

## DS26LV32AT 3V Enhanced CMOS Quad Differential Line Receiver

 Check for Samples: [DS26LV32AT](#)

### 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
- $\pm 7V$  Common Mode Range @  $V_{ID} = 3V$
- $\pm 10V$  Common Mode Range @  $V_{ID} = 0.2V$
- 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)

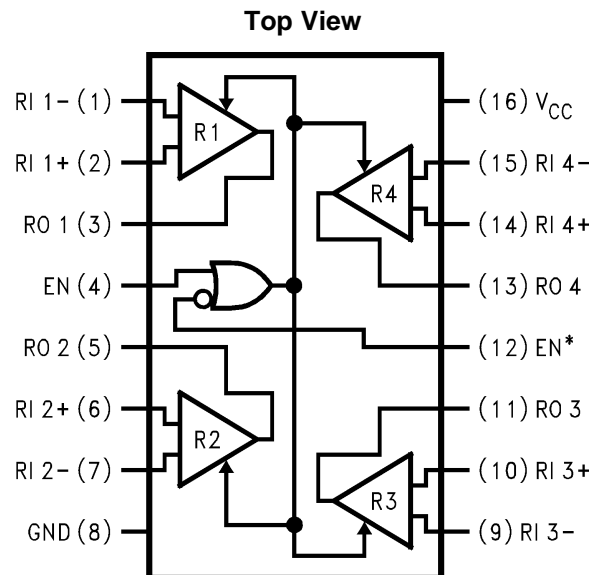
- Available in SOIC and CLGA Packaging
- Standard Microcircuit Drawing (SMD) 5962-98585

### 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  $\pm 10V$ . The receiver outputs (RO) are compatible with TTL and LVCMOS levels.

### Connection Diagram



**Figure 1.**  
**SOIC Package**  
See Package Numbers D0016A or NAD0016A



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Truth Table<sup>(1)</sup>

Enables		Inputs	Output
EN	EN*	RI+–RI–	RO
L	H	X	Z
All other combinations of enable inputs		$V_{ID} \geq +0.2V$	H
		$V_{ID} \leq -0.2V$	L
		Open <sup>(2)</sup>	H

- (1) L = Logic Low  
H = Logic High  
X = Irrelevant  
Z = TRI-STATE
- (2) Open, not terminated



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<sup>(1)(2)</sup>

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–)	$\pm 14V$
Receiver Input Voltage (VCM: RI+, RI–)	$\pm 14V$
Receiver Output Voltage (RO)	–0.5V to $V_{CC} + 0.5V$
Receiver Output Current (RO)	$\pm 25$ mA Maximum
Maximum Package Power Dissipation @ +25°C	
D0016A Package	1190 mW
NAD0016A Package	1087 mW
Derate D0016A Package 9.8 mW/°C above +25°C	
Derate NAD0016A 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 k $\Omega$ , 100 pF)	
Receiver Inputs and Enables	$\geq 6.5$ kV
Other Pins	$\geq 2$ kV

- (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 [Electrical Characteristics](#) specifies conditions of device operation.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.

