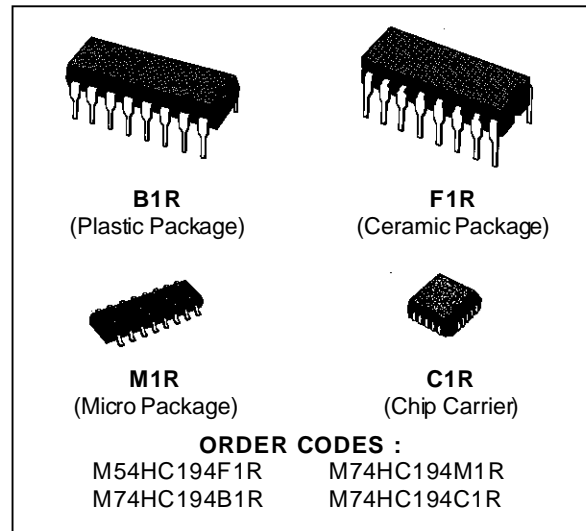


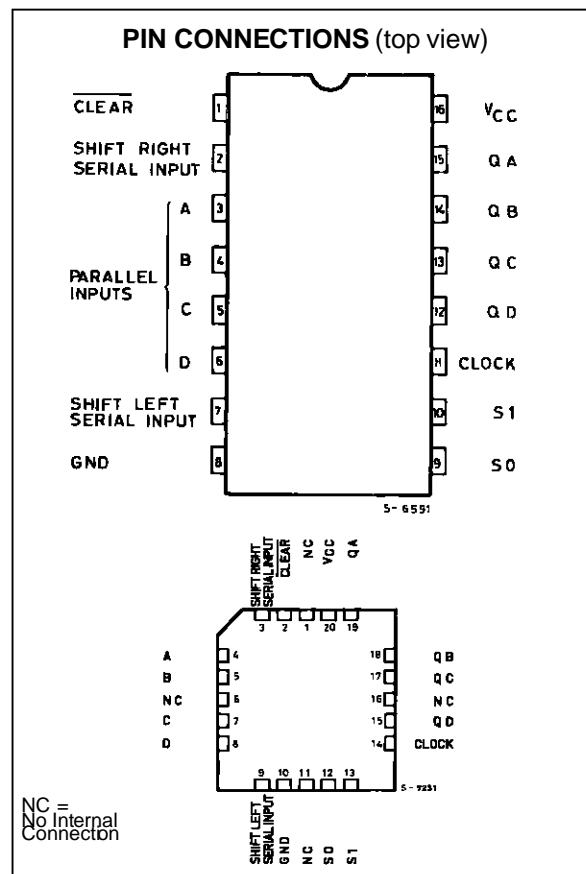
4 BIT PIPO SHIFT REGISTER

- HIGH SPEED
 $t_{PD} = 12 \text{ ns (TYP.) AT } V_{CC} = 5 \text{ V}$
- LOW POWER DISSIPATION
 $I_{CC} = 4 \mu\text{A (MAX.) AT } T_A = 25 \text{ }^\circ\text{C}$
- OUTPUT DRIVE CAPABILITY
 10 LSTTL LOADS
- SYMMETRICAL OUTPUT IMPEDANCE
 $|I_{OH}| = I_{OL} = 4 \text{ mA (MIN.)}$
- BALANCED PROPAGATION DELAYS
 $t_{PLH} = t_{PHL}$
- HIGH NOISE IMMUNITY
 $V_{NIH} = V_{NIL} = 28 \% V_{CC} \text{ (MIN.)}$
- WIDE OPERATING VOLTAGE RANGE
 $V_{CC} \text{ (OPR)} = 2 \text{ V TO } 6 \text{ V}$
- PIN AND FUNCTION COMPATIBLE
 WITH 54/74LS194



