

# TC7SZ17FE

## 1. Functional Description

- Schmitt Buffer

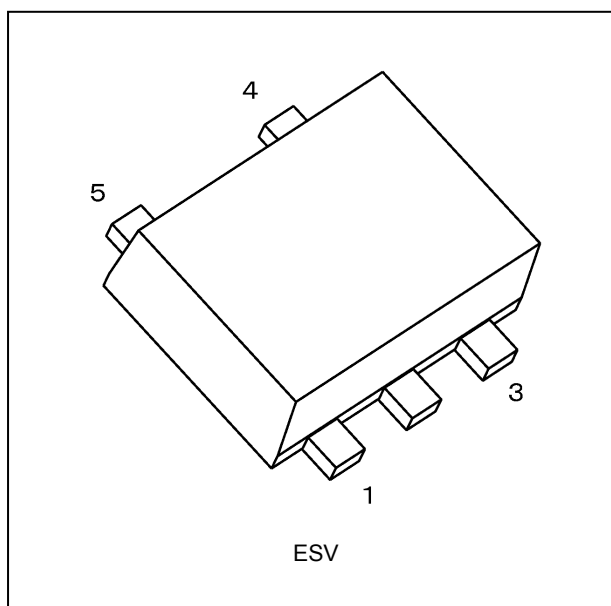
## 2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125^{\circ}\text{C}$  (Note 2)
- (3) High output current:  $\pm 24$  mA (min) at  $V_{CC} = 3.0$  V
- (4) Super high speed operation:  $t_{pd} = 3.7$  ns (typ.) at  $V_{CC} = 5.0$  V,  $C_L = 50$  pF
- (5) Operation voltage range:  $V_{CC} = 1.65$  to  $5.5$  V
- (6)  $5.5$  V tolerant inputs
- (7)  $5.5$  V power down protection output
- (8) Matches the performance of TC74LCX series when operated at  $3.3$  V  $V_{CC}$

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

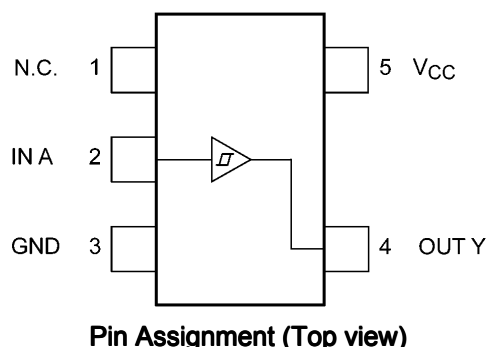
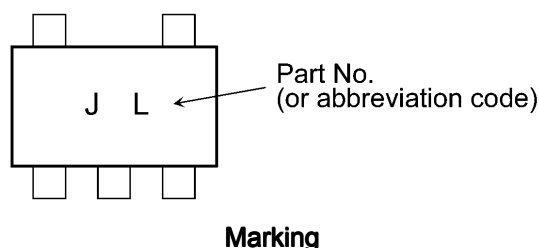
Note 2: For devices with the ordering part number ending in J(CT).  $T_{opr} = -40$  to  $85^{\circ}\text{C}$  for the other devices.

## 3. Packaging

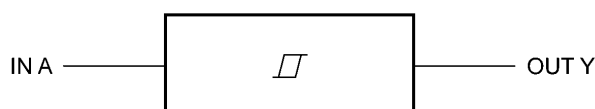


Start of commercial production  
2008-11

## 4. Marking and Pin Assignment



## 5. IEC Logic Symbol



## 6. Truth Table

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

## 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                  |
|                          |           | (Note 2) | -0.5 to $V_{CC} + 0.5$ |                    |
| Input diode current      | $I_{IK}$  |          | -20                    | mA                 |
| Output diode current     | $I_{OK}$  | (Note 3) | -20                    | mA                 |
| DC output current        | $I_{OUT}$ |          | $\pm 50$               | mA                 |
| $V_{CC}$ /ground current | $I_{CC}$  |          | $\pm 50$               | mA                 |
| Power dissipation        | $P_D$     |          | 150                    | 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:  $V_{CC} = 0\text{ V}$

Note 2: High (H) or Low (L) state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 3:  $V_{OUT} < \text{GND}$

## 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        | $V_{OUT}$ | (Note 2) | 0 to 5.5      | V    |
|                       |           | (Note 3) | 0 to $V_{CC}$ |      |
| Operating temperature | $T_{opr}$ | (Note 4) | -40 to 125    | °C   |
|                       |           | (Note 5) | -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:  $V_{CC} = 0$  V

Note 3: High (H) or Low (L) state.

