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[Texas Instruments](#)
[SN65LBC176QDRQ1](#)

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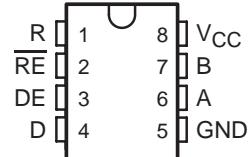
SN65LBC176-Q1

DIFFERENTIAL BUS TRANSCEIVER

SGLS211A – OCTOBER 2003 – REVISED MAY 2008

- Qualified for Automotive Applications
- 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 μ 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

D PACKAGE
(TOP VIEW)



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/ordering information

The SN65LBC176 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 meets ANSI Standard RS-485 and ISO 8482:1987(E).

ORDERING INFORMATION[†]

TA	PACKAGE [‡]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 125°C	SOIC – D	Tape and reel	SN65LBC176QDRQ1	L176Q1

[†] For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

[‡] Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.



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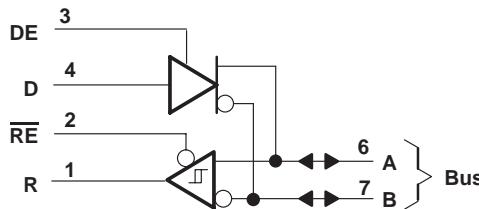
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description (continued)

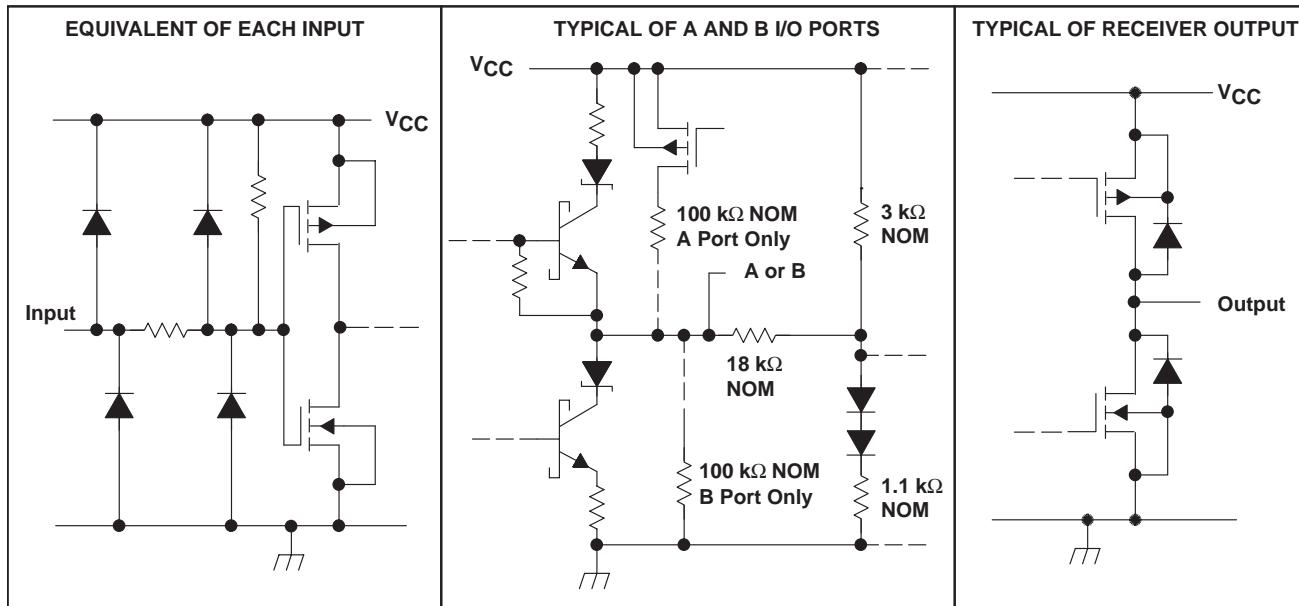
The SN65LBC176 combines a 3-state, differential line driver and a differential input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can externally connect together to function as a direction control. 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.

