HEF4516B MSI Binary up/down counter

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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/$\overline{DN}$), 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 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.

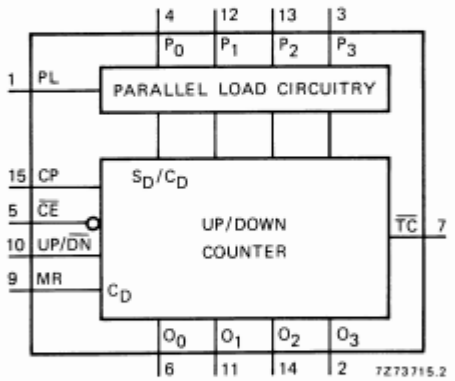

Fig.1 Functional diagram.

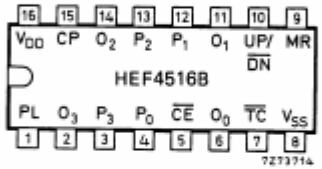

Fig.2 Pinning diagram.

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

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

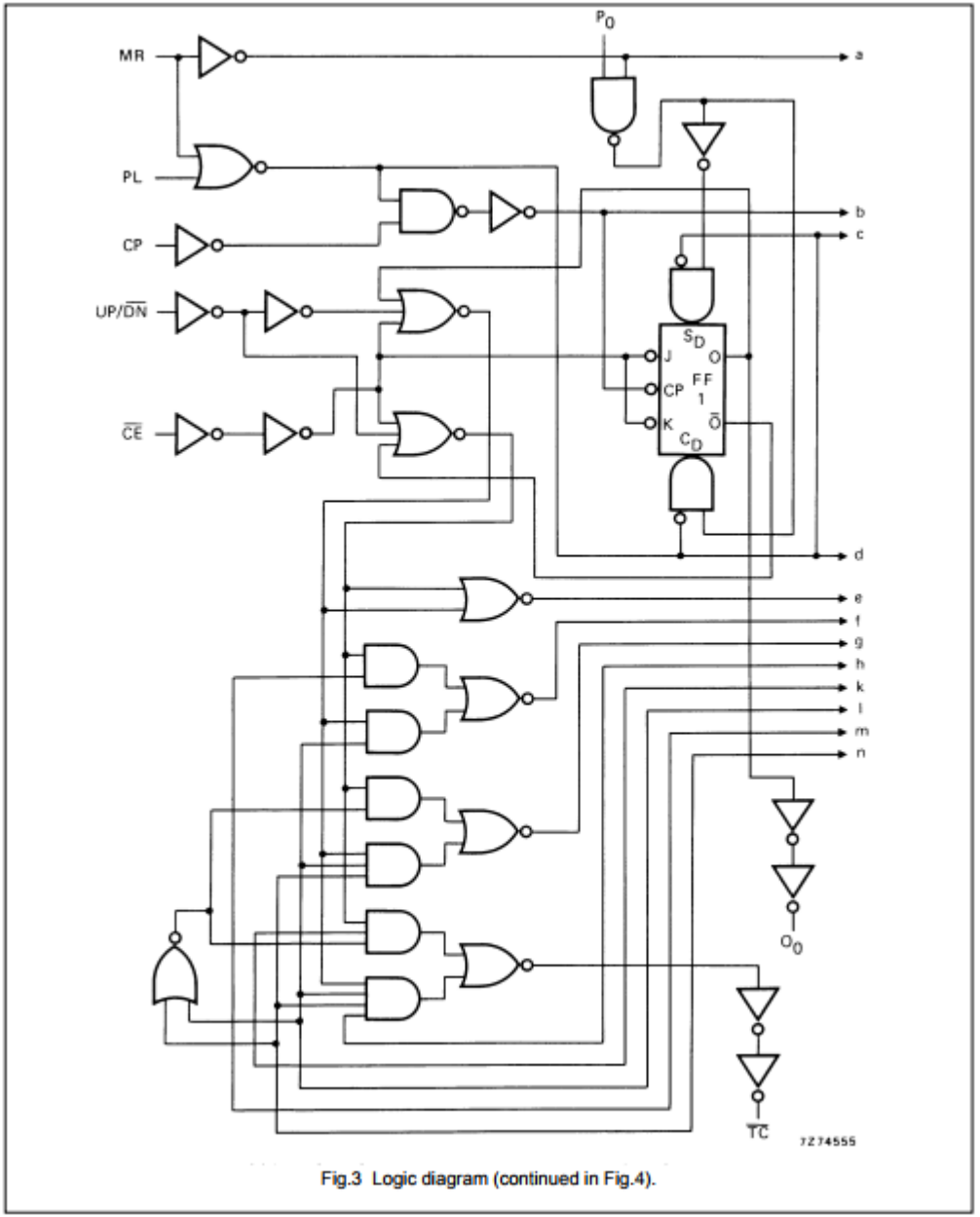

Fig.3 Logic diagram (continued in Fig.4).

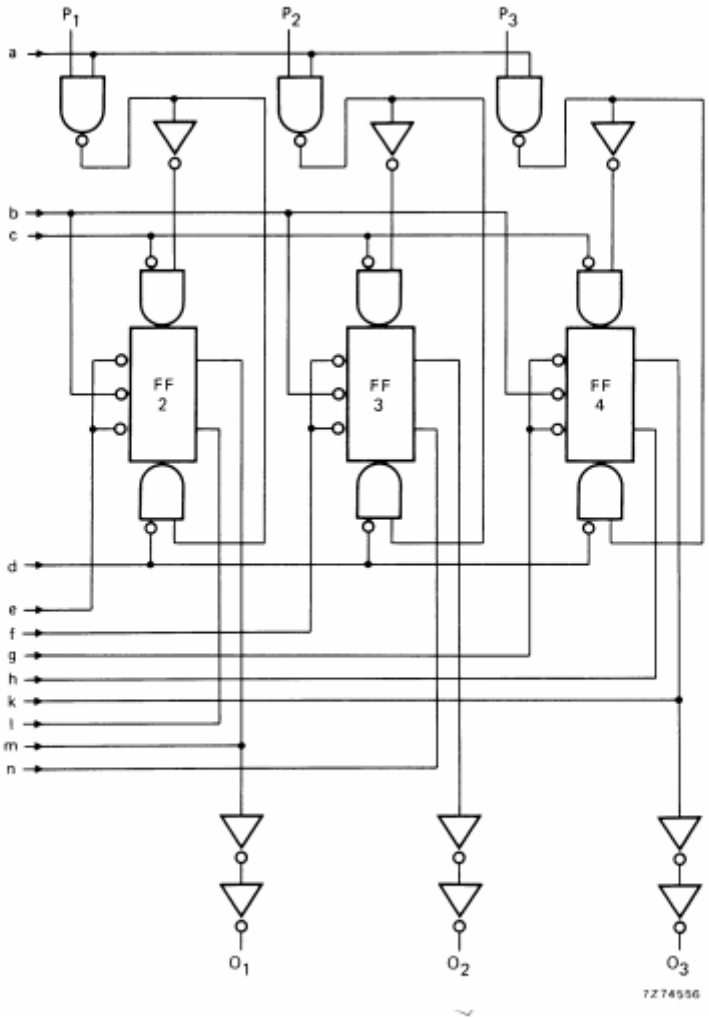

Fig.4 Logic diagram (continued from Fig.3).

