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## 74AC138 • 74ACT138

### 1-of-8 Decoder/Demultiplexer

#### General Description

The AC/ACT138 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 AC/ACT138 devices or a 1-of-32 decoder using four AC/ACT138 devices and one inverter.

#### Features

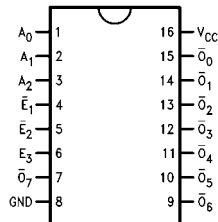
- $I_{CC}$  reduced by 50%
- Demultiplexing capability
- Multiple input enable for easy expansion
- Active LOW mutually exclusive outputs
- Outputs source/sink 24 mA
- ACT138 has TTL-compatible inputs

#### Ordering Code:

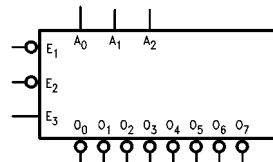
| Order Number | Package Number | Package Description                                                          |
|--------------|----------------|------------------------------------------------------------------------------|
| 74AC138SC    | M16A           | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| 74AC138SJ    | M16D           | 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide                |
| 74AC138MTC   | MTC16          | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  |
| 74AC138PC    | N16E           | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide       |
| 74ACT138SC   | M16A           | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| 74ACT138SJ   | M16D           | 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide                |
| 74ACT138PC   | N16E           | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide       |

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

#### Connection Diagram

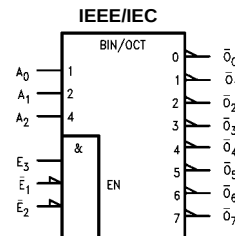


#### Logic Symbols



#### Pin Descriptions

| Pin Names                 | Description    |
|---------------------------|----------------|
| $A_0$ – $A_2$             | Address Inputs |
| $\bar{E}_1$ – $\bar{E}_2$ | Enable Inputs  |
| $E_3$                     | Enable Input   |
| $\bar{O}_0$ – $\bar{O}_7$ | Outputs        |



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## Truth Table

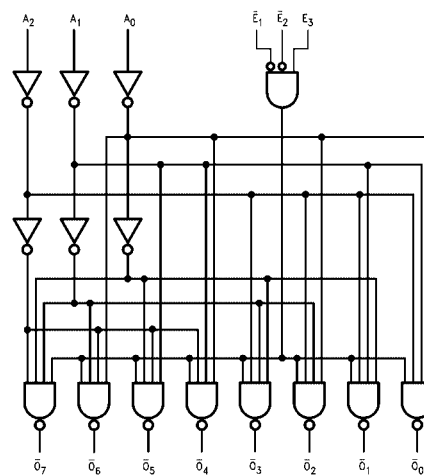
| Inputs           |                  |       |       |       |       | Outputs          |                  |                  |                  |                  |                  |                  |                  |
|------------------|------------------|-------|-------|-------|-------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| $\overline{E}_1$ | $\overline{E}_2$ | $E_3$ | $A_0$ | $A_1$ | $A_2$ | $\overline{O}_0$ | $\overline{O}_1$ | $\overline{O}_2$ | $\overline{O}_3$ | $\overline{O}_4$ | $\overline{O}_5$ | $\overline{O}_6$ | $\overline{O}_7$ |
| 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 AC/ACT138 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 AC/ACT138 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 AC/ACT138 devices and one inverter (see Figure 1). The AC/ACT138 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.

## 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.

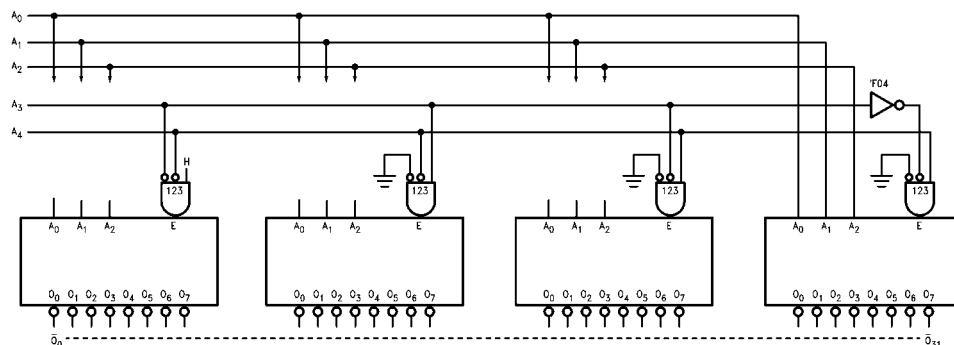


FIGURE 1. Expansion to 1-of-32 Decoding

**Absolute Maximum Ratings**(Note 1)

|                                          |                          |
|------------------------------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )              | -0.5V to +7.0V           |
| DC Input Diode Current ( $I_{IK}$ )      |                          |
| $V_I = -0.5V$                            | -20 mA                   |
| $V_I = V_{CC} + 0.5V$                    | +20 mA                   |
| DC Input Voltage ( $V_I$ )               | -0.5V to $V_{CC} + 0.5V$ |
| DC Output Diode Current ( $I_{OK}$ )     |                          |
| $V_O = -0.5V$                            | -20 mA                   |
| $V_O = V_{CC} + 0.5V$                    | +20 mA                   |
| DC Output Voltage ( $V_O$ )              | -0.5V to $V_{CC} + 0.5V$ |
| DC Output Source                         |                          |
| or Sink Current ( $I_O$ )                | $\pm 50$ mA              |
| DC $V_{CC}$ or Ground Current            |                          |
| per Output Pin ( $I_{CC}$ or $I_{GND}$ ) | $\pm 50$ mA              |
| Storage Temperature ( $T_{STG}$ )        | -65°C to +150°C          |
| Junction Temperature ( $T_J$ )           |                          |
| PDIP                                     | 140°C                    |

**Recommended Operating Conditions**

|                                                 |                |
|-------------------------------------------------|----------------|
| Supply Voltage ( $V_{CC}$ )                     |                |
| AC                                              | 2.0V to 6.0V   |
| ACT                                             | 4.5V to 5.5V   |
| Input Voltage ( $V_I$ )                         | 0V to $V_{CC}$ |
| Output Voltage ( $V_O$ )                        | 0V to $V_{CC}$ |
| Operating Temperature ( $T_A$ )                 | -40°C to +85°C |
| Minimum Input Edge Rate ( $\Delta V/\Delta t$ ) |                |
| AC Devices                                      |                |
| $V_{IN}$ from 30% to 70% of $V_{CC}$            |                |
| $V_{CC}$ @ 3.3V, 4.5V, 5.5V                     | 125 mV/ns      |
| Minimum Input Edge Rate ( $\Delta V/\Delta t$ ) |                |
| ACT Devices                                     |                |
| $V_{IN}$ from 0.8V to 2.0V                      |                |
| $V_{CC}$ @ 4.5V, 5.5V                           | 125 mV/ns      |

**Note 1:** Absolute maximum ratings are those values beyond which damage to the device may occur. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. Fairchild does not recommend operation of FACT™ circuits outside databook specifications.

