

# 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

## HEF4522B

### MSI

## Programmable 4-bit BCD down counter

Product specification  
File under Integrated Circuits, IC04

January 1995

# Programmable 4-bit BCD down counter

**HEF4522B**  
**MSI**

**DESCRIPTION**

The HEF4522B is a synchronous programmable 4-bit BCD down counter with an active HIGH and an active LOW clock input ( $CP_0$ ,  $\overline{CP}_1$ ), an asynchronous parallel load input (PL), four parallel inputs ( $P_0$  to  $P_3$ ), a cascade feedback input (CF), four buffered parallel outputs ( $O_0$  to  $O_3$ ), a terminal count output (TC) and an overriding asynchronous master reset input (MR).

This device is a programmable, cascadable down counter with a decoded TC output for divide-by-n applications. In single stage applications the TC output is connected to PL. CF allows cascade divide-by-n operation with no additional gates required.

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  $\overline{CP}_1$  are LOW, the counter advances on a LOW to HIGH transition of  $CP_0$ . When PL is LOW and  $CP_0$  is HIGH, the counter advances on a HIGH to LOW transition of  $\overline{CP}_1$ . TC is HIGH when the counter is in the zero state ( $O_0 = O_1 = O_2 = O_3 = \text{LOW}$ ) and CF is HIGH and PL is LOW. A HIGH on MR resets the counter ( $O_0$  to  $O_3 = \text{LOW}$ ) independent of other input conditions.

Schmitt-trigger action in the clock input makes the circuit highly tolerant to slower clock rise and fall times.

