FAIRCHILD SEMICONDUCTOR™

April 1988
Revised September 2000

# 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

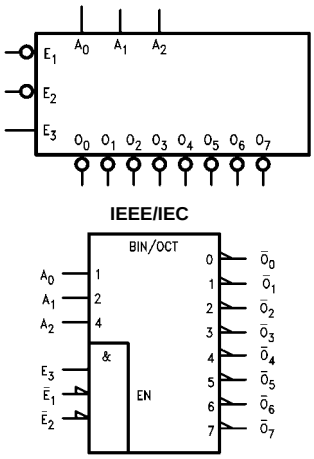
- Demultiplexing capability
- Multiple input enable for easy expansion
- Active LOW mutually exclusive outputs

## Ordering Code:

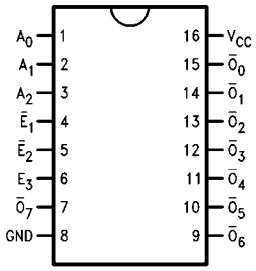
| Order Number | Package Number | Package Description |
|---|---|---|
| 74F138SC | M16A | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow |
| 74F138SJ | M16D | 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide |
| 74F138PC | N16E | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide |

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

## Logic Symbols




## Connection Diagram



## Unit Loading/Fan Out

| Pin Names | Description | U.L. HIGH/LOW | Input $I_{IH}/I_{IL}$ Output $I_{OH}/I_{OL}$ |
|---|---|---|---|
| $A_0$–$A_2$ | Address Inputs | 1.0/1.0 | 20 µA/–0.6 mA |
| $\overline{E}_1$, $\overline{E}_2$ | Enable Inputs (Active LOW) | 1.0/1.0 | 20 µA/–0.6 mA |
| $E_3$ | Enable Input (Active HIGH) | 1.0/1.0 | 20 µA/–0.6 mA |
| $\overline{O}_0$–$\overline{O}_7$ | Outputs (Active LOW) | 50/33.3 | –1 mA/20 mA |

## Truth Table

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

## 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 ($\overline{O}_0$–$\overline{O}_7$). The F138 features three Enable inputs, two active LOW ($\overline{E}_1$, $\overline{E}_2$) and one active HIGH ($E_3$). All outputs will be HIGH unless $\overline{E}_1$ and $\overline{E}_2$ 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.

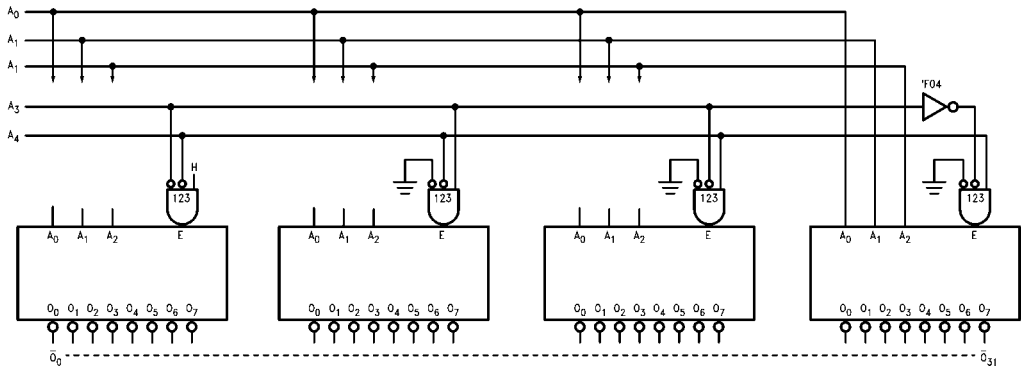
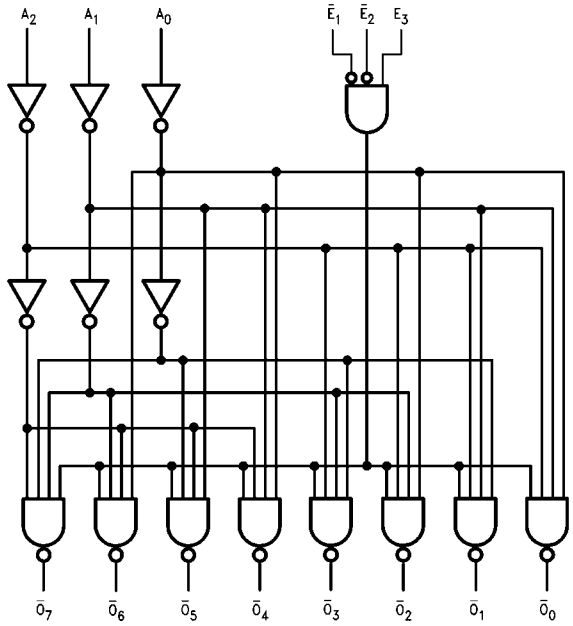



