

## DS96172/DS96174 RS-485/RS-422 Quad Differential Line Drivers

Check for Samples: [DS96172](#), [DS96174](#)

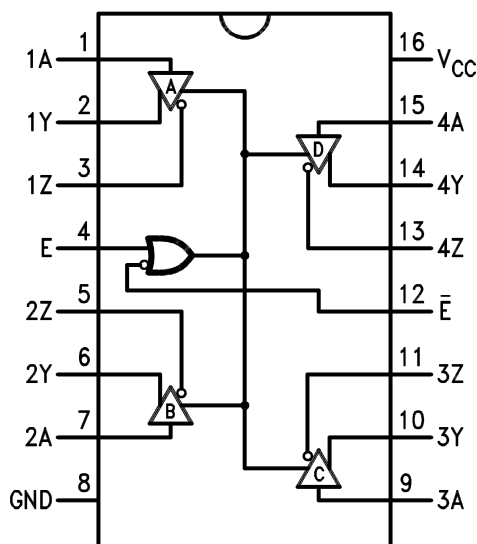
### FEATURES

- Meets EIA Standard RS-485 and RS-422A
- Monotonic Differential Output Switching
- Transmission Rate to 10 Mbs
- Tri-state Outputs
- Designed for Multipoint Bus Transmission
- Common Mode Output Voltage Range:  $-7V$  to  $+12V$
- Operates from Single  $+5V$  Supply
- Thermal Shutdown Protection
- DS96172/DS96174 are Lead and Function Compatible with the SN75172/75174 or the AM26LS31/MC3487, Respectively

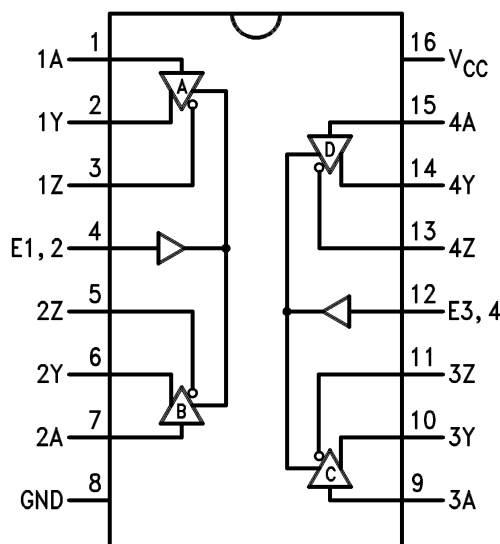
### DESCRIPTION

The DS96172 and DS96174 are high speed quad differential line drivers designed to meet EIA Standard RS-485. The devices have tri-state outputs and are optimized for balanced multipoint data bus transmission at rates up to 10 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 and occurs at junction temperature of approximately  $160^{\circ}C$ . The DS96172 features an active high and active low Enable, common to all four drivers. The DS96174 features separate active high Enables for each driver pair. Compatible RS-485 receivers, transceivers, and repeaters are also offered to provide optimum bus performance. The respective device types are DS96173, DS96175, DS96176, AND DS96177.

### Connection Diagrams



**Figure 1. 16-Lead PDIP DS96172  
Top View  
See Package Number NFG0016E**



**Figure 2. 16-Lead PDIP DS96174  
Top View  
See Package Number NFG0016E**



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings<sup>(1)(2)</sup>

|                                                   |                 |
|---------------------------------------------------|-----------------|
| Storage Temperature Range Molded PDIP             | –65°C to +150°C |
| Operating Temperature Range                       | 0°C to +70°C    |
| Lead Temperature Molded PDIP (soldering, 10 sec.) | 265°C           |
| Supply Voltage                                    | 7V              |
| Enable Input Voltage                              | 5.5V            |
| Maximum Power Dissipation <sup>(3)</sup>          | 25°C            |
| PDIP Package                                      | 1.98W           |

(1) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. 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.

(2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.

(3) Derate molded PDIP package 16mW/°C above 25°C.

