

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

HEF4510B

MSI

BCD up/down counter

Product specification
File under Integrated Circuits, IC04

January 1995

BCD up/down counter

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DESCRIPTION

The HEF4510B is an edge-triggered synchronous up/down BCD counter with a clock input (CP), an up/down count control input (UP/DN), an active LOW count enable input ($\overline{\text{CE}}$), an asynchronous active HIGH parallel load input (PL), four parallel inputs (P_0 to P_3), four parallel outputs (O_0 to O_3), an active LOW terminal count output ($\overline{\text{TC}}$), and an overriding asynchronous master reset input (MR).

Information on P_0 to P_3 is loaded into the counter while PL is HIGH, independent of all other input conditions except the MR input, which must be LOW. With PL LOW, the counter changes on the LOW to HIGH transition of CP if $\overline{\text{CE}}$ is LOW. UP/DN determines the direction of the count, HIGH for counting up, LOW for counting down. When counting up, $\overline{\text{TC}}$ is LOW when O_0 and O_3 are HIGH and $\overline{\text{CE}}$ is LOW. When counting down, $\overline{\text{TC}}$ is LOW when O_0 to O_3 and $\overline{\text{CE}}$ are LOW. A HIGH on MR resets the counter (O_0 to $\text{O}_3 = \text{LOW}$) independent of all other input conditions.

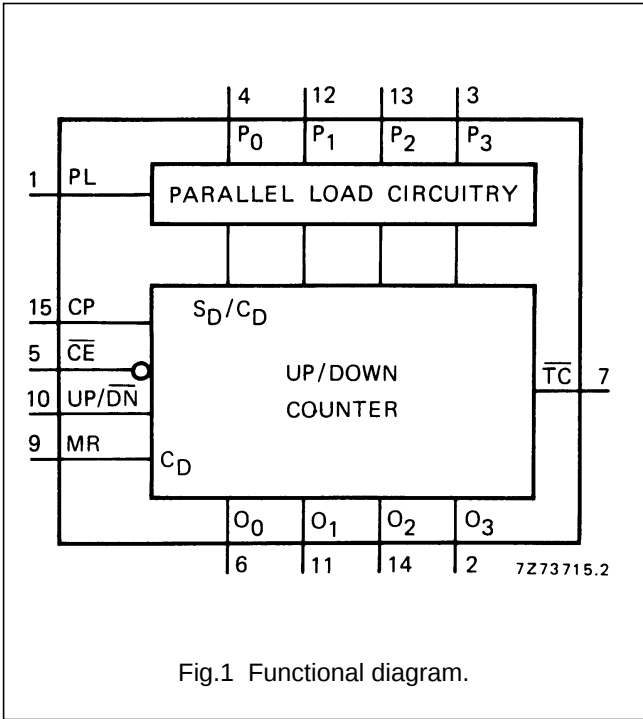


Fig.1 Functional diagram.

- HEF4510BP(N): 16-lead DIL; plastic (SOT38-1)
- HEF4510BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)
- HEF4510BT(D): 16-lead SO; plastic (SOT109-1)
- (): Package Designator North America

PINNING

- PL parallel load input (active HIGH)
- P_0 to P_3 parallel inputs
- $\overline{\text{CE}}$ count enable input (active LOW)
- CP clock pulse input (LOW to HIGH, edge triggered)
- $\text{UP}/\overline{\text{DN}}$ up/down count control input
- MR master reset input
- $\overline{\text{TC}}$ terminal count output (active LOW)
- O_0 to O_3 parallel outputs

FAMILY DATA, I_{DD} LIMITS category MSI

See Family Specifications

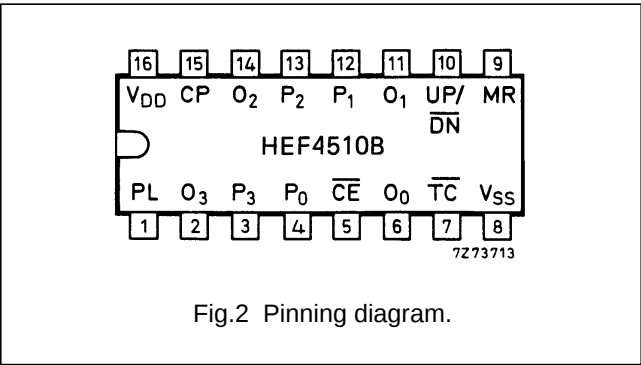


Fig.2 Pinning diagram.