This transceiver is 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 extended temperature range.

logic diagram (positive logic)



schematics of inputs and outputs



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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 SN65LBC176Q	-40°C to 125°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	$T_A \leq 25^\circ C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ C$	$T_A = 70^\circ C$	$T_A = 85^\circ C$	$T_A = 125^\circ C$
			POWER RATING	POWER RATING	POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	145 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
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	
	Receiver			8	mA
Operating free-air temperature, T_A	SN65LBC176Q	-40		125	°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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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}	$I_I = -18 \text{ mA}$			-1.5	V
V_O	$I_O = 0$		0	6	V
$ V_{OD1} $	$I_O = 0$		1.5	6	V
V_{OD3}	Differential output voltage	$V_{test} = -7 \text{ V to } 12 \text{ V}$, See Figure 2, See Note 3	1.1		V
$ V_{OD2} $	Differential output voltage	$R_L = 54 \Omega$, See Figure 1, See Note 3	1.1		V
$\Delta V_{OD} $	Change in magnitude of differential output voltage [†]			± 0.2	V
V_{OC}	Common-mode output voltage	$R_L = 54 \Omega$ or 100Ω , See Figure 1	3	V	
$\Delta V_{OC} $	Change in magnitude of common-mode output voltage [†]				
I_O	Output current				
I_{IH}	High-level input current	$V_I = 2.4 \text{ V}$		-100	μA
I_{IL}	Low-level input current	$V_I = 0.4 \text{ V}$		-100	μA
I_{OS}	Short-circuit output current	$V_O = -7 \text{ V}$		-250	mA
		$V_O = 0$		-150	
		$V_O = V_{CC}$			
		$V_O = 12 \text{ V}$		250	
I_{CC}	Supply current	$V_I = 0$ or V_{CC} , No load	Receiver disabled and driver enabled	1.75	mA
			Receiver and driver disabled	0.25	

[†] $\Delta|V_{OD}|$ 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°C only.
 4. This applies for both power on and off; refer to ANSI Standard RS-485 for exact conditions.

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

PARAMETER	TEST CONDITIONS	MIN	TYPT [†]	MAX	UNIT
$t_{d(OD)}$	$R_L = 54 \Omega$, $C_L = 50 \text{ pF}$, See Figure 3	8		31	ns
$t_{t(OD)}$			12		ns
$t_{sk(p)}$			6		ns
t_{PZH}	$R_L = 110 \Omega$, See Figure 4		65		ns
t_{PZL}	$R_L = 110 \Omega$, See Figure 5		65		ns
t_{PHZ}	$R_L = 110 \Omega$, See Figure 4		105		ns
t_{PLZ}	$R_L = 110 \Omega$, See Figure 5		105		ns

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

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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}

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‡		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	$V_{ID} = 200 \text{ mV}$, $I_{OH} = -400 \mu\text{A}$, See Figure 6		2.7			V
V_{OL} Low-level output voltage	$V_{ID} = 200 \text{ mV}$, $I_{OL} = 8 \text{ mA}$, See Figure 6			0.45		V
I_{OZ} High-impedance-state output current	$V_O = 0.4 \text{ V}$ to 2.4 V				± 20	μA
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	μA
I_{IL} Low-level enable-input current	$V_{IL} = 0.4 \text{ V}$				-100	μA
r_I Input resistance				12		$\text{k}\Omega$
I_{CC} Supply current	$V_I = 0$ or V_{CC} , No load	Receiver enabled and driver disabled		3.9		mA
		Receiver and driver disabled		0.25		

† 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.

