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## RS-485/RS-422 Quad Differential Line Drivers

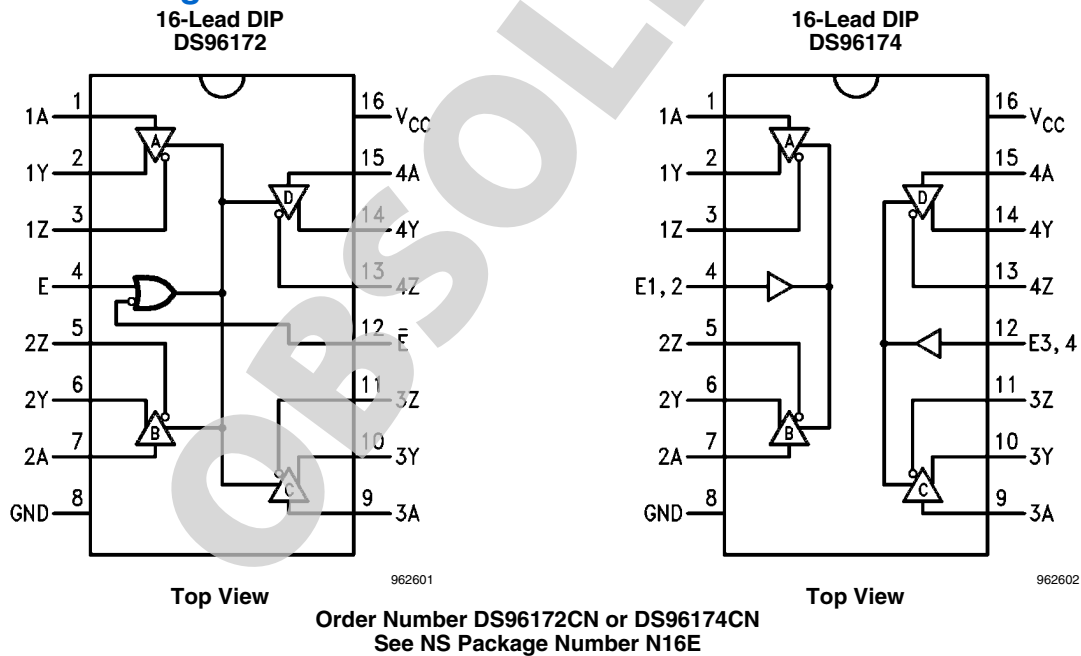
### General Description

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 Mbps
- 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



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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)

N-Molded Package

25°C

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** (Note 3, Note 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	$R_L = 54\Omega$ , Figure 1	1.5	2		V
		$R_L = 100\Omega$ , Figure 1	2	2.3		V
$\Delta V_{OD} $	Change in Magnitude of Differential Output Voltage (Note 5)	$R_L = 54\Omega$ or $100\Omega$ , Figure 1			$\pm 0.2$	V
$V_{OC}$	Common Mode Output Voltage (Note 6)	$R_L = 54\Omega$ , Figure 1			3	V
$\Delta V_{OC} $	Change in Magnitude of Common Mode Output Voltage (Note 5)				$\pm 0.2$	V
$I_O$	Output Current with Power Off	$V_{CC} = 0V$ , $V_O = -7.0V$ to $12V$			$\pm 100$	$\mu A$
$I_{OZ}$	High Impedance State Output Current	$V_O = -7.0V$ to $12V$		$\pm 50$	$\pm 200$	$\mu A$
$I_{IH}$	Input Current HIGH	$V_I = 2.7V$			20	$\mu A$
$I_{IL}$	Input Current LOW	$V_I = 0.5V$			-100	$\mu A$
$I_{OS}$	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				mA
		Outputs Enabled		50	70	
		Output Disabled		50	60	

## Switching Characteristics

$V_{CC} = 5V$ ,  $T_A = 25^\circ C$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{DD}$	Differential Output Delay Time	$R_L = 60\Omega$ , <i>Figure 2</i>		15	25	ns
$t_{TD}$	Differential Output Transition Time			15	25	ns
$t_{PLH}$	Propagation Delay Time, Low-to-High Level Output	$R_L = 27\Omega$ , <i>Figure 3</i>		12	20	ns
$t_{PHL}$	Propagation Delay Time, High-to-Low Level Output			12	20	ns
$t_{PZH}$	Output Enable Time to High Level	$R_L = 110\Omega$ , <i>Figure 4</i>		30	45	ns
$t_{PZL}$	Output Enable Time to Low Level	$R_L = 110\Omega$ , <i>Figure 5</i>		30	45	ns
$t_{PHZ}$	Output Disable Time from High Level	$R_L = 110\Omega$ , <i>Figure 4</i>		25	35	ns
$t_{PLZ}$	Output Disable Time from Low Level	$R_L = 110\Omega$ , <i>Figure 5</i>		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  $0^\circ C$  to  $+70^\circ C$  range for the DS96172/DS96174. All typicals are given for  $V_{CC} = 5V$  and  $T_A = 25^\circ C$ .

