

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

HEF40163B

MSI

4-bit synchronous binary counter
with synchronous reset

Product specification
File under Integrated Circuits, IC04

January 1995

4-bit synchronous binary counter with synchronous reset

**HEF40163B
MSI**

DESCRIPTION

The HEF40163B is a fully synchronous edge-triggered 4-bit binary counter with a clock input (CP), four synchronous parallel data inputs (P₀ to P₃), four synchronous mode control inputs (parallel enable (\overline{PE}), count enable parallel (CEP), count enable trickle (CET) and synchronous reset (\overline{SR})), buffered outputs from all four bit positions (O₀ to O₃) and a terminal count output (TC).

Operation is fully synchronous 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. 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 (O₀ to O₃ = HIGH) and when CET is HIGH. A LOW on \overline{SR} sets all outputs (O₀ to O₃ and TC) LOW on the next LOW to HIGH transition of CP, independent of the state of all other synchronous mode control inputs (CEP, CET and \overline{PE}). 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, \overline{PE} and \overline{SR} must be stable only during the set-up time before the LOW to HIGH transition of CP.

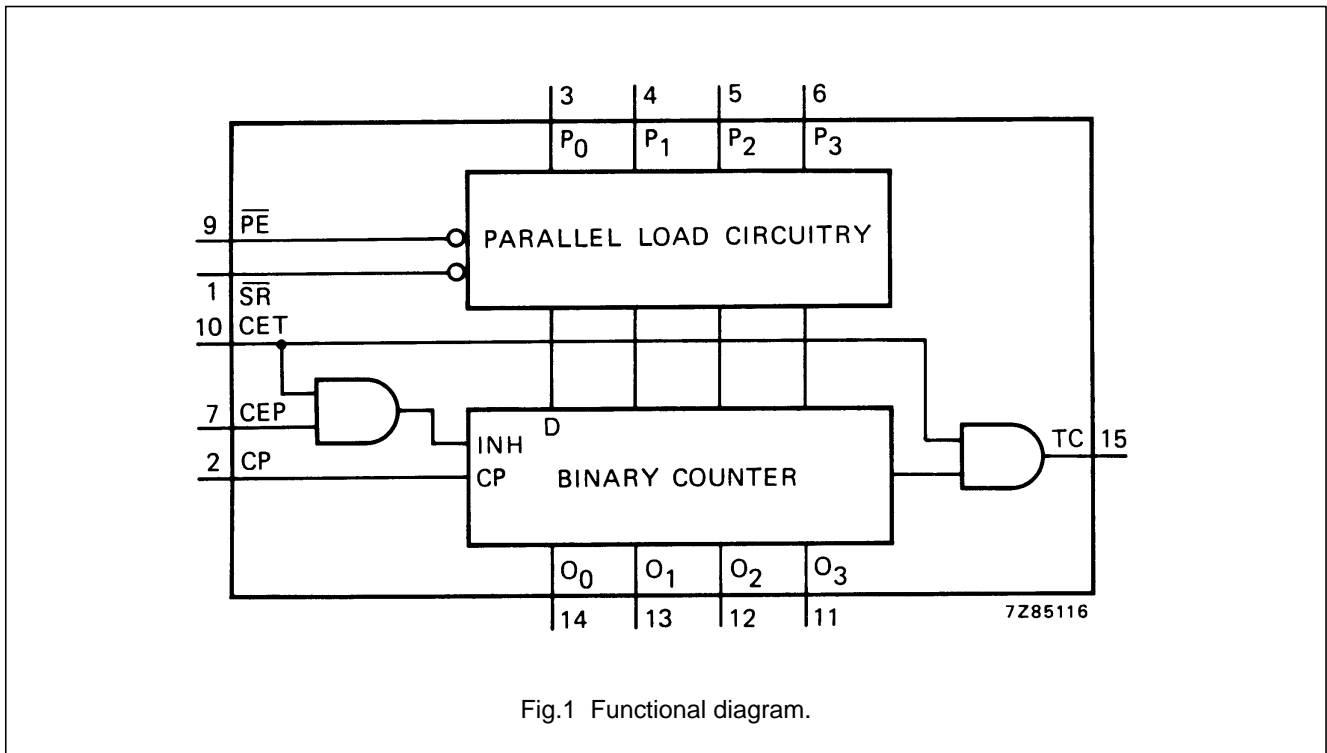


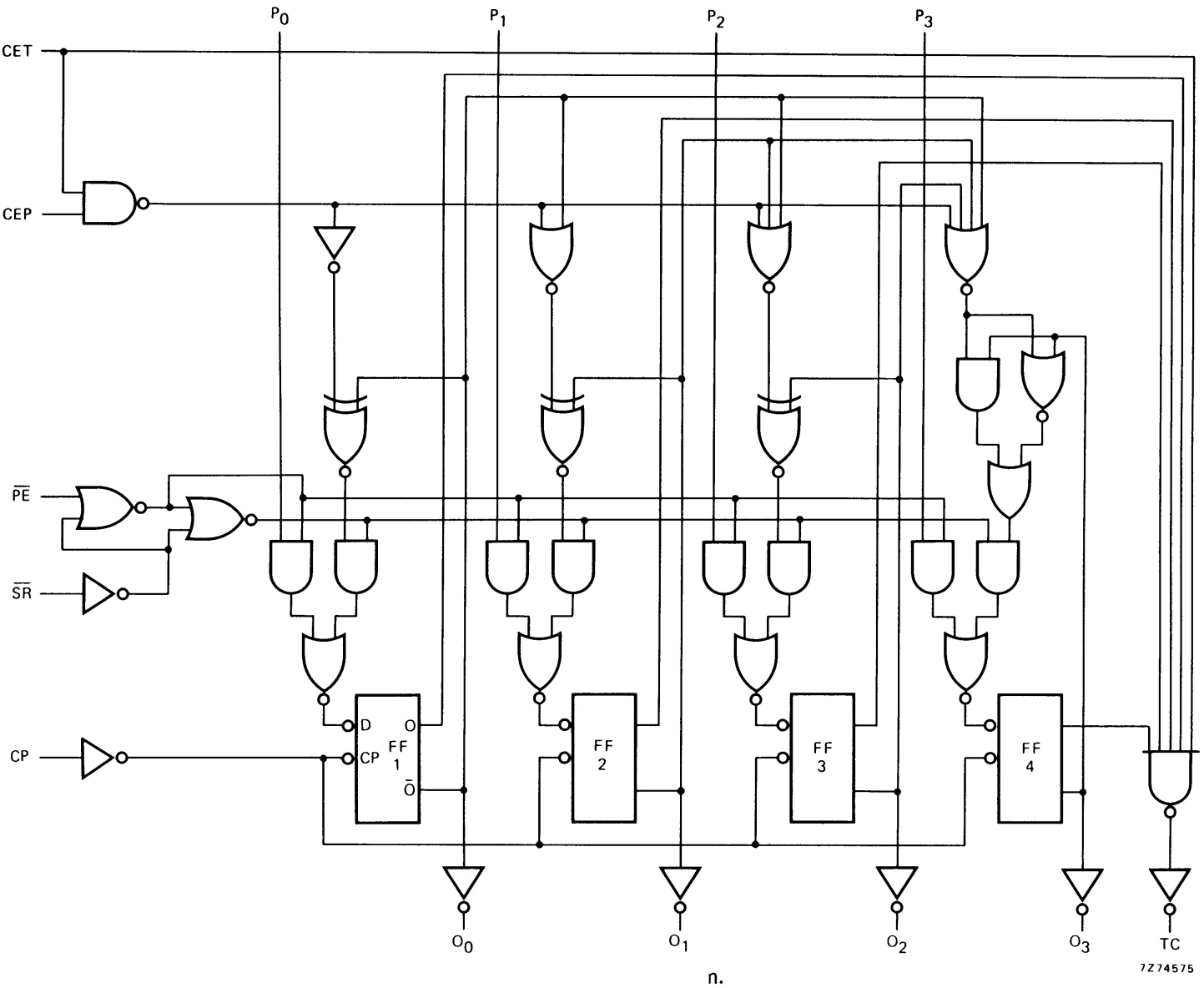
Fig.1 Functional diagram.

FAMILY DATA, I_{DD} LIMITS category MSI

See Family Specifications

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Fig.2 Logic diagram.

