These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically 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 (26 V for the LM2902), 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 more easily implemented in single-supply-voltage systems. For example, the LM124 can be operated directly from the standard 5-V supply that is used in digital systems and provides the required interface electronics, without requiring additional ±15-V supplies.
## ORDERING INFORMATION

<table>
<thead>
<tr>
<th>$T_A$</th>
<th>$V_{io\text{max}}$ AT 25°C</th>
<th>MAX TESTED $V_{cc}$</th>
<th>PACKAGE</th>
<th>ORDERABLE PART NUMBER</th>
<th>TOP-SIDE MARKING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>PDIP (N)</td>
<td>Tube of 25</td>
<td>LM324N</td>
</tr>
<tr>
<td>$7 , mV$</td>
<td>$30 , V$</td>
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<td>Tube of 50</td>
<td>LM324D</td>
<td>LM324K</td>
</tr>
<tr>
<td>$0°C$ to $70°C$</td>
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<td></td>
<td>Reel of 5000</td>
<td>LM324DR</td>
<td>LM324</td>
</tr>
<tr>
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<td>$30 , V$</td>
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<td>LM324K</td>
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<tr>
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<td>LM324</td>
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<tr>
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<td>SOIC (D)</td>
<td>Reel of 2500</td>
<td>LM324K</td>
</tr>
<tr>
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<td>$30 , V$</td>
<td></td>
<td>Tube of 50</td>
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<td>LM324</td>
</tr>
<tr>
<td>$0°C$ to $70°C$</td>
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<td>Reel of 2500</td>
<td>LM324K</td>
<td>LM324</td>
</tr>
<tr>
<td>$5 , mV$</td>
<td>$30 , V$</td>
<td></td>
<td>Tube of 50</td>
<td>LM324K</td>
<td>LM324</td>
</tr>
<tr>
<td>$-25°C$ to $85°C$</td>
<td></td>
<td></td>
<td>Reel of 2500</td>
<td>LM324K</td>
<td>LM324</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SOP (NS)</td>
<td>Tube of 90</td>
<td>LM324PWR</td>
</tr>
<tr>
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<td>$30 , V$</td>
<td></td>
<td>Reel of 2500</td>
<td>LM324K</td>
<td>LM324</td>
</tr>
<tr>
<td>$0°C$ to $70°C$</td>
<td></td>
<td></td>
<td>Tube of 90</td>
<td>LM324K</td>
<td>LM324</td>
</tr>
<tr>
<td>$5 , mV$</td>
<td>$30 , V$</td>
<td></td>
<td>Reel of 2500</td>
<td>LM324K</td>
<td>LM324</td>
</tr>
<tr>
<td>$-25°C$ to $85°C$</td>
<td></td>
<td></td>
<td>Tube of 90</td>
<td>LM324K</td>
<td>LM324</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SSOP (DB)</td>
<td>Tube of 25</td>
<td>LM324ADBR</td>
</tr>
<tr>
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<td>$30 , V$</td>
<td></td>
<td>Tube of 50</td>
<td>LM324AD</td>
<td>LM324</td>
</tr>
<tr>
<td>$0°C$ to $70°C$</td>
<td></td>
<td></td>
<td>Reel of 2500</td>
<td>LM324ADR</td>
<td>LM324</td>
</tr>
<tr>
<td>$5 , mV$</td>
<td>$30 , V$</td>
<td></td>
<td>Tube of 50</td>
<td>LM324AD</td>
<td>LM324</td>
</tr>
<tr>
<td>$-25°C$ to $85°C$</td>
<td></td>
<td></td>
<td>Reel of 2500</td>
<td>LM324ADR</td>
<td>LM324</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>TSSOP (PW)</td>
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<td>LM324APWR</td>
</tr>
<tr>
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<td>$30 , V$</td>
<td></td>
<td>Tube of 50</td>
<td>LM324APW</td>
<td>LM324</td>
</tr>
<tr>
<td>$-25°C$ to $85°C$</td>
<td></td>
<td></td>
<td>Reel of 2500</td>
<td>LM324APW</td>
<td>LM324</td>
</tr>
</tbody>
</table>

