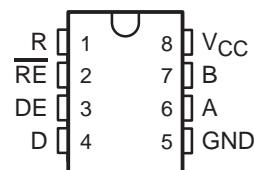


# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

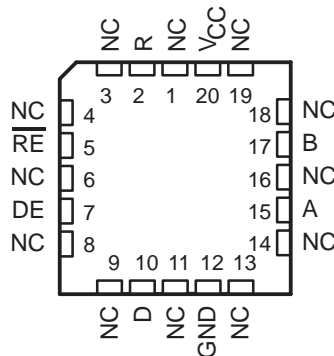
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- Bidirectional Transceiver
- Meet or Exceed the Requirements of ANSI Standard RS-485 and ISO 8482:1987(E)
- High-Speed Low-Power LinBiCMOS™ Circuitry
- Designed for High-Speed Operation in Both Serial and Parallel Applications
- Low Skew
- Designed for Multipoint Transmission on Long Bus Lines in Noisy Environments
- Very Low Disabled Supply-Current Requirements . . . 200  $\mu$ A Maximum
- Wide Positive and Negative Input/Output Bus Voltage Ranges
- Driver Output Capacity . . .  $\pm 60$  mA
- Thermal-Shutdown Protection
- Driver Positive-and Negative-Current Limiting
- Open-Circuit Fail-Safe Receiver Design
- Receiver Input Sensitivity . . .  $\pm 200$  mV Max
- Receiver Input Hysteresis . . . 50 mV Typ
- Operate From a Single 5-V Supply
- Glitch-Free Power-Up and Power-Down Protection
- Available in Q-Temp Automotive HighRel Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards

D, JG, OR P PACKAGE  
(TOP VIEW)



FK PACKAGE  
(TOP VIEW)



NC—No internal connection

## 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
$V_{ID} \geq 0.2$ 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)

## description

The SN55LBC176, SN65LBC176, SN65LBC176Q, and SN75LBC176 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 meet ANSI Standard RS-485 and ISO 8482:1987(E).



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.

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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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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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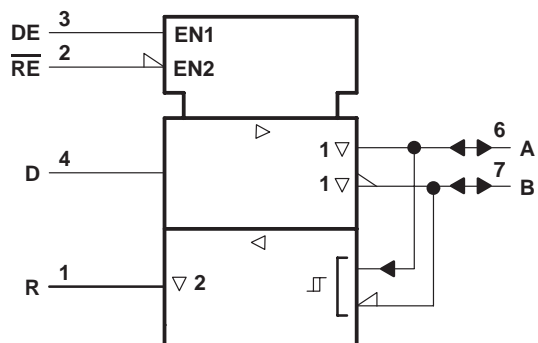
## description (continued)

The SN55LBC176, SN65LBC176, SN65LBC176Q, and SN75LBC176 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. Both the driver and receiver are available as cells in the Texas Instruments LinASIC™ Library.

These transceivers are suitable for ANSI Standard RS-485 and ISO 8482:1987 (E) applications to the extent that they are specified in the operating conditions and characteristics section of this data sheet. Certain limits contained in the ANSI Standard RS-485 and ISO 8482:1987 (E) are not met or cannot be tested over the entire military temperature range.

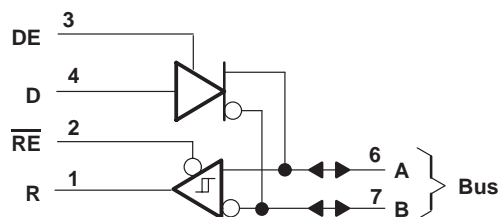
The SN55LBC176 is characterized for operation from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN65LBC176 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , and the SN65LBC176Q is characterized for operation from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN75LBC176 is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

## logic symbol†



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

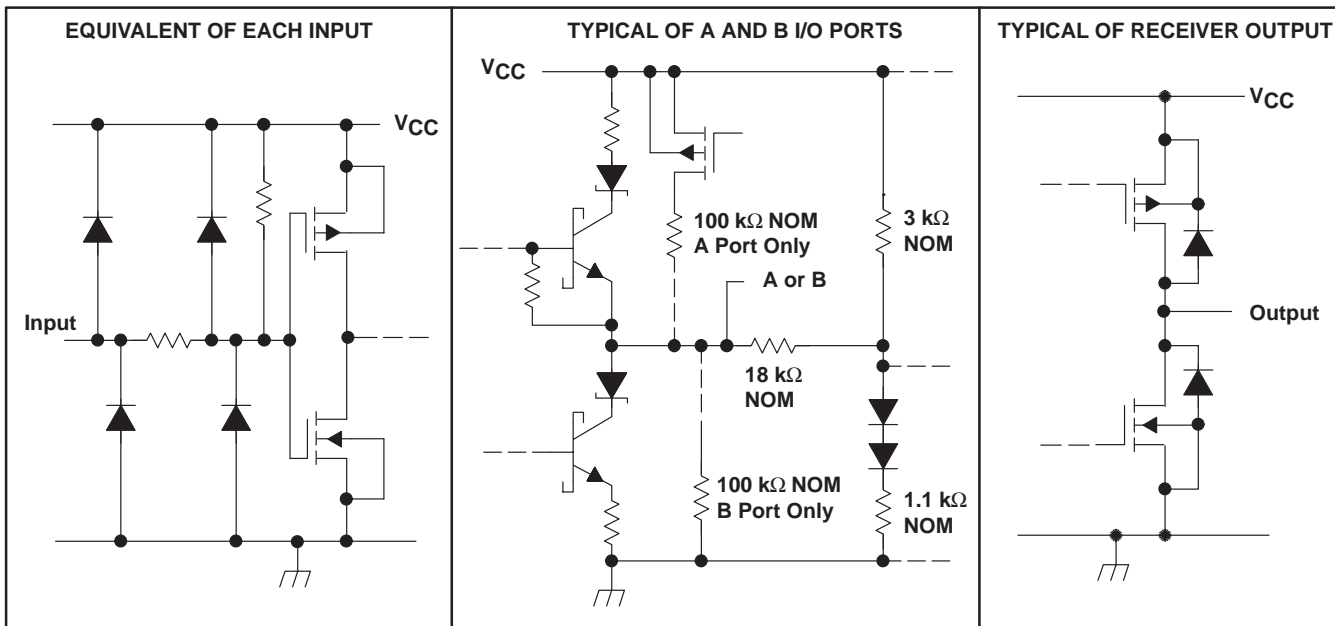
## logic diagram (positive logic)



# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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## schematics of inputs and outputs



# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Voltage range at any bus terminal	-10 V to 15 V
Input voltage, $V_I$ (D, DE, R, or $\overline{RE}$ )	-0.3 V to $V_{CC} + 0.5$ V
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : SN55LBC176	-55°C to 125°C
SN65LBC176	-40°C to 85°C
SN65LBC176Q	-40°C to 125°C
SN75LBC176	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 I/O bus voltage, are with respect to network ground terminal.

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	$T_A = 110^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	—
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	440 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	—

## 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, $V_{IH}$	D, DE, and $\overline{RE}$	2			V
Low-level input voltage, $V_{IL}$	D, DE, and $\overline{RE}$			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	mA
	Receiver			8	
Operating free-air temperature, $T_A$	SN55LBC176	-55		125	°C
	SN65LBC176	-40		85	
	SN65LBC176Q	-40		125	
	SN75LBC176	0		70	

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



# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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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		MIN	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	6	V
$ V_{OD2} $	Differential output voltage	$R_L = 54 \Omega$ , See Note 3	See Figure 1,	55LBC176, 65LBC176, 65LBC176Q	1.1	V
				75LBC176	1.5	
$V_{OD3}$	Differential output voltage	$V_{\text{test}} = -7 \text{ V to } 12 \text{ V}$ , See Note 3	See Figure 2,	55LBC176, 65LBC176, 65LBC176Q	1.1	V
				75LBC176	1.5	
$\Delta V_{OD} $	Change in magnitude of differential output voltage <sup>†</sup>				$\pm 0.2$	V
$V_{OC}$	Common-mode output voltage	$R_L = 54 \Omega$ or $100 \Omega$ ,	See Figure 1		3	V
					-1	
$\Delta V_{OC} $	Change in magnitude of common-mode output voltage <sup>†</sup>				$\pm 0.2$	V
$I_O$	Output current	Output disabled, See Note 4	$V_O = 12 \text{ V}$		1	mA
			$V_O = -7 \text{ V}$		-0.8	
$I_{IH}$	High-level input current	$V_I = 2.4 \text{ V}$			-100	$\mu\text{A}$
$I_{IL}$	Low-level input current	$V_I = 0.4 \text{ V}$			-100	$\mu\text{A}$
$I_{OS}$	Short-circuit output current	$V_O = -7 \text{ V}$			-250	mA
		$V_O = 0$			-150	
		$V_O = V_{CC}$			250	
		$V_O = 12 \text{ V}$				
$I_{CC}$	Supply current	$V_I = 0$ or $V_{CC}$ , No load	Receiver disabled and driver enabled	55LBC176, 65LBC176Q	1.75	mA
				65LBC176, 75LBC176	1.5	
			Receiver and driver disabled	55LBC176, 65LBC176Q	0.25	
				65LBC176, 75LBC176	0.2	

<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 changes from a high level to a low level.

NOTES: 3. This device meets the ANSI Standard RS-485  $V_{OD}$  requirements above  $0^\circ\text{C}$  only.

4. This applies for both power on and off; refer to ANSI Standard RS-485 for exact conditions.



# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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## switching characteristics over recommended ranges of supply voltage and operating free-air temperature

PARAMETER	TEST CONDITIONS	SN55LBC176 SN65LBC176Q			SN65LBC176 SN75LBC176			UNIT
		MIN	TYP	MAX	MIN	TYP†	MAX	
$t_{d(OD)}$ Differential output delay time	$R_L = 54 \Omega$ , $C_L = 50 \text{ pF}$ , See Figure 3	8		31	8		25	ns
$t_{t(OD)}$ Differential output transition time			12			12		ns
$t_{sk(p)}$ Pulse skew ( $ t_{d(ODH)} - t_{d(ODL)} $ )				6		0	6	ns
$t_{PZH}$ Output enable time to high level	$R_L = 110 \Omega$ , See Figure 4			65			35	ns
$t_{PZL}$ Output enable time to low level	$R_L = 110 \Omega$ , See Figure 5			65			35	ns
$t_{PHZ}$ Output disable time from high level	$R_L = 110 \Omega$ , See Figure 4			105			60	ns
$t_{PLZ}$ Output disable time from low level	$R_L = 110 \Omega$ , See Figure 5			105			35	ns

