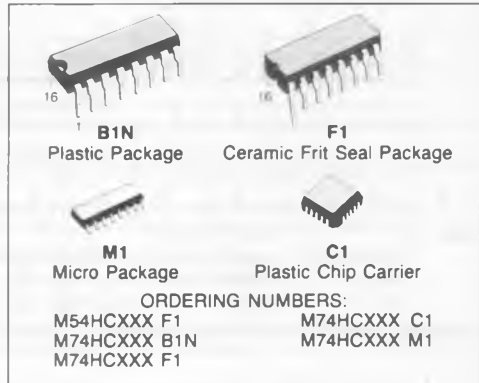


SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- **HIGH SPEED**
 $f_{MAX} = 50 \text{ MHz (TYP.) at } V_{CC} = 5V$
- **LOW POWER DISSIPATION**
 $I_{CC} = 4 \mu A \text{ (MAX.) at } 25^\circ C$
- **OUTPUT DRIVE CAPABILITY**
 10 LSTTL LOADS
- **BALANCED PROPAGATION DELAYS**
 $t_{PLH} = t_{PHL}$
- **HIGH NOISE IMMUNITY**
 $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (MIN.)}$
- **WIDE OPERATING VOLTAGE RANGE**
 $V_{CC} \text{ (OPR)} = 2V \text{ to } 6V$
- **PIN AND FUNCTION COMPATIBLE**
 WITH 54/74LS160 ~ 163



DESCRIPTION

M54/74HC160 Decade, Asynchronous Clear
 M54/74HC161 Binary, Asynchronous Clear
 M54/74HC162 Decade, Synchronous Clear
 M54/74HC163 Binary, Synchronous Clear

The M54/74HC160, 161, 162 and 163 are high speed CMOS SYNCHRONOUS PRESETTABLE COUNTERS fabricated with silicon gate C²MOS technology.

They have the same high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The M54/74HC160/162 are BCD Decade counters and the M54/74HC161/163 are 4 bit binary counters.

The **CLOCK** input is active on the rising edge. Both **LOAD** and **CLEAR** inputs are active Low.

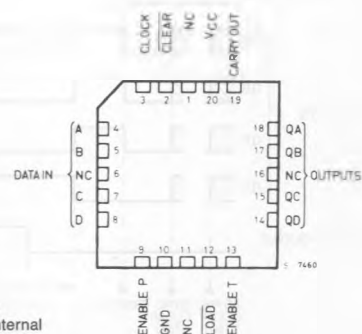
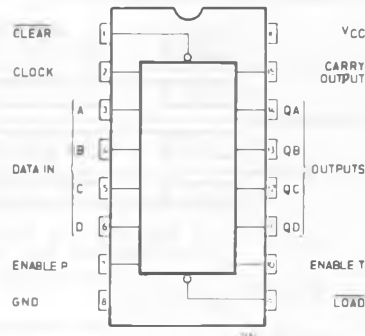
Presetting of all four IC's is synchronous on the rising edge of the **CLOCK**.

The function on the M54/74HC162/163 is synchronous to **CLOCK**, while the M54/74HC160/161 counters are cleared asynchronously.

Two enable inputs (TE and PE) and **CARRY** output are provided to enable easy cascading of counters, which facilitates easy implementation of N-bit counters without using external gates.

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

PIN CONNECTIONS (top view)



