

## DS96F172M/DS96F174C/DS96F174M EIA-485/EIA-422 Quad Differential Drivers

Check for Samples: [DS96F172M](#), [DS96F174C](#), [DS96F174M](#)

### FEATURES

- Meets EIA-485 and EIA-422 Standards
- Monotonic Differential Output Switching
- Tri-state Outputs
- Designed for Multipoint Bus Transmission
- Common Mode Output Voltage Range: -7.0V to +12V
- Operates from Single +5.0V Supply
- Reduced Power Consumption
- Thermal Shutdown Protection
- DS96F172 and DS96F174 are Lead and Function Compatible with the SN75172/174 or the AM26LS31/MC3487
- Military Temperature Range Available
- Qualified for MIL-STD-883C
- Standard Military Drawings Available (SMD)
- Available in CDIP (NFE), LCCC (NAJ), and CLGA (NAD) Packages

### Logic Diagrams

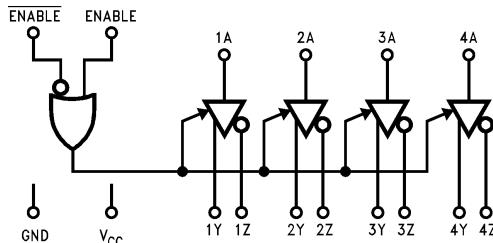


Figure 1. DS96F172

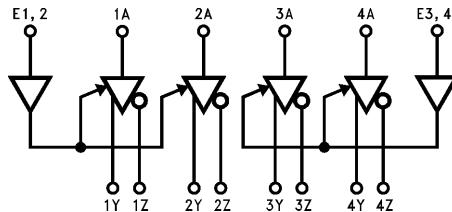


Figure 2. DS96F174

### DESCRIPTION

The DS96F172 and the DS96F174 are high speed quad differential line drivers designed to meet EIA-485 Standards. The DS96F172 and the DS96F174 offer improved performance due to the use of L-FAST bipolar technology. The use of LFAST technology allows the DS96F172 and DS96F174 to operate at higher speeds while minimizing power consumption.

The DS96F172 and the DS96F174 have tri-state outputs and are optimized for balanced multipoint data bus transmission at rates up to 15 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. The DS96F172 features an active high and active low Enable, common to all four drivers. The DS96F174 features separate active high Enables for each driver pair.



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**Function Tables**

(Each Driver)

**Table 1. DS96F172<sup>(1)</sup>**

Input	Enable		Outputs		
	A	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

(1) H = High Level  
 L = Low Level  
 X = Don't Care  
 Z = High Impedance (Off)

**Table 2. DS96F174<sup>(1)</sup>**

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

(1) H = High Level  
 L = Low Level  
 X = Don't Care  
 Z = High Impedance (Off)



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings COMMERCIAL<sup>(1)</sup>

Specifications for the 883 version of this product are listed separately on the following pages.

Storage Temperature Range (T <sub>STG</sub> )	-65°C to +175°C		
Lead Temperature (Soldering, 60 sec.)	300°C		
Maximum Package Power Dissipation <sup>(2)</sup> at 25°C	Ceramic DIP (NFE)	1500 mW	
	Supply Voltage	7.0V	
	Enable Input Voltage	5.5V	

(1) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. 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.

(2) Derate "NFE" package 10 mW/°C above 25°C.

## Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage (V <sub>CC</sub> ) DS96F174C	4.75	5.0	5.25	V
Common Mode Output Voltage (V <sub>OC</sub> )	-7.0		+12.0	V
Output Current HIGH (I <sub>OH</sub> )			-60	mA
Output Current LOW (I <sub>OL</sub> )			60	mA
Operating Temperature (T <sub>A</sub> )DS96F174C	0		+70	°C

**Electrical Characteristics<sup>(1)(2)</sup>**

Over recommended supply voltage and operating temperature range, unless otherwise specified

