

# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

SLLS262H – JULY 1997 – REVISED MARCH 2000

- Meets or Exceeds the Requirements of ANSI TIA/EIA-644 Standard
- Operates with a Single 3.3-V Supply
- Designed for Signaling Rate of Up To 400 Mbps
- Differential Input Thresholds  $\pm 100$  mV Max
- Typical Propagation Delay Time of 2.1 ns
- Power Dissipation 60 mW Typical per Receiver at 200 MHz
- Bus-Terminal ESD Protection Exceeds 8 kV
- Low-Voltage TTL (LVTTTL) Logic Output Levels
- Pin-Compatible with the AM26LS32, MC3486, and  $\mu$ A9637
- Open-Circuit Fail Safe

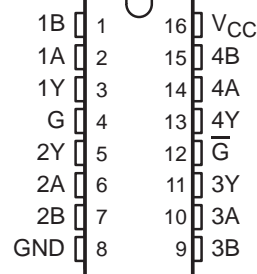
## description

The SN55LVDS32, SN65LVDS32, SN65LVDS3486, and SN65LVDS9637 are differential line receivers that implement the electrical characteristics of low-voltage differential signaling (LVDS). This signaling technique lowers the output voltage levels of 5-V differential standard levels (such as EIA/TIA-422B) to reduce the power, increase the switching speeds, and allow operation with a 3.3-V supply rail. Any of the four differential receivers provides a valid logical output state with a  $\pm 100$  mV differential input voltage within the input common-mode voltage range. The input common-mode voltage range allows 1 V of ground potential difference between two LVDS nodes.

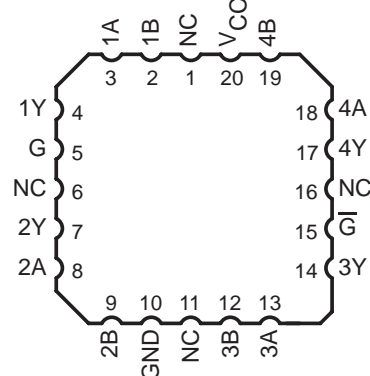
The intended application of these devices and signaling technique is both point-to-point and multidrop (one driver and multiple receivers) data transmission over controlled impedance media of approximately 100  $\Omega$ . The transmission media may be printed-circuit board traces, backplanes, or cables. The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media and the noise coupling to the environment.

The SN65LVDS32, SN65LVDS3486, and SN65LVDS9637 are characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The SN55LVDS32 is characterized for operation from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

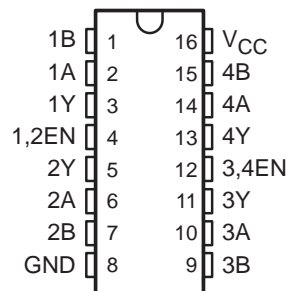
SN55LVDS32 . . . J OR W  
SN65LVDS32D  
(Marked as LVDS32 or 65LVDS32)  
(TOP VIEW)



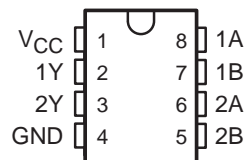
SN55LVDS32FK  
(TOP VIEW)



SN65LVDS3486D (Marked as LVDS3486)  
(TOP VIEW)



SN65LVDS9637D (Marked as DK637 or LVDS37)  
SN65LVDS9637DGN (Marked as L37)  
(TOP VIEW)



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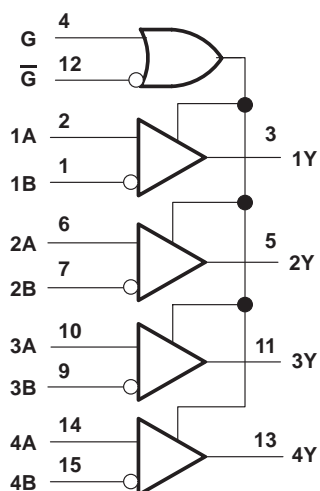
# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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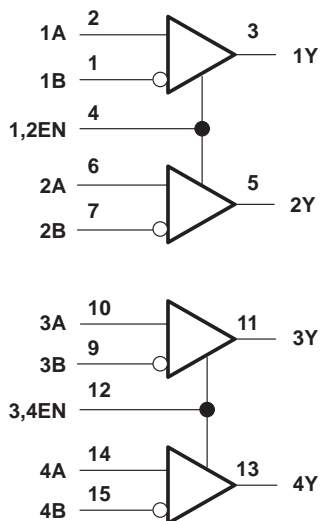
## AVAILABLE OPTIONS

| T <sub>A</sub> | PACKAGE           |                 |                   |                 |               |
|----------------|-------------------|-----------------|-------------------|-----------------|---------------|
|                | SMALL OUTLINE (D) | MSOP (DGN)      | CHIP CARRIER (FK) | CERAMIC DIP (J) | FLAT PACK (W) |
| -40°C to 85°C  | SN65LVDS32D       | —               | —                 | —               | —             |
|                | SN65LVDS3486D     | —               | —                 | —               | —             |
|                | SN65LVDS9637D     | SN65LVDS9637DGN | —                 | —               | —             |
| -55°C to 125°C | —                 | —               | SN55LVDS32FK      | SN55LVDS32J     | SN55LVDS32W   |

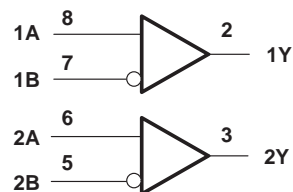
'LVDS32 logic diagram (positive logic)



'LVDS3486D logic diagram (positive logic)



'LVDS9637D logic diagram (positive logic)



# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

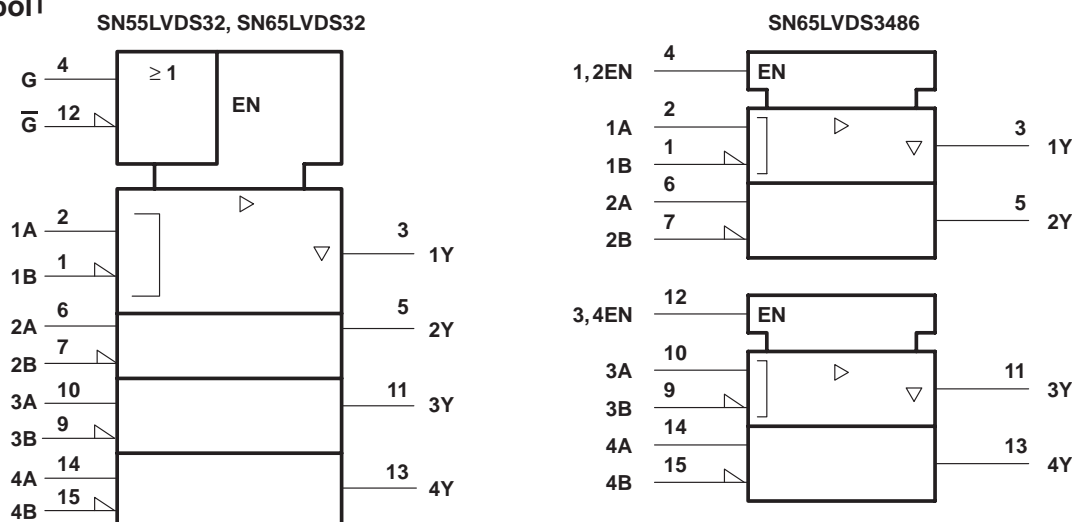
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## Function Tables

| SN55LVDS32, SN65LVDS32                      |         |           |        | SN65LVDS3486                                |        |        |
|---|---------|-----------|--------|---|--------|--------|
| DIFFERENTIAL INPUT                          | ENABLES |           | OUTPUT | DIFFERENTIAL INPUT                          | ENABLE | OUTPUT |
| A, B  | G       | $\bar{G}$ | Y      | A, B  | EN     | Y      |
| $V_{ID} \geq 100 \text{ mV}$                | H<br>X  | X<br>L    | H<br>H | $V_{ID} \geq 100 \text{ mV}$                | H<br>X | H<br>H |
| $-100 \text{ mV} < V_{ID} < 100 \text{ mV}$ | H<br>X  | X<br>L    | ?<br>? | $-100 \text{ mV} < V_{ID} < 100 \text{ mV}$ | H<br>X | ?<br>? |
| $V_{ID} \leq -100 \text{ mV}$               | H<br>X  | X<br>L    | L<br>L | $V_{ID} \leq -100 \text{ mV}$               | H<br>X | L<br>L |
| X   | L       | H         | Z      | X   | L      | Z      |
| Open  | H<br>X  | X<br>L    | H<br>H | Open  | H<br>X | H<br>H |

H = high level, L = low level, X = irrelevant, Z = high impedance (off), ? = indeterminate

### logic symbol†



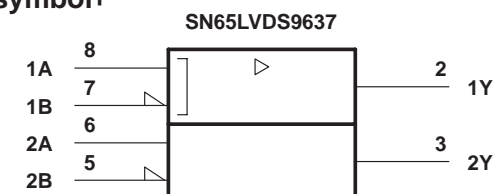
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

