

## FEATURES

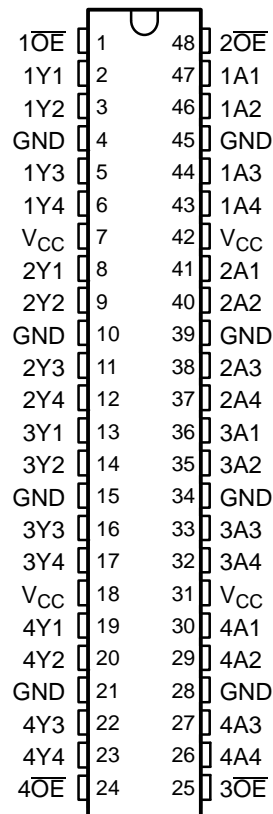
- Member of the Texas Instruments Widebus™ Family
- Operates From 1.65 V to 3.6 V
- Inputs Accept Voltages to 5.5 V
- Max  $t_{pd}$  of 4.4 ns at 3.3 V
- Typical  $V_{OLP}$  (Output Ground Bounce) <0.8 V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Typical  $V_{OHV}$  (Output  $V_{OH}$  Undershoot) >2 V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V  $V_{CC}$ )
- Output Ports Have Equivalent 26- $\Omega$  Series Resistors, So No External Resistors Are Required
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 1000-V Charged-Device Model (C101)

## DESCRIPTION/ORDERING INFORMATION

This 16-bit buffer/driver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

The SN74LVC162244A 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 device can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer. It provides true outputs and symmetrical active-low output-enable ( $\overline{OE}$ ) inputs.

DGG, DGV, OR DL PACKAGE  
(TOP VIEW)



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.

# SN74LVC162244A

## 16-BIT BUFFER/DRIVER

## WITH 3-STATE OUTPUTS

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### ORDERING INFORMATION

T <sub>A</sub>	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	FBGA – GRD	Tape and reel	SN74LVC162244AGRDR	LD2244A
	FBGA – ZRD (Pb-free)		SN74LVC162244AZRDR	
	SSOP – DL	Tube	SN74LVC162244ADL	LVC162244A
		Tape and reel	SN74LVC162244ADLR	
	TSSOP – DGG	Tape and reel	SN74LVC162244ADGGR	LVC162244A
			74LVC162244ADGGRG4	
	TVSOP – DGV	Tape and reel	SN74LVC162244ADGVR	LD2244A
			74LVC162244ADGVRE4	
	VFBGA – GQL	Tape and reel	SN74LVC162244AGQLR	LD2244A
	VFBGA – ZQL (Pb-free)		SN74LVC162244AZQLR	

(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).

## DESCRIPTION/ORDERING INFORMATION (CONTINUED)

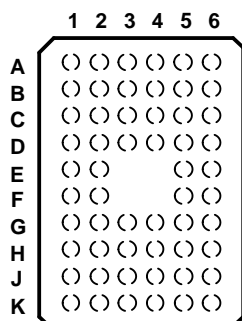
The outputs, which are designed to sink up to 12 mA, include equivalent 26-Ω resistors to reduce overshoot and undershoot.

Inputs can be driven from either 3.3-V or 5-V devices. This feature allows the use of this device as a translator in a mixed 3.3-V/5-V system environment.

This device is fully specified for partial-power-down applications using  $I_{off}$ . The  $I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

To ensure the high-impedance state during power up or power down,  $\overline{OE}$  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.

