

SN65LBC176A, SN75LBC176A DIFFERENTIAL BUS TRANSCEIVERS

SLLS376C– MAY 2000 – REVISED DECEMBER 2000

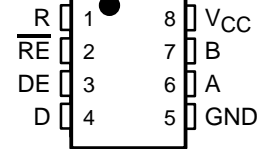
- High-Speed Low-Power LinBiCMOS™ Circuitry Designed for Signaling Rates† Up to 30 Mbps
- Bus-Pin ESD Protection Exceeds 12 kV HBM
- Compatible With ANSI Standard TIA/EIA-485-A and ISO 8482:1987(E)
- Low Skew
- Designed for Multipoint Transmission on Long Bus Lines in Noisy Environments
- Very Low Disabled Supply-Current Requirements . . . 700 μ A Maximum
- Common Mode Voltage Range of -7 V to 12 V
- Thermal-Shutdown Protection
- Driver Positive and Negative Current Limiting
- Open-Circuit Fail-Safe Receiver Design
- Receiver Input Sensitivity . . . ± 200 mV Max
- Receiver Input Hysteresis . . . 50 mV Typ
- Glitch-Free Power-Up and Power-Down Protection
- Available in Q-Temp Automotive High Reliability Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards

description

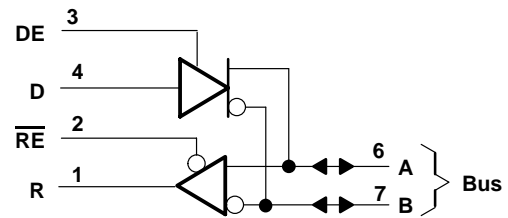
The SN65LBC176A, SN65LBC176AQ, and SN75LBC176A differential bus transceivers are monolithic, integrated circuits designed for bidirectional data communication on multipoint bus-transmission lines. They are designed for balanced transmission lines and are compatible with ANSI standard TIA/EIA-485-A and ISO 8482. The A version offers improved switching performance over its predecessors without sacrificing significantly more power.

SN65LBC176AQD (Marked as B176AQ)
 SN65LBC176AD (Marked as BL176A)
 SN65LBC176AP (Marked as 65LBC176A)
 SN75LBC176AD (Marked as LB176A)
 SN75LBC176AP (Marked as 75LBC176A)

(TOP VIEW)



logic diagram (positive logic)



Function Tables

DRIVER

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

RECEIVER

DIFFERENTIAL INPUTS $V_A - V_B$	ENABLE \overline{RE}	OUTPUT 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	L	H

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



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

† Signaling rate by TIA/EIA-485-A definition restrict transition times to 30% of the bit length, and much higher signaling rates may be achieved without this requirement as displayed in the *TYPICAL CHARACTERISTICS* of this device.

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SN65LBC176A, SN75LBC176A DIFFERENTIAL BUS TRANSCEIVERS

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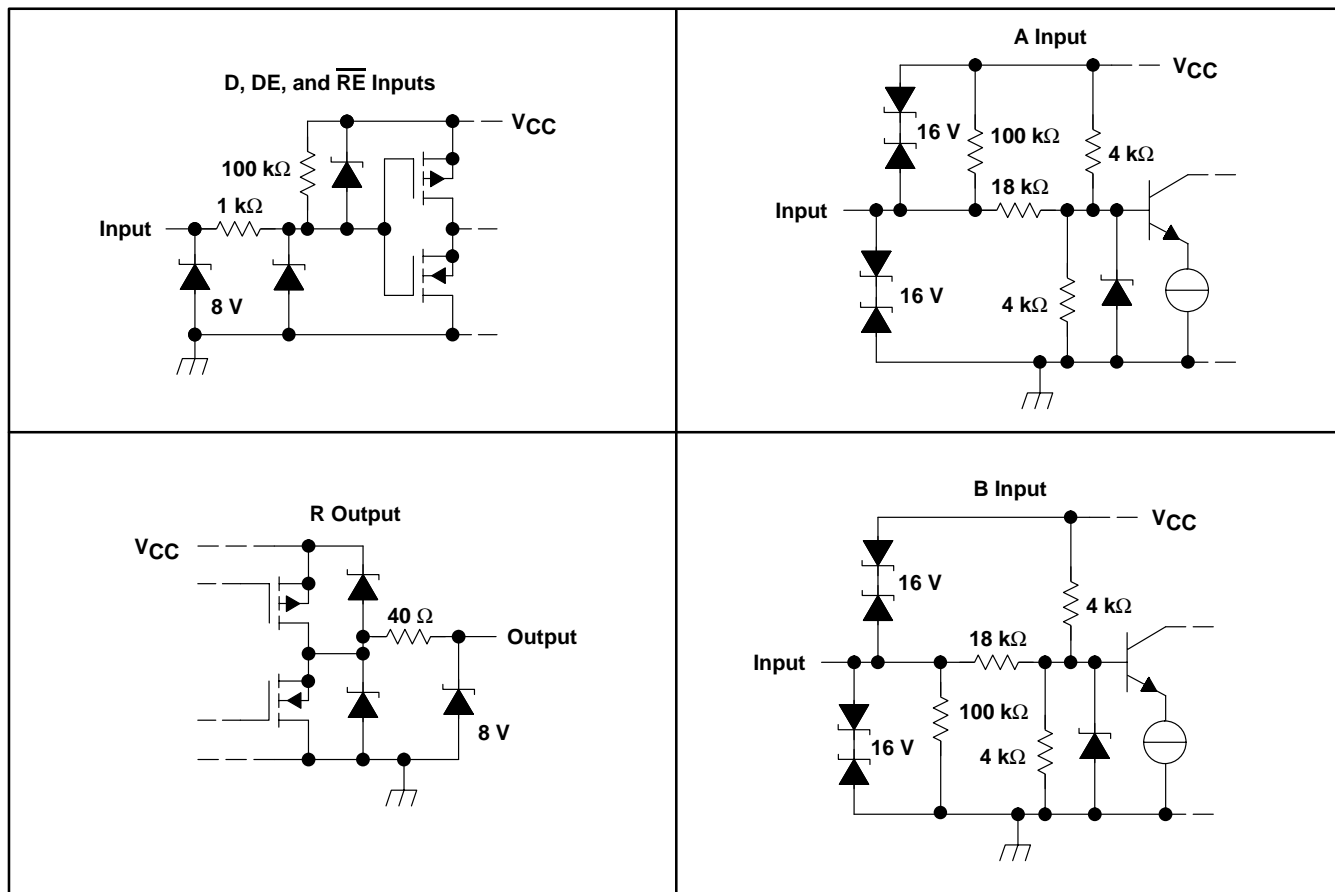
description (continued)

The SN65LBC176A, SN65LBC176AQ, and SN75LBC176A combine a 3-state, differential line driver and a differential input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can externally connect together to function as a direction control. The driver differential outputs and the receiver differential inputs connect internally to form a differential input/output (I/O) bus port that is designed to offer minimum loading to the bus whenever the driver is disabled or $V_{CC} = 0$. This port features wide positive and negative common-mode voltage ranges, making the device suitable for party-line applications. Very low device supply current can be achieved by disabling the driver and the receiver.

