

# 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

## **HEF4022B**

### **MSI**

## **4-stage divide-by-8 Johnson counter**

Product specification  
File under Integrated Circuits, IC04

January 1995

# 4-stage divide-by-8 Johnson counter

**HEF4022B**  
**MSI**

**DESCRIPTION**

The HEF4022B is a 4-stage divide-by-8 Johnson counter with eight spike-free decoded active HIGH outputs ( $O_0$  to  $O_7$ ), an active LOW output from the most significant flip-flop ( $\overline{O}_{4-7}$ ), active HIGH and active LOW clock inputs ( $CP_0$ ,  $\overline{CP}_1$ ) and an overriding asynchronous master reset input (MR).

The counter is advanced by either a LOW to HIGH transition at  $CP_0$  while  $\overline{CP}_1$  is LOW or a HIGH to LOW transition at  $\overline{CP}_1$  while  $CP_0$  is HIGH (see also function table). Either  $CP_0$  or  $CP_1$  may be used as clock input to the

counter and the other clock input may be used as a clock enable input. When cascading counters, the  $\overline{O}_{4-7}$  output, which is LOW while the counter is in states, 4, 5, 6 and 7, can be used to drive the  $CP_0$  input of the next counter.

A HIGH on MR resets the counter to zero ( $O_0 = \overline{O}_{4-7} = \text{HIGH}$ ;  $O_1$  to  $O_7 = \text{LOW}$ ) independent of the clock inputs ( $CP_0$ ,  $\overline{CP}_1$ ).

Automatic code correction of the counter is provided by an internal circuit, following any illegal code the counter returns to a proper counting mode within 11 clock pulses.

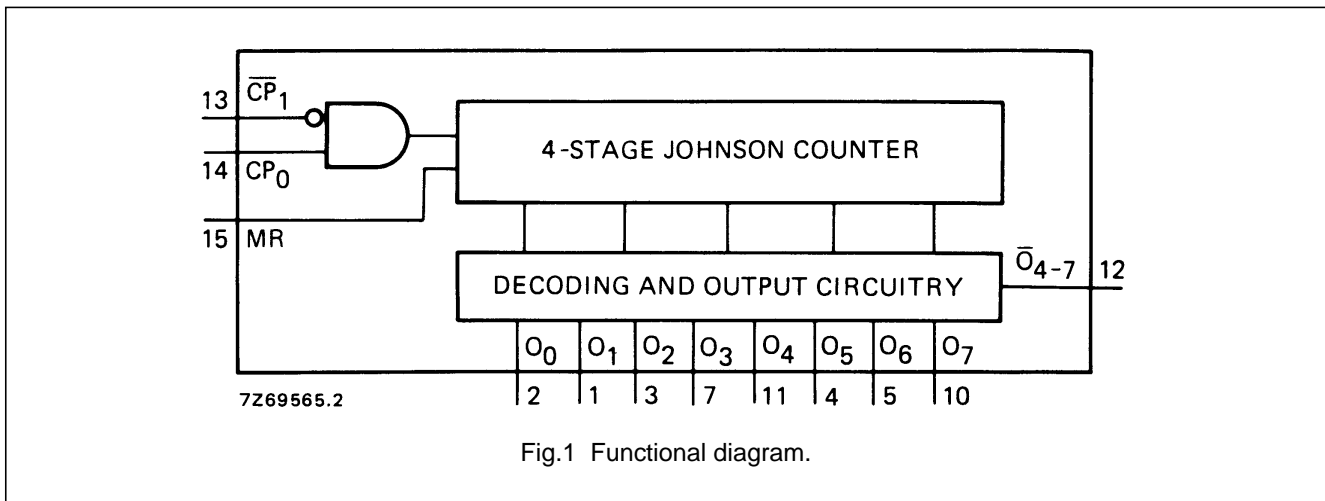


Fig.1 Functional diagram.

