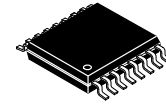


# 3-of-8 Decoder/Demultiplexer

## 74VHCT138A


TSSOP 16  
CASE 948AH

### General Description

The VHCT138A is an advanced high speed CMOS 3-to-8 DECODER fabricated with silicon gate CMOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

When the device is enabled, 3 Binary Select inputs ( $A_0$ ,  $A_1$  and  $A_2$ ) determine which one of the outputs ( $\bar{O}_0$ – $\bar{O}_7$ ) will go LOW. When enable input  $E_3$  is held LOW or either  $\bar{E}_1$  or  $\bar{E}_2$  is held HIGH, decoding function is inhibited and all outputs go HIGH.  $E_3$ ,  $\bar{E}_1$  and  $\bar{E}_2$  inputs are provided to ease cascade connection and for use as an address decoder for memory systems. Protection circuits ensure that 0 V to 5.5 V can be applied to the input pins without regard to the supply voltage and to the output pins with  $V_{CC} = 0$  V. These circuits prevent device destruction due to mismatched supply and input/output voltages. This device can be used to interface 3 V to 5 V systems and two supply systems such as battery backup.

### Features

- High Speed:  $t_{PD} = 7.6$  ns (Typ) at  $V_{CC} = 5$  V
- Low Power Dissipation:  $I_{CC} = 4$   $\mu$ A (Max.) at  $T_A = 25$  °C
- Power Down Protection Provided on All Inputs and Outputs
- Pin and Function Compatible with 74HCT138
- This Device is Pb-Free, Halide Free and is RoHS Compliant

### Logic Symbols

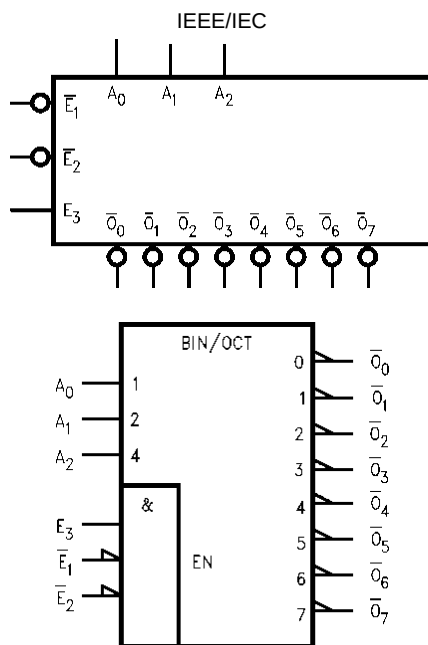
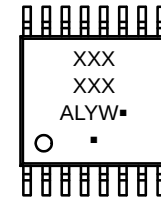


Figure 1. Logic Symbols

### MARKING DIAGRAMS



TSSOP 16

XXXXXX = Specific Device Code

A = Assembly Location

L = Wafer Lot

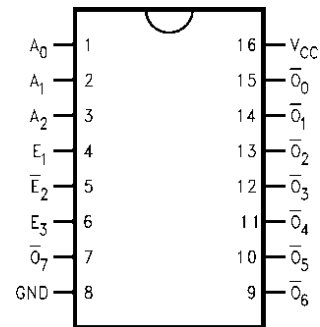
Y = Year

W = Work Week

▪ = Pb-Free Package

(Note: Microdot may be in either location)

### CONNECTION DIAGRAM



### PIN DESCRIPTION

| Pin Names                 | Description    |
|---------------------------|----------------|
| $A_0$ – $A_2$             | Address Inputs |
| $\bar{E}_1$ – $\bar{E}_2$ | Enable Inputs  |
| $E_3$                     | Enable Input   |
| $\bar{O}_0$ – $\bar{O}_7$ | Outputs        |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

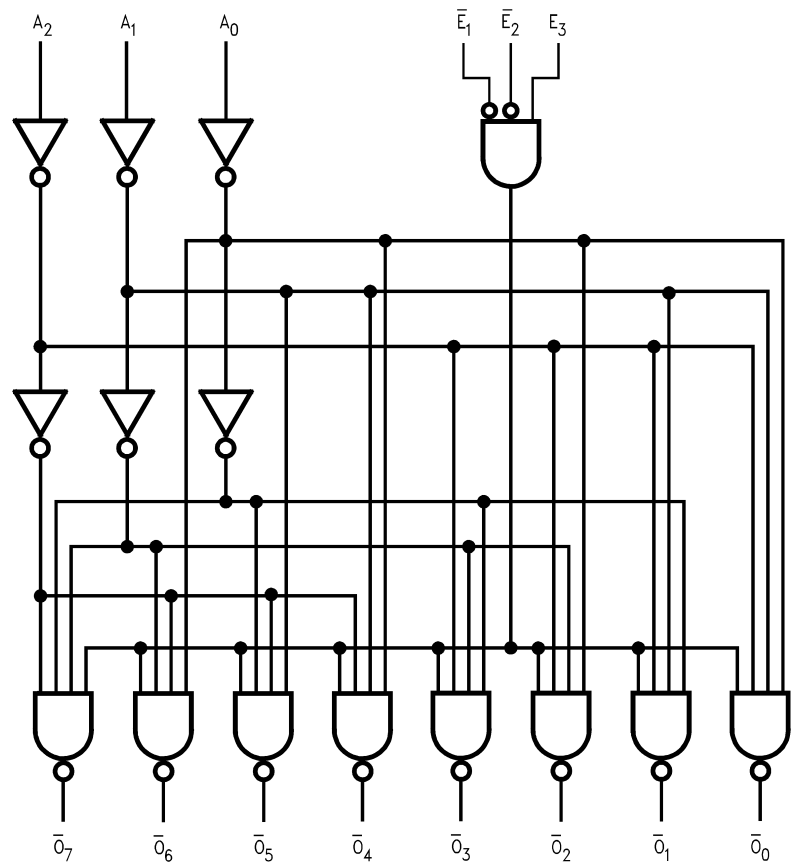
74VHCT138A

TRUTH TABLE

| Inputs      |             |       |       |       |       | Outputs     |             |             |             |             |             |             |             |
|-------------|-------------|-------|-------|-------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| $\bar{E}_1$ | $\bar{E}_2$ | $E_3$ | $A_0$ | $A_1$ | $A_2$ | $\bar{O}_0$ | $\bar{O}_1$ | $\bar{O}_2$ | $\bar{O}_3$ | $\bar{O}_4$ | $\bar{O}_5$ | $\bar{O}_6$ | $\bar{O}_7$ |
| H           | X           | X     | X     | X     | X     | H           | H           | H           | H           | H           | H           | H           | H           |
| X           | H           | X     | X     | X     | X     | H           | H           | H           | H           | H           | H           | H           | H           |
| X           | X           | L     | X     | X     | X     | H           | H           | H           | H           | H           | H           | H           | H           |
|             |             |       |       |       |       |             |             |             |             |             |             |             |             |
| L           | L           | H     | L     | L     | L     | L           | H           | H           | H           | H           | H           | H           | H           |
| L           | L           | H     | H     | L     | L     | H           | L           | H           | H           | H           | H           | H           | H           |
| L           | L           | H     | L     | H     | L     | H           | H           | L           | H           | H           | H           | H           | H           |
| L           | L           | H     | H     | H     | L     | H           | H           | H           | L           | H           | H           | H           | H           |
|             |             |       |       |       |       |             |             |             |             |             |             |             |             |
| L           | L           | H     | L     | L     | H     | H           | H           | H           | H           | L           | H           | H           | H           |
| L           | L           | H     | H     | L     | H     | H           | H           | H           | H           | H           | L           | H           | H           |
| L           | L           | H     | L     | H     | H     | H           | H           | H           | H           | H           | H           | L           | H           |
| L           | L           | H     | H     | H     | H     | H           | H           | H           | H           | H           | H           | H           | L           |

