

- **Members of the Texas Instruments Widebus™ Family**
- **5-Ω Switch Connection Between Two Ports**
- **TTL-Compatible Input Levels**

**description/ordering information**

The SN54CBT16209 and SN74CBT16209A devices provide 18 bits of high-speed TTL-compatible bus switching or exchanging. The low on-state resistance of the switches allows connections to be made with minimal propagation delay.

The devices operate as an 18-bit bus switch or a 9-bit bus exchanger, which provides data exchanging between the four signal ports via the data-select (S0, S1, S2) terminals.

SN54CBT16209 . . . WD PACKAGE  
SN74CBT16209A . . . DGG, DGV, OR DL PACKAGE  
(TOP VIEW)

|                 |    |    |     |
|-----------------|----|----|-----|
| S0              | 1  | 48 | S1  |
| 1A1             | 2  | 47 | S2  |
| 1A2             | 3  | 46 | 1B1 |
| GND             | 4  | 45 | 1B2 |
| 2A1             | 5  | 44 | 2B1 |
| 2A2             | 6  | 43 | 2B2 |
| V <sub>CC</sub> | 7  | 42 | GND |
| 3A1             | 8  | 41 | 3B1 |
| 3A2             | 9  | 40 | 3B2 |
| GND             | 10 | 39 | GND |
| 4A1             | 11 | 38 | 4B1 |
| 4A2             | 12 | 37 | 4B2 |
| 5A1             | 13 | 36 | 5B1 |
| 5A2             | 14 | 35 | 5B2 |
| GND             | 15 | 34 | GND |
| 6A1             | 16 | 33 | 6B1 |
| 6A2             | 17 | 32 | 6B2 |
| 7A1             | 18 | 31 | 7B1 |
| 7A2             | 19 | 30 | 7B2 |
| GND             | 20 | 29 | GND |
| 8A1             | 21 | 28 | 8B1 |
| 8A2             | 22 | 27 | 8B2 |
| 9A1             | 23 | 26 | 9B1 |
| 9A2             | 24 | 25 | 9B2 |

## ORDERING INFORMATION

| T <sub>A</sub> | PACKAGE†    |               | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|----------------|-------------|---------------|--------------------------|---------------------|
| -40°C to 85°C  | SSOP – DL   | Tube          | SN74CBT16209ADL          | CBT16209A           |
|                |             | Tape and reel | SN74CBT16209ADLR         |                     |
|                | TSSOP – DGG | Tape and reel | SN74CBT16209ADGGR        | CBT16209A           |
|                | TVSOP – DGV | Tape and reel | SN74CBT16209ADGVR        | CY209A              |
| -55°C to 125°C | CFP – WD    | Tube          | SNJ54CBT16209WD          | SNJ54CBT16209WD     |

† 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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# TEXAS

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processing does not necessarily include testing of all parameters.