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

### SYMBOL EQUIVALENTS

DATA SHEET PARAMETER	RS-485
$V_O$	$V_{Oa}, V_{Ob}$
$ V_{OD1} $	$V_O$
$ V_{OD2} $	$V_t (R_L = 54 \Omega)$
$ V_{OD3} $	$V_t$ (test termination measurement 2)
$\Delta  V_{OD} $	$  V_t  -  \bar{V}_t  $
$V_{OC}$	$ V_{Os} $
$\Delta  V_{OC} $	$ V_{Os} - \bar{V}_{Os} $
$I_{OS}$	None
$I_O$	$I_{ia}, I_{ib}$



# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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## 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	$V_O = 2.7\text{ V}$ ,	$I_O = -0.4\text{ mA}$			0.2	V
$V_{IT-}$	Negative-going input threshold voltage	$V_O = 0.5\text{ V}$ ,	$I_O = 8\text{ mA}$	$-0.2\ddagger$			V
$V_{hys}$	Hysteresis voltage ( $V_{IT+} - V_{IT-}$ ) (see Figure 4)				50		mV
$V_{IK}$	Enable-input clamp voltage	$I_I = -18\text{ mA}$				-1.5	V
$V_{OH}$	High-level output voltage	$V_{ID} = 200\text{ mV}$ , See Figure 6	$I_{OH} = -400\text{ }\mu\text{A}$ ,		2.7		V
$V_{OL}$	Low-level output voltage	$V_{ID} = 200\text{ mV}$ , See Figure 6	$I_{OL} = 8\text{ mA}$ ,			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	$V_{IH} = 2.7\text{ V}$				-100	$\mu\text{A}$
$I_{IL}$	Low-level enable-input current	$V_{IL} = 0.4\text{ V}$				-100	$\mu\text{A}$
$r_I$	Input resistance				12		k $\Omega$
$I_{CC}$	Supply current	$V_I = 0\text{ or }V_{CC}$ , No load	Receiver enabled and driver disabled			3.9	mA
			Receiver and driver disabled	SN55LBC176, SN65LBC176, SN65LBC176Q		0.25	
				SN75LBC176		0.2	

† 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 common-mode input voltage and threshold voltage levels only.

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

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 15\text{ pF}$**

PARAMETER	TEST CONDITIONS	SN55LBC176 SN65LBC176Q		SN65LBC176 SN75LBC176		UNIT	
		MIN	MAX	MIN	TYP†		MAX
$t_{PLH}$	Propagation delay time, low- to high-level single-ended output	$V_{ID} = -1.5\text{ V to }1.5\text{ V}$ , See Figure 7	11	37	11	33	ns
$t_{PHL}$	Propagation delay time, high- to low-level single-ended output		11	37	11	33	ns
$t_{sk(p)}$	Pulse skew ( $ t_d(\text{ODH}) - t_d(\text{ODL}) $ )			10		3	6
$t_{PZH}$	Output enable time to high level	See Figure 8		35		35	ns
$t_{PZL}$	Output enable time to low level			35		30	ns
$t_{PHZ}$	Output disable time from high level	See Figure 8		35		35	ns
$t_{PLZ}$	Output disable time from low level			35		30	ns

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



# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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## PARAMETER MEASUREMENT INFORMATION

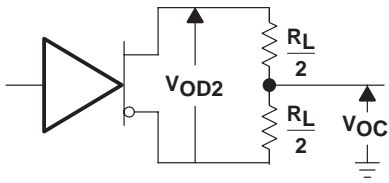


Figure 1. Driver  $V_{OD2}$  and  $V_{OC}$

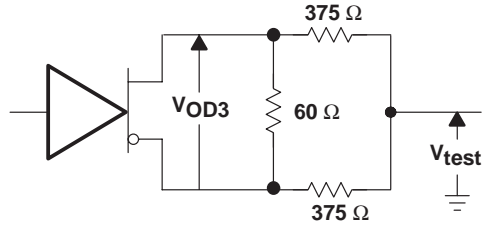
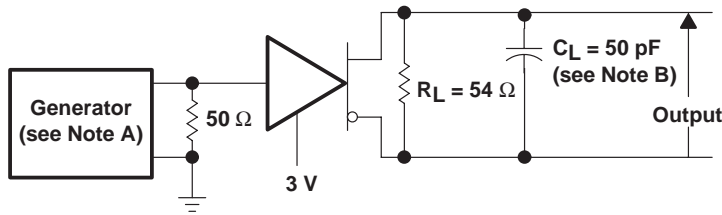
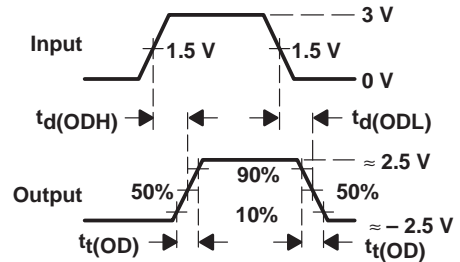


