

## SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- HIGH SPEED  
 $f_{MAX} = 50 \text{ MHz (TYP.) AT } V_{CC} = 5 \text{ V}$
- LOW POWER DISSIPATION  
 $I_{CC} = 4 \mu\text{A (MAX.) AT } 25^\circ\text{C}$
- OUTPUT DRIVE CAPABILITY  
 10 LSTTL LOADS
- BALANCED PROPAGATION DELAYS  
 $t_{PLH} = t_{PHL}$
- SYMMETRICAL OUTPUT IMPEDANCE  
 $I_{OH} = I_{OL} = 4 \text{ mA (MIN.)}$
- COMPATIBLE WITH TTL OUTPUTS  
 $V_{IH} = 2 \text{ V (MIN.)}; V_{IL} = 0.8 \text{ V (MAX.)}$
- PIN AND FUNCTION COMPATIBLE  
 WITH 54/74LS160 ~ 163

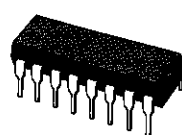
### DESCRIPTION

M54/74HCT160 Decade, Asynchronous Clear  
 M54/74HCT161 Binary, Asynchronous Clear  
 M54/74HCT162 Decade, Synchronous Clear  
 M54/74HCT163 Binary, Synchronous Clear

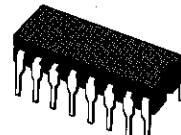
The M54/74HCT160, 161, 162 and 163 are high speed CMOS SYNCHRONOUS PRESETTABLE COUNTERS fabricated with silicon gate  $C^2$ MOS technology. They have the same high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The M54/74HCT160/162 are BCD Decade counters and the M54/74HCT161/163 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 M54/74HCT162/163 is synchronous to **CLOCK**, while the M54/74HCT160/161 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. This integrated circuit has input and output characteristics that are fully compatible with 54/74 LSTTL logic families. M54/74HCT devices are designed to directly interface HSC<sup>2</sup>MOS systems with TTL and NMOS components. They are also plug in replacements for LSTTL devices giving a reduction of power consumption. All inputs are equipped with



**B1R**  
(Plastic Package)



**F1R**  
(Ceramic Package)



**M1R**  
(Micro Package)

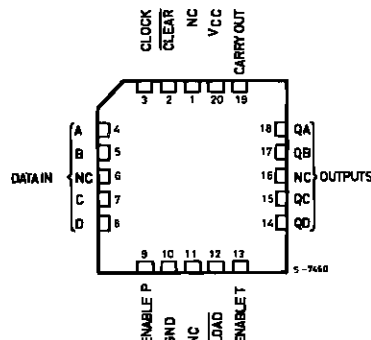
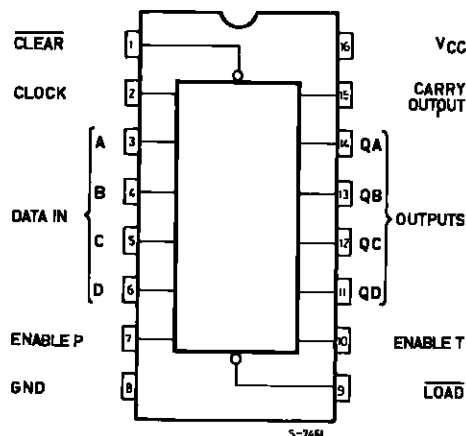


**C1R**  
(Chip Carrier)

#### ORDER CODES :

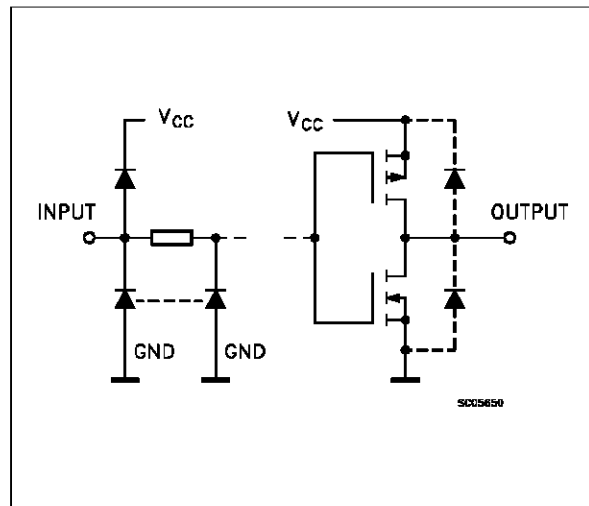
|              |              |
|--------------|--------------|
| M54HCTXXXF1R | M74HCTXXXM1R |
| M74HCTXXXB1R | M74HCTXXXC1R |

#### PIN CONNECTIONS (top view)



NC =  
No Internal Con-

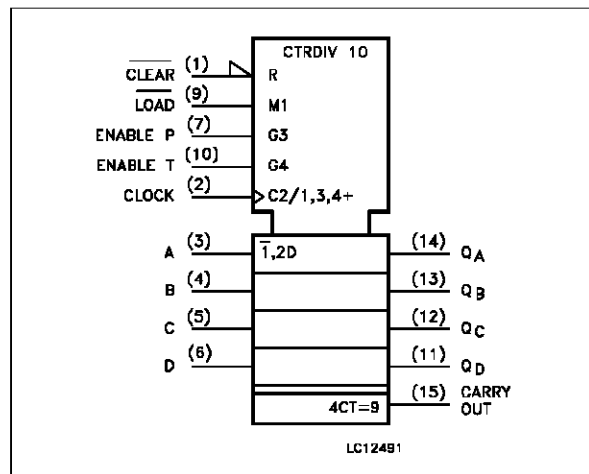
## INPUT AND OUTPUT EQUIVALENT CIRCUIT



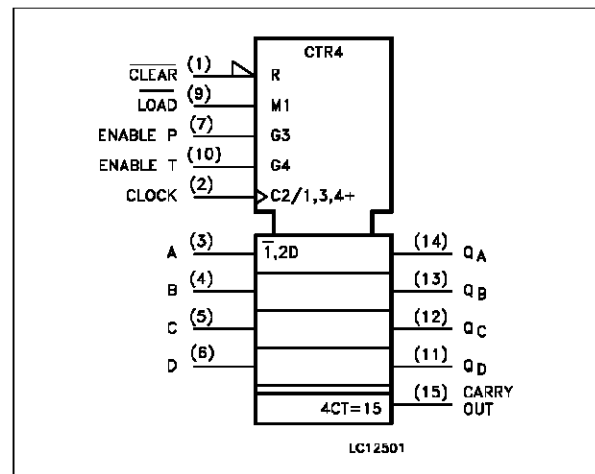
## PIN DESCRIPTION

| PIN No         | SYMBOL       | NAME AND FUNCTION                         |
|----------------|--------------|-------------------------------------------|
| 1              | CLEAR        | Master Reset                              |
| 2              | CLOCK        | Clock Input (LOW to HIGH, Edge-triggered) |
| 3, 4, 5, 6     | A, B, C, D   | Data Inputs                               |
| 7              | ENABLE P     | Count Enable Input                        |
| 10             | ENABLE T     | Count Enable Carry Input                  |
| 9              | LOAD         | Parallel Enable Input                     |
| 14, 13, 12, 11 | QA to QD     | Flip Flop Outputs                         |
| 15             | CARRY OUTPUT | Terminal Count Output                     |
| 8              | GND          | Ground (0V)                               |
| 16             | Vcc          | Positive Supply Voltage                   |

