

SN75LVDS179, SN75LVDS180, SN75LVDS050, SN75LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

SLLS361A – JUNE 1999 – REVISED MARCH 2000

- Meets or Exceeds the Requirements of ANSI TIA/EIA-644-1995 Standard
- Signaling Rates up to 155 Mbps
- Operates From a Single 3.3-V Supply
- Low-Voltage Differential Signaling With Typical Output Voltages of 350 mV and a 100 Ω Load
- 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)
- Characterized For Operation From 0°C to 70°C

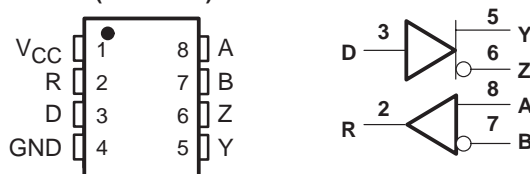
description

The SN75LVDS179, SN75LVDS180, SN75LVDS050, and SN75LVDS051 are differential line drivers and receivers that use low-voltage differential signaling (LVDS) to achieve signaling rates as high as 155 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.

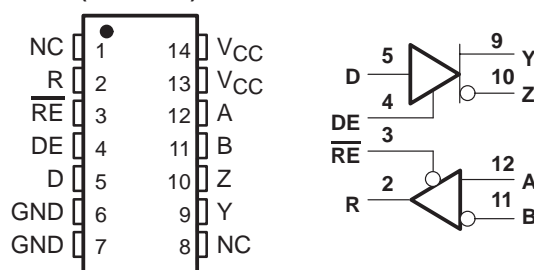
The intended application of this device and signaling technique is for point-to-point baseband data transmission over controlled impedance media of approximately 100 Ω characteristic impedance. The transmission media may be printed-circuit board traces, backplanes, or cables. (Note: The ultimate rate 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).

The SN75LVDS179, SN75LVDS180, SN75LVDS050, and SN75LVDS051 are characterized for operation from 0°C to 70°C.

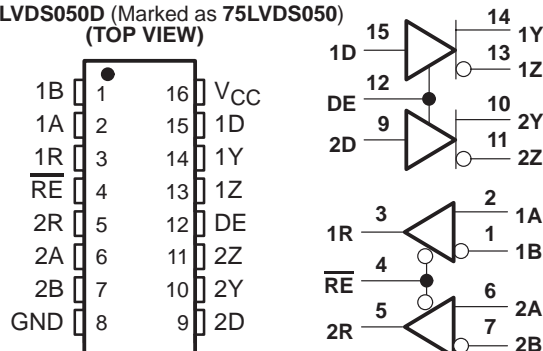
SN75LVDS179D (Marked as DS179 or 7LS179)
(TOP VIEW)



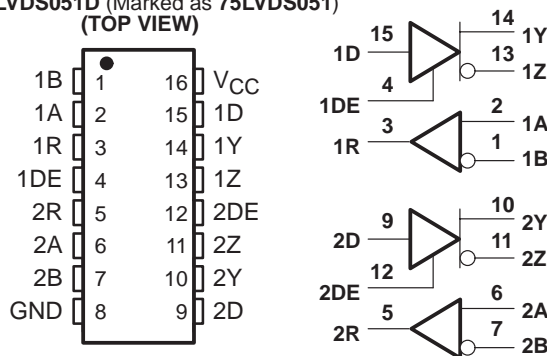
SN75LVDS180D (Marked as 7LVDS180)
(TOP VIEW)



SN75LVDS050D (Marked as 75LVDS050)
(TOP VIEW)



SN75LVDS051D (Marked as 75LVDS051)
(TOP VIEW)



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

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SN75LVDS179, SN75LVDS180, SN75LVDS050, SN75LVDS051 HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

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Function Tables

SN75LVDS179 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

SN75LVDS179 DRIVER

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

H = high level, L = low level

SN75LVDS180, SN75LVDS050, and SN75LVDS051 RECEIVER

| INPUTS | | OUTPUT |
|---|------------------------|--------|
| $V_{ID} = V_A - V_B$ | $\overline{\text{RE}}$ | 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

