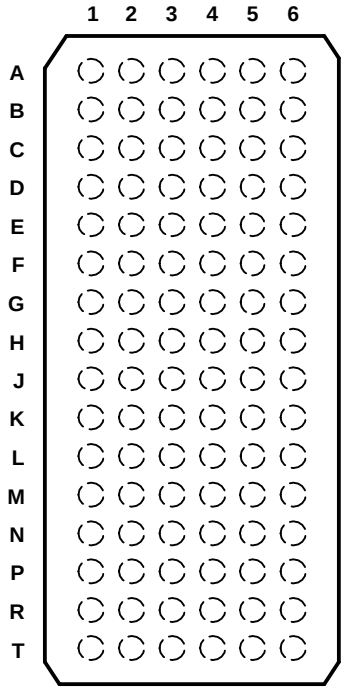
# SN74LVCZ32245A
# 32-BIT BUS TRANSCEIVER WITH 3-STATE OUTPUTS

SCES423–JANUARY 2003–REVISED JUNE 2005

## FEATURES

- **Member of the Texas Instruments Widebus+™ Family**
- **Operates From 2.7 V to 3.6 V**
- **Inputs Accept Voltages to 5.5 V**
- **Max $t_{pd}$ of 3.7 ns at 3.3 V**
- **$I_{off}$ and Power-Up 3-State Support Hot Insertion**
- **Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V $V_{CC}$)**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Protection Exceeds JESD 22**
  - **2000-V Human-Body Model (A114-A)**
  - **1000-V Charged-Device Model (C101)**

**GKE PACKAGE**
**(TOP VIEW)**




**TERMINAL ASSIGNMENTS**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **A** | 1B2 | 1B1 | 1DIR | $1\overline{OE}$ | 1A1 | 1A2 |
| **B** | 1B4 | 1B3 | GND | GND | 1A3 | 1A4 |
| **C** | 1B6 | 1B5 | $V_{CC}$ | $V_{CC}$ | 1A5 | 1A6 |
| **D** | 1B8 | 1B7 | GND | GND | 1A7 | 1A8 |
| **E** | 2B2 | 2B1 | GND | GND | 2A1 | 2A2 |
| **F** | 2B4 | 2B3 | $V_{CC}$ | $V_{CC}$ | 2A3 | 2A4 |
| **G** | 2B6 | 2B5 | GND | GND | 2A5 | 2A6 |
| **H** | 2B7 | 2B8 | 2DIR | $2\overline{OE}$ | 2A8 | 2A7 |
| **J** | 3B2 | 3B1 | 3DIR | $3\overline{OE}$ | 3A1 | 3A2 |
| **K** | 3B4 | 3B3 | GND | GND | 3A3 | 3A4 |
| **L** | 3B6 | 3B5 | $V_{CC}$ | $V_{CC}$ | 3A5 | 3A6 |
| **M** | 3B8 | 3B7 | GND | GND | 3A7 | 3A8 |
| **N** | 4B2 | 4B1 | GND | GND | 4A1 | 4A2 |
| **P** | 4B4 | 4B3 | $V_{CC}$ | $V_{CC}$ | 4A3 | 4A4 |
| **R** | 4B6 | 4B5 | GND | GND | 4A5 | 4A6 |
| **T** | 4B7 | 4B8 | 4DIR | $4\overline{OE}$ | 4A8 | 4A7 |

## DESCRIPTION/ORDERING INFORMATION

This 32-bit (quad-octal) noninverting bus transceiver is designed for 2.7-V to 3.6-V $V_{CC}$ operation.

The SN74LVCZ32245A is designed for asynchronous communication between data buses. The control-function implementation minimizes external timing requirements.

**ORDERING INFORMATION**

| $T_A$ | PACKAGE(1) | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| –40°C to 85°C | LFBGA – GKE | Tape and reel | SN74LVCZ32245AGKER | ZC245A |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

## DESCRIPTION/ORDERING INFORMATION (CONTINUED)

This device can be used as four 8-bit transceivers, two 16-bit transceivers, or one 32-bit transceiver. It allows data transmission from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable ($\overline{OE}$) input can be used to disable the device so that the buses effectively are isolated.

