

- Bidirectional Transceiver With Fail-Safe Receiver
- Meets or Exceeds the Requirements of ITU Recommendation V.11
- Electrically Compatible With ANSI Standards EIA/TIA-422-B and RS-485
- Designed for Multipoint Transmission on Long Bus Lines in Noisy Environments
- 3-State Driver and Receiver Outputs
- Individual Driver and Receiver Enables
- Wide Positive and Negative Input/Output Bus Voltage Ranges
- Driver Output Capability . . .  $\pm 60$  mA Max
- Thermal Shutdown Protection
- Driver Positive and Negative Current Limiting
- Receiver Input Impedance . . .  $12\text{ k}\Omega$  Min
- Receiver Input Sensitivity . . .  $-300\text{ mV}/0\text{mV}$
- Operates From Single 5-V Supply
- Pin Compatible With SN75176A Footprint

#### description

The SN75276 differential bus transceiver is a monolithic, integrated circuit designed for bidirectional data communication on multipoint bus transmission lines. It is designed for balanced transmission lines and is electrically compatible with ANSI Standards EIA/TIA-422-B and RS-485, and meets ITU Recommendation V.11.

The fail-safe operation ensures a known level on the circuit output under bus fault conditions. The circuit provides a high-level output under floating-line, idle-line, open-circuit, and short-circuit bus conditions (see Function Tables).

#### Function Tables

##### DRIVER

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

##### RECEIVER

DIFFERENTIAL INPUTS A - B	ENABLE RE	OUTPUT R
$V_{ID} \geq 0\text{ V}$	L	H
$-0.3\text{ V} < V_{ID} < 0\text{ V}$	L	?
$V_{ID} \leq -0.3$	L	L
X	H	Z
Open	L	H

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

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.

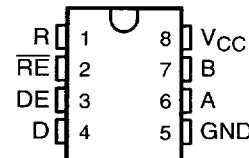
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 **TEXAS  
INSTRUMENTS**

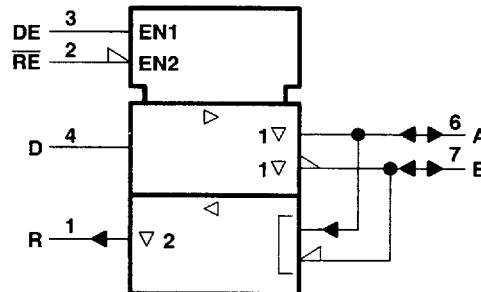
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D OR P PACKAGE  
(TOP VIEW)

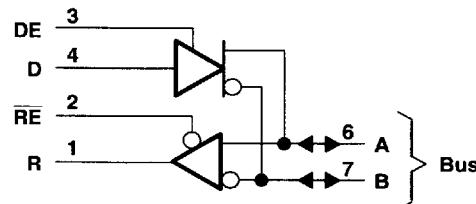


logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic diagram (positive logic)



# **SN75276** **FAIL-SAFE DIFFERENTIAL BUS TRANSCEIVER**

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**description (continued)**

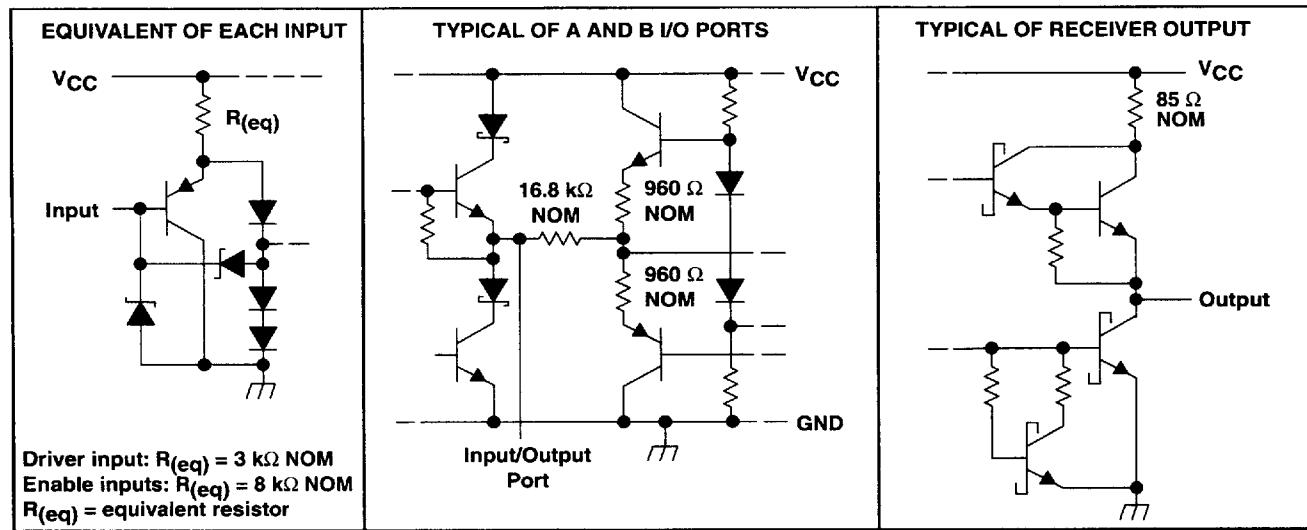
The SN75276 combines a 3-state, differential line driver and a differential input line receiver, both of which operate from a single, 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, that can be externally connected together to function as a direction control. The driver differential outputs and the receiver differential inputs are connected internally to form differential input/output (I/O) bus ports that are designed to offer minimum loading to the bus whenever the driver is disabled or  $V_{CC} = 0$ . These ports feature wide positive and negative common-mode voltage ranges making the device suitable for party-line applications.

