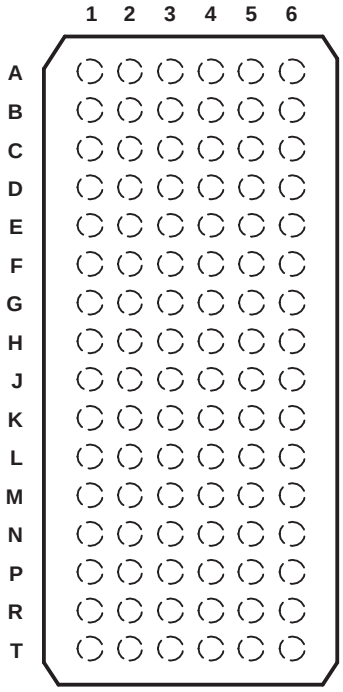
SN74LVTH32245
3.3-V ABT 32-BIT BUS TRANSCEIVER WITH 3-STATE OUTPUTS

SCBS750B – OCTOBER 2000 – REVISED NOVEMBER 2006

FEATURES

- **Member of the Texas Instruments Widebus+™ Family**
- **State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low Static-Power Dissipation**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at V_{CC} = 3.3 V, T_A = 25°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	1B2	1B1	1DIR	1$\overline{OE}$	1A1	1A2
B	1B4	1B3	GND	GND	1A3	1A4
C	1B6	1B5	1V_{CC}	1V_{CC}	1A5	1A6
D	1B8	1B7	GND	GND	1A7	1A8
E	2B2	2B1	GND	GND	2A1	2A2
F	2B4	2B3	1V_{CC}	1V_{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	2V_{CC}	2V_{CC}	3A5	3A6
M	3B8	3B7	GND	GND	3A7	3A8
N	4B2	4B1	GND	GND	4A1	4A2
P	4B4	4B3	2V_{CC}	2V_{CC}	4A3	4A4
R	4B6	4B5	GND	GND	4A5	4A6
T	4B7	4B8	4DIR	4$\overline{OE}$	4A8	4A7

ORDERING INFORMATION

T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	LFBGA – GKE	Reel of 1000	SN74LVTH32245GKER	HV245
	LFBGA – ZKE (Pb-free)	Reel of 1000	SN74LVTH32245ZKER	HV245

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

DESCRIPTION/ORDERING INFORMATION

The SN74LVTH32245 is a 32-bit noninverting 3-state transceiver designed for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.

This device can be used as four 8-bit transceivers, two 16-bit transceivers, or one 32-bit transceiver. The device 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 devices so that the buses are effectively isolated.

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.

