

# 74VHC74FT

## 1. Functional Description

- Dual D-Type Flip-Flop with Preset and Clear

## 2. General

The 74VHC74FT is an advanced high speed CMOS D-FLIP FLOP 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.

The signal level applied to the D INPUT is transferred to Q OUTPUT during the positive going transition of the CK pulse.

$\overline{\text{CLR}}$  and  $\overline{\text{PR}}$  are independent of the CK and are accomplished by setting the appropriate input low.

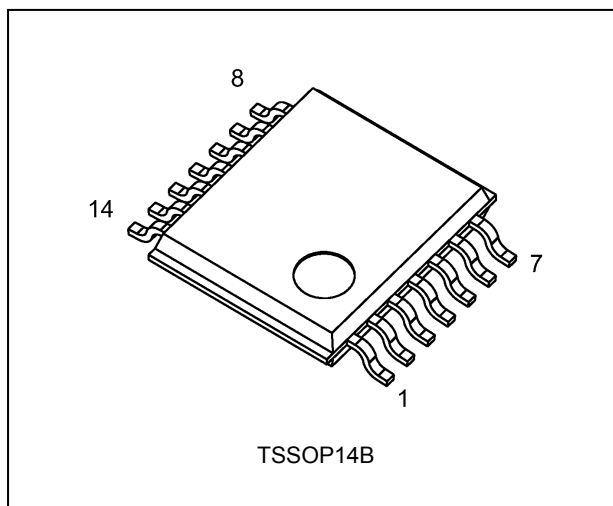
An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{\text{opr}} = -40$  to  $125$  °C
- (3) High speed:  $f_{\text{MAX}} = 170$  MHz (typ.) at  $V_{\text{CC}} = 5.0$  V
- (4) Low power dissipation:  $I_{\text{CC}} = 2.0$   $\mu\text{A}$  (max) at  $T_a = 25$ °C
- (5) High noise immunity:  $V_{\text{NIH}} = V_{\text{NIL}} = 28\%$   $V_{\text{CC}}$  (min)
- (6) Power-down protection is provided on all inputs.
- (7) Balanced propagation delays:  $t_{\text{PLH}} \approx t_{\text{PHL}}$
- (8) Wide operating voltage range:  $V_{\text{CC(opr)}} = 2.0$  V to 5.5 V
- (9) Pin and function compatible with the 74 series (74AC/HC/AHC etc.) 74 type.

