DM74LS138, 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 decoder 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 Fairchild Semiconductor Sales Office/Distributor for specifications.

Connection Diagrams

See Package Number E20A, J16A, M16A, N16E or W16A
Dual-in-Line Package

Order Number 54LS139DMQB, 54LS139FMQB, 54LS139LMQB, DM54LS139J, DM54LS139W, DM74LS139M or DM74LS139N
See Package Number E20A, J16A, M16A, N16E or W16A
Dual-in-Line Package
Absolute Maximum Ratings  (Note 1)  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DM54LS and 54LS</th>
<th>DM74LS</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>7V</td>
<td>0°C to +70°C</td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td>7V</td>
<td>Storage Temperature Range</td>
<td>−65°C to +150°C</td>
</tr>
<tr>
<td>Operating Free Air Temperature Range</td>
<td>−55°C to +125°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>DM54LS138</th>
<th>DM74LS138</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>Supply Voltage</td>
<td>Min Nom Max</td>
<td>Min Nom Max</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;IH&lt;/sub&gt;</td>
<td>High Level Input Voltage</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;IL&lt;/sub&gt;</td>
<td>Low Level Input Voltage</td>
<td>0.7</td>
<td>0.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>High Level Output Current</td>
<td>−0.4</td>
<td>−0.4</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>Low Level Output Current</td>
<td>4</td>
<td>8</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>T&lt;sub&gt;A&lt;/sub&gt;</td>
<td>Free Air Operating Temperature</td>
<td>−55</td>
<td>125</td>
<td>0</td>
<td>70</td>
</tr>
</tbody>
</table>

Note 1: 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.

'LS138 Electrical Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ (Note 2)</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;I&lt;/sub&gt;</td>
<td>Input Clamp Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Min, I&lt;sub&gt;I&lt;/sub&gt; = −18 mA</td>
<td>−1.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>High Level Output Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Min, I&lt;sub&gt;OH&lt;/sub&gt; = Max, V&lt;sub&gt;I&lt;/sub&gt; = Max, V&lt;sub&gt;IH&lt;/sub&gt; = Min</td>
<td>DM54 2.5</td>
<td>3.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>Low Level Output Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Min, I&lt;sub&gt;OL&lt;/sub&gt; = Max, V&lt;sub&gt;I&lt;/sub&gt; = Max, V&lt;sub&gt;IH&lt;/sub&gt; = Min</td>
<td>DM74 2.7</td>
<td>3.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;I&lt;/sub&gt;</td>
<td>Input Current @ Max Input Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Max, V&lt;sub&gt;I&lt;/sub&gt; = 7V</td>
<td>0.1</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>High Level Input Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Max, V&lt;sub&gt;I&lt;/sub&gt; = 2.7V</td>
<td>20</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;IL&lt;/sub&gt;</td>
<td>Low Level Input Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Max, V&lt;sub&gt;I&lt;/sub&gt; = 0.4V</td>
<td>−0.36</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OSS&lt;/sub&gt;</td>
<td>Short Circuit Output Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Max</td>
<td>DM54 −20</td>
<td>−100</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>Supply Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = Max (Note 4)</td>
<td>6.3</td>
<td>10</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

Note 2: All typicals are at V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C.
Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.
Note 4: I<sub>CC</sub> is measured with all outputs enabled and open.

'LS138 Switching Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>From (Input) To (Output)</th>
<th>Levels of Delay</th>
<th>R&lt;sub&gt;L&lt;/sub&gt; = 2 kΩ</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>Propagation Delay Time Low to High Level Output</td>
<td>Select to Output</td>
<td>2</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td>t&lt;sub&gt;PHL&lt;/sub&gt;</td>
<td>Propagation Delay Time High to Low Level Output</td>
<td>Select to Output</td>
<td>2</td>
<td>27</td>
<td>40</td>
</tr>
<tr>
<td>t&lt;sub&gt;PLH&lt;/sub&gt;</td>
<td>Propagation Delay Time Low to High Level Output</td>
<td>Select to Output</td>
<td>3</td>
<td>18</td>
<td>27</td>
</tr>
</tbody>
</table>

www.fairchildsemi.com
### LS138 Switching Characteristics (Continued)

at \( V_{CC} = 5V \) and \( T_A = 25^\circ C \)

<table>
<thead>
<tr>
<th>Symbol ( t_{PHL} )</th>
<th>Parameter</th>
<th>From (Input) Levels ( R_L = 2k\Omega )</th>
<th>Levels of Delay</th>
<th>( C_L = 15, pF )</th>
<th>( C_L = 50, pF )</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Select to High Output</td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{PLH} )</td>
<td>Propagation Delay Time High to Low Level Output</td>
<td>3</td>
<td>27</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enable to Low Output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t_{PHL} )</td>
<td>Propagation Delay Time High to Low Level Output</td>
<td>2</td>
<td>18</td>
<td>27</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enable to Low Output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t_{PLH} )</td>
<td>Propagation Delay Time Low to High Level Output</td>
<td>2</td>
<td>24</td>
<td>40</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enable to High Output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t_{PHL} )</td>
<td>Propagation Delay Time High to Low Level Output</td>
<td>3</td>
<td>18</td>
<td>27</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enable to Low Output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>DM54LS139</th>
<th>DM74LS139</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CC} )</td>
<td>Supply Voltage</td>
<td>( V_{CC} = Min )</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
</tr>
<tr>
<td>( V_{IH} )</td>
<td>High Level Input Voltage</td>
<td>( V_{IL} = Max )</td>
<td>2</td>
<td>2</td>
<td>V</td>
</tr>
<tr>
<td>( V_{IL} )</td>
<td>Low Level Input Voltage</td>
<td>( V_{IH} = Min )</td>
<td>0.7</td>
<td>0.8</td>
<td>V</td>
</tr>
<tr>
<td>( I_{OH} )</td>
<td>High Level Output Current</td>
<td>( V_{CC} = Min )</td>
<td>-0.4</td>
<td>-0.4</td>
<td>mA</td>
</tr>
<tr>
<td>( I_{OL} )</td>
<td>Low Level Output Current</td>
<td>( V_{CC} = Min )</td>
<td>4</td>
<td>8</td>
<td>mA</td>
</tr>
<tr>
<td>( T_A )</td>
<td>Free Air Operating Temperature</td>
<td>( T_A = Min )</td>
<td>-55</td>
<td>125</td>
<td>0</td>
</tr>
</tbody>
</table>