### Function Table

| SN65LVDS9637                                |        |
|---|--------|
| DIFFERENTIAL INPUT                          | OUTPUT |
| A, B  | Y      |
| $V_{ID} \geq 100 \text{ mV}$                | H      |
| $-100 \text{ mV} < V_{ID} < 100 \text{ mV}$ | ?      |
| $V_{ID} \leq -100 \text{ mV}$               | L      |
| Open  | H      |

H = high level, L = low level, ? = indeterminate

### logic symbol†



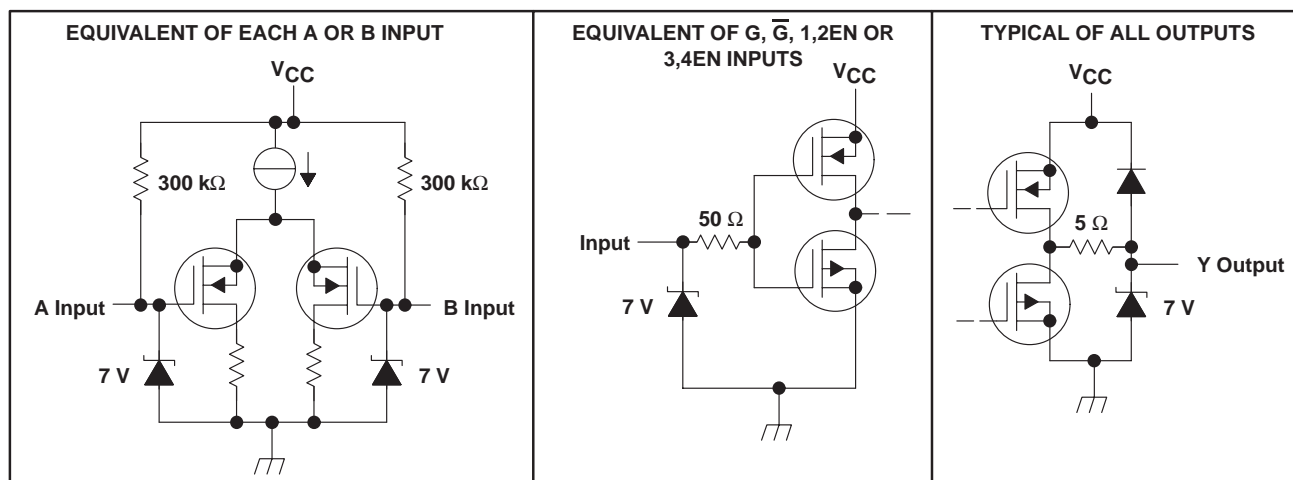
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.



# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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## equivalent input and output schematic diagrams



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

|  |                              |
|--|------------------------------|
| Supply voltage range, $V_{CC}$ (see Note 1) .....                  | -0.5 V to 4 V                |
| Input voltage range, $V_I$ .....                                   | -0.5 V to $V_{CC} + 0.5$ V   |
| Input voltage range, $V_I$ (A or B) .....                          | -0.5 V to 4 V                |
| Continuous total power dissipation .....                           | See Dissipation Rating Table |
| Storage temperature range, $T_{stg}$ .....                         | -65°C to 150°C               |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ..... | 260°C                        |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltages, except differential I/O bus voltages, are with respect to the network ground terminal.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING FACTOR‡<br>ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 85^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>POWER RATING |
|---------|---|--|--|--|---|
| D (8)   | 725 mW                                      | 5.8 mW/°C  | 464 mW                                   | 377 mW                                   | —   |
| D (16)  | 950 mW                                      | 7.6 mW/°C  | 608 mW                                   | 494 mW                                   | —   |
| DGN     | 2.14 W                                      | 17.1 mW/°C   | 1.37 W                                   | 1.11 W                                   | —   |
| FK      | 1375 mW                                     | 11.0 mW/°C   | 880 mW                                   | 715 mW                                   | 275 mW                                    |
| J       | 1375 mW                                     | 11.0 mW/°C   | 880 mW                                   | 715 mW                                   | 275 mW                                    |
| W       | 1000 mW                                     | 8.0 mW/°C  | 640 mW                                   | 520 mW                                   | 200 mW                                    |

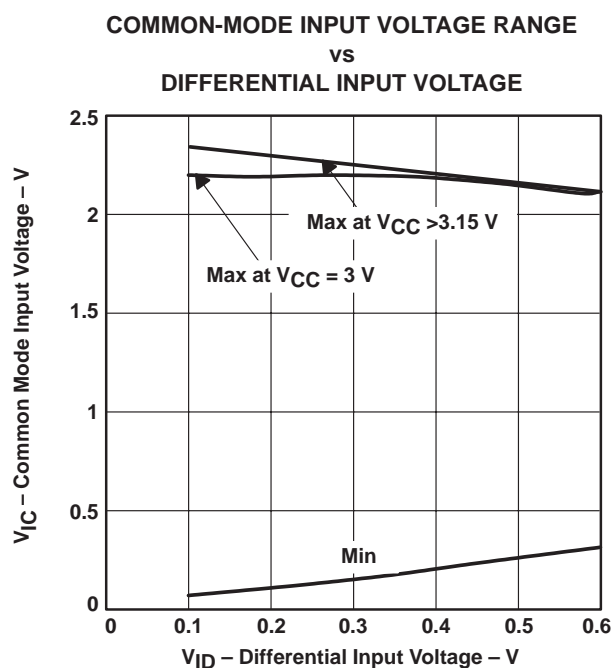
‡ This is the inverse of the junction-to-ambient thermal resistance when board mounted and with no air flow.

# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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## recommended operating conditions

|   |  | MIN                  | NOM                        | MAX | UNIT |
|---|--|----------------------|----------------------------|-----|------|
| Supply voltage, $V_{CC}$                            |  | 3                    | 3.3                        | 3.6 | V    |
| High-level input voltage, $V_{IH}$                  | $G, \bar{G}, 1, 2EN, \text{ or } 3, 4EN$ | 2                    |                            |     | V    |
| Low-level input voltage, $V_{IL}$                   | $G, \bar{G}, 1, 2EN, \text{ or } 3, 4EN$ |                      |                            | 0.8 | V    |
| Magnitude of differential input voltage, $ V_{ID} $ |  | 0.1                  |                            | 0.6 | V    |
| Common-mode input voltage, $V_{IC}$ (see Figure 1)  |  | $\frac{ V_{ID} }{2}$ | $2.4 - \frac{ V_{ID} }{2}$ |     | V    |
|   |  |                      | $V_{CC} - 0.8$             |     | V    |
| Operating free-air temperature, $T_A$               |  | SN65 prefix          |                            | 85  | °C   |
|   |  | SN55 prefix          | -55                        | 125 |      |



# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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## SN65LVDSxxxx electrical characteristics over recommended operating conditions (unless otherwise noted)

| PARAMETER    |  | TEST CONDITIONS              | SN65LVDS32,<br>SN65LVDS3486,<br>SN65LVDS9637 |      |     | UNIT    |
|--------------|--|------------------------------|--|------|-----|---------|
|              |  |                              | MIN  | TYP† | MAX |         |
| $V_{ITH+}$   | Positive-going differential input voltage threshold        | See Figure 2 and Table 1     | 100  |      |     | mV      |
| $V_{ITH-}$   | Negative-going differential input voltage threshold‡       |                              | -100   |      |     | mV      |
| $V_{OH}$     | High-level output voltage                                  | $I_{OH} = -8$ mA             | 2.4  |      |     | V       |
| $V_{OL}$     | Low-level output voltage                                   | $I_{OL} = 8$ mA              | 0.4  |      |     | V       |
| $I_{CC}$     | Supply current   | SN65LVDS32,<br>SN65LVDS3486  | Enabled, No load                             | 10   | 18  | mA      |
|              |  |                              | Disabled                                     | 0.25 | 0.5 |         |
|              |  | SN65LVDS9637                 | No load                                      | 5.5  | 10  |         |
| $I_I$        | Input current (A or B inputs)                              | $V_I = 0$                    | -2   | -10  | -20 | $\mu$ A |
|              |  | $V_I = 2.4$ V                | -1.2   | -3   |     |         |
| $I_{I(OFF)}$ | Power-off input current (A or B inputs)                    | $V_{CC} = 0$ , $V_I = 3.6$ V | 6  | 20   |     | $\mu$ A |
| $I_{IH}$     | High-level input current (EN, G, or $\overline{G}$ inputs) | $V_{IH} = 2$ V               | 10   |      |     | $\mu$ A |
| $I_{IL}$     | Low-level input current (EN, G, or $\overline{G}$ inputs)  | $V_{IL} = 0.8$ V             | 10   |      |     | $\mu$ A |
| $I_{OZ}$     | High-impedance output current                              | $V_O = 0$ or $V_{CC}$        | $\pm 10$                                     |      |     | $\mu$ A |

† All typical values are at  $T_A = 25^\circ\text{C}$  and with  $V_{CC} = 3.3$  V.