### Recommended Operating Conditions

|                             |                                  | Min  | Typ | Max  | Units |
|-----------------------------|----------------------------------|------|-----|------|-------|
| Supply Voltage ( $V_{CC}$ ) |                                  | 4.75 | 5   | 5.25 | V     |
| Common Mode                 | Output Voltage ( $V_{OC}$ )      | –7   |     | +12  | V     |
|                             | Output Current HIGH ( $I_{OH}$ ) |      |     | –60  | mA    |
|                             | Output Current LOW ( $I_{OL}$ )  |      |     | 60   | mA    |
|                             | Operating Temperature ( $T_A$ )  | 0    | 25  | 70   | °C    |

## Electrical Characteristics<sup>(1)(2)</sup>

over recommended temperature and supply voltage ranges, unless otherwise specified

| Symbol           | Parameter                                                         | Conditions                                                     | Min | Typ      | Max       | Units   |
|------------------|-------------------------------------------------------------------|----------------------------------------------------------------|-----|----------|-----------|---------|
| $V_{IH}$         | Input Voltage HIGH                                                |                                                                | 2   |          |           | V       |
| $V_{IL}$         | Input Voltage LOW                                                 |                                                                |     |          | 0.8       | V       |
| $V_{OH}$         | Output Voltage HIGH                                               | $I_{OH} = -20$ mA                                              |     | 3.1      |           | V       |
| $V_{OL}$         | Output Voltage LOW                                                | $I_{OL} = 20$ mA                                               |     | 0.8      |           | V       |
| $V_{IC}$         | Input Clamp Voltage                                               | $I_I = -18$ mA                                                 |     |          | -1.5      | V       |
| $ V_{OD1} $      | Differential Output Voltage                                       | $I_O = 0$ mA                                                   |     |          | 6         | V       |
| $ V_{OD2} $      | Differential Output Voltage                                       | $R_L = 54\Omega$ , See <a href="#">Figure 3</a>                | 1.5 | 2        |           | V       |
|                  |                                                                   | $R_L = 100\Omega$ , See <a href="#">Figure 3</a>               | 2   | 2.3      |           | V       |
| $\Delta V_{OD} $ | Change in Magnitude of Differential Output Voltage <sup>(3)</sup> | $R_L = 54\Omega$ or $100\Omega$ , See <a href="#">Figure 3</a> |     |          | $\pm 0.2$ | V       |
| $V_{OC}$         | Common Mode Output Voltage <sup>(4)</sup>                         | $R_L = 54\Omega$ , See <a href="#">Figure 3</a>                |     |          | 3         | V       |
| $\Delta V_{OC} $ | Change in Magnitude of Common Mode Output Voltage <sup>(3)</sup>  |                                                                |     |          | $\pm 0.2$ | V       |
| $I_O$            | Output Current with Power Off                                     | $V_{CC} = 0$ V, $V_O = -7.0$ V to 12 V                         |     |          | $\pm 100$ | $\mu$ A |
| $I_{OZ}$         | High Impedance State Output Current                               | $V_O = -7.0$ V to 12 V                                         |     | $\pm 50$ | $\pm 200$ | $\mu$ A |
| $I_{IH}$         | Input Current HIGH                                                | $V_I = 2.7$ V                                                  |     |          | 20        | $\mu$ A |
| $I_{IL}$         | Input Current LOW                                                 | $V_I = 0.5$ V                                                  |     |          | -100      | $\mu$ A |
| $I_{OS}$         | Short Circuit Output Current <sup>(5)</sup>                       | $V_O = -7.0$ V                                                 |     |          | -250      | mA      |
|                  |                                                                   | $V_O = 0$ V                                                    |     |          | -150      |         |
|                  |                                                                   | $V_O = V_{CC}$                                                 |     |          | 150       |         |
|                  |                                                                   | $V_O = 12$ V                                                   |     |          | 250       |         |
| $I_{CC}$         | Supply Current (All Drivers)                                      | No Load                                                        |     |          |           | mA      |
|                  |                                                                   | Outputs Enabled                                                |     | 50       | 70        |         |
|                  |                                                                   | Output Disabled                                                |     | 50       | 60        |         |

