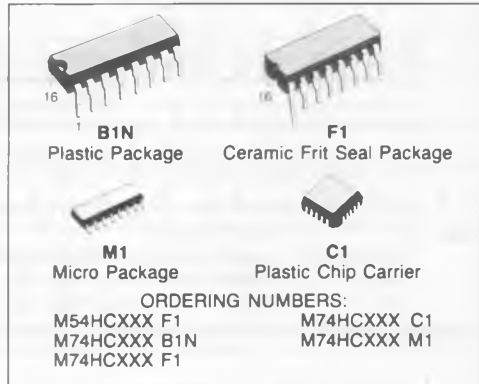


## SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- **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 C<sup>2</sup>MOS 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.

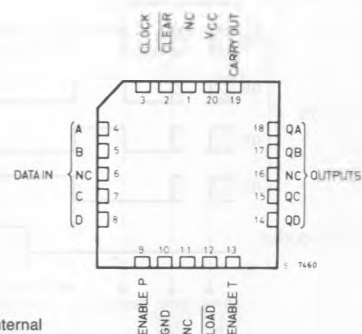
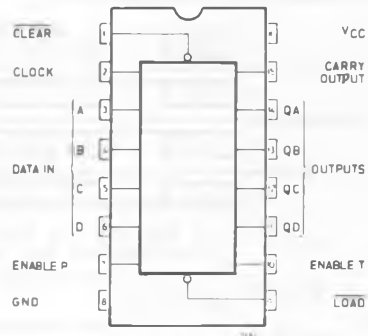
Presetting of all four IC's is synchronous on the rising edge of the **CLOCK**.

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)



