

## 54AC/74AC138 • 54ACT/74ACT138

### 1-of-8 Decoder/Demultiplexer

#### General Description

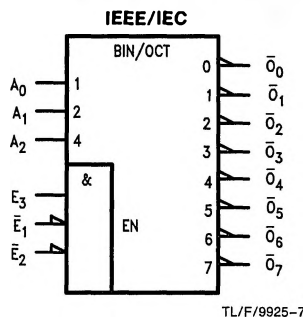
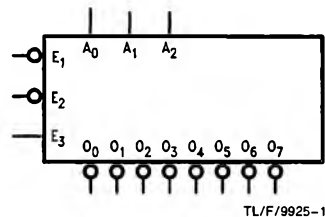
The 'AC/'ACT138 is a high-speed 1-of-8 decoder/demultiplexer. This device is ideally suited for high-speed bipolar memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three 'AC/'ACT138 devices or a 1-of-32 decoder using four 'AC/'ACT138 devices and one inverter.

#### Features

- Demultiplexing capability
- Multiple input enable for easy expansion
- Active LOW mutually exclusive outputs
- Outputs source/sink 24 mA
- 'ACT138 has TTL-compatible inputs
- Standard Military Drawing (SMD)
  - 'AC138: 5962-87622
  - 'ACT138: 5962-87554

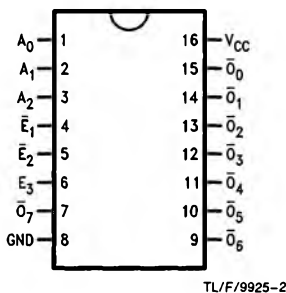
**Ordering Code:** See Section 8

#### Logic Symbol

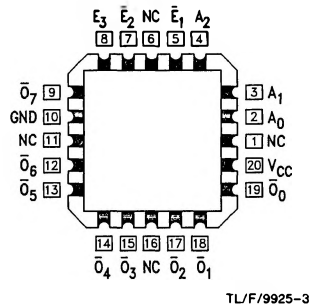


#### Connection Diagrams

Pin Assignment  
for DIP, Flatpak and SOIC



Pin Assignment  
for LCC



## 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 ( $\bar{O}_0$ – $\bar{O}_7$ ). The 'AC/'ACT138 features three Enable inputs, two active-LOW ( $\bar{E}_1$ ,  $\bar{E}_2$ ) and one active-HIGH ( $E_3$ ). All outputs will be HIGH unless  $\bar{E}_1$  and  $\bar{E}_2$  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.

## Truth Table

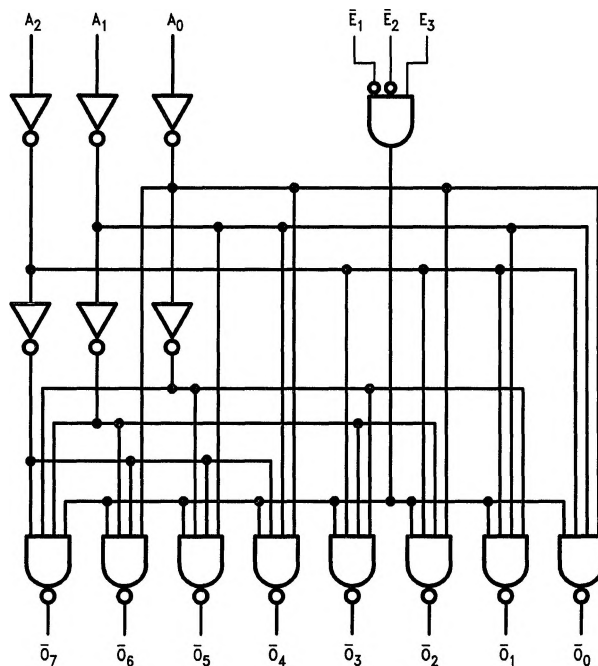
| Inputs      |             |       |       |       |       | Outputs     |             |             |             |             |             |             |             |
|-------------|-------------|-------|-------|-------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|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