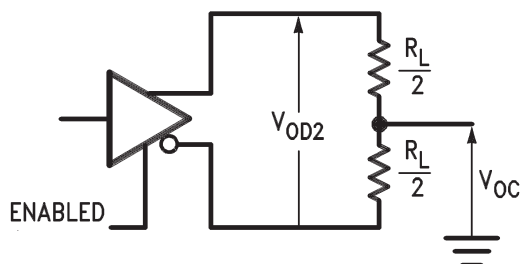
- (1) Unless otherwise specified min/max limits apply across the 0°C to +70°C range for the DS96172/DS96174. All typicals are given for  $V_{CC} = 5$  V and  $T_A = 25^\circ\text{C}$ .
- (2) All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are referenced to ground unless otherwise specified.
- (3)  $\Delta|V_{OD}|$  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.
- (4) In EIA Standards RS-422A and RS-485,  $V_{OC}$ , which is the average of the two output voltages with respect to ground, is called output offset voltage,  $V_{OS}$ .
- (5) Only one output at a time should be shorted.

## Switching Characteristics

 $V_{CC} = 5V, T_A = 25^\circ C$ 

| Symbol    | Parameter                                        | Conditions                                       | Min | Typ | Max | Units |
|-----------|--------------------------------------------------|--------------------------------------------------|-----|-----|-----|-------|
| $t_{DD}$  | Differential Output Delay Time                   | $R_L = 60\Omega$ , See <a href="#">Figure 4</a>  |     | 15  | 25  | ns    |
| $t_{TD}$  | Differential Output Transition Time              |                                                  |     | 15  | 25  | ns    |
| $t_{PLH}$ | Propagation Delay Time, Low-to-High Level Output | $R_L = 27\Omega$ , See <a href="#">Figure 5</a>  |     | 12  | 20  | ns    |
| $t_{PHL}$ | Propagation Delay Time, High-to-Low Level Output |                                                  |     | 12  | 20  | ns    |
| $t_{PZH}$ | Output Enable Time to High Level                 | $R_L = 110\Omega$ , See <a href="#">Figure 6</a> |     | 30  | 45  | ns    |
| $t_{PZL}$ | Output Enable Time to Low Level                  | $R_L = 110\Omega$ , See <a href="#">Figure 7</a> |     | 30  | 45  | ns    |
| $t_{PHZ}$ | Output Disable Time from High Level              | $R_L = 110\Omega$ , See <a href="#">Figure 6</a> |     | 25  | 35  | ns    |
| $t_{PLZ}$ | Output Disable Time from Low Level               | $R_L = 110\Omega$ , See <a href="#">Figure 7</a> |     | 30  | 45  | ns    |

## Parameter Measurement Information<sup>(1)(2)(3)(4)</sup>



**Figure 3. Differential and Common Mode Output Voltage**

- (1) The input pulse is supplied by a generator having the following characteristics: PRR = 1.0 MHz, duty cycle = 50%,  $t_r \leq 5.0$  ns,  $t_f \leq 5.0$  ns,  $Z_O = 50\Omega$ .
- (2)  $C_L$  includes probe and jig capacitance.
- (3) DS96172 with active high and active low Enables is shown here. DS96174 has active high Enable only.
- (4) To test the active low Enable  $\bar{E}$  of DS96172, ground E and apply an inverted waveform to  $\bar{E}$ . DS96174 has active high Enable only.

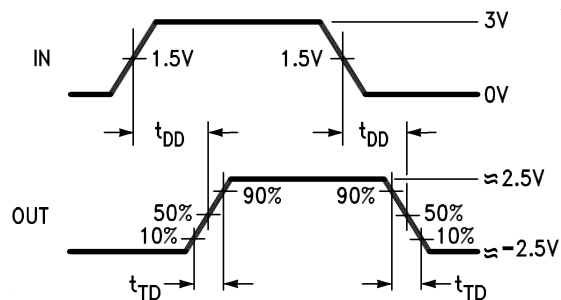
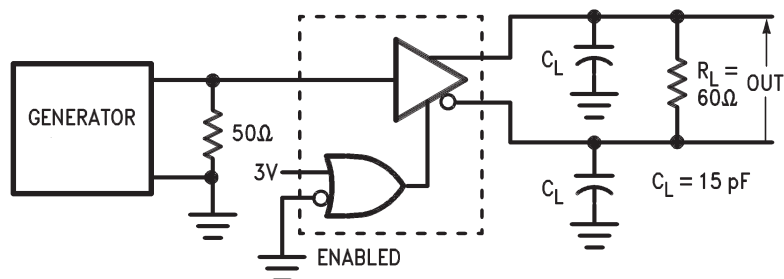