**FIGURE 1. Expansion to 1-of-32 Decoding**

## Logic Diagram




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)

| | |
|---|---|
| Storage Temperature | −65°C to +150°C |
| Ambient Temperature under Bias | −55°C to +125°C |
| Junction Temperature under Bias | −55°C to +150°C |
| $V_{CC}$ 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 $V_{CC}$ = 0V) | |
| Standard Output | −0.5V to $V_{CC}$ |
| 3-STATE Output | −0.5V to +5.5V |
| Current Applied to Output | |
| in LOW State (Max) | twice the rated $I_{OL}$ (mA) |
| ESD Last Passing Voltage (Min) | 4000V |

## Recommended Operating Conditions

| | |
|---|---|
| Free Air Ambient Temperature | 0°C to +70°C |
| Supply Voltage | +4.5V to +5.5V |

**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.

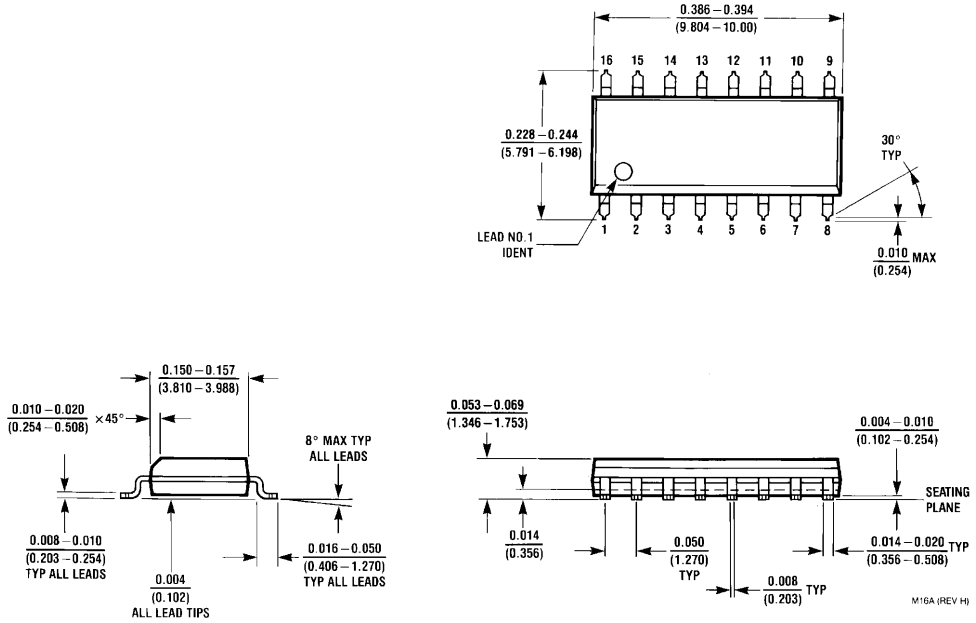
## DC Electrical Characteristics

| Symbol | Parameter | | Min | Typ | Max | Units | $V_{CC}$ | Conditions |
|---|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Voltage | | 2.0 | | | V | | Recognized as a HIGH Signal |
| $V_{IL}$ | Input LOW Voltage | | | | 0.8 | V | | Recognized as a LOW Signal |
| $V_{CD}$ | Input Clamp Diode Voltage | | | | −1.2 | V | Min | $I_{IN}$ = −18 mA |
| $V_{OH}$ | Output HIGH | 10% $V_{CC}$ | 2.5 | | | V | Min | $I_{OH}$ = −1 mA |
| | Voltage | 5% $V_{CC}$ | 2.7 | | | | | $I_{OH}$ = −1 mA |
| $V_{OL}$ | Output LOW | 10% $V_{CC}$ | | | 0.5 | V | Min | $I_{OL}$ = 20 mA |
| | Voltage | | | | | | | |
| $I_{IH}$ | Input HIGH | | | | 5.0 | µA | Max | $V_{IN}$ = 2.7V |
| | Current | | | | | | | |
