

## 54LS138/DM54LS138/DM74LS138, 54LS139/DM54LS139/DM74LS139 Decoders/Demultiplexers

### General Description

These Schottky-clamped circuits are designed to be used in high-performance memory-decoding or data-routing applications, requiring very short propagation delay times. In high-performance memory systems these decoders can be used to minimize the effects of system decoding. When used with high-speed memories, the delay times of these decoders are usually less than the typical access time of the memory. This means that the effective system delay introduced by the decoder is negligible.

The LS138 decodes one-of-eight lines, based upon the conditions at the three binary select inputs and the three enable inputs. Two active-low and one active-high enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented with no 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 LS139 comprises two separate two-line-to-four-line decoders in a single package. The active-low enable input can be used as a data line in demultiplexing applications.

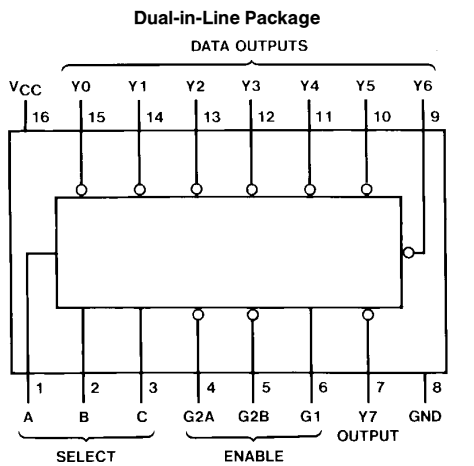
All of these decoders/demultiplexers feature fully buffered inputs, presenting only one normalized load to its driving circuit. All inputs are clamped with high-performance

Schottky diodes to suppress line-ringing and simplify system design.

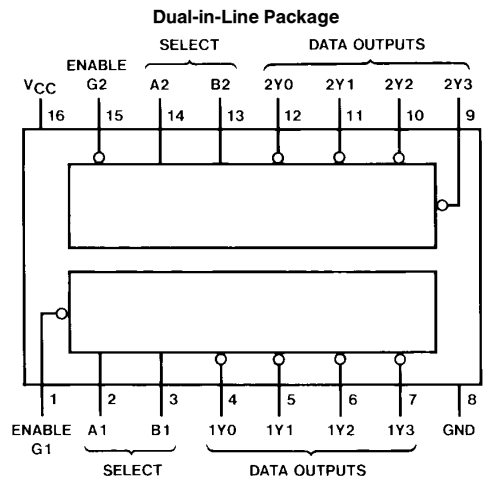
### Features

- Designed specifically for high speed:
  - Memory decoders
  - Data transmission systems
- LS138 3-to-8-line decoders incorporates 3 enable inputs to simplify cascading and/or data reception
- LS139 contains two fully independent 2-to-4-line decoders/demultiplexers
- Schottky clamped for high performance
- Typical propagation delay (3 levels of logic)
  - LS138 21 ns
  - LS139 21 ns
- Typical power dissipation
  - LS138 32 mW
  - LS139 34 mW
- Alternate Military/Aerospace devices (54LS138, 54LS139) are available. Contact a National Semiconductor Sales Office/Distributor for specifications.

### Connection Diagrams



Order Number 54LS138DMQB, 54LS138FMBQ,  
54LS138LMQB, DM54LS138J, DM54LS138W,  
DM74LS138M or DM74LS138N  
See NS Package Number E20A, J16A,  
M16A, N16E or W16A



Order Number 54LS139DMQB, 54LS139FMBQ,  
54LS139LMQB, DM54LS139J, DM54LS139W,  
DM74LS139M or DM74LS139N  
See NS Package Number E20A, J16A,  
M16A, N16E or W16A

## Absolute Maximum Ratings (Note)

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

|                                      |                 |
|--------------------------------------|-----------------|
| Supply Voltage                       | 7V              |
| Input Voltage                        | 7V              |
| Operating Free Air Temperature Range |                 |
| DM54LS and 54LS                      | −55°C to +125°C |
| DM74LS                               | 0°C to +70°C    |
| Storage Temperature Range            | −65°C to +150°C |