Inputs can be driven from either 3.3-V or 5-V devices. This feature allows the use of these devices as translators in a mixed 3.3-V/5-V system environment.

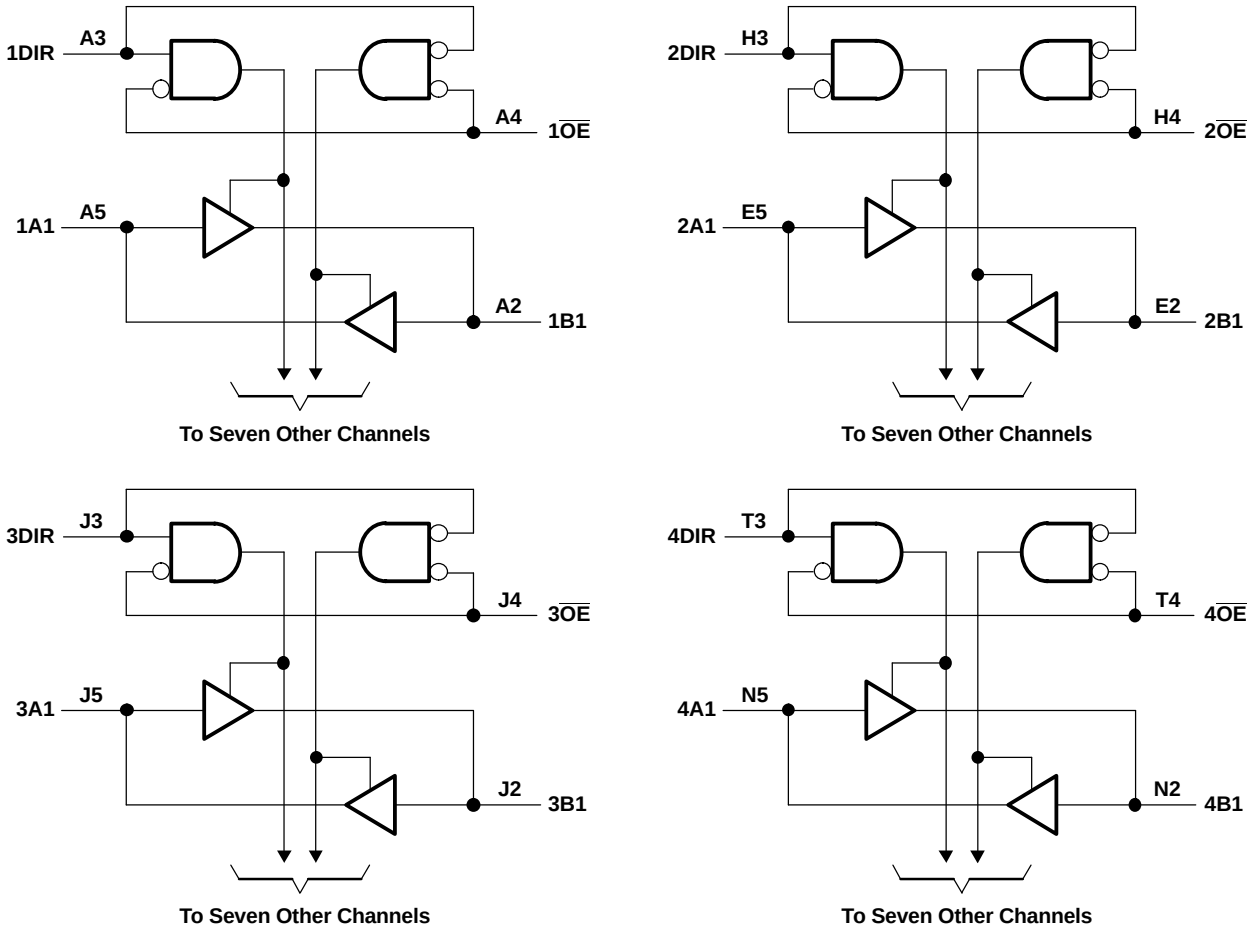
When $V_{CC}$ is between 0 and 1.5 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, $\overline{OE}$ should be tied to $V_{CC}$ through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

