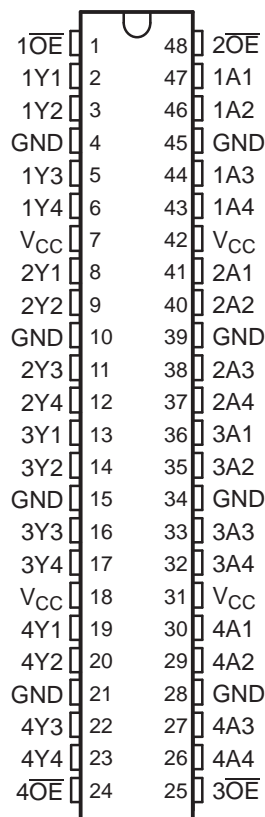


## FEATURES

- Members of the Texas Instruments Widebus™ Family
- Output Ports Have Equivalent 22-Ω Series Resistors, So No External Resistors Are Required
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V<sub>CC</sub>)
- Support Unregulated Battery Operation Down to 2.7 V
- Typical V<sub>OLP</sub> (Output Ground Bounce) <0.8 V at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C
- I<sub>off</sub> and Power-Up 3-State Support Hot Insertion
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Distributed V<sub>CC</sub> and GND Pins Minimize High-Speed Switching Noise
- Flow-Through Architecture Optimizes PCB Layout
- Latch-Up Performance Exceeds 500 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)

SN54LVTH162244... WD PACKAGE  
SN74LVTH162244... DGG OR DL PACKAGE  
(TOP VIEW)



## DESCRIPTION/ORDERING INFORMATION

### ORDERING INFORMATION

T <sub>A</sub>	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	FBGA – GRD	Reel of 1000	74LVTH162244GRDR	LL2244
	FBGA – ZRD (Pb-free)		74LVTH162244ZRDR	
	SSOP – DL	Tube of 25	SN74LVTH162244DL	LVTH162244
			SN74LVTH162244DLG4	
		Reel of 1000	SN74LVTH162244DLR	
			74LVTH162244DLRG4	
	TSSOP – DGG	Reel of 2000	SN74LVTH162244DGGR	LVTH162244
			74LVTH162244DGGRG4	
			74LVTH162244GRE4	
	VFBGA – GQL	Reel of 1000	SN74LVTH162244KR	LL2244
74LVTH162244ZQLR				
–55°C to 125°C	CFP – WD	Tube	SNJ54LVTH162244WD	SNJ54LVTH162244WD

(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).



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.

# SN54LVTH162244, SN74LVTH162244 3.3-V ABT 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCBS258N–JUNE 1993–REVISED NOVEMBER 2006

---

## DESCRIPTION/ORDERING INFORMATION (CONTINUED)

The LVTH162244 devices are 16-bit buffers and line drivers 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. These devices can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer. These devices provide true outputs and symmetrical active-low output-enable ( $\overline{OE}$ ) inputs.

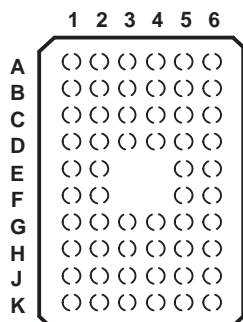
The outputs, which are designed to source or sink up to 12 mA, include equivalent 22- $\Omega$  series resistors to reduce overshoot and undershoot.

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.

When  $V_{CC}$  is between 0 and 1.5 V, the devices are 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.

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.

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

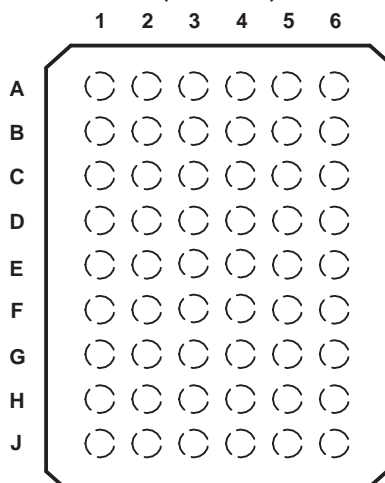


**TERMINAL ASSIGNMENTS<sup>(1)</sup>  
(56-Ball GQL/ZQL Package)**

	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 <sub>CC</sub>	V <sub>CC</sub>	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 <sub>CC</sub>	V <sub>CC</sub>	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 <sub>CC</sub>	V <sub>CC</sub>	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 <sub>CC</sub>	V <sub>CC</sub>	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

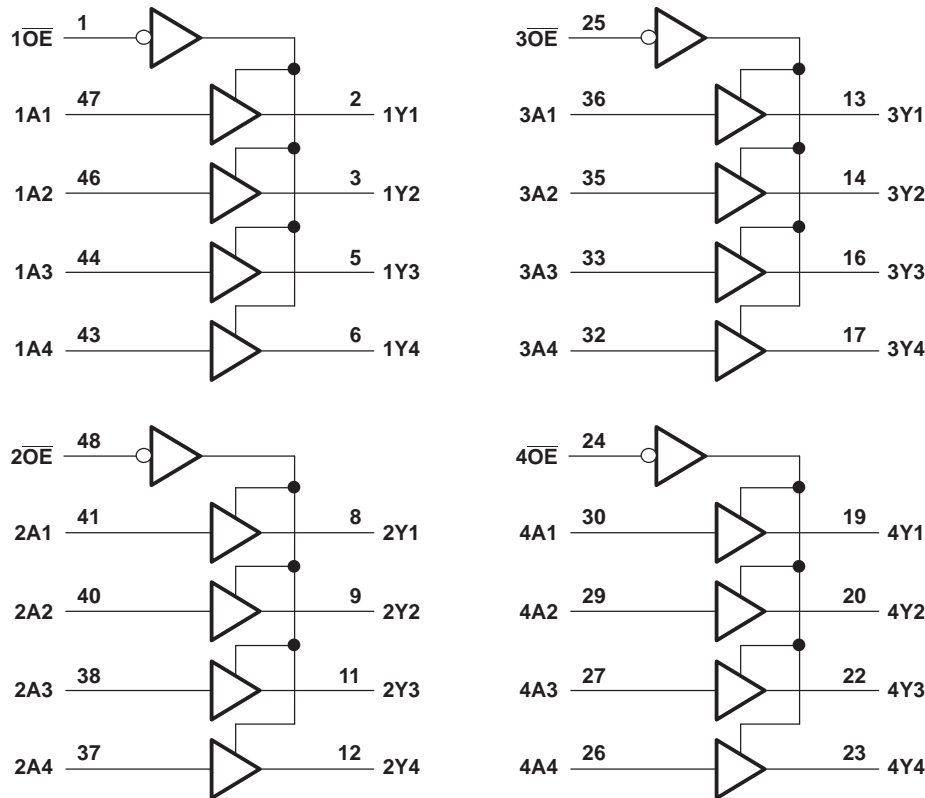
**FUNCTION TABLE  
(EACH 4-BIT BUFFER)**

