National Semiconductor

June 1998

DS96172/DS96174
RS-485/RS-422 Quad Differential Line Drivers

General Description

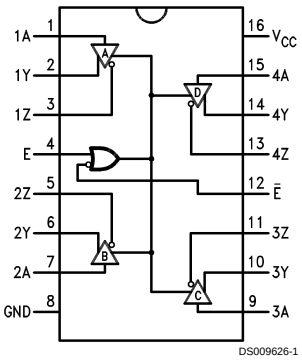
The DS96172 and DS96174 are high speed quad differential line drivers designed to meet EIA Standard RS-485. The devices have TRI-STATE® outputs and are optimized for balanced multipoint data bus transmission at rates up to 10 Mbps. The drivers have wide positive and negative common mode range for multipoint applications in noisy environments. Positive and negative current-limiting is provided which protects the drivers from line fault conditions over a +12V to −7.0V common mode range. A thermal shutdown feature is also provided and occurs at junction temperature of approximately 160˚C. The DS96172 features an active high and active low Enable, common to all four drivers. The DS96174 features separate active high Enables for each driver pair. Compatible RS-485 receivers, transceivers, and repeaters are also offered to provide optimum bus performance. The respective device types are DS96173, DS96175, DS96176 AND DS96177.

Features

- Meets EIA Standard RS-485 and RS-422A
- Monotonic differential output switching
- Transmission rate to 10 Mbs
- TRI-STATE outputs
- Designed for multipoint bus transmission
- Common mode output voltage range: −7V to +12V
- Operates from single +5V supply
- Thermal shutdown protection
- DS96172/DS96174 are lead and function compatible with the SN75172/75174 or the AM26LS31/MC3487 respectively

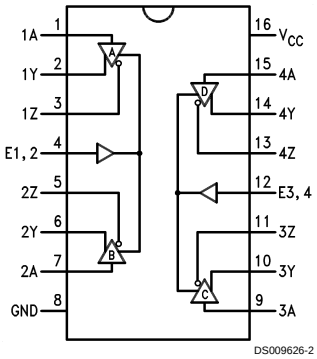
Connection Diagrams

16-Lead DIP
DS96172



Top View

16-Lead DIP
DS96174



Top View

Order Number DS96172CN or DS96174CN
See NS Package Number N16E

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Absolute Maximum Ratings (Note 2)

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

Storage Temperature Range	
Molded DIP	−65˚C to +150˚C
Operating Temperature Range	0˚C to +70˚C
Lead Temperature	
Molded DIP (soldering, 10 sec.)	265˚C
Supply Voltage	7V
Enable Input Voltage	5.5V
Maximum Power Dissipation (Note 1)	25˚C
N-Molded Package	1.98W

Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage (V_{CC})	4.75	5	5.25	V
Common Mode Output Voltage (V_{OC})	−7		+12	V
Output Current HIGH (I_{OH})			−60	mA
Output Current LOW (I_{OL})			60	mA
Operating Temperature (T_A)	0	25	70	˚C

Note 1: Derate molded DIP package 16mW/˚C above 25˚C.

Electrical Characteristics (Notes 3, 4)

over recommended temperature and supply voltage ranges, unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{IH}	Input Voltage HIGH			2			V
V_{IL}	Input Voltage LOW					0.8	V
V_{OH}	Output Voltage HIGH	I_{OH} = −20 mA			3.1		V
V_{OL}	Output Voltage LOW	I_{OL} = 20 mA			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	V
$\|V_{OD2}\|$	Differential Output Voltage	R_L = 54Ω, *Figure 1*		1.5	2		V
		R_L = 100Ω, *Figure 1*		2	2.3		V
$\Delta\|V_{OD}\|$	Change in Magnitude of Differential Output Voltage (Note 5)	R_L = 54Ω or 100Ω, *Figure 1*				±0.2	V
V_{OC}	Common Mode Output Voltage (Note 6)	R_L = 54Ω, *Figure 1*				3	V
$\Delta\|V_{OC}\|$	Change in Magnitude of Common Mode Output Voltage (Note 5)					±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 7)	V_O = −7.0V				−250	mA
		V_O = 0V				−150	
		V_O = V_{CC}				150	
		V_O = 12V				250	
I_{CC}	Supply Current (All Drivers)	No Load	Outputs Enabled		50	70	mA
			Output Disabled		50	60	

