

## DS90LV032A 3-V LVDS Quad CMOS Differential Line Receiver

### 1 Features

- >400 Mbps (200 MHz) Switching Rates
- 0.1-ns Channel-to-Channel Skew (Typical)
- 0.1-ns Differential Skew (Typical)
- 3.3-ns Maximum Propagation Delay
- 3.3-V Power Supply Design
- Power Down High Impedance on LVDS Inputs
- Low Power Design (40 mW at 3.3 V Static)
- Interoperable With Existing 5-V LVDS Networks
- Accepts Small Swing (350 mV Typical) VID
- Supports Open, Short, and Terminated Input Fail-Safe
- Compatible With ANSI/TIA/EIA-644
- Industrial Temperature Operating Range (–40°C to 85°C)
- Available in SOIC and TSSOP Packaging

### 2 Applications

- Building And Factory Automation
- Grid Infrastructure

### 3 Description

The DS90LV032A is a quad CMOS differential line receiver designed for applications requiring ultra-low power dissipation and high data rates. The device is designed to support data rates in excess of 400 Mbps (200 MHz) using Low Voltage Differential Signaling (LVDS) technology.

The DS90LV032A accepts low voltage (350 mV typical) differential input signals and translates them to 3-V CMOS output levels. The receiver supports a TRI-STATE function that may be used to multiplex outputs. The receiver also supports open, shorted, and terminated (100  $\Omega$ ) input Fail-safe. The receiver output is HIGH for all fail-safe conditions.

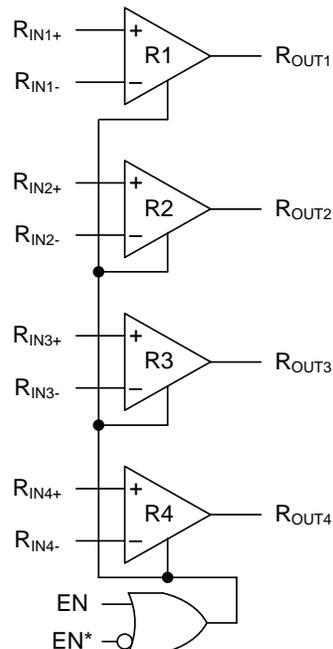
The DS90LV032A and companion LVDS line driver (for example, DS90LV031A) provide a new alternative to high power PECL or ECL devices for high speed point-to-point interface applications.

#### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
DS90LV032A	SOIC (16)	9.90 mm x 3.91 mm
	TSSOP (16)	5.00 mm x 4.40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

#### Block Diagram



Copyright © 2016, Texas Instruments Incorporated



## Table of Contents

<b>1 Features</b> ..... 1 <b>2 Applications</b> ..... 1 <b>3 Description</b> ..... 1 <b>4 Revision History</b> ..... 2 <b>5 Pin Configuration and Functions</b> ..... 3 <b>6 Specifications</b> ..... 3 6.1 Absolute Maximum Ratings ..... 3 6.2 ESD Ratings ..... 4 6.3 Recommended Operating Conditions ..... 4 6.4 Thermal Information ..... 4 6.5 Electrical Characteristics ..... 5 6.6 Switching Characteristics ..... 6 6.7 Dissipation Ratings ..... 6 6.8 Typical Characteristics ..... 7 <b>7 Parameter Measurement Information</b> ..... 8 <b>8 Detailed Description</b> ..... 10 8.1 Overview ..... 10 8.2 Functional Block Diagram ..... 10	8.3 Feature Description ..... 10 8.4 Device Functional Modes ..... 11 <b>9 Application and Implementation</b> ..... 12 9.1 Application Information ..... 12 9.2 Typical Application ..... 12 <b>10 Power Supply Recommendations</b> ..... 14 <b>11 Layout</b> ..... 14 11.1 Layout Guidelines ..... 14 11.2 Layout Example ..... 15 <b>12 Device and Documentation Support</b> ..... 16 12.1 Documentation Support ..... 16 12.2 Receiving Notification of Documentation Updates ..... 16 12.3 Community Resources ..... 16 12.4 Trademarks ..... 16 12.5 Electrostatic Discharge Caution ..... 16 12.6 Glossary ..... 16 <b>13 Mechanical, Packaging, and Orderable Information</b> ..... 16
---	---

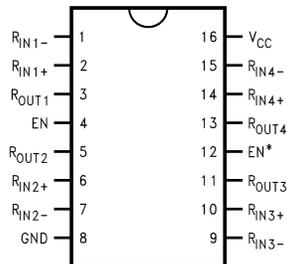
## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (April 2013) to Revision D	Page
<ul style="list-style-type: none"> <li>• Added <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> section, <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section. .... 1</li> <li>• Added <i>Thermal Information</i> table. .... 4</li> </ul>	1
Changes from Revision B (April 2013) to Revision C	Page
<ul style="list-style-type: none"> <li>• Changed layout of National Semiconductor Data Sheet to TI format ..... 7</li> </ul>	7

## 5 Pin Configuration and Functions

**D or PW Package  
16-Pin SOIC or TSSOP  
Top View**



**Pin Functions**

PIN		I/O	DESCRIPTION
NAME	NO.		
EN	4	I	Active high enable pin, OR-ed with $\overline{\text{EN}}$
$\overline{\text{EN}}$	12	I	Active low enable pin, OR-ed with EN
GND	8	—	Ground pin
R <sub>IN-</sub>	1, 7, 9, 15	I	Inverting receiver input pin
R <sub>IN+</sub>	2, 6, 10, 14	I	Noninverting receiver input pin
R <sub>OUT</sub>	3, 5, 11, 13	O	Receiver output pin
V <sub>CC</sub>	16	—	Power supply pin, 3.3 V ± 0.3 V

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
Supply voltage	V <sub>CC</sub>	-0.3	4	V
Input voltage	R <sub>IN+</sub> , R <sub>IN-</sub>	-0.3	3.9	V
Enable input voltage	EN, EN*	-0.3	V <sub>CC</sub> + 0.3	V
Output voltage	R <sub>OUT</sub>	-0.3	V <sub>CC</sub> + 0.3	V
Lead temperature, soldering (4 s)			260	°C
Maximum junction temperature, T <sub>J</sub>			150	°C
Storage temperature, T <sub>stg</sub>		-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

