

# SN74CBTK32245 32-BIT FET BUS SWITCH WITH ACTIVE-CLAMP UNDERSHOOT-PROTECTION CIRCUIT

SCDS106E – APRIL 2000 – REVISED SEPTEMBER 2003

- Member of the Texas Instruments Widebus+™ Family
- 5-Ω Switch Connection Between Two Ports
- TTL-Compatible Input Levels
- I<sub>off</sub> Supports Partial-Power-Down Mode Operation
- Active-Clamp Undershoot-Protection Circuit on the I/Os Clamps Undershoots Up To -2 V
- Flow-Through Architecture Optimizes PCB Layout
- 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)

## description/ordering information

The SN74CBTK32245 provides 32 bits of high-speed TTL-compatible bus switching. The low on-state resistance of the switch allows connections to be made with minimal propagation delay.

The A and B ports have an active-clamp undershoot-protection circuit. When there is an undershoot, the active-clamp circuit is enabled and current from V<sub>CC</sub> is supplied to clamp the output, preventing the pass transistor from turning on.

The device is organized as four 8-bit bus switches, two 16-bit bus switches, or one 32-bit bus switch. When the output-enable ( $\overline{OE}$ ) input is low, the switch is on and port A is connected to port B. When  $\overline{OE}$  is high, the switch is open and the high-impedance state exists between the two ports.

This device is fully specified for partial-power-down applications using I<sub>off</sub>. The I<sub>off</sub> circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

## ORDERING INFORMATION

T <sub>A</sub>	PACKAGE†	Tape and reel	ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	LFBGA – GKE		SN74CBTK32245GKER	KT245
	LFBGA – ZKE (Pb-free)		SN74CBTK32245ZKER	

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

**FUNCTION TABLE**  
(each 8-bit bus switch)

INPUT $\overline{OE}$	FUNCTION
L	A port = B port
H	Disconnect



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.

**PRODUCTION DATA** information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



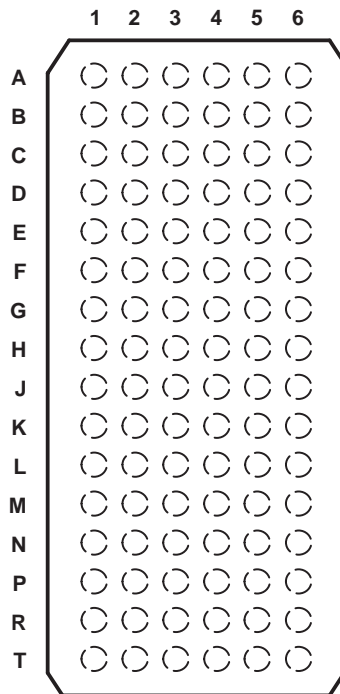
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2003, Texas Instruments Incorporated

**SN74CBTK32245**  
**32-BIT FET BUS SWITCH**  
**WITH ACTIVE-CLAMP UNDERSHOOT-PROTECTION CIRCUIT**

SCDS106E – APRIL 2000 – REVISED SEPTEMBER 2003

**GKE OR ZKE PACKAGE**  
**(TOP VIEW)**



**terminal assignments**

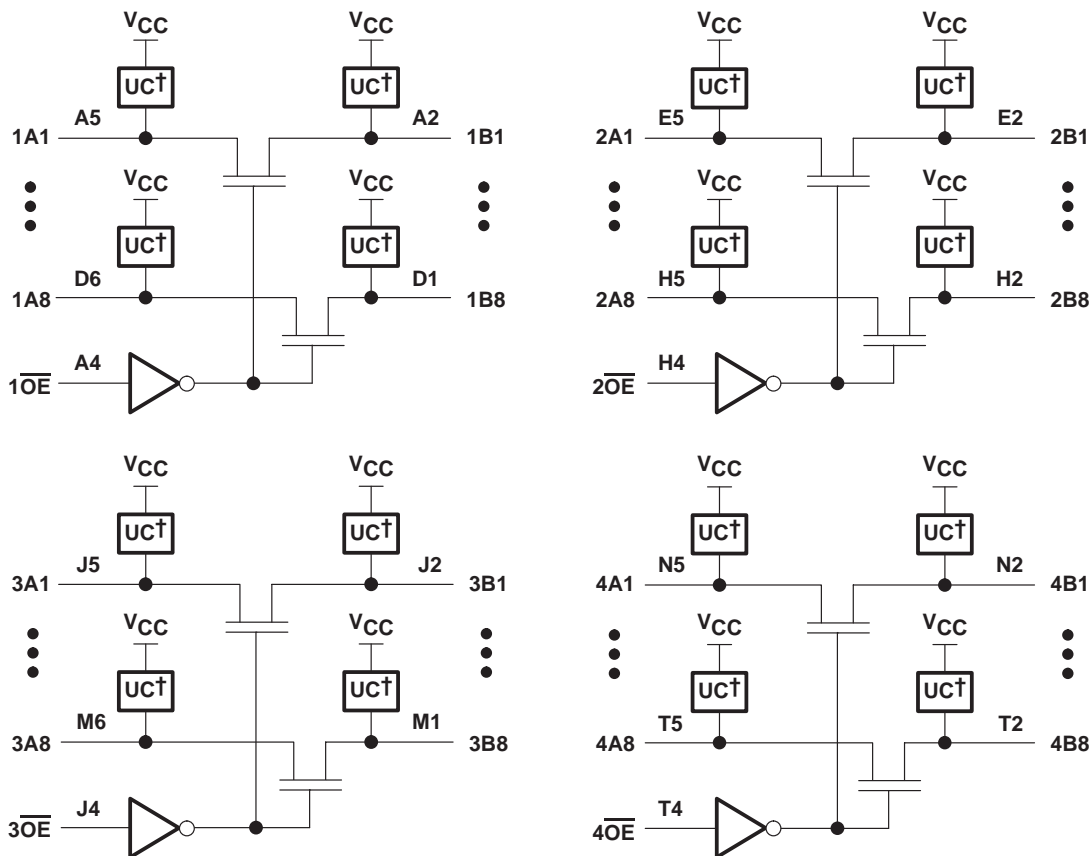
	1	2	3	4	5	6
A	1B2	1B1	NC	$\overline{1OE}$	1A1	1A2
B	1B4	1B3	GND	GND	1A3	1A4
C	1B6	1B5	V <sub>CC</sub>	V <sub>CC</sub>	1A5	1A6
D	1B8	1B7	GND	GND	1A7	1A8
E	2B2	2B1	GND	GND	2A1	2A2
F	2B4	2B3	V <sub>CC</sub>	V <sub>CC</sub>	2A3	2A4
G	2B6	2B5	GND	GND	2A5	2A6
H	2B7	2B8	NC	$\overline{2OE}$	2A8	2A7
J	3B2	3B1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

NC – No internal connection

**SN74CBTK32245**  
**32-BIT FET BUS SWITCH**  
**WITH ACTIVE-CLAMP UNDERSHOOT-PROTECTION CIRCUIT**

SCDS106E – APRIL 2000 – REVISED SEPTEMBER 2003

**logic diagram (positive logic)**



† Undershoot clamp

**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)‡**

Supply voltage range, $V_{CC}$ .....	-0.5 V to 7 V
Input voltage range, $V_I$ (see Note 1) .....	-0.5 V to 7 V
Continuous channel current .....	128 mA
Input clamp current, $I_{IK}$ ( $V_{I/O} < 0$ ) .....	-50 mA
Package thermal impedance, $\theta_{JA}$ (see Note 2): GKE/ZKE package .....	40°C/W
Storage temperature range, $T_{Stg}$ .....	-65°C to 150°C

‡ 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.

- NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.  
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

# SN74CBTK32245

## 32-BIT FET BUS SWITCH

### WITH ACTIVE-CLAMP UNDERSHOOT-PROTECTION CIRCUIT

SCDS106E – APRIL 2000 – REVISED SEPTEMBER 2003

#### recommended operating conditions (see Note 3)

	MIN	MAX	UNIT
V <sub>CC</sub> Supply voltage	4	5.5	V
V <sub>IH</sub> High-level control input voltage	2		V
V <sub>IL</sub> Low-level control input voltage		0.8	V
T <sub>A</sub> Operating free-air temperature	-40	85	°C

NOTE 3: All unused control inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to 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†	MAX	UNIT
V <sub>IK</sub>	V <sub>CC</sub> = 4.5 V,	I <sub>I</sub> = -18 mA			-1.2	V
V <sub>IKU</sub>	V <sub>CC</sub> = 5.5 V,	0 mA ≥ I <sub>I</sub> ≥ -50 mA, $\overline{OE} = 5.5$ V			-2	V
I <sub>I</sub>	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = 5.5 V or GND			±5	μA
I <sub>off</sub>	V <sub>CC</sub> = 0,	V <sub>I</sub> or V <sub>O</sub> = 0 to 5.5 V			20	μA
I <sub>CC</sub>	V <sub>CC</sub> = 5.5 V,	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0			6	μA
ΔI <sub>CC</sub> ‡	Control inputs	V <sub>CC</sub> = 5.5 V, One input at 3.4 V, Other inputs at V <sub>CC</sub> or GND			3.5	mA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = 3 V or 0			3.5	pF
C <sub>io(OFF)</sub>	V <sub>O</sub> = 3 V or 0,	$\overline{OE} = V_{CC}$			5.5	pF
r <sub>on</sub> §	V <sub>CC</sub> = 4 V, TYP at V <sub>CC</sub> = 4 V	V <sub>I</sub> = 2.4 V,	I <sub>I</sub> = 15 mA	14	20	Ω
		V <sub>I</sub> = 0	I <sub>I</sub> = 64 mA	5	7	
	V <sub>CC</sub> = 4.5 V	V <sub>I</sub> = 0	I <sub>I</sub> = 30 mA	5	7	
		V <sub>I</sub> = 2.4 V,	I <sub>I</sub> = 15 mA	8	12	

† All typical values are at V<sub>CC</sub> = 5 V (unless otherwise noted), T<sub>A</sub> = 25°C.

‡ This is the increase in supply current for each input that is at the specified TTL-voltage level, rather than V<sub>CC</sub> or GND.

§ Measured by the voltage drop between the A and B terminals at the indicated current through the switch. On-state resistance is determined by the lower of the voltages of the two (A or B) terminals.

#### switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4 V		V <sub>CC</sub> = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	
t <sub>pd</sub> ¶	A or B	B or A		0.35		0.25	ns
t <sub>en</sub>	$\overline{OE}$	A or B		7.4	1.6	4.9	ns
t <sub>dis</sub>	$\overline{OE}$	A or B		7.4	4.2	7.5	ns

¶ The propagation delay is the calculated RC time constant of the typical on-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).

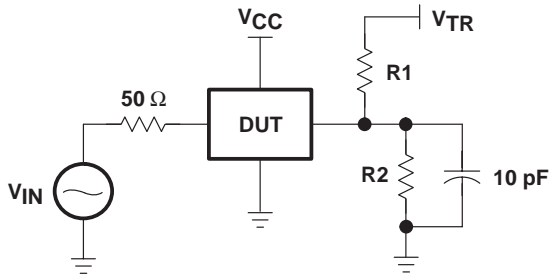


**SN74CBTK32245**  
**32-BIT FET BUS SWITCH**  
**WITH ACTIVE-CLAMP UNDERSHOOT-PROTECTION CIRCUIT**  
SCDS106E – APRIL 2000 – REVISED SEPTEMBER 2003

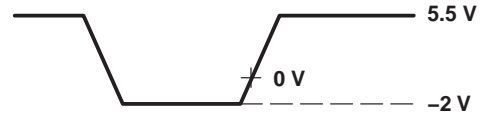
**undershoot characteristics**

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{OUTU}$	See Figures 1 and 2, and Table 1	2	$V_{OH}-0.3$		V

† All typical values are at  $V_{CC} = 5\text{ V}$  (unless otherwise noted),  $T_A = 25^\circ\text{C}$ .



