

# 74VHCT574AFT

## 1. Functional Description

- Octal D-Type Flip Flop with 3-State Outputs

## 2. General

The 74VHCT574AFT is an advanced high speed CMOS OCTAL FLIP-FLOP with 3-STATE OUTPUT fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

This 8-bit D-type flip-flop is controlled by a clock input (CK) and an output enable input ( $\overline{OE}$ ).

When the  $\overline{OE}$  input is high, the eight outputs are in a high impedance state.

The input voltage is compatible with TTL output voltage.

This device may be used as a level converter for interfacing 3.3 V to 5 V system.

Input protection and output circuit ensure that 0 to 5.5 V can be applied to the input and output (Note) pins without regard to the supply voltage. These structure prevents device destruction due to mismatched supply and input/output voltages such as battery back up, hot board insertion, etc.

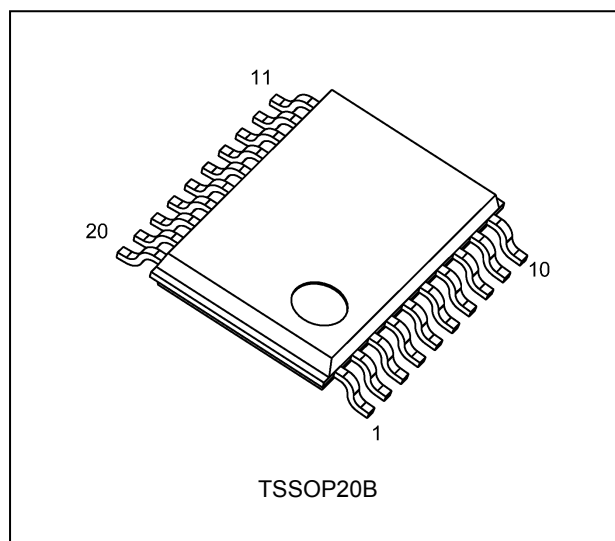
Note: Output in off-state

## 3. Features

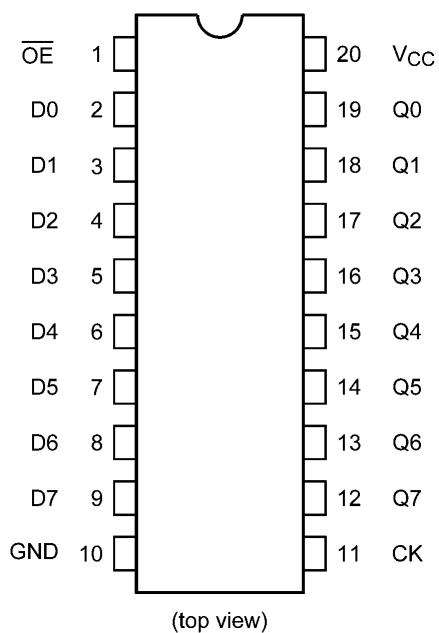
- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125^{\circ}\text{C}$
- (3) High speed:  $f_{MAX} = 140\text{MHz}$  (typ.) at  $V_{CC} = 5.0\text{ V}$
- (4) Low power dissipation:  $I_{CC} = 4.0\text{ }\mu\text{A}$  (max) at  $T_a = 25^{\circ}\text{C}$
- (5) Compatible with TTL inputs:  $V_{IL} = 0.8\text{V}$  (max)  
 $V_{IH} = 2.0\text{V}$  (min)
- (6) Power-down protection is provided on all inputs and outputs.
- (7) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (8) Low noise:  $V_{OLP} = 1.5\text{ V}$  (max)
- (9) Pin and function compatible with the 74 series (74ACT/HCT/AHCT etc.) 574 type.

