

## 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,  $T_A = 25^\circ\text{C}$
- Typical  $V_{OHV}$  (Output  $V_{OH}$  Undershoot) > 2 V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- $I_{off}$  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

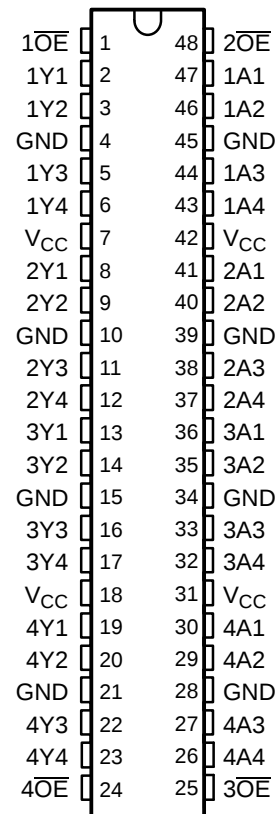
This 16-bit buffer/driver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

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.

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.

DGG, DGV, OR DL PACKAGE  
(TOP VIEW)



## ORDERING INFORMATION

| $T_A$         | PACKAGE <sup>(1)</sup> |               | 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        |
|               | TVSOP – DGV            | Tape and reel | SN74LVC16244ADGVR     | LD244A           |
|               | 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](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.

# SN74LVC16244A

## 16-BIT BUFFER/DRIVER

### WITH 3-STATE OUTPUTS

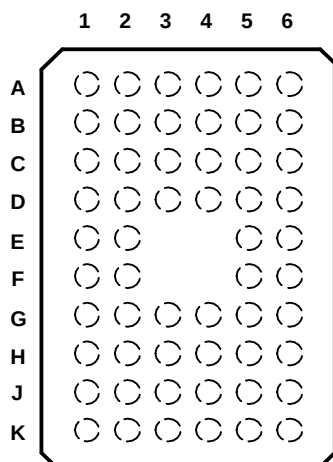
SCAS699–AUGUST 2003–REVISED MARCH 2005

## 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 PACKAGE**  
(TOP VIEW)

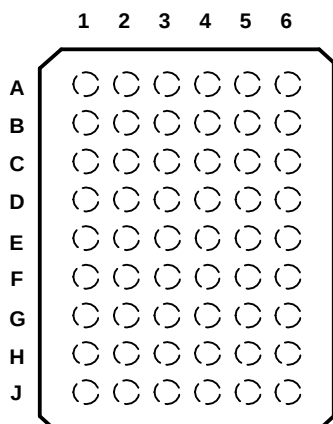


**TERMINAL ASSIGNMENTS<sup>(1)</sup>**

|   | 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<sup>(1)</sup>**

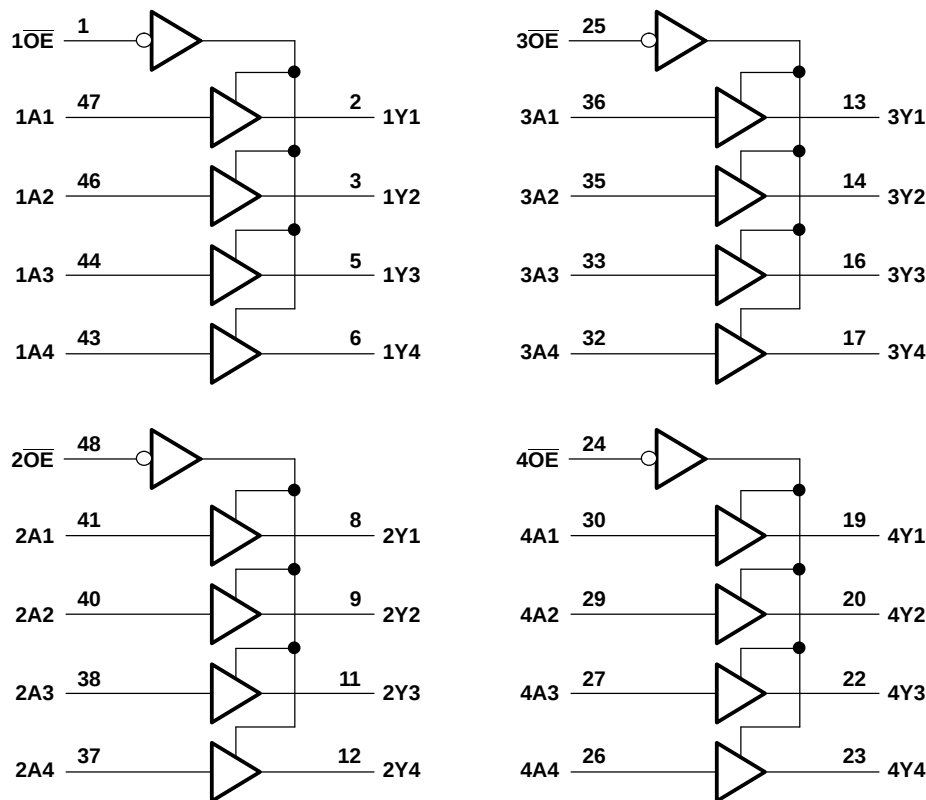
|   | 1   | 2   | 3                | 4                | 5   | 6   |
|---|-----|-----|------------------|------------------|-----|-----|
| A | 1Y1 | NC  | $1\overline{OE}$ | $2\overline{OE}$ | NC  | 1A1 |
| B | 1Y3 | 1Y1 | NC               | NC               | 1A2 | 1A3 |
| C | 2Y1 | 1Y4 | $V_{CC}$  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

