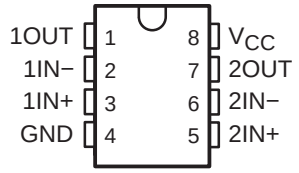
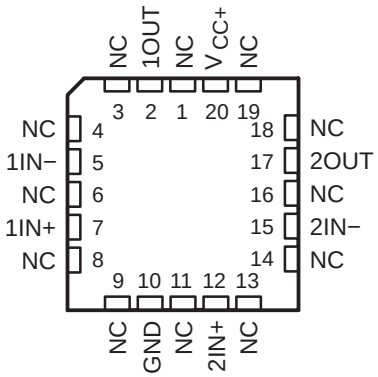
- **Wide Supply Range:**
  - **Single Supply . . . 3 V to 32 V (26 V for LM2904)**
  - **or Dual Supplies . . . ±1.5 V to ±16 V (±13 V for LM2904)**
- **Low Supply-Current Drain, Independent of Supply Voltage . . . 0.7 mA Typ**
- **Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground**
- **Low Input Bias and Offset Parameters:**
  - **Input Offset Voltage . . . 3 mV Typ**
    **A Versions . . . 2 mV Typ**
  - **Input Offset Current . . . 2 nA Typ**
  - **Input Bias Current . . . 20 nA Typ**
    **A Versions . . . 15 nA Typ**
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . . 32 V (26 V for LM2904)**
- **Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

**LM158, LM158A . . . JG PACKAGE**
**LM258, LM258A . . . D, DGK, OR P PACKAGE**
**LM358 . . . D, DGK, P, PS, OR PW PACKAGE**
**LM358A . . . D, DGK, P, OR PW PACKAGE**
**LM2904 . . . D, DGK, P, PS, OR PW PACKAGE**
**(TOP VIEW)**




**LM158, LM158A . . . FK PACKAGE**
**(TOP VIEW)**




NC − No internal connection

## description/ordering information

These devices consist of two independent, high-gain, frequency-compensated operational amplifiers designed to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V (3 V to 26 V for the LM2904), and $V_{CC}$ is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational amplifier circuits that now can be implemented more easily in single-supply-voltage systems. For example, these devices can be operated directly from the standard 5-V supply used in digital systems and easily can provide the required interface electronics without additional ±5-V supplies.

## description/ordering information (continued)

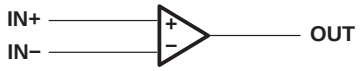
**ORDERING INFORMATION**

| $T_A$ | $V_{IO}$max AT 25°C | MAX TESTED $V_{CC}$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|---|
| 0°C to 70°C | 7 mV | 30 V | PDIP (P) | Tube of 50 | LM358P | LM358P |
| | | | SOIC (D) | Tube of 75 | LM358D | LM358 |
| | | | | Reel of 2500 | LM358DR | |
| | | | SOP (PS) | Reel of 2000 | LM358PSR | L358 |
| | | | TSSOP (PW) | Tube of 150 | LM358PW | L358 |
| | | | | Reel of 2000 | LM358PWR | |
| | | | MSOP/VSSOP (DGK) | Reel of 2500 | LM358DGKR | M5_‡ |
| | 3 mV | 30 V | PDIP (P) | Tube of 50 | LM358AP | LM358AP |
| | | | SOIC (D) | Tube of 75 | LM358AD | LM358A |
| | | | | Reel of 2500 | LM358ADR | |
| | | | TSSOP (PW) | Tube of 150 | LM358APW | L358A |
| | | | | Reel of 2000 | LM358APWR | |
| | | | MSOP/VSSOP (DGK) | Reel of 2500 | LM358ADGKR | M6_‡ |
| −25°C to 85°C | 5 mV | 30 V | PDIP (P) | Tube of 50 | LM258P | LM258P |
| | | | SOIC (D) | Tube of 75 | LM258D | LM258 |
| | | | | Reel of 2500 | LM258DR | |
| | | | MSOP/VSSOP (DGK) | Reel of 2500 | LM258DGKR | M2_‡ |
| | 3 mV | 30 V | PDIP (P) | Tube of 50 | LM258AP | LM258AP |
| | | | SOIC (D) | Tube of 75 | LM258AD | LM258A |
| | | | | Reel of 2500 | LM258ADR | |
| | | | MSOP/VSSOP (DGK) | Reel of 2500 | LM258ADGKR | M3_‡ |
| −40°C to 125°C | 7 mV | 26 V | PDIP (P) | Tube of 50 | LM2904P | LM2904P |
| | | | SOIC (D) | Tube of 75 | LM2904D | LM2904 |
| | | | | Reel of 2500 | LM2904DR | |
| | | | SOP (PS) | Reel of 2000 | LM2904PSR | L2904 |
| | | | TSSOP (PW) | Tube of 150 | LM2904PW | L2904 |
| | | | | Reel of 2000 | LM2904PWR | |
| | | | MSOP/VSSOP (DGK) | Reel of 2500 | LM2904DGKR | MB_‡ |
| | 7 mV | 32 V | SOIC (D) | Reel of 2500 | LM2904VQDR | L2904V |
| | | | TSSOP (PW) | Reel of 2000 | LM2904VQPWR | L2904V |
| | 2 mV | 32 V | SOIC (D) | Reel of 2500 | LM2904AVQDR | L2904AV |
| | | | TSSOP (PW) | Reel of 2000 | LM2904AVQPWR | L2904AV |
| −55°C to 125°C | 5 mV | 30 V | CDIP (JG) | Tube of 50 | LM158JG | LM158JG |
| | | | LCCC (FK) | Tube of 55 | LM158FK | LM158FK |
| | 2 mV | 30 V | CDIP (JG) | Tube of 50 | LM158AJG | LM158AJG |
| | | | LCCC (FK) | Tube of 55 | LM158AFK | LM158AFK |

