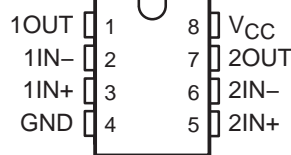


LM158, LM158A, LM258, LM258A LM358, LM358A, LM2904, LM2904V DUAL OPERATIONAL AMPLIFIERS

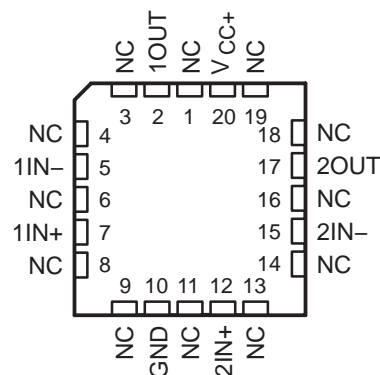
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- **Wide Supply Range:**
 - Single Supply . . . 3 V to 32 V
(26 V for LM2904)
 - or Dual Supplies . . . ± 1.5 V to ± 16 V
(± 13 V for LM2904)
- **Low Supply-Current Drain, Independent of Supply Voltage . . . 0.7 mA Typ**
- **Common-Mode Input Voltage 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 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.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

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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.

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LM358, LM358A, LM2904, LM2904V
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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 | | | | |
| | VSSOP (DGK) | Reel of 2500 | LM358DGKR | M5S | | |
| | 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 | | | | |
| VSSOP (DGK) | Reel of 2500 | LM358ADGKR | M6S | | | |
| -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 | | | | |
| | 3 mV | 30 V | PDIP (P) | Tube of 50 | LM258AP | LM258AP |
| SOIC (D) | | | Tube of 75 | LM258AD | LM258A | |
| | Reel of 2500 | LM258ADR | | | | |
| -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 | | | | |
| | VSSOP (DGK) | Reel of 2500 | LM2904DGKR | MBS | | |
| | 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 |

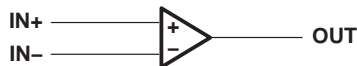
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



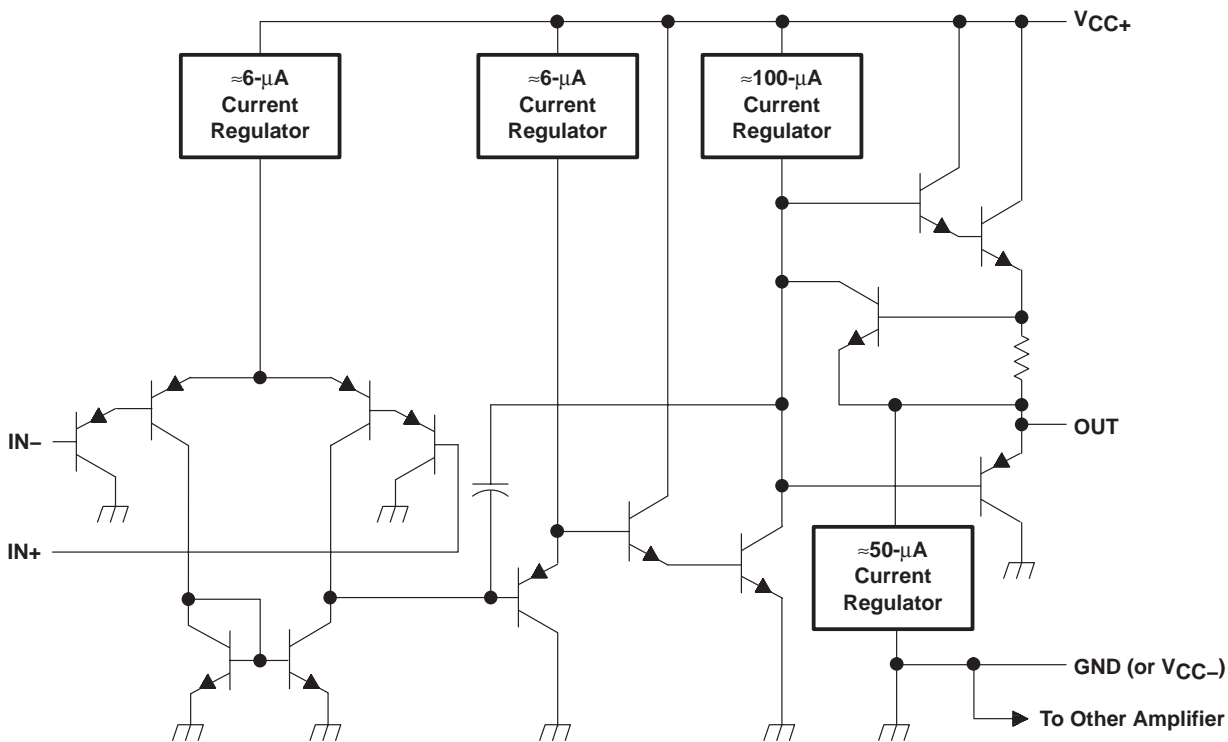
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LM358, LM358A, LM2904, LM2904V
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symbol (each amplifier)