SN54CBT16209, SN74CBT16209A  
18-BIT FET BUS-EXCHANGE SWITCHES

SCDS006O – NOVEMBER 1992 – REVISED NOVEMBER 2004

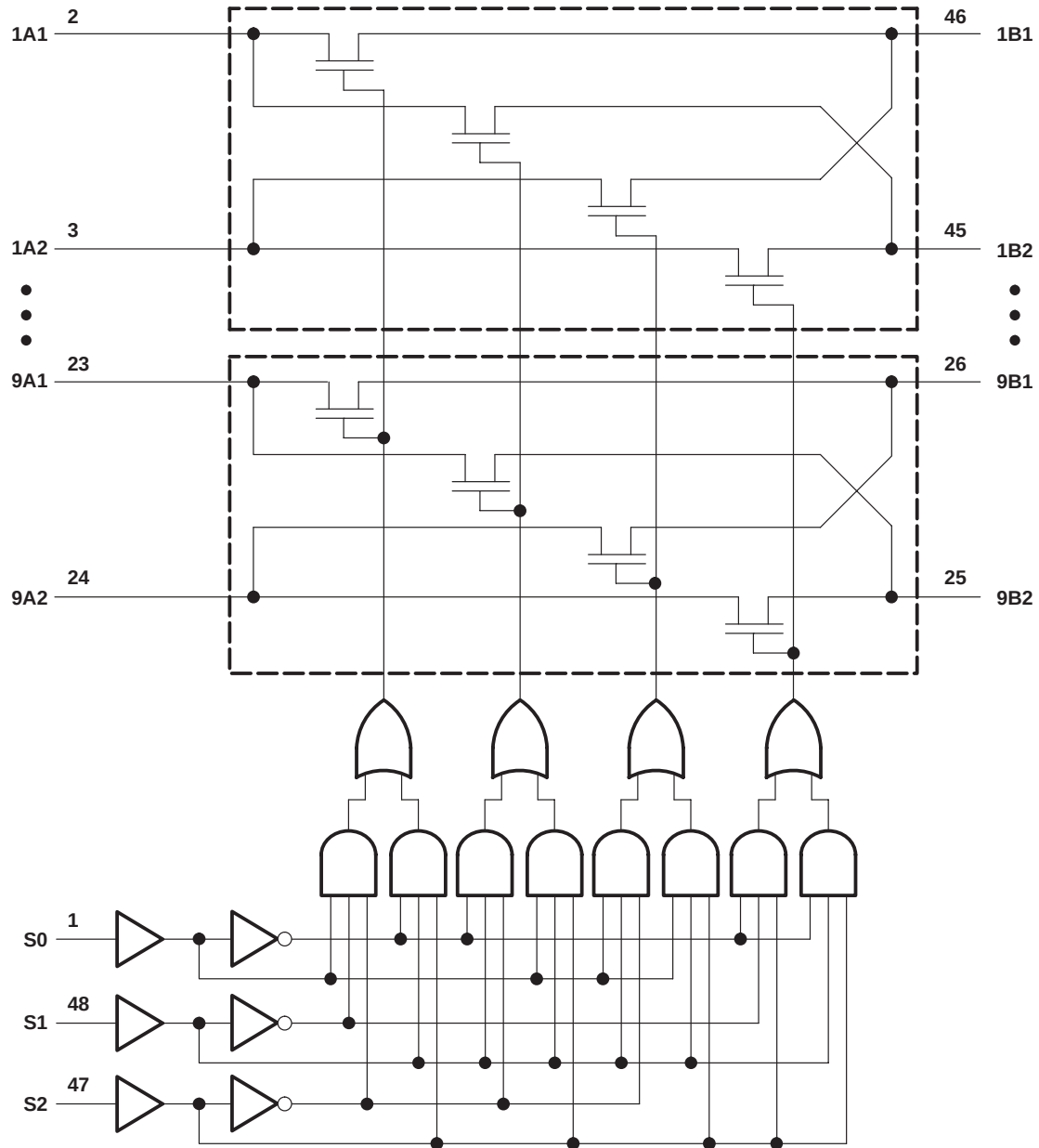
FUNCTION TABLE

| INPUTS |    |    | INPUTS/OUTPUTS |    | FUNCTION                               |
|--------|----|----|----------------|----|----------------------------------------|
| S2     | S1 | S0 | A1             | A2 |                                        |
| L      | L  | L  | Z              | Z  | Disconnect                             |
| L      | L  | H  | B1             | Z  | A1 port = B1 port                      |
| L      | H  | L  | B2             | Z  | A1 port = B2 port                      |
| L      | H  | H  | Z              | B1 | A2 port = B1 port                      |
| H      | L  | L  | Z              | B2 | A2 port = B2 port                      |
| H      | L  | H  | Z              | Z  | Disconnect                             |
| H      | H  | L  | B1             | B2 | A1 port = B1 port<br>A2 port = B2 port |
| H      | H  | H  | B2             | B1 | A1 port = B2 port<br>A2 port = B1 port |

# SN54CBT16209, SN74CBT16209A 18-BIT FET BUS-EXCHANGE SWITCHES

SCDS006O – NOVEMBER 1992 – REVISED NOVEMBER 2004

logic diagram (positive logic)



# SN54CBT16209, SN74CBT16209A

## 18-BIT FET BUS-EXCHANGE SWITCHES

SCDS0060 – NOVEMBER 1992 – REVISED NOVEMBER 2004

### 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 7 V  |
| Continuous channel current                                         | 128 mA         |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ )                        | –50 mA         |
| Package thermal impedance, $\theta_{JA}$ (see Note 2): DGG package | 70°C/W         |
| DGV package                                                        | 58°C/W         |
| DL package                                                         | 63°C/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 negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.  
2. The package thermal impedance is calculated in accordance with JESD 51-7.

### recommended operating conditions (see Note 3)

|          |                                  | SN54CBT16209 |     | SN74CBT16209A |     | UNIT |
|----------|----------------------------------|--------------|-----|---------------|-----|------|
|          |                                  | MIN          | MAX | MIN           | MAX |      |
| $V_{CC}$ | Supply voltage                   | 4            | 5.5 | 4             | 5.5 | V    |
| $V_{IH}$ | High-level control input voltage | 2            |     | 2             |     | V    |
| $V_{IL}$ | Low-level control input voltage  |              | 0.8 |               | 0.8 | V    |
| $T_A$    | Operating free-air temperature   | –55          | 125 | –40           | 85  | °C   |