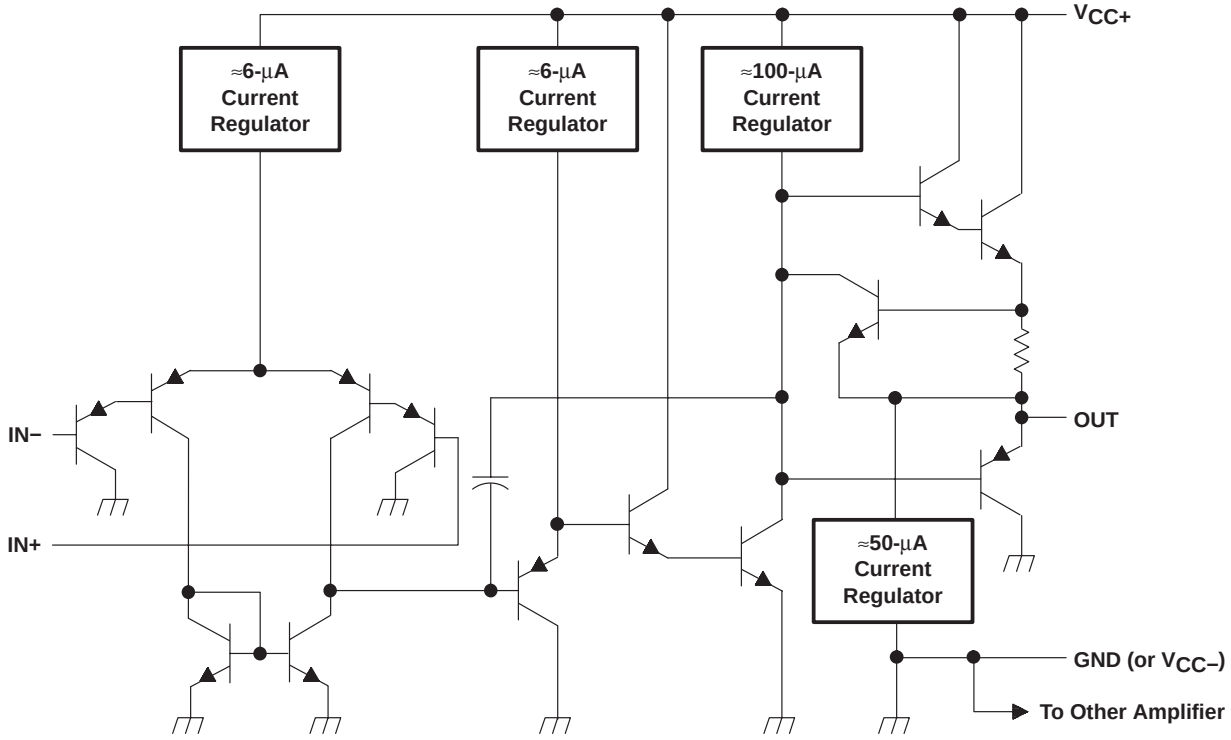
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

‡ The actual top-side marking has one additional character that designates the assembly/test site.

## symbol (each amplifier)




## schematic (each amplifier)




| COMPONENT COUNT | |
|---|---|
| Epi-FET | 1 |
| Diodes | 2 |
| Resistors | 7 |
| Transistors | 51 |
| Capacitors | 2 |

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

| | | LM158, LM158A LM258, LM258A LM358, LM358A LM2904V | LM2904 | UNIT |
|---|---|---|---|---|
| Supply voltage, $V_{CC}$ (see Note 1) | | ±16 or 32 | ±13 or 26 | V |
| Differential input voltage, $V_{ID}$ (see Note 2) | | ±32 | ±26 | V |
| Input voltage, $V_I$ (either input) | | −0.3 to 32 | −0.3 to 26 | V |
| Duration of output short circuit (one amplifier) to ground at (or below) 25°C free-air temperature ($V_{CC}$ ≤ 15 V) (see Note 3) | | Unlimited | Unlimited | |
| Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5) | D package | 97 | 97 | °C/W |
| | DGK package | 172 | 172 | |
| | P package | 85 | 85 | |
| | PS package | 95 | 95 | |
| | PW package | 149 | 149 | |
| Package thermal impedance, $\theta_{JC}$ (see Notes 6 and 7) | FK package | 5.61 | | °C/W |
| | JG package | 14.5 | | |
| Operating free-air temperature range, $T_A$ | LM158, LM158A | −55 to 125 | | °C |
| | LM258, LM258A | −25 to 85 | | |
| | LM358, LM358A | 0 to 70 | | |
| | LM2904 | −40 to 125 | −40 to 125 | |
| Operating virtual junction temperature, $T_J$ | | 150 | 150 | °C |
| Case temperature for 60 seconds | FK package | 260 | | °C |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds | JG package | 300 | 300 | °C |
| Storage temperature range, $T_{stg}$ | | −65 to 150 | −65 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 and $V_{CC}$ specified for measurement of $I_{OS}$, are with respect to the network ground terminal.
2. Differential voltages are at IN+ with respect to IN−.
3. Short circuits from outputs to $V_{CC}$ can cause excessive heating and eventual destruction.
4. 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.
5. The package thermal impedance is calculated in accordance with JESD 51-7.
6. 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.
7. The package thermal impedance is calculated in accordance with MIL-STD-883.

## electrical characteristics at specified free-air temperature, $V_{CC}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | | $T_A$‡ | LM158 LM258 | | | LM358 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP§ | MAX | MIN | TYP§ | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{CC}$ = 5 V to MAX, $V_{IC} = V_{ICR(min)}$, $V_O$ = 1.4 V | | 25°C | | 3 | 5 | | 3 | 7 | mV |
| | | | | Full range | | | 7 | | | 9 | |
| $\alpha_{V_{IO}}$ | Average temperature coefficient of input offset voltage | | | Full range | | 7 | | | 7 | | μV/°C |
| $I_{IO}$ | Input offset current | $V_O$ = 1.4 V | | 25°C | | 2 | 30 | | 2 | 50 | nA |
| | | | | Full range | | | 100 | | | 150 | |
| $\alpha_{I_{IO}}$ | Average temperature coefficient of input offset current | | | Full range | | 10 | | | 10 | | pA/°C |
| $I_{IB}$ | Input bias current | $V_O$ = 1.4 V | | 25°C | | −20 | −150 | | −20 | −250 | nA |
| | | | | Full range | | | −300 | | | −500 | |
| $V_{ICR}$ | Common-mode input voltage range | $V_{CC}$ = 5 V to MAX | | 25°C | 0 to $V_{CC}$ − 1.5 | | | 0 to $V_{CC}$ − 1.5 | | | V |
| | | | | Full range | 0 to $V_{CC}$ − 2 | | | 0 to $V_{CC}$ − 2 | | | |
| $V_{OH}$ | High-level output voltage | $R_L \geq 2$ kΩ | | 25°C | $V_{CC}$ − 1.5 | | | $V_{CC}$ − 1.5 | | | V |
| | | $R_L \geq 10$ kΩ | | 25°C | | | | | | | |
| | | $V_{CC}$ = MAX | $R_L$ = 2 kΩ | Full range | 26 | | | 26 | | | |
| | | | $R_L \geq 10$ kΩ | Full range | 27 | 28 | | 27 | 28 | | |
| $V_{OL}$ | Low-level output voltage | $R_L \leq 10$ kΩ | | Full range | | 5 | 20 | | 5 | 20 | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{CC}$ = 15 V, $V_O$ = 1 V to 11 V, $R_L \geq 2$ kΩ | | 25°C | 50 | 100 | | 25 | 100 | | V/mV |
| | | | | Full range | 25 | | | 15 | | | |
| CMRR | Common-mode rejection ratio | $V_{CC}$ = 5 V to MAX, $V_{IC} = V_{ICR(min)}$ | | 25°C | 70 | 80 | | 65 | 80 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{CC}$ = 5 V to MAX | | 25°C | 65 | 100 | | 65 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | f = 1 kHz to 20 kHz | | 25°C | | 120 | | | 120 | | dB |
| $I_O$ | Output current | $V_{CC}$ = 15 V, $V_{ID}$ = 1 V, $V_O$ = 0 | Source | 25°C | −20 | −30 | | −20 | −30 | | mA |
| | | | | Full range | −10 | | | −10 | | | |
| | | $V_{CC}$ = 15 V, $V_{ID}$ = −1 V, $V_O$ = 15 V | Sink | 25°C | 10 | 20 | | 10 | 20 | | |
| | | | | Full range | 5 | | | 5 | | | |
| $I_O$ | Output current | $V_{ID}$ = −1 V, $V_O$ = 200 mV | | 25°C | 12 | 30 | | 12 | 30 | | μA |
| $I_{OS}$ | Short-circuit output current | $V_{CC}$ at 5 V, GND at −5 V, $V_O$ = 0 | | 25°C | | ±40 | ±60 | | ±40 | ±60 | mA |
| $I_{CC}$ | Supply current (two amplifiers) | $V_O$ = 2.5 V, No load | | Full range | | 0.7 | 1.2 | | 0.7 | 1.2 | mA |
| | | $V_{CC}$ = MAX, $V_O$ = 0.5 V, No load | | Full range | | 1 | 2 | | 1 | 2 | |