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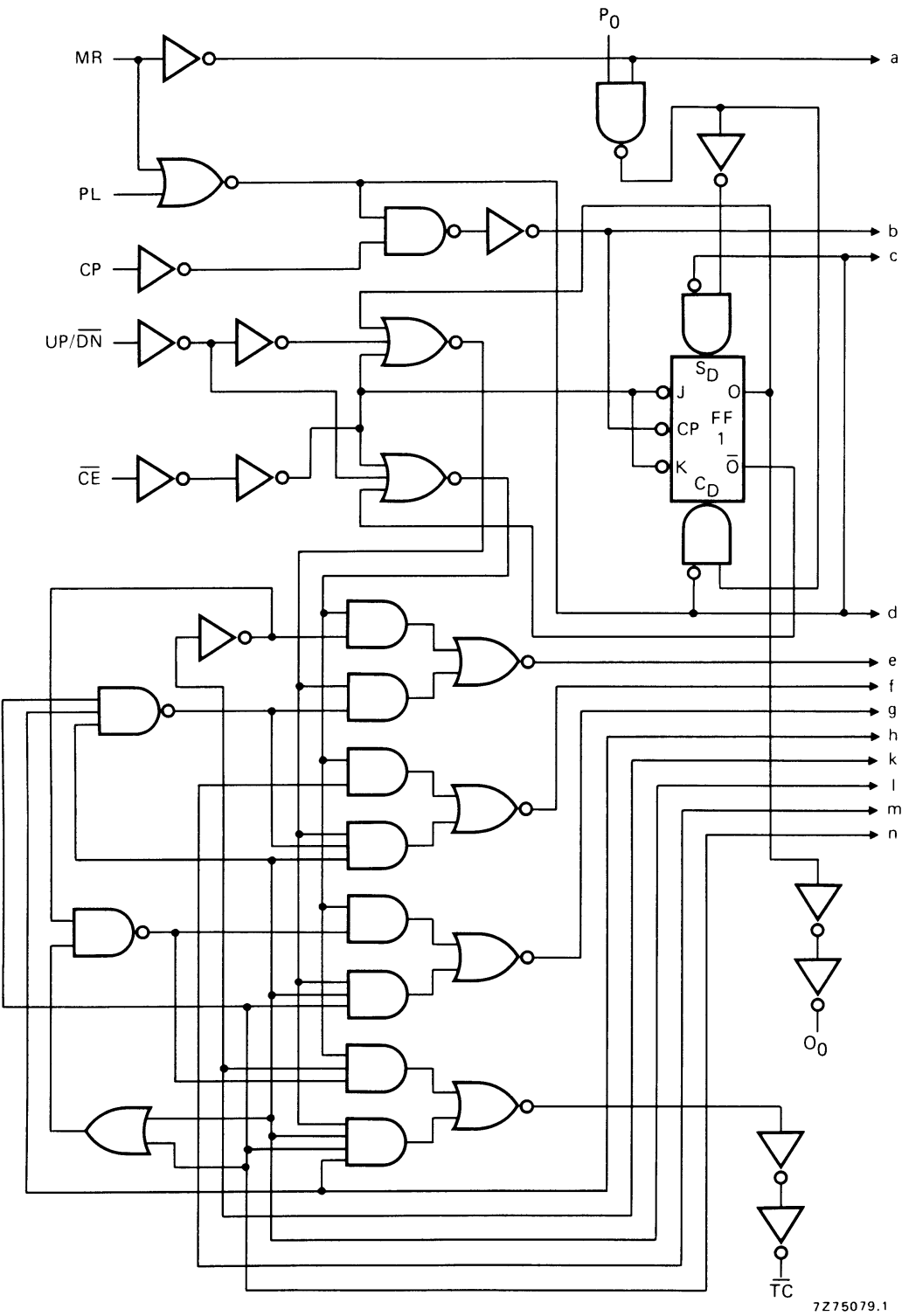
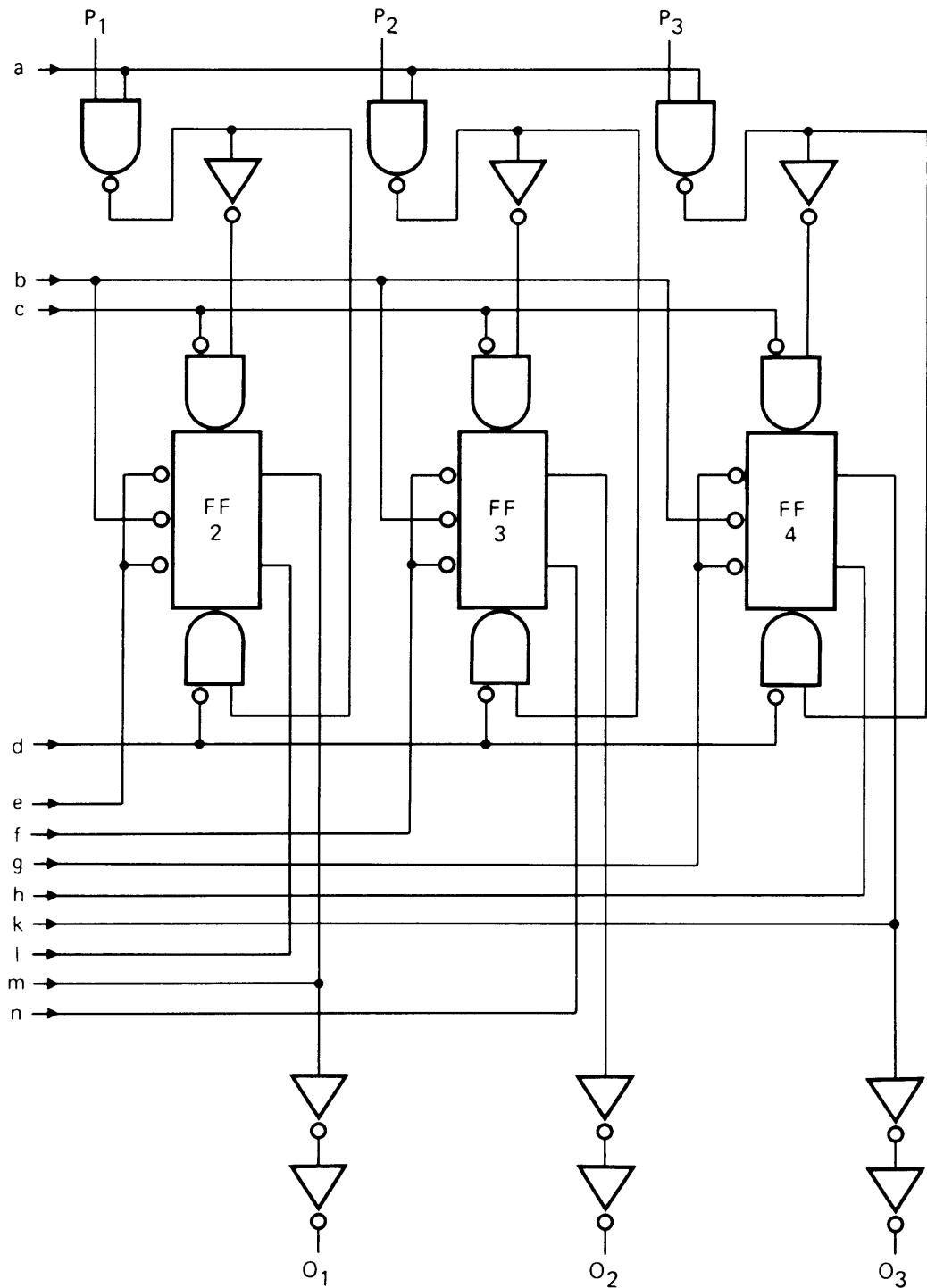


