National Semiconductor

DS96177
RS-485/RS-422 Differential Bus Repeater

General Description

The DS96177 Differential Bus Repeater is a monolithic integrated device designed for one-way data communication on multipoint bus transmission lines. This device is designed for balanced transmission bus line applications and meets EIA Standard RS-485 and RS-422A. The device is designed to improve the performance of the data communication over long bus lines. The DS96177 has an active high Enable.

The DS96177 features positive and negative current limiting and TRI-STATE® outputs for the receiver and driver. The receiver features high input impedance, input hysteresis for increased noise immunity, and input sensitivity of 200 mV over a common mode input voltage range of −12V to +12V. The driver features thermal shutdown for protection from line fault conditions. Thermal shutdown is designed to occur at a junction temperature of approximately 160°C. The driver is designed to drive current loads up to 60 mA maximum.

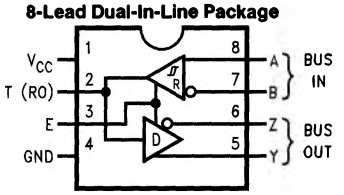
The DS96177 is designed for optimum performance when used on transmission buses employing the DS96172 and DS96174 differential line drivers, DS96173 and DS96175 differential line receivers, or DS96176 differential bus transceivers.

Features

- Meets EIA Standard RS-422A and RS-485
- Designed for multipoint transmission on long bus lines in noisy environments
- TRI-STATE outputs
- Bus voltage range −7.0V to +12V
- Positive and negative current limiting
- Driver output capability ±60 mA max
- Driver thermal shutdown protection
- Receiver input high impedance
- Receiver input sensitivity of ±200 mV
- Receiver input hysteresis of 50 mV typical
- Operates from single 5.0V supply
- Low power requirements

Connection Diagram

8-Lead Dual-In-Line Package



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Top View

Order Number DS96177CN
See NS Package Number N08E

Function Table

Differential Inputs	Enable	Outputs		
A–B	E	T	Y	Z
$V_{ID} \geq 0.2V$	H	H	H	L
$V_{ID} \leq -0.2V$	H	L	L	H
X	L	Z	Z	Z

Note: T is an output pin only, monitoring the BUS (RO).

H = High Level
L = Low Level
X = Immaterial
Z = High Impedance (off)

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature Range
- Ceramic DIP: −65°C to +175°C
- Molded DIP: −65°C to +150°C

Lead Temperature
- Ceramic DIP (Soldering, 60 sec.): 300°C
- Molded DIP (Soldering, 10 sec.): 265°C

Maximum Power Dissipation* at 25°C
- Molded Package: 930 mW

Supply Voltage: 7.0V

Input Voltage: 5.5V

*Derate molded DIP package 7.5 mW/°C above 25°C.

Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage (V_{CC})	4.75	5.0	5.25	V
Voltage at any Bus Terminal (Separately or Common Mode) (V_I or V_{CM})	−7.0		12	V
Differential Input Voltage (V_{ID})			±12	V
Output Current HIGH (I_{OH})				
Driver			−60	mA
Receiver			−400	μA
Output Current LOW (I_{OL})				
Driver			60	mA
Receiver			16	
Operating Temperature (T_A)	0	25	70	°C

Electrical Characteristics

Over recommended temperature, common mode input voltage, and supply voltage ranges, unless otherwise specified (Notes 2 and 3)

DRIVER SECTION

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{IH}	Input Voltage HIGH			2.0			V
V_{IL}	Input Voltage LOW					0.8	V
V_{IC}	Input Clamp Voltage	I_I = −18 mA				−1.5	V
$\|V_{OD1}\|$	Differential Output Voltage	I_O = 0 mA				6.0	V
$\|V_{OD2}\|$	Differential Output Voltage	R_L = 100Ω, *Figure 1*		2.0	2.25		V
		R_L = 54Ω, *Figure 1* and *2*		1.5	2.0		
$\Delta\|V_{OD2}\|$	Change in Magnitude of Differential Output Voltage (Note 4)	R_L = 100Ω, *Figure 1*				±0.2	V
		R_L = 54Ω *Figure 1* and *2*	V_{CM} = 0V				
V_{OC}	Common Mode Output Voltage (Note 5)	R_L = 54Ω or 100Ω *Figure 1*				3.0	V
$\Delta\|V_{OC}\|$	Change in Magnitude of Common Mode Output Voltage (Note 4)					±0.2	V
I_O	Output Current with Power Off	V_{CC} = 0V, V_O = −7.0V to +12V				±100	μA
I_{OZ}	High Impedance State Output Current	V_O = −7.0V to +12V			±50	±200	μA
I_{IH}	Input Current HIGH	V_I = 2.7V				20	μA
I_{IL}	Input Current LOW	V_I = 0.5V				−100	μA
I_{OS}	Short Circuit Output Current (Note 9)	V_O = −7.0V				−250	mA
		V_O = 0V				−150	
		V_O = V_{CC}				150	
		V_O = 12V				250	
I_{CC}	Supply Current	No Load	Outputs Enabled			35	mA
			Outputs Disabled			40	

RECEIVER SECTION

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{TH}	Differential Input High Threshold Voltage	V_O = 2.7V, I_O = −0.4 mA			0.2	V
V_{TL}	Differential Input Low Threshold Voltage (Note 6)	V_O = 0.5V, I_O = 8.0 mA	−0.2			V
$V_{T+} - V_{T-}$	Hysteresis (Note 7)	V_{CM} = 0V		50		mV
V_{IH}	Enable Input Voltage HIGH		2.0			V
V_{IL}	Enable Input Voltage LOW				0.8	V
V_{IC}	Enable Input Clamp Voltage	I_I = −18 mA			−1.5	V

Electrical Characteristics (Continued)

Over recommended temperature, common mode input voltage, and supply voltage ranges, unless otherwise specified

RECEIVER SECTION (Continued)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{OH}	High Level Output Voltage	V_{ID} = 200 mV, I_{OH} = −400 μA, *Figure 3*		2.7			V
V_{OL}	Low Level Output Voltage	V_{ID} = −200 mV, *Figure 3*	I_{OL} = 8.0 mA			0.45	V
			I_{OL} = 16 mA			0.50	
I_{OZ}	High-Impedance State Output	V_O = 0.4V				−360	μA
		V_O = 2.4V				20	
I_I	Line Input Current (Note 8)	Other Input = 0V	V_I = 12V			1.0	mA
			V_I = −7.0V			−0.8	
I_{IH}	Enable Input Current HIGH	V_{IH} = 2.7V				20	μA
I_{IL}	Enable Input Current LOW	V_{IL} = 0.4V				−100	μA
R_I	Input Resistance				12		kΩ
I_{OS}	Short Circuit Output Current	(Note 9)		−15		−85	mA
I_{CC}	Supply Current (Total Package)	No Load	Outputs Enabled			35	mA
			Outputs Disabled			40	

Drive Switching Characteristics V_{CC} = 5.0V, T_A = 25°C

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{DD}	Differential Output Delay Time	R_L = 60Ω, *Figure 4*		15	25	ns
t_{TD}	Differential Output Transition Time	R_L = 60Ω, *Figure 4*		15	25	ns
t_{PLH}	Propagation Delay Time, Low-to-High Level Output	R_L = 27Ω, *Figure 5*		12	20	ns
t_{PHL}	Propagation Delay Time, High-to-Low Level Output	R_L = 27Ω, *Figure 5*		12	20	ns
t_{PZH}	Output Enable Time to High Level	R_L = 110Ω, *Figure 6*		25	45	ns
t_{PZL}	Output Enable Time to Low Level	R_L = 110Ω, *Figure 7*		25	40	ns
t_{PHZ}	Output Disable Time from High Level	R_L = 110Ω, *Figure 6*		20	25	ns
t_{PLZ}	Output Disable Time from Low Level	R_L = 110Ω, *Figure 7*		29	35	ns

Receiver Switching Characteristics V_{CC} = 5.0V, T_A = 25°C

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PLH}	Propagation Delay Time, Low-to-High Level Output	V_{ID} = 0V to 3.0V, C_L = 15 pF, *Figure 8*		16	25	ns
t_{PHL}	Propagation Delay Time, High-to-Low Level Output			16	25	ns
t_{PZH}	Output Enable Time to High Level	C_L = 15 pF, *Figure 9*		15	22	ns
t_{PZL}	Output Enable Time to Low Level			15	22	ns
t_{PHZ}	Output Disable Time from High Level	C_L = 5.0 pF, *Figure 9*		14	30	ns
t_{PLZ}	Output Disable Time from Low Level			24	40	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The tables of "Electrical Characteristics" provide conditions for actual device operation.

Note 2: Unless otherwise specified Min/Max limits apply across the 0°C to +70°C range for the DS96177. All typicals are given for V_{CC} = 5V and T_A = 25°C.

Note 3: All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are referenced to ground unless otherwise specified.

Note 4: $\Delta|V_{OD}|$ and $\Delta|V_{OC}|$ are the changes in magnitude of V_{OD}, V_{OC} respectively, that occur when the input is changed from a high level to a low level.

Note 5: In EIA Standards RS-422A and RS-485, V_{OC}, which is the average of the two output voltages with respect to ground, is called output offset voltage, V_{OS}.

Note 6: The algebraic convention, when 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 7: Hysteresis is the difference between the positive-going input threshold voltage, V_{T+}, and the negative going input threshold voltage, V_{T-}.

Note 8: Refer to EIA Standards RS-485 for exact conditions.

Note 9: Only one output at a time should be shorted.

Parameter Measurement Information

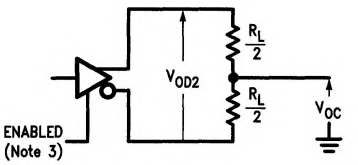

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FIGURE 1. Driver V_{OD2} and V_{OC}

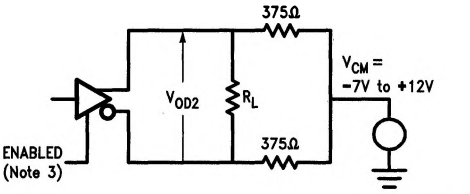

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FIGURE 2. Driver V_{OD2} with Varying Common Mode Voltage

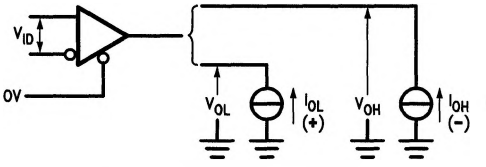

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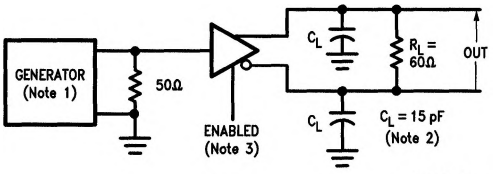
FIGURE 3. Receiver V_{OH} and V_{OL}



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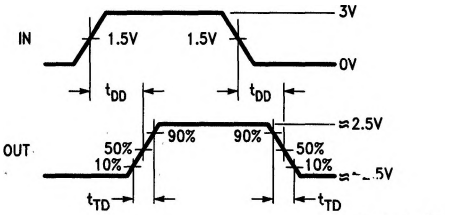

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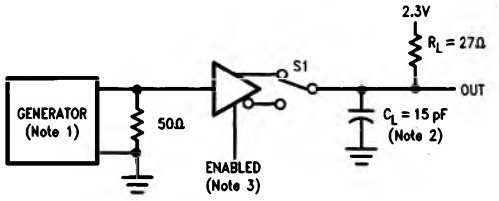
FIGURE 4. Driver Differential Output Delay and Transition Times



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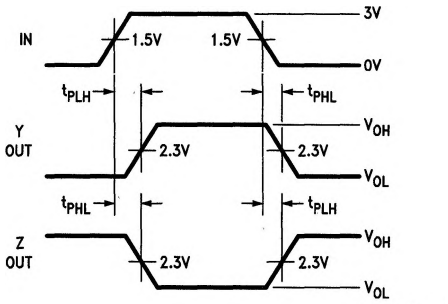

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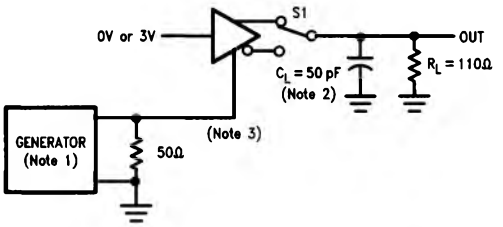
FIGURE 5. Drive Propagation Times

Parameter Measurement Information (Continued)



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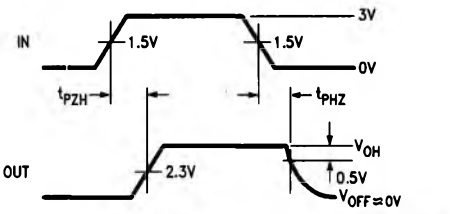

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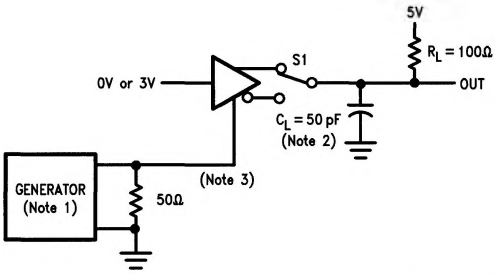
FIGURE 6. Driver Enable and Disable Times (t_{PZH}, t_{PHZ})



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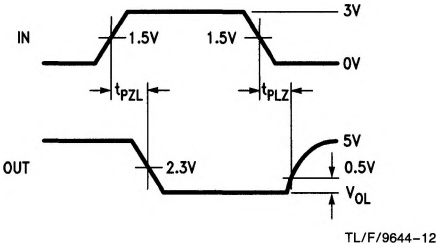

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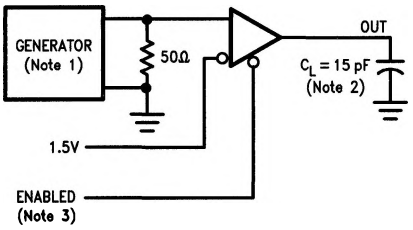
FIGURE 7. Driver Enable and Disable Times (t_{PZL}, t_{PLZ})



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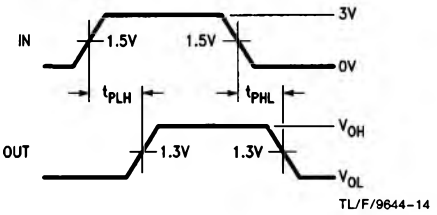

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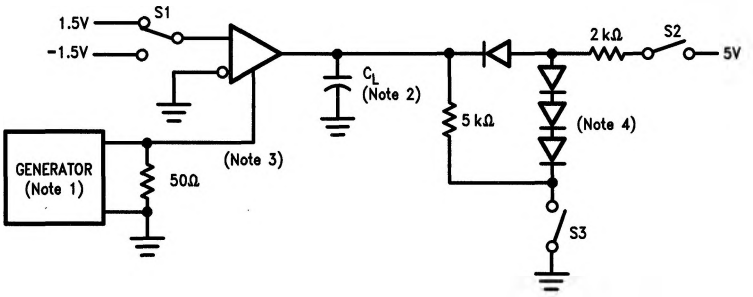
FIGURE 8. Receiver Propagation Delay Times

