

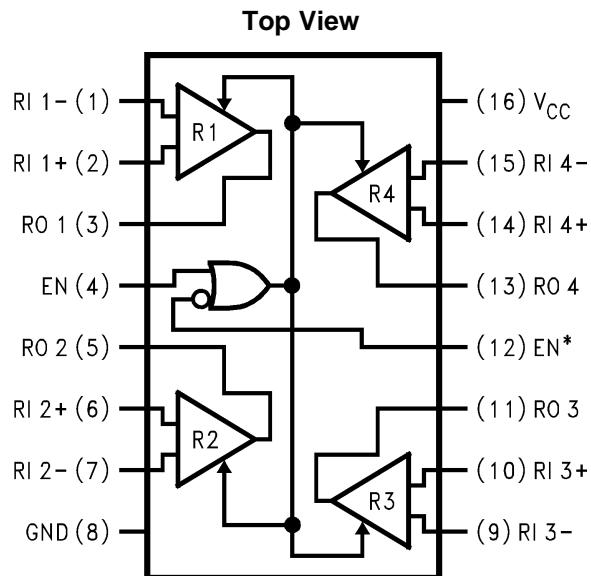
## DS26LV32AT 3V Enhanced CMOS Quad Differential Line Receiver

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)

### Connection Diagram



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



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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

| Enables                                       |     | Inputs              | Output |
|---|-----|---------------------|--------|
| EN  | EN* | RI+–RI–             | RO     |
| L   | H   | X                   | Z      |
| All other<br>combinations of<br>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–) | ±14V                    |  |  |
| Receiver Input Voltage<br>(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     |                         |  |  |
| 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<br>(4 Sec.)  | +260°C                  |  |  |
| ESD Ratings (HBM, 1.5 kΩ, 100 pF)             |                         |  |  |
| Receiver Inputs and Enables                   | ≥ 6.5 kV                |  |  |
| Other Pins                                    | ≥ 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 <sup>(1)</sup> <sup>(2)</sup>

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

| Parameter |  | Test Conditions  |  | Pin         | Min  | Typ            | Max      | Units |  |
|-----------|--|--|--|-------------|------|----------------|----------|-------|--|
| $V_{TH}$  | Differential Input Threshold   | $V_{OUT} = V_{OH}$ or $V_{OL}$   | $V_{CM} = -7V$ to $+7V$ ,<br>$T_A = -40^\circ C$ to<br>$+85^\circ C$                     | RI+,<br>RI- | -200 | $\pm 17.5$     | +200     | mV    |  |
|           |  |  | $V_{CM} = -0.5V$ to<br>$+5.5V$ , $T_A = -55^\circ C$<br>to $+125^\circ C$ <sup>(3)</sup> |             | -200 |                | +200     | mV    |  |
| $V_{HY}$  | Hysteresis   | $V_{CM} = 1.5V$  |  |             |      | 35             |          | mV    |  |
| $V_{IH}$  | Minimum High Level Input Voltage                                       |  |  | EN,<br>EN*  | 2.0  |                |          | V     |  |
|           |  |  |  |             |      |                | 0.8      | V     |  |
| $R_{IN}$  | Input Resistance   | $V_{IN} = -7V$ , $+7V$ , $T_A = -40^\circ C$ to $+85^\circ C$<br>(Other Input = GND)                     |  | RI+,<br>RI- | 5.0  | 8.5            |          | kΩ    |  |
|           |  | $V_{IN} = -0.5V$ , $+5.5V$ , $T_A = -55^\circ C$ to $+125^\circ C$<br>(Other Input = GND) <sup>(3)</sup> |  |             | 5.0  |                |          | kΩ    |  |
| $I_{IN}$  | Input Current<br>(Other Input = 0V,<br>Power On, or<br>$V_{CC} = 0V$ ) | $V_{IN} = +10V$  | $T_A = -40^\circ C$ to<br>$+85^\circ C$  | RI+,<br>RI- | 0    | 1.1            | 1.8      | mA    |  |
|           |  | $V_{IN} = +3V$   |  |             | 0    | 0.27           |          | mA    |  |
|           |  | $V_{IN} = 0.5V$  |  |             |      | -0.02          |          | mA    |  |
|           |  | $V_{IN} = -3V$   |  |             | 0    | -0.43          |          | mA    |  |
|           |  | $V_{IN} = -10V$  |  |             | 0    | -1.26          | -2.2     | mA    |  |
|           |  | $V_{IN} = -0.5V$   | $T_A = -55^\circ C$ to<br>$+125^\circ C$ <sup>(3)</sup>                                  |             | 0    |                | -1.8     | mA    |  |
|           |  | $V_{IN} = 5.5V$  | 0  |             |      | 1.8            | mA       |       |  |
| $I_{EN}$  | Input Current  | $V_{IN} = 0V$ to $V_{CC}$  |  | EN,<br>EN*  |      |                | $\pm 1$  | μA    |  |
| $V_{OH}$  | High Level Output Voltage  | $I_{OH} = -6$ mA, $V_{ID} = +1V$   |  | RO          | 2.4  | 3              |          | V     |  |
|           |  | $I_{OH} = -6$ mA, $V_{ID} = \text{OPEN}$   |  |             |      |                |          |       |  |
| $V_{OH}$  | High Level Output Voltage  | $I_{OH} = -100$ μA, $V_{ID} = +1V$   |  |             |      | $V_{CC} - 0.1$ |          | V     |  |
|           |  | $I_{OH} = -100$ μA, $V_{ID} = \text{OPEN}$   |  |             |      |                |          |       |  |
| $V_{OL}$  | 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  |  |             |      |                | $\pm 50$ | μA    |  |
|           |  | $EN = V_{IL}$ , $EN^* = V_{IH}$  |  |             |      |                |          |       |  |
| $I_{SC}$  | Output Short Circuit Current   | $V_O = 0V$ , $V_{ID} \geq  200$ mV  <sup>(4)</sup>   |  |             | -10  | -35            | -70      | mA    |  |
| $I_{CC}$  | Power Supply Current   | No Load, All RI+,<br>R1- = OPEN, EN,<br>$EN^* = V_{CC}$ or GND   | $T_A = -40^\circ C$ to<br>$+85^\circ C$  | $V_{CC}$    |      | 9              | 15       | mA    |  |
|           |  |  | $T_A = -55^\circ C$ to<br>$+125^\circ C$   |             |      |                | 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  $V_{ID}$ .
- (2) All typicals are given for:  $V_{CC} = +3.3V$ ,  $T_A = +25^\circ C$ .
- (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)</sup> <sup>(2)</sup>

