

November 1994

# 54F/74F251A

## 8-Input Multiplexer with TRI-STATE® Outputs

### General Description

The 'F251A is a high-speed 8-input digital multiplexer. It provides, in one package, the ability to select one bit of data from up to eight sources. It can be used as a universal function generator to generate any logic function of four variables. Both assertion and negation outputs are provided.

### Features

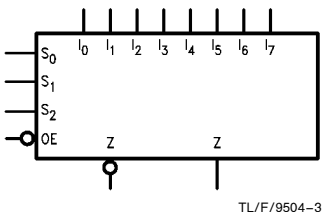
- Multifunctional capability
- On-chip select logic decoding
- Inverting and non-inverting TRI-STATE outputs

| Commercial         | Military           | Package Number | Package Description                               |
|--------------------|--------------------|----------------|---------------------------------------------------|
| 74F251APC          |                    | N16E           | 16-Lead (0.300" Wide) Molded Dual-In-Line         |
|                    | 54F251ADM (Note 2) | J16A           | 16-Lead Ceramic Dual-In-Line                      |
| 74F251ASC (Note 1) |                    | M16A           | 16-Lead (0.150" Wide) Molded Small Outline, JEDEC |
| 74F251ASJ (Note 1) |                    | M16D           | 16-Lead (0.300" Wide) Molded Small Outline, EIAJ  |
|                    | 54F251AFM (Note 2) | W16A           | 16-Lead Cerpack                                   |
|                    | 54F251ALL (Note 2) | E20A           | 20-Lead Ceramic Leadless Chip Carrier, Type C     |

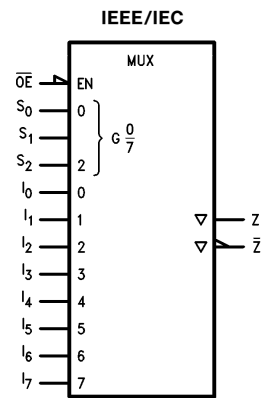
**Note 1:** Devices also available in 13" reel. Use suffix = SCX and SJX.

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

### Logic Symbols

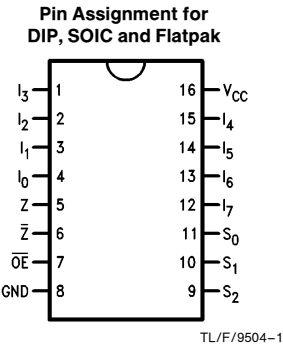


TL/F/9504-3

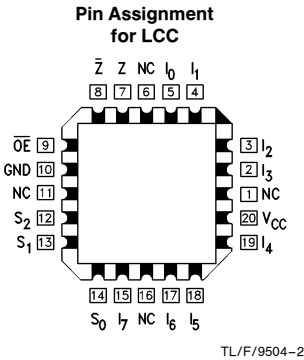


TL/F/9504-5

### Connection Diagrams



TL/F/9504-1



TL/F/9504-2

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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 $I_{OH}/I_{OL}$ |
| $S_0-S_2$       | Select Inputs                              | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| $\overline{OE}$ | TRI-STATE Output Enable Input (Active LOW) | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| $I_0-I_7$       | Multiplexer Inputs                         | 1.0/1.0          | 20 $\mu$ A/ -0.6 mA                             |
| Z               | TRI-STATE Multiplexer Output               | 150/40 (33.3)    | -3 mA/24 mA (20 mA)                             |
| $\overline{Z}$  | Complementary TRI-STATE Multiplexer Output | 150/40 (33.3)    | -3 mA/24 mA (20 mA)                             |

### Functional Description

This device is a logical implementation of a single-pole, 8-position switch with the switch position controlled by the state of three Select inputs,  $S_0$ ,  $S_1$ ,  $S_2$ . Both assertion and negation outputs are provided. The Output Enable input ( $\overline{OE}$ ) is active LOW. When it is activated, the logic function provided at the output is:

$$Z = \overline{OE} \cdot (I_0 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2} + I_1 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2} + I_2 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2} + I_3 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2} + I_4 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2} + I_5 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2} + I_6 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2} + I_7 \cdot \overline{S_0} \cdot \overline{S_1} \cdot \overline{S_2})$$

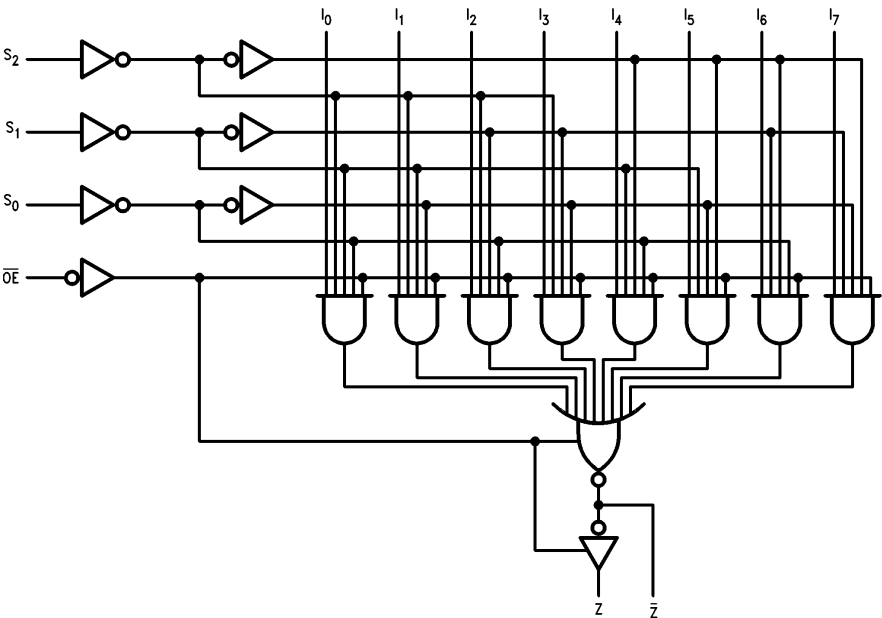
When the Output Enable is HIGH, both outputs are in the high impedance (High Z) state. This feature allows multiplexer expansion by tying the outputs of up to 128 devices together. When the outputs of the TRI-STATE devices are tied together, all but one device must be in the high impedance state to avoid high currents that would exceed the maximum ratings. The Output Enable signals should be designed to ensure there is no overlap in the active LOW portion of the enable voltages.

### Truth Table

| Inputs          |       |       |       | Outputs          |       |
|-----------------|-------|-------|-------|------------------|-------|
| $\overline{OE}$ | $S_2$ | $S_1$ | $S_0$ | $\overline{Z}$   | Z     |
| H               | X     | X     | X     | Z                | Z     |
| L               | L     | L     | L     | $\overline{I_0}$ | $I_0$ |
| L               | L     | L     | H     | $\overline{I_1}$ | $I_1$ |
| L               | L     | H     | L     | $\overline{I_2}$ | $I_2$ |
| L               | L     | H     | H     | $\overline{I_3}$ | $I_3$ |
| L               | H     | L     | L     | $\overline{I_4}$ | $I_4$ |
| L               | H     | L     | H     | $\overline{I_5}$ | $I_5$ |
| L               | H     | H     | L     | $\overline{I_6}$ | $I_6$ |
| L               | H     | H     | H     | $\overline{I_7}$ | $I_7$ |

H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Immaterial  
Z = High Impedance

### 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)

**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 |

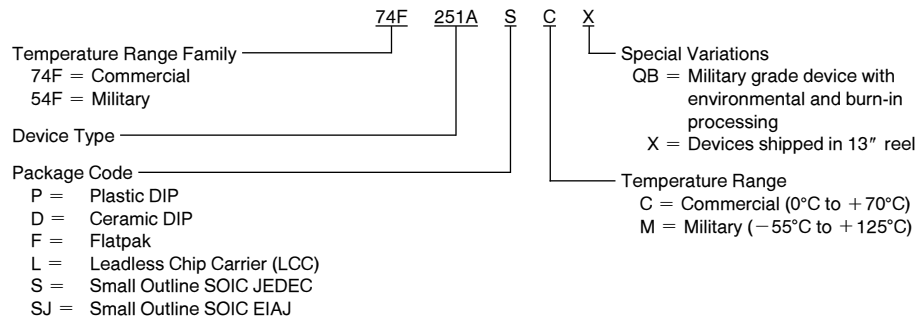
## DC Electrical Characteristics

| 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                 |                                                                                                                                                              |                                        | 0.8         | 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><br>54F 10% V <sub>CC</sub><br>74F 10% V <sub>CC</sub><br>74F 10% V <sub>CC</sub><br>74F 5% V <sub>CC</sub><br>74F 5% V <sub>CC</sub> | 2.5<br>2.4<br>2.5<br>2.4<br>2.7<br>2.7 |             | V     | Min             | I <sub>OH</sub> = −1 mA<br>I <sub>OH</sub> = −3 mA<br>I <sub>OH</sub> = −1 mA<br>I <sub>OH</sub> = −3 mA<br>I <sub>OH</sub> = −1 mA<br>I <sub>OH</sub> = −3 mA |
| V <sub>OL</sub>  | Output LOW Voltage                | 54F 10% V <sub>CC</sub><br>74F 10% V <sub>CC</sub>                                                                                                           |                                        | 0.5<br>0.5  | V     | Min             | I <sub>OL</sub> = 20 mA<br>I <sub>OL</sub> = 24 mA                                                                                                             |
| I <sub>IH</sub>  | Input HIGH Current                | 54F<br>74F                                                                                                                                                   |                                        | 20.0<br>5.0 | μA    | Max             | V <sub>IN</sub> = 2.7V                                                                                                                                         |
| I <sub>BVI</sub> | Input HIGH Current Breakdown Test | 54F<br>74F                                                                                                                                                   |                                        | 100<br>7.0  | μA    | Max             | V <sub>IN</sub> = 7.0V                                                                                                                                         |
| I <sub>CEX</sub> | Output HIGH Leakage Current       | 54F<br>74F                                                                                                                                                   |                                        | 250<br>50   | μA    | Max             | V <sub>OUT</sub> = V <sub>CC</sub>                                                                                                                             |
| 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>ID</sub> = 150 mV<br>All Other Pins Grounded                                                                                                            |
| I <sub>IL</sub>  | Input LOW Current                 |                                                                                                                                                              |                                        | −0.6        | mA    | Max             | V <sub>IN</sub> = 0.5V                                                                                                                                         |
| I <sub>OZH</sub> | Output Leakage Current            |                                                                                                                                                              |                                        | 50          | μA    | Max             | V <sub>OUT</sub> = 2.7V                                                                                                                                        |
| I <sub>OZL</sub> | Output Leakage Current            |                                                                                                                                                              |                                        | −50         | μA    | Max             | V <sub>OUT</sub> = 0.5V                                                                                                                                        |
| I <sub>OS</sub>  | Output Short-Circuit Current      |                                                                                                                                                              | −60                                    | −150        | mA    | Max             | V <sub>OUT</sub> = 0V                                                                                                                                          |
| I <sub>ZZ</sub>  | Bus Drainage Test                 |                                                                                                                                                              |                                        | 500         | μA    | 0.0V            | V <sub>OUT</sub> = 5.25V                                                                                                                                       |
| I <sub>CCL</sub> | Power Supply Current              |                                                                                                                                                              | 15                                     | 22          | mA    | Max             | V <sub>O</sub> = LOW                                                                                                                                           |
| I <sub>CCZ</sub> | Power Supply Current              |                                                                                                                                                              | 16                                     | 24          | mA    | Max             | V <sub>O</sub> = HIGH Z                                                                                                                                        |