Note: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

## Recommended Operating Conditions

| Symbol          | Parameter                      | DM54LS138 |     |      | DM74LS138 |     |      | Units |
|-----------------|--------------------------------|-----------|-----|------|-----------|-----|------|-------|
|                 |                                | Min       | Nom | Max  | Min       | Nom | Max  |       |
| V <sub>CC</sub> | Supply Voltage                 | 4.5       | 5   | 5.5  | 4.75      | 5   | 5.25 | V     |
| V <sub>IH</sub> | High Level Input Voltage       | 2         |     |      | 2         |     |      | V     |
| V <sub>IL</sub> | Low Level Input Voltage        |           |     | 0.7  |           |     | 0.8  | V     |
| I <sub>OH</sub> | High Level Output Current      |           |     | −0.4 |           |     | −0.4 | mA    |
| I <sub>OL</sub> | Low Level Output Current       |           |     | 4    |           |     | 8    | mA    |
| T <sub>A</sub>  | Free Air Operating Temperature | −55       |     | 125  | 0         |     | 70   | °C    |

## 'LS138 Electrical Characteristics

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

| Symbol          | Parameter                         | Conditions                                                                                    | Min  | Typ<br>(Note 1) | Max   | Units |
|-----------------|-----------------------------------|-----------------------------------------------------------------------------------------------|------|-----------------|-------|-------|
| V <sub>I</sub>  | Input Clamp Voltage               | V <sub>CC</sub> = Min, I <sub>I</sub> = −18 mA                                                |      |                 | −1.5  | V     |
| V <sub>OH</sub> | High Level Output Voltage         | V <sub>CC</sub> = Min, I <sub>OH</sub> = Max,<br>V <sub>IL</sub> = Max, V <sub>IH</sub> = Min | DM54 | 2.5             | 3.4   | V     |
|                 |                                   |                                                                                               | DM74 | 2.7             | 3.4   |       |
| V <sub>OL</sub> | Low Level Output Voltage          | V <sub>CC</sub> = Min, I <sub>OL</sub> = Max,<br>V <sub>IL</sub> = Max, V <sub>IH</sub> = Min | DM54 |                 | 0.25  | V     |
|                 |                                   |                                                                                               | DM74 |                 | 0.35  |       |
|                 |                                   | I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = Min                                                 | DM74 |                 | 0.25  |       |
| I <sub>I</sub>  | Input Current @ Max Input Voltage | V <sub>CC</sub> = Max, V <sub>I</sub> = 7V                                                    |      |                 | 0.1   | mA    |
| I <sub>IH</sub> | High Level Input Current          | V <sub>CC</sub> = Max, V <sub>I</sub> = 2.7V                                                  |      |                 | 20    | μA    |
| I <sub>IL</sub> | Low Level Input Current           | V <sub>CC</sub> = Max, V <sub>I</sub> = 0.4V                                                  |      |                 | −0.36 | mA    |
| I <sub>OS</sub> | Short Circuit Output Current      | V <sub>CC</sub> = Max<br>(Note 2)                                                             | DM54 | −20             | −100  | mA    |
|                 |                                   |                                                                                               | DM74 | −20             | −100  |       |
| I <sub>CC</sub> | Supply Current                    | V <sub>CC</sub> = Max (Note 3)                                                                |      | 6.3             | 10    | mA    |

Note 1: All typicals are at V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C.

Note 2: Not more than one output should be shorted at a time, and the duration should not exceed one second.

Note 3: I<sub>CC</sub> is measured with all outputs enabled and open.