4-bit synchronous binary counter with synchronous reset

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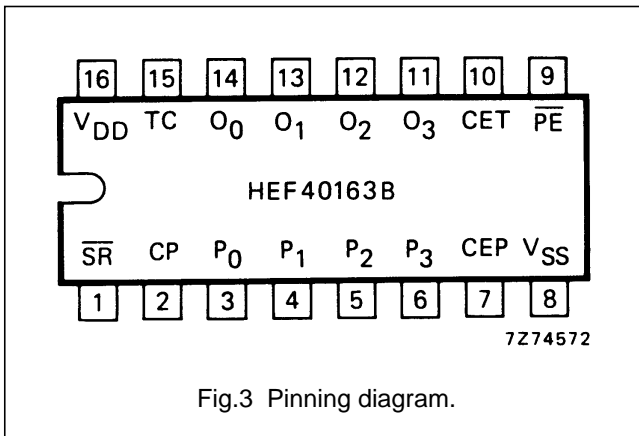


Fig.3 Pinning diagram.

PINNING

- \overline{PE} parallel enable input
- P₀ to P₃ parallel data inputs
- CEP count enable parallel input
- CET count enable trickle input
- CP clock input (LOW to HIGH, edge-triggered)
- \overline{SR} synchronous reset input (active LOW)
- O₀ to O₃ parallel outputs
- TC terminal count output

HEF40163BP(N): 16-lead DIL; plastic (SOT38-1)

HEF40163BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)

HEF40163BT(D): 16-lead SO; plastic (SOT109-1)

(): Package Designator North America

SYNCHRONOUS MODE SELECTION

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

Notes

- H = HIGH state (the more positive voltage)
- L = LOW state (the less positive voltage)
- X = state is immaterial

TERMINAL COUNT GENERATION

CET	(O ₀ · O ₁ · O ₂ · O ₃)	TC
L	L	L
L	H	L
H	L	L
H	H	H

Note

- TC = CET · O₀ · O₁ · O₂ · O₃

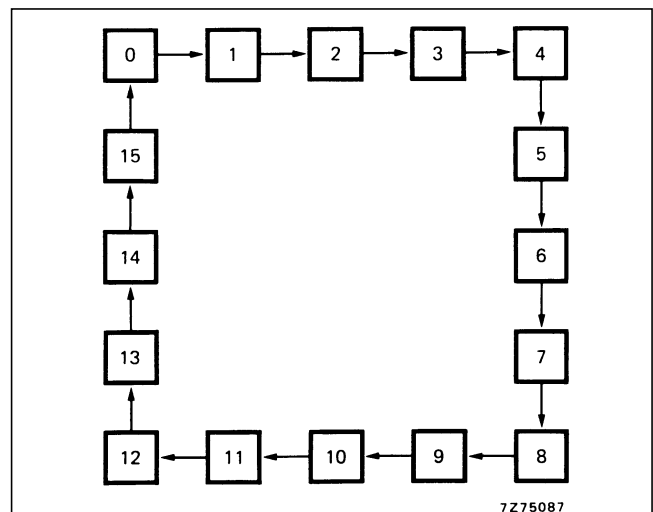


Fig.4 State diagram.

4-bit synchronous binary counter with synchronous reset

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AC CHARACTERISTICS

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

	V_{DD} V	TYPICAL FORMULA FOR P (μW)	
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

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

	V_{DD} V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA	
Propagation delays CP \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	$17\text{ ns} + (0,16\text{ ns/pF}) C_L$
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	$6\text{ ns} + (0,28\text{ ns/pF}) C_L$

