

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

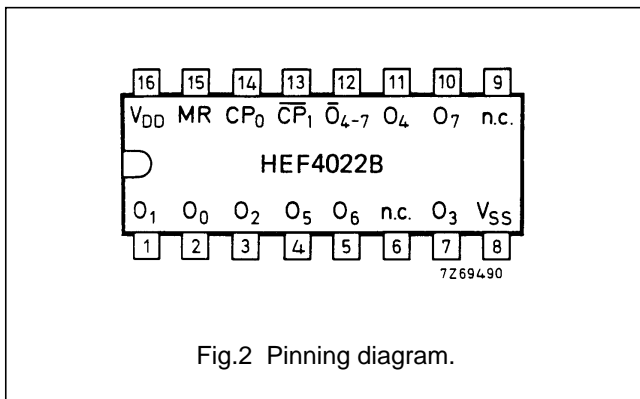
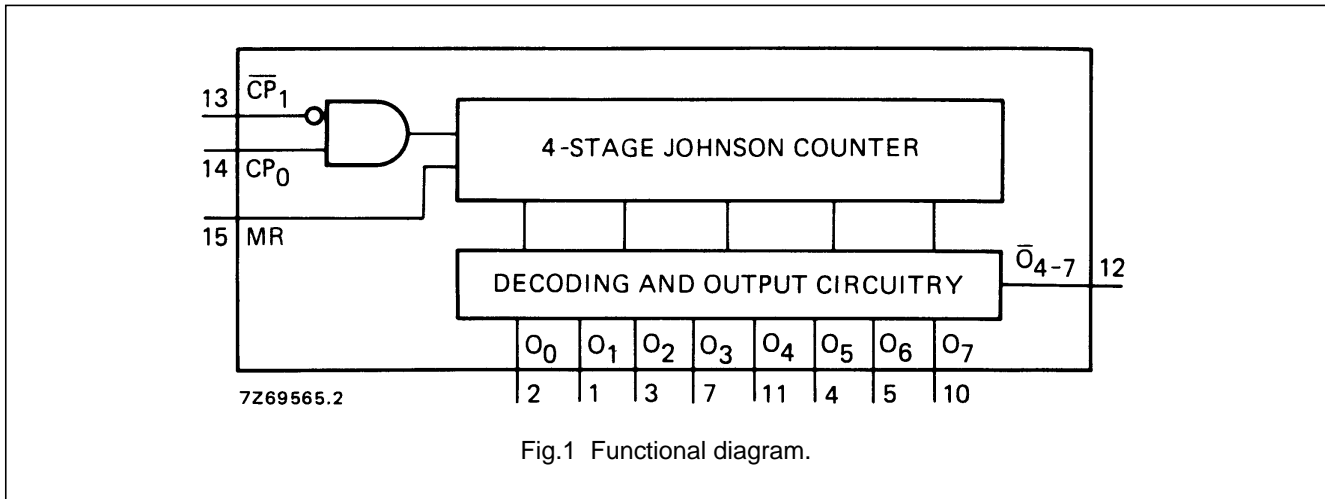
The HEF4022B is a 4-stage divide-by-8 Johnson counter with eight spike-free decoded active HIGH outputs (O_0 to O_7), an active LOW output from the most significant flip-flop (\overline{O}_{4-7}), active HIGH and active LOW clock inputs (CP_0 , \overline{CP}_1) and an overriding asynchronous master reset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



- 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_{DD} 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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FUNCTION TABLE

| MR | CP ₀ | $\overline{\text{CP}}_1$ | OPERATION |
|----|-----------------|--------------------------|--|
| H | X | X | O ₀ = $\overline{\text{O}}_{4-7}$ = H; O ₁ to O ₇ = L |
| L | H | \nearrow | Counter advances |
| L | \searrow | L | Counter advances |
| L | L | X | No change |
| L | X | H | No change |
| L | H | \searrow | No change |
| L | \nearrow | L | No change |