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX $V_{CC}$ for testing purposes is 26 V for the LM2904 and 30 V for others.
‡ Full range is −55°C to 125°C for LM158, −25°C to 85°C for LM258, 0°C to 70°C for LM358, and −40°C to 125°C for LM2904.
§ All typical values are at $T_A$ = 25°C.

## electrical characteristics at specified free-air temperature, $V_{CC}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | | $T_A$‡ | LM2904 | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP§ | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{CC}$ = 5 V to MAX, $V_{IC} = V_{ICR(min)}$, $V_O$ = 1.4 V | Non-A devices | 25°C | | 3 | 7 | mV |
| | | | | Full range | | | 10 | |
| | | | A-suffix devices | 25°C | | 1 | 2 | |
| | | | | Full range | | | 4 | |
| $\alpha_{V_{IO}}$ | Average temperature coefficient of input offset voltage | | | Full range | | 7 | | µV/°C |
| $I_{IO}$ | Input offset current | $V_O$ = 1.4 V | Non-V device | 25°C | | 2 | 50 | nA |
| | | | | Full range | | | 300 | |
| | | | V-suffix device | 25°C | | 2 | 50 | |
| | | | | Full range | | | 150 | |
| $\alpha_{I_{IO}}$ | Average temperature coefficient of input offset current | | | Full range | | 10 | | pA/°C |
| $I_{IB}$ | Input bias current | $V_O$ = 1.4 V | | 25°C | | −20 | −250 | nA |
| | | | | Full range | | | −500 | |
| $V_{ICR}$ | Common-mode input voltage range | $V_{CC}$ = 5 V to MAX | | 25°C | 0 to $V_{CC}$ − 1.5 | | | V |
| | | | | Full range | 0 to $V_{CC}$ − 2 | | | |
| $V_{OH}$ | High-level output voltage | $R_L \geq 10\ k\Omega$ | | 25°C | $V_{CC}$ − 1.5 | | | V |
| | | $V_{CC}$ = MAX, Non-V device | $R_L$ = 2 kΩ | Full range | 22 | | | |
| | | | $R_L \geq 10\ k\Omega$ | Full range | 23 | 24 | | |
| | | $V_{CC}$ = MAX, V-suffix device | $R_L$ = 2 kΩ | Full range | 26 | | | |
| | | | $R_L \geq 10\ k\Omega$ | Full range | 27 | 28 | | |
| $V_{OL}$ | Low-level output voltage | $R_L \leq 10\ k\Omega$ | | Full range | | 5 | 20 | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{CC}$ = 15 V, $V_O$ = 1 V to 11 V, $R_L \geq 2\ k\Omega$ | | 25°C | 25 | 100 | | V/mV |
| | | | | Full range | 15 | | | |
| CMRR | Common-mode rejection ratio | $V_{CC}$ = 5 V to MAX, $V_{IC} = V_{ICR(min)}$ | Non-V device | 25°C | 50 | 80 | | dB |
| | | | V-suffix device | 25°C | 65 | 80 | | |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{CC}$ = 5 V to MAX | | 25°C | 65 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | f = 1 kHz to 20 kHz | | 25°C | | 120 | | dB |
| $I_O$ | Output current | $V_{CC}$ = 15 V, $V_{ID}$ = 1 V, $V_O$ = 0 | Source | 25°C | −20 | −30 | | mA |
| | | | | Full range | −10 | | | mA |
| | | $V_{CC}$ = 15 V, $V_{ID}$ = −1 V, $V_O$ = 15 V | Sink | 25°C | 10 | 20 | | mA |
| | | | | Full range | 5 | | | mA |
| | | $V_{ID}$ = −1 V, $V_O$ = 200 mV | Non-V device | 25°C | | 30 | | µA |
| | | | V-suffix device | 25°C | 12 | 40 | | |
| $I_{OS}$ | Short-circuit output current | $V_{CC}$ at 5 V, GND at −5 V, $V_O$ = 0 | | 25°C | | ±40 | ±60 | mA |
| $I_{CC}$ | Supply current (two amplifiers) | $V_O$ = 2.5 V, No load | | Full range | | 0.7 | 1.2 | mA |
| | | $V_{CC}$ = MAX, $V_O$ = 0.5 V, No load | | Full range | | 1 | 2 | |

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX $V_{CC}$ for testing purposes is 26 V for the LM2904, 32 V for the LM2904V, and 30 V for others.
‡ Full range is −55°C to 125°C for LM158, −25°C to 85°C for LM258, 0°C to 70°C for LM358, and −40°C to 125°C for LM2904.
§ All typical values are at $T_A$ = 25°C.