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

# SN54LVTH162244, SN74LVTH162244 3.3-V ABT 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCBS258N–JUNE 1993–REVISED NOVEMBER 2006

## LOGIC DIAGRAM (POSITIVE LOGIC)



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

## Absolute Maximum Ratings<sup>(1)</sup>

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 <sup>(2)</sup>	-0.5	7	V
$V_O$	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>	-0.5	7	V
$V_O$	Voltage range applied to any output in the high state <sup>(2)</sup>	-0.5	$V_{CC} + 0.5$	V
$I_O$	Current into any output in the low state		30	mA
$I_O$	Current into any output in the high state <sup>(3)</sup>		30	mA
$I_{IK}$	Input clamp current	$V_I < 0$	-50	mA
$I_{OK}$	Output clamp current	$V_O < 0$	-50	mA
$\theta_{JA}$	Package thermal impedance <sup>(4)</sup>	DGG package	70	°C/W
		DL package	63	
		GQL/ZQL package	42	
		GRD/ZRD package	36	
$T_{stg}$	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<sup>(1)</sup>

		SN54LVTH162244		SN74LVTH162244		UNIT
		MIN	MAX	MIN	MAX	
V <sub>CC</sub>	Supply voltage	2.7	3.6	2.7	3.6	V
V <sub>IH</sub>	High-level input voltage	2		2		V
V <sub>IL</sub>	Low-level input voltage		0.8		0.8	V
V <sub>I</sub>	Input voltage		5.5		5.5	V
I <sub>OH</sub>	High-level output current		–12		–12	mA
I <sub>OL</sub>	Low-level output current		12		12	mA
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10	10	ns/V
Δt/ΔV <sub>CC</sub>	Power-up ramp rate	200		200		μs/V
T <sub>A</sub>	Operating free-air temperature	–55	125	–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.

## Electrical Characteristics

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

PARAMETER		TEST CONDITIONS		SN54LVTH162244		SN74LVTH162244		UNIT
				MIN	TYP <sup>(1)</sup>	MAX	MIN	
V <sub>IK</sub>		V <sub>CC</sub> = 2.7 V,	I <sub>I</sub> = –18 mA			–1.2	–1.2	V
V <sub>OH</sub>		V <sub>CC</sub> = 3 V,	I <sub>OH</sub> = –12 mA	2		2		V
V <sub>OL</sub>		V <sub>CC</sub> = 3 V,	I <sub>OL</sub> = 12 mA			0.8	0.8	V
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 0 or 3.6 V, V <sub>I</sub> = 5.5 V				10	10	μA
		V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = V <sub>CC</sub> or GND				±1	±1	
		V <sub>CC</sub> = 3.6 V		V <sub>I</sub> = V <sub>CC</sub>			1	
	Data inputs	V <sub>CC</sub> = 3.6 V				–5	–5	
		V <sub>I</sub> = 0						
I <sub>off</sub>		V <sub>CC</sub> = 0,	V <sub>I</sub> or V <sub>O</sub> = 0 to 4.5 V				±100	μA
I <sub>I(hold)</sub>	Data inputs	V <sub>CC</sub> = 3 V	V <sub>I</sub> = 0.8 V	75		75		μA
			V <sub>I</sub> = 2 V	–75		–75		
		V <sub>CC</sub> = 3.6 V, <sup>(2)</sup>	V <sub>I</sub> = 0 to 3.6 V				500 –750	
I <sub>OZH</sub>		V <sub>CC</sub> = 3.6 V,	V <sub>O</sub> = 3 V			5	5	μA
I <sub>OZL</sub>		V <sub>CC</sub> = 3.6 V,	V <sub>O</sub> = 0.5 V			–5	–5	μA
I <sub>OZPU</sub>		V <sub>CC</sub> = 0 to 1.5 V, V <sub>O</sub> = 0.5 V to 3 V, $\overline{OE}$ = don't care				±100 <sup>(3)</sup>	±100	μA
I <sub>OZPD</sub>		V <sub>CC</sub> = 1.5 V to 0, V <sub>O</sub> = 0.5 V to 3 V, $\overline{OE}$ = don't care				±100 <sup>(3)</sup>	±100	μA
I <sub>CC</sub>		V <sub>CC</sub> = 3.6 V, I <sub>O</sub> = 0, V <sub>I</sub> = V <sub>CC</sub> or GND		Outputs high		0.19	0.19	mA
				Outputs low		5	5	
				Outputs disabled		0.19	0.19	
ΔI <sub>CC</sub> <sup>(4)</sup>		V <sub>CC</sub> = 3 V to 3.6 V, One input at V <sub>CC</sub> – 0.6 V, Other inputs at V <sub>CC</sub> or GND				0.2	0.2	mA
C <sub>i</sub>		V <sub>I</sub> = 3 V or 0				4	4	pF
C <sub>o</sub>		V <sub>O</sub> = 3 V or 0				9	9	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) On products compliant to MIL-PRF-38535, this parameter is not production tested.