## 6.2 ESD Ratings

			VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge <sup>(1)</sup>	Human-body model (HBM) <sup>(1)</sup>	±4500	V
		Machine model (MM), EIAJ	±250	

(1) ESD Ratings: HBM (1.5 k $\Omega$ , 100 pF)  $\geq$  4.5 kV and EIAJ (0  $\Omega$ , 200 pF)  $\geq$  250 V

## 6.3 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
V <sub>CC</sub>	Supply voltage	3	3.3	3.6	V
	Receiver input voltage	GND		3	V
T <sub>A</sub>	Operating free-air temperature	-40	25	85	°C

## 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		DS90LV032A		UNIT
		PW (TSSOP)	D (SOIC)	
		16 PINS	16 PINS	
R <sub><math>\theta</math>JA</sub>	Junction-to-ambient thermal resistance	110	75	°C/W
R <sub><math>\theta</math>JC(top)</sub>	Junction-to-case (top) thermal resistance	47	36	°C/W
R <sub><math>\theta</math>JB</sub>	Junction-to-board thermal resistance	55	32	°C/W
$\Psi$ <sub>JT</sub>	Junction-to-top characterization parameter	6	6	°C/W
$\Psi$ <sub>JB</sub>	Junction-to-board characterization parameter	54	31.7	°C/W

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 6.5 Electrical Characteristics

over supply voltage and operating temperature ranges (unless otherwise noted)<sup>(1)</sup>

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>TH</sub>	Differential input high threshold	V <sub>CM</sub> = 1.2 V, R <sub>IN+</sub> , R <sub>IN-</sub> pin <sup>(2)</sup>		20	100	mV
V <sub>TL</sub>	Differential input low threshold		-100	-20		mV
V <sub>CMR</sub>	Common mode voltage range	V <sub>ID</sub> = 200 mV peak to peak, R <sub>IN+</sub> , R <sub>IN-</sub> pin <sup>(3)</sup>	0.1		2.3	V
I <sub>IN</sub>	Input current	V <sub>CC</sub> = 3.6 V or 0 V, R <sub>IN+</sub> , R <sub>IN-</sub> pin	V <sub>IN</sub> = 2.8 V		10	μA
			V <sub>IN</sub> = 0 V		10	μA
		V <sub>CC</sub> = 0 V, V <sub>IN</sub> = 3.6 V, R <sub>IN+</sub> , R <sub>IN-</sub> pin	-20		20	μA
V <sub>OH</sub>	Output high voltage	I <sub>OH</sub> = -0.4 mA, V <sub>ID</sub> = 200 mV, R <sub>OUT</sub> pin	2.7	3		V
		I <sub>OH</sub> = -0.4 mA, input terminated, R <sub>OUT</sub> pin	2.7	3		V
		I <sub>OH</sub> = -0.4 mA, input shorted, R <sub>OUT</sub> pin	2.7	3		V
V <sub>OL</sub>	Output low voltage	I <sub>OL</sub> = 2 mA, V <sub>ID</sub> = -200 mV, R <sub>OUT</sub> pin		0.1	0.25	V
I <sub>OS</sub>	Output short-circuit current	Enabled, V <sub>OUT</sub> = 0 V, R <sub>OUT</sub> pin <sup>(4)</sup>	-15	-48	-120	mA
I <sub>OZ</sub>	Output TRI-STATE current	Disabled, V <sub>OUT</sub> = 0 V or V <sub>CC</sub>	-10	±1	10	μA
V <sub>IH</sub>	Input high voltage	EN, EN* pins	2		V <sub>CC</sub>	V
V <sub>IL</sub>	Input low voltage	EN, EN* pins	GND		0.8	V
I <sub>I</sub>	Input current	V <sub>IN</sub> = 0 V or V <sub>CC</sub> , other input = V <sub>CC</sub> or GND, EN, EN* pins	-10	±1	10	μA
V <sub>CL</sub>	Input clamp voltage	I <sub>CL</sub> = -18 mA, EN, EN* pins	-1.5	-0.8		V
I <sub>CC</sub>	No load supply current	EN, EN* = V <sub>CC</sub> or GND, inputs open, V <sub>CC</sub> pin		10	15	mA
	Receivers enabled	EN, EN* = 2.4 V or 0.5 V, inputs open, V <sub>CC</sub> pin		10	15	mA
I <sub>CCZ</sub>	No load supply current	Receivers disabled, EN = GND, EN* = V <sub>CC</sub> , inputs open, V <sub>CC</sub> pin		3	5	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 unless otherwise specified.
- (2) V<sub>CC</sub> is always higher than R<sub>IN+</sub> and R<sub>IN-</sub> voltage. R<sub>IN-</sub> and R<sub>IN+</sub> are allowed to have a voltage range -0.2 V to V<sub>CC</sub> - V<sub>ID</sub> / 2. However, to be compliant with AC specifications, the common mode voltage range is 0.1 V to 2.3 V
- (3) The V<sub>CMR</sub> range is reduced for larger V<sub>ID</sub>. Example: if V<sub>ID</sub> = 400 mV, the V<sub>CMR</sub> is 0.2 V to 2.2 V. The fail-safe condition with inputs shorted is valid over a common mode range of 0 V to 2.3 V. A V<sub>ID</sub> up to V<sub>CC</sub> - 0 V may be applied to the R<sub>IN+</sub>/ R<sub>IN-</sub> inputs with the common mode voltage set to V<sub>CC</sub> / 2. Propagation delay and differential pulse skew decrease when V<sub>ID</sub> is increased from 200 mV to 400 mV. Skew specifications apply for 200 mV ≤ V<sub>ID</sub> ≤ 800 mV over the common mode range.
- (4) Output short-circuit current (I<sub>OS</sub>) is specified as magnitude only, minus sign indicates direction only. Only one output must be shorted at a time, do not exceed maximum junction temperature specification.

