

# 3-of-8 Decoder/Demultiplexer

## 74VHC138

### General Description

The VHC138 is an advanced high speed CMOS 3-to-8 decoder/demultiplexer 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. An input protection circuit ensures that 0 V to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

### Features

- High Speed:  $t_{PD} = 5.7$  ns (Typ) at  $T_A = 25$  °C
- Low Power Dissipation:  $I_{CC} = 4$   $\mu$ A (Max.) at  $T_A = 25$  °C
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$  (Min.)
- Power Down Protection Provided on All Inputs
- Pin and Function Compatible with 74HC138
- These Devices are Pb-Free and are RoHS Compliant

### Logic Symbols

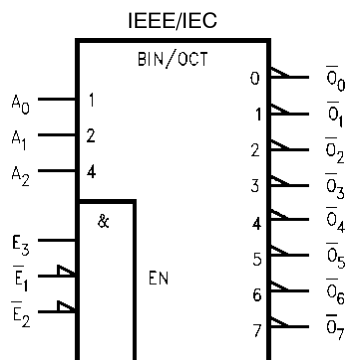
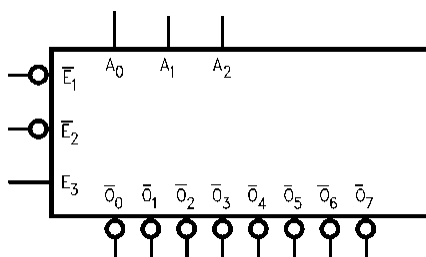
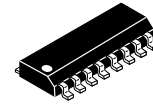
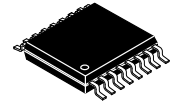


Figure 1. Logic Symbols

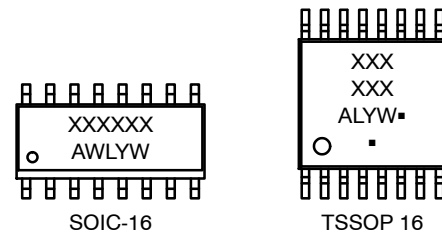


SOIC-16, 150 mils  
CASE 751BG



TSSOP 16  
CASE 948AH

### MARKING DIAGRAMS



XXXXXX = Specific Device Code

A = Assembly Location

WL, L = Wafer Lot

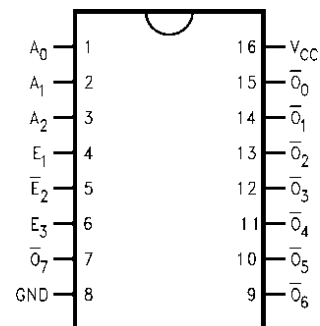
Y = Year

WW, W = Work Week

G or  $\blacksquare$  = Pb-Free Package

(Note: Microdot may be in either location)

### CONNECTION DIAGRAM



### PIN DESCRIPTIONS

| Pins                      | Function       |
|---------------------------|----------------|
| $A_0$ – $A_2$             | 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.

# 74VHC138

## TRUTH TABLE

| Inputs         |                |                |                |                |                | Outputs        |                |                |                |                |                |                |                |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| E <sub>1</sub> | E <sub>2</sub> | E <sub>3</sub> | A <sub>0</sub> | A <sub>1</sub> | A <sub>2</sub> | O <sub>0</sub> | O <sub>1</sub> | O <sub>2</sub> | O <sub>3</sub> | O <sub>4</sub> | O <sub>5</sub> | O <sub>6</sub> | O <sub>7</sub> |
| 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

## 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                               | −0.5 to V <sub>CC</sub> + 0.5                           | 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)                     | SOIC-16<br>TSSOP 16<br>126<br>159                       | °C/W |
| P <sub>D</sub>   | Power Dissipation in Still Air at 25 °C         | SOIC-16<br>TSSOP 16<br>995<br>787                       | mW   |
| MSL              | Moisture Sensitivity                            | Level 1   |      |
| F <sub>R</sub>   | Flammability Rating                             | Oxygen Index: 28 to 34<br>UL 94 V-0 @ 0.138 in          |      |
| V <sub>ESD</sub> | ESD Withstand Voltage (Note 3)                  | Human Body Model<br>Charged Device Model<br>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 76mm-by-114mm, 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) | 0  | V <sub>CC</sub> | V    |
| T <sub>A</sub>                  | Operating Temperature      | −40  | +85             | °C   |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise and Fall Time   | V <sub>CC</sub> = 3.0 V to 3.6 V<br>V <sub>CC</sub> = 4.5 V to 5.5 V | 0<br>100<br>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.

## 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  |   |  | 2.0<br>3.0–5.5      | 1.50<br>0.7 V <sub>CC</sub> | –<br>–            | –<br>–                      | 1.50<br>0.7 V <sub>CC</sub>      | –<br>–                      | V    |
| V <sub>IL</sub> | LOW Level Input Voltage   |   |  | 2.0<br>3.0–5.5      | –<br>–                      | –<br>–            | 0.50<br>0.3 V <sub>CC</sub> | –<br>–                           | 0.50<br>0.3 V <sub>CC</sub> | V    |
| V <sub>OH</sub> | HIGH Level Output Voltage | V <sub>IN</sub> = V <sub>IH</sub><br>or V <sub>IL</sub> | I <sub>OH</sub> = −50 μA                           | 2.0<br>3.0<br>4.5   | 1.9<br>2.9<br>4.4           | 2.0<br>3.0<br>4.5 | –<br>–<br>–                 | 1.9<br>2.9<br>4.4                | –<br>–<br>–                 | V    |
|                 |                           |   | I <sub>OH</sub> = −4 mA<br>I <sub>OH</sub> = −8 mA | 3.0<br>4.5          | 2.58<br>3.94                | –<br>–            | –<br>–                      | 2.48<br>3.80                     | –<br>–                      | V    |
| V <sub>OL</sub> | LOW Level Output Voltage  | V <sub>IN</sub> = V <sub>IH</sub><br>or V <sub>IL</sub> | I <sub>OL</sub> = 50 μA                            | 2.0<br>3.0<br>4.5   | –<br>–<br>–                 | 0.0<br>0.0<br>0.0 | 0.1<br>0.1<br>0.1           | –<br>–<br>–                      | 0.1<br>0.1<br>0.1           | V    |
|                 |                           |   | I <sub>OL</sub> = 4 mA<br>I <sub>OL</sub> = 8 mA   | 3.0<br>4.5          | –<br>–                      | –<br>–            | 0.36<br>0.36                | –<br>–                           | 0.44<br>0.44                | V    |
| 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                         | –                                | 40.0                        | μA   |

# 74VHC138

## 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> ,<br>t <sub>PHL</sub> | Propagation Delay<br>A <sub>n</sub> to $\bar{O}_n$             | C <sub>L</sub> = 15 pF | 3.3 ±0.3            | –                      | 8.2  | 11.4 | 1.0                              | 13.5 | ns   |
|  |  | C <sub>L</sub> = 50 pF |                     | –                      | 10.0 | 15.8 | 1.0                              | 18.0 |      |
|  |  | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                      | 5.7  | 8.1  | 1.0                              | 9.5  | ns   |
|  |  | C <sub>L</sub> = 50 pF |                     | –                      | 7.2  | 10.1 | 1.0                              | 11.5 |      |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Propagation Delay<br>E <sub>3</sub> to $\bar{O}_n$             | C <sub>L</sub> = 15 pF | 3.3 ±0.3            | –                      | 8.1  | 12.8 | 1.0                              | 15.0 | ns   |
|  |  | C <sub>L</sub> = 50 pF |                     | –                      | 10.6 | 16.3 | 1.0                              | 18.5 |      |
|  |  | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                      | 5.6  | 8.1  | 1.0                              | 9.5  | ns   |
|  |  | C <sub>L</sub> = 50 pF |                     | –                      | 7.1  | 10.1 | 1.0                              | 11.5 |      |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Propagation Delay<br>$\bar{E}_1$ or $\bar{E}_2$ to $\bar{O}_n$ | C <sub>L</sub> = 15 pF | 3.3 ±0.3            | –                      | 8.2  | 11.4 | 1.0                              | 13.5 | ns   |
|  |  | C <sub>L</sub> = 50 pF |                     | –                      | 10.7 | 14.9 | 1.0                              | 17.0 |      |
|  |  | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                      | 5.8  | 8.1  | 1.0                              | 9.5  | ns   |
|  |  | C <sub>L</sub> = 50 pF |                     | –                      | 7.3  | 10.1 | 1.0                              | 11.5 |      |
| C <sub>IN</sub>                        | Input Capacitance  | V <sub>CC</sub> = Open | –                   | –                      | 4    | 10   | –                                | 10   | pF   |
| C <sub>PD</sub>                        | Power Dissipation Capacitance                                  | (Note 5)               | –                   | –                      | 34   | –    | –                                | –    | 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>.

