

# SN65LVDM31 HIGH-SPEED DIFFERENTIAL LINE DRIVER

SLLS417C – MARCH 2000 – REVISED MAY 2001

- Designed for Signaling Rates† Up to 150 Mbps
- Low-Voltage Differential Signaling With Typical Output Voltage of 700 mV and a 100-Ω Load
- Propagation Delay Time of 2.3 ns, Typical
- Single 3.3-V Supply Operation
- One Driver's Power Dissipation at 75 MHz, 50 mW, Typical
- High-Impedance Outputs When Disabled or With  $V_{CC} < 1.5$  V
- Bus-Pin ESD Protection Exceeds 12 kV
- Low-Voltage CMOS (LVCMOS) Logic Input Levels Are 5-V Tolerant

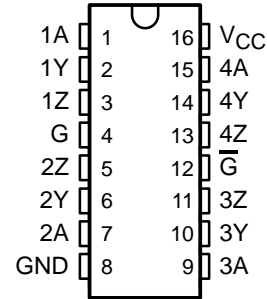
## description

The SN65LVDM31 incorporates four differential line drivers that implement the electrical characteristics of low-voltage differential signaling. This product offers a low-power alternative to 5-V PECL drivers with similar signal levels. Any of the four current-mode drivers will deliver a minimum differential output voltage magnitude of 540 mV into a 100-Ω load when enabled by either an active-low or active-high enable input.

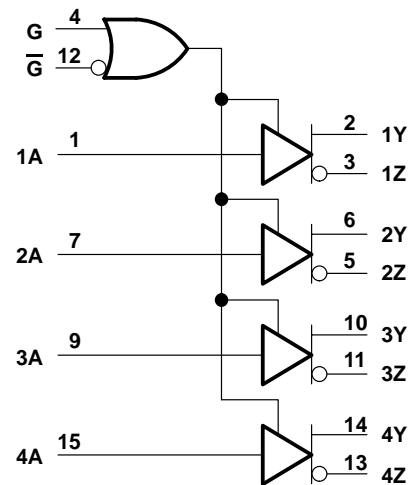
The intended application of this device and signaling technique is for both point-to-point and multiplexed baseband data transmission over controlled impedance media of approximately 100 Ω. The transmission media may be printed-circuit board traces, backplanes, or cables. The ultimate rate and distance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

The SN65LVDM31 is characterized for operation from -40°C to 85°C.

SN65LVDM31D (Marked as LVDM31)  
(TOP VIEW)



## functional block diagram



FUNCTION TABLE

INPUT	ENABLES		OUTPUTS	
	G	$\bar{G}$	Y	Z
H	H	X	H	L
L	H	X	L	H
H	X	L	H	L
L	X	L	L	H
X	L	H	Z	Z
Open	H	X	L	H
Open	X	L	L	H



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†The signaling rate is the number of voltage transitions that can be made per second.

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**

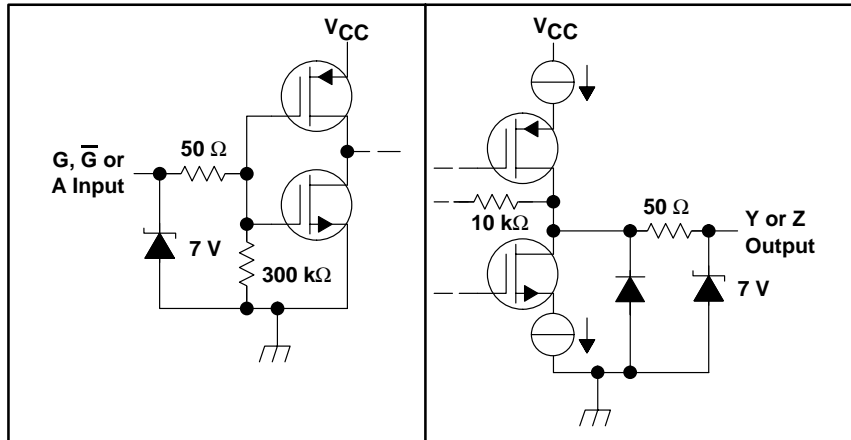
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## equivalent input and output schematic diagrams



