

AD706—SPECIFICATIONS (@ T_A = +25°C, V_{CM} = 0 V and ±15 V dc, unless otherwise noted.)

Parameter	Conditions	Min	AD706J/A Typ	Max	Unit
INPUT OFFSET VOLTAGE					
Initial Offset			30	100	μV
Offset	T _{MIN} to T _{MAX}		40	150	μV
vs. Temperature, Average TC			0.2	1.5	μV/°C
vs. Supply (PSRR)	V _S = ±2 V to ±18 V	110	132		dB
T _{MIN} to T _{MAX}	V _S = ±2.5 V to ±18 V	106	126		dB
Long Term Stability			0.3		μV/Month
INPUT BIAS CURRENT ¹	V _{CM} = 0 V		50	200	pA
	V _{CM} = ±13.5 V			250	pA
vs. Temperature, Average TC			0.3		pA/°C
T _{MIN} to T _{MAX}	V _{CM} = 0 V			300	pA
T _{MIN} to T _{MAX}	V _{CM} = ±13.5 V			400	pA
INPUT OFFSET CURRENT	V _{CM} = 0 V		30	150	pA
	V _{CM} = ±13.5 V			250	pA
vs. Temperature, Average TC			0.6		pA/°C
T _{MIN} to T _{MAX}	V _{CM} = 0 V		80	250	pA
T _{MIN} to T _{MAX}	V _{CM} = ±13.5 V		80	350	pA
MATCHING CHARACTERISTICS					
Offset Voltage				150	μV
	T _{MIN} to T _{MAX}			250	μV
Input Bias Current ²				300	pA
	T _{MIN} to T _{MAX}			500	pA
Common-Mode Rejection		106			dB
	T _{MIN} to T _{MAX}	106			dB
Power Supply Rejection		106			dB
	T _{MIN} to T _{MAX}	104			dB
Crosstalk (Figure 2a)	T _{MIN} to T _{MAX} @ f = 10 Hz R _L = 2 kΩ		150		dB
FREQUENCY RESPONSE					
Unity Gain Crossover Frequency			0.8		MHz
Slew Rate	G = -1		0.15		V/μs
	T _{MIN} to T _{MAX}		0.15		V/μs
INPUT IMPEDANCE					
Differential			40 2		MΩ pF
Common Mode			300 2		GΩ pF
INPUT VOLTAGE RANGE					
Common-Mode Voltage		±13.5	±14		V
Common-Mode Rejection Ratio	V _{CM} = ±13.5 V	110	132		dB
	T _{MIN} to T _{MAX}	108	128		dB
INPUT CURRENT NOISE	0.1 Hz to 10 Hz		3		pA p-p
	f = 10 Hz		50		fA/√Hz
INPUT VOLTAGE NOISE	0.1 Hz to 10 Hz		0.5		μV p-p
	f = 10 Hz		17		nV/√Hz
	f = 1 kHz		15	22	nV/√Hz
OPEN-LOOP GAIN	V _O = ±12 V				
	R _{LOAD} = 10 kΩ	200	2000		V/mV
	T _{MIN} to T _{MAX}	150	1500		V/mV
	V _O = ±10 V				
	R _{LOAD} = 2 kΩ	200	1000		V/mV
	T _{MIN} to T _{MAX}	150	1000		V/mV
OUTPUT CHARACTERISTICS					
Voltage Swing	R _{LOAD} = 10 kΩ	±13	±14		V
	T _{MIN} to T _{MAX}	±13	±14		V
Current	Short Circuit		±15		mA
Capacitive Load Drive Capability	Gain = +1		10,000		pF

SPECIFICATIONS (continued)

Parameter	Conditions	Min	AD706J/A Typ	Max	Unit
POWER SUPPLY					
Rated Performance			±15		V
Operating Range		±2.0		±18	V
Quiescent Current, Total	T _{MIN} to T _{MAX}		0.75 0.8	1.2 1.4	mA mA
TRANSISTOR COUNT	Number of Transistors		90		

NOTES

¹Bias current specifications are guaranteed maximum at either input.

²Input bias current match is the difference between corresponding inputs (I_B of –IN of Amplifier 1 minus I_B of –IN of Amplifier 2).

CMRR match is the difference between $\frac{\Delta V_{OS1}}{\Delta V_{CM}}$ for Amplifier 1 and $\frac{\Delta V_{OS2}}{\Delta V_{CM}}$ for Amplifier 2, expressed in dB.