Symbol	Parameter	Conditions		Min	Typ <sup>(3)</sup>	Max	Unit s
$V_{IH}$	Input Voltage HIGH			2.0			V
$V_{IL}$	Input Voltage LOW	$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$	$T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$		0.8		V
					0.7		
$V_{OH}$	Output Voltage HIGH	$I_{OH} = -33 \text{ mA}$	$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$	3.0			V
$V_{OL}$	Output Voltage LOW	$I_{OL} = 33 \text{ mA}$	$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$			2.0	V
$V_{IC}$	Input Clamp Voltage	$I_I = -18 \text{ mA}$				-1.5	V
$ V_{OD1} $	Differential Output Voltage	$I_O = 0 \text{ mA}$				6.0	V
$ V_{OD2} $	Differential Output Voltage	$R_L = 54\Omega$ , See <a href="#">Figure 3</a>	$T_A = -55^\circ\text{C}$	1.2	2.0		V
				1.5			
$V_{OD}$	Differential Output Voltage	<a href="#">See Figure 4</a>	$T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$	1.0			V
$\Delta V_{OD} $	Change in Magnitude of Differential Output Voltage <sup>(4)</sup>	$R_L = 54\Omega$ or $100\Omega$ , <a href="#">Figure 3</a>	$-40^\circ\text{C}$ to $+125^\circ\text{C}$			$\pm 0.2$	V
			$-55^\circ\text{C}$ to $+125^\circ\text{C}$			$\pm 0.4$	
$V_{OC}$	Common Mode Output Voltage <sup>(5)</sup>	$R_L = 54\Omega$ or $100\Omega$ , See <a href="#">Figure 3</a>				3.0	V
$\Delta V_{OC} $	Change in Magnitude of Common Mode Output Voltage <sup>(4)</sup>	$R_L = 54\Omega$ or $100\Omega$ , See <a href="#">Figure 3</a>				$\pm 0.2$	V
$I_O$	Output Current with Power Off	$V_{CC} = 0\text{V}$ , $V_O = -7.0\text{V}$ to $+12\text{V}$				$\pm 50$	$\mu\text{A}$
$I_{OZ}$	High Impedance State Output Current	$V_O = -7.0\text{V}$ to $+12\text{V}$			$\pm 20$	$\pm 50$	$\mu\text{A}$
$I_{IH}$	Input Current HIGH	$V_I = 2.4\text{V}$				20	$\mu\text{A}$
$I_{IL}$	Input Current LOW	$V_I = 0.4\text{V}$				-50	$\mu\text{A}$
$I_{OS}$	Short Circuit Output Current <sup>(6)</sup>	$V_O = -7.0\text{V}$				-250	mA
		$V_O = 0\text{V}$				-150	
		$V_O = V_{CC}$				150	
		$V_O = +12\text{V}$				250	
$I_{CC}$	Supply Current (All Drivers)	No Load	Outputs Enabled			50	mA
			Outputs Disabled			30	

- (1) Unless otherwise specified min/max limits apply across the  $0^\circ\text{C}$  to  $+70^\circ\text{C}$  range for the DS96F174C. All typicals are given for  $V_{CC} = 5\text{V}$  and  $T_A = 25^\circ\text{C}$ .
- (2) All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are reference to ground unless otherwise specified.
- (3) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. 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.
- (4)  $\Delta|V_{OP}|$  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.
- (5) In EIA-422A and EIA-485 standards,  $V_{OC}$ , which is the average of the two output voltages with respect to ground, is called output offset voltage,  $V_{OS}$ .
- (6) Only one output at a time should be shorted.

**COMMERCIAL Switching Characteristics**
 $V_{CC} = 5.0V, T_A = 25^\circ C$ 

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{DD}$	Differential Output Delay Time	$R_L = 60\Omega$ , See <a href="#">Figure 5</a>		15	20	ns
$t_{TD}$	Differential Output Transition Time			15	22	ns
$t_{PLH}$	Propagation Delay Time, Low-to-High Level Output	$R_L = 27\Omega$ , See <a href="#">Figure 6</a>		12	16	ns
$t_{PHL}$	Propagation Delay Time, High-to-Low Level Output			12	16	ns
$t_{ZH}$	Output Enable Time to High Level	$R_L = 110\Omega$ , See <a href="#">Figure 6</a>		25	32	ns
$t_{ZL}$	Output Enable Time to Low Level	$R_L = 110\Omega$ , See <a href="#">Figure 8</a>		25	32	ns
$t_{HZ}$	Output Disable Time from High Level	$R_L = 110\Omega$ , See <a href="#">Figure 7</a>		25	30	ns
$t_{LZ}$	Output Disable Time from Low Level	$R_L = 110\Omega$ , See <a href="#">Figure 8</a>		20	25	ns
$t_{LZL}$	Output Disable Time from Low Level with Load Resistor to GND	See <a href="#">Figure 8</a>		300		ns
$t_{SKEW}$	Driver Output to Output	$R_L = 60\Omega$		1.0	4.0	ns