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

Supply voltage range (see Note 1) $V_{CC}$ .....	-0.5 V to 4 V
Input voltage range, Inputs .....	-0.5 V to 6 V
Y or Z .....	-0.5 V to 4 V
Electrostatic discharge, (see Note 2): Y, Z, and GND .....	Class 3, A:12 kV, B:600 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 .....	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 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	OPERATING FACTOR‡ ABOVE $T_A = 25^\circ\text{C}$	$T_A = 85^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/°C	494 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, $V_{IH}$	2.0			V
Low-level input voltage, $V_{IL}$			0.8	V
Operating free-air temperature, $T_A$	-40		85	°C



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

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V <sub>OD</sub>	Differential output voltage magnitude	R <sub>L</sub> = 100 Ω, See Figure 2	540	700	860	mV
		R <sub>L</sub> = 50 Ω, See Figure 2	270	350	430	
Δ V <sub>OD</sub>	Change in differential output voltage magnitude between logic states	See Figure 2	-25	0	25	mV
V <sub>OC(SS)</sub>	Steady-state common-mode output voltage	See Figure 3	1.14	1.2	1.3	V
ΔV <sub>OC(SS)</sub>	Change in steady-state common-mode output voltage between logic states		-30	0	30	mV
V <sub>OC(PP)</sub>	Peak-to-peak common-mode output voltage		70	100		
I <sub>CC</sub>	Supply current	Enabled, No load	V <sub>IN</sub> = 0 or V <sub>CC</sub>	6	10	mA
		Enabled, R <sub>L</sub> = 100 Ω		35	40	
		Disabled		0.5	0.7	
I <sub>IH</sub>	High-level input current	V <sub>IH</sub> = 3 V	-10	3	10	μA
I <sub>IL</sub>	Low-level input current	V <sub>IL</sub> = 0 V	-10	0	10	μA
I <sub>OS</sub>	Short-circuit output current	V <sub>OY</sub> or V <sub>OZ</sub> = 0 V		7	10	mA
		V <sub>OD</sub> = 0 V		7	10	
I <sub>OZ</sub>	High-impedance state output current	V <sub>O</sub> = 0 V or V <sub>CC</sub>			±1	μA
I <sub>O(OFF)</sub>	Power-off output current	V <sub>CC</sub> = 1.5 V, V <sub>O</sub> = 3.6 V			±1	μA

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

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t <sub>PLH</sub>	Propagation delay time, low-to-high-level output	See Figure 4	1.8	2.3	2.9	ns
t <sub>PHL</sub>	Propagation delay time, high-to-low-level output		1.8	2.3	2.9	ns
t <sub>r</sub>	Differential output signal rise time		0.4	0.6	1.0	ns
t <sub>f</sub>	Differential output signal fall time		0.4	0.6	1.0	ns
t <sub>sk(p)</sub>	Pulse skew ( t <sub>PHL</sub> - t <sub>PLH</sub>  )			50	350	ps
t <sub>sk(o)</sub>	Channel-to-channel output skew (see Note 3)				200	ps
t <sub>sk(pp)</sub>	Part-to-part skew (see Note 4)	See Figure 5			1	ns
t <sub>PZH</sub>	Propagation delay time, high-impedance-to-high-level output			6	15	ns
t <sub>PZL</sub>	Propagation delay time, high-impedance-to-low level output			6	15	ns
t <sub>PHz</sub>	Propagation delay time, high-level-to-high-impedance output			6	15	ns
t <sub>PLz</sub>	Propagation delay time, low-level-to-high-impedance output			6	15	ns

- NOTES: 3. t<sub>sk(o)</sub> is the maximum delay time difference between drivers on the same device.  
 4. t<sub>sk(pp)</sub> 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, at the same temperature, and have identical packages and test circuits.

