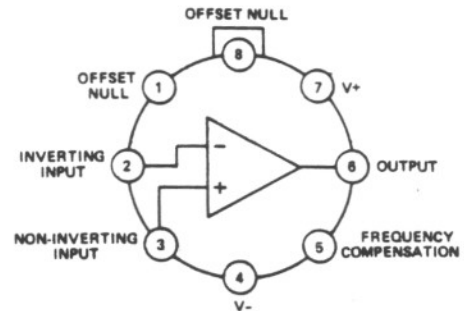


### FEATURES

- Low  $V_{OS}$ :  $500\mu V$  max (AD504M)
- High Gain:  $10^6$  min (AD504L, M, S)
- Low Drift:  $0.5\mu V/^\circ C$  max (AD504M)
- Free of Popcorn Noise

### AD504 FUNCTIONAL BLOCK DIAGRAM



TO-99  
TOP VIEW

# OBSOLETE

### PRODUCT DESCRIPTION

The Analog Devices AD504J, K, L, M and S IC operational amplifiers provide ultra-low drift and extremely high gain, comparable to that of modular amplifiers, for precision applications. A new double integrator circuit concept combined with a precise thermally balanced layout achieves gain greater than  $10^6$ , offset voltage drift of less than  $1\mu V/^\circ C$ , small signal unity gain bandwidth of 300kHz, and slew rate of  $0.12V/\mu s$ . Because of monolithic construction, the cost of the AD504 is significantly below that of modules, and becomes even lower with larger quantity requirements. The amplifier is externally compensated for unity gain with a single 470pF capacitor; no compensation is required for gains above 500. The inputs are fully protected, which permits differential input voltages of up to  $\pm V_S$  without voltage gain or bias current degradation due to reverse breakdown. The output is also protected from short circuits to ground and/or either supply voltage, and is capable of driving 1000pF of load capacitance. The AD504J, K, L and M are supplied in the hermetically sealed TO-99 package, and are specified for operation over the 0 to  $+70^\circ C$  temperature range. The AD504S is specified over the  $-55^\circ C$  to  $+125^\circ C$  temperature range and is also supplied in the TO-99 package.

### PRODUCT HIGHLIGHTS

1. Fully guaranteed and 100% tested  $1\mu V/^\circ C$  maximum voltage drift combined with voltage offset of  $500\mu V$  (AD504L).
2. Fully protected input ( $\pm V_S$ ) and output circuitry. The input protection circuit prevents offset voltage and bias current degradation due to reverse breakdown, and is of critical importance in this type of device whose overall performance is strongly dependent upon front-end stability.
3. Single capacitor compensation eliminates elaborate stabilizing networks while providing flexibility not possible with an internally compensated op amp. This feature allows bandwidth to be optimized by the user for his particular application.
4. High gain is maintained independent of offset nulling, power supply voltage and load resistance.
5. Bootstrapping of the critical input transistor quad produces CMRR and PSRR compatible with the tight  $1\mu V/^\circ C$  drift. CMRR and PSRR are both in the vicinity of 120dB.
6. Noise performance is closely monitored at Outgoing QC to ensure compatibility with the low error budgets afforded by the performance of all other parameters.
7. Every AD504 receives a stabilization bake for 24 hours at  $150^\circ C$  to ensure reliability and long term stability.
8. The 100 piece price of the AD504 is 1/3 to 1/2 less than that of modular low drift operational amplifiers, and is competitive with the price of less accurate IC op amps.

