BINARY UP/DOWN COUNTER

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/$\overline{DN}$), 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 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/$\overline{DN}$ determines the direction of the count, HIGH for counting up, LOW for counting down. When counting up, $\overline{TC}$ is LOW when O_0 to 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.

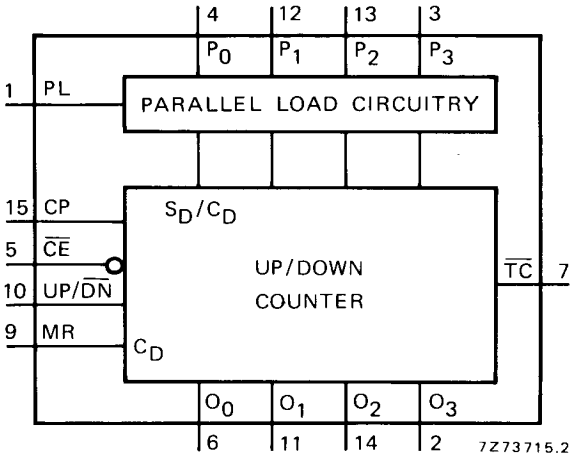

Fig. 1 Functional diagram.

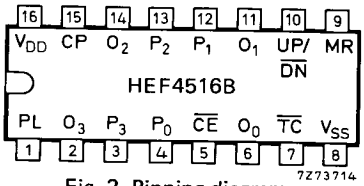

Fig. 2 Pinning diagram.

HEF4516BP : 16-lead DIL; plastic (SOT-38Z).
HEF4516BD: 16-lead DIL; ceramic (cerdip) (SOT-74).
HEF4516BT : 16-lead mini-pack; plastic (SO-16; SOT-109A).

PINNING

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

FAMILY DATA

see Family Specifications

I_{DD} LIMITS category MSI

Products approved to CECC 90 104-069.

