

TC7WH74FK

1. Functional Description

- D-Type Flip Flop with Preset and Clear

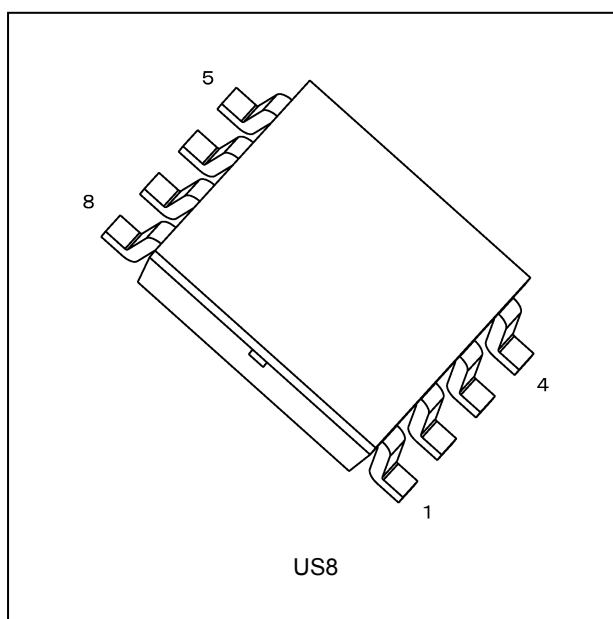
2. Features

- (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 speed operation: $f_{MAX} = 170\text{ MHz}$ (typ.) ($V_{CC} = 5.0\text{ V}$)
- (4) Low power dissipation: $I_{CC} = 2.0\text{ }\mu\text{A}$ (max) ($T_a = 25\text{ }^{\circ}\text{C}$)
- (5) High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
- (6) 5.5 V tolerant inputs
- (7) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range: $V_{CC} = 2.0$ to 5.5 V

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.

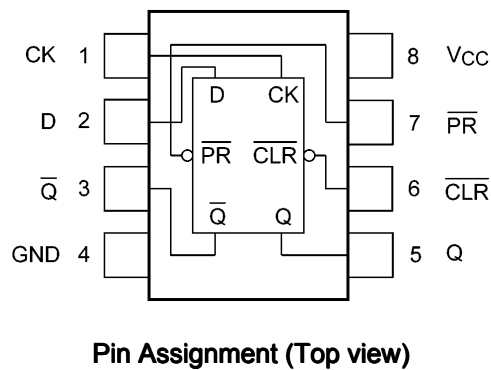
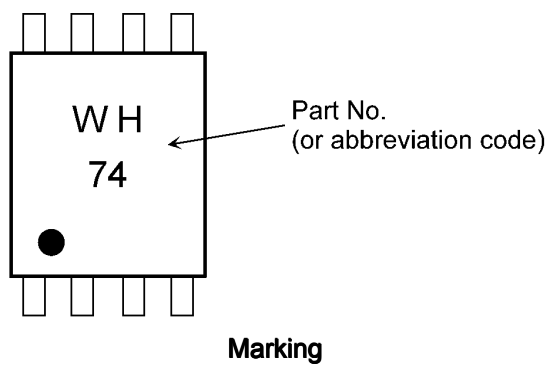
3. Packaging



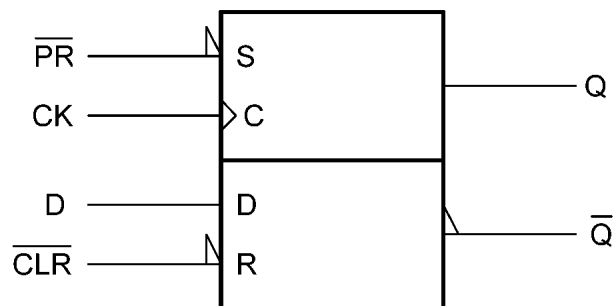
Start of commercial production

1994-07

4. Marking and Pin Assignment



5. IEC Logic Symbol



6. Truth Table

| Inputs | | | | Outputs | | Function |
|---------|--------|---|----|----------------|---------------------|-----------|
| CLR-bar | PR-bar | D | CK | Q | Q-bar | |
| L | H | X | X | L | H | Clear |
| H | L | X | X | H | L | Preset |
| L | L | X | X | H | H | — |
| H | H | L | ↑ | L | H | — |
| H | H | H | ↑ | H | L | — |
| H | H | X | ↓ | Q _n | Q _n -bar | No Change |