This device is fully specified for hot-insertion applications using $I_{off}$ and power-up 3-state. The $I_{off}$ circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

**FUNCTION TABLE
(EACH 8-BIT SECTION)**

| INPUTS | | OPERATION |
|---|---|---|
| $\overline{OE}$ | DIR | |
| L | L | B data to A bus |
| L | H | A data to B bus |
| H | X | Isolation |

**LOGIC DIAGRAM (POSITIVE LOGIC)**




## Absolute Maximum Ratings[1]

over operating free-air temperature range (unless otherwise noted)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage range | | –0.5 | 6.5 | V |
| $V_I$ | Input voltage range[2] | | –0.5 | 6.5 | V |
| $V_O$ | Voltage range applied to any output in the high-impedance or power-off state[2] | | –0.5 | 6.5 | V |
| $V_O$ | Voltage range applied to any output in the high or low state[2][3] | | –0.5 | $V_{CC}$ + 0.5 | V |
| $I_{IK}$ | Input clamp current | $V_I$ < 0 | | –50 | mA |
| $I_{OK}$ | Output clamp current | $V_O$ < 0 | | –50 | mA |
| $I_O$ | Continuous output current | | | ±50 | mA |
| | Continuous current through each $V_{CC}$ or GND | | | ±100 | mA |
| $\theta_{JA}$ | Package thermal impedance[4] | | | 40 | °C/W |
| $T_{stg}$ | Storage temperature range | | –65 | 150 | °C |

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The value of $V_{CC}$ is provided in the recommended operating conditions table.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

## Recommended Operating Conditions(1)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | 2.7 | 3.6 | V |
| $V_{IH}$ | High-level input voltage | $V_{CC}$ = 2.7 V to 3.6 V | 2 | | V |
| $V_{IL}$ | Low-level input voltage | $V_{CC}$ = 2.7 V to 3.6 V | | 0.8 | V |
| $V_I$ | Input voltage | | 0 | 5.5 | V |
| $V_O$ | Output voltage | High or low state | 0 | $V_{CC}$ | V |
| | | 3-state | 0 | 5.5 | |
| $I_{OH}$ | High-level output current | $V_{CC}$ = 2.7 V | | –12 | mA |
| | | $V_{CC}$ = 3 V | | –24 | |
| $I_{OL}$ | Low-level output current | $V_{CC}$ = 2.7 V | | 12 | mA |
| | | $V_{CC}$ = 3 V | | 24 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | | | 6 | ns/V |
| $\Delta t/\Delta V_{CC}$ | Power-up ramp rate | | 150 | | μs/V |
| $T_A$ | Operating free-air temperature | | –40 | 85 | °C |

(1) All unused inputs of the device must be held at $V_{CC}$ or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

## Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $V_{CC}$ | MIN | TYP(1) | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | | $I_{OH}$ = –100 μA | | 2.7 V to 3.6 V | $V_{CC}$ – 0.2 | | | V |
| | | $I_{OH}$ = –12 mA | | 2.7 V | 2.2 | | | |
| | | | | 3 V | 2.4 | | | |
| | | $I_{OH}$ = –24 mA | | 3 V | 2.2 | | | |
| $V_{OL}$ | | $I_{OL}$ = 100 μA | | 2.7 V to 3.6 V | | | 0.2 | V |
| | | $I_{OL}$ = 12 mA | | 2.7 V | | | 0.4 | |
| | | $I_{OL}$ = 24 mA | | 3 V | | | 0.55 | |
| $I_I$ | Control inputs | $V_I$ = 0 to 5.5 V | | 3.6 V | | | ±5 | μA |
| $I_{off}$ | | $V_I$ or $V_O$ = 5.5 V | | 0 | | | ±5 | μA |
| $I_{OZ}$(2) | | $V_O$ = 0 to 5.5 V | | 3.6 V | | | ±5 | μA |
| $I_{OZPU}$ | | $V_O$ = 0.5 V to 2.5 V, | $\overline{OE}$ = don't care | 0 to 1.5 V | | | ±5 | μA |
| $I_{OZPD}$ | | $V_O$ = 0.5 V to 2.5 V, | $\overline{OE}$ = don't care | 1.5 V to 0 | | | ±5 | μA |
| $I_{CC}$ | | $V_I$ = $V_{CC}$ or GND | $I_O$ = 0 | 3.6 V | | | 120 | μA |
| | | 3.6 V ≤ $V_I$ ≤ 5.5 V(3) | | | | | 120 | |
| $\Delta I_{CC}$ | | One input at $V_{CC}$ – 0.6 V, Other inputs at $V_{CC}$ or GND | | 2.7 V to 3.6 V | | | 500 | μA |
| $C_i$ | Control inputs | $V_I$ = $V_{CC}$ or GND | | 3.3 V | | 5 | | pF |
| $C_{io}$ | A or B ports | $V_O$ = $V_{CC}$ or GND | | 3.3 V | | 6.5 | | pF |