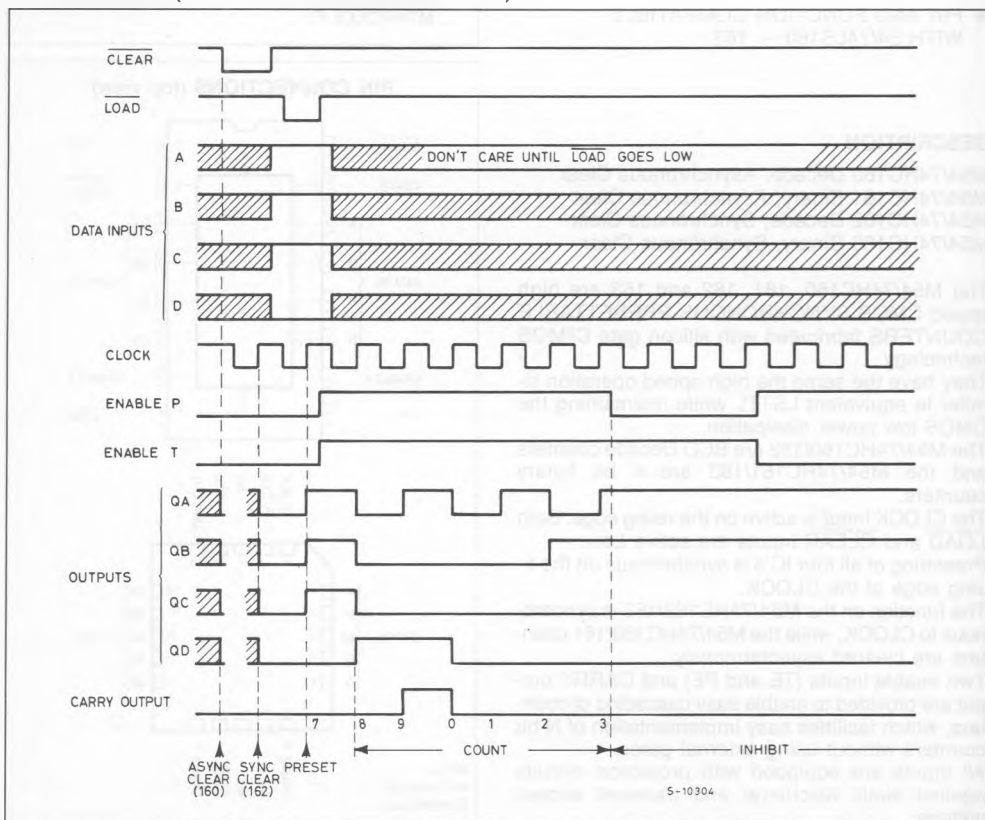
NC =
No Internal
Connection

TRUTH TABLE

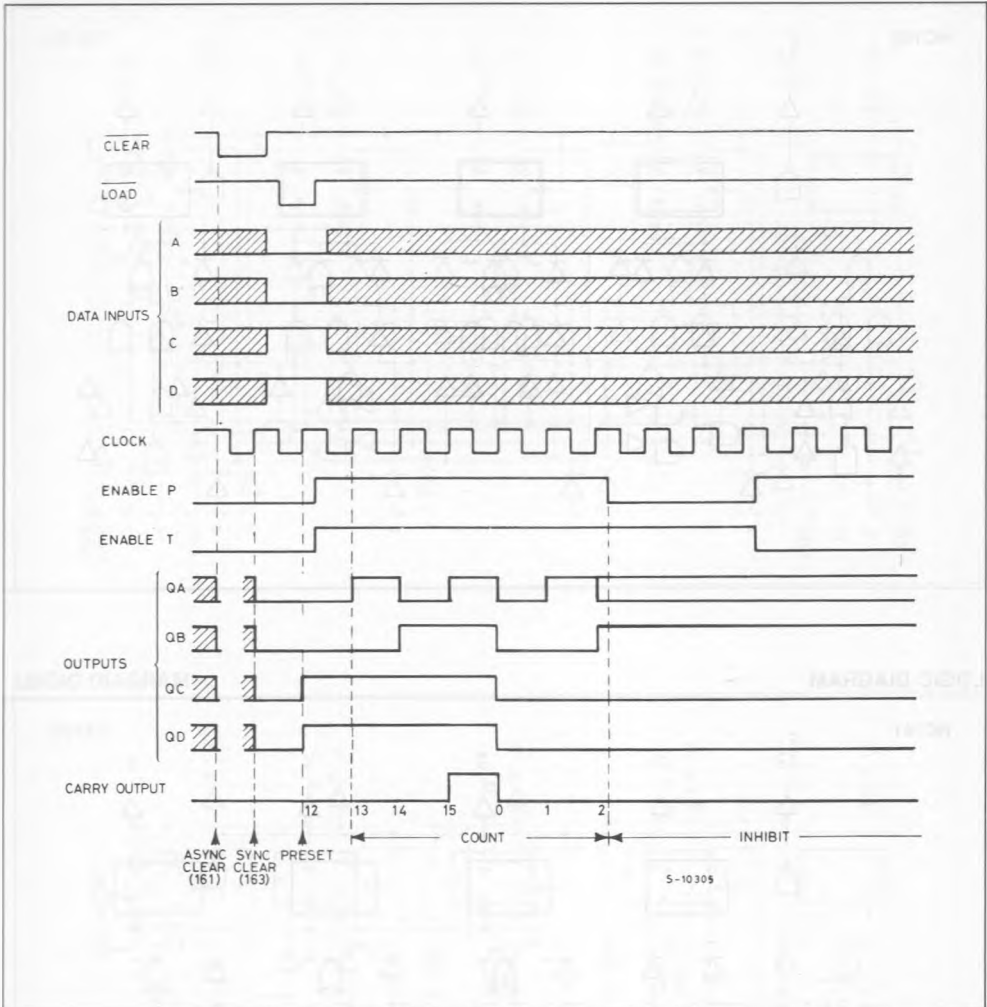
M54/74HC160/161					M54/74HC162/163					OUTPUTS				FUNCTION
INPUTS					INPUTS									
CLR	LD	PE	TE	CK	CLR	LD	PE	TE	CK	QA	QB	QC	QD	
L	X	X	X	X	L	X	X	X		L	L	L	L	RESET TO "0"
H	L	X	X		H	L	X	X		A	B	C	D	PRESET DATA
H	H	X	L		H	H	X	L		NO CHANGE				NO COUNT
H	H	L	X		H	H	L	X		NO CHANGE				NO COUNT
H	H	H	H		H	H	H	H		COUNT UP				COUNT
H	X	X	X		X	X	X	X		NO CHANGE				NO COUNT