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

| Parameter | Test Conditions  | Min | Typ  | Max | Units |
|-----------|--|-----|------|-----|-------|
| $t_{PHL}$ | $C_L = 15 \text{ pF}, V_{CM} = 1.5V$ ( <a href="#">Figure 2</a> and <a href="#">Figure 3</a> ) | 6   | 17.5 | 35  | ns    |
| $t_{PLH}$ |  | 6   | 17.8 | 35  | ns    |
| $t_r$     |  |     | 4.1  | 10  | ns    |
| $t_f$     |  |     | 3.3  | 10  | ns    |
| $t_{PHZ}$ | $C_L = 50 \text{ pF}, V_{CM} = 1.5V$ ( <a href="#">Figure 4</a> and <a href="#">Figure 5</a> ) |     |      | 40  | ns    |
| $t_{PLZ}$ |  |     |      | 40  | ns    |
| $t_{PZH}$ |  |     |      | 40  | ns    |
| $t_{PZL}$ |  |     |      | 40  | ns    |
| $t_{SK1}$ | $C_L = 15 \text{ pF}, V_{CM} = 1.5V$   |     | 0.3  | 4   | ns    |
| $t_{SK2}$ |  |     | 0.6  | 4   | ns    |
| $t_{SK3}$ |  |     | 7    | 17  | ns    |
| $f_{MAX}$ | $C_L = 15 \text{ pF}, V_{CM} = 1.5V$   | 32  |      |     | MHz   |

(1) All typicals are given for:  $V_{CC} = +3.3V$ ,  $T_A = +25^\circ\text{C}$ .

(2)  $t_{SK3}$  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  $T_A = \pm 5^\circ\text{C}$  (between devices) within the operating temperature range. This parameter is guaranteed by design and characterization.

(3)  $t_{SK1}$  is the  $|t_{PHL} - t_{PLH}|$  of a channel.

(4)  $t_{SK2}$  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,  $t_r/t_f \leq 5$  ns. This parameter is guaranteed by design and characterization.

