钍地半导体
Tudi Semiconductor

# Product Specification

## TUDI-SN65LBC176A/SN75LBC176A

Differential bus transceiver

网址 www.sztdbdt.com

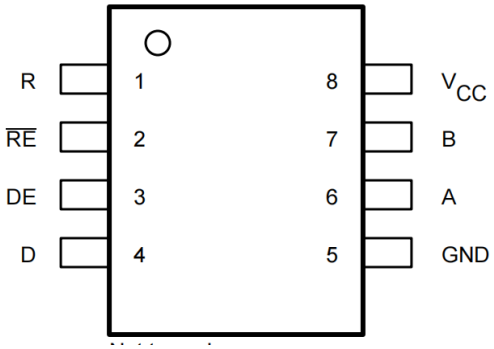
**用芯智造·卓越品质**

**semiconductor device manufacturer**

- Design
- research and development
- production
- and sales

## Features

●Designed for signal transmission rates up to 30Mbps 1
● Bus pin ESD protection exceeds 12kV HBM
● Complies with ANSI standards TIA/EIA-485-A and ISO 8482:1987(E)
●Low skew
● Suitable for multi-point transmission on long-distance bus lines in noisy environments
● Ultra-low disabled supply current requirement: 700 mA (max)
● Common-mode voltage range of -7V to 12V
● Thermal shutdown protection
● Driver positive and negative current limiting
●Open-circuit fail-safe receiver design
● Receiver input sensitivity: ±200mV (max)
● Receiver input hysteresis: 50mV (typ)
● Interference-free power-up and power-down protection
● Suitable for Q-grade temperature automotive
– High-reliability automotive applications
– Supports configuration control/printing
– Automotive standard certified



Top View

## Description

The SN65LBC176A, SN65LBC176AQ, and SN75LBC176A differential bus transceivers are monolithic integrated circuits designed for bidirectional data communication on multi-point bus transmission lines. These devices are designed for balanced transmission lines and comply with ANSI standards TIA/EIA-485-A and ISO 8482. Compared to previous generations, the A version provides higher switching performance without significantly increasing power consumption.
The SN65LBC176A, SN65LBC176AQ, and SN75LBC176A integrate a three-state differential line driver and a differential input line receiver, both of which are powered by a single 5V supply. The driver and receiver have high-level active and low-level active enable pins, respectively, which can be externally connected to be used for direction control. The driver differential outputs and receiver differential inputs are internally connected to form a differential input/output (I/O) bus port, which provides a minimum load to the bus when the driver is disabled or VCC = 0. This port has a wide positive and negative common-mode voltage range, making the device suitable for combined-line applications. Ultra-low device standby current can be achieved by disabling the driver and receiver.

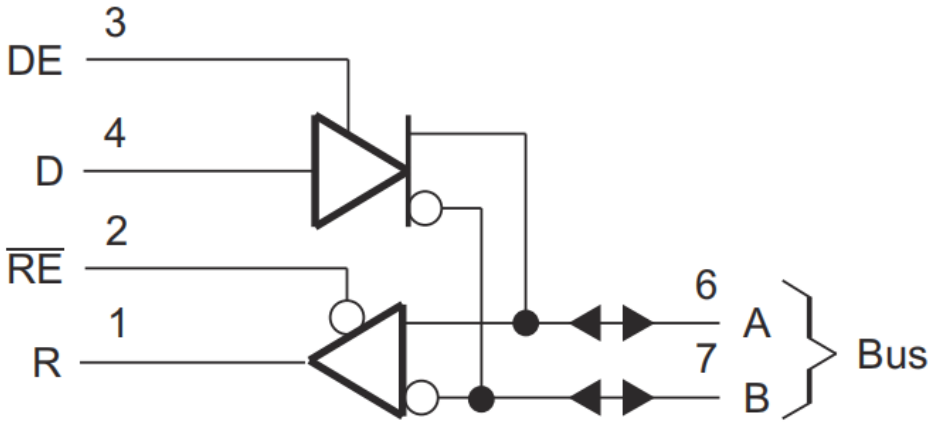



表 **4-1. Pin Functions**

| NO | NAME | TYPE | DESCRIPTION |
|---|---|---|---|
| 1 | R | O | Receive data output |
| 2 | $\overline{RE}$ | I | Receiver enable, active low |
| 3 | DE | I | Driver enable, active high |
| 4 | D | I | Driver data input |
| 5 | GND | GND | Device ground |
| 6 | A | I/O | Bus I/O port, A (complementary to B) |
| 7 | B | I/O | Bus I/O port, B(complementary to A) |
| 8 | $V_{CC}$ | P | 5 V Supply Pin |

# 5 Specifications

## 5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

| | | VALUE | UNIT |
|---|---|---|---|
| Supply voltage, $V_{CC}$ (2) | | – 0.3 to 6 | V |
| Voltage range at any bus terminal (A or B) | | – 10 to 15 | V |
| Input voltage, $V_I$ (D, DE, R, or $\overline{RE}$) | | – 0.3 to $V_{CC}$ + 0.5 | V |
| Electrostatic discharge: | Bus terminals and GND, Class 3, A: (3) | 12 | kV |
| | Bus terminals and GND, Class 3, B: (3) | 400 | V |
| | All terminals, Class 3, A | 3 | kV |
| | All terminals, Class 3, B | 400 | V |
| Continuous total power dissipation(4) | | See Dissipation Rating Table | |
| Storage temperature range, $T_{stg}$ | | – 65 to 150 | °C |