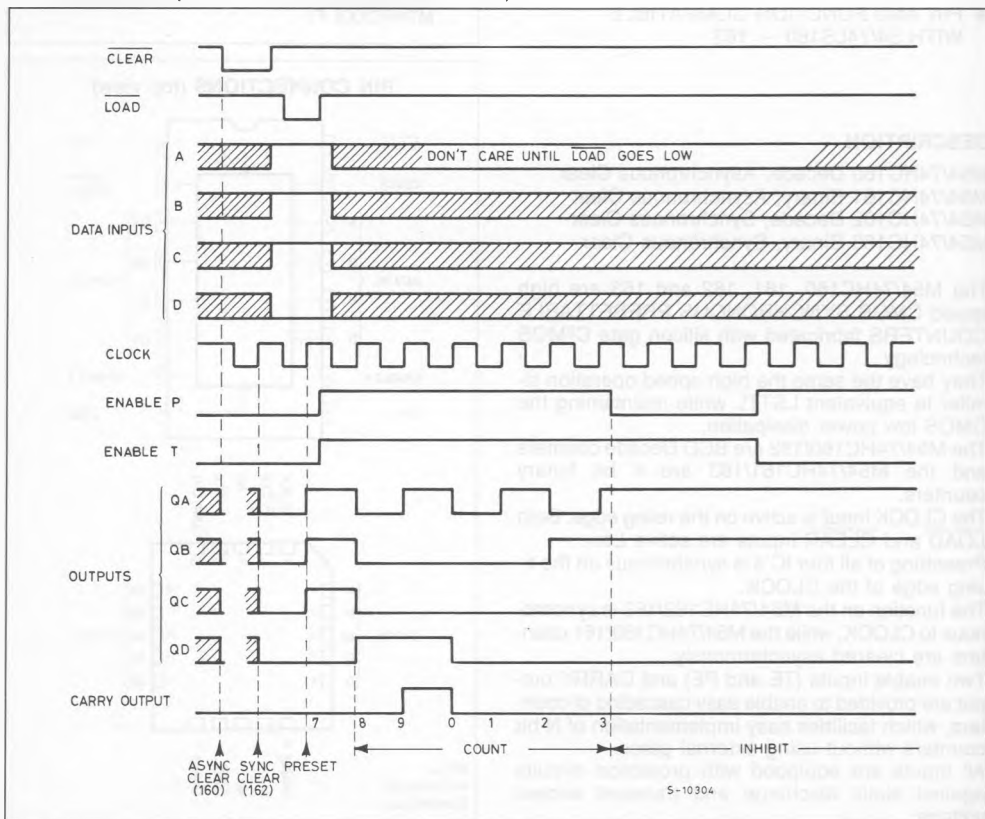
NC =  
No Internal  
Connection

## TRUTH TABLE

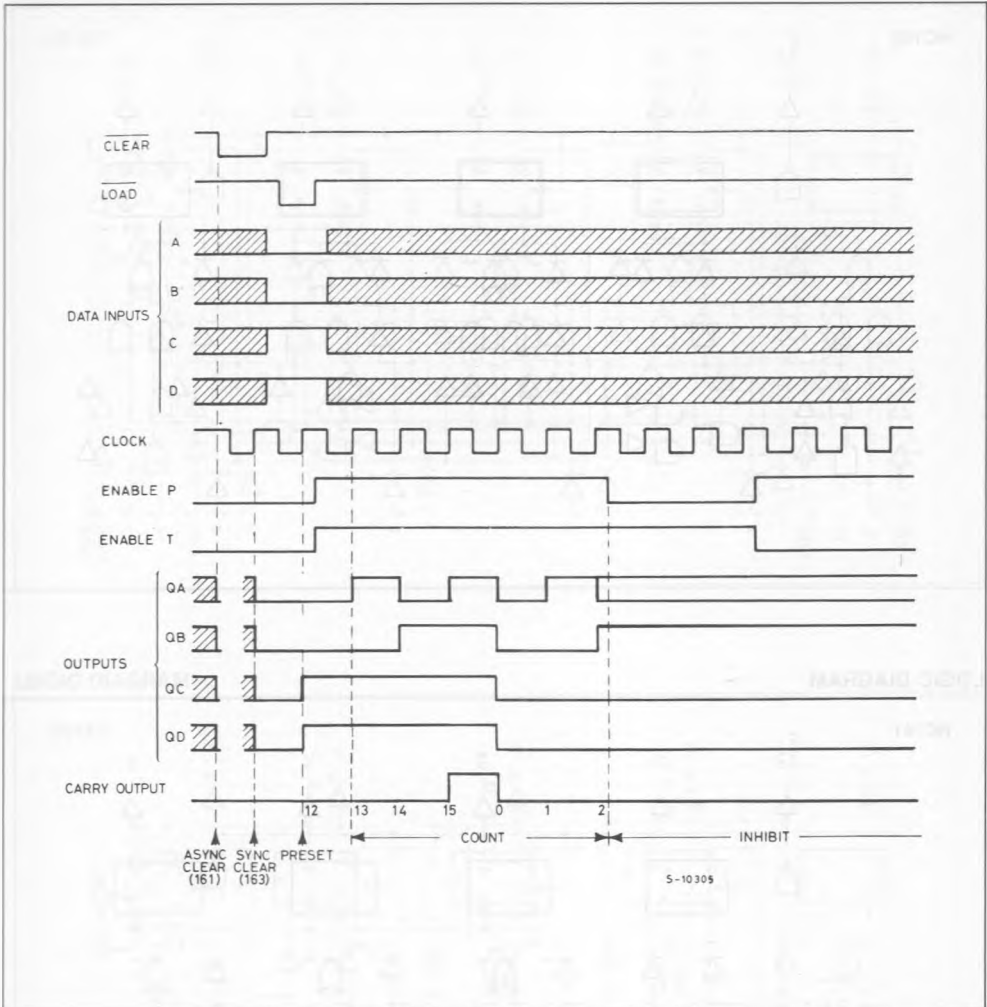
| M54/74HC160/161 |    |    |    |    | M54/74HC162/163 |    |    |    |    | OUTPUTS   |    |    |    | FUNCTION     |
|-----------------|----|----|----|----|-----------------|----|----|----|----|-----------|----|----|----|--------------|
| INPUTS          |    |    |    |    | INPUTS          |    |    |    |    |           |    |    |    |              |
| 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)

