

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 C²MOS 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.

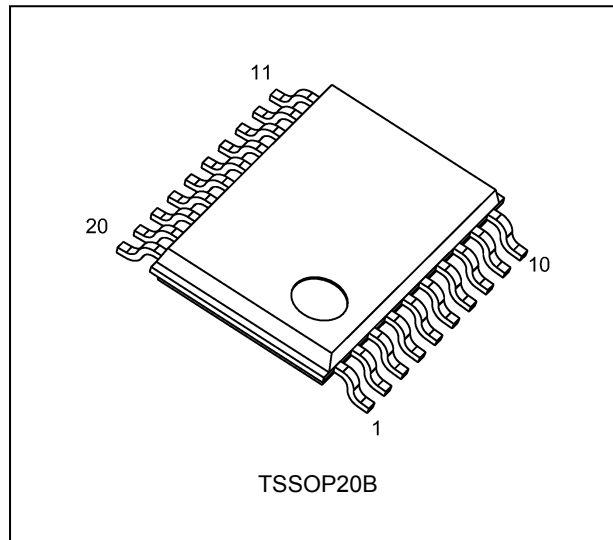
Note: Output in off-state

3. Features

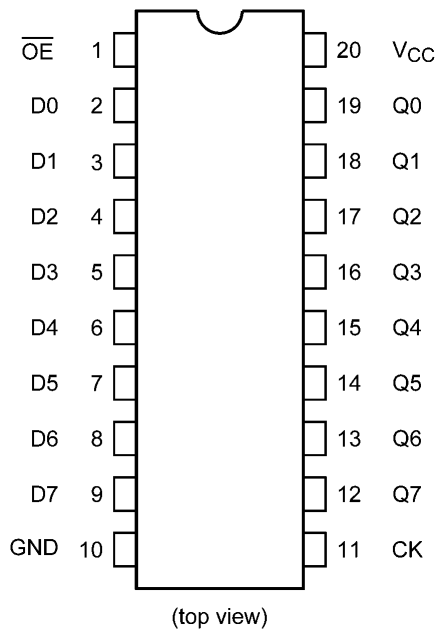
- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range: $T_{opr} = -40$ to 125 °C
- (3) High speed: $f_{MAX} = 140$ MHz (typ.) at $V_{CC} = 5.0$ V
- (4) Low power dissipation: $I_{CC} = 4.0$ μ A (max) at $T_a = 25$ °C
- (5) Compatible with TTL inputs: $V_{IL} = 0.8$ V (max)
 $V_{IH} = 2.0$ 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: $V_{OLP} = 1.5$ 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.

