

# SN65LBC180, SN75LBC180

## LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIRS

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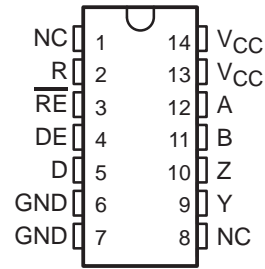
- Designed for High-Speed Multipoint Data Transmission Over Long Cables
- Operate With Pulse Durations as Low as 30 ns
- Low Supply Current . . . 5 mA Max
- Meet or Exceed the Requirements of ANSI Standard RS-485 and ISO 8482:1987(E)
- 3-State Outputs for Party-Line Buses
- Common-Mode Voltage Range of -7 V to 12 V
- Thermal Shutdown Protection Prevents Driver Damage From Bus Contention
- Positive and Negative Output Current Limiting
- Pin Compatible With the SN75ALS180

### description

The SN65LBC180 and SN75LBC180 differential driver and receiver pairs are monolithic integrated circuits designed for bidirectional data communication over long cables that take on the characteristics of transmission lines. They are balanced, or differential, voltage mode devices that meet or exceed the requirements of industry standards ANSI RS-485 and ISO 8482:1987(E). Both devices are designed using TI's proprietary LinBiCMOS™ with the low power consumption of CMOS and the precision and robustness of bipolar transistors in the same circuit.

Both the SN65LBC180 and SN75LBC180 combine a differential line driver and receiver with 3-state outputs and operate from a single 5-V supply. The driver and receiver have active-high and active-low enables, respectively, which can be externally connected to function as a direction control. The driver differential outputs and the receiver differential inputs are connected to separate terminals for full-duplex operation and are designed to present minimum loading to the bus whether disabled or powered off ( $V_{CC} = 0$ ). These parts feature a wide common-mode voltage range making them suitable for point-to-point or multipoint data-bus applications.

**D OR N PACKAGE  
(TOP VIEW)**



NC—No internal connection

### Function Tables

#### DRIVER

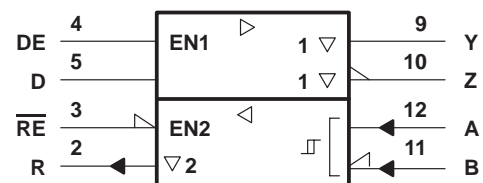
| INPUT<br>D | ENABLE<br>DE | OUTPUTS |   |
|------------|--------------|---------|---|
|            |              | Y       | Z |
| H          | H            | H       | L |
| L          | H            | L       | H |
| X          | L            | Z       | Z |

#### RECEIVER

| DIFFERENTIAL INPUTS<br>A-B  | ENABLE<br>RE | OUTPUT<br>R |
|-----------------------------|--------------|-------------|
| $V_{ID} \geq 0.2$ V         | L            | H           |
| $-0.2$ V < $V_{ID} < 0.2$ V | L            | ?           |
| $V_{ID} \leq -0.2$ V        | L            | L           |
| X                           | H            | Z           |
| Open circuit                | L            | H           |

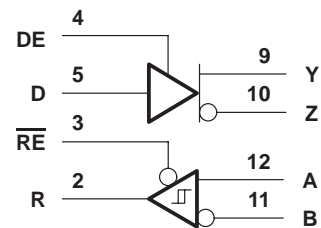
H = high level, L = low level, ? = indeterminate, X = irrelevant, Z = high impedance (off)

### logic symbol†



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

### logic diagram (positive logic)



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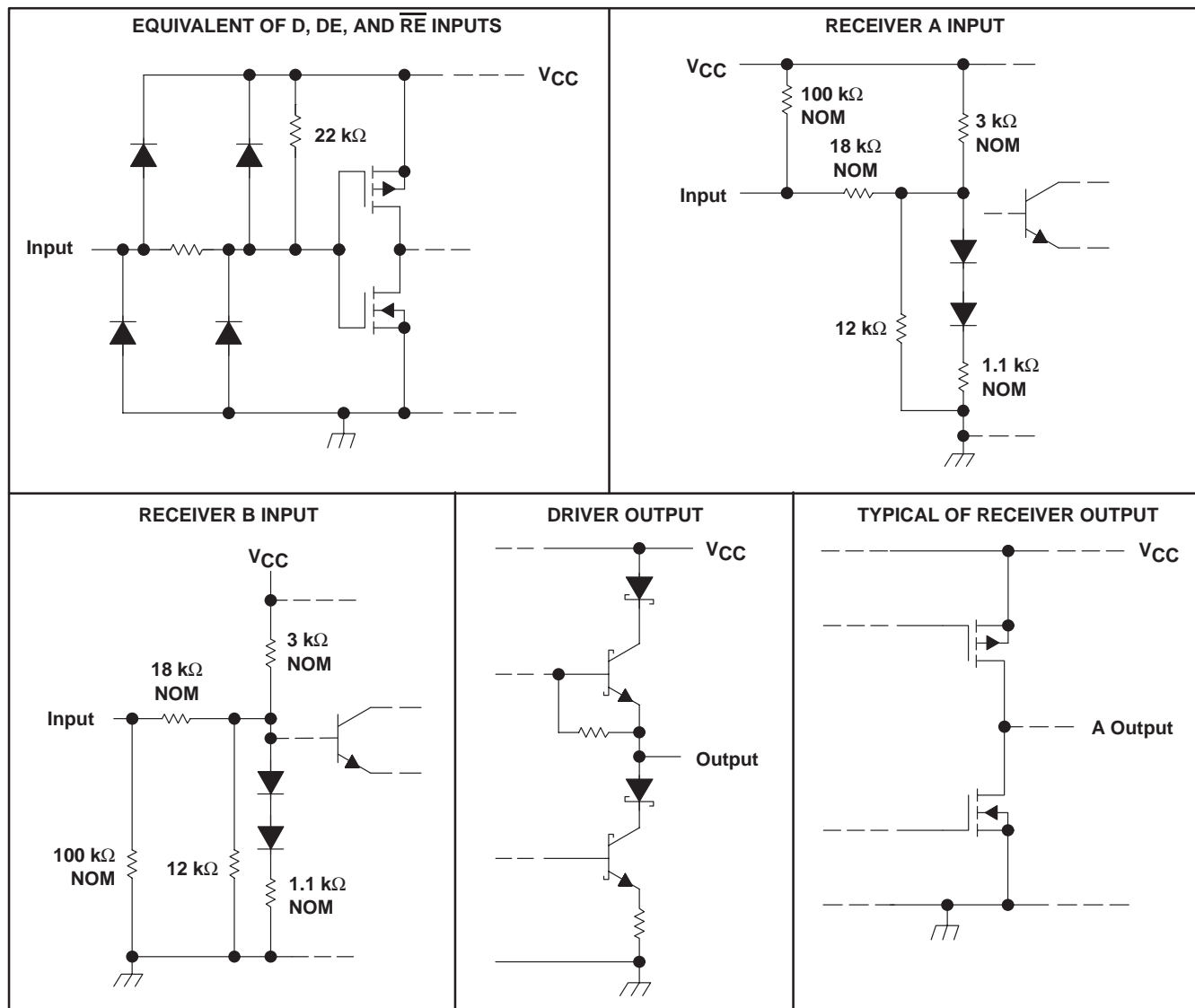
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## description (continued)

The devices also provide positive and negative output-current limiting and thermal shutdown for protection from line fault conditions. The line driver shuts down at a junction temperature of approximately 172°C.

