

# LMS75ALS176A

## Differential Bus Transceivers

### General Description

The LMS75ALS176A is a differential bus/line transceiver designed for bidirectional data communication on multipoint bus transmission lines. It is designed for balanced transmission lines. It meets ANSI Standards TIA/EIA RS422-B, TIA/EIA RS485-A and ITU recommendation V.11 and X.27. The LMS75ALS176A combines a TRI-STATE™ differential line driver and differential input receiver, both of which operate from a single 5.0V power supply. The driver and receiver have an active high and active low enable, respectively, that can be externally connected to function as a direction control. The driver and receiver differential inputs are internally connected to form differential input/output (I/O) bus ports that are designed to offer minimum loading to bus whenever the driver is disabled or when  $V_{CC} = 0V$ . These ports feature wide positive and negative common mode voltage ranges, making the device suitable for multipoint applications in noisy environments. The LMS75ALS176A is available in a 8-Pin SOIC package. It is a drop-in socket replacement to TI's SN75ALS176A.

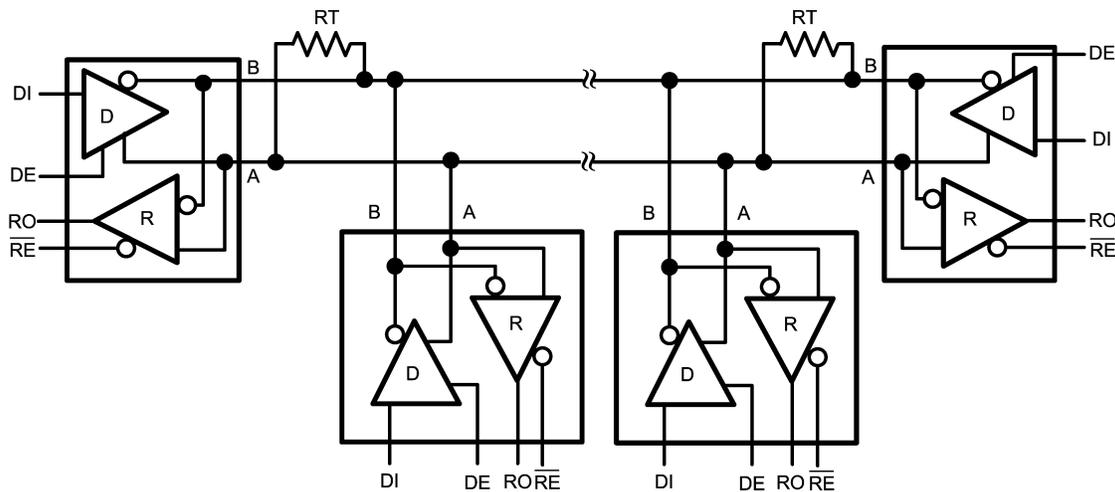
### Features

- Bidirectional transceiver
- Meet ANSI standard RS-485-A and RS-422-B
- Low skew, 2ns
- Low supply current, 8mA (max.)
- Wide input and output voltage range
- High output drive capacity  $\pm 60mA$
- Thermal shutdown protection
- Open circuit fail-safe for receiver
- Receiver input sensitivity  $\pm 200mV$
- Receiver input hysteresis 10mV (min.)
- Single supply voltage operation, 5V
- Glitch free power-up and power-down operation
- Data rates up to 35 Mbaud
- Pin and functional compatible with TI's SN75ALS176A
- 8-Pin SOIC

### Applications

- Network hubs, bridges, and routers
- Point of sales equipment (ATM, barcode readers,...)
- Industrial programmable logic controllers
- High speed parallel and serial applications
- Multipoint applications with noisy environment

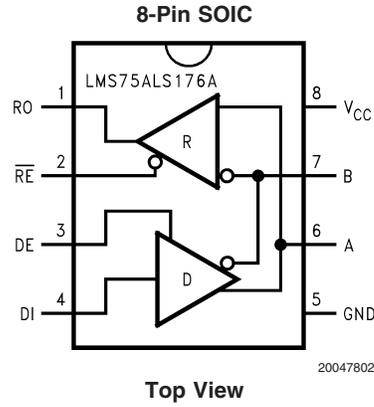
### Typical Application



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A Typical multipoint application is shown in the above figure. Terminating resistors,  $RT$ , are typically required but only located at the two ends of the cable. Pull up and pull down resistors maybe required at the end of the bus to provide failsafe biasing. The biasing resistors provide a bias to the cable when all drivers are in TRI-STATE, See National Application Note, AN-847 for further information.