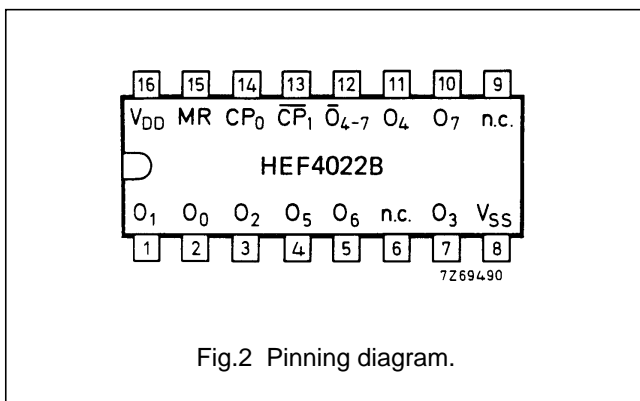


Fig.2 Pinning diagram.

- HEF4022BP(N): 16-lead DIL; plastic (SOT38-1)
- HEF4022BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)
- HEF4022BT(D): 16-lead SO; plastic (SOT109-1)
- ( ): Package Designator North America

**FAMILY DATA, I<sub>DD</sub> LIMITS category MSI**

See Family Specifications

**PINNING**

- $CP_0$  clock input (LOW to HIGH; edge-triggered)
- $\overline{CP}_1$  clock input (HIGH to LOW; edge-triggered)
- MR master reset input
- $O_0$  to  $O_7$  decoded outputs
- $O_{4-7}$  carry output (active LOW)

### 4-stage divide-by-8 Johnson counter

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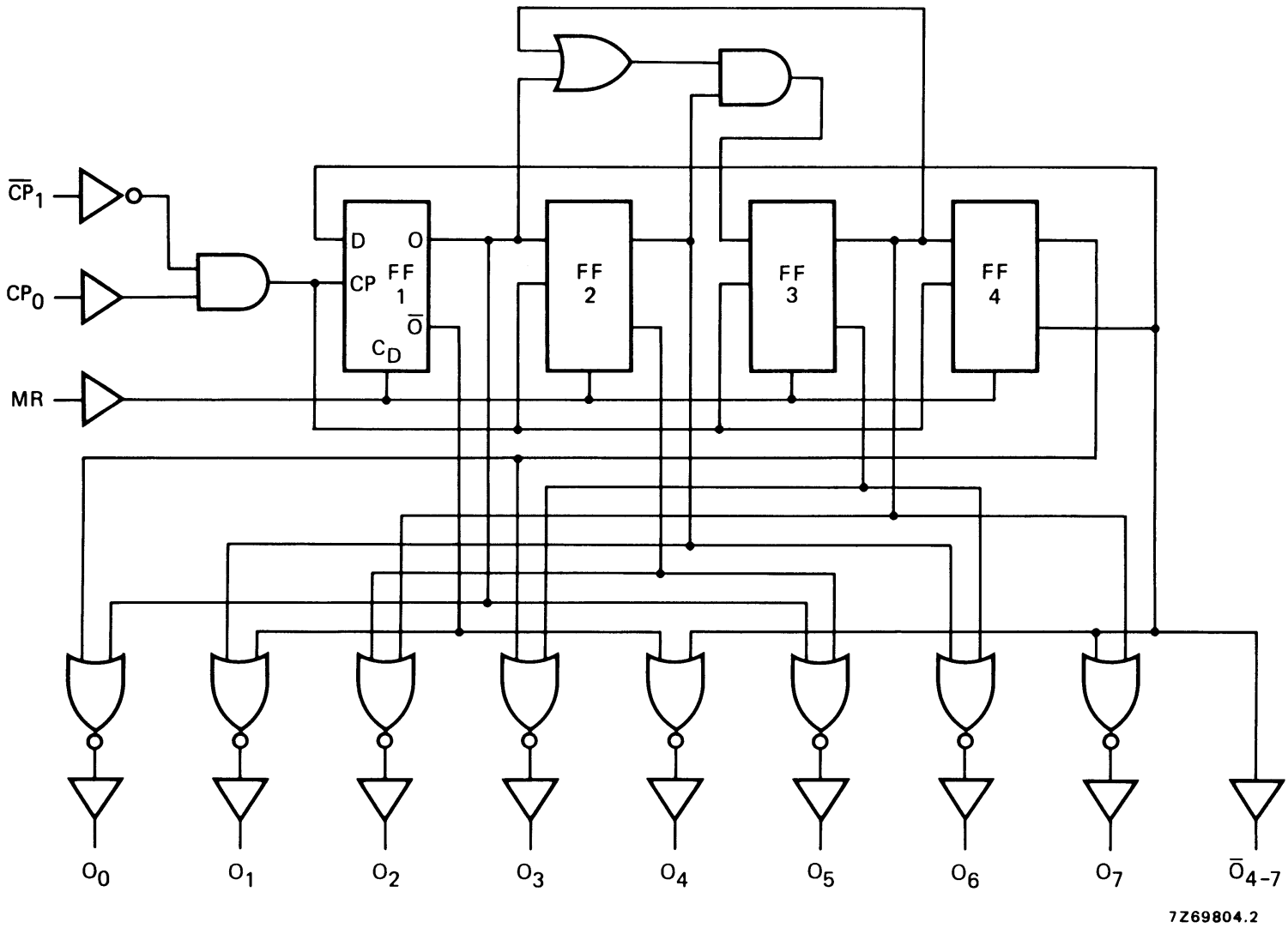


