Ultralow Offset and Drift Operational Amplifiers

AD707/AD708

FEATURES

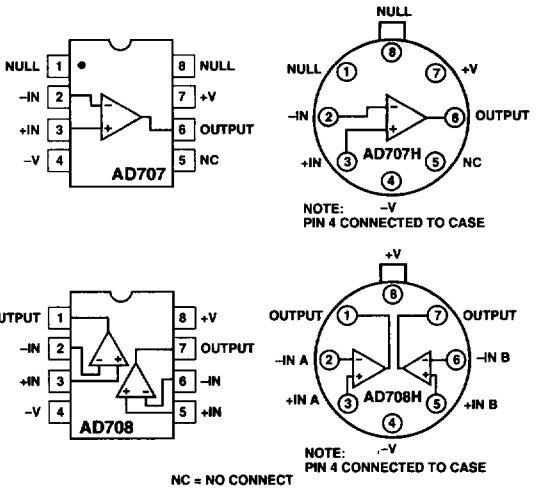
Very High DC Precision
- **Low Offset Voltages**
  - **(15 μV max: AD707)**
  - **(30 μV max: AD708)**
- **Low Offset Drift**
  - **(0.1 μV/°C max: AD707)**
  - **(0.3 μV/°C max: AD708)**
- **Low Input Bias Current: 1 nA max**

Low Noise: 0.35 μV p-p max (0.1 Hz to 10 Hz)
130 dB min CMRR
120 dB min PSRR
AC Performance
- **0.3 V/μs Slew Rate**
- **900 kHz Closed-Loop Bandwidth**

Matching Characteristics
- **30 μV max Offset Voltage Match**
- **0.3 μV/°C max Offset Drift Match**
- **130 dB min CMRR Match**

MIL-STD-883B Versions Available
Single: AD707
Dual: AD708

FUNCTIONAL BLOCK DIAGRAMS



PRODUCT DESCRIPTION

The AD707 (single) and AD708 (dual) are very high precision, monolithic operational amplifiers. Each device offers excellent dc precision with the best available max offset voltage and max offset voltage drift of any single/dual bipolar combination available.

The AD707 and AD708 set new standards for precision op amps by providing 5 V/μV min open-loop gain and guaranteed max input voltage noise of 350 nV p-p (0.1 Hz to 10 Hz). All dc specifications show excellent stability over temperature, with offset voltage drift typically 0.1 μV/°C and input bias current drift of 25 pA/°C max. Both CMRR (130 dB max) and PSRR (120 dB max) are an order of magnitude improved over any available monolithic op amp.

The AD707 and AD708 are available in seven performance grades. The "J" and "K" grades are rated over the commercial temperature range of 0°C to +70°C. The "A," "B" and "C" grades are rated over the industrial temperature range of –40°C to +85°C. The "S" and "T" grades are rated over the military temperature range of –55°C to +125°C. Select versions are also available processed to MIL-STD-883B, Rev. C.

PRODUCT HIGHLIGHTS

1. The combination of outstanding matching and individual specifications make the AD707 and AD708 ideal for constructing high gain, precision instrumentation amplifiers.
2. The low offset voltage drift and low noise of the AD707 and AD708 allow the user to amplify very small signals without sacrificing overall system performance.
3. The AD707 and AD708 can be used where chopper amplifiers are required, but without the inherent noise and application problems.
4. The AD707 is an improved, pin-for-pin replacement for the LT1001, and the AD708 is an improved, pin-for-pin replacement for the LT1002.

This is an abridged data sheet. To obtain the most recent version or complete data sheet, call our fax retrieval system at 1-800-446-6212.

SPECIFICATIONS (V_{DD} = ±15 V @ T_A = +25°C unless otherwise noted)

