National Semiconductor

July 2003

# 54AC151/54ACT151
# 8-Input Multiplexer

## General Description

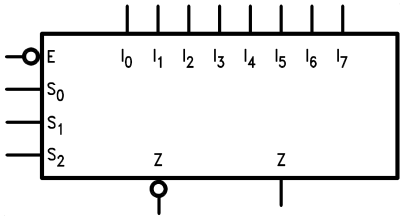
The 'AC/'ACT151 is a high-speed 8-input digital multiplexer. It provides, in one package, the ability to select one line of data from up to eight sources. The 'AC/'ACT151 can be used as a universal function generator to generate any logic function of four variables. Both true and complementary outputs are provided.

- 'ACT151 has TTL-compatible inputs
- Standard Microcircuit Drawing (SMD)
  - —'AC151: 5962-87691
  - —'ACT151: 5962-88756
- 54AC151 now qualified to 300Krad RHA designation, refer to the SMD for more information

## Features

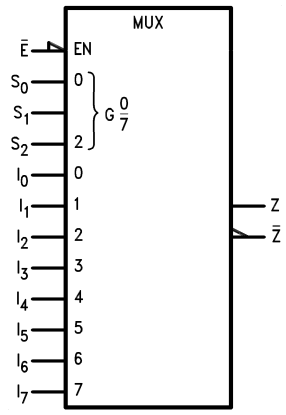
- $I_{CC}$ reduced by 50%
- Outputs source/sink 24 mA

## Logic Symbols




10027001

IEEE/IEC




10027006

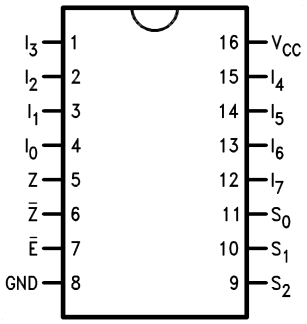
| Pin Names | Description |
|---|---|
| $I_0$–$I_7$ | Data Inputs |
| $S_0$–$S_2$ | Select Inputs |
| $\overline{E}$ | Enable Input |
| Z | Data Output |
| $\overline{Z}$ | Inverted Data Output |

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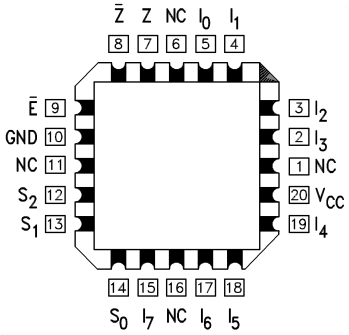
## Connection Diagrams

**Pin Assignment for DIP and Flatpak**




10027002

**Pin Assignment for LCC**




10027003

## Truth Table

| Inputs | | | | Outputs | |
|---|---|---|---|---|---|
| $\overline{E}$ | $S_2$ | $S_1$ | $S_0$ | $\overline{Z}$ | Z |
| H | X | X | X | H | L |
| L | L | L | L | $\overline{I}_0$ | $I_0$ |
| L | L | L | H | $\overline{I}_1$ | $I_1$ |
| L | L | H | L | $\overline{I}_2$ | $I_2$ |
| L | L | H | H | $\overline{I}_3$ | $I_3$ |
| L | H | L | L | $\overline{I}_4$ | $I_4$ |
| L | H | L | H | $\overline{I}_5$ | $I_5$ |
| L | H | H | L | $\overline{I}_6$ | $I_6$ |
| L | H | H | H | $\overline{I}_7$ | $I_7$ |