4-bit synchronous binary counter with
synchronous reset

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AC CHARACTERISTICS

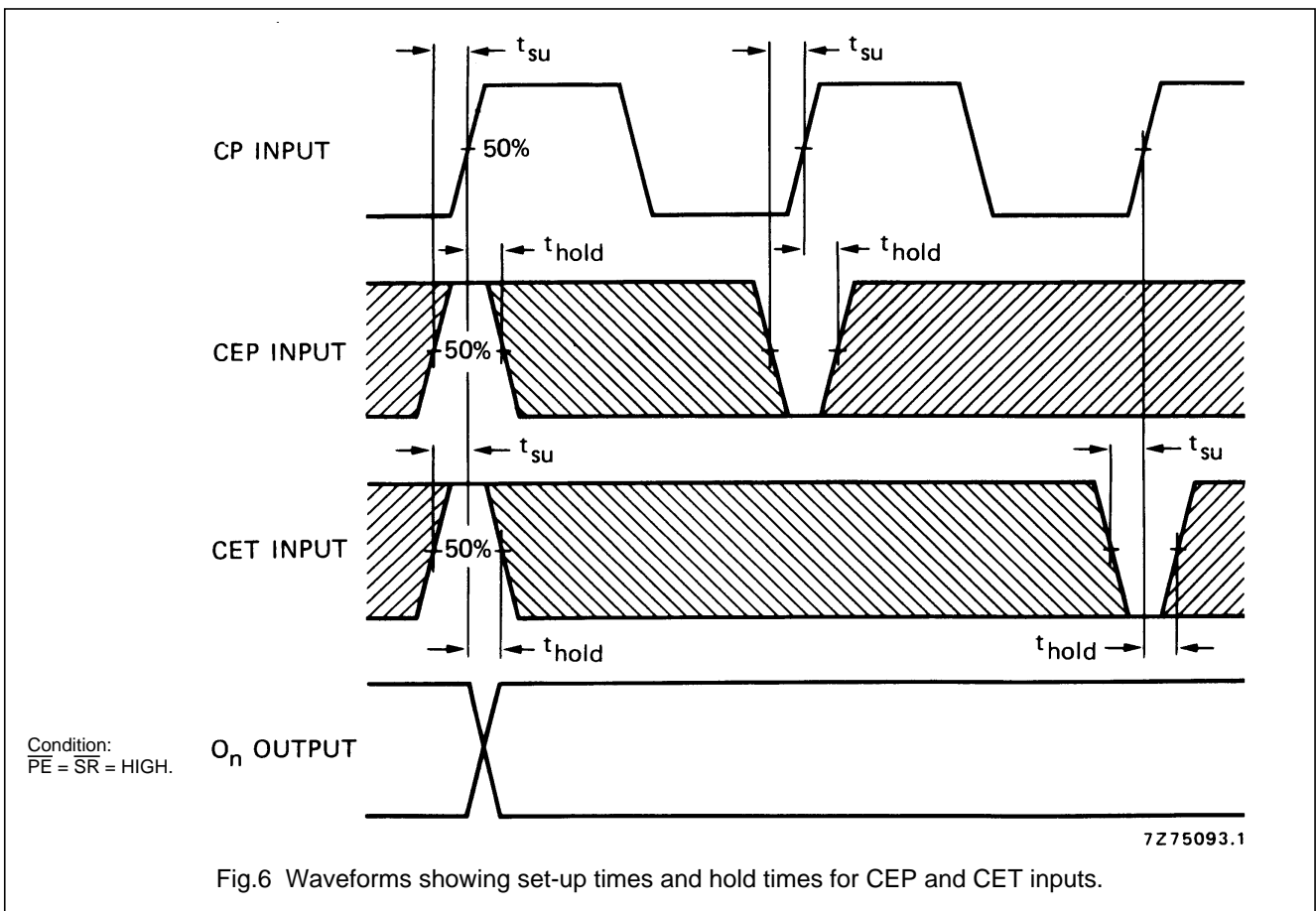
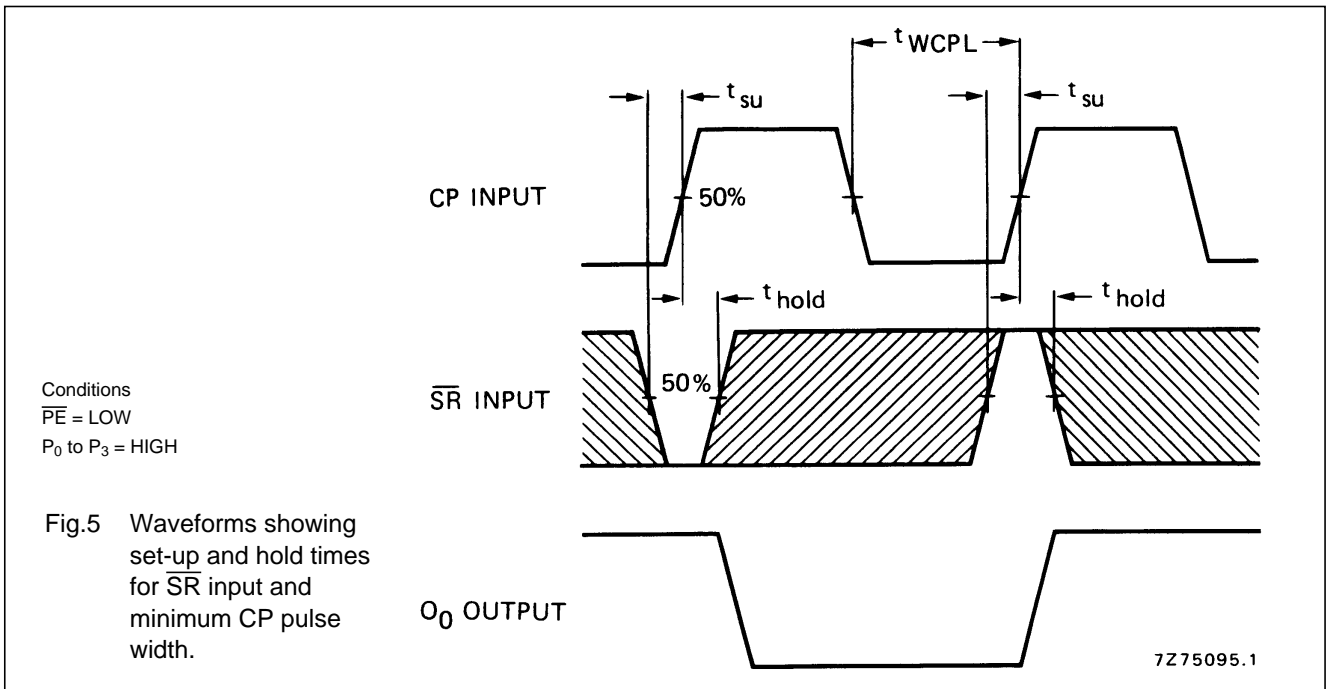
$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$; $C_L = 50\text{ pF}$; input transition times $\leq 20\text{ ns}$