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

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
t_{PLH}	$V_{ID} = -1.5 \text{ V to } 1.5 \text{ V}$, See Figure 7	11	37	ns
t_{PHL}		11	37	ns
$t_{sk(p)}$		10	ns	
t_{PZH}	See Figure 8	35	ns	
t_{PZL}		35	ns	
t_{PHZ}	See Figure 8	35	ns	
t_{PLZ}		35	ns	

PARAMETER MEASUREMENT INFORMATION

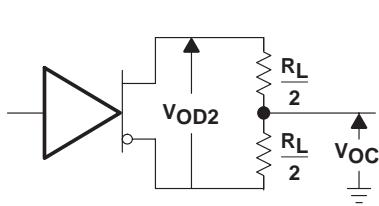


Figure 1. Driver V_{OD} and V_{OC}

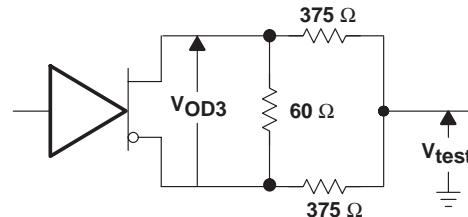


Figure 2. Driver V_{OD3}

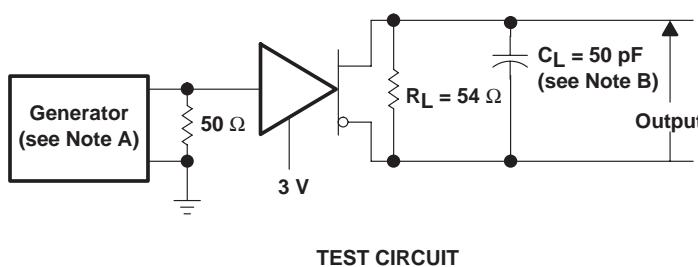


Figure 3. Driver Test Circuit and Voltage Waveforms

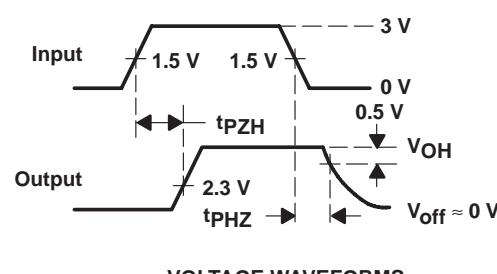
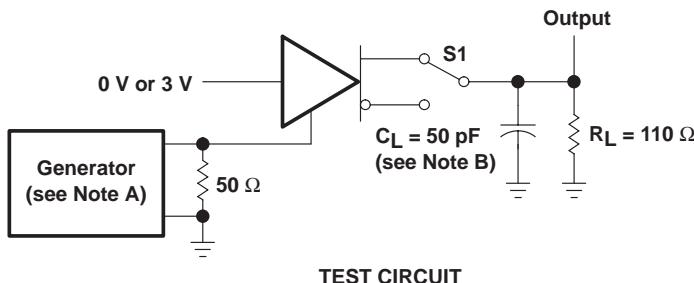
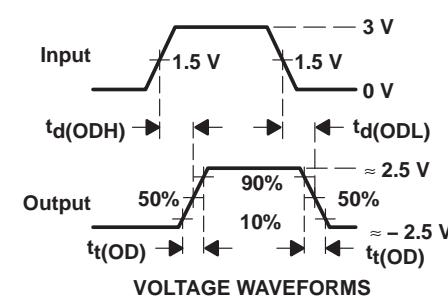


Figure 4. Driver Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

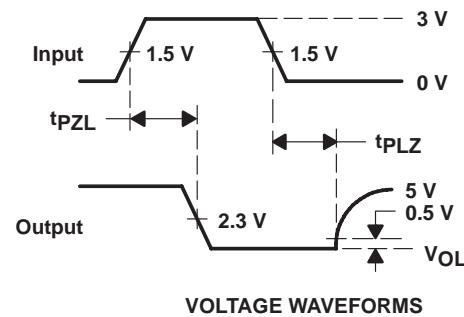
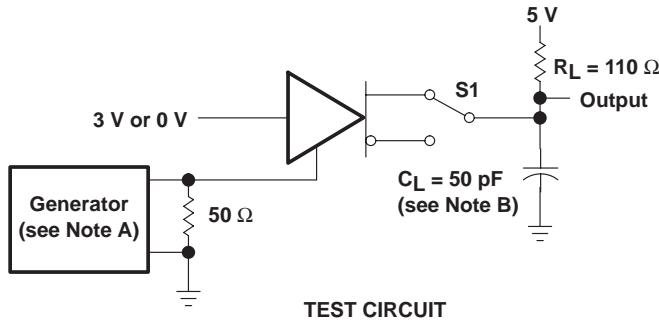


