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

Philips Semiconductors

PHILIPS

BCD up/down counter

HEF4510B
MSI

DESCRIPTION

The HEF4510B is an edge-triggered synchronous up/down BCD counter with a clock input (CP), an up/down count control input (UP/$\overline{DN}$), an active LOW count enable input ($\overline{CE}$), 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 ($\overline{TC}$), 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 $\overline{CE}$ is LOW. UP/$\overline{DN}$ determines the direction of the count, HIGH for counting up, LOW for counting down. When counting up, $\overline{TC}$ is LOW when O_0 and O_3 are HIGH and $\overline{CE}$ is LOW. When counting down, $\overline{TC}$ is LOW when O_0 to O_3 and $\overline{CE}$ are LOW. A HIGH on MR resets the counter (O_0 to O_3 = LOW) independent of all other input conditions.

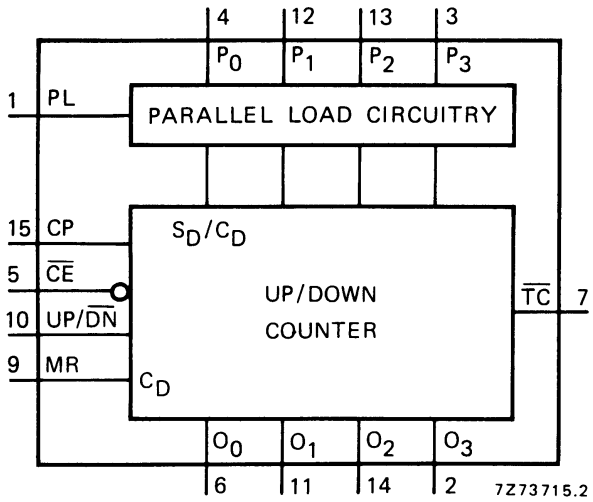


Fig.1 Functional diagram.

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

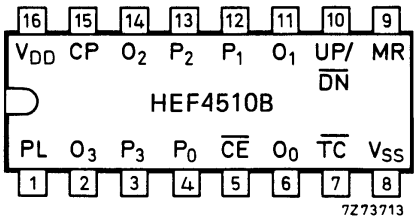


Fig.2 Pinning diagram.