---

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

‡ Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
**ORDERING INFORMATION (CONTINUED)**

| $T_A$ | $V_{|0|\text{max}}$ AT 25°C | MAX TESTED $V_{CC}$ | PACKAGE† | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|-------|-----------------------------|---------------------|----------|-----------------------|------------------|
| 7 mV  | 26 V                        | PDIP (N)            | Tube of 25 | LM2902N               | LM2902N          |
|       |                             | PDIP (N)            | Tube of 25 | LM2902KN              | LM2902KN         |
|       |                             | SOIC (D)            | Tube of 50 | LM2902D               |                  |
|       |                             | SOIC (D)            | Reel of 2500 | LM2902DR             |                  |
|       |                             | SOIC (D)            | Tube of 50 | LM2902K               |                  |
|       |                             | SOIC (D)            | Reel of 2500 | LM2902KDR           |                  |
|       | 32 V                        | SOIC (D)            | Reel of 2000 | LM2902NSR             |                  |
|       |                             | SOIC (D)            | Tube of 50 | LM2902KNS              |                  |
|       |                             | SOIC (D)            | Reel of 2000 | LM2902KNSR           |                  |
|       |                             | SSOP (DB)           | Tube of 80 | LM2902KDB             | L2902K          |
|       |                             | SSOP (DB)           | Reel of 2000 | LM2902KDBR          | L2902K          |
|       | 32 V                        | TSSOP (PW)          | Tube of 90 | LM2902PW              | L2902           |
|       |                             | TSSOP (PW)          | Reel of 2000 | LM2902PWR            | L2902           |
|       |                             | TSSOP (PW)          | Tube of 90 | LM2902KPW             | L2902K          |
|       |                             | TSSOP (PW)          | Reel of 2000 | LM2902KPWR           | L2902K          |
| 2 mV  | 32 V                        | SOIC (D)            | Reel of 2500 | LM2902KVQDR         | L2902KV         |
|       |                             | SOIC (D)            | Reel of 2000 | LM2902KVQWR          | L2902KV         |
|       | 5 mV                        | CDIP (J)            | Tube of 25 | LM124J               | LM124J          |
|       |                             | CFP (W)             | Tube of 25 | LM124W               | LM124W          |
|       |                             | LCCC (FK)           | Tube of 55 | LM124FK              | LM124FK         |
|       |                             | SOIC (D)            | Tube of 50 | LM124D               | LM124           |
|       |                             | SOIC (D)            | Reel of 2500 | LM124DR             | LM124           |
| 2 mV  | 30 V                        | CDIP (J)            | Tube of 25 | LM124AJ              | LM124AJ         |
|       |                             | CFP (W)             | Tube of 25 | LM124AW              | LM124AW         |
|       |                             | LCCC (FK)           | Tube of 55 | LM124AFK             | LM124AFK        |

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

symbol (each amplifier)
schematic (each amplifier)

![Schematic Diagram]

**COMPONENT COUNT**

<table>
<thead>
<tr>
<th>Component</th>
<th>Count</th>
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<tbody>
<tr>
<td>Epi-FET</td>
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<tr>
<td>Transistors</td>
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<td>Diodes</td>
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<tr>
<td>Resistors</td>
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<tr>
<td>Capacitors</td>
<td>4</td>
</tr>
</tbody>
</table>

† ESD protection cells - available on LM324K and LM324KA only
## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

<table>
<thead>
<tr>
<th></th>
<th>LM2902</th>
<th>ALL OTHER DEVICES</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage, VCC (see Note 1)</td>
<td>±13 or 26</td>
<td>±16 or 32</td>
<td>V</td>
</tr>
<tr>
<td>Differential input voltage, V_ID (see Note 2)</td>
<td>±26</td>
<td>±32</td>
<td>V</td>
</tr>
<tr>
<td>Input voltage, V_I (either input)</td>
<td>−0.3 to 26</td>
<td>−0.3 to 32</td>
<td>V</td>
</tr>
<tr>
<td>Duration of output short circuit (one amplifier) to ground at (or below) TA = 25°C, VCC ≤ 15 V (see Note 3)</td>
<td>Unlimited</td>
<td>Unlimited</td>
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</table>

