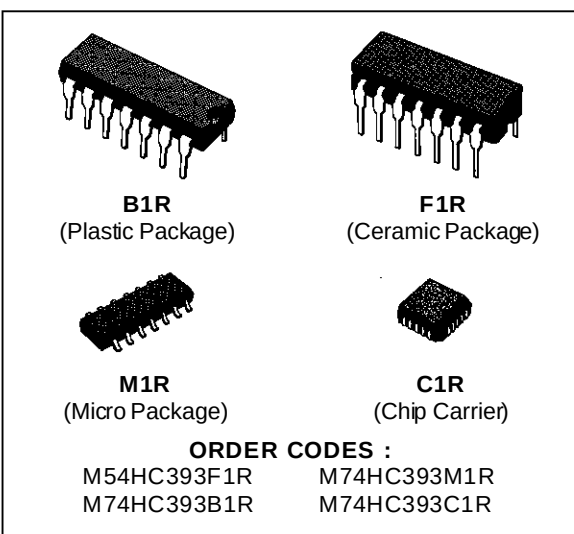


## DUAL BINARY COUNTER

- **HIGH SPEED**  
 $f_{MAX} = 72 \text{ MHz (TYP.) AT } V_{CC} = 5 \text{ V}$
- **LOW POWER DISSIPATION**  
 $I_{CC} = 4 \mu\text{A (MAX.) AT } T_A = 25^\circ\text{C}$
- **HIGH NOISE IMMUNITY**  
 $V_{NIH} = V_{NIL} = 28 \% V_{CC} \text{ (MIN.)}$
- **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**  
 $V_{CC} \text{ (OPR)} = 2 \text{ V TO } 6 \text{ V}$
- **PIN AND FUNCTION COMPATIBLE**  
WITH 54/74LS393



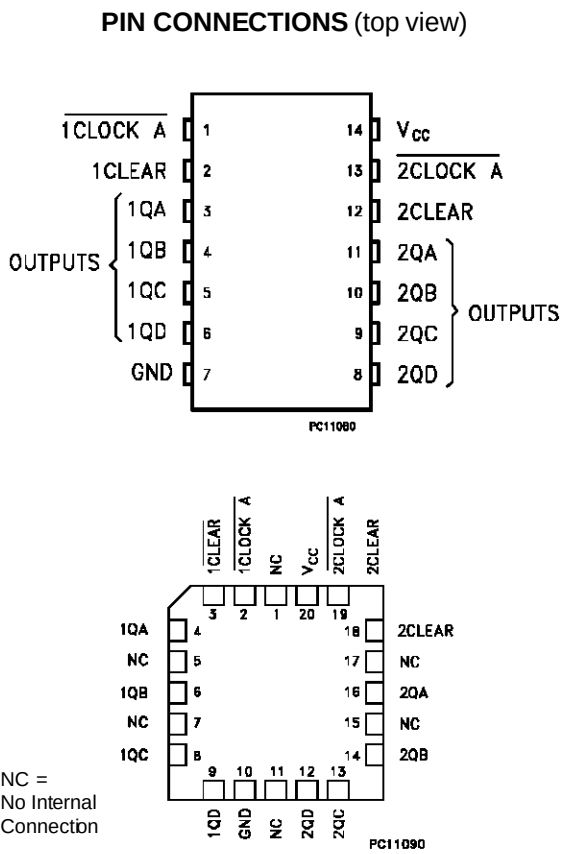
### DESCRIPTION

The M54/74HC393 is a high speed CMOS DUAL BINARY COUNTER fabricated in silicon gate C2MOS technology. It has the same high speed performance of LSTTL combined with true COMS low power consumption.

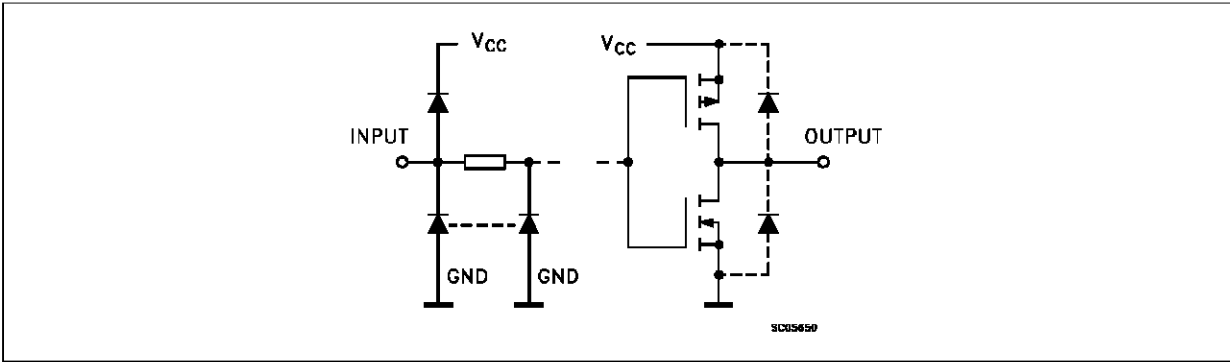
This counter circuit contains independent ripple carry counters and two 4-bit ripple carry binary counters, which can be cascaded to create a single divide by 256 counter.