(1) NC – No internal connection

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

| INPUTS          |   | OUTPUT<br>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 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  $V_{CC}$  is provided in the recommended operating conditions table.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

**SN74LVC16244A**  
**16-BIT BUFFER/DRIVER**  
**WITH 3-STATE OUTPUTS**

SCAS699–AUGUST 2003–REVISED MARCH 2005

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

|                 |                                    |                                    | MIN                    | MAX                    | UNIT |
|-----------------|------------------------------------|------------------------------------|------------------------|------------------------|------|
| V <sub>CC</sub> | Supply voltage                     | Operating                          | 1.65                   | 3.6                    | V    |
|                 |                                    | Data retention only                | 1.5                    |                        |      |
| 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>        | V    |
|                 |                                    | 3-state                            | 0                      | 5.5                    |      |
| I <sub>OH</sub> | High-level output current          | V <sub>CC</sub> = 1.65 V           |                        | –4                     | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3 V            |                        | –8                     |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V            |                        | –12                    |      |
|                 |                                    | V <sub>CC</sub> = 3 V              |                        | –24                    |      |
| I <sub>OL</sub> | Low-level output current           | V <sub>CC</sub> = 1.65 V           |                        | 4                      | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3 V            |                        | 8                      |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V            |                        | 12                     |      |
|                 |                                    | V <sub>CC</sub> = 3 V              |                        | 24                     |      |
| 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.

## 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> = –4 mA                                                      | 1.65 V          | 1.2                   |                    |     |      |
|                  | I <sub>OH</sub> = –8 mA                                                      | 2.3 V           | 1.7                   |                    |     |      |
|                  | I <sub>OH</sub> = –12 mA                                                     | 2.7 V           | 2.2                   |                    |     |      |
|                  |                                                                              | 3 V             | 2.4                   |                    |     |      |
|                  | I <sub>OH</sub> = –24 mA                                                     | 3 V             | 2.2                   |                    |     |      |
| V <sub>OL</sub>  | I <sub>OL</sub> = 100 µA                                                     | 1.65 V to 3.6 V | 0.2                   |                    |     | V    |
|                  | I <sub>OL</sub> = 4 mA                                                       | 1.65 V          | 0.45                  |                    |     |      |
|                  | I <sub>OL</sub> = 8 mA                                                       | 2.3 V           | 0.7                   |                    |     |      |
|                  | 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 <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)

