- **State-of-the-Art Advanced BiCMOS Technology (ABT) *Widebus*™ Design for 2.5-V and 3.3-V Operation and Low Static Power Dissipation**
- **Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 2.3-V to 3.6-V V_{CC})**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at V_{CC} = 3.3 V, T_A = 25°C**
- **High Drive (–24/24 mA at 2.5-V V_{CC} and –32/64 mA at 3.3-V V_{CC})**
- **I_{off} and Power-Up 3-State Support Hot Insertion**
- **Use Bus Hold on Data Inputs in Place of External Pullup/Pulldown Resistors to Prevent the Bus From Floating**
- **Auto3-State Eliminates Bus Current Loading When Output Exceeds V_{CC} + 0.5 V**
- **Flow-Through Architecture Facilitates Printed Circuit Board Layout**
- **Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **ESD Protection Exceeds JESD-22**
  - **2000-V Human-Body Model (A114-A)**
  - **200-V Machine Model (A115-A)**
  - **1000-V Charged-Device Model (C101)**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **Packaged in Plastic Fine-Pitch Ball Grid Array Package**

NOTE: For tape and reel order entry:
The GKER package is abbreviated to KR.

description

The ’ALVTH32244 devices are 32-bit buffers/line drivers designed for 2.5-V or 3.3-V V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment. These devices can be used as eight 4-bit buffers, four 8-bit buffers, two 16-bit buffers, or one 32-bit buffer. These devices provide true outputs and symmetrical active-low output-enable ($\overline{OE}$) inputs.

When V_{CC} is between 0 and 1.2-V, the devices are in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.2-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.

These devices are 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 devices when they are 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.

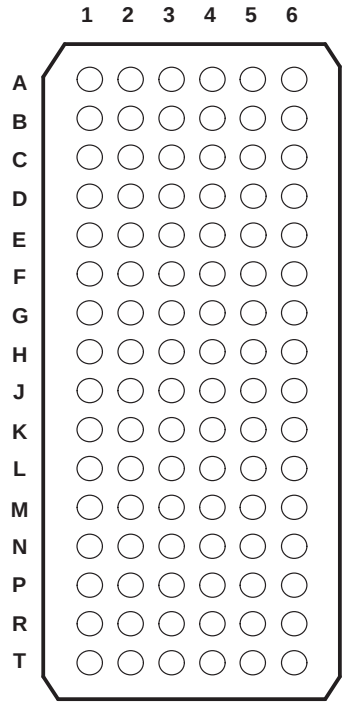
Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

The SN54ALVTH32244 is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74ALVTH32244 is characterized for operation from –40°C to 85°C.

FUNCTION TABLE
(each 4-bit buffer)

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

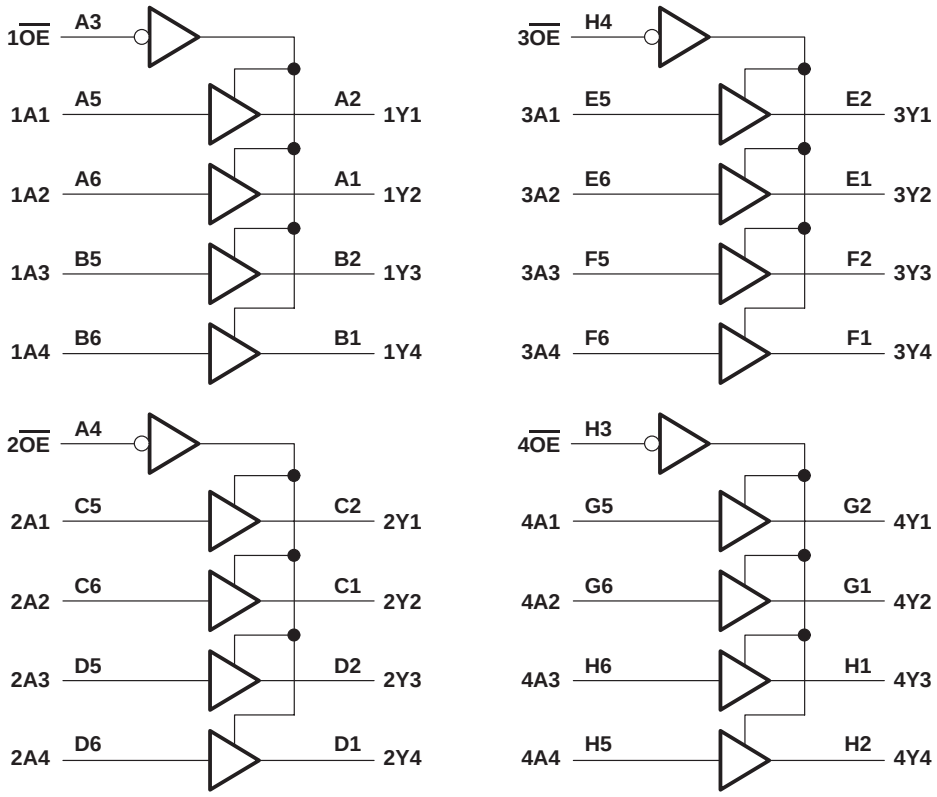
GKE PACKAGE
(TOP VIEW)



