12-STAGE BINARY RIPPLE COUNTER

FEATURES

- **Output capability: standard**
- **I_{CC} category: MSI**

GENERAL DESCRIPTION

The 74HC/HCT4040 are high-speed Si-gate CMOS devices and are pin compatible with the "4040" of the "4000B" series. They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT4040 are 12-stage binary ripple counters with a clock input ($\overline{CP}$), an overriding asynchronous master reset input (MR) and twelve parallel outputs (Q_0 to Q_{11}).

The counter advances 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.

APPLICATIONS

- **Frequency dividing circuits**
- **Time delay circuits**
- **Control counters**

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PHL}/t_{PLH}	propagation delay $\overline{CP}$ to Q_0 Q_n to Q_{n+1}	C_L = 15 pF V_{CC} = 5 V	14 8	16 8	ns ns
f_{max}	maximum clock frequency		90	79	MHz
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per package	notes 1 and 2	20	20	pF

GND = 0 V; T_{amb} = 25 °C; $t_r = t_f$ = 6 ns

Notes

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):
   $P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o)$ where:
   f_i = input frequency in MHz
   f_o = output frequency in MHz
   C_L = output load capacitance in pF
   V_{CC} = supply voltage in V
   $\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs
2. For HC the condition is V_I = GND to V_{CC}
   For HCT the condition is V_I = GND to V_{CC} − 1.5 V

PACKAGE OUTLINES

16-lead DIL; plastic (SOT38Z).
16-lead mini-pack; plastic (SO16; SOT109A).

PIN DESCRIPTION

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

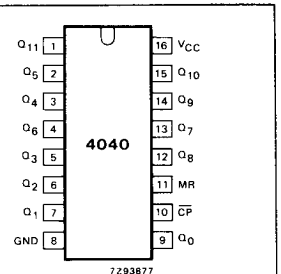

Fig. 1 Pin configuration.

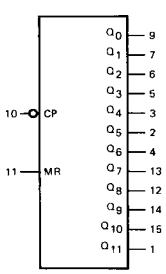

Fig. 2 Logic symbol.

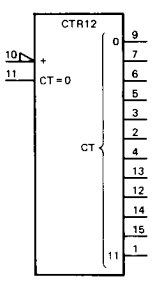

Fig. 3 IEC logic symbol.

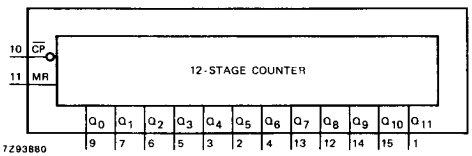

Fig. 4 Functional diagram.

FUNCTION TABLE

INPUTS		OUTPUTS
$\overline{CP}$	MR	Q_n
↑	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

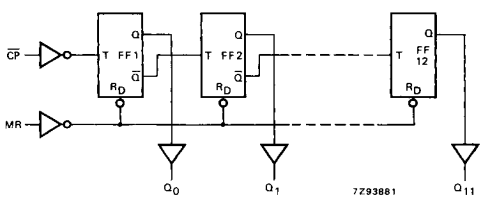

Fig. 5 Logic diagram.

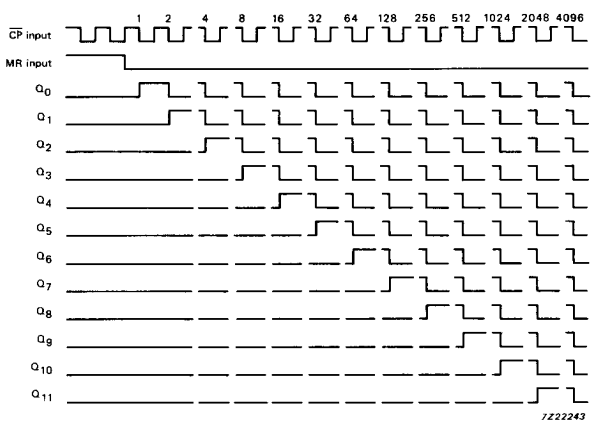

Fig. 6 Timing diagram.

DC CHARACTERISTICS FOR 74HC

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

Output capability: standard
I_{CC} category: MSI

AC CHARACTERISTICS FOR 74HC

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

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS	
		74HC								V_{CC} V	WAVEFORMS
		+25			−40 to +85		−40 to +125				
		min.	typ.	max.	min.	max.	min.	max.			
t_{PHL}/t_{PLH}	propagation delay $\overline{CP}$ to Q_0		47 17 14	150 30 26		190 38 33		225 45 38	ns	2.0 4.5 6.0	Fig. 7
t_{PHL}/t_{PLH}	propagation delay Q_n to Q_{n+1}		28 10 8	100 20 17		125 25 21		150 30 26	ns	2.0 4.5 6.0	Fig. 7
t_{PHL}	propagation delay MR to Q_n		61 22 18	185 37 31		230 46 39		280 56 48	ns	2.0 4.5 6.0	Fig. 7
t_{THL}/t_{TLH}	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_W	clock pulse width HIGH or LOW	80 16 14	14 5 4		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig. 7
t_W	master reset pulse width; HIGH	80 16 14	22 8 6		100 20 17		120 24 20		ns	2.0 4.5 6.0	Fig. 7
t_{rem}	removal time MR to $\overline{CP}$	50 10 9	8 3 2		65 13 11		75 15 13		ns	2.0 4.5 6.0	Fig. 7
f_{max}	maximum clock pulse frequency	6.0 30 35	27 82 98		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_{CC} category: MSI

Note to HCT types

The value of additional quiescent supply current (ΔI_{CC}) for a unit load of 1 is given in the family specifications. To determine ΔI_{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_{amb} (°C)							UNIT	TEST CONDITIONS	
		74HCT								V_{CC} V	WAVEFORMS
		+25			−40 to +85		−40 to +125				
		min.	typ.	max.	min.	max.	min.	max.			
t_{PHL}/t_{PLH}	propagation delay $\overline{CP}$ to Q_0		19	40		50		60	ns	4.5	Fig. 7
t_{PHL}/t_{PLH}	propagation delay Q_n to Q_{n+1}		10	20		25		30	ns	4.5	Fig. 7
t_{PHL}	propagation delay MR to Q_n		23	45		56		68	ns	4.5	Fig. 7
t_{THL}/t_{TLH}	output transition time		7	15		19		22	ns	4.5	Fig. 7
t_W	clock pulse width HIGH or LOW	16	7		20		24		ns	4.5	Fig. 7
t_W	master reset pulse width; HIGH	16	6		20		24		ns	4.5	Fig. 7
t_{rem}	removal time MR to $\overline{CP}$	10	2		13		15		ns	4.5	Fig. 7
f_{max}	maximum clock pulse frequency	30	72		24		20		MHz	4.5	Fig. 7

AC WAVEFORMS

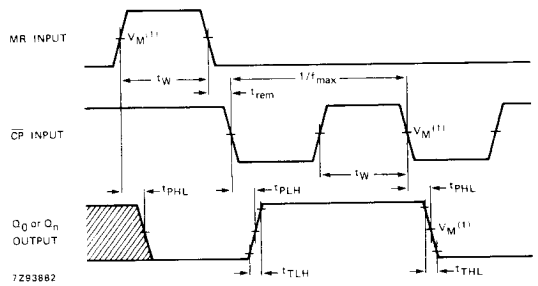

Fig. 7 Waveforms showing the clock ($\overline{CP}$) to output (Q_n) propagation delays, the clock pulse width, the output transition times and the maximum clock pulse frequency.

Also 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 = GND to V_{CC}.
HCT: V_M = 1.3 V; V_I = GND to 3 V.