Jameco Part Number 918129

![Texas Instruments logo] **TEXAS INSTRUMENTS**
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SN74LVC16244A
16-BIT BUFFER/DRIVER
WITH 3-STATE OUTPUTS
SCAS699A – AUGUST 2003 – REVISED OCTOBER 2005

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 4.1 ns at 3.3 V**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at V_{CC} = 3.3 V, T_A = 25°C**
- **Typical V_{OHV} (Output V_{OH} Undershoot) >2 V at V_{CC} = 3.3 V, T_A = 25°C**
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V V_{CC})**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **ESD Protection Exceeds JESD 22**
    - **2000-V Human-Body Model (A114-A)**
    - **1000-V Charged-Device Model (C101)**
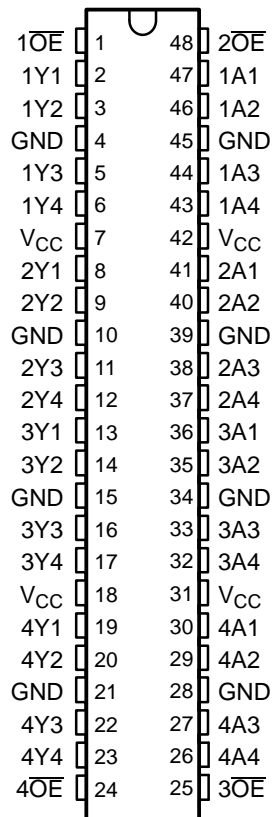
DESCRIPTION/ORDERING INFORMATION

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

The SN74LVC16244A is designed specifically to improve the performance and density of 3-state memory address drivers, clock drivers, and bus-oriented receivers and transmitters.

DGG, DGV, OR DL PACKAGE
(TOP VIEW)

1$\overline{OE}$	1		48	2$\overline{OE}$
1Y1	2		47	1A1
1Y2	3		46	1A2
GND	4		45	GND
1Y3	5		44	1A3
1Y4	6		43	1A4
V_{CC}	7		42	V_{CC}
2Y1	8		41	2A1
2Y2	9		40	2A2
GND	10		39	GND
2Y3	11		38	2A3
2Y4	12		37	2A4
3Y1	13		36	3A1
3Y2	14		35	3A2
GND	15		34	GND
3Y3	16		33	3A3
3Y4	17		32	3A4
V_{CC}	18		31	V_{CC}
4Y1	19		30	4A1
4Y2	20		29	4A2
GND	21		28	GND
4Y3	22		27	4A3
4Y4	23		26	4A4
4$\overline{OE}$	24		25	3$\overline{OE}$

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.

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.

ORDERING INFORMATION

T_A	PACKAGE[1]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	FBGA – GRD	Tape and reel	SN74LVC16244AGRDR	LD244A
	FBGA – ZRD (Pb-free)		SN74LVC16244AZRDR	
	SSOP – DL	Tube	SN74LVC16244ADL	LVC16244A
		Tape and reel	SN74LVC16244ADLR	
	TSSOP – DGG	Tape and reel	SN74LVC16244ADGGR	LVC16244A
			74LVC16244ADGGRG4	
	TVSOP – DGV	Tape and reel	SN74LVC16244ADGVR	LD244A
			74LVC16244ADGVRE4	
	VFBGA – GQL	Tape and reel	SN74LVC16244AGQLR	LD244A

(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.

Widebus is a trademark of Texas Instruments.

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

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.
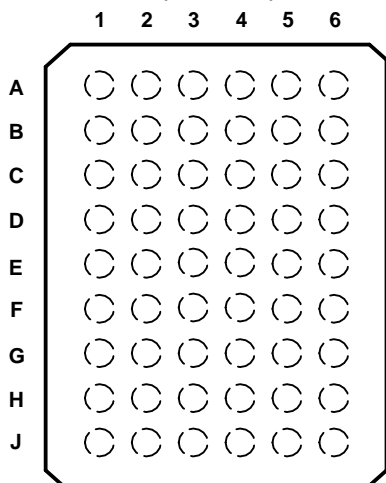
GQL OR ZQL PACKAGE
(TOP VIEW)
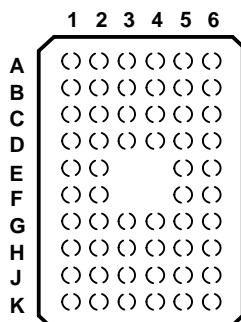
TERMINAL ASSIGNMENTS[1]
(56-Ball GQL Package)

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

(1) NC – No internal connection

GRD OR ZRD PACKAGE
(TOP VIEW)

