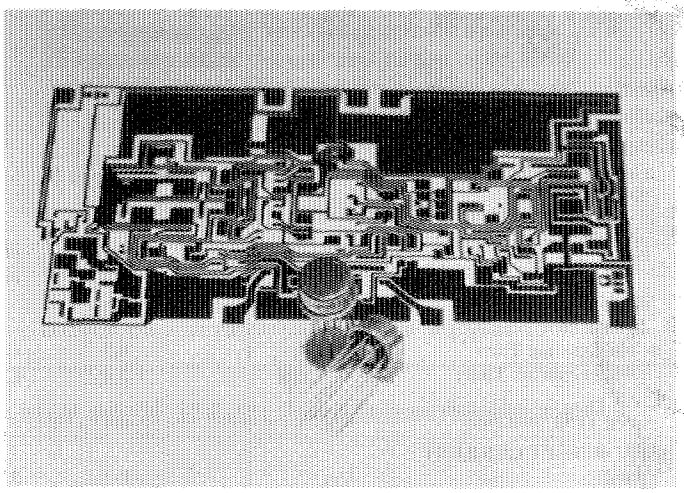
ANALOG DEVICES

Ultra-Low Offset Voltage Op Amp

AD OP-07

FEATURES

- Ten Times More Gain Than Other OP-07 Devices (3.0M min)
- Ultra-Low Offset Voltage: 10μV
- Ultra-Low Offset Voltage Drift: 0.2μV/°C
- Ultra-Stable vs. Time: 0.2μV/month
- Ultra-Low Noise: 0.35μV p-p
- No External Components Required
- Monolithic Construction
- High Common Mode Input Range: ±14.0V
- Wide Power Supply Voltage Range: ±3V to ±18V
- Fits 725, 108A/308A Sockets



PRODUCT DESCRIPTION

The AD OP-07 is an improved version of the industry-standard OP-07 precision operational amplifier. A guaranteed minimum open-loop voltage gain of 3,000,000 (AD OP-07A) represents an order of magnitude improvement over older designs; this affords increased accuracy in high closed loop gain applications. Input offset voltages as low as 10μV, bias currents of 0.7nA, internal compensation and device protection eliminate the need for external components and adjustments. An input offset voltage temperature coefficient of 0.2μV/°C and long-term stability of 0.2μV/month eliminate recalibration or loss of initial accuracy.

A true differential operational amplifier, the AD OP-07 has a high common mode input voltage range (±14V) high common mode rejection ratio (up to 126dB) and high differential input impedance (50MΩ); these features combine to assure high accuracy in noninverting configurations. Such applications include instrumentation amplifiers, where the increased open-loop gain maintains high linearity at high closed-loop gains.

The AD OP-07 is available in five performance grades. The AD OP-07E, AD OP-07C and AD OP-07D are specified for operation over the 0 to +70°C temperature range, while the AD OP-07A and AD OP-07 are specified for −55°C to +125°C operation. Processing to the requirements of MIL-STD-883, Class B, is available on the AD OP-07 and AD OP-07A. The devices are packaged in either TO-99 hermetically-sealed metal cans or plastic 8-pin mini DIPS.

PRODUCT HIGHLIGHTS

1. Increased open-loop voltage gain (3.0 million, min) results in better accuracy and linearity in high closed-loop gain applications.
2. Ultra-low offset voltage and offset voltage drift, combined with low input bias currents, allow the AD OP-07 to maintain high accuracy over the entire operating temperature range.
3. Internal frequency compensation, ultra-low input offset voltage and full device protection eliminate the need for additional components. This reduces circuit size and complexity and increases reliability.
4. High input impedances, large common mode input voltage range and high common mode rejection ratio make the AD OP-07 ideal for noninverting and differential instrumentation applications.
5. Monolithic construction along with advanced circuit design and processing techniques result in low cost.
6. The input offset voltage is trimmed at the wafer stage. Unmounted chips are available for hybrid circuit applications.

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SPECIFICATIONS (T_A = +25°C, V_S = ±15V, unless otherwise specified)