Note X ; DON'T CARE
 A, B, C, D ; LOGIC LEVEL OF DATA INPUTS
 Carry : $CARRY = TE \cdot Q_A \cdot Q_B \cdot Q_C \cdot Q_D$ (M54/74HC160/162)
 : $CARRY = TE \cdot Q_A \cdot Q_B \cdot Q_C \cdot Q_D$ (M54/74HC161/163)

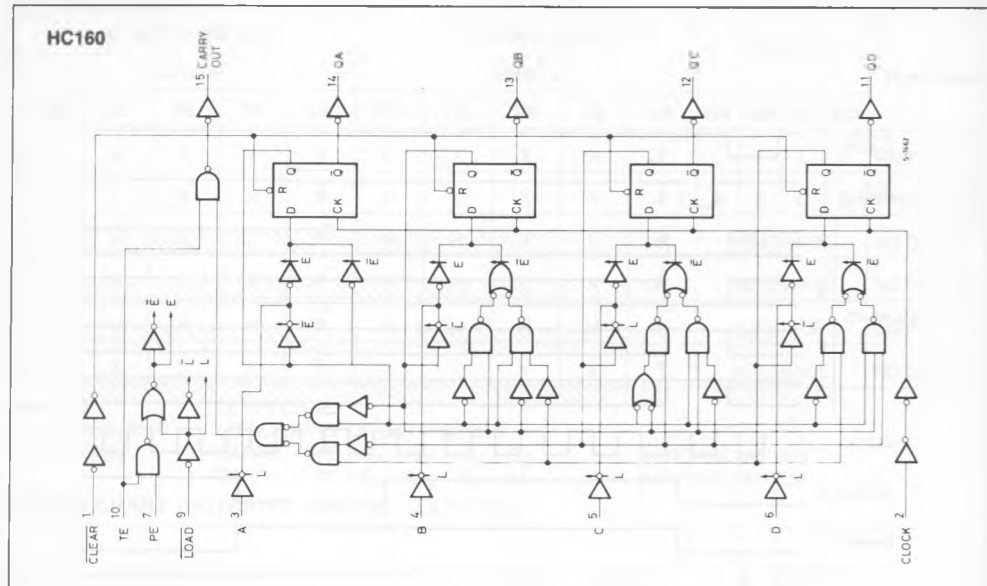
TIMING CHART (HC160/162: DECADE COUNTER)