SN75LVDS180, SN75LVDS050, and SN75LVDS051 DRIVER

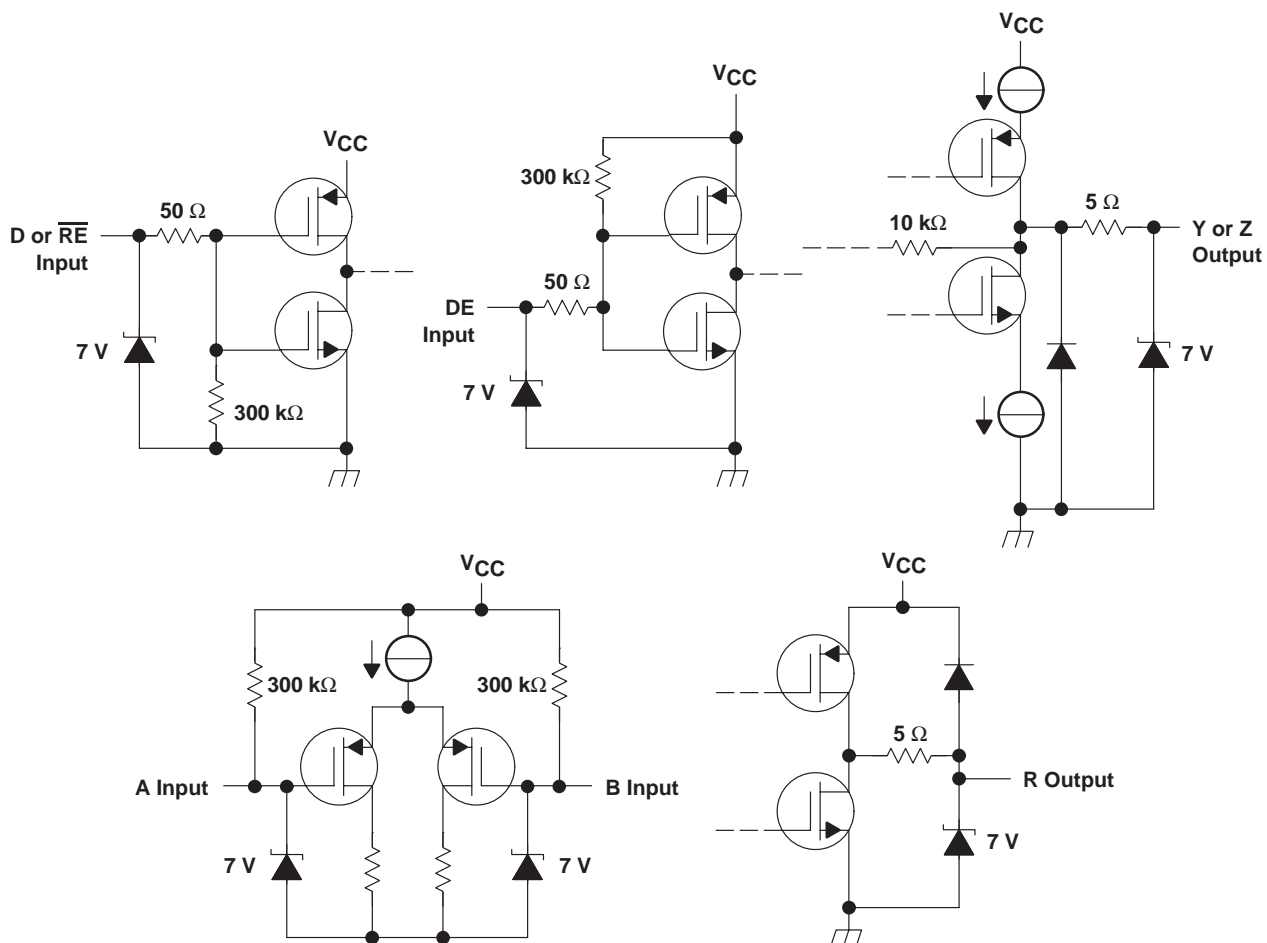
| INPUTS | | OUTPUTS | |
|--------|----|---------|---|
| D | DE | Y | Z |
| L | H | L | H |
| H | H | H | L |
| Open | H | L | H |
| X | L | Z | Z |

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

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equivalent input and output schematic diagrams



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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 |
| 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 $T_A = 25^\circ\text{C}$ † | $T_A = 70^\circ\text{C}$ POWER RATING |
|------------|---|---|--|
| D8 | 725 mW | 5.8 mW/°C | 464 mW |
| D14 or D16 | 950 mW | 7.8 mW/°C | 608 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 | 0 | | 70 | °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 | SN75LVDS179 | No receiver load, driver R _L = 100 Ω | | 9 | 12 | mA |
| | SN75LVDS180 | Driver and receiver enabled, No receiver load, Driver R _L = 100 Ω | | 9 | 12 | mA |
| | | Driver enabled, receiver disabled, R _L = 100 Ω | | 5 | 7 | |
| | | Driver disabled, receiver enabled, No load | | 1.5 | 2 | |
| | | Disabled | | 0.5 | 1 | |
| | SN75LVDS050 | 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 | |
| | SN75LVDS051 | 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 _{ITH+} Positive-going differential input voltage threshold | See Figure 5 and Table 1 | | | 100 | mV |
| V _{ITH-} 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 | R _L = 100Ω, C _L = 10 pF, See Figure 6 | | | 6 | ns |
| t _{PHL} Propagation delay time, high-to-low-level output | | | | 6 | ns |
| t _r Differential output signal rise time | | 0.8 | 1.2 | | ns |
| t _f Differential output signal fall time | | 0.8 | 1.2 | | ns |
| t _{sk(p)} Pulse skew (t _{pHL} - t _{pLH})‡ | | | | 0.6 | ps |
| t _{sk(o)} Channel-to-channel output skew§ | | | | 0.6 | ps |
| t _{sk(pp)} Part-to-part skew¶ | | | | 1 | ps |
| t _{PZH} Propagation delay time, high-impedance-to-high-level output | See Figure 7 | | | 25 | ns |
| t _{PZL} Propagation delay time, high-impedance-to-low-level output | | | | 25 | ns |
| t _{PHZ} Propagation delay time, high-level-to-high-impedance output | | | | 25 | ns |
| t _{pLZ} Propagation delay time, low-level-to-high-impedance output | | | | 25 | ns |

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

‡ t_{sk(p)} is the magnitude of the time difference between the high-to-low and low-to-high propagation delay times at an output

§ t_{sk(o)} is the magnitude of the time difference between the outputs of a single device with all of their inputs connected together.