AVAILABLE OPTIONS

T _A	PACKAGE	
	SMALL OUTLINE (D)	PLASTIC DUAL-IN-LINE
0°C to 70°C	SN75LBC176AD	SN75LBC176AP
–40°C to 85°C	SN65LBC176AD	SN65LBC176AP
–40°C to 125°C	SN65LBC176AQD	—

schematics of inputs and outputs



absolute maximum ratings†

Supply voltage, V_{CC} (see Note 1)	–0.3 V to 6 V
Voltage range at any bus terminal (A or B)	–10 V to 15 V
Input voltage, V_I (D, DE, R, or \overline{RE})	–0.3 V to $V_{CC} + 0.5$ V
Electrostatic discharge: Bus terminals and GND, Class 3, A: (see Note 2)	12 kV
Bus terminals and GND, Class 3, B: (see Note 2)	400 V
All terminals, Class 3, A:	4 kV
All terminals, Class 3, B:	400 V
Continuous total power dissipation (see Note 3)	See Dissipation Rating Table
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. The maximum operating junction temperature is internally limited. Use the dissipation rating table to operate below this temperature.
 3. 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	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
P	1000 mW	8.0 mW/°C	640 mW	520 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}		4.75	5	5.25	V
Voltage at any bus terminal (separately or common mode), V_I or V_{IC}				12	V
		–7			
High-level input voltage, V_{IH} (output recessive)	D, DE, and \overline{RE}	2		V_{CC}	V
Low-level input voltage, V_{IL} (output dominant)	D, DE, and \overline{RE}	0		0.8	V
Differential input voltage, V_{ID} (see Note 4)		–12§		12	V
High-level output current, I_{OH}	Driver	–60			mA
	Receiver	–8			
Low-level output current, I_{OL}	Driver			60	mA
	Receiver			8	
Operating free-air temperature, T_A	SN65LBC176AQ	–40		125	°C
	SN65LBC176A	–40		85	
	SN75LBC176A	0		70	

§ The algebraic convention, in which the least positive (most negative) limit is designated as minimum, is used in this data sheet.

NOTE 4: Differential input/output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.

SN65LBC176A, SN75LBC176A DIFFERENTIAL BUS TRANSCEIVERS

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

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IK}	Input clamp voltage	$I_I = -18$ mA		-1.5	-0.8		V
$ V_{OD} $	Differential output voltage	$I_O = 0$	SN65LBC176AQ	1.5	4	6	V
			SN65LBC176A, SN75LBC176A		4		
		$R_L = 54 \Omega$, See Figure 1	SN65LBC176AQ	0.9	1.5	6	V
			SN65LBC176A	1	1.5	3	
			SN75LBC176A	1.1	1.5	3	
		$V_{test} = -7$ V to 12 V, See Figure 2	SN65LBC176AQ	0.9	1.5	6	V
			SN65LBC176A	1	1.5	3	
SN75LBC176A	1.1		1.5	3			
$\Delta V_{OD} $	Change in magnitude of differential output voltage	See Figures 1 and 2		-0.2		0.2	V
$V_{OC(SS)}$	Steady-state common-mode output voltage	See Figure 1	SN65LBC176AQ	1.8	2.4	3	V
$\Delta V_{OC(SS)}$	Change in steady-state common-mode output voltage†		SN65LBC176A, SN75LBC176A	1.8	2.4	2.8	
			SN65LBC176AQ	-0.2		0.2	
			SN65LBC176A, SN75LBC176A	-0.1		0.1	
I_{OZ}	High-impedance output current	See receiver input currents					
I_{IH}	High-level enable input current	$V_I = 2$ V		-100			μ A
I_{IL}	Low-level enable input current	$V_I = 0.8$ V		-100			μ A
I_{OS}	Short-circuit output current	-7 V $\leq V_O \leq 12$ V		-250	± 70	250	mA
I_{CC}	Supply current	$V_I = 0$ or V_{CC} , No load	Receiver disabled and driver enabled		5	9	mA
			Receiver disabled and driver disabled		0.4	0.7	
			Receiver enabled and driver enabled		8.5	15	

† All typical values are at $V_{CC} = 5$ V, $T_A = 25^\circ$ C.

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

PARAMETER	TEST CONDITIONS	SN65LBC176AQ			SN65LBC176A SN75LBC176A			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
t_{PLH}	Propagation delay time, low-to-high-level output		2	12	2	6	12	ns
t_{PHL}	Propagation delay time, high-to-low-level output		2	12	2	6	12	ns
$t_{sk(p)}$	Pulse skew ($ t_{PLH} - t_{PHL} $)			2		0.3	1	ns
t_r	Differential output signal rise time		1.2	11	4	7.5	11	ns
t_f	Differential output signal fall time		1.2	11	4	7.5	11	ns
t_{PZH}	Propagation delay time, high-impedance-to-high-level output	$R_L = 110 \Omega$, See Figure 4		22		12	22	ns
t_{PZL}	Propagation delay time, high-impedance-to-low-level output	$R_L = 110 \Omega$, See Figure 5		25		12	22	ns
t_{PHZ}	Propagation delay time, high-level-to-high-impedance output	$R_L = 110 \Omega$, See Figure 4		22		12	22	ns
t_{PLZ}	Propagation delay time, low-level-to-high-impedance output	$R_L = 110 \Omega$, See Figure 5		22		12	22	ns

† All typical values are at $V_{CC} = 5$ V, $T_A = 25^\circ$ C.



