

# 74VHCV574FT

## 1. Functional Description

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

## 2. General

The 74VHCV574FT is advanced high speed CMOS OCTAL FLIP-FLOP with 3-STATE OUTPUT fabricated with silicon gate CMOS 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.

Input pin have hysteresis between the positive-going and negative-going thresholds. Thus the 74VHCV574FT is capable of squaring up transitions of slowly changing input signals and provides an improved noise immunity.

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, etc.

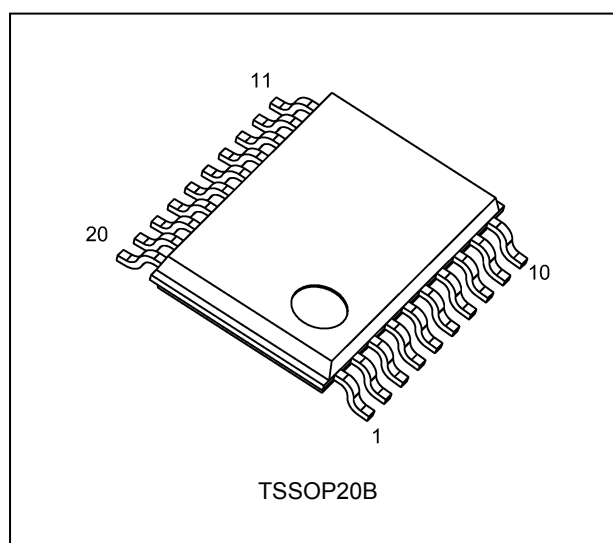
Note: Output in off-state.

## 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:  $f_{MAX} = 180$  MHz (typ.) at  $V_{CC} = 5.0$  V
- (4) Low power dissipation:  $I_{CC} = 2.0$   $\mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- (5) Wide operating voltage range:  $V_{CC(opr)} = 1.8$  V to  $5.5$  V
- (6) Output current:  $|I_{OH}|/I_{OL} = 16$  mA (min) ( $V_{CC} = 4.5$  V)
- (7) Power-down protection is provided on all inputs and outputs.
- (8) Pin and function compatible with the 74 series (74AC/HC/AHC/LV etc.) 574 type.

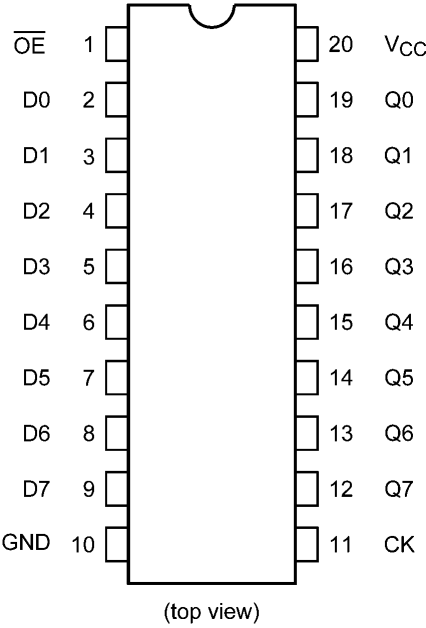
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

