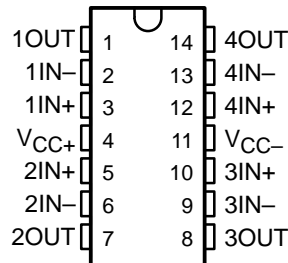


MC3303, MC3403 QUADRUPLE LOW-POWER OPERATIONAL AMPLIFIERS

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- Wide Range of Supply Voltages, Single Supply . . . 3 V to 36 V or Dual Supplies
- Class AB Output Stage
- True Differential Input Stage
- Low Input Bias Current
- Internal Frequency Compensation
- Short-Circuit Protection
- Designed to Be Interchangeable With Motorola MC3303, MC3403

MC3303 . . . D, N, OR PW PACKAGE
MC3403 . . . D, DB, N, NS, OR PW PACKAGE
(TOP VIEW)



description

The MC3303 and the MC3403 are quadruple operational amplifiers similar in performance to the μ A741, but with several distinct advantages. They are designed to operate from a single supply over a range of voltages from 3 V to 36 V. Operation from split supplies also is possible, provided the difference between the two supplies is 3 V to 36 V. The common-mode input range includes the negative supply. Output range is from the negative supply to $V_{CC} - 1.5$ V. Quiescent supply currents are less than one-half those of the μ A741.

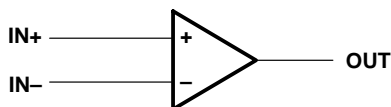
The MC3303 is characterized for operation from -40°C to 85°C , and the MC3403 is characterized for operation from 0°C to 70°C .

AVAILABLE OPTIONS

| T _A | V _{IO} MAX AT 25°C | PACKAGE | | | |
|---|--------------------------------|-------------------------------------|---|-----------------------|---|
| | | PLASTIC SMALL OUTLINE (D, NS) | PLASTIC SHRINK SMALL OUTLINE (DB) | PLASTIC DIP (N) | PLASTIC THIN SHRINK SMALL OUTLINE (PW) |
| 0°C to 70°C | 10 mV | MC3403D MC3403NS | MC3403DB | MC3403N | MC3403PW |
| -40°C to 85°C | 8 mV | MC3303D | — | MC3303N | MC3303PW |

The D package is available taped and reeled. Add R suffix to the device type (e.g., MC3403DR). The DB, NS, and PW packages are only available taped and reeled.

logic diagram (each amplifier)



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.

PRODUCTION DATA information is 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**

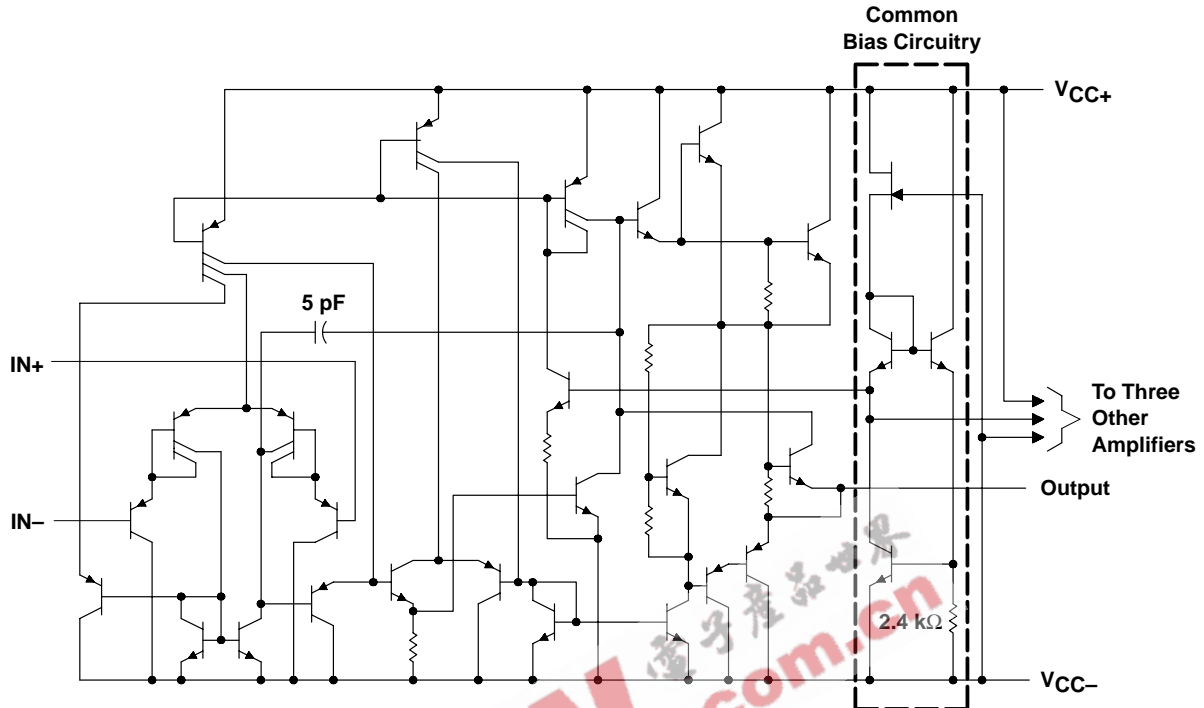
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MC3303, MC3403 QUADRUPLE LOW-POWER OPERATIONAL AMPLIFIERS