### 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** (1) (2)

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

Parameter	Test Conditions	Pin	Min	Typ	Max	Units				
V <sub>TH</sub>	Differential Input Threshold V <sub>OUT</sub> = V <sub>OH</sub> or V <sub>OL</sub>	RI+, RI-	-200	±17.5	+200	mV				
							mV			
V <sub>HY</sub>	Hysteresis V <sub>CM</sub> = 1.5V			35		mV				
V <sub>IH</sub>	Minimum High Level Input Voltage	EN, EN*	2.0			V				
V <sub>IL</sub>	Maximum Low Level Input Voltage				0.8	V				
R <sub>IN</sub>	Input Resistance V <sub>IN</sub> = -7V, +7V, T <sub>A</sub> = -40°C to +85°C (Other Input = GND)		5.0	8.5		kΩ				
						kΩ				
I <sub>IN</sub>	Input Current (Other Input = 0V, Power On, or V <sub>CC</sub> = 0V)	RI+, RI-				T <sub>A</sub> = -40°C to +85°C				
						V <sub>IN</sub> = +10V	0	1.1	1.8	mA
						V <sub>IN</sub> = +3V	0	0.27		mA
						V <sub>IN</sub> = 0.5V		-0.02		mA
						V <sub>IN</sub> = -3V	0	-0.43		mA
						V <sub>IN</sub> = -10V	0	-1.26	-2.2	mA
						T <sub>A</sub> = -55°C to +125°C (3)				
V <sub>IN</sub> = -0.5V	0		-1.8	mA						
V <sub>IN</sub> = 5.5V	0		1.8	mA						
I <sub>EN</sub>	Input Current V <sub>IN</sub> = 0V to V <sub>CC</sub>	EN, EN*			±1	μA				
V <sub>OH</sub>	High Level Output Voltage I <sub>OH</sub> = -6 mA, V <sub>ID</sub> = +1V		2.4	3		V				
							I <sub>OH</sub> = -6 mA, V <sub>ID</sub> = OPEN			
V <sub>OH</sub>	High Level Output Voltage I <sub>OH</sub> = -100 μA, V <sub>ID</sub> = +1V				V <sub>CC</sub> - 0.1	V				
							I <sub>OH</sub> = -100 μA, V <sub>ID</sub> = OPEN			
V <sub>OL</sub>	Low Level Output Voltage I <sub>OL</sub> = +6 mA, V <sub>ID</sub> = -1V				0.13	0.5	V			
I <sub>OZ</sub>	Output TRI-STATE Leakage Current V <sub>OUT</sub> = V <sub>CC</sub> or GND					±50	μA			
								EN = V <sub>IL</sub> , EN* = V <sub>IH</sub>		
I <sub>SC</sub>	Output Short Circuit Current V <sub>O</sub> = 0V, V <sub>ID</sub> ≥  200 mV  (4)		-10	-35	-70	mA				
I <sub>CC</sub>	Power Supply Current No Load, All RI+, R1- = OPEN, EN, EN* = V <sub>CC</sub> or GND	V <sub>CC</sub>				T <sub>A</sub> = -40°C to +85°C	9	15	mA	
						T <sub>A</sub> = -55°C to +125°C			20	mA

 (1) 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<sub>ID</sub>.

 (2) All typicals are given for: V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C.

(3) This parameter does not meet the TIA/EIA-422-B specification.

(4) Short one output at a time to ground. Do not exceed package.

## Switching Characteristics - Industrial <sup>(1) (2)</sup>

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

Parameter		Test Conditions	Min	Typ	Max	Units
t <sub>PHL</sub>	Propagation Delay High to Low	C <sub>L</sub> = 15 pF, V <sub>CM</sub> = 1.5V (Figure 2 and Figure 3)	6	17.5	35	ns
t <sub>PLH</sub>	Propagation Delay Low to High		6	17.8	35	ns
t <sub>r</sub>	Rise Time (20% to 80%)			4.1	10	ns
t <sub>f</sub>	Fall Time (80% to 20%)			3.3	10	ns
t <sub>PHZ</sub>	Disable Time	C <sub>L</sub> = 50 pF, V <sub>CM</sub> = 1.5V (Figure 4 and Figure 5)			40	ns
t <sub>PLZ</sub>	Disable Time				40	ns
t <sub>PZH</sub>	Enable Time				40	ns
t <sub>PZL</sub>	Enable Time				40	ns
t <sub>SK1</sub>	Skew,  t <sub>PHL</sub> - t <sub>PLH</sub>   <sup>(3)</sup>	C <sub>L</sub> = 15 pF, V <sub>CM</sub> = 1.5V		0.3	4	ns
t <sub>SK2</sub>	Skew, Pin to Pin <sup>(4)</sup>			0.6	4	ns
t <sub>SK3</sub>	Skew, Part to Part <sup>(2)</sup>			7	17	ns
f <sub>MAX</sub>	Maximum Operating Frequency <sup>(5)</sup>	C <sub>L</sub> = 15 pF, V <sub>CM</sub> = 1.5V	32			MHz

(1) All typicals are given for: V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C.