PINNING

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

FAMILY DATA, I_{DD} LIMITS category MSI

See Family Specifications

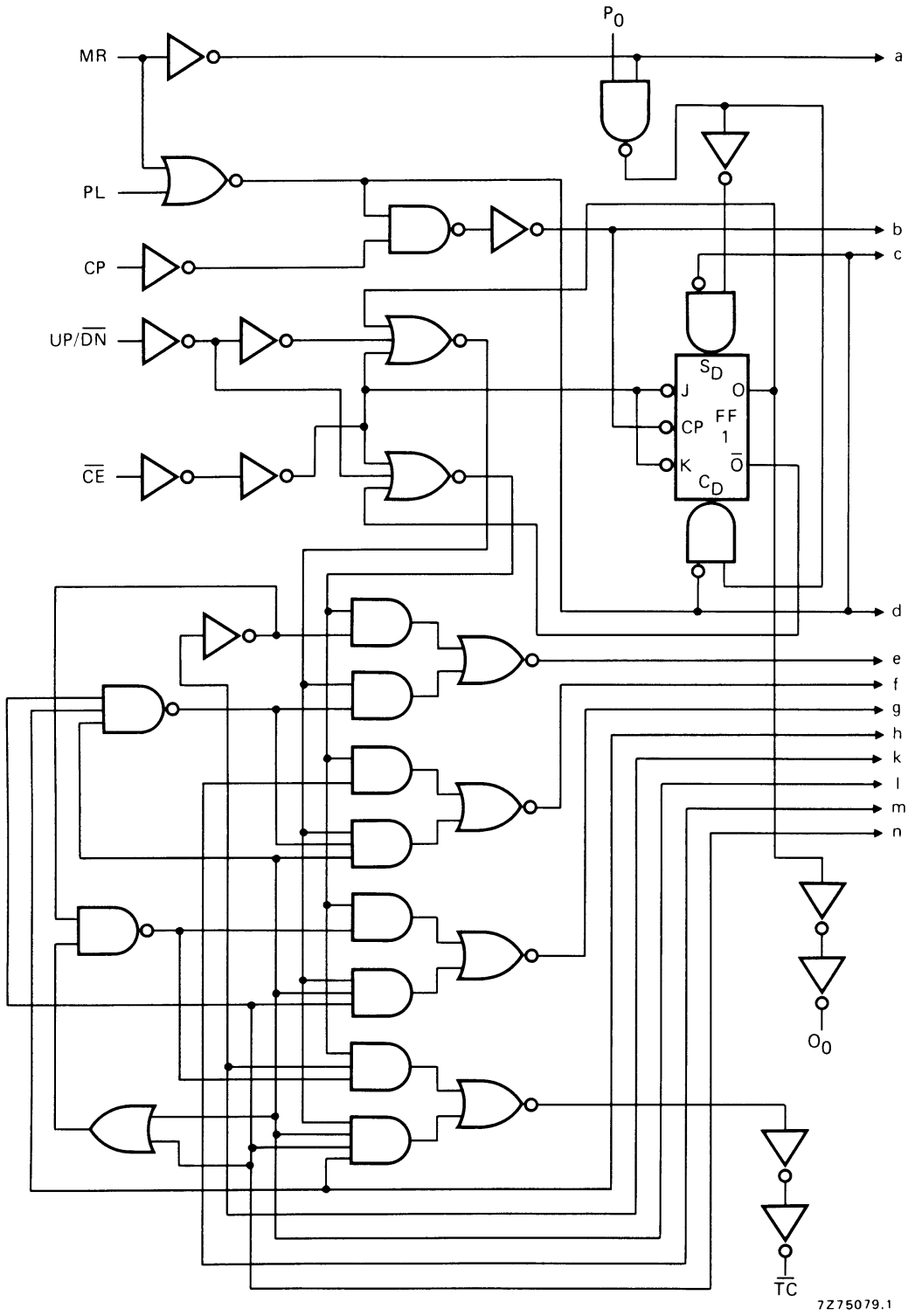


Fig.3 Logic diagram (continued in Fig.4).