**Absolute Maximum RatingsMIL-STD-883C<sup>(1)</sup>****For complete Military Specifications, refer to the appropriate SMD or MDS.**

Storage Temperature Range ( $T_{STG}$ )	-65°C to +175°C		
Lead Temperature (Soldering, 60 sec.)	300°C		
Maximum Package Power Dissipation <sup>(2)</sup> at 25°C	Ceramic LCCC (NAJ)	2000 mW	
	Ceramic DIP (NFE)	1800 mW	
	Ceramic Flatpak (NAD)	1000 mW	
	Supply Voltage	7.0V	
	Enable Input Voltage	5.5V	

(1) Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. 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.

(2) Above  $T_A = 25^\circ\text{C}$ , derate "NAJ" package 13.4, "NFE" package 12.5, "NAD" package 7.1 mW/°C

**Recommended Operating Conditions**

		Min	Typ	Max	Units
Supply Voltage ( $V_{CC}$ )	DS96F172M/DS96F174M	4.50	5.0	5.50	V
Common Mode Output Voltage ( $V_{OC}$ )		-7.0		+12.0	V
Output Current HIGH ( $I_{OH}$ )				-60	mA
Output Current LOW ( $I_{OL}$ )				60	mA
Operating Temperature ( $T_A$ )	DS96F172M/DS96F174M	-55		+125	°C

**Electrical Characteristics<sup>(1)(2)</sup>**

Over recommended supply voltage and operating temperature range unless otherwise specified