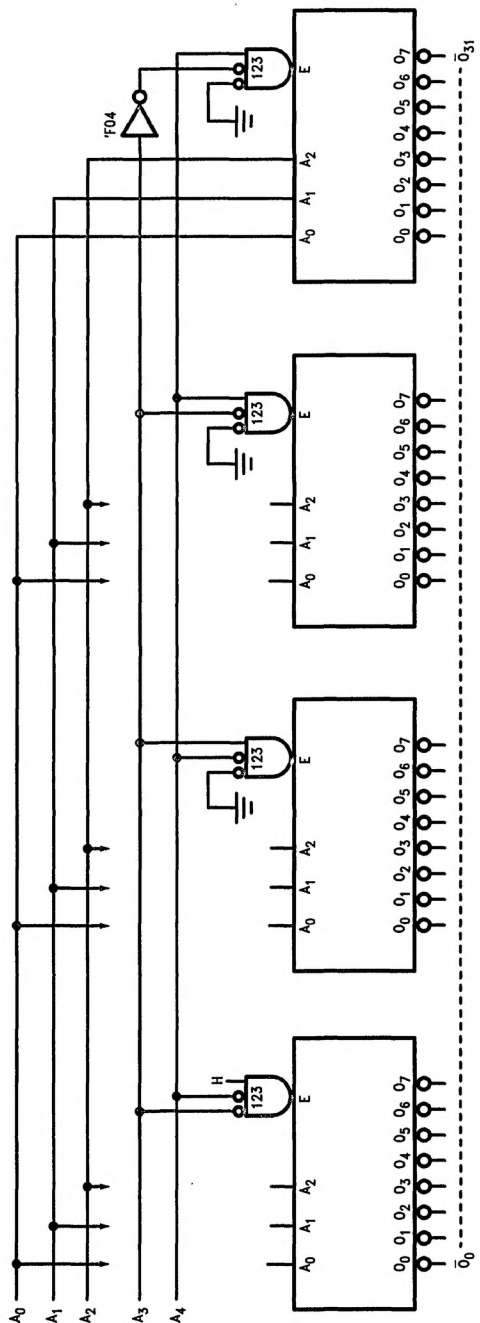
X = Immaterial

## Logic Diagram



TL/F/9925-4

Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.



TL/F/9925-5

FIGURE 1. Expansion to 1-of-32 Decoding

## Absolute Maximum Rating (Note 1)

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

|                                                                        |                          |
|------------------------------------------------------------------------|--------------------------|
| 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 ( $I_O$ )                             | ±50 mA                   |
| DC $V_{CC}$ or Ground Current per Output Pin ( $I_{CC}$ or $I_{GND}$ ) | ±50 mA                   |
| Storage Temperature ( $T_{STG}$ )                                      | -65°C to +150°C          |
| Junction Temperature ( $T_J$ )                                         |                          |
| CDIP                                                                   | 175°C                    |
| PDIP                                                                   | 140°C                    |

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. National does not recommend operation of FACT™ circuits outside databook specifications.

## 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 ( $T_A$ )                 |                 |
| 74AC/ACT                                        | -40°C to +85°C  |
| 54AC/ACT                                        | -55°C to +125°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       |