Notes

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

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 ₀ , $\overline{\text{CP}}_1$ → O _n HIGH to LOW | 5 | t _{PHL} | | 195 | 390 | ns | 168 ns + (0,55 ns/pF) C _L | |
| | 10 | | 75 | 145 | ns | 64 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} | | 245 | 485 | ns | 218 ns + (0,55 ns/pF) C _L |
| | | 10 | | 95 | 195 | ns | 84 ns + (0,23 ns/pF) C _L | |
| | | 15 | | 60 | 125 | ns | 52 ns + (0,16 ns/pF) C _L | |
| CP ₀ , $\overline{\text{CP}}_1$ → $\overline{\text{O}}_{4-7}$ HIGH to LOW | 5 | t _{PHL} | | 245 | 485 | ns | 218 ns + (0,55 ns/pF) C _L | |
| | 10 | | 90 | 185 | ns | 79 ns + (0,23 ns/pF) C _L | | |
| | 15 | | 60 | 120 | ns | 52 ns + (0,16 ns/pF) C _L | | |
| | LOW to HIGH | 5 | t _{PLH} | | 190 | 380 | ns | 163 ns + (0,55 ns/pF) C _L |
| | | 10 | | 75 | 145 | ns | 64 ns + (0,23 ns/pF) C _L | |
| | | 15 | | 50 | 105 | ns | 42 ns + (0,16 ns/pF) C _L | |
| MR → O ₁ to O ₇ HIGH to LOW | 5 | t _{PHL} | | 130 | 260 | ns | 103 ns + (0,55 ns/pF) C _L | |
| | 10 | | 55 | 105 | ns | 44 ns + (0,23 ns/pF) C _L | | |
| | 15 | | 40 | 75 | ns | 32 ns + (0,16 ns/pF) C _L | | |
| MR → O ₀ LOW to HIGH | 5 | t _{PLH} | | 130 | 260 | ns | 103 ns + (0,55 ns/pF) C _L | |
| | 10 | | 55 | 105 | ns | 44 ns + (0,23 ns/pF) C _L | | |
| | 15 | | 40 | 75 | ns | 32 ns + (0,16 ns/pF) C _L | | |
| MR → $\overline{\text{O}}_{4-7}$ LOW to HIGH | 5 | t _{PLH} | | 110 | 220 | ns | 83 ns + (0,55 ns/pF) C _L | |
| | 10 | | 45 | 90 | ns | 34 ns + (0,23 ns/pF) C _L | | |
| | 15 | | 35 | 70 | ns | 27 ns + (0,16 ns/pF) C _L | | |
| Output transition times HIGH to LOW | 5 | t _{THL} | | 60 | 120 | ns | 10 ns + (1,0 ns/pF) C _L | |
| | 10 | | 30 | 60 | ns | 9 ns + (0,42 ns/pF) C _L | | |
| | 15 | | 20 | 40 | ns | 6 ns + (0,28 ns/pF) C _L | | |
| | LOW to HIGH | 5 | t _{TLH} | | 60 | 120 | ns | 10 ns + (1,0 ns/pF) C _L |
| | | 10 | | 30 | 60 | ns | 9 ns + (0,42 ns/pF) C _L | |
| | | 15 | | 20 | 40 | ns | 6 ns + (0,28 ns/pF) C _L | |