‡ The algebraic convention, in which the less positive (more negative) limit is designated minimum, is used in this data sheet for the negative-going differential input voltage threshold only.

## SN65LVDSxxxx switching characteristics over recommended operating conditions (unless otherwise noted)

| PARAMETER    |   | TEST CONDITIONS             | SN65LVDS32,<br>SN65LVDS3486,<br>SN65LVDS9637 |     |     | UNIT |
|--------------|---|-----------------------------|--|-----|-----|------|
|              |   |                             | MIN  | TYP | MAX |      |
| $t_{pLH}$    | Propagation delay time, low-to-high-level output            | $C_L = 10$ pF, See Figure 3 | 1.5  | 2.1 | 3   | ns   |
| $t_{pHL}$    | Propagation delay time, high-to-low-level output            |                             | 1.5  | 2.1 | 3   | ns   |
| $t_{sk(p)}$  | Pulse skew ( $ t_{pHL} - t_{pLH} $ )                        |                             | 0  | 0.4 |     | ns   |
| $t_{sk(o)}$  | Channel-to-channel output skew†                             |                             | 0.1  | 0.3 |     | ns   |
| $t_{sk(pp)}$ | Part-to-part skew‡  |                             | 1  |     |     | ns   |
| $t_r$        | Output signal rise time, 20% to 80%                         |                             | 0.6  |     |     | ns   |
| $t_f$        | Output signal fall time, 80% to 20%                         |                             | 0.7  |     |     | ns   |
| $t_{pHZ}$    | Propagation delay time, high-level-to-high-impedance output |                             | See Figure 4                                 | 6.5 | 12  |      |
| $t_{pLZ}$    | Propagation delay time, low-level-to-high-impedance output  | 5.5                         |  | 12  |     | ns   |
| $t_{pZH}$    | Propagation delay time, high-impedance-to-high-level output | 8                           |  | 12  |     | ns   |
| $t_{pZL}$    | Propagation delay time, high-impedance-to-low-level output  | 3                           |  | 12  |     | ns   |

†  $t_{sk(o)}$  is the skew between specified outputs of a single device with all driving inputs connected together and the outputs switching in the same direction while driving identical specified loads.

‡  $t_{sk(pp)}$  is the magnitude of the different in propagation delay times between any specified terminals of two devices when both devices operate with the same supply voltages, same temperature, and have identical packages and test circuits.



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## SN55LVDS32 Selectrical characteristics over recommended operating conditions (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS                             | SN55LVDS32 |      |     | UNIT |
|--|---|------------|------|-----|------|
|  |   | MIN        | TYP† | MAX |      |
| V <sub>ITH+</sub> Positive-going differential input voltage threshold      | See Figure 2, Table 1, and Note 2           | 100        |      |     | mV   |
| V <sub>ITH-</sub> Negative-going differential input voltage threshold‡     |   | -100       |      |     | mV   |
| V <sub>OH</sub> High-level output voltage                                  | I <sub>OH</sub> = -8 mA                     | 2.4        |      |     | V    |
| V <sub>OL</sub> Low-level output voltage                                   | I <sub>OL</sub> = 8 mA                      | 0.4        |      |     | V    |
| I <sub>CC</sub> Supply current   | Enabled, No load                            | 10 18      |      |     | mA   |
|  | Disabled                                    | 0.25 0.5   |      |     |      |
| I <sub>I</sub> Input current (A or B inputs)                               | V <sub>I</sub> = 0                          | -2         | -10  | -20 | μA   |
|  | V <sub>I</sub> = 2.4 V                      | -1.2       | -3   |     |      |
| I <sub>I(OFF)</sub> Power-off input current (A or B inputs)                | V <sub>CC</sub> = 0, V <sub>I</sub> = 2.4 V | 6 20       |      |     | μA   |
| I <sub>IH</sub> High-level input current (EN, G, or $\overline{G}$ inputs) | V <sub>IH</sub> = 2 V                       | 10         |      |     | μA   |
| I <sub>IL</sub> Low-level input current (EN, G, or $\overline{G}$ inputs)  | V <sub>IL</sub> = 0.8 V                     | 10         |      |     | μA   |
| I <sub>OZ</sub> High-impedance output current                              | V <sub>O</sub> = 0 or V <sub>CC</sub>       | ±12        |      |     | μA   |

† All typical values are at T<sub>A</sub> = 25°C and with V<sub>CC</sub> = 3.3 V.

‡ The algebraic convention, in which the less positive (more negative) limit is designated minimum, is used in this data sheet for the negative-going differential input voltage threshold only.

NOTE 2: |V<sub>ITH</sub>| = 200 mV for operation at -55°C.

## SN55LVDS32 switching characteristics over recommended operating conditions (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS                      | SN55LVDS32 |     |     | UNIT |
|--|--------------------------------------|------------|-----|-----|------|
|  |                                      | MIN        | TYP | MAX |      |
| t <sub>pLH</sub> Propagation delay time, low-to-high-level output            | C <sub>L</sub> = 10 pF, See Figure 3 | 1.3        | 2.3 | 6   | ns   |
| t <sub>pHL</sub> Propagation delay time, high-to-low-level output            |                                      | 1.4        | 2.2 | 6.1 |      |
| t <sub>sk(o)</sub> Channel-to-channel output skew†                           |                                      | 0.1        |     |     | ns   |
| t <sub>r</sub> Output signal rise time, 20% to 80%                           | C <sub>L</sub> = 10 pF, See Figure 3 | 0.6        |     |     | ns   |
| t <sub>f</sub> Output signal fall time, 80% to 20%                           |                                      | 0.7        |     |     |      |
| t <sub>pHZ</sub> Propagation delay time, high-level-to-high-impedance output | See Figure 4                         | 6.5 12     |     |     | ns   |
| t <sub>pLZ</sub> Propagation delay time, low-level-to-high-impedance output  |                                      | 5.5 12     |     |     |      |
| t <sub>pZH</sub> Propagation delay time, high-impedance-to-high-level output |                                      | 8 14       |     |     |      |
| t <sub>pZL</sub> Propagation delay time, high-impedance-to-low-level output  |                                      | 3 12       |     |     |      |

† t<sub>sk(o)</sub> is the maximum delay time difference between drivers on the same device.



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## PARAMETER MEASUREMENT INFORMATION

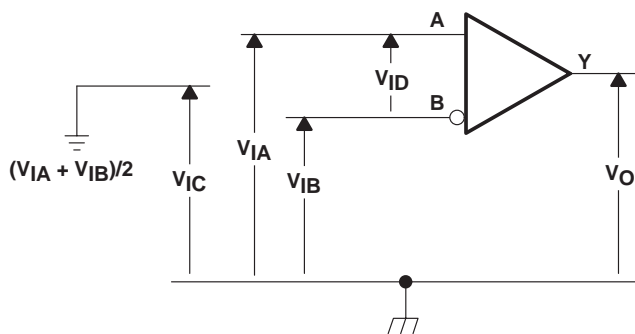


Figure 2. Voltage Definitions

Table 1. Receiver Minimum and Maximum Input Threshold Test Voltages

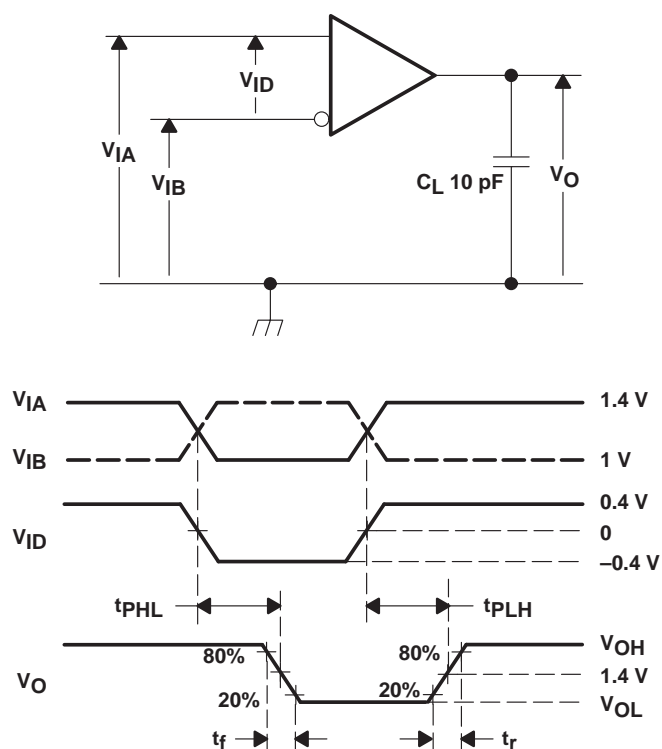
| APPLIED VOLTAGES |                 | RESULTING DIFFERENTIAL INPUT VOLTAGE | RESULTING COMMON-MODE INPUT VOLTAGE |
|------------------|-----------------|--------------------------------------|-------------------------------------|
| V <sub>IA</sub>  | V <sub>IB</sub> | V <sub>ID</sub>                      | V <sub>IC</sub>                     |
| 1.25 V           | 1.15 V          | 100 mV                               | 1.2 V                               |
| 1.15 V           | 1.25 V          | -100 mV                              | 1.2 V                               |
| 2.4 V            | 2.3 V           | 100 mV                               | 2.35 V                              |
| 2.3 V            | 2.4 V           | -100 mV                              | 2.35 V                              |
| 0.1 V            | 0 V             | 100 mV                               | 0.05 V                              |
| 0 V              | 0.1 V           | -100 mV                              | 0.05 V                              |
| 1.5 V            | 0.9 V           | 600 mV                               | 1.2 V                               |
| 0.9 V            | 1.5 V           | -600 mV                              | 1.2 V                               |
| 2.4 V            | 1.8 V           | 600 mV                               | 2.1 V                               |
| 1.8 V            | 2.4 V           | -600 mV                              | 2.1 V                               |
| 0.6 V            | 0 V             | 600 mV                               | 0.3 V                               |
| 0 V              | 0.6 V           | -600 mV                              | 0.3 V                               |