¶ t_{sk(pp)} is the magnitude of the difference 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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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 | $C_L = 10 \text{ pF}$, See Figure 6 | | 2.1 | 6 | ns |
| t_{PHL} Propagation delay time, high-to-low-level output | | | 2.1 | 6 | ns |
| t_r Output signal rise time | | | 0.6 | 1.5 | ns |
| t_f Output signal fall time | | | 0.7 | 1.5 | ns |
| $t_{sk(p)}$ Pulse skew ($ t_{pHL} - t_{pLH} $)‡ | | | | 0.6 | ns |
| $t_{sk(o)}$ Channel-to-channel output skew§ | | | | 0.6 | ns |
| $t_{sk(pp)}$ Part-to-part skew¶ | | | | 1 | ns |
| t_{PZH} Propagation delay time, high-level-to-high-impedance output | See Figure 7 | | | 25 | ns |
| t_{PZL} Propagation delay time, low-level-to-low-impedance output | | | | 25 | ns |
| t_{PHZ} Propagation delay time, high-impedance-to-high-level output | | | | 25 | ns |
| t_{PLZ} Propagation delay time, low-impedance-to-high-level output | | | | 25 | ns |

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

‡ $t_{sk(p)}$ is the magnitude of the time difference between the high-to-low and low-to-high propagation delay times at an output

§ $t_{sk(o)}$ is the magnitude of the time difference between the outputs of a single device with all of their inputs connected together.

¶ $t_{sk(pp)}$ is the magnitude of the difference 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.

PARAMETER MEASUREMENT INFORMATION

driver

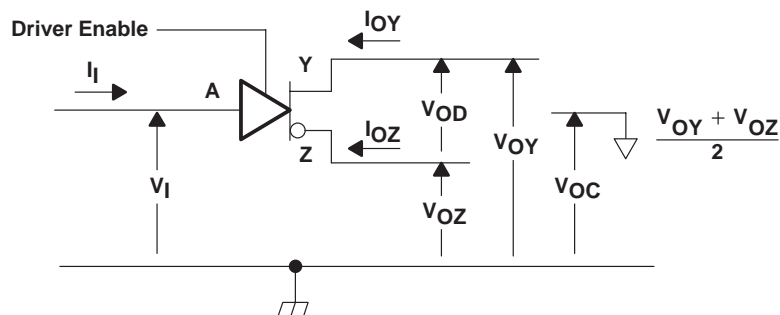
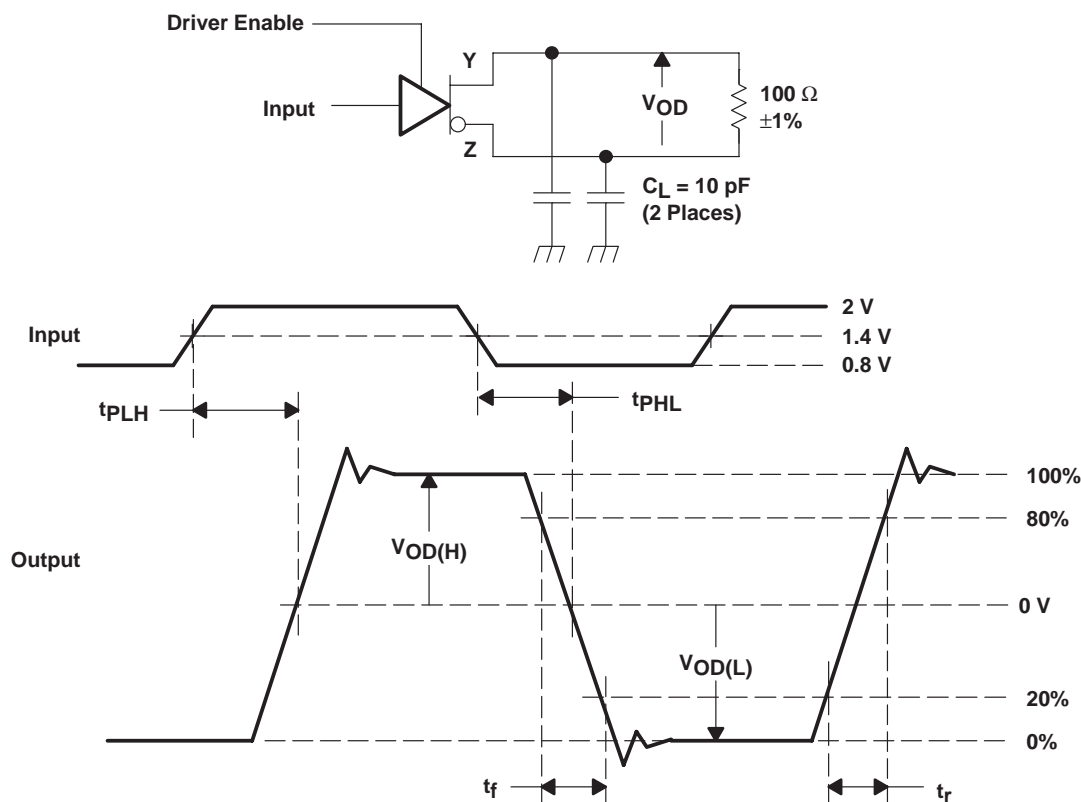


