

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 (P₀ to P₃), four parallel outputs (O₀ to O₃), an active LOW terminal count output (\overline{TC}), and an overriding asynchronous master reset input (MR).

Information on P₀ to P₃ 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 O₀ and O₃ are HIGH and \overline{CE} is LOW. When counting down, \overline{TC} is LOW when O₀ to O₃ and \overline{CE} are LOW. A HIGH on MR resets the counter (O₀ to O₃ = LOW) independent of all other input conditions.

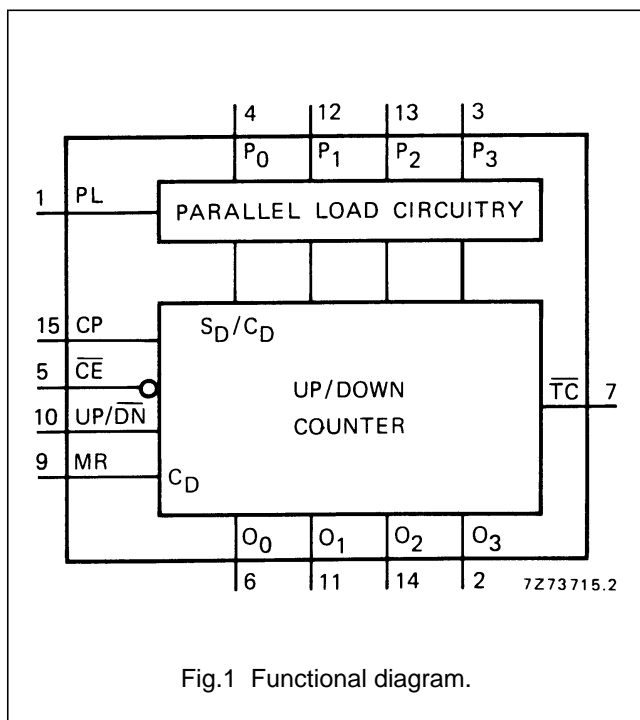


Fig.1 Functional diagram.

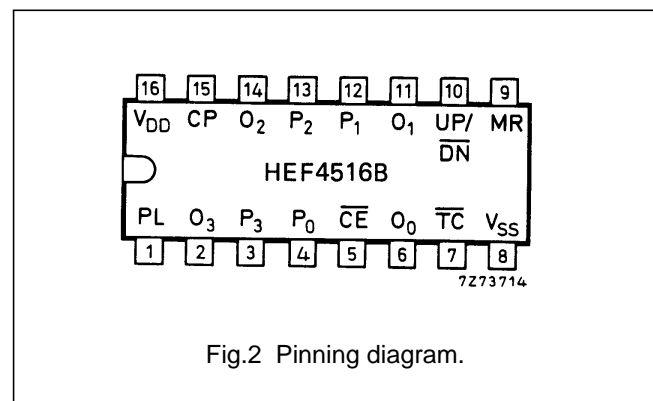


Fig.2 Pinning diagram.

PINNING

- PL parallel load input (active HIGH)
- P₀ to P₃ 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)
- O₀ to O₃ parallel outputs