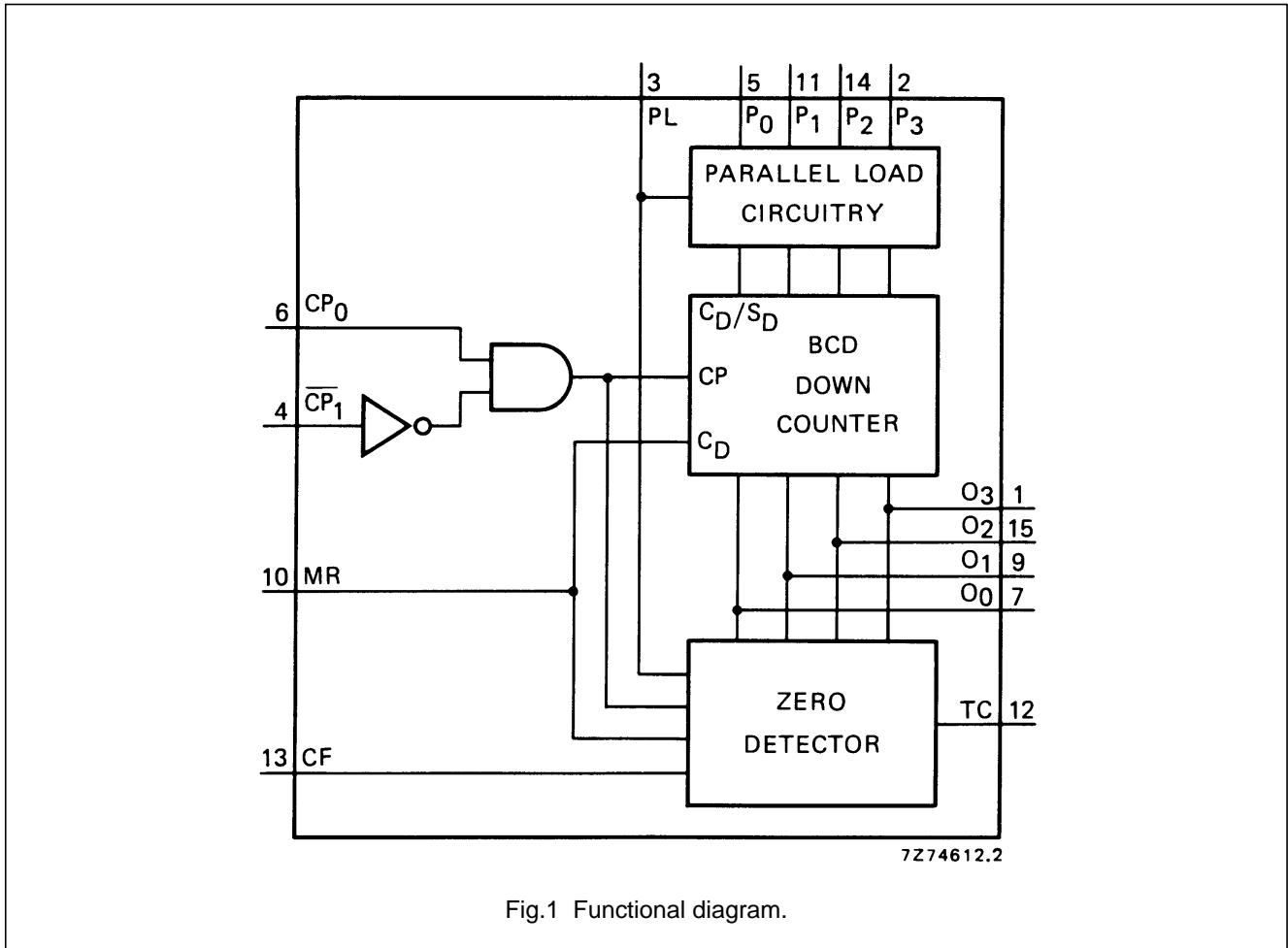


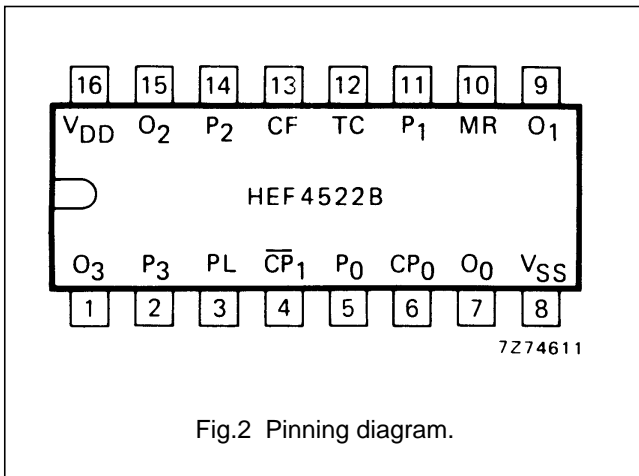
Fig.1 Functional diagram.

**FAMILY DATA,  $I_{DD}$  LIMITS category MSI**

See Family Specifications

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HEF4522BP(N): 16-lead DIL; plastic (SOT38-1)  
 HEF4522BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)  
 HEF4522BT(D): 16-lead SO; plastic (SOT109-1)  
 ( ): Package Designator North America

**PINNING**

- PL parallel load input
- P<sub>0</sub> to P<sub>3</sub> parallel inputs
- CF cascade feedback input
- CP<sub>0</sub> clock input (LOW to HIGH, triggered)
- $\overline{CP}_1$  clock input (HIGH to LOW, triggered)
- MR asynchronous master reset input
- TC terminal count output
- O<sub>0</sub> to O<sub>3</sub> buffered parallel outputs

**COUNTING MODE**

CF = HIGH; PL = LOW; MR = LOW

COUNT	OUTPUTS			
	O <sub>3</sub>	O <sub>2</sub>	O <sub>1</sub>	O <sub>0</sub>
9	H	L	L	H
8	H	L	L	L
7	L	H	H	H
6	L	H	H	L
5	L	H	L	H
4	L	H	L	L
3	L	L	H	H
2	L	L	H	L
1	L	L	L	H
0	L	L	L	L

**FUNCTION TABLE**

MR	PL	CP <sub>0</sub>	$\overline{CP}_1$	MODE
H	X	X	X	reset (asynchronous)
L	H	X	X	preset (asynchronous)
L	L	↗	H	no change
L	L	L	↘	no change
L	L	↘	X	no change
L	L	X	↗	no change
L	L	↗	L	counter advances
L	L	H	↘	counter advances

**Notes**

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

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**SINGLE STAGE OPERATION**

Divide-by-n; MR = LOW; CF = HIGH;  $\overline{CP}_1$  = LOW

PL	P <sub>3</sub>	P <sub>2</sub>	P <sub>1</sub>	P <sub>0</sub>	DIVIDE BY	TC OUTPUT PULSE WIDTH
L	X	X	X	X	10	one clock period
TC	H	H	H	H	15	clock pulse HIGH
TC	H	H	H	L	14	
TC	H	H	L	H	13	
TC	H	H	L	L	12	
TC	H	L	H	H	11	
TC	H	L	H	L	10	
TC	H	L	L	H	9	
TC	H	L	L	L	8	
TC	L	H	H	H	7	
TC	L	H	H	L	6	
TC	L	H	L	H	5	
TC	L	H	L	L	4	
TC	L	L	H	H	3	
TC	L	L	H	L	2	
TC	L	L	L	H	1	
TC	L	L	L	L	no operation	