## 'LS138 Switching Characteristics

at  $V_{CC} = 5V$  and  $T_A = 25^\circ C$  (See Section 1 for Test Waveforms and Output Load)

| Symbol           | Parameter                                          | From (Input)<br>To (Output) | Levels<br>of Delay | R <sub>L</sub> = 2 kΩ  |     |                        |     | Units |
|------------------|----------------------------------------------------|-----------------------------|--------------------|------------------------|-----|------------------------|-----|-------|
|                  |                                                    |                             |                    | C <sub>L</sub> = 15 pF |     | C <sub>L</sub> = 50 pF |     |       |
|                  |                                                    |                             |                    | Min                    | Max | Min                    | Max |       |
| t <sub>PLH</sub> | Propagation Delay Time<br>Low to High Level Output | Select to<br>Output         | 2                  |                        | 18  |                        | 27  | ns    |
| t <sub>PHL</sub> | Propagation Delay Time<br>High to Low Level Output | Select to<br>Output         | 2                  |                        | 27  |                        | 40  | ns    |
| t <sub>PLH</sub> | Propagation Delay Time<br>Low to High Level Output | Select to<br>Output         | 3                  |                        | 18  |                        | 27  | ns    |
| t <sub>PHL</sub> | Propagation Delay Time<br>High to Low Level Output | Select to<br>Output         | 3                  |                        | 27  |                        | 40  | ns    |
| t <sub>PLH</sub> | Propagation Delay Time<br>Low to High Level Output | Enable to<br>Output         | 2                  |                        | 18  |                        | 27  | ns    |
| t <sub>PHL</sub> | Propagation Delay Time<br>High to Low Level Output | Enable to<br>Output         | 2                  |                        | 24  |                        | 40  | ns    |
| t <sub>PLH</sub> | Propagation Delay Time<br>Low to High Level Output | Enable to<br>Output         | 3                  |                        | 18  |                        | 27  | ns    |
| t <sub>PHL</sub> | Propagation Delay Time<br>High to Low Level Output | Enable to<br>Output         | 3                  |                        | 28  |                        | 40  | ns    |

## Recommended Operating Conditions

| Symbol   | Parameter                      | DM54LS139 |     |      | DM74LS139 |     |      | Units      |
|----------|--------------------------------|-----------|-----|------|-----------|-----|------|------------|
|          |                                | Min       | Nom | Max  | Min       | Nom | Max  |            |
| $V_{CC}$ | Supply Voltage                 | 4.5       | 5   | 5.5  | 4.75      | 5   | 5.25 | V          |
| $V_{IH}$ | High Level Input Voltage       | 2         |     |      | 2         |     |      | V          |
| $V_{IL}$ | Low Level Input Voltage        |           |     | 0.7  |           |     | 0.8  | V          |
| $I_{OH}$ | High Level Output Current      |           |     | -0.4 |           |     | -0.4 | mA         |
| $I_{OL}$ | Low Level Output Current       |           |     | 4    |           |     | 8    | mA         |
| $T_A$    | Free Air Operating Temperature | -55       |     | 125  | 0         |     | 70   | $^\circ C$ |

## 'LS139 Electrical Characteristics

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

| Symbol   | Parameter                         | Conditions                                                                           | Min         | Typ<br>(Note 1) | Max   | Units         |
|----------|-----------------------------------|--------------------------------------------------------------------------------------|-------------|-----------------|-------|---------------|
| $V_I$    | Input Clamp Voltage               | $V_{CC} = \text{Min}, I_I = -18 \text{ mA}$                                          |             |                 | -1.5  | V             |
| $V_{OH}$ | High Level Output Voltage         | $V_{CC} = \text{Min}, I_{OH} = \text{Max}, V_{IL} = \text{Max}, V_{IH} = \text{Min}$ | DM54<br>2.5 | 3.4             |       | V             |
|          |                                   |                                                                                      | DM74<br>2.7 | 3.4             |       |               |
| $V_{OL}$ | Low Level Output Voltage          | $V_{CC} = \text{Min}, I_{OL} = \text{Max}, V_{IL} = \text{Max}, V_{IH} = \text{Min}$ | DM54        | 0.25            | 0.4   | V             |
|          |                                   |                                                                                      | DM74        | 0.35            | 0.5   |               |
|          |                                   | $I_{OL} = 4 \text{ mA}, V_{CC} = \text{Min}$                                         | DM74        | 0.25            | 0.4   |               |
| $I_I$    | Input Current @ Max Input Voltage | $V_{CC} = \text{Max}, V_I = 7V$                                                      |             |                 | 0.1   | mA            |
| $I_{IH}$ | High Level Input Current          | $V_{CC} = \text{Max}, V_I = 2.7V$                                                    |             |                 | 20    | $\mu\text{A}$ |
| $I_{IL}$ | Low Level Input Current           | $V_{CC} = \text{Max}, V_I = 0.4V$                                                    |             |                 | -0.36 | mA            |
| $I_{OS}$ | Short Circuit Output Current      | $V_{CC} = \text{Max}$<br>(Note 2)                                                    | DM54<br>-20 |                 | -100  | mA            |
|          |                                   |                                                                                      | DM74<br>-20 |                 | -100  |               |
| $I_{CC}$ | Supply Current                    | $V_{CC} = \text{Max}$ (Note 3)                                                       |             | 6.8             | 11    | mA            |

