

## FEATURES

- Member of the Texas Instruments Widebus+™ Family
- UBT™ Transceiver Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, or Clocked Mode
- Operates From 1.65 V to 3.6 V
- Max  $t_{pd}$  of 3.9 ns at 3.3 V
- $\pm 24$ -mA Output Drive at 3.3 V
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)

## DESCRIPTION/ORDERING INFORMATION

This 36-bit universal bus transceiver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

This device can be used as two 18-bit transceivers or one 36-bit transceiver. Data flow in each direction is controlled by output enable ( $\overline{OEAB}$  and  $\overline{OEBA}$ ), latch enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs. For A-to-B data flow, the device operates in the transparent mode when LEAB is high. When LEAB is low, the A data is latched if CLKAB is held at a high or low logic level. If LEAB is low, the A data is stored in the latch/flip-flop on the low-to-high transition of CLKAB. When  $\overline{OEAB}$  is high, the outputs are active. When  $\overline{OEAB}$  is low, the outputs are in the high-impedance state.

Data flow for B to A is similar to that of A to B, but uses  $\overline{OEBA}$ , LEBA, and CLKBA. The output enables are complementary ( $\overline{OEAB}$  is active high and  $\overline{OEBA}$  is active low).

To ensure the high-impedance state during power up or power down,  $\overline{OEBA}$  should be tied to  $V_{CC}$  through a pullup resistor, and  $\overline{OEAB}$  should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

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.

## ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	LFBGA - GKF	Tape and reel	SN74ALVCH32501KR	ACH501
	LFBGA - ZKF (Pb-free)		74ALVCH32501ZKFR	

(1) 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).



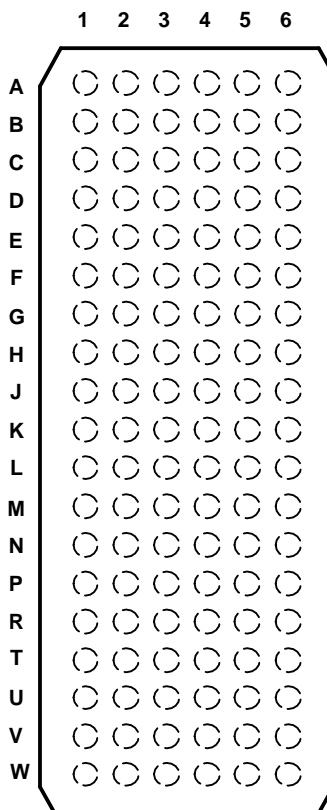
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**SN74ALVCH32501**  
**36-BIT UNIVERSAL BUS TRANSCEIVER**  
**WITH 3-STATE OUTPUTS**

SCES144G—OCTOBER 1998—REVISED OCTOBER 2004

**GKF OR ZKF PACKAGE**  
**(TOP VIEW)**



**TERMINAL ASSIGNMENTS<sup>(1)</sup>**

	1	2	3	4	5	6
<b>A</b>	1A2	1A1	1LEAB	1CLKAB	1B1	1B2
<b>B</b>	1A4	1A3	1OEAB	GND	1B3	1B4
<b>C</b>	1A6	1A5	GND	GND	1B5	1B6
<b>D</b>	1A8	1A7	V <sub>CC</sub>	V <sub>CC</sub>	1B7	1B8
<b>E</b>	1A10	1A9	GND	GND	1B9	1B10
<b>F</b>	1A12	1A11	GND	GND	1B11	1B12
<b>G</b>	1A14	1A13	V <sub>CC</sub>	V <sub>CC</sub>	1B13	1B14
<b>H</b>	1A15	1A16	GND	GND	1B16	1B15
<b>J</b>	1A17	1A18	1 $\overline{OEBA}$	1CLKBA	1B18	1B17
<b>K</b>	NC	2LEAB	1LEAB	GND	2CLKAB	NC
<b>L</b>	2A2	2A1	2OEAB	GND	2B1	2B2
<b>M</b>	2A4	2A3	GND	GND	2B3	2B4
<b>N</b>	2A6	2A5	V <sub>CC</sub>	V <sub>CC</sub>	2B5	2B6
<b>P</b>	2A8	2A7	GND	GND	2B7	2B8
<b>R</b>	2A10	2A9	GND	GND	2B9	2B10
<b>T</b>	2A12	2A11	V <sub>CC</sub>	V <sub>CC</sub>	2B11	2B12
<b>U</b>	2A14	2A13	GND	GND	2B13	2B14
<b>V</b>	2A15	2A16	2 $\overline{OEBA}$	2CLKBA	2B16	2B15
<b>W</b>	2A17	2A18	2LEBA	GND	2B18	2B17