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

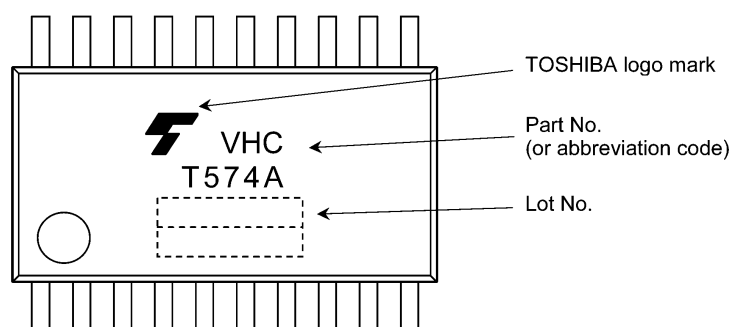
## 4. Packaging



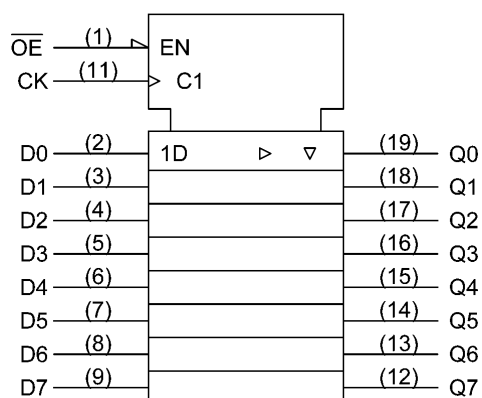
## 5. Pin Assignment



## 6. Marking



## 7. IEC Logic Symbol

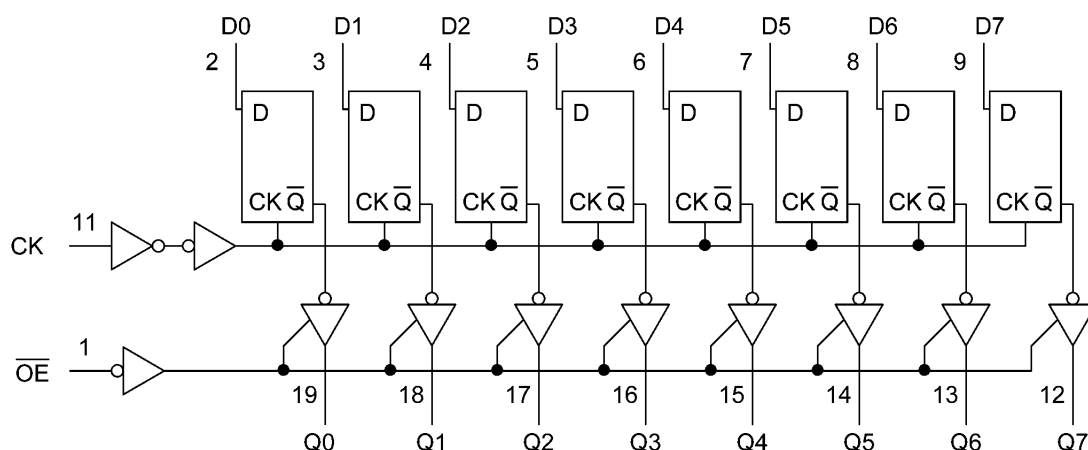


## 8. Truth Table

| Inputs          |    |   | Output |
|-----------------|----|---|--------|
| $\overline{OE}$ | CK | D |        |
| H               | X  | X | Z      |
| L               |    | X | Qn     |
| L               |    | L | L      |
| L               |    | H | H      |

X: Don't care  
 Z: High impedance  
 Qn: No change

## 9. System Diagram



## 10. Absolute Maximum Ratings (Note)

| Characteristics          | Symbol    | Note     | Rating                 | Unit |
|--------------------------|-----------|----------|------------------------|------|
| Supply voltage           | $V_{CC}$  |          | -0.5 to 7.0            | V    |
| Input voltage            | $V_{IN}$  |          | -0.5 to 7.0            | V    |
| Output voltage           | $V_{OUT}$ | (Note 1) | -0.5 to 7.0            | V    |
|                          |           | (Note 2) | -0.5 to $V_{CC} + 0.5$ |      |
| Input diode current      | $I_{IK}$  |          | -20                    | mA   |
| Output diode current     | $I_{OK}$  | (Note 3) | $\pm 20$               | mA   |
| Output current           | $I_{OUT}$ |          | $\pm 25$               | mA   |
| $V_{CC}$ /ground current | $I_{CC}$  |          | $\pm 75$               | mA   |
| Power dissipation        | $P_D$     | (Note 4) | 180                    | mW   |
| Storage temperature      | $T_{stg}$ |          | -65 to 150             | °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: Output in off-state.

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

Note 3:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

Note 4: 180 mW in the range of  $T_a = -40$  to  $85$  °C. From  $T_a = 85$  to  $125$  °C a derating factor of  $-3.25$  mW/°C shall be applied until 50 mW.

## 11. Operating Ranges (Note)

| Characteristics           | Symbol    | Note     | Rating        | Unit |
|---------------------------|-----------|----------|---------------|------|
| Supply voltage            | $V_{CC}$  |          | 4.5 to 5.5    | V    |
| Input voltage             | $V_{IN}$  |          | 0 to 5.5      | V    |
| Output voltage            | $V_{OUT}$ | (Note 1) | 0 to 5.5      | V    |
|                           |           | (Note 2) | 0 to $V_{CC}$ |      |
| Operating temperature     | $T_{opr}$ |          | -40 to 125    | °C   |
| Input rise and fall times | $dt/dv$   |          | 0 to 20       | ns/V |

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: Output in Off-state.

Note 2: High (H) or Low (L) state.

## 12. Electrical Characteristics

### 12.1. 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                 | $V_{IH}$  | —                                                                  | 4.5 to 5.5                        | 2.0 | —    | —          | V             |
| Low-level input voltage                  | $V_{IL}$  | —                                                                  | 4.5 to 5.5                        | —   | —    | 0.8        | V             |
| High-level output voltage                | $V_{OH}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                      | $I_{OH} = -50\text{ }\mu\text{A}$ | 4.5 | 4.40 | 4.50       | V             |
|                                          |           |                                                                    | $I_{OH} = -8\text{ mA}$           | 4.5 | 3.94 | —          |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                      | $I_{OL} = 50\text{ }\mu\text{A}$  | 4.5 | —    | 0.10       | V             |
|                                          |           |                                                                    | $I_{OL} = 8\text{ mA}$            | 4.5 | —    | 0.36       |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = V_{CC}$ or GND         | 5.5                               | —   | —    | $\pm 0.25$ | $\mu\text{A}$ |
| Input leakage current                    | $I_{IN}$  | $V_{IN} = 5.5\text{ V}$ or GND                                     | 0 to 5.5                          | —   | —    | $\pm 0.1$  | $\mu\text{A}$ |
| Quiescent supply current                 | $I_{CC}$  | $V_{IN} = V_{CC}$ or GND                                           | 5.5                               | —   | —    | 4.0        | $\mu\text{A}$ |
|                                          | $I_{CCT}$ | Per input: $V_{IN} = 3.4\text{ V}$<br>Other input: $V_{CC}$ or GND | 5.5                               | —   | —    | 1.35       | mA            |
| Output leakage current (Power-OFF)       | $I_{OPD}$ | $V_{OUT} = 5.5\text{ V}$                                           | 0                                 | —   | —    | 0.5        | $\mu\text{A}$ |

### 12.2. 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                 | $V_{IH}$  | —                                                                  | 4.5 to 5.5                        | 2.0 | —          | V             |
| Low-level input voltage                  | $V_{IL}$  | —                                                                  | 4.5 to 5.5                        | —   | 0.8        | V             |
| High-level output voltage                | $V_{OH}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                      | $I_{OH} = -50\text{ }\mu\text{A}$ | 4.5 | 4.40       | V             |
|                                          |           |                                                                    | $I_{OH} = -8\text{ mA}$           | 4.5 | 3.80       |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                      | $I_{OL} = 50\text{ }\mu\text{A}$  | 4.5 | —          | V             |
|                                          |           |                                                                    | $I_{OL} = 8\text{ mA}$            | 4.5 | —          |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = V_{CC}$ or GND         | 5.5                               | —   | $\pm 2.50$ | $\mu\text{A}$ |
| Input leakage current                    | $I_{IN}$  | $V_{IN} = 5.5\text{ V}$ or GND                                     | 0 to 5.5                          | —   | $\pm 1.0$  | $\mu\text{A}$ |
| Quiescent supply current                 | $I_{CC}$  | $V_{IN} = V_{CC}$ or GND                                           | 5.5                               | —   | 40.0       | $\mu\text{A}$ |
|                                          | $I_{CCT}$ | Per input: $V_{IN} = 3.4\text{ V}$<br>Other input: $V_{CC}$ or GND | 5.5                               | —   | 1.50       | mA            |
| Output leakage current (Power-OFF)       | $I_{OPD}$ | $V_{OUT} = 5.5\text{ V}$                                           | 0                                 | —   | 5.0        | $\mu\text{A}$ |

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

| Characteristics                          | Symbol    | Test Condition                                                     | $V_{CC}$ (V)                      | Min | Max        | Unit          |
|------------------------------------------|-----------|--------------------------------------------------------------------|-----------------------------------|-----|------------|---------------|
| High-level input voltage                 | $V_{IH}$  | —                                                                  | 4.5 to 5.5                        | 2.0 | —          | V             |
| Low-level input voltage                  | $V_{IL}$  | —                                                                  | 4.5 to 5.5                        | —   | 0.8        | V             |
| High-level output voltage                | $V_{OH}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                      | $I_{OH} = -50\text{ }\mu\text{A}$ | 4.5 | 4.40       | V             |
|                                          |           |                                                                    | $I_{OH} = -8\text{ mA}$           | 4.5 | 3.70       |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                      | $I_{OL} = 50\text{ }\mu\text{A}$  | 4.5 | —          | V             |
|                                          |           |                                                                    | $I_{OL} = 8\text{ mA}$            | 4.5 | —          |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = V_{CC}$ or GND         | 5.5                               | —   | $\pm 10.0$ | $\mu\text{A}$ |
| Input leakage current                    | $I_{IN}$  | $V_{IN} = 5.5\text{ V}$ or GND                                     | 0 to 5.5                          | —   | $\pm 2.0$  | $\mu\text{A}$ |
| Quiescent supply current                 | $I_{CC}$  | $V_{IN} = V_{CC}$ or GND                                           | 5.5                               | —   | 80.0       | $\mu\text{A}$ |
|                                          | $I_{CCT}$ | Per input: $V_{IN} = 3.4\text{ V}$<br>Other input: $V_{CC}$ or GND | 5.5                               | —   | 1.50       | mA            |
| Output leakage current (Power-OFF)       | $I_{OPD}$ | $V_{OUT} = 5.5\text{ V}$                                           | 0                                 | —   | 20.0       | $\mu\text{A}$ |

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

| Characteristics          | Symbol               | $V_{CC}$ (V)  | Typ. | Limit | Unit |
|--------------------------|----------------------|---------------|------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | $5.0 \pm 0.5$ | —    | 6.5   | ns   |
| Minimum setup time       | $t_s$                | $5.0 \pm 0.5$ | —    | 2.5   | ns   |
| Minimum hold time        | $t_h$                | $5.0 \pm 0.5$ | —    | 2.5   | ns   |

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

| Characteristics          | Symbol               | $V_{CC}$ (V)  | Limit | Unit |
|--------------------------|----------------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | $5.0 \pm 0.5$ | 8.5   | ns   |
| Minimum setup time       | $t_s$                | $5.0 \pm 0.5$ | 2.5   | ns   |
| Minimum hold time        | $t_h$                | $5.0 \pm 0.5$ | 2.5   | ns   |

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

| Characteristics          | Symbol               | $V_{CC}$ (V)  | Limit | Unit |
|--------------------------|----------------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | $5.0 \pm 0.5$ | 8.5   | ns   |
| Minimum setup time       | $t_s$                | $5.0 \pm 0.5$ | 3.0   | ns   |
| Minimum hold time        | $t_h$                | $5.0 \pm 0.5$ | 2.5   | ns   |

#### 12.7. AC Characteristics (Unless otherwise specified, $T_a = 25^\circ\text{C}$ , 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) | $t_{PLH}, t_{PHL}$   |          | —                        | $5.0 \pm 0.5$ | 15         | —   | 4.1  | 9.4  | ns   |
|                               |                      |          |                          |               | 50         | —   | 5.6  | 10.4 |      |
| 3-state output enable time    | $t_{PZL}, t_{PZH}$   |          | $R_L = 1\text{ k}\Omega$ | $5.0 \pm 0.5$ | 15         | —   | 6.5  | 10.2 | ns   |
|                               |                      |          |                          |               | 50         | —   | 7.3  | 11.2 |      |
| 3-state output disable time   | $t_{PLZ}, t_{PHZ}$   |          | $R_L = 1\text{ k}\Omega$ | $5.0 \pm 0.5$ | 50         | —   | 7.0  | 11.2 | ns   |
| Maximum clock frequency       | $f_{MAX}$            |          | —                        | $5.0 \pm 0.5$ | 15         | 90  | 140  | —    | MHz  |
|                               |                      |          |                          |               | 50         | 85  | 130  | —    |      |
| Output skew                   | $t_{osLH}, t_{osHL}$ | (Note 1) | —                        | $5.0 \pm 0.5$ | 50         | —   | —    | 1.0  | ns   |
| Input capacitance             | $C_{IN}$             |          | —                        |               |            | —   | 4    | 10   | pF   |
| Output capacitance            | $C_{OUT}$            |          | —                        |               |            | —   | 9    | —    | pF   |
| Power dissipation capacitance | $C_{PD}$             | (Note 2) | —                        |               |            | —   | 25   | —    | pF   |

