

# CD4063B Types

## CMOS 4-Bit Magnitude Comparator

High Voltage Types (20-Volt Rating)

■ CD4063B is a 4-bit magnitude comparator designed for use in computer and logic applications that require the comparison of two 4-bit words. This logic circuit determines whether one 4-bit word (Binary or BCD) is “less than”, “equal to”, or “greater than” a second 4-bit word.

The CD4063B has eight comparing inputs (A3, B3, through A0, B0), three outputs (A < B, A = B, A > B) and three cascading inputs (A < B, A = B, A > B) that permit systems designers to expand the comparator function to 8, 12, 16 . . . 4N bits. When a single CD4063B is used, the cascading inputs are connected as follows: (A < B) = low, (A = B) = high, (A > B) = low.

For words longer than 4 bits, CD4063B devices may be cascaded by connecting the outputs of the less-significant comparator to the corresponding cascading inputs of the more-significant comparator. Cascading inputs (A < B, A = B, and A > B) on the least significant comparator are connected to a low, a high, and a low level, respectively.

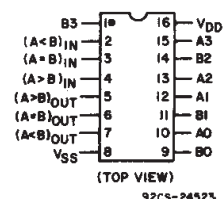
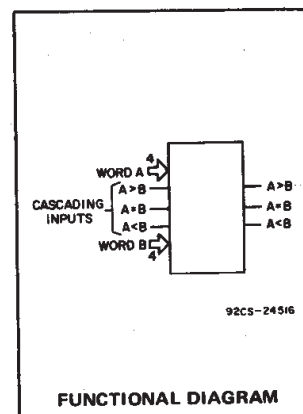
The CD4063B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (M, M96, MT, and NSR suffixes), and 16-lead thin shrink small-outline packages (PW and PWR suffixes). This device is pin-compatible with the standard 7485 TTL type.

### Features:

- Expansion to 8, 12, 16 . . . 4N bits by cascading units
- Medium-speed operation:  
compares two 4-bit words  
in 250 ns (typ.) at 10 V
- 100% tested for quiescent current at 20 V
- Standardized symmetrical output characteristics
- 5-V, 10-V, and 15-V parametric ratings
- Maximum input current of 1  $\mu$ A at 18 V  
over full package temperature range;  
100 nA at 18 V and 25°C
- Noise margin (full package temperature range)  
range) = 1 V at  $V_{DD} = 5$  V  
2 V at  $V_{DD} = 10$  V  
2.5 V at  $V_{DD} = 15$  V
- Meets all requirements of JEDEC Tentative  
Standard No. 13B, “Standard Specifications  
for Description of ‘B’ Series CMOS Devices”

### Applications:

- Servo motor controls ■ Process controllers

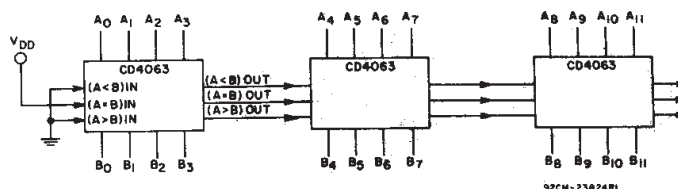


### MAXIMUM RATINGS, Absolute-Maximum Values:

|                                                                             |                                                      |
|-----------------------------------------------------------------------------|------------------------------------------------------|
| DC SUPPLY-VOLTAGE RANGE, ( $V_{DD}$ )                                       | -.0.5V to +20V                                       |
| Voltages referenced to $V_{SS}$ Terminal                                    |                                                      |
| INPUT VOLTAGE RANGE, ALL INPUTS                                             | -.0.5V to $V_{DD} + 0.5$ V                           |
| DC INPUT CURRENT, ANY ONE INPUT                                             | $\pm 10$ mA                                          |
| POWER DISSIPATION PER PACKAGE ( $P_D$ ):                                    |                                                      |
| For $T_A = -55^\circ\text{C}$ to $+100^\circ\text{C}$                       | 500 mW                                               |
| For $T_A = +100^\circ\text{C}$ to $+125^\circ\text{C}$                      | Derate Linearly at 12 mW/ $^\circ\text{C}$ to 200 mW |
| DEVICE DISSIPATION PER OUTPUT TRANSISTOR                                    |                                                      |
| FOR $T_A = \text{FULL PACKAGE-TEMPERATURE RANGE (All Package Types)}$       | 100 mW                                               |
| OPERATING-TEMPERATURE RANGE ( $T_A$ )                                       | $-55^\circ\text{C}$ to $+125^\circ\text{C}$          |
| STORAGE TEMPERATURE RANGE ( $T_{stg}$ )                                     | $-65^\circ\text{C}$ to $+150^\circ\text{C}$          |
| LEAD TEMPERATURE (DURING SOLDERING):                                        |                                                      |
| At distance 1/16 $\pm$ 1/32 inch (1.59 $\pm$ 0.79 mm) from case for 10s max | $+265^\circ\text{C}$                                 |