**GQL OR ZQL PACKAGE**  
(TOP VIEW)

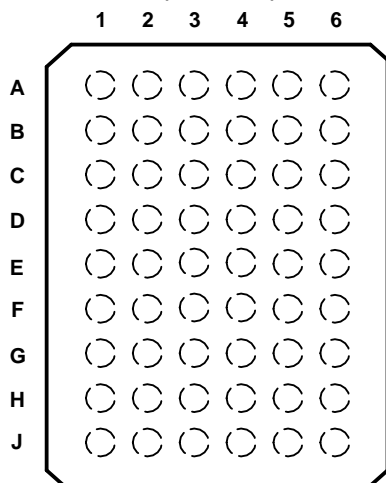


**TERMINAL ASSIGNMENTS<sup>(1)</sup>**  
(56-Ball GQL/ZQL Package)

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

(1) NC - No internal connection

**GRD OR ZRD PACKAGE**  
(TOP VIEW)



**TERMINAL ASSIGNMENTS<sup>(1)</sup>**  
(54-Ball GRD/ZRD Package)

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

(1) NC - No internal connection

# SN74LVC162244A

## 16-BIT BUFFER/DRIVER

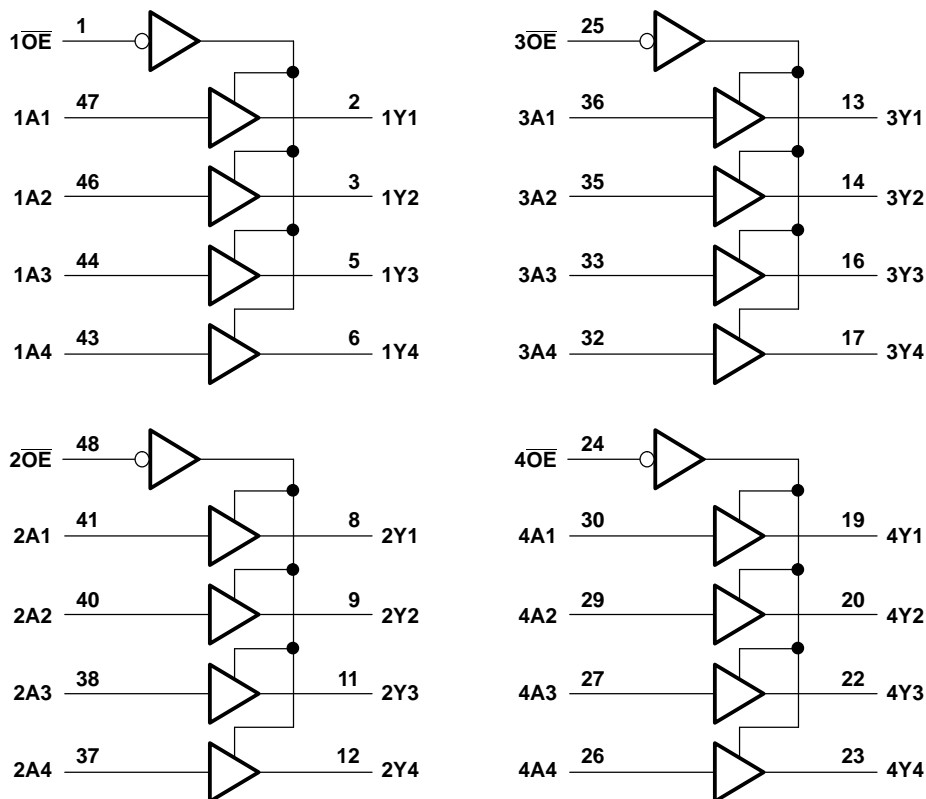
### WITH 3-STATE OUTPUTS

SCAS758A–DECEMBER 2003–REVISED OCTOBER 2005

**FUNCTION TABLE**  
**(EACH 4-BIT BUFFER)**

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

**LOGIC DIAGRAM (POSITIVE LOGIC)**



Pin numbers shown are for the DGG, DGV, and DL packages.

