

SN65LVDS179, SN65LVDS180, SN65LVDS050, SN65LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

SLLS301E – APRIL 1998 – REVISED JANUARY 1999

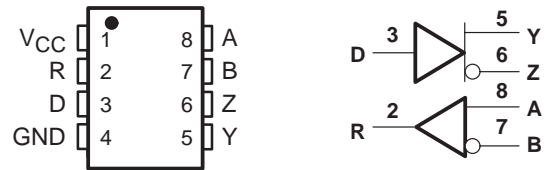
- Meets or Exceeds the Requirements of ANSI TIA/EIA-644-1995 Standard
- Signaling Rates up to 400 Mbit/s
- Bus-Terminal ESD Exceeds 12 kV
- Operates from a Single 3.3-V Supply
- Low-Voltage Differential Signaling with Typical Output Voltages of 350 mV and a 100 Ω Load
- Propagation Delay Times
 - Driver: 1.7 ns Typ
 - Receiver: 3.7 ns Typ
- Power Dissipation at 200 MHz
 - Driver: 25 mW Typical
 - Receiver: 60 mW Typical
- LVTTTL Input Levels are 5 V Tolerant
- Driver is High Impedance When Disabled or With $V_{CC} < 1.5$ V
- Receiver has Open-Circuit Fail Safe
- Surface-Mount Packaging
 - D Package (SOIC)
 - DGK Package (MSOP) ('LVDS179 Only)

description

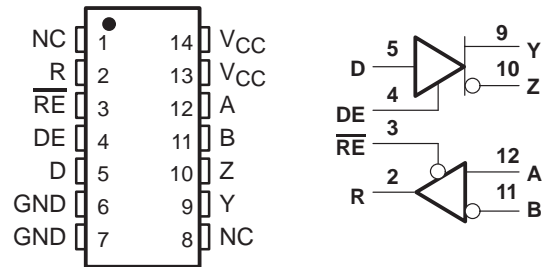
The SN65LVDS179, SN65LVDS180, SN65LVDS050, and SN65LVDS051 are differential line drivers and receivers that use low-voltage differential signaling (LVDS) to achieve signaling rates as high as 400 Mbps. The TIA/EIA-644 standard compliant electrical interface provides a minimum differential output voltage magnitude of 247 mV into a 100 Ω load and receipt of 100 mV signals with up to 1 V of ground potential difference between a transmitter and receiver.

The intended application of this device and signaling technique is for point-to-point baseband data transmission over controlled impedance media of approximately 100 Ω characteristic impedance. The transmission media may be printed-circuit board traces, backplanes, or cables. (Note: The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media, the noise coupling to the environment, and other application specific characteristics).

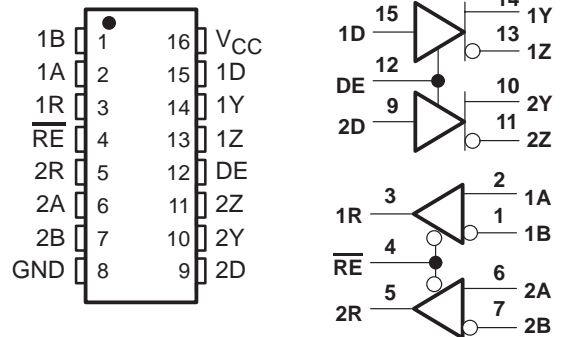
SN65LVDS179 . . . D OR DGK PACKAGE
(TOP VIEW)



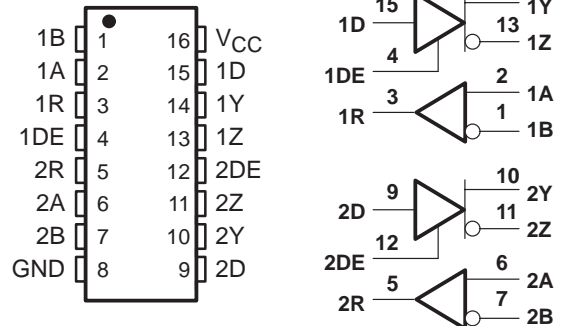
SN65LVDS180 . . . D PACKAGE
(TOP VIEW)



SN65LVDS050 . . . D PACKAGE
(TOP VIEW)



SN65LVDS051 . . . D PACKAGE
(TOP VIEW)



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**TEXAS
INSTRUMENTS**

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description (continued)

| AVAILABLE OPTIONS | | |
|-------------------|-------------------|---------------------|
| T _A | PACKAGE | |
| | SMALL OUTLINE (D) | SMALL OUTLINE (DGK) |
| -40°C to 85°C | SN65LVDS050D | — |
| | SN65LVDS051D | — |
| | SN65LVDS179D | SN65LVDS179DGK |
| | SN65LVDS180D | — |

NOTE:

The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media, the noise coupling to the environment, and other application specific characteristics.

The SN65LVDS179, SN65LVDS180, SN65LVDS050, and SN65LVDS051 are characterized for operation from -40°C to 85°C.

Function Tables

SN65LVDS179 RECEIVER

| INPUTS | OUTPUT |
|---|--------|
| $V_{ID} = V_A - V_B$ | R |
| $V_{ID} \geq 100 \text{ mV}$ | 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

SN65LVDS179 DRIVER

| INPUT | OUTPUTS | |
|-------|---------|---|
| D | Y | Z |
| L | L | H |
| H | H | L |
| Open | L | H |

H = high level, L = low level

SN65LVDS180, SN65LVDS050, and SN65LVDS051 RECEIVER

| INPUTS | | OUTPUT |
|---|-----------------|--------|
| $V_{ID} = V_A - V_B$ | \overline{RE} | R |
| $V_{ID} \geq 100 \text{ mV}$ | L | H |
| $-100 \text{ mV} < V_{ID} < 100 \text{ mV}$ | L | ? |
| $V_{ID} \leq -100 \text{ mV}$ | L | L |
| Open | L | H |
| X | H | Z |

H = high level, L = low level, Z = high impedance, X = don't care



SN65LVDS179, SN65LVDS180, SN65LVDS050, SN65LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