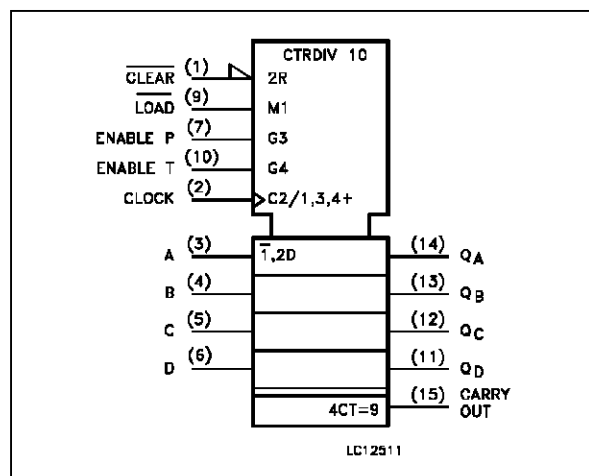
## IEC LOGIC SYMBOL (HCT160)



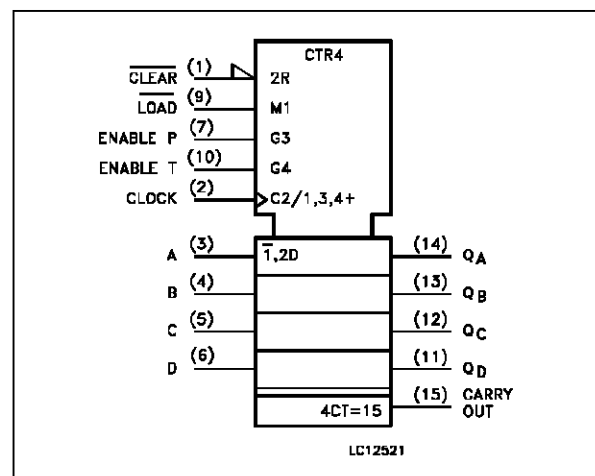
## IEC LOGIC SYMBOL (HCT161)



