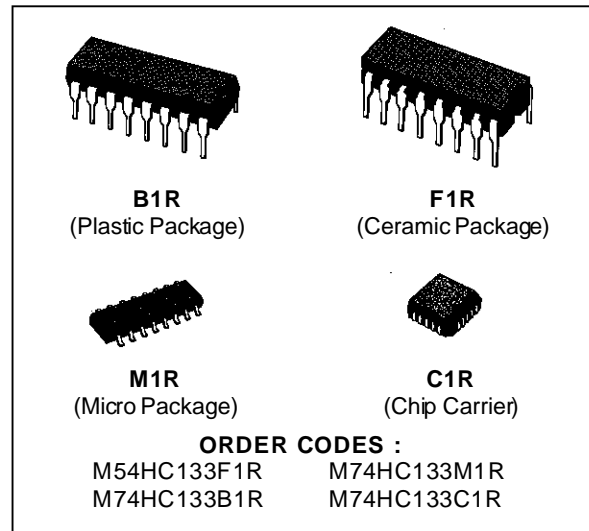


**13 INPUT NAND GATE**

- HIGH SPEED  
 $t_{PD} = 13 \text{ ns (TYP.)}$  at  $V_{CC} = 5 \text{ V}$
- LOW POWER DISSIPATION  
 $I_{CC} = 1 \mu\text{A (MAX.)}$  at  $T_A = 25^\circ \text{ C}$
- HIGH NOISE IMMUNITY  
 $V_{NIH} = V_{NIL} = 28 \% V_{CC}$  (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 54/74LS133

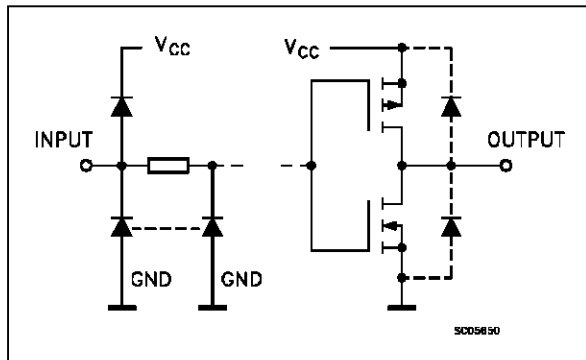


**DESCRIPTION**

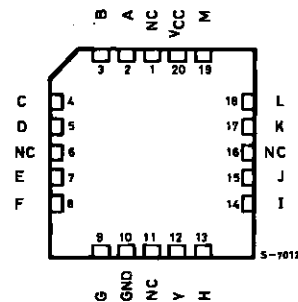
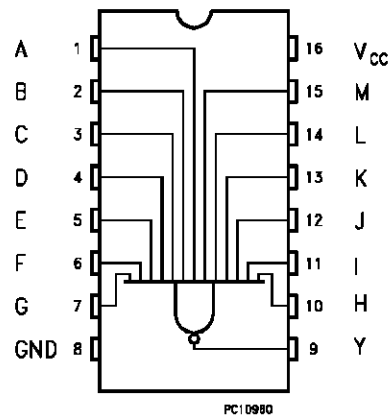
The M54/74HC133 is a high speed CMOS 13-INPUT NAND GATE fabricated in silicon gate C<sup>2</sup>MOS technology. It has the same high speed performance of LSTTL combined with true CMOS low power consumption.

The internal circuit is composed of 7 stages including buffer output, which gives high noise immunity and stable output. All inputs are equipped with protection circuits against static discharge and transient excess voltage.