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## PARAMETER MEASUREMENT INFORMATION



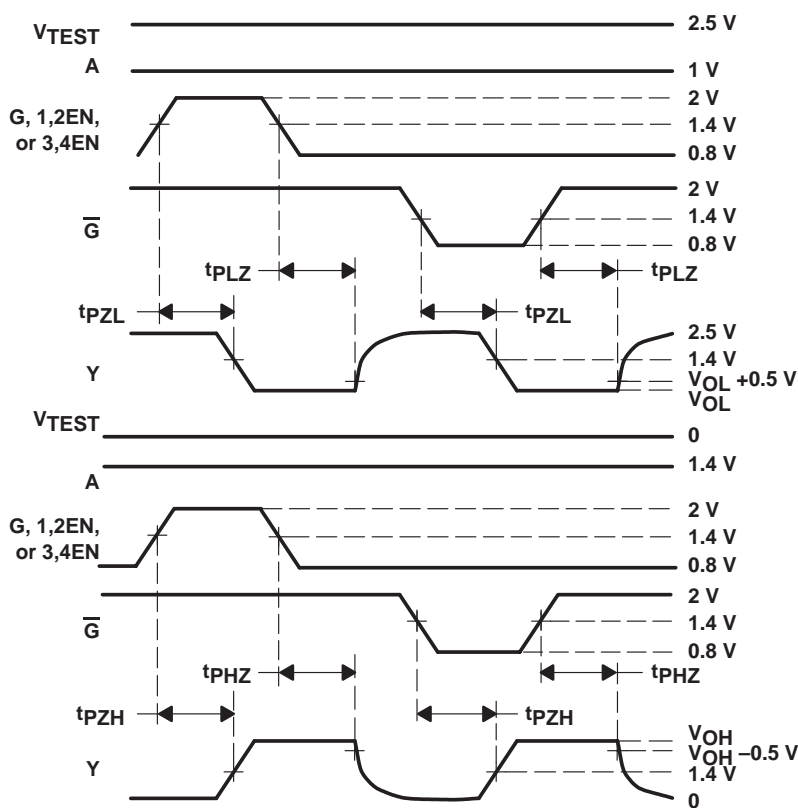
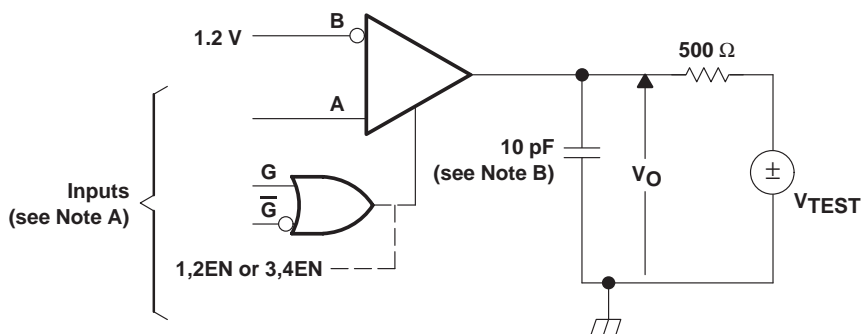
- NOTES: A. All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1 \text{ ns}$ , pulse repetition rate (PRR) = 50 Mpps, pulse width =  $10 \pm 0.2 \text{ ns}$ .  
B.  $C_L$  includes instrumentation and fixture capacitance within 6 mm of the D.U.T.

**Figure 3. Timing Test Circuit and Wave Forms**

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## PARAMETER MEASUREMENT INFORMATION



- NOTES: A. All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1$  ns, pulse repetition rate (PRR) = 0.5 Mpps, pulse width =  $500 \pm 10$  ns.  
B.  $C_L$  includes instrumentation and fixture capacitance within 6 mm of the D.U.T.

Figure 4. Enable/Disable Time Test Circuit and Wave Forms

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## TYPICAL CHARACTERISTICS

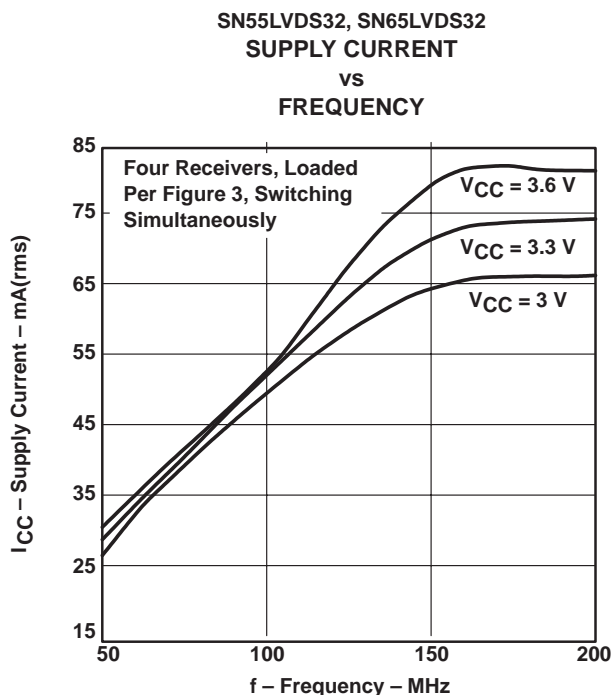


Figure 5

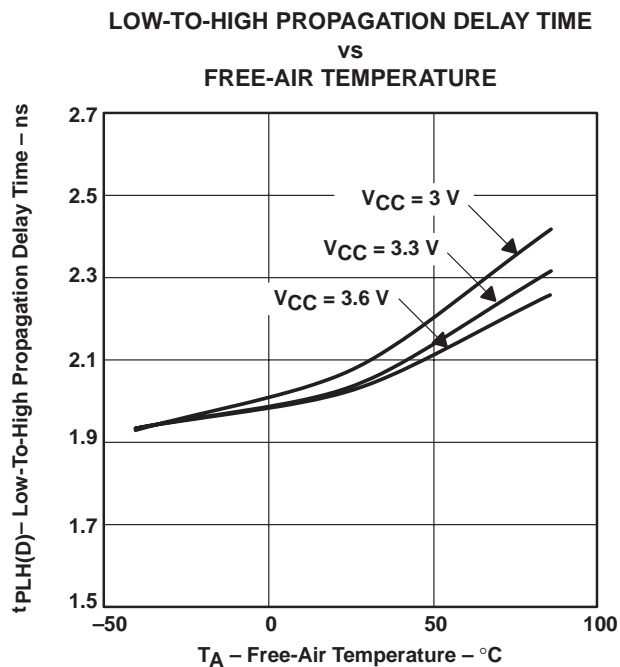


Figure 6

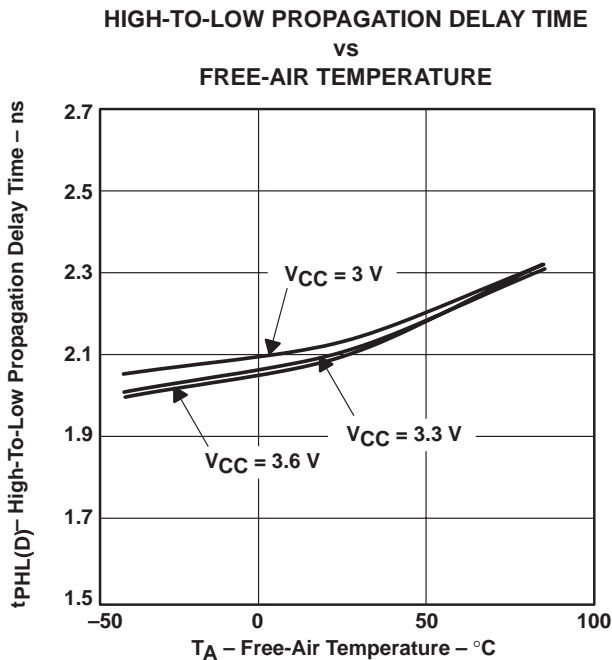


Figure 7



# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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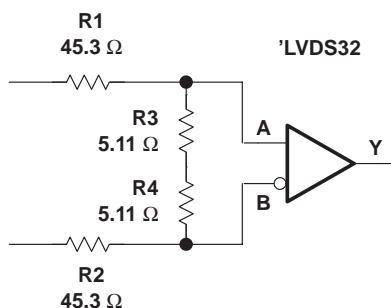
## APPLICATION INFORMATION

### using an LVDS receiver with RS-422 data

Receipt of data from a TIA/EIA-422 line driver may be accomplished using a TIA/EIA-644 line receiver with the addition of an attenuator circuit. This technique gives the user a very high-speed and low-power 422 receiver.