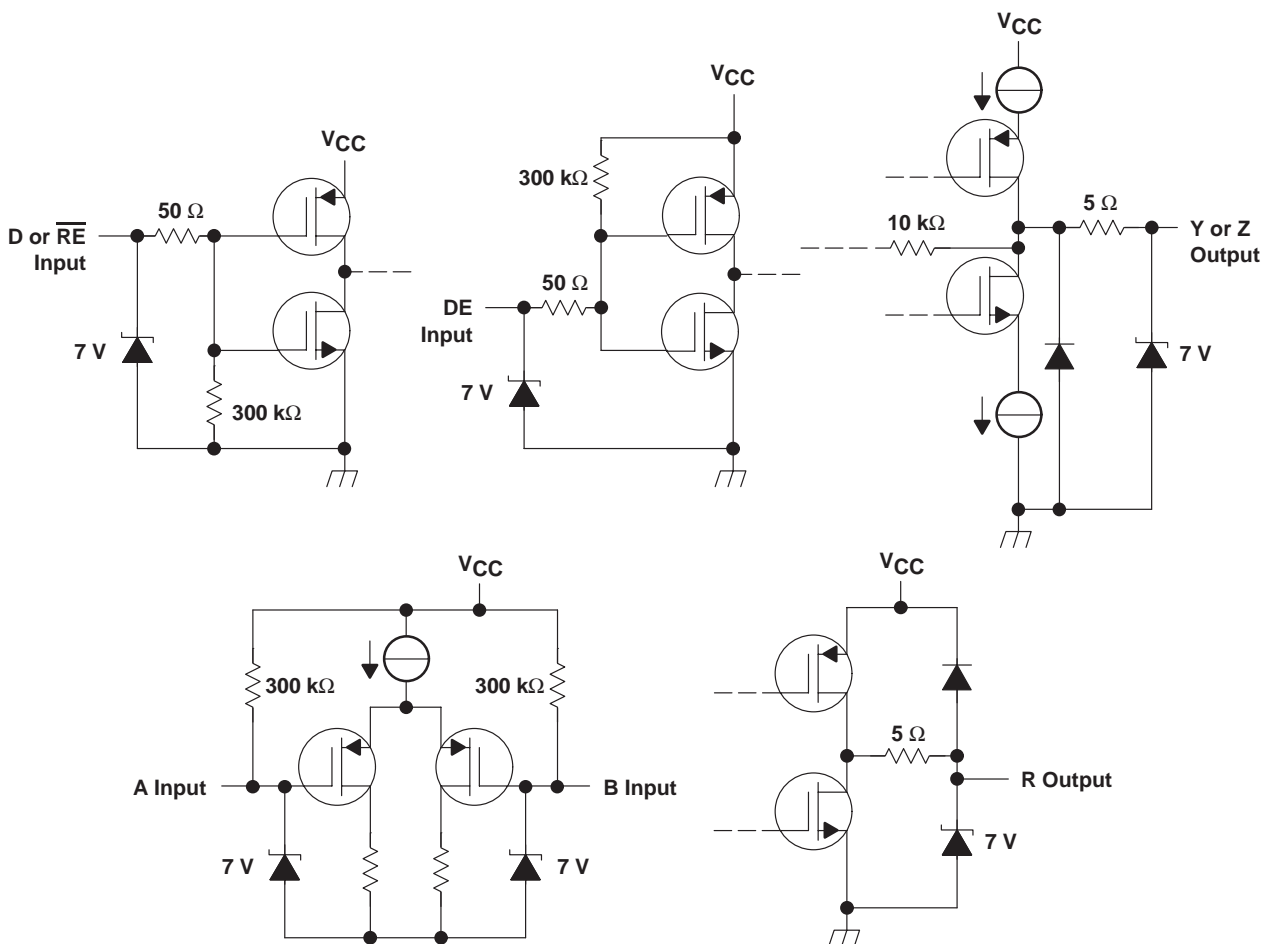
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SN65LVDS180, SN65LVDS050, and
SN65LVDS051 DRIVER

| INPUTS | | OUTPUTS | |
|--------|----|---------|---|
| D | DE | Y | Z |
| L | H | L | H |
| H | H | H | L |
| Open | H | L | H |
| X | L | Z | Z |

H = high level, L = low level, Z = high impedance,
X = don't care

equivalent input and output schematic diagrams



SN65LVDS179, SN65LVDS180, SN65LVDS050, SN65LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

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

| | |
|--|------------------------------|
| Supply voltage range, V_{CC} (see Note 1) | –0.5 V to 4 V |
| Voltage range (D, R, DE, \overline{RE}) | –0.5 V to 6 V |
| Electrostatic discharge: Y, Z, A, B, and GND (see Note 2) | Class 3, A:12 kV, B:600 V |
| All | Class 3, A:7 kV, B:500 V |
| Continuous power dissipation | see dissipation rating table |
| Storage temperature range | –65°C to 150°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 250°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, except differential I/O bus voltages are with respect to network ground terminal.
2. Tested in accordance with MIL-STD-883C Method 3015.7.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$ † | $T_A = 85^\circ\text{C}$ POWER RATING |
|------------|---|---|--|
| D8 | 725 mW | 5.8 mW/°C | 377 mW |
| D14 or D16 | 950 mW | 7.8 mW/°C | 494 mW |
| DGK | 424 mW | 3.4 mW/°C | 220 mW |

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

recommended operating conditions

| | MIN | NOM | MAX | UNIT |
|---|----------------------|--------------|----------------------|------|
| Supply voltage, V_{CC} | 3 | 3.3 | 3.6 | V |
| High-level input voltage, V_{IH} | 2 | | | V |
| Low-level input voltage, V_{IL} | | | 0.8 | V |
| Magnitude of differential input voltage, $ V_{ID} $ | 0.1 | | 0.6 | V |
| Common-mode input voltage, V_{IC} (see Figure 6) | $\frac{ V_{ID} }{2}$ | 2.4 | $\frac{ V_{ID} }{2}$ | V |
| | | $V_{CC}-0.8$ | | |
| Operating free-air temperature, T_A | –40 | | 85 | °C |



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

| PARAMETER | | TEST CONDITIONS | MIN | TYP† | MAX | UNIT | |
|-----------------|----------------|-----------------|---|------|-----|------|----|
| I _{CC} | Supply current | SN65LVDS179 | No receiver load, Driver R _L = 100 Ω | | 9 | 12 | mA |
| | | SN65LVDS180 | Driver and receiver enabled, No receiver load, Driver R _L = 100 Ω | | 9 | 12 | |
| | | | Driver enabled, Receiver disabled, R _L = 100 Ω | | 5 | 7 | |
| | | | Driver disabled, Receiver enabled, No load | | 1.5 | 2 | |
| | | | Disabled | | 0.5 | 1 | |
| | | SN65LVDS050 | Drivers and receivers enabled, No receiver loads, Driver R _L = 100 Ω | | 12 | 20 | mA |
| | | | Drivers enabled, Receivers disabled, R _L = 100 Ω | | 10 | 16 | |
| | | | Drivers disabled, Receivers enabled, No loads | | 3 | 6 | |
| | | | Disabled | | 0.5 | 1 | |
| | | SN65LVDS051 | Drivers enabled, No receiver loads, Driver R _L = 100 Ω | | 12 | 20 | mA |
| | | | Drivers disabled, No loads | | 3 | 6 | |

† All typical values are at 25°C and with a 3.3-V supply.

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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|----------------------|--|---|-------------------------|------|-------|------|
| V _{OD} | Differential output voltage magnitude | R _L = 100Ω, See Figure 1 and Figure 2 | 247 | 340 | 454 | mV |
| Δ V _{OD} | Change in differential output voltage magnitude between logic states | | -50 | | 50 | |
| V _{OC(SS)} | Steady-state common-mode output voltage | See Figure 3 | 1.125 | 1.2 | 1.375 | V |
| ΔV _{OC(SS)} | Change in steady-state common-mode output voltage between logic states | | -50 | | 50 | mV |
| V _{OC(PP)} | Peak-to-peak common-mode output voltage | | 50 | | 150 | mV |
| I _{IH} | High-level input current | DE | V _{IH} = 5 V | -0.5 | -20 | μA |
| | | D | | 2 | 20 | |
| I _{IL} | Low-level input current | DE | V _{IL} = 0.8 V | -0.5 | -10 | μA |
| | | D | | 2 | 10 | |
| I _{OS} | Short-circuit output current | V _{OY} or V _{OZ} = 0 V | | 3 | 10 | mA |
| | | V _{OD} = 0 V | | 3 | 10 | |
| I _{OZ} | High-impedance output current | V _{OD} = 600 mV | | | ±1 | μA |
| | | V _O = 0 V or V _{CC} | | | ±1 | |
| I _{O(OFF)} | Power-off output current | V _{CC} = 0 V, V _O = 3.6 V | | | ±1 | μA |
| C _{IN} | Input capacitance | | | 3 | | pF |



