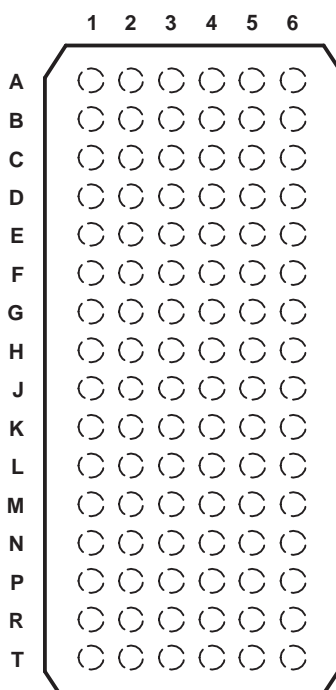


FEATURES

- Member of the Texas Instruments Widebus+™ Family
- Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- I_{off} and Power-Up 3-State Support Hot Insertion
- Supports Unregulated Battery Operation Down to 2.7 V
- Supports Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)
 - 1000-V Charged-Device Model (C101)

GKE OR ZKE PACKAGE
(TOP VIEW)



TERMINAL ASSIGNMENTS

	1	2	3	4	5	6
A	1Y2	1Y1	1 \overline{OE}	2 \overline{OE}	1A1	1A2
B	1Y4	1Y3	GND	GND	1A3	1A4
C	2Y2	2Y1	1V _{CC}	1V _{CC}	2A1	2A2
D	2Y4	2Y3	GND	GND	2A3	2A4
E	3Y2	3Y1	GND	GND	3A1	3A2
F	3Y4	3Y3	1V _{CC}	1V _{CC}	3A3	3A4
G	4Y2	4Y1	GND	GND	4A1	4A2
H	4Y3	4Y4	4 \overline{OE}	3 \overline{OE}	4A4	4A3
J	5Y2	5Y1	5 \overline{OE}	6 \overline{OE}	5A1	5A2
K	5Y4	5Y3	GND	GND	5A3	5A4
L	6Y2	6Y1	2V _{CC}	2V _{CC}	6A1	6A2
M	6Y4	6Y3	GND	GND	6A3	6A4
N	7Y2	7Y1	GND	GND	7A1	7A2
P	7Y4	7Y3	2V _{CC}	2V _{CC}	7A3	7A4
R	8Y2	8Y1	GND	GND	8A1	8A2
T	8Y3	8Y4	8 \overline{OE}	7 \overline{OE}	8A4	8A3

DESCRIPTION/ORDERING INFORMATION

ORDERING INFORMATION

T_A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	LFBGA – GKE	Reel of 1000	SN74LVTH32244GKER	HV244
	LFBGA – ZKE (Pb-free)		SN74LVTH32244ZKER	

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



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.

Widebus+ is a trademark of Texas Instruments.

SN74LVTH32244

3.3-V ABT 32-BIT BUFFER/DRIVER WITH 3-STATE OUTPUTS

SCBS749C—OCTOBER 2000—REVISED DECEMBER 2006

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

The SN74LVTH32244 is a 32-bit buffer and line driver designed for low-voltage (3.3-V) V_{CC} operation, with the capability to provide a TTL interface to a 5-V system environment. This device can be used as eight 4-bit buffers, four 8-bit buffers, two 16-bit buffers, or one 32-bit buffer. The device provides true outputs and has symmetrical active-low output-enable (\overline{OE}) inputs. It is designed specifically to improve both the performance and density of 3-state memory address drivers, clock drivers, and bus-oriented receivers and transmitters.