DESCRIPTION

The M54/74HC194 is a high speed CMOS 4 BIT PIPO SHIFT REGISTER fabricated in silicon gate C²MOS technology. It has the same high speed performance of LSTTL combined with true CMOS low power consumption. This SHIFT REGISTER is designed to incorporate virtually all of the features a system designer may want in a shift register. It features parallel inputs, parallel outputs, right shift and left shift serial inputs, clear line. The register has four distinct modes of operation : PARALLEL (broadside) LOAD ; SHIFT RIGHT (in the direction Q_A Q_D) ; SHIFT LEFT ; INHIBIT CLOCK (do nothing). Synchronous parallel loading is accomplished by applying the four data bits and taking both mode control inputs, S₀ and S₁ high. The data are loaded into their respective flip-flops and appear at the outputs after the positive transition of the CLOCK input. During loading, serial data flow is inhibited. Shift right is accomplished synchronously with the rising edge of the clock pulse when S₀ is high and S₁ is low. Serial data for this mode is entered at the SHIFT RIGHT data input. When S₀ is low and S₁ is high, data shifts left synchronously and new data is entered at the SHIFT LEFT serial input. Clocking of the flip flops is inhibited when both mode control inputs are low. The mode control inputs should be changed only when the CLOCK input is high. All inputs are equipped with protection circuits against static discharge and transient excess voltage.



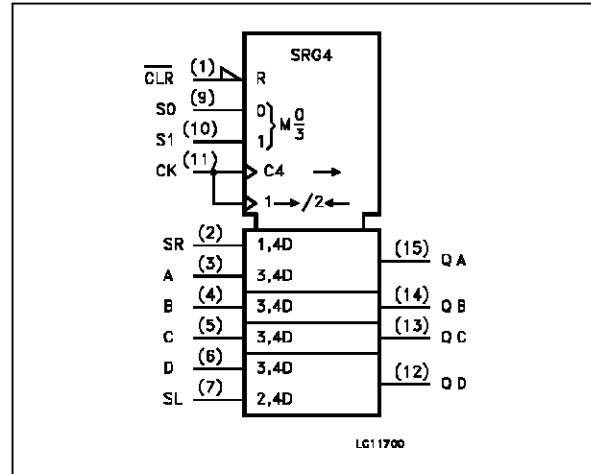
INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

| PIN No | SYMBOL | NAME AND FUNCTION |
|----------------|---------------------------|--|
| 1 | $\overline{\text{CLEAR}}$ | Asynchronous Reset Input (Active LOW) |
| 2 | SR | Serial Data Input (Shift Right) |
| 3, 4, 5, 6 | A to D | Parallel Data Input |
| 7 | SL | Serial Data Input (Shift Left) |
| 9, 10 | S0, S1 | Mode Control Inputs |
| 11 | CLOCK | Clock Input (LOW to HIGH Edge-triggered) |
| 15, 14, 13, 12 | QA to QD | Parallel Outputs |
| 8 | GND | Ground (0V) |
| 16 | Vcc | Positive Supply Voltage |