	V_{DD} V	SYMBOL	MIN.	TYP.	MAX.
Minimum clock pulse width; LOW	5	t_{WCPL}	100	50	ns
	10		40	20	ns
	15		30	15	ns
Set-up times $P_n \rightarrow CP$	5	t_{su}	110	55	ns
	10		40	20	ns
	15		30	15	ns
$\overline{PE} \rightarrow CP$	5	t_{su}	120	60	ns
	10		40	20	ns
	15		25	10	ns
CEP, CET \rightarrow CP	5	t_{su}	260	130	ns
	10		100	50	ns
	15		70	35	ns
$\overline{SR} \rightarrow CP$	5	t_{su}	50	25	ns
	10		20	10	ns
	15		15	10	ns
Hold times $P_n \rightarrow CP$	5	t_{hold}	20	-35	ns
	10		10	-10	ns
	15		5	-10	ns
$\overline{PE} \rightarrow CP$	5	t_{hold}	15	-45	ns
	10		5	-15	ns
	15		5	-10	ns
CEP, CET \rightarrow CP	5	t_{hold}	25	-105	ns
	10		15	-35	ns
	15		10	-25	ns
$\overline{SR} \rightarrow CP$	5	t_{hold}	15	-10	ns
	10		5	-5	ns
	15		5	0	ns
Maximum clock pulse frequency	5	f_{max}	2,5	5	MHz
	10		7	14	MHz
	15		9	18	MHz

