

SN65LVDM176 HIGH-SPEED DIFFERENTIAL LINE TRANSCEIVER

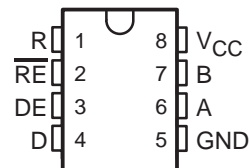
SLLS320C – DECEMBER 1998 – REVISED MARCH 2000

- Low-Voltage Differential Driver and Receiver for Half-Duplex Operation
- Designed for Signaling Rates of 400 Mbit/s
- ESD Protection Exceeds 15 kV on Bus Pins
- Operates from a Single 3.3 V Supply
- Low-Voltage Differential Signaling with Typical Output Voltages of 350 mV and a 50Ω Load
- Propagation Delay Times
 - Driver: 1.7 ns Typ
 - Receiver: 3.7 ns Typ
- Power Dissipation at 200 MHz
 - Driver: 50 mW Typical
 - Receiver: 60 mW Typical
- LVTTTL Levels are 5 V Tolerant
- Bus Pins are High Impedance When Disabled or With V_{CC} Less Than 1.5 V
- Open-Circuit Fail-Safe Receiver
- Surface-Mount Packaging
 - D Package (SOIC)
 - DGK Package (MSOP)

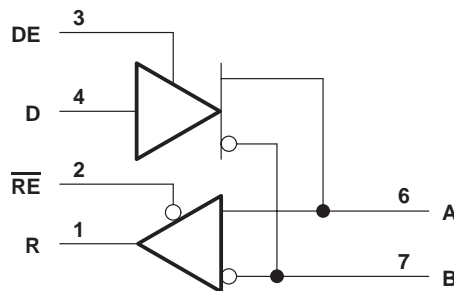
SN65LVDM176D (Marked as DM176 or LVM176)

SN65LVDM176DGK (Marked as M76)

(TOP VIEW)



logic diagram (positive logic)



description

The SN65LVDM176 is a differential line driver and receiver configured as a transceiver that uses low-voltage differential signaling (LVDS) to achieve signaling rates as high as 400 Mbit/s. These circuits are similar to TIA/EIA-644 standard compliant devices (SN65LVDS) counterparts except that the output current of the drivers is doubled. This modification provides a minimum differential output voltage magnitude of 247 mV into a 50Ω load and allows double-terminated lines and half-duplex operation. The receivers detect a voltage difference of less than 100 mV 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 half-duplex or multiplex 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 SN65LVDM176 is characterized for operation from –40°C to 85°C.



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**TEXAS
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AVAILABLE OPTIONS

T _A	PACKAGE	
	SMALL OUTLINE (D) [†]	MSOP (DGK) [†]
-40°C to 85°C	SN65LVDM176D	SN65LVDM176DGK

[†]The D package is available taped and reeled. Add the suffix R to the device type (e.g., SN65LVDM176DR).

Function Tables

DRIVER

INPUT D	ENABLE DE	OUTPUTS	
		A	B
L	H	L	H
H	H	H	L
Open	H	L	H
X	L	Z	Z

H = high level, L = low level, X = irrelevant,
Z = high impedance

RECEIVER

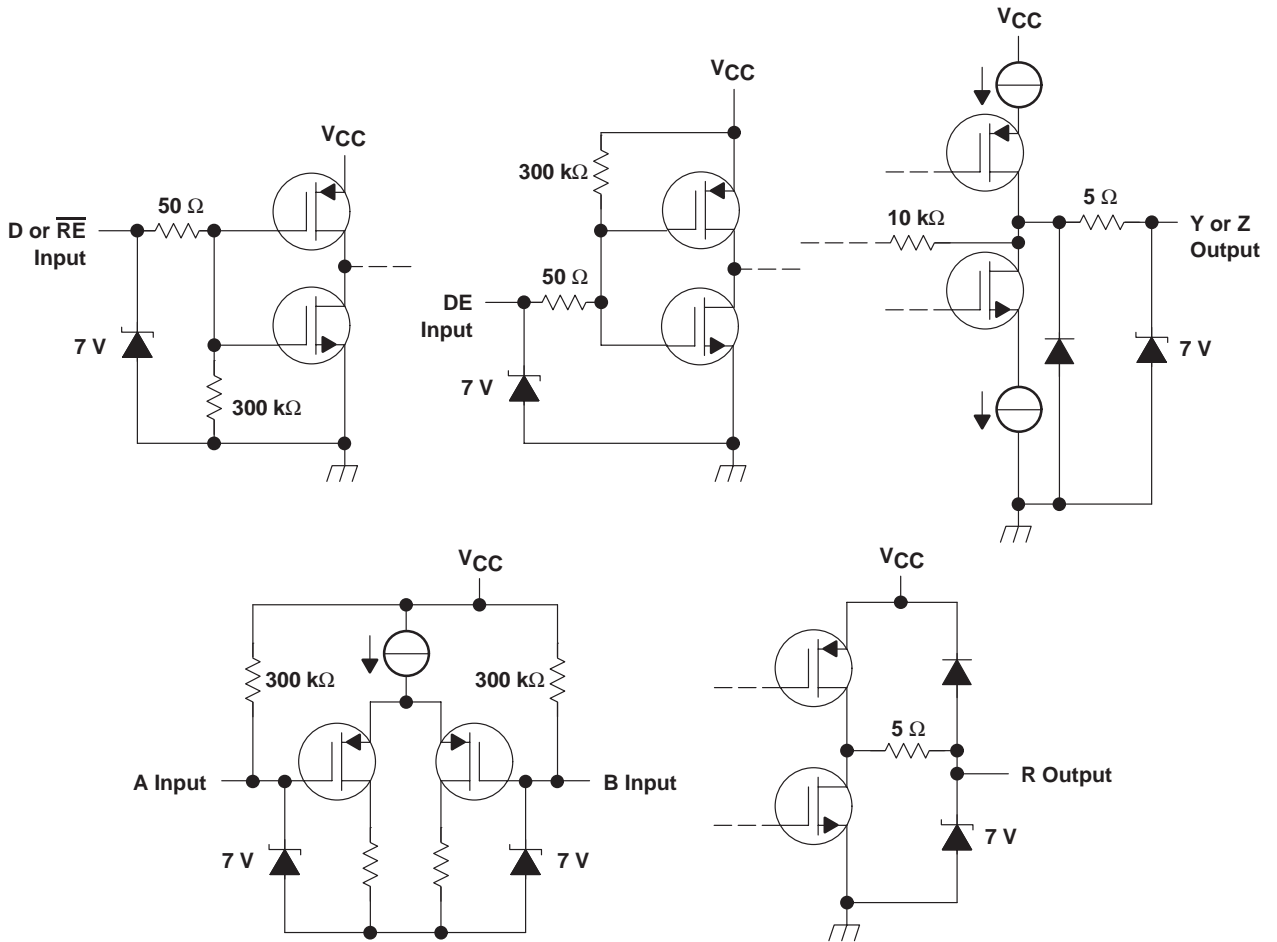
DIFFERENTIAL INPUTS $V_{ID} = V_A - V_B$	ENABLE \overline{RE}	OUTPUT R
$V_{ID} \geq 100$ mV	L	H
-100 mV < V_{ID} < 100 mV	L	?
$V_{ID} \leq -100$ mV	L	L
Open	L	H
X	H	Z