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

| PARAMETER | TEST CONDITIONS | MIN | TYP† | MAX | UNIT | |
|---------------------|---|---------------------------|------|------|------|----|
| V _I TH+ | Positive-going differential input voltage threshold | | | 100 | mV | |
| V _I TH- | Negative-going differential input voltage threshold | | | -100 | | |
| 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 _I | Input current (A or B inputs) | V _I = 0 | -2 | -11 | -20 | μA |
| | | V _I = 2.4 V | -1.2 | -3 | | |
| I _{I(OFF)} | Power-off input current (A or B inputs) | V _{CC} = 0 | | ±20 | μA | |
| I _{IH} | High-level input current (enables) | V _{IH} = 5 V | | ±10 | μA | |
| I _{IL} | Low-level input current (enables) | V _{IL} = 0.8 V | | ±10 | μA | |
| I _{OZ} | High-impedance output current | V _O = 0 or 5 V | | ±10 | μA | |
| C _I | Input capacitance | | 5 | | pF | |

† All typical values are at 25°C and with a 3.3-V supply.

driver switching characteristics over recommended operating conditions (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP† | MAX | UNIT |
|--------------------|---|---|------|-----|------|
| t _{PLH} | Propagation delay time, low-to-high-level output | | 1.7 | 2.7 | ns |
| t _{PHL} | Propagation delay time, high-to-low-level output | | 1.7 | 2.7 | ns |
| t _r | Differential output signal rise time | R _L = 100Ω, C _L = 10 pF, See Figure 6 | 0.8 | 1 | ns |
| t _f | Differential output signal fall time | | 0.8 | 1 | ns |
| t _{sk(p)} | Pulse skew (t _{pHL} - t _{pLH}) | | 300 | | ps |
| t _{sk(o)} | Channel-to-channel output skew‡ | | 150 | | ps |
| t _{PZH} | Propagation delay time, high-impedance-to-high-level output | See Figure 7 | 4.3 | 10 | ns |
| t _{PZL} | Propagation delay time, high-impedance-to-low-level output | | 4.6 | 10 | ns |
| t _{PHZ} | Propagation delay time, high-level-to-high-impedance output | | 3.1 | 10 | ns |
| t _{pLZ} | Propagation delay time, low-level-to-high-impedance output | | 3.4 | 10 | ns |

† All typical values are at 25°C and with a 3.3-V supply.

‡ t_{sk(o)} is the maximum delay time difference between drivers on the same device.



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receiver switching characteristics over recommended operating conditions (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP† | MAX | UNIT |
|--------------------|---|---|-----|------|-----|------|
| t _{PLH} | Propagation delay time, low-to-high-level output | C _L = 10 pF, See Figure 6 | | 3.7 | 4.5 | ns |
| t _{PHL} | Propagation delay time, high-to-low-level output | | | 3.7 | 4.5 | ns |
| t _{sk(p)} | Pulse skew (t _{pHL} – t _{pLH}) | | | 0.3 | | ns |
| t _r | Output signal rise time | | | 0.7 | 1.5 | ns |
| t _f | Output signal fall time | | | 0.9 | 1.5 | ns |
| t _{PZH} | Propagation delay time, high-level-to-high-impedance output | See Figure 7 | | 2.5 | | ns |
| t _{PZL} | Propagation delay time, low-level-to-low-impedance output | | | 2.5 | | ns |
| t _{PHZ} | Propagation delay time, high-impedance-to-high-level output | | | 7 | | ns |
| t _{PLZ} | Propagation delay time, low-impedance-to-high-level output | | | 4 | | ns |

† All typical values are at 25°C and with a 3.3-V supply.

PARAMETER MEASUREMENT INFORMATION

driver

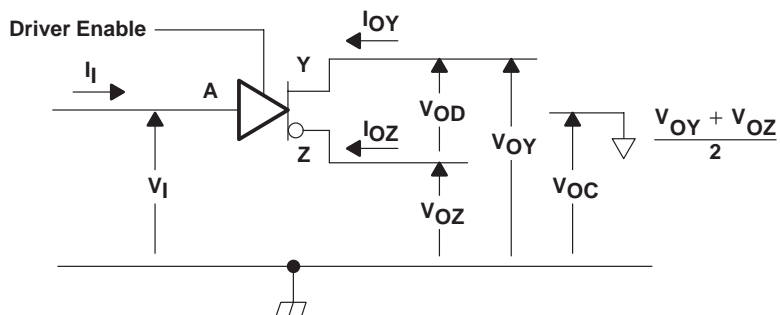


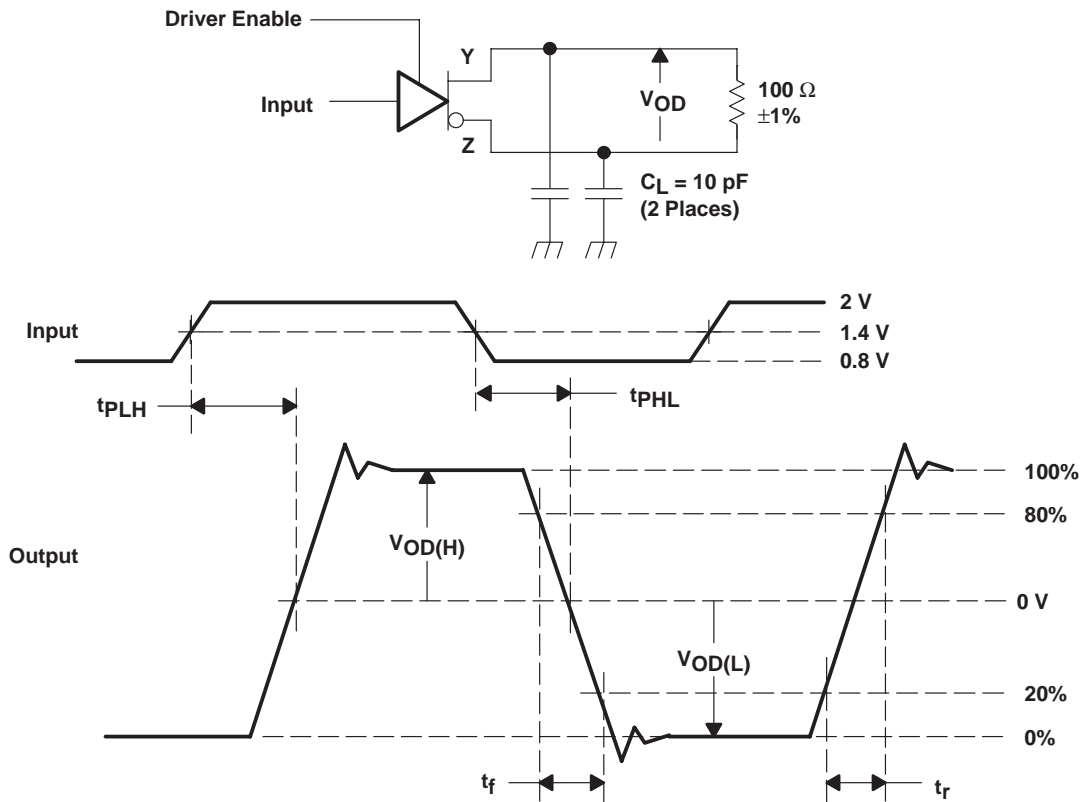
Figure 1. Driver Voltage and Current Definitions

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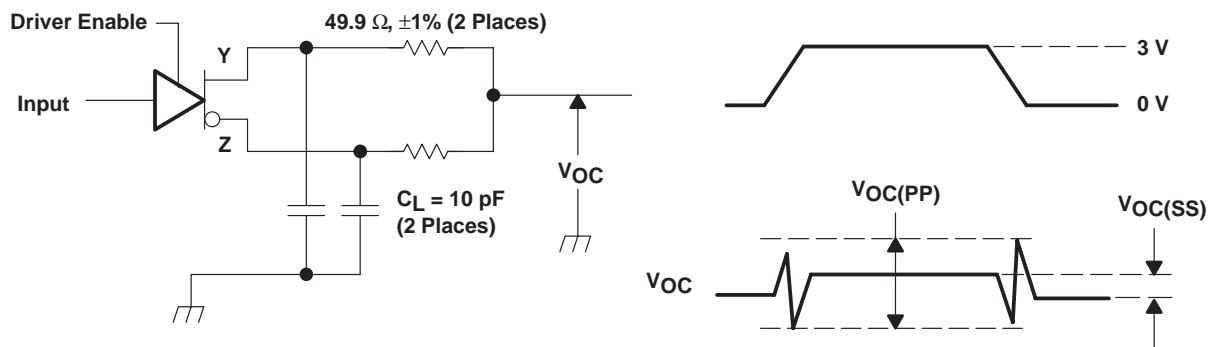
PARAMETER MEASUREMENT INFORMATION

driver (continued)



NOTE 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) = 50 Mpps, pulse width = 10 ± 0.2 ns. C_L includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T.

