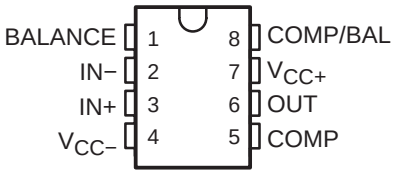
SLOS070B − JULY 1979 − REVISED FEBRUARY 2004

- **Equivalent Input Noise Voltage . . . 3.5 nV/$\sqrt{\text{Hz}}$**
- **Unity-Gain Bandwidth . . . 10 MHz Typ**
- **Common-Mode Rejection Ratio . . . 100 dB Typ**
- **High DC Voltage Gain . . . 100 V/mV Typ**
- **Peak-to-Peak Output Voltage Swing 32 V Typ With $V_{CC\pm}$ = ±18 V and $R_L$ = 600 Ω**
- **High Slew Rate . . . 13 V/μs Typ**
- **Wide Supply-Voltage Range ±3 V to ±20 V**
- **Low Harmonic Distortion**
- **Offset Nulling Capability**
- **External Compensation Capability**

**NE5534 . . . D, P, OR PS PACKAGE**
**NE5534A . . . D OR P PACKAGE**
**(TOP VIEW)**




## description/ordering information

The NE5534 and NE5534A are high-performance operational amplifiers combining excellent dc and ac characteristics. Some of the features include very low noise, high output-drive capability, high unity-gain and maximum-output-swing bandwidths, low distortion, and high slew rate.

These operational amplifiers are compensated internally for a gain equal to or greater than three. Optimization of the frequency response for various applications can be obtained by use of an external compensation capacitor between COMP and COMP/BAL. The devices feature input-protection diodes, output short-circuit protection, and offset-voltage nulling capability with use of the BALANCE and COMP/BAL pins (see the *application circuit* diagram).

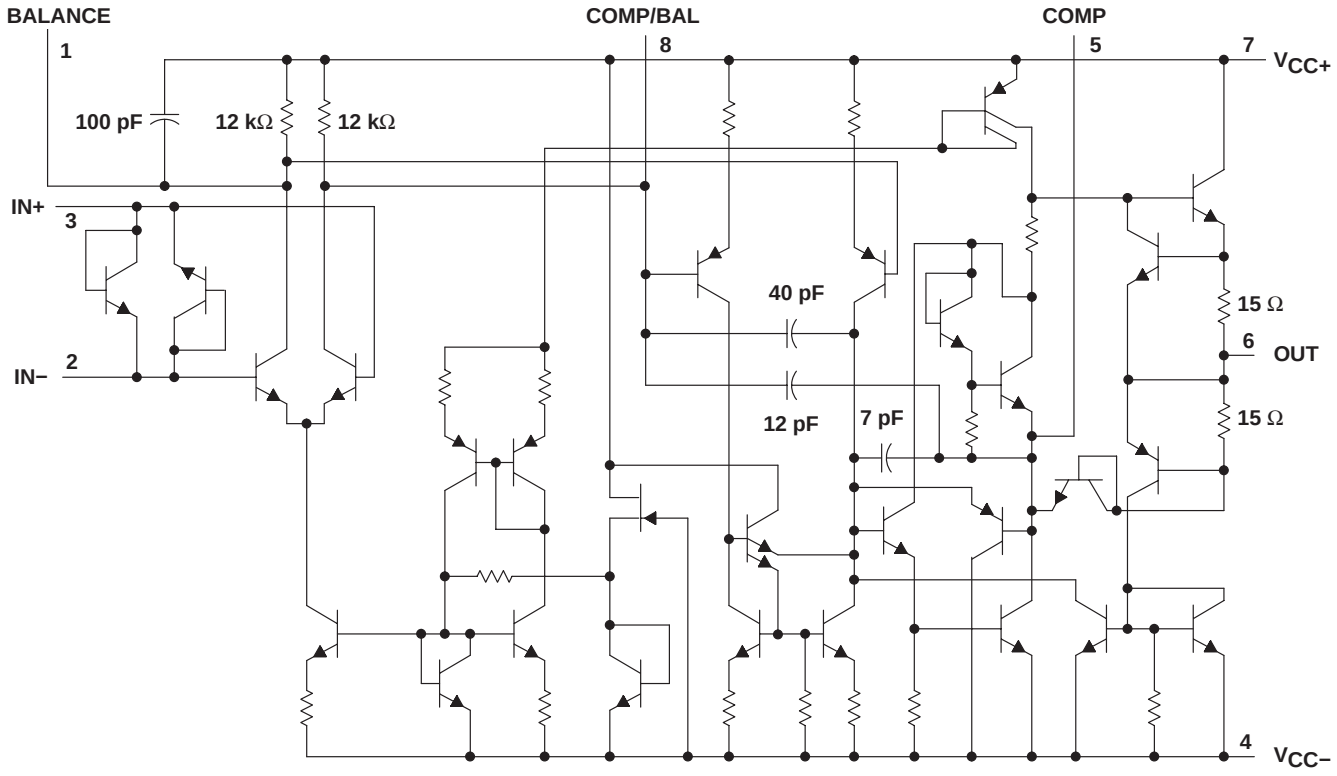
For the NE5534A, a maximum limit is specified for the equivalent input noise voltage.

