



April 1999

## DS26LV32AT 3V Enhanced CMOS Quad Differential Line Receiver

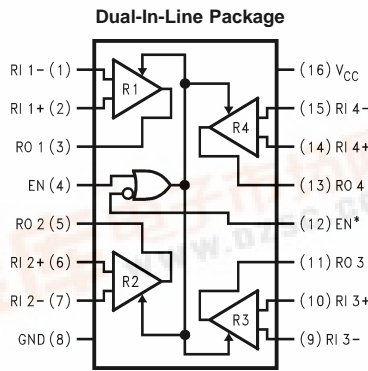
### General Description

The DS26LV32A is a high speed quad differential CMOS receiver that meets the requirements of both TIA/EIA-422-B and ITU-T V.11. The CMOS DS26LV32AT features typical low static  $I_{CC}$  of 9 mA which makes it ideal for battery powered and power conscious applications. The TRI-STATE® enables, EN and EN\*, allow the device to be active High or active Low. The enables are common to all four receivers. The receiver output (RO) is guaranteed to be High when the inputs are left open. The receiver can detect signals as low as  $\pm 200$  mV over the common mode range of  $\pm 10$ V. The receiver outputs (RO) are compatible with TTL and LVCMOS levels.

### Features

- Low Power CMOS design (30 mW typical)
- Interoperable with existing 5V RS-422 networks
- Industrial and Military Temperature Range
- Conforms to TIA/EIA-422-B (RS-422) and ITU-T V.11 Recommendation
- 3.3V Operation
- $\pm 7$ V Common Mode Range @  $V_{ID} = 3$ V
- $\pm 10$ V Common Mode Range @  $V_{ID} = 0.2$ V
- Receiver OPEN input failsafe feature
- Guaranteed AC Parameter:
  - Maximum Receiver Skew: 4 ns
  - Maximum Transition Time: 10 ns
- Pin compatible with DS26C32AT
- 32 MHz Toggle Frequency
- > 6.5k ESD Tolerance (HBM)
- Available in SOIC and Cerpack Packaging
- Standard Microcircuit Drawing (SMD) 5962-98585

### Connection Diagram



### Truth Table

Enables		Inputs	Output
EN	EN*	RI+–RI–	RO
L	H	X	Z
All Other Combinations of Enable Inputs		$V_{ID} \geq +0.2$ V	H
		$V_{ID} \leq -0.2$ V	L
		Open†	H

† Open, not terminated  
L = Logic Low  
H = Logic High  
X = Irrelevant  
Z = TRI-STATE

TRI-STATE® is a registered trademark of National Semiconductor Corporation.



## 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 ( $V_{CC}$ )	-0.5V to +7V
Enable Input Voltage (EN, EN*)	-0.5V to $V_{CC}$ +0.5V
Receiver Input Voltage ( $V_{ID}$ : RI+, RI-)	±14V
Receiver Input Voltage (VCM: RI+, RI-)	±14V
Receiver Output Voltage (RO)	-0.5V to $V_{CC}$ +0.5V
Receiver Output Current (RO)	±25 mA Maximum
Maximum Package Power Dissipation @ +25°C	
M Package	1190 mW
W Package	1087 mW
Derate M Package 9.8 mW/°C above +25°C	
Derate W Package 7.3 mW/°C above +25°C	

Storage Temperature Range	-65°C to +150°C
Lead Temperature Range Soldering (4 Sec.)	+260°C
ESD Ratings (HBM, 1.5 kΩ, 100 pF)	
Receiver Inputs and Enables	≥ 6.5 kV
Other Pins	≥ 2 kV

## Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage ( $V_{CC}$ )	3.0	3.3	3.6	V
Operating Free Air Temperature Range ( $T_A$ )				
DS26LV32AT	-40	+25	+85	°C
DS26LV32AW	-55	+25	+125	°C