## 4. Packaging

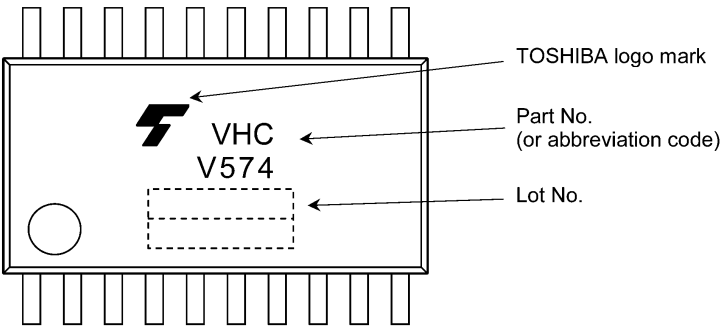


Start of commercial production  
2014-07

5. Pin Assignment



6. Marking

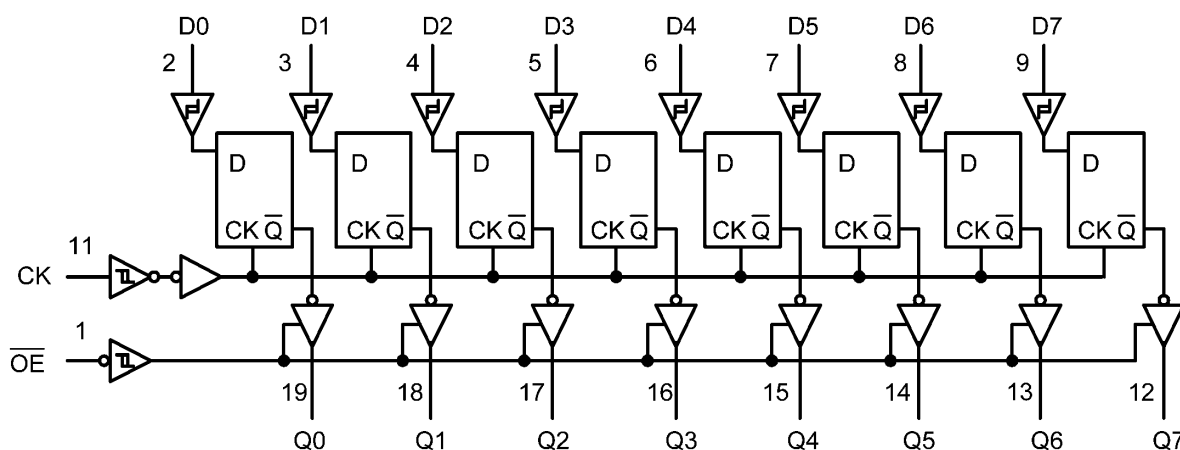


7. Truth Table

| 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

## 8. System Diagram



## 9. 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      | $I_{IK}$         |          | -50                    | mA   |
| Output diode current     | $I_{OK}$         | (Note 3) | $\pm 50$               | mA   |
| Output current           | $I_{OUT}$        |          | $\pm 50$               | mA   |
| Power dissipation        | $P_D$            | (Note 4) | 180                    | mW   |
| $V_{CC}$ /ground current | $I_{CC}/I_{GND}$ |          | $\pm 100$              | mA   |
| 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.

## 10. Operating Ranges (Note)

| Characteristics           | Symbol    | Test Condition           | Note     | Rating        | Unit |
|---------------------------|-----------|--------------------------|----------|---------------|------|
| Supply voltage            | $V_{CC}$  | —                        |          | 1.8 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 | $dt/dv$   | $V_{CC} = 3.3 \pm 0.3$ V |          | 0 to 20       | ms/V |
|                           |           | $V_{CC} = 5 \pm 0.5$ V   |          | 0 to 1        |      |

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.

## 11. Electrical Characteristics

11.1. 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               | $V_P$     | —                                                                |                                   | 1.8          | —    | —    | 1.65      | V             |
|                                          |           |                                                                  |                                   | 2.3          | —    | —    | 1.85      |               |
|                                          |           |                                                                  |                                   | 3.0          | —    | —    | 2.20      |               |
|                                          |           |                                                                  |                                   | 4.5          | —    | —    | 3.15      |               |
|                                          |           |                                                                  |                                   | 5.5          | —    | —    | 3.85      |               |
| Negative threshold voltage               | $V_N$     | —                                                                |                                   | 1.8          | 0.15 | —    | —         | V             |
|                                          |           |                                                                  |                                   | 2.3          | 0.45 | —    | —         |               |
|                                          |           |                                                                  |                                   | 3.0          | 0.90 | —    | —         |               |
|                                          |           |                                                                  |                                   | 4.5          | 1.35 | —    | —         |               |
|                                          |           |                                                                  |                                   | 5.5          | 1.65 | —    | —         |               |
| Hysteresis voltage                       | $V_H$     | —                                                                |                                   | 1.8          | 0.15 | —    | 1.05      | V             |
|                                          |           |                                                                  |                                   | 2.3          | 0.20 | —    | 1.10      |               |
|                                          |           |                                                                  |                                   | 3.0          | 0.30 | —    | 1.20      |               |
|                                          |           |                                                                  |                                   | 4.5          | 0.40 | —    | 1.40      |               |
|                                          |           |                                                                  |                                   | 5.5          | 0.50 | —    | 1.60      |               |
| High-level output voltage                | $V_{OH}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                    | $I_{OH} = -50\text{ }\mu\text{A}$ | 1.8          | 1.7  | 1.8  | —         | V             |
|                                          |           |                                                                  |                                   | 3.0          | 2.9  | 3.0  | —         |               |
|                                          |           |                                                                  |                                   | 4.5          | 4.4  | 4.5  | —         |               |
|                                          |           |                                                                  | $I_{OH} = -8\text{ mA}$           | 3.0          | 2.58 | —    | —         |               |
|                                          |           |                                                                  | $I_{OH} = -16\text{ mA}$          | 4.5          | 3.94 | —    | —         |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                    | $I_{OL} = 50\text{ }\mu\text{A}$  | 1.8          | —    | 0.0  | 0.1       | V             |
|                                          |           |                                                                  |                                   | 3.0          | —    | 0.0  | 0.1       |               |
|                                          |           |                                                                  |                                   | 4.5          | —    | 0.0  | 0.1       |               |
|                                          |           |                                                                  | $I_{OL} = 8\text{ mA}$            | 3.0          | —    | —    | 0.36      |               |
|                                          |           |                                                                  | $I_{OL} = 16\text{ mA}$           | 4.5          | —    | —    | 0.44      |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = 0$ to $5.5\text{ V}$ |                                   | 1.8 to 5.5   | —    | —    | $\pm 0.5$ | $\mu\text{A}$ |
| Power-OFF leakage current                | $I_{OFF}$ | $V_{IN}/V_{OUT} = 5.5\text{ V}$                                  |                                   | 0            | —    | —    | 0.5       | $\mu\text{A}$ |
| 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          | —    | —    | 2.0       | $\mu\text{A}$ |