The driver is designed for up to 60 mA of sink or source current. The driver features positive- and negative-current limiting and thermal shutdown for protection from line fault conditions. Thermal shutdown is designed to occur at a junction temperature of approximately 150°C. The receiver features a minimum input impedance of 12 kΩ.

The SN75276 can be used in transmission line applications employing the SN75172 and SN75174 quadruple differential line drivers and SN75173 and SN75175 quadruple differential line receivers.

SN75276 is characterized for operation from 0°C to 70°C.

## **schematics of inputs and outputs**



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

Supply voltage, $V_{CC}$ (see Note 1) .....	7 V
Voltage at any bus terminal .....	-10 V to 15 V
Enable input voltage, $V_I$ .....	5.5 V
Continuous total power dissipation .....	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ .....	0°C to 70°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.

NOTE 1: All voltage values, except differential input/output bus voltage, are with respect to network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ C$	$T_A = 70^\circ C$	$T_A = 105^\circ C$
			POWER RATING	POWER RATING
D	725 mW	5.8 mW/°C	464 mW	261 mW
P	1100 mW	8.8 mW/°C	704 mW	396 mW

**recommended operating conditions**

		MIN	TYP	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, $V_{IH}$	D, DE, and RE		2		V
Low-level input voltage, $V_{IL}$	D, DE, and RE			0.8	V
Differential input voltage, $V_{ID}$ (see Note 2)				±12	V
High-level output current, $I_{OH}$	Driver			-60	mA
	Receiver			-400	μA
Low-level output current, $I_{OL}$	Driver			60	
	Receiver			8	mA
Operating free-air temperature, $T_A$	SN75276	0		70	°C

NOTE 2: Differential input/output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.



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# SN75276

## FAIL-SAFE DIFFERENTIAL BUS TRANSCEIVER

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### DRIVER SECTION

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS <sup>†</sup>	MIN	TYP <sup>‡</sup>	MAX	UNIT
$V_{IK}$	Input clamp voltage	$I_I = -18 \text{ mA}$		-1.5	V
$V_O$	Output voltage	$I_O = 0$	0	6	V
$ V_{OD1} $	Differential output voltage	$I_O = 0$	1.5	3.6	V
$ V_{OD2} $	Differential output voltage	$R_L = 100 \Omega$ , See Figure 1	1/2 $V_{OD1}$ or 2 <sup>§</sup>		V
		$R_L = 54 \Omega$ , See Figure 1		1.5	V
$V_{OD3}$	Differential output voltage	See Note 3	1.5	5	V
$\Delta V_{OD} $	Change in magnitude of differential output voltage <sup>¶</sup>	$R_L = 54 \Omega$ or $100 \Omega$ , See Figure 1		$\pm 0.2$	V
$V_{OC}$	Common-mode output voltage			$+3$ $-1$	V
$\Delta V_{OC} $	Change in magnitude of common-mode output voltage <sup>¶</sup>			$\pm 0.2$	V
$I_O$	Output current	Output disabled,	$V_O = 12 \text{ V}$	1	mA
		See Note 4	$V_O = -7 \text{ V}$	-0.8	
$I_{IH}$	High-level input current	$V_I = 2.4 \text{ V}$		20	$\mu\text{A}$
$I_{IL}$	Low-level input current	$V_I = 0.4 \text{ V}$		-400	$\mu\text{A}$
$I_{OS}$	Short-circuit output current	$V_O = -7 \text{ V}$		-250	mA
		$V_O = 0$		150	
		$V_O = V_{CC}$		250	
		$V_O = 12 \text{ V}$		250	
$I_{CC}$	Supply current (total package)	No load	Outputs enabled	42	mA
			Outputs disabled	26	

<sup>†</sup>The power-off measurement in ANSI Standard EIA/TIA-422-B applies to disabled outputs only and is not applied to combined inputs and outputs.

<sup>‡</sup>All typical values are at  $V_{CC} = 5 \text{ V}$  and  $T_A = 25^\circ\text{C}$ .

<sup>§</sup>The minimum  $V_{OD2}$  with a  $100\text{-}\Omega$  load is either  $1/2 V_{OD1}$  or  $2 \text{ V}$ , whichever is greater.

<sup>¶</sup> $\Delta|V_{OD}|$  and  $\Delta|V_{OC}|$  are the changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input is changed from a high level to a low level.

NOTES: 3. This applies for both power on and off; refer to ANSI Standard RS-485 for exact conditions. The EIA/TIA-422-B limit does not apply for a combined driver and receiver terminal.

4. See ANSI Standard RS-485 Figure 3.5, Test Termination Measurement 2.

### switching characteristics, $V_{CC} = 5 \text{ V}$ , $R_L = 110 \text{ k}\Omega$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{d(OD)}$	$R_L = 54 \Omega$ , See Figure 3		15	22	ns
$t_{t(OD)}$			20	30	ns
$t_{PZH}$	See Figure 4		85	120	ns
$t_{PZL}$	See Figure 5		40	60	ns
$t_{PHZ}$	See Figure 4		150	250	ns
$t_{PLZ}$	See Figure 5		20	30	ns

## DRIVER SECTION

### SYMBOL EQUIVALENTS

DATA SHEET PARAMETER	EIA/TIA-422-B	RS-485
$V_O$	$V_{oa}, V_{ob}$	$V_{oa}, V_{ob}$
$ V_{OD1} $	$V_o$	$V_o$
$ V_{OD2} $	$V_t (R_L = 100 \Omega)$	$V_t (R_L = 54 \Omega)$
$V_{OD3}$	None	$V_t$ (Test Termination Measurement 2)
$\Delta V_{OD1}$	$ V_t  -  \bar{V}_t $	$ V_t  -  \bar{V}_t $
$V_{OC}$	$ V_{os} $	$ V_{os} $
$\Delta V_{OC1}$	$ V_{os} - \bar{V}_{os} $	$ V_{os} - \bar{V}_{os} $
$I_{OS}$	$ I_{sal}, I_{sbl} $	
$I_O$	$ I_{xa}, I_{xb} $	$I_{ia}, I_{ib}$