**Figure 1. Device Test Setup**



**Figure 2. Transient Input Voltage Waveform**

**Table 1. Device Test Conditions**

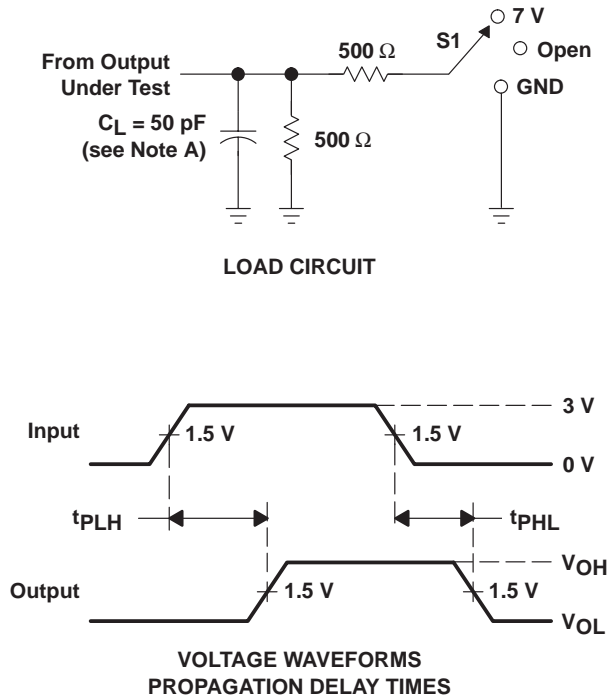
PARAMETER	VALUE	UNIT
B port under test†	See Figure 1	
$V_{IN}$	See Figure 2	V
$t_w$	20	ns
$t_r$	2	ns
$t_f$	2	ns
$R1 = R2$	100	k $\Omega$
$V_{TR}$	11	V
$V_{CC}$	5.5	V

† Other B-port outputs are open

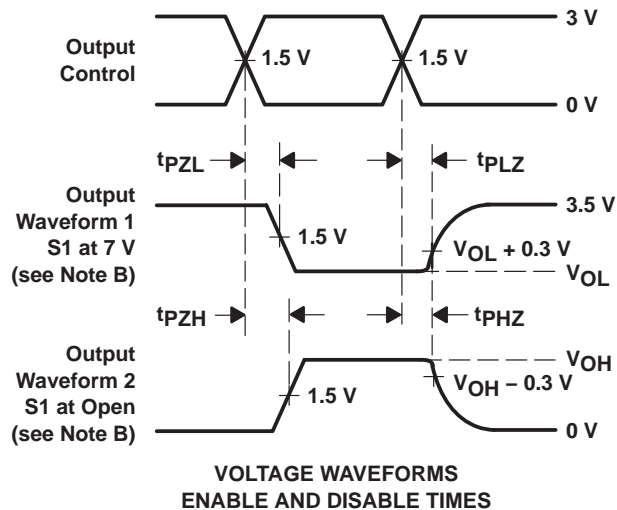
**SN74CBTK32245**  
**32-BIT FET BUS SWITCH**  
**WITH ACTIVE-CLAMP UNDERSHOOT-PROTECTION CIRCUIT**

SCDS106E – APRIL 2000 – REVISED SEPTEMBER 2003

**PARAMETER MEASUREMENT INFORMATION**



TEST	S1
t <sub>pd</sub>	Open
t <sub>PLZ</sub> /t <sub>PZL</sub>	7 V
t <sub>PHZ</sub> /t <sub>PZH</sub>	Open



- NOTES: A. C<sub>L</sub> 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<sub>O</sub> = 50 Ω, t<sub>r</sub> ≤ 2.5 ns, t<sub>f</sub> ≤ 2.5 ns.  
 D. The outputs are measured one at a time with one transition per measurement.  
 E. t<sub>PLZ</sub> and t<sub>PHZ</sub> are the same as t<sub>dis</sub>.  
 F. t<sub>PZL</sub> and t<sub>PZH</sub> are the same as t<sub>en</sub>.  
 G. t<sub>PLH</sub> and t<sub>PHL</sub> are the same as t<sub>pd</sub>.  
 H. All parameters and waveforms are not applicable to all devices.

**Figure 3. 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
SN74CBTK32245GKER	NRND	LFBGA	GKE	96	1000	TBD	SNPB	Level-2-235C-1 YEAR	-40 to 85	KT245	
SN74CBTK32245ZKER	ACTIVE	LFBGA	ZKE	96	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	KT245	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.

