

TC7WH74FK

1. Functional Description

- D-Type Flip Flop with Preset and Clear

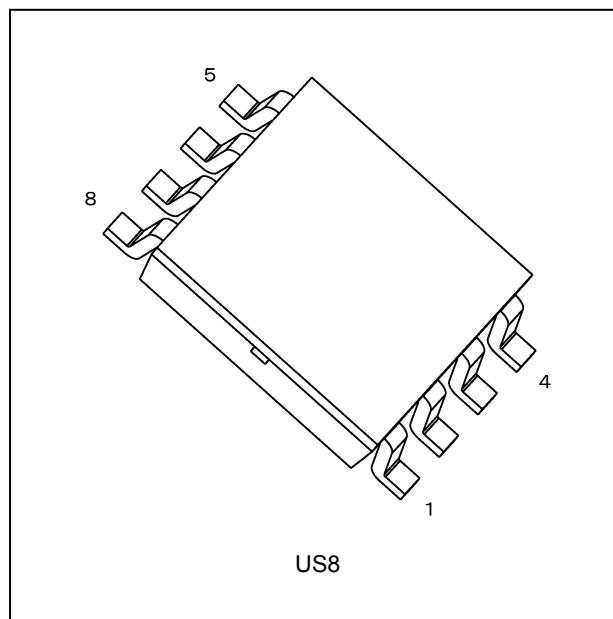
2. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range: $T_{opr} = -40$ to 125 °C (Note 2)
- (3) High speed operation: $f_{MAX} = 170$ MHz (typ.) ($V_{CC} = 5.0$ V)
- (4) Low power dissipation: $I_{CC} = 2.0$ μ A (max) ($T_a = 25$ °C)
- (5) High noise immunity: $V_{NIH} = V_{NIL} = 28\%$ V_{CC} (min)
- (6) 5.5 V tolerant inputs
- (7) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range: $V_{CC} = 2.0$ to 5.5 V

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

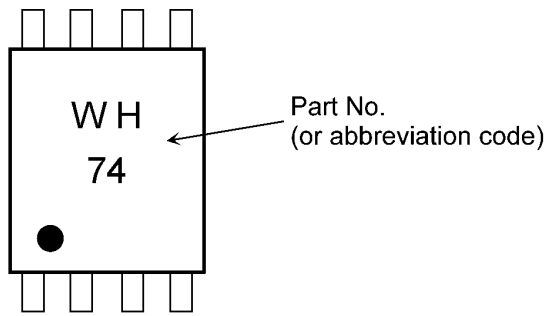
Note 2: For devices with the ordering part number ending in J(CT). $T_{opr} = -40$ to 85 °C for the other devices.

3. Packaging

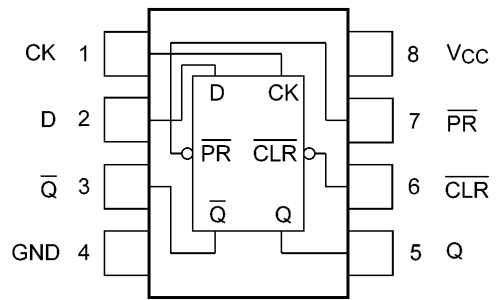


Start of commercial production
1994-07

4. Marking and Pin Assignment

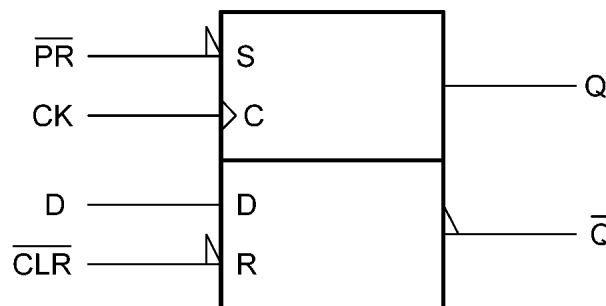


Marking



Pin Assignment (Top view)

5. IEC Logic Symbol



6. Truth Table

Inputs				Outputs		Function
$\overline{\text{CLR}}$	$\overline{\text{PR}}$	D	CK	Q	$\overline{\text{Q}}$	
L	H	X	X	L	H	Clear
H	L	X	X	H	L	Preset
L	L	X	X	H	H	—
H	H	L	\uparrow	L	H	—
H	H	H	\uparrow	H	L	—
H	H	X	\downarrow	Q_n	\overline{Q}_n	No Change

