National Semiconductor

July 2000

# DS96F172M/DS96F174C/DS96F174M EIA-485/EIA-422 Quad Differential Drivers

## General Description

The DS96F172 and the DS96F174 are high speed quad differential line drivers designed to meet EIA-485 Standards. The DS96F172 and the DS96F174 offer improved performance due to the use of L-FAST bipolar technology. The use of LFAST technology allows the DS96F172 and DS96F174 to operate at higher speeds while minimizing power consumption.

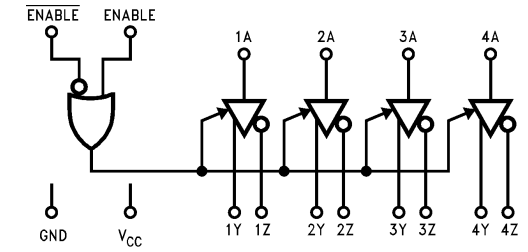
The DS96F172 and the DS96F174 have TRI-STATE® outputs and are optimized for balanced multipoint data bus transmission at rates up to 15 Mbps. The drivers have wide positive and negative common mode range for multipoint applications in noisy environments. Positive and negative current-limiting is provided which protects the drivers from line fault conditions over a +12V to −7.0V common mode range. A thermal shutdown feature is also provided. The DS96F172 features an active high and active low Enable, common to all four drivers. The DS96F174 features separate active high Enables for each driver pair.

## Features

- Meets EIA-485 and EIA-422 standards
- Monotonic differential output switching
- TRI-STATE outputs
- Designed for multipoint bus transmission
- Common mode output voltage range: −7.0V to +12V
- Operates from single +5.0V supply
- Reduced power consumption
- Thermal shutdown protection
- DS96F172 and DS96F174 are lead and function compatible with the SN75172/174 or the AM26LS31/MC3487
- Military temperature range available
- Qualified for MIL-STD-883C
- Standard military drawings available (SMD)
- Available in DIP (J), LCC (E), and Flatpak (W) packages

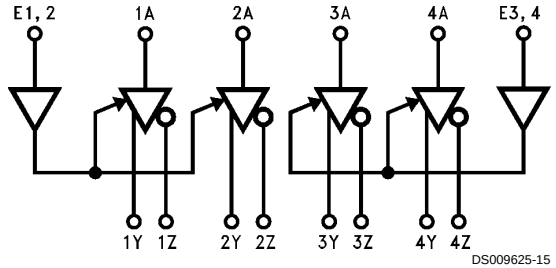
## Logic Diagrams

**DS96F172**




DS009625-14

**DS96F174**




DS009625-15

## Function Tables (Each Driver)

### DS96F172

| Input | Enable | | Outputs | |
|---|---|---|---|---|
| A | E | $\overline{E}$ | Y | Z |
| H | H | X | H | L |
| L | H | X | L | H |
| H | X | L | H | L |
| L | X | L | L | H |
| X | L | H | Z | Z |

### DS96F174

| Input | Enable | Outputs | |
|---|---|---|---|
| A | E | Y | Z |
| H | H | H | L |
| L | H | L | H |
| X | L | Z | Z |

H = High Level
L = Low Level
X = Don't Care
Z = High Impedance (Off)

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## COMMERCIAL

### Absolute Maximum Ratings (Note 2)

**Specifications for the 883 version of this product are listed separately on the following pages.**

| | |
|---|---|
| Storage Temperature Range ($T_{STG}$) | −65˚C to +175˚C |
| Lead Temperature (Soldering, 60 sec.) | 300˚C |
| Maximum Package Power Dissipation (Note 1) at 25˚C | |
| Ceramic DIP (J) | 1500 mW |
| Supply Voltage | 7.0V |
| Enable Input Voltage | 5.5V |

### Recommended Operating Conditions

| | Min | Typ | Max | Units |
|---|---|---|---|---|
| Supply Voltage ($V_{CC}$) | | | | |
| DS96F174C | 4.75 | 5.0 | 5.25 | V |
| Common Mode | −7.0 | | +12.0 | V |
| Output Voltage ($V_{OC}$) | | | | |
| Output Current HIGH ($I_{OH}$) | | | −60 | mA |
| Output Current LOW ($I_{OL}$) | | | 60 | mA |
| Operating Temperature ($T_A$) | | | | |
| DS96F174C | 0 | | +70 | ˚C |

