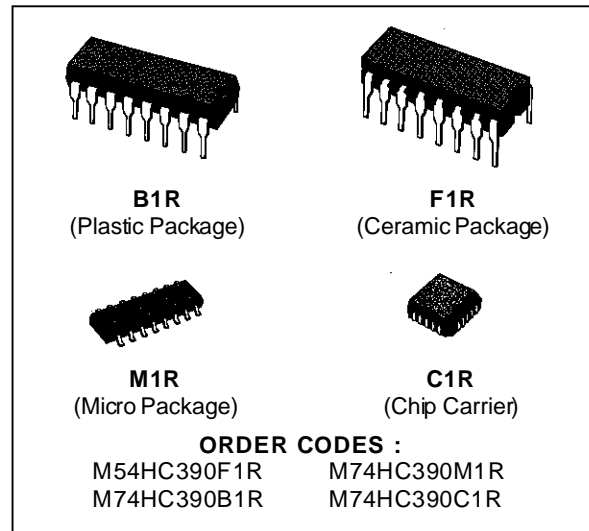


**DUAL DECADE COUNTER**

- HIGH SPEED  
f<sub>MAX</sub> = 84 MHz (TYP.) AT V<sub>CC</sub> = 5 V
- LOW POWER DISSIPATION  
I<sub>CC</sub> = 4 μA (MAX.) AT T<sub>A</sub> = 25 °C
- HIGH NOISE IMMUNITY  
V<sub>NIH</sub> = V<sub>NIL</sub> = 28 % V<sub>CC</sub> (MIN.)
- OUTPUT DRIVE CAPABILITY  
10 LSTTL LOADS
- SYMMETRICAL OUTPUT IMPEDANCE  
|I<sub>OH</sub>| = I<sub>OL</sub> = 4 mA (MIN.)
- BALANCED PROPAGATION DELAYS  
t<sub>PLH</sub> = t<sub>PHL</sub>
- WIDE OPERATING VOLTAGE RANGE  
V<sub>CC</sub> (OPR) = 2 V TO 6 V
- PIN AND FUNCTION COMPATIBLE WITH  
54/74LS390



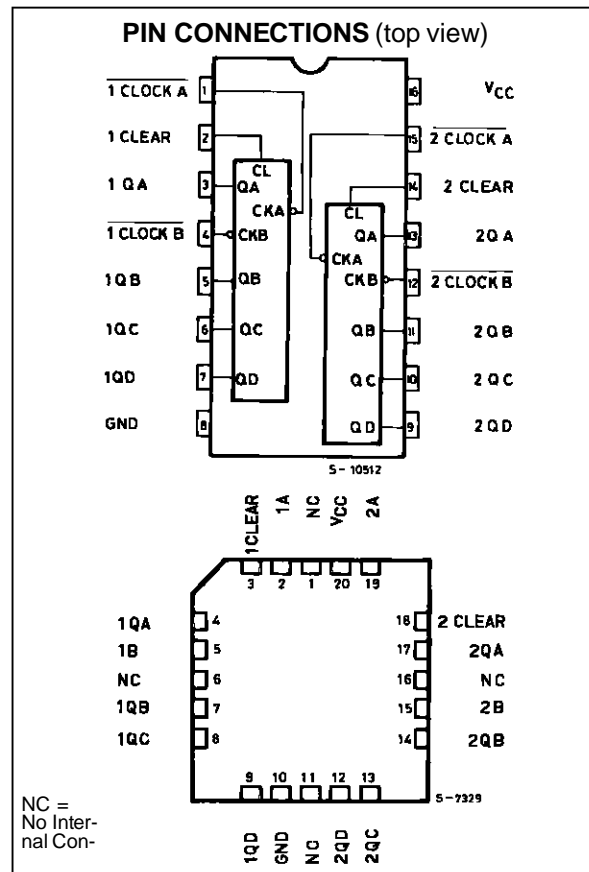
**DESCRIPTION**

The M54/74HC390 is a high speed CMOS DUAL DECADE COUNTER fabricated in silicon gate C<sup>2</sup>MOS technology. It has the same high speed performance of LSTTL combined with true CMOS low power consumption.

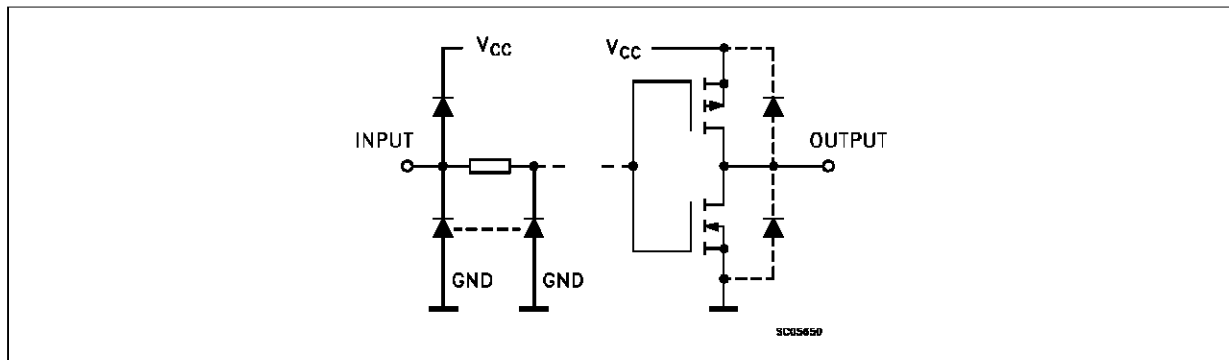
This dual decade counter contains two independent ripple carry counters. Each counter is composed of a divide-by-two and divide-by-five counter. The divide-by-two and divide-by-five counters can be cascaded to form dual decade, dual biquinary, or various combinations up to a single divide-by-100 counter.

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 low all four bits of each counter are set to low. 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

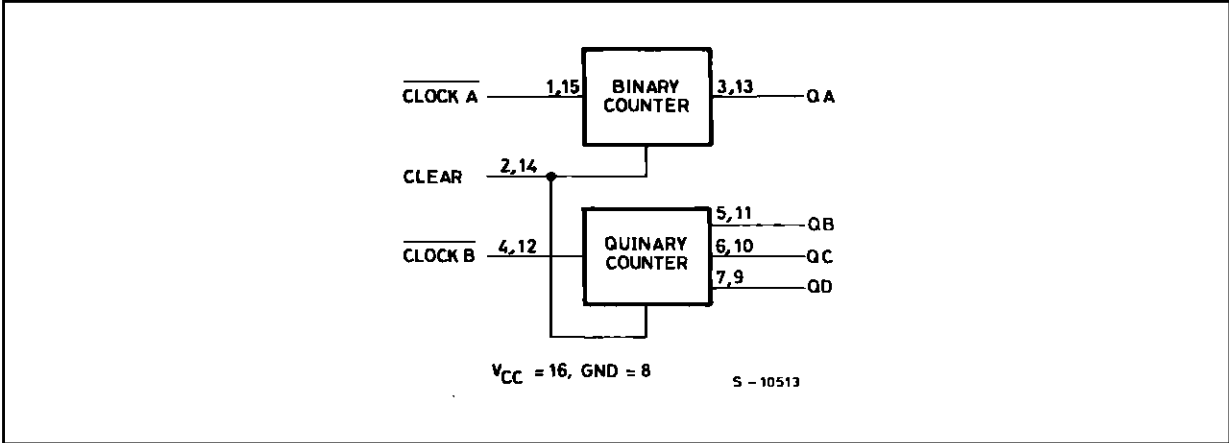
| COUNT | OUTPUTS     |    |    |    |               |    |    |    |
|-------|-------------|----|----|----|---------------|----|----|----|
|       | BCD COUNT * |    |    |    | BI-QUINARY ** |    |    |    |
|       | QD          | QC | QB | QA | QA            | QD | QC | QB |
| 0     | L           | L  | L  | L  | L             | L  | L  | L  |
| 1     | L           | L  | L  | H  | L             | L  | L  | H  |
| 2     | L           | L  | H  | L  | L             | L  | H  | L  |
| 3     | L           | L  | H  | H  | L             | L  | H  | H  |
| 4     | L           | H  | L  | L  | L             | H  | L  | L  |
| 5     | L           | H  | L  | H  | H             | L  | L  | L  |
| 6     | L           | H  | H  | L  | H             | L  | L  | H  |
| 7     | L           | H  | H  | H  | H             | L  | H  | L  |
| 8     | H           | L  | L  | L  | H             | L  | H  | H  |
| 9     | H           | L  | L  | H  | H             | H  | L  | L  |