## Electrical Characteristics (Notes 2, 3)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified.

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units	
$V_{TH}$	Differential Input Threshold	$V_{OUT} = V_{OH}$ or $V_{OL}$	RI+, RI-	$V_{CM} = -7V$ to +7V, $T_A = -40^\circ C$ to +85°C	-200	±17.5	+200	mV
				$V_{CM} = -0.5V$ to +5.5V, $T_A = -55^\circ C$ to +125°C (Note 9)	-200		+200	mV
$V_{HY}$	Hysteresis	$V_{CM} = 1.5V$			35		mV	
$V_{IH}$	Minimum High Level Input Voltage		EN, EN*	2.0			V	
$V_{IL}$	Maximum Low Level Input Voltage		EN, EN*			0.8	V	
$R_{IN}$	Input Resistance	$V_{IN} = -7V, +7V, T_A = -40^\circ C$ to +85°C (Other Input = GND)	RI+, RI-	5.0	8.5		kΩ	
		$V_{IN} = -0.5V, +5.5V, T_A = -55^\circ C$ to +125°C (Other Input = GND) (Note 9)		5.0			kΩ	
$I_{IN}$	Input Current (Other Input = 0V, Power On, or $V_{CC} = 0V$ )	$V_{IN} = +10V$ $V_{IN} = +3V$ $V_{IN} = 0.5V$ $V_{IN} = -3V$ $V_{IN} = -10V$ $V_{IN} = -0.5V$ $V_{IN} = 5.5V$	RI+, RI-	$T_A = -40^\circ C$ to +85°C	0	1.1	1.8	mA
					0	0.27		mA
						-0.02		mA
					0	-0.43		mA
					0	-1.26	-2.2	mA
					0		-1.8	mA
				1.8	mA			

## Electrical Characteristics (Notes 2, 3) (Continued)

Over Supply Voltage and Operating Temperature ranges, unless otherwise specified.

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units
$I_{EN}$	Input Current	$V_{IN} = 0V$ to $V_{CC}$	EN, EN*			$\pm 1$	$\mu A$
$V_{OH}$	High Level Output Voltage	$I_{OH} = -6 mA$ , $V_{ID} = +1V$ $I_{OH} = -6 mA$ , $V_{ID} = OPEN$	RO	2.4	3		V
$V_{OH}$	High Level Output Voltage	$I_{OH} = -100 \mu A$ , $V_{ID} = +1V$ $I_{OH} = -100 \mu A$ , $V_{ID} = OPEN$			$V_{CC} - 0.1$		V
$V_{OL}$	Low Level Output Voltage	$I_{OL} = +6 mA$ , $V_{ID} = -1V$			0.13	0.5	V
$I_{OZ}$	Output TRI-STATE Leakage Current	$V_{OUT} = V_{CC}$ or GND EN = $V_{IL}$ , EN* = $V_{IH}$				$\pm 50$	$\mu A$
$I_{SC}$	Output Short Circuit Current	$V_O = 0V$ , $V_{ID} \geq  200 mV $ (Note 4)		-10	-35	-70	mA
$I_{CC}$	Power Supply Current	No Load, All RI+, R1- = OPEN, EN, EN* = $V_{CC}$ or GND	$V_{CC}$		9	15	mA
						20	mA

## Switching Characteristics - Industrial (Notes 3, 7, 10, 11)

Over Supply Voltage and -40°C to +85°C Operating Temperature range, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{PHL}$	Propagation Delay High to Low	$C_L = 15 pF$ , $V_{CM} = 1.5V$ (Figures 1, 2)	6	17.5	35	ns
$t_{PLH}$	Propagation Delay Low to High		6	17.8	35	ns
$t_r$	Rise Time (20% to 80%)			4.1	10	ns
$t_f$	Fall Time (80% to 20%)			3.3	10	ns
$t_{PHZ}$	Disable Time	$C_L = 50 pF$ , $V_{CM} = 1.5V$ (Figures 3, 4)			40	ns
$t_{PLZ}$	Disable Time				40	ns
$t_{PZH}$	Enable Time				40	ns
$t_{PZL}$	Enable Time				40	ns
$t_{SK1}$	Skew, $ t_{PHL} - t_{PLH} $ (Note 5)	$C_L = 15 pF$ , $V_{CM} = 1.5V$		0.3	4	ns
$t_{SK2}$	Skew, Pin to Pin (Note 6)			0.6	4	ns
$t_{SK3}$	Skew, Part to Part (Note 7)			7	17	ns
$f_{MAX}$	Maximum Operating Frequency (Note 8)	$C_L = 15 pF$ , $V_{CM} = 1.5V$	32			MHz

