Features of OP27A and OP27C:
- 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
  - OP27A . . . 25 μV Max
  - OP27C . . . 100 μV Max
- High Voltage Amplification
  - OP27A . . . 1 V/μV Min
  - OP27C . . . 0.7 V/μV Min

description

The OP27 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 make these devices excellent choices for low-noise amplifier applications requiring precision performance and reliability.

The OP27 series is compensated for unity gain.

The OP27A and OP27C are characterized for operation over the full military temperature range of −55°C to 125°C.

AVAILABLE OPTIONS

<table>
<thead>
<tr>
<th>T_A</th>
<th>V_{IO}max AT 25°C</th>
<th>STABLE GAIN</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<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>1</td>
<td>OP27CJG</td>
</tr>
</tbody>
</table>

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.
schematic

\[ V_{\text{IO TRIM}} \]

\[ V_{\text{CC}} \]

\[ V_{\text{OUT}} \]

\[ V_{\text{IN}} \]

\[ V_{\text{IN}} \]

\[ 480 \mu A \]

\[ 750 \mu A \]

\[ 260 \mu A \]

\[ 240 \mu A \]

\[ 120 \mu A \]

\[ 340 \mu A \]

\[ 240 \mu A \]

\[ 120 \mu A \]

\[ 340 \mu A \]

\[ C1^\dagger \]

\[ C1 = 120 \text{ pF for OP27} \]
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 .............................. −55°C to 125°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

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 ≤ 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>
</tbody>
</table>
### Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>OP27A (MIN)</th>
<th>OP27A (NOM)</th>
<th>OP27A (MAX)</th>
<th>OP27C (MIN)</th>
<th>OP27C (NOM)</th>
<th>OP27C (MAX)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage, $V_{CC+}$</td>
<td>4</td>
<td>15</td>
<td>22</td>
<td>4</td>
<td>15</td>
<td>22</td>
<td>V</td>
</tr>
<tr>
<td>Supply voltage, $V_{CC-}$</td>
<td>-4</td>
<td>-15</td>
<td>-22</td>
<td>-4</td>
<td>-15</td>
<td>-22</td>
<td>V</td>
</tr>
<tr>
<td>Common-mode input voltage, $V_{IC}$</td>
<td>$V_{CC} = \pm 15$ V, $TA = 25^\circ C$</td>
<td>$\pm 11$</td>
<td>$\pm 11$</td>
<td>$V_{CC} = \pm 15$ V, $TA = -55^\circ C$ to $125^\circ C$</td>
<td>$\pm 10.3$</td>
<td>$\pm 10.2$</td>
<td>V</td>
</tr>
<tr>
<td>Operating free-air temperature, $T_A$</td>
<td>$-55$</td>
<td>125</td>
<td>$-55$</td>
<td>125</td>
<td>$^\circ C$</td>
<td>$^\circ C$</td>
<td>V</td>
</tr>
</tbody>
</table>