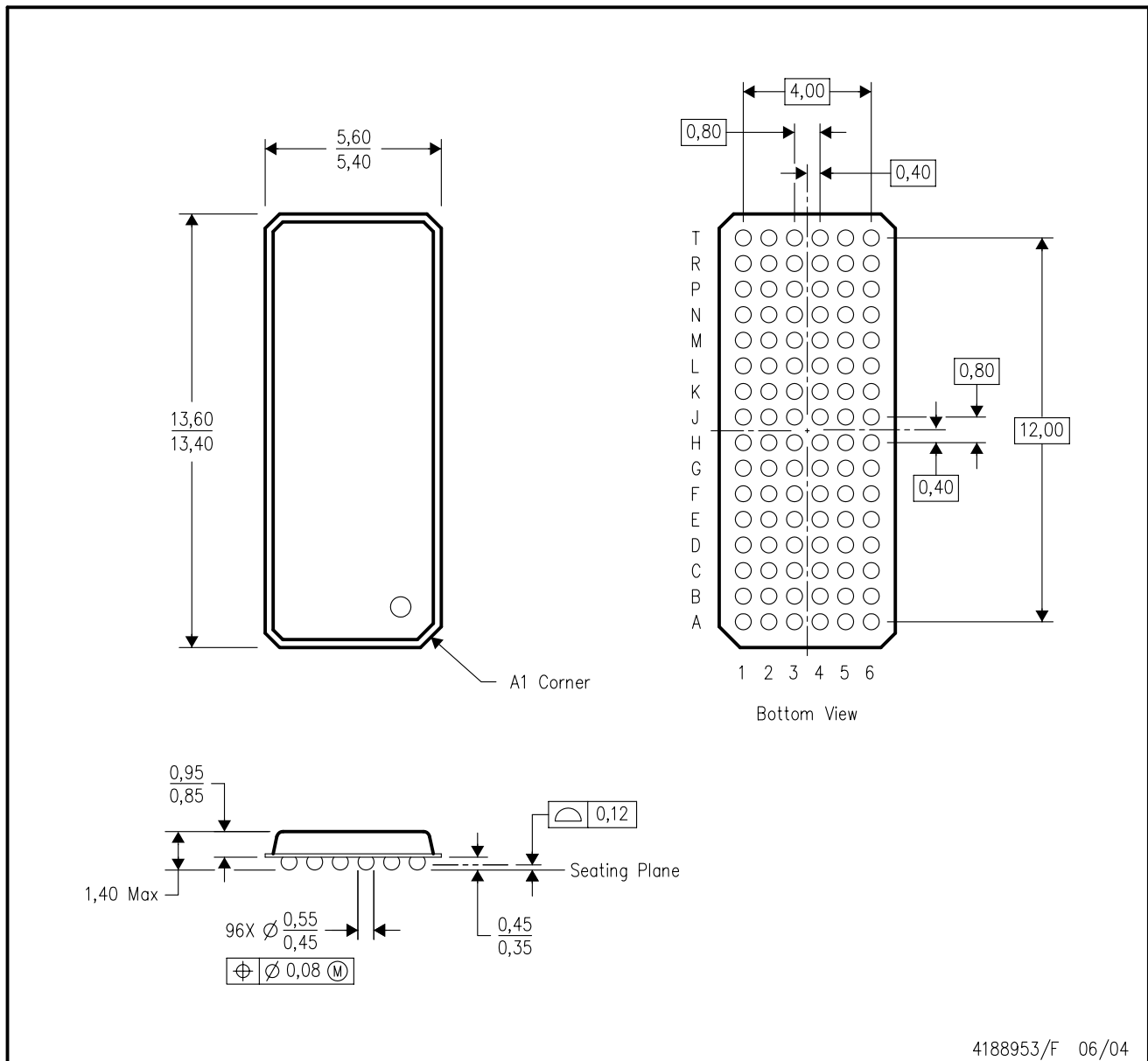
(4) Only one of markings shown within the brackets will appear on the physical device.

