

Dual Precision JFET Input Operational Amplifiers

FEATURES

- Internally Trimmed Offset Voltage
- Offset Voltage Drift
- High Slew Rate
- Wide Bandwidth
- Low Supply Current per Amplifier
- Low Input Bias Current
- Standard 8-Pin Configuration
- All Packages Available:

1mV Max.
 $10\mu\text{V}/^\circ\text{C}$ Max.
 $10\text{V}/\mu\text{s}$ Min.
 3.5MHz Min.
 1.8mA Typ.
 10pA Typ.

Metal Can
 Hermetic DIP
 Plastic DIP

APPLICATIONS

- Sample and Hold Amplifiers
- Output Amplifier for Dual Current Output DACs
- High Speed Integrators
- Photocell Amplifiers
- High Input Impedance Instrumentation Amplifiers

DESCRIPTION

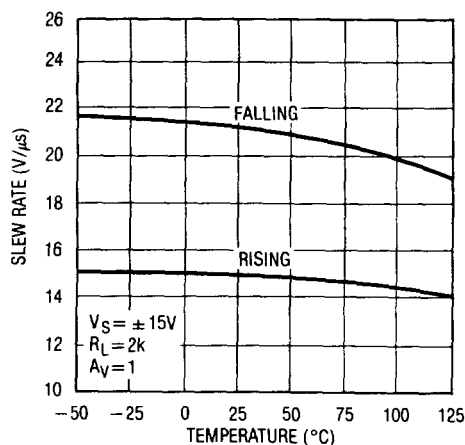
Linear Technology's LF412A and OP-215 series of dual JFET input op amps feature several improvements compared to similar types from other manufacturers.

Both devices have lower input bias and offset currents over the entire temperature range, and are available in all standard 8-pin packages.

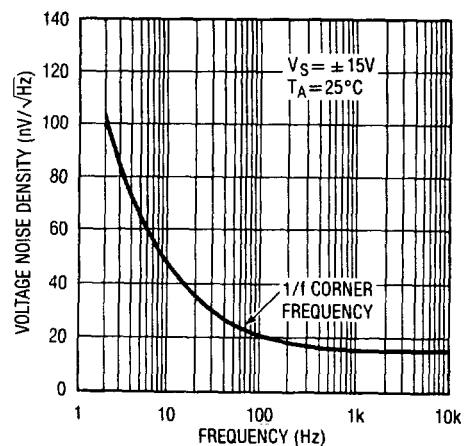
In addition, Linear's LF412A has lower voltage noise and higher voltage gain. Linear's OP-215 supply currents are nearly halved.

Please see the LT1057/LT1058 data sheet for applications requiring higher performance. The LT1057 is a pin compatible JFET input dual, the LT1058 is a JFET input quad op amp in the standard 14-pin DIP configuration.

Slew Rate



Voltage Noise Density vs Frequency



LF412A/OP-215

ABSOLUTE MAXIMUM RATINGS

| | |
|---|----------------|
| Supply Voltage | |
| LF412AM/AC, OP-215A/E..... | ± 22V |
| LF412M/C, OP-215C/G | ± 18V |
| Internal Power Dissipation | 670mW |
| Operating Temperature Range | |
| LF412AM/M, OP-215A/C..... | -55°C to 125°C |
| LF412AC/C, OP-215E/G | 0°C to 70°C |
| Differential Input Voltage | |
| LF412AM/AC, OP-215A/E..... | ± 40V |
| LF412M/C, OP-215C/G..... | ± 30V |
| Input Voltage (Note A) | |
| LF412AM/AC, OP-215A/E..... | ± 20V |
| LF412M/C, OP-215C/G | ± 16V |
| Output Short Circuit Duration..... | Indefinite |
| Storage Temperature Range..... | -65°C to 150°C |
| Lead Temperature (Soldering, 10 sec)..... | 300°C |

Note A: Maximum negative input voltage is equal to the negative supply voltage.