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schematic (each amplifier)



Component values shown are nominal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

| | |
|--|----------------|
| Supply voltage (see Note 1): V_{CC+} | 18 V |
| V_{CC-} | -18 V |
| Supply voltage, V_{CC+} with respect to V_{CC-} | 36 V |
| Differential input voltage (see Note 2) | ± 36 V |
| Input voltage (see Notes 1 and 3) | ± 18 V |
| Package thermal impedance, θ_{JA} (see Note 4): D package | 86°C/W |
| DB package | 96°C/W |
| N package | 80°C/W |
| NS package | 76°C/W |
| PW package | 113°C/W |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260°C |
| Storage temperature range, T_{stg} | -65°C to 150°C |

† 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. These voltage values are with respect to the midpoint between V_{CC+} and V_{CC-} .
2. Differential voltages are at $IN+$ with respect to $IN-$.
3. Neither input must ever be more positive than V_{CC+} or more negative than V_{CC-} .
4. The package thermal impedance is calculated in accordance with JESD 51-7.

MC3303, MC3403 QUADRUPLE LOW-POWER OPERATIONAL AMPLIFIERS

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recommended operating conditions

| | | MIN | MAX | UNIT | |
|---------------------|--------------------------------|-----------|------|------|----|
| V_{CC} | Supply voltage | 5 | 30 | V | |
| Dual-supply voltage | | V_{CC+} | 2.5 | 15 | V |
| | | V_{CC-} | -2.5 | -15 | V |
| T_A | Operating free-air temperature | MC3303 | -40 | 85 | °C |
| | | MC3403 | 0 | 70 | |

electrical characteristics at specified free-air temperature, $V_{CC+} = 14$ V, $V_{CC-} = 0$ V for MC3303, $V_{CC\pm} = \pm 15$ V for MC3403 (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | MC3303 | | | MC3403 | | | UNIT | |
|-------------------|---|------------|-----------------|-------------------|-----------------|-------------------|------------------------------|----------|----|
| | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{IO} | Input offset voltage See Note 5 | 25°C | 2 | 8 | 2 | 10 | mV | | |
| | | Full range | | 10 | | 12 | | | |
| $\alpha_{V_{IO}}$ | Temperature coefficient of input offset voltage See Note 5 | Full range | 10 | | 10 | | $\mu\text{V}/^\circ\text{C}$ | | |
| I_{IO} | Input offset current See Note 5 | 25°C | 30 | 75 | 30 | 50 | nA | | |
| | | Full range | | 250 | | 200 | | | |
| $\alpha_{I_{IO}}$ | Temperature coefficient of input offset current See Note 5 | Full range | 50 | | 50 | | pA/C | | |
| I_{IB} | Input bias current See Note 5 | 25°C | -0.2 | -0.5 | -0.2 | -0.5 | μA | | |
| | | Full range | | -1 | | -0.8 | | | |
| V_{ICR} | Common-mode input voltage range‡ | 25°C | V_{CC-} to 12 | V_{CC-} to 12.5 | V_{CC-} to 13 | V_{CC-} to 13.5 | V | | |
| V_{OM} | Peak output voltage swing $R_L = 10$ k Ω | 25°C | 12 | 12.5 | ± 12 | ± 13.5 | V | | |
| | | 25°C | 10 | 12 | ± 10 | ± 13 | | | |
| | | Full range | 10 | | ± 10 | | | | |
| A_{VD} | Large-signal differential voltage amplification $V_O = \pm 10$ V, $R_L = 2$ k Ω | 25°C | 20 | 200 | 20 | 200 | V/mV | | |
| | | Full range | 15 | | 15 | | | | |
| B_{OM} | Maximum-output-swing bandwidth $V_{OPP} = 20$ V, $A_{VD} = 1$, $\text{THD} \leq 5\%$, $R_L = 2$ k Ω | 25°C | 9 | | 9 | | kHz | | |
| B_1 | Unity-gain bandwidth $V_O = 50$ mV, $R_L = 10$ k Ω | 25°C | 1 | | 1 | | MHz | | |
| ϕ_m | Phase margin $C_L = 200$ pF, $R_L = 2$ k Ω | 25°C | 60° | | 60° | | | | |
| r_i | Input resistance $f = 20$ Hz | 25°C | 0.3 | 1 | 0.3 | 1 | M Ω | | |
| r_o | Output resistance $f = 20$ Hz | 25°C | 75 | | 75 | | Ω | | |
| CMRR | Common-mode rejection ratio $V_{IC} = V_{ICRmin}$ | 25°C | 70 | 90 | 70 | 90 | dB | | |
| k_{SVS} | Supply voltage sensitivity ($\Delta V_{IO}/\Delta V_{CC}$) $V_{CC\pm} = \pm 2.5$ to ± 15 V | 25°C | 30 | 150 | 30 | 150 | $\mu\text{V}/\text{V}$ | | |
| I_{OS} | Short-circuit output current§ | 25°C | ± 10 | ± 30 | ± 45 | ± 10 | ± 30 | ± 45 | mA |
| I_{CC} | Total supply current No load, See Note 5 | 25°C | 2.8 | 7 | 2.8 | 7 | mA | | |