X: Don't care

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 7.0 | V |
| Input voltage | V_{IN} | | -0.5 to 7.0 | |
| DC output voltage | V_{OUT} | | -0.5 to $V_{CC} + 0.5$ | |
| Input diode current | I_{IK} | | -20 | mA |
| Output diode current | I_{OK} | (Note 1) | ± 20 | |
| DC output current | I_{OUT} | | ± 25 | |
| V_{CC} /ground current | I_{CC} | | ± 50 | |
| 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 | Test Condition | Rating | Unit |
|--------------------------|-----------|----------|---------------------------------|---------------|--------------------|
| Supply voltage | V_{CC} | | — | 2.0 to 5.5 | V |
| Input voltage | V_{IN} | | — | 0 to 5.5 | |
| Output voltage | V_{OUT} | | — | 0 to V_{CC} | |
| Operating temperature | T_{opr} | (Note 1) | — | -40 to 125 | $^{\circ}\text{C}$ |
| | | (Note 2) | — | -40 to 85 | |
| Input rise and fall time | dt/dv | | $V_{CC} = 3.3 \pm 0.3\text{ V}$ | 0 to 100 | ns/V |
| | | | $V_{CC} = 5.0 \pm 0.5\text{ V}$ | 0 to 20 | |

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

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

Note 1: For devices with the ordering part number ending in J(CT).

Note 2: 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} | — | | 2.0 | 1.5 | — | — | V |
| | | | | 3.0 to 5.5 | $V_{CC} \times 0.7$ | — | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | — | 0.5 | V |
| | | | | 3.0 to 5.5 | — | — | $V_{CC} \times 0.3$ | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL} \text{ or } V_{IH}$ | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0 | 1.9 | 2.0 | — | V |
| | | | | 3.0 | 2.9 | 3.0 | — | |
| | | | | 4.5 | 4.4 | 4.5 | — | |
| | | | $I_{OH} = -4\text{ mA}$ | 3.0 | 2.58 | — | — | |
| | | | $I_{OH} = -8\text{ mA}$ | 4.5 | 3.94 | — | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL} \text{ or } V_{IH}$ | $I_{OL} = 50\text{ }\mu\text{A}$ | 2.0 | — | 0.0 | 0.1 | V |
| | | | | 3.0 | — | 0.0 | 0.1 | |
| | | | | 4.5 | — | 0.0 | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 3.0 | — | — | 0.36 | |
| | | | $I_{OL} = 8\text{ mA}$ | 4.5 | — | — | 0.36 | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V or GND}$ | | 0 to 5.5 | — | — | ± 0.1 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC} \text{ or GND}$ | | 5.5 | — | — | 2.0 | μA |

