

# 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

## **HEF40192B**

### **MSI**

## **4-bit up/down decade counter**

Product specification  
File under Integrated Circuits, IC04

January 1995

# 4-bit up/down decade counter

# HEF40192B MSI

### DESCRIPTION

The HEF40192B is a 4-bit synchronous up/down decade counter. The counter has a count-up clock input (CP<sub>U</sub>), a count-down clock input (CP<sub>D</sub>), an asynchronous parallel load input ( $\overline{PL}$ ), four parallel data inputs (P<sub>0</sub> to P<sub>3</sub>), an asynchronous master reset input (MR), four counter outputs (O<sub>0</sub> to O<sub>3</sub>), an active LOW terminal count-up (carry) output ( $\overline{TC}_U$ ) and an active LOW terminal count-down (borrow) output ( $\overline{TC}_D$ ).

The counter outputs change state on the LOW to HIGH transition of either clock input. However, for correct

counting, both clock inputs cannot be LOW simultaneously. The outputs  $\overline{TC}_U$  and  $\overline{TC}_D$  are normally HIGH. When the circuit has reached the maximum count state of '9', the next HIGH to LOW transition of CP<sub>U</sub> will cause  $\overline{TC}_U$  to go LOW.  $\overline{TC}_U$  will stay LOW until CP<sub>U</sub> goes HIGH again. Likewise, output  $\overline{TC}_D$  will go LOW when the circuit is in the zero state and CP<sub>D</sub> goes LOW. When  $\overline{PL}$  is LOW, the information on P<sub>0</sub> to P<sub>3</sub> is asynchronously loaded into the counter. A HIGH on MR resets the counter independent of all other input conditions. The counter stages are of a static toggle type flip-flop.

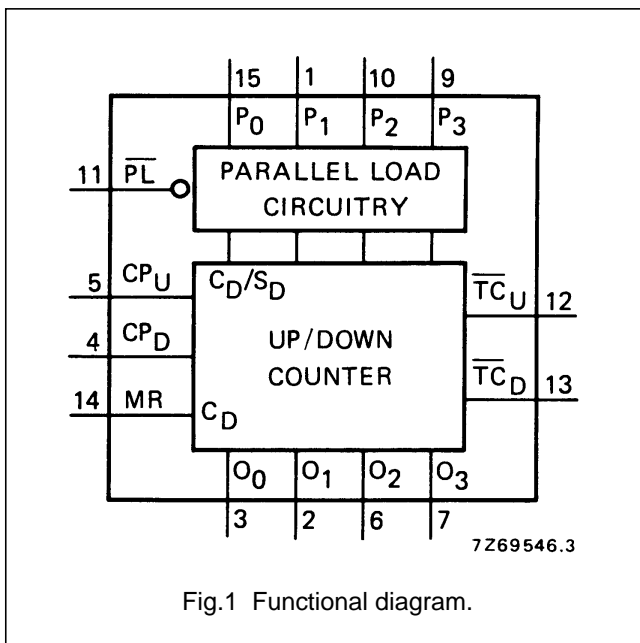


Fig.1 Functional diagram.

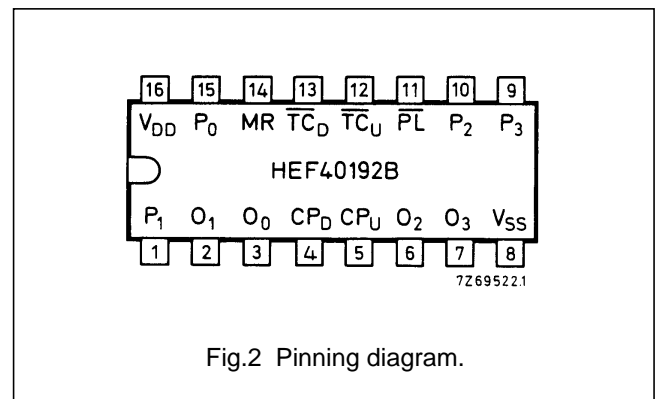


Fig.2 Pinning diagram.