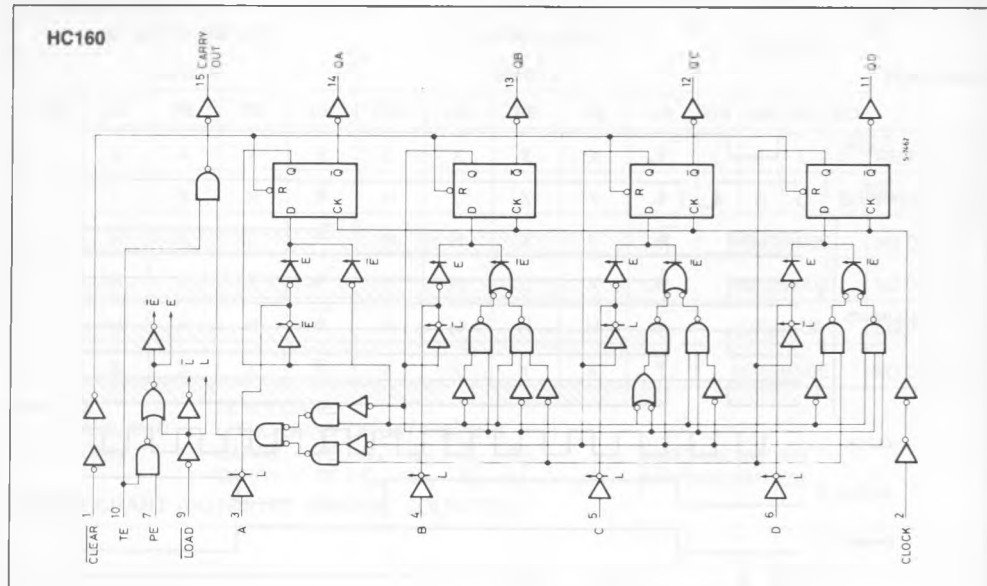
## TIMING CHART (HC160/162: DECADE COUNTER)



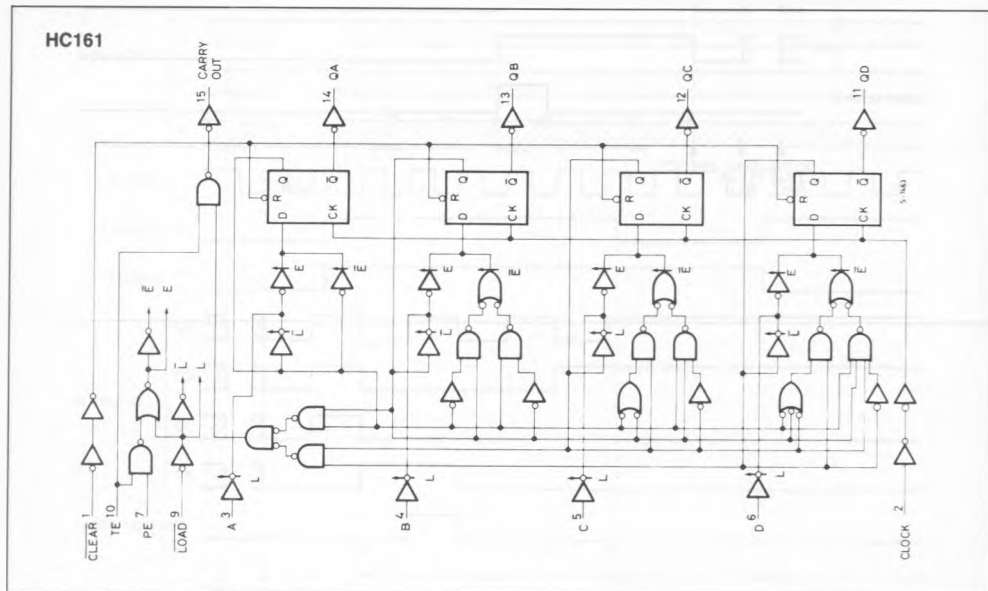
## TIMING CHART (HC161/163: BINARY COUNTER)



