

# 54AC16244, 74AC16244 16-BIT BUFFERS/LINE DRIVERS WITH 3-STATE OUTPUTS

SCAS120A – MARCH 1990 – REVISED APRIL 1996

- Members of the Texas Instruments *Widebus*™ Family
- 3-State Outputs Drive Bus Lines or Buffer Memory Address Registers
- Flow-Through Architecture Optimizes PCB Layout
- Distributed  $V_{CC}$  and GND Configuration Minimizes High-Speed Switching Noise
- *EPIC*™ (Enhanced-Performance Implanted CMOS) 1- $\mu$ m Process
- 500-mA Typical Latch-Up Immunity at 125°C
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages Using 25-mil Center-to-Center Pin Spacings, and 380-mil Fine-Pitch Ceramic Flat (WD) Packages Using 25-mil Center-to-Center Pin Spacings

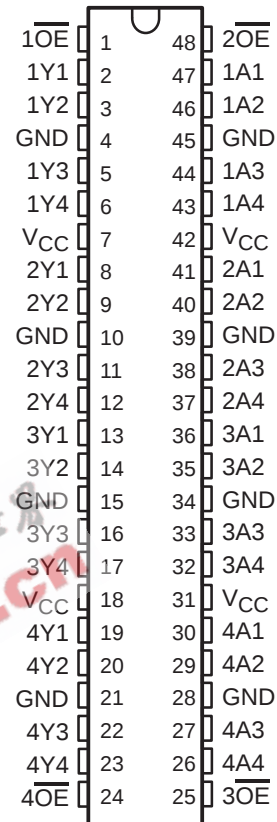
## description

The 'AC16244 are 16-bit buffers/line drivers designed specifically to improve both the performance and density of 3-state memory address drivers, clock drivers, and bus-oriented receivers and transmitters. They can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer. These devices provide true outputs and symmetrical active-low output-enable ( $\overline{OE}$ ) inputs. When  $\overline{OE}$  is low, the device passes noninverted data from the A inputs to the Y outputs. When  $\overline{OE}$  is high, the outputs are in the high-impedance state.

The 74AC16244 is packaged in the TI's shrink small-outline package, which provides twice the I/O pin count and functionality of standard small-outline packages in the same printed-circuit-board area.

The 54AC16244 is characterized for operation over the full military temperature range of –55°C to 125°C. The 74AC16244 is characterized for operation from –40°C to 85°C.

54AC16244...WD PACKAGE  
74AC16244...DGG OR DL PACKAGE  
(TOP VIEW)



FUNCTION TABLE  
(each driver)

| INPUTS          |   | OUTPUT<br>Y |
|-----------------|---|-------------|
| $\overline{OE}$ | A |             |
| L               | H | H           |
| L               | L | L           |
| H               | X | Z           |



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.

EPIC and Widebus are trademarks of Texas Instruments Incorporated.

UNLESS OTHERWISE NOTED this document contains PRODUCTION DATA information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

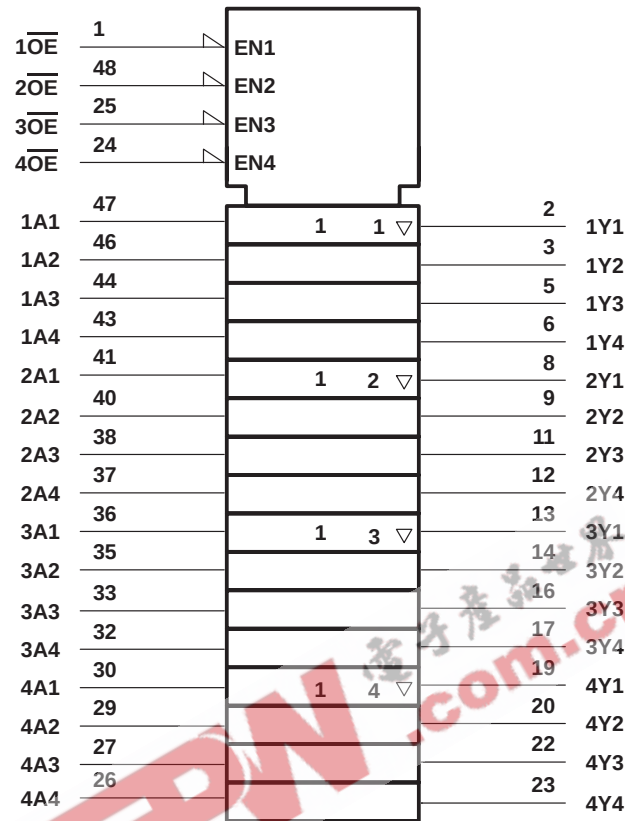
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1996, Texas Instruments Incorporated

54AC16244, 74AC16244  
16-BIT BUFFERS/LINE DRIVERS  
WITH 3-STATE OUTPUTS

SCAS120A – MARCH 1990 – REVISED APRIL 1996

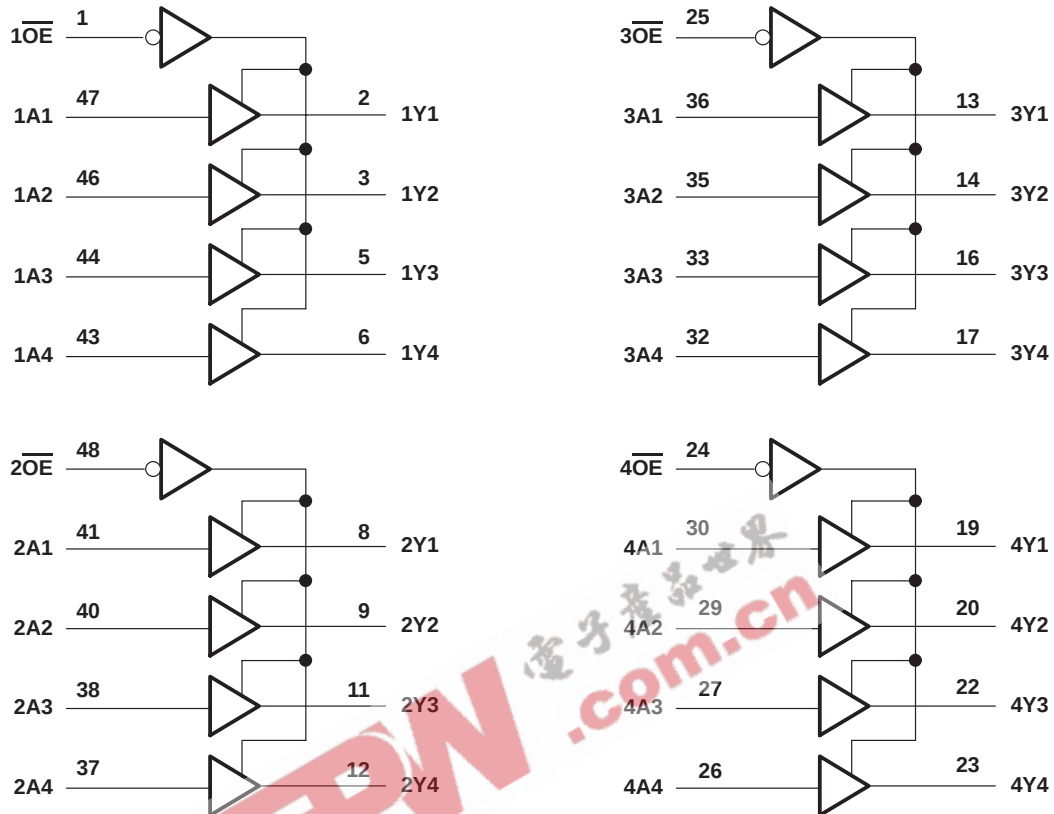
logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

**54AC16244, 74AC16244**  
**16-BIT BUFFERS/LINE DRIVERS**  
**WITH 3-STATE OUTPUTS**  
SCAS120A – MARCH 1990 – REVISED APRIL 1996

**logic diagram (positive logic)**



**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

|                                                                                    |                            |
|------------------------------------------------------------------------------------|----------------------------|
| Supply voltage range, $V_{CC}$                                                     | –0.5 V to 7 V              |
| Input voltage range, $V_I$ (see Note 1)                                            | –0.5 V to $V_{CC} + 0.5$ V |
| Output voltage range, $V_O$ (see Note 1)                                           | –0.5 V to $V_{CC} + 0.5$ V |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ or $V_I > V_{CC}$ )                      | ±20 mA                     |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ )                     | ±50 mA                     |
| Continuous output current, $I_O$ ( $V_O = 0$ to $V_{CC}$ )                         | ±50 mA                     |
| Continuous current through $V_{CC}$ or GND                                         | ±400 mA                    |
| Maximum power dissipation at $T_A = 55^\circ\text{C}$ (in still air) (see Note 2): |                            |
| DGG package                                                                        | 0.85 W                     |
| DL package                                                                         | 1.2 W                      |
| Storage temperature range, $T_{stg}$                                               | –65°C to 150°C             |

<sup>†</sup> 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.

- NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.  
2. The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils.

# 54AC16244, 74AC16244

## 16-BIT BUFFERS/LINE DRIVERS

### WITH 3-STATE OUTPUTS

SCAS120A – MARCH 1990 – REVISED APRIL 1996

#### recommended operating conditions (see Note 3)

|                 |                                    |                         | 54AC16244 |     |                 | 74AC16244 |     |                 | UNIT |
|-----------------|------------------------------------|-------------------------|-----------|-----|-----------------|-----------|-----|-----------------|------|
|                 |                                    |                         | MIN       | NOM | MAX             | MIN       | NOM | MAX             |      |
| V <sub>CC</sub> | Supply voltage (see Note 4)        |                         | 3         | 5   | 5.5             | 3         | 5   | 5.5             | V    |
| V <sub>IH</sub> | High-level input voltage           | V <sub>CC</sub> = 3 V   | 2.1       |     |                 | 2.1       |     |                 | V    |
|                 |                                    | V <sub>CC</sub> = 4.5 V | 3.15      |     |                 | 3.15      |     |                 |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V | 3.85      |     |                 | 3.85      |     |                 |      |
| V <sub>IL</sub> | Low-level input voltage            | V <sub>CC</sub> = 3 V   |           |     | 0.9             |           |     | 0.9             | V    |
|                 |                                    | V <sub>CC</sub> = 4.5 V |           |     | 1.35            |           |     | 1.35            |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V |           |     | 1.65            |           |     | 1.65            |      |
| V <sub>I</sub>  | Input voltage                      |                         | 0         |     | V <sub>CC</sub> | 0         |     | V <sub>CC</sub> | V    |
| V <sub>O</sub>  | Output voltage                     |                         | 0         |     | V <sub>CC</sub> | 0         |     | V <sub>CC</sub> | V    |
| I <sub>OH</sub> | High-level output current          | V <sub>CC</sub> = 3 V   |           |     | –4              |           |     | –4              | mA   |
|                 |                                    | V <sub>CC</sub> = 4.5 V |           |     | –24             |           |     | –24             |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V |           |     | –24             |           |     | –24             |      |
| I <sub>OL</sub> | Low-level output current           | V <sub>CC</sub> = 3 V   |           |     | 12              |           |     | 12              | mA   |
|                 |                                    | V <sub>CC</sub> = 4.5 V |           |     | 24              |           |     | 24              |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V |           |     | 24              |           |     | 24              |      |
| Δt/Δv           | Input transition rise or fall rate |                         | 0         |     | 10              | 0         |     | 10              | ns/V |
| T <sub>A</sub>  | Operating free-air temperature     |                         | –55       |     | 125             | –40       |     | 85              | °C   |

NOTES: 3. Unused inputs should be tied to V<sub>CC</sub> through a pullup resistor of approximately 5 kΩ or greater to prevent them from floating.

4. All V<sub>CC</sub> and GND pins must be connected to the proper voltage supply.

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

| PARAMETER       | TEST CONDITIONS                                             | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     |      | 54AC16244 |      | 74AC16244 |      | UNIT |
|-----------------|-------------------------------------------------------------|-----------------|-----------------------|-----|------|-----------|------|-----------|------|------|
|                 |                                                             |                 | MIN                   | TYP | MAX  | MIN       | MAX  | MIN       | MAX  |      |
| V <sub>OH</sub> | I <sub>OH</sub> = –50 μA                                    | 3 V             | 2.9                   |     |      | 2.9       |      | 2.9       |      | V    |
|                 |                                                             | 4.5 V           | 4.4                   |     |      | 4.4       |      | 4.4       |      |      |
|                 |                                                             | 5.5 V           | 5.4                   |     |      | 5.4       |      | 5.4       |      |      |
|                 | I <sub>OH</sub> = –4 mA                                     | 3 V             | 2.58                  |     |      | 2.48      |      | 2.48      |      |      |
|                 |                                                             | 4.5 V           | 3.94                  |     |      | 3.8       |      | 3.8       |      |      |
|                 |                                                             | 5.5 V           | 4.94                  |     |      | 4.8       |      | 4.8       |      |      |
|                 | I <sub>OH</sub> = –75 mA <sup>†</sup>                       | 5.5 V           |                       |     |      | 3.85      |      | 3.85      |      |      |
| V <sub>OL</sub> | I <sub>OL</sub> = –50 μA                                    | 3 V             |                       |     | 0.1  |           | 0.1  |           | 0.1  | V    |
|                 |                                                             | 4.5 V           |                       |     | 0.1  |           | 0.1  |           | 0.1  |      |
|                 |                                                             | 5.5 V           |                       |     | 0.1  |           | 0.1  |           | 0.1  |      |
|                 | I <sub>OL</sub> = 12 mA                                     | 3 V             |                       |     | 0.36 |           | 0.44 |           | 0.44 |      |
|                 |                                                             | 4.5 V           |                       |     | 0.36 |           | 0.44 |           | 0.44 |      |
|                 |                                                             | 5.5 V           |                       |     | 0.36 |           | 0.44 |           | 0.44 |      |
|                 | I <sub>OL</sub> = 75 mA <sup>†</sup>                        | 5.5 V           |                       |     |      | 1.65      |      | 1.65      |      |      |
| I <sub>I</sub>  | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5.5 V           |                       |     | ±0.1 |           | ±1   |           | ±1   | μA   |
| I <sub>OZ</sub> | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5.5 V           |                       |     | ±0.5 |           | ±5   |           | ±5   | μA   |
| I <sub>CC</sub> | V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0 | 5.5 V           |                       |     | 8    |           | 80   |           | 80   | μA   |
| C <sub>i</sub>  | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5 V             |                       | 4.5 |      |           |      |           |      | pF   |
| C <sub>0</sub>  | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5 V             |                       | 12  |      |           |      |           |      |      |

<sup>†</sup> Not more than one output should be tested at a time, and the duration of the test should not exceed 10 ms.

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

**54AC16244, 74AC16244**  
**16-BIT BUFFERS/LINE DRIVERS**  
**WITH 3-STATE OUTPUTS**

SCAS120A – MARCH 1990 – REVISED APRIL 1996

switching characteristics over recommended operating free-air temperature range,  
 $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$  (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM<br>(INPUT) | TO<br>(OUTPUT) | $T_A = 25^\circ\text{C}$ |      |      | 54AC16244 |      | 74AC16244 |      | UNIT |
|-----------|-----------------|----------------|--------------------------|------|------|-----------|------|-----------|------|------|
|           |                 |                | MIN                      | TYP  | MAX  | MIN       | MAX  | MIN       | MAX  |      |
| $t_{PLH}$ | A               | Y              | 2                        | 7.1  | 9.4  | 2         | 10.8 | 2         | 10.8 | ns   |
| $t_{PHL}$ |                 |                | 2.4                      | 8.3  | 10.7 | 2.4       | 11.8 | 2.4       | 11.8 |      |
| $t_{PZH}$ | $\overline{OE}$ | Y              | 2.2                      | 7.5  | 10   | 2.2       | 11.5 | 2.2       | 11.5 | ns   |
| $t_{PZL}$ |                 |                | 2.9                      | 10.4 | 13   | 2.9       | 14.6 | 2.9       | 14.6 |      |
| $t_{PHZ}$ | $\overline{OE}$ | Y              | 4.1                      | 6.8  | 8.4  | 4.1       | 9.1  | 4.1       | 9.1  | ns   |
| $t_{PLZ}$ |                 |                | 3.7                      | 6.5  | 8.1  | 3.7       | 8.8  | 3.7       | 8.8  |      |

switching characteristics over recommended operating free-air temperature range,  
 $V_{CC} = 5 \text{ V} \pm 0.5 \text{ V}$  (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM<br>(INPUT) | TO<br>(OUTPUT) | $T_A = 25^\circ\text{C}$ |     |     | 54AC16244 |     | 74AC16244 |     | UNIT |
|-----------|-----------------|----------------|--------------------------|-----|-----|-----------|-----|-----------|-----|------|
|           |                 |                | MIN                      | TYP | MAX | MIN       | MAX | MIN       | MAX |      |
| $t_{PLH}$ | A               | Y              | 1.6                      | 4.6 | 6.3 | 1.6       | 7.1 | 1.6       | 7.1 | ns   |
| $t_{PHL}$ |                 |                | 2                        | 5.3 | 7   | 2         | 7.9 | 2         | 7.9 |      |
| $t_{PZH}$ | $\overline{OE}$ | Y              | 1.7                      | 4.8 | 6.7 | 1.7       | 7.5 | 1.7       | 7.5 | ns   |
| $t_{PZL}$ |                 |                | 2.2                      | 6.1 | 8.1 | 2.2       | 9   | 2.2       | 9   |      |
| $t_{PHZ}$ | $\overline{OE}$ | Y              | 4                        | 6.4 | 7.8 | 4         | 8.4 | 4         | 8.4 | ns   |
| $t_{PLZ}$ |                 |                | 3.5                      | 5.5 | 7.2 | 3.5       | 7.6 | 3.5       | 7.6 |      |