Figure 5. Driver Test Circuit and Voltage Waveforms

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

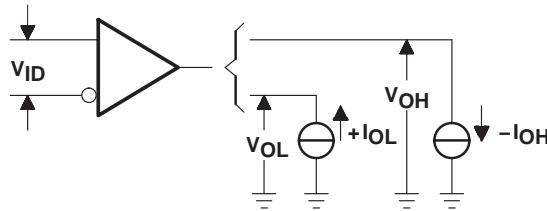
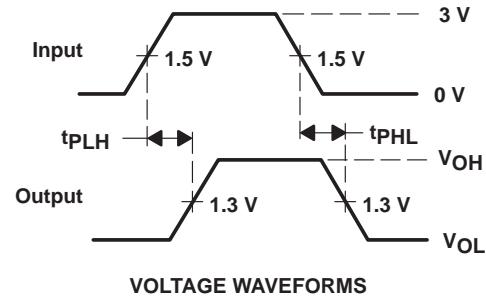
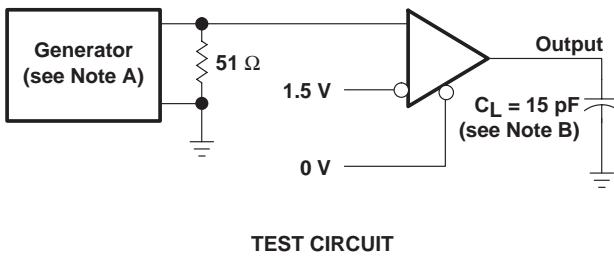


Figure 6. Receiver V_{OH} and V_{OL}



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

Figure 7. Receiver Test Circuit and Voltage Waveforms

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PARAMETER MEASUREMENT INFORMATION