terminal assignments

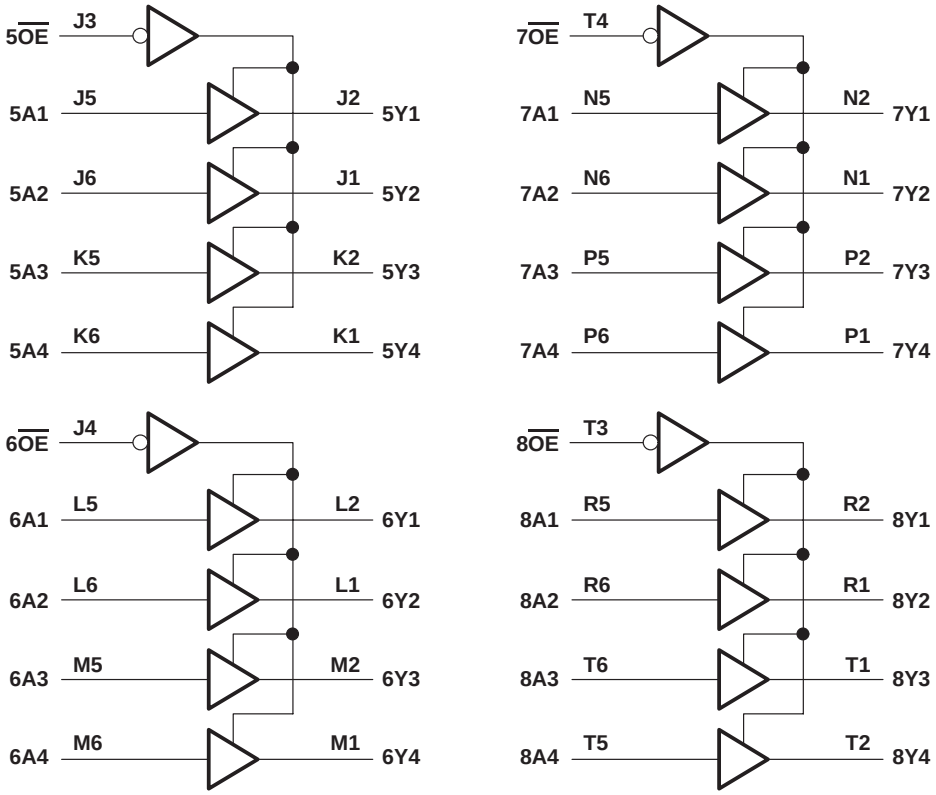
	1	2	3	4	5	6
A	1Y2	1Y1	$1\overline{OE}$	$2\overline{OE}$	1A1	1A2
B	1Y4	1Y3	GND	GND	1A3	1A4
C	2Y2	2Y1	$1V_{CC}$	$1V_{CC}$	2A1	2A2
D	2Y4	2Y3	GND	GND	2A3	2A4
E	3Y2	3Y1	GND	GND	3A1	3A2
F	3Y4	3Y3	$1V_{CC}$	$1V_{CC}$	3A3	3A4
G	4Y2	4Y1	GND	GND	4A1	4A2
H	4Y3	4Y4	$4\overline{OE}$	$3\overline{OE}$	4A4	4A3
J	5Y2	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

logic diagram (positive logic)