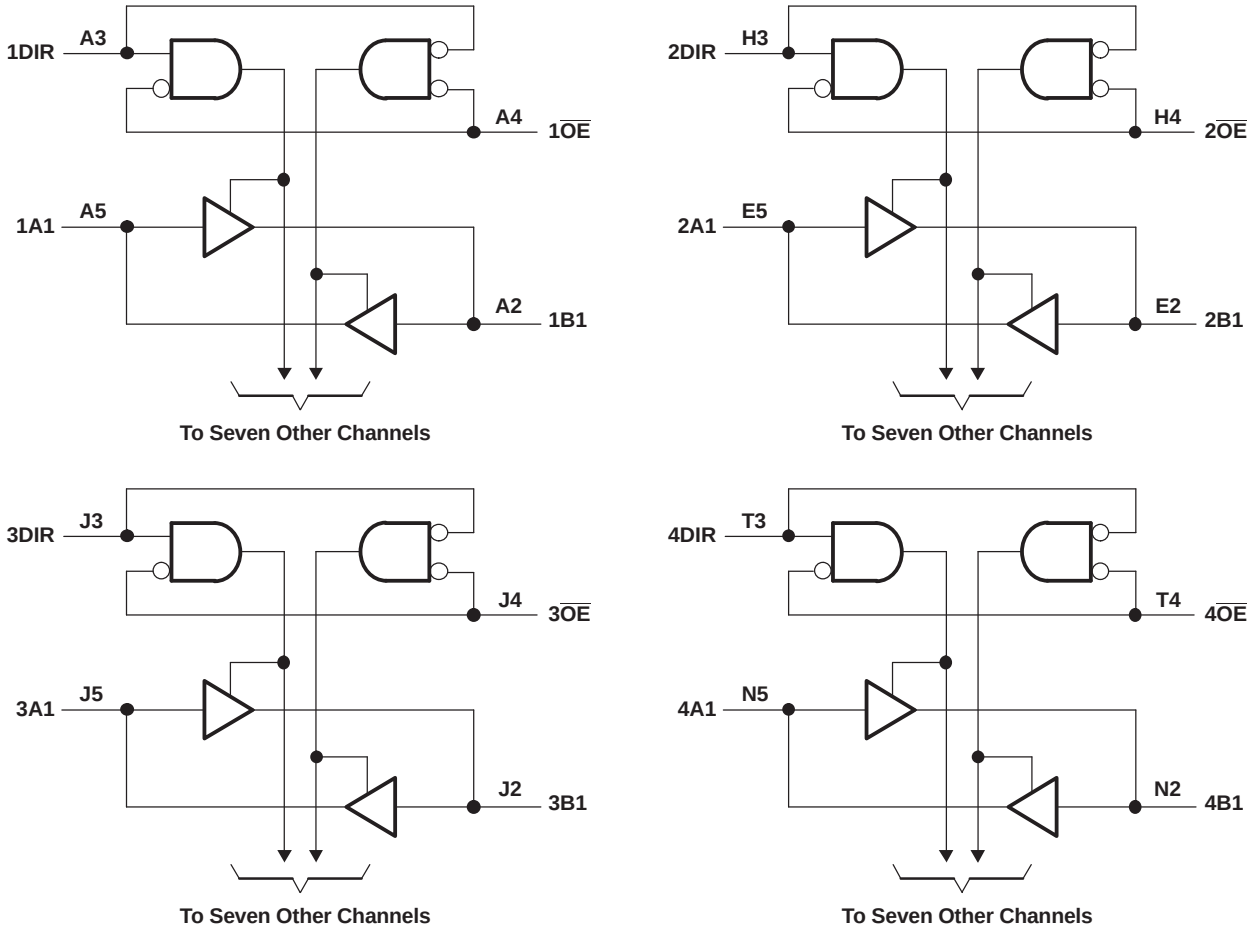
This device is fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state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

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 8-bit transceiver

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	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	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 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 V,	I_I = –18 mA			–1.2	V
V_{OH}		V_{CC} = 2.7 V to 3.6 V,	I_{OH} = –100 µA	V_{CC} – 0.2			V
		V_{CC} = 2.7 V,	I_{OH} = –8 mA	2.4			
		V_{CC} = 3 V,	I_{OH} = –32 mA	2			
V_{OL}		V_{CC} = 2.7 V	I_{OL} = 100 µA			0.2	V
			I_{OL} = 24 mA			0.5	
		V_{CC} = 3 V	I_{OL} = 16 mA			0.4	
			I_{OL} = 32 mA			0.5	
			I_{OL} = 64 mA			0.55	
I_I	Control inputs	V_{CC} = 3.6 V,	V_I = V_{CC} or GND			±1	µA
		V_{CC} = 0 or 3.6 V,	V_I = 5.5 V			10	
	A or B ports(2)	V_{CC} = 3.6 V	V_I = 5.5 V			20	
			V_I = V_{CC}			1	
			V_I = 0			–5	
I_{off}		V_{CC} = 0,	V_I or V_O = 0 to 4.5 V			±100	µA
$I_{I(hold)}$	A or B ports	V_{CC} = 3 V	V_I = 0.8 V	75			µA
			V_I = 2 V	–75			
		V_{CC} = 3.6 V,(3)	V_I = 0 to 3.6 V			±500	
I_{OZPU}		V_{CC} = 0 to 1.5 V, V_O = 0.5 V to 3 V, $\overline{OE}$ = don't care				±100	µA
I_{OZPD}		V_{CC} = 1.5 V to 0, V_O = 0.5 V to 3 V, $\overline{OE}$ = don't care				±100	µA
I_{CC}		V_{CC} = 3.6 V, I_O = 0, V_I = V_{CC} or GND	Outputs high			0.38	mA
			Outputs low			10	
			Outputs disabled			0.38	
ΔI_{CC}(4)		V_{CC} = 3 V to 3.6 V, One input at V_{CC} – 0.6 V, Other inputs at V_{CC} or GND				0.2	mA
C_I		V_I = 3 V or 0			4		pF
C_o		V_O = 3 V or 0			10		pF

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
(2) Unused pins at V_{CC} or GND
(3) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.
(4) This is the increase in supply current for each input that is at the specified TTL voltage level, rather than V_{CC} or GND.