H = high level, L = low level, X = irrelevant,
Z = high impedance

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equivalent input and output schematic diagrams



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

Supply voltage, 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 (A, B, and GND) (see Note 2)	.....	Class 3, A:15 kV, B:600 V
All terminals	.....	Class 3, A:7 kV, B:500 V
Continuous total power dissipation	.....	See Dissipation Rating Table
Operating free-air temperature range, T_A	.....	-40°C to 85°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, except differential I/O bus voltage, 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
D	725 mW	5.8 mW/°C	377 mW
DGK	424 mW	3.4 mW/°C	220 mW

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 1)	$\frac{|V_{ID}|}{2}$		$2.4 - \frac{|V_{ID}|}{2}$	V
			$V_{CC} - 0.8$	
Operating free-air temperature, T_A	-40		85	°C



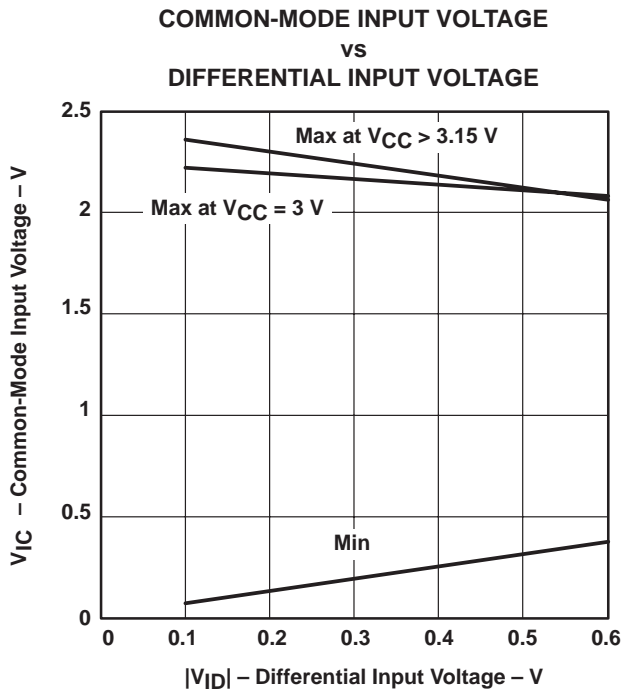


Figure 1

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

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
I _{CC} Supply current	Driver and receiver enabled, No receiver load, Driver R _L = 50 Ω		10	15	mA
	Driver enabled, Receiver disabled, R _L = 50 Ω		9	15	
	Driver disabled, Receiver enabled, No load		1.8	5	
	Disabled		0.5	2	

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

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$|V_{OD}|$	Differential output voltage magnitude	$R_L = 50\Omega$, See Figure 2 and Figure 3	247	340	454	mV
$\Delta|V_{OD}|$	Change in differential output voltage magnitude between logic states		-50		50	
$V_{OC(SS)}$	Steady-state common-mode output voltage	See Figure 4	1.125		1.375	V
$\Delta V_{OC(SS)}$	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	$V_{IH} = 5\text{ V}$	0.5	10	μA
		D		2	20	
I_{IL}	Low-level input current [†]	DE	$V_{IL} = 0.8\text{ V}$	-0.5	-10	μA
		D		2	10	
I_{OS}	Short-circuit output current [†]	V_{OA} or $V_{OB} = 0\text{ V}$			-10	mA
		$V_{OD} = 0\text{ V}$			-10	
C_I	Input capacitance			3		pF

[†] The non-algebraic convention, where the more positive (least negative) limit is designated maximum, is used in this data sheet for this parameter.

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 6			100	mV
V_{ITH-}	Negative-going differential input voltage threshold		-100			
V_{OH}	High-level output voltage	$I_{OH} = -8\text{ mA}$	2.4			V
V_{OL}	Low-level output voltage	$I_{OL} = 8\text{ mA}$			0.4	V
I_I	Input current (A or B inputs) [‡]	$V_I = 0\text{ V}$	-2		-20	μA
		$V_I = 2.4\text{ V}$	-1.2			
$I_{I(OFF)}$	Power-off input current (A or B inputs)	$V_{CC} = 0\text{ V}$ or 1.8 V			20	μA
I_{IH}	High-level input current (enables)	$V_{IH} = 5\text{ V}$			10	μA
I_{IL}	Low-level input current (enables)	$V_{IL} = 0.8\text{ V}$			10	μA
I_{OZ}	High-impedance output current [‡]	$V_O = 0\text{ V}$ or 5 V			± 1	μA

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

[‡] The non-algebraic convention, where the more positive (least negative) limit is designated maximum, is used in this data sheet for this parameter.



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 = 50Ω, C _L = 10 pF, See Figure 3	0.5	1.7	2.7	ns
t _{PHL}	Propagation delay time, high-to-low-level output		0.5	1.7	2.7	
t _{sk(p)}	Pulse skew (|t _{pHL} – t _{pLH}|)			0.2		ns
t _r	Differential output signal rise time			0.6	1	ns
t _f	Differential output signal fall time			0.6	1	
t _{PZH}	Propagation delay time, high-impedance-to-high-level output	See Figure 5		8	12	ns
t _{PZL}	Propagation delay time, high-impedance-to-low-level output			7	10	
t _{PHZ}	Propagation delay time, high-level-to-high-impedance output			3	10	
t _{PLZ}	Propagation delay time, low-level-to-high-impedance output			4	10	

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

‡ t_{sk(lim)} is the maximum delay time difference between drivers over temperature, V_{CC}, and process.

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 7	2.3	3.7	4.5	ns
t _{PHL}	Propagation delay time, high-to-low-level output		2.3	3.7	4.5	
t _{sk(p)}	Pulse skew (|t _{pHL} – t _{pLH}|)			0.4		ns
t _r	Output signal rise time	See Figure 8		0.8	1.5	ns
t _f	Output signal fall time			0.8	1.5	
t _{PZH}	Propagation delay time, high-level-to-high-impedance output			3	10	ns
t _{PZL}	Propagation delay time, low-level-to-low-impedance output			3	10	
t _{PHZ}	Propagation delay time, high-impedance-to-high-level output			4	10	
t _{PLZ}	Propagation delay time, low-impedance-to-high-level output		6	10		

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

‡ t_{sk(lim)} is the maximum delay time difference between drivers over temperature, V_{CC}, and process.