## Switching Characteristics - Military (Notes 10, 11)

Over Supply Voltage and -55°C to +125°C Operating Temperature range, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Max	Units
$t_{PHL}$	Propagation Delay High to Low	$C_L = 50 \text{ pF}$ , $V_{CM} = 1.5V$ (Figures 1, 2)	6	45	ns
$t_{PLH}$	Propagation Delay Low to High		6	45	ns
$t_{PHZ}$	Disable Time	$C_L = 50 \text{ pF}$ , $V_{CM} = 1.5V$ (Figures 3, 4)		50	ns
$t_{PLZ}$	Disable Time			50	ns
$t_{PZH}$	Enable Time			50	ns
$t_{PZL}$	Enable Time			50	ns
$t_{SK1}$	Skew, $ t_{PHL} - t_{PLH} $ (Note 5)	$C_L = 50 \text{ pF}$ , $V_{CM} = 1.5V$		6	ns
$t_{SK2}$	Skew, Pin to Pin (Note 6)			6	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 table of "Electrical Characteristics" specifies conditions of device operation.

**Note 2:** Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except  $V_{ID}$ .

**Note 3:** All typicals are given for:  $V_{CC} = +3.3V$ ,  $T_A = +25^\circ C$ .

**Note 4:** Short one output at a time to ground. Do not exceed package.

**Note 5:**  $t_{SK1}$  is the  $|t_{PHL} - t_{PLH}|$  of a channel.

**Note 6:**  $t_{SK2}$  is the maximum skew between any two channels within a device, either edge.

**Note 7:**  $t_{SK3}$  is the difference in propagation delay times between any channels of any devices. This specification (maximum limit) applies to devices within  $V_{CC} \pm 0.1V$  of one another, and a  $\Delta T_A = \pm 5^\circ C$  (between devices) within the operating temperature range. This parameter is guaranteed by design and characterization.

**Note 8:** All channels switching. Output Duty Cycle criteria is 40%/60% measured at 50%. Input = 1V to 2V, 50% Duty Cycle,  $t_r/t_f \leq 5 \text{ ns}$ . This parameter is guaranteed by design and characterization.

**Note 9:** This parameter does not meet the TIA/EIA-422-B specification.

## Parameter Measurement Information

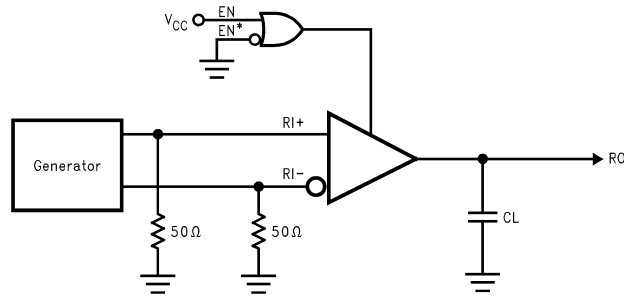
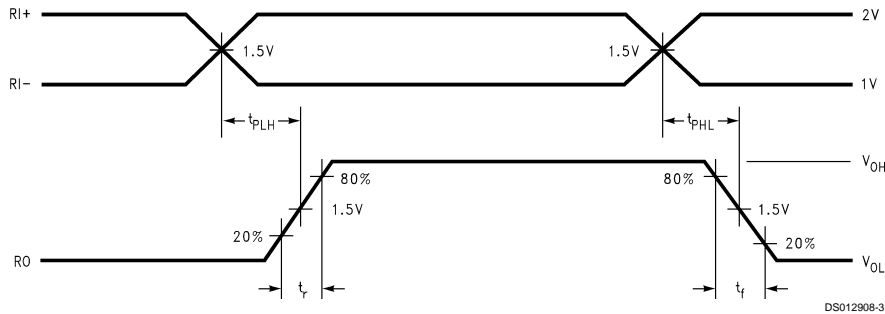


FIGURE 1. Receiver Propagation Delay and Transition Time Test Circuit (Notes 10, 11)

## Parameter Measurement Information (Continued)



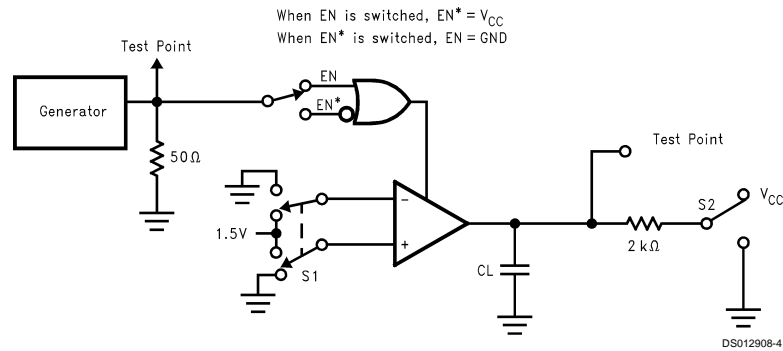
**Note 10:** Generator waveform for all tests unless otherwise specified:  $f = 1 \text{ MHz}$ , Duty Cycle = 50%,  $Z_0 = 50\Omega$ ,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ .

**Note 11:**  $C_L$  includes probe and jig capacitance.

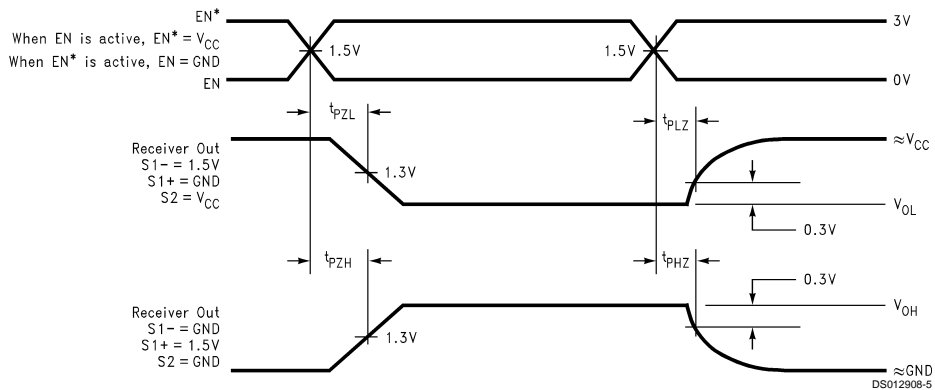
**Note 12:** For military grade product,  $t_r \leq 6 \text{ ns}$  and  $t_f \leq 6 \text{ ns}$ .

**Note 13:** For military grade product the measure point is  $1/2 V_{CC}$  for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_{PZL}$ , and  $t_{PZH}$

**FIGURE 2. Receiver Propagation Delay and Transition Time Waveform (Notes 10, 11, 12, 13)**



**FIGURE 3. Receiver TRI-STATE Test Circuit**



**FIGURE 4. Receiver TRI-STATE Output Enable and Disable Waveforms (Notes 10, 11, 12, 13)**

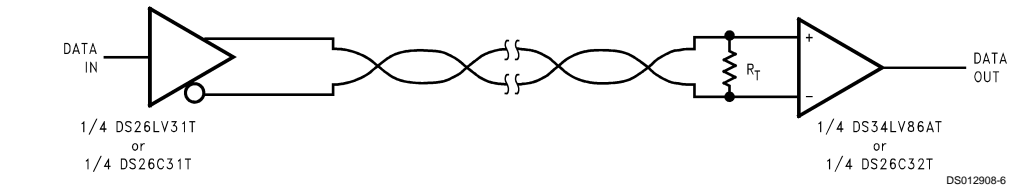
## Typical Application Information

General application guidelines and hints for differential drivers and receivers may be found in the following application notes:

AN-214, AN-457, AN-805, AN-847, AN-903, AN-912, AN-916

### Power Decoupling Recommendations:

Bypass caps must be used on power pins. High frequency ceramic (surface mount is recommended) 0.1  $\mu\text{F}$  in parallel with 0.01  $\mu\text{F}$  at the power supply pin. A 10  $\mu\text{F}$  or greater solid tantalum or electrolytic should be connected at the power entry point on the printed circuit board.