PSRR match is the difference between $\frac{\Delta V_{OS1}}{\Delta V_{SUPPLY}}$ for Amplifier 1 and $\frac{\Delta V_{OS2}}{\Delta V_{SUPPLY}}$ for Amplifier 2, expressed in dB.

All min and max specifications are guaranteed.
Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS¹

Supply Voltage	±18 V
Internal Power Dissipation (Total: Both Amplifiers) ²	650 mW
Input Voltage	±V _S
Differential Input Voltage ³	+0.7 V
Output Short Circuit Duration	Indefinite
Storage Temperature Range (N, R)	–65°C to +125°C
Operating Temperature Range	
AD706J	0°C to +70°C
AD706A	–40°C to +85°C
Lead Temperature (Soldering 10 secs)	300°C

NOTES

¹Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; 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.

²Specification is for device in free air:

8-Lead PDIP Package: $\theta_{JA} = 100^{\circ}\text{C/W}$

8-Lead Small Outline Package: $\theta_{JA} = 155^{\circ}\text{C/W}$

³The input pins of this amplifier are protected by back-to-back diodes. If the differential voltage exceeds ±0.7 V, external series protection resistors should be added to limit the input current to less than 25 mA.

ESD CAUTION



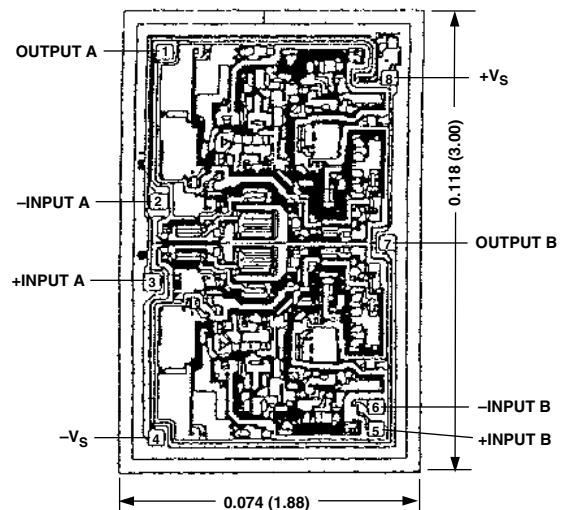
ESD (electrostatic discharge) sensitive device.

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

METALIZATION PHOTOGRAPH

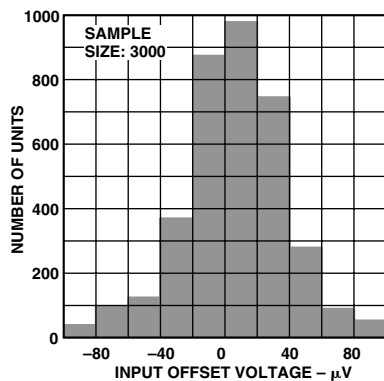
Dimensions shown in inches and (mm).

Contact factory for latest dimensions.

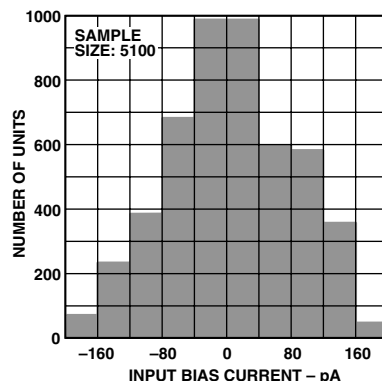


AD706—Typical Performance Characteristics

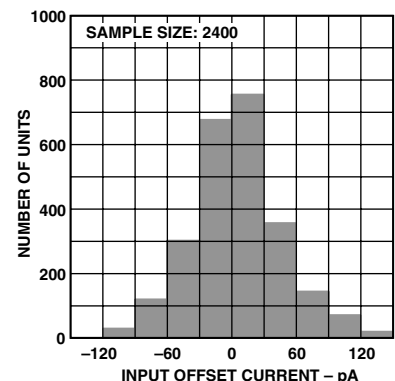
(Default Conditions: ± 5 V, $C_L = 5$ pF, $G = 2$, $R_g = R_f = 1$ k Ω , $R_L = 2$ k Ω , $V_O = 2$ V p-p, Frequency = 1 MHz, $T_A = 25^\circ\text{C}$)



