

# 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

## **HEF4516B**

## **MSI**

## **Binary up/down counter**

Product specification  
File under Integrated Circuits, IC04

January 1995

# Binary up/down counter

# HEF4516B MSI

### DESCRIPTION

The HEF4516B is an edge-triggered synchronous up/down 4-bit binary counter with a clock input (CP), an up/down count control input (UP/DN), an active LOW count enable input ( $\overline{CE}$ ), an asynchronous active HIGH parallel load input (PL), four parallel inputs (P<sub>0</sub> to P<sub>3</sub>), four parallel outputs (O<sub>0</sub> to O<sub>3</sub>), an active LOW terminal count output ( $\overline{TC}$ ), and an overriding asynchronous master reset input (MR).

Information on P<sub>0</sub> to P<sub>3</sub> is loaded into the counter while PL is HIGH, independent of all other input conditions except MR which must be LOW. When PL and  $\overline{CE}$  are LOW, the counter changes on the LOW to HIGH transition of CP. Input UP/DN determines the direction of the count, HIGH for counting up, LOW for counting down. When counting up,  $\overline{TC}$  is LOW when O<sub>0</sub> and O<sub>3</sub> are HIGH and  $\overline{CE}$  is LOW. When counting down,  $\overline{TC}$  is LOW when O<sub>0</sub> to O<sub>3</sub> and  $\overline{CE}$  are LOW. A HIGH on MR resets the counter (O<sub>0</sub> to O<sub>3</sub> = LOW) independent of all other input conditions.

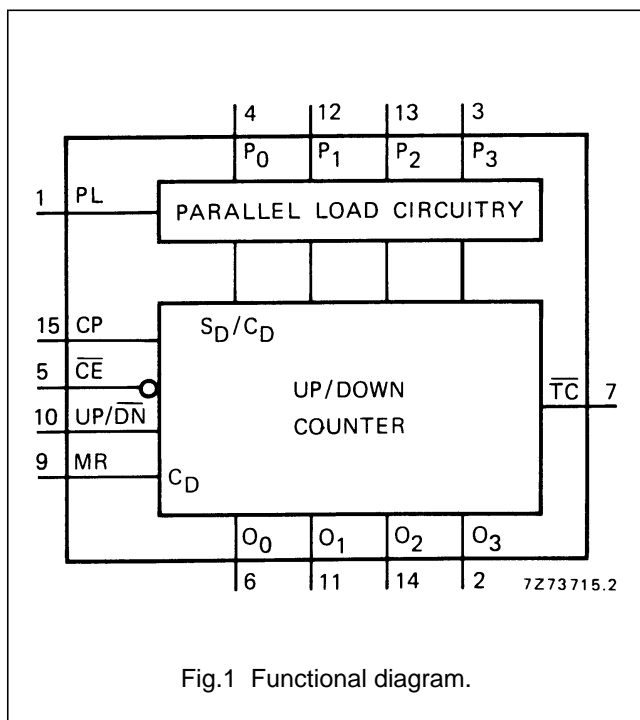


Fig.1 Functional diagram.

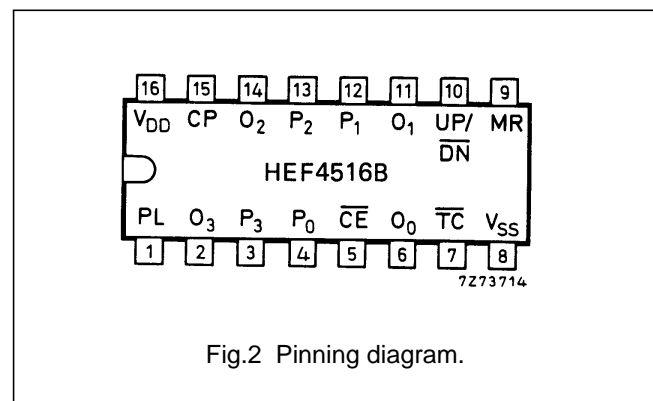


Fig.2 Pinning diagram.