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

Note 2:  $C_{PD}$  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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8 \text{ (per F/F)}$$

And the total  $C_{PD}$  when n pcs of F/F operate can be gained by the following equation.

$$C_{PD} \text{ (total)} = 14 + 11 \times n$$

## 12.8. AC Characteristics

(Unless otherwise specified,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 3$  ns)

| Characteristics               | Symbol               | Note     | Test Condition       | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|-------------------------------|----------------------|----------|----------------------|---------------|------------|-----|------|------|
| Propagation delay time (CK-Q) | $t_{PLH}, t_{PHL}$   |          | —                    | $5.0 \pm 0.5$ | 15         | 1.0 | 10.5 | ns   |
|                               |                      |          |                      |               | 50         | 1.0 | 11.5 |      |
| 3-state output enable time    | $t_{PZL}, t_{PZH}$   |          | $R_L = 1$ k $\Omega$ | $5.0 \pm 0.5$ | 15         | 1.0 | 11.5 | ns   |
|                               |                      |          |                      |               | 50         | 1.0 | 12.5 |      |
| 3-state output disable time   | $t_{PLZ}, t_{PHZ}$   |          | $R_L = 1$ k $\Omega$ | $5.0 \pm 0.5$ | 50         | 1.0 | 12.0 | ns   |
| Maximum clock frequency       | $f_{MAX}$            |          | —                    | $5.0 \pm 0.5$ | 15         | 80  | —    | MHz  |
|                               |                      |          |                      |               | 50         | 75  | —    |      |
| Output skew                   | $t_{osLH}, t_{osHL}$ | (Note 1) | —                    | $5.0 \pm 0.5$ | 50         | —   | 1.0  | ns   |
| Input capacitance             | $C_{IN}$             |          | —                    |               |            | —   | 10   | pF   |

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

## 12.9. AC Characteristics

(Unless otherwise specified,  $T_a = -40$  to  $125$  °C, Input:  $t_r = t_f = 3$  ns)