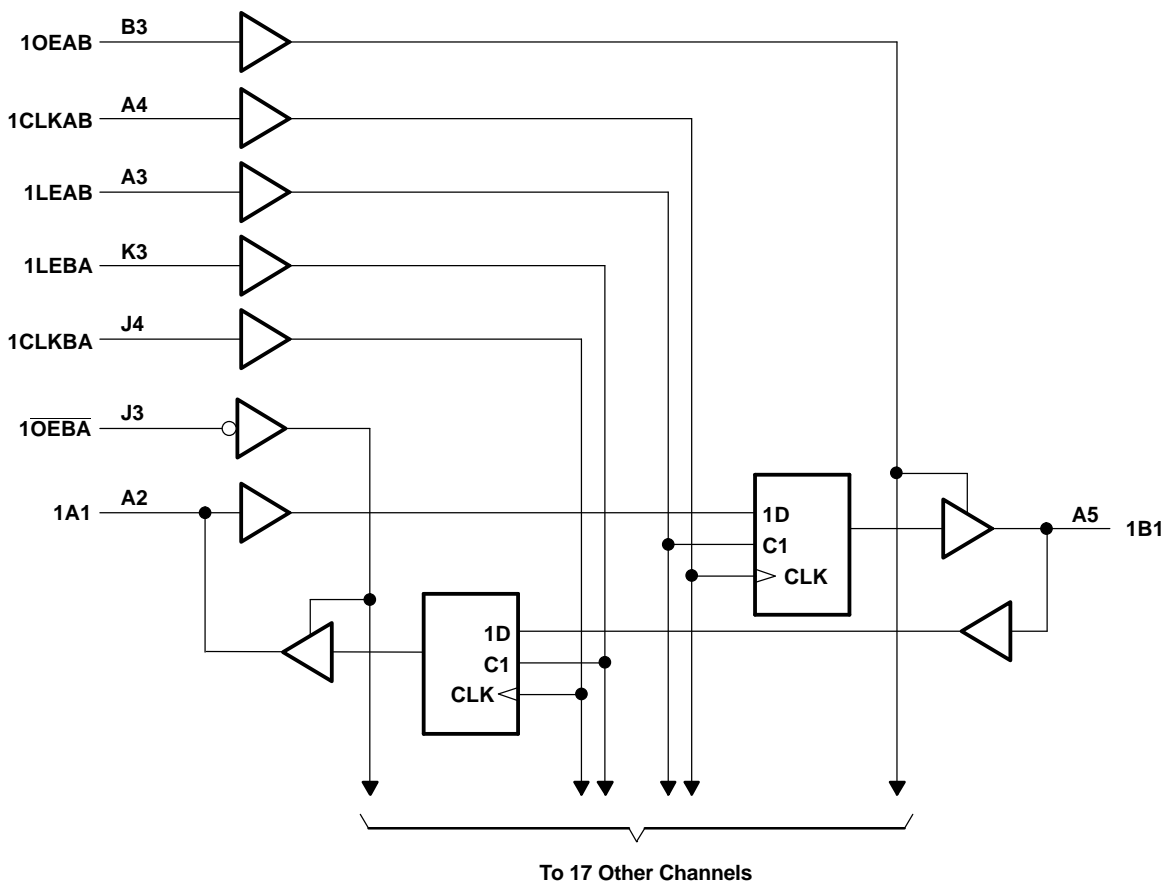
(1) NC - No internal connection

**FUNCTION TABLE<sup>(1)</sup>**

INPUTS				OUTPUT B
OEAB	LEAB	CLKAB	A	
L	X	X	X	Z
H	H	X	L	L
H	H	X	H	H
H	L	↑	L	L
H	L	↑	H	H
H	L	H	X	B <sub>0</sub> <sup>(2)</sup>
H	L	L	X	B <sub>0</sub> <sup>(3)</sup>

- (1) A-to-B data flow is shown; B-to-A flow is similar, but uses  $\overline{OEBA}$ ,  $\overline{LEBA}$ , and  $\overline{CLKBA}$ .
- (2) Output level before the indicated steady-state input conditions were established, provided that  $\overline{CLKAB}$  was high before  $\overline{LEAB}$  went low
- (3) Output level before the indicated steady-state input conditions were established

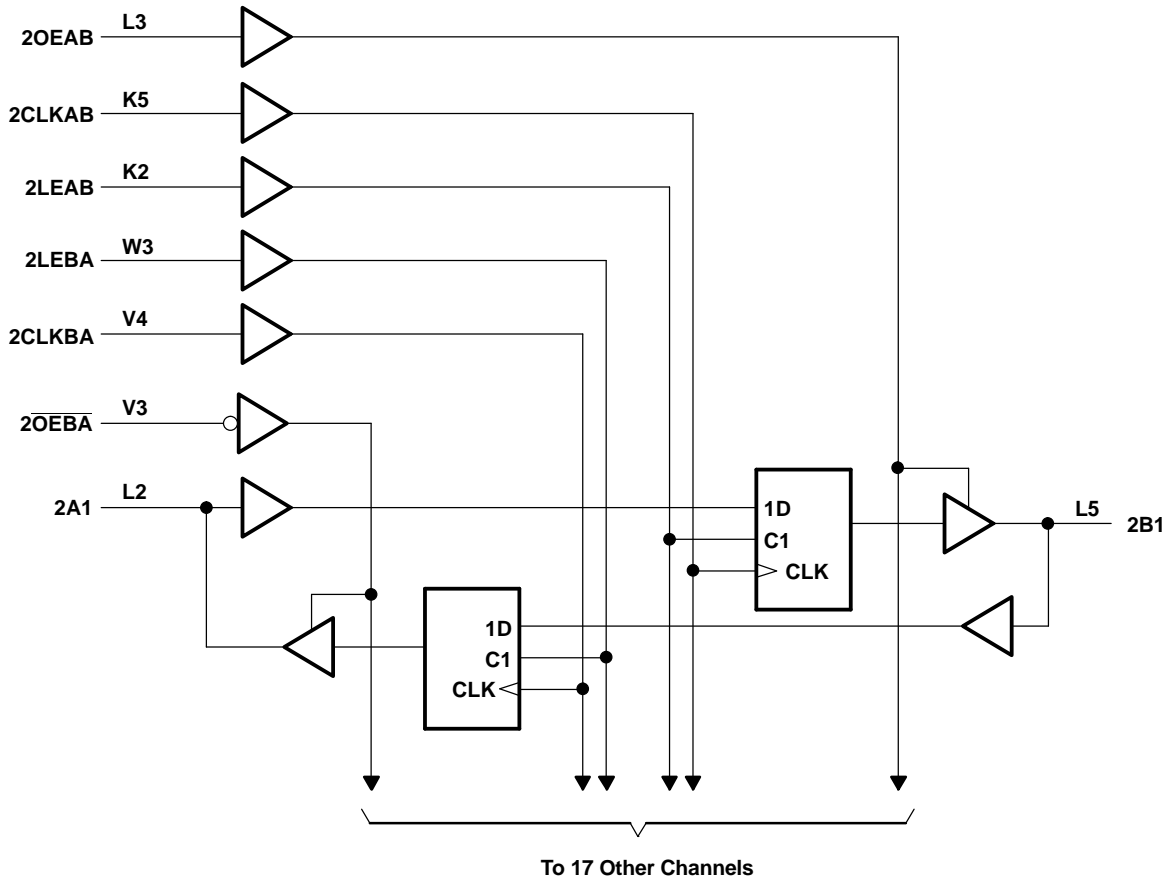
**LOGIC DIAGRAM (POSITIVE LOGIC)**



**SN74ALVCH32501**  
**36-BIT UNIVERSAL BUS TRANSCEIVER**  
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SCES144G—OCTOBER 1998—REVISED OCTOBER 2004