Fig.3 Logic diagram (continued in Fig.4).

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

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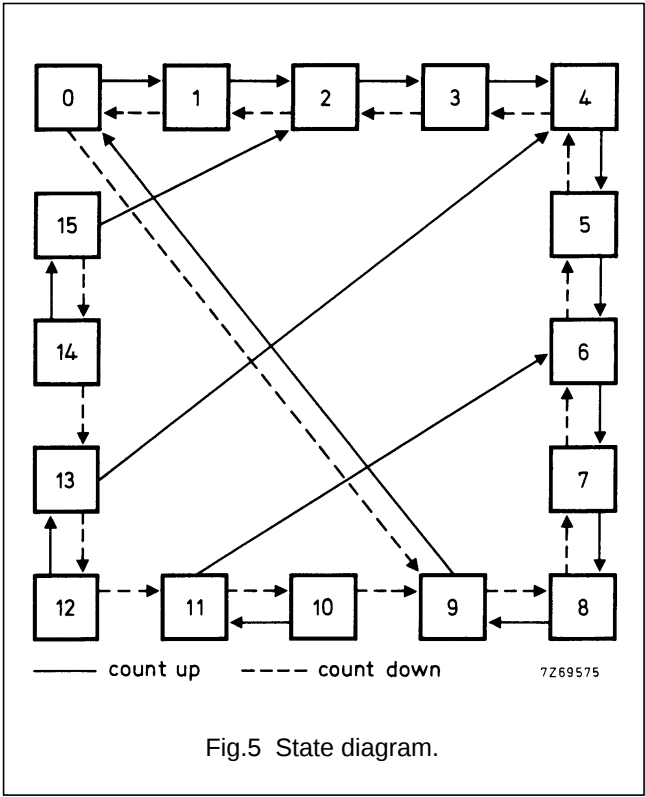
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FUNCTION TABLE

MR	PL	UP/DN	CE	CP	MODE
L	H	X	X	X	parallel load
L	L	X	H	X	no change
L	L	L	L		count down
L	L	H	L		count up
H	X	X	X	X	reset

Notes

1.
- H = HIGH state (the more positive voltage)
L = LOW state (the less positive voltage)
X = state is immaterial
 = positive-going transition



Logic equation for terminal count:

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

A.C. CHARACTERISTICS

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

	V _{DD} V	TYPICAL FORMULA FOR P (μW)	
Dynamic power dissipation per package (P)	5 10 15	1000 f _i + Σ (f _o C _L) × V _{DD} ² 4500 f _i + Σ (f _o C _L) × V _{DD} ² 11 200 f _i + Σ (f _o C _L) × V _{DD} ²	where f _i = input freq. (MHz) f _o = output freq. (MHz) C _L = load capacitance (pF) Σ (f _o C _L) = sum of outputs V _{DD} = supply voltage (V)

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AC CHARACTERISTICS

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

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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 ns + (1,0 ns/pF) C_L
	10			30	60 ns	9 ns + (0,42 ns/pF) C_L
	15			20	40 ns	6 ns + (0,28 ns/pF) C_L
LOW to HIGH	5	t_{TLH}		60	120 ns	10 ns + (1,0 ns/pF) C_L
	10			30	60 ns	9 ns + (0,42 ns/pF) C_L
	15			20	40 ns	6 ns + (0,28 ns/pF) C_L

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	V _{DD} V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA
Minimum clock pulse width; LOW	5	t _{WCPL}	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 _{WPLH}	105	55	ns	
	10		45	25	ns	
	15		35	15	ns	
Minimum MR pulse width; HIGH	5	t _{WMRH}	120	60	ns	
	10		50	25	ns	
	15		40	20	ns	
Recovery time for MR	5	t _{RMR}	130	65	ns	
	10		45	20	ns	
	15		30	15	ns	
Recovery time for PL	5	t _{RPL}	150	75	ns	
	10		50	25	ns	
	15		30	15	ns	
Set-up times P _n → PL UP/ $\overline{\text{DN}}$ → CP $\overline{\text{CE}}$ → PL	5	t _{su}	100	50	ns	
	10		50	25	ns	
	15		40	20	ns	
	5	t _{su}	250	125	ns	
	10		100	50	ns	
	15		75	35	ns	
	5	t _{su}	120	60	ns	
	10		40	20	ns	
	15		25	10	ns	
Hold times P _n → PL UP/ $\overline{\text{DN}}$ → CP $\overline{\text{CE}}$ → CP	5	t _{hold}	10	−40	ns	
	10		5	−20	ns	
	15		0	−20	ns	
	5	t _{hold}	35	−90	ns	
	10		15	−35	ns	
	15		15	−25	ns	
	5	t _{hold}	20	−40	ns	
	10		5	−15	ns	
	15		5	−10	ns	
Maximum clock pulse frequency	5	f _{max}	5	10	MHz	
	10		12	24	MHz	
	15		17	34	MHz	