SN65LBC176A, SN75LBC176A DIFFERENTIAL BUS TRANSCEIVERS

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

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT	
V_{IT+}	Positive-going input threshold voltage	$I_O = -8$ mA			0.2	V	
V_{IT-}	Negative-going input threshold voltage	$I_O = 8$ mA	-0.2			V	
V_{hys}	Hysteresis voltage ($V_{IT+} - V_{IT-}$)			50		mV	
V_{IK}	Enable-input clamp voltage	$I_I = -18$ mA	-1.5	-0.8		V	
V_{OH}	High-level output voltage	$V_{ID} = 200$ mV, $I_{OH} = -8$ mA, See Figure 6	4	4.9		V	
V_{OL}	Low-level output voltage	$V_{ID} = 200$ mV, $I_{OL} = 8$ mA, See Figure 6		0.1	0.8	V	
I_{OZ}	High-impedance-state output current	$V_O = 0$ to V_{CC}	SN65LBC176AQ		-10	10	μ A
			SN65LBC176A, SN75LBC176A		-1	1	
I_I	Bus input current	$V_{IH} = 12$ V, $V_{CC} = 5$ V	Other input at 0 V		0.4	1	mA
		$V_{IH} = 12$ V, $V_{CC} = 0$			0.5	1	
		$V_{IH} = -7$ V, $V_{CC} = 5$ V			-0.8	-0.4	
		$V_{IH} = -7$ V, $V_{CC} = 0$			-0.8	-0.3	
I_{IH}	High-level enable-input current	$V_{IH} = 2$ V	-100			μ A	
I_{IL}	Low-level enable-input current	$V_{IL} = 0.8$ V	-100			μ A	
I_{CC}	Supply current	$V_I = 0$ or V_{CC} , No load	Receiver enabled and driver disabled		4	7	mA
			Receiver disabled and driver disabled		0.4	0.7	
			Receiver enabled and driver enabled		8.5	15	

† All typical values are at $V_{CC} = 5$ V, $T_A = 25^\circ$ C.

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

PARAMETER	TEST CONDITIONS	SN65LBC176AQ			SN65LBC176A SN75LBC176A			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
t_{PLH}	Propagation delay time, output \uparrow	7	30	30	7	13	20	ns
t_{PHL}	Propagation delay time, output \downarrow							
$t_{sk(p)}$	Pulse skew ($ t_{PHL} - t_{PLH} $)							
t_r	Rise time, output	5	5	5	2.1	3.3	ns	
t_f	Fall time, output							
t_{PZH}	Output enable time to high level	50	50	50	30	45	ns	
t_{PZL}	Output enable time to low level							
t_{PHZ}	Output disable time from high level							
t_{PLZ}	Output disable time from low level							

† All typical values are at $V_{CC} = 5$ V, $T_A = 25^\circ$ C.

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PARAMETER MEASUREMENT INFORMATION

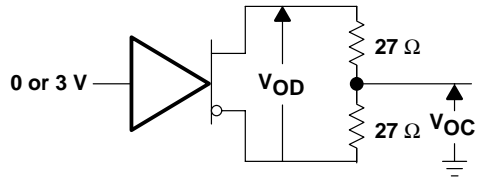
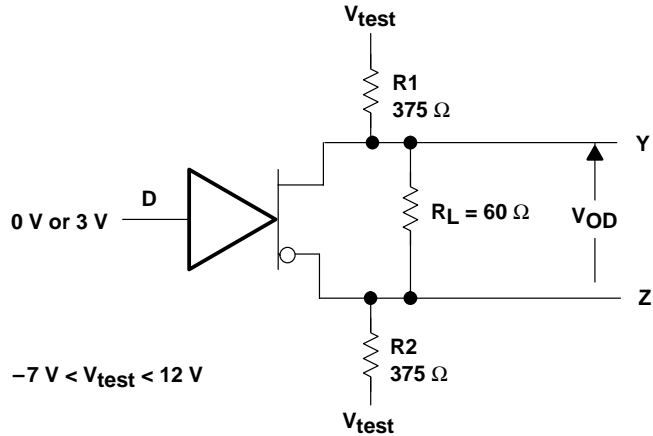
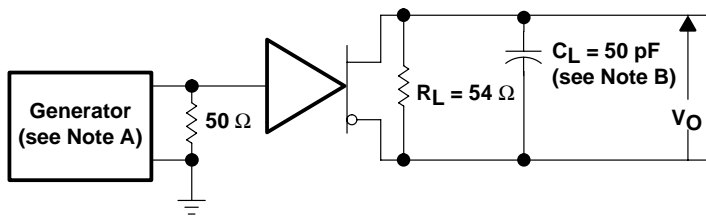


Figure 1. Driver V_{OD} and V_{OC}

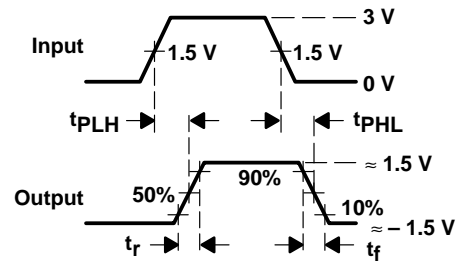


$-7\text{ V} < V_{\text{test}} < 12\text{ V}$

Figure 2. Driver V_{OD3}



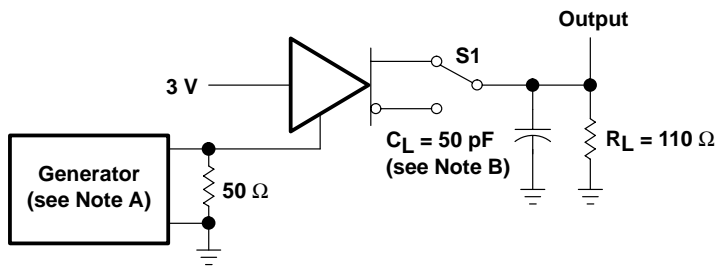
TEST CIRCUIT



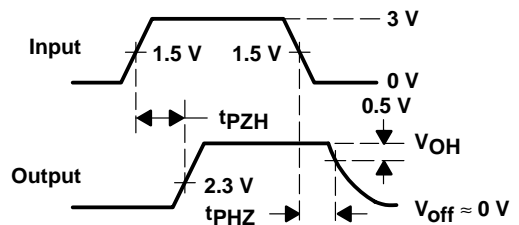
VOLTAGE WAVEFORMS

- NOTES: A. The input pulse is supplied by a generator having the following characteristics: $\text{PRR} \leq 1\text{ MHz}$, 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 3. Driver Test Circuit and Voltage Waveforms