(4) 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.

# SN54LVTH162244, SN74LVTH162244 3.3-V ABT 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCBS258N–JUNE 1993–REVISED NOVEMBER 2006

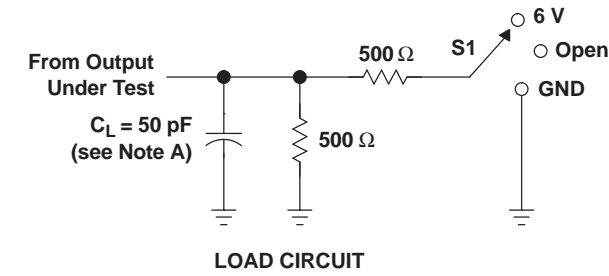
## Switching Characteristics

over recommended operating free-air temperature range,  $C_L = 50$  pF (unless otherwise noted) (see [Figure 1](#))

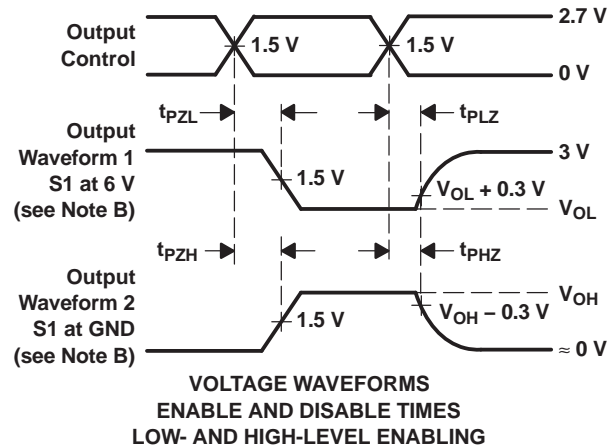
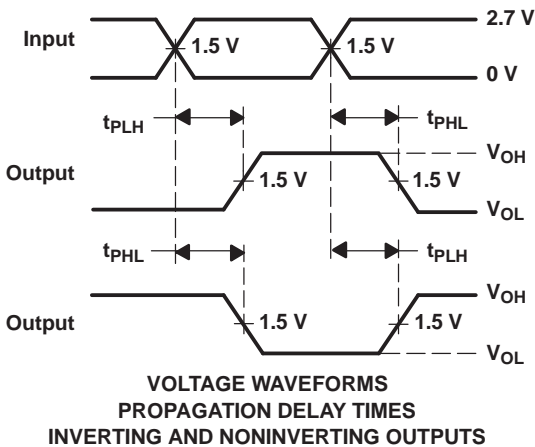
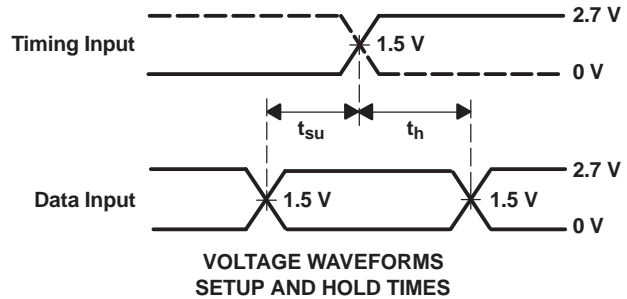
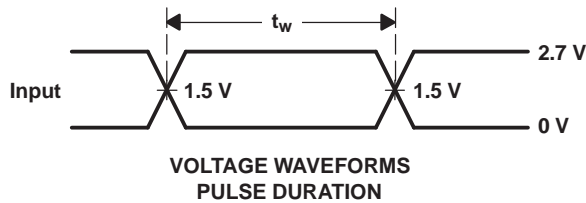
PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH162244				SN74LVTH162244				UNIT	
			$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$			$V_{CC} = 2.7\text{ V}$		
			MIN	MAX	MIN	MAX	MIN	TYP <sup>(1)</sup>	MAX	MIN		MAX
$t_{PLH}$	A	Y	1.1	4.6	5.1		1.4	3.4	4	4.8		ns
$t_{PHL}$			1.1	3.9	4.5		1.2	2.9	3.6	4.1		
$t_{PZH}$	$\overline{OE}$	Y	1.1	5.4	6.7		1.2	3.9	5.1	6.5		ns
$t_{PZL}$			1.3	4.9	6.1		1.4	3.8	4.5	5.8		
$t_{PHZ}$	$\overline{OE}$	Y	1.6	5.9	6.5		2.2	4.4	5.0	5.4		ns
$t_{PLZ}$			1	5.9	5.8		2	4.2	5.0	5.4		
$t_{sk(LH)}$								0.5			ns	
$t_{sk(HL)}$								0.5				

(1) All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

**PARAMETER MEASUREMENT INFORMATION**



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



- 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:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .
- 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 <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
5962-9680901QXA	ACTIVE	CFP	WD	48	1	TBD	A42	N / A for Pkg Type
5962-9680901VXA	ACTIVE	CFP	WD	48	1	TBD	A42	N / A for Pkg Type
74LVTH162244DGGRG4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74LVTH162244DLRG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74LVTH162244GRDR	ACTIVE	BGA MI CROSTA R JUNI OR	GRD	54	1000	TBD	SNPB	Level-1-240C-UNLIM
74LVTH162244GRE4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74LVTH162244ZQLR	ACTIVE	BGA MI CROSTA R JUNI OR	ZQL	56	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
74LVTH162244ZRDR	ACTIVE	BGA MI CROSTA R JUNI OR	ZRD	54	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
SN74LVTH162244DGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH162244DL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH162244DLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH162244DLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH162244KR	NRND	BGA MI CROSTA R JUNI OR	GQL	56	1000	TBD	SNPB	Level-1-240C-UNLIM
SNJ54LVTH162244WD	ACTIVE	CFP	WD	48	1	TBD	A42	N / A for Pkg Type

<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)



(3) 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.