PACKAGE/ORDER INFORMATION

| | |
|--|---|
| <p>TOP VIEW V+ OUTPUT A 1 8 OUTPUT B -IN A 2 + +IN A 3 - V- (CASE) H PACKAGE METAL CAN</p> | ORDER PART NUMBER |
| | LF412AMH OP-215AH LF412MH OP-215CH LF412ACH OP-215EH LF412CH OP-215GH |
| <p>TOP VIEW OUTPUT A 1 8 V+ -IN A 2 7 OUTPUT B +IN A 3 + V- 4 - J8 PACKAGE HERMETIC DIP N8 PACKAGE PLASTIC DIP</p> | ORDER PART NUMBER |
| | LF412AMJ8 OP-215AJ8 LF412MJ8 OP-215CJ8 LF412ACJ8 OP-215EJ8 LF412CJ8 OP-215GJ8 LF412ACN8 OP-215EN8 LF412CN8 OP-215GN8 |

ELECTRICAL CHARACTERISTICS

$V_S = \pm 20V$ for LF412A, $V_S = \pm 15V$ for all other grades.
 $V_{CM} = 0V$, $T_A = 25^\circ C$ unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | OP-215A/E | | | LF412AM/AC | | | LF412, OP-215C/G | | | UNITS |
|-----------|------------------------------|---|-----------|------------------|-------|------------|------------------|-------|------------------|------------------|-------|-----------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| V_{OS} | Input Offset Voltage | | — | 0.2 | 1.0 | — | 0.3 | 1.0 | — | 0.5 | 3.0 | mV |
| I_{OS} | Input Offset Current | $T_j = 25^\circ C$ (Note 1) Warmed-Up $V_S = \pm 15V$ | — | 6 | 50 | — | 6 | 50 | — | 10 | 100 | pA |
| I_B | Input Bias Current | $T_j = 25^\circ C$ (Note 1) Warmed-Up $V_S = \pm 15V$ | — | ± 10 | ± 100 | — | ± 10 | ± 100 | — | ± 15 | ± 200 | pA |
| R_{IN} | Input Resistance | | — | 10^{12} | — | — | 10^{12} | — | — | 10^{12} | — | Ω |
| A_{VOL} | Large Signal Voltage Gain | $R_L \geq 2k\Omega$, $V_O = \pm 10V$ $V_S = \pm 15V$ | 150 | 400 | — | 100 | 300 | — | 50 | 250 | — | V/mV |
| V_O | Output Voltage Swing | $R_L = 10k\Omega$, $V_S = \pm 15V$ $R_L = 2k\Omega$, $V_S = \pm 15V$ | ± 12 | ± 13 | — | ± 12 | ± 13 | — | ± 12 | ± 13 | — | V |
| I_S | Supply Current | | — | 3.8 | 6.0 | — | 3.6 | 5.6 | — | 3.8 | 6.8 | mA |
| SR | Slew Rate | $V_S = \pm 15V$ | 10 | 15 | — | 10 | 15 | — | 8 | 13 | — | V/ μs |
| GBW | Gain Bandwidth Product | $V_S = \pm 15V$ (Note 2) | 3.5 | 5.7 | — | 3.5 | 5.7 | — | 3.0 | 5.5 | — | MHz |
| | Settling Time | to 0.01% to 0.10% | — | 2.3 | — | — | 2.3 | — | — | 2.4 | — | μs |
| | Input Voltage Range | | ± 11 | + 14.5 - 11.5 | — | ± 16 | + 19.5 - 16.5 | — | ± 11 | + 14.5 - 11.5 | — | V |
| CMRR | Common-Mode Rejection Ratio | $V_{CM} = \pm 16V$ | — | — | — | 80 | 100 | — | — | — | — | dB |
| | | $V_{CM} = \pm 11V$ | 78 | 100 | — | — | — | — | 72 | 100 | — | dB |
| | | $V_{CM} = \pm 10.5V$ | 86 | 100 | — | — | — | — | — | 82 | 100 | — |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 10V$ to $\pm 20V$ | — | — | — | 80 | 100 | — | — | — | — | dB |
| | | $V_S = \pm 10V$ to $\pm 18V$ | 86 | 100 | — | — | — | — | 80 | 100 | — | dB |
| e_n | Input Noise Voltage Density | $f_o = 100Hz$ | — | 20 | — | — | 20 | — | — | 20 | — | nV/ \sqrt{Hz} |
| | | $f_o = 1000Hz$ | — | 15 | — | — | 15 | — | — | 15 | — | nV/ \sqrt{Hz} |
| i_n | Input Noise Current Density | $f_o = 100Hz$ | — | 0.01 | — | — | 0.01 | — | — | 0.01 | — | pA/ \sqrt{Hz} |
| | | $f_o = 1000Hz$ | — | 0.01 | — | — | 0.01 | — | — | 0.01 | — | pA/ \sqrt{Hz} |
| | Channel Separation | $f = 1Hz$ to $20kHz$ | — | 120 | — | — | 120 | — | — | 120 | — | dB |

ELECTRICAL CHARACTERISTICS $V_S = \pm 20V$ for LF412A, $V_S = \pm 15V$ for all other grades.
 $V_{CM} = 0V$, $-55^\circ C \leq T_A \leq 125^\circ C$ unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | OP-215A | | | LF412AM | | | LF412M, OP-215C | | | UNITS | |
|-----------|------------------------------------|--|---------|------------|--------------------|----------|----------|--------------------|-----------------|------------|--------------------|----------|------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{OS} | Input Offset Voltage | | ● | — | 0.5 | 2.0 | — | 0.7 | 2.0 | — | 1.0 | 5.0 | mV |
| | Average Input Offset Voltage Drift | | ● | — | 3 | 10 | — | 4 | 10 | — | 5 | 20 | $\mu V/^\circ C$ |
| I_{OS} | Input Offset Current | $T_J = 125^\circ C$ (Note 1) | ● | — | 0.8 | 8 | — | 0.8 | 8 | — | 1.0 | 12 | nA |
| | | $T_A = 125^\circ C$, Warmed-Up $V_S = \pm 15V$ | ● | — | 1.2 | 14 | — | 1.2 | 14 | — | 1.5 | 22 | nA |
| I_B | Input Bias Current | $T_J = 125^\circ C$ (Note 1) | ● | — | ± 1.5 | ± 10 | — | ± 1.5 | ± 10 | — | ± 1.8 | ± 15 | nA |
| | | $T_A = 125^\circ C$, Warmed-Up $V_S = \pm 15V$ | ● | — | ± 2.2 | ± 18 | — | ± 2.2 | ± 18 | — | ± 2.7 | ± 28 | nA |
| | Input Voltage Range | OP-215 | ● | ± 10.3 | $+14.5$ -11.5 | — | — | — | — | ± 10.3 | $+14.5$ -11.5 | — | V |
| | | LF412 | ● | — | — | — | ± 16 | $+19.5$ -16.5 | — | ± 11 | $+14.5$ -11.5 | — | V |
| CMRR | Common-Mode Rejection Ratio | $V_{CM} = \pm 16V$ | ● | — | — | — | 80 | 100 | — | — | — | — | dB |
| | | $V_{CM} = \pm 11V$ | ● | — | — | — | — | — | — | 70 | 100 | — | dB |
| | | $V_{CM} = \pm 10.3V$ | ● | 82 | 100 | — | — | — | — | 80 | 100 | — | dB |
| I_S | Supply Current | | ● | — | 4.2 | 6.8 | — | 4.0 | 5.6 | — | 4.2 | 6.8 | mA |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 10V$ to $\pm 20V$ | ● | — | — | — | 80 | 100 | — | — | — | — | dB |
| | | $V_S = \pm 10V$ to $\pm 16V$ | ● | 80 | 100 | — | — | — | — | 78 | 100 | — | dB |
| A_{VOL} | Large Signal Voltage Gain | $R_L \geq 2k\Omega$, $V_O = \pm 10V$ $V_S = \pm 15V$ | ● | 30 | 150 | — | 30 | 150 | — | 25 | 150 | — | V/mV |
| V_O | Output Voltage Swing | $R_L \geq 10k\Omega$, $V_S = \pm 15V$ | ● | ± 12 | ± 13 | — | ± 12 | ± 13 | — | ± 12 | ± 13 | — | V |

ELECTRICAL CHARACTERISTICS $V_S = \pm 20V$ for LF412A, $V_S = \pm 15V$ for all other grades.
 $V_{CM} = 0V$, $0^\circ C \leq T_A \leq 70^\circ C$ unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | OP-215E | | | LF412AC | | | LF412C, OP-215G | | | UNITS | |
|-----------|------------------------------------|--|---------|------------|--------------------|-----------|----------|--------------------|-----------------|------------|--------------------|-----------|------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | | |
| V_{OS} | Input Offset Voltage | | ● | — | 0.4 | 1.65 | — | 0.5 | 1.45 | — | 0.7 | 3.9 | mV |
| | Average Input Offset Voltage Drift | | ● | — | 3 | 15 | — | 4 | 10 | — | 5 | 20 | $\mu V/^\circ C$ |
| I_{OS} | Input Offset Current | $T_J = 70^\circ C$ (Note 1) | ● | — | 0.06 | 0.45 | — | 0.06 | 0.45 | — | 0.08 | 0.65 | nA |
| | | $T_A = 70^\circ C$, Warmed-Up $V_S = \pm 15V$ | ● | — | 0.08 | 0.8 | — | 0.08 | 0.8 | — | 0.10 | 1.2 | nA |
| I_B | Input Bias Current | $T_J = 70^\circ C$ (Note 1) | ● | — | ± 0.12 | ± 0.7 | — | ± 0.12 | ± 0.7 | — | ± 0.14 | ± 0.9 | nA |
| | | $T_A = 70^\circ C$, Warmed-Up $V_S = \pm 15V$ | ● | — | ± 0.16 | ± 1.4 | — | ± 0.16 | ± 1.4 | — | ± 0.19 | ± 1.8 | nA |
| | Input Voltage Range | OP-215 | ● | ± 10.3 | $+14.5$ -11.5 | — | — | — | — | ± 10.3 | $+14.5$ -11.5 | — | V |
| | | LF412 | ● | — | — | — | ± 16 | $+19.5$ -11.5 | — | ± 11 | $+14.5$ -11.5 | — | V |
| CMRR | Common-Mode Rejection Ratio | $V_{CM} = \pm 16V$ | ● | — | — | — | 80 | 100 | — | — | — | — | dB |
| | | $V_{CM} = \pm 11V$ | ● | — | — | — | — | — | — | 70 | 100 | — | dB |
| | | $V_{CM} = \pm 10.3V$ | ● | 80 | 100 | — | — | — | — | 76 | 100 | — | dB |
| I_S | Supply Current | | ● | — | 4.0 | 6.8 | — | 3.8 | 5.6 | — | 4.0 | 6.8 | mA |
| PSRR | Power Supply Rejection Ratio | $V_S = \pm 10V$ to $\pm 20V$ | ● | — | — | — | 80 | 100 | — | — | — | — | dB |
| | | $V_S = \pm 10V$ to $\pm 16V$ | ● | 80 | 100 | — | — | — | — | 76 | 100 | — | dB |
| A_{VOL} | Large Signal Voltage Gain | $R_L \geq 2k\Omega$, $V_O = \pm 10V$ $V_S = \pm 15V$ | ● | 50 | 180 | — | 50 | 180 | — | 35 | 180 | — | V/mV |
| V_O | Output Voltage Swing | $R_L \geq 10k\Omega$, $V_S = \pm 15V$ | ● | ± 12 | ± 13 | — | ± 12 | ± 13 | — | ± 12 | ± 13 | — | V |

The ● denotes the specifications which apply over the full operating temperature range. The shaded electrical specifications indicate those parameters which have been improved or guaranteed test limits provided for the first time.

Note 1: Input bias and offset currents are specified for two different conditions. The T specification is with the junction at ambient temperature; the

warmed-up specification is with the device operating in a warmed-up condition at the ambient temperature specified.

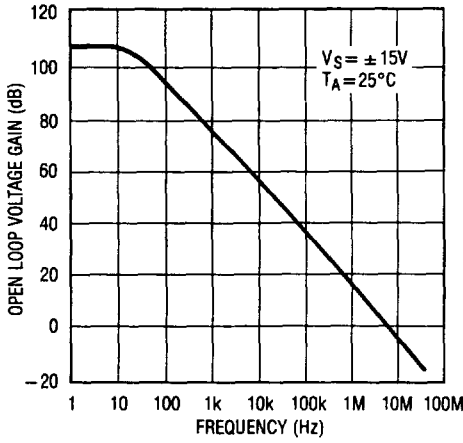
Note 2: Gain-bandwidth product is not tested. It is guaranteed by design and by inference from the slew rate measurement.

Note 3: The LF412A is 100% tested to this specification. All other grades are sample tested.