**RECOMMENDED OPERATING CONDITIONS**  
For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

| CHARACTERISTIC                                                               | LIMITS |      | UNITS |
|------------------------------------------------------------------------------|--------|------|-------|
|                                                                              | Min.   | Max. |       |
| Supply-Voltage Range<br>(For $T_A = \text{Full Package-Temperature Range}$ ) | 3      | 18   | V     |



$$t_{p \text{ TOTAL}} = t_{p \text{ (COMPARE)}} + 3 \times t_{p \text{ (CASCADE)}} \text{ AT } V_{DD} = 10\text{V}$$

$$(3 \text{ STAGES})$$

$$= 250 + (2 \times 200) = 650 \text{ ns (TYP.)}$$

Fig. 1 – Typical speed characteristics of a 12-bit comparator.

# CD4063B Types

## STATIC ELECTRICAL CHARACTERISTICS

| CHARACTER-<br>ISTIC                                         | CONDITIONS            |                        |                        | LIMITS AT INDICATED TEMPERATURES (°C) |       |       |       |       |                   |      | UNITS |
|-------------------------------------------------------------|-----------------------|------------------------|------------------------|---------------------------------------|-------|-------|-------|-------|-------------------|------|-------|
|                                                             | V <sub>O</sub><br>(V) | V <sub>IN</sub><br>(V) | V <sub>DD</sub><br>(V) |                                       |       |       |       | +25   |                   |      |       |
|                                                             |                       |                        |                        | -55                                   | -40   | +85   | +125  | Min.  | Typ.              | Max. |       |
| Quiescent Device<br>Current,<br>I <sub>DD</sub> Max.        | —                     | 0,5                    | 5                      | 5                                     | 5     | 150   | 150   | —     | 0.04              | 5    | μA    |
|                                                             | —                     | 0,10                   | 10                     | 10                                    | 10    | 300   | 300   | —     | 0.04              | 10   |       |
|                                                             | —                     | 0,15                   | 15                     | 20                                    | 20    | 600   | 600   | —     | 0.04              | 20   |       |
|                                                             | —                     | 0,20                   | 20                     | 100                                   | 100   | 3000  | 3000  | —     | 0.08              | 100  |       |
| Output Low<br>(Sink) Current<br>I <sub>OL</sub> Min.        | 0.4                   | 0,5                    | 5                      | 0.64                                  | 0.61  | 0.42  | 0.36  | 0.51  | 1                 | —    | mA    |
|                                                             | 0.5                   | 0,10                   | 10                     | 1.6                                   | 1.5   | 1.1   | 0.9   | 1.3   | 2.6               | —    |       |
|                                                             | 1.5                   | 0,15                   | 15                     | 4.2                                   | 4     | 2.8   | 2.4   | 3.4   | 6.8               | —    |       |
| Output High<br>(Source)<br>Current,<br>I <sub>OH</sub> Min. | 4.6                   | 0,5                    | 5                      | -0.64                                 | -0.61 | -0.42 | -0.36 | -0.51 | -1                | —    | mA    |
|                                                             | 2.5                   | 0,5                    | 5                      | -2                                    | -1.8  | -1.3  | -1.15 | -1.6  | -3.2              | —    |       |
|                                                             | 9.5                   | 0,10                   | 10                     | -1.6                                  | -1.5  | -1.1  | -0.9  | -1.3  | -2.6              | —    |       |
|                                                             | 13.5                  | 0,15                   | 15                     | -4.2                                  | -4    | -2.8  | -2.4  | -3.4  | -6.8              | —    |       |
| Output Voltage:<br>Low-Level,<br>V <sub>OL</sub> Max.       | —                     | 0,5                    | 5                      | 0.05                                  |       |       |       | —     | 0                 | 0.05 | V     |
|                                                             | —                     | 0,10                   | 10                     | 0.05                                  |       |       |       | —     | 0                 | 0.05 |       |
|                                                             | —                     | 0,15                   | 15                     | 0.05                                  |       |       |       | —     | 0                 | 0.05 |       |
| Output Voltage:<br>High-Level,<br>V <sub>OH</sub> Min.      | —                     | 0,5                    | 5                      | 4.95                                  |       |       |       | 4.95  | 5                 | —    | V     |
|                                                             | —                     | 0,10                   | 10                     | 9.95                                  |       |       |       | 9.95  | 10                | —    |       |
|                                                             | —                     | 0,15                   | 15                     | 14.95                                 |       |       |       | 14.95 | 15                | —    |       |
| Input Low<br>Voltage,<br>V <sub>IL</sub> Max.               | 0.5, 4.5              | —                      | 5                      | 1.5                                   |       |       |       | —     | —                 | 1.5  | V     |
|                                                             | 1, 9                  | —                      | 10                     | 3                                     |       |       |       | —     | —                 | 3    |       |
|                                                             | 1.5,13.5              | —                      | 15                     | 4                                     |       |       |       | —     | —                 | 4    |       |
| Input High<br>Voltage,<br>V <sub>IH</sub> Min.              | 0.5, 4.5              | —                      | 5                      | 3.5                                   |       |       |       | 3.5   | —                 | —    | V     |
|                                                             | 1, 9                  | —                      | 10                     | 7                                     |       |       |       | 7     | —                 | —    |       |
|                                                             | 1.5,13.5              | —                      | 15                     | 11                                    |       |       |       | 11    | —                 | —    |       |
| Input Current<br>I <sub>IN</sub> Max.                       | —                     | 0,18                   | 18                     | ±0.1                                  | ±0.1  | ±1    | ±1    | —     | ±10 <sup>-5</sup> | ±0.1 | μA    |