**Note 1:** Derate "J" package 10 mW/˚C above 25˚C.

### Electrical Characteristics (Notes 3, 4)

Over recommended supply voltage and operating temperature range, unless otherwise specified

| Symbol | Parameter | Conditions | | Min | Typ (Note 2) | Max | Units |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input Voltage HIGH | | | 2.0 | | | V |
| $V_{IL}$ | Input Voltage LOW | | $T_A$ = 0˚C to +70˚C | | | 0.8 | V |
| | | | $T_A$ = −55˚C to +125˚C | | | 0.7 | |
| $V_{OH}$ | Output Voltage HIGH | $I_{OH}$ = −33 mA | $T_A$ = 0˚C to +70˚C | 3.0 | | | V |
| $V_{OL}$ | Output Voltage LOW | $I_{OL}$ = 33 mA | $T_A$ = 0˚C to +70˚C | | | 2.0 | V |
| $V_{IC}$ | Input Clamp Voltage | $I_I$ = −18 mA | | | | −1.5 | V |
| $\|V_{OD1}\|$ | Differential Output Voltage | $I_O$ = 0 mA | | | | 6.0 | V |
| $\|V_{OD2}\|$ | Differential Output Voltage | $R_L$ = 54Ω, *Figure 1* | $T_A$ = −55˚C | 1.2 | 2.0 | | V |
| | | | | 1.5 | | | |
| | | $R_L$ = 100Ω, *Figure 1* | | 2.0 | 2.3 | | |
| $V_{OD}$ | Differential Output Voltage | *Figure 2* | $T_A$ = 0˚C to +70˚C | 1.0 | | | V |
| $\Delta\|V_{OD}\|$ | Change in Magnitude of Differential Output Voltage (Note 5) | $R_L$ = 54Ω or 100Ω, *Figure 1* | −40˚C to +125˚C | | | ±0.2 | V |
| | | | −55˚C to +125˚C | | | ±0.4 | |
| $V_{OC}$ | Common Mode Output Voltage (Note 6) | $R_L$ = 54Ω or 100Ω, *Figure 1* | | | | 3.0 | V |
| $\Delta\|V_{OC}\|$ | Change in Magnitude of Common Mode Output Voltage (Note 5) | $R_L$ = 54Ω or 100Ω, *Figure 1* | | | | ±0.2 | V |
| $I_O$ | Output Current with Power Off | $V_{CC}$ = 0V, $V_O$ = −7.0V to +12V | | | | ±50 | µA |
| $I_{OZ}$ | High Impedance State Output Current | $V_O$ = −7.0V to +12V | | | ±20 | ±50 | µA |
| $I_{IH}$ | Input Current HIGH | $V_I$ = 2.4V | | | | 20 | µA |
| $I_{IL}$ | Input Current LOW | $V_I$ = 0.4V | | | | −50 | µA |
| $I_{OS}$ | Short Circuit Output Current (Note 7) | $V_O$ = −7.0V | | | | −250 | mA |
| | | $V_O$ = 0V | | | | −150 | |
| | | $V_O$ = $V_{CC}$ | | | | 150 | |
| | | $V_O$ = +12V | | | | 250 | |
| $I_{CC}$ | Supply Current (All Drivers) | No Load | Outputs Enabled | | | 50 | mA |
| $I_{CCX}$ | | | Outputs Disabled | | | 30 | |

## COMMERCIAL

## Switching Characteristics

$V_{CC}$ = 5.0V, $T_A$ = 25˚C

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $t_{DD}$ | Differential Output Delay Time | $R_L$ = 60Ω, *Figure 3* | | 15 | 20 | ns |
| $t_{TD}$ | Differential Output Transition Time | | | 15 | 22 | ns |
| $t_{PLH}$ | Propagation Delay Time, Low-to-High Level Output | $R_L$ = 27Ω, *Figure 4* | | 12 | 16 | ns |
| $t_{PHL}$ | Propagation Delay Time, High-to-Low Level Output | | | 12 | 16 | ns |
| $t_{ZH}$ | Output Enable Time to High Level | $R_L$ = 110Ω, *FIgure 4* | | 25 | 32 | ns |
| $t_{ZL}$ | Output Enable Time to Low Level | $R_L$ = 110Ω, *Figure 6* | | 25 | 32 | ns |
| $t_{HZ}$ | Output Disable Time from High Level | $R_L$ = 110Ω, *Figure 5* | | 25 | 30 | ns |
| $t_{LZ}$ | Output Disable Time from Low Level | $R_L$ = 110Ω, *Figure 6* | | 20 | 25 | ns |
| $t_{LZL}$ | Output Disable Time from Low Level with Load Resistor to GND (Note 8) | *Figure 6* | | 300 | | ns |
| $t_{SKEW}$ | Driver Output to Output | $R_L$ = 60Ω | | 1.0 | 4.0 | ns |

**Note 2:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.

**Note 3:** Unless otherwise specified min/max limits apply across the 0˚C to +70˚C range for the DS96F174C. All typicals are given for $V_{CC}$ = 5V and $T_A$ = 25˚C.

**Note 4:** All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are reference to ground unless otherwise specified.

**Note 5:** $\Delta|V_{OD}|$ and $\Delta|V_{OC}|$ are the changes in magnitude of $V_{OD}$ and $V_{OC}$ respectively, that occur when the input is changed from a high level to a low level.