## electrical characteristics at specified free-air temperature, $V_{CC}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | | $T_A$‡ | LM158A | | | LM258A | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP§ | MAX | MIN | TYP§ | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{CC}$ = 5 V to 30 V, $V_{IC} = V_{ICR(min)}$, $V_O$ = 1.4 V | | 25°C | | | 2 | | 2 | 3 | mV |
| | | | | Full range | | | 4 | | | 4 | |
| $\alpha_{V_{IO}}$ | Average temperature coefficient of input offset voltage | | | Full range | | 7 | 15* | | 7 | 15 | µV/°C |
| $I_{IO}$ | Input offset current | $V_O$ = 1.4 V | | 25°C | | 2 | 10 | | 2 | 15 | nA |
| | | | | Full range | | | 30 | | | 30 | |
| $\alpha_{I_{IO}}$ | Average temperature coefficient of input offset current | | | Full range | | 10 | 200 | | 10 | 200 | pA/°C |
| $I_{IB}$ | Input bias current | $V_O$ = 1.4 V | | 25°C | | −15 | −50 | | −15 | −80 | nA |
| | | | | Full range | | | −100 | | | −100 | |
| $V_{ICR}$ | Common-mode input voltage range | $V_{CC}$ = 30 V | | 25°C | 0 to $V_{CC}$ − 1.5 | | | 0 to $V_{CC}$ − 1.5 | | | V |
| | | | | Full range | 0 to $V_{CC}$ − 2 | | | 0 to $V_{CC}$ − 2 | | | |
| $V_{OH}$ | High-level output voltage | $R_L \geq 2$ kΩ | | 25°C | $V_{CC}$ − 1.5 | | | $V_{CC}$ − 1.5 | | | V |
| | | $V_{CC}$ = 30 V | $R_L$ = 2 kΩ | Full range | 26 | | | 26 | | | |
| | | | $R_L \geq 10$ kΩ | Full range | 27 | 28 | | 27 | 28 | | |
| $V_{OL}$ | Low-level output voltage | $R_L \leq 10$ kΩ | | Full range | | 5 | 20 | | 5 | 20 | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{CC}$ = 15 V, $V_O$ = 1 V to 11 V, $R_L \geq 2$ kΩ | | 25°C | 50 | 100 | | 50 | 100 | | V/mV |
| | | | | Full range | 25 | | | 25 | | | |
| CMRR | Common-mode rejection ratio | | | 25°C | 70 | 80 | | 70 | 80 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | | 25°C | 65 | 100 | | 65 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | f = 1 kHz to 20 kHz | | 25°C | | 120 | | | 120 | | dB |
| $I_O$ | Output current | $V_{CC}$ = 15 V, $V_{ID}$ = 1 V, $V_O$ = 0 | Source | 25°C | −20 | −30 | −60 | −20 | −30 | −60 | mA |
| | | | | Full range | −10 | | | −10 | | | |
| | | $V_{CC}$ = 15 V, $V_{ID}$ = −1 V, $V_O$ = 15 | Sink | 25°C | 10 | 20 | | 10 | 20 | | |
| | | | | Full range | 5 | | | 5 | | | |
| | | $V_{ID}$ = −1 V, $V_O$ = 200 mV | | 25°C | 12 | 30 | | 12 | 30 | | µA |
| $I_{OS}$ | Short-circuit output current | $V_{CC}$ at 5 V, GND at −5 V, $V_O$ = 0 | | 25°C | | ±40 | ±60 | | ±40 | ±60 | mA |
| $I_{CC}$ | Supply current (two amplifiers) | $V_O$ = 2.5 V, No load | | Full range | | 0.7 | 1.2 | | 0.7 | 1.2 | mA |
| | | $V_{CC}$ = MAX, $V_O$ = 0.5 V, No load | | Full range | | 1 | 2 | | 1 | 2 | |

*On products compliant to MIL-PRF-38535, this parameter is not production tested.
† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX $V_{CC}$ for testing purposes is 26 V for LM2904 and 30 V for others.
‡ Full range is −55°C to 125°C for LM158A, −25°C to 85°C for LM258A, and 0°C to 70°C for LM358A.
§ All typical values are at $T_A$ = 25°C.

## electrical characteristics at specified free-air temperature, $V_{CC}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | | $T_A$‡ | LM358A | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP§ | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{CC}$ = 5 V to 30 V, $V_{IC} = V_{ICR(min)}$, $V_O$ = 1.4 V | | 25°C | | 2 | 3 | mV |
| | | | | Full range | | | 5 | |
| $\alpha_{V_{IO}}$ | Average temperature coefficient of input offset voltage | | | Full range | | 7 | 20 | µV/°C |
| $I_{IO}$ | Input offset current | $V_O$ = 1.4 V | | 25°C | | 2 | 30 | nA |
| | | | | Full range | | | 75 | |
| $\alpha_{I_{IO}}$ | Average temperature coefficient of input offset current | | | Full range | | 10 | 300 | pA/°C |
| $I_{IB}$ | Input bias current | $V_O$ = 1.4 V | | 25°C | | −15 | −100 | nA |
| | | | | Full range | | | −200 | |
| $V_{ICR}$ | Common-mode input voltage range | $V_{CC}$ = 30 V | | 25°C | 0 to $V_{CC}$ − 1.5 | | | V |
| | | | | Full range | 0 to $V_{CC}$ −2 | | | |
| $V_{OH}$ | High-level output voltage | $R_L \geq 2$ kΩ | | 25°C | $V_{CC}$ − 1.5 | | | V |
| | | $V_{CC}$ = 30 V | $R_L$ = 2 kΩ | Full range | 26 | | | |
| | | | $R_L \geq 10$ kΩ | Full range | 27 | 28 | | |
| $V_{OL}$ | Low-level output voltage | $R_L \leq 10$ kΩ | | Full range | | 5 | 20 | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{CC}$ = 15 V, $V_O$ = 1 V to 11 V, $R_L \geq 2$ kΩ | | 25°C | 25 | 100 | | V/mV |
| | | | | Full range | 15 | | | |
| CMRR | Common-mode rejection ratio | | | 25°C | 65 | 80 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | | | 25°C | 65 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | f = 1 kHz to 20 kHz | | 25°C | | 120 | | dB |
| $I_O$ | Output current | $V_{CC}$ = 15 V, $V_{ID}$ = 1 V, $V_O$ = 0 | Source | 25°C | −20 | −30 | −60 | mA |
| | | | | Full range | −10 | | | |
| | | $V_{CC}$ = 15 V, $V_{ID}$ = −1 V, $V_O$ = 15 V | Sink | 25°C | 10 | 20 | | |
| | | | | Full range | 5 | | | |
| | | $V_{ID}$ = −1 V, $V_O$ = 200 mV | | 25°C | | 30 | | µA |
| $I_{OS}$ | Short-circuit output current | $V_{CC}$ at 5 V, GND at −5 V, $V_O$ = 0 | | 25°C | | ±40 | ±60 | mA |
| $I_{CC}$ | Supply current (two amplifiers) | $V_O$ = 2.5 V, No load | | Full range | | 0.7 | 1.2 | mA |
| | | $V_{CC}$ = MAX, $V_O$ = 0.5 V, No load | | Full range | | 1 | 2 | |

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX $V_{CC}$ for testing purposes is 26 V for LM2904 and 30 V for others.
‡ Full range is −55°C to 125°C for LM158A, −25°C to 85°C for LM258A, and 0°C to 70°C for LM358A.
§ All typical values are at $T_A$ = 25°C.

