

## 14-STAGE BINARY RIPPLE COUNTER

### FEATURES

- Output capability: standard
- I<sub>CC</sub> category: MSI

### GENERAL DESCRIPTION

The 74HC/HCT4020 are high-speed Si-gate CMOS devices and are pin compatible with the "4020" of the "4000B" series. They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT4020 are 14-stage binary ripple counters with a clock input ( $\overline{CP}$ ), an overriding asynchronous master reset input (MR) and twelve fully buffered parallel outputs ( $Q_0, Q_3$  to  $Q_{13}$ ).

The counter is advanced on the HIGH-to-LOW transition of  $\overline{CP}$ .

A HIGH on MR clears all counter stages and forces all outputs LOW, independent of the state of  $\overline{CP}$ .

Each counter stage is a static toggle flip-flop.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
$t_{PHL}/t_{PLH}$	propagation delay $\overline{CP}$ to $Q_0$ $Q_n$ to $Q_{n+1}$ MR to $Q_n$	$C_L = 15 \text{ pF}$ $V_{CC} = 5 \text{ V}$	11	15	ns
			6	6	ns
			17	19	ns
$f_{max}$	maximum clock frequency		101	52	MHz
$C_I$	input capacitance		3.5	3.5	pF
$C_{PD}$	power dissipation capacitance per package	notes 1 and 2	19	20	pF

GND = 0 V;  $T_{amb} = 25^\circ\text{C}$ ;  $t_r = t_f = 6 \text{ ns}$

### Notes

1.  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

$f_i$  = input frequency in MHz       $C_L$  = output load capacitance in pF

$f_o$  = output frequency in MHz       $V_{CC}$  = supply voltage in V

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs

2. For HC the condition is  $V_I = \text{GND to } V_{CC}$   
For HCT the condition is  $V_I = \text{GND to } V_{CC} - 1.5 \text{ V}$

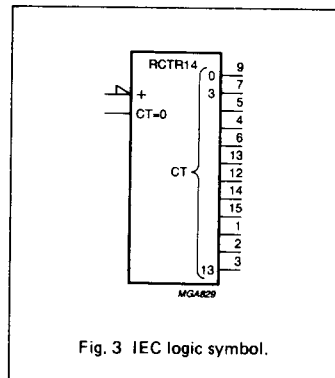
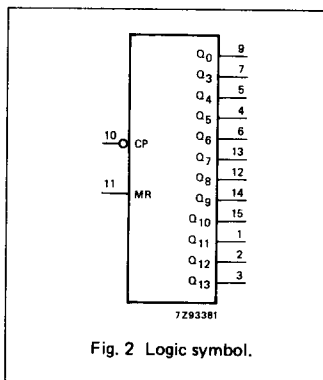
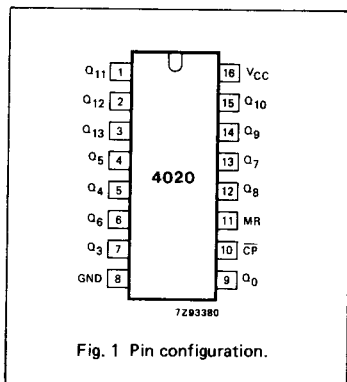
### PACKAGE OUTLINES

16-lead DIL; plastic (SOT38Z).

16-lead mini-pack; plastic (SO16; SOT109A).

### PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
9, 7, 5, 4, 6, 13, 12, 14, 15, 1, 2, 3	$Q_0, Q_3$ to $Q_{13}$	parallel outputs
8	GND	ground (0 V)
10	$\overline{CP}$	clock input (HIGH-to-LOW, edge-triggered)
11	MR	master reset input (active HIGH)
16	$V_{CC}$	positive supply voltage



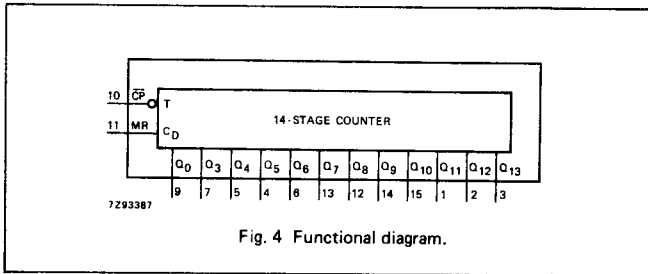


Fig. 4 Functional diagram.

