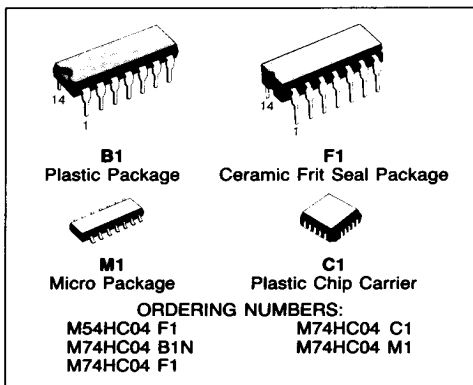


## HEX INVERTER

- **HIGH SPEED**  
 $t_{PD} = 8 \text{ ns (TYP.) at } V_{CC} = 5V$
- **LOW POWER DISSIPATION**  
 $I_{CC} = 1 \mu A \text{ (MAX.) at } T_A = 25^\circ C$
- **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**  
 $V_{CC} \text{ (OPR)} = 2V \text{ to } 6V$
- **PIN AND FUNCTION COMPATIBLE**  
 WITH 54/74LS04

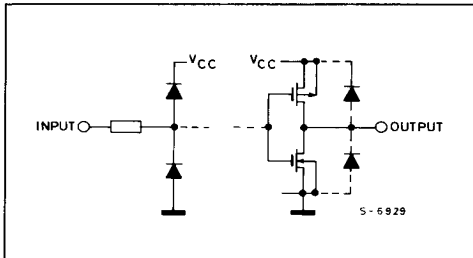


### DESCRIPTION

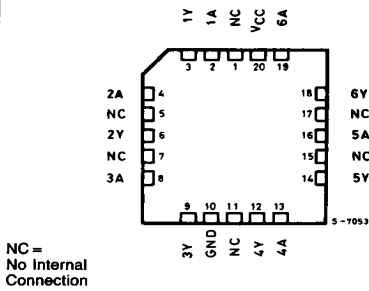
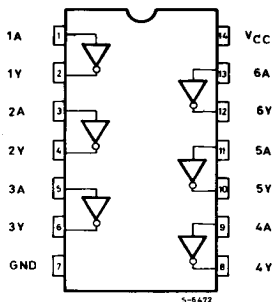
The M54/74HC04 is a high speed CMOS HEX INVERTER fabricated in silicon gate C<sup>2</sup>MOS technology. It has the same high speed performance of LSTTL combined with true CMOS low power consumption.

The internal circuit is composed of 3 stages including buffer output, which enables high noise immunity and stable output. All inputs are equipped with circuits against static discharge and transient excess voltage.

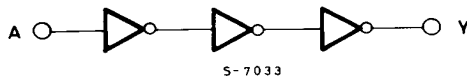
### INPUT AND OUTPUT EQUIVALENT CIRCUIT



### PIN CONNECTIONS (top view)



## LOGIC DIAGRAM (Per Gate)



## 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           | $^{\circ}\text{C}$ |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

(\*) 500 mW:  $\approx 65^{\circ}\text{C}$  derate to 300 mW by 10 mW/ $^{\circ}\text{C}$ :  $85^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

## 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                  |
| $T_A$      | Operating Temperature<br>74HC Series<br>54HC Series | -40 to 85<br>-55 to 125                                                                                                                     | $^{\circ}\text{C}$ |
| $t_r, t_f$ | Input Rise and Fall Time                            | $V_{CC} \begin{cases} 2 \text{ V} & 0 \text{ to } 1000 \\ 4.5 \text{ V} & 0 \text{ to } 500 \\ 6 \text{ V} & 0 \text{ to } 400 \end{cases}$ | ns                 |

## DC SPECIFICATIONS

| Symbol          | Parameter                 | V <sub>CC</sub>   | Test Condition                          | T <sub>A</sub> = 25°C<br>54HC and 74HC |              |                    | - 40 to 85°C<br>74HC |                    | - 55 to 125°C<br>54HC |                    | Unit         |
|-----------------|---------------------------|-------------------|-----------------------------------------|----------------------------------------|--------------|--------------------|----------------------|--------------------|-----------------------|--------------------|--------------|
|                 |                           |                   |                                         | Min.                                   | Typ.         | Max.               | Min.                 | Max.               | Min.                  | Max.               |              |
| V <sub>IH</sub> | High Level Input Voltage  | 2.0<br>4.5<br>6.0 |                                         | 1.5<br>3.15<br>4.2                     | —<br>—<br>—  | —<br>—<br>—        | 1.5<br>3.15<br>4.2   | —<br>—<br>—        | 1.5<br>3.15<br>4.2    | —<br>—<br>—        | V            |
| V <sub>IL</sub> | Low Level Input Voltage   | 2.0<br>4.5<br>6.0 |                                         | —<br>—<br>—                            | —<br>—<br>—  | 0.5<br>1.35<br>1.8 | —<br>1.35<br>—       | 0.5<br>1.35<br>1.8 | —<br>—<br>—           | 0.5<br>1.35<br>1.8 | V            |
| V <sub>OH</sub> | High Level Output Voltage | 2.0               | V <sub>I</sub>                          | I <sub>O</sub>                         | 1.9          | 2.0                | —                    | 1.9                | —                     | 1.9                | V            |
|                 |                           | 4.5               | V <sub>IH</sub>                         |                                        | 4.4          | 4.5                | —                    | 4.4                | —                     | 4.4                |              |
|                 |                           | 6.0               | V <sub>IH</sub> or V <sub>IL</sub>      | — 20 µA                                | 5.9          | 6.0                | —                    | 5.9                | —                     | 5.9                |              |
|                 |                           | 4.5<br>6.0        |                                         | — 4.0 mA<br>— 5.2 mA                   | 4.18<br>5.68 | 4.31<br>5.8        | —<br>—               | 4.13<br>5.63       | —<br>—                | 4.10<br>5.60       |              |
| V <sub>OL</sub> | Low Level Output Voltage  | 2.0               | V <sub>IH</sub> or V <sub>IL</sub>      | 20 µA                                  | —            | 0.0                | 0.1                  | —                  | 0.1                   | —                  | V            |
|                 |                           | 4.5               |                                         |                                        | —            | 0.0                | 0.1                  | —                  | 0.1                   | —                  |              |
|                 |                           | 6.0               |                                         |                                        | —            | 0.0                | 0.1                  | —                  | 0.1                   | —                  |              |
|                 |                           | 4.5<br>6.0        |                                         | 4.0 mA<br>5.2 mA                       | —<br>—       | 0.17<br>0.18       | 0.26<br>0.26         | —<br>—             | 0.33<br>0.33          | —<br>—             | 0.40<br>0.40 |
| I <sub>I</sub>  | Input Leakage Current     | 6.0               | V <sub>I</sub> = V <sub>CC</sub> or GND |                                        | —            | —                  | ±0.1                 | —                  | ±1.0                  | —                  | 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 (V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C, C<sub>L</sub> = 15pF, Input t<sub>r</sub> = t<sub>f</sub> = 6ns)