TEST CIRCUIT

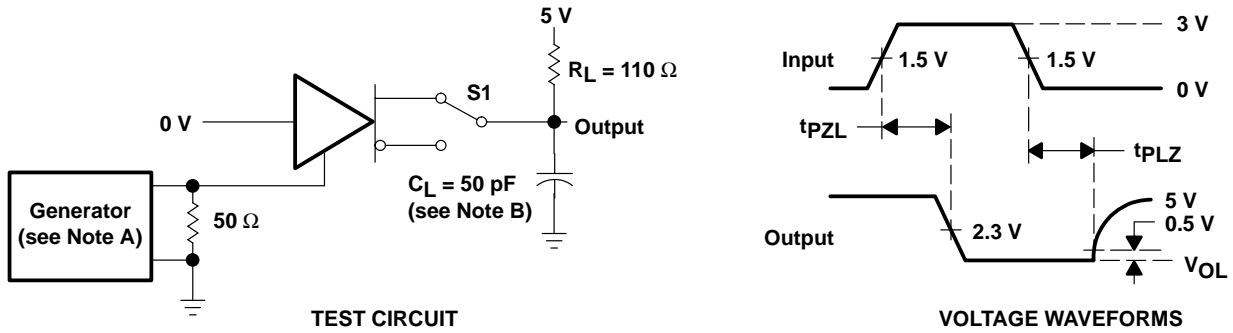


VOLTAGE WAVEFORMS

- NOTES: A. The input pulse is supplied by a generator having the following characteristics: $\text{PRR} \leq 1\text{ MHz}$, 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 4. Driver Test Circuit and Voltage Waveforms

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 5. Driver Test Circuit and Voltage Waveforms

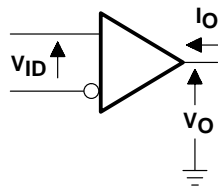
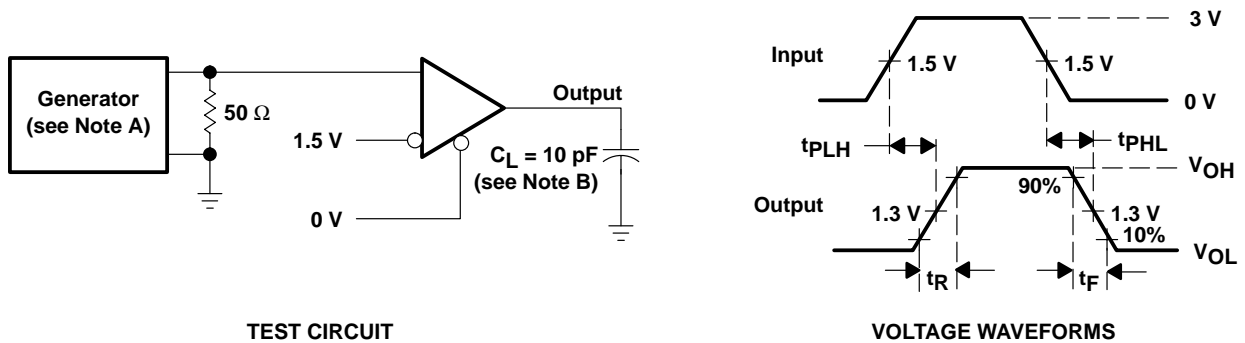


Figure 6. Receiver V_{OH} and V_{OL}



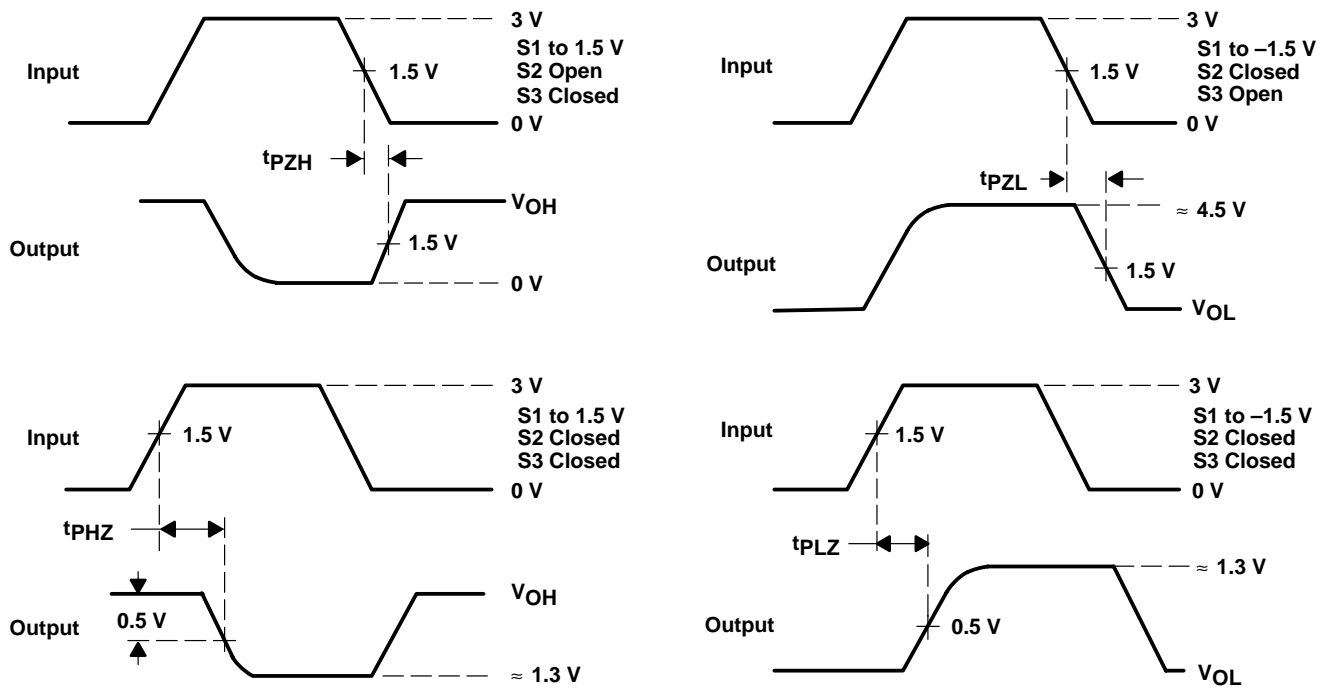
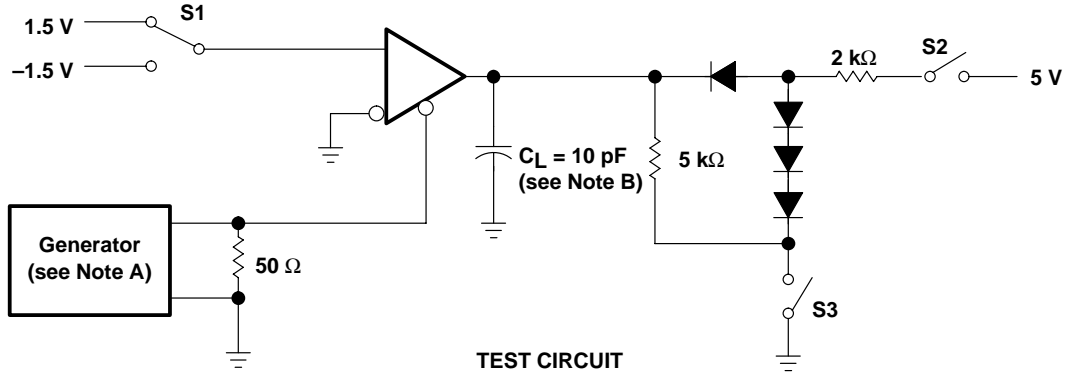
- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR \leq 1 MHz, 50% duty cycle, $t_r \leq$ 6 ns, $t_f \leq$ 6 ns, $Z_0 = 50 \Omega$.
B. C_L includes probe and jig capacitance.