### PINNING

- $\overline{PL}$  parallel load input (active LOW)
- P<sub>0</sub> to P<sub>3</sub> parallel data inputs
- CP<sub>U</sub> count-up clock pulse input (LOW to HIGH, edge-triggered)
- CP<sub>D</sub> count-down clock pulse input (LOW to HIGH, edge-triggered)
- MR master reset input (asynchronous)
- $\overline{TC}_U$  buffered terminal count-up (carry) output (active LOW)
- $\overline{TC}_D$  buffered terminal count-down (borrow) output (active LOW)
- O<sub>0</sub> to O<sub>3</sub> buffered counter outputs

- HEF40192BP(N): 16-lead DIL; plastic (SOT38-1)
- HEF40192BD(F): 16-lead DIL; ceramic (cerdip) (SOT74)
- HEF40192BT(D): 16-lead SO; plastic (SOT109-1)
- ( ): Package Designator North America

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

See Family Specifications

4-bit up/down decade counter

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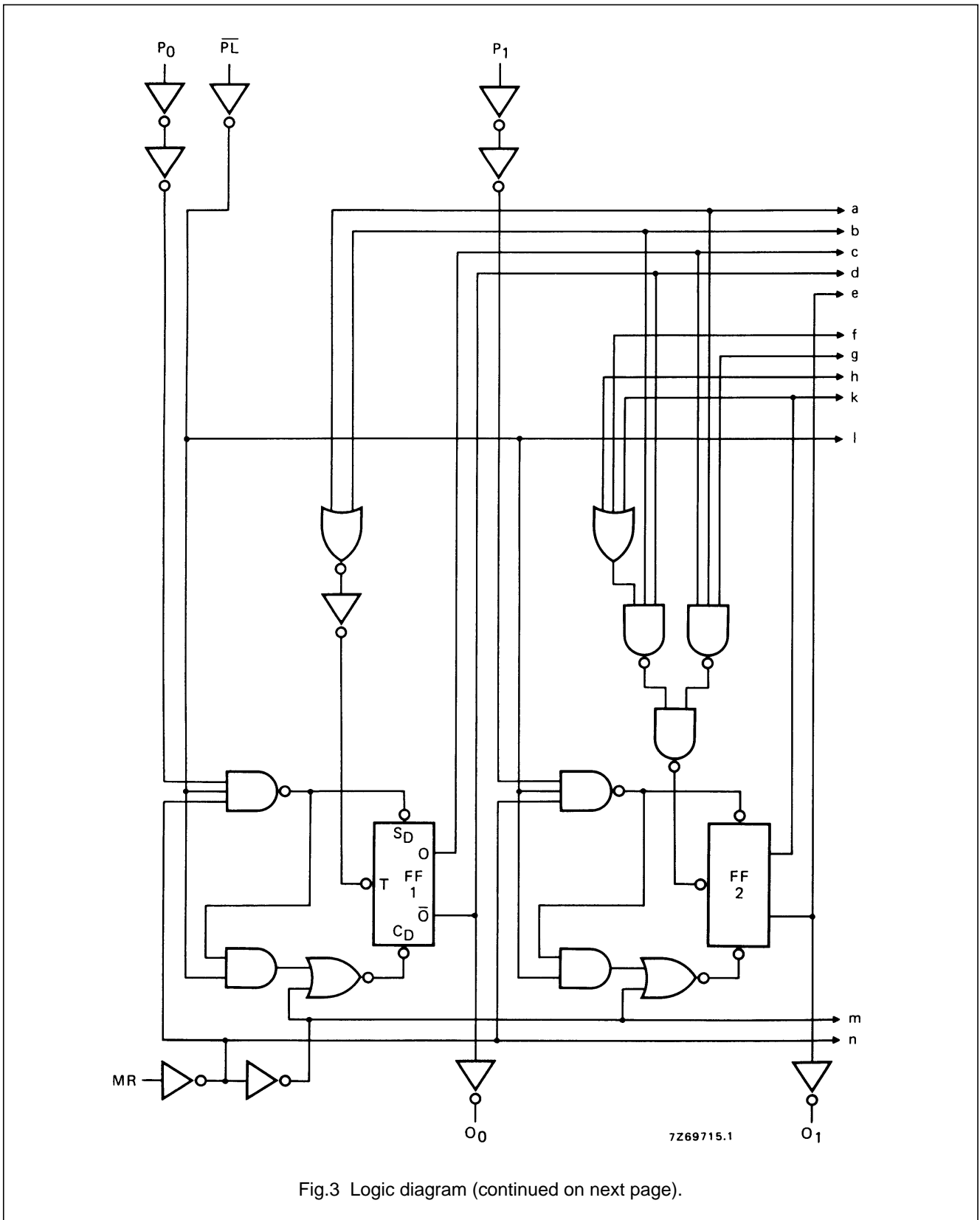


