

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

HEF40161B

MSI

4-bit synchronous binary counter
with asynchronous reset

Product specification
File under Integrated Circuits, IC04

January 1995

4-bit synchronous binary counter with asynchronous reset

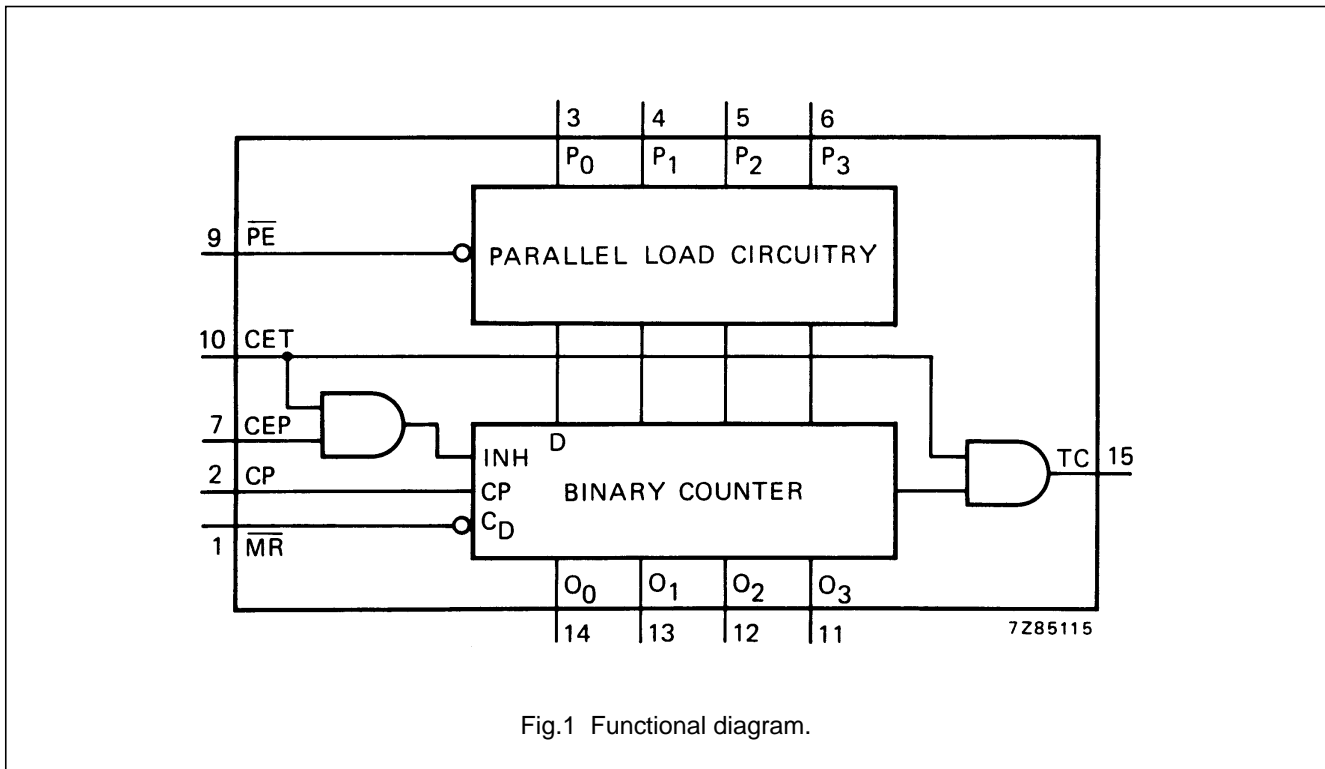
**HEF40161B
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DESCRIPTION

The HEF40161B is a fully synchronous edge-triggered 4-bit binary counter with a clock input (CP), an overriding asynchronous master reset (MR), four parallel data inputs (P₀ to P₃), three synchronous mode control inputs (parallel enable (PE), count enable parallel (CEP) and count enable trickle (CET)), buffered outputs from all four bit positions (O₀ to O₃) and a terminal count output (TC).

Operation is fully synchronous (except for the \overline{MR} input) and occurs on the LOW to HIGH transition of CP. When \overline{PE} is LOW, the next LOW to HIGH transition of CP loads data into the counter from P₀ to P₃ regardless of the levels of CEP and CET inputs.

When \overline{PE} is HIGH, the next LOW to HIGH transition of CP advances the counter to its next state only if both CEP and CET are HIGH; otherwise, no change occurs in the state of the counter. TC is HIGH when the state of the counter is 15 (O₁ to O₃ = HIGH) and when CET is HIGH. A LOW on \overline{MR} sets all outputs (O₀ to O₃ and TC) LOW, independent of the state of all other inputs. Multistage synchronous counting is possible without additional components by using a carry look-ahead counting technique; in this case, TC is used to enable successive cascaded stages. CEP, CET and \overline{PE} must be stable only during the set-up time before the LOW to HIGH transition of CP.