**INPUT AND OUTPUT EQUIVALENT CIRCUIT**



**PIN CONNECTIONS (top view)**



NC =  
No Internal  
Connection

# M54/M74HC133

## TRUTH TABLE

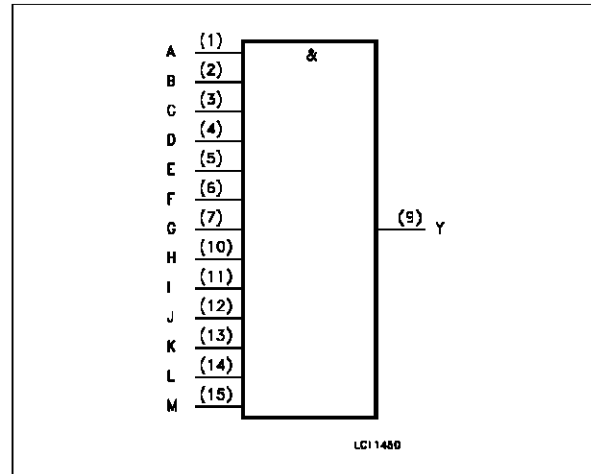
| A | B | C | D | E | F | G | H | I | J | K | L | M | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | X | X | X | X | X | X | X | X | X | X | X | X | H |
| X | L | X | X | X | X | X | X | X | X | X | X | X | H |
| X | X | L | X | X | X | X | X | X | X | X | X | X | H |
| X | X | X | L | X | X | X | X | X | X | X | X | X | H |
| X | X | X | X | L | X | X | X | X | X | X | X | X | H |
| X | X | X | X | X | L | X | X | X | X | X | X | X | H |
| X | X | X | X | X | X | L | X | X | X | X | X | X | H |
| X | X | X | X | X | X | X | L | X | X | X | X | X | H |
| X | X | X | X | X | X | X | X | L | X | X | X | X | H |
| X | X | X | X | X | X | X | X | X | L | X | X | X | H |
| X | X | X | X | X | X | X | X | X | X | L | X | X | H |
| X | X | X | X | X | X | X | X | X | X | X | L | X | H |
| X | X | X | X | X | X | X | X | X | X | X | X | L | H |
| H | H | H | H | H | H | H | H | H | H | H | H | H | L |