**LOGIC DIAGRAM (POSITIVE LOGIC)**



**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

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

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range	-0.5	4.6	V
V <sub>I</sub>	Input voltage range	Except I/O ports <sup>(2)</sup>		V
		-0.5	4.6	
V <sub>O</sub>	Output voltage range <sup>(2)(3)</sup>	I/O ports <sup>(2)(3)</sup>		V
		-0.5	V <sub>CC</sub> + 0.5	
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0		mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0		mA
I <sub>O</sub>	Continuous output current			mA
		Continuous current through each V <sub>CC</sub> or GND		±100
θ <sub>JA</sub>	Package thermal impedance <sup>(4)</sup>	GKF/ZKF package		°C/W
T <sub>stg</sub>	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) This value is limited to 4.6 V maximum.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

**RECOMMENDED OPERATING CONDITIONS<sup>(1)</sup>**

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage	1.65	3.6	V
V <sub>IH</sub>	High-level input voltage	V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.7	
		V <sub>CC</sub> = 2.7 V to 3.6 V	2	
V <sub>IL</sub>	Low-level input voltage	V <sub>CC</sub> = 1.65 V to 1.95 V	0.35 × V <sub>CC</sub>	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.7	
		V <sub>CC</sub> = 2.7 V to 3.6 V	0.8	
V <sub>I</sub>	Input voltage	0	V <sub>CC</sub>	V
V <sub>O</sub>	Output voltage	0	V <sub>CC</sub>	V
I <sub>OH</sub>	High-level output current	V <sub>CC</sub> = 1.65 V	-4	mA
		V <sub>CC</sub> = 2.3 V	-12	
		V <sub>CC</sub> = 2.7 V	-12	
		V <sub>CC</sub> = 3 V	-24	
I <sub>OL</sub>	Low-level output current	V <sub>CC</sub> = 1.65 V	4	mA
		V <sub>CC</sub> = 2.3 V	12	
		V <sub>CC</sub> = 2.7 V	12	
		V <sub>CC</sub> = 3 V	24	
Δt/Δv	Input transition rise or fall rate		10	ns/V
T <sub>A</sub>	Operating free-air temperature	-40	85	°C

- (1) All unused control inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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**ELECTRICAL CHARACTERISTICS**

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

PARAMETER		TEST CONDITIONS	V <sub>CC</sub>	MIN	TYP <sup>(1)</sup>	MAX	UNIT
V <sub>OH</sub>		I <sub>OH</sub> = -100 μA	1.65 V to 3.6 V	V <sub>CC</sub> - 0.2			V
		I <sub>OH</sub> = -4 mA	1.65 V	1.2			
		I <sub>OH</sub> = -6 mA	2.3 V	2			
		I <sub>OH</sub> = -12 mA	2.3 V	1.7			
			2.7 V	2.2			
			3 V	2.4			
	I <sub>OH</sub> = -24 mA	3 V	2				
V <sub>OL</sub>		I <sub>OL</sub> = 100 μA	1.65 V to 3.6 V			0.2	V
		I <sub>OL</sub> = 4 mA	1.65 V			0.45	
		I <sub>OL</sub> = 6 mA	2.3 V			0.4	
		I <sub>OL</sub> = 12 mA	2.3 V			0.7	
			2.7 V			0.4	
		I <sub>OL</sub> = 24 mA	3 V			0.55	
I <sub>I</sub>		V <sub>I</sub> = V <sub>CC</sub> or GND	3.6 V			±5	μA
I <sub>I(hold)</sub>		V <sub>I</sub> = 0.58 V	1.65 V	25			μA
		V <sub>I</sub> = 1.07 V		-25			
		V <sub>I</sub> = 0.7 V	2.3 V	45			
		V <sub>I</sub> = 1.7 V		-45			
		V <sub>I</sub> = 0.8 V	3 V	75			
		V <sub>I</sub> = 2 V		-75			
		V <sub>I</sub> = 0 to 3.6 V <sup>(2)</sup>				±500	
I <sub>OZ</sub> <sup>(3)</sup>		V <sub>O</sub> = V <sub>CC</sub> or GND	3.6 V			±10	μA
I <sub>CC</sub>		V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0	3.6 V			80	μA
ΔI <sub>CC</sub>		One input at V <sub>CC</sub> - 0.6 V, Other inputs at V <sub>CC</sub> or GND	3 V to 3.6 V			750	μA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	3.3 V		4		pF
C <sub>io</sub>	A or B ports	V <sub>O</sub> = V <sub>CC</sub> or GND	3.3 V		8		pF

(1) All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°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) For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