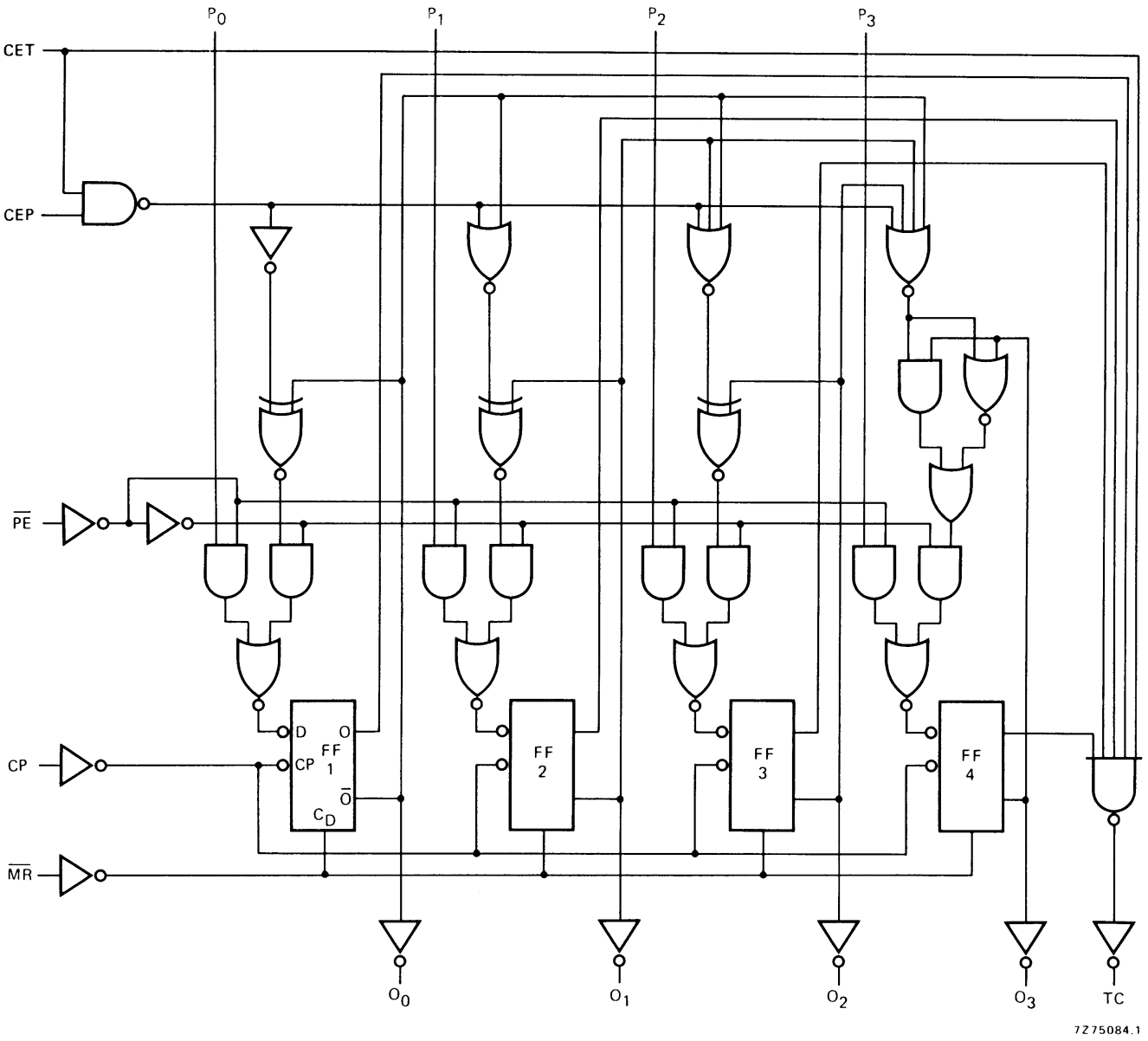


FAMILY DATA, I_{DD} LIMITS category MSI

See Family Specifications

4-bit synchronous binary counter with asynchronous reset

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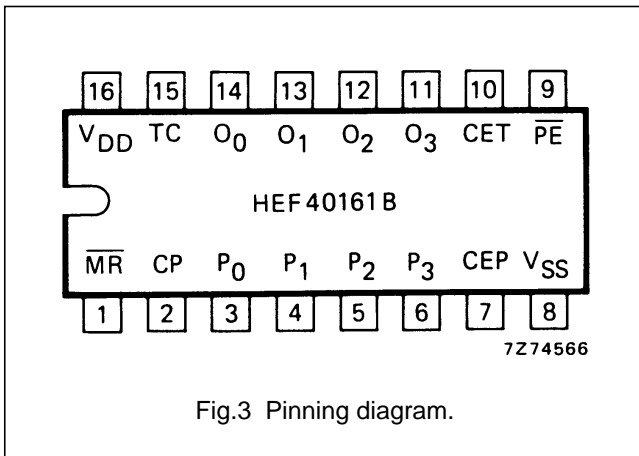


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Fig.2 Logic diagram.