Figure 7. Receiver Test Circuit and Voltage Waveforms

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PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

- 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, $Z_O = 50 \Omega$.
 B. C_L includes probe and jig capacitance.

Figure 8. Receiver Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

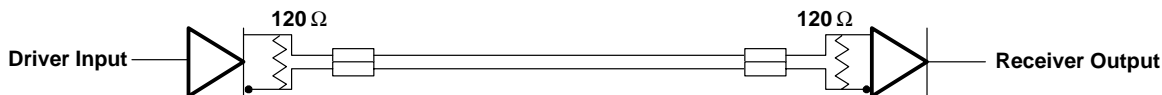
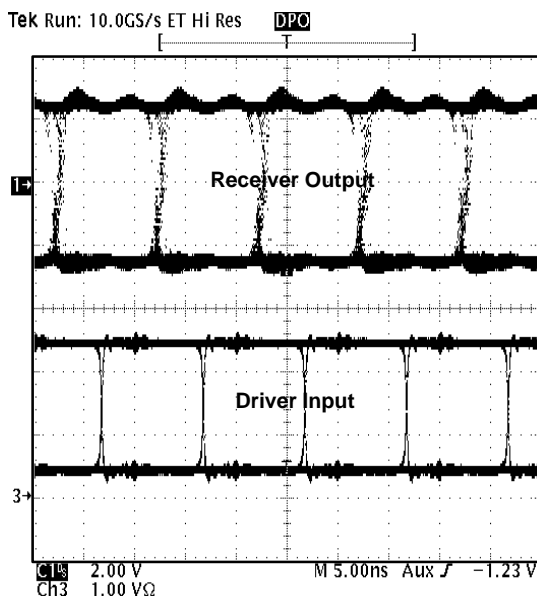


Figure 9. Typical Waveform of Non-Return-To-Zero (NRZ), Pseudorandom Binary Sequence (PRBS) Data at 100 Mbps Through 15m, of CAT 5 Unshielded Twisted Pair (UTP) Cable

TIA/EIA-485-A defines a maximum signaling rate as that in which the transition time of the voltage transition of a logic-state change remains less than or equal to 30% of the bit length. Transition times of greater length perform quite well even though they do not meet the standard by definition.