### PINNING

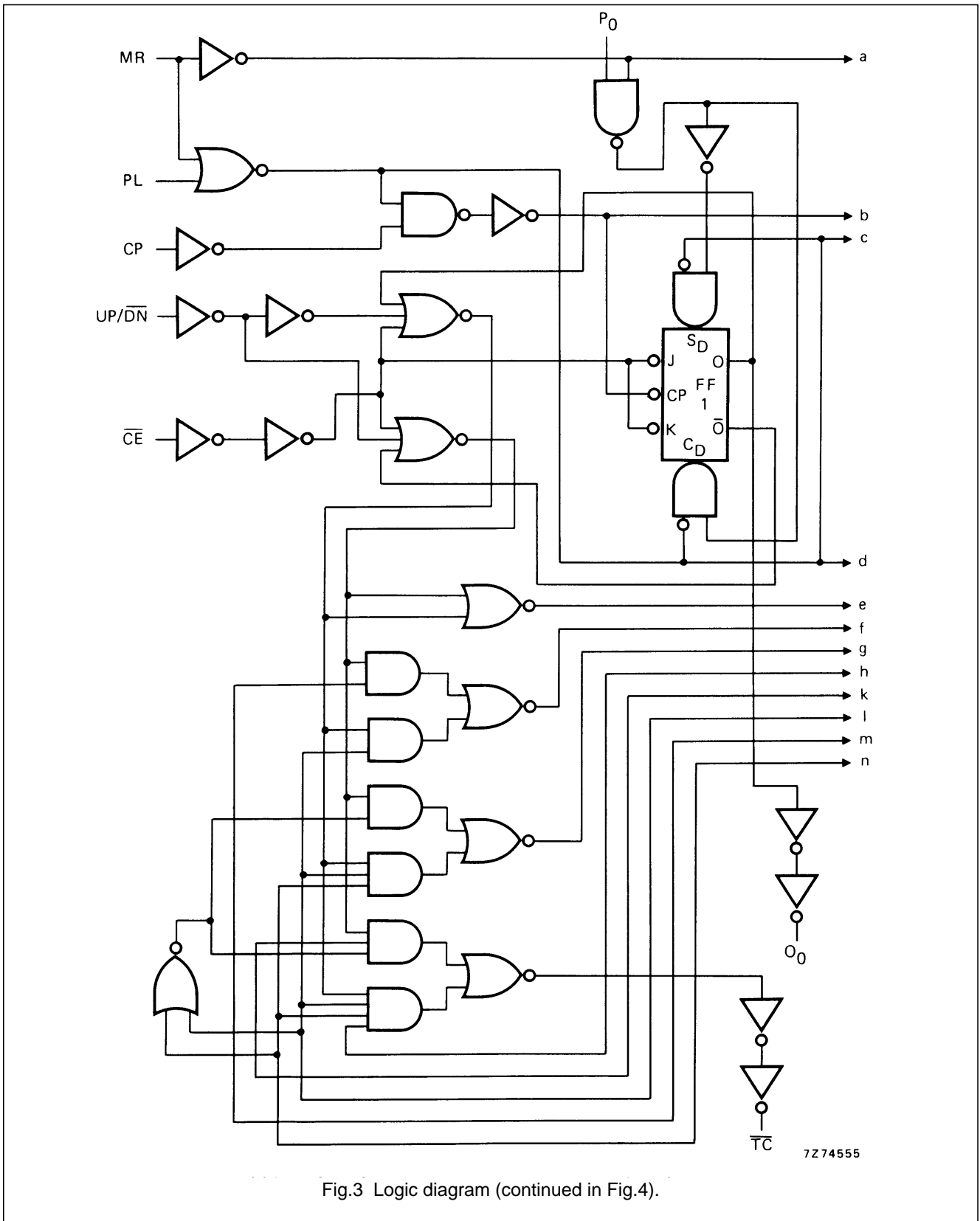
- PL parallel load input (active HIGH)
- P<sub>0</sub> to P<sub>3</sub> parallel inputs
- $\overline{CE}$  count enable input (active LOW)
- CP clock pulse input (LOW to HIGH, edge triggered)
- UP/DN up/down count control input
- MR master reset input
- $\overline{TC}$  terminal count output (active LOW)
- O<sub>0</sub> to O<sub>3</sub> parallel outputs

