 50         | 1.5 | 6.5 | ns   |
|                        |                    |      |                           | $5.0 \pm 0.5$  |            | 0.8 | 5.5 |      |

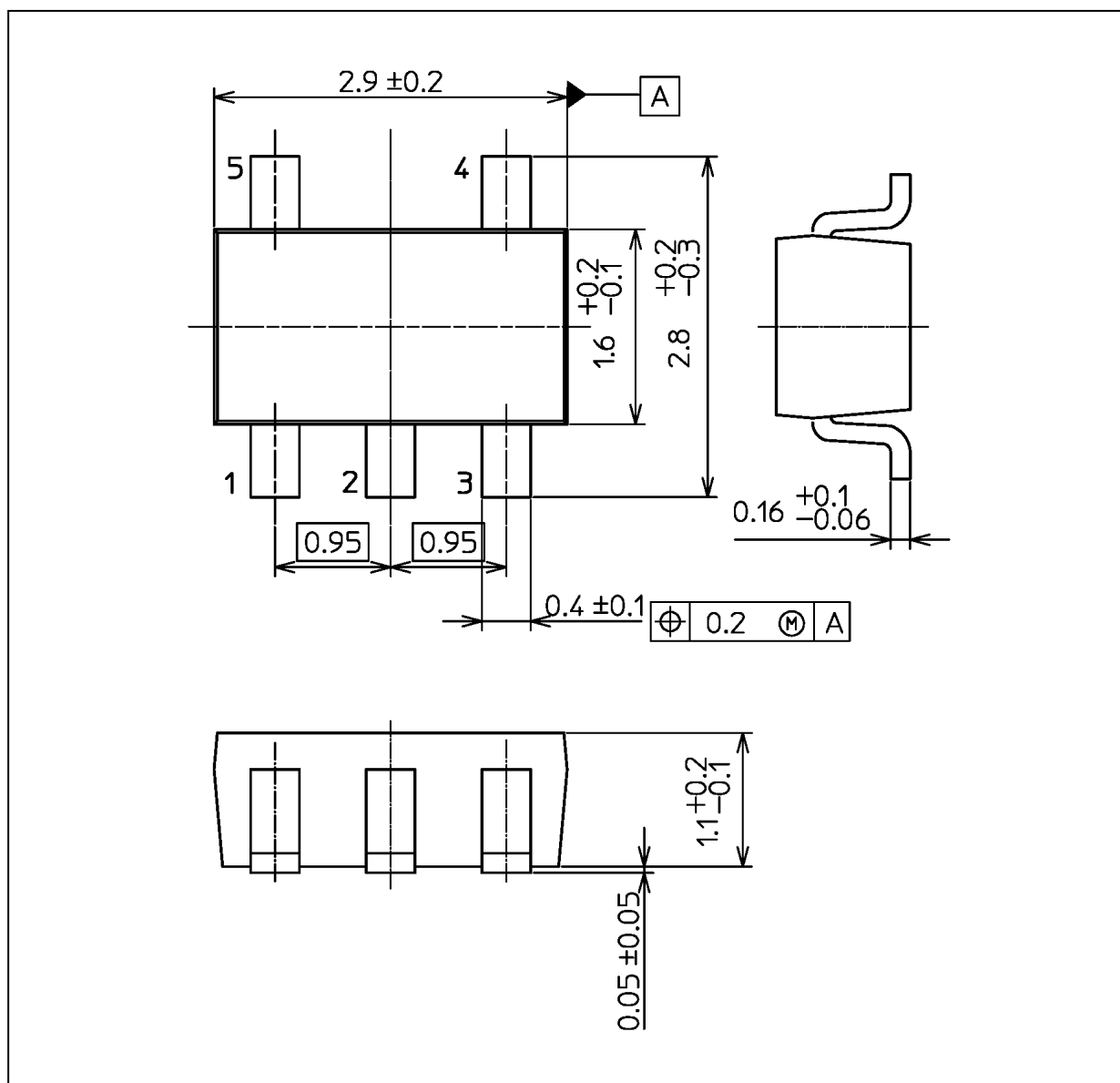
### 9.6. AC Characteristics (Note) (Unless otherwise specified, $T_a = -40\text{ to }125\text{ }^{\circ}\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

| Characteristics        | Symbol             | Note | Test Condition            | $V_{CC}$ (V)   | $C_L$ (pF) | Min | Max  | Unit |
|------------------------|--------------------|------|---------------------------|----------------|------------|-----|------|------|
| Propagation delay time | $t_{PLH}, t_{PHL}$ |      | $R_L = 1\text{ M}\Omega$  | $1.8 \pm 0.15$ | 15         | 1.0 | 10.0 | ns   |
|                        |                    |      |                           | $2.5 \pm 0.2$  |            | 0.8 | 7.5  |      |
|                        |                    |      |                           | $3.3 \pm 0.3$  |            | 0.5 | 5.5  |      |
|                        |                    |      |                           | $5.0 \pm 0.5$  |            | 0.5 | 5.0  |      |
|                        |                    |      | $R_L = 500\text{ }\Omega$ | $3.3 \pm 0.3$  | 50         | 1.5 | 7.5  | ns   |
|                        |                    |      |                           | $5.0 \pm 0.5$  |            | 0.8 | 6.5  |      |

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

## Package Dimensions

Unit: mm



Weight: 14 mg (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-25   |
| Nickname: SMV   |

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