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TYPICAL CHARACTERISTICS

**AVERAGE SUPPLY CURRENT
vs
FREQUENCY**

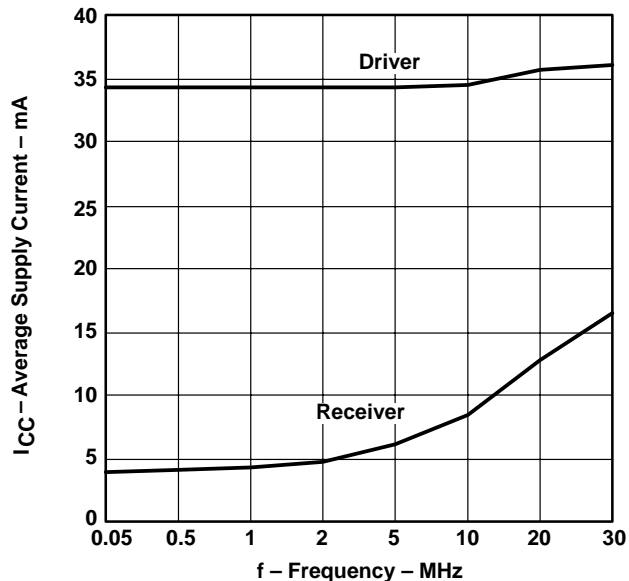


Figure 10

**LOGIC INPUT CURRENT
vs
INPUT VOLTAGE**

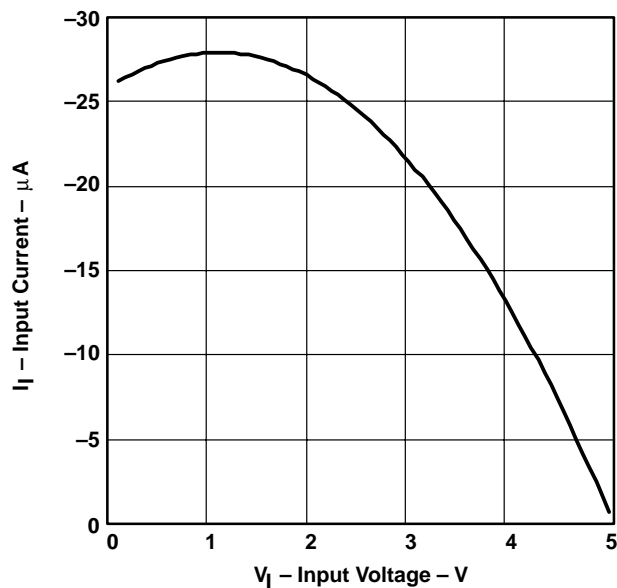


Figure 11

**INPUT CURRENT
vs
INPUT VOLTAGE**

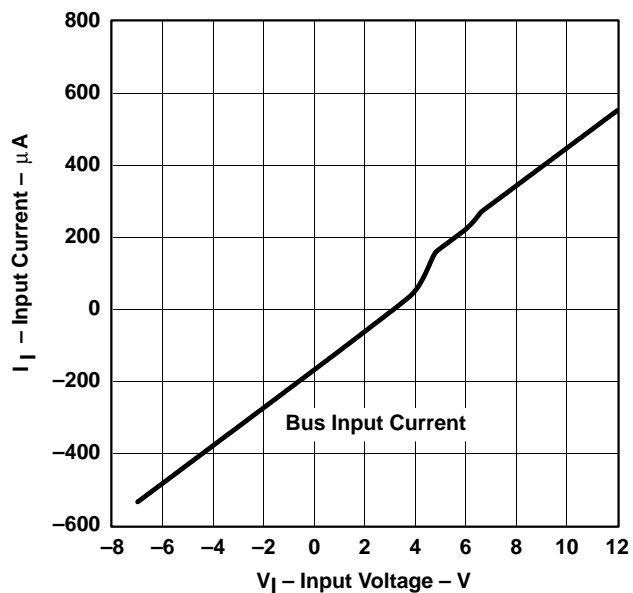


Figure 12

**LOW-LEVEL OUTPUT VOLTAGE
vs
LOW-LEVEL OUTPUT CURRENT**

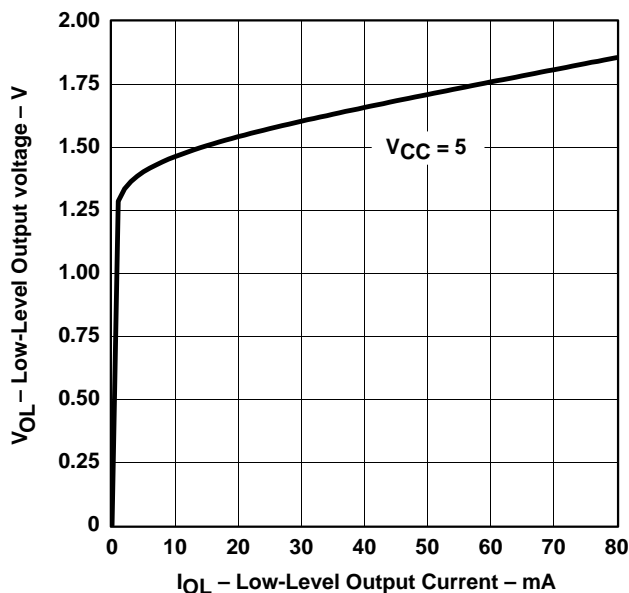


Figure 13



TYPICAL CHARACTERISTICS