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

| PARAMETER | | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| SR | Slew rate at unity gain | $R_L$ = 1 MΩ, $C_L$ = 30 pF, $V_I$ = ±10 V (see Figure 1) | 0.3 | V/μs |
| $B_1$ | Unity-gain bandwidth | $R_L$ = 1 MΩ, $C_L$ = 20 pF (see Figure 1) | 0.7 | MHz |
| $V_n$ | Equivalent input noise voltage | $R_S$ = 100 Ω, $V_I$ = 0 V, f = 1 kHz (see Figure 2) | 40 | nV/√Hz |

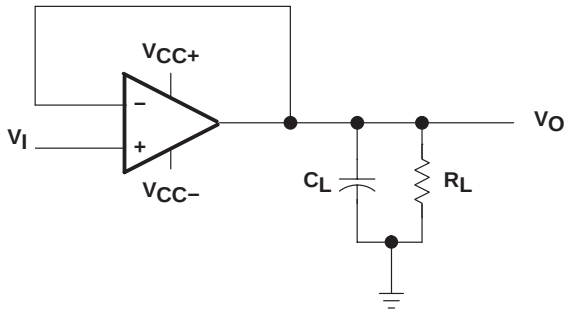



**Figure 1. Unity-Gain Amplifier**

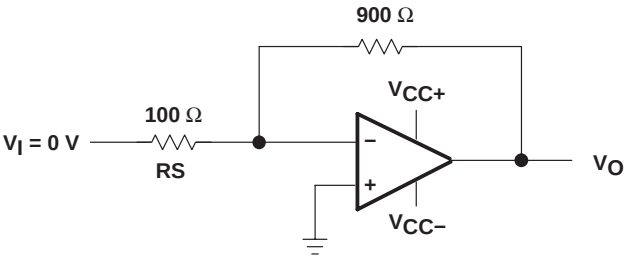
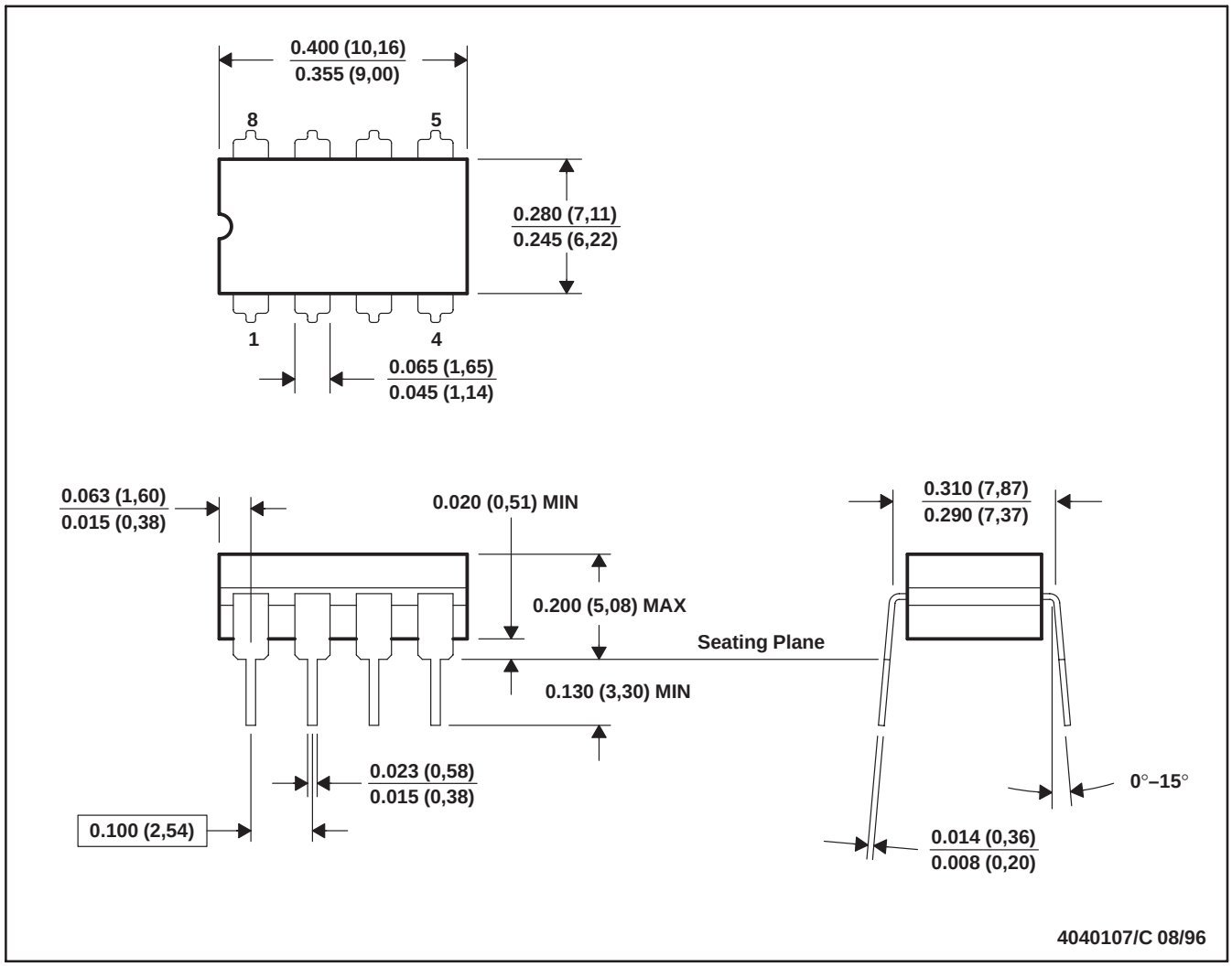