IEC LOGIC SYMBOL

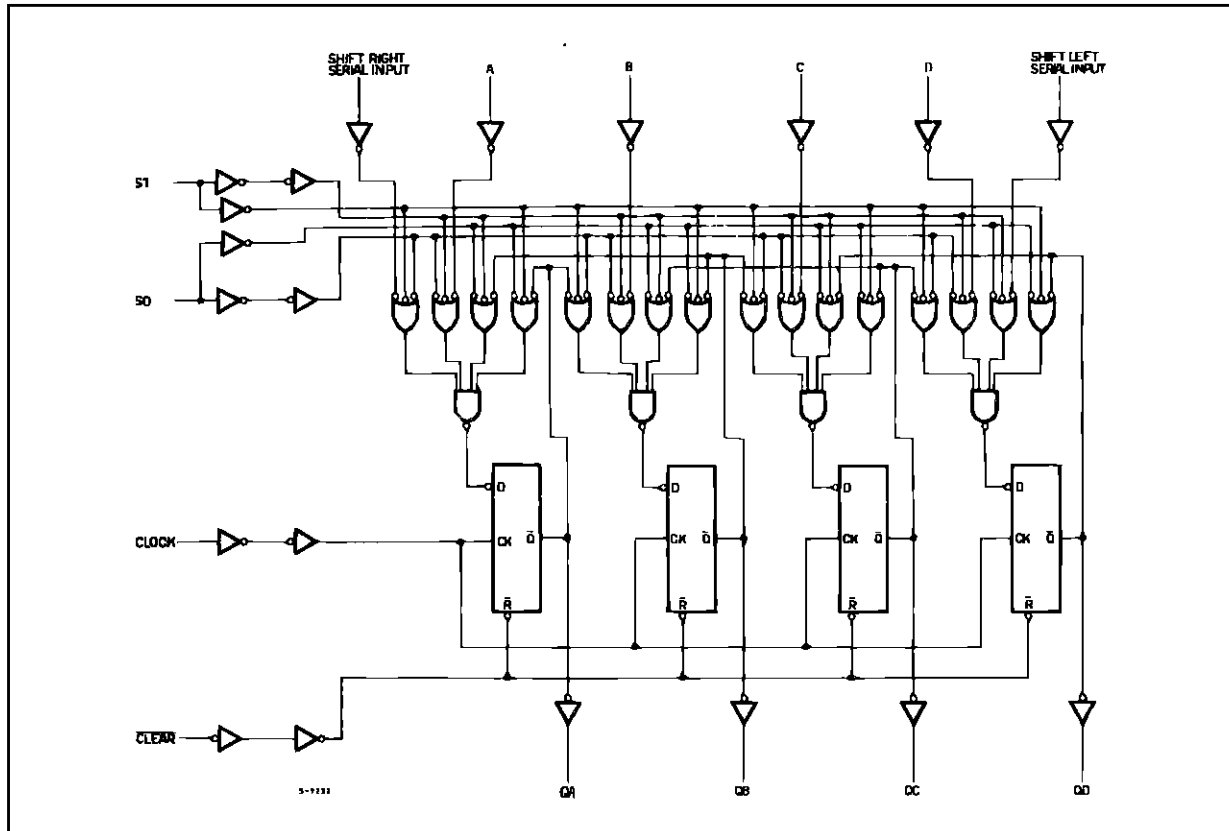


TRUTH TABLE

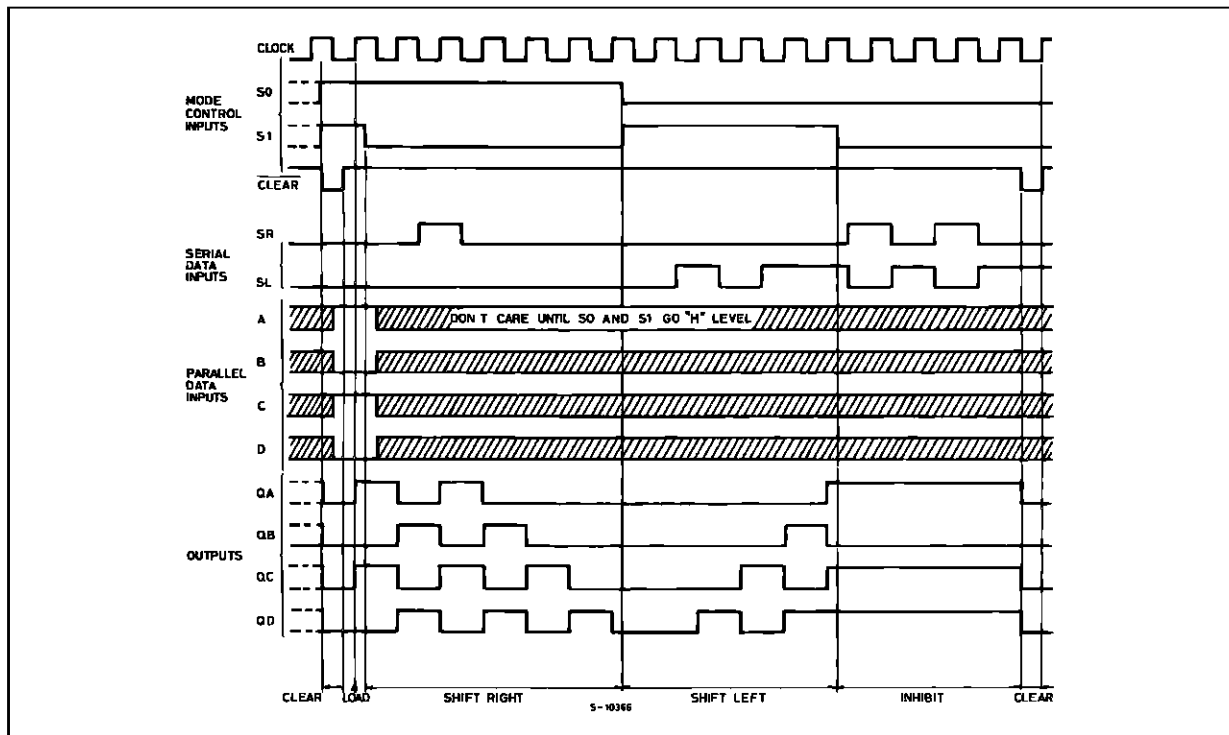
| CLEAR | MODE | | CLOCK | INPUTS | | | | | | OUTPUTS | | | |
|-------|------|----|--------------|--------|-------|----------|---|---|---|---------|-----|-----|-----|
| | S1 | S0 | | SERIAL | | PARALLEL | | | | QA | QB | QC | QD |
| | | | | LEFT | RIGHT | A | B | C | D | | | | |
| L | X | X | X | X | X | X | X | X | X | L | L | L | L |
| H | X | X | \downarrow | X | X | X | X | X | X | QA0 | QB0 | QC0 | QD0 |
| H | H | H | \uparrow | X | X | a | b | c | d | a | b | c | d |
| H | L | H | \uparrow | X | H | X | X | X | X | H | QAn | QBn | QCn |
| H | L | H | \uparrow | X | L | X | X | X | X | L | QAn | QBn | QCn |
| H | H | L | \uparrow | H | X | X | X | X | X | QBn | QCn | QDn | H |
| H | H | L | \uparrow | L | X | X | X | X | X | QBn | QCn | QDn | L |
| H | L | L | X | X | X | X | X | X | X | QA0 | QB0 | QC0 | QD0 |