(1) 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.
(2) All voltage values, except differential I/O bus voltage, are with respect to network ground terminal.
(3) The maximum operating junction temperature is internally limited. Use the dissipation rating table to operate below this temperature.
(4) Tested in accordance with MIL-STD-883C, Method 3015.7

## 5.2 Dissipation Ratings

| PACKAGE | $T_A \leq 25°C$ POWER RATING | DERATING FACTOR(1) ABOVE $T_A = 25°C$ | $T_A = 70°C$ POWER RATING | $T_A = 85°C$ POWER RATING | $T_A = 125°C$ POWER RATING |
|---|---|---|---|---|---|
| D | 725 mW | 5.5 mW/°C | 464 mW | 377 mW | 145 mW |
| P | 1000 mW | 8.0 mW/°C | 640 mW | 520 mW | — |

(1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.

## 5.3 Recommended Operating Conditions

| | | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | 4.75 | 5 | 5.25 | V |
| $V_I$ or $V_{IC}$ | Voltage at any bus terminal (separately or common mode) | | – 7 | | 12 | V |
| $V_{IH}$ | High-level input voltage | D, DE, and $\overline{RE}$ | 2 | | $V_{CC}$ | V |
| $V_{IL}$ | Low-level input voltage | D, DE, and $\overline{RE}$ | 0 | | 0.8 | V |
| $V_{ID}$ | Differential input voltage(2) | | – 12(1) | | 12 | V |
| $I_{OH}$ | High-level output current | Driver | – 60 | | | mA |
| | | Receiver | – 8 | | | |
| $I_{OL}$ | Low-level output current | Driver | | | 60 | mA |
| | | Reciever | | | 8 | |
| $T_A$ | Operating free-air temperature | SN65LBC176AQ | – 40 | | 125 | °C |
| | | SN65LBC176A | – 40 | | 85 | |
| | | SN75LBC176A | 0 | | 70 | |

(1) The algebraic convention, in which the least positive (most negative) limit is designated as minimum, is used in this data sheet.
(2) Differential input /output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.

## 5.4 Thermal Information

| THERMAL METRIC(1) | | All Devices in 'P' Package | SN65LBC176ADR SN65LBC176AQDR | OPNs Not Listed in Previous Column | UNIT |
|---|---|---|---|---|---|
| | | P (PDIP) | D (SOIC) | D (SOIC) | |
| | | 8-Pins | 8-Pins | 8-Pins | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 65.7 | 116.7 | 110 | °C/W |
| $R_{\theta JC}$ | Junction-to-case thermal resistance | 54.7 | 56.3 | 44.1 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 42.1 | 63.4 | 53.5 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 23 | 8.8 | 4.8 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 41.7 | 62.9 | 52.7 | °C/W |

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC package thermal metrics* application report.

## 5.5 Driver Electrical Characteristics

over recommended operating conditions (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | MIN | TYP(1) | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{IK}$ | Input clamp voltage | $I_I$ = − 18 mA | | − 1.5 | − 0.8 | | V |
| $\lvert V_{OD} \rvert$ | Differential output voltage | $I_O$ = 0 | SN65LBC176AQ | 1.5 | 4 | 6 | V |
| | | | SN65LBC176A, SN75LBC176A | | 4 | | |
| | | $R_L$ = 54 Ω, See 图 6-1 | SN65LBC176AQ | 0.9 | 1.5 | 6 | V |
| | | | SN65LBC176A | 1 | 1.5 | 3 | |
| | | | SN75LBC176A | 1.1 | 1.5 | 3 | |
| | | $V_{test}$ = − 7 to 12 V, See 图 6-2 | SN65LBC176AQ | 0.9 | 1.5 | 6 | V |
| | | | SN65LBC176A | 1 | 1.5 | 3 | |
| | | | SN75LBC176A | 1.1 | 1.5 | 3 | |
| $\Delta \lvert V_{OD} \rvert$ | Change in magnitude of differential output voltage | See 图 6-1 and 图 6-2 | | − 0.2 | | 0.2 | V |
| $V_{OC(SS)}$ | Steady-state common-mode output voltage | See 图 6-1 | SN65LBC176AQ | 1.8 | 2.4 | 3 | V |
| | | | SN65LBC176A, SN75LBC176A | 1.8 | 2.4 | 2.8 | |
| $\Delta V_{OC(SS)}$ | Change in steady-state common-mode output voltage | | SN65LBC176AQ | − 0.2 | | 0.2 | V |
| | | | SN65LBC176A, SN75LBC176A | − 0.1 | | 0.1 | |
| $I_{OZ}$ | High-impedance output current | See receiver input currents | | | | | |
| $I_{IH}$ | High-level enable input current | $V_I$ = 2 V | | − 100 | | | µA |
| $I_{IL}$ | Low-level enable input current | $V_I$ = 0.8 V | | − 100 | | | µA |
| $I_{OS}$ | Short-circuit output current | − 7 V ≤ $V_O$ ≤ 12 V | | − 250 | | 250 | mA |
| $I_{CC}$ | Supply current | $V_I$ = 0 or $V_{CC}$, No load | Receiver disabled and driver enabled | | 5 | 9 | mA |
| | | | Receiver disabled and driver disabled | | 0.4 | 0.7 | |
| | | | Receiver enabled and driver enabled | | 8.5 | 15 | |

(1) All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.