X: Don't care

7. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 7.0	V
Input voltage	V_{IN}		-0.5 to 7.0	
DC output voltage	V_{OUT}		-0.5 to $V_{CC} + 0.5$	
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}	(Note 1)	± 20	
DC output current	I_{OUT}		± 25	
V_{CC} /ground current	I_{CC}		± 50	
Power dissipation	P_D		200	mW
Storage temperature	T_{stg}		-65 to 150	$^\circ\text{C}$

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: $V_{OUT} < \text{GND}$, $V_{OUT} > V_{CC}$

8. Operating Ranges (Note)

Characteristics	Symbol	Note	Test Condition	Rating	Unit
Supply voltage	V_{CC}		—	2.0 to 5.5	V
Input voltage	V_{IN}		—	0 to 5.5	
Output voltage	V_{OUT}		—	0 to V_{CC}	
Operating temperature	T_{opr}	(Note 1)	—	-40 to 125	$^\circ\text{C}$
		(Note 2)	—	-40 to 85	
Input rise and fall time	dt/dv		$V_{CC} = 3.3 \pm 0.3\text{ V}$	0 to 100	ns/V
			$V_{CC} = 5.0 \pm 0.5\text{ V}$	0 to 20	

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs and bus inputs must be tied to either V_{CC} or GND.

Note 1: For devices with the ordering part number ending in J(CT).

Note 2: For devices except those with the ordering part number ending in J(CT).

9. Electrical Characteristics

9.1. 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	1.5	—	—	V	
			3.0 to 5.5	$V_{CC} \times 0.7$	—	—		
Low-level input voltage	V_{IL}	—	2.0	—	—	0.5	V	
			3.0 to 5.5	—	—	$V_{CC} \times 0.3$		
High-level output voltage	V_{OH}	$V_{IN} = V_{IL}$ or V_{IH}	$I_{OH} = -50\text{ }\mu\text{A}$	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}	$V_{IN} = V_{IL}$ or V_{IH}	$I_{OL} = 50\text{ }\mu\text{A}$	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	—	—	± 0.1	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	—	2.0	μA	

9.2. 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	1.5	—	V	
			3.0 to 5.5	$V_{CC} \times 0.7$	—		
Low-level input voltage	V_{IL}	—	2.0	—	0.5	V	
			3.0 to 5.5	—	$V_{CC} \times 0.3$		
High-level output voltage	V_{OH}	$V_{IN} = V_{IL}$ or V_{IH}	$I_{OH} = -50\text{ }\mu\text{A}$	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}	$V_{IN} = V_{IL}$ or V_{IH}	$I_{OL} = 50\text{ }\mu\text{A}$	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	—	± 1.0	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	20.0	μA	

9.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to 125 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		2.0	1.5	—	V
				3.0 to 5.5	$V_{CC} \times 0.7$	—	
Low-level input voltage	V_{IL}	—		2.0	—	0.5	V
				3.0 to 5.5	—	$V_{CC} \times 0.3$	
High-level output voltage	V_{OH}	$V_{IN} = V_{IL}$ or V_{IH}	$I_{OH} = -50 \mu A$	2.0	1.9	—	V
				3.0	2.9	—	
				4.5	4.4	—	
				$I_{OH} = -4$ mA	3.0	2.40	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IL}$ or V_{IH}	$I_{OL} = 50 \mu A$	2.0	—	0.1	V
				3.0	—	0.1	
				4.5	—	0.1	
				$I_{OL} = 4$ mA	3.0	—	
Input leakage current	I_{IN}	$V_{IN} = 5.5$ V or GND		0 to 5.5	—	± 2.0	μA
				5.5	—	40.0	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		5.5	—	40.0	μA

Note: For devices with the ordering part number ending in J(CT).

