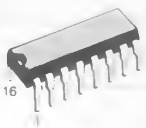
# 3 TO 8 LINE DECODER (INVERTING)

- HIGH SPEED
  $t_{PD}$ = 17ns (TYP.) at $V_{CC}$ = 5V
- LOW POWER DISSIPATION
  $I_{CC}$ = 4 $\mu$A at $T_A$ = 25°C
- OUTPUT DRIVE CAPABILITY
  10 LSTTL LOADS
- BALANCED PROPAGATION DELAYS
  $t_{PLH} = t_{PHL}$
- SYMMETRICAL OUTPUT IMPEDANCE
  $|I_{OH}| = I_{OL}$
- HIGH NOISE IMMUNITY
  $V_{NIH} = V_{NIL}$ = 28% $V_{CC}$ (MIN.)
- WIDE OPERATING VOLTAGE RANGE
  $V_{CC}$ (OPR) = 2 to 6V
- PIN AND FUNCTION COMPATIBLE
  WITH 54/74LS138



**B1N**
Plastic Package

**F1**
Ceramic Frit Seal Package

**M1**
Micro Package

**C1**
Plastic Chip Carrier

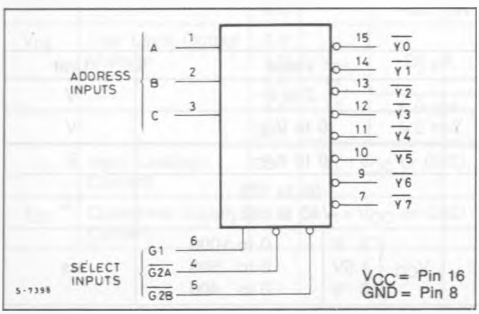
ORDERING NUMBERS:

- M54HC138 F1
  M74HC138 B1N
  M74HC138 F1
  M74HC138 C1
  M74HC138 M1

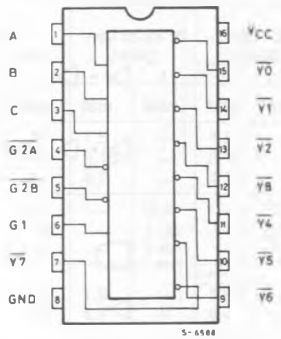
## DESCRIPTION

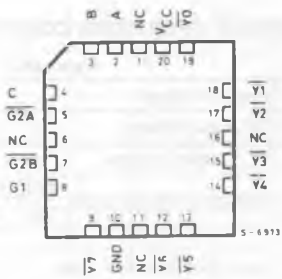
The M54/74HC138 is a high speed CMOS 3 TO 8 LINE DECODER fabricated in silicon gate C²MOS technology.
It has the same high speed performance of LSTTL combined with true CMOS low power consumption. If the device is enabled, 3 binary select inputs (A, B and C) determine which one of the outputs will go low. If enable input G1 is held low or either $\overline{G2A}$ or $\overline{G2B}$ is held high, the decoding function is inhibited and all the 8 outputs go high.
Three enable inputs are provided to ease cascade connection and application of address decoders for memory systems. All inputs are equipped with protection circuits against static discharge and transient excess voltage.