**Note 6:** In EIA-422A and EIA-485 standards, $V_{OC}$, which is the average of the two output voltages with respect to ground, is called output offset voltage, $V_{OS}$.

**Note 7:** Only one output at a time should be shorted.

**Note 8:** For more information see Application Bulletin, contact Product Marketing.

**Order Number: DS96F174CJ**
**DS96F174CN**
**NS Package Number J16A or N16E**

## MIL-STD-883C

## Absolute Maximum Ratings (Note 2)

**For complete Military Specifications, refer to the appropriate SMD or MDS.**

| | |
|---|---|
| Storage Temperature Range ($T_{STG}$) | −65˚C to +175˚C |
| Lead Temperature (Soldering, 60 sec.) | 300˚C |
| Maximum Package Power Dissipation (Note 9) at 25˚C | |
| Ceramic LCC (E) | 2000 mW |
| Ceramic DIP (J) | 1800 mW |
| Ceramic Flatpak (W) | 1000 mW |
| Supply Voltage | 7.0V |
| Enable Input Voltage | 5.5V |

## Recommended Operating Conditions

| | Min | Typ | Max | Units |
|---|---|---|---|---|
| Supply Voltage ($V_{CC}$) | | | | |
| DS96F172M/DS96F174M | 4.50 | 5.0 | 5.50 | V |
| Common Mode | −7.0 | | +12.0 | V |
| Output Voltage ($V_{OC}$) | | | | |
| Output Current HIGH ($I_{OH}$) | | | −60 | mA |
| Output Current LOW ($I_{OL}$) | | | 60 | mA |
| Operating Temperature ($T_A$) | | | | |
| DS96F172M/DS96F174M | −55 | | +125 | |

**Note 9:** Above $T_A$ = 25˚C, derate “E” package 13.4, “J” package 12.5, “W” package 7.1 mW/˚C

## Electrical Characteristics (Notes 3, 4)

Over recommended supply voltage and operating temperature range unless otherwise specified

| Symbol | Parameter | Conditions | | Min | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IH}$ | Input Voltage HIGH | | | 2.0 | | V |
| $V_{IL}$ | Input Voltage LOW | | $T_A$ = 25˚C | | 0.8 | V |
| | | | $T_A$ = −55˚C, or +125˚C | | 0.7 | |
| $V_{IC}$ | Input Clamp Voltage | $I_I$ = −18 mA | | | −1.5 | V |
| $\|V_{OD1}\|$ | Differential Output Voltage | $I_O$ = 0 mA | | | 6.0 | V |
| $\|V_{OD2}\|$ | Differential Output Voltage | $R_L$ = 54Ω, $V_{CC}$ = 4.5V | $T_A$ = −55˚C | 1.2 | | V |
| | | *Figure 1* | $T_A$ = 25˚C, or +125˚C | 1.5 | | |
| | | $R_L$ = 100Ω, $V_{CC}$ = 4.5V, *Figure 1* | | 2.0 | | |
| $\Delta\|V_{OD}\|$ | Change in Magnitude of Differential | $R_L$ = 54Ω or 100Ω, | $T_A$ = 25˚C, or +125˚C | | ±0.2 | V |
| | Output Voltage (Note 5) | $V_{CC}$ = 4.5V, *Figure 1* | $T_A$ = −55˚C | | ±0.4 | V |
| $V_{OC}$ | Common Mode Output Voltage (Note 6) | $R_L$ = 54Ω or 100Ω, *Figure 1* | | | 3.0 | V |
| $\Delta\|V_{OC}\|$ | Change in Magnitude of Common Mode Output Voltage (Note 5) | $R_L$ = 54Ω or 100Ω, $V_{CC}$ = 4.5V, *Figure 1* | | | ±0.2 | V |
| $I_O$ | Output Current with Power Off | $V_{CC}$ = 0V, $V_O$ = −7.0V to +12V | | | ±50 | µA |
| $I_{OZ}$ | High Impedance State Output Current | $V_O$ = −7.0V to +12V | | | ±50 | µA |
| $I_{IH}$ | Input Current HIGH | $V_I$ = 2.4V | | | 20 | µA |
| $I_{IL}$ | Input Current LOW | $V_I$ = 0.4V | | | −50 | µA |
| $I_{OS}$ | Short Circuit Output Current (Note 7) | $V_O$ = −7.0V | | | −250 | mA |
| | | $V_O$ = 0V | | | −150 | |
| | | $V_O$ = $V_{CC}$ | | | 150 | |
| | | $V_O$ = +12V | | | 250 | |
| $I_{CC}$ | Supply Current (All Drivers) | No Load | Outputs Enabled | | 50 | mA |
| $I_{CCX}$ | | | Outputs Disabled | | 30 | |