H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Immaterial

LOGIC DIAGRAM



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Figure 2. Logic Diagram

# 74VHCT138A

## MAXIMUM RATINGS

| Symbol           | Parameter                                                                                                                | Value                                                         | Unit |
|------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|------|
| V <sub>CC</sub>  | DC Supply Voltage                                                                                                        | −0.5 to +6.5                                                  | V    |
| V <sub>IN</sub>  | DC Input Voltage                                                                                                         | −0.5 to +6.5                                                  | V    |
| V <sub>OUT</sub> | DC Output Voltage<br>Active Mode (High or Low State)<br>Tristate Mode (Note 1)<br>Power-Off Mode (V <sub>CC</sub> = 0 V) | −0.5 to V <sub>CC</sub> + 0.5<br>−0.5 to +6.5<br>−0.5 to +6.5 | V    |
| I <sub>IN</sub>  | DC Input Current, per Pin                                                                                                | ±20                                                           | mA   |
| I <sub>OUT</sub> | DC Output Current, Per Pin                                                                                               | ±25                                                           | mA   |
| I <sub>CC</sub>  | DC Supply Current, V <sub>CC</sub> and GND Pins                                                                          | ±75                                                           | mA   |
| I <sub>IK</sub>  | Input Clamp Current                                                                                                      | −20                                                           | mA   |
| I <sub>OK</sub>  | Output Clamp Current                                                                                                     | −20                                                           | mA   |
| T <sub>STG</sub> | Storage Temperature Range                                                                                                | −65 to +150                                                   | °C   |
| T <sub>L</sub>   | Lead Temperature, 1 mm from Case for 10 Seconds                                                                          | 260                                                           | °C   |
| T <sub>J</sub>   | Junction Temperature Under Bias                                                                                          | +150                                                          | °C   |
| θ <sub>JA</sub>  | Thermal Resistance (Note 2)                                                                                              | 159                                                           | °C/W |
| P <sub>D</sub>   | Power Dissipation in Still Air at 25 °C                                                                                  | 787                                                           | mW   |
| MSL              | Moisture Sensitivity                                                                                                     | Level 1                                                       |      |
| F <sub>R</sub>   | Flammability Rating<br>Oxygen Index: 28 to 34                                                                            | UL 94 V-0 @ 0.138 in                                          |      |
| V <sub>ESD</sub> | ESD Withstand Voltage (Note 3)<br>Human Body Model<br>Charged Device Model                                               | 2000<br>N/A                                                   | V    |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Applicable to devices with outputs that may be tri-stated.
2. Measured with minimum pad spacing on an FR4 board, using 76 mm-by-114 mm, 2-ounce copper trace no air flow per JESD51-7.
3. HBM tested to EIA / JESD22-A114-A. CDM tested to JESD22-C101-A. JEDEC recommends that ESD qualification to EIA/JESD22-A115A (Machine Model) be discontinued.

## RECOMMENDED OPERATING CONDITIONS

| Symbol                          | Parameter                                                                                                                | Min         | Max                            | Unit |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------|------|
| V <sub>CC</sub>                 | DC Supply Voltage                                                                                                        | 2.0         | 5.5                            | V    |
| V <sub>IN</sub>                 | DC Input Voltage (Note 4)                                                                                                | 0           | 5.5                            | V    |
| V <sub>OUT</sub>                | DC Output Voltage (Note 4)<br>Active Mode (High or Low State)<br>Tristate Mode<br>Power-Off Mode (V <sub>CC</sub> = 0 V) | 0<br>0<br>0 | V <sub>CC</sub><br>5.5<br>53.5 | V    |
| T <sub>A</sub>                  | Operating Temperature                                                                                                    | −40         | +85                            | °C   |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise and Fall Time<br>V <sub>CC</sub> = 4.5 V to 5.5 V                                                             | 0           | 20                             | ns/V |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

4. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V<sub>CC</sub>). Unused outputs must be left open.

# 74VHCT138A

## DC ELECTRICAL CHARACTERISTICS

| Symbol           | Parameter                       | Conditions                                                         | V <sub>CC</sub> (V) | T <sub>A</sub> = 25 °C |     |      | T <sub>A</sub> = -40 °C to 85 °C |      | Unit |
|------------------|---------------------------------|--------------------------------------------------------------------|---------------------|------------------------|-----|------|----------------------------------|------|------|
|                  |                                 |                                                                    |                     | Min                    | Typ | Max  | Min                              | Max  |      |
| V <sub>IH</sub>  | HIGH Level Input Voltage        |                                                                    | 4.5–5.5             | 2.0                    | –   | –    | 2.0                              | –    | V    |
| V <sub>IL</sub>  | LOW Level Input Voltage         |                                                                    | 4.5–5.5             | –                      | –   | 0.8  | –                                | 0.8  | V    |
| V <sub>OH</sub>  | HIGH Level Output Voltage       | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>               | 4.5                 | 4.4                    | 4.5 | –    | 4.4                              | –    | V    |
|                  |                                 |                                                                    |                     | 3.94                   | –   | –    | 3.80                             | –    |      |
| V <sub>OL</sub>  | LOW Level Output Voltage        | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>               | 4.5                 | –                      | 0.0 | 0.1  | –                                | 0.1  | V    |
|                  |                                 |                                                                    |                     | –                      | –   | 0.36 | –                                | 0.44 |      |
| I <sub>IN</sub>  | Input Leakage Current           | V <sub>IN</sub> = 5.5 V or GND                                     | 0–5.5               | –                      | –   | ±0.1 | –                                | ±1.0 | μA   |
| I <sub>CC</sub>  | Quiescent Supply Current        | V <sub>IN</sub> = V <sub>CC</sub> or GND                           | 5.5                 | –                      | –   | 4.0  | –                                | 20.0 | μA   |
| I <sub>CCT</sub> | Maximum I <sub>CC</sub> / Input | V <sub>IN</sub> = 3.4 V, All other inputs = V <sub>CC</sub> or GND | 5.5                 | –                      | –   | 1.35 | –                                | 1.50 | mA   |
| I <sub>OFF</sub> | Output Leakage Current          | V <sub>OUT</sub> = 5.5 V                                           | 0                   | –                      | –   | 0.5  | –                                | 5.0  | μA   |