## DC Characteristics for 'AC Family Devices

| Symbol          | Parameter                         | V <sub>CC</sub><br>(V) | 74AC                   |                   | 54AC                                | 74AC                               | Units | Conditions                                                                                          |
|-----------------|-----------------------------------|------------------------|------------------------|-------------------|-------------------------------------|------------------------------------|-------|-----------------------------------------------------------------------------------------------------|
|                 |                                   |                        | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> =<br>−55°C to +125°C | T <sub>A</sub> =<br>−40°C to +85°C |       |                                                                                                     |
|                 |                                   |                        | Typ                    | Guaranteed Limits |                                     |                                    |       |                                                                                                     |
| V <sub>IH</sub> | Minimum High Level Input Voltage  | 3.0                    | 1.5                    | 2.1               | 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                                | 3.15                               |       |                                                                                                     |
|                 |                                   | 5.5                    | 2.75                   | 3.85              | 3.85                                | 3.85                               |       |                                                                                                     |
| V <sub>IL</sub> | Maximum Low Level Input Voltage   | 3.0                    | 1.5                    | 0.9               | 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                                | 1.35                               |       |                                                                                                     |
|                 |                                   | 5.5                    | 2.75                   | 1.65              | 1.65                                | 1.65                               |       |                                                                                                     |
| V <sub>OH</sub> | Minimum High Level Output Voltage | 3.0                    | 2.99                   | 2.9               | 2.9                                 | 2.9                                | V     | I <sub>OUT</sub> = −50 μA                                                                           |
|                 |                                   | 4.5                    | 4.49                   | 4.4               | 4.4                                 | 4.4                                |       |                                                                                                     |
|                 |                                   | 5.5                    | 5.49                   | 5.4               | 5.4                                 | 5.4                                |       |                                                                                                     |
|                 |                                   | 3.0                    |                        | 2.56              | 2.4                                 | 2.46                               | V     | *V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>−12 mA<br>I <sub>OH</sub> −24 mA<br>−24 mA |
|                 |                                   | 4.5                    |                        | 3.86              | 3.7                                 | 3.76                               |       |                                                                                                     |
|                 |                                   | 5.5                    |                        | 4.86              | 4.7                                 | 4.76                               |       |                                                                                                     |
|                 |                                   |                        |                        |                   |                                     |                                    |       |                                                                                                     |
| V <sub>OL</sub> | Maximum Low Level Output Voltage  | 3.0                    | 0.002                  | 0.1               | 0.1                                 | 0.1                                | V     | I <sub>OUT</sub> = 50 μA                                                                            |
|                 |                                   | 4.5                    | 0.001                  | 0.1               | 0.1                                 | 0.1                                |       |                                                                                                     |
|                 |                                   | 5.5                    | 0.001                  | 0.1               | 0.1                                 | 0.1                                |       |                                                                                                     |
|                 |                                   | 3.0                    |                        | 0.36              | 0.50                                | 0.44                               | V     | *V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>12 mA<br>I <sub>OL</sub> 24 mA<br>24 mA    |
|                 |                                   | 4.5                    |                        | 0.36              | 0.50                                | 0.44                               |       |                                                                                                     |
|                 |                                   | 5.5                    |                        | 0.36              | 0.50                                | 0.44                               |       |                                                                                                     |
|                 |                                   |                        |                        |                   |                                     |                                    |       |                                                                                                     |
| I <sub>IN</sub> | Maximum Input Leakage Current     | 5.5                    |                        | ±0.1              | ±1.0                                | ±1.0                               | μA    | V <sub>I</sub> = V <sub>CC</sub> , GND                                                              |

\*All outputs loaded; thresholds on input associated with output under test.

†Maximum test duration 2.0 ms, one output loaded at a time.

## DC Characteristics for 'AC Family Devices (Continued)

| Symbol           | Parameter                           | V <sub>CC</sub><br>(V) | 74AC                   |                   | 54AC                                |  | 74AC                               |  | Units | Conditions                                  |
|------------------|-------------------------------------|------------------------|------------------------|-------------------|-------------------------------------|--|------------------------------------|--|-------|---------------------------------------------|
|                  |                                     |                        | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> =<br>–55°C to +125°C |  | T <sub>A</sub> =<br>–40°C to +85°C |  |       |                                             |
|                  |                                     |                        | Typ                    | Guaranteed Limits |                                     |  |                                    |  |       |                                             |
| I <sub>OLD</sub> | †Minimum Dynamic<br>Output Current  | 5.5                    |                        |                   | 50                                  |  | 75                                 |  | mA    | V <sub>OLD</sub> = 1.65V Max                |
| I <sub>OHD</sub> |                                     | 5.5                    |                        |                   | –50                                 |  | –75                                |  | mA    | V <sub>OHD</sub> = 3.85V Min                |
| I <sub>CC</sub>  | Maximum Quiescent<br>Supply Current | 5.5                    |                        | 8.0               | 160.0                               |  | 80.0                               |  | μA    | V <sub>IN</sub> = V <sub>CC</sub><br>or GND |

\*All outputs loaded; thresholds on input associated with output under test.