PARAMETER MEASUREMENT INFORMATION

driver

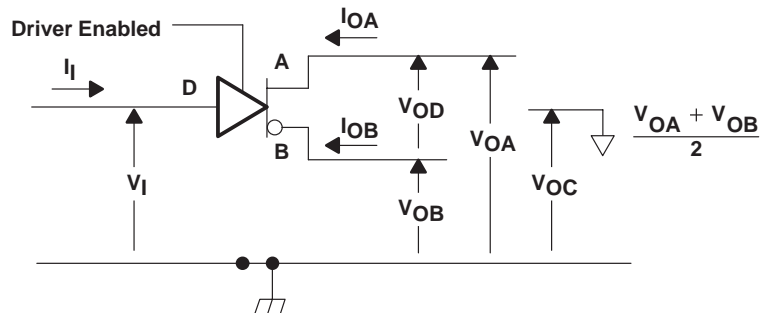


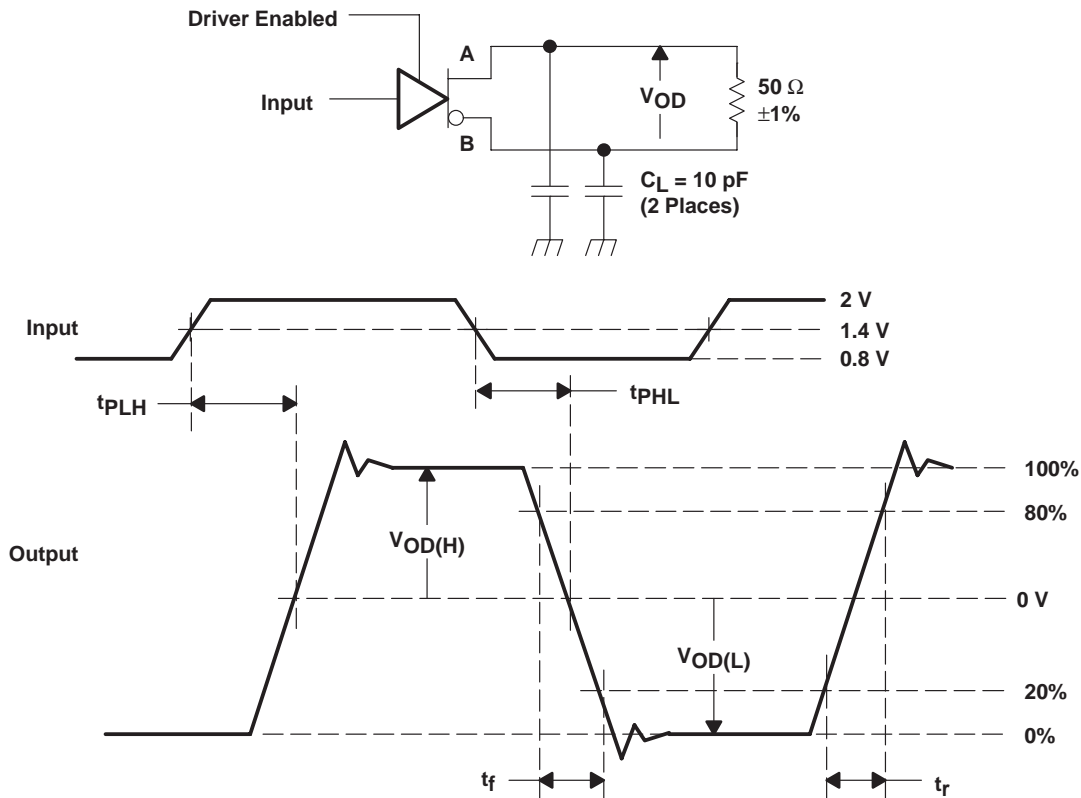
Figure 2. Driver Voltage and Current Definitions

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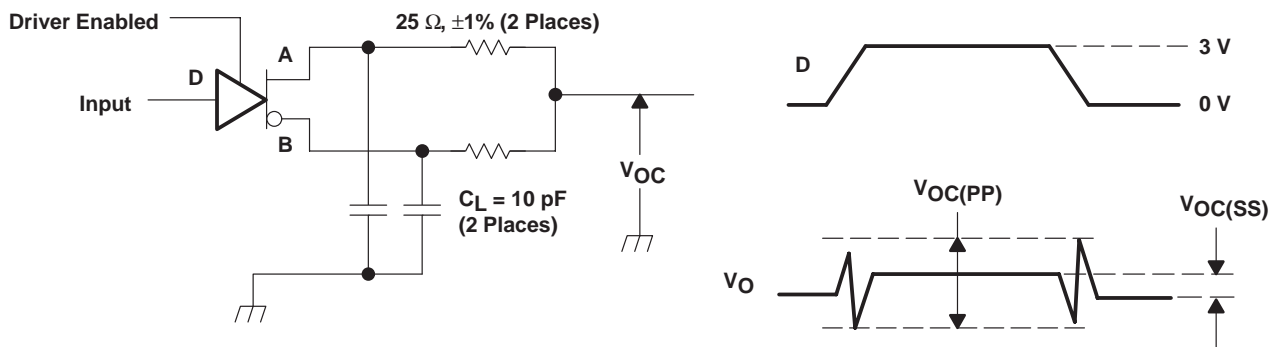
PARAMETER MEASUREMENT INFORMATION