If the ground noise between the transmitter and receiver is not a concern (less than  $\pm 1$  V), the answer can be as simple as shown below in Figure 8. The use of a resistor divider circuit in front of the LVDS receiver attenuates the 422 differential signal to LVDS levels.

The resistors present a total differential load of  $100\ \Omega$  to match the characteristic impedance of the transmission line and to reduce the signal 10:1. The maximum 422 differential output signal of 6 V is reduced to 600 mV. The high input impedance of the LVDS receiver prevents input bias offsets and maintains a better than 200-mV differential input voltage threshold at the inputs to the divider. This circuit is used in front of each LVDS channel that also receives 422 signals.



NOTE A: The components used were standard values.

R1, R2 = NRC12F45R3TR, NIC Components, 45.3 Ohm, 1/8W, 1%, 1206 Package

R3, R4 = NRC12F5R11TR, NIC Components, 5.11 Ohm, 1/8W, 1%, 1206 Package

The resistor values do not need to be 1% tolerance. However, it can be difficult locating a supplier of resistors having values less than  $100\ \Omega$  in stock and readily available. The user may find other suppliers with comparable parts having tolerances of 5% or even 10%. These parts are adequate for use in this circuit.

**Figure 8. RS-422 Data Input to an LVDS Receiver Under Low Ground Noise Conditions**

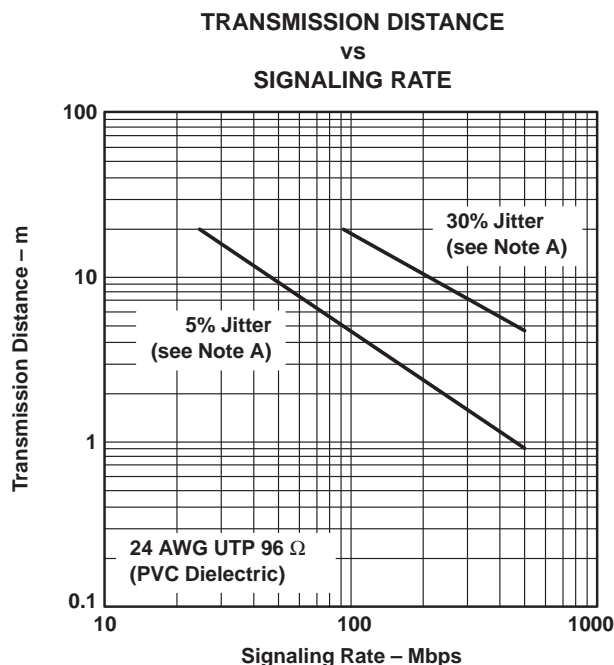
If ground noise between the RS-422 driver and LVDS receiver is a concern, then the common-mode voltage must be attenuated. The circuit must then be modified to connect the node between R3 and R4 to the LVDS receiver ground. This modification to the circuit increases the common-mode voltage from  $\pm 1$  V to greater than  $\pm 4.5$  V.

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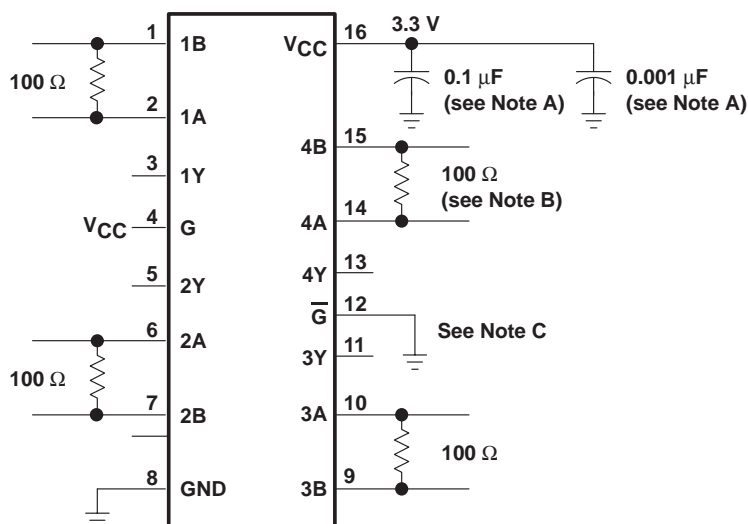
## APPLICATIONS INFORMATION

The devices are generally used as building blocks for high-speed point-to-point data transmission where ground differences are less than 1 V. Devices can interoperate with RS-422, PECL, and IEEE-P1596. Drivers/receivers approach ECL speeds without the power and dual supply requirements.



NOTE A: This parameter is the percentage of distortion of the unit interval (UI) with a pseudo-random data pattern.

**Figure 9. Typical Transmission Distance Versus Signaling Rate**



- NOTES: A. Place a 0.1  $\mu\text{F}$  and a 0.001  $\mu\text{F}$  Z5U ceramic, mica or polystyrene dielectric, 0805 size, chip capacitor between  $V_{CC}$  and the ground plane. The capacitors should be located as close as possible to the device terminals.  
 B. The termination resistance value should match the nominal characteristic impedance of the transmission media with  $\pm 10\%$ .  
 C. Unused enable inputs should be tied to  $V_{CC}$  or GND as appropriate.

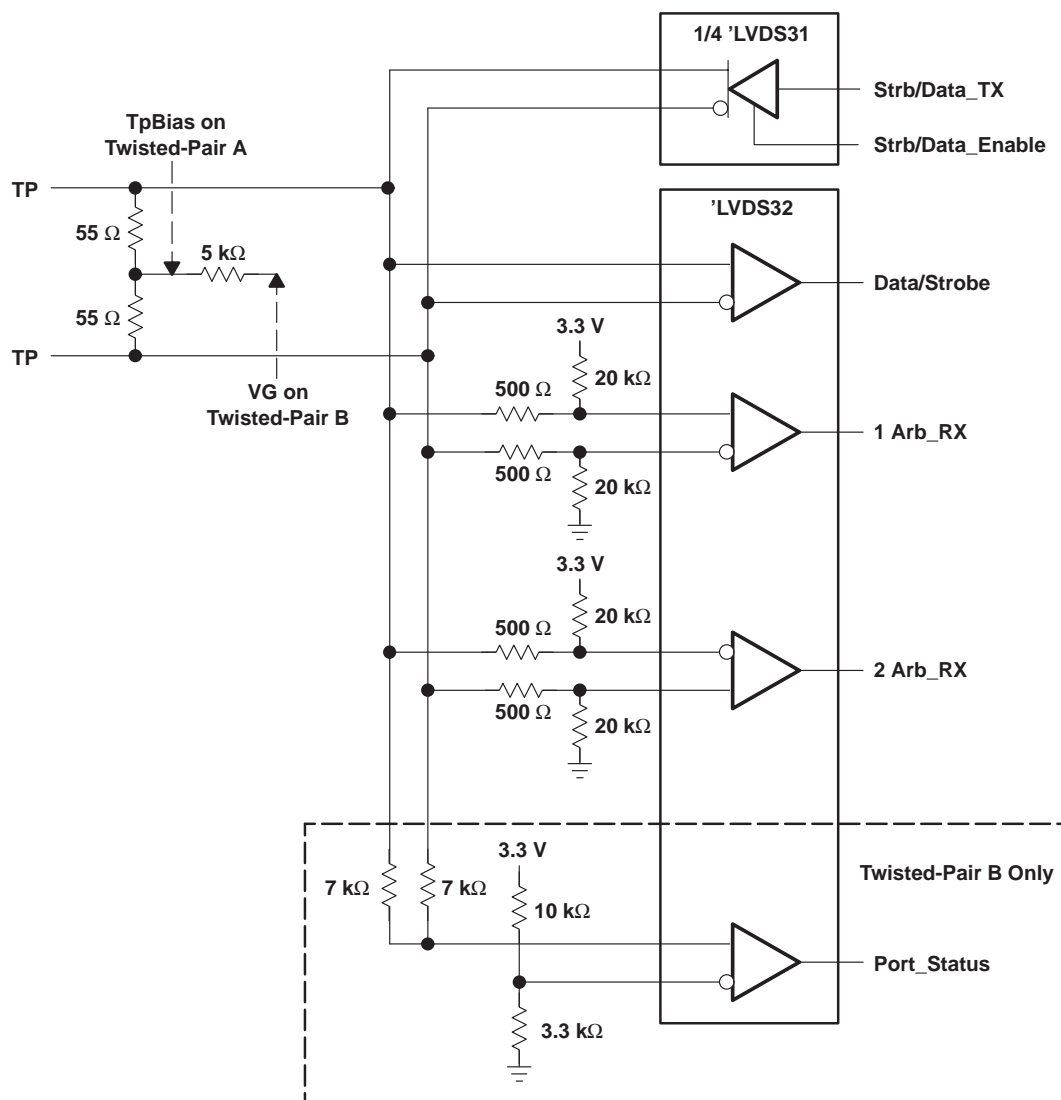
**Figure 10. Typical Application Circuit Schematic**



# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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## APPLICATION INFORMATION



- NOTES: A. Resistors are leadless thick-film (0603) 5% tolerance.  
 B. Decoupling capacitance is not shown but recommended.  
 C.  $V_{CC}$  is 3 V to 3.6 V.  
 D. The differential output voltage of the 'LVDS31 can exceed that allowed by IEEE1394.

Figure 11. 100-Mbps IEEE 1394 Transceiver

APPLICATION INFORMATION

fail safe

One of the most common problems with differential signaling applications is how the system responds when no differential voltage is present on the signal pair. The LVDS receiver is like most differential line receivers, in that its output logic state can be indeterminate when the differential input voltage is between  $-100\text{ mV}$  and  $100\text{ mV}$  if it is within its recommended input common-mode voltage range. TI's LVDS receiver is different in how it handles the open-input circuit situation, however.

Open-circuit means that there is little or no input current to the receiver from the data line itself. This could be when the driver is in a high-impedance state or the cable is disconnected. When this occurs, the LVDS receiver will pull each line of the signal pair to near  $V_{CC}$  through  $300\text{-k}\Omega$  resistors as shown in Figure 11. The fail-safe feature uses an AND gate with input voltage thresholds at about  $2.3\text{ V}$  to detect this condition and force the output to a high level, regardless of the differential input voltage.

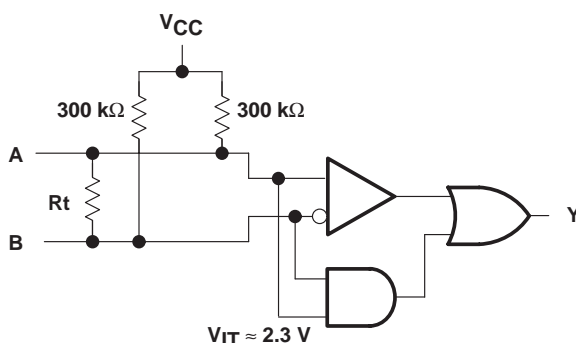


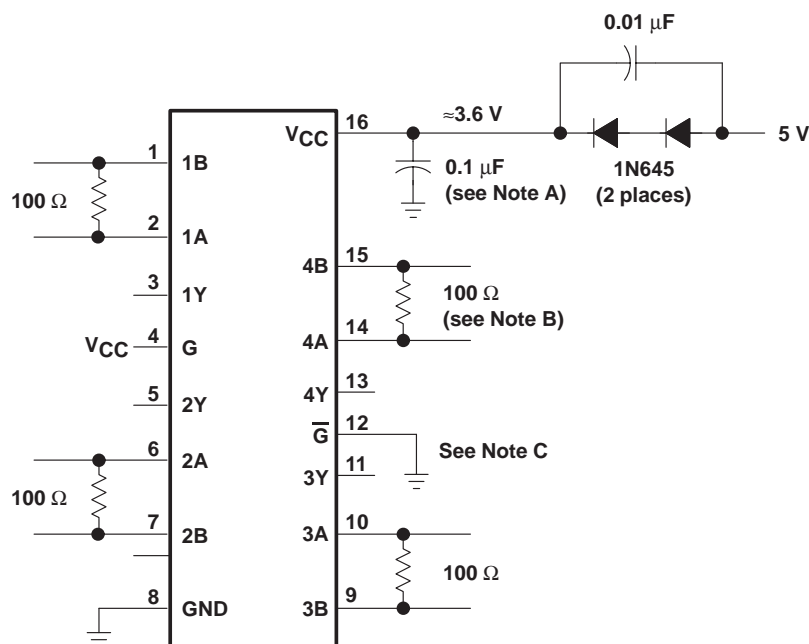
Figure 12. Open-Circuit Fail Safe of the LVDS Receiver

It is only under these conditions that the output of the receiver will be valid with less than a  $100\text{-mV}$  differential input voltage magnitude. The presence of the termination resistor,  $R_t$ , does not affect the fail-safe function as long as it is connected as shown in the figure. Other termination circuits may allow a dc current to ground that could defeat the pull-up currents from the receiver and the fail-safe feature.

# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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## APPLICATION INFORMATION



- NOTES: A. Place a 0.1  $\mu\text{F}$  Z5U ceramic, mica or polystyrene dielectric, 0805 size, chip capacitor between  $V_{CC}$  and the ground plane. The capacitor should be located as close as possible to the device terminals.
- B. The termination resistance value should match the nominal characteristic impedance of the transmission media with  $\pm 10\%$ .
- C. Unused enable inputs should be tied to  $V_{CC}$  or GND as appropriate.

Figure 13. Operation with 5-V Supply

### related information

IBIS modeling is available for this device. Please contact the local TI sales office or the TI Web site at [www.ti.com](http://www.ti.com) for more information.

For more application guidelines, please see the following documents:

- *Low-Voltage Differential Signalling Design Notes* (TI literature number SLLA014)
- *Interface Circuits for TIA/EIA-644 (LVDS)* (SLLA038)
- *Reducing EMI with LVDS* (SLLA030)
- *Slew Rate Control of LVDS Circuits* (SLLA034)
- *Using an LVDS Receiver with RS-422 Data* (SLLA031)
- *Evaluating the LVDS EVM* (SLLA033)



# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

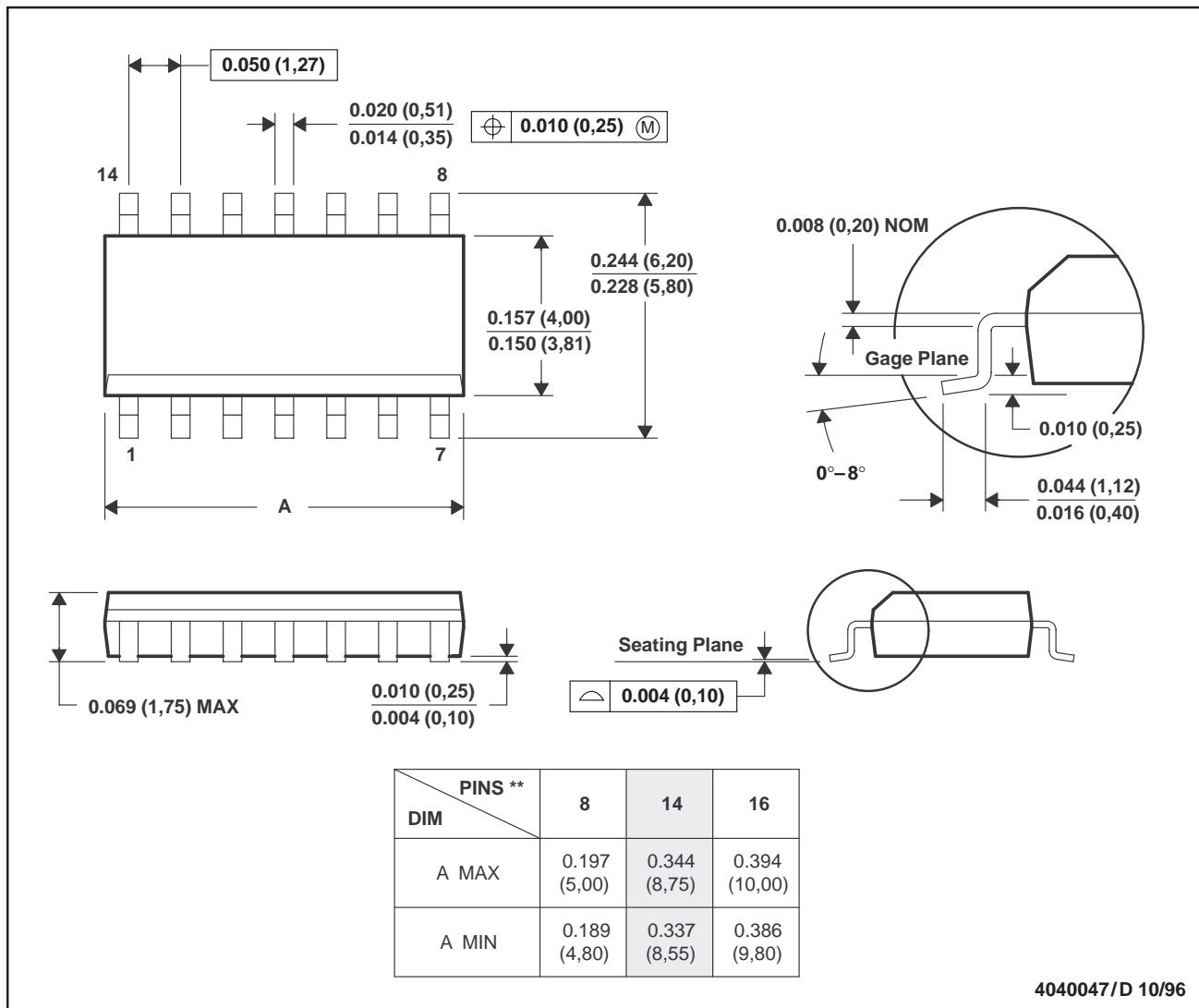
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## MECHANICAL INFORMATION