**Note 1:** All typicals are at  $V_{CC} = 5V, T_A = 25^\circ\text{C}$ .

**Note 2:** Not more than one output should be shorted at a time, and the duration should not exceed one second.

**Note 3:**  $I_{CC}$  is measured with all outputs enabled and open.

## 'LS139 Switching Characteristics

at  $V_{CC} = 5V$  and  $T_A = 25^\circ\text{C}$  (See Section 1 for Test Waveforms and Output Load)

| Symbol    | Parameter                                          | From (Input)<br>To (Output) | $R_L = 2\text{ k}\Omega$ |     |                      |     | Units |
|-----------|----------------------------------------------------|-----------------------------|--------------------------|-----|----------------------|-----|-------|
|           |                                                    |                             | $C_L = 15\text{ pF}$     |     | $C_L = 50\text{ pF}$ |     |       |
|           |                                                    |                             | Min                      | Max | Min                  | Max |       |
| $t_{PLH}$ | Propagation Delay Time<br>Low to High Level Output | Select to<br>Output         |                          | 18  |                      | 27  | ns    |
| $t_{PHL}$ | Propagation Delay Time<br>High to Low Level Output | Select to<br>Output         |                          | 27  |                      | 40  | ns    |
| $t_{PLH}$ | Propagation Delay Time<br>Low to High Level Output | Enable to<br>Output         |                          | 18  |                      | 27  | ns    |
| $t_{PHL}$ | Propagation Delay Time<br>High to Low Level Output | Enable to<br>Output         |                          | 24  |                      | 40  | ns    |

## Function Tables

LS138

| Inputs |     |        | Outputs |   |    |    |    |    |    |    |    |    |
|--------|-----|--------|---------|---|----|----|----|----|----|----|----|----|
| Enable |     | Select |         |   |    |    |    |    |    |    |    |    |
| G1     | G2* | C      | B       | A | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 |
| X      | H   | X      | X       | X | H  | H  | H  | H  | H  | H  | H  | H  |
| L      | X   | X      | X       | X | H  | H  | H  | H  | H  | H  | H  | H  |
| H      | L   | L      | L       | L | L  | H  | H  | H  | H  | H  | H  | H  |
| H      | L   | L      | L       | H | H  | L  | H  | H  | H  | H  | H  | H  |
| H      | L   | L      | H       | L | H  | H  | L  | H  | H  | H  | H  | H  |
| H      | L   | L      | H       | H | H  | H  | L  | H  | H  | H  | H  | H  |
| H      | L   | H      | L       | L | H  | H  | H  | H  | L  | H  | H  | H  |
| H      | L   | H      | L       | H | H  | H  | H  | H  | H  | L  | H  | H  |
| H      | L   | H      | H       | L | H  | H  | H  | H  | H  | H  | L  | H  |
| H      | L   | H      | H       | H | H  | H  | H  | H  | H  | H  | H  | L  |