## TRUTH TABLE

| INPUTS    |         |         |         |           |       |       | OUTPUTS |       |       |
|-----------|---------|---------|---------|-----------|-------|-------|---------|-------|-------|
| COMPARING |         |         |         | CASCADING |       |       |         |       |       |
| A3, B3    | A2, B2  | A1, B1  | A0, B0  | A < B     | A = B | A > B | A < B   | A = B | A > B |
| A3 > B3   | X       | X       | X       | X         | X     | X     | 0       | 0     | 1     |
| A3 = B3   | A2 > B2 | X       | X       | X         | X     | X     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 > B1 | X       | X         | X     | X     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 > B0 | X         | X     | X     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 = B0 | 0         | 0     | 1     | 0       | 0     | 1     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 = B0 | 0         | 1     | 0     | 0       | 1     | 0     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 = B0 | 1         | 0     | 0     | 1       | 0     | 0     |
| A3 = B3   | A2 = B2 | A1 = B1 | A0 < B0 | X         | X     | X     | 1       | 0     | 0     |
| A3 = B3   | A2 = B2 | A1 < B1 | X       | X         | X     | X     | 1       | 0     | 0     |
| A3 = B3   | A2 < B2 | X       | X       | X         | X     | X     | 1       | 0     | 0     |
| A3 < B3   | X       | X       | X       | X         | X     | X     | 1       | 0     | 0     |