Each 4-bit counter is incremented on the high to low transition (negative edge) of the clock input, and each has an independent clear input. When clear is set to low all four bits of each counter are set to a low level. This enables count truncation and allows the implementation of divide by N counter configurations.

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



INPUT AND OUTPUT EQUIVALENT CIRCUIT



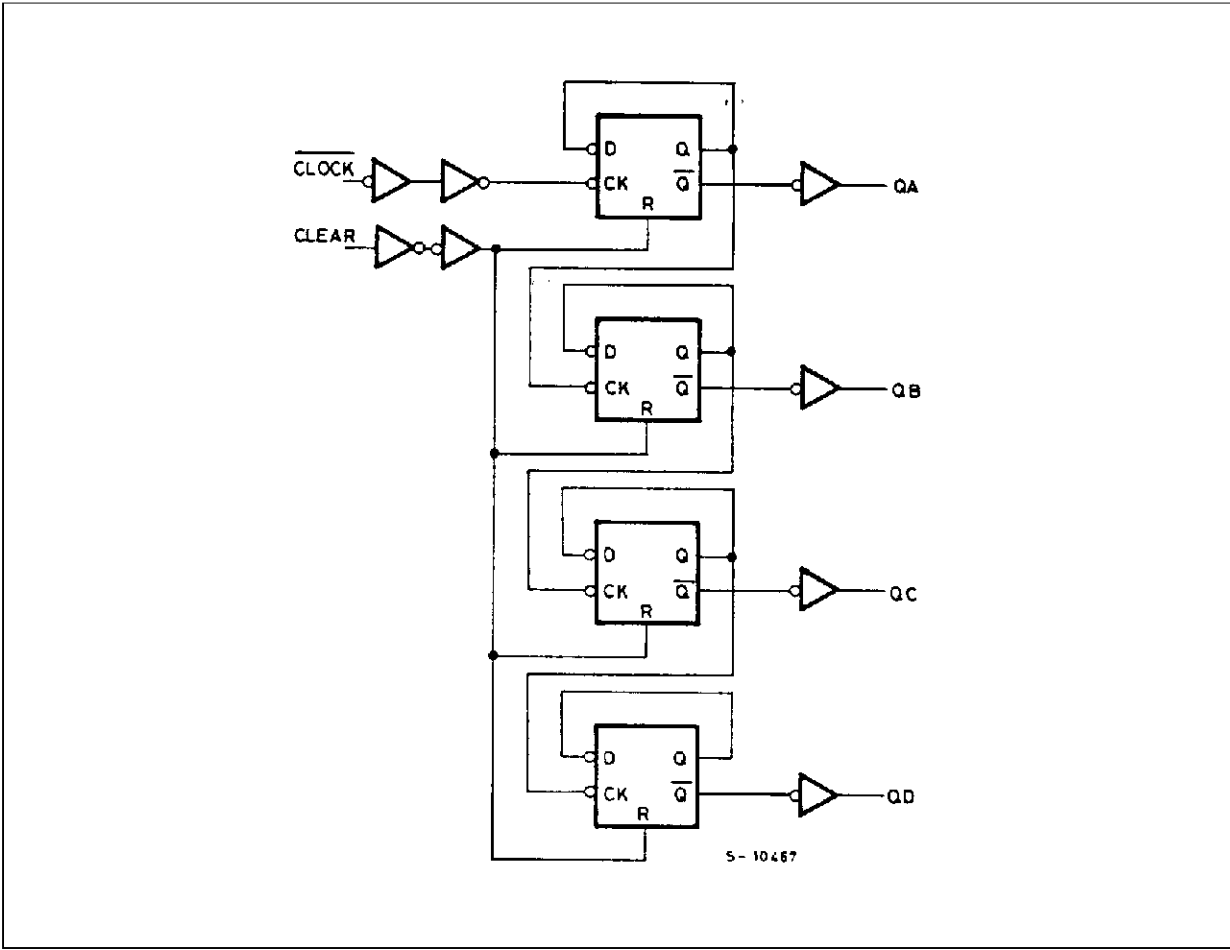
TRUTH TABLE

| INPUTS |       | OUTPUTS   |    |    |    |
|--------|-------|-----------|----|----|----|
| CLOCK  | CLEAR | QD        | QC | QB | QA |
| X      | H     | L         | L  | L  | L  |
|        | L     | COUNT UP  |    |    |    |
|        | L     | NO CHANGE |    |    |    |