## 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	6.5	V
V <sub>I</sub>	Input voltage range <sup>(2)</sup>	−0.5	6.5	V
V <sub>O</sub>	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>	−0.5	6.5	V
V <sub>O</sub>	Voltage range applied to any output in the high or low state <sup>(2)(3)</sup>	−0.5	V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0		−50 mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0		−50 mA
I <sub>O</sub>	Continuous output current			±50 mA
	Continuous current through each V <sub>CC</sub> or GND			±100 mA
θ <sub>JA</sub>	Package thermal impedance <sup>(4)</sup>	DGG package		70 °C/W
		DGV package		58
		DL package		63
		GQL/ZQL package		42
		GRD/ZRD package		36
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) The value of V<sub>CC</sub> is provided in the recommended operating conditions table.
- (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	Operating	1.65	3.6
		Data retention only	1.5	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	5.5	V
V <sub>O</sub>	Output voltage	High or low state	0	V <sub>CC</sub>
		High-impedance state	0	5.5
I <sub>OH</sub>	High-level output current	V <sub>CC</sub> = 1.65 V	−2	mA
		V <sub>CC</sub> = 2.3 V	−4	
		V <sub>CC</sub> = 2.7 V	−8	
		V <sub>CC</sub> = 3 V	−12	
I <sub>OL</sub>	Low-level output current	V <sub>CC</sub> = 1.65 V	2	mA
		V <sub>CC</sub> = 2.3 V	4	
		V <sub>CC</sub> = 2.7 V	8	
		V <sub>CC</sub> = 3 V	12	
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 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.

# SN74LVC162244A

## 16-BIT BUFFER/DRIVER

### WITH 3-STATE OUTPUTS

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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> = –2 mA	1.65 V	1.2			
	I <sub>OH</sub> = –4 mA	2.3 V	1.7			
		2.7 V	2.2			
	I <sub>OH</sub> = –6 mA	3 V	2.4			
	I <sub>OH</sub> = –8 mA	2.7 V	2			
	I <sub>OH</sub> = –12 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> = 2 mA	1.65 V	0.45			
	I <sub>OL</sub> = 4 mA	2.3 V	0.7			
		2.7 V	0.4			
	I <sub>OL</sub> = 6 mA	3 V	0.55			
	I <sub>OL</sub> = 8 mA	2.7 V	0.6			
	I <sub>OL</sub> = 12 mA	3 V	0.8			
I <sub>I</sub>	V <sub>I</sub> = 0 to 5.5 V	3.6 V	±5			µA
I <sub>off</sub>	V <sub>I</sub> or V <sub>O</sub> = 5.5 V	0	±10			µA
I <sub>OZ</sub>	V <sub>O</sub> = 0 to 5.5 V	3.6 V	±10			µA
I <sub>CC</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND	3.6 V	20			µA
	3.6 V ≤ V <sub>I</sub> ≤ 5.5 V <sup>(2)</sup>		20			
ΔI <sub>CC</sub>	One input at V <sub>CC</sub> – 0.6 V, Other inputs at V <sub>CC</sub> or GND	2.7 V to 3.6 V	500			µA
C <sub>i</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND	3.3 V	5.5			pF
C <sub>o</sub>	V <sub>O</sub> = V <sub>CC</sub> or GND	3.3 V	6			pF

(1) All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

(2) This applies in the disabled state only.

## Switching Characteristics

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

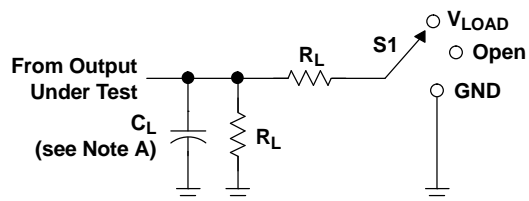
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 1.8 V ± 0.15 V		V <sub>CC</sub> = 2.5 V ± 0.2 V		V <sub>CC</sub> = 2.7 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>pd</sub>	A	Y	1.5	6	1	4.3	1	5.6	1.1	4.4	ns
t <sub>en</sub>	$\overline{\text{OE}}$	Y	1.5	7.3	1	5	1	6.9	1	5.5	ns
t <sub>dis</sub>	$\overline{\text{OE}}$	Y	1.5	8.9	1	5.5	1	6.8	1.8	6.3	ns

## Operating Characteristics

T<sub>A</sub> = 25°C

PARAMETER			TEST CONDITIONS	V <sub>CC</sub> = 1.8 V	V <sub>CC</sub> = 2.5 V	V <sub>CC</sub> = 3.3 V	UNIT
				TYP	TYP	TYP	
C <sub>pd</sub>	Power dissipation capacitance per buffer/driver	Outputs enabled	f = 10 MHz	31	33	35	pF
		Outputs disabled		2	3	4	