TERMINAL ASSIGNMENTS[1]
(54-Ball GRD/ZRD Package)

	1	2	3	4	5	6
A	1Y1	NC	1$\overline{OE}$	2$\overline{OE}$	NC	1A1
B	1Y3	1Y2	NC	NC	1A2	1A3
C	2Y1	1Y4	V_{CC}	V_{CC}	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_{CC}	3A4	4A1
H	4Y3	4Y2	NC	NC	4A2	4A3
J	4Y4	NC	4$\overline{OE}$	3$\overline{OE}$	NC	4A4

(1) NC – No internal connection

FUNCTION TABLE
(EACH 4-BIT BUFFER)

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

2

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LOGIC DIAGRAM (POSITIVE LOGIC)
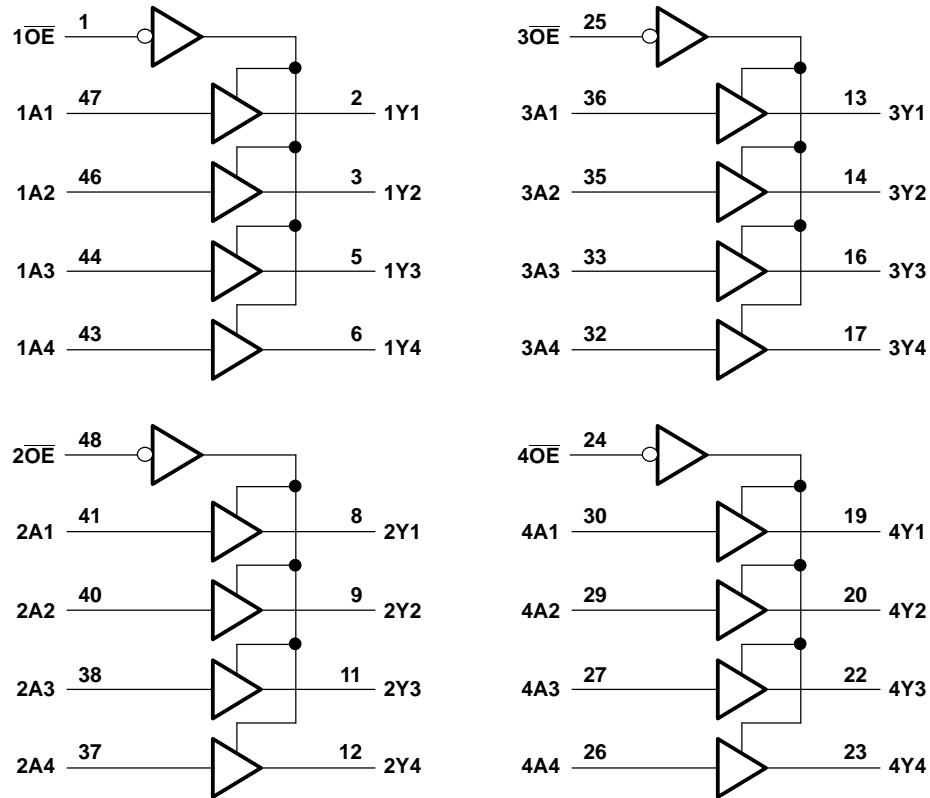
Pin numbers shown are for the DGG, DGV, and DL packages.

Absolute Maximum Ratings[(1)]

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		−0.5	6.5	V
V_I	Input voltage range[(2)]		−0.5	6.5	V
V_O	Voltage range applied to any output in the high-impedance or power-off state[(2)]		−0.5	6.5	V
V_O	Voltage range applied to any output in the high or low state[(2)] [(3)]		−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
θ_{JA}	Package thermal impedance[(4)]	DGG package		70	°C/W
		DGV package		58	
		DL package		63	
		GQL 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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
(3) 'The value of V_{CC} is provided in the recommended operating conditions table.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

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Recommended Operating Conditions[1]