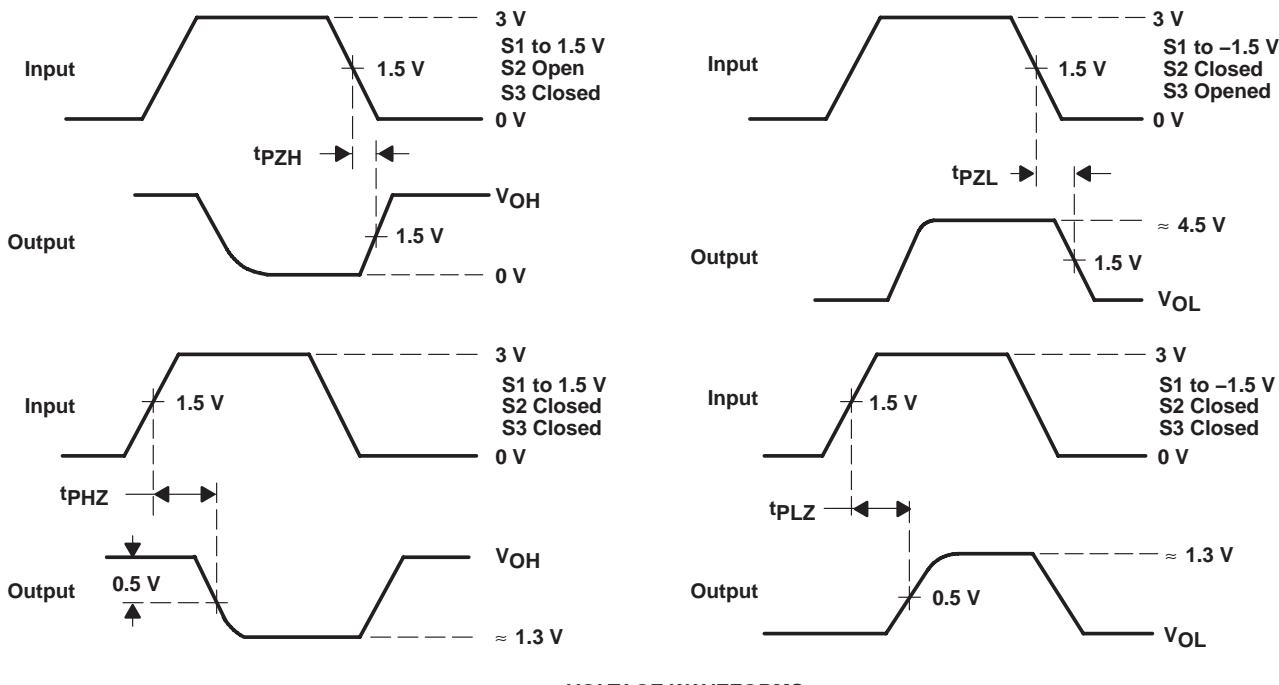
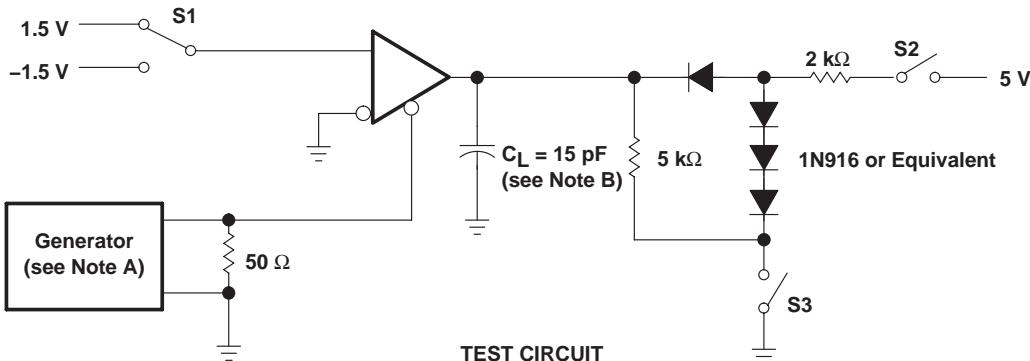


Figure 8. Receiver Test Circuit and Voltage Waveforms

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.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN65LBC176QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	J176Q1	Samples
SN65LBC176QDRQ1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	J176Q1	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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Datasheet of SN65LBC176QDRQ1 - IC TXRX DIFF BUS HS LP 8-SOIC