\*  $G2 = G2A + G2B$

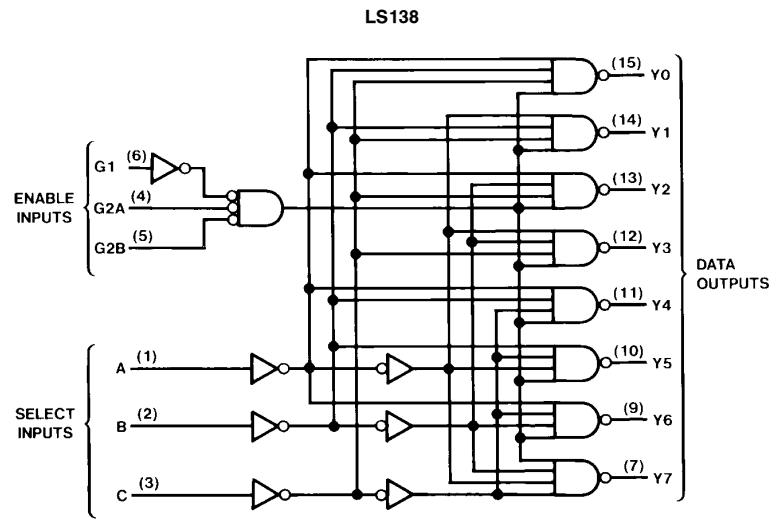
H = High Level, L = Low Level, X = Don't Care

LS139

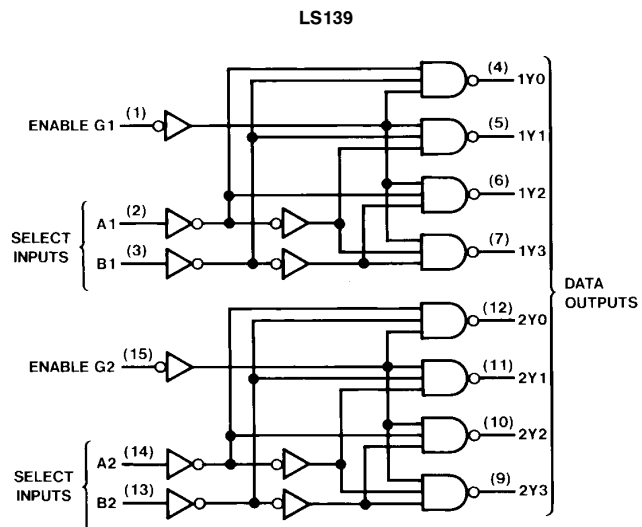
| Inputs |        |   | Outputs |    |    |    |
|--------|--------|---|---------|----|----|----|
| Enable | Select |   |         |    |    |    |
| G      | B      | A | Y0      | Y1 | Y2 | Y3 |
| H      | X      | X | H       | H  | H  | H  |
| L      | L      | L | L       | H  | H  | H  |
| L      | L      | H | H       | L  | H  | H  |
| L      | H      | L | H       | H  | L  | H  |
| L      | H      | H | H       | H  | H  | L  |

H = High Level, L = Low Level, X = Don't Care

## Logic Diagrams



TL/F/6391-3



TL/F/6391-4

**Top View**

Overall width:  $0.350 \pm 0.008$  (8.890 ± 0.203)

**Side View**

Overall height:  $0.063 - 0.075$  (1.600 - 1.905)