### Electrical Characteristics at Specified Free-Air Temperature, $V_{CC} = \pm 15$ V (unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>$T_A^\dagger$</th>
<th>OP27A (MIN)</th>
<th>OP27A (TYP)</th>
<th>OP27A (MAX)</th>
<th>OP27C (MIN)</th>
<th>OP27C (TYP)</th>
<th>OP27C (MAX)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IO}$ Input offset voltage</td>
<td>$V_O = 0$, $V_{IC} = 0$</td>
<td>$25^\circ C$</td>
<td>10</td>
<td>25</td>
<td>30</td>
<td>100</td>
<td>$\mu V$</td>
<td>$\mu V$</td>
<td>$\mu V$</td>
</tr>
<tr>
<td>$\alpha_{VIO}$ 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>
<td>$\mu V/^\circ C$</td>
<td>$\mu V/^\circ C$</td>
<td>$\mu V/^\circ C$</td>
<td>$\mu V/^\circ C$</td>
</tr>
<tr>
<td>$I_{IO}$ Input offset current</td>
<td>$V_O = 0$, $V_{IC} = 0$</td>
<td>$25^\circ C$</td>
<td>7</td>
<td>35</td>
<td>12</td>
<td>75</td>
<td>nA</td>
<td>nA</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{IB}$ Input bias current</td>
<td>$V_O = 0$, $V_{IC} = 0$</td>
<td>$25^\circ C$</td>
<td>$\pm 10$</td>
<td>$\pm 40$</td>
<td>$\pm 15$</td>
<td>$\pm 80$</td>
<td>nA</td>
<td>nA</td>
<td>nA</td>
</tr>
<tr>
<td>$V_{ICR}$ Common-mode input voltage range</td>
<td>$25^\circ C$</td>
<td>11</td>
<td>to</td>
<td>-11</td>
<td>11</td>
<td>to</td>
<td>-11</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OM}$ Peak output voltage swing</td>
<td>$R_L \geq 2 , k\Omega$</td>
<td>$\pm 12$</td>
<td>$\pm 13.8$</td>
<td>$\pm 11.5$</td>
<td>$\pm 13.5$</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>$A_{VD}$ Large-signal differential voltage amplification</td>
<td>$R_L \geq 2 , k\Omega$, $V_O = \pm 10$ V</td>
<td>$1000$</td>
<td>$1800$</td>
<td>$700$</td>
<td>$1500$</td>
<td>V/mV</td>
<td>V/mV</td>
<td>V/mV</td>
<td>V/mV</td>
</tr>
<tr>
<td>$f_{(CM)}$ Common-mode input resistance</td>
<td>$V_O = 0$, $I_O = 0$</td>
<td>$25^\circ C$</td>
<td>$3$</td>
<td>$2$</td>
<td>$G\Omega$</td>
<td>$G\Omega$</td>
<td>$G\Omega$</td>
<td>$G\Omega$</td>
<td>$G\Omega$</td>
</tr>
<tr>
<td>$r_o$ Output resistance</td>
<td>$V_{IC} = \pm 11$ V</td>
<td>$25^\circ C$</td>
<td>114</td>
<td>126</td>
<td>100</td>
<td>120</td>
<td>dB</td>
<td>dB</td>
<td>dB</td>
</tr>
<tr>
<td>$CMRR$ Common-mode rejection ratio</td>
<td>$V_{IC} = \pm 10$ V</td>
<td>Full range</td>
<td>110</td>
<td>94</td>
<td>94</td>
<td>118</td>
<td>dB</td>
<td>dB</td>
<td>dB</td>
</tr>
<tr>
<td>$k_{SVR}$ Supply voltage rejection ratio</td>
<td>$V_{CC} = \pm 4$ V to $\pm 18$ V</td>
<td>$25^\circ C$</td>
<td>100</td>
<td>120</td>
<td>94</td>
<td>118</td>
<td>dB</td>
<td>dB</td>
<td>dB</td>
</tr>
</tbody>
</table>

$^\dagger$ Full range is $-55^\circ C$ to $125^\circ C$.

**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 $2.5 \, \mu V$ (see Figure 3).
### OP27 operating characteristics, \( V_{CC} = \pm 15 \text{ V}, T_A = 25\degree C \)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>OP27A</th>
<th>OP27C</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slew rate (SR)</td>
<td>( A_{VD} \geq 1, \quad R_L \geq 2 \text{ k}\Omega )</td>
<td>1.7</td>
<td>2.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Peak-to-peak equivalent input noise voltage (( V_{NPP} ))</td>
<td>( f = 0.1 \text{ Hz to } 10 \text{ Hz}, \quad R_S = 20 \Omega, \quad \text{See Figure 26} )</td>
<td>0.225</td>
<td>0.375</td>
<td>0.225</td>
</tr>
<tr>
<td>Equivalent input noise voltage (( V_n ))</td>
<td>( f = 10 \text{ Hz}, \quad R_S = 20 \Omega )</td>
<td>3.5</td>
<td>8</td>
<td>3.8</td>
</tr>
<tr>
<td>Equivalent input noise current (( I_n ))</td>
<td>( f = 1 \text{ kHz}, \quad R_S = 20 \Omega )</td>
<td>3</td>
<td>4</td>
<td>3.2</td>
</tr>
<tr>
<td>Gain-bandwidth product</td>
<td>( f = 100 \text{ kHz} )</td>
<td>5</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>
## TYPICAL CHARACTERISTICS