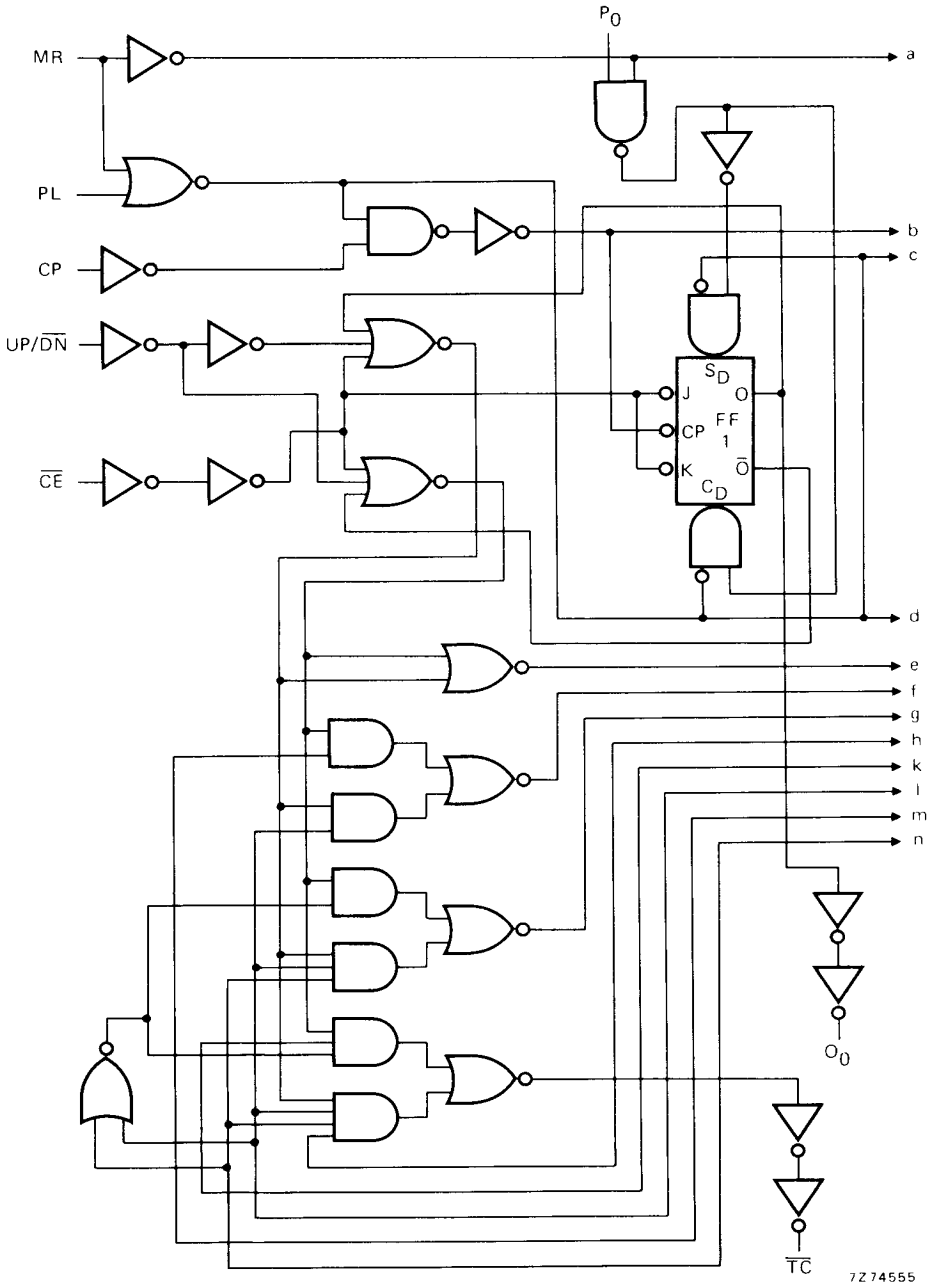

Fig. 3a Logic diagram (continued in Fig. 3b).