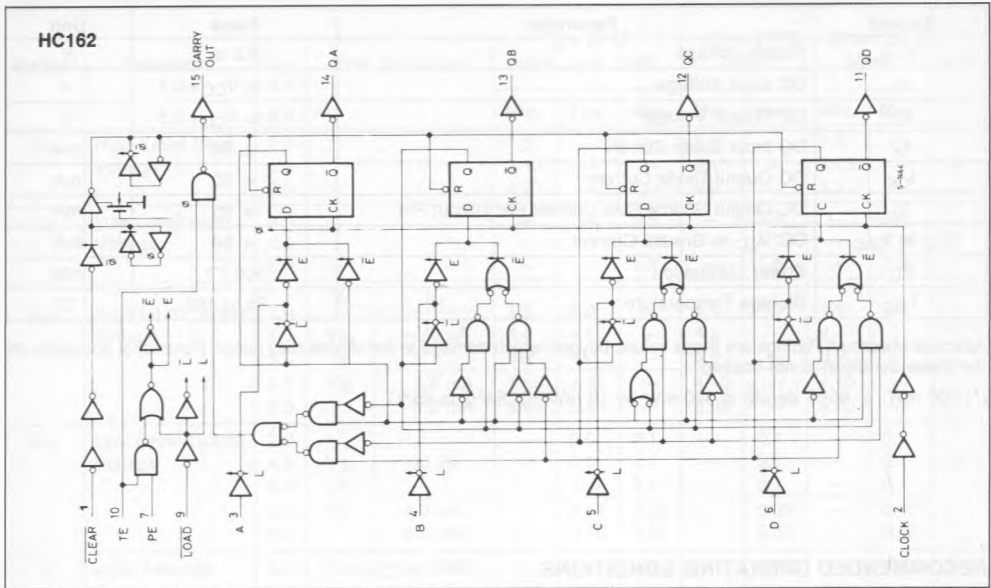
## LOGIC DIAGRAM



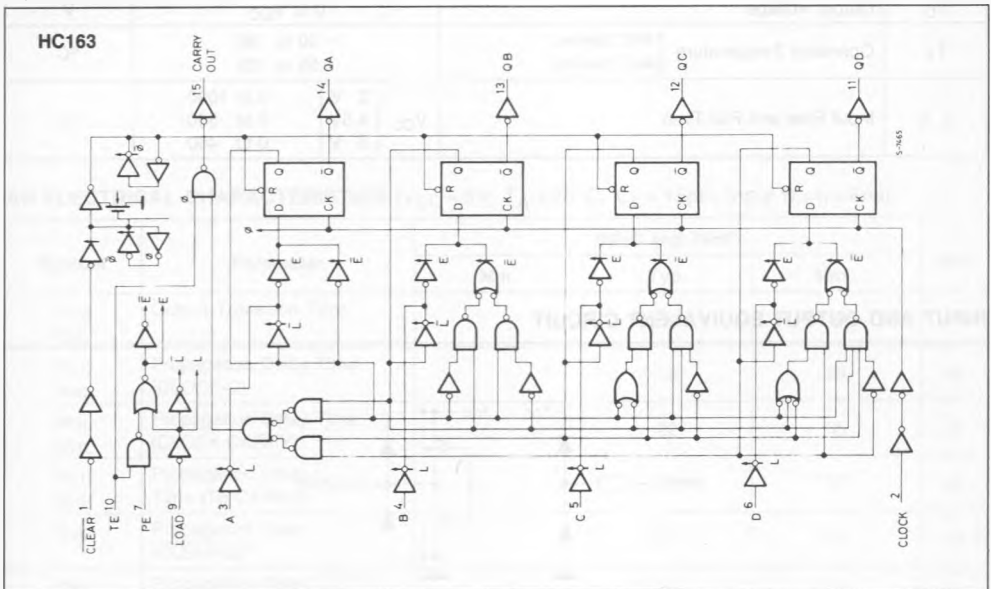
## LOGIC DIAGRAM



## 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                       | $\pm 20$                | 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             | $^{\circ}\text{C}$ |

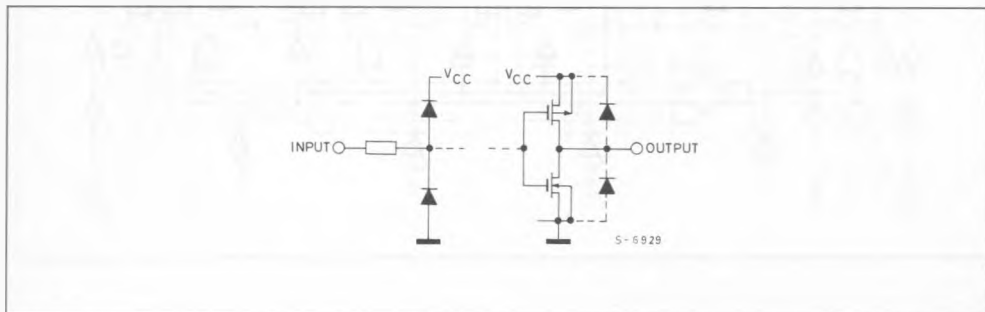
Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

(\*) 500 mW:  $\cong 65^{\circ}\text{C}$  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<br>74HC Series<br>54HC Series | - 40 to 85<br>- 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                 |

## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## DC ELECTRICAL CHARACTERISTICS

| Symbol          | Parameter                 | V <sub>CC</sub>   | Test Condition                                                   |                                                           | T <sub>A</sub> = 25°C<br>54HC and 74HC |             |                    | – 40 to 85°C<br>74HC |                    | – 55 to 125°C<br>54HC |                    | Unit |
|-----------------|---------------------------|-------------------|------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------|-------------|--------------------|----------------------|--------------------|-----------------------|--------------------|------|
|                 |                           |                   |                                                                  |                                                           | Min.                                   | Typ.        | Max.               | Min.                 | Max.               | Min.                  | Max.               |      |
| V <sub>IH</sub> | High Level Input Voltage  | 2.0<br>4.5<br>6.0 |                                                                  |                                                           | 1.5<br>3.15<br>4.2                     | —<br>—<br>— | —<br>—<br>—        | 1.5<br>3.15<br>4.2   | —<br>—<br>—        | 1.5<br>3.15<br>4.2    | —<br>—<br>—        | V    |
| V <sub>IL</sub> | Low Level Input Voltage   | 2.0<br>4.5<br>6.0 |                                                                  |                                                           | —<br>—<br>—                            | —<br>—<br>— | 0.5<br>1.35<br>1.8 | —<br>—<br>—          | 0.5<br>1.35<br>1.8 | —<br>—<br>—           | 0.5<br>1.35<br>1.8 | V    |
| V <sub>OH</sub> | High Level Output Voltage | 2.0               | V <sub>I</sub><br>or<br>V <sub>IH</sub><br>or<br>V <sub>IL</sub> | I <sub>O</sub><br><br>– 20 μA<br><br>– 4.0 mA<br>– 5.2 mA | 1.9                                    | 2.0         | —                  | 1.9                  | —                  | 1.9                   | —                  | V    |
|                 |                           | 4.4               |                                                                  |                                                           | 4.5                                    | —           | 4.4                | —                    | 4.4                | —                     |                    |      |
|                 |                           | 5.9               |                                                                  |                                                           | 6.0                                    | —           | 5.9                | —                    | 5.9                | —                     |                    |      |
|                 |                           | 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><br>or<br>V <sub>IL</sub>                         | 20 μA<br><br>4.0 mA<br>5.2 mA                             | —                                      | 0.0         | 0.1                | —                    | 0.1                | —                     | 0.1                | V    |
|                 |                           | —                 |                                                                  |                                                           | 0.0                                    | 0.1         | —                  | 0.1                  | —                  | 0.1                   | —                  |      |
|                 |                           | —                 |                                                                  |                                                           | 0.0                                    | 0.1         | —                  | 0.1                  | —                  | 0.1                   | —                  |      |
|                 |                           | —                 |                                                                  |                                                           | 0.17                                   | 0.26        | —                  | 0.33                 | —                  | 0.40                  | —                  |      |
|                 |                           | 6.0               |                                                                  |                                                           | —                                      | 0.18        | 0.26               | —                    | 0.33               | —                     | 0.40               | —    |
| I <sub>I</sub>  | Input Leakage Current     | 6.0               | V <sub>I</sub> = V <sub>CC</sub> or GND                          |                                                           | —                                      | —           | ± 0.1              | —                    | ± 1.0              | —                     | ± 1.0              | μA   |
| I <sub>CC</sub> | Quiescent Supply Current  | 6.0               | V <sub>I</sub> = V <sub>CC</sub> or GND                          |                                                           | —                                      | —           | 4                  | —                    | 40                 | —                     | 80                 | μA   |