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PINNING

- \overline{PE} parallel enable input
- P_0 to P_3 parallel data inputs
- CEP count enable parallel input
- CET count enable trickle input
- CP clock input (LOW to HIGH, edge-triggered)
- \overline{MR} master reset input (active LOW)
- O_0 to O_3 parallel outputs
- TC terminal count output

HEF40161BP(N): 16-lead DIL; plastic (SOT38-1)
 HEF40161BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)
 HEF40161BT(D): 16-lead SO; plastic (SOT109-1)
 (): Package Designator North America

SYNCHRONOUS MODE SELECTION

\overline{PE}	CEP	CET	MODE
L	X	X	preset
H	L	X	no change
H	X	L	no change
H	H	H	count

Notes

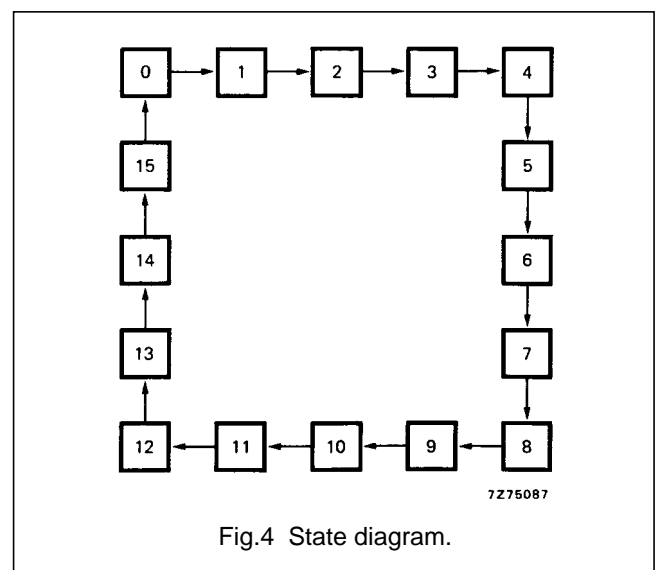
1. \overline{MR} = HIGH
2. H = HIGH state (the more positive voltage)
3. L = LOW state (the less positive voltage)
4. X = state is immaterial

TERMINAL COUNT GENERATION

CET	$(O_0 \cdot O_1 \cdot O_2 \cdot O_3)$	TC
L	L	L
L	H	L
H	L	L
H	H	H

Note

1. $TC = CET \cdot O_0 \cdot O_1 \cdot O_2 \cdot O_3$



4-bit synchronous binary counter with asynchronous reset

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AC CHARACTERISTICS

$V_{SS} = 0$ V; $T_{amb} = 25$ °C; input transition times ≤ 20 ns

	V_{DD} V	TYPICAL FORMULA FOR P (μ W)	
Dynamic power dissipation per package (P)	5	$1\,200 f_i + \sum (f_o C_L) \times V_{DD}^2$	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	$5\,600 f_i + \sum (f_o C_L) \times V_{DD}^2$	
	15	$16\,000 f_i + \sum (f_o C_L) \times V_{DD}^2$	

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 HIGH to LOW	5	t_{PHL}		110	220	ns	$83 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			45	90	ns	$34 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			30	60	ns	$22 \text{ ns} + (0,16 \text{ ns/pF}) C_L$
LOW to HIGH	5	t_{PLH}		115	230	ns	$88 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			45	95	ns	$34 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			35	65	ns	$27 \text{ ns} + (0,16 \text{ ns/pF}) C_L$
CP \rightarrow TC HIGH to LOW	5	t_{PHL}		130	260	ns	$103 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			55	105	ns	$44 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			35	75	ns	$27 \text{ ns} + (0,16 \text{ ns/pF}) C_L$
LOW to HIGH	5	t_{PLH}		140	280	ns	$113 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			55	115	ns	$44 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			40	80	ns	$32 \text{ ns} + (0,16 \text{ ns/pF}) C_L$
CET \rightarrow TC HIGH to LOW	5	t_{PHL}		105	210	ns	$78 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			50	100	ns	$39 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			35	75	ns	$27 \text{ ns} + (0,16 \text{ ns/pF}) C_L$
LOW to HIGH	5	t_{PLH}		90	185	ns	$63 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			35	70	ns	$24 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			25	50	ns	$17 \text{ ns} + (0,16 \text{ ns/pF}) C_L$
$\overline{\text{MR}} \rightarrow$ O _n HIGH to LOW	5	t_{PHL}		120	245	ns	$93 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			50	100	ns	$39 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			35	70	ns	$27 \text{ ns} + (0,16 \text{ ns/pF}) C_L$
$\overline{\text{MR}} \rightarrow$ TC HIGH to LOW	5	t_{PHL}		145	295	ns	$118 \text{ ns} + (0,55 \text{ ns/pF}) C_L$
	10			60	120	ns	$49 \text{ ns} + (0,23 \text{ ns/pF}) C_L$
	15			45	85	ns	$37 \text{ ns} + (0,16 \text{ ns/pF}) C_L$