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.

**OTHER QUALIFIED VERSIONS OF SN54LVTH162244, SN54LVTH162244-SP, SN74LVTH162244 :**

- Enhanced Product: [SN74LVTH162244-EP](#)

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications

**TAPE AND REEL INFORMATION**



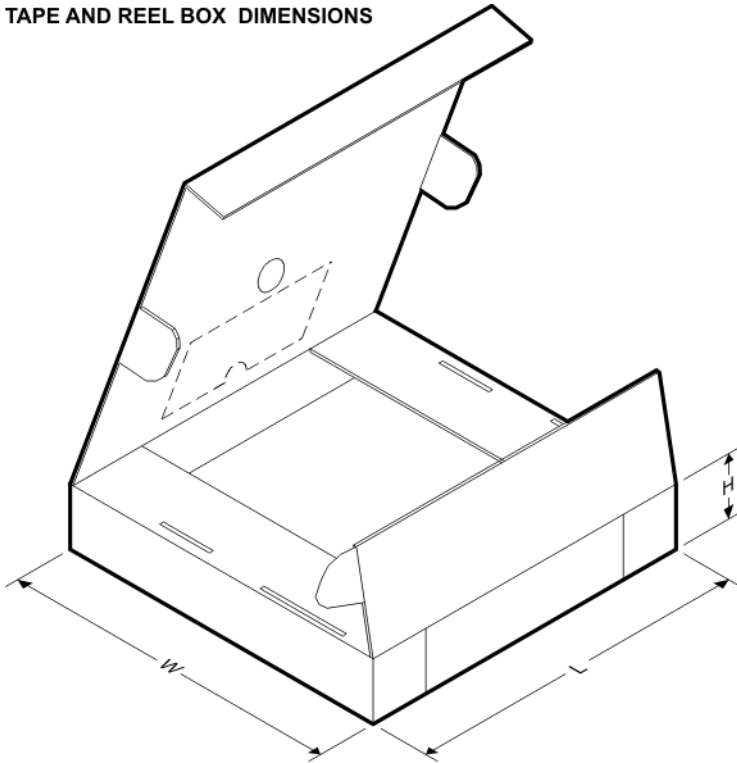
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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
74LVTH162244GRDR	BGA MICROSTAR JUNIOR	GRD	54	1000	330.0	16.4	5.8	8.3	1.55	8.0	16.0	Q1
74LVTH162244ZQLR	BGA MICROSTAR JUNIOR	ZQL	56	1000	330.0	16.4	4.8	7.3	1.45	8.0	16.0	Q1
74LVTH162244ZRDR	BGA MICROSTAR JUNIOR	ZRD	54	1000	330.0	16.4	5.8	8.3	1.55	8.0	16.0	Q1
SN74LVTH162244DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1
SN74LVTH162244DLR	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1
SN74LVTH162244KR	BGA MICROSTAR JUNIOR	GQL	56	1000	330.0	16.4	4.8	7.3	1.45	8.0	16.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