Switching Characteristics

V_{CC} = 5V, T_A = 25˚C

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{DD}	Differential Output Delay Time	R_L = 60Ω, *Figure 2*		15	25	ns
t_{TD}	Differential Output Transition Time			15	25	ns
t_{PLH}	Propagation Delay Time, Low-to-High Level Output	R_L = 27Ω, *Figure 3*		12	20	ns
t_{PHL}	Propagation Delay Time, High-to-Low Level Output			12	20	ns
t_{PZH}	Output Enable Time to High Level	R_L = 110Ω, *Figure 4*		30	45	ns
t_{PZL}	Output Enable Time to Low Level	R_L = 110Ω, *Figure 5*		30	45	ns

Switching Characteristics (Continued)

V_{CC} = 5V, T_A = 25˚C

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{PHZ}	Output Disable Time from High Level	R_L = 110Ω, *Figure 4*		25	35	ns
t_{PLZ}	Output Disable Time from Low Level	R_L = 110Ω, *Figure 5*		30	45	ns

Note 2: "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 3: Unless otherwise specified min/max limits apply across the 0˚C to +70˚C range for the DS96172/DS96174. All typicals are given for V_{CC} = 5V and T_A = 25˚C.

Note 4: 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 5: Δ $|V_{OD}|$ and Δ$|V_{OC}|$ 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.

Note 6: 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 7: Only one output at a time should be shorted.

Parameter Measurement Information

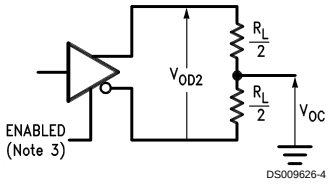


FIGURE 1. Differential and Common Mode Output Voltage

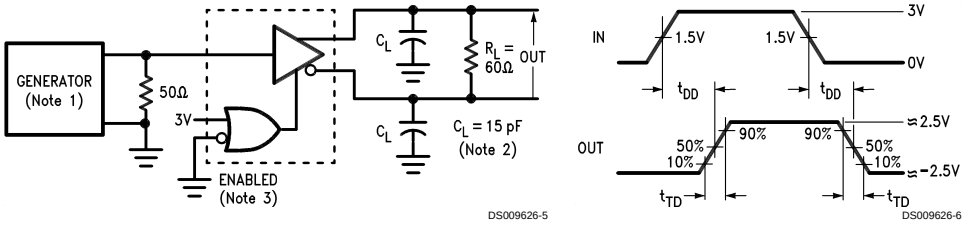


FIGURE 2. Differential Output Delay and Transition Times

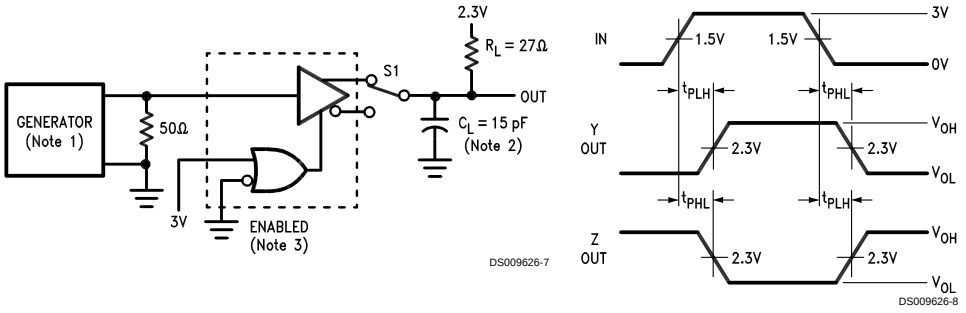


FIGURE 3. Propagation Delay Times

Parameter Measurement Information (Continued)