			MIN	MAX	UNIT
V_{CC}	Supply voltage	Operating	1.65	3.6	V
		Data retention only	1.5		
V_{IH}	High-level input voltage	V_{CC} = 1.65 V to 1.95 V	$0.65 \times V_{CC}$		V
		V_{CC} = 2.3 V to 2.7 V	1.7		
		V_{CC} = 2.7 V to 3.6 V	2		
V_{IL}	Low-level input voltage	V_{CC} = 1.65 V to 1.95 V		$0.35 \times V_{CC}$	V
		V_{CC} = 2.3 V to 2.7 V		0.7	
		V_{CC} = 2.7 V to 3.6 V		0.8	
V_I	Input voltage		0	5.5	V
V_O	Output voltage	High or low state	0	V_{CC}	V
		3-state	0	5.5	
I_{OH}	High-level output current	V_{CC} = 1.65 V		−4	mA
		V_{CC} = 2.3 V		−8	
		V_{CC} = 2.7 V		−12	
		V_{CC} = 3 V		−24	
I_{OL}	Low-level output current	V_{CC} = 1.65 V		4	mA
		V_{CC} = 2.3 V		8	
		V_{CC} = 2.7 V		12	
		V_{CC} = 3 V		24	
$\Delta t/\Delta v$	Input transition rise or fall rate			10	ns/V
T_A	Operating free-air temperature		−40	85	°C

(1) 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.

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Electrical Characteristics

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

PARAMETER	TEST CONDITIONS		V_{CC}	MIN	TYP[1]	MAX	UNIT
V_{OH}	$I_{OH} = -100$ µA		1.65 V to 3.6 V	$V_{CC} - 0.2$			V
	$I_{OH} = -4$ mA		1.65 V	1.2			
	$I_{OH} = -8$ mA		2.3 V	1.7			
	$I_{OH} = -12$ mA		2.7 V	2.2			
			3 V	2.4			
	$I_{OH} = -24$ mA		3 V	2.2			
V_{OL}	$I_{OL} = 100$ µA		1.65 V to 3.6 V			0.2	V
	$I_{OL} = 4$ mA		1.65 V			0.45	
	$I_{OL} = 8$ mA		2.3 V			0.7	
	$I_{OL} = 12$ mA		2.7 V			0.4	
	$I_{OL} = 24$ mA		3 V			0.55	
I_I	$V_I = 0$ to 5.5 V		3.6 V			±5	µA
I_{off}	V_I or $V_O = 5.5$ V		0			±10	µA
I_{OZ}	$V_O = 0$ to 5.5 V		3.6 V			±10	µA
I_{CC}	$V_I = V_{CC}$ or GND	$I_O = 0$	3.6 V			20	µA
	$3.6\ V \le V_I \le 5.5\ V$[2]					20	
ΔI_{CC}	One input at $V_{CC} - 0.6$ V, Other inputs at V_{CC} or GND		2.7 V to 3.6 V			500	µA
C_i	$V_I = V_{CC}$ or GND		3.3 V		5.5		pF
C_o	$V_O = V_{CC}$ or GND		3.3 V		6		pF

(1)   All typical values are at $V_{CC} = 3.3$ V, $T_A = 25°C$.
(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)	$V_{CC} = 1.8$ V ± 0.15 V		$V_{CC} = 2.5$ V ± 0.2 V		$V_{CC} = 2.7$ V		$V_{CC} = 3.3$ V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{pd}	A	Y	1.5	6.6	1	3.9	1	4.7	1.1	4.1	ns
t_{en}	$\overline{OE}$	Y	1.5	7.5	1	4.7	1	5.8	1	4.6	ns
t_{dis}	$\overline{OE}$	Y	1.5	10.3	1	5.3	1	6.2	1.8	5.8	ns
$t_{sk(o)}$										1	ns

Operating Characteristics

$T_A = 25°C$

PARAMETER		TEST CONDITIONS	$V_{CC} = 1.8$ V TYP	$V_{CC} = 2.5$ V TYP	$V_{CC} = 3.3$ V TYP	UNIT
C_{pd}	Power dissipation capacitance per buffer/driver	Outputs enabled	33	35	39	pF
		Outputs disabled	2	3	4	
		f = 10 MHz				

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PARAMETER MEASUREMENT INFORMATION
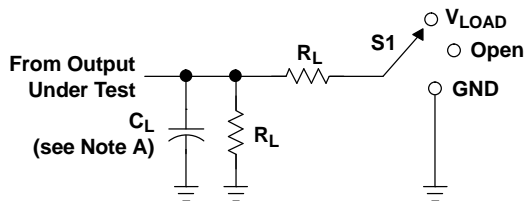
LOAD CIRCUIT