## AC ELECTRICAL CHARACTERISTICS

| Symbol                              | Parameter                                                    | Conditions             | V <sub>CC</sub> (V) | T <sub>A</sub> = 25 °C |     |      | T <sub>A</sub> = -40 °C to 85 °C |      | Unit |
|-------------------------------------|--------------------------------------------------------------|------------------------|---------------------|------------------------|-----|------|----------------------------------|------|------|
|                                     |                                                              |                        |                     | Min                    | Typ | Max  | Min                              | Max  |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay, A <sub>n</sub> to $\bar{O}_n$             | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                      | 7.6 | 10.4 | 1.0                              | 12.0 | ns   |
|                                     |                                                              | C <sub>L</sub> = 50 pF |                     | –                      | 8.1 | 11.4 | 1.0                              | 13.0 |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay, E <sub>3</sub> to $\bar{O}_n$             | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                      | 6.6 | 9.1  | 1.0                              | 10.5 | ns   |
|                                     |                                                              | C <sub>L</sub> = 50 pF |                     | –                      | 7.1 | 10.1 | 1.0                              | 11.5 |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation Delay, $\bar{E}_1$ or $\bar{E}_2$ to $\bar{O}_n$ | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                      | 7.0 | 9.6  | 1.0                              | 11.0 | ns   |
|                                     |                                                              | C <sub>L</sub> = 50 pF |                     | –                      | 7.5 | 10.6 | 1.0                              | 12.0 |      |
| C <sub>IN</sub>                     | Input Capacitance                                            | V <sub>CC</sub> = Open | –                   | –                      | 4   | 10   | –                                | 10   | pF   |
| C <sub>PD</sub>                     | Power Dissipation Capacitance                                | (Note 5)               | –                   | –                      | 49  | –    | –                                | –    | pF   |

5. C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I<sub>CC</sub> (opr.) = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>IN</sub> + I<sub>CC</sub>.