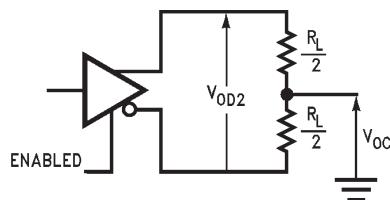
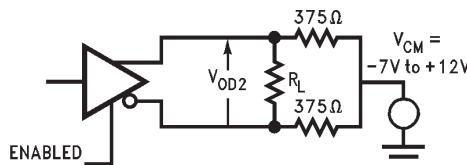
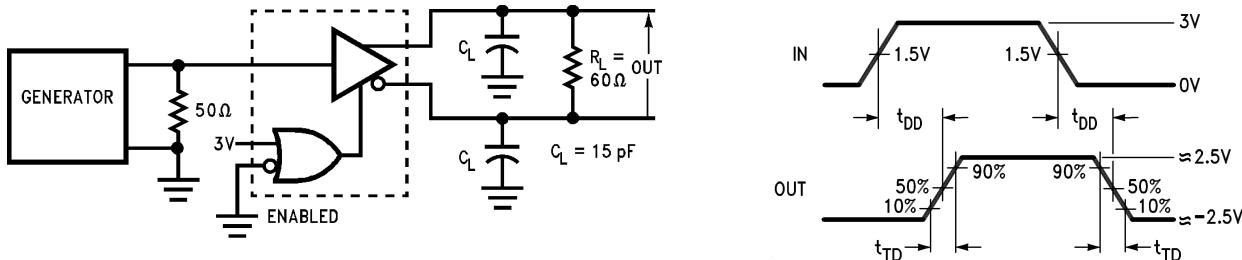
Symbol	Parameter	Conditions	Min	Max	Units
$V_{IH}$	Input Voltage HIGH		2.0		V
$V_{IL}$	Input Voltage LOW		$T_A = 25^\circ\text{C}$	0.8	V
			$T_A = -55^\circ\text{C}$ , or $+125^\circ\text{C}$	0.7	
$V_{IC}$	Input Clamp Voltage	$I_I = -18 \text{ mA}$		-1.5	V
$ V_{OD1} $	Differential Output Voltage	$I_O = 0 \text{ mA}$		6.0	V
$ V_{OD2} $	Differential Output Voltage	$R_L = 54\Omega$ , $V_{CC} = 4.5\text{V}$ See <a href="#">Figure 3</a>	$T_A = -55^\circ\text{C}$	1.2	V
			$T_A = 25^\circ\text{C}$ , or $+125^\circ\text{C}$	1.5	
		$R_L = 100\Omega$ , $V_{CC} = 4.5\text{V}$ , See <a href="#">Figure 3</a>		2.0	
$\Delta V_{OD} $	Change in Magnitude of Differential Output Voltage <sup>(3)</sup>	$R_L = 54\Omega$ or $100\Omega$ , $V_{CC} = 4.5\text{V}$ , See <a href="#">Figure 3</a>	$T_A = 25^\circ\text{C}$ , or $+125^\circ\text{C}$	$\pm 0.2$	V
			$T_A = -55^\circ\text{C}$	$\pm 0.4$	
$V_{OC}$	Common Mode Output Voltage <sup>(4)</sup>	$R_L = 54\Omega$ or $100\Omega$ , See <a href="#">Figure 3</a>		3.0	V
$\Delta V_{OCL}$	Change in Magnitude of Common Mode Output Voltage <sup>(3)</sup>	$R_L = 54\Omega$ or $100\Omega$ , $V_{CC} = 4.5\text{V}$ , See <a href="#">Figure 3</a>		$\pm 0.2$	V
$I_O$	Output Current with Power Off	$V_{CC} = 0\text{V}$ , $V_O = -7.0\text{V}$ to $+12\text{V}$		$\pm 50$	$\mu\text{A}$
$I_{OZ}$	High Impedance State Output Current	$V_O = -7.0\text{V}$ to $+12\text{V}$		$\pm 50$	$\mu\text{A}$
$I_{IH}$	Input Current HIGH	$V_I = 2.4\text{V}$		20	$\mu\text{A}$
$I_{IL}$	Input Current LOW	$V_I = 0.4\text{V}$		-50	$\mu\text{A}$
$I_{OS}$	Short Circuit Output Current <sup>(5)</sup>	$V_O = -7.0\text{V}$		-250	mA
		$V_O = 0\text{V}$		-150	
		$V_O = V_{CC}$		150	
		$V_O = +12\text{V}$		250	
$I_{CC}$	Supply Current (All Drivers)	No Load	Outputs Enabled	50	mA
			Outputs Disabled	30	

- (1) Unless otherwise specified min/max limits apply across the  $0^\circ\text{C}$  to  $+70^\circ\text{C}$  range for the DS96F174C. All typicals are given for  $V_{CC} = 5\text{V}$  and  $T_A = 25^\circ\text{C}$ .
- (2) All currents into the device pins are positive; all currents out of the device pins are negative. All voltages are reference to ground unless otherwise specified.
- (3)  $\Delta|V_{OD}|$  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.
- (4) In EIA-422A and EIA-485 standards,  $V_{OC}$ , which is the average of the two output voltages with respect to ground, is called output offset voltage,  $V_{OS}$ .
- (5) Only one output at a time should be shorted.