| INPUTS                |                       |       | OUTPUTS          |    |    |    |
|-----------------------|-----------------------|-------|------------------|----|----|----|
| CLOCK A               | CLOCK B               | CLEAR | QA               | QB | QC | QD |
| X                     | X                     | H     | L                | L  | L  | L  |
| $\overline{\text{L}}$ | X                     | L     | BINARY COUNT UP  |    |    |    |
| X                     | $\overline{\text{L}}$ | L     | QUINARY COUNT UP |    |    |    |

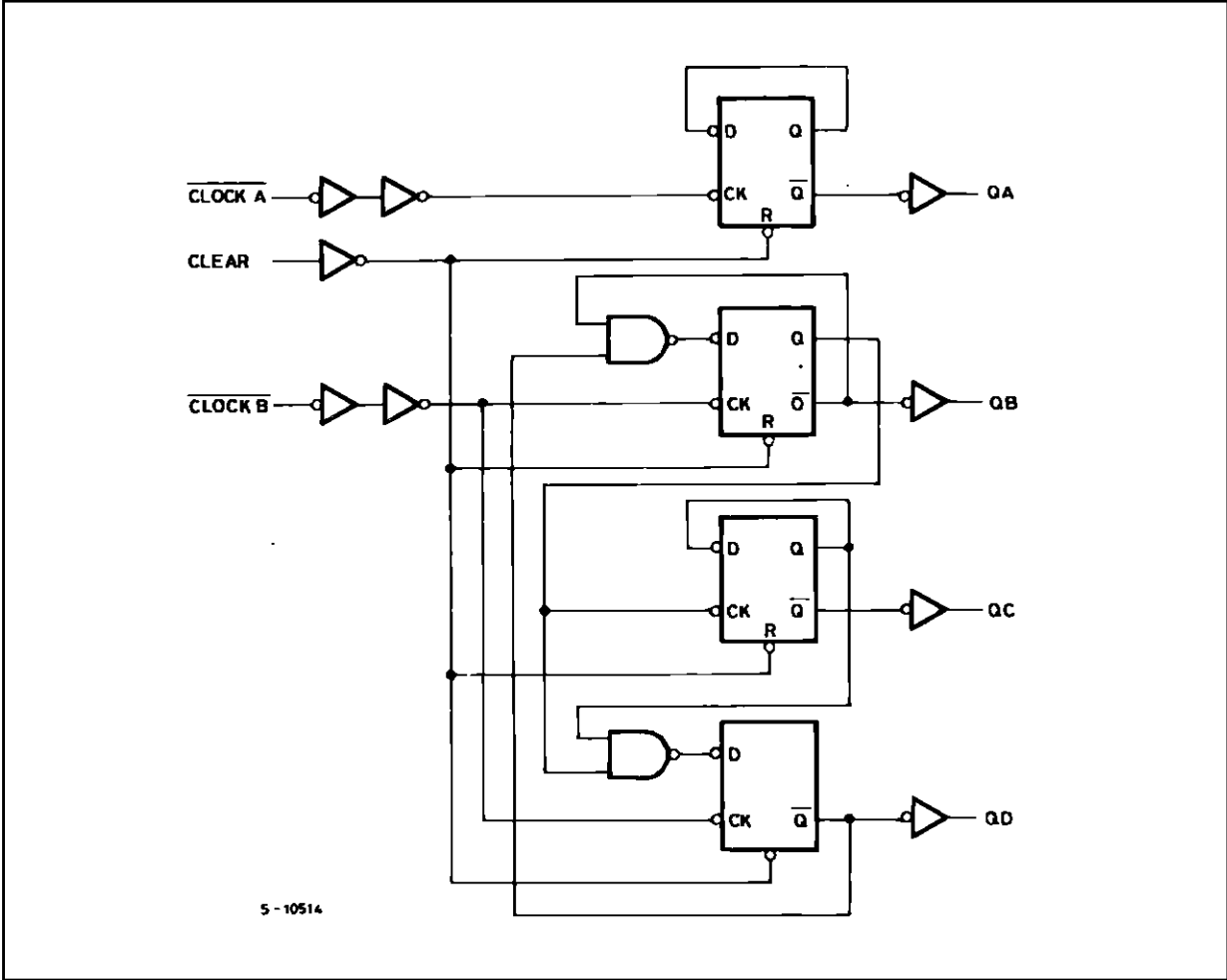
Note: \* Output QA is connected to input  $\overline{\text{CLOCK B}}$  for BCD count.

