

# 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.

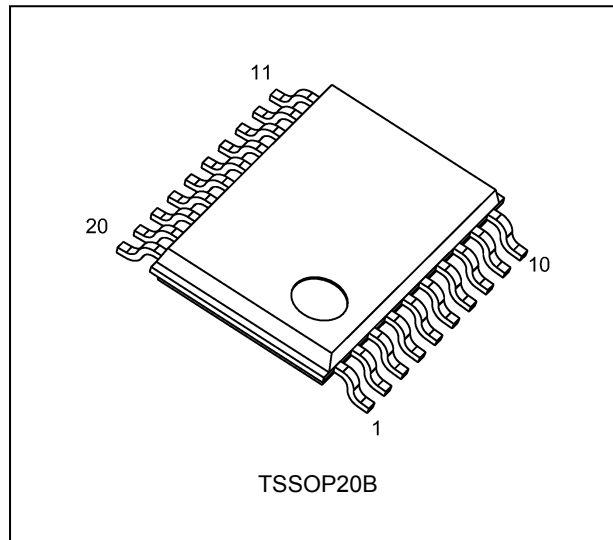
Note: Output in off-state

## 3. Features

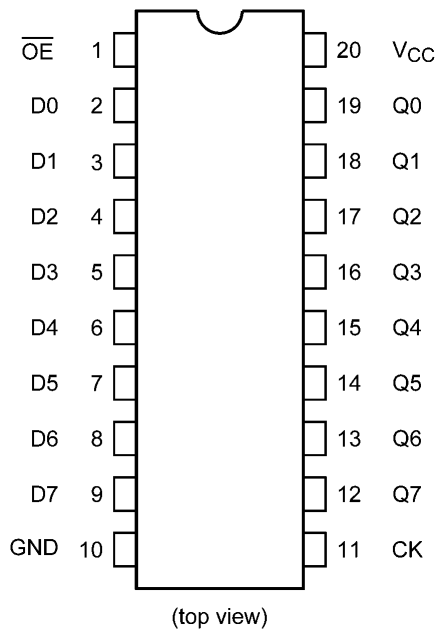
- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C
- (3) High speed:  $f_{MAX} = 140$ MHz (typ.) at  $V_{CC} = 5.0$  V
- (4) Low power dissipation:  $I_{CC} = 4.0$   $\mu$ A (max) at  $T_a = 25$ °C
- (5) Compatible with TTL inputs:  $V_{IL} = 0.8$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

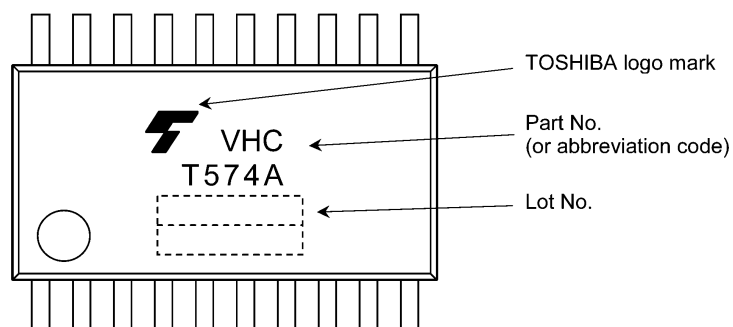
**4. Packaging**



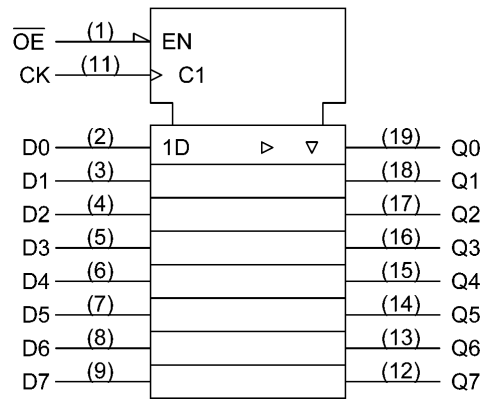
**5. Pin Assignment**



**6. Marking**



**7. IEC Logic Symbol**

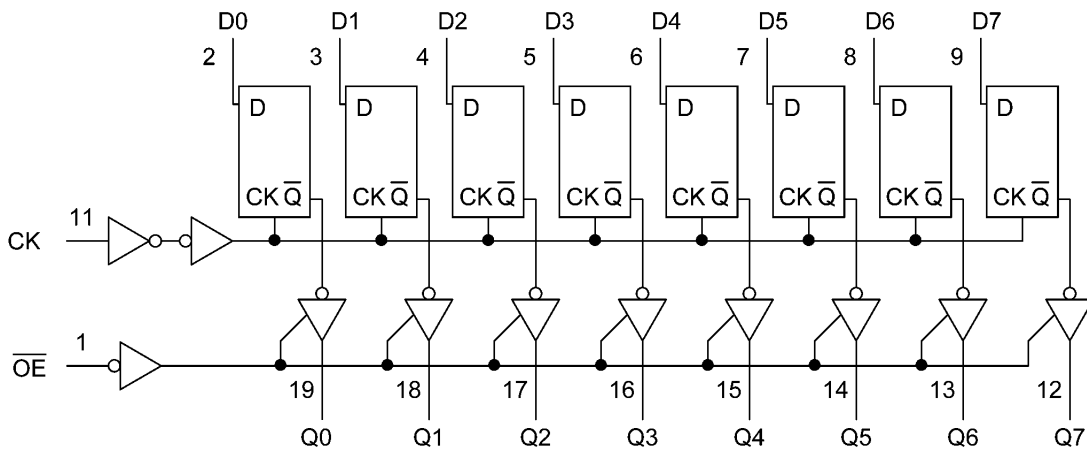


**8. Truth Table**

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)	$\pm 20$	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	$^{\circ}C$

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	—	—	$\pm 0.25$	$\mu\text{A}$	
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: $V_{IN} = 3.4\text{ V}$ 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,  $T_a = -40$  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	—	$\pm 2.50$	$\mu\text{A}$	
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: $V_{IN} = 3.4\text{ V}$ 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,  $T_a = -40$  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	—	$\pm 10.0$	$\mu\text{A}$	
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: $V_{IN} = 3.4\text{ V}$ 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
					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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