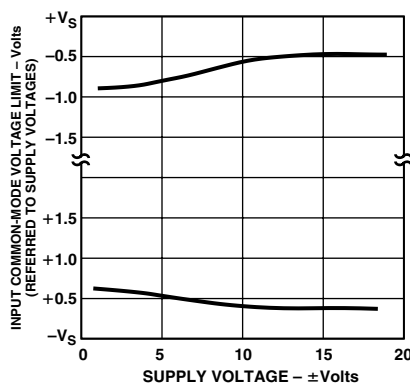
TPC 1. Typical Distribution of Input Offset Voltage



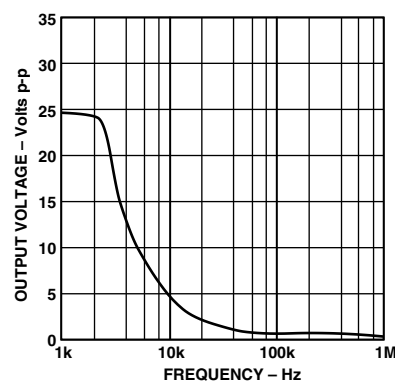
TPC 2. Typical Distribution of Input Bias Current



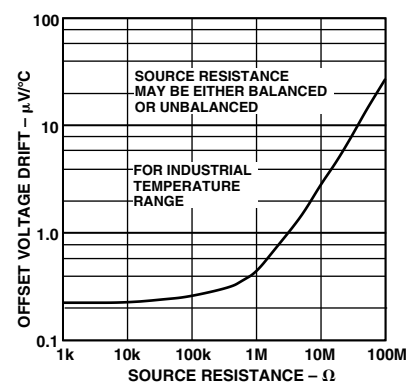
TPC 3. Typical Distribution of Input Offset Current



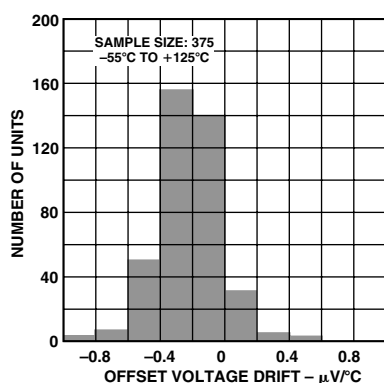
TPC 4. Input Common-Mode Voltage Range vs. Supply Voltage



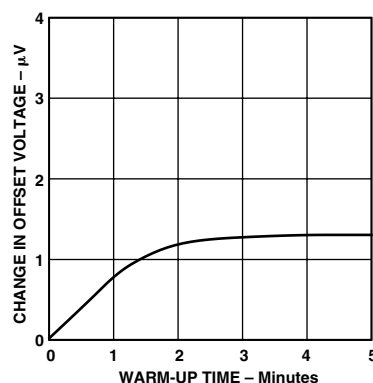
TPC 5. Large Signal Frequency Response



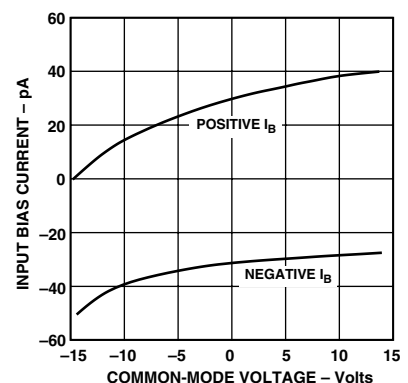
TPC 6. Offset Voltage Drift vs. Source Resistance



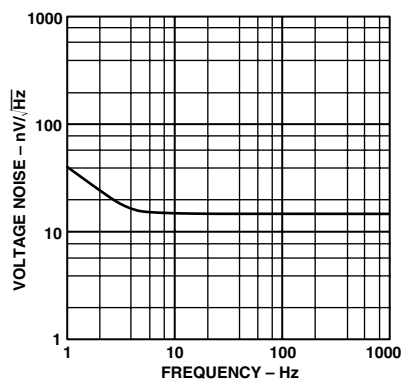
TPC 7. Typical Distribution of Offset Voltage Drift



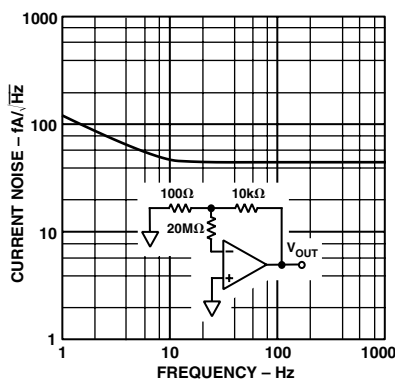
TPC 8. Change in Input Offset Voltage vs. Warm-Up Time