## Switching Characteristics - Military

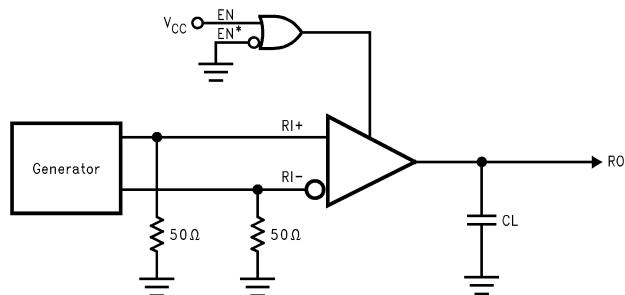
Over Supply Voltage and -55°C to +125°C Operating Temperature range, unless otherwise specified.

| Parameter | Test Conditions  | Min | Max | Units |
|-----------|--|-----|-----|-------|
| $t_{PHL}$ | $C_L = 50 \text{ pF}, V_{CM} = 1.5V$ ( <a href="#">Figure 2</a> and <a href="#">Figure 3</a> ) | 6   | 45  | ns    |
| $t_{PLH}$ |  | 6   | 45  | ns    |
| $t_{PHZ}$ | $C_L = 50 \text{ pF}, V_{CM} = 1.5V$ ( <a href="#">Figure 4</a> and <a href="#">Figure 5</a> ) |     | 50  | ns    |
| $t_{PLZ}$ |  |     | 50  | ns    |
| $t_{PZH}$ |  |     | 50  | ns    |
| $t_{PZL}$ |  |     | 50  | ns    |
| $t_{SK1}$ | $C_L = 50 \text{ pF}, V_{CM} = 1.5V$   |     | 6   | ns    |
| $t_{SK2}$ |  |     | 6   | ns    |

(1)  $t_{SK1}$  is the  $|t_{PHL} - t_{PLH}|$  of a channel.

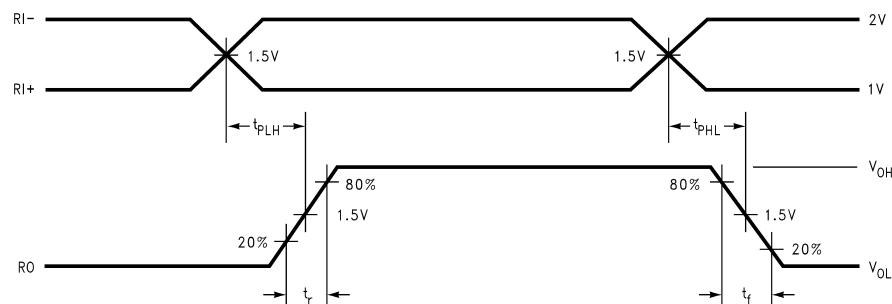
(2)  $t_{SK2}$  is the maximum skew between any two channels within a device, either edge.

## PARAMETER MEASUREMENT INFORMATION



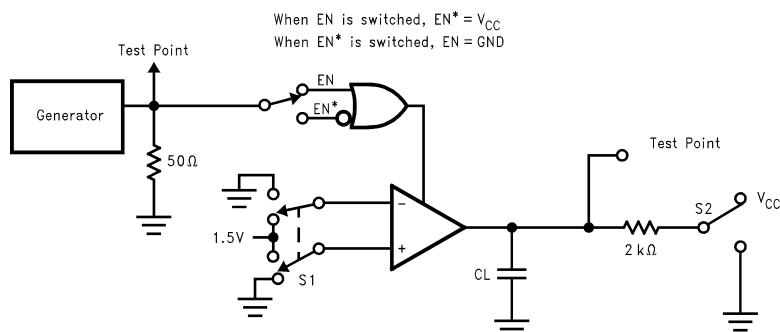
- A. Generator waveform for all tests unless otherwise specified:  $f = 1$  MHz, Duty Cycle = 50%,  $Z_O = 50\Omega$ ,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.
- B.  $C_L$  includes probe and jig capacitance.

**Figure 2. Receiver Propagation Delay and Transition Time Test Circuit**

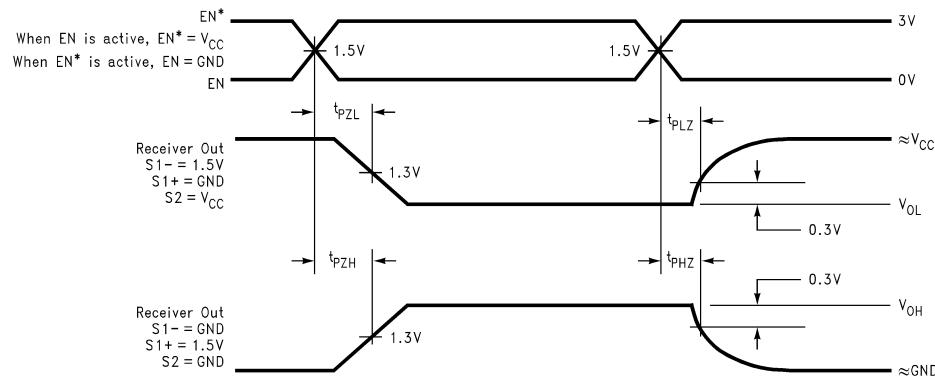


- A. Generator waveform for all tests unless otherwise specified:  $f = 1$  MHz, Duty Cycle = 50%,  $Z_O = 50\Omega$ ,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.
- B.  $C_L$  includes probe and jig capacitance.
- C. For military grade product,  $t_r \leq 6$  ns and  $t_f \leq 6$  ns.
- D. For military grade 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**



