

DATA SHEET

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- The IC04 LOCMOS HE4000B Logic Family Specifications HEF, HEC
- The IC04 LOCMOS HE4000B Logic Package Outlines/Information HEF, HEC

HEF4534B

LSI

Real time 5-decade counter

Product specification
File under Integrated Circuits, IC04

January 1995

Real time 5-decade counter

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DESCRIPTION

The HEF4534B is a 5-decade ripple counter. The binary outputs of the decade counters are time-multiplexed by an internal scanner on four BCD outputs (O_0 to O_3). The selected decade is indicated by a logic HIGH on the appropriate digit select output (OS_0 : units, 1; OS_1 : tens, 10; OS_2 : hundreds, 10^2 ; OS_3 : thousands, 10^3 ; OS_4 : ten thousands, 10^4).

The binary outputs (O_0 to O_3) and the select outputs (OS_0 to OS_4) are 3-state controlled via enable inputs $\overline{EO}$ and $\overline{EOS}$ respectively, allowing interface with other bus orientated devices. Cascading may be accomplished by using the carry out (TC). The counter is triggered by a LOW to HIGH transition on the decade clock (CPA) and is reset by a HIGH level on the master reset (MR). The

scanner is triggered by a LOW to HIGH transition on the scanner clock (CPS) and is reset (select ten thousand counter) by a HIGH level on the scanner reset (MR_{sc}).

The counter can operate in four modes depending on the state of the mode select inputs (S_A , S_B). The error detector will detect an error when a positive edge on CPA is not accompanied by a negative edge on the error detector clock $\overline{CPE}$ or vice versa, within time limits adjusted by external capacitors connected to $C_{ext\ 1}$ and $C_{ext\ 2}$. Three or more detected errors result in a HIGH level on the error output (OER). The error detector is reset by a HIGH level on MR.

Schmitt-trigger action in the clock inputs makes the circuit highly tolerant to slower clock rise and fall times.

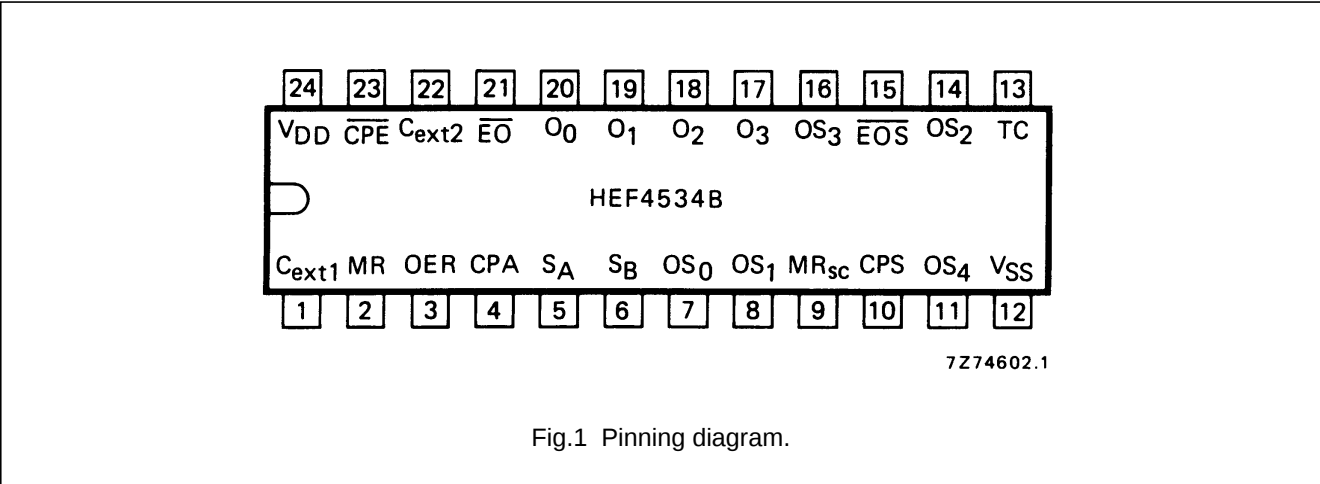


Fig.1 Pinning diagram.