Figure 2. Driver  $V_{OD3}$

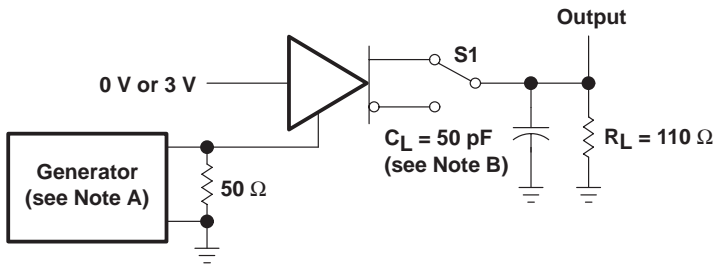


TEST CIRCUIT

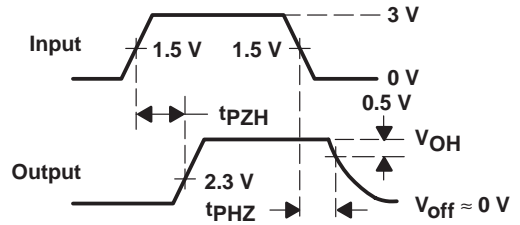


VOLTAGE WAVEFORMS

Figure 3. Driver Test Circuit and Voltage Waveforms

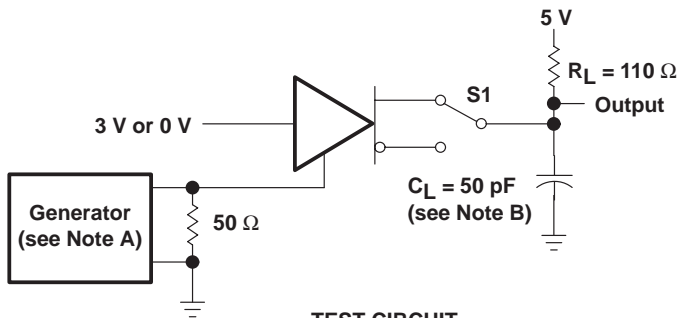


TEST CIRCUIT

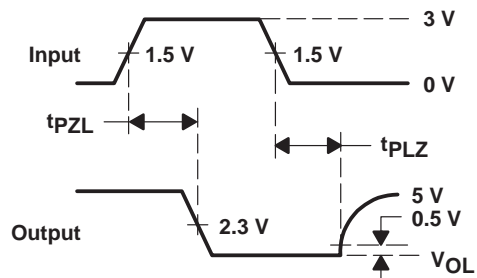


VOLTAGE WAVEFORMS

Figure 4. Driver Test Circuit and Voltage Waveforms



TEST CIRCUIT



VOLTAGE WAVEFORMS

Figure 5. Driver 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,  $Z_0 = 50 \Omega$ .  
B.  $C_L$  includes probe and jig capacitance.



PARAMETER MEASUREMENT INFORMATION

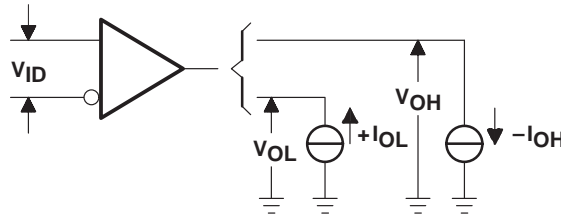
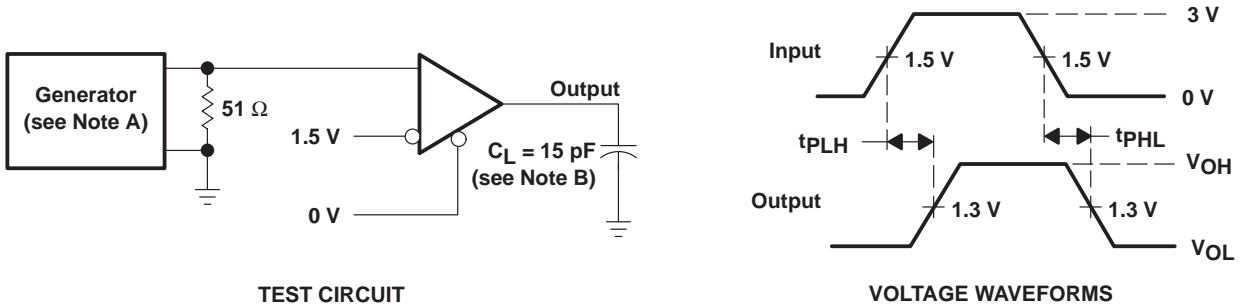


Figure 6. Receiver  $V_{OH}$  and  $V_{OL}$



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ , 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 7. Receiver Test Circuit and Voltage Waveforms

# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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## PARAMETER MEASUREMENT INFORMATION