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

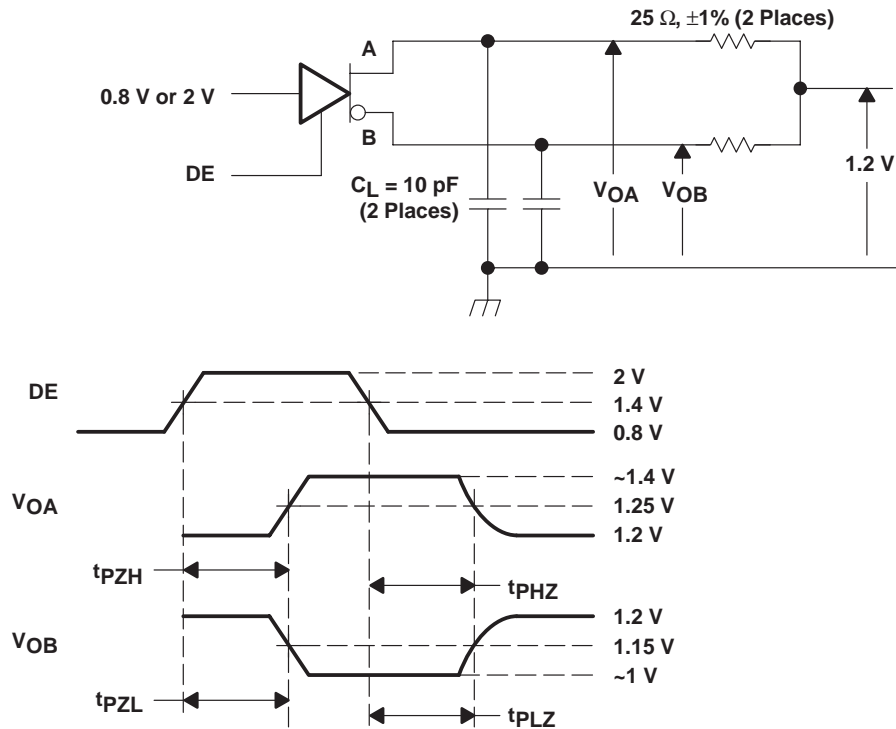


NOTE A: All input pulses are supplied by a generator having the following characteristics: t_r or $t_f \leq 1$ ns, pulse repetition rate (PRR) = 0.5 Mpps, pulse width = 500 ± 10 ns. C_L includes instrumentation and fixture capacitance within 0.06 mm of the D.U.T. The measurement of $V_{OC(PP)}$ is made on test equipment with a -3 dB bandwidth of at least 300 MHz.

Figure 4. 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 5. Enable and Disable Time Circuit and Definitions

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PARAMETER MEASUREMENT INFORMATION

receiver

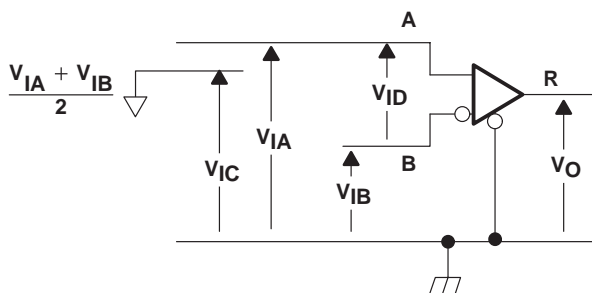


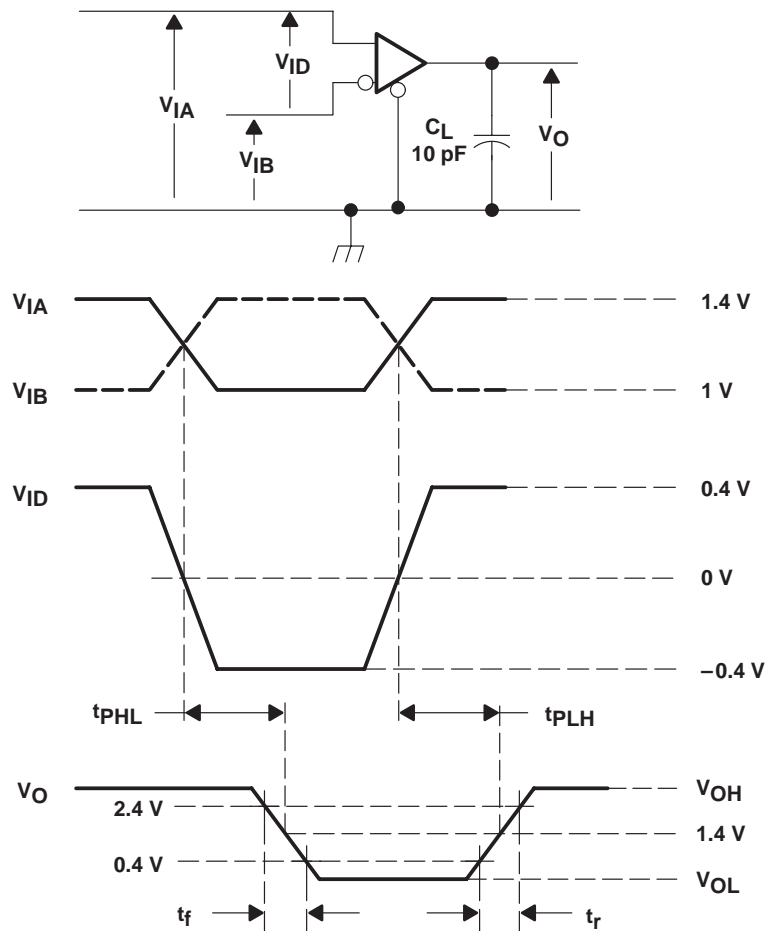
Figure 6. Receiver Voltage Definitions

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}
1.215	1.185	30	1.2
1.185	1.215	-30	1.2
2.4	2.37	30	2.385
2.37	2.4	-30	2.385
0.03	0	30	0.015
0	0.03	-30	0.015
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.

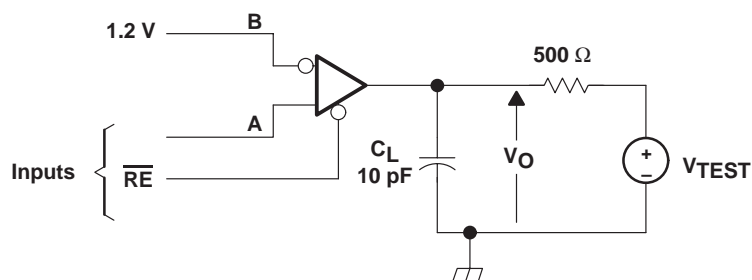
Figure 7. Timing Test Circuit and Waveforms

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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 = 5000 ± 10 ns. C_L includes instrumentation and fixture capacitance within 0.06 m of the D.U.T.