The SN65LBC180 and SN75LBC180 are available in the 14-pin dual-in-line and small-outline packages. The SN75LBC180 is characterized for operation over the commercial temperature range of 0°C to 70°C. The SN65LBC180 is characterized over the industrial temperature range of -40°C to 85°C.

## schematics of inputs and outputs



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

|  |                              |
|--|------------------------------|
| Supply voltage range, $V_{CC}$ (see Note 1)                  | –0.3 V to 7 V                |
| Input voltage range, $V_I$ (A, B)(see Note 1)                | –10 V to 15 V                |
| Voltage range at D, R, DE, $\overline{RE}$ (see Note 1)      | –0.3 V to $V_{CC} + 0.5$ V   |
| Continuous total power dissipation (see Note 2)              | Internally limited           |
| Total power dissipation                                      | See Dissipation Rating Table |
| Operating free-air temperature range, $T_A$ : SN65LBC180     | –40°C to 85°C                |
| SN75LBC180   | 0°C to 70°C                  |
| 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.

- NOTES: 1. All voltage values are with respect to GND.  
2. The maximum operating junction temperature is internally limited. Use the dissipation rating table to operate below this temperature.

**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 |
|---------|---|---|--|--|
| D       | 950 mW                                      | 7.6 mW/°C   | 608 mW                                   | 494 mW                                   |
| N       | 1150 mW                                     | 9.2 mW/°C   | 736 mW                                   | 598 mW                                   |

## recommended operating conditions

|  |                            | MIN  | NOM | MAX  | UNIT |
|--|----------------------------|------|-----|------|------|
| Supply voltage, $V_{CC}$   |                            | 4.75 | 5   | 5.25 | V    |
| High-level input voltage, $V_{IH}$   | D, DE, and $\overline{RE}$ | 2    |     |      | V    |
| Low-level input voltage, $V_{IL}$  | D, DE, and $\overline{RE}$ |      |     | 0.8  | V    |
| Differential input voltage, $V_{ID}$   |                            | –6‡  |     | 6    | V    |
| Voltage at any bus terminal (separately or common mode), $V_O$ , $V_I$ , or $V_{IC}$ | A, B, Y, or Z              | –7‡  |     | 12   | V    |
| High-level output current, $I_{OH}$  | Y or Z                     |      |     | –60  | mA   |
|  | R                          |      |     | –8   |      |
| Low-level output current, $I_{OL}$   | Y or Z                     |      |     | 60   | mA   |
|  | R                          |      |     | 8    |      |
| Operating free-air temperature, $T_A$  | SN65LBC180                 | –40  |     | 85   | °C   |
|  | SN75LBC180                 | 0    |     | 70   |      |

‡ The algebraic convention where the least positive (more negative) limit is designated minimum, is used in this data sheet for the differential input voltage, voltage at any bus terminal, operating temperature, input threshold voltage, and common-mode output voltage.



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## DRIVER SECTION

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

| PARAMETER         |   | TEST CONDITIONS                                    |                  | MIN | TYP† | MAX  | UNIT |
|-------------------|---|--|------------------|-----|------|------|------|
| V <sub>IK</sub>   | Input clamp voltage   | I <sub>I</sub> = -18 mA                            |                  |     |      | -1.5 | V    |
| V <sub>OD</sub>   | Differential output voltage magnitude (see Note 3)              | R <sub>L</sub> = 54 Ω,<br>See Figure 1             | SN65LBC180       | 1.1 | 2.5  | 5    | V    |
|                   |   |  | SN75LBC180       | 1.5 | 2.5  | 5    |      |
|                   |   | R <sub>L</sub> = 60 Ω,<br>See Figure 2             | SN65LBC180       | 1.1 | 2    | 5    |      |
|                   |   |  | SN75LBC180       | 1.5 | 2    | 5    |      |
| Δ V <sub>OD</sub> | Change in magnitude of differential output voltage (see Note 4) | See Figures 1 and 2                                |                  |     |      | ±0.2 | V    |
| V <sub>OC</sub>   | Common-mode output voltage                                      | R <sub>L</sub> = 54 Ω, See Figure 1                |                  | 1   | 2.5  | 3    | V    |
| Δ V <sub>OC</sub> | Change in magnitude of common-mode output voltage (see Note 4)  |  |                  |     |      | ±0.2 | V    |
| I <sub>O</sub>    | Output current with power off                                   | V <sub>CC</sub> = 0, V <sub>O</sub> = -7 V to 12 V |                  |     |      | ±100 | μA   |
| I <sub>OZ</sub>   | High-impedance-state output current                             | V <sub>O</sub> = -7 V to 12 V                      |                  |     |      | ±100 | μA   |
| I <sub>IH</sub>   | High-level input current  | V <sub>I</sub> = 2.4 V                             |                  |     |      | -100 | μA   |
| I <sub>IL</sub>   | Low-level input current   | V <sub>I</sub> = 0.4 V                             |                  |     |      | -100 | μA   |
| I <sub>OS</sub>   | Short-circuit output current                                    | -7 V ≤ V <sub>O</sub> ≤ 12 V                       |                  |     |      | ±250 | mA   |
| I <sub>CC</sub>   | Supply current  | Receiver disabled                                  | Outputs enabled  |     |      | 5    | mA   |
|                   |   |  | Outputs disabled |     |      | 3    |      |

† All typical values are at V<sub>CC</sub> = 5 V and T<sub>A</sub> = 25°C.

NOTES: 3. The minimum V<sub>OD</sub> specification of the SN65LBC180 may not fully comply with ANSI RS-485 at operating temperatures below 0°C. System designers should take the possibly lower output signal into account in determining the maximum signal-transmission distance.

4. Δ|V<sub>OD</sub>| and Δ|V<sub>OC</sub>| are the changes in the steady-state magnitude of V<sub>OD</sub> and V<sub>OC</sub>, respectively, that occur when the input is changed from a high level to a low level.

### switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C

| PARAMETER          |                                     | TEST CONDITIONS                      |  | MIN | TYP | MAX | UNIT |
|--------------------|-------------------------------------|--------------------------------------|--|-----|-----|-----|------|
| t <sub>d(OD)</sub> | Differential output delay time      | R <sub>L</sub> = 54 Ω, See Figure 3  |  | 7   | 12  | 18  | ns   |
| t <sub>t(OD)</sub> | Differential output transition time |                                      |  | 5   | 10  | 20  | ns   |
| t <sub>pZH</sub>   | Output enable time to high level    | R <sub>L</sub> = 110 Ω, See Figure 4 |  |     |     | 35  | ns   |
| t <sub>pZL</sub>   | Output enable time to low level     | R <sub>L</sub> = 110 Ω, See Figure 5 |  |     |     | 35  | ns   |
| t <sub>pHZ</sub>   | Output disable time from high level | R <sub>L</sub> = 110 Ω, See Figure 4 |  |     |     | 50  | ns   |
| t <sub>pLZ</sub>   | Output disable time from low level  | R <sub>L</sub> = 110 Ω, See Figure 5 |  |     |     | 35  | ns   |



