

## DUAL 4-BIT SYNCHRONOUS BINARY COUNTER

### FEATURES

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

### GENERAL DESCRIPTION

The 74HC/HCT4520 are high-speed Si-gate CMOS devices and are pin compatible with the "4520" of the "4000B" series. They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT4520 are dual 4-bit internally synchronous binary counters with an active HIGH clock input (nCP<sub>0</sub>) and an active LOW clock input (nCP<sub>1</sub>), buffered outputs from all four bit positions (nQ<sub>0</sub> to nQ<sub>3</sub>) and an active HIGH overriding asynchronous master reset input (nMR).

The counter advances on either the LOW-to-HIGH transition of nCP<sub>0</sub> if nCP<sub>1</sub> is HIGH or the HIGH-to-LOW transition of nCP<sub>1</sub> if nCP<sub>0</sub> is LOW. Either nCP<sub>0</sub> or nCP<sub>1</sub> may be used as the clock input to the counter and the other clock input may be used as a clock enable input. A HIGH on nMR resets the counter (nQ<sub>0</sub> to nQ<sub>3</sub> = LOW) independent of nCP<sub>0</sub> and nCP<sub>1</sub>.

### APPLICATIONS

- Multistage synchronous counting
- Multistage asynchronous counting
- Frequency dividers

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay nCP <sub>0</sub> , nCP <sub>1</sub> to nQ <sub>n</sub>	C <sub>L</sub> = 15 pF V <sub>CC</sub> = 5 V	24	24	ns
t <sub>PHL</sub>	propagation delay nMR to nQ <sub>n</sub>		13	13	ns
f <sub>max</sub>	maximum clock frequency		68	64	MHz
C <sub>I</sub>	input capacitance		3.5	3.5	pF
CPD	power dissipation capacitance per counter	notes 1 and 2	29	24	pF

GND = 0 V; T<sub>amb</sub> = 25 °C; t<sub>r</sub> = t<sub>f</sub> = 6 ns

### Notes

1. CPD is used to determine the dynamic power dissipation (P<sub>D</sub> in μW):

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

f<sub>i</sub> = input frequency in MHz      C<sub>L</sub> = output load capacitance in pF  
f<sub>o</sub> = output frequency in MHz      V<sub>CC</sub> = supply voltage in V

Σ (C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of outputs

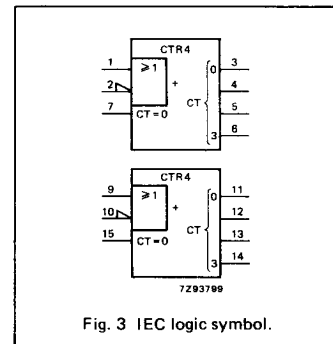
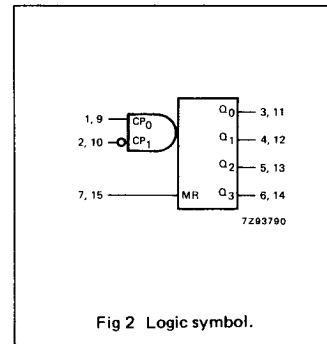
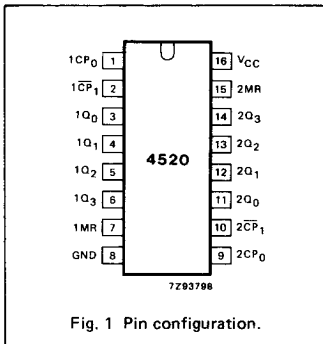
2. For HC the condition is V<sub>I</sub> = GND to V<sub>CC</sub>  
For HCT the condition is V<sub>I</sub> = GND to V<sub>CC</sub> - 1.5 V

### PACKAGE OUTLINES

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

### PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
1, 9	1CP <sub>0</sub> , 2CP <sub>0</sub>	clock inputs (LOW-to-HIGH, edge-triggered)
2, 10	1CP <sub>1</sub> , 2CP <sub>1</sub>	clock inputs (HIGH-to-LOW, edge-triggered)
3, 4, 5, 6	1Q <sub>0</sub> to 1Q <sub>3</sub>	data outputs
7, 15	1MR, 2MR	asynchronous master reset inputs (active HIGH)
8	GND	ground (0 V)
11, 12, 13, 14	2Q <sub>0</sub> to 2Q <sub>3</sub>	data outputs
16	V <sub>CC</sub>	positive supply voltage



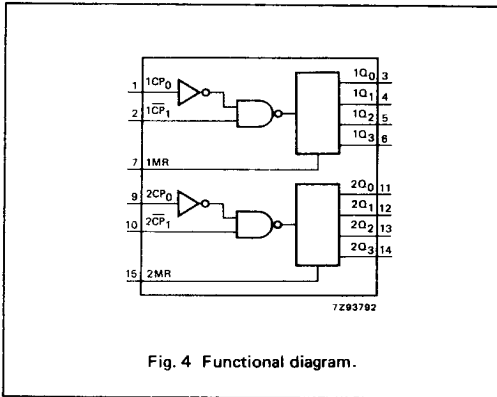


Fig. 4 Functional diagram.