**MIL-STD-883C**  
**Switching Characteristics<sup>(1)(2)</sup>**
 $V_{CC} = 5.0V$ 

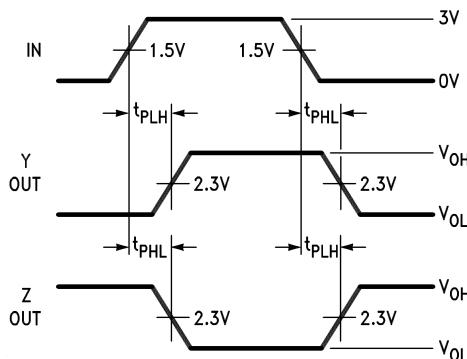
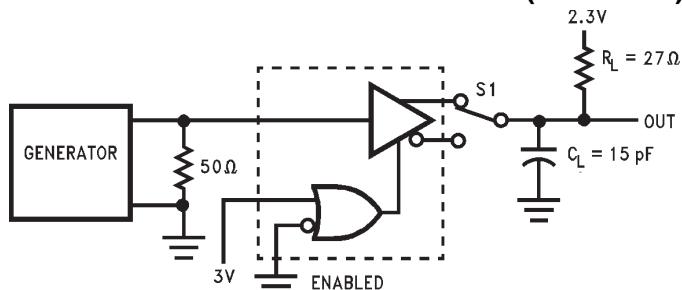
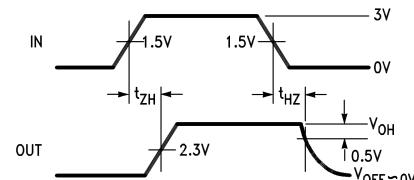
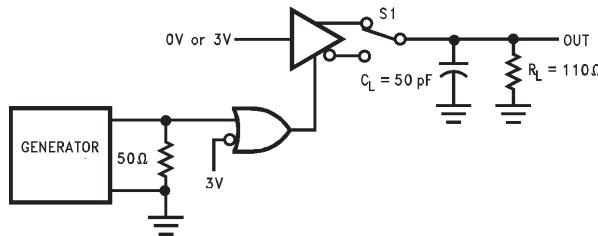
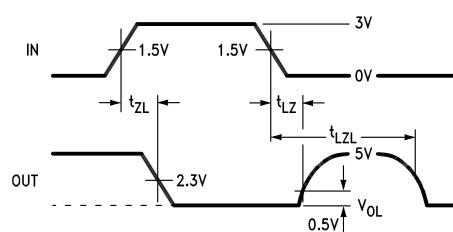
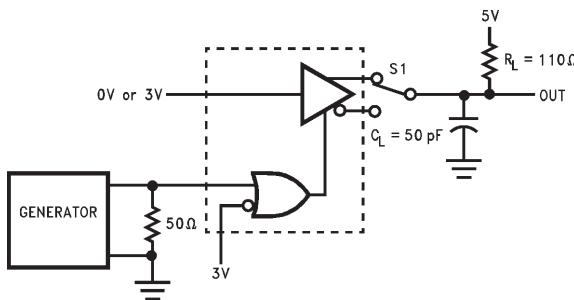
Symbol	Parameter	Conditions	$T_A = 25^\circ C$		$T_A = 55^\circ C$	$T_A = 125^\circ C$	Units
			Typ	Max	Max	Max	
$t_{DD}$	Differential Output Delay Time	$R_L = 60\Omega$ , $C_L = 15 \text{ pF}$ , See <i>Figure 5</i>	15	22	30	30	ns
$t_{TD}$	Differential Output Transition Time		15	22	40	40	ns
$t_{PLH}$	Propagation Delay Time, Low-to-High Level Output	$R_L = 27\Omega$ , $C_L = 15 \text{ pF}$ , See <i>Figure 6</i>	12	16	25	25	ns
$t_{PHL}$	Propagation Delay Time, High-to-Low Level Output		12	16	25	25	ns
$t_{ZH}$	Output Enable Time to High Level	$R_L = 110\Omega$ , See <i>Figure 7</i>	25	32	40	40	ns
$t_{ZL}$	Output Enable Time to Low Level	$R_L = 110\Omega$ , See <i>Figure 8</i>	25	35	100	100	ns
$t_{HZ}$	Output Disable Time from High Level	$R_L = 110\Omega$ , See <i>Figure 7</i> , <sup>(3)</sup>	25	30	80	80	ns
$t_{LZ}$	Output Disable Time from Low Level	$R_L = 110\Omega$ , See <i>Figure 8</i>	20	25	40	40	ns
$t_{LZL}$	Output Disable Time from Low Level with Load Resistor to GND	See <i>Figure 8</i>	300				ns
$t_{SKEW}$	Driver Output to Output	$R_L = 60\Omega$	1.0	4.0	10	10	ns

(1) DS96F172 with active high and active low Enables is shown. DS96F174 has active high Enable only.  
 (2) To test the active low Enable  $\bar{E}$  of DS96F172 ground  $E$  and apply an inverted waveform to  $\bar{E}$ . DS96F174 has active high Enable only.  
 (3) Not tested for DS96F172MW-MIL device.