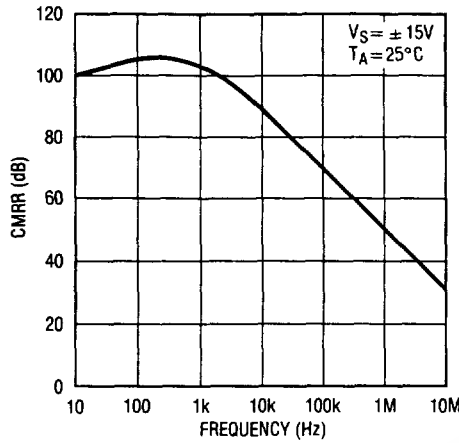
LF412A/OP-215

TYPICAL PERFORMANCE CHARACTERISTICS

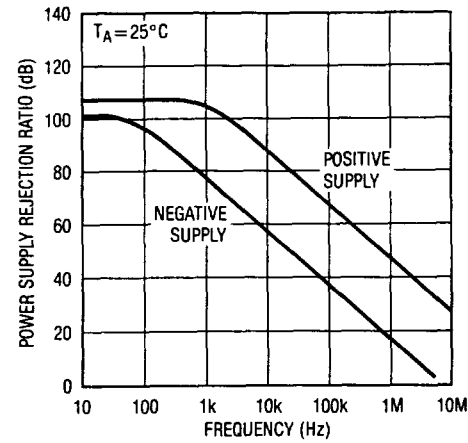
Open-Loop Frequency Response



Common-Mode Rejection Ratio vs Frequency

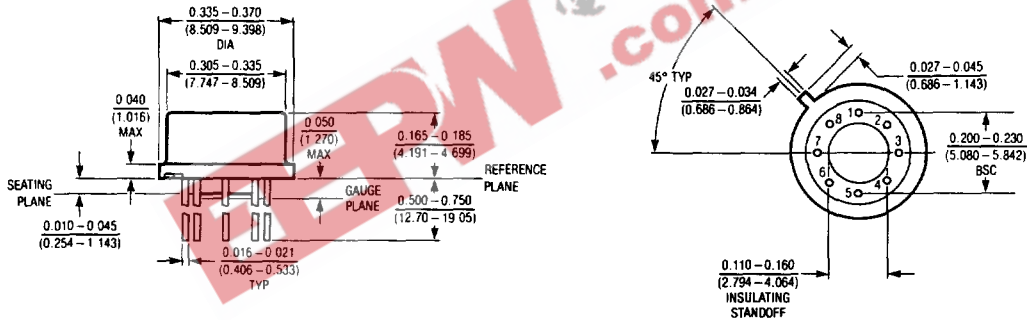


Power Supply Rejection Ratio vs Frequency



PACKAGE DESCRIPTIONS Dimensions in inches (millimeters) unless otherwise noted.

**H Package
TO-5 Metal Can**

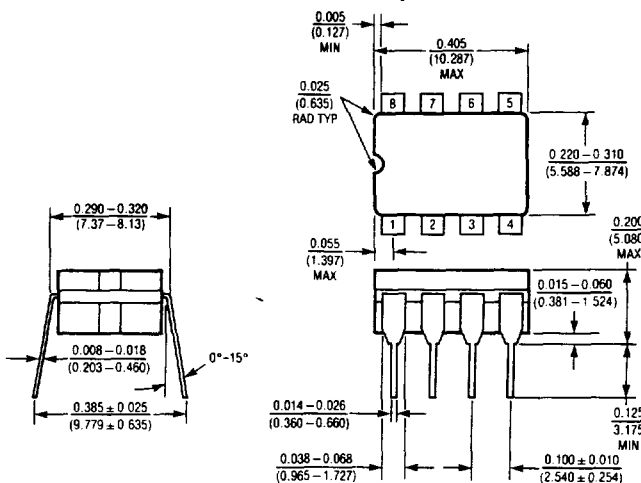


| | | |
|-----------|---------------|---------------|
| T_j max | θ_{ja} | θ_{jc} |
| 165°C | 140°C/W | 40°C/W |

NOTE: LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND SEATING PLANE.

MS100

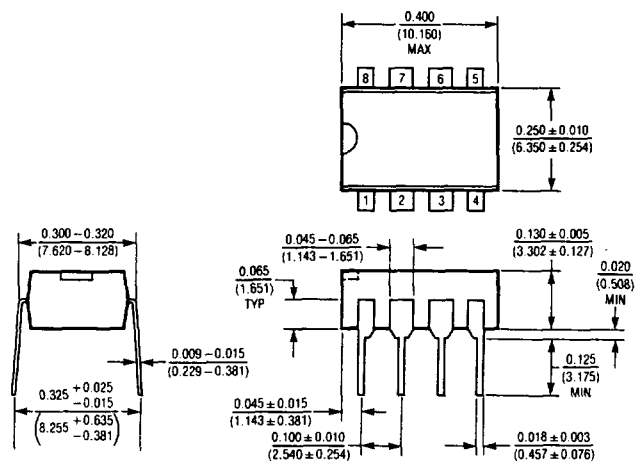
**J Package
8 Lead Cerdip**



| | |
|-----------|---------------|
| T_j max | θ_{ja} |
| 155°C | 100°C/W |

J0100

**N Package
8 Lead Molded Dip**



| | |
|-----------|---------------|
| T_j max | θ_{ja} |
| 115°C | 130°C/W |

MS100