| $I_{BVI}$ | Input HIGH Current | | | | 7.0 | µA | Max | $V_{IN}$ = 7.0V |
| | Breakdown Test | | | | | | | |
| $I_{CEX}$ | Output HIGH | | | | 50 | µA | Max | $V_{OUT}$ = $V_{CC}$ |
| | Leakage Current | | | | | | | |
| $V_{ID}$ | Input Leakage | | 4.75 | | | V | 0.0 | $I_{ID}$ = 1.9 µA |
| | Test | | | | | | | All Other Pins Grounded |
| $I_{OD}$ | Output Leakage | | | | 3.75 | µA | 0.0 | $V_{IOD}$ = 150 mV |
| | Circuit Current | | | | | | | All Other Pins Grounded |
| $I_{IL}$ | Input LOW Current | | | | −0.6 | mA | Max | $V_{IN}$ = 0.5V |
| $I_{OS}$ | Output Short-Circuit Current | | −60 | | −150 | mA | Max | $V_{OUT}$ = 0V |
| $I_{CCH}$ | Power Supply Current | | | 13 | 20 | mA | Max | $V_O$ = HIGH |
| $I_{CCL}$ | Power Supply Current | | | 13 | 20 | mA | Max | $V_O$ = LOW |

## AC Electrical Characteristics

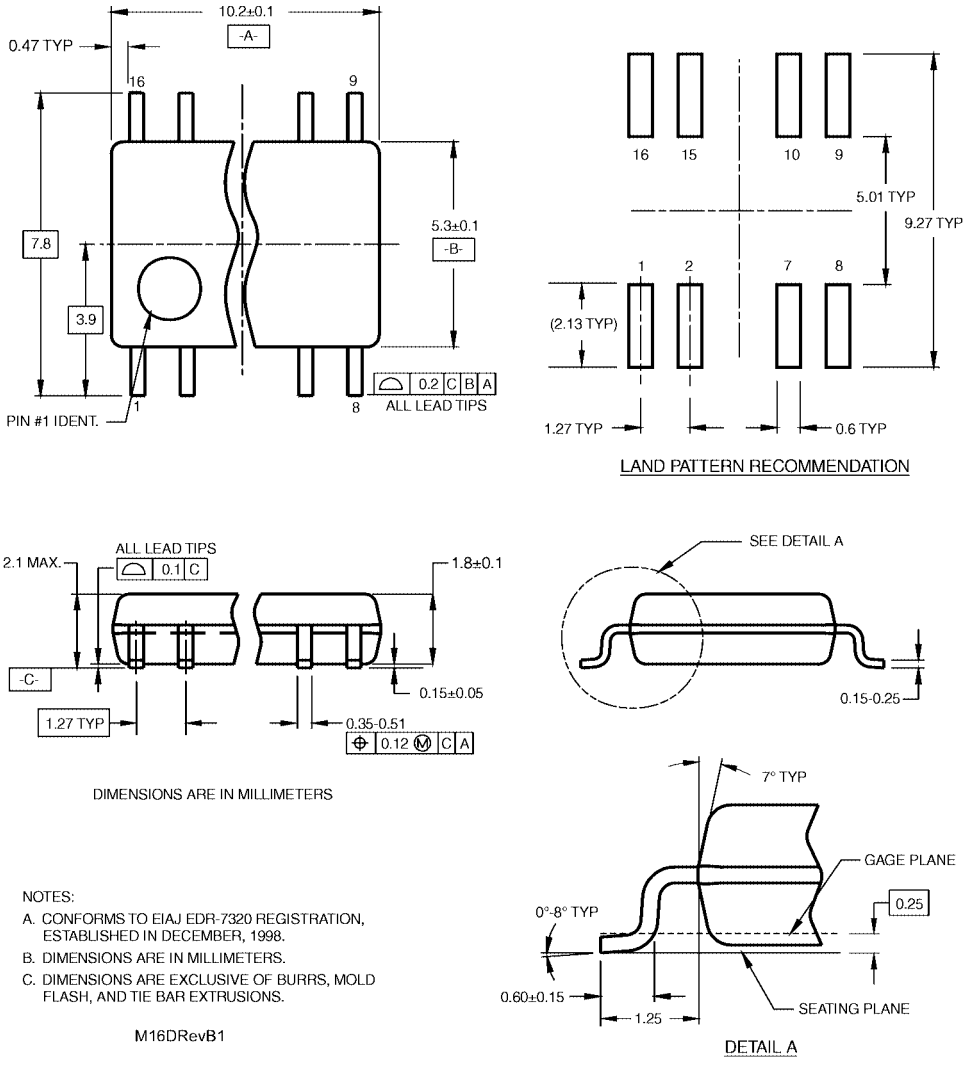
| Symbol | Parameter | $T_A$ = +25°C, $V_{CC}$ = +5.0V, $C_L$ = 50 pF | | | $T_A$ = 0°C to +70°C, $V_{CC}$ = +5.0V, $C_L$ = 50 pF | | Units |
|---|---|---|---|---|---|---|---|
| | | Min | Typ | Max | Min | Max | |
| $t_{PLH}$ | Propagation Delay | 3.5 | 5.6 | 7.5 | 3.5 | 8.5 | ns |
| $t_{PHL}$ | $A_n$ to $\overline{O}_n$ | 4.0 | 6.1 | 8.0 | 4.0 | 9.0 | |
| $t_{PLH}$ | Propagation Delay | 3.5 | 5.4 | 7.0 | 3.5 | 8.0 | ns |
| $t_{PHL}$ | $\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 3.0 | 5.3 | 7.0 | 3.0 | 7.5 | |
| $t_{PLH}$ | Propagation Delay | 4.0 | 6.2 | 8.0 | 4.0 | 9.0 | ns |
| $t_{PHL}$ | $E_3$ to $\overline{O}_n$ | 3.5 | 5.6 | 7.5 | 3.5 | 8.5 | |

## Physical Dimensions inches (millimeters) unless otherwise noted




**16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow**
**Package Number M16A**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




NOTES:

A. CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.

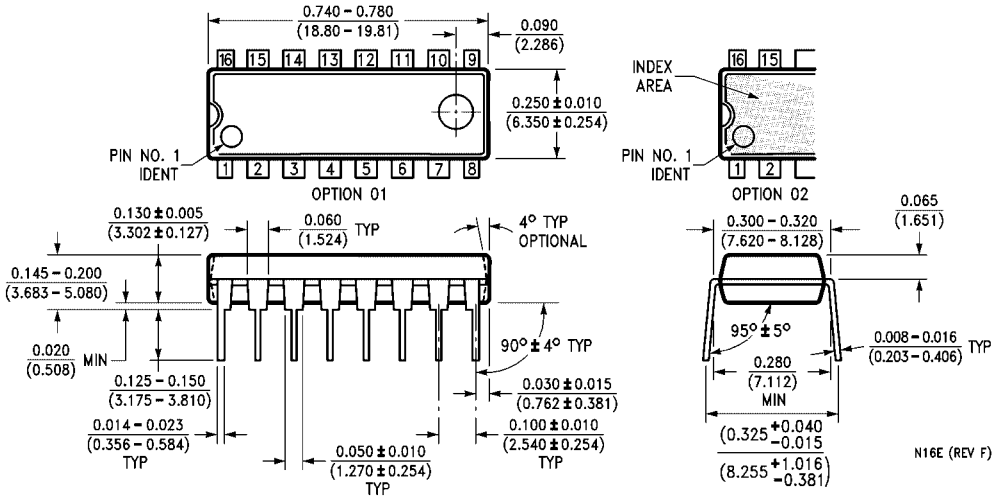
B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

M16DRevB1

**16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide**
**Package Number M16D**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




**16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide**
**Package Number N16E**