## 6.6 Switching Characteristics

 over supply voltage and operating temperature ranges (unless otherwise noted)<sup>(1)(2)</sup>

PARAMETER		TEST CONDITIONS	MIN	NOM	MAX	UNIT
$t_{PHLD}$	Differential propagation delay, high to low	$C_L = 10 \text{ pF}$	1.8		3.3	ns
$t_{PLHD}$	Differential propagation delay, low to high	$V_{ID} = 200 \text{ mV}$	1.8		3.3	ns
$t_{SKD1}$	Differential pulse skew <sup>(3)</sup> $ t_{PHLD} - t_{PLHD} $	See <a href="#">Figure 4</a> and <a href="#">Figure 5</a>	0	0.1	0.35	ns
$t_{SKD2}$	Differential channel-to-channel skew <sup>(4)</sup>	Same device	0	0.1	0.5	ns
$t_{SKD3}$	Differential part-to-part skew <sup>(5)</sup>				1	ns
$t_{SKD4}$	Differential part-to-part skew <sup>(6)</sup>				1.5	ns
$t_{TLH}$	Rise time			0.35	1.2	ns
$t_{THL}$	Fall time			0.35	1.2	ns
$t_{PHZ}$	Disable time high to Z	$R_L = 2 \text{ k}\Omega$		8	12	ns
$t_{PLZ}$	Disable time low to Z	$C_L = 10 \text{ pF}$		6	12	ns
$t_{PZH}$	Enable time Z to high	See <a href="#">Figure 6</a> and <a href="#">Figure 7</a>		11	17	ns
$t_{PZL}$	Enable time Z to low			11	17	ns
$f_{MAX}$	Maximum operating frequency <sup>(7)</sup>	All channels switching	200	250		MHz

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

(2) Generator waveform for all tests unless otherwise specified:  $f = 1 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r$  and  $t_f$  (0% to 100%)  $\leq 3 \text{ ns}$  for  $R_{IN}$ .

(3)  $t_{SKD1}$  is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel

(4)  $t_{SKD2}$ , channel-to-channel skew, is defined as the difference between the propagation delay of one channel and that of the others on the same chip with any event on the inputs.

(5)  $t_{SKD3}$ , part-to-part skew, is the differential channel-to-channel skew of any event between devices. This specification applies to devices at the same  $V_{CC}$ , and within  $5^\circ\text{C}$  of each other within the operating temperature range.

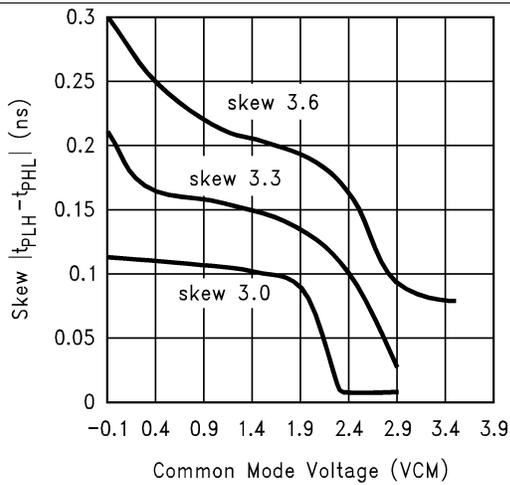
(6)  $t_{SKD4}$ , part-to-part skew, is the differential channel-to-channel skew of any event between devices. This specification applies to devices over recommended operating temperature and voltage ranges, and across process distribution.  $t_{SKD4}$  is defined as |Maximum – Minimum| differential propagation delay.

(7)  $f_{MAX}$  generator input conditions:  $t_r = t_f < 1 \text{ ns}$  (0% to 100%), 50% duty cycle, differential (1.05-V to 1.35-V peak-to-peak). Output criteria: 60% / 40% duty cycle,  $V_{OL}$  (maximum: 0.4 V),  $V_{OH}$  (minimum: 2.7 V), load = 10 pF (stray plus probes).

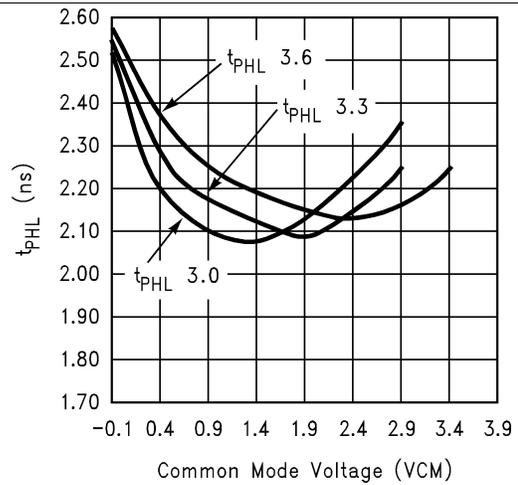
## 6.7 Dissipation Ratings

	MAXIMUM PACKAGE POWER DISSIPATION AT 25°C
D package	1025 mW
PW package	866 mW
Derate D package	8.2 mW/°C above 25°C
Derate PW package	6.9 mW/°C above 25°C

