

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VHC4020F, TC74VHC4020FK

14-Stage Ripple Carry Binary Counter

The TC74VHC4020 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.

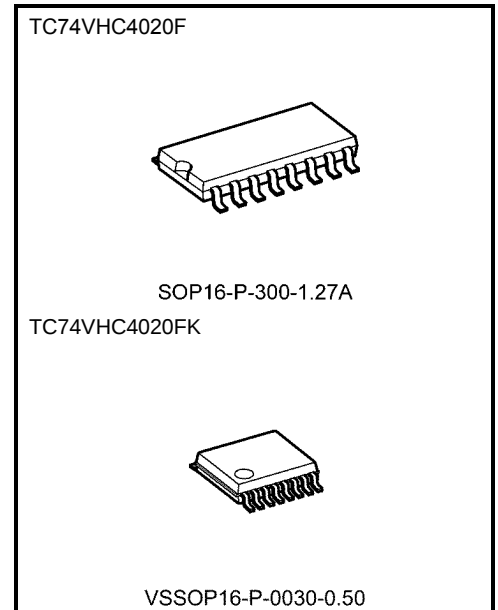
A negative transition on the $\overline{CK}$ input brings one increment into the counter.

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.

Features

- High speed: $f_{max} = 210 \text{ MHz}$ (typ.) at $V_{CC} = 5 \text{ V}$
- Low power dissipation: $I_{CC} = 4 \mu\text{A}$ (max) at $T_a = 25^\circ\text{C}$
- High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays: $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range: $V_{CC}(\text{opr}) = 2 \text{ V}$ to 5.5 V
- Low noise: $V_{OLP} = 1.5 \text{ V}$ (max)
- Pin and function compatible with 74HC4020

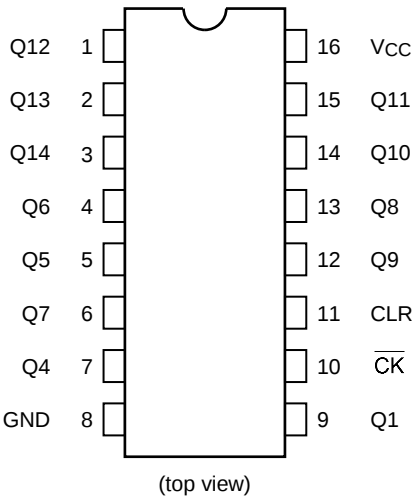


Weight

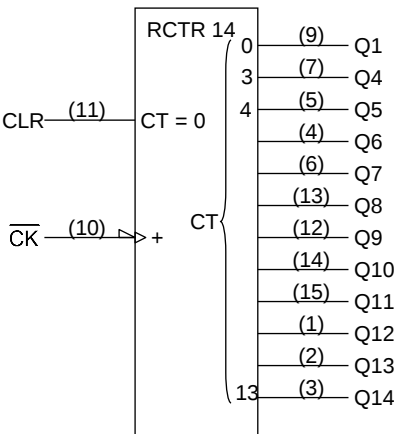
SOP16-P-300-1.27A	: 0.18 g (typ.)
VSSOP16-P-0030-0.50	: 0.02 g (typ.)