## Connection Diagram



## Ordering Information

Package	Part Number	Package Marking	Transport Media	NSC Drawing
8-Pin SOIC	LMS75ALS176AM	LMS75LS176A	Rail	M08A
	LMS75ALS176AMX		2.5k Units Tape and Reel	

## Truth Table

DRIVER SECTION				
$\overline{RE}$	DE	DI	A	B
X	H	H	H	L
X	H	L	L	H
X	L	X	Z	Z
RECEIVER SECTION				
$\overline{RE}$	DE	A-B		RO
L	L	$\geq +0.2V$		H
L	L	$\leq -0.2V$		L
H	X	X		Z
L	L	OPEN *		H

**Note:** \* = Non Terminated, Open Input only

- X = Irrelevant
- Z = TRI-STATE
- H = High level
- L = Low level

**Absolute Maximum Ratings** (Note 1)

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

Supply Voltage, $V_{CC}$ (Note 2)	7V
Voltage Range at Any Bus Terminal	-7V to 12V
Input Voltage, $V_{IN}$ (DI, DE, or $\overline{RE}$ )	-0.3V to $V_{CC} + 0.3V$
Package Thermal Impedance, $\theta_{JA}$	125C/W
Junction Temperature (Note 3)	150°C
Operating Free-Air Temperature Range, $T_A$	0°C to 70°C
Storage Temperature Range	-65°C to 150°C
Soldering Information	
Infrared or Convection (20 sec.)	235°C
ESD Rating (Note 4)	2KV

**Operating Ratings**

	Min	Nom	Max	
Supply Voltage, $V_{CC}$	4.75	5.0	5.25	V
Voltage at any Bus Terminal (Separately or Common Mode)			12	V
			-7	
$V_{IN}$ or $V_{IC}$				
High-Level Input Voltage, $V_{IH}$ (Note 5)	2			V
Low-Level Input Voltage, $V_{IL}$ (Note 5)			0.8	V
Differential Input Voltage, $V_{ID}$ (Note 6)			±12	V
High-Level Output				
Driver, $I_{OH}$			-60	mA
Receiver, $I_{OH}$			-400	µA
Low-Level Output				
Driver, $I_{OL}$			60	mA
Receiver, $I_{OL}$			8	mA

**Electrical Characteristics**

$V_{CC} = 5V$ ,  $T_A = 0^\circ C$  to  $70^\circ C$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>Driver Section</b>						
$V_{CL}$	Input Clamp Voltage	$I_I = -18mA$			-1.5	V
$V_O$	Output Voltage	$I_O = 0$	0		6	V
$ V_{OD1} $	Differential Output Voltage	$I_O = 0$	1.5		6	V
$ V_{OD2} $	Differential Output Voltage	$R_L = 100\Omega$ ,	2			V
		$R_L = 54\Omega$	1.5	1.9	5	
$V_{OD3}$	Differential Output Voltage	$V_{TEST} = -7V$ to $12V$	1.5		5	V
$\Delta V_{OD}$	Change in Magnitude of Differential Output Voltage (Note 7)	$R_L = 54\Omega$ or $100\Omega$			±0.2	V
$V_{OC}$	Common-Mode Output Voltage	$R_L = 54\Omega$ or $100\Omega$			3	V
					-1	
$\Delta V_{OC}$	Change in Magnitude of Differential Output Voltage (Note 7)	$R_L = 54\Omega$ or $100\Omega$			±0.2	V
$I_O$	Output Current	Output Disabled (Note 8)	$V_O = 12V$		1	mA
			$V_O = -7V$		-0.8	
$I_{IH}$	High-Level Input Current	$V_{IN} = 2.4V$			20	µA
$I_{IL}$	Low-Level Input Current	$V_{IN} = 0.4V$			-400	µA
$I_{OSD}$	Short-Circuit Output Current	$V_O = -7V$			-250	mA
		$V_O = 0$			-150	
		$V_O = V_{CC}$			250	
		$V_O = 8V$			250	
$I_{CC}$	Supply Current	No Load		4.8	8	mA
		Outputs Enabled or Disabled				
<b>Switching Characteristics</b>						
$t_d$ (OD)	Differential Output Delay Time	$R_L = 54\Omega$ , $C_L = 50pF$	3	7	14	ns