4-bit synchronous binary counter with asynchronous reset

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	V _{DD} V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA	
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

AC CHARACTERISTICS

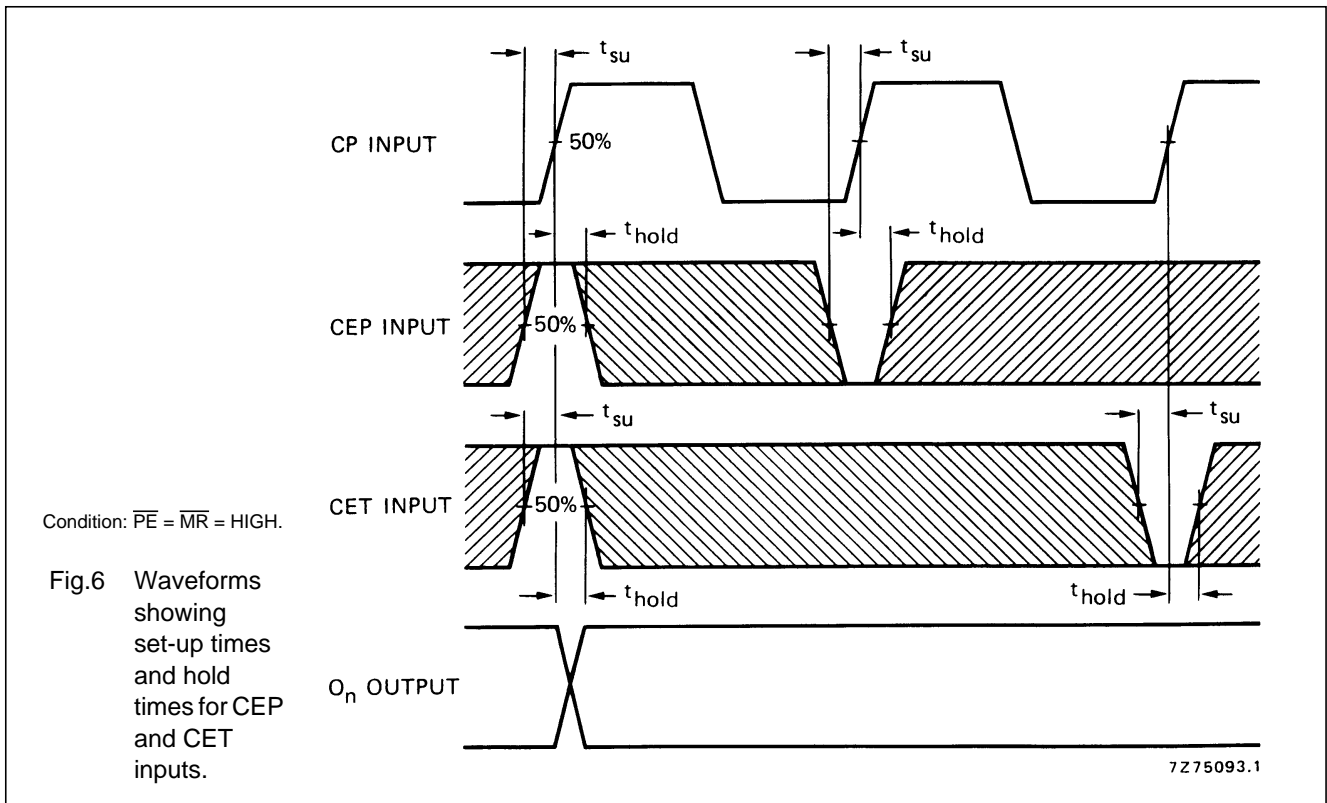
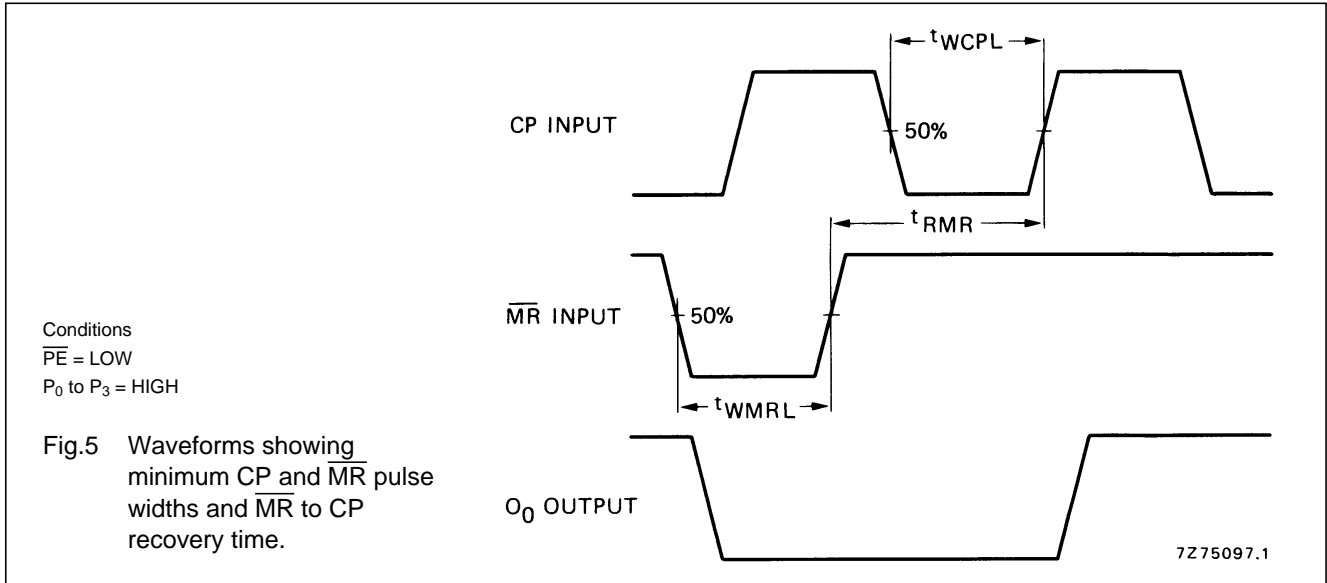
V_{SS} = 0 V; T_{amb} = 25 °C; C_L = 50 pF; input transition times ≤ 20 ns