**Figure 2. Noise-Test Circuit**

MCER001A – JANUARY 1995 – REVISED JANUARY 1997

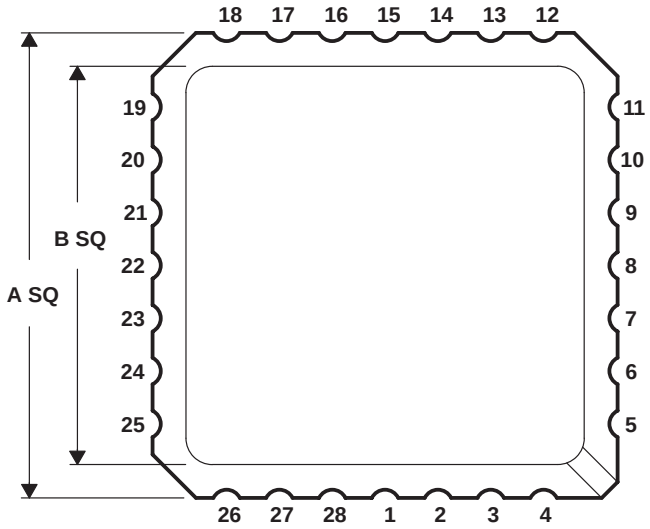
**JG (R-GDIP-T8)** **CERAMIC DUAL-IN-LINE**