Start of commercial production
2004-10

Pin Assignment



IEC Logic Symbol

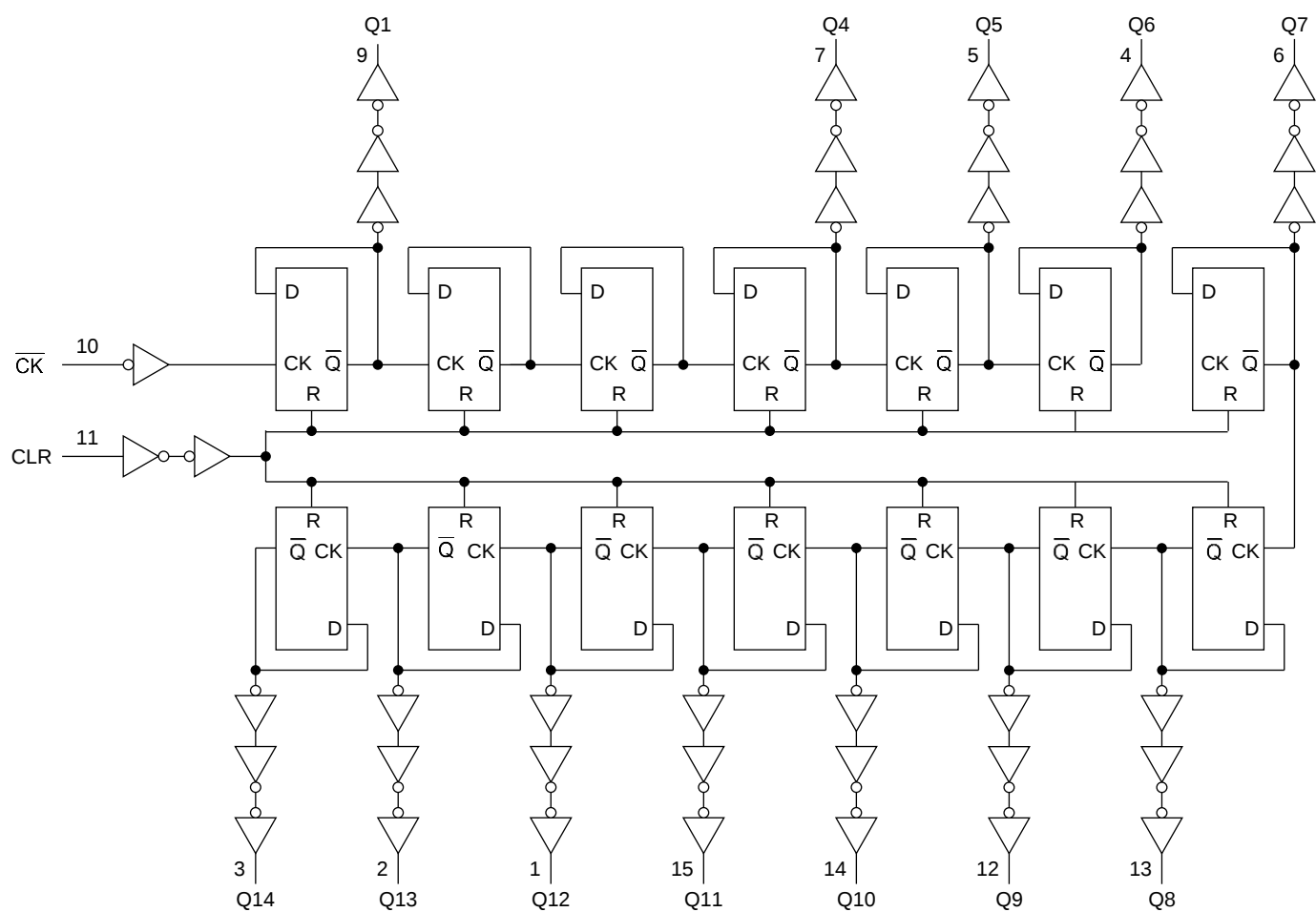


Truth Table

CK	CLR	Output State
X	H	All Outputs = "L"
↑	L	No Change
↓	L	Advance to Next State

X: Don't care

System Diagram



Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V _{CC}	-0.5 to 7.0	V
DC input voltage	V _{IN}	-0.5 to 7.0	V
DC 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
DC output current	I _{OUT}	±25	mA
DC V _{CC} /ground current	I _{CC}	±100	mA
Power dissipation	P _D	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).

Operating Ranges (Note)

Characteristics	Symbol	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 85	°C
Input rise and fall time	dt/dv	0 to 100 (V _{CC} = 3.3 ± 0.3 V) 0 to 20 (V _{CC} = 5 ± 0.5 V)	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.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40 to 85°C		Unit	
				VCC (V)	Min	Typ.	Max	Min		Max
High-level input voltage	VIH	—		2.0 3.0 to 5.5	1.50 VCC × 0.7	— —	— —	1.50 VCC × 0.7	— —	V
Low-level input voltage	VIL	—		2.0 3.0 to 5.5	— —	— —	0.50 VCC × 0.3	— —	0.50 VCC × 0.3	V
High-level output voltage	VOH	VIN = VIH or VIL	IOH = -50 µA	2.0	1.9	2.0	—	1.9	—	V
				3.0	2.9	3.0	—	2.9	—	
			IOH = -4 mA IOH = -8 mA	4.5	4.4	4.5	—	4.4	—	
				3.0 4.5	2.58 3.94	— —	— —	2.48 3.80	— —	
Low-level output voltage	VOL	VIN = VIH or VIL	IOL = 50 µA	2.0	—	0.0	0.1	—	0.1	V
				3.0	—	0.0	0.1	—	0.1	
			IOL = 4 mA IOL = 8 mA	4.5	—	0.0	0.1	—	0.1	
				3.0 4.5	— —	— —	0.36 0.36	— —	0.44 0.44	
Input leakage current	IIN	VIN = 5.5 V or GND		0 to 5.5	—	—	±0.1	—	±1.0	µA
Quiescent supply current	ICC	VIN = VCC or GND		5.5	—	—	4.0	—	40.0	µA

Timing Requirements (input: tr = tf = 3 ns)