<table>
<thead>
<tr>
<th>Package thermal impedance, θJA (see Notes 4 and 5)</th>
<th>D package</th>
<th>86</th>
<th>86</th>
<th>°C/W</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>DB package</td>
<td>96</td>
<td>96</td>
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</tr>
<tr>
<td></td>
<td>N package</td>
<td>80</td>
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<td>NS package</td>
<td>76</td>
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<tr>
<td></td>
<td>PW package</td>
<td>113</td>
<td>113</td>
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</tr>
<tr>
<td>Package thermal impedance, θJC (see Notes 6 and 7)</td>
<td>FK package</td>
<td>5.61</td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td></td>
<td>J package</td>
<td>15.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>W package</td>
<td>14.65</td>
<td></td>
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</tr>
</tbody>
</table>

| 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 | J or W 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 VCC specified for the measurement of IDS) are with respect to the network GND.
2. Differential voltages are at IN+, with respect to IN−.
3. Short circuits from outputs to VCC can cause excessive heating and eventual destruction.
4. Maximum power dissipation is a function of T_J(max), θJA, and TA. The maximum allowable power dissipation at any allowable ambient temperature is PD = (T_J(max) − TA)/θJA. 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), θJC, and TC. The maximum allowable power dissipation at any allowable case temperature is PD = (T_J(max) − TC)/θJC. 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.

## ESD protection

<table>
<thead>
<tr>
<th>TEST CONDITIONS</th>
<th>TYP</th>
<th>UNIT</th>
</tr>
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<tbody>
<tr>
<td>Human-Body Model</td>
<td>±2</td>
<td>kV</td>
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</tbody>
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**Texas Instruments**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
electrical characteristics at specified free-air temperature, $V_{CC} = 5 \, \text{V}$ (unless otherwise noted)

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<th>PARAMETER</th>
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<th>LM224</th>
<th>LM324K</th>
<th>LM324KA</th>
<th>LM2902</th>
<th>LM2902KV</th>
<th>LM2902KAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IO}$</td>
<td>Input offset voltage</td>
<td>$V_{CC} = 5 , \text{V} \text{ to } \text{MAX}, \quad V_O = 1.4 , \text{V}$</td>
<td>25°C</td>
<td>MIN TYP $\delta$ MAX</td>
<td>MIN TYP $\delta$ MAX</td>
<td>mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{IO}$</td>
<td>Input offset current</td>
<td>$V_O = 1.4 , \text{V}$</td>
<td>25°C</td>
<td>2 30</td>
<td>2 50</td>
<td>nA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{IB}$</td>
<td>Input bias current</td>
<td>$V_O = 1.4 , \text{V}$</td>
<td>25°C</td>
<td>–20 –150</td>
<td>–20 –250</td>
<td>nA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{ICR}$</td>
<td>Common-mode input voltage range</td>
<td>$V_{CC} = 5 , \text{V} \text{ to } \text{MAX}$</td>
<td>25°C</td>
<td>0 to $V_{CC} – 1.5$</td>
<td>0 to $V_{CC} – 1.5$</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OH}$</td>
<td>High-level output voltage</td>
<td>$R_L = 2 , \text{k} \Omega$</td>
<td>25°C</td>
<td>$V_{CC} – 1.5$</td>
<td>$V_{CC} – 1.5$</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Low-level output voltage</td>
<td>$R_L \leq 10 , \text{k} \Omega$</td>
<td>Full range</td>
<td>5 20</td>
<td>5 20</td>
<td>mV</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>$A_{VD}$</td>
<td>Large-signal differential voltage amplification</td>
<td>$V_{CC} = 15 , \text{V}, \quad V_O = 1 , \text{V} \text{ to } 11 , \text{V}, \quad R_L \geq 2 , \text{k} \Omega$</td>
<td>25°C</td>
<td>50 100</td>
<td>25 100</td>
<td>V/mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{CMRR}$</td>
<td>Common-mode rejection ratio</td>
<td>$V_{IC} = V_{ICR\text{min}}$</td>
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<td>70 80</td>
<td>65 80</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$k_{SVR}$</td>
<td>Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)</td>
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<td>25°C</td>
<td>65 100</td>
<td>65 100</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>$V_{O1}/V_{O2}$</td>
<td>Crosstalk attenuation</td>
<td>f = 1 kHz to 20 kHz</td>
<td>25°C</td>
<td>120</td>
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<td>dB</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$I_{O}$</td>
<td>Output current</td>
<td>$V_{CC} = 15 , \text{V}, \quad V_O = 1 , \text{V}, \quad V_O = 0$</td>
<td>Source</td>
<td>25°C</td>
<td>–20 –30 –60 –20 –30 –60</td>
<td>mA</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = 15 , \text{V}, \quad V_O = –1 , \text{V}, \quad V_O = 15 , \text{V}$</td>
<td>Sink</td>
<td>Full range</td>
<td>–10</td>
<td>–10</td>
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</tr>
<tr>
<td>$I_{OS}$</td>
<td>Short-circuit output current</td>
<td>$V_{CC} = 5 , \text{V}, \quad GND \text{ at } –5 , \text{V}$</td>
<td>$V_O = 0$,</td>
<td>25°C</td>
<td>±40 ±60</td>
<td>±40 ±60</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CC}$</td>
<td>Supply current (four amplifiers)</td>
<td>$V_O = 2.5 , \text{V}$, No load</td>
<td>Full range</td>
<td>0.7 1.2</td>
<td>0.7 1.2</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CC} = \text{MAX}$,</td>
<td>$V_O = 0.5 , V_{CC}$, No load</td>
<td>Full range</td>
<td>1.4 3</td>
<td>1.4 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† 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 LM2902 and 30 V for the others.
‡ Full range is –55°C to 125°C for LM124, –25°C to 85°C for LM224, and 0°C to 70°C for LM324.
§ All typical values are at $T_A = 25°C$. 