X: Don't Care

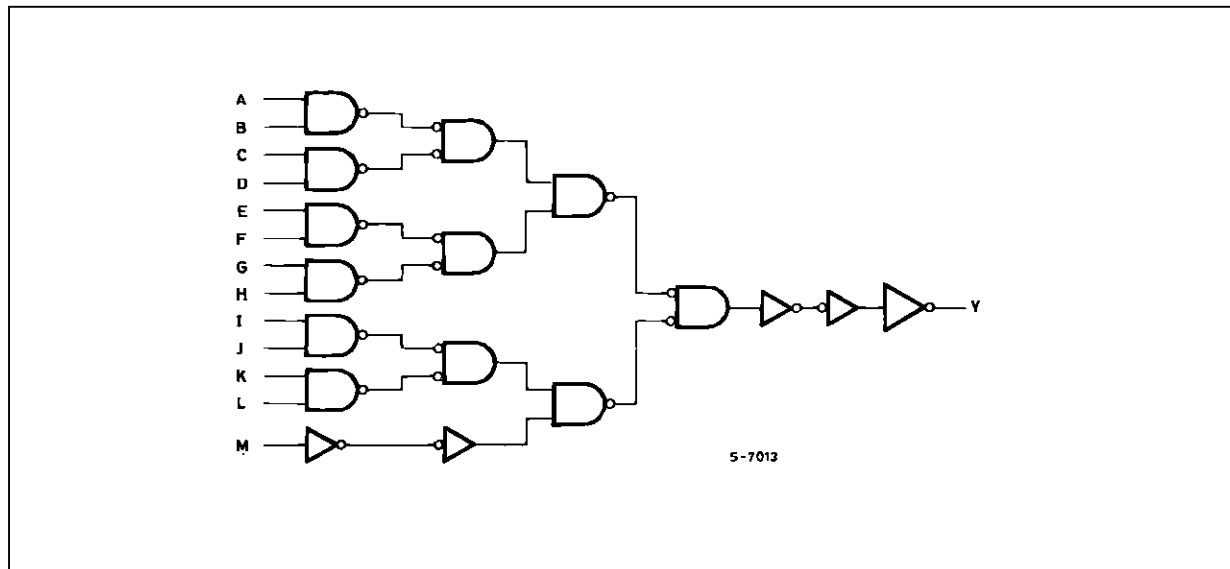
## PIN DESCRIPTION

| PIN No              | SYMBOL            | NAME AND FUNCTION       |
|---------------------|-------------------|-------------------------|
| 1 to 7,<br>10 to 15 | A to G,<br>H to M | Data Inputs             |
| 9                   | Y                 | Data Output             |
| 8                   | GND               | Ground (0V)             |
| 16                  | Vcc               | Positive Supply Voltage |

## IEC LOGIC SYMBOL



## LOGIC DIAGRAM (1/2 Package)



**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>V <sub>CC</sub> = 4.5 V<br>V <sub>CC</sub> = 6 V | 0 to 1000<br>0 to 500<br>0 to 400 | ns |

**DC SPECIFICATIONS**

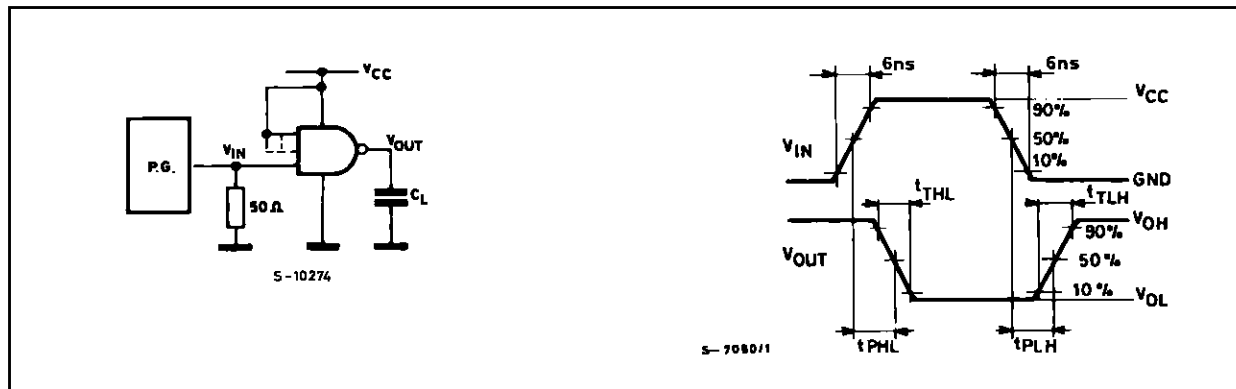
| Symbol          | Parameter                 | Test Conditions        |  | Value                                   |                         |      |                      |      |                       | Unit |      |      |
|-----------------|---------------------------|------------------------|--|---|-------------------------|------|----------------------|------|-----------------------|------|------|------|
|                 |                           | 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                   |      | 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                      |   |                         | 1    |                      | 10   |                       | 20   | μA   |      |