(1) All typical values are at $V_{CC}$ = 3.3 V, $T_A$ = 25°C.
(2) For I/O ports, the parameter $I_{OZ}$ includes the input leakage current.
(3) This applies in the disabled state only.

## Switching Characteristics

over recommended operating free-air temperature range, $C_L$ = 50 pF (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC}$ = 2.7 V | | $V_{CC}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A or B | B or A | | 4.2 | 1.3 | 4 | ns |
| $t_{en}$ | $\overline{OE}$ | A or B | | 6.1 | 1.4 | 5.6 | ns |
| $t_{dis}$ | $\overline{OE}$ | A or B | | 7.1 | 2 | 6.6 | ns |

## Switching Characteristics

over recommended operating free-air temperature range, $C_L$ = 30 pF (unless otherwise noted) (see Figure 1)

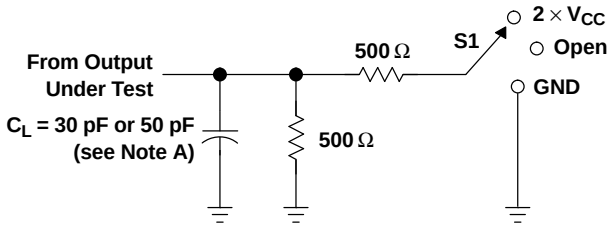
| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC}$ = 2.7 V | | $V_{CC}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A or B | B or A | | 3.9 | 1 | 3.7 | ns |
| $t_{en}$ | $\overline{OE}$ | A or B | | 5.9 | 1.1 | 5.4 | ns |
| $t_{dis}$ | $\overline{OE}$ | A or B | | 6.7 | 1.6 | 6.2 | ns |

## Operating Characteristics

$T_A$ = 25°C

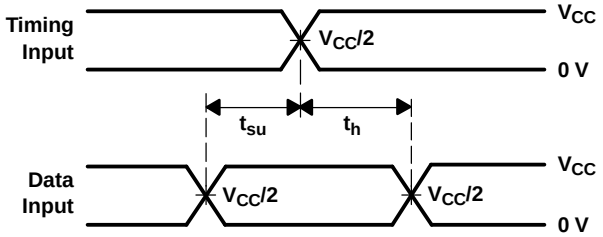
| PARAMETER | | | TEST CONDITIONS | $V_{CC}$ = 3.3 V | UNIT |
|---|---|---|---|---|---|
| | | | | TYP | |
| $C_{pd}$ | Power dissipation capacitance per transceiver | Outputs enabled | f = 10 MHz | 42 | pF |
| | | Outputs disabled | | 4 | |

