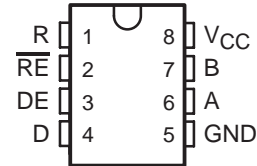


- Qualified for Automotive Applications
- Bidirectional Transceiver
- Meet or Exceed the Requirements of ANSI Standard RS-485 and ISO 8482:1987(E)
- High-Speed Low-Power LinBiCMOS™ Circuitry
- Designed for High-Speed Operation in Both Serial and Parallel Applications
- Low Skew
- Designed for Multipoint 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

**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†

| T_A | 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>.



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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SN65LBC176-Q1

DIFFERENTIAL BUS TRANSCEIVER

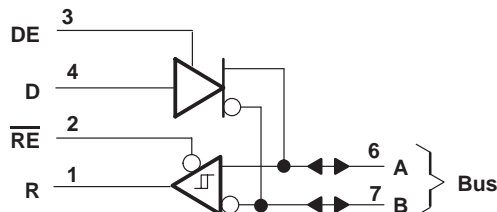
SGLS211A – OCTOBER 2003 – REVISED MAY 2008

description (continued)

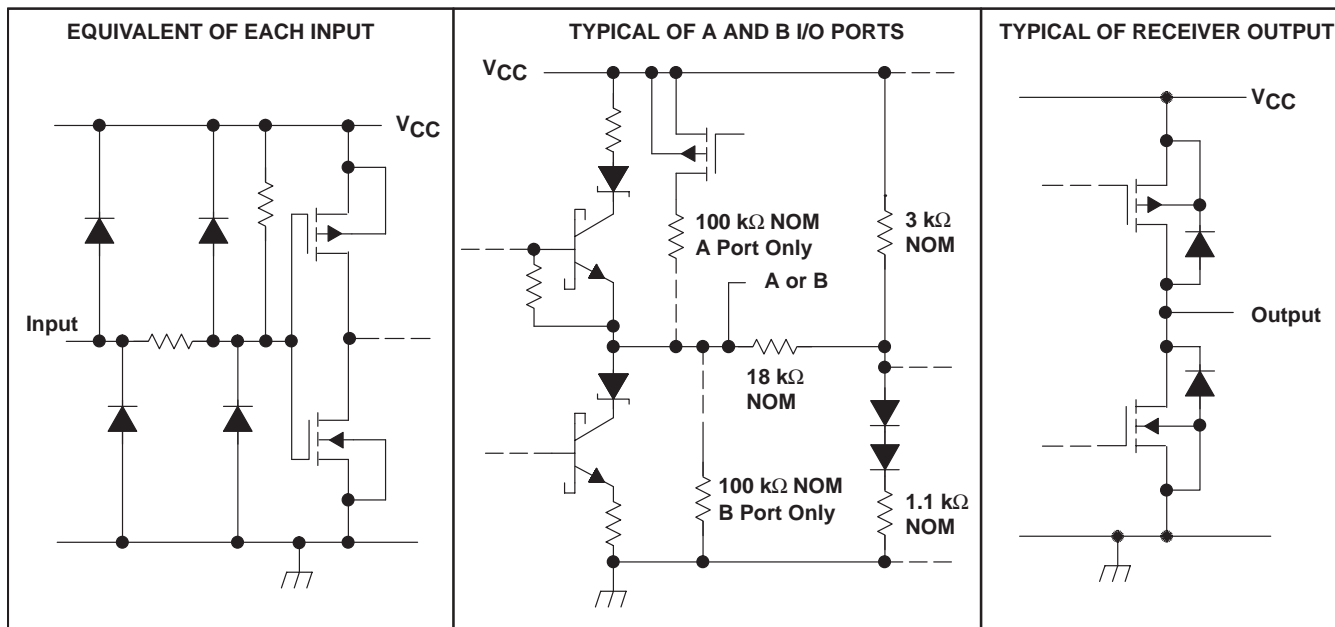
The SN65LBC176 combines a 3-state, differential line driver and a differential input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can externally connect together to function as a direction control.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



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 | | 3 | | V |
| | | -1 | | V |
| $\Delta V_{OC} $ Change in magnitude of common-mode output voltage [†] | $R_L = 54$ Ω or 100 Ω , See Figure 1 | ± 0.2 | | V |
| I_O Output current | | Output disabled, See Note 4 | $V_O = 12$ V | 1 |
| | | | $V_O = -7$ 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 |
| | | 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 , $C_L = 50$ pF, See Figure 3 | 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, $T_A = 25^\circ\text{C}$.



