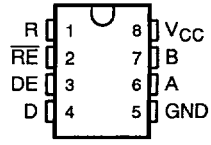
SLLS067B – D3502, AUGUST 1990 – REVISED FEBRUARY 1993

- **Bidirectional Transceiver**
- **Meets EIA 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 μA 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**
- **Operates From a Single 5-V Supply**
- **Glitch-Free Power-Up and Power-Down Protection**

D, JG, OR P PACKAGE
(TOP VIEW)



Function Tables

DRIVER

INPUT	ENABLE	OUTPUTS	
D	DE	A	B
H	H	H	L
L	H	L	H
X	L	Z	Z

RECEIVER

DIFFERENTIAL INPUTS A–B	ENABLE $\overline{RE}$	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, 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 EIA Standard RS-485 and ISO 8482:1987(E).

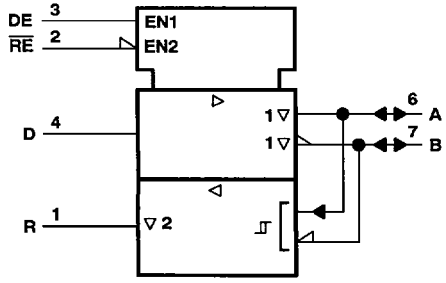
The SN65LBC176 and SN75LBC176 combine a 3-state differential-line driver and a differential-input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can be externally connected together to function as a direction control. The driver differential outputs and the receiver differential inputs are connected 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 RS-485 and ISO 8482:1987 (E) applications to the extent that they are specific in the operating conditions and characteristics section of this data sheet. Certain limits contained in the RS-485 and ISO 8482:1987 (E) are not met or cannot be tested over the entire military temperature range.

description (continued)

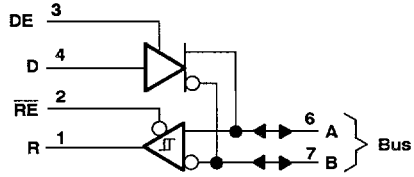
The SN55LBC176 is characterized for operation from −55°C to 125°C. The SN65LBC176 is characterized for operation from −40°C to 85°C, and the SN75LBC176 is characterized for operation from 0°C to 70°C.

logic symbol†

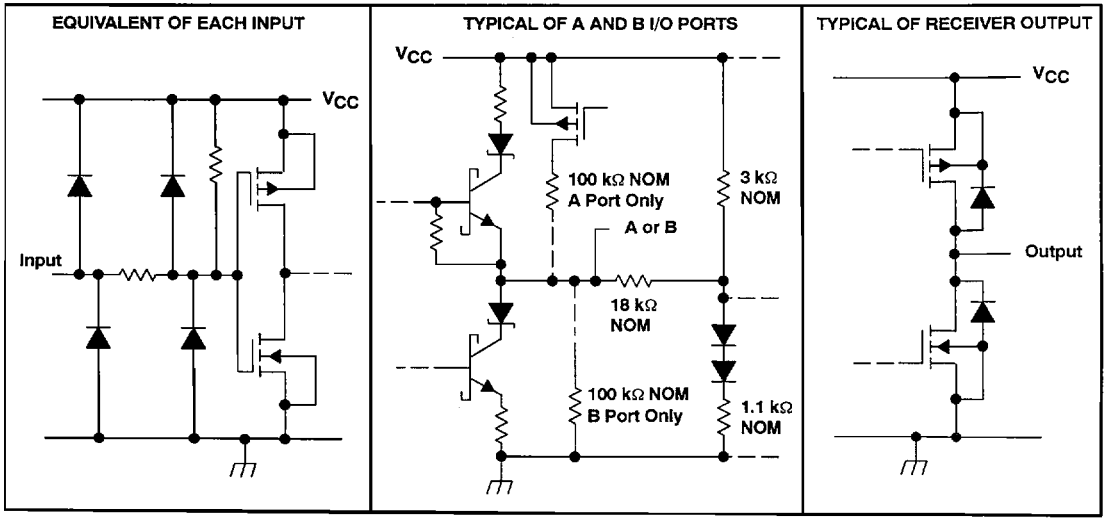


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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
Enable input voltage ..... 5.5 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
SN75LBC176 ..... 0°C to 70°C
Storage temperature range ..... −65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ..... 260°C

NOTE 1: All voltage values, except differential I/O bus voltage, are with respect to network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR 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	5.8 mW/°C	464 mW	377 mW	—
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	336 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	—

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}	SN55LBC176	4.5	5	5.5	V
	SN65/75LBC176	4.75	5	5.25	
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	
	SN75LBC176	0		70	