see also waveforms
Figs 5, 6, 7 and 8

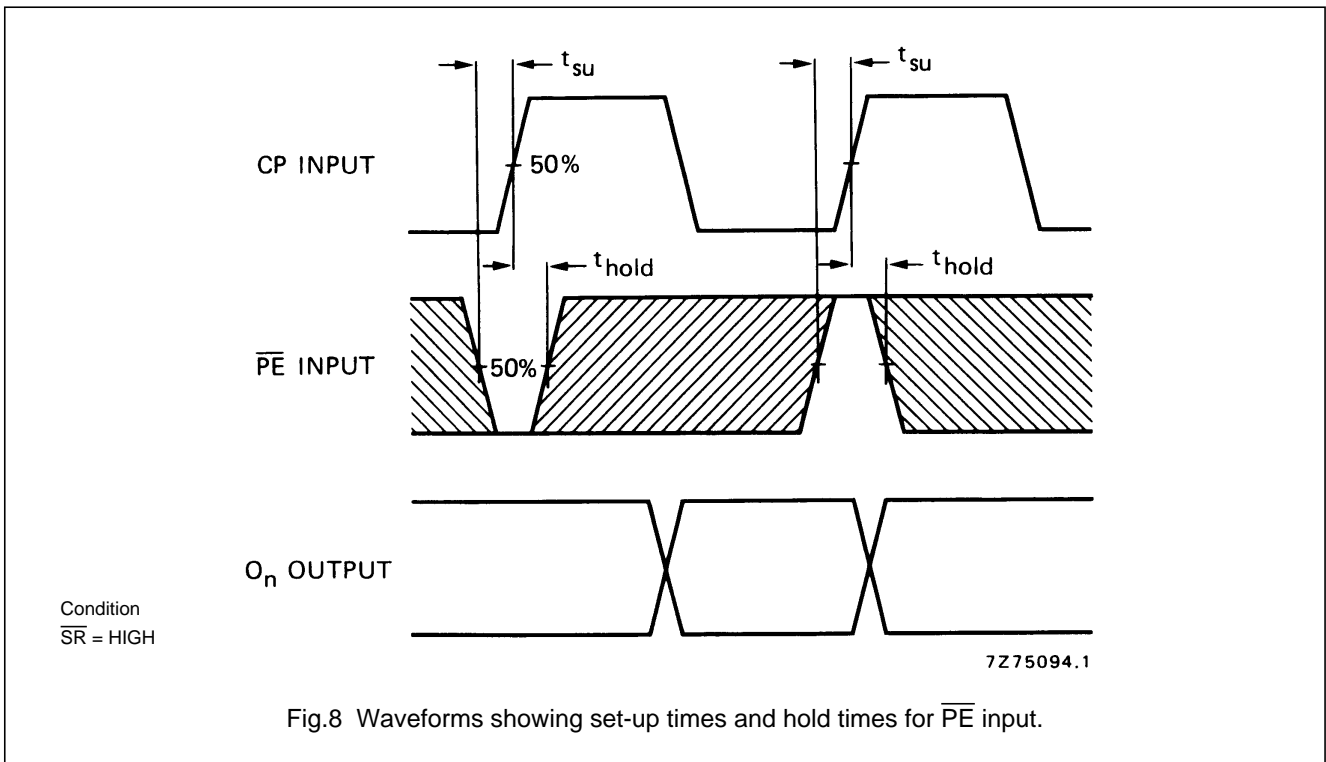
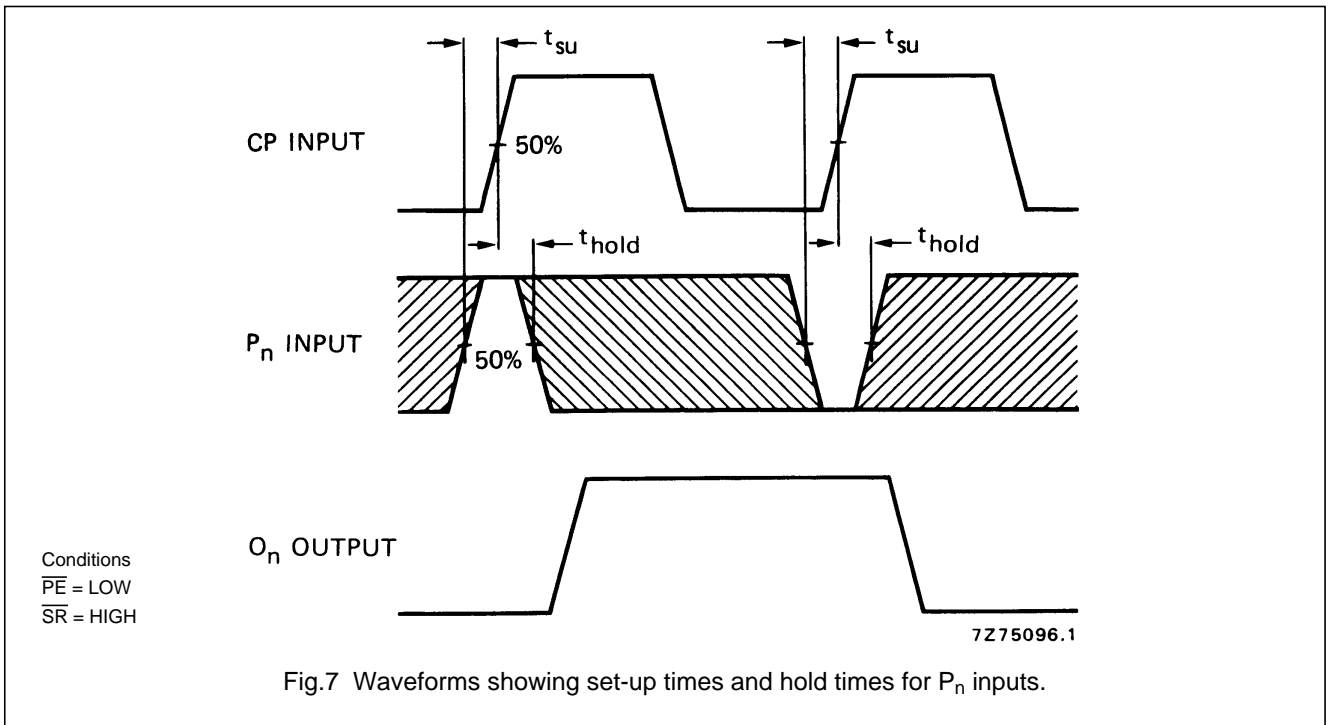
4-bit synchronous binary counter with synchronous reset