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## PARAMETER MEASUREMENT INFORMATION

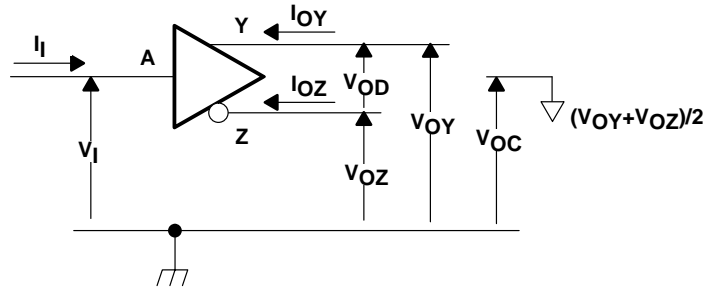


Figure 1. Driver Voltage and Current Definitions

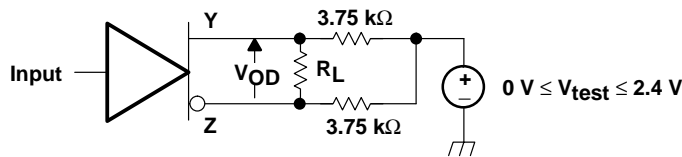
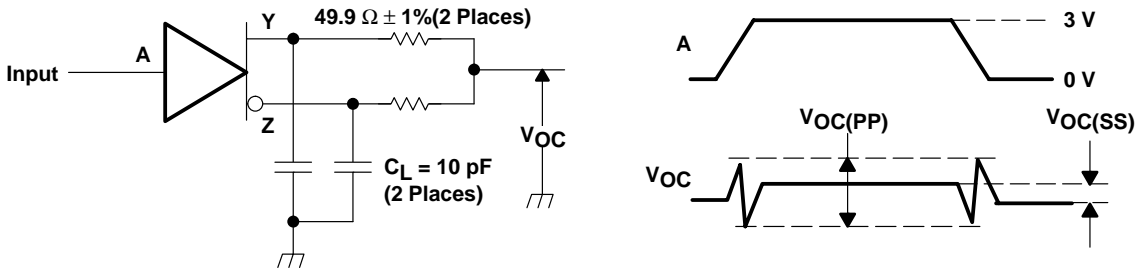