Note 4: For devices with the ordering part number ending in J(CT).

Note 5: 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          |
|----------------------------|-----------|--------------------------------------|------------------------------------|--------------|------|------|---------|---------------|
| Positive threshold voltage | $V_P$     | —                                    |                                    | 1.65         | 0.6  | 1.0  | 1.4     | V             |
|                            |           |                                      |                                    | 1.8          | 0.7  | 1.1  | 1.5     |               |
|                            |           |                                      |                                    | 2.3          | 1.0  | 1.4  | 1.8     |               |
|                            |           |                                      |                                    | 3.0          | 1.3  | 1.75 | 2.2     |               |
|                            |           |                                      |                                    | 4.5          | 1.9  | 2.45 | 3.1     |               |
|                            |           |                                      |                                    | 5.5          | 2.2  | 2.9  | 3.6     |               |
| Negative threshold voltage | $V_N$     | —                                    |                                    | 1.65         | 0.2  | 0.5  | 0.8     | V             |
|                            |           |                                      |                                    | 1.8          | 0.25 | 0.55 | 0.9     |               |
|                            |           |                                      |                                    | 2.3          | 0.4  | 0.75 | 1.15    |               |
|                            |           |                                      |                                    | 3.0          | 0.6  | 1.0  | 1.5     |               |
|                            |           |                                      |                                    | 4.5          | 1.0  | 1.43 | 2.0     |               |
|                            |           |                                      |                                    | 5.5          | 1.2  | 1.7  | 2.4     |               |
| Hysteresis voltage         | $V_H$     | —                                    |                                    | 1.65         | 0.1  | 0.48 | 0.9     | V             |
|                            |           |                                      |                                    | 1.8          | 0.15 | 0.54 | 1.0     |               |
|                            |           |                                      |                                    | 2.3          | 0.25 | 0.65 | 1.1     |               |
|                            |           |                                      |                                    | 3.0          | 0.4  | 0.77 | 1.2     |               |
|                            |           |                                      |                                    | 4.5          | 0.6  | 1.01 | 1.5     |               |
|                            |           |                                      |                                    | 5.5          | 0.7  | 1.18 | 1.7     |               |
| High-level output voltage  | $V_{OH}$  | $V_{IN} = V_P$                       | $I_{OH} = -100\text{ }\mu\text{A}$ | 1.65         | 1.55 | 1.65 | —       | V             |
|                            |           |                                      |                                    | 1.8          | 1.7  | 1.8  | —       |               |
|                            |           |                                      |                                    | 2.3          | 2.2  | 2.3  | —       |               |
|                            |           |                                      |                                    | 3.0          | 2.9  | 3.0  | —       |               |
|                            |           |                                      |                                    | 4.5          | 4.4  | 4.5  | —       |               |
|                            |           |                                      | $I_{OH} = -4\text{ mA}$            | 1.65         | 1.29 | 1.52 | —       |               |
|                            |           |                                      | $I_{OH} = -8\text{ mA}$            | 2.3          | 1.9  | 2.15 | —       |               |
|                            |           |                                      | $I_{OH} = -16\text{ mA}$           | 3.0          | 2.4  | 2.8  | —       |               |
|                            |           |                                      | $I_{OH} = -24\text{ mA}$           | 3.0          | 2.3  | 2.68 | —       |               |
|                            |           |                                      | $I_{OH} = -32\text{ mA}$           | 4.5          | 3.8  | 4.2  | —       |               |
| Low-level output voltage   | $V_{OL}$  | $V_{IN} = V_N$                       | $I_{OL} = 100\text{ }\mu\text{A}$  | 1.65         | —    | 0.0  | 0.1     | V             |
|                            |           |                                      |                                    | 1.8          | —    | 0.0  | 0.1     |               |
|                            |           |                                      |                                    | 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    |               |
|                            |           |                                      | $I_{OL} = 32\text{ mA}$            | 4.5          | —    | 0.22 | 0.55    |               |
| Input leakage current      | $I_{IN}$  | $V_{IN} = 5.5\text{ V or GND}$       |                                    | 0 to 5.5     | —    | —    | $\pm 1$ | $\mu\text{A}$ |
| Power-OFF leakage current  | $I_{OFF}$ | $V_{IN}$ or $V_{OUT} = 5.5\text{ V}$ |                                    | 0            | —    | —    | 1       | $\mu\text{A}$ |
| Quiescent supply current   | $I_{CC}$  | $V_{IN} = V_{CC}$ or GND             |                                    | 1.65 to 5.5  | —    | —    | 2       | $\mu\text{A}$ |