4-stage divide-by-8 Johnson counter

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AC CHARACTERISTICS

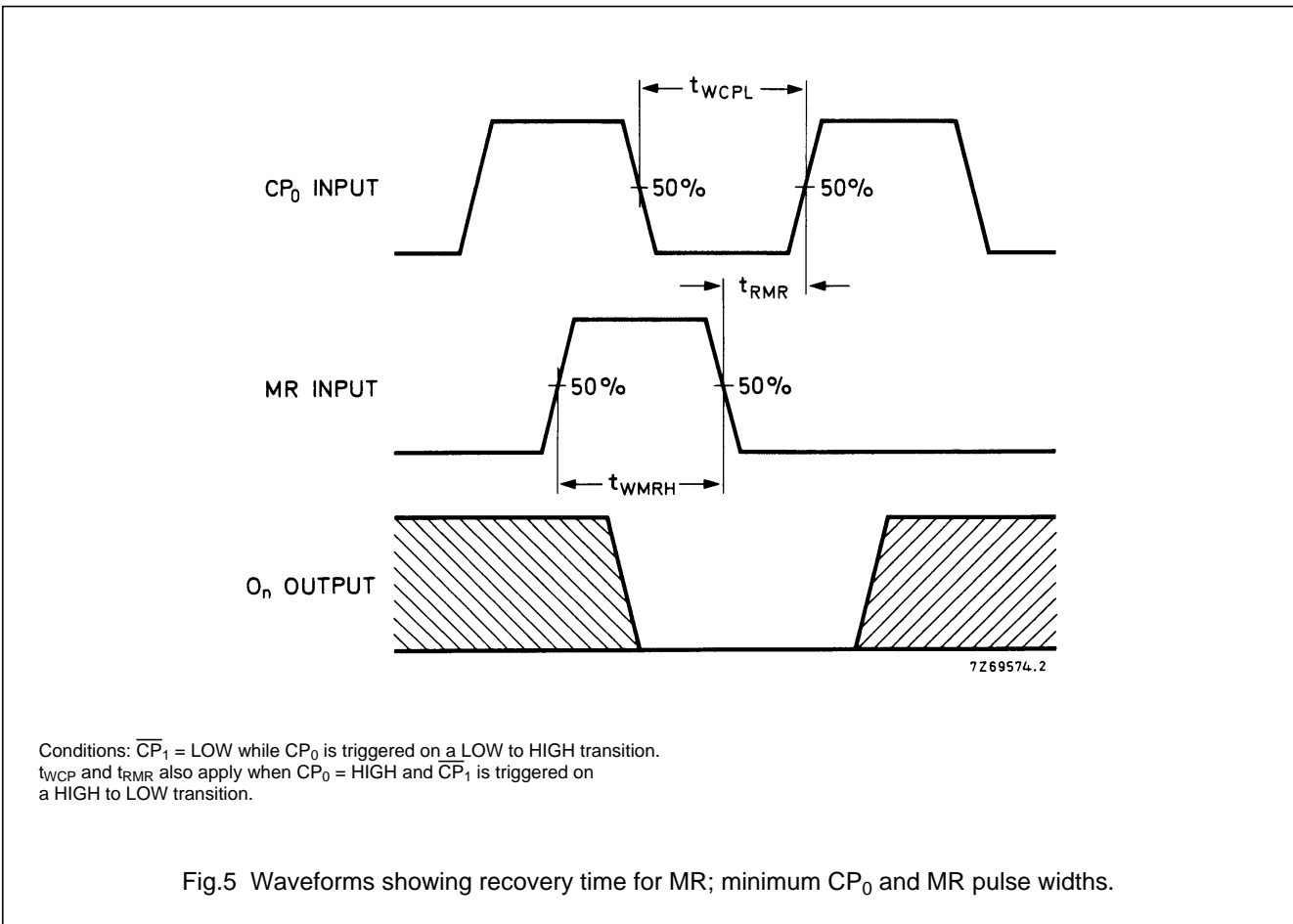
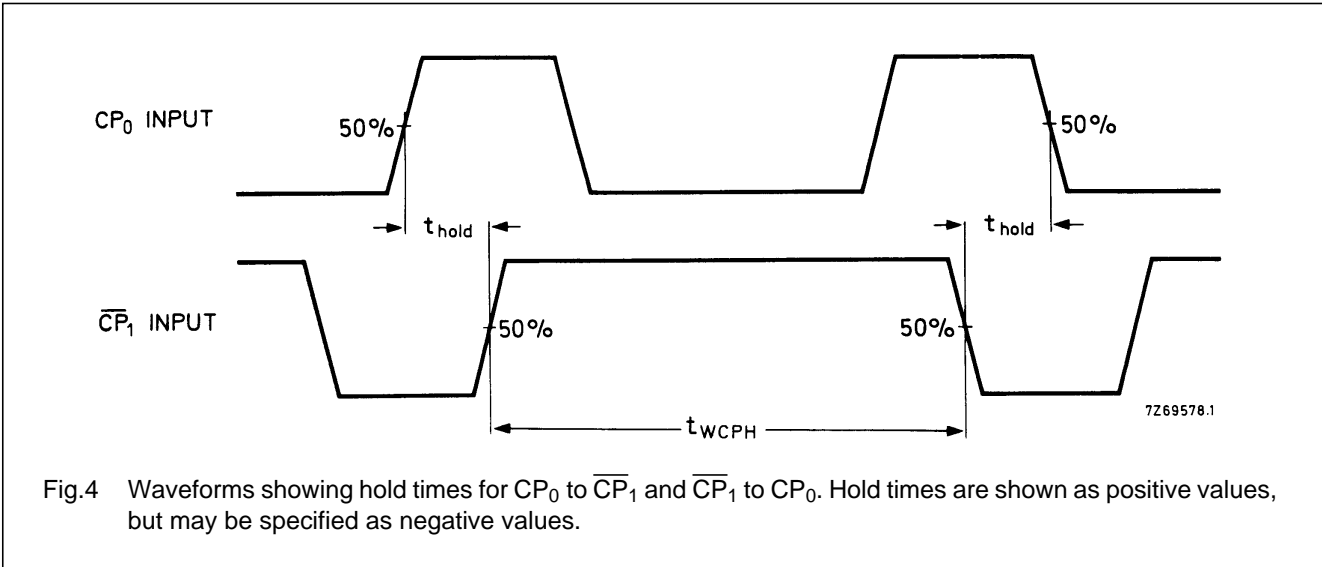
$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; $C_L = 50\text{ pF}$; input transition times $\leq 20\text{ ns}$