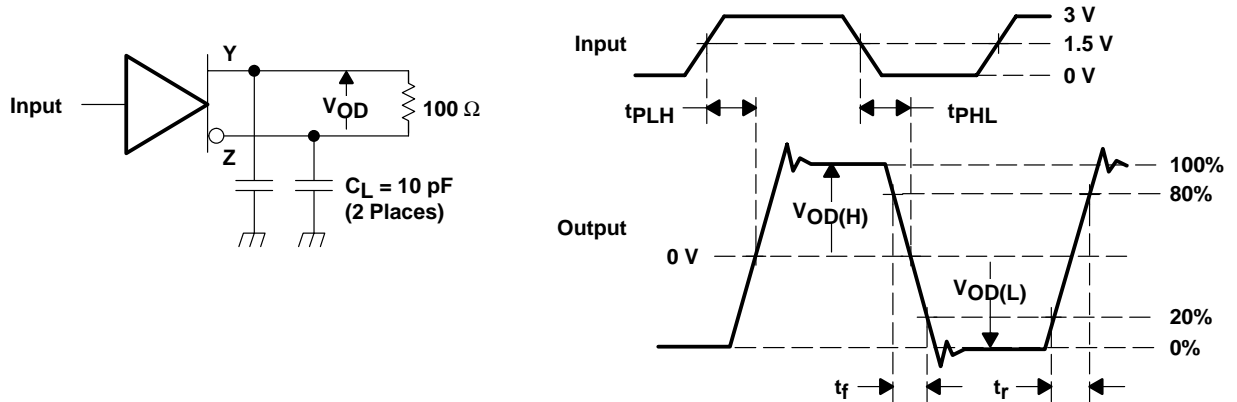
Figure 2.  $V_{OD}$  Test Circuit



NOTE: All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1$  ns, pulse repetition rate (PRR) = 0.5 Mpps, pulse width =  $500 \pm 10$  ns.  $C_L$  includes instrumentation and fixture capacitance within 0,06 mm of the DUT. The measurement of  $V_{OC(PP)}$  is made on test equipment with a  $-3$  dB bandwidth of at least 300 MHz.

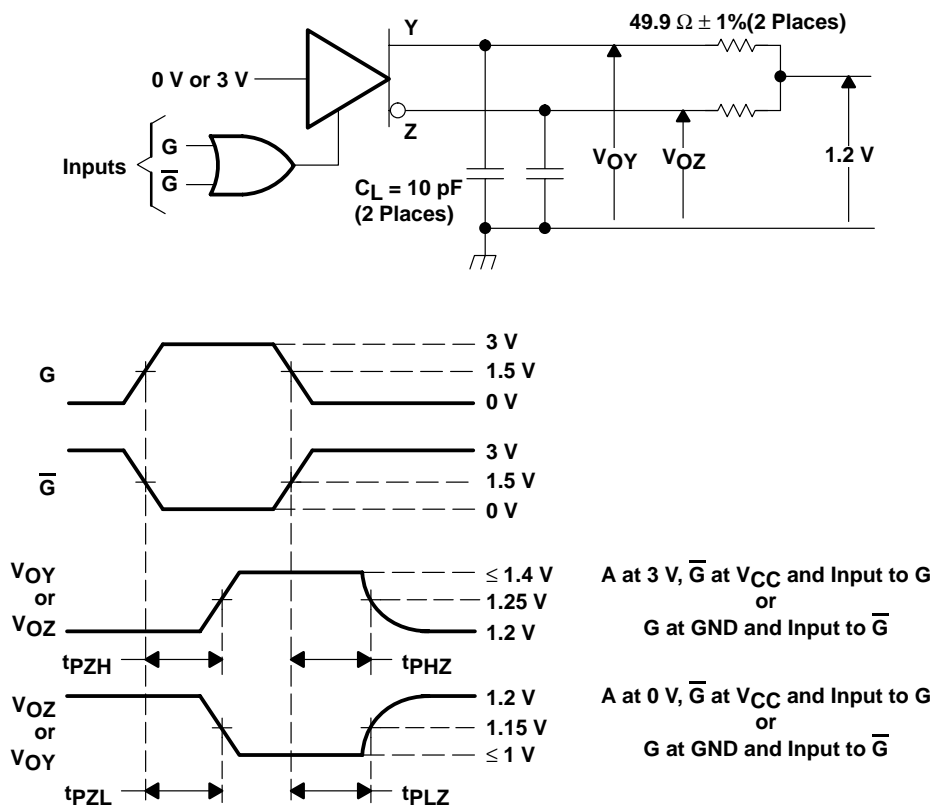
Figure 3. Test Circuit and Definitions for the Driver Common-Mode Output Voltage

PARAMETER MEASUREMENT INFORMATION



NOTE: 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 =  $10 \pm 0.2$  ns.  $C_L$  includes instrumentation and fixture capacitance within 0,06 mm of the DUT.

Figure 4. Test Circuit, Timing, and Voltage Definitions for the Differential Output Signal



NOTE: All input pulses are supplied by a generator having the following characteristics:  $t_r$  or  $t_f \leq 1$  ns, pulse repetition rate (PRR) = 0.5 Mpps, pulse width =  $500 \pm 10$  ns.  $C_L$  includes instrumentation and fixture capacitance within 0,06 mm of the DUT.