**DC Electrical Characteristics for AC**

| Symbol                      | Parameter                         | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> = −40°C to +85°C | Units | Conditions                                                                                                                                        |
|-----------------------------|-----------------------------------|------------------------|------------------------|-------------------|---------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|
|                             |                                   |                        | Typ                    | Guaranteed Limits |                                 |       |                                                                                                                                                   |
| V <sub>IH</sub>             | Minimum HIGH Level Input Voltage  | 3.0                    | 1.5                    | 2.1               | 2.1                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> − 0.1V                                                                                              |
|                             |                                   | 4.5                    | 2.25                   | 3.15              | 3.15                            |       |                                                                                                                                                   |
|                             |                                   | 5.5                    | 2.75                   | 3.85              | 3.85                            |       |                                                                                                                                                   |
| V <sub>IL</sub>             | Maximum LOW Level Input Voltage   | 3.0                    | 1.5                    | 0.9               | 0.9                             | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> − 0.1V                                                                                              |
|                             |                                   | 4.5                    | 2.25                   | 1.35              | 1.35                            |       |                                                                                                                                                   |
|                             |                                   | 5.5                    | 2.75                   | 1.65              | 1.65                            |       |                                                                                                                                                   |
| V <sub>OH</sub>             | Minimum HIGH Level Output Voltage | 3.0                    | 2.99                   | 2.9               | 2.9                             | V     | I <sub>OUT</sub> = −50 μA                                                                                                                         |
|                             |                                   | 4.5                    | 4.49                   | 4.4               | 4.4                             |       |                                                                                                                                                   |
|                             |                                   | 5.5                    | 5.49                   | 5.4               | 5.4                             |       |                                                                                                                                                   |
|                             |                                   | 3.0                    |                        | 2.56              | 2.46                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OH</sub> = −12 mA<br>I <sub>OH</sub> = −24 mA<br>I <sub>OH</sub> = −24 mA (Note 2) |
|                             |                                   | 4.5                    |                        | 3.86              | 3.76                            |       |                                                                                                                                                   |
|                             |                                   | 5.5                    |                        | 4.86              | 4.76                            |       |                                                                                                                                                   |
| V <sub>OL</sub>             | Maximum LOW Level Output Voltage  | 3.0                    | 0.002                  | 0.1               | 0.1                             | V     | I <sub>OUT</sub> = 50 μA                                                                                                                          |
|                             |                                   | 4.5                    | 0.001                  | 0.1               | 0.1                             |       |                                                                                                                                                   |
|                             |                                   | 5.5                    | 0.001                  | 0.1               | 0.1                             |       |                                                                                                                                                   |
|                             |                                   | 3.0                    |                        | 0.36              | 0.44                            | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OL</sub> = 12 mA<br>I <sub>OL</sub> = 24 mA 0<br>I <sub>OL</sub> = 24 mA (Note 2)  |
|                             |                                   | 4.5                    |                        | 0.36              | 0.44                            |       |                                                                                                                                                   |
|                             |                                   | 5.5                    |                        | 0.36              | 0.44                            |       |                                                                                                                                                   |
| I <sub>IN</sub><br>(Note 4) | Maximum Input Leakage Current     | 5.5                    |                        | ±0.1              | ±1.0                            | μA    | V <sub>I</sub> = V <sub>CC</sub> , GND                                                                                                            |
| I <sub>OLD</sub>            | Minimum Dynamic                   | 5.5                    |                        |                   | 75                              | mA    | V <sub>OLD</sub> = 1.65V Max                                                                                                                      |
| I <sub>OHD</sub>            | Output Current (Note 3)           | 5.5                    |                        |                   | −75                             | mA    | V <sub>OHD</sub> = 3.85V Min                                                                                                                      |
| I <sub>CC</sub><br>(Note 4) | Maximum Quiescent Supply Current  | 5.5                    |                        | 4.0               | 40.0                            | μA    | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                                                                          |

**Note 2:** All outputs loaded; thresholds on input associated with output under test.

**Note 3:** Maximum test duration 2.0 ms, one output loaded at a time.

**Note 4:**  $I_{IN}$  and  $I_{CC}$  @ 3.0V are guaranteed to be less than or equal to the respective limit @ 5.5V  $V_{CC}$ .