## IEC LOGIC SYMBOL (HCT162)



## IEC LOGIC SYMBOL (HCT163)

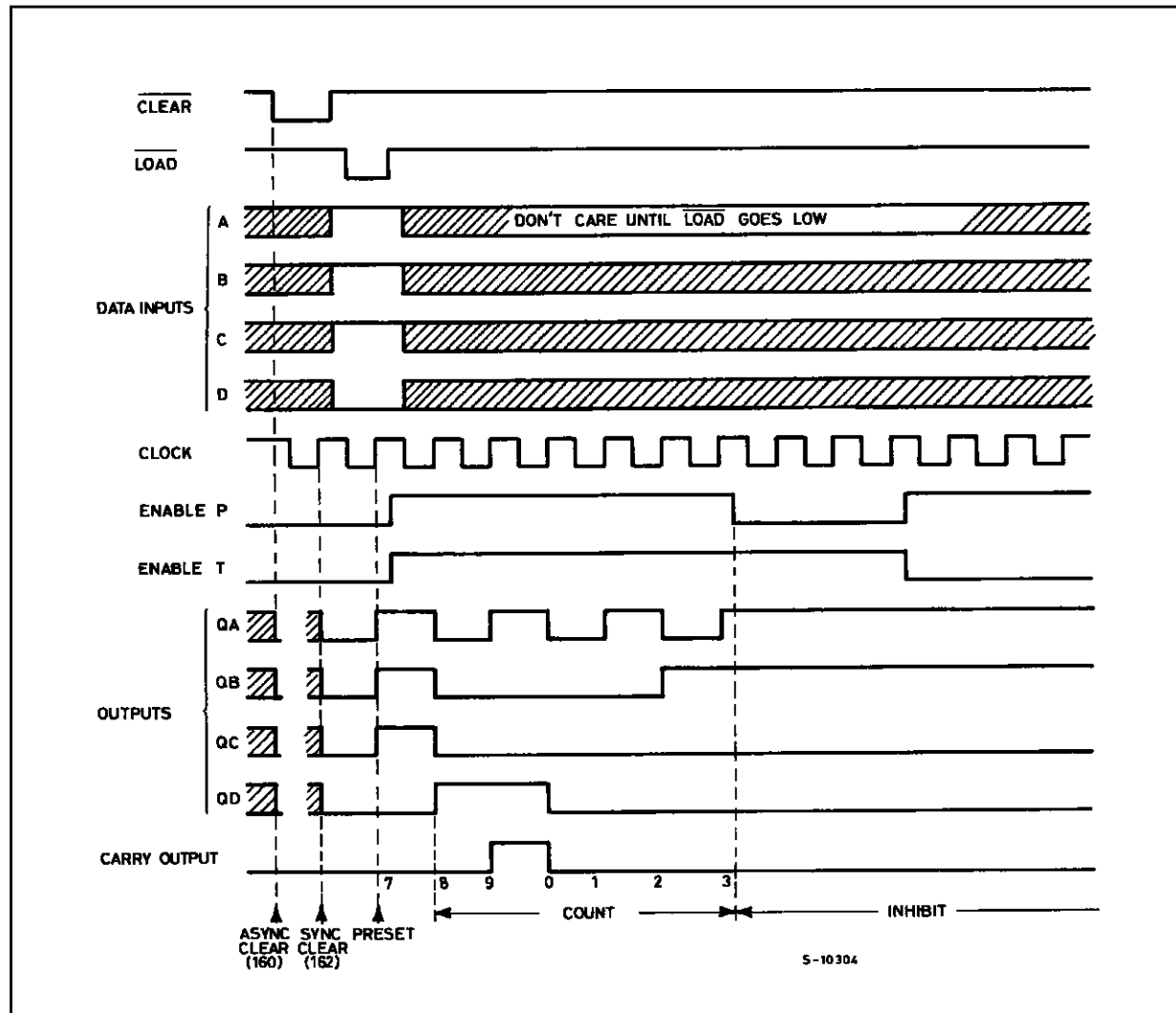


## TRUTH TABLE

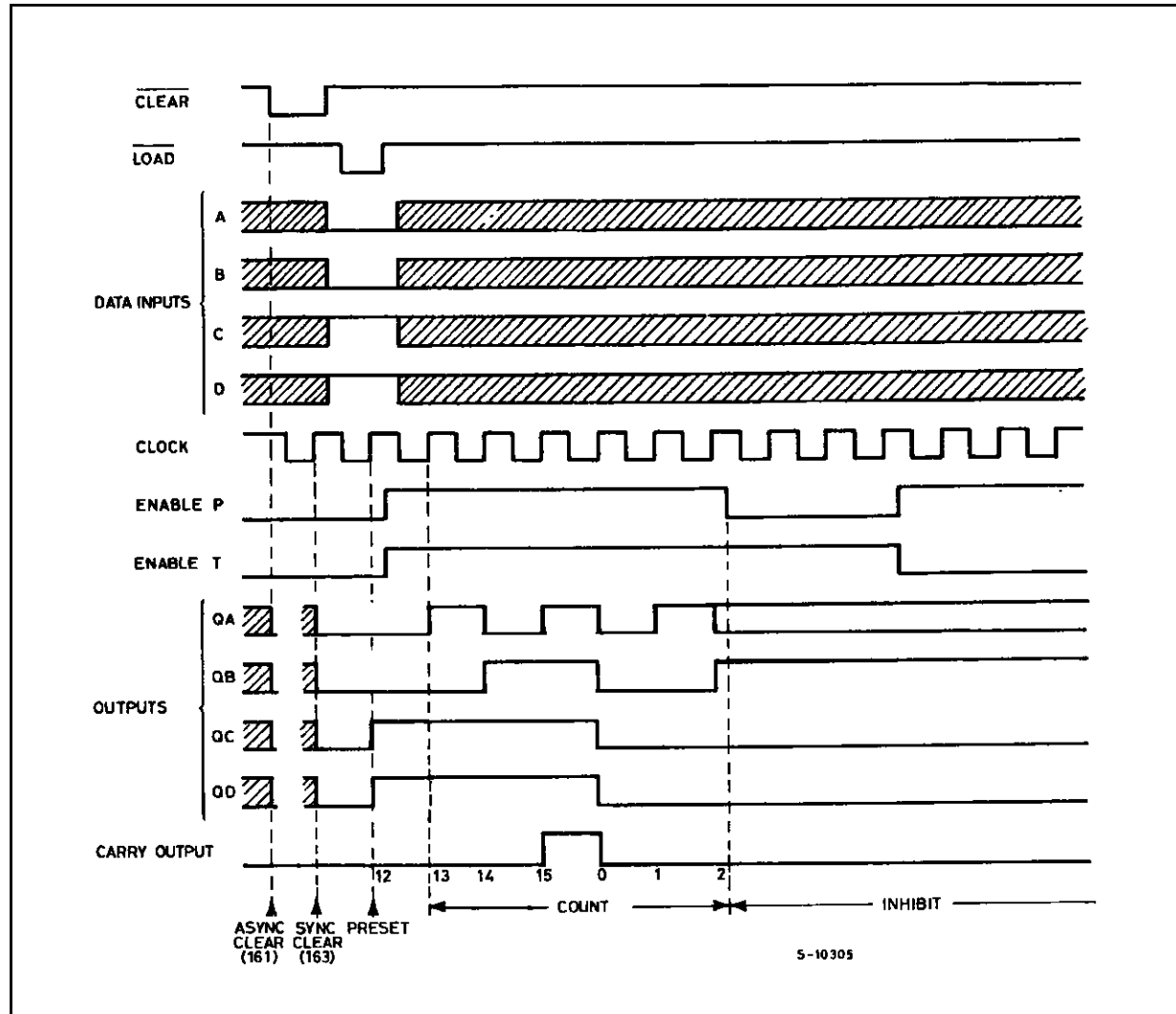
| M54/74HCT160/161 |    |    |    |    | M54/74HCT162/163 |    |    |    |    | OUTPUTS   |    |    |    | FUNCTION     |
|------------------|----|----|----|----|------------------|----|----|----|----|-----------|----|----|----|--------------|
| INPUTS           |    |    |    |    | INPUTS           |    |    |    |    |           |    |    |    |              |
| 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 :  $CARRY = TE \cdot Q_A \cdot Q_B \cdot \bar{Q}_C \cdot Q_D$  ..... (M54/74HCT160/162)  
:  $CARRY = TE \cdot Q_A \cdot Q_B \cdot Q_C \cdot Q_D$  ..... (M54/74HCT161/163)

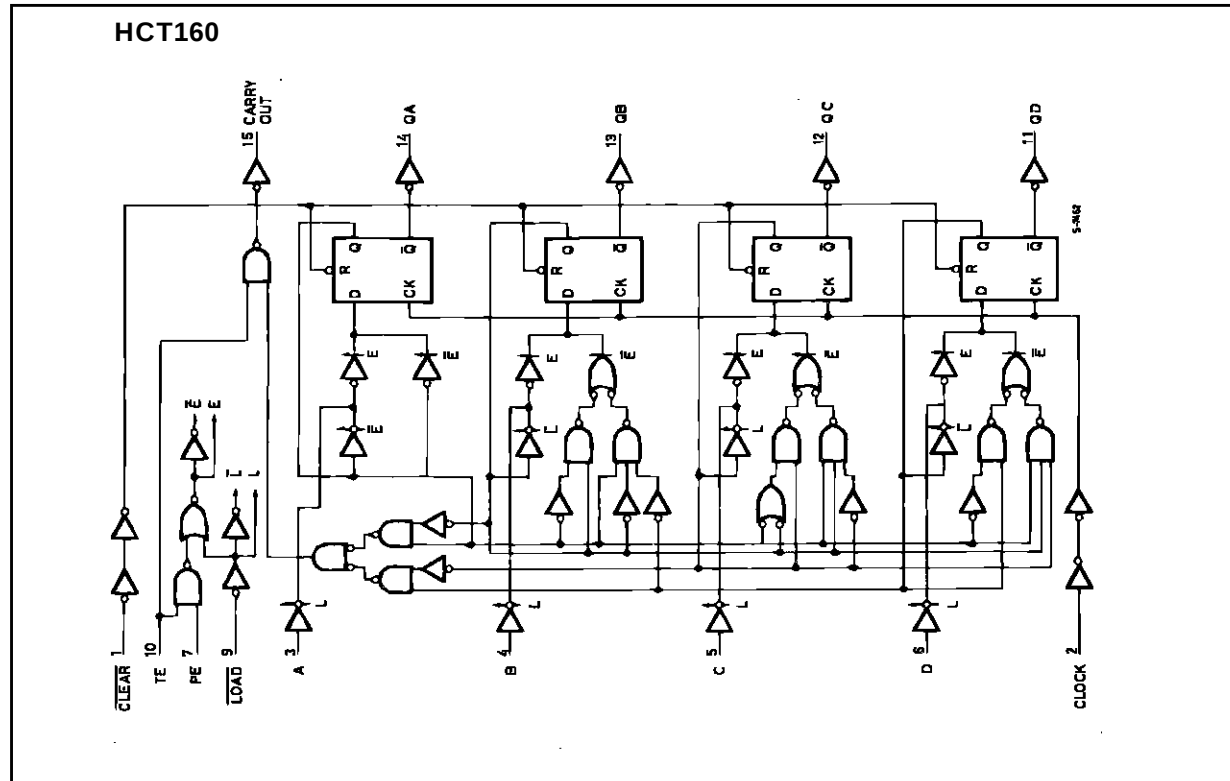
## TIMING CHART (HCT160/162 : decade counter)