Figure 5. Enable and Disable Time Circuit and Definitions

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## TYPICAL CHARACTERISTICS

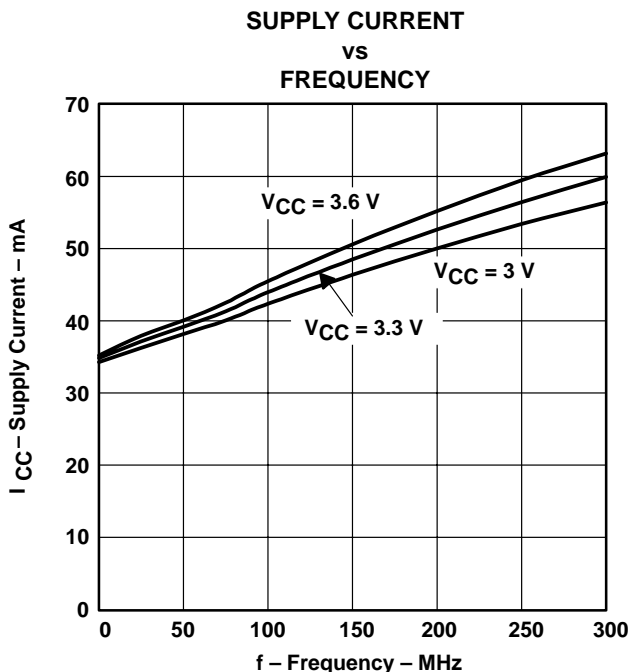


Figure 6

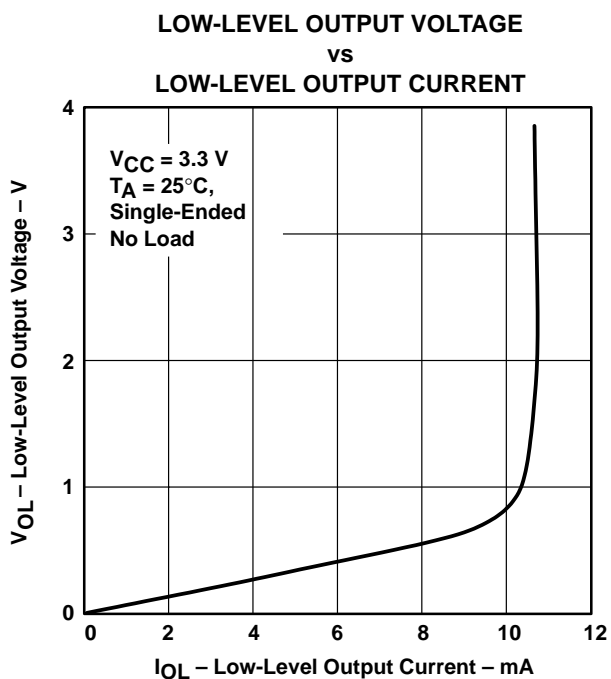