## DC Electrical Characteristics for ACT

| Symbol           | Parameter                            | V <sub>CC</sub><br>(V) | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> = -40°C to +85°C |  | Units | Conditions                                                                                                            |
|------------------|--------------------------------------|------------------------|------------------------|-------------------|---------------------------------|--|-------|-----------------------------------------------------------------------------------------------------------------------|
|                  |                                      |                        | Typ                    | Guaranteed Limits |                                 |  |       |                                                                                                                       |
| V <sub>IH</sub>  | Minimum HIGH Level<br>Input Voltage  | 4.5                    | 1.5                    | 2.0               | 2.0                             |  | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V                                                                  |
|                  |                                      | 5.5                    | 1.5                    | 2.0               | 2.0                             |  |       |                                                                                                                       |
| V <sub>IL</sub>  | Maximum LOW Level<br>Input Voltage   | 4.5                    | 1.5                    | 0.8               | 0.8                             |  | V     | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> - 0.1V                                                                  |
|                  |                                      | 5.5                    | 1.5                    | 0.8               | 0.8                             |  |       |                                                                                                                       |
| V <sub>OH</sub>  | Minimum HIGH Level<br>Output Voltage | 4.5                    | 4.49                   | 4.4               | 4.4                             |  | V     | I <sub>OUT</sub> = -50 μA                                                                                             |
|                  |                                      | 5.5                    | 5.49                   | 5.4               | 5.4                             |  |       |                                                                                                                       |
|                  |                                      | 4.5                    |                        | 3.86              | 3.76                            |  | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OH</sub> = -24 mA<br>I <sub>OH</sub> = -24 mA (Note 5) |
|                  |                                      | 5.5                    |                        | 4.86              | 4.76                            |  |       |                                                                                                                       |
| V <sub>OL</sub>  | Maximum LOW Level<br>Output Voltage  | 4.5                    | 0.001                  | 0.1               | 0.1                             |  | V     | I <sub>OUT</sub> = 50 μA                                                                                              |
|                  |                                      | 5.5                    | 0.001                  | 0.1               | 0.1                             |  |       |                                                                                                                       |
|                  |                                      | 4.5                    |                        | 0.36              | 0.44                            |  | V     | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OL</sub> 24 mA<br>I <sub>OL</sub> = 24 mA (Note 5)     |
|                  |                                      | 5.5                    |                        | 0.36              | 0.44                            |  |       |                                                                                                                       |
| I <sub>IN</sub>  | Maximum Input<br>Leakage Current     | 5.5                    |                        | ±0.1              | ±1.0                            |  | μA    | V <sub>I</sub> = V <sub>CC</sub> , GND                                                                                |
| I <sub>CCT</sub> | Maximum<br>I <sub>CC</sub> /Input    | 5.5                    | 0.6                    |                   | 1.5                             |  | mA    | V <sub>I</sub> = V <sub>CC</sub> - 2.1V                                                                               |
| I <sub>OLD</sub> | Minimum Dynamic                      | 5.5                    |                        |                   | 75                              |  | mA    | V <sub>OLD</sub> = 1.65V Max                                                                                          |
| I <sub>OHD</sub> | Output Current (Note 6)              | 5.5                    |                        |                   | -75                             |  | mA    | V <sub>OHD</sub> = 3.85V Min                                                                                          |
| I <sub>CC</sub>  | Maximum Quiescent<br>Supply Current  | 5.5                    |                        | 4.0               | 40.0                            |  | μA    | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                                              |