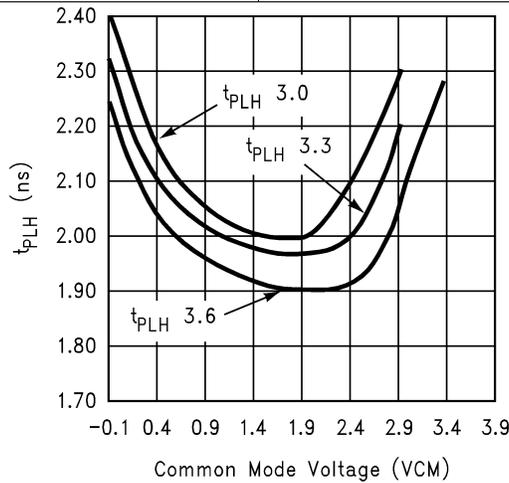
### 6.8 Typical Characteristics



**Figure 1. Typical Pulse Skew Variation vs Common Mode Voltage**

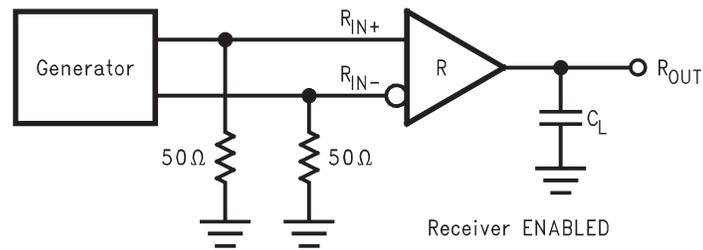


**Figure 2. Variation in High-to-Low Propagation Delay vs VCM**

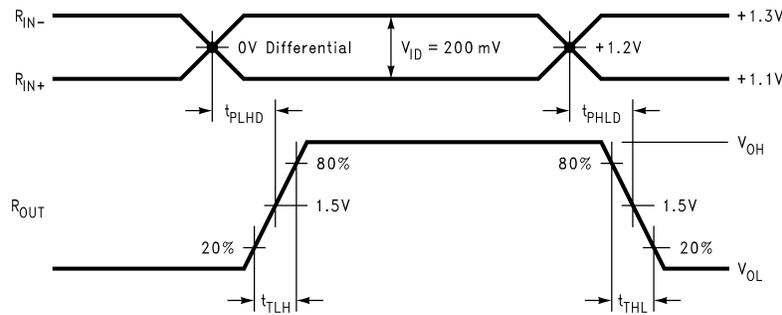


**Figure 3. Variation in Low-to-High Propagation Delay vs VCM**

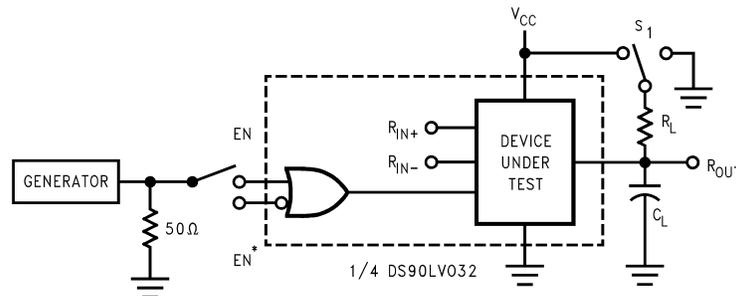
## 7 Parameter Measurement Information



**Figure 4. Receiver Propagation Delay and Transition Time Test Circuit**



**Figure 5. Receiver Propagation Delay and Transition Time Waveforms**



$C_L$  includes load and test jig capacitance.  
 $S_1 = V_{CC}$  for  $t_{PZL}$  and  $t_{PLZ}$  measurements.  
 $S_1 = GND$  for  $t_{PZH}$  and  $t_{PHZ}$  measurements.

**Figure 6. Receiver TRI-STATE Delay Test Circuit**

Parameter Measurement Information (continued)

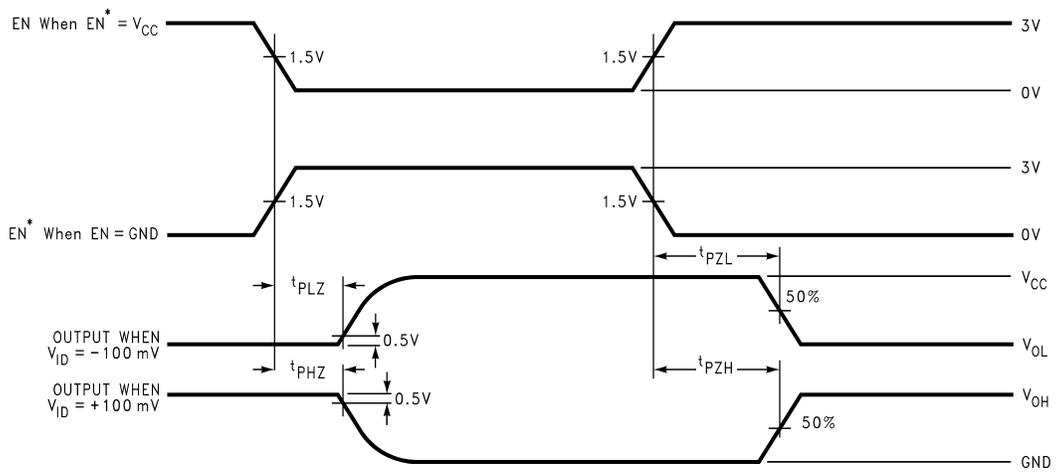


Figure 7. Receiver TRI-STATE Delay Waveforms

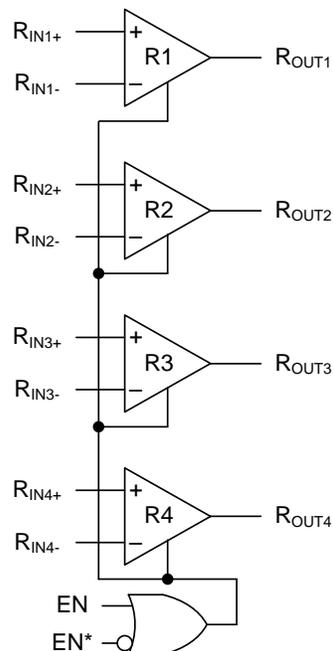
## 8 Detailed Description

### 8.1 Overview

LVDS drivers and receivers are intended to be primarily used in an uncomplicated point-to-point configuration as is shown in Figure 8. This configuration provides a clean signaling environment for the fast edge rates of the drivers. The receiver is connected to the driver through a balanced media which may be a standard twisted pair cable, a parallel pair cable, or simply PCB traces. Typically, the characteristic impedance of the media is in the range of 100  $\Omega$ . A termination resistor of 100  $\Omega$  (selected to match the media) is located as close to the receiver input pins as possible. Other configurations are possible such as a multi-receiver configuration, but the effects of a mid-stream connector(s), cable stub(s), and other impedance discontinuities as well as ground shifting, noise margin limits, and total termination loading must be considered.