**Bottom View**

Overall width:  $0.200 \pm 0.005$  (5.080 ± 0.127) TYP

Overall height:  $0.015 \pm 0.010$  (0.381 ± 0.254) 45° ×

Pin #1 INDEX

Pin pitch:  $0.007 - 0.011$  (0.178 - 0.279) R TYP

Pin width:  $0.022 - 0.028$  (0.559 - 0.711) TYP

Pin height:  $0.045 - 0.055$  (1.143 - 1.397) TYP

Pin length:  $0.067 - 0.083$  (1.702 - 2.108) TYP

Pin spacing:  $0.045 - 0.055$  (1.143 - 1.397) TYP

Pin angle: 45° ×  $0.040 \pm 0.010$  (1.016 ± 0.254) 3 PLCS

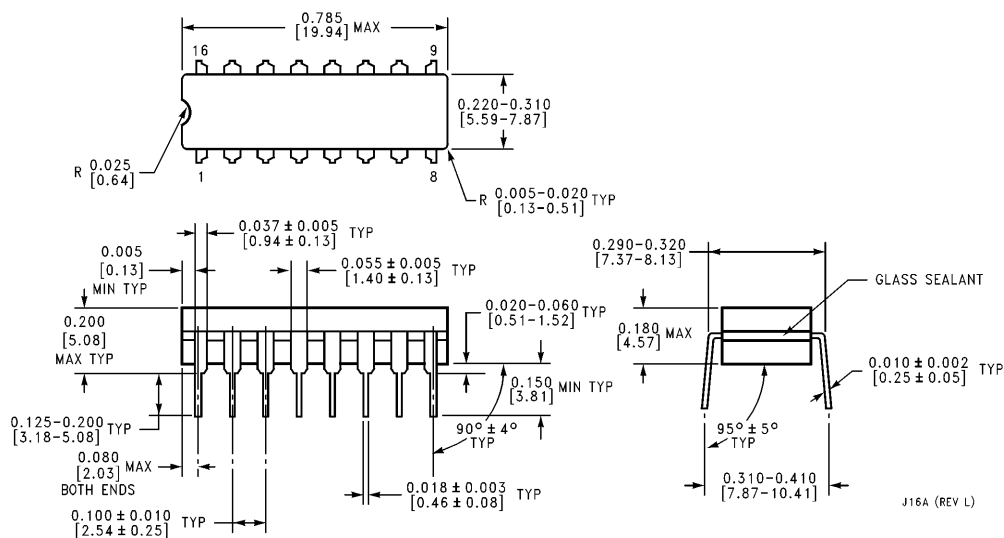
**Detail A**

Detail A shows a cross-section of the pin and its connection to the PCB. Dimensions include:

- Pin diameter:  $0.003$  (0.076) MIN TYP
- Pin height:  $0.022$  (0.559) MAX TYP
- Pin width:  $0.015$  (0.381) MAX TYP
- Pin length:  $0.006$  (0.152) MIN TYP

**Ceramic Leadless Chip Carrier Package (E)**  
**Order Number 54LS138LMQB or 54LS139LMQB**  
**NS Package Number E20A**

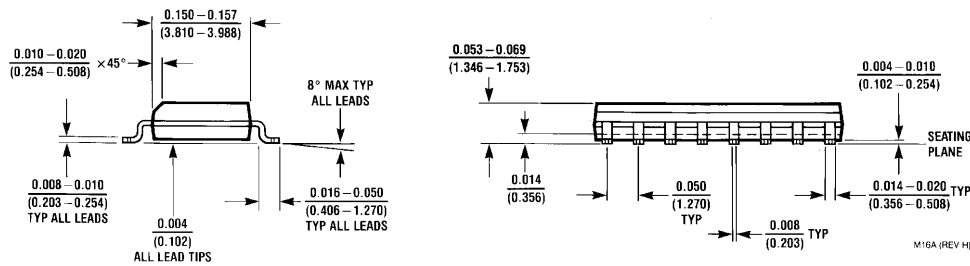
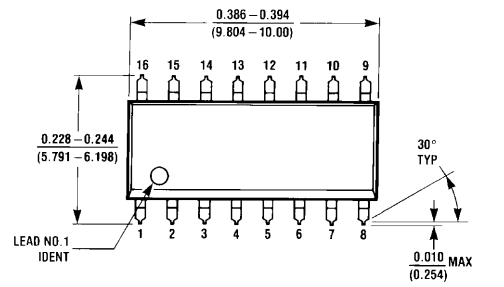
E20A (REV D)



