- **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**
- **Low Noise**
  **$V_n$ = 18 nV/$\sqrt{Hz}$ Typ at f = 1 kHz**
- **High Input Impedance . . . JFET Input Stage**
- **Internal Frequency Compensation**
- **Latch-Up-Free Operation**
- **High Slew Rate . . . 13 V/μs Typ**
- **Common-Mode Input Voltage Range Includes $V_{CC+}$**

## description/ordering information

The JFET-input operational amplifiers in the TL07x series are similar to the TL08x series, with low input bias and offset currents and fast slew rate. The low harmonic distortion and low noise make the TL07x series ideally suited for high-fidelity and audio preamplifier applications. Each amplifier features JFET inputs (for high input impedance) coupled with bipolar output stages integrated on a single monolithic chip.

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 M-suffix devices are characterized for operation over the full military temperature range of −55°C to 125°C.

## description/ordering information (continued)

**ORDERING INFORMATION**

| $T_A$ | $V_{IO}$max AT 25°C | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|
| 0°C to 70°C | 10 mV | PDIP (P) | Tube of 50 | TL071CP | TL071CP |
| | | | Tube of 50 | TL072CP | TL072CP |
| | | PDIP (N) | Tube of 25 | TL074CN | TL074CN |
| | | SOIC (D) | Tube of 75 | TL071CD | TL071C |
| | | | Reel of 2500 | TL071CDR | |
| | | | Tube of 75 | TL072CD | TL072C |
| | | | Reel of 2500 | TL072CDR | |
| | | | Tube of 50 | TL074CD | TL074C |
| | | | Reel of 2500 | TL074CDR | |
| | | SOP (NS) | Reel of 2000 | TL074CNSR | TL074 |
| | | SOP (PS) | Reel of 2000 | TL071CPSR | TL071 |
| | | | Reel of 2000 | TL072CPSR | T072 |
| | | TSSOP (PW) | Reel of 2000 | TL072CPWR | T072 |
| | | | Tube of 90 | TL074CPW | T074 |
| | | | Reel of 2000 | TL074CPWR | |
| | 6 mV | PDIP (P) | Tube of 50 | TL071ACP | TL071ACP |
| | | | Tube of 50 | TL072ACP | TL072ACP |
| | | PDIP (N) | Tube of 25 | TL074ACN | TL074ACN |
| | | SOIC (D) | Tube of 75 | TL071ACD | 071AC |
| | | | Reel of 2500 | TL071ACDR | |
| | | | Tube of 75 | TL072ACD | 072AC |
| | | | Reel of 2500 | TL072ACDR | |
| | | | Tube of 50 | TL074ACD | TL074AC |
| | | | Reel of 2500 | TL074ACDR | |
| | | SOP (PS) | Reel of 2000 | TL072ACPSR | T072A |
| | | SOP (NS) | Reel of 2000 | TL074ACNSR | TL074A |
| | 3 mV | PDIP (P) | Tube of 50 | TL071BCP | TL071BCP |
| | | | Tube of 50 | TL072BCP | TL072BCP |
| | | PDIP (N) | Tube of 25 | TL074BCN | TL074BCN |
| | | SOIC (D) | Tube of 75 | TL071BCD | 071BC |
| | | | Reel of 2500 | TL071BCDR | |
| | | | Tube of 75 | TL072BCD | 072BC |
| | | | Reel of 2500 | TL072BCDR | |
| | | | Tube of 50 | TL074BCD | TL074BC |
| | | | Reel of 2500 | TL074BCDR | |
| | | SOP (NS) | Reel of 2000 | TL074BCNSR | TL074B |

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

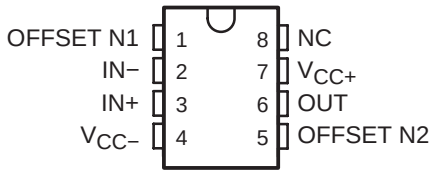
## description/ordering information (continued)

**ORDERING INFORMATION**

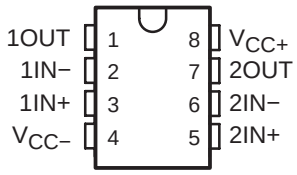
| $T_A$ | $V_{IO}$max AT 25°C | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|
| −40°C to 85°C | 6 mV | PDIP (P) | Tube of 50 | TL071IP | TL071IP |
| | | | Tube of 50 | TL072IP | TL072IP |
| | | PDIP (N) | Tube of 25 | TL074IN | TL074IN |
| | | SOIC (D) | Tube of 75 | TL071ID | TL071I |
| | | | Reel of 2500 | TL071IDR | |
| | | | Tube of 75 | TL072ID | TL072I |
| | | | Reel of 2500 | TL072IDR | |
| | | | Tube of 50 | TL074ID | TL074I |
| | | | Reel of 2500 | TL074IDR | |
| −55°C to 125°C | 6 mV | CDIP (JG) | Tube of 50 | TL072MJGB | TL072MJGB |
| | | CFP (U) | Tube of 150 | TL072MUB | TL072MUB |
| | | LCCC (FK) | Tube of 55 | TL072MFKB | TL072MFKB |
| | 9 mV | CDIP (J) | Tube of 25 | TL074MJB | TL074MJB |
| | | CFP (W) | Tube of 25 | TL074MWB | TL074MWB |
| | | LCCC (FK) | Tube of 55 | TL074MFKB | TL074MFKB |

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

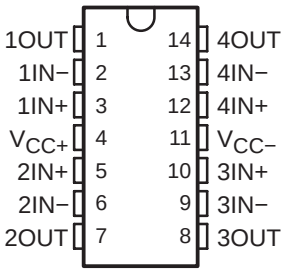
**TL071, TL071A, TL071B**
**D, P, OR PS PACKAGE**
**(TOP VIEW)**



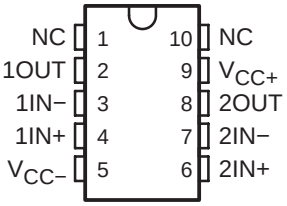

**TL072, TL072A, TL072B**
**D, JG, P, PS, OR PW PACKAGE**
**(TOP VIEW)**



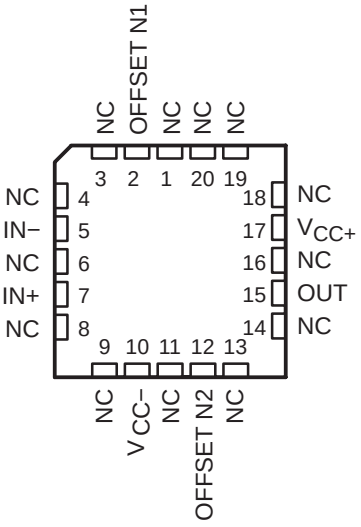

**TL074A, TL074B**
**D, J, N, NS, OR PW PACKAGE**
**TL074 . . . D, J, N, NS, PW,**
**OR W PACKAGE**
**(TOP VIEW)**



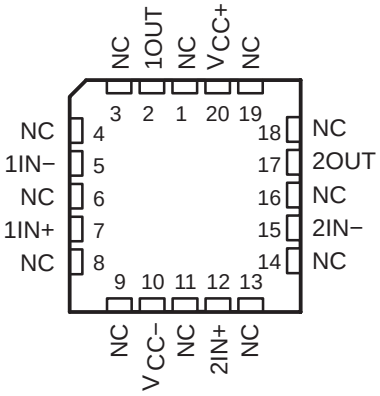

**TL072**
**U PACKAGE**
**(TOP VIEW)**



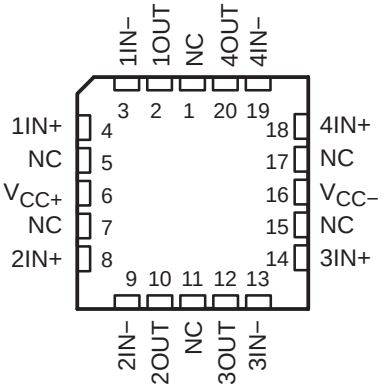

**TL071**
**FK PACKAGE**
**(TOP VIEW)**




**TL072**
**FK PACKAGE**
**(TOP VIEW)**



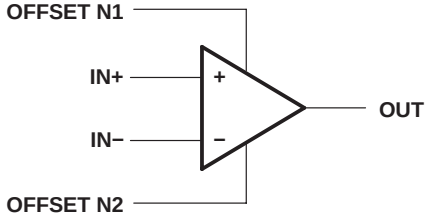

**TL074**
**FK PACKAGE**
**(TOP VIEW)**



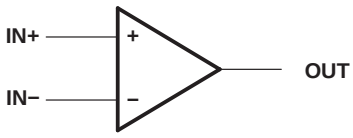

NC − No internal connection

## symbols

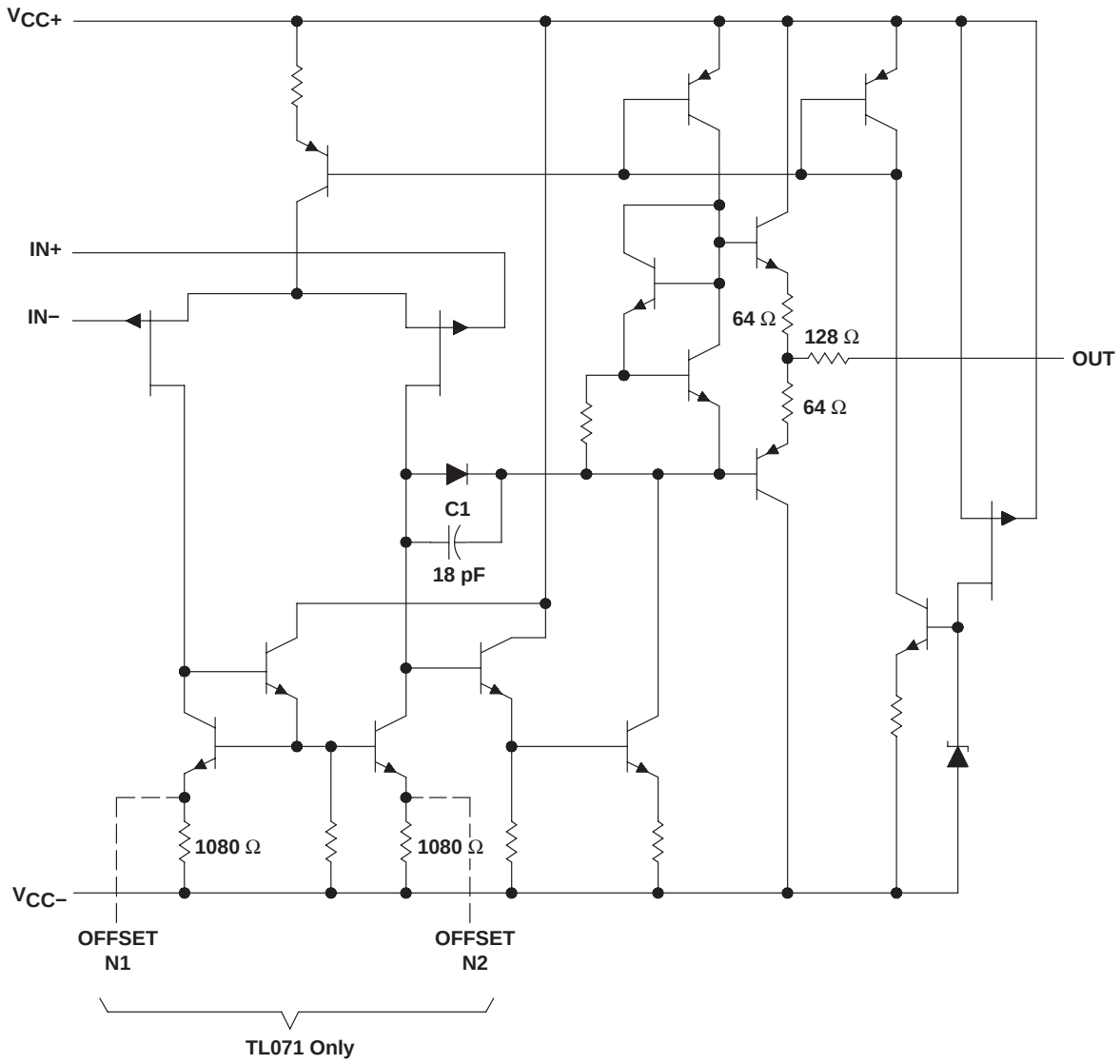
**TL071**




**TL072 (each amplifier)**
**TL074 (each amplifier)**



## schematic (each amplifier)




All component values shown are nominal.

| COMPONENT COUNT† | | | |
|---|---|---|---|
| COMPONENT TYPE | TL071 | TL072 | TL074 |
| Resistors | 11 | 22 | 44 |
| Transistors | 14 | 28 | 56 |
| JFET | 2 | 4 | 6 |
| Diodes | 1 | 2 | 4 |
| Capacitors | 1 | 2 | 4 |
| epi-FET | 1 | 2 | 4 |

† Includes bias and trim circuitry

### 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 |
| Differential input voltage, $V_{ID}$ (see Note 2) | | ±30 V |
| Input voltage, $V_I$ (see Notes 1 and 3) | | ±15 V |
| Duration of output short circuit (see Note 4) | | Unlimited |
| Package thermal impedance, $\theta_{JA}$ (see Notes 5 and 6): | D package (8 pin) | 97°C/W |
| | D package (14 pin) | 86°C/W |
| | N package | 80°C/W |
| | NS package | 76°C/W |
| | P package | 85°C/W |
| | PS package | 95°C/W |
| | PW package (8 pin) | 149°C/W |
| | PW package (14 pin) | 113°C/W |
| | U package | 185°C/W |
| Package thermal impedance, $\theta_{JC}$ (see Notes 7 and 8): | FK package | 5.61°C/W |
| | J package | 15.05°C/W |
| | JG package | 14.5°C/W |
| | W package | 14.65°C/W |
| Operating virtual junction temperature, $T_J$ | | 150°C |
| Case temperature for 60 seconds: FK package | | 260°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J, JG, or W package | | 300°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. 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.
7. Maximum power dissipation is a function of $T_J(max)$, $\theta_{JC}$, and $T_C$. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_J(max) - T_C)/\theta_{JC}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.
8. The package thermal impedance is calculated in accordance with MIL-STD-883.

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

| PARAMETER | | TEST CONDITIONS† | | $T_A$‡ | TL071C, TL072C, TL074C | | | TL071AC, TL072AC, TL074AC | | | TL071BC, TL072BC, TL074BC | | | TL071I, TL072I, TL074I | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_O$ = 0, | $R_S$ = 50 Ω | 25°C | | 3 | 10 | | 3 | 6 | | 2 | 3 | | 3 | 6 | mV |
| | | | | Full range | | | 13 | | | 7.5 | | | 5 | | | 8 | |
| $\alpha_{V_{IO}}$ | Temperature coefficient of input offset voltage | $V_O$ = 0, | $R_S$ = 50 Ω | Full range | | 18 | | | 18 | | | 18 | | | 18 | | µV/°C |
| $I_{IO}$ | Input offset current | $V_O$ = 0 | | 25°C | | 5 | 100 | | 5 | 100 | | 5 | 100 | | 5 | 100 | pA |
| | | | | Full range | | | 10 | | | 2 | | | 2 | | | 2 | nA |
| $I_{IB}$ | Input bias current§ | $V_O$ = 0 | | 25°C | | 65 | 200 | | 65 | 200 | | 65 | 200 | | 65 | 200 | pA |
| | | | | Full range | | | 7 | | | 7 | | | 7 | | | 20 | nA |
| $V_{ICR}$ | Common-mode input voltage range | | | 25°C | ±11 | −12 to 15 | | ±11 | −12 to 15 | | ±11 | −12 to 15 | | ±11 | −12 to 15 | | V |
| $V_{OM}$ | Maximum peak output voltage swing | $R_L$ = 10 kΩ | | 25°C | ±12 | ±13.5 | | ±12 | ±13.5 | | ±12 | ±13.5 | | ±12 | ±13.5 | | V |
| | | $R_L$ ≥ 10 kΩ | | Full range | ±12 | | | ±12 | | | ±12 | | | ±12 | | | |
| | | $R_L$ ≥ 2 kΩ | | | ±10 | | | ±10 | | | ±10 | | | ±10 | | | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_O$ = ±10 V, | $R_L$ ≥ 2 kΩ | 25°C | 25 | 200 | | 50 | 200 | | 50 | 200 | | 50 | 200 | | V/mV |
| | | | | Full range | 15 | | | 25 | | | 25 | | | 25 | | | |
| $B_1$ | Unity-gain bandwidth | | | 25°C | | 3 | | | 3 | | | 3 | | | 3 | | MHz |
| $r_i$ | Input resistance | | | 25°C | | $10^{12}$ | | | $10^{12}$ | | | $10^{12}$ | | | $10^{12}$ | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = $V_{ICR}$min, $V_O$ = 0, | $R_S$ = 50 Ω | 25°C | 70 | 100 | | 75 | 100 | | 75 | 100 | | 75 | 100 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$) | $V_{CC}$ = ±9 V to ±15 V, $V_O$ = 0, | $R_S$ = 50 Ω | 25°C | 70 | 100 | | 80 | 100 | | 80 | 100 | | 80 | 100 | | dB |
| $I_{CC}$ | Supply current (each amplifier) | $V_O$ = 0, | No load | 25°C | | 1.4 | 2.5 | | 1.4 | 2.5 | | 1.4 | 2.5 | | 1.4 | 2.5 | mA |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | $A_{VD}$ = 100 | | 25°C | | 120 | | | 120 | | | 120 | | | 120 | | dB |

† All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified.
‡ Full range is $T_A$ = 0°C to 70°C for TL07_C, TL07_AC, TL07_BC and is $T_A$ = −40°C to 85°C for TL07_I.
§ Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 4. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

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

| PARAMETER | | TEST CONDITIONS† | $T_A$‡ | TL071M TL072M | | | TL074M | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{IO}$ | Input offset voltage | $V_O$ = 0, $R_S$ = 50 Ω | 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 Ω | Full range | | 18 | | | 18 | | µV/°C |
| $I_{IO}$ | Input offset current | $V_O$ = 0 | 25°C | | 5 | 100 | | 5 | 100 | pA |
| | | | Full range | | | 20 | | | 20 | nA |
| $I_{IB}$ | Input bias current‡ | $V_O$ = 0 | 25°C | | 65 | 200 | | 65 | 200 | pA |
| | | | | | | 50 | | | 50 | nA |
| $V_{ICR}$ | Common-mode input voltage range | | 25°C | ±11 | −12 to 15 | | ±11 | −12 to 15 | | V |
| $V_{OM}$ | Maximum peak output voltage swing | $R_L$ = 10 kΩ | 25°C | ±12 | ±13.5 | | ±12 | ±13.5 | | V |
| | | $R_L$ ≥ 10 kΩ | Full range | ±12 | | | ±12 | | | |
| | | $R_L$ ≥ 2 kΩ | | ±10 | | | ±10 | | | |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_O$ = ±10 V, $R_L$ ≥ 2 kΩ | 25°C | 35 | 200 | | 35 | 200 | | V/mV |
| | | | | 15 | | | 15 | | | |
| $B_1$ | Unity-gain bandwidth | $T_A$ = 25°C | | | 3 | | | 3 | | MHz |
| $r_i$ | Input resistance | $T_A$ = 25°C | | | $10^{12}$ | | | $10^{12}$ | | Ω |
| CMRR | Common-mode rejection ratio | $V_{IC}$ = $V_{ICR}$min, $V_O$ = 0, $R_S$ = 50 Ω | 25°C | 80 | 86 | | 80 | 86 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$) | $V_{CC}$ = ±9 V to ±15 V, $V_O$ = 0, $R_S$ = 50 Ω | 25°C | 80 | 86 | | 80 | 86 | | dB |
| $I_{CC}$ | Supply current (each amplifier) | $V_O$ = 0, No load | 25°C | | 1.4 | 2.5 | | 1.4 | 2.5 | mA |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | $A_{VD}$ = 100 | 25°C | | 120 | | | 120 | | dB |

† Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive, as shown in Figure 4. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

‡ All characteristics are measured under open-loop conditions with zero common-mode voltage, unless otherwise specified. Full range is $T_A$ = −55°C to 125°C.

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

| PARAMETER | | TEST CONDITIONS | | TL07xM | | | ALL OTHERS | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| SR | Slew rate at unity gain | $V_I$ = 10 V, $C_L$ = 100 pF, | $R_L$ = 2 kΩ, See Figure 1 | 5 | 13 | | 8 | 13 | | V/μs |
| $t_r$ | Rise-time overshoot factor | $V_I$ = 20 mV, $C_L$ = 100 pF, | $R_L$ = 2 kΩ, See Figure 1 | | 0.1 | | | 0.1 | | μs |
| | | | | | 20% | | | 20% | | |
| $V_n$ | Equivalent input noise voltage | $R_S$ = 20 Ω | f = 1 kHz | | 18 | | | 18 | | nV/√Hz |
| | | | f = 10 Hz to 10 kHz | | 4 | | | 4 | | μV |
| $I_n$ | Equivalent input noise current | $R_S$ = 20 Ω, | f = 1 kHz | | 0.01 | | | 0.01 | | pA/√Hz |
| THD | Total harmonic distortion | $V_I$rms = 6 V, $R_L \geq$ 2 kΩ, f = 1 kHz | $A_{VD}$ = 1, $R_S \leq$ 1 kΩ, | | 0.003 % | | | 0.003% | | |

## PARAMETER MEASUREMENT INFORMATION

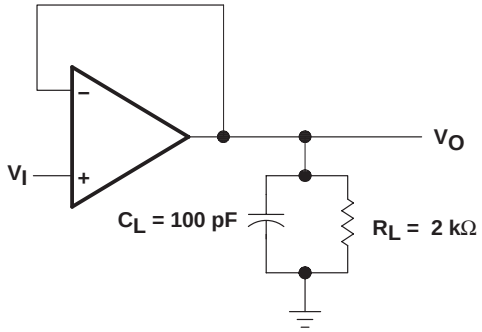



**Figure 1. Unity-Gain Amplifier**

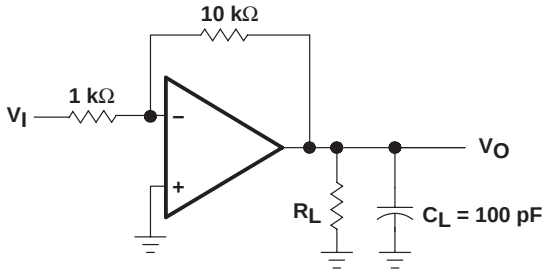



**Figure 2. Gain-of-10 Inverting Amplifier**

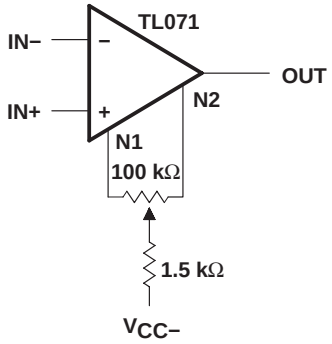



**Figure 3. Input Offset-Voltage Null Circuit**

## TYPICAL CHARACTERISTICS

### Table of Graphs

| | | | FIGURE |
|---|---|---|---|
| $I_{IB}$ | Input bias current | vs Free-air temperature | 4 |
| $V_{OM}$ | Maximum output voltage | vs Frequency<br>vs Free-air temperature<br>vs Load resistance<br>vs Supply voltage | 5, 6, 7<br>8<br>9<br>10 |
| $A_{VD}$ | Large-signal differential voltage amplification | vs Free-air temperature<br>vs Frequency | 11<br>12 |
| | Phase shift | vs Frequency | 12 |
| | Normalized unity-gain bandwidth | vs Free-air temperature | 13 |
| | Normalized phase shift | vs Free-air temperature | 13 |
| CMRR | Common-mode rejection ratio | vs Free-air temperature | 14 |
| $I_{CC}$ | Supply current | vs Supply voltage<br>vs Free-air temperature | 15<br>16 |
| $P_D$ | Total power dissipation | vs Free-air temperature | 17 |
| | Normalized slew rate | vs Free-air temperature | 18 |
| $V_n$ | Equivalent input noise voltage | vs Frequency | 19 |
| THD | Total harmonic distortion | vs Frequency | 20 |
| | Large-signal pulse response | vs Time | 21 |
| $V_O$ | Output voltage | vs Elapsed time | 22 |

## TYPICAL CHARACTERISTICS†

**INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE**

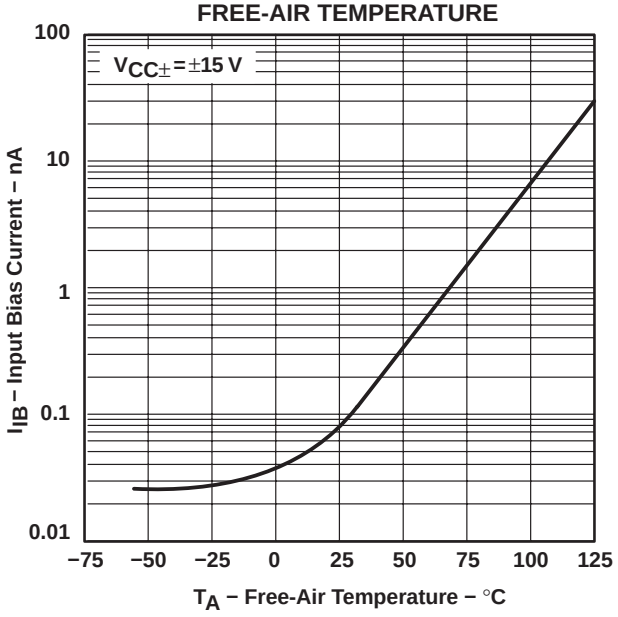



Figure 4

**MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY**

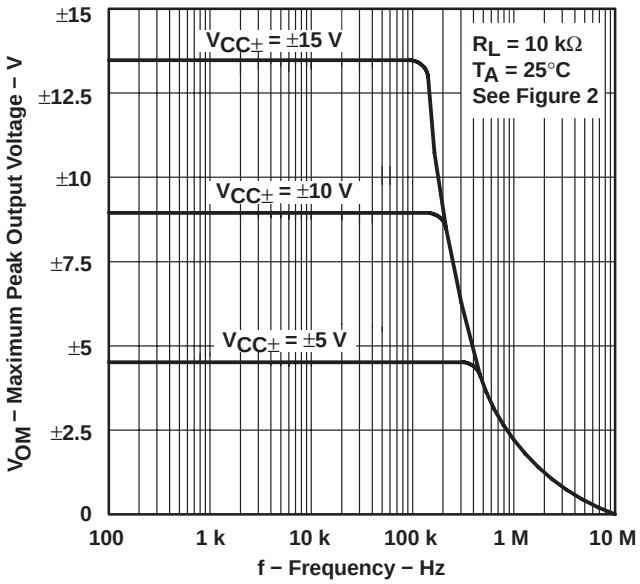



Figure 5

**MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY**

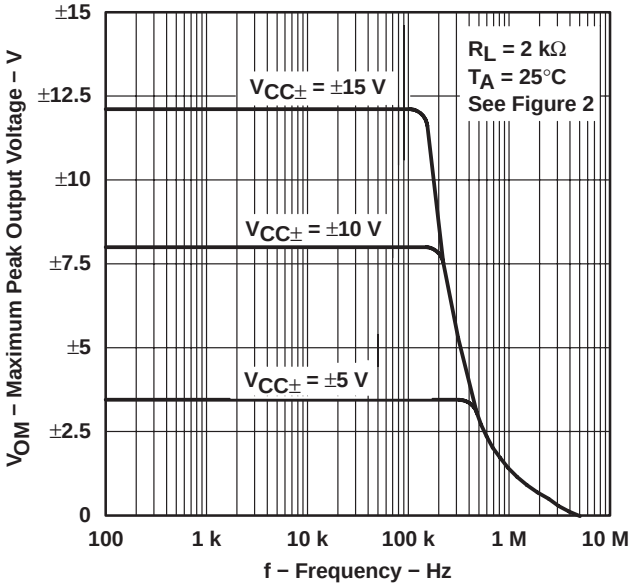



Figure 6

**MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY**

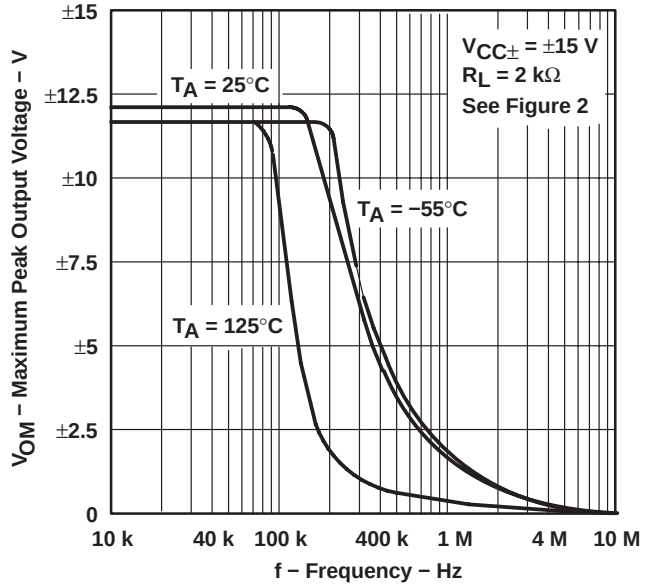



Figure 7

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

## TYPICAL CHARACTERISTICS†

**MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE**

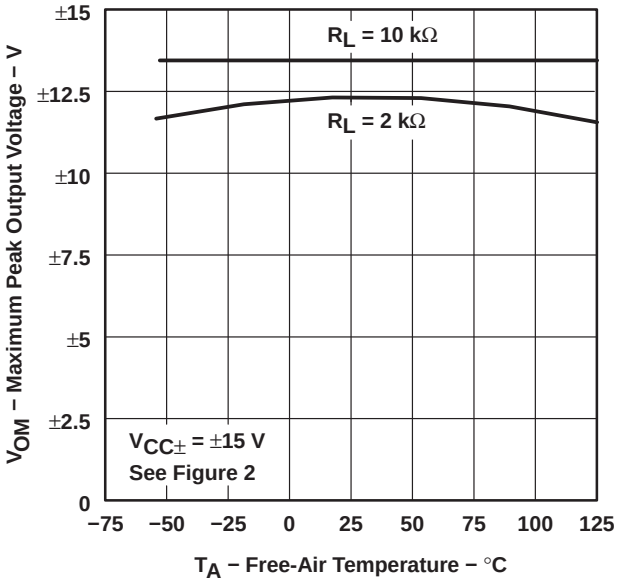



Figure 8

**MAXIMUM PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE**

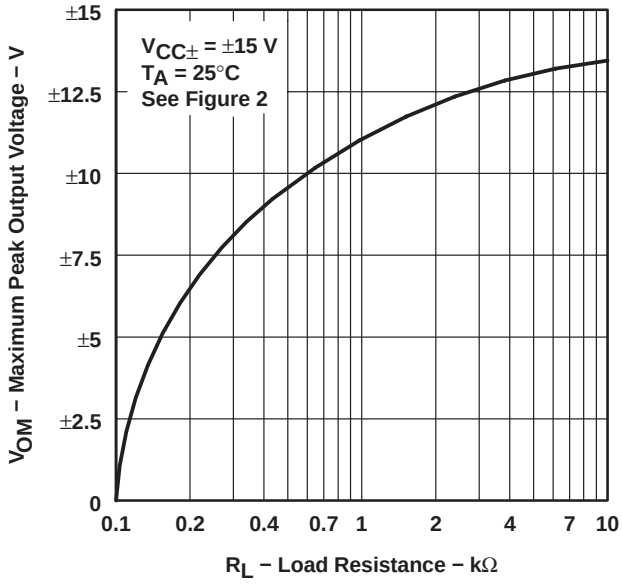



Figure 9

**MAXIMUM PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE**

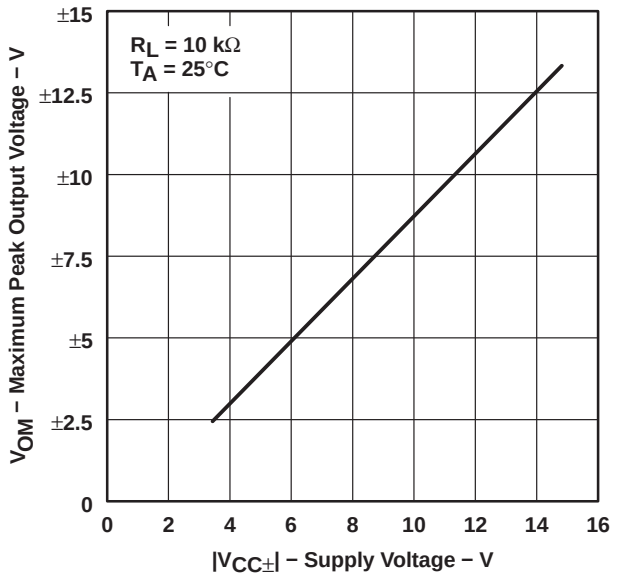



Figure 10

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE**

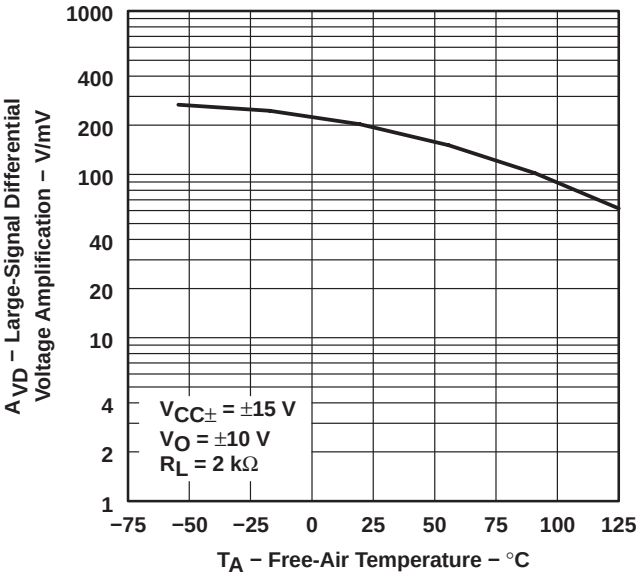



Figure 11

† 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 AND PHASE SHIFT vs FREQUENCY**

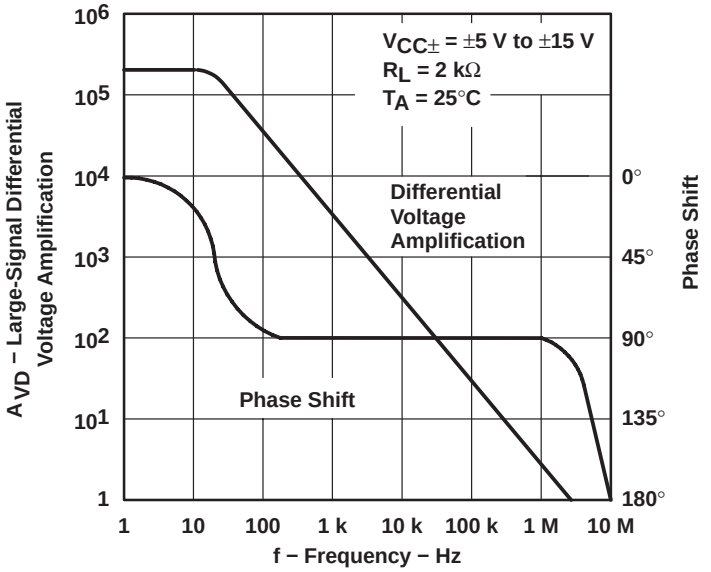



**Figure 12**

**NORMALIZED UNITY-GAIN BANDWIDTH AND PHASE SHIFT vs FREE-AIR TEMPERATURE**

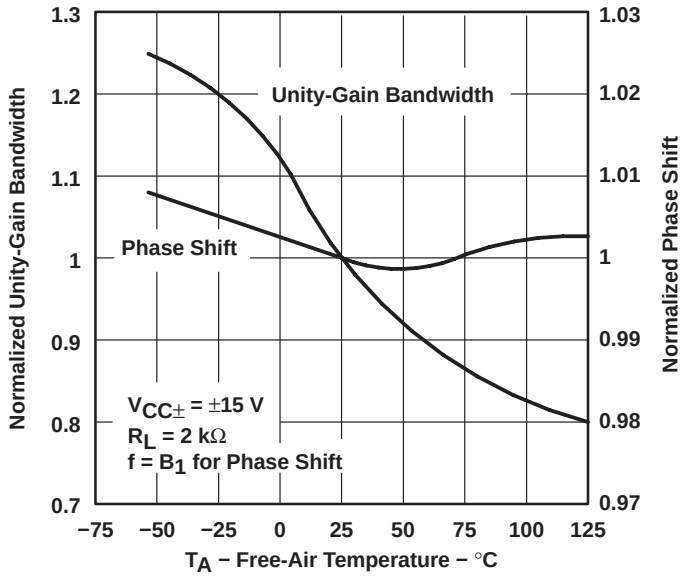



**Figure 13**

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

## TYPICAL CHARACTERISTICS†

**COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE**

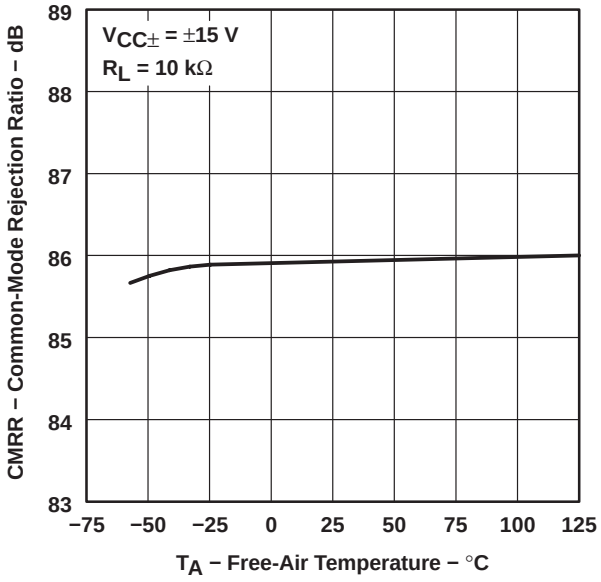



Figure 14

**SUPPLY CURRENT PER AMPLIFIER vs SUPPLY VOLTAGE**

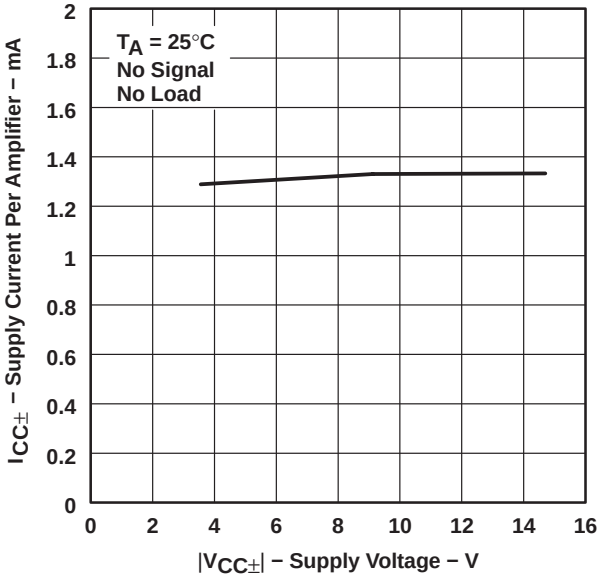



Figure 15

**SUPPLY CURRENT PER AMPLIFIER vs FREE-AIR TEMPERATURE**

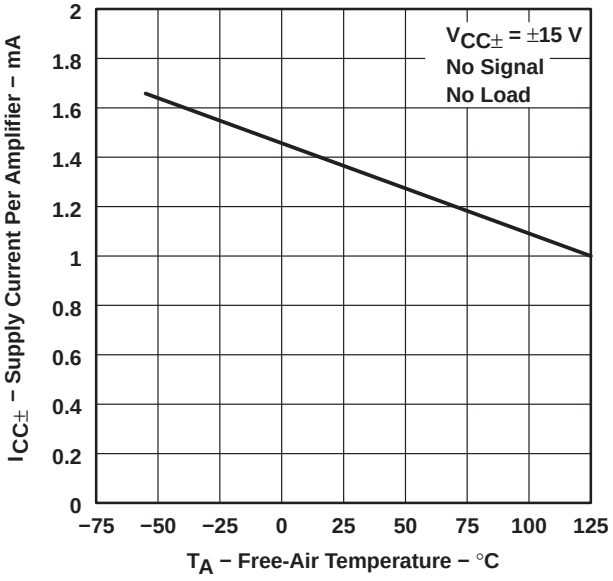



Figure 16

**TOTAL POWER DISSIPATION vs FREE-AIR TEMPERATURE**

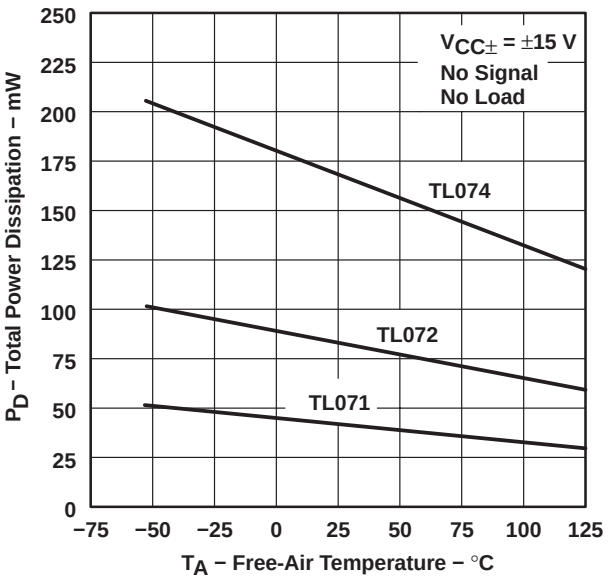



Figure 17

† 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 vs FREE-AIR TEMPERATURE**

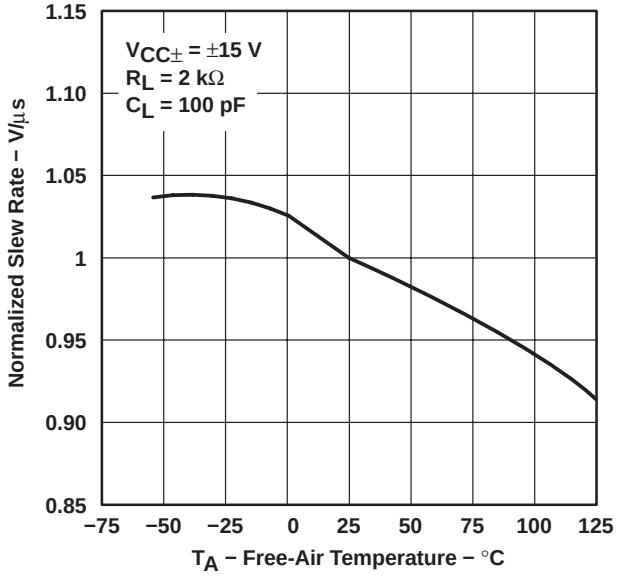



Figure 18

**EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY**

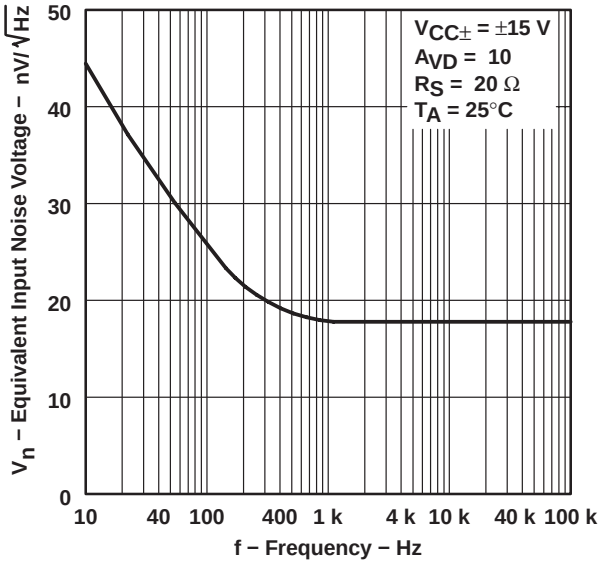



Figure 19

**TOTAL HARMONIC DISTORTION vs FREQUENCY**

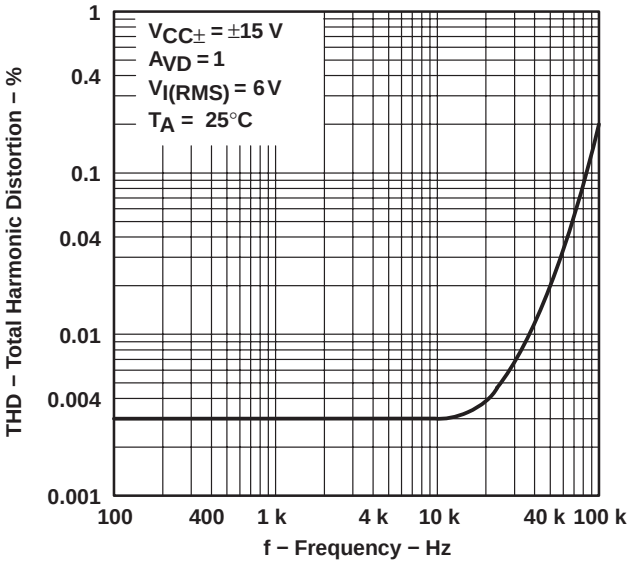



Figure 20

**VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE**

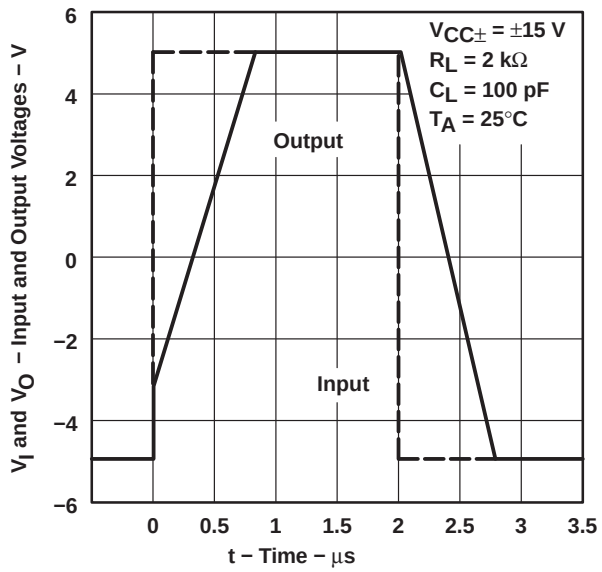



Figure 21

## TYPICAL CHARACTERISTICS

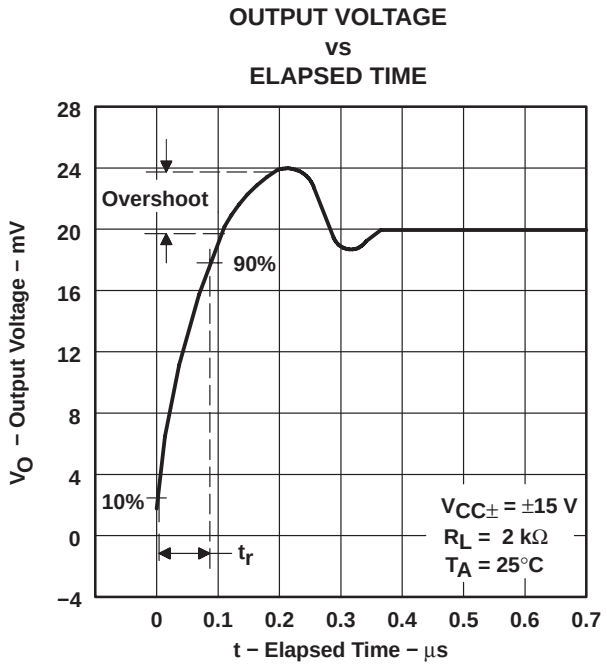



**Figure 22**

## APPLICATION INFORMATION

**Table of Application Diagrams**

| APPLICATION DIAGRAM | PART NUMBER | FIGURE |
|---|---|---|
| 0.5-Hz square-wave oscillator | TL071 | 23 |
| High-Q notch filter | TL071 | 24 |
| Audio-distribution amplifier | TL074 | 25 |
| 100-kHz quadrature oscillator | TL072 | 26 |
| AC amplifier | TL071 | 27 |

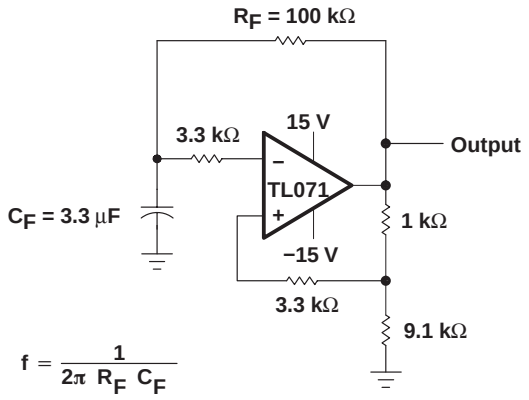



**Figure 23. 0.5-Hz Square-Wave Oscillator**

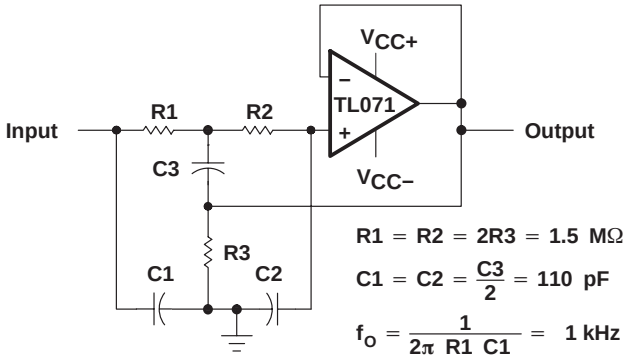



**Figure 24. High-Q Notch Filter**

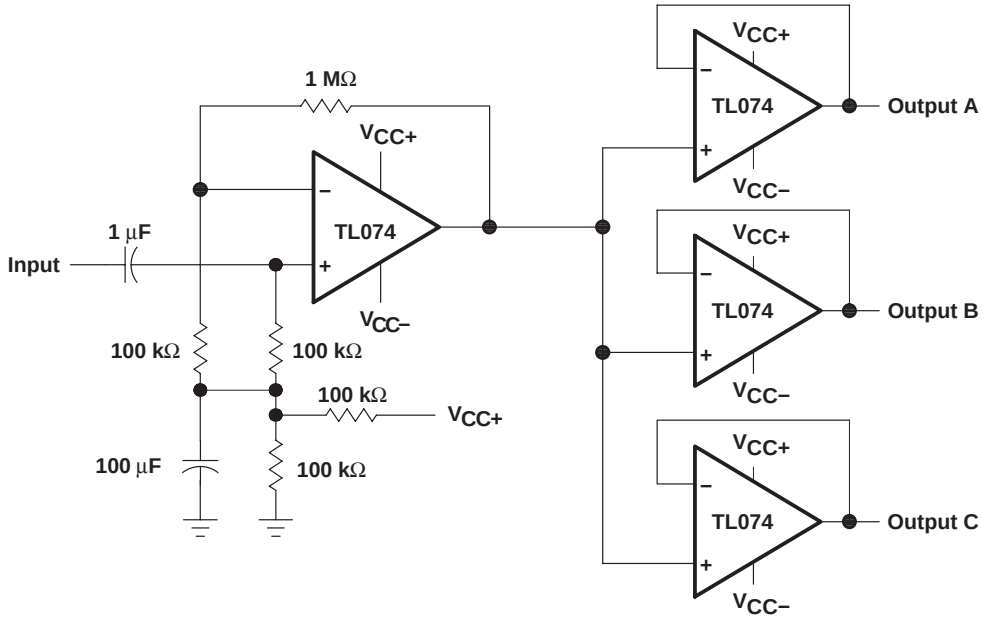
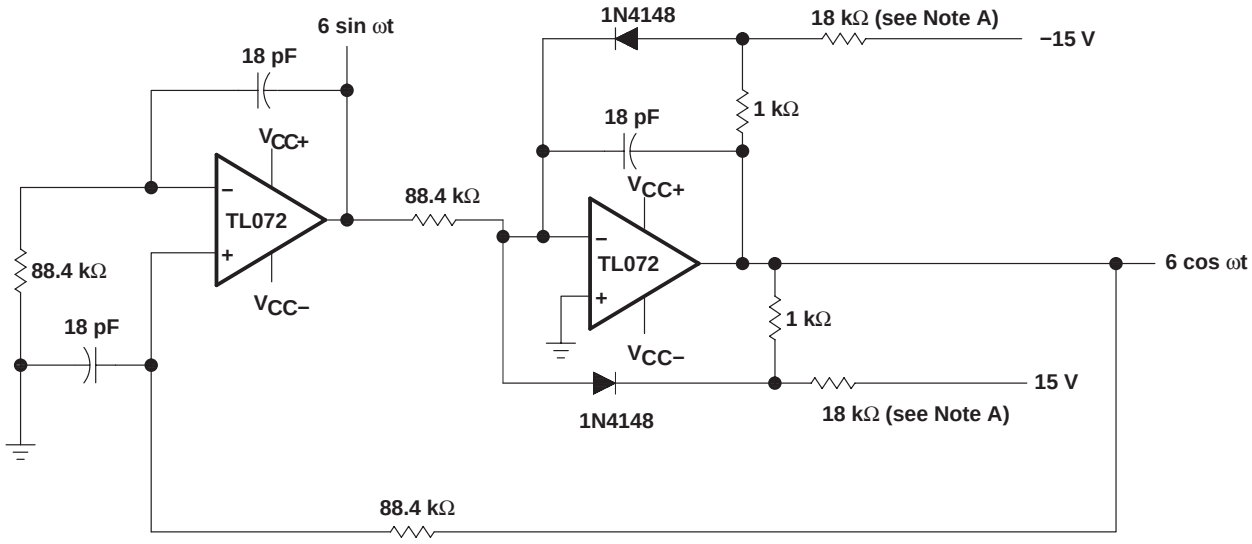



**Figure 25. Audio-Distribution Amplifier**

## APPLICATION INFORMATION




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

**Figure 26. 100-kHz Quadrature Oscillator**

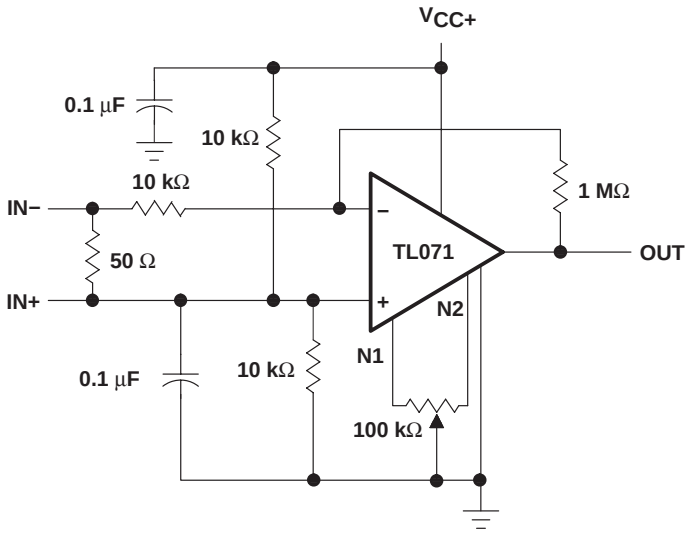



**Figure 27. AC Amplifier**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| 8102304HA | OBSOLETE | | | 10 | | TBD | Call TI | Call TI |
| 81023052A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | Level-NC-NC-NC |
| 8102305HA | ACTIVE | CFP | U | 10 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| 8102305PA | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| 81023062A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | Level-NC-NC-NC |
| 8102306CA | ACTIVE | CDIP | J | 14 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| 8102306DA | ACTIVE | CFP | W | 14 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| JM38510/11905BPA | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| JM38510/11906BCA | OBSOLETE | CDIP | J | 14 | | TBD | Call TI | Call TI |
| TL071ACD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071ACDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071ACDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071ACDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071ACP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071ACPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071BCD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071BCDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071BCDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071BCDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071BCP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071BCPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071CD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071CDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071CDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071CDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071CPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071CPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071CPSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | no Sb/Br) | | |
| TL071CPWLE | OBSOLETE | TSSOP | PW | 8 | | TBD | Call TI | Call TI |
| TL071ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071IDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071IDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL071IJG | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI |
| TL071IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071IPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL071MFKB | OBSOLETE | LCCC | FK | 20 | | TBD | Call TI | Call TI |
| TL071MJG | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI |
| TL071MJGB | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI |
| TL072ACD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072ACDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072ACDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072ACDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072ACJG | OBSOLETE | CDIP | JG | 8 | | TBD | Call TI | Call TI |
| TL072ACP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072ACPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072ACPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072ACPSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072BCD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072BCDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072BCDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072BCDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072BCP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072BCPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072CD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072CDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & | CU NIPDAU | Level-2-260C-1YEAR |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | no Sb/Br) | | |
| TL072CDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072CDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072CDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072CDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072CPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072CPSLE | OBSOLETE | SO | PS | 8 | | TBD | Call TI | Call TI |
| TL072CPSR | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072CPSRE4 | ACTIVE | SO | PS | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072CPWR | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072CPWRE4 | ACTIVE | TSSOP | PW | 8 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL072ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072IDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072IDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072IDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072IDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1YEAR |
| TL072IP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072IPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL072MFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | Level-NC-NC-NC |
| TL072MJG | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| TL072MJGB | ACTIVE | CDIP | JG | 8 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| TL072MUB | ACTIVE | CFP | U | 10 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| TL074ACD | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074ACDE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074ACDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074ACDRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| TL074ACJ | OBSOLETE | CDIP | J | 14 | | TBD | Call TI | Call TI |
| TL074ACN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL074ACNE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL074ACNSR | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074ACNSRE4 | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074BCD | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074BCDE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074BCDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074BCDRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074BCN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL074BCNE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL074BCNSR | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074BCNSRE4 | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CD | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CDE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CDRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL074CNSR | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CNSRE4 | ACTIVE | SO | NS | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CPW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CPWE4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CPWLE | OBSOLETE | TSSOP | PW | 14 | | TBD | Call TI | Call TI |
| TL074CPWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074CPWRE4 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074ID | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074IDE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & | CU NIPDAU | Level-1-260C-UNLIM |

| Orderable Device | Status [1] | Package Type | Package Drawing | Pins | Package Qty | Eco Plan [2] | Lead/Ball Finish | MSL Peak Temp [3] |
|---|---|---|---|---|---|---|---|---|
| | | | | | | no Sb/Br) | | |
| TL074IDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074IDRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TL074IJ | OBSOLETE | CDIP | J | 14 | | TBD | Call TI | Call TI |
| TL074IN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL074INE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | Level-NC-NC-NC |
| TL074MFK | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | Level-NC-NC-NC |
| TL074MFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | Level-NC-NC-NC |
| TL074MJ | ACTIVE | CDIP | J | 14 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| TL074MJB | ACTIVE | CDIP | J | 14 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |
| TL074MWB | ACTIVE | CFP | W | 14 | 1 | TBD | A42 SNPB | Level-NC-NC-NC |

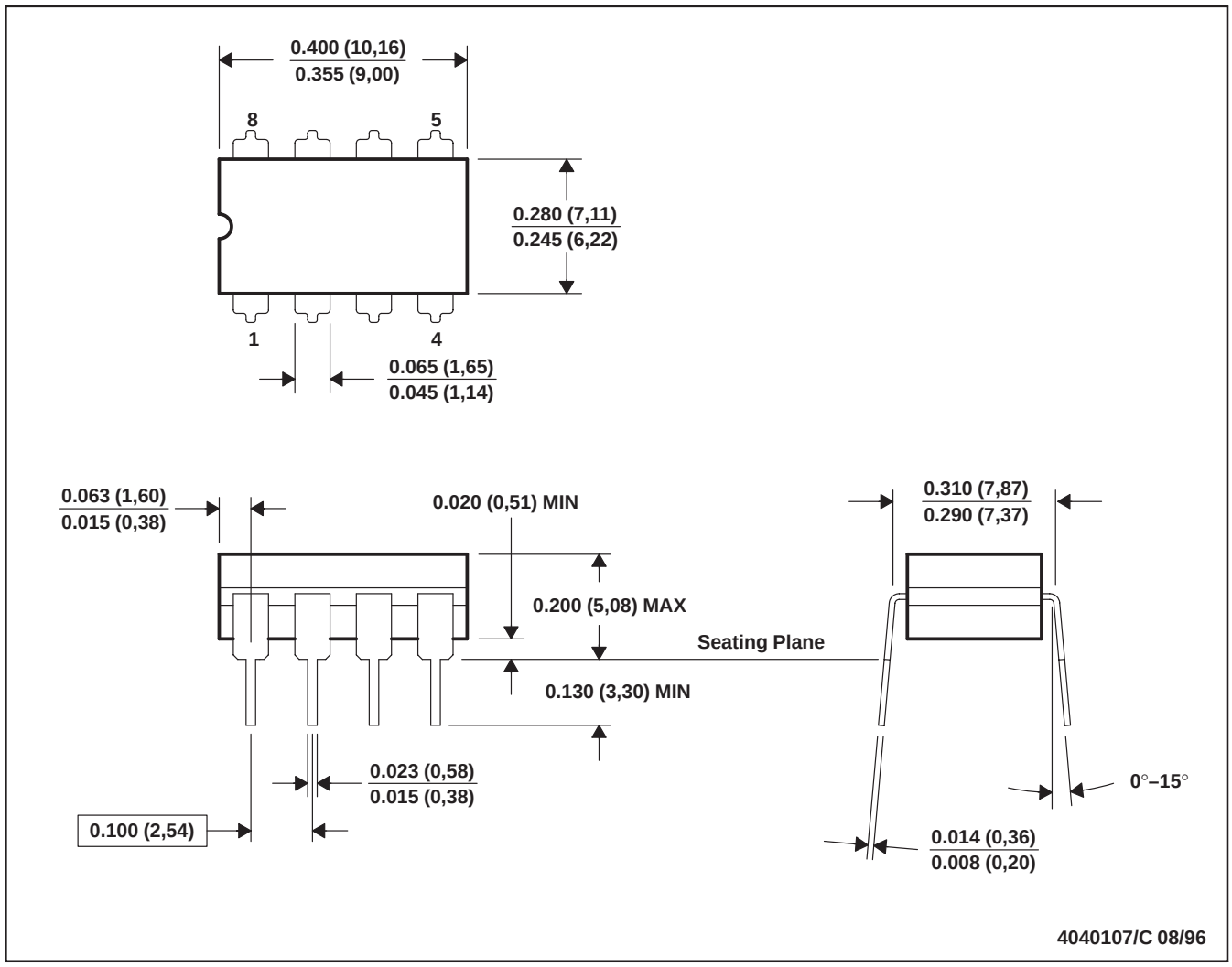
[1] The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing 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) 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.
**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.

MCER001A – JANUARY 1995 – REVISED JANUARY 1997

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

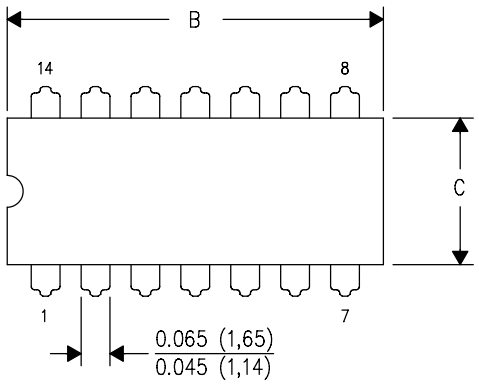



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP1-T8

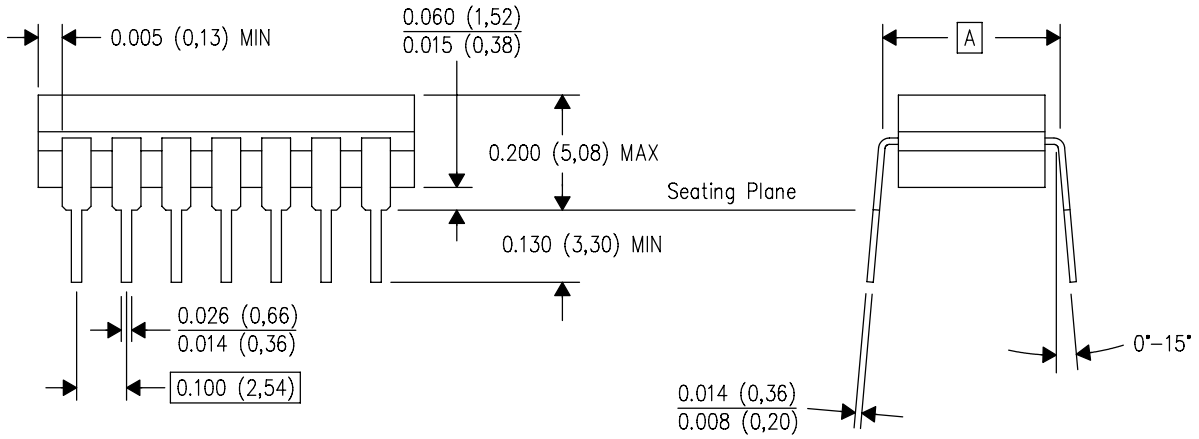
J (R–GDIP–T**)

14 LEADS SHOWN

# CERAMIC DUAL IN–LINE PACKAGE



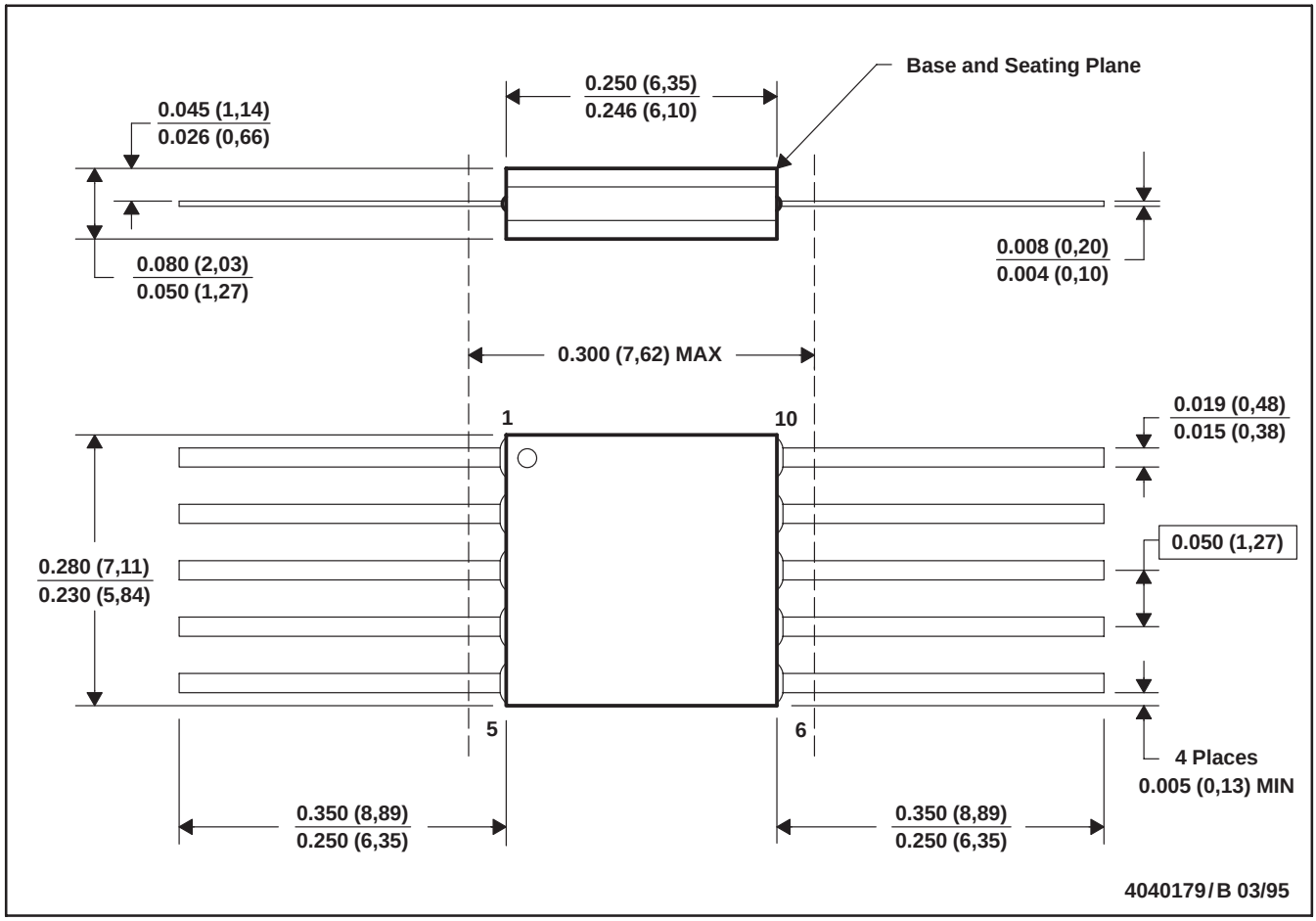

| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300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




4040083/F 03/03

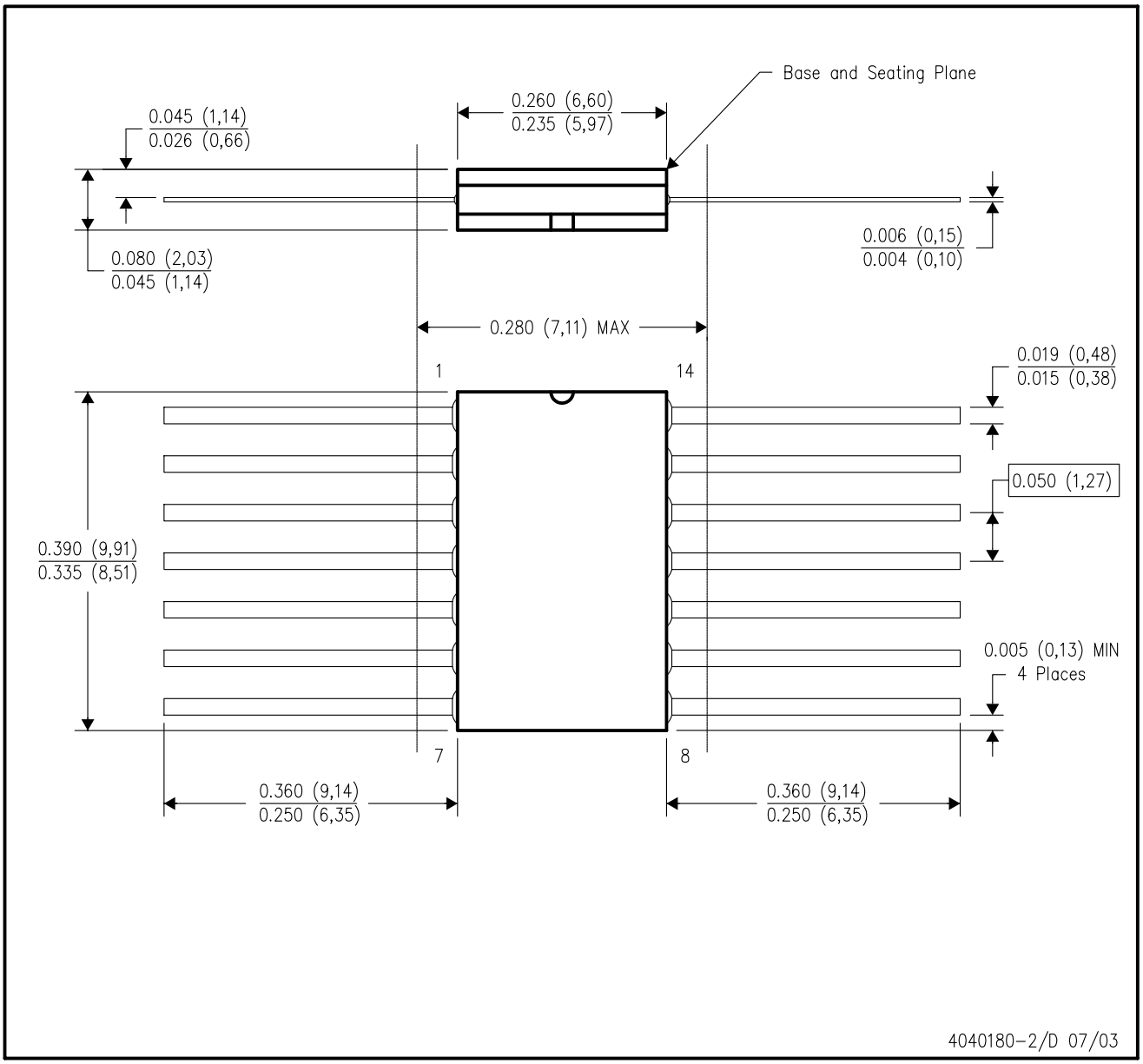
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls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

**U (S-GDFP-F10)** **CERAMIC DUAL FLATPACK**




NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA

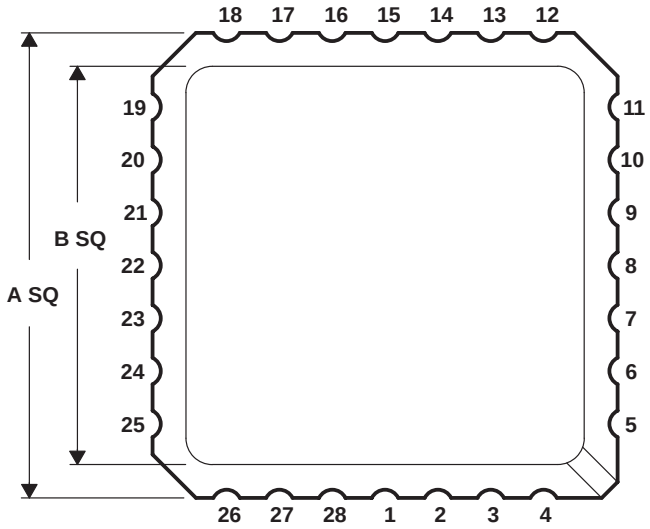
## W (R–GDFP–F14) CERAMIC DUAL FLATPACK



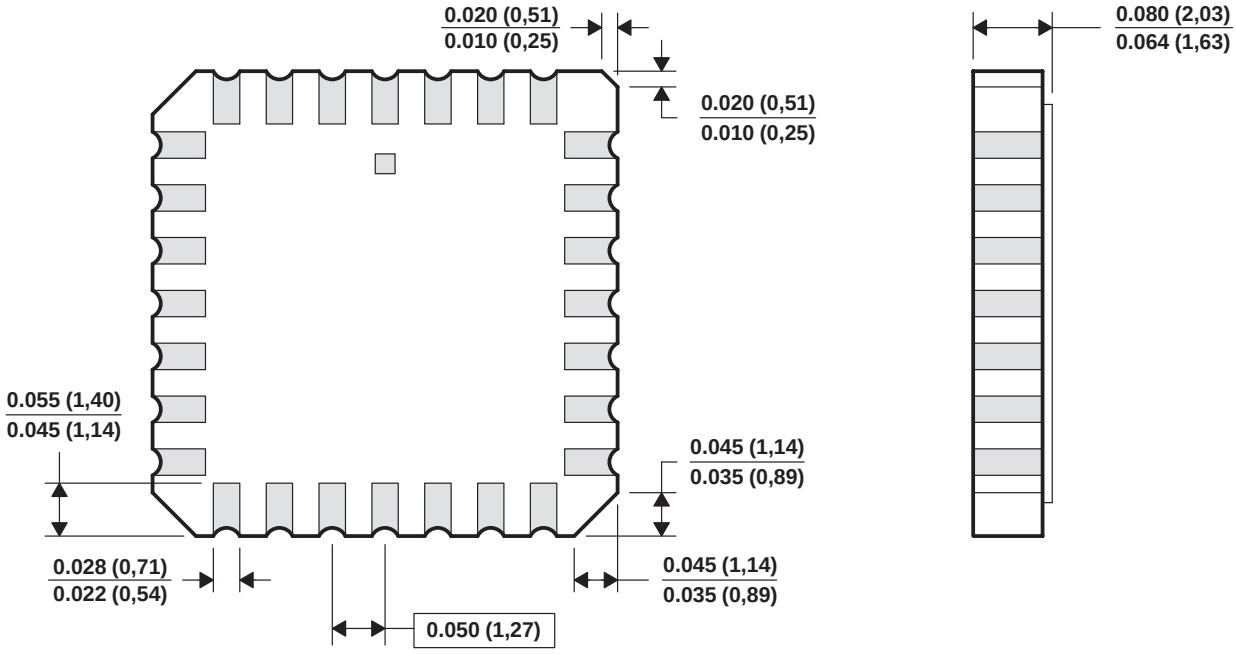

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only.
E. Falls within MIL STD 1835 GDFP1–F14 and JEDEC MO–092AB

**FK (S-CQCC-N**)** **LEADLESS CERAMIC CHIP CARRIER**

**28 TERMINAL SHOWN**




| NO. OF TERMINALS ** | A | | B | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| 20 | 0.342 (8,69) | 0.358 (9,09) | 0.307 (7,80) | 0.358 (9,09) |
| 28 | 0.442 (11,23) | 0.458 (11,63) | 0.406 (10,31) | 0.458 (11,63) |
| 44 | 0.640 (16,26) | 0.660 (16,76) | 0.495 (12,58) | 0.560 (14,22) |
| 52 | 0.739 (18,78) | 0.761 (19,32) | 0.495 (12,58) | 0.560 (14,22) |
| 68 | 0.938 (23,83) | 0.962 (24,43) | 0.850 (21,6) | 0.858 (21,8) |
| 84 | 1.141 (28,99) | 1.165 (29,59) | 1.047 (26,6) | 1.063 (27,0) |

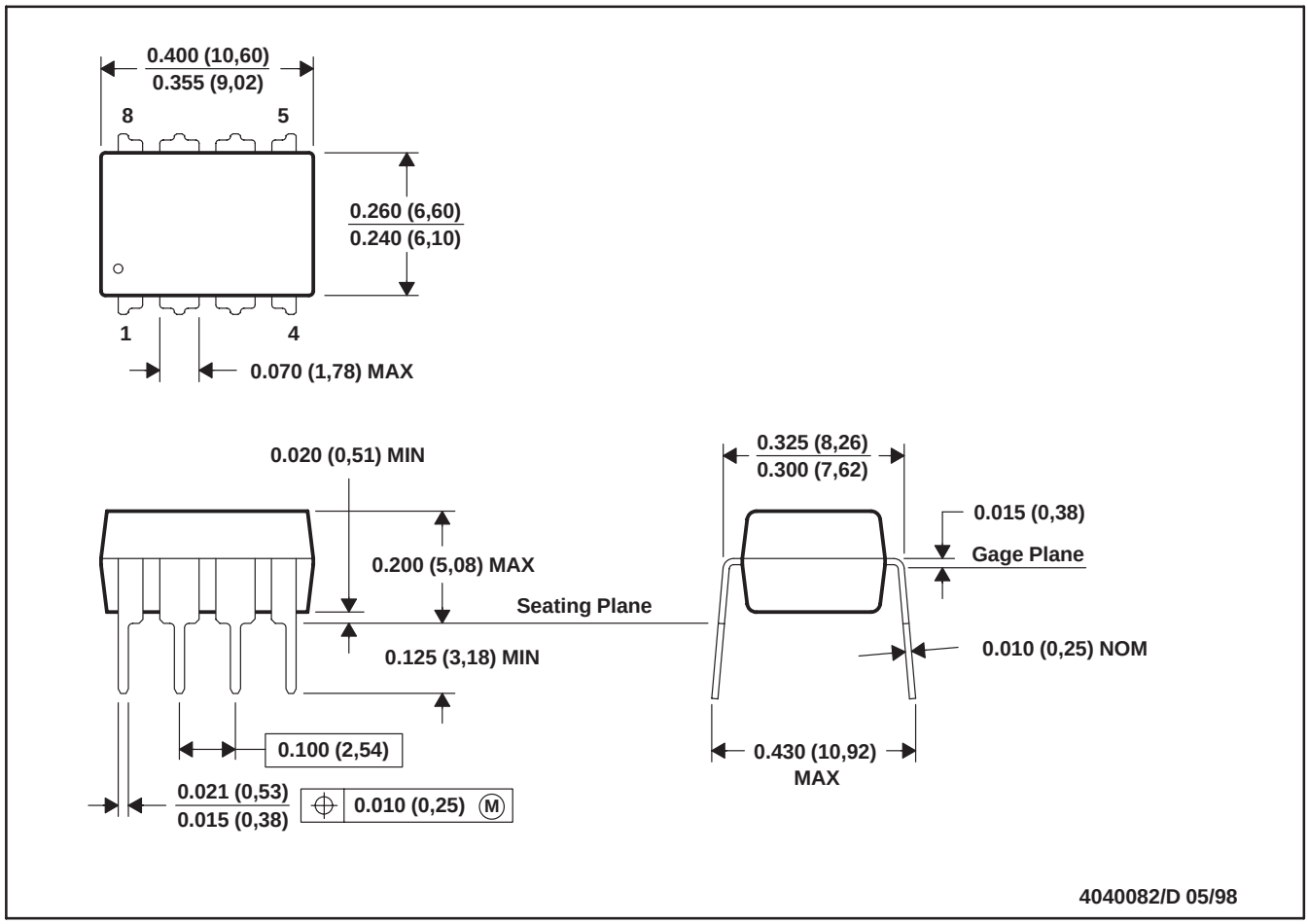



**4040140/D 10/96**

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 metal lid.
D. The terminals are gold plated.
E. Falls within JEDEC MS-004

MPDI001A – JANUARY 1995 – REVISED JUNE 1999

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



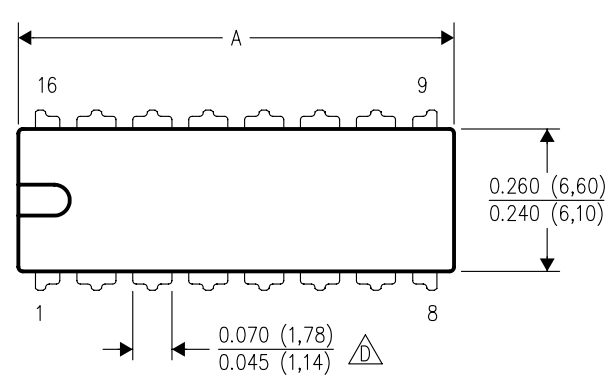

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

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

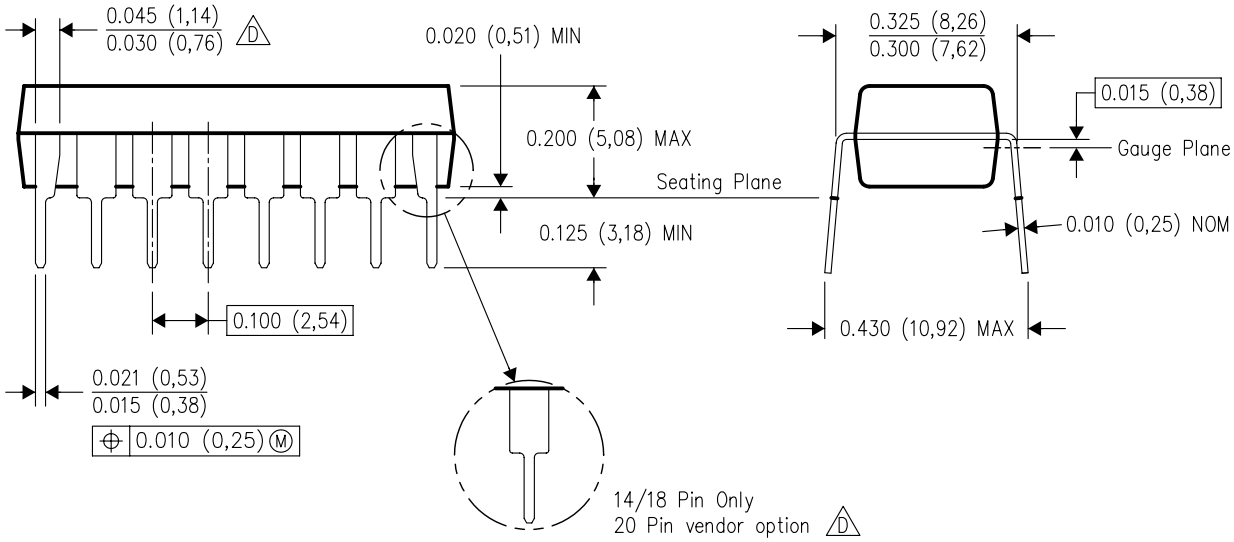
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



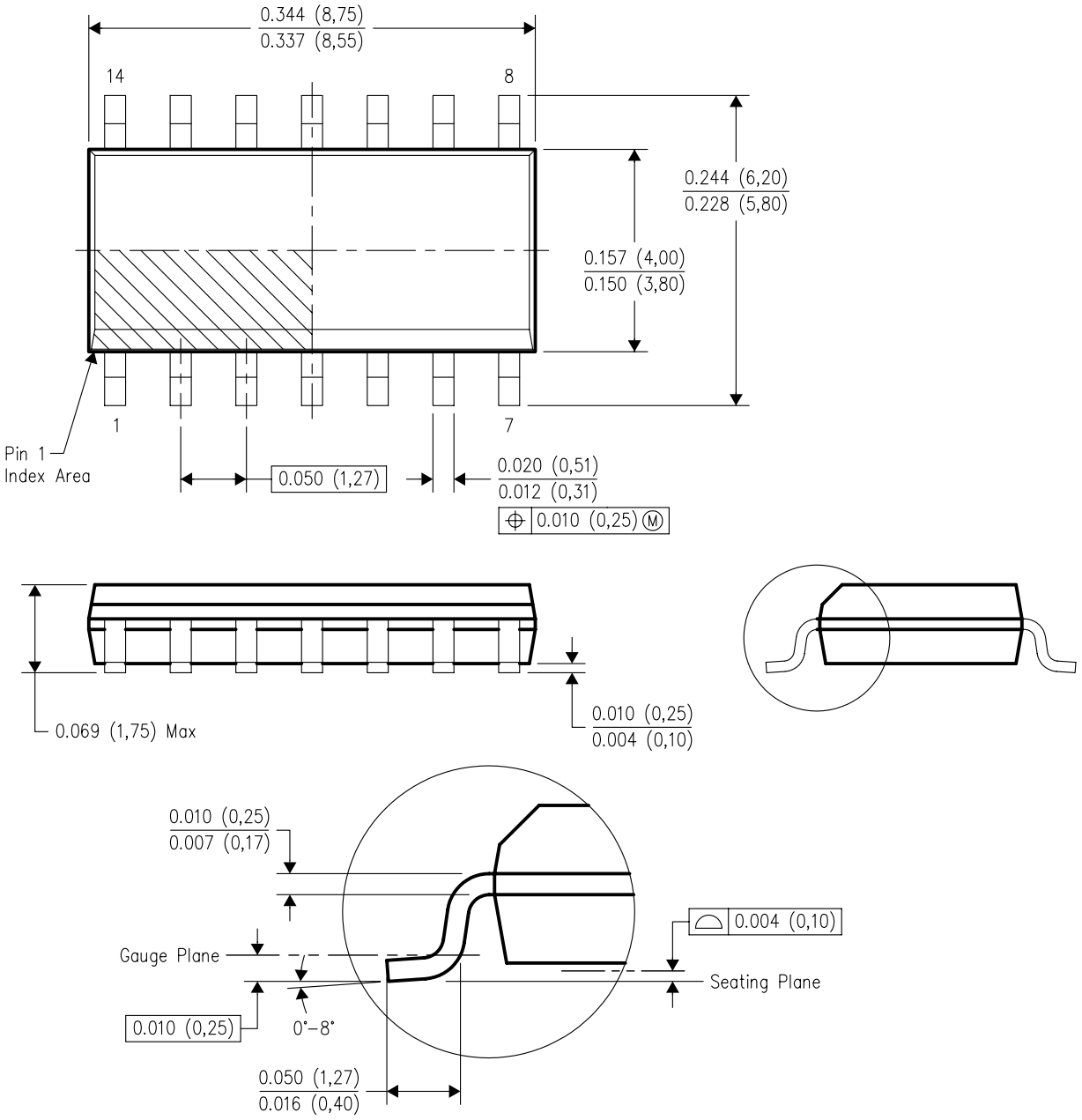

| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23,37) | 1.060 (26,92) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21,59) | 0.940 (23,88) |
| MS–001 VARIATION (C) | AA | BB | AC | AD |




4040049/E 12/2002

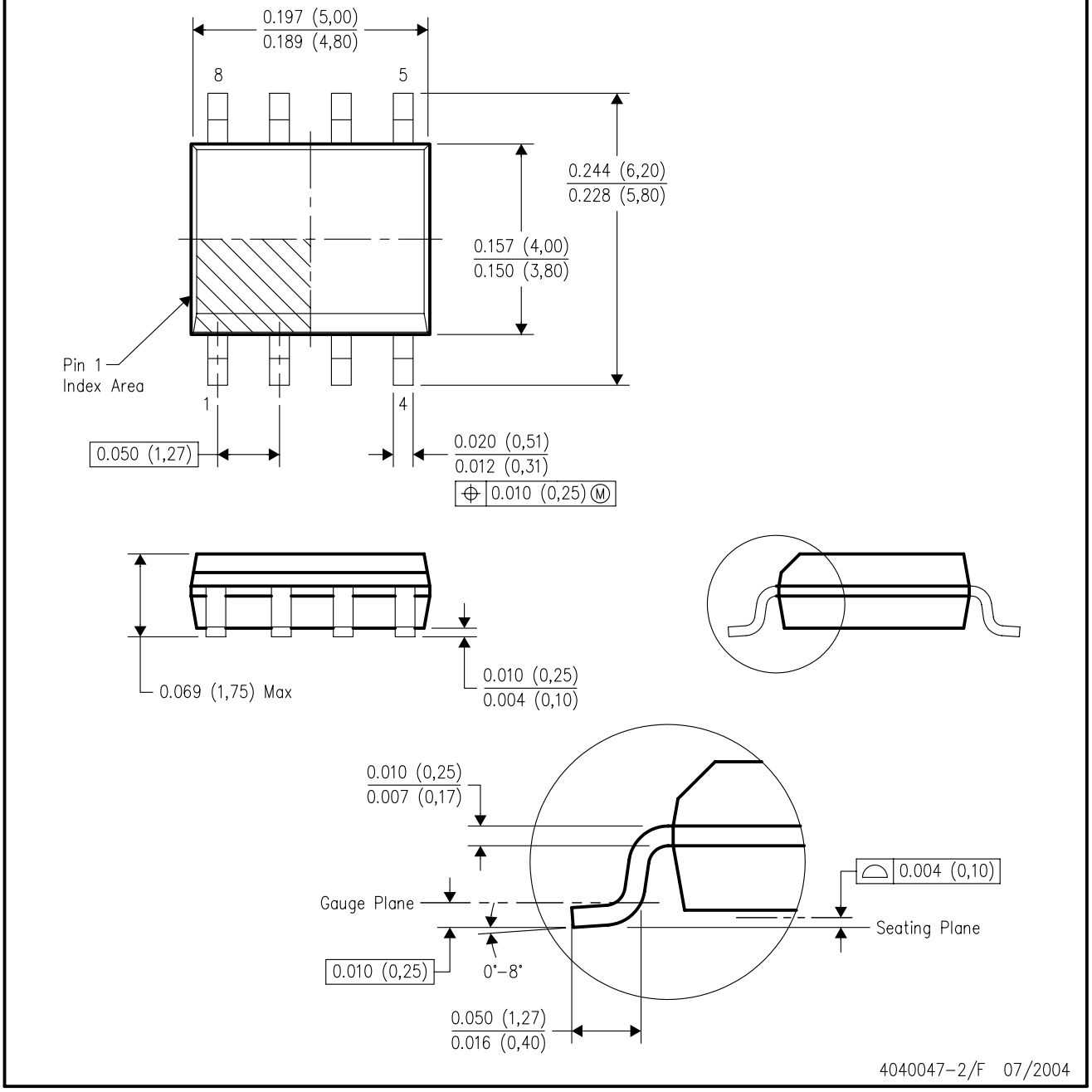
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R–PDSO–G14) PLASTIC SMALL–OUTLINE PACKAGE




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 variation AB.

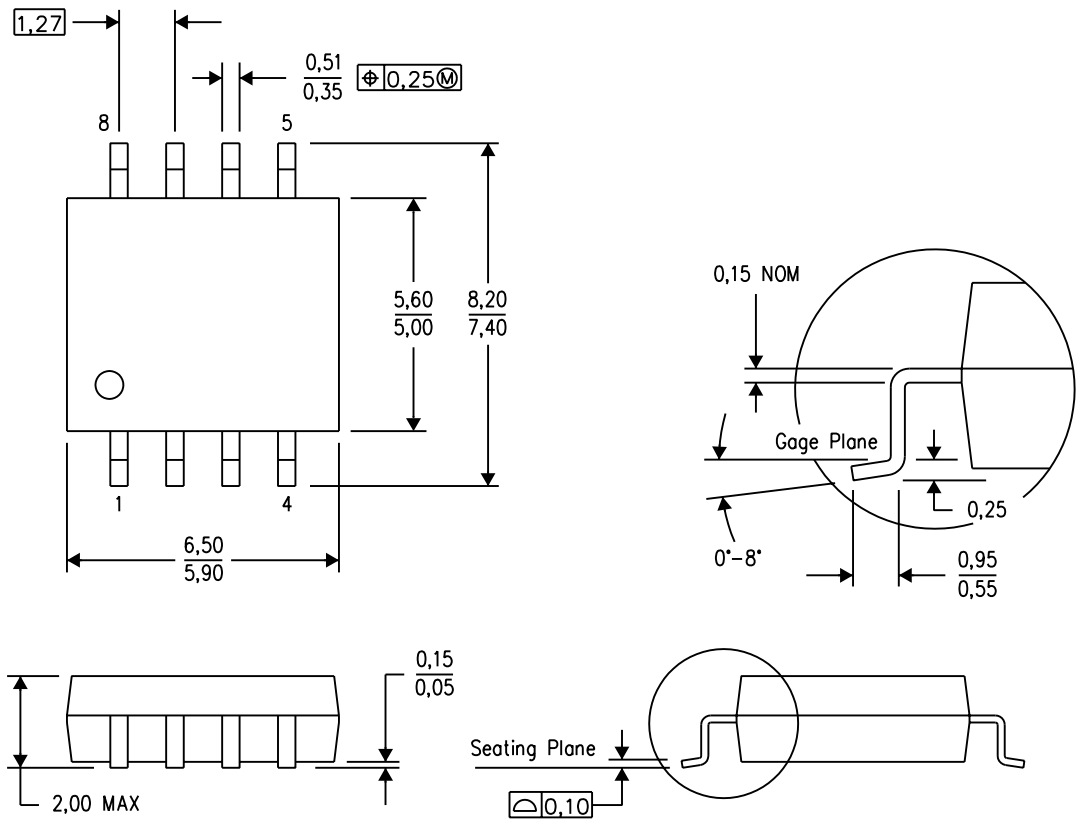
## D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




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 variation AA.

## MECHANICAL DATA

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



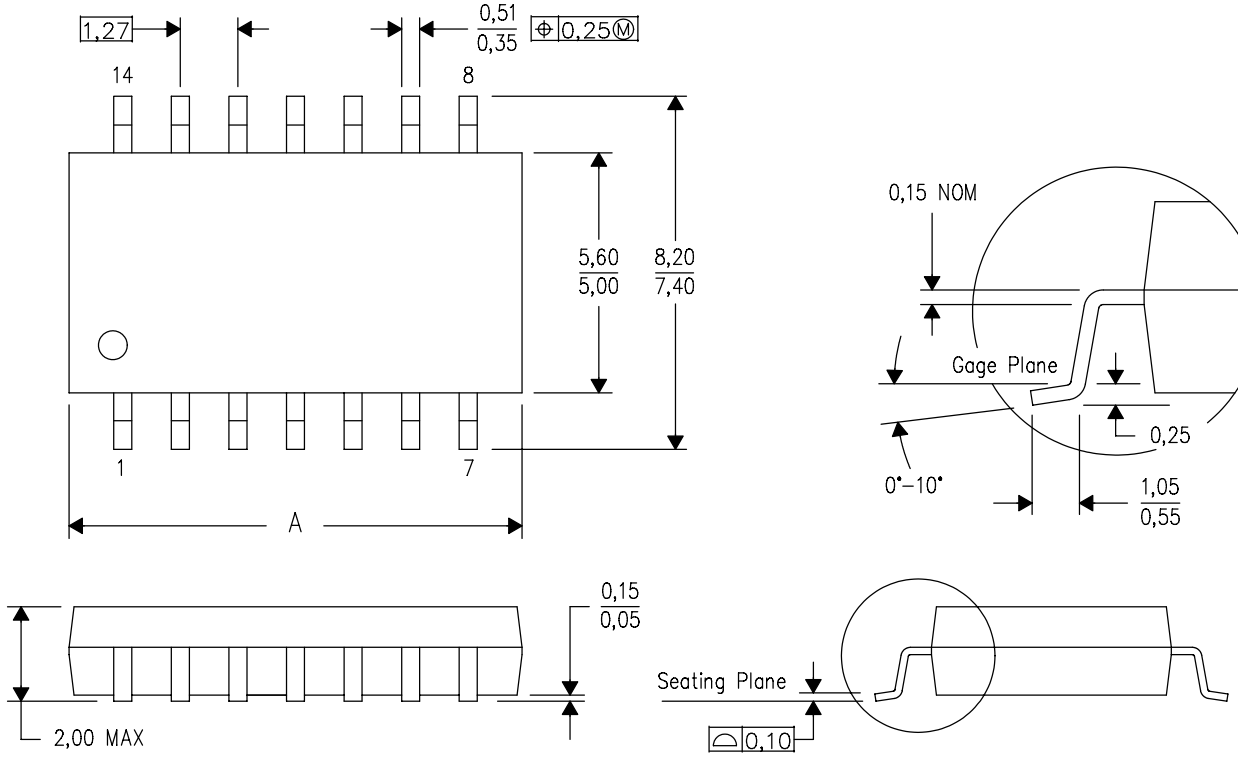

4040063/C 03/03

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**



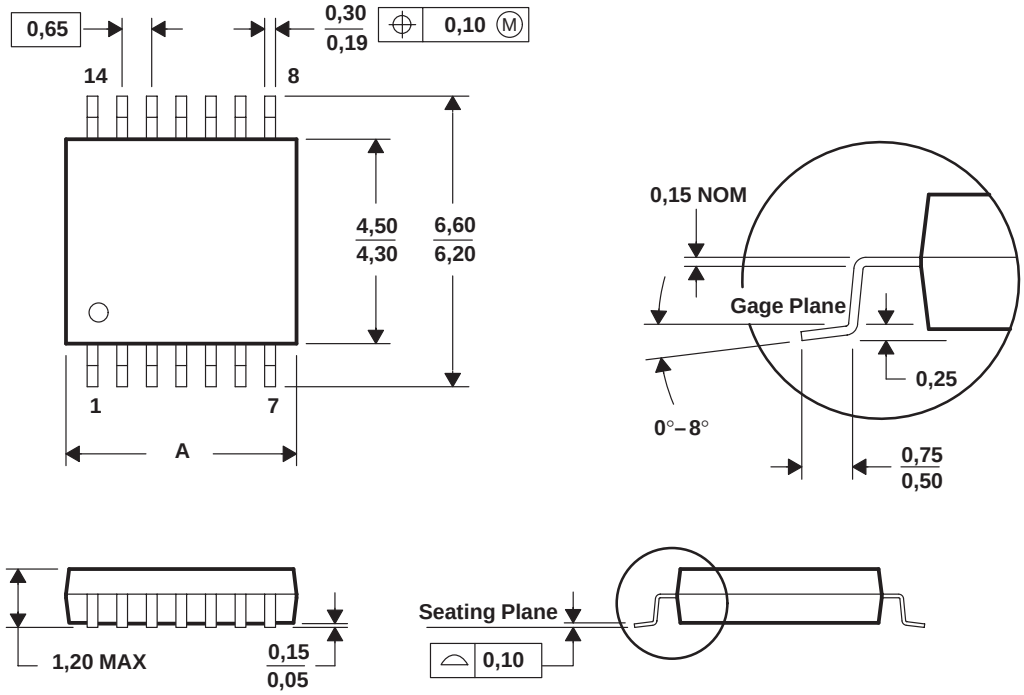

| DIM \ PINS ** | 14 | 16 | 20 | 24 |
|---|---|---|---|---|
| A MAX | 10,50 | 10,50 | 12,90 | 15,30 |
| A MIN | 9,90 | 9,90 | 12,30 | 14,70 |

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**




| DIM \ PINS ** | 8 | 14 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

**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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