

# 54F138,74F138

*54F138 1-of-8 Decoder/Demultiplexer*



Literature Number: SNOS152A

## 54F/74F138 1-of-8 Decoder/Demultiplexer

### General Description

The 'F138 is a high-speed 1-of-8 decoder/demultiplexer. This device is ideally suited for high-speed bipolar memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three 'F138 devices or a 1-of-32 decoder using four 'F138 devices and one inverter.

### Features

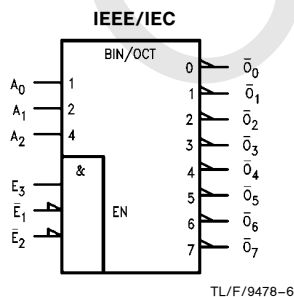
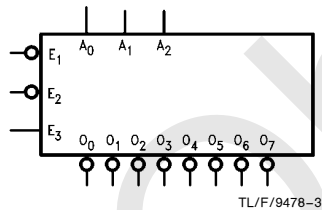
- Demultiplexing capability
- Multiple input enable for easy expansion
- Active LOW mutually exclusive outputs
- Guaranteed 4000V minimum ESD protection

| Commercial        | Military          | Package Number | Package Description                               |
|-------------------|-------------------|----------------|---|
| 74F138PC          |                   | N16E           | 16-Lead (0.300" Wide) Molded Dual-In-Line         |
|                   | 54F138DM (Note 2) | J16A           | 16-Lead Ceramic Dual-In-Line                      |
| 74F138SC (Note 1) |                   | M16A           | 16-Lead (0.150" Wide) Molded Small Outline, JEDEC |
| 74F138SJ (Note 1) |                   | M16D           | 16-Lead (0.300" Wide) Molded Small Outline, EIAJ  |
|                   | 54F138FM (Note 2) | W16A           | 16-Lead Cerpack                                   |
|                   | 54F138LM (Note 2) | E20A           | 20-Lead Ceramic Leadless Chip Carrier, Type C     |

**Note 1:** Devices also available in 13" reel. Use suffix = SCX and SJX.

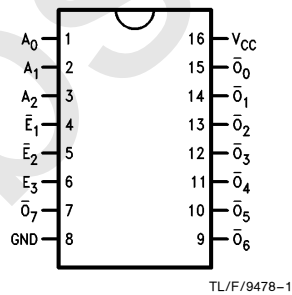
**Note 2:** Military grade device with environmental and burn-in processing. Use suffix = DMQB, FMQB and LMQB.

### Logic Symbols

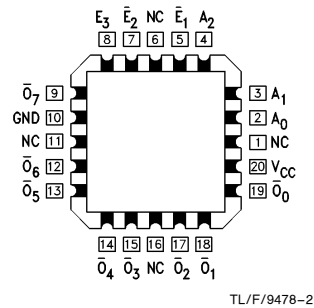


### Connection Diagrams

Pin Assignment for DIP, SOIC and Flatpak



Pin Assignment for LCC



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## Unit Loading/Fan Out

| Pin Names              | Description                | 54F/74F          |   |
|------------------------|----------------------------|------------------|---|
|                        |                            | U.L.<br>HIGH/LOW | Input $I_{IH}/I_{IL}$<br>Output $I_{OH}/I_{OL}$ |
| $A_0-A_2$              | Address Inputs             | 1.0/1.0          | 20 $\mu A$ / -0.6 mA                            |
| $\bar{E}_1, \bar{E}_2$ | Enable Inputs (Active LOW) | 1.0/1.0          | 20 $\mu A$ / -0.6 mA                            |
| $E_3$                  | Enable Input (Active HIGH) | 1.0/1.0          | 20 $\mu A$ / -0.6 mA                            |
| $\bar{O}_0-\bar{O}_7$  | Outputs (Active LOW)       | 50/33.3          | -1 mA/20 mA                                     |