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

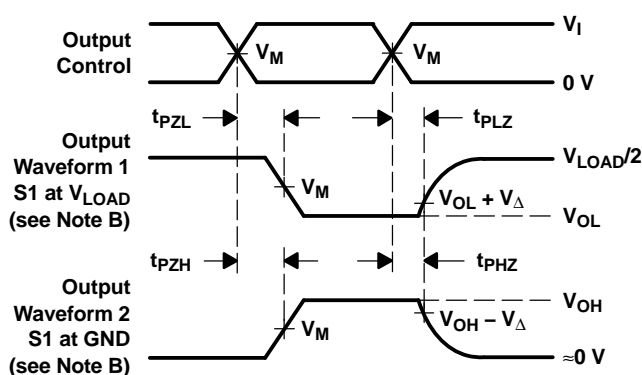| V_{CC}	INPUTS		V_M	V_{LOAD}	C_L	R_L	V_Δ
	V_I	t_r/t_f					
1.8 V ± 0.15 V	V_{CC}	≤2 ns	$V_{CC}/2$	2 × V_{CC}	30 pF	1 kΩ	0.15 V
2.5 V ± 0.2 V	V_{CC}	≤2 ns	$V_{CC}/2$	2 × V_{CC}	30 pF	500 Ω	0.15 V
2.7 V	2.7 V	≤2.5 ns	1.5 V	6 V	50 pF	500 Ω	0.3 V
3.3 V ± 0.3 V	2.7 V	≤2.5 ns	1.5 V	6 V	50 pF	500 Ω	0.3 V
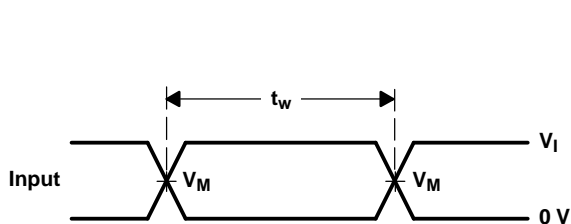
VOLTAGE WAVEFORMS
PULSE DURATION
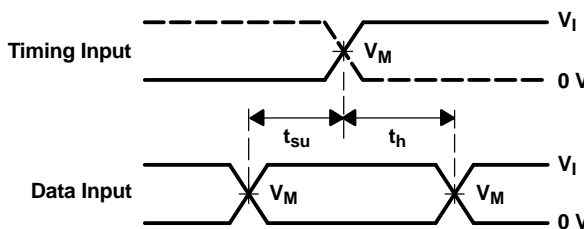
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES
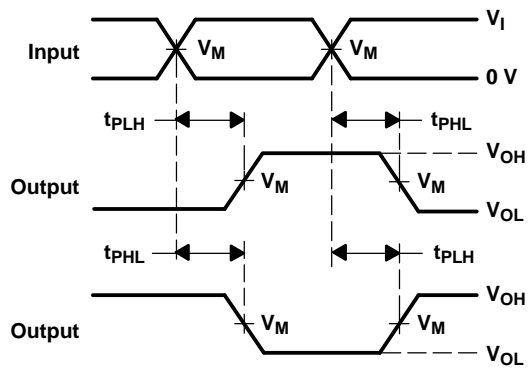
VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS

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

NOTES: 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.
   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_{PZL} and t_{PZH} are the same as t_{en}.
   G. t_{PLH} and t_{PHL} are the same as t_{pd}.
   H. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
74LVC16244ADGGRG4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74LVC16244ADGVRE4	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC16244ADGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC16244ADGVR	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC16244ADL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC16244ADLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC16244ADLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC16244ADLRG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVC16244AGQLR	ACTIVE	BGA MICROSTAR JUNIOR	GQL	56	1000	TBD	SNPB	Level-1-240C-UNLIM
SN74LVC16244AGRDR	ACTIVE	BGA MICROSTAR JUNIOR	GRD	54	1000	TBD	SNPB	Level-1-240C-UNLIM
SN74LVC16244AZQLR	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
SN74LVC16244AZRDR	ACTIVE	BGA MICROSTAR JUNIOR	ZRD	54	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM

(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) 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
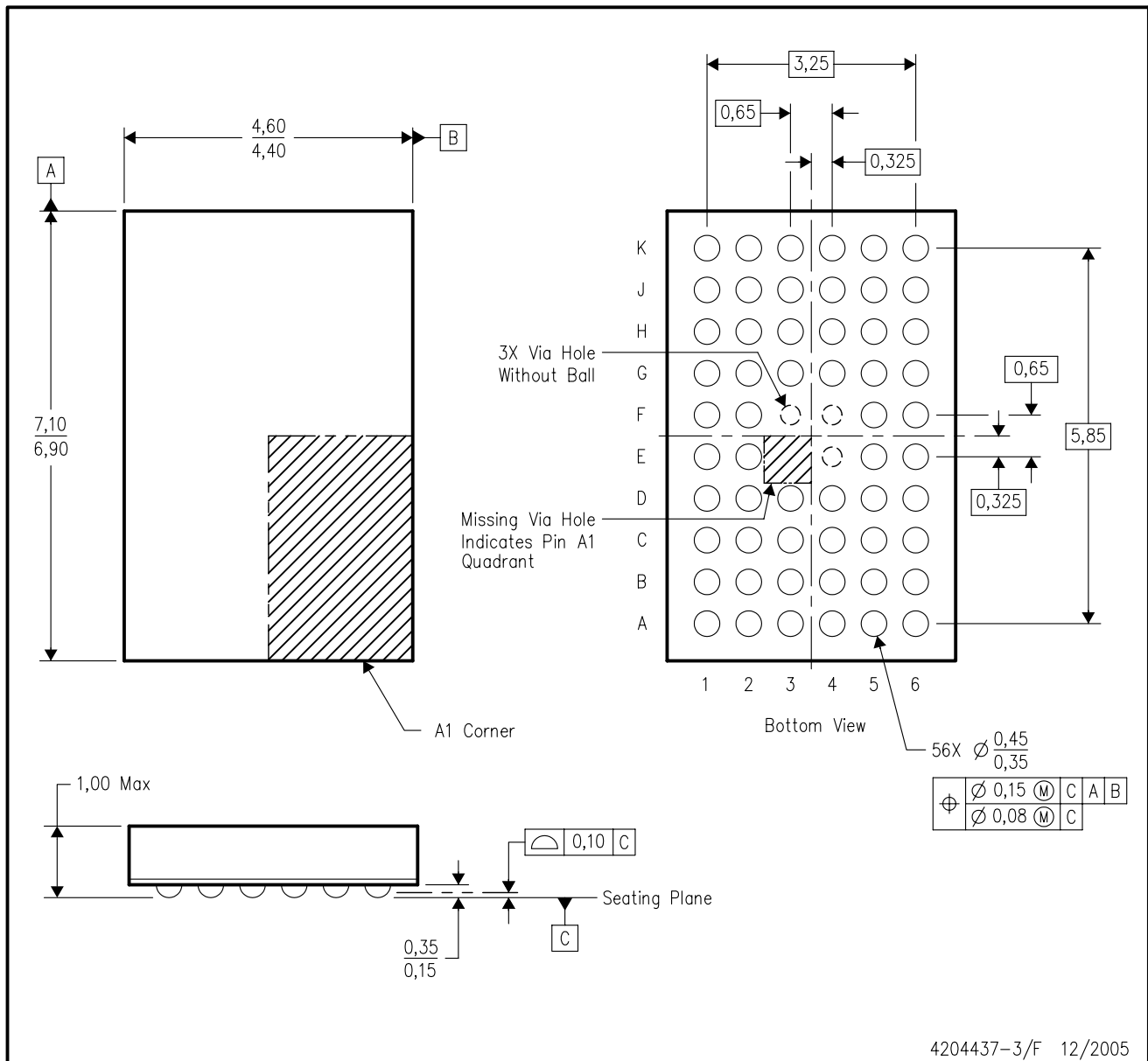
temperature.

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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

4,60 / 4,40 B

A

7,10 / 6,90

A1 Corner

1,00 Max

0,10 C

Seating Plane

C

0,35 / 0,15

3,25

0,65

0,325

K
J
H
G
F
E
D
C
B
A

3X Via Hole
Without Ball

Missing Via Hole
Indicates Pin A1
Quadrant

1　2　3　4　5　6

Bottom View

0,65

5,85

0,325

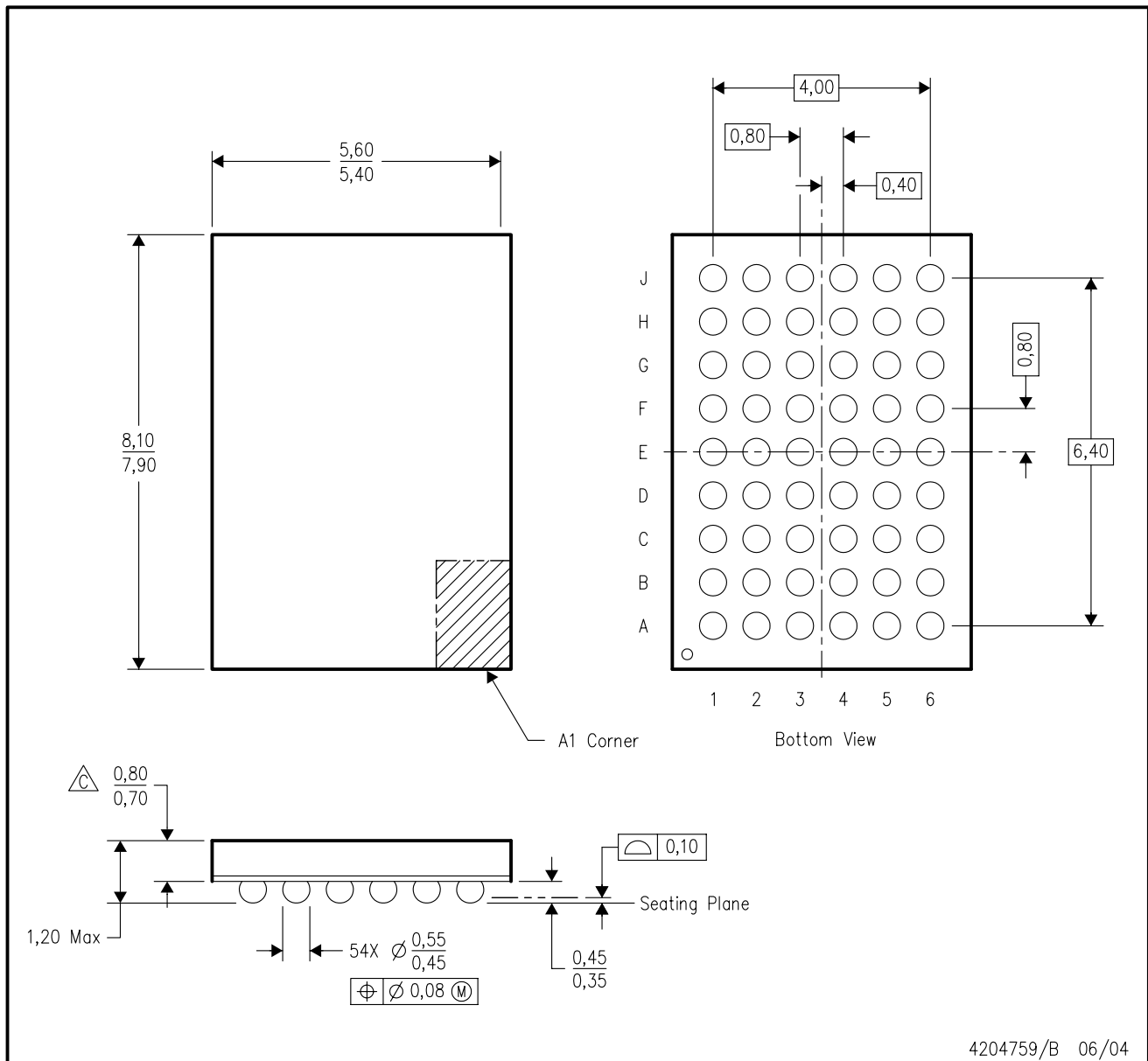56X Ø 0,45 / 0,35

⊕ | Ø 0,15 Ⓜ | C | A | B |
　 | Ø 0,08 Ⓜ | C |

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).

GRD (R-PBGA-N54)   PLASTIC BALL GRID ARRAY

5,60
5,40

8,10
7,90

A1 Corner

4,00

0,80

0,40

J
H
G
F
E
D
C
B
A

1   2   3   4   5   6

Bottom View

0,80

6,40

0,80
0,70

0,10

Seating Plane

1,20 Max

54X Ø 0,55
        0,45

⊕ Ø 0,08 Ⓜ

0,45
0,35

4204759/B 06/04

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.

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ZRD (R–PBGA–N54) PLASTIC BALL GRID ARRAY