**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:**  $\Delta |V_{OD}|$  and  $\Delta |V_{OC}|$  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

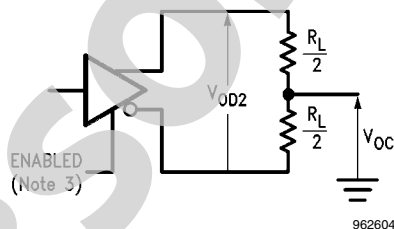


FIGURE 1. Differential and Common Mode Output Voltage

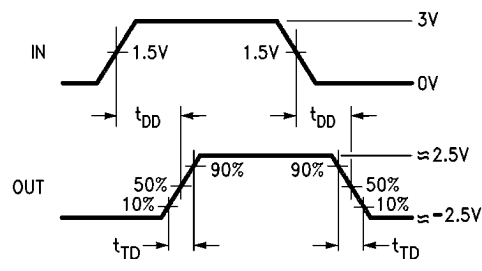
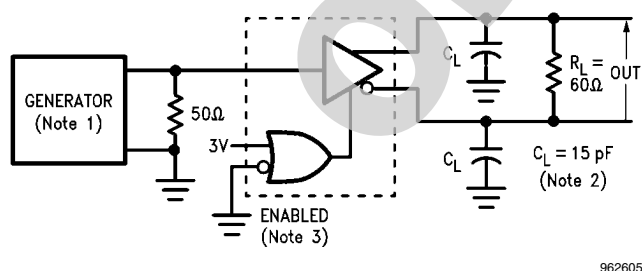


FIGURE 2. Differential Output Delay and Transition Times

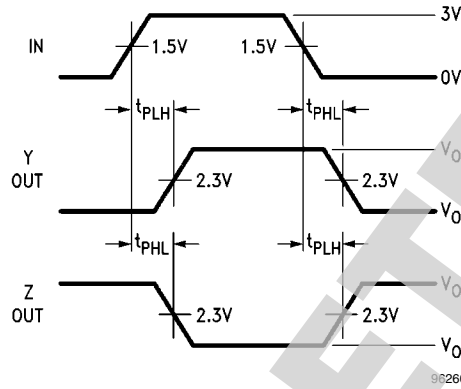
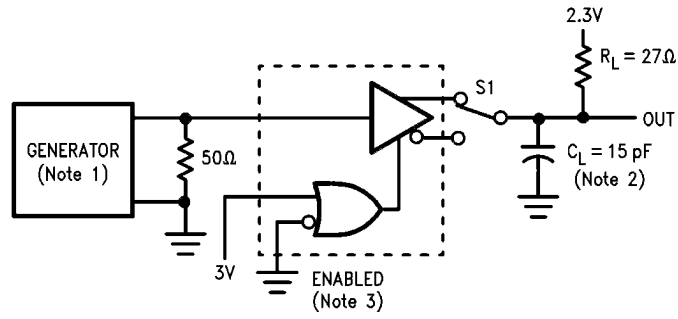


FIGURE 3. Propagation Delay Times

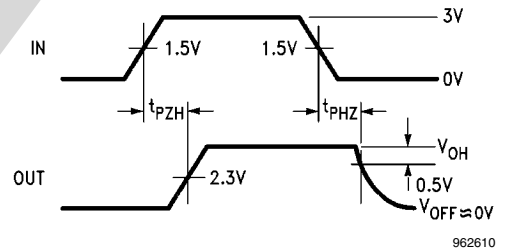
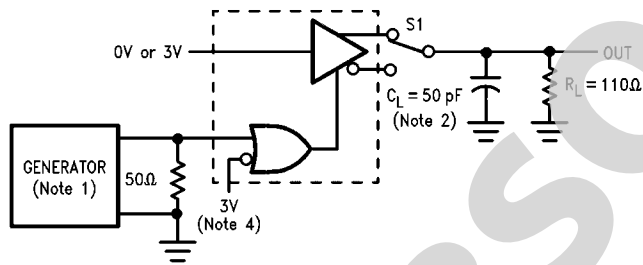


FIGURE 4.  $t_{PZH}$  and  $t_{PHZ}$

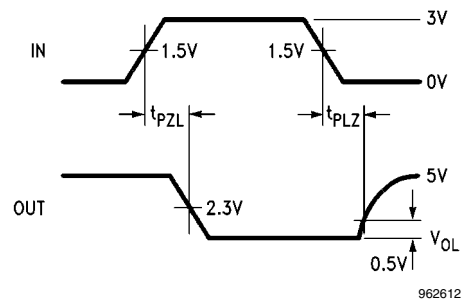
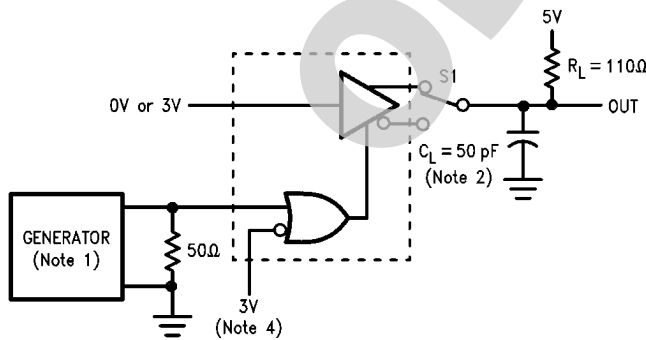


FIGURE 5.  $t_{PZL}$  and  $t_{PLZ}$

**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,  $Z_0 = 50\Omega$ .

**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  $\bar{E}$  of DS96172, ground E and apply an inverted waveform to  $\bar{E}$ . DS96174 has active high Enable only.