## Functional Description

The 'F138 high-speed 1-of-8 decoder/demultiplexer accepts three binary weighted inputs ( $A_0, A_1, A_2$ ) and, when enabled, provides eight mutually exclusive active LOW outputs ( $\bar{O}_0-\bar{O}_7$ ). The 'F138 features three Enable inputs, two active LOW ( $\bar{E}_1, \bar{E}_2$ ) and one active HIGH ( $E_3$ ). All outputs will be HIGH unless  $\bar{E}_1$  and  $\bar{E}_2$  are LOW and  $E_3$  is HIGH. This multiple enable function allows easy parallel expansion

of the device to a 1-of-32 (5 lines to 32 lines) decoder with just four 'F138 devices and one inverter (See *Figure 1*). The 'F138 can be used as an 8-output demultiplexer by using one of the active LOW Enable inputs as the data input and the other Enable inputs as strobes. The Enable inputs which are not used must be permanently tied to their appropriate active HIGH or active LOW state.

## Truth Table

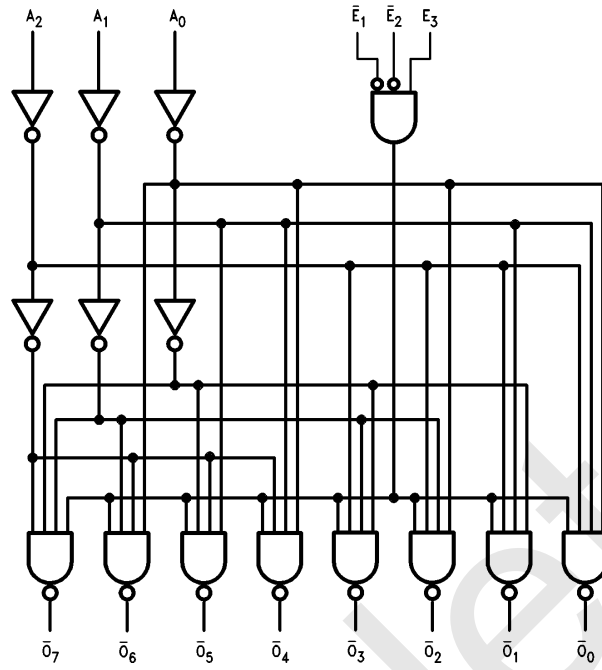
| Inputs      |             |       |       | Outputs |       |             |             |             |             |             |             |             |             |
|-------------|-------------|-------|-------|---------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|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



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

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                 |                 |
|---------------------------------|-----------------|
| Storage Temperature             | −65°C to +150°C |
| Ambient Temperature under Bias  | −55°C to +125°C |
| Junction Temperature under Bias | −55°C to +175°C |
| Plastic                         | −55°C to +150°C |

V<sub>CC</sub> Pin Potential to Ground Pin −0.5V to +7.0V

Input Voltage (Note 2) −0.5V to +7.0V

Input Current (Note 2) −30 mA to +5.0 mA

Voltage Applied to Output in HIGH State (with V<sub>CC</sub> = 0V)

|                   |                          |
|-------------------|--------------------------|
| Standard Output   | −0.5V to V <sub>CC</sub> |
| TRI-STATE® Output | −0.5V to +5.5V           |

Current Applied to Output in LOW State (Max) twice the rated I<sub>OL</sub> (mA)

ESD Last Passing Voltage (Min) 4000V

**Note 1:** Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

**Note 2:** Either voltage limit or current limit is sufficient to protect inputs.

## Recommended Operating Conditions

|                              |                 |
|------------------------------|-----------------|
| Free Air Ambient Temperature |                 |
| Military                     | −55°C to +125°C |
| Commercial                   | 0°C to +70°C    |
| Supply Voltage               |                 |
| Military                     | +4.5V to +5.5V  |
| Commercial                   | +4.5V to +5.5V  |

