

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.

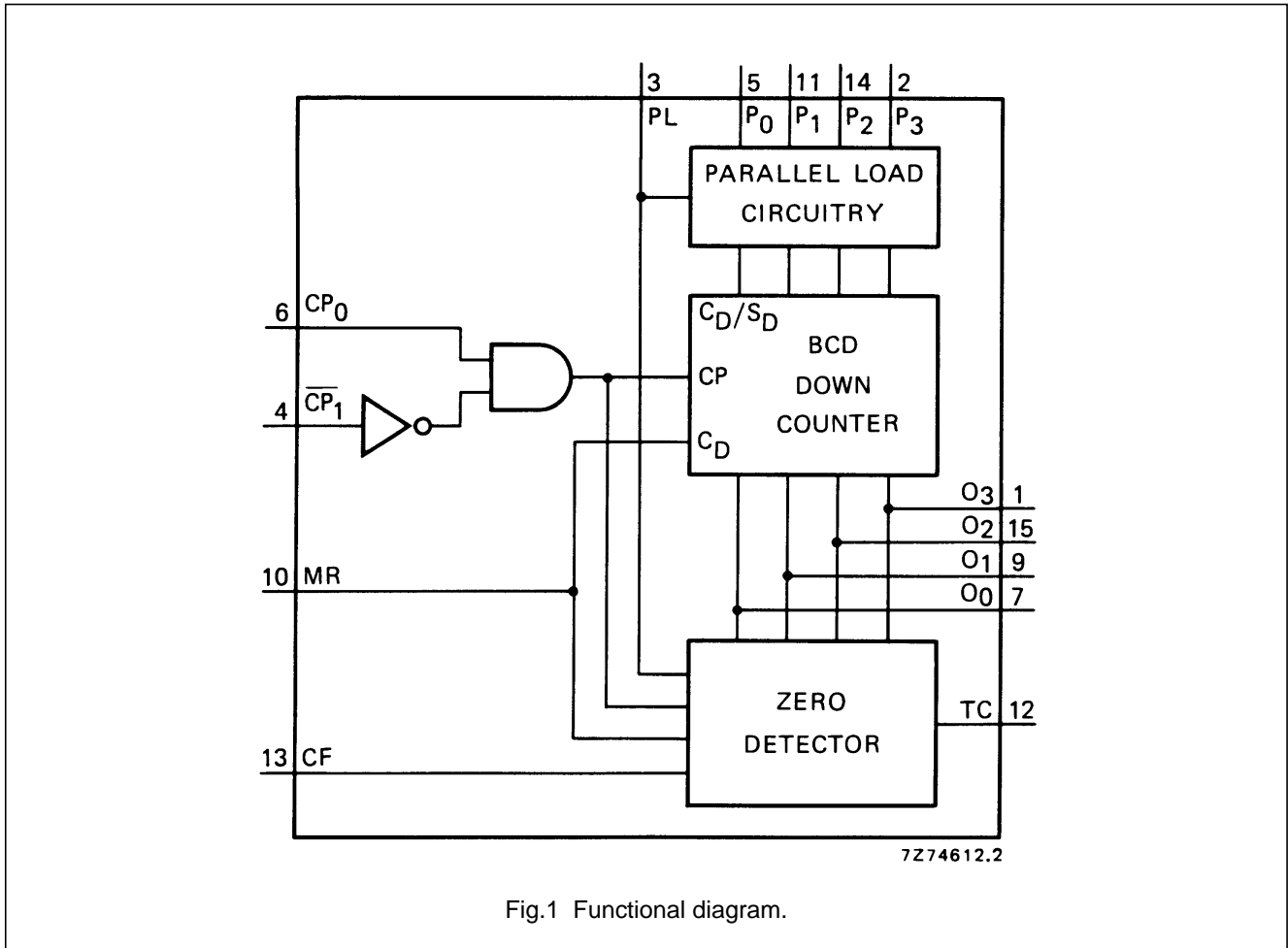


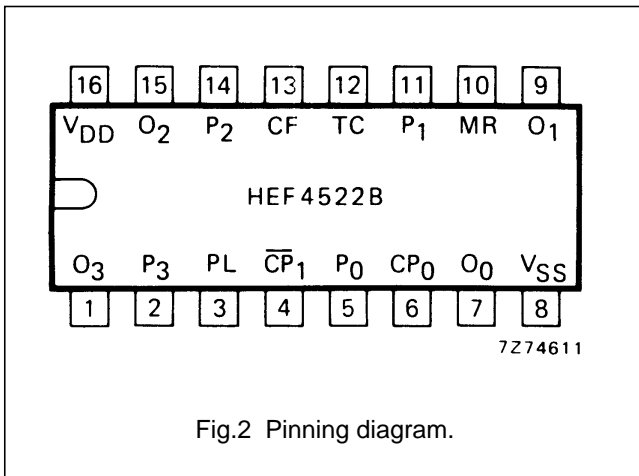
Fig.1 Functional diagram.

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
- P₀ to P₃ parallel inputs
- CF cascade feedback input
- CP₀ clock input (LOW to HIGH, triggered)
- \overline{CP}_1 clock input (HIGH to LOW, triggered)
- MR asynchronous master reset input
- TC terminal count output
- O₀ to O₃ buffered parallel outputs

COUNTING MODE

CF = HIGH; PL = LOW; MR = LOW

COUNT	OUTPUTS			
	O ₃	O ₂	O ₁	O ₀
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 ₀	\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

1. 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 ₃	P ₂	P ₁	P ₀	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	