### Table of Graphs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>FIGURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IO}$</td>
<td>Input offset voltage</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta V_{IO}$</td>
<td>Change in input offset voltage</td>
<td>2, 3</td>
</tr>
<tr>
<td>$I_{IO}$</td>
<td>Input offset current</td>
<td>4</td>
</tr>
<tr>
<td>$I_{IB}$</td>
<td>Input bias current</td>
<td>5</td>
</tr>
<tr>
<td>$V_{ICR}$</td>
<td>Common-mode input voltage range</td>
<td>6</td>
</tr>
<tr>
<td>$V_{OM}$</td>
<td>Maximum peak output voltage</td>
<td>7</td>
</tr>
<tr>
<td>$V_{O(PP)}$</td>
<td>Maximum peak-to-peak output voltage</td>
<td>8</td>
</tr>
<tr>
<td>$A_{VD}$</td>
<td>Differential voltage amplification</td>
<td>9, 10</td>
</tr>
<tr>
<td>$k_{SVR}$</td>
<td>Common-mode rejection ratio</td>
<td>13</td>
</tr>
<tr>
<td>$k_{SVR}$</td>
<td>Supply voltage rejection ratio</td>
<td>14</td>
</tr>
<tr>
<td>$SR$</td>
<td>Slew rate</td>
<td>15</td>
</tr>
<tr>
<td>$\phi_m$</td>
<td>Phase margin</td>
<td>16</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Phase shift</td>
<td>11</td>
</tr>
<tr>
<td>$V_n$</td>
<td>Equivalent input noise voltage</td>
<td>17, 18</td>
</tr>
<tr>
<td></td>
<td>Gain-bandwidth product</td>
<td>19, 20</td>
</tr>
<tr>
<td>$I_{OS}$</td>
<td>Short-circuit output current</td>
<td>22</td>
</tr>
<tr>
<td>$I_{CC}$</td>
<td>Supply current</td>
<td>23</td>
</tr>
<tr>
<td>Pulse response</td>
<td>Small signal</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Large signal</td>
<td>25</td>
</tr>
</tbody>
</table>
TYPICAL CHARACTERISTICS

INPUT OFFSET VOLTAGE OF REPRESENTATIVE INDIVIDUAL UNITS VS FREE-AIR TEMPERATURE

WARM-UP CHANGE IN INPUT OFFSET VOLTAGE VS ELAPSED TIME

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

Figure 1

Figure 2

Figure 3
TYPICAL CHARACTERISTICS

INPUT OFFSET CURRENT vs FREE-AIR TEMPERATURE

- $V_{CC} = \pm 15$ V
- $T_A$ - Free-Air Temperature - °C
- $I_{O}$ - Input Offset Current - nA
- OP27A
- OP27C

Figure 4

INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE

- $V_{CC} = \pm 15$ V
- $T_A$ - Free-Air Temperature - °C
- $I_{B}$ - Input Bias Current - nA
- OP27A
- OP27C

Figure 5

COMMON-MODE INPUT VOLTAGE RANGE LIMITS vs SUPPLY VOLTAGE

- $V_{CC}$ + - Supply Voltage - V
- $V_{CMR}$ - Common-Mode Input Voltage Range Limits - V
- $T_A = -55$ °C
- $T_A = 25$ °C
- $T_A = 125$ °C

Figure 6

MAXIMUM PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE

- $V_{CC} = \pm 15$ V
- $T_A = 25$ °C
- $V_{OM}$ - Maximum Peak Output Voltage - V
- $R_L$ - Load Resistance - kΩ
- Positive Swing
- Negative Swing

Figure 7
TYPICAL CHARACTERISTICS

OP27
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

Figure 8.

OP27A
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
TOTAL SUPPLY VOLTAGE

Figure 9

OP27A
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
LOAD RESISTANCE

Figure 10
TYPICAL CHARACTERISTICS

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

Figure 11.