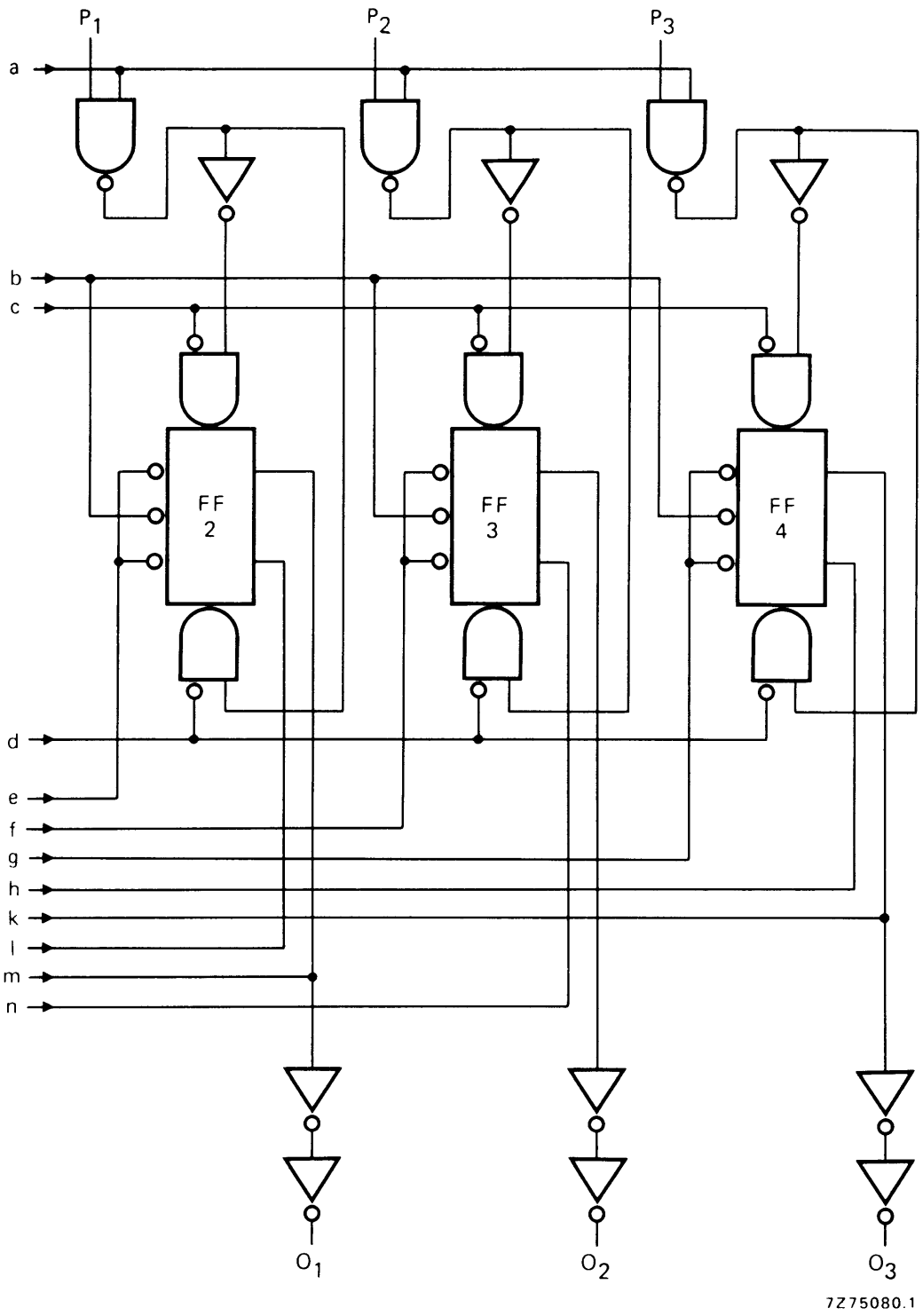


Fig.4 Logic diagram (continued from Fig.3).

FUNCTION TABLE

MR	PL	UP/$\overline{DN}$	$\overline{CE}$	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

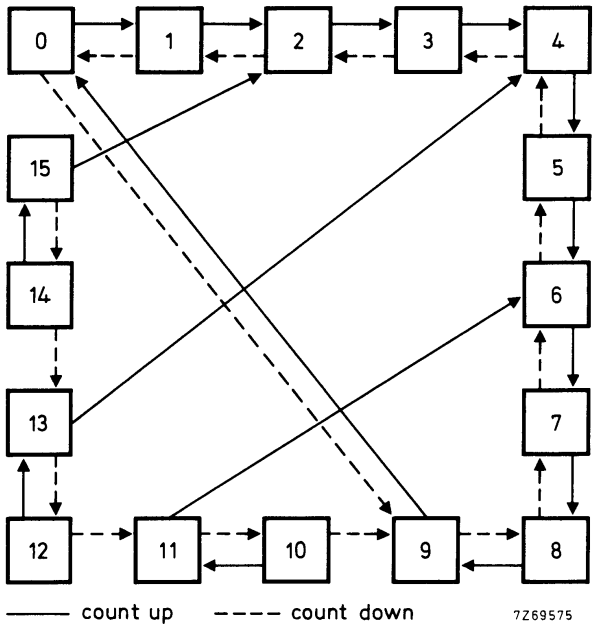


Fig.5 State diagram.