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

| Characteristics                          | Symbol    | Test Condition                                                   |                                   | $V_{CC}$ (V) | Min  | Max       | Unit          |
|------------------------------------------|-----------|------------------------------------------------------------------|-----------------------------------|--------------|------|-----------|---------------|
| Positive threshold voltage               | $V_P$     | —                                                                |                                   | 1.8          | —    | 1.65      | V             |
|                                          |           |                                                                  |                                   | 2.3          | —    | 1.85      |               |
|                                          |           |                                                                  |                                   | 3.0          | —    | 2.20      |               |
|                                          |           |                                                                  |                                   | 4.5          | —    | 3.15      |               |
|                                          |           |                                                                  |                                   | 5.5          | —    | 3.85      |               |
| Negative threshold voltage               | $V_N$     | —                                                                |                                   | 1.8          | 0.15 | —         | V             |
|                                          |           |                                                                  |                                   | 2.3          | 0.45 | —         |               |
|                                          |           |                                                                  |                                   | 3.0          | 0.90 | —         |               |
|                                          |           |                                                                  |                                   | 4.5          | 1.35 | —         |               |
|                                          |           |                                                                  |                                   | 5.5          | 1.65 | —         |               |
| Hysteresis voltage                       | $V_H$     | —                                                                |                                   | 1.8          | 0.15 | 1.05      | V             |
|                                          |           |                                                                  |                                   | 2.3          | 0.20 | 1.10      |               |
|                                          |           |                                                                  |                                   | 3.0          | 0.30 | 1.20      |               |
|                                          |           |                                                                  |                                   | 4.5          | 0.40 | 1.40      |               |
|                                          |           |                                                                  |                                   | 5.5          | 0.50 | 1.60      |               |
| High-level output voltage                | $V_{OH}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                    | $I_{OH} = -50\text{ }\mu\text{A}$ | 1.8          | 1.7  | —         | V             |
|                                          |           |                                                                  |                                   | 3.0          | 2.9  | —         |               |
|                                          |           |                                                                  |                                   | 4.5          | 4.4  | —         |               |
|                                          |           |                                                                  | $I_{OH} = -8\text{ mA}$           | 3.0          | 2.48 | —         |               |
|                                          |           |                                                                  | $I_{OH} = -16\text{ mA}$          | 4.5          | 3.80 | —         |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                    | $I_{OL} = 50\text{ }\mu\text{A}$  | 1.8          | —    | 0.1       | V             |
|                                          |           |                                                                  |                                   | 3.0          | —    | 0.1       |               |
|                                          |           |                                                                  |                                   | 4.5          | —    | 0.1       |               |
|                                          |           |                                                                  | $I_{OL} = 8\text{ mA}$            | 3.0          | —    | 0.44      |               |
|                                          |           |                                                                  | $I_{OL} = 16\text{ mA}$           | 4.5          | —    | 0.55      |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = 0$ to $5.5\text{ V}$ |                                   | 1.8 to 5.5   | —    | $\pm 5.0$ | $\mu\text{A}$ |
| Power-OFF leakage current                | $I_{OFF}$ | $V_{IN}/V_{OUT} = 5.5\text{ V}$                                  |                                   | 0            | —    | 5.0       | $\mu\text{A}$ |
| 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          | —    | 20.0      | $\mu\text{A}$ |