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4-bit synchronous binary counter with
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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
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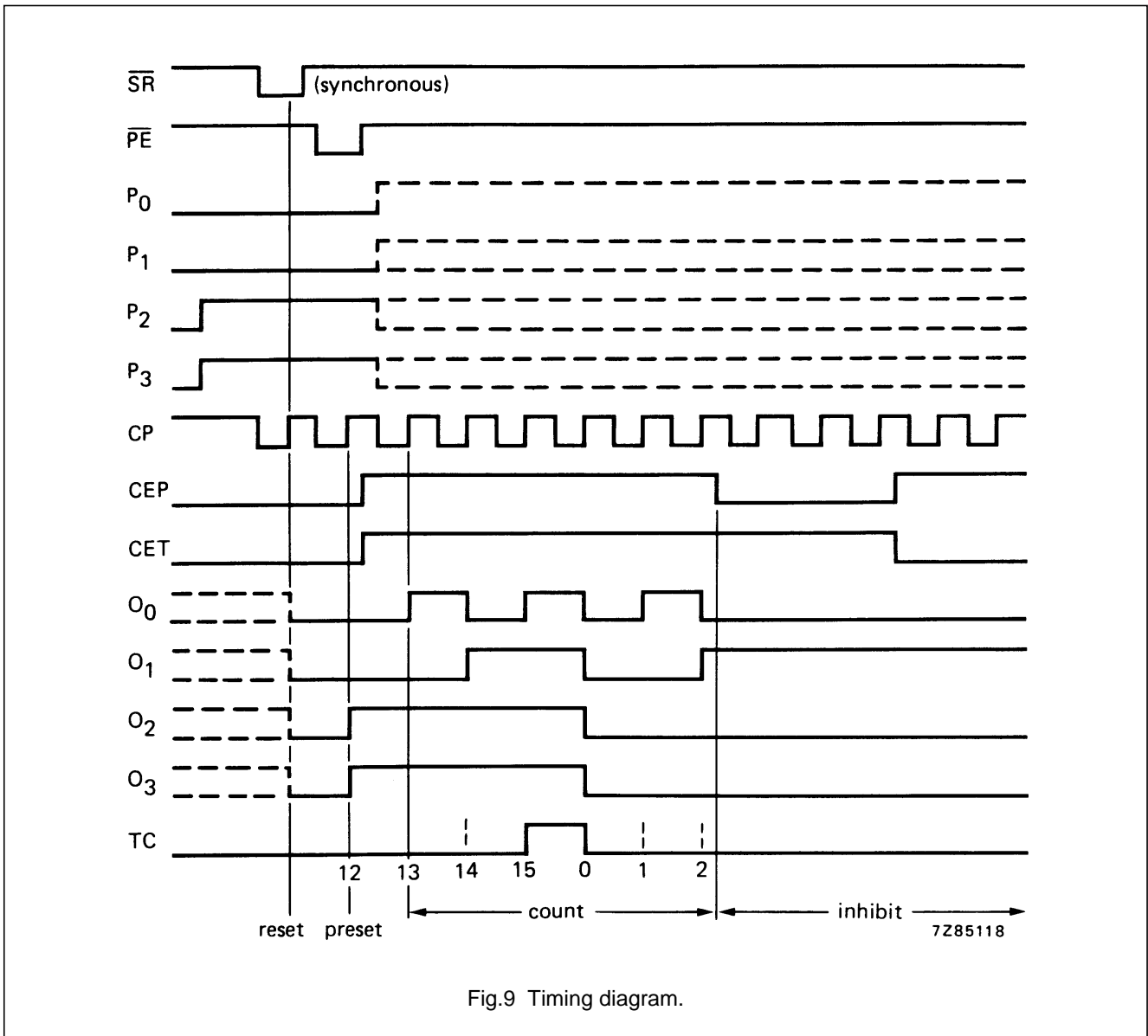


Fig.9 Timing diagram.