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

| Characteristics            | Symbol    | Test Condition                               |                           | $V_{CC}$ (V) | Min  | Max      | Unit    |
|----------------------------|-----------|----------------------------------------------|---------------------------|--------------|------|----------|---------|
| Positive threshold voltage | $V_P$     | —                                            |                           | 1.65         | 0.6  | 1.4      | V       |
|                            |           |                                              |                           | 1.8          | 0.7  | 1.5      |         |
|                            |           |                                              |                           | 2.3          | 1.0  | 1.8      |         |
|                            |           |                                              |                           | 3.0          | 1.3  | 2.2      |         |
|                            |           |                                              |                           | 4.5          | 1.9  | 3.1      |         |
|                            |           |                                              |                           | 5.5          | 2.2  | 3.6      |         |
| Negative threshold voltage | $V_N$     | —                                            |                           | 1.65         | 0.2  | 0.8      | V       |
|                            |           |                                              |                           | 1.8          | 0.25 | 0.9      |         |
|                            |           |                                              |                           | 2.3          | 0.4  | 1.15     |         |
|                            |           |                                              |                           | 3.0          | 0.6  | 1.5      |         |
|                            |           |                                              |                           | 4.5          | 1.0  | 2.0      |         |
|                            |           |                                              |                           | 5.5          | 1.2  | 2.4      |         |
| Hysteresis voltage         | $V_H$     | —                                            |                           | 1.65         | 0.1  | 1.0      | V       |
|                            |           |                                              |                           | 1.8          | 0.15 | 1.0      |         |
|                            |           |                                              |                           | 2.3          | 0.25 | 1.1      |         |
|                            |           |                                              |                           | 3.0          | 0.4  | 1.2      |         |
|                            |           |                                              |                           | 4.5          | 0.6  | 1.5      |         |
|                            |           |                                              |                           | 5.5          | 0.7  | 1.7      |         |
| High-level output voltage  | $V_{OH}$  | $V_{IN} = V_P$                               | $I_{OH} = -100 \mu A$     | 1.65         | 1.55 | —        | V       |
|                            |           |                                              |                           | 1.8          | 1.7  | —        |         |
|                            |           |                                              |                           | 2.3          | 2.2  | —        |         |
|                            |           |                                              |                           | 3.0          | 2.9  | —        |         |
|                            |           |                                              |                           | 4.5          | 4.4  | —        |         |
|                            |           |                                              | $I_{OH} = -4 \text{ mA}$  | 1.65         | 1.29 | —        |         |
|                            |           |                                              | $I_{OH} = -8 \text{ mA}$  | 2.3          | 1.9  | —        |         |
|                            |           |                                              | $I_{OH} = -16 \text{ mA}$ | 3.0          | 2.4  | —        |         |
|                            |           |                                              | $I_{OH} = -24 \text{ mA}$ | 3.0          | 2.3  | —        |         |
|                            |           |                                              | $I_{OH} = -32 \text{ mA}$ | 4.5          | 3.8  | —        |         |
| Low-level output voltage   | $V_{OL}$  | $V_{IN} = V_N$                               | $I_{OL} = 100 \mu A$      | 1.65         | —    | 0.1      | V       |
|                            |           |                                              |                           | 1.8          | —    | 0.1      |         |
|                            |           |                                              |                           | 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     |         |
| Input leakage current      | $I_{IN}$  | $V_{IN} = 5.5 \text{ V or GND}$              |                           | 0 to 5.5     | —    | $\pm 10$ | $\mu A$ |
| Power-OFF leakage current  | $I_{OFF}$ | $V_{IN} \text{ or } V_{OUT} = 5.5 \text{ V}$ |                           | 0            | —    | 10       | $\mu A$ |
| Quiescent supply current   | $I_{CC}$  | $V_{IN} = V_{CC} \text{ or GND}$             |                           | 1.65 to 5.5  | —    | 20       | $\mu A$ |