## 5.6 Driver Switching Characteristics

over recommended operating conditions (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | SN65LBC176AQ | | | SN65LBC176A SN75LBC176A | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP(1) | MAX | MIN | TYP(1) | MAX | |
| $t_{PLH}$ | Propagation delay time, low-to-high-level output | $R_L$ = 54 Ω, $C_L$ = 50 pF, See 图 6-3 | 2 | | 12 | 2 | 6 | 12 | ns |
| $t_{PHL}$ | Propagation delay time, high-to-low-level output | | 2 | | 12 | 2 | 6 | 12 | ns |
| $t_{sk(p)}$ | Pulse skew ( \| $t_{PLH}$ – $t_{PHL}$ \| ) | | | | 2 | | 0.3 | 1 | ns |
| $t_r$ | Differential output signal rise time | | 1.2 | | 11 | 4 | 7.5 | 11 | ns |
| $t_f$ | Differential output signal fall time | | 1.2 | | 11 | 4 | 7.5 | 11 | ns |
| $t_{PZH}$ | Propagation delay time, high-impedance-to-high-level output | $R_L$ = 110 Ω, See 图 6-4 | | | 22 | | 12 | 22 | ns |
| $t_{PZL}$ | Propagation delay time, high-impedance-to-low- level output | $R_L$ = 110 Ω, See 图 6-5 | | | 25 | | 12 | 22 | ns |
| $t_{PHZ}$ | Propagation delay time, high-level-to-high- impedance output | $R_L$ = 110 Ω, See 图 6-4 | | | 22 | | 12 | 22 | ns |
| $t_{PLZ}$ | Propagation delay time, low-level-to-high- impedance output | $R_L$ = 110 Ω, See 图 6-5 | | | 22 | | 12 | 22 | ns |

(1) All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.

## 5.7 Receiver Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP(1) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{IT+}$ | Positive-going input threshold voltage | $I_O$ = – 8 mA | | | | | 0.2 | V |
| $V_{IT-}$ | Negative-going input threshold voltage | $I_O$ = 8 mA | | | – 0.2 | | | V |
| $V_{hys}$ | Hysteresis voltage (VIT + - VIT -) | | | | | 50 | | mV |
| $V_{IK}$ | Enable-input clamp voltage | II = - 18 mA | | | – 1.5 | – 0.8 | | V |
| $V_{OH}$ | High-level output voltage | $V_{ID}$ = 200 mV, | $I_{OH}$ = – 8 mA, | See 图 6-6 | 4 | 4.9 | | V |
| $V_{OL}$ | Low-level output voltage | $V_{ID}$ = – 200 mV, | $I_{OH}$ = 8 mA, | See 图 6-6 | | 0.1 | 0.8 | V |
| $I_{OZ}$ | High-impedance-state output current | $V_O$ = 0 to $V_{CC}$ | | SN65LBC176AQ | – 10 | | 10 | μA |
| | | | | SN65LBC176A, SN75LBC176A | – 1 | | 1 | |
| $I_I$ | Bus input current | $V_{IH}$ = 12 V, | $V_{CC}$ = 5 V | Other input at 0 V | | 0.4 | 1 | mA |
| | | $V_{IH}$ = 12 V, | $V_{CC}$ = 0 | | | 0.5 | 1 | |
| | | $V_{IH}$ = – 7 V, | $V_{CC}$ = 5 V | | – 0.8 | – 0.4 | | |
| | | $V_{IH}$ = – 7 V, | $V_{CC}$ = 0 | | – 0.8 | – 0.3 | | |
| $I_{IH}$ | High-level enable-input current | $V_{IH}$ = 2 V | | | – 100 | | | μA |
| $I_{IL}$ | Low-level enable-input current | $V_{IL}$ = 0.8 V | | | – 100 | | | μA |
| $I_{CC}$ | Supply current | $V_I$ = 0 or $V_{CC}$, No load | Receiver enabled and driver disabled | | | 4 | 7 | mA |
| | | | Receiver disabled and driver disabled | | | 0.4 | 0.7 | |
| | | | Receiver enabled and driver enabled | | | 8.5 | 15 | |

(1) All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.