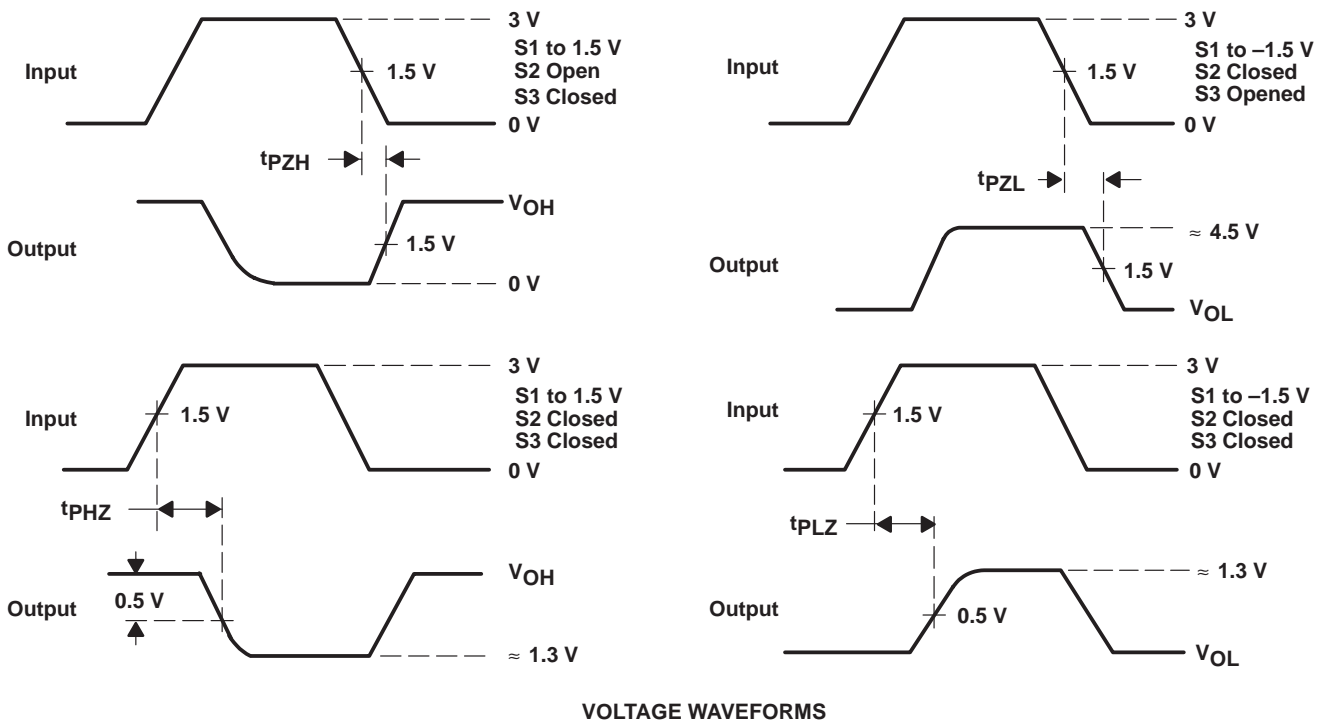
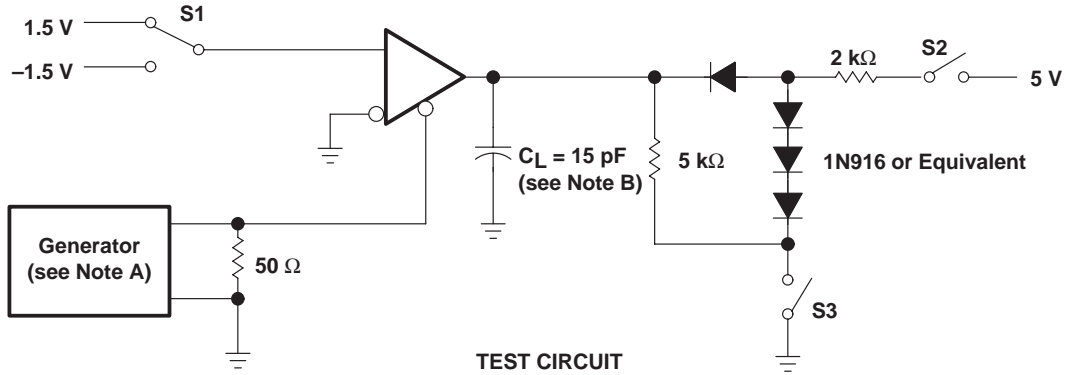


Figure 8. Receiver Test Circuit and Voltage Waveforms

- 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.

# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

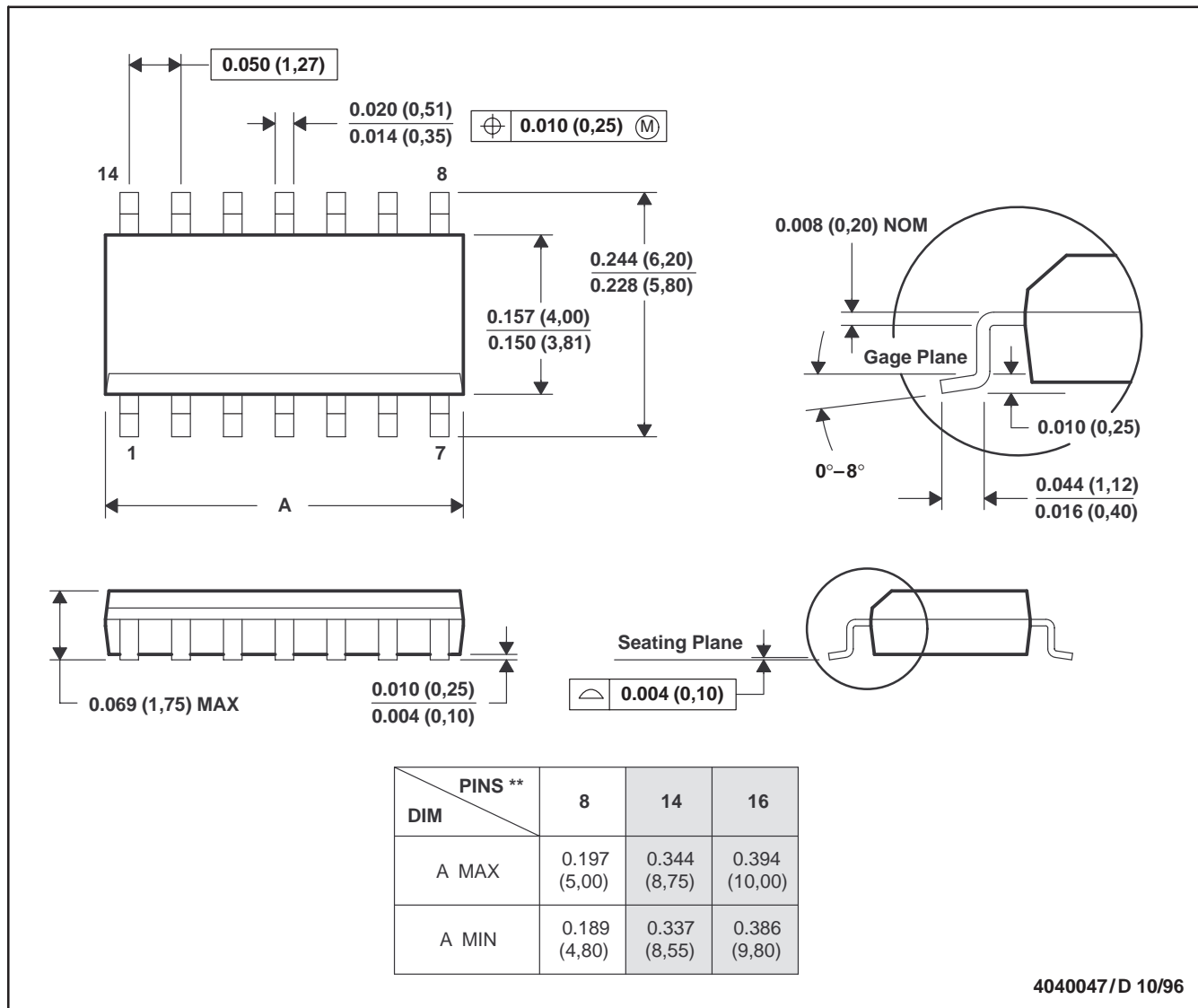
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## MECHANICAL INFORMATION

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

# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

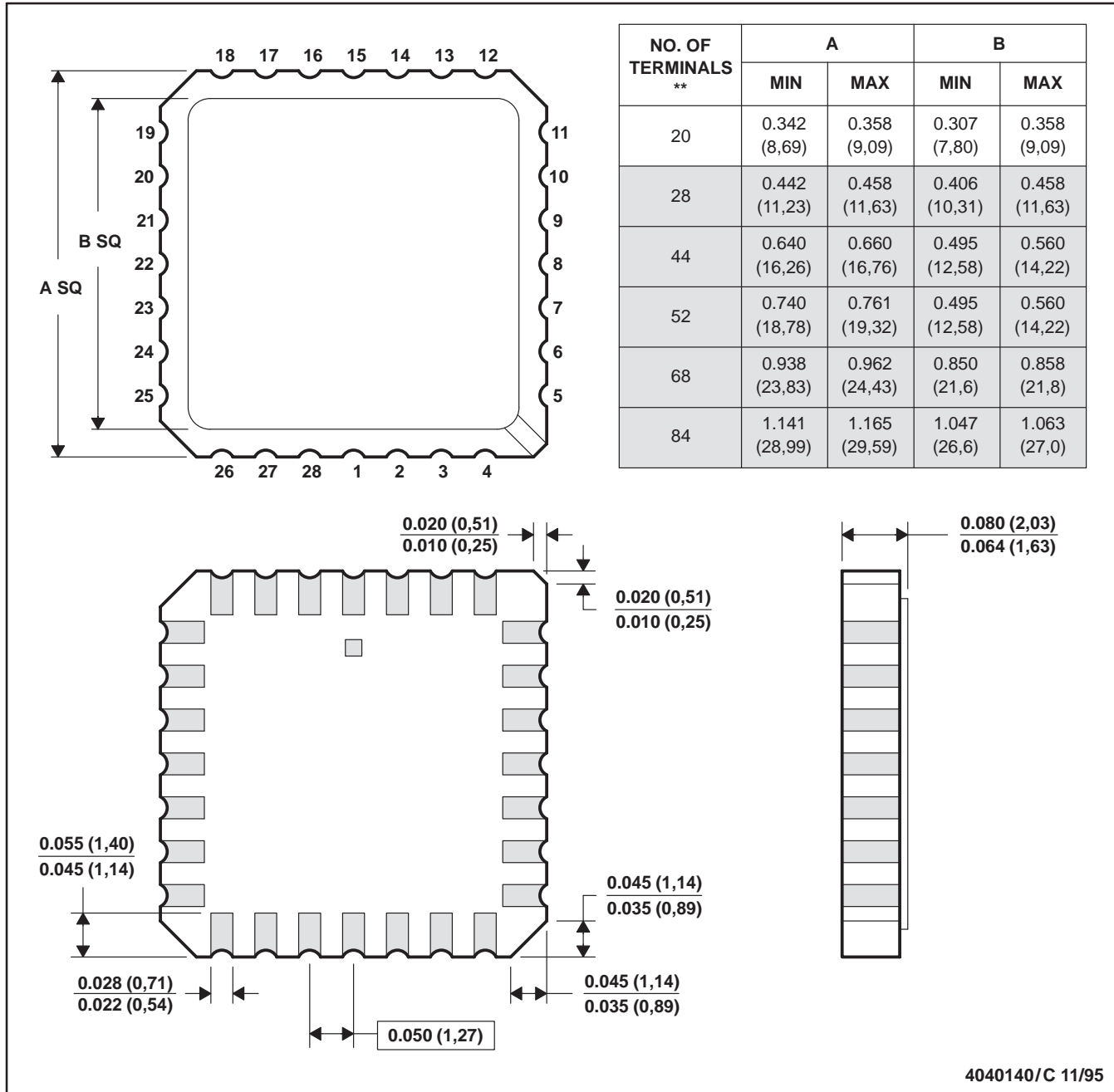
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## MECHANICAL INFORMATION