Fig.3 Logic diagram (continued on next page).

4-bit up/down decade counter

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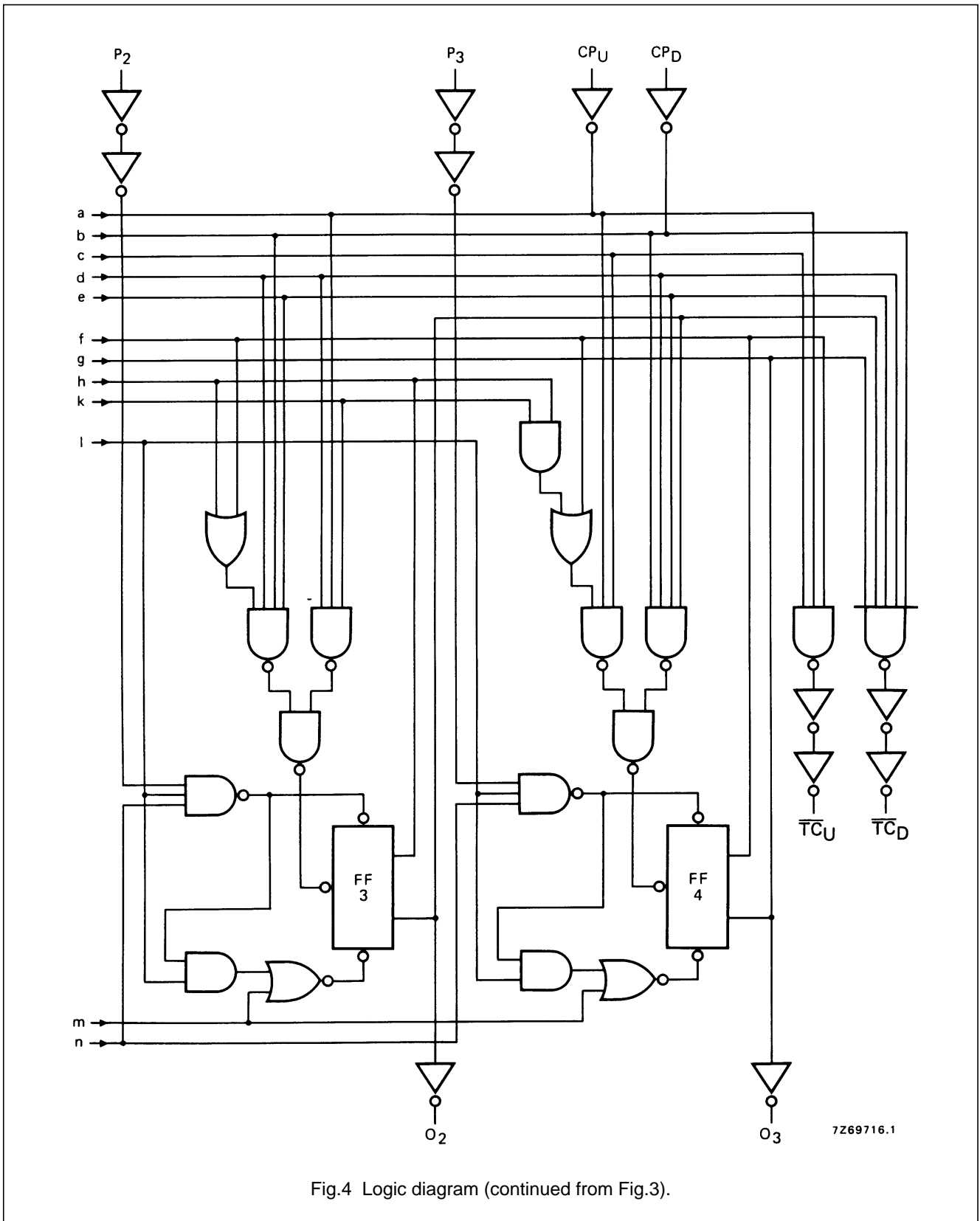




