

## HC192 - SYNCHRONOUS UP/DOWN DECADE COUNTER

## HC193 - SYNCHRONOUS UP/DOWN BINARY COUNTER

- LOW POWER DISSIPATION  
 $I_{CC} = 4 \mu A$  (MAX.) at  $T_A = 25^\circ C$
- HIGH NOISE IMMUNITY  
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min.)
- OUTPUT DRIVE CAPABILITY  
 10 LSTTL LOADS
- SYMMETRICAL OUTPUT IMPEDANCE  
 $|I_{OH}| = |I_{OL}| = 4 \text{ mA}$  (MIN.)
- BALANCED PROPAGATION DELAYS  
 $t_{PLH} = t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE  
 $V_{CC}$  (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE  
 WITH 54/74LS192-193

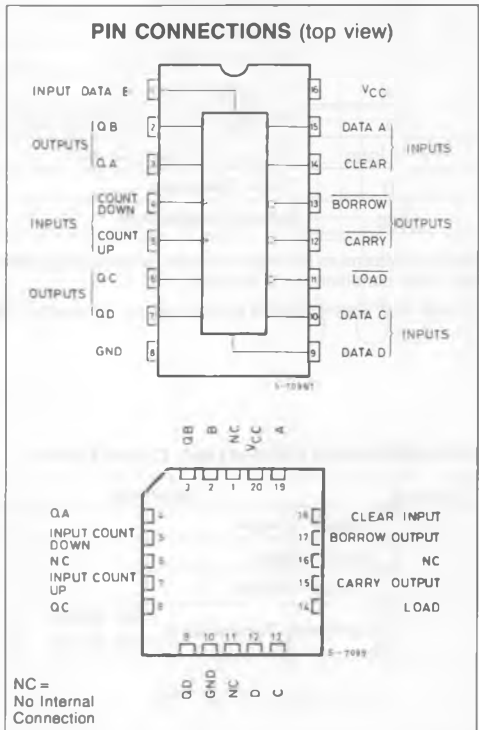
### DESCRIPTION

The M54/74HC192/193 are a high speed CMOS SYNCHRONOUS UP/DOWN DECADE COUNTERS fabricated in silicon gate C<sup>2</sup>MOS technology. They have the same high speed performance of LSTTL combined with true CMOS low power consumption. The counter has two separate clock inputs, an UP COUNT input and a DOWN COUNT input. All outputs of the flip-flop are simultaneously triggered on the low to high transition of either clock while the other input is held high. The direction of counting is determined by which input is clocked. This counter may be preset by entering the desired data on the DATA A, DATA B, DATA C, and DATA D input. When the LOAD input is taken low the data is loaded independently of either clock input. This feature allows the counters to be used as divide-by-n counters by modifying the count length with the preset inputs.

In addition the counter can also be cleared. This is accomplished by inputting a high on the CLEAR input. All 4 internal stages are set to low independently of either COUNT input.

Both a BORROW and CARRY output are provided to enable cascading of both up and down counting functions. The BORROW output produces a negative going pulse when the counter underflows and the CARRY outputs a pulse when the counter overflows. The counter can be cascaded by connecting the CARRY and BORROW outputs of one device to the COUNT UP and COUNT DOWN inputs, respectively, of the next device.

All inputs are equipped with protection circuits against static discharge and transient excess voltage.

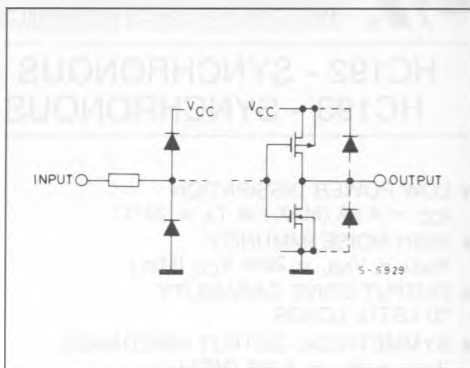


## TRUTH TABLE

Count Up	Count Down	$\overline{\text{Load}}$	Clear	Function
	H	H	L	COUNT UP
	H	H	L	NO COUNT
H		H	L	COUNT DOWN
H		H	L	NO COUNT
X	X	L	L	PRESET
X	X	X	H	RESET