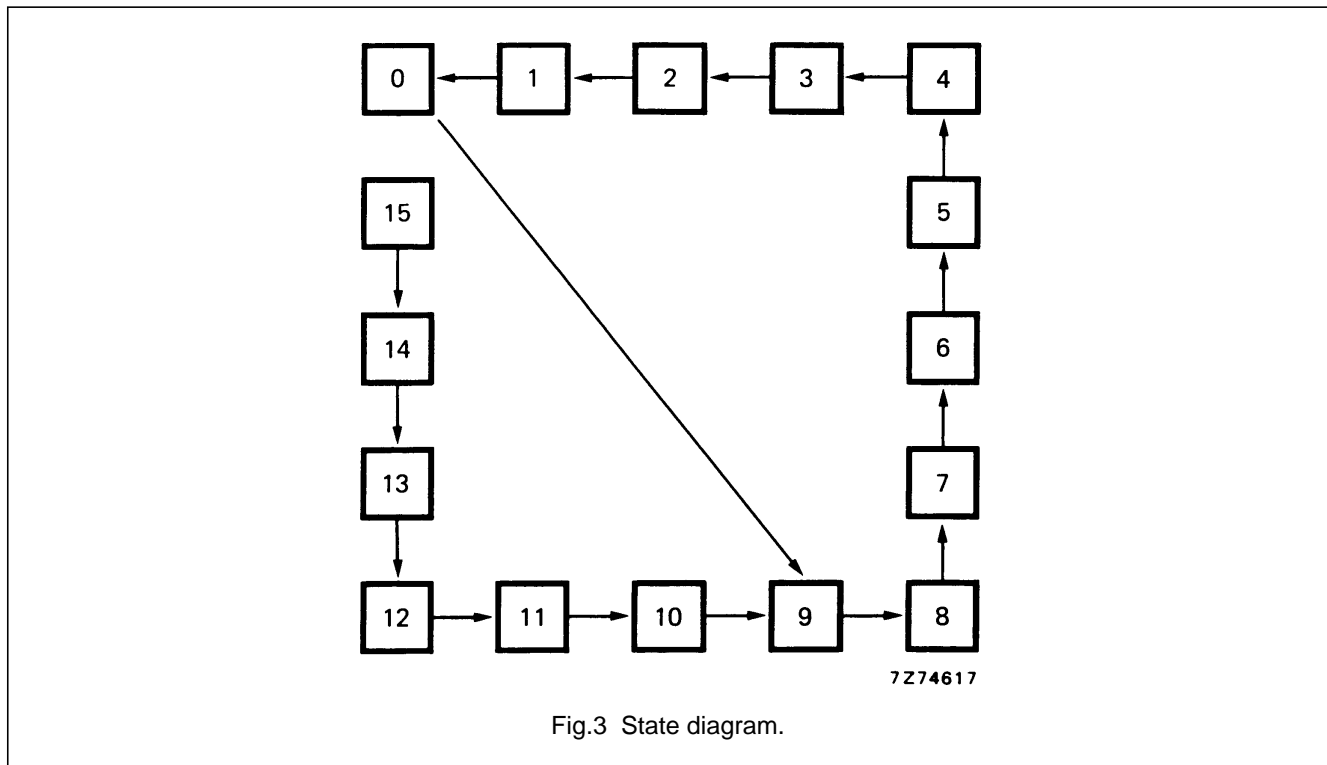


Fig.3 State diagram.