\*\* Output QD is connected to input  $\overline{\text{CLOCK A}}$  for bi-quinary count.

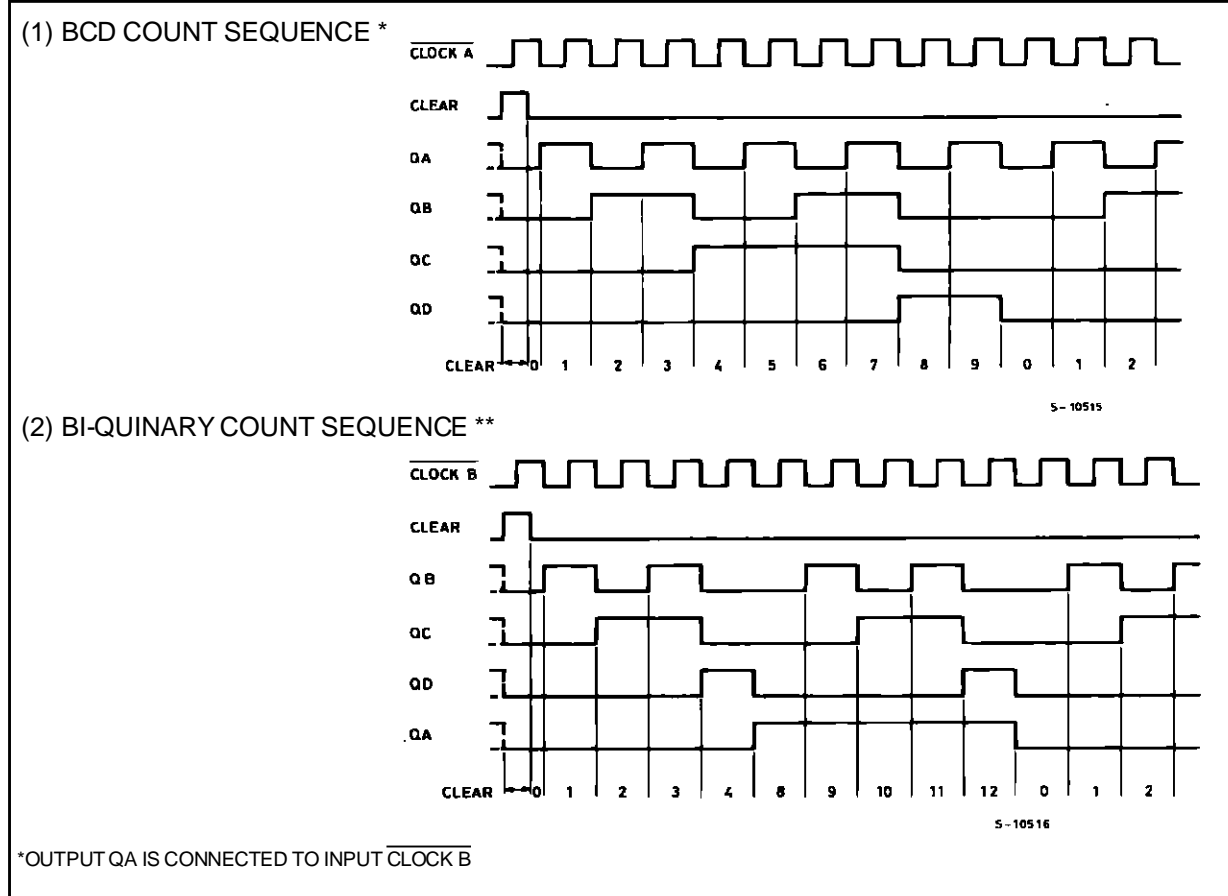
BLOCK DIAGRAM



LOGIC DIAGRAM



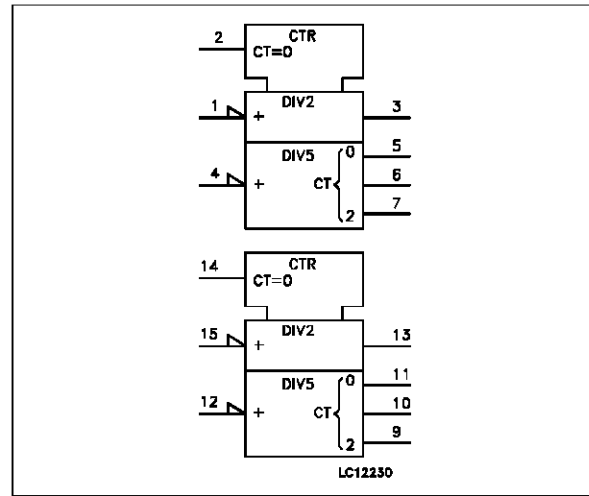
TIMING CHART



**PIN DESCRIPTION**

| PIN No        | SYMBOL                 | NAME AND FUNCTION  |
|---------------|------------------------|--|
| 1, 15         | 1 CLOCK A<br>2 CLOCK B | Clock Input Divide by 2 Section (HIGH to LOW Edge-triggered) |
| 2, 14         | 1 CLEAR<br>2 CLEAR     | Asynchronous Master Reset Inputs                             |
| 3, 5, 6, 7    | 1QA to 1QD             | Flip Flop Outputs  |
| 4, 12         | 1 CLOCK B<br>2 CLOCK B | Clock Input Divide by 5 Section (HIGH to LOW Edge-triggered) |
| 13, 11, 10, 9 | 2QA to 2QD             | Flip Flop Outputs  |
| 8             | GND                    | Ground (0V)  |
| 16            | 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     | 0 to 1000 | ns |
|                                 |   | V <sub>CC</sub> = 4.5 V   | 0 to 500  |    |
|                                 |   | V <sub>CC</sub> = 6 V     | 0 to 400  |    |