Fig.3 Logic diagram.

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## FUNCTION TABLE

MR	CP <sub>0</sub>	$\overline{CP}_1$	OPERATION
H	X	X	O <sub>0</sub> = $\overline{O}_{4-7}$ = H; O <sub>1</sub> to O <sub>7</sub> = L
L	H	$\searrow$	Counter advances
L	$\swarrow$	L	Counter advances
L	L	X	No change
L	X	H	No change
L	H	$\swarrow$	No change
L	$\searrow$	L	No change

## Notes

- H = HIGH state (the more positive voltage)  
L = LOW state (the less positive voltage)  
X = state is immaterial  
 $\swarrow$  = positive-going transition  
 $\searrow$  = negative-going transition

## AC CHARACTERISTICS

V<sub>SS</sub> = 0 V; T<sub>amb</sub> = 25 °C; C<sub>L</sub> = 50 pF; input transition times ≤ 20 ns

	V <sub>DD</sub> V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA		
Propagation delays CP <sub>0</sub> , $\overline{CP}_1$ → O <sub>n</sub> HIGH to LOW	5	t <sub>PHL</sub>		195	390	ns	168 ns + (0,55 ns/pF) C <sub>L</sub>	
	10		75	145	ns	64 ns + (0,23 ns/pF) C <sub>L</sub>		
	15		50	100	ns	42 ns + (0,16 ns/pF) C <sub>L</sub>		
	LOW to HIGH	5	t <sub>PLH</sub>		245	485	ns	218 ns + (0,55 ns/pF) C <sub>L</sub>
		10		95	195	ns	84 ns + (0,23 ns/pF) C <sub>L</sub>	
		15		60	125	ns	52 ns + (0,16 ns/pF) C <sub>L</sub>	
CP <sub>0</sub> , $\overline{CP}_1$ → $\overline{O}_{4-7}$ HIGH to LOW	5	t <sub>PHL</sub>		245	485	ns	218 ns + (0,55 ns/pF) C <sub>L</sub>	
	10		90	185	ns	79 ns + (0,23 ns/pF) C <sub>L</sub>		
	15		60	120	ns	52 ns + (0,16 ns/pF) C <sub>L</sub>		
	LOW to HIGH	5	t <sub>PLH</sub>		190	380	ns	163 ns + (0,55 ns/pF) C <sub>L</sub>
		10		75	145	ns	64 ns + (0,23 ns/pF) C <sub>L</sub>	
		15		50	105	ns	42 ns + (0,16 ns/pF) C <sub>L</sub>	
MR → O <sub>1</sub> to O <sub>7</sub> HIGH to LOW	5	t <sub>PHL</sub>		130	260	ns	103 ns + (0,55 ns/pF) C <sub>L</sub>	
	10		55	105	ns	44 ns + (0,23 ns/pF) C <sub>L</sub>		
	15		40	75	ns	32 ns + (0,16 ns/pF) C <sub>L</sub>		
MR → O <sub>0</sub> LOW to HIGH	5	t <sub>PLH</sub>		130	260	ns	103 ns + (0,55 ns/pF) C <sub>L</sub>	
	10		55	105	ns	44 ns + (0,23 ns/pF) C <sub>L</sub>		
	15		40	75	ns	32 ns + (0,16 ns/pF) C <sub>L</sub>		
MR → $\overline{O}_{4-7}$ LOW to HIGH	5	t <sub>PLH</sub>		110	220	ns	83 ns + (0,55 ns/pF) C <sub>L</sub>	
	10		45	90	ns	34 ns + (0,23 ns/pF) C <sub>L</sub>		
	15		35	70	ns	27 ns + (0,16 ns/pF) C <sub>L</sub>		
Output transition times HIGH to LOW	5	t <sub>THL</sub>		60	120	ns	10 ns + (1,0 ns/pF) C <sub>L</sub>	
	10		30	60	ns	9 ns + (0,42 ns/pF) C <sub>L</sub>		
	15		20	40	ns	6 ns + (0,28 ns/pF) C <sub>L</sub>		
	LOW to HIGH	5	t <sub>TLH</sub>		60	120	ns	10 ns + (1,0 ns/pF) C <sub>L</sub>
		10		30	60	ns	9 ns + (0,42 ns/pF) C <sub>L</sub>	
		15		20	40	ns	6 ns + (0,28 ns/pF) C <sub>L</sub>	