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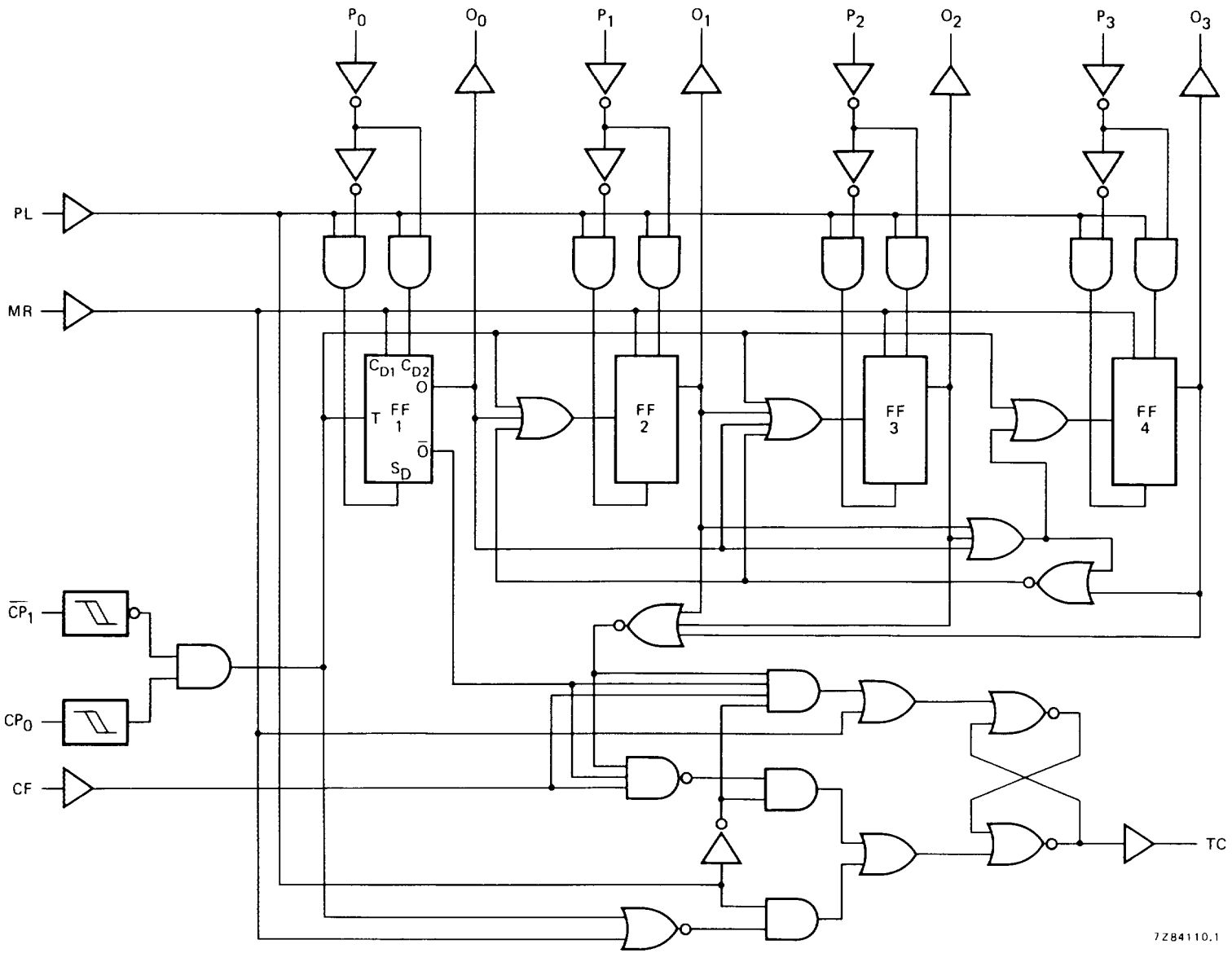


Fig.4 Logic diagram.

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## AC CHARACTERISTICS

 $V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; input transition times  $\leq 20\text{ ns}$ 

	$V_{DD}$ V	TYPICAL FORMULA FOR P ( $\mu\text{W}$ )	
Dynamic power dissipation per package (P)	5	$1000 f_i + \sum (f_o C_L) \times V_{DD}^2$	where $f_i$ = input freq. (MHz) $f_o$ = output freq. (MHz) $C_L$ = load capacitance (pF) $\sum (f_o C_L)$ = sum of outputs $V_{DD}$ = supply voltage (V)
	10	$4000 f_i + \sum (f_o C_L) \times V_{DD}^2$	
	15	$10\,000 f_i + \sum (f_o C_L) \times V_{DD}^2$	