Parameter	Conditions	Model	J/A Min	J/A Typ	J/A Max	K/B/S Min	K/B/S Typ	K/B/S Max	C/T Min	C/T Typ	C/T Max	Units
INPUT OFFSET VOLTAGE[1]												
Initial Offset		AD707		30	**90**		10	**25**		5	**15**	µV
		AD708		30	**100**		15	65/65/**50**				µV
vs. Temperature	T_{MIN} to T_{MAX}	AD707		50	100		15	**45**		7/8	**25**	µV
		AD708		50	150		15	65				µV
Drift		AD707		0.3	1.0		0.1	**0.3**		0.03	**0.1**	µV/°C
		AD708		0.3	1.0		0.1	0.4/0.4/**0.4**				µV/°C
Adjustment Range		AD707		±4			±4			±4		mV
Long-Term Stability		Both		0.3			0.3			0.2		µV/Month
INPUT BIAS CURRENT		AD707		1.0	**2.5**		0.5	**1.5**		0.5	**1.0**	nA
		AD708		1.0	**2.5**		0.5	**1.0**				nA
vs. Temperature	T_{MIN} to T_{MAX}	AD707		2.0	4.0		1.5	**3.0**		1.0	**2.0**	nA
		AD708		2.0	4.0		1.0	2.0/2.0/**4.0**				nA
Average Drift		AD707		15	40		15	25/25/35		1	25	pA/°C
		AD708		15	40		10	25/25/30				pA/°C
INPUT OFFSET CURRENT	V_{CM} = 0 V	AD707		0.5	**2.0**		0.3	**1.5**		0.1	**1.0**	nA
		AD708		0.5	2.0		0.1	**1.0**				nA
	T_{MIN} to T_{MAX}	AD707		2.0	4.0		1.5	**3.0**		0.2	**1.5**	nA
		AD708		2.0	4.0		0.2	1.5/1.5/**1.5**				nA
Average Drift		AD707		2	40		1	25/25/35		1	25	pA/°C
		AD708		2	60		1	25				pA/°C
MATCHING CHARACTERISTICS[2]												
Offset Voltage		AD708			**80**			**50/50/50**				µV
	T_{MIN} to T_{MAX}	AD708			150			75/75/75				µV
Offset Voltage Drift		AD708			1.0			0.4/0.4/**0.4**				µV/°C
Input Bias Current		AD708			**4.0**			**1.0**				nA
	T_{MIN} to T_{MAX}	AD708			5.0			2.0/2.0/**2.0**				nA
Common-Mode Rejection		AD708	**120**		300	**130/130/120**	140					dB
	T_{MIN} to T_{MAX}	AD708	110		600	130/130/115						dB
Power Supply Rejection		AD708	**110**			**120**						dB
	T_{MIN} to T_{MAX}	AD708	110		500	120						dB
Channel Separation		AD708	135			140						dB
INPUT VOLTAGE NOISE	0.1 Hz to 10 Hz	AD707		0.23	0.6		0.23	0.6		0.23	**0.35**	µV p-p
		AD708		0.23	0.6		0.23	0.6/0.6/**0.6**				µV p-p
	f = 10 Hz	AD707		10.3	15.0		10.3	14.0		10.3	13.0	nV/√Hz
		AD708		10.3	18.0		10.3	12.0				nV/√Hz
	f = 100 Hz	AD707		10.0	13.0		10.0	12.0		10.0	11.0	nV/√Hz
		AD708		10.0	13.0		10.0	11.0				nV/√Hz
	f = 1 kHz	AD707		9.6	11.0		9.6	11.0		9.6	11.0	nV/√Hz
		AD708		9.6	11.0		9.6	11.0				nV/√Hz
INPUT CURRENT NOISE	0.1 Hz to 10 Hz	AD707		14	35		14	30		14	**30**	pA p-p
		AD708		14	35		14	35				pA p-p
	f = 10 Hz	AD707		0.32	0.9		0.32	0.8		0.32	0.8	pA/√Hz
		AD708		0.32	0.9		0.32	0.8				pA/√Hz
	f = 100 Hz	AD707		0.14	0.27		0.14	0.23		0.14	0.23	pA/√Hz
		AD708		0.14	0.27		0.14	0.23				pA/√Hz
	f = 1 kHz	AD707		0.12	0.18		0.12	0.17		0.12	0.17	pA/√Hz
		AD708		0.12	0.18		0.12	0.17				pA/√Hz
COMMON-MODE REJECTION RATIO	V_{CM} = ±13 V	Both	**120**	140		**130**	140		**130**	140		dB
	T_{MIN} to T_{MAX}	Both	120	140		**130**	140		**130**	140		dB
OPEN-LOOP GAIN	V_O = ±10 V											
	R_L ≥ 2 kΩ	AD707	**3**	13		**5**	13		**8**	13		V/µV
		AD708	**3**	10		5/5/**4**	10					V/µV
	T_{MIN} to T_{MAX}	AD707	3	13		**5**	13		**8**	13		V/µV
		AD708	3	10		5/5/**4**	10/10/**7**					V/µV
POWER SUPPLY REJECTION RATIO	V_S = ±3 V to ±18 V	AD707	**110**	130		**115**	130		**120**	130		dB
		AD708	**120**	130		**120**	130					dB
	T_{MIN} to T_{MAX}	AD707	110	130		**115**	130		**120**	130		dB
		AD708	110	130		120	130					dB
FREQUENCY RESPONSE												
Closed Loop Bandwidth		Both	0.5	0.9		0.5	0.9		0.5	0.9		MHz
Slew Rate		Both	0.15	0.3		0.15	0.3		0.15	0.3		V/µs