4-stage divide-by-8 Johnson counter

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**AC CHARACTERISTICS**

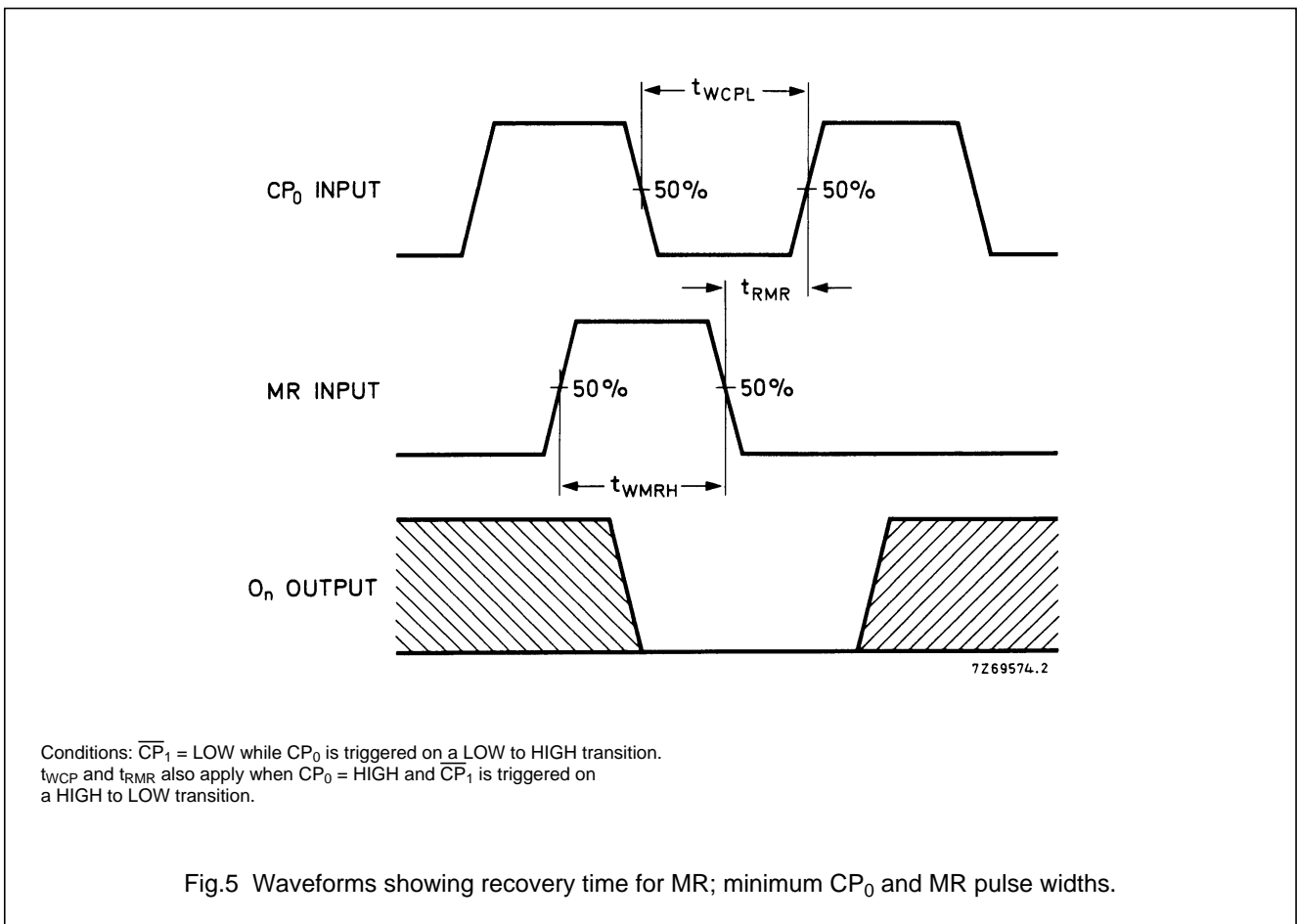