†Maximum test duration 2.0 ms, one output loaded at a time.

Note: I<sub>IN</sub> and I<sub>CC</sub> @ 3.0V are guaranteed to be less than or equal to the respective limit @ 5.5V V<sub>CC</sub>.

I<sub>CC</sub> for 54AC @ 25°C is identical to 74AC @ 25°C.

## DC Characteristics for 'ACT Family Devices

| Symbol           | Parameter                         | V <sub>CC</sub><br>(V) | 74ACT                  |                   | 54ACT                               |              | 74ACT                              |                                                                                           | Units                                                | Conditions |
|------------------|-----------------------------------|------------------------|------------------------|-------------------|-------------------------------------|--------------|------------------------------------|-------------------------------------------------------------------------------------------|------------------------------------------------------|------------|
|                  |                                   |                        | T <sub>A</sub> = +25°C |                   | T <sub>A</sub> =<br>–55°C to +125°C |              | T <sub>A</sub> =<br>–40°C to +85°C |                                                                                           |                                                      |            |
|                  |                                   |                        | Typ                    | Guaranteed Limits |                                     |              |                                    |                                                                                           |                                                      |            |
| V <sub>IH</sub>  | Minimum High Level Input Voltage  | 4.5<br>5.5             | 1.5<br>1.5             | 2.0<br>2.0        | 2.0<br>2.0                          | 2.0<br>2.0   | 2.0<br>2.0                         | V                                                                                         | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> – 0.1V |            |
| V <sub>IL</sub>  | Maximum Low Level Input Voltage   | 4.5<br>5.5             | 1.5<br>1.5             | 0.8<br>0.8        | 0.8<br>0.8                          | 0.8<br>0.8   | 0.8<br>0.8                         | V                                                                                         | V <sub>OUT</sub> = 0.1V<br>or V <sub>CC</sub> – 0.1V |            |
| V <sub>OH</sub>  | Minimum High Level Output Voltage | 4.5<br>5.5             | 4.49<br>5.49           | 4.4<br>5.4        | 4.4<br>5.4                          | 4.4<br>5.4   | 4.4<br>5.4                         | V                                                                                         | I <sub>OUT</sub> = –50 μA                            |            |
|                  |                                   | 4.5<br>5.5             |                        | 3.86<br>4.86      | 3.70<br>4.70                        | 3.76<br>4.76 | V                                  | *V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>–24 mA<br>I <sub>OH</sub> –24 mA |                                                      |            |
|                  |                                   |                        |                        |                   |                                     |              |                                    |                                                                                           |                                                      |            |
| V <sub>OL</sub>  | Maximum Low Level Output Voltage  | 4.5<br>5.5             | 0.001<br>0.001         | 0.1<br>0.1        | 0.1<br>0.1                          | 0.1<br>0.1   | 0.1<br>0.1                         | V                                                                                         | I <sub>OUT</sub> = 50 μA                             |            |
|                  |                                   | 4.5<br>5.5             |                        | 0.36<br>0.36      | 0.50<br>0.50                        | 0.44<br>0.44 | V                                  | *V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>24 mA<br>I <sub>OL</sub> 24 mA   |                                                      |            |
|                  |                                   |                        |                        |                   |                                     |              |                                    |                                                                                           |                                                      |            |
| I <sub>IN</sub>  | Maximum Input Leakage Current     | 5.5                    |                        | ±0.1              | ±1.0                                | ±1.0         | μA                                 | V <sub>I</sub> = V <sub>CC</sub> , GND                                                    |                                                      |            |
| I <sub>CC1</sub> | Maximum I <sub>CC</sub> /Input    | 5.5                    | 0.6                    |                   | 1.6                                 | 1.5          | mA                                 | V <sub>I</sub> = V <sub>CC</sub> – 2.1V                                                   |                                                      |            |
| I <sub>OLD</sub> | †Minimum Dynamic Output Current   | 5.5                    |                        |                   | 50                                  | 75           | mA                                 | V <sub>OLD</sub> = 1.65V Max                                                              |                                                      |            |
| I <sub>OHD</sub> |                                   | 5.5                    |                        |                   | –50                                 | –75          | mA                                 | V <sub>OHD</sub> = 3.85V Min                                                              |                                                      |            |
| I <sub>CC</sub>  | Maximum Quiescent Supply Current  | 5.5                    |                        | 8.0               | 160.0                               | 80.0         | μA                                 | V <sub>IN</sub> = V <sub>CC</sub><br>or GND                                               |                                                      |            |