## 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		
Propagation delays $CP_0, \overline{CP}_1 \rightarrow O_n$ HIGH to LOW	5	$t_{PHL}$		150	300	ns	$123\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			65	130	ns	$54\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			50	100	ns	$42\text{ ns} + (0,16\text{ ns/pF}) C_L$	
	LOW to HIGH	5	$t_{PLH}$		150	300	ns	$123\text{ ns} + (0,55\text{ ns/pF}) C_L$
		10			65	130	ns	$54\text{ ns} + (0,23\text{ ns/pF}) C_L$
		15			50	100	ns	$42\text{ ns} + (0,16\text{ ns/pF}) C_L$
$CP_0, \overline{CP}_1 \rightarrow TC$ HIGH to LOW	5	$t_{PHL}$		210	420	ns	$183\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			90	180	ns	$79\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			70	140	ns	$62\text{ ns} + (0,16\text{ ns/pF}) C_L$	
	LOW to HIGH	5	$t_{PLH}$		210	420	ns	$183\text{ ns} + (0,55\text{ ns/pF}) C_L$
		10			90	180	ns	$79\text{ ns} + (0,23\text{ ns/pF}) C_L$
		15			70	140	ns	$62\text{ ns} + (0,16\text{ ns/pF}) C_L$
PL $\rightarrow O_n$ HIGH to LOW	5	$t_{PHL}$		200	400	ns	$173\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			80	160	ns	$69\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			60	120	ns	$52\text{ ns} + (0,16\text{ ns/pF}) C_L$	
	LOW to HIGH	5	$t_{PLH}$		180	360	ns	$153\text{ ns} + (0,55\text{ ns/pF}) C_L$
		10			70	140	ns	$59\text{ ns} + (0,23\text{ ns/pF}) C_L$
		15			50	100	ns	$42\text{ ns} + (0,16\text{ ns/pF}) C_L$
MR $\rightarrow O_n$ HIGH to LOW	5	$t_{PHL}$		140	280	ns	$113\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			55	110	ns	$44\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			40	80	ns	$32\text{ ns} + (0,16\text{ ns/pF}) C_L$	
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	$6\text{ ns} + (0,28\text{ ns/pF}) C_L$

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	$V_{DD}$ V	SYMBOL	MIN.	TYP.	MAX.	
Minimum clock pulse width; $CP_0$ LOW	5	$t_{WCPL}$	80	40	ns	see also waveforms Figs 5 and 6
	10		40	20	ns	
	15		30	15	ns	
Minimum clock pulse width; $\overline{CP}_1$ HIGH	5	$t_{WCPH}$	80	40	ns	
	10		40	20	ns	
	15		30	15	ns	
Minimum PL pulse width; HIGH	5	$t_{WPLH}$	100	50	ns	
	10		40	20	ns	
	15		32	16	ns	
Minimum MR pulse width; HIGH	5	$t_{WMRH}$	130	65	ns	
	10		50	25	ns	
	15		40	20	ns	
Hold time $P_n \rightarrow PL$	5	$t_{hold}$	30	5	ns	
	10		20	5	ns	
	15		15	5	ns	
Set-up time $P_n \rightarrow PL$	5	$t_{su}$	30	0	ns	
	10		20	0	ns	
	15		15	0	ns	
Maximum clock pulse frequency PL = LOW	5	$f_{max}$	6	12	MHz	see note 1
	10		12	25	MHz	
	15		16	32	MHz	

**Note**

1. In the divide-by-n mode (PL connected to TC), one has to observe the maximum HIGH to LOW propagation delay for CP to TC, before applying the next clock pulse.

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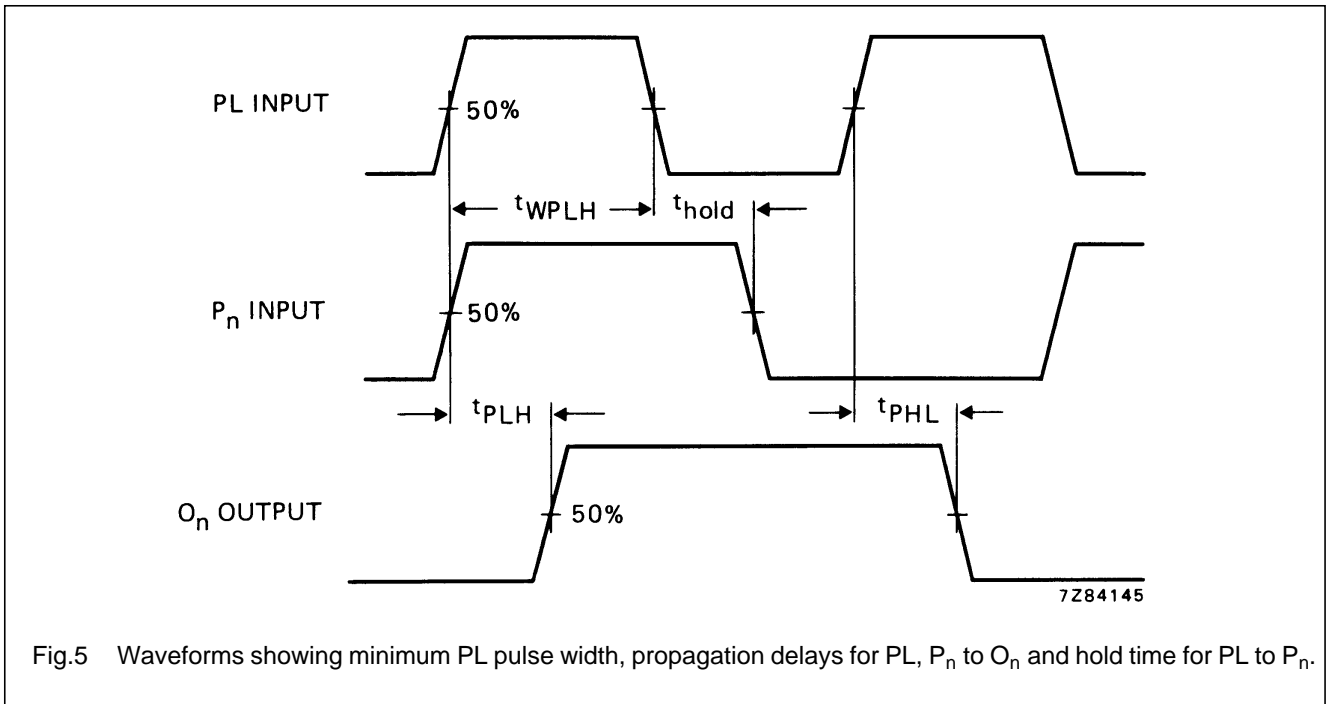