Figure 2. Test Circuit, Timing, and Voltage Definitions for the Differential Output Signal

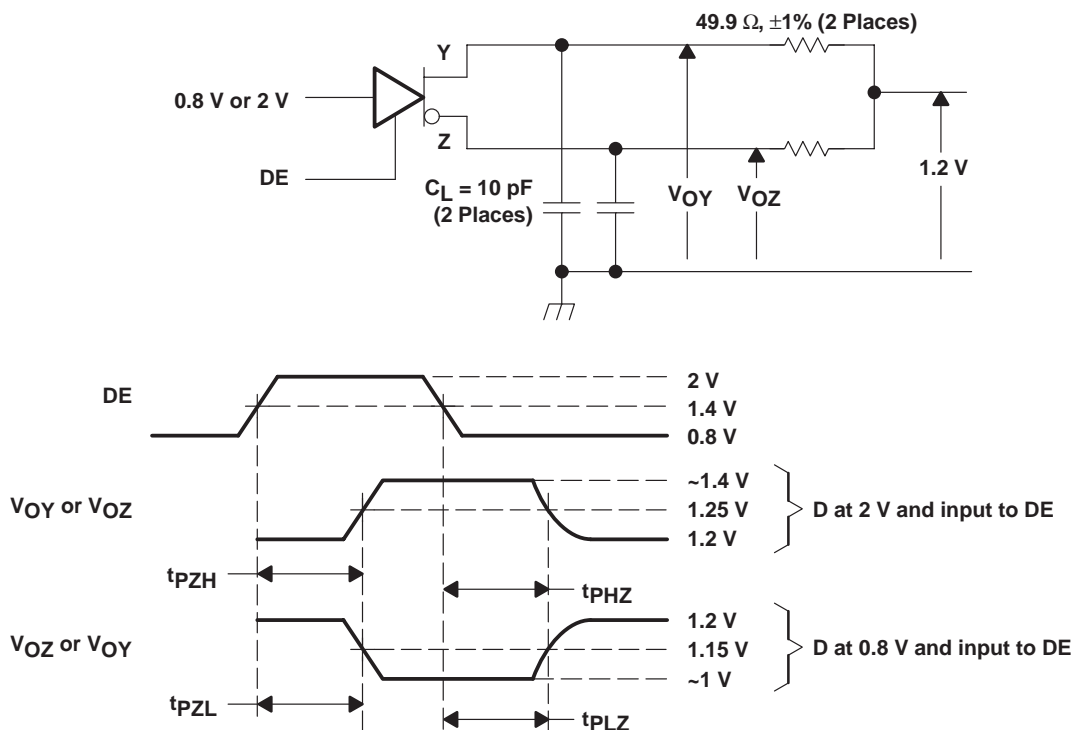


NOTE A: All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq 1$ ns, pulse repetition rate (PRR) = 50 Mpps, pulse width = 10 ± 0.2 ns. C_L includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T. The measurement of $V_{OC(PP)}$ is made on test equipment with a -3 dB bandwidth of at least 300 MHz.

Figure 3. Test Circuit and Definitions for the Driver Common-Mode Output Voltage

PARAMETER MEASUREMENT INFORMATION

driver (continued)



NOTE 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) = 0.5 Mpps, pulse width = $500 \pm 10 \text{ ns}$. C_L includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T.

Figure 4. Enable and Disable Time Circuit and Definitions

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PARAMETER MEASUREMENT INFORMATION

receiver

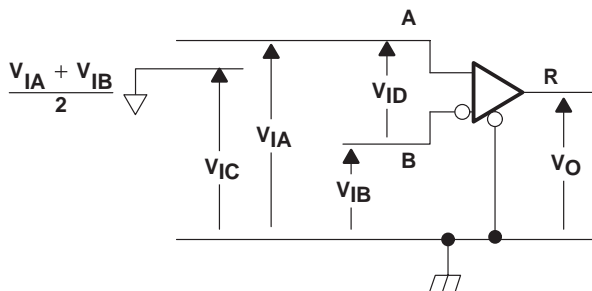


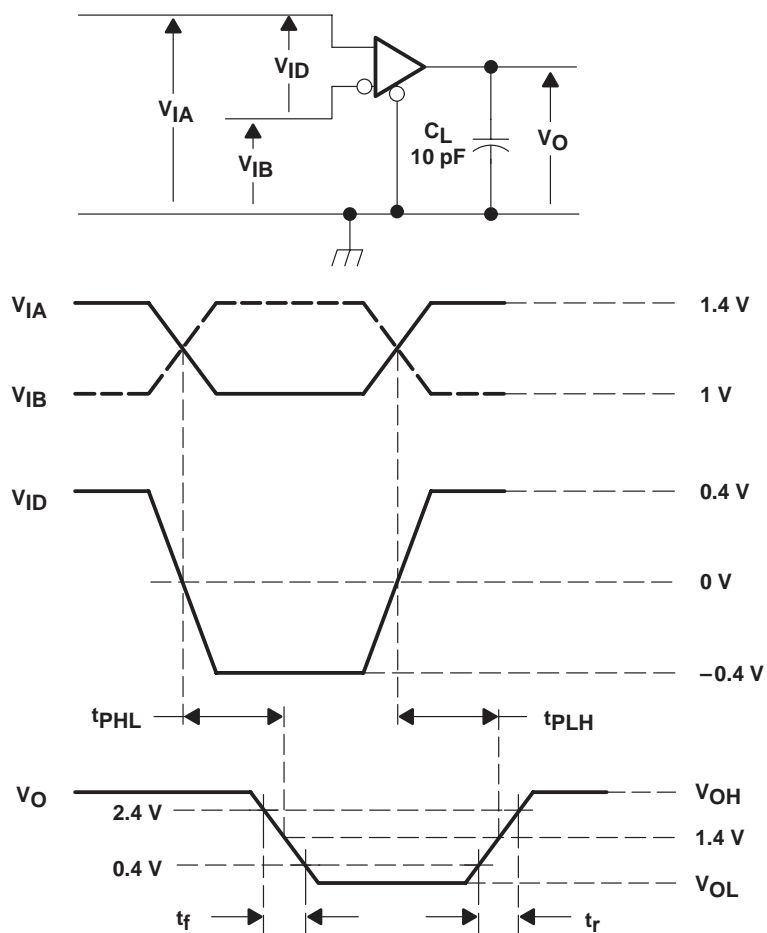
Figure 5. Receiver Voltage Definitions

Table 1. Receiver Minimum and Maximum Input Threshold Test Voltages

| APPLIED VOLTAGES (V) | | RESULTING DIFFERENTIAL INPUT VOLTAGE (mV) | RESULTING COMMON-MODE INPUT VOLTAGE (V) |
|----------------------|-----------------|---|---|
| V _{IA} | V _{IB} | V _{ID} | V _{IC} |
| 1.25 | 1.15 | 100 | 1.2 |
| 1.15 | 1.25 | -100 | 1.2 |
| 2.4 | 2.3 | 100 | 2.35 |
| 2.3 | 2.4 | -100 | 2.35 |
| 0.1 | 0 | 100 | 0.05 |
| 0 | 0.1 | -100 | 0.05 |
| 1.5 | 0.9 | 600 | 1.2 |
| 0.9 | 1.5 | -600 | 1.2 |
| 2.4 | 1.8 | 600 | 2.1 |
| 1.8 | 2.4 | -600 | 2.1 |
| 0.6 | 0 | 600 | 0.3 |
| 0 | 0.6 | -600 | 0.3 |

PARAMETER MEASUREMENT INFORMATION

receiver (continued)



NOTE 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) = 50 Mpps, pulse width = 10 ± 0.2 ns. C_L includes instrumentation and fixture capacitance within 0,06 m of the D.U.T.