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

See Family Specifications

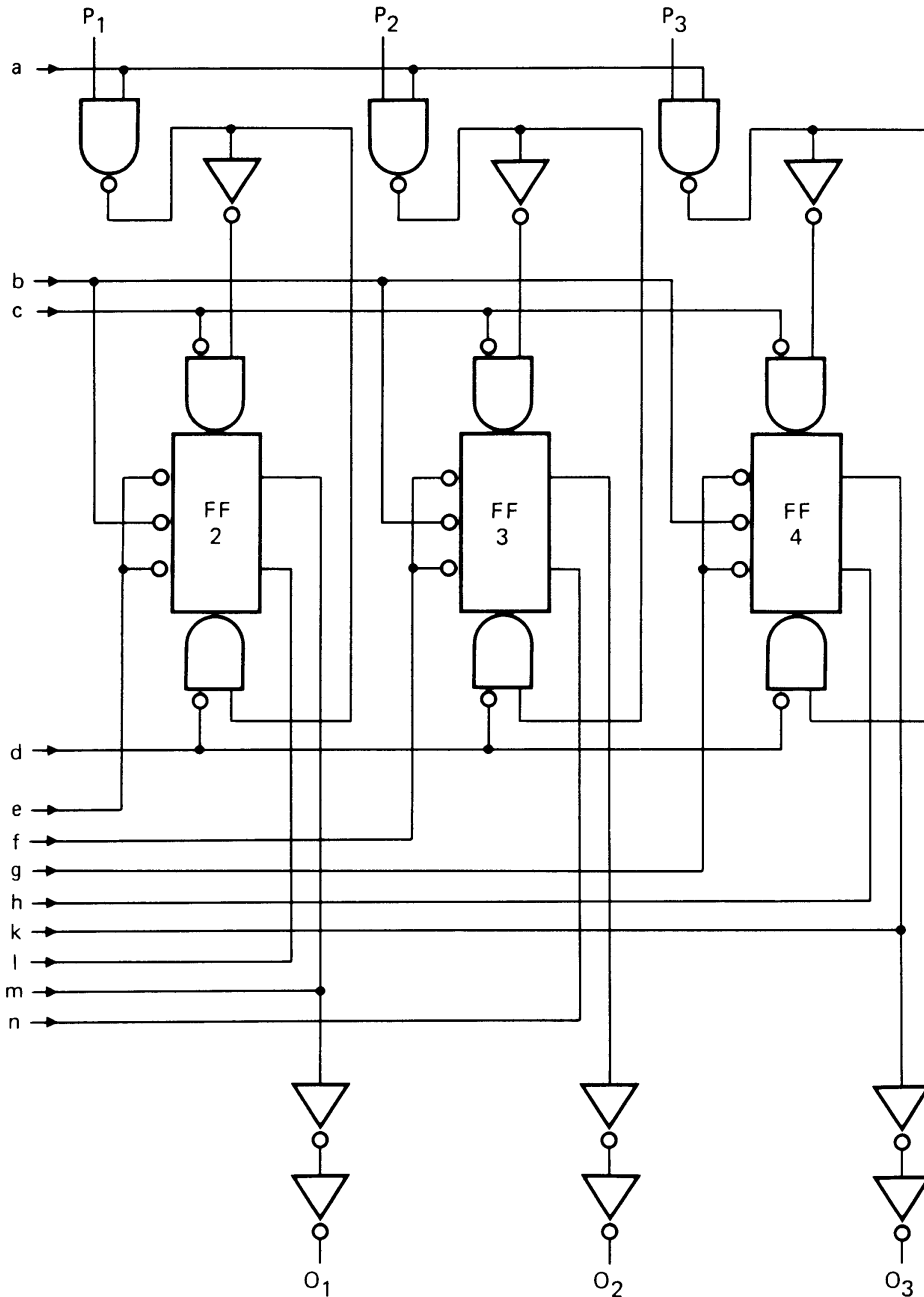
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Fig.4 Logic diagram (continued from Fig.3).