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

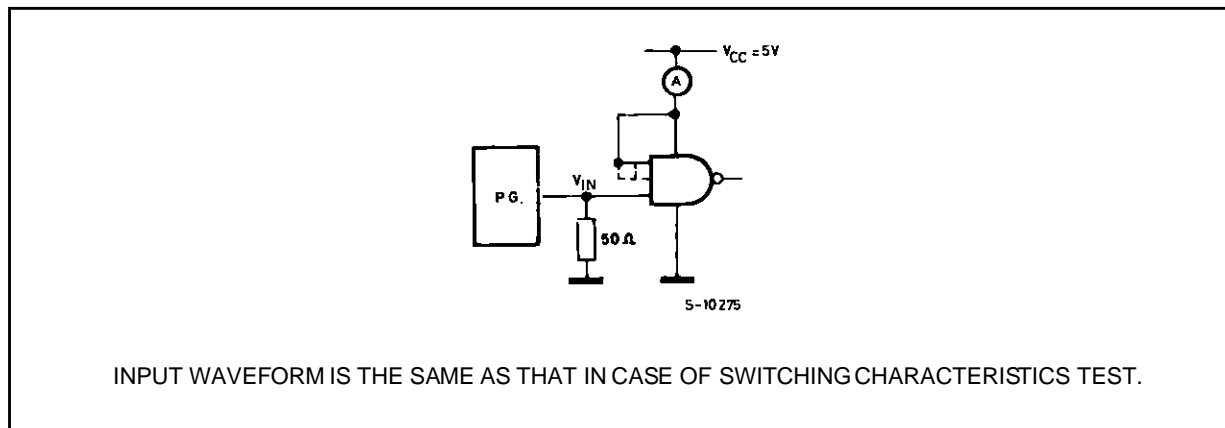
| Symbol                 | Parameter                     | Test Conditions |  | Value  |      |      |   |      |  | Unit |      |
|------------------------|-------------------------------|-----------------|--|--|------|------|---|------|--|------|------|
|                        |                               | $V_{CC}$<br>(V) |  | $T_A = 25 \text{ }^\circ\text{C}$<br>54HC and 74HC |      |      | $-40 \text{ to } 85 \text{ }^\circ\text{C}$<br>74HC |      | $-55 \text{ to } 125 \text{ }^\circ\text{C}$<br>54HC |      |      |
|                        |                               |                 |  | Min.   | Typ. | Max. | Min.  | Max. | Min.   |      | Max. |
| $t_{TLH}$<br>$t_{THL}$ | Output Transition Time        | 2.0             |  |  | 30   | 75   |   | 95   |  | 110  | ns   |
|                        |                               | 4.5             |  |  | 8    | 15   |   | 19   |  | 22   |      |
|                        |                               | 6.0             |  |  | 7    | 13   |   | 16   |  | 19   |      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay Time        | 2.0             |  |  | 42   | 130  |   | 165  |  | 195  | ns   |
|                        |                               | 4.5             |  |  | 16   | 26   |   | 33   |  | 39   |      |
|                        |                               | 6.0             |  |  | 14   | 22   |   | 28   |  | 33   |      |
| $C_{IN}$               | Input Capacitance             |                 |  |  | 5    | 10   |   | 10   |  | 10   | pF   |
| $C_{PD} (*)$           | Power Dissipation Capacitance |                 |  |  | 29   |      |   |      |  |      | 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 CIRCUIT**