Logic equation for terminal count:

$$\overline{TC} = \overline{\overline{CE}} \cdot \{ (UP/\overline{DN}) \cdot O_0 \cdot O_3 + \overline{(UP/\overline{DN})} \cdot \overline{O}_0 \cdot \overline{O}_1 \cdot \overline{O}_2 \cdot \overline{O}_3 \}$$

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	5	$1000\ f_i + \sum (f_o C_L) \times V_{DD}^2$	where
dissipation per	10	$4500\ f_i + \sum (f_o C_L) \times V_{DD}^2$	f_i = input freq. (MHz)
package (P)	15	$11\ 200\ f_i + \sum (f_o C_L) \times V_{DD}^2$	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 ≤ 20 ns

	V_{DD} V	SYMBOL	MIN.	TYP.	MAX.		TYPICAL EXTRAPOLATION FORMULA
Propagation delays							
CP → 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
	5			155	310	ns	128 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		65	130	ns	54 ns + (0,23 ns/pF) C_L
	15			45	90	ns	37 ns + (0,16 ns/pF) C_L
CP → $\overline{TC}$	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
	5			180	360	ns	153 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			55	115	ns	47 ns + (0,16 ns/pF) C_L
PL → 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
	5			170	340	ns	143 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		70	140	ns	59 ns + (0,23 ns/pF) C_L
	15			50	105	ns	42 ns + (0,16 ns/pF) C_L
PL → $\overline{TC}$	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
	5			250	500	ns	223 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		110	220	ns	99 ns + (0,23 ns/pF) C_L
	15			80	160	ns	72 ns + (0,16 ns/pF) C_L
$\overline{CE}$ → $\overline{TC}$	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
	5			145	290	ns	118 ns + (0,55 ns/pF) C_L
LOW to HIGH	10	t_{PLH}		60	125	ns	49 ns + (0,23 ns/pF) C_L
	15			45	95	ns	37 ns + (0,16 ns/pF) C_L
MR → 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 → $\overline{TC}$	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

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

	V_{DD} V	SYMBOL	MIN.	TYP.	MAX.		TYPICAL EXTRAPOLATION FORMULA
Minimum clock	5			95	45	ns	see also waveforms Figs 6 and 7
pulse width; LOW	10	t_{WCPL}		35	20	ns	
	15			25	15	ns	
Minimum PL	5			105	55	ns	
pulse width; HIGH	10	t_{WPLH}		45	25	ns	
	15			35	15	ns	
Minimum MR	5			120	60	ns	
pulse width; HIGH	10	t_{WMRH}		50	25	ns	
	15			40	20	ns	
Recovery time	5			130	65	ns	
for MR	10	t_{RMR}		45	20	ns	
	15			30	15	ns	
Recovery time	5			150	75	ns	
for PL	10	t_{RPL}		50	25	ns	
	15			30	15	ns	
Set-up times	5			100	50	ns	
$P_n \rightarrow PL$	10	t_{su}		50	25	ns	
	15			40	20	ns	
	5			250	125	ns	
$UP/\overline{DN} \rightarrow CP$	10	t_{su}		100	50	ns	
	15			75	35	ns	
	5			120	60	ns	
$\overline{CE} \rightarrow PL$	10	t_{su}		40	20	ns	
	15			25	10	ns	
Hold times	5			10	–40	ns	
$P_n \rightarrow PL$	10	t_{hold}		5	–20	ns	
	15			0	–20	ns	
	5			35	–90	ns	
$UP/\overline{DN} \rightarrow CP$	10	t_{hold}		15	–35	ns	
	15			15	–25	ns	
	5			20	–40	ns	
$\overline{CE} \rightarrow CP$	10	t_{hold}		5	–15	ns	
	15			5	–10	ns	
Maximum clock	5			5	10	MHz	
pulse frequency	10	f_{max}		12	24	MHz	
	15			17	34	MHz	