NOTE A: $1V_{CC}$ is associated with these channels.

logic diagram (positive logic)



NOTE A: $2V_{CC}$ is associated with these channels.

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

Supply voltage range, V_{CC} . . . . . –0.5 V to 4.6 V
Input voltage range, V_I (see Note 1) . . . . . –0.5 V to 7 V
Voltage range applied to any output in the high-impedance
or power-off state, V_O (see Note 1) . . . . . –0.5 V to 7 V
Voltage range applied to any output in the high state, V_O (see Note 1) . . . . . –0.5 V to 7 V
Current into any output in the low state, I_O: SN54ALVTH32244 . . . . . 96 mA
SN74ALVTH32244 . . . . . 128 mA
Current into any output in the high state, I_O (see Note 2): SN54ALVTH32244 . . . . . 48 mA
SN74ALVTH32244 . . . . . 64 mA
Input clamp current, I_{IK} ($V_I < 0$) . . . . . –50 mA
Output clamp current, I_{OK} ($V_O < 0$) . . . . . –50 mA
Package thermal impedance, θ_{JA} (see Note 3) . . . . . 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. This current flows only when the output is in the high state and $V_O > V_{CC}$.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions, V_{CC} = 2.5 V ± 0.2 V (see Note 4)

			SN54ALVTH32244		SN74ALVTH32244		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		2.3	2.7	2.3	2.7	V
V_{IH}	High-level input voltage		1.7		1.7		V
V_{IL}	Low-level input voltage			0.7		0.7	V
V_I	Input voltage		0	5.5	0	5.5	V
I_{OH}	High-level output current			–6		–8	mA
I_{OL}	Low-level output current			6		8	mA
	Low-level output current; current duty cycle ≤ 50%; f ≥ 1 kHz			18		24	
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200		200		μs/V
T_A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 4: All unused control 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.

recommended operating conditions, V_{CC} = 3.3 V ± 0.3 V (see Note 4)

