Features of OP27A, OP27C, OP37A, and OP37C:

- **Maximum Equivalent Input Noise Voltage:**
  - 3.8 nV/√Hz at 1 kHz
  - 5.5 nV/√Hz at 10 kHz
- **Very Low Peak-to-Peak Noise Voltage at 0.1 Hz to 10 Hz . . . 80 nV Typ**
- **Low Input Offset Voltage . . . 25 nV Max**
- **High Voltage Amplification . . . 1 V/µV Min**

Feature of OP37 Series:

- **Minimum Slew Rate . . . 11 V/µs**

**description**

The OP27 and OP37 operational amplifiers combine outstanding noise performance with excellent precision and high-speed specifications. The wideband noise is only 3 nV/√Hz and with the 1/f noise corner at 2.7 Hz, low noise is maintained for all low-frequency applications.

The outstanding characteristics of the OP27 and OP37 make these devices excellent choices for low-noise amplifier applications requiring precision performance and reliability. Additionally, the OP37 is free of latch-up in high-gain, large-capacitive-feedback configurations.

The OP27 series is compensated for unity gain. The OP37 series is decompensated for increased bandwidth and slew rate and is stable down to a gain of 5.

The OP27A, OP27C, OP37A, and OP37C are characterized for operation over the full military temperature range of –55°C to 125°C. The OP27E, OP27G, OP37E, and OP37G are characterized for operation from –25°C to 85°C.

**AVAILABLE OPTIONS**

<table>
<thead>
<tr>
<th>TA</th>
<th>VIOmax AT 25°C</th>
<th>STABLE GAIN</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>–25°C to 85°C</td>
<td>25 µV</td>
<td>1</td>
<td>CERAMIC DIP (JG)</td>
</tr>
<tr>
<td></td>
<td>100 µV</td>
<td>5</td>
<td>CERAMIC DIP (JG)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CHIP CARRIER (FK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CHIP CARRIER (FK)</td>
</tr>
<tr>
<td>–55°C to 125°C</td>
<td>25 µV</td>
<td>1</td>
<td>OP27AJG</td>
</tr>
<tr>
<td></td>
<td>100 µV</td>
<td>5</td>
<td>OP37AJG</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OP27CJG</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OP37CJG</td>
</tr>
</tbody>
</table>

**symbol**

Pin numbers are for the JG and P packages.
†C1 = 120 pF for OP27
C1 = 15 pF for OP37
absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC+}$ (see Note 1) ................................................................. 22 V
Supply voltage, $V_{CC-}$ (see Note 1) ................................................................. −22 V
Input voltage, $V_I$ .................................................................................................. $V_{CC±}$
Duration of output short circuit ........................................................................ unlimited
Differential input current (see Note 2) ................................................................. ±25 mA
Continuous power dissipation ........................................................................... See Dissipation Rating Table
Operating free-air temperature range: OP27A, OP27C, OP37A, OP37C ............ −55°C to 125°C
OP27E, OP27G, OP37E, OP37G ................................................................. −25°C to 85°C
Storage temperature range ................................................................................ −65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG or FK package ................................................................. 300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds : P package .......... 260°C

NOTES:
1. All voltage values are with respect to the midpoint between $V_{CC+}$ and $V_{CC-}$ unless otherwise noted.
2. The inputs are protected by back-to-back diodes. Current-limiting resistors are not used in order to achieve low noise. Excessive input current will flow if a differential input voltage in excess of approximately ±0.7 V is applied between the inputs unless some limiting resistance is used.

Dissipation Rating Table

<table>
<thead>
<tr>
<th>PACKAGE</th>
<th>$T_A \leq 25°C$ POWER RATING</th>
<th>DERATING FACTOR ABOVE $T_A = 25°C$</th>
<th>$T_A = 85°C$ POWER RATING</th>
<th>$T_A = 125°C$ POWER RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>JG</td>
<td>1050 mW</td>
<td>8.4 mW/°C</td>
<td>546 mW</td>
<td>210 mW</td>
</tr>
<tr>
<td>FK</td>
<td>1375 mW</td>
<td>11.0 mW/°C</td>
<td>715 mW</td>
<td>275 mW</td>
</tr>
<tr>
<td>P</td>
<td>1000 mW</td>
<td>8.0 mW/°C</td>
<td>520 mW</td>
<td>N/A</td>
</tr>
</tbody>
</table>
recommended operating conditions

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>TA†</th>
<th>OP27A, OP37A</th>
<th>OP27C, OP37C</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage, ( V_{CC+} )</td>
<td></td>
<td></td>
<td>MIN</td>
<td>NOM</td>
<td>MAX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage, ( V_{CC-} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common-mode input voltage, ( V_{IC} )</td>
<td>( V_{CC} = \pm 15 \text{ V}, \ TA = 25^\circ \text{C} )</td>
<td>±11</td>
<td>11</td>
<td>±11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>( V_{CC} = \pm 15 \text{ V}, \ TA = -55^\circ \text{C} \text{ to } 125^\circ \text{C} )</td>
<td>±10.3</td>
<td>10.3</td>
<td>±10.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Operating free-air temperature, ( TA )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-55</td>
<td>125</td>
<td>125</td>
</tr>
</tbody>
</table>

electrical characteristics at specified free-air temperature, \( V_{CC} = \pm 15 \text{ V} \) (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>TA†</th>
<th>OP27A, OP37A</th>
<th>OP27C, OP37C</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{IO} ) Input offset voltage</td>
<td>( V_O = 0, \ V_{IC} = 0 ), See Note 3</td>
<td>25°C</td>
<td>10</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>( \alpha V_{IO} ) Average temperature coefficient of input offset voltage</td>
<td>Full range</td>
<td>0.2</td>
<td>0.6</td>
<td>0.4</td>
<td>1.8</td>
</tr>
<tr>
<td>( I_{IO} ) Input offset current</td>
<td>( V_O = 0, \ V_{IC} = 0 )</td>
<td>25°C</td>
<td>7</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>( I_{IB} ) Input bias current</td>
<td>( V_O = 0, \ V_{IC} = 0 )</td>
<td>25°C</td>
<td>±10</td>
<td>±40</td>
<td>±15</td>
</tr>
<tr>
<td>( V_{ICR} ) Common-mode input voltage range</td>
<td>25°C</td>
<td>11  to 11</td>
<td>11  to 11</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full range</td>
<td>10.3 to -10.3</td>
<td>10.5 to -10.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( V_{OM} ) Peak output voltage swing</td>
<td>( R_L \geq 2 \text{kΩ} )</td>
<td>±12</td>
<td>±13.8</td>
<td>±11.5</td>
<td>±13.5</td>
</tr>
<tr>
<td></td>
<td>( R_L \geq 0.6 \text{kΩ} )</td>
<td>±10</td>
<td>±11.5</td>
<td>±10</td>
<td>±11.5</td>
</tr>
<tr>
<td></td>
<td>( R_L \geq 2 \text{kΩ} )</td>
<td>Full range</td>
<td>±11.5</td>
<td>10.5</td>
<td>V</td>
</tr>
<tr>
<td>( A_{VD} ) Large-signal differential voltage amplification</td>
<td>( R_L \geq 2 \text{kΩ} , \ V_O = \pm 10 \text{ V} )</td>
<td>1000</td>
<td>1800</td>
<td>700</td>
<td>1500</td>
</tr>
<tr>
<td></td>
<td>( R_L \geq 1 \text{kΩ} , \ V_O = \pm 10 \text{ V} )</td>
<td>800</td>
<td>1500</td>
<td>1500</td>
<td>V/mV</td>
</tr>
<tr>
<td></td>
<td>( R_L \geq 0.6 \text{kΩ} , \ V_O = \pm 1 \text{ V} , \ V_{CC} = \pm 4 \text{ V} )</td>
<td>250</td>
<td>700</td>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>( R_L \geq 2 \text{kΩ} , \ V_O = \pm 10 \text{ V} )</td>
<td>Full range</td>
<td>600</td>
<td>300</td>
<td>V/mV</td>
</tr>
<tr>
<td>( r_{i(CM)} ) Common-mode input resistance</td>
<td>Full range</td>
<td>3</td>
<td>2</td>
<td>GΩ</td>
<td></td>
</tr>
<tr>
<td>( r_o ) Output resistance</td>
<td>( V_O = 0, \ I_O = 0 )</td>
<td>25°C</td>
<td>70</td>
<td>70</td>
<td>Ω</td>
</tr>
<tr>
<td>CMRR Common-mode rejection ratio</td>
<td>( V_{IC} = \pm 11 \text{ V} )</td>
<td>25°C</td>
<td>114</td>
<td>126</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>( V_{IC} = \pm 10 \text{ V} )</td>
<td>Full range</td>
<td>110</td>
<td>94</td>
<td>dB</td>
</tr>
<tr>
<td>( k_{SVR} ) Supply voltage rejection ratio</td>
<td>( V_{CC} = \pm 4 \text{ V} \text{ to } \pm 18 \text{ V} )</td>
<td>25°C</td>
<td>100</td>
<td>120</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>( V_{CC} = \pm 4.5 \text{ V} \text{ to } \pm 18 \text{ V} )</td>
<td>Full range</td>
<td>96</td>
<td>86</td>
<td>dB</td>
</tr>
</tbody>
</table>

† Full range is –55°C to 125°C.

NOTES:
3. Input offset voltage measurements are performed by automatic test equipment approximately 0.5 seconds after applying power.
4. Long-term drift of input offset voltage refers to the average trend line of offset voltage versus time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in \( V_{IO} \) during the first 30 days are typically 2.5 μV (see Figure 3).
### Electrical Characteristics at Specified Free-Air Temperature, $V_{CC} = \pm 15\, \text{V}$ (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>$T_A$†</th>
<th>OP27E, OP37E</th>
<th>OP27G, OP37G</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IO}$ Input offset voltage</td>
<td>$V_O = 0$, $V_{IC} = 0$</td>
<td>$25^\circ\text{C}$</td>
<td>10 25</td>
<td>30 100</td>
<td>μV</td>
</tr>
<tr>
<td></td>
<td>$R_S = 50 , \Omega$, See Note 3</td>
<td>Full range</td>
<td>60</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>$\alpha V_{IO}$ Average temperature coefficient of input offset voltage</td>
<td></td>
<td>$25^\circ\text{C}$</td>
<td>0.2 0.6</td>
<td>0.4 1.8</td>
<td>μV/°C</td>
</tr>
<tr>
<td>$I_{IO}$ Input offset current</td>
<td>$V_O = 0$, $V_{IC} = 0$</td>
<td>$25^\circ\text{C}$</td>
<td>7 35</td>
<td>12 75</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{IB}$ Input bias current</td>
<td>$V_O = 0$, $V_{IC} = 0$</td>
<td>$25^\circ\text{C}$</td>
<td>$\pm 10$ $\pm 40$</td>
<td>$\pm 15$ $\pm 80$</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{ICR}$ Common-mode input voltage range</td>
<td>$V_{IC} = \pm 11, \text{V}$</td>
<td>$25^\circ\text{C}$</td>
<td>11 to 11</td>
<td>11 to 11</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>$R_L \geq 2 , \text{k}\Omega$, Full range</td>
<td>10.3 to 10.5</td>
<td>10.5 to 10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OM}$ Peak output voltage swing</td>
<td>$R_L \geq 2 , \text{k}\Omega$</td>
<td>$\pm 12$ $\pm 13.8$</td>
<td>$\pm 11.5$ $\pm 13.5$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_L \geq 0.6 , \text{k}\Omega$</td>
<td>$\pm 10$ $\pm 11.5$</td>
<td>$\pm 10$ $\pm 11.5$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_D$ Large-signal differential voltage amplification</td>
<td>$R_L \geq 2 , \text{k}\Omega$, $V_O = \pm 10, \text{V}$</td>
<td>$1000$ $1800$</td>
<td>$700$ $1500$</td>
<td>V/mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_L \geq 1 , \text{k}\Omega$, $V_O = \pm 10, \text{V}$</td>
<td>$800$ $1500$</td>
<td>$1500$ $1500$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_L \geq 0.6 , \text{k}\Omega$, $V_{IC} = \pm 1, \text{V}$, $V_{ICR} = \pm 4, \text{V}$</td>
<td>$250$ $700$</td>
<td>$200$ $500$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_L \geq 2 , \text{k}\Omega$, $V_O = \pm 10, \text{V}$</td>
<td>$\pm 11.5$</td>
<td>$\pm 10.5$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_i(CM)$ Common-mode input resistance</td>
<td></td>
<td>$\pm 12$ $\pm 13.8$</td>
<td>$\pm 11.5$ $\pm 13.5$</td>
<td>GΩ</td>
<td></td>
</tr>
<tr>
<td>$r_O$ Output resistance</td>
<td>$V_O = 0$, $I_O = 0$</td>
<td>$25^\circ\text{C}$</td>
<td>70</td>
<td>70</td>
<td>Ω</td>
</tr>
<tr>
<td>CMRR Common-mode rejection ratio</td>
<td>$V_{IC} = \pm 11, \text{V}$</td>
<td>$25^\circ\text{C}$</td>
<td>114 126</td>
<td>100 120</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>$V_{IC} = \pm 10, \text{V}$</td>
<td></td>
<td>110</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>$k_{SVR}$ Supply voltage rejection ratio</td>
<td>$V_{CC} = \pm 4, \text{V}$ to $\pm 18, \text{V}$</td>
<td>$25^\circ\text{C}$</td>
<td>100 120</td>
<td>94 118</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td>$V_{CC} = \pm 4.5, \text{V}$ to $\pm 18, \text{V}$</td>
<td>$\pm 11.5$ $\pm 10.5$</td>
<td>$\pm 10.5$ $\pm 10.5$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full range</td>
<td>600</td>
<td>450</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† Full range is –25°C to 85°C.

NOTES: 3. Input offset voltage measurements are performed by automatic test equipment approximately 0.5 seconds after applying power.
4. Long-term drift of input offset voltage refers to the average trend line of offset voltage versus time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in $V_{IO}$ during the first 30 days are typically 2.5 μV (see Figure 3).
### OP27 operating characteristics over operating free-air temperature range, $V_{CC} = \pm 15 \text{ V}$

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>OP27A, OP27E</th>
<th>OP27C, OP27G</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>$A_{VD} \geq 1, \quad R_L \geq 2 \text{k}\Omega$</td>
<td>1.7 2.8</td>
<td>1.7 2.8</td>
<td>V/$\mu$s</td>
</tr>
<tr>
<td>$V_{N(PP)}$</td>
<td>$f = 0.1$ Hz to $10$ Hz, $R_S = 20 \text{ \Omega}$, See Figure 34</td>
<td>0.08 0.18</td>
<td>0.09 0.25</td>
<td>$\mu$V</td>
</tr>
<tr>
<td>$V_n$</td>
<td>$f = 10$ Hz, $R_S = 20 \text{ \Omega}$</td>
<td>3.5 5.5</td>
<td>3.8 8</td>
<td>nV/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 30$ Hz, $R_S = 20 \text{ \Omega}$</td>
<td>3.1 4.5</td>
<td>3.3 5.6</td>
<td>nV/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td>$I_n$</td>
<td>$f = 1$ kHz, $R_S = 20 \text{ \Omega}$</td>
<td>3 3.8</td>
<td>3.2 4.5</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 10$ Hz, See Figure 35</td>
<td>1.5 4</td>
<td>1.5</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 30$ Hz, See Figure 35</td>
<td>1 2.3</td>
<td>1</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 1$ kHz, See Figure 35</td>
<td>0.4 0.6</td>
<td>0.4 0.6</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td>Gain-bandwidth product</td>
<td>$f = 100$ kHz</td>
<td>5 8</td>
<td>5 8</td>
<td>MHz</td>
</tr>
</tbody>
</table>

### OP37 operating characteristics over operating free-air temperature range, $V_{CC} = \pm 15 \text{ V}$

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>OP37A, OP37E</th>
<th>OP37C, OP37G</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>$A_{VD} \geq 5, \quad R_L \geq 2 \text{k}\Omega$</td>
<td>11 17</td>
<td>11 17</td>
<td>V/$\mu$s</td>
</tr>
<tr>
<td>$V_{N(PP)}$</td>
<td>$f = 0.1$ Hz to $10$ Hz, $R_S = 20 \text{ \Omega}$, See Figure 34</td>
<td>0.08 0.18</td>
<td>0.09 0.25</td>
<td>$\mu$V</td>
</tr>
<tr>
<td>$V_n$</td>
<td>$f = 10$ Hz, $R_S = 20 \text{ \Omega}$</td>
<td>3.5 5.5</td>
<td>3.8 8</td>
<td>nV/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 30$ Hz, $R_S = 20 \text{ \Omega}$</td>
<td>3.1 4.5</td>
<td>3.3 5.6</td>
<td>nV/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td>$I_n$</td>
<td>$f = 1$ kHz, $R_S = 20 \text{ \Omega}$</td>
<td>3 3.8</td>
<td>3.2 4.5</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 10$ Hz, See Figure 35</td>
<td>1.5 4</td>
<td>1.5</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 30$ Hz, See Figure 35</td>
<td>1 2.3</td>
<td>1</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td></td>
<td>$f = 1$ kHz, See Figure 35</td>
<td>0.4 0.6</td>
<td>0.4 0.6</td>
<td>pA/$\sqrt{\text{Hz}}$</td>
</tr>
<tr>
<td>Gain-bandwidth product</td>
<td>$f = 10$ kHz</td>
<td>45 63</td>
<td>45 63</td>
<td>MHz</td>
</tr>
</tbody>
</table>
## TYPICAL CHARACTERISTICS

### Table of Graphs

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>FIGURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{IO} ) Input offset voltage</td>
<td>1</td>
</tr>
<tr>
<td>( \Delta V_{IO} ) Change in input offset voltage</td>
<td>2, 3</td>
</tr>
<tr>
<td>( I_{IO} ) Input offset current</td>
<td>4</td>
</tr>
<tr>
<td>( I_{IB} ) Input bias current</td>
<td>5</td>
</tr>
<tr>
<td>( V_{ICR} ) Common-mode input voltage range</td>
<td>6</td>
</tr>
<tr>
<td>( V_{OM} ) Maximum peak output voltage</td>
<td>7</td>
</tr>
<tr>
<td>( V_{O(PP)} ) Maximum peak-to-peak output voltage</td>
<td>8, 9</td>
</tr>
<tr>
<td>( A_{VD} ) Differential voltage amplification</td>
<td>10, 11, 12, 13, 14</td>
</tr>
<tr>
<td>( CMRR ) Common-mode rejection ratio</td>
<td>15</td>
</tr>
<tr>
<td>( K_{SVR} ) Supply voltage rejection ratio</td>
<td>16</td>
</tr>
<tr>
<td>( SR ) Slew rate</td>
<td>17, 18</td>
</tr>
<tr>
<td>( \phi_m ) Phase margin</td>
<td>19</td>
</tr>
<tr>
<td>( \phi ) Phase shift</td>
<td>20, 21</td>
</tr>
<tr>
<td>( V_n ) Equivalent input noise voltage</td>
<td>22, 23, 24, 25, 26</td>
</tr>
<tr>
<td>( I_n ) Equivalent input noise current</td>
<td>27</td>
</tr>
<tr>
<td>( G_{BP} ) Gain-bandwidth product</td>
<td>28</td>
</tr>
<tr>
<td>( I_{OS} ) Short-circuit output current</td>
<td>29</td>
</tr>
<tr>
<td>( I_{CC} ) Supply current</td>
<td>30, 32</td>
</tr>
<tr>
<td>Pulse response</td>
<td>31, 33</td>
</tr>
</tbody>
</table>
TYPICAL CHARACTERISTICS†

**INPUT OFFSET VOLTAGE OF REPRESENTATIVE INDIVIDUAL UNITS**

*vs FREE-AIR TEMPERATURE*

![Graph showing input offset voltage vs free-air temperature for different devices.](image1)

**WARM-UP CHANGE IN INPUT OFFSET VOLTAGE**

*vs ELAPSED TIME*

![Graph showing warm-up change in input offset voltage vs elapsed time for different devices.](image2)

**LONG-TERM DRIFT OF INPUT OFFSET VOLTAGE OF REPRESENTATIVE INDIVIDUAL UNITS**

![Graph showing long-term drift of input offset voltage for different devices.](image3)

† Data for temperatures below –25°C and above 85°C are applicable to the OP27A, OP27C, OP37A, and OP37C only.
TYPICAL CHARACTERISTICS†

INPUT OFFSET CURRENT
VERSUS FREE-AIR TEMPERATURE

V_
\text{CC}
\pm = \pm 15 \text{ V}

\begin{align*}
0 & \quad 10 & \quad 20 & \quad 30 & \quad 40 & \quad 50 \\
\text{IO} & \quad \text{Input Offset Current} - \text{nA} \\
\hline
\text{OP27A/E} & \quad \text{OP37A/E} \\
\text{OP27C/G} & \quad \text{OP37C/G}
\end{align*}

\begin{align*}
\text{T}_\text{A} & \quad \text{Free-Air Temperature} – °\text{C} \\
-75 & \quad -50 & \quad -25 & \quad 0 & \quad 25 & \quad 50 & \quad 75 & \quad 100 & \quad 125
\end{align*}

Figure 4

INPUT BIAS CURRENT
VERSUS FREE-AIR TEMPERATURE

V_
\text{CC}
\pm = \pm 15 \text{ V}

\begin{align*}
0 & \quad 10 & \quad 20 & \quad 30 & \quad 40 & \quad 50 \\
\text{IB} & \quad \text{Input Bias Current} - \text{nA} \\
\hline
\text{OP27A/E} & \quad \text{OP37A/E} \\
\text{OP27C/G} & \quad \text{OP37C/G}
\end{align*}

\begin{align*}
\text{T}_\text{A} & \quad \text{Free-Air Temperature} – °\text{C} \\
-75 & \quad -50 & \quad -25 & \quad 0 & \quad 25 & \quad 50 & \quad 75 & \quad 100 & \quad 125
\end{align*}

Figure 5

COMMON-MODE INPUT VOLTAGE RANGE LIMITS
VERSUS SUPPLY VOLTAGE

V_{\text{ICR}} – \text{Common-Mode Input Voltage Range Limits} – \text{V}

\begin{align*}
0 & \quad 4 & \quad 8 & \quad 12 & \quad 16 \\
\text{V}_{\text{ICR}} & \quad \text{Common-Mode Input Voltage Range Limits} – \text{V} \\
\hline
\text{V}_{\text{CC+}} & \quad \text{Supply Voltage} – \text{V} \\
0 & \quad \pm 5 & \quad \pm 10 & \quad \pm 15 & \quad \pm 20
\end{align*}

\begin{align*}
\text{T}_\text{A} & \quad \text{Free-Air Temperature} – °\text{C} \\
-55 & \quad 25 & \quad 125
\end{align*}

Figure 6

MAXIMUM PEAK OUTPUT VOLTAGE
VERSUS LOAD RESISTANCE

V_{\text{OM}} – \text{Maximum Peak Output Voltage} – \text{V}

\begin{align*}
0 & \quad 2 & \quad 4 & \quad 6 & \quad 8 & \quad 10 & \quad 12 & \quad 14 & \quad 16 & \quad 18 & \quad 20 \\
\text{V}_{\text{OM}} & \quad \text{Maximum Peak Output Voltage} – \text{V} \\
\hline
\text{V}_{\text{CC+}} = \pm 15 \text{ V} \\
\text{T}_\text{A} = 25°C
\end{align*}

\begin{align*}
\text{R}_\text{L} & \quad \text{Load Resistance} – \text{kΩ} \\
0.1 & \quad 1 & \quad 10
\end{align*}

Figure 7

† Data for temperatures below –25°C and above 85°C are applicable to the OP27A, OP27C, OP37A, and OP37C only.
TYPICAL CHARACTERISTICS

OP27
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

V_O(PP) – Maximum Peak-to-Peak Output Voltage – V

f – Frequency – Hz

V_CC ± = ± 15 V
R_L = 1 kΩ
T_A = 25°C

Figure 8

OP37
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

V_O(PP) – Maximum Peak-to-Peak Output Voltage – V

f – Frequency – Hz

V_CC ± = ± 15 V
R_L = 1 kΩ
T_A = 25°C

Figure 9

OP27A, OP27E, OP37A, OP37E
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
TOTAL SUPPLY VOLTAGE

A_VD – Differential Voltage Amplification – V/mV

V_CC+ – V_CC– – Total Supply Voltage – V

V_O = ± 10 V
T_A = 25°C

RL = 2 kΩ
RL = 1 kΩ

Figure 10

OP27A, OP27E, OP37A, OP37E
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
LOAD RESISTANCE

A_VD – Differential Voltage Amplification – V/mV

R_L – Load Resistance – kΩ

V_CC ± = ± 15 V
V_O = ± 10 V
T_A = 25°C

Figure 11
TYPICAL CHARACTERISTICS

OP27
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT
vs FREQUENCY

OP37
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT
vs FREQUENCY

Figure 12
Figure 13

Figure 14
Figure 15
TYPICAL CHARACTERISTICS†

SUPPLY VOLTAGE REJECTION RATIO

\[
\text{V}_{CC} = \pm 4 \text{ V to } \pm 18 \text{ V} \quad T_A = 25^\circ C
\]

<table>
<thead>
<tr>
<th>f – Frequency – Hz</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>kSVR – Supply Voltage Rejection Ratio – dB</td>
<td>160</td>
<td>140</td>
<td>120</td>
<td>100</td>
<td>80</td>
<td>60</td>
<td>40</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>18</td>
<td>16</td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

Figure 16

SLEW RATE

\[
\text{V}_{CC} = \pm 15 \text{ V} \quad R_L \geq 2 \text{ k}\Omega
\]

<table>
<thead>
<tr>
<th>T_A – Free Air Temperature – °C</th>
<th>-50</th>
<th>-25</th>
<th>0</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR – Slew Rate – V/\mu s</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

Figure 17

OP37

SLEW RATE

| A_{VD} = 5 | \text{Rise} |
| R_L = 2 \text{ k}\Omega | \text{Fall} |
| T_A = 25^\circ C |

<table>
<thead>
<tr>
<th>f – Frequency – Hz</th>
<th>1</th>
<th>10</th>
<th>100</th>
<th>1 k</th>
<th>10 k</th>
<th>100 k</th>
<th>1 M</th>
<th>10 M</th>
<th>100 M</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR – Slew Rate – V/\mu s</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
</tbody>
</table>

Figure 18

OP37

SLEW RATE

| V_{CC} = \pm 15 \text{ V} | A_{VD} = 5 | V_O(PP) = 20 \text{ V} | T_A = 25^\circ C |

<table>
<thead>
<tr>
<th>f – Frequency – Hz</th>
<th>0.1</th>
<th>1</th>
<th>10</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR – Slew Rate – V/\mu s</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
</tr>
</tbody>
</table>

Figure 19

† Data for temperatures below –25°C and above 85°C are applicable to the OP27A, OP27C, OP37A, and OP37C only.
TYPICAL CHARACTERISTICS†

**OP27**

**PHASE MARGIN AND GAIN-BANDWIDTH PRODUCT**

**VS**

**FREE-AIR TEMPERATURE**

---

**OP37**

**PHASE MARGIN AND GAIN-BANDWIDTH PRODUCT**

**VS**

**FREE-AIR TEMPERATURE**

---

**EQUIVALENT INPUT NOISE VOLTAGE**

**VS**

**BANDWIDTH**

---

**TOTAL EQUIVALENT INPUT NOISE VOLTAGE**

**VS**

**SOURCE RESISTANCE**

---

† Data for temperatures below – 25°C and above 85°C are applicable to the OP27A, OP27C, OP37A, and OP37C only.
TYPICAL CHARACTERISTICS†

OP27A, OP27E, OP37A, OP37E
EQUIVALENT INPUT NOISE VOLTAGE
VS TOTAL SUPPLY VOLTAGE

\[
\begin{align*}
V_{n} & \quad \text{Equivalent Input Noise Voltage} \quad \text{– nV/Hz} \\
V_{CC^+} - V_{CC^-} & \quad \text{Total Supply Voltage} \quad \text{– V}
\end{align*}
\]

- \(R_S = 20 \, \Omega\)
- \(BW = 1 \, \text{Hz}\)
- \(T_A = 25^\circ \text{C}\)

\(f = 10 \, \text{Hz}\)
\(f = 1 \, \text{kHz}\)

**Figure 24**

OP27A, OP27E, OP37A, OP37E
EQUIVALENT INPUT NOISE VOLTAGE
VS FREE-AIR TEMPERATURE

\[
\begin{align*}
V_{n} & \quad \text{Equivalent Input Noise Voltage} \quad \text{– nV/Hz} \\
T_A & \quad \text{Free-Air Temperature} \quad \text{– } \circ \text{C}
\end{align*}
\]

- \(V_{CC^+} = \pm 15 \, \text{V}\)
- \(R_S = 20 \, \Omega\)
- \(BW = 1 \, \text{Hz}\)

\(f = 10 \, \text{Hz}\)
\(f = 1 \, \text{kHz}\)

**Figure 25**

**OP27A, OP27E, OP37A, OP37E**
EQUIVALENT INPUT NOISE VOLTAGE
VS FREQUENCY

\[
\begin{align*}
V_{n} & \quad \text{Equivalent Input Noise Voltage} \quad \text{– nV/Hz} \\
\text{f} & \quad \text{Frequency} \quad \text{– Hz}
\end{align*}
\]

- \(V_{CC^+} = \pm 15 \, \text{V}\)
- \(R_S = 20 \, \Omega\)
- \(BW = 1 \, \text{Hz}\)
- \(T_A = 25^\circ \text{C}\)

\(1/f \text{ Corner} = 2.7 \, \text{Hz}\)

**Figure 26**

**EQUIVALENT INPUT NOISE CURRENT**
VS FREQUENCY

\[
\begin{align*}
I_{n} & \quad \text{Equivalent Input Noise Current} \quad \text{– pA/\text{Hz}} \\
\text{f} & \quad \text{Frequency} \quad \text{– Hz}
\end{align*}
\]

- \(V_{CC^+} = \pm 15 \, \text{V}\)
- \(BW = 1 \, \text{Hz}\)
- \(T_A = 25^\circ \text{C}\)

\(1/f \text{ Corner} = 140 \, \text{Hz}\)

**Figure 27**

† Data for temperatures below –25°C and above 85°C are applicable to the OP27A, OP27C, OP37A, and OP37C only.
TYPICAL CHARACTERISTICS†

SHORT-CIRCUIT OUTPUT CURRENT

\[ V_{CC} = \pm 15 \text{ V} \]
\[ T_A = 25^\circ \text{C} \]

\[ I_{OS-} \]
\[ I_{OS+} \]

SUPPLY CURRENT

\[ V_{CC} = V_{CC-} - V_{CC+} = \text{Total Supply Voltage} = \text{V} \]

\[ T_A = 25^\circ \text{C} \]
\[ T_A = 55^\circ \text{C} \]
\[ T_A = 125^\circ \text{C} \]

Figure 28

Figure 29

OP27
VOLTAGE FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

\[ V_{CC} = \pm 15 \text{ V} \]
\[ A_V = 1 \]
\[ C_L = 15 \text{ pF} \]
\[ T_A = 25^\circ \text{C} \]

\[ V_o = \text{Output Voltage} = \text{mV} \]

0 0.5 1 1.5 2 2.5 3

Figure 30

OP27
VOLTAGE FOLLOWER
LARGE-SIGNAL
PULSE RESPONSE

\[ V_{CC} = \pm 15 \text{ V} \]
\[ A_V = -1 \]
\[ T_A = 25^\circ \text{C} \]

\[ V_o = \text{Output Voltage} = \text{V} \]

0 2 4 6 8 10 12

Figure 31

† Data for temperatures below \(-25^\circ \text{C}\) and above \(85^\circ \text{C}\) are applicable to the OP27A, OP27C, OP37A, and OP37C only.
TYPICAL CHARACTERISTICS

Figure 32

Figure 33

APPLICATION INFORMATION

general

The OP27 and OP37 series devices can be inserted directly onto OP07, OP05, µA725, and SE5534 sockets with or without removing external compensation or nulling components. In addition, the OP27 and OP37 can be fitted to µA741 sockets by removing or modifying external nulling components.

noise testing

Figure 34 shows a test circuit for 0.1-Hz to 10-Hz peak-to-peak noise measurement of the OP27 and OP37. The frequency response of this noise tester indicates that the 0.1-Hz corner is defined by only one zero. Because the time limit acts as an additional zero to eliminate noise contributions from the frequency band below 0.1 Hz, the test time to measure 0.1-Hz to 10-Hz noise should not exceed 10 seconds.

Measuring the typical 80-nV peak-to-peak noise performance of the OP27 and OP37 requires the following special test precautions:

1. The device should be warmed up for at least five minutes. As the operational amplifier warms up, the offset voltage typically changes 4 μV due to the chip temperature increasing from 10°C to 20°C starting from the moment the power supplies are turned on. In the 10-s measurement interval, these temperature-induced effects can easily exceed tens of nanovolts.

2. For similar reasons, the device should be well shielded from air currents to eliminate the possibility of thermoelectric effects in excess of a few nanovolts, which would invalidate the measurements.

3. Sudden motion in the vicinity of the device should be avoided, as it produces a feedthrough effect that increases observed noise.
APPLICATION INFORMATION

NOTE: All capacitor values are for nonpolarized capacitors only.

Figure 34. 0.1-Hz to 10-Hz Peak-to-Peak Noise Test Circuit and Frequency Response
APPLICATION INFORMATION

When measuring noise on a large number of units, a noise-voltage density test is recommended. A 10-Hz noise-voltage density measurement correlates well with a 0.1-Hz to 10-Hz peak-to-peak noise reading since both results are determined by the white noise and the location of the 1/f corner frequency.

Figure 35 shows a circuit measuring current noise and the formula for calculating current noise.

\[ I_n = \frac{|V_{no}^2 - (130 \text{ nV})^2|^{1/2}}{1 \text{ M}\Omega \times 100} \]

Figure 35. Current Noise Test Circuit and Formula

offset voltage adjustment

The input offset voltage and temperature coefficient of the OP27 and OP37 are permanently trimmed to a low level at wafer testing. However, if further adjustment of \(V_{IO}\) is necessary, using a 10-k\(\Omega\) nulling potentiometer as shown in Figure 36 does not degrade the temperature coefficient \(\alpha_{VIO}\). Trimming to a value other than zero creates an \(\alpha_{VIO}\) of \(V_{IO}/300 \mu V/^\circ C\). For example, if \(V_{IO}\) is adjusted to 300 \(\mu V\), the change in \(\alpha_{VIO}\) is 1 \(\mu V/^\circ C\).

The adjustment range with a 10-k\(\Omega\) potentiometer is approximately \(\pm 2.5 \text{ mV}\). If a smaller adjustment range is needed, the sensitivity and resolution of the nulling can be improved by using a smaller potentiometer in conjunction with fixed resistors. The example in Figure 37 has an approximate null range of \(\pm 200 \mu V\).

offset voltage and drift

Unless proper care is exercised, thermoelectric effects caused by temperature gradients across dissimilar metals at the contacts to the input terminals can exceed the inherent temperature coefficient \(\alpha_{VIO}\) of the amplifier. Air currents should be minimized, package leads should be short, and the two input leads should be close together and at the same temperature.
APPLICATION INFORMATION

offset voltage and drift (continued)

The circuit shown in Figure 38 measures offset voltage. This circuit can also be used as the burn-in configuration for the OP27 and OP37 with the supply voltage increased to 20 V, $R_1 = R_3 = 10 \, \text{k}\Omega$, $R_2 = 200 \, \Omega$, and $A_{VD} = 100$.

![Circuit Diagram](image)

NOTE A: Resistors must have low thermoelectric potential.

Figure 38. Test Circuit for Offset Voltage and Offset Voltage Temperature Coefficient

unity gain buffer applications

The resulting output waveform, when $R_f \leq 100 \, \Omega$ and the input is driven with a fast large-signal pulse ($> 1 \, \text{V}$), is shown in the pulsed-operation diagram in Figure 39.

![Waveform Diagram](image)

Figure 39. Pulsed Operation

During the initial (fast-feedthrough-like) portion of the output waveform, the input protection diodes effectively short the output to the input, and a current, limited only by the output short-circuit protection, is drawn by the signal generator. When $R_f \geq 500 \, \Omega$, the output is capable of handling the current requirements (load current $\leq 20 \, \text{mA}$ at 10 V), the amplifier stays in its active mode, and a smooth transition occurs. When $R_f > 2 \, \text{k}\Omega$, a pole is created with $R_f$ and the amplifier’s input capacitance, creating additional phase shift and reducing the phase margin. A small capacitor ($20 \, \text{pF}$ to $50 \, \text{pF}$) in parallel with $R_f$ eliminates this problem.
APPLICATION INFORMATION

Type S Thermocouples
5.4 µV/°C at 0°C

NOTE A: If 24 channels are multiplexed per second and the output is required to settle to 0.1 % accuracy, the amplifier’s bandwidth cannot be limited to less than 30 Hz. The peak-to-peak noise contribution of the OP27 will still be only 0.11 µV, which is equivalent to an error of only 0.02°C.

Figure 40. Low-Noise, Multiplexed Thermocouple Amplifier and 0.1-Hz To 10-Hz Peak-to-Peak Noise Voltage
IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE (“CRITICAL APPLICATIONS”). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER’S RISK.

In order to minimize risks associated with the customer’s applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.

Copyright © 1998, Texas Instruments Incorporated