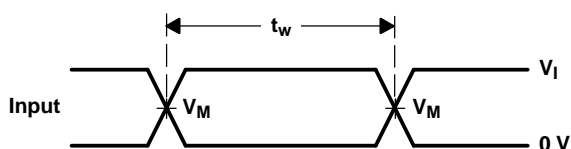
## PARAMETER MEASUREMENT INFORMATION



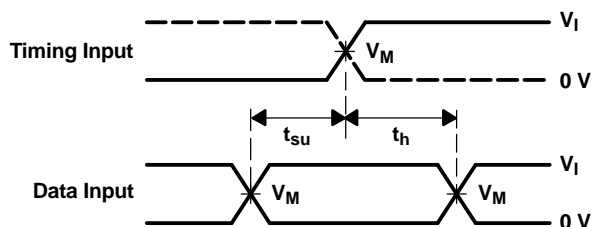
LOAD CIRCUIT

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

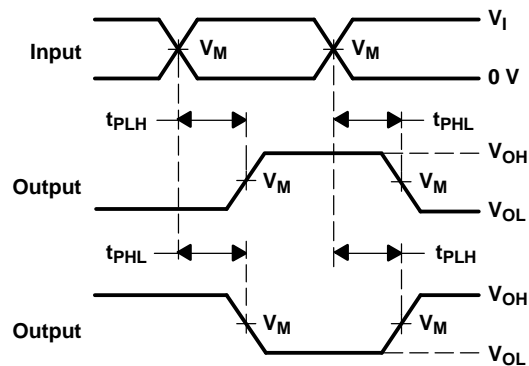
$V_{CC}$	INPUTS		$V_M$	$V_{LOAD}$	$C_L$	$R_L$	$V_{\Delta}$
	$V_I$	$t_r/t_f$					
$1.8\text{ V} \pm 0.15\text{ V}$	$V_{CC}$	$\leq 2\text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	1 k $\Omega$	0.15 V
$2.5\text{ V} \pm 0.2\text{ V}$	$V_{CC}$	$\leq 2\text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	500 $\Omega$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



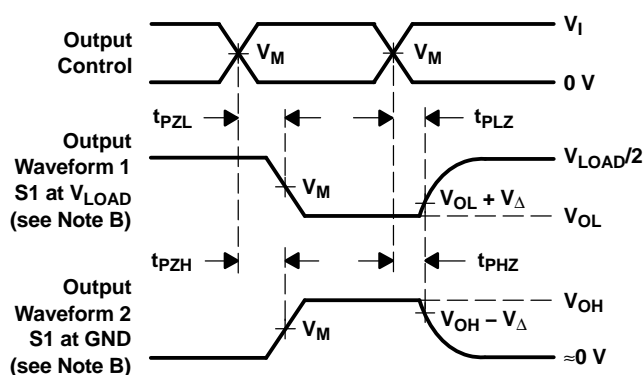
VOLTAGE WAVEFORMS  
PULSE DURATION



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:
- $C_L$  includes probe and jig capacitance.
  - 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.
  - All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ .
  - The outputs are measured one at a time, with one transition per measurement.
  - $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
  - 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>
74LVC162244ADGGRE4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74LVC162244ADGGRG4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74LVC162244ADGVRE4	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74LVC162244ADLRG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC162244ADGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC162244ADGVR	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC162244ADL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC162244ADLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC162244ADLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC162244AGQLR	ACTIVE	BGA MICROSTAR JUNIOR	GQL	56	1000	TBD	SNPB	Level-1-240C-UNLIM
SN74LVC162244AZQLR	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM

<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.