## 5.8 Receiver Switching Characteristics

over recommended operating conditions (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | SN65LBC176AQ | | | SN65LBC176A SN75LBC176A | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP(1) | MAX | MIN | TYP(1) | MAX | |
| $t_{PLH}$ | Propagation delay time output ↑ | $V_{ID}$ = – 1.5 V to 1.5 V, See 图 6-7 | 7 | | 30 | 7 | 13 | 20 | ns |
| $t_{PHL}$ | Propagation delay time output ↓ | | 7 | | 30 | 7 | 13 | 20 | ns |
| $t_{sk(p)}$ | Pulse skew ( \| $t_{PLH}$ – $t_{PHL}$ \| ) | | | | 6 | | 0.5 | 1.5 | ns |
| $t_r$ | Rise time, output | See 图 6-7 | | | 5 | | 2.1 | 3.3 | ns |
| $t_f$ | Fall time, output | | | | 5 | | 2.1 | 3.3 | ns |
| $t_{PZH}$ | Output enable time to high level | $C_L$ = 10 pF, See 图 6-8 | | | 50 | | 30 | 45 | ns |
| $t_{PZL}$ | Output enable time to low level | | | | 50 | | 30 | 45 | ns |
| $t_{PHZ}$ | Output disable time to high level | | | | 60 | | 20 | 40 | ns |
| $t_{PLZ}$ | Output disable time to low level | | | | 60 | | 20 | 40 | ns |

(1) All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.

## 参数测量信息

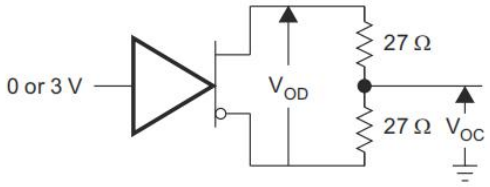



图 6-1. 驱动器 $V_{OD}$ 和 $V_{OC}$

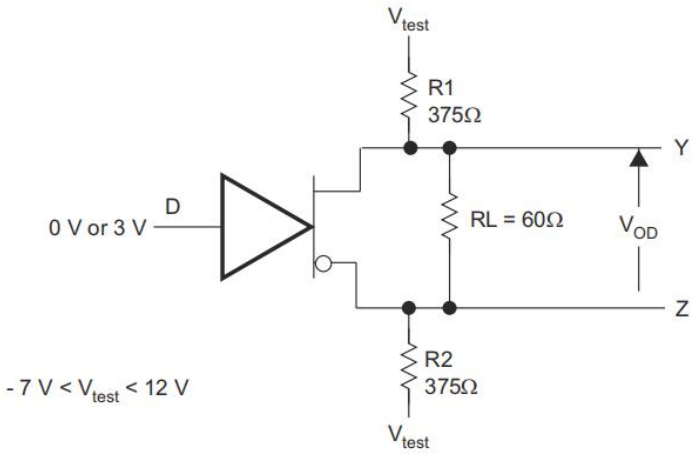
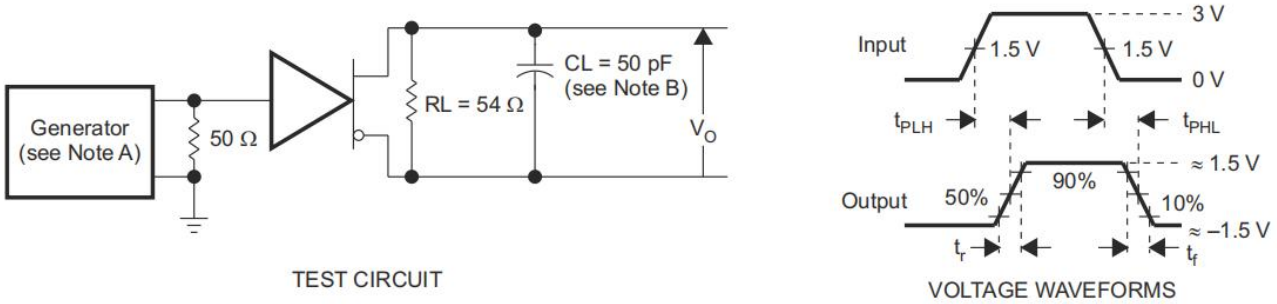