### 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          |
|----------------------------|-----------|--------------------------------------|------------------------------------|--------------|------|----------|---------------|
| Positive threshold voltage | $V_P$     | —                                    |                                    | 1.65         | 0.6  | 1.4      | V             |
|                            |           |                                      |                                    | 1.8          | 0.7  | 1.5      |               |
|                            |           |                                      |                                    | 2.3          | 1.0  | 1.8      |               |
|                            |           |                                      |                                    | 3.0          | 1.3  | 2.2      |               |
|                            |           |                                      |                                    | 4.5          | 1.9  | 3.1      |               |
|                            |           |                                      |                                    | 5.5          | 2.2  | 3.6      |               |
| Negative threshold voltage | $V_N$     | —                                    |                                    | 1.65         | 0.2  | 0.8      | V             |
|                            |           |                                      |                                    | 1.8          | 0.25 | 0.9      |               |
|                            |           |                                      |                                    | 2.3          | 0.4  | 1.15     |               |
|                            |           |                                      |                                    | 3.0          | 0.6  | 1.5      |               |
|                            |           |                                      |                                    | 4.5          | 1.0  | 2.0      |               |
|                            |           |                                      |                                    | 5.5          | 1.2  | 2.4      |               |
| Hysteresis voltage         | $V_H$     | —                                    |                                    | 1.65         | 0.1  | 1.0      | V             |
|                            |           |                                      |                                    | 1.8          | 0.15 | 1.0      |               |
|                            |           |                                      |                                    | 2.3          | 0.25 | 1.1      |               |
|                            |           |                                      |                                    | 3.0          | 0.4  | 1.2      |               |
|                            |           |                                      |                                    | 4.5          | 0.6  | 1.5      |               |
|                            |           |                                      |                                    | 5.5          | 0.7  | 1.7      |               |
| High-level output voltage  | $V_{OH}$  | $V_{IN} = V_P$                       | $I_{OH} = -100\text{ }\mu\text{A}$ | 1.65         | 1.55 | —        | V             |
|                            |           |                                      |                                    | 1.8          | 1.7  | —        |               |
|                            |           |                                      |                                    | 2.3          | 2.2  | —        |               |
|                            |           |                                      |                                    | 3.0          | 2.9  | —        |               |
|                            |           |                                      |                                    | 4.5          | 4.4  | —        |               |
|                            |           |                                      | $I_{OH} = -4\text{ mA}$            | 1.65         | 0.95 | —        |               |
|                            |           |                                      | $I_{OH} = -8\text{ mA}$            | 2.3          | 1.7  | —        |               |
|                            |           |                                      | $I_{OH} = -16\text{ mA}$           | 3.0          | 2.2  | —        |               |
|                            |           |                                      | $I_{OH} = -24\text{ mA}$           | 3.0          | 2.0  | —        |               |
|                            |           |                                      | $I_{OH} = -32\text{ mA}$           | 4.5          | 3.4  | —        |               |
| Low-level output voltage   | $V_{OL}$  | $V_{IN} = V_N$                       | $I_{OL} = 100\text{ }\mu\text{A}$  | 1.65         | —    | 0.1      | V             |
|                            |           |                                      |                                    | 1.8          | —    | 0.1      |               |
|                            |           |                                      |                                    | 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      |               |
| Input leakage current      | $I_{IN}$  | $V_{IN} = 5.5\text{ V or GND}$       |                                    | 0 to 5.5     | —    | $\pm 20$ | $\mu\text{A}$ |
| Power-OFF leakage current  | $I_{OFF}$ | $V_{IN}$ or $V_{OUT} = 5.5\text{ V}$ |                                    | 0            | —    | 100      | $\mu\text{A}$ |
| Quiescent supply current   | $I_{CC}$  | $V_{IN} = V_{CC}$ or GND             |                                    | 1.65 to 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         | 2.0 | 9.1  | 15.0 | ns   |
|                               |                    |          |                           | $2.5 \pm 0.2$  |            | 1.0 | 5.0  | 9.0  |      |
|                               |                    |          |                           | $3.3 \pm 0.3$  |            | 1.0 | 3.7  | 6.3  |      |
|                               |                    |          |                           | $5.0 \pm 0.5$  |            | 0.5 | 3.1  | 5.2  |      |
|                               |                    |          | $R_L = 500\text{ }\Omega$ | $3.3 \pm 0.3$  | 50         | 1.5 | 4.4  | 7.2  | ns   |
|                               |                    |          |                           | $5.0 \pm 0.5$  |            | 0.5 | 3.7  | 5.9  |      |
| Input capacitance             | $C_{IN}$           |          | —                         | 0 to 5.5       | —          | —   | 4    | —    | pF   |
| Power dissipation capacitance | $C_{PD}$           | (Note 1) | —                         | 3.3            | —          | —   | 24   | —    | pF   |
|                               |                    |          |                           | 5.5            |            | —   | 30   | —    |      |