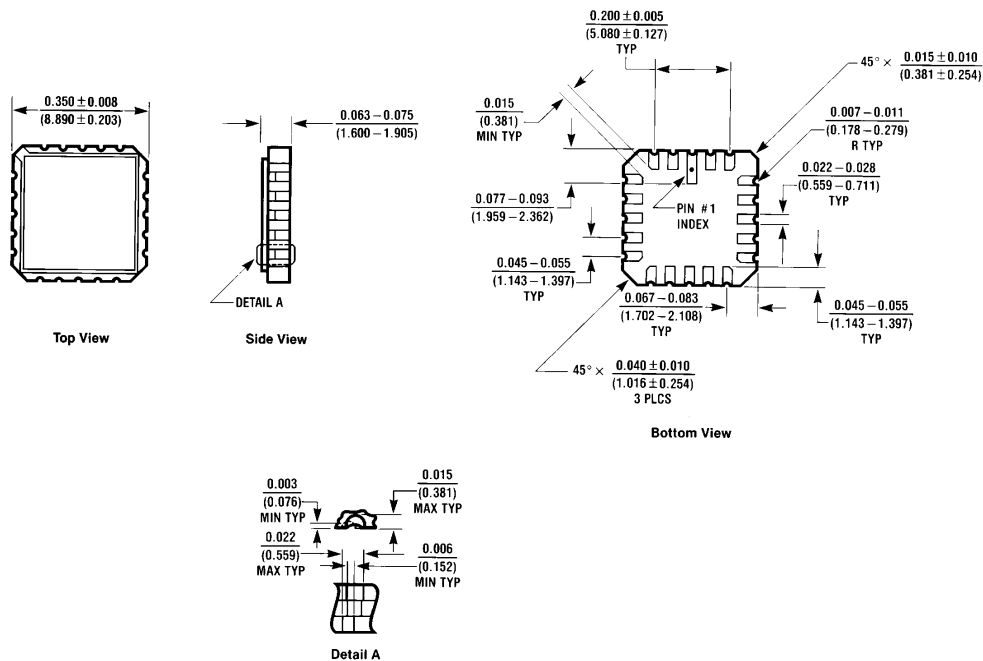
| AC Electrical Characteristics        |                                                     |                                                                             |            |             |                                                                  |              |                                                                  |             |       |
|--------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------|------------|-------------|------------------------------------------------------------------|--------------|------------------------------------------------------------------|-------------|-------|
| Symbol                               | Parameter                                           | 74F                                                                         |            |             | 54F                                                              |              | 74F                                                              |             | Units |
|                                      |                                                     | T <sub>A</sub> = +25°C<br>V <sub>CC</sub> = +5.0V<br>C <sub>L</sub> = 50 pF |            |             | T <sub>A</sub> , V <sub>CC</sub> = Mil<br>C <sub>L</sub> = 50 pF |              | T <sub>A</sub> , V <sub>CC</sub> = Com<br>C <sub>L</sub> = 50 pF |             |       |
|                                      |                                                     | Min                                                                         | Typ        | Max         | Min                                                              | Max          | Min                                                              | Max         |       |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>S <sub>n</sub> to $\bar{Z}$    | 3.5<br>3.2                                                                  | 6.0<br>5.0 | 9.0<br>7.5  | 3.5<br>3.2                                                       | 11.5<br>8.0  | 3.5<br>3.2                                                       | 9.5<br>7.5  | ns    |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>S <sub>n</sub> to Z            | 4.5<br>4.0                                                                  | 7.5<br>6.0 | 10.5<br>8.5 | 3.5<br>3.0                                                       | 14.0<br>10.5 | 4.5<br>4.0                                                       | 12.5<br>9.0 | ns    |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>I <sub>n</sub> to $\bar{Z}$    | 3.0<br>1.5                                                                  | 5.0<br>2.5 | 6.5<br>4.0  | 2.5<br>1.5                                                       | 8.0<br>6.0   | 3.0<br>1.5                                                       | 7.0<br>5.0  | ns    |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>I <sub>n</sub> to Z            | 3.5<br>3.5                                                                  | 5.0<br>5.5 | 7.0<br>7.0  | 2.5<br>3.5                                                       | 9.0<br>9.0   | 2.5<br>3.5                                                       | 8.0<br>7.5  | ns    |
| t <sub>PZH</sub><br>t <sub>PZL</sub> | Output Enable Time<br>$\overline{OE}$ to $\bar{Z}$  | 2.5<br>2.5                                                                  | 4.3<br>4.3 | 6.0<br>6.0  | 2.0<br>2.5                                                       | 7.0<br>7.5   | 2.5<br>2.5                                                       | 7.0<br>6.5  | ns    |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub> | Output Disable Time<br>$\overline{OE}$ to $\bar{Z}$ | 2.5<br>1.5                                                                  | 4.0<br>3.0 | 5.5<br>4.5  | 2.5<br>1.5                                                       | 6.0<br>5.0   | 2.5<br>1.5                                                       | 6.0<br>4.5  |       |
| t <sub>PZH</sub><br>t <sub>PZL</sub> | Output Enable Time<br>$\overline{OE}$ to Z          | 3.5<br>3.5                                                                  | 5.0<br>5.5 | 7.0<br>7.5  | 3.0<br>3.5                                                       | 8.5<br>9.0   | 3.0<br>3.5                                                       | 7.5<br>8.0  | ns    |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub> | Output Disable Time<br>$\overline{OE}$ to Z         | 2.0<br>1.5                                                                  | 3.8<br>3.0 | 5.5<br>4.5  | 2.0<br>1.5                                                       | 5.5<br>5.5   | 2.0<br>1.5                                                       | 5.5<br>4.5  |       |