11.3. DC Characteristics (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               | $V_P$     | —                                                                |                                   | 1.8          | —    | 1.65       | V             |
|                                          |           |                                                                  |                                   | 2.3          | —    | 1.85       |               |
|                                          |           |                                                                  |                                   | 3.0          | —    | 2.20       |               |
|                                          |           |                                                                  |                                   | 4.5          | —    | 3.15       |               |
|                                          |           |                                                                  |                                   | 5.5          | —    | 3.85       |               |
| Negative threshold voltage               | $V_N$     | —                                                                |                                   | 1.8          | 0.15 | —          | V             |
|                                          |           |                                                                  |                                   | 2.3          | 0.45 | —          |               |
|                                          |           |                                                                  |                                   | 3.0          | 0.90 | —          |               |
|                                          |           |                                                                  |                                   | 4.5          | 1.35 | —          |               |
|                                          |           |                                                                  |                                   | 5.5          | 1.65 | —          |               |
| Hysteresis voltage                       | $V_H$     | —                                                                |                                   | 1.8          | 0.15 | 1.05       | V             |
|                                          |           |                                                                  |                                   | 2.3          | 0.20 | 1.10       |               |
|                                          |           |                                                                  |                                   | 3.0          | 0.30 | 1.20       |               |
|                                          |           |                                                                  |                                   | 4.5          | 0.40 | 1.40       |               |
|                                          |           |                                                                  |                                   | 5.5          | 0.50 | 1.60       |               |
| High-level output voltage                | $V_{OH}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                    | $I_{OH} = -50\text{ }\mu\text{A}$ | 1.8          | 1.7  | —          | V             |
|                                          |           |                                                                  |                                   | 3.0          | 2.9  | —          |               |
|                                          |           |                                                                  |                                   | 4.5          | 4.4  | —          |               |
|                                          |           |                                                                  | $I_{OH} = -8\text{ mA}$           | 3.0          | 2.40 | —          |               |
|                                          |           |                                                                  | $I_{OH} = -16\text{ mA}$          | 4.5          | 3.70 | —          |               |
| Low-level output voltage                 | $V_{OL}$  | $V_{IN} = V_{IH}$ or $V_{IL}$                                    | $I_{OL} = 50\text{ }\mu\text{A}$  | 1.8          | —    | 0.1        | V             |
|                                          |           |                                                                  |                                   | 3.0          | —    | 0.1        |               |
|                                          |           |                                                                  |                                   | 4.5          | —    | 0.1        |               |
|                                          |           |                                                                  | $I_{OL} = 8\text{ mA}$            | 3.0          | —    | 0.55       |               |
|                                          |           |                                                                  | $I_{OL} = 16\text{ mA}$           | 4.5          | —    | 0.65       |               |
| 3-state output OFF-state leakage current | $I_{OZ}$  | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = 0$ to $5.5\text{ V}$ |                                   | 1.8 to 5.5   | —    | $\pm 20.0$ | $\mu\text{A}$ |
| Power-OFF leakage current                | $I_{OFF}$ | $V_{IN}/V_{OUT} = 5.5\text{ V}$                                  |                                   | 0            | —    | 20.0       | $\mu\text{A}$ |
| 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          | —    | 40.0       | $\mu\text{A}$ |

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

| Characteristics          | Symbol               | $V_{CC}$ (V)  | Limit | Unit |
|--------------------------|----------------------|---------------|-------|------|
| Minimum pulse width (CK) | $t_{w(L)}, t_{w(H)}$ | $2.5 \pm 0.2$ | 7.0   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 5.0   |      |
|                          |                      | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time       | $t_s$                | $2.5 \pm 0.2$ | 5.5   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 3.5   |      |
|                          |                      | $5.0 \pm 0.5$ | 3.5   |      |
| Minimum hold time        | $t_h$                | $2.5 \pm 0.2$ | 2.0   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 1.5   |      |
|                          |                      | $5.0 \pm 0.5$ | 1.5   |      |