**Electrical Characteristics** (Continued) $V_{CC} = 5V, T_A = 0^\circ C \text{ to } 70^\circ C$ 

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
$t_t$ (OD)	Differential Output Transition Time	$R_L = 54\Omega, C_L = 50pF$		8		ns	
$t_{sk(p)}$	Pulse Skew, ( $t_{d(ODH)} - t_{d(ODL)}$ )	$R_L = 54\Omega, C_L = 50pF$		0	3	ns	
$t_{sk(lim)}$	Pulse Skew	$R_L = 54\Omega, C_L = 50pF$ (Note 9)		4		ns	
$t_{PZH}$	Output Enable Time to High Level	$R_L = 110\Omega, C_L = 50pF$		18	50	ns	
$t_{PZL}$	Output Enable Time to Low Level	$R_L = 110\Omega, C_L = 50pF$		18	35	ns	
$t_{PHZ}$	Output Disable Time from High Level	$R_L = 110\Omega, C_L = 50pF$		9	35	ns	
$t_{PLZ}$	Output Disable Time from Low Level	$R_L = 110\Omega, C_L = 50pF$		10	17	ns	
<b>Receiver Section</b>							
$V_{TH+}$	Positive-Going Input Threshold Voltage	$V_O = 2.7V, I_O = -0.4mA$			0.2	V	
$V_{TH-}$	Negative-Going Input Threshold Voltage	$V_O = 0.5V, I_O = 8mA$	-0.2			V	
$\Delta V_{TH}$	Hysteresis Voltage ( $V_{TH+} - V_{TH-}$ )		10			mV	
$V_{CL}$	Enable-Input Clamp Voltage	$I_I = -18mA$			1.5	V	
$V_{OH}$	High-Level Output Voltage	$V_{ID} = 200mV, I_{OH} = -400\mu A$	2.7			V	
$V_{OL}$	Low-Level Output Voltage	$V_{ID} = -200mV, I_{OL} = 8mA$			0.45	V	
$I_{OZ}$	High-Impedance-State Output Current	$V_O = 0.4V \text{ to } 2.4V$			$\pm 20$	$\mu A$	
$I_{IN}$	Line Input Current	Other Input = 0V, (Note 5)		$V_{IN} = 12V$ $V_{IN} = -7V$	1 -0.8	mA	
$I_{IH}$	High-Level Enable-Input Current	$V_{IH} = 2.7V$			20	$\mu A$	
$I_{IL}$	Low-Level Enable-Input Current	$V_{IL} = 0.4V$			-100	$\mu A$	
$R_{IN}$	Input Resistance		12	20		$k\Omega$	
$I_{OSR}$	Short-Circuit Output Current	$V_{ID} = 200mV, V_O = 0V$	-15		-85	mA	
$I_{CC}$	Supply Current	No Load		Outputs Enabled or Disabled	4.8	8	mA
<b>Switching Characteristics</b>							
$t_{PD}$	Propagation Delay Time	$V_{ID} = -1.5V \text{ to } 1.5V, C_L = 15pF$	8	18	30	ns	
$t_{sk(p)}$	Pulse Skew ( $t_{PLH} - t_{PHL}$ )	$V_{ID} = -1.5V \text{ to } 1.5V, C_L = 15pF$		2		ns	
$t_{sk(lim)}$	Pulse Skew	$R_L = 54\Omega, C_L = 50pF$ (Note 9)		7.5		ns	
$t_{PZH}$	Output Enable Time to High Level	$C_L = 15pF$		5	35	ns	
$t_{PZL}$	Output Enable Time to Low Level	$C_L = 15pF$		5	35	ns	
$t_{PHZ}$	Output Disable Time from High Level	$C_L = 15pF$		20	35	ns	
$t_{PLZ}$	Output Disable Time from Low Level	$C_L = 15pF$		10	17	ns	

## Electrical Characteristics (Continued)

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics

**Note 2:** All voltage values, except differential I/O bus voltage, are with respect to network ground terminal.

**Note 3:** The maximum power dissipation is a function of  $T_{J(MAX)}$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$ . All numbers apply for packages soldered directly into a PC board.

**Note 4:** ESD rating based upon human body model, 100pF discharged through 1.5kΩ.

**Note 5:** Voltage limits apply to DI, DE,  $\overline{RE}$  pins.

**Note 6:** Differential input/output bus voltage is measured at the non-inverting terminal A with respect to the inverting terminal B.

