

SN54HCT138, SN74HCT138 3-LINE TO 8-LINE DECODERS/DEMULPLEXERS

SCLS171C – MARCH 1984 – REVISED MAY 1997

- Inputs Are TTL-Voltage Compatible
- Designed Specifically for High-Speed Memory Decoders and Data Transmission Systems
- Incorporate Three Enable Inputs to Simplify Cascading and/or Data Reception
- Package Options Include Plastic Small-Outline (D), Thin Shrink Small-Outline (PW), and Ceramic Flat (W) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) 300-mil DIPs

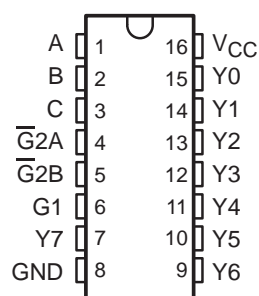
description

The 'HCT138 are designed for high-performance memory-decoding or data-routing applications requiring very short propagation delay times. In high-performance memory systems, these decoders can 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 decoders is negligible.

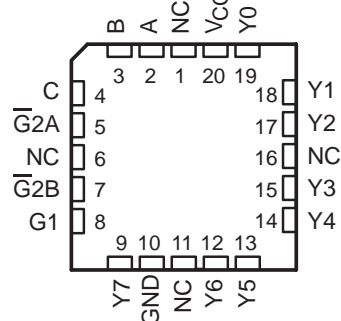
The conditions at the binary-select inputs and the three enable inputs select one of eight output lines. Two active-low (\overline{G}) and one active-high (G) enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications.

The SN54HCT138 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74HCT138 is characterized for operation from -40°C to 85°C .

SN54HCT138 . . . J OR W PACKAGE
SN74HCT138 . . . D, N, OR PW PACKAGE
(TOP VIEW)



SN54HCT138 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

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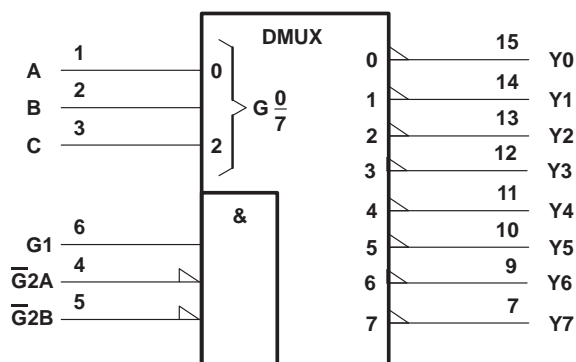
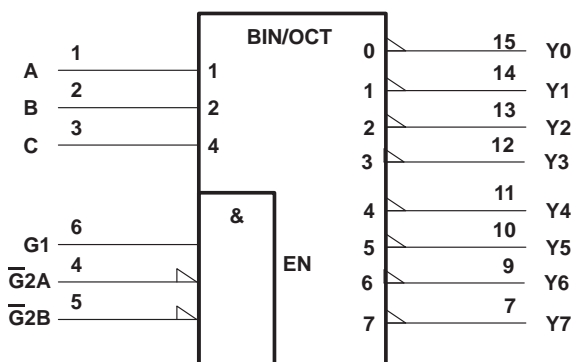
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FUNCTION TABLE

| INPUTS | | | | | | OUTPUTS | | | | | | | |
|--------|------------------|------------------|--------|---|---|---------|----|----|----|----|----|----|----|
| ENABLE | | | SELECT | | | | | | | | | | |
| G1 | $\overline{G2A}$ | $\overline{G2B}$ | C | B | A | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H |
| X | X | H | X | X | X | H | H | H | H | H | H | H | H |
| L | X | X | X | X | X | H | H | H | H | H | H | H | H |
| H | L | L | L | L | L | L | H | H | H | H | H | H | H |
| H | L | L | L | L | H | H | L | H | H | H | H | H | H |
| H | L | L | L | H | L | H | H | L | H | H | H | H | H |
| H | L | L | L | H | H | H | H | H | L | H | H | H | H |
| H | L | L | H | L | L | H | H | H | H | L | H | H | H |
| H | L | L | H | H | L | H | H | H | H | H | L | H | H |
| H | L | L | H | H | H | H | H | H | H | H | H | L | H |
| H | L | L | H | H | H | H | H | H | H | H | H | H | L |