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### RECEIVER SECTION

**electrical characteristics over recommended operating conditions (unless otherwise noted)**

| PARAMETER |  | TEST CONDITIONS   | MIN              | TYP  | MAX      | UNIT          |
|-----------|--|---|------------------|------|----------|---------------|
| $V_{IT+}$ | Positive-going input threshold voltage     | $I_O = -8 \text{ mA}$   |                  |      | 0.2      | V             |
| $V_{IT-}$ | Negative-going input threshold voltage     | $I_O = 8 \text{ mA}$  | -0.2             |      |          | V             |
| $V_{hys}$ | Hysteresis voltage ( $V_{IT+} - V_{IT-}$ ) |   |                  | 45   |          | mV            |
| $V_{IK}$  | Enable-input clamp voltage                 | $I_I = -18 \text{ mA}$  |                  |      | -1.5     | V             |
| $V_{OH}$  | High-level output voltage                  | $V_{ID} = 200 \text{ mV}$ , $I_{OH} = -8 \text{ mA}$                  | 3.5              | 4.5  |          | V             |
| $V_{OL}$  | Low-level output voltage                   | $V_{ID} = -200 \text{ mV}$ , $I_{OL} = 8 \text{ mA}$                  |                  | 0.3  | 0.5      | V             |
| $I_{OZ}$  | High-impedance-state output current        | $V_O = 0 \text{ V to } V_{CC}$  |                  |      | $\pm 20$ | $\mu\text{A}$ |
| $I_{IH}$  | High-level enable-input current            | $V_{IH} = 2.4 \text{ V}$  |                  |      | -50      | $\mu\text{A}$ |
| $I_{IL}$  | Low-level enable-input current             | $V_{IL} = 0.4 \text{ V}$  |                  |      | -100     | $\mu\text{A}$ |
| $I_I$     | Bus input current                          | $V_I = 12 \text{ V}$ , $V_{CC} = 5 \text{ V}$ ,<br>Other input at 0 V |                  | 0.7  | 1        | mA            |
|           |  | $V_I = 12 \text{ V}$ , $V_{CC} = 0 \text{ V}$ ,<br>Other input at 0 V |                  | 0.8  | 1        |               |
|           |  | $V_I = -7 \text{ V}$ , $V_{CC} = 5 \text{ V}$ ,<br>Other input at 0 V |                  | -0.5 | -0.8     |               |
|           |  | $V_I = -7 \text{ V}$ , $V_{CC} = 0 \text{ V}$ ,<br>Other input at 0 V |                  | -0.5 | -0.8     |               |
| $I_{CC}$  | Supply current                             | Driver disabled   | Outputs enabled  |      | 5        | mA            |
|           |  |   | Outputs disabled |      | 3        |               |

**switching characteristics,  $V_{CC} = 5 \text{ V}$ ,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |   | TEST CONDITIONS  | MIN | TYP | MAX | UNIT |
|-------------|---|--|-----|-----|-----|------|
| $t_{PHL}$   | Propagation delay time, high- to low-level output | $V_{ID} = -1.5 \text{ V to } 1.5 \text{ V}$ , See Figure 6 | 11  | 22  | 33  | ns   |
| $t_{PLH}$   | Propagation delay time, low- to high-level output |  | 11  | 22  | 33  | ns   |
| $t_{sk(p)}$ | Pulse skew ( $ t_{PHL} - t_{PLH} $ )              |  |     | 3   | 6   | ns   |
| $t_t$       | Transition time                                   |  |     | 5   | 8   | ns   |
| $t_{PZH}$   | Output enable time to high level                  | See Figure 7   |     |     | 35  | ns   |
| $t_{PZL}$   | Output enable time to low level                   |  |     |     | 30  | ns   |
| $t_{PHZ}$   | Output disable time from high level               |  |     |     | 35  | ns   |
| $t_{PLZ}$   | Output disable time from low level                |  |     |     | 30  | ns   |

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## PARAMETER MEASUREMENT INFORMATION

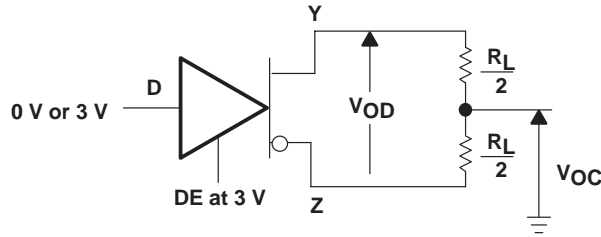


Figure 1. Differential and Common-Mode Output Voltages

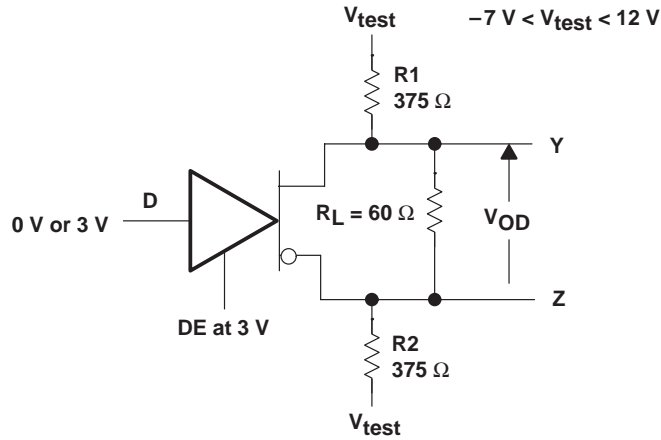
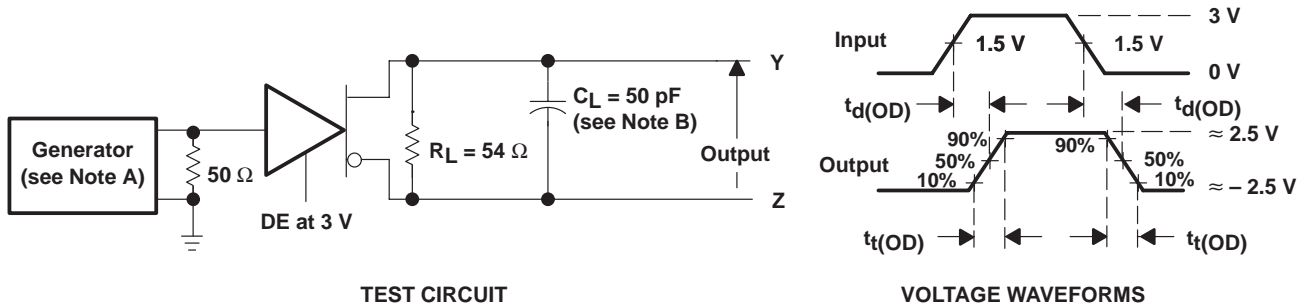


Figure 2. Driver  $V_{OD}$  Test Circuit



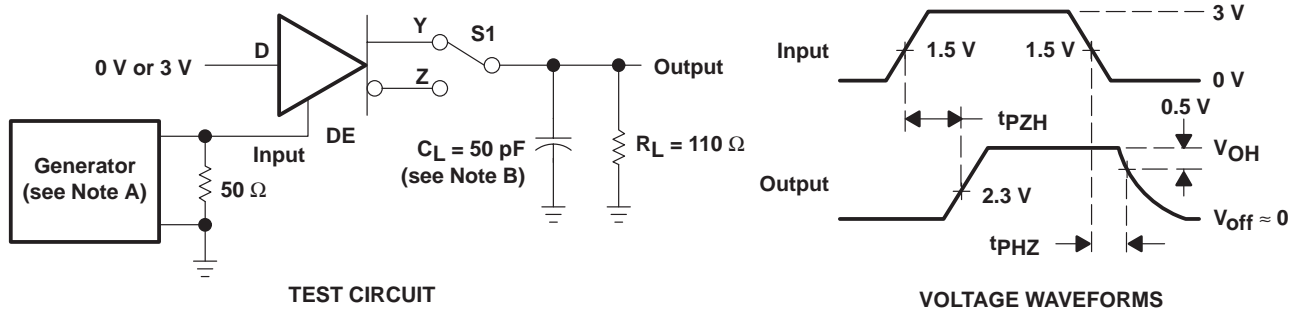
- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR > 1 MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_O = 50 \Omega$ .  
B.  $C_L$  includes probe and jig capacitance.