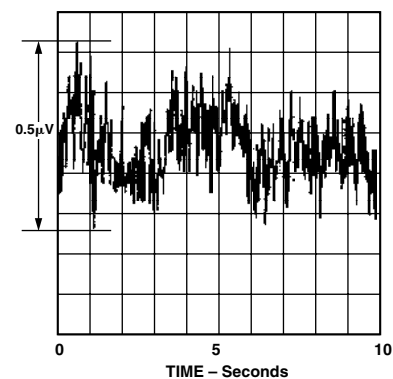
TPC 9. Input Bias Current vs. Common-Mode Voltage



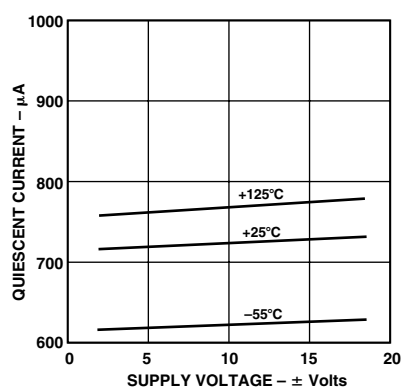
TPC 10. Input Noise Voltage Spectral Density



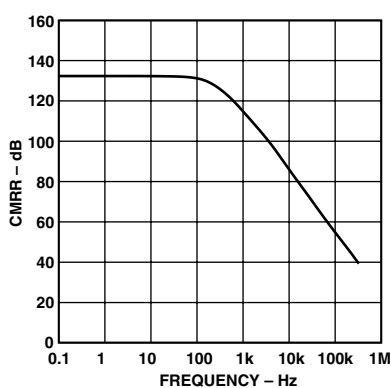
TPC 11. Input Noise Current Spectral Density



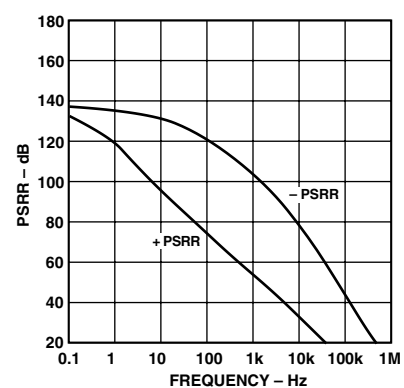
TPC 12. 0.1 Hz to 10 Hz Noise Voltage



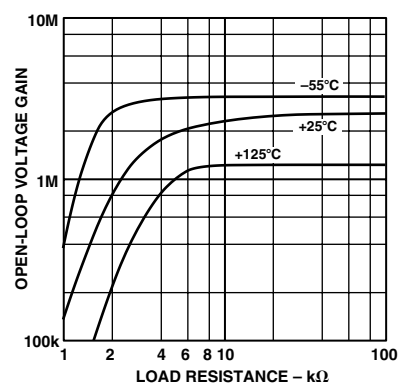
TPC 13. Quiescent Supply Current vs. Supply Voltage



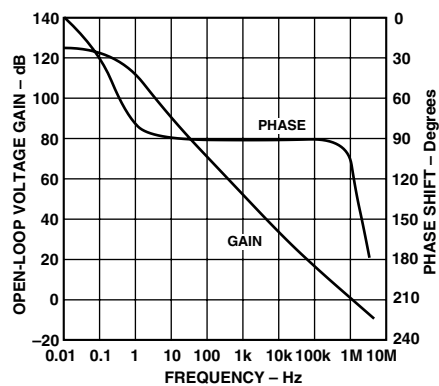
TPC 14. Common-Mode Rejection Ratio vs. Frequency



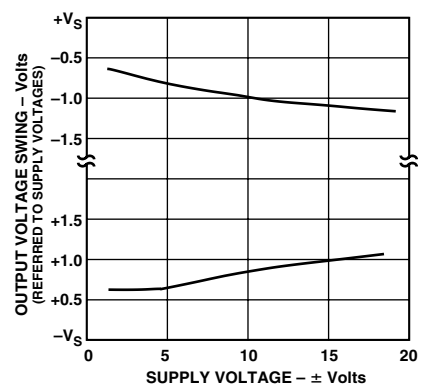
TPC 15. Power Supply Rejection Ratio vs. Frequency