**11.5. 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) | $t_{w(L)}, t_{w(H)}$ | $2.5 \pm 0.2$ | 7.0   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 5.0   |      |
|                          |                      | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time       | $t_s$                | $2.5 \pm 0.2$ | 5.5   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 3.5   |      |
|                          |                      | $5.0 \pm 0.5$ | 3.5   |      |
| Minimum hold time        | $t_h$                | $2.5 \pm 0.2$ | 2.0   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 1.5   |      |
|                          |                      | $5.0 \pm 0.5$ | 1.5   |      |

**11.6. 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) | $t_{w(L)}, t_{w(H)}$ | $2.5 \pm 0.2$ | 7.0   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 5.0   |      |
|                          |                      | $5.0 \pm 0.5$ | 5.0   |      |
| Minimum setup time       | $t_s$                | $2.5 \pm 0.2$ | 7.0   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 4.5   |      |
|                          |                      | $5.0 \pm 0.5$ | 4.0   |      |
| Minimum hold time        | $t_h$                | $2.5 \pm 0.2$ | 2.0   | ns   |
|                          |                      | $3.3 \pm 0.3$ | 1.5   |      |
|                          |                      | $5.0 \pm 0.5$ | 1.5   |      |

11.7. 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) | $t_{PLH}, t_{PHL}$   |          | —                        | $2.5 \pm 0.2$ | 15         | —   | 9.1  | 16.6 | ns   |
|                               |                      |          |                          |               | 50         | —   | 11.9 | 19.6 |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | —   | 6.7  | 13.2 |      |
|                               |                      |          |                          |               | 50         | —   | 8.9  | 16.7 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | —   | 5.0  | 8.6  |      |
|                               |                      |          |                          |               | 50         | —   | 6.7  | 10.6 |      |
| 3-state output enable time    | $t_{PZL}, t_{PZH}$   |          | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 15         | —   | 7.6  | 16.1 | ns   |
|                               |                      |          |                          |               | 50         | —   | 10.7 | 19.0 |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | —   | 5.7  | 12.8 |      |
|                               |                      |          |                          |               | 50         | —   | 8.1  | 16.3 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | —   | 4.2  | 9.0  |      |
|                               |                      |          |                          |               | 50         | —   | 6.1  | 11.0 |      |
| 3-state output disable time   | $t_{PLZ}, t_{PHZ}$   |          | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 50         | —   | 13.6 | 17.5 | ns   |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 50         | —   | 10.5 | 15.0 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 50         | —   | 8.2  | 10.1 |      |
| Maximum clock frequency       | $f_{MAX}$            |          | —                        | $2.5 \pm 0.2$ | 15         | 60  | 95   | —    | MHz  |
|                               |                      |          |                          |               | 50         | 50  | 75   | —    |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | 80  | 135  | —    |      |
|                               |                      |          |                          |               | 50         | 55  | 100  | —    |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | 130 | 180  | —    |      |
|                               |                      |          |                          |               | 50         | 85  | 135  | —    |      |
| Output skew                   | $t_{osLH}, t_{osHL}$ | (Note 1) | —                        | $2.5 \pm 0.2$ | 50         | —   | —    | 2.0  | ns   |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 50         | —   | —    | 1.5  | ns   |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 50         | —   | —    | 1.0  | ns   |
| Input capacitance             | $C_{IN}$             |          | —                        |               |            | —   | 4    | 10   | pF   |
| Output capacitance            | $C_{OUT}$            |          | —                        |               |            | —   | 6    | —    | pF   |
| Power dissipation capacitance | $C_{PD}$             | (Note 2) | —                        |               |            | —   | 26   | —    | 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.

