# SN54LS138, SN54S138, SN74LS138, SN74S138A
# 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SDLS014

DECEMBER 1972—REVISED MARCH 1988

- **Designed Specifically for High-Speed:**
  **Memory Decoders**
  **Data Transmission Systems**
- **3 Enable Inputs to Simplify Cascading and/or Data Reception**
- **Schottky-Clamped for High Performance**

## description

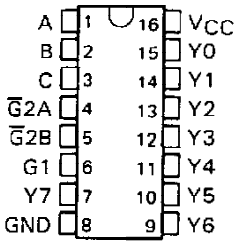
These Schottky-clamped TTL MSI circuits are designed to be used in high-performance memory decoding or data-routing applications requiring very short propagation delay times. In high-performance memory systems, these decoders can be used to minimize the effects of system decoding. When employed with high-speed memories utilizing a fast enable circuit, the delay times of these decoders and the enable time of the memory are usually less than the typical access time of the memory. This means that the effective system delay introduced by the Schottky-clamped system decoder is negligible.

The 'LS138, SN54S138, and SN74S138A decode one of eight lines dependent on the conditions at the three binary select inputs and the three enable inputs. Two active-low and one active-high enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications.

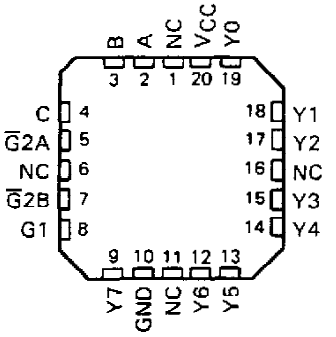
All of these decoder/demultiplexers feature fully buffered inputs, each of which represents only one normalized load to its driving circuit. All inputs are clamped with high-performance Schottky diodes to suppress line-ringing and to simplify system design.

The SN54LS138 and SN54S138 are characterized for operation over the full military temperature range of −55°C to 125°C. The SN74LS138 and SN74S138A are characterized for operation from 0°C to 70°C.

**SN54LS138, SN54S138 . . . J OR W PACKAGE**
**SN74LS138, SN74S138A . . . D OR N PACKAGE**
**(TOP VIEW)**

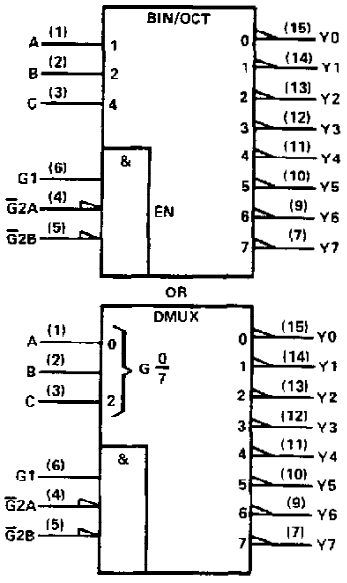



**SN54LS138, SN54S138 . . . FK PACKAGE**
**(TOP VIEW)**




NC—No internal connection

## logic symbols†




†These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, N, and W packages.

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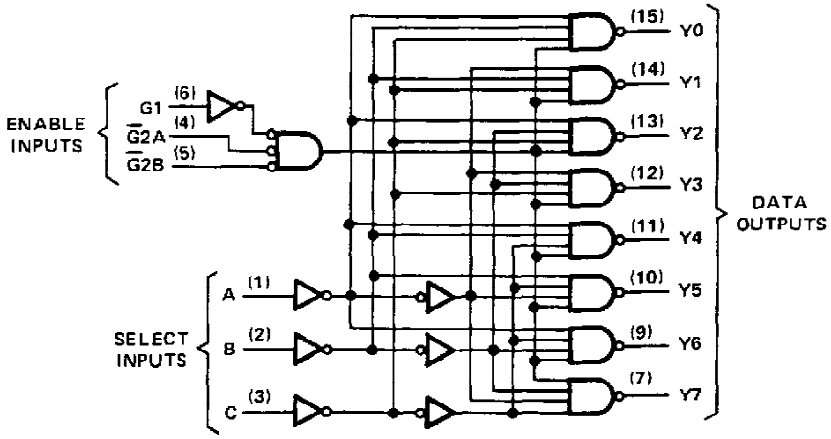
## logic diagram and function table