X: Don't Care : Don't Care
 a ~ d : The level of steady state input voltage at input A ~ D respectively
 QA0 ~ QD0 : No change
 QAn ~ QDn : The level of QA, QB, QC, respectively, before the most recent positive transition of the clock.

LOGIC DIAGRAM



TIMING CHART



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|-------------------------------------|--|-------------------------------|------|
| V _{CC} | Supply Voltage | -0.5 to +7 | V |
| V _I | DC Input Voltage | -0.5 to V _{CC} + 0.5 | V |
| V _O | DC Output Voltage | -0.5 to V _{CC} + 0.5 | V |
| I _{IK} | DC Input Diode Current | ± 20 | mA |
| I _{OK} | DC Output Diode Current | ± 20 | mA |
| I _O | DC Output Source Sink Current Per Output Pin | ± 25 | mA |
| I _{CC} or I _{GND} | DC V _{CC} or Ground Current | ± 50 | mA |
| P _D | Power Dissipation | 500 (*) | mW |
| T _{stg} | Storage Temperature | -65 to +150 | °C |
| 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 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 _{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 _{op} | Operating Temperature: M54HC Series M74HC Series | -55 to +125 -40 to +85 | °C °C | |
| t _r , t _f | Input Rise and Fall Time | V _{CC} = 2 V V _{CC} = 4.5 V V _{CC} = 6 V | 0 to 1000 0 to 500 0 to 400 | ns |

DC SPECIFICATIONS

| Symbol | Parameter | Test Conditions | | Value | | | | | | Unit | | |
|-----------------|---------------------------|------------------------|--|---|-------------------------|------|----------------------|------|-----------------------|------|------|---|
| | | V _{CC} (V) | | T _A = 25 °C 54HC and 74HC | | | -40 to 85 °C 74HC | | -55 to 125 °C 54HC | | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. | |
| V _{IH} | 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 _{IL} | 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 _{OH} | High Level Output Voltage | 2.0 | V _I = V _{IH} or V _{IL} | I _O = -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 _O = -4.0 mA | 4.18 | 4.31 | | 4.13 | | 4.10 | | | |
| | | 6.0 | | I _O = -5.2 mA | 5.68 | 5.8 | | 5.63 | | 5.60 | | |
| V _{OL} | Low Level Output Voltage | 2.0 | V _I = V _{IH} or V _{IL} | I _O = 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 _O = 4.0 mA | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| | | 6.0 | | | I _O = 5.2 mA | | 0.18 | 0.26 | | 0.33 | | |
| I _I | Input Leakage Current | 6.0 | V _I = V _{CC} or GND | | | ±0.1 | | ±1 | | ±1 | μA | |
| I _{CC} | Quiescent Supply Current | 6.0 | V _I = V _{CC} or GND | | | 4 | | 40 | | 80 | μA | |