# SPECIFICATIONS (typical @ +25°C and ±15V dc unless otherwise noted)

PARAMETER	AD504J	AD504K	AD504L
<b>OPEN LOOP GAIN</b>			
$V_{OS} = \pm 10V, R_L \geq 2k\Omega$	250,000 min (4 x 10 <sup>6</sup> typ)	500,000 min (4 x 10 <sup>6</sup> typ)	10 <sup>6</sup> min (8 x 10 <sup>6</sup> typ)
$T_{min} < T_A < T_{max}$	125,000 min (10 <sup>6</sup> typ)	250,000 min (10 <sup>6</sup> typ)	500,000 min (10 <sup>6</sup> typ)
<b>OUTPUT CHARACTERISTICS</b>			
Voltage at $R_L \geq 2k\Omega, T_{min} < T_A < T_{max}$	±10V min (±13V typ)	*	*
Load Capacitance	1000pF	*	*
Output Current	10mA min	*	*
Short Circuit Current	25mA	*	*
<b>FREQUENCY RESPONSE</b>			
Unity Gain, Small Signal, $C_c = 390pF$	300kHz	*	*
Full Power Response, $C_c = 390pF$	1.5kHz	*	*
Slew Rate, Unity Gain, $C_c = 390pF$	0.12V/μs	*	*
<b>INPUT OFFSET VOLTAGE</b>			
Initial Offset, $R_S \leq 10k$	2.5mV max (0.5mV typ)	1.5mV max (0.5mV typ)	0.5mV max (0.2mV typ)
vs Temp, $T_{min} < T_A < T_{max}, V_{OS}$ nulled	5.0μV/°C max (0.5μV/°C typ)	3.0μV/°C max (0.5μV/°C typ)	1.0μV/°C max (0.3μV/°C typ)
$T_{min} < T_A < T_{max}, V_{OS}$ unnullcd†	10μV/°C max (1.5μV/°C typ)	5.0μV/°C max (1.5μV/°C typ)	2.0μV/°C max (1.0μV/°C typ)
vs Supply	25μV/V max	15μV/V max	10μV/V max
@ $T_{min} < T_A < T_{max}$	40μV/V	25μV/V max	15μV/V max
vs Time	20μV/mo	15μV/mo	10μV/mo
<b>INPUT OFFSET CURRENT</b>			
@ $T_A = 25^\circ C$	40nA max	15nA max	10nA max
<b>INPUT BIAS CURRENT</b>			
Initial	200nA max	100nA max	80nA max
$T_{min}$ to $T_{max}$	300nA max	150nA max	100nA max
vs Temp, $T_{min}$ to $T_{max}$	300pA/°C	250pA/°C	200pA/°C
<b>INPUT IMPEDANCE</b>			
Differential	0.5MΩ	1.0MΩ	1.3MΩ
Common Mode	100MΩ/14pF	*	*
<b>INPUT NOISE</b>			
Voltage, 0.1 to 10Hz	1.0μV (p-p)	*	*
100Hz	10nV/√Hz(rms)	*	*
1kHz	8nV/√Hz(rms)	*	*
Current, 0.1 to 10Hz	50pA(p-p)	*	*
100Hz	0.6pA/√Hz(rms)	*	*
1kHz	0.5pA/√Hz(rms)	*	*
<b>INPUT VOLTAGE RANGE</b>			
Differential or Common Mode, Max Safe	±V <sub>S</sub>	*	*
Common Mode Rejection, $V_{IN} = \pm 10V$	94dB min (120dB typ)	100dB min (120dB typ)	110dB min (120dB typ)
<b>POWER SUPPLY</b>			
Rated Performance	±15V	*	*
Operating	±(5 to 18)V	*	*
Current, Quiescent	±4.0mA max (±1.5mA typ)	±3.0mA max (±1.5mA typ)	±3.0mA max (±1.5mA typ)
<b>TEMPERATURE RANGE</b>			
Operating, Rated Performance			
( $T_{min}$ to $T_{max}$ )	0 to +70°C	*	*
Storage	-65°C to +150°C	*	*
<b>PACKAGE OPTION:<sup>1</sup> TO-99 Style (H08B)</b>			
	AD504JH	AD504KH	AD504LH

## NOTES

\*Specifications same as for AD504J.

<sup>1</sup> See Section 19 for package outline information.

Specifications subject to change without notice.

## NOTE

Analog Devices 100% tests and guarantees all specified maximum and minimum limits. Certain parameters, because of the relative difficulty and cost of 100% testing, have been specified as "typical" numbers. At ADI, "typical" numbers are subjected to rigid statistical sampling and outgoing quality control procedures, resulting in "typicals" that are indicative of the performance that can be expected by the user.

AD504S(AD504S/883)

10<sup>6</sup> typ) 10<sup>6</sup> min (8 x 10<sup>6</sup> typ)  
 10<sup>6</sup> typ) 250,000 min

•  
•  
•  
•

•  
•  
•

(0.2mV typ) 0.5mV max  
 max (0.2μV/°C typ) 1.0μV/°C max (0.3μV/°C typ)  
 max (0.5μV/°C typ) 2.0μV/°C max (1.0μV/°C typ)  
 max 10μV/V max  
 max 20μV/V max  
 10μV/mo

10nA max

80nA max  
 200nA max  
 200pA/°C

1.3MΩ

p-p) max  
 /Hz max  
 Hz max  
 p-p max  
 √Hz max  
 √Hz max

•

3 min (120dB typ) 110dB min (120dB typ)

•  
•

nA max (±1.5mA typ) ±3mA max (±1.5mA typ)

-55°C to +125°C  
 -65°C to +150°C

504MH

AD504SH

OBSOLETE