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial

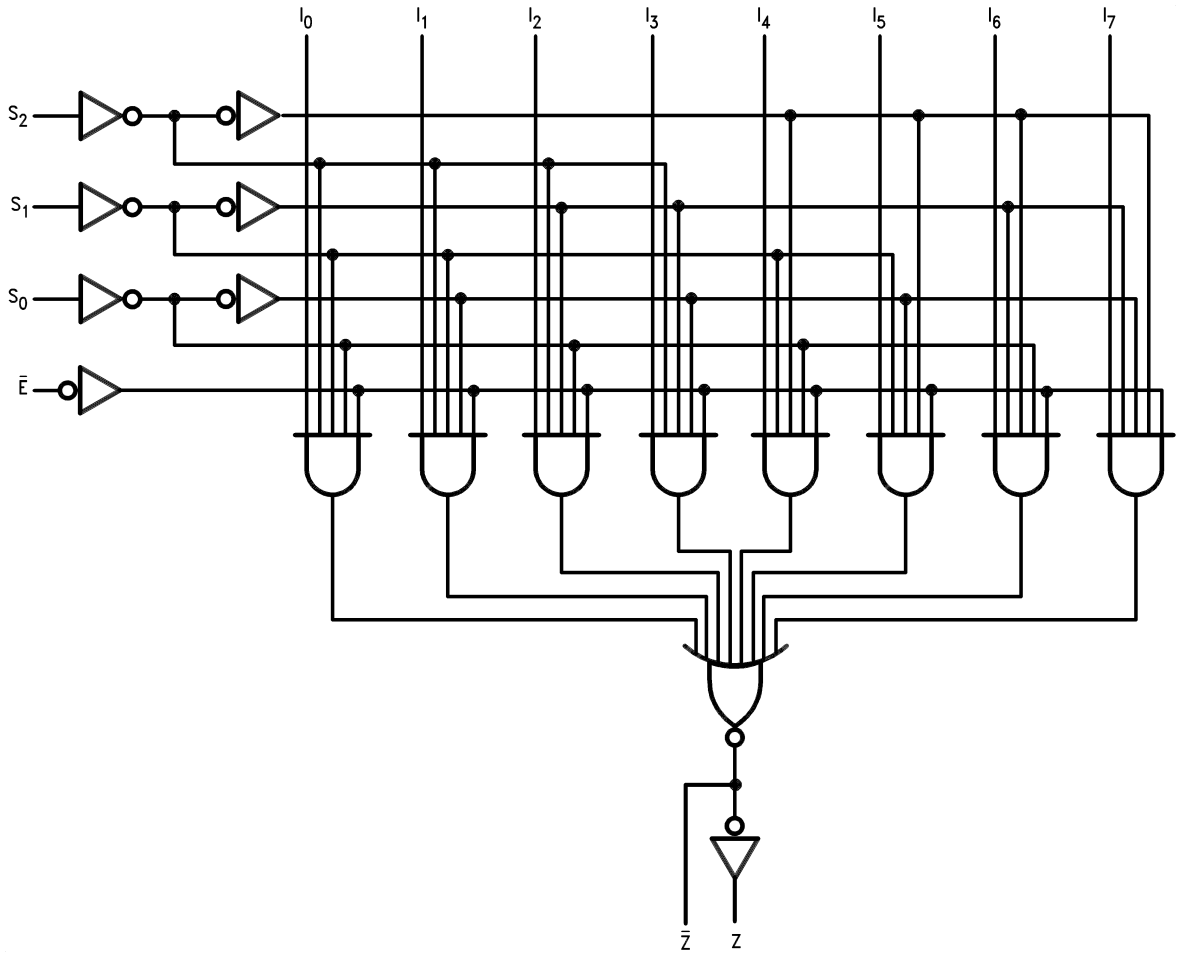
## Functional Description

The ’AC/’ACT151 is a logic implementation of a single pole, 8-position switch with the switch position controlled by the state of three Select inputs, $S_0$, $S_1$, $S_2$. Both true and complementary outputs are provided. The Enable input ($\overline{E}$) is active LOW. When it is not activated, the complementary output is HIGH and the true output is LOW regardless of all other inputs. The logic function provided at the output is:

$$Z = \overline{E} \bullet (I_0 \bullet \overline{S}_0 \bullet \overline{S}_1 \bullet \overline{S}_2 + I_1 \bullet S_0 \bullet \overline{S}_1 \bullet \overline{S}_2 + I_2 \bullet \overline{S}_0 \bullet S_1 \bullet \overline{S}_2 + I_3 \bullet S_0 \bullet S_1 \bullet \overline{S}_2 + I_4 \bullet \overline{S}_0 \bullet \overline{S}_1 \bullet S_2 + I_5 \bullet S_0 \bullet \overline{S}_1 \bullet \overline{S}_2 + I_6 \bullet \overline{S}_0 \bullet S_1 \bullet S_2 + I_7 \bullet S_0 \bullet S_1 \bullet S_2)$$

The ’AC/’ACT151 provides the ability, in one package to select from eight sources of data or control information. By proper manipulation of the inputs, the ’AC/’ACT151 can provide any logic function of four variables and its complement.

## Logic Diagram




10027004

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)

**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 |

## 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 ($T_A$) | |
| 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 |

**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.

## DC Characteristics for 'AC Family Devices

| Symbol | Parameter | $V_{CC}$ (V) | 54AC $T_A$ = −55˚C to +125˚C Guaranteed Limits | Units | Conditions |
|---|---|---|---|---|---|
| $V_{IH}$ | Minimum High Level Input Voltage | 3.0 | 2.1 | V | $V_{OUT}$ = 0.1V or $V_{CC}$ − 0.1V |
| | | 4.5 | 3.15 | | |
| | | 5.5 | 3.85 | | |
| $V_{IL}$ | Maximum Low Level Input Voltage | 3.0 | 0.9 | V | $V_{OUT}$ = 0.1V or $V_{CC}$ − 0.1V |
| | | 4.5 | 1.35 | | |
| | | 5.5 | 1.65 | | |
| $V_{OH}$ | Minimum High Level Output Voltage | 3.0 | 2.9 | V | $I_{OUT}$ = −50 µA |
| | | 4.5 | 4.4 | | |
| | | 5.5 | 5.4 | | |
| | | | | | (Note 2) $V_{IN}$ = $V_{IL}$ or $V_{IH}$ |
| | | 3.0 | 2.4 | | $I_{OH}$ = −12 mA |
| | | 4.5 | 3.7 | V | $I_{OH}$ = −24 mA |
| | | 5.5 | 4.7 | | $I_{OH}$ = −24 mA |
| $V_{OL}$ | Maximum Low Level Output Voltage | 3.0 | 0.1 | V | $I_{OUT}$ = 50 µA |
| | | 4.5 | 0.1 | | |
| | | 5.5 | 0.1 | | |
| | | | | | (Note 2) $V_{IN}$ = $V_{IL}$ or $V_{IH}$ |
| | | 3.0 | 0.50 | | $I_{OL}$ = 12 mA |
| | | 4.5 | 0.50 | V | $I_{OL}$ = 24 mA |
| | | 5.5 | 0.50 | | $I_{OL}$ = 24 mA |
| $I_{IN}$ | Maximum Input Leakage Current | 5.5 | ±1.0 | µA | $V_I$ = $V_{CC}$, GND |

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

| Symbol | Parameter | $V_{CC}$ (V) | 54AC $T_A$ = −55°C to +125°C Guaranteed Limits | Units | Conditions |
|---|---|---|---|---|---|
| $I_{OLD}$ | Minimum Dynamic Output Current (Note 3) | 5.5 | 50 | mA | $V_{OLD}$ = 1.65V Max |
| $I_{OHD}$ | | 5.5 | −50 | mA | $V_{OHD}$ = 3.85V Min |
| $I_{CC}$ | Maximum Quiescent Supply Current | 5.5 | 80.0 | µA | $V_{IN}$ = $V_{CC}$ 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 $V_{CC}$.
$I_{CC}$ for 54AC @ 25°C is identical to 74AC @ 25°C