**Note 5:** All outputs loaded; thresholds on input associated with output under test.

**Note 6:** Maximum test duration 2.0 ms, one output loaded at a time.

## AC Electrical Characteristics for AC

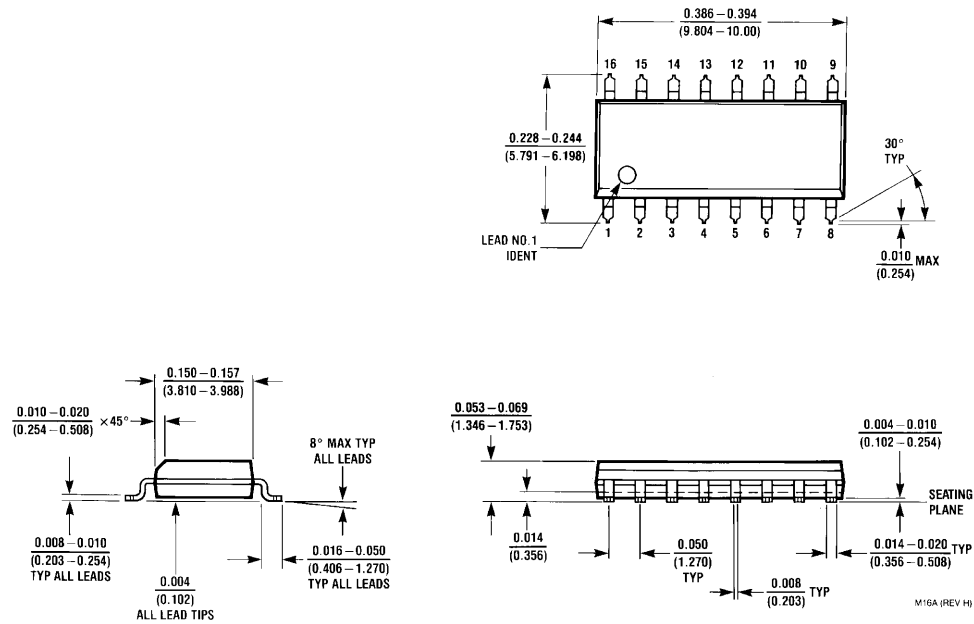
| Symbol           | Parameter                                                                     | V <sub>CC</sub><br>(V)<br>(Note 7) | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |      |      | T <sub>A</sub> = -40°C to +85°C<br>C <sub>L</sub> = 50 pF |      | Units |
|------------------|-------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------|------|------|-----------------------------------------------------------|------|-------|
|                  |                                                                               |                                    | Min                                              | Typ  | Max  | Min                                                       | Max  |       |
|                  |                                                                               |                                    |                                                  |      |      |                                                           |      |       |
| t <sub>PLH</sub> | Propagation Delay<br>A <sub>n</sub> to $\overline{O}_n$                       | 3.3                                | 1.5                                              | 8.5  | 13.0 | 1.5                                                       | 15.0 | ns    |
|                  |                                                                               | 5.0                                | 1.5                                              | 6.5  | 9.5  | 1.5                                                       | 10.5 |       |
| t <sub>PHL</sub> | Propagation Delay<br>A <sub>n</sub> to $\overline{O}_n$                       | 3.3                                | 1.5                                              | 8.0  | 12.5 | 1.5                                                       | 14.0 | ns    |
|                  |                                                                               | 5.0                                | 1.5                                              | 6.0  | 9.0  | 1.5                                                       | 10.5 |       |
| t <sub>PLH</sub> | Propagation Delay<br>$\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 3.3                                | 1.5                                              | 11.0 | 15.0 | 1.5                                                       | 16.0 | ns    |
|                  |                                                                               | 5.0                                | 1.5                                              | 8.0  | 11.0 | 1.5                                                       | 12.0 |       |
| t <sub>PHL</sub> | Propagation Delay<br>$\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 3.3                                | 1.5                                              | 9.5  | 13.5 | 1.5                                                       | 15.0 | ns    |
|                  |                                                                               | 5.0                                | 1.5                                              | 7.0  | 9.5  | 1.5                                                       | 10.5 |       |
| t <sub>PLH</sub> | Propagation Delay<br>E <sub>3</sub> to $\overline{O}_n$                       | 3.3                                | 1.5                                              | 11.0 | 15.5 | 1.5                                                       | 16.5 | ns    |
|                  |                                                                               | 5.0                                | 1.5                                              | 8.0  | 11.0 | 1.5                                                       | 12.5 |       |
| t <sub>PHL</sub> | Propagation Delay<br>E <sub>3</sub> to $\overline{O}_n$                       | 3.3                                | 1.5                                              | 8.5  | 13.0 | 1.5                                                       | 14.0 | ns    |
|                  |                                                                               | 5.0                                | 1.5                                              | 6.0  | 8.0  | 1.0                                                       | 9.5  |       |

**Note 7:** Voltage Range 3.3 is 3.3V ± 0.3V

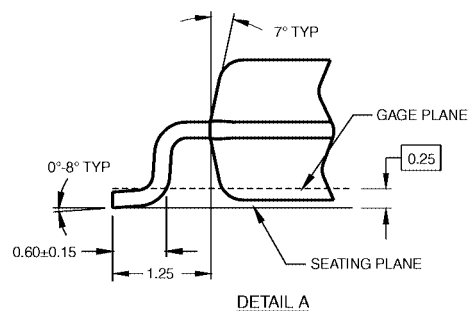
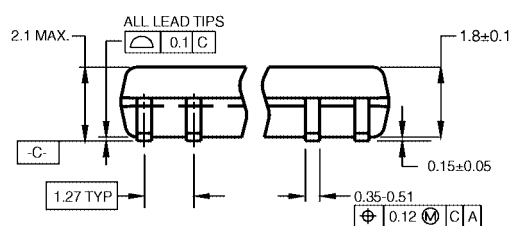
Voltage Range 5.0 is 5.0V ± 0.5V