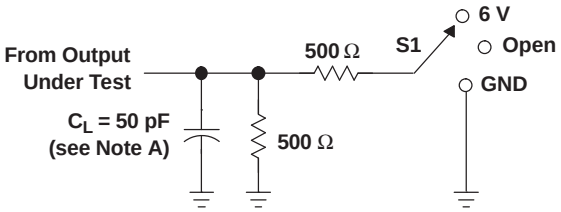
Switching Characteristics

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 3.3 V ± 0.3 V			V_{CC} = 2.7 V		UNIT
			MIN	TYP(1)	MAX	MIN	MAX	
t_{PLH}	A or B	B or A	1.5	2.3	3.3		3.7	ns
t_{PHL}			1.3	2.1	3.3		3.5	
t_{PZH}	$\overline{OE}$	A or B	1.5	2.8	4.5		5.3	ns
t_{PZL}			1.6	2.9	4.6		5.2	
t_{PHZ}	$\overline{OE}$	A or B	2.3	3.7	5.1		5.5	ns
t_{PLZ}			2.2	3.5	5.1		5.4	
$t_{sk(LH)}$					0.5			ns
$t_{sk(HL)}$					0.5			

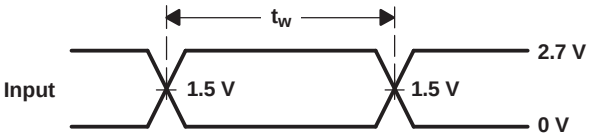
(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION

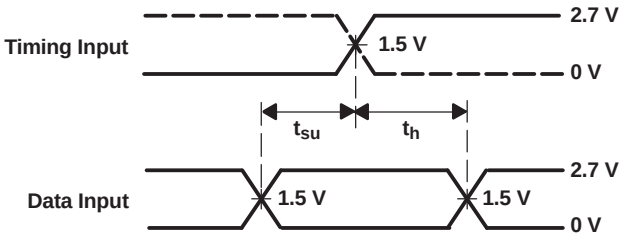


LOAD CIRCUIT

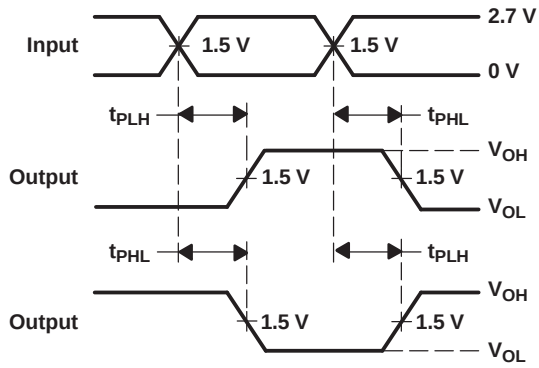
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



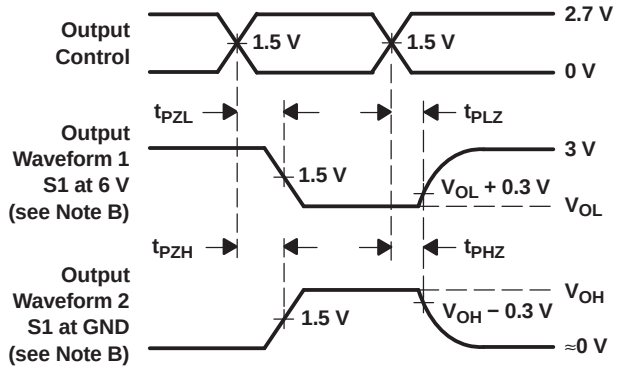
VOLTAGE WAVEFORMS
PULSE DURATION



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 ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 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)	Op Temp (°C)	Top-Side Markings (4)	Samples
SN74LVTH32245GKER	NRND	LFBGA	GKE	96	1000	TBD	SNPB	Level-2-235C-1 YEAR	-40 to 85	HV245	
SN74LVTH32245ZKER	ACTIVE	LFBGA	ZKE	96	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	-40 to 85	HV245	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.