(2) t<sub>SK3</sub> is the difference in propagation delay times between any channels of any devices. This specification (maximum limit) applies to devices within V<sub>CC</sub> ±0.1V of one another, and a Delta T<sub>A</sub> = ±5°C (between devices) within the operating temperature range. This parameter is guaranteed by design and characterization.

(3) t<sub>SK1</sub> is the |t<sub>PHL</sub> - t<sub>PLH</sub>| of a channel.

(4) t<sub>SK2</sub> is the maximum skew between any two channels within a device, either edge.

(5) All channels switching, Output Duty Cycle criteria is 40%/60% measured at 50%. Input = 1V to 2V, 50% Duty Cycle, t<sub>r</sub>/t<sub>f</sub> ≤ 5 ns. This parameter is guaranteed by design and characterization.

## Switching Characteristics - Military

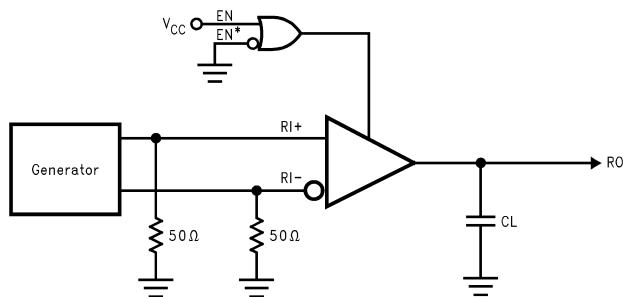
Over Supply Voltage and -55°C to +125°C Operating Temperature range, unless otherwise specified.

Parameter		Test Conditions	Min	Max	Units
t <sub>PHL</sub>	Propagation Delay High to Low	C <sub>L</sub> = 50 pF, V <sub>CM</sub> = 1.5V (Figure 2 and Figure 3)	6	45	ns
t <sub>PLH</sub>	Propagation Delay Low to High		6	45	ns
t <sub>PHZ</sub>	Disable Time	C <sub>L</sub> = 50 pF, V <sub>CM</sub> = 1.5V (Figure 4 and Figure 5)		50	ns
t <sub>PLZ</sub>	Disable Time			50	ns
t <sub>PZH</sub>	Enable Time			50	ns
t <sub>PZL</sub>	Enable Time			50	ns
t <sub>SK1</sub>	Skew,  t <sub>PHL</sub> - t <sub>PLH</sub>   <sup>(1)</sup>	C <sub>L</sub> = 50 pF, V <sub>CM</sub> = 1.5V		6	ns
t <sub>SK2</sub>	Skew, Pin to Pin <sup>(2)</sup>			6	ns

(1) t<sub>SK1</sub> is the |t<sub>PHL</sub> - t<sub>PLH</sub>| of a channel.

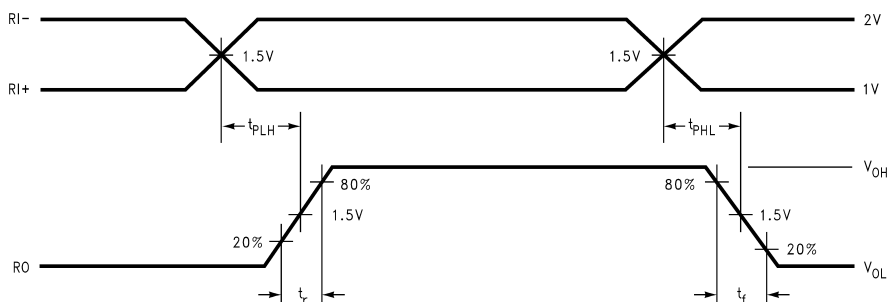
(2) t<sub>SK2</sub> is the maximum skew between any two channels within a device, either edge.

PARAMETER MEASUREMENT INFORMATION



- A. Generator waveform for all tests unless otherwise specified:  $f = 1 \text{ MHz}$ , Duty Cycle = 50%,  $Z_O = 50\Omega$ ,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ .
- B.  $C_L$  includes probe and jig capacitance.