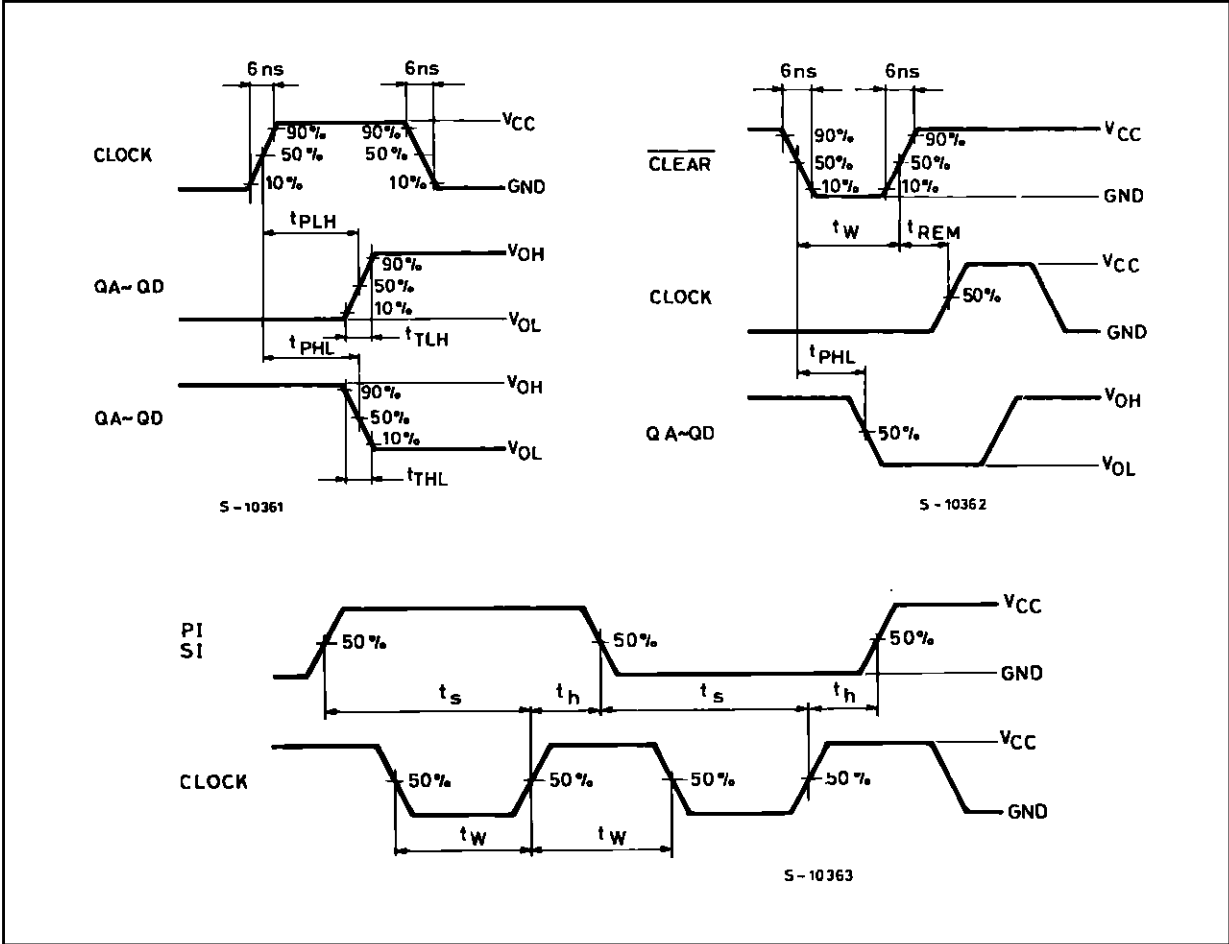
M54/M74HC194

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

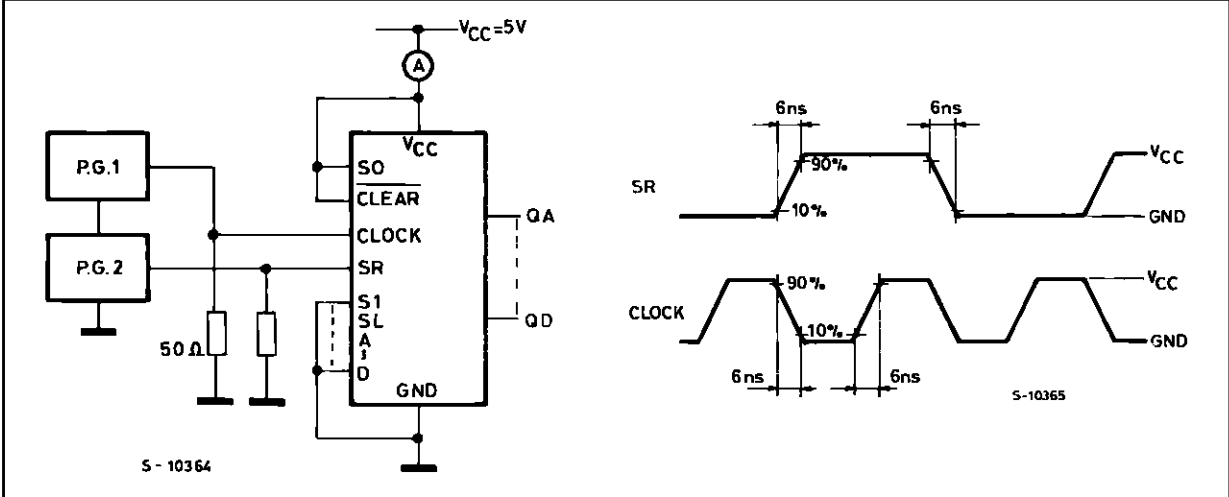
| Symbol | Parameter | Test Conditions | | Value | | | | | | Unit | |
|--------------------------|------------------------------------|-----------------|--|--|------|------|---|------|--|------|------|
| | | V_{CC} (V) | | $T_A = 25 \text{ }^\circ\text{C}$ 54HC and 74HC | | | $-40 \text{ to } 85 \text{ }^\circ\text{C}$ 74HC | | $-55 \text{ to } 125 \text{ }^\circ\text{C}$ 54HC | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | | Max. |
| t_{TLH} t_{THL} | Output Transition Time | 2.0 | | | 30 | 75 | | 95 | | 115 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 23 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 20 | |
| t_{PLH} t_{PHL} | Propagation Delay Time (CLOCK - Q) | 2.0 | | | 48 | 115 | | 145 | | 175 | ns |
| | | 4.5 | | | 15 | 23 | | 29 | | 35 | |
| | | 6.0 | | | 13 | 20 | | 25 | | 30 | |
| t_{PHL} | Propagation Delay Time (CLEAR - Q) | 2.0 | | | 52 | 125 | | 155 | | 190 | ns |
| | | 4.5 | | | 17 | 25 | | 31 | | 38 | |
| | | 6.0 | | | 15 | 21 | | 26 | | 32 | |
| f_{MAX} | Maximum Clock Frequency | 2.0 | | 6.2 | 13 | | 5.0 | | 4.2 | | MHz |
| | | 4.5 | | 31 | 50 | | 25 | | 21 | | |
| | | 6.0 | | 37 | 59 | | 30 | | 25 | | |