logic symbols (alternatives)†

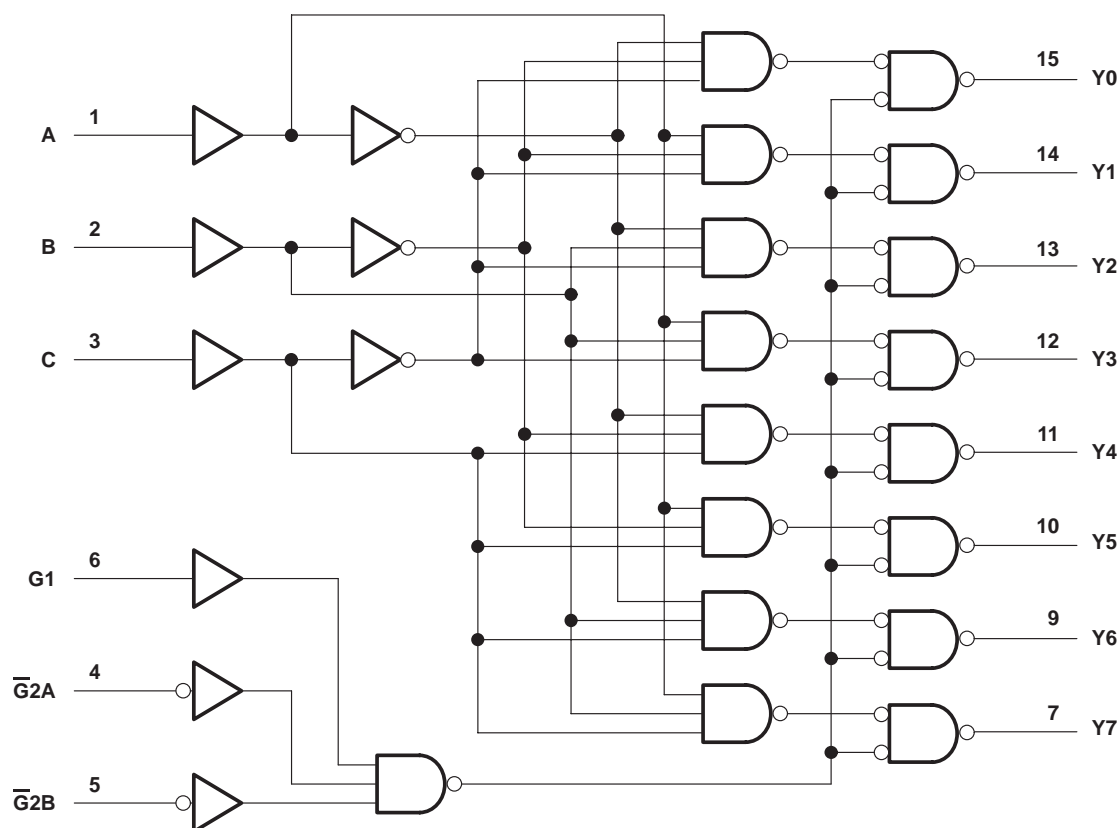


† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12. Pin numbers shown are for the D, J, N, PW, and W packages.

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logic diagram (positive logic)



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

absolute maximum ratings over operating free-air temperature range†

| | |
|---|----------------|
| Supply voltage range, V_{CC} | -0.5 V to 7 V |
| Input clamp current, I_{IK} ($V_I < 0$ or $V_I > V_{CC}$) (see Note 1) | ± 20 mA |
| Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) (see Note 1) | ± 20 mA |
| Continuous output current, I_O ($V_O = 0$ to V_{CC}) | ± 25 mA |
| Continuous current through V_{CC} or GND | ± 50 mA |
| Package thermal impedance, θ_{JA} (see Note 2): D package | 113°C/W |
| N package | 78°C/W |
| Storage temperature range, T_{stg} | -65°C to 150°C |

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
 2. The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace length of zero.



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recommended operating conditions

| | | SN54HCT138 | | | SN74HCT138 | | | UNIT |
|----------|---------------------------------------|---|----------|-----|------------|----------|-----|------|
| | | MIN | NOM | MAX | MIN | NOM | MAX | |
| V_{CC} | Supply voltage | 4.5 | 5 | 5.5 | 4.5 | 5 | 5.5 | V |
| V_{IH} | High-level input voltage | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | 2 | 2 | | V | |
| V_{IL} | Low-level input voltage | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | | 0 | 0.8 | | V | |
| V_I | Input voltage | 0 | V_{CC} | | 0 | V_{CC} | | V |
| V_O | Output voltage | 0 | V_{CC} | | 0 | V_{CC} | | V |
| t_t | Input transition (rise and fall) time | 0 | 500 | | 0 | 500 | | ns |
| T_A | Operating free-air temperature | -55 | | 125 | -40 | | 85 | °C |