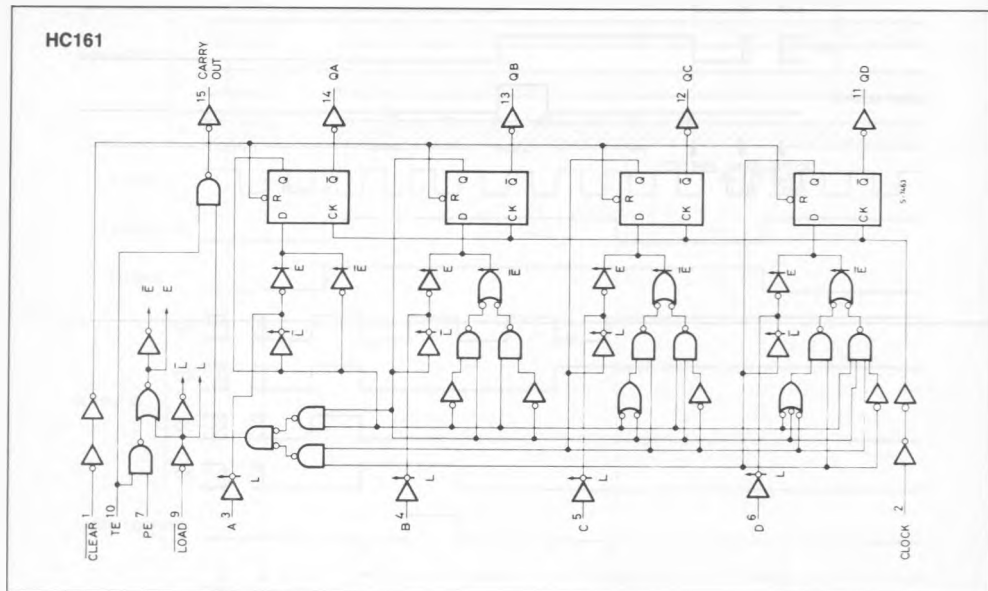
TIMING CHART (HC161/163: BINARY COUNTER)