| Symbol                               | Parameter              | 54HC and 74HC |      |      | Unit |
|--------------------------------------|------------------------|---------------|------|------|------|
|                                      |                        | Min.          | Typ. | Max. |      |
| t <sub>TLH</sub><br>t <sub>THL</sub> | Output Transition Time |               | 4    | 8    | ns   |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay Time |               | 9    | 15   | ns   |

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

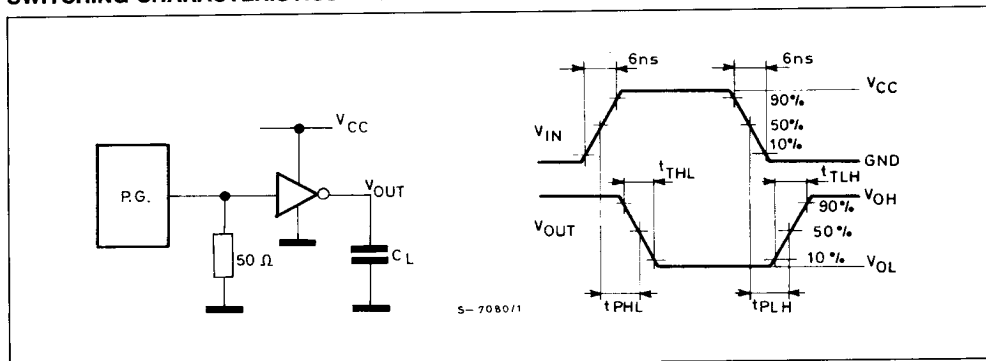
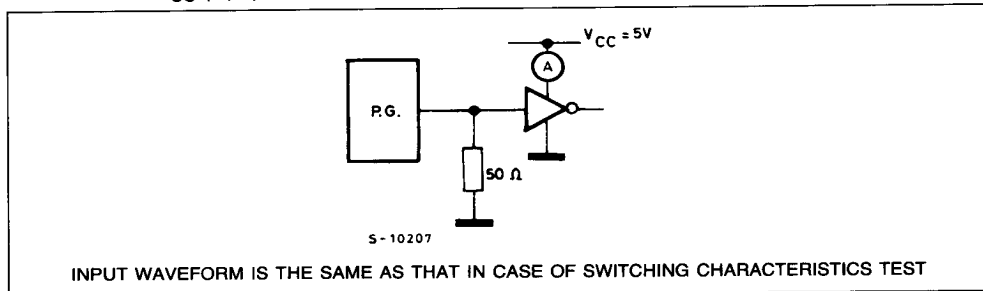
| Symbol                 | Parameter                     | $V_{CC}$          | Test Condition | $T_A = 25^\circ\text{C}$<br>54HC and 74HC |               |                | $-40 \text{ to } 85^\circ\text{C}$<br>74HC |                 | $-55 \text{ to } 125^\circ\text{C}$<br>54HC |                 | Unit |
|------------------------|-------------------------------|-------------------|----------------|-------------------------------------------|---------------|----------------|--------------------------------------------|-----------------|---------------------------------------------|-----------------|------|
|                        |                               |                   |                | Min.                                      | Typ.          | Max.           | Min.                                       | Max.            | Min.                                        | Max.            |      |
| $t_{TLH}$<br>$t_{THL}$ | Output Transition Time        | 2.0<br>4.5<br>6.0 |                | —                                         | 30<br>8<br>7  | 75<br>15<br>13 | —                                          | 95<br>19<br>16  |                                             | 110<br>22<br>19 | ns   |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay Time        | 2.0<br>4.5<br>6.0 |                | —                                         | 40<br>10<br>9 | 90<br>18<br>15 | —                                          | 115<br>23<br>20 |                                             | 135<br>27<br>23 | ns   |
| $C_{IN}$               | Input Capacitance             |                   |                | —                                         | 5             | 10             | —                                          | 10              |                                             | 10              | pF   |
| $C_{PD} (*)$           | Power Dissipation Capacitance |                   |                | —                                         | 22            | —              | —                                          | —               |                                             |                 | pF   |

Note (\*)  $C_{PD}$  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.

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/6 \text{ (per Gate).}$$

## SWITCHING CHARACTERISTICS TEST CIRCUIT

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

INPUT WAVEFORM IS THE SAME AS THAT IN CASE OF SWITCHING CHARACTERISTICS TEST