PINNING		
HEF4534BP(N):	24-lead DIL; plastic (SOT101-1)	O_1 to O_3 BCD outputs
HEF4534BD(F):	24-lead DIL; ceramic (cerdip) (SOT94)	OS_0 to OS_3 digit select outputs
HEF4534BT(D):	24-lead SO; plastic (SOT137-1)	OER error output
(): Package Designator North America		CPA decade clock input
		CPS scanner clock input
		$\overline{CPE}$ error detector clock input
		S_A , S_B mode select inputs
		MR master reset input
		MR_{sc} scanner reset input
		TC carry out

FAMILY DATA, I_{DD} LIMITS category LSI

See Family Specifications

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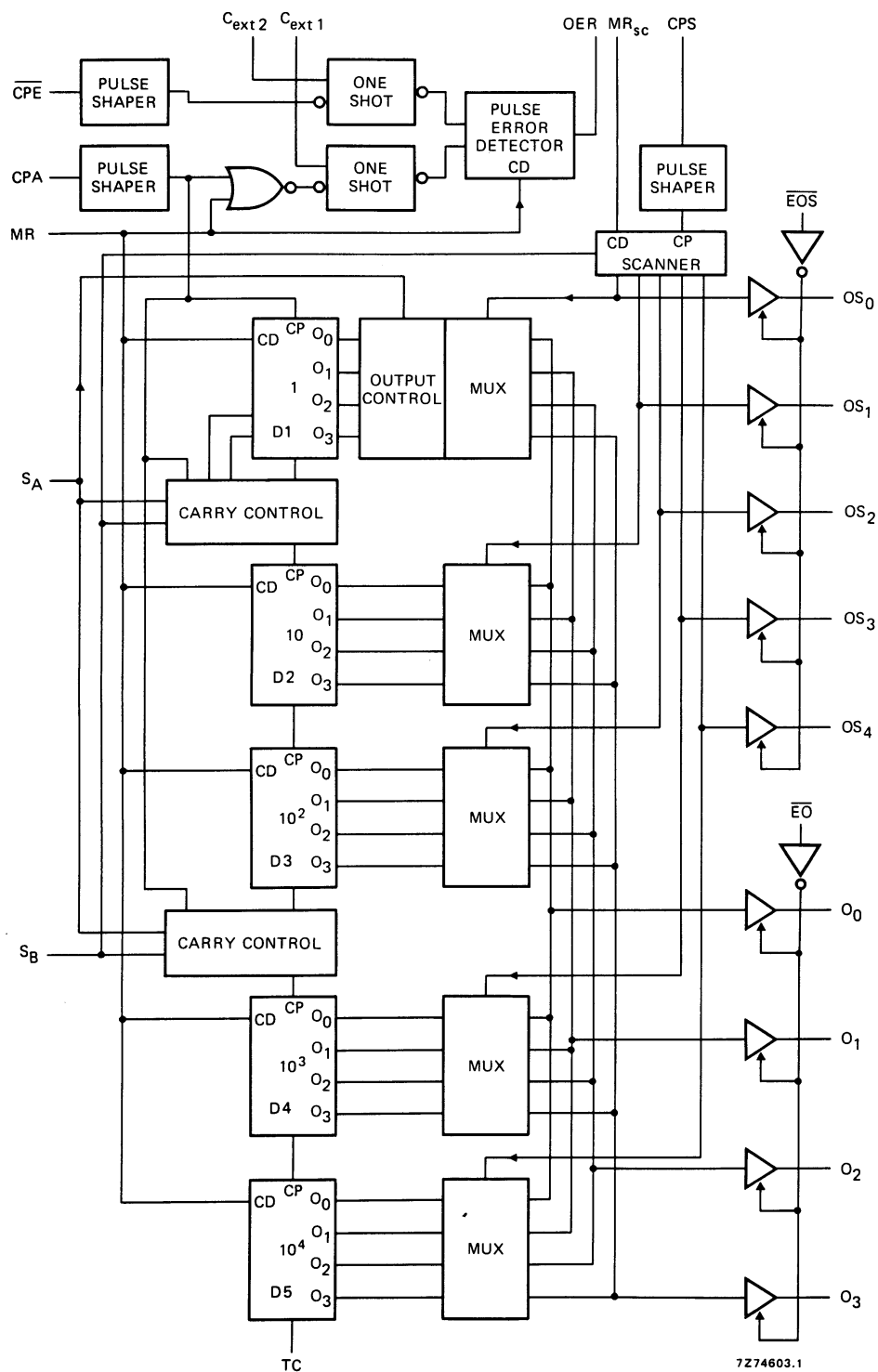
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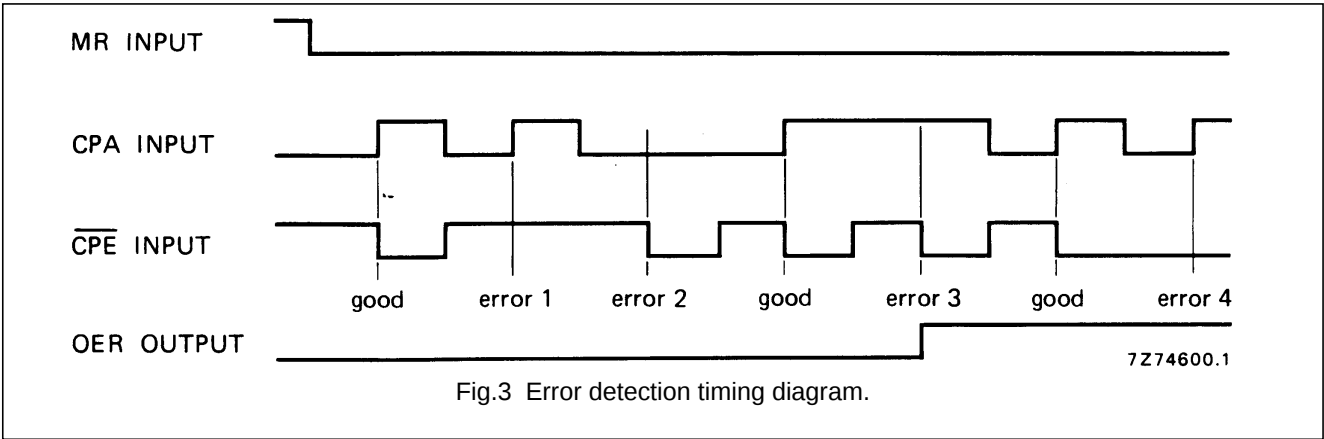
Fig.2 Functional block diagram.