schematic (each amplifier)



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

LM158, LM158A, LM258, LM258A LM358, LM358A, LM2904, LM2904V DUAL OPERATIONAL AMPLIFIERS

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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 ($V_{CC} \leq 15$ V) (see Note 3) | | Unlimited | Unlimited | |
| Package thermal impedance, θ_{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, θ_{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 $T_J(max)$, θ_{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 $T_J(max)$, θ_{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.



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LM358, LM358A, LM2904, LM2904V
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONST | T_A ‡ | LM158 LM258 | | | LM358 | | | UNIT |
|--|--|------------------------------|---------------------|------|----------|---------------------|------|------------------------------|------|
| | | | MIN | TYP§ | MAX | MIN | TYP§ | MAX | |
| V_{IO} Input offset voltage | $V_{CC} = 5\text{ V to MAX}$, $V_{IC} = V_{ICR(\text{min})}$, $V_O = 1.4\text{ V}$ | 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 | | $\mu\text{V}/^\circ\text{C}$ | |
| I_{IO} Input offset current | $V_O = 1.4\text{ V}$ | 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 | | $\text{pA}/^\circ\text{C}$ | |
| I_{IB} Input bias current | $V_O = 1.4\text{ V}$ | 25°C | –20 | | –150 | –20 | | –250 | nA |
| | | Full range | | | –300 | | | –500 | |
| V_{ICR} Common-mode input voltage range | $V_{CC} = 5\text{ V to MAX}$ | 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 | $R_L \geq 2\text{ k}\Omega$ | 25°C | $V_{CC} - 1.5$ | | | $V_{CC} - 1.5$ | | V | |
| | | 25°C | $V_{CC} - 1.5$ | | | $V_{CC} - 1.5$ | | | |
| | $V_{CC} = \text{MAX}$ | $R_L = 2\text{ k}\Omega$ | Full range | 26 | | | 26 | | |
| | | $R_L \geq 10\text{ k}\Omega$ | Full range | 27 | 28 | | 27 | | 28 |
| V_{OL} Low-level output voltage | $R_L \leq 10\text{ k}\Omega$ | Full range | 5 | | 20 | 5 | | 20 | mV |
| A_{VD} Large-signal differential voltage amplification | $V_{CC} = 15\text{ V}$, $V_O = 1\text{ V to }11\text{ V}$, $R_L \geq 2\text{ k}\Omega$ | 25°C | 50 | 100 | | 25 | 100 | V/mV | |
| | | Full range | 25 | | | 15 | | | |
| CMRR Common-mode rejection ratio | $V_{CC} = 5\text{ V to MAX}$, $V_{IC} = V_{ICR(\text{min})}$ | 25°C | 70 | 80 | | 65 | 80 | dB | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{CC} = 5\text{ V to MAX}$ | 25°C | 65 | 100 | | 65 | 100 | dB | |
| V_{O1}/V_{O2} Crosstalk attenuation | $f = 1\text{ kHz to }20\text{ kHz}$ | 25°C | 120 | | | 120 | | dB | |
| I_O Output current | $V_{CC} = 15\text{ V}$, $V_{ID} = 1\text{ V}$, $V_O = 0$ | Source | 25°C | –20 | –30 | | –20 | –30 | mA |
| | | | Full range | –10 | | | –10 | | |
| | Sink | 25°C | 10 | 20 | | 10 | 20 | | |
| | | Full range | 5 | | | 5 | | | |
| I_O Output current | $V_{ID} = -1\text{ V}$, $V_O = 200\text{ mV}$ | 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) | $V_O = 2.5\text{ V}$, No load | Full range | 0.7 | 1.2 | | 0.7 | 1.2 | mA | |
| | $V_{CC} = \text{MAX}$, $V_O = 0.5\text{ V}$, 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 $T_A = 25^\circ\text{C}$.



**LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904V
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | | T_A ‡ | LM2904 | | | UNIT |
|--|---|---|------------------------------|------------|---------------------|------------------------------|------|
| | | | | MIN | TYP§ | MAX | |
| V_{IO} Input offset voltage | $V_{CC} = 5\text{ V to MAX,}$ $V_{IC} = V_{ICR(min)},$ $V_O = 1.4\text{ V}$ | 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 | | $\mu\text{V}/^\circ\text{C}$ | |
| I_{IO} Input offset current | $V_O = 1.4\text{ V}$ | 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 | | $\text{pA}/^\circ\text{C}$ | |
| I_{IB} Input bias current | $V_O = 1.4\text{ V}$ | | | 25°C | -20 | -250 | nA |
| | | | | Full range | -500 | | |
| V_{ICR} Common-mode input voltage range | $V_{CC} = 5\text{ V to MAX}$ | | | 25°C | 0 to $V_{CC} - 1.5$ | | V |
| | | | | Full range | 0 to $V_{CC} - 2$ | | |
| V_{OH} High-level output voltage | $R_L \geq 10\text{ k}\Omega$ | | | 25°C | $V_{CC} - 1.5$ | | V |
| | | $V_{CC} = \text{MAX,}$ Non-V device | $R_L = 2\text{ k}\Omega$ | Full range | 22 | | |
| | | | $R_L \geq 10\text{ k}\Omega$ | Full range | 23 | 24 | |
| | | $V_{CC} = \text{MAX,}$ V-suffix device | $R_L = 2\text{ k}\Omega$ | Full range | 26 | | |
| $R_L \geq 10\text{ k}\Omega$ | Full range | | 27 | 28 | | | |
| V_{OL} Low-level output voltage | $R_L \leq 10\text{ k}\Omega$ | | | Full range | 5 | 20 | mV |
| A_{VD} Large-signal differential voltage amplification | $V_{CC} = 15\text{ V, } V_O = 1\text{ V to } 11\text{ V,}$ $R_L \geq 2\text{ k}\Omega$ | | | 25°C | 25 | 100 | V/mV |
| | | | | Full range | 15 | | |
| CMRR Common-mode rejection ratio | $V_{CC} = 5\text{ V to MAX,}$ $V_{IC} = V_{ICR(min)}$ | Non-V device | 25°C | 50 | 80 | dB | |
| | | V-suffix device | 25°C | 65 | 80 | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{CC} = 5\text{ V to MAX}$ | | | 25°C | 65 | 100 | dB |
| V_{O1}/V_{O2} Crosstalk attenuation | $f = 1\text{ kHz to } 20\text{ kHz}$ | | | 25°C | 120 | | dB |
| I_O Output current | $V_{CC} = 15\text{ V,}$ $V_{ID} = 1\text{ V, } V_O = 0$ | Source | 25°C | -20 | -30 | mA | |
| | | | Full range | -10 | | mA | |
| | $V_{CC} = 15\text{ V,}$ $V_{ID} = -1\text{ V,}$ $V_O = 15\text{ V}$ | Sink | 25°C | 10 | 20 | mA | |
| | | | Full range | 5 | | mA | |
| | $V_{ID} = -1\text{ V,}$ $V_O = 200\text{ mV}$ | 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) | $V_O = 2.5\text{ V, No load}$ | | | Full range | 0.7 | 1.2 | mA |
| | $V_{CC} = \text{MAX, } V_O = 0.5\text{ V, No load}$ | | | 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 $T_A = 25^\circ\text{C}$.



LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904V
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONST | T_A ‡ | LM158A | | | LM258A | | | UNIT | |
|--|--|------------|---------------------|-------------|-----|---------------------|-------------|-----|------------------------------|----|
| | | | MIN | TYP§ | MAX | MIN | TYP§ | MAX | | |
| V_{IO} Input offset voltage | $V_{CC} = 5\text{ V to }30\text{ V}$, $V_{IC} = V_{ICR(\text{min})}$, $V_O = 1.4\text{ V}$ | 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 | | | $\mu\text{V}/^\circ\text{C}$ | |
| I_{IO} Input offset current | $V_O = 1.4\text{ V}$ | 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 | | | $\text{pA}/^\circ\text{C}$ | |
| I_{IB} Input bias current | $V_O = 1.4\text{ V}$ | 25°C | –15 –50 | | | –15 –80 | | | nA | |
| | | Full range | –100 | | | –100 | | | | |
| V_{ICR} Common-mode input voltage range | $V_{CC} = 30\text{ V}$ | 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 | $R_L \geq 2\text{ k}\Omega$ $V_{CC} = 30\text{ V}$ | 25°C | $V_{CC} - 1.5$ | | | $V_{CC} - 1.5$ | | | V | |
| | | Full range | 26 | | | 26 | | | | |
| | | | 27 28 | | | 27 28 | | | | |
| V_{OL} Low-level output voltage | $R_L \leq 10\text{ k}\Omega$ | Full range | 5 20 | | | 5 20 | | | mV | |
| A_{VD} Large-signal differential voltage amplification | $V_{CC} = 15\text{ V}$, $V_O = 1\text{ V to }11\text{ V}$, $R_L \geq 2\text{ k}\Omega$ | 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 | $f = 1\text{ kHz to }20\text{ kHz}$ | 25°C | 120 | | | 120 | | | dB | |
| I_O Output current | $V_{CC} = 15\text{ V}$, $V_{ID} = 1\text{ V}$, $V_O = 0$ | Source | 25°C | –20 –30 –60 | | | –20 –30 –60 | | | mA |
| | | | Full range | –10 | | | –10 | | | |
| | $V_{CC} = 15\text{ V}$, $V_{ID} = -1\text{ V}$, $V_O = 15$ | Sink | 25°C | 10 20 | | | 10 20 | | | |
| | | | Full range | 5 | | | 5 | | | |
| | $V_{ID} = -1\text{ V}$, $V_O = 200\text{ mV}$ | 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 | $\pm 40 \pm 60$ | | | $\pm 40 \pm 60$ | | | mA | |
| I_{CC} Supply current (two amplifiers) | $V_O = 2.5\text{ V}$, No load | Full range | 0.7 1.2 | | | 0.7 1.2 | | | mA | |
| | $V_{CC} = \text{MAX}$, $V_O = 0.5\text{ V}$, 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 $T_A = 25^\circ\text{C}$.



**LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904V
DUAL OPERATIONAL AMPLIFIERS**

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

| PARAMETER | TEST CONDITIONS† | T_A ‡ | LM358A | | | UNIT | |
|--|---|------------|------------------------------|----------|------|------------------------------|----|
| | | | MIN | TYP§ | MAX | | |
| V_{IO} Input offset voltage | $V_{CC} = 5\text{ V to }30\text{ V}$, $V_{IC} = V_{ICR(min)}$, $V_O = 1.4\text{ V}$ | 25°C | 2 | 3 | | mV | |
| | | Full range | | | 5 | | |
| $\alpha_{V_{IO}}$ Average temperature coefficient of input offset voltage | | Full range | 7 | 20 | | $\mu\text{V}/^\circ\text{C}$ | |
| I_{IO} Input offset current | $V_O = 1.4\text{ V}$ | 25°C | 2 | 30 | | nA | |
| | | Full range | | | 75 | | |
| $\alpha_{I_{IO}}$ Average temperature coefficient of input offset current | | Full range | 10 | 300 | | $\text{pA}/^\circ\text{C}$ | |
| I_{IB} Input bias current | $V_O = 1.4\text{ V}$ | 25°C | -15 | -100 | | nA | |
| | | Full range | | | -200 | | |
| V_{ICR} Common-mode input voltage range | $V_{CC} = 30\text{ V}$ | 25°C | 0 to $V_{CC} - 1.5$ | | | V | |
| | | Full range | 0 to $V_{CC} - 2$ | | | | |
| V_{OH} High-level output voltage | $R_L \geq 2\text{ k}\Omega$ $V_{CC} = 30\text{ V}$ | 25°C | $V_{CC} - 1.5$ | | | V | |
| | | Full range | $R_L = 2\text{ k}\Omega$ | 26 | | | |
| | | | $R_L \geq 10\text{ k}\Omega$ | 27 | 28 | | |
| V_{OL} Low-level output voltage | $R_L \leq 10\text{ k}\Omega$ | Full range | 5 | 20 | | mV | |
| A_{VD} Large-signal differential voltage amplification | $V_{CC} = 15\text{ V}$, $V_O = 1\text{ V to }11\text{ V}$, $R_L \geq 2\text{ k}\Omega$ | 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 | $f = 1\text{ kHz to }20\text{ kHz}$ | 25°C | 120 | | | dB | |
| I_O Output current | $V_{CC} = 15\text{ V}$, $V_{ID} = 1\text{ V}$, $V_O = 0$ | Source | 25°C | -20 | -30 | -60 | mA |
| | | | Full range | -10 | | | |
| | $V_{CC} = 15\text{ V}$, $V_{ID} = -1\text{ V}$, $V_O = 15\text{ V}$ | Sink | 25°C | 10 | 20 | | |
| | | | Full range | 5 | | | |
| | $V_{ID} = -1\text{ V}$, $V_O = 200\text{ mV}$ | 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) | $V_O = 2.5\text{ V}$, No load | Full range | 0.7 | 1.2 | | mA | |
| | $V_{CC} = \text{MAX}$, $V_O = 0.5\text{ V}$, 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 $-55^\circ\text{C to }125^\circ\text{C}$ for LM158A, $-25^\circ\text{C to }85^\circ\text{C}$ for LM258A, and $0^\circ\text{C to }70^\circ\text{C}$ for LM358A.

§ All typical values are at $T_A = 25^\circ\text{C}$.



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

| PARAMETER | | TEST CONDITIONS | TYP | UNIT |
|-----------|--------------------------------|---|-----|------------------------------|
| SR | Slew rate at unity gain | $R_L = 1\text{ M}\Omega$, $C_L = 30\text{ pF}$, $V_I = \pm 10\text{ V}$ (see Figure 1) | 0.3 | $\text{V}/\mu\text{s}$ |
| B_1 | Unity-gain bandwidth | $R_L = 1\text{ M}\Omega$, $C_L = 20\text{ pF}$ (see Figure 1) | 0.7 | MHz |
| V_n | Equivalent input noise voltage | $R_S = 100\ \Omega$, $V_I = 0\text{ V}$, $f = 1\text{ kHz}$ (see Figure 2) | 40 | $\text{nV}/\sqrt{\text{Hz}}$ |