operating characteristics,  $V_{CC} = 5 \text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER |                                         | TEST CONDITIONS                             |  | TYP | UNIT |
|-----------|-----------------------------------------|---------------------------------------------|--|-----|------|
| $C_{pd}$  | Power dissipation capacitance per latch | $C_L = 50 \text{ pF}$ , $f = 1 \text{ MHz}$ |  | 43  | pF   |
|           |                                         |                                             |  | 7   |      |

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.

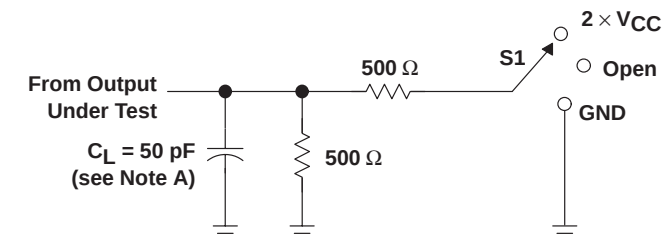


POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

# 54AC16244, 74AC16244 16-BIT BUFFERS/LINE DRIVERS WITH 3-STATE OUTPUTS

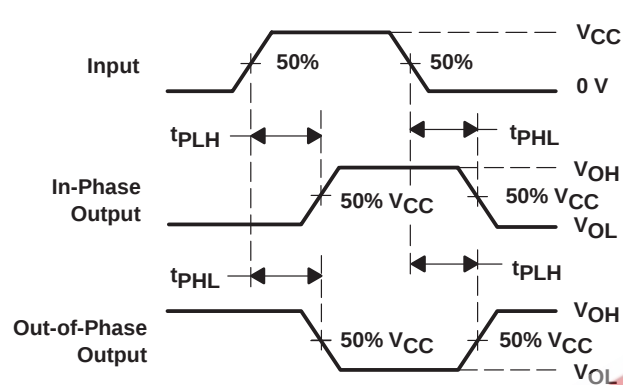
SCAS120A – MARCH 1990 – REVISED APRIL 1996

## PARAMETER MEASUREMENT INFORMATION

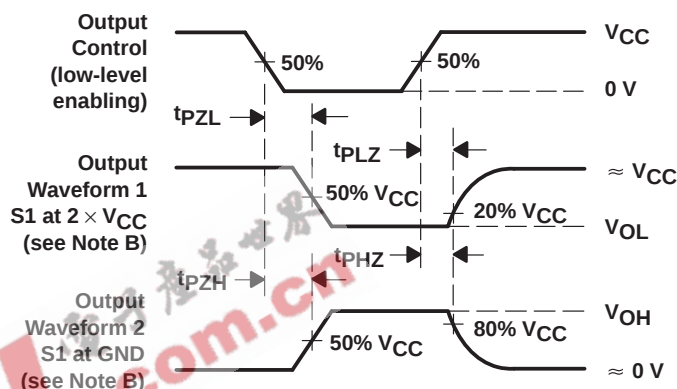


LOAD CIRCUIT

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



VOLTAGE WAVEFORMS



VOLTAGE WAVEFORMS

- 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:  $PRR \leq 1 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = 3 \text{ ns}$ ,  $t_f = 3 \text{ ns}$ .
  - The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

## PACKAGING INFORMATION

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 74AC16244DGGR    | ACTIVE                | TSSOP        | DGG             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74AC16244DGGRE4  | ACTIVE                | TSSOP        | DGG             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74AC16244DGGRG4  | ACTIVE                | TSSOP        | DGG             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74AC16244DL      | ACTIVE                | SSOP         | DL              | 48   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74AC16244DLG4    | ACTIVE                | SSOP         | DL              | 48   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74AC16244DLR     | ACTIVE                | SSOP         | DL              | 48   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74AC16244DLRG4   | ACTIVE                | SSOP         | DL              | 48   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