X = DON'T CARE

## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	- 0.5 to 7	V
$V_I$	DC Input Voltage	- 0.5 to $V_{CC} + 0.5$	V
$V_O$	DC Output Voltage	- 0.5 to $V_{CC} + 0.5$	V
$I_{IK}$	DC Input Diode Current	$\pm 20$	mA
$I_{OK}$	DC Output Diode Current	$\pm 20$	mA
$I_O$	DC Output Source Sink Current Per Output Pin	$\pm 25$	mA
$I_{CC}$ or $I_{GND}$	DC $V_{CC}$ or Ground Current	$\pm 50$	mA
$P_D$	Power Dissipation	500 (*)	mW
$T_{stg}$	Storage Temperature	- 65 to 150	$^{\circ}\text{C}$

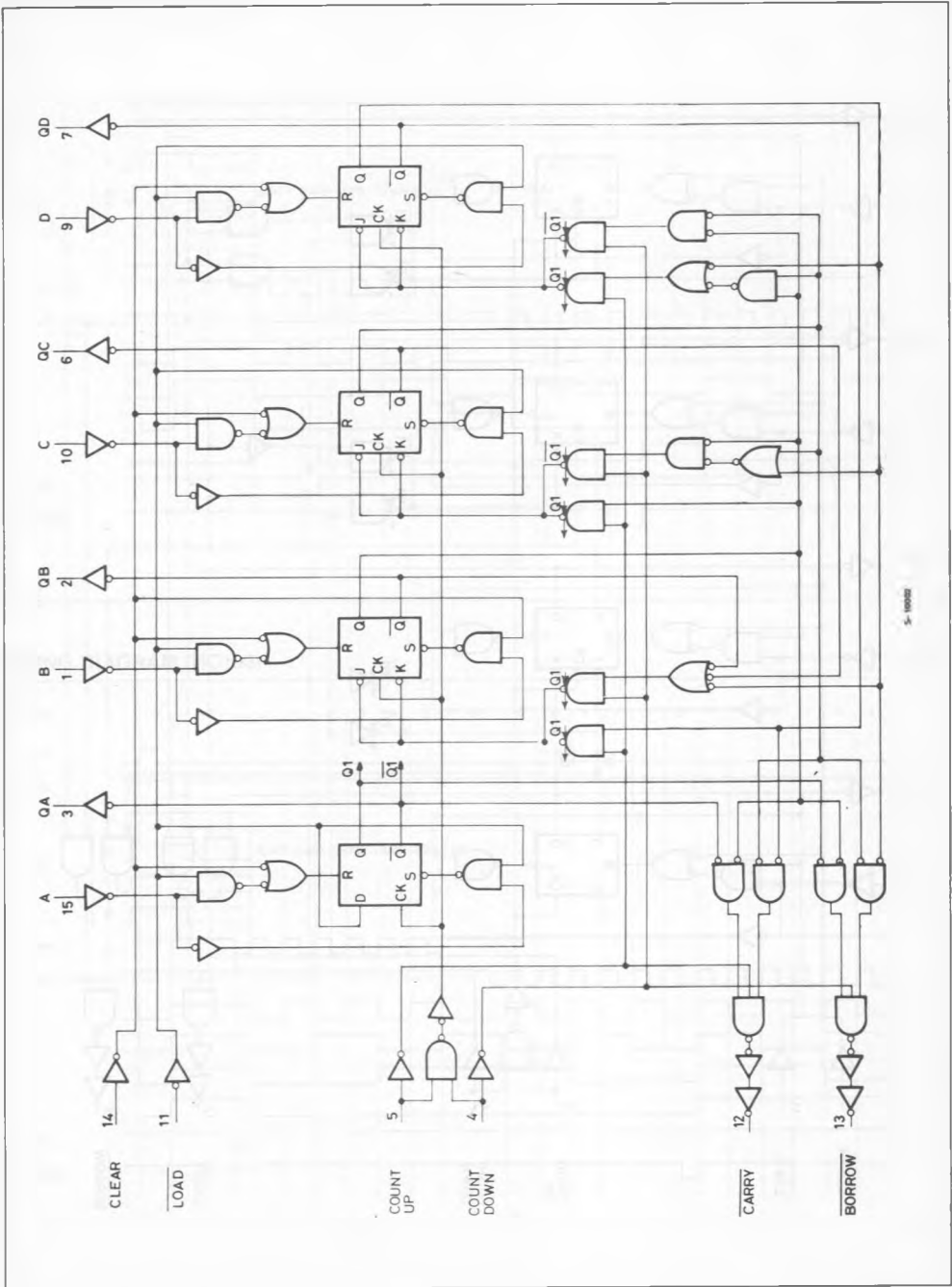
Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