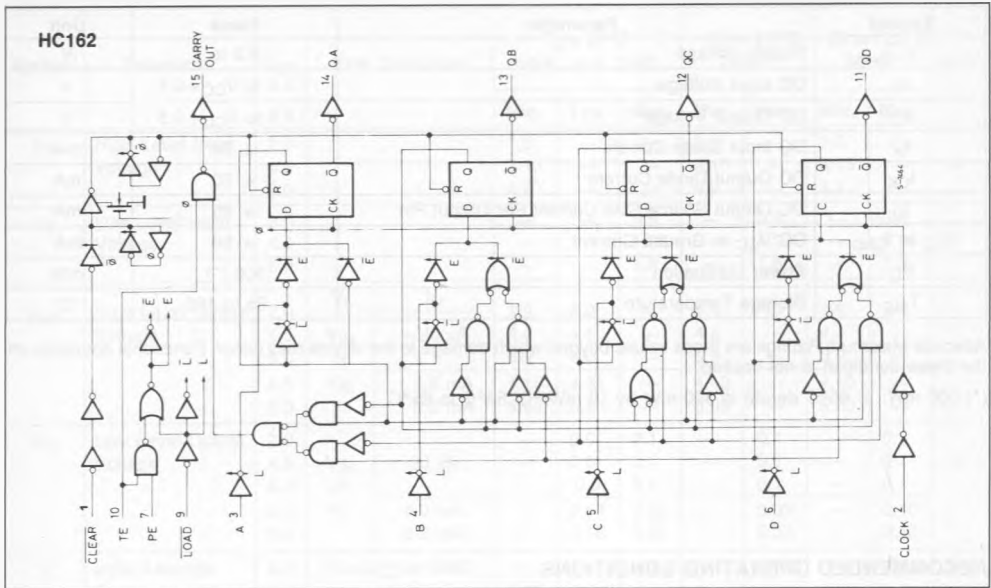
LOGIC DIAGRAM



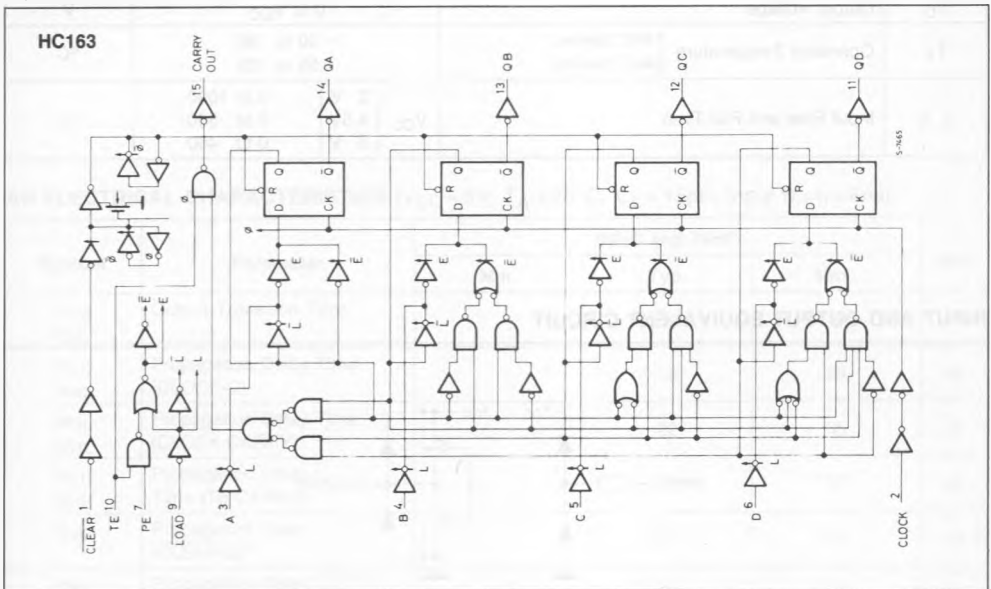
LOGIC DIAGRAM



LOGIC DIAGRAM



LOGIC DIAGRAM



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	± 20	mA
I _{OK}	DC Output Diode Current	± 20	mA
I _O	DC Output Source Sink Current Per Output Pin	± 25	mA
I _{CC} or I _{GND}	DC V _{CC} or Ground Current	± 50	mA
P _D	Power Dissipation	500 (*)	mW
T _{stg}	Storage Temperature	− 65 to 150	°C

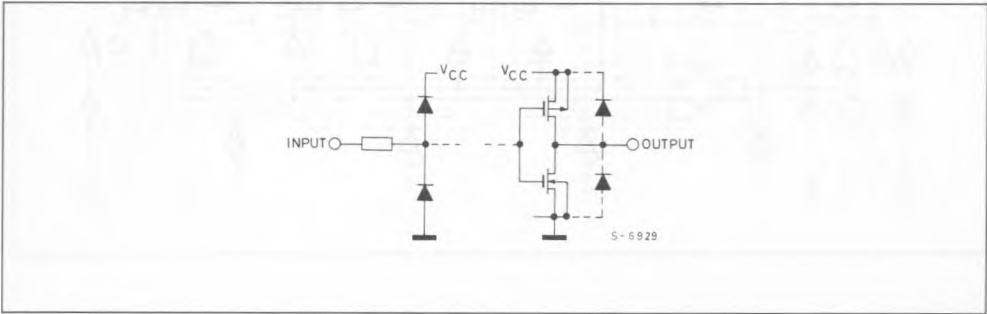
Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

(*) 500 mW: ≅ 65°C derate to 300 mW by 10 mW/°C: 65°C to 85°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 54HC Series	− 40 to 85 − 55 to 125	°C
t _r , t _f	Input Rise and Fall Time	V _{CC} { 2 V 0 to 1000 4.5V 0 to 500 6 V 0 to 400	ns