## 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:



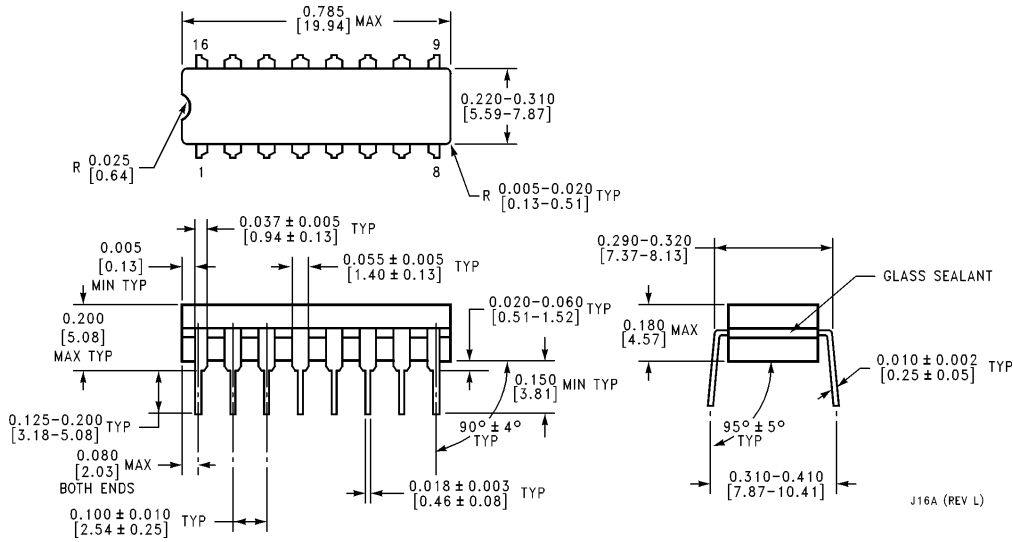
## Physical Dimensions inches (millimeters)



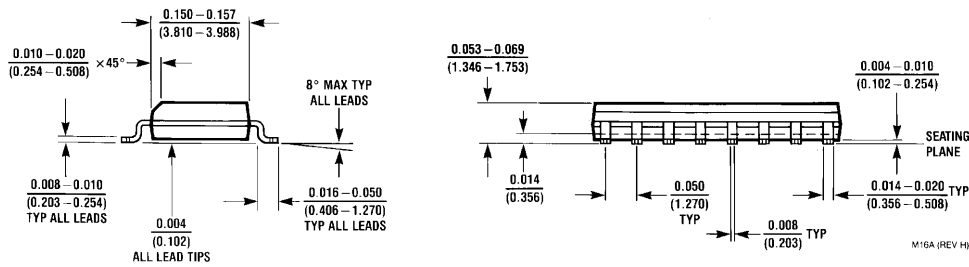
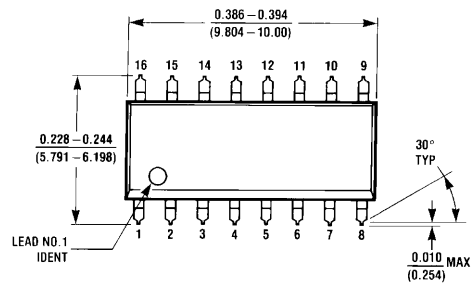
**20-Lead Ceramic Leadless Chip Carrier (L)  
NS Package Number E20A**

E20A (REV D)