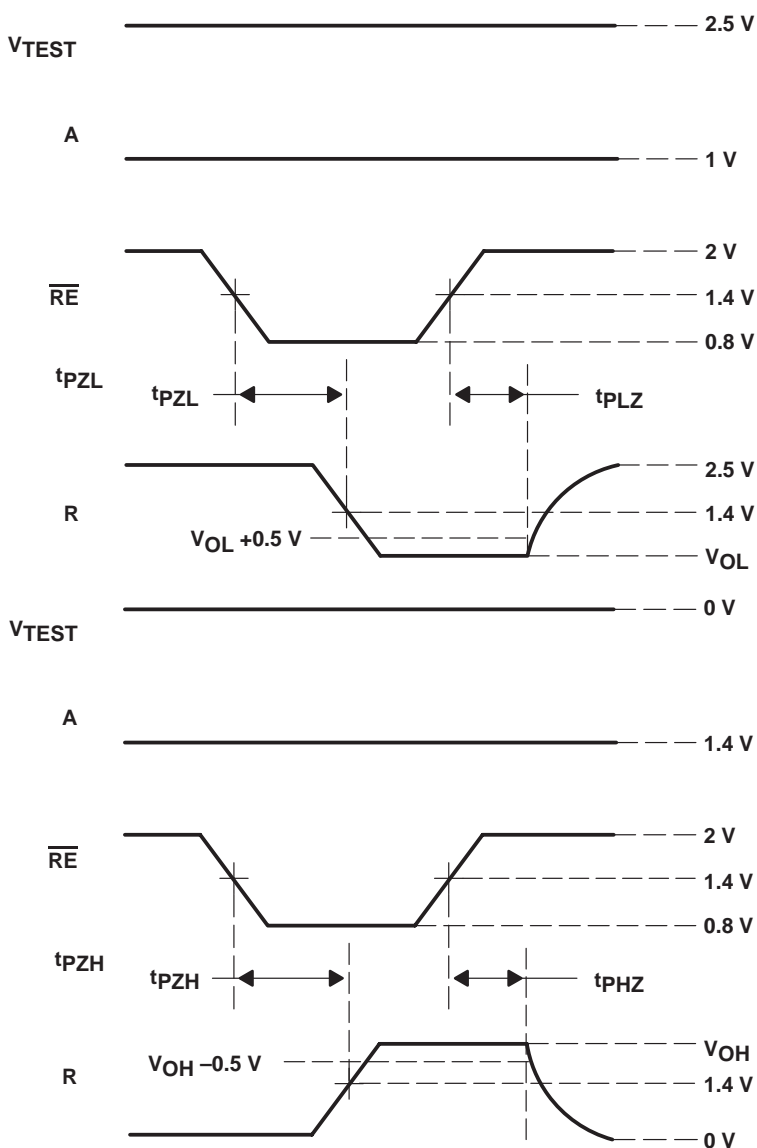
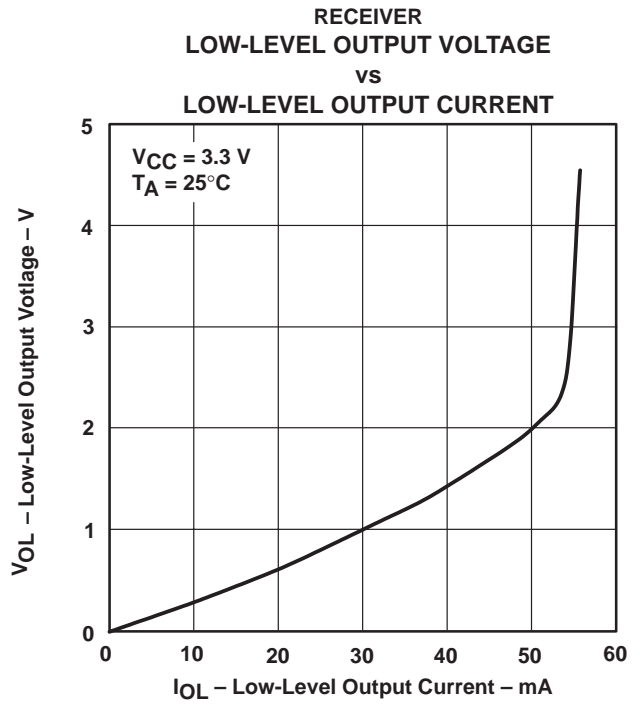
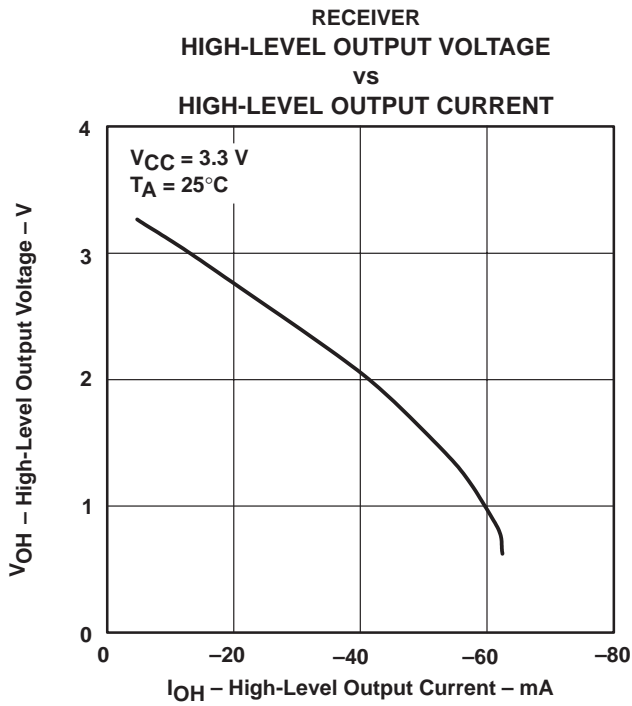
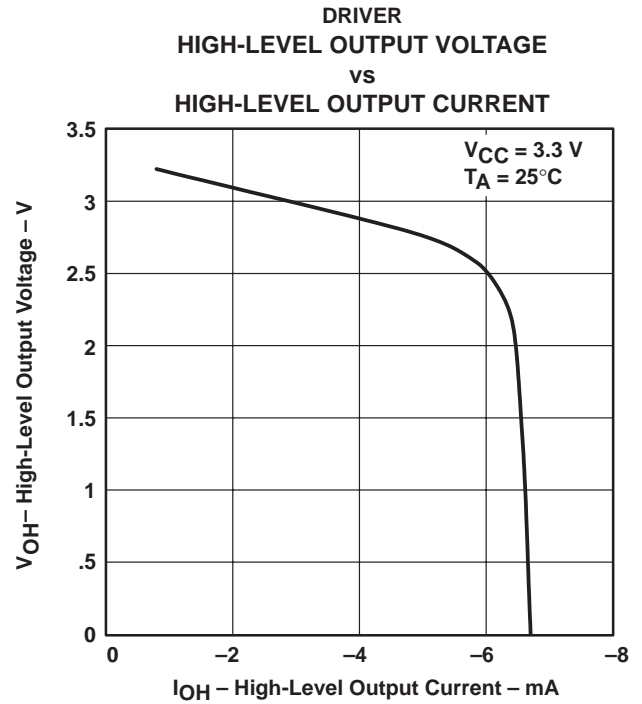
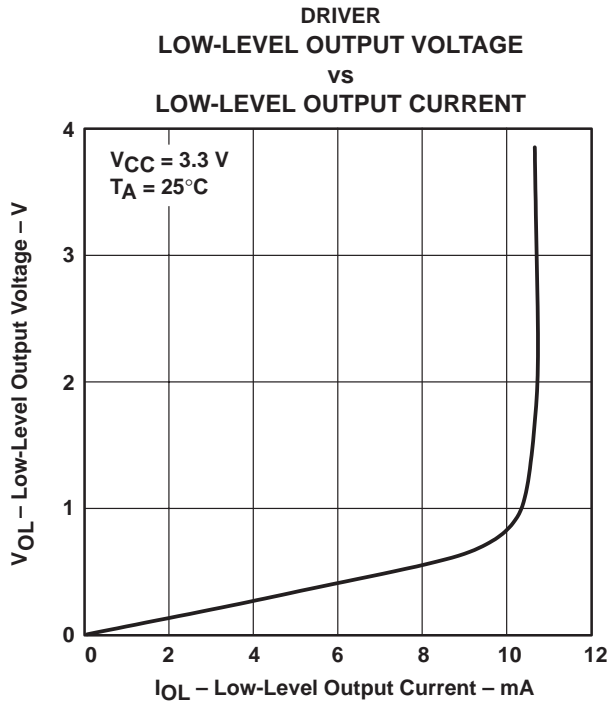