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range for T_A is -40°C to 85°C for MC3303, and 0°C to 70°C for MC3403.

‡ The V_{ICR} limits are linked directly, volt-for-volt, to supply voltage; the positive limit is 2 V less than V_{CC+} .

§ Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

NOTE 5: V_{IO} , I_{IO} , I_{IB} , and I_{CC} are defined at $V_O = 0$ for MC3403 and $V_O = 7$ V for MC3303.

MC3303, MC3403

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electrical characteristics, $V_{CC+} = 5\text{ V}$, $V_{CC-} = 0\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | MC3303 | | | MC3403 | | | UNIT | |
|-----------------|---|---|-----|-----|-------------------|------|-------------------|---------------|-----------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{IO} | Input offset voltage | $V_O = 2.5\text{ V}$ | | | 10 | 2 | 10 | mV | |
| I_{IO} | Input offset current | $V_O = 2.5\text{ V}$ | | | 75 | 30 | 50 | nA | |
| I_{IB} | Input bias current | $V_O = 2.5\text{ V}$ | | | -0.5 | -0.2 | -0.5 | μA | |
| V_{OM} | Peak output voltage swing‡ | $R_L = 10\text{ k}\Omega$ | | | 3.3 | 3.5 | 3.3 | 3.5 | V |
| | | $R_L = 10\text{ k}\Omega$, $V_{CC+} = 5\text{ V to } 30\text{ V}$ | | | V_{CC+} -1.7 | | V_{CC+} -1.7 | | |
| A_{VD} | Large-signal differential voltage amplification | $V_O = 1.7\text{ V to } 3.3\text{ V}$, $R_L = 2\text{ k}\Omega$ | | | 20 | 200 | 20 | 200 | V/mV |
| k_{SVS} | Supply-voltage sensitivity ($\Delta V_{IO}/\Delta V_{CC\pm}$) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ | | | 150 | | | 150 | $\mu\text{V/V}$ |
| I_{CC} | Supply current | $V_O = 2.5\text{ V}$, No load | | | 2.5 | 7 | 2.5 | 7 | mA |
| V_{O1}/V_{O2} | Crosstalk attenuation | $f = 1\text{ kHz to } 20\text{ kHz}$ | | | 120 | | | 120 | dB |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified.

‡ Output will swing essentially to ground.

operating characteristics, $V_{CC+} = 14\text{ V}$, $V_{CC-} = 0\text{ V}$ for MC3303, $V_{CC\pm} = \pm 15\text{ V}$ for MC3403, $T_A = 25^\circ\text{C}$, $A_{VD} = 1$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | | | | TYP | UNIT | |
|-----------|-------------------------|-------------------------------|--------------------------|-----------------------------|--------------|------|------------------|
| SR | Slew rate at unity gain | $V_I = \pm 10\text{ V}$, | $C_L = 100\text{ pF}$, | $R_L = 2\text{ k}\Omega$, | See Figure 1 | 0.6 | V/ μs |
| t_r | Rise time | $\Delta V_O = 50\text{ mV}$, | $C_L = 100\text{ pF}$, | $R_L = 10\text{ k}\Omega$, | See Figure 1 | 0.35 | μs |
| t_f | Fall time | $\Delta V_O = 50\text{ mV}$, | $C_L = 100\text{ pF}$, | $R_L = 10\text{ k}\Omega$, | See Figure 1 | 0.35 | μs |
| | Overshoot factor | $\Delta V_O = 50\text{ mV}$, | $C_L = 100\text{ pF}$, | $R_L = 10\text{ k}\Omega$, | See Figure 1 | 20 | % |
| | Crossover distortion | $V_{I(PP)} = 30\text{ mV}$, | $V_{OPP} = 2\text{ V}$, | $f = 10\text{ kHz}$ | | 1 | % |