The DS90LV032A differential line receiver is capable of detecting signals as low as 100 mV, over a  $\pm 1$ -V common-mode range centered around 1.2 V. This is related to the driver offset voltage which is typically 1.2 V. The driven signal is centered around this voltage and may shift  $\pm 1$  V around this center point. The  $\pm 1$ -V shifting may be the result of a ground potential difference between the ground reference of the driver and the ground reference of the receiver, the common-mode effects of coupled noise, or a combination of the two. The AC parameters of both receiver input pins are optimized for a recommended operating input voltage range of 0 V to 2.4 V (measured from each pin to ground). The device operates for receiver input voltages up to VCC, but exceeding VCC turns on the ESD protection circuitry which clamps the bus voltages.

### 8.2 Functional Block Diagram



Copyright © 2016, Texas Instruments Incorporated

### 8.3 Feature Description

#### 8.3.1 Fail-Safe Feature

The LVDS receiver is a high-gain, high-speed device that amplifies a small differential signal (20 mV) to CMOS logic levels. Due to the high gain and tight threshold of the receiver, take care to prevent noise from appearing as a valid signal.

The internal fail-safe circuitry of the receiver is designed to source or sink a small amount of current, providing fail-safe protection (a stable known state of HIGH output voltage) for floating, terminated, or shorted receiver inputs.

## Feature Description (continued)

1. *Open input pins:* The DS90LV032A is a quad receiver device, and if an application requires only 1, 2, or 3 receivers, the unused channel(s) inputs must be left OPEN. Do not tie unused receiver inputs to ground or any other voltages. The input is biased by internal high value pullup and pulldown resistors to set the output to a HIGH state. This internal circuitry ensures a HIGH, stable output state for open inputs.
2. *Terminated input:* If the driver is disconnected (cable unplugged), or if the driver is in a TRI-STATE or power-off condition, the receiver output is in a HIGH state, even with the end of cable 100- $\Omega$  termination resistor across the input pins. The unplugged cable can become a floating antenna which can pick up noise. If the cable picks up more than 10 mV of differential noise, the receiver may see the noise as a valid signal and switch. To insure that any noise is seen as common-mode and not differential, a balanced interconnect must be used. Twisted pair cable offers better balance than flat ribbon cable.
3. *Shorted inputs:* If a fault condition occurs that shorts the receiver inputs together, thus resulting in a 0-V differential input voltage, the receiver output remains in a HIGH state. Shorted input fail-safe is not supported across the common-mode range of the device (GND to 2.4 V). It is only supported with inputs shorted and no external common-mode voltage applied.

External lower value pullup and pulldown resistors (for a stronger bias) may be used to boost fail-safe in the presence of higher noise levels. The pullup and pulldown resistors must be in the 5-k $\Omega$  to 15-k $\Omega$  range to minimize loading and waveform distortion to the driver. The common-mode bias point must be set to approximately 1.2 V (less than 1.75 V) to be compatible with the internal circuitry.

The footprint of the DS90LV032A is the same as the industry standard 26LS32 Quad Differential (RS-422) Receiver.

## 8.4 Device Functional Modes

[Table 1](#) lists the functional modes of the DS90LV032A.

**Table 1. Truth Table**

ENABLES		INPUTS	OUTPUT
EN	EN*	$R_{IN+} - R_{IN-}$	$R_{OUT}$
L	H	X	Z
All other combinations of ENABLE inputs		$V_{ID} \geq 0.1 \text{ V}$	H
		$V_{ID} \leq -0.1 \text{ V}$	L
		Full Fail-safe OPEN/SHORT or Terminated	H

## 9 Application and Implementation

### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

The DS90LV032A LVDS receiver and DS90LV031A driver are intended to be primarily used in an uncomplicated point-to-point configuration as shown in [Figure 8](#). This configuration provides a clean signaling environment for the fast edge rates of the drivers. The receiver is connected to the driver through a balanced media which may be a standard twisted pair cable, a parallel pair cable, or simply PCB traces. Typically the characteristic impedance of the media is in the range of 100  $\Omega$ .

#### 9.1.1 Probing LVDS Transmission Lines

Always use high impedance (>100 k $\Omega$ ), low capacitance (<2 pF) scope probes with a wide bandwidth (1 GHz) scope. Improper probing gives deceiving results.

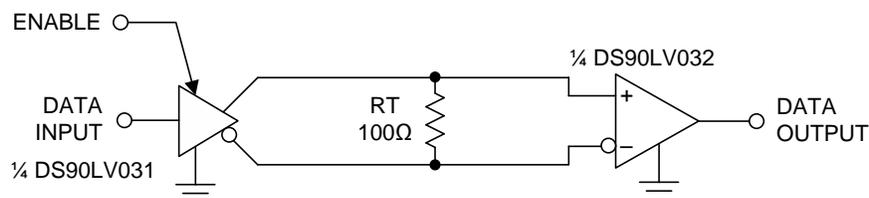
#### 9.1.2 Cables and Connectors, General Comments

When choosing cable and connectors for LVDS it is important to remember:

- Use controlled impedance media.  
The cables and connectors you use must have a matched differential impedance of about 100  $\Omega$ . They must not introduce major impedance discontinuities.
- Balanced cables (that is, twisted pair) are usually better than unbalanced cables (such as ribbon cable or simple coax) for noise reduction and signal quality.

Balanced cables tend to generate less EMI due to field canceling effects and also tend to pick up electromagnetic radiation as common-mode (not differential mode) noise which is rejected by the receiver. For cable distances <0.5 m, most cables can be made to work effectively. For distances  $0.5 \text{ m} \leq d \leq 10 \text{ m}$ , Category 3 (CAT 3) twisted pair cable works well, is readily available, and relatively inexpensive.

### 9.2 Typical Application



Copyright © 2016, Texas Instruments Incorporated

**Figure 8. Balanced System Point-to-Point Application**

#### 9.2.1 Design Requirements

When using LVDS devices, it is important to remember to specify controlled impedance PCB traces, cable assemblies, and connectors. All components of the transmission media must have a matched differential impedance of about 100  $\Omega$ . They must not introduce major impedance discontinuities. Balanced cables (for example, twisted pair) are usually better than unbalanced cables (ribbon cable) for noise reduction and signal quality. Balanced cables tend to generate less EMI due to field canceling effects and also tend to pick up electromagnetic radiation as common-mode (not differential mode) noise which is rejected by the LVDS receiver.