Fig.4 Logic diagram (continued from Fig.3).

4-bit up/down decade counter


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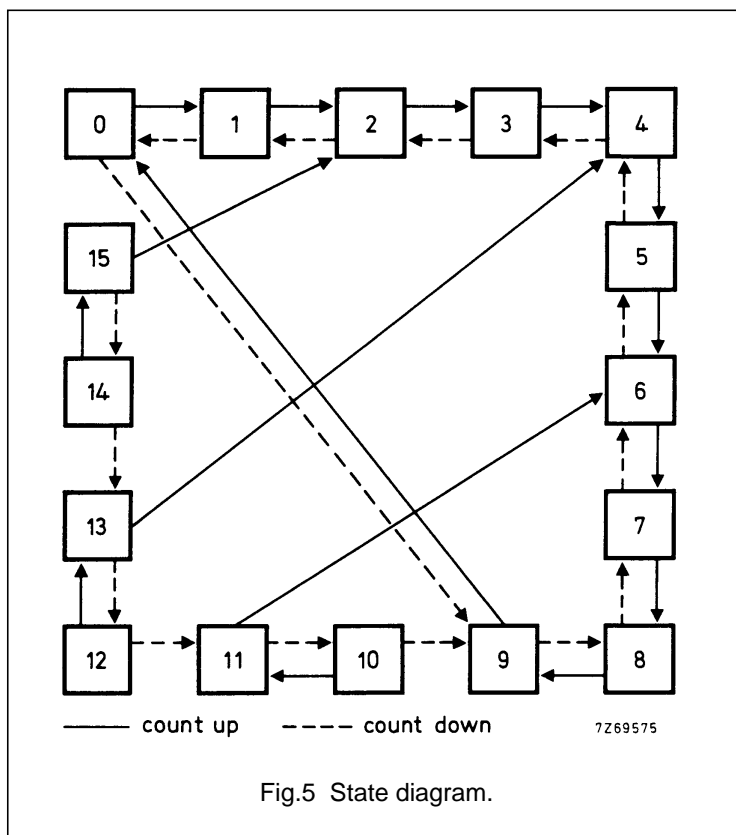
FUNCTION TABLE

MR	$\overline{PL}$	CP <sub>U</sub>	CP <sub>D</sub>	MODE
H	X	X	X	reset (asyn.)
L	L	X	X	parallel load
L	H		H	count-up
L	H	H		count-down

Notes

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

 = positive-going transition



Logic equations for terminal count:

$$\overline{TC}_D = \overline{O_0} \cdot \overline{O_1} \cdot \overline{O_2} \cdot \overline{O_3} \cdot \overline{CP}_D$$

$$\overline{TC}_U = \overline{O_0} \cdot \overline{O_3} \cdot \overline{CP}_U$$

AC CHARACTERISTICS

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

	V <sub>DD</sub> V	TYPICAL FORMULA FOR P (μW)	
Dynamic power dissipation per package (P)	5 10 15	550 f <sub>i</sub> + Σ(f <sub>o</sub> C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup> 2400 f <sub>i</sub> + Σ(f <sub>o</sub> C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup> 6500 f <sub>i</sub> + Σ(f <sub>o</sub> C <sub>L</sub> ) × V <sub>DD</sub> <sup>2</sup>	where f <sub>i</sub> = input freq. (MHz) f <sub>o</sub> = output freq. (MHz) C <sub>L</sub> = load capacitance (pF) Σ (f <sub>o</sub> C <sub>L</sub> ) = sum of outputs V <sub>DD</sub> = supply voltage (V)