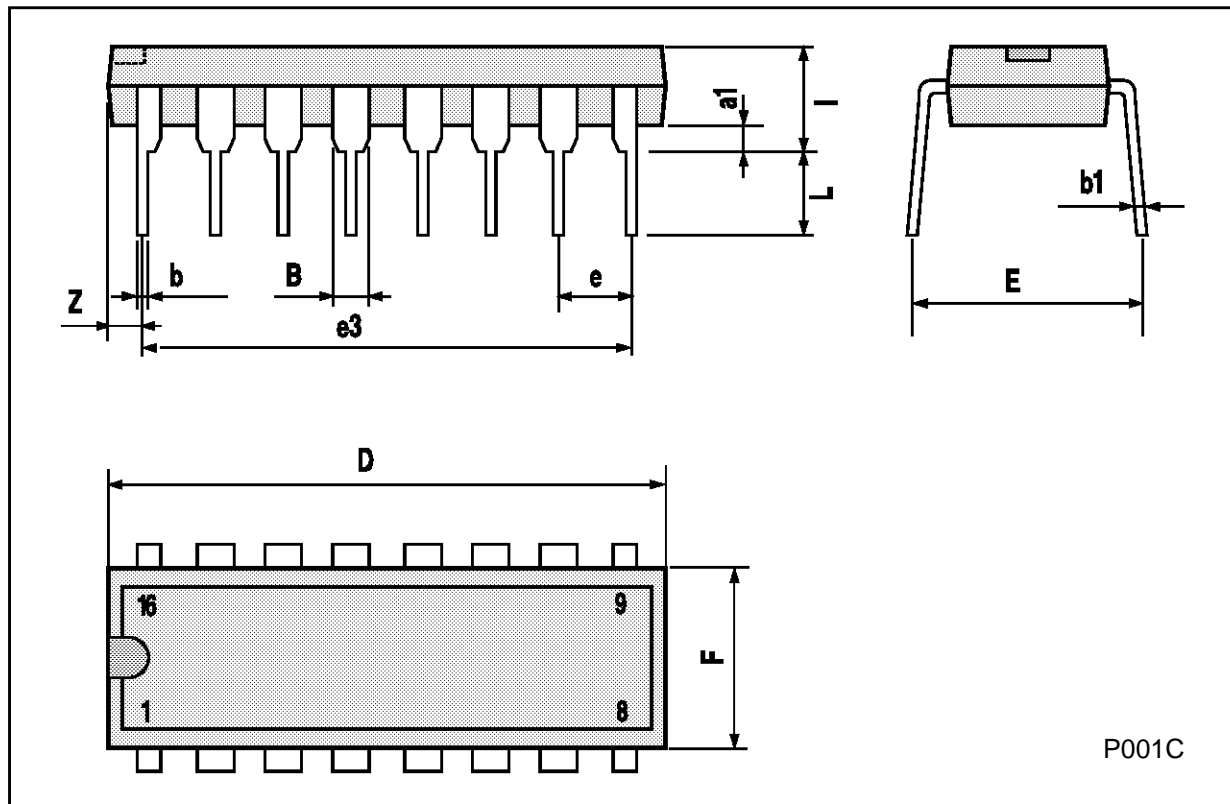


**TEST CIRCUIT  $I_{CC}$  (Opr.)**



**Plastic DIP16 (0.25) MECHANICAL DATA**

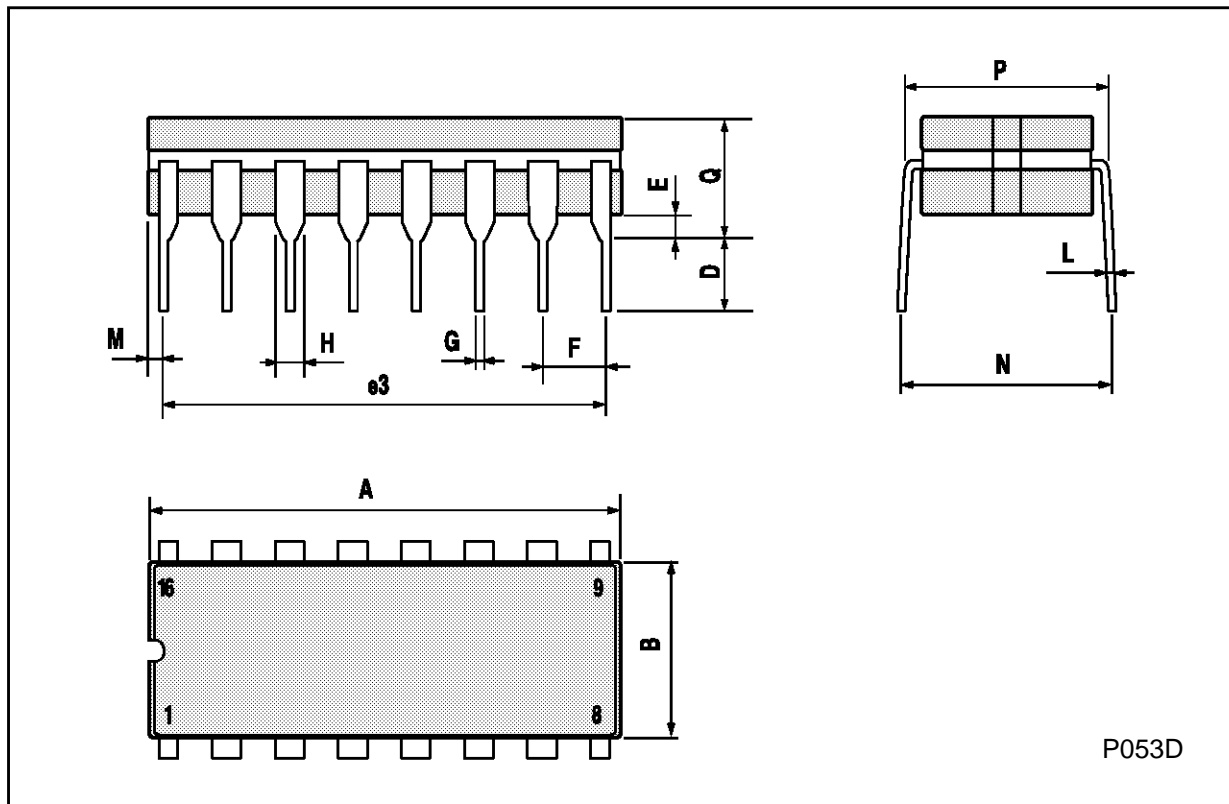
| DIM. | mm   |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 0.77 |       | 1.65 | 0.030 |       | 0.065 |
| b    |      | 0.5   |      |       | 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