NOTE 3: All unused control inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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

| PARAMETER                    |                | TEST CONDITIONS                         |                                                     | MIN | TYP <sup>‡</sup> | MAX     | UNIT     |
|------------------------------|----------------|-----------------------------------------|-----------------------------------------------------|-----|------------------|---------|----------|
| $V_{IK}$                     |                | $V_{CC} = 4.5$ V,                       | $I_I = -18$ mA                                      |     |                  | –1.2    | V        |
| $I_I$                        |                | $V_{CC} = 0$ ,                          | $V_I = 5.5$ V                                       |     |                  | 10      | $\mu$ A  |
|                              |                | $V_{CC} = 5.5$ V,                       | $V_I = 5.5$ V or GND                                |     |                  | $\pm 1$ |          |
| $I_{CC}$                     |                | $V_{CC} = 5.5$ V,                       | $I_O = 0$ , $V_I = V_{CC}$ or GND                   |     |                  | 3       | $\mu$ A  |
| $\Delta I_{CC}$ <sup>§</sup> | Control inputs | $V_{CC} = 5.5$ V,                       | One input at 3.4 V, Other inputs at $V_{CC}$ or GND |     |                  | 2.5     | mA       |
| $C_i$                        | Control inputs | $V_I = 3$ V or 0                        |                                                     |     |                  | 4       | pF       |
| $C_{io(OFF)}$                |                | $V_O = 3$ V or 0,                       | S0, S1, and S2 = GND                                |     |                  | 7.5     | pF       |
| $r_{on}$ <sup>¶</sup>        |                | $V_{CC} = 4$ V<br>TYP at $V_{CC} = 4$ V | $V_I = 2.4$ V, $I_I = 15$ mA                        |     |                  | 14 20   | $\Omega$ |
|                              |                | $V_{CC} = 4.5$ V                        | $V_I = 0$                                           |     |                  | 4 8     |          |
|                              |                |                                         | $I_I = 64$ mA                                       |     |                  | 4 8     |          |
|                              |                |                                         | $I_I = 30$ mA                                       |     |                  | 4 8     |          |
| $r_{on}$ <sup>¶</sup>        |                | $V_{CC} = 4.5$ V                        | $V_I = 2.4$ V, $I_I = 15$ mA                        |     |                  | 6 15    | $\Omega$ |
|                              |                |                                         |                                                     |     |                  |         |          |

<sup>‡</sup> All typical values are at  $V_{CC} = 5$  V (unless otherwise noted),  $T_A = 25^\circ\text{C}$ .

<sup>§</sup> This is the increase in supply current for each input that is at the specified TTL voltage level, rather than  $V_{CC}$  or GND.

<sup>¶</sup> Measured by the voltage drop between the A and B terminals at the indicated current through the switch. On-state resistance is determined by the lower of the voltages of the two (A or B) terminals.

# SN54CBT16209, SN74CBT16209A 18-BIT FET BUS-EXCHANGE SWITCHES

SCDS006O – NOVEMBER 1992 – REVISED NOVEMBER 2004

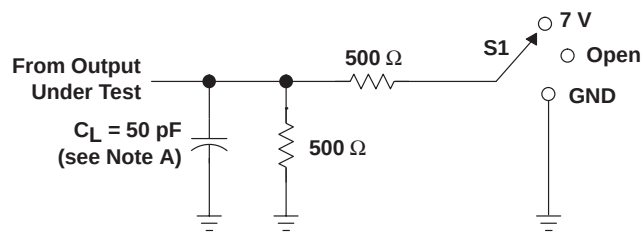
switching characteristics over recommended operating free-air temperature range,  $C_L = 50$  pF (unless otherwise noted) (see Figure 1)

| PARAMETER                    | FROM<br>(INPUT) | TO<br>(OUTPUT) | SN54CBT16209          |      |                                  |      | SN74CBT16209A         |      |                                  |     | UNIT |
|------------------------------|-----------------|----------------|-----------------------|------|----------------------------------|------|-----------------------|------|----------------------------------|-----|------|
|                              |                 |                | V <sub>CC</sub> = 4 V |      | V <sub>CC</sub> = 5 V<br>± 0.5 V |      | V <sub>CC</sub> = 4 V |      | V <sub>CC</sub> = 5 V<br>± 0.5 V |     |      |
|                              |                 |                | MIN                   | MAX  | MIN                              | MAX  | MIN                   | MAX  | MIN                              | MAX |      |
| t <sub>pd</sub> <sup>†</sup> | A or B          | B or A         |                       |      | 0.8*                             |      | 0.35                  |      | 0.25                             | ns  |      |
| t <sub>pd</sub>              | S               | A or B         |                       | 14   | 2                                | 13.1 |                       | 9.9  | 1.5                              | 9   | ns   |
| t <sub>en</sub>              | S               | A or B         |                       | 16   | 1.7                              | 15.3 |                       | 10.3 | 1.5                              | 9.8 | ns   |
| t <sub>dis</sub>             | S               | A or B         |                       | 14.5 | 1                                | 13.2 |                       | 9.3  | 1.5                              | 8.8 | ns   |

\* On products compliant to MIL-PRF-38535, this parameter is not production tested.