9.2. DC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^{\circ}\text{C}$)

| Characteristics | Symbol | Test Condition | | V_{CC} (V) | Min | Max | Unit |
|---------------------------|----------|--------------------------------------|-----------------------------------|--------------|---------------------|---------------------|---------------|
| High-level input voltage | V_{IH} | — | | 2.0 | 1.5 | — | V |
| | | | | 3.0 to 5.5 | $V_{CC} \times 0.7$ | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | 0.5 | V |
| | | | | 3.0 to 5.5 | — | $V_{CC} \times 0.3$ | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL} \text{ or } V_{IH}$ | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0 | 1.9 | — | V |
| | | | | 3.0 | 2.9 | — | |
| | | | | 4.5 | 4.4 | — | |
| | | | $I_{OH} = -4\text{ mA}$ | 3.0 | 2.48 | — | |
| | | | $I_{OH} = -8\text{ mA}$ | 4.5 | 3.80 | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL} \text{ or } V_{IH}$ | $I_{OL} = 50\text{ }\mu\text{A}$ | 2.0 | — | 0.1 | V |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 3.0 | — | 0.44 | |
| | | | $I_{OL} = 8\text{ mA}$ | 4.5 | — | 0.44 | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V or GND}$ | | 0 to 5.5 | — | ± 1.0 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC} \text{ or GND}$ | | 5.5 | — | 20.0 | 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} | — | | 2.0 | 1.5 | — | V |
| | | | | 3.0 to 5.5 | $V_{CC} \times 0.7$ | — | |
| Low-level input voltage | V_{IL} | — | | 2.0 | — | 0.5 | V |
| | | | | 3.0 to 5.5 | — | $V_{CC} \times 0.3$ | |
| High-level output voltage | V_{OH} | $V_{IN} = V_{IL}$ or V_{IH} | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0 | 1.9 | — | V |
| | | | | 3.0 | 2.9 | — | |
| | | | | 4.5 | 4.4 | — | |
| | | $I_{OH} = -4\text{ mA}$ | $I_{OH} = -8\text{ mA}$ | 3.0 | 2.40 | — | |
| | | | | 4.5 | 3.70 | — | |
| Low-level output voltage | V_{OL} | $V_{IN} = V_{IL}$ or V_{IH} | $I_{OL} = 50\text{ }\mu\text{A}$ | 2.0 | — | 0.1 | V |
| | | | | 3.0 | — | 0.1 | |
| | | | | 4.5 | — | 0.1 | |
| | | | $I_{OL} = 4\text{ mA}$ | 3.0 | — | 0.55 | |
| | | | $I_{OL} = 8\text{ mA}$ | 4.5 | — | 0.55 | |
| Input leakage current | I_{IN} | $V_{IN} = 5.5\text{ V}$ or GND | | 0 to 5.5 | — | ± 2.0 | μA |
| Quiescent supply current | I_{CC} | $V_{IN} = V_{CC}$ or GND | | 5.5 | — | 40.0 | μA |

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

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

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Limit | Unit |
|--------------------------------|----------------------|----------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{W(L)}, t_{W(H)}$ | — | 3.3 ± 0.3 | 6.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum pulse width (CLR, PR) | $t_{W(L)}$ | — | 3.3 ± 0.3 | 6.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum setup time | t_S | — | 3.3 ± 0.3 | 6.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum hold time | t_H | — | 3.3 ± 0.3 | 0.5 | ns |
| | | | 5.0 ± 0.5 | 0.5 | |
| Minimum removal time (CLR, PR) | t_{rem} | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 3.0 | |

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

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Limit | Unit |
|--------------------------------|----------------------|----------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{W(L)}, t_{W(H)}$ | — | 3.3 ± 0.3 | 7.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum pulse width (CLR, PR) | $t_{W(L)}$ | — | 3.3 ± 0.3 | 7.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum setup time | t_S | — | 3.3 ± 0.3 | 7.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum hold time | t_H | — | 3.3 ± 0.3 | 0.5 | ns |
| | | | 5.0 ± 0.5 | 0.5 | |
| Minimum removal time (CLR, PR) | t_{rem} | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 3.0 | |

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

| Characteristics | Symbol | Test Condition | V_{CC} (V) | Limit | Unit |
|--------------------------------|----------------------|----------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{W(L)}, t_{W(H)}$ | — | 3.3 ± 0.3 | 7.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum pulse width (CLR, PR) | $t_{W(L)}$ | — | 3.3 ± 0.3 | 7.0 | ns |
| | | | 5.0 ± 0.5 | 5.0 | |
| Minimum setup time | t_s | — | 3.3 ± 0.3 | 8.0 | ns |
| | | | 5.0 ± 0.5 | 5.5 | |
| Minimum hold time | t_h | — | 3.3 ± 0.3 | 0.5 | ns |
| | | | 5.0 ± 0.5 | 0.5 | |
| Minimum removal time (CLR, PR) | t_{rem} | — | 3.3 ± 0.3 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 3.0 | |

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

9.7. 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 (CK-Q, \bar{Q}) | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | — | 6.7 | 11.9 | ns |
| | | | | | 50 | — | 9.2 | 15.4 | |
| | | | | 5.0 ± 0.5 | 15 | — | 4.6 | 7.3 | |
| | | | | | 50 | — | 6.1 | 9.3 | |
| Propagation delay time (CLR, PR-Q, \bar{Q}) | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | — | 7.6 | 12.3 | ns |
| | | | | | 50 | — | 10.1 | 15.8 | |
| | | | | 5.0 ± 0.5 | 15 | — | 4.8 | 7.7 | |
| | | | | | 50 | — | 6.3 | 9.7 | |
| Maximum clock frequency | f_{MAX} | | — | 3.3 ± 0.3 | 15 | 80 | 125 | — | MHz |
| | | | | | 50 | 50 | 75 | — | |
| | | | | 5.0 ± 0.5 | 15 | 130 | 170 | — | |
| | | | | | 50 | 90 | 115 | — | |
| Input capacitance | C_{IN} | | — | | | — | 4 | 10 | pF |
| Power dissipation capacitance | C_{PD} | (Note 1) | — | | | — | 22 | — | pF |

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.

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

9.8. AC Characteristics

(Unless otherwise specified, $T_a = -40$ 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 (CK-Q, \bar{Q}) | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | 1.0 | 14.0 | ns |
| | | | | | 50 | 1.0 | 17.5 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 8.5 | |
| | | | | | 50 | 1.0 | 10.5 | |
| Propagation delay time (CLR, PR-Q, \bar{Q}) | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | 1.0 | 14.5 | ns |
| | | | | | 50 | 1.0 | 18.0 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 9.0 | |
| | | | | | 50 | 1.0 | 11.0 | |
| Maximum clock frequency | f_{MAX} | | — | 3.3 ± 0.3 | 15 | 70 | — | MHz |
| | | | | | 50 | 45 | — | |
| | | | | 5.0 ± 0.5 | 15 | 110 | — | |
| | | | | | 50 | 75 | — | |
| Input capacitance | C_{IN} | | — | | | — | 10 | pF |

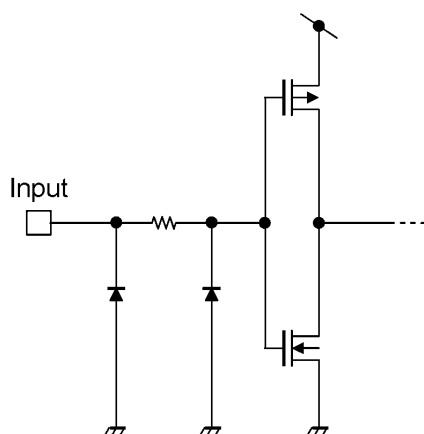
9.9. AC Characteristics (Note)

(Unless otherwise specified, $T_a = -40$ 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 (CK-Q, \bar{Q}) | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | 1.0 | 16.0 | ns |
| | | | | | 50 | 1.0 | 19.5 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 10.0 | |
| | | | | | 50 | 1.0 | 12.0 | |
| Propagation delay time (CLR, PR-Q, \bar{Q}) | t_{PLH}, t_{PHL} | | — | 3.3 ± 0.3 | 15 | 1.0 | 16.5 | ns |
| | | | | | 50 | 1.0 | 20.0 | |
| | | | | 5.0 ± 0.5 | 15 | 1.0 | 10.5 | |
| | | | | | 50 | 1.0 | 12.5 | |
| Maximum clock frequency | f_{MAX} | | — | 3.3 ± 0.3 | 15 | 60 | — | MHz |
| | | | | | 50 | 40 | — | |
| | | | | 5.0 ± 0.5 | 15 | 100 | — | |
| | | | | | 50 | 70 | — | |
| Input capacitance | C_{IN} | | — | | | — | 10 | pF |

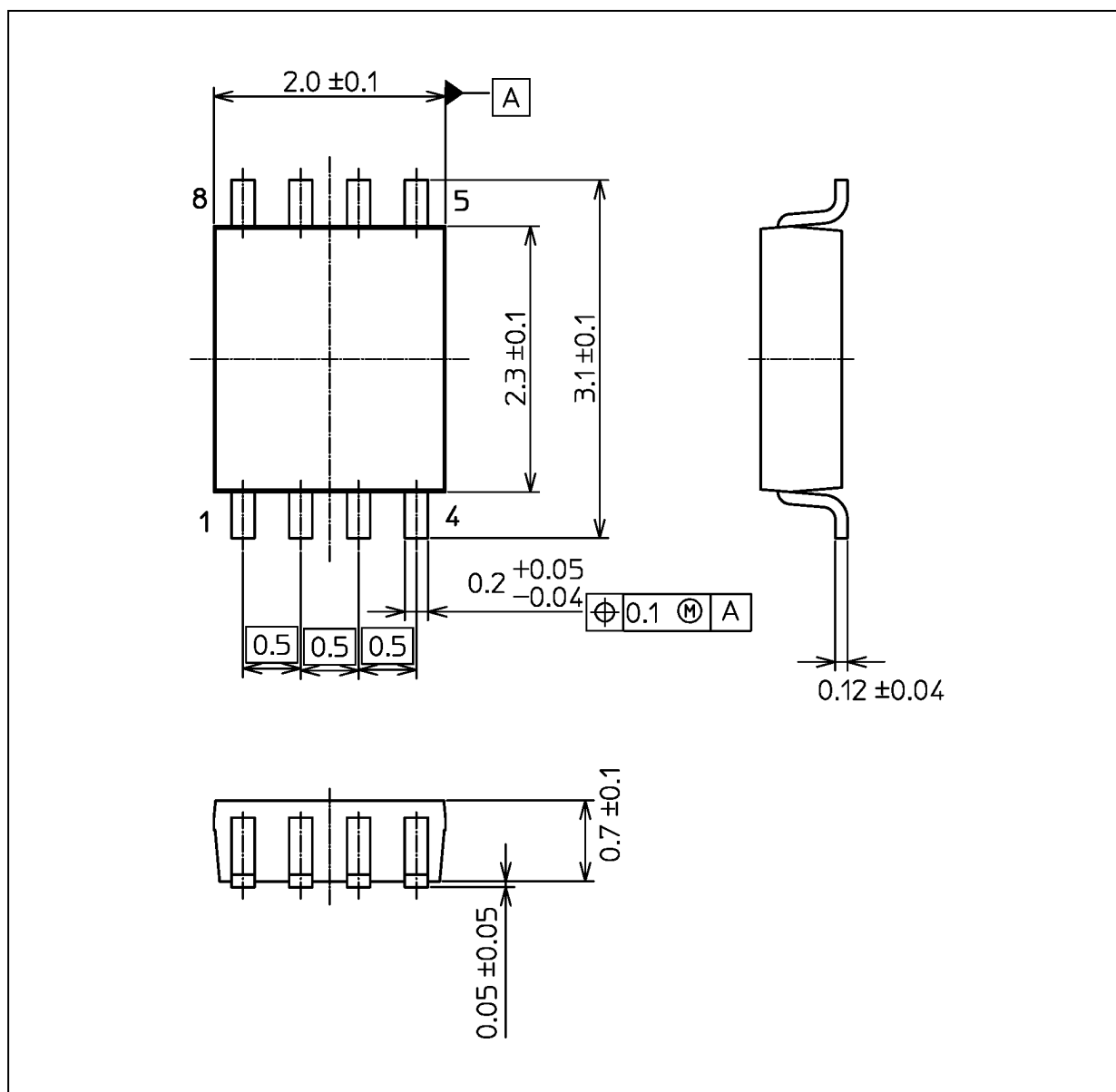
Note: For devices with the ordering part number ending in J(CT).

9.10. Input Equivalent Circuit



Package Dimensions

Unit: mm



Weight: 0.01 g (typ.)

| Package Name(s) |
|-----------------|
| JEDEC: SOT-765 |
| Nickname: US8 |

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