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FUNCTION TABLE

MR	PL	UP/DN	$\overline{CE}$	CP	MODE
L	H	X	X	X	parallel load
L	L	X	H	X	no change
L	L	L	L	$\nearrow$	count down
L	L	H	L	$\searrow$	count up
H	X	X	X	X	reset

Notes

- H = HIGH state (the more positive voltage)  
L = LOW state (the less positive voltage)  
X = state is immaterial  
 $\nearrow$  = positive-going transition

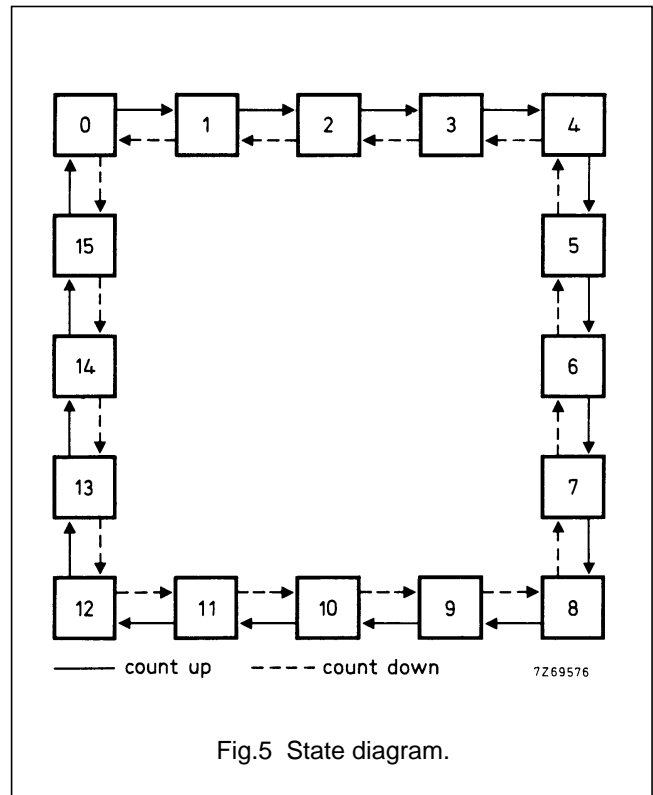


Fig.5 State diagram.

Logic equation for terminal count:

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

AC CHARACTERISTICS

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

	$V_{DD}$ V	TYPICAL FORMULA FOR P ( $\mu\text{W}$ )	
Dynamic power dissipation per package (P)	5 10 15	$1000 f_i + \sum (f_o C_L) \times V_{DD}^2$ $4500 f_i + \sum (f_o C_L) \times V_{DD}^2$ $11\ 200 f_i + \sum (f_o C_L) \times V_{DD}^2$	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)