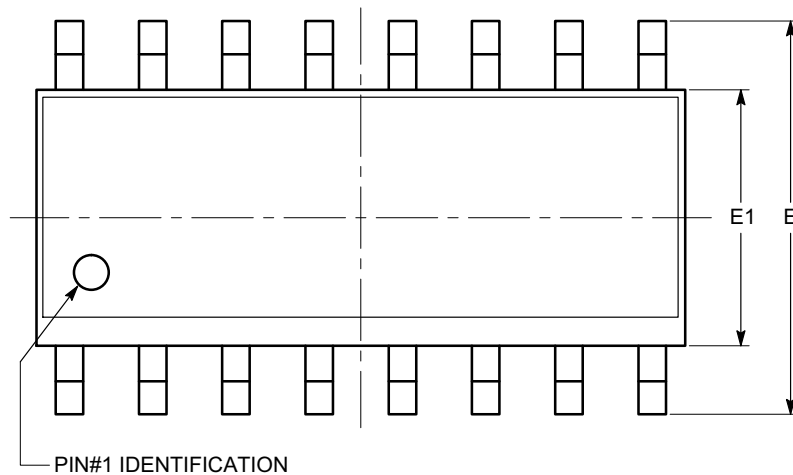
## ORDERING INFORMATION

| Device       | Marking    | Package               | Shipping <sup>†</sup> |
|--------------|------------|-----------------------|-----------------------|
| 74VHC138MX   | VHC138G    | SOIC-16<br>(Pb-Free)  | 2500 Tape & Reel      |
| 74VHC138MTCX | VHC<br>138 | TSSOP 16<br>(Pb-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.

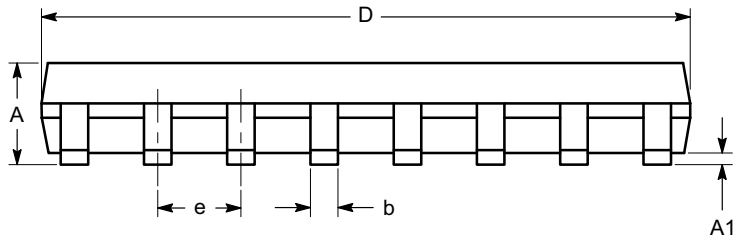
**SOIC-16, 150 mils**  
**CASE 751BG**  
**ISSUE O**

DATE 19 DEC 2008

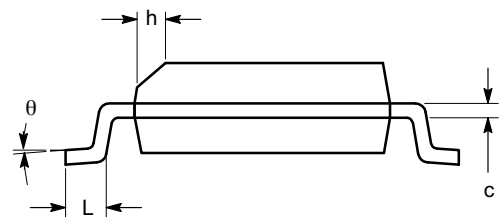


| SYMBOL   | MIN      | NOM  | MAX   |
|----------|----------|------|-------|
| A        | 1.35     |      | 1.75  |
| A1       | 0.10     |      | 0.25  |
| b        | 0.33     |      | 0.51  |
| c        | 0.19     |      | 0.25  |
| D        | 9.80     | 9.90 | 10.00 |
| E        | 5.80     | 6.00 | 6.20  |
| E1       | 3.80     | 3.90 | 4.00  |
| e        | 1.27 BSC |      |       |
| h        | 0.25     |      | 0.50  |
| L        | 0.40     |      | 1.27  |
| $\theta$ | 0°       |      | 8°    |