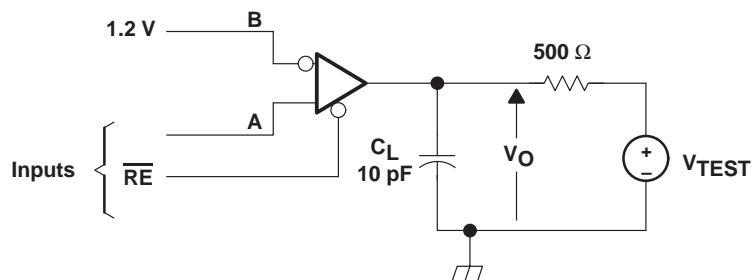
Figure 6. Timing Test Circuit and Waveforms

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PARAMETER MEASUREMENT INFORMATION

receiver (continued)



NOTE 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 ± 10 ns. C_L includes instrumentation and fixture capacitance within 0,06 m of the D.U.T.

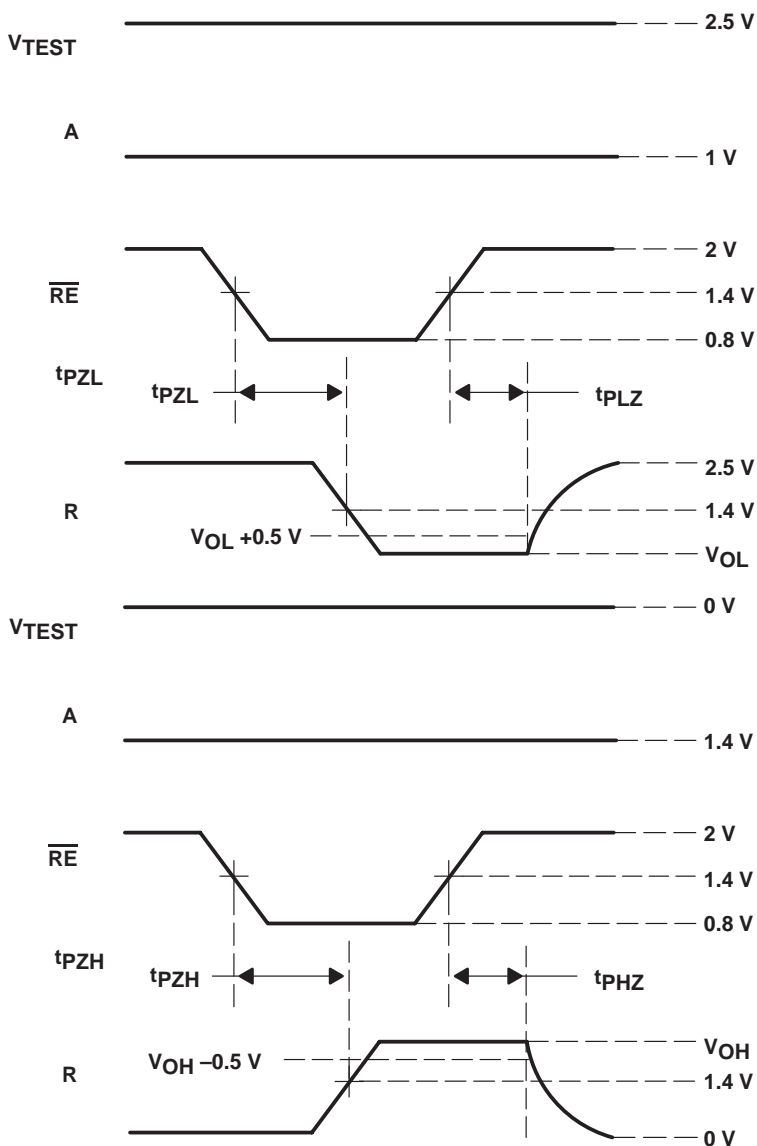


Figure 7. Enable/Disable Time Test Circuit and Waveforms

TYPICAL CHARACTERISTICS

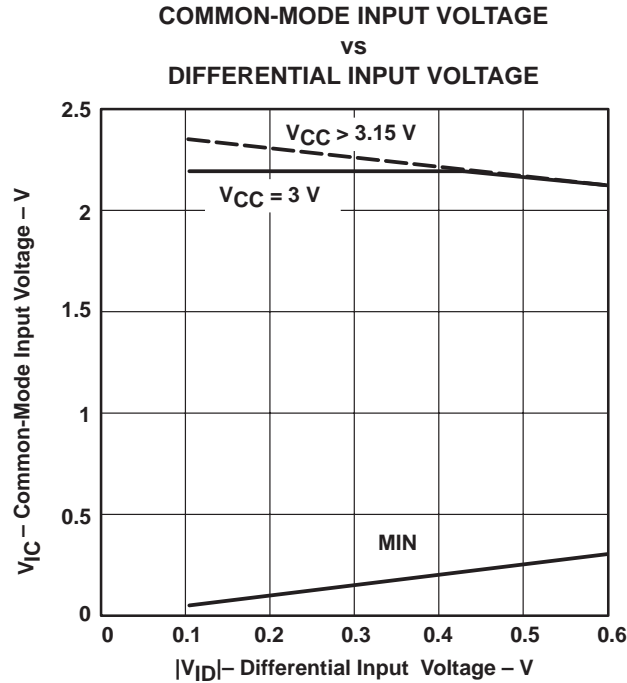


Figure 8

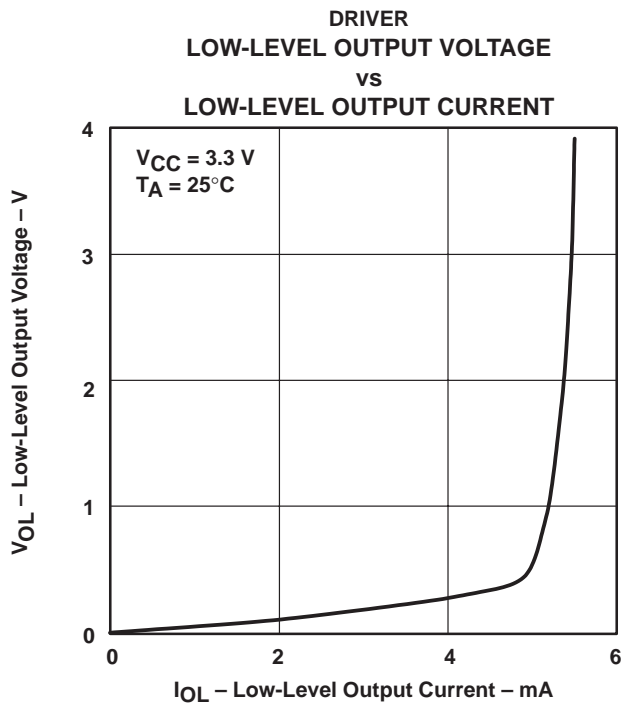


Figure 9

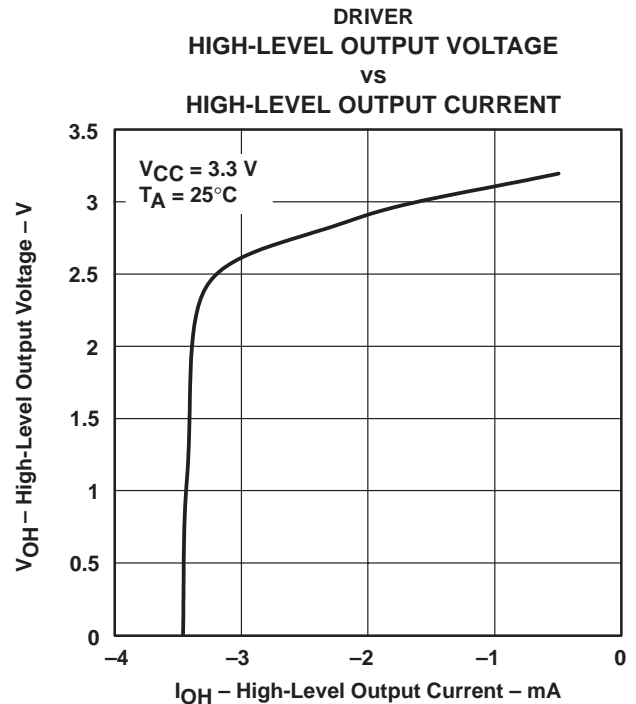


Figure 10

SN65LVDS179, SN65LVDS180, SN65LVDS050, SN65LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

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TYPICAL CHARACTERISTICS

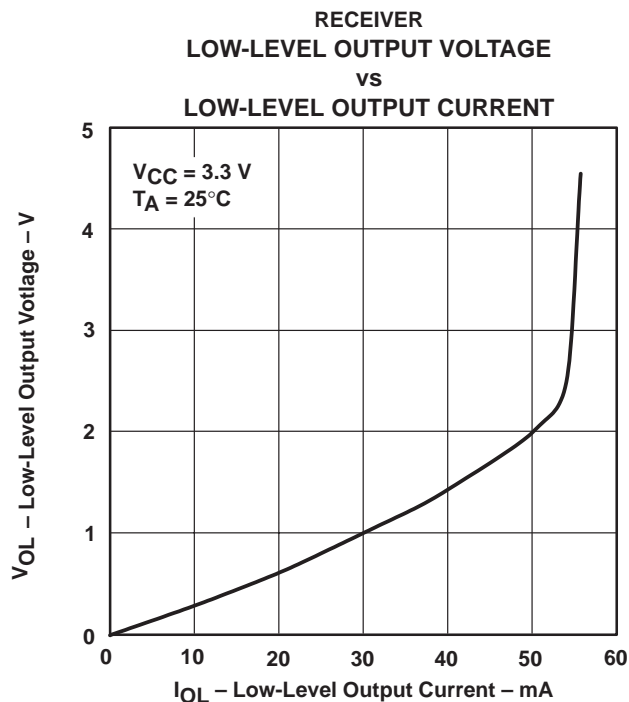


Figure 11

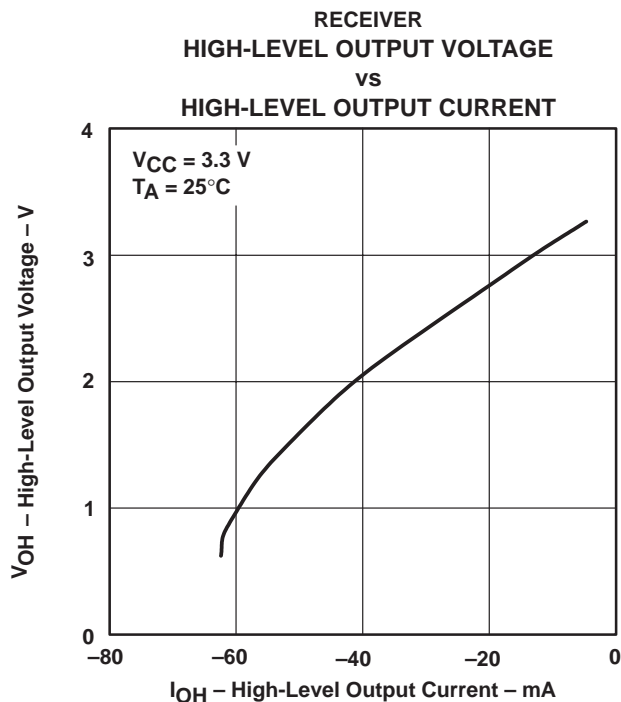


Figure 12

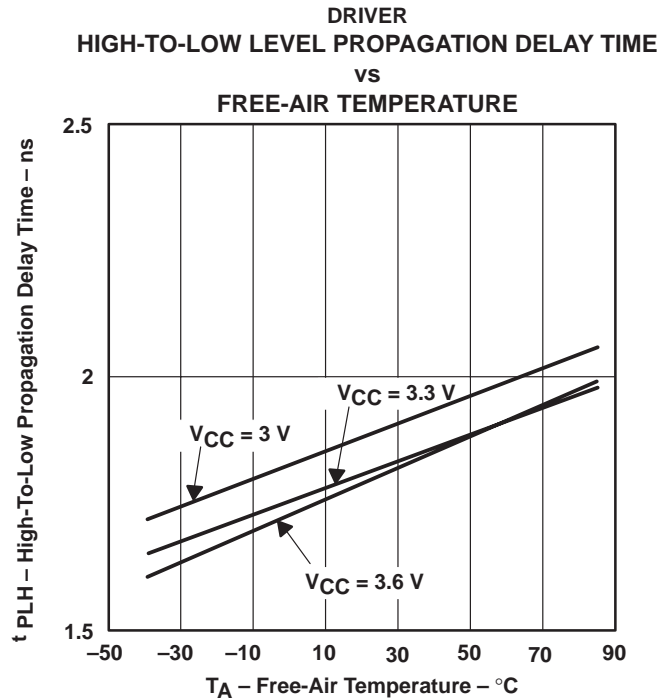


Figure 13

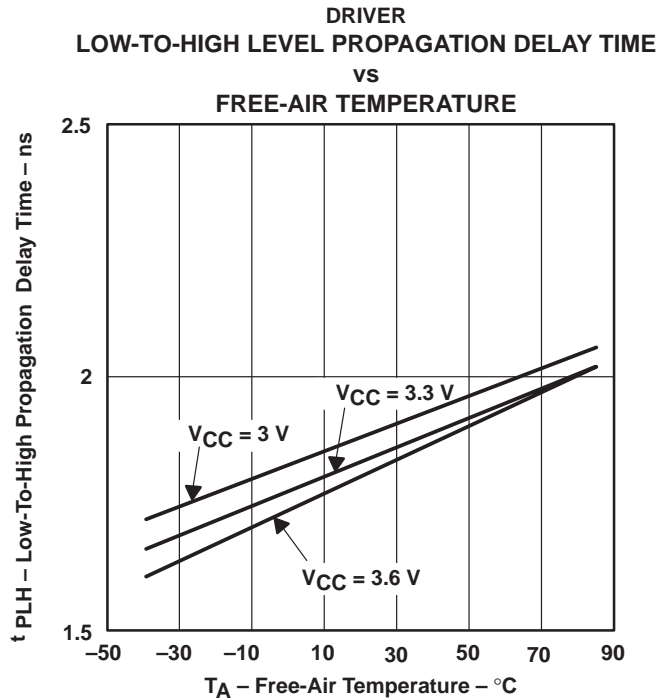


Figure 14



TYPICAL CHARACTERISTICS

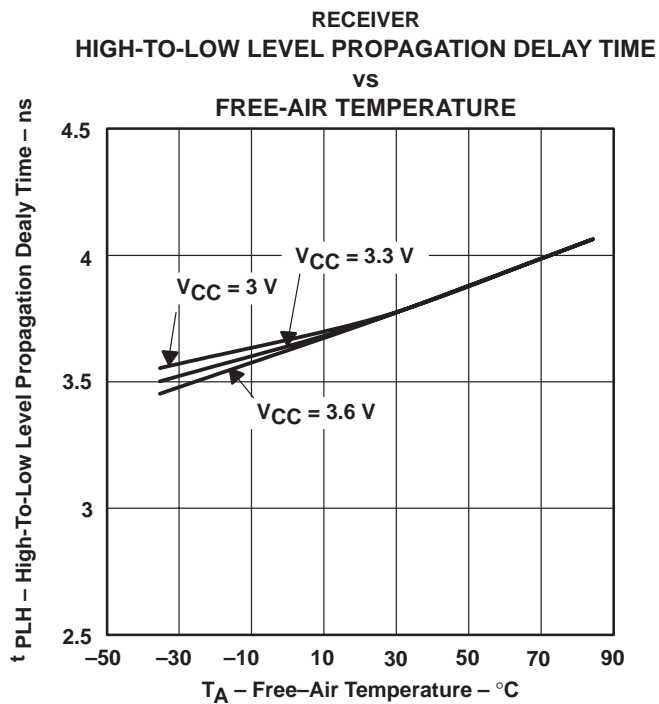


Figure 15

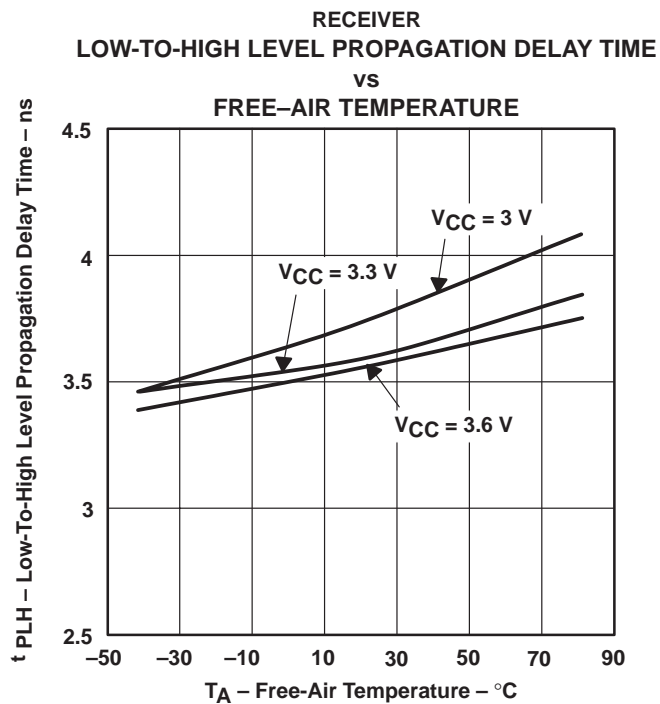


Figure 16

SN65LVDS179, SN65LVDS180, SN65LVDS050, SN65LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

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APPLICATION INFORMATION

The devices are generally used as building blocks for high-speed point-to-point data transmission. Ground differences are less than 1 V with a low common-mode output and balanced interface for very low noise emissions. Devices can interoperate with RS-422, PECL, and IEEE-P1596. Drivers/Receivers maintain ECL speeds without the power and dual supply requirements.

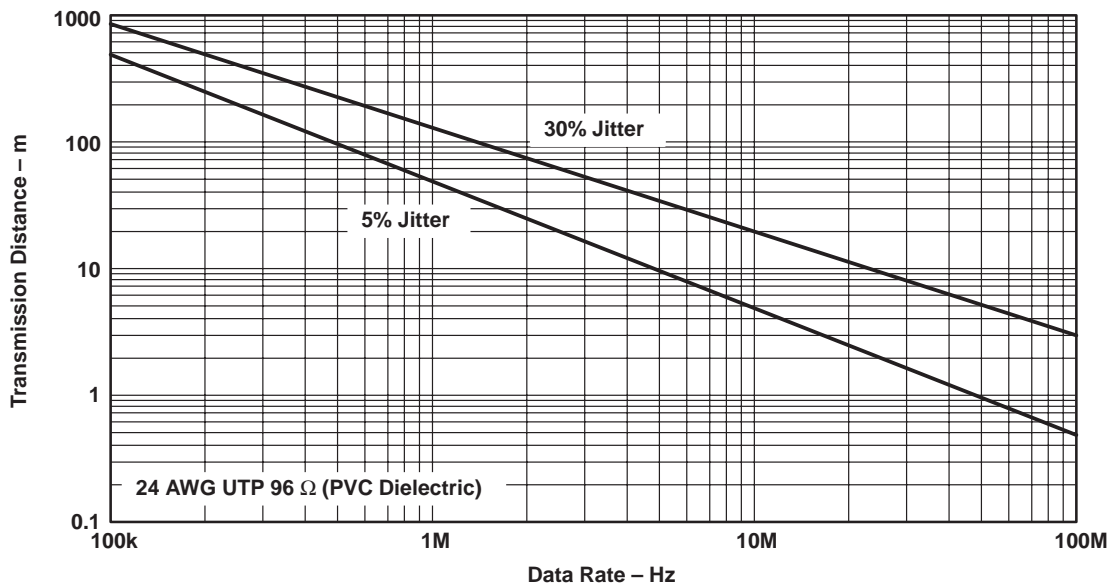


Figure 17. Data Transmission Distance Versus Rate



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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 mV and 100 mV and 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 V to detect this condition and force the output to a high-level regardless of the differential input voltage.

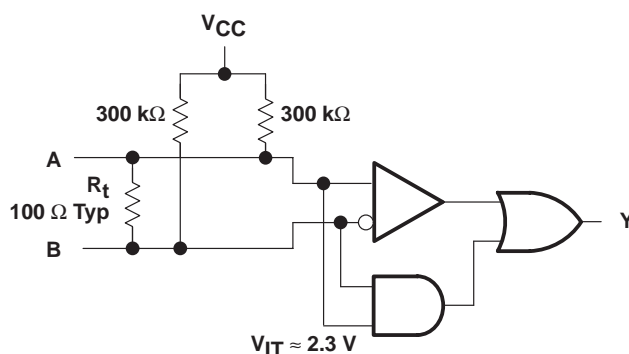


Figure 18. Open-Circuit Fail Safe of the LVDS Receiver

It is only under these conditions that the output of the receiver will be valid with less than a 100-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.