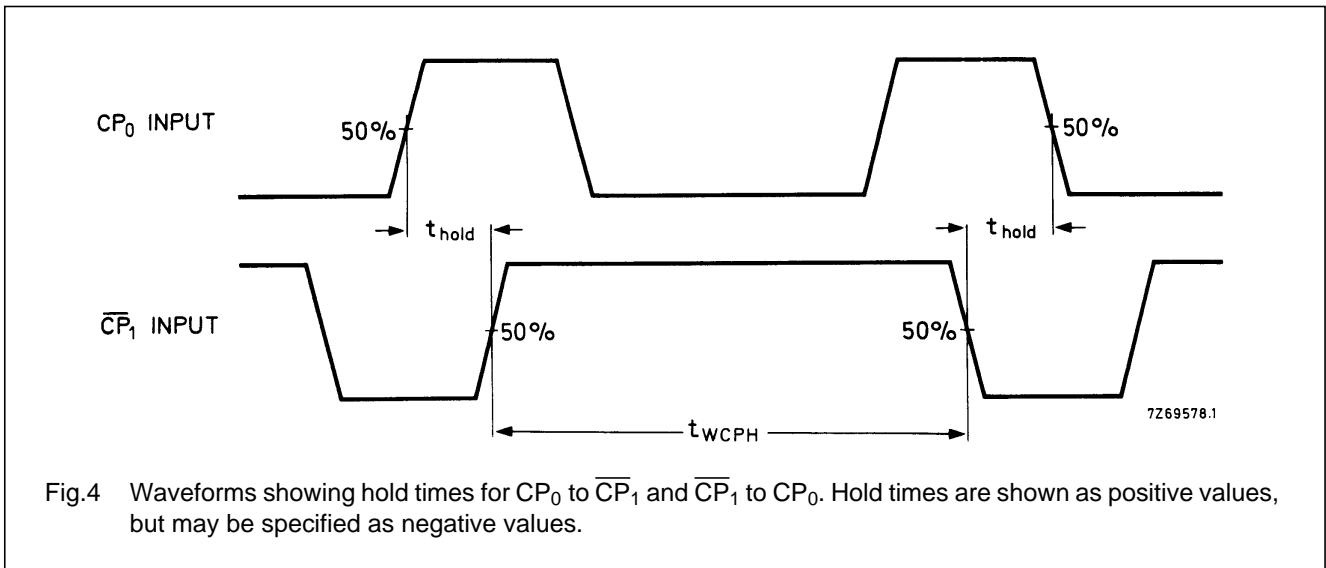
$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ ;  $C_L = 50\text{ pF}$ ; input transition times  $\leq 20\text{ ns}$

	$V_{DD}$ V	SYMBOL	MIN.	TYP.	MAX.	
Hold times $CP_0 \rightarrow \overline{CP}_1$	5	$t_{hold}$	140	70	ns	see also waveforms Figs 4 and 5
	10		50	25	ns	
	15		30	15	ns	
$\overline{CP}_1 \rightarrow CP_0$	5	$t_{hold}$	170	85	ns	
	10		60	30	ns	
	15		40	20	ns	
Minimum clock pulse width	5	$t_{WCP}$	75	35	ns	
	10		30	15	ns	
	15		20	10	ns	
Minimum MR pulse width; HIGH	5	$t_{WMRH}$	70	35	ns	
	10		30	15	ns	
	15		20	10	ns	
Recovery time for MR	5	$t_{RMR}$	30	10	ns	
	10		15	5	ns	
	15		10	5	ns	
Maximum clock pulse frequency	5	$f_{max}$	3	6	MHz	
	10		8	16	MHz	
	15		12	24	MHz	

	$V_{DD}$ V	TYPICAL FORMULA FOR P ( $\mu\text{W}$ )	
Dynamic power dissipation per package (P)	5	$475 f_i + \sum (f_o CL) \times V_{DD}^2$	where $f_i$ = input freq. (MHz) $f_o$ = output freq. (MHz) $C_L$ = total load capacitance (pF) $\sum (f_o C_L)$ = sum of outputs $V_{DD}$ = supply voltage (V)
	10	$2400 f_i + \sum (f_o CL) \times V_{DD}^2$	
	15	$6700 f_i + \sum (f_o CL) \times V_{DD}^2$	

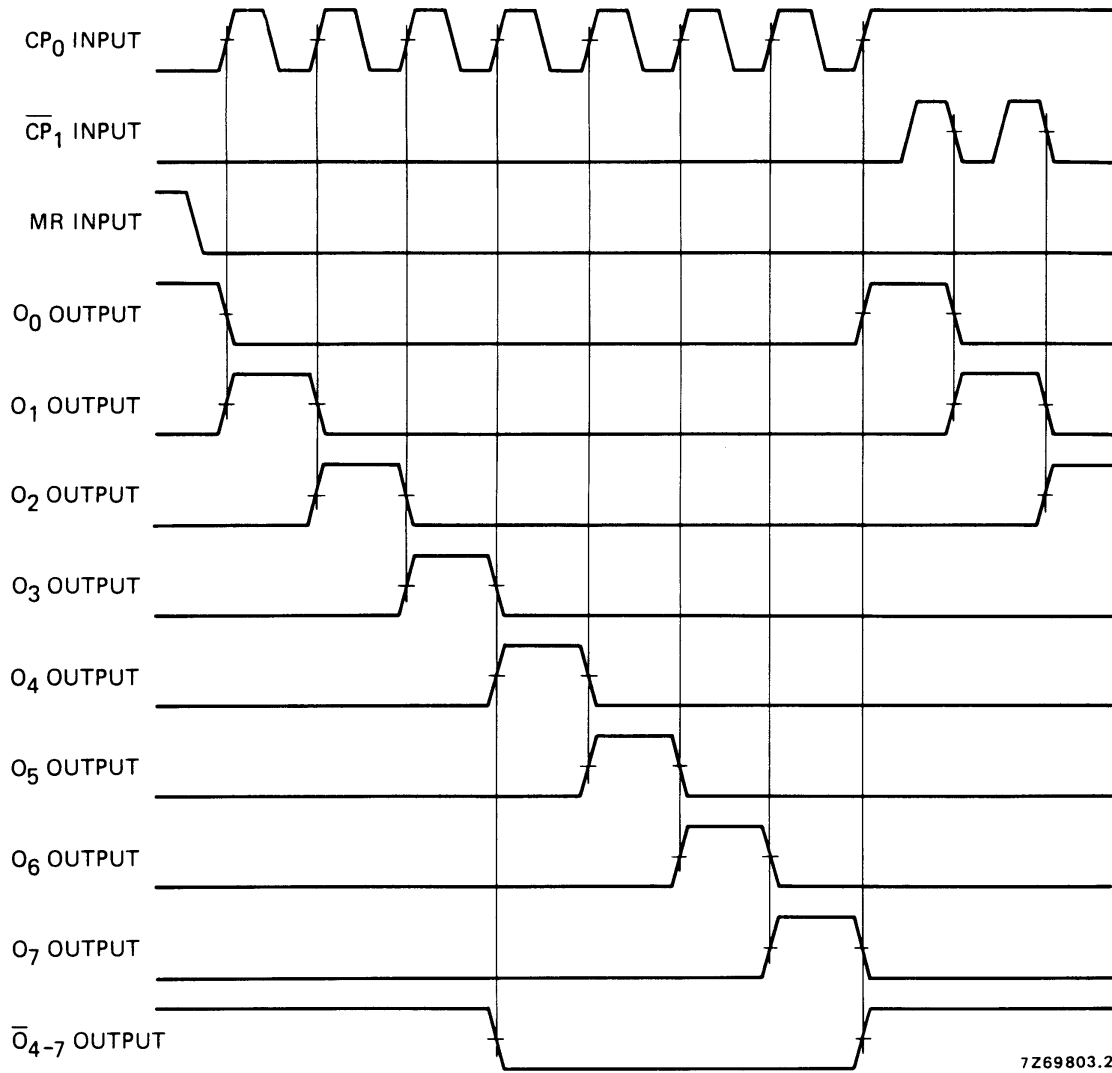
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Fig.6 Timing diagram.

# 4-stage divide-by-8 Johnson counter

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### APPLICATION INFORMATION

Some of the features of the HEF4022B are:

- High speed
- Spike-free decoded outputs
- Carry output for cascading

Figure 7 shows a technique for extending the number of decoded output states for the HEF4022B. Decoded outputs are sequential within each stage and from stage to stage, with no dead time (except propagation delay).

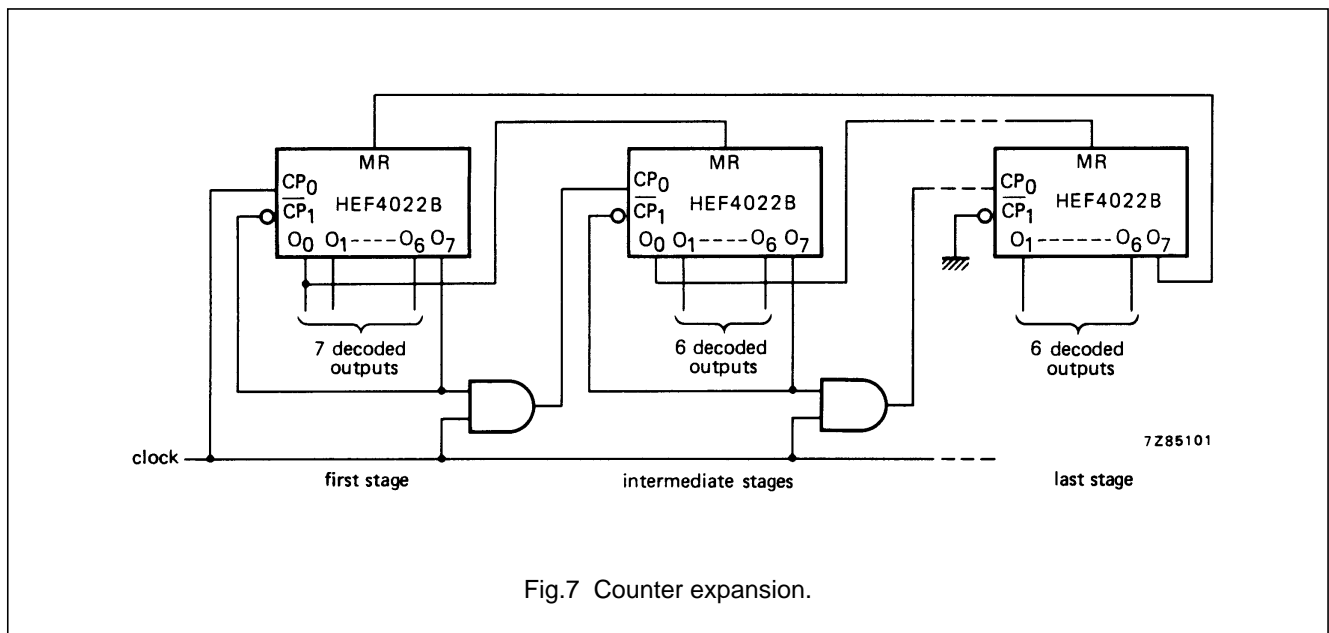


Fig.7 Counter expansion.