FUNCTION TABLE

INPUTS		OUTPUTS
$\overline{CP}$	MR	$Q_0, Q_3$ to $Q_{13}$
↑	L	no change
↓	L	count
X	H	L

H = HIGH voltage level  
L = LOW voltage level  
X = don't care  
↑ = LOW-to-HIGH clock transition.  
↓ = HIGH-to-LOW clock transition

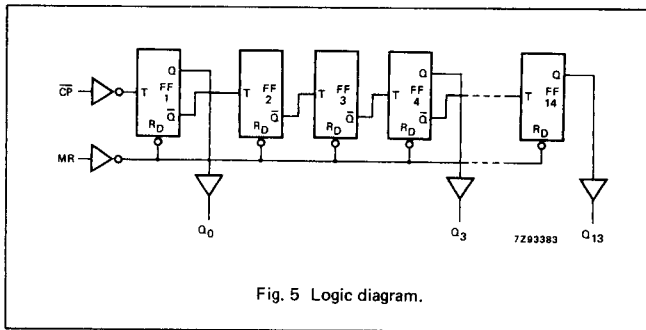


Fig. 5 Logic diagram.

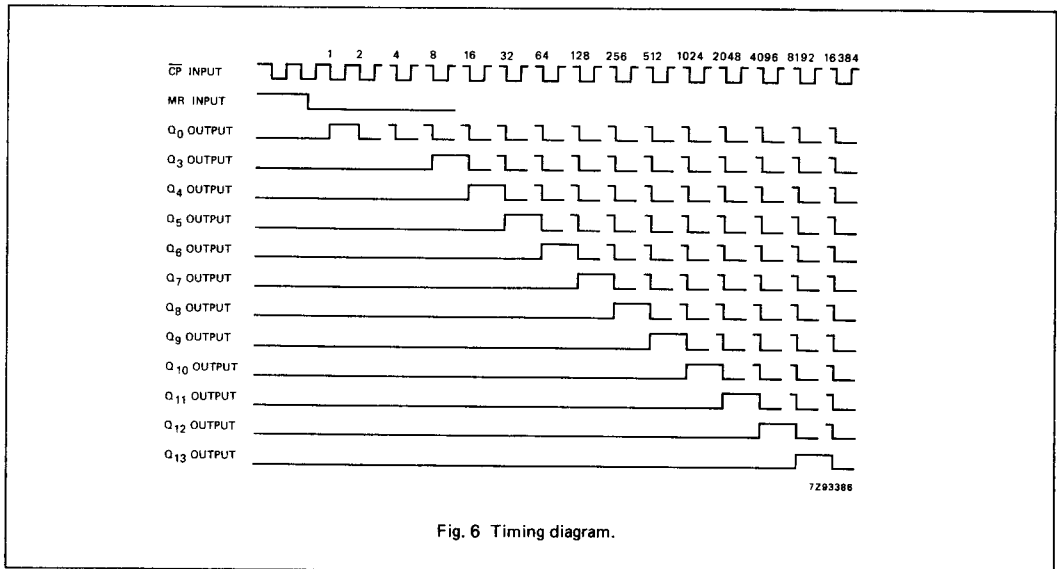


Fig. 6 Timing diagram.

## DC CHARACTERISTICS FOR 74HC

For the DC characteristics see chapter "HCMOS family characteristics", section "Family specifications".

Output capability: standard

I<sub>CC</sub> category: MSI

## AC CHARACTERISTICS FOR 74HC

GND = 0 V; t<sub>r</sub> = t<sub>f</sub> = 6 ns; C<sub>L</sub> = 50 pF

SYMBOL	PARAMETER	T <sub>amb</sub> (°C)						UNIT	TEST CONDITIONS		
		74HC							V <sub>CC</sub> V	WAVEFORMS	
		+25			-40 to +85		-40 to +125				
		min.	typ.	max.	min.	max.	min.				max.
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay CP to Q <sub>0</sub>		39 14 11	140 28 24		175 35 30		210 42 36	ns	2.0 4.5 6.0	Fig. 7
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay Q <sub>n</sub> to Q <sub>n+1</sub>		22 8 6	75 15 13		95 19 16		110 22 19	ns	2.0 4.5 6.0	Fig. 7
t <sub>PHL</sub>	propagation delay MR to Q <sub>n</sub>		55 20 16	170 34 29		215 43 37		225 51 43	ns	2.0 4.5 6.0	Fig. 8
t <sub>THL</sub> / t <sub>TLH</sub>	output transition time		19 7 6	75 15 13		95 19 16		110 22 19	ns	2.0 4.5 6.0	Fig. 7
t <sub>W</sub>	clock pulse width HIGH or LOW	80 16 14	11 4 3		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig. 7
t <sub>W</sub>	master reset pulse width HIGH	80 16 14	17 6 5		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig. 8
t <sub>rem</sub>	removal time MR to CP	50 10 9	6 2 2		65 13 11		75 15 13		ns	2.0 4.5 6.0	Fig. 8
f <sub>max</sub>	maximum clock pulse frequency	6.0 30 35	30 92 109		4.8 24 28		4.0 20 24		MHz	2.0 4.5 6.0	Fig. 7

**DC CHARACTERISTICS FOR 74HCT**

For the DC characteristics see chapter "HCMOS family characteristics", section "Family specifications".