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## AC CHARACTERISTICS

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

	$V_{DD}$ V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA
Propagation delays						
CP $\rightarrow$ $O_n$	5			145	290 ns	118 ns + (0,55 ns/pF) $C_L$
HIGH to LOW	10	$t_{PHL}$		60	120 ns	49 ns + (0,23 ns/pF) $C_L$
	15			45	90 ns	37 ns + (0,16 ns/pF) $C_L$
LOW to HIGH	5	$t_{PLH}$		155	310 ns	128 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) $C_L$
CP $\rightarrow$ $\overline{TC}$	5			260	525 ns	233 ns + (0,55 ns/pF) $C_L$
HIGH to LOW	10	$t_{PHL}$		105	210 ns	94 ns + (0,23 ns/pF) $C_L$
	15			75	150 ns	67 ns + (0,16 ns/pF) $C_L$
LOW to HIGH	5	$t_{PLH}$		180	360 ns	153 ns + (0,55 ns/pF) $C_L$
	10			75	150 ns	64 ns + (0,23 ns/pF) $C_L$
	15			55	115 ns	47 ns + (0,16 ns/pF) $C_L$
PL $\rightarrow$ $O_n$	5			125	255 ns	98 ns + (0,55 ns/pF) $C_L$
HIGH to LOW	10	$t_{PHL}$		55	110 ns	44 ns + (0,23 ns/pF) $C_L$
	15			40	85 ns	32 ns + (0,16 ns/pF) $C_L$
LOW to HIGH	5	$t_{PLH}$		170	340 ns	143 ns + (0,55 ns/pF) $C_L$
	10			70	140 ns	59 ns + (0,23 ns/pF) $C_L$
	15			50	105 ns	42 ns + (0,16 ns/pF) $C_L$
PL $\rightarrow$ $\overline{TC}$	5			250	500 ns	223 ns + (0,55 ns/pF) $C_L$
HIGH to LOW	10	$t_{PHL}$		110	220 ns	99 ns + (0,23 ns/pF) $C_L$
	15			80	160 ns	72 ns + (0,16 ns/pF) $C_L$
LOW to HIGH	5	$t_{PLH}$		250	500 ns	223 ns + (0,55 ns/pF) $C_L$
	10			110	220 ns	99 ns + (0,23 ns/pF) $C_L$
	15			80	160 ns	72 ns + (0,16 ns/pF) $C_L$
$\overline{CE} \rightarrow \overline{TC}$	5			165	330 ns	138 ns + (0,55 ns/pF) $C_L$
HIGH to LOW	10	$t_{PHL}$		65	135 ns	54 ns + (0,23 ns/pF) $C_L$
	15			50	100 ns	42 ns + (0,16 ns/pF) $C_L$
LOW to HIGH	5	$t_{PLH}$		145	290 ns	118 ns + (0,55 ns/pF) $C_L$
	10			60	125 ns	49 ns + (0,23 ns/pF) $C_L$
	15			45	95 ns	37 ns + (0,16 ns/pF) $C_L$
MR $\rightarrow$ $O_n, \overline{TC}$	5			205	405 ns	178 ns + (0,55 ns/pF) $C_L$
HIGH to LOW	10	$t_{PHL}$		65	130 ns	54 ns + (0,23 ns/pF) $C_L$
	15			45	85 ns	37 ns + (0,16 ns/pF) $C_L$
MR $\rightarrow$ $\overline{TC}$	5			225	450 ns	198 ns + (0,55 ns/pF) $C_L$
LOW to HIGH	10	$t_{PLH}$		75	150 ns	64 ns + (0,23 ns/pF) $C_L$
	15			50	100 ns	42 ns + (0,16 ns/pF) $C_L$

## Binary up/down counter

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	$V_{DD}$ V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA
Output transition times HIGH to LOW	5	$t_{THL}$		60	120 ns	$10 \text{ ns} + (1,0 \text{ ns/pF}) C_L$
	10			30	60 ns	$9 \text{ ns} + (0,42 \text{ ns/pF}) C_L$
	15			20	40 ns	$6 \text{ ns} + (0,28 \text{ ns/pF}) C_L$
LOW to HIGH	5	$t_{TLH}$		60	120 ns	$10 \text{ ns} + (1,0 \text{ ns/pF}) C_L$
	10			30	60 ns	$9 \text{ ns} + (0,42 \text{ ns/pF}) C_L$
	15			20	40 ns	$6 \text{ ns} + (0,28 \text{ ns/pF}) C_L$