$R_T$  is optional although highly recommended to reduce reflection

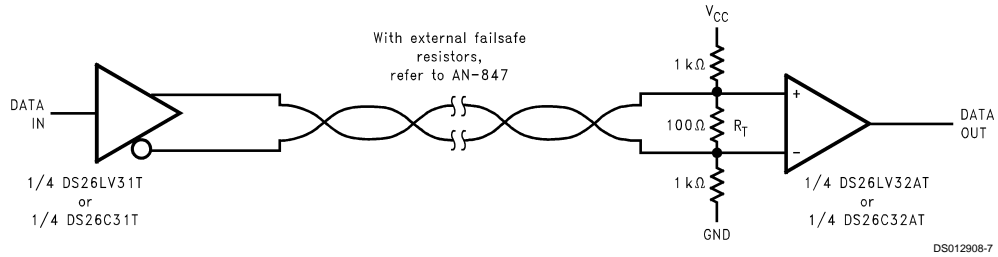


FIGURE 5. Typical Receiver Connections

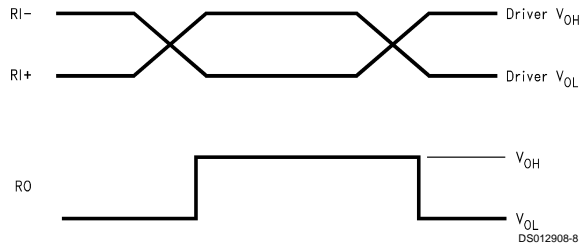


FIGURE 6. Typical Receiver Output Waveforms

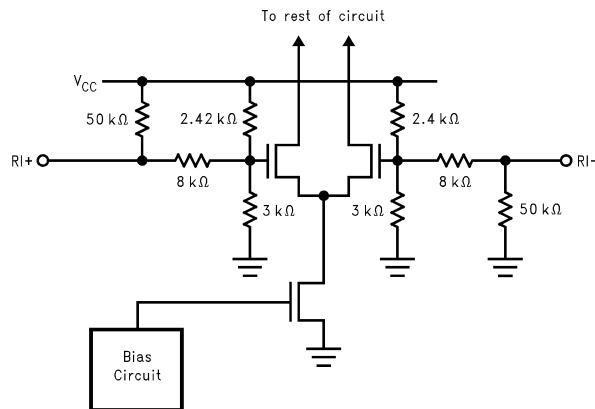
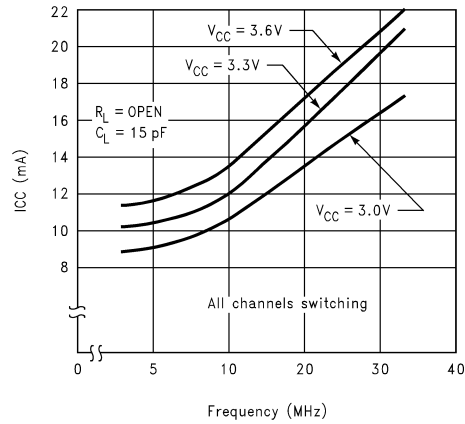
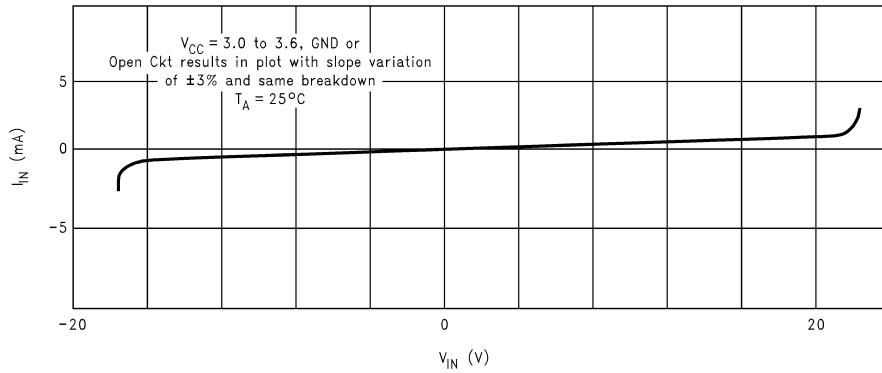


FIGURE 7. Typical Receiver Input Circuit

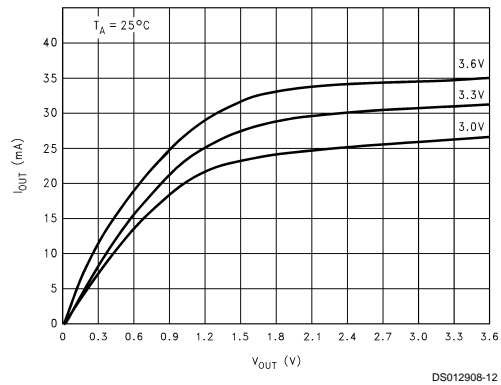
**Typical Application Information** (Continued)