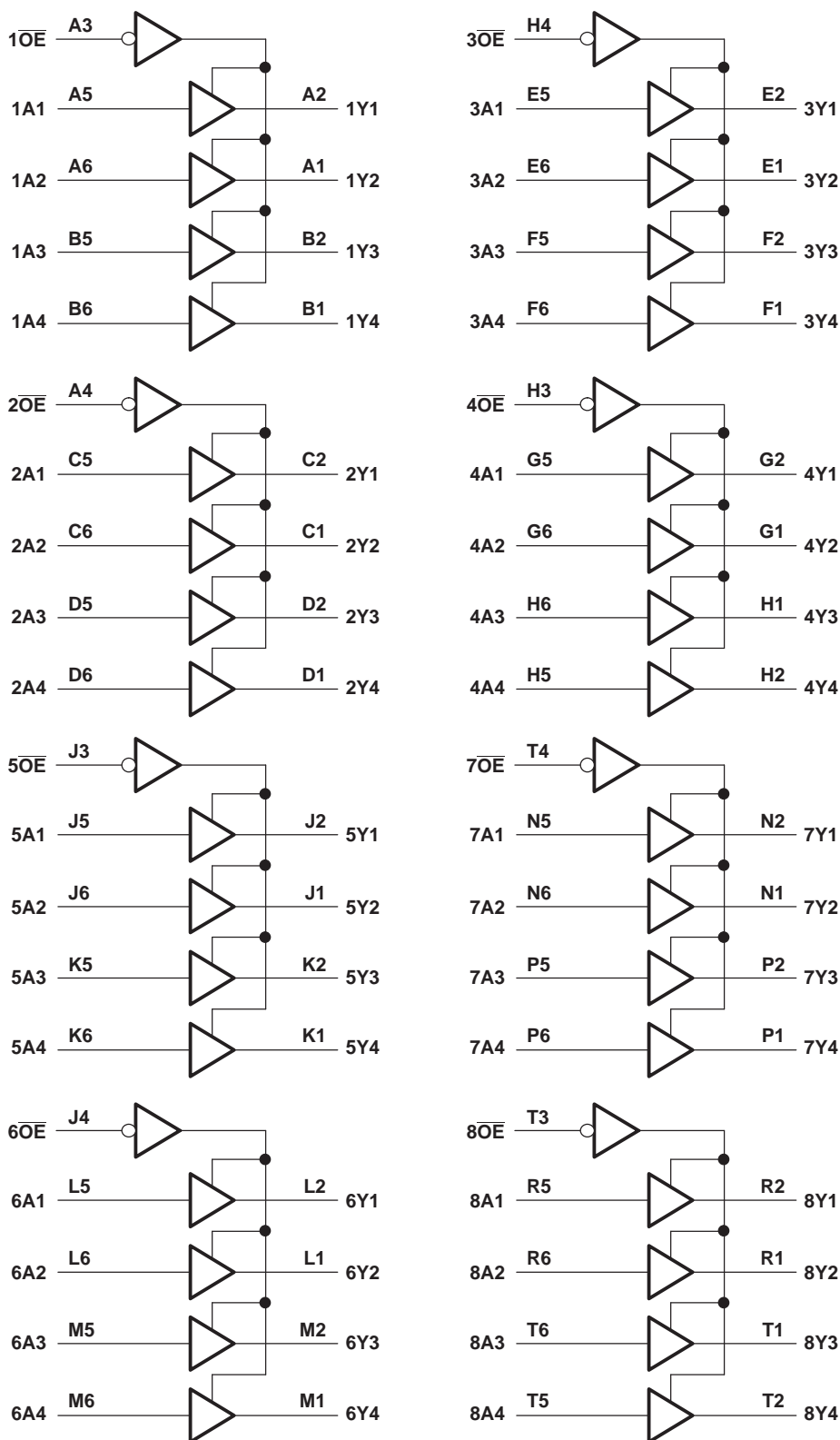
The SN74LVTH32244 is fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

Active bus-hold circuitry holds unused or undriven inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

FUNCTION TABLE
(each 4-bit buffer/driver)

INPUTS		OUTPUT Y
\overline{OE}	A	
L	H	H
L	L	L
H	X	Z

LOGIC DIAGRAM (POSITIVE LOGIC)



SN74LVTH32244

3.3-V ABT 32-BIT BUFFER/DRIVER WITH 3-STATE OUTPUTS

SCBS749C—OCTOBER 2000—REVISED DECEMBER 2006

Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT
V_{CC}	Supply voltage range	−0.5	4.6	V
V_I	Input voltage range ⁽²⁾	−0.5	7	V
V_O	Voltage range applied to any output in the high-impedance or power-off state ⁽²⁾	−0.5	7	V
V_O	Voltage range applied to any output in the high state ⁽²⁾	−0.5	$V_{CC} + 0.5$	V
I_O	Current into any output in the low state		128	mA
I_O	Current into any output in the high state ⁽³⁾		64	mA
I_{IK}	Input clamp current	$V_I < 0$	−50	mA
I_{OK}	Output clamp current	$V_O < 0$	−50	mA
θ_{JA}	Package thermal impedance ⁽⁴⁾	GKE/ZKE package		40 °C/W
T_{stg}	Storage temperature range	−65	160	°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 and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

(3) This current flows only when the output is in the high state and $V_O > V_{CC}$.