MODEL		AD OP-07E			AD OP-07C			AD OP-07D		
PARAMETER	SYMBOL	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
OPEN LOOP GAIN	A_{VO}	2,000	5,000		1,200	4,000		1,200	4,000	
		1,800	4,500		1,000	4,000		1,000	4,000	
		300	1,000		300	1,000		300	1,000	
OUTPUT CHARACTERISTICS										
Maximum Output Swing	V_{OM}	±12.5	±13.0		±12.0	±13.0		±12.0	±13.0	
		±12.0	±12.8		±11.5	±12.8		±11.5	±12.8	
		±10.5	±12.0			±12.0				
		±12.0	±12.6		±11.0	±12.6		±11.0	±12.6	
Open-Loop Output Resistance	R_O		60			60			60	
FREQUENCY RESPONSE										
Closed Loop Bandwidth	BW		0.6			0.6			0.6	
Slew Rate	SR		0.17			0.17			0.17	
INPUT OFFSET VOLTAGE										
Initial	V_{OS}		30	75		60	150		60	150
			45	130		85	250		85	250
Adjustment Range			±4			±4			±4	
Average Drift							(Note 3)			(Note 3)
No External Trim	TCV_{OS}		0.3	1.3		0.5	1.8		0.7	2.5
With External Trim	TCV_{OSN}		0.3	1.3		0.4	1.6		0.7	2.5
							(Note 3)			(Note 3)
Long Term Stability	V_{OS}/Time		0.3	1.5		0.4	2.0		0.5	3.0
INPUT OFFSET CURRENT										
Initial	I_{OS}		0.5	3.8		0.8	6.0		0.8	6.0
			0.9	5.3		1.6	8.0		1.6	8.0
Average Drift	TCI_{OS}		8 (Note 3)	35		12 (Note 3)	50		12 (Note 3)	50
INPUT BIAS CURRENT										
Initial	I_B		±1.2	±4.0		±1.8	±7.0		±2.0	±12
			±1.5	±5.5		±2.2	±9.0		±3.0	±14
Average Drift	TCI_B		13 (Note 3)	35		18 (Note 3)	50		18 (Note 3)	50
INPUT RESISTANCE										
Differential	R_{IN}	15	50		8	33		7	31	
Common Mode	R_{IN} CM		160			120			120	
INPUT NOISE										
Voltage	e_n p-p		0.35	0.6		0.38	0.65		0.38	0.65
Voltage Density	e_n		10.3	18.0		10.5	20.0		10.5	20.0
			10.0	13.0		10.2	13.5		10.2	13.5
			9.6	11.0		9.8	11.5		9.8	11.5
Current	i_n p-p		14	30		15	35		15	35
Current Density	i_n		0.32	0.80		0.35	0.90		0.35	0.90
			0.14	0.23		0.15	0.27		0.15	0.27
			0.12	0.17		0.13	0.18		0.13	0.18
INPUT VOLTAGE RANGE										
Common Mode	CMVR	±13.0	±14.0		±13.0	±14.0		±13.0	±14.0	
		±13.0	±13.5		±13.0	±13.5		±13.0	±13.5	
Common Mode Rejection Ratio	CMRR	106	123		100	120		94	110	
		103	123		97	120		94	106	
POWER SUPPLY										
Current, Quiescent	I_Q		3.0	4.0		3.5	5.0		3.5	5.0
Power Consumption	P_D		90	120		105	150		105	150
			6.0	8.4		6.0	8.4		6.0	8.4
Rejection Ratio	PSRR	94	107		90	104		90	104	
		90	104		86	100		86	100	
OPERATING TEMPERATURE										
RANGE	T_{min}, T_{max}	0		+70	0		+70	0		+70
PACKAGE STYLE										
"N" Package										
8-Pin Mini DIP			AD OP-07EN			AD OP-07CN			AD OP-07DN	
"H" Package										
TO-99			AD OP-07EH			AD OP-07CH			AD OP-07DH	

NOTES:
[1] The AD OP-07A and AD OP-07 are available processed to MIL-STD-883, Class B. Order AD OP-07AH-883B or AD OP-07H-883B.
[2] Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power. Additionally, AD OP-07A offset voltage is measured five minutes after power supply application at 25°C, -55°C and +125°C.
[3] Parameter is not 100% tested; 90% of units meet this specification.
[4] Long Term Input Offset Voltage Stability refers to the averaged trend line of V_{OS} vs. Time over extended periods of time and is extrapolated from high temperature test data. Excluding the initial hour of operation, changes in V_{OS} during the first 30 operating days are typically 2.5μV -- Parameter is not 100% tested: 90% of units meet this specification.

Specifications subject to change without notice.