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PACKAGE OPTION ADDENDUM

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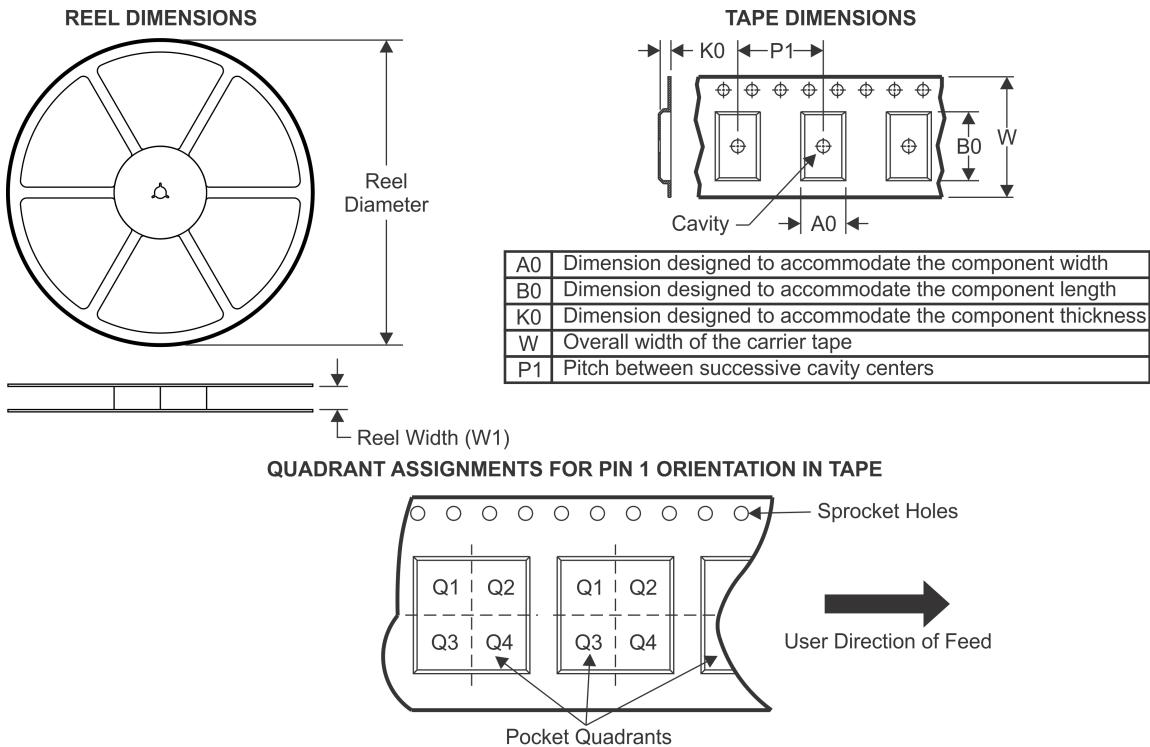
OTHER QUALIFIED VERSIONS OF SN65LBC176-Q1 :

- Catalog: [SN65LBC176](#)

NOTE: Qualified Version Definitions:

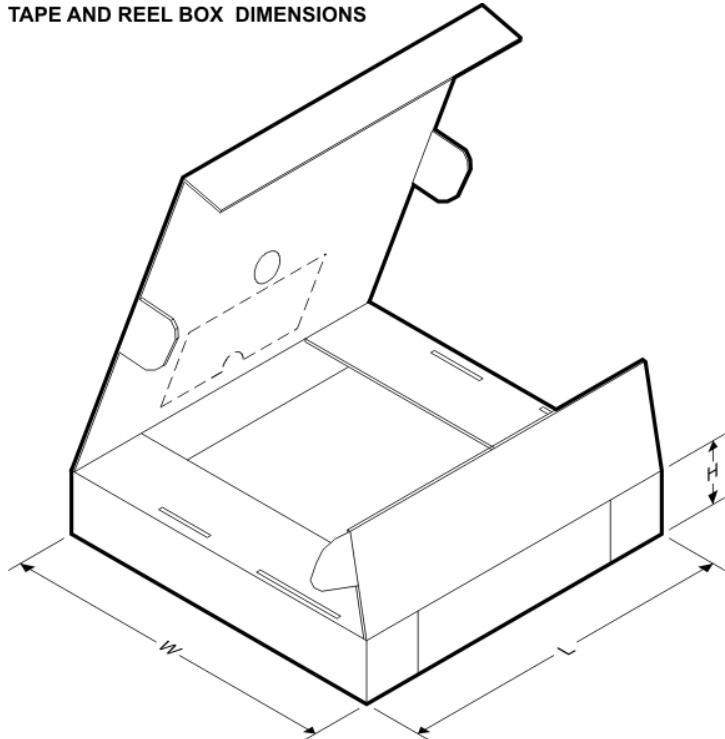
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN65LBC176QDRG4Q1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