FUNCTION TABLE

nCP <sub>0</sub>	nCP <sub>1</sub>	MR	MODE
↑	H	L	counter advances
L	↓	L	counter advances
↓	X	L	no change
X	↑	L	no change
↑	L	L	no change
H	↓	L	no change
X	X	H	Q <sub>0</sub> to Q <sub>3</sub> = LOW

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

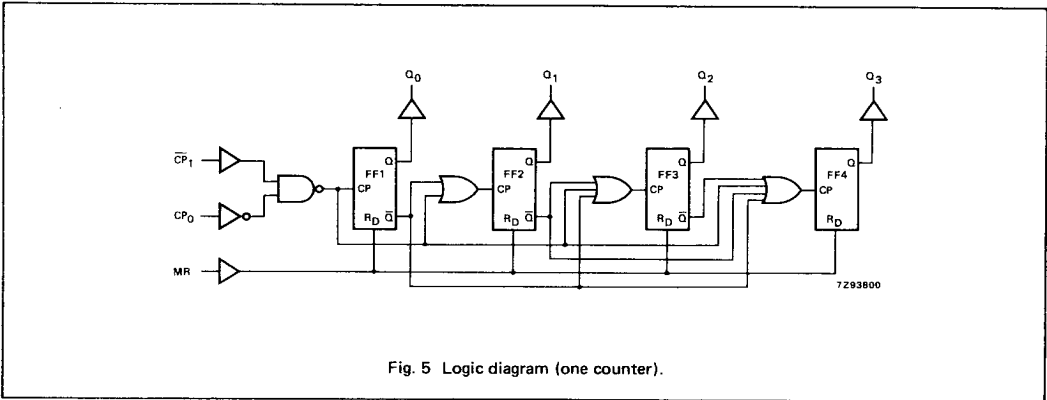


Fig. 5 Logic diagram (one counter).

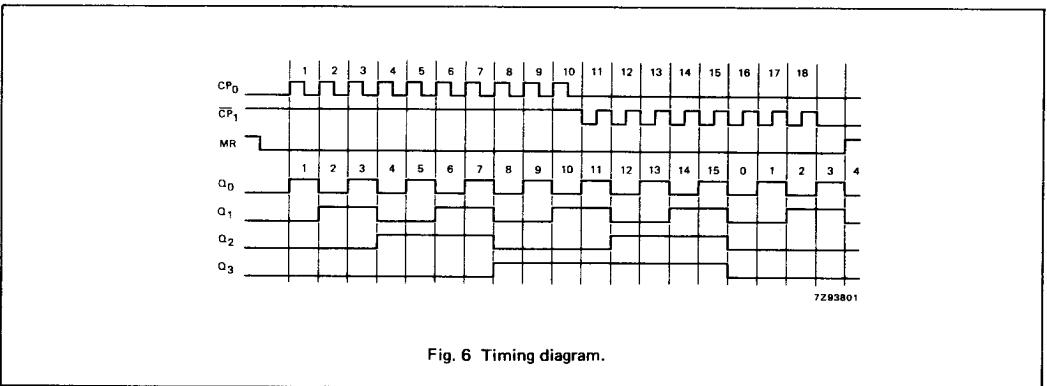


Fig. 6 Timing diagram.

**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 nCP <sub>0</sub> to nQ <sub>n</sub>		77 28 22	240 48 41			300 60 51		360 72 61	ns	2.0 4.5 6.0	Fig. 8
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay nCP <sub>1</sub> to nQ <sub>n</sub>		77 28 22	240 48 41			300 60 51		360 72 61	ns	2.0 4.5 6.0	Fig. 8
t <sub>PHL</sub>	propagation delay nMR to nQ <sub>n</sub>		44 16 13	150 30 26			190 38 33		225 45 38	ns	2.0 4.5 6.0	Fig. 9
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. 8
t <sub>w</sub>	clock pulse width HIGH or LOW	80 16 14	22 8 6		100 20 17			120 24 20		ns	2.0 4.5 6.0	Fig. 7
t <sub>w</sub>	master reset pulse width HIGH	120 24 20	39 14 11		150 30 26			180 36 31		ns	2.0 4.5 6.0	Fig. 7
t <sub>rem</sub>	removal time nMR to nCP <sub>0</sub> ; nCP <sub>1</sub>	0 0 0	-28 -10 -8		0 0 0			0 0 0		ns	2.0 4.5 6.0	Fig. 7
t <sub>su</sub>	set-up time nCP <sub>1</sub> to nCP <sub>0</sub> ; nCP <sub>0</sub> to nCP <sub>1</sub>	80 16 14	14 5 4		100 20 17			120 24 20		ns	2.0 4.5 6.0	Fig. 8
f <sub>max</sub>	maximum clock pulse frequency	6.0 30 35	19 58 69		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.