## TIMING REQUIREMENTS

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

		$V_{CC} = 1.8\text{ V}$		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\text{clock}}$	Clock frequency	(1)		150		150		150		MHz
$t_w$	Pulse duration	LE high		(1)	3.3	3.3	3.3	3.3		ns
		CLK high or low		(1)	3.3	3.3	3.3	3.3		
$t_{\text{su}}$	Setup time	Data before CLK $\uparrow$		(1)	2.2	2.1	1.7			ns
		Data before LE $\downarrow$	CLK high	(1)	1.9	1.6	1.5			
			CLK low	(1)	1.3	1.1	1			
$t_h$	Hold time	Data after CLK $\uparrow$		(1)	0.6	0.6	0.7			ns
		Data after LE $\downarrow$	CLK high or low	(1)	1.4	1.7	1.4			

(1) This information was not available at the time of publication.

## SWITCHING CHARACTERISTICS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 1.8\text{ V}$		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			MIN	TYP	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\text{max}}$			(1)		150		150		150		MHz
$t_{\text{pd}}$	A or B	B or A	(1)		1	4.8	4.5	1	3.9	ns	
	LE	A or B	(1)	1.1	5.7	5.3	1.3	4.6			
	CLK		(1)	1.2	6.1	5.6	1.4	4.9			
$t_{\text{en}}$	OEAB	B	(1)	1	5.8	5.3	1	4.6	ns		
$t_{\text{dis}}$	OEAB	B	(1)	1.5	6.2	5.7	1.4	5	ns		
$t_{\text{en}}$	$\overline{\text{OEBA}}$	A	(1)	1.3	6.3	6	1.1	5	ns		
$t_{\text{dis}}$	$\overline{\text{OEBA}}$	A	(1)	1.3	5.3	4.6	1.3	4.2	ns		

(1) This information was not available at the time of publication.

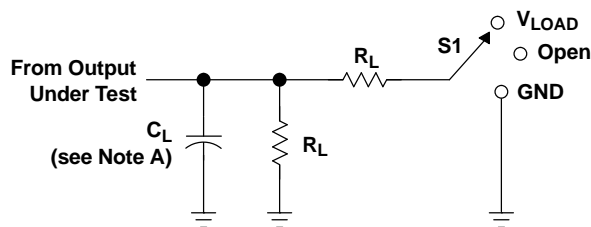
## OPERATING CHARACTERISTICS

$T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	$V_{CC} = 1.8\text{ V}$	$V_{CC} = 2.5\text{ V}$	$V_{CC} = 3.3\text{ V}$	UNIT
			TYP	TYP	TYP	
$C_{\text{pd}}$	Power dissipation capacitance	$C_L = 0, f = 10\text{ MHz}$	(1)	44	54	pF
	Outputs enabled		(1)	6	6	
	Outputs disabled					

(1) This information was not available at the time of publication.

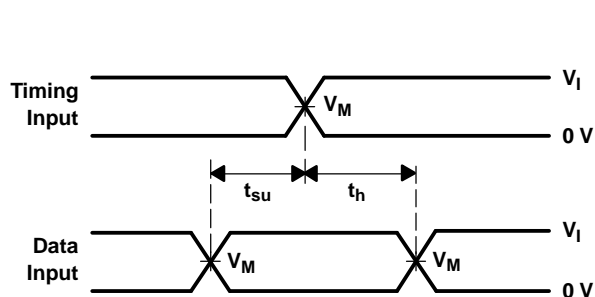
**PARAMETER MEASUREMENT INFORMATION**



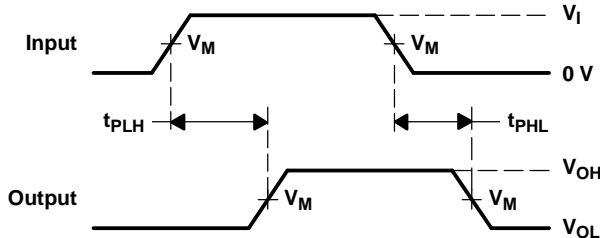
TEST	S1
$t_{pd}$ $t_{PLZ}/t_{PZL}$ $t_{PHZ}/t_{PZH}$	Open $V_{LOAD}$ GND