TPC 16. Open-Loop Gain vs. Load Resistance vs. Load Resistance



TPC 17. Open-Loop Gain and Phase Shift vs. Frequency



TPC 18. Output Voltage Swing vs. Supply Voltage

AD706

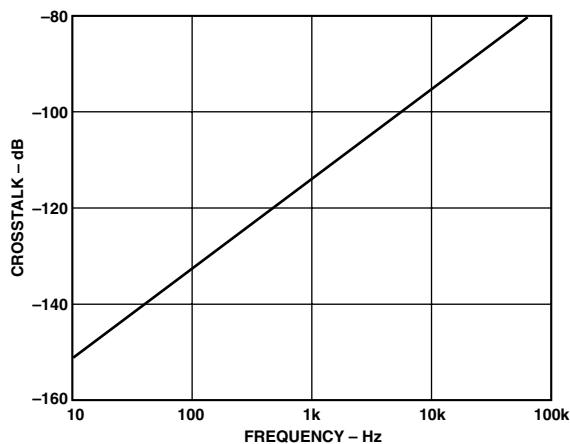


Figure 2a. Crosstalk vs. Frequency

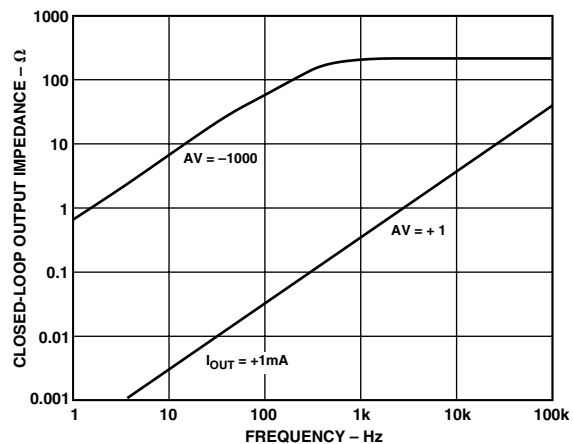


Figure 3. Magnitude of Closed-Loop Output Impedance vs. Frequency

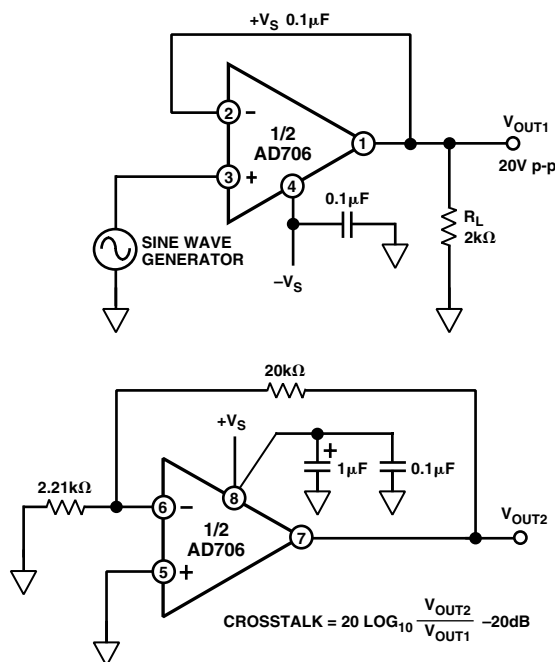


Figure 2b. Crosstalk Test Circuit

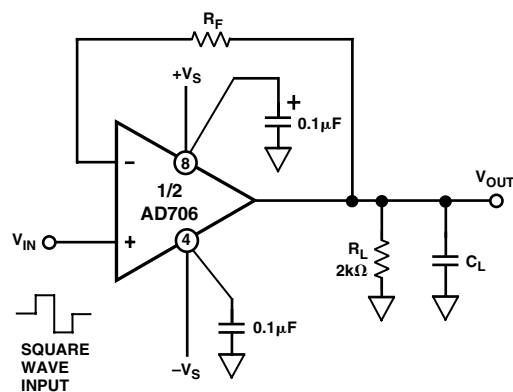


Figure 4a. Unity Gain Follower (For large signal applications, resistor R_F limits the current through the input protection diodes.)