## BLOCK DIAGRAM




## PIN CONNECTIONS (top view)



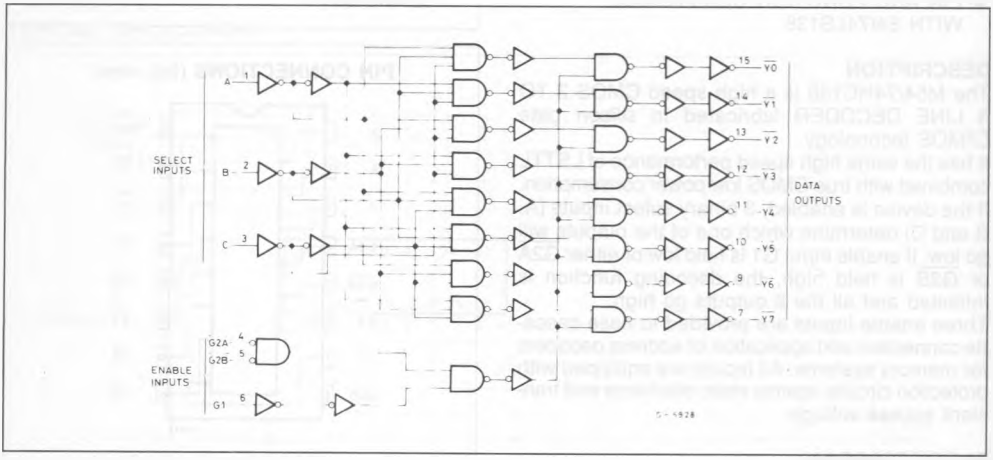

NC = No Internal Connection

## TRUTH TABLE

| INPUTS | | | | | | OUTPUTS | | | | | | | | SELECTED OUTPUT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENABLE | | | SELECT | | | | | | | | | | | |
| G1 | $\overline{G2A}$ | $\overline{G2B}$ | C | B | A | $\overline{Y0}$ | $\overline{Y1}$ | $\overline{Y2}$ | $\overline{Y3}$ | $\overline{Y4}$ | $\overline{Y5}$ | $\overline{Y6}$ | $\overline{Y7}$ | |
| L | X | X | X | X | X | H | H | H | H | H | H | H | H | NONE |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H | NONE |
| X | X | H | X | X | X | H | H | H | H | H | H | H | H | NONE |
| H | L | L | L | L | L | L | H | H | H | H | H | H | H | $\overline{Y0}$ |
| H | L | L | L | L | H | H | L | H | H | H | H | H | H | $\overline{Y1}$ |
| H | L | L | L | H | L | H | H | L | H | H | H | H | H | $\overline{Y2}$ |
| H | L | L | L | H | H | H | H | H | L | H | H | H | H | $\overline{Y3}$ |
| H | L | L | H | L | L | H | H | H | H | L | H | H | H | $\overline{Y4}$ |
| H | L | L | H | L | H | H | H | H | H | H | L | H | H | $\overline{Y5}$ |
| H | L | L | H | H | L | H | H | H | H | H | H | L | H | $\overline{Y6}$ |
| H | L | L | H | H | H | H | H | H | H | H | H | H | L | $\overline{Y7}$ |

X: DON'T CARE

## LOGIC DIAGRAM




## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 2 to 6 | | V |
| $V_I$ | DC Input Voltage | 0 to $V_{CC}$ | | V |
| $V_O$ | DC Output Voltage | 0 to $V_{CC}$ | | V |
| $T_A$ | Operating Temperature 74HC Series<br>54HC Series | −55 to 125<br>−40 to 85 | | °C |
| $t_r$, $t_f$ | Input Rise and Fall Time | $V_{CC}$ = 2 V | 0 to 1000 | ns |
| | | $V_{CC}$ = 4.5V | 0 to 500 | |
| | | $V_{CC}$ = 6 V | 0 to 400 | |

## 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 |

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

(*) 500 mW = derate to 10 mW/°C from 65°C to 85°C for plastic package
(*) 500 mW = derate to 12 mW/°C from 100 to 125°C for frit-seal package

## DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | $V_{CC}$ | Test Condition | | $T_A$ = 25°C 54HC and 74HC | | | −40 to 85°C 74HC | | −55 to 125°C 54HC | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 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 | $V_I$ | $I_O$ | 1.9 | 2.0 | — | 1.9 | — | 1.9 | — | V |
| | | 4.5 | $V_{IH}$ or $V_{IL}$ | −20 μA | 4.4 | 4.5 | — | 4.4 | — | 4.4 | — | |
| | | 6.0 | | | 5.9 | 6.0 | — | 5.9 | — | 5.9 | — | |
| | | 4.5 | | −4.0 mA | 4.18 | 4.31 | — | 4.13 | — | 4.10 | — | |
| | | 6.0 | | −5.2 mA | 5.68 | 5.8 | — | 5.63 | — | 5.60 | — | |
| $V_{OL}$ | Low Level Output Voltage | 2.0 | $V_{IH}$ or $V_{IL}$ | 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 | | 4.0 mA | — | 0.17 | 0.26 | — | 0.33 | — | 0.40 | |
| | | 6.0 | | 5.2 mA | — | 0.18 | 0.26 | — | 0.33 | — | 0.40 | |
| $I_I$ | Input Leakage Current | 6.0 | $V_I$ = $V_{CC}$ or GND | | — | — | ±0.1 | — | ±1.0 | — | ±1.0 | μA |
| $I_{CC}$ | Quiescent Supply Current | 6.0 | $V_I$ = $V_{CC}$ or GND | | — | — | 4 | — | 40 | — | 80 | μA |

**AC ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = 5V, $T_A$ = 25°C, $C_L$ = 15pF, Input $t_r = t_f$ = 6ns)

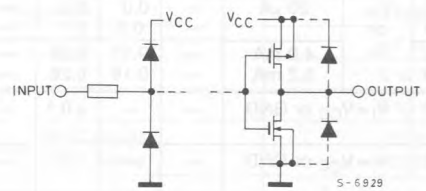
| Symbol | Parameter | 54HC and 74HC | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time | | 4 | 8 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (A,B,C-Y) | | 17 | 27 | ns |
| $t_{PHL}$ | Propagation Delay Time ($\overline{G}$, $\overline{G}$-Y) | | 15 | 23 | ns |

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

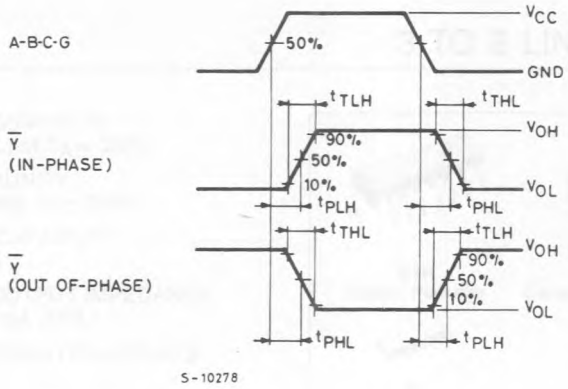
| Symbol | Parameter | $V_{CC}$ | Test Condition | $T_A$ = 25°C 54HC and 74HC | | | −40 to 85°C 74HC | | −55 to 125°C 54HC | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time | 2.0<br>4.5<br>6.0 | | —<br>—<br>— | 30<br>8<br>7 | 75<br>15<br>13 | —<br>—<br>— | 95<br>19<br>16 | | 110<br>22<br>19 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (A,B,C-$\overline{Y}$) | 2.0<br>4.5<br>6.0 | | —<br>—<br>— | 84<br>21<br>18 | 165<br>33<br>28 | —<br>—<br>— | 205<br>41<br>35 | | 250<br>50<br>43 | ns |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time ($\overline{G}$, $\overline{G}$-$\overline{Y}$) | 2.0<br>4.5<br>6.0 | | —<br>—<br>— | 72<br>18<br>15 | 145<br>29<br>25 | —<br>—<br>— | 180<br>36<br>31 | | 220<br>44<br>37 | ns |
| $C_{IN}$ | Input Capacitance | | | — | 5 | 10 | — | 10 | | 10 | pF |
| $C_{PD}$ (*) | Power Dissipation Capacitance | | | — | 57 | — | — | — | | | 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.
Average operating current is: $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

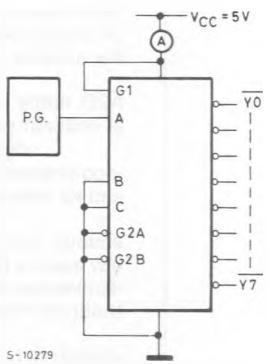
**INPUT AND OUTPUT EQUIVALENT CIRCUIT**



## SWITCHING CHARACTERISTICS TEST WAVEFORM




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




INPUT TRANSITION TIME IS TH SAME AS THAT IN CASE OF SWITCHING CHARACTERISTICS TEST.