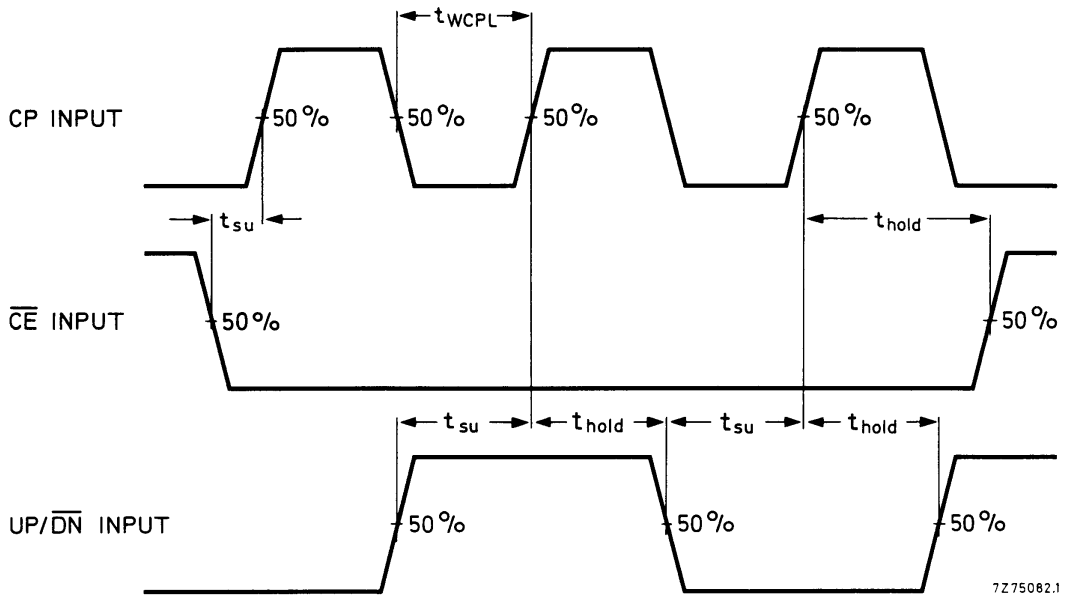


Fig.6 Waveforms showing minimum pulse width for CP, set-up and hold times for $\overline{CE}$ to CP and UP/$\overline{DN}$ to CP.

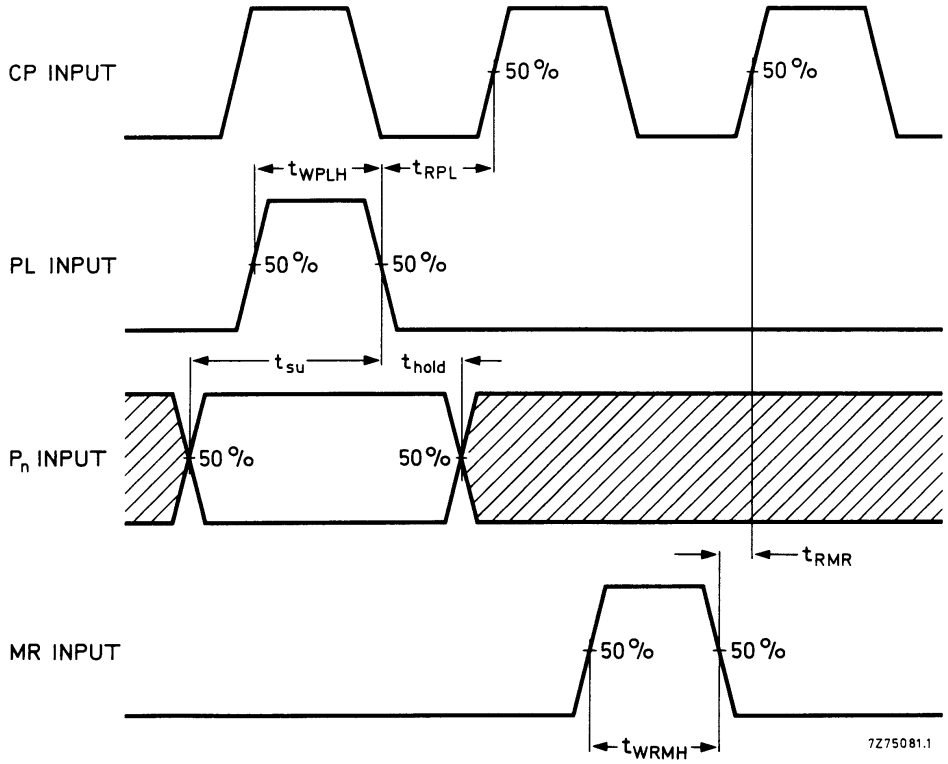


Fig.7 Waveforms showing minimum pulse width for PL and MR, recovery time for PL and MR and set-up and hold times for P_n to PL.