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 | $t_{PLH}, t_{PHL}$ | $R_L = 1\text{ M}\Omega$  | $1.8 \pm 0.15$ | 15         | 2.0 | 15.6 | ns   |
|                        |                    |                           | $2.5 \pm 0.2$  |            | 1.0 | 9.5  |      |
|                        |                    |                           | $3.3 \pm 0.3$  |            | 1.0 | 6.5  |      |
|                        |                    |                           | $5.0 \pm 0.5$  |            | 0.5 | 5.5  |      |
|                        |                    | $R_L = 500\text{ }\Omega$ | $3.3 \pm 0.3$  | 50         | 1.5 | 7.5  | ns   |
|                        |                    |                           | $5.0 \pm 0.5$  |            | 0.5 | 6.2  |      |

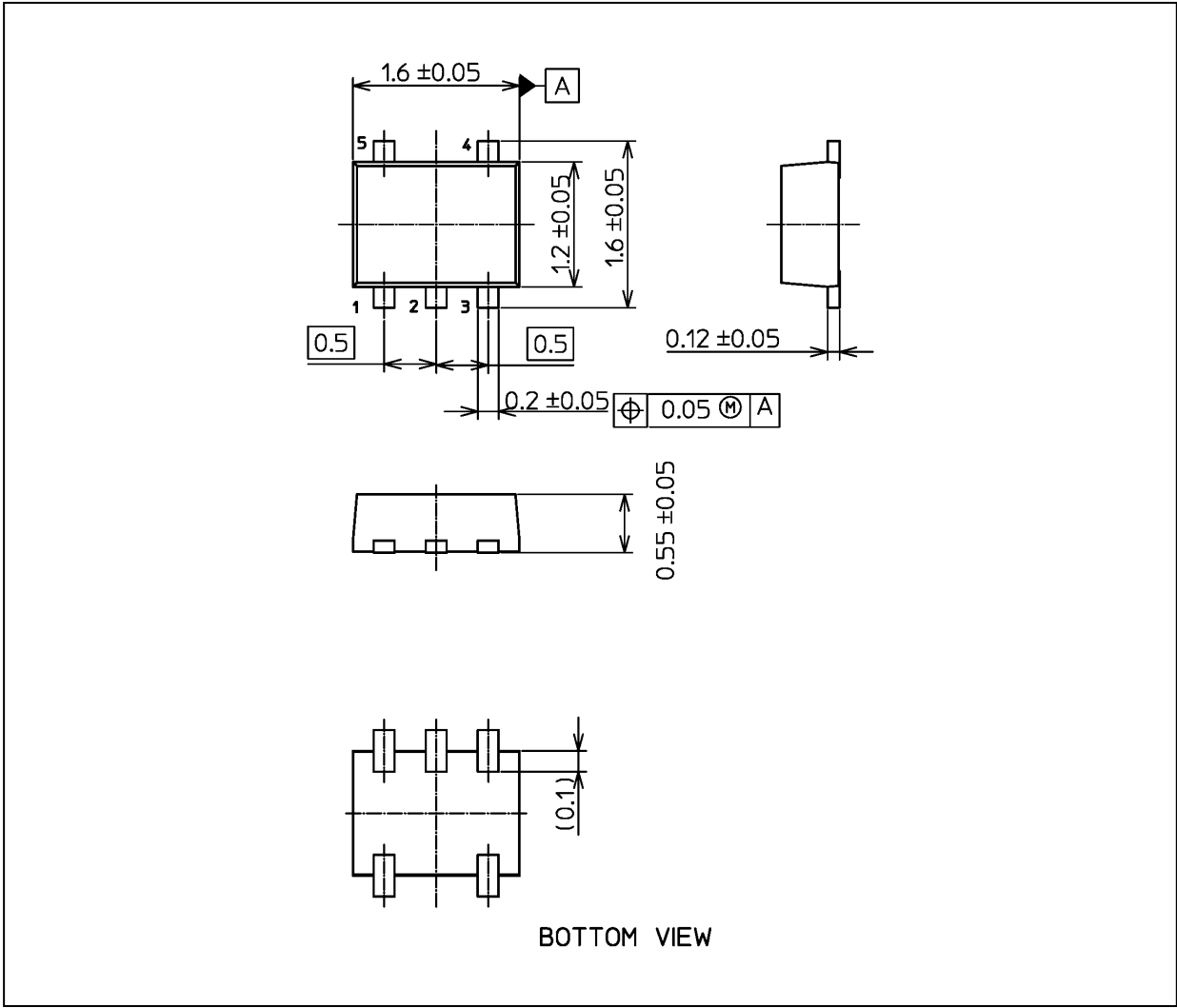
### 9.6. AC Characteristics (Note) (Unless otherwise specified, $T_a = -40\text{ to }125\text{ }^{\circ}\text{C}$ , Input: $t_r = t_f = 3\text{ ns}$ )

| Characteristics        | Symbol             | Test Condition            | $V_{CC}$ (V)   | $C_L$ (pF) | Min | Max  | Unit |
|------------------------|--------------------|---------------------------|----------------|------------|-----|------|------|
| Propagation delay time | $t_{PLH}, t_{PHL}$ | $R_L = 1\text{ M}\Omega$  | $1.8 \pm 0.15$ | 15         | 2.0 | 17.5 | ns   |
|                        |                    |                           | $2.5 \pm 0.2$  |            | 1.0 | 10.5 |      |
|                        |                    |                           | $3.3 \pm 0.3$  |            | 1.0 | 7.5  |      |
|                        |                    |                           | $5.0 \pm 0.5$  |            | 0.5 | 6.5  |      |
|                        |                    | $R_L = 500\text{ }\Omega$ | $3.3 \pm 0.3$  | 50         | 1.5 | 8.5  | ns   |
|                        |                    |                           | $5.0 \pm 0.5$  |            | 0.5 | 7.0  |      |

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

Package Dimensions

Unit: mm



Weight: 3.0 mg (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-553  |
| Nickname: ESV   |



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