'LS138, SN54S138, SN74S138A



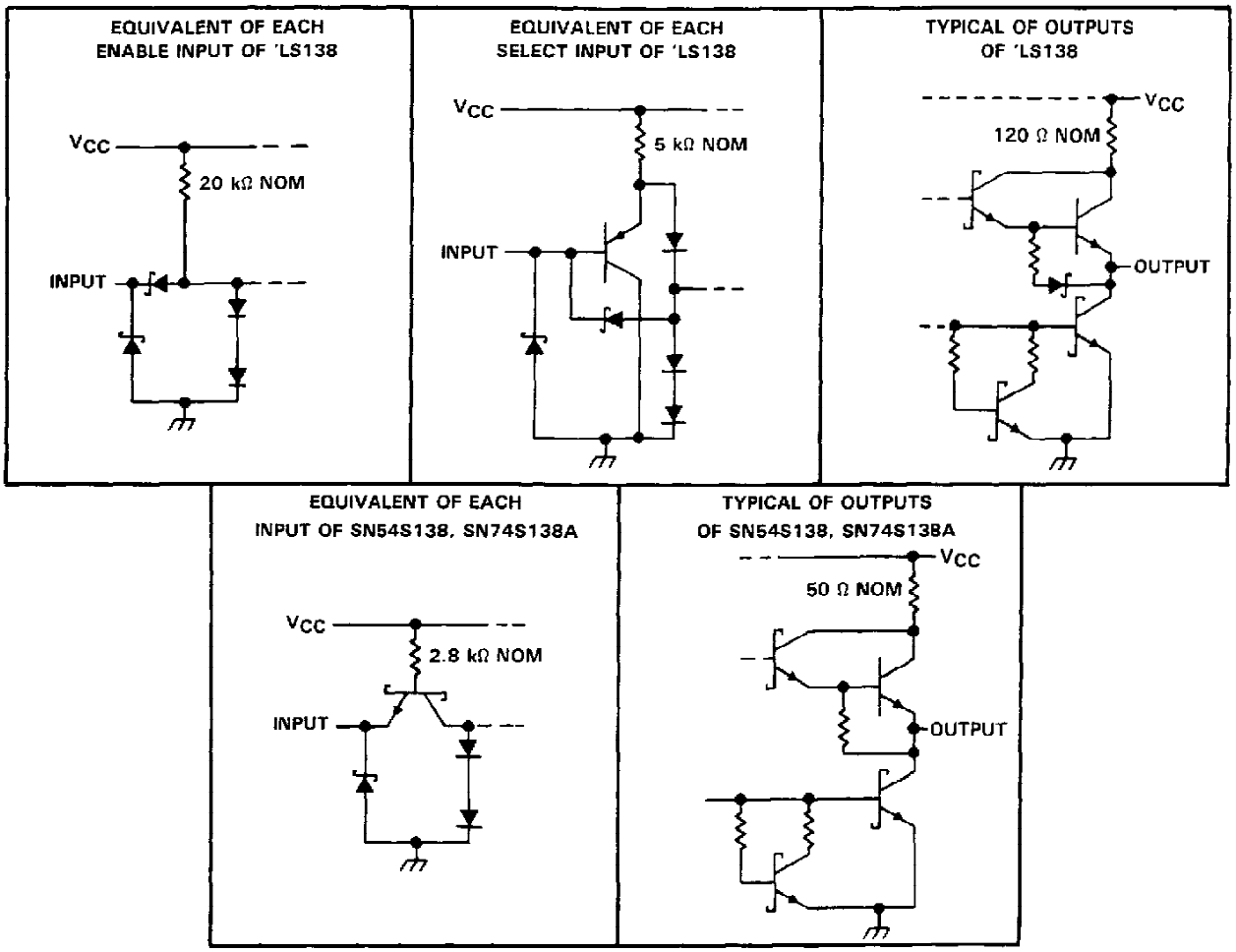

Pin numbers shown are for D, J, N, and W packages.