OP27A
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION
vs FREQUENCY

Figure 12

OP27A
COMMON-MODE REJECTION RATIO
vs FREQUENCY

Figure 13
TYPICAL CHARACTERISTICS

SUPPLY VOLTAGE REJECTION RATIO

vs FREQUENCY

VCC = ±4 V to ±18 V
- TA = 25°C

Negative Supply

Positive Supply

Figure 14

SLEW RATE

vs FREE-AIR TEMPERATURE

VCC = ±15 V
Rl ≥ 2 kΩ

OP27 (AVD ≥ 1)

Figure 15

OP27

PHASE MARGIN AND GAIN-BANDWIDTH PRODUCT

vs FREE-AIR TEMPERATURE

VCC = ±15 V

θm

GBW (f = 100 kHz)

Figure 16.
TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE vs BANDWIDTH

- $V_{CC} = \pm 15 \text{ V}$
- $R_S = 20 \Omega$
- $T_A = 25^\circ \text{C}$

TOTAL EQUIVALENT INPUT NOISE VOLTAGE vs SOURCE RESISTANCE

- $V_{CC} = \pm 15 \text{ V}$
- $BW = 1 \text{ Hz}$
- $T_A = 25^\circ \text{C}$

Figure 17

OP27A EQUIVALENT INPUT NOISE VOLTAGE vs TOTAL SUPPLY VOLTAGE

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

Figure 19

Figure 18

OP27A EQUIVALENT INPUT NOISE VOLTAGE vs FREE-AIR TEMPERATURE

- $V_{CC} = \pm 15 \text{ V}$
- $R_S = 20 \Omega$
- $BW = 1 \text{ Hz}$

Figure 20
TYPICAL CHARACTERISTICS

OP27A
EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

Figure 21

SHORT-CIRCUIT OUTPUT CURRENT
vs
ELAPSED TIME

SUPPLY CURRENT
vs
TOTAL SUPPLY VOLTAGE

Figure 22

Figure 23
APPLICATION INFORMATION

general

The OP27 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 can be fitted to μA741 sockets by removing or modifying external nulling components.

noise testing

Figure 26 shows a test circuit for 0.1-Hz to 10-Hz peak-to-peak noise measurement of the OP27. 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 requires the following special test precautions:

---

TYPICAL CHARACTERISTICS

Figure 24

Figure 25

---
APPLICATION INFORMATION

noise testing (continued)

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.

Figure 26. 0.1-Hz to 10-Hz Peak-to-Peak Noise Test Circuit and Frequency Response

NOTE: All capacitor values are for nonpolarized capacitors only.
APPLICATION INFORMATION

noise testing (continued)

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 27 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 27. Current Noise Test Circuit and Formula

offset voltage adjustment

The input offset voltage and temperature coefficient of the OP27 are permanently trimmed to a low level at wafer testing. However, if further adjustment of \(V_{\text{IO}}\) is necessary, using a 10-k\(\Omega\) nulling potentiometer as shown in Figure 28 does not degrade the temperature coefficient \(\alpha_{V_{\text{IO}}}\). Trimming to a value other than zero creates an \(\alpha_{V_{\text{IO}}}\) of \(V_{\text{IO}}/300 \mu\text{V}/\circ\text{C}\). For example, if \(V_{\text{IO}}\) is adjusted to 300 \(\mu\text{V}\), the change in \(\alpha_{V_{\text{IO}}}\) is 1 \(\mu\text{V}/\circ\text{C}\).

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 29 has an approximate null range of \(\pm 200 \mu\text{V}\).

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 \(\propto V_{\text{IO}}\) 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 30 measures offset voltage. This circuit can also be used as the burn-in configuration for the OP27 with the supply voltage increased to 20 V, $R_1 = R_3 = 10 \, \text{k}\Omega$, $R_2 = 200 \, \text{\Omega}$, and $A_{VD} = 100$.

![Figure 30. Test Circuit for Offset Voltage and Offset Voltage Temperature Coefficient](image)

NOTE A: Resistors must have low thermoelectric potential.

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 V), is shown in the pulsed-operation diagram in Figure 31.