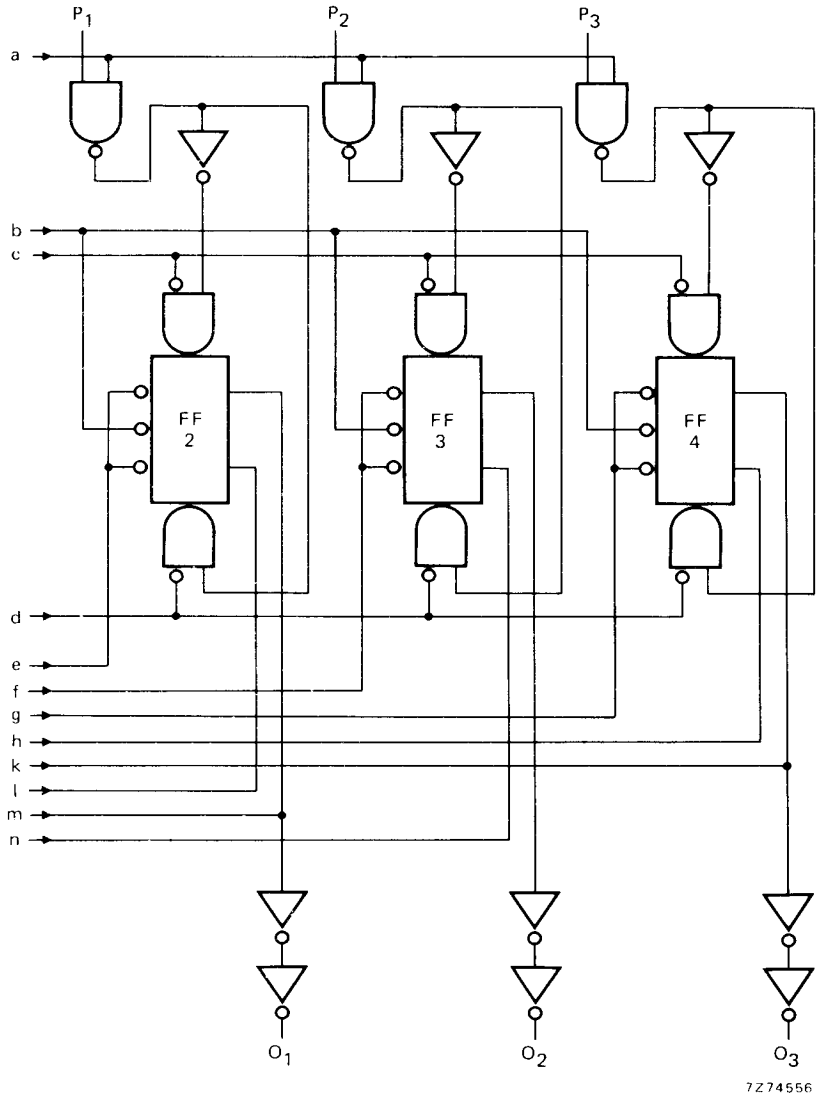

Fig. 3b Logic diagram (continued from Fig. 3a).

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

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

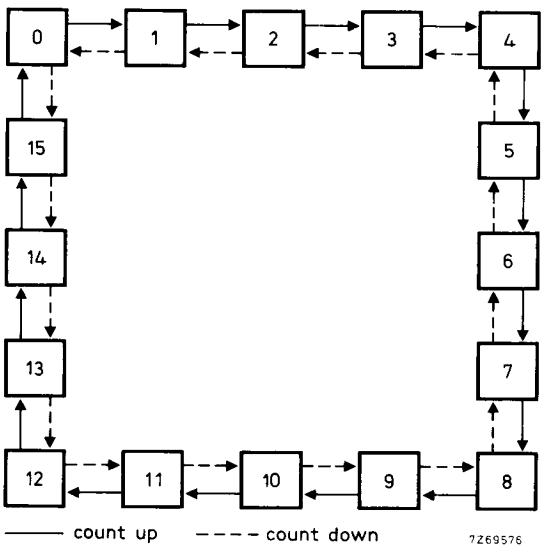

Fig. 4 State diagram.

Logic equation for terminal count:

$$\overline{TC} = \overline{\overline{CE}} \cdot \{(UP/\overline{DN}) \cdot O_0 \cdot O_1 \cdot O_2 \cdot O_3 + (\overline{UP/\overline{DN}}) \cdot \overline{O}_0 \cdot \overline{O}_1 \cdot \overline{O}_2 \cdot \overline{O}_3\}$$

A.C. CHARACTERISTICS

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

	V_{DD} V	typical formula for P (μW)	where
Dynamic power dissipation per package (P)	5	1000 f_i + Σ($f_o C_L$) x V_{DD}^2	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)
	10	4500 f_i + Σ($f_o C_L$) x V_{DD}^2	
	15	11 200 f_i + Σ($f_o C_L$) x V_{DD}^2	

A.C. 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

A.C. 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
Minimum clock pulse width; LOW	5		95	45		ns	
	10	t_{WCPL}	35	20		ns	
	15		25	15		ns	
Minimum PL pulse width; HIGH	5		105	55		ns	
	10	t_{WPLH}	45	25		ns	
	15		35	15		ns	
Minimum MR pulse width; HIGH	5		120	60		ns	
	10	t_{WMRH}	50	25		ns	
	15		40	20		ns	
Recovery time for MR	5		130	65		ns	
	10	t_{RMR}	45	20		ns	
	15		30	15		ns	
Recovery time for PL	5		150	75		ns	
	10	t_{RPL}	50	25		ns	
	15		30	15		ns	
Set-up times $P_n \rightarrow PL$	5		100	50		ns	
	10	t_{su}	50	25		ns	
	15		40	20		ns	see also waveforms Figs 5 and 6
$UP/\overline{DN} \rightarrow CP$	5		250	125		ns	
	10	t_{su}	100	50		ns	
	15		75	35		ns	
$\overline{CE} \rightarrow CP$	5		120	60		ns	
	10	t_{su}	40	20		ns	
	15		25	10		ns	
Hold times $P_n \rightarrow PL$	5		10	−40		ns	
	10	t_{hold}	5	−20		ns	
	15		0	−20		ns	
$UP/\overline{DN} \rightarrow CP$	5		35	−90		ns	
	10	t_{hold}	15	−35		ns	
	15		15	−25		ns	
$\overline{CE} \rightarrow CP$	5		20	−40		ns	
	10	t_{hold}	5	−15		ns	
	15		5	−10		ns	
Maximum clock pulse frequency	5		3	6		MHz	
	10	f_{max}	7	14		MHz	
	15		9	18		MHz	