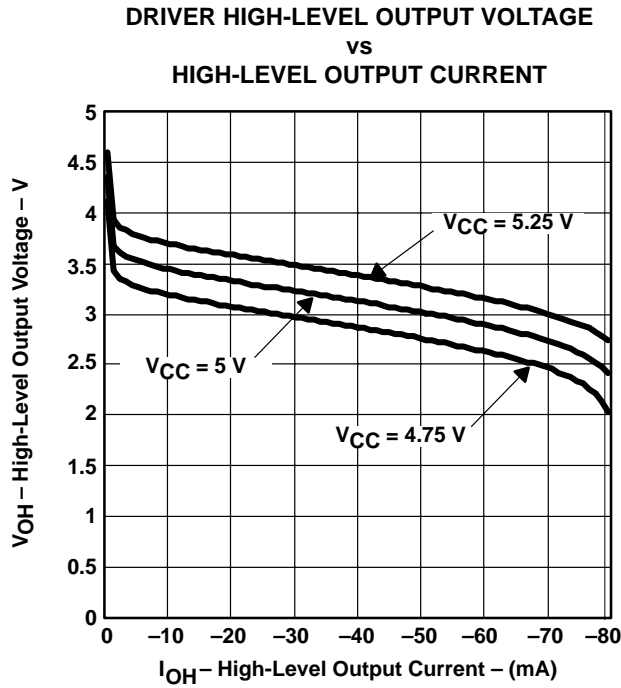


Figure 14

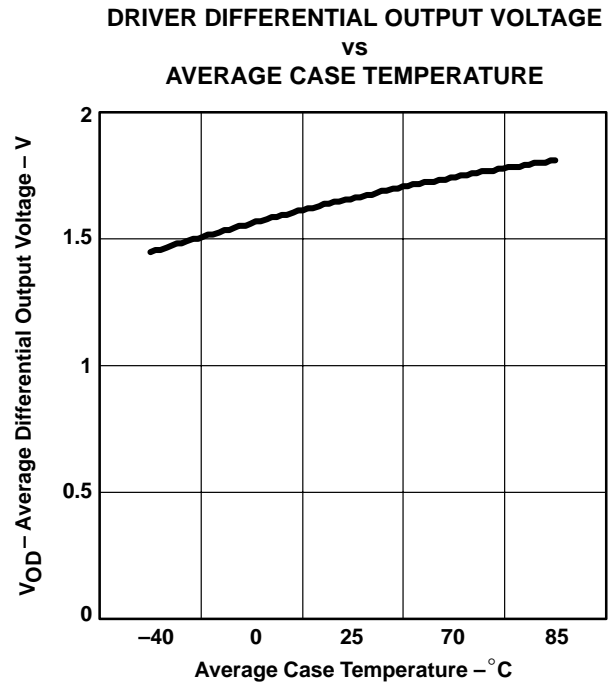


Figure 15

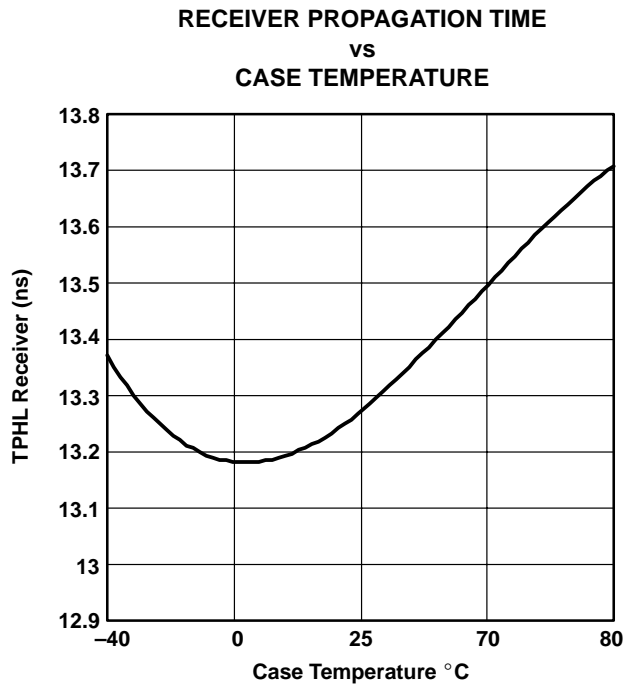


Figure 16

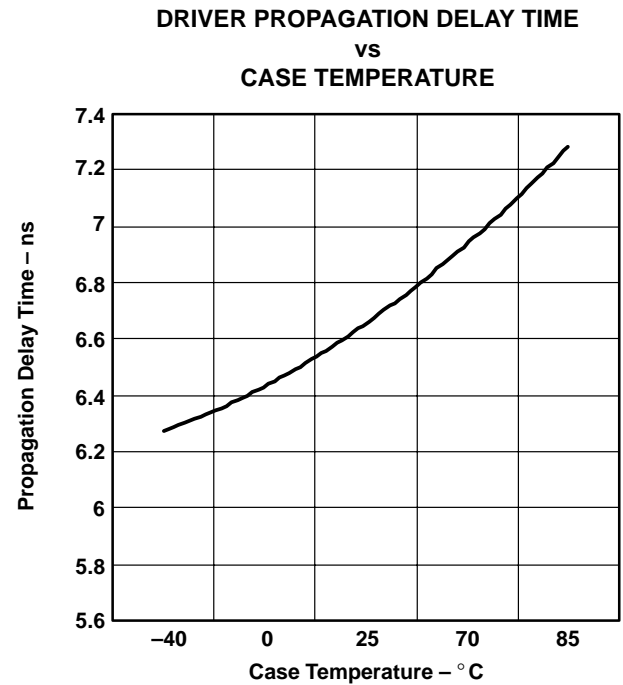


Figure 17

SN65LBC176A, SN75LBC176A DIFFERENTIAL BUS TRANSCEIVERS

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TYPICAL CHARACTERISTICS

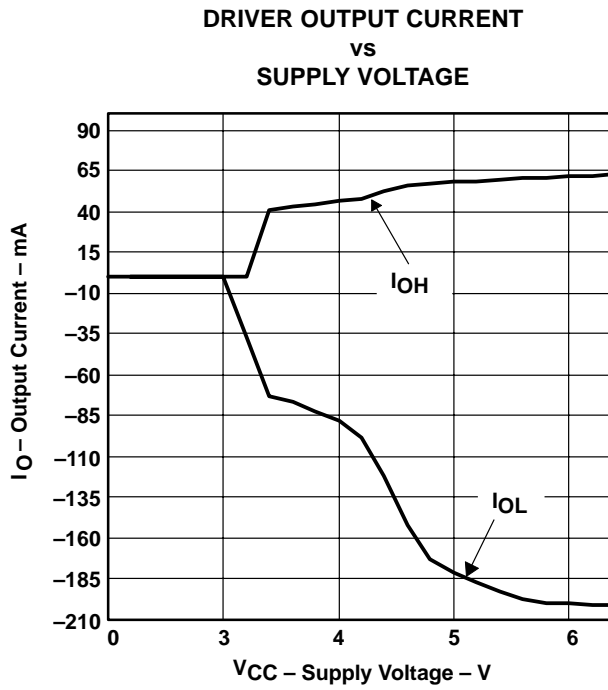


Figure 18

SN65LBC176A, SN75LBC176A DIFFERENTIAL BUS TRANSCEIVERS

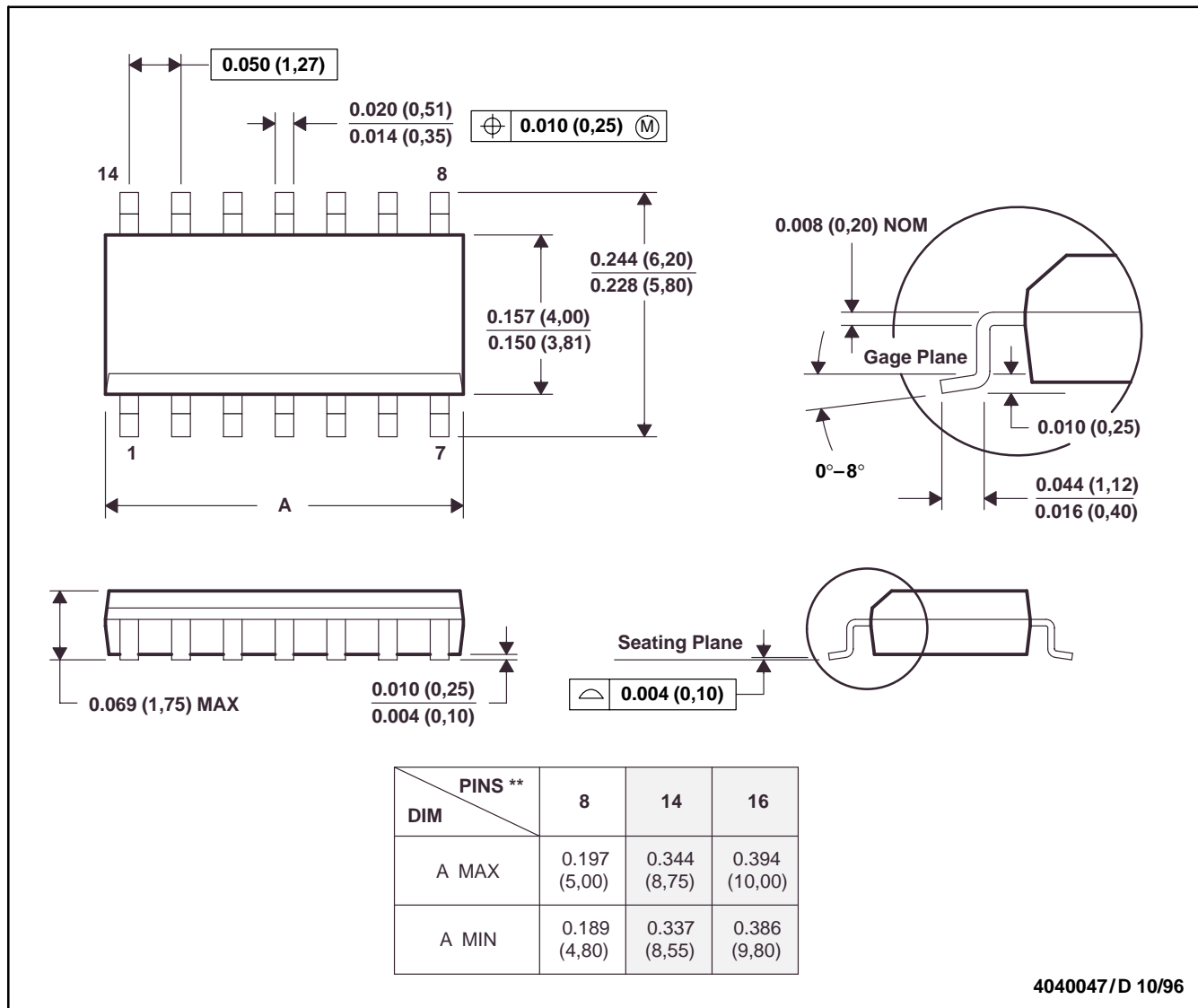