AC ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C, C<sub>L</sub> = 15pF, Input t<sub>r</sub> = t<sub>f</sub> = 6ns)

| Symbol                               | Parameter                            | 54HC and 74HC |      |      | Unit |
|--------------------------------------|--------------------------------------|---------------|------|------|------|
|                                      |                                      | Min.          | Typ. | Max. |      |
| t <sub>TLH</sub><br>t <sub>THL</sub> | Output Transition Time               |               | 4    | 8    | ns   |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay Time (CLOCK-Q)     |               | 18   | 28   | ns   |
| t <sub>PHL</sub><br>t <sub>PHL</sub> | Propagation Delay Time (CLOCK-CARRY) |               | 22   | 35   | ns   |
| t <sub>PLH</sub><br>t <sub>PHH</sub> | Propagation Delay Time (TE-CARRY)    |               | 10   | 17   | ns   |
| t <sub>PHL</sub>                     | Propagation Delay (CLEAR-Q)*         |               | 21   | 33   | ns   |
| t <sub>PHL</sub>                     | Propagation Delay time (CLEAR-CARRY) |               | 23   | 37   | ns   |
| f <sub>MAX</sub>                     | 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 | $T_A = 25^\circ\text{C}$<br>54HC and 74HC |                 |                 | - 40 to $85^\circ\text{C}$<br>74HC |                 | - 55 to $125^\circ\text{C}$<br>54HC |                 | Unit |
|--------------------------|----------------------------------------------------------------|-------------------|----------------|-------------------------------------------|-----------------|-----------------|------------------------------------|-----------------|-------------------------------------|-----------------|------|
|                          |                                                                |                   |                | Min.                                      | Typ.            | Max.            | Min.                               | Max.            | Min.                                | Max.            |      |
| $t_{TLH}$<br>$t_{THL}$   | Output Transition Time                                         | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 30<br>8<br>7    | 75<br>15<br>13  | —<br>—<br>—                        | 95<br>19<br>16  | —<br>—<br>—                         | 110<br>22<br>19 | ns   |
| $t_{PLH}$<br>$t_{PHL}$   | Propagation Delay Time<br>(CLOCK - Q)                          | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 88<br>22<br>19  | 165<br>33<br>28 | —<br>—<br>—                        | 205<br>41<br>35 | —<br>—<br>—                         | 250<br>50<br>43 | ns   |
| $t_{PLH}$<br>$t_{PHL}$   | Propagation Delay Time<br>(CLOCK-CARRY)                        | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 104<br>26<br>22 | 200<br>40<br>34 | —<br>—<br>—                        | 250<br>50<br>43 | —<br>—<br>—                         | 300<br>60<br>51 | ns   |
| $t_{PLH}$<br>$t_{PHL}$   | Propagation Delay Time<br>(TE-CARRY)                           | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 52<br>13<br>11  | 100<br>20<br>17 | —<br>—<br>—                        | 125<br>25<br>21 | —<br>—<br>—                         | 150<br>30<br>26 | ns   |
| $t_{PHL}$                | Propagation Delay Time<br>( $\overline{\text{CLEAR}}$ -Q)•     | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 100<br>25<br>21 | 185<br>37<br>31 | —<br>—<br>—                        | 230<br>46<br>39 | —<br>—<br>—                         | 280<br>56<br>48 | ns   |
| $t_{PHL}$                | Propagation Delay Time<br>( $\overline{\text{CLEAR}}$ -CARRY)• | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 112<br>28<br>24 | 210<br>42<br>36 | —<br>—<br>—                        | 265<br>53<br>45 | —<br>—<br>—                         | 315<br>63<br>54 | ns   |
| $f_{MAX}$                | Maximum Clock Frequency                                        | 2.0<br>4.5<br>6.0 |                | 5.4<br>27<br>32                           | 11<br>45<br>53  | —<br>—<br>—     | 4.4<br>22<br>26                    | —<br>—<br>—     | 3.5<br>18<br>21                     | —<br>—<br>—     | MHz  |
| $t_{W(H)}$<br>$t_{W(L)}$ | Minimum Pulse Width (CLOCK)                                    | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 30<br>8<br>7    | 75<br>15<br>13  | —<br>—<br>—                        | 95<br>19<br>16  | —<br>—<br>—                         | 110<br>22<br>19 | ns   |
| $t_{W(L)}$               | Minimum Pulse Width ( $\overline{\text{CLEAR}}$ )•             | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 30<br>8<br>7    | 75<br>15<br>13  | —<br>—<br>—                        | 95<br>19<br>16  | —<br>—<br>—                         | 110<br>22<br>19 | ns   |
| $t_s$                    | Minimum Set-up Time<br>(LOAD PE, TE)                           | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 50<br>13<br>11  | 125<br>25<br>21 | —<br>—<br>—                        | 155<br>31<br>26 | —<br>—<br>—                         | 190<br>38<br>22 | ns   |
| $t_s$                    | Minimum Set-up Time<br>(A,B,C,D)                               | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 30<br>8<br>7    | 75<br>15<br>13  | —<br>—<br>—                        | 95<br>19<br>16  | —<br>—<br>—                         | 110<br>22<br>19 | ns   |
| $t_s$                    | Minimum Set-up Time<br>( $\overline{\text{CLEAR}}$ ) ••        | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | 35<br>9<br>7    | 75<br>15<br>13  | —<br>—<br>—                        | 95<br>19<br>16  | —<br>—<br>—                         | 110<br>22<br>19 | ns   |
| $t_h$                    | Minimum Hold Time                                              | 2.0<br>4.5<br>6.0 |                | —<br>—<br>—                               | —<br>—<br>—     | 0<br>0<br>0     | —<br>—<br>—                        | 0<br>0<br>0     | 0<br>0<br>0                         | 0<br>0<br>0     | ns   |