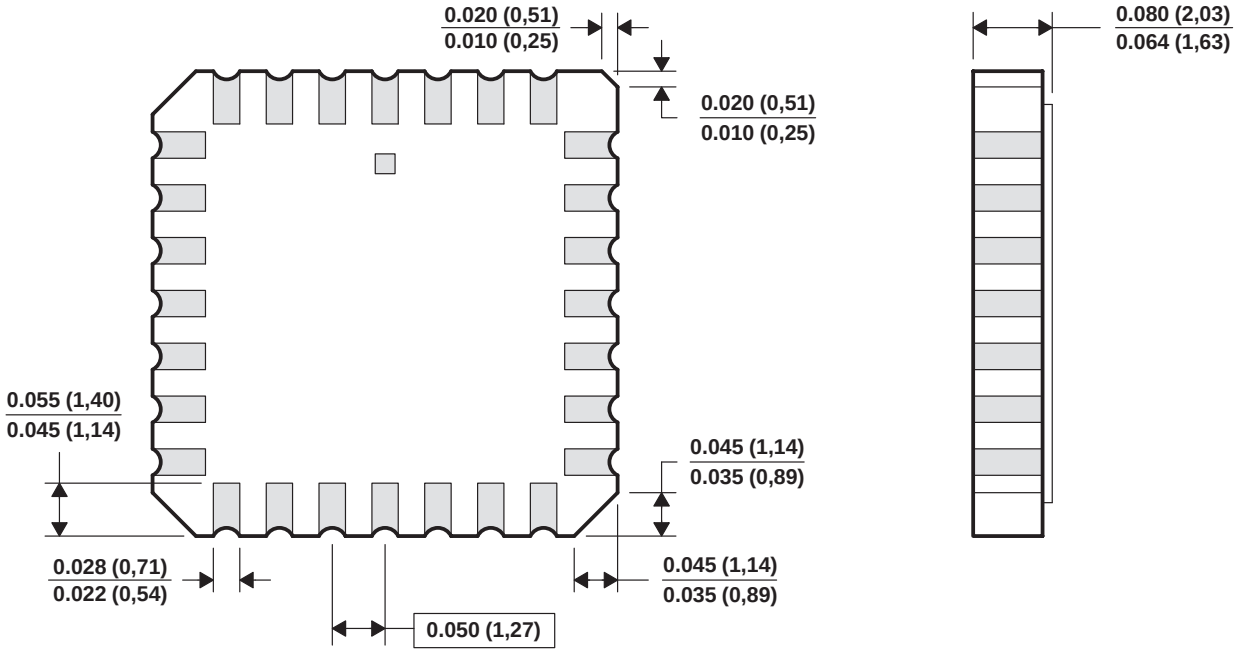

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP1-T8

**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) |

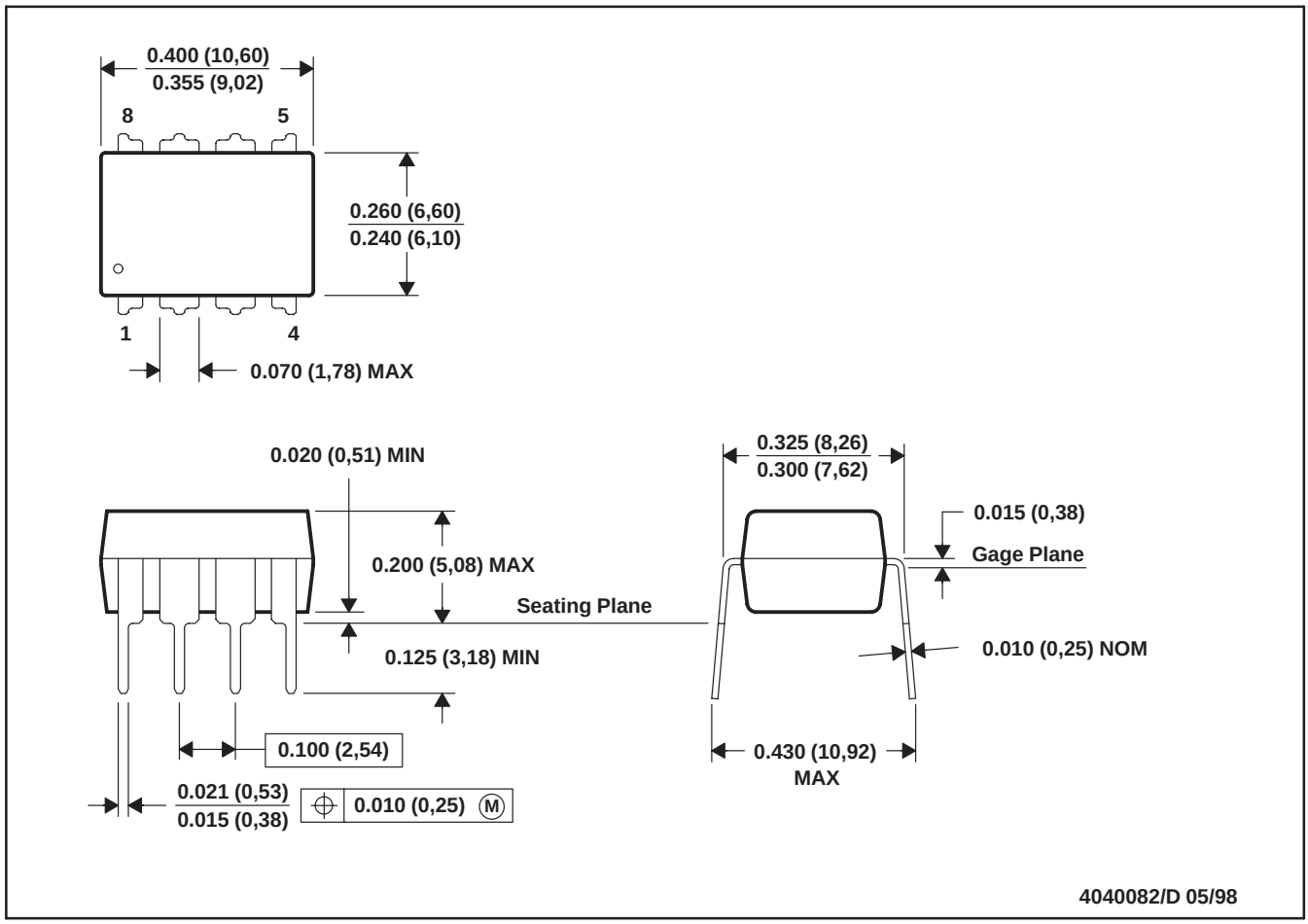



**4040140/D 10/96**

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

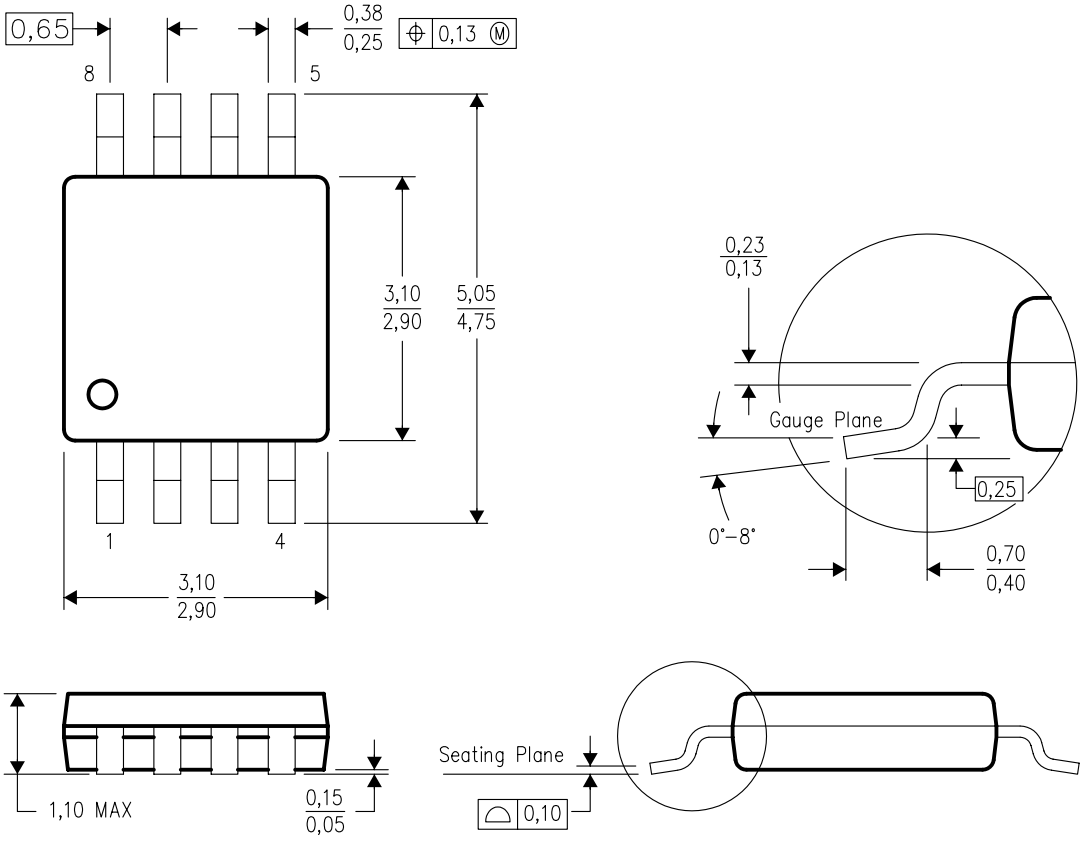
**P (R-PDIP-T8)** **PLASTIC DUAL-IN-LINE**




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

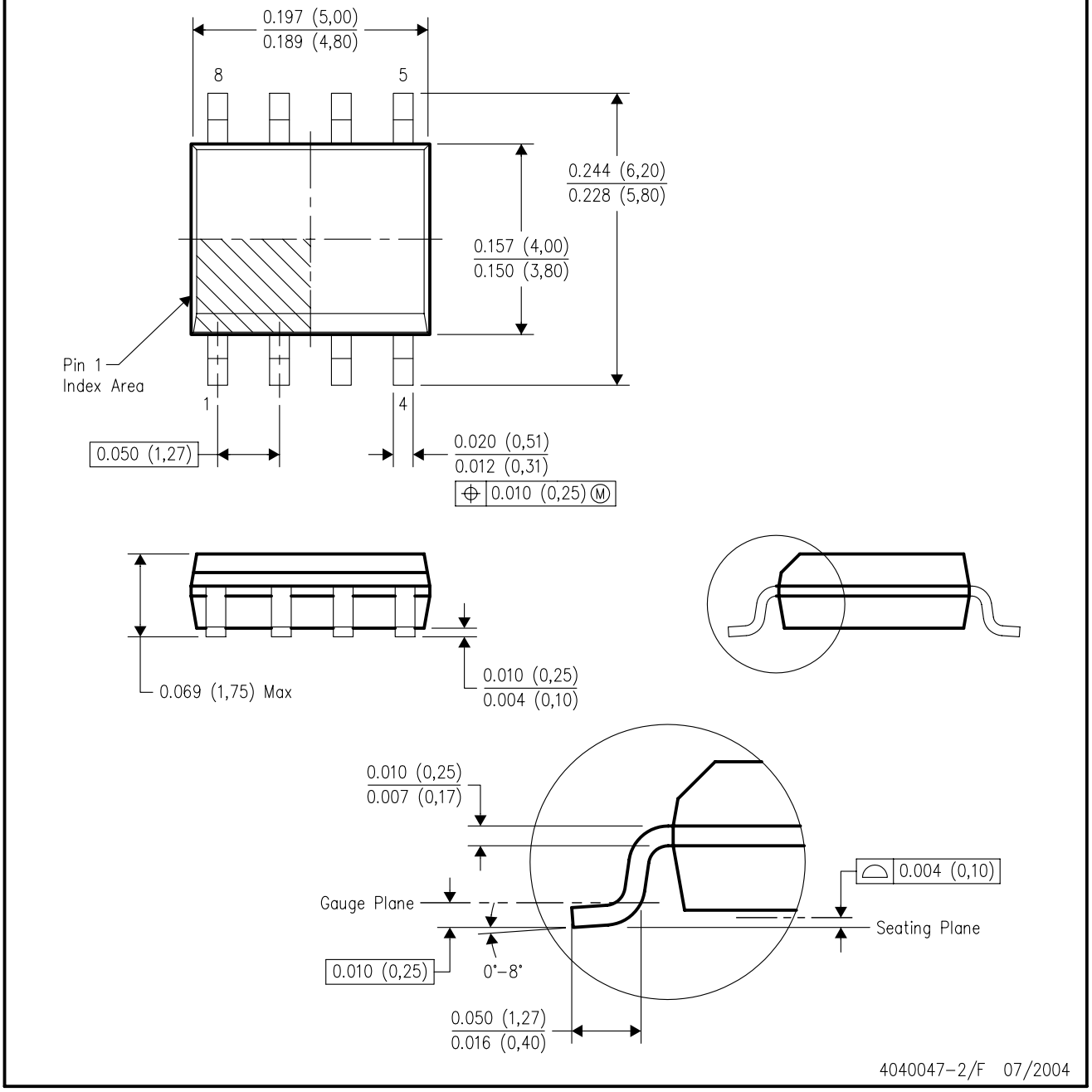
## DGK (S–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