Figure 1. Driver Voltage and Current Definitions

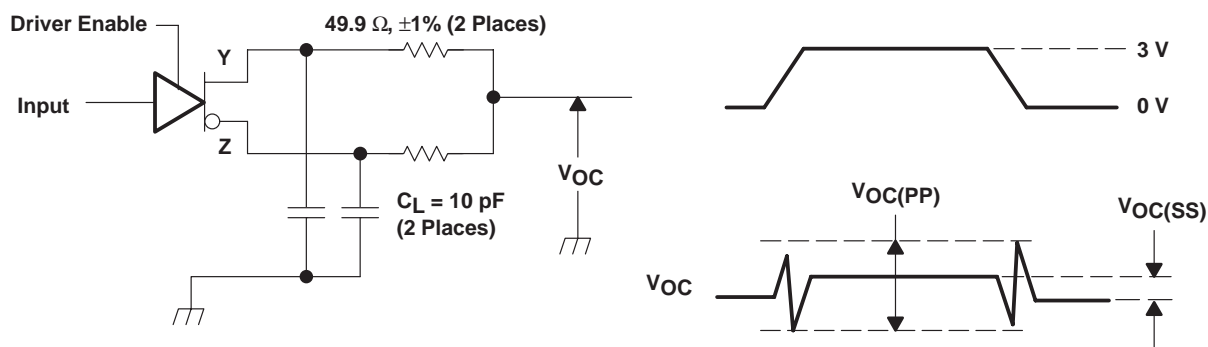
PARAMETER MEASUREMENT INFORMATION

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) = 50 Mpps, pulse width = $10 \pm 0.2\ \text{ns}$. 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

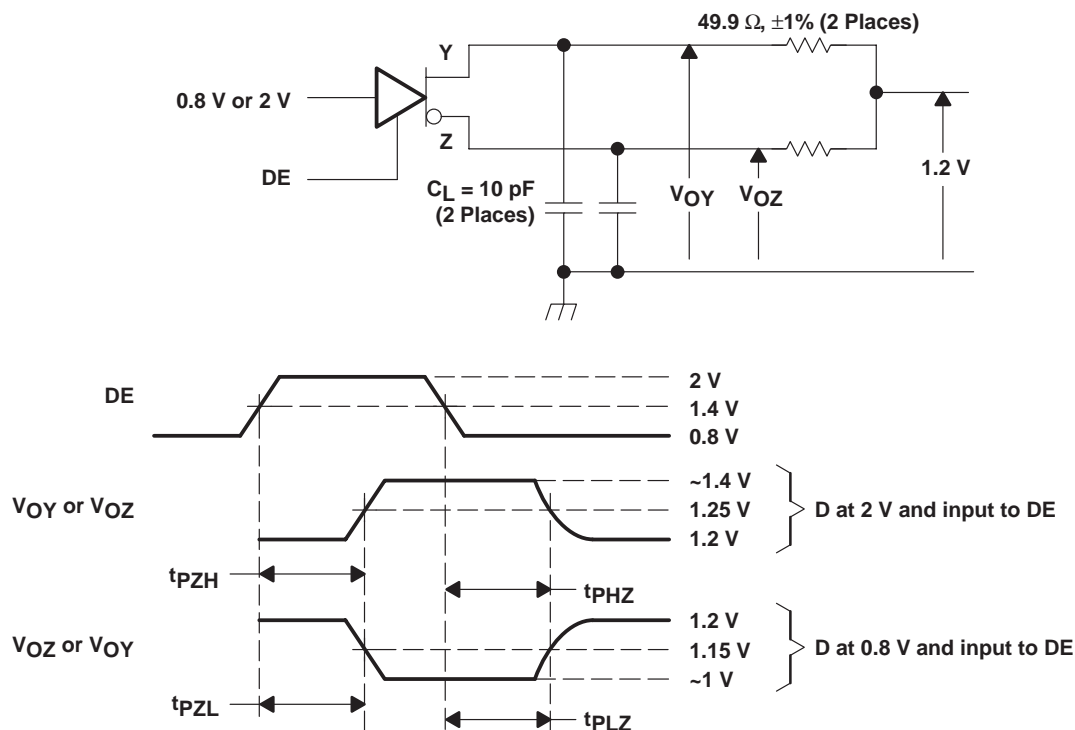


NOTE A: All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq 1\ \text{ns}$, pulse repetition rate (PRR) = 50 Mpps, pulse width = $10 \pm 0.2\ \text{ns}$. C_L includes instrumentation and fixture capacitance within 0,06 mm of the D.U.T. The measurement of $V_{OC(PP)}$ 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 $t_f \leq 1$ ns, pulse repetition rate (PRR) = 0.5 Mpps, pulse width = 500 ± 10 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