## MIL-STD-883C

## Switching Characteristics

$V_{CC}$ = 5.0V

| Symbol | Parameter | Conditions | $T_A$ = 25˚C | | $T_A$ = 55˚C | $T_A$ = 125˚C | Units |
|---|---|---|---|---|---|---|---|
| | | | Typ | Max | Max | Max | |
| $t_{DD}$ | Differential Output Delay Time | $R_L$ = 60Ω, $C_L$ = 15 pF, *Figure 3* | 15 | 22 | 30 | 30 | ns |
| $t_{TD}$ | Differential Output Transition Time | | 15 | 22 | 40 | 40 | ns |
| $t_{PLH}$ | Propagation Delay Time, Low-to-High Level Output | $R_L$ = 27Ω, $C_L$ = 15 pF, *Figure 4* | 12 | 16 | 25 | 25 | ns |
| $t_{PHL}$ | Propagation Delay Time, High-to-Low Level Output | | 12 | 16 | 25 | 25 | ns |
| $t_{ZH}$ | Output Enable Time to High Level | $R_L$ = 110Ω, *Figure 5* | 25 | 32 | 40 | 40 | ns |
| $t_{ZL}$ | Output Enable Time to Low Level | $R_L$ = 110Ω, *Figure 6* | 25 | 35 | 100 | 100 | ns |
| $t_{HZ}$ | Output Disable Time from High Level | $R_L$ = 110Ω, *Figure 5,* Note 13 | 25 | 30 | 80 | 80 | ns |
| $t_{LZ}$ | Output Disable Time from Low Level | $R_L$ = 110Ω, *Figure 6* | 20 | 25 | 40 | 40 | ns |
| $t_{LZL}$ | Output Disable Time from Low Level with Load Resistor to GND (Note 12) | *Figure 6* | 300 | | | | ns |
| $t_{SKEW}$ | Driver Output to Output | $R_L$ = 60Ω | 1.0 | 4.0 | 10 | 10 | ns |

**SMD Numbers: DS96F172MJ/883 5962-9076501MEA**
**DS96F174MJ/883 5962-9076502MEA**

**DS96F172ME/883 5962-9076501M2A**
**DS96F174MW/883 5962-9076502MFA**
**DS96F174ME/883 5962-9076502M2A**

**Order Number: DS96F172MJ/883, DS96F174MJ/883**
**NS Package Number J16A**
**DS96F172ME/883, DS96F174ME/883**
**NS Package Number E20A**
**DS96F172MW-MIL, DS96F174MW/883**
**NS Package Number W16A**