| $t_{W(H)}$ $t_{W(L)}$ | Minimum Pulse Width (CLOCK) | 2.0 | | | 20 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 5 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 4 | 13 | | 16 | | 19 | |
| $t_{W(L)}$ | Minimum Pulse Width (CLEAR) | 2.0 | | | 24 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 6 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 5 | 13 | | 16 | | 19 | |
| t_s | Minimum Set-up Time (SI, PI - CK) | 2.0 | | | 20 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 5 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 4 | 13 | | 16 | | 20 | |
| t_s | Minimum Set-up Time (S0, S1 - CK) | 2.0 | | | 28 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 7 | 15 | | 19 | | 23 | |
| | | 6.0 | | | 6 | 13 | | 16 | | 20 | |
| t_h | Minimum Hold Time | 2.0 | | | | 0 | | 0 | | 0 | ns |
| | | 4.5 | | | | 0 | | 0 | | 0 | |
| | | 6.0 | | | | 0 | | 0 | | 0 | |
| t_{REM} | Minimum Removal Time | 2.0 | | | | 5 | | 5 | | 5 | ns |
| | | 4.5 | | | | 5 | | 5 | | 5 | |
| | | 6.0 | | | | 5 | | 5 | | 5 | |
| C_{IN} | Input Capacitance | | | | 5 | 10 | | 10 | | 10 | pF |
| $C_{PD} (*)$ | Power Dissipation Capacitance | | | | 85 | | | | | | 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. $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