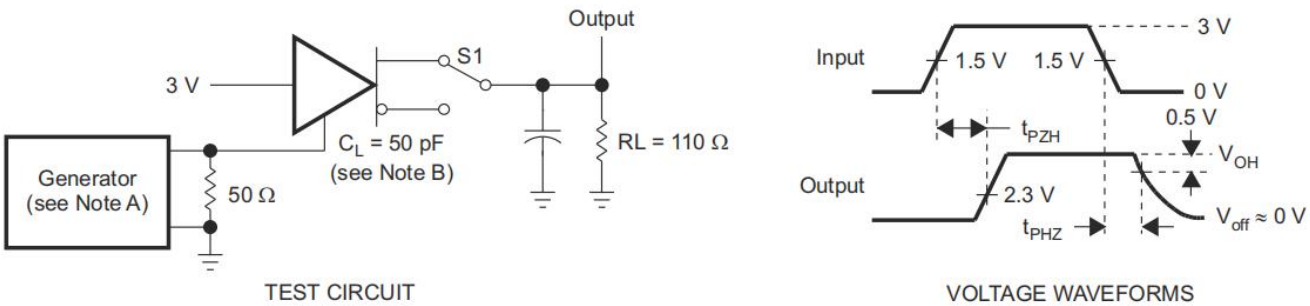

图 6-2. 驱动器 $V_{OD3}$




A. 输入脉冲由具有以下特性的发生器提供：PRR ≤ 1MHz，50% 占空比，$t_r$ ≤ 6ns，$t_f$ ≤ 6ns，$Z_O$ = 50Ω。

B. $C_L$ 包括探头和夹具电容。

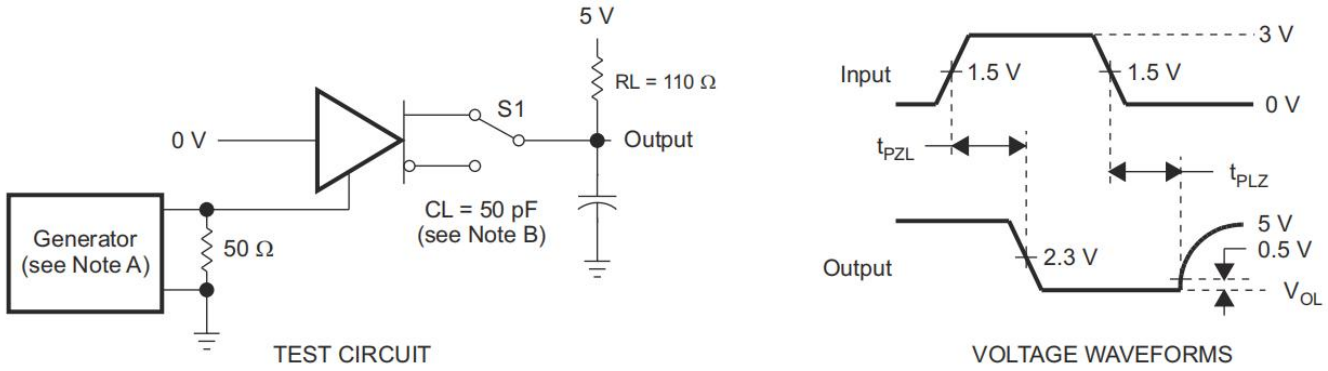
图 6-3. 驱动器测试电路和电压波形




A. 输入脉冲由具有以下特性的发生器提供：PRR ≤ 1MHz，50% 占空比，$t_r$ ≤ 6ns，$t_f$ ≤ 6ns，$Z_O$ = 50Ω。

B. $C_L$ 包括探头和夹具电容。

图 6-4. 驱动器测试电路和电压波形




A. 输入脉冲由具有以下特性的发生器提供：PRR ≤ 1MHz，50% 占空比，$t_r$ ≤ 6ns，$t_f$ ≤ 6ns，$Z_O$ = 50Ω。

B. $C_L$ 包括探头和夹具电容。

**图 6-5.** 驱动器测试电路和电压波形

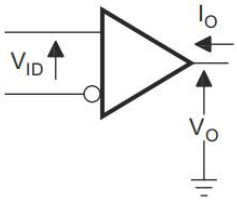
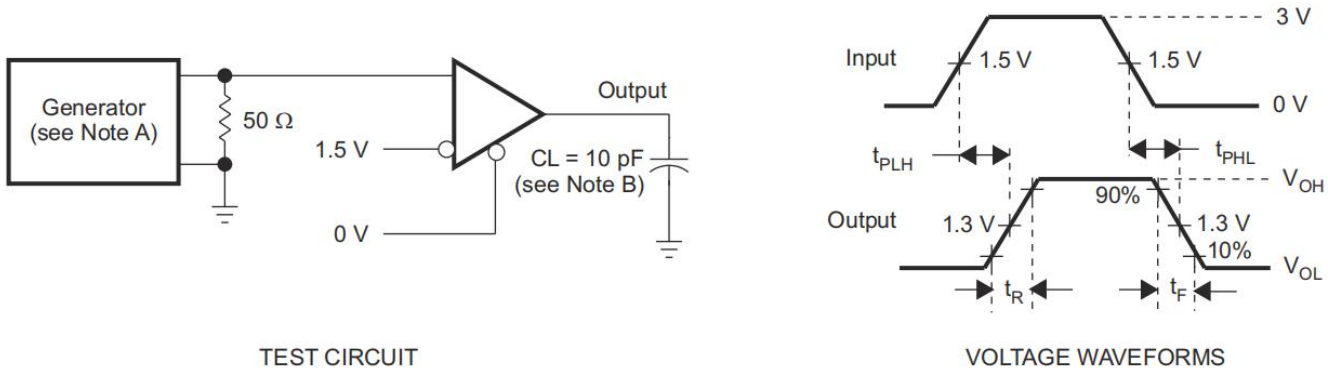