**LOAD CIRCUIT**

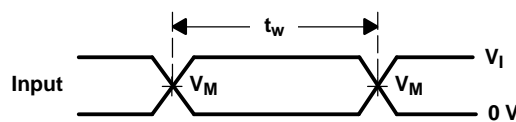
$V_{CC}$	INPUT		$V_M$	$V_{LOAD}$	$C_L$	$R_L$	$V_{\Delta}$
	$V_I$	$t_r/t_f$					
$1.8\text{ V} \pm 0.15\text{ V}$	$V_{CC}$	$\leq 2\text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	1 k $\Omega$	0.15 V
$2.5\text{ V} \pm 0.2\text{ V}$	$V_{CC}$	$\leq 2\text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	500 $\Omega$	0.15 V
2.7 V	2.7 V	$\leq 2.5\text{ ns}$	1.5 V	6 V	50 pF	500 $\Omega$	0.3 V
$3.3\text{ V} \pm 0.3\text{ V}$	2.7 V	$\leq 2.5\text{ ns}$	1.5 V	6 V	50 pF	500 $\Omega$	0.3 V



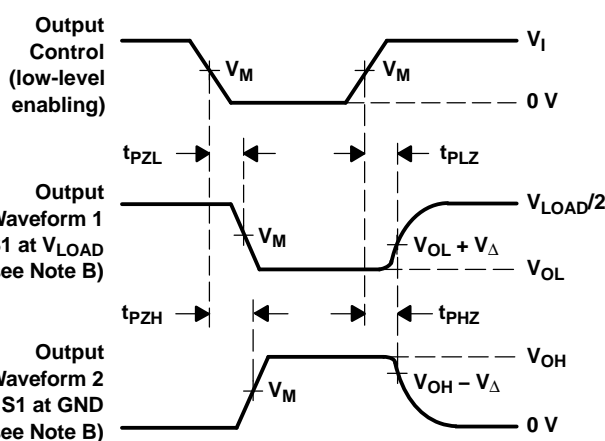
**VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES**



**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:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ .  
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 <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
74ALVCH32501ZKFR	ACTIVE	LFBGA	ZKF	114	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR
SN74ALVCH32501KR	NRND	BGA MI CROSTA R	GKF	114	1000	TBD	SNPB	Level-2-235C-1 YEAR

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

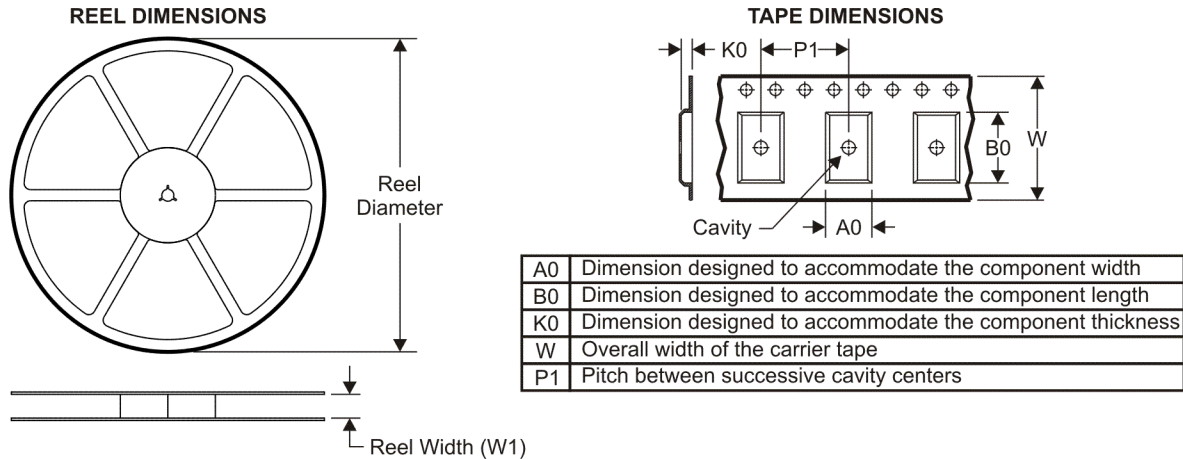
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**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)

<sup>(3)</sup> 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.