## DC Electrical Characteristics

| Symbol           | Parameter                         | 54F/74F                 |      |      | Units | V <sub>CC</sub> | Conditions  |
|------------------|-----------------------------------|-------------------------|------|------|-------|-----------------|---|
|                  |                                   | Min                     | Typ  | Max  |       |                 |   |
| V <sub>IH</sub>  | Input HIGH Voltage                | 2.0                     |      |      | V     |                 | Recognized as a HIGH Signal   |
| V <sub>IL</sub>  | Input LOW Voltage                 |                         |      |      | V     |                 | Recognized as a LOW Signal  |
| V <sub>CD</sub>  | Input Clamp Diode Voltage         | −1.2                    |      |      | V     | Min             | I <sub>IN</sub> = −18 mA  |
| V <sub>OH</sub>  | Output HIGH Voltage               | 54F 10% V <sub>CC</sub> | 2.5  |      | V     | Min             | I <sub>OH</sub> = −1 mA<br>I <sub>OH</sub> = −1 mA<br>I <sub>OH</sub> = −1 mA |
|                  |                                   | 74F 10% V <sub>CC</sub> | 2.5  |      |       |                 |   |
|                  |                                   | 74F 5% V <sub>CC</sub>  | 2.7  |      |       |                 |   |
| V <sub>OL</sub>  | Output LOW Voltage                | 54F 10% V <sub>CC</sub> |      | 0.5  | V     | Min             | I <sub>OL</sub> = 20 mA<br>I <sub>OL</sub> = 20 mA                            |
|                  |                                   | 74F 10% V <sub>CC</sub> |      | 0.5  |       |                 |   |
| I <sub>IH</sub>  | Input HIGH Current                | 54F                     |      | 20.0 | μA    | Max             | V <sub>IN</sub> = 2.7V  |
|                  |                                   | 74F                     |      | 5.0  |       |                 |   |
| I <sub>BVI</sub> | Input HIGH Current Breakdown Test | 54F                     |      | 100  | μA    | Max             | V <sub>IN</sub> = 7.0V  |
|                  |                                   | 74F                     |      | 7.0  |       |                 |   |
| I <sub>CEx</sub> | Output HIGH Leakage Current       | 54F                     |      | 250  | μA    | Max             | V <sub>OUT</sub> = V <sub>CC</sub>  |
|                  |                                   | 74F                     |      | 50   |       |                 |   |
| V <sub>ID</sub>  | Input Leakage Test                | 74F                     | 4.75 |      | V     | 0.0             | I <sub>ID</sub> = 1.9 μA<br>All Other Pins Grounded                           |
| I <sub>OD</sub>  | Output Leakage Circuit Current    | 74F                     |      | 3.75 | μA    | 0.0             | V <sub>IOD</sub> = 150 mV<br>All Other Pins Grounded                          |
| I <sub>IL</sub>  | Input LOW Current                 |                         |      |      | mA    | Max             | V <sub>IN</sub> = 0.5V  |
| I <sub>OS</sub>  | Output Short-Circuit Current      | −60                     |      | −150 | mA    | Max             | V <sub>OUT</sub> = 0V   |
| I <sub>CCH</sub> | Power Supply Current              | 13 20                   |      |      | mA    | Max             | V <sub>O</sub> = HIGH   |
| I <sub>CCL</sub> | Power Supply Current              | 13 20                   |      |      | mA    | Max             | V <sub>O</sub> = LOW  |