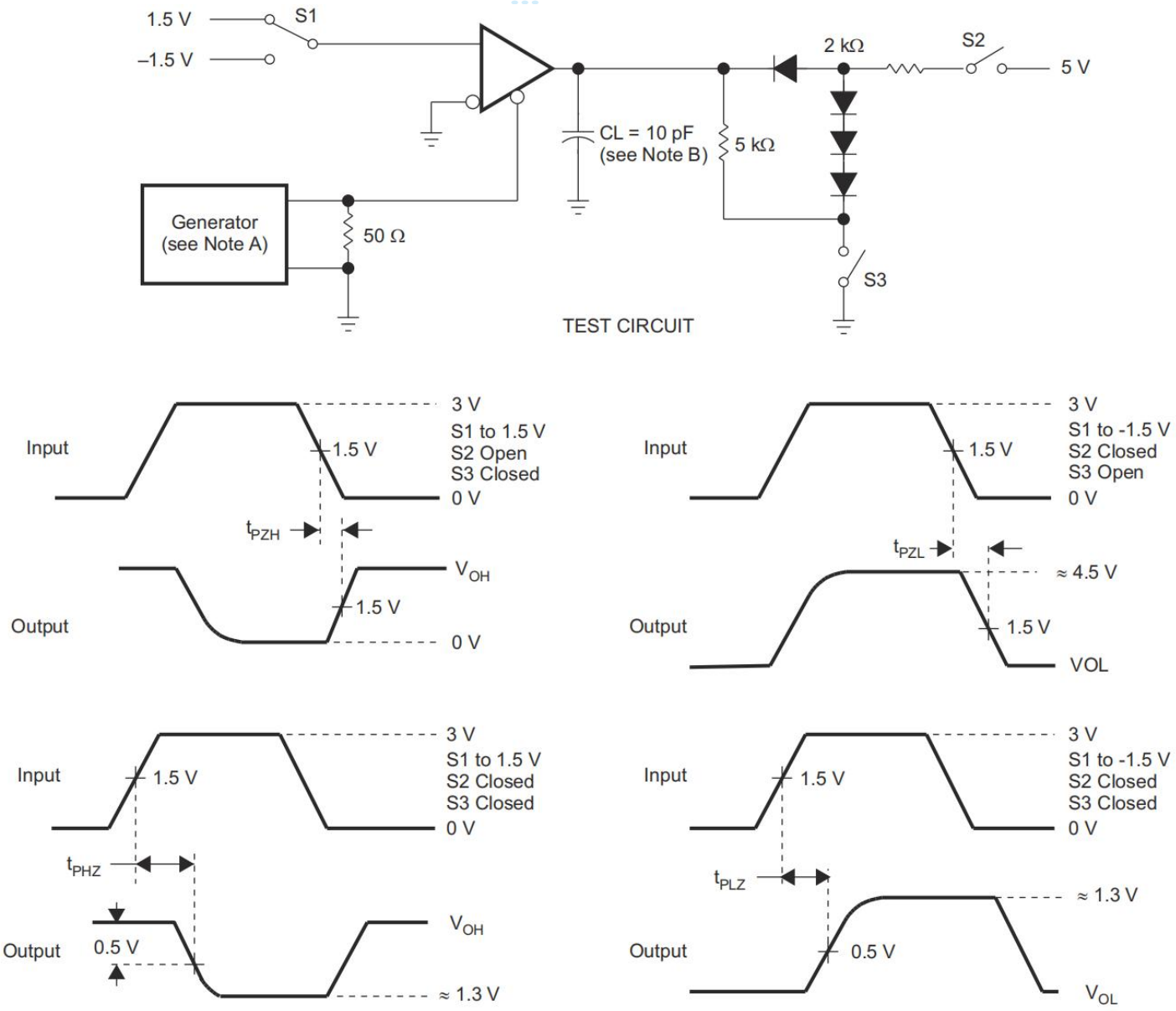

**图 6-6.** 接收器 $V_{OH}$ 和 $V_{OL}$




A. 输入脉冲由具有以下特性的发生器提供：PRR ≤ 1MHz，50% 占空比，$t_r$ ≤ 6ns，$t_f$ ≤ 6ns，$Z_O$ = 50Ω。

B. $C_L$ 包括探头和夹具电容。

**图 6-7.** 接收器测试电路和电压波形




VOLTAGE WAVEFORMS

A. 输入脉冲由具有以下特性的发生器提供：PRR ≤ 1MHz，50% 占空比，$t_r$ ≤ 6ns，$t_f$ ≤ 6ns，$Z_O$ = 50Ω。

B. $C_L$ 包括探头和夹具电容。

**图 6-8. 接收器测试电路和电压波形**

# 6 Detailed Description

## 6.1 Device Functional Modes

### 6.1.1 Function Tables

| DRIVER | | | |
|---|---|---|---|
| INPUT D | ENABLE DE | OUTPUTS A | OUTPUTS B |
| H | H | H | L |
| L | H | L | H |
| X | L | Z | Z |
| Open | H | H | L |

| RECEIVER | | |
|---|---|---|
| DIFFERENTIAL INPUTS $V_A - V_B$ | ENABLE(1) $\overline{RE}$ | OUTPUT(1) 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 |

(1) H = high level, L - low level, ? = indeterminate, X = Irrelevant, Z = high impedance (off)