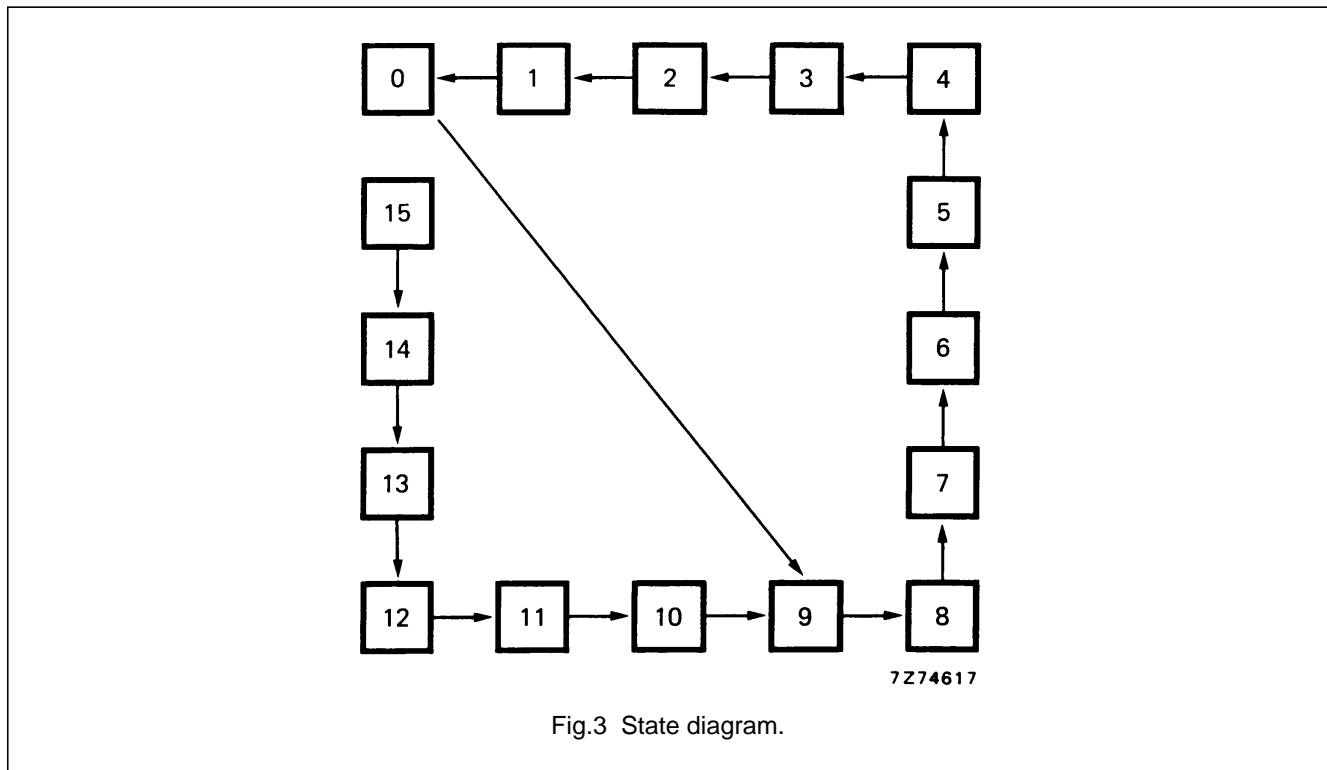


Fig.3 State diagram.

