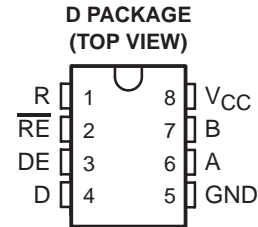


SN65LBC176-Q1 DIFFERENTIAL BUS TRANSCEIVER

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 . . . ± 60 mA
- 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
- Operate From a Single 5-V Supply
- Glitch-Free Power-Up and Power-Down Protection



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†

T _A	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
	SOIC – D	Tape and reel		
–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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SN65LBC176-Q1 DIFFERENTIAL BUS TRANSCEIVER

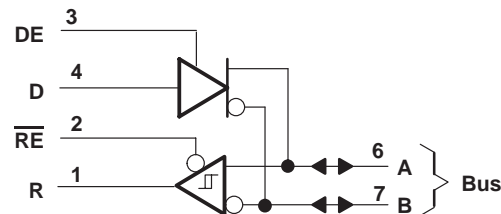
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description (continued)

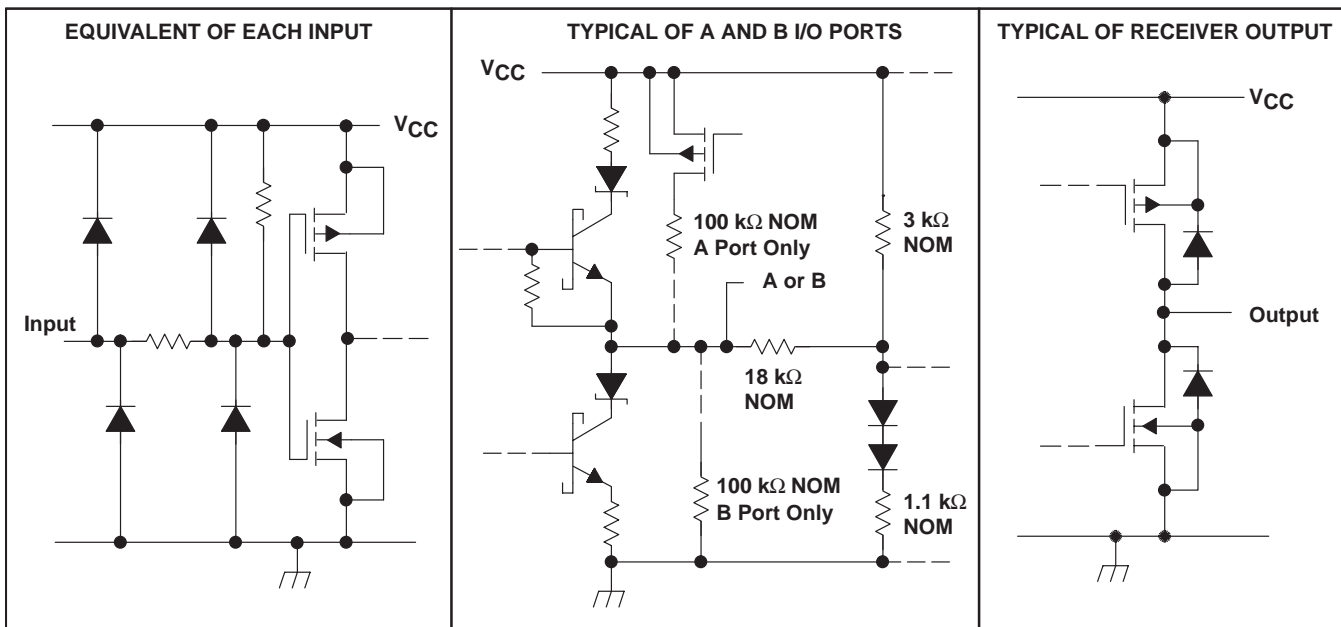
The SN65LBC176 combines a 3-state, differential line driver and a differential input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can externally connect together to function as a direction control.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



SN65LBC176-Q1 DIFFERENTIAL BUS TRANSCEIVER

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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	$T_A \leq 25^\circ\text{C}$ 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

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	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.



SN65LBC176-Q1

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		MIN	MAX	UNIT
V_{IK}	Input clamp voltage	$I_I = -18$ 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_{OD3}	Differential output voltage	$V_{test} = -7$ V to 12 V,	See Figure 2, See Note 3	1.1		V
$ V_{OD2} $	Differential output voltage	$R_L = 54$ Ω ,	See Figure 1, See Note 3	1.1		V
$\Delta V_{OD} $	Change in magnitude of differential output voltage [†]	$R_L = 54$ Ω or 100 Ω , See Figure 1		± 0.2		V
V_{OC}	Common-mode output voltage			± 0.2		V
$\Delta V_{OC} $	Change in magnitude of common-mode output voltage [†]			± 0.2		V
I_O	Output current	Output disabled, See Note 4	$V_O = 12$ V	1		mA
			$V_O = -7$ V	-0.8		
I_{IH}	High-level input current	$V_I = 2.4$ V		-100		μ A
I_{IL}	Low-level input current	$V_I = 0.4$ V		-100		μ A
I_{OS}	Short-circuit output current	$V_O = -7$ V		-250		mA
		$V_O = 0$		-150		
		$V_O = V_{CC}$		250		
		$V_O = 12$ 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	TYP [†]	MAX	UNIT
$t_{d(OD)}$	Differential output delay time	$R_L = 54$ Ω , See Figure 3	$C_L = 50$ pF,	8		31	ns
$t_t(OD)$	Differential output transition time			12		ns	
$t_{sk(p)}$	Pulse skew ($ t_{d(ODH)} - t_{d(ODL)} $)			6		ns	
t_{pZH}	Output enable time to high level	$R_L = 110$ Ω ,	See Figure 4	65		ns	
t_{pZL}	Output enable time to low level	$R_L = 110$ Ω ,	See Figure 5	65		ns	
t_{PHZ}	Output disable time from high level	$R_L = 110$ Ω ,	See Figure 4	105		ns	
t_{PLZ}	Output disable time from low level	$R_L = 110$ Ω ,	See Figure 5	105		ns	

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

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	$V_O = 2.7 V,$	$I_O = -0.4 mA$			0.2	V
V_{IT-}	Negative-going input threshold voltage	$V_O = 0.5 V,$	$I_O = 8 mA$	$-0.2\ddagger$			V
V_{hys}	Hysteresis voltage ($V_{IT+} - V_{IT-}$) (see Figure 4)				50		mV
V_{IK}	Enable-input clamp voltage	$I_I = -18 mA$				-1.5	V
V_{OH}	High-level output voltage	$V_{ID} = 200 mV,$	$I_{OH} = -400 \mu A,$		2.7		V
V_{OL}	Low-level output voltage	$V_{ID} = 200 mV,$	$I_{OL} = 8 mA,$			0.45	V
I_{OZ}	High-impedance-state output current	$V_O = 0.4 V$ to $2.4 V$				± 20	μA
I_I	Line input current	Other input = 0 V, See Note 5	$V_I = 12 V$			1	mA
			$V_I = -7 V$			-0.8	
I_{IH}	High-level enable-input current	$V_{IH} = 2.7 V$				-100	μA
I_{IL}	Low-level enable-input current	$V_{IL} = 0.4 V$				-100	μA
r_I	Input resistance			12			k Ω
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 $V_{CC} = 5 V, T_A = 25^\circ C.$

‡ 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.

SN65LBC176-Q1 DIFFERENTIAL BUS TRANSCEIVER

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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} 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	ns
t_{PHL} Propagation delay time, high- to low-level single-ended output		11	37	ns
$t_{sk(p)}$ Pulse skew ($ t_d(ODH) - t_d(ODL) $)			10	ns
t_{PZH} Output enable time to high level	See Figure 8		35	ns
t_{PZL} Output enable time to low level			35	ns
t_{PHZ} Output disable time from high level	See Figure 8		35	ns
t_{PLZ} Output disable time from low level			35	ns

PARAMETER MEASUREMENT INFORMATION

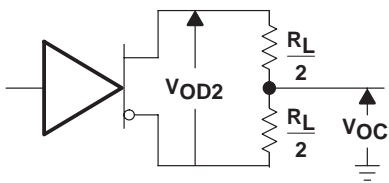


Figure 1. Driver V_{OD} and V_{OC}

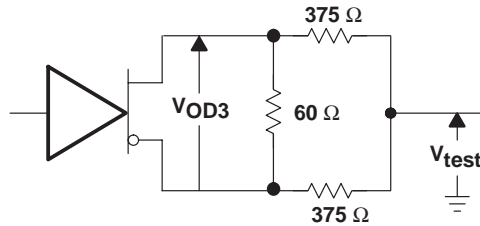
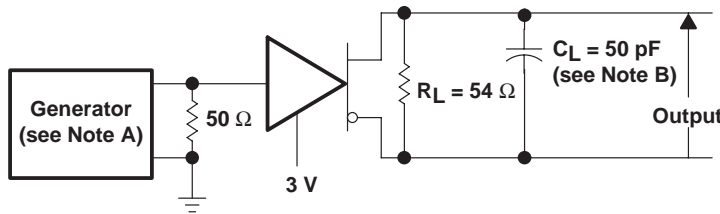
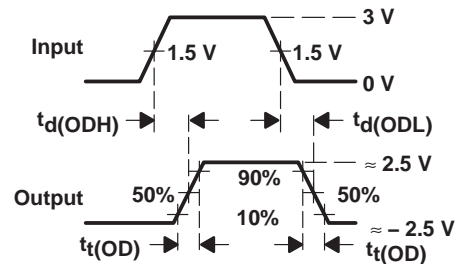


Figure 2. Driver V_{OD3}

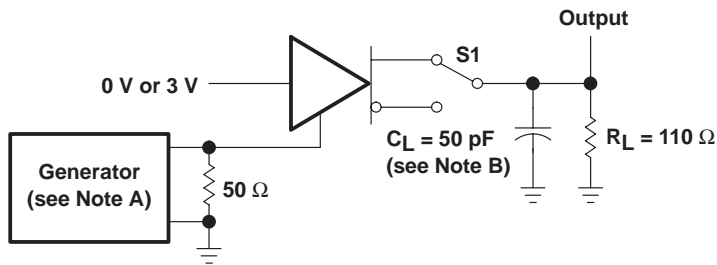


TEST CIRCUIT

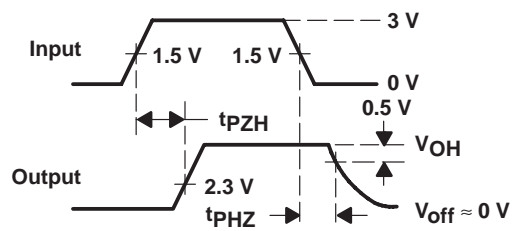


VOLTAGE WAVEFORMS

Figure 3. Driver Test Circuit and Voltage Waveforms



TEST CIRCUIT



VOLTAGE WAVEFORMS

Figure 4. Driver Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

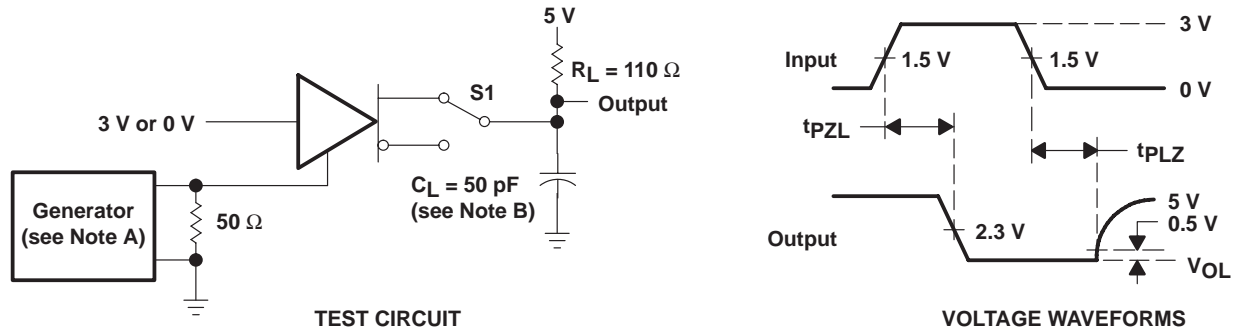


Figure 5. Driver Test Circuit and Voltage Waveforms

- 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.

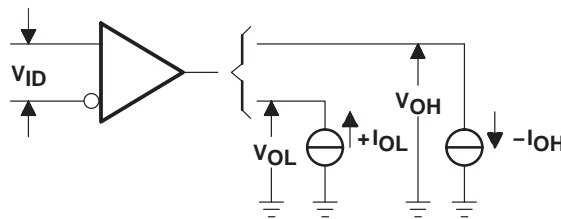
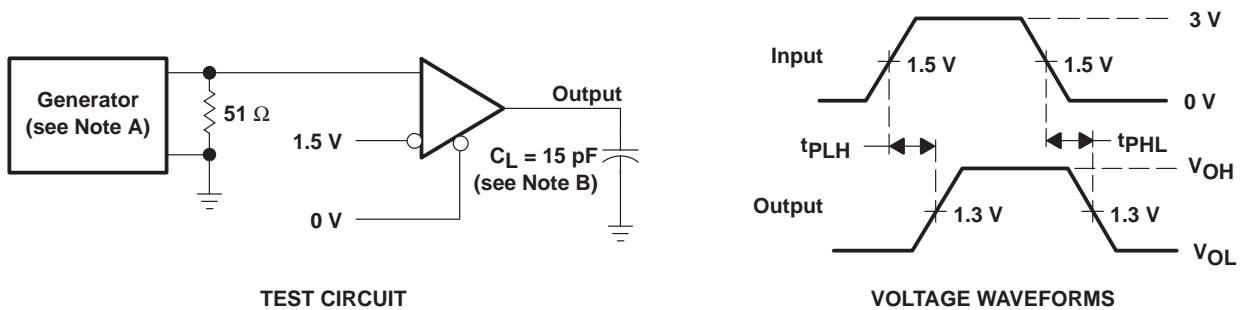


Figure 6. Receiver V_{OH} and V_{OL}



- 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

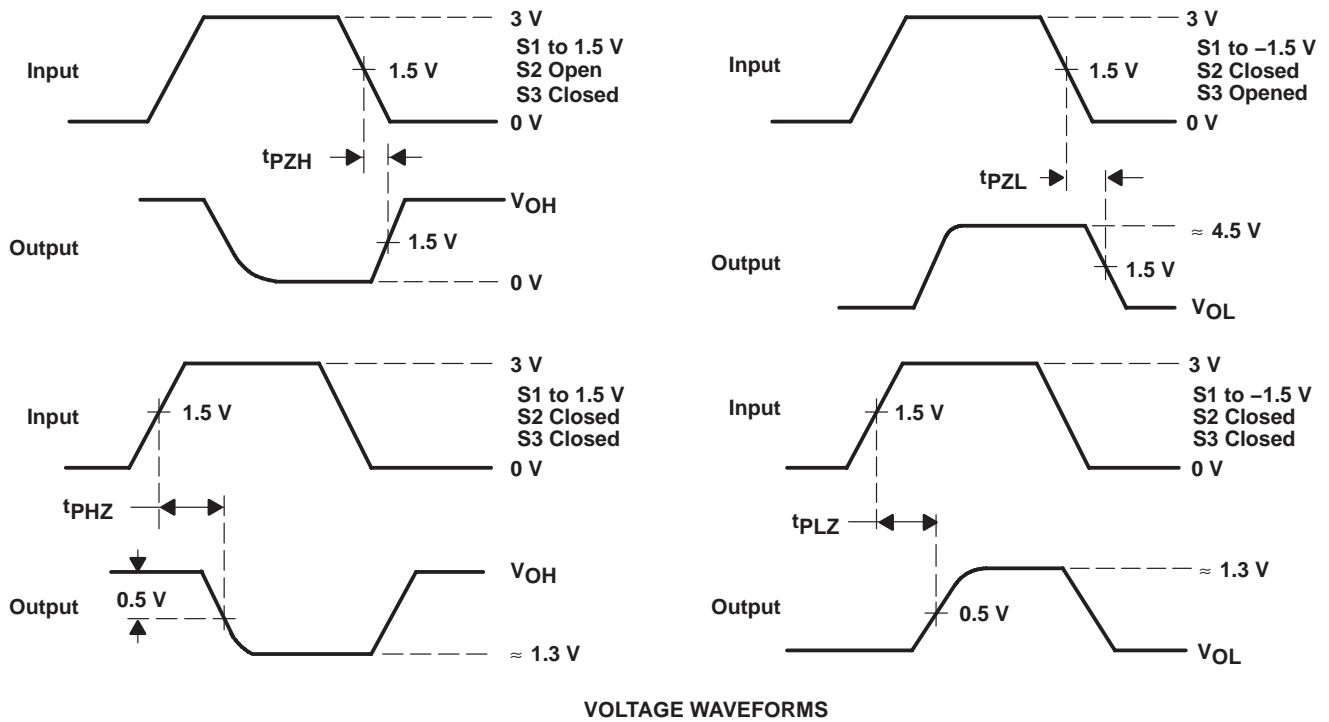
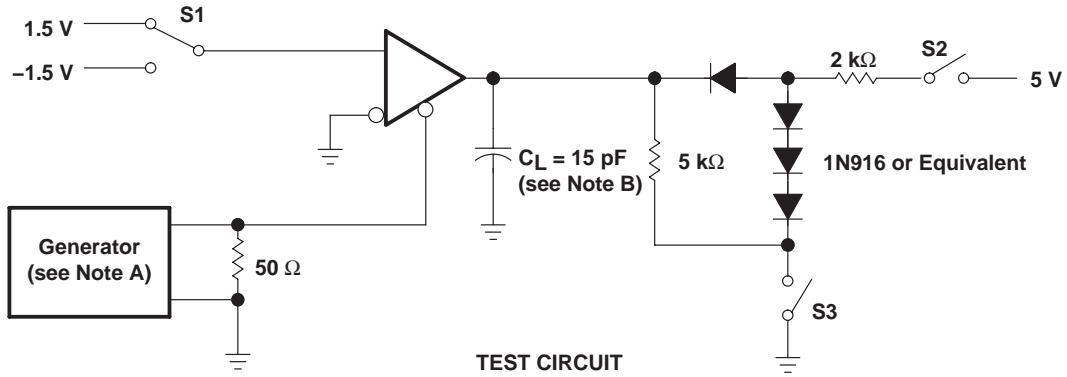


Figure 8. Receiver Test Circuit and Voltage Waveforms

- 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)	Top-Side Markings (4)	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-2-260C-1 YEAR	-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) Only one of markings shown within the brackets will appear on the physical device.

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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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*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

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.
 -  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.
 -  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.

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