### 6.1.2 Schematics

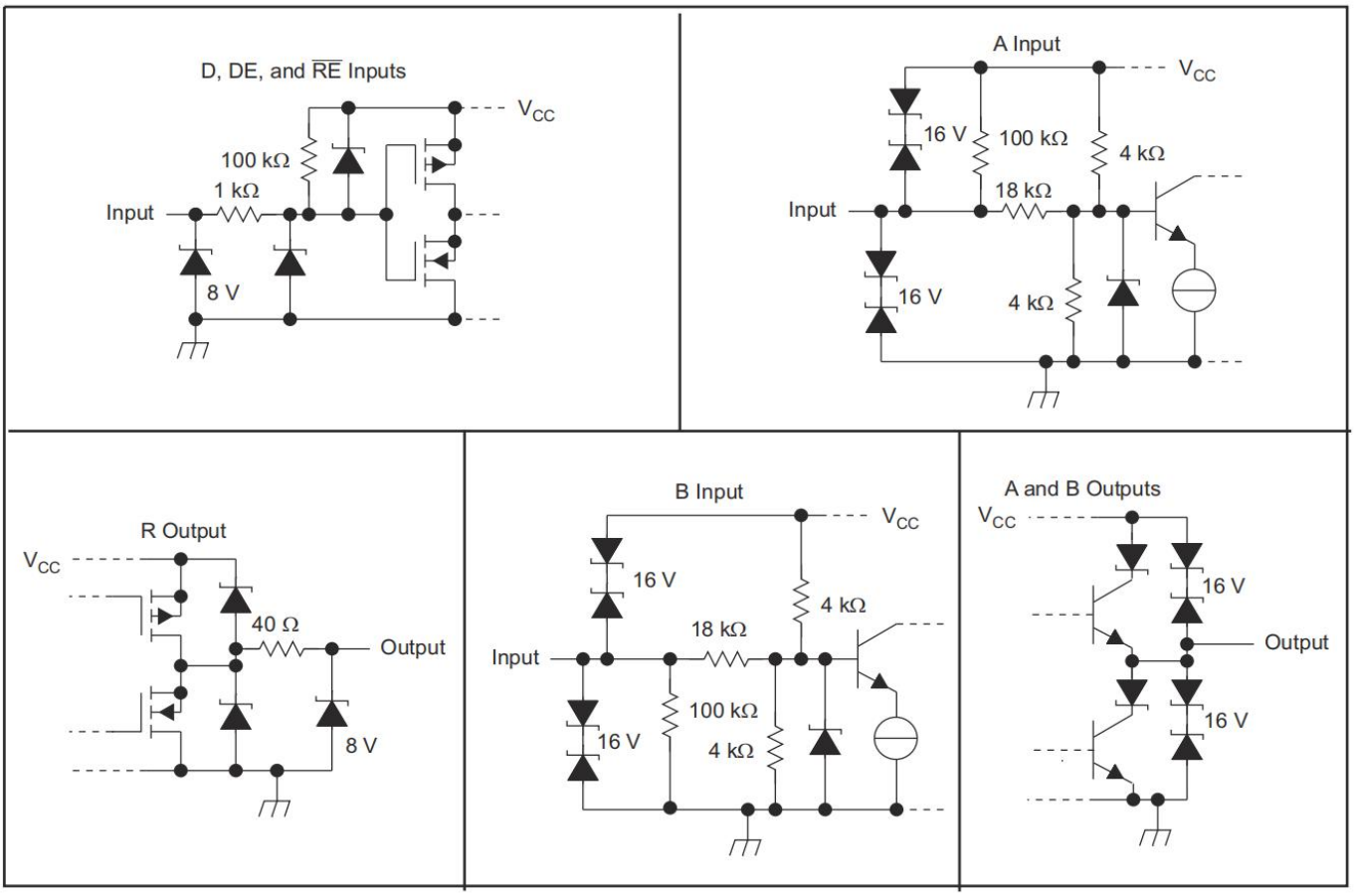
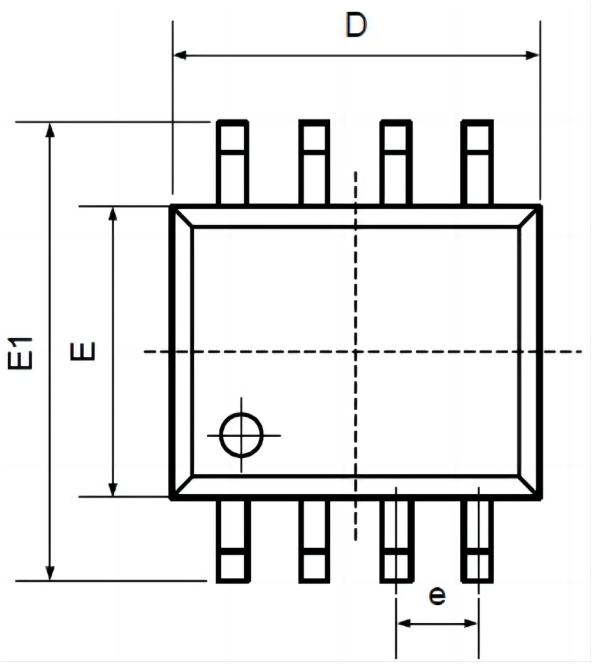