	V _{DD} V	SYMBOL	MIN.	TYP.	MAX.	
Minimum clock pulse width; LOW	5	t _{WCPL}	100	50	ns	see also waveforms Figs 5, 6, 7 and 8
	10		40	20	ns	
	15		30	15	ns	
Minimum $\overline{\text{MR}}$ pulse width; LOW	5	t _{WMRL}	100	50	ns	
	10		40	20	ns	
	15		30	15	ns	
Recovery time for $\overline{\text{MR}}$	5	t _{RMR}	25	0	ns	
	10		15	0	ns	
	15		10	0	ns	
Set-up times P _n → CP	5	t _{su}	110	55	ns	
	10		40	20	ns	
	15		30	15	ns	
$\overline{\text{PE}}$ → CP	5	t _{su}	120	60	ns	
	10		40	20	ns	
	15		25	10	ns	
CEP, CET → CP	5	t _{su}	260	130	ns	
	10		100	50	ns	
	15		70	35	ns	
Hold times P _n → CP	5	t _{hold}	20	-35	ns	
	10		10	-10	ns	
	15		5	-10	ns	
$\overline{\text{PE}}$ → CP	5	t _{hold}	15	-45	ns	
	10		5	-15	ns	
	15		5	-10	ns	
CEP, CET → CP	5	t _{hold}	25	-105	ns	
	10		15	-35	ns	
	15		10	-25	ns	