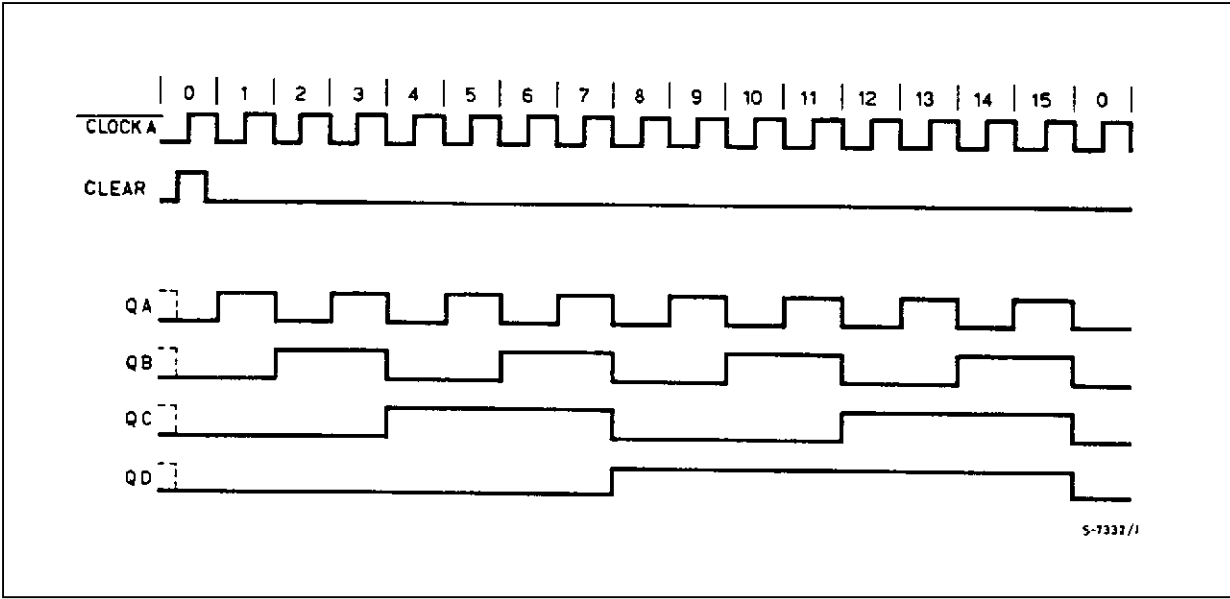
X: Don't Care

| COUNT | OUTPUT |    |    |    |
|-------|--------|----|----|----|
|       | QD     | QC | QB | QA |
| 0     | L      | L  | L  | L  |
| 1     | L      | L  | L  | H  |
| 2     | L      | L  | H  | L  |
| 3     | L      | L  | H  | H  |
| 4     | L      | H  | L  | L  |
| 5     | L      | H  | L  | H  |
| 6     | L      | H  | H  | L  |
| 7     | L      | H  | H  | H  |
| 8     | H      | L  | L  | L  |
| 9     | H      | L  | L  | H  |
| 10    | H      | L  | H  | L  |
| 11    | H      | L  | H  | H  |
| 12    | H      | H  | L  | L  |
| 13    | H      | H  | L  | H  |
| 14    | H      | H  | H  | L  |
| 15    | H      | H  | H  | H  |

LOGIC DIAGRAM

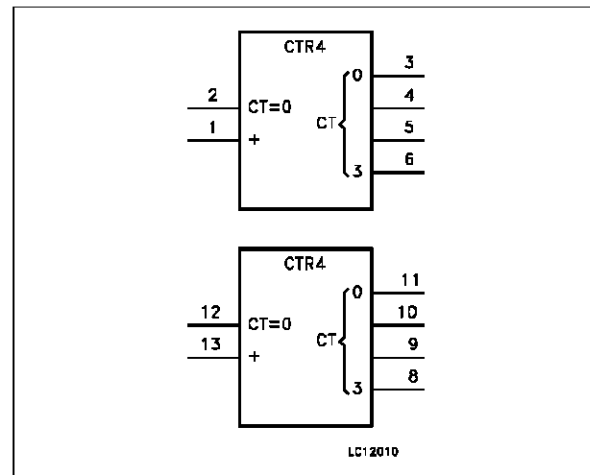


TIMING CHART



**PIN DESCRIPTION**

| PIN No       | SYMBOL                 | NAME AND FUNCTION                        |
|--------------|------------------------|------------------------------------------|
| 1, 13        | 1 CLOCK A<br>2 CLOCK A | Clock Input (HIGH to LOW Edge triggered) |
| 2, 12        | 1 CLEAR<br>2 CLEAR     | Asynchronous Master Reset Inputs         |
| 3, 4, 5, 6   | 1QA to 1QD             | Flip Flop Outputs                        |
| 11, 10, 9, 8 | 2QA to 2QD             | Flip Flop Outputs                        |
| 7            | GND                    | Ground (0V)                              |
| 14           | V <sub>CC</sub>        | Positive Supply Voltage                  |

**IEC LOGIC SYMBOL**

**ABSOLUTE MAXIMUM RATINGS**

| Symbol                              | Parameter                                    | Value                         | Unit |
|-------------------------------------|----------------------------------------------|-------------------------------|------|
| V <sub>CC</sub>                     | Supply Voltage                               | -0.5 to +7                    | V    |
| V <sub>I</sub>                      | DC Input Voltage                             | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| V <sub>O</sub>                      | DC Output Voltage                            | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| I <sub>IK</sub>                     | DC Input Diode Current                       | ± 20                          | mA   |
| I <sub>OK</sub>                     | DC Output Diode Current                      | ± 20                          | mA   |
| I <sub>O</sub>                      | DC Output Source Sink Current Per Output Pin | ± 25                          | mA   |
| I <sub>CC</sub> or I <sub>GND</sub> | DC V <sub>CC</sub> or Ground Current         | ± 50                          | mA   |
| P <sub>D</sub>                      | Power Dissipation                            | 500 (*)                       | mW   |
| T <sub>stg</sub>                    | Storage Temperature                          | -65 to +150                   | °C   |
| T <sub>L</sub>                      | Lead Temperature (10 sec)                    | 300                           | °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 10mW/°C: 65 °C to 85 °C