**ORDERING INFORMATION**

| $T_A$ | $V_{IO}$max AT 25°C | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|
| 0°C to 70°C | 4 mV | PDIP (P) | Tube of 50 | NE5534P | NE5534P |
| | | | Tube of 50 | NE5534AP | NE5534AP |
| | | SOIC (D) | Tube of 75 | NE5534D | NE5534 |
| | | | Reel of 2500 | NE5534DR | |
| | | | Tube of 75 | NE5534AD | 5534A |
| | | | Reel of 2500 | NE5534ADR | |
| | | SOP (PS) | Reel of 2000 | NE5534PS | N5534 |

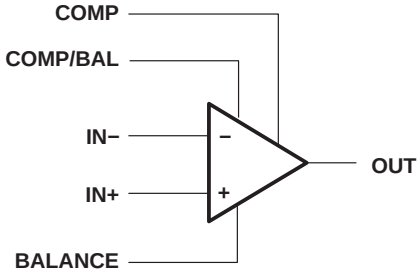
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

## schematic

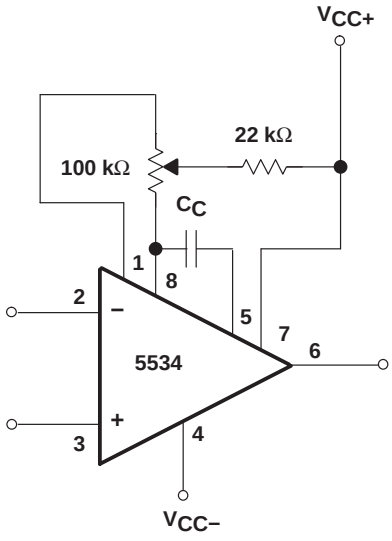



All component values shown are nominal.

## symbol




## application circuit




**Frequency Compensation and Offset-Voltage Nulling Circuit**

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

Supply voltage: $V_{CC+}$ (see Note 1) . . . . . 22 V
$V_{CC-}$ (see Note 1) . . . . . −22 V
Input voltage either input (see Notes 1 and 2) . . . . . $V_{CC+}$
Input current (see Note 3) . . . . . ±10 mA
Duration of output short circuit (see Note 4) . . . . . Unlimited
Package thermal impedance, $\theta_{JA}$ (see Notes 5 and 6): D package . . . . . 97°C/W
P package . . . . . 85°C/W
PS package . . . . . 95°C/W
Operating virtual junction temperature, $T_J$ . . . . . 150°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. All voltage values, except differential voltages, are with respect to the midpoint between $V_{CC+}$ and $V_{CC-}$.
2. The magnitude of the input voltage must never exceed the magnitude of the supply voltage.
3. Excessive current will flow if a differential input voltage in excess of approximately 0.6 V is applied between the inputs, unless some limiting resistance is used.
4. The output may be shorted to ground or to either power supply. Temperature and/or supply voltages must be limited to ensure the maximum dissipation rating is not exceeded.
5. Maximum power dissipation is a function of $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.
6. The package thermal impedance is calculated in accordance with JESD 51-7.

## recommended operating conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{CC+}$ | Supply voltage | 5 | 15 | V |
| $V_{CC-}$ | Supply voltage | −5 | −15 | V |

## electrical characteristics, $V_{CC}\pm$ = ±15 V, $T_A$ = 25°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | $V_O$ = 0, $R_S$ = 50 Ω | $T_A$ = 25°C | | 0.5 | 4 | mV |
| | | | $T_A$ = Full range | | | 5 | |
| $I_{IO}$ | Input offset current | $V_O$ = 0 | $T_A$ = 25°C | | 20 | 300 | nA |
| | | | $T_A$ = Full range | | | 400 | |
| $I_{IB}$ | Input bias current | $V_O$ = 0 | $T_A$ = 25°C | | 500 | 1500 | nA |
| | | | $T_A$ = Full range | | | 2000 | |
| $V_{ICR}$ | Common-mode input voltage range | | | ±12 | ±13 | | V |
| $V_{O(PP)}$ | Maximum peak-to-peak output voltage swing | $R_L$ ≥ 600 Ω | $V_{CC\pm}$ = ±15 V | 24 | 26 | | V |
| | | | $V_{CC\pm}$ = ±18 V | 30 | 32 | | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_O$ = ±10 V, $R_L$ ≥ 600 Ω | $T_A$ = 25°C | 25 | 100 | | V/mV |
| | | | $T_A$ = Full range | 15 | | | |
| $A_{vd}$ | Small-signal differential voltage amplification | f = 10 kHz | $C_C$ = 0 | | 6 | | V/mV |
| | | | $C_C$ = 22 pF | | 2.2 | | |
| $B_{OM}$ | Maximum-output-swing bandwidth | $V_O$ = ±10 V | $C_C$ = 0 | | 200 | | kHz |
| | | | $C_C$ = 22 pF | | 95 | | |
| | | $V_{CC\pm}$ = ±18 V, $R_L$ ≥ 600 Ω, | $V_O$ = ±14 V, $C_C$ = 22 pF | | 70 | | |
| $B_1$ | Unity-gain bandwidth | $C_C$ = 22 pF, | $C_L$ = 100 pF | | 10 | | MHz |
| $r_i$ | Input resistance | | | 30 | 100 | | kΩ |
| $z_o$ | Output impedance | $A_{VD}$ = 30 dB, $C_C$ = 22 pF, | $R_L$ ≥ 600 Ω, f = 10 kHz | | 0.3 | | Ω |
| CMRR | Common-mode rejection ratio | $V_O$ = 0, $R_S$ = 50 Ω | $V_{IC}$ = $V_{ICR}$min, | 70 | 100 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) | $V_{CC+}$ = ±9 V to ±15 V, $V_O$ = 0 | $R_S$ = 50 Ω, | 80 | 100 | | dB |
| $I_{OS}$ | Output short-circuit current | | | | 38 | | mA |
| $I_{CC}$ | Supply current | $V_O$ = 0, No load | $T_A$ = 25°C | | 4 | 8 | mA |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage, unless otherwise specified. Full range is $T_A$ = 0°C to 70°C.