Figure 3. Driver Test Circuit and Differential Output Delay and Transition Time Voltage Waveforms

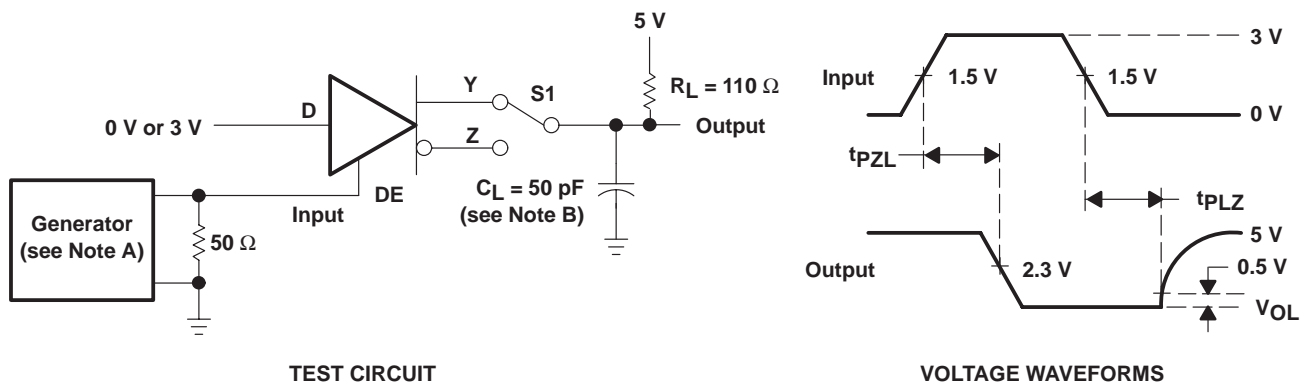
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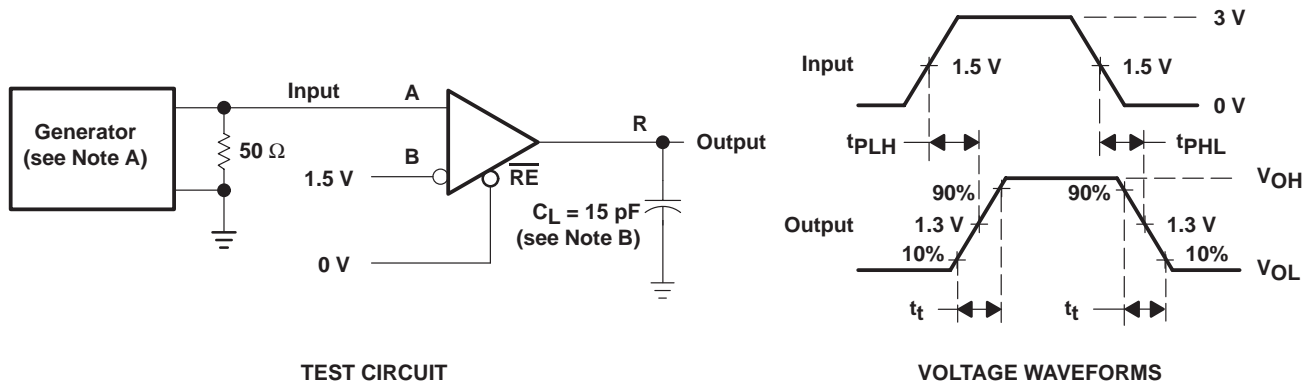
## PARAMETER MEASUREMENT INFORMATION



**Figure 4. Driver Test Circuit and Enable and Disable Time Waveforms**



**Figure 5. Driver Test Circuit and Enable and Disable Time Voltage Waveforms**



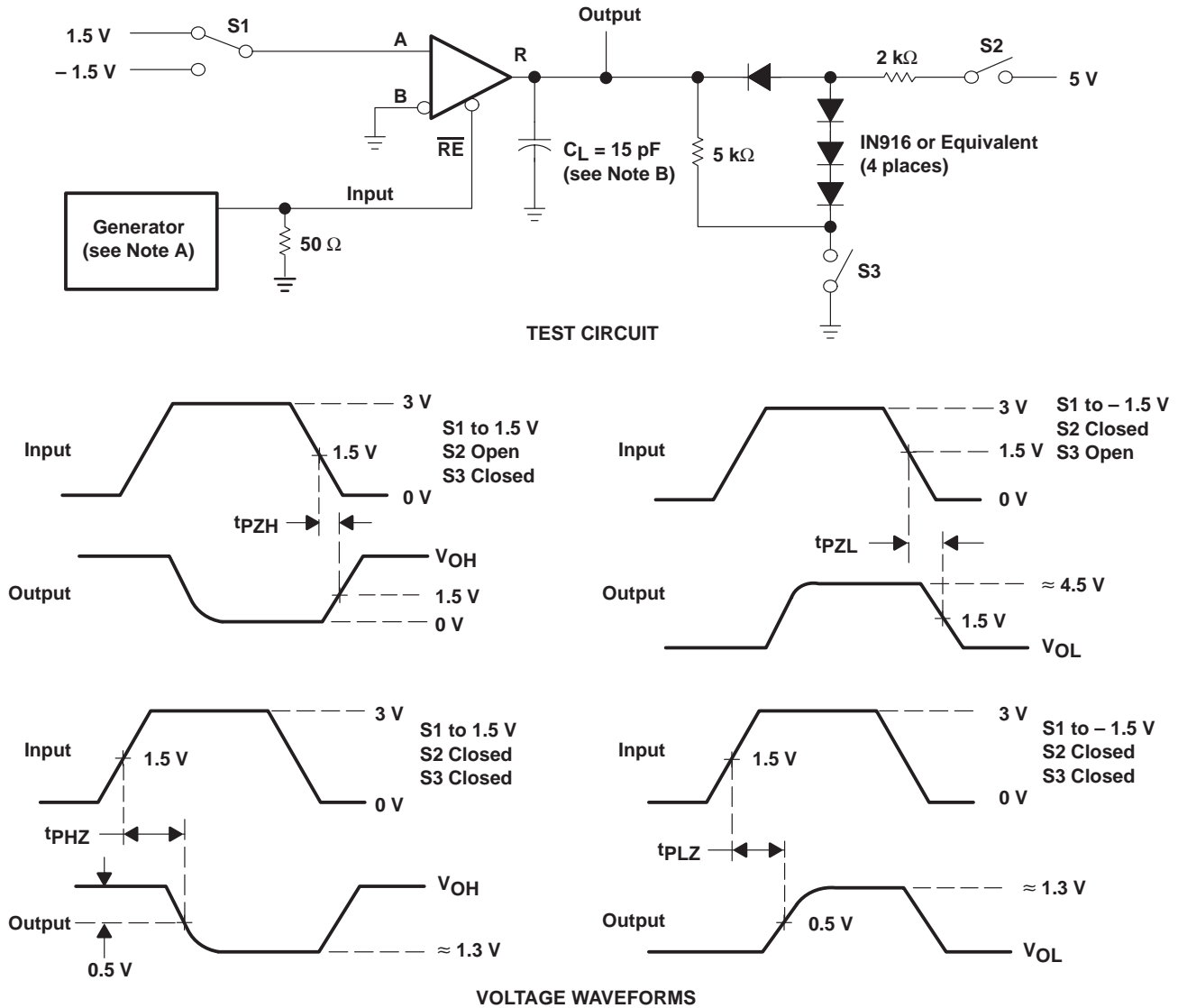
- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ , 50% duty cycle,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$ ,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