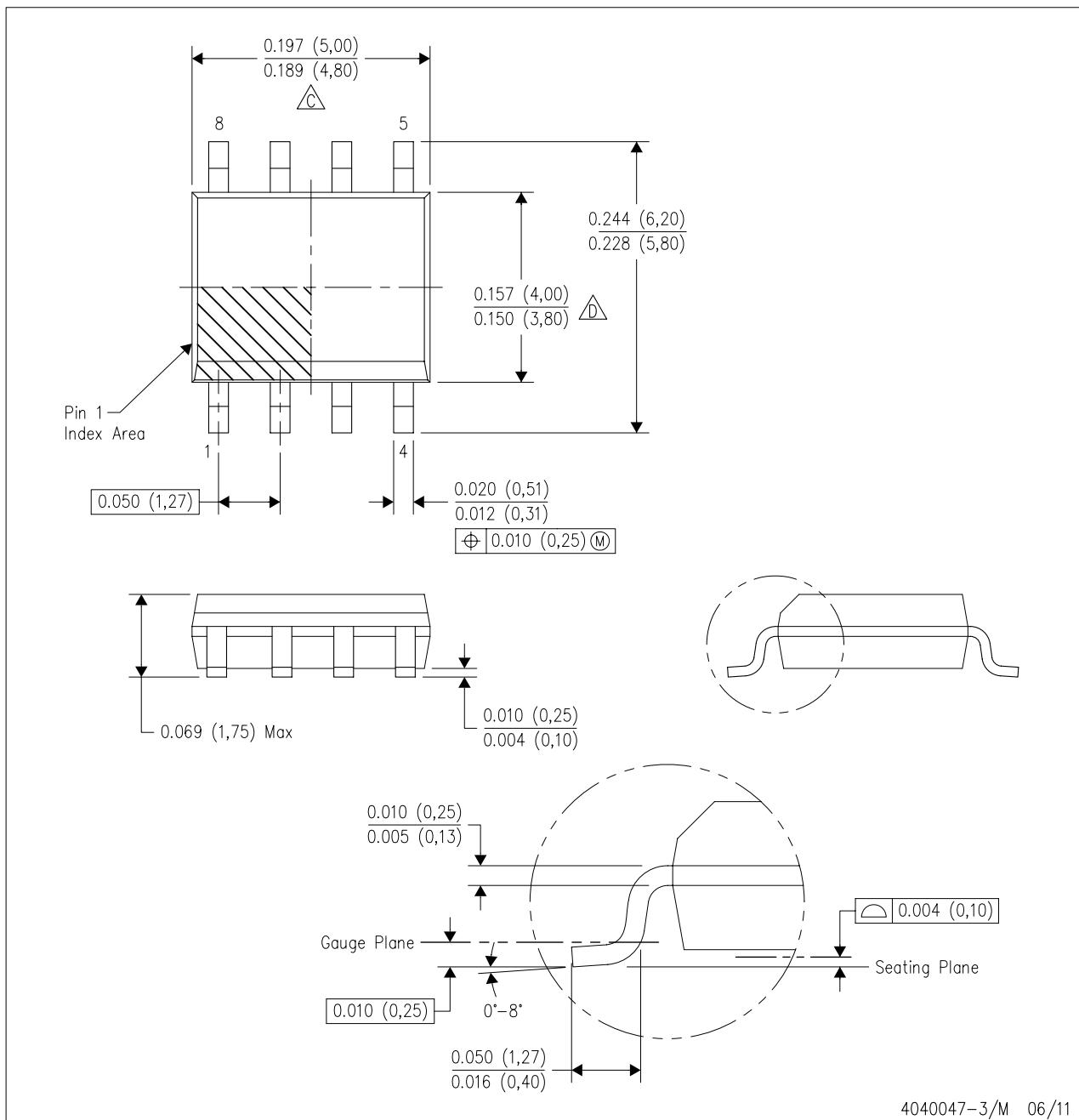
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65LBC176QDRG4Q1	SOIC	D	8	2500	340.5	338.1	20.6

MECHANICAL DATA

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.

△C Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.