APPLICATION INFORMATION

An example of an application for the HEF40163B is:

- Programmable binary counter.

4-bit synchronous binary counter with synchronous reset

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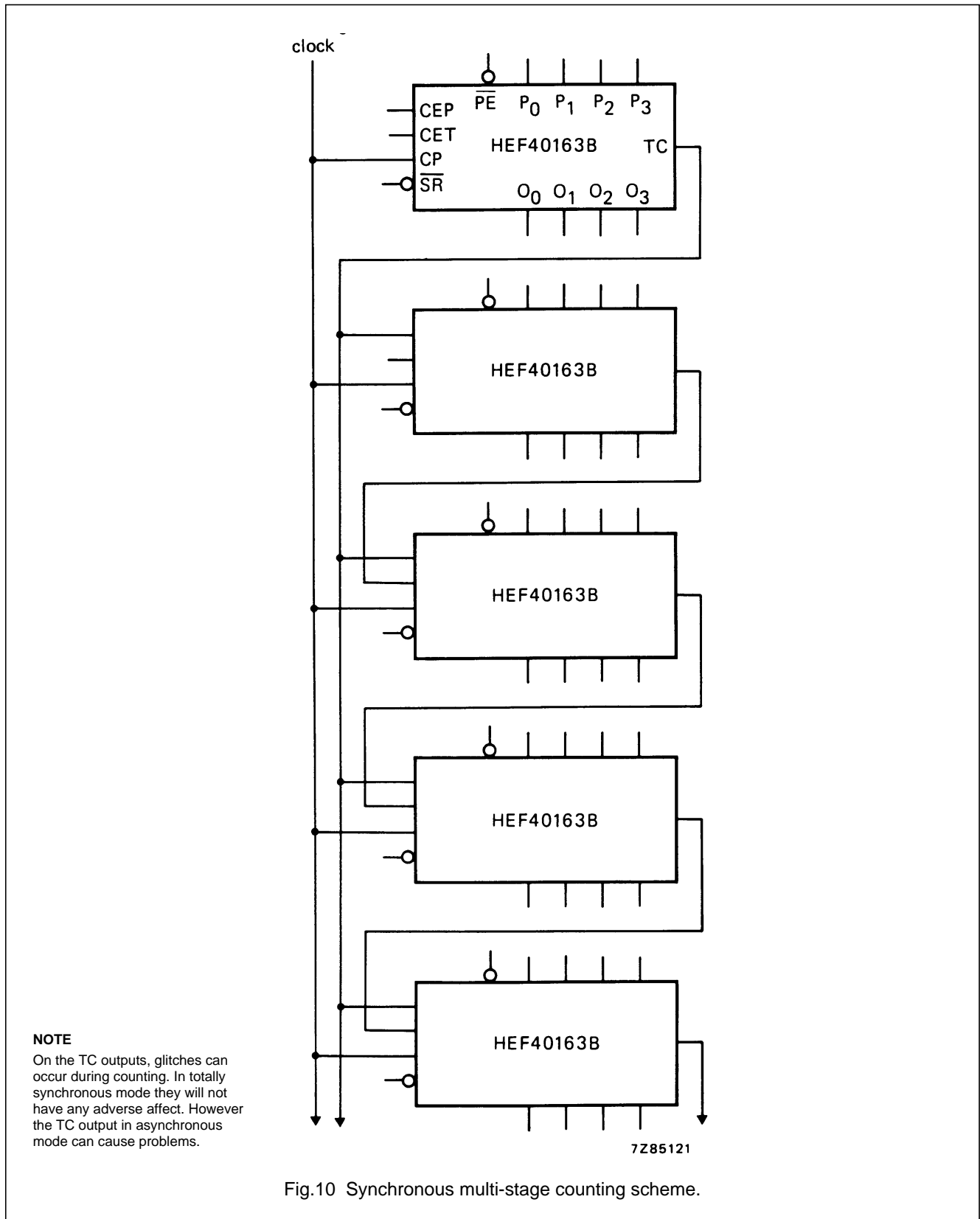


Fig.10 Synchronous multi-stage counting scheme.