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**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
74ALVCH32501ZKFR	LFBGA	ZKF	114	1000	330.0	24.4	5.8	16.3	1.8	8.0	24.0	Q1
SN74ALVCH32501KR	BGA MICROSTAR	GKF	114	1000	330.0	24.4	5.8	16.3	1.8	8.0	24.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

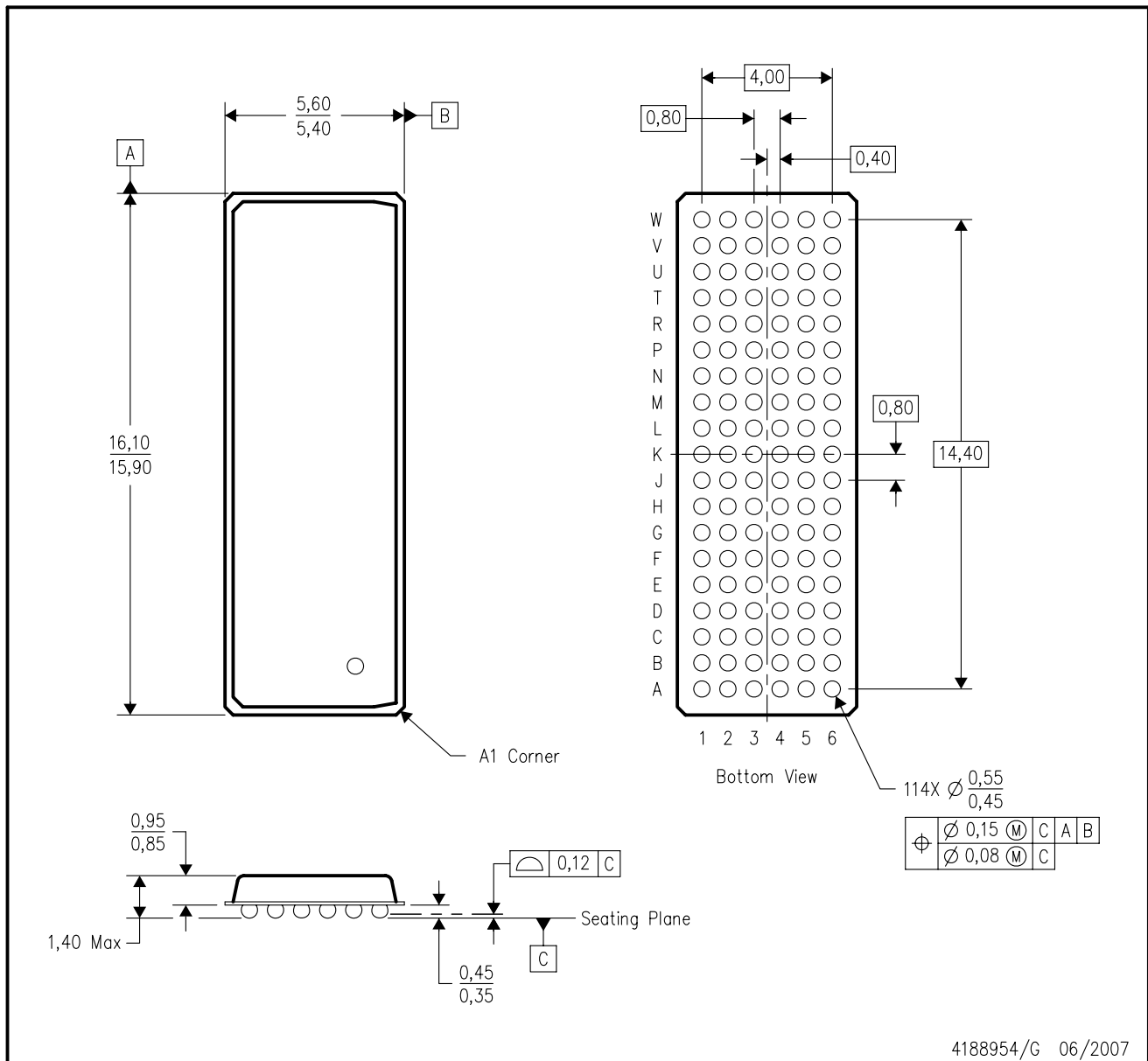


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
74ALVCH32501ZKFR	LFBGA	ZKF	114	1000	333.2	345.9	31.8
SN74ALVCH32501KR	BGA MICROSTAR	GKF	114	1000	333.2	345.9	31.8

GKF (R-PBGA-N114)

