

# DATA SHEET

For a complete data sheet, please also download:

- The IC04 LOCMOS HE4000B Logic Family Specifications HEF, HEC
- The IC04 LOCMOS HE4000B Logic Package Outlines/Information HEF, HEC

## HEF4029B

### MSI

Synchronous up/down counter,  
binary/decade counter

Product specification  
File under Integrated Circuits, IC04

January 1995

# Synchronous up/down counter, binary/decade counter

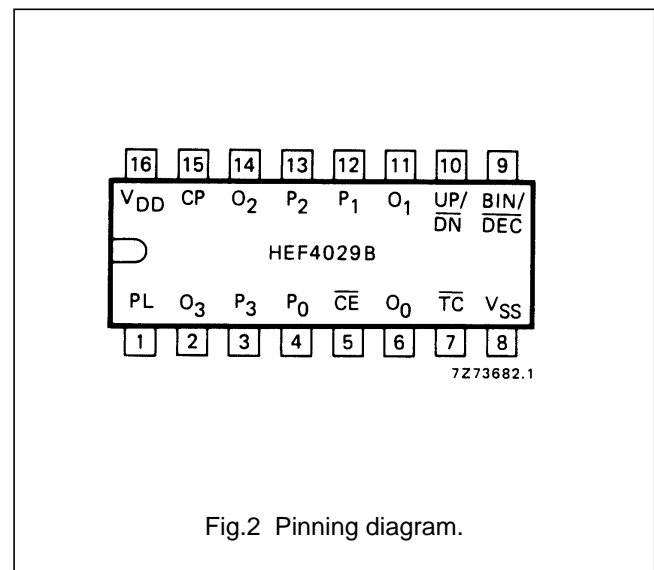
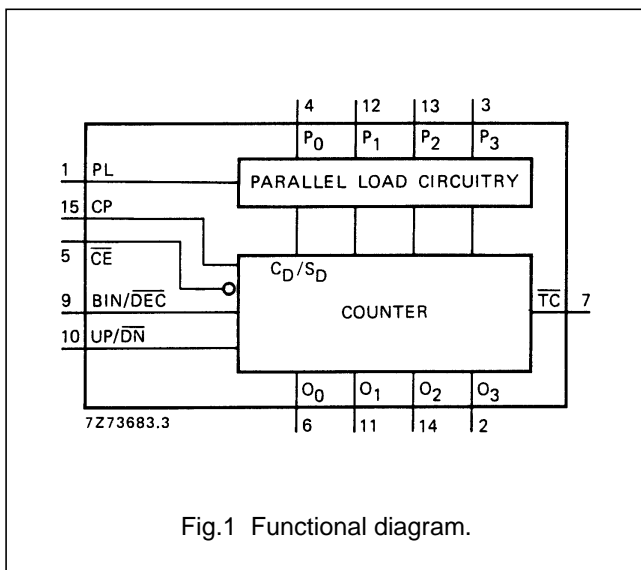
## HEF4029B MSI

### DESCRIPTION

The HEF4029B is a synchronous edge-triggered up/down 4-bit binary/BCD decade counter with a clock input (CP), an active LOW count enable input ( $\overline{CE}$ ), an up/down control input ( $\overline{UP/DN}$ ), a binary/decade control input ( $\overline{BIN/DEC}$ ), an overriding asynchronous active HIGH parallel load input (PL), four parallel data inputs ( $P_0$  to  $P_3$ ), four parallel buffered outputs ( $O_0$  to  $O_3$ ) and an active LOW terminal count output ( $\overline{TC}$ ).

Information on  $P_0$  to  $P_3$  is asynchronously loaded into the counter while PL is HIGH, independent of CP.

The counter is advanced one count on the LOW to HIGH transition of CP when  $\overline{CE}$  and PL are LOW. The  $\overline{TC}$  signal is normally HIGH and goes LOW when the counter reaches its maximum count in the UP mode, or the minimum count in the DOWN mode provided  $\overline{CE}$  is LOW.



- HEF4029BP(N): 16-lead DIL; plastic (SOT38-1)
  - HEF4029BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)
  - HEF4029BT(D): 16-lead SO; plastic (SOT109-1)
- ( ): Package Designator North America

### PINNING

- PL parallel load input
- $P_0$  to  $P_3$  parallel data inputs
- $\overline{BIN/DEC}$  binary/decade control input
- $\overline{UP/DN}$  up/down control input
- $\overline{CE}$  count enable input (active LOW)
- CP clock input (LOW to HIGH, edge triggered)
- $O_0$  to  $O_3$  buffered parallel outputs
- $\overline{TC}$  terminal count output (active LOW)