## operating characteristics, $V_{CC}\pm$ = ±15 V, $T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | | NE5534 | NE5534A | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | TYP | MIN | TYP | MAX | |
| SR | Slew rate | $C_C$ = 0 | | 13 | | 13 | | V/μs |
| | | $C_C$ = 22 pF | | 6 | | 6 | | |
| $t_r$ | Rise time | $V_I$ = 50 mV, $R_L$ = 600 Ω, $C_L$ = 100 pF | $A_{VD}$ = 1, $C_C$ = 22 pF | 20 | | 20 | | ns |
| | Overshoot factor | | | 20 | | 20 | | % |
| | Rise time | $V_I$ = 50 mV, $R_L$ = 600 Ω, $C_L$ = 500 pF | $A_{VD}$ = 1, $C_C$ = 47 pF | 50 | | 50 | | ns |
| | Overshoot factor | | | 35 | | 35 | | % |
| $V_n$ | Equivalent input noise voltage | f = 30 Hz | | 7 | | 5.5 | 7 | nV/√Hz |
| | | f = 1 kHz | | 4 | | 3.5 | 4.5 | |
| $I_n$ | Equivalent input noise current | f = 30 Hz | | 2.5 | | 1.5 | | pA/√Hz |
| | | f = 1 kHz | | 0.6 | | 0.4 | | |
| $\overline{F}$ | Average noise figure | $R_S$ = 5 kΩ, | f = 10 Hz to 20 kHz | | | 0.9 | | dB |

## TYPICAL CHARACTERISTICS†

**NORMALIZED INPUT BIAS CURRENT AND INPUT OFFSET CURRENT vs FREE-AIR TEMPERATURE**

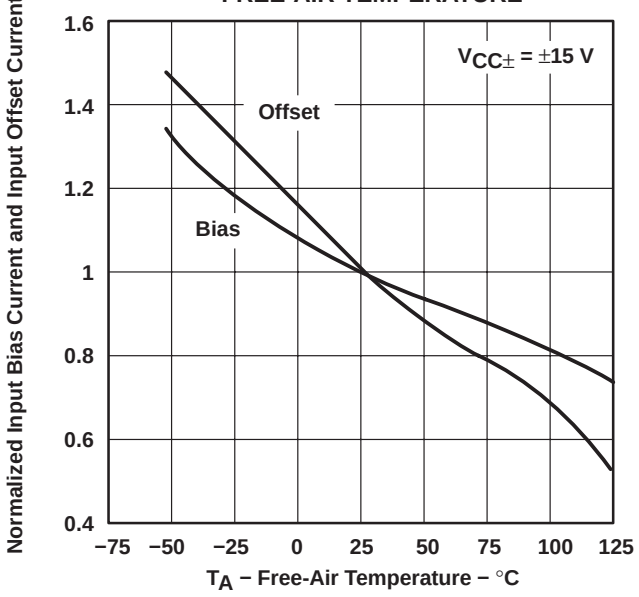



Figure 1

**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE vs FREQUENCY**

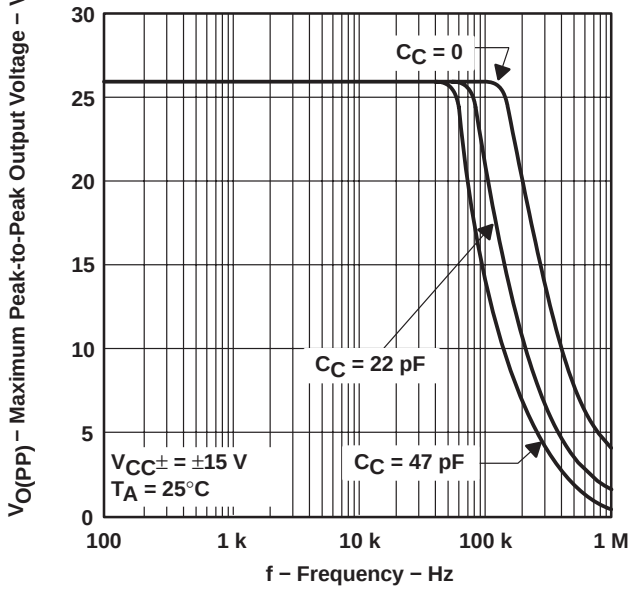



Figure 2

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREQUENCY**

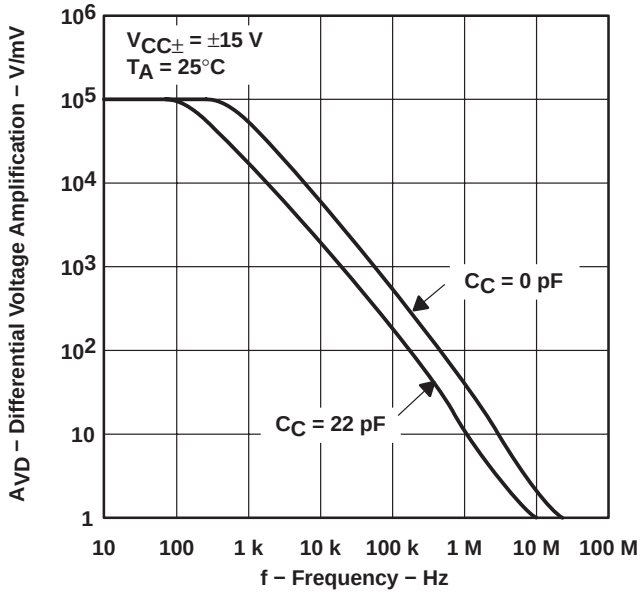



Figure 3

**NORMALIZED SLEW RATE AND UNITY-GAIN BANDWIDTH vs SUPPLY VOLTAGE**

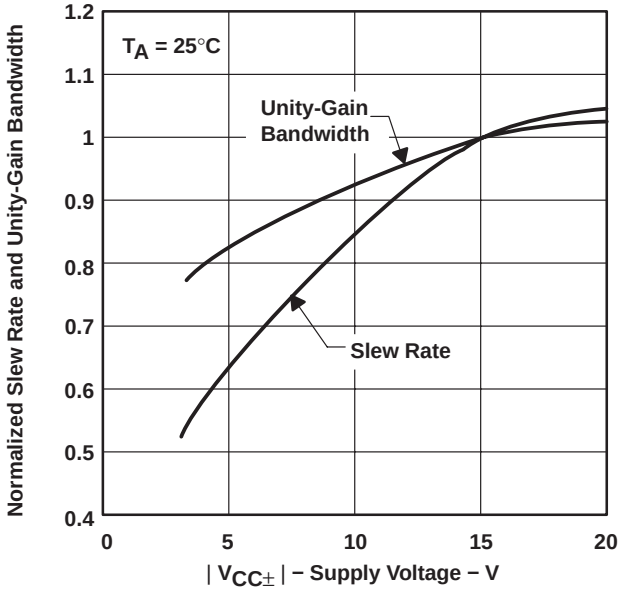



Figure 4

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS†

NORMALIZED SLEW RATE AND UNITY-GAIN BANDWIDTH vs FREE-AIR TEMPERATURE

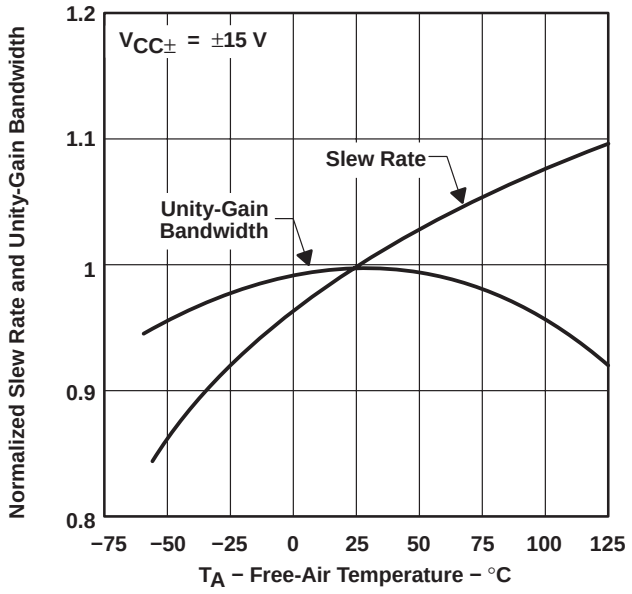



Figure 5

TOTAL HARMONIC DISTORTION vs FREQUENCY

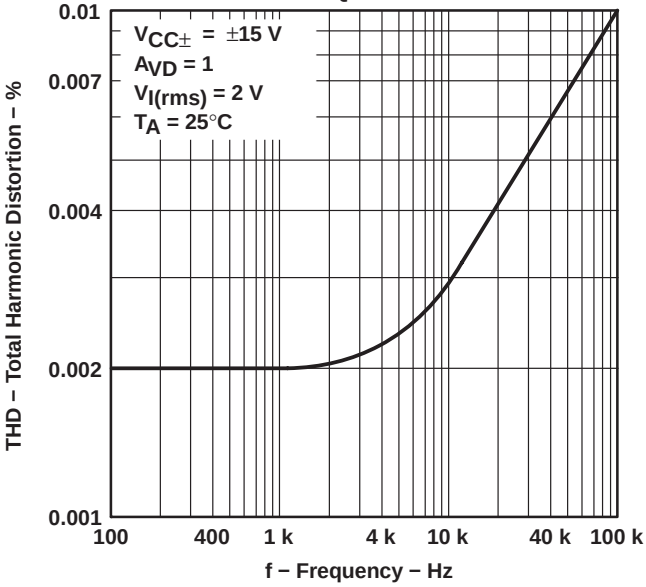



Figure 6

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

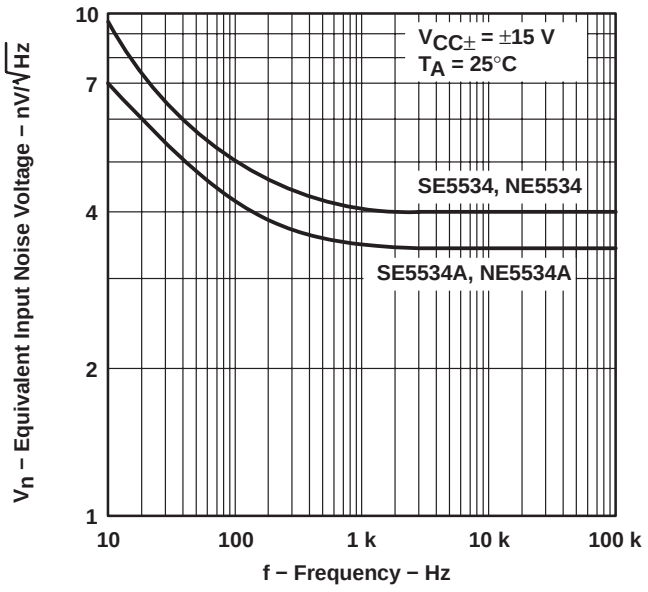



Figure 7

EQUIVALENT INPUT NOISE CURRENT vs FREQUENCY

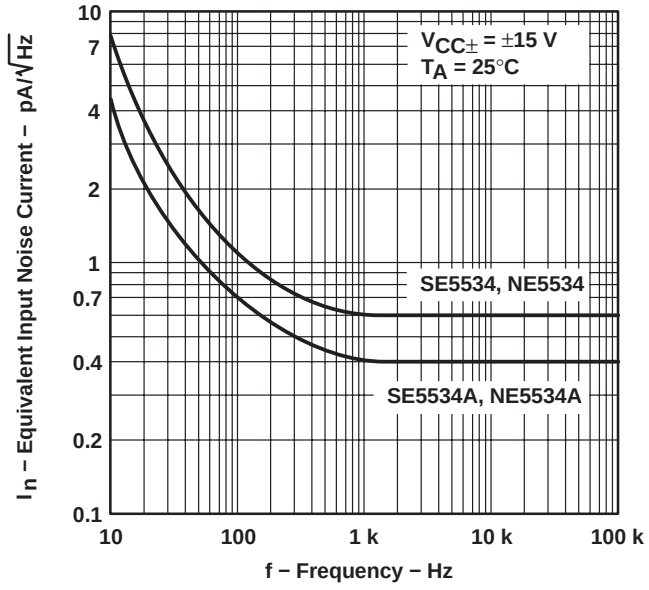



Figure 8

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

## TYPICAL CHARACTERISTICS

**TOTAL EQUIVALENT INPUT NOISE VOLTAGE
vs
SOURCE RESISTANCE**

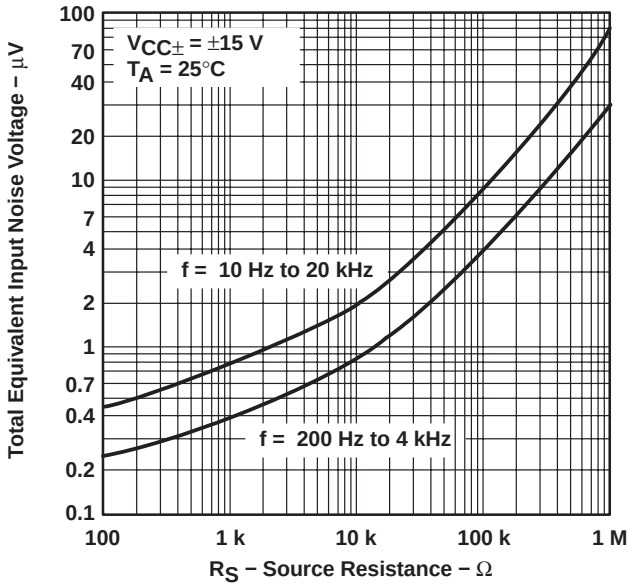
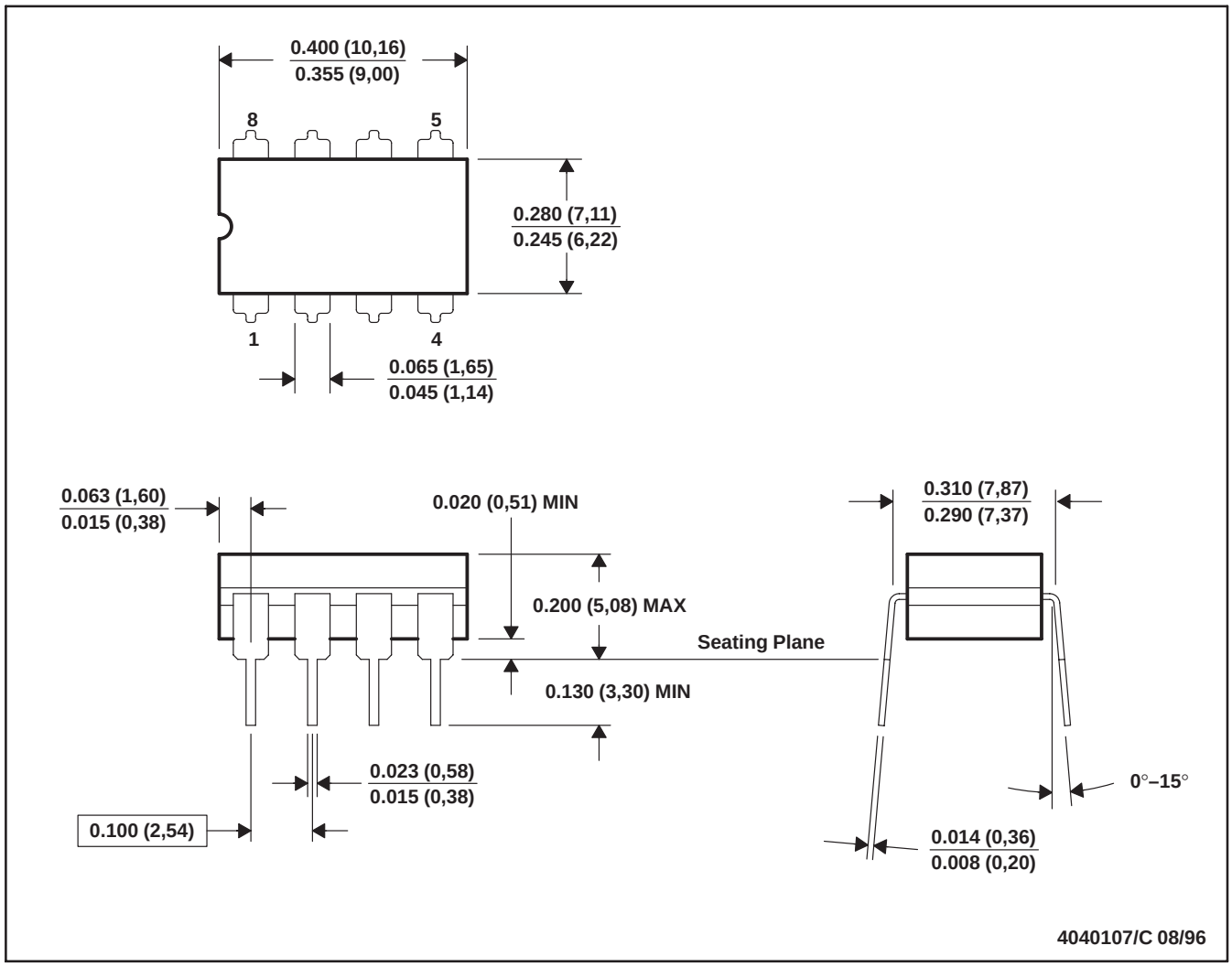



**Figure 9**

MCER001A – JANUARY 1995 – REVISED JANUARY 1997

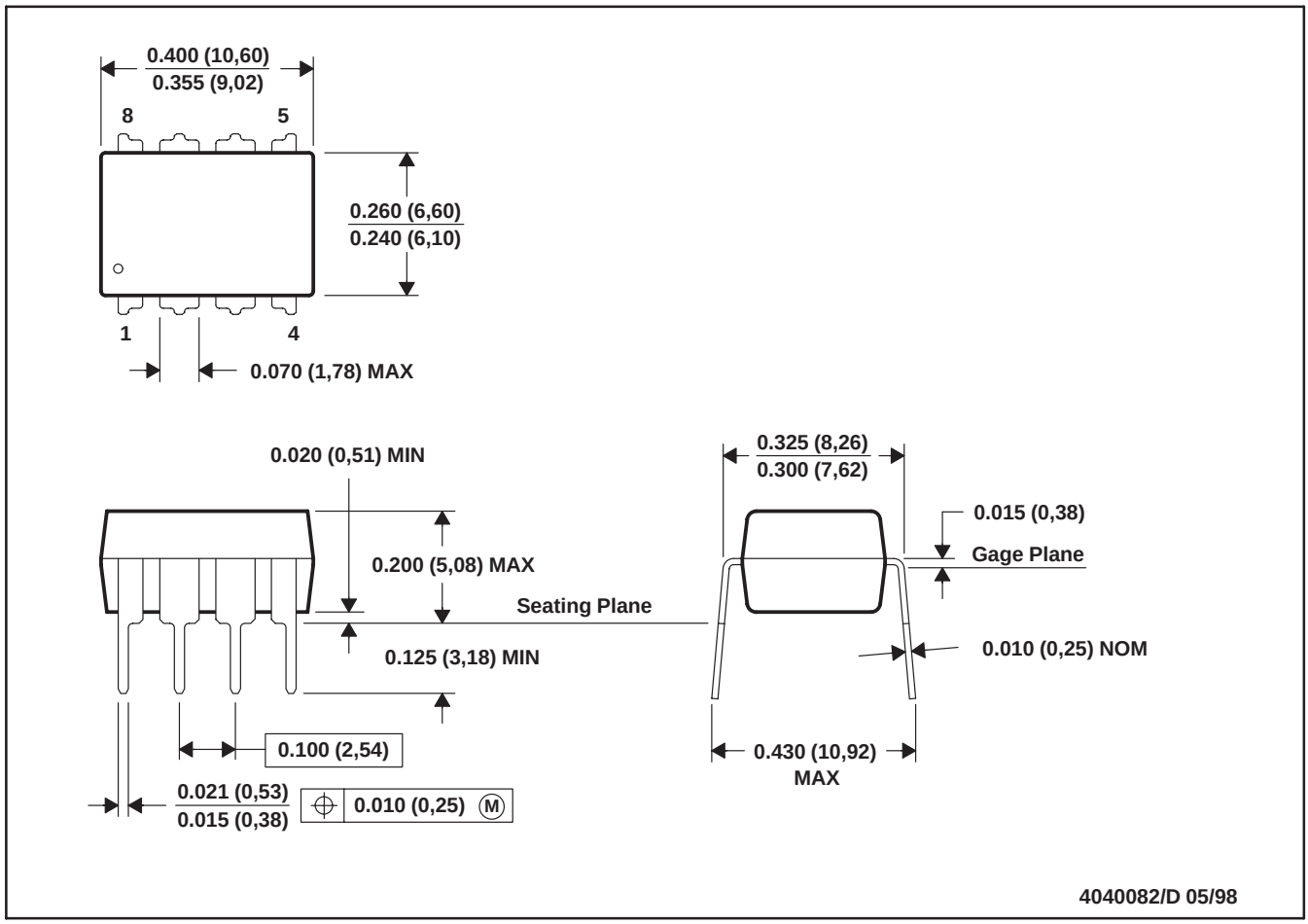
**JG (R-GDIP-T8)** **CERAMIC DUAL-IN-LINE**




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.
E. Falls within MIL STD 1835 GDIP1-T8

MPDI001A – JANUARY 1995 – REVISED JUNE 1999

**P (R-PDIP-T8)** **PLASTIC DUAL-IN-LINE**




NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

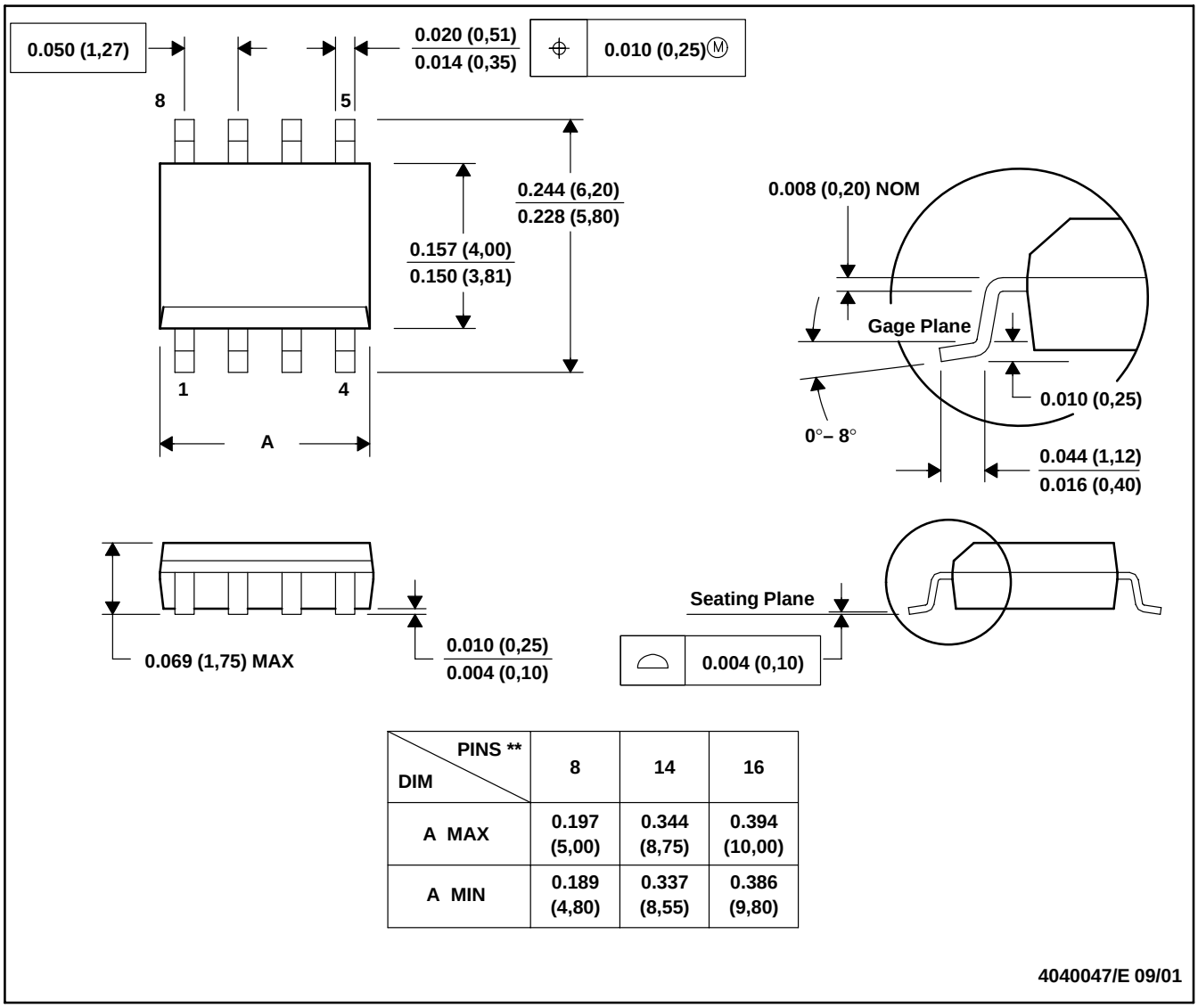
For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