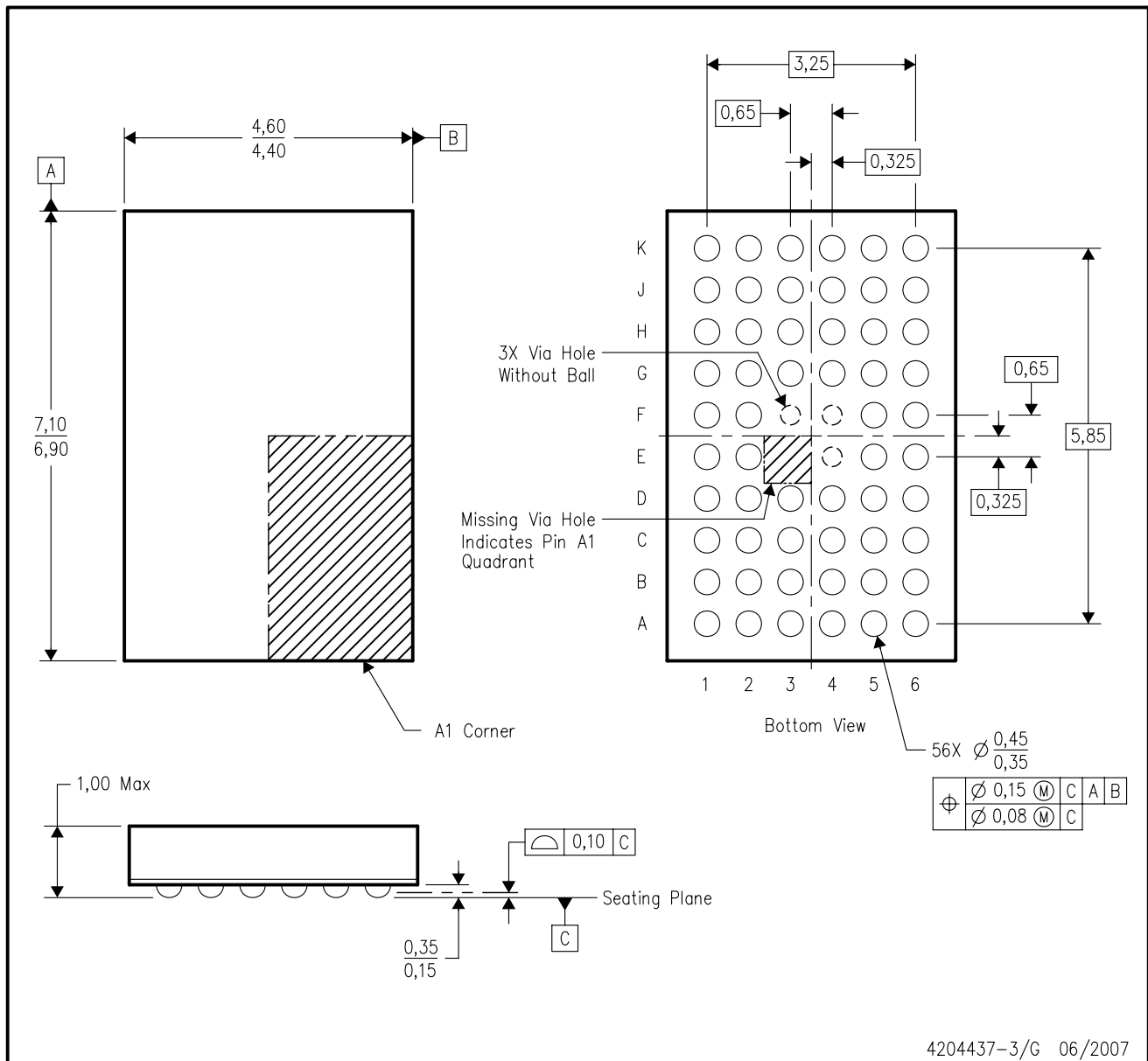


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
74LVTH162244GRDR	BGA MICROSTAR JUNIOR	GRD	54	1000	346.0	346.0	33.0
74LVTH162244ZQLR	BGA MICROSTAR JUNIOR	ZQL	56	1000	346.0	346.0	33.0
74LVTH162244ZRDR	BGA MICROSTAR JUNIOR	ZRD	54	1000	346.0	346.0	33.0
SN74LVTH162244DGGR	TSSOP	DGG	48	2000	346.0	346.0	41.0
SN74LVTH162244DLR	SSOP	DL	48	1000	346.0	346.0	49.0
SN74LVTH162244KR	BGA MICROSTAR JUNIOR	GQL	56	1000	346.0	346.0	33.0

ZQL (R-PBGA-N56)

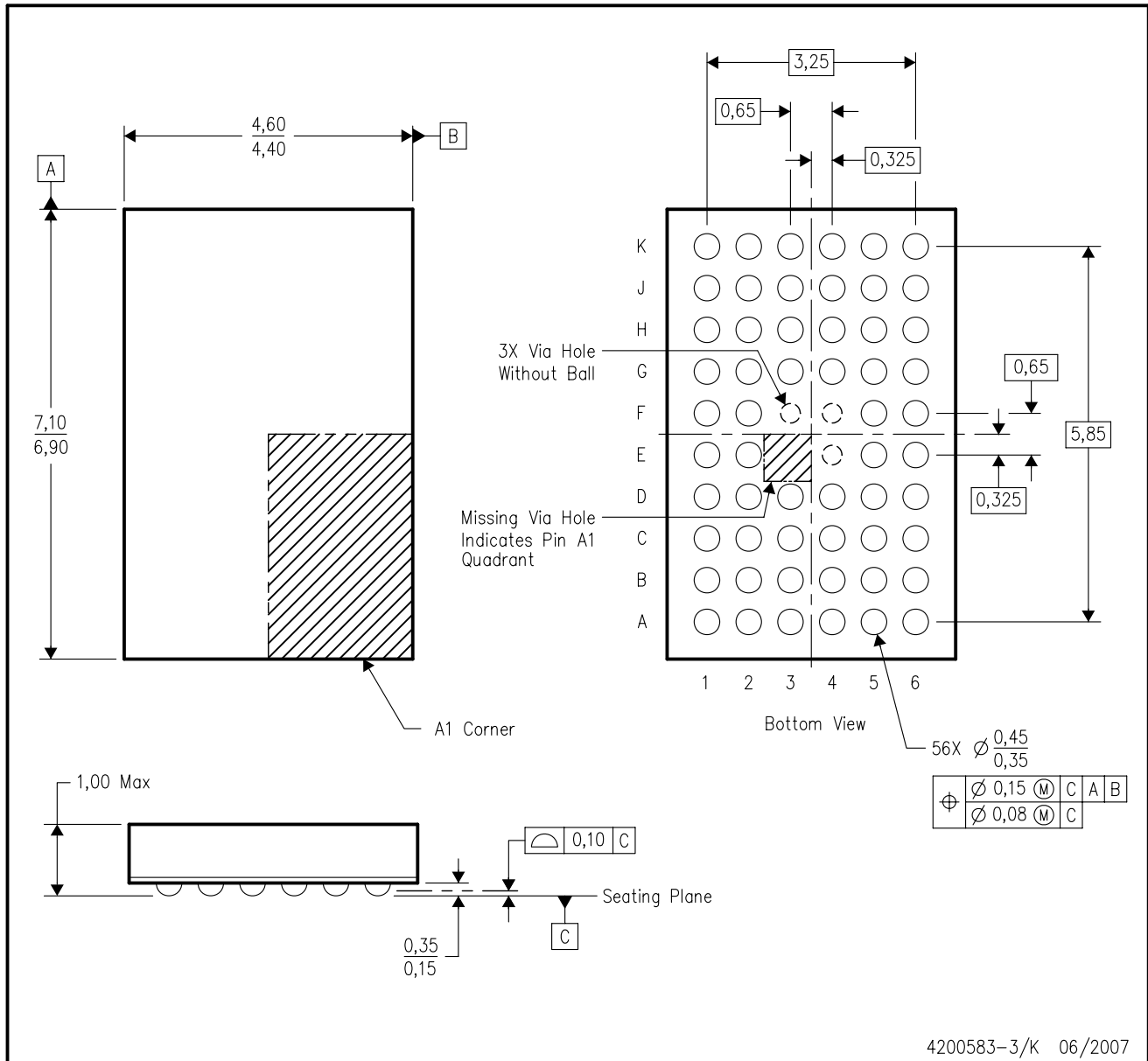
PLASTIC BALL GRID ARRAY



- 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-285 variation BA-2.
  - D. This package is lead-free. Refer to the 56 GQL package (drawing 4200583) for tin-lead (SnPb).