## RECEIVER SECTION

electrical characteristics over recommended ranges of common-mode input voltage, supply voltage, and operating free-air temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$V_{IT+}$ Positive-going input threshold voltage	$V_O = 2.7 \text{ V}$ ,	$I_O = -0.4 \text{ mA}$		0		V
$V_{IT-}$ Negative-going input threshold voltage	$V_O = 0.5 \text{ V}$ ,	$I_O = 8 \text{ mA}$	-0.3‡			V
$V_{IK}$ Enable clamp voltage	$I_I = -18 \text{ mA}$			-1.5		V
$V_{OH}$ High-level output voltage	$V_{ID} = 0$ , See Figure 2	$I_{OH} = -400 \mu\text{A}$ ,	2.7			V
$V_{OL}$ Low-level output voltage	$V_{ID} = -300 \text{ mV}$ , See Figure 2	$I_{OL} = 8 \text{ mA}$ ,		0.45		V
$I_{OZ}$ High-impedance-state output current	$V_O = 0.4 \text{ V}$ to $2.4 \text{ V}$			$\pm 20$		$\mu\text{A}$
$I_I$ Line input current	Other input = 0 V, See Note 5	$V_I = 12 \text{ V}$		1		mA
		$V_I = -7 \text{ V}$		-0.8		
$I_{IH}$ High-level enable input current	$V_{IH} = 2.7 \text{ V}$			20		$\mu\text{A}$
$I_{IL}$ Low-level enable input current	$V_{IL} = 0.4 \text{ V}$			-100		$\mu\text{A}$
$r_I$ Input resistance	$V_I = 12 \text{ V}$		12			$\text{k}\Omega$
$I_{OS}$ Short-circuit output current			-15	-85		mA
$I_{CC}$ Supply current (total package)	No load	Outputs enabled	42	55		mA
		Outputs disabled	26	35		

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

‡ The algebraic convention, in which the less-positive (more negative) limit is designated minimum, is used in this data sheet for negative-going input threshold voltage levels only.

NOTE 5: This applies for both power on and power off. Refer to ANSI Standard RS-485 for exact conditions.



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# SN75276

## FAIL-SAFE DIFFERENTIAL BUS TRANSCEIVER

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### RECEIVER SECTION

switching characteristics,  $V_{CC} = 5$  V,  $C_L = 15$  pF,  $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ Propagation delay time, low- to high-level output	$V_{ID} = 0$ to 3 V, See Figure 6	21	35	ns	
$t_{PHL}$ Propagation delay time, high- to low-level output		23	35	ns	
$t_{PZH}$ Output enable time to high level	See Figure 7	10	20	ns	
$t_{PZL}$ Output enable time to low level		12	20	ns	
$t_{PHZ}$ Output disable time from high level	See Figure 7	20	35	ns	
$t_{PLZ}$ Output disable time from low level		17	25	ns	

### PARAMETER MEASUREMENT INFORMATION

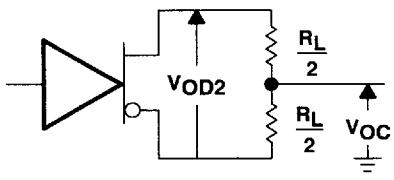


Figure 1. Driver  $V_{OD}$  and  $V_{OC}$

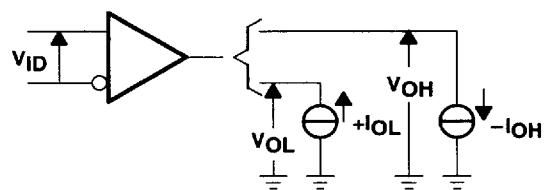


Figure 2. Receiver  $V_{OH}$  and  $V_{OL}$

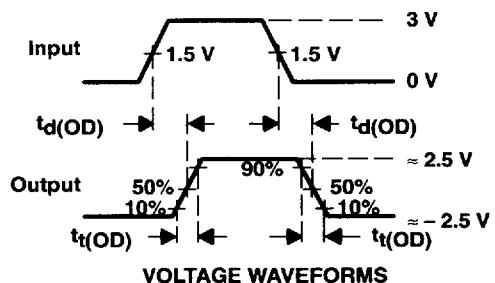
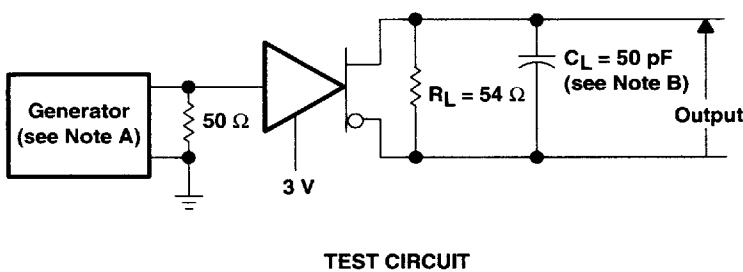


Figure 3. Driver Test Circuit and Voltage Waveforms

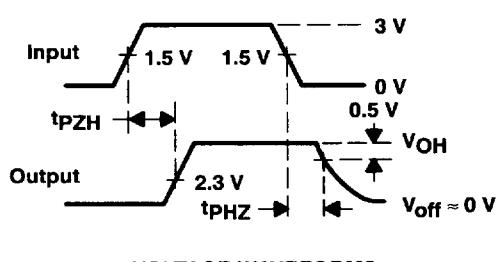
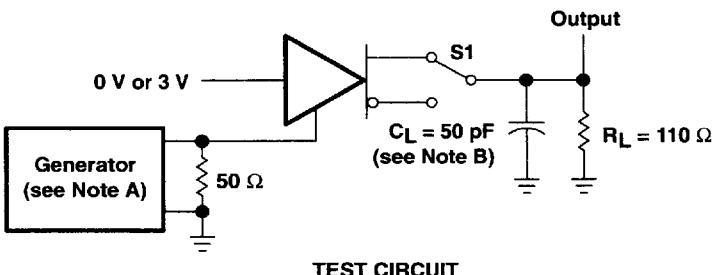