For cable distances < 0.5 m, most cables work effectively. For distances  $0.5 \text{ m} \leq d \leq 10 \text{ m}$ , Category 5 (CAT5) twisted pair cable works well, is readily available, and relatively inexpensive.

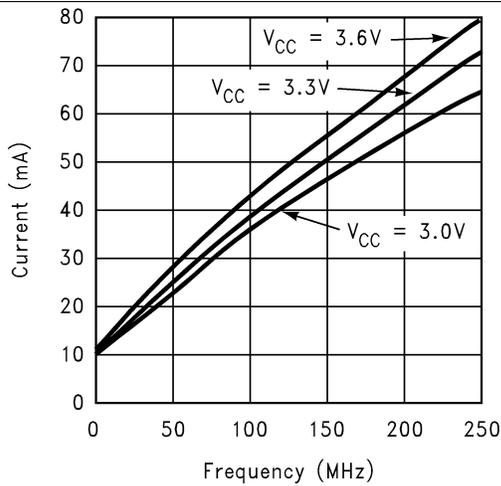
**Typical Application (continued)**

**9.2.2 Detailed Design Procedure**

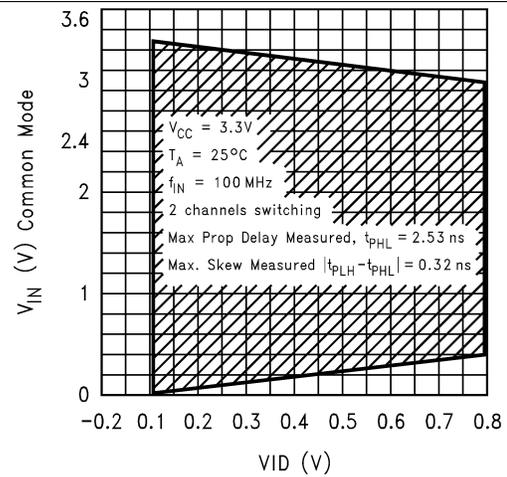
**9.2.2.1 Probing LVDS Transmission Lines**

Always use high impedance (>100 kΩ), low capacitance (<2 pF) scope probes with a wide bandwidth (1 GHz) scope. Improper probing gives deceiving results.

**9.2.3 Application Curves**



**Figure 9. ICC vs Frequency, Four Channels Switching**



**Figure 10. Typical Common Mode Range Variation With Respect to Amplitude of Differential Input**

## 10 Power Supply Recommendations

Although the DS90LV032A draws very little power, there is a dynamic current component which increases the overall power consumption at higher switching frequencies. The DS90LV032A power supply connection must take this additional current consumption into consideration for maximum power requirements.

## 11 Layout

### 11.1 Layout Guidelines

- Use at least 4 PCB layers (top to bottom): LVDS signals, ground, power, and TTL signals.
- Isolate TTL signals from LVDS signals, otherwise the TTL may couple onto the LVDS lines. It is best to put TTL and LVDS signals on different layers which are isolated by power or ground plane(s).
- Keep drivers and receivers as close to the (LVDS port side) connectors as possible.

#### 11.1.1 Power Decoupling Recommendations

Bypass capacitors must be used on power pins. High-frequency ceramic (surface-mount recommended) 0.1- $\mu$ F in parallel with 0.01- $\mu$ F, in parallel with 0.001- $\mu$ F at the power supply pin as well as scattered capacitors over the printed-circuit board. Multiple vias must be used to connect the decoupling capacitors to the power planes. A 10- $\mu$ F, 35-V (or greater) solid tantalum capacitor must be connected at the power entry point on the printed-circuit board.

#### 11.1.2 Differential Traces

Use controlled impedance traces which match the differential impedance of your transmission medium (that is, cable) and termination resistor. Run the differential pair trace lines as close together as possible as soon as they leave the IC (stubs must be <10 mm long). This helps eliminate reflections and ensure noise is coupled as common-mode. Lab experiments show that differential signals which are 1 mm apart radiate far less noise than traces 3 mm apart because magnetic field cancellation is much better with the closer traces. Plus, noise induced on the differential lines is much more likely to appear as common-mode which is rejected by the receiver.

Match electrical lengths between traces to reduce skew. Skew between the signals of a pair means a phase difference between signals which destroys the magnetic field cancellation benefits of differential signals and results in EMI. Note the velocity of propagation,  $v = c/Er$  where  $c$  (the speed of light) = 0.2997 mm/ps or 0.0118 in/ps. Do not rely solely on the auto-route function for differential traces. Carefully review dimensions to match differential impedance and provide isolation for the differential lines. Minimize the number of vias and other discontinuities on the line.

Avoid 90° turns (these cause impedance discontinuities). Use arcs or 45° bevels.

Within a pair of traces, the distance between the two traces must be minimized to maintain common-mode rejection of the receivers. On the printed-circuit board, this distance must remain constant to avoid discontinuities in differential impedance. Minor violations at connection points are allowable.

#### 11.1.3 Termination

Use a resistor which best matches the differential impedance of your transmission line. The resistor must be between 90  $\Omega$  and 130  $\Omega$ . Remember that the current mode outputs need the termination resistor to generate the differential voltage. LVDS does not work without resistor termination. Typically, connect a single resistor across the pair at the receiver end.

Surface-mount 1% to 2% resistors are best. PCB stubs, component lead, and the distance from the termination to the receiver inputs must be minimized. The distance between the termination resistor and the receiver must be <10 mm (12 mm maximum).