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

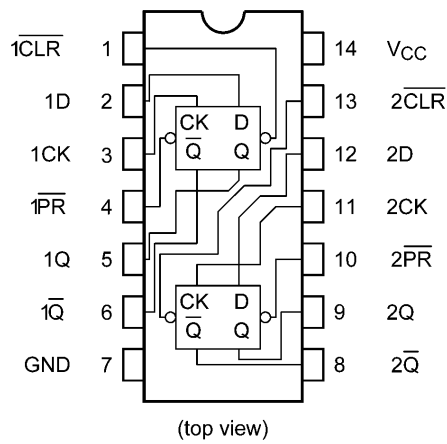
## 4. Packaging



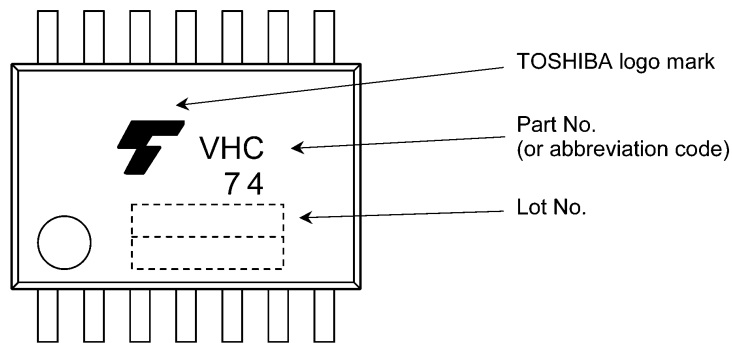
Start of commercial production

2013-05

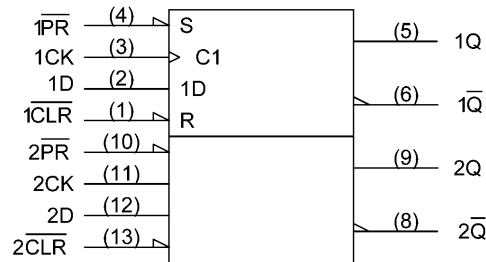
**5. Pin Assignment**



**6. Marking**



**7. IEC Logic Symbol**



**8. Truth Table**

Inputs				Outputs		Function
CLR	PR	D	CK	Q	Q̄	
L	H	X	X	L	H	Clear
H	L	X	X	H	L	Preset
L	L	X	X	H	H	—
H	H	L	↑	L	H	—
H	H	H	↑	H	L	—
H	H	X	↓	Q <sub>n</sub>	Q̄ <sub>n</sub>	No Change

X: Don't care

## 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	$V_{OUT}$		-0.5 to $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$		-20	mA
Output diode current	$I_{OK}$		$\pm 20$	mA
Output current	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 1)	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: 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	Rating	Unit
Supply voltage	$V_{CC}$		2.0 to 5.5	V
Input voltage	$V_{IN}$		0 to 5.5	V
Output voltage	$V_{OUT}$		0 to $V_{CC}$	V
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 100	ns/V
		$V_{CC} = 5.0 \pm 0.5$ V	0 to 20	

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.

**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
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	—	0.50	V
				3.0 to 5.5	—	—	$V_{CC} \times 0.3$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	2.0	—	V
				3.0	2.9	3.0	—	
			4.5	4.4	4.5	—		
			$I_{OH} = -4\text{ mA}$	3.0	2.58	—	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.94	—	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.0	0.1	V
				3.0	—	0.0	0.1	
				4.5	—	0.0	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	—	0.36	
			$I_{OL} = 8\text{ mA}$	4.5	—	—	0.36	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	—	2.0	

**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
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
			$I_{OH} = -4\text{ mA}$	3.0	2.48	—	
			$I_{OH} = -8\text{ mA}$	4.5	3.80	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
			$I_{OL} = 4\text{ mA}$	3.0	—	0.44	
			$I_{OL} = 8\text{ mA}$	4.5	—	0.44	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	$\pm 1.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		5.5	—	20.0	

**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
High-level input voltage	$V_{IH}$	—		2.0	1.50	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -50\text{ }\mu\text{A}$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
				$I_{OH} = -4\text{ mA}$	3.0	2.40	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 50\text{ }\mu\text{A}$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
				$I_{OL} = 4\text{ mA}$	3.0	—	
Input leakage current	$I_{IN}$	$V_{IN} = 5.5\text{ V}$ or GND		0 to 5.5	—	$\pm 2.0$	$\mu\text{A}$
				$I_{CC}$	$V_{IN} = V_{CC}$ or GND		

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Limit	Unit
Minimum pulse width (CK)	$t_{w(L)}, t_{w(H)}$	—	$3.3 \pm 0.3$	6.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum pulse width (CLR, PR)	$t_{w(L)}$	—	$3.3 \pm 0.3$	6.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum setup time	$t_s$	—	$3.3 \pm 0.3$	6.0	ns
			$5.0 \pm 0.5$	5.0	
Minimum hold time	$t_h$	—	$3.3 \pm 0.3$	0.5	ns
			$5.0 \pm 0.5$	0.5	
Minimum removal time (CLR, PR)	$t_{rem}$	—	$3.3 \pm 0.3$	5.0	ns
			$5.0 \pm 0.5$	3.0	