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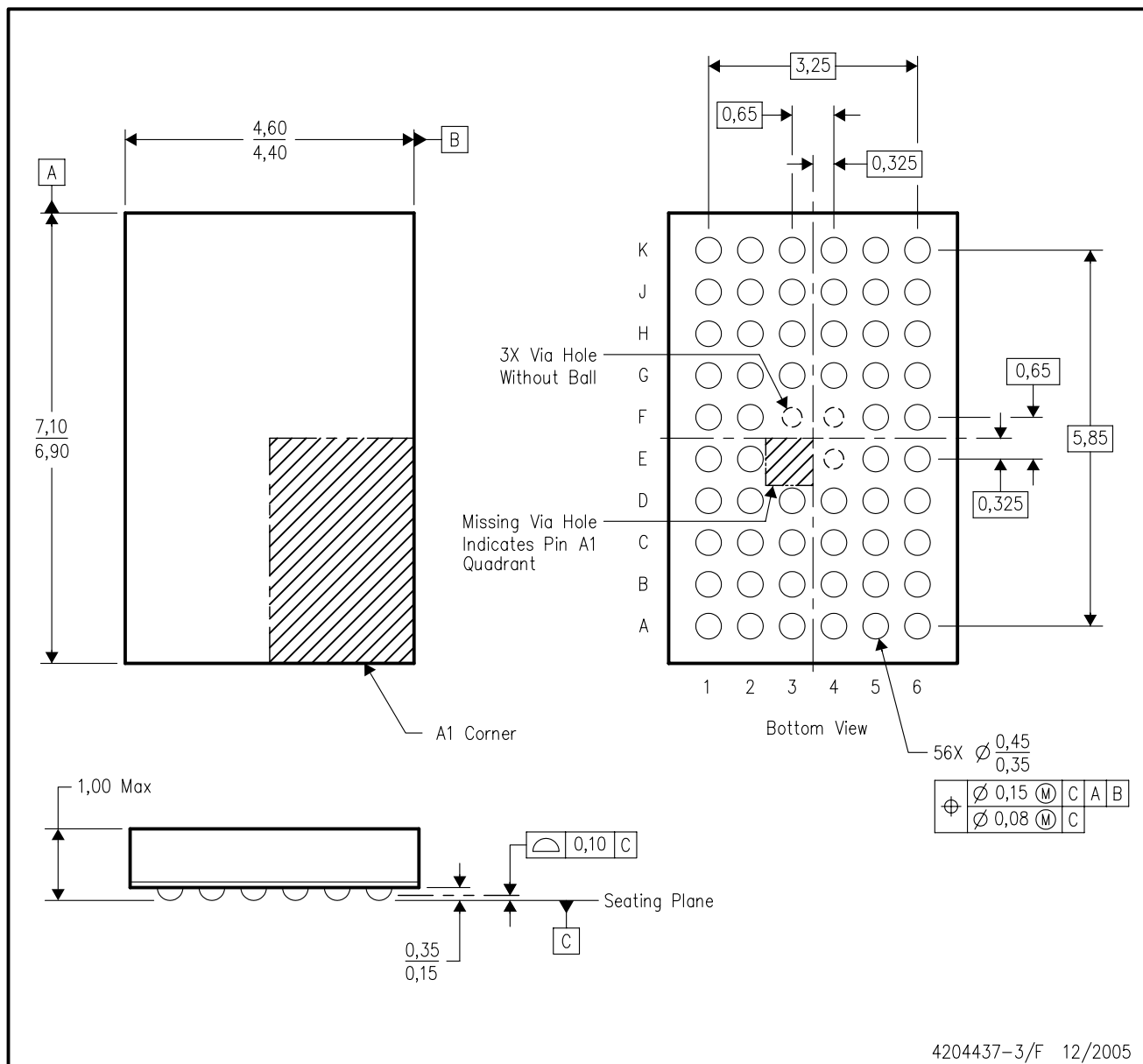


incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

## ZQL (R-PBGA-N56)

## PLASTIC BALL GRID ARRAY



4204437-3/F 12/2005

- 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-225 variation BA.
  - D. This package is lead-free. Refer to the 56 GQL package (drawing 4200583) for tin-lead (SnPb).