INPUT AND OUTPUT EQUIVALENT CIRCUIT



DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	V _{CC}	Test Condition		T _A = 25°C 54HC and 74HC			– 40 to 85°C 74HC		– 55 to 125°C 54HC		Unit
					Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
V _{IH}	High Level Input Voltage	2.0 4.5 6.0			1.5 3.15 4.2	— — —	— — —	1.5 3.15 4.2	— — —	1.5 3.15 4.2	— — —	V
V _{IL}	Low Level Input Voltage	2.0 4.5 6.0			— — —	— — —	0.5 1.35 1.8	— — —	0.5 1.35 1.8	— — —	0.5 1.35 1.8	V
V _{OH}	High Level Output Voltage	2.0	V _I or V _{IH} or V _{IL}	I _O – 20 μA – 4.0 mA – 5.2 mA	1.9	2.0	—	1.9	—	1.9	—	V
		4.5			4.5	—	4.4	—	4.4	—		
		6.0			5.9	6.0	—	5.9	—	5.9	—	
		4.5 6.0			4.18 5.68	4.31 5.8	— —	4.13 5.63	— —	4.10 5.60	— —	
V _{OL}	Low Level Output Voltage	2.0	V _{IH} or V _{IL}	20 μA 4.0 mA 5.2 mA	—	0.0	0.1	—	0.1	—	0.1	V
		4.5			—	0.0	0.1	—	0.1	—	0.1	
		6.0			—	0.0	0.1	—	0.1	—	0.1	
		4.5 6.0			— —	0.17 0.18	0.26 0.26	— —	0.33 0.33	— —	0.40 0.40	
I _I	Input Leakage Current	6.0	V _I = V _{CC} or GND		—	—	± 0.1	—	± 1.0	—	± 1.0	μA
I _{CC}	Quiescent Supply Current	6.0	V _I = V _{CC} or GND		—	—	4	—	40	—	80	μA

AC ELECTRICAL CHARACTERISTICS (V_{CC} = 5V, T_A = 25°C, C_L = 15pF, Input t_r = t_f = 6ns)

Symbol	Parameter	54HC and 74HC			Unit
		Min.	Typ.	Max.	
t _{TLH} t _{THL}	Output Transition Time		4	8	ns
t _{PLH} t _{PHL}	Propagation Delay Time (CLOCK-Q)		18	28	ns
t _{PHL} t _{PHL}	Propagation Delay Time (CLOCK-CARRY)		22	35	ns
t _{PLH} t _{PHH}	Propagation Delay Time (TE-CARRY)		10	17	ns
t _{PHL}	Propagation Delay (CLEAR-Q)*		21	33	ns
t _{PHL}	Propagation Delay time (CLEAR-CARRY)		23	37	ns
f _{MAX}	Maximum Clock Frequency	30	50		MHz

AC ELECTRICAL CHARACTERISTICS ($C_L = 50\text{pF}$, Input $t_r = t_f = 6\text{ns}$)