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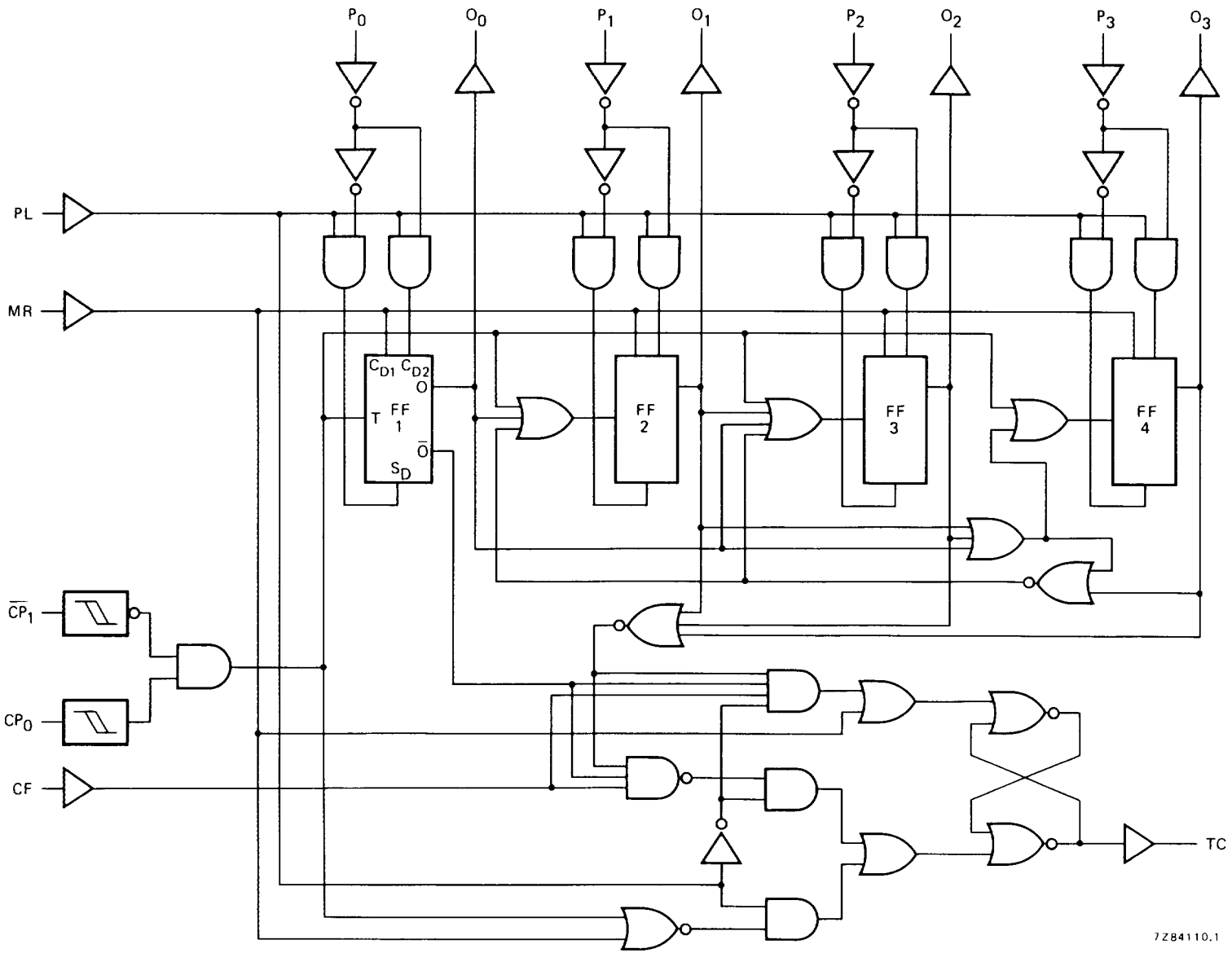


Fig.4 Logic diagram.

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	V_{DD} V	TYPICAL FORMULA FOR P (μW)	
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 $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; $C_L = 50\text{ pF}$; 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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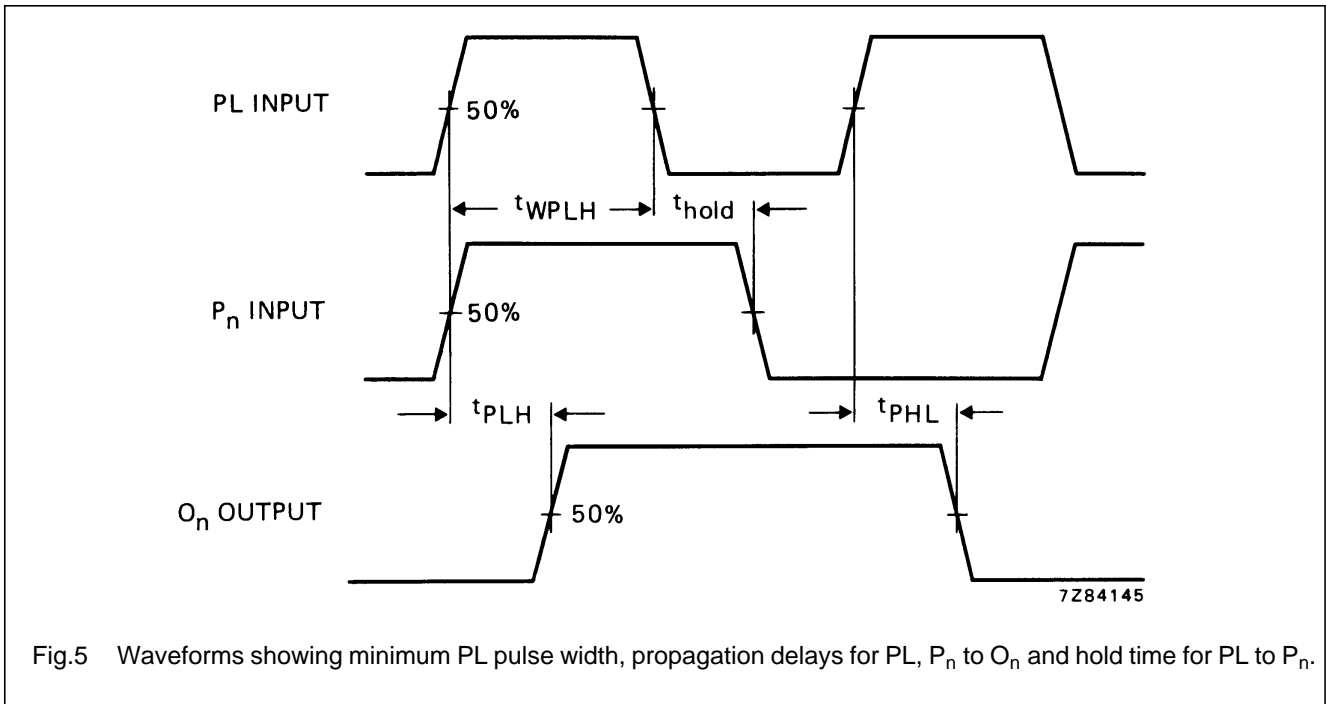


Fig.5 Waveforms showing minimum PL pulse width, propagation delays for PL, P_n to O_n and hold time for PL to P_n.

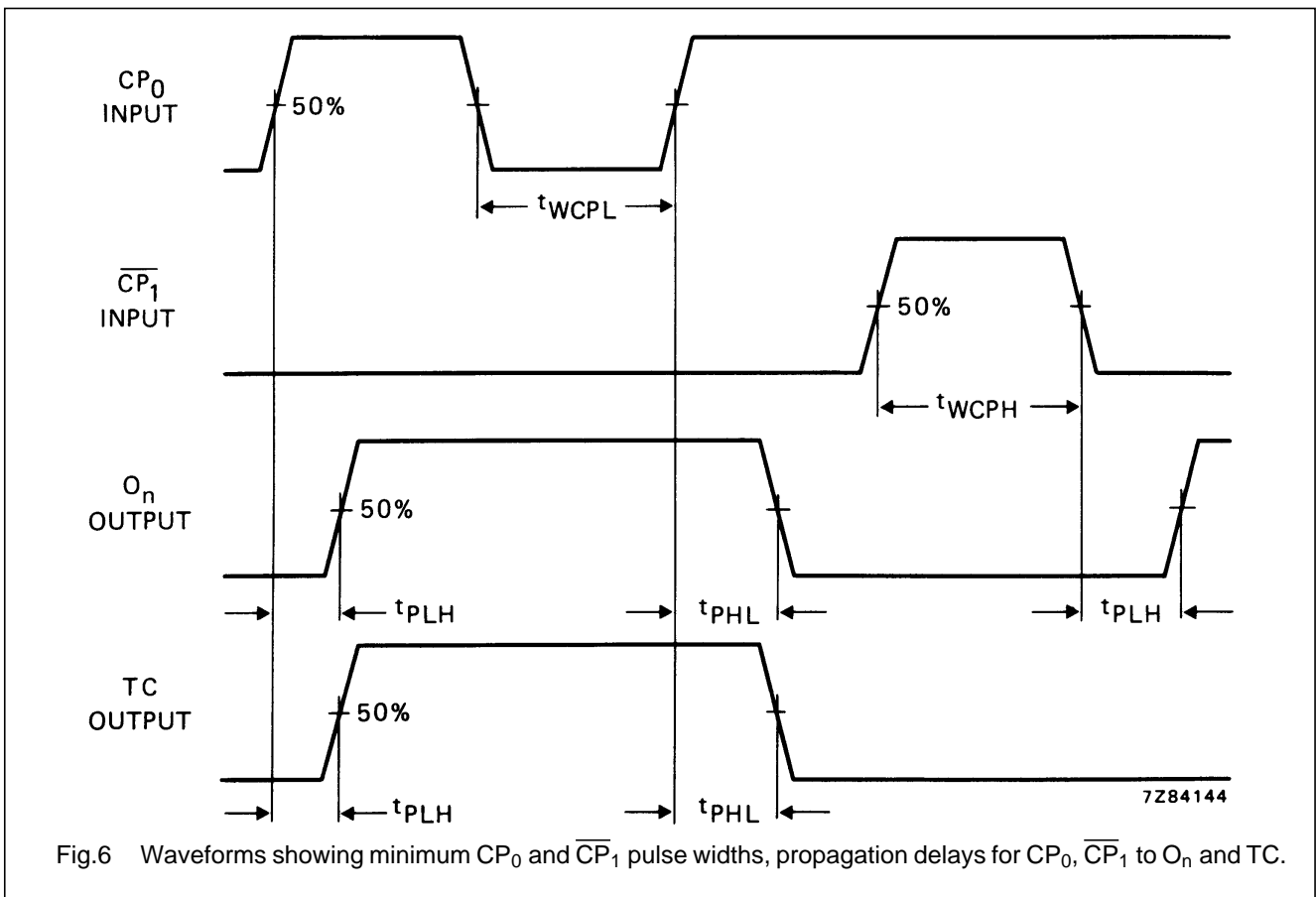


Fig.6 Waveforms showing minimum CP₀ and CP₁ pulse widths, propagation delays for CP₀, CP₁ to O_n and TC.

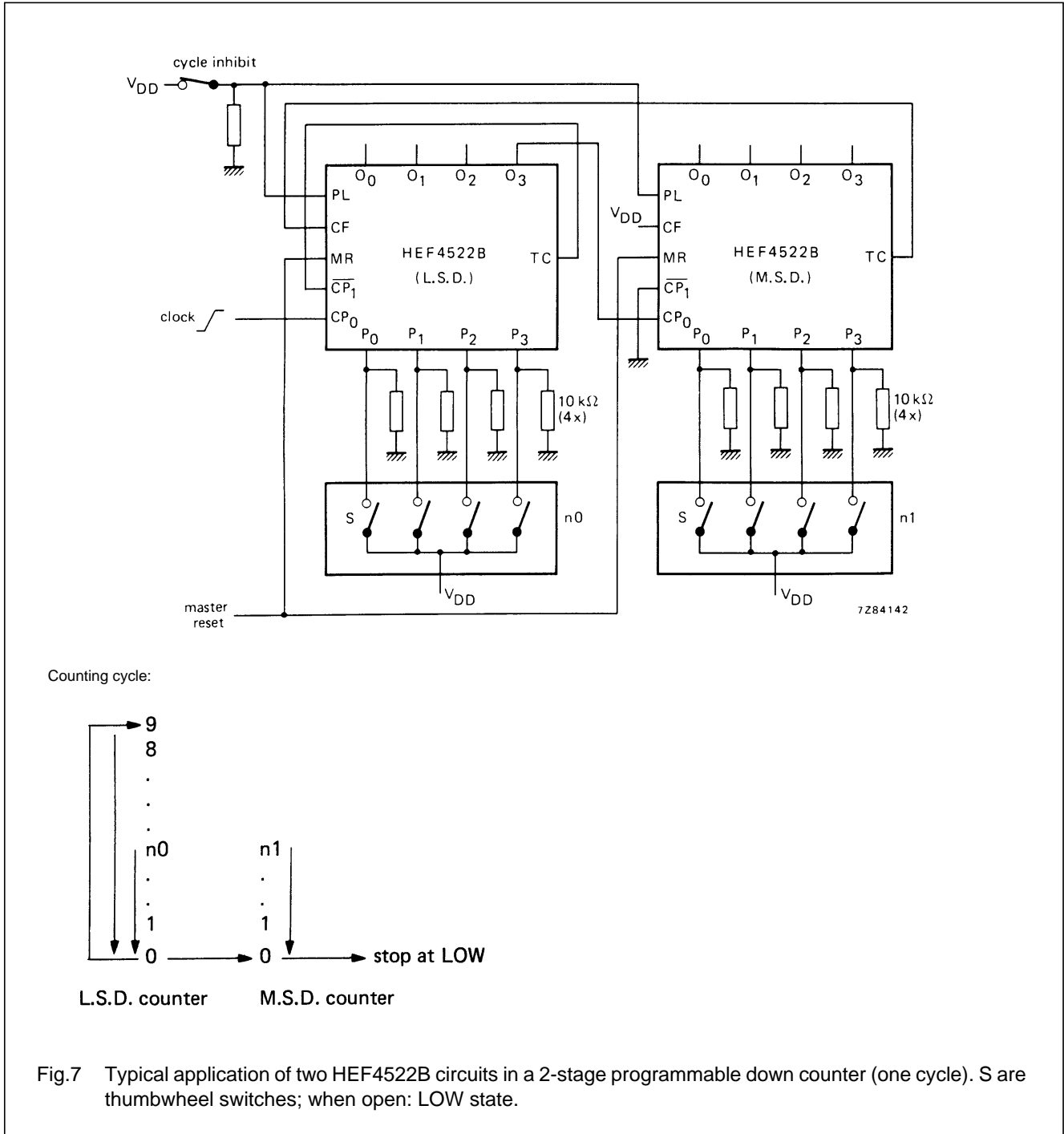
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APPLICATION INFORMATION

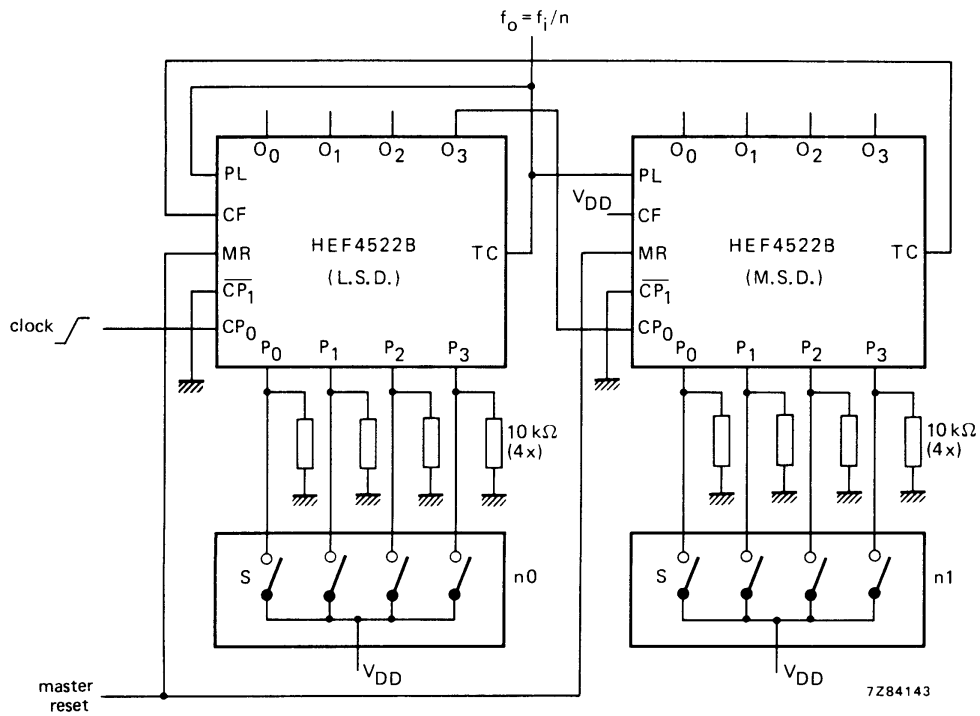
Some examples of applications for the HEF4522B are:

- Divide-by-n counter
- Programmable frequency divider



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Counting cycle:

Counting cycle:

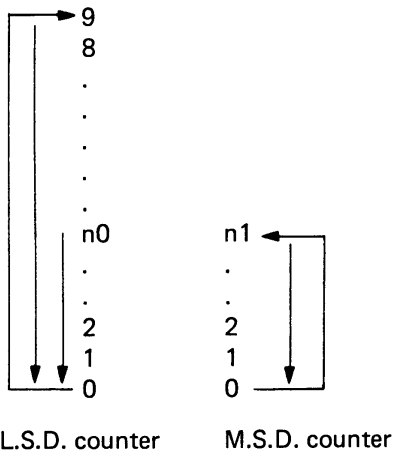


Fig.8 Typical application of two HEF4522B circuits in a 2-stage programmable frequency divider. S are thumbwheel switches; when open: LOW state.

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