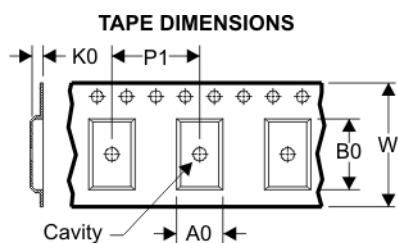
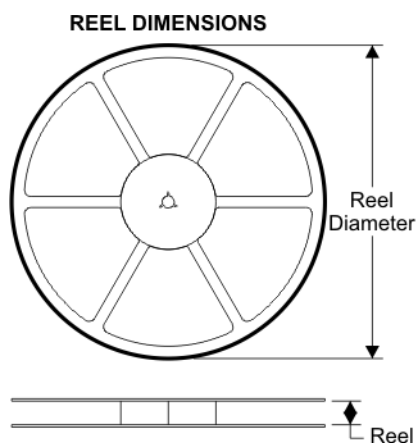
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

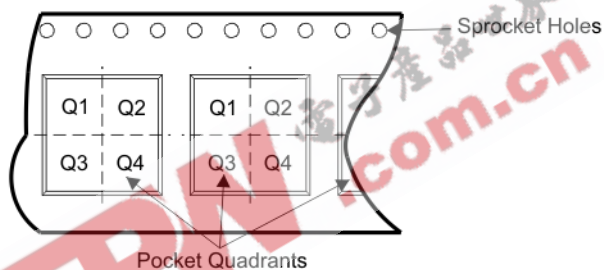
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL BOX INFORMATION**



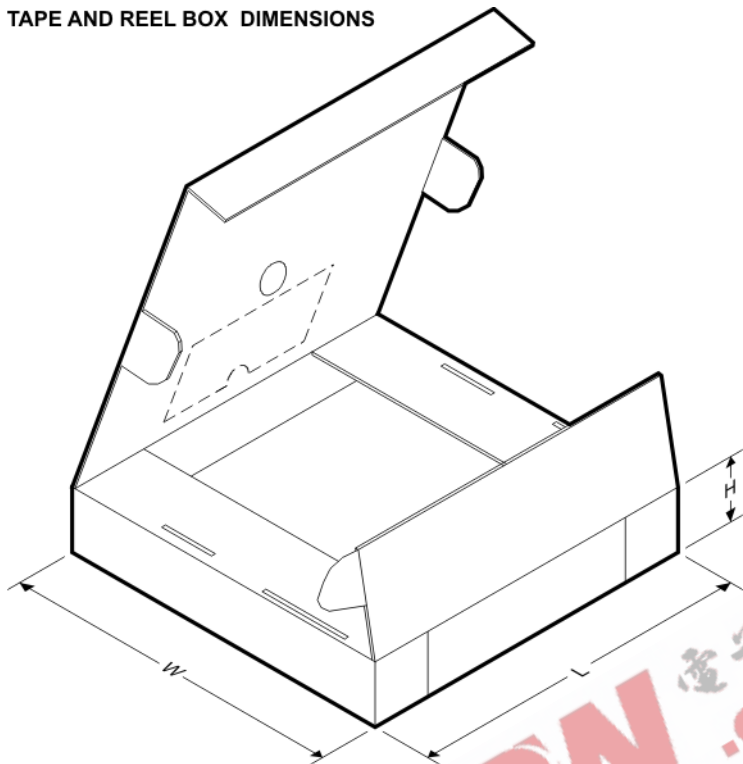
|    |                                                           |
|----|-----------------------------------------------------------|
| A0 | Dimension designed to accommodate the component width     |
| B0 | Dimension designed to accommodate the component length    |
| K0 | Dimension designed to accommodate the component thickness |
| W  | Overall width of the carrier tape                         |
| P1 | Pitch between successive cavity centers                   |

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



| Device        | Package | Pins | Site    | Reel Diameter (mm) | Reel Width (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|---------|------|---------|--------------------|-----------------|---------|---------|---------|---------|--------|---------------|
| 74AC16244DGGR | DGG     | 48   | SITE 41 | 330                | 24              | 8.6     | 15.8    | 1.8     | 12      | 24     | Q1            |
| 74AC16244DLR  | DL      | 48   | SITE 41 | 330                | 32              | 11.35   | 16.2    | 3.1     | 16      | 32     | Q1            |

## TAPE AND REEL BOX DIMENSIONS



| Device        | Package | Pins | Site    | Length (mm) | Width (mm) | Height (mm) |
|---------------|---------|------|---------|-------------|------------|-------------|
| 74AC16244DGGR | DGG     | 48   | SITE 41 | 346.0       | 346.0      | 41.0        |
| 74AC16244DLR  | DL      | 48   | SITE 41 | 346.0       | 346.0      | 49.0        |

