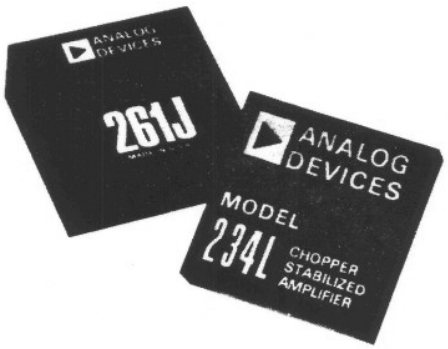
LOW VOLTAGE DRIFT-CHOPPER STABILIZED
MODELS 234, 233, 260, 261, 231, 210



GENERAL DESCRIPTION

Chopper stabilized amplifiers employ modulation techniques for processing the "low frequency" components of a signal and an AC coupled amplifier for the higher frequencies. This chopping technique makes it possible to process wide-band signals and yet achieve superior low drift and long term stability. Analog Devices, a pioneer in the development of encapsulated chopper stabilized amplifiers, offers designs with drifts between 0.1 to 1μV/°C, low frequency voltage noise to 1½μV p-p and bias currents from 50 to 300pA. Long term stability averages 1μV/month. These amplifiers are widely accepted as the best choice when it is essential to maintain either low voltage offsets and bias currents versus time or against severe environmental changes, or whenever external offset adjustments are not possible or desirable.

MODEL 234 J/K/L: LOWEST NOISE, WIDEBAND

This latest inverting amplifier design from Analog Devices is virtually free of chopper spikes and is singled out as the industry's quietest, wide band chopper stabilized amplifier in a low cost module. To illustrate the significant improvement in performance, comparative noise signals are presented in the figure for model 234 and its predecessor model 232.

Available in three drift selections (1, 0.3 and 0.1μV/°C), model 234 specifications include voltage noise of 1½μV p-p, current noise of 2pA p-p, and 2.5MHz bandwidth. Slew rate is 30V/μsec. The wide bandwidth of 234 makes it especially useful for 16-bit D/A converters, high speed integrators as well as for low frequency applications including control systems, DVM input amplifier designs and other precision instrumentation. Attractively priced, its consistent unit-to-unit performance makes it an ideal choice for new OEM designs.

MODEL 233 J/K/L: LOWEST COST, 0.1μV/°C

The popular model 233 is a good choice for many low drift, high gain applications including precision integrators, instrument preamplifiers and null detectors as used to resolve microvolt error signals.

The combination of IC's and improved design techniques in this 0.4" high module results in good performance at low cost for OEM designs.

Typical specifications for this inverting amplifier include 500kHz bandwidth, 0.25V/μsec slew rate, 50pA bias current and 3μV p-p noise in a 10Hz bandwidth. It is available with three drift selections: 1; 0.3; and 0.1μV/°C.

MODEL 260 J/K: $10^9\Omega$ NONINVERTING, 0.1μV/°C

Analog Devices pioneered in the development of new "chopper" amplifier designs to provide high input impedance without compromising the excellent low frequency characteristics of chopper type amplifiers. As embodied in the model 260, this design is useful as a noninverting buffer amplifier for processing microvolt signals with minimal source loading errors. Typical specifications for the model 260 are $10^9\Omega$ input impedance, drift to 0.1μV/°C and CMR of 110dB at ±1V.

MODEL 261: GUARANTEED NOISE OF LESS THAN 1μV

The model 261 is a second generation design which typically provides a significant improvement in the noise and bandwidth characteristics of model 260 and other competitive models.