(\*) 500 mW:  $\approx 65^{\circ}\text{C}$  derate to 300 mW by 10 mW/ $^{\circ}\text{C}$ :  $65^{\circ}\text{C}$  to  $85^{\circ}\text{C}$

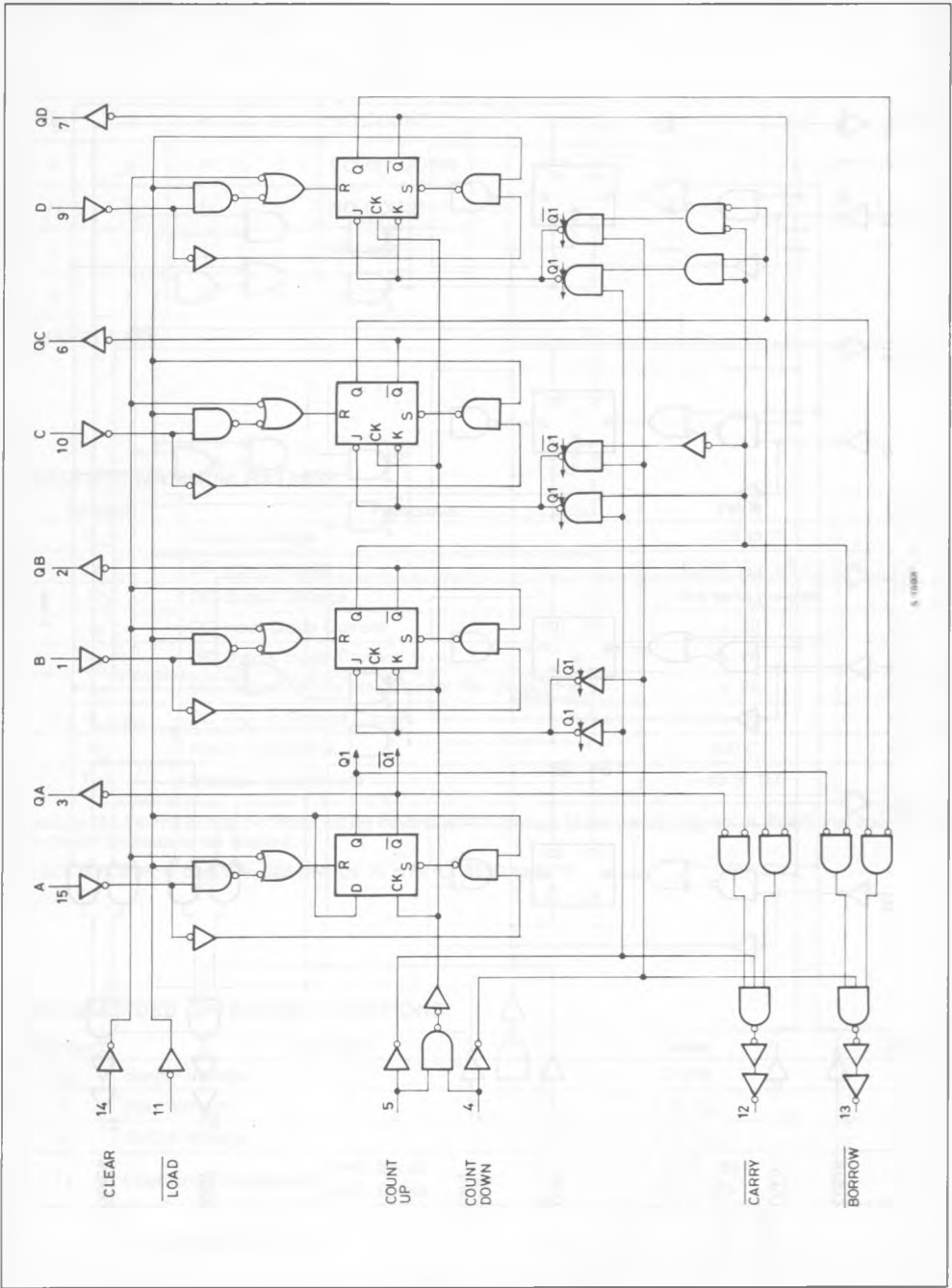
## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	2 to 6	V
$V_I$	Input Voltage	0 to $V_{CC}$	V
$V_O$	Output Voltage	0 to $V_{CC}$	V
$T_A$	Operating Temperature	74HC Series - 40 to 85 54HC Series - 55 to 125	$^{\circ}\text{C}$
$t_r, t_f$	Input Rise and Fall Time	$V_{CC} \begin{cases} 2 \text{ V} & 0 \text{ to } 1000 \\ 4.5 \text{ V} & 0 \text{ to } 500 \\ 6 \text{ V} & 0 \text{ to } 400 \end{cases}$	ns