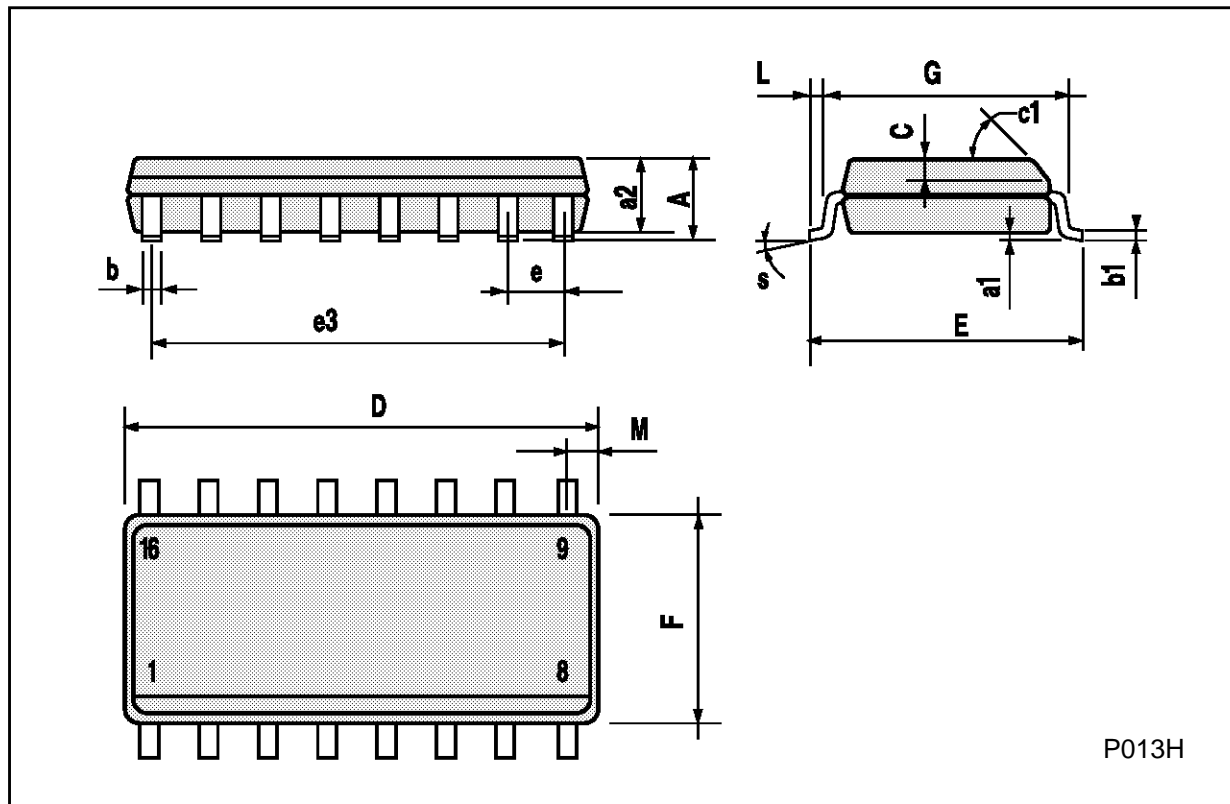
**Ceramic DIP16/1 MECHANICAL DATA**

| 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

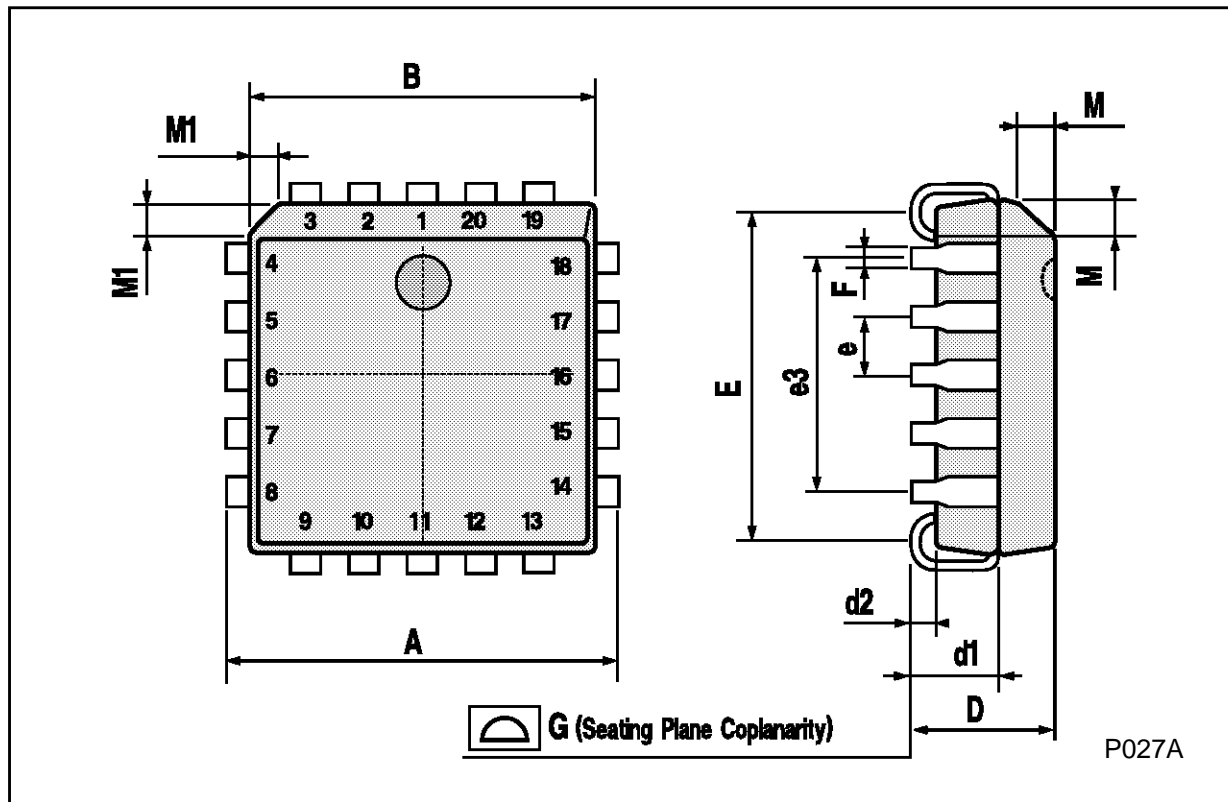
| DIM. | mm         |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.004 |       | 0.007 |
| 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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