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**Texas Instruments**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
### Electrical Characteristics

- **V_{io}**: Input Offset Voltage
- **ΔV_{io}/ΔT**: Input Offset Voltage Temperature Drift
- **I_{io}**: Input Offset Current
- **V_{oc}**: Common-Mode Input Voltage Range
- **V_{oh}**: High-Level Output Voltage
- **V_{ol}**: Low-Level Output Voltage
- **A_{vd}**: Large-Signal Differential Voltage Amplification
- **CMRR**: Common-Mode Rejection Ratio
- **k_{bvr}**: Supply-Voltage Rejection Ratio (ΔV_{cc}/ΔV_{io})
- **V_{o1}/V_{o2}**: Crosstalk Attenuation
- **I_{o}**: Output Current
- **I_{os}**: Short-Circuit Output Current
- **I_{cc}**: Supply Current (Four Amplifiers)

#### Test Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions†</th>
<th>T_A‡</th>
<th>LM2902</th>
<th>LM2902V</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>V_{io}</td>
<td>V_{cc} = 5 V to MAX, V_{o} = 1.4 V</td>
<td>25°C</td>
<td>3</td>
<td>7</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td>Non-A-suffix devices</td>
<td>Full range</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A-suffix devices</td>
<td>25°C</td>
<td>1</td>
<td>2</td>
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<tr>
<td></td>
<td>Full range</td>
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<tr>
<td>ΔV_{io}/ΔT</td>
<td>R_S = 0 Ω</td>
<td>Full range</td>
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<td>10 pA/°C</td>
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<tr>
<td>I_{io}</td>
<td>V_{o} = 1.4 V</td>
<td>25°C</td>
<td>2</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Full range</td>
<td>300</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔI_{io}/ΔT</td>
<td>Input Offset Current Temperature Drift</td>
<td>Full range</td>
<td>10</td>
<td>pA/°C</td>
<td></td>
</tr>
<tr>
<td>I_{ib}</td>
<td>V_{o} = 1.4 V</td>
<td>25°C</td>
<td>0 to 20</td>
<td>250</td>
<td>nA</td>
</tr>
<tr>
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<td>Full range</td>
<td>500</td>
<td>500</td>
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</tr>
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<td>V_{oc}</td>
<td>V_{ccc} = 5 V to MAX</td>
<td>25°C</td>
<td>0 to V_{cc} – 1.5</td>
<td>0 to V_{cc} – 1.5</td>
<td>V</td>
</tr>
<tr>
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<td>Full range</td>
<td>0 to V_{cc} – 2</td>
<td>0 to V_{cc} – 2</td>
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<tr>
<td>V_{oh}</td>
<td>R_L = 2 kΩ</td>
<td>25°C</td>
<td>V_{ccc} = 1.5</td>
<td>V_{ccc} = 1.5</td>
<td>V</td>
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<td>R_L &gt; 2 kΩ</td>
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<td>A_{vd}</td>
<td>V_{ccc} = 15 V, V_{o} = 1 V to 11 V, R_L ≥ 2 kΩ</td>
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<td>V_{ccc} = V_{icr}min</td>
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<td>k_{bvr}</td>
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<td>V_{o1}/V_{o2}</td>
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<td>I_{o}</td>
<td>V_{ccc} = 15 V, V_{o} = 0, V_{o} = 1 V</td>
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<td>I_{cc}</td>
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<td>V_{ccc} = MAX, V_{o} = 0.5 V_{ccc}, No load</td>
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† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX V_{ccc} for testing purposes is 26 V for LM2902 and 32 V for LM2902V.
‡ Full range is –40°C to 125°C for LM2902.
§ All typical values are at T_A = 25°C.
### Electrical Characteristics