Fig.5 Waveforms showing minimum PL pulse width, propagation delays for PL, P<sub>n</sub> to O<sub>n</sub> and hold time for PL to P<sub>n</sub>.

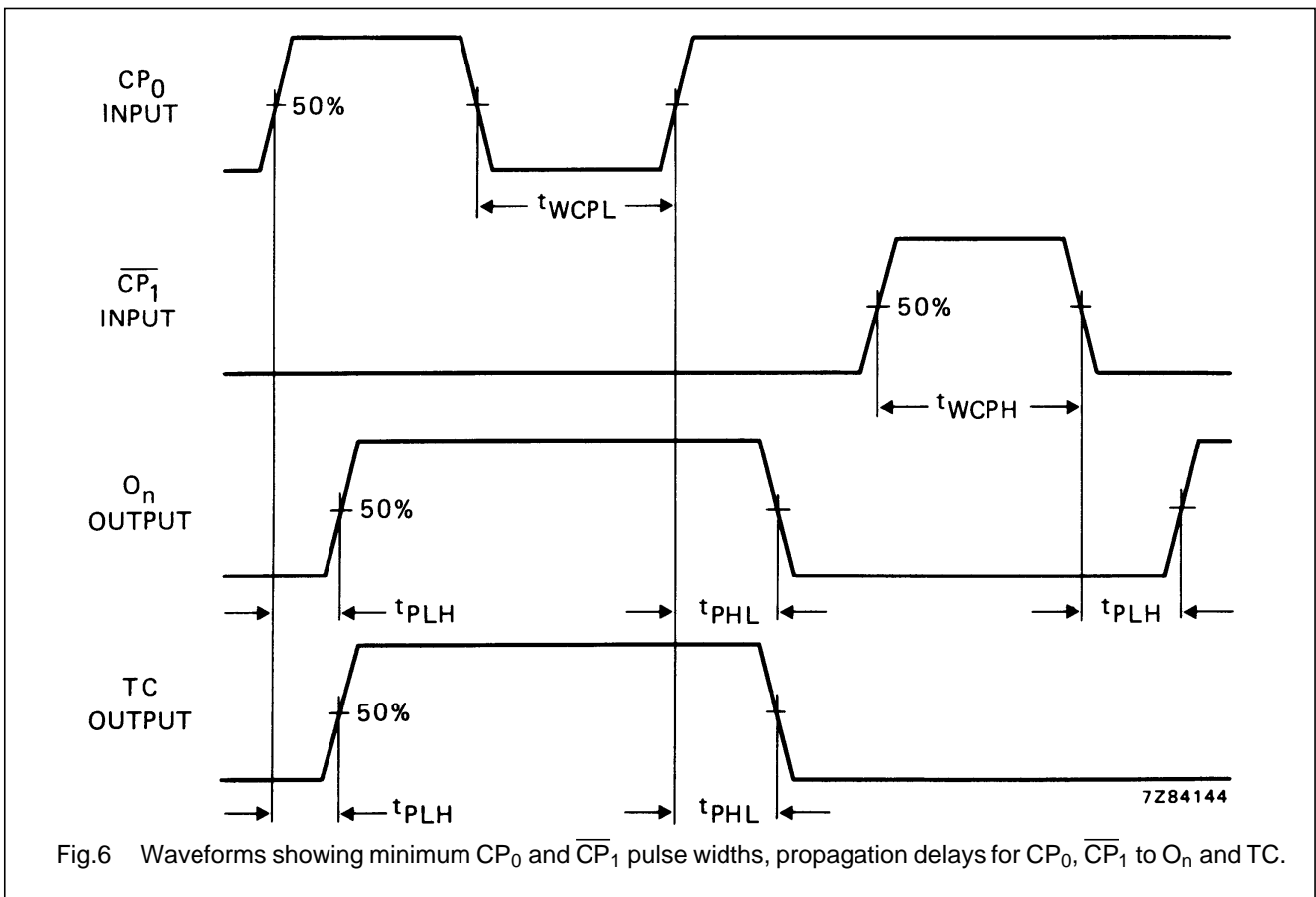


Fig.6 Waveforms showing minimum CP<sub>0</sub> and