			SN54ALVTH32244		SN74ALVTH32244		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		3	3.6	3	3.6	V
V_{IH}	High-level input voltage		2		2		V
V_{IL}	Low-level input voltage			0.8		0.8	V
V_I	Input voltage		0	5.5	0	5.5	V
I_{OH}	High-level output current			–24		–32	mA
I_{OL}	Low-level output current			24		32	mA
	Low-level output current; current duty cycle ≤ 50%; f ≥ 1 kHz			48		64	
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200		200		μs/V
T_A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 4: All unused control 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, V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54ALVTH32244			SN74ALVTH32244			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 2.3 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 2.3 V to 2.7 V,	I_{OH} = –100 µA	V_{CC}–0.2			V_{CC}–0.2			V
		V_{CC} = 2.3 V	I_{OH} = –6 mA	1.8						
			I_{OH} = –8 mA				1.8			
V_{OL}		V_{CC} = 2.3 V to 2.7 V,	I_{OL} = 100 µA			0.2			0.2	V
		V_{CC} = 2.3 V	I_{OL} = 6 mA			0.4				
			I_{OL} = 8 mA						0.4	
			I_{OL} = 18 mA			0.5				
			I_{OL} = 24 mA						0.5	
I_I	Control inputs	V_{CC} = 2.7 V,	V_I = V_{CC} or GND			±1			±1	µA
		V_{CC} = 0 or 2.7 V,	V_I = 5.5 V			10			10	
	Data inputs	V_{CC} = 2.7 V	V_I = V_{CC}			1			1	
			V_I = 0			–5			–5	
I_{off}		V_{CC} = 0,	V_I or V_O = 0 to 4.5 V						±100	µA
I_{BHL}‡		V_{CC} = 2.3 V,	V_I = 0.7 V		115			115		µA
I_{BHH}§		V_{CC} = 2.3 V,	V_I = 1.7 V		–10			–10		µA
I_{BHLO}¶		V_{CC} = 2.7 V,	V_I = 0 to V_{CC}	300			300			µA
I_{BHHO}#		V_{CC} = 2.7 V,	V_I = 0 to V_{CC}	–300			–300			µA
I_{EX}‖		V_{CC} = 2.3 V,	V_O = 5.5 V			125			125	µA
$I_{OZ(PU/PD)}$☆		V_{CC} ≤ 1.2 V, V_O = 0.5 V to V_{CC}, V_I = GND or V_{CC}, $\overline{OE}$ = don't care				±100			±100	µA
I_{OZH}		V_{CC} = 2.7 V	V_O = 2.3 V, V_I = 0.7 V or 1.7 V			5			5	µA
I_{OZL}		V_{CC} = 2.7 V	V_O = 0.5 V, V_I = 0.7 V or 1.7 V			–5			–5	µA
I_{CC}		V_{CC} = 2.7 V, I_O = 0, V_I = V_{CC} or GND	Outputs high		0.04	0.1		0.04	0.1	mA
			Outputs low		2.3	4.5		2.3	4.5	
			Outputs disabled		0.04	0.1		0.04	0.1	
C_i		V_{CC} = 2.5 V,	V_I = 2.5 V or 0		3			3		pF
C_o		V_{CC} = 2.5 V,	V_O = 2.5 V or 0		6			6		pF

† All typical values are at V_{CC} = 2.5 V, T_A = 25°C.
‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.
§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.
¶ An external driver must source at least I_{BHLO} to switch this node from low to high.
# An external driver must sink at least I_{BHHO} to switch this node from high to low.
‖ Current into an output in the high state when V_O > V_{CC}
☆High-impedance state during power up or power down

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54ALVTH32244			SN74ALVTH32244			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 3 V,	I_I = –18 mA			–1.2			–1.2	V
V_{OH}		V_{CC} = 3 V to 3.6 V,	I_{OH} = –100 µA	V_{CC}–0.2			V_{CC}–0.2			V
		V_{CC} = 3 V	I_{OH} = –24 mA	2						
			I_{OH} = –32 mA				2			
V_{OL}		V_{CC} = 3 V to 3.6 V,	I_{OL} = 100 µA			0.2			0.2	V
		V_{CC} = 3 V	I_{OL} = 16 mA						0.4	
			I_{OL} = 24 mA			0.5				
			I_{OL} = 32 mA						0.5	
			I_{OL} = 48 mA			0.55				
			I_{OL} = 64 mA						0.55	
I_I	Control inputs	V_{CC} = 3.6 V,	V_I = V_{CC} or GND			±1			±1	µA
		V_{CC} = 0 or 3.6 V,	V_I = 5.5 V			10			10	
	Data inputs	V_{CC} = 3.6 V	V_I = 5.5 V			20			20	
			V_I = V_{CC}			1			1	
			V_I = 0			–5			–5	
I_{off}		V_{CC} = 0,	V_I or V_O = 0 to 4.5 V						±100	µA
I_{BHL}‡		V_{CC} = 3 V,	V_I = 0.8 V	75			75			µA
I_{BHH}§		V_{CC} = 3 V,	V_I = 2 V	–75			–75			µA
I_{BHLO}¶		V_{CC} = 3.6 V,	V_I = 0 to V_{CC}	500			500			µA
I_{BHHO}#		V_{CC} = 3.6 V,	V_I = 0 to V_{CC}	–500			–500			µA
I_{EX}‖		V_{CC} = 3 V,	V_O = 5.5 V			125			125	µA
$I_{OZ(PU/PD)}$☆		V_{CC} ≤ 1.2 V, V_O = 0.5 V to V_{CC}, V_I = GND or V_{CC}, $\overline{OE}$ = don't care				±100			±100	µA
I_{OZH}		V_{CC} = 3.6 V	V_O = 3 V, V_I = 0.8 V or 2 V			5			5	µA
I_{OZL}		V_{CC} = 3.6 V	V_O = 0.5 V, V_I = 0.8 V or 2 V			–5			–5	µA
I_{CC}		V_{CC} = 3.6 V, I_O = 0, V_I = V_{CC} or GND	Outputs high		0.07	0.1		0.07	0.1	mA
			Outputs low		3.2	5		3.2	5	
			Outputs disabled		0.07	0.1		0.07	0.1	
ΔI_{CC}□		V_{CC} = 3 V to 3.6 V, One input at V_{CC} – 0.6 V, Other inputs at V_{CC} or GND				0.4			0.4	mA
C_i		V_{CC} = 3.3 V,			3			3		pF
C_o		V_{CC} = 3.3 V,			6			6		pF