(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	2		V
V_{IL}	Low-level input voltage		0.8	V
V_I	Input voltage		5.5	V
I_{OH}	High-level output current		−32	mA
I_{OL}	Low-level output current		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10 ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate	200		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		MIN	TYP ⁽¹⁾	MAX	UNIT
V_{IK}		$V_{CC} = 2.7\text{ V}$,	$I_I = -18\text{ mA}$			-1.2	V
V_{OH}		$V_{CC} = 2.7\text{ V to } 3.6\text{ V}$,	$I_{OH} = -100\text{ }\mu\text{A}$	$V_{CC} - 0.2$			V
		$V_{CC} = 2.7\text{ V}$,	$I_{OH} = -8\text{ mA}$	2.4			
		$V_{CC} = 3\text{ V}$,	$I_{OH} = -32\text{ mA}$	2			
V_{OL}	$V_{CC} = 2.7\text{ V}$		$I_{OL} = 100\text{ }\mu\text{A}$			0.2	V
			$I_{OL} = 24\text{ mA}$			0.5	
	$V_{CC} = 3\text{ V}$		$I_{OL} = 16\text{ mA}$			0.4	
			$I_{OL} = 32\text{ mA}$			0.5	
			$I_{OL} = 64\text{ mA}$			0.55	
I_I		$V_{CC} = 0\text{ or } 3.6\text{ V}$,	$V_I = 5.5\text{ V}$			10	μA
	Control inputs	$V_{CC} = 3.6\text{ V}$,	$V_I = V_{CC}\text{ or GND}$			± 1	
	Data inputs	$V_{CC} = 3.6\text{ V}$	$V_I = V_{CC}$			1	
			$V_I = 0$			-5	
I_{off}		$V_{CC} = 0$,	$V_I\text{ or } V_O = 0\text{ to } 4.5\text{ V}$			± 100	μA
$I_{I(hold)}$	Data inputs	$V_{CC} = 3\text{ V}$	$V_I = 0.8\text{ V}$	75			μA
			$V_I = 2\text{ V}$	-75			
		$V_{CC} = 3.6\text{ V}$, ⁽²⁾	$V_I = 0\text{ to } 3.6\text{ V}$			± 500	
I_{OZH}		$V_{CC} = 3.6\text{ V}$,	$V_O = 3\text{ V}$			5	μA
I_{OZL}		$V_{CC} = 3.6\text{ V}$,	$V_O = 0.5\text{ V}$			-5	μA
I_{OZPU}		$V_{CC} = 0\text{ to } 1.5\text{ V}$, $V_O = 0.5\text{ V to } 3\text{ V}$, $\overline{OE} = \text{don't care}$				± 100	μA
I_{OZPD}		$V_{CC} = 1.5\text{ V to } 0$, $V_O = 0.5\text{ V to } 3\text{ V}$, $\overline{OE} = \text{don't care}$				± 100	μA
I_{CC}		$V_{CC} = 3.6\text{ V}$, $I_O = 0$, $V_I = V_{CC}\text{ or GND}$	Outputs high			0.38	mA
			Outputs low			10	
			Outputs disabled			0.38	
$\Delta I_{CC}^{(3)}$		$V_{CC} = 3\text{ V to } 3.6\text{ V}$, One input at $V_{CC} - 0.6\text{ V}$, Other inputs at $V_{CC}\text{ or GND}$				0.2	mA
C_I		$V_I = 3\text{ V or } 0$			4		pF
C_O		$V_O = 3\text{ V or } 0$			9		pF

(1) All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

(2) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

(3) This is the increase in supply current for each input that is at the specified TTL voltage level, rather than V_{CC} or GND.