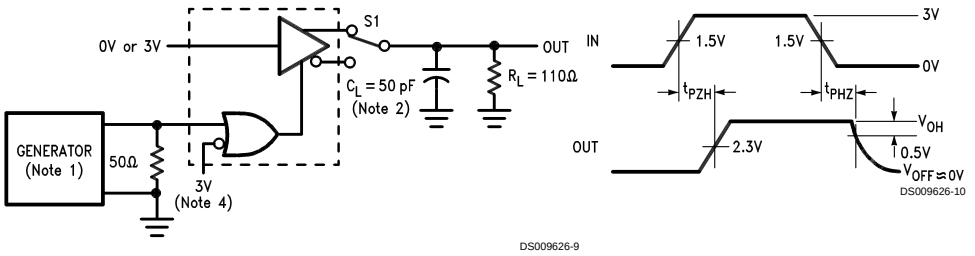


FIGURE 4. t_{PZH} and t_{PHZ}

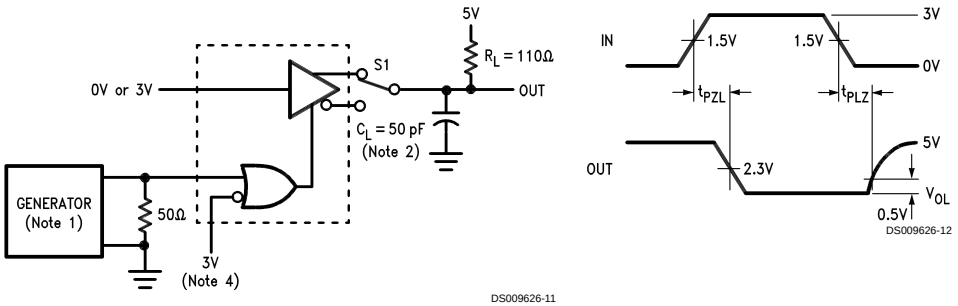


FIGURE 5. t_{PZL} and t_{PLZ}

Note 8: The input pulse is supplied by a generator having the following characteristics: PRR = 1.0 MHz, duty cycle = 50%, $t_r \leq 5.0$ ns, $t_f \leq 5.0$ ns, $Z_O = 50\Omega$.

Note 9: C_L includes probe and jig capacitance.

Note 10: DS96172 with active high and active low Enables is shown here. DS96174 has active high Enable only.

Note 11: To test the active low Enable $\overline{E}$ of DS96172, ground E and apply an inverted waveform to $\overline{E}$. DS96174 has active high Enable only.

Function Tables

DS96172

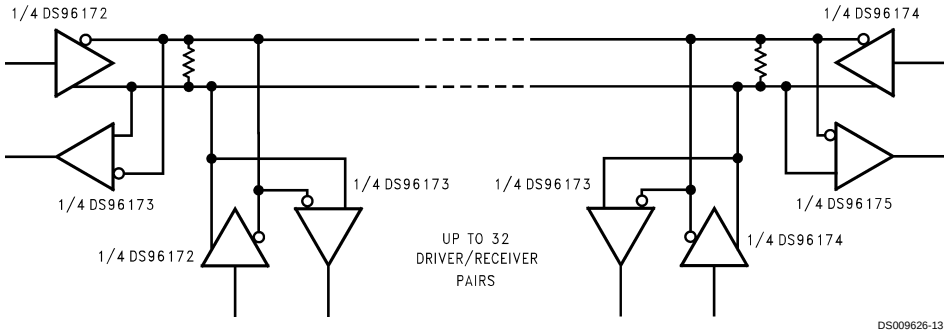
Input	Enables		Outputs	
A	E	$\overline{E}$	Y	Z
H	H	X	H	L
L	H	X	L	H
H	X	L	H	L
L	X	L	L	H
X	L	H	Z	Z

DS96174

Input	Enable	Outputs	
		Y	Z
H	H	H	L
L	H	L	H
X	L	Z	Z

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

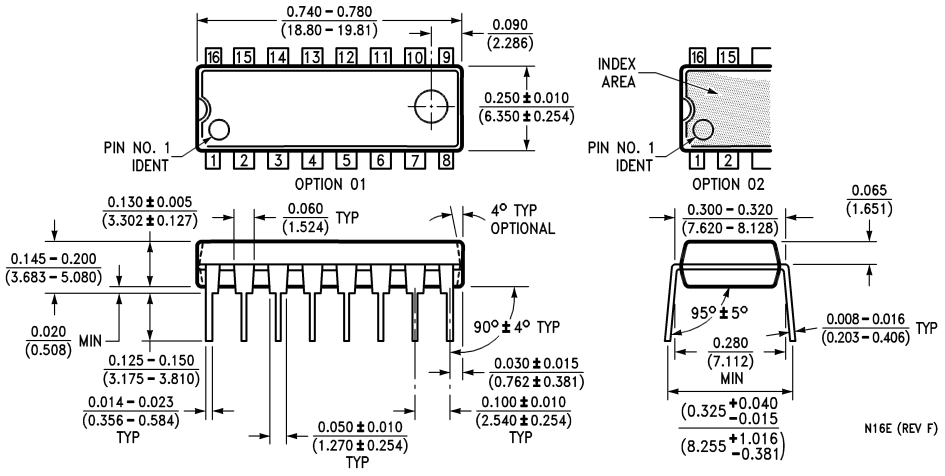
Typical Application



Note: 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.

FIGURE 6.

Physical Dimensions inches (millimeters) unless otherwise noted



Molded Dual-In-Line Package (N)
Order Number DS96172CN or DS96174CN
NS Package Number N16E

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