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINALS SHOWN



4040140/C 11/95

- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a metal lid.  
 D. The terminals are gold-plated.  
 E. Falls within JEDEC MS-004

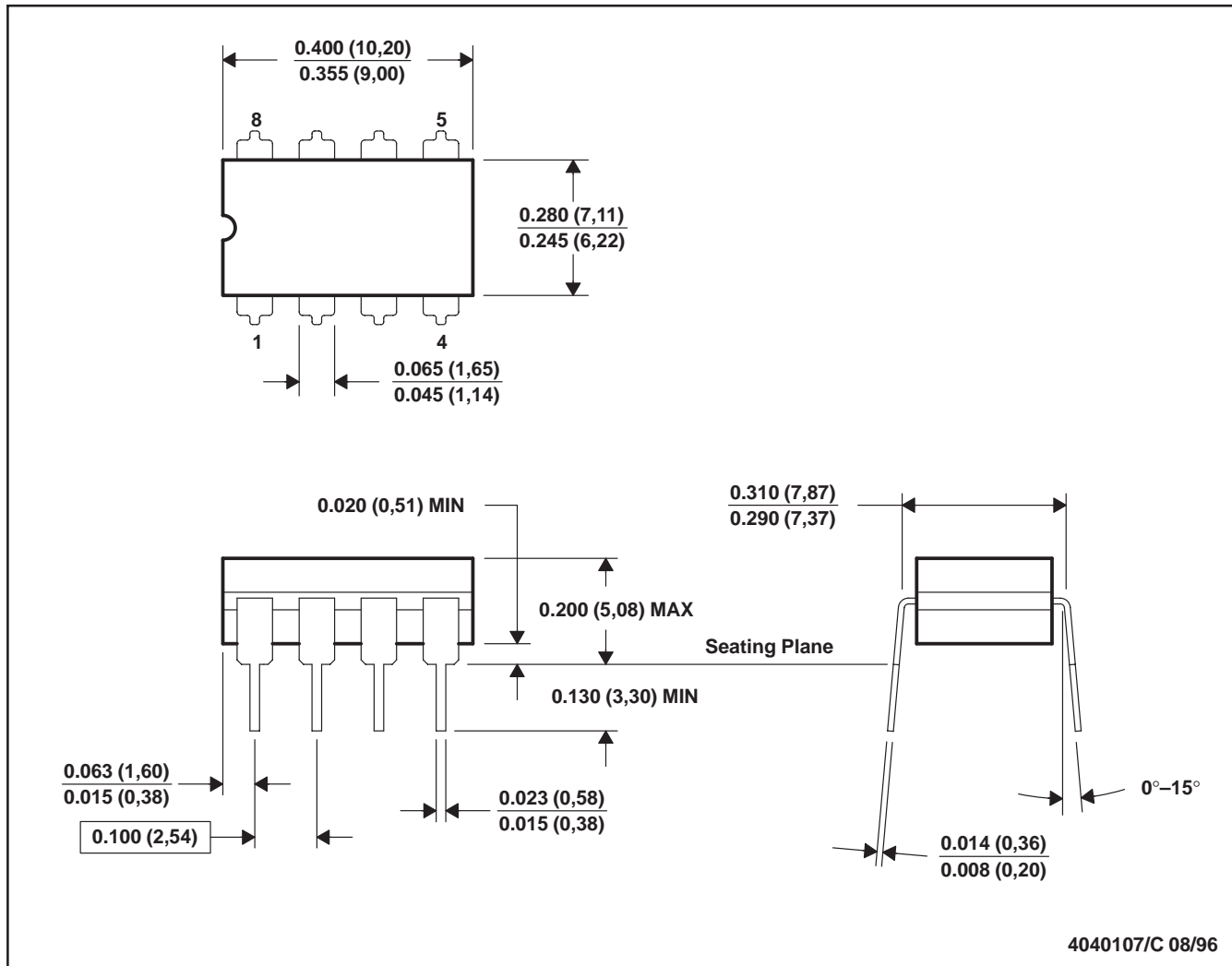
# SN55LBC176, SN65LBC176, SN65LBC176Q, SN75LBC176 DIFFERENTIAL BUS TRANSCEIVERS

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## MECHANICAL INFORMATION