X = Don't Care

Logic 1 ≡ High Level

Logic 0 ≡ Low Level

# CD4063B Types

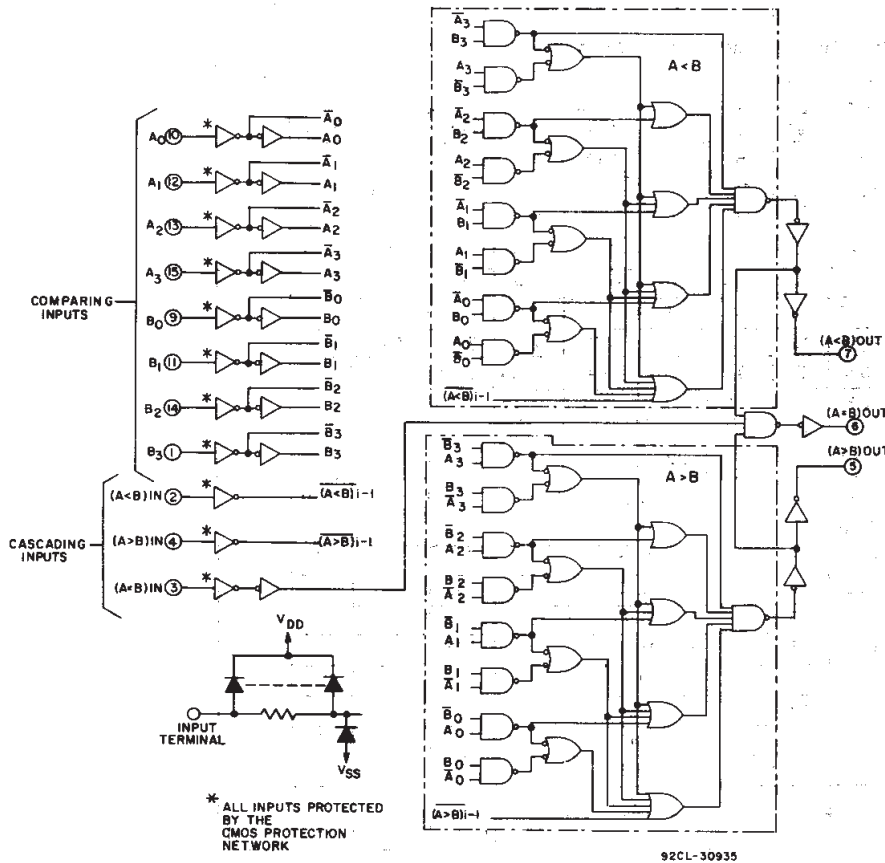


Fig. 2 – Logic diagram for CD4063B.

## DYNAMIC ELECTRICAL CHARACTERISTICS

At  $T_A = 25^\circ\text{C}$ ; Input  $t_r, t_f = 20\text{ ns}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ k}\Omega$

| CHARACTERISTIC                                                                                 | TEST CONDITIONS | LIMITS                   |      |      | UNITS |
|------------------------------------------------------------------------------------------------|-----------------|--------------------------|------|------|-------|
|                                                                                                |                 | V <sub>DD</sub><br>Volts | Typ. | Max. |       |
| Propagation Delay Time:<br>Comparing Inputs to<br>Outputs, t <sub>PHL</sub> , t <sub>PLH</sub> |                 | 5                        | 625  | 1250 | ns    |
|                                                                                                |                 | 10                       | 250  | 500  |       |
|                                                                                                |                 | 15                       | 175  | 350  |       |
| Cascading Inputs to<br>Outputs, t <sub>PHL</sub> , t <sub>PLH</sub>                            |                 | 5                        | 500  | 1000 |       |
|                                                                                                |                 | 10                       | 200  | 400  |       |
|                                                                                                |                 | 15                       | 140  | 280  |       |
| Transition Time,<br>t <sub>THL</sub> , t <sub>TLH</sub>                                        |                 | 5                        | 100  | 200  | ns    |
|                                                                                                |                 | 10                       | 50   | 100  |       |
|                                                                                                |                 | 15                       | 40   | 80   |       |
| Input Capacitance, C <sub>IN</sub>                                                             | Any Input       |                          | 5    | 7.5  | pF    |

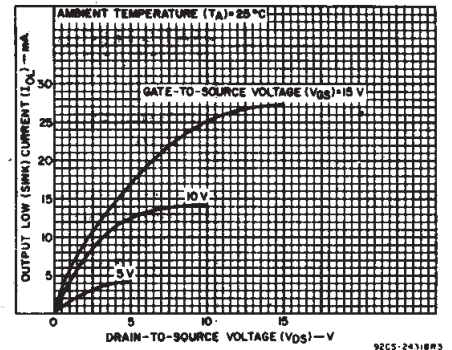


Fig. 3 – Typical output low (sink) current characteristics.