### FAMILY DATA, I<sub>DD</sub> LIMITS category MSI

See Family Specifications

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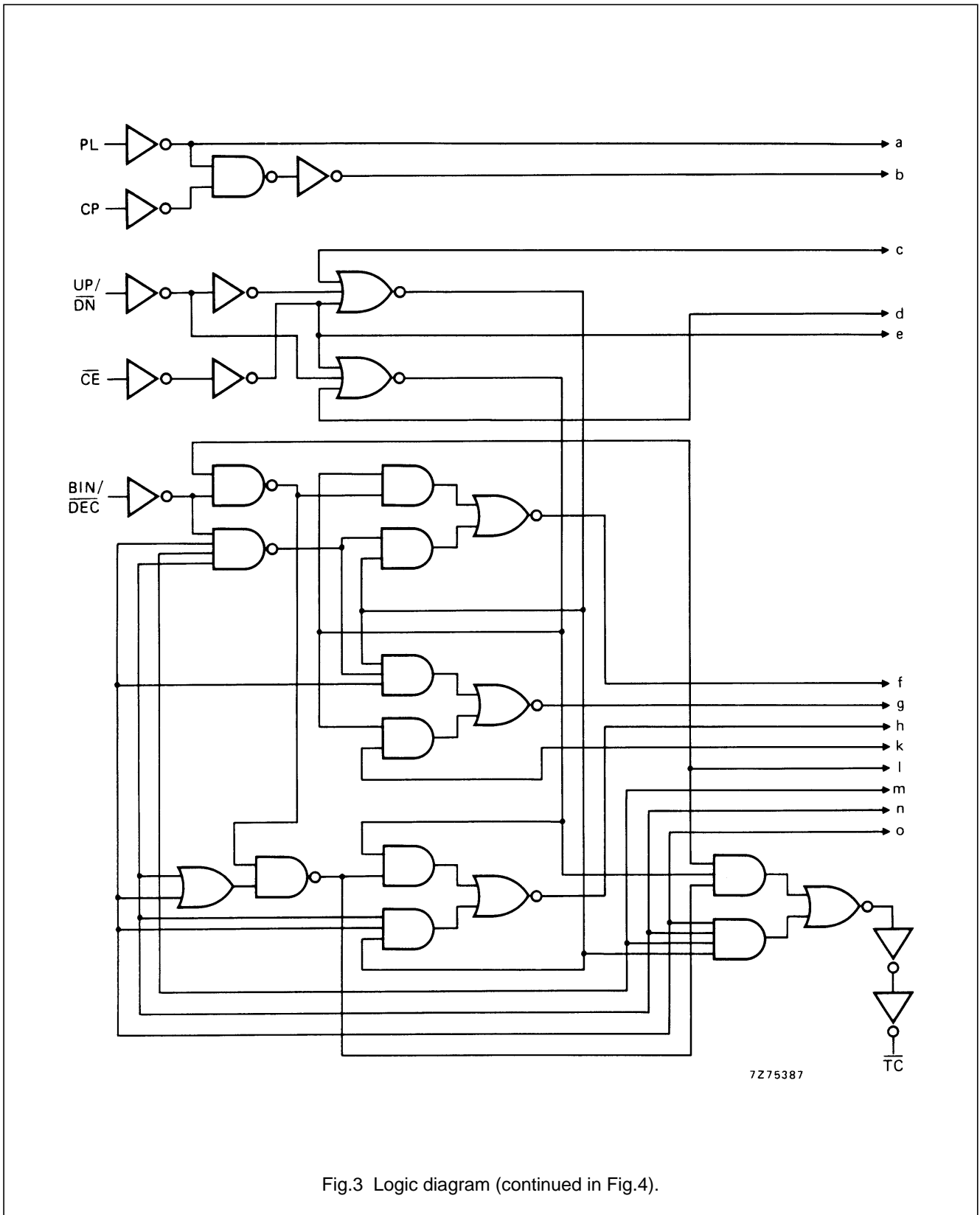
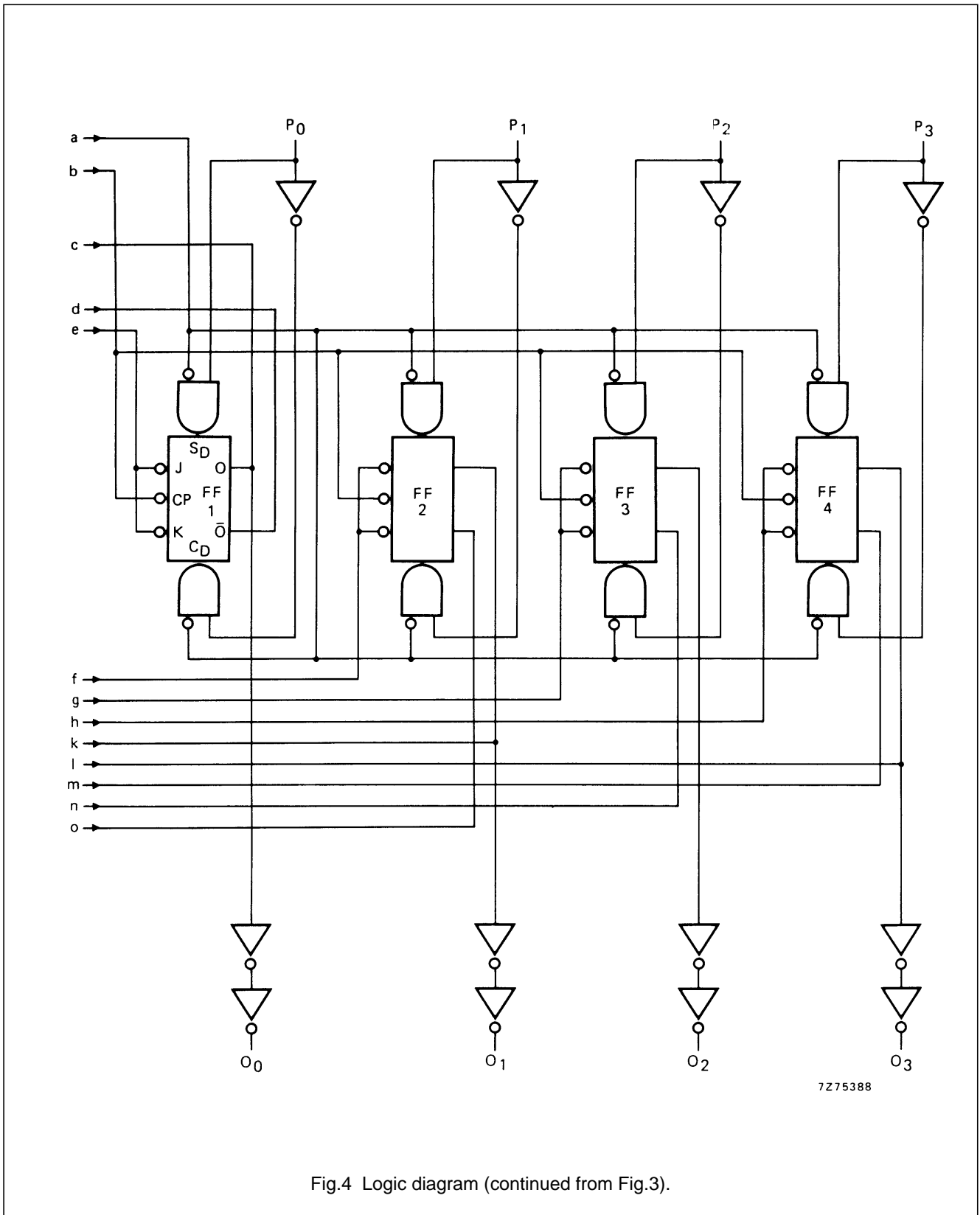