Figure 8. Enable/Disable Time Test Circuit and Waveforms

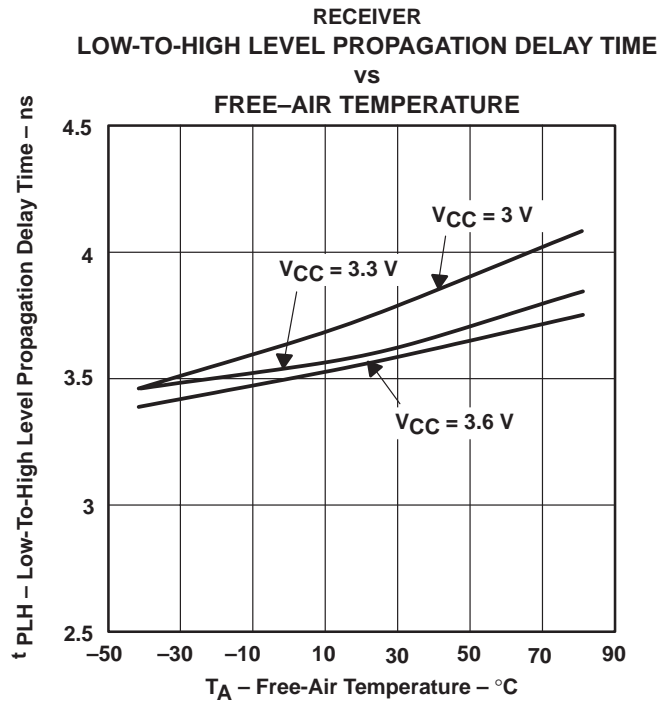
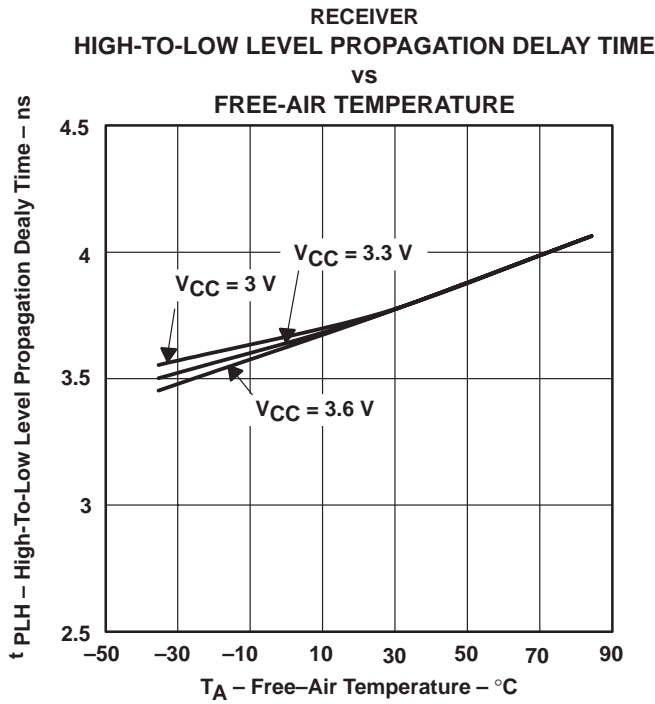
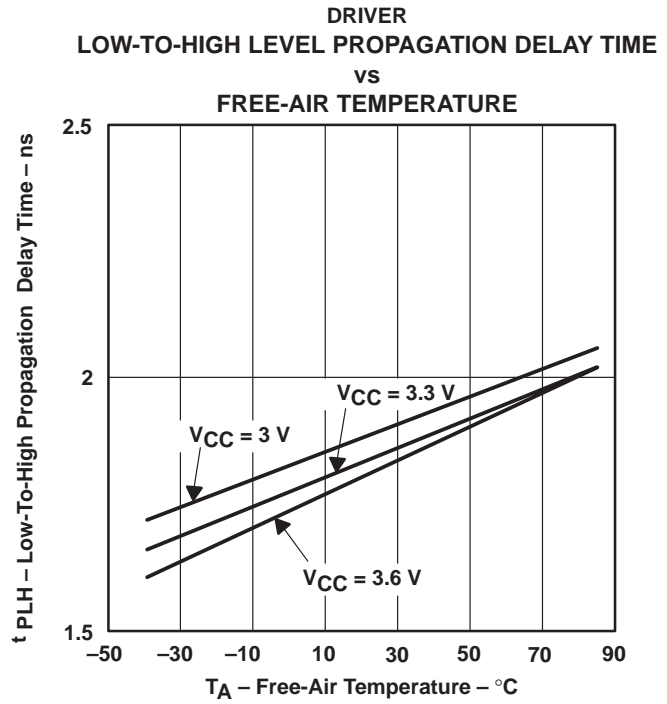
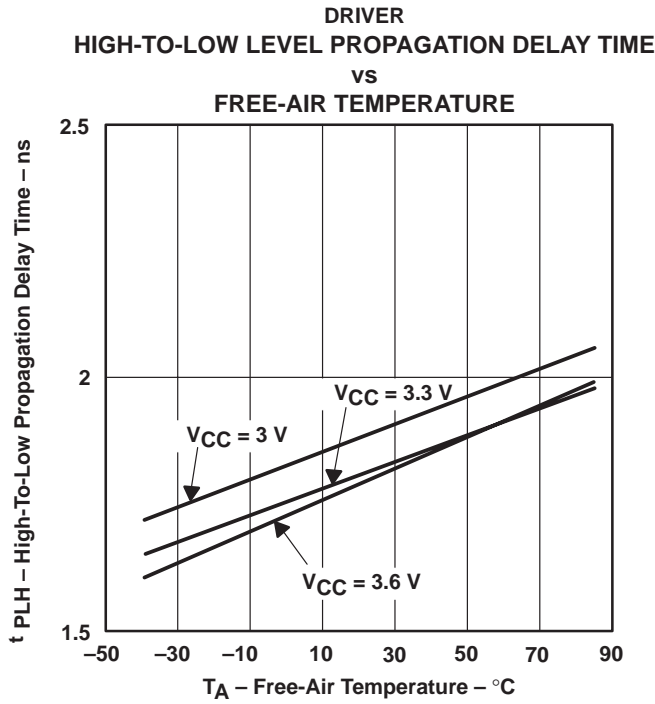
TYPICAL CHARACTERISTICS



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TYPICAL CHARACTERISTICS



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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.