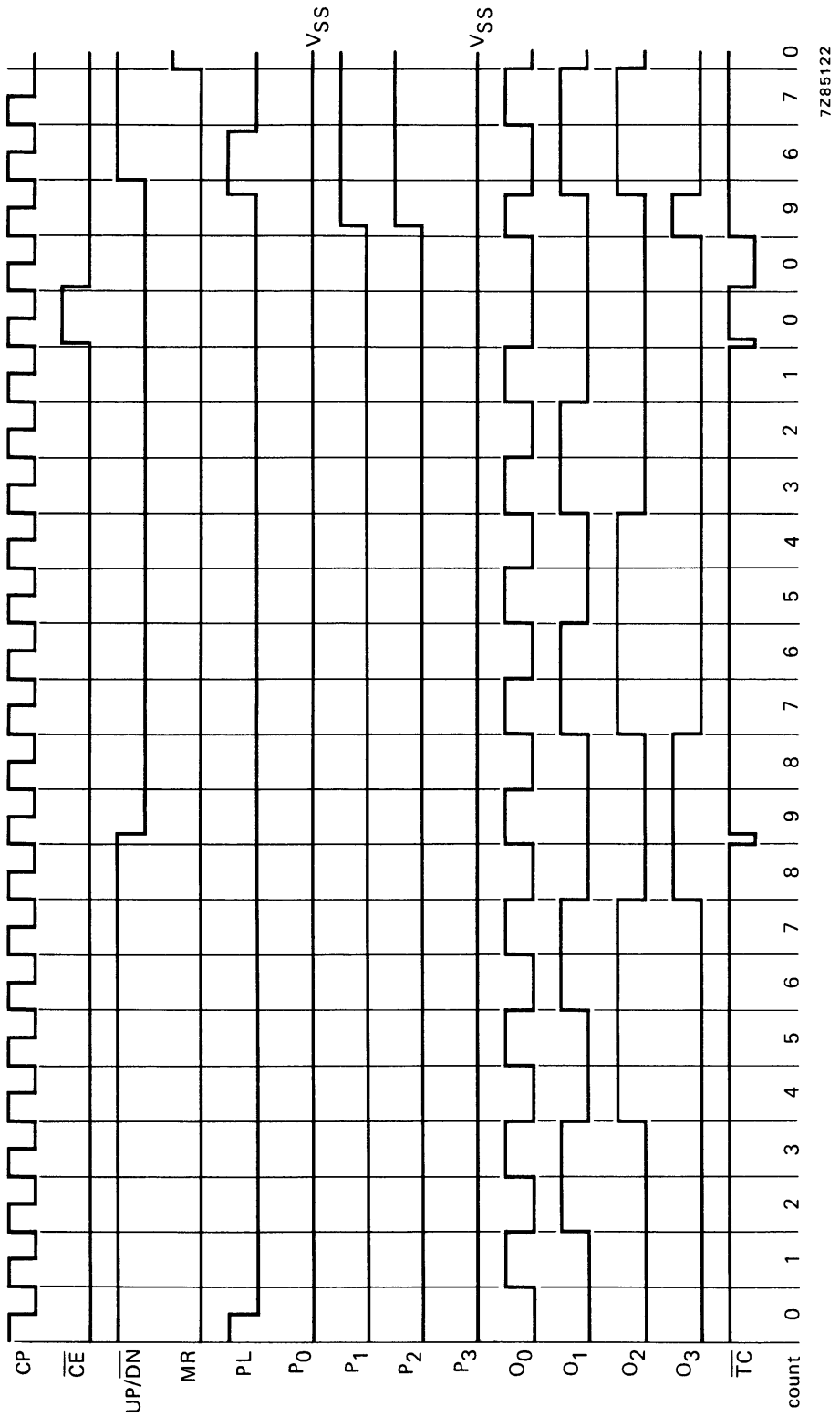


Fig.8 Timing diagram.