### LS139 Electrical Characteristics

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ (Note 5)</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{I} )</td>
<td>Input Clamp Voltage</td>
<td>( V_{CC} = Min, I_{I} = -18, mA )</td>
<td>-1.5</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{OH} )</td>
<td>High Level Output Voltage</td>
<td>( V_{CC} = Min, I_{OH} = Max, V_{IL} = Max, V_{IH} = Min )</td>
<td>2.5</td>
<td>3.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( V_{OL} )</td>
<td>Low Level Output Voltage</td>
<td>( V_{CC} = Min, I_{OL} = Max, V_{IL} = Max, V_{IH} = Min )</td>
<td>0.25</td>
<td>0.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( I_{I} )</td>
<td>Input Current</td>
<td>( V_{CC} = Max, V_{I} = 7V )</td>
<td>0.1</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{IH} )</td>
<td>High Level Input Current</td>
<td>( V_{CC} = Max, V_{I} = 2.7V )</td>
<td>20</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{IL} )</td>
<td>Low Level Input Current</td>
<td>( V_{CC} = Max, V_{I} = 0.4V )</td>
<td>-0.36</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{OS} )</td>
<td>Short Circuit Output Current</td>
<td>( V_{CC} = Max )</td>
<td>-20</td>
<td>-100</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>( I_{OC} )</td>
<td>Supply Current</td>
<td>( V_{CC} = Max )</td>
<td>6.8</td>
<td>11</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- **Note 5:** All typicals are at \( V_{CC} = 5V, T_A = 25^\circ C \).
- **Note 6:** Not more than one output should be shorted at a time, and the duration should not exceed one second.
- **Note 7:** \( I_{OC} \) is measured with all outputs enabled and open.
### 'LS139 Switching Characteristics

at \( V_{CC} = 5V \) and \( T_A = 25^\circ C \)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>From (Input)</th>
<th>To (Output)</th>
<th>( R_L = 2 , k\Omega )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( C_L = 15 , pF ) Min</td>
</tr>
<tr>
<td>( t_{PLH} )</td>
<td>Propagation Delay Time</td>
<td>Select to</td>
<td>Output</td>
<td>18</td>
</tr>
<tr>
<td>( t_{PHL} )</td>
<td>Propagation Delay Time</td>
<td>Select to</td>
<td>Output</td>
<td>27</td>
</tr>
<tr>
<td>( t_{PLH} )</td>
<td>Propagation Delay Time</td>
<td>Enable to</td>
<td>Output</td>
<td>18</td>
</tr>
<tr>
<td>( t_{PHL} )</td>
<td>Propagation Delay Time</td>
<td>Enable to</td>
<td>Output</td>
<td>24</td>
</tr>
</tbody>
</table>

### Function Tables

**LS138**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable</td>
<td>Select</td>
</tr>
<tr>
<td>G1</td>
<td>G2 (Note 8)</td>
</tr>
<tr>
<td>X</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>X</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

\( H = \text{High Level}, \, L = \text{Low Level}, \, X = \text{Don't Care} \)

**Note 8:** \( G2 = G2A + G2B \)

**LS139**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable</td>
<td>Select</td>
</tr>
<tr>
<td>G</td>
<td>B</td>
</tr>
<tr>
<td>H</td>
<td>X</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>

\( H = \text{High Level}, \, L = \text{Low Level}, \, X = \text{Don't Care} \)
Logic Diagrams

LS138

Enable Inputs

G1 (6)
G2A (4)
G2B (5)

Select Inputs

A (1)
B (2)
C (3)

Data Outputs

Y0 (15)
Y1 (14)
Y2 (13)
Y3 (12)
Y4 (11)
Y5 (10)
Y6 (9)
Y7 (7)

LS139

Enable G1 (1)

Select Inputs

A1 (2)
B1 (3)

Data Outputs

Y0 (4)
Y1 (5)
Y2 (6)
Y3 (7)

Enable G2 (15)

Select Inputs

A2 (14)
B2 (13)

G063391-3
G063391-4
Physical Dimensions inches (millimeters) unless otherwise noted

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

16-Lead Ceramic Dual-In-Line Package (J)
Order Number 54LS138DMQB, 54LS139DMQB, DM54LS138J or DM54LS139J
Package Number J16A
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

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

16-Lead Molded Dual-In-Line Package (N)
Order Number DM74LS138N or DM74LS139N
Package Number N16E
LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.

2. A critical component in 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.