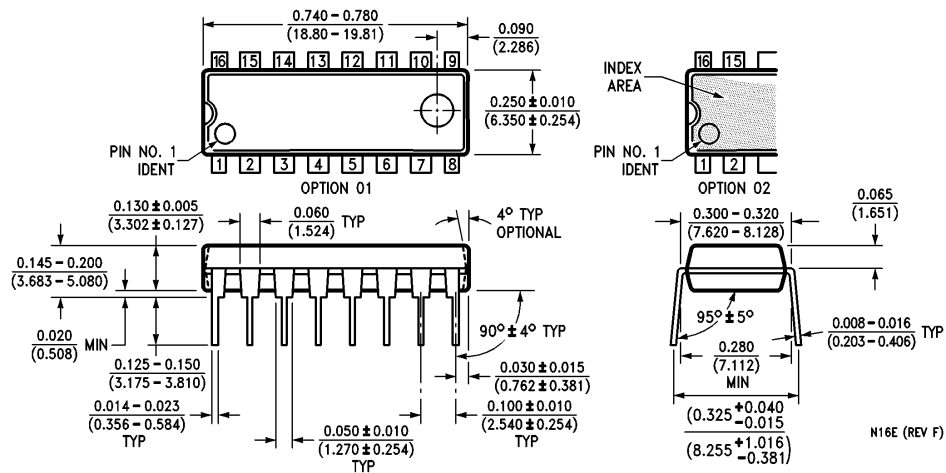
**16-Lead Ceramic Dual-In-Line Package (J)**  
**Order Number 54LS138DMQB, 54LS139DMQB, DM54LS138J or DM54LS139J**  
**NS Package Number J16A**

J16A (REV L)

# Physical Dimensions inches (millimeters) (Continued)

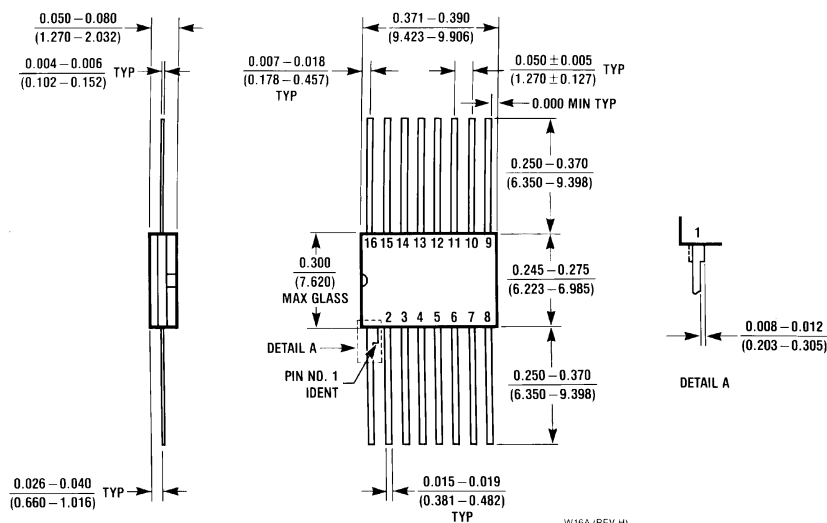


**16-Lead Small Outline Molded Package (M)**  
**Order Number DM74LS138M or DM74LS139M**  
**NS Package Number M16A**



**16-Lead Molded Dual-In-Line Package (N)**  
**Order Number DM74LS138N or DM74LS139N**  
**NS Package Number N16E**

## Physical Dimensions inches (millimeters) (Continued)



### 16-Lead Ceramic Flat Package (W)

Order Number 54LS138FMQB, 54LS139FMQB, DM54LS138W or DM54LS139W  
NS Package Number W16A

## 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.



**National Semiconductor Corporation**  
1111 West Bardin Road  
Arlington, TX 76017  
Tel: 1(800) 272-9959  
Fax: 1(800) 737-7018

**National Semiconductor Europe**  
Fax: (+49) 0-180-530 85 86  
Email: cnjwge@tevm2.nsc.com  
Deutsch Tel: (+49) 0-180-530 85 85  
English Tel: (+49) 0-180-532 78 32  
Français Tel: (+49) 0-180-532 93 58  
Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
13th Floor, Straight Block,  
Ocean Centre, 5 Canton Rd.  
Tsimshatsui, Kowloon  
Hong Kong  
Tel: (852) 2737-1600  
Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
Tel: 81-043-299-2309  
Fax: 81-043-299-2408

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