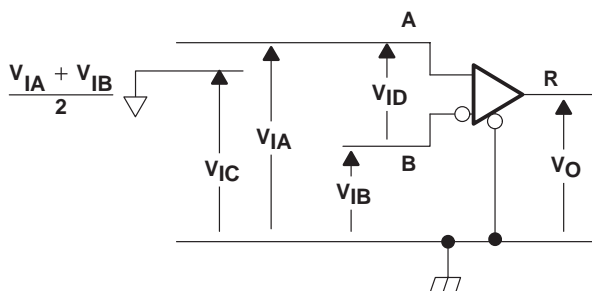
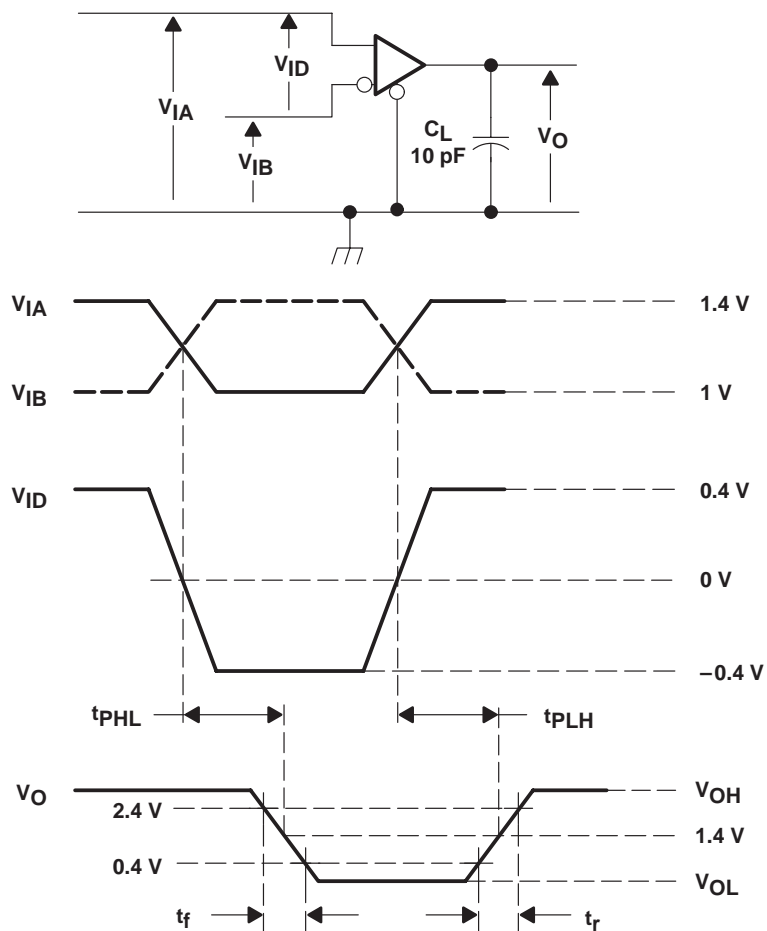
receiver

Figure 5. Receiver Voltage Definitions

| 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 $t_f \leq 1 \text{ ns}$, pulse repetition rate (PRR) = 50 Mpps, pulse width = $10 \pm 0.2 \text{ ns}$. C_L includes instrumentation and fixture capacitance within 0.06 m of the D.U.T.

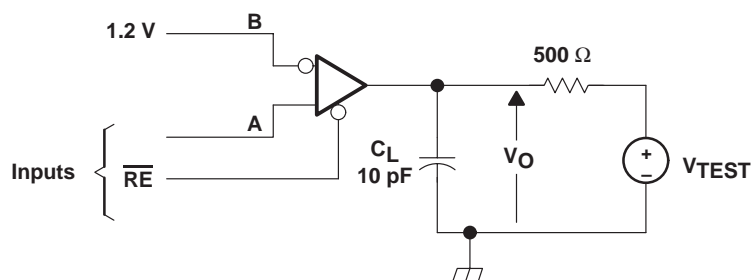
Figure 6. Timing Test Circuit and Waveforms

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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.