PARAMETER MEASUREMENT INFORMATION

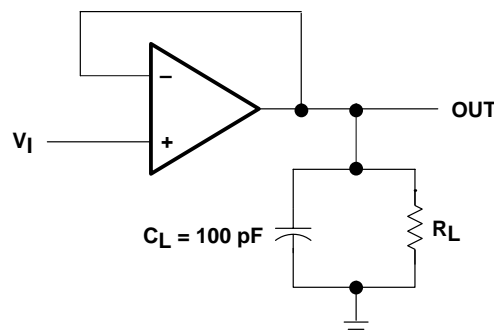


Figure 1. Unity-Gain Amplifier

MC3303, MC3403 QUADRUPLE LOW-POWER OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS†

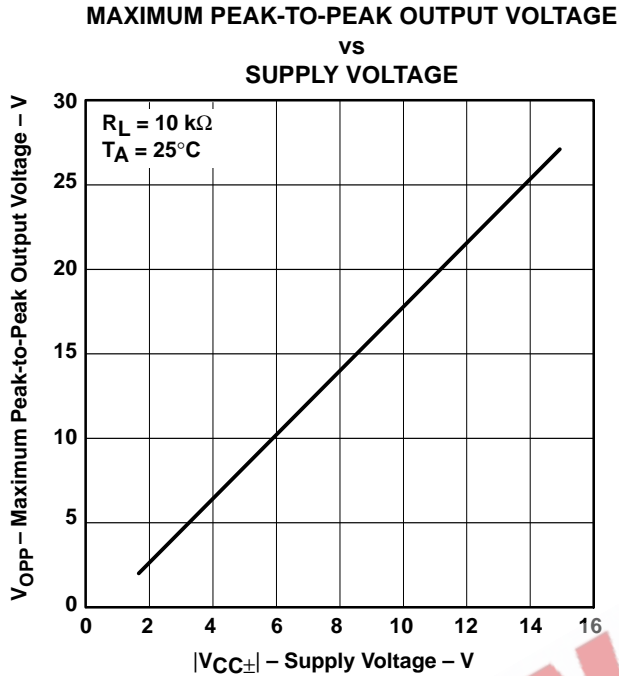


Figure 2

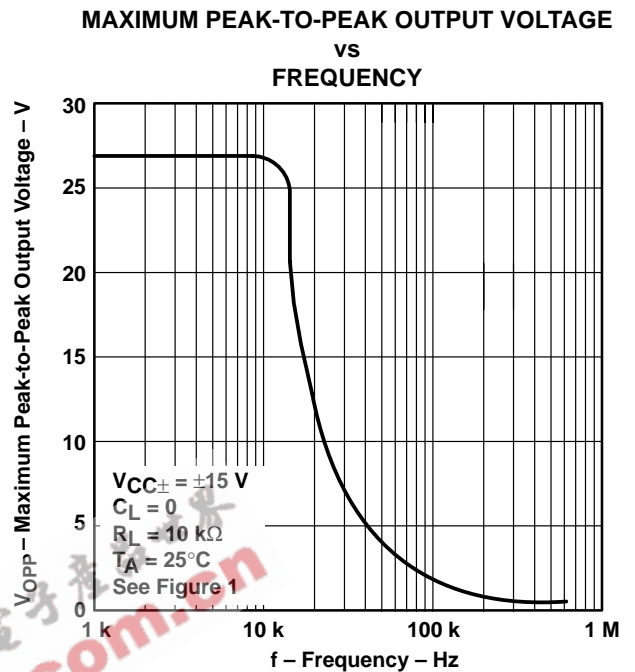


Figure 3

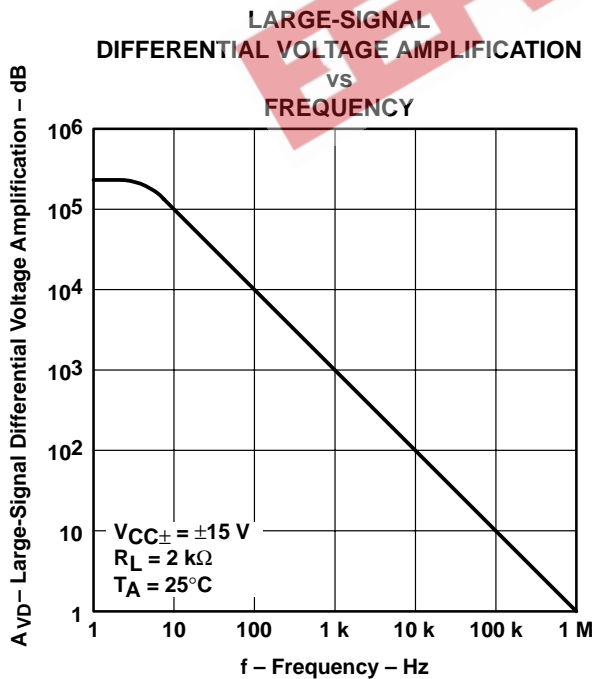


Figure 4

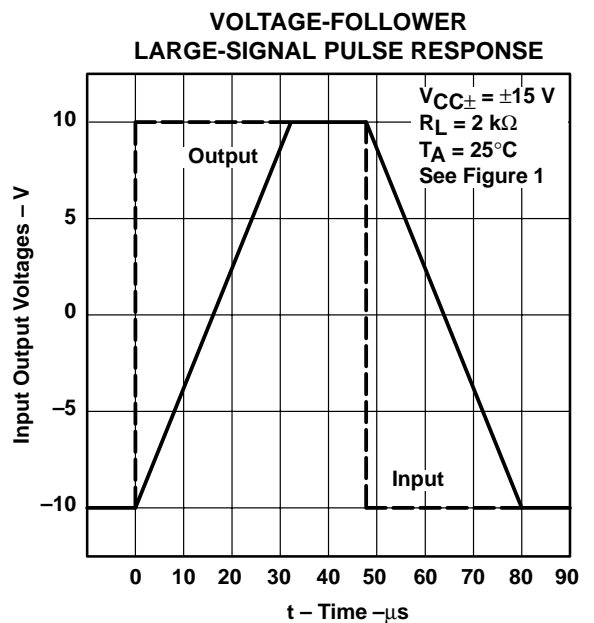


Figure 5

† Operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.

MC3303, MC3403 QUADRUPLE LOW-POWER OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS†

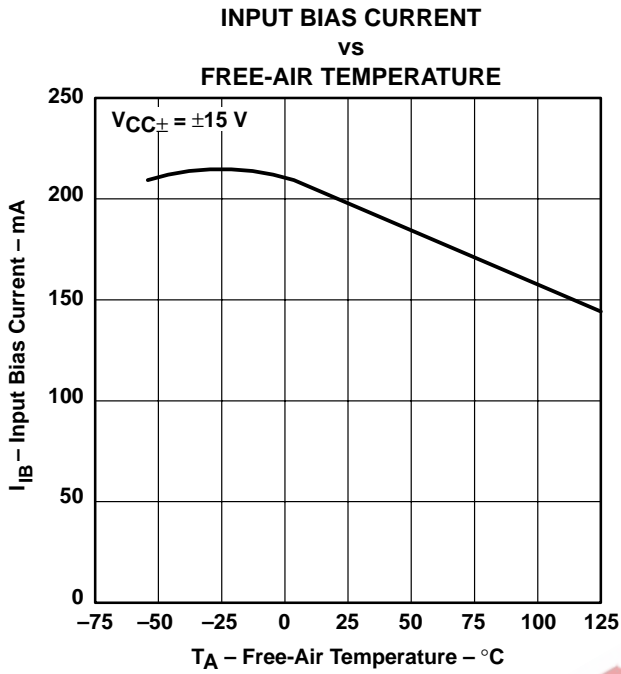


Figure 6

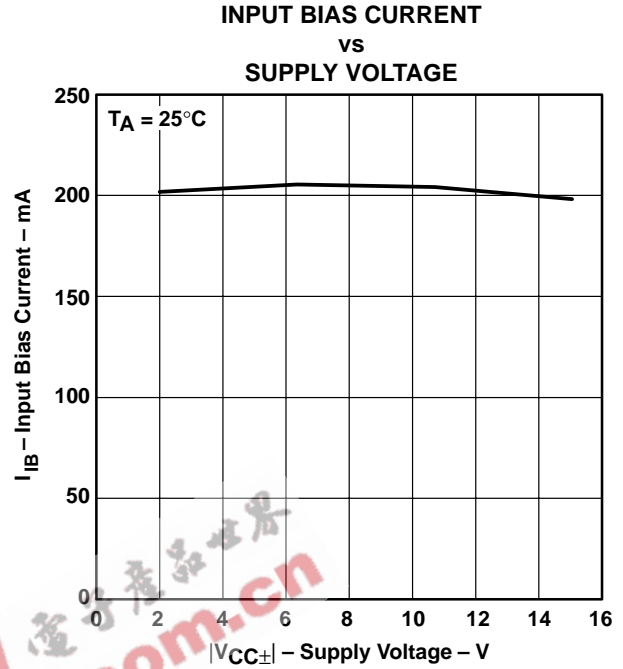


Figure 7

† Operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| MC3303D | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3303DE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3303DR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3303DRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3303N | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MC3303NE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MC3303PW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3303PWE4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3303PWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3303PWRE4 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403D | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403DE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403DR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403DRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403N | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MC3403NE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| MC3403NSLE | OBSOLETE | SO | NS | 14 | | TBD | Call TI | Call TI |
| MC3403NSR | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403NSRG4 | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403PW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403PWE4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403PWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| MC3403PWRE4 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

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

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

a new design.