**FIGURE 8. Typical  $I_{CC}$  vs Frequency**



**FIGURE 9. Receiver  $I_{IN}$  vs  $V_{IN}$  (Power On or Power Off)**



**FIGURE 10.  $I_{OL}$  vs  $V_{OL}$**

### Typical Application Information (Continued)

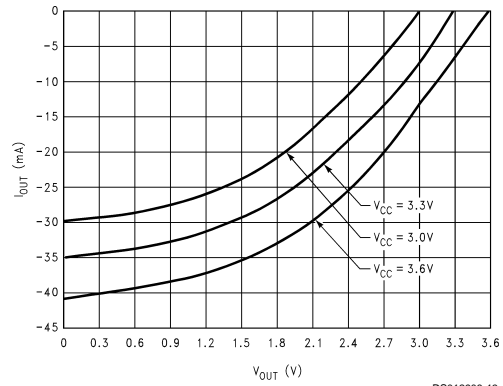
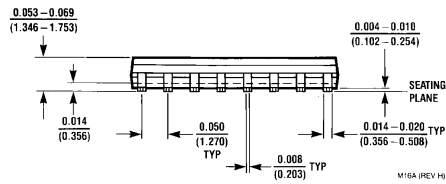
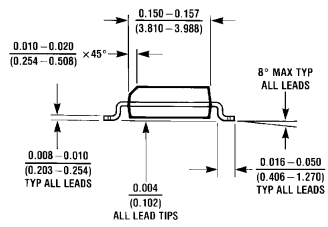
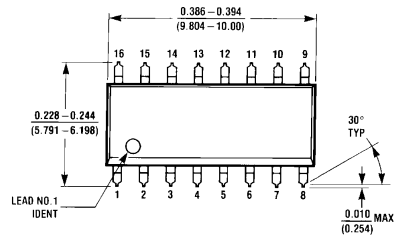


FIGURE 11.  $I_{OH}$  vs  $V_{OH}$

DS012908-13



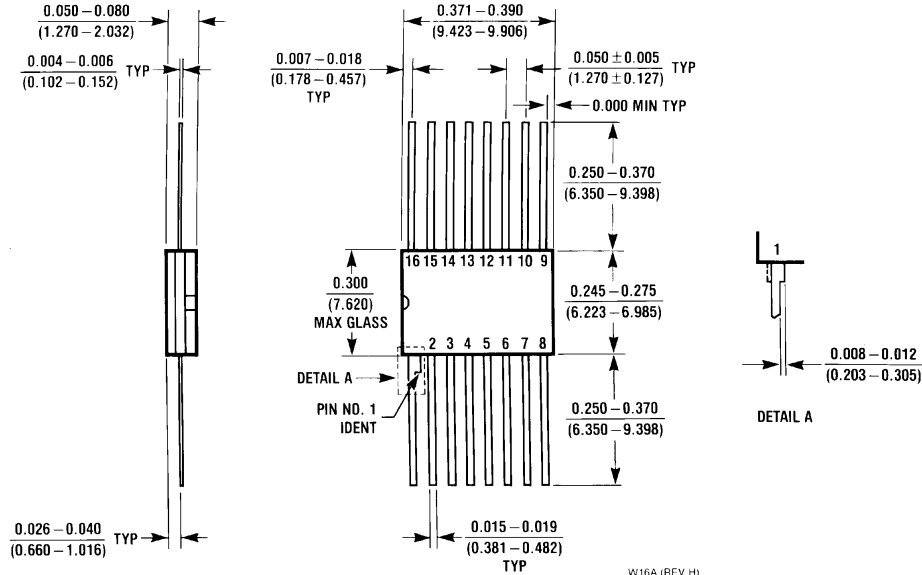
**Physical Dimensions** inches (millimeters) unless otherwise noted



**Order Number DS26LV32ATM**  
**NS Package Number M16A**

DS26LV32AT 3V Enhanced CMOS Quad Differential Line Receiver

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



W16A (REV H)

**Order Number DS26LV32AW**  
**NS Package Number W16A**

**LIFE SUPPORT POLICY**

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
Americas  
Tel: 1-800-272-9959  
Fax: 1-800-737-7018  
Email: support@nsc.com

www.national.com

**National Semiconductor Europe**

Fax: +49 (0) 1 80-530 85 86  
Email: europe.support@nsc.com  
Deutsch Tel: +49 (0) 1 80-530 85 85  
English Tel: +49 (0) 1 80-532 78 32  
Français Tel: +49 (0) 1 80-532 93 58  
Italiano Tel: +49 (0) 1 80-534 16 80

**National Semiconductor Asia Pacific Customer Response Group**

Tel: 65-2544466  
Fax: 65-2504466  
Email: sea.support@nsc.com

**National Semiconductor Japan Ltd.**

Tel: 81-3-5639-7560  
Fax: 81-3-5639-7507