Model	Lowest Cost General Purpose 233 J	K	L
Open Loop Gain			
DC Rated Load, V/V min		10^7	
Rated Output, min		±10V@5mA	
Frequency Response			
Unity Gain, Small Signal		500kHz	
Full Power Response, min		4kHz	
Slewing Rate, min		0.25V/μs	
Overload Recovery		—	
Input Offset Voltage			
Initial, 25°C (Adj. to zero) max	±50μV	±20μV	±20μV
Avg. vs. Temp (0°C to 70°C) max	±1.0	±0.3	±0.1μV/°C
vs. Supply Voltage		±0.2μV/%	
vs. Time		±2μV/mo.	
Input Bias Current			
Initial, 25°C, max		±50pA	
Avg. vs. Temp (0°C to 70°C) max	±2	±1	±0.5pA/°C
Input Impedance			
Differential		600kΩ	
Common Mode		NA	
Input Noise			
Voltage, 0.01 to 1Hz, p-p		1μV	
0.1 to 10Hz, p-p		3μV	
10Hz to 10kHz, rms		3μV	
Current, 0.01 to 1Hz, p-p		3pA	
0.1 to 10Hz, p-p		6pA	
Input Voltage Range			
Common Mode Voltage, min		NA	
Common Mode Rejection		NA	
Max Safe Differential Voltage		±15V	
Power Supply Range (VDC)		±(12 to 18)V	
Rated Specification (VDC)		±15V@5mA	
Temperature Range			
Operating, Rated Specifications		0 to +70°C	
Package Outline		F-3	
Case Dimensions		1.5" x 1.5" x 0.4"	
Price			
1-9	$45	$54	$75
10-24	$40	$49	$68

(1)Model 260 inverting input bias current ±3nA, max.

Operating at a higher carrier frequency, this noninverting design features extremely low noise, 0.4μVp-p in a 1Hz bandwidth; low drift, 0.1μV/°C; and an output that is virtually free of chopper spikes.

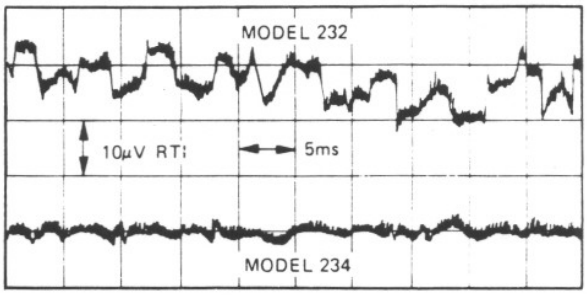
Model 261 also offers a solution to beat frequency problems caused by a low frequency carrier mixing with harmonics of the AC line. The carrier frequency on this design is nearly a decade higher than that of models previously available, thereby eliminating the possibility of any interaction with the line frequency or its harmonics.

The new model should be considered for all new instruments and circuit applications, or wherever improved performance, at no increase in cost, is desirable for existing sockets. Models 260 and 261 are mechanically and electrically interchangeable for these applications.

Model 261 will be available in production quantities by June of 1973. Evaluation units are available from stock.

MODEL 231 J/K: 25mA OUTPUT, 0.1μV/°C
Model 231, available in two drift selections (231J, 0.25μV/°C and 231K, 0.1μV/°C) is an inverting chopper stabilized amplifier with increased output current capability (25mA). With stable 3kHz full power response and low drift, it offers higher output without use of an additional booster stage for heavier load requirements.

MODELS 210/211: 100V/μsec WIDEBAND, 1μV/°C
Models 210/211 with 20mA output, are inverting chopper stabilized amplifiers for that class of application requiring low drift performance with good high frequency performance. This design will provide slew rates of 100V/μsec and 90dB of loop gain at 10kHz for improved wideband accuracy. Incorporating internal limiting circuitry, these amplifiers have exceptionally fast overload recovery, (0.2μsec) and stable input characteristics for high speed integrator and comparator designs. They are available in two drift selections (model 210, 1μV/°C, model 211, 2μV/°C).



DC to 1kHz Noise, Referred to the Input; 234 vs 232.

	High Performance Wideband 1μV p-p Lowest Noise 234			Low Cost Non-Inverting High Z_{IN} 260		General Purpose 25mA Output 231		High Bandwidth 20mA Output 210/211	
	J	K	L	J	K	J	K	210	211
Open Loop Gain	10^7			5×10^6		10^7		10^8	
Output	±10V@5mA			±10V@5mA		±10V@25mA		±10V@20mA	
Small Signal Bandwidth	2.5MHz			100Hz		500kHz		20MHz	
Full Power Response	500kHz			2 to 50Hz		3kHz		500kHz	
Slew Rate	30V/μs			100V/s		0.2V/μs		100V/μs	
Settling Time to 0.01%	—			30ms		3.0sec		0.2μs	
Offset Voltage, Max.	±50μV	±25μV	±25μV	±25μV		±15μV	±10μV	±100μV	
Offset Voltage, Typ.	±1.0	±0.3	±0.1μV/°C	±0.3	±0.1μV/°C	±0.25	±0.1μV/°C	±0.5	±1μV/°C
Offset Voltage, Max. Change	±0.2μV/%			±0.1μV/%		±0.1μV/%		±10μV/%	
Offset Voltage, Max. Stability	±2μV/mo.			±1.0μV/mo.		±1.0μV/mo.		±1.0μV/day	
Input Bias Current, Max.	±100pA			±300pA[1]		±100pA	±50pA	±100pA	±150pA
Input Bias Current, Typ.	±4	±2	±2pA/°C	±10pA/°C		±1.0	±0.5pA/°C	±1	±3pA/°C
Input Impedance, Diff.	300kΩ			80kΩ//0.01μF		300kΩ		500kΩ	
Input Impedance, C.M.	NA			10^9Ω//0.02μF		NA		NA	
Noise, 0.1Hz to 10Hz	0.7μV			0.4μV		1.5μV		5μV	10μV
Noise, 10Hz to 1kHz	1.5μV			1.0μV		10μV		—	
Noise, 10Hz to 10kHz	2μV			—		5μV		10μV	
Noise Current, 0.1Hz to 10Hz	2pA			4pA		10pA		10pA	
Noise Current, 10Hz to 1kHz	4pA			10pA		35pA		—	
Common Mode Range	NA			±1.0V		NA		NA	
Common Mode Rejection	NA			110dB		NA		NA	
Power Supply Sensitivity	±15V			±20V		±15V		±15V	
Power Supply Range	±(12 to 18)V			±(10 to 18)V		±(12 to 18)V		±(12 to 18)V	
Power Supply Drain	±15V@5mA			±15V@6mA		±15V@+8, -10mA		±15V@+30, -4mA	
Temperature Range	0 to +70°C			0 to +70°C		0 to +70°C		0 to +70°C	
Package	F–3			FA–6		WA–1		R–7	
Dimensions	1.5" x 1.5" x 0.4"			1.5" x 1.5" x 0.62"		3.6" x 1.6" x 0.4"		2.87" x 1.37" x 0.99"	
Price	$54	$65	$89	$49	$64	$80	$115	$157	$113
Price, 10-24	$49	$59	$82	$45	$58	$74	$105	$148	$107

LOW VOLTAGE DRIFT-CHOPPER STABILIZED
MODELS 234, 233, 260, 261, 231, 210

GENERAL DESCRIPTION

Chopper stabilized amplifiers employ modulation techniques for processing the "low frequency" components of a signal and an AC coupled amplifier for the higher frequencies. This chopping technique makes it possible to process wideband signals and yet achieve superior low drift and long term stability. Analog Devices, a pioneer in the development of encapsulated chopper stabilized amplifiers, offers designs with drifts between 0.1 to 1μV/°C, low frequency voltage noise to 1½μV p-p and bias currents from 50 to 300pA. Long term stability averages 1μV/month. These amplifiers are widely accepted as the best choice when it is essential to maintain either low voltage offsets and bias currents versus time or against severe environmental changes, or whenever external offset adjustments are not possible or desirable.

MODEL 234 J/K/L: LOWEST NOISE, WIDEBAND

This latest inverting amplifier design from Analog Devices is virtually free of chopper spikes and is singled out as the industry's quietest, wide band chopper stabilized amplifier in a low cost module. To illustrate the significant improvement in performance, comparative noise signals are presented in the figure for model 234 and its predecessor model 232.