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

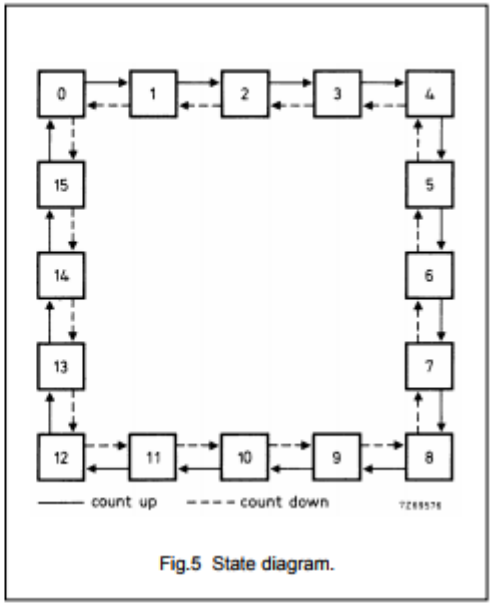

Fig.5 State diagram.

Logic equation for terminal count:

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

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	$1000\ f_i + \Sigma (f_o C_L) \times V_{DD}^2$	where
	10	$4500\ f_i + \Sigma (f_o C_L) \times V_{DD}^2$	f_i = input freq. (MHz)
	15	$11\ 200\ f_i + \Sigma (f_o C_L) \times V_{DD}^2$	f_o = output freq. (MHz)
			C_L = load capacitance (pF)
			$\Sigma (f_o C_L)$ = 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							
$CP \rightarrow O_n$	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
	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
$CP \rightarrow \overline{TC}$	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
	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
$PL \rightarrow O_n$	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
	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
$PL \rightarrow \overline{TC}$	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
	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
$\overline{CE} \rightarrow \overline{TC}$	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
	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
$MR \rightarrow O_n, \overline{TC}$	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

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 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 $P_n \rightarrow PL$	5	t_{su}	100	50		ns	
	10		50	25		ns	
	15		40	20		ns	
$UP/\overline{DN} \rightarrow CP$	5	t_{su}	250	125		ns	
	10		100	50		ns	
	15		75	35		ns	
$\overline{CE} \rightarrow CP$	5	t_{su}	120	60		ns	
	10		40	20		ns	
	15		25	10		ns	
Hold times $P_n \rightarrow PL$	5	t_{hold}	10	−40		ns	
	10		5	−20		ns	
	15		0	−20		ns	
$UP/\overline{DN} \rightarrow CP$	5	t_{hold}	35	−90		ns	
	10		15	−35		ns	
	15		15	−25		ns	
$\overline{CE} \rightarrow CP$	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	

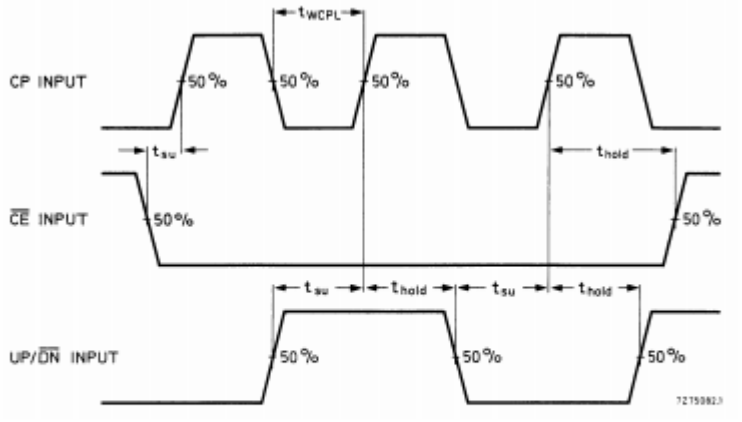

Fig.6 Waveforms showing minimum pulse width for CP, set-up and hold times for $\overline{CE}$ to CP and UP/$\overline{DN}$ to CP.