**TOP VIEW**



**SIDE VIEW**



**END VIEW**

**Notes:**

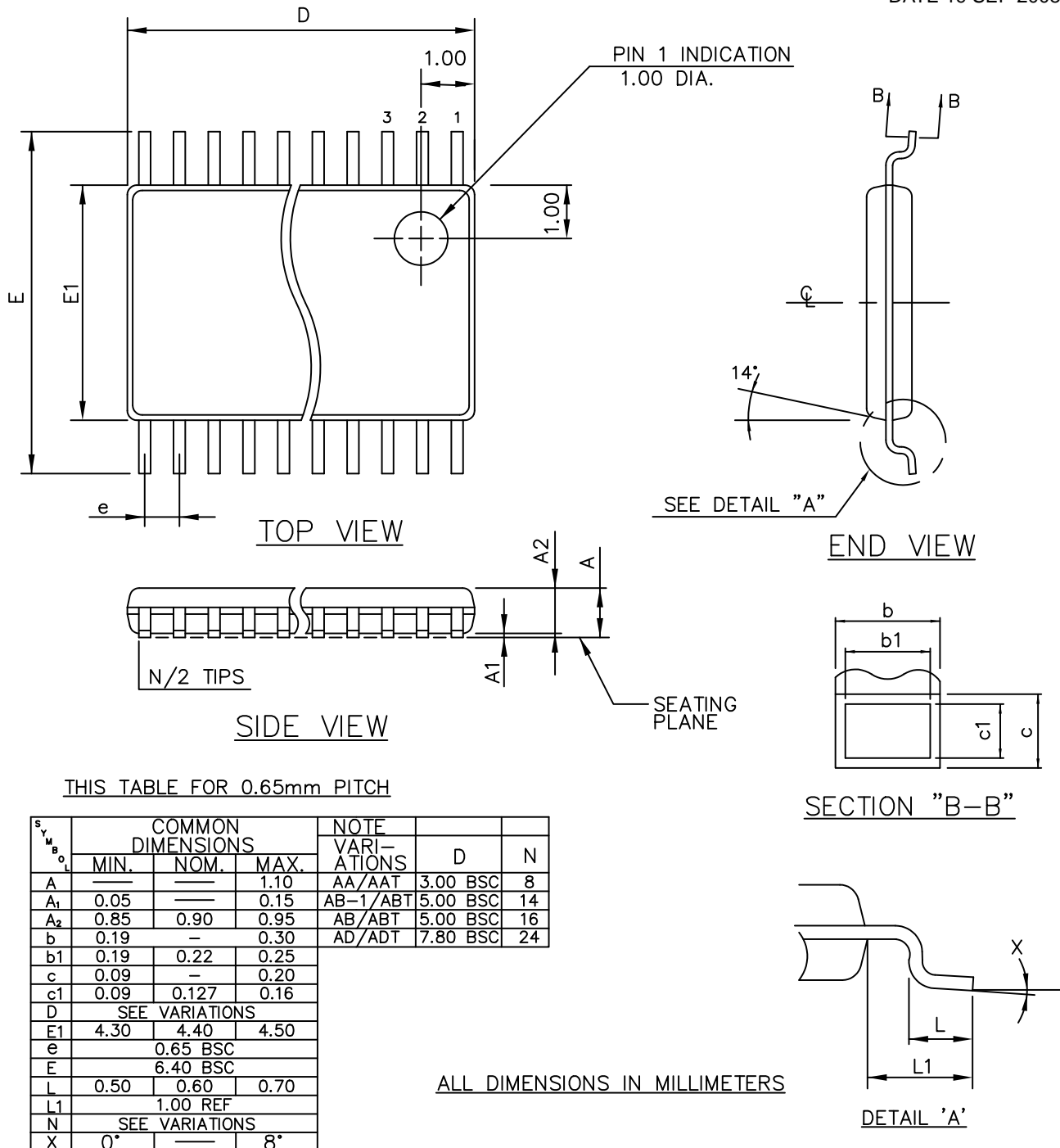
- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC MS-012.

|                         |                          |   |
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**TSSOP 16**  
**CASE 948AH**  
**ISSUE O**

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