\*All outputs loaded; thresholds on input associated with output under test.

†Maximum test duration 2.0 ms, one output loaded at a time.

Note: I<sub>CC</sub> for 54ACT @ 25°C is identical to 74ACT @ 25°C.

### AC Electrical Characteristics: See Section 2 for Waveforms

| Symbol           | Parameter                                                                     | V <sub>CC</sub> *<br>(V) | 74AC                                             |             |              | 54AC                                                          |              | 74AC                                                         |              | Units | Fig. No. |
|------------------|-------------------------------------------------------------------------------|--------------------------|--------------------------------------------------|-------------|--------------|---------------------------------------------------------------|--------------|--------------------------------------------------------------|--------------|-------|----------|
|                  |                                                                               |                          | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |             |              | T <sub>A</sub> = -55°C<br>to +125°C<br>C <sub>L</sub> = 50 pF |              | T <sub>A</sub> = -40°C<br>to +85°C<br>C <sub>L</sub> = 50 pF |              |       |          |
|                  |                                                                               |                          | Min                                              | Typ         | Max          | Min                                                           | Max          | Min                                                          | Max          |       |          |
| t <sub>PLH</sub> | Propagation Delay<br>A <sub>n</sub> to $\overline{O}_n$                       | 3.3<br>5.0               | 1.5<br>1.5                                       | 8.5<br>6.5  | 13.0<br>9.5  | 1.0<br>1.0                                                    | 16.0<br>12.0 | 1.5<br>1.5                                                   | 15.0<br>10.5 | ns    | 2-3, 4   |
| t <sub>PHL</sub> | Propagation Delay<br>A <sub>n</sub> to $\overline{O}_n$                       | 3.3<br>5.0               | 1.5<br>1.5                                       | 8.0<br>6.0  | 12.5<br>9.0  | 1.0<br>1.0                                                    | 15.0<br>11.5 | 1.5<br>1.5                                                   | 14.0<br>10.5 | ns    | 2-3, 4   |
| t <sub>PLH</sub> | Propagation Delay<br>$\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 3.3<br>5.0               | 1.5<br>1.5                                       | 11.0<br>8.0 | 15.0<br>11.0 | 1.0<br>1.0                                                    | 16.5<br>13.0 | 1.5<br>1.5                                                   | 16.0<br>12.0 | ns    | 2-3, 4   |
| t <sub>PHL</sub> | Propagation Delay<br>$\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | 3.3<br>5.0               | 1.5<br>1.5                                       | 9.5<br>7.0  | 13.5<br>9.5  | 1.0<br>1.0                                                    | 15.5<br>12.0 | 1.5<br>1.5                                                   | 15.0<br>10.5 | ns    | 2-3, 4   |
| t <sub>PLH</sub> | Propagation Delay<br>E <sub>3</sub> to $\overline{O}_n$                       | 3.3<br>5.0               | 1.5<br>1.5                                       | 11.0<br>8.0 | 15.5<br>11.0 | 1.0<br>1.0                                                    | 17.0<br>13.5 | 1.5<br>1.5                                                   | 16.5<br>12.5 | ns    | 2-3, 4   |
| t <sub>PHL</sub> | Propagation Delay<br>E <sub>3</sub> to $\overline{O}_n$                       | 3.3<br>5.0               | 1.5<br>1.5                                       | 8.5<br>6.0  | 13.0<br>8.0  | 1.0<br>1.0                                                    | 15.0<br>11.0 | 1.5<br>1.0                                                   | 14.0<br>9.5  | ns    | 2-3, 4   |