![Figure 31. Pulsed Operation](image)

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 pF to 50 pF) in parallel with $R_f$ eliminates this problem.
unity gain buffer applications (continued)

![Diagram of thermocouple amplifier](image)

**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 32. Low-Noise, Multiplexed Thermocouple Amplifier and 0.1-Hz to 10-Hz Peak-to-Peak Noise Voltage**
# Packaging Information

<table>
<thead>
<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 Finish/Ball Material</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>JM38510/13506BPA</td>
<td>ACTIVE</td>
<td>CDIP</td>
<td>JG</td>
<td>8</td>
<td>1</td>
<td>Non-RoHS &amp; Green</td>
<td>SNPB</td>
<td>N / A for Pkg Type</td>
<td>-55 to 125</td>
<td>JM38510/13506BPA</td>
<td>Samples</td>
</tr>
<tr>
<td>M38510/13506BPA</td>
<td>ACTIVE</td>
<td>CDIP</td>
<td>JG</td>
<td>8</td>
<td>1</td>
<td>Non-RoHS &amp; Green</td>
<td>SNPB</td>
<td>N / A for Pkg Type</td>
<td>-55 to 125</td>
<td>M38510/13506BPA</td>
<td>Samples</td>
</tr>
<tr>
<td>OP27AFKB</td>
<td>ACTIVE</td>
<td>LCCC</td>
<td>FK</td>
<td>20</td>
<td>1</td>
<td>Non-RoHS &amp; Green</td>
<td>SNPB</td>
<td>N / A for Pkg Type</td>
<td></td>
<td>OP27AFKB</td>
<td>Samples</td>
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<tr>
<td>OP27AJGB</td>
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<td>CDIP</td>
<td>JG</td>
<td>8</td>
<td>1</td>
<td>Non-RoHS &amp; Green</td>
<td>SNPB</td>
<td>N / A for Pkg Type</td>
<td></td>
<td>OP27AJGB</td>
<td>Samples</td>
</tr>
<tr>
<td>OP27CJGB</td>
<td>ACTIVE</td>
<td>CDIP</td>
<td>JG</td>
<td>8</td>
<td>1</td>
<td>Non-RoHS &amp; Green</td>
<td>SNPB</td>
<td>N / A for Pkg Type</td>
<td></td>
<td>OP27CJGB</td>
<td>Samples</td>
</tr>
</tbody>
</table>

(1) The marketing status values are defined as follows:
- **ACTIVE:** Product device recommended for new designs.
- **LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
- **NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
- **PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
- **OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) **Lead finish/Ball material -** Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.
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**LEADLESS CERAMIC CHIP CARRIER**

28 TERMINAL SHOWN

<table>
<thead>
<tr>
<th>NO. OF TERMINALS **</th>
<th>A MIN</th>
<th>A MAX</th>
<th>B MIN</th>
<th>B MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.342 (8,69)</td>
<td>0.358 (9,09)</td>
<td>0.307 (7,80)</td>
<td>0.358 (9,09)</td>
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<tr>
<td>28</td>
<td>0.442 (11,23)</td>
<td>0.458 (11,63)</td>
<td>0.406 (10,31)</td>
<td>0.458 (11,63)</td>
</tr>
<tr>
<td>44</td>
<td>0.640 (16,26)</td>
<td>0.660 (16,76)</td>
<td>0.495 (12,58)</td>
<td>0.560 (14,22)</td>
</tr>
<tr>
<td>52</td>
<td>0.740 (18,78)</td>
<td>0.761 (19,32)</td>
<td>0.495 (12,58)</td>
<td>0.560 (14,22)</td>
</tr>
<tr>
<td>68</td>
<td>0.938 (23,83)</td>
<td>0.962 (24,43)</td>
<td>0.850 (21,6)</td>
<td>0.858 (21,8)</td>
</tr>
<tr>
<td>84</td>
<td>1.141 (28,99)</td>
<td>1.165 (29,59)</td>
<td>1.047 (26,6)</td>
<td>1.063 (27,0)</td>
</tr>
</tbody>
</table>

**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.
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
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