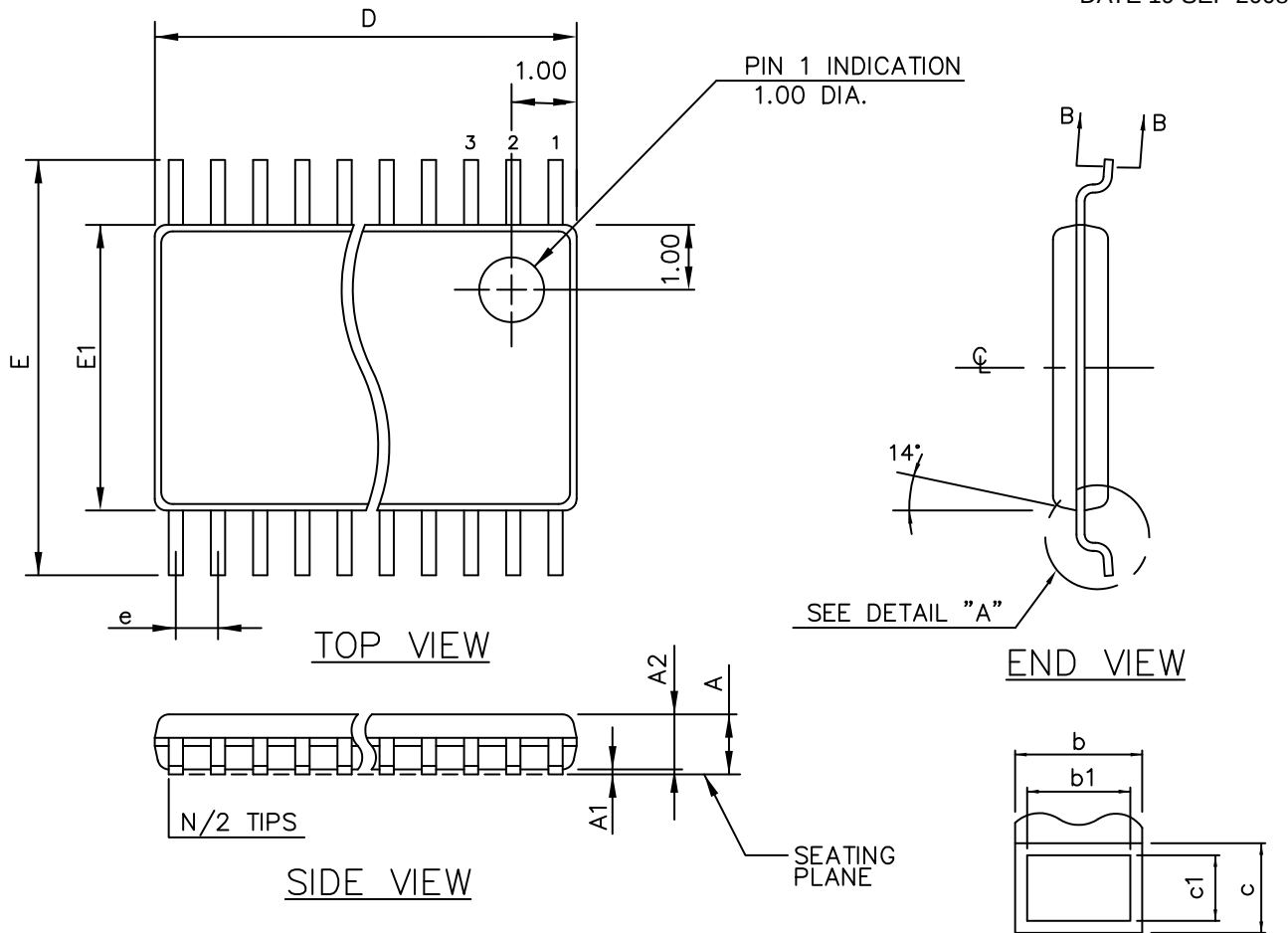
## ORDERING INFORMATION

| Device         | Marking      | Package                            | Shipping <sup>†</sup> |
|----------------|--------------|------------------------------------|-----------------------|
| 74VHCT138AMTCX | VHCT<br>138A | TSSOP 16<br>(Pb-Free, Halide Free) | 2500 Tape & Reel      |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

**TSSOP 16**  
CASE 948AH  
ISSUE O

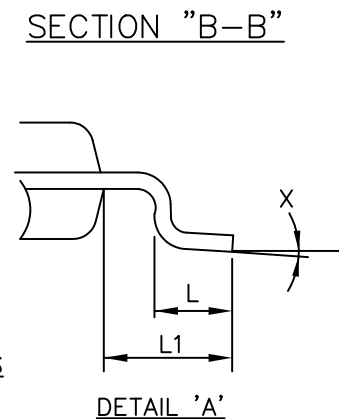
DATE 19 SEP 2008



THIS TABLE FOR 0.65mm PITCH

| SYMBOL         | COMMON DIMENSIONS |       |      | NOTE VARIATIONS | D        | N  |
|----------------|-------------------|-------|------|-----------------|----------|----|
|                | MIN.              | NOM.  | MAX. |                 |          |    |
| A              | —                 | —     | 1.10 | AA/AAT          | 3.00 BSC | 8  |
| A <sub>1</sub> | 0.05              | —     | 0.15 | AB-1/ABT        | 5.00 BSC | 14 |
| A <sub>2</sub> | 0.85              | 0.90  | 0.95 | AB/ABT          | 5.00 BSC | 16 |
| b              | 0.19              | —     | 0.30 | AD/ADT          | 7.80 BSC | 24 |
| b <sub>1</sub> | 0.19              | 0.22  | 0.25 |                 |          |    |
| c              | 0.09              | —     | 0.20 |                 |          |    |
| c <sub>1</sub> | 0.09              | 0.127 | 0.16 |                 |          |    |
| D              | SEE VARIATIONS    |       |      |                 |          |    |
| E <sub>1</sub> | 4.30              | 4.40  | 4.50 |                 |          |    |
| e              | 0.65 BSC          |       |      |                 |          |    |
| E              | 6.40 BSC          |       |      |                 |          |    |
| L              | 0.50              | 0.60  | 0.70 |                 |          |    |
| L <sub>1</sub> | 1.00 REF          |       |      |                 |          |    |
| N              | SEE VARIATIONS    |       |      |                 |          |    |
| X              | 0°                | —     | 8°   |                 |          |    |

ALL DIMENSIONS IN MILLIMETERS



MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15mm ON D PER SIDE

|                         |                    |                                                                                                                                                                                     |
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