## PARAMETER MEASUREMENT INFORMATION
## $V_{CC}$ = 2.7 V AND 3.3 V ± 0.3 V

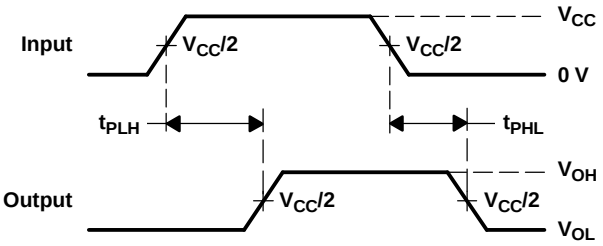



LOAD CIRCUIT

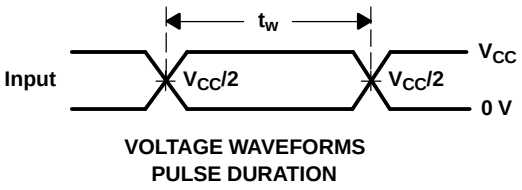
| TEST | S1 |
|---|---|
| $t_{pd}$ | Open |
| $t_{PLZ}/t_{PZL}$ | 2 × $V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND |



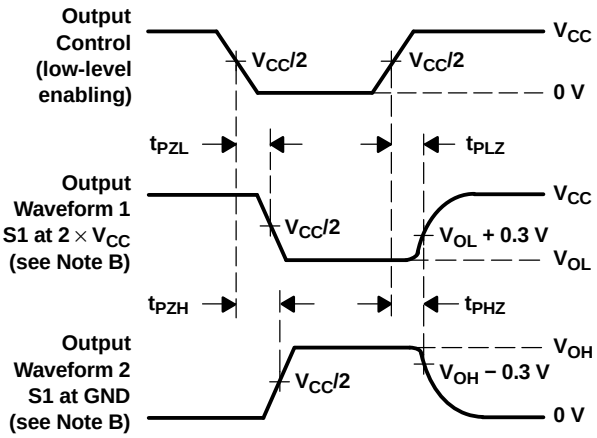

VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES




VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES




VOLTAGE WAVEFORMS
PULSE DURATION




VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

NOTES: A. $C_L$ includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, $Z_O$ = 50 Ω, $t_r$ ≤ 2 ns, $t_f$ ≤ 2 ns.
D. The outputs are measured one at a time, with one transition per measurement.
E. $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{dis}$.
F. $t_{PZL}$ and $t_{PZH}$ are the same as $t_{en}$.
G. $t_{PLH}$ and $t_{PHL}$ are the same as $t_{pd}$.
H. All parameters and waveforms are not applicable to all devices.

**Figure 1. Load Circuit and Voltage Waveforms**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SN74LVCZ32245AGKER | NRND | LFBGA | GKE | 96 | 1000 | TBD | SNPB | Level-2-235C-1 YEAR | -40 to 85 | ZC245A | |
| SN74LVCZ32245AZKER | ACTIVE | LFBGA | ZKE | 96 | 1000 | Green (RoHS & no Sb/Br) | SNAGCU | Level-3-260C-168 HR | -40 to 85 | ZC245A | 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.

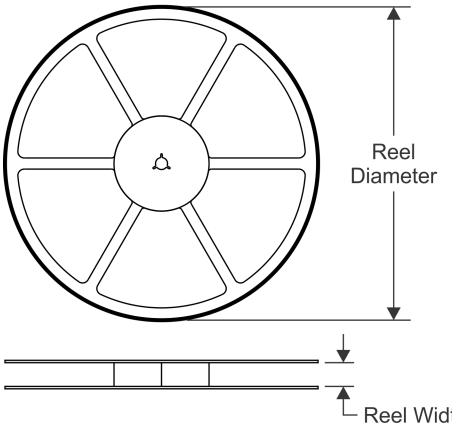
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not 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.

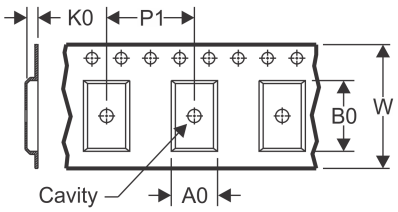
(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