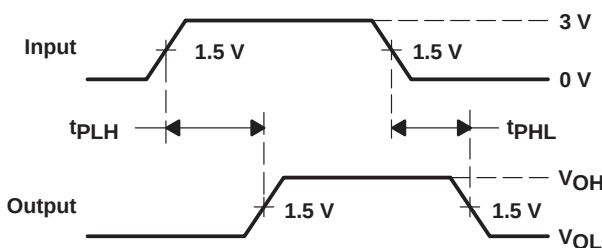
$^\dagger$  The propagation delay is the calculated RC time constant of the typical on-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).

## PARAMETER MEASUREMENT INFORMATION

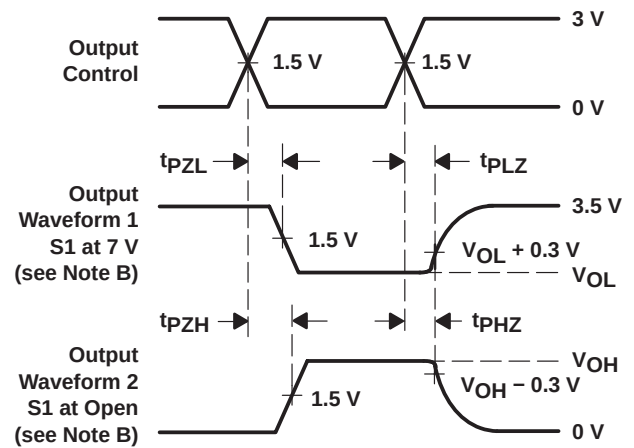


LOAD CIRCUIT

| TEST              | S1   |
|-------------------|------|
| $t_{pd}$          | Open |
| $t_{PLZ}/t_{PZL}$ | 7 V  |
| $t_{PHZ}/t_{PZH}$ | Open |



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES

- 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,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns.
  - 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  $t_{pd}$ .

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> |
|--------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 5962-9669701QXA    | ACTIVE                | CFP          | WD              | 48   | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |
| 74CBT16209ADGGRE4  | ACTIVE                | TSSOP        | DGG             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74CBT16209ADGGRG4  | ACTIVE                | TSSOP        | DGG             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74CBT16209ADGVRE4  | ACTIVE                | TVSOP        | DGV             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| 74CBT16209ADGVRG4  | ACTIVE                | TVSOP        | DGV             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SN74CBT16209ADGGR  | ACTIVE                | TSSOP        | DGG             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SN74CBT16209ADGVR  | ACTIVE                | TVSOP        | DGV             | 48   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SN74CBT16209ADL    | ACTIVE                | SSOP         | DL              | 48   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SN74CBT16209ADLG4  | ACTIVE                | SSOP         | DL              | 48   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SN74CBT16209ADLR   | ACTIVE                | SSOP         | DL              | 48   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SN74CBT16209ADLRG4 | ACTIVE                | SSOP         | DL              | 48   | 1000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| SNJ54CBT16209WD    | ACTIVE                | CFP          | WD              | 48   | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type           |

<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)

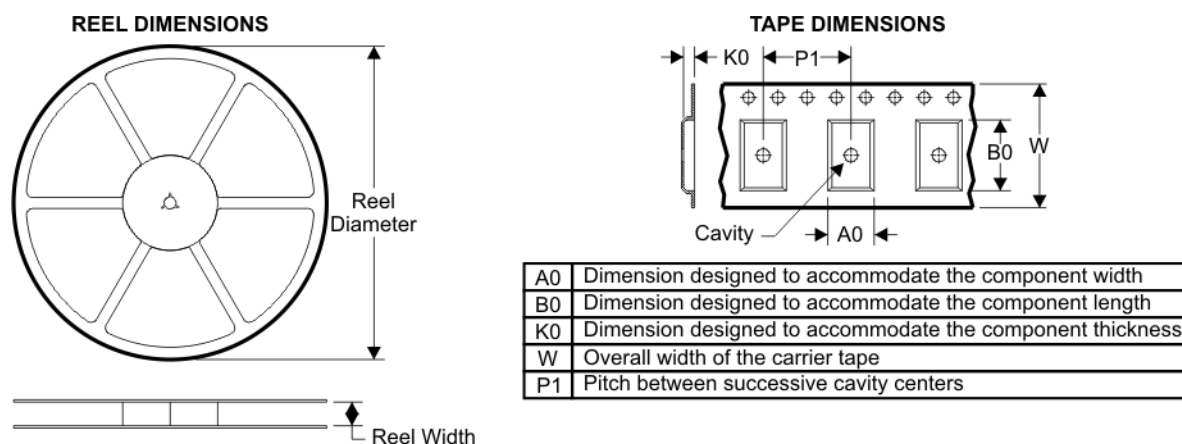
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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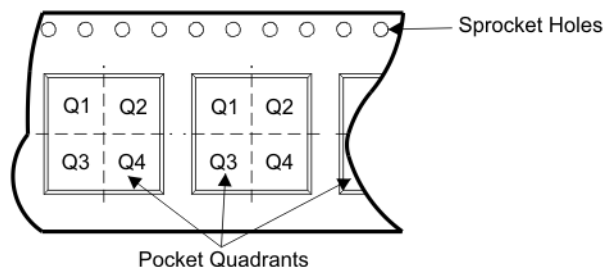
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**TAPE AND REEL BOX INFORMATION**