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.
§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.
¶ An external driver must source at least I_{BHLO} to switch this node from low to high.
# An external driver must sink at least I_{BHHO} to switch this node from high to low.
‖ Current into an output in the high state when V_O > V_{CC}
☆ High-impedance state during power up or power down
□ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

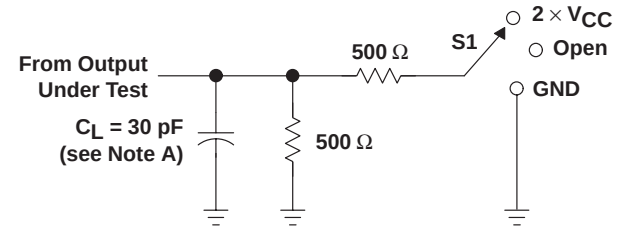
switching characteristics over recommended operating free-air temperature range, C_L = 30 pF, V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH32244		SN74ALVTH32244		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	Y	1	3.1	1	3	ns
t_{PHL}			1	3.6	1	3.5	
t_{PZH}	$\overline{OE}$	Y	1.1	6	1.1	5.9	ns
t_{PZL}			1.1	4.8	1.1	4.7	
t_{PHZ}	$\overline{OE}$	Y	1.5	4.5	1.5	4.4	ns
t_{PLZ}			1	3.5	1	3.4	

switching characteristics over recommended operating free-air temperature range, C_L = 50 pF, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 2)

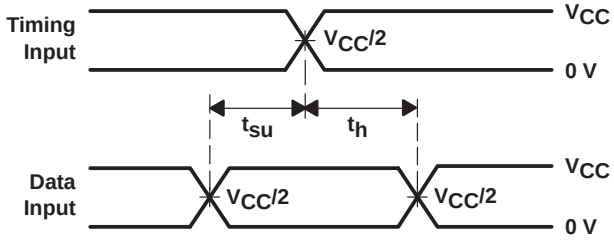
PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH32244		SN74ALVTH32244		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	Y	1	2.6	1	2.4	ns
t_{PHL}			1	2.6	1	2.5	
t_{PZH}	$\overline{OE}$	Y	1	3.9	1	3.8	ns
t_{PZL}			1	3	1	2.9	
t_{PHZ}	$\overline{OE}$	Y	1.5	4.3	1.5	4.2	ns
t_{PLZ}			1.5	3.7	1.5	3.6	

