

# Dual Precision JFET Input Operational Amplifiers

## FEATURES

- Internally Trimmed Offset Voltage 1mV Max.
- Offset Voltage Drift  $10\mu\text{V}/^\circ\text{C}$  Max.
- High Slew Rate  $10\text{V}/\mu\text{s}$  Min.
- Wide Bandwidth 3.5MHz Min.
- Low Supply Current per Amplifier 1.8mA Typ.
- Low Input Bias Current 10pA Typ.
- Standard 8-Pin Configuration
- All Packages Available: 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.

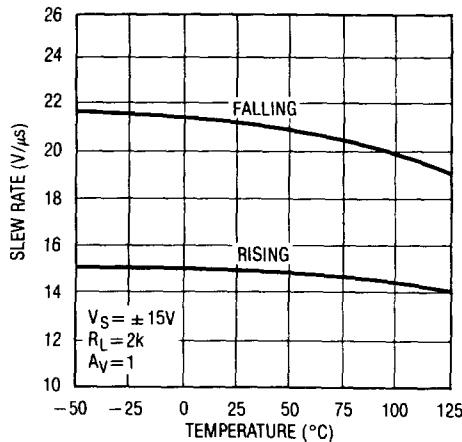
Both devices have lower input bias and offset currents over the entire temperature range, and are available in all standard 8-pin packages.

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

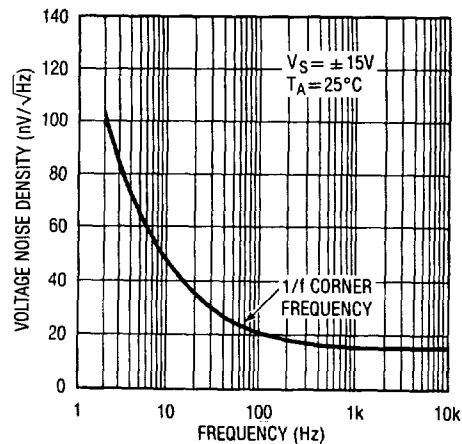
Please see the LT1057/LT1058 data sheet for applications requiring higher performance. The LT1057 is a pin compatible JFET input dual, the LT1058 is a JFET input quad op amp in the standard 14-pin DIP configuration.

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Slew Rate



Voltage Noise Density vs Frequency



**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)    OUTPUT B (7)                  -IN A (2)    -IN B (6)                  +IN A (3)    +IN B (5)                  V- (CASE) (4)                  H PACKAGE METAL CAN</p>	<b>ORDER PART NUMBER</b>	
	LF412AMH	OP-215AH
	LF412MH	OP-215CH
	LF412ACH	OP-215EH
<p>TOP VIEW                  OUTPUT A (1)    V+ (8)                  -IN A (2)    OUTPUT B (7)                  +IN A (3)    -IN B (6)                  V- (4)    +IN B (5)                  J8 PACKAGE HERMETIC DIP                  N8 PACKAGE PLASTIC DIP</p>	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	$T_I = 25^\circ C$ (Note 1) Warmed-Up $V_S = \pm 15V$	—	6	50	—	6	50	—	10	100	pA
			—	10	100	—	10	100	—	15	200	pA
$I_B$	Input Bias Current	$T_I = 25^\circ C$ (Note 1) Warmed-Up $V_S = \pm 15V$	—	± 10	± 100	—	± 10	± 100	—	± 15	± 200	pA
			—	± 15	± 300	—	± 15	± 300	—	± 20	± 400	pA
$R_{IN}$	Input Resistance		—	$10^{12}$	—	—	$10^{12}$	—	—	$10^{12}$	—	$\Omega$
$A_{VOL}$	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
			± 11	± 12.7	—	± 11	± 12.7	—	± 11	± 12.7	—	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/ $\mu s$
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%	—	2.3	—	—	2.3	—	—	2.4	—	$\mu s$
		to 0.10%	—	1.1	—	—	1.1	—	—	1.2	—	$\mu s$
	Input Voltage Range		± 11	+14.5	—	± 16	+19.5	—	± 11	+14.5	—	V
				-11.5	—		-16.5	—		-11.5	—	
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	—	dB
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)	●	—	$\pm 1.5$	$\pm 10$	—	$\pm 1.5$	$\pm 10$	—	$\pm 1.8$	$\pm 15$	nA
		$T_A = 125^\circ C$ , Warmed-Up $V_S = \pm 15V$	●	—	$\pm 2.2$	$\pm 18$	—	$\pm 2.2$	$\pm 18$	—	$\pm 2.7$	$\pm 28$	nA
	Input Voltage Range	OP-215	●	$\pm 10.3$	$+14.5$ $-11.5$	—	—	—	—	$\pm 10.3$	$+14.5$ $-11.5$	—	V
		LF412	●	—	—	—	$\pm 16$	$+19.5$ $-16.5$	—	$\pm 11$	$+14.5$ $-11.5$	—	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	$R_L \geq 10k\Omega$ , $V_S = \pm 15V$	●	$\pm 12$	$\pm 13$	—	$\pm 12$	$\pm 13$	—	$\pm 12$	$\pm 13$	—	V

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**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)	●	—	$\pm 0.12$	$\pm 0.7$	—	$\pm 0.12$	$\pm 0.7$	—	$\pm 0.14$	$\pm 0.9$	nA
		$T_A = 70^\circ C$ , Warmed-Up $V_S = \pm 15V$	●	—	$\pm 0.16$	$\pm 1.4$	—	$\pm 0.16$	$\pm 1.4$	—	$\pm 0.19$	$\pm 1.8$	nA
	Input Voltage Range	OP-215	●	$\pm 10.3$	$+14.5$ $-11.5$	—	—	—	—	$\pm 10.3$	$+14.5$ $-11.5$	—	V
		LF412	●	—	—	—	$\pm 16$	$+19.5$ $-11.5$	—	$\pm 11$	$+14.5$ $-11.5$	—	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	$R_L \geq 10k\Omega$ , $V_S = \pm 15V$	●	$\pm 12$	$\pm 13$	—	$\pm 12$	$\pm 13$	—	$\pm 12$	$\pm 13$	—	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

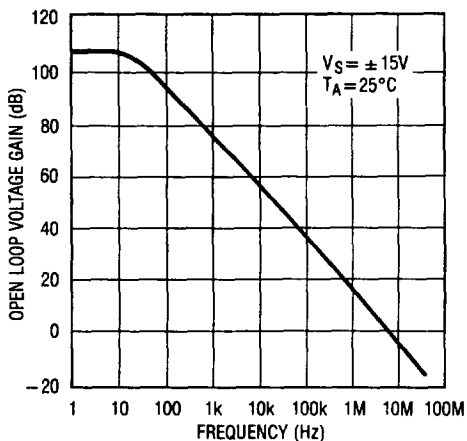
warmed-up specification is with the device operating in a warmed-up condition at the ambient temperature specified.

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

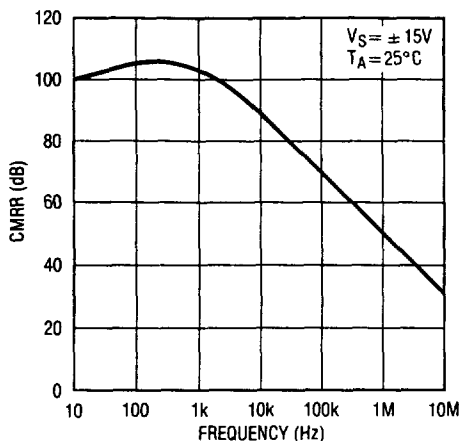
**Note 3:** The LF412A is 100% tested to this specification. All other grades are sample tested.

## TYPICAL PERFORMANCE CHARACTERISTICS

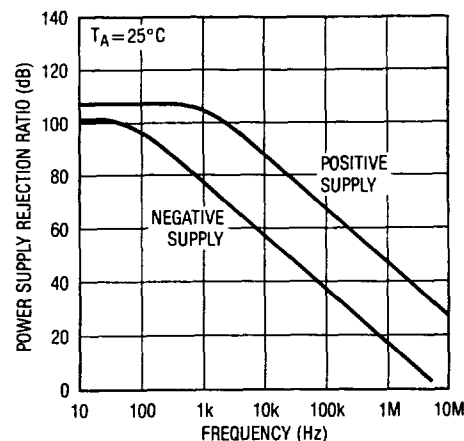
### Open-Loop Frequency Response



### Common-Mode Rejection Ratio vs Frequency

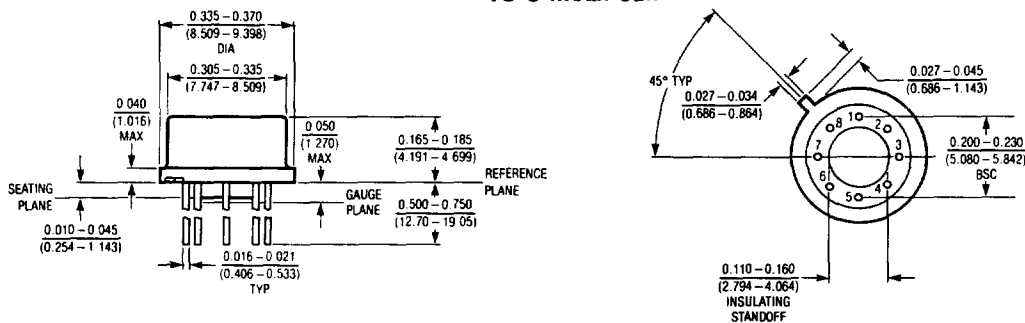


### Power Supply Rejection Ratio vs Frequency



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

### H Package TO-5 Metal Can

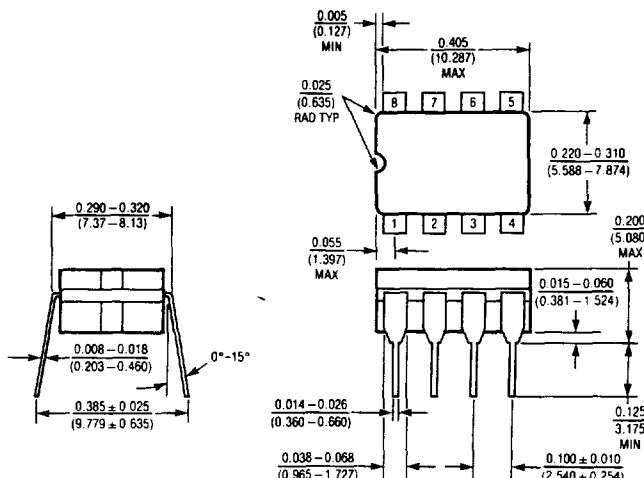


$T_{jmax}$	$\theta_{ja}$	$\theta_{jc}$
165°C	140°C/W	40°C/W

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

MS108

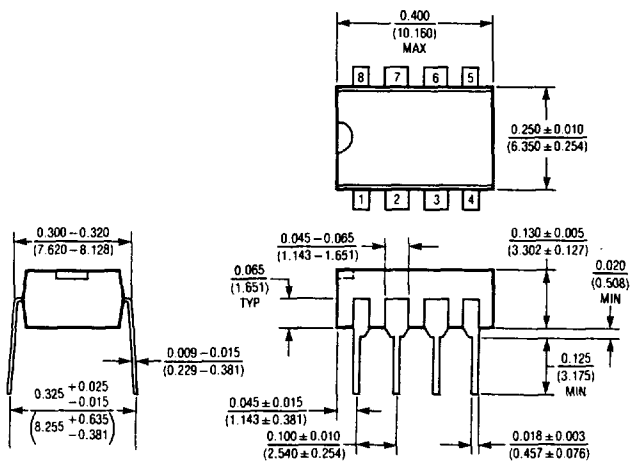
### J Package 8 Lead Cerdip



$T_{jmax}$	$\theta_{ja}$
155°C	100°C/W

MS108

### N Package 8 Lead Molded Dip



$T_{jmax}$	$\theta_{ja}$
115°C	130°C/W

MS108

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Datasheets for electronic components.