**Figure 6. Receiver Test Circuit and Propagation Delay Time Voltage Waveforms**

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## PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_0 = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

**Figure 7. Receiver Output Enable and Disable Times**



TYPICAL CHARACTERISTICS

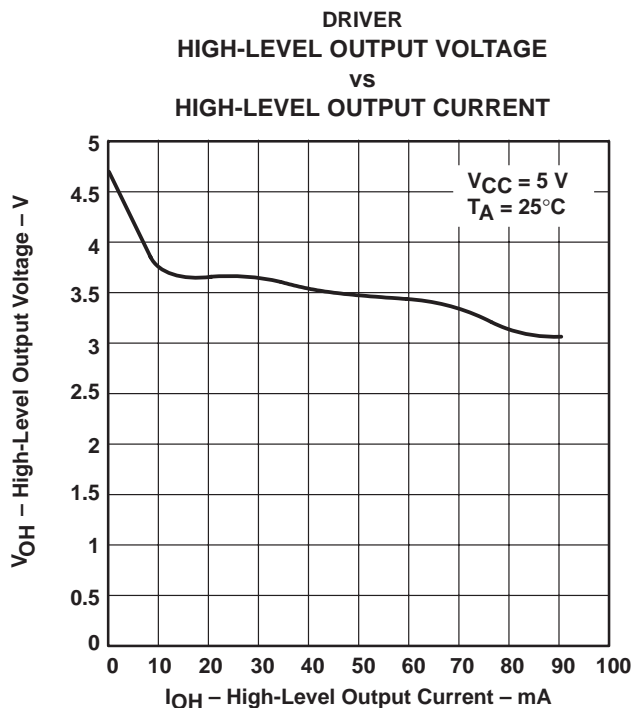


Figure 8

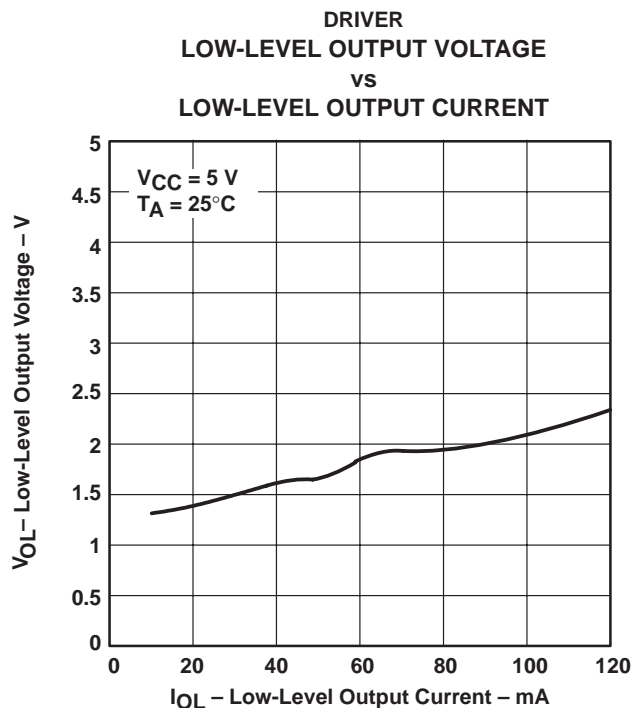


Figure 9

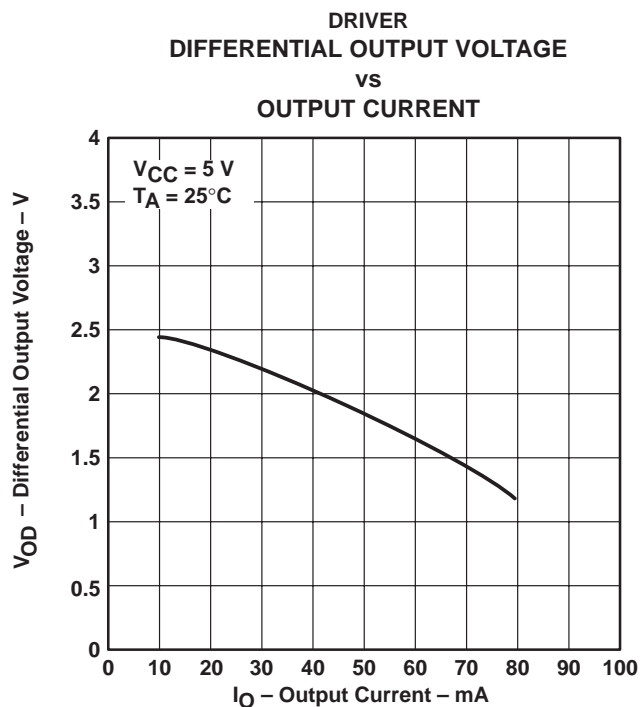


Figure 10

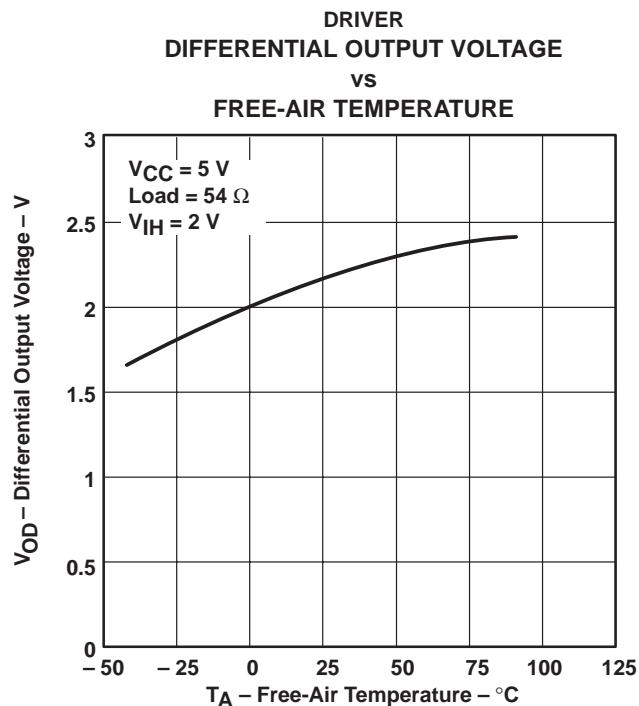


Figure 11

# SN65LBC180, SN75LBC180 LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIRS

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## TYPICAL CHARACTERISTICS

