

# TL081, TL081A, TL081B, TL082, TL082A, TL082B TL084, TL084A, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

- Low Power Consumption
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- Low Total Harmonic Distortion . . . 0.003% Typ
- High Input Impedance . . . JFET-Input Stage
- Latch-Up-Free Operation
- High Slew Rate . . . 13 V/ $\mu$ s Typ
- Common-Mode Input Voltage Range Includes  $V_{CC+}$

## description/ordering information

The TL08x JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset currents, and low offset-voltage temperature coefficient. Offset adjustment and external compensation options are available within the TL08x family.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C. The Q-suffix devices are characterized for operation from –40°C to 125°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

## ORDERING INFORMATION

| $T_J$       | $V_{IOmax}$<br>AT 25°C | PACKAGE†   |              | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|-------------|------------------------|------------|--------------|--------------------------|---------------------|
| 0°C to 70°C | 15 mV                  | PDIP (P)   | Tube of 50   | TL081CP                  | TL081CP             |
|             |                        |            | Tube of 50   | TL082CP                  | TL082CP             |
|             |                        | PDIP (N)   | Tube of 25   | TL084CN                  | TL084CN             |
|             |                        | SOIC (D)   | Tube of 75   | TL081CD                  | TL081C              |
|             |                        |            | Reel of 2500 | TL081CDR                 |                     |
|             |                        |            | Tube of 75   | TL082CD                  | TL082C              |
|             |                        |            | Reel of 2500 | TL082CDR                 |                     |
|             |                        |            | Tube of 50   | TL084CD                  | TL084C              |
|             |                        |            | Reel of 2500 | TL084CDR                 |                     |
|             |                        | SOP (PS)   | Reel of 2000 | TL081CPSR                | T081                |
|             |                        |            | Reel of 2000 | TL082CPSR                | T082                |
|             |                        | SOP (NS)   | Reel of 2000 | TL084CNSR                | TL084               |
|             |                        | TSSOP (PW) | Tube of 150  | TL082CPW                 | T082                |
|             |                        |            | Reel of 2000 | TL082CPWR                |                     |
|             |                        |            | Tube of 90   | TL084CPW                 | T084                |
|             |                        |            | Reel of 2000 | TL084CPWR                |                     |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at



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.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2004, Texas Instruments Incorporated  
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

**TL081, TL081A, TL081B, TL082, TL082A, TL082B**  
**TL084, TL084A, TL084B**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

**description/ordering information (continued)**

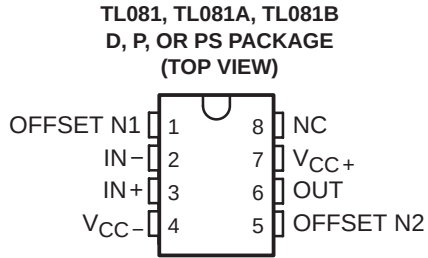
**ORDERING INFORMATION**

| $T_J$          | $V_{IOmax}$<br>AT 25°C | PACKAGE†   |              | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|----------------|------------------------|------------|--------------|--------------------------|---------------------|
| 0°C to 70°C    | 6 mV                   | PDIP (P)   | Tube of 50   | TL081ACP                 | TL081ACP            |
|                |                        |            | Tube of 50   | TL082ACP                 | TL082ACP            |
|                |                        | PDIP (N)   | Tube of 25   | TL084ACN                 | TL084ACN            |
|                |                        | SOIC (D)   | Tube of 75   | TL081ACD                 | 081AC               |
|                |                        |            | Reel of 2500 | TL081ACDR                |                     |
|                |                        |            | Tube of 75   | TL082ACD                 | 082AC               |
|                |                        |            | Reel of 2500 | TL082ACDR                |                     |
|                |                        |            | Tube of 50   | TL084ACD                 | TL084AC             |
|                |                        |            | Reel of 2500 | TL084ACDR                |                     |
|                |                        | SOP (PS)   | Reel of 2000 | TL082ACPSR               | T082A               |
|                |                        | SOP (NS)   | Reel of 2000 | TL084ACNSR               | TL084A              |
|                | 3 mV                   | PDIP (P)   | Tube of 50   | TL081BCP                 | TL081BCP            |
|                |                        |            | Tube of 50   | TL082BCP                 | TL082BCP            |
|                |                        | PDIP (N)   | Tube of 25   | TL084BCN                 | TL084BCN            |
|                |                        | SOIC (D)   | Tube of 75   | TL081BCD                 | 081BC               |
|                |                        |            | Reel of 2500 | TL081BCDR                |                     |
|                |                        |            | Tube of 75   | TL082BCD                 | 082BC               |
|                |                        |            | Reel of 2500 | TL082BCDR                |                     |
|                |                        |            | Tube of 50   | TL084BCD                 | TL084BC             |
|                |                        |            | Reel of 2500 | TL084BCDR                |                     |
| –40°C to 85°C  | 6 mV                   | PDIP (P)   | Tube of 50   | TL081IP                  | TL081IP             |
|                |                        |            | Tube of 50   | TL082IP                  | TL082IP             |
|                |                        | PDIP (N)   | Tube of 25   | TL084IN                  | TL081IN             |
|                |                        | SOIC (D)   | Tube of 75   | TL081ID                  | TL081I              |
|                |                        |            | Reel of 2500 | TL081IDR                 |                     |
|                |                        |            | Tube of 75   | TL082ID                  | TL082I              |
|                |                        |            | Reel of 2500 | TL082IDR                 |                     |
|                |                        |            | Tube of 50   | TL084ID                  | TL084I              |
|                |                        |            | Reel of 2500 | TL084IDR                 |                     |
|                |                        | TSSOP (PW) | Reel of 2000 | TL082IPWR                | Z082                |
| –40°C to 125°C | 9 mV                   | SOIC (D)   | Tube of 50   | TL084QD                  | TL084QD             |
|                |                        |            | Reel of 2500 | TL084QDR                 |                     |
| –55°C to 125°C | 9 mV                   | CDIP (J)   | Tube of 25   | TL084MJ                  | TL084MJ             |
|                |                        | LCCC (FK)  | Reel of 55   | TL084FK                  | TL084FK             |
|                | 6 mV                   | CDIP (JG)  | Tube of 50   | TL082MJG                 | TL082MJG            |
|                |                        | LCCC (FK)  | Tube of 55   | TL082MFK                 | TL082MFK            |

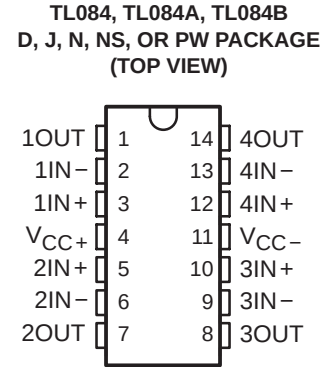
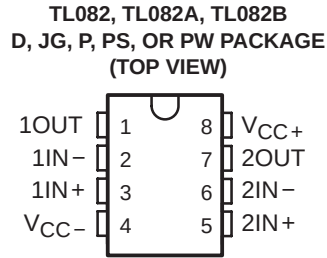
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

# TL081, TL081A, TL081B, TL082, TL082A, TL082B TL084, TL084A, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

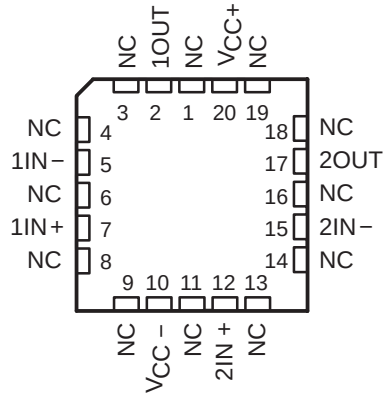
SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004



NC – No internal connection

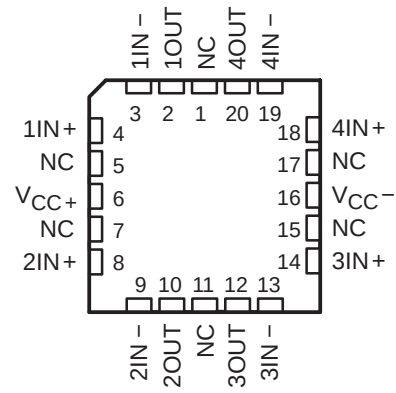


**TL082M . . . FK PACKAGE**  
(TOP VIEW)



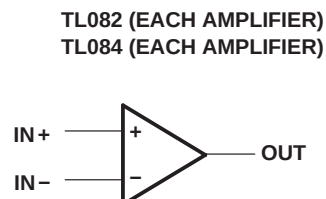
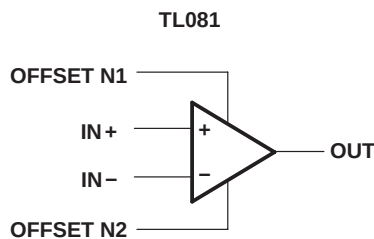
NC – No internal connection

**TL084M . . . FK PACKAGE**  
(TOP VIEW)



NC – No internal connection

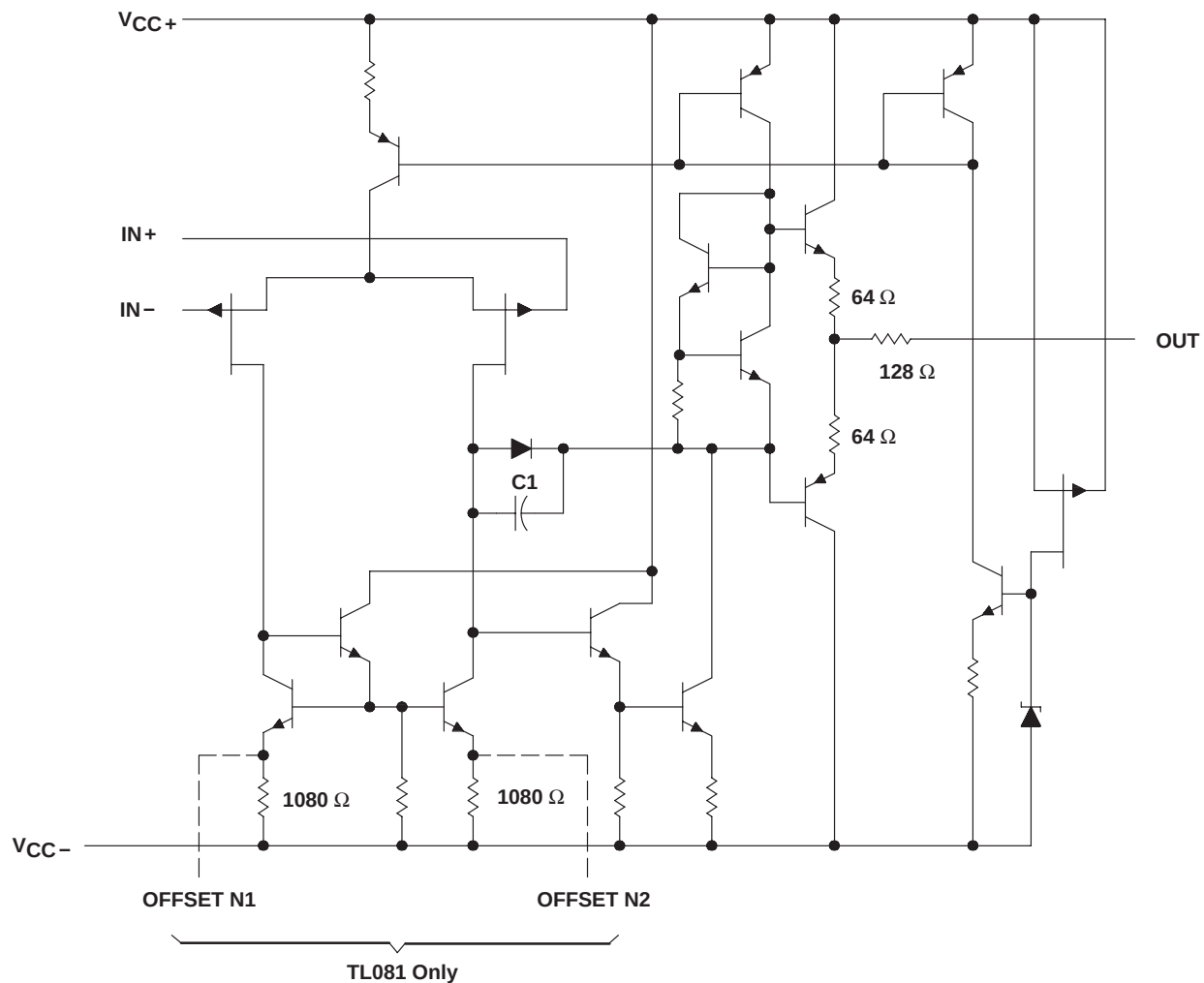
## symbols



# TL081, TL081A, TL081B, TL082, TL082A, TL082B TL084, TL084A, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

## schematic (each amplifier)



Component values shown are nominal.

**TL081, TL081A, TL081B, TL082, TL082A, TL082B  
TL084, TL084A, TL084B  
JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

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

|                                                                 |                     | TL08_C<br>TL08_AC<br>TL08_BC | TL08_I     | TL084Q     | TL08_M     | UNIT |
|-----------------------------------------------------------------|---------------------|------------------------------|------------|------------|------------|------|
| Supply voltage, $V_{CC+}$ (see Note 1)                          |                     | 18                           | 18         | 18         | 18         | V    |
| Supply voltage $V_{CC-}$ (see Note 1)                           |                     | –18                          | –18        | –18        | –18        | V    |
| Differential input voltage, $V_{ID}$ (see Note 2)               |                     | $\pm 30$                     | $\pm 30$   | $\pm 30$   | $\pm 30$   | V    |
| Input voltage, $V_I$ (see Notes 1 and 3)                        |                     | $\pm 15$                     | $\pm 15$   | $\pm 15$   | $\pm 15$   | V    |
| Duration of output short circuit (see Note 4)                   |                     | Unlimited                    | Unlimited  | Unlimited  | Unlimited  |      |
| Continuous total power dissipation                              |                     | See Dissipation Rating Table |            |            |            |      |
| Operating free-air temperature range, $T_A$                     |                     | 0 to 70                      | –40 to 85  | –40 to 125 | –55 to 125 | °C   |
| Package thermal impedance, $\theta_{JA}$<br>(see Notes 5 and 6) | D package (8-pin)   | 97                           | 97         |            |            | °C/W |
|                                                                 | D package (14-pin)  | 86                           | 86         |            |            |      |
|                                                                 | N package (14-pin)  | 76                           | 76         |            |            |      |
|                                                                 | NS package (14-pin) | 80                           |            |            |            |      |
|                                                                 | P package (8-pin)   | 85                           | 85         |            |            |      |
|                                                                 | PS package (8-pin)  | 95                           | 95         |            |            |      |
|                                                                 | PW package (8-pin)  | 149                          |            |            |            |      |
|                                                                 | PW package (14-pin) | 113                          | 113        |            |            |      |
| Operating virtual junction temperature                          |                     | 150                          | 150        | 150        | 150        | °C   |
| Case temperature for 60 seconds, $T_C$                          | FK package          |                              |            |            | 260        | °C   |
| Lead temperature 1.6 mm (1/16 inch) from case for 60 seconds    | J or JG package     |                              |            |            | 300        | °C   |
| Storage temperature range, $T_{stg}$                            |                     | –65 to 150                   | –65 to 150 | –65 to 150 | –65 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. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .

2. Differential voltages are at  $IN+$  with respect to  $IN-$ .

3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.

4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the 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.

**DISSIPATION RATING TABLE**

| PACKAGE    | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING<br>FACTOR | DERATE<br>ABOVE $T_A$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 85^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>POWER RATING |
|------------|---------------------------------------------|--------------------|-----------------------|------------------------------------------|------------------------------------------|-------------------------------------------|
| D (14 pin) | 680 mW                                      | 7.6 mW/°C          | 60°C                  | 604 mW                                   | 490 mW                                   | 186 mW                                    |
| FK         | 680 mW                                      | 11.0 mW/°C         | 88°C                  | 680 mW                                   | 680 mW                                   | 273 mW                                    |
| J          | 680 mW                                      | 11.0 mW/°C         | 88°C                  | 680 mW                                   | 680 mW                                   | 273 mW                                    |
| JG         | 680 mW                                      | 8.4 mW/°C          | 69°C                  | 672 mW                                   | 546 mW                                   | 210 mW                                    |



**TL081, TL081A, TL081B, TL082, TL082A, TL082B  
TL084, TL084A, TL084B  
JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

electrical characteristics,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted)

| PARAMETER                        | TEST CONDITIONS                                                                                                                                              | T <sub>A</sub> <sup>†</sup> | TL081C<br>TL082C<br>TL084C |                  |     | TL081AC<br>TL082AC<br>TL084AC |                  |     | TL081BC<br>TL082BC<br>TL084BC |                  |     | TL081I<br>TL082I<br>TL084I |                  |     | UNIT  |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------------------------|------------------|-----|-------------------------------|------------------|-----|-------------------------------|------------------|-----|----------------------------|------------------|-----|-------|
|                                  |                                                                                                                                                              |                             | MIN                        | TYP              | MAX | MIN                           | TYP              | MAX | MIN                           | TYP              | MAX | MIN                        | TYP              | MAX |       |
| V <sub>IO</sub>                  | Input offset voltage<br>V <sub>O</sub> = 0<br>R <sub>S</sub> = 50 Ω                                                                                          | 25°C<br>Full range          | 3                          | 15               | 20  | 3                             | 6                | 7.5 | 2                             | 3                | 5   | 3                          | 6                | 9   | mV    |
| α <sub>VIO</sub>                 | Temperature<br>coefficient of input<br>offset voltage<br>V <sub>O</sub> = 0<br>R <sub>S</sub> = 50 Ω                                                         | Full range                  | 18                         |                  |     | 18                            |                  |     | 18                            |                  |     | 18                         |                  |     | μV/°C |
| I <sub>IO</sub>                  | Input offset current <sup>‡</sup><br>V <sub>O</sub> = 0                                                                                                      | 25°C<br>Full range          | 5                          | 200              |     | 5                             | 100              |     | 5                             | 100              |     | 5                          | 100              |     | pA    |
| I <sub>IB</sub>                  | Input bias current <sup>‡</sup><br>V <sub>O</sub> = 0                                                                                                        | 25°C<br>Full range          | 30                         | 400              | 10  | 30                            | 200              | 7   | 30                            | 200              | 7   | 30                         | 200              | 20  | nA    |
| V <sub>ICR</sub>                 | Common-mode input<br>voltage range                                                                                                                           | 25°C                        | ±11                        | -12<br>to<br>15  |     | ±11                           | -12<br>to<br>15  |     | ±11                           | -12<br>to<br>15  |     | ±11                        | -12<br>to<br>15  |     | V     |
| V <sub>OM</sub>                  | Maximum peak<br>output voltage swing<br>R <sub>L</sub> = 10 kΩ                                                                                               | 25°C                        | ±12                        | ±13.5            |     | ±12                           | ±13.5            |     | ±12                           | ±13.5            |     | ±12                        | ±13.5            |     | V     |
|                                  | R <sub>L</sub> ≥ 10 kΩ                                                                                                                                       | Full range                  | ±12                        |                  |     | ±12                           |                  |     | ±12                           |                  |     | ±12                        |                  |     |       |
|                                  | R <sub>L</sub> ≥ 2 kΩ                                                                                                                                        |                             | ±10                        | ±12              |     | ±10                           | ±12              |     | ±10                           | ±12              |     | ±10                        | ±12              |     |       |
| A <sub>VD</sub>                  | Large-signal<br>differential voltage<br>amplification<br>V <sub>O</sub> = ±10 V, R <sub>L</sub> ≥ 2 kΩ                                                       | 25°C                        | 25                         | 200              |     | 50                            | 200              |     | 50                            | 200              |     | 50                         | 200              |     | V/mV  |
|                                  | V <sub>O</sub> = ±10 V, R <sub>L</sub> ≥ 2 kΩ                                                                                                                | Full range                  | 15                         |                  |     | 25                            |                  |     | 25                            |                  |     | 25                         |                  |     |       |
| B <sub>1</sub>                   | Unity-gain bandwidth                                                                                                                                         | 25°C                        |                            | 3                |     |                               | 3                |     |                               | 3                |     |                            | 3                |     | MHz   |
| r <sub>i</sub>                   | Input resistance                                                                                                                                             | 25°C                        |                            | 10 <sup>12</sup> |     |                               | 10 <sup>12</sup> |     |                               | 10 <sup>12</sup> |     |                            | 10 <sup>12</sup> |     | Ω     |
| CMRR                             | Common-mode<br>rejection ratio<br>V <sub>IC</sub> = V <sub>ICRmin</sub> ,<br>V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω                                       | 25°C                        | 70                         | 86               |     | 75                            | 86               |     | 75                            | 86               |     | 75                         | 86               |     | dB    |
| KSVR                             | Supply-voltage<br>rejection ratio<br>(ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> )<br>V <sub>CC</sub> = ±15 V to ±9 V,<br>V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω | 25°C                        | 70                         | 86               |     | 80                            | 86               |     | 80                            | 86               |     | 80                         | 86               |     | dB    |
| I <sub>CC</sub>                  | Supply current<br>(per amplifier)<br>V <sub>O</sub> = 0, No load                                                                                             | 25°C                        |                            | 1.4              | 2.8 |                               | 1.4              | 2.8 |                               | 1.4              | 2.8 |                            | 1.4              | 2.8 | mA    |
| V <sub>O1</sub> /V <sub>O2</sub> | Crosstalk attenuation<br>A <sub>VD</sub> = 100                                                                                                               | 25°C                        |                            | 120              |     |                               | 120              |     |                               | 120              |     |                            | 120              |     | dB    |

<sup>†</sup> All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified. Full range for T<sub>A</sub> is 0°C to 70°C for TL08\_C, TL08\_AC, TL08\_BC and -40°C to 85°C for TL08\_I.

<sup>‡</sup> Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 17. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

**TL081, TL081A, TL081B, TL082, TL082A, TL082B  
TL084, TL084A, TL084B  
JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

**electrical characteristics,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS†                                                         | $T_A$      | TL081M, TL082M |            |     | TL084Q, TL084M |            |     | UNIT                         |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------|----------------|------------|-----|----------------|------------|-----|------------------------------|
|                                                                               |                                                                          |            | MIN            | TYP        | MAX | MIN            | TYP        | MAX |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 0, R_S = 50\ \Omega$                                              | 25°C       |                | 3          | 6   |                | 3          | 9   | mV                           |
|                                                                               |                                                                          | Full range |                |            | 9   |                |            | 15  |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                | $V_O = 0, R_S = 50\ \Omega$                                              | Full range |                | 18         |     |                | 18         |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current‡                                                | $V_O = 0$                                                                | 25°C       |                | 5          | 100 |                | 5          | 100 | pA                           |
|                                                                               |                                                                          | 125°C      |                |            | 20  |                |            | 20  | nA                           |
| $I_{IB}$ Input bias current‡                                                  | $V_O = 0$                                                                | 25°C       |                | 30         | 200 |                | 30         | 200 | pA                           |
|                                                                               |                                                                          | 125°C      |                |            | 50  |                |            | 50  | nA                           |
| $V_{ICR}$ Common-mode input voltage range                                     |                                                                          | 25°C       | $\pm 11$       | –12 to 15  |     | $\pm 11$       | –12 to 15  |     | V                            |
| $V_{OM}$ Maximum peak output voltage swing                                    | $R_L = 10\text{ k}\Omega$                                                | 25°C       | $\pm 12$       | $\pm 13.5$ |     | $\pm 12$       | $\pm 13.5$ |     | V                            |
|                                                                               | $R_L \geq 10\text{ k}\Omega$                                             | Full range | $\pm 12$       |            |     | $\pm 12$       |            |     |                              |
|                                                                               | $R_L \geq 2\text{ k}\Omega$                                              |            | $\pm 10$       | $\pm 12$   |     | $\pm 10$       | $\pm 12$   |     |                              |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10\text{ V}, R_L \geq 2\text{ k}\Omega$                       | 25°C       | 25             | 200        |     | 25             | 200        |     | V/mV                         |
|                                                                               | $V_O = \pm 10\text{ V}, R_L \geq 2\text{ k}\Omega$                       | Full range | 15             |            |     | 15             |            |     |                              |
| $B_1$ Unity-gain bandwidth                                                    |                                                                          | 25°C       |                | 3          |     |                | 3          |     | MHz                          |
| $r_i$ Input resistance                                                        |                                                                          | 25°C       |                | $10^{12}$  |     |                | $10^{12}$  |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\ \Omega$                         | 25°C       | 80             | 86         |     | 80             | 86         |     | dB                           |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC} = \pm 15\text{ V to } \pm 9\text{ V}, V_O = 0, R_S = 50\ \Omega$ | 25°C       | 80             | 86         |     | 80             | 86         |     | dB                           |
| $I_{CC}$ Supply current (per amplifier)                                       | $V_O = 0, \text{ No load}$                                               | 25°C       |                | 1.4        | 2.8 |                | 1.4        | 2.8 | mA                           |
| $V_{O1}/V_{O2}$ Crosstalk attenuation                                         | $A_{VD} = 100$                                                           | 25°C       |                | 120        |     |                | 120        |     | dB                           |

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

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 17. Pulse techniques must be used that maintain the junction temperatures as close to the ambient temperature as possible.

**operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}, T_A = 25^\circ\text{C}$  (unless otherwise noted)**

| PARAMETER      |                                | TEST CONDITIONS                                                                      |                        |                          |                        | MIN   | TYP | MAX | UNIT   |
|----------------|--------------------------------|--------------------------------------------------------------------------------------|------------------------|--------------------------|------------------------|-------|-----|-----|--------|
| SR             | Slew rate at unity gain        | V <sub>I</sub> = 10 V,                                                               | R <sub>L</sub> = 2 kΩ, | C <sub>L</sub> = 100 pF, | See Figure 1           | 8*    | 13  |     | V/μs   |
|                |                                | V <sub>I</sub> = 10 V,<br>T <sub>A</sub> = − 55°C to 125°C,                          | R <sub>L</sub> = 2 kΩ, | C <sub>L</sub> = 100 pF, | See Figure 1           | 5*    |     |     |        |
| t <sub>r</sub> | Rise time                      | V <sub>I</sub> = 20 mV, R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, See Figure 1 |                        |                          |                        | 0.05  |     |     | μs     |
|                | Overshoot factor               |                                                                                      |                        |                          |                        | 20    |     |     | %      |
| V <sub>n</sub> | Equivalent input noise voltage | R <sub>S</sub> = 20 Ω                                                                | f = 1 kHz              |                          |                        | 18    |     |     | nV/√Hz |
|                |                                |                                                                                      | f = 10 Hz to 10 kHz    |                          |                        | 4     |     |     | μV     |
| I <sub>n</sub> | Equivalent input noise current | R <sub>S</sub> = 20 Ω,                                                               | f = 1 kHz              |                          |                        | 0.01  |     |     | pA/√Hz |
| THD            | Total harmonic distortion      | V <sub>Irms</sub> = 6 V,<br>f = 1 kHz                                                | A <sub>VD</sub> = 1,   | R <sub>S</sub> ≤ 1 kΩ,   | R <sub>L</sub> ≥ 2 kΩ, | 0.003 |     |     | %      |

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



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

**TL081, TL081A, TL081B, TL082, TL082A, TL082B**  
**TL084, TL084A, TL084B**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^{\circ}\text{C}$

| PARAMETER |                                | TEST CONDITIONS                                                                        |                                     |                                                                | MIN | TYP   | MAX | UNIT                         |
|-----------|--------------------------------|----------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------|-----|-------|-----|------------------------------|
| SR        | Slew rate at unity gain        | $V_I = 10\text{ V}$ ,                                                                  | $R_L = 2\text{ k}\Omega$ ,          | $C_L = 100\text{ pF}$ , See Figure 1                           | 8   | 13    |     | $\text{V}/\mu\text{s}$       |
| $t_r$     | Rise time                      | $V_I = 20\text{ mV}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , See Figure 1 |                                     |                                                                |     | 0.05  |     | $\mu\text{s}$                |
|           | Overshoot factor               |                                                                                        |                                     |                                                                |     | 20    |     | %                            |
| $V_n$     | Equivalent input noise voltage | $R_S = 20\text{ }\Omega$                                                               | $f = 1\text{ kHz}$                  |                                                                |     | 18    |     | $\text{nV}/\sqrt{\text{Hz}}$ |
|           |                                |                                                                                        | $f = 10\text{ Hz to }10\text{ kHz}$ |                                                                |     | 4     |     | $\mu\text{V}$                |
| $I_n$     | Equivalent input noise current | $R_S = 20\text{ }\Omega$ ,                                                             | $f = 1\text{ kHz}$                  |                                                                |     | 0.01  |     | $\text{pA}/\sqrt{\text{Hz}}$ |
| THD       | Total harmonic distortion      | $V_{I\text{rms}} = 6\text{ V}$ ,<br>$f = 1\text{ kHz}$                                 | $A_{VD} = 1$ ,                      | $R_S \leq 1\text{ k}\Omega$ ,<br>$R_L \geq 2\text{ k}\Omega$ , |     | 0.003 |     | %                            |

PARAMETER MEASUREMENT INFORMATION

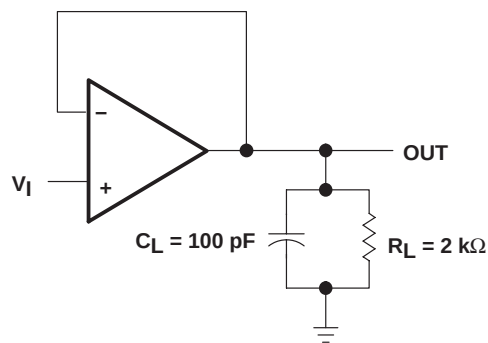


Figure 1

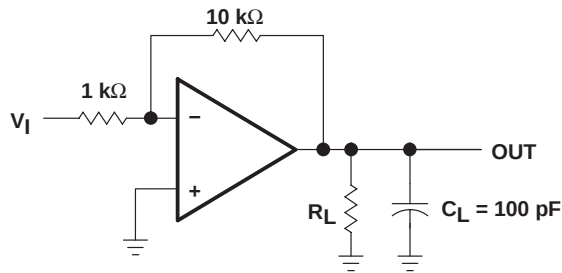


Figure 2

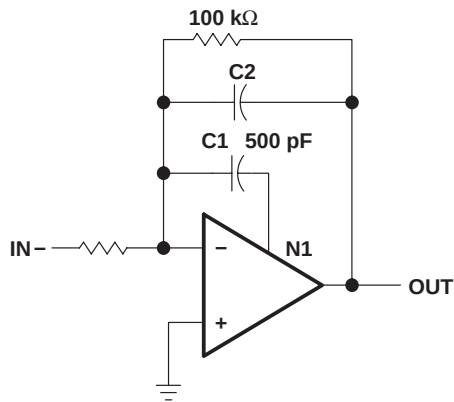


Figure 3

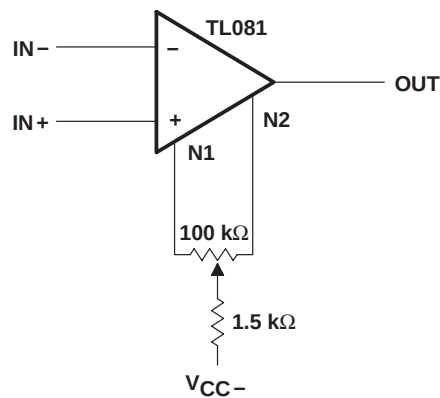


Figure 4



TL081, TL081A, TL081B, TL082, TL082A, TL082B  
TL084, TL084A, TL084B  
JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

TYPICAL CHARACTERISTICS

Table of Graphs

|          |                                                 | FIGURE  |
|----------|-------------------------------------------------|---------|
| $V_{OM}$ | Maximum peak output voltage                     | 5, 6, 7 |
|          | vs Frequency                                    | 8       |
|          | vs Load resistance                              | 9       |
|          | vs Supply voltage                               | 10      |
| $A_{VD}$ | Large-signal differential voltage amplification | 11      |
|          | vs Frequency                                    | 12      |
| $A_{VD}$ | Differential voltage amplification              | 13      |
|          | vs Frequency with feed-forward compensation     | 13      |
| $P_D$    | Total power dissipation                         | 14      |
| $I_{CC}$ | Supply current                                  | 15      |
|          | vs Supply voltage                               | 16      |
| $I_{IB}$ | Input bias current                              | 17      |
|          | Large-signal pulse response                     | 18      |
| $V_O$    | Output voltage                                  | 19      |
| CMRR     | Common-mode rejection ratio                     | 20      |
| $V_n$    | Equivalent input noise voltage                  | 21      |
| THD      | Total harmonic distortion                       | 22      |

MAXIMUM PEAK OUTPUT VOLTAGE  
vs  
FREQUENCY

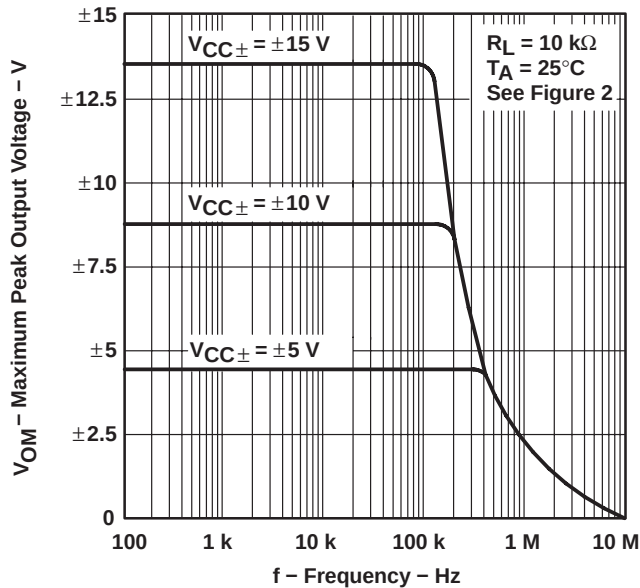


Figure 5

MAXIMUM PEAK OUTPUT VOLTAGE  
vs  
FREQUENCY

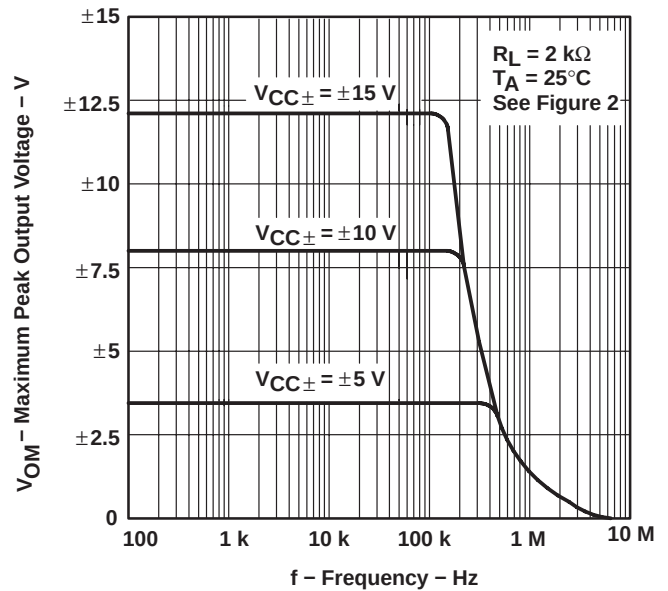
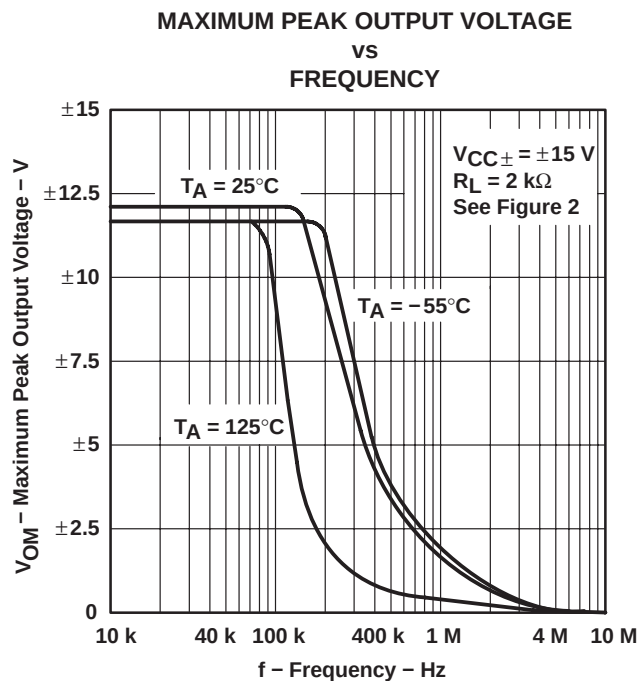


Figure 6

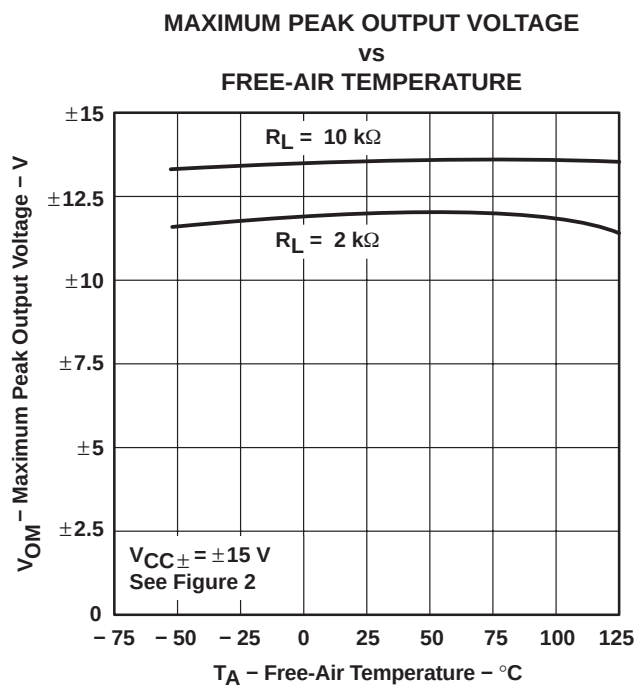
**TL081, TL081A, TL081B, TL082, TL082A, TL082B**  
**TL084, TL084A, TL084B**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

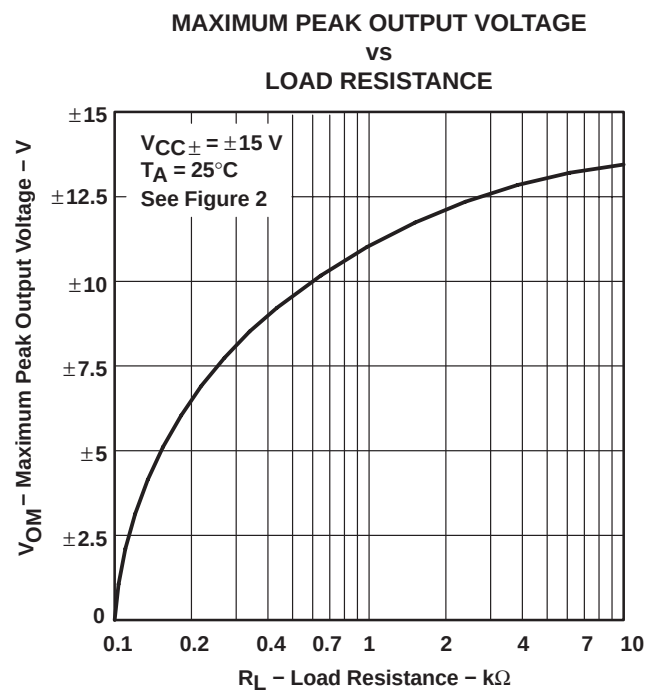
**TYPICAL CHARACTERISTICS†**



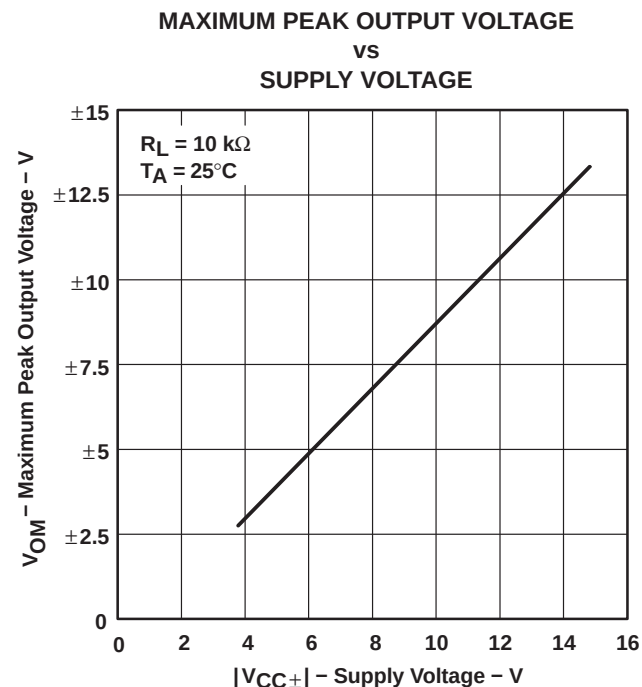
**Figure 7**



**Figure 8**



**Figure 9**



**Figure 10**

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

# TYPICAL CHARACTERISTICS†

## LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION VS FREE-AIR TEMPERATURE

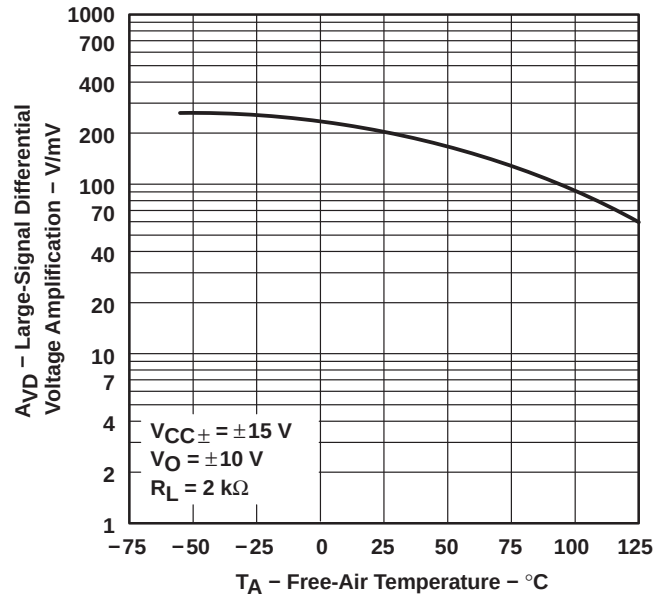


Figure 11

## LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION VS FREQUENCY

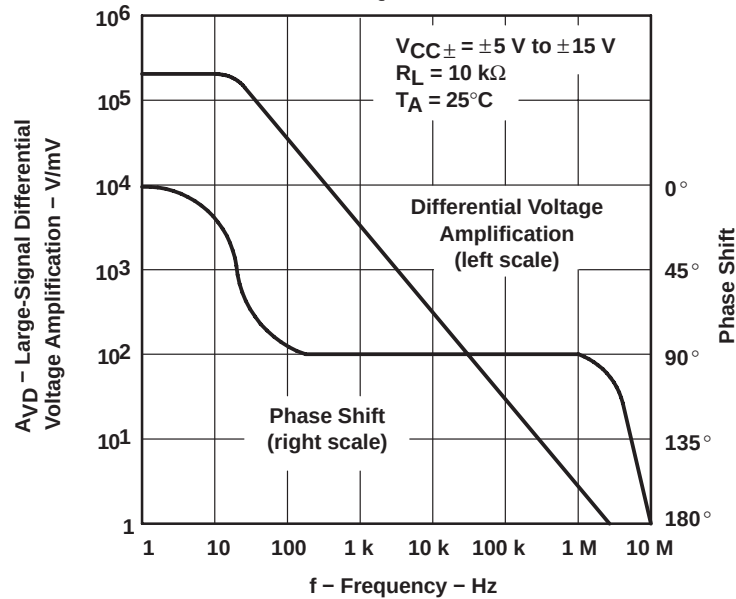


Figure 12

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

# TL081, TL081A, TL081B, TL082, TL082A, TL082B TL084, TL084A, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

## TYPICAL CHARACTERISTICS†

DIFFERENTIAL VOLTAGE AMPLIFICATION  
vs  
FREQUENCY WITH FEED-FORWARD COMPENSATION

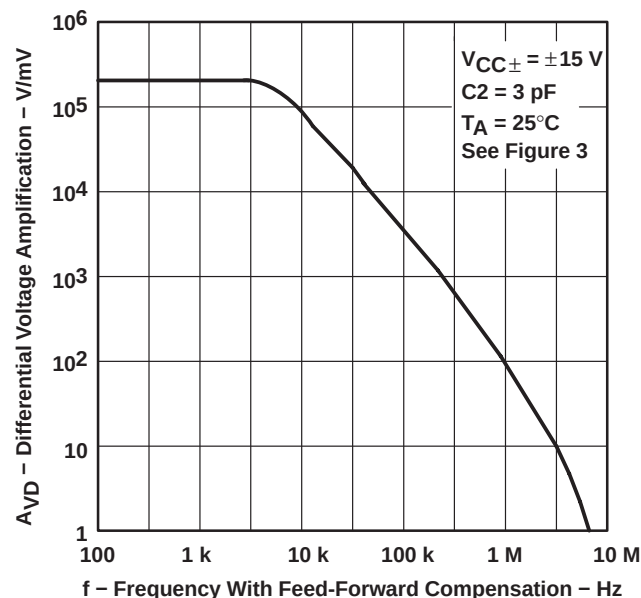


Figure 13

TOTAL POWER DISSIPATION  
vs  
FREE-AIR TEMPERATURE

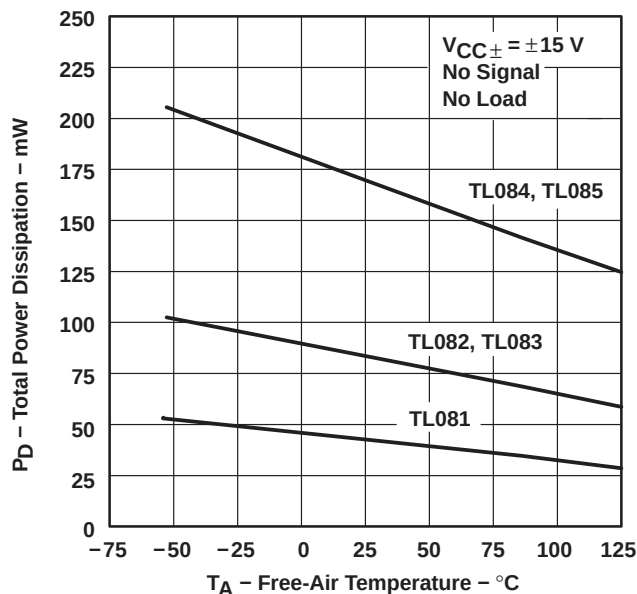


Figure 14

SUPPLY CURRENT PER AMPLIFIER  
vs  
FREE-AIR TEMPERATURE

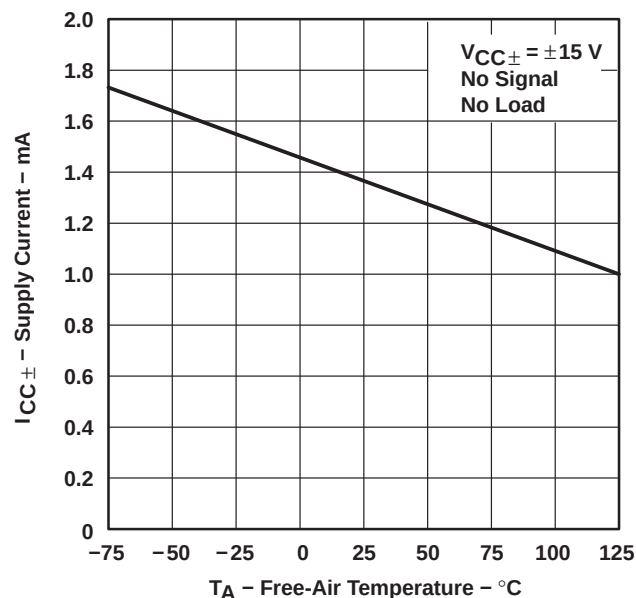


Figure 15

SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE

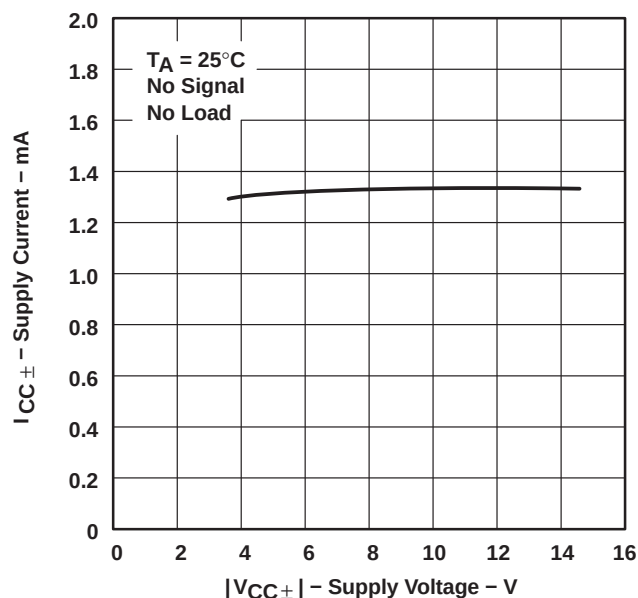


Figure 16

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

**TYPICAL CHARACTERISTICS†**

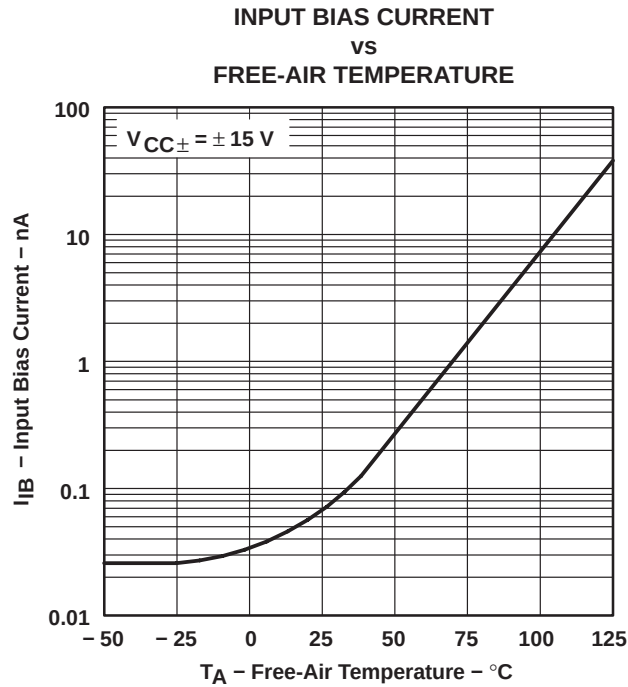


Figure 17

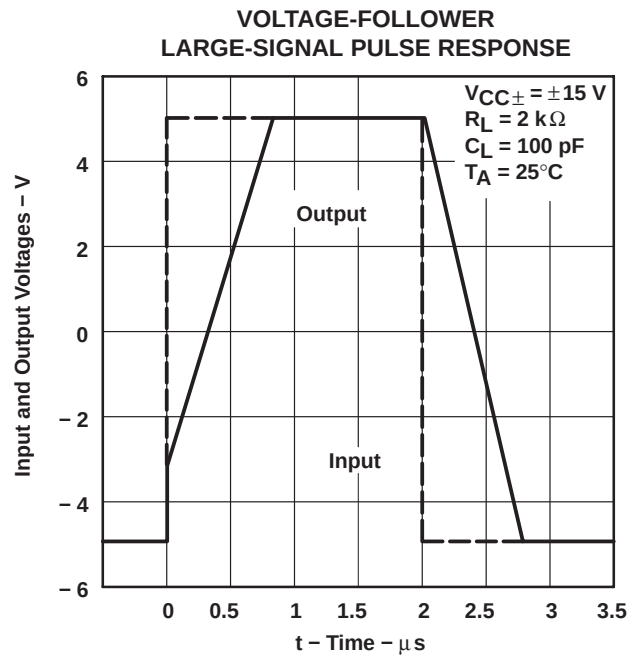


Figure 18

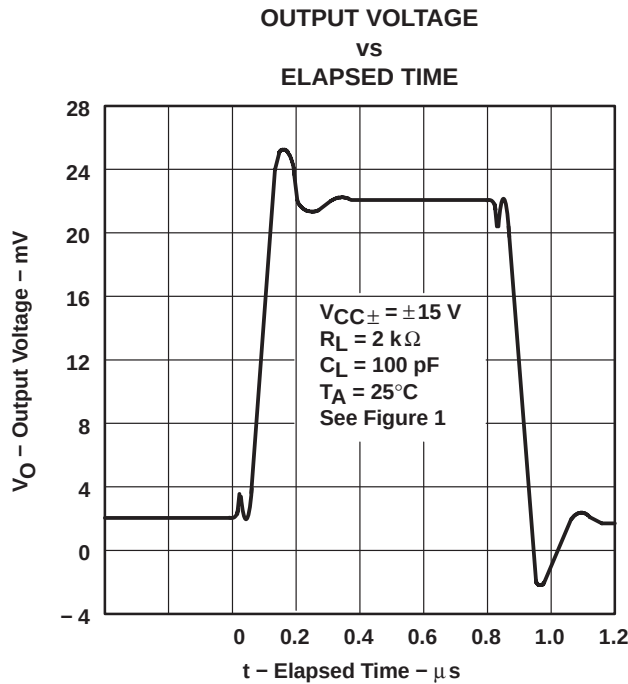


Figure 19

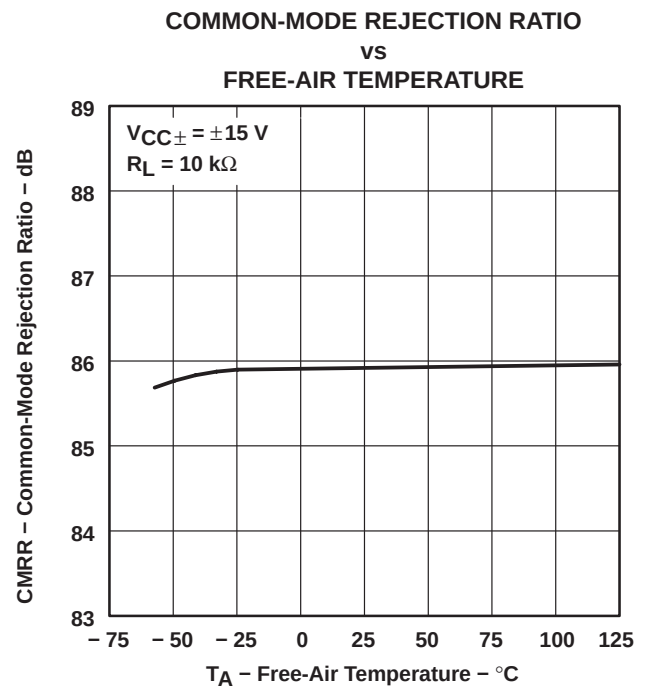


Figure 20

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

# TL081, TL081A, TL081B, TL082, TL082A, TL082B TL084, TL084A, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

## TYPICAL CHARACTERISTICS†

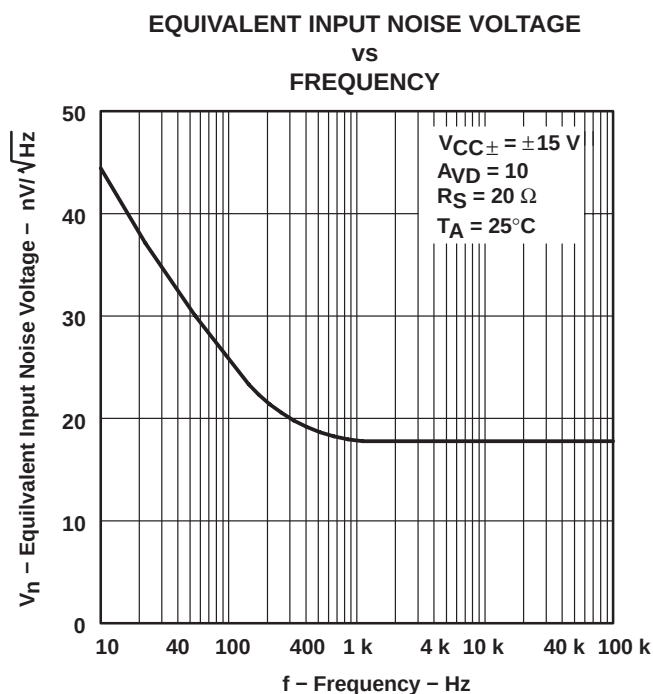


Figure 21

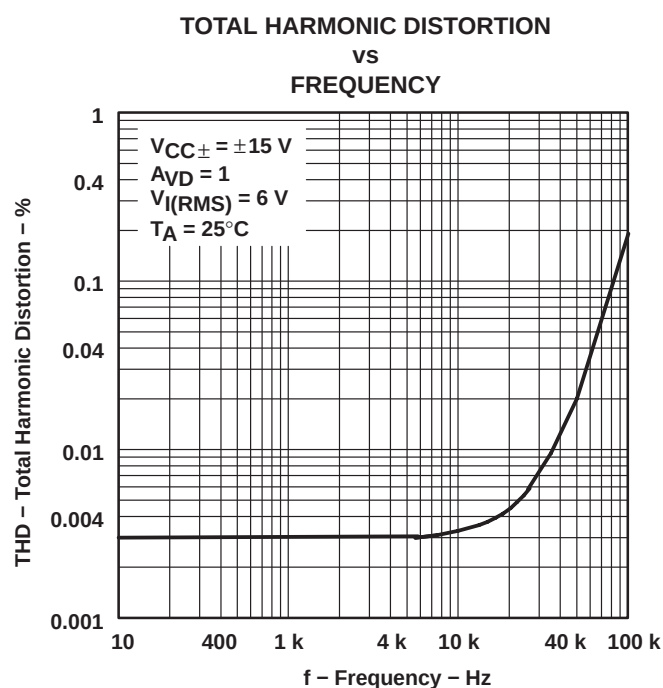


Figure 22

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

## APPLICATION INFORMATION

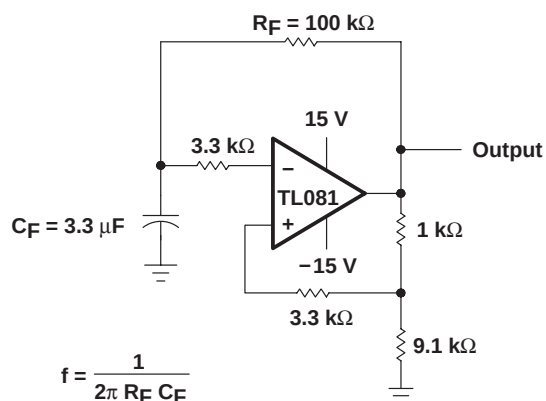


Figure 23

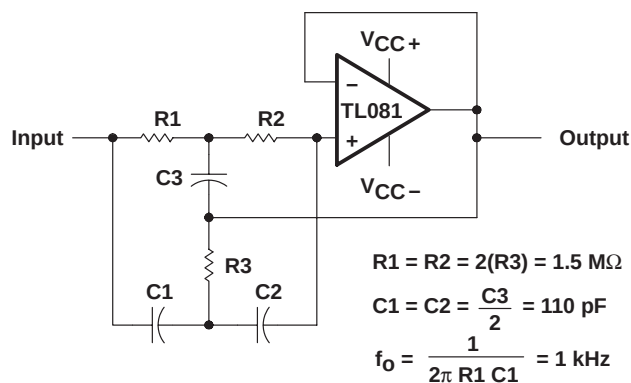


Figure 24

## APPLICATION INFORMATION

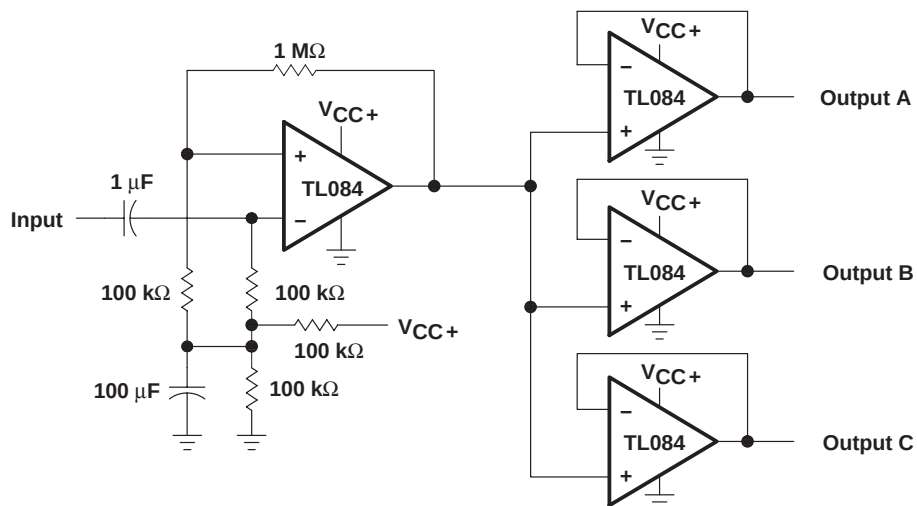
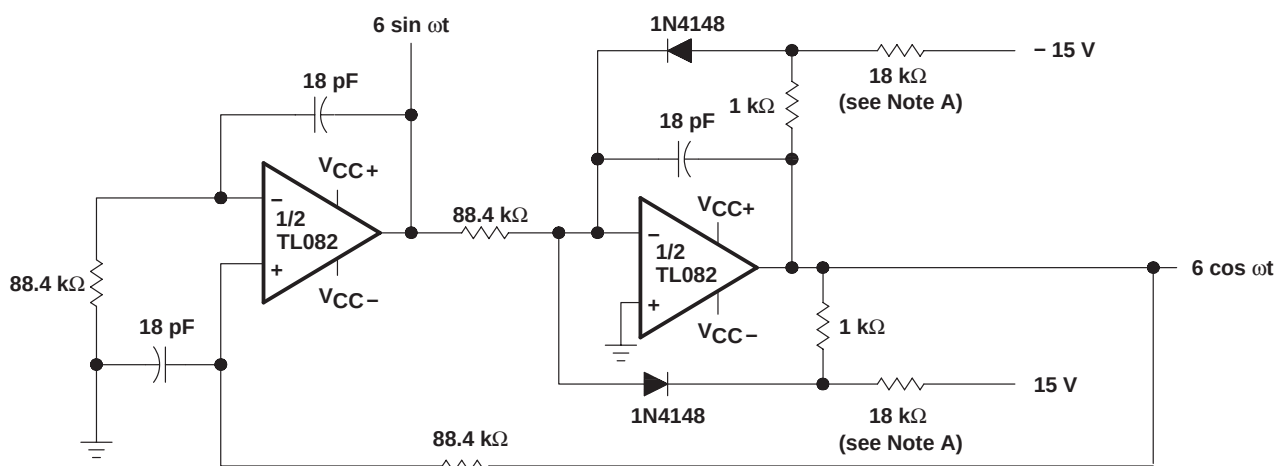


Figure 25. Audio-Distribution Amplifier



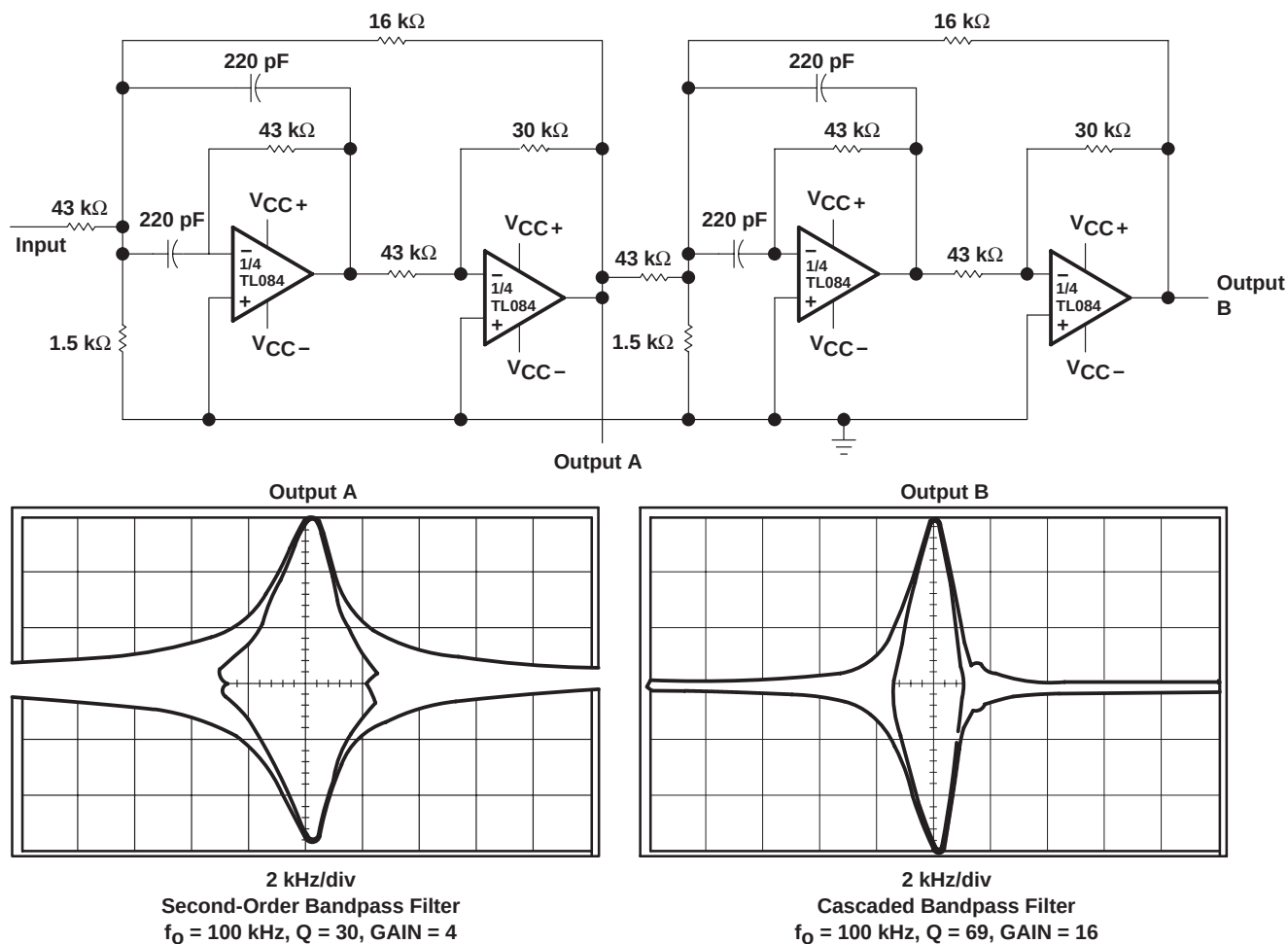
NOTE A: These resistor values may be adjusted for a symmetrical output.

Figure 26. 100-KHz Quadrature Oscillator

TL081, TL081A, TL081B, TL082, TL082A, TL082B  
 TL084, TL084A, TL084B  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS081G – FEBRUARY 1977 – REVISED SEPTEMBER 2004

**APPLICATION INFORMATION**

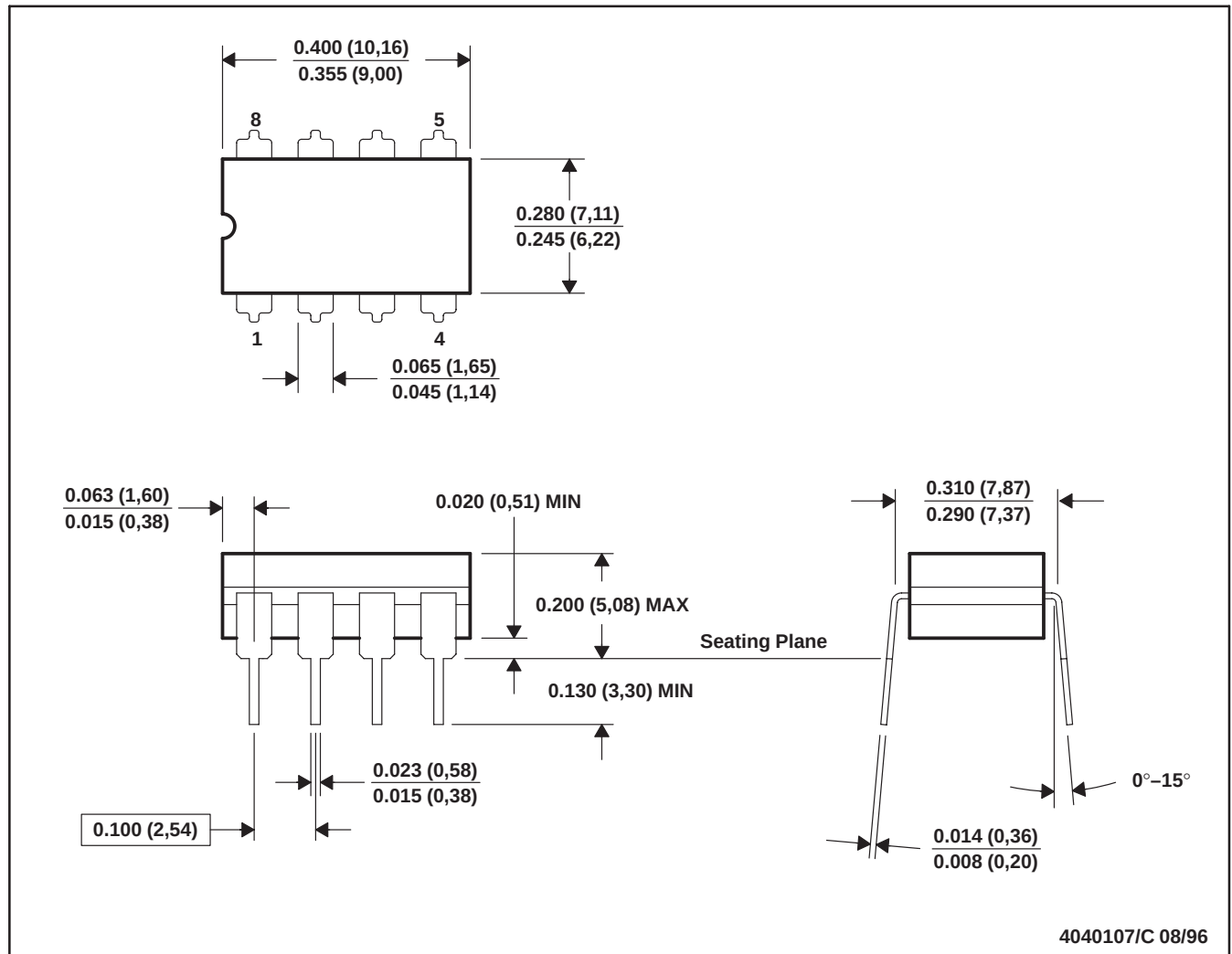


**Figure 27. Positive-Feedback Bandpass Filter**



## JG (R-GDIP-T8)

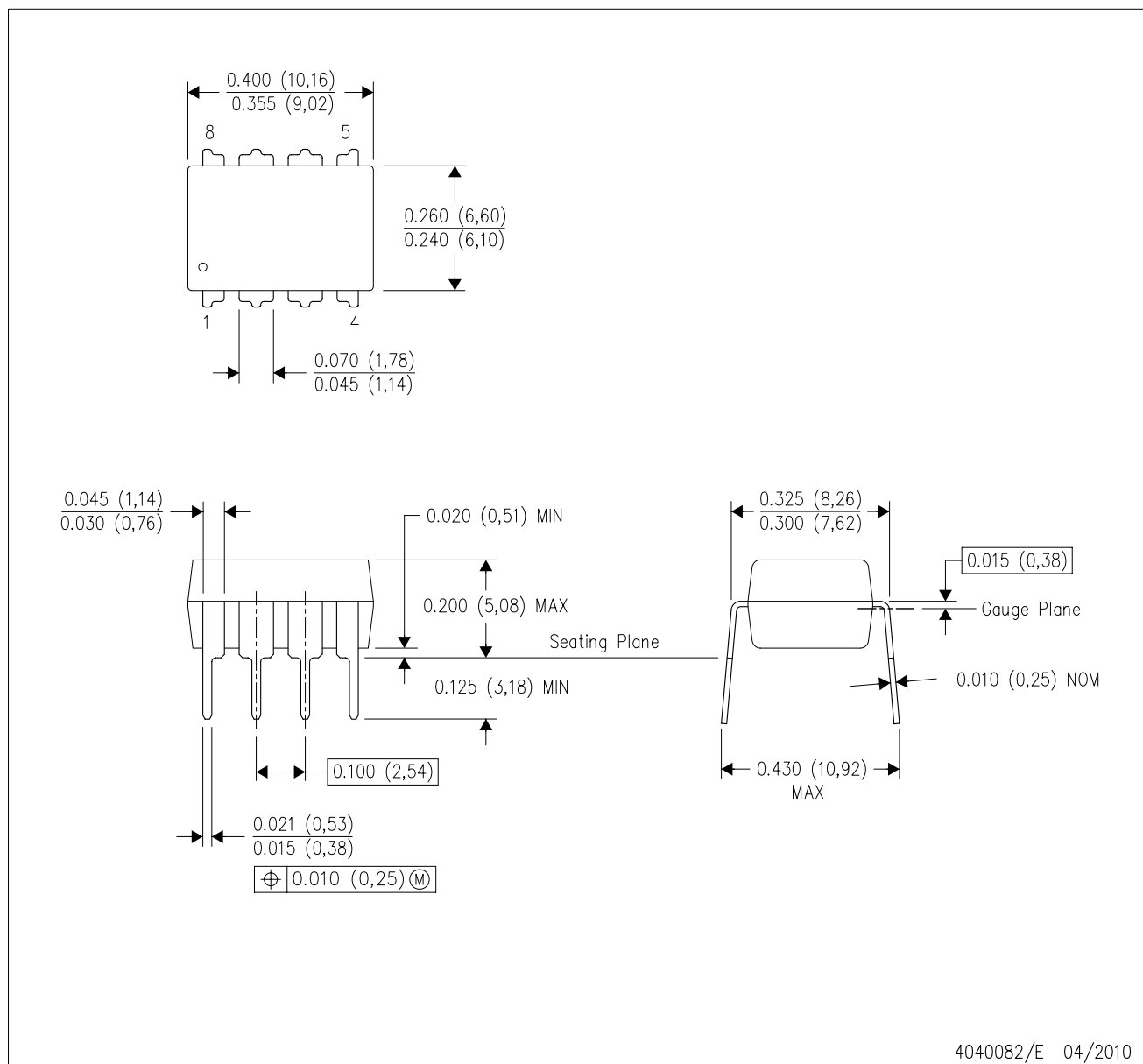
## CERAMIC DUAL-IN-LINE



- 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

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE

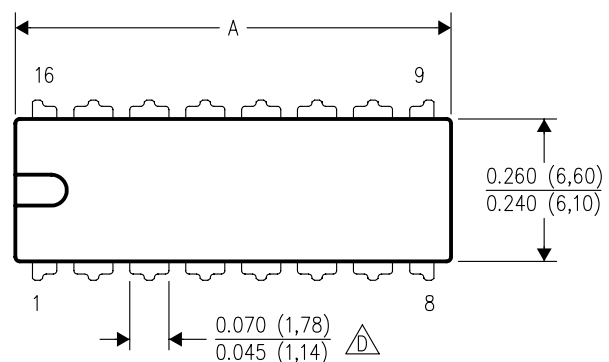


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

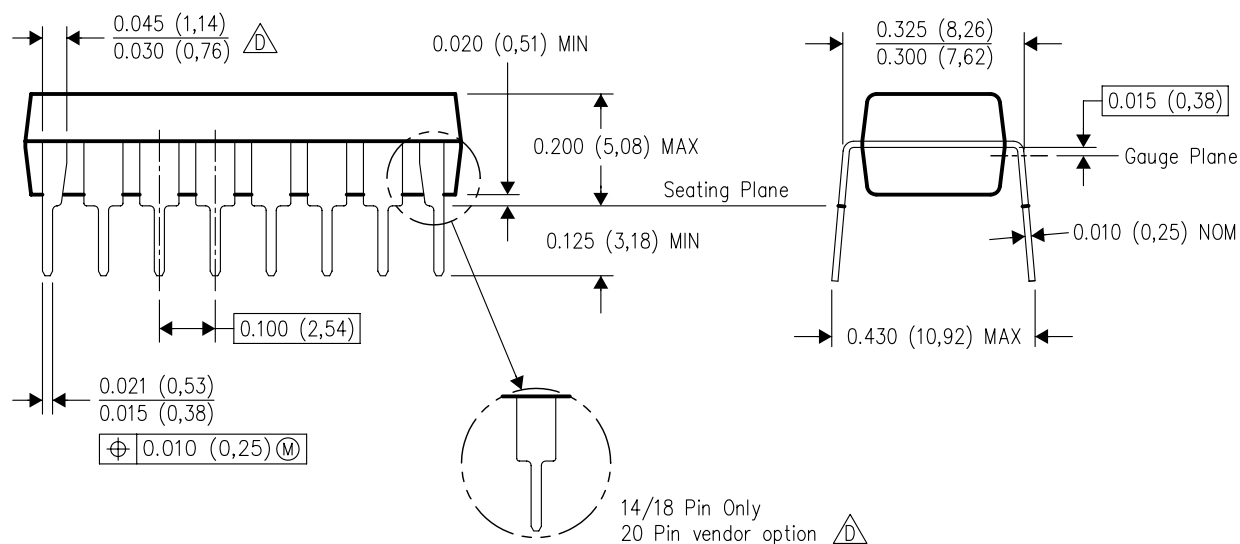
## N (R-PDIP-T\*\*)

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               |

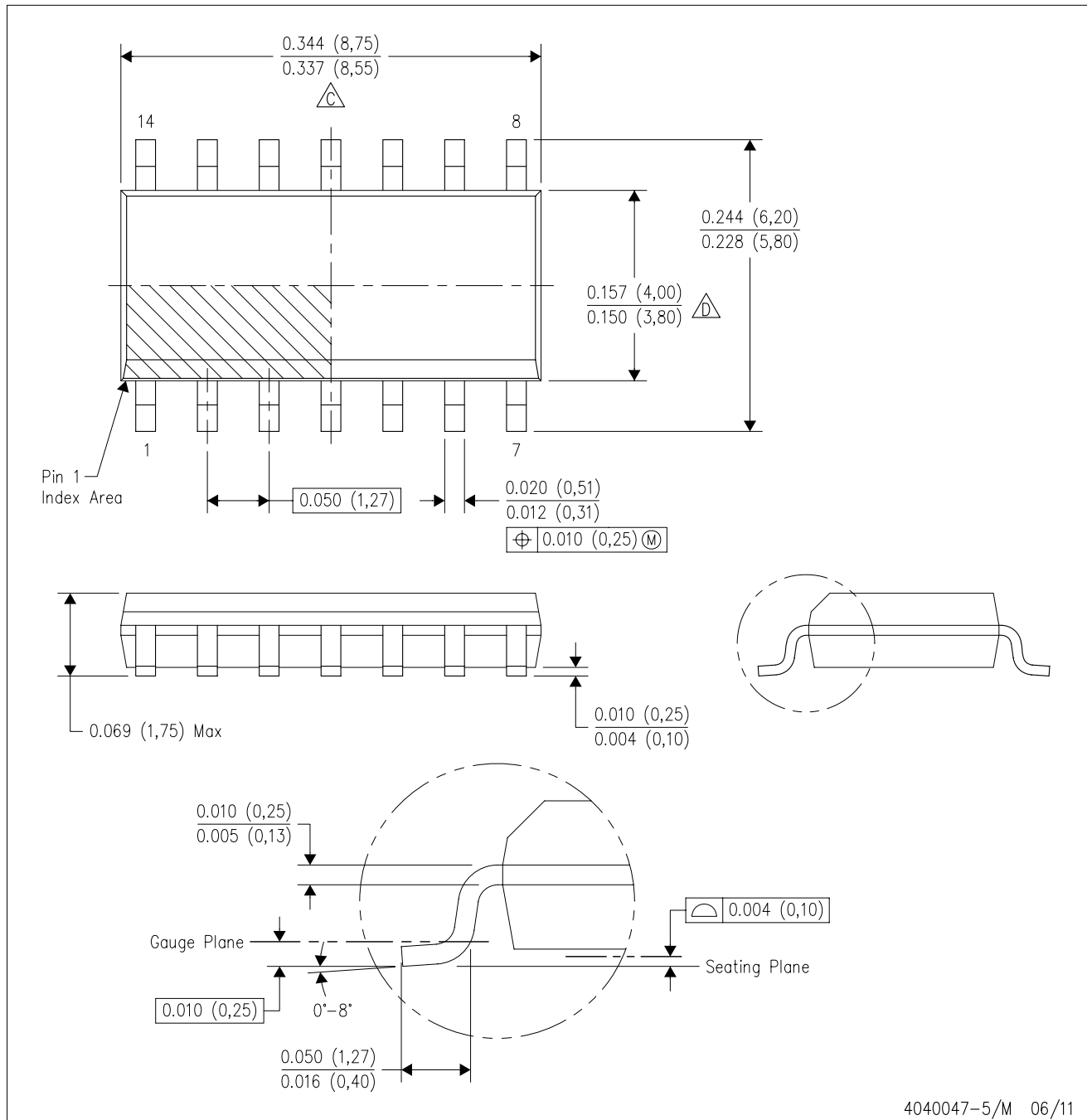


4040049/E 12/2002

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

D (R-PDSO-G14)

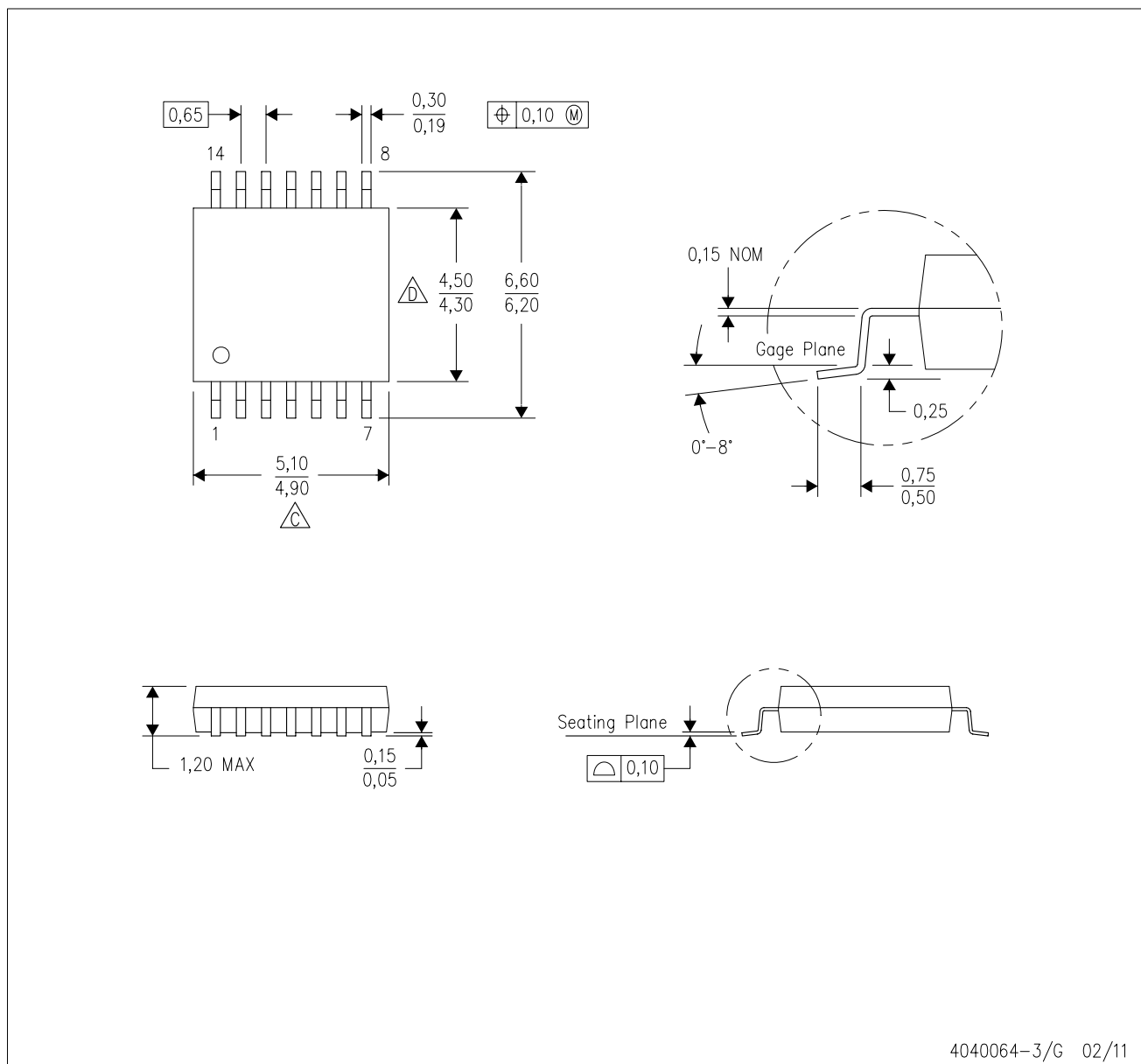
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AB.

PW (R-PDSO-G14)

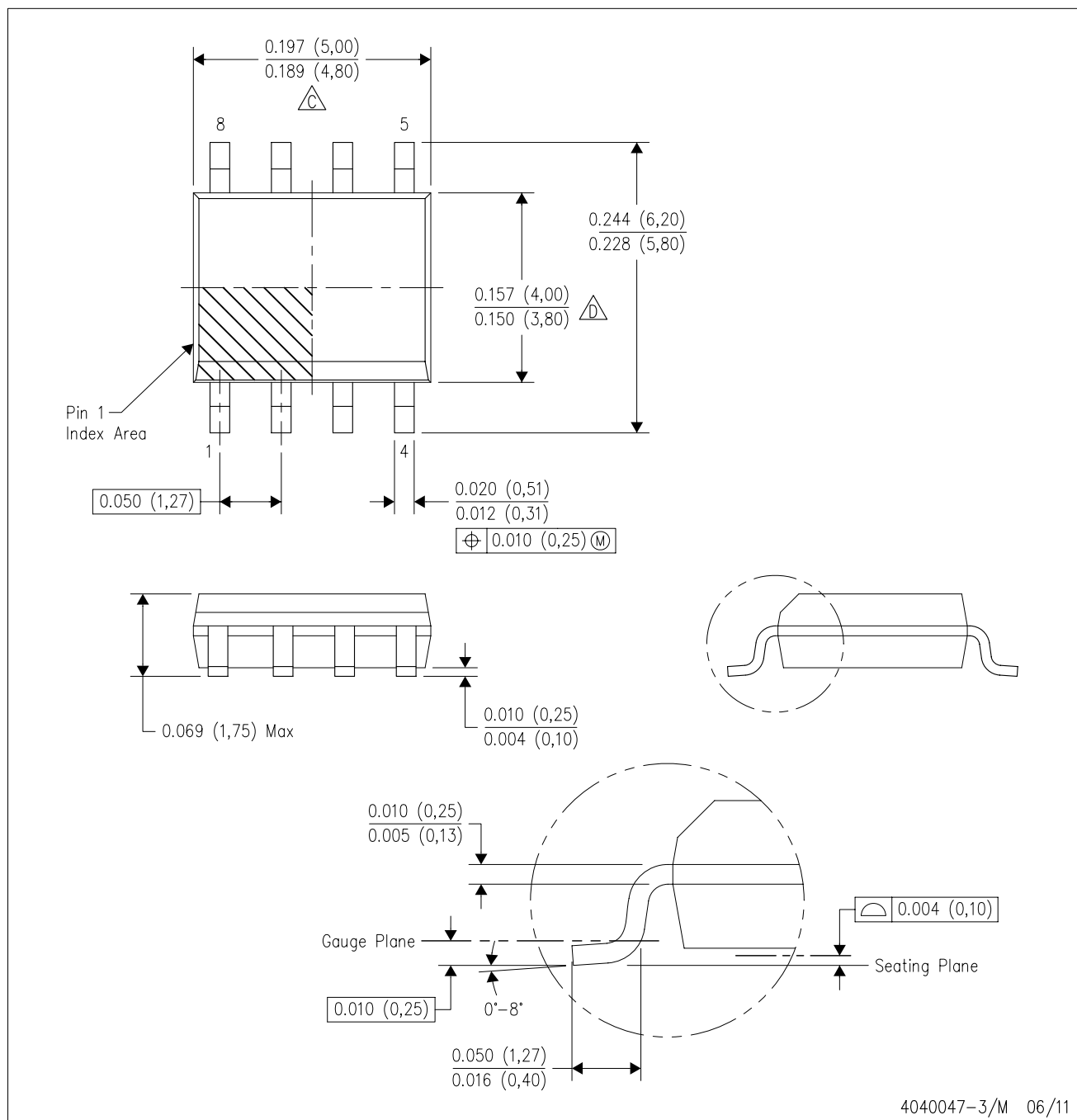
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



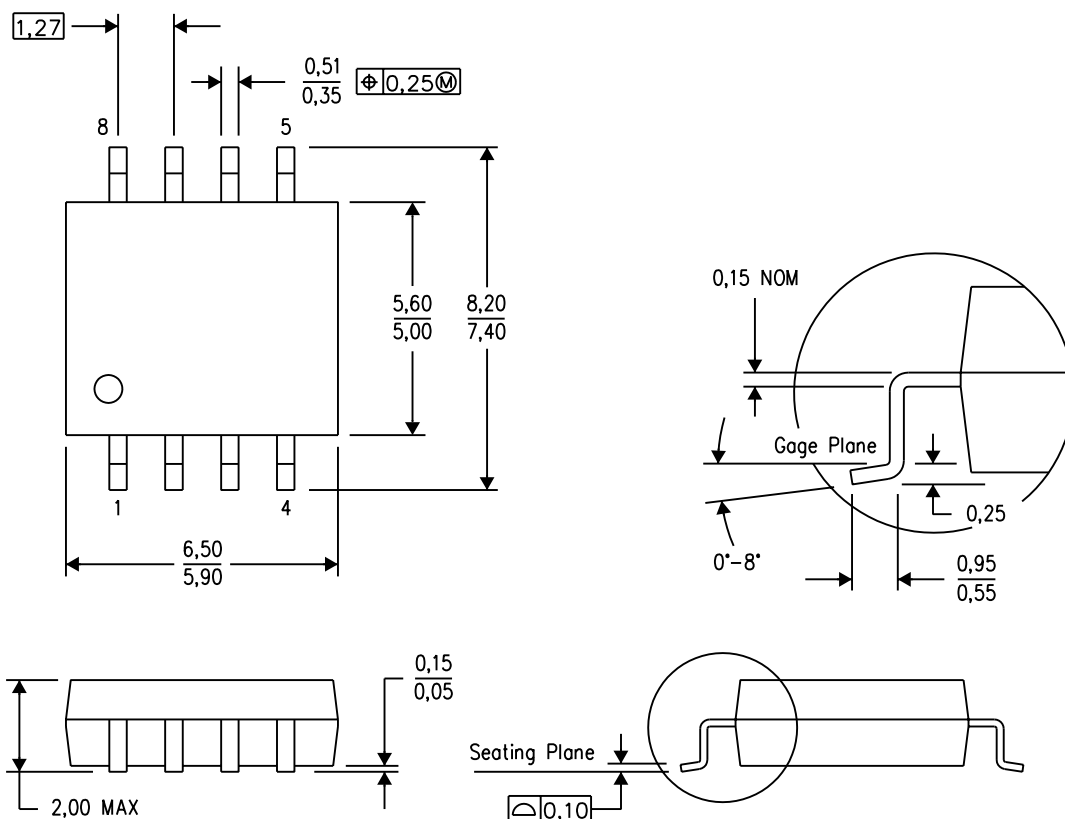
## NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AA.

## MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



4040063/C 03/03

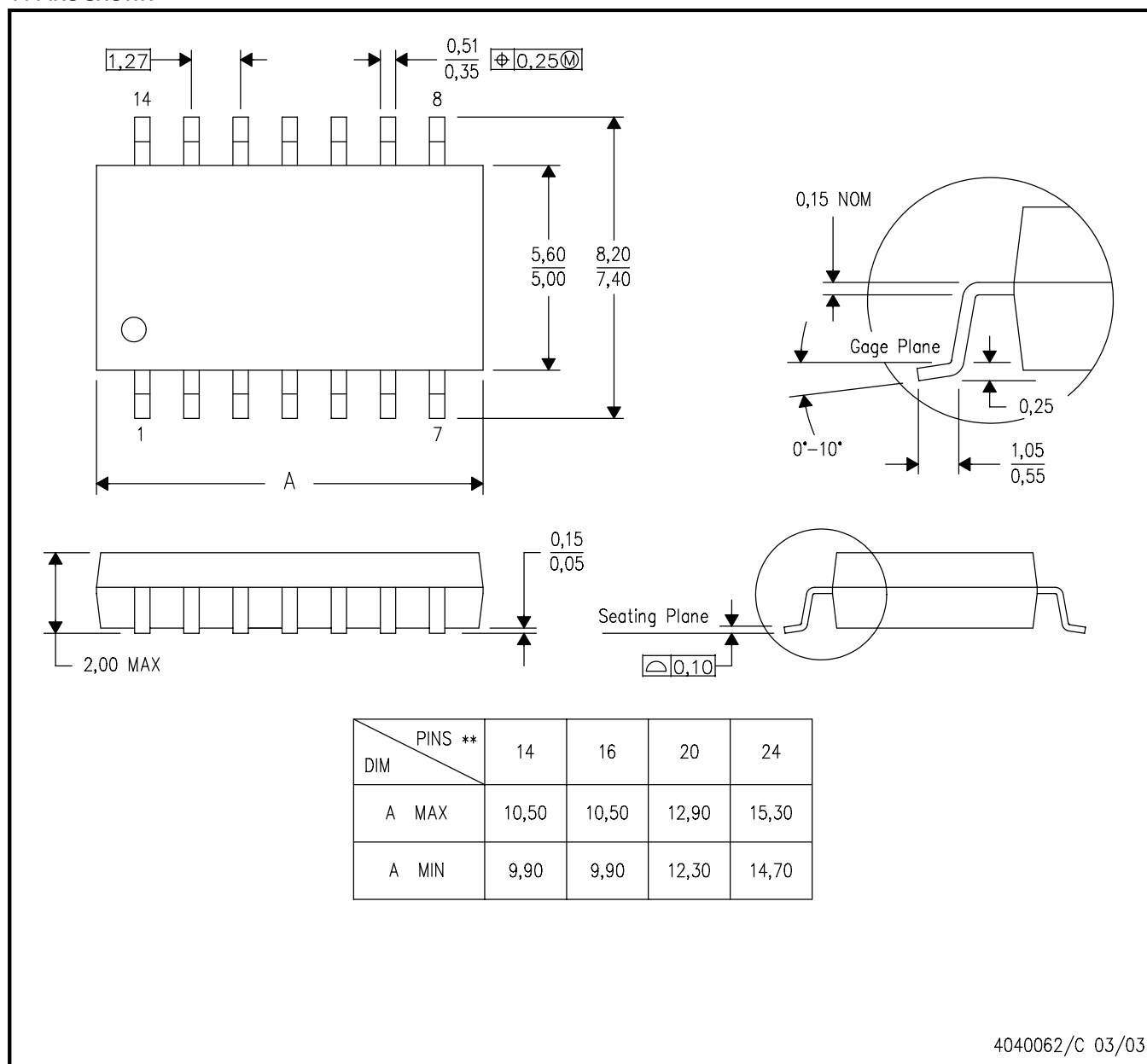
- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

# 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.