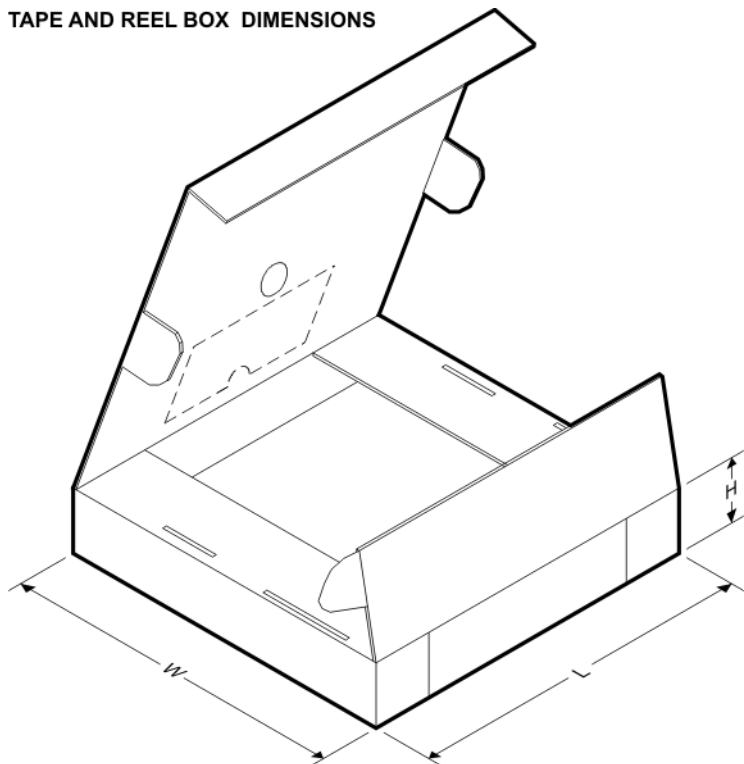
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



| Device            | Package | Pins | Site    | Reel Diameter (mm) | Reel Width (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------------|---------|------|---------|--------------------|-----------------|---------|---------|---------|---------|--------|---------------|
| SN74CBT16209ADGGR | DGG     | 48   | SITE 41 | 330                | 24              | 8.6     | 15.8    | 1.8     | 12      | 24     | Q1            |
| SN74CBT16209ADGVR | DGV     | 48   | SITE 41 | 330                | 24              | 6.8     | 10.1    | 1.6     | 12      | 24     | Q1            |
| SN74CBT16209ADLR  | 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) |
|-------------------|---------|------|---------|-------------|------------|-------------|
| SN74CBT16209ADGGR | DGG     | 48   | SITE 41 | 346.0       | 346.0      | 41.0        |
| SN74CBT16209ADGVR | DGV     | 48   | SITE 41 | 346.0       | 346.0      | 41.0        |
| SN74CBT16209ADLR  | DL      | 48   | SITE 41 | 346.0       | 346.0      | 49.0        |

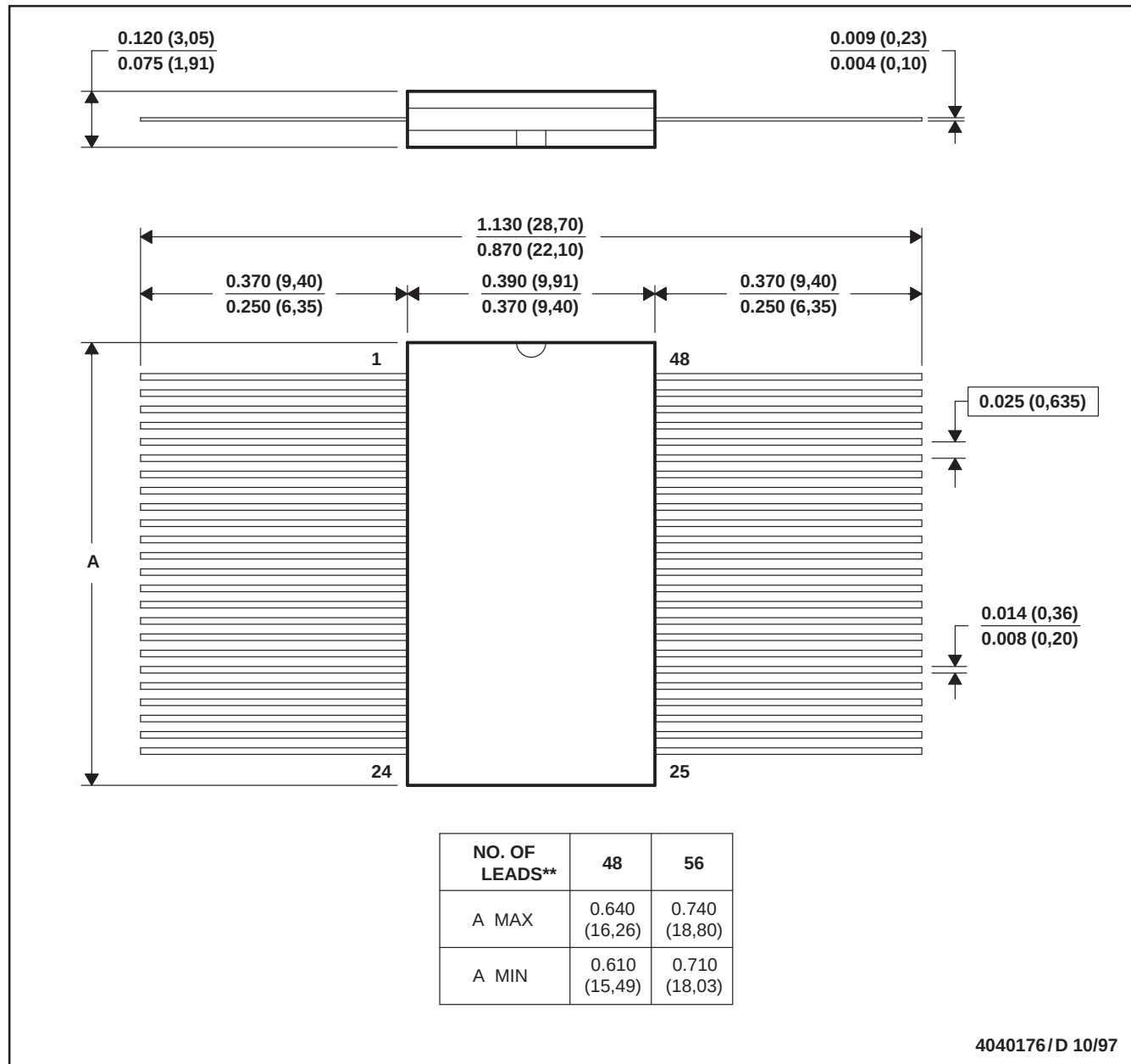
# MECHANICAL DATA

MCFP010B – JANUARY 1995 – REVISED NOVEMBER 1997

WD (R-GDFP-F\*\*)

CERAMIC DUAL FLATPACK

48 LEADS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only
  - E. Falls within MIL STD 1835: GDFP1-F48 and JEDEC MO-146AA  
GDFP1-F56 and JEDEC MO-146AB