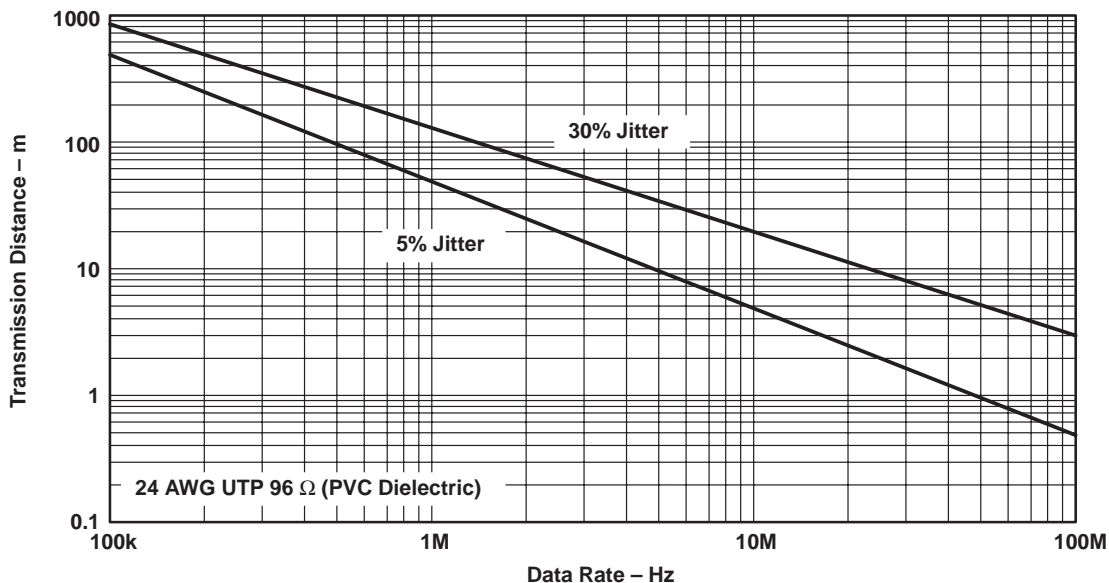


Figure 17. Data Transmission Distance Versus Rate

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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.

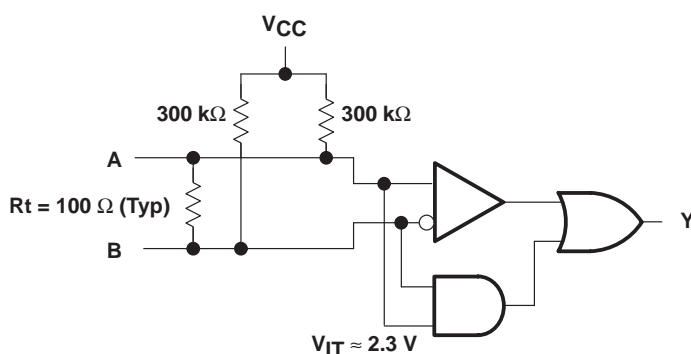
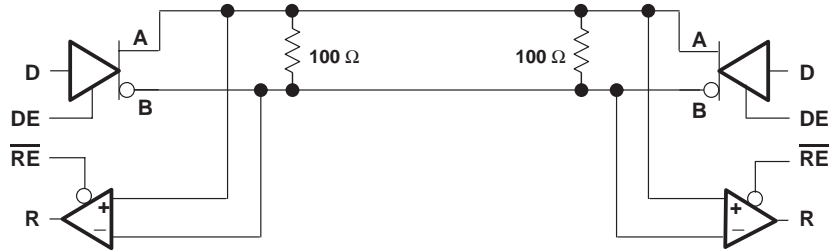


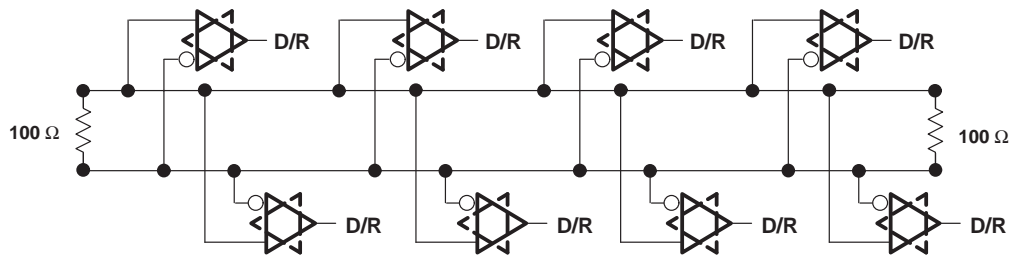
Figure 18. Open-Circuit Fail Safe of the LVDS Receiver

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.

APPLICATIONS INFORMATION



Bidirectional Half-Duplex Applications



Multipoint Bus Applications

Note A: Keep drivers and receivers as close to the LVDS bus side connector as possible.