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

| PARAMETER | TEST CONDITIONS | V_{CC} | $T_A = 25^\circ\text{C}$ | | | SN54HCT138 | | SN74HCT138 | | UNIT |
|-------------------------|--|----------------|-----------------------------|-----------|------------|------------|---------------|------------|-----|------|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| V_{OH} | $V_I = V_{IH}$ or V_{IL} | 4.5 V | $I_{OH} = -20\ \mu\text{A}$ | | 4.4 | 4.499 | 4.4 | 4.4 | V | |
| | | | $I_{OH} = -4\ \text{mA}$ | | 3.98 | 4.3 | 3.7 | 3.84 | | |
| V_{OL} | $V_I = V_{IH}$ or V_{IL} | 4.5 V | $I_{OL} = 20\ \mu\text{A}$ | | 0.001 | 0.1 | 0.1 | 0.1 | V | |
| | | | $I_{OL} = 4\ \text{mA}$ | | 0.17 | 0.26 | 0.4 | 0.33 | | |
| I_I | $V_I = V_{CC}$ or 0 | 5.5 V | ± 0.1 | ± 100 | ± 1000 | ± 1000 | nA | | | |
| I_{CC} | $V_I = V_{CC}$ or 0, $I_O = 0$ | 5.5 V | 8 | | 160 | 80 | μA | | | |
| ΔI_{CC}^\dagger | One input at 0.5 V or 2.4 V, Other inputs at 0 or V_{CC} | 5.5 V | 1.4 | 2.4 | 3 | 2.9 | mA | | | |
| C_i | | 4.5 V to 5.5 V | 3 | 10 | 10 | 10 | pF | | | |

† This is the increase in supply current for each input that is at one of the specified TTL voltage levels rather than 0 V or V_{CC} .

switching characteristics over recommended operating free-air temperature range, $C_L = 50\ \text{pF}$ (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | V_{CC} | $T_A = 25^\circ\text{C}$ | | | SN54HCT138 | | SN74HCT138 | | UNIT |
|-----------|--------------|-------------|----------|--------------------------|-----|-----|------------|-----|------------|-----|------|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| t_{pd} | A, B, or C | Any Y | 4.5 V | 23 | 36 | 54 | 45 | ns | | | |
| | | | 5.5 V | 17 | 32 | 49 | 34 | | | | |
| | Enable | Any Y | 4.5 V | 22 | 33 | 50 | 42 | | | | |
| | | | 5.5 V | 18 | 30 | 45 | 38 | | | | |
| t_t | | Y | 4.5 V | 12 | 15 | 22 | 19 | ns | | | |
| | | | 5.5 V | 11 | 14 | 20 | 17 | | | | |

operating characteristics, $T_A = 25^\circ\text{C}$

| PARAMETER | TEST CONDITIONS | TYP | UNIT |
|--|-----------------|-----|------|
| C_{pd} Power dissipation capacitance | No load | 85 | pF |

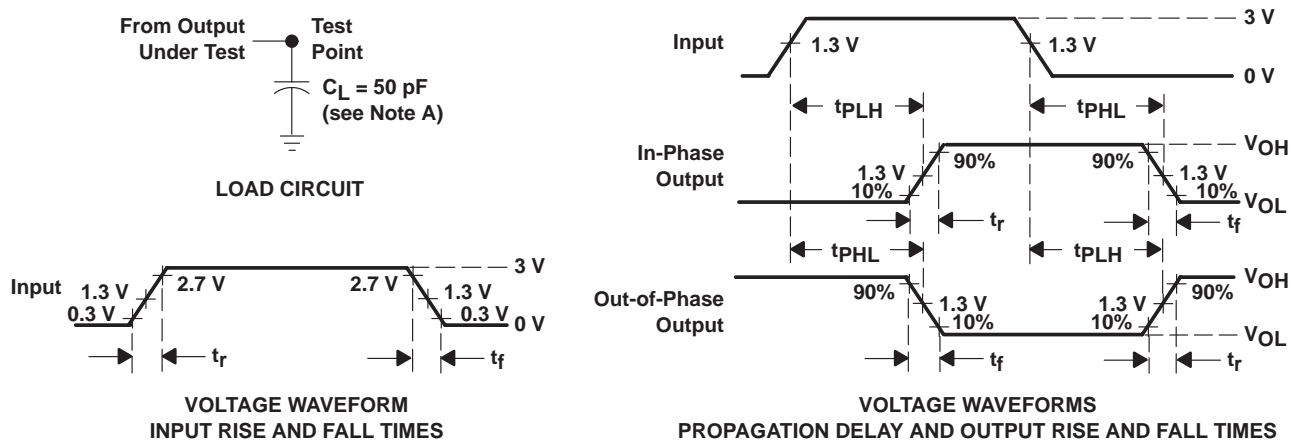


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PARAMETER MEASUREMENT INFORMATION



- NOTES:
- A. C_L includes probe and test-fixture capacitance.
 - B. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r = 6 \text{ ns}$, $t_f = 6 \text{ ns}$.
 - C. The outputs are measured one at a time with one input transition per measurement.
 - D. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 1. Load Circuit and Voltage Waveforms

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