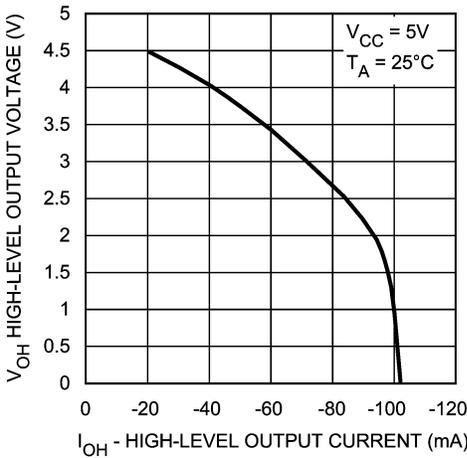
**Note 7:**  $|\Delta V_{OD}|$  and  $|\Delta V_{OC}|$  are changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively when the input changes from high to low levels.

**Note 8:** Applies to both power on and off (ANSI Standard RS-485 conditions). Does not apply to TIA/EIA-422-B for a combined driver and receiver combination.

**Note 9:** Skew limit is the maximum difference in propagation delay between any two channels of any two devices.

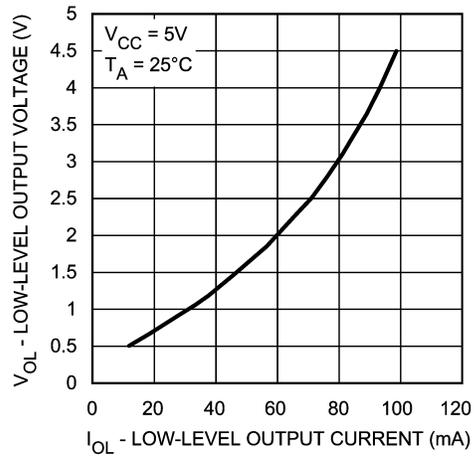
## Typical Performance Characteristics

Driver High-Level Output Voltage vs. High-Level Output Current



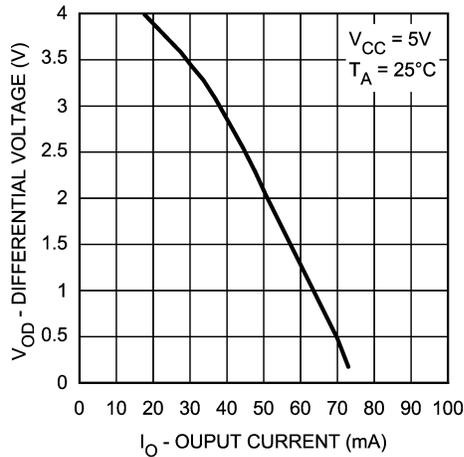
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Driver Low-Level Output Voltage vs. Low-Level Output Current



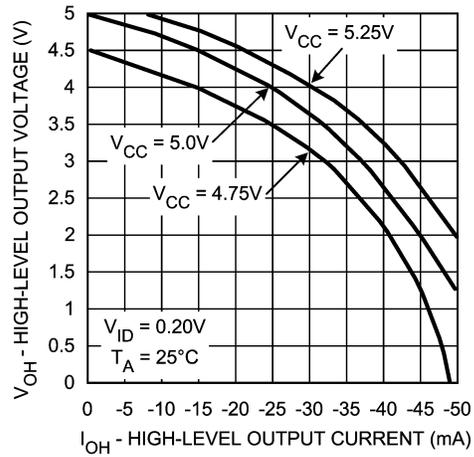
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Driver Differential Output Voltage vs. Output Current



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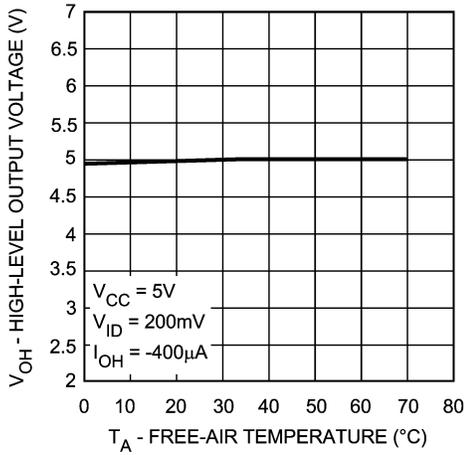
Receiver High-Level Output Voltage vs. High-Level Output Current