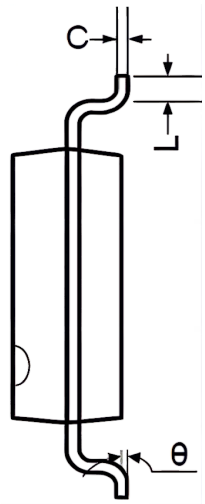

图 6-1. Schematics of Inputs and Outputs

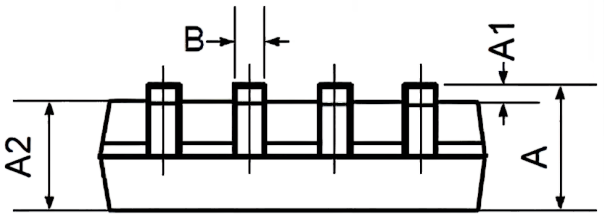
# Order information

| Order Number | Package | Package Quantity | Marking On The park |
|---|---|---|---|
| SN65LBC176ADR-TUDI | SOP8 | Tape,Reel,2500 | SN65LBC176ADR |
| SN65LBC176DR-TUDI | SOP8 | Tape,Reel,2500 | SN65LBC176DR |
| SN65LBC176P-TUDI | DIP8 | Tube,50,A box of 2000 | SN65LBC176P |
| SN65LBC176QDR-TUDI | SOP8 | Tape,Reel,2500 | SN65LBC176QDR |
| SN75LBC176ADR-TUDI | SOP8 | Tape,Reel,2500 | SN75LBC176ADR |
| SN75LBC176DR-TUDI | SOP8 | Tape,Reel,2500 | SN75LBC176DR |
| SN75LBC176P-TUDI | DIP8 | Tube,50,A box of 2000 | SN75LBC176P |

# Package SOP8

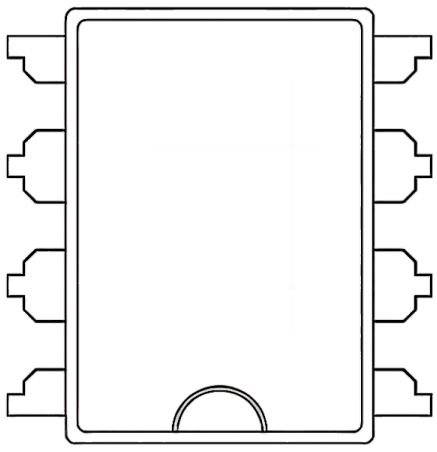


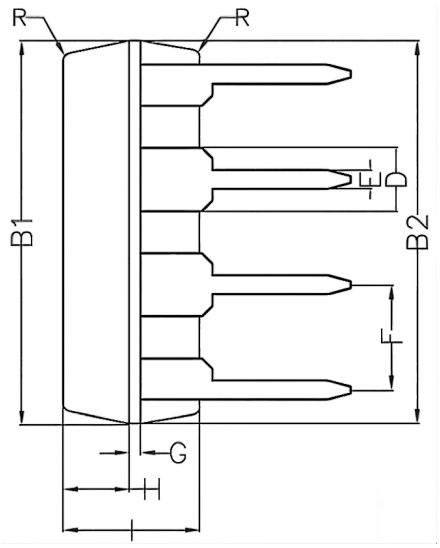



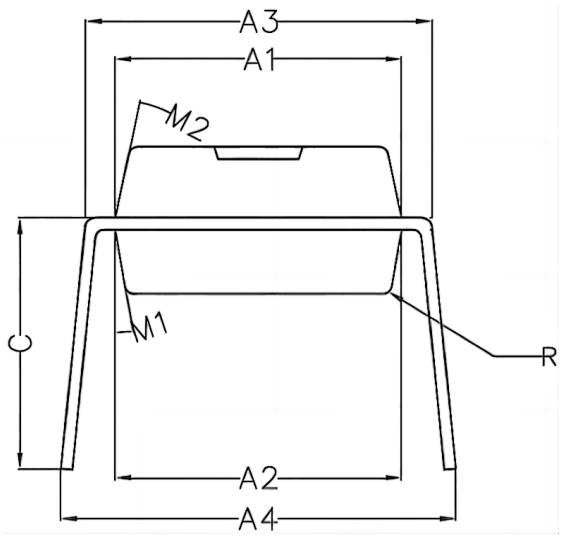




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| B | 0.330 | 0.510 | 0.013 | 0.020 |
| C | 0.190 | 0.250 | 0.007 | 0.010 |
| D | 4.780 | 5.000 | 0.188 | 0.197 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.300 | 0.228 | 0.248 |
| e | 1.270TYP | | 0.050TYP | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

# Package DIP8






| Symbol | Min | Non | Max |
|---|---|---|---|
| A1 | 6.28 | 6.33 | 6.38 |
| A2 | 6.33 | 6.38 | 6.43 |
| A3 | 7.52 | 7.62 | 7.72 |
| A4 | 7.80 | 8.40 | 9.00 |
| B1 | 9.15 | 9.20 | 9.25 |
| B2 | 9.20 | 9.25 | 9.30 |
| C | | 5.57 | |
| D | | 1.52 | |
| E | 0.43 | 0.45 | 0.47 |
| F | | 2.54 | |
| G | | 0.25 | |
| H | 1.54 | 1.59 | 1.64 |
| 工 | 3.22 | 3.27 | 3.32 |
| R | | 0.20 | |
| M1 | 9° | 10° | 11° |
| M2 | 11° | 12° | 13° |

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