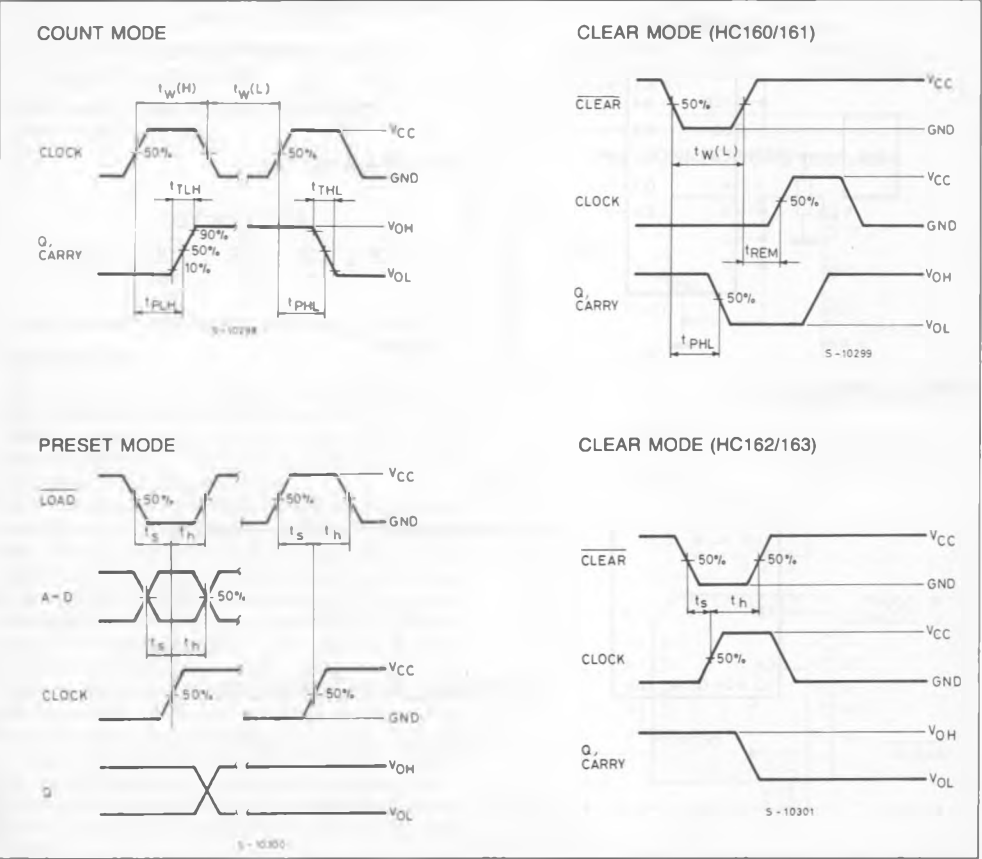
Symbol	Parameter	V_{CC}	Test Condition	$T_A = 25^\circ\text{C}$ 54HC and 74HC			- 40 to 85°C 74HC		- 55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_{TLH} t_{THL}	Output Transition Time	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - Q)	2.0 4.5 6.0		— — —	88 22 19	165 33 28	— — —	205 41 35	— — —	250 50 43	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK-CARRY)	2.0 4.5 6.0		— — —	104 26 22	200 40 34	— — —	250 50 43	— — —	300 60 51	ns
t_{PLH} t_{PHL}	Propagation Delay Time (TE-CARRY)	2.0 4.5 6.0		— — —	52 13 11	100 20 17	— — —	125 25 21	— — —	150 30 26	ns
t_{PHL}	Propagation Delay Time ($\overline{\text{CLEAR}}$ -Q)•	2.0 4.5 6.0		— — —	100 25 21	185 37 31	— — —	230 46 39	— — —	280 56 48	ns
t_{PHL}	Propagation Delay Time ($\overline{\text{CLEAR}}$ -CARRY)•	2.0 4.5 6.0		— — —	112 28 24	210 42 36	— — —	265 53 45	— — —	315 63 54	ns
f_{MAX}	Maximum Clock Frequency	2.0 4.5 6.0		5.4 27 32	11 45 53	— — —	4.4 22 26	— — —	3.5 18 21	— — —	MHz
$t_{W(H)}$ $t_{W(L)}$	Minimum Pulse Width (CLOCK)	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
$t_{W(L)}$	Minimum Pulse Width ($\overline{\text{CLEAR}}$)•	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_s	Minimum Set-up Time (LOAD PE, TE)	2.0 4.5 6.0		— — —	50 13 11	125 25 21	— — —	155 31 26	— — —	190 38 22	ns
t_s	Minimum Set-up Time (A,B,C,D)	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_s	Minimum Set-up Time ($\overline{\text{CLEAR}}$) ••	2.0 4.5 6.0		— — —	35 9 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_h	Minimum Hold Time	2.0 4.5 6.0		— — —	— — —	0 0 0	— — —	0 0 0	0 0 0	0 0 0	ns

AC ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	V _{CC}	Test Condition	T _A = 25°C 54HC and 74HC			- 40 to 85°C 74HC		- 55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t _{REM}	Minimum Time (CLEAR)*	2.0 4.5 6.0		—	5 1 1	50 10 9	—	65 13 11	—	75 15 13	ns
C _{IN}	Input Capacitance			—	5	7.5	—	7.5	—	—	pF
C _{PD} (*)	Power Dissipation Capacitance			—	57	—	—	—	—	—	pF