9.4. Timing Requirements (Unless otherwise specified, $T_a = 25$ °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 ± 0.3	6.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width (CLR, PR)	$t_{W(L)}$	—	3.3 ± 0.3	6.0	ns
			5.0 ± 0.5	5.0	
Minimum setup time	t_S	—	3.3 ± 0.3	6.0	ns
			5.0 ± 0.5	5.0	
Minimum hold time	t_H	—	3.3 ± 0.3	0.5	ns
			5.0 ± 0.5	0.5	
Minimum removal time (CLR, PR)	t_{rem}	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	3.0	

9.5. Timing Requirements (Unless otherwise specified, $T_a = -40$ to 85 °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 ± 0.3	7.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width (CLR, PR)	$t_{W(L)}$	—	3.3 ± 0.3	7.0	ns
			5.0 ± 0.5	5.0	
Minimum setup time	t_S	—	3.3 ± 0.3	7.0	ns
			5.0 ± 0.5	5.0	
Minimum hold time	t_H	—	3.3 ± 0.3	0.5	ns
			5.0 ± 0.5	0.5	
Minimum removal time (CLR, PR)	t_{rem}	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	3.0	

9.6. Timing Requirements (Note)
 (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 ± 0.3	7.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width (CLR, PR)	$t_{W(L)}$	—	3.3 ± 0.3	7.0	ns
			5.0 ± 0.5	5.0	
Minimum setup time	t_s	—	3.3 ± 0.3	8.0	ns
			5.0 ± 0.5	5.5	
Minimum hold time	t_h	—	3.3 ± 0.3	0.5	ns
			5.0 ± 0.5	0.5	
Minimum removal time (CLR, PR)	t_{rem}	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	3.0	

Note: For devices with the ordering part number ending in J(CT).

9.7. 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 ± 0.3	15	—	6.7	11.9	ns
					50	—	9.2	15.4	
				5.0 ± 0.5	15	—	4.6	7.3	
					50	—	6.1	9.3	
Propagation delay time (CLR, PR-Q, \bar{Q})	t_{PLH}, t_{PHL}		—	3.3 ± 0.3	15	—	7.6	12.3	ns
					50	—	10.1	15.8	
				5.0 ± 0.5	15	—	4.8	7.7	
					50	—	6.3	9.7	
Maximum clock frequency	f_{MAX}		—	3.3 ± 0.3	15	80	125	—	MHz
					50	50	75	—	
				5.0 ± 0.5	15	130	170	—	
					50	90	115	—	
Input capacitance	C_{IN}		—		—	4	10	pF	
Power dissipation capacitance	C_{PD}	(Note 1)	—		—	22	—	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.

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

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

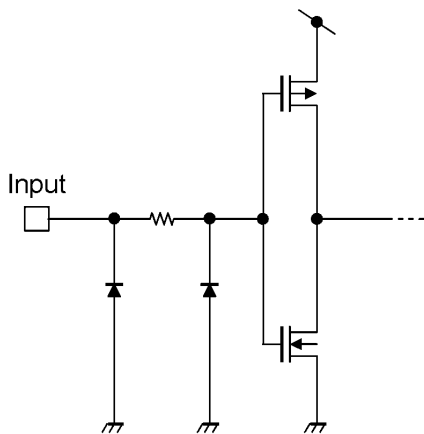
Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (CK-Q, \bar{Q})	t_{PLH}, t_{PHL}		—	3.3 ± 0.3	15	1.0	14.0	ns
					50	1.0	17.5	
				5.0 ± 0.5	15	1.0	8.5	
					50	1.0	10.5	
Propagation delay time (CLR, PR-Q, \bar{Q})	t_{PLH}, t_{PHL}		—	3.3 ± 0.3	15	1.0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

9.9. AC Characteristics (Note)
 (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, \bar{Q})	t_{PLH}, t_{PHL}		—	3.3 ± 0.3	15	1.0	16.0	ns
					50	1.0	19.5	
				5.0 ± 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 ± 0.3	15	1.0	16.5	ns
					50	1.0	20.0	
				5.0 ± 0.5	15	1.0	10.5	
					50	1.0	12.5	
Maximum clock frequency	f_{MAX}		—	3.3 ± 0.3	15	60	—	MHz
					50	40	—	
				5.0 ± 0.5	15	100	—	
					50	70	—	
Input capacitance	C_{IN}		—			—	10	pF

Note: For devices with the ordering part number ending in J(CT).

9.10. Input Equivalent Circuit



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