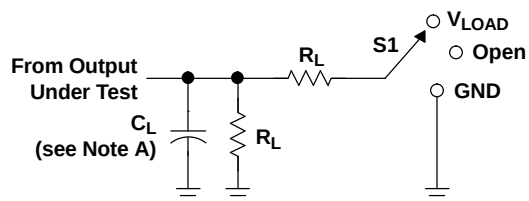
| PARAMETER          | FROM<br>(INPUT) | TO<br>(OUTPUT) | V <sub>CC</sub> = 1.8 V<br>± 0.15 V |      | V <sub>CC</sub> = 2.5 V<br>± 0.2 V |     | V <sub>CC</sub> = 2.7 V |     | V <sub>CC</sub> = 3.3 V<br>± 0.3 V |     | UNIT |
|--------------------|-----------------|----------------|-------------------------------------|------|------------------------------------|-----|-------------------------|-----|------------------------------------|-----|------|
|                    |                 |                | MIN                                 | MAX  | MIN                                | MAX | MIN                     | MAX | MIN                                | MAX |      |
| t <sub>pd</sub>    | A               | Y              | 1.5                                 | 6.6  | 1                                  | 3.9 | 1                       | 4.7 | 1.1                                | 4.1 | ns   |
| t <sub>en</sub>    | $\overline{OE}$ | Y              | 1.5                                 | 7.5  | 1                                  | 4.7 | 1                       | 5.8 | 1                                  | 4.6 | ns   |
| t <sub>dis</sub>   | $\overline{OE}$ | Y              | 1.5                                 | 10.3 | 1                                  | 5.3 | 1                       | 6.2 | 1.8                                | 5.8 | ns   |
| t <sub>sk(o)</sub> |                 |                |                                     |      |                                    |     |                         |     | 1                                  |     | ns   |

## Operating Characteristics

T<sub>A</sub> = 25°C

| PARAMETER       |                                                    |                  | TEST<br>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<br>per buffer/driver | Outputs enabled  | f = 10 MHz         | 33                      | 35                      | 39                      | pF   |
|                 |                                                    | Outputs disabled |                    | 2                       | 3                       | 4                       |      |

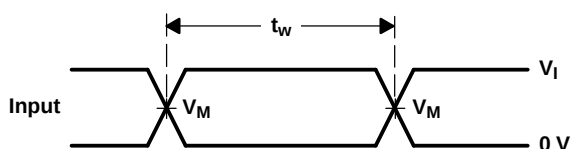
## PARAMETER MEASUREMENT INFORMATION



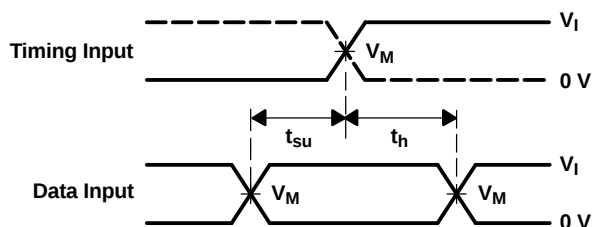
LOAD CIRCUIT

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

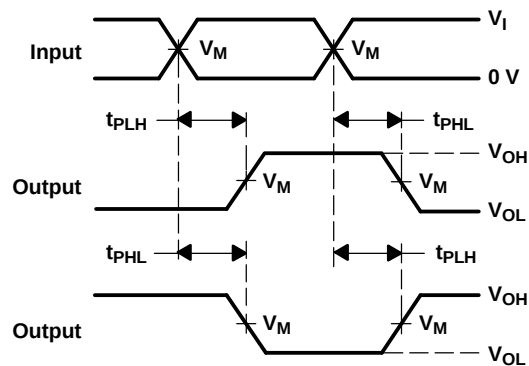
| $V_{CC}$                         | INPUTS   |                      | $V_M$      | $V_{LOAD}$        | $C_L$ | $R_L$        | $V_{\Delta}$ |
|----------------------------------|----------|----------------------|------------|-------------------|-------|--------------|--------------|
|                                  | $V_I$    | $t_r/t_f$            |            |                   |       |              |              |
| $1.8\text{ V} \pm 0.15\text{ V}$ | $V_{CC}$ | $\leq 2\text{ ns}$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 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        |



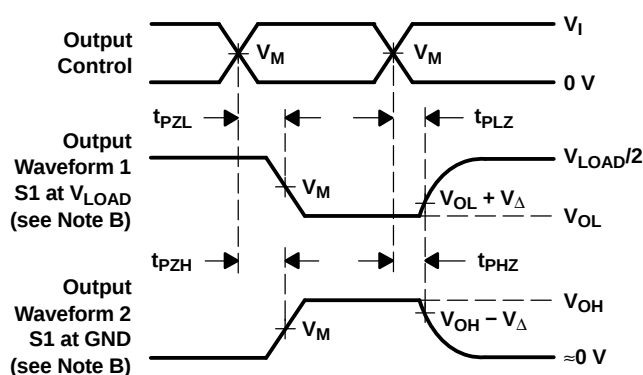
VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES  
INVERTING AND NONINVERTING OUTPUTS



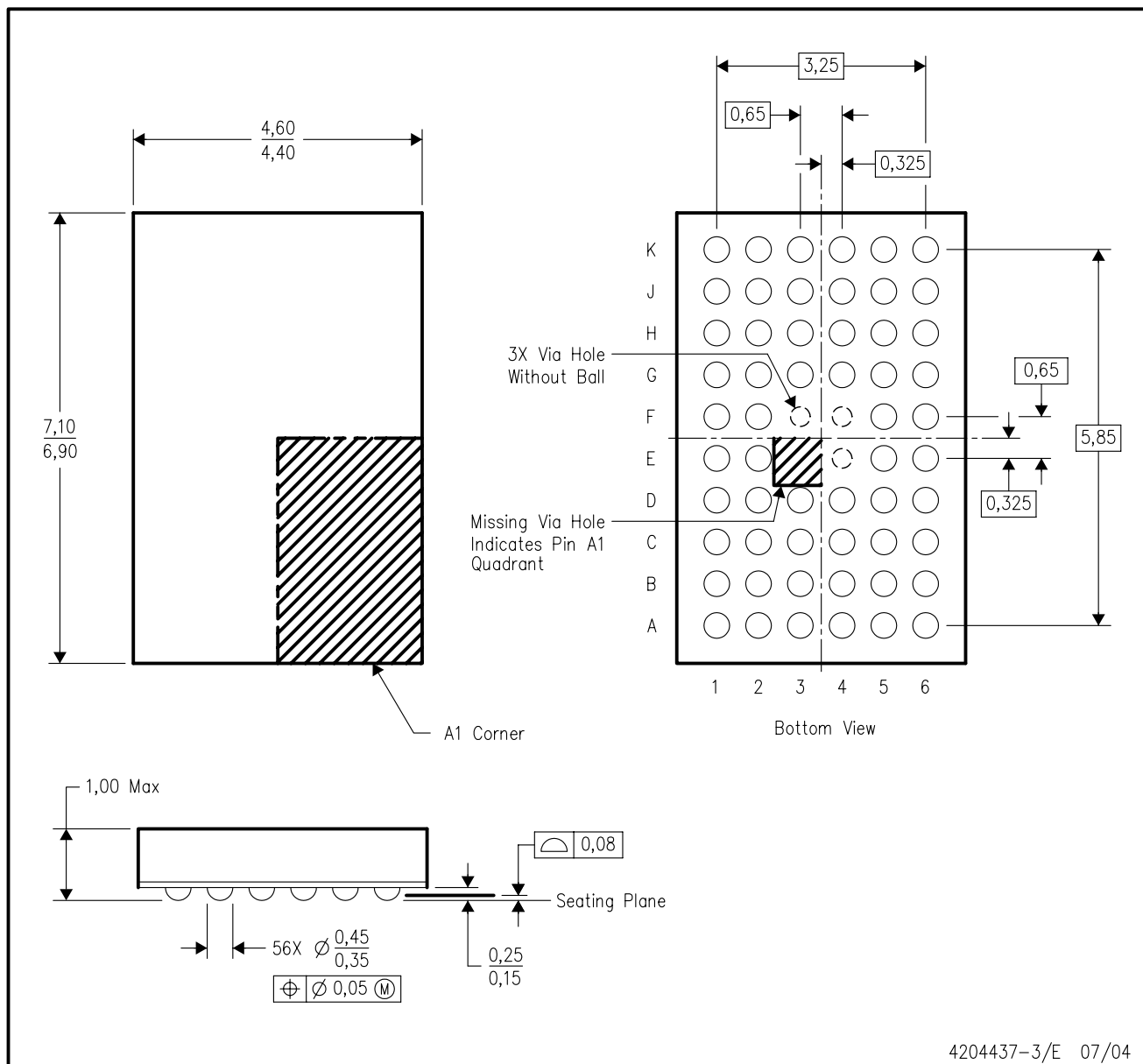
VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES  
LOW- AND HIGH-LEVEL ENABLING

- 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

## ZQL (R-PBGA-N56)

## PLASTIC BALL GRID ARRAY

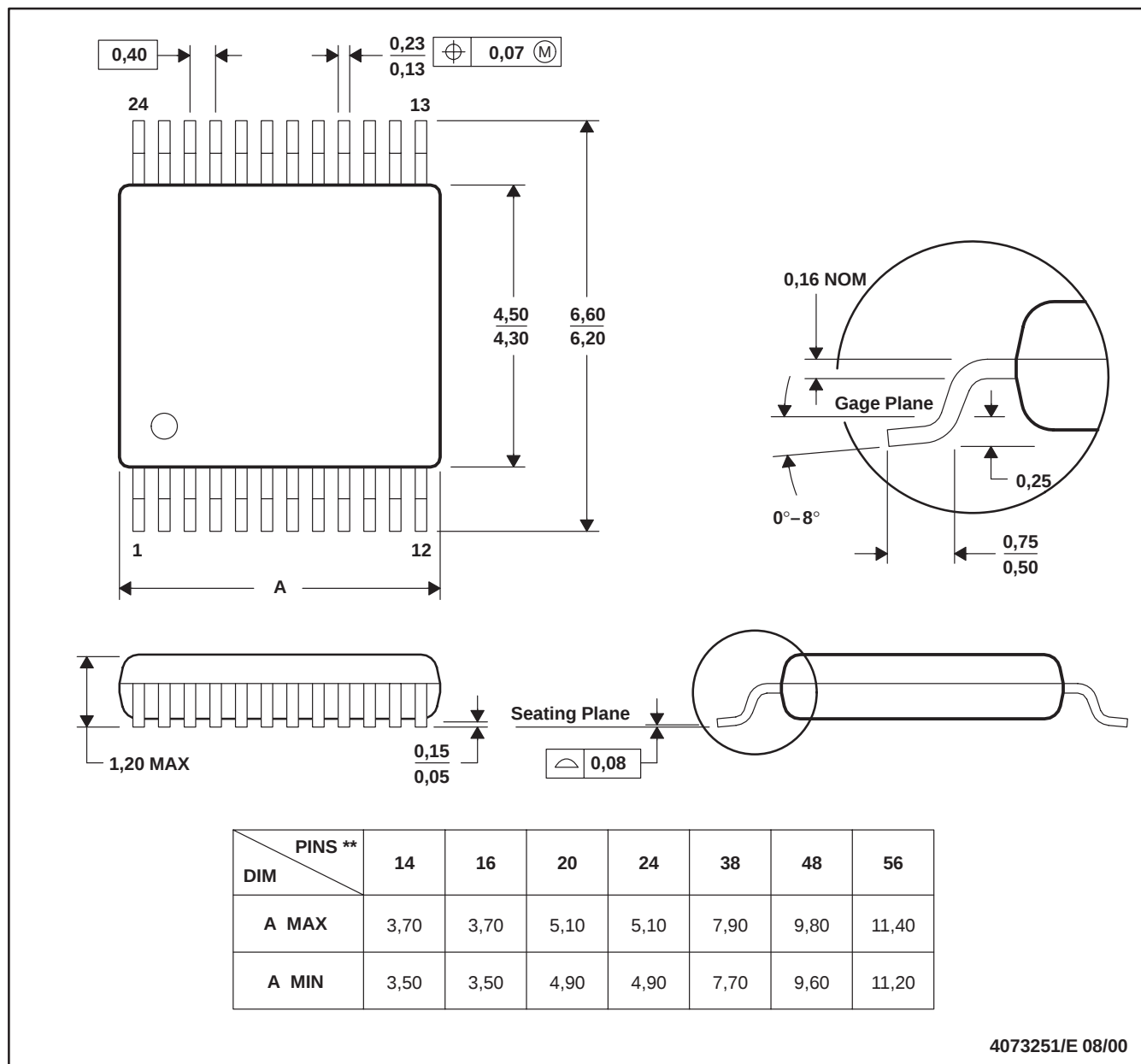


- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Falls within JEDEC MO-225 variation BA.
  - This package is lead-free. Refer to the 56 GQL package (drawing 4200583) for tin-lead (SnPb).

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

## PLASTIC SMALL-OUTLINE

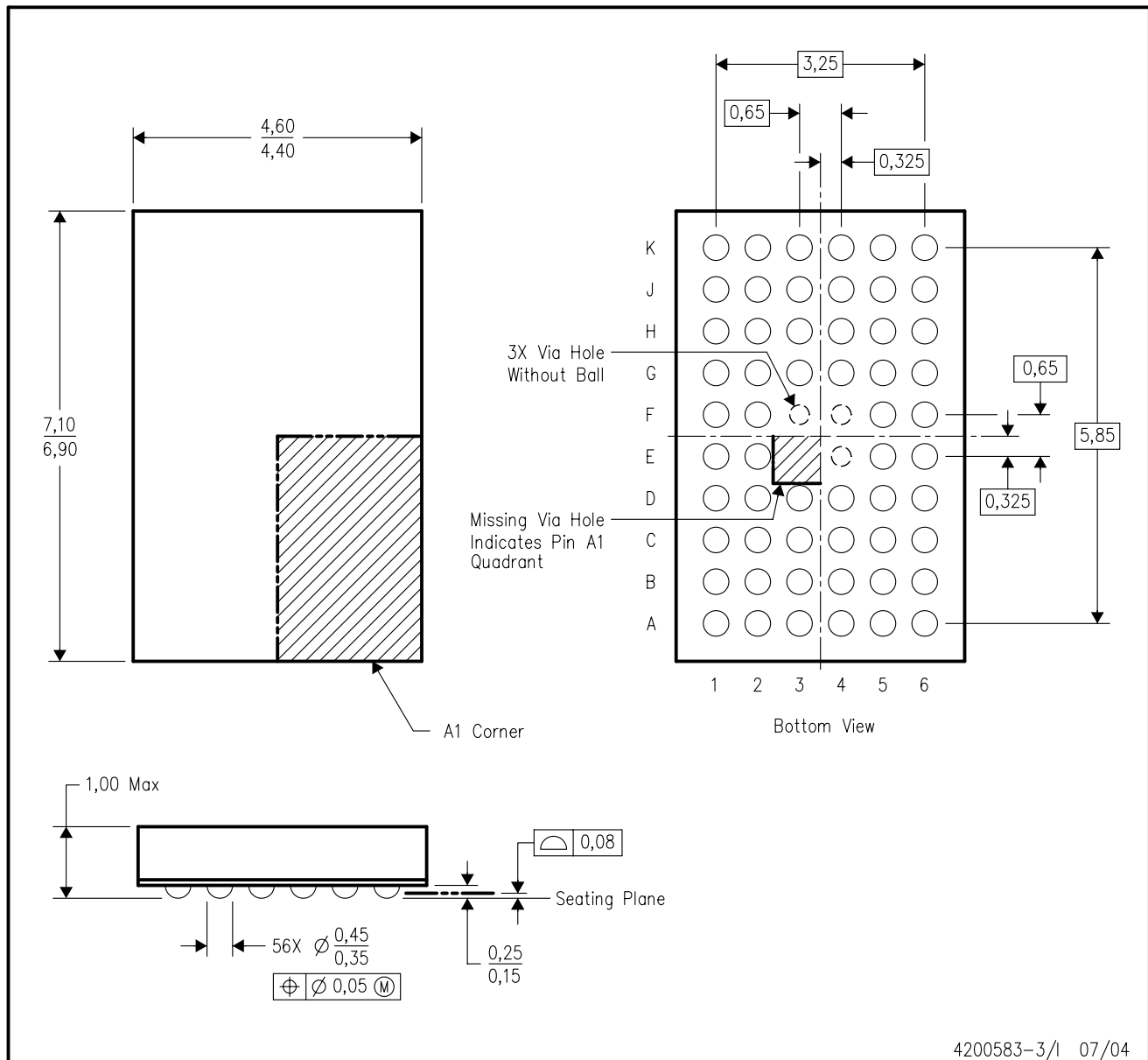
24 PINS SHOWN



- 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