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 2.5 V ± 0.2 V

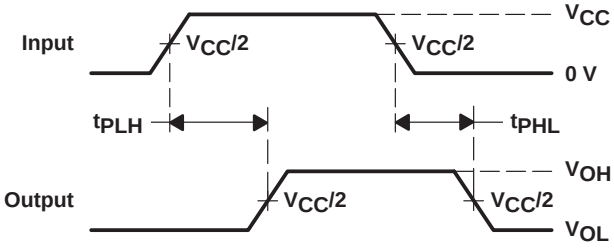


TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND

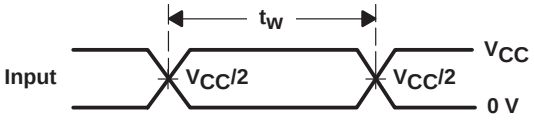
LOAD CIRCUIT



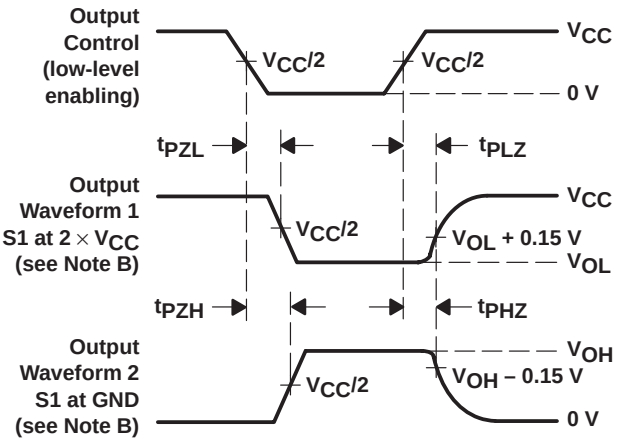
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION

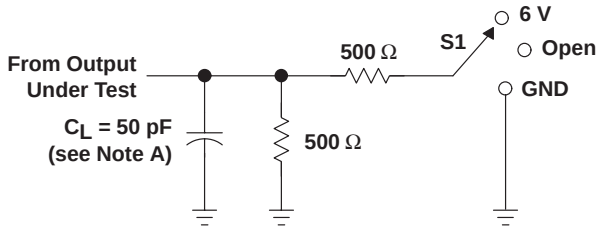


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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.

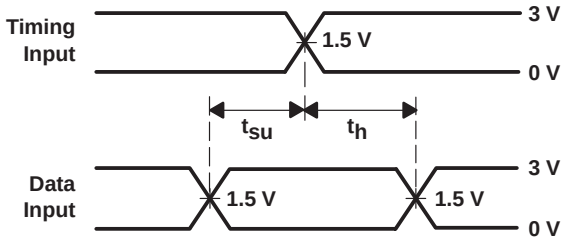
Figure 1. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 3.3 V ± 0.3 V

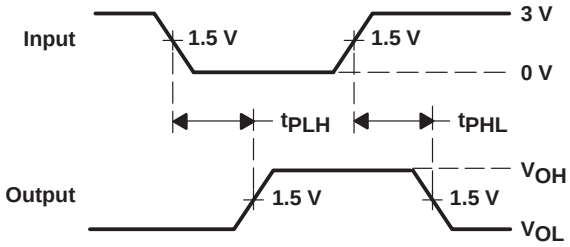


TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND

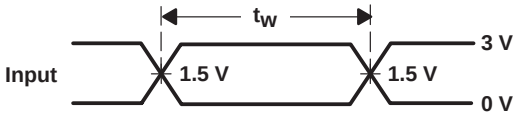
LOAD CIRCUIT



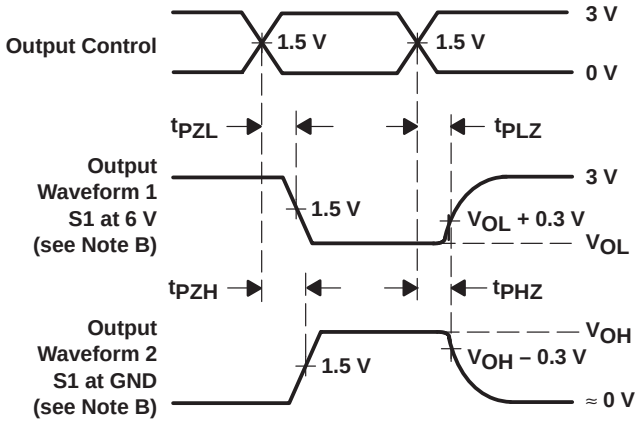
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
PULSE DURATION