Figure 2. Receiver Propagation Delay and Transition Time Test Circuit



- A. Generator waveform for all tests unless otherwise specified:  $f = 1 \text{ MHz}$ , Duty Cycle = 50%,  $Z_O = 50\Omega$ ,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ .
- B.  $C_L$  includes probe and jig capacitance.
- C. For military grade product,  $t_r \leq 6\text{ns}$  and  $t_f \leq 6\text{ns}$ .
- D. For military grade product the measure point is  $1/2 V_{CC}$  for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_{PZL}$ , and  $t_{PZH}$ .

Figure 3. Receiver Propagation Delay and Transition Time Waveform

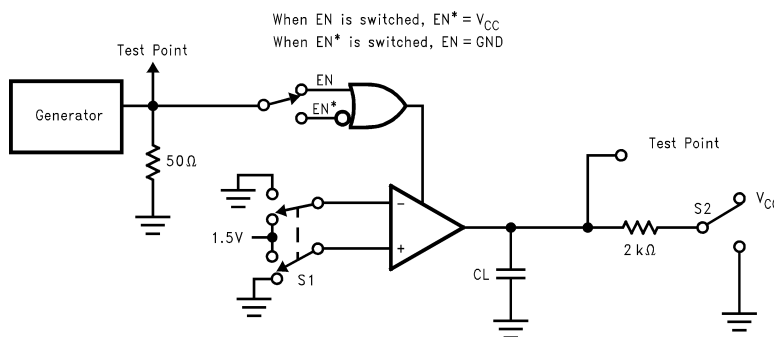
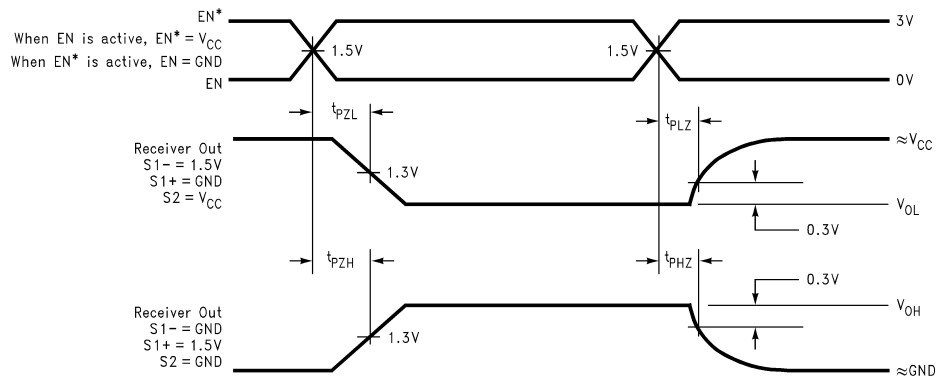


Figure 4. Receiver TRI-STATE Test Circuit



- Generator waveform for all tests unless otherwise specified:  $f = 1 \text{ MHz}$ , Duty Cycle = 50%,  $Z_O = 50\Omega$ ,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10 \text{ ns}$ .
- $C_L$  includes probe and jig capacitance.
- For military grade product,  $t_r \leq 6\text{ns}$  and  $t_f \leq 6\text{ns}$ .
- For military grade product the measure point is  $1/2 V_{CC}$  for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_{PZL}$ , and  $t_{PZH}$ .