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

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

$$C_{PD} \text{ (total)} = 14 + 12 \times n$$

## 11.8. 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) | $t_{PLH}, t_{PHL}$   |          | —                        | $2.5 \pm 0.2$ | 15         | 1.0 | 20.0 | ns   |
|                               |                      |          |                          |               | 50         | 1.0 | 23.0 |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | 1.0 | 15.5 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 19.0 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | 1.0 | 10.0 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 12.0 |      |
| 3-state output enable time    | $t_{PZL}, t_{PZH}$   |          | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 15         | 1.0 | 19.0 | ns   |
|                               |                      |          |                          |               | 50         | 1.0 | 22.0 |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | 1.0 | 15.0 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 18.5 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | 1.0 | 10.5 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 12.5 |      |
| 3-state output disable time   | $t_{PLZ}, t_{PHZ}$   |          | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 50         | 1.0 | 20.0 | ns   |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 50         | 1.0 | 17.0 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 50         | 1.0 | 11.5 |      |
| Maximum clock frequency       | $f_{MAX}$            |          | —                        | $2.5 \pm 0.2$ | 15         | 50  | —    | MHz  |
|                               |                      |          |                          |               | 50         | 40  | —    |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | 65  | —    |      |
|                               |                      |          |                          |               | 50         | 45  | —    |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | 110 | —    |      |
|                               |                      |          |                          |               | 50         | 75  | —    |      |
| Output skew                   | $t_{osLH}, t_{osHL}$ | (Note 1) | —                        | $2.5 \pm 0.2$ | 50         | —   | 2.0  | ns   |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 50         | —   | 1.5  | ns   |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 50         | —   | 1.0  |      |
| Input capacitance             | $C_{IN}$             |          | —                        |               |            | —   | 10   | pF   |