SN74LVTH32244

3.3-V ABT 32-BIT BUFFER/DRIVER WITH 3-STATE OUTPUTS

SCBS749C—OCTOBER 2000—REVISED DECEMBER 2006

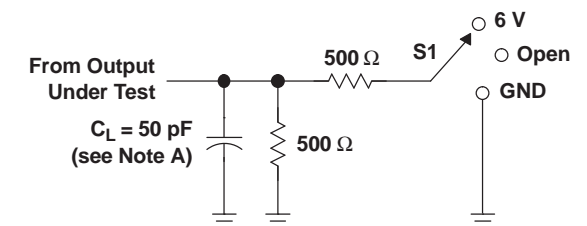
Switching Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 1](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$			$V_{CC} = 2.7\text{ V}$		UNIT
			MIN	TYP ⁽¹⁾	MAX	MIN	MAX	
t_{PLH}	A	Y	1.2	2.3	3.2	3.7		ns
t_{PHL}			1.2	2	3.2	3.7		
t_{PZH}	\overline{OE}	Y	1.2	2.6	4	5		ns
t_{PZL}			1.2	2.7	4	5		
t_{PHZ}	\overline{OE}	Y	2.2	3.3	4.5	5		ns
t_{PLZ}			2	3.1	4.2	4.4		
$t_{sk(LH)}$					0.5			ns
$t_{sk(HL)}$					0.5			

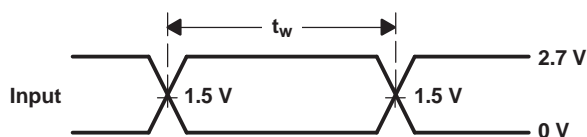
(1) All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

PARAMETER MEASUREMENT INFORMATION

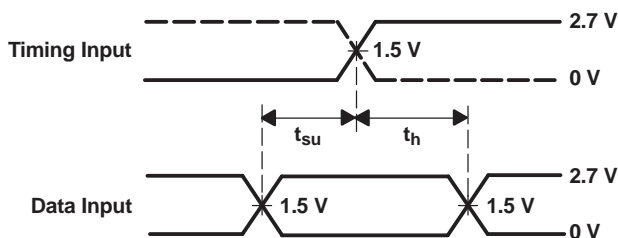


LOAD CIRCUIT

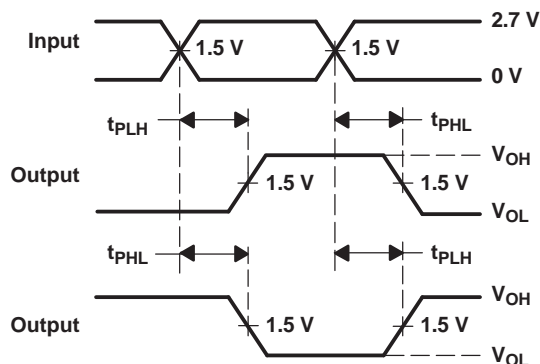
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



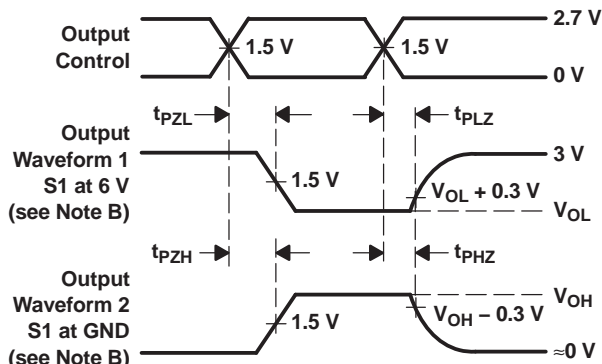
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

- 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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
D. The outputs are measured one at a time, with one transition per measurement.

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⁾
SN74LVTH32244GKER	NRND	LFBGA	GKE	96	1000	TBD	SNPB	Level-2-235C-1 YEAR
SN74LVTH32244ZKER	ACTIVE	LFBGA	ZKE	96	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR

⁽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.

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.