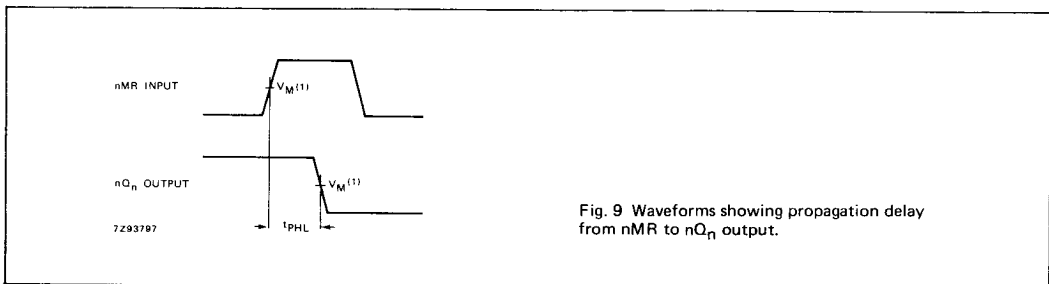
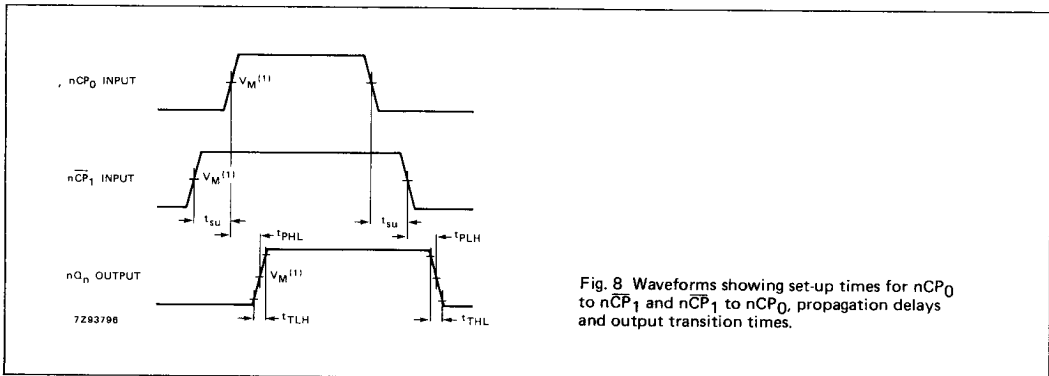
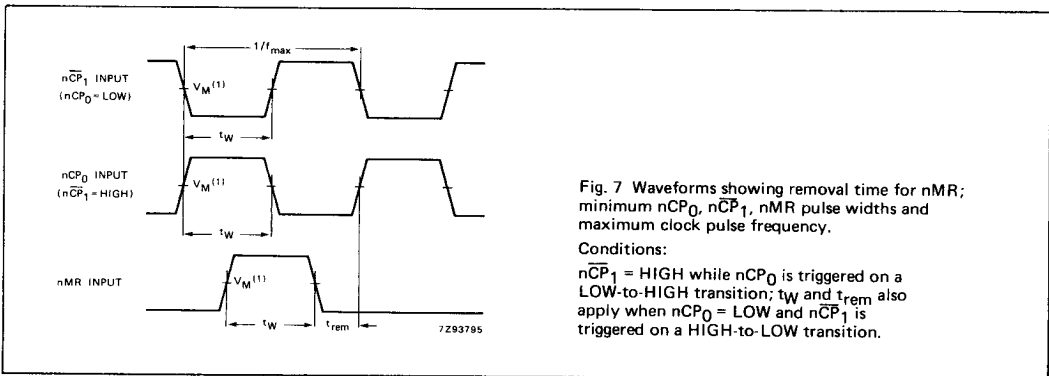
INPUT	UNIT LOAD COEFFICIENT
nCP <sub>0</sub> , nCP <sub>1</sub>	0.80
nMR	1.50

**AC CHARACTERISTICS FOR 74HCT**

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		
		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 nCP <sub>0</sub> to nQ <sub>n</sub>		28	53		66		80	ns	4.5	Fig. 8
t <sub>PHL</sub> / t <sub>PLH</sub>	propagation delay nCP <sub>1</sub> to nQ <sub>n</sub>		25	53		66		80	ns	4.5	Fig. 8
t <sub>PHL</sub>	propagation delay nMR to nQ <sub>n</sub>		16	35		44		53	ns	4.5	Fig. 9
t <sub>THL</sub> / t <sub>TLH</sub>	output transition time		7	15		19		22	ns	4.5	Fig. 8
t <sub>w</sub>	clock pulse width HIGH or LOW	20	10		25		30		ns	4.5	Fig. 7
t <sub>w</sub>	master reset pulse width HIGH	20	12		25		30		ns	4.5	Fig. 7
t <sub>rem</sub>	removal time nMR to nCP <sub>0</sub> ; nCP <sub>1</sub>	0	-8		0		0		ns	4.5	Fig. 7
t <sub>su</sub>	set-up time nCP <sub>1</sub> to nCP <sub>0</sub> ; nCP <sub>0</sub> to nCP <sub>1</sub>	16	6		20		24		ns	4.5	Fig. 8
f <sub>max</sub>	maximum clock pulse frequency	30	58		24		20		MHz	4.5	Fig. 7

## AC WAVEFORMS



## Note to AC waveforms

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