**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.

GKE (R-PBGA-N96)

PLASTIC BALL GRID ARRAY

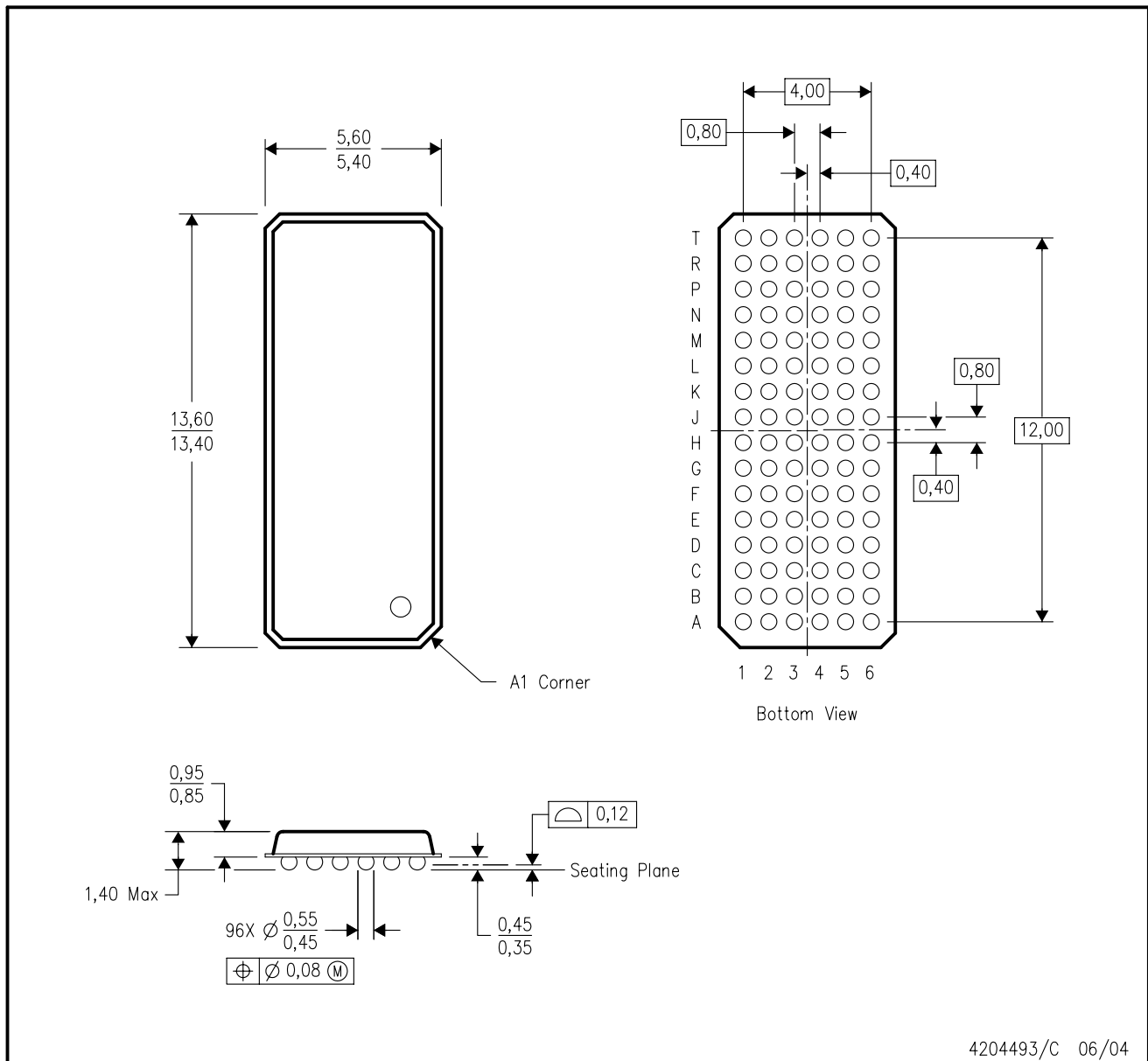


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MO-205 variation CC.
  - D. This package is tin-lead (SnPb). Refer to the 96 ZKE package (drawing 4204493) for lead-free.



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

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)