

74VHC4020FT

1. Functional Description

- 14-Stage Ripple Carry Binary Counter

2. General

The 74VHC4020FT is an advanced high speed CMOS 14-STAGE BINARY COUNTER/DIVIDER 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.

Setting CLR to high resets the counter to low.

A negative transition on the \overline{CK} input brings one increment into the counter.

This counter provides all divided output stages, and at Q12, a 1/4096 divided frequency will be output.

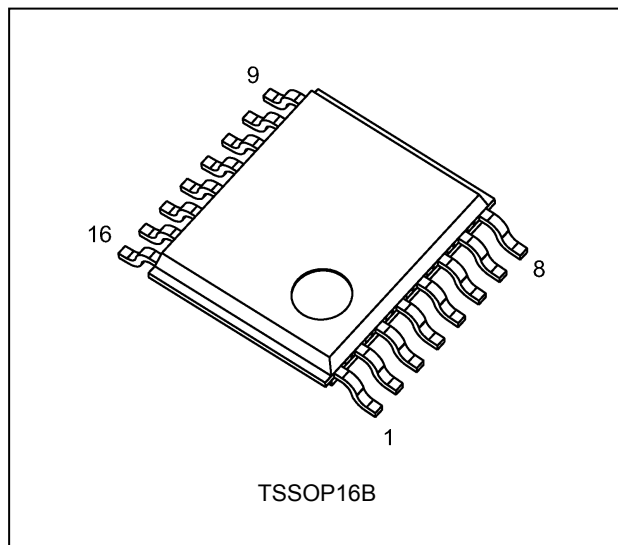
An input protection circuit ensures that 0 to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input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

3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range: $T_{opr} = -40$ to 125 °C
- (3) High speed: $f_{MAX} = 210$ MHz (typ.) at $V_{CC} = 5$ V
- (4) Low power dissipation: $I_{CC} = 4.0$ μ A (max) at $T_a = 25$ °C
- (5) High noise immunity: $V_{NIH} = V_{NIL} = 28\%$ V_{CC} (min)
- (6) Power-down protection is provided on all inputs.
- (7) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$
- (8) Wide operating voltage range: $V_{CC(opr)} = 2.0$ V to 5.5 V
- (9) Low noise: $V_{OLP} = 1.5$ V (max)
- (10) Pin and function compatible with 74HC4020

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

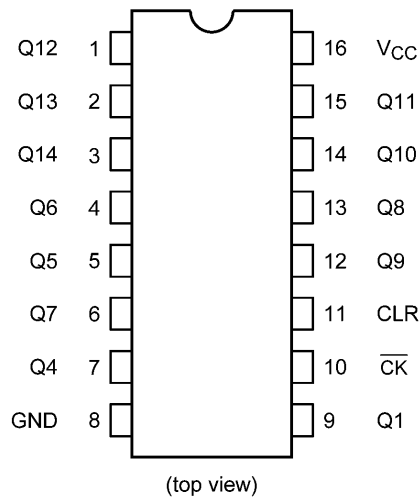
4. Packaging



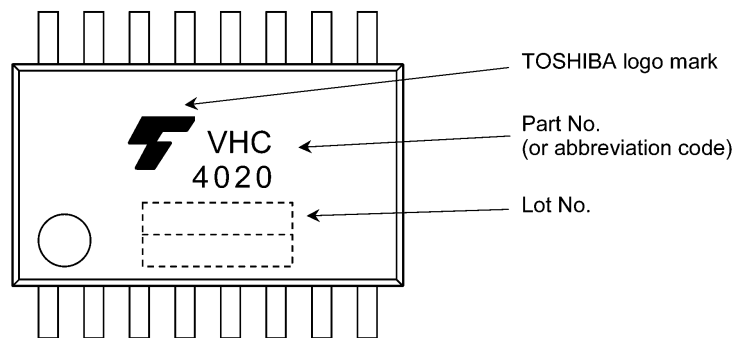
Start of commercial production

2014-10

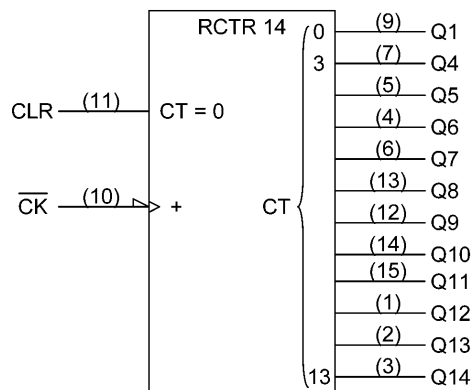
5. Pin Assignment





6. Marking



7. IEC Logic Symbol

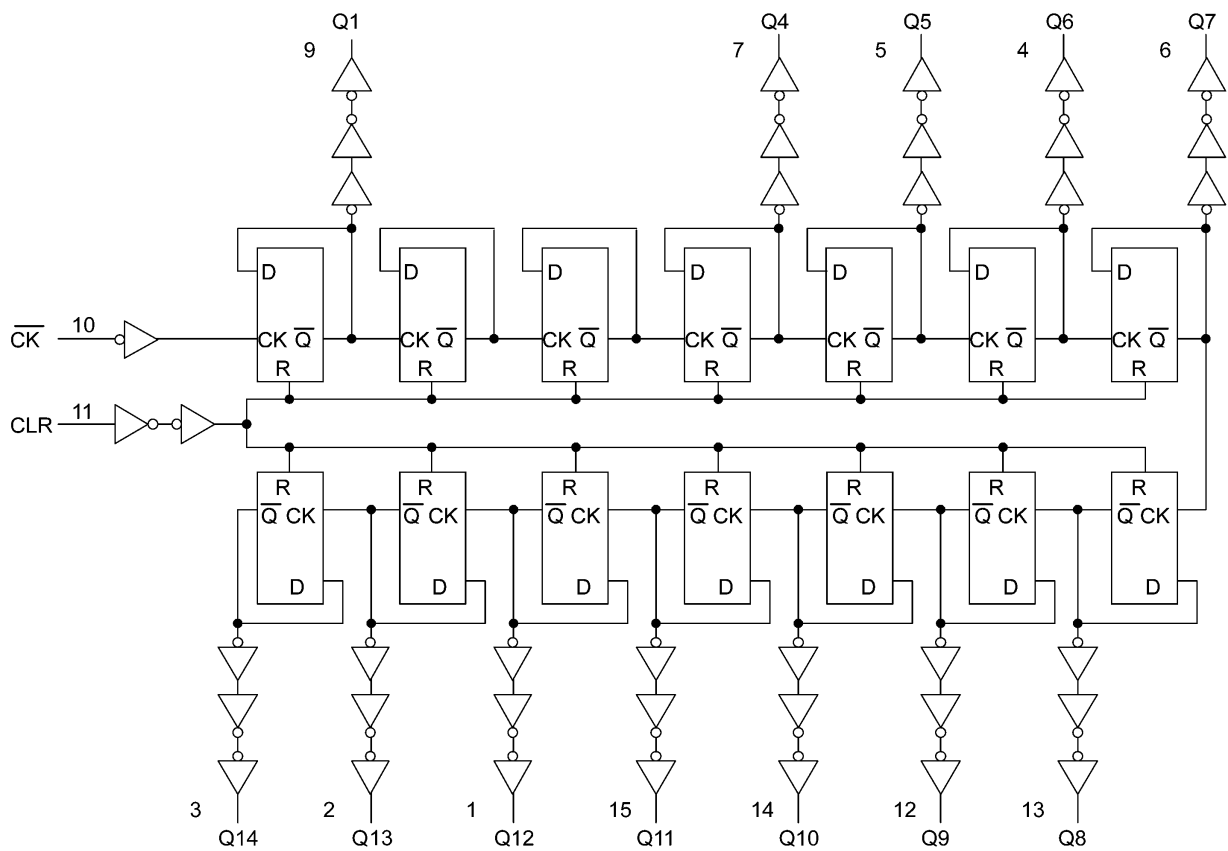


8. Truth Table

\overline{CK}	CLR	Output State
X	H	All Outputs = "L"
	L	No Change
	L	Advance to Next State

X: Don't care

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}		-0.5 to $V_{CC} + 0.5$	V
Input diode current	I_{IK}		-20	mA
Output diode current	I_{OK}		± 20	mA
Output current	I_{OUT}		± 25	mA
V_{CC} /ground current	I_{CC}		± 100	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.

11. 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
		$V_{CC} = 5 \pm 0.5$ 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.

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}	—		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	—	—	± 0.1	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		5.5	—	—	4.0	μA

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}	—		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	—	± 1.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		5.5	—	40.0	μA

12.3. DC Characteristics (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	1.50	—	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}	$I_{OH} = -50 \mu A$	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}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 50 \mu A$	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	—	80.0	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		5.5	—	80.0	μA

12.4. 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	5.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width (CLR)	$t_{w(H)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum removal time	t_{rem}	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	

12.5. 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	5.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width (CLR)	$t_{w(H)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum removal time	t_{rem}	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	

12.6. 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 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum pulse width (CLR)	$t_{w(H)}$	—	3.3 ± 0.3	5.0	ns
			5.0 ± 0.5	5.0	
Minimum removal time	t_{rem}	—	3.3 ± 0.3	6.0	ns
			5.0 ± 0.5	5.5	

12.7. 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-Q1)	t_{PLH}, t_{PHL}		—	3.3 ± 0.3	15	—	7.5	11.9	ns	
					50	—	10.0	15.4		
				5.0 ± 0.5	15	—	4.8	7.3		
					50	—	6.3	9.3		
Propagation delay time (Q_n - Q_{n+1})	Δt_{PD}		—	3.3 ± 0.3	50	—	2.4	4.4	ns	
				5.0 ± 0.5	50	—	1.6	3.1		
Propagation delay time (CLR-Q)	t_{PHL}		—	3.3 ± 0.3	15	—	8.3	12.8	ns	
					50	—	10.8	16.3		
				5.0 ± 0.5	15	—	5.6	8.6		
					50	—	7.1	10.6		
Maximum clock frequency	f_{MAX}		—	3.3 ± 0.3	15	75	140	—	MHz	
					50	55	80	—		
				5.0 ± 0.5	15	150	210	—		
					50	95	125	—		
Input capacitance	C_{IN}		—			—	4	10	pF	
Power dissipation capacitance	C_{PD}	(Note 1)	—				—	21	—	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.

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

12.8. AC Characteristics (Unless otherwise specified, $T_a = -40\text{ to }85\text{ }^\circ\text{C}$, Input: $t_r = t_f = 3\text{ ns}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (CK-Q1)	t_{PLH}, t_{PHL}	—	3.3 ± 0.3	15	—	14.0	ns
				50	—	17.5	
			5.0 ± 0.5	15	—	8.5	
				50	—	10.5	
Propagation delay time (Q_n - Q_{n+1})	Δt_{PD}	—	3.3 ± 0.3	50	—	5.0	ns
			5.0 ± 0.5	50	—	3.5	
Propagation delay time (CLR-Q)	t_{PHL}	—	3.3 ± 0.3	15	—	15.0	ns
				50	—	18.5	
			5.0 ± 0.5	15	—	10.0	
				50	—	12.0	
Maximum clock frequency	f_{MAX}	—	3.3 ± 0.3	15	75	—	MHz
				50	50	—	
			5.0 ± 0.5	15	125	—	
				50	80	—	
Input capacitance	C_{IN}				—	10	pF

12.9. AC Characteristics

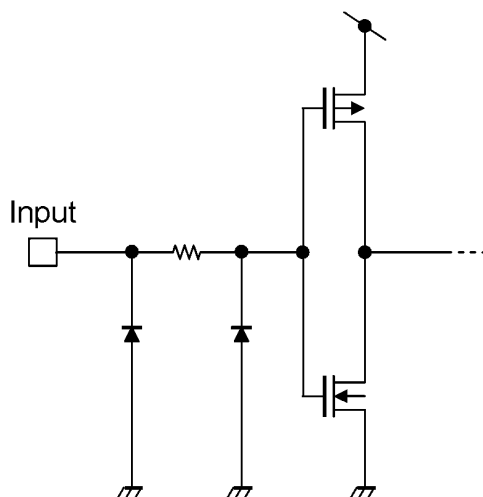
(Unless otherwise specified, $T_a = -40$ to 125 °C, Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	C_L (pF)	Min	Max	Unit
Propagation delay time (CK-Q1)	t_{PLH}, t_{PHL}	—	3.3 ± 0.3	15	—	16.0	ns
				50	—	19.5	
			5.0 ± 0.5	15	—	10.0	
				50	—	12.0	
Propagation delay time (Q_n-Q_{n+1})	Δt_{PD}	—	3.3 ± 0.3	50	—	5.5	ns
			5.0 ± 0.5	50	—	4.0	
Propagation delay time (CLR-Q)	t_{PHL}	—	3.3 ± 0.3	15	—	17.0	ns
				50	—	20.5	
			5.0 ± 0.5	15	—	11.5	
				50	—	13.5	
Maximum clock frequency	f_{MAX}	—	3.3 ± 0.3	15	60	—	MHz
				50	40	—	
			5.0 ± 0.5	15	120	—	
				50	75	—	
Input capacitance	C_{IN}	—			—	10	pF

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	1.2	1.5	V
Quiet output minimum dynamic V_{OL}	V_{OLV}	$C_L = 50$ pF	5.0	-1.2	-1.5	V
Minimum high-level dynamic input voltage	V_{IHD}	$C_L = 50$ pF	5.0	—	3.5	V
Maximum low-level dynamic input voltage	V_{ILD}	$C_L = 50$ pF	5.0	—	1.5	V

13. Input Equivalent Circuit



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