

## FEATURES

- Member of the Texas Instruments Widebus™ Family
- DOC™ (Dynamic Output Control) Circuit Dynamically Changes Output Impedance, Resulting in Noise Reduction Without Speed Degradation
- Less Than 2-ns Maximum Propagation Delay at 2.5-V and 3.3-V  $V_{CC}$
- Dynamic Drive Capability Is Equivalent to Standard Outputs With  $I_{OH}$  and  $I_{OL}$  of  $\pm 24$  mA at 2.5-V  $V_{CC}$
- Overtolerance-Tolerant Inputs/Outputs Allow Mixed-Voltage-Mode Data Communications
- $I_{off}$  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)
  - 200-V Machine Model (A115-A)

## DESCRIPTION/ORDERING INFORMATION

A Dynamic Output Control (DOC) circuit is implemented, which, during the transition, initially lowers the output impedance to effectively drive the load and, subsequently, raises the impedance to reduce noise. Figure 1 shows typical  $V_{OL}$  vs  $I_{OL}$  and  $V_{OH}$  vs  $I_{OH}$  curves to illustrate the output impedance and drive capability of the circuit. At the beginning of the signal transition, the DOC circuit provides a maximum dynamic drive that is equivalent to a high-drive standard-output device. For more information, refer to the TI application reports, *AVC Logic Family Technology and Applications*, literature number SCEA006, and *Dynamic Output Control (DOC™) Circuitry Technology and Applications*, literature number SCEA009.

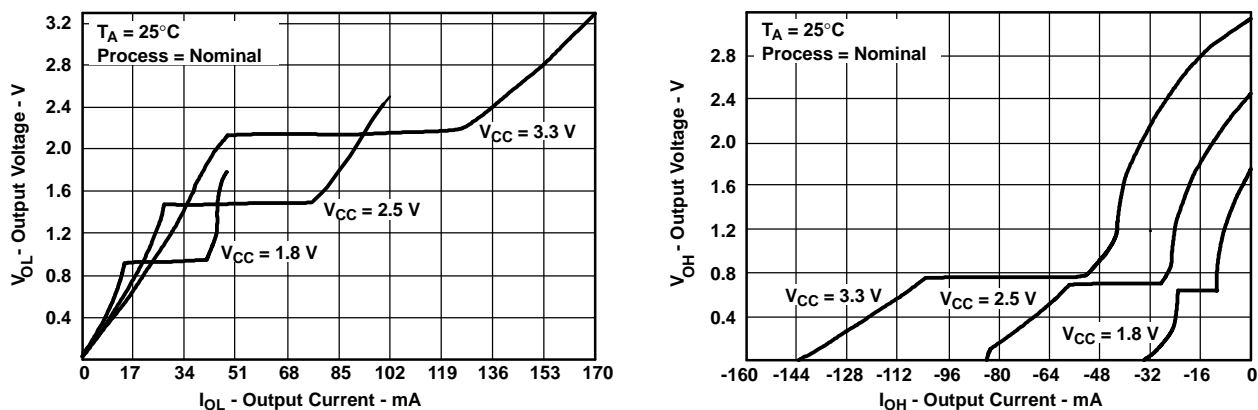


Figure 1. Output Voltage vs Output Current

## ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	TSSOP – DGG	Tape and reel	SN74AVC16244DGGR	AVC16244
	TVSOP – DGV	Tape and reel	SN74AVC16244DGVR	CVA244
	VFBGA – GQL	Tape and reel	SN74AVC16244GQLR	CVA244
	VFBGA – ZQL (Pb-free)		SN74AVC16244ZQLR	

(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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**SN74AVC16244**  
**16-BIT BUFFER/DRIVER**  
**WITH 3-STATE OUTPUTS**

SCES141N–JULY 1998–REVISED MARCH 2005

**DESCRIPTION/ORDERING INFORMATION (CONTINUED)**

This 16-bit buffer/driver is operational at 1.2-V to 3.6-V  $V_{CC}$ , but is designed specifically for 1.65-V to 3.6-V  $V_{CC}$  operation.

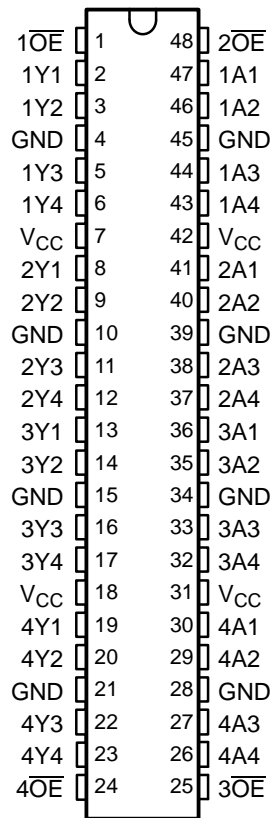
The SN74AVC16244 is designed specifically to improve the performance and density of 3-state memory address drivers, clock drivers, and bus-oriented receivers and transmitters.

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.

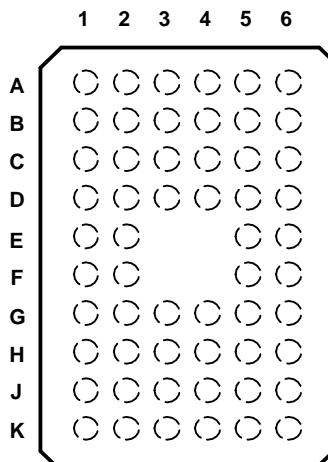
This device is fully specified for partial-power-down applications using  $I_{off}$ . The  $I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

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.

**DGG OR DGV PACKAGE**  
**(TOP VIEW)**



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



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

	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

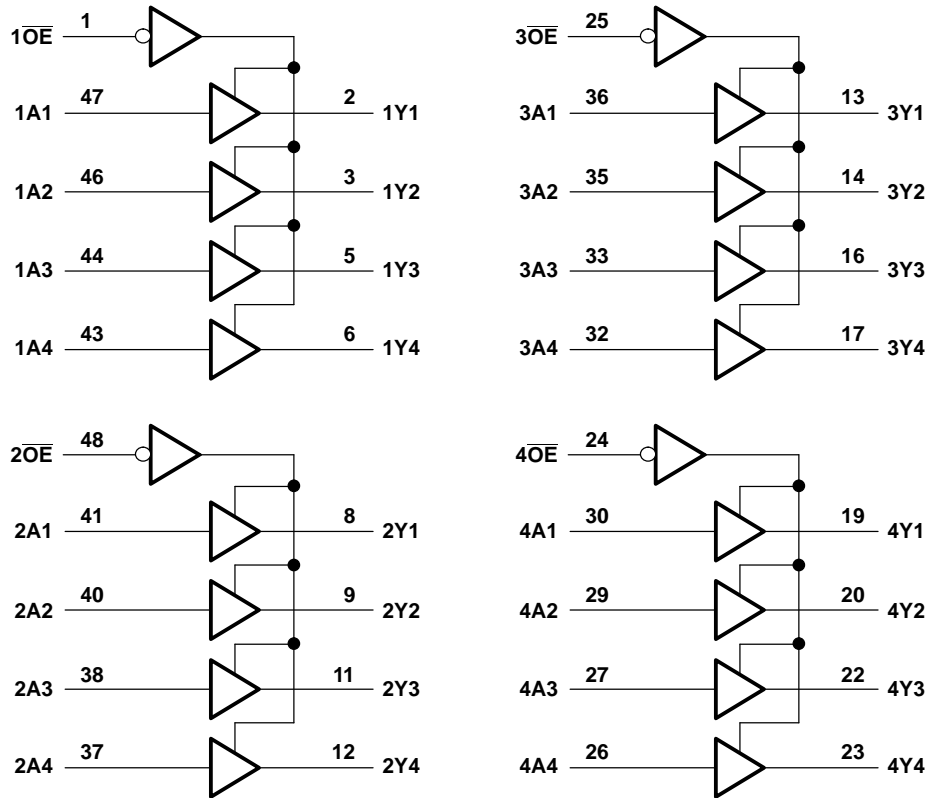
**FUNCTION TABLE  
(EACH 4-BIT BUFFER)**

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

**SN74AVC16244**  
**16-BIT BUFFER/DRIVER**  
**WITH 3-STATE OUTPUTS**

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**LOGIC DIAGRAM (POSITIVE LOGIC)**



**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	4.6	V
$V_O$	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>	-0.5	4.6	V
$V_O$	Voltage range applied to any output in the high or low state <sup>(2)(3)</sup>	-0.5	$V_{CC} + 0.5$	V
$I_{IK}$	Input clamp current	$V_I < 0$	-50	mA
$I_{OK}$	Output clamp current	$V_O < 0$	-50	mA
$I_O$	Continuous output current		±50	mA
	Continuous current through each $V_{CC}$ or GND		±100	mA
$\theta_{JA}$	Package thermal impedance <sup>(4)</sup>	DGG package	70	°C/W
		DGV package	58	
		GQL/ZQL package	42	
$T_{stg}$	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 current ratings are observed.
- (3) The output positive-voltage rating may be exceeded up to 4.6 V maximum if the output current rating is observed.
- (4) The package thermal impedance is calculated in accordance with JESD 51.

**Recommended Operating Conditions<sup>(1)</sup>**

		MIN	MAX	UNIT	
V <sub>CC</sub>	Supply voltage	Operating	1.4	3.6	V
		Data retention only	1.2		
V <sub>IH</sub>	High-level input voltage	V <sub>CC</sub> = 1.2 V	V <sub>CC</sub>		V
		V <sub>CC</sub> = 1.4 V to 1.6 V	0.65 × V <sub>CC</sub>		
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>		
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.7		
		V <sub>CC</sub> = 3 V to 3.6 V	2		
V <sub>IL</sub>	Low-level input voltage	V <sub>CC</sub> = 1.2 V	GND		V
		V <sub>CC</sub> = 1.4 V to 1.6 V	0.35 × V <sub>CC</sub>		
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.35 × V <sub>CC</sub>		
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.7		
		V <sub>CC</sub> = 3 V to 3.6 V	0.8		
V <sub>I</sub>	Input voltage	0	3.6	V	
V <sub>O</sub>	Output voltage	Active state	0	V <sub>CC</sub>	V
		3-state	0	3.6	
I <sub>OHS</sub>	Static high-level output current <sup>(2)</sup>	V <sub>CC</sub> = 1.4 V to 1.6 V	–2		mA
		V <sub>CC</sub> = 1.65 V to 1.95 V	–4		
		V <sub>CC</sub> = 2.3 V to 2.7 V	–8		
		V <sub>CC</sub> = 3 V to 3.6 V	–12		
I <sub>OLS</sub>	Static low-level output current <sup>(2)</sup>	V <sub>CC</sub> = 1.4 V to 1.6 V	2		mA
		V <sub>CC</sub> = 1.65 V to 1.95 V	4		
		V <sub>CC</sub> = 2.3 V to 2.7 V	8		
		V <sub>CC</sub> = 3 V to 3.6 V	12		
Δt/Δv	Input transition rise or fall rate	V <sub>CC</sub> = 1.4 V to 3.6 V		5	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.

(2) Dynamic drive capability is equivalent to standard outputs with I<sub>OH</sub> and I<sub>OL</sub> of ±24 mA at 2.5-V V<sub>CC</sub>. See Figure 1 for V<sub>OL</sub> vs I<sub>OL</sub> and V<sub>OH</sub> vs I<sub>OH</sub> characteristics. Refer to the TI application reports, *AVC Logic Family Technology and Applications*, literature number SCEA006, and *Dynamic Output Control (DOC™) Circuitry Technology and Applications*, literature number SCEA009.

**SN74AVC16244**  
**16-BIT BUFFER/DRIVER**  
**WITH 3-STATE OUTPUTS**



SCES141N–JULY 1998–REVISED MARCH 2005

**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>OHS</sub> = -100 μA	1.4 V to 3.6 V	V <sub>CC</sub> - 0.2			V
		I <sub>OHS</sub> = -2 mA, V <sub>IH</sub> = 0.91 V	1.4 V	1.05			
		I <sub>OHS</sub> = -4 mA, V <sub>IH</sub> = 1.07 V	1.65 V	1.2			
		I <sub>OHS</sub> = -8 mA, V <sub>IH</sub> = 1.7 V	2.3 V	1.75			
		I <sub>OHS</sub> = -12 mA, V <sub>IH</sub> = 2 V	3 V	2.3			
V <sub>OL</sub>		I <sub>OLS</sub> = 100 μA	1.4 V to 3.6 V			0.2	V
		I <sub>OLS</sub> = 2 mA, V <sub>IL</sub> = 0.49 V	1.4 V			0.4	
		I <sub>OLS</sub> = 4 mA, V <sub>IL</sub> = 0.57 V	1.65 V			0.45	
		I <sub>OLS</sub> = 8 mA, V <sub>IL</sub> = 0.7 V	2.3 V			0.55	
		I <sub>OLS</sub> = 12 mA, V <sub>IL</sub> = 0.8 V	3 V			0.7	
I <sub>I</sub>		V <sub>I</sub> = V <sub>CC</sub> or GND	3.6 V			±2.5	μA
I <sub>off</sub>		V <sub>I</sub> or V <sub>O</sub> = 3.6 V	0			±10	μA
I <sub>OZ</sub>		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			40	μA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	2.5 V	3.5		pF	
			3.3 V	3.5			
	Data inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	2.5 V	6			
			3.3 V	6			
C <sub>O</sub>	Outputs	V <sub>O</sub> = V <sub>CC</sub> or GND	2.5 V	6.5		pF	
			3.3 V	6.5			

(1) Typical values are measured at T<sub>A</sub> = 25°C.

**Switching Characteristics**

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

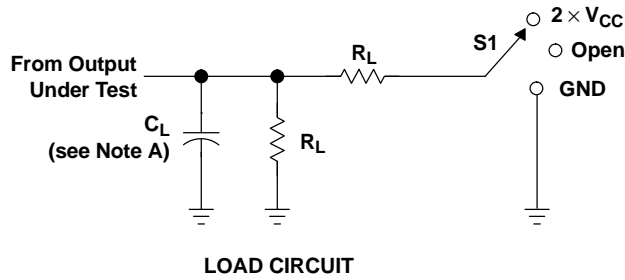
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 1.2 V		V <sub>CC</sub> = 1.5 V ± 0.1 V		V <sub>CC</sub> = 1.8 V ± 0.15 V		V <sub>CC</sub> = 2.5 V ± 0.2 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
t <sub>pd</sub>	A	Y	3.1	0.6	3.3	0.7	2.9	0.6	1.9	0.5	1.7	ns	
t <sub>en</sub>	$\overline{OE}$	Y	7.6	1.4	8	1.3	6.8	0.9	4	0.7	3.5	ns	
t <sub>dis</sub>	$\overline{OE}$	Y	7.2	1.7	7.3	1.6	6.2	1	4.3	1	3.5	ns	

**Operating Characteristics**

T<sub>A</sub> = 25°C

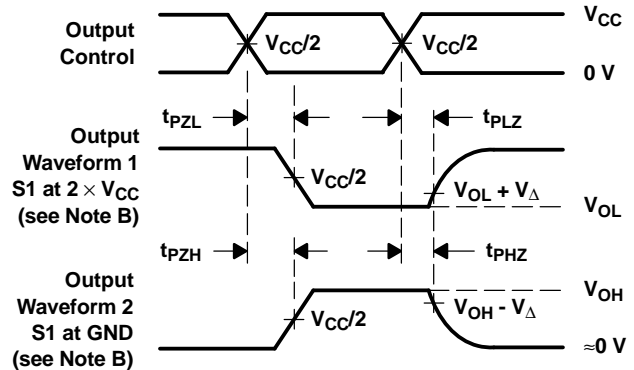
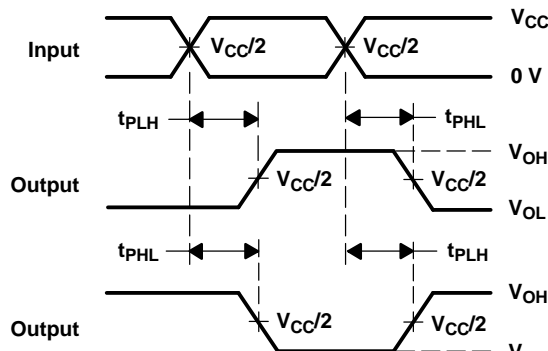
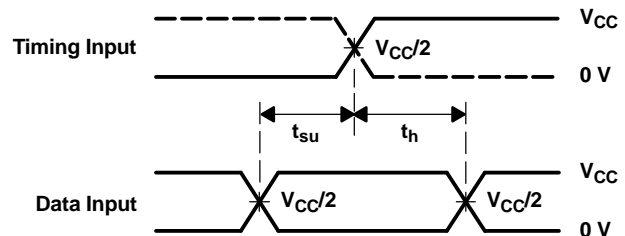
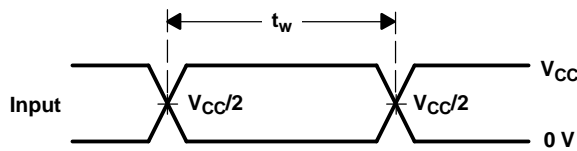
PARAMETER		TEST CONDITIONS	V <sub>CC</sub> = 1.8 V	V <sub>CC</sub> = 2.5 V	V <sub>CC</sub> = 3.3 V	UNIT	
			TYP	TYP	TYP		
C <sub>pd</sub>	Power dissipation capacitance	Outputs enabled	C <sub>L</sub> = 0, f = 10 MHz	23	27	33	pF
		Outputs disabled		0.1	0.1	0.1	

PARAMETER MEASUREMENT INFORMATION



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

$V_{CC}$	$C_L$	$R_L$	$V_{\Delta}$
1.2 V	15 pF	2 k $\Omega$	0.1 V
1.5 V $\pm$ 0.1 V	15 pF	2 k $\Omega$	0.1 V
1.8 V $\pm$ 0.15 V	30 pF	1 k $\Omega$	0.15 V
2.5 V $\pm$ 0.2 V	30 pF	500 $\Omega$	0.15 V
3.3 V $\pm$ 0.3 V	30 pF	500 $\Omega$	0.3 V



- 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 MHz,  $Z_O = 50 \Omega$ , slew rate  $\geq$  1 V/ns.
  - The outputs are measured one at a time, with one transition per measurement.
  - $t_{PZL}$  and  $t_{PZH}$  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 2. Load Circuit and Voltage Waveforms

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74AVC16244DGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16244	<a href="#">Samples</a>
SN74AVC16244DGVR	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CVA244	<a href="#">Samples</a>
SN74AVC16244ZQLR	LIFEBUY	BGA MICROSTAR JUNIOR	ZQL	56	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	CVA244	

(1) 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.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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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## TAPE AND REEL INFORMATION



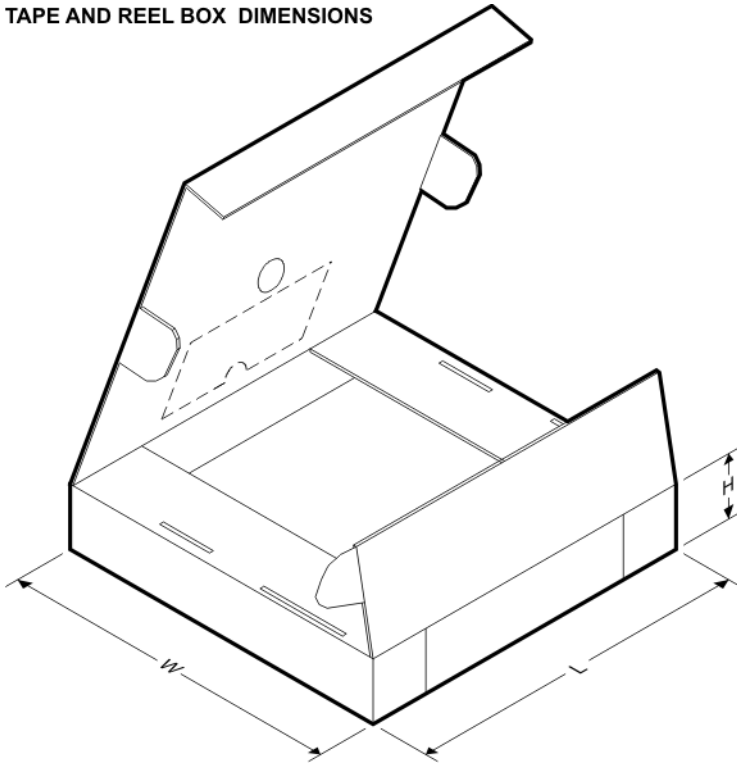
### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*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
SN74AVC16244DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74AVC16244DGVR	TVSOP	DGV	48	2000	330.0	16.4	7.1	10.2	1.6	12.0	16.0	Q1
SN74AVC16244ZQLR	BGA MICROSTAR JUNIOR	ZQL	56	1000	330.0	16.4	4.8	7.3	1.5	8.0	16.0	Q1

## TAPE AND REEL BOX DIMENSIONS



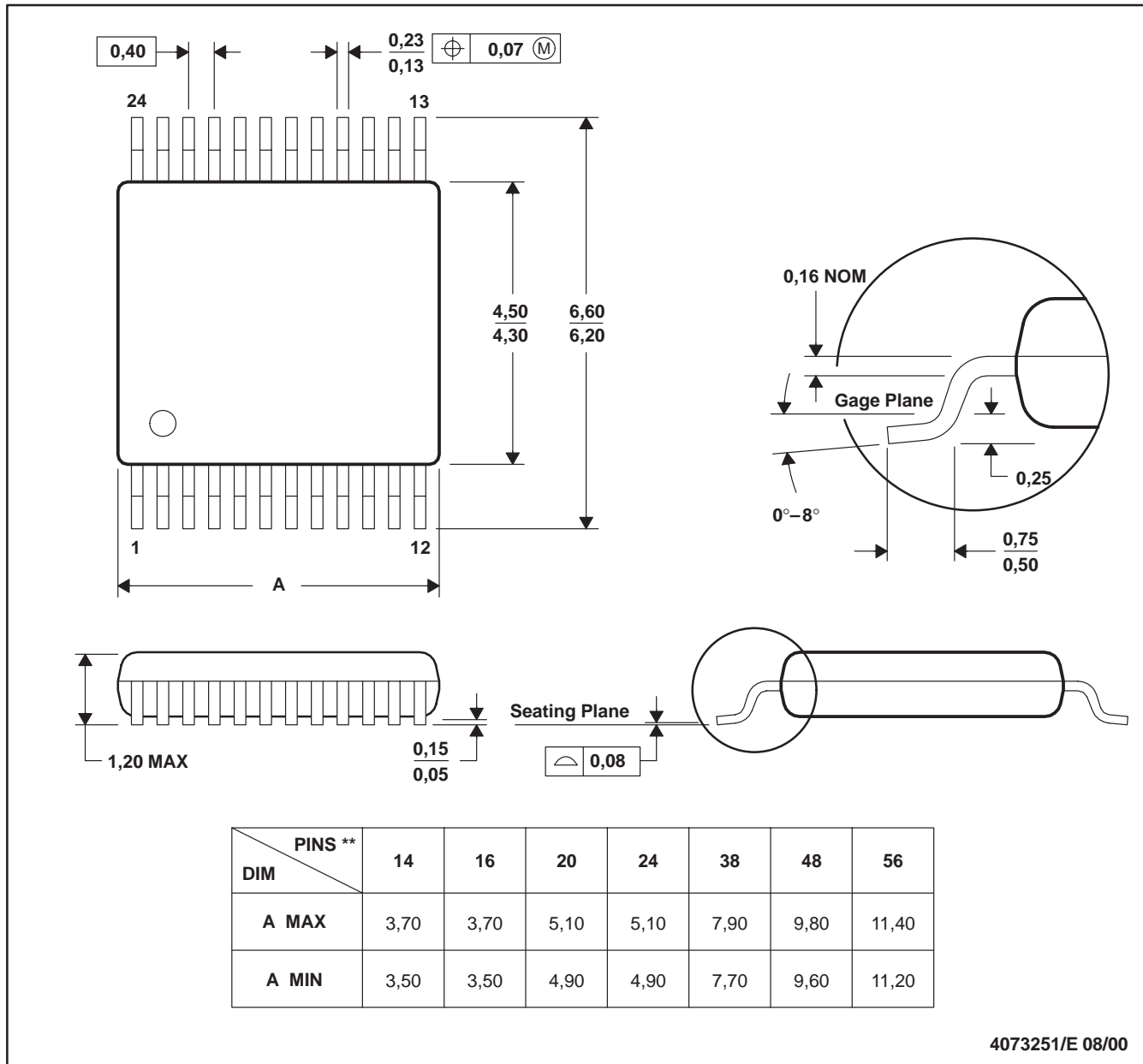
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AVC16244DGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
SN74AVC16244DGVR	TVSOP	DGV	48	2000	367.0	367.0	38.0
SN74AVC16244ZQLR	BGA MICROSTAR JUNIOR	ZQL	56	1000	350.0	350.0	43.0

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

PLASTIC SMALL-OUTLINE

24 PINS SHOWN

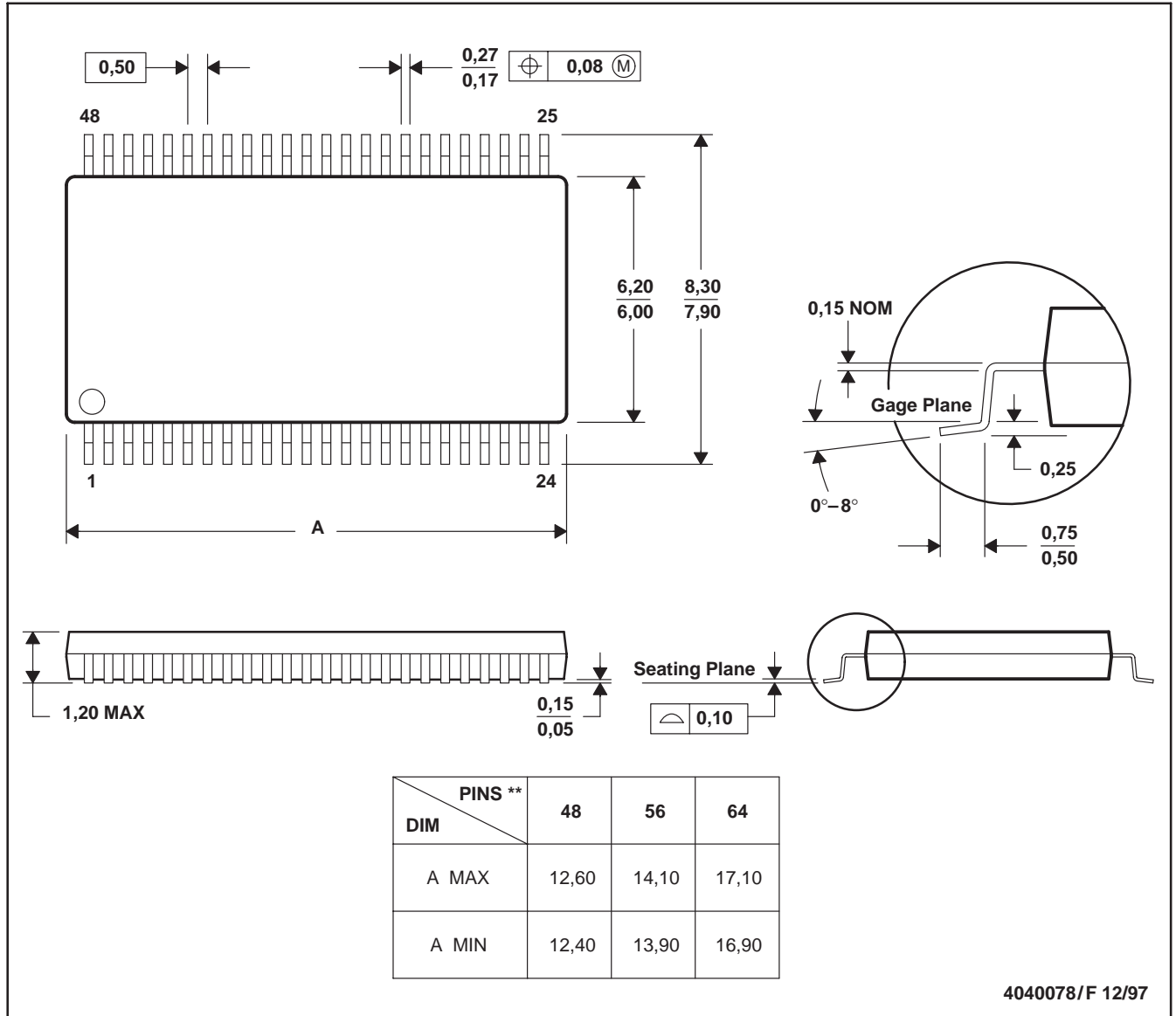


- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.  
 D. Falls within JEDEC: 24/48 Pins – MO-153  
 14/16/20/56 Pins – MO-194

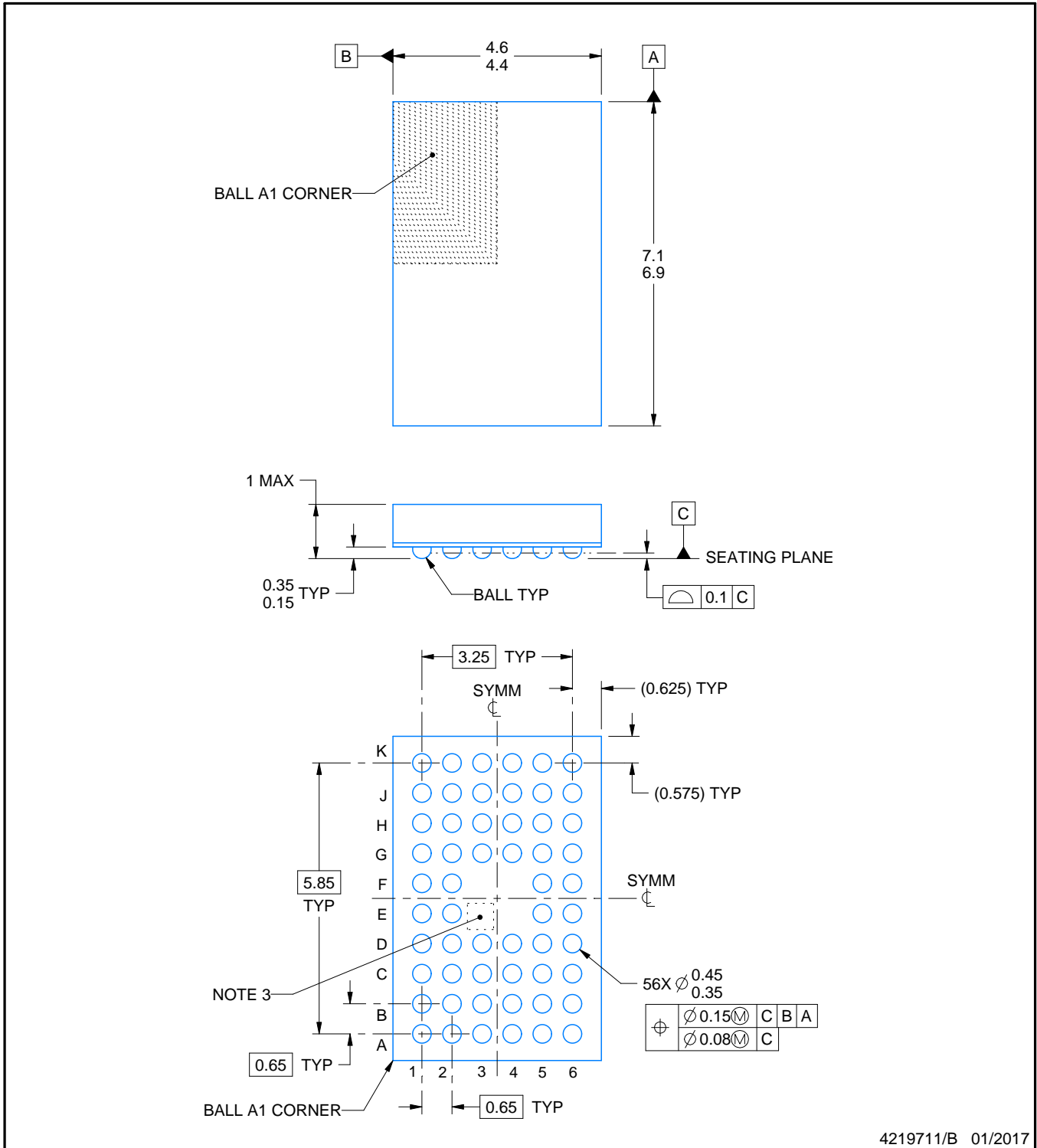
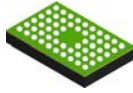
DGG (R-PDSO-G\*\*)

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



4219711/B 01/2017

NOTES:

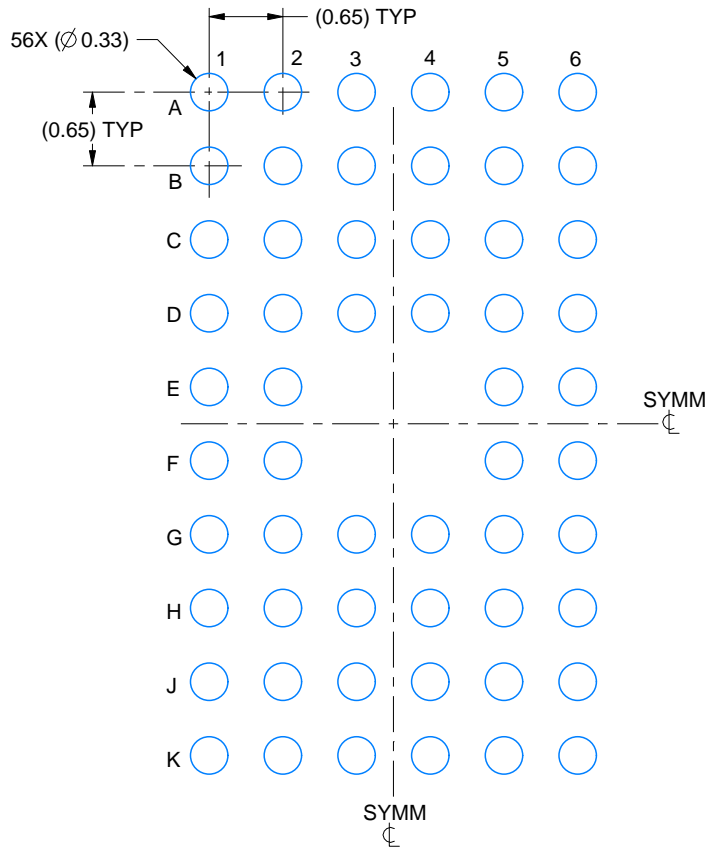
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. No metal in this area, indicates orientation.

# EXAMPLE BOARD LAYOUT

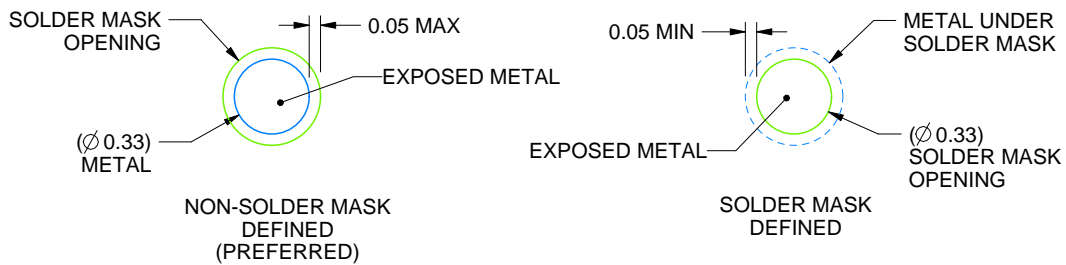
ZQL0056A

JRBGA - 1 mm max height

PLASTIC BALL GRID ARRAY



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS  
NOT TO SCALE

4219711/B 01/2017

NOTES: (continued)

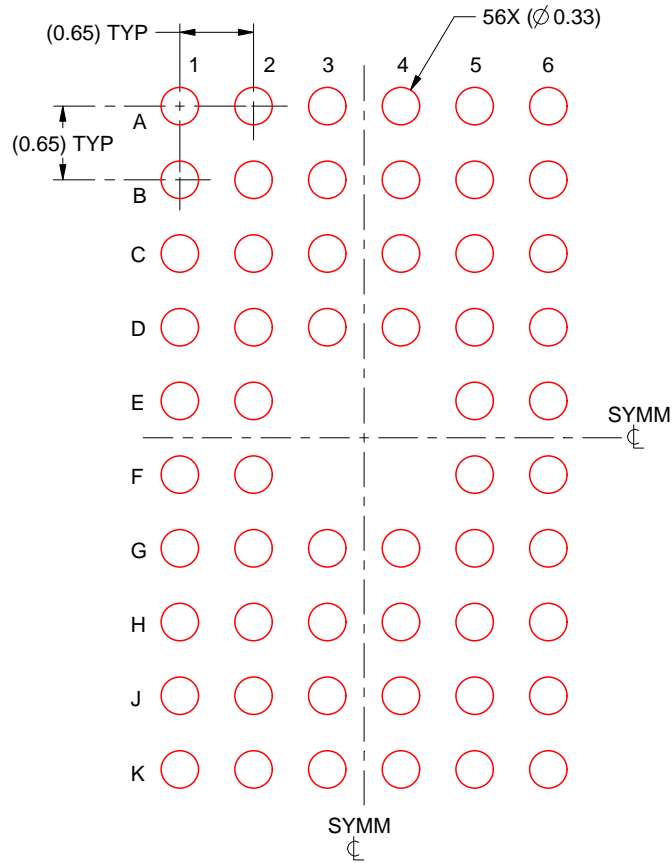
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For information, see Texas Instruments literature number SPRAA99 ([www.ti.com/lit/spraa99](http://www.ti.com/lit/spraa99)).

# EXAMPLE STENCIL DESIGN

ZQL0056A

JRBGA - 1 mm max height

PLASTIC BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4219711/B 01/2017

NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.



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