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

OBSOLETE: TI has discontinued the production of the device.

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

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

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

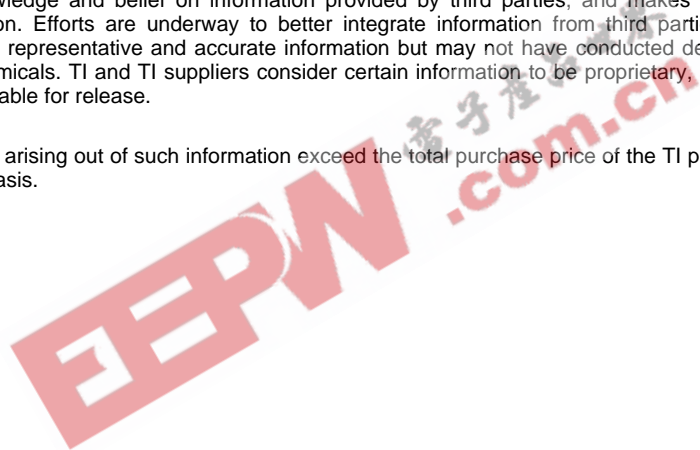
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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

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

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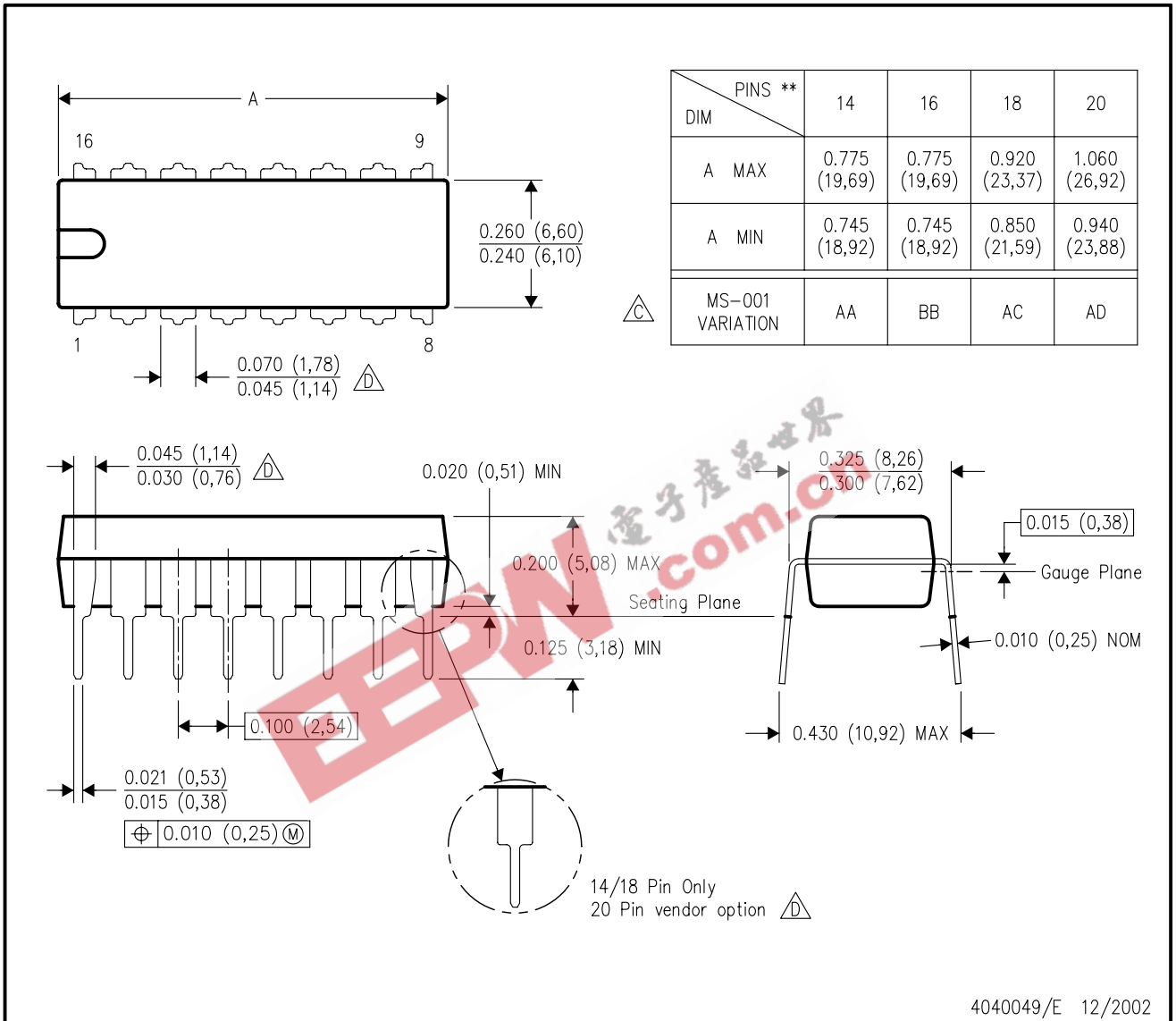