## DC Characteristics for 'ACT Family Devices

| Symbol | Parameter | $V_{CC}$ (V) | 54ACT $T_A$ = −55°C to +125°C Guaranteed Limits | Units | Conditions |
|---|---|---|---|---|---|
| $V_{IH}$ | Minimum High Level Input Voltage | 4.5 | 2.0 | V | $V_{OUT}$ = 0.1V or $V_{CC}$ − 0.1V |
| | | 5.5 | 2.0 | | |
| $V_{IL}$ | Maximum Low Level Input Voltage | 4.5 | 0.8 | V | $V_{OUT}$ = 0.1V or $V_{CC}$ − 0.1V |
| | | 5.5 | 0.8 | | |
| $V_{OH}$ | Minimum High Level Output Voltage | 4.5 | 4.4 | V | $I_{OUT}$ = −50 µA |
| | | 5.5 | 5.4 | | |
| | | | | | (Note 5) $V_{IN}$ = $V_{IL}$ or $V_{IH}$ |
| | | 4.5 | 3.70 | V | $I_{OH}$ = −24 mA |
| | | 5.5 | 4.70 | | $I_{OH}$ = −24 mA |
| $V_{OL}$ | Maximum Low Level Output Voltage | 4.5 | 0.1 | V | $I_{OUT}$ = 50 µA |
| | | 5.5 | 0.1 | | |
| | | | | | (Note 5) $V_{IN}$ = $V_{IL}$ or $V_{IH}$ |
| | | 4.5 | 0.50 | V | $I_{OL}$ = 24 mA |
| | | 5.5 | 0.50 | | $I_{OL}$ = 24 mA |
| $I_{IN}$ | Maximum Input Leakage Current | 5.5 | ±1.0 | µA | $V_I$ = $V_{CC}$, GND |
| $I_{CCT}$ | Maximum $I_{CC}$/Input | 5.5 | 1.6 | mA | $V_I$ = $V_{CC}$ − 2.1V |
| $I_{OLD}$ | Minimum Dynamic Output Current (Note 6) | 5.5 | 50 | mA | $V_{OLD}$ = 1.65V Max |
| $I_{OHD}$ | | 5.5 | −50 | mA | $V_{OHD}$ = 3.85V Min |
| $I_{CC}$ | Maximum Quiescent Supply Current | 5.5 | 80.0 | µA | $V_{IN}$ = $V_{CC}$ 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.

**Note 7:** $I_{CC}$ for 54ACT @ 25°C is identical to 74ACT @ 25°C.

## AC Electrical Characteristics

| Symbol | Parameter | $V_{CC}$ (V) (Note 8) | 54AC $T_A = -55^\circ C$ to $+125^\circ C$ $C_L = 50$ pF | | Units | Fig. No. |
|---|---|---|---|---|---|---|
| | | | Min | Max | | |
| $t_{PLH}$ | Propagation Delay $S_n$ to Z or $\overline{Z}$ | 3.3 | 1.0 | 22.0 | ns | |
| | | 5.0 | 1.0 | 15.5 | | |
| $t_{PHL}$ | Propagation Delay $S_n$ to Z or $\overline{Z}$ | 3.3 | 1.0 | 22.0 | ns | |
| | | 5.0 | 1.0 | 15.5 | | |
| $t_{PLH}$ | Propagation Delay $\overline{E}$ to Z or $\overline{Z}$ | 3.3 | 1.0 | 15.5 | ns | |
| | | 5.0 | 1.0 | 12.0 | | |
| $t_{PHL}$ | Propagation Delay $\overline{E}$ to Z or $\overline{Z}$ | 3.3 | 1.0 | 15.5 | ns | |
| | | 5.0 | 1.0 | 12.0 | | |
| $t_{PLH}$ | Propagation Delay $I_n$ to Z or $\overline{Z}$ | 3.3 | 1.0 | 16.0 | ns | |
| | | 5.0 | 1.0 | 12.0 | | |
| $t_{PHL}$ | Propagation Delay $I_n$ to Z or $\overline{Z}$ | 3.3 | 1.0 | 18.0 | ns | |
| | | 5.0 | 1.0 | 13.0 | | |