**DC SPECIFICATIONS**

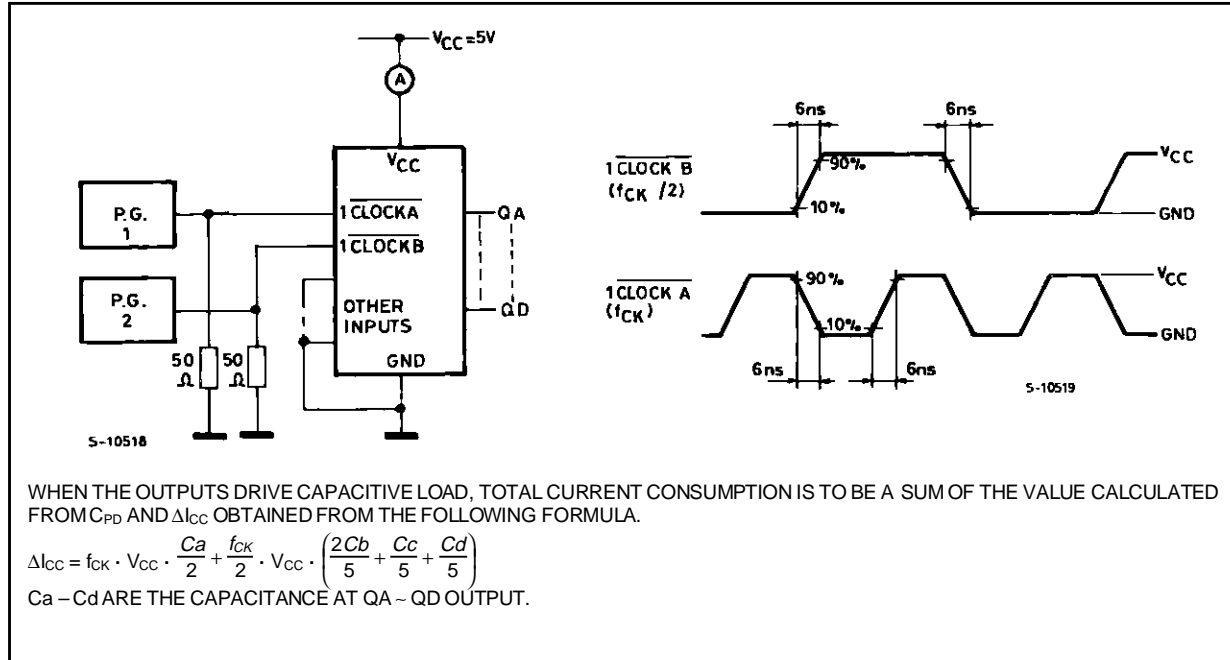
| Symbol          | Parameter                 | Test Conditions        |  | Value                                   |                         |      |                      |      |                       | Unit |      |   |
|-----------------|---------------------------|------------------------|--|---|-------------------------|------|----------------------|------|-----------------------|------|------|---|
|                 |                           | 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 |      |   |
| 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  $t_r = t_f = 6 \text{ ns}$ )