SN65LVDS179, SN65LVDS180, SN65LVDS050, SN65LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

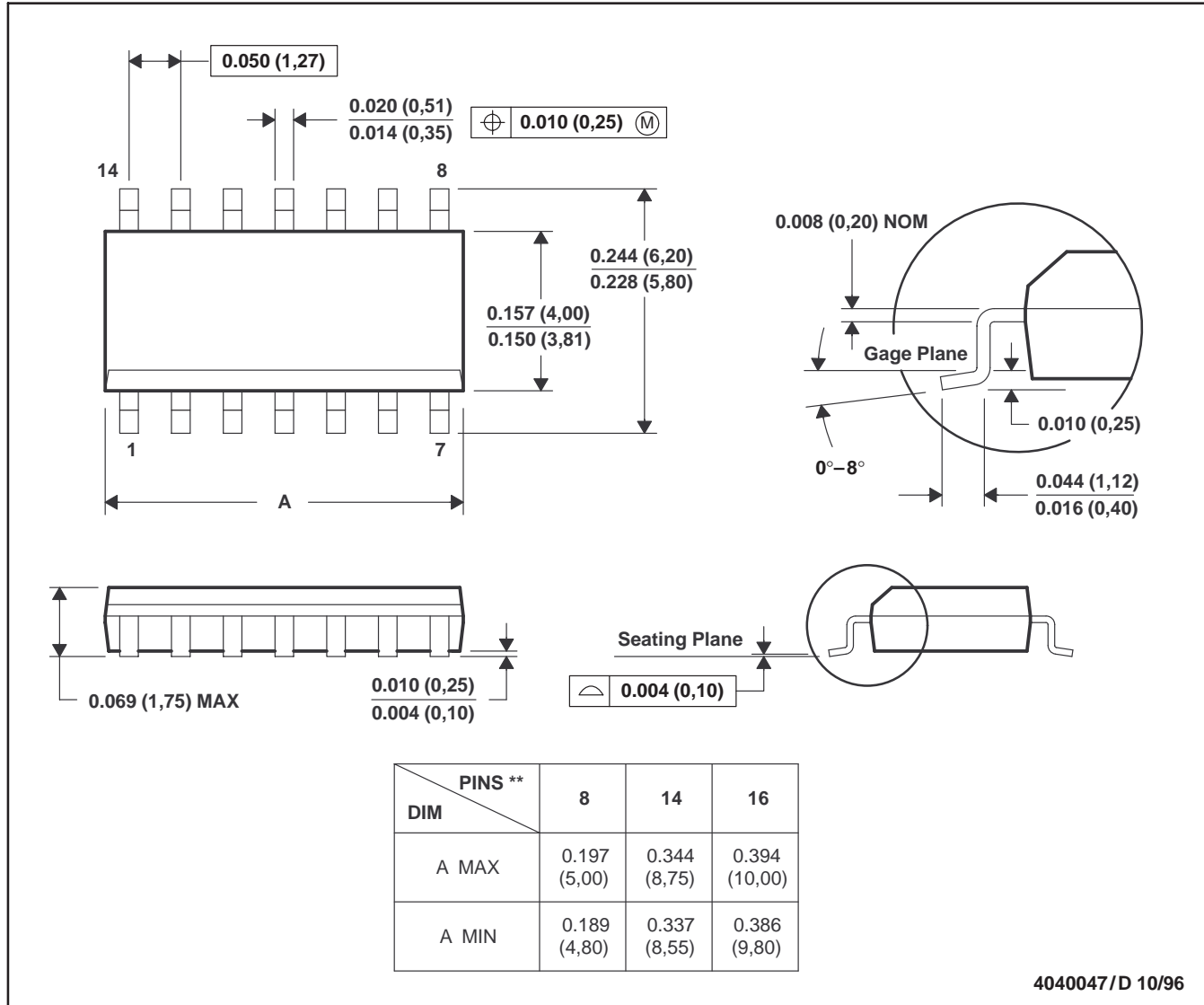
SLLS301E – APRIL 1998 – REVISED JANUARY 1999

MECHANICAL DATA

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

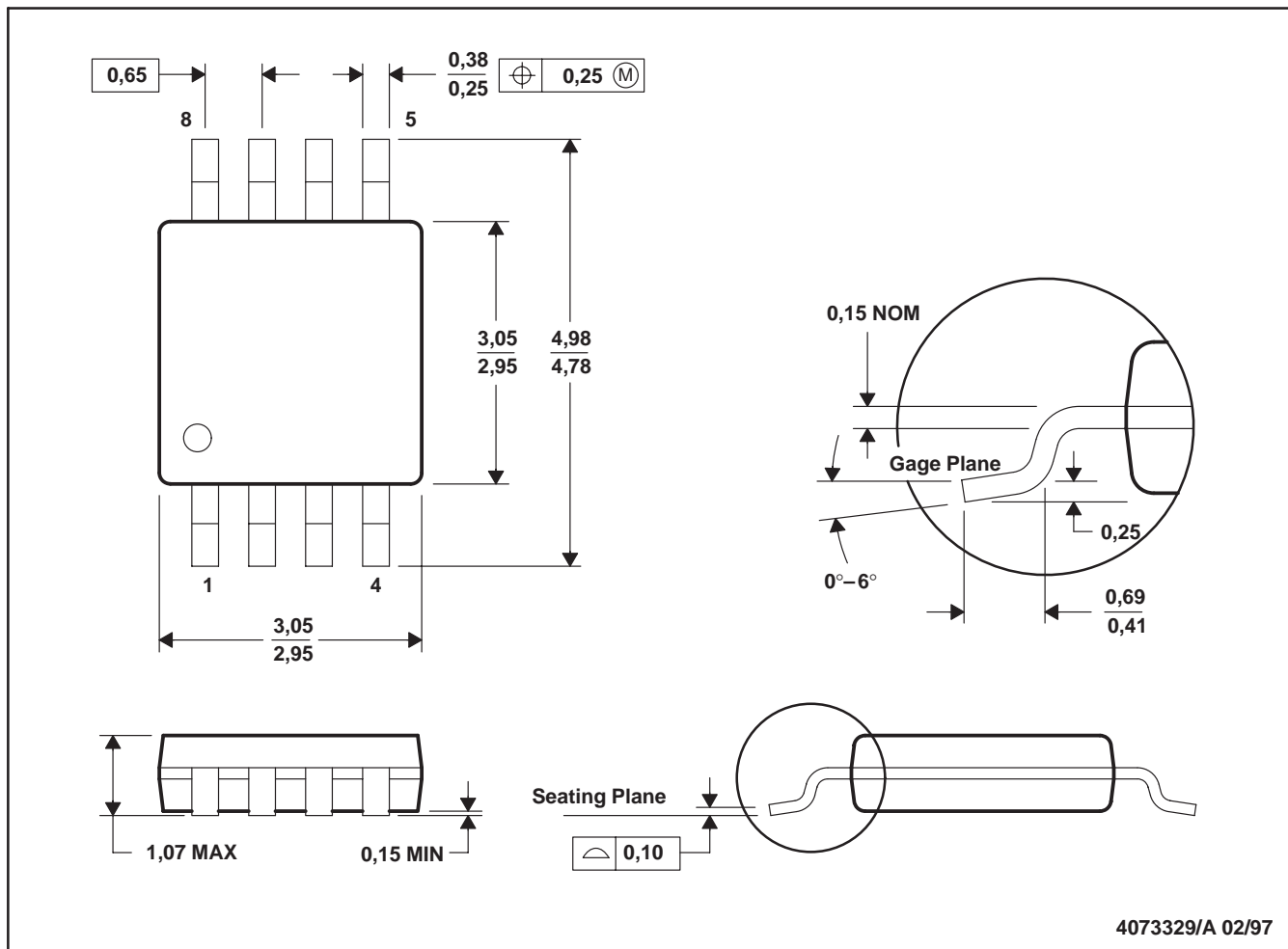
SN65LVDS179, SN65LVDS180, SN65LVDS050, SN65LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

SLLS301E – APRIL 1998 – REVISED JANUARY 1999

MECHANICAL DATA

DGK (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



4073329/A 02/97

- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion.
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