LOGIC DIAGRAM (HC192)

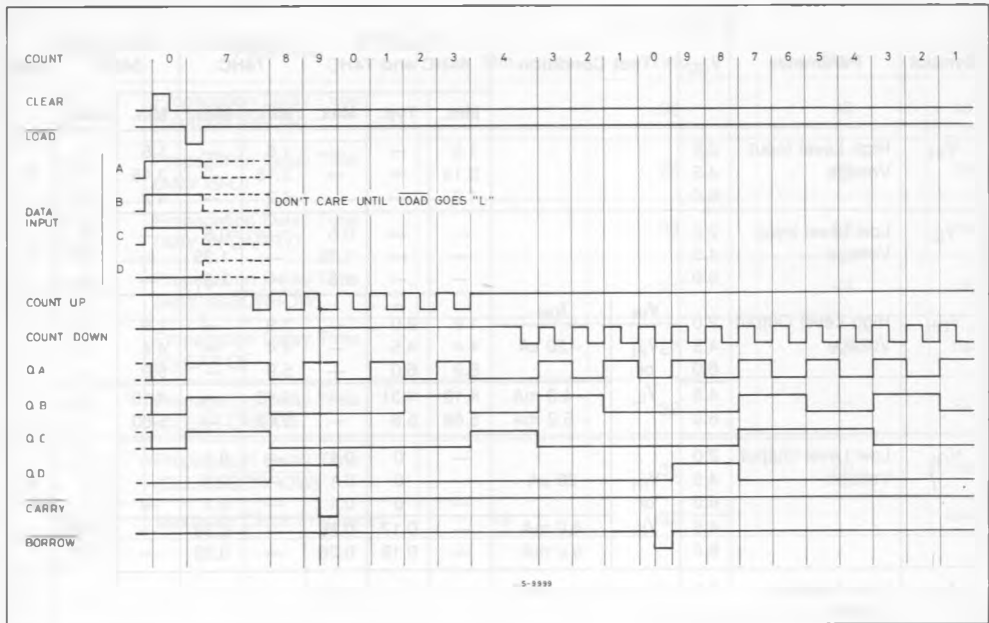


LOGIC DIAGRAM (HC193)