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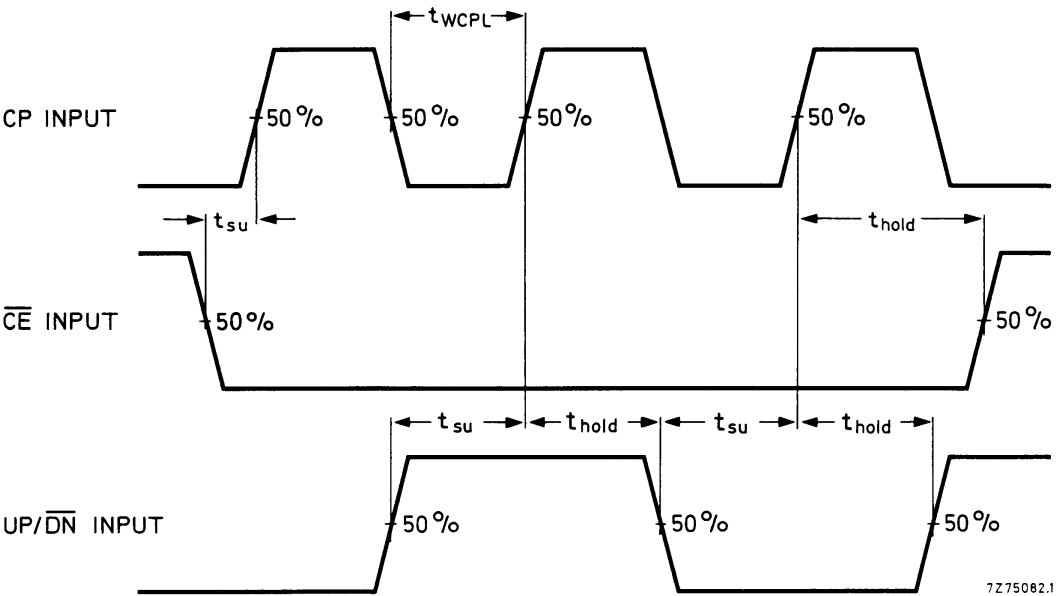


Fig.6 Waveforms showing minimum pulse width for CP, set-up and hold times for $\overline{CE}$ to CP and UP/ $\overline{DN}$ to CP.

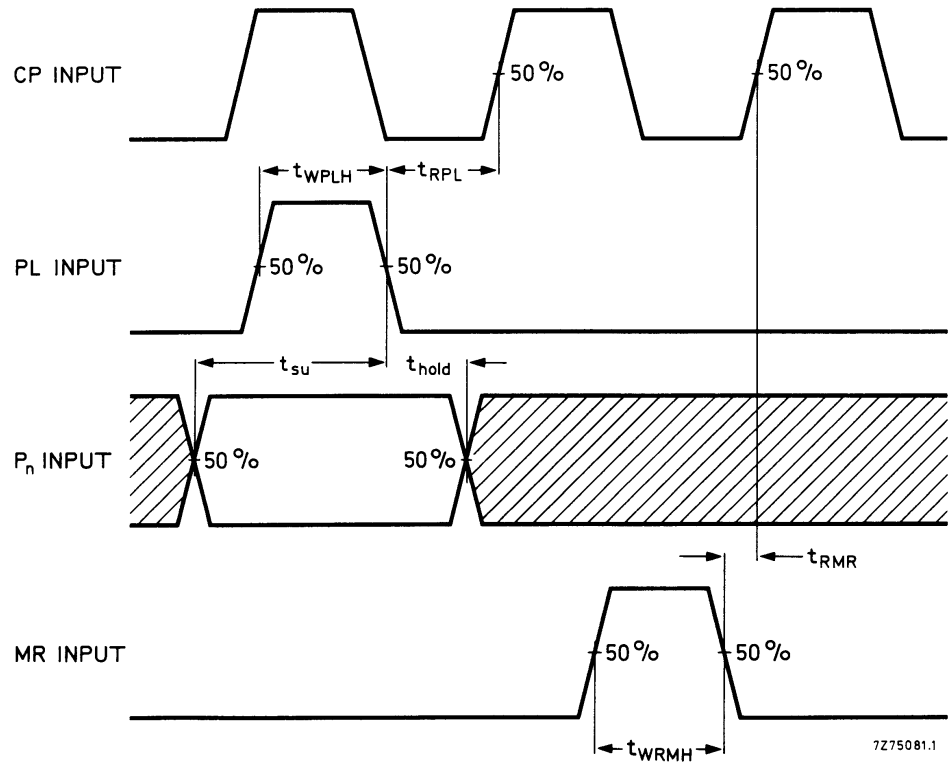


Fig.7 Waveforms showing minimum pulse width for PL and MR, recovery time for PL and MR and set-up and hold times for P_n to PL.