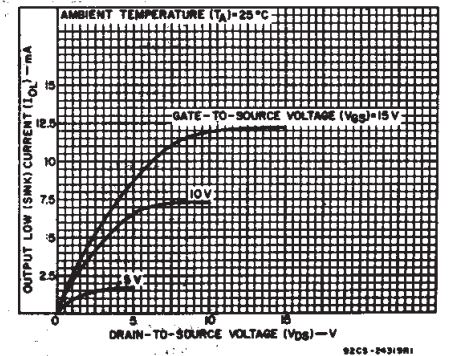


Fig. 4 – Minimum output low (sink) current characteristics.

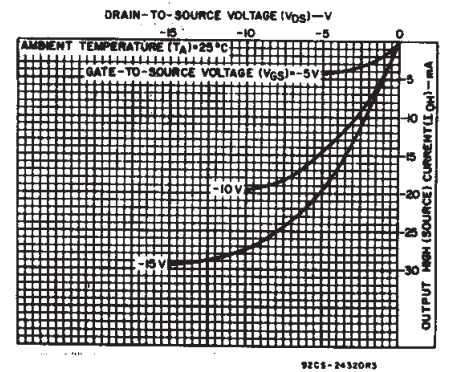


Fig. 5 – Typical output high (source) current characteristics.

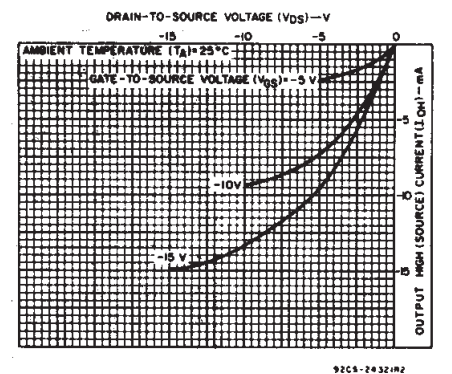


Fig. 6 – Minimum output high (source) current characteristics.

## CD4063B Types

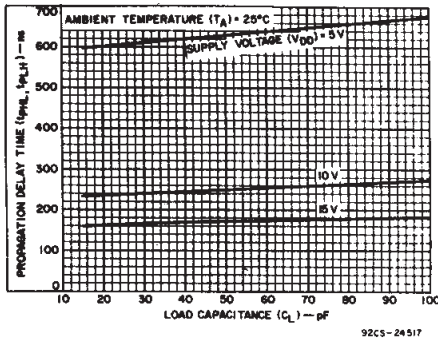


Fig. 7 - Typical propagation delay time vs. load capacitance ("comparing inputs" to outputs).

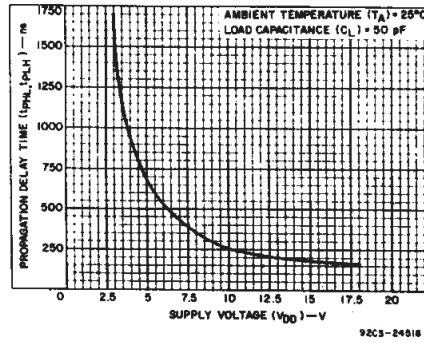


Fig. 8 - Typical propagation delay time vs. supply voltage ("comparing inputs" to outputs).

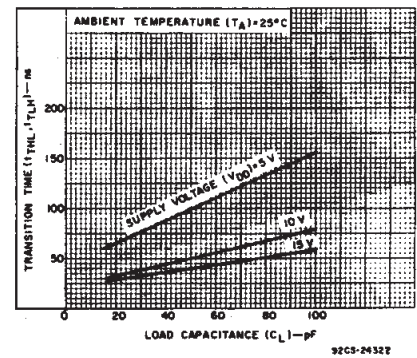


Fig. 9 - Typical transition time vs. load capacitance.