Figure 4. Driver Test Circuit and Voltage Waveforms

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PARAMETER MEASUREMENT INFORMATION

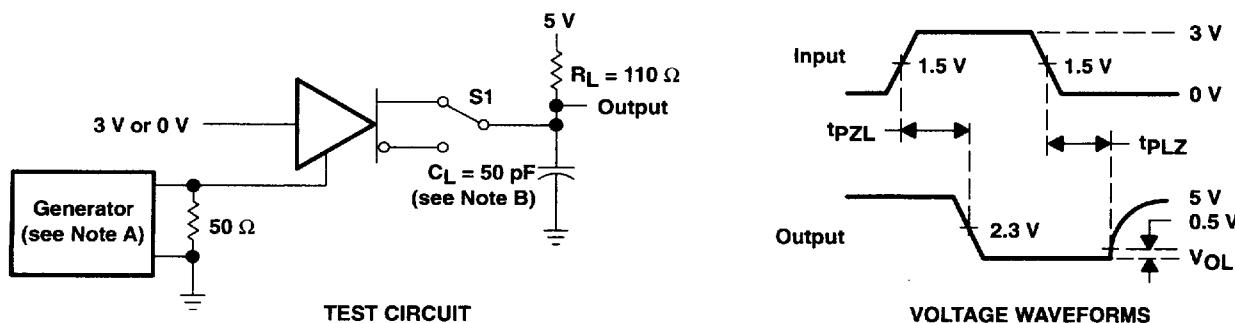


Figure 5. Driver Test Circuit and Voltage Waveforms

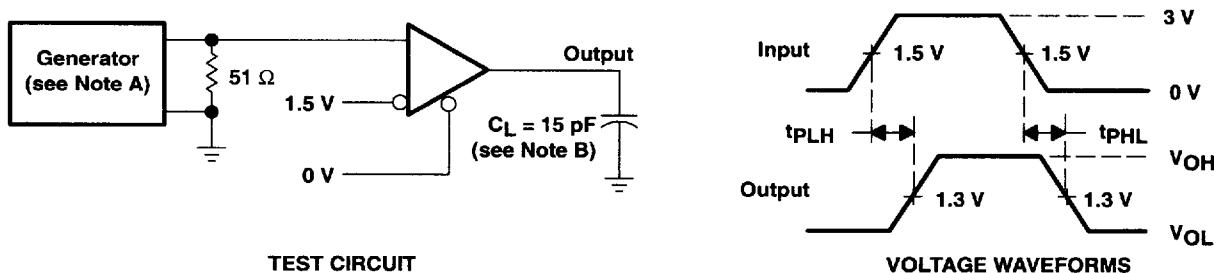


Figure 6. Receiver Test Circuit and Voltage Waveforms

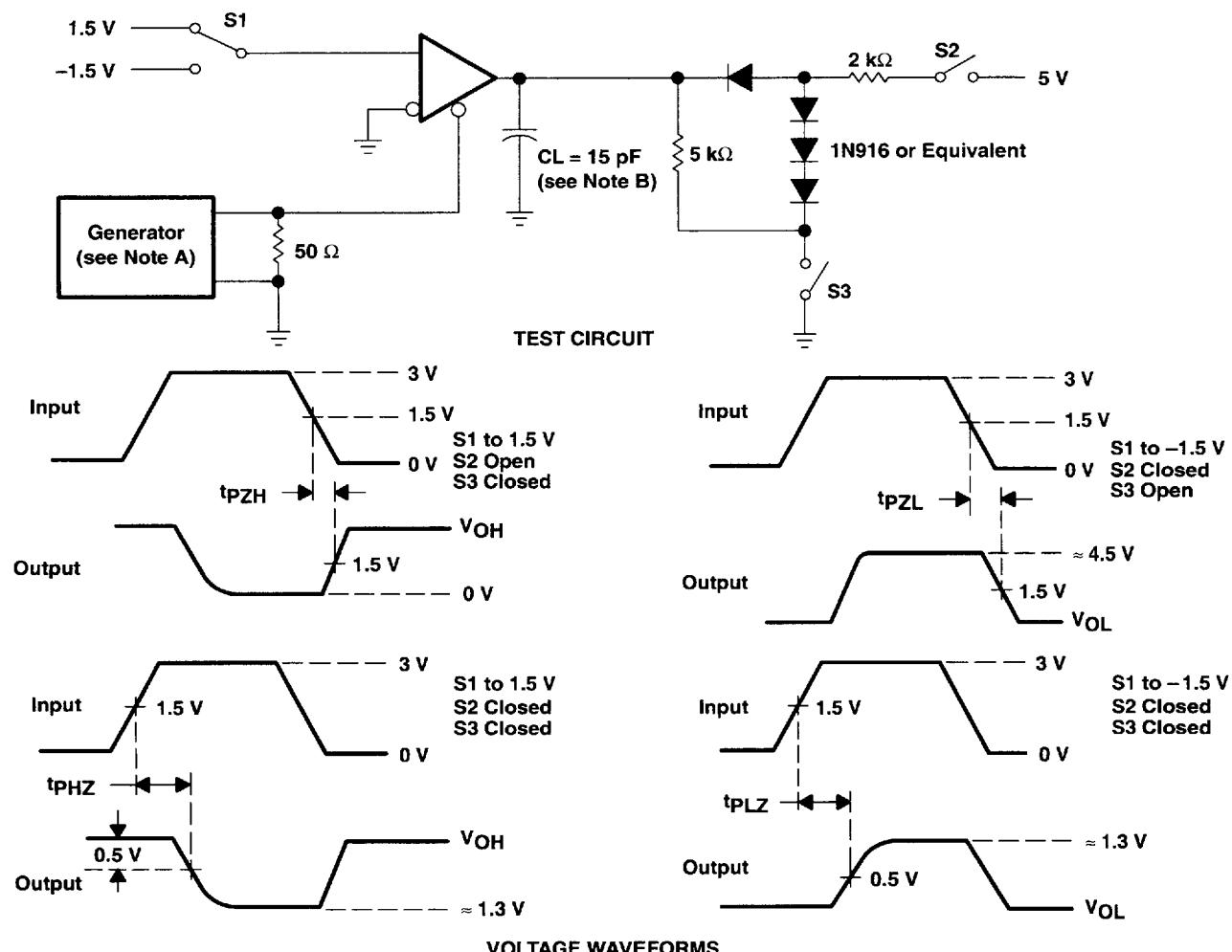
NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1 MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