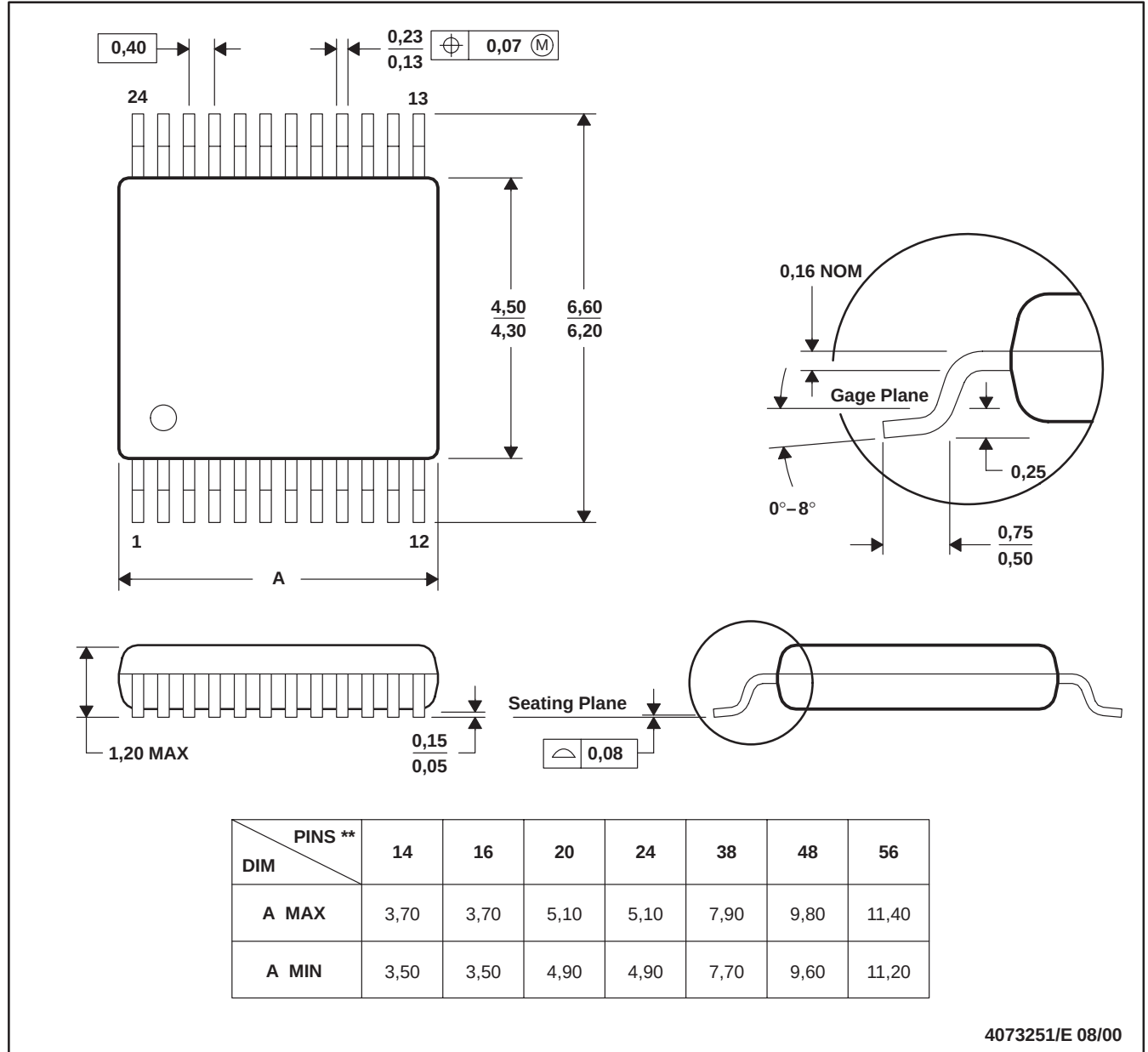
# MECHANICAL DATA

MPDS006C – FEBRUARY 1996 – REVISED AUGUST 2000

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

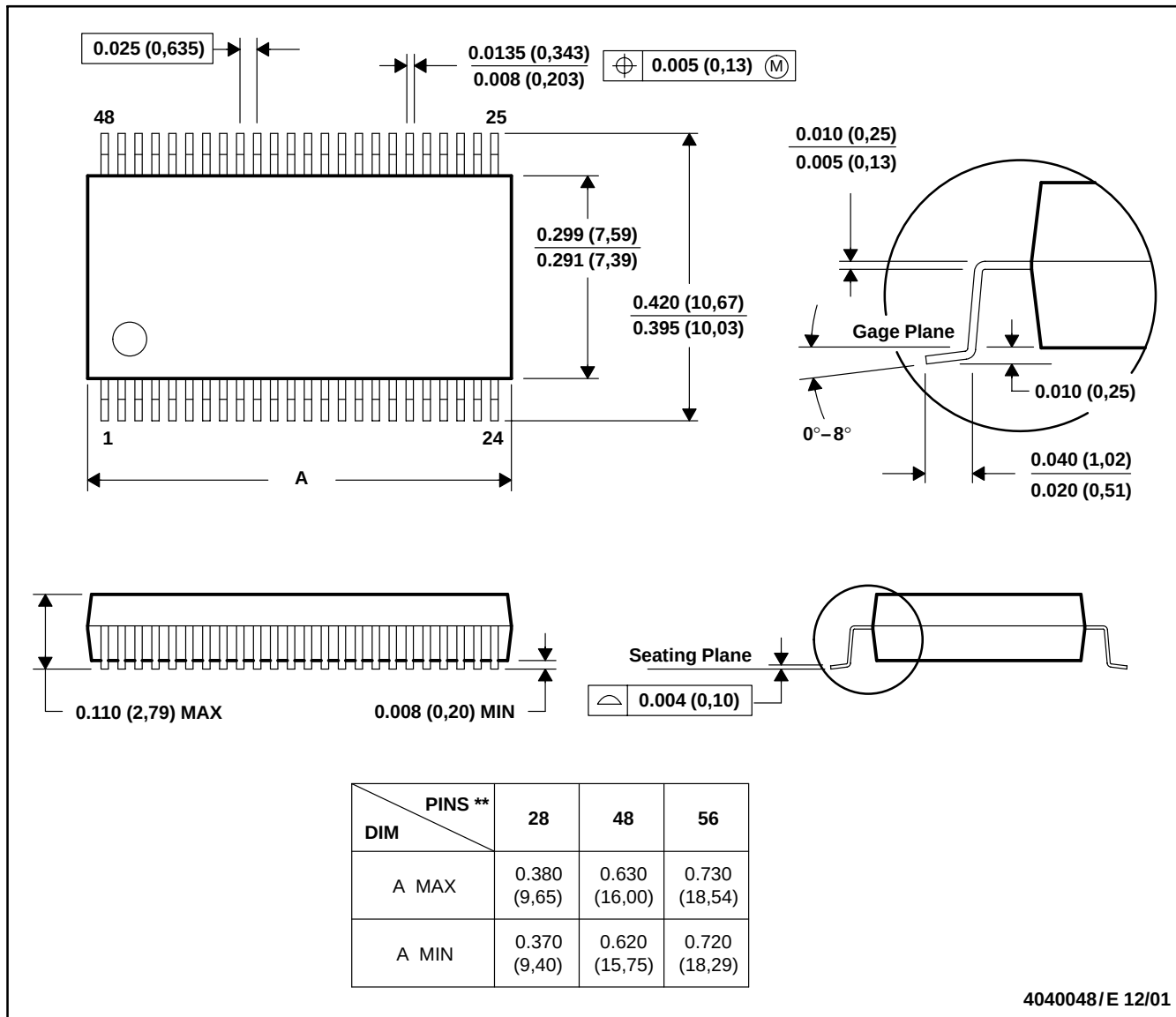
# MECHANICAL DATA

MSS0001C – JANUARY 1995 – REVISED DECEMBER 2001

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

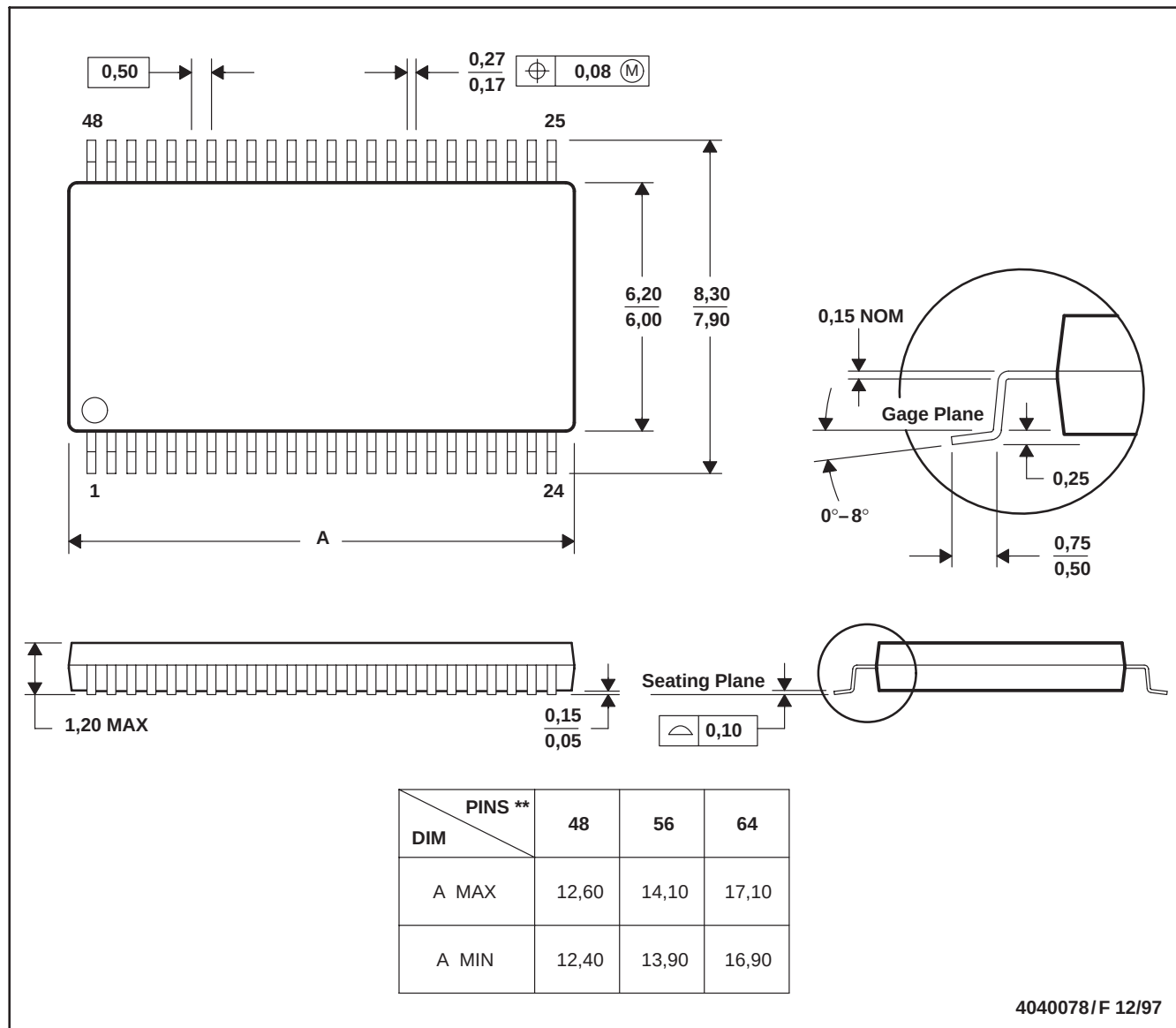
# MECHANICAL DATA

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

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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        | <a href="http://www.ti.com/lpw">www.ti.com/lpw</a>                 |
| Wireless         |                                                                    |

### 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>             |