AD OP-07AH (AD OP-07-AH-883B)[1]			AD OP-07H (AD OP-07-H-883B)[1]				
MIN	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**TEST CONDITIONS**	**UNITS**
3,000	5,000		2,000	5,000		$R_L \geq 2k\Omega$, $V_O = \pm 10V$	V/mV
2,000	4,000		1,500	4,000		$R_L \geq 2k\Omega$, $V_O = \pm 10V$, T_{min} to T_{max}	V/mV
300	1,000		300	1,000		$R_L \geq 500\Omega$, $V_O = \pm 0.5V$, $V_S = \pm 3V$	V/mV
±12.5	±13.0		±12.5	±13.0		$R_L \geq 10k\Omega$	V
±12.0	±12.8		±12.0	±12.8		$R_L \geq 2k\Omega$	V
±10.5	±12.0		±10.5	±12.0		$R_L \geq 1k\Omega$	V
±12.0	±12.6		±12.0	±12.6		$R_L \geq 2k\Omega$, T_{min} to T_{max}	V
	60			60		$V_O = 0$, $I_O = 0$	Ω
	0.6			0.6		$A_{VCL} = +1.0$	MHz
	0.17			0.17		$R_L \geq 2k$	V/μs
	10	25		30	75	Note 2	μV
	25	60		60	200	Note 2, T_{min} to T_{max}	μV
	±4			±4		$R_P = 20k\Omega$	mV
	0.2	0.6		0.3	1.3	T_{min} to T_{max}	μV/°C
	0.2	0.6		0.3	1.3	$R_P = 20k\Omega$, T_{min} to T_{max}	μV/°C
	0.2	1.0		0.2	1.0	Note 4	μV/Month
	0.3	2.0		0.4	2.8		nA
	0.8	4.0		1.2	5.6	T_{min} to T_{max}	nA
	5	25		8	50	T_{min} to T_{max}	pA/°C
	±0.7	±2.0		±1.0	±3.0		nA
	±1.0	±4.0		±2.0	±6.0	T_{min} to T_{max}	nA
	8	25		13	50	T_{min} to T_{max}	pA/°C
30	80		20	60			MΩ
	200			200			GΩ
	0.35	0.6		0.35	0.6	0.1Hz to 10Hz, Note 3	μV p-p
	10.3	18.0		10.3	18.0	f_O = 10Hz, Note 3	nV/√Hz
	10.0	13.0		10.0	13.0	f_O = 100Hz, Note 3	nV/√Hz
	9.6	11.0		9.6	11.0	f_O = 1kHz, Note 3	nV/√Hz
	14	30		14	30	0.1Hz to 10Hz, Note 3	pA p-p
	0.32	0.80		0.32	0.80	f_O = 10Hz, Note 3	pA/√Hz
	0.14	0.23		0.14	0.23	f_O = 100Hz, Note 3	pA/√Hz
	0.12	0.17		0.12	0.17	f_O = 1kHz, Note 3	pA/√Hz
±13.0	±14.0		±13.0	±14.0			V
±13.0	±13.5		±13.0	±13.5		T_{min} to T_{max}	V
110	126		110	126		V_{CM} = ±CMVR	dB
106	123		106	123		V_{CM} = ±CMVR, T_{min} to T_{max}	dB
	3.0	4.0		3.0	4.0	$V_S = \pm 15V$	mA
	90	120		90	120	$V_S = \pm 15V$	mW
	6.0	8.4		6.0	8.4	$V_S = \pm 3V$	mW
100	110		100	110		$V_S = \pm 3V$ to $\pm 18V$	dB
94	106		94	106		$V_S = \pm 3V$ to $\pm 18V$, T_{min} to T_{max}	dB
-55		+125	-55		+125		°C
	—			—			
	AD OP-07AH			AD OP-07H			

ABSOLUTE MAXIMUM RATINGS

Supply Voltage . . . . . ±22V
Internal Power Dissipation (Note 1) 500mW
Differential Input Voltage . . . . . ±30V
Input Voltage (Note 2) . . . . . ±22V
Output Short Circuit Duration . . . . . Indefinite
Storage Temperature Range . . . . . -65°C to +150°C
Operating Temperature Range
OP-07A, OP-07 . . . . . -55°C to +125°C
OP-07E, OP-07C, OP-07D . . . . . 0 to +70°C
Lead Temperature Range (Soldering, 60sec) . . . . . 300°C

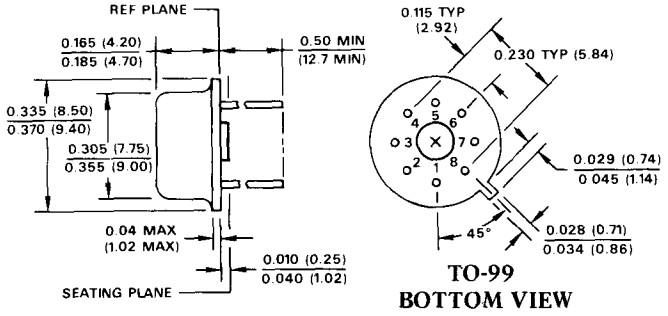
NOTES:
Note 1: Maximum package power dissipation vs. ambient temperature.