Output capability: standard

I<sub>CC</sub> category: MSI

**Note to HCT types**

The value of additional quiescent supply current ( $\Delta I_{CC}$ ) for a unit load of 1 is given in the family specifications. To determine  $\Delta I_{CC}$  per input, multiply this value by the unit load coefficient shown in the table below.

INPUT	UNIT LOAD COEFFICIENT
$\overline{CP}$	0.85
MR	1.10

**AC CHARACTERISTICS FOR 74HCT**

GND = 0 V;  $t_r = t_f = 6$  ns;  $C_L = 50$  pF

SYMBOL	PARAMETER	T <sub>amb</sub> (°C)						UNIT	TEST CONDITIONS		
		74HCT							V <sub>CC</sub> V	WAVEFORMS	
		+25			-40 to +85		-40 to +125				
		min.	typ.	max.	min.	max.	min.				max.
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay $\overline{CP}$ to Q <sub>0</sub>		18	36		45		54	ns	4.5	Fig. 7
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay Q <sub>n</sub> to Q <sub>n+1</sub>		8	15		19		22	ns	4.5	Fig. 7
t <sub>PHL</sub>	propagation delay MR to Q <sub>n</sub>		22	45		56		68	ns	4.5	Fig. 8
t <sub>THL</sub> / t <sub>TLH</sub>	output transition time		7	15		19		22	ns	4.5	Fig. 7
t <sub>W</sub>	clock pulse width HIGH or LOW	20	7		25		30		ns	4.5	Fig. 7
t <sub>W</sub>	master reset pulse width HIGH	20	8		25		30		ns	4.5	Fig. 8
t <sub>rem</sub>	removal time MR to $\overline{CP}$	10	2		13		15		ns	4.5	Fig. 8
f <sub>max</sub>	maximum clock pulse frequency	25	47		20		17		MHz	4.5	Fig. 7

AC WAVEFORMS

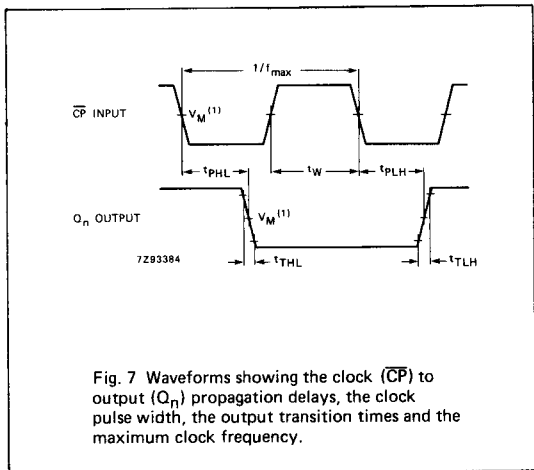


Fig. 7 Waveforms showing the clock ( $\overline{CP}$ ) to output ( $Q_n$ ) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency.

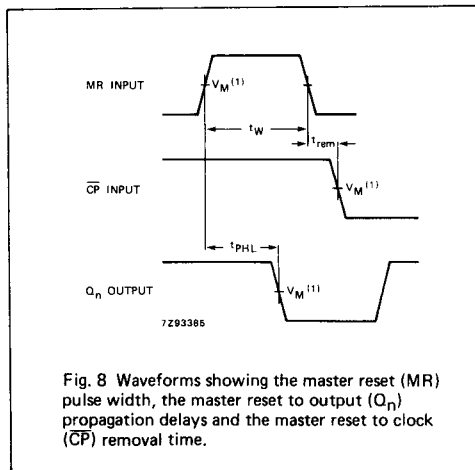


Fig. 8 Waveforms showing the master reset (MR) pulse width, the master reset to output ( $Q_n$ ) propagation delays and the master reset to clock ( $\overline{CP}$ ) removal time.

Note to AC waveforms

- (1) HC :  $V_M = 50\%$ ;  $V_I = \text{GND to } V_{CC}$ .
- HCT:  $V_M = 1.3 \text{ V}$ ;  $V_I = \text{GND to } 3 \text{ V}$ .