Figure 19. Bidirectional Half-Duplex and Multipoint Bus Applications

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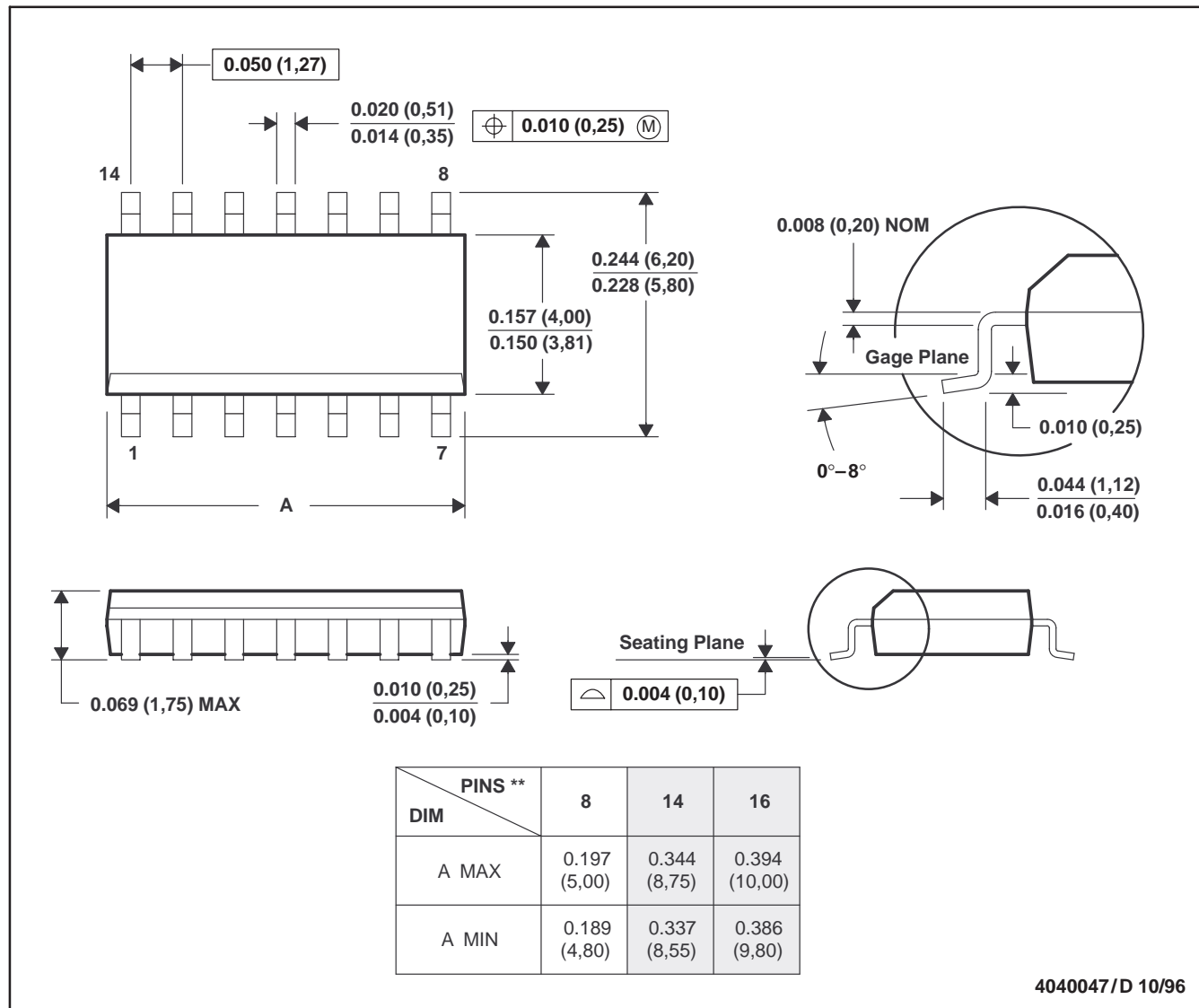
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MECHANICAL DATA

D (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN

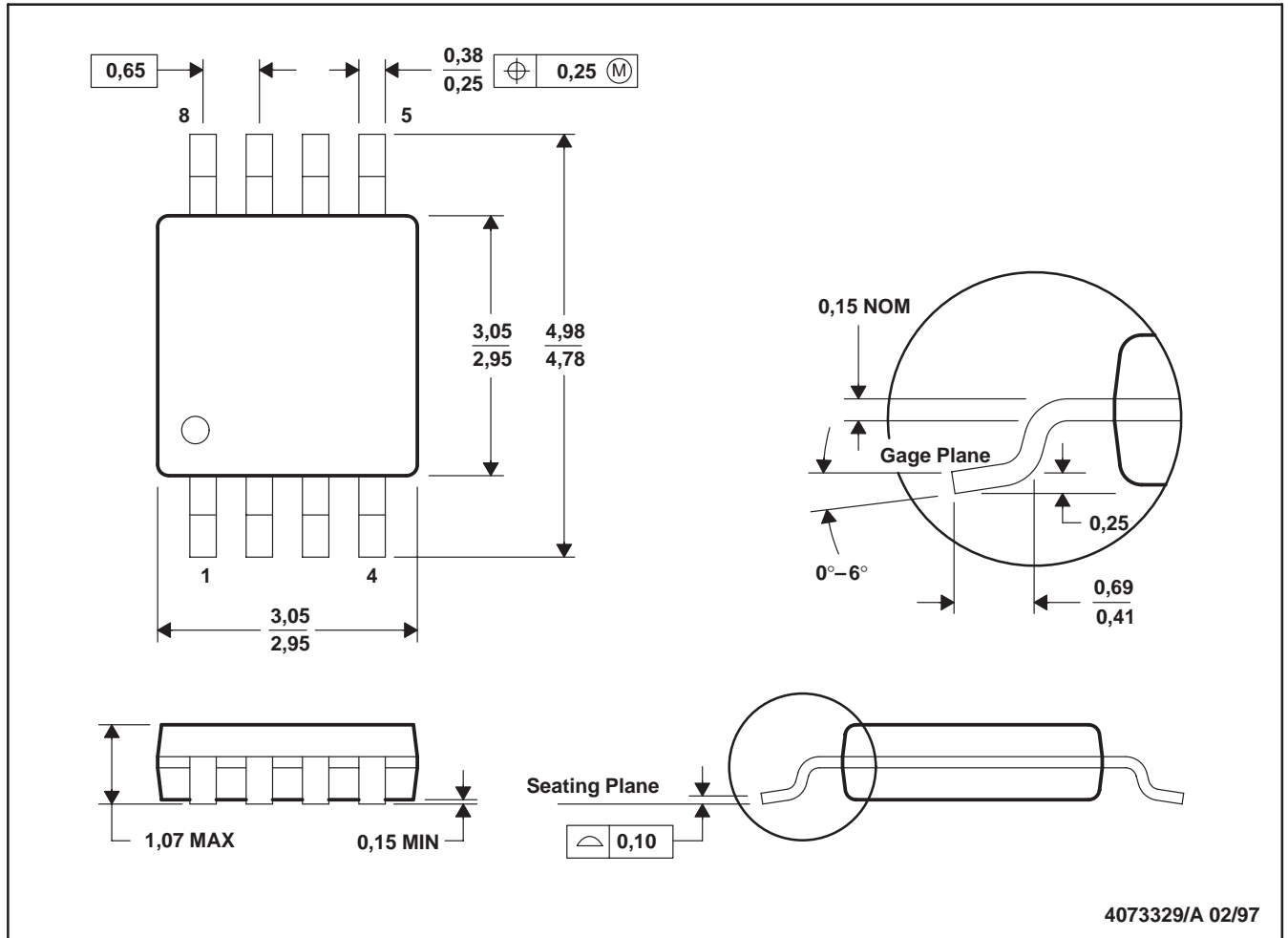


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
 D. Falls within JEDEC MS-012

MECHANICAL DATA

DGK (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- 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.
 D. Falls within JEDEC MO-187

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