Parameter	Conditions	Model	J/A Min	J/A Typ	J/A Max	K/B/S Min	K/B/S Typ	K/B/S Max	C/T Min	C/T Typ	C/T Max	Units
INPUT RESISTANCE												
Differential		AD707	24	100		45	200		60	200		MΩ
		AD708		60			200					MΩ
Common Mode		AD707		200			300			400		GΩ
		AD708		200			400					GΩ
OUTPUT CHARACTERISTICS												
Voltage	$R_L \geq 10$ kΩ	Both	**13.5**	14.0		**13.5**	14.0		**13.5**	14.0		±V
	$R_L \geq 2$ kΩ	Both	**12.5**	13.0		**12.5**	13.0		**12.5**	13.0		±V
	$R_L \geq 1$ kΩ	Both	**12.0**	12.5		**12.0**	12.5		**12.0**	12.5		±V
	$R_L \geq 2$ kΩ T_{MIN} to T_{MAX}	Both	12.0	13.0		**12.0**	13.0		**12.0**	13.0		±V
OPEN-LOOP OUTPUT RESISTANCE		Both		60			60			60		Ω
POWER SUPPLY												
Quiescent Current		AD707		2.5	**3.0**		2.5	**3.0**		2.5	**3.0**	mA
		AD708		4.5	**5.5**		4.5	**5.5**				mA
Power Consumption, No Load	$V_S = \pm 15$ V	AD707		75	**90**		75	**90**		75	**90**	mW
		AD708		135	**165**		135	**165**				mW
	$V_S = \pm 3$ V	AD707		7.5	**9.0**		7.5	**9.0**		7.5	**9.0**	mW
		AD708		12	**18**		12	**18**				mW
		Both	±3		±18	±3		±18	±3		±18	V

NOTES
[1]Input offset voltage specifications are guaranteed after 5 minutes of operation at T_A = +25°C.
[2]Matching is defined as the difference between parameters of the two amplifiers.

All min and max specifications are guaranteed. Specifications in **boldface** are tested on all production units at final electrical test. Results from those tests are used to calculate outgoing quality levels.
Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage ..... ±22 V
Internal Power Dissipation[2] ..... 500 mW
Input Voltage ..... $\pm V_S$
Differential Input Voltage ..... $+V_S$ and $-V_S$
Output Short Circuit Duration ..... Indefinite
Storage Temperature Range (N, R) ..... –65°C to +125°C
Storage Temperature Range (Q, H) ..... –65°C to +150°C
Operating Temperature Range
AD70xJ/K ..... 0°C to +70°C
AD70xA/B ..... –40°C to +85°C
AD70xS/T ..... –55°C to +125°C
Lead Temperature Range
(Soldering 60 sec) ..... +300°C

NOTES
[1]Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
[2]Specification is for device in free air: 8-pin plastic package, θ_{JA} = 165°C/Watt; 8-pin cerdip package, θ_{JA} = 110°C/Watt; 8-pin small outline package, θ_{JA} = 155°C/Watt; 8-pin header package, θ_{JA} = 200°C/Watt.

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option*
AD707AH	–40°C to +85°C	8-Pin Metal Can	H-08A
AD707AQ	–40°C to +85°C	8-Pin Ceramic DIP	Q-8
AD707AR	–40°C to +85°C	8-Pin Plastic SOIC	R-8
AD707AR-REEL	–40°C to +85°C	8-Pin Plastic SOIC	R-8
AD707AR-REEL7	–40°C to +85°C	8-Pin Plastic SOIC	R-8
AD707BH	–40°C to +85°C	8-Pin Metal Can	H-08A
AD707BQ	–40°C to +85°C	8-Pin Ceramic DIP	Q-8
AD707CH	–40°C to +85°C	8-Pin Metal Can	H-08A
AD707CQ	–40°C to +85°C	8-Pin Ceramic DIP	Q-8
AD707JN	0°C to +70°C	8-Pin Plastic DIP	N-8
AD707JR	0°C to +70°C	8-Pin Plastic SOIC	R-8
AD707JR-REEL	0°C to +70°C	8-Pin Plastic SOIC	R-8
AD707JR-REEL7	0°C to +70°C	8-Pin Plastic SOIC	R-8
AD707KN	0°C to +70°C	8-Pin Plastic DIP	N-8
AD707KR	0°C to +70°C	8-Pin Plastic SOIC	R-8
AD707KR-REEL	0°C to +70°C	8-Pin Plastic SOIC	R-8
AD707KR-REEL7	0°C to +70°C	8-Pin Plastic SOIC	R-8
AD707SH/883B	–55°C to +125°C	8-Pin Metal Can	H-08A
AD707SQ/883B	–55°C to +125°C	8-Pin Ceramic DIP	Q-8
AD707TH/883B	–55°C to +125°C	8-Pin Metal Can	H-08A
AD707TQ/883B	–55°C to +125°C	8-Pin Ceramic DIP	Q-8
AD708AH	–40°C to +85°C	8-Pin Metal Can	H-08A
AD708AQ	–40°C to +85°C	8-Pin Ceramic DIP	Q-8
AD708BH	–40°C to +85°C	8-Pin Metal Can	H-08A
AD708BQ	–40°C to +85°C	8-Pin Ceramic DIP	Q-8
AD708JCHIPS	0°C to +70°C	Bare Die	
AD708JN	0°C to +70°C	8-Pin Plastic DIP	N-8
AD708SQ	–55°C to +125°C	8-Pin Ceramic DIP	Q-8
AD708SQ/883B	–55°C to +125°C	8-Pin Ceramic DIP	Q-8

*For outline information see Package Information section.

CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD707 and AD708 feature proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.