Fig.3 Logic diagram (continued in Fig.4).

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### FUNCTION TABLE

PL	BIN/DEC	UP/DN	CE	CP	MODE
H	X	X	X	X	parallel load ( $P_n \rightarrow O_n$ )
L	X	X	H	X	no change
L	L	L	L	$\nearrow$	count-down, decade
L	L	H	L	$\nearrow$	count-up, decade
L	H	L	L	$\nearrow$	count-down, binary
L	H	H	L	$\nearrow$	count-up, binary

### Notes

- 1. H = HIGH state (the more positive voltage)
- L = LOW state (the less positive voltage)
- X = state is immaterial
- $\nearrow$  = positive-going clock pulse edge

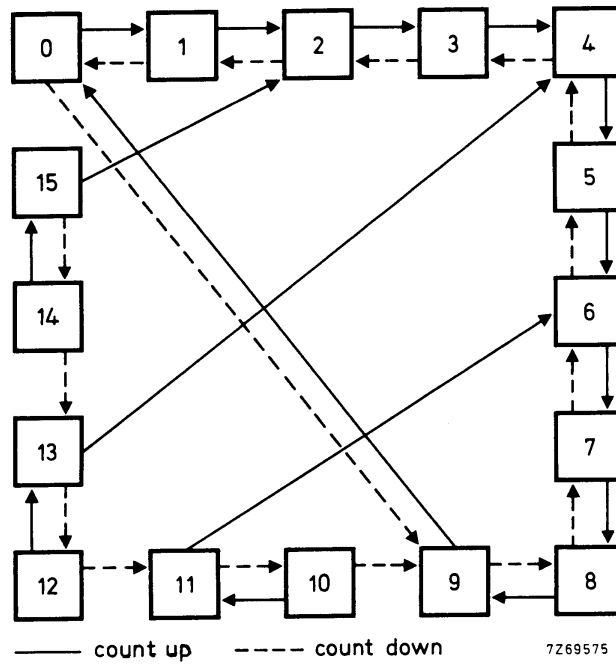
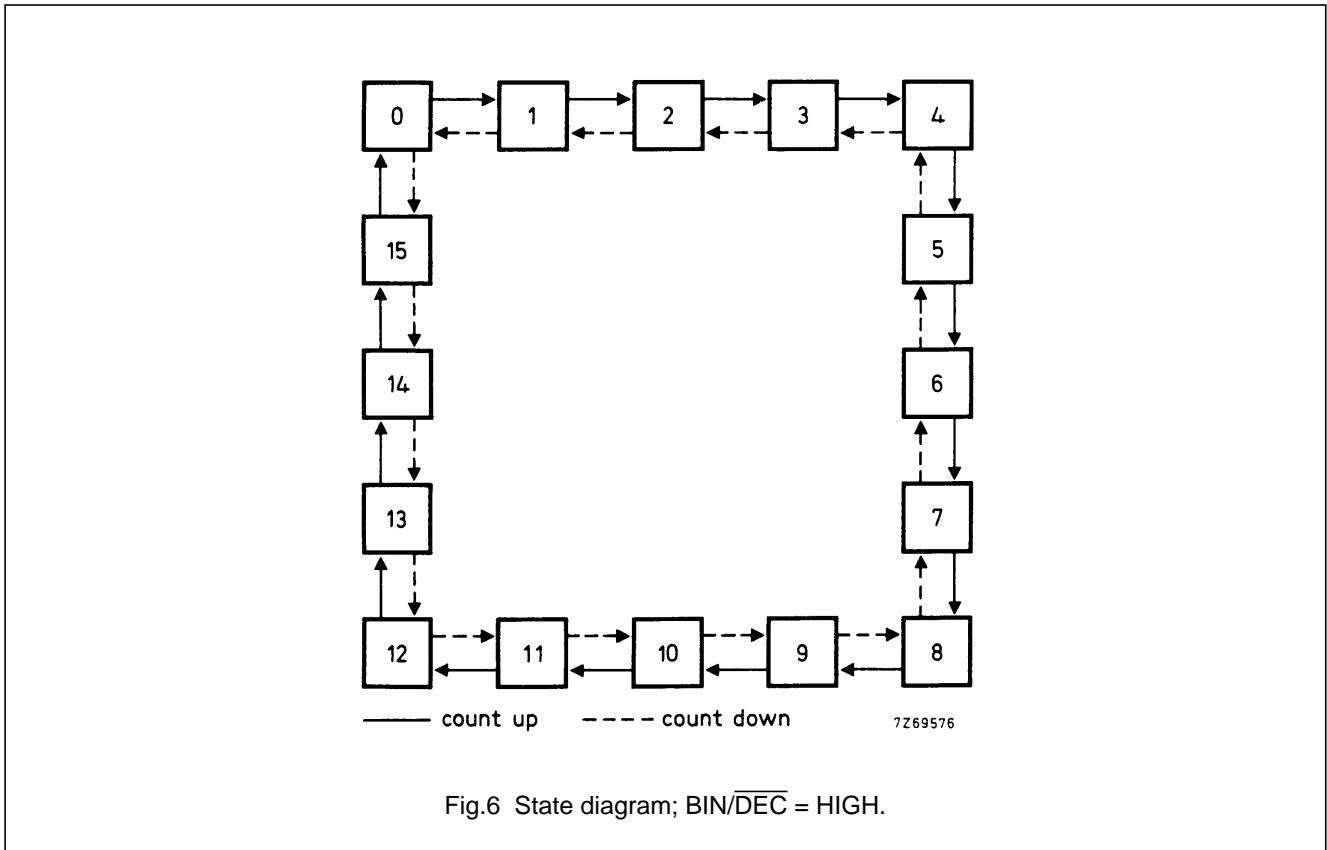


Fig.5 State diagram; BIN/DEC = LOW.

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Logic equation for terminal count:

$$TC = \overline{CE} (\overline{BIN/\overline{DEC}} \cdot \overline{UP/\overline{DN}} \cdot O_0 \cdot O_1 \cdot O_2 \cdot O_3 + \overline{BIN/\overline{DEC}} \cdot \overline{UP/\overline{DN}} \cdot \overline{O_0} \cdot \overline{O_1} \cdot \overline{O_2} \cdot \overline{O_3} + \overline{BIN/\overline{DEC}} \cdot \overline{UP/\overline{DN}} \cdot O_0 \cdot O_3 + \overline{BIN/\overline{DEC}} \cdot \overline{UP/\overline{DN}} \cdot \overline{O_0} \cdot \overline{O_1} \cdot \overline{O_2} \cdot \overline{O_3} )$$

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### AC CHARACTERISTICS

$V_{SS} = 0$  V;  $T_{amb} = 25$  °C; input transition times  $\leq 20$  ns

	$V_{DD}$ V	TYPICAL FORMULA FOR P ( $\mu$ W)	
Dynamic power dissipation per package (P)	5 10 15	$1000 f_i + \sum(f_o C_L) \times V_{DD}^2$ $4500 f_i + \sum(f_o C_L) \times V_{DD}^2$ $11\,500 f_i + \sum(f_o C_L) \times V_{DD}^2$	where $f_i$ = input freq. (MHz) $f_o$ = output freq. (MHz) $C_L$ = load capacitance (pF) $\sum(f_o C_L)$ = sum of outputs $V_{DD}$ = supply voltage (V)

### AC CHARACTERISTICS

$V_{SS} = 0$  V;  $T_{amb} = 25$  °C;  $C_L = 50$  pF; input transition times  $\leq 20$  ns

	$V_{DD}$ V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA		
Propagation delays CP $\rightarrow$ O <sub>n</sub> HIGH to LOW	5	$t_{PHL}$		145	290	ns	118 ns + (0,55 ns/pF) $C_L$	
	10		55	110	ns	44 ns + (0,23 ns/pF) $C_L$		
	15		40	75	ns	32 ns + (0,16 ns/pF) $C_L$		
	LOW to HIGH	5	$t_{PLH}$		160	315	ns	133 ns + (0,55 ns/pF) $C_L$
		10		60	120	ns	49 ns + (0,23 ns/pF) $C_L$	
		15		40	80	ns	32 ns + (0,16 ns/pF) $C_L$	
CP $\rightarrow$ $\overline{TC}$ HIGH to LOW	5	$t_{PHL}$		280	560	ns	253 ns + (0,55 ns/pF) $C_L$	
	10		105	205	ns	94 ns + (0,23 ns/pF) $C_L$		
	15		70	140	ns	62 ns + (0,16 ns/pF) $C_L$		
	LOW to HIGH	5	$t_{PLH}$		195	385	ns	168 ns + (0,55 ns/pF) $C_L$
		10		75	150	ns	64 ns + (0,23 ns/pF) $C_L$	
		15		55	105	ns	47 ns + (0,16 ns/pF) $C_L$	
PL $\rightarrow$ O <sub>n</sub> HIGH to LOW	5	$t_{PHL}$		120	240	ns	93 ns + (0,55 ns/pF) $C_L$	
	10		50	100	ns	39 ns + (0,23 ns/pF) $C_L$		
	15		35	70	ns	27 ns + (0,16 ns/pF) $C_L$		
	LOW to HIGH	5	$t_{PLH}$		170	335	ns	143 ns + (0,55 ns/pF) $C_L$
		10		65	130	ns	54 ns + (0,23 ns/pF) $C_L$	
		15		45	90	ns	37 ns + (0,16 ns/pF) $C_L$	
$\overline{CE} \rightarrow \overline{TC}$ HIGH to LOW	5	$t_{PHL}$		180	360	ns	153 ns + (0,55 ns/pF) $C_L$	
	10		70	140	ns	59 ns + (0,23 ns/pF) $C_L$		
	15		50	100	ns	42 ns + (0,16 ns/pF) $C_L$		
	LOW to HIGH	5	$t_{PLH}$		170	335	ns	143 ns + (0,55 ns/pF) $C_L$
		10		65	135	ns	54 ns + (0,23 ns/pF) $C_L$	
		15		50	100	ns	42 ns + (0,16 ns/pF) $C_L$	

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	V <sub>DD</sub> V	SYMBOL	MIN.	TYP.	MAX.		TYPICAL EXTRAPOLATION FORMULA
Output transition times HIGH to LOW	5	t <sub>THL</sub>		60	120	ns	10 ns + (1,0 ns/pF) C <sub>L</sub>
	10			30	60	ns	9 ns + (0,42 ns/pF) C <sub>L</sub>
	15			20	40	ns	6 ns + (0,28 ns/pF) C <sub>L</sub>
LOW to HIGH	5	t <sub>TLH</sub>		60	120	ns	10 ns + (1,0 ns/pF) C <sub>L</sub>
	10			30	60	ns	9 ns + (0,42 ns/pF) C <sub>L</sub>
	15			20	40	ns	6 ns + (0,28 ns/pF) C <sub>L</sub>



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### AC CHARACTERISTICS

$V_{SS} = 0$  V;  $T_{amb} = 25$  °C;  $C_L = 50$  pF; input transition times  $\leq 20$  ns

	$V_{DD}$ V	SYMBOL	MIN	TYP	MAX	
Minimum clock pulse width; LOW	5	$t_{WCPL}$	110	55	ns	see also waveforms Figs 7 and 8
	10		35	20	ns	
	15		25	15	ns	
Minimum PL pulse width; HIGH	5	$t_{WPLH}$	160	80	ns	
	10		55	25	ns	
	15		35	15	ns	
Recovery time for PL	5	$t_{RPL}$	150	75	ns	
	10		50	25	ns	
	15		35	20	ns	
Set-up times $\overline{BIN}/\overline{DEC} \rightarrow CP$	5	$t_{su}$	270	135	ns	
	10		90	45	ns	
	15		60	30	ns	
$UP/\overline{DN} \rightarrow CP$	5	$t_{su}$	300	150	ns	
	10		105	55	ns	
	15		75	35	ns	
$\overline{CE} \rightarrow CP$	5	$t_{su}$	240	120	ns	
	10		90	50	ns	
	15		70	40	ns	
$P_n \rightarrow PL$	5	$t_{su}$	70	35	ns	
	10		20	10	ns	
	15		10	5	ns	
Hold times $\overline{BIN}/\overline{DEC} \rightarrow CP$	5	$t_{hold}$	45	-90	ns	
	10		15	-30	ns	
	15		10	-20	ns	
$UP/\overline{DN} \rightarrow CP$	5	$t_{hold}$	15	-135	ns	
	10		0	-50	ns	
	15		-5	-35	ns	
$\overline{CE} \rightarrow CP$	5	$t_{hold}$	30	-30	ns	
	10		10	-10	ns	
	15		5	-10	ns	
$P_n \rightarrow PL$	5	$t_{hold}$	15	-20	ns	
	10		0	-10	ns	
	15		0	-5	ns	
Maximum clock pulse frequency	5	$f_{max}$	2	4	MHz	
	10		5	10	MHz	
	15		8	15	MHz	

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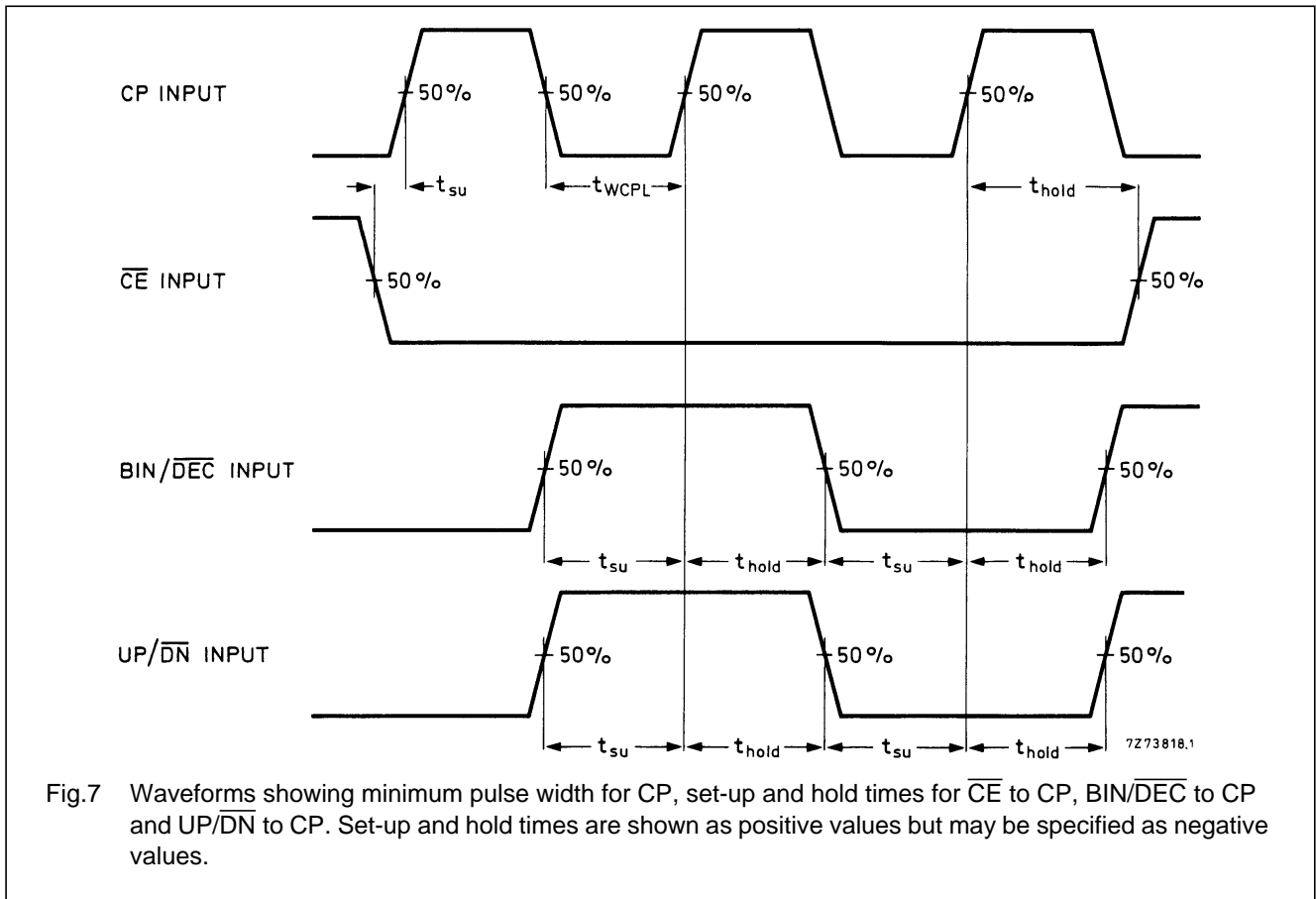


Fig.7 Waveforms showing minimum pulse width for CP, set-up and hold times for  $\overline{CE}$  to CP, BIN/ $\overline{DEC}$  to CP and UP/ $\overline{DN}$  to CP. Set-up and hold times are shown as positive values but may be specified as negative values.

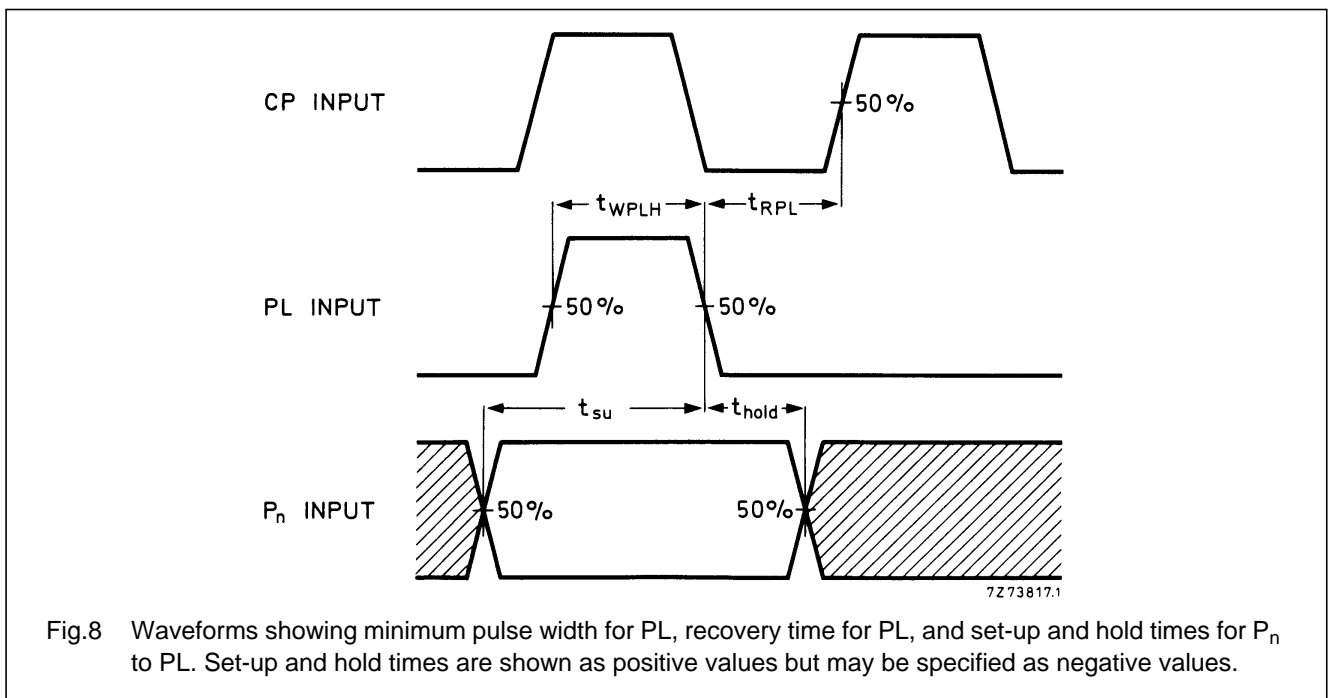


Fig.8 Waveforms showing minimum pulse width for PL, recovery time for PL, and set-up and hold times for  $P_n$  to PL. Set-up and hold times are shown as positive values but may be specified as negative values.

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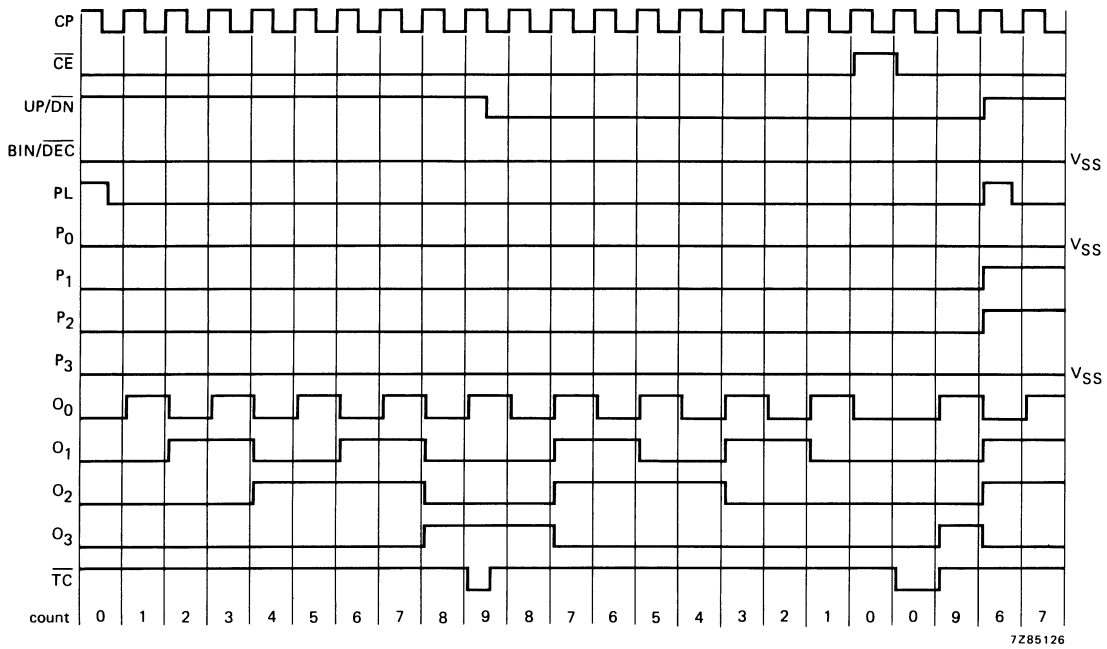


Fig.9 Timing diagram; decade mode; P<sub>0</sub> = LOW; P<sub>3</sub> = LOW; BIN/DEC = LOW.

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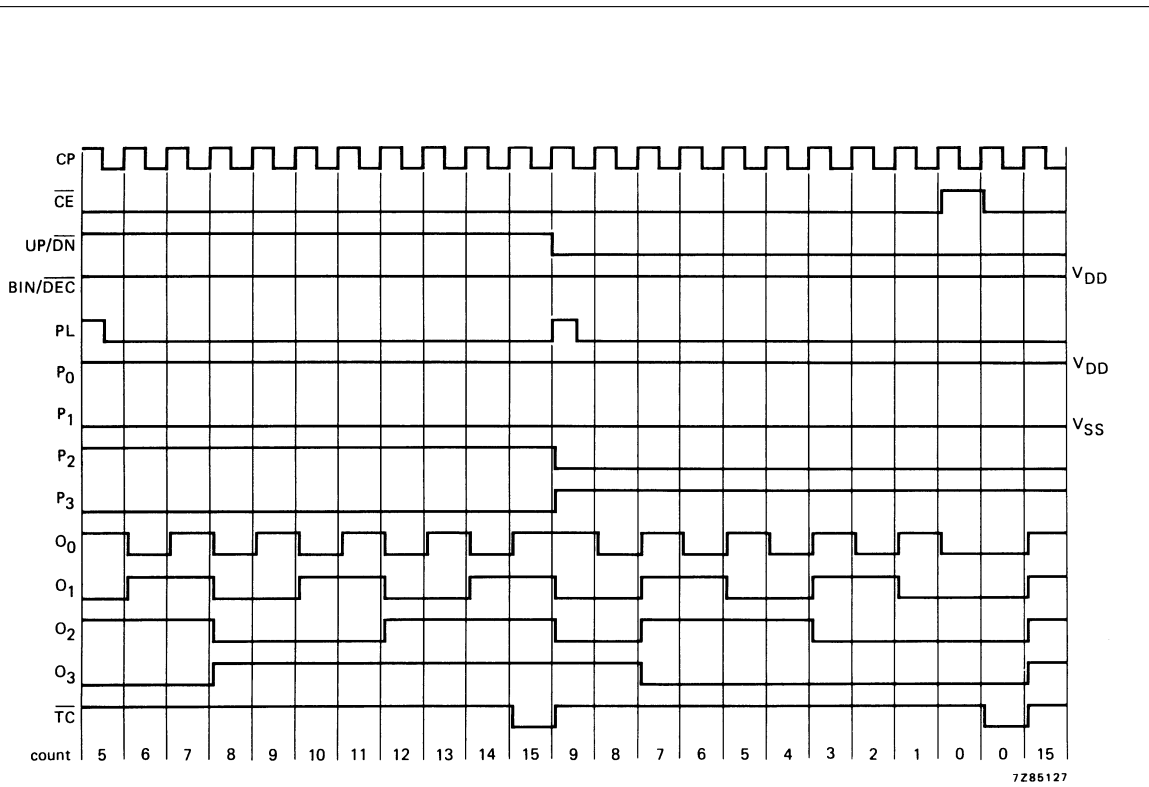


Fig.10 Timing diagram; binary mode; P<sub>0</sub> = HIGH; P<sub>1</sub> = LOW; BIN/DEC = HIGH.

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**APPLICATION INFORMATION**

Some examples of applications for the HEF4029B are:

- Programmable binary and decade counting/frequency synthesizers - BCD output.
- Analogue-to-digital and digital-to-analogue conversion.
- Up/down binary counting.
- Magnitude and sign generation.
- Up/down decade counting.
- Difference counting.

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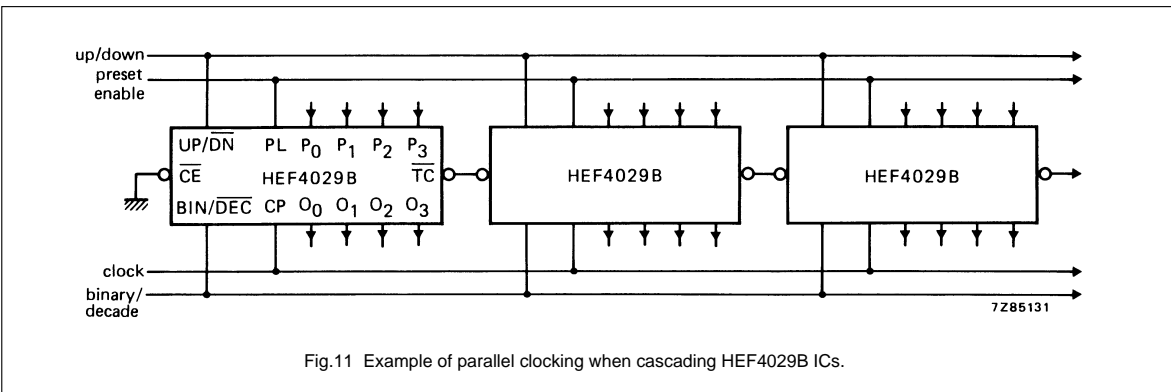
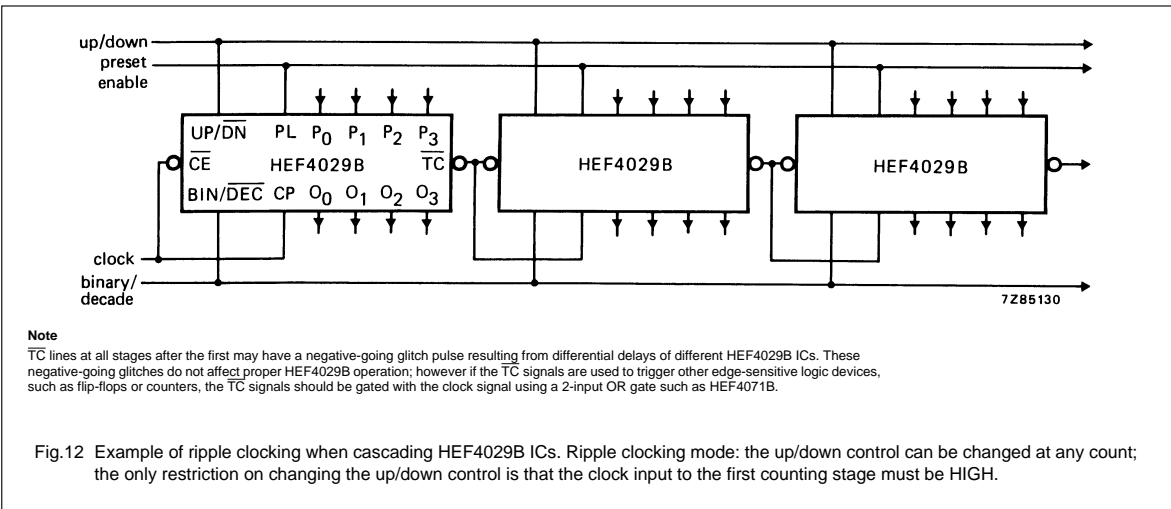


Fig.11 Example of parallel clocking when cascading HEF4029B ICs.



**Note**

TC lines at all stages after the first may have a negative-going glitch pulse resulting from differential delays of different HEF4029B ICs. These negative-going glitches do not affect proper HEF4029B operation; however if the TC signals are used to trigger other edge-sensitive logic devices, such as flip-flops or counters, the TC signals should be gated with the clock signal using a 2-input OR gate such as HEF4071B.

Fig.12 Example of ripple clocking when cascading HEF4029B ICs. Ripple clocking mode: the up/down control can be changed at any count; the only restriction on changing the up/down control is that the clock input to the first counting stage must be HIGH.