5,60
5,40

4,00

0,80

0,40

8,10
7,90

0,80

6,40

J H G F E D C B A

1 2 3 4 5 6

Bottom View

A1 Corner

C 0,80
0,70

0,10
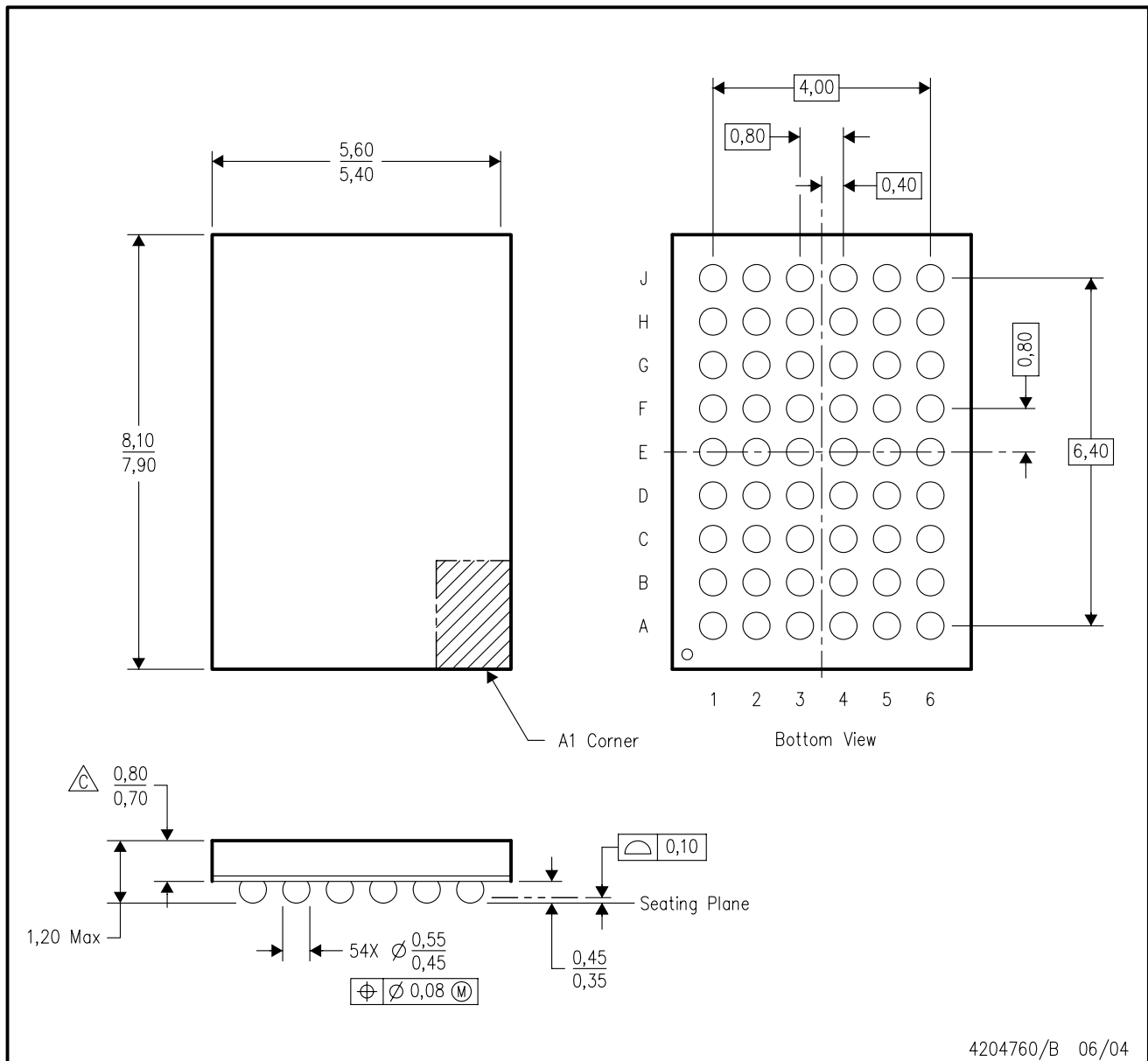
Seating Plane

1,20 Max

54X ⌀ 0,55
0,45

0,45
0,35

⌖ ⌀ 0,08 Ⓜ

4204760/B 06/04

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 lead–free. Refer to the 54 GRD package (drawing 4204759) for tin–lead (SnPb).

DGV (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE**

24 PINS SHOWN

DIM \ PINS **	14	16	20	24	38	48	56
A MAX	3,70	3,70	5,10	5,10	7,90	9,80	11,40
A MIN	3,50	3,50	4,90	4,90	7,70	9,60	11,20

4073251/E 08/00
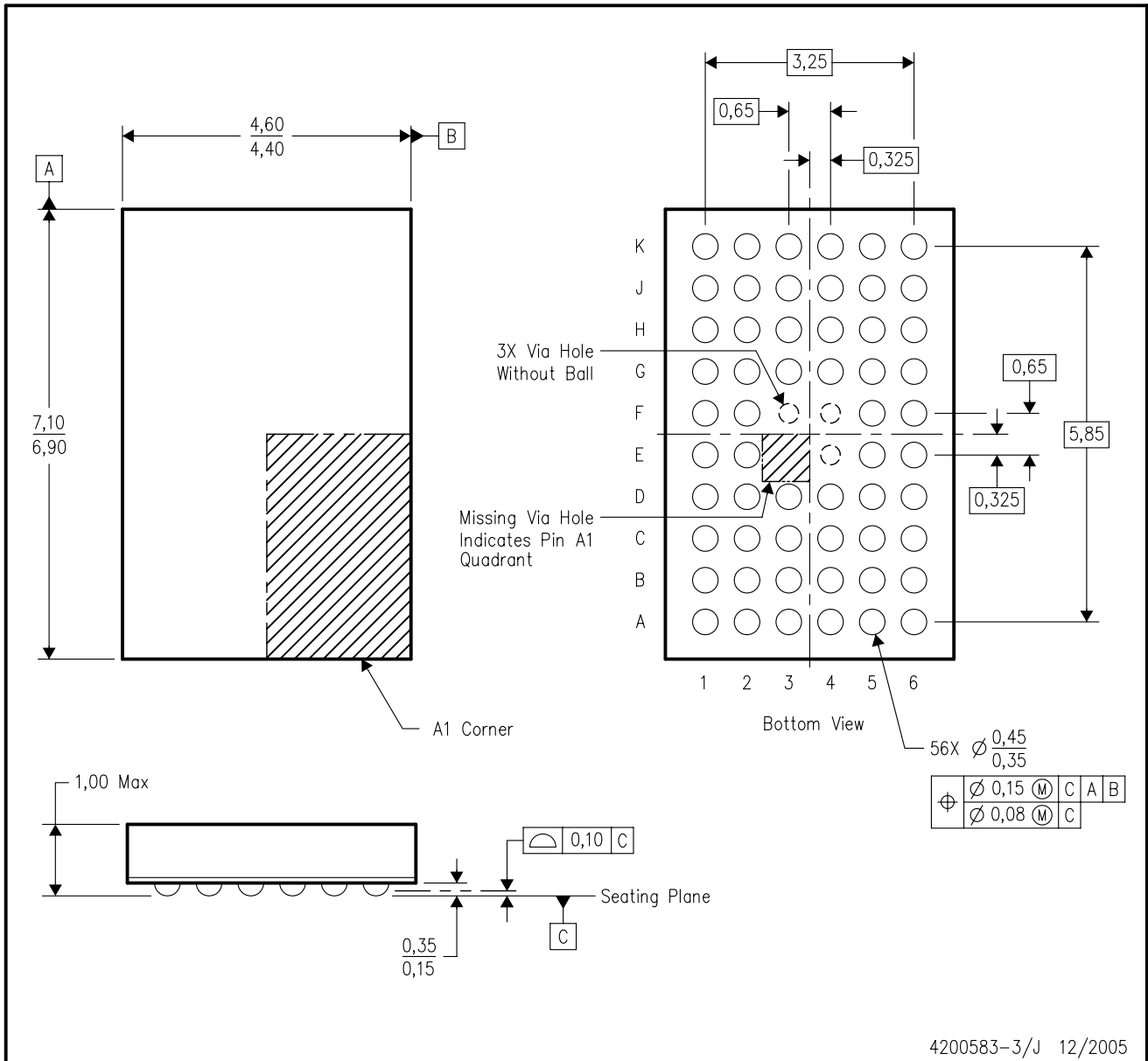
NOTES: A.   All linear dimensions are in millimeters.
B.   This drawing is subject to change without notice.
C.   Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D.   Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

GQL (R−PBGA−N56)   PLASTIC BALL GRID ARRAY

3X Via Hole
Without Ball

Missing Via Hole
Indicates Pin A1
Quadrant

A1 Corner

Bottom View

56X ∅ $\frac{0,45}{0,35}$

1,00 Max

0,10 | C

Seating Plane

$\frac{0,35}{0,15}$

⊕	∅ 0,15 Ⓜ	C	A	B
	∅ 0,08 Ⓜ	C		

4200583−3/J   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 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

0.025 (0,635)

0.0135 (0,343)
0.008 (0,203)

⊕ 0.005 (0,13) Ⓜ

48   25

0.299 (7,59)
0.291 (7,39)

0.420 (10,67)
0.395 (10,03)

1   24

A

0.010 (0,25)
0.005 (0,13)

Gage Plane

0°–8°

0.010 (0,25)

0.040 (1,02)
0.020 (0,51)

0.110 (2,79) MAX   0.008 (0,20) MIN

Seating Plane

⌒ 0.004 (0,10)

DIM \ PINS **	28	48	56
A MAX	0.380 (9,65)	0.630 (16,00)	0.730 (18,54)
A MIN	0.370 (9,40)	0.620 (15,75)	0.720 (18,29)

4040048 / E 12/01

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

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DGG (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE PACKAGE**

48 PINS SHOWN

PINS **	48	56	64
DIM			
A MAX	12,60	14,10	17,10
A MIN	12,40	13,90	16,90

4040078 / F 12/97

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

TEXAS INSTRUMENTS

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