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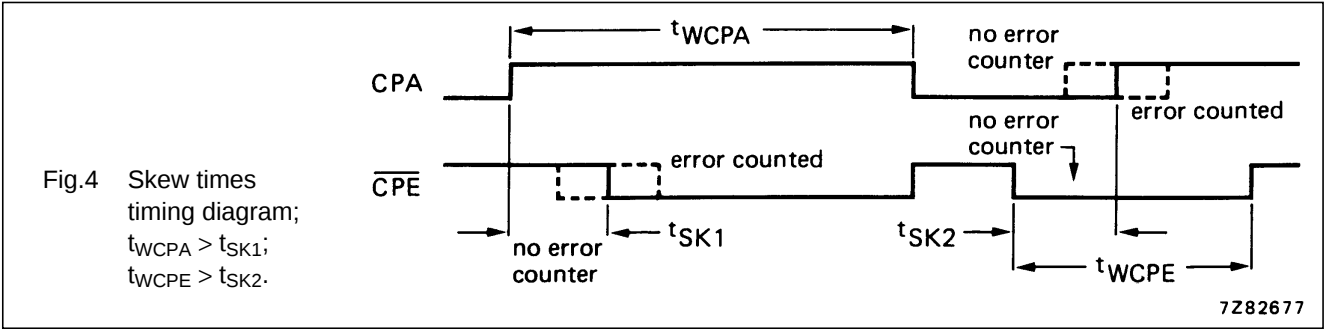
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MODE CONTROL FUNCTION TABLE

SELECT INPUTS		1ST DECADE OUTPUT	CARRY TO 2ND STAGE	CARRY TO 4TH STAGE	MODE
S _A	S _B				
L	L	normal count and display	at 9 to 0 transition of the 1st decade	at 9 to 0 transition of the 3rd decade	5-decade counter
L	H	inhibited	input clock	input clock	test purposes: clock directly into stages 1, 2 and 4
H	H	inhibited	at 4 to 5 transition of the 1st decade	at 9 to 0 transition of the 3rd decade	4-decade counter with ÷ 10 and round- off at front end
H	L	display counts: 3, 4, 5, 6, 7 = 5 8, 9, 0, 1, 2 = 0	at 7 to 8 transition of the 1st decade	at 9 to 0 transition of the 3rd decade	4-decade counter; ½-pence capability

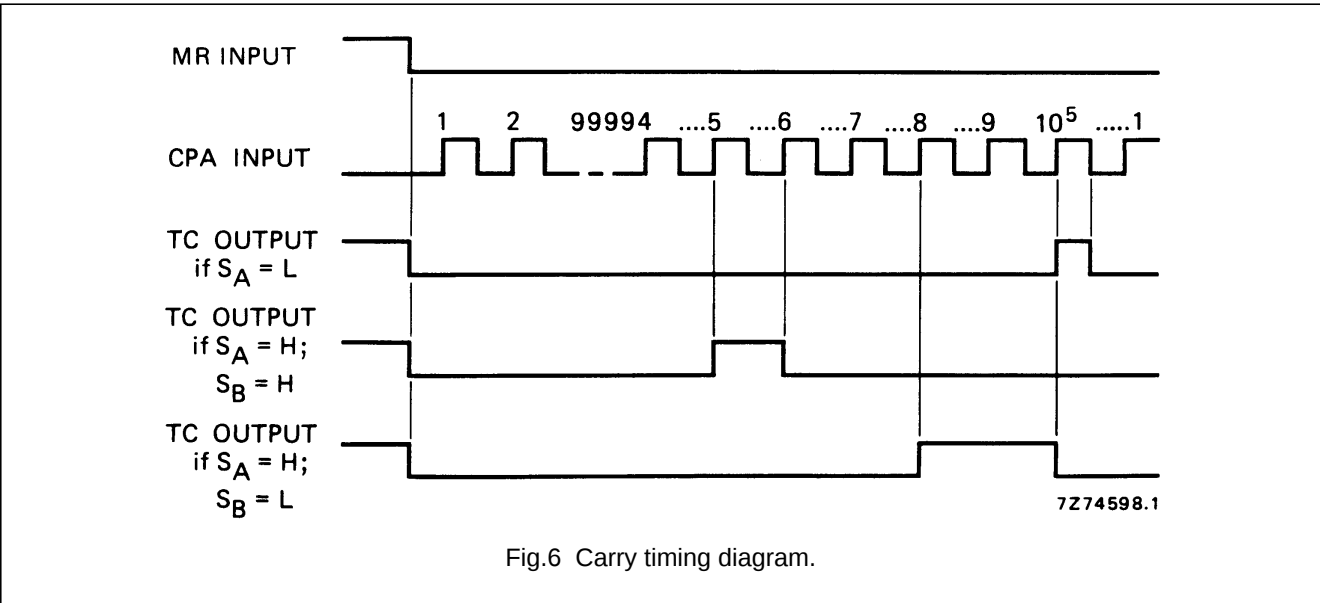
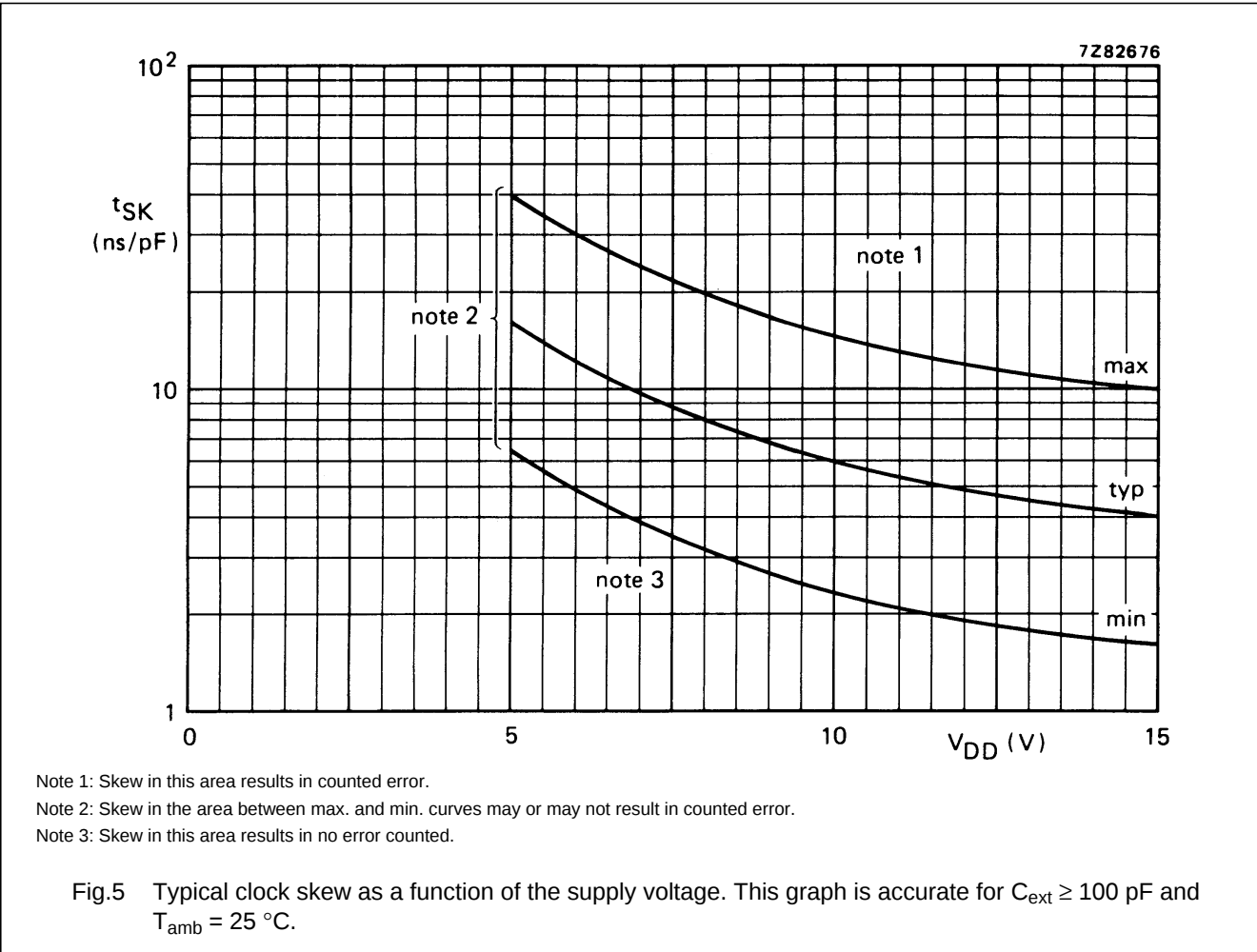


The skew time is the time difference between the LOW to HIGH transition of CPA and the HIGH to LOW transition of $\overline{\text{CPE}}$ or vice versa (see Fig.4). The skew time is typically proportional to the external capacitor (C_{ext}) connected from $C_{\text{ext}1}$ and $C_{\text{ext}2}$ (pins 1 and 22) to V_{SS} . The error detector will count an error when a positive edge on the counter clock CPA is not succeeded by a negative edge on the error detector clock $\overline{\text{CPE}}$ within a skew time $t_{\text{SK}1}$ (adjustable by $C_{\text{ext}1}$ at pin 1). The same holds for a negative edge at CPE succeeded by a positive on CPA within a skew time $t_{\text{SK}2}$ (adjustable by $C_{\text{ext}2}$ at pin 22). If error detection is not needed, $\overline{\text{CPE}}$ must be either HIGH or LOW and no C_{ext} is applied. For further information see Fig.5.



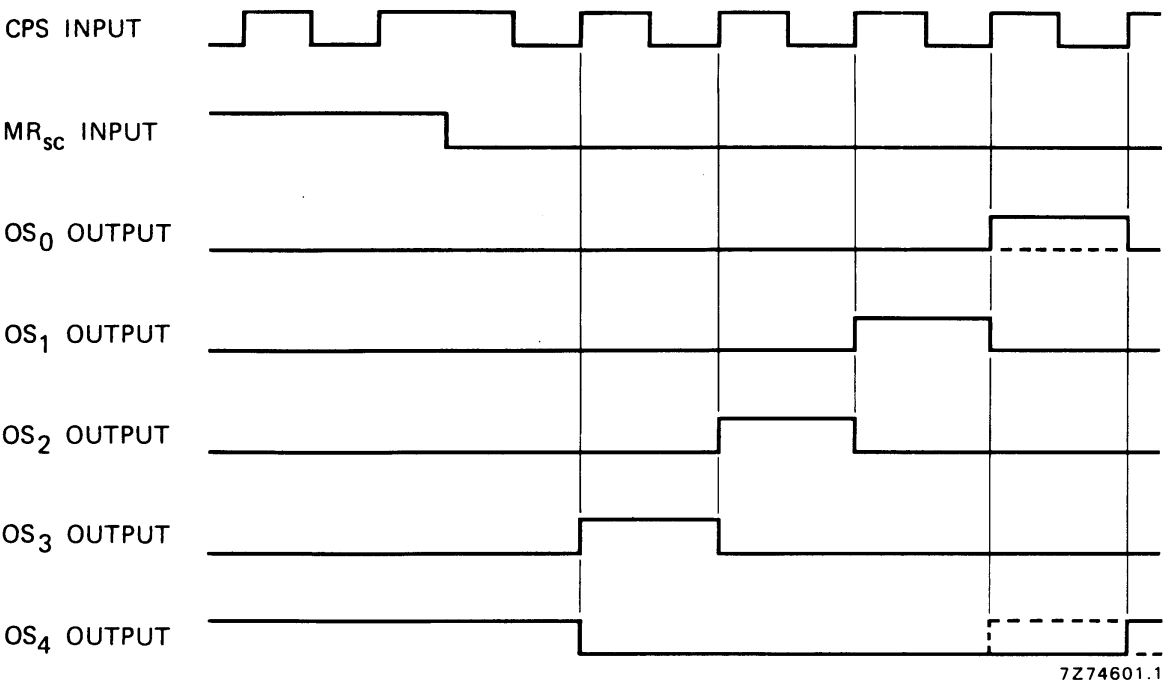
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Note: If S_B = H, the 1st decade is inhibited and the cycle will be shortened to four stages (see dotted lines).

Fig.7 Scanner timing diagram.

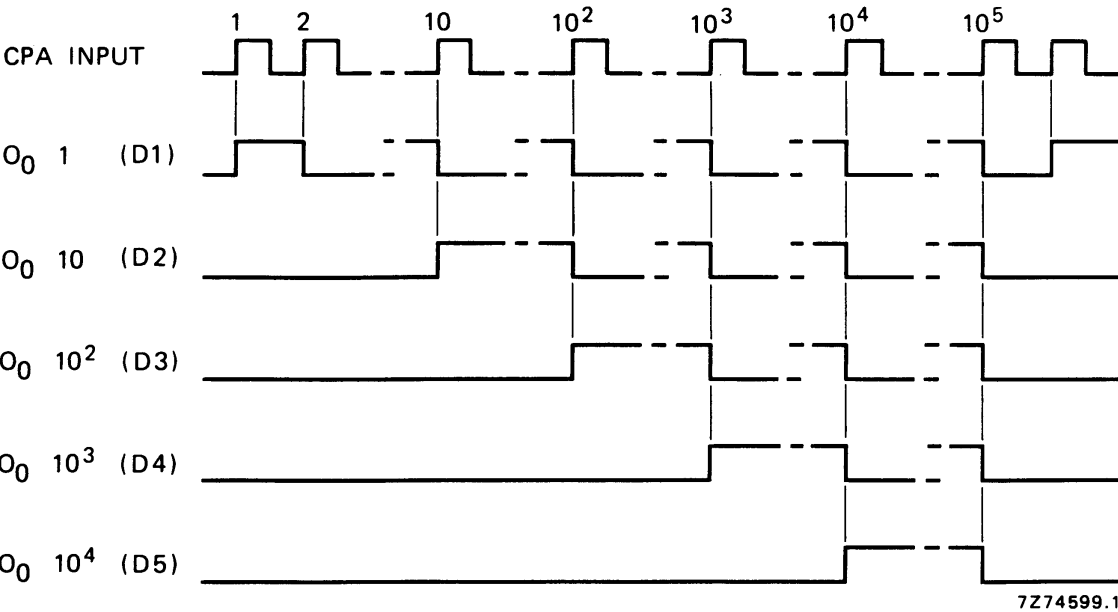


Fig.8 Counter timing diagram.

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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.	TYPICAL EXTRAPOLATION FORMULA
Propagation delays						
CPA $\rightarrow$ O _n	5			300	600 ns	283 ns + (0,55 ns/pF) C _L
D1 selected	10	t_{PHL}		130	260 ns	119 ns + (0,23 ns/pF) C _L
HIGH to LOW	15			95	190 ns	87 ns + (0,16 ns/pF) C _L
LOW to HIGH	5	t_{PLH}		240	480 ns	213 ns + (0,55 ns/pF) C _L
	10			100	200 ns	89 ns + (0,23 ns/pF) C _L
	15			75	150 ns	67 ns + (0,16 ns/pF) C _L
CPA $\rightarrow$ O _n	5			550	1100 ns	523 ns + (0,55 ns/pF) C _L
D5 selected	10	t_{PHL}		230	460 ns	219 ns + (0,23 ns/pF) C _L
HIGH to LOW	15			170	340 ns	162 ns + (0,16 ns/pF) C _L
LOW to HIGH	5	t_{PLH}		550	1100 ns	523 ns + (0,55 ns/pF) C _L
	10			230	460 ns	219 ns + (0,23 ns/pF) C _L
	15			170	340 ns	162 ns + (0,16 ns/pF) C _L
CPA $\rightarrow$ TC	5			420	840 ns	393 ns + (0,55 ns/pF) C _L
LOW to HIGH	10	t_{PLH}		190	380 ns	179 ns + (0,23 ns/pF) C _L
	15			140	280 ns	132 ns + (0,16 ns/pF) C _L
MR $\rightarrow$ O _n	5			200	400 ns	173 ns + (0,55 ns/pF) C _L
HIGH to LOW	10	t_{PHL}		85	170 ns	74 ns + (0,23 ns/pF) C _L
	15			60	120 ns	52 ns + (0,16 ns/pF) C _L
MR $\rightarrow$ OER	5			140	280 ns	113 ns + (0,55 ns/pF) C _L
HIGH to LOW	10	t_{PHL}		65	130 ns	54 ns + (0,23 ns/pF) C _L
	15			50	100 ns	42 ns + (0,16 ns/pF) C _L
CPS $\rightarrow$ O _n	5			225	450 ns	198 ns + (0,55 ns/pF) C _L
HIGH to LOW	10	t_{PHL}		95	190 ns	84 ns + (0,23 ns/pF) C _L
	15			70	140 ns	62 ns + (0,16 ns/pF) C _L
LOW to HIGH	5	t_{PLH}		225	450 ns	198 ns + (0,55 ns/pF) C _L
	10			95	190 ns	84 ns + (0,23 ns/pF) C _L
	15			70	140 ns	62 ns + (0,16 ns/pF) C _L
CPS $\rightarrow$ OS _n	5			170	340 ns	143 ns + (0,55 ns/pF) C _L
HIGH to LOW	10	t_{PHL}		70	140 ns	59 ns + (0,23 ns/pF) C _L
	15			50	100 ns	42 ns + (0,16 ns/pF) C _L
CPS $\rightarrow$ OS _n	5			170	340 ns	143 ns + (0,55 ns/pF) C _L
LOW to HIGH	10	t_{PLH}		70	140 ns	59 ns + (0,23 ns/pF) C _L
	15			50	100 ns	42 ns + (0,16 ns/pF) C _L

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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.	
3-state propagation delays						
Output disable times						
$\overline{EO} \rightarrow O_n$;	5	t _{PHZ}		30	60	ns
$\overline{EOS} \rightarrow OS_n$	10			25	50	ns
HIGH	15			20	40	ns
LOW	5	t _{PLZ}		40	80	ns
	10			25	50	ns
	15			20	40	ns
Output enable times						
$\overline{EO} \rightarrow O_n$;	5	t _{PZH}		35	70	ns
$\overline{EOS} \rightarrow OS_n$	10			20	40	ns
HIGH	15			15	30	ns
LOW	5	t _{PZL}		50	100	ns
	10			25	50	ns
	15			15	30	ns
Minimum clock pulse width; CPA, CPS	5	t _{WCPH}	70	35		ns
HIGH	10		40	20		ns
	15		30	15		ns
Minimum reset pulse width; MR, MR _{SC}	5	t _{WMRH}	90	45		ns
HIGH	10		60	30		ns
	15		40	20		ns
Recovery time for MR	5	t _{RMR}	120	60		ns
	10		60	30		ns
	15		50	25		ns
Recovery time for MR _{SC}	5	t _{RMR}	60	30		ns
	10		40	20		ns
	15		30	15		ns

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	V _{DD} V	SYMBOL	MIN.	TYP.	MAX.	
Maximum clock	5		2,5	5		MHz
pulse frequency	10	f _{max}	6	12		MHz
CPA and CPS	15		8	16		MHz

	V _{DD} V	TYPICAL FORMULA FOR P (μW)	
Dynamic power dissipation per package (P) ⁽¹⁾	5 10 15	$1\,100\,f_i + \sum (f_o C_L) \times V_{DD}^2$ $4\,800\,f_i + \sum (f_o C_L) \times V_{DD}^2$ $12\,000\,f_i + \sum (f_o C_L) \times V_{DD}^2$	where f _i = input freq. (MHz) f _o = output freq. (MHz) C _L = load cap. (pF) Σ (f _o C _L) = sum of outputs V _{DD} = supply voltage (V)

Note

1. C_{ext} = 0.

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APPLICATION INFORMATION

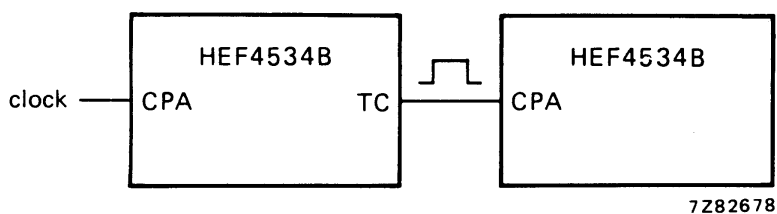


Fig.9 Two HEF4534B ICs connected for cascade operation. TC is HIGH for a single clock period when all five BCD decades go to zero. TC also goes HIGH when MR is applied.

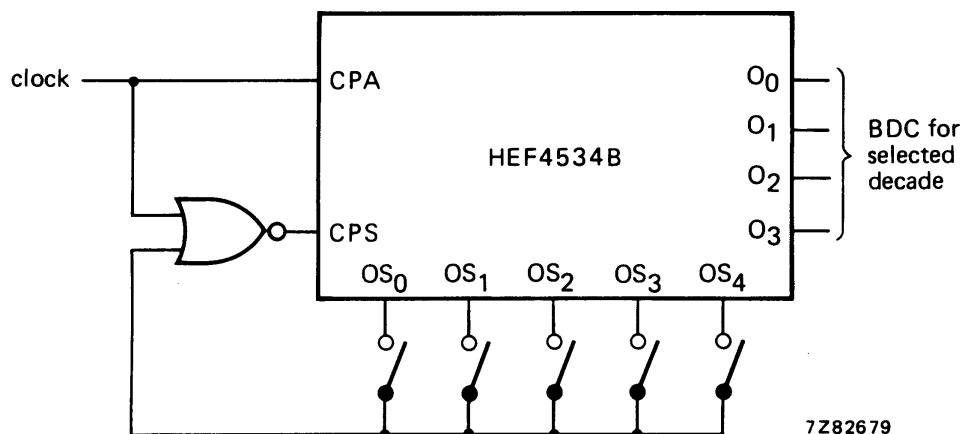


Fig.10 Forcing a decade to the O_n outputs. When the O_n outputs of a given decade are required, this configuration will lock-up the selected decade within four clock cycles. The select line feed back may be hardwired or switched.