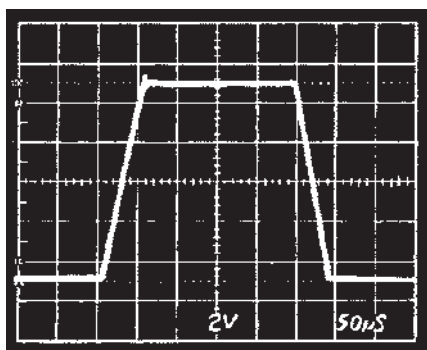


Figure 4b. Unity Gain Follower Large Signal Pulse Response, $R_F = 10 \text{ k}\Omega$, $C_L = 1,000 \text{ pF}$

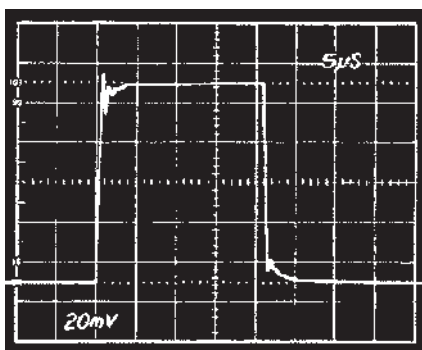


Figure 4c. Unity Gain Follower Small Signal Pulse Response, $R_F = 0 \Omega$, $C_L = 100 \text{ pF}$

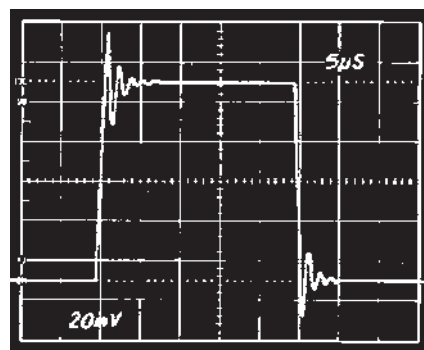


Figure 4d. Unity Gain Follower Small Signal Pulse Response, $R_F = 0 \Omega$, $C_L = 1000 \text{ pF}$

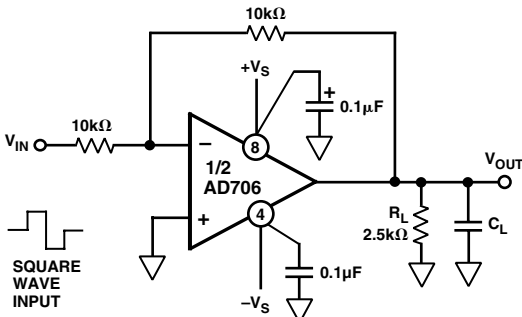


Figure 5a. Unity Gain Inverter Connection

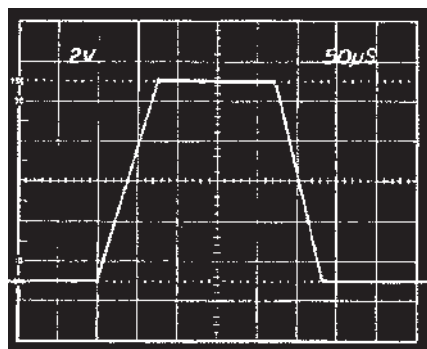


Figure 5b. Unity Gain Inverter Large Signal Pulse Response, $C_L = 1,000$ pF

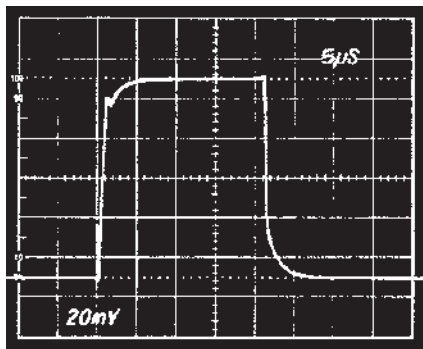


Figure 5c. Unity Gain Inverter Small Signal Pulse Response, $C_L = 100$ pF

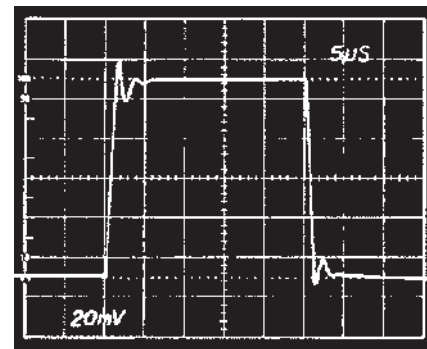


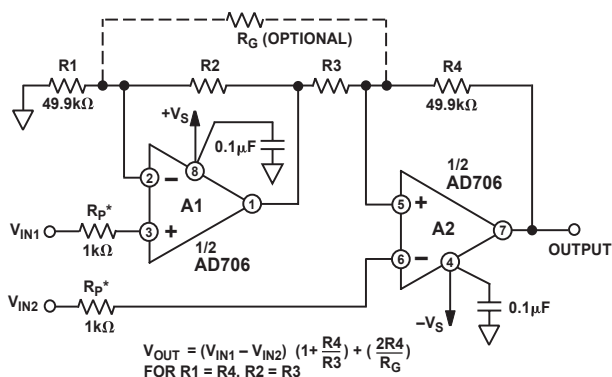
Figure 5d. Unity Gain Inverter Small Signal Pulse Response, $C_L = 1000 \text{ pF}$