**RECOMMENDED OPERATING CONDITIONS**

| Symbol                          | Parameter                                                         | Value                                                                                                          | Unit     |
|---------------------------------|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------|
| V <sub>CC</sub>                 | Supply Voltage                                                    | 2 to 6                                                                                                         | V        |
| V <sub>I</sub>                  | Input Voltage                                                     | 0 to V <sub>CC</sub>                                                                                           | V        |
| V <sub>O</sub>                  | Output Voltage                                                    | 0 to V <sub>CC</sub>                                                                                           | V        |
| T <sub>op</sub>                 | Operating Temperature: <b>M54HC Series</b><br><b>M74HC Series</b> | -55 to +125<br>-40 to +85                                                                                      | °C<br>°C |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise and Fall Time                                          | V <sub>CC</sub> = 2 V<br>0 to 1000<br>V <sub>CC</sub> = 4.5 V<br>0 to 500<br>V <sub>CC</sub> = 6 V<br>0 to 400 | ns       |

## DC SPECIFICATIONS

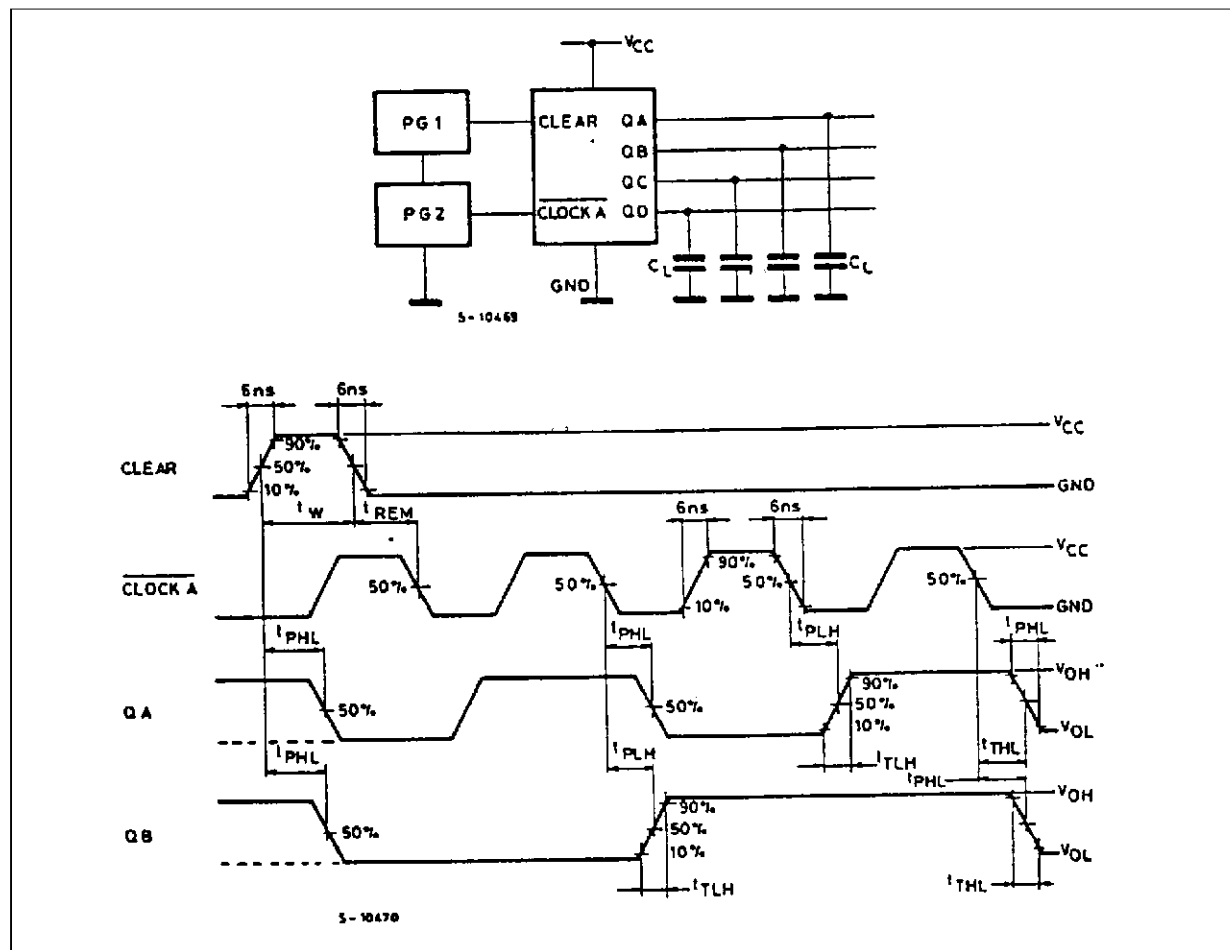
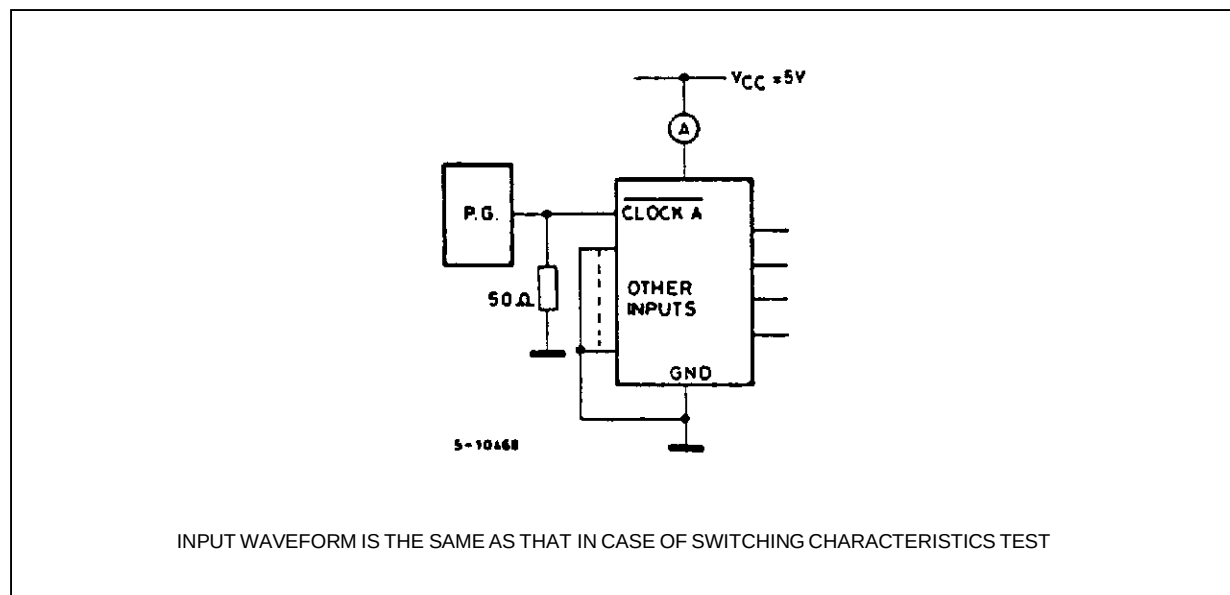
| Symbol          | Parameter                 | Test Conditions        |                                                              |                                         | Value |      |                      |      |                       |      | Unit |    |      |  |
|-----------------|---------------------------|------------------------|--------------------------------------------------------------|-----------------------------------------|-------|------|----------------------|------|-----------------------|------|------|----|------|--|
|                 |                           | 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  | 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>I</sub> =<br>V <sub>IH</sub><br>or<br>V <sub>IL</sub> | I <sub>O</sub> =-20 µA                  | 1.9   | 2.0  |                      | 1.9  |                       | 1.9  |      | V  |      |  |
|                 |                           | 4.5                    |                                                              |                                         | 4.4   | 4.5  |                      | 4.4  |                       | 4.4  |      |    |      |  |
|                 |                           | 6.0                    |                                                              |                                         | 5.9   | 6.0  |                      | 5.9  |                       | 5.9  |      |    |      |  |
|                 |                           | 4.5                    |                                                              | I <sub>O</sub> =-4.0 mA                 |       | 4.18 | 4.31                 |      | 4.13                  |      | 4.10 |    |      |  |
|                 |                           | 6.0                    |                                                              | I <sub>O</sub> =-5.2 mA                 |       | 5.68 | 5.8                  |      | 5.63                  |      | 5.60 |    |      |  |
| V <sub>OL</sub> | Low Level Output Voltage  | 2.0                    | V <sub>I</sub> =<br>V <sub>IH</sub><br>or<br>V <sub>IL</sub> | I <sub>O</sub> = 20 µA                  |       | 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                    |                                                              | I <sub>O</sub> = 4.0 mA                 |       |      | 0.17                 | 0.26 |                       | 0.33 |      |    | 0.40 |  |
|                 |                           | 6.0                    |                                                              | I <sub>O</sub> = 5.2 mA                 |       |      | 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                    |      | ±1   | 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** ( $C_L = 50 \text{ pF}$ , 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                 | 2.0                    |  |                                         | 30   | 75   |                      | 95   |                       | 110  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 8    | 15   |                      | 19   |                       | 22   |      |
|                                        |                                        | 6.0                    |  |                                         | 7    | 13   |                      | 16   |                       | 19   |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time<br>(CLOCK - QA) | 2.0                    |  |                                         | 50   | 120  |                      | 150  |                       | 180  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 15   | 24   |                      | 30   |                       | 36   |      |