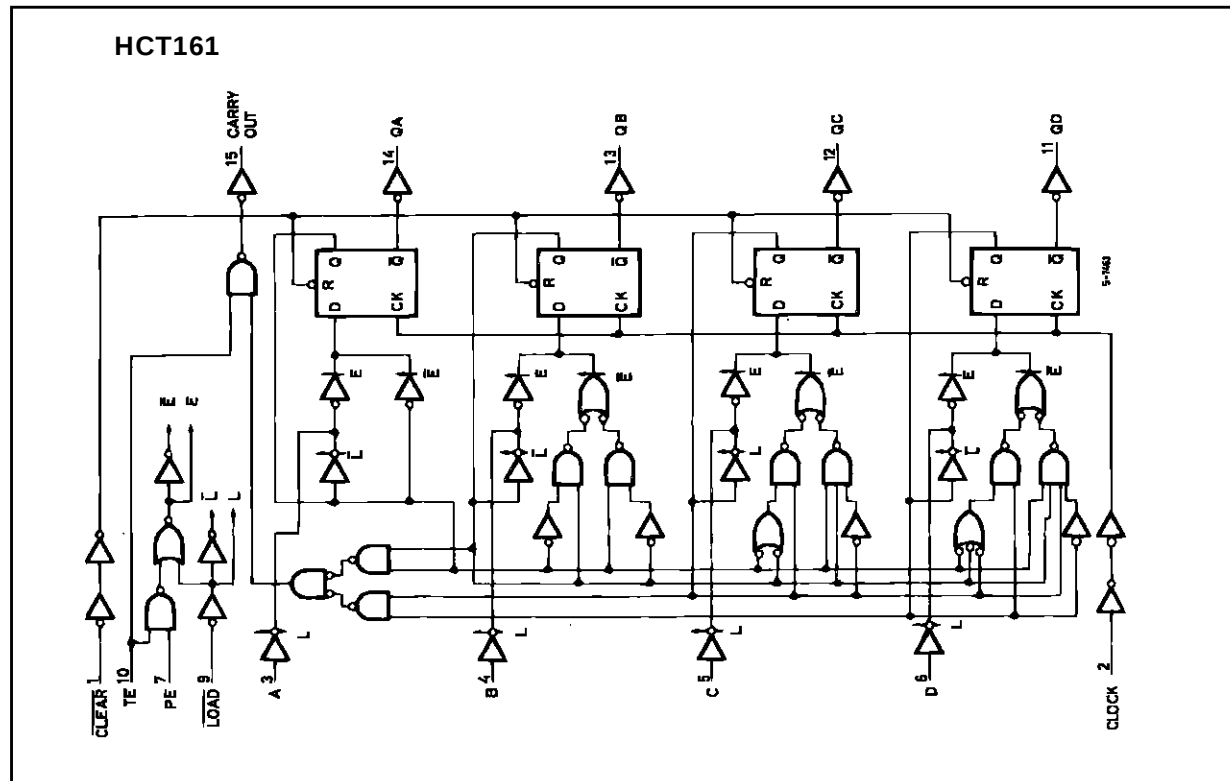
TIMING CHART (HCT161/163 : binary counter)