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE PACKAGE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.  
 E. Falls within MIL-STD-1835 GDIP1-T8

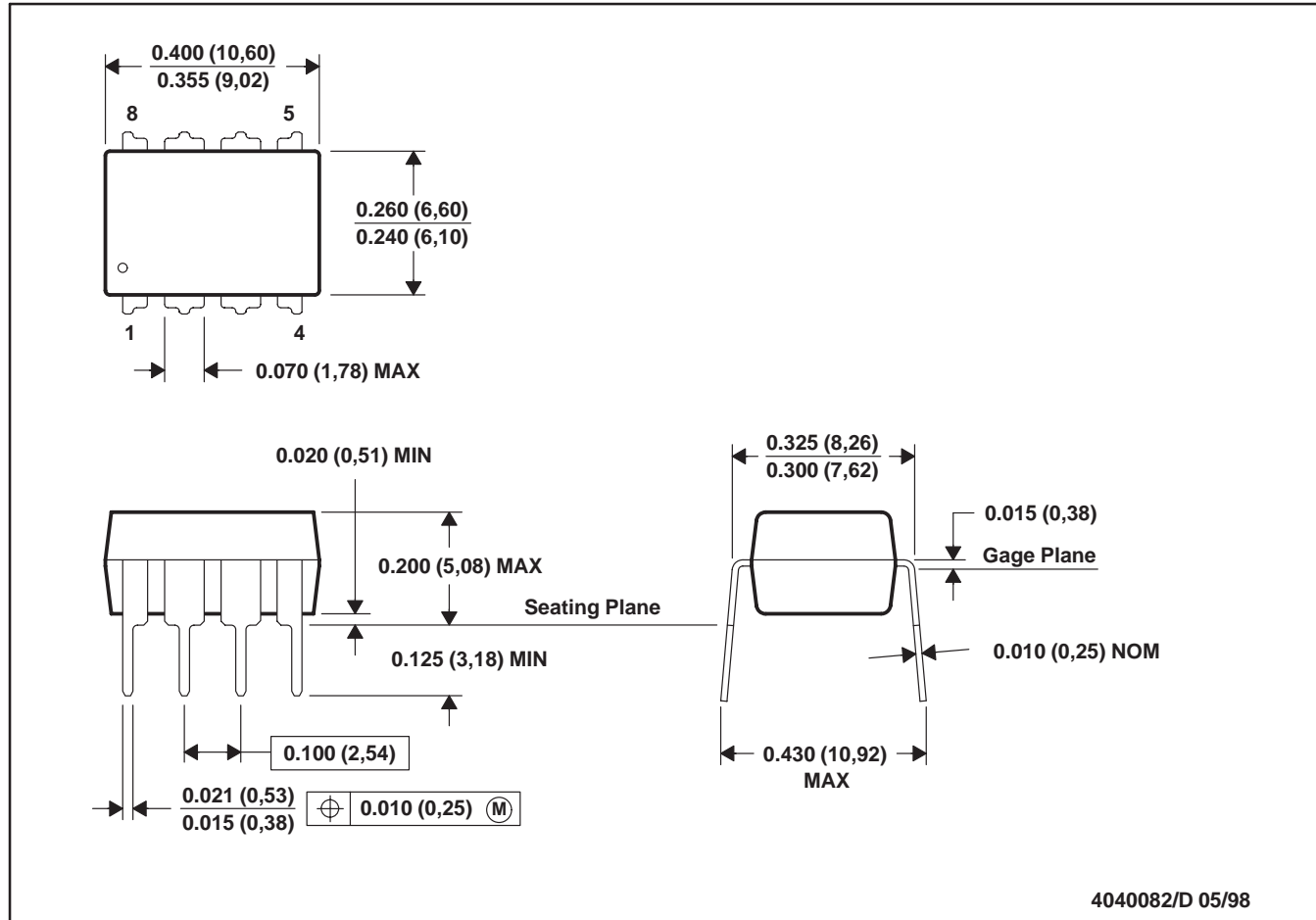
# MECHANICAL DATA

MPDI001A – JANUARY 1995 – REVISED JUNE 1999

## 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](http://www.ti.com/sc/docs/package/pkg_info.htm)



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