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

## 11.9. AC Characteristics

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

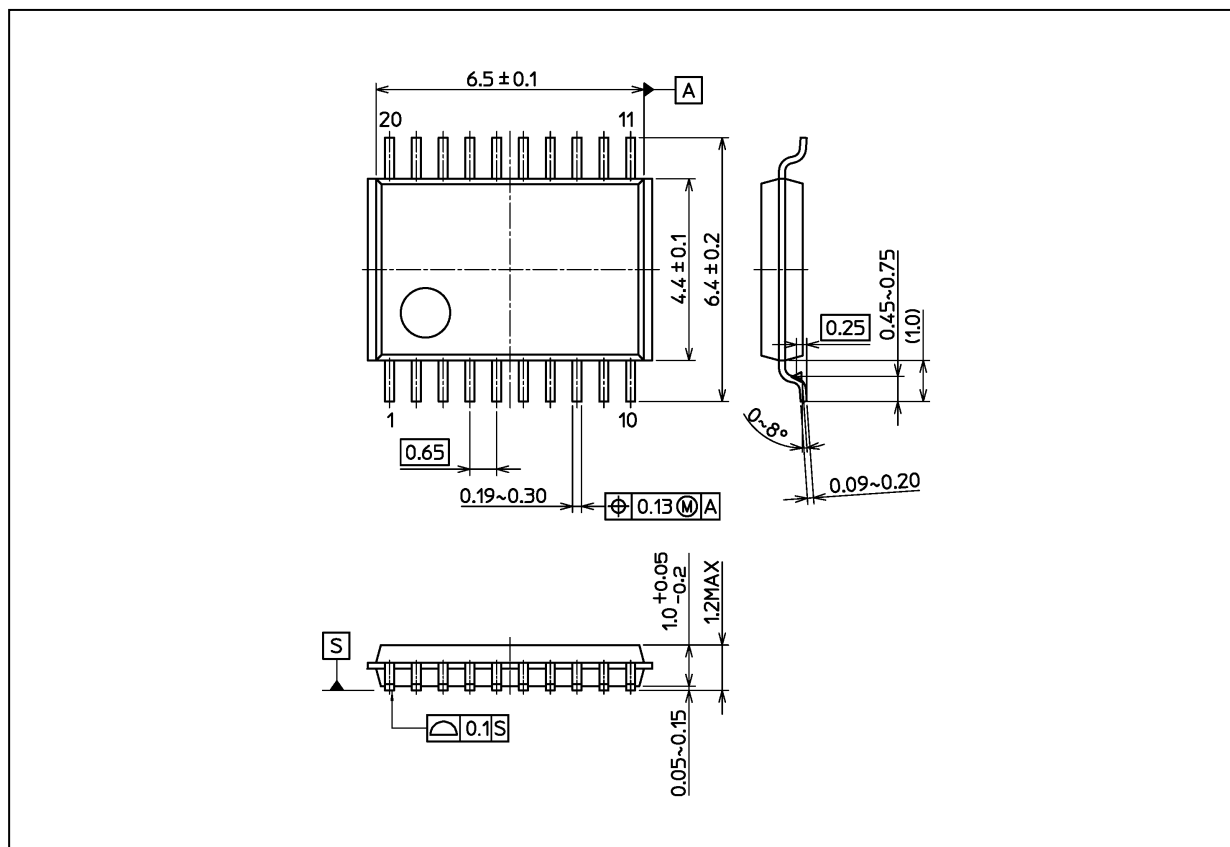
| Characteristics               | Symbol               | Note     | Test Condition           | $V_{CC}$ (V)  | $C_L$ (pF) | Min | Max  | Unit |
|-------------------------------|----------------------|----------|--------------------------|---------------|------------|-----|------|------|
| Propagation delay time (CK-Q) | $t_{PLH}, t_{PHL}$   |          | —                        | $2.5 \pm 0.2$ | 15         | 1.0 | 22.5 | ns   |
|                               |                      |          |                          |               | 50         | 1.0 | 25.5 |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | 1.0 | 17.5 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 21.0 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | 1.0 | 11.5 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 13.5 |      |
| 3-state output enable time    | $t_{PZL}, t_{PZH}$   |          | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 15         | 1.0 | 21.0 | ns   |
|                               |                      |          |                          |               | 50         | 1.0 | 24.0 |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | 1.0 | 17.0 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 20.5 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | 1.0 | 12.0 |      |
|                               |                      |          |                          |               | 50         | 1.0 | 14.0 |      |
| 3-state output disable time   | $t_{PLZ}, t_{PHZ}$   |          | $R_L = 1\text{ k}\Omega$ | $2.5 \pm 0.2$ | 50         | 1.0 | 22.0 | ns   |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 50         | 1.0 | 19.0 |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 50         | 1.0 | 13.0 |      |
| Maximum clock frequency       | $f_{MAX}$            |          | —                        | $2.5 \pm 0.2$ | 15         | 40  | —    | MHz  |
|                               |                      |          |                          |               | 50         | 30  | —    |      |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 15         | 60  | —    |      |
|                               |                      |          |                          |               | 50         | 40  | —    |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 15         | 100 | —    |      |
|                               |                      |          |                          |               | 50         | 65  | —    |      |
| Output skew                   | $t_{OSLH}, t_{OSHL}$ | (Note 1) | —                        | $2.5 \pm 0.2$ | 50         | —   | 2.0  | ns   |
|                               |                      |          |                          | $3.3 \pm 0.3$ | 50         | —   | 1.5  |      |
|                               |                      |          |                          | $5.0 \pm 0.5$ | 50         | —   | 1.0  |      |
| Input capacitance             | $C_{IN}$             |          | —                        |               |            | —   | 10   | pF   |

Note 1: Parameter guaranteed by design. ( $t_{OSLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{OSHL} = |t_{PHLM} - t_{PHLN}|$ )11.10. Noise Characteristics (Unless otherwise specified,  $T_a = 25^\circ\text{C}$ , Input:  $t_r = t_f = 3\text{ ns}$ )

| Characteristics                          | Symbol    | Test Condition       | $V_{CC}$ (V) | Typ. | Max | Unit |
|------------------------------------------|-----------|----------------------|--------------|------|-----|------|
| Quiet output maximum dynamic $V_{OL}$    | $V_{OLP}$ | $C_L = 50\text{ pF}$ | 3.3          | 0.4  | —   | V    |
|                                          |           |                      | 5.0          | 0.8  | —   |      |
| Quiet output minimum dynamic $V_{OL}$    | $V_{OLV}$ | $C_L = 50\text{ pF}$ | 3.3          | -0.1 | —   | V    |
|                                          |           |                      | 5.0          | -0.4 | —   |      |
| Minimum high-level dynamic input voltage | $V_{IHD}$ | $C_L = 50\text{ pF}$ | 5.0          | —    | 3.5 | V    |
| Maximum low-level dynamic input voltage  | $V_{ILD}$ | $C_L = 50\text{ pF}$ | 5.0          | —    | 1.5 | V    |

## Package Dimensions

Unit: mm



Weight: 0.071 g (typ.)

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

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