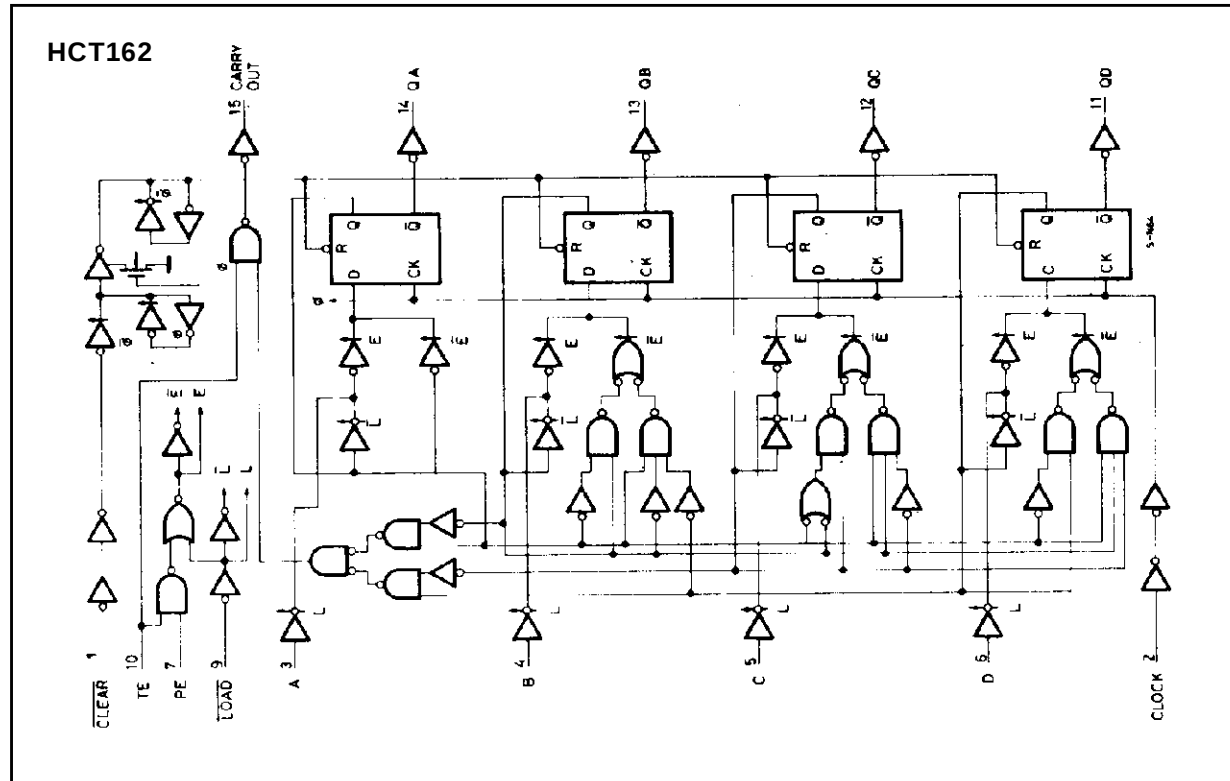
## LOGIC DIAGRAM



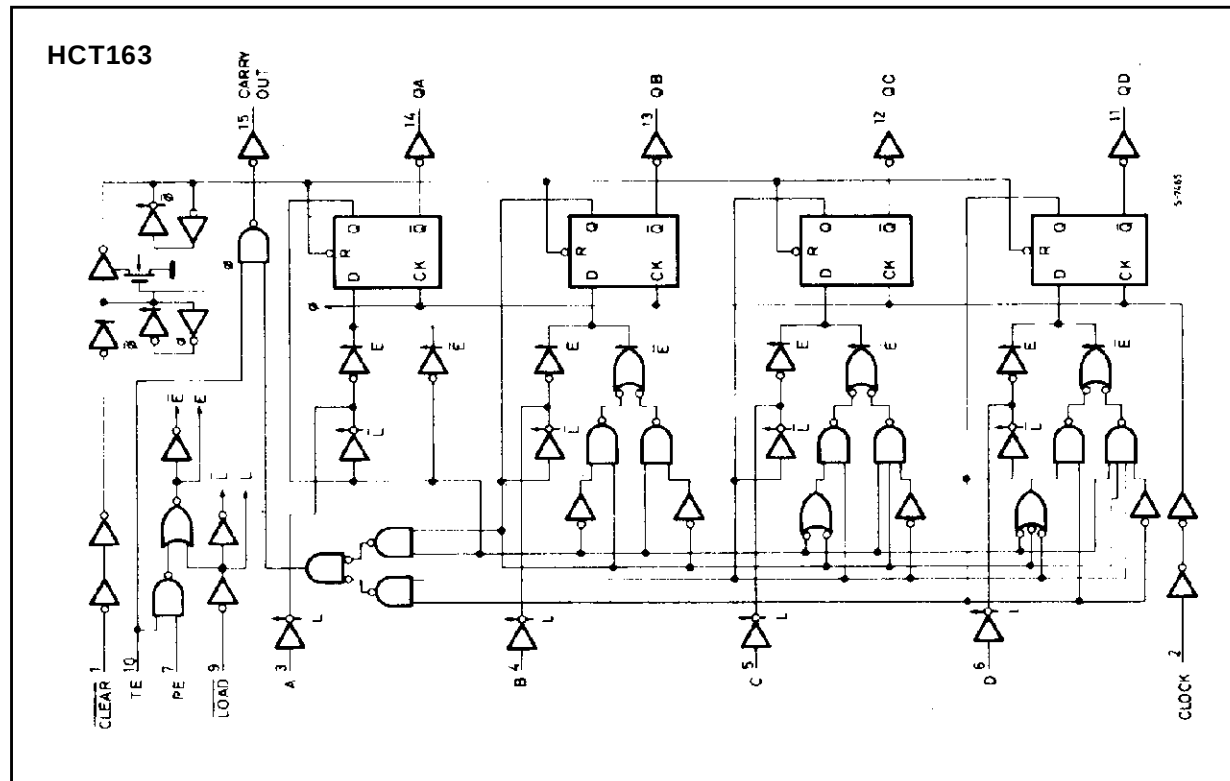
## LOGIC DIAGRAM



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            | °C   |
| $T_L$                 | Lead Temperature (10 sec)                    | 300                    | °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:  $\equiv 65^\circ\text{C}$  derate to 300 mW by 10mW/°C:  $65^\circ\text{C}$  to  $85^\circ\text{C}$

**RECOMMENDED OPERATING CONDITIONS**

| Symbol     | Parameter                                                    | Value         | Unit |
|------------|--------------------------------------------------------------|---------------|------|
| $V_{CC}$   | Supply Voltage                                               | 4.5 to 5.5    | V    |
| $V_I$      | Input Voltage                                                | 0 to $V_{CC}$ | V    |
| $V_O$      | Output Voltage                                               | 0 to $V_{CC}$ | V    |
| $T_{op}$   | Operating Temperature: <b>M54HC Series</b>                   | -55 to +125   | °C   |
|            | <b>M74HC Series</b>                                          | -40 to +85    | °C   |
| $t_r, t_f$ | Input Rise and Fall Time ( $V_{CC} = 4.5$ to $5.5\text{V}$ ) | 0 to 500      | ns   |

**DC SPECIFICATIONS**

| Symbol           | Parameter                            | Test Conditions        |                                                                                                                 |                         |                                         | Value |      |                      |      |                       |      | Unit |
|------------------|--------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------------|-------|------|----------------------|------|-----------------------|------|------|
|                  |                                      | V <sub>CC</sub><br>(V) |                                                                                                                 |                         | T <sub>A</sub> = 25 °C<br>54HC and 74HC |       |      | -40 to 85 °C<br>74HC |      | -55 to 125 °C<br>54HC |      |      |
|                  |                                      |                        |                                                                                                                 |                         | Min.                                    | Typ.  | Max. | Min.                 | Max. | Min.                  | Max. |      |
| V <sub>IH</sub>  | High Level Input Voltage             | 4.5 to 5.5             |                                                                                                                 |                         | 2.0                                     |       |      | 2.0                  |      | 2.0                   |      | V    |
| V <sub>IL</sub>  | Low Level Input Voltage              | 4.5 to 5.5             |                                                                                                                 |                         |                                         |       | 0.8  |                      | 0.8  |                       | 0.8  | V    |
| V <sub>OH</sub>  | High Level Output Voltage            | 4.5                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                                             | I <sub>O</sub> =-20 μA  | 4.4                                     | 4.5   |      | 4.4                  |      | 4.4                   |      | V    |
|                  |                                      |                        |                                                                                                                 | I <sub>O</sub> =-4.0 mA | 4.18                                    | 4.31  |      | 4.13                 |      | 4.10                  |      |      |
| V <sub>OL</sub>  | Low Level Output Voltage             | 4.5                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                                             | I <sub>O</sub> = 20 μA  |                                         | 0.0   | 0.1  |                      | 0.1  |                       | 0.1  | V    |
|                  |                                      |                        |                                                                                                                 | I <sub>O</sub> = 4.0 mA |                                         | 0.17  | 0.26 |                      | 0.33 |                       | 0.4  |      |
| I <sub>I</sub>   | Input Leakage Current                | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                                                         |                         |                                         |       | ±0.1 |                      | ±1   |                       | ±1   | μA   |
| I <sub>CC</sub>  | Quiescent Supply Current             | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                                                         |                         |                                         |       | 4    |                      | 40   |                       | 80   | μA   |
| ΔI <sub>CC</sub> | Additional worst case supply current | 5.5                    | Per Input pin<br>V <sub>I</sub> = 0.5V or<br>V <sub>I</sub> = 2.4V<br>Other Inputs at<br>V <sub>CC</sub> or GND |                         |                                         |       | 2.0  |                      | 2.9  |                       | 3.0  | mA   |

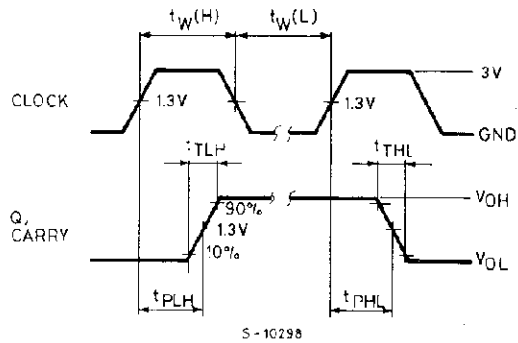
**AC ELECTRICAL CHARACTERISTICS** ( $C_L = 50 \text{ pF}$ , Input  $t_r = t_f = 6 \text{ ns}$ )

| Symbol                                 | Parameter                          | Test Conditions        |                     | Value                                   |      |      |                      |      |                       | Unit |      |
|----------------------------------------|------------------------------------|------------------------|---------------------|-----------------------------------------|------|------|----------------------|------|-----------------------|------|------|
|                                        |                                    | V <sub>CC</sub><br>(V) |                     | T <sub>A</sub> = 25 °C<br>54HC and 74HC |      |      | -40 to 85 °C<br>74HC |      | -55 to 125 °C<br>54HC |      |      |
|                                        |                                    |                        |                     | Min.                                    | Typ. | Max. | Min.                 | Max. | Min.                  |      | Max. |
| t <sub>TLH</sub><br>t <sub>THL</sub>   | Output Transition Time             | 4.5                    |                     |                                         | 8    | 15   |                      | 19   |                       | 22   | ns   |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time (CK - Q)    | 4.5                    |                     |                                         | 23   | 36   |                      | 45   |                       | 54   | ns   |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time (CK-CO)     | 4.5                    |                     |                                         | 27   | 42   |                      | 53   |                       | 63   | ns   |
| t <sub>PLH</sub>                       | Propagation Delay Time (TE-CO)     | 4.5                    |                     |                                         | 21   | 33   |                      | 41   |                       | 50   | ns   |
| t <sub>PLH</sub>                       | Propagation Delay Time (CLEAR - Q) | 4.5                    | for HCT160/161 only |                                         | 26   | 40   |                      | 50   |                       | 60   | ns   |
| t <sub>PHL</sub>                       | Propagation Delay Time (CLEAR-CO)  | 4.5                    | for HCT160/161 only |                                         | 28   | 43   |                      | 54   |                       | 65   | ns   |
| f <sub>MAX</sub>                       | Maximum Clock Frequency            | 4.5                    |                     | 31                                      | 49   |      | 25                   |      | 21                    |      | MHz  |
| t <sub>W(H)</sub><br>t <sub>W(L)</sub> | Minimum Pulse Width (CK)           | 4.5                    |                     |                                         | 8    | 15   |                      | 19   |                       | 22   | ns   |
| t <sub>W(L)</sub>                      | Minimum Pulse Width (CLEAR)        | 4.5                    | for HCT160/161 only |                                         | 8    | 15   |                      | 19   |                       | 22   | ns   |
| t <sub>s</sub>                         | Minimum Set-up Time (LOAD, PE, TE) | 4.5                    |                     |                                         | 11   | 20   |                      | 25   |                       | 30   | ns   |
| t <sub>s</sub>                         | Minimum Set-up Time (A, B, C, D)   | 4.5                    |                     |                                         | 5    | 15   |                      | 19   |                       | 22   | ns   |
| t <sub>s</sub>                         | Minimum Set-up Time (CLEAR)        | 4.5                    | for HCT162/163 only |                                         | 5    | 15   |                      | 19   |                       | 22   | ns   |
| t <sub>h</sub>                         | Minimum Hold Time                  | 4.5                    |                     |                                         |      | 5    |                      | 5    |                       | 8    | ns   |
| t <sub>REM</sub>                       | Minimum Removal Time (CLEAR)       | 4.5                    | for HCT160/161 only |                                         | 5    | 15   |                      | 19   |                       | 22   | ns   |
| C <sub>IN</sub>                        | Input Capacitance                  |                        |                     |                                         | 5    | 10   |                      | 10   |                       | 10   | pF   |
| C <sub>PD</sub> (*)                    | Power Dissipation Capacitance      |                        |                     |                                         | 33   |      |                      |      |                       |      | pF   |

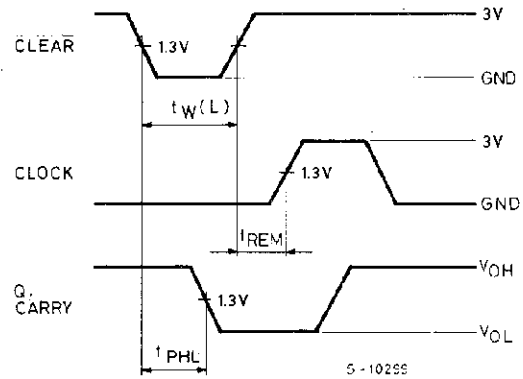
(\*) C<sub>PD</sub> is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

SWITCHING CHARACTERISTICS TEST WAVEFORM

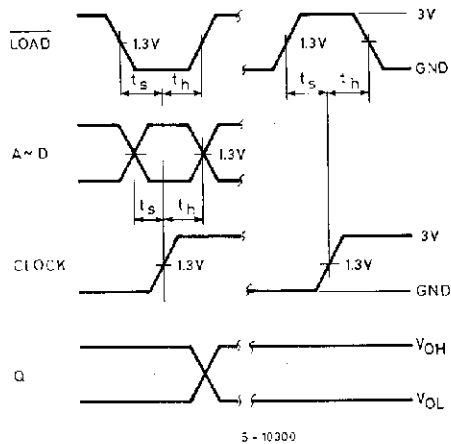
COUNT MODE



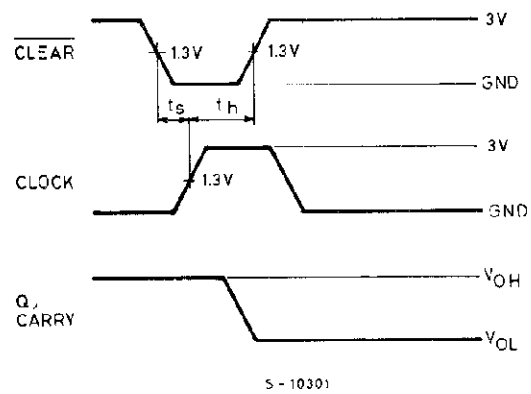
CLEAR MODE (HCT160/161)



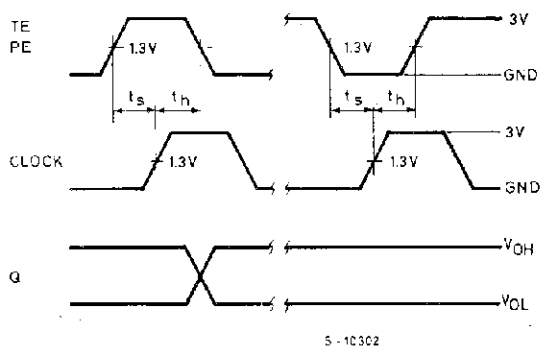
PRESET MODE



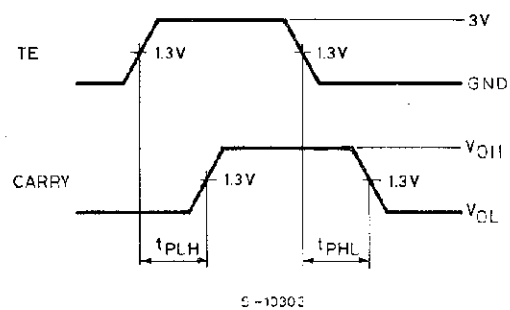
CLEAR MODE (HCT162/163)



COUNTENABLE MODE



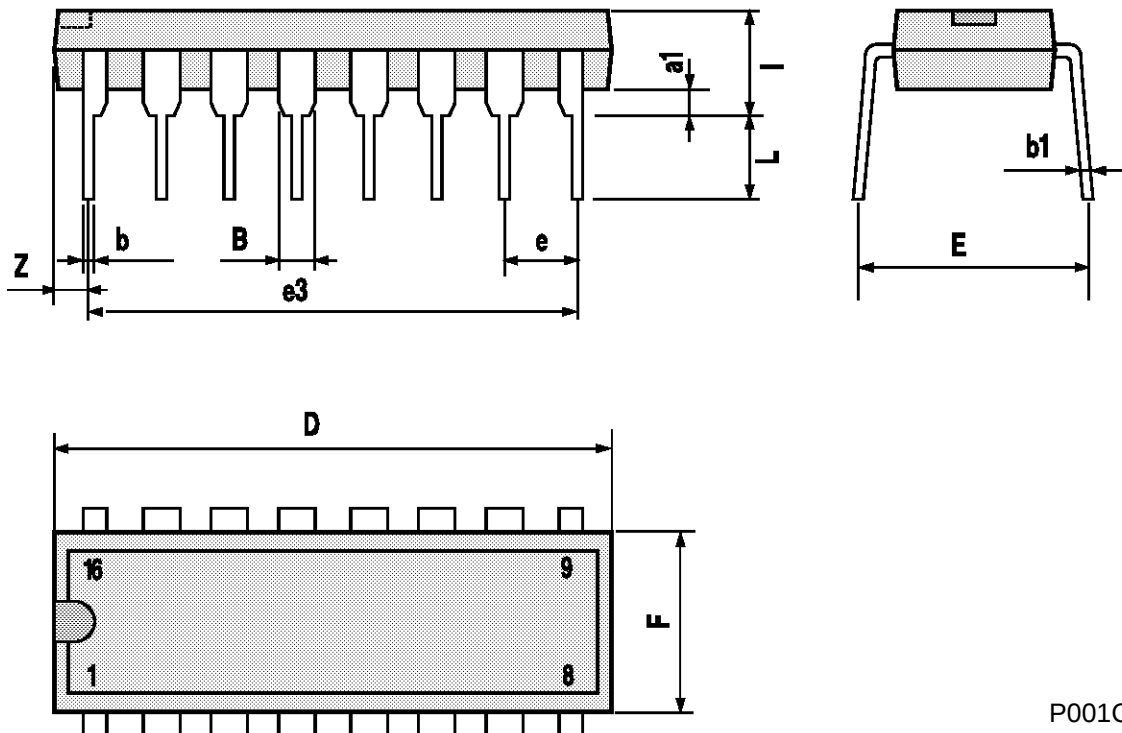
CASCADE MODE  
(fix maximum count)





**Plastic DIP16 (0.25) MECHANICAL DATA**

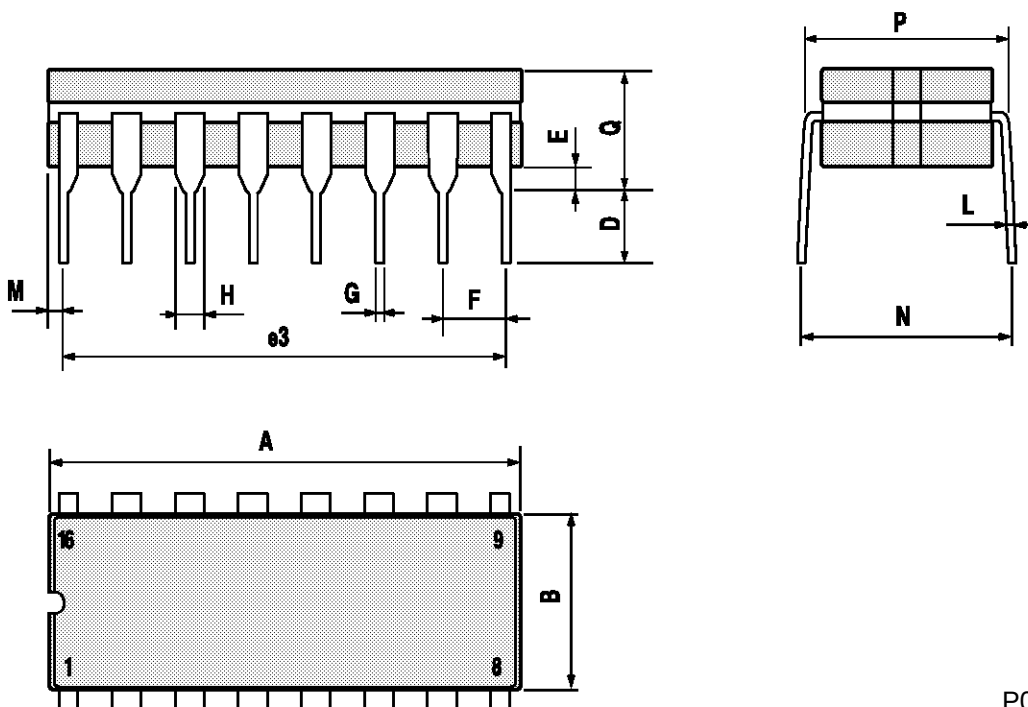
| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 0.77 |       | 1.65 | 0.030 |       | 0.065 |
| b    |      | 0.5   |      |       | 0.020 |       |
| b1   |      | 0.25  |      |       | 0.010 |       |
| D    |      |       | 20   |       |       | 0.787 |
| E    |      | 8.5   |      |       | 0.335 |       |
| e    |      | 2.54  |      |       | 0.100 |       |
| e3   |      | 17.78 |      |       | 0.700 |       |
| F    |      |       | 7.1  |       |       | 0.280 |
| I    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    |      |       | 1.27 |       |       | 0.050 |