- A. Generator waveform for all tests unless otherwise specified:  $f = 1$  MHz, Duty Cycle = 50%,  $Z_0 = 50\Omega$ ,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns.
- B.  $C_L$  includes probe and jig capacitance.
- C. For military grade product,  $t_r \leq 6$  ns and  $t_f \leq 6$  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 5. Receiver TRI-STATE Output Enable and Disable Waveforms**

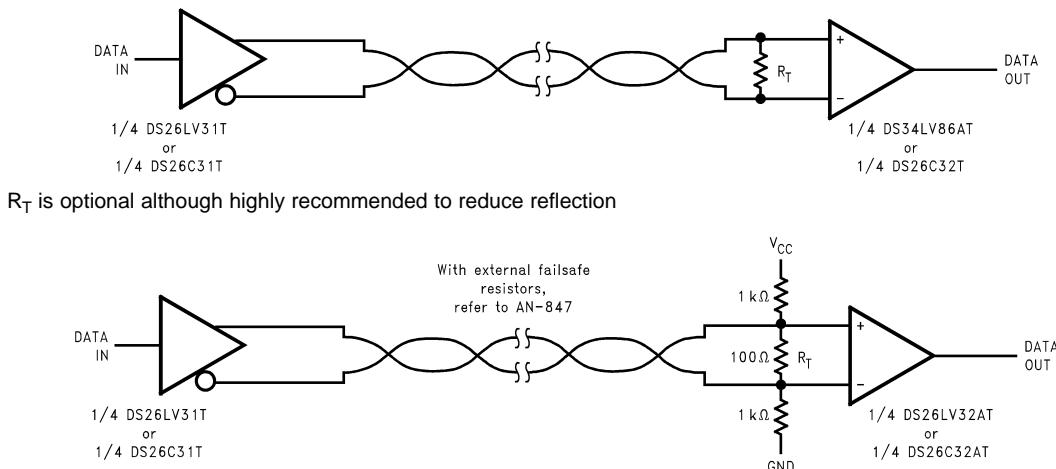
## TYPICAL APPLICATION INFORMATION

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

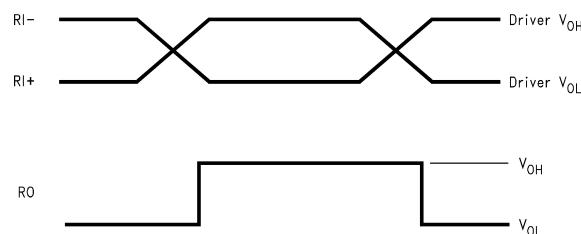
- AN-214
- AN-457
- AN-805
- AN-847
- AN-903
- AN-912
- AN-916

### Power Decoupling Recommendations:

Bypass caps must be used on power pins. High frequency ceramic (surface mount is recommended) 0.1  $\mu$ F in parallel with 0.01  $\mu$ F at the power supply pin. A 10  $\mu$ 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**