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

DRIVER SECTION

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (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
$\lvert V_{OD1} \rvert$	Differential output voltage	$I_O = 0$			1.5	6	V
$\lvert V_{OD2} \rvert$	Differential output voltage	$R_L = 54\ \Omega$, See Note 3	See Figure 1,	55LBC176	1.1		V
				65LBC176	1.1		
				75LBC176	1.5	5	
V_{OD3}	Differential output voltage	$V_{test} = -7$ V to 12 V, See Note 3	See Figure 2,	55LCB176	1.1		V
				65LBC176	1		
				75LBC176	1.5	5	
$\Delta\lvert V_{OD} \rvert$	Change in magnitude of differential output voltage†	$R_L = 54\ \Omega$ or 100 Ω,	See Figure 1			±0.2	V
V_{OC}	Common-mode output voltage					3	V
						−1	
$\Delta\lvert V_{OC} \rvert$	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				20	μA
I_{IL}	Low-level input current	$V_I = 0.4$ V				−100	μA
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					
I_{CC}	Supply current	$V_I = 0$ or V_{CC}, No load	Receiver disabled and driver enabled	55LBC176		1.75	mA
				65LBC176		1.5	
				75LBC176			
			Receiver and driver disabled	55LBC176		0.25	
				65LBC176		0.2	
				75LBC176			

† $\Delta\lvert V_{OD} \rvert$ and $\Delta\lvert V_{OC} \rvert$ are the changes in magnitude of V_{OD} and V_{OC} respectively, that occur when the input is changed from a high level to a low level.

NOTES: 3. This device meets the RS485 V_{OD} requirements above 0°C only.
4. This applies for both power on and off; refer to EIA standard RS-485 for exact conditions.

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

PARAMETER		TEST CONDITIONS		SN55LBC176		SN65LBC176 SN75LBC176			UNIT
				MIN	MAX	MIN	TYP†	MAX	
t_{dD}	Differential-output delay time	R_L = 54 Ω, See Figure 3	C_L = 50 pF,	8	31	8		25	ns
$t_{sk(p)}$	Pulse skew ($\lvert t_{dDH} - t_{dDL} \rvert$)				6		0	6	ns
t_{PLH}	Propagation time, low-to-high-level single-ended output							26	ns
t_{PHL}	Propagation time, high-to-low-level single-ended output							26	ns
t_{PZH}	Output enable time to high level	R_L = 110 Ω,	See Figure 4		65			60	ns
t_{PZL}	Output enable time to low level	R_L = 110 Ω,	See Figure 5		65			60	ns
t_{PHZ}	Output disable time from high level	R_L = 110 Ω,	See Figure 4		105			60	ns
t_{PLZ}	Output disable time from low level	R_L = 110 Ω,	See Figure 5		105			60	ns

† All typical values are at V_{CC} = 5 V, T_A = 25°C.

SYMBOL EQUIVALENTS

DATA SHEET PARAMETER	RS-485
V_O	V_{oa}, V_{ob}
$\lvert V_{OD1} \rvert$	V_o
$\lvert V_{OD2} \rvert$	V_t (R_L = 54 Ω)
$\lvert V_{OD3} \rvert$	V_t (Test Termination Measurement 2)
$\Delta \lvert V_{OD} \rvert$	$\lvert\lvert V_t \rvert - \lvert \overline{V}_t \rvert\rvert$
V_{OC}	$\lvert V_{os} \rvert$
$\Delta \lvert V_{OC} \rvert$	$\lvert V_{os} - \overline{V}_{os} \rvert$
I_{OS}	
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_{T+}	Positive-going threshold voltage	V_O = 2.7 V,	I_O = −0.4 mA				0.2	V
V_{T-}	Negative-going threshold voltage	V_O = 0.5 V,	I_O = 8 mA		−0.2‡			V
V_{hys}	Hysteresis ($V_{T+} - V_{T-}$) (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, See Figure 6	I_{OH} = −400 µA,		2.7			V
V_{OL}	Low-level output voltage	V_{ID} = 200 mV, See Figure 6	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					20	µA
I_{IL}	Low-level enable-input current	V_{IL} = 0.4 V					−100	µA
r_i	Input resistance				12			kΩ
I_{CC}	Supply current	V_I = 0 or V_{CC}, No load	Receiver enabled and driver disabled				3.9	mA
			Receiver and driver disabled	SN55LBC176			0.25	mA
				SN65LBC176			0.2	
				SN75LBC176				

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 15 pF

PARAMETER		TEST CONDITIONS	SN55LBC176		SN65LBC176 SN75LBC176			UNIT
			MIN	MAX	MIN	TYP†	MAX	
t_{PLH}	Propagation time, low-to-high-level single-ended output	V_{ID} = −1.5 V to 1.5 V, See Figure 7	20	37	20		30	ns
t_{PHL}	Propagation time, high-to-low-level single-ended output		20	55	28		45	ns
$t_{sk(p)}$	Pulse skew ($\lvert t_{dDH} - t_{dDL} \rvert$)			22		10	18	ns
t_{PZH}	Output enable time to high level	See Figure 8		34			30	ns
t_{PZL}	Output enable time to low level			34			30	ns
t_{PHZ}	Output disable time from high level	See Figure 8		34			30	ns
t_{PLZ}	Output disable time from low level			34			30	ns

† All typical values are at V_{CC} = 5 V, T_A = 25°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 EIA Standard RS-485 for exact conditions.

PARAMETER MEASUREMENT INFORMATION

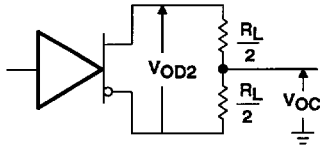


Figure 1. Driver V_{OD} and V_{OC}

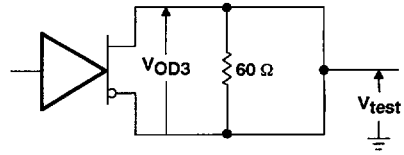


Figure 2. Driver V_{OD3}

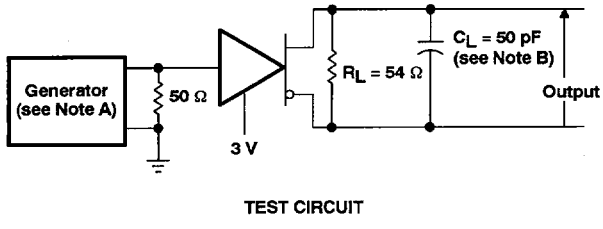


Figure 3. Driver Test Circuit and Voltage Waveforms

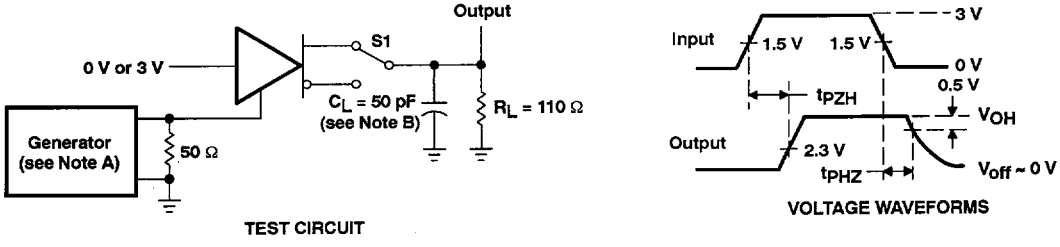


Figure 4. Driver Test Circuit and Voltage Waveforms

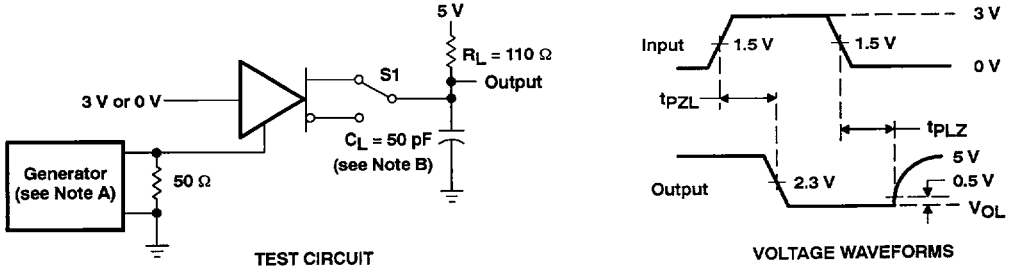


Figure 5. Driver Test Circuit and Voltage Waveforms

NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1 MHz, 50% duty cycle, t_r ≤ 6 ns, t_f ≤ 6 ns, Z_O = 50 Ω.
B. C_L includes probe and jig capacitance.

PARAMETER MEASUREMENT INFORMATION

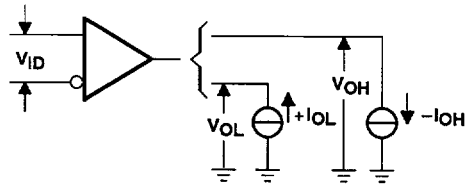


Figure 6. Receiver V_{OH} and V_{OL}

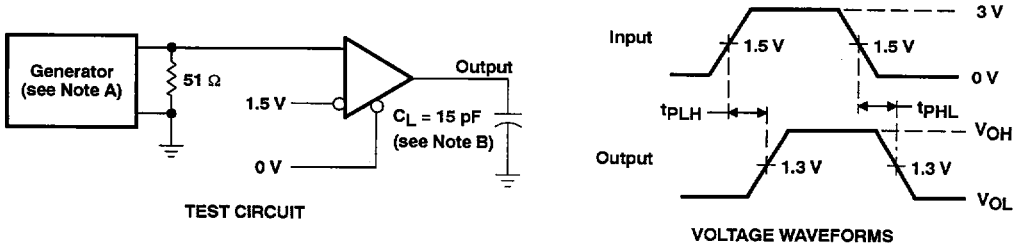


Figure 7. Receiver Test Circuit and Voltage Waveforms

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PARAMETER MEASUREMENT INFORMATION

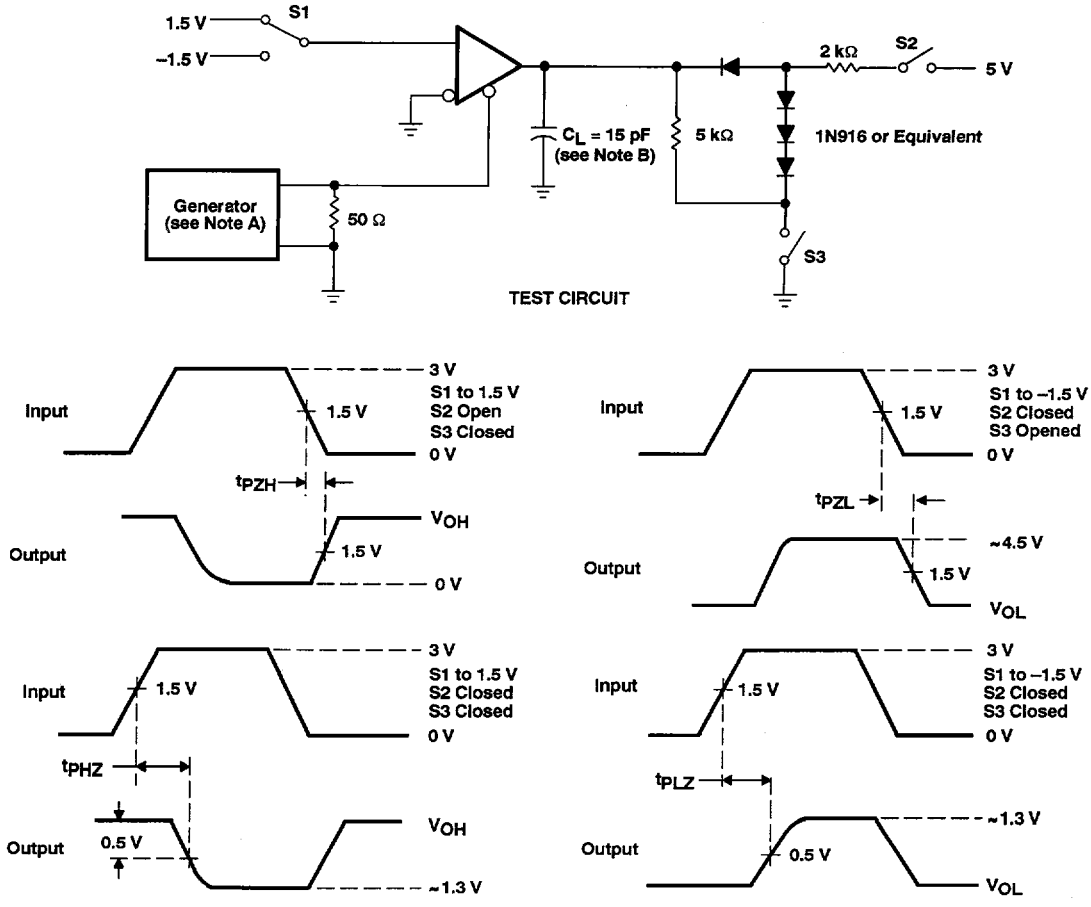

Figure 8. Receiver Test Circuit and Voltage Waveforms

NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1 MHz, 50% duty cycle, t_r ≤ 6 ns, t_f ≤ 6 ns, Z_O = 50 Ω.
B. C_L includes probe and jig capacitance.