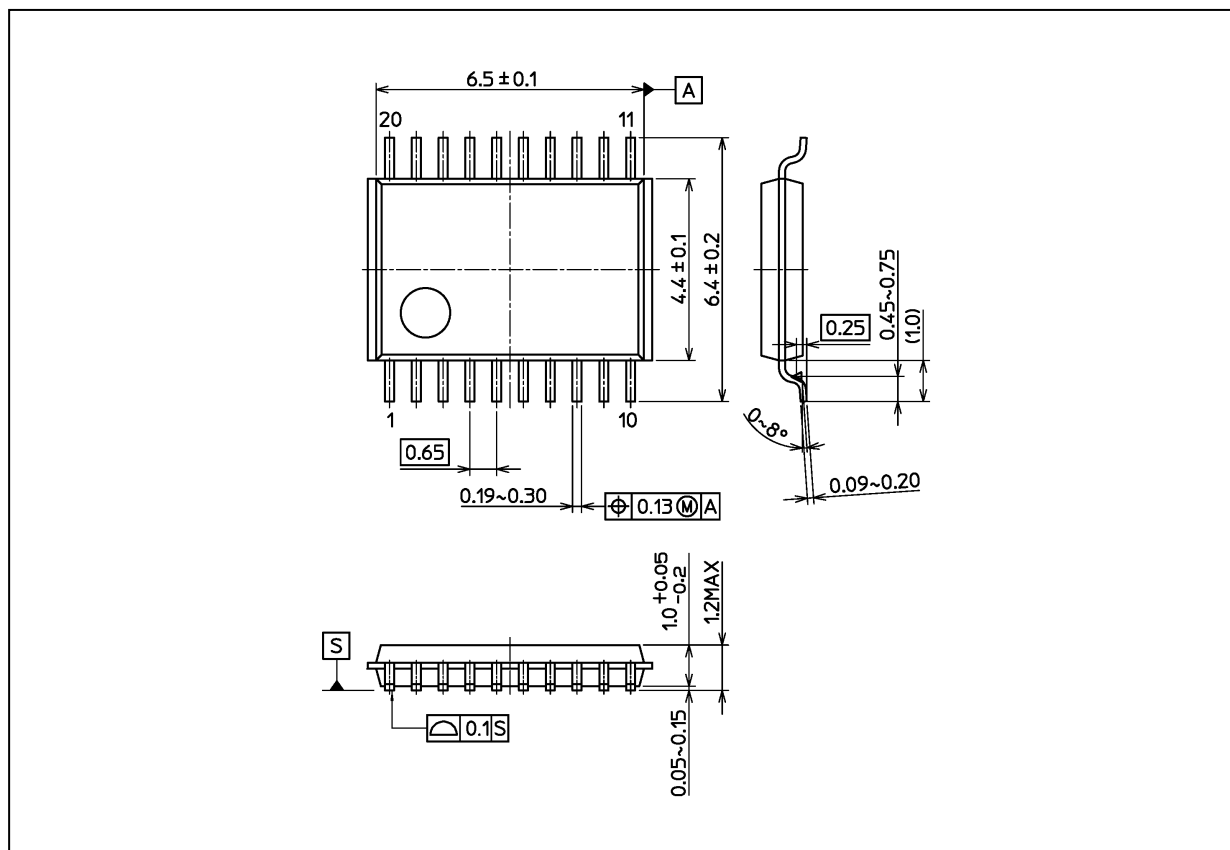
| Characteristics               | Symbol               | Note     | Test Condition       | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|-------------------------------|----------------------|----------|----------------------|---------------|------------|-----|------|------|
| Propagation delay time (CK-Q) | $t_{PLH}, t_{PHL}$   |          | —                    | $5.0 \pm 0.5$ | 15         | 1.0 | 12.0 | ns   |
|                               |                      |          |                      |               | 50         | 1.0 | 13.0 |      |
| 3-state output enable time    | $t_{PZL}, t_{PZH}$   |          | $R_L = 1$ k $\Omega$ | $5.0 \pm 0.5$ | 15         | 1.0 | 13.0 | ns   |
|                               |                      |          |                      |               | 50         | 1.0 | 14.0 |      |
| 3-state output disable time   | $t_{PLZ}, t_{PHZ}$   |          | $R_L = 1$ k $\Omega$ | $5.0 \pm 0.5$ | 50         | 1.0 | 14.0 | ns   |
| Maximum clock frequency       | $f_{MAX}$            |          | —                    | $5.0 \pm 0.5$ | 15         | 70  | —    | MHz  |
|                               |                      |          |                      | $5.0 \pm 0.5$ | 50         | 65  | —    |      |
| Output skew                   | $t_{osLH}, t_{osHL}$ | (Note 1) | —                    | $5.0 \pm 0.5$ | 50         | —   | 1.0  | ns   |
| Input capacitance             | $C_{IN}$             |          | —                    |               |            | —   | 10   | pF   |

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )12.10. Noise Characteristics (Unless otherwise specified,  $T_a = 25$ °C, Input:  $t_r = t_f = 3$  ns)

| Characteristics                          | Symbol    | Test Condition | $V_{CC}$ (V) | Typ. | Limit | Unit |
|------------------------------------------|-----------|----------------|--------------|------|-------|------|
| Quiet output maximum dynamic $V_{OL}$    | $V_{OLP}$ | $C_L = 50$ pF  | 5.0          | 1.1  | 1.5   | V    |
| Quiet output minimum dynamic $V_{OL}$    | $V_{OLV}$ | $C_L = 50$ pF  | 5.0          | -1.1 | -1.5  | V    |
| Minimum high-level dynamic input voltage | $V_{IHD}$ | $C_L = 50$ pF  | 5.0          | —    | 2.0   | V    |
| Maximum low-level dynamic input voltage  | $V_{ILD}$ | $C_L = 50$ pF  | 5.0          | —    | 0.8   | V    |

## Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

| Package Name(s)    |
|--------------------|
| Nickname: TSSOP20B |



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