CP<sub>1</sub> pulse widths, propagation delays for CP<sub>0</sub>, CP<sub>1</sub> to O<sub>n</sub> and TC.



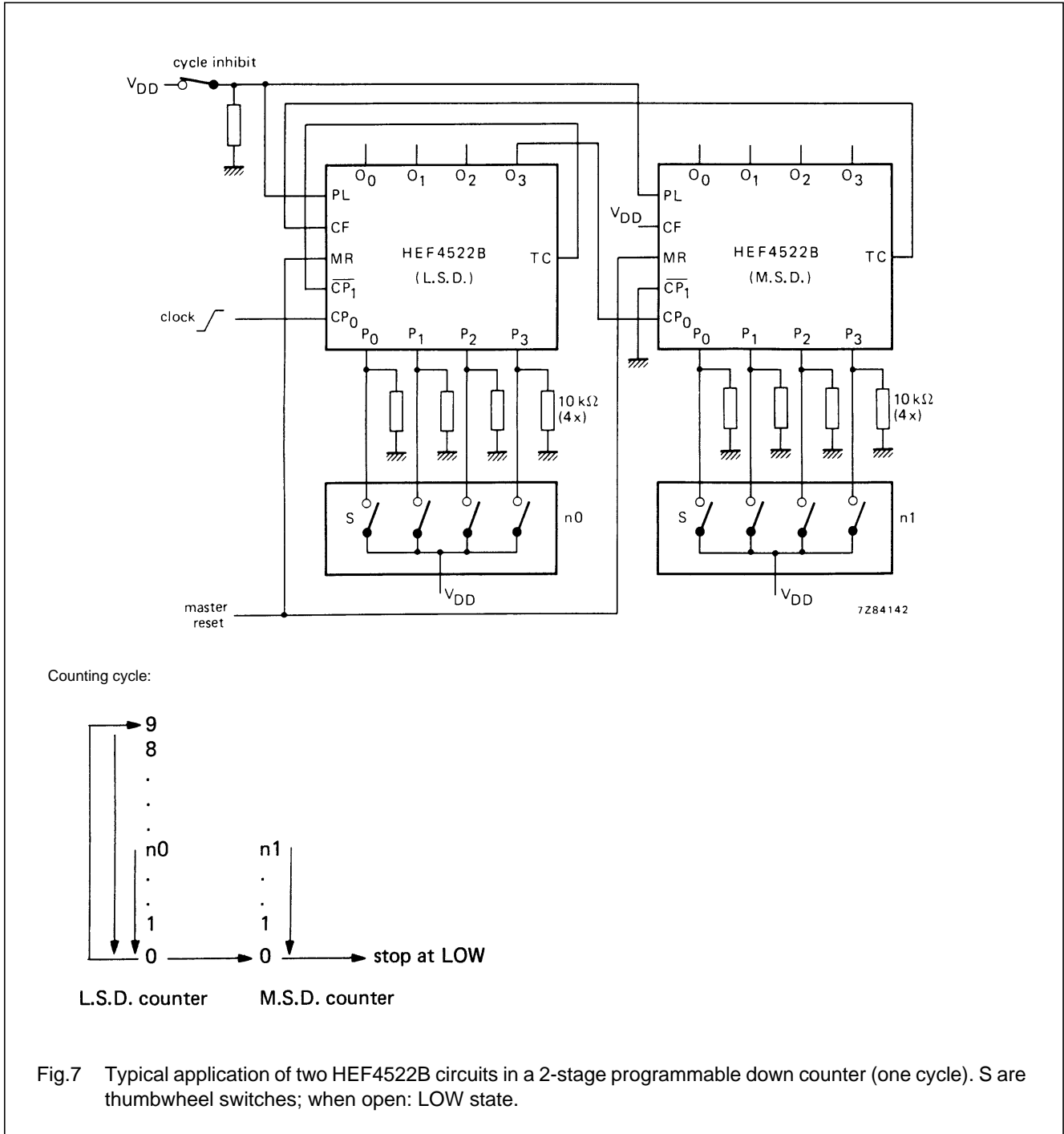
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APPLICATION INFORMATION