SWITCHING CHARACTERISTICS TEST WAVEFORM



TEST CIRCUIT I_{CC} (Opr.)



Plastic DIP16 (0.25) MECHANICAL DATA

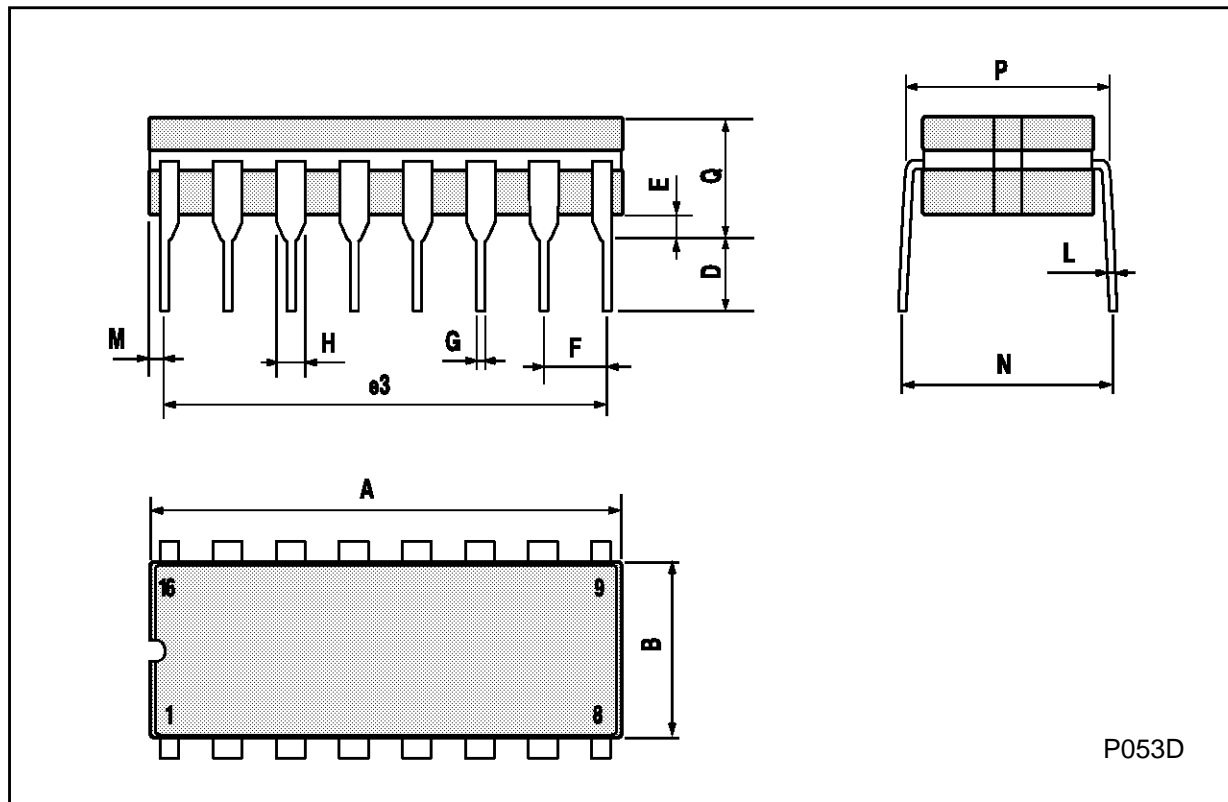
| DIM. | mm | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 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 |



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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