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	V <sub>DD</sub> V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA	
Minimum clock pulse width; LOW	5	t <sub>WCPL</sub>	95	45	ns	see also waveforms Figs 6 and 7	
	10		35	20	ns		
	15		25	15	ns		
Minimum PL pulse width; HIGH	5	t <sub>WPLH</sub>	105	55	ns		
	10		45	25	ns		
	15		35	15	ns		
Minimum MR pulse width; HIGH	5	t <sub>WMRH</sub>	120	60	ns		
	10		50	25	ns		
	15		40	20	ns		
Recovery time for MR	5	t <sub>RMR</sub>	130	65	ns		
	10		45	20	ns		
	15		30	15	ns		
Recovery time for PL	5	t <sub>RPL</sub>	150	75	ns		
	10		50	25	ns		
	15		30	15	ns		
Set-up times P <sub>n</sub> → PL	5	t <sub>su</sub>	100	50	ns		
	10		50	25	ns		
	15		40	20	ns		
	UP/ $\overline{\text{DN}}$ → CP	5	t <sub>su</sub>	250	125		ns
		10		100	50		ns
		15		75	35		ns
	$\overline{\text{CE}}$ → CP	5	t <sub>su</sub>	120	60	ns	
		10		40	20	ns	
		15		25	10	ns	
Hold times P <sub>n</sub> → PL	5	t <sub>hold</sub>	10	-40	ns		
	10		5	-20	ns		
	15		0	-20	ns		
	UP/ $\overline{\text{DN}}$ → CP	5	t <sub>hold</sub>	35	-90	ns	
		10		15	-35	ns	
		15		15	-25	ns	
	$\overline{\text{CE}}$ → CP	5	t <sub>hold</sub>	20	-40	ns	
		10		5	-15	ns	
		15		5	-10	ns	
Maximum clock pulse frequency	5	f <sub>max</sub>	3	6	MHz		
	10		7	14	MHz		
	15		9	18	MHz		



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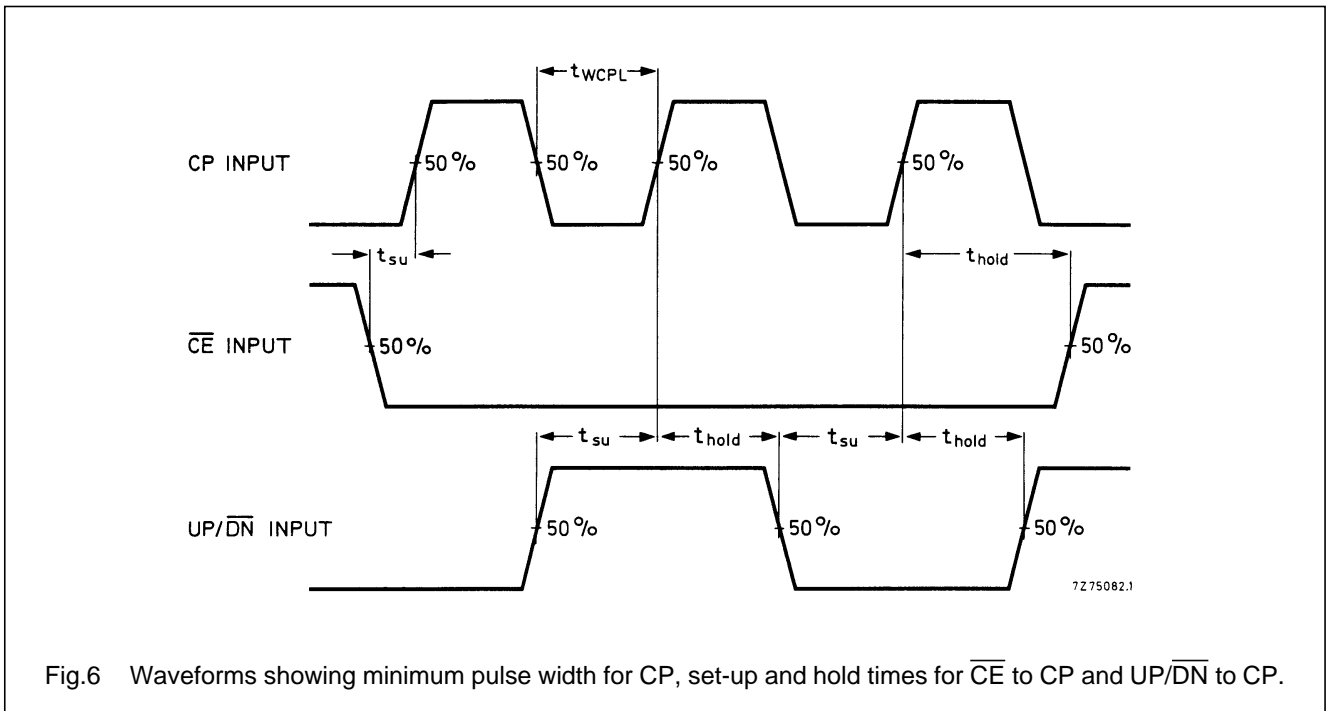


Fig.6 Waveforms showing minimum pulse width for CP, set-up and hold times for  $\overline{CE}$  to CP and UP/ $\overline{DN}$  to CP.