## AC Electrical Characteristics

| Symbol                 | Parameter   | 74F  |            |            | 54F  |             | 74F  |            | Units | Fig. No. |
|------------------------|---|--|------------|------------|--|-------------|--|------------|-------|----------|
|                        |   | $T_A = +25^\circ\text{C}$<br>$V_{CC} = +5.0\text{V}$<br>$C_L = 50\text{ pF}$ |            |            | $T_A, V_{CC} = \text{Mil}$<br>$C_L = 50\text{ pF}$ |             | $T_A, V_{CC} = \text{Com}$<br>$C_L = 50\text{ pF}$ |            |       |          |
|                        |   | Min  | Typ        | Max        | Min  | Max         | Min  | Max        |       |          |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$A_n$ to $\overline{O}_n$                                | 3.5<br>4.0   | 5.6<br>6.1 | 7.5<br>8.0 | 3.0<br>4.0   | 12.0<br>9.5 | 3.5<br>4.0   | 8.5<br>9.0 | ns    | ◆-3      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 3.5<br>3.0   | 5.4<br>5.3 | 7.0<br>7.0 | 3.0<br>3.0   | 11.0<br>8.0 | 3.5<br>3.0   | 8.0<br>7.5 | ns    | ◆-4      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$E_3$ to $\overline{O}_n$                                | 4.0<br>3.5   | 6.2<br>5.6 | 8.0<br>7.5 | 3.5<br>3.5   | 12.5<br>8.5 | 4.0<br>3.5   | 9.0<br>8.5 | ns    | ◆-4      |

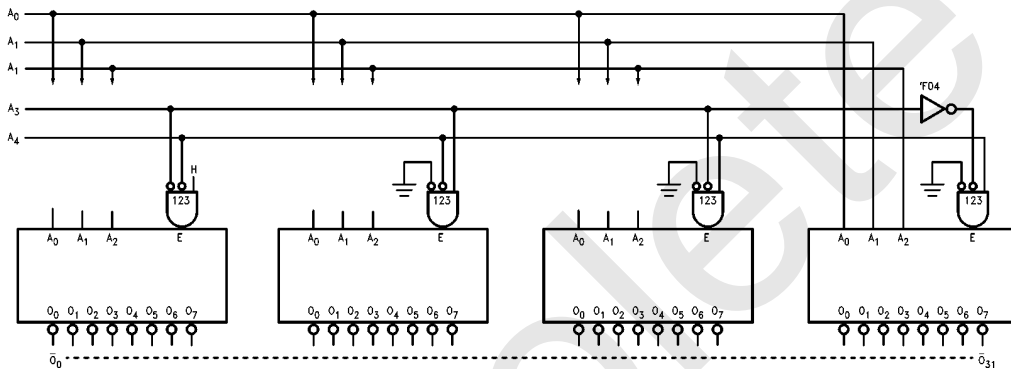
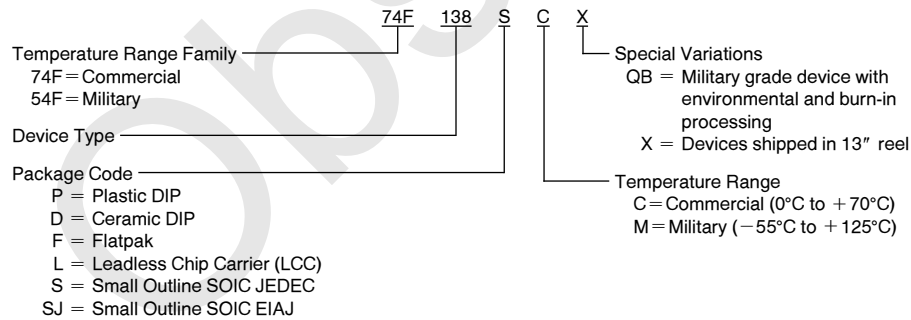