DRIVER  
DIFFERENTIAL DELAY TIMES  
vs  
FREE-AIR TEMPERATURE

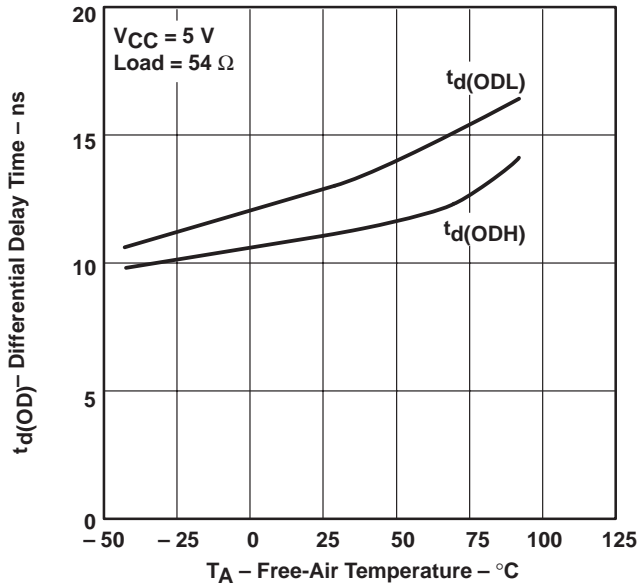


Figure 12

DRIVER  
OUTPUT CURRENT  
vs  
SUPPLY VOLTAGE

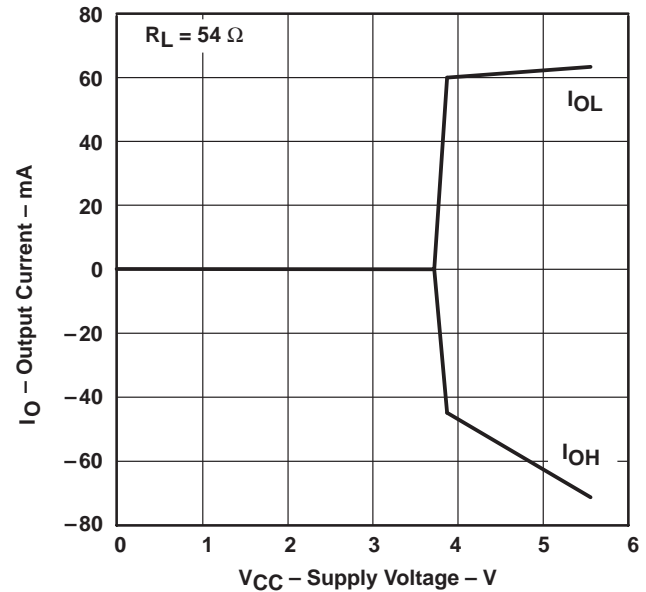


Figure 13

RECEIVER  
HIGH-LEVEL OUTPUT VOLTAGE  
vs  
HIGH-LEVEL OUTPUT CURRENT

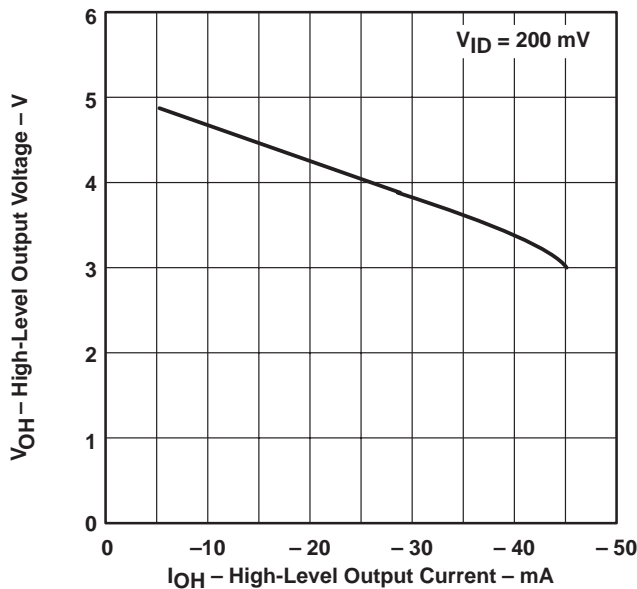


Figure 14

RECEIVER  
LOW-LEVEL OUTPUT VOLTAGE  
vs  
LOW-LEVEL OUTPUT CURRENT

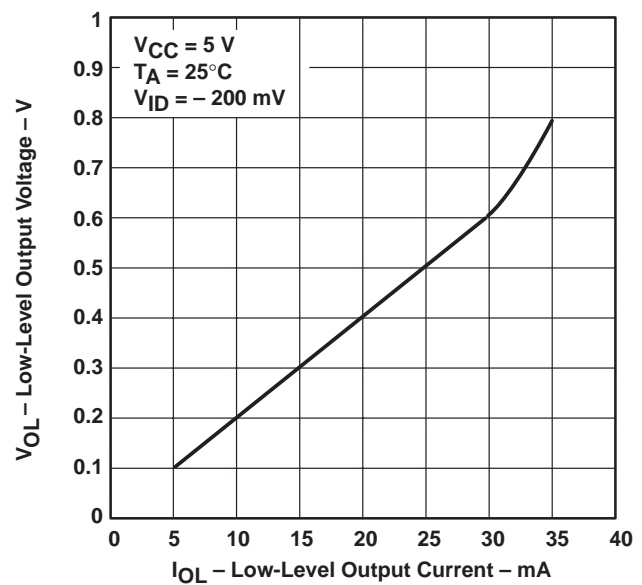
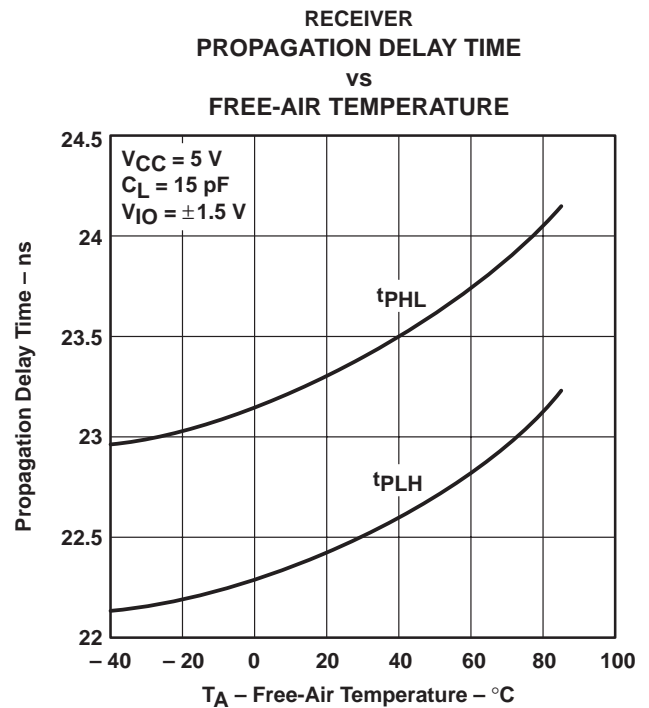
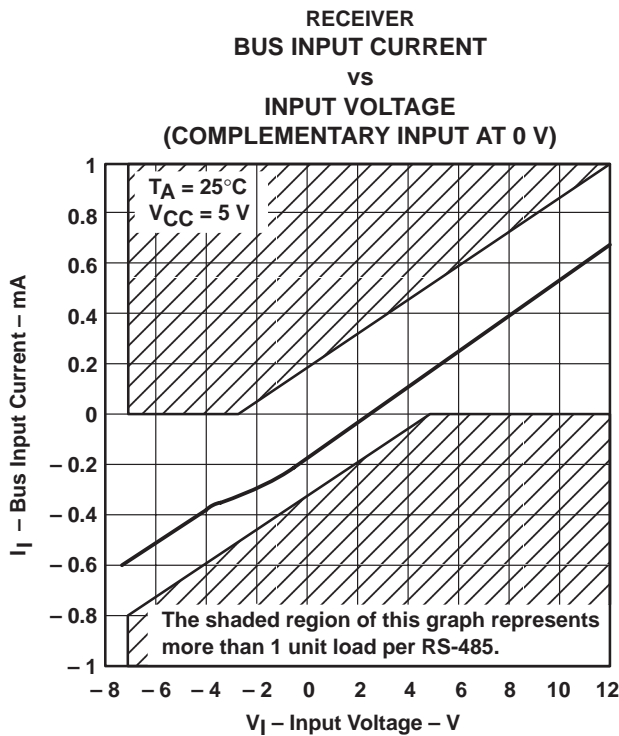
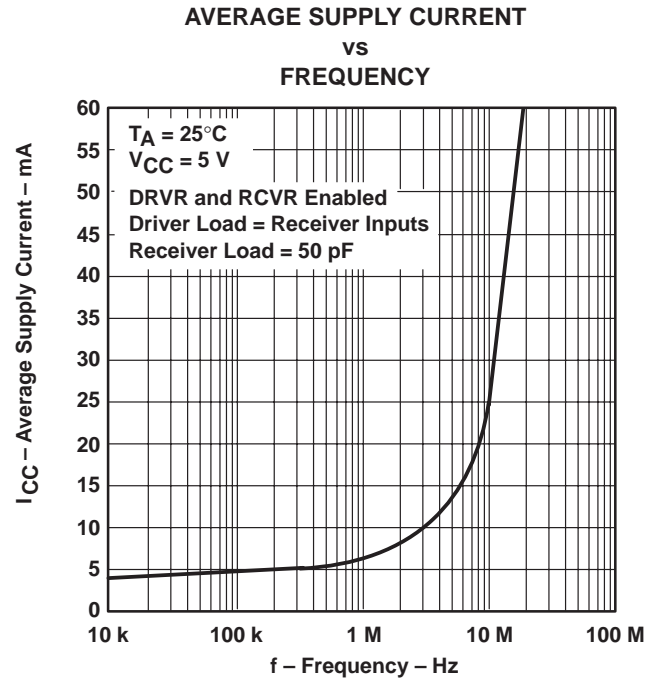
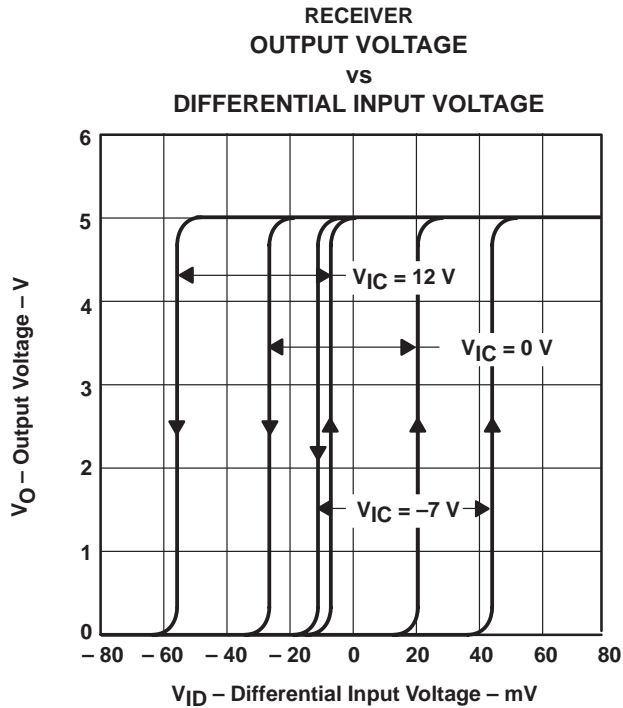


Figure 15

# SN65LBC180, SN75LBC180 LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIRS

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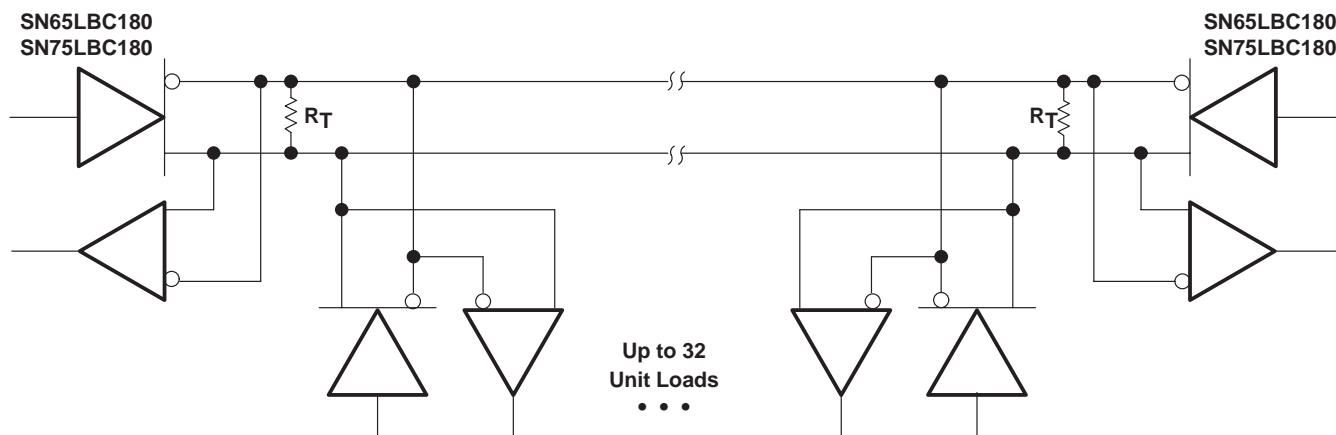
## TYPICAL CHARACTERISTICS



# SN65LBC180, SN75LBC180 LOW-POWER DIFFERENTIAL LINE DRIVER AND RECEIVER PAIRS

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## APPLICATION INFORMATION



NOTE A: The line should be terminated at both ends in its characteristic impedance ( $R_T = Z_0$ ). Stub lengths off the main line should be kept as short as possible. One SN75LBC180 typically represents less than one unit load.