MSOI002B – JANUARY 1995 – REVISED SEPTEMBER 2001

## D (R-PDSO-G**)

## PLASTIC SMALL-OUTLINE PACKAGE

**8 PINS SHOWN**



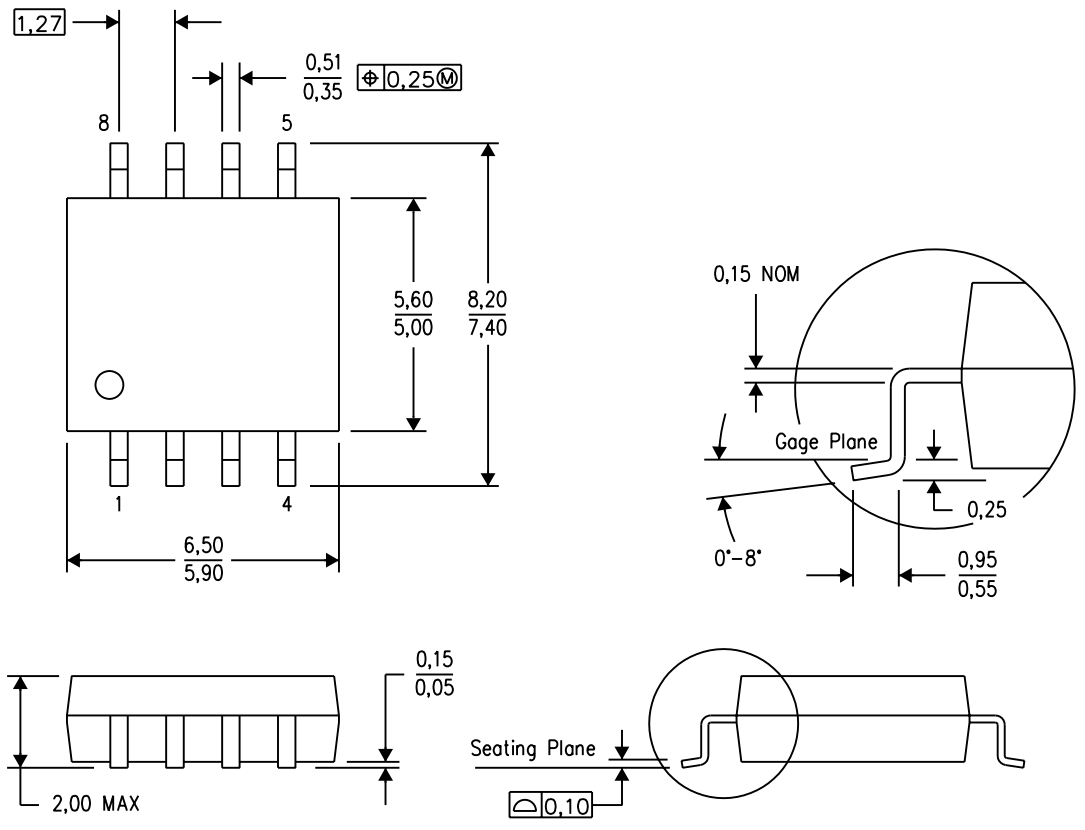

| DIM \ PINS ** | 8 | 14 | 16 |
|---|---|---|---|
| A MAX | 0.197 (5,00) | 0.344 (8,75) | 0.394 (10,00) |
| A MIN | 0.189 (4,80) | 0.337 (8,55) | 0.386 (9,80) |

**4040047/E 09/01**

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 MS-012

## MECHANICAL DATA

**PS (R-PDSO-G8)** **PLASTIC SMALL-OUTLINE PACKAGE**




4040063/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.

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