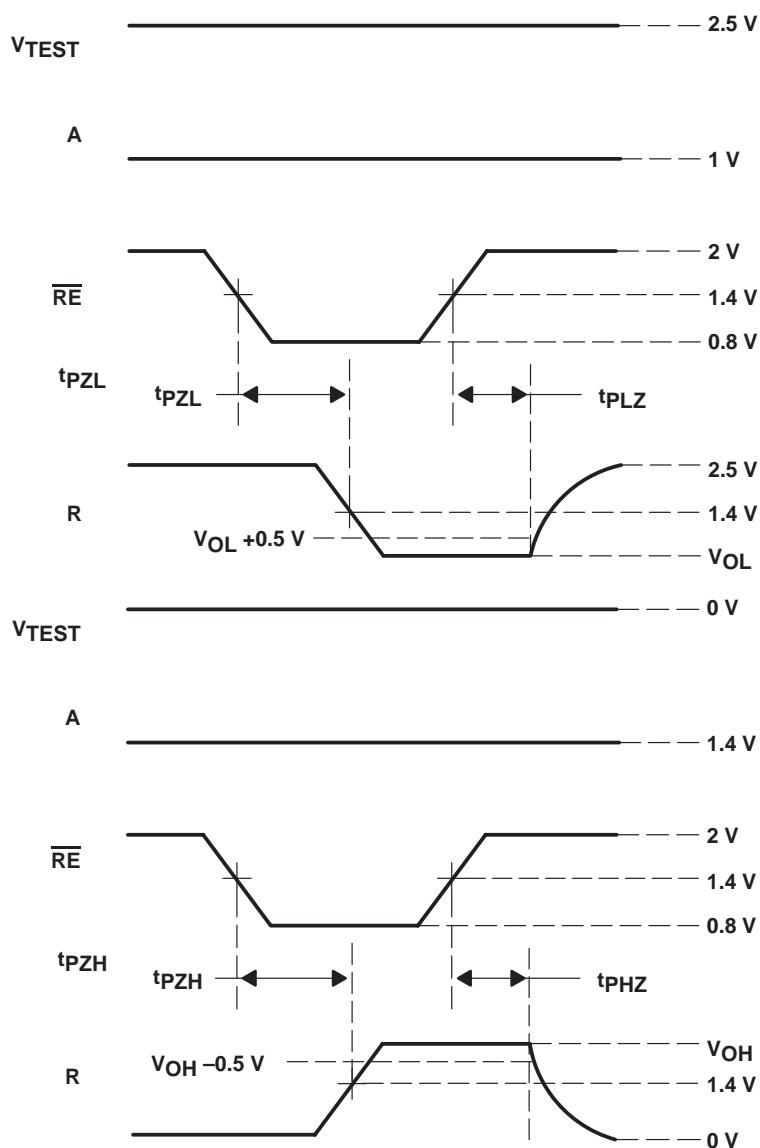


Figure 7. Enable/Disable Time Test Circuit and Waveforms

TYPICAL CHARACTERISTICS

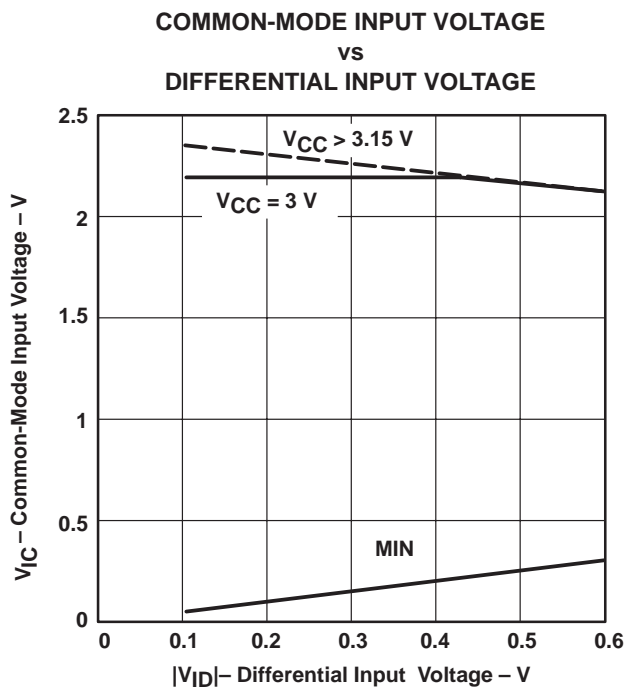


Figure 8

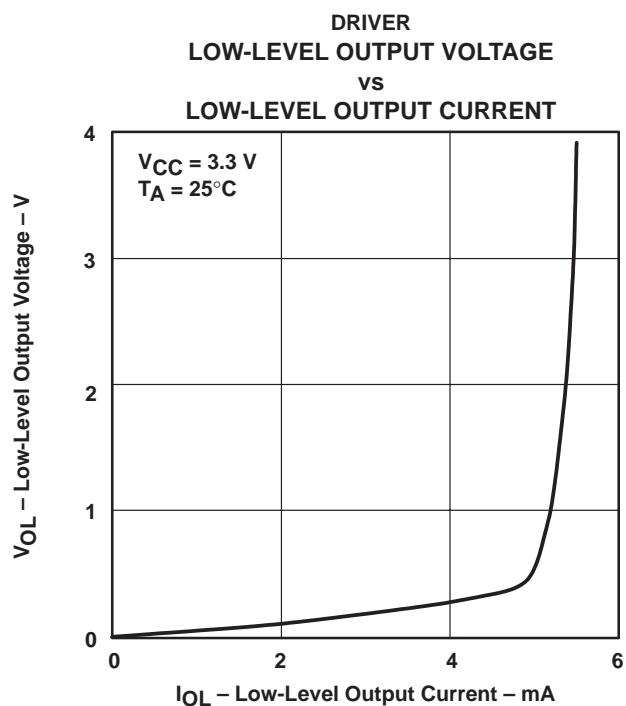


Figure 9

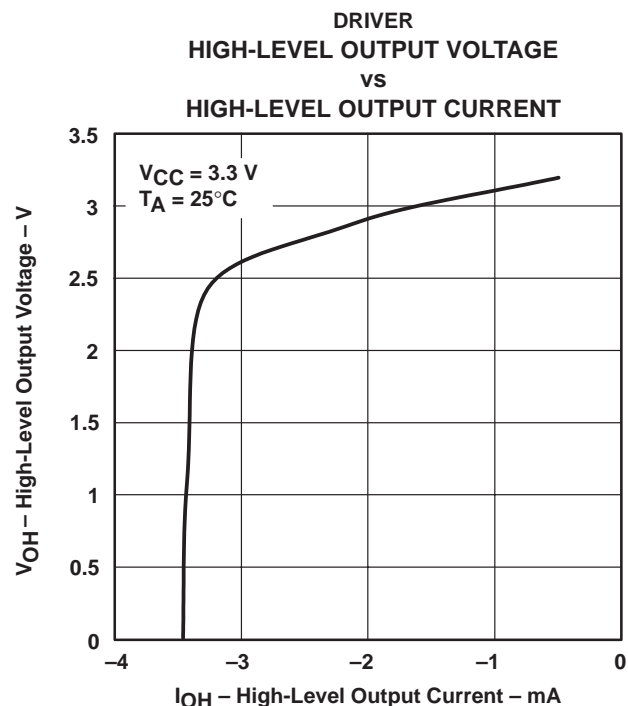


Figure 10

SN75LVDS179, SN75LVDS180, SN75LVDS050, SN75LVDS051
HIGH-SPEED DIFFERENTIAL LINE DRIVERS AND RECEIVERS