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### 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 7. Receiver Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

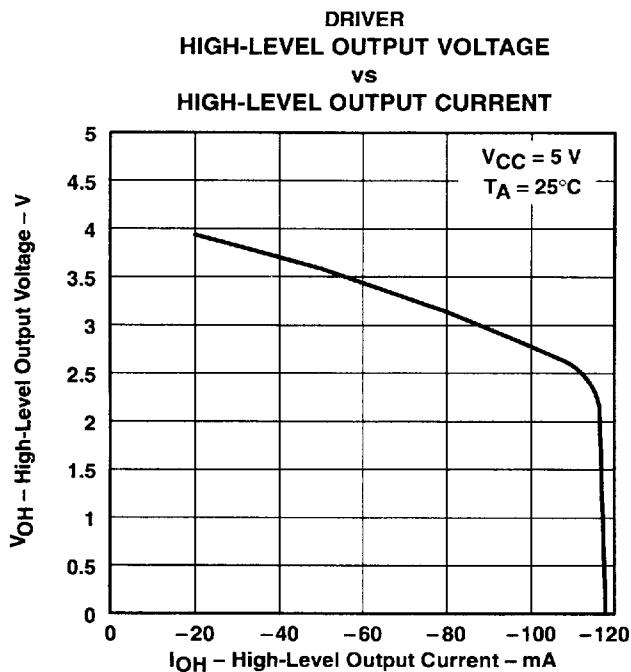


Figure 8

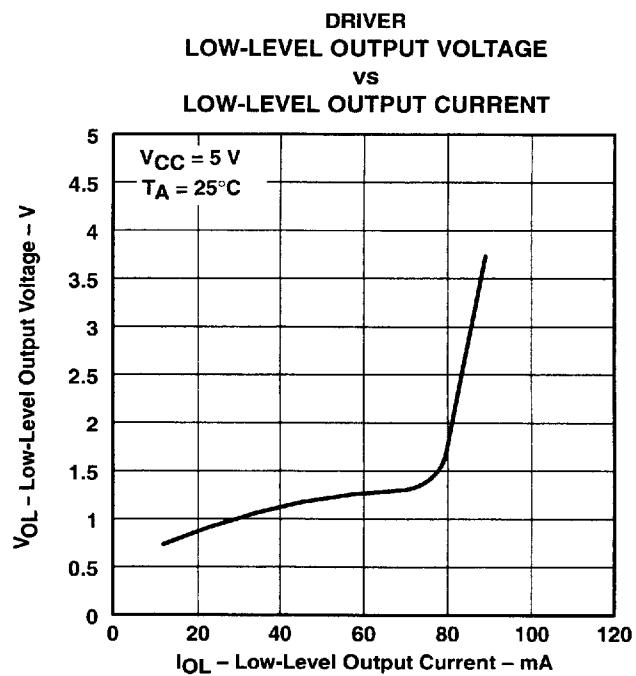


Figure 9

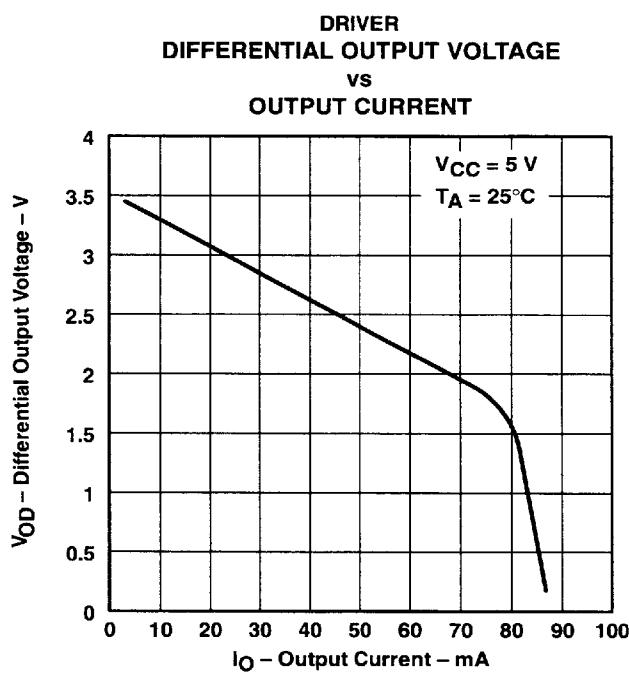


Figure 10

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## FAIL-SAFE DIFFERENTIAL BUS TRANSCEIVER

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### TYPICAL CHARACTERISTICS

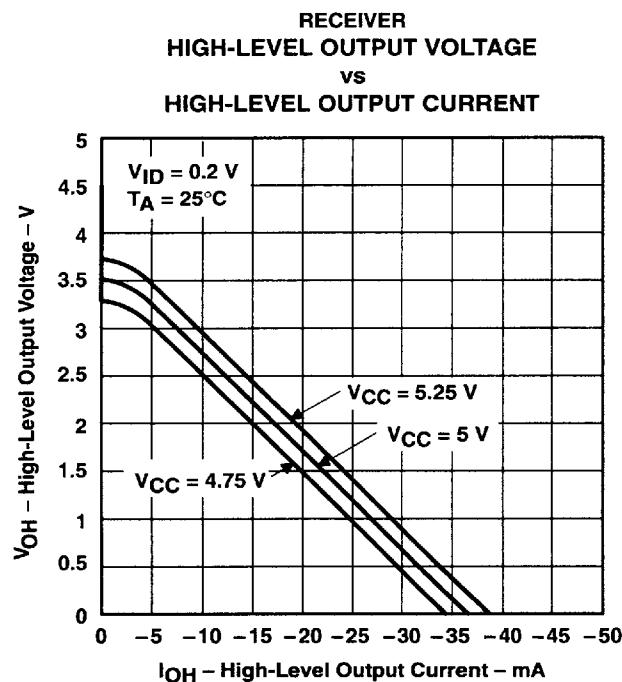


Figure 11

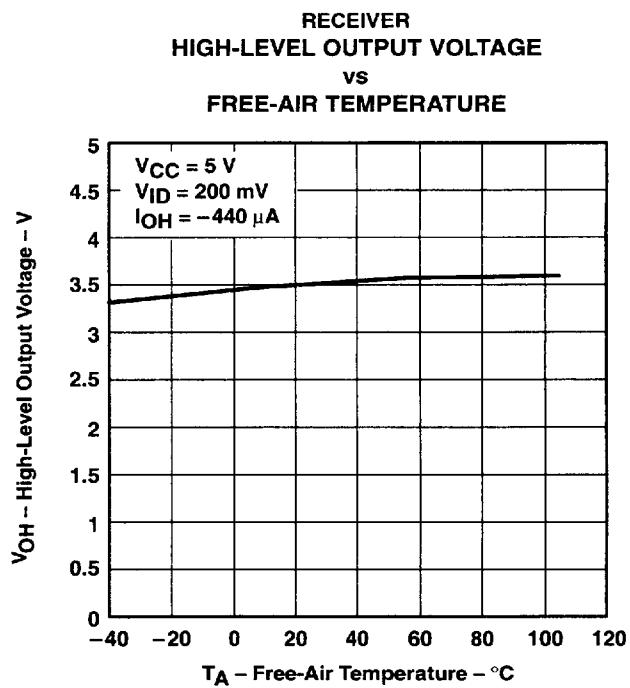


Figure 12

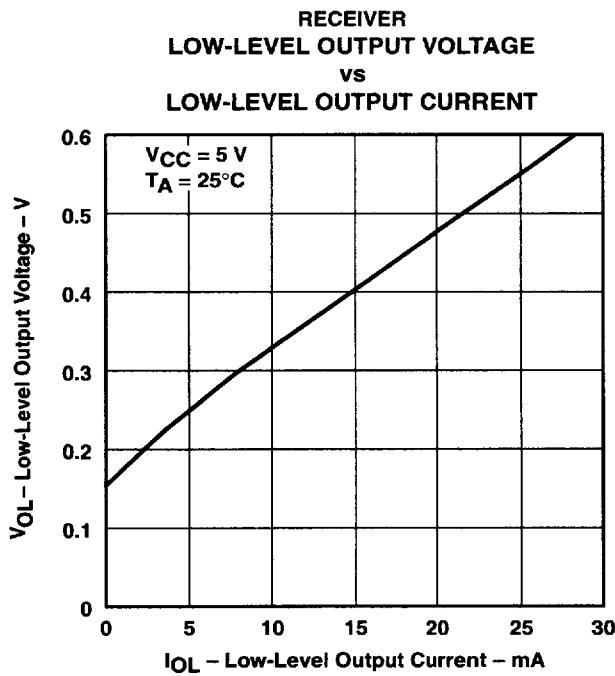


Figure 13

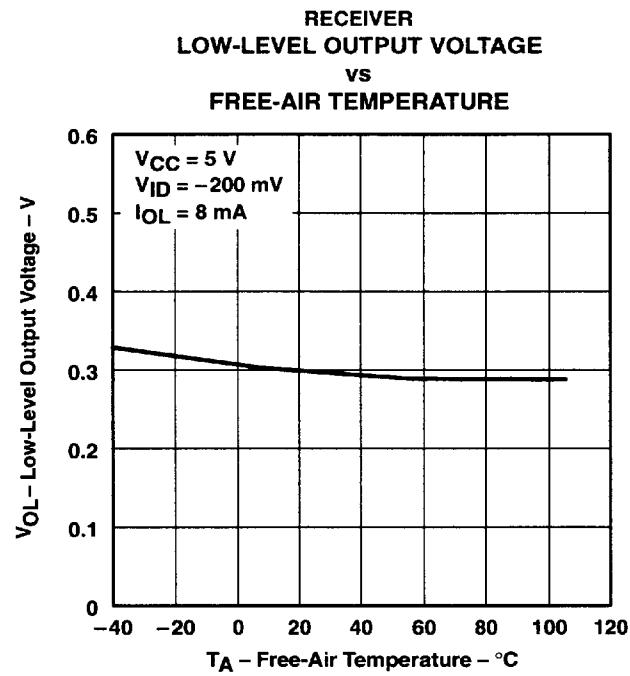


Figure 14

TYPICAL CHARACTERISTICS

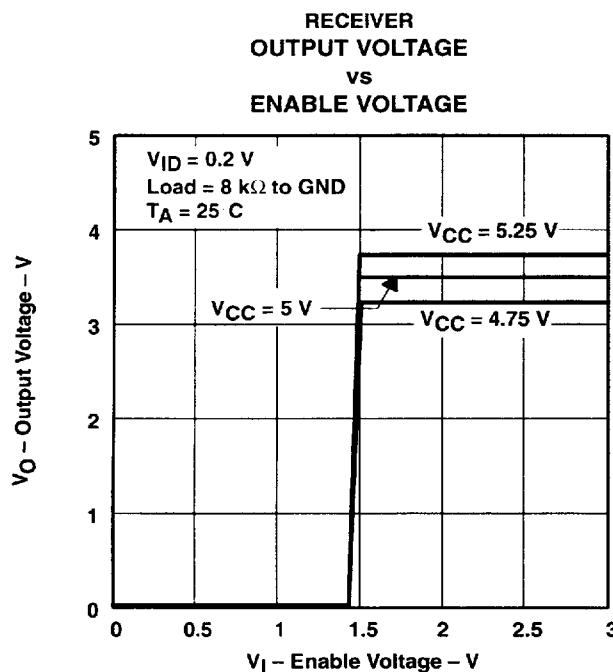


Figure 15

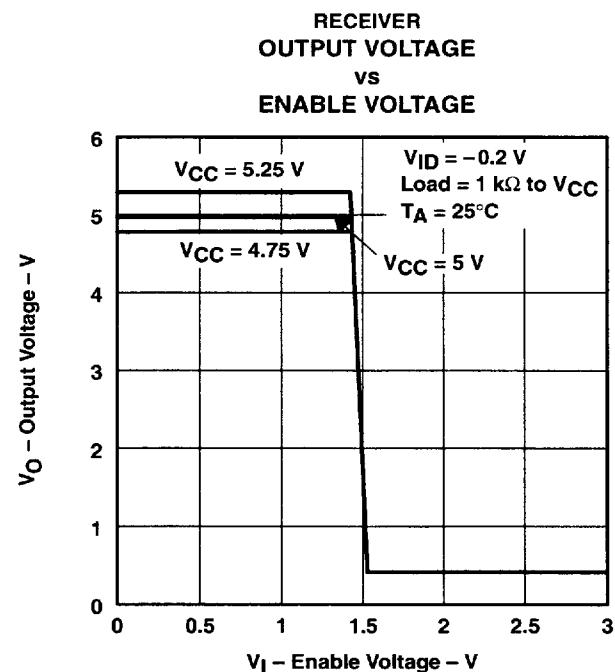