'LS138, SN54138, SN74S138A
FUNCTION TABLE

| INPUTS | | | | | OUTPUTS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENABLE | | SELECT | | | | | | | | | | |
| G1 | $\overline{G}$2* | C | B | A | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 |
| X | H | X | X | X | H | H | H | H | H | H | H | H |
| L | X | X | X | X | H | H | H | H | H | H | H | H |
| H | L | L | L | L | L | H | H | H | H | H | H | H |
| H | L | L | L | H | H | L | H | H | H | H | H | H |
| H | L | L | H | L | H | H | L | H | H | H | H | H |
| H | L | L | H | H | H | H | H | L | H | H | H | H |
| H | L | H | L | L | H | H | H | H | L | H | H | H |
| H | L | H | L | H | H | H | H | H | H | L | H | H |
| H | L | H | H | L | H | H | H | H | H | H | L | H |
| H | L | H | H | H | H | H | H | H | H | H | H | L |

*$\overline{G}2 = \overline{G}2A + \overline{G}2B$
H = high level, L = low level, X = irrelevant

## schematics of inputs and outputs




## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1) . . . . . 7 V
Input voltage . . . . . 7 V
Operating free-air temperature range: SN54LS138, SN54S138 . . . . . −55°C to 125°C
SN74LS138, SN74S138A . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

## recommended operating conditions

| | | SN54LS138 | | | SN74LS138 | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | MIN | NOM | MAX | MIN | NOM | MAX | |
| $V_{CC}$ | Supply voltage | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| $V_{IH}$ | High-level input voltage | 2 | | | 2 | | | V |
| $V_{IL}$ | Low-level input voltage | | | 0.7 | | | 0.8 | V |
| $I_{OH}$ | High-level output current | | | −0.4 | | | −0.4 | mA |
| $I_{OL}$ | Low-level output current | | | 4 | | | 8 | mA |
| $T_A$ | Operating free-air temperature | −55 | | 125 | 0 | | 70 | °C |

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | | SN54LS138 | | | SN74LS138 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP‡ | MAX | MIN | TYP‡ | MAX | |
| $V_{IK}$ | $V_{CC}$ = MIN, $I_I$ = −18 mA | | | | −1.5 | | | −1.5 | V |
| $V_{OH}$ | $V_{CC}$ = MIN, $V_{IH}$ = 2 V, $V_{IL}$ = MAX, $I_{OH}$ = −0.4 mA | | 2.5 | 3.4 | | 2.7 | 3.4 | | V |
| $V_{OL}$ | $V_{CC}$ = MIN, $V_{IH}$ = 2 V, $V_{IL}$ = MAX | $I_{OL}$ = 4 mA | | 0.25 | 0.4 | | 0.25 | 0.4 | V |
| | | $I_{OL}$ = 8 mA | | | | | 0.35 | 0.5 | |
| $I_I$ | $V_{CC}$ = MAX, $V_I$ = 7 V | | | | 0.1 | | | 0.1 | mA |
| $I_{IH}$ | $V_{CC}$ = MAX, $V_I$ = 2.7 V | | | | 20 | | | 20 | μA |
| $I_{IL}$ | $V_{CC}$ = MAX, $V_I$ = 0.4 V | Enable | | | −0.4 | | | −0.4 | mA |
| | | A, B, C | | | −0.2 | | | −0.2 | |
| $I_{OS}$§ | $V_{CC}$ = MAX | | −20 | | −100 | −20 | | −100 | mA |
| $I_{CC}$ | $V_{CC}$ = MAX, Outputs enabled and open | | | 6.3 | 10 | | 6.3 | 10 | mA |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.
§ Not more than one output should be shorted at a time, and duration of the short-circuit test should not exceed one second.

## switching characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C

| PARAMETER¶ | FROM (INPUT) | TO (OUTPUT) | LEVELS OF DELAY | TEST CONDITIONS | SN54LS138 SN74LS138 | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $t_{PLH}$ | Binary Select | Any | 2 | $R_L$ = 2 kΩ, $C_L$ = 15 pF, See Note 2 | | 11 | 20 | ns |
| $t_{PHL}$ | | | | | | 18 | 41 | ns |
| $t_{PLH}$ | | | 3 | | | 21 | 27 | ns |
| $t_{PHL}$ | | | | | | 20 | 39 | ns |
| $t_{PLH}$ | Enable | Any | 2 | | | 12 | 18 | ns |
| $t_{PHL}$ | | | | | | 20 | 32 | ns |
| $t_{PLH}$ | | | 3 | | | 14 | 26 | ns |
| $t_{PHL}$ | | | | | | 13 | 38 | ns |

¶ $t_{PLH}$ = propagation delay time, low-to-high-level ouput
$t_{PHL}$ = propagation delay time, high-to-low-level output
NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Operating free-air temperature range: SN54S138 . . . . . −55°C to 125°C
SN74S138A . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

### recommended operating conditions

| | | SN54S138 | | | SN74S138A | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | MIN | NOM | MAX | MIN | NOM | MAX | |
| $V_{CC}$ | Supply voltage | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| $V_{IH}$ | High-level input voltage | 2 | | | 2 | | | V |
| $V_{IL}$ | Low-level input voltage | | | 0.8 | | | 0.8 | V |
| $I_{OH}$ | High-level output current | | | −1 | | | −1 | mA |
| $I_{OL}$ | Low-level output current | | | 20 | | | 20 | mA |
| $T_A$ | Operating free-air temperature | −55 | | 125 | 0 | | 70 | °C |

### electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | | SN54S138 SN74S138A | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP‡ | MAX | |
| $V_{IK}$ | $V_{CC}$ = MIN, $I_I$ = −18 mA | | | | −1.2 | V |
| $V_{OH}$ | $V_{CC}$ = MIN, $V_{IH}$ = 2 V, $V_{IL}$ = 0.8 V, $I_{OH}$ = −1 mA | SN54S' | 2.5 | 3.4 | | V |
| | | SN74S' | 2.7 | 3.4 | | |
| $V_{OL}$ | $V_{CC}$ = MIN, $V_{IH}$ = 2 V, $V_{IL}$ = 0.8 V, $I_{OL}$ = 20 mA | | | | 0.5 | V |
| $I_I$ | $V_{CC}$ = MAX, $V_I$ = 5.5 V | | | | 1 | mA |
| $I_{IH}$ | $V_{CC}$ = MAX, $V_I$ = 2.7 V | | | | 50 | μA |
| $I_{IL}$ | $V_{CC}$ = MAX, $V_I$ = 0.5 V | | | | −2 | mA |
| $I_{OS}$§ | $V_{CC}$ = MAX | | −40 | | −100 | mA |
| $I_{CC}$ | $V_{CC}$ = MAX, Outputs enabled and open | | | 49 | 74 | mA |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.
§ Not more than one output should be shorted at a time, and duration of the short circuit test should not exceed one second.

## switching characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C

| PARAMETER† | FROM (INPUT) | TO (OUTPUT) | LEVELS OF DELAY | TEST CONDITIONS | SN54S138 SN74S138A | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | |
| $t_{PLH}$ | Binary Select | Any | 2 | $R_L$ = 280 Ω, $C_L$ = 15 pF, See Note 2 | | 4.5 | 7 | ns |
| $t_{PHL}$ | | | | | | 7 | 10.5 | ns |
| $t_{PLH}$ | | | 3 | | | 7.5 | 12 | ns |
| $t_{PHL}$ | | | | | | 8 | 12 | ns |
| $t_{PLH}$ | Enable | Any | 2 | | | 5 | 8 | ns |
| $t_{PHL}$ | | | | | | 7 | 11 | ns |
| $t_{PLH}$ | | | 3 | | | 7 | 11 | ns |
| $t_{PHL}$ | | | | | | 7 | 11 | ns |

†$t_{PLH}$ = propagation delay time, low-to-high-level output
$t_{PHL}$ = propagation delay time, high-to-low-level output
NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

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