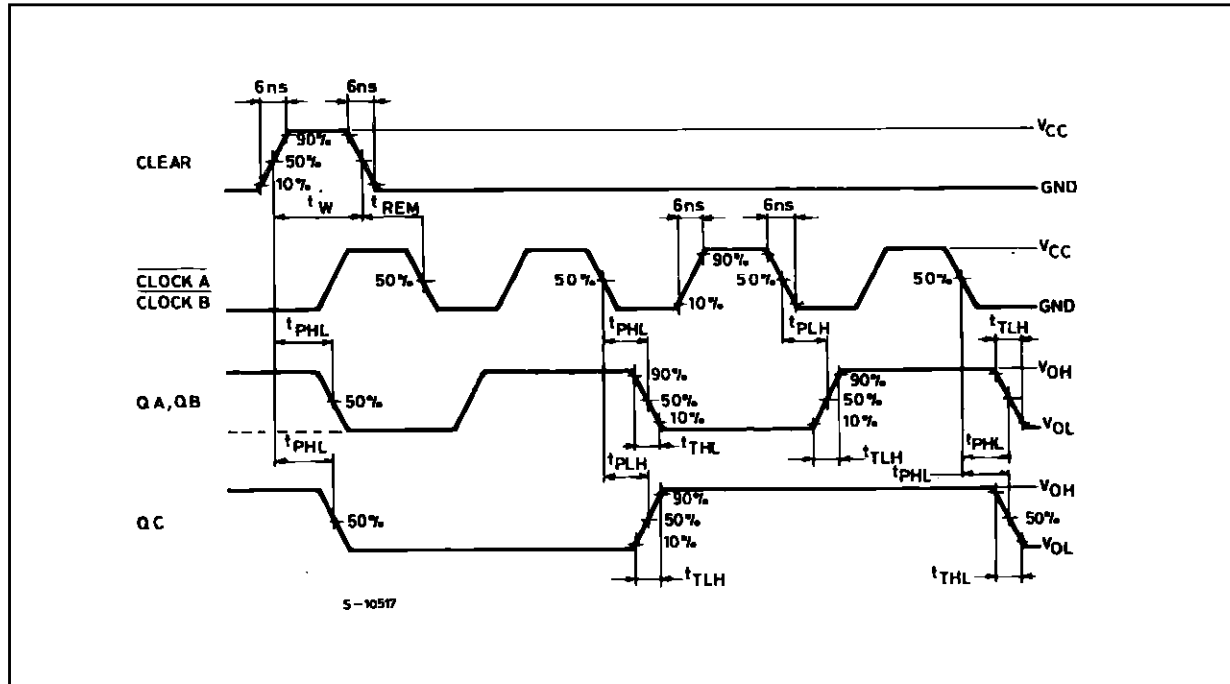
| Symbol                                 | Parameter                                    | Test Conditions        |                     | Value                                   |      |      |                      |      |                       | Unit |      |
|--|--|------------------------|---------------------|---|------|------|----------------------|------|-----------------------|------|------|
|  |  | 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 A - QA)     | 2.0                    |                     |   | 42   | 120  |                      | 150  |                       | 180  | ns   |
|  |  | 4.5                    |                     |   | 14   | 24   |                      | 30   |                       | 36   |      |
|  |  | 6.0                    |                     |   | 12   | 20   |                      | 26   |                       | 31   |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time<br>(CLOCK A - QB, QD) | 2.0                    |                     |   | 45   | 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 A - QC)     | 2.0                    | QA Connected to CKB |   | 108  | 280  |                      | 350  |                       | 420  | ns   |
|  |  | 4.5                    |                     |   | 36   | 56   |                      | 70   |                       | 84   |      |
|  |  | 6.0                    |                     |   | 31   | 48   |                      | 60   |                       | 71   |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time<br>(CLOCK B - QC)     | 2.0                    |                     |   | 72   | 185  |                      | 230  |                       | 280  | ns   |
|  |  | 4.5                    |                     |   | 24   | 37   |                      | 46   |                       | 56   |      |
|  |  | 6.0                    |                     |   | 20   | 31   |                      | 39   |                       | 48   |      |
| t <sub>PHL</sub>                       | Propagation Delay Time<br>(CLEAR - Qn)       | 2.0                    |                     |   | 45   | 125  |                      | 155  |                       | 190  | ns   |
|  |  | 4.5                    |                     |   | 15   | 25   |                      | 31   |                       | 38   |      |
|  |  | 6.0                    |                     |   | 13   | 21   |                      | 26   |                       | 32   |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency<br>(CLOCK A - QA)    | 2.0                    |                     |   | 8.4  | 17   |                      | 6.8  |                       | 5.6  | ns   |