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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 | $V_O = 0.4 \text{ V to } 2.4 \text{ V}$ | | | ± 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 | | | k Ω |
| 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 | | 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 pF

| PARAMETER | TEST CONDITIONS | MIN | MAX | UNIT |
|---|--|-----|-----|------|
| t _{PLH} Propagation delay time, low- to high-level single-ended output | V _{ID} = –1.5 V to 1.5 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

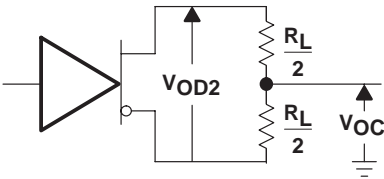


Figure 1. Driver V_{OD} and V_{OC}

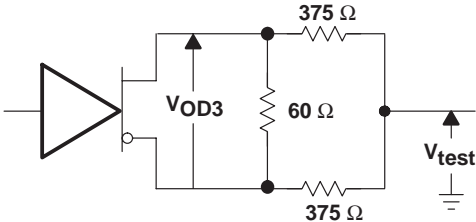
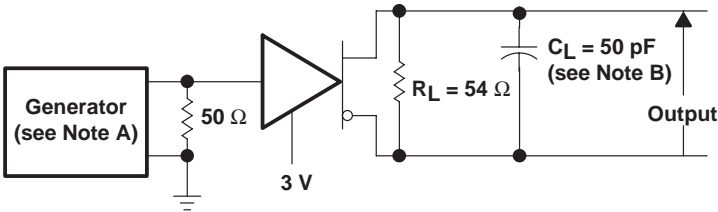
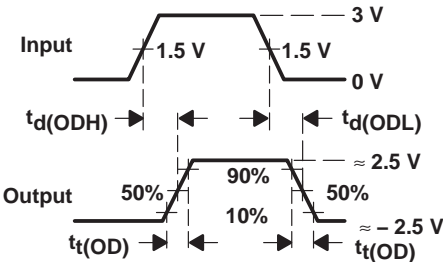


Figure 2. Driver V_{OD3}

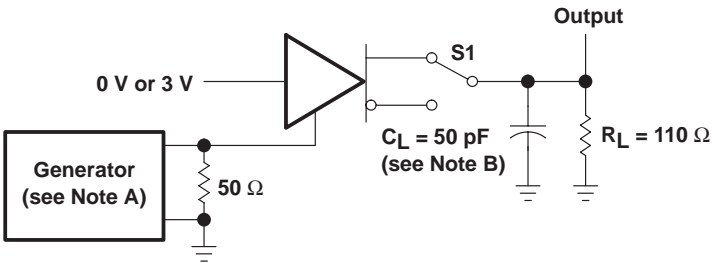


TEST CIRCUIT

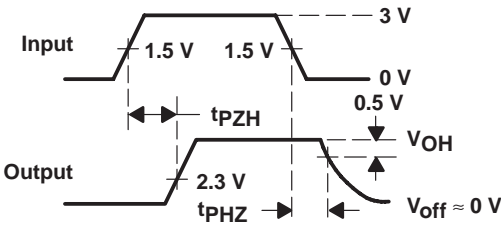


VOLTAGE WAVEFORMS

Figure 3. Driver Test Circuit and Voltage Waveforms



TEST CIRCUIT



VOLTAGE WAVEFORMS

Figure 4. Driver Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

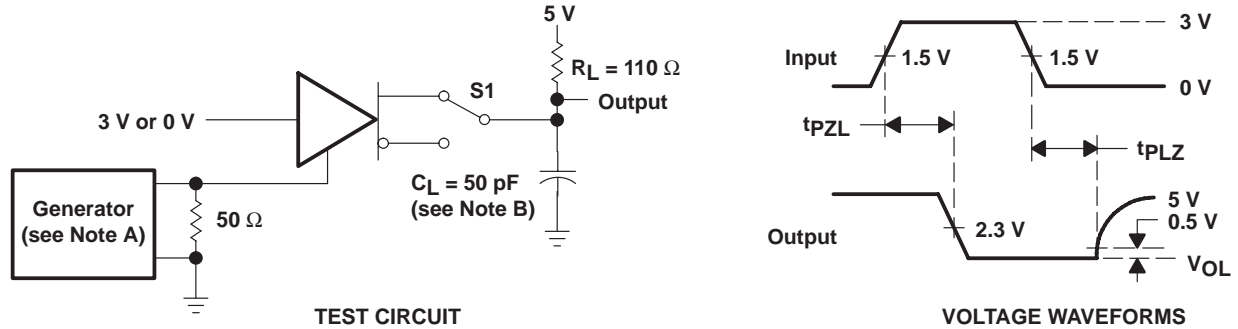


Figure 5. Driver Test Circuit and Voltage Waveforms

- 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.

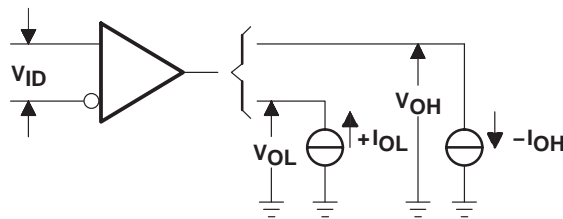
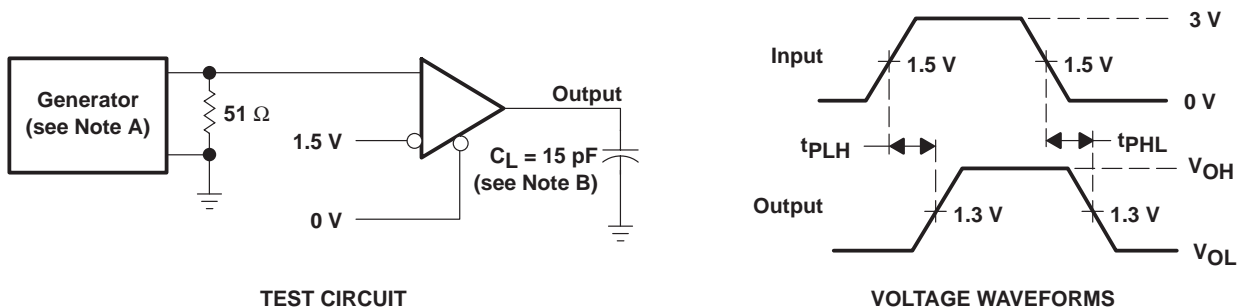


Figure 6. Receiver V_{OH} and V_{OL}



- 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

SN65LBC176-Q1

DIFFERENTIAL BUS TRANSCEIVER

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PARAMETER MEASUREMENT INFORMATION