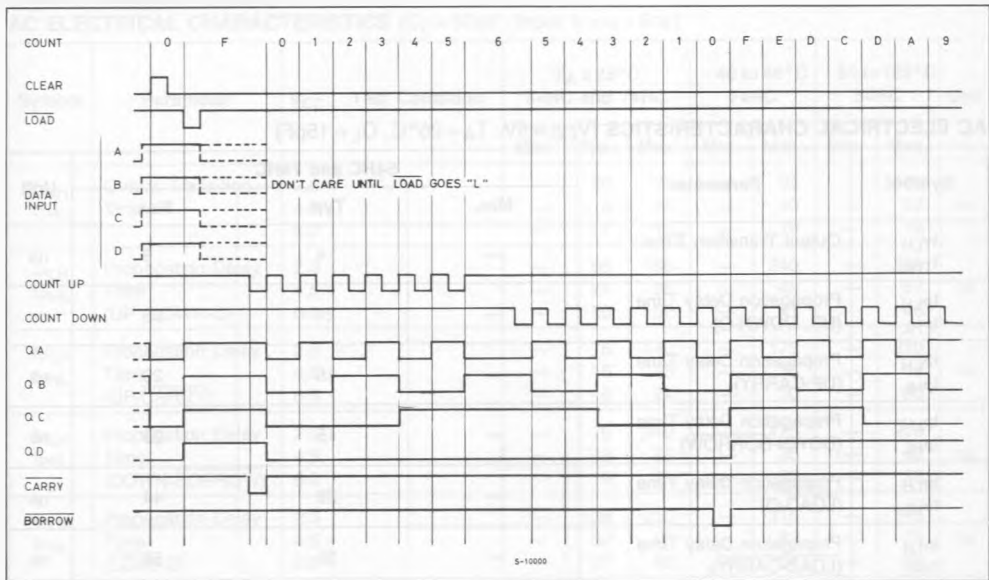


5-11000\*

## TIMING DIAGRAM (HC192)



## TIMING DIAGRAM (HC193)



## DC SPECIFICATIONS

Symbol	Parameter	V <sub>CC</sub>	Test Condition	T <sub>A</sub> = 25°C 54HC and 74HC			- 40 to 85°C 74HC		- 55 to 125°C 54HC		Unit	
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.		
V <sub>IH</sub>	High Level Input Voltage	2.0		1.5	—	—	1.5	—	1.5	—	V	
		4.5		3.15	—	—	3.15	—	3.15	—		
		6.0		4.2	—	—	4.2	—	4.2	—		
V <sub>IL</sub>	Low Level Input Voltage	2.0		—	—	0.5	—	0.5	—	0.5	V	
		4.5		—	—	1.35	—	1.35	—	1.35		
		6.0		—	—	1.8	—	1.8	—	1.8		
V <sub>OH</sub>	High Level Output Voltage	2.0	V <sub>IH</sub>	I <sub>OH</sub>	1.9	2.0	—	1.9	—	1.9	—	V
		4.5	V <sub>IH</sub> or V <sub>IL</sub>	- 20 μA	4.4	4.5	—	4.4	—	4.4	—	
		6.0			5.9	6.0	—	5.9	—	5.9	—	
		4.5	V <sub>IH</sub> or V <sub>IL</sub>	- 4.0 mA - 5.2 mA	4.18	4.31	—	4.13	—	4.10	—	
6.0	5.68	5.8			—	5.63	—	5.60	—			
V <sub>OL</sub>	Low Level Output Voltage	2.0	V <sub>IH</sub> or V <sub>IL</sub>	20 μA	—	0	0.1	—	0.1	—	0.1	V
		4.5			—	0	0.1	—	0.1	—	0.1	
		6.0			—	0	0.1	—	0.1	—	0.1	
		4.5			V <sub>IH</sub> or V <sub>IL</sub>	4.0 mA 5.2 mA	—	0.17	0.26	—	0.33	
6.0	—	0.18	0.26	—			0.33	—	0.40			
I <sub>IN</sub>	Input Leakage Current	6.0	V <sub>IN</sub> = V <sub>CC</sub> or GND		—	—	±0.1	—	±1	—	±1	μA
I <sub>CC</sub>	Quiescent Supply Current	6.0	V <sub>IN</sub> = V <sub>CC</sub> or GND		—	—	4	—	40	—	80	

AC ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C, C<sub>L</sub> = 15pF)