Characteristics	Symbol	Test Condition	Ta = 25°C		Ta = -40 to 85°C	Unit	
			VCC (V)	Typ.	Limit		Limit
Minimum pulse width (CK)	tw (L)	—	3.3 ± 0.3	—	5.0	5.0	ns
	tw (H)		5.0 ± 0.5	—	5.0		
Minimum pulse width (CLR)	tw (H)	—	3.3 ± 0.3	—	5.0	5.0	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum removal time	trem	—	3.3 ± 0.3	—	5.0	5.0	ns
			5.0 ± 0.5	—	5.0	5.0	

AC Characteristics (input: $t_r = t_f = 3 \text{ ns}$)

Characteristics	Symbol	Test Condition			Ta = 25°C			Ta = −40 to 85°C		Unit
			VCC (V)	CL (pF)	Min	Typ.	Max	Min	Max	
Propagation delay time (CK -Q1)	t _{pLH} t _{pHL}	—	3.3 ± 0.3	15	—	7.5	11.9	—	14.0	ns
				50	—	10.0	15.4	—	17.5	
			5.0 ± 0.5	15	—	4.8	7.3	—	8.5	
				50	—	6.3	9.3	—	10.5	
Propagation delay time (Q _n -Q _n + 1)	Δt _{pd}	—	3.3 ± 0.3	50	—	2.4	4.4	—	5.0	ns
			5.0 ± 0.5	50	—	1.6	3.1	—	3.5	
Propagation delay time (CLR-Q)	t _{pHL}	—	3.3 ± 0.3	15	—	8.3	12.8	—	15.0	ns
				50	—	10.8	16.3	—	18.5	
			5.0 ± 0.5	15	—	5.6	8.6	—	10.0	
				50	—	7.1	10.6	—	12.0	
Maximum clock frequency	f _{max}	—	3.3 ± 0.3	15	75	140	—	75	—	MHz
				50	55	80	—	50	—	
			5.0 ± 0.5	15	150	210	—	125	—	
				50	95	125	—	80	—	
Input capacitance	C _{IN}	—			—	4	10	—	10	pF
Power dissipation capacitance	C _{PD}	(Note)			—	21	—	—	—	pF

Note: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

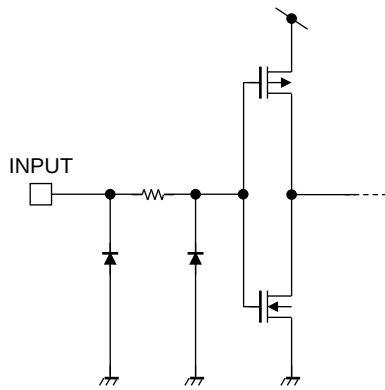
Average operating current can be obtained by the equation:

$$I_{\text{CC (opr)}} = \text{CPD} \cdot V_{\text{CC}} \cdot f_{\text{IN}} + I_{\text{CC}}$$

Noise Characteristics (input: $t_r = t_f = 3 \text{ ns}$)

Characteristics	Symbol	Test Condition	Ta = 25°C		Unit
			V _{CC} (V)	Typ. Limit	
Quiet output maximum dynamic V _{OL}	V _{OLP}	C _L = 50 pF	5.0	1.2	V
Quiet output minimum dynamic V _{OL}	V _{OLV}	C _L = 50 pF	5.0	-1.2	V
Minimum high level dynamic input voltage	V _{IHD}	C _L = 50 pF	5.0	—	V
Maximum low level dynamic input voltage	V _{ILD}	C _L = 50 pF	5.0	—	V