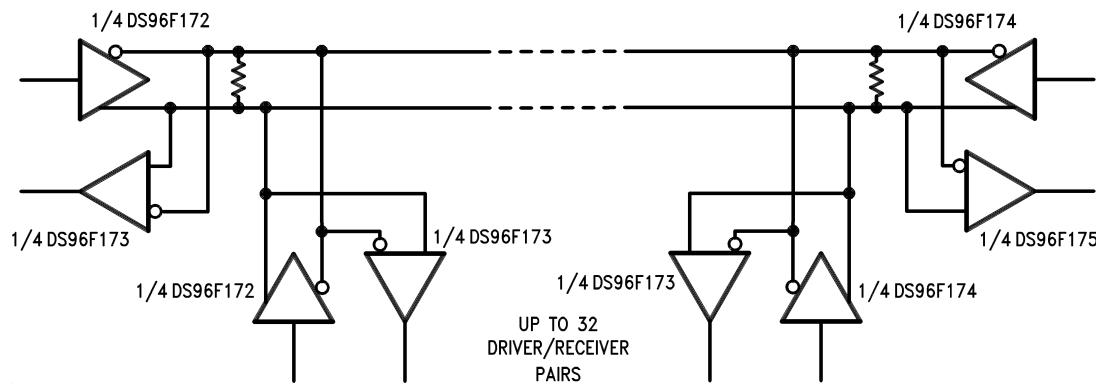
**Parameter Measurement Information**

**Figure 3. Differential and Common Mode Output Voltage<sup>(4)</sup>**

**Figure 4. Differential Output Voltage with Varying Common Mode Voltage<sup>(4)</sup>**

**Figure 5. Differential Output Delay and Transition Times<sup>(5)(4)</sup>**

- (4) The input pulse is supplied by a generator having the following characteristics:  $f = 1.0$  MHz, duty cycle = 50%,  $t_r \leq 5.0$  ns,  $t_f \leq 5.0$  ns,  $Z_o = 50\Omega$ .
- (5) Above  $T_A = 25^\circ\text{C}$ , derate “NAJ” package 13.4, “NFE” package 12.5, “NAD” package 7.1 mW/°C

## Parameter Measurement Information (continued)

Figure 6. Propagation Delay Times<sup>(6)(7)</sup>Figure 7.  $t_{ZH}$  and  $t_{HZ}$ <sup>(6)(8)</sup>Figure 8.  $t_{ZL}$ ,  $t_{LZ}$ ,  $t_{LZL}$ <sup>(6)(8)</sup>

- (6) Above  $T_A = 25^\circ\text{C}$ , derate “NAJ” package 13.4, “NFE” package 12.5, “NAD” package 7.1 mW/°C
- (7) The input pulse is supplied by a generator having the following characteristics:  $f = 1.0 \text{ MHz}$ , duty cycle = 50%,  $t_r \leq 5.0 \text{ ns}$ ,  $t_f \leq 5.0 \text{ ns}$ ,  $Z_0 = 50\Omega$ .
- (8)  $C_L$  includes probe and jig capacitance

**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.

## Connection Diagrams

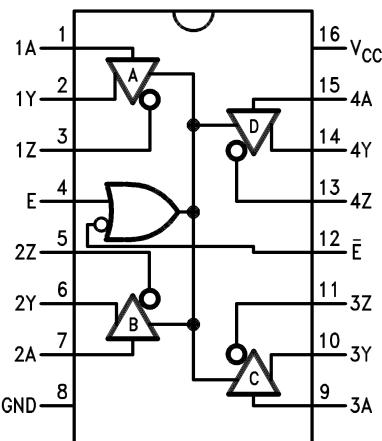


Figure 9. DS96F172 (Top View)  
CDIP - 16-Lead Ceramic Dual-In-Line Package  
See Package Number NFE