D (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012

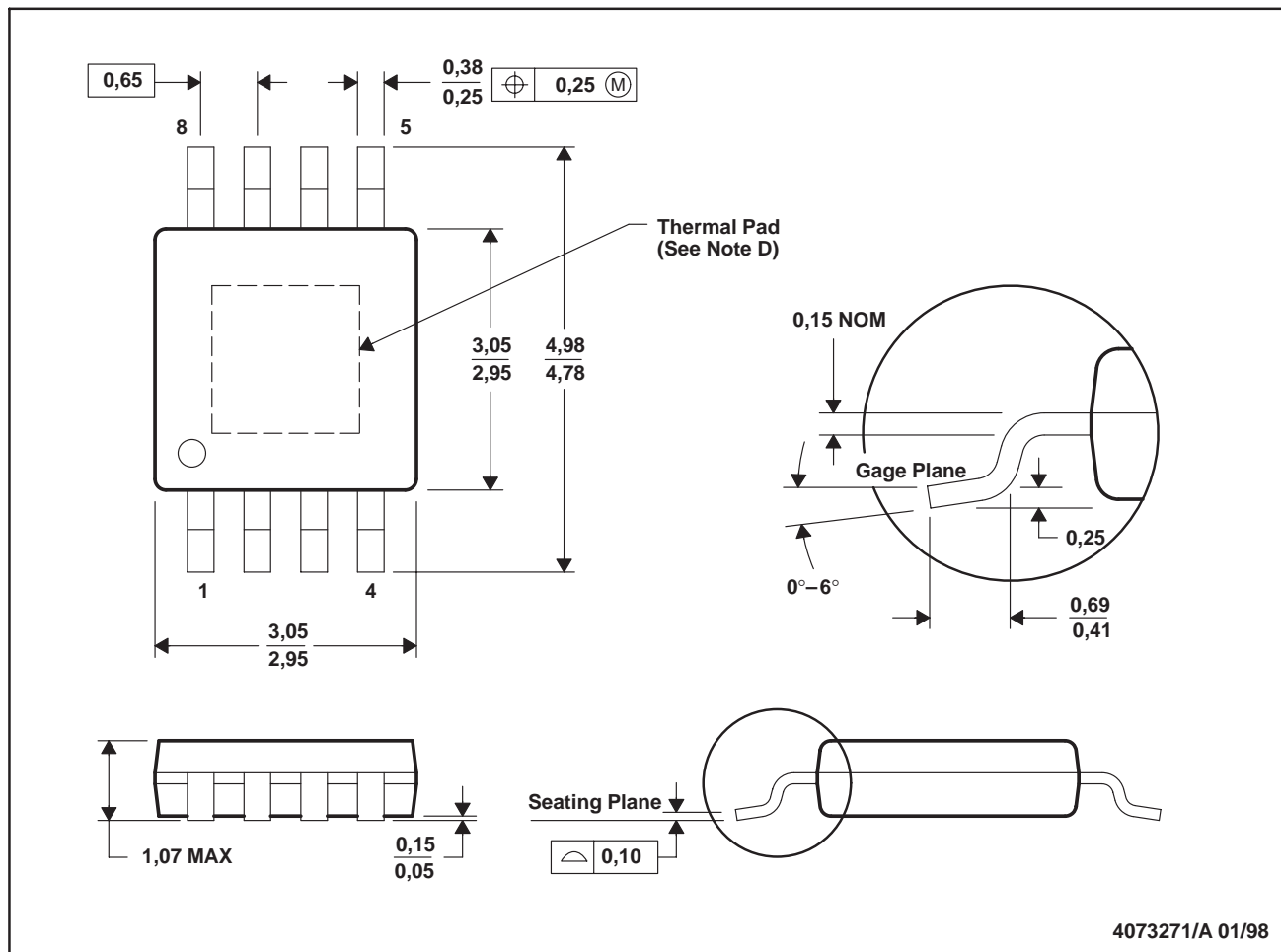
# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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## MECHANICAL INFORMATION

DGN (S-PDSO-G8)

PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions include mold flash or protrusions.
  - D. The package thermal performance may be enhanced by attaching an external heat sink to the thermal pad. This pad is electrically and thermally connected to the backside of the die and possibly selected leads.
  - E. Falls within JEDEC MO-187

PowerPAD is a trademark of Texas Instruments Incorporated.



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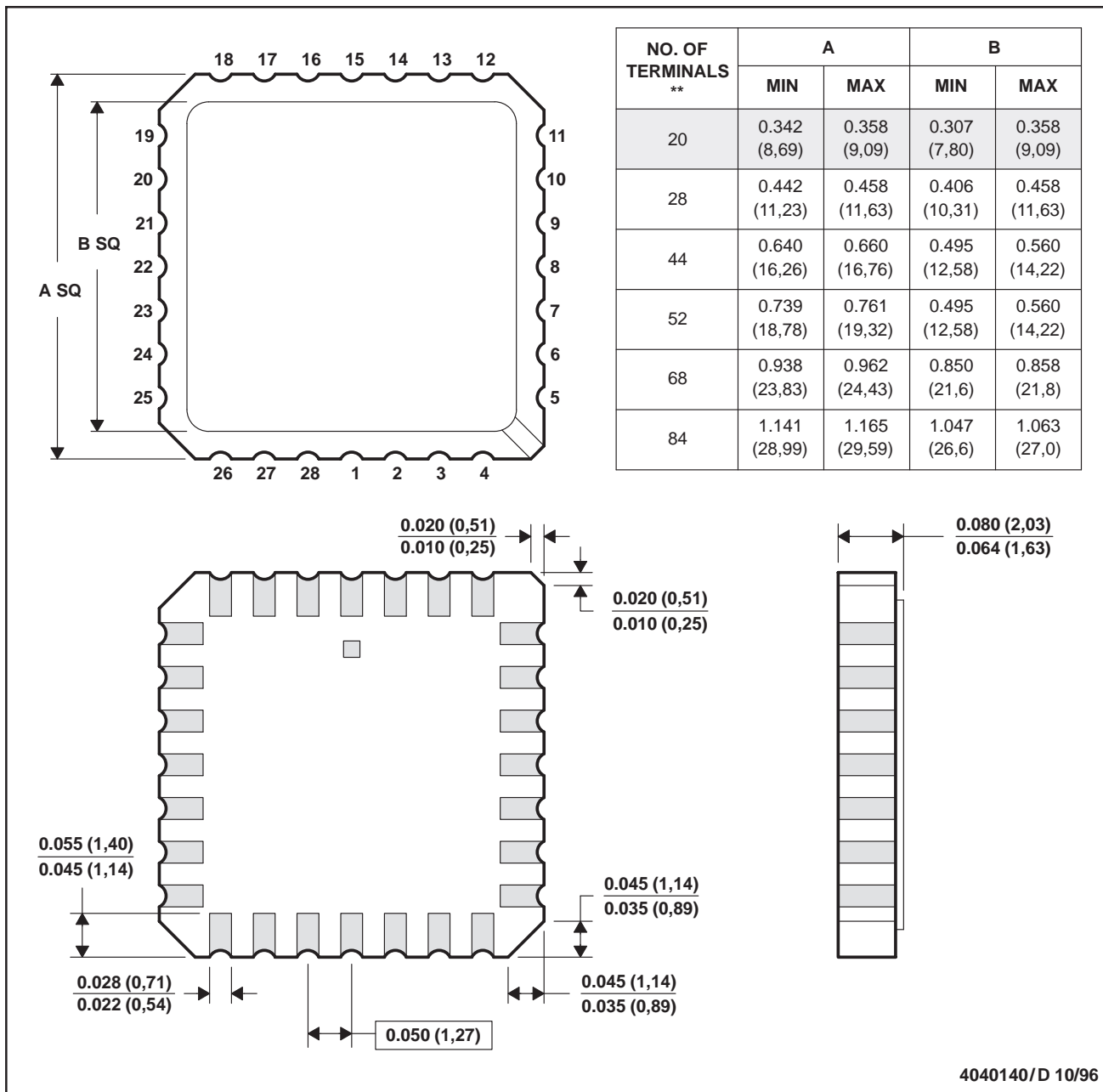
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## MECHANICAL INFORMATION