## DGV (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE

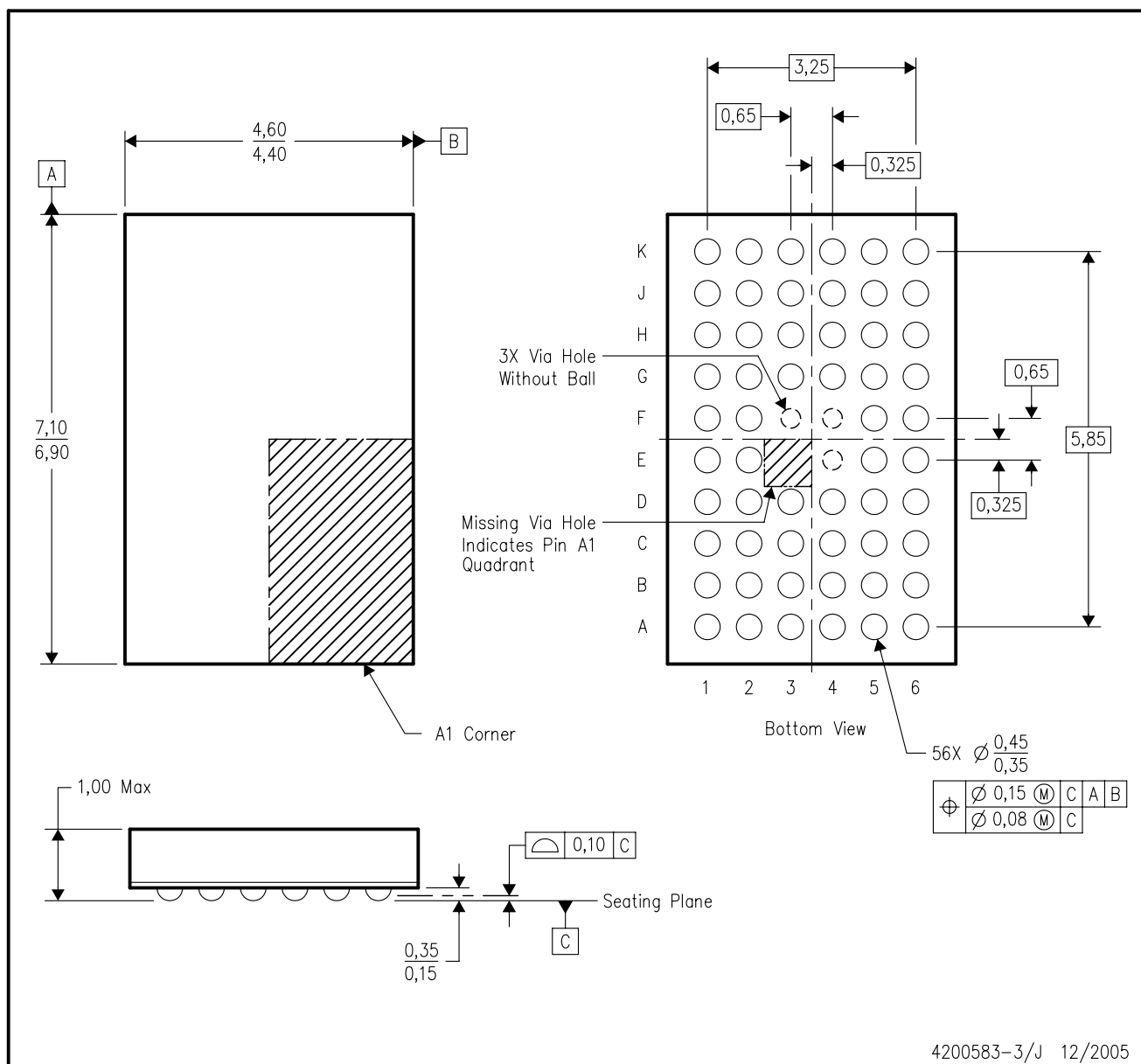
24 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.  
 D. Falls within JEDEC: 24/48 Pins – MO-153  
 14/16/20/56 Pins – MO-194

## GQL (R-PBGA-N56)

## 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-225 variation BA.
  - D. This package is tin-lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for lead-free.

DL (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MO-118

## DGG (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

## IMPORTANT NOTICE

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Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265

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