## 11.2 Layout Example

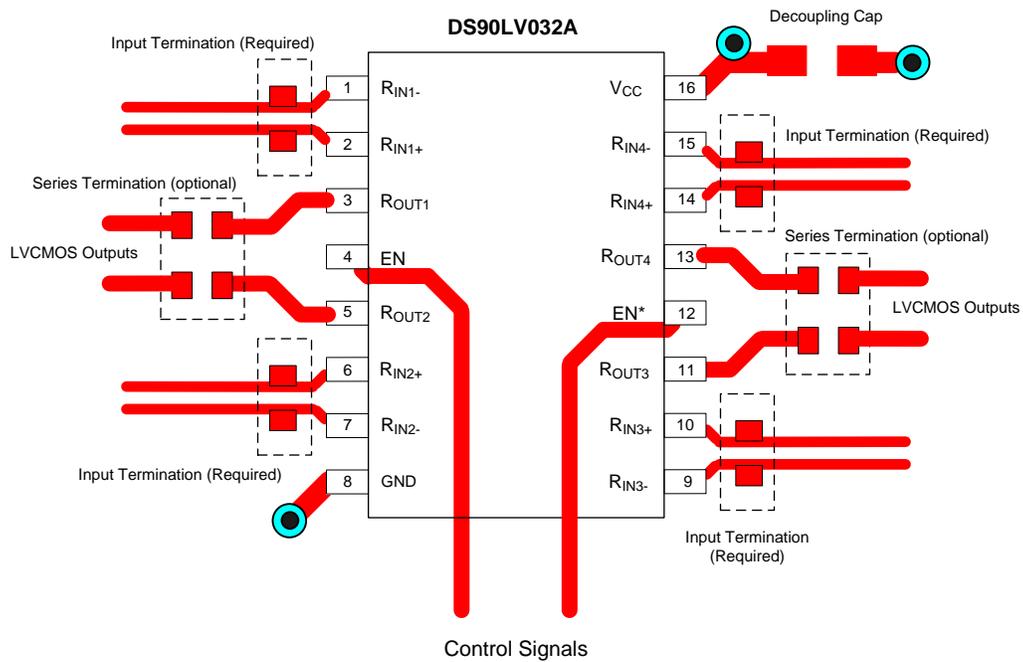


Figure 11. DS90LV032A Layout Example

## 12 Device and Documentation Support

### 12.1 Documentation Support

#### 12.1.1 Related Documentation

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

- [LVDS Owner's Manual](#)
- [AN-808 Long Transmission Lines and Data Signal Quality](#) (SNLA028)
- [AN-977 LVDS Signal Quality: Jitter Measurements Using Eye Patterns Test Report #1](#) (SNLA166)
- [AN-971 An Overview of LVDS Technology](#) (SNLA165)
- [AN-916 A Practical Guide to Cable Selection](#) (SNLA219)
- [AN-805 Calculating Power Dissipation for Differential Line Drivers](#) (SNOA233)
- [AN-903 A Comparison of Differential Termination Techniques](#) (SNLA034)
- [AN-1035 PCB Design Guidelines for LVDS Technology](#) (SNOA355)

#### 12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](http://ti.com). In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

#### 12.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At [e2e.ti.com](http://e2e.ti.com), you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

#### 12.4 Trademarks

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

#### 12.5 Electrostatic Discharge Caution



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.

#### 12.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

**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
DS90LV032ATM	NRND	SOIC	D	16	48	TBD	Call TI	Call TI	-40 to 85	DS90LV032A TM	
DS90LV032ATM/NOPB	ACTIVE	SOIC	D	16	48	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS90LV032A TM	<b>Samples</b>
DS90LV032ATMTC	NRND	TSSOP	PW	16	92	TBD	Call TI	Call TI	-40 to 85	DS90LV 032AT	
DS90LV032ATMTC/NOPB	ACTIVE	TSSOP	PW	16	92	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS90LV 032AT	<b>Samples</b>
DS90LV032ATMTCX	NRND	TSSOP	PW	16	2500	TBD	Call TI	Call TI	-40 to 85	DS90LV 032AT	
DS90LV032ATMTCX/NOPB	ACTIVE	TSSOP	PW	16	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS90LV 032AT	<b>Samples</b>
DS90LV032ATMX	NRND	SOIC	D	16	2500	TBD	Call TI	Call TI	-40 to 85	DS90LV032A TM	
DS90LV032ATMX/NOPB	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	DS90LV032A TM	<b>Samples</b>

(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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

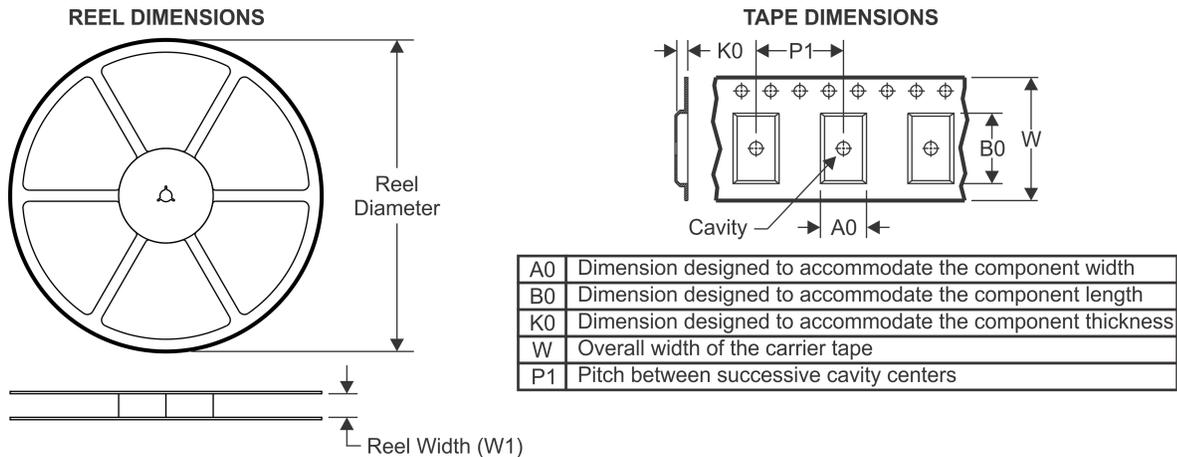
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