Figure 4. Differential Output Delay and Transition Times

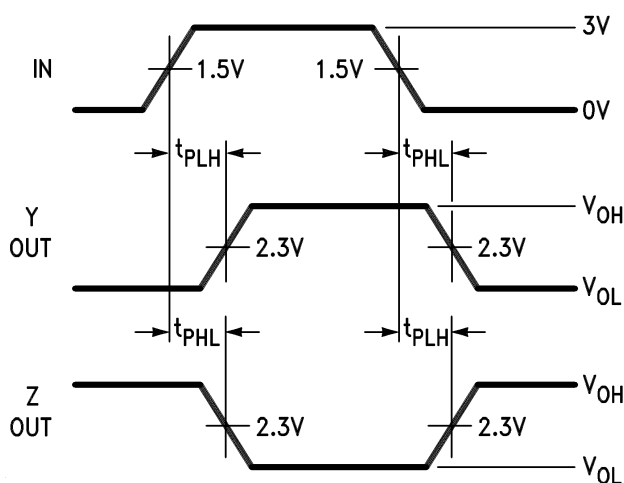
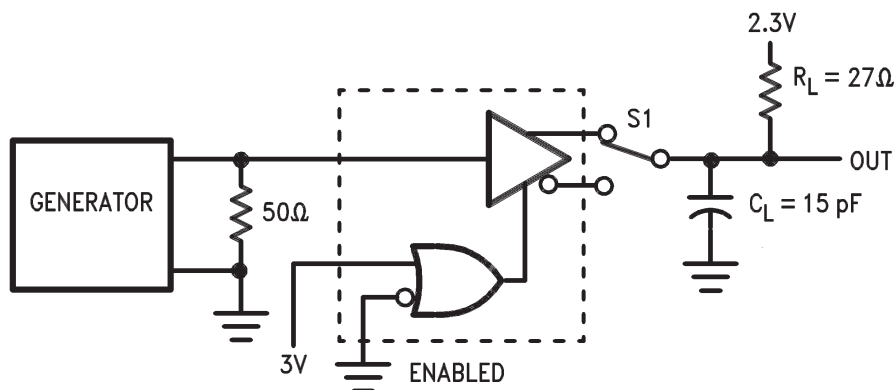