Parameter Measurement Information (Continued)



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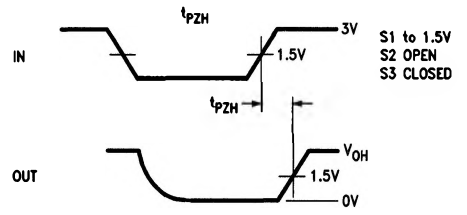

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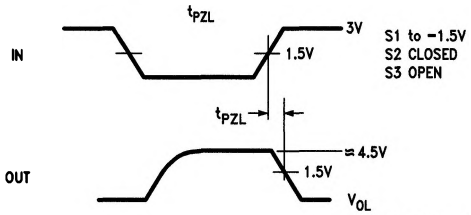

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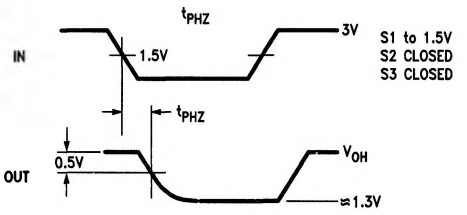

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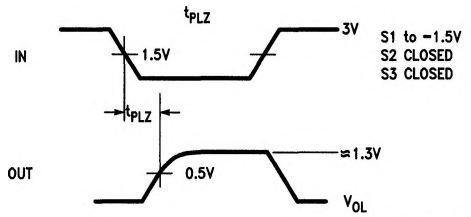

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FIGURE 9. Receiver Enable and Disable Times

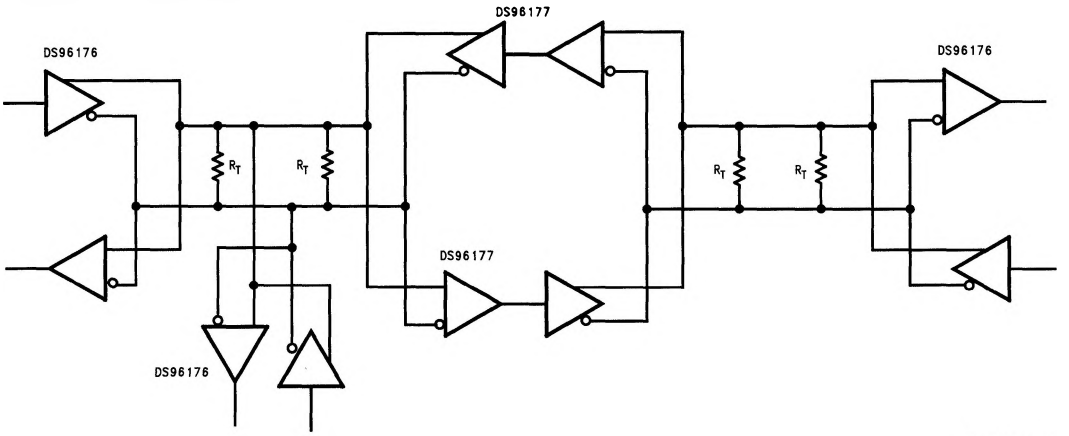
Note 1: The input pulse is supplied by a generator having the following characteristics: PRR = 1.0 MHz, duty cycle ≈ 50%, $t_r \leq 6.0$ ns, $t_f \leq 6.0$ ns, $Z_O = 50\Omega$.

Note 2: C_L includes probe and stray capacitance.

Note 3: DS96177 Enable is active high.

Note 4: All diodes are 1N916 or equivalent.

Typical Application



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Notes:

The line length should be terminated at both ends in its characteristic impedance.

Stub lengths off the main line should be kept as short as possible.

Repeater control logic not shown

FIGURE 10