GQL (R-PBGA-N56)

PLASTIC BALL GRID ARRAY

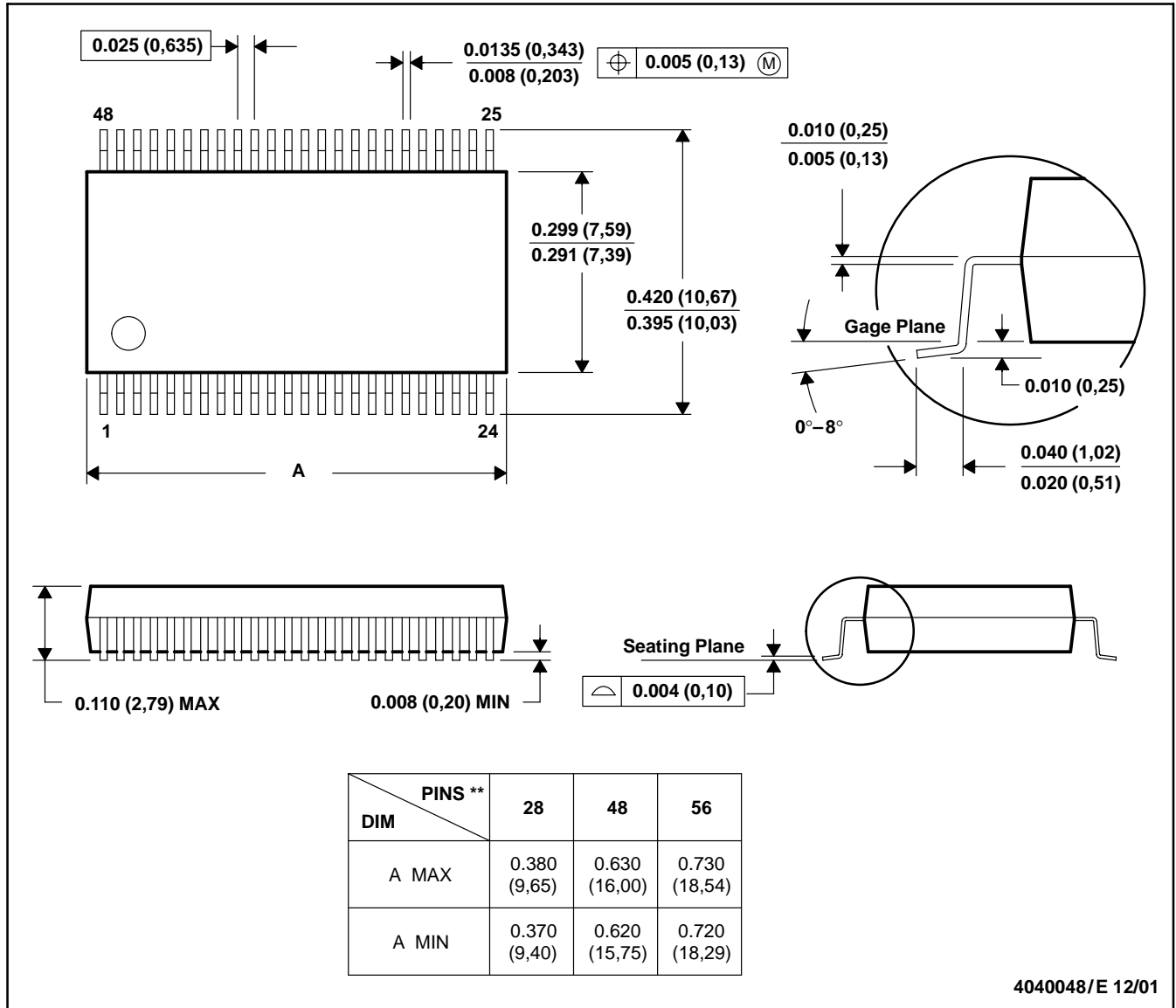


- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MO-285 variation BA-2.
  - D. This package is tin-lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for 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