#### Specified Free-Air Temperature
- **V<sub>CC</sub> = 5 V (unless otherwise noted)**

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<th>LM224A</th>
<th>LM324A, LM324KA</th>
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<td><strong>V&lt;sub&gt;I0&lt;/sub&gt;</strong></td>
<td>Input offset voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = 5 V to 30 V, V&lt;sub&gt;OD&lt;/sub&gt; = 1.4 V</td>
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<td>Input offset current</td>
<td>V&lt;sub&gt;OD&lt;/sub&gt; = 1.4 V</td>
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<td>Common-mode input voltage range</td>
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<td><strong>V&lt;sub&gt;Qh&lt;/sub&gt;</strong></td>
<td>High-level output voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = 30 V, R&lt;sub&gt;L&lt;/sub&gt; = 2 k&lt;i&gt;Ω&lt;/i&gt;</td>
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<td><strong>V&lt;sub&gt;Ol&lt;/sub&gt;</strong></td>
<td>Low-level output voltage</td>
<td>R&lt;sub&gt;L&lt;/sub&gt; ≤ 10 k&lt;i&gt;Ω&lt;/i&gt;</td>
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<td>Large-signal differential voltage amplification</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = 15 V, V&lt;sub&gt;OD&lt;/sub&gt; = 1 V to 11 V, R&lt;sub&gt;L&lt;/sub&gt; ≥ 2 k&lt;i&gt;Ω&lt;/i&gt;</td>
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<td><strong>CMRR</strong></td>
<td>Common-mode rejection ratio</td>
<td>V&lt;sub&gt;ICR&lt;/sub&gt; = V&lt;sub&gt;ICRmin&lt;/sub&gt;</td>
<td><strong>T</strong>&lt;sub&gt;A&lt;/sub&gt;</td>
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<tr>
<td><strong>SV&lt;sub&gt;SR&lt;/sub&gt;</strong></td>
<td>Supply-voltage rejection ratio (ΔV&lt;sub&gt;CC&lt;/sub&gt;/ΔV&lt;sub&gt;IO&lt;/sub&gt;)</td>
<td>25°C</td>
<td><strong>T</strong>&lt;sub&gt;A&lt;/sub&gt;</td>
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<td><strong>TYP</strong>§</td>
<td><strong>MAX</strong></td>
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<td><strong>V&lt;sub&gt;O1&lt;/sub&gt;/V&lt;sub&gt;O2&lt;/sub&gt;</strong></td>
<td>Crosstalk attenuation</td>
<td>f = 1 kHz to 20 kHz</td>
<td><strong>T</strong>&lt;sub&gt;A&lt;/sub&gt;</td>
<td><strong>MIN</strong></td>
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<td><strong>MAX</strong></td>
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<td><strong>I&lt;sub&gt;O&lt;/sub&gt;</strong></td>
<td>Output current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = 15 V, V&lt;sub&gt;OD&lt;/sub&gt; = 1 V, V&lt;sub&gt;OD&lt;/sub&gt; = 0</td>
<td><strong>T</strong>&lt;sub&gt;A&lt;/sub&gt;</td>
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<td><strong>TYP</strong>§</td>
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<td><strong>I&lt;sub&gt;OS&lt;/sub&gt;</strong></td>
<td>Short-circuit output current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; at 5 V, V&lt;sub&gt;OD&lt;/sub&gt; = 200 mV</td>
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<tr>
<td><strong>I&lt;sub&gt;Cc&lt;/sub&gt;</strong></td>
<td>Supply current (four amplifiers)</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; = 30 V, V&lt;sub&gt;OD&lt;/sub&gt; = 15 V</td>
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<td>Full range</td>
<td>1.4</td>
<td>3</td>
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† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
‡ Full range is –55°C to 125°C for LM124A, –25°C to 85°C for LM224A, and 0°C to 70°C for LM324A.
§ All typical values are at T<sub>A</sub> = 25°C.
operating conditions, $V_{CC} = \pm 15 \, \text{V}, \, T_A = 25^\circ\text{C}$