Figure 16

APPLICATION INFORMATION

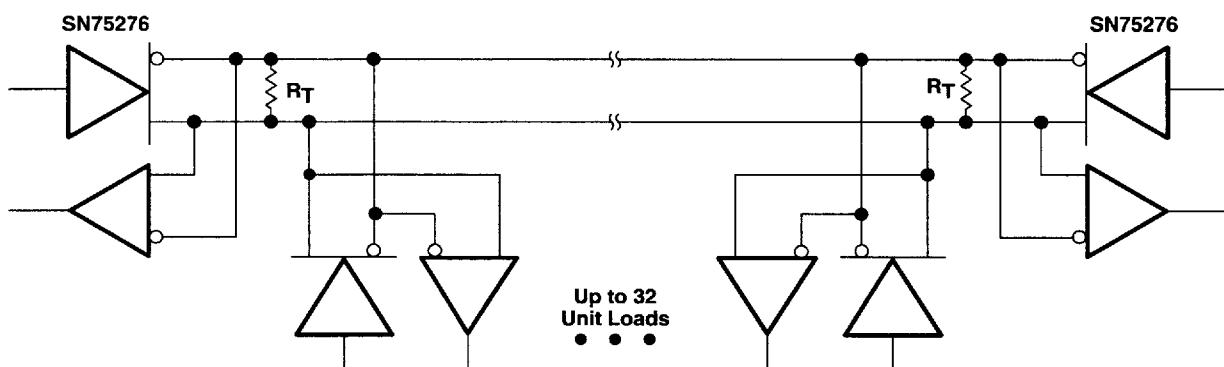


Figure 17. Typical Application Circuit

NOTE A: The line should be terminated at both ends in its characteristic impedance. Stub lengths off the main line should be kept as short as possible ( $R_T = Z_0$ ).

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## FAIL-SAFE DIFFERENTIAL BUS TRANSCEIVER