Figure 20. Typical Application Circuit

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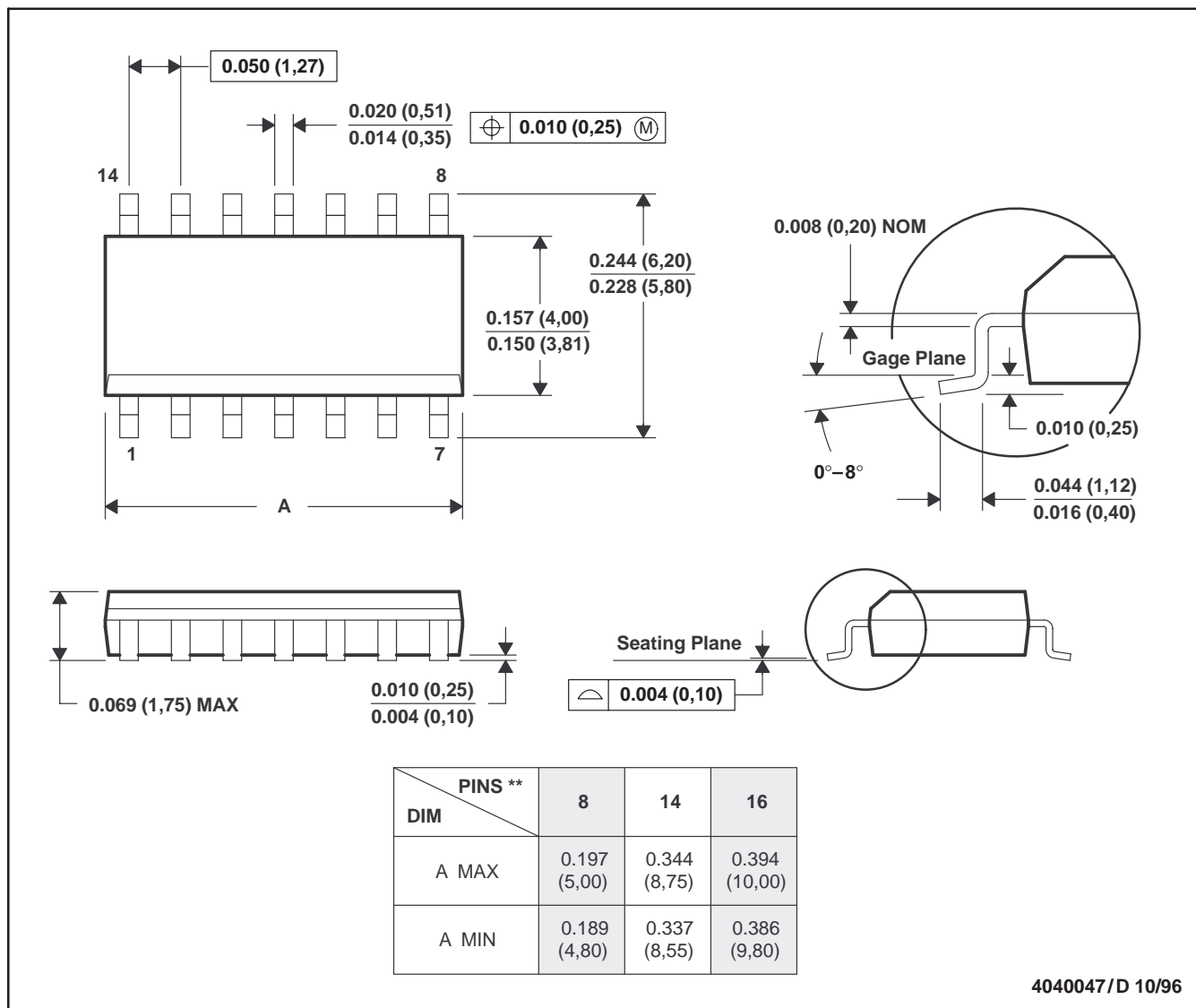
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## MECHANICAL DATA

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

**PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS 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

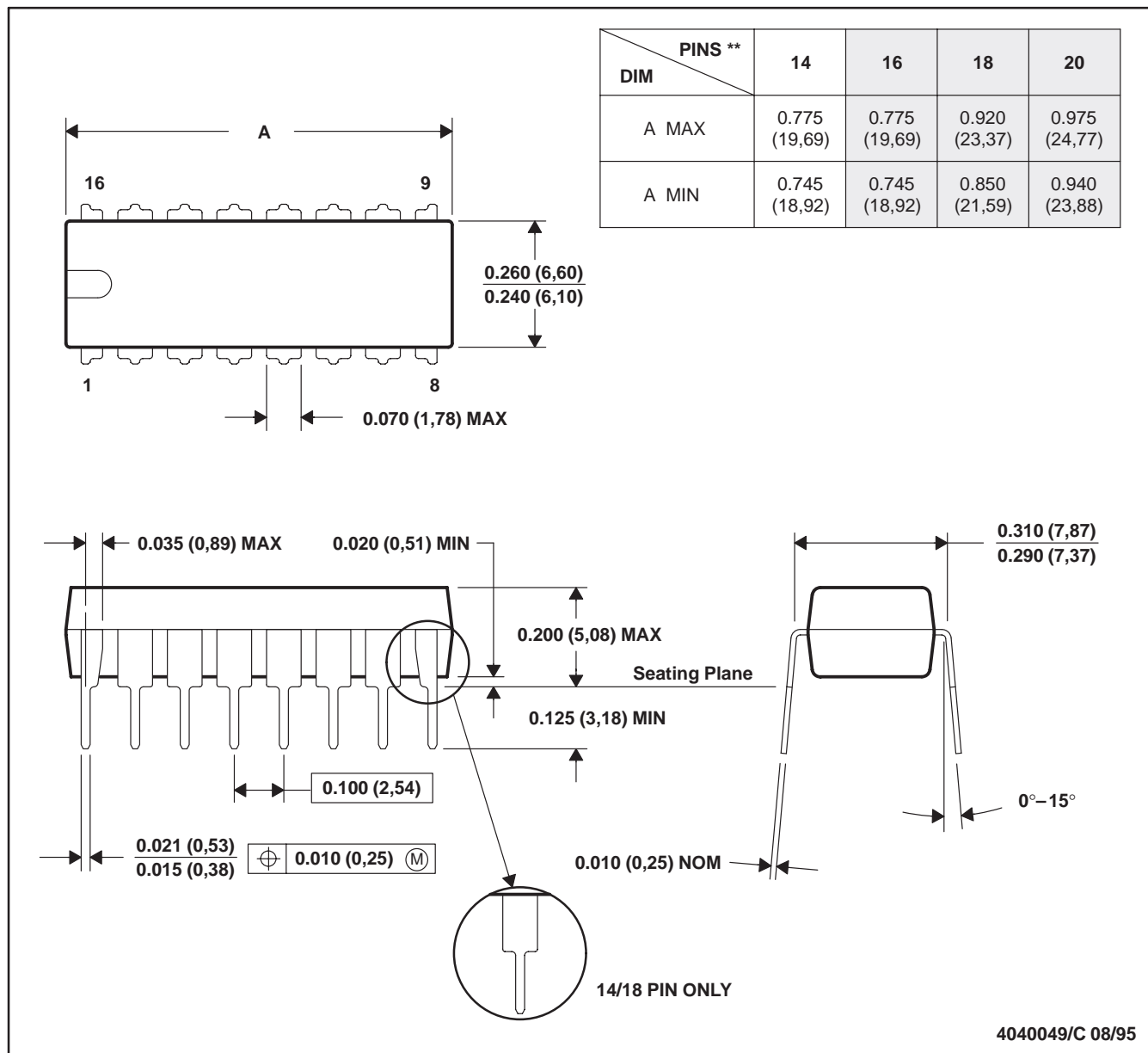
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SLLS174B – FEBRUARY 1994 – REVISED JANUARY 2000

## MECHANICAL DATA

**N (R-PDIP-T\*\*)**  
16 PINS SHOWN

**PLASTIC DUAL-IN-LINE PACKAGE**



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001 (20-pin package is shorter than MS-001).

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