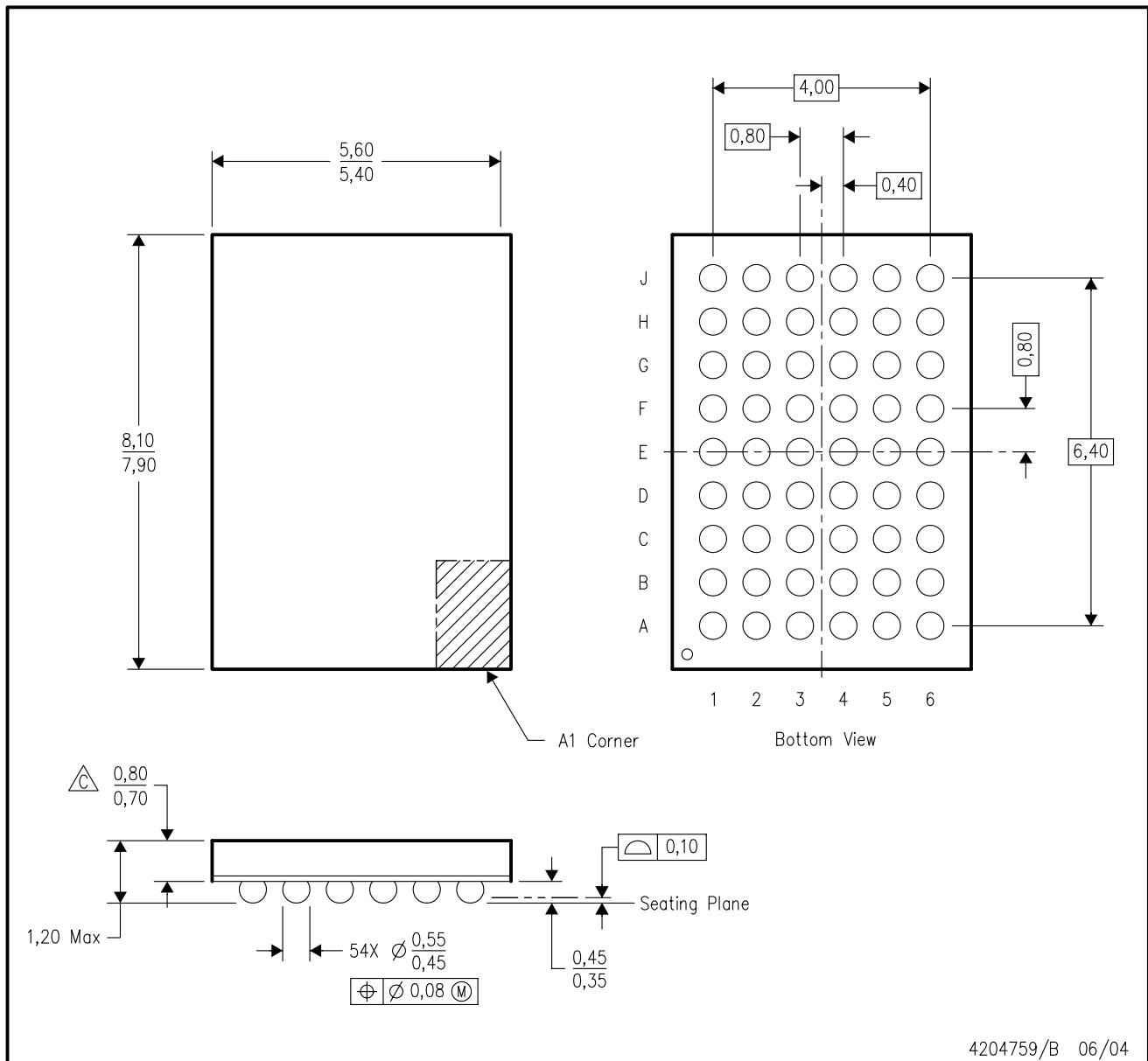
48 PINS SHOWN



- 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

GRD (R-PBGA-N54)