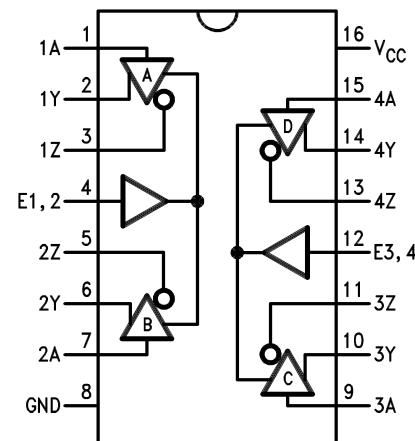
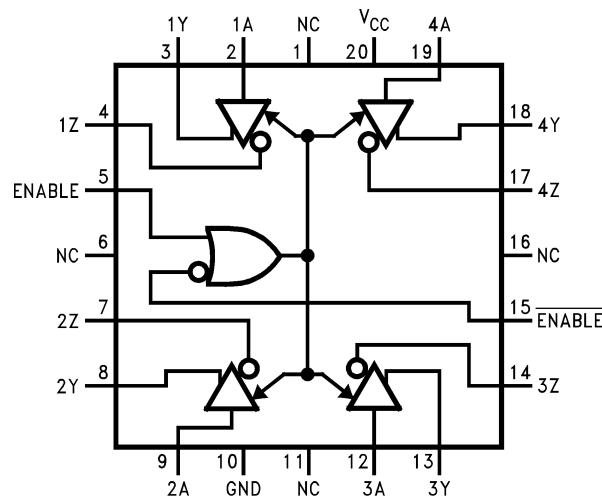
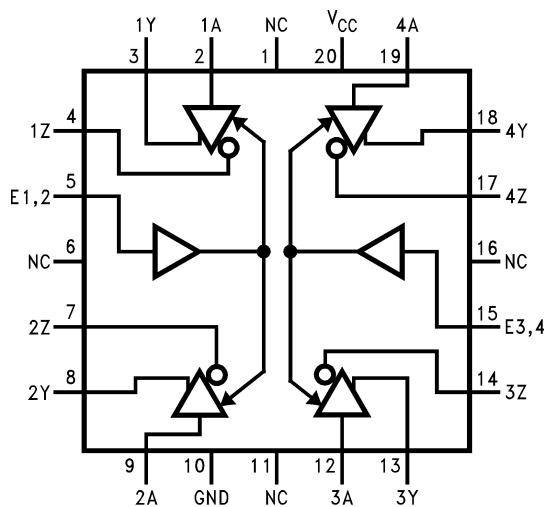


Figure 10. DS96F174 (Top View)  
CDIP - 16-Lead Ceramic Dual-In-Line Package  
See Package Number NFE



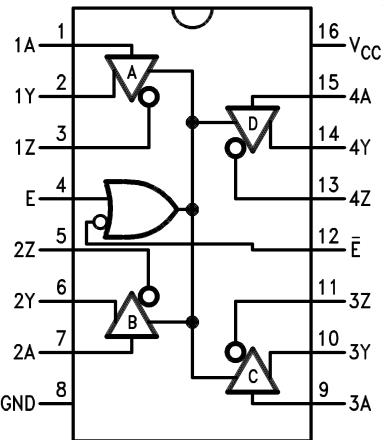
NC = No connection

Figure 11. 20-Lead Ceramic Leadless Chip Carrier - LCCC (Top View)  
See Package Number NAJ

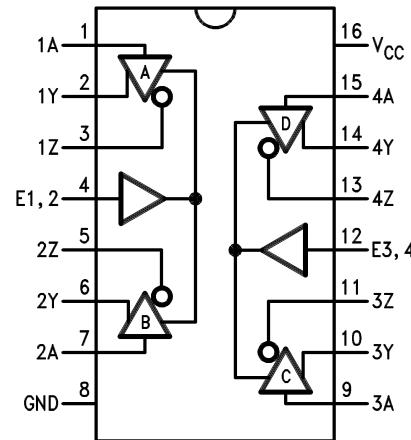


NC = No connection

**Figure 12. 20-Lead Ceramic Leadless Chip Carrier - LCCC (Top View)**  
See Package Number NAJ



**Figure 13. 16-Lead Ceramic Flatpack - CLGA**  
(Top View)  
See Package Number NAD



**Figure 14. 16-Lead Ceramic Flatpack - CLGA**  
(Top View)  
See Package Number NAD

## REVISION HISTORY

Changes from Revision E (April 2013) to Revision F	Page
• Changed layout of National Data Sheet to TI format .....	13

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