4-bit synchronous binary counter with asynchronous reset

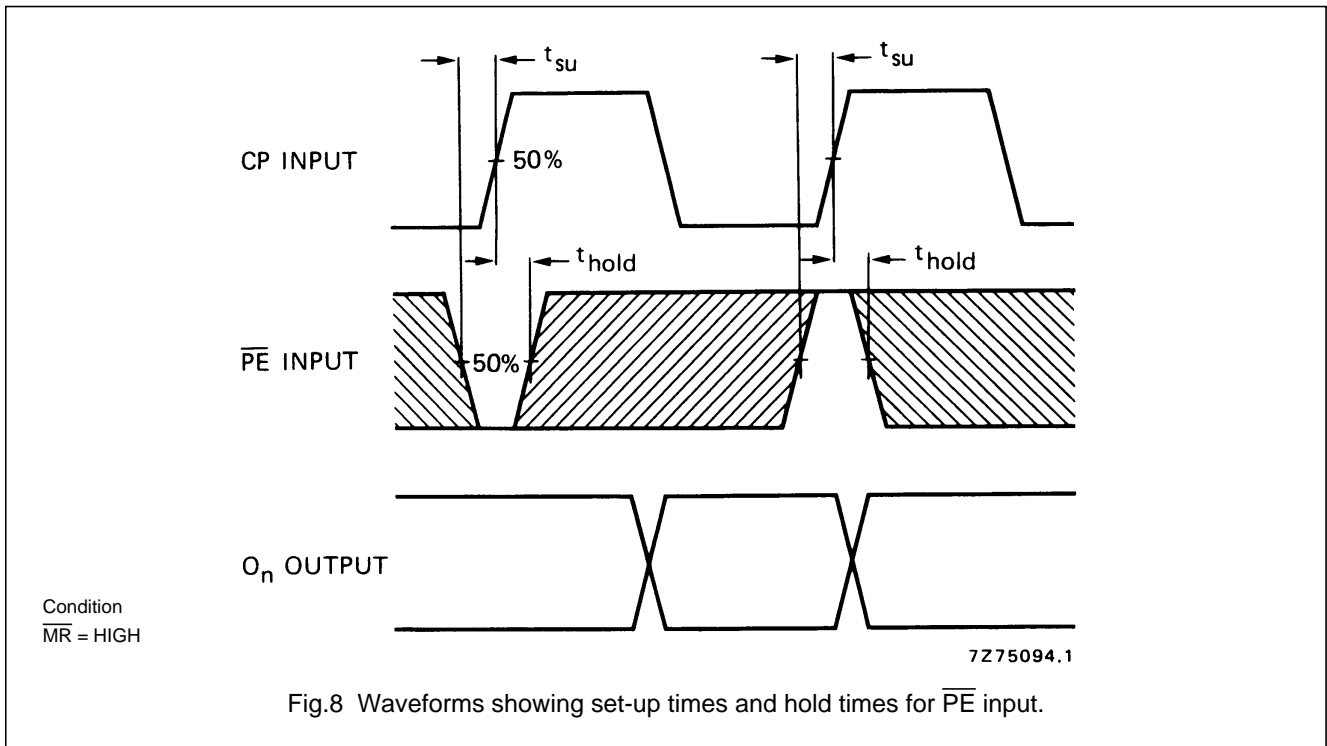
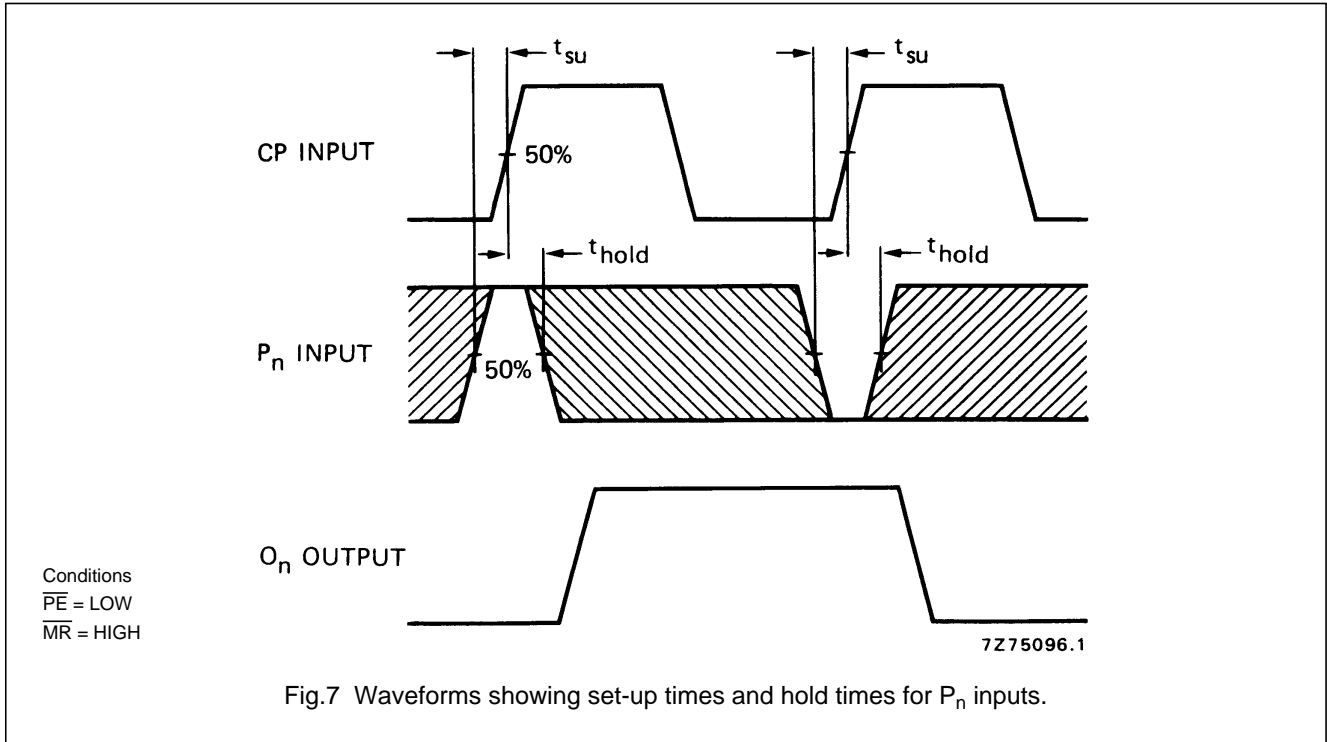
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	V _{DD} V	SYMBOL	MIN.	TYP.	MAX.	
Maximum clock pulse frequency	5	f _{max}	2,5	5	MHz	
	10		7	14	MHz	
	15		9	18	MHz	



4-bit synchronous binary counter with asynchronous reset

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Note

Set-up and hold times are shown as positive values but may be specified as negative values.

4-bit synchronous binary counter with asynchronous reset

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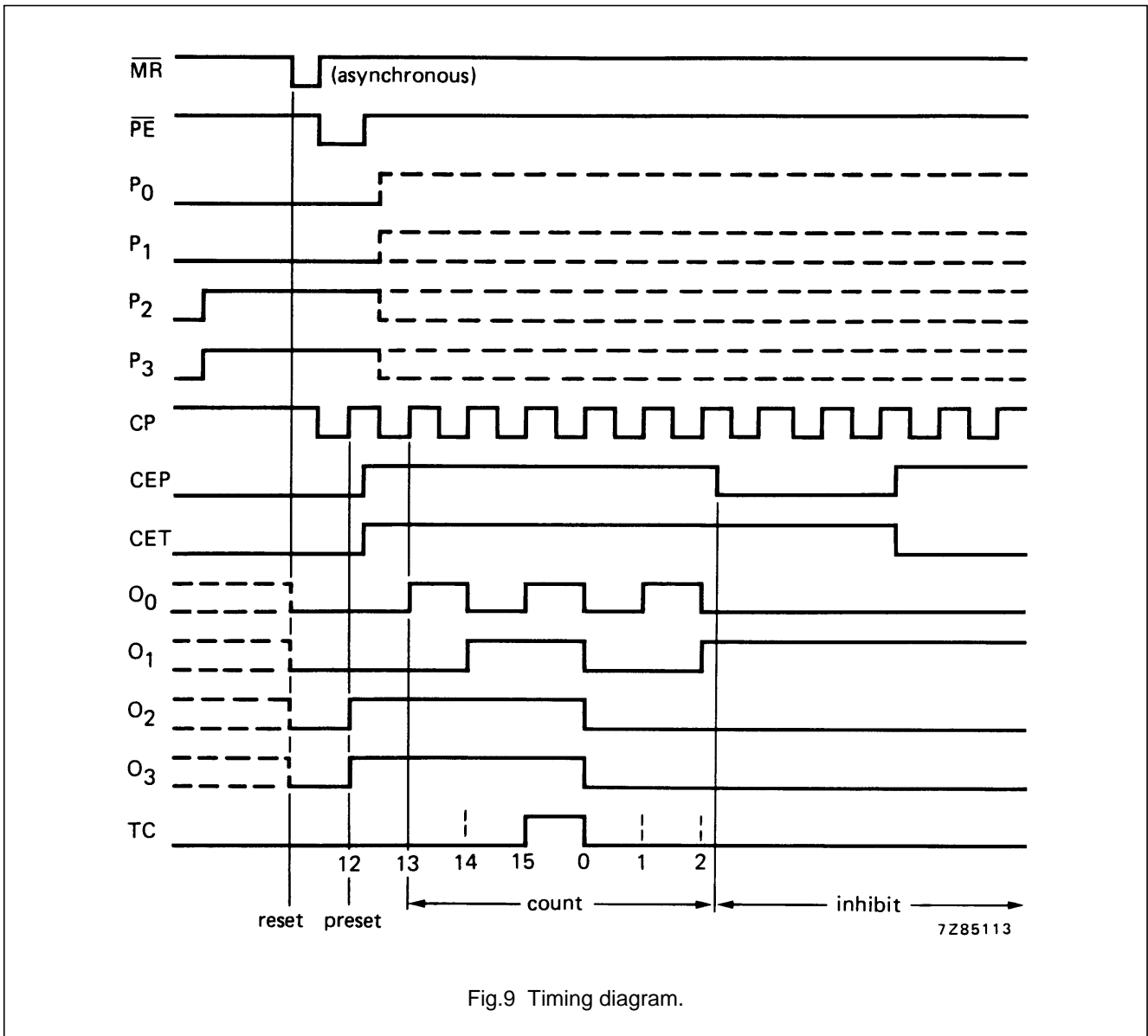


Fig.9 Timing diagram.

APPLICATION INFORMATION

An example of an application for the HEF40161B is:

- Programmable binary counter.

4-bit synchronous binary counter with asynchronous reset

HEF40161B
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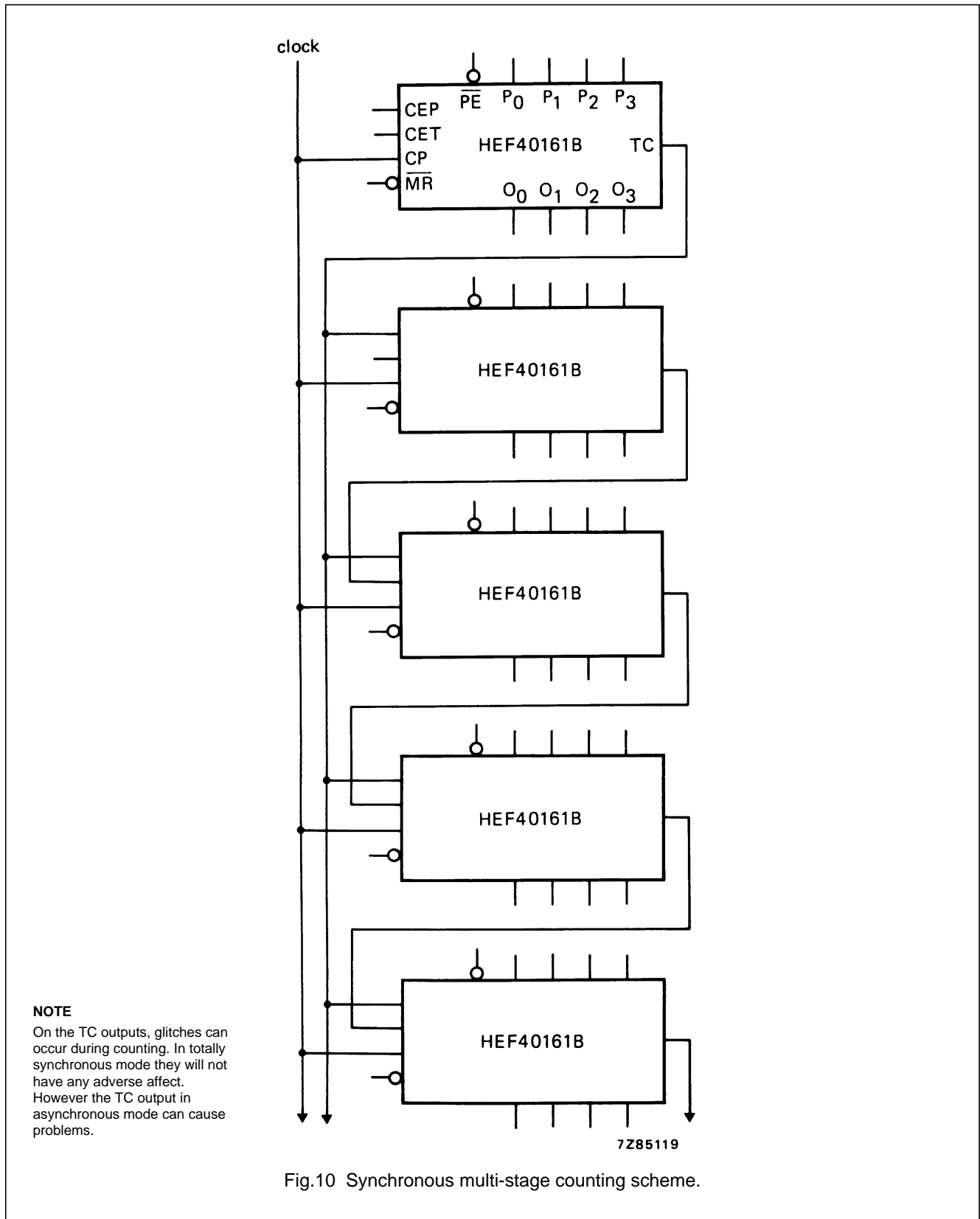


Fig.10 Synchronous multi-stage counting scheme.