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

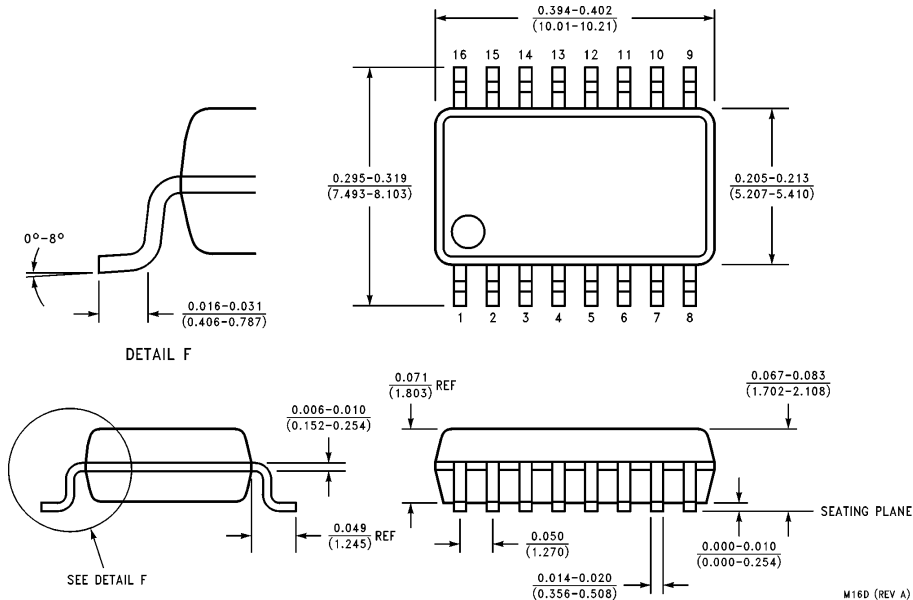


**16-Lead Ceramic Dual-In-Line Package (D)**  
**NS Package Number J16A**

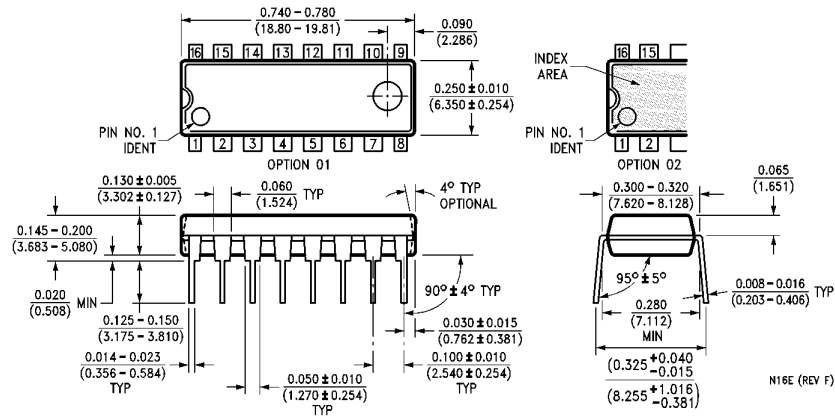


**16-Lead (0.150" Wide) Molded Small Outline Package, JEDEC (S)**  
**NS Package Number M16A**

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

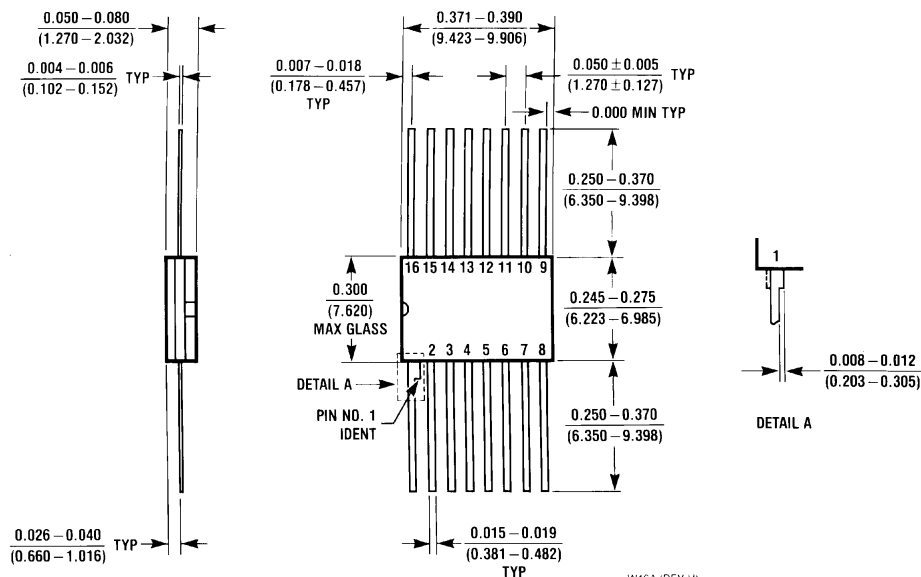


**16-Lead (0.300" Wide) Molded Small Outline Package, EIAJ (SJ)**  
**NS Package Number M16D**



**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)

## LIFE SUPPORT POLICY

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



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