## AC ELECTRICAL CHARACTERISTICS (Continued)

| Symbol              | Parameter                     | V <sub>CC</sub>   | Test Condition | T <sub>A</sub> = 25°C<br>54HC and 74HC |             |               | - 40 to 85°C<br>74HC |                | - 55 to 125°C<br>54HC |                | Unit |
|---------------------|-------------------------------|-------------------|----------------|----------------------------------------|-------------|---------------|----------------------|----------------|-----------------------|----------------|------|
|                     |                               |                   |                | Min.                                   | Typ.        | Max.          | Min.                 | Max.           | Min.                  | Max.           |      |
| t <sub>REM</sub>    | Minimum Time (CLEAR)*         | 2.0<br>4.5<br>6.0 |                | —                                      | 5<br>1<br>1 | 50<br>10<br>9 | —                    | 65<br>13<br>11 | —                     | 75<br>15<br>13 | ns   |
| C <sub>IN</sub>     | Input Capacitance             |                   |                | —                                      | 5           | 7.5           | —                    | 7.5            | —                     | —              | pF   |
| C <sub>PD</sub> (*) | Power Dissipation Capacitance |                   |                | —                                      | 57          | —             | —                    | —              | —                     | —              | 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. Average operating current can be obtained by the following equation.

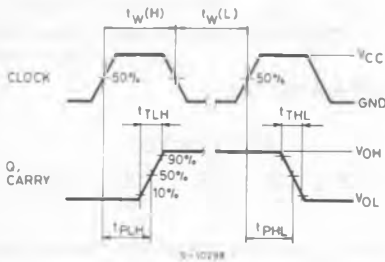
$$I_{CC}(\text{Opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