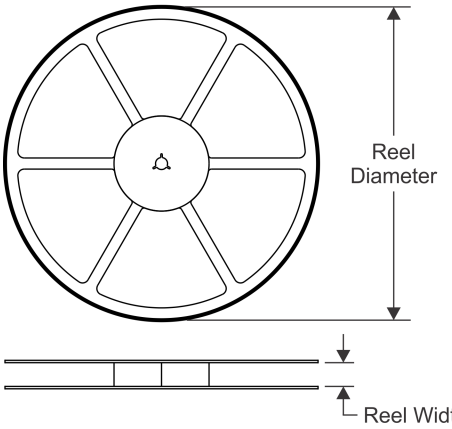
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been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

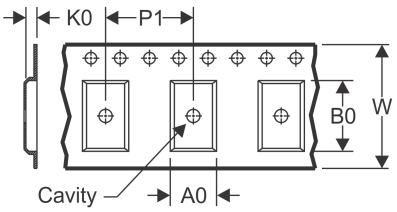
(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

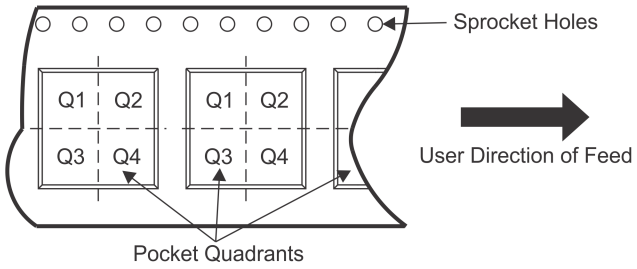


TAPE DIMENSIONS



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

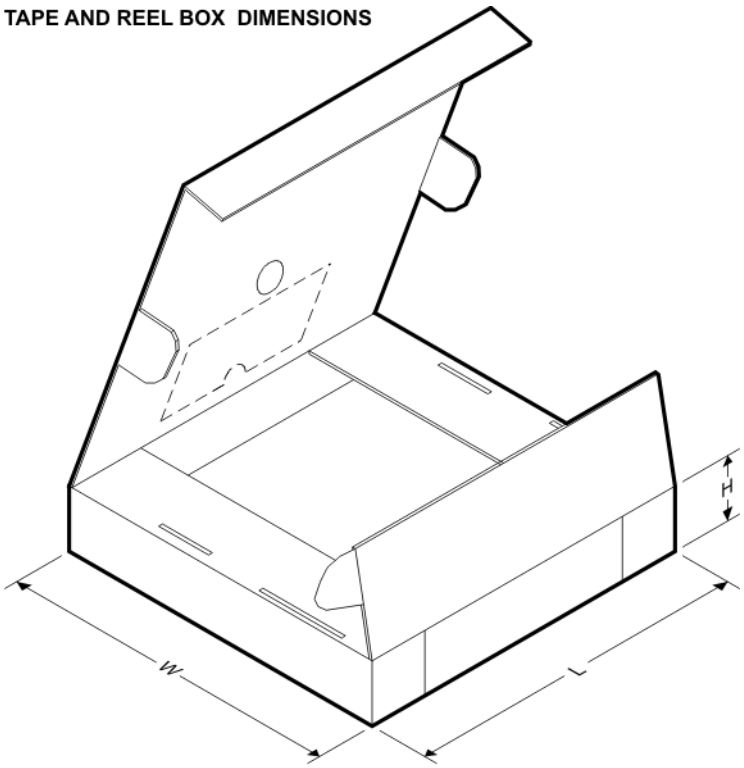
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74LVTH32245GKER	LFBGA	GKE	96	1000	330.0	24.4	5.7	13.7	2.0	8.0	24.0	Q1
SN74LVTH32245ZKER	LFBGA	ZKE	96	1000	330.0	24.4	5.7	13.7	2.0	8.0	24.0	Q1