## 4-bit up/down decade counter

HEF40192B  
MSI**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.	TYPICAL EXTRAPOLATION FORMULA		
Propagation delays $CP_U \rightarrow O_n$ HIGH to LOW	5	$t_{PHL}$		210	415	ns	$183\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			85	165	ns	$74\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			60	120	ns	$52\text{ ns} + (0,16\text{ ns/pF}) C_L$	
	LOW to HIGH	5	$t_{PLH}$		170	340	ns	$143\text{ ns} + (0,55\text{ ns/pF}) C_L$
		10			70	140	ns	$59\text{ ns} + (0,23\text{ ns/pF}) C_L$
		15			50	100	ns	$42\text{ ns} + (0,16\text{ ns/pF}) C_L$
$CP_D \rightarrow O_n$ HIGH to LOW	5	$t_{PHL}$		210	420	ns	$183\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			85	170	ns	$74\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			65	125	ns	$57\text{ ns} + (0,16\text{ ns/pF}) C_L$	
	LOW to HIGH	5	$t_{PLH}$		170	340	ns	$143\text{ ns} + (0,55\text{ ns/pF}) C_L$
		10			70	140	ns	$59\text{ ns} + (0,23\text{ ns/pF}) C_L$
		15			50	100	ns	$42\text{ ns} + (0,16\text{ ns/pF}) C_L$
$CP_U \rightarrow \overline{TC_U}$ HIGH to LOW	5	$t_{PHL}$		125	250	ns	$98\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			50	100	ns	$39\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			35	70	ns	$27\text{ ns} + (0,16\text{ ns/pF}) C_L$	
	LOW to HIGH	5	$t_{PLH}$		95	185	ns	$68\text{ ns} + (0,55\text{ ns/pF}) C_L$
		10			40	80	ns	$29\text{ ns} + (0,23\text{ ns/pF}) C_L$
		15			30	60	ns	$22\text{ ns} + (0,16\text{ ns/pF}) C_L$
$CP_D \rightarrow \overline{TC_D}$ 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	$32\text{ ns} + (0,16\text{ ns/pF}) C_L$	
	LOW to HIGH	5	$t_{PLH}$		100	195	ns	$73\text{ ns} + (0,55\text{ ns/pF}) C_L$
		10			40	85	ns	$29\text{ ns} + (0,23\text{ ns/pF}) C_L$
		15			30	65	ns	$22\text{ ns} + (0,16\text{ ns/pF}) C_L$
$MR \rightarrow O_n$ HIGH to LOW	5	$t_{PHL}$		195	390	ns	$168\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			80	160	ns	$69\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			60	120	ns	$52\text{ ns} + (0,16\text{ ns/pF}) C_L$	
$MR \rightarrow \overline{TC_U}$ LOW to HIGH	5	$t_{PLH}$		145	285	ns	$118\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			60	115	ns	$49\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			45	90	ns	$37\text{ ns} + (0,16\text{ ns/pF}) C_L$	
$MR \rightarrow \overline{TC_D}$ HIGH to LOW	5	$t_{PHL}$		365	730	ns	$338\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			130	265	ns	$119\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			100	205	ns	$92\text{ ns} + (0,16\text{ ns/pF}) C_L$	
$\overline{PL} \rightarrow O_n$ HIGH to LOW	5	$t_{PHL}$		185	360	ns	$158\text{ ns} + (0,55\text{ ns/pF}) C_L$	
	10			75	150	ns	$64\text{ ns} + (0,23\text{ ns/pF}) C_L$	
	15			55	110	ns	$47\text{ ns} + (0,16\text{ ns/pF}) C_L$	

## 4-bit up/down decade counter

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	V <sub>DD</sub> V	SYMBOL	MIN.	TYP.	MAX.	TYPICAL EXTRAPOLATION FORMULA	
LOW to HIGH	5	t <sub>PLH</sub>		145	290	ns	118 ns + (0,55 ns/pF) C <sub>L</sub>
	10		60	120	ns	49 ns + (0,23 ns/pF) C <sub>L</sub>	
	15		45	90	ns	37 ns + (0,16 ns/pF) C <sub>L</sub>	

**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	
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>	
Set-up time P <sub>n</sub> → $\overline{P_L}$	5	t <sub>su</sub>	160	80		ns	see also waveforms Fig.6
	10		60	30		ns	
	15		50	25		ns	
Hold time P <sub>n</sub> → $\overline{P_L}$	5	t <sub>hold</sub>	10	-70		ns	
	10		5	-25		ns	
	15		5	-20		ns	
Minimum CP <sub>U</sub> or CP <sub>D</sub> pulse width; LOW	5	t <sub>WCPL</sub>	150	75		ns	
	10		50	25		ns	
	15		35	20		ns	
Minimum MR pulse width; HIGH	5	t <sub>WMRH</sub>	180	90		ns	
	10		70	35		ns	
	15		60	30		ns	
Minimum $\overline{P_L}$ pulse width; LOW	5	t <sub>WPLL</sub>	120	60		ns	
	10		45	20		ns	
	15		30	15		ns	
Recovery time for MR	5	t <sub>RMR</sub>	125	65		ns	
	10		70	35		ns	
	15		50	25		ns	
Recovery time for $\overline{P_L}$	5	t <sub>RPL</sub>	90	45		ns	
	10		35	15		ns	
	15		25	10		ns	
Maximum clock pulse frequency	5	f <sub>max</sub>	2,5	5		MHz	
	10		7	14		MHz	
	15		9	18		MHz	

4-bit up/down decade counter

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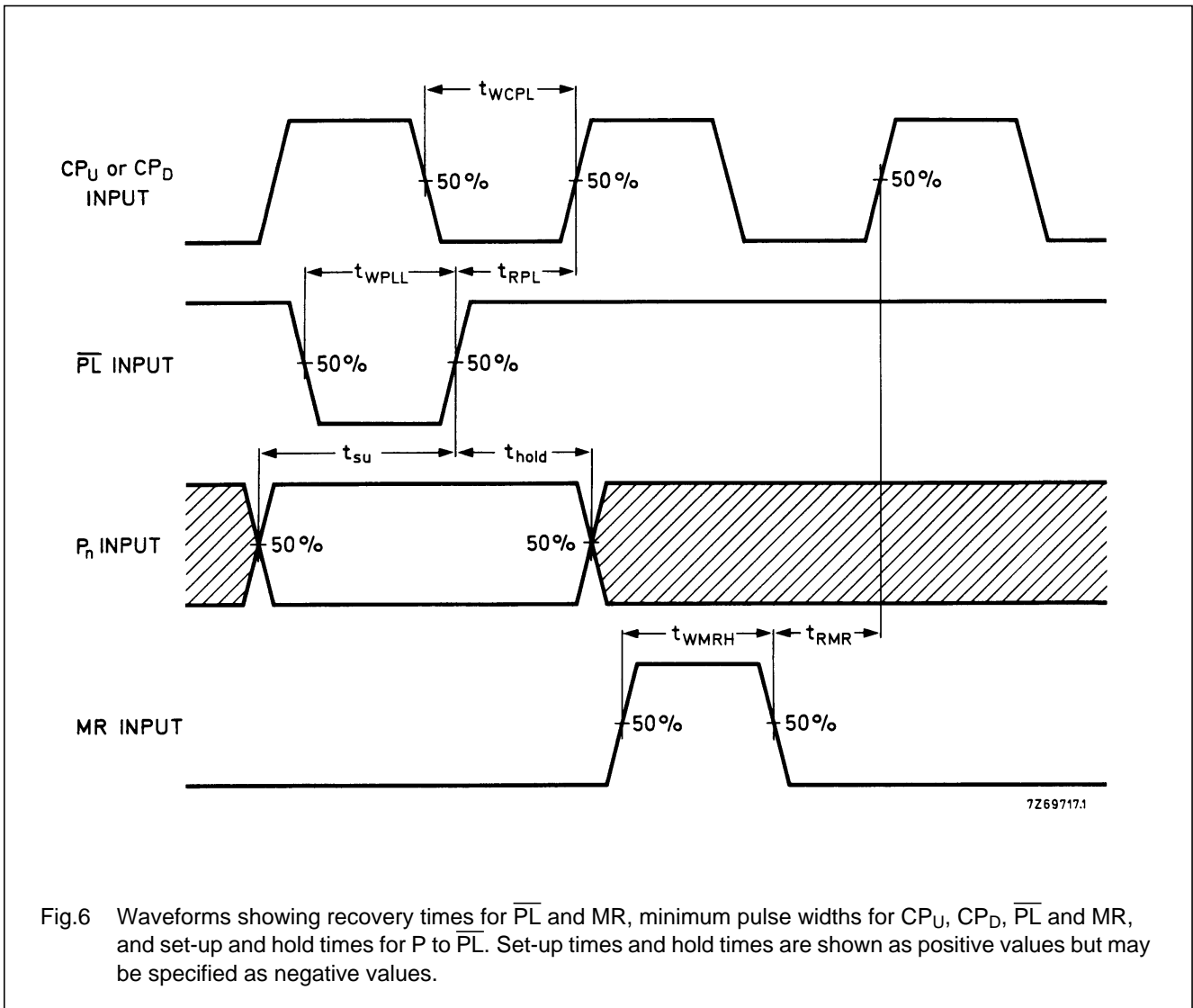


Fig.6 Waveforms showing recovery times for  $\overline{P_L}$  and MR, minimum pulse widths for CP<sub>U</sub>, CP<sub>D</sub>,  $\overline{P_L}$  and MR, and set-up and hold times for P to  $\overline{P_L}$ . Set-up times and hold times are shown as positive values but may be specified as negative values.

4-bit up/down decade counter

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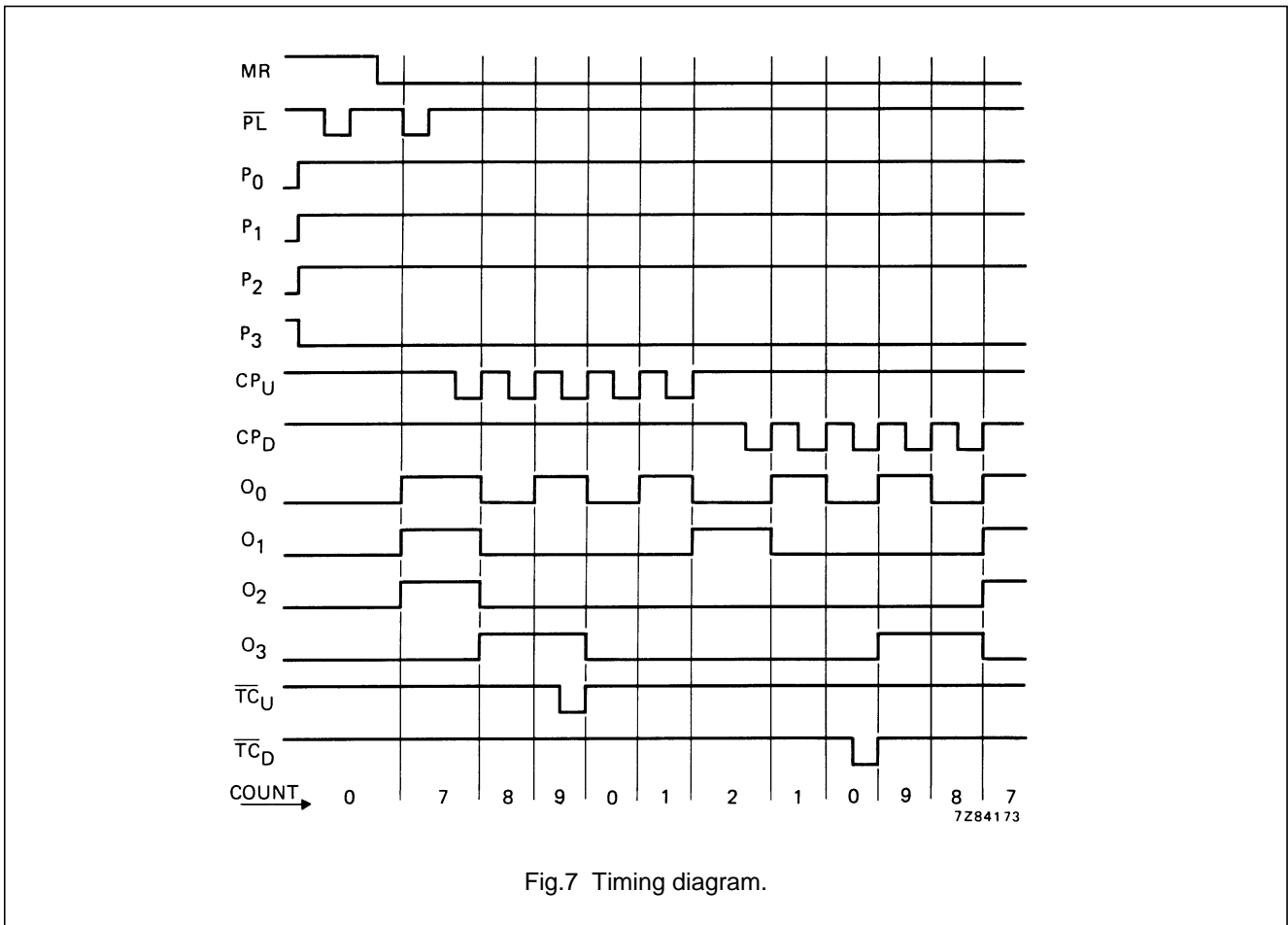


Fig.7 Timing diagram.

**APPLICATION INFORMATION**

Some examples of applications for the HEF40192B are:

- Up/down difference counting
- Multistage ripple counting
- Multistage synchronous counting.

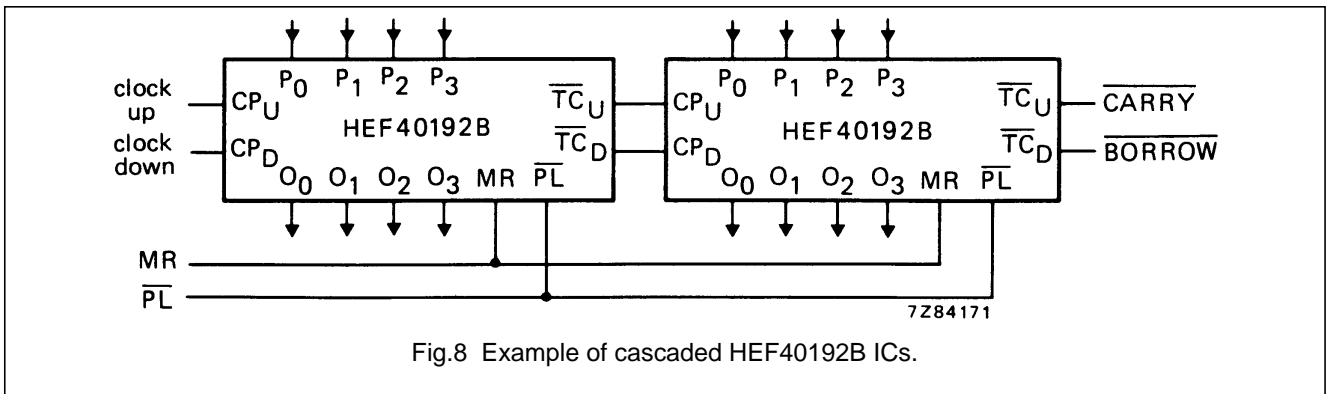


Fig.8 Example of cascaded HEF40192B ICs.



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