## Function Tables

DS96172

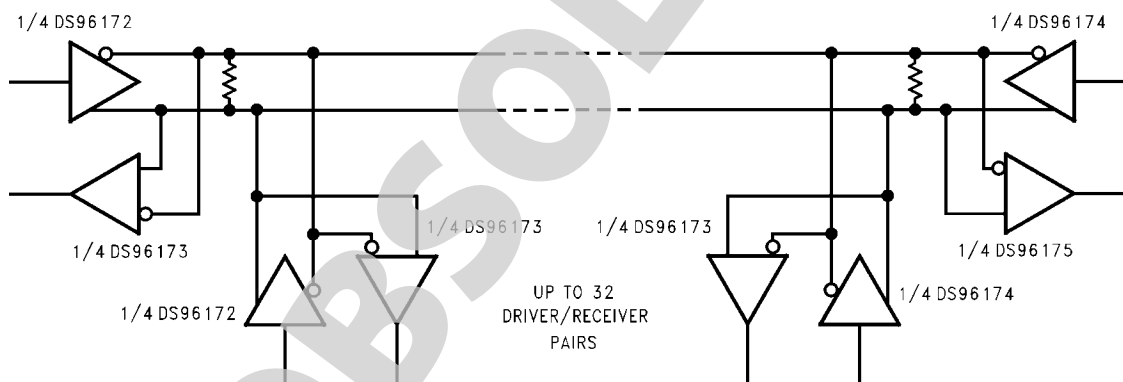
Input A	Enables		Outputs	
	E	$\bar{E}$	Y	Z
H	H	X	H	L
L	H	X	L	H
H	X	L	H	L
L	X	L	L	H
X	L	H	Z	Z

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

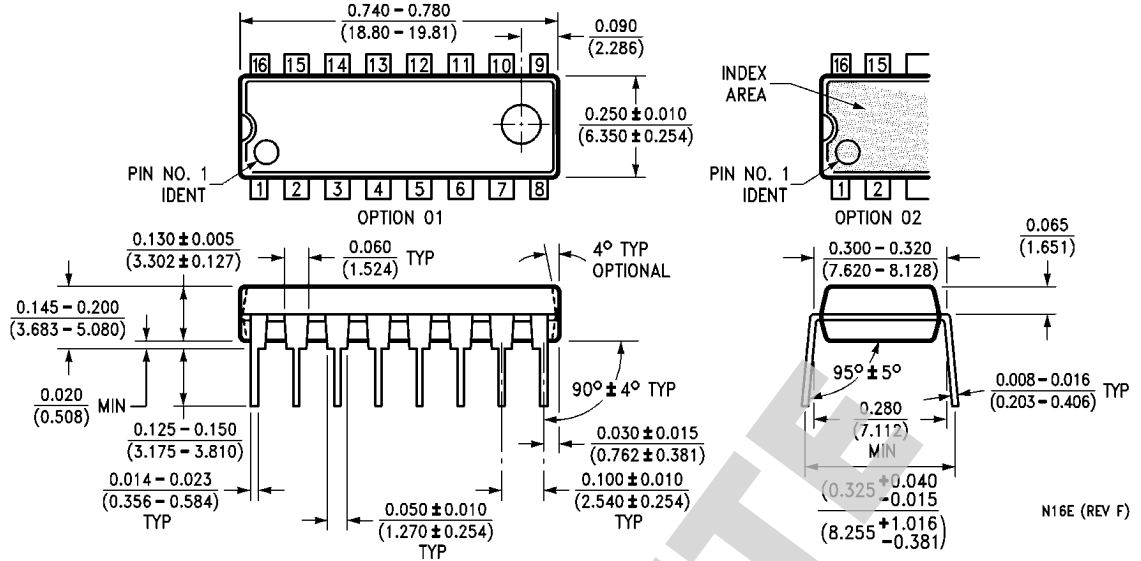


962613

**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**

N16E (REV F)

OBSOLETE

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Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Eval Boards	<a href="http://www.national.com/evalboards">www.national.com/evalboards</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Packaging	<a href="http://www.national.com/packaging">www.national.com/packaging</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage References	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Applications & Markets	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
Temperature Sensors	<a href="http://www.national.com/tempensors">www.national.com/tempensors</a>	SolarMagic™	<a href="http://www.national.com/solarmagic">www.national.com/solarmagic</a>
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