| AC Electrical Characteristics for ACT    |                                                                               |                                    |                                                  |                        |      |                                                           |      |       |
|------------------------------------------|-------------------------------------------------------------------------------|------------------------------------|--------------------------------------------------|------------------------|------|-----------------------------------------------------------|------|-------|
| Symbol                                   | Parameter                                                                     | V <sub>CC</sub><br>(V)<br>(Note 8) | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |                        |      | T <sub>A</sub> = -40°C to +85°C<br>C <sub>L</sub> = 50 pF |      | Units |
|                                          |                                                                               |                                    | Min                                              | Typ                    | Max  | Min                                                       | Max  |       |
| t <sub>PLH</sub>                         | Propagation Delay<br>A <sub>n</sub> to $\overline{O}_n$                       | 5.0                                | 1.5                                              | 7.0                    | 10.5 | 1.5                                                       | 11.5 | ns    |
| t <sub>PHL</sub>                         | Propagation Delay<br>A <sub>n</sub> to $\overline{O}_n$                       | 5.0                                | 1.5                                              | 6.5                    | 10.5 | 1.5                                                       | 11.5 | ns    |
| t <sub>PLH</sub>                         | Propagation Delay<br>$\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 5.0                                | 2.5                                              | 8.0                    | 11.5 | 2.0                                                       | 12.5 | ns    |
| t <sub>PHL</sub>                         | Propagation Delay<br>$\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 5.0                                | 2.0                                              | 7.5                    | 11.5 | 2.0                                                       | 12.5 | ns    |
| t <sub>PLH</sub>                         | Propagation Delay<br>E <sub>3</sub> to $\overline{O}_n$                       | 5.0                                | 2.5                                              | 8.0                    | 12.0 | 2.0                                                       | 13.0 | ns    |
| t <sub>PHL</sub>                         | Propagation Delay<br>E <sub>3</sub> to $\overline{O}_n$                       | 5.0                                | 2.0                                              | 6.5                    | 10.5 | 1.5                                                       | 11.5 | ns    |
| Note 8: Voltage Range 5.0 is 5.0V ± 0.5V |                                                                               |                                    |                                                  |                        |      |                                                           |      |       |
| Capacitance                              |                                                                               |                                    |                                                  |                        |      |                                                           |      |       |
| Symbol                                   | Parameter                                                                     | Typ                                | Units                                            | Conditions             |      |                                                           |      |       |
| C <sub>IN</sub>                          | Input Capacitance                                                             | 4.5                                | pF                                               | V <sub>CC</sub> = OPEN |      |                                                           |      |       |
| C <sub>PD</sub>                          | Power Dissipation Capacitance                                                 | 60.0                               | pF                                               | V <sub>CC</sub> = 5.0V |      |                                                           |      |       |

# Physical Dimensions inches (millimeters) unless otherwise noted



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



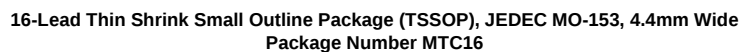
A. CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.

B. DIMENSIONS ARE IN MILLIMETERS.

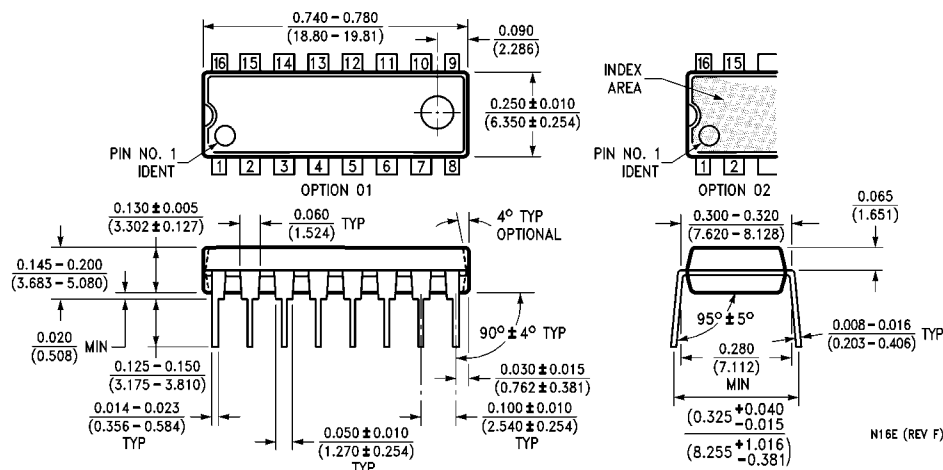
C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

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

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