OTHER QUALIFIED VERSIONS OF SN74LVTH32244 :

- Enhanced Product: [SN74LVTH32244-EP](#)

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION


*All dimensions are nominal

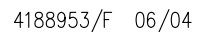
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74LVTH32244GKER	LFBGA	GKE	96	1000	330.0	24.4	5.7	13.7	2.0	8.0	24.0	Q1
SN74LVTH32244ZKER	LFBGA	ZKE	96	1000	330.0	24.4	5.7	13.7	2.0	8.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LVTH32244GKER	LFBGA	GKE	96	1000	333.2	345.9	31.8
SN74LVTH32244ZKER	LFBGA	ZKE	96	1000	333.2	345.9	31.8

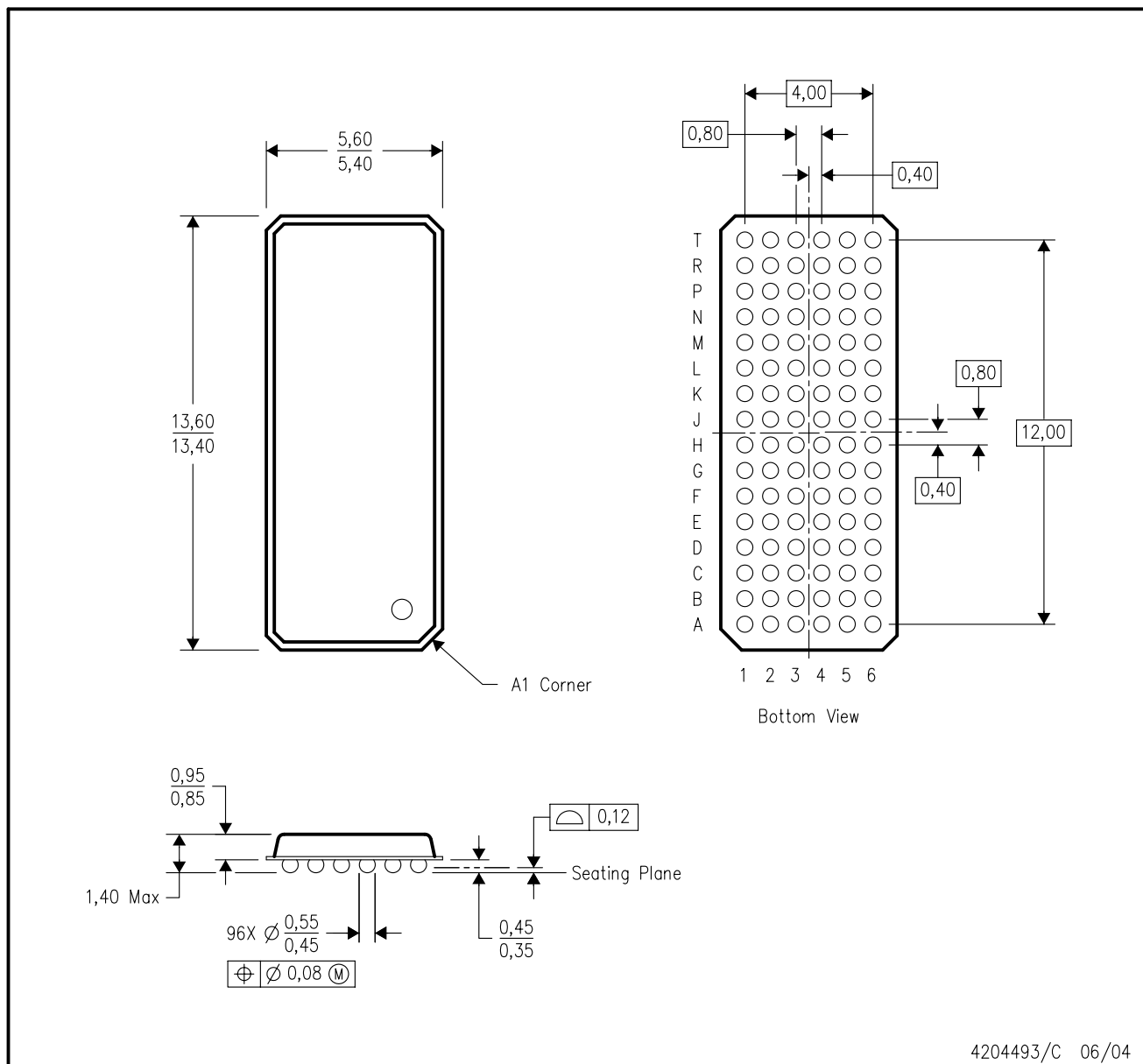


NOTES:

- 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, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video
Wireless	www.ti.com/wireless-apps

TI E2E Community Home Page

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated