



#### **FEATURES**

- Member of the Texas Instruments Widebus™
  Family
- Operates From 1.65 V to 3.6 V
- Max t<sub>pd</sub> of 3 ns at 3.3 V
- ±24-mA Output Drive at 3.3 V
- 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)
  - 1000-V Charged-Device Model (C101)

#### **DESCRIPTION/ORDERING INFORMATION**

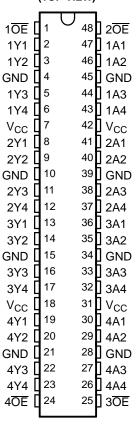
This 16-bit buffer/driver is designed for 1.65-V to 3.6-V  $V_{\rm CC}$  operation.

The SN74ALVC16244A is designed specifically to improve 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.

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.

# DGG OR DL PACKAGE (TOP VIEW)



#### ORDERING INFORMATION

T <sub>A</sub>	PACKAGE <sup>(1</sup>	)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
	FBGA – GRD	Tana and root	SN74ALVC16244AGRDR	VC244A
	FBGA – ZRD (Pb-free)	Tape and reel	SN74ALVC16244AZRDR	VC244A
	SSOP – DL	Tube	SN74ALVC16244ADL	ALVC16244A
–40°C to 85°C	220b - DF	Tape and reel	SN74ALVC16244ADLR	ALVC 16244A
-40°C 10 85°C	TSSOP – DGG	Tana and real	SN74ALVC16244ADGGR	ALVC16244A
	1550P – DGG	Tape and reel	SN74ALVC16244ADGGRE4	ALVC 16244A
	VFBGA – GQL	Tana and real	SN74ALVC16244AGQLR	VC244A
	VFBGA – ZQL (Pb-free)	Tape and reel	SN74ALVC16244AZQLR	VC244A

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at 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.

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# GQL OR ZQL PACKAGE (TOP VIEW)

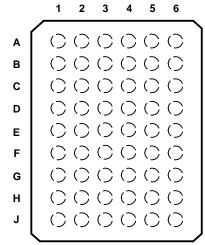
#### 1 2 3 4 5 6 000000 000000В 000000 С 000000 D OOOOΕ F ()()()()000000 G 000000 Н 000000 J 000000 K

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

	1	2	3 4		5	6
Α	1 <del>OE</del>	NC	NC	NC	NC	2 <del>OE</del>
В	1Y2	1Y1	GND	GND	1A1	1A2
С	1Y4	1Y3	V <sub>CC</sub>	V <sub>CC</sub>	1A3	1A4
D	2Y2	2Y1	GND	GND	2A1	2A2
E	2Y4	2Y3			2A3	2A4
F	3Y1	3Y2			3A2	3A1
G	3Y3	3Y4	GND	GND	3A4	3A3
Н	4Y1	4Y2	V <sub>CC</sub>	V <sub>CC</sub>	4A2	4A1
J	4Y3	4Y4	GND	GND	4A4	4A3
K	4 <del>OE</del>	NC	NC	NC	NC	3 <del>OE</del>

#### (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
Α	1Y1	NC	1 <del>OE</del>	2 <del>OE</del>	NC	1A1
В	1Y3	1Y2	NC	NC	1A2	1A3
С	2Y1	1Y4	$V_{CC}$	V <sub>CC</sub>	1A4	2A1
D	2Y3	2Y2	GND	GND	2A2	2A3
E	3Y1	2Y4	GND	GND	2A4	3A1
F	3Y3	3Y2	GND	GND	3A2	3A3
G	4Y1	3Y4	$V_{CC}$	V <sub>CC</sub>	3A4	4A1
Н	4Y3	4Y2	NC	NC	4A2	4A3
J	4Y4	NC	4 <del>OE</del>	3 <del>OE</del>	NC	4A4

#### (1) NC - No internal connection

# FUNCTION TABLE (EACH 4-BIT BUFFER)

INP	UTS	OUTPUT
ŌĒ	Α	Y
L	Н	Н
L	L	L
Н	Χ	Z

23 4Y4



#### **LOGIC DIAGRAM (POSITIVE LOGIC)** 3<u>OE</u> 13 3Y1 3A1 3 1Y2 3A2 1A2 - 3Y2 16 3Y3 3A3 <del>3</del> 1A3 -17 3Y4 1A4 3A4 40E 2OE 19 4Y1 8 2Y1 30 9 20 4Y2 2A2 2Y2 22 4Y3 11 2Y3 2A3

26

Pin numbers shown are for the DGG and DL packages.

12

## Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range		-0.5	4.6	V
VI	Input voltage range <sup>(2)</sup>	voltage range <sup>(2)</sup> Control Inputs <sup>(3)</sup>		V <sub>CC</sub> + 0.5	V
		Data Inputs	-0.5	4.6	
Vo	Output voltage range <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
Io	Continuous output current			±50	mA
	Continuous current through each V <sub>CC</sub> or GNE	)		±100	mA
		DGG package		70	
	Decks as the real impedance (4)	DL package		63 42 36	
$\theta_{JA}$	Package thermal impedance <sup>(4)</sup>	GQL/ZQL package			
		GRD/ZRD package			
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	
$V_{CC}$	Supply voltage		1.65	3.6	V	
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>			
$V_{IH}$	High-level input voltage	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	1.7		V	
		$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$	2			
		$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$		$0.35 \times V_{CC}$		
$V_{IL}$	Low-level input voltage	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$		0.7	V	
		$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$		0.8		
V <sub>I</sub>	Input voltage	Control Inputs	0	$V_{CC}$	V	
۷۱	input voitage	Data Inputs	0	3.6	V	
Vo	Output voltage		0	$V_{CC}$	V	
		$V_{CC} = 1.65 \text{ V}$		-4		
	High-level output current	$V_{CC} = 2.3 \text{ V}$		-12	mA	
I <sub>OH</sub>	riigii-ievei output current	$V_{CC} = 2.7 \text{ V}$		-12		
		$V_{CC} = 3 V$		-24		
		V <sub>CC</sub> = 1.65 V		4		
	Low level output ourrent	V <sub>CC</sub> = 2.3 V		12	mΛ	
I <sub>OL</sub>	Low-level output current	V <sub>CC</sub> = 2.7 V	12		mA	
		V <sub>CC</sub> = 3 V		24		
Δt/Δν	Input transition rise or fall rate			10	ns/V	
T <sub>A</sub>	Operating free-air temperature		-40	85	°C	

<sup>(1)</sup> 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)

PARAMET	TER	TEST COM	NDITIONS	V <sub>CC</sub>	MIN	TYP <sup>(1)</sup>	MAX	UNIT	
		$I_{OH} = -100 \mu A$		1.65 V to 3.6 V	V <sub>CC</sub> - 0.2				
		$I_{OH} = -4 \text{ mA}$		1.65 V	1.2				
		$I_{OH} = -6 \text{ mA}$		2.3 V	2				
V <sub>OH</sub>	$V_{OH}$			2.3 V	1.7			V	
		$I_{OH} = -12 \text{ mA}$	$I_{OH} = -12 \text{ mA}$						
			3 V	2.4					
	I <sub>OH</sub> = -24 mA	3 V	2						
	I <sub>OL</sub> = 100 μA	1.65 V to 3.6 V			0.2				
		I <sub>OL</sub> = 4 mA	1.65 V			0.45			
.,		I <sub>OL</sub> = 6 mA	2.3 V			0.4			
V <sub>OL</sub>		1 40 4	2.3 V			0.7	V		
		I <sub>OL</sub> = 12 mA	2.7 V			0.4			
		I <sub>OL</sub> = 24 mA		3 V			0.55		
I <sub>I</sub>		$V_I = V_{CC}$ or GND		3.6 V			±5	μΑ	
I <sub>OZ</sub>		$V_O = V_{CC}$ or GND		3.6 V			±10	μΑ	
I <sub>CC</sub>		$V_I = V_{CC}$ or GND,	I <sub>O</sub> = 0	3.6 V			40	μΑ	
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	μΑ	
Control	inputs	V V or CND		2.2.1/		3		~F	
C <sub>i</sub> Data inp	outs	$V_I = V_{CC}$ or GND	3.3 V		6		pF		

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

**SN74ALVC16244A** 



### **Electrical Characteristics (continued)**

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

F	PARAMETER TEST CONDITIONS		V <sub>cc</sub>	MIN TYP(1) MAX	UNIT
Co	Outputs	$V_O = V_{CC}$ or GND	3.3 V	7	pF

### **Switching Characteristics**

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

PARAMETER	FROM	TO (OUTPUT)	V <sub>CC</sub> = 1.8 V	V <sub>CC</sub> = ± 0.	2.5 V 2 V	V <sub>CC</sub> =	2.7 V	V <sub>CC</sub> = ± 0.	3.3 V 3 V	UNIT
	(INPUT)	(INPUT) (OUTPUT)	TYP	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>pd</sub>	А	Y	(1)	1	3.7		3.6	1	3	ns
t <sub>en</sub>	ŌĒ	Y	(1)	1	5.7		5.4	1	4.4	ns
t <sub>dis</sub>	ŌĒ	Υ	(1)	1	5.2		4.6	1	4.1	ns

<sup>(1)</sup> This information was not available at the time of publication.

## **Operating Characteristics**

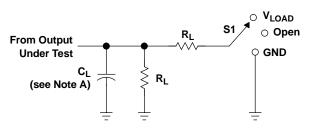
 $T_A = 25^{\circ}C$ 

	PARAMETE	R	TEST CONDITIONS	V <sub>CC</sub> = 1.8 V TYP	V <sub>CC</sub> = 2.5 V TYP	V <sub>CC</sub> = 3.3 V TYP	UNIT
0	Power dissipation	Outputs enabled	C F0 pF f 40 MHz	(1)	16	19	pF
$C_{pd}$	capacitance	Outputs disabled	$C_L = 50 \text{ pF, f} = 10 \text{ MHz}$	(1)	4	5	þΕ

<sup>(1)</sup> This information was not available at the time of publication.



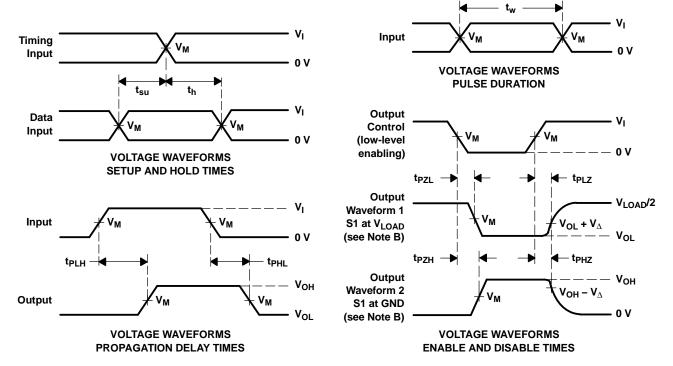
## PARAMETER MEASUREMENT INFORMATION



TEST	S1
t <sub>pd</sub>	Open
t <sub>PLZ</sub> /t <sub>PZL</sub>	V <sub>LOAD</sub>
t <sub>PHZ</sub> /t <sub>PZH</sub>	GND

**LOAD CIRCUIT** 

v	INPUT		V	v	•	_	V
V <sub>CC</sub>	VI	t <sub>r</sub> /t <sub>f</sub>	V <sub>M</sub>	V <sub>LOAD</sub>	CL	R <sub>L</sub>	$V_\Delta$
1.8 V	V <sub>CC</sub>	≤2 ns	V <sub>CC</sub> /2	2×V <sub>CC</sub>	30 pF	<b>1 k</b> Ω	0.15 V
2.5 V $\pm$ 0.2 V	V <sub>CC</sub>	≤2 ns	V <sub>CC</sub> /2	2×V <sub>CC</sub>	30 pF	500 Ω	0.15 V
2.7 V	2.7 V	≤2.5 ns	1.5 V	6 V	50 pF	500 Ω	0.3 V
3.3 V $\pm$ 0.3 V	2.7 V	≤2.5 ns	1.5 V	6 V	50 pF	<b>500</b> Ω	0.3 V



NOTES: A. C<sub>L</sub> 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 MHz,  $Z_0 = 50 \ \Omega$ .
- 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<sub>PZL</sub> and t<sub>PZH</sub> are the same as t<sub>en</sub>.
- G. t<sub>PLH</sub> and t<sub>PHL</sub> are the same as t<sub>pd</sub>.
- H. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms





10-Jun-2014

#### PACKAGING INFORMATION

Orderable Device	Status	Package Type	Package Drawing	Pins	_		Lead/Ball Finish	MSL Peak Temp	Op Temp (°C)	Device Marking	Samples
	(1)				Qty	(2)	(6)	(3)		(4/5)	
74ALVC16244ADGGRE4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVC16244A	Samples
SN74ALVC16244ADGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVC16244A	Samples
SN74ALVC16244ADGGRE4	ACTIVE	TSSOP	DGG	48		TBD	Call TI	Call TI	-40 to 85		Samples
SN74ALVC16244ADL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVC16244A	Samples
SN74ALVC16244ADLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVC16244A	Samples
SN74ALVC16244ADLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVC16244A	Samples
SN74ALVC16244AGQLR	OBSOLETE	BGA MICROSTAR JUNIOR	GQL	56		TBD	Call TI	Call TI	-40 to 85		
SN74ALVC16244AGRDR	OBSOLETE	BGA MICROSTAR JUNIOR	GRD	54		TBD	Call TI	Call TI	-40 to 85		
SN74ALVC16244AZQLR	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	VC244A	Samples

<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.

**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.

<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.



## **PACKAGE OPTION ADDENDUM**

10-Jun-2014

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) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.
- (5) Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.
- (6) Lead/Ball Finish Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

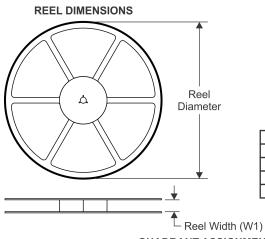
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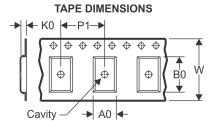
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## PACKAGE MATERIALS INFORMATION

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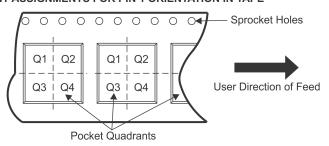
### TAPE AND REEL INFORMATION





_		
		Dimension designed to accommodate the component width
		Dimension designed to accommodate the component length
		Dimension designed to accommodate the component thickness
	W	Overall width of the carrier tape
Γ	P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



#### \*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74ALVC16244ADGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1
SN74ALVC16244ADLR	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1
SN74ALVC16244AZQLR	BGA MI CROSTA R JUNI OR	ZQL	56	1000	330.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1

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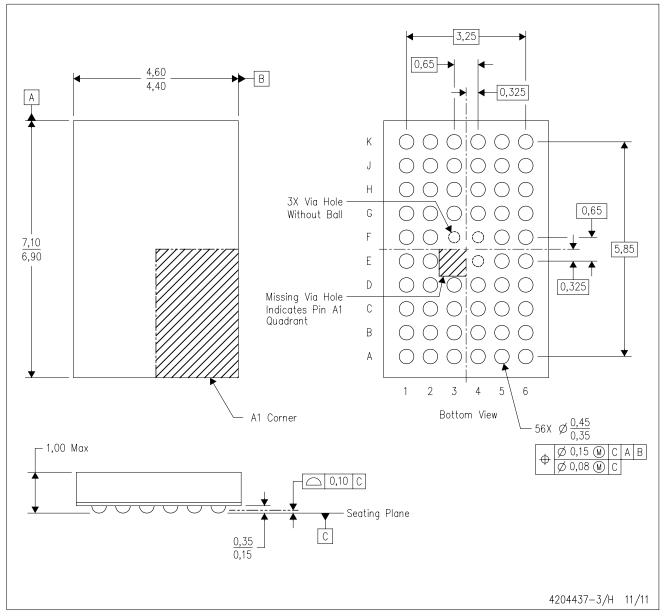


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ALVC16244ADGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
SN74ALVC16244ADLR	SSOP	DL	48	1000	367.0	367.0	55.0
SN74ALVC16244AZQLR	BGA MICROSTAR JUNIOR	ZQL	56	1000	336.6	336.6	28.6

# ZQL (R-PBGA-N56)

### PLASTIC BALL GRID ARRAY



NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.

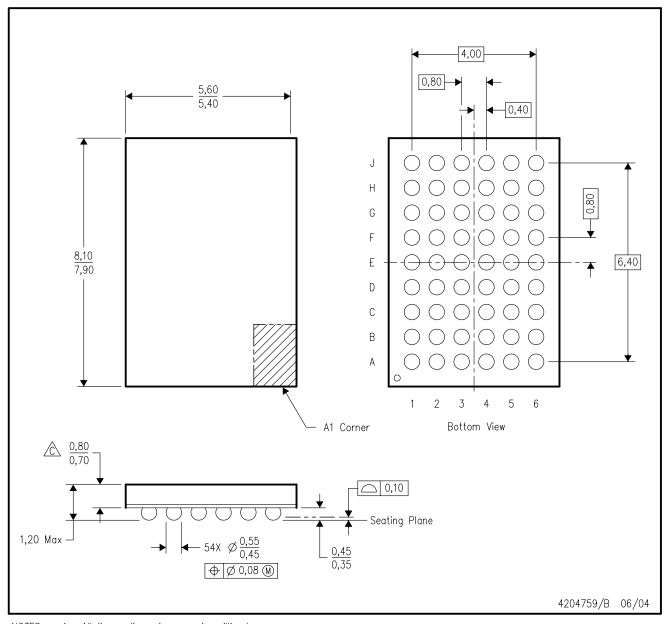
- B. This drawing is subject to change without notice.
- C. Falls within JEDEC MO-285 variation BA-2.
- D. This package is Pb-free. Refer to the 56 GQL package (drawing 4200583) for tin-lead (SnPb).

MicroStar Junior is a trademark of Texas Instruments



# GRD (R-PBGA-N54)

# PLASTIC BALL GRID ARRAY



 $\hbox{NOTES:} \quad \hbox{A. All linear dimensions are in millimeters.}$ 

B. This drawing is subject to change without notice.

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.



# DL (R-PDSO-G48)

# PLASTIC SMALL-OUTLINE PACKAGE



NOTES:

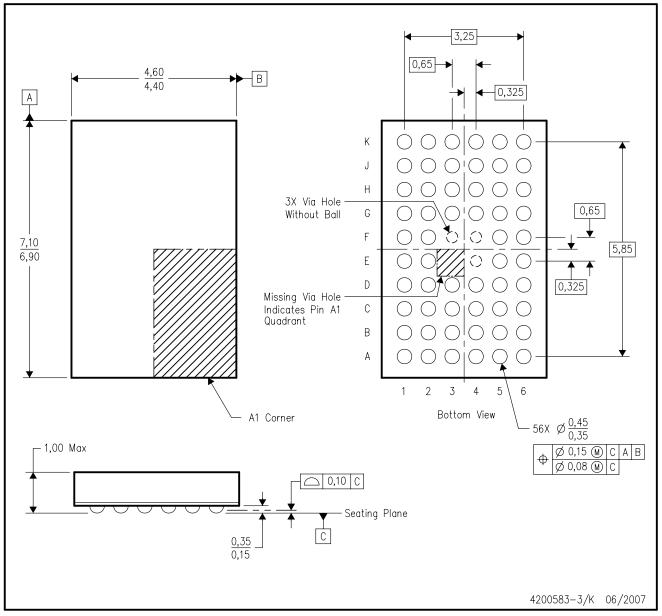
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
- D. Falls within JEDEC MO-118

PowerPAD is a trademark of Texas Instruments.



# 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.



### 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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