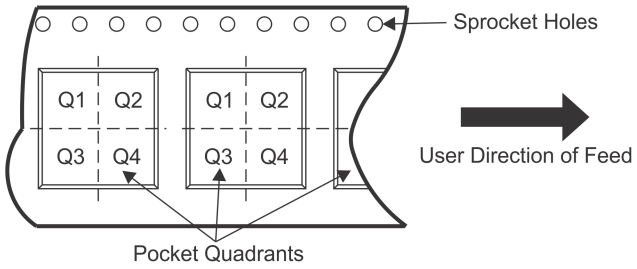



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

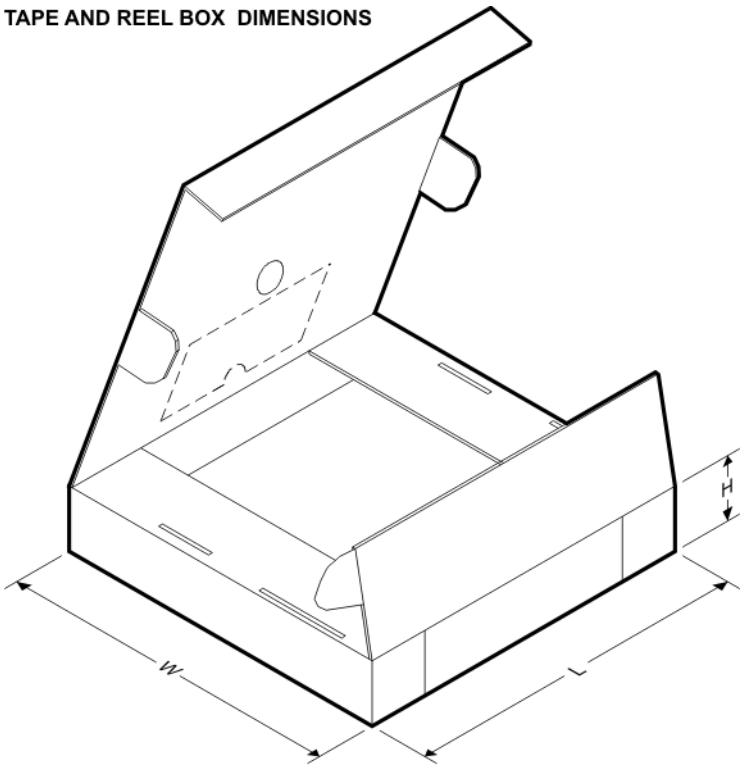
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SN74LVCZ32245AGKER | LFBGA | GKE | 96 | 1000 | 330.0 | 24.4 | 5.7 | 13.7 | 2.0 | 8.0 | 24.0 | Q1 |
| SN74LVCZ32245AZKER | LFBGA | ZKE | 96 | 1000 | 330.0 | 24.4 | 5.7 | 13.7 | 2.0 | 8.0 | 24.0 | Q1 |