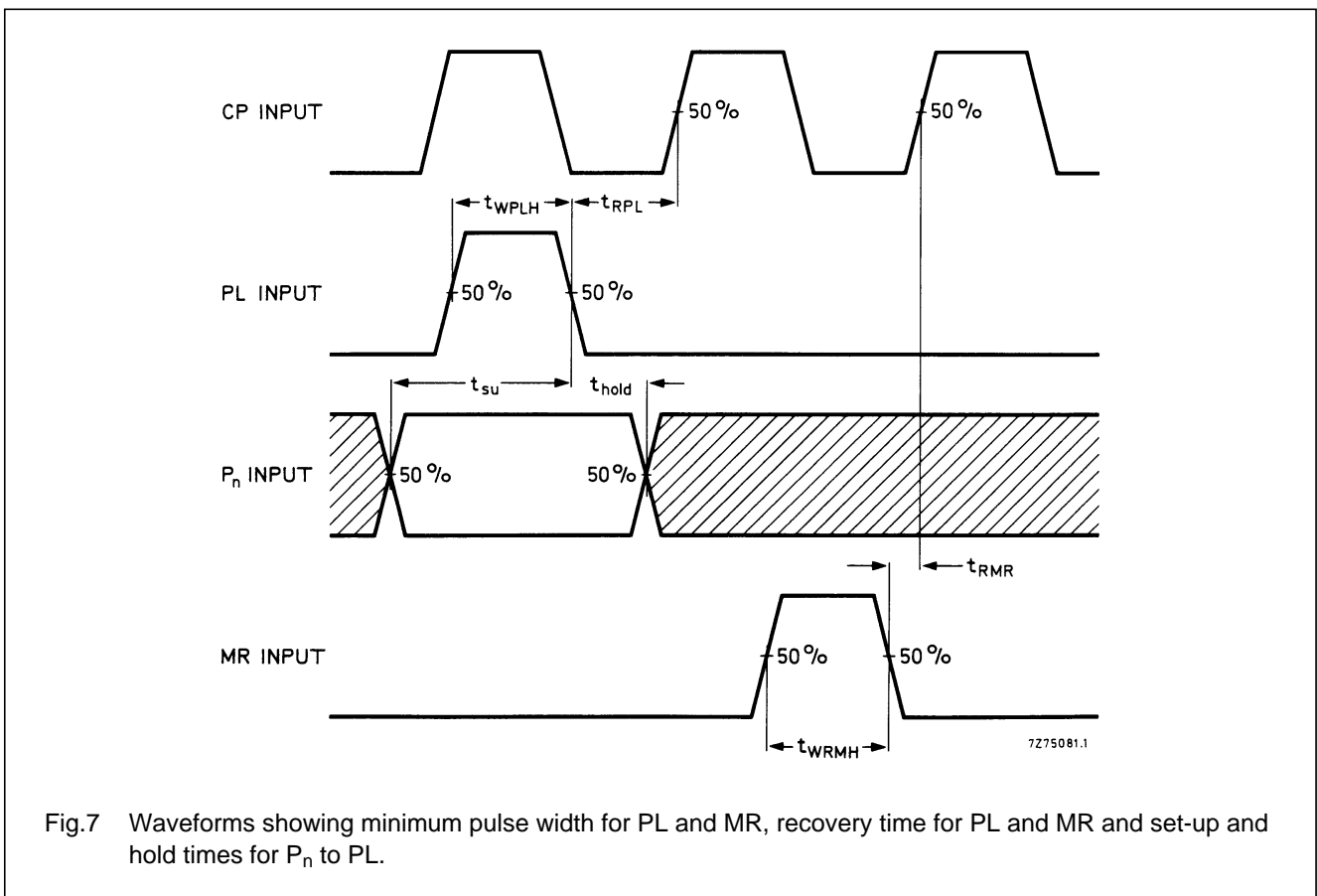


Fig.7 Waveforms showing minimum pulse width for PL and MR, recovery time for PL and MR and set-up and hold times for  $P_n$  to PL.