| | V_{DD} V | SYMBOL | MIN. | TYP. | MAX. | |
|--|---------------|------------|------|------|------|------------------------------------|
| 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 (μW) | |
|---|---------------|--|---|
| 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 | $6700 f_i + \sum (f_o CL) \times V_{DD}^2$ | |

4-stage divide-by-8 Johnson counter

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4-stage divide-by-8 Johnson counter

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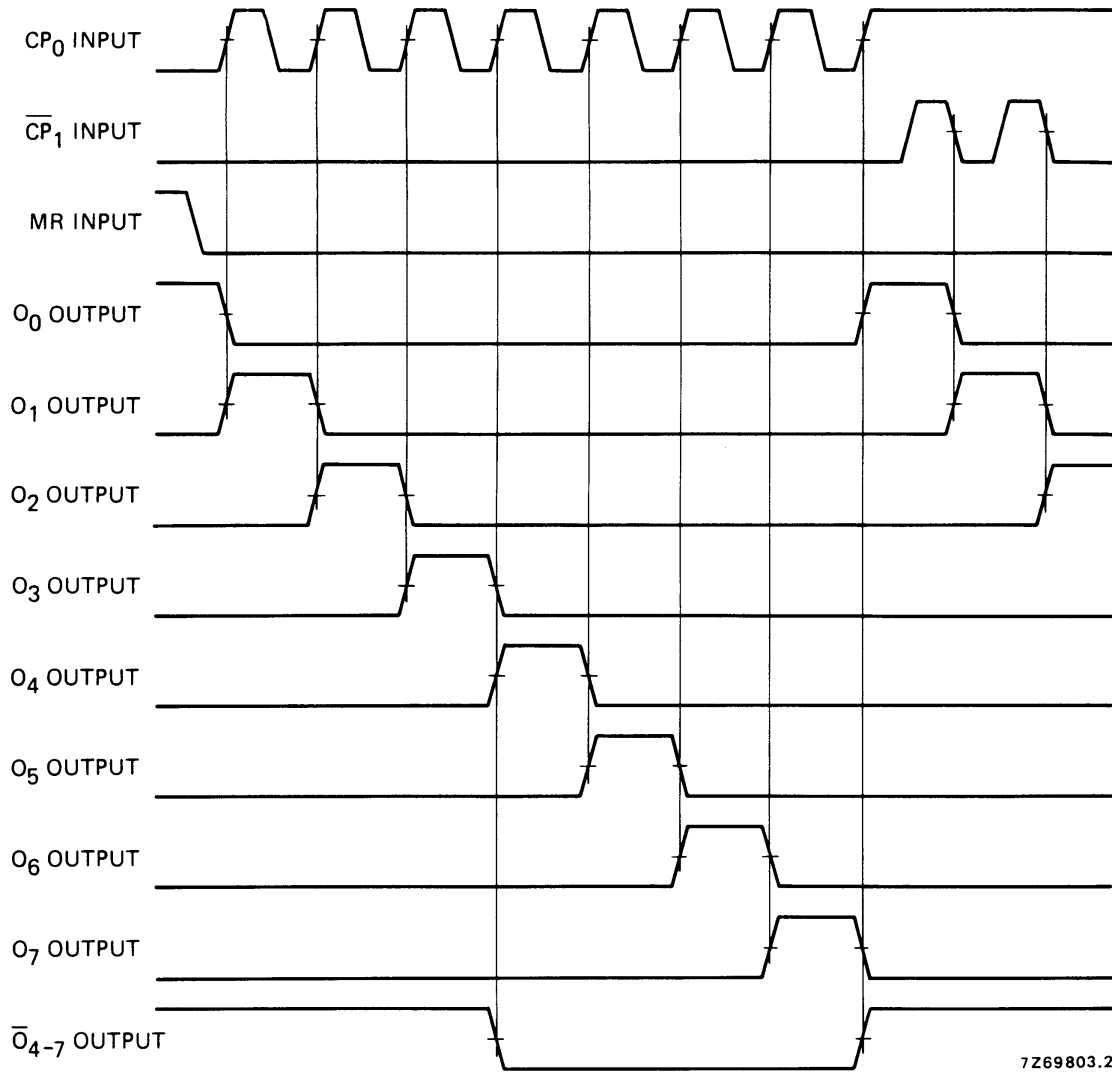