Figure 6 shows an in-amp circuit that has the obvious advantage of requiring only one AD706, rather than three op amps, with subsequent savings in cost and power consumption. The transfer function of this circuit (without R_G) is

$$V_{OUT} = (V_{IN1} - V_{IN2}) \left(1 + \frac{R4}{R3} \right)$$

for $R1 = R4$ and $R2 = R3$.

Input resistance is high, thus permitting the signal source to have an unbalanced output impedance.



* OPTIONAL INPUT PROTECTION RESISTOR FOR GAINS GREATER THAN 100 OR INPUT VOLTAGES EXCEEDING THE SUPPLY VOLTAGE.

Figure 6. Two Op Amp Instrumentation Amplifier

Furthermore, the circuit gain may be fine trimmed using an optional trim resistor, R_G . Like the three op amp circuit, CMR increases with gain, once initial trimming is accomplished—but

CMR is still dependent upon the ratio matching of Resistors R1 through R4. Resistor values for this circuit, using the optional gain resistor, R_G , can be calculated using

$$R1 = R4 = 49.9 \text{ k}\Omega$$

$$R2 = R3 = \frac{49.9 \text{ k}\Omega}{0.9 \text{ G}-1}$$

$$R_G = \frac{99.8 \text{ k}\Omega}{0.06 \text{ G}}$$

where G = The desired circuit gain.

Table I provides practical 1% resistance values. Note that without resistor R_G , R_2 and $R_3 = 49.9 \text{ k}\Omega/\text{G}-1$.

Table I. Operating Gains of Amplifiers A1 and A2 and Practical 1% Resistor Values for the Circuit of Figure 6

Circuit	Gain	Gain of A1	Gain of A2	R2, R3	R1, R4
1.10		11.00	1.10	499 k Ω	49.9 k Ω
1.33		4.01	1.33	150 k Ω	49.9 k Ω
1.50		3.00	1.50	100 k Ω	49.9 k Ω
2.00		2.00	2.00	49.9 k Ω	49.9 k Ω
10.1		1.11	10.10	5.49 k Ω	49.9 k Ω
101.0		1.01	101.0	499 Ω	49.9 k Ω
1001		1.001	1001	49.9 Ω	49.9 k Ω

For a much more comprehensive discussion of in-amp applications, refer to the *Instrumentation Amplifier Applications Guide*—available free from Analog Devices, Inc.

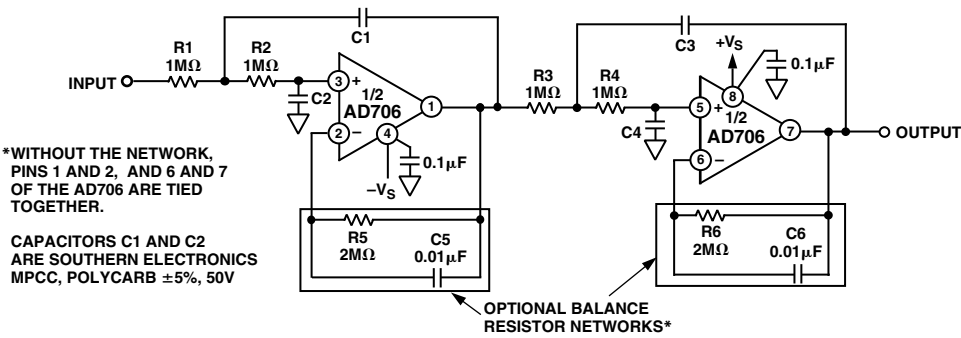


Figure 7. 1 Hz, 4-Pole Active Filter

1 Hz, 4-Pole, Active Filter

Figure 7 shows the AD706 in an active filter application. An important characteristic of the AD706 is that both the input bias current, input offset current, and their drift remain low over most of the op amp's rated temperature range. Therefore, for most applications, there is no need to use the normal balancing resistor. Adding the balancing resistor enhances performance at high temperatures, as shown by Figure 8.