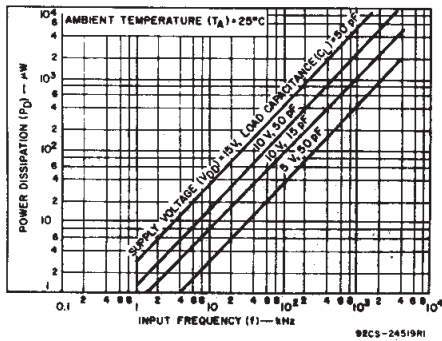


Fig. 10 - Typical power dissipation vs. frequency (see Fig. 12 - dynamic power dissipation test circuit).

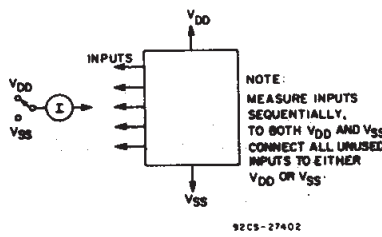


Fig. 11 - Input current test circuit.

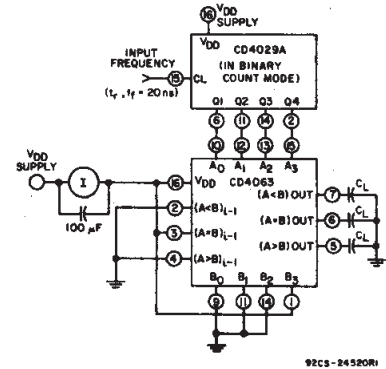


Fig. 12 - Dynamic power dissipation test circuit.

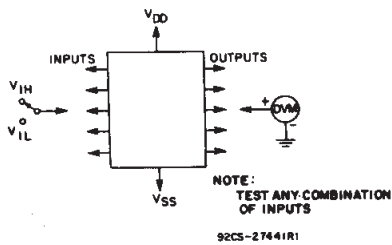


Fig. 13 - Input-voltage test circuit.

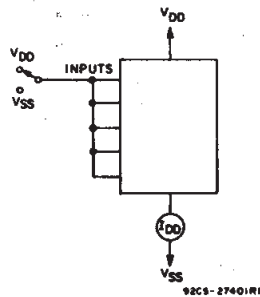
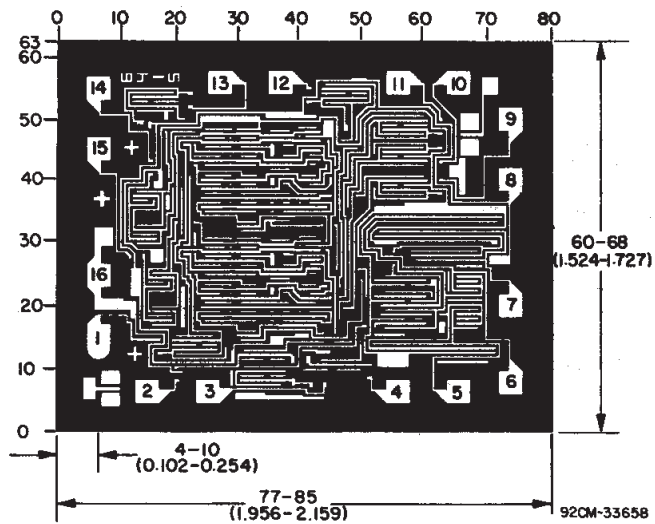


Fig. 14 - Quiescent-device-current test circuit.



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

**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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| CD4063BE         | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD4063BEE4       | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| CD4063BF         | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| CD4063BF3A       | ACTIVE                | CDIP         | J               | 16   | 1           | TBD                     | Call TI          | N / A for Pkg Type           |
| CD4063BM         | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BM96       | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BM96E4     | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BME4       | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BMT        | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BMTE4      | ACTIVE                | SOIC         | D               | 16   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BNSR       | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BNSRE4     | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BPW        | ACTIVE                | TSSOP        | PW              | 16   | 90          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BPWE4      | ACTIVE                | TSSOP        | PW              | 16   | 90          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BPWR       | ACTIVE                | TSSOP        | PW              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CD4063BPWRE4     | ACTIVE                | TSSOP        | PW              | 16   | 2000        | 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.