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a metal lid.  
 D. The terminals are gold plated.  
 E. Falls within JEDEC MS-004



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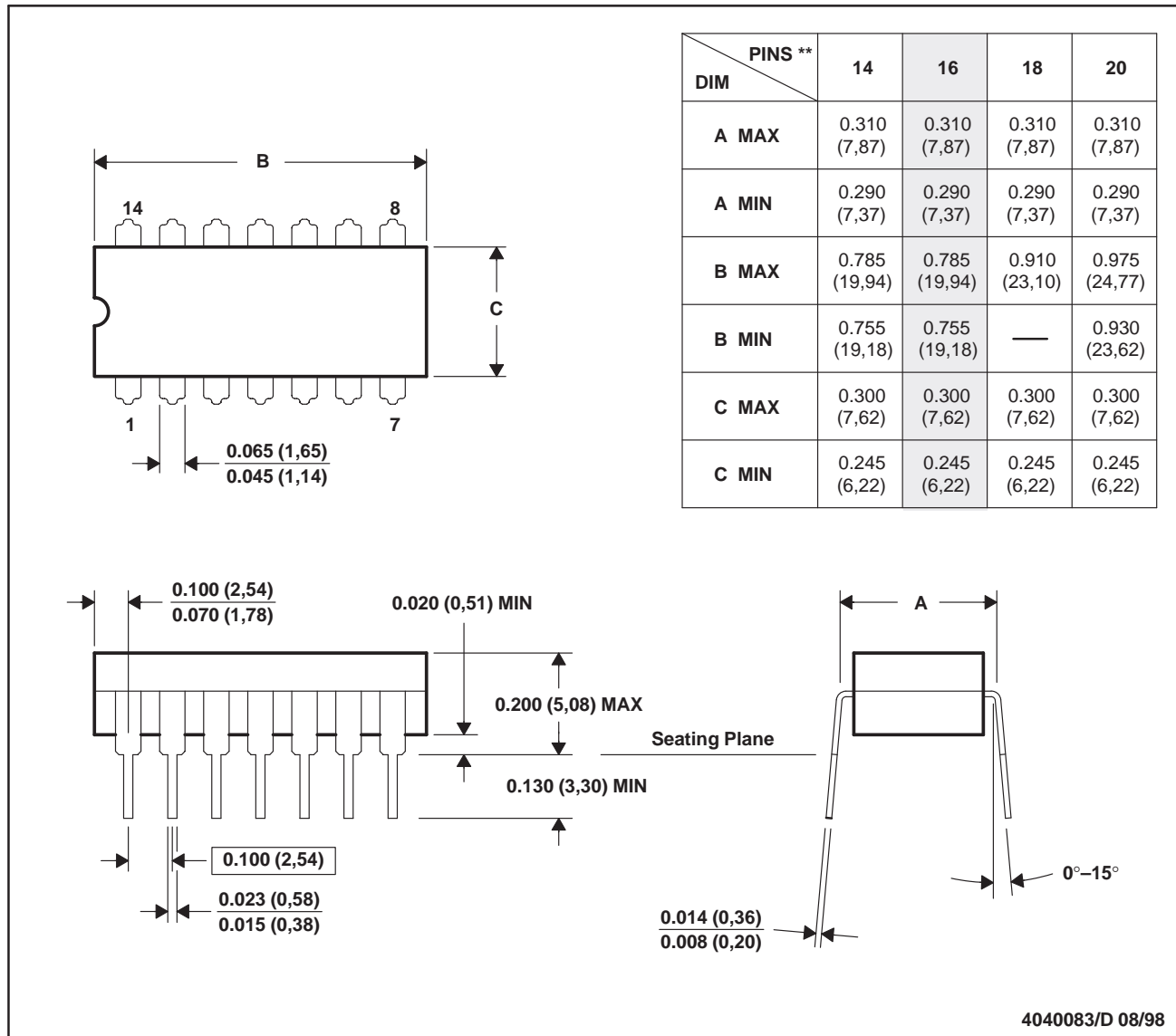
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## MECHANICAL INFORMATION

J (R-GDIP-T\*\*)

CERAMIC DUAL-IN-LINE PACKAGE

14 PIN SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18, GDIP1-T20, and GDIP1-T22.

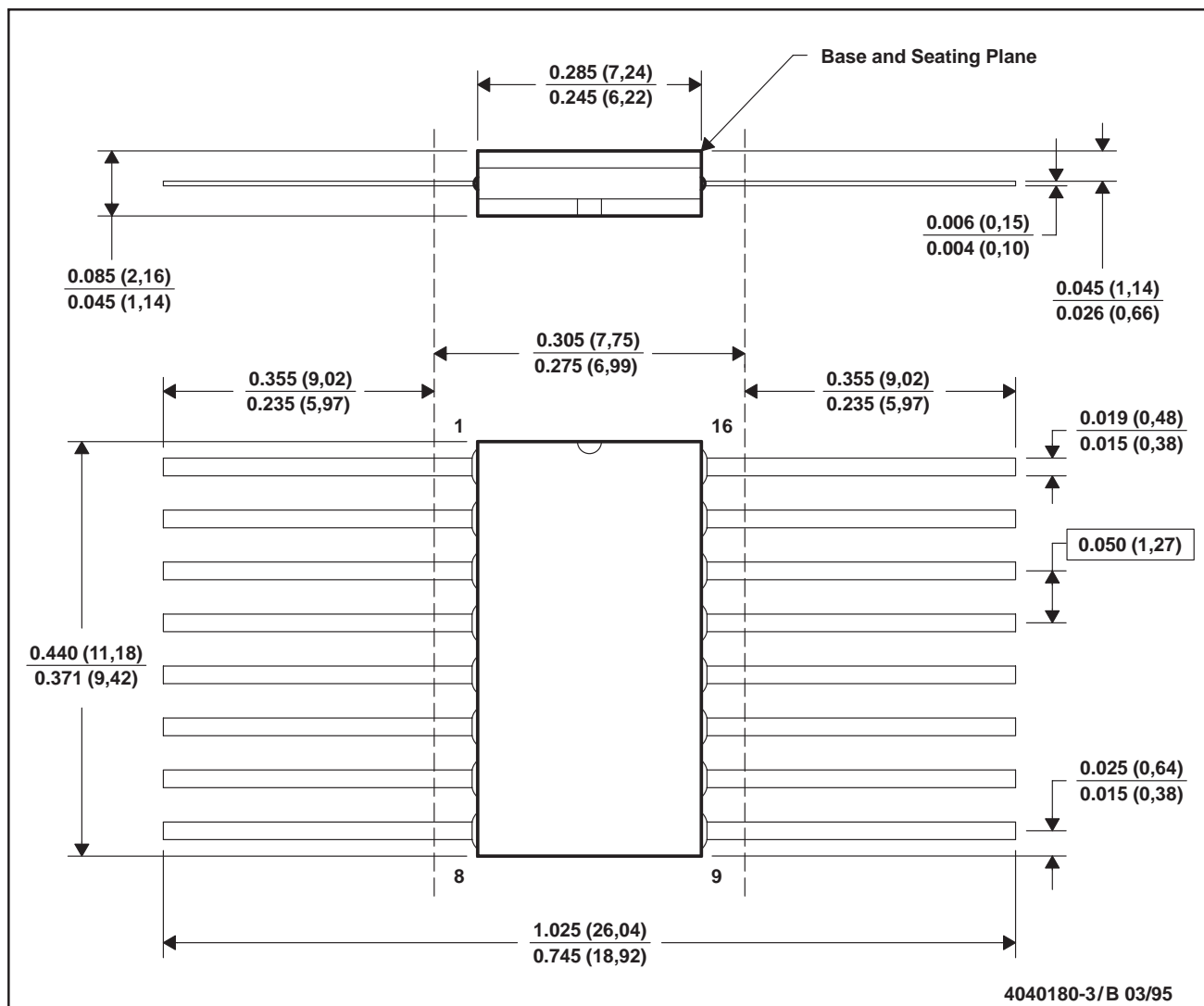
# SN55LVDS32, SN65LVDS32, SN65LVDS3486, SN65LVDS9637 HIGH-SPEED DIFFERENTIAL LINE RECEIVERS

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## MECHANICAL INFORMATION

W (R-GDFP-F16)

CERAMIC DUAL FLATPACK



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only.  
 E. Falls within MIL-STD-1835 GDFP1-F16 and JEDEC MO-092AC

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