**Note 8:** Voltage Range 3.3 is 3.3V ±0.3V
Voltage Range 5.0 is 5.0V ±0.5V

## AC Electrical Characteristics

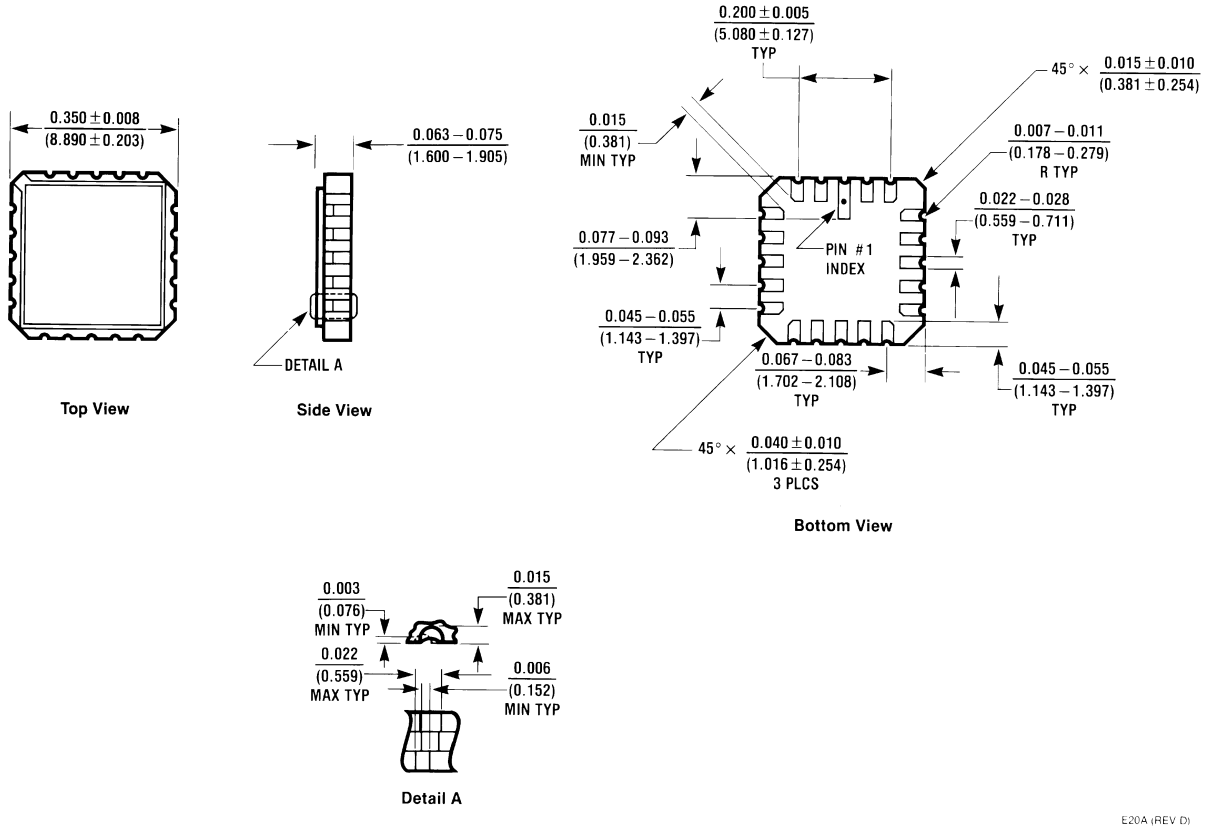
| Symbol | Parameter | $V_{CC}$ (V) (Note 9) | 54ACT $T_A = -55^\circ C$ to $+125^\circ C$ $C_L = 50$ pF | | Units | Fig. No. |
|---|---|---|---|---|---|---|
| | | | Min | Max | | |
| $t_{PLH}$ | Propagation Delay $S_n$ to Z | 5.0 | 1.0 | 19.5 | ns | |
| $t_{PHL}$ | Propagation Delay $S_n$ to Z | 5.0 | 1.0 | 20.0 | ns | |
| $t_{PLH}$ | Propagation Delay $S_n$ to $\overline{Z}$ | 5.0 | 1.0 | 19.5 | ns | |
| $t_{PHL}$ | Propagation Delay $S_n$ to $\overline{Z}$ | 5.0 | 1.0 | 20.0 | ns | |
| $t_{PLH}$ | Propagation Delay $\overline{E}$ to Z | 5.0 | 1.0 | 12.0 | ns | |
| $t_{PHL}$ | Propagation Delay $\overline{E}$ to Z | 5.0 | 1.0 | 12.5 | ns | |
| $t_{PLH}$ | Propagation Delay $\overline{E}$ to $\overline{Z}$ | 5.0 | 1.0 | 12.0 | ns | |
| $t_{PHL}$ | Propagation Delay $\overline{E}$ to $\overline{Z}$ | 5.0 | 1.0 | 12.5 | ns | |
| $t_{PLH}$ | Propagation Delay $I_n$ to Z | 5.0 | 1.0 | 15.0 | ns | |
| $t_{PHL}$ | Propagation Delay $I_n$ to Z | 5.0 | 1.0 | 16.0 | ns | |
| $t_{PLH}$ | Propagation Delay $I_n$ to $\overline{Z}$ | 5.0 | 1.0 | 15.0 | ns | |
| $t_{PHL}$ | Propagation Delay $I_n$ to $\overline{Z}$ | 5.0 | 1.0 | 16.0 | ns | |