Package Type	Maximum Ambient Temperature for Rating	Derate Above Maximum Ambient Temperature
TO-99 (H)	80°C	7.1mW/°C

Note 2: For supply voltages less than ±22V, the absolute maximum input voltage is equal to the supply voltage.

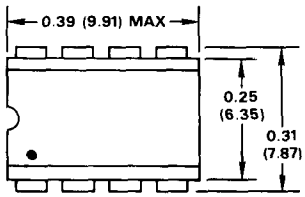
OUTLINE DIMENSIONS

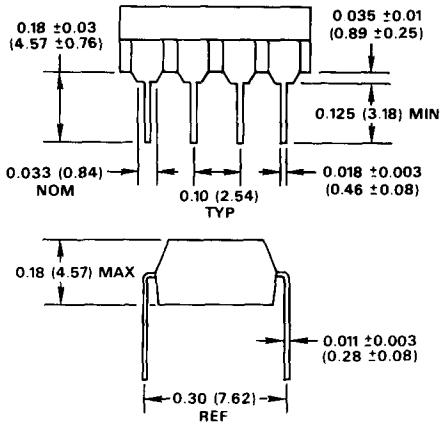
Dimensions shown in inches and (mm).



TO-99
BOTTOM VIEW

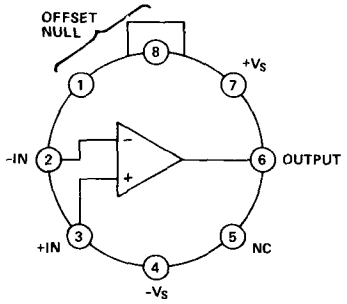
H-PACKAGE



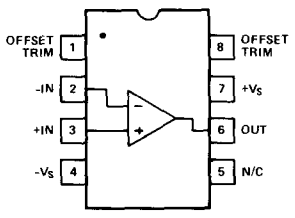


N-PACKAGE

PIN CONFIGURATION
TOP VIEW



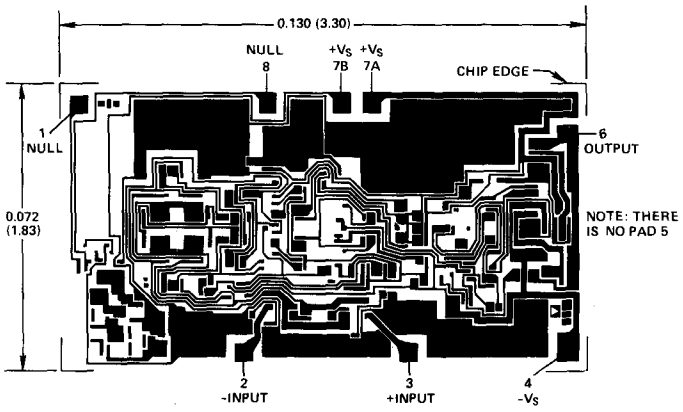
H-PACKAGE



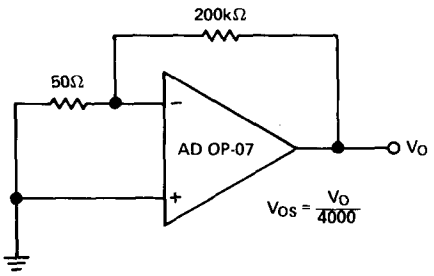
N-PACKAGE

CHIP DIMENSIONS AND BONDING DIAGRAM

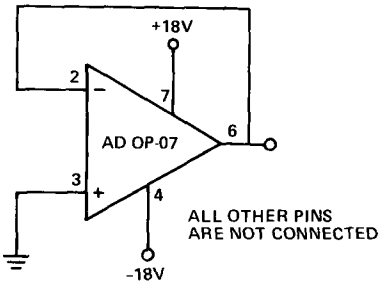
Dimensions shown in inches and (mm).



The AD OP-07 is available in wafer-trimmed chip form for precision hybrids. Consult the factory directly for details.



Offset Voltage Test Circuit



Burn-In Circuit

The AD OP-07 may be directly substituted for other OP-07's as well as 725, 108/208/308, 108A/208A/308A, 714, OP-05 or LM11 devices, with or without removal of external frequency compensation or offset nulling components. If used to replace 741 devices, offset nulling components must be removed (or referenced to $+V_S$). Input offset voltage of the AD OP-07 is very low, but if additional nulling is required, the circuit shown in Figure 1 is recommended.

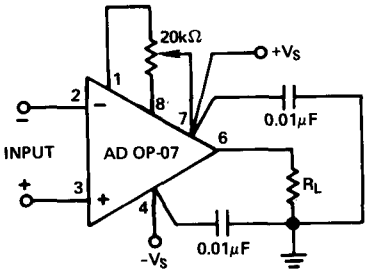