FIGURE 1. Expansion to 1-of-32 Decoding

TL/F/9478-5

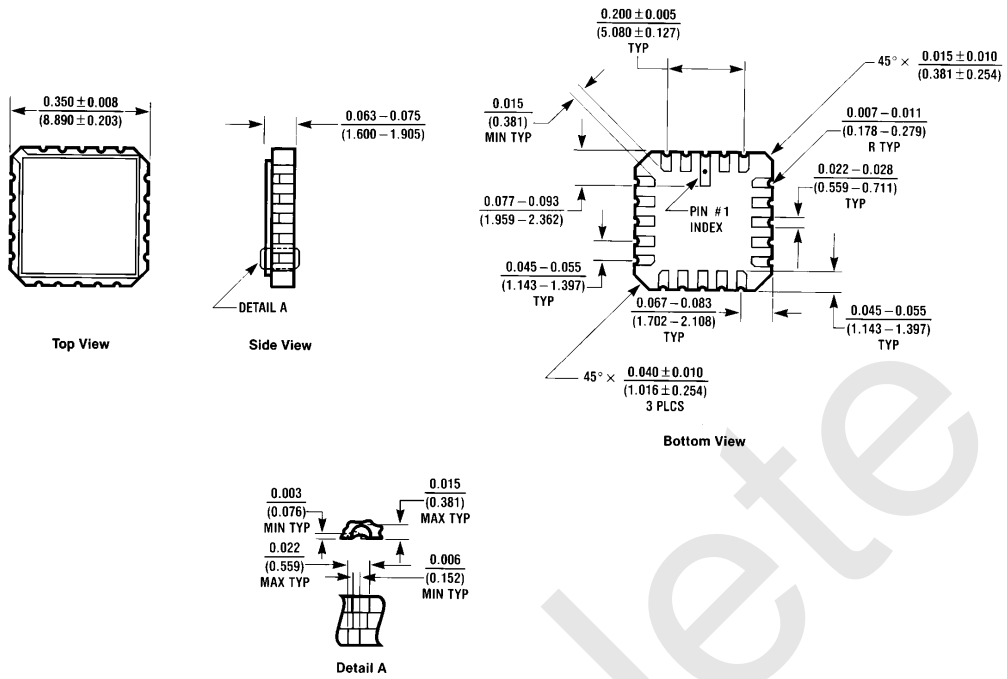
## Ordering Information

The device number is used to form part of a simplified purchasing code where the package type and temperature range are defined as follows:



Obsolete

**Physical Dimensions** inches (millimeters)

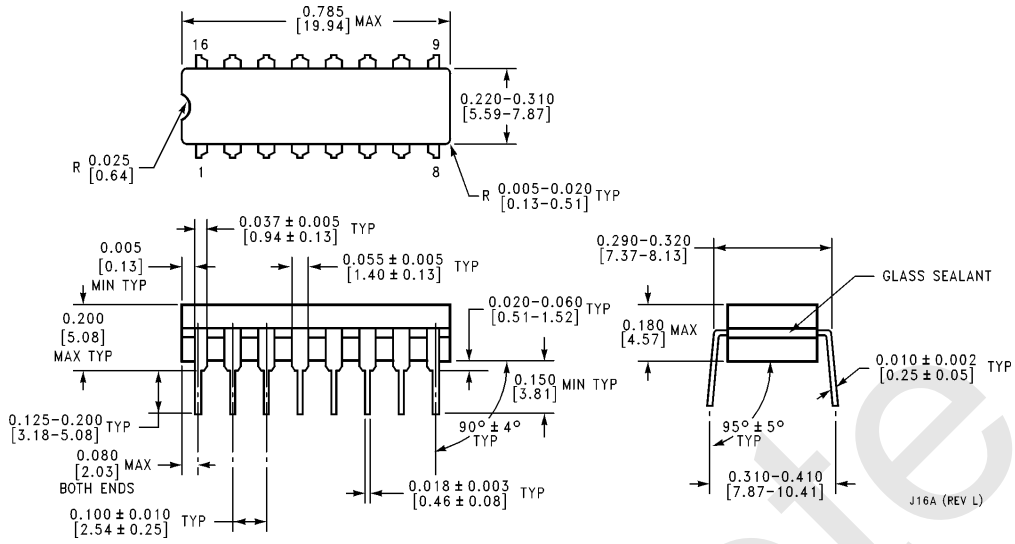


**20-Lead Ceramic Leadless Chip Carrier (L)  
NS Package Number E20A**

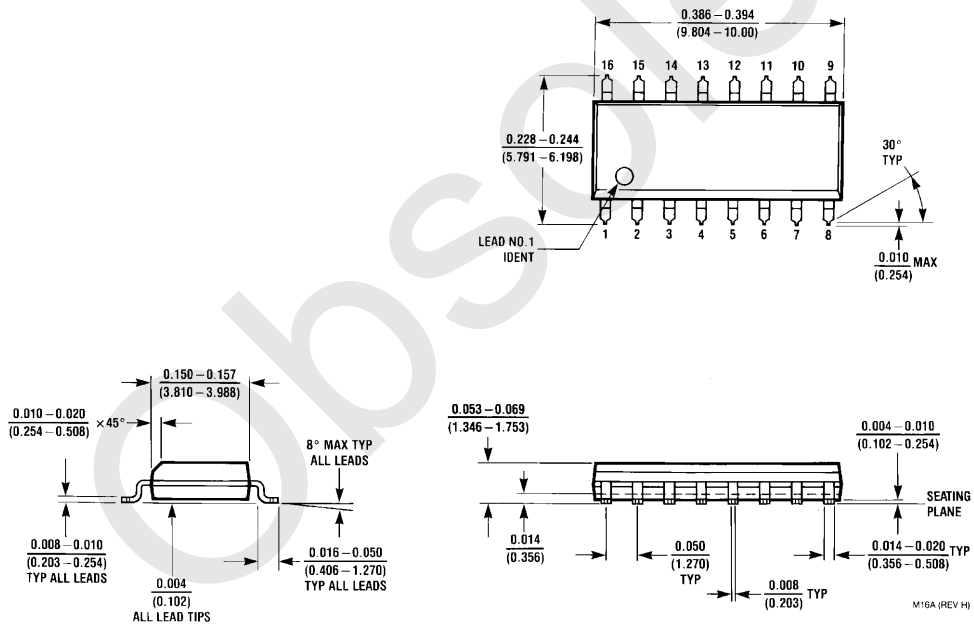
E20A (REV D)