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J (R-GDIP-T\*\*)

14 LEADS SHOWN

# CERAMIC DUAL IN-LINE PACKAGE



| PINS **<br>DIM | 14                     | 16                     | 18                     | 20                     |
|----------------|------------------------|------------------------|------------------------|------------------------|
| A              | 0.300<br>(7,62)<br>BSC | 0.300<br>(7,62)<br>BSC | 0.300<br>(7,62)<br>BSC | 0.300<br>(7,62)<br>BSC |
| B MAX          | 0.785<br>(19,94)       | .840<br>(21,34)        | 0.960<br>(24,38)       | 1.060<br>(26,92)       |
| B MIN          | —                      | —                      | —                      | —                      |
| C MAX          | 0.300<br>(7,62)        | 0.300<br>(7,62)        | 0.310<br>(7,87)        | 0.300<br>(7,62)        |
| C MIN          | 0.245<br>(6,22)        | 0.245<br>(6,22)        | 0.220<br>(5,59)        | 0.245<br>(6,22)        |



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package is hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

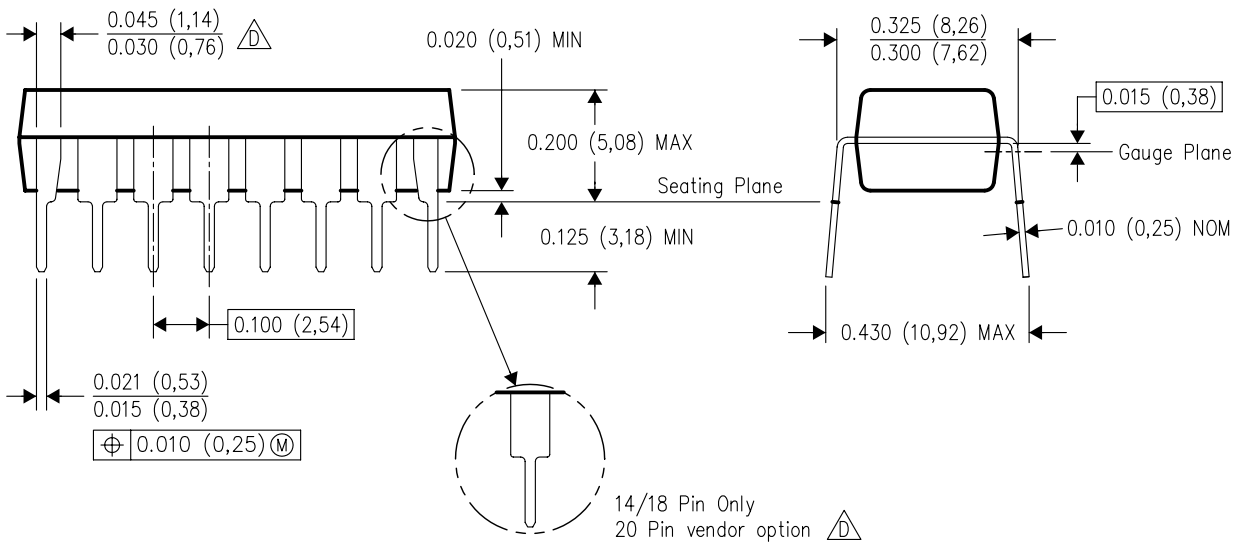
## N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



| PINS **             | 14               | 16               | 18               | 20               |
|---------------------|------------------|------------------|------------------|------------------|
| DIM                 |                  |                  |                  |                  |
| A MAX               | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 1.060<br>(26,92) |
| A MIN               | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |
| MS-001<br>VARIATION | AA               | BB               | AC               | AD               |