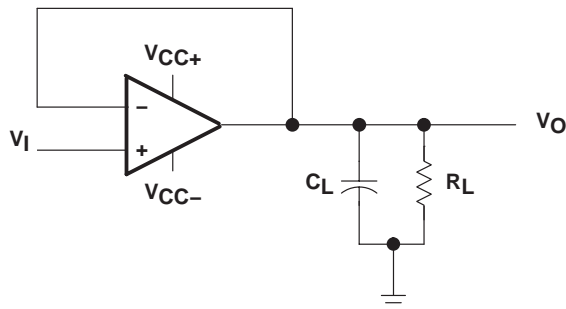


Figure 1. Unity-Gain Amplifier

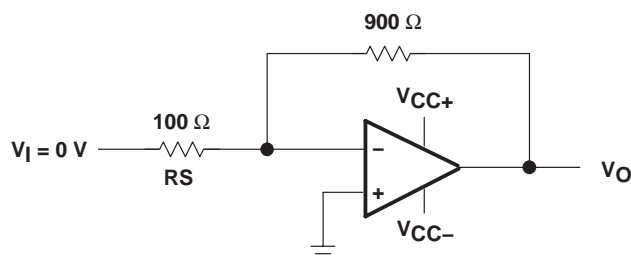


Figure 2. Noise-Test Circuit

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



- 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

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



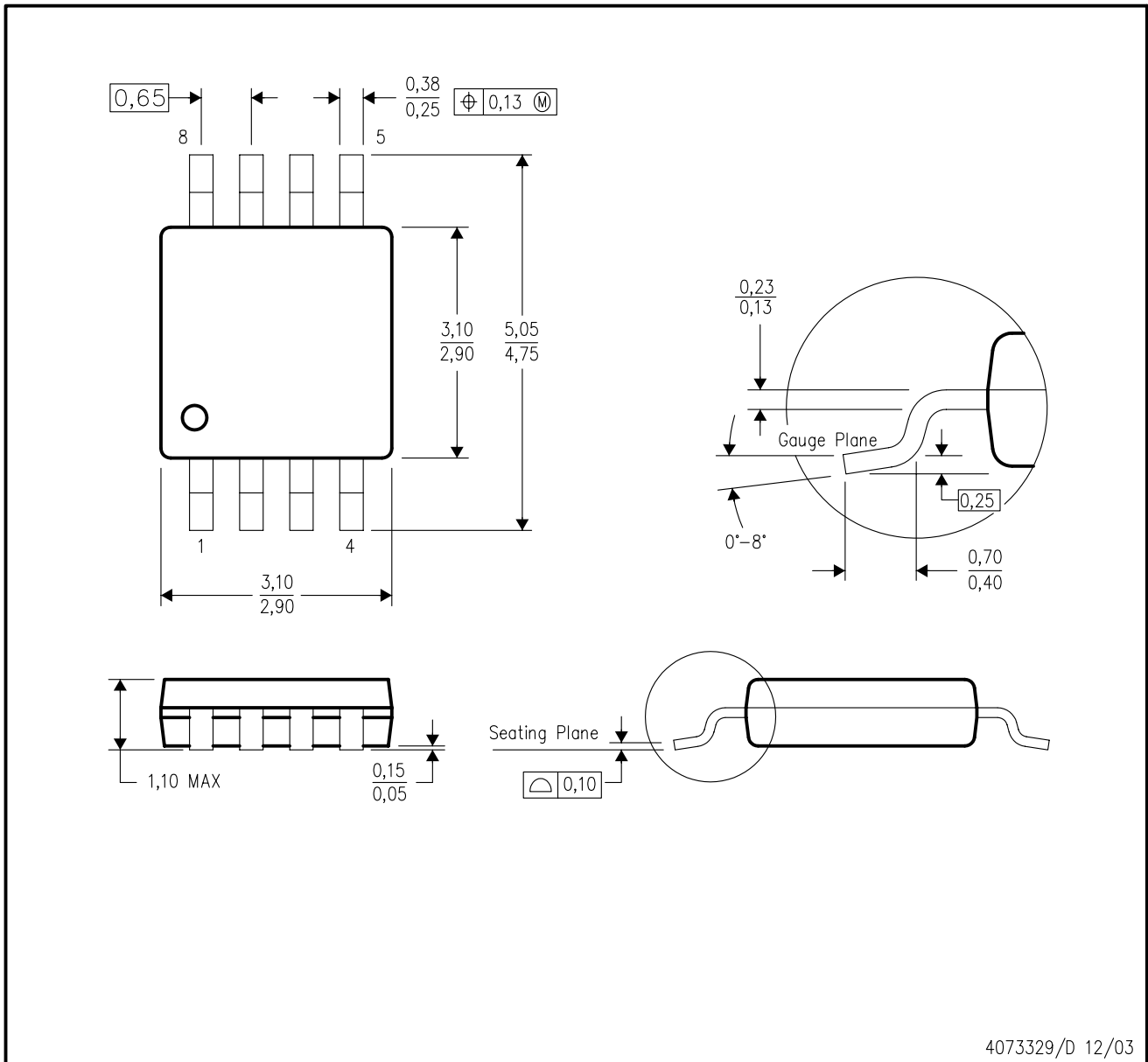
- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Falls within JEDEC MS-001

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



- 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



- 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



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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