**Physical Dimensions** inches (millimeters) (Continued)

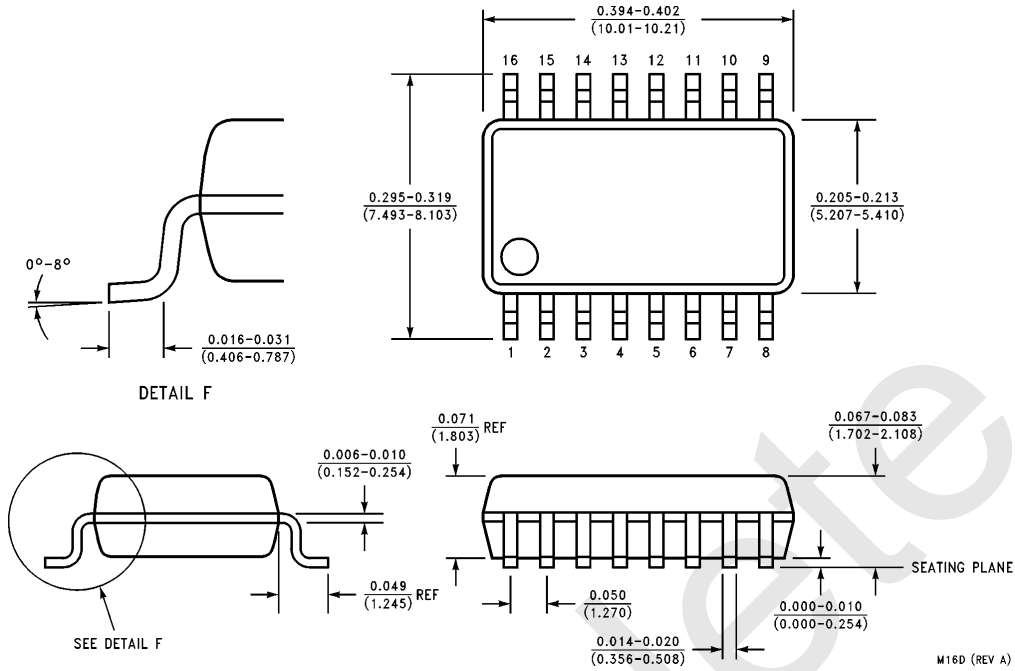


**16-Lead Ceramic Dual-In-Line Package (D)  
NS Package Number J16A**

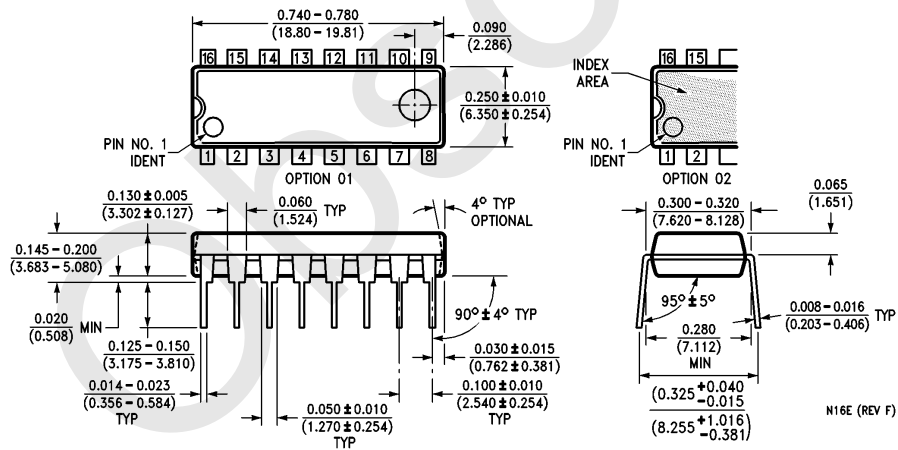


**16-Lead (0.150" Wide) Molded Small Outline Package, JEDEC (S)  
NS Package Number M16A**

**Physical Dimensions** inches (millimeters) (Continued)

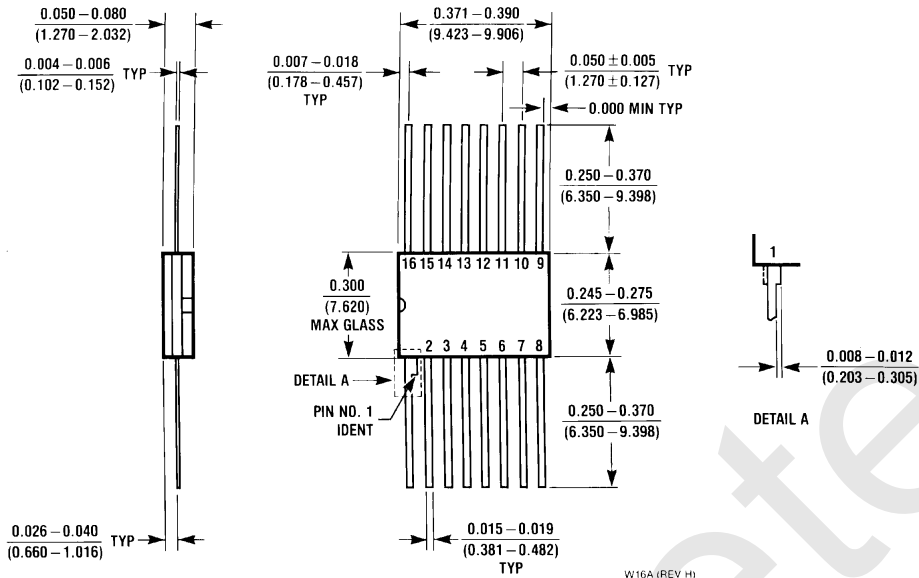


**16-Lead (0.300" Wide) Molded Small Outline Package, EIAJ (SJ)  
NS Package Number M16D**



**16-Lead (0.300" Wide) Molded Dual-In-Line Package (P)  
NS Package Number N16E**

**Physical Dimensions** inches (millimeters) (Continued)



**16-Lead Ceramic Flatpak (F)  
NS Package Number W16A**

W16A (REV H)

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