**For Complete Military Product Specifications, refer to the appropriate SMD or MDS.**

## Parameter Measurement Information

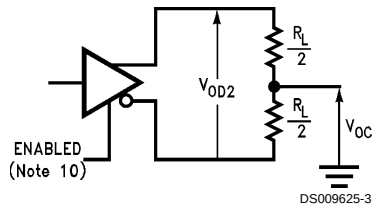



**FIGURE 1. Differential and Common Mode Output Voltage**

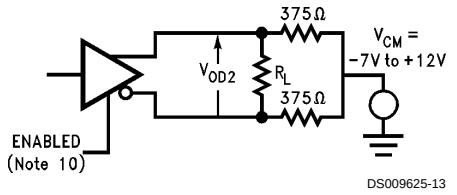



**FIGURE 2. Differential Output Voltage with Varying Common Mode Voltage**

## Parameter Measurement Information (Continued)

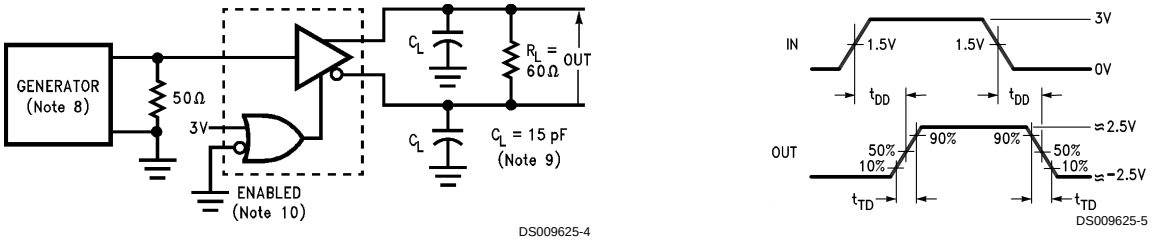



**FIGURE 3. Differential Output Delay and Transition Times**

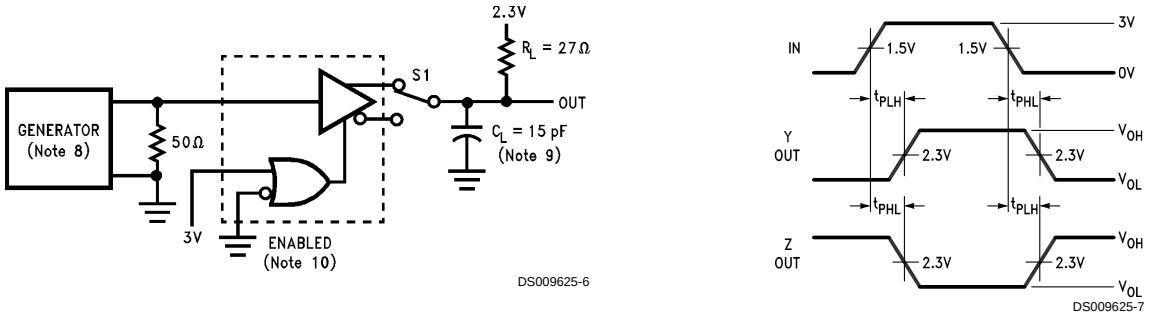



**FIGURE 4. Propagation Delay Times**

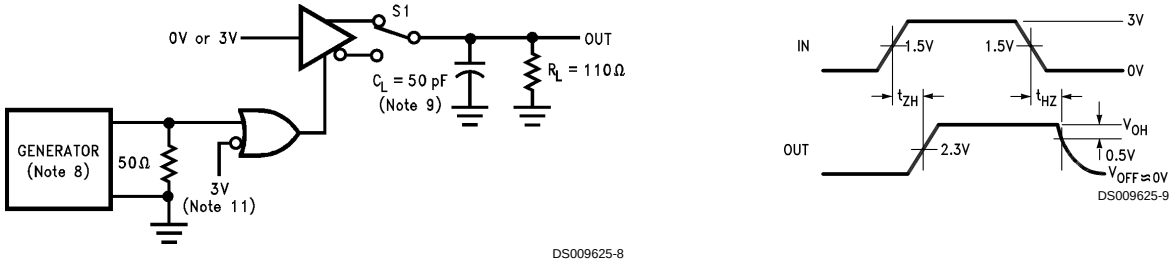



**FIGURE 5. $t_{ZH}$ and $t_{HZ}$**

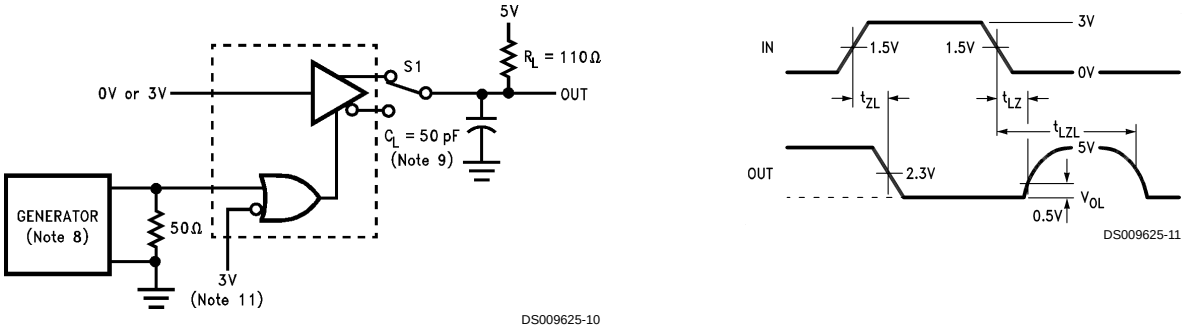



**FIGURE 6. $t_{ZL}$, $t_{LZ}$, $t_{LZL}$**

**Note 10:** The input pulse is supplied by a generator having the following characteristics: f = 1.0 MHz, duty cycle = 50%, $t_r \leq 5.0$ ns, $t_f \leq 5.0$ ns, $Z_O = 50\Omega$.

**Note 11:** $C_L$ includes probe and jig capacitance.

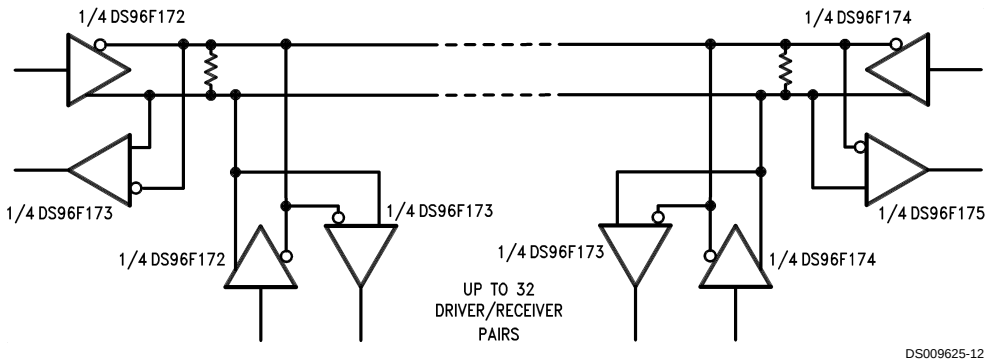
**Note 12:** DS96F172 with active high and active low Enables is shown. DS96F174 has active high Enable only.