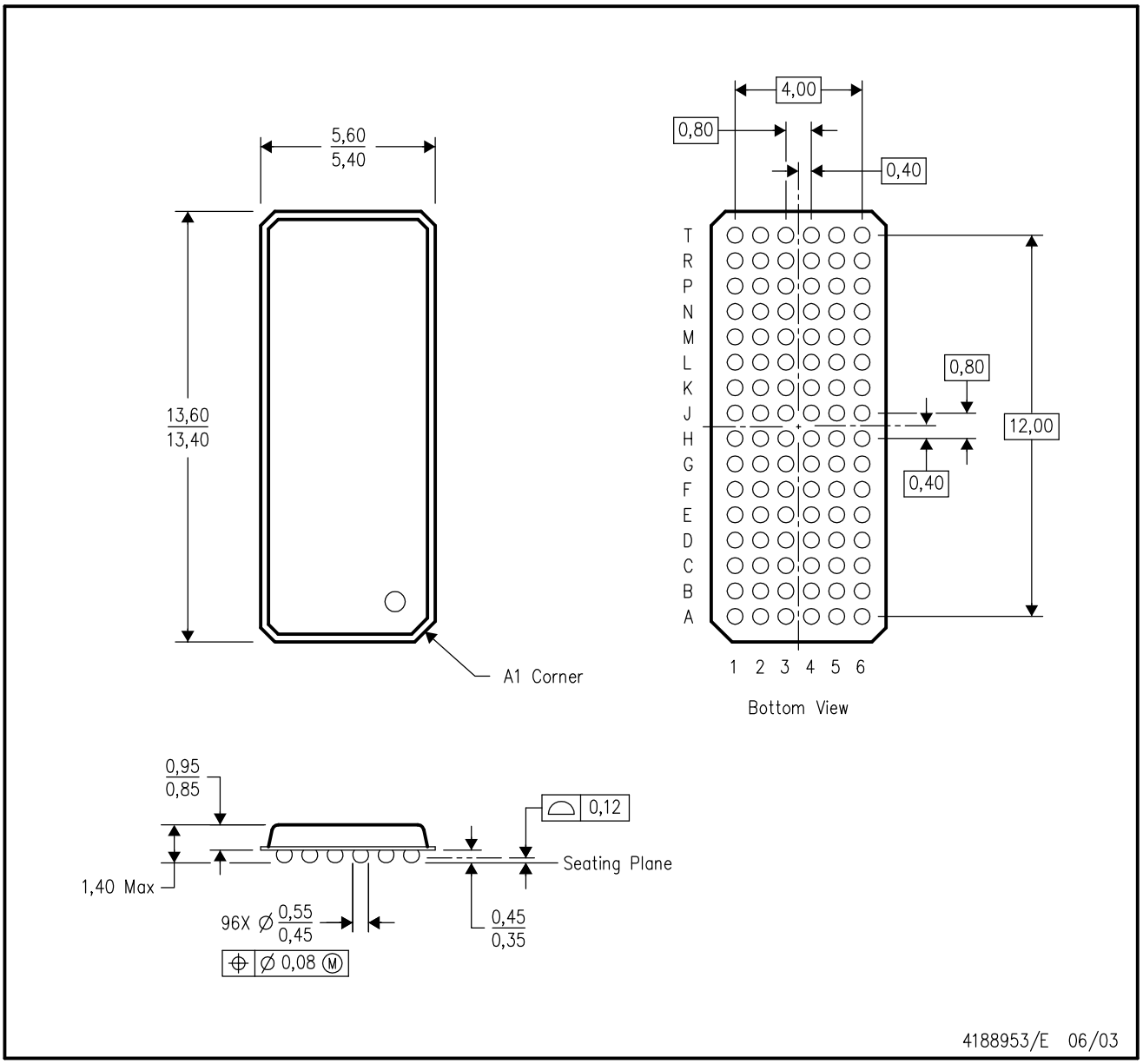


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

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 2. Load Circuit and Voltage Waveforms