4073329/D 12/03

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.
D. Falls within JEDEC MO–187 variation AA.

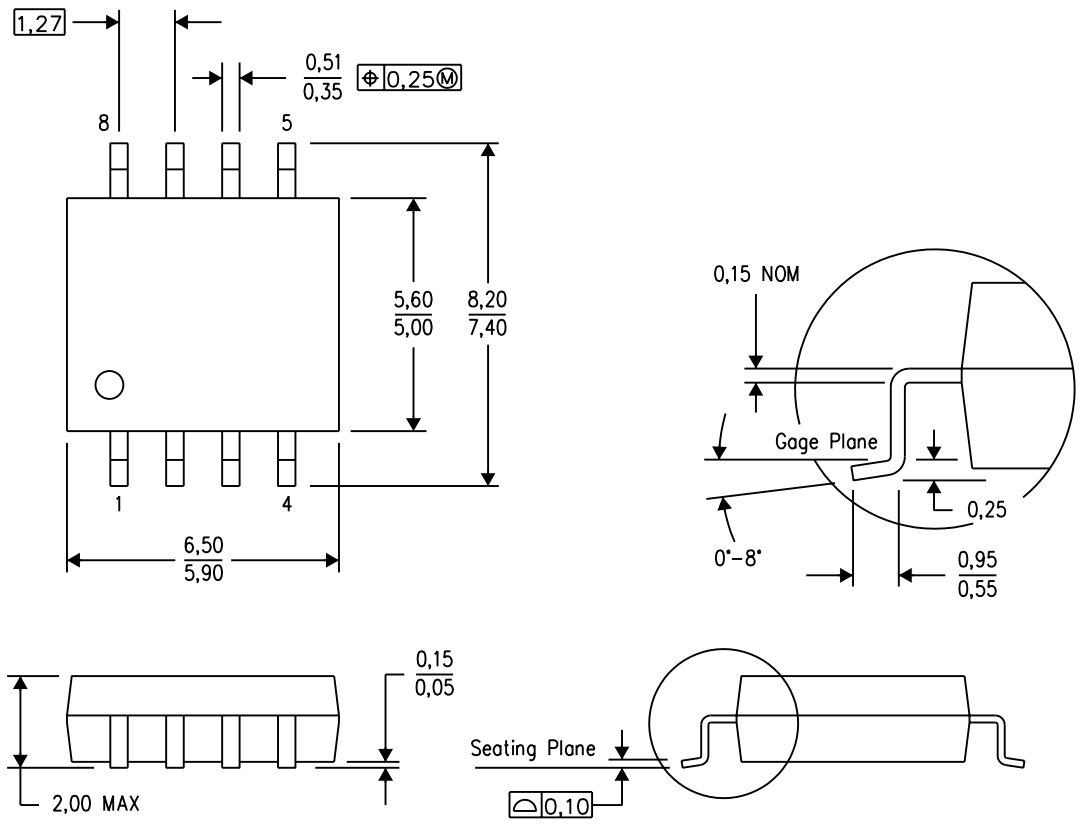
## D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




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**

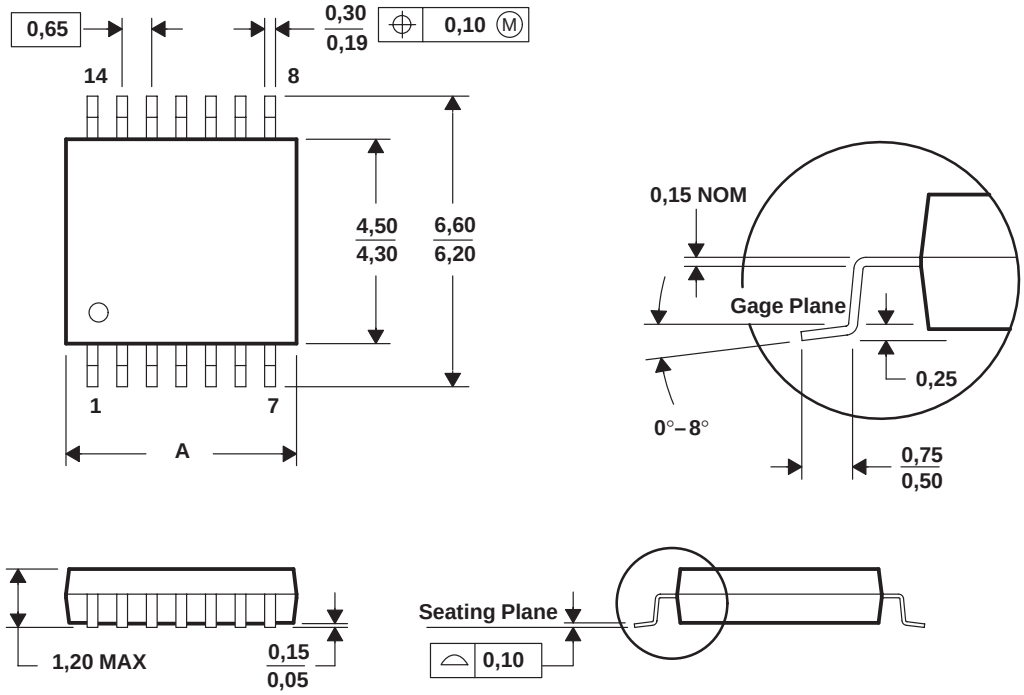



4040063/C 03/03

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.

**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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