Symbol	Parameter	54HC and 74HC			Unit
		Min.	Typ.	Max.	
t <sub>TLH</sub> t <sub>THL</sub>	Output Transition Time	—	4	8	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (UP, DOWN-Q)	—	21	33	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (UP-CARRY)	—	15	23	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (DOWN-BORROW)	—	15	23	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (LOAD-Q)	—	28	44	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (LOAD-CARRY)	—	35	54	ns

## AC ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	54HC and 74HC			Unit
		Min.	Typ.	Max.	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (LOAD-BORROW)		32	49	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (ANY IN-Q)		26	40	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (ANY IN-CARRY)		38	58	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (ANY IN-BORROW)		31	48	ns
t <sub>PHL</sub>	Propagation Delay Time (CLEAR-Q)		27	43	ns
t <sub>PLH</sub>	Propagation Delay Time (CLEAR-CARRY)		32	50	ns
t <sub>PHL</sub>	Propagation Delay Time (CLEAR-BORROW)		32	50	ns
f <sub>MAX</sub>	Maximum Clock Frequency	18	32		MHz

AC ELECTRICAL CHARACTERISTICS (C<sub>L</sub> = 50pF, Input t<sub>r</sub> = t<sub>f</sub> = 6ns)

Symbol	Parameter	V <sub>CC</sub>	Test Condition	T <sub>A</sub> = 25°C 54HC and 74HC			- 40 to 85°C 74HC		- 55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t <sub>TLH</sub> t <sub>THL</sub>	Output Transition Time	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (UP, DOWN-Q)	2.0 4.5 6.0		— — —	96 24 20	190 38 32	— — —	240 48 41	— — —	285 57 48	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (UP-CARRY)	2.0 4.5 6.0		— — —	76 18 15	140 28 24	— — —	175 35 30	— — —	210 42 36	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (DOWN-BORROW)	2.0 4.5 6.0		— — —	76 18 15	140 28 24	— — —	175 35 30	— — —	210 42 36	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (LOAD-Q)	2.0 4.5 6.0		— — —	128 32 27	250 50 43	— — —	315 63 54	— — —	375 75 64	ns

## AC ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	V <sub>CC</sub>	Test Condition	T <sub>A</sub> = 25°C 54HC and 74HC			- 40 to 85°C 74HC		- 55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (LOAD-CARRY)	2.0 4.5 6.0		— — —	160 40 34	310 62 53	— — —	390 78 66	— — —	465 93 79	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (LOAD-BORROW)	2.0 4.5 6.0		— — —	144 36 31	280 56 48	— — —	350 70 60	— — —	420 84 71	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (ANY IN-Q)	2.0 4.5 6.0		— — —	116 29 25	230 46 39	— — —	290 58 49	— — —	345 69 59	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (ANY IN-CARRY)	2.0 4.5 6.0		— — —	172 43 37	330 66 56	— — —	415 83 71	— — —	495 99 84	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (ANY IN-BORROW)	2.0 4.5 6.0		— — —	144 36 31	275 55 47	— — —	345 69 59	— — —	415 83 71	ns
t <sub>PHL</sub>	Propagation Delay Time (CLEAR-Q)	2.0 4.5 6.0		— — —	128 32 27	245 49 42	— — —	305 61 52	— — —	370 74 63	ns
t <sub>PLH</sub>	Propagation Delay Time (CLEAR-CARRY)	2.0 4.5 6.0		— — —	148 37 31	285 57 48	— — —	355 71 60	— — —	430 86 73	ns
t <sub>PHL</sub>	Propagation Delay Time (CLEAR-BORROW)	2.0 4.5 6.0		— — —	148 37 31	285 57 48	— — —	355 71 60	— — —	430 86 73	ns
f <sub>MAX</sub>	Maximum Clock Frequency	2.0 4.5 6.0		3 16 19	7 29 34	— — —	2.6 13 15	— — —	2 11 13	— — —	MHz
t <sub>W(H)</sub> t <sub>W(L)</sub>	Minimum Pulse Width (CLOCK)	2.0 4.5 6.0		— — —	70 17 14	150 30 26	— — —	190 38 33	— — —	225 45 38	ns
t <sub>W(H)</sub>	Minimum Pulse Width (LOAD)	2.0 4.5 6.0		— — —	50 12 10	100 20 17	— — —	125 25 21	— — —	150 30 26	ns
t <sub>W(H)</sub>	Minimum Pulse Width (CLEAR)	2.0 4.5 6.0		— — —	45 11 9	100 20 17	— — —	125 25 21	— — —	150 30 26	ns
t <sub>REM</sub>	Minimum Removal Time (LOAD)	2.0 4.5 6.0		— — —	20 5 4	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t <sub>REM</sub>	Minimum Removal Time (CLEAR)	2.0 4.5 6.0		— — —	5 1 1	50 10 9	— — —	65 13 11	— — —	75 15 13	ns