\*: for M54/74HC160/161 only

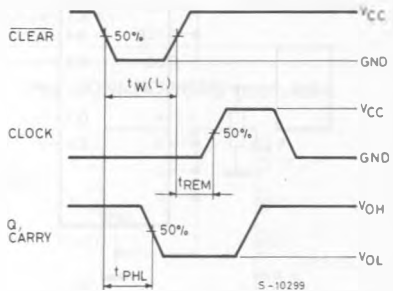
\*\* : for M54/74HC162/163 only

## SWITCHING CHARACTERISTICS TEST WAVEFORM

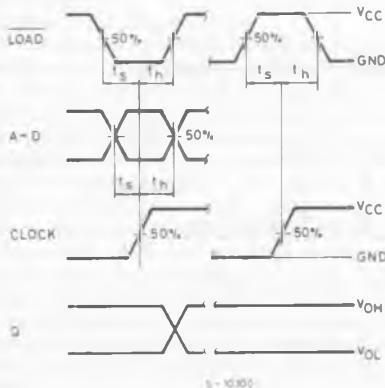
## COUNT MODE



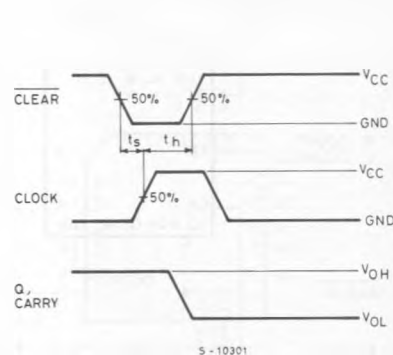
## CLEAR MODE (HC160/161)



## PRESET MODE

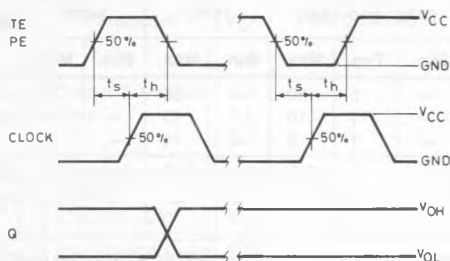


## CLEAR MODE (HC162/163)

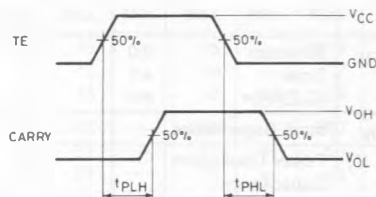


## SWITCHING CHARACTERISTICS TEST WAVEFORM (Continued)

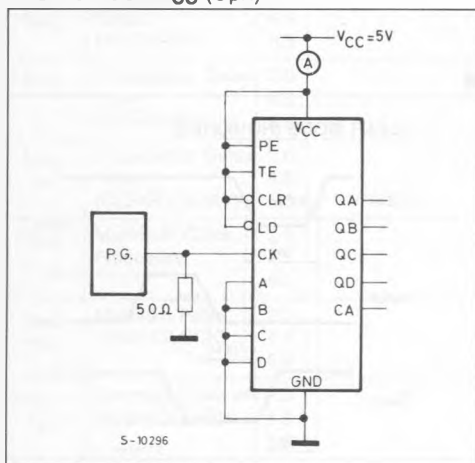
## COUNT ENABLE MODE



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:

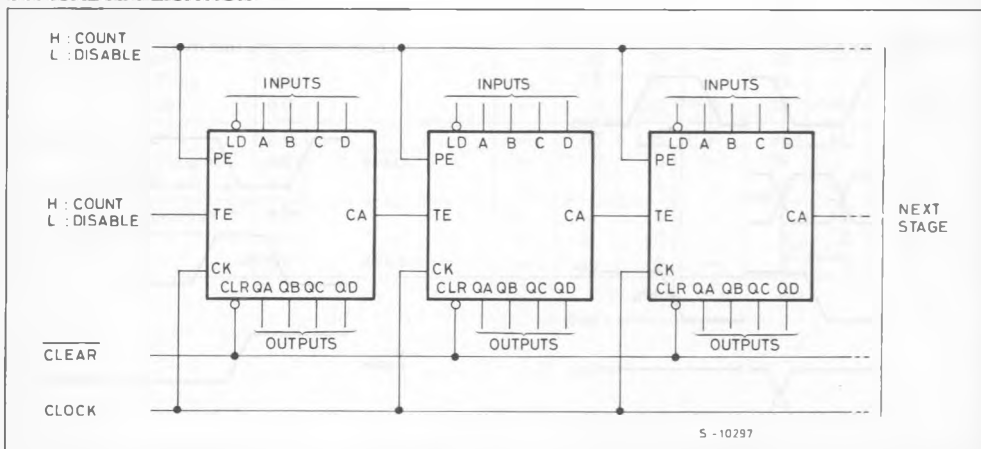
$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \cdot \left( \frac{C_a}{2} + \frac{C_b}{5} + \frac{C_c}{10} + \frac{C_d}{10} + \frac{C_{ca}}{10} \right)$$

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