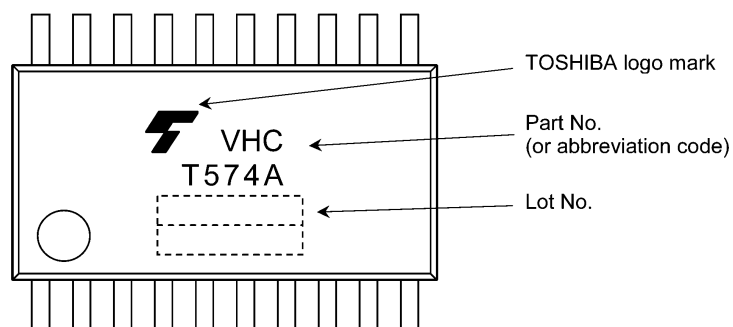
4. Packaging



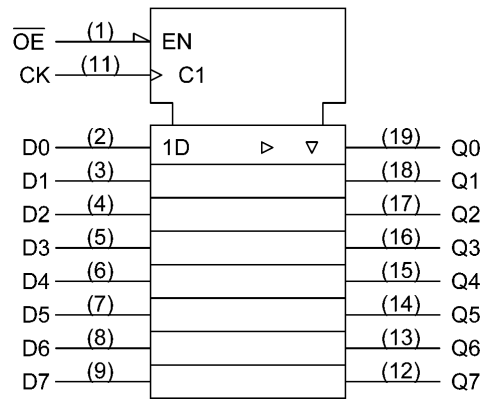
5. Pin Assignment



6. Marking



7. IEC Logic Symbol

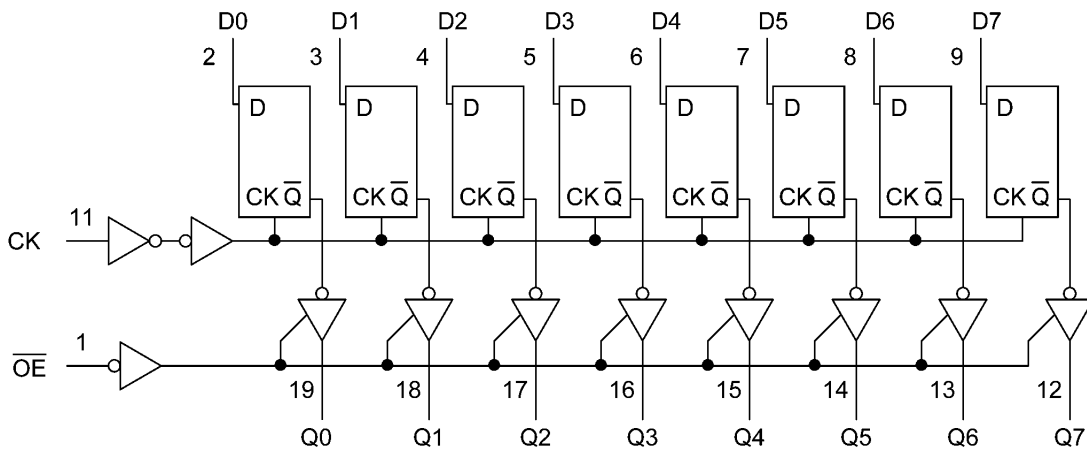


8. Truth Table

| Inputs | | | Output |
|-----------------|--------------|---|--------|
| \overline{OE} | CK | D | |
| H | X | X | Z |
| L | \downarrow | X | Qn |
| L | \uparrow | L | L |
| L | \uparrow | 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) | ± 20 | mA |
| Output current | I_{OUT} | | ± 25 | mA |
| V_{CC} /ground current | I_{CC} | | ± 75 | mA |
| Power dissipation | P_D | (Note 4) | 180 | mW |
| Storage temperature | T_{stg} | | -65 to 150 | $^{\circ}C$ |

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 $85^{\circ}C$. From $T_a = 85$ to $125^{\circ}C$ a derating factor of -3.25 mW/ $^{\circ}C$ 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 | $^{\circ}C$ |
| 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 | — | 0.0 | 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} $V_{OUT} = V_{CC}$ or GND | 5.5 | — | — | ± 0.25 | μA | |
| 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} | $V_{IN} = V_{CC}$ or GND | 5.5 | — | — | 4.0 | μA | |
| | I_{CCT} | Per input: $V_{IN} = 3.4\text{ V}$ 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 | μA | |

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 | — | 0.10 | V |
| | | | $I_{OL} = 8\text{ mA}$ | 4.5 | — | 0.44 | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = V_{CC}$ or GND | 5.5 | — | ± 2.50 | μA | |
| 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} | $V_{IN} = V_{CC}$ or GND | 5.5 | — | 40.0 | μA | |
| | I_{CCT} | Per input: $V_{IN} = 3.4\text{ V}$ 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 | μA | |

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 | — | 0.10 | V |
| | | | $I_{OL} = 8\text{ mA}$ | 4.5 | — | 0.55 | |
| 3-state output OFF-state leakage current | I_{OZ} | $V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = V_{CC}$ or GND | 5.5 | — | ± 10.0 | μA | |
| 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 | — | 80.0 | μA | |
| | I_{CCT} | Per input: $V_{IN} = 3.4\text{ V}$ 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 | μA | |

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 ± 0.5 | — | 6.5 | ns |
| Minimum setup time | t_S | 5.0 ± 0.5 | — | 2.5 | ns |
| Minimum hold time | t_h | 5.0 ± 0.5 | — | 2.5 | ns |

12.5. Timing Requirements (Unless otherwise specified, $T_a = -40$ to 85°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 ± 0.5 | 8.5 | ns |
| Minimum setup time | t_S | 5.0 ± 0.5 | 2.5 | ns |
| Minimum hold time | t_h | 5.0 ± 0.5 | 2.5 | ns |

12.6. Timing Requirements (Unless otherwise specified, $T_a = -40$ to 125°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 ± 0.5 | 8.5 | ns |
| Minimum setup time | t_S | 5.0 ± 0.5 | 3.0 | ns |
| Minimum hold time | t_h | 5.0 ± 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 ± 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 ± 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 ± 0.5 | 50 | — | 7.0 | 11.2 | ns |
| Maximum clock frequency | f_{MAX} | | — | 5.0 ± 0.5 | 15 | 90 | 140 | — | MHz |
| | | | | | 50 | 85 | 130 | — | |
| Output skew | $t_{oS LH}, t_{oS HL}$ | (Note 1) | — | 5.0 ± 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. ($t_{oS LH} = |t_{PLHM} - t_{PLHN}|$, $t_{oS HL} = |t_{PHLM} - t_{PHLN}|$)

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 ± 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 Ω | 5.0 ± 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 Ω | 5.0 ± 0.5 | 50 | 1.0 | 12.0 | ns |
| Maximum clock frequency | f_{MAX} | | — | 5.0 ± 0.5 | 15 | 80 | — | MHz |
| | | | | | 50 | 75 | — | |
| Output skew | t_{osLH}, t_{osHL} | (Note 1) | — | 5.0 ± 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 ± 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 Ω | 5.0 ± 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 Ω | 5.0 ± 0.5 | 50 | 1.0 | 14.0 | ns |
| Maximum clock frequency | f_{MAX} | | — | 5.0 ± 0.5 | 15 | 70 | — | MHz |
| | | | | | 50 | 65 | — | |
| Output skew | t_{osLH}, t_{osHL} | (Note 1) | — | 5.0 ± 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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