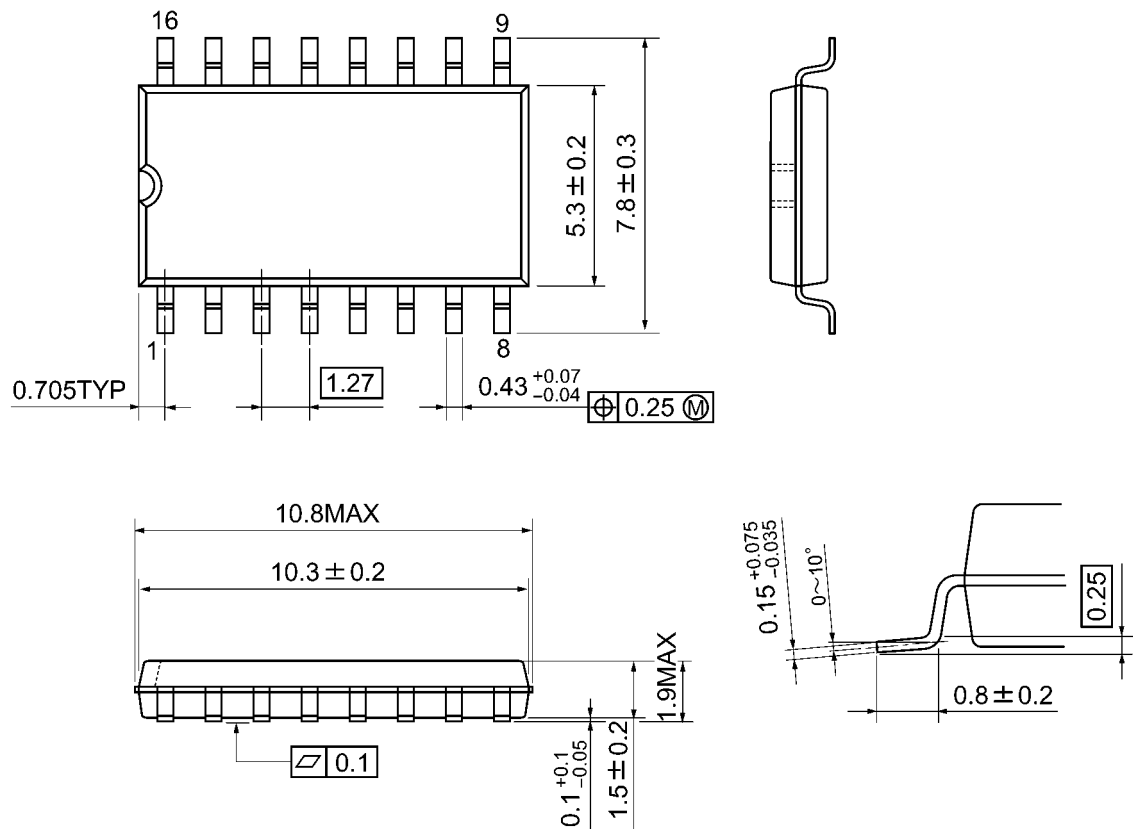
Input Equivalent Circuit



Package Dimensions

SOP16-P-300-1.27A

Unit: mm

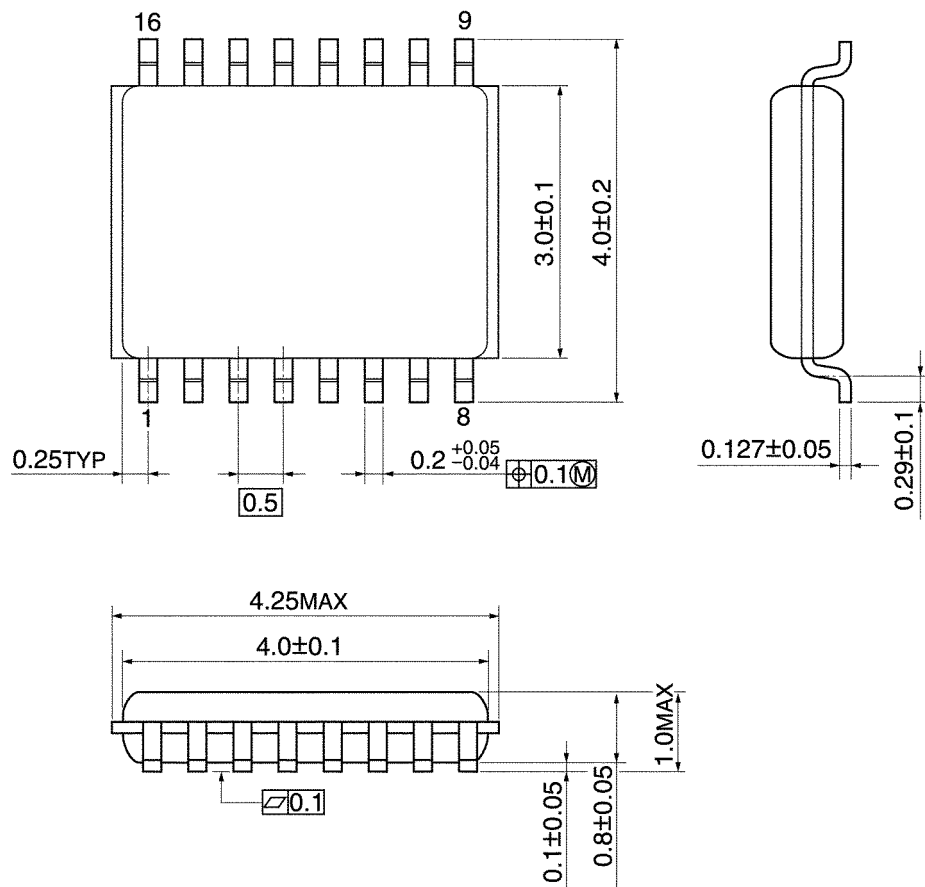


Weight: 0.18 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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