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MECHANICAL INFORMATION

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

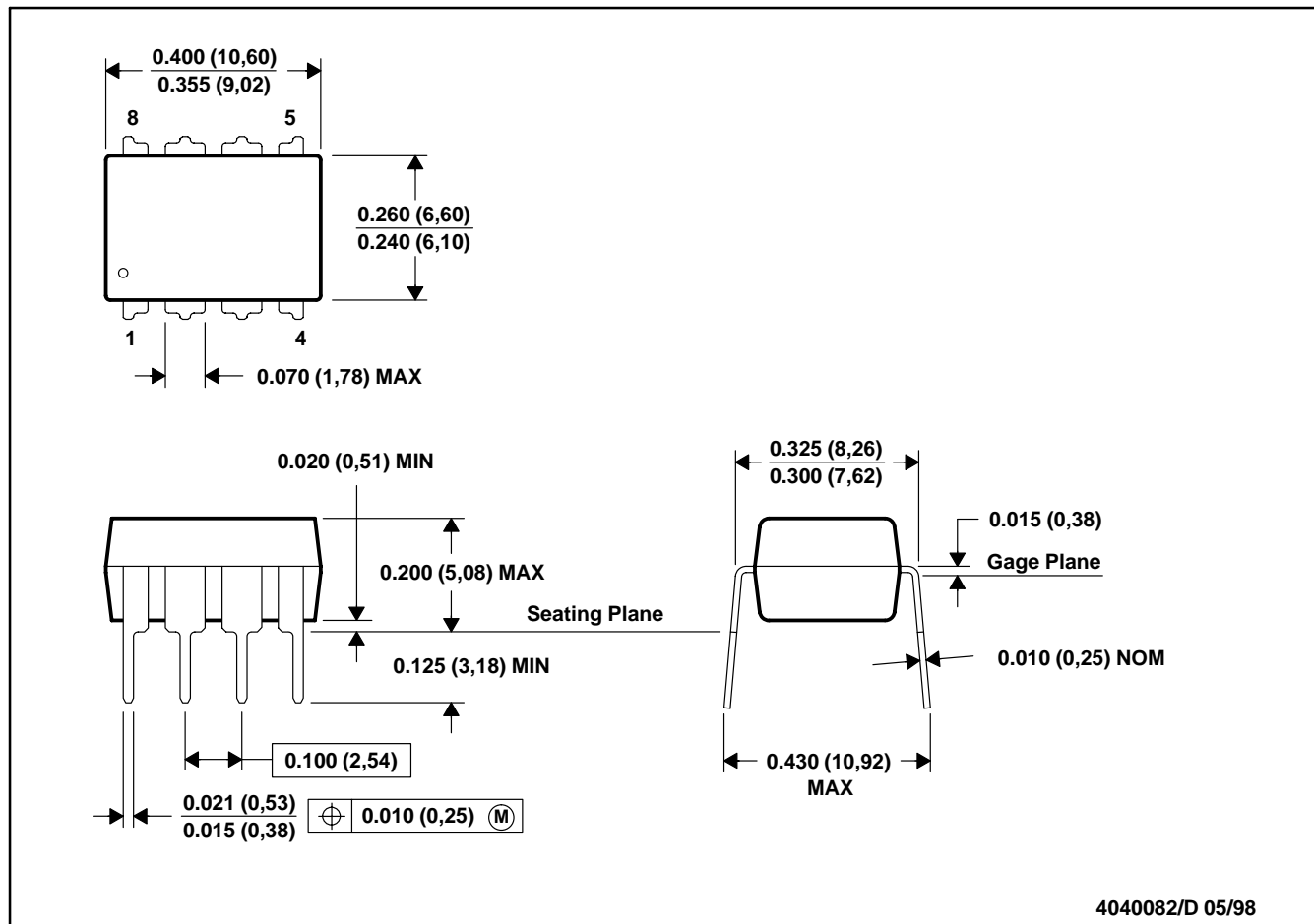
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MECHANICAL INFORMATION

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



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

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm



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