**Note 13:** To test the active low Enable $\overline{E}$ of DS96F172 ground E and apply an inverted waveform to $\overline{E}$ . DS96F174 has active high Enable only.

**Note 14:** For more information see Application Bulletin, Contact Product Marketing.

**Note 15:** Not tested for DS96F172MW-MIL device.

## Typical Application

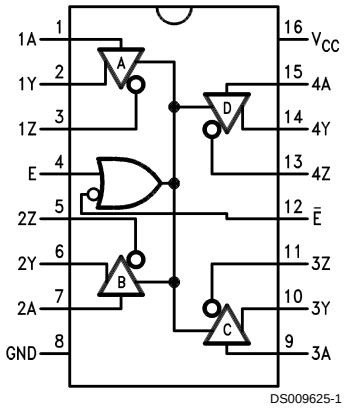



The line length should be terminated at both ends in its characteristic impedance.
Stub lengths off the main line should be kept as short as possible.

## Connection Diagrams

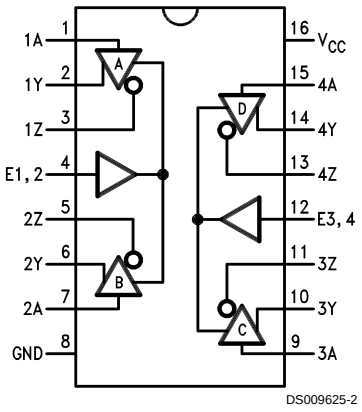
**16-Lead Ceramic Dual-In-Line Package**
**NS Package Number J16A**