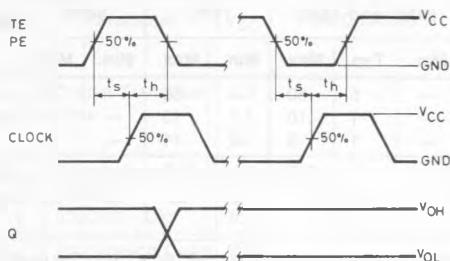
Note (*) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the following equation.
 $I_{CC} (Opr) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$ *: for M54/74HC160/161 only **: for M54/74HC162/163 only

SWITCHING CHARACTERISTICS TEST WAVEFORM

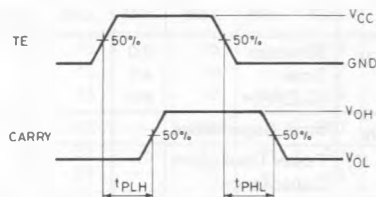


SWITCHING CHARACTERISTICS TEST WAVEFORM (Continued)

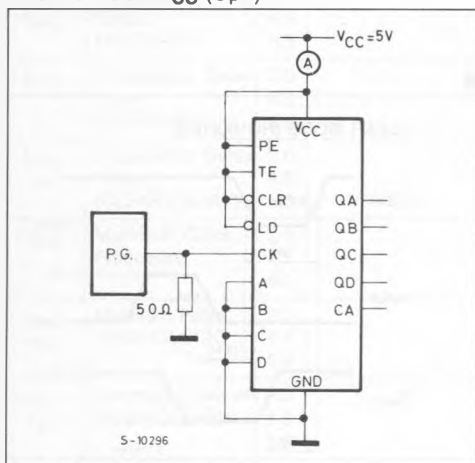
COUNT ENABLE MODE



S - 10302

CASCADE MODE
(Fix Maximum Count)

S - 10303

TEST CIRCUIT I_{CC} (Opr.)

S - 10296

TOTAL OPERATING CURRENT WHEN USING A CAPACITIVE LOAD

When the outputs drive a capacitive load, the total current can be calculated as follows:
For M74HC160/162:

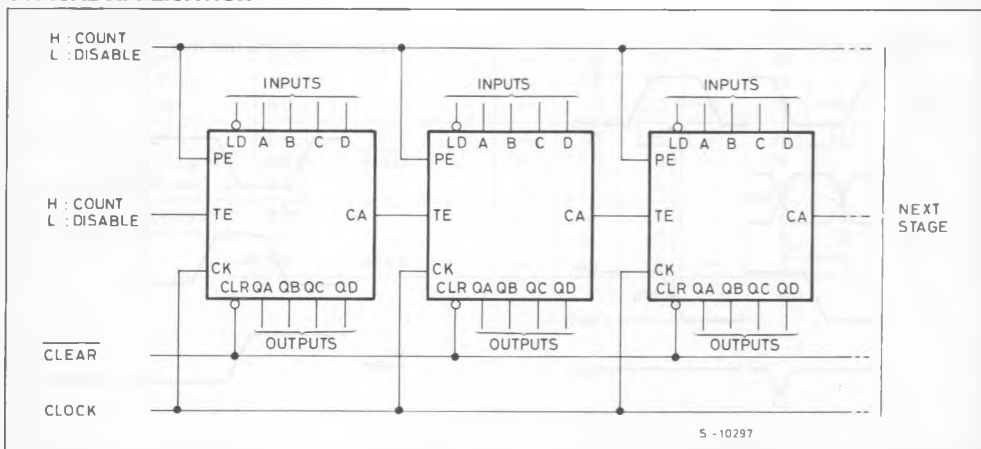
$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \cdot \left(\frac{C_a}{2} + \frac{C_b}{5} + \frac{C_c}{10} + \frac{C_d}{10} + \frac{C_{ca}}{10} \right)$$

For M74HC161/163

$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \cdot \left(\frac{C_a}{2} + \frac{C_b}{4} + \frac{C_c}{8} + \frac{C_d}{16} + \frac{C_{ca}}{16} \right)$$

C_a to C_{ca} are the capacitors loading the outputs.

TYPICAL APPLICATION



S - 10297