|                                        |                                        | 6.0                    |  |                                         | 13   | 20   |                      | 26   |                       | 31   |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time<br>(CLOCK - QB) | 2.0                    |  |                                         | 70   | 160  |                      | 200  |                       | 240  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 20   | 32   |                      | 40   |                       | 48   |      |
|                                        |                                        | 6.0                    |  |                                         | 17   | 27   |                      | 34   |                       | 41   |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time<br>(CLOCK - QC) | 2.0                    |  |                                         | 90   | 195  |                      | 245  |                       | 295  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 25   | 39   |                      | 49   |                       | 59   |      |
|                                        |                                        | 6.0                    |  |                                         | 21   | 33   |                      | 42   |                       | 50   |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time<br>(CLOCK - QD) | 2.0                    |  |                                         | 120  | 230  |                      | 290  |                       | 345  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 30   | 46   |                      | 58   |                       | 69   |      |
|                                        |                                        | 6.0                    |  |                                         | 26   | 39   |                      | 49   |                       | 59   |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time<br>(CLEAR - Qn) | 2.0                    |  |                                         | 55   | 150  |                      | 190  |                       | 225  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 18   | 30   |                      | 38   |                       | 45   |      |
|                                        |                                        | 6.0                    |  |                                         | 15   | 26   |                      | 32   |                       | 38   |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency                | 2.0                    |  | 8.4                                     | 17   |      | 6.8                  |      | 5.6                   |      | MHz  |
|                                        |                                        | 4.5                    |  | 42                                      | 67   |      | 34                   |      | 28                    |      |      |
|                                        |                                        | 6.0                    |  | 50                                      | 79   |      | 40                   |      | 33                    |      |      |
| t <sub>W(H)</sub><br>t <sub>W(L)</sub> | Minimum Pulse Width<br>(CLOCK)         | 2.0                    |  |                                         | 28   | 75   |                      | 95   |                       | 110  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 7    | 15   |                      | 19   |                       | 22   |      |
|                                        |                                        | 6.0                    |  |                                         | 6    | 13   |                      | 16   |                       | 19   |      |
| t <sub>W(H)</sub>                      | Minimum Pulse Width<br>(CLEAR)         | 2.0                    |  |                                         | 28   | 75   |                      | 95   |                       | 110  | ns   |
|                                        |                                        | 4.5                    |  |                                         | 7    | 15   |                      | 19   |                       | 22   |      |
|                                        |                                        | 6.0                    |  |                                         | 6    | 13   |                      | 16   |                       | 19   |      |
| t <sub>REM</sub>                       | Minimum Removal Time                   | 2.0                    |  |                                         |      | 25   |                      | 30   |                       | 35   | ns   |
|                                        |                                        | 4.5                    |  |                                         |      | 5    |                      | 6    |                       | 7    |      |
|                                        |                                        | 6.0                    |  |                                         |      | 5    |                      | 5    |                       | 6    |      |
| C <sub>IN</sub>                        | Input Capacitance                      |                        |  |                                         | 5    | 10   |                      | 10   |                       | 10   | pF   |
| C <sub>PD</sub> (*)                    | Power Dissipation Capacitance          |                        |  |                                         | 35   |      |                      |      |                       |      | pF   |

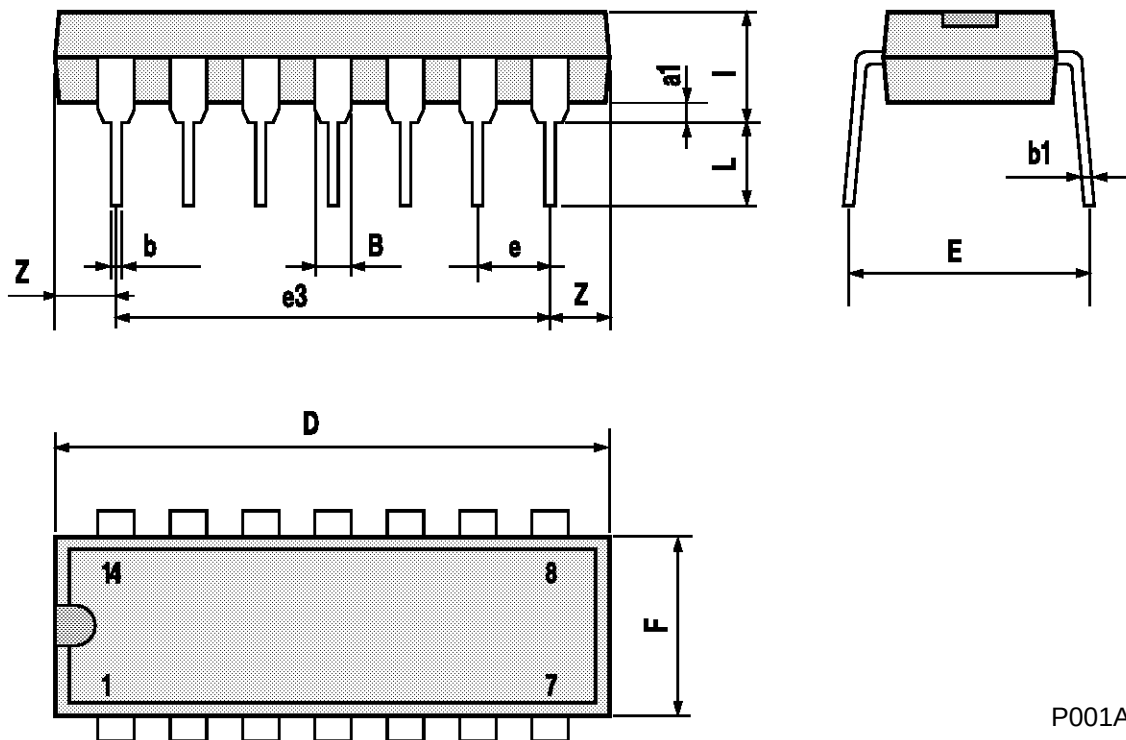
(\*)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/4$  (per Flip Flop)

## SWITCHING CHARACTERISTICS TEST WAVEFORM

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

## Plastic DIP14 MECHANICAL DATA

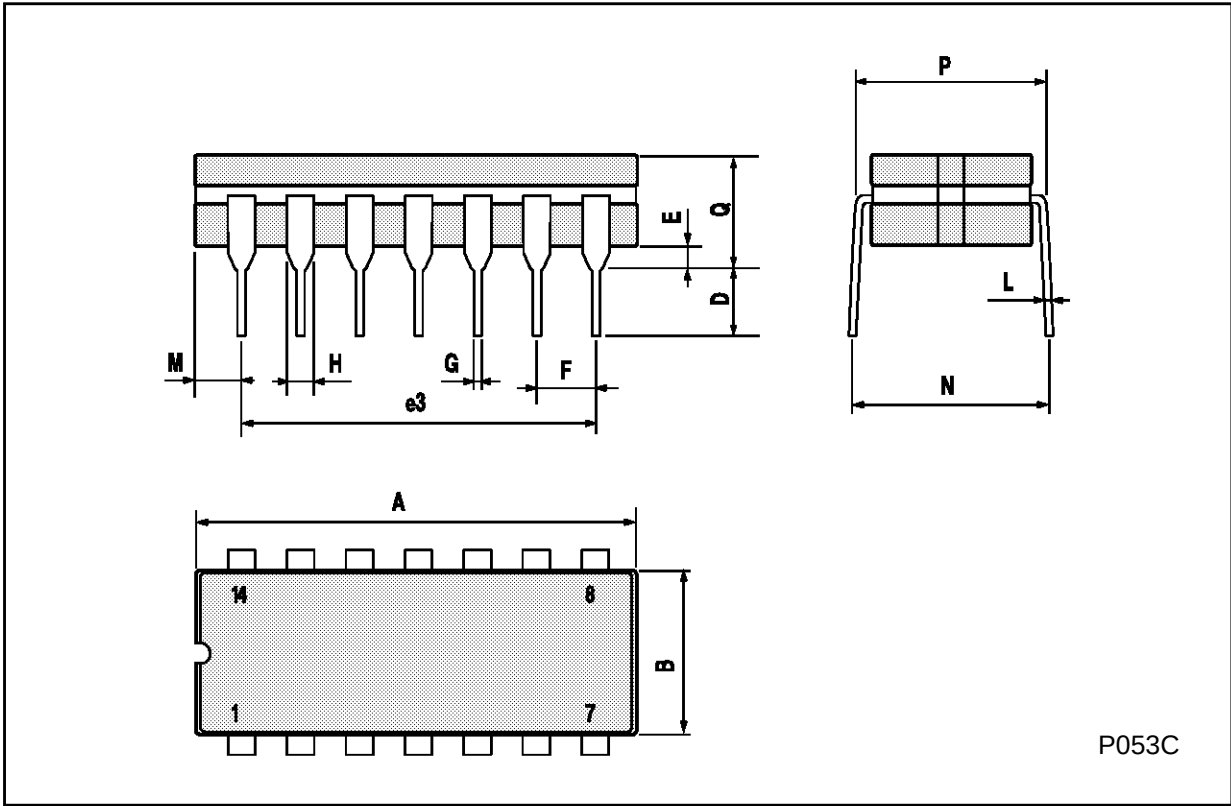
| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 1.39 |       | 1.65 | 0.055 |       | 0.065 |
| b    |      | 0.5   |      |       | 0.020 |       |
| b1   |      | 0.25  |      |       | 0.010 |       |
| D    |      |       | 20   |       |       | 0.787 |
| E    |      | 8.5   |      |       | 0.335 |       |
| e    |      | 2.54  |      |       | 0.100 |       |
| e3   |      | 15.24 |      |       | 0.600 |       |
| F    |      |       | 7.1  |       |       | 0.280 |
| I    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    | 1.27 |       | 2.54 | 0.050 |       | 0.100 |





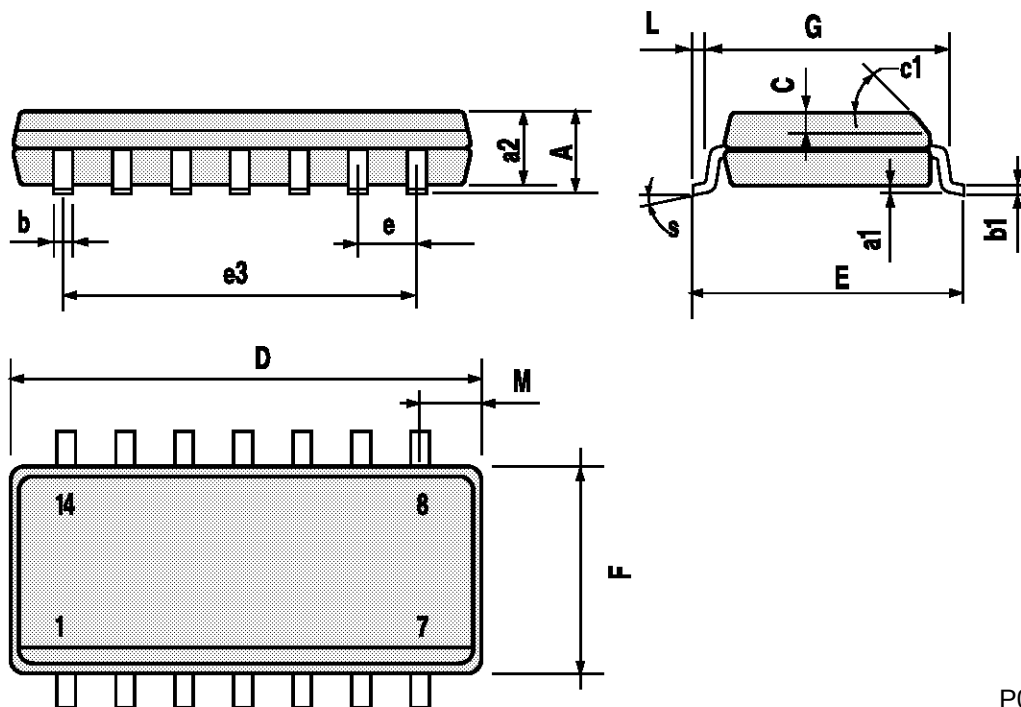
Ceramic DIP14/1 MECHANICAL DATA

| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |      |       | 20   |       |       | 0.787 |
| B    |      |       | 7.0  |       |       | 0.276 |
| D    |      | 3.3   |      |       | 0.130 |       |
| E    | 0.38 |       |      | 0.015 |       |       |
| e3   |      | 15.24 |      |       | 0.600 |       |
| 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    | 1.52 |       | 2.54 | 0.060 |       | 0.100 |
| N    |      |       | 10.3 |       |       | 0.406 |
| P    | 7.8  |       | 8.05 | 0.307 |       | 0.317 |
| Q    |      |       | 5.08 |       |       | 0.200 |



## SO14 MECHANICAL DATA

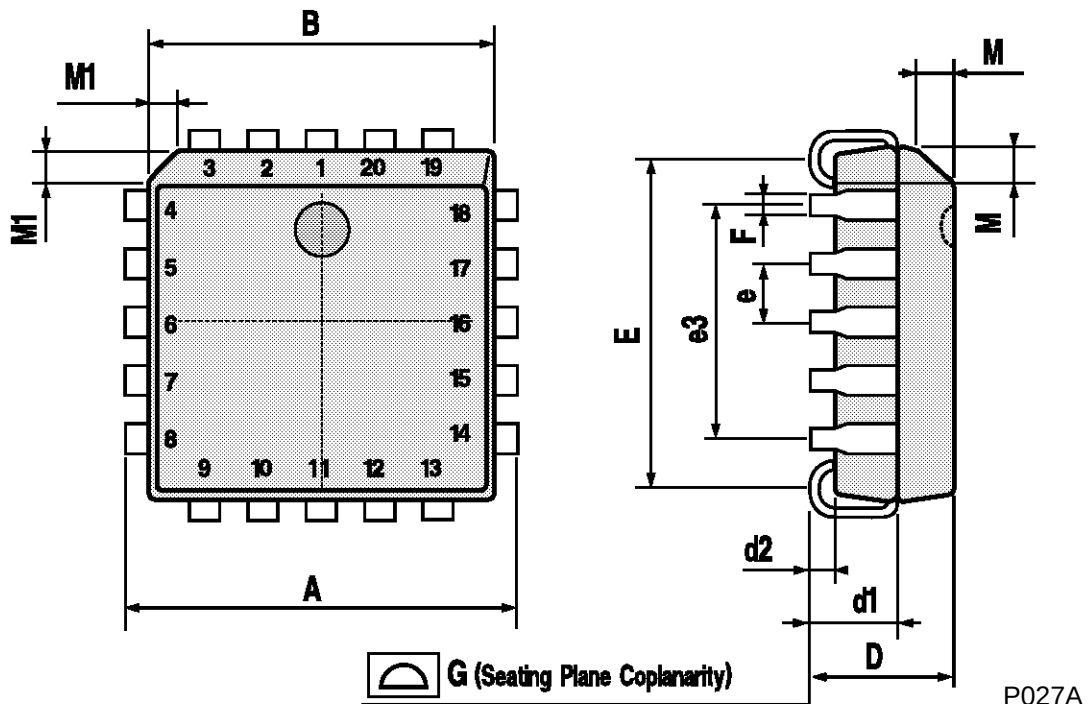
| DIM. | mm         |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 0.007 |
| 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    | 8.55       |      | 8.75 | 0.336 |       | 0.344 |
| E    | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e    |            | 1.27 |      |       | 0.050 |       |
| e3   |            | 7.62 |      |       | 0.300 |       |
| 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    |            |      | 0.68 |       |       | 0.026 |
| S    | 8° (max.)  |      |      |       |       |       |



P013G

## 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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