**Note 9:** Voltage Range 5.0 is 5.0V ±0.5V

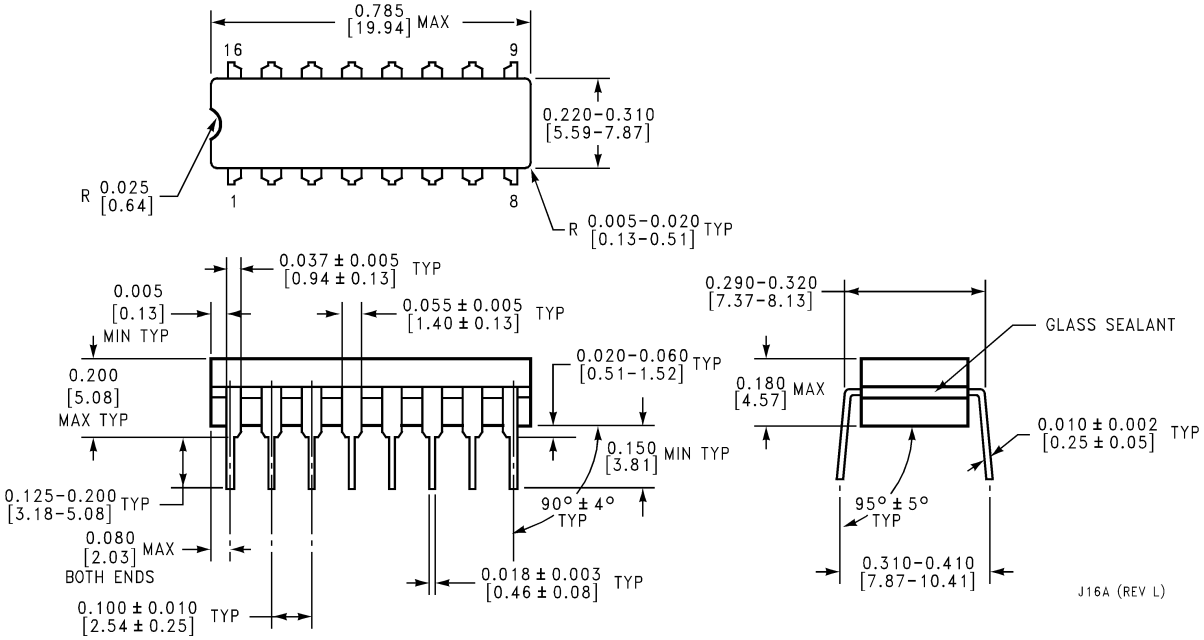
## Capacitance

| Symbol | Parameter | Typ | Units | Conditions |
|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | 4.5 | pF | $V_{CC}$ = OPEN |
| $C_{PD}$ | Power Dissipation Capacitance | 70.0 | pF | $V_{CC}$ = 5.0V |

## Physical Dimensions inches (millimeters) unless otherwise noted

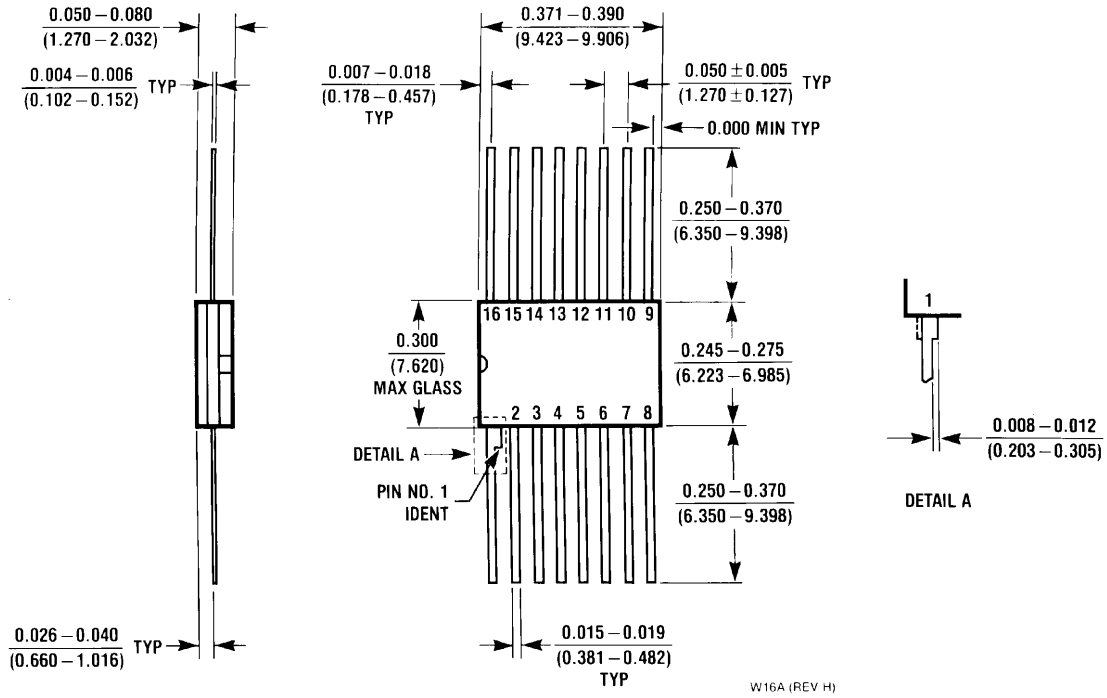



**20 Terminal Ceramic Leadless Chip Carrier (L)**
**NS Package Number E20A**




**16 Lead Ceramic Dual-In-Line Package (D)**
**NS Package Number J16A**

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




**16 Lead Ceramic Flatpak (F)**
**NS Package Number W16A**

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