Figure 7

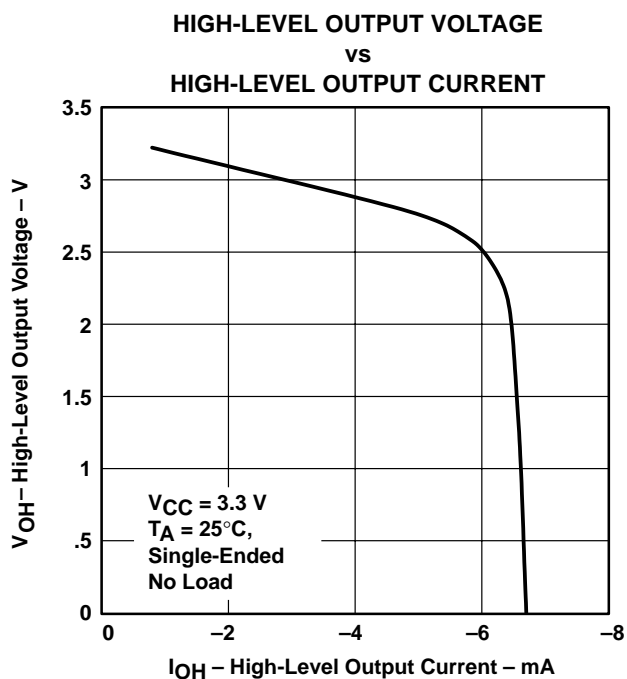


Figure 8



TYPICAL CHARACTERISTICS

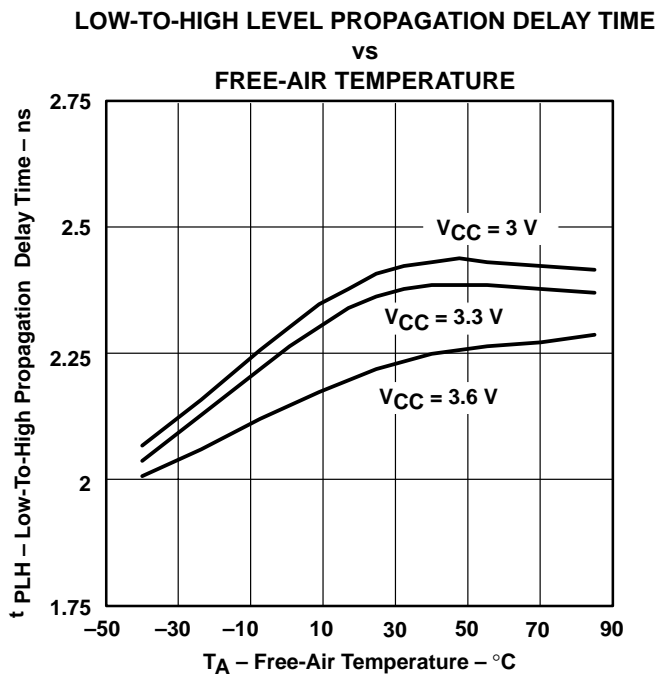


Figure 9

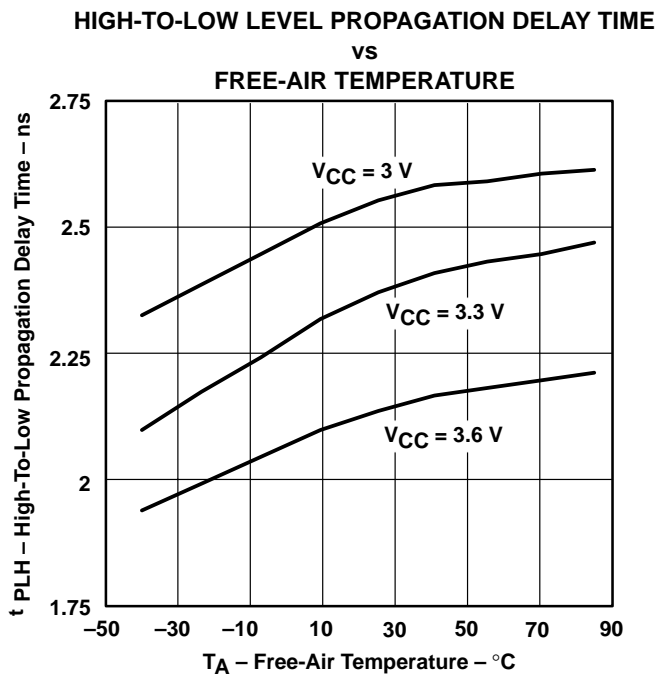


Figure 10

# SN65LVDM31 HIGH-SPEED DIFFERENTIAL