P001C

## Ceramic DIP16/1 MECHANICAL DATA

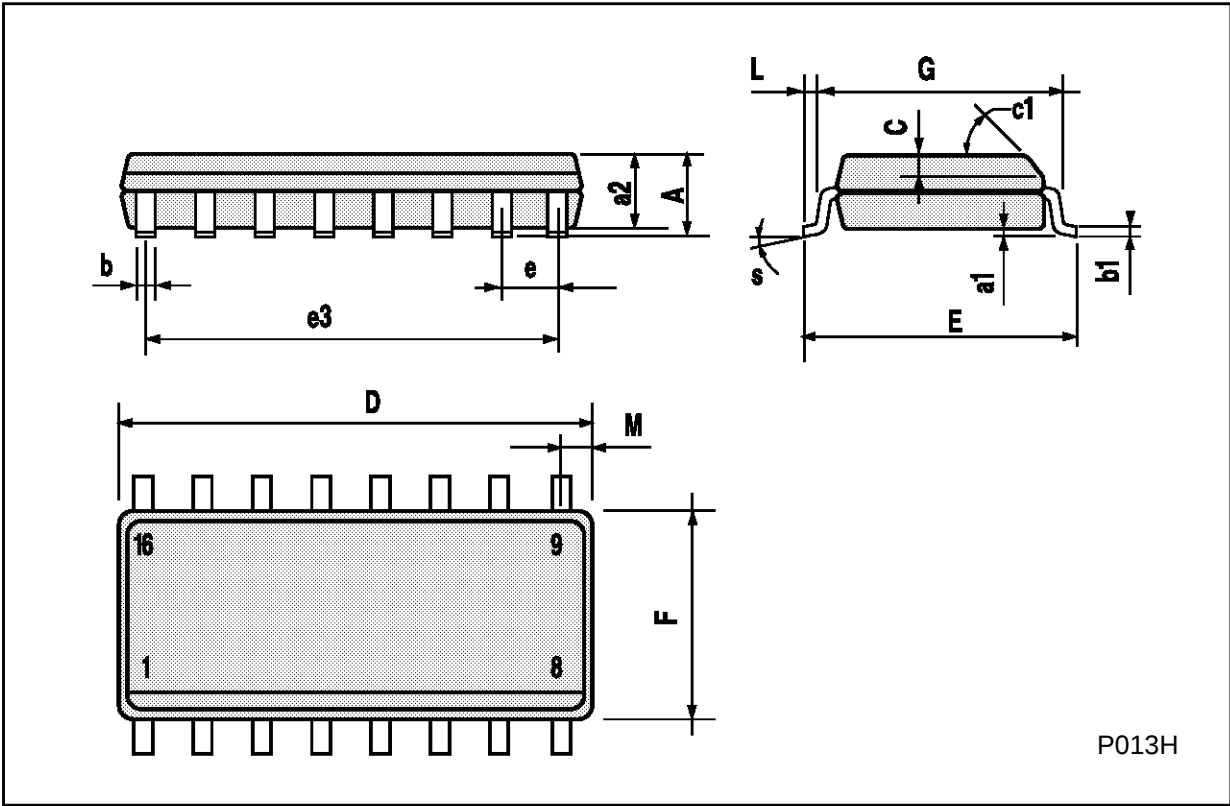
| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |      |       | 20   |       |       | 0.787 |
| B    |      |       | 7    |       |       | 0.276 |
| D    |      | 3.3   |      |       | 0.130 |       |
| E    | 0.38 |       |      | 0.015 |       |       |
| e3   |      | 17.78 |      |       | 0.700 |       |
| F    | 2.29 |       | 2.79 | 0.090 |       | 0.110 |
| G    | 0.4  |       | 0.55 | 0.016 |       | 0.022 |
| H    | 1.17 |       | 1.52 | 0.046 |       | 0.060 |
| L    | 0.22 |       | 0.31 | 0.009 |       | 0.012 |
| M    | 0.51 |       | 1.27 | 0.020 |       | 0.050 |
| N    |      |       | 10.3 |       |       | 0.406 |
| P    | 7.8  |       | 8.05 | 0.307 |       | 0.317 |
| Q    |      |       | 5.08 |       |       | 0.200 |



P053D

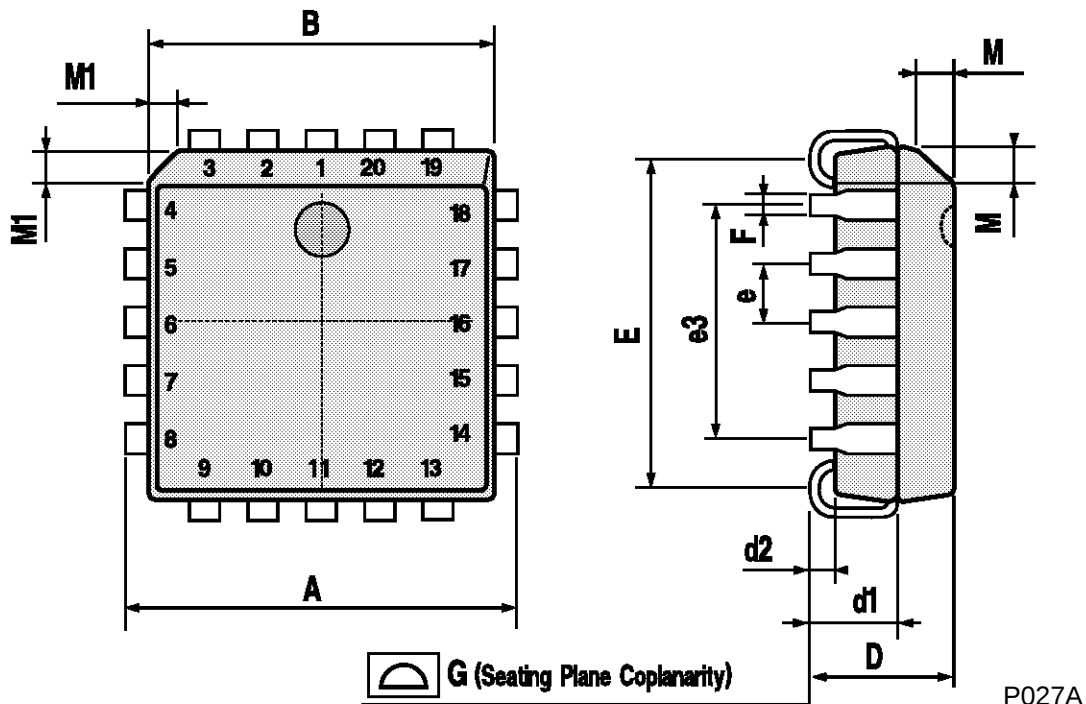
SO16 (Narrow) MECHANICAL DATA

| DIM. | mm         |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.004 |       | 0.007 |
| a2   |            |      | 1.65 |       |       | 0.064 |
| b    | 0.35       |      | 0.46 | 0.013 |       | 0.018 |
| b1   | 0.19       |      | 0.25 | 0.007 |       | 0.010 |
| C    |            | 0.5  |      |       | 0.019 |       |
| c1   | 45° (typ.) |      |      |       |       |       |
| D    | 9.8        |      | 10   | 0.385 |       | 0.393 |
| E    | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e    |            | 1.27 |      |       | 0.050 |       |
| e3   |            | 8.89 |      |       | 0.350 |       |
| F    | 3.8        |      | 4.0  | 0.149 |       | 0.157 |
| G    | 4.6        |      | 5.3  | 0.181 |       | 0.208 |
| L    | 0.5        |      | 1.27 | 0.019 |       | 0.050 |
| M    |            |      | 0.62 |       |       | 0.024 |
| S    | 8° (max.)  |      |      |       |       |       |



## PLCC20 MECHANICAL DATA

| DIM. | mm   |      |       | inch  |       |       |
|------|------|------|-------|-------|-------|-------|
|      | MIN. | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 9.78 |      | 10.03 | 0.385 |       | 0.395 |
| B    | 8.89 |      | 9.04  | 0.350 |       | 0.356 |
| D    | 4.2  |      | 4.57  | 0.165 |       | 0.180 |
| d1   |      | 2.54 |       |       | 0.100 |       |
| d2   |      | 0.56 |       |       | 0.022 |       |
| E    | 7.37 |      | 8.38  | 0.290 |       | 0.330 |
| e    |      | 1.27 |       |       | 0.050 |       |
| e3   |      | 5.08 |       |       | 0.200 |       |
| F    |      | 0.38 |       |       | 0.015 |       |
| G    |      |      | 0.101 |       |       | 0.004 |
| M    |      | 1.27 |       |       | 0.050 |       |
| M1   |      | 1.14 |       |       | 0.045 |       |



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