Some examples of applications for the HEF4522B are:

- Divide-by-n counter
- Programmable frequency divider



Counting cycle:

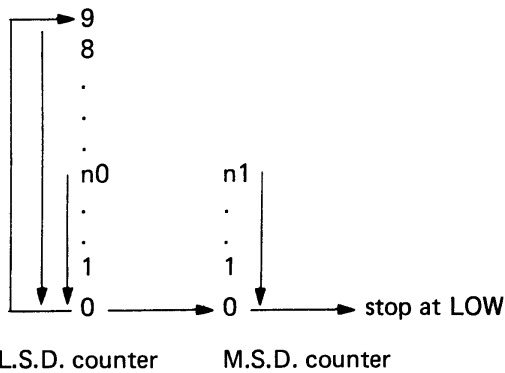
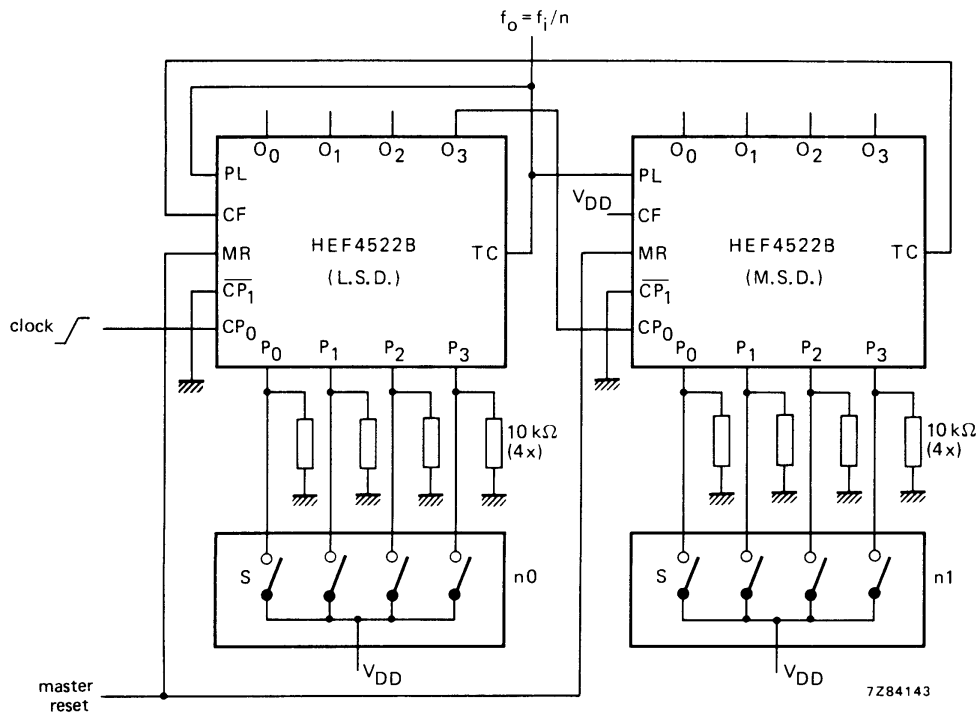


Fig.7 Typical application of two HEF4522B circuits in a 2-stage programmable down counter (one cycle). S are thumbwheel switches; when open: LOW state.

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Counting cycle:

Counting cycle:

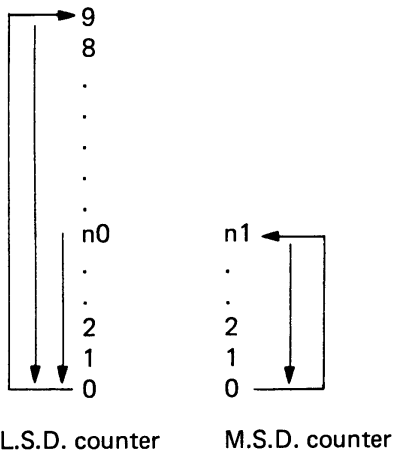


Fig.8 Typical application of two HEF4522B circuits in a 2-stage programmable frequency divider. S are thumbwheel switches; when open: LOW state.