**Figure 5. Receiver TRI-STATE Output Enable and Disable Waveforms**

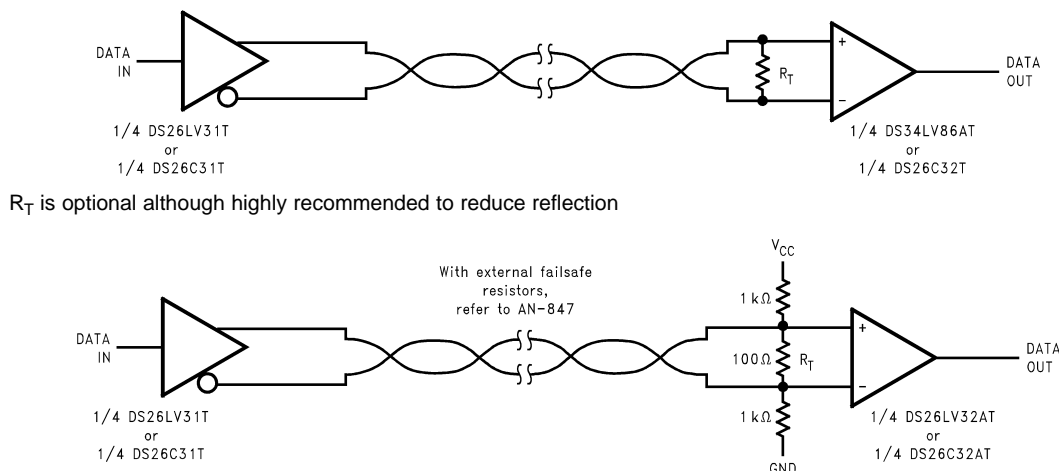
### TYPICAL APPLICATION INFORMATION

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

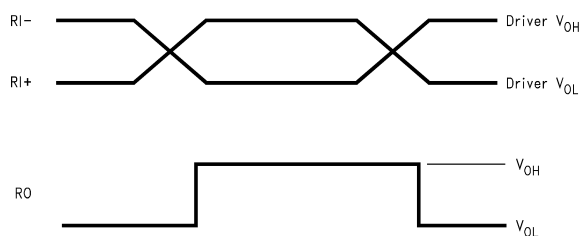
- AN-214
- AN-457
- AN-805
- AN-847
- AN-903
- AN-912
- AN-916