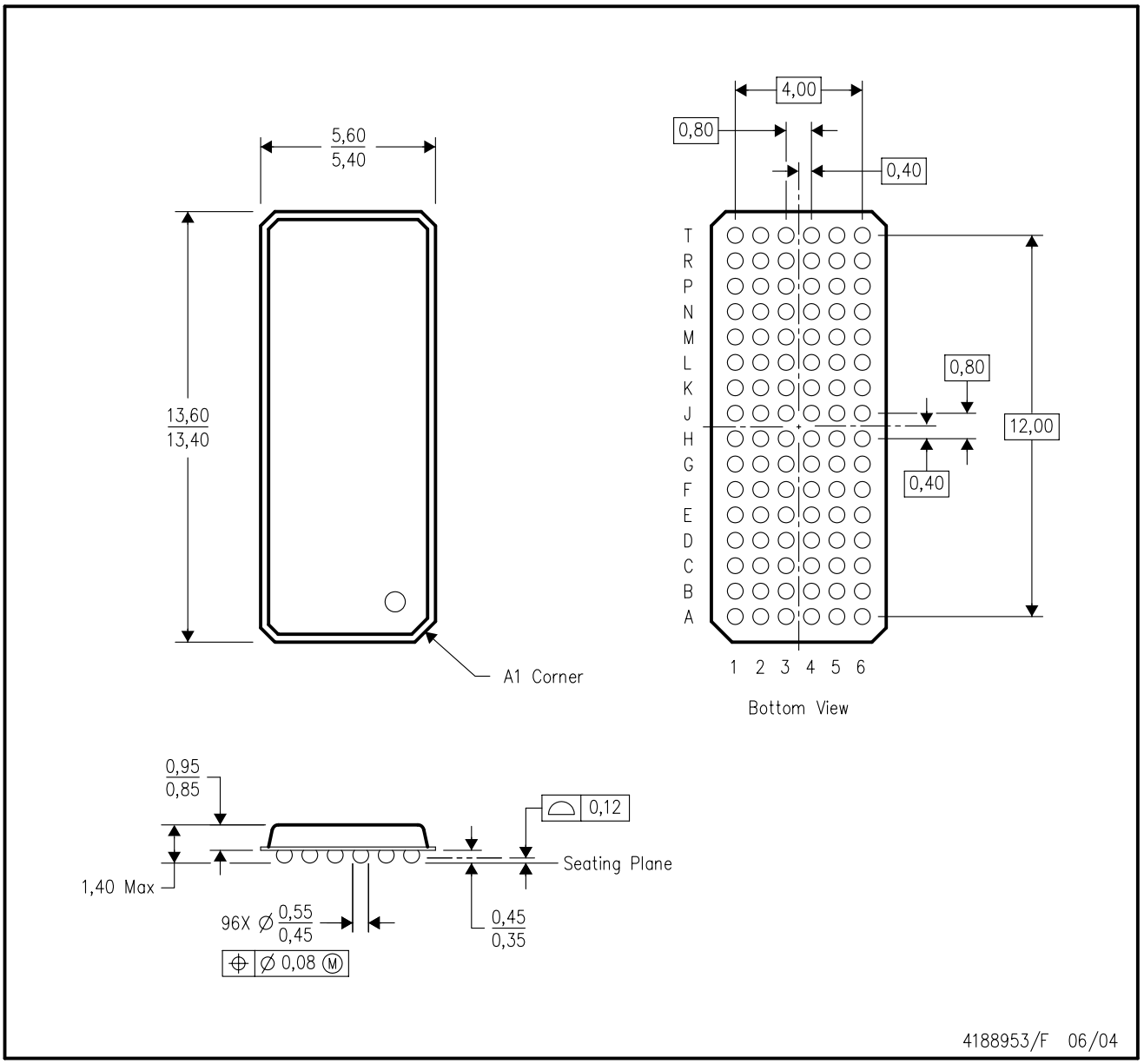
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