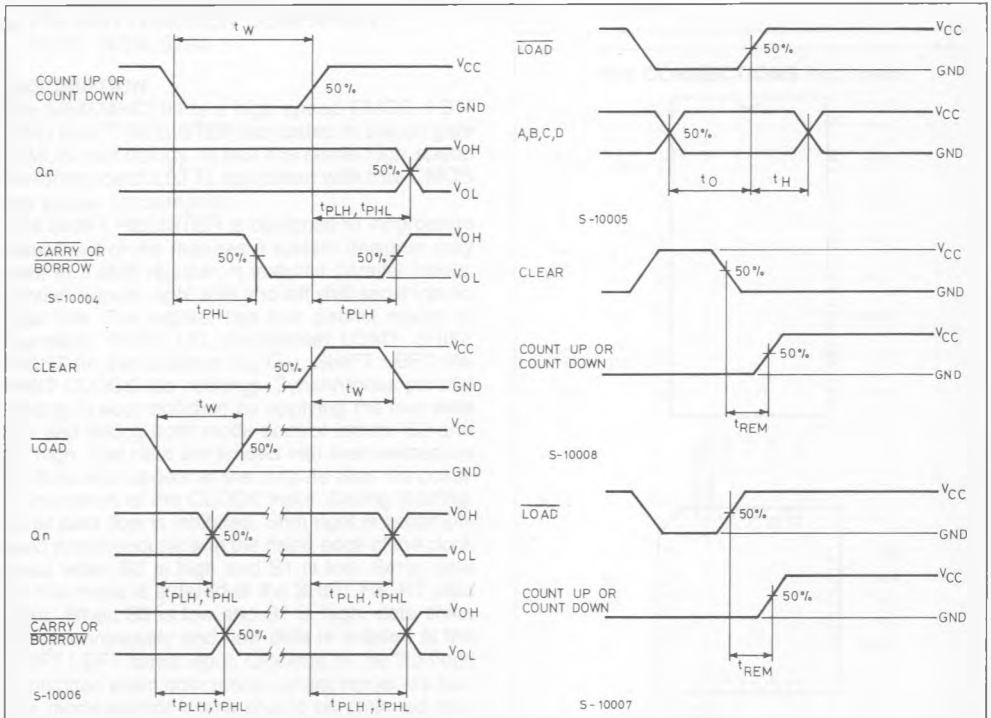
## AC ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	V <sub>CC</sub>	Test Condition	T <sub>A</sub> = 25°C 54HC and 74HC			- 40 to 85°C 74HC		- 55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t <sub>s</sub>	Minimum Set-up Time (DATA-LOAD)	2.0		—	40	100	—	125	—	150	ns
		4.5		—	10	20	—	25	—	30	
		6.0		—	9	17	—	21	—	26	
t <sub>h</sub>	Minimum Hold Time (DATA-LOAD)	2.0		—	—	0	—	0	—	0	ns
		4.5		—	—	0	—	0	—	0	
		6.0		—	—	0	—	0	—	0	
C <sub>IN</sub>	Input Capacitance			—	5	10	—	10	—	10	pF
C <sub>PD</sub> (*)	Power Dissipation Capacitance			—	66	—	—	—	—	—	pF

Note (\*) C<sub>PD</sub> is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit)

Average operating current is: I<sub>CC(opr.)</sub> = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>IN</sub> + I<sub>CC</sub>

## SWITCHING CHARACTERISTICS TEST WAVEFORM



TEST CIRCUIT  $I_{CC}$  (Opr.)