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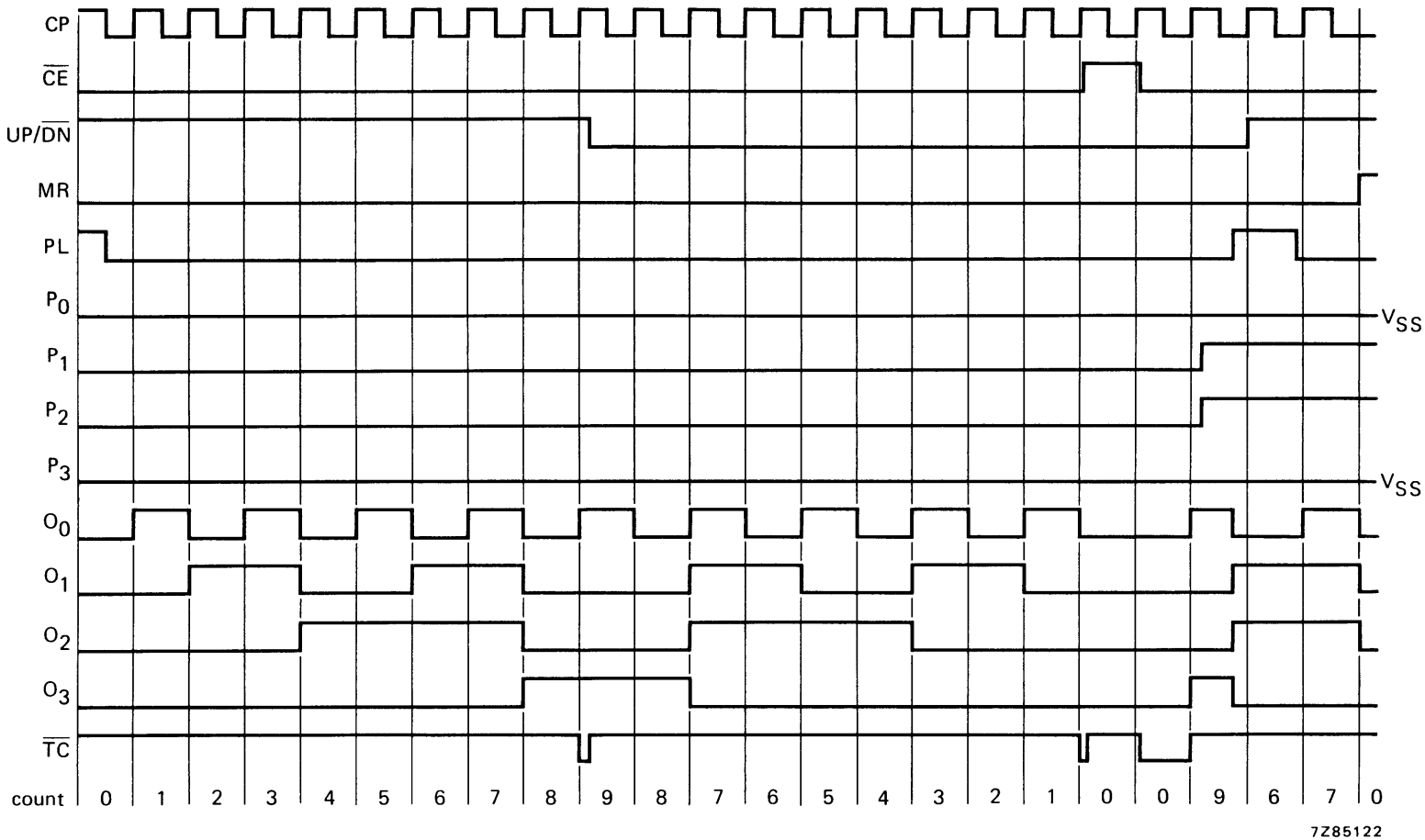


Fig.8 Timing diagram.

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