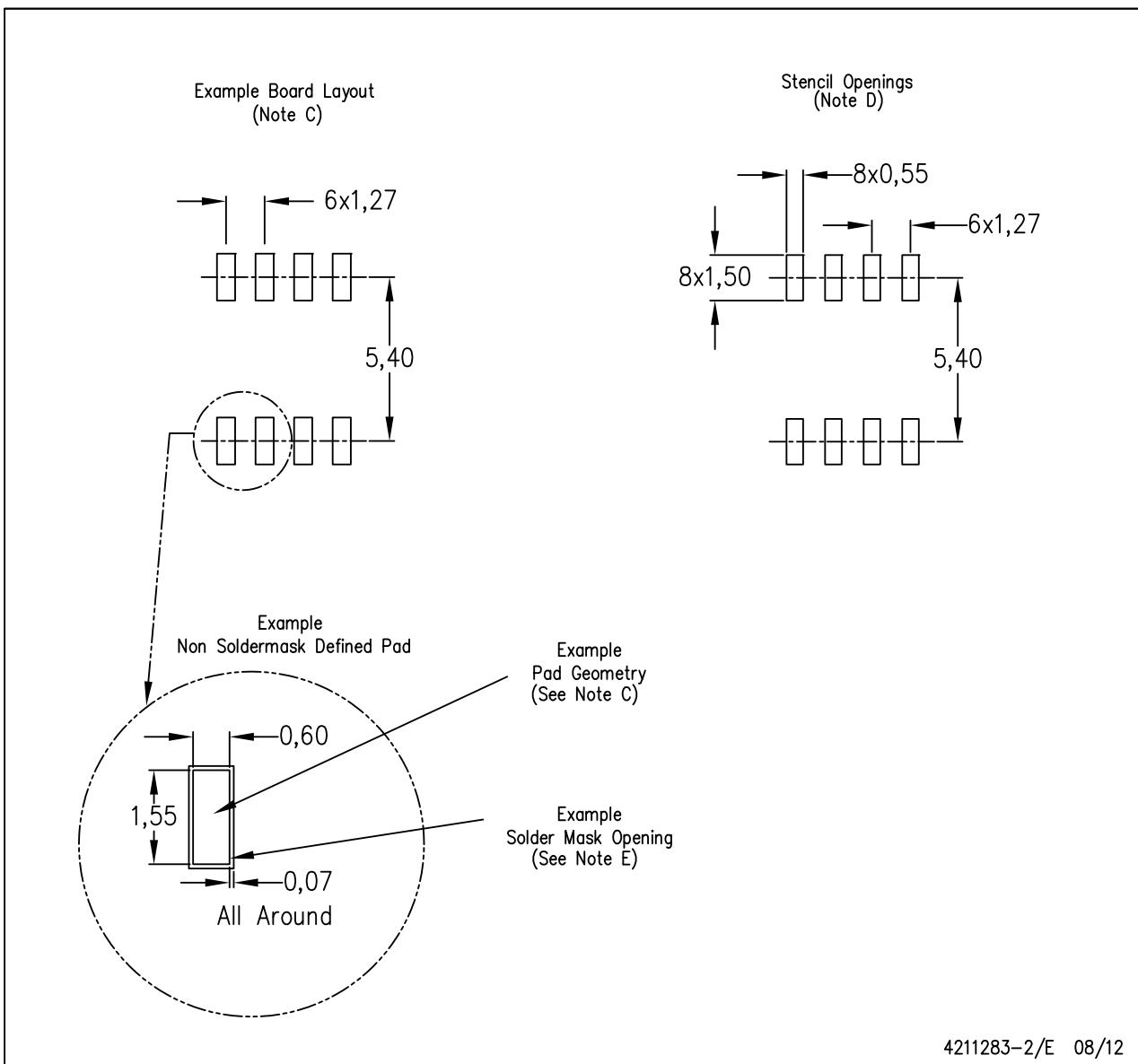
△D Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.

E. Reference JEDEC MS-012 variation AA.

LAND PATTERN DATA

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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