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TYPICAL CHARACTERISTICS

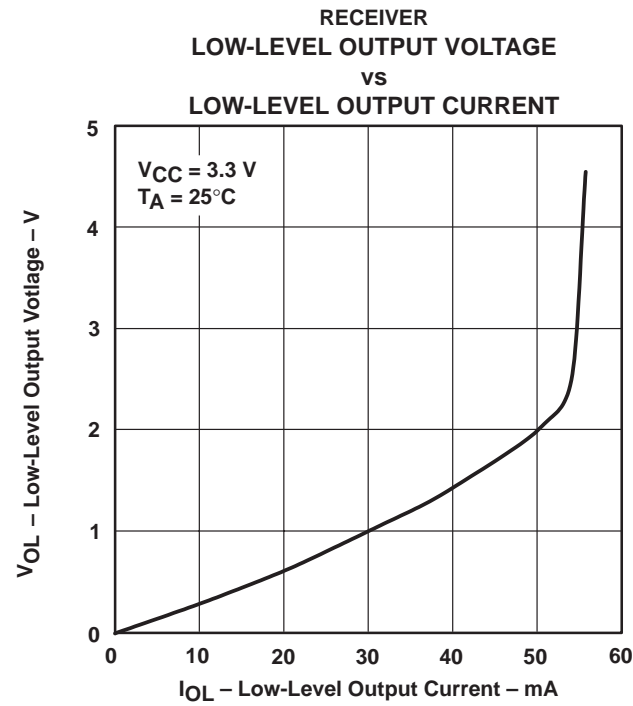


Figure 11

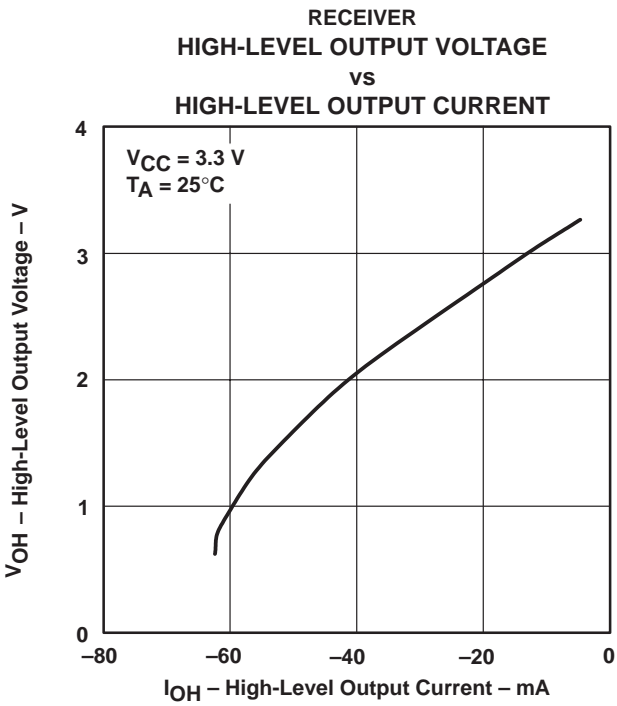


Figure 12

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.

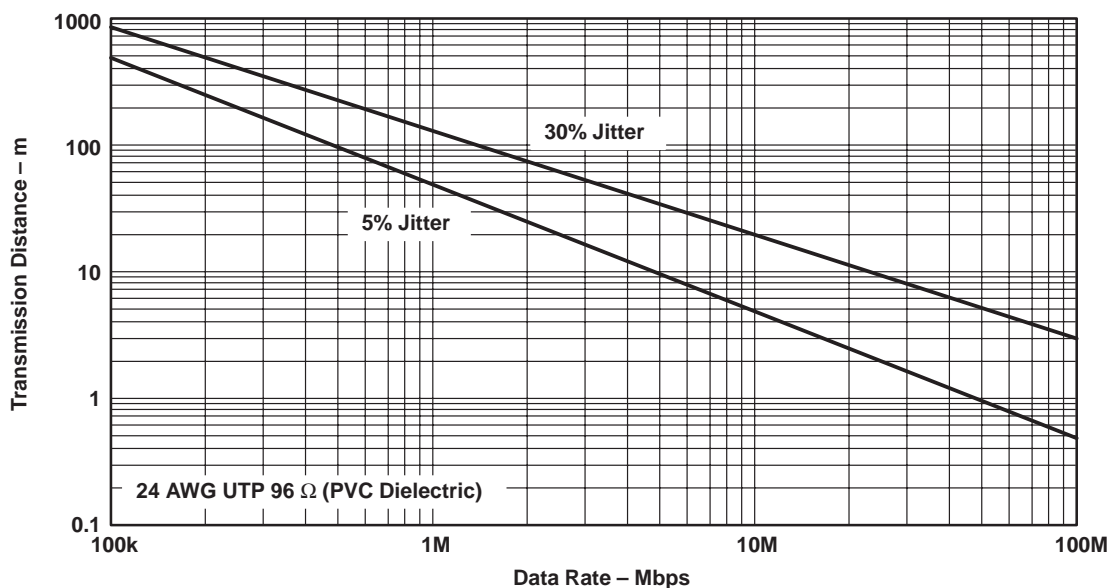


Figure 13. Data Transmission Distance Versus Rate

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 14. 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.