<table>
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<th>TYP</th>
<th>UNIT</th>
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<tr>
<td>SR</td>
<td>$R_L = 1 , \text{M} \Omega, , C_L = 30 , \text{pF}, , V_I = \pm 10 , \text{V}$ (see Figure 1)</td>
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<td>V/μs</td>
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<tr>
<td>$B_1$</td>
<td>$R_L = 1 , \text{M} \Omega, , C_L = 20 , \text{pF}$ (see Figure 1)</td>
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<td>$V_n$</td>
<td>$R_S = 100 , \Omega, , V_I = 0 , \text{V}, , f = 1 , \text{kHz}$ (see Figure 2)</td>
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<td>nV/√Hz</td>
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**Figure 1. Unity-Gain Amplifier**

**Figure 2. Noise-Test Circuit**
### PACKAGING INFORMATION

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<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/ Ball Finish</th>
<th>MSL Peak Temp (3)</th>
<th>Samples (Requires Login)</th>
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<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check [http://www.ti.com/productcontent](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.
- **Pb-Free (RoHS Exempt)**: This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
- **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)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM124, LM124-SP, LM124M, LM2902**
• Catalog: LM124, LM124

• Automotive: LM2902-Q1

• Enhanced Product: LM2902-EP

• Military: LM124M, LM124M

• Space: LM124-SP, LM124-SP

NOTE: Qualified Version Definitions:
  • Catalog - TI's standard catalog product
  • Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
  • Enhanced Product - Supports Defense, Aerospace and Medical Applications
  • Military - QML certified for Military and Defense Applications
  • Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application
# TAPE AND REEL INFORMATION

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**TAPE DIMENSIONS**

- **A0**: Dimension designed to accommodate the component width
- **B0**: Dimension designed to accommodate the component length
- **K0**: Dimension designed to accommodate the component thickness
- **W**: Overall width of the carrier tape
- **P1**: Pitch between successive cavity centers

**REEL DIMENSIONS**

- **Reel Diameter**: Diameter of the reel
- **Reel Width**: Width of the reel

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**

- **Sprocket Holes**: Holes for sprocket engagement
- **Pocket Quadrants**: Quadrants for component orientation
- **User Direction of Feed**: Direction of component feed

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*www.ti.com 12-Nov-2012*
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CERAMIC DUAL IN-LINE PACKAGE

14 LEADS SHOWN

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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.
MECHANICAL DATA

W (R-GDFP-F14) CERAMIC DUAL FLATPACK

BASE AND SEATING PLANE

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

4040180-2/D 07/03

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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. Falls within JEDEC MS-004
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.

⚠️ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0.15) each side.
⚠️ Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0.43) each side.
E. Reference JEDEC MS-012 variation AB.
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC-7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
NOTES:

A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.

B. This drawing is subject to change without notice.

Caution: Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 each side.

Caution: Body width does not include interlead flash. Interlead flash shall not exceed 0.25 each side.

E. Falls within JEDEC MO-153
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC-7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
MECHANICAL DATA

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.

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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-150

DIM 14 16 20 24 28 30 38
A. MAX 6.50 6.50 7.50 8.50 10.50 10.50 12.90
A. MIN 5.90 5.90 6.90 7.90 9.90 9.90 12.30

4040065 /E 12/01
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