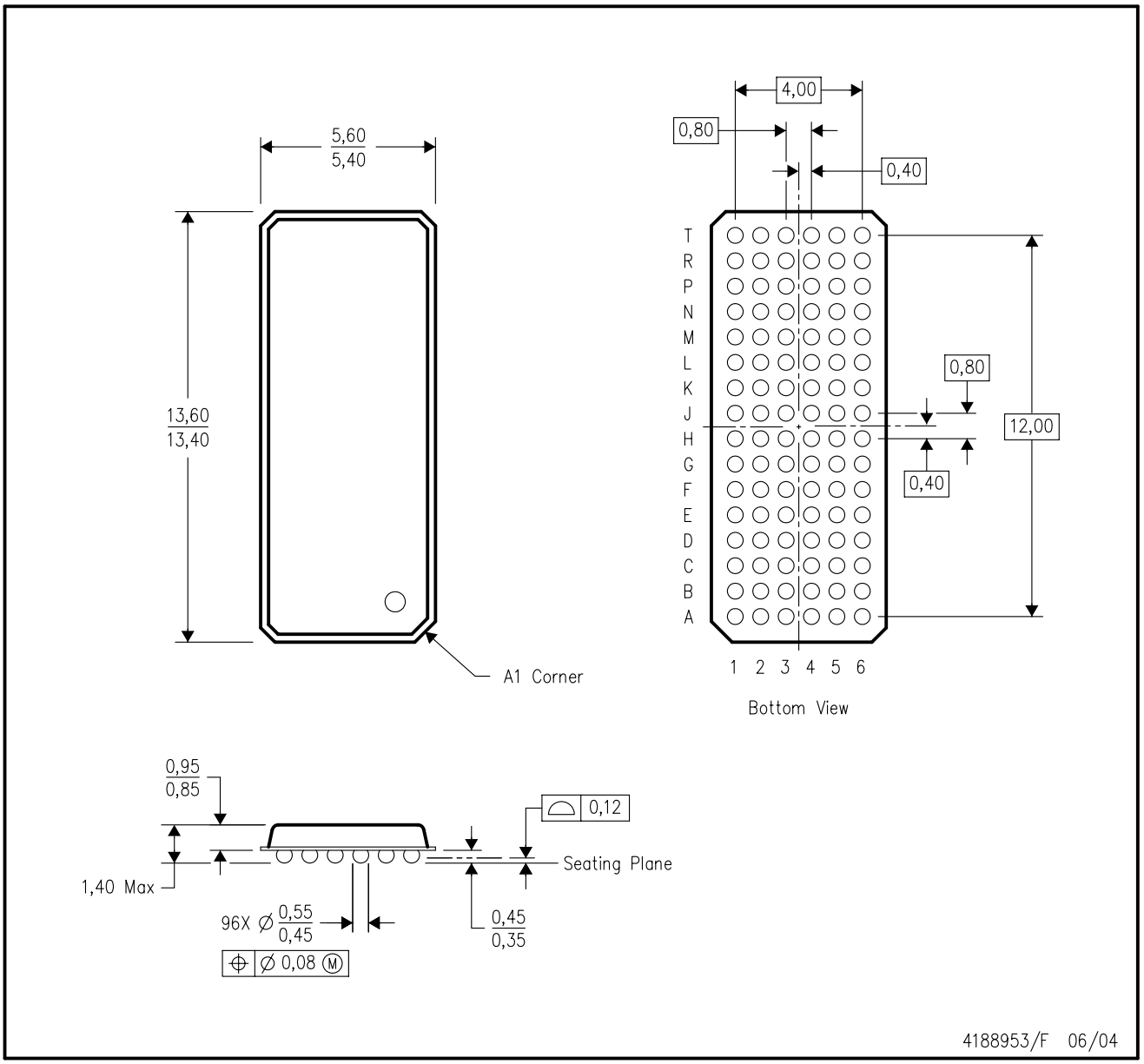
**TAPE AND REEL BOX DIMENSIONS**




*All dimensions are nominal

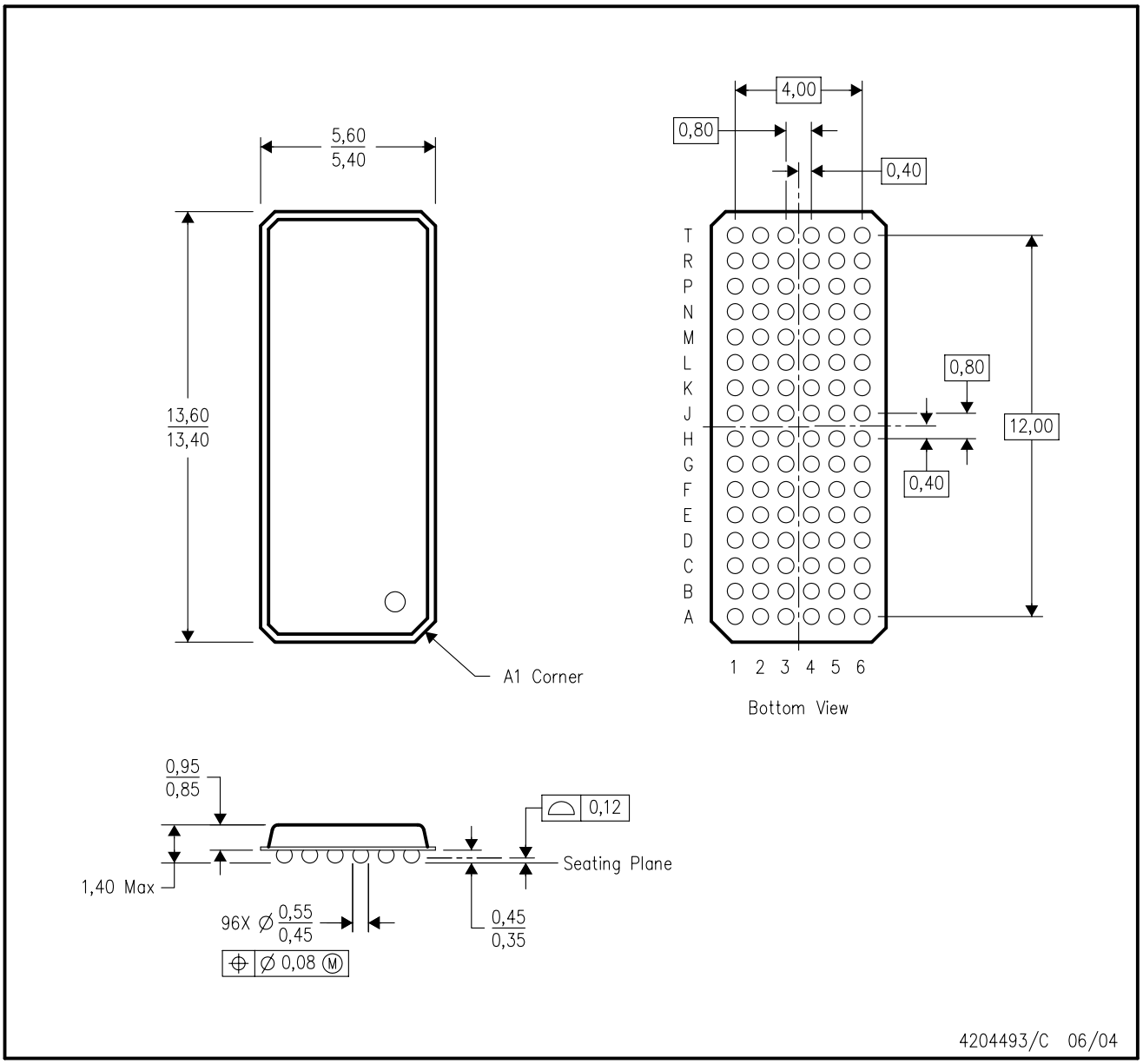
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| SN74LVCZ32245AGKER | LFBGA | GKE | 96 | 1000 | 336.6 | 336.6 | 41.3 |
| SN74LVCZ32245AZKER | LFBGA | ZKE | 96 | 1000 | 336.6 | 336.6 | 41.3 |

GKE (R–PBGA–N96) PLASTIC BALL GRID ARRAY




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO–205 variation CC.
D. This package is tin–lead (SnPb). Refer to the 96 ZKE package (drawing 4204493) for lead–free.

ZKE (R–PBGA–N96) PLASTIC BALL GRID ARRAY




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Falls within JEDEC MO–205 variation CC.
D. This package is lead–free. Refer to the 96 GKE package (drawing 4188953) for tin–lead (SnPb).

## 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** | | **Applications** | |
|---|---|---|---|
| Audio | www.ti.com/audio | Automotive and Transportation | www.ti.com/automotive |
| Amplifiers | amplifier.ti.com | Communications and Telecom | www.ti.com/communications |
| Data Converters | dataconverter.ti.com | Computers and Peripherals | www.ti.com/computers |
| DLP® Products | www.dlp.com | Consumer Electronics | www.ti.com/consumer-apps |
| DSP | dsp.ti.com | Energy and Lighting | www.ti.com/energy |
| Clocks and Timers | www.ti.com/clocks | Industrial | www.ti.com/industrial |
| Interface | interface.ti.com | Medical | www.ti.com/medical |
| Logic | logic.ti.com | Security | www.ti.com/security |
| Power Mgmt | power.ti.com | Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Microcontrollers | microcontroller.ti.com | Video and Imaging | www.ti.com/video |
| RFID | www.ti-rfid.com | | |
| OMAP Applications Processors | www.ti.com/omap | **TI E2E Community** | e2e.ti.com |
| Wireless Connectivity | www.ti.com/wirelessconnectivity | | |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265