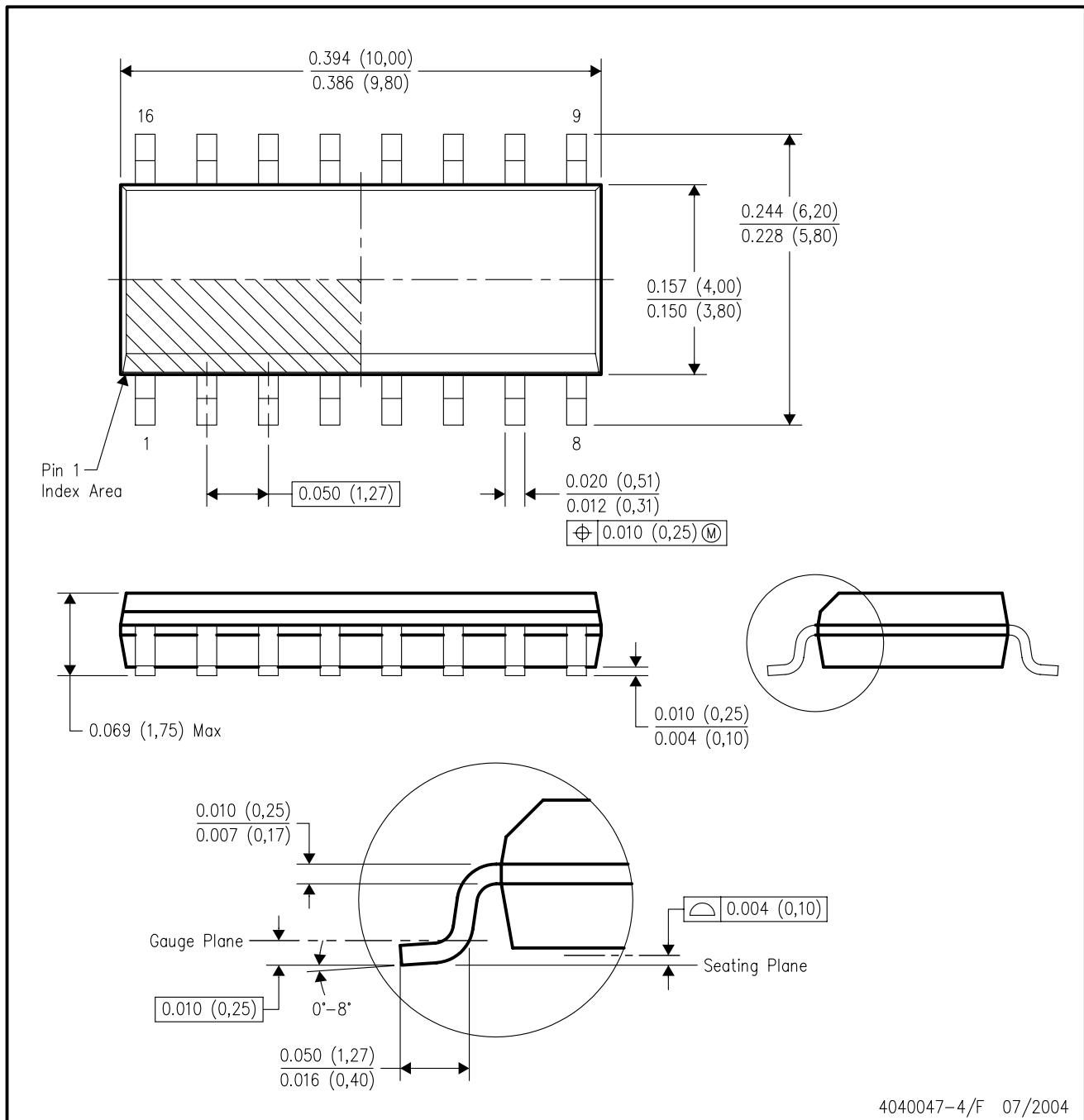


4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

## D (R-PDSO-G16)

## PLASTIC SMALL-OUTLINE PACKAGE



- 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 MS-012 variation AC.

# MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



| DIM \ PINS ** | 14    | 16    | 20    | 24    |
|---------------|-------|-------|-------|-------|
| A MAX         | 10,50 | 10,50 | 12,90 | 15,30 |
| A MIN         | 9,90  | 9,90  | 12,30 | 14,70 |

4040062/C 03/03

- 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.

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

## PLASTIC SMALL-OUTLINE PACKAGE

14 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.  
 D. Falls within JEDEC MO-153

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