|  |  | 4.5                    |                     |   | 42   | 65   |                      | 34   |                       | 28   |      |
|  |  | 6.0                    |                     |   | 50   | 79   |                      | 40   |                       | 33   |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency<br>(CLOCK B - QB)    | 2.0                    |                     |   | 8.4  | 17   |                      | 6.8  |                       | 5.6  | ns   |
|  |  | 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                    |                     |   | 24   | 75   |                      | 95   |                       | 110  | ns   |
|  |  | 4.5                    |                     |   | 6    | 15   |                      | 19   |                       | 22   |      |
|  |  | 6.0                    |                     |   | 5    | 13   |                      | 16   |                       | 19   |      |
| t <sub>W(H)</sub>                      | Minimum Pulse Width<br>(CLEAR)               | 2.0                    |                     |   | 24   | 75   |                      | 95   |                       | 110  | ns   |
|  |  | 4.5                    |                     |   | 6    | 15   |                      | 19   |                       | 22   |      |
|  |  | 6.0                    |                     |   | 5    | 13   |                      | 16   |                       | 19   |      |
| t <sub>REM</sub>                       | Propagation Delay Time                       | 2.0                    |                     |   |      | 25   |                      | 30   |                       | 35   | ns   |
|  |  | 4.5                    |                     |   |      | 5    |                      | 6    |                       | 7    |      |
|  |  | 6.0                    |                     |   |      |      | 5                    |      | 5                     |      |      |
| C <sub>IN</sub>                        | Input Capacitance                            |                        |                     |   | 5    | 10   |                      | 10   |                       | 10   | pF   |
| C <sub>PD</sub> (*)                    | Power Dissipation Capacitance                |                        |                     |   | 84   |      |                      |      |                       |      | 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.  $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

TEST CIRCUIT I<sub>CC</sub> (Opr.)