PLASTIC BALL GRID ARRAY

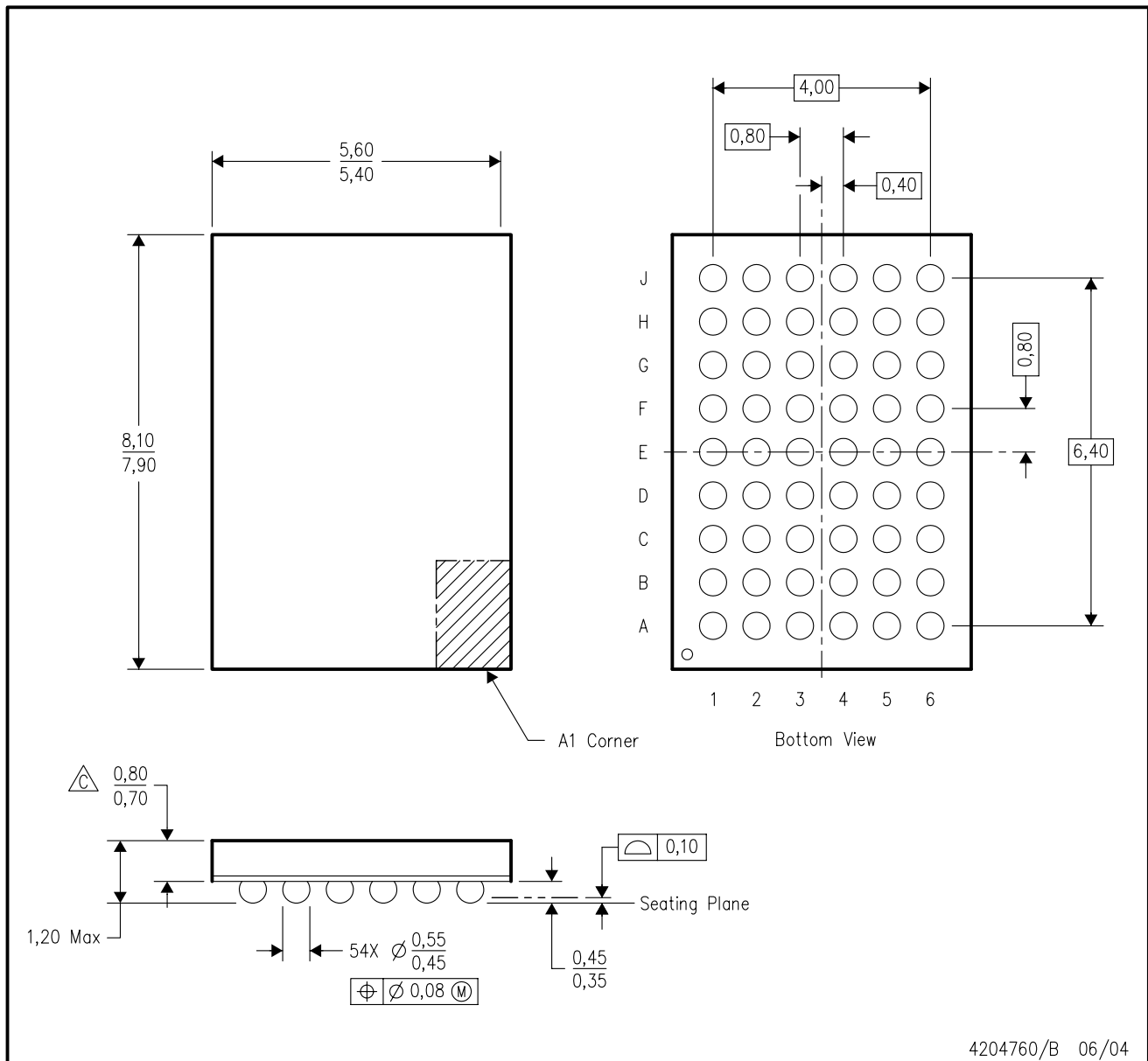


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MO-205 variation DD.
  - D. This package is tin-lead (SnPb). Refer to the 54 ZRD package (drawing 4204760) for lead-free.



ZRD (R-PBGA-N54)

PLASTIC BALL GRID ARRAY

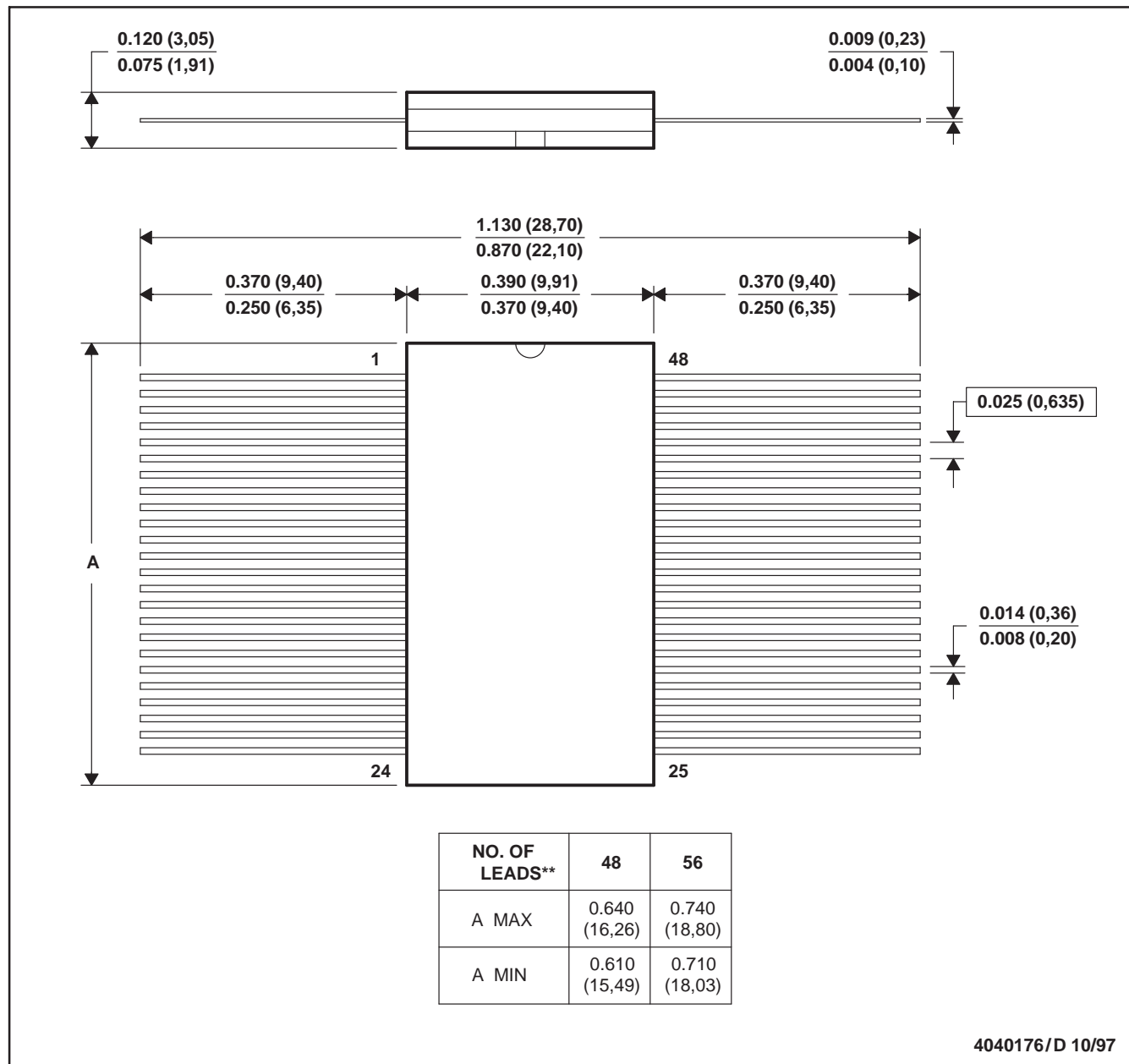


- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Falls within JEDEC MO-205 variation DD.
  - D. This package is lead-free. Refer to the 54 GRD package (drawing 4204759) for tin-lead (SnPb).

WD (R-GDFP-F\*\*)

CERAMIC DUAL FLATPACK

48 LEADS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only  
 E. Falls within MIL STD 1835: GDFP1-F48 and JEDEC MO-146AA  
 GDFP1-F56 and JEDEC MO-146AB

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

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>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2009, Texas Instruments Incorporated