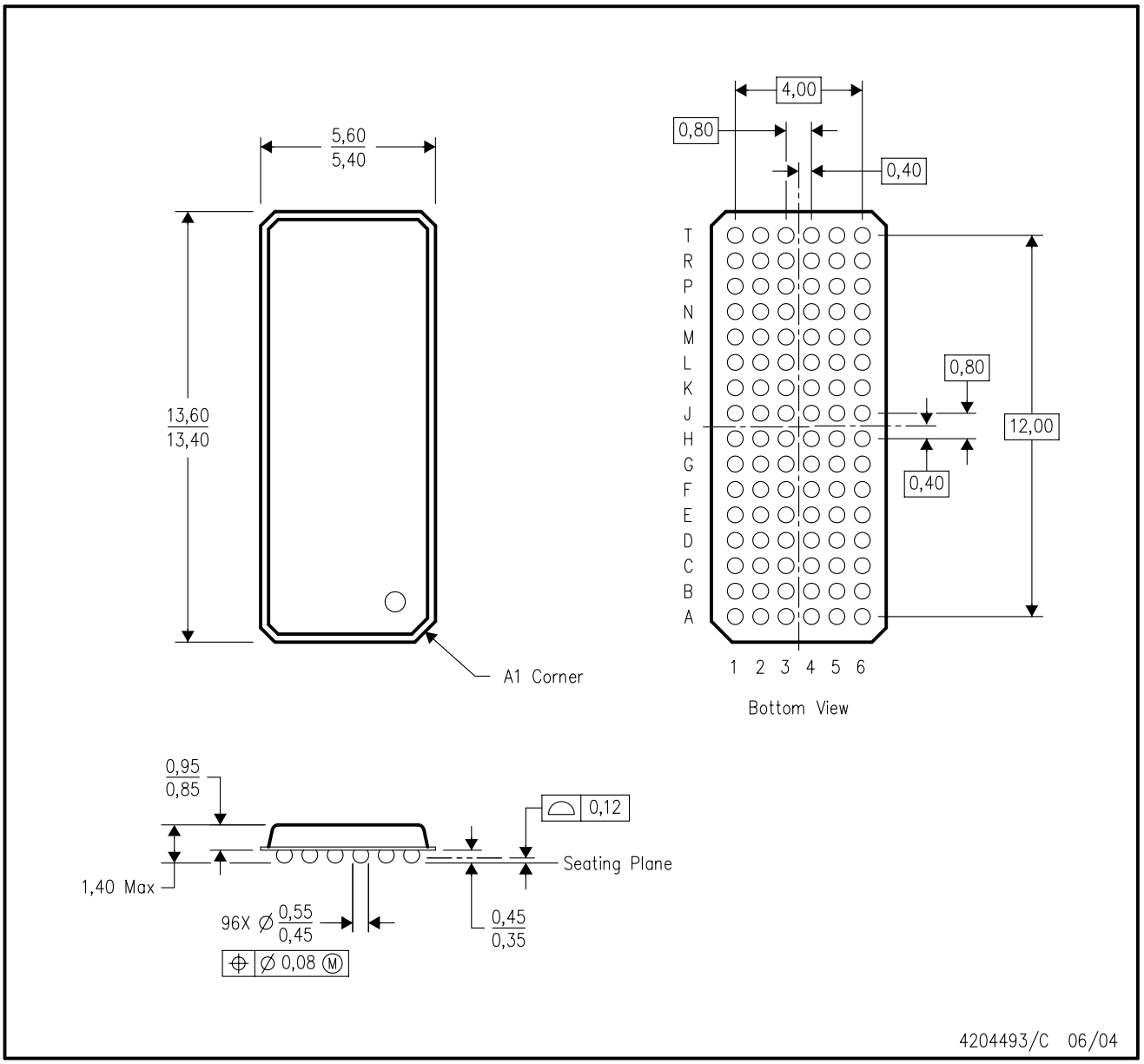
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LVTH32245GKER	LFBGA	GKE	96	1000	336.6	336.6	41.3
SN74LVTH32245ZKER	LFBGA	ZKE	96	1000	336.6	336.6	41.3

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).

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