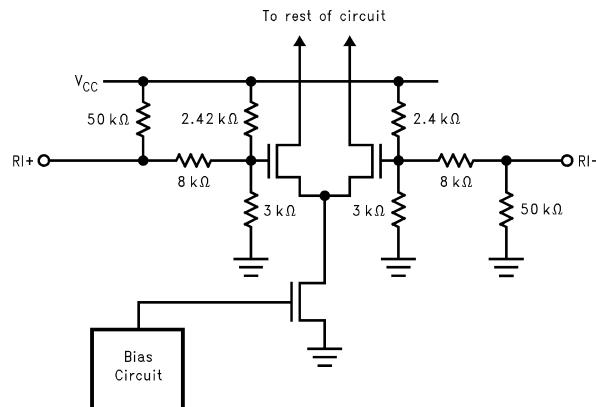
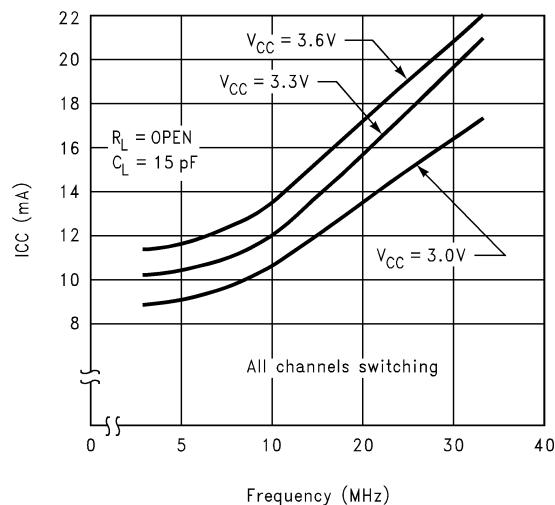
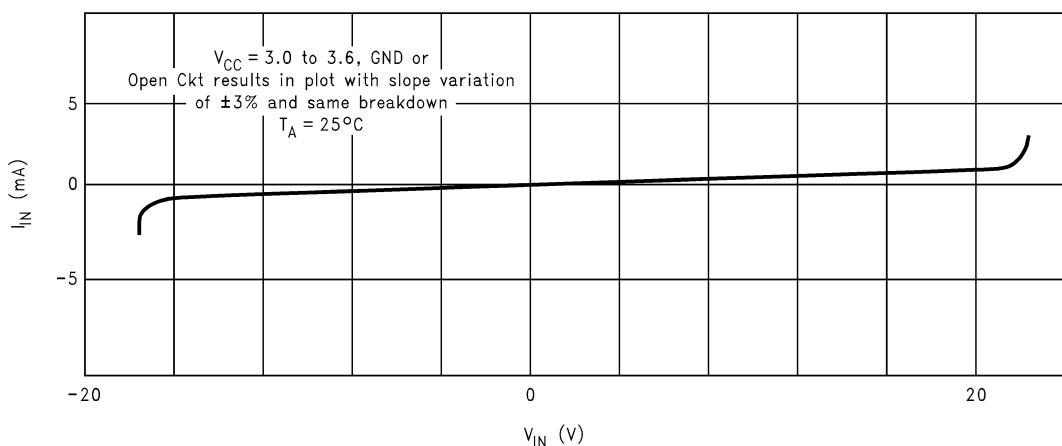
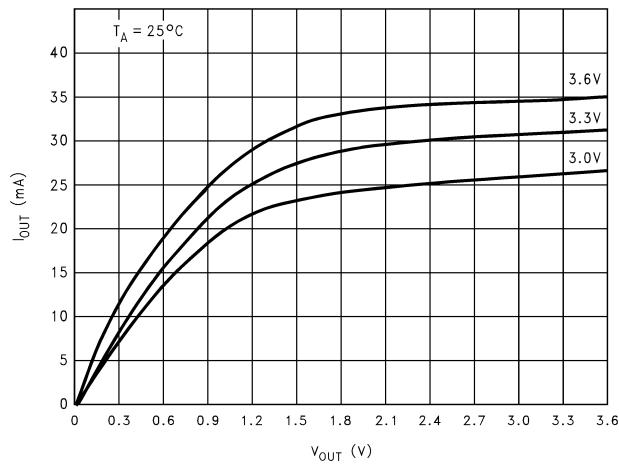
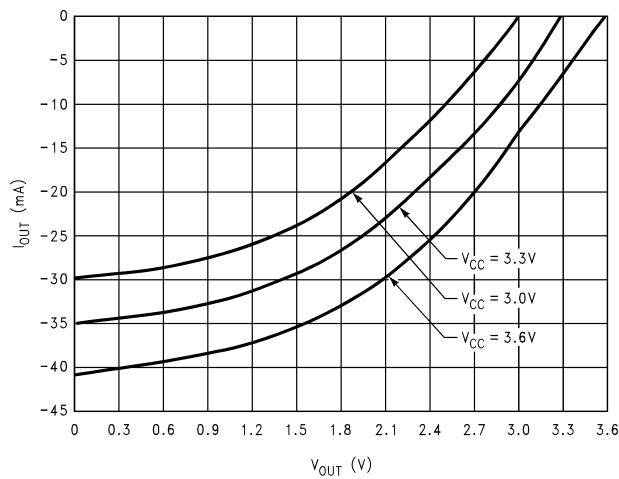


Figure 8. Typical Receiver Input Circuit

Figure 9. Typical  $I_{CC}$  vs FrequencyFigure 10. Receiver  $I_{IN}$  vs  $V_{IN}$  (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 ..... | 9    |

**PACKAGING INFORMATION**

| Orderable part number | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-----------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| DS26LV32ATMX/NOPB.B   | Obsolete      | Production           | SOIC (D)   16  | -                     | -           | Call TI                              | Call TI                           | -40 to 85    |                     |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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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