Available in three drift selections (1, 0.3 and 0.1μV/°C), model 234 specifications include voltage noise of 1½μV p-p, current noise of 2pA p-p, and 2.5MHz bandwidth. Slew rate is 30V/μsec. The wide bandwidth of 234 makes it especially useful for 16-bit D/A converters, high speed integrators as well as for low frequency applications including control systems, DVM input amplifier designs and other precision instrumentation. Attractively priced, its consistent unit-to-unit performance makes it an ideal choice for new OEM designs.

MODEL 233 J/K/L: LOWEST COST, 0.1μV/°C

The popular model 233 is a good choice for many low drift, high gain applications including precision integrators, instrument preamplifiers and null detectors as used to resolve microvolt error signals.

The combination of IC's and improved design techniques in this 0.4" high module results in good performance at low cost for OEM designs.

Typical specifications for this inverting amplifier include 500kHz bandwidth, 0.25V/μsec slew rate, 50pA bias current and 3μV p-p noise in a 10Hz bandwidth. It is available with three drift selections: 1; 0.3; and 0.1μV/°C.

MODEL 260 J/K: $10^9\Omega$ NONINVERTING, 0.1μV/°C

Analog Devices pioneered in the development of new "chopper" amplifier designs to provide high input impedance without compromising the excellent low frequency characteristics of chopper type amplifiers. As embodied in the model 260, this design is useful as a noninverting buffer amplifier for processing microvolt signals with minimal source loading errors. Typical specifications for the model 260 are $10^9\Omega$ input impedance, drift to 0.1μV/°C and CMR of 110dB at ±1V.

MODEL 261: GUARANTEED NOISE OF LESS THAN 1μV

The model 261 is a second generation design which typically provides a significant improvement in the noise and bandwidth characteristics of model 260 and other competitive models.

Model	Lowest Cost General Purpose 233 J	K	L
Open Loop Gain			
DC Rated Load, V/V min		10^7	
Rated Output, min		±10V@5mA	
Frequency Response			
Unity Gain, Small Signal		500kHz	
Full Power Response, min		4kHz	
Slewing Rate, min		0.25V/μs	
Overload Recovery		—	
Input Offset Voltage			
Initial, 25°C (Adj. to zero) max	±50μV	±20μV	±20μV
Avg. vs. Temp (0°C to 70°C) max	±1.0	±0.3	±0.1μV/°C
vs. Supply Voltage		±0.2μV/%	
vs. Time		±2μV/mo.	
Input Bias Current			
Initial, 25°C, max		±50pA	
Avg. vs. Temp (0°C to 70°C) max	±2	±1	±0.5pA/°C
Input Impedance			
Differential		600kΩ	
Common Mode		NA	
Input Noise			
Voltage, 0.01 to 1Hz, p-p		1μV	
0.1 to 10Hz, p-p		3μV	
10Hz to 10kHz, rms		3μV	
Current, 0.01 to 1Hz, p-p		3pA	
0.1 to 10Hz, p-p		6pA	
Input Voltage Range			
Common Mode Voltage, min		NA	
Common Mode Rejection		NA	
Max Safe Differential Voltage		±15V	
Power Supply Range (VDC)		±(12 to 18)V	
Rated Specification (VDC)		±15V@5mA	
Temperature Range			
Operating, Rated Specifications		0 to +70°C	
Package Outline		F-3	
Case Dimensions		1.5" x 1.5" x 0.4"	
Price			
1-9	$45	$54	$75
10-24	$40	$49	$68

(1)Model 260 inverting input bias current ±3nA, max.

Operating at a higher carrier frequency, this noninverting design features extremely low noise, 0.4μVp-p in a 1Hz bandwidth; low drift, 0.1μV/°C; and an output that is virtually free of chopper spikes.

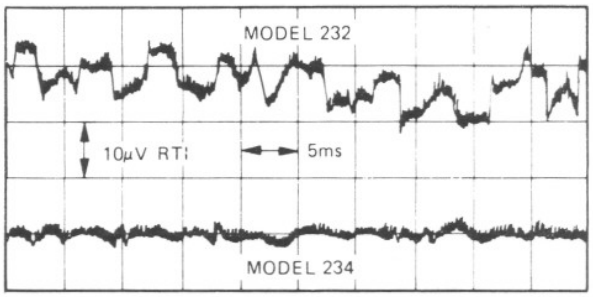
Model 261 also offers a solution to beat frequency problems caused by a low frequency carrier mixing with harmonics of the AC line. The carrier frequency on this design is nearly a decade higher than that of models previously available, thereby eliminating the possibility of any interaction with the line frequency or its harmonics.

The new model should be considered for all new instruments and circuit applications, or wherever improved performance, at no increase in cost, is desirable for existing sockets. Models 260 and 261 are mechanically and electrically interchangeable for these applications.

Model 261 will be available in production quantities by June of 1973. Evaluation units are available from stock.

MODEL 231 J/K: 25mA OUTPUT, 0.1μV/°C
Model 231, available in two drift selections (231J, 0.25μV/°C and 231K, 0.1μV/°C) is an inverting chopper stabilized amplifier with increased output current capability (25mA). With stable 3kHz full power response and low drift, it offers higher output without use of an additional booster stage for heavier load requirements.

MODELS 210/211: 100V/μsec WIDEBAND, 1μV/°C
Models 210/211 with 20mA output, are inverting chopper stabilized amplifiers for that class of application requiring low drift performance with good high frequency performance. This design will provide slew rates of 100V/μsec and 90dB of loop gain at 10kHz for improved wideband accuracy. Incorporating internal limiting circuitry, these amplifiers have exceptionally fast overload recovery, (0.2μsec) and stable input characteristics for high speed integrator and comparator designs. They are available in two drift selections (model 210, 1μV/°C, model 211, 2μV/°C).

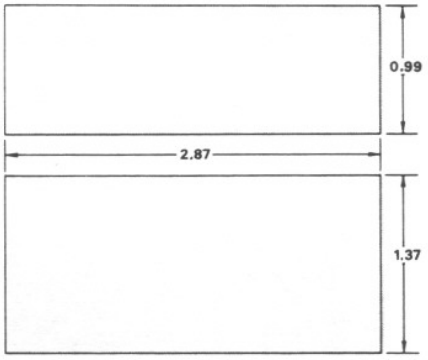


DC to 1kHz Noise, Referred to the Input; 234 vs 232.

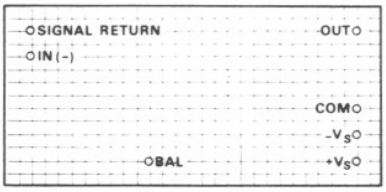
High Performance Wideband 1μV p-p Lowest Noise 234			Low Cost Non-Inverting High Z_{IN} 260		General Purpose 25mA Output 231		High Bandwidth 20mA Output 210/211	
J	K	L	J	K	J	K	210	211
10^7			5×10^6		10^7		10^8	
±10V@5mA			±10V@5mA		±10V@25mA		±10V@20mA	
2.5MHz 500kHz 30V/μs —			100Hz 2 to 50Hz 100V/s 30ms		500kHz 3kHz 0.2V/μs 3.0sec		20MHz 500kHz 100V/μs 0.2μs	
±50μV ±1.0	±25μV ±0.3 ±0.2μV/% ±2μV/mo.	±25μV ±0.1μV/°C	±25μV ±0.3	±0.1μV/°C ±0.1μV/% ±1.0μV/mo.	±15μV ±0.25	±10μV ±0.1μV/°C ±0.1μV/% ±1.0μV/mo.	±100μV ±0.5	±1μV/°C ±10μV/% ±1.0μV/day
±4	±100pA ±2	±2pA/°C	±300pA[1] ±10pA/°C		±100pA ±1.0	±50pA ±0.5pA/°C	±100pA ±1	±150pA ±3pA/°C
300kΩ NA			80kΩ//0.01μF 10^9Ω//0.02μF		300kΩ NA		500kΩ NA	
0.7μV 1.5μV 2μV 2pA 4pA			0.4μV 1.0μV — 4pA 10pA		1.5μV 10μV 5μV 10pA 35pA		5μV — 10μV 10pA —	10μV
NA NA ±15V			±1.0V 110dB ±20V		NA NA ±15V		NA NA ±15V	
±(12 to 18)V ±15V@5mA			±(10 to 18)V ±15V@6mA		±(12 to 18)V ±15V@+8, -10mA		±(12 to 18)V ±15V@+30, -4mA	
0 to +70°C			0 to +70°C		0 to +70°C		0 to +70°C	
F–3 1.5" x 1.5" x 0.4"			FA–6 1.5" x 1.5" x 0.62"		WA–1 3.6" x 1.6" x 0.4"		R–7 2.87" x 1.37" x 0.99"	
$54 $49	$65 $59	$89 $82	$49 $45	$64 $58	$80 $74	$115 $105	$157 $148	$113 $107

R PACKAGE

MODELS 210, 211

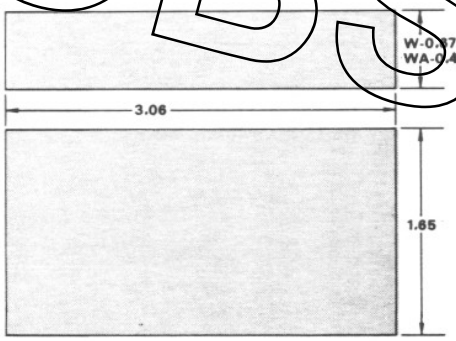


R-7
AC 1002

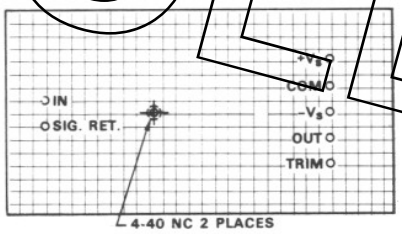


W, WA PACKAGES

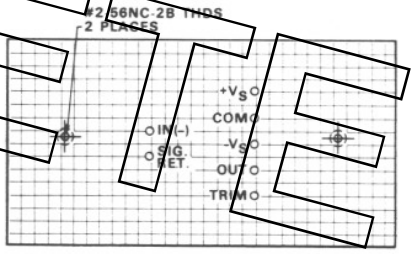
MODELS 231, 310, 311



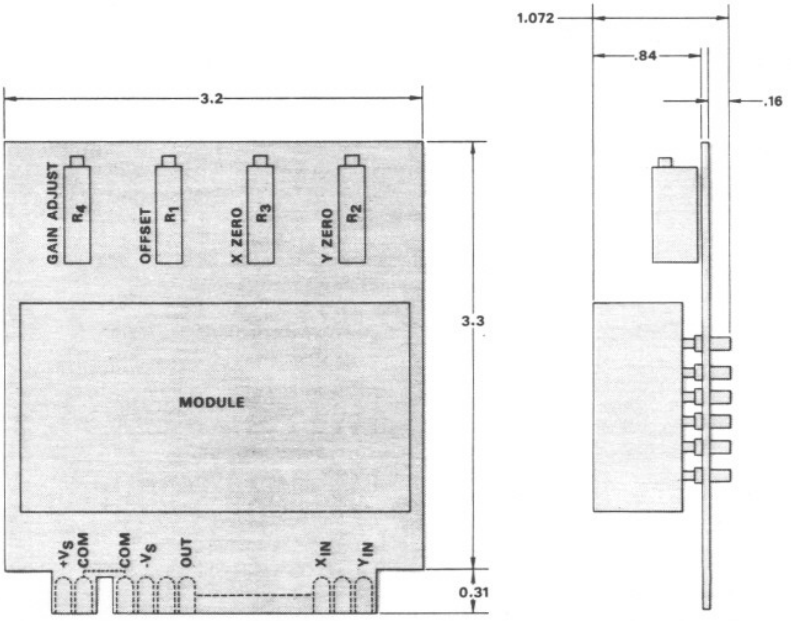
W-1
AC 1017



WA-1
AC 1014



MODEL 425 OUTLINE



NOTES:

1. Model 425 gain adjust pot in series with X input.
2. Mating socket supplied with unit (ADI part no. 60-42820).