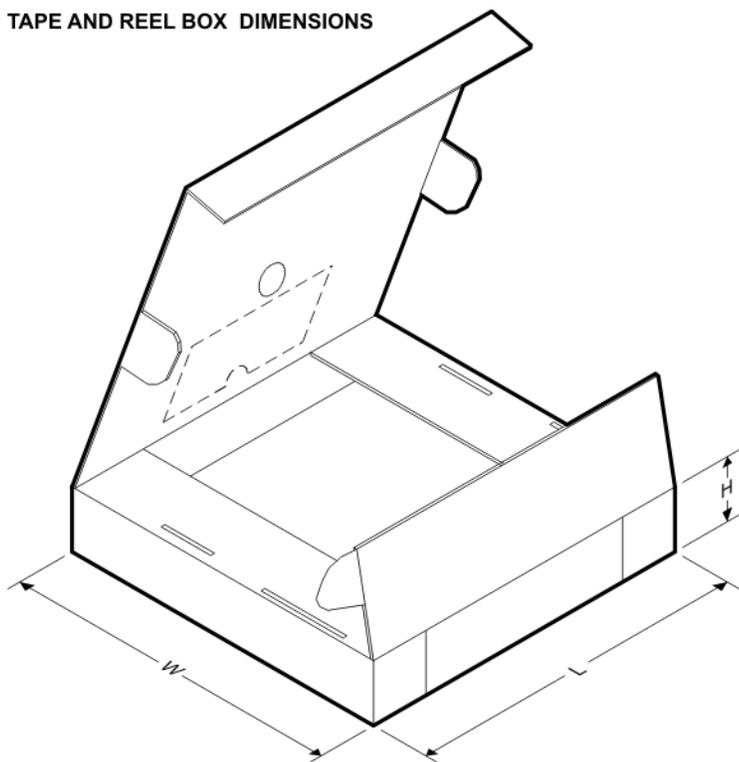
**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**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
DS90LV032ATMTCX	TSSOP	PW	16	2500	330.0	12.4	6.95	5.6	1.6	8.0	12.0	Q1
DS90LV032ATMTCX/NO PB	TSSOP	PW	16	2500	330.0	12.4	6.95	5.6	1.6	8.0	12.0	Q1
DS90LV032ATMX	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.3	8.0	16.0	Q1
DS90LV032ATMX/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**


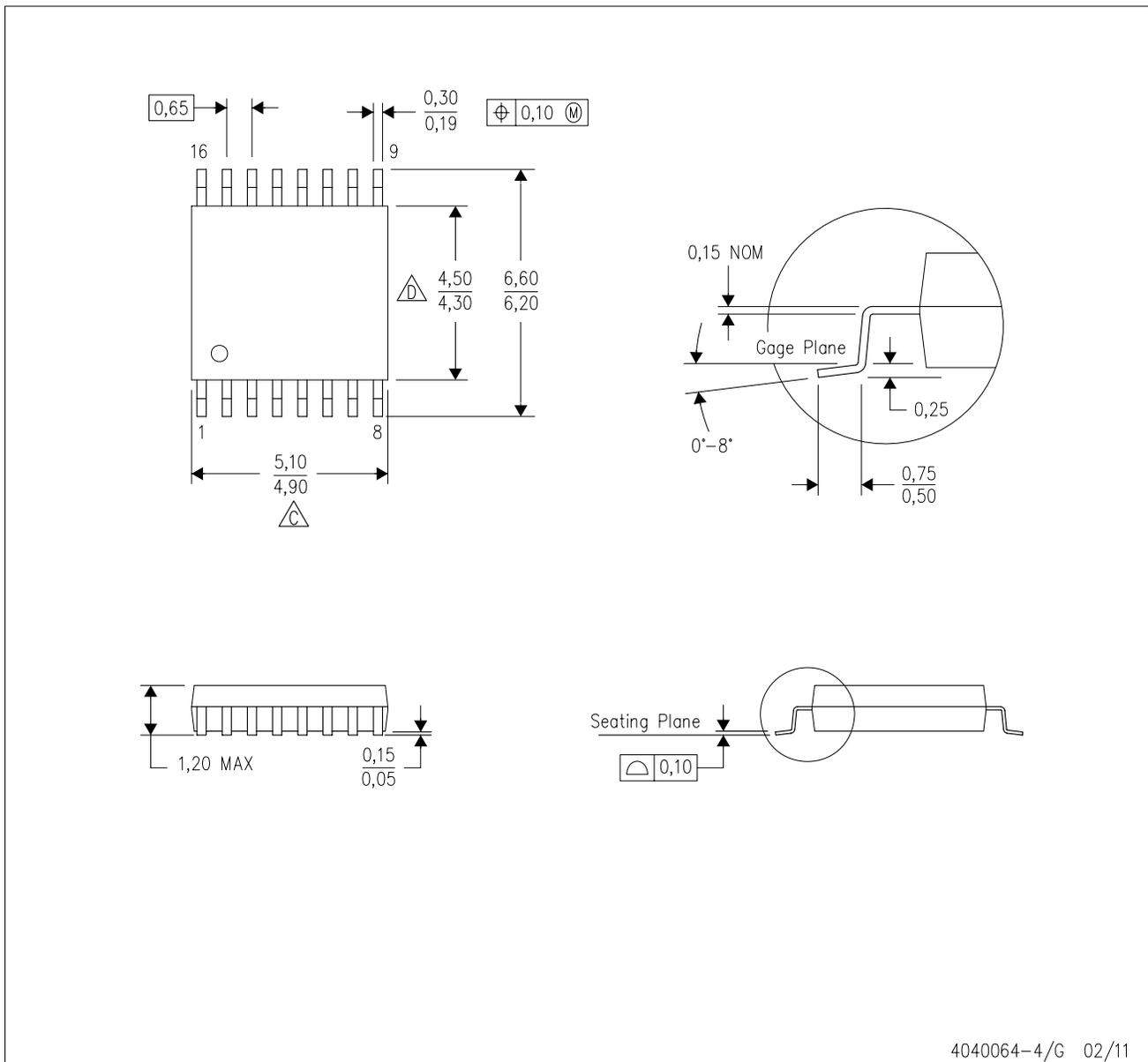
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS90LV032ATMTCX	TSSOP	PW	16	2500	367.0	367.0	35.0
DS90LV032ATMTCX/NOPB	TSSOP	PW	16	2500	367.0	367.0	35.0
DS90LV032ATMX	SOIC	D	16	2500	367.0	367.0	35.0
DS90LV032ATMX/NOPB	SOIC	D	16	2500	367.0	367.0	35.0



PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4040064-4/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - 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 0,15 each side.
  -  D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)