SWITCHING CHARACTERISTICS TEST WAVEFORM





## 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 |



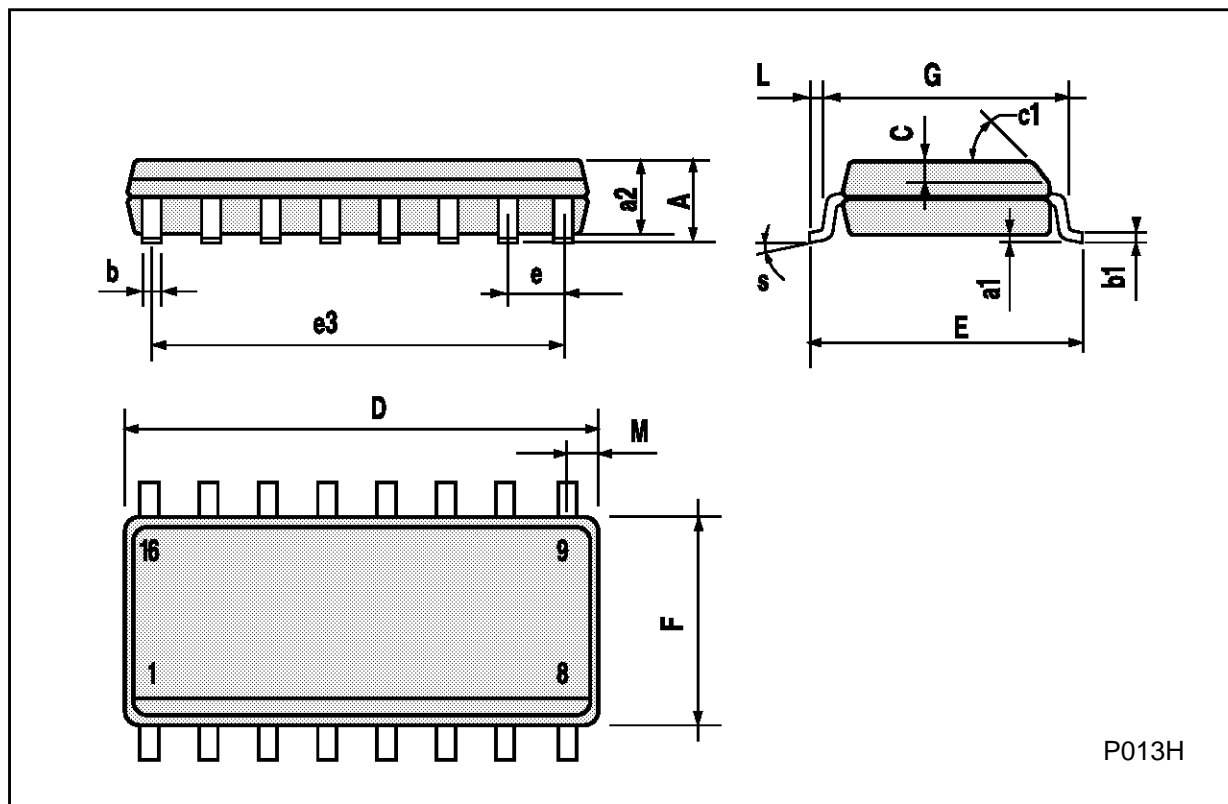
**Ceramic DIP16/1 MECHANICAL DATA**

| 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 |



## 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.)  |      |      |       |       |       |



P013H

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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