Fig.6 Timing diagram.

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).

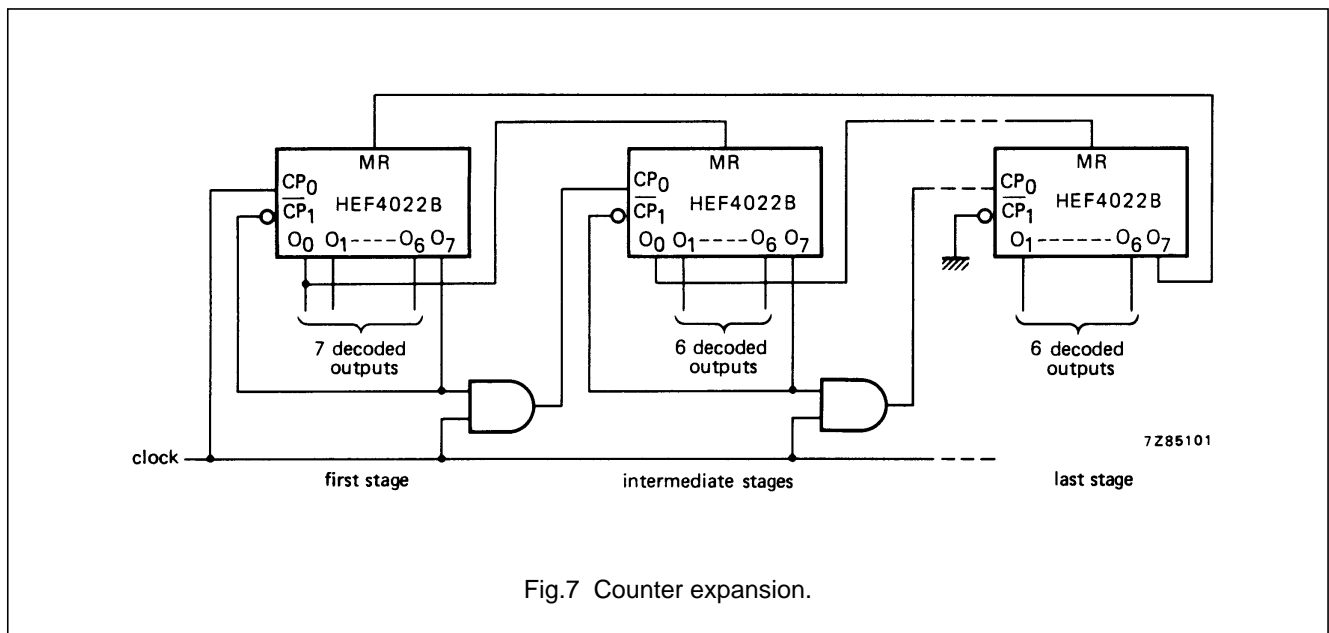


Fig.7 Counter expansion.