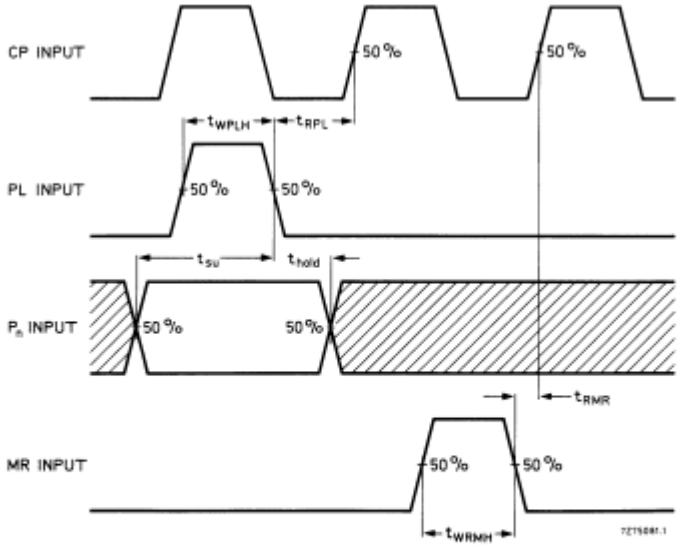

Fig.7 Waveforms showing minimum pulse width for PL and MR, recovery time for PL and MR and set-up and hold times for P_n to PL.

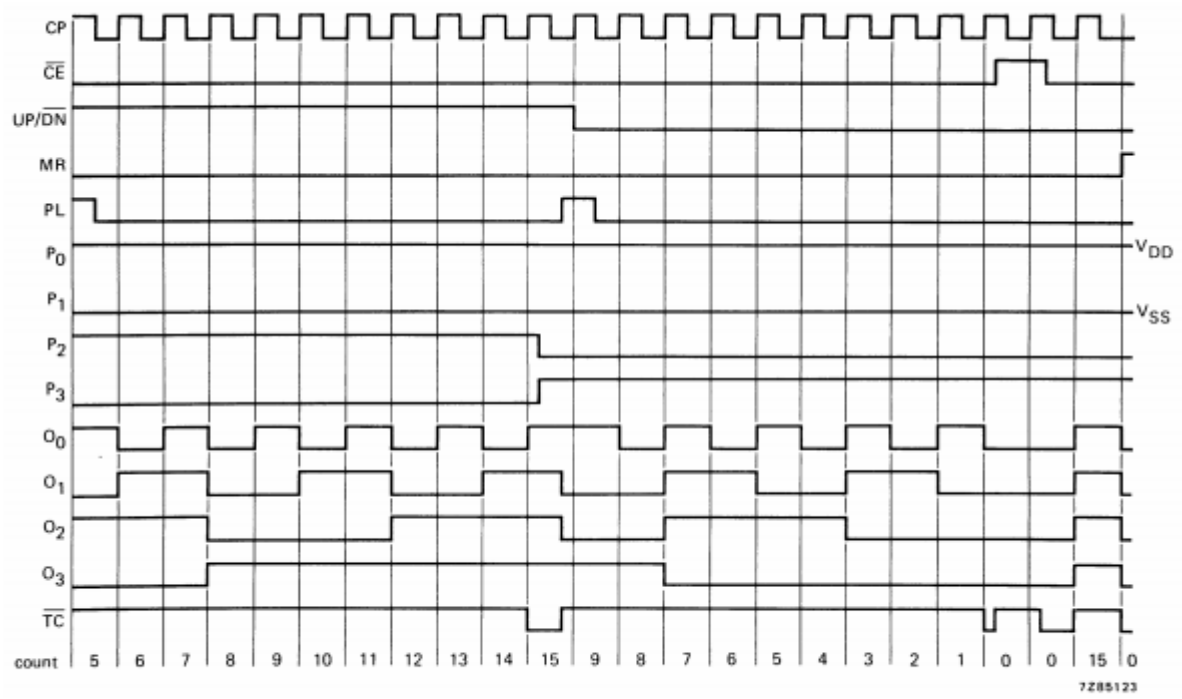

Fig.8 Timing diagram.