**DS96F172**



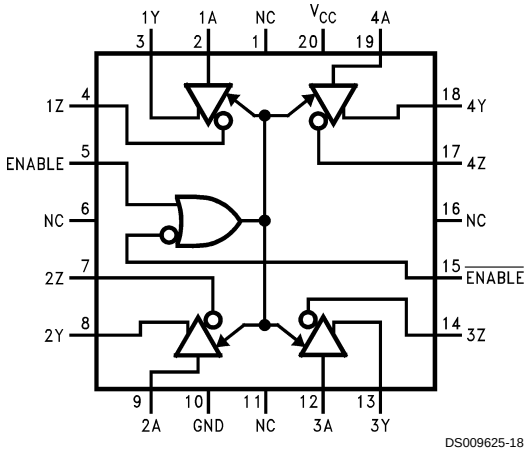

**Top View**

**DS96F174**



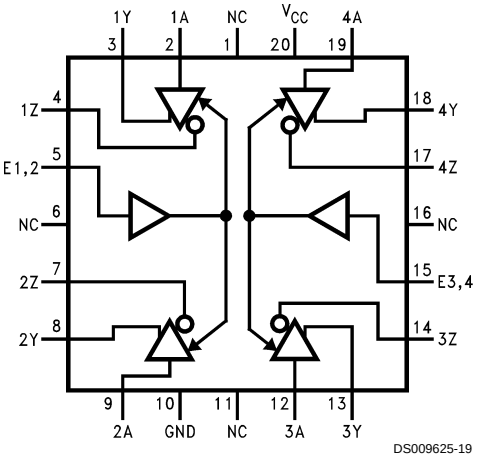

**Top View**

**20-Lead Ceramic Leadless Chip Carrier**
**NS Package Number E20A**




NC = No connection

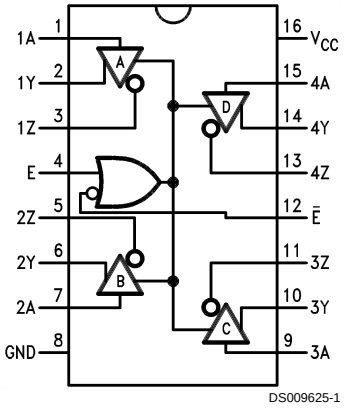
**Top View**



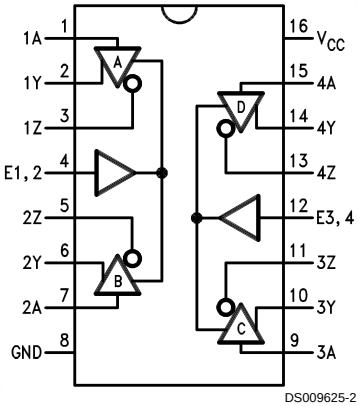

**Top View**

## Connection Diagrams (Continued)

**16-Lead Ceramic Flatpak**
**NS Package Number W16A**



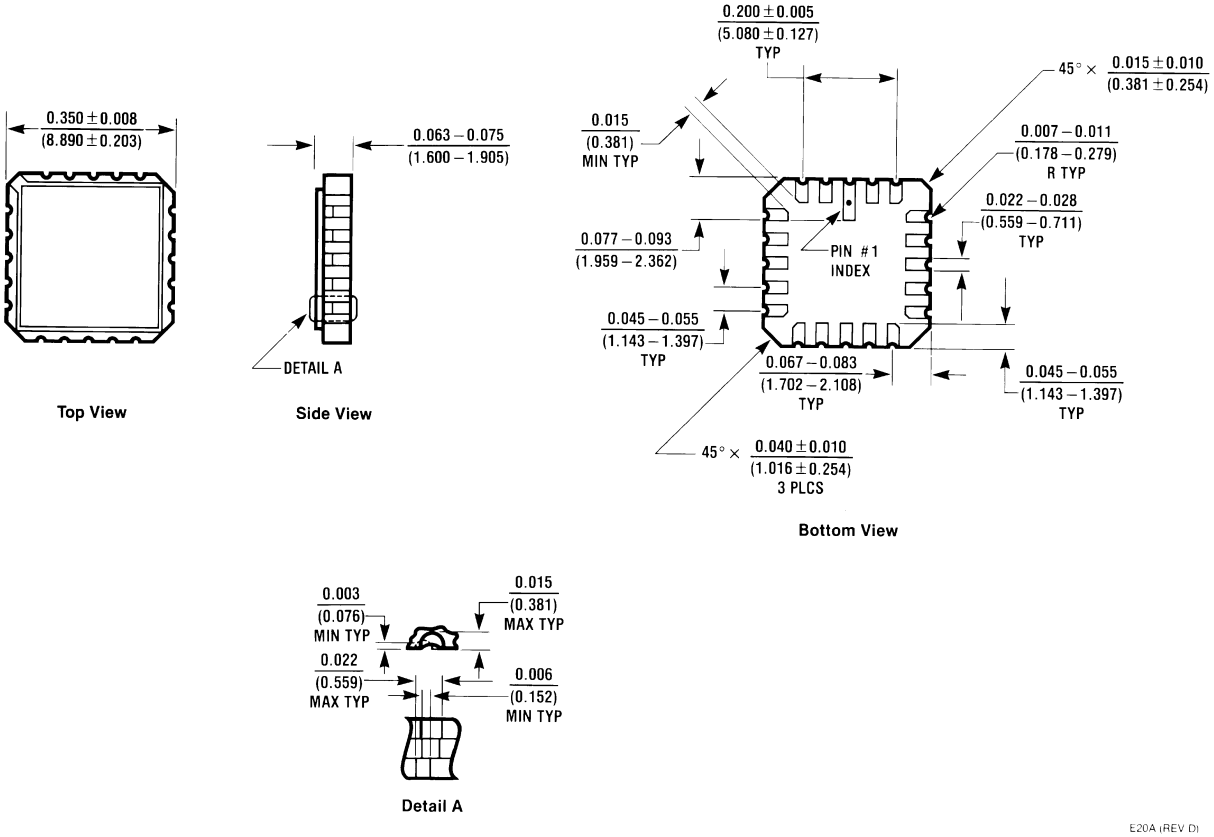

**Top View**



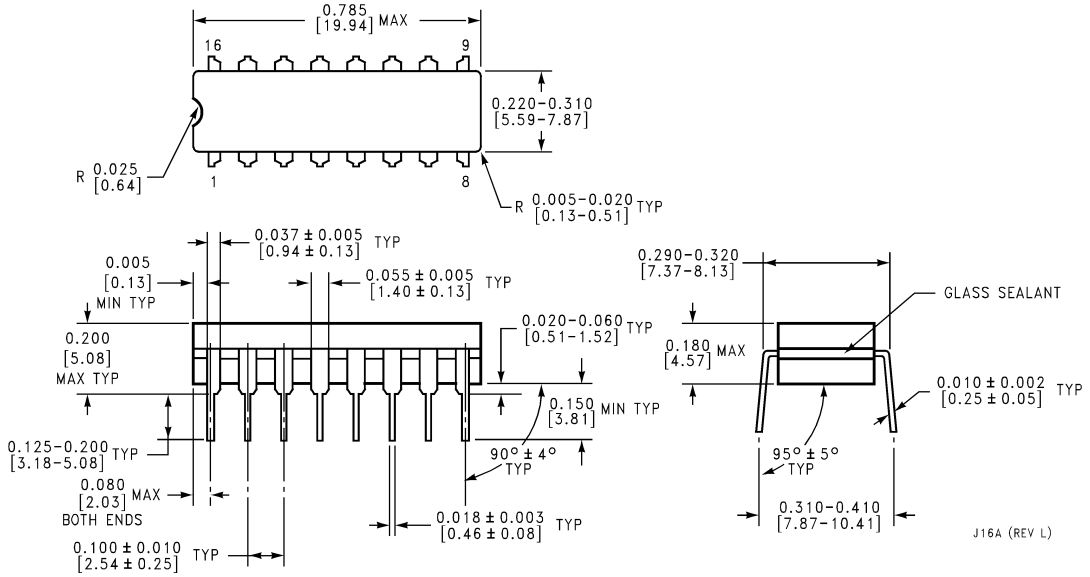

**Top View**

**Order Numbers are located at the end of the respective Electrical Tables.**

## Physical Dimensions inches (millimeters) unless otherwise noted

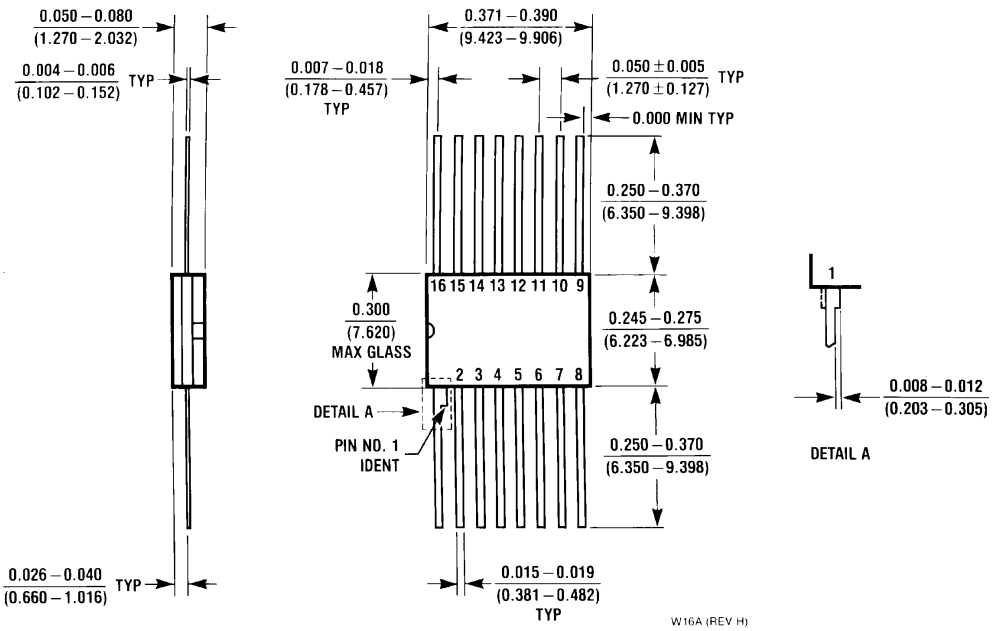



**20-Lead Ceramic Leadless Chip Carrier (E)**
**Order Number DS96F172ME/883, DS96F174ME/883**
**NS Package Number E20A**

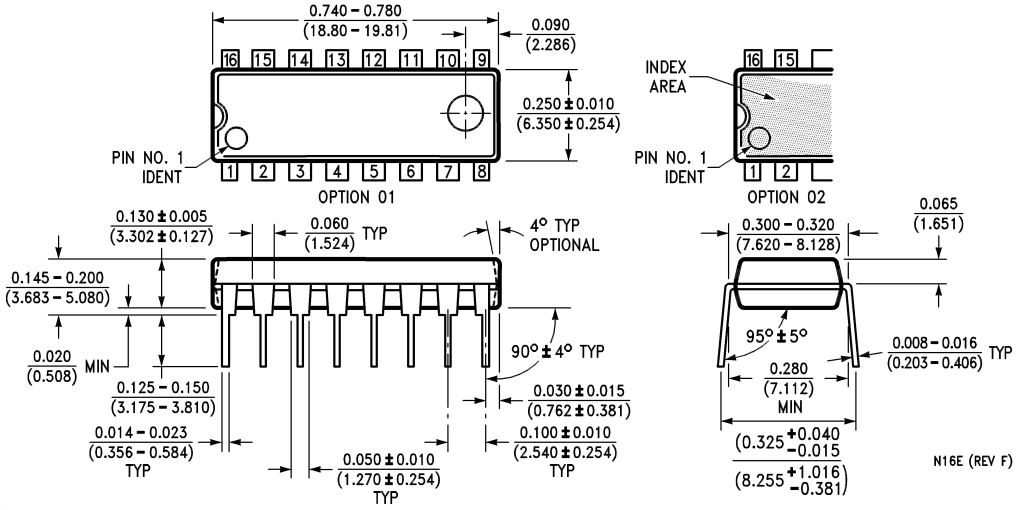



**16-Lead Ceramic Dual-In-Line Package (J)**
**Order Number DS96F172MJ/883,**
**DS96F174CJ, DS96F174MJ/883**
**NS Package Number J16A**

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




**16-Lead Ceramic Flatpack (W)**
**Order Number DS96F172MW/883, DS96F174MW/883**
**NS Package Number W16A**




**Molded Dual-In-Line Package (N)**
**Order Number DS96F174CN**
**NS Package Number N16E**

## Notes

**LIFE SUPPORT POLICY**

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

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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