Figure 5. Propagation Delay Times

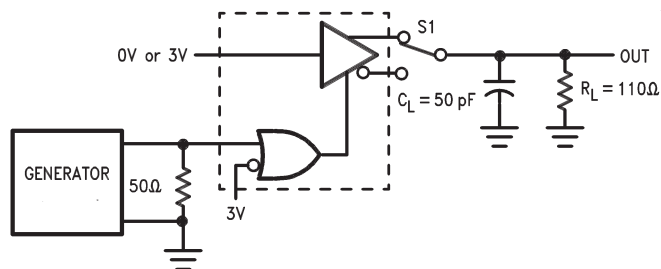
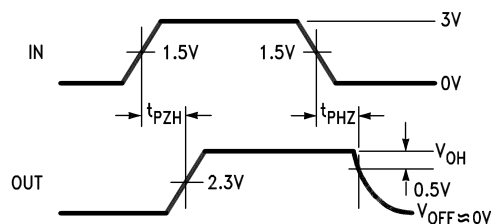
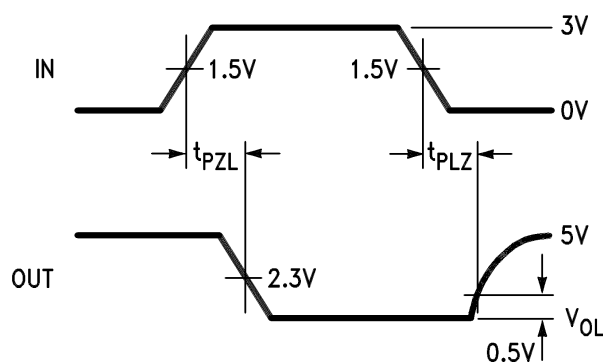
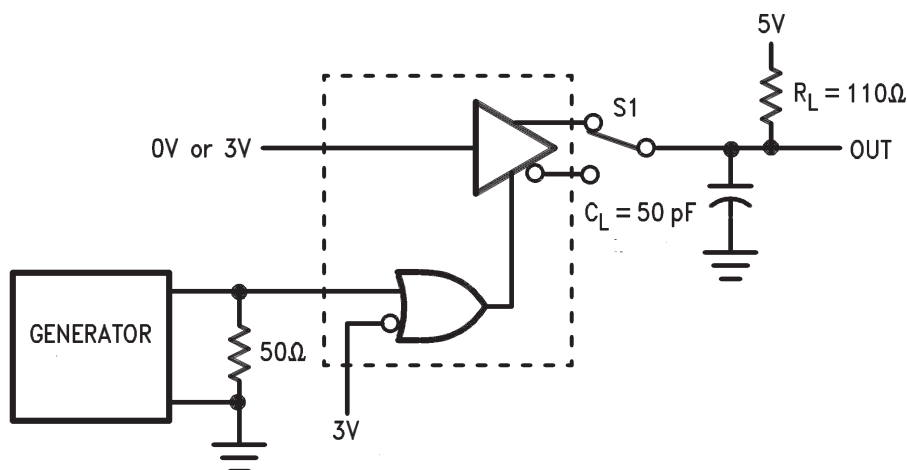


Figure 5.

Figure 6.  $t_{PZH}$  and  $t_{PHZ}$ Figure 7.  $t_{PZL}$  and  $t_{PLZ}$ 

## Function Tables

Table 1. DS96172

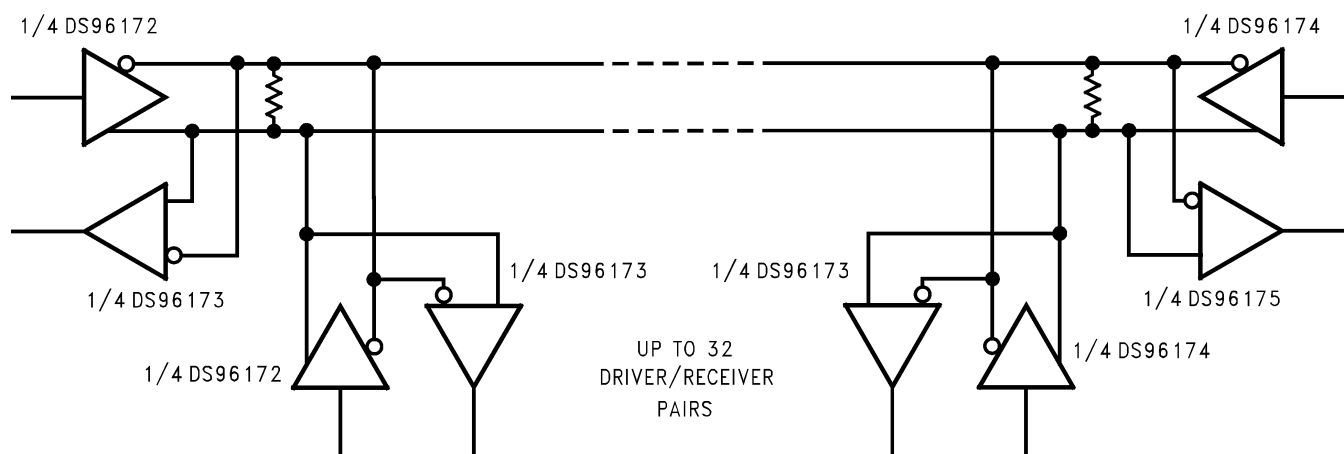
| Input | Enables |           | Outputs |   |
|-------|---------|-----------|---------|---|
| A     | E       | $\bar{E}$ | Y       | Z |
| H     | H       | X         | H       | L |
| L     | H       | X         | L       | H |
| H     | X       | L         | H       | L |
| L     | X       | L         | L       | H |
| X     | L       | H         | Z       | Z |

**Table 2. DS96174<sup>(1)</sup>**

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

- (1) H = High Level  
 X = Immaterial  
 L = Low Level  
 Z = High Impedance (off)

## Typical Application



**Figure 8.**

### NOTE

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.