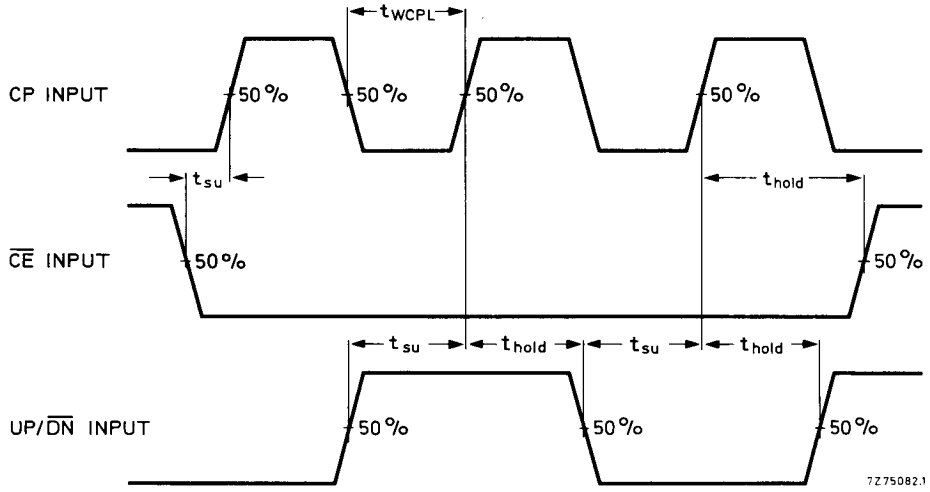

Fig. 5 Waveforms showing minimum pulse width for CP, set-up and hold times for $\overline{CE}$ to CP and UP/$\overline{DN}$ to CP.

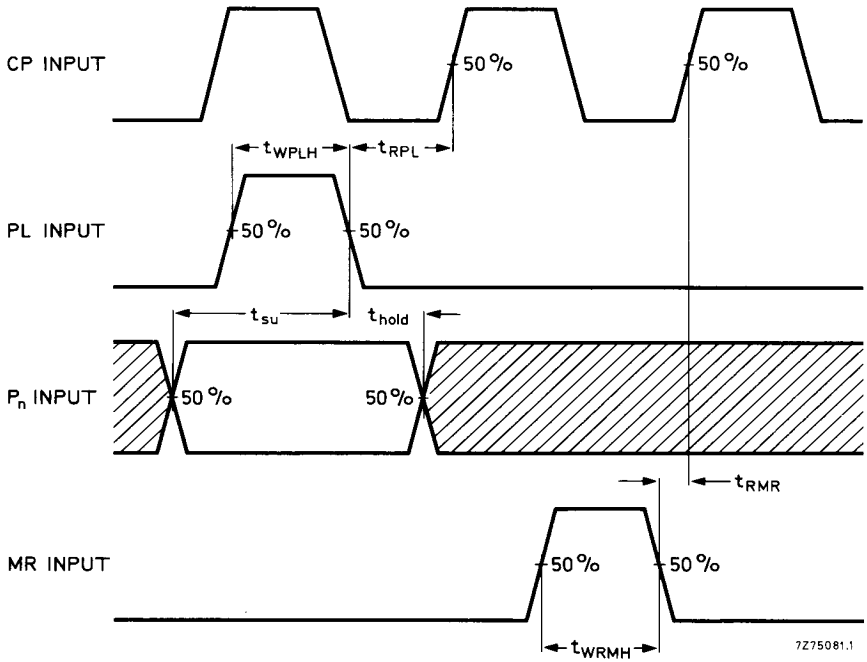

Fig. 6 Waveforms showing minimum pulse width for PL and MR, recovery time for PL and MR and set-up and hold times for P_n to PL.

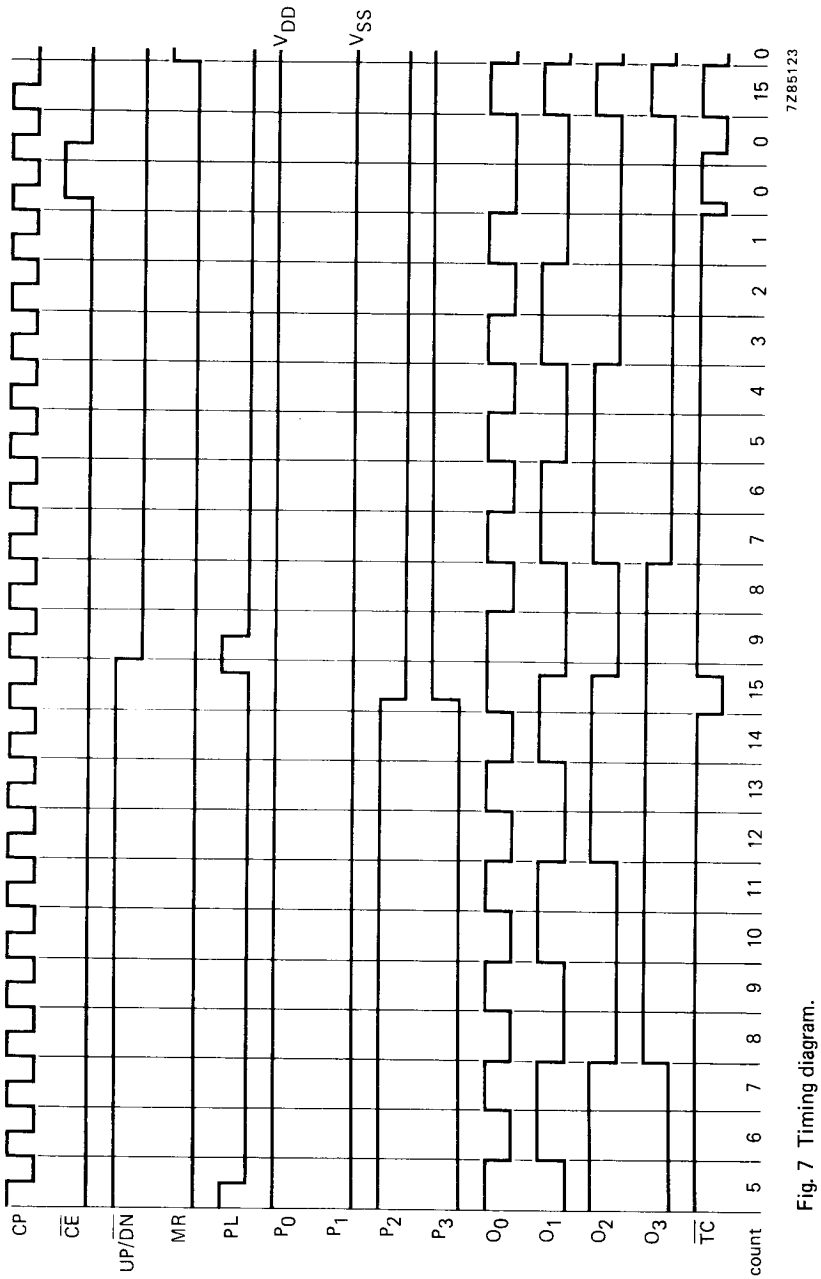

Fig. 7 Timing diagram.