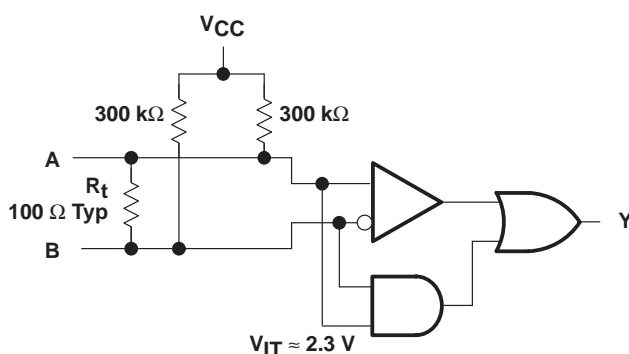


Figure 14. Open-Circuit Fail Safe of the LVDS Receiver

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 pullup currents from the receiver and the fail-safe feature.

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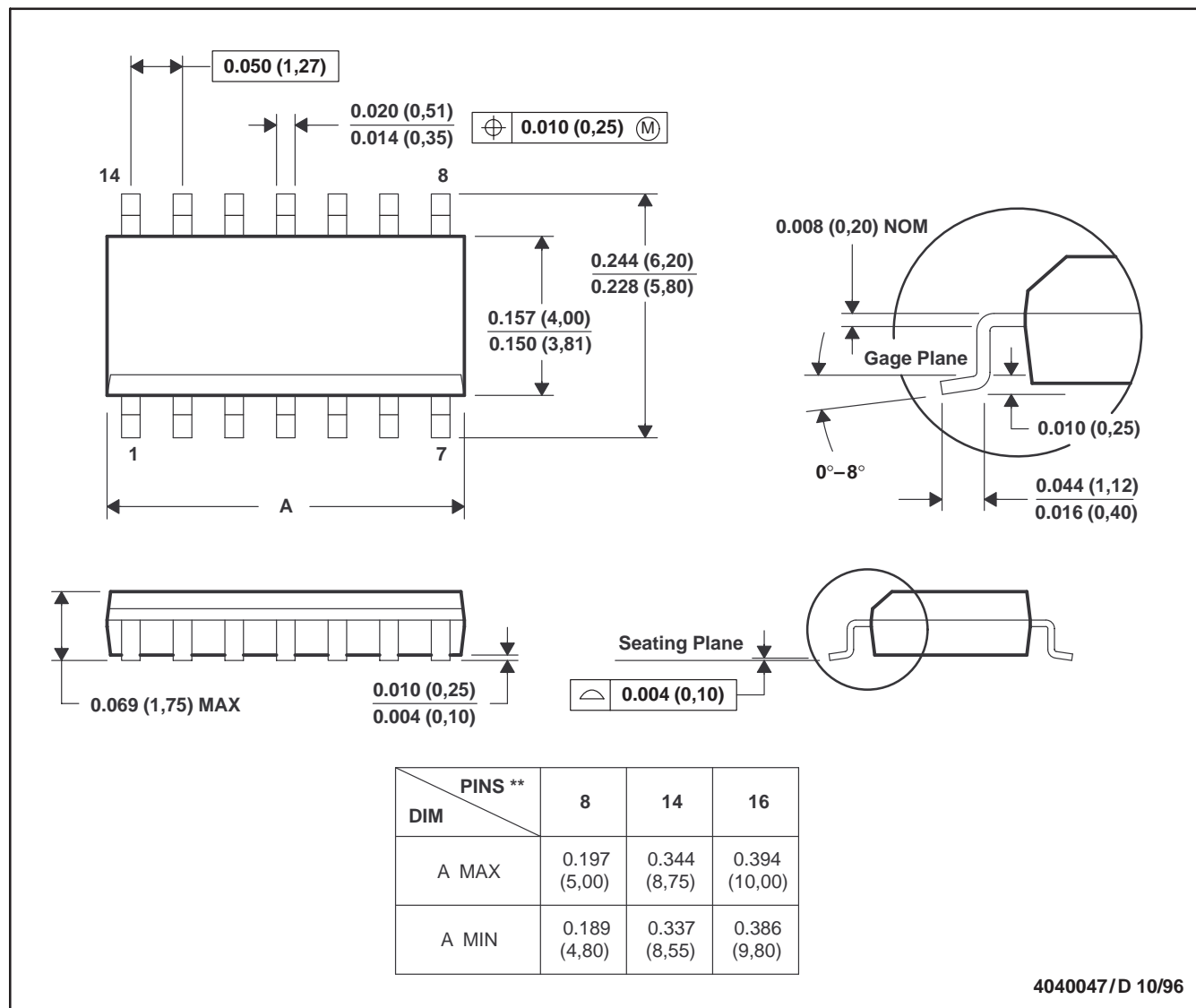
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MECHANICAL DATA

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

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| SN75LVDS051D | ACTIVE | SOIC | D | 16 | 40 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 70 | 75LVDS051 | Samples |

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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