## REVISION HISTORY

### Changes from Revision C (April 2013) to Revision D

**Page**

- Changed layout of National Data Sheet to TI format ..... [8](#)

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| DS96174CN        | ACTIVE        | PDIP         | NFG                | 16   | 25             | TBD                        | Call TI          | Call TI              | 0 to 70      | DS96174CN                | <a href="#">Samples</a> |
| DS96174CN/NOPB   | ACTIVE        | PDIP         | NFG                | 16   | 25             | Green (RoHS<br>& no Sb/Br) | Call TI          | Level-1-NA-UNLIM     | 0 to 70      | DS96174CN                | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

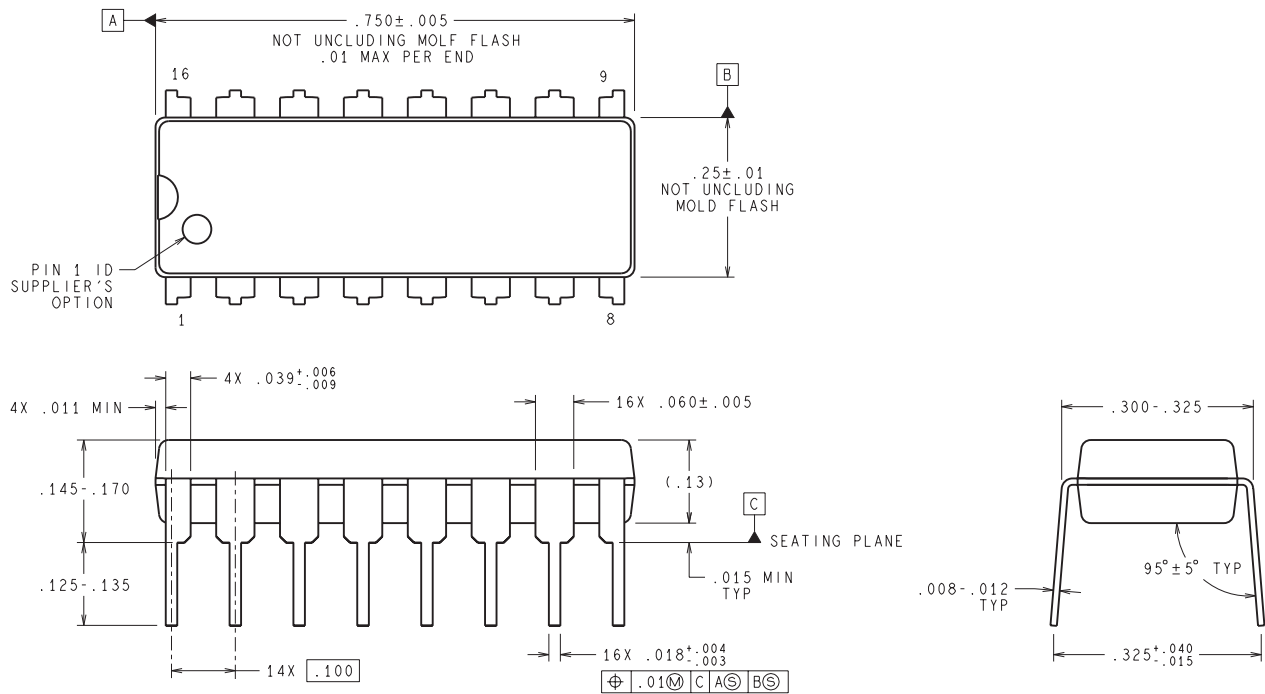
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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