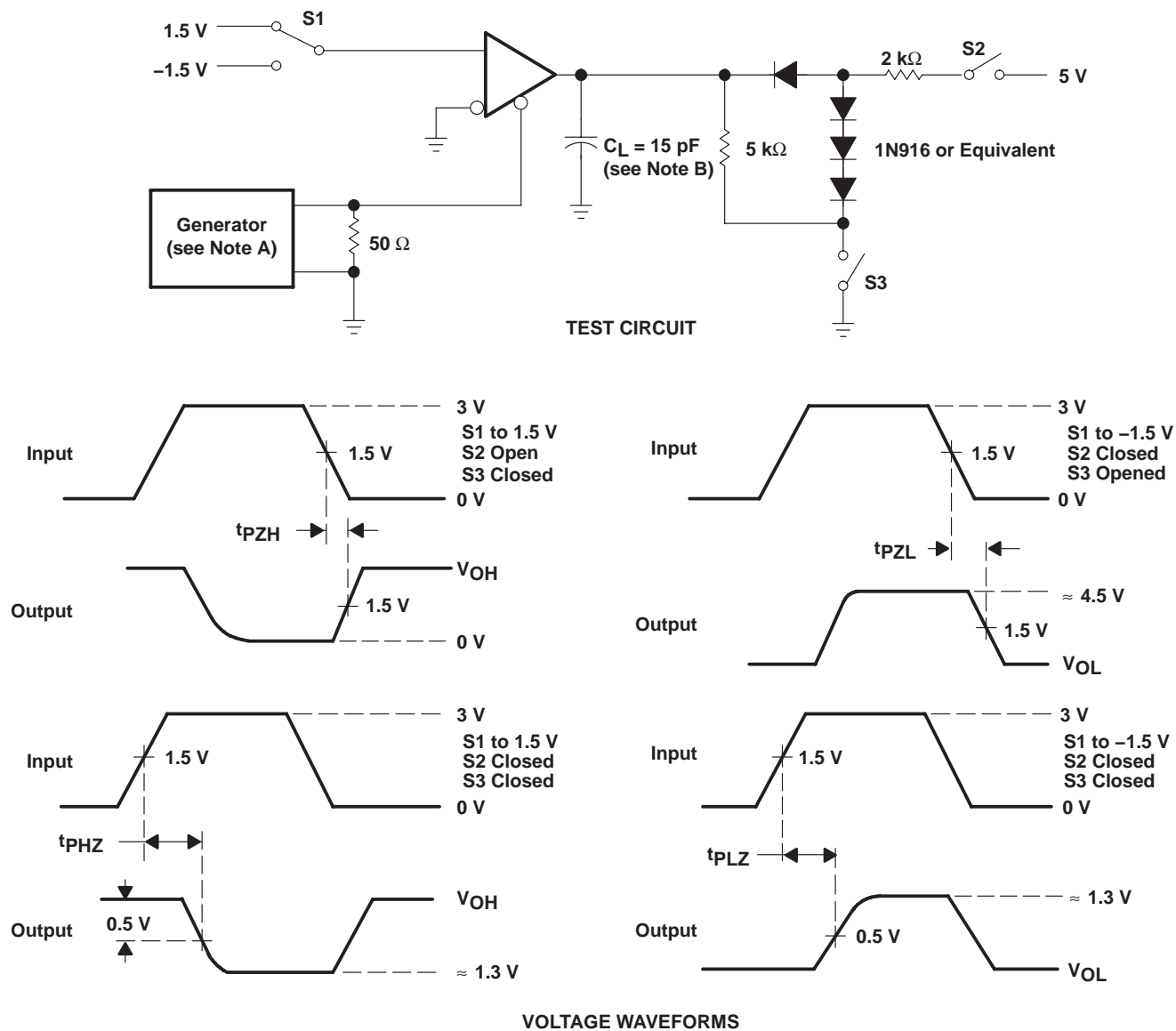


Figure 8. Receiver Test Circuit and Voltage Waveforms

- 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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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

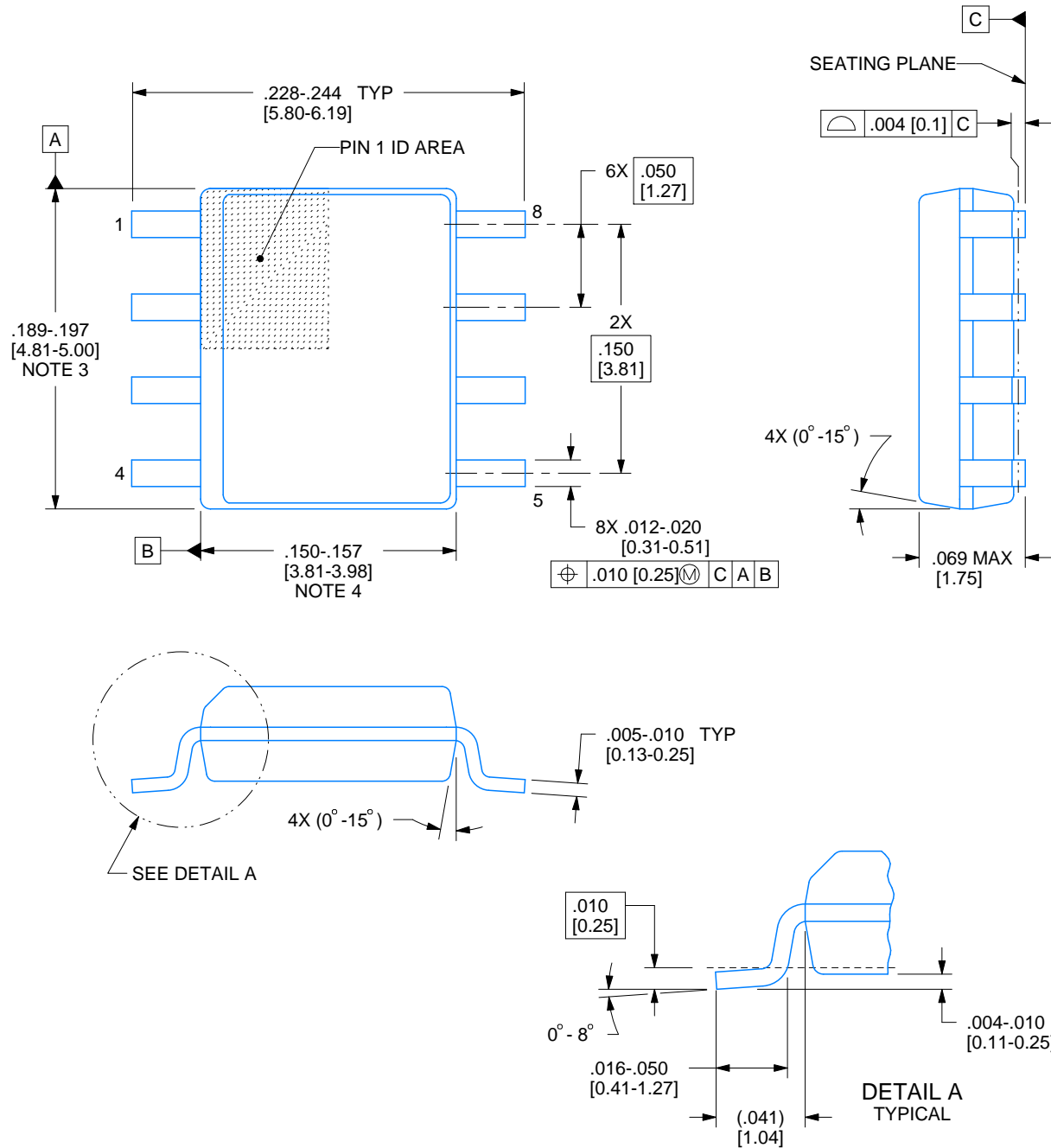
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN65LBC176QDRG4Q1 | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |

D0008A

PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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