MECHANICAL DATA

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



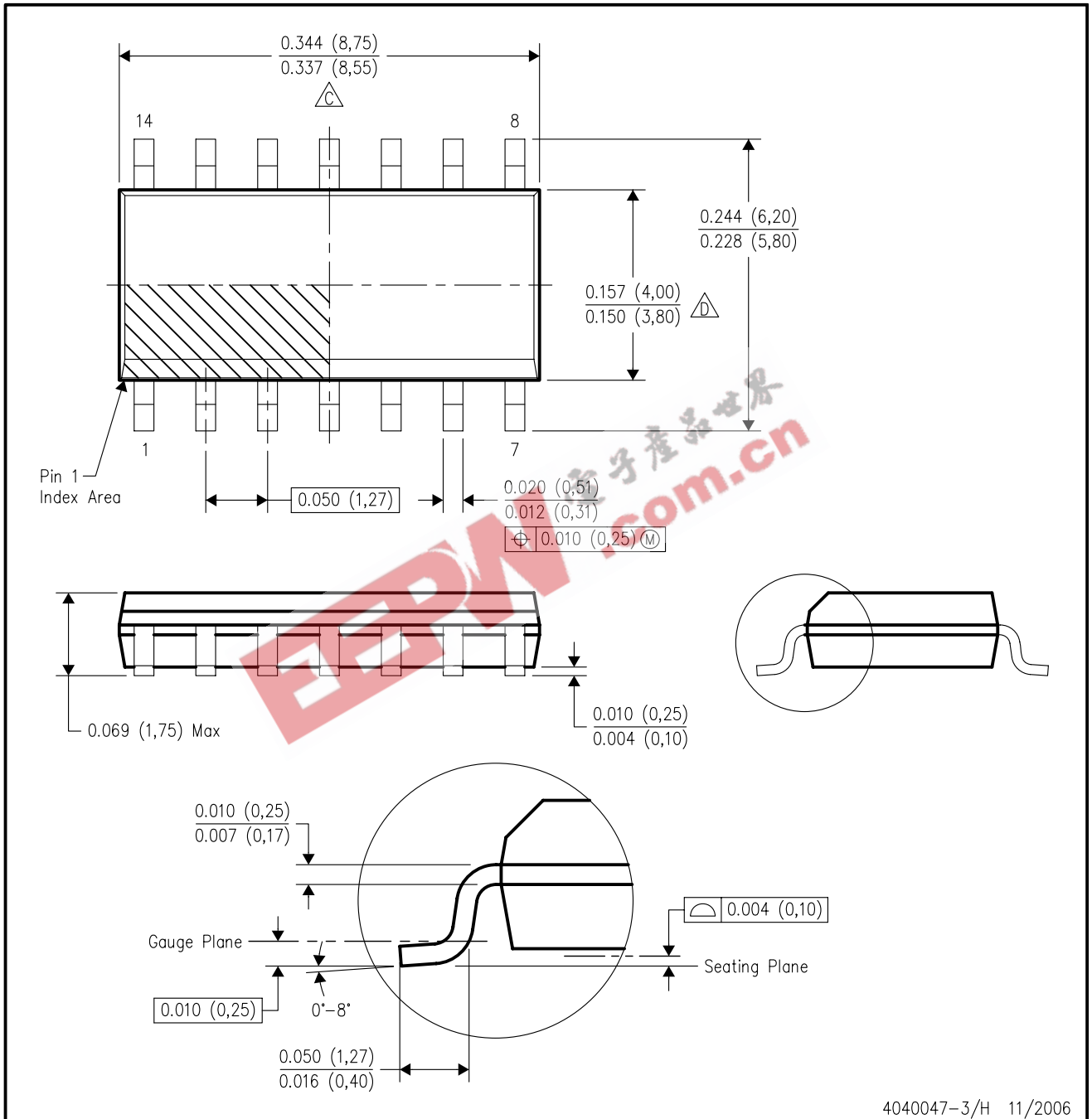
NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.

- △ Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 △ The 20 pin end lead shoulder width is a vendor option, either half or full width.

MECHANICAL DATA

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-3/H 11/2006

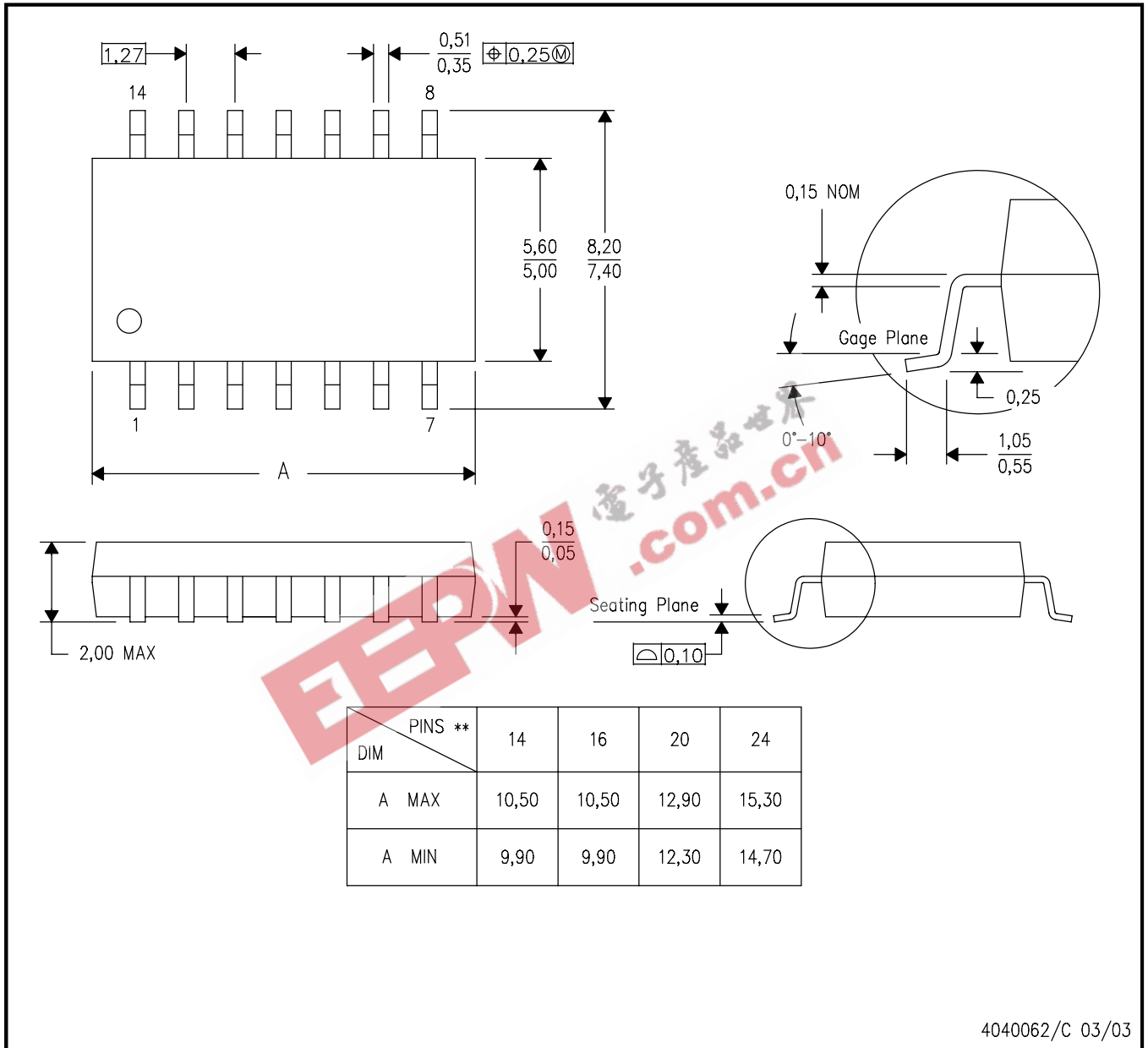
- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - Reference JEDEC MS-012 variation AB.

MECHANICAL DATA

NS (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.

MECHANICAL DATA

MTSS001C – JANUARY 1995 – REVISED FEBRUARY 1999

PW (R-PDSO-G)**

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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