LINE DRIVER

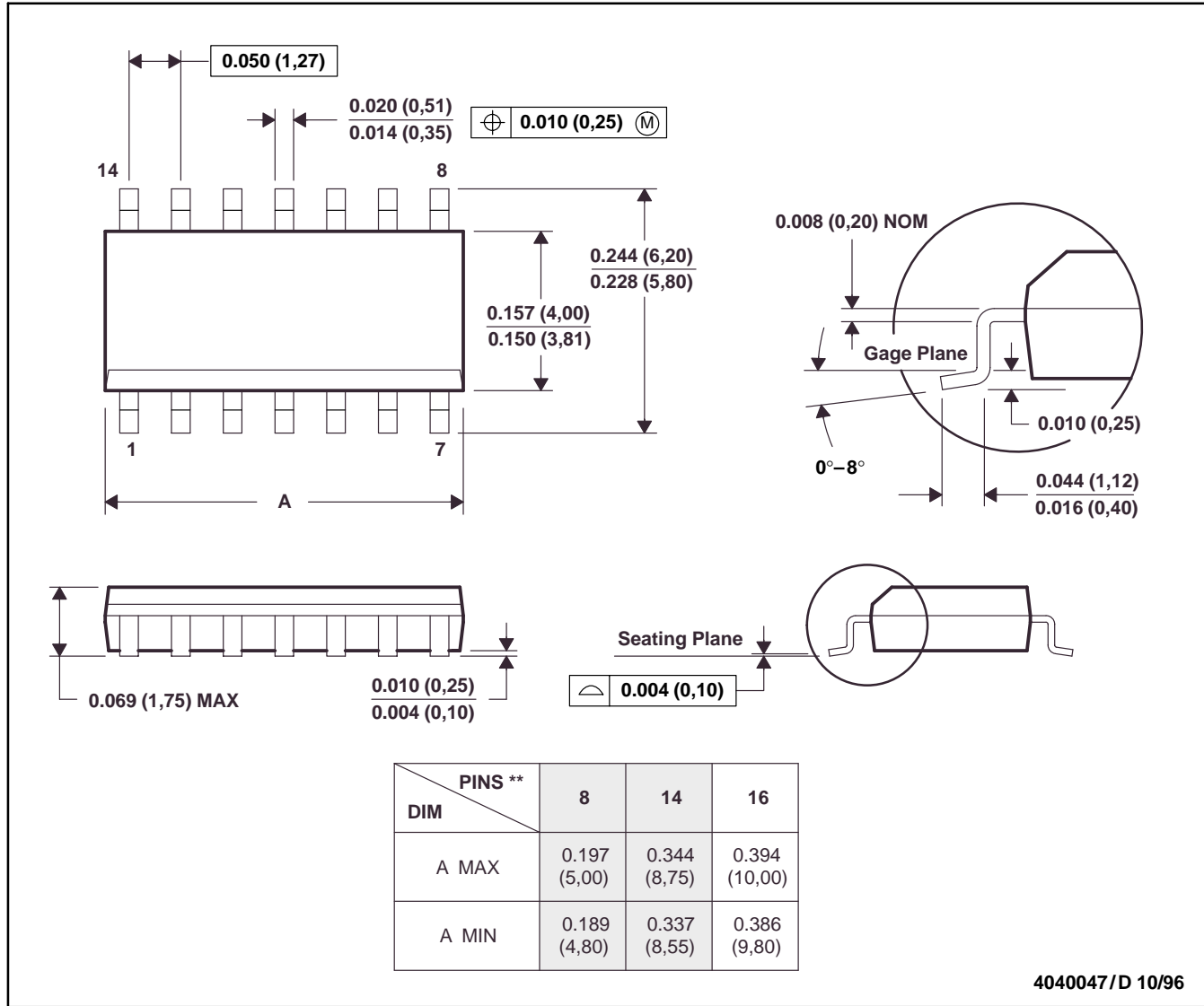
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## MECHANICAL DATA

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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