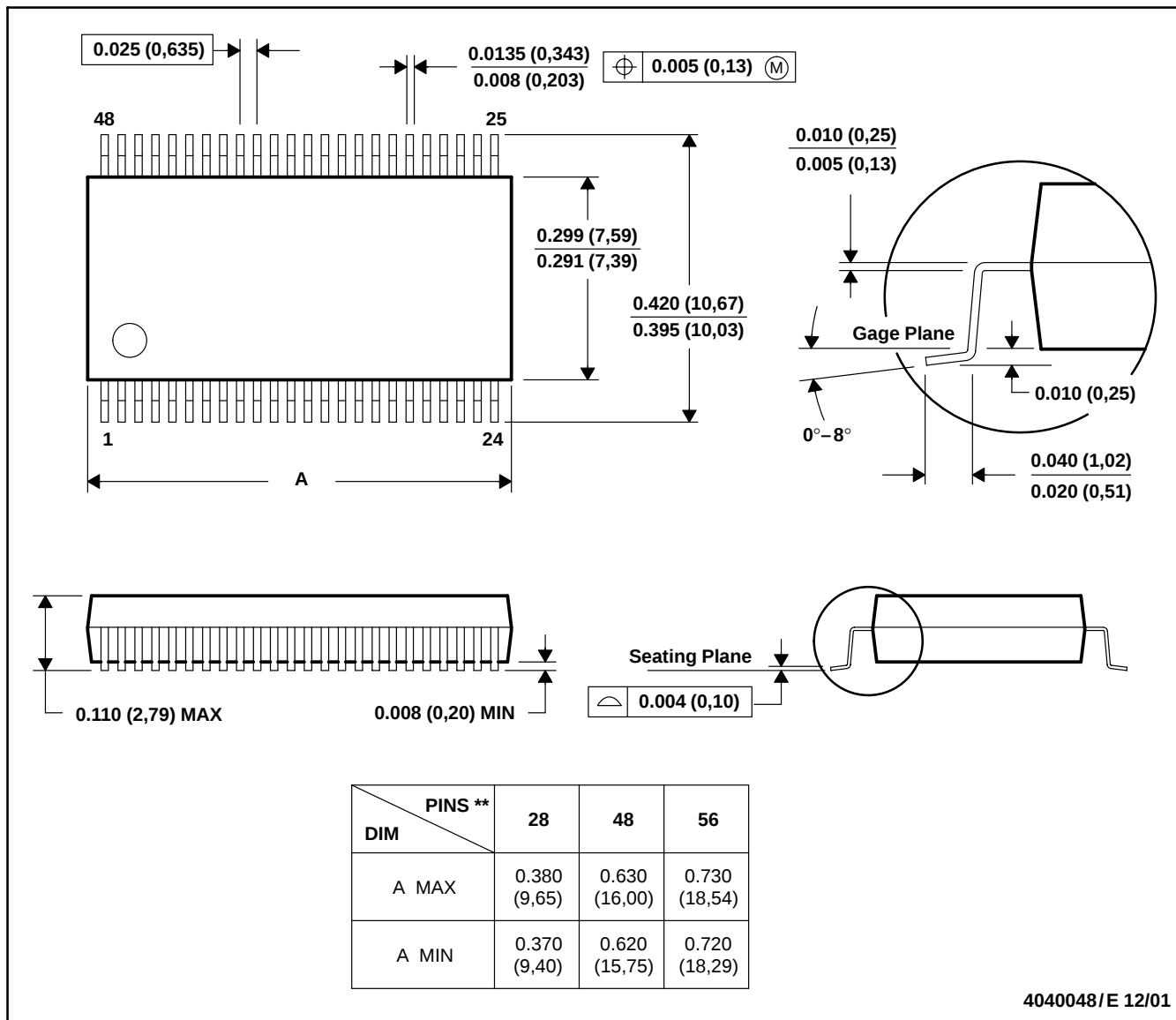


- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Falls within JEDEC MO-225 variation BA.
  - This package is tin-lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for lead-free.