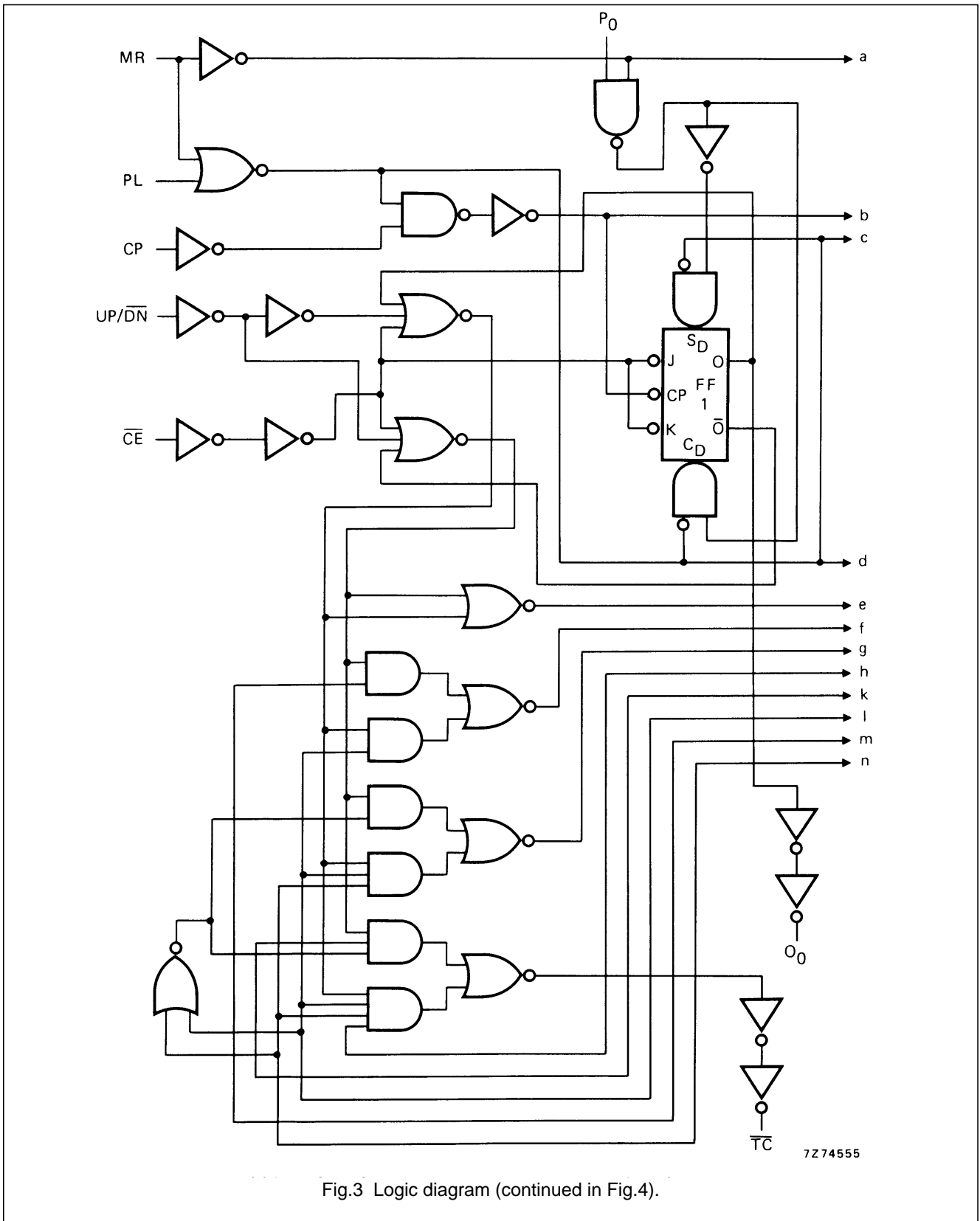
FAMILY DATA, I_{DD} LIMITS category MSI

See Family Specifications

- HEF4516BP(N): 16-lead DIL; plastic (SOT38-1)
- HEF4516BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)
- HEF4516BT(D): 16-lead SO; plastic (SOT109-1)
- (): Package Designator North America

Binary up/down counter

HEF4516B
MSI



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HEF4516B
MSI

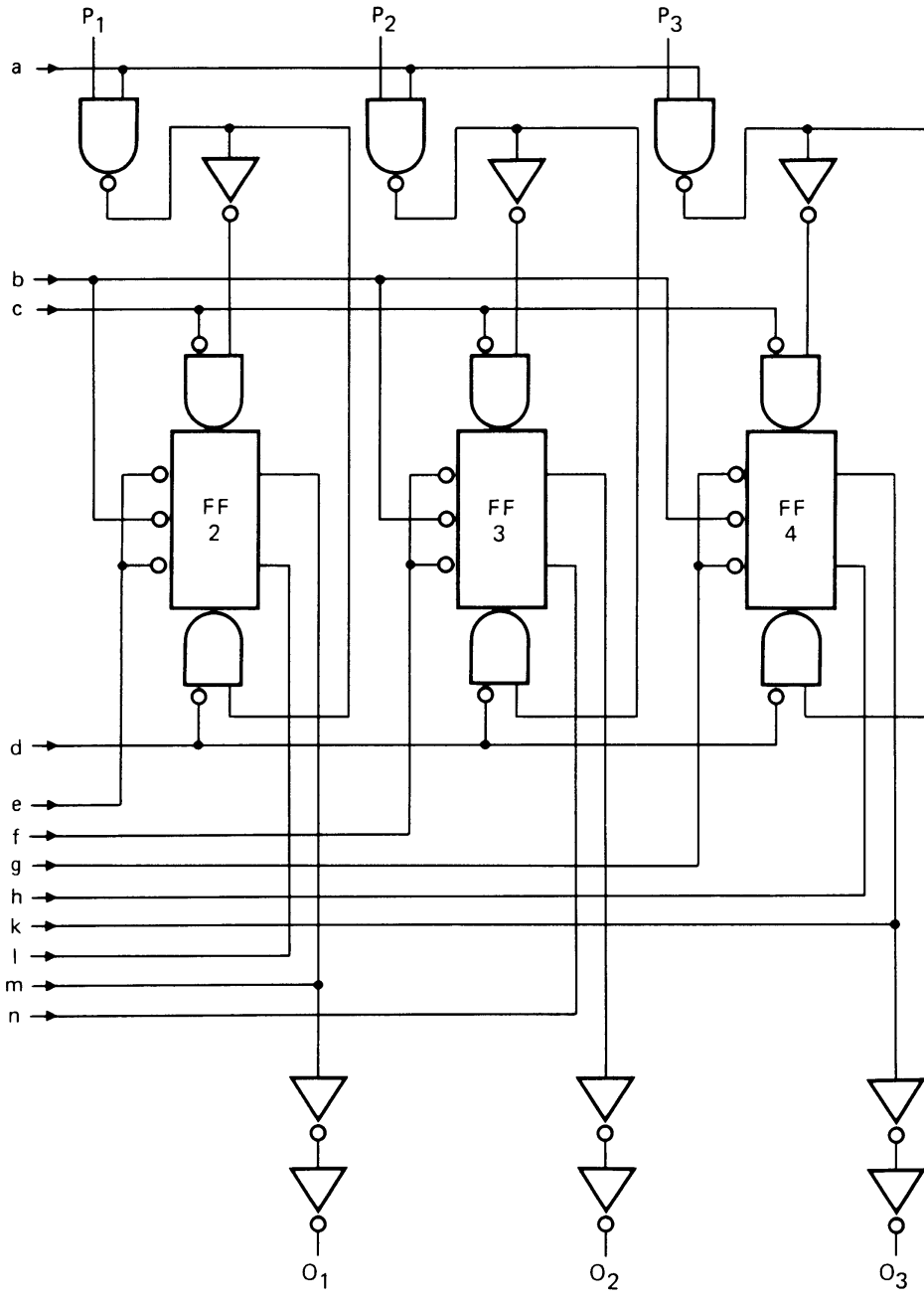


Fig.4 Logic diagram (continued from Fig.3).

Binary up/down counter

HEF4516B
MSI

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

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

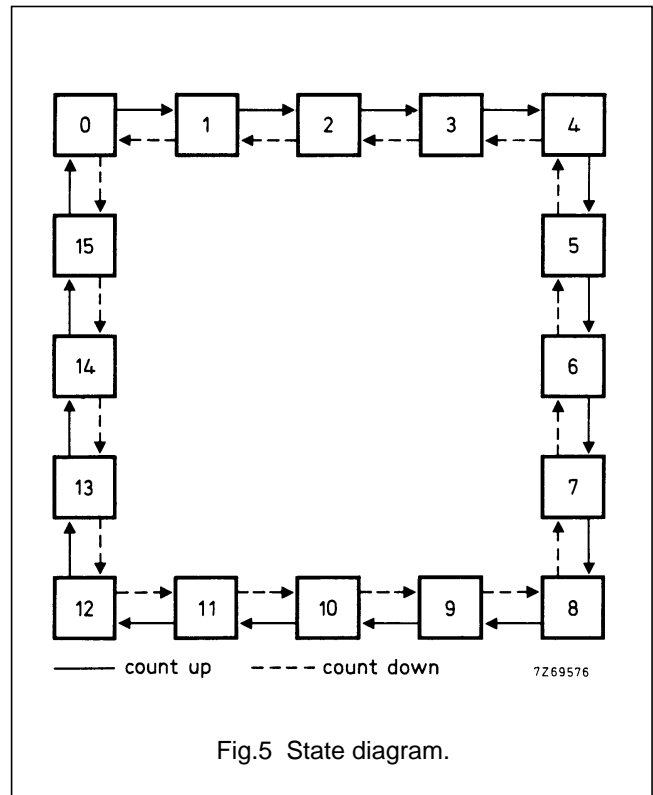


Fig.5 State diagram.

Logic equation for terminal count:

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

AC CHARACTERISTICS

V_{SS} = 0 V; T_{amb} = 25 °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 + ∑ (f _o C _L) × V _{DD} ² 4500 f _i + ∑ (f _o C _L) × V _{DD} ² 11 200 f _i + ∑ (f _o C _L) × V _{DD} ²	where f _i = input freq. (MHz) f _o = output freq. (MHz) C _L = load capacitance (pF) ∑ (f _o C _L) = sum of outputs V _{DD} = supply voltage (V)

Binary up/down counter

HEF4516B
MSI

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

Binary up/down counter

HEF4516B
MSI**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
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	$6 \text{ ns} + (0,28 \text{ ns/pF}) C_L$

Binary up/down counter

HEF4516B
MSI

	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	5	t _{su}	100	50	ns		
	10		50	25	ns		
	15		40	20	ns		
	UP/ $\overline{\text{DN}}$ → CP	5	t _{su}	250	125		ns
		10		100	50		ns
		15		75	35		ns
	$\overline{\text{CE}}$ → CP	5	t _{su}	120	60	ns	
		10		40	20	ns	
		15		25	10	ns	
Hold times P _n → PL	5	t _{hold}	10	-40	ns		
	10		5	-20	ns		
	15		0	-20	ns		
	UP/ $\overline{\text{DN}}$ → CP	5	t _{hold}	35	-90	ns	
		10		15	-35	ns	
		15		15	-25	ns	
	$\overline{\text{CE}}$ → CP	5	t _{hold}	20	-40	ns	
		10		5	-15	ns	
		15		5	-10	ns	
Maximum clock pulse frequency	5	f _{max}	3	6	MHz		
	10		7	14	MHz		
	15		9	18	MHz		

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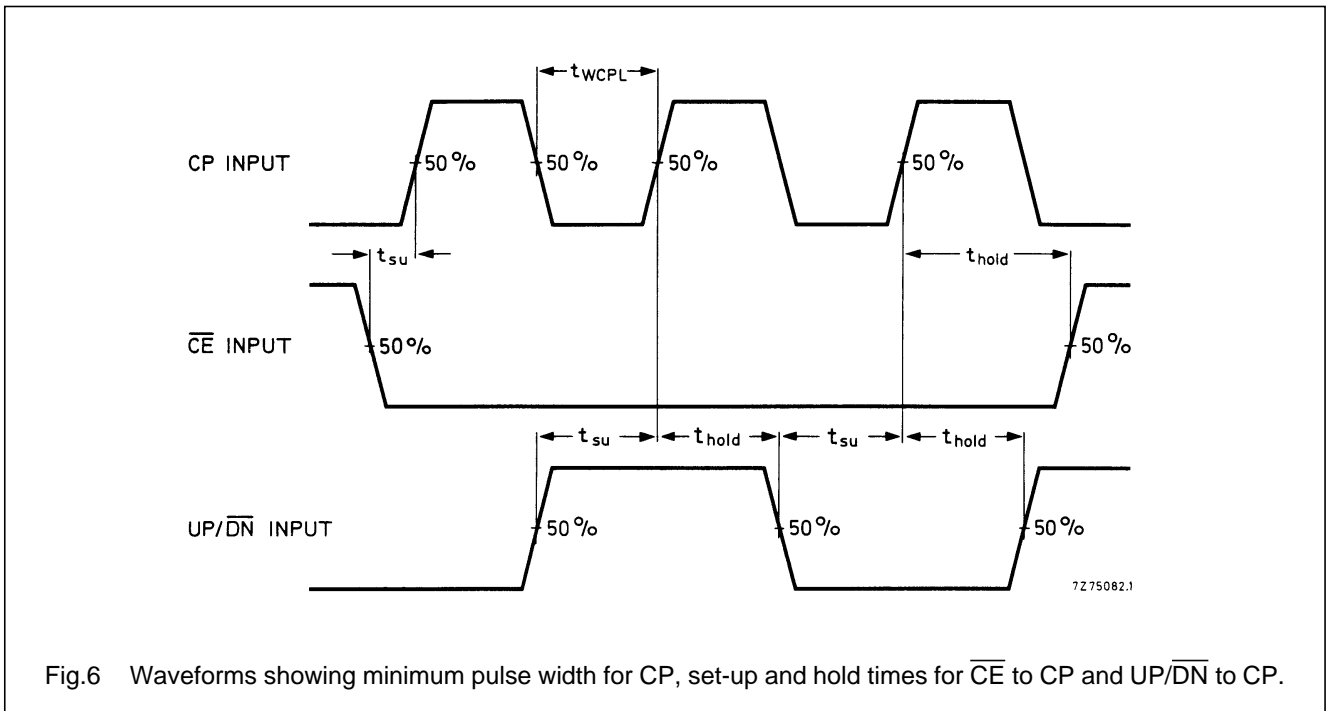


Fig.6 Waveforms showing minimum pulse width for CP, set-up and hold times for \overline{CE} to CP and UP/ \overline{DN} to CP.

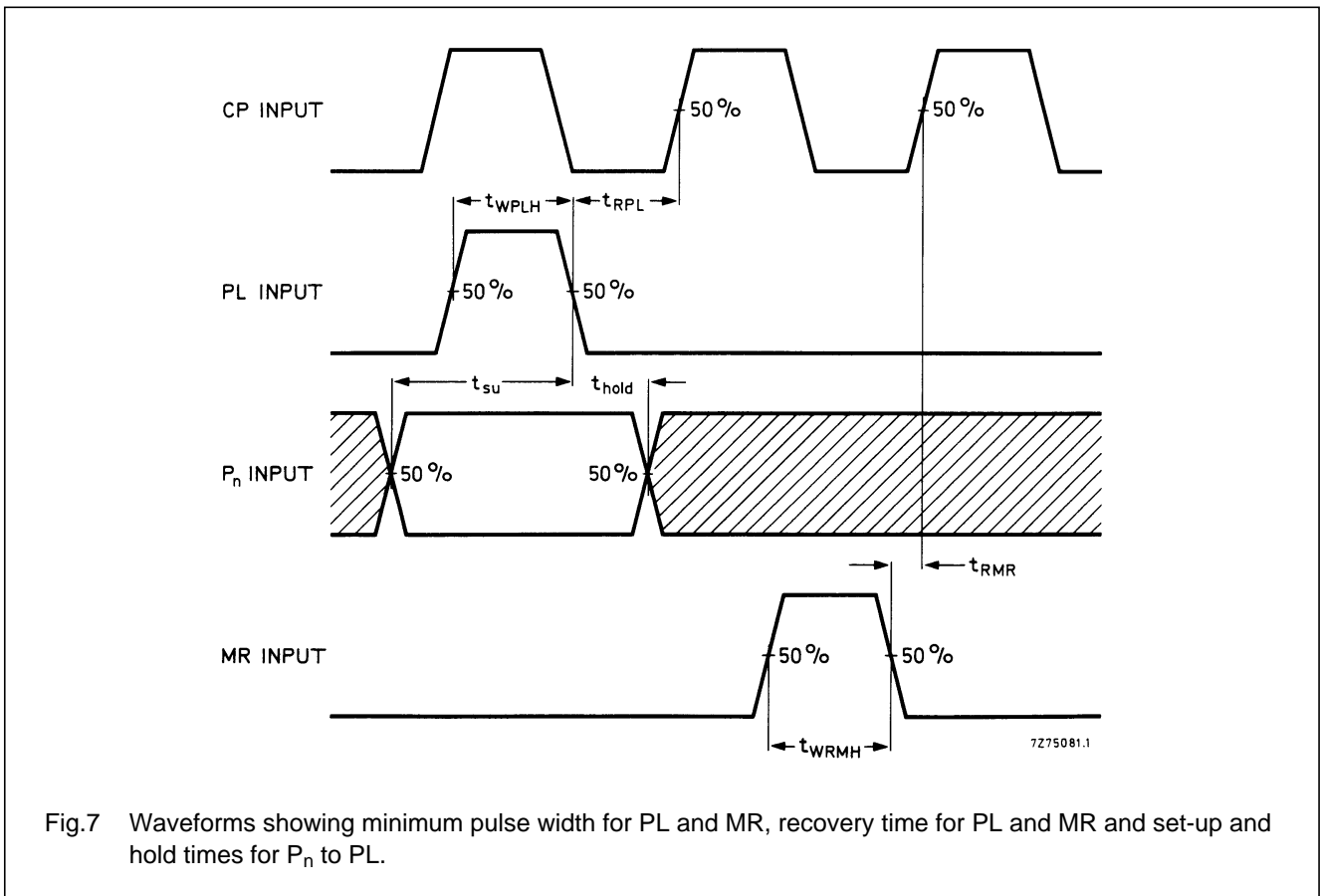


Fig.7 Waveforms showing minimum pulse width for PL and MR, recovery time for PL and MR and set-up and hold times for P_n to PL.

Binary up/down counter

HEF4516B
MSI

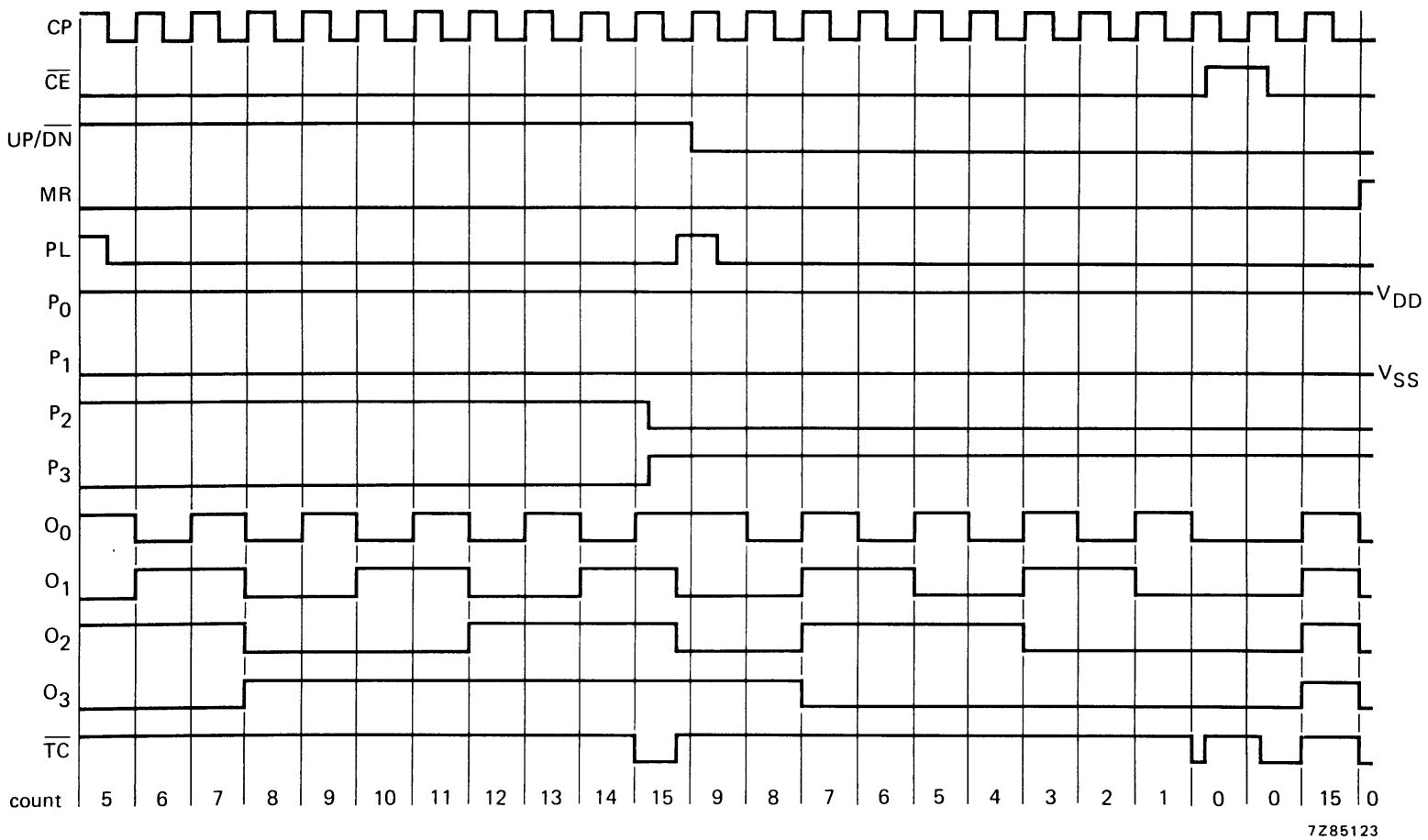


Fig.8 Timing diagram.