\*Voltage Range 3.3 is 3.3V ±0.3V

Voltage Range 5.0 is 5.0V ±0.5V

### AC Electrical Characteristics: See Section 2 for Waveforms

| Symbol           | Parameter                                                      | V <sub>CC</sub> *<br>(V) | 74ACT                                            |     |      | 54ACT                                                         |      | 74ACT                                                        |      | Units | Fig.<br>No. |
|------------------|----------------------------------------------------------------|--------------------------|--------------------------------------------------|-----|------|---------------------------------------------------------------|------|--------------------------------------------------------------|------|-------|-------------|
|                  |                                                                |                          | T <sub>A</sub> = +25°C<br>C <sub>L</sub> = 50 pF |     |      | T <sub>A</sub> = −55°C<br>to +125°C<br>C <sub>L</sub> = 50 pF |      | T <sub>A</sub> = −40°C<br>to +85°C<br>C <sub>L</sub> = 50 pF |      |       |             |
|                  |                                                                |                          | Min                                              | Typ | Max  | Min                                                           | Max  | Min                                                          | Max  |       |             |
| t <sub>PLH</sub> | Propagation Delay<br>A <sub>n</sub> to $\bar{O}_n$             | 5.0                      | 1.5                                              | 7.0 | 10.5 | 1.0                                                           | 12.5 | 1.5                                                          | 11.5 | ns    | 2-3, 4      |
| t <sub>PHL</sub> | Propagation Delay<br>A <sub>n</sub> to $\bar{O}_n$             | 5.0                      | 1.5                                              | 6.5 | 10.5 | 1.0                                                           | 12.5 | 1.5                                                          | 11.5 | ns    | 2-3, 4      |
| t <sub>PLH</sub> | Propagation Delay<br>$\bar{E}_1$ or $\bar{E}_2$ to $\bar{O}_n$ | 5.0                      | 2.5                                              | 8.0 | 11.5 | 1.0                                                           | 13.5 | 2.0                                                          | 12.5 | ns    | 2-3, 4      |
| t <sub>PHL</sub> | Propagation Delay<br>$\bar{E}_1$ or $\bar{E}_2$ to $\bar{O}_n$ | 5.0                      | 2.0                                              | 7.5 | 11.5 | 1.0                                                           | 12.5 | 2.0                                                          | 12.5 | ns    | 2-3, 4      |
| t <sub>PLH</sub> | Propagation Delay<br>E <sub>3</sub> to $\bar{O}_n$             | 5.0                      | 2.5                                              | 8.0 | 12.0 | 1.0                                                           | 14.0 | 2.0                                                          | 13.0 | ns    | 2-3, 4      |
| t <sub>PHL</sub> | Propagation Delay<br>E <sub>3</sub> to $\bar{O}_n$             | 5.0                      | 2.0                                              | 6.5 | 10.5 | 1.0                                                           | 12.0 | 1.5                                                          | 11.5 | ns    | 2-3, 4      |

\*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> = 5.0V |
| C <sub>PD</sub> | Power Dissipation Capacitance | 60.0 | pF    | V <sub>CC</sub> = 5.0V |