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

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

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

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

**11.7. AC Characteristics** (Unless otherwise specified,  $T_a = 25$  °C, Input:  $t_r = t_f = 3$  ns)

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Typ.	Max	Unit
Propagation delay time (CK-Q, $\bar{Q}$ )	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	—	6.7	11.9	ns
					50	—	9.2	15.4	
				$5.0 \pm 0.5$	15	—	4.6	7.3	
					50	—	6.1	9.3	
Propagation delay time (CLR, PR, $\bar{Q}$ , $\bar{Q}$ )	$t_{PLH}, t_{PHL}$		—	$3.3 \pm 0.3$	15	—	7.6	12.3	ns
					50	—	10.1	15.8	
				$5.0 \pm 0.5$	15	—	4.8	7.7	
					50	—	6.3	9.7	
Maximum clock frequency	$f_{MAX}$		—	$3.3 \pm 0.3$	15	80	125	—	MHz
					50	50	75	—	
				$5.0 \pm 0.5$	15	130	170	—	
					50	90	115	—	
Input capacitance	$C_{IN}$		—			—	4	10	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—			—	25	—	pF

Note 1:  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/2 \text{ (per F/F)}$$

**11.8. AC Characteristics**

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

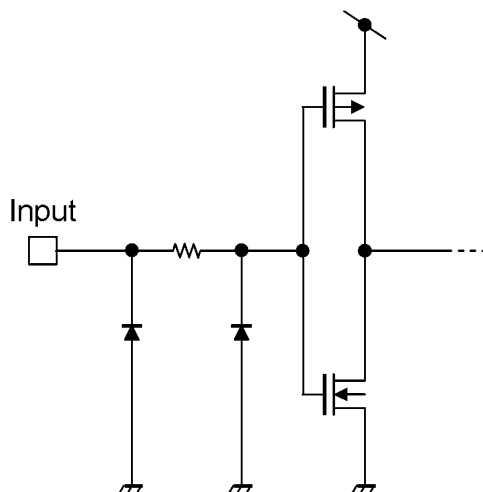
Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time (CK-Q, $\bar{Q}$ )	$t_{PLH}, t_{PHL}$	—	$3.3 \pm 0.3$	15	1.0	14.0	ns
				50	1.0	17.5	
			$5.0 \pm 0.5$	15	1.0	8.5	
				50	1.0	10.5	
Propagation delay time (CLR, PR-Q, $\bar{Q}$ )	$t_{PLH}, t_{PHL}$	—	$3.3 \pm 0.3$	15	1.0	14.5	ns
				50	1.0	18.0	
			$5.0 \pm 0.5$	15	1.0	9.0	
				50	1.0	11.0	
Maximum clock frequency	$f_{MAX}$	—	$3.3 \pm 0.3$	15	70	—	MHz
				50	45	—	
			$5.0 \pm 0.5$	15	110	—	
				50	75	—	
Input capacitance	$C_{IN}$	—			—	10	pF

**11.9. AC Characteristics**

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	$C_L$ (pF)	Min	Max	Unit
Propagation delay time (CK-Q, $\bar{Q}$ )	$t_{PLH}, t_{PHL}$	—	$3.3 \pm 0.3$	15	1.0	16.0	ns
				50	1.0	19.5	
			$5.0 \pm 0.5$	15	1.0	10.0	
				50	1.0	12.0	
Propagation delay time (CLR, PR-Q, $\bar{Q}$ )	$t_{PLH}, t_{PHL}$	—	$3.3 \pm 0.3$	15	1.0	16.5	ns
				50	1.0	20.0	
			$5.0 \pm 0.5$	15	1.0	10.5	
				50	1.0	12.5	
Maximum clock frequency	$f_{MAX}$	—	$3.3 \pm 0.3$	15	60	—	MHz
				50	40	—	
			$5.0 \pm 0.5$	15	100	—	
				50	70	—	
Input capacitance	$C_{IN}$	—			—	10	pF

**12. Input Equivalent Circuit**







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