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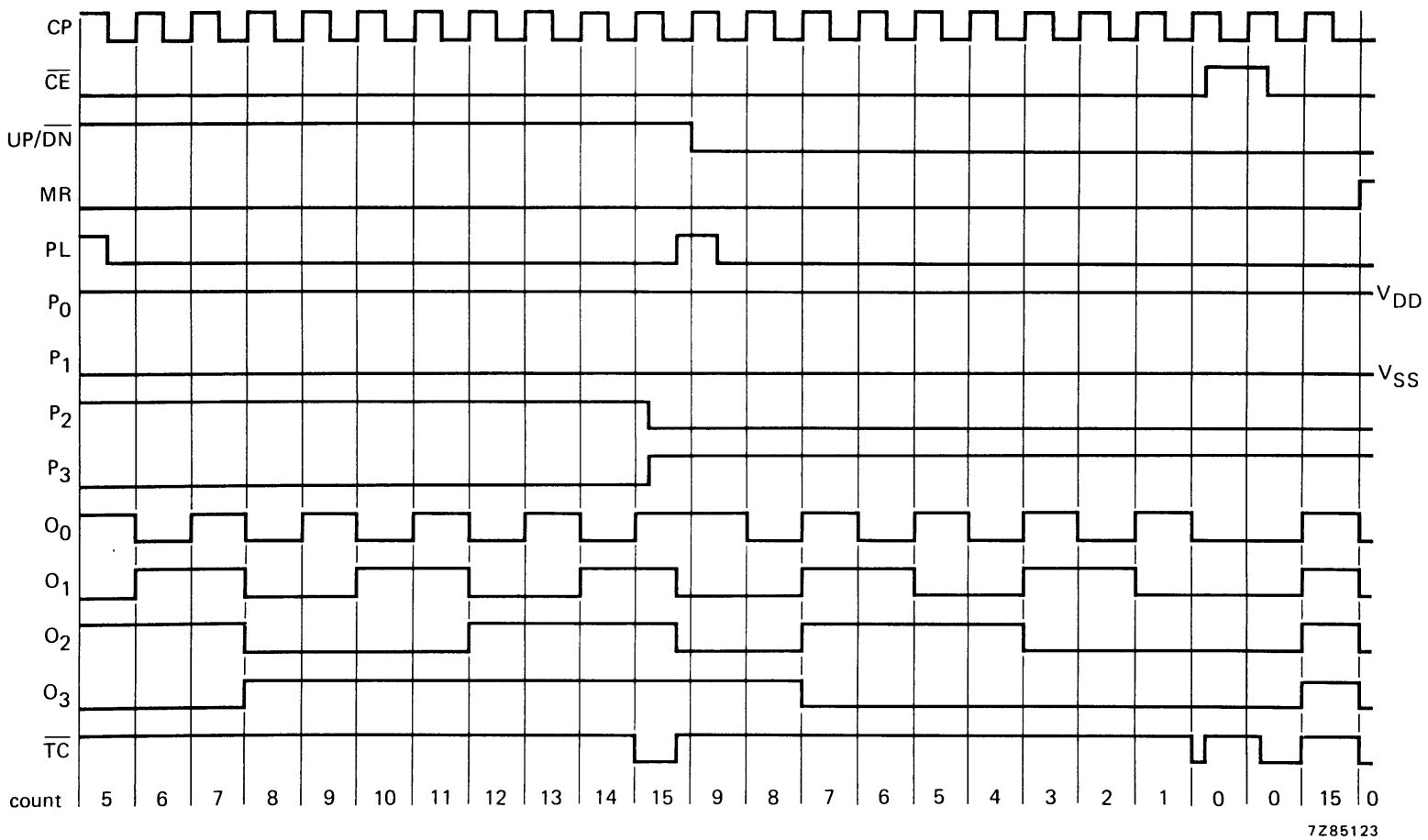


Fig.8 Timing diagram.