#### 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.



**Figure 6. Typical Receiver Connections**



**Figure 7. Typical Receiver Output Waveforms**

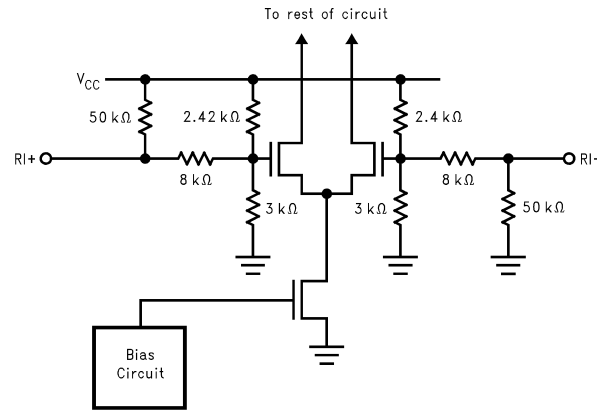


Figure 8. Typical Receiver Input Circuit

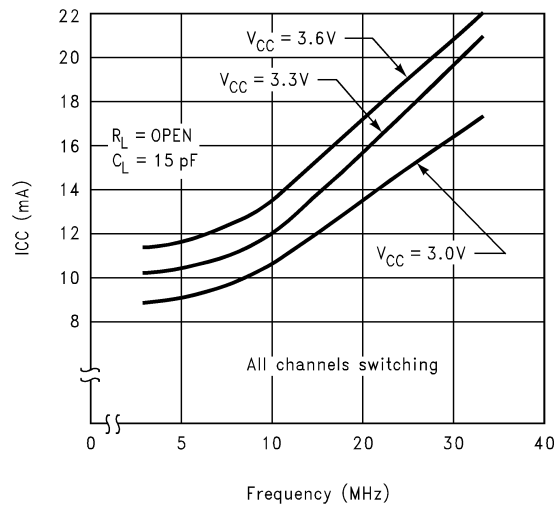


Figure 9. Typical I<sub>CC</sub> vs Frequency

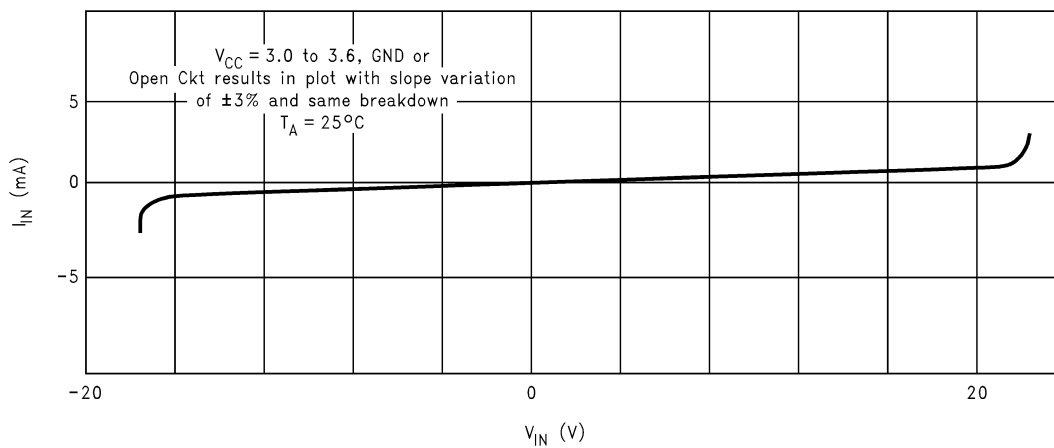
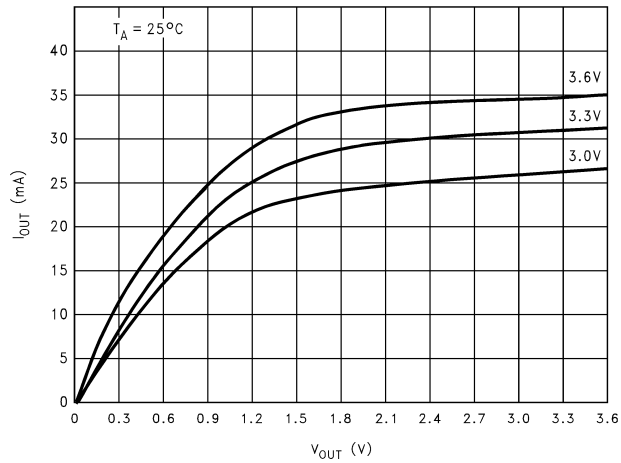
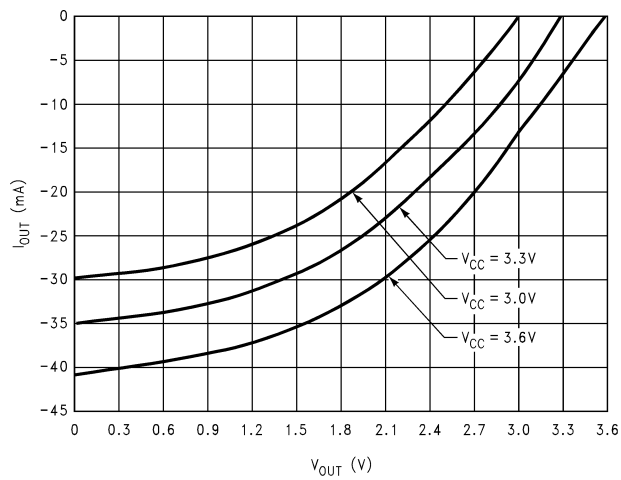


Figure 10. Receiver I<sub>IN</sub> vs V<sub>IN</sub> (Power On or Power Off)





**Figure 11.  $I_{OL}$  vs  $V_{OL}$**



**Figure 12.  $I_{OH}$  vs  $V_{OH}$**

## REVISION HISTORY

Changes from Revision B (February 2013) to Revision C	Page
• Changed layout of National Data Sheet to TI format .....	<a href="#">9</a>

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DS26LV32ATM	LIFEBUY	SOIC	D	16	48	TBD	Call TI	Call TI	-40 to 85	DS26LV32A TM	
DS26LV32ATM/NOPB	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS26LV32A TM	Samples
DS26LV32ATMX	LIFEBUY	SOIC	D	16	2500	TBD	Call TI	Call TI	-40 to 85	DS26LV32A TM	
DS26LV32ATMX/NOPB	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS26LV32A TM	Samples

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS26LV32ATMX	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.3	8.0	16.0	Q1
DS26LV32ATMX/NOPB	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.3	8.0	16.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS26LV32ATMX	SOIC	D	16	2500	367.0	367.0	35.0
DS26LV32ATMX/NOPB	SOIC	D	16	2500	367.0	367.0	35.0

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AC.

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