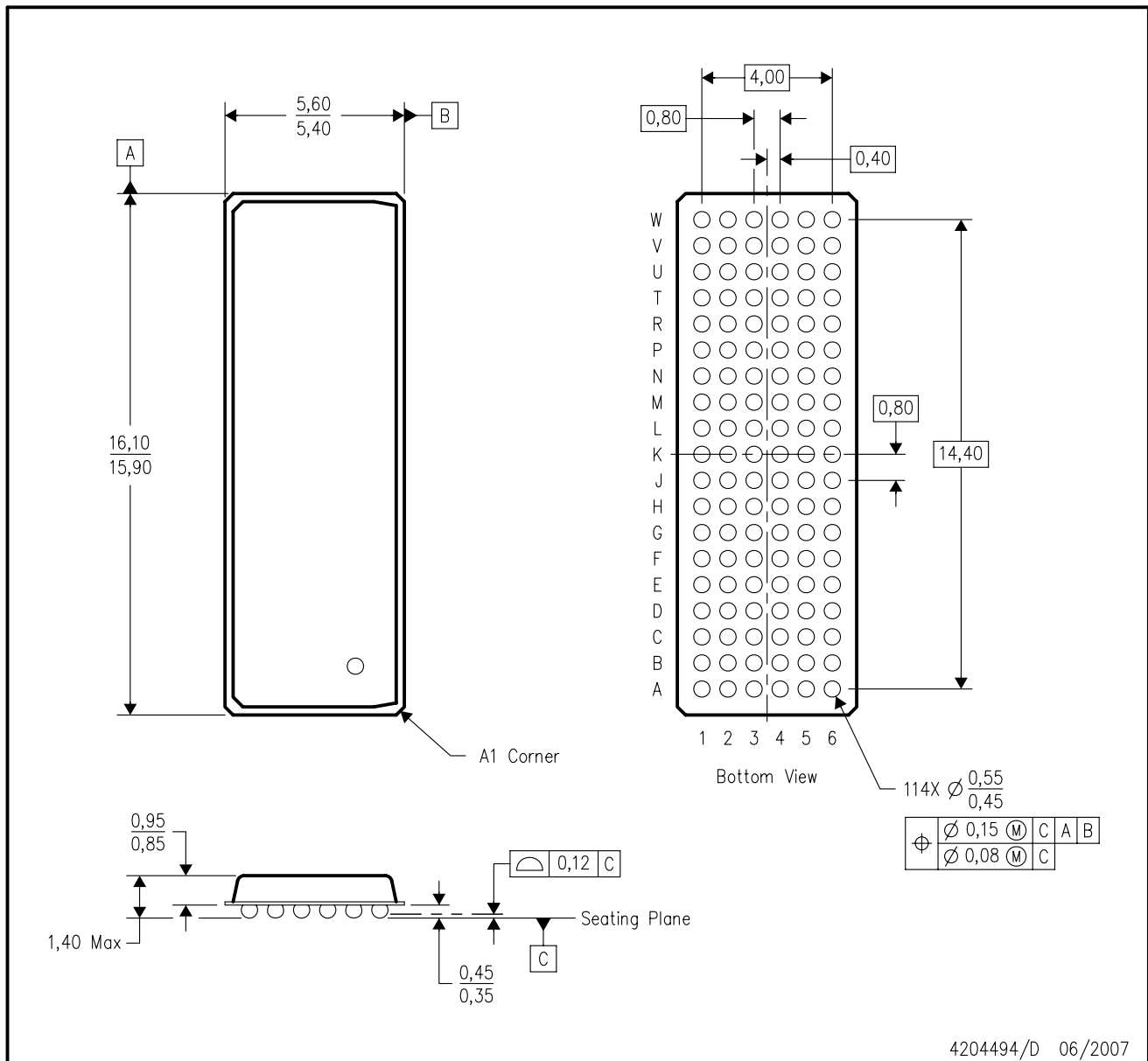
PLASTIC BALL GRID ARRAY



- 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. Falls within JEDEC MO-205 variation DC.
  - D. This package is tin-lead (SnPb). Refer to the 114 ZKF package (drawing 4204494) for lead-free.

ZKF (R-PBGA-N114)

PLASTIC BALL GRID ARRAY



4204494/D 06/2007

- 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. Falls within JEDEC MO-205 variation DC.
  - D. This package is lead-free. Refer to the 114 GKF package (drawing 4188954) for tin-lead (SnPb).

## IMPORTANT NOTICE

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