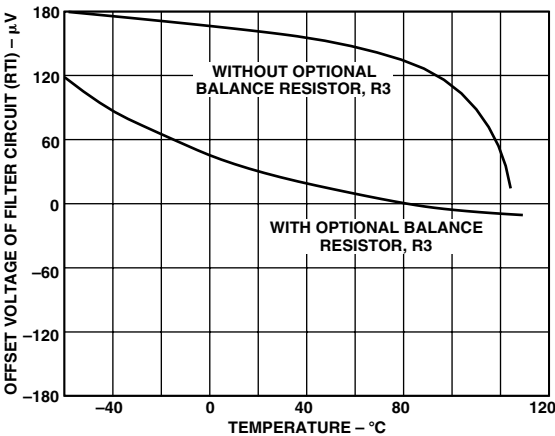


Figure 8. V_{OS} vs. Temperature Performance of the 1 Hz Filter

Table II. 1 Hz, 4-Pole, Low Pass Filter Recommended Component Values

Desired Low Pass Response	Section 1 Frequency (Hz)	Q	Section 2 Frequency (Hz)	Q	C1 (μF)	C2 (μF)	C3 (μF)	C4 (μF)
Bessel	1.43	0.522	1.60	0.806	0.116	0.107	0.160	0.0616
Butterworth	1.00	0.541	1.00	1.31	0.172	0.147	0.416	0.0609
0.1 dB Chebychev	0.648	0.619	0.948	2.18	0.304	0.198	0.733	0.0385
0.2 dB Chebychev	0.603	0.646	0.941	2.44	0.341	0.204	0.823	0.0347
0.5 dB Chebychev	0.540	0.705	0.932	2.94	0.416	0.209	1.00	0.0290
1.0 dB Chebychev	0.492	0.785	0.925	3.56	0.508	0.206	1.23	0.0242

NOTE
Specified Values are for a -3 dB point of 1.0 Hz. For other frequencies simply scale capacitors C1 through C4 directly, i.e. for 3 Hz Bessel response, C1 = 0.0387 μF, C2 = 0.0357 μF, C3 = 0.0533 μF, C4 = 0.0205 μF.

Figure 1: Mechanical drawings of the BSC 1000. The figure includes three views: a top view, a front view, and a side view. The top view shows a rectangular component with dimensions 0.400 (10.16) x 0.365 (9.27) x 0.355 (9.02). It features four pins labeled 1, 4, 5, and 8. The front view shows the component's profile with dimensions 0.280 (7.11) x 0.250 (6.35) x 0.240 (6.10). The side view shows the component's side profile with dimensions 0.325 (8.26) x 0.310 (7.87) x 0.300 (7.62). The BSC 1000 is a 10-pin connector with a 0.100 (2.54) pitch. The drawing also shows the seating plane and gauge plane, and the minimum and maximum dimensions for the pins and the component body.

070606-A

Dimensions shown in inches and (millimeters)

012407-A

Figure 10. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-8)

Model	Temperature Range	Package Description	Package Option
AD706AR	−40°C to +85°C	8-Lead SOIC_N	R-8
AD706ARZ	−40°C to +85°C	8-Lead SOIC_N	R-8
AD706ARZ-REEL	−40°C to +85°C	8-Lead SOIC_N, 13" Tape and Reel	R-8
AD706ARZ-REEL7	−40°C to +85°C	8-Lead SOIC_N, 7" Tape and Reel	R-8
AD706JNZ	0°C to +70°C	8-Lead PDIP	N-8
AD706JRZ	0°C to +70°C	8-Lead SOIC_N	R-8
AD706JRZ-REEL	0°C to +70°C	8-Lead SOIC_N, 13" Tape and Reel	R-8
AD706JRZ-REEL7	0°C to +70°C	8-Lead SOIC_N, 7" Tape and Reel	R-8

REVISION HISTORY**7/2018—Rev. F to Rev. G**

Changed Plastic Mini-DIP to PDIP	Universal
Updated Outline Dimensions.....	10

8/2017—Rev. E to Rev. F

Changes to Figure 6.....	6
Updated Outline Dimensions.....	10
Changes to Ordering Guide.....	10

10/2003—Rev. D to Rev. E

Removed K Version	Universal
Changes to Features and Product Description.....	1
Renumbered TPC's	4
Renumbered Figured	6
Updated Outline Dimensions.....	9

10/2002—Rev. C to Rev. D

Deleted 8-Lead Cerdip (Q-8) Package	Universal
Changes to Features and Product Description.....	1
Changes to Specifications Section.....	2
Changes to Absolute Maximum Ratings Section.....	3
Changes to Ordering Guide.....	3
Updated Outline Dimensions.....	15