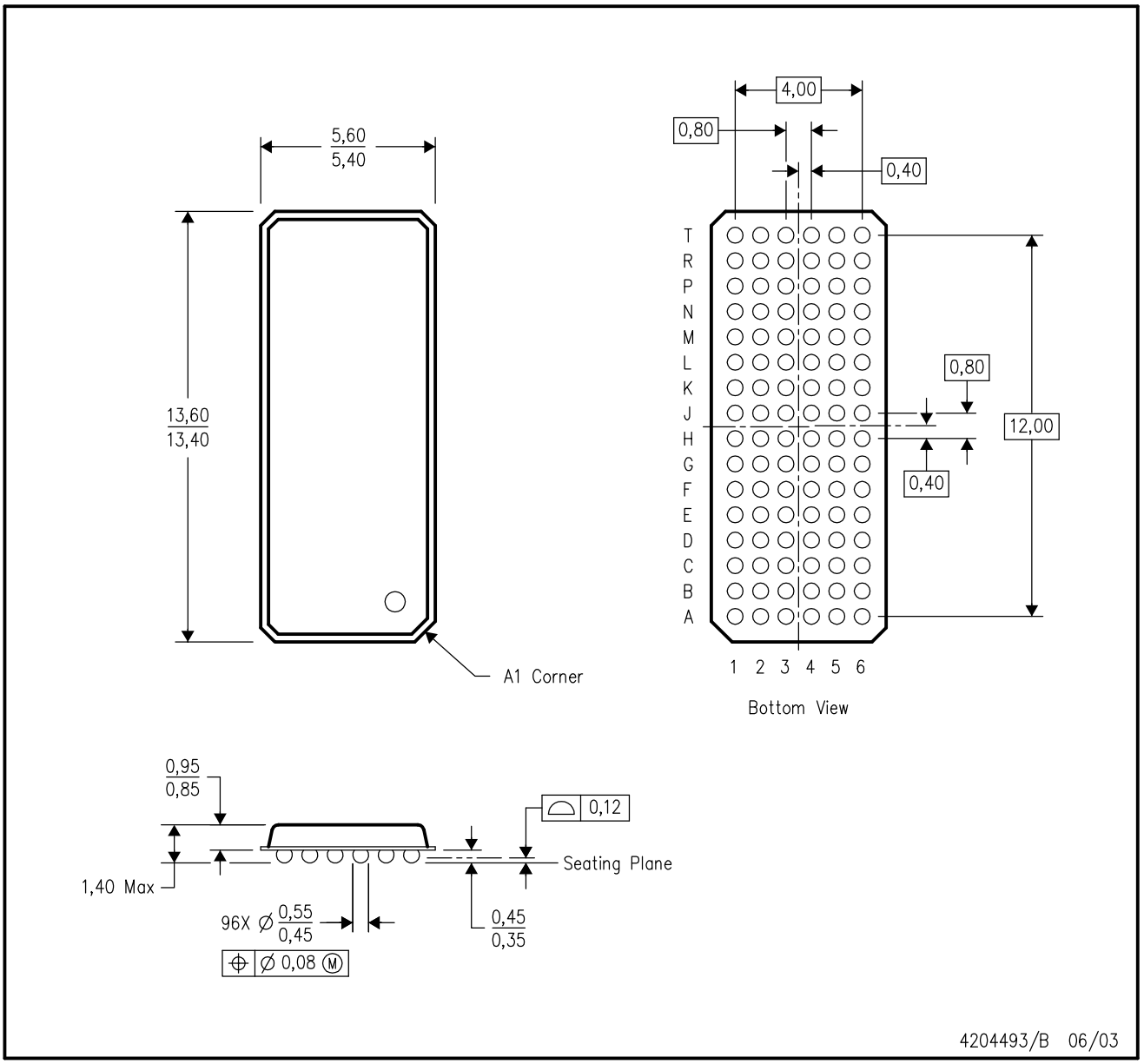
GKE (R–PBGA–N96) PLASTIC BALL GRID ARRAY



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

MicroStar BGA is a trademark of Texas Instruments.

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. MicroStar BGA™ configuration
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