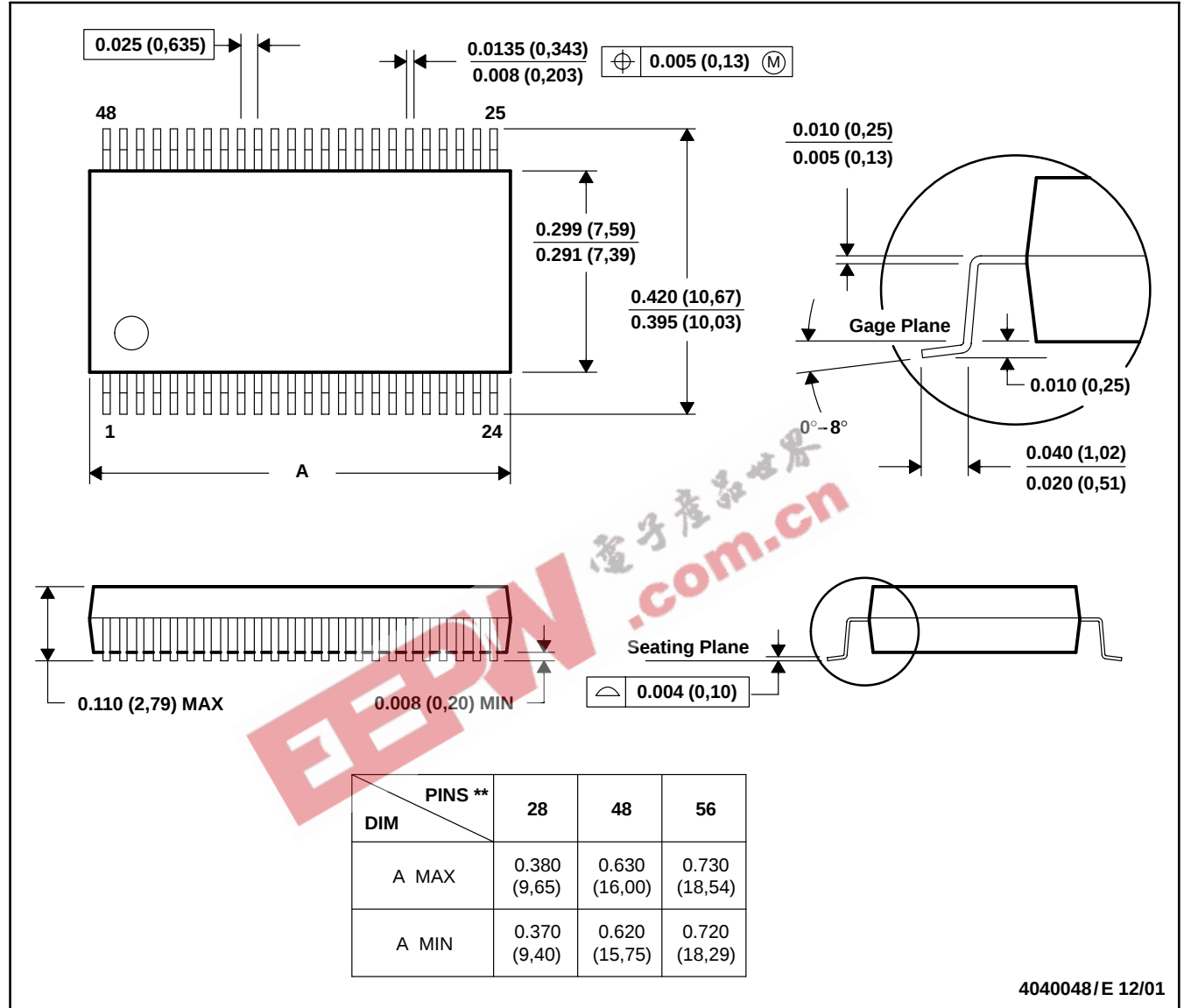
# MECHANICAL DATA

MSS0001C – JANUARY 1995 – REVISED DECEMBER 2001

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

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



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

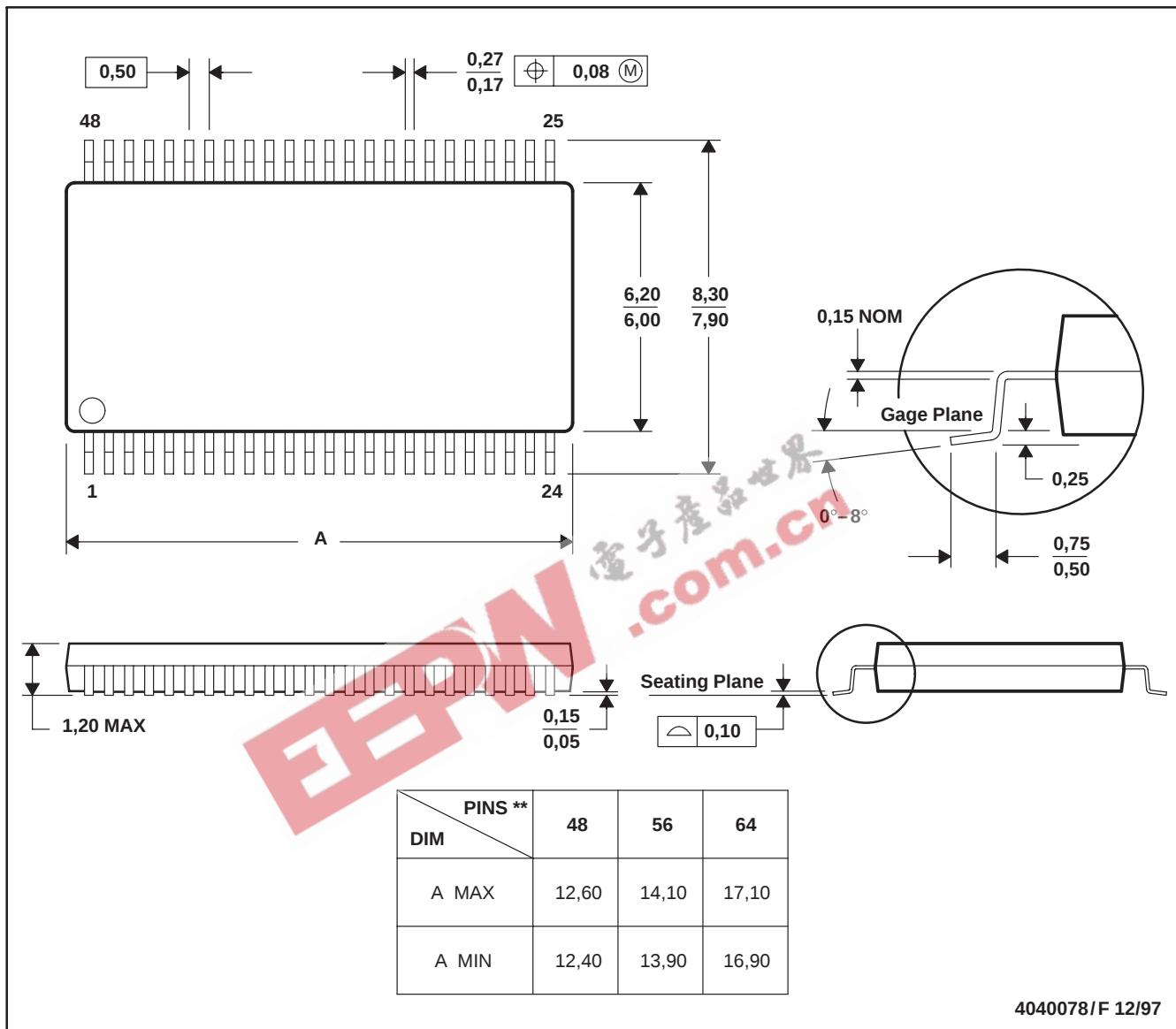
# MECHANICAL DATA

MTSS003D – JANUARY 1995 – REVISED JANUARY 1998

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 TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

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

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

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

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

### Products

|                    |                                                                    |
|--------------------|--------------------------------------------------------------------|
| Amplifiers         | <a href="http://amplifier.ti.com">amplifier.ti.com</a>             |
| Data Converters    | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     |
| DSP                | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
| Interface          | <a href="http://interface.ti.com">interface.ti.com</a>             |
| Logic              | <a href="http://logic.ti.com">logic.ti.com</a>                     |
| Power Mgmt         | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers   | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
| RFID               | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               |
| Low Power Wireless | <a href="http://www.ti.com/lpw">www.ti.com/lpw</a>                 |

### Applications

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2007, Texas Instruments Incorporated