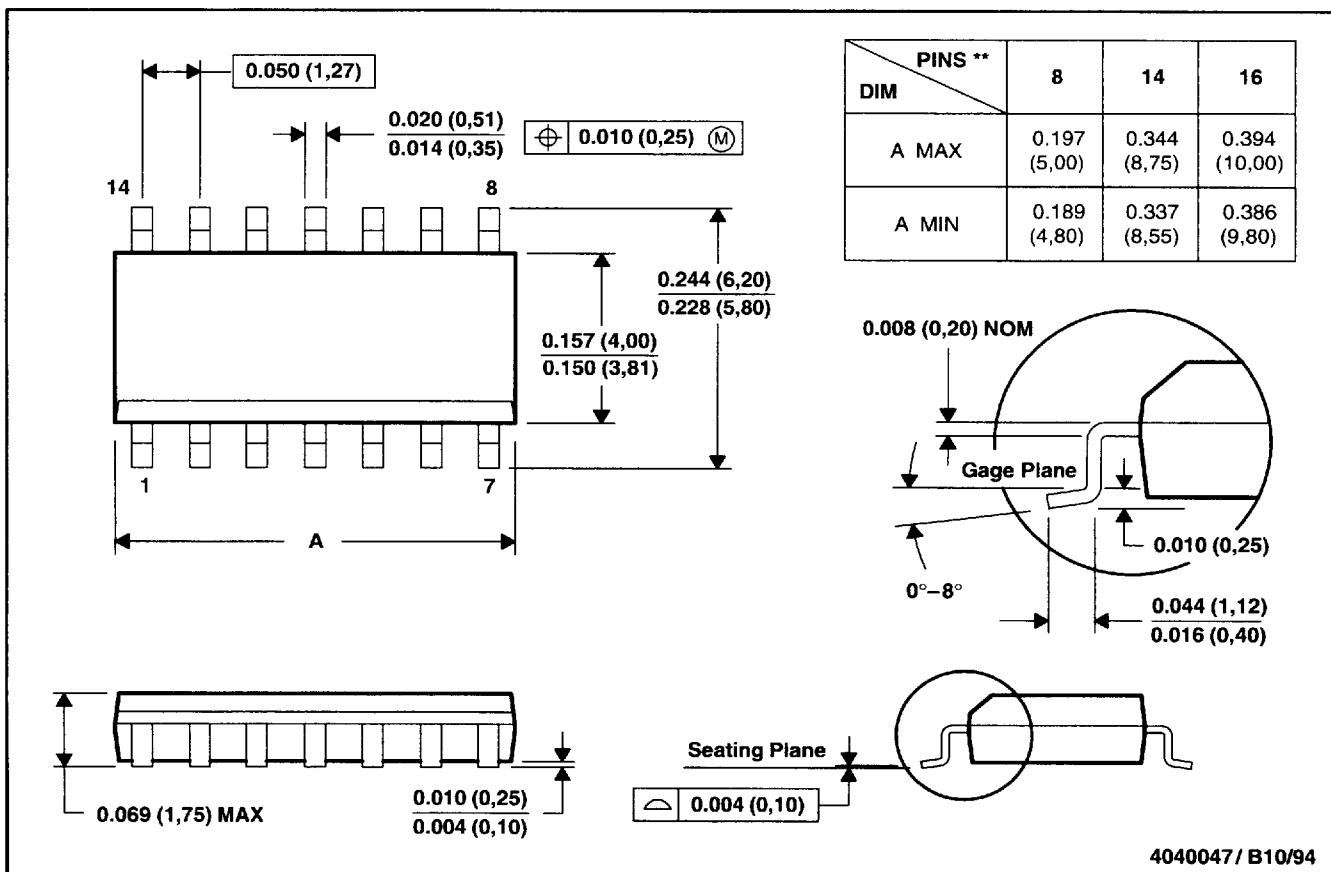
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### MECHANICAL INFORMATION

D (R-PDSO-G\*\*)

14 PIN SHOWN

PLASTIC SMALL-OUTLINE PACKAGE

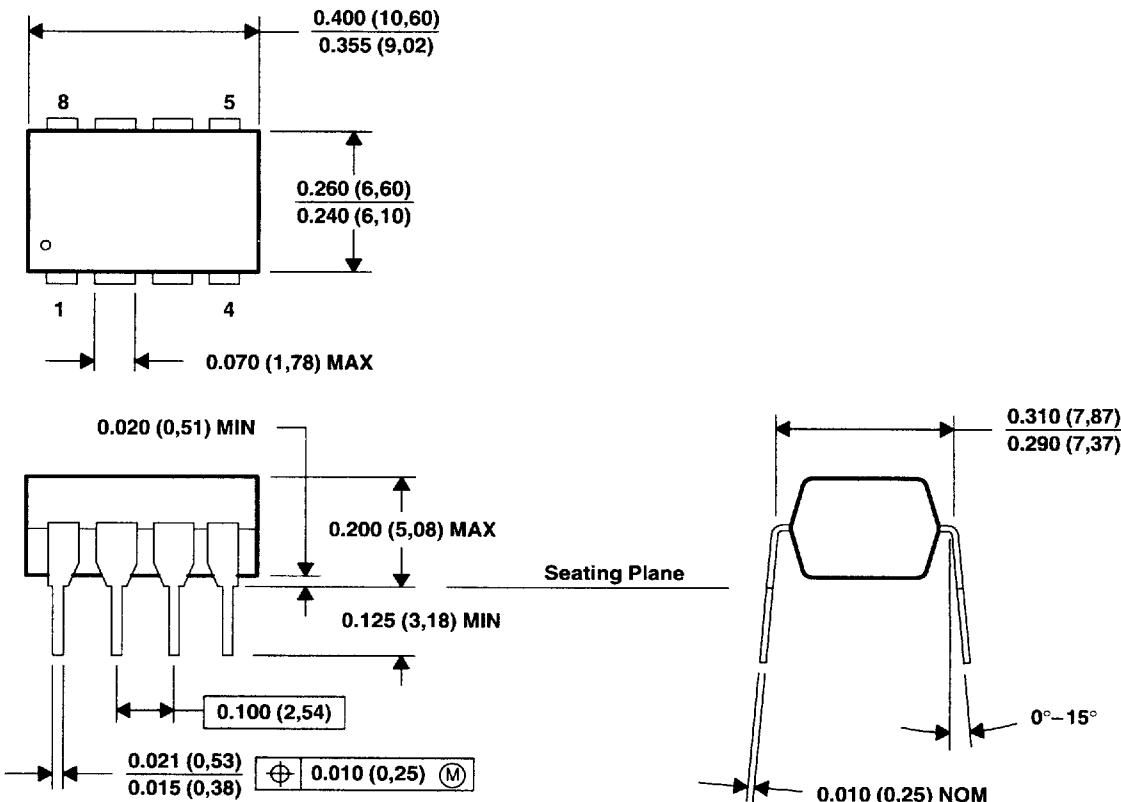


NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not exceed 0.006 (0.15).  
 D. Four center pins are connected to die mount pad.  
 E. Falls within JEDEC MS-012

MECHANICAL INFORMATION

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



4040082/B 10/94

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