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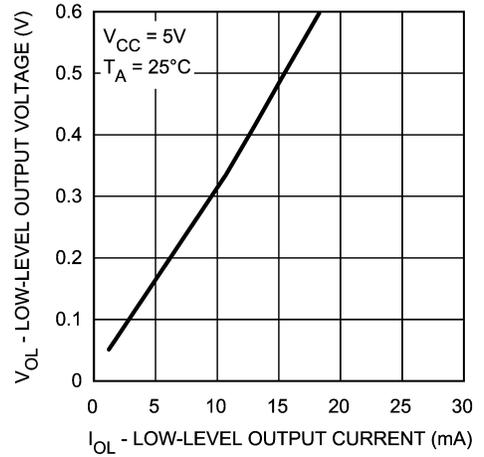
# Typical Performance Characteristics (Continued)

**Receiver High-Level Output Voltage vs. Free-Air Temperature**



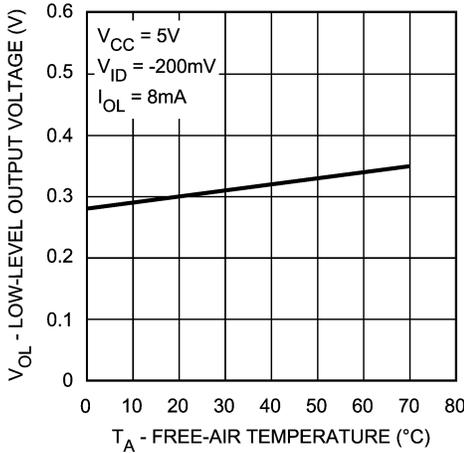
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**Receiver Low-Level Output Voltage vs. Low-Level Output Current**



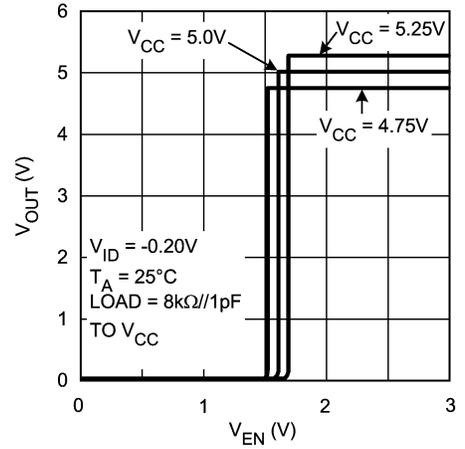
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**Receiver Low-Level Output Voltage vs. Free-Air Temperature**



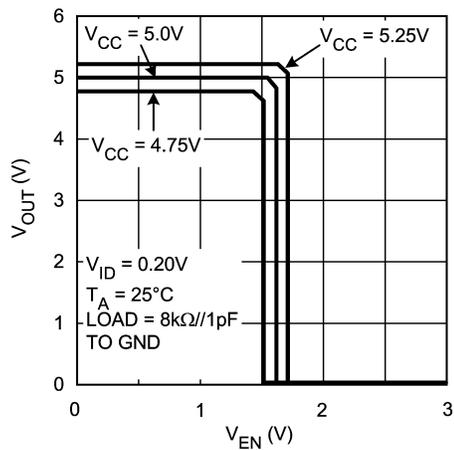
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**Receiver Output Voltage vs. Enable Voltage**



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**Receiver Output Voltage vs. Enable Voltage**



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# Parameter Measuring Information

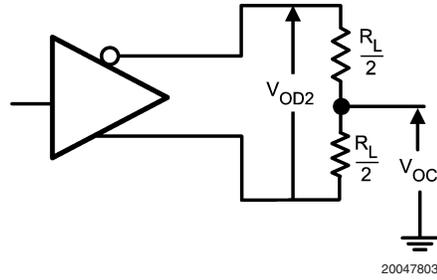


FIGURE 1. Test Circuit for  $V_{OD2}$  and  $V_{OC}$

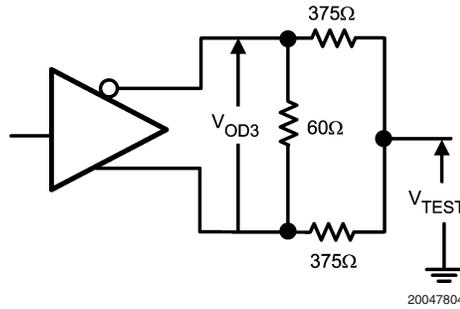


FIGURE 2. Test Circuit for  $V_{OD3}$

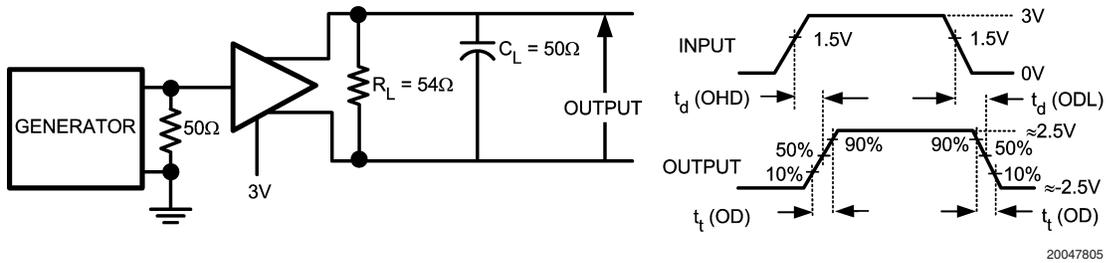


FIGURE 3. Test Circuit for Driver Differential Output Delay and Transition Times

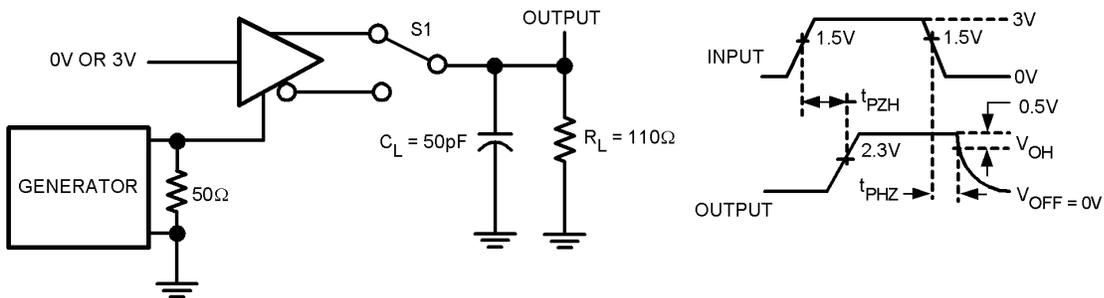
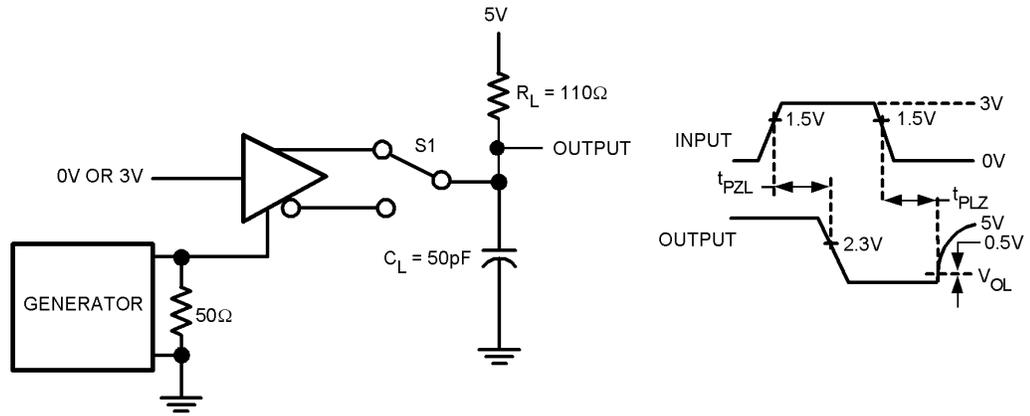


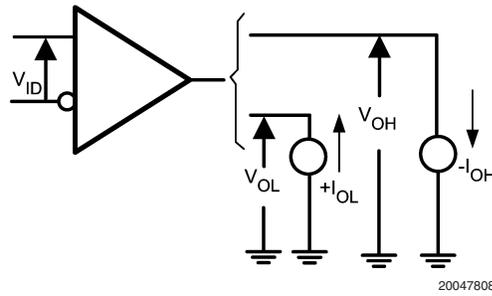
FIGURE 4. Test Circuit for Driver  $T_{PZH}$  and  $T_{PHZ}$

Parameter Measuring Information (Continued)



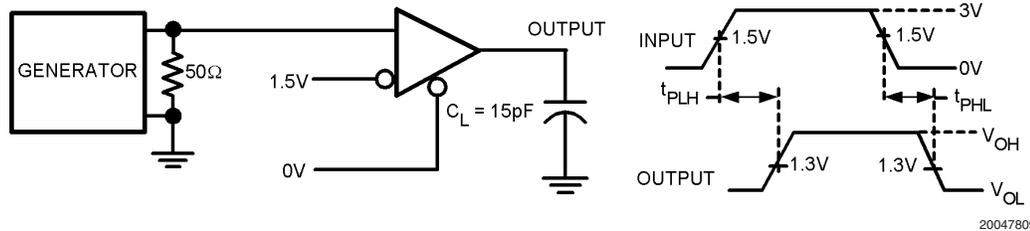
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FIGURE 5. Test Circuit for  $T_{PZL}$  and  $T_{PLZ}$



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FIGURE 6. Test Circuit for Receiver  $V_{OH}$  and  $V_{OL}$

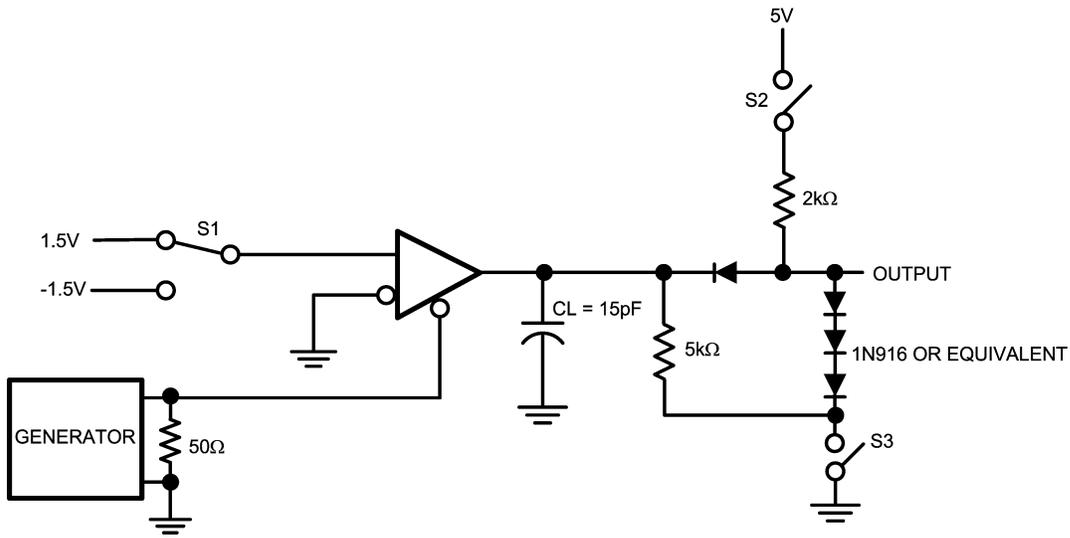


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FIGURE 7. Test Circuit for  $T_{PLH}$  and  $T_{PHL}$

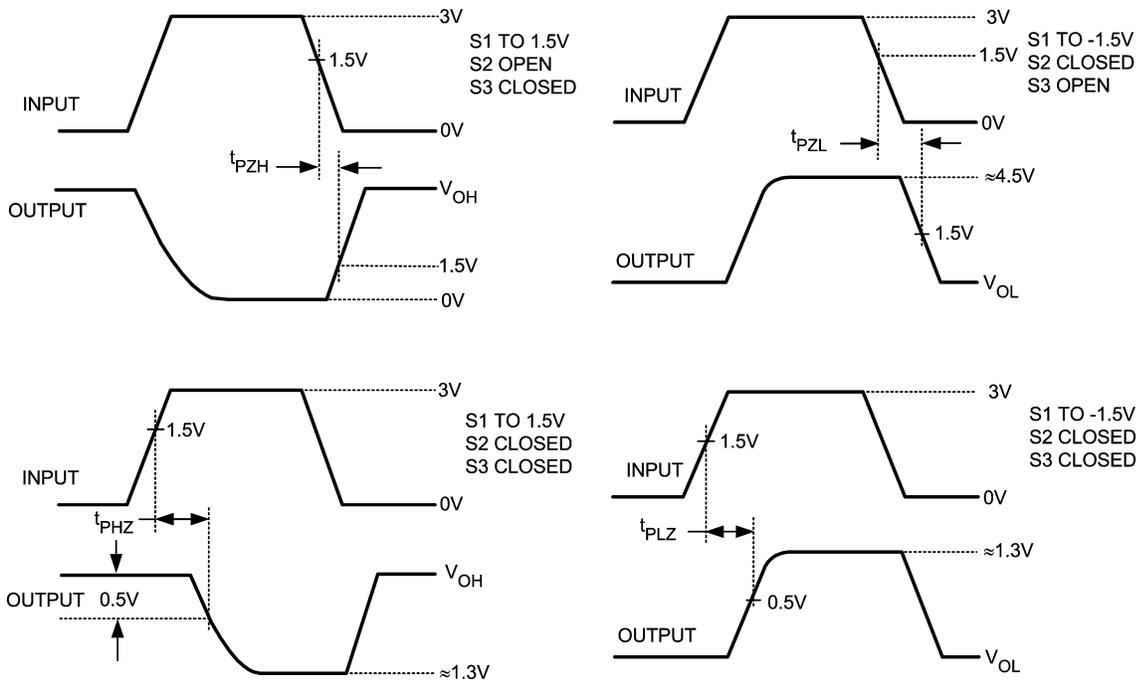
Parameter Measuring Information (Continued)

Test Circuit



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Voltage Waveforms



VOLTAGE WAVEFORMS

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FIGURE 8. Test Circuit for Receiver  $T_{PZH}/T_{PZL}$  and  $T_{PHZ}/T_{PLZ}$

## Application Information

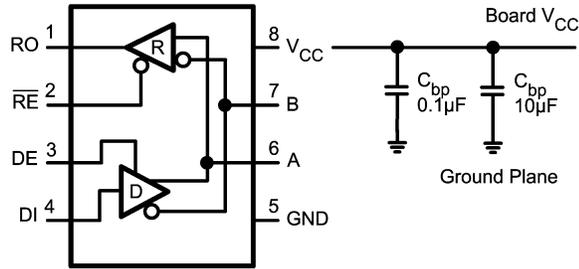
### POWER LINE NOISE FILTERING

A factor to consider in designing power and ground is noise filtering. A noise filtering circuit is designed to prevent noise generated by the integrated circuit (IC) as well as noise entering the IC from other devices. A common filtering method is to place by-pass capacitors ( $C_{bp}$ ) between the power and ground lines.

Placing a by-pass capacitor ( $C_{bp}$ ) with the correct value at the proper location solves many power supply noise problems. Choosing the correct capacitor value is based upon the desired noise filtering range. Since capacitors are not

ideal, they may act more like inductors or resistors over a specific frequency range. Thus, many times two by-pass capacitors may be used to filter a wider bandwidth of noise. It is highly recommended to place a larger capacitor, such as  $10\mu\text{F}$ , between the power supply pin and ground to filter out low frequencies and a  $0.1\mu\text{F}$  to filter out high frequencies.

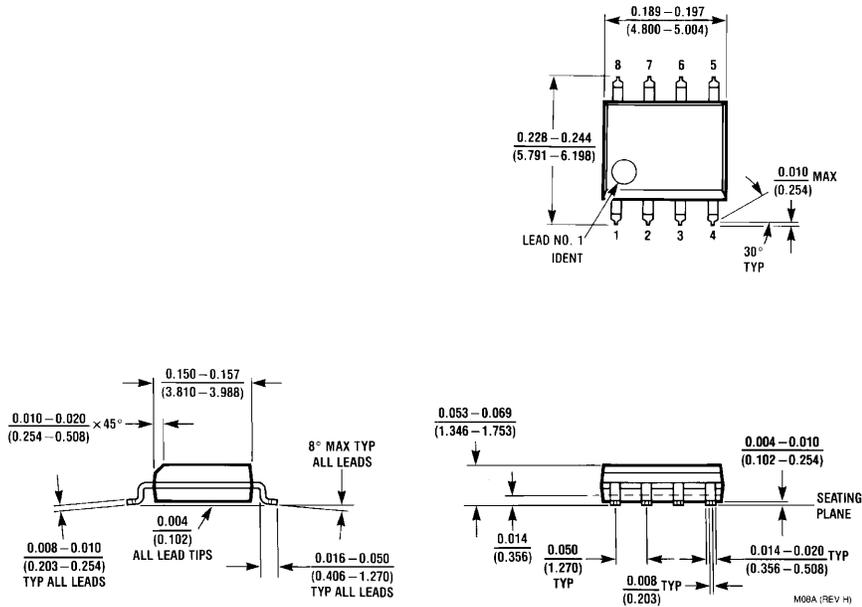
By pass-capacitors must be mounted as close as possible to the IC to be effective. Long leads produce higher impedance at higher frequencies due to stray inductance. Thus, this will reduce the by-pass capacitor's effectiveness. Surface mounted chip capacitors are the best solution because they have lower inductance.



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FIGURE 9. Placement of by-pass Capacitors,  $C_{bp}$

**Physical Dimensions** inches (millimeters) unless otherwise noted



**8-Pin SOIC  
NS Package Number M08A**

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