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

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN

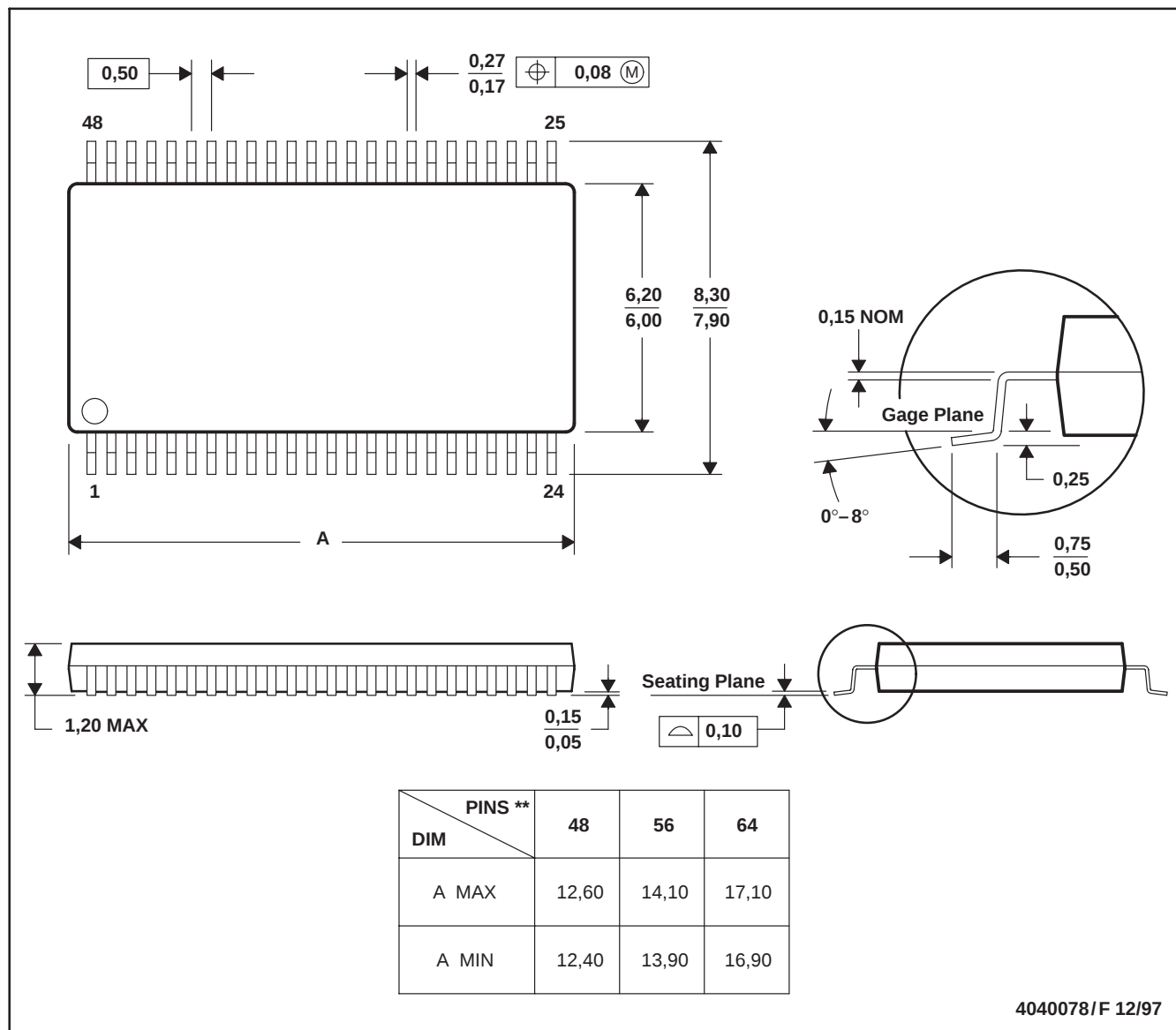


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MO-118

## 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

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 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.

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.

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

| <b>Products</b>  |                                                                    | <b>Applications</b> |                                                                          |
|------------------|--------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------|
| Amplifiers       | <a href="http://amplifier.ti.com">amplifier.ti.com</a>             | Audio               | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                   |
| Data Converters  | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     | Automotive          | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| DSP              | <a href="http://dsp.ti.com">dsp.ti.com</a>                         | Broadband           | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Interface        | <a href="http://interface.ti.com">interface.ti.com</a>             | Digital Control     | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
| Logic            | <a href="http://logic.ti.com">logic.ti.com</a>                     | Military            | <a href="http://www.ti.com/military">www.ti.com/military</a>             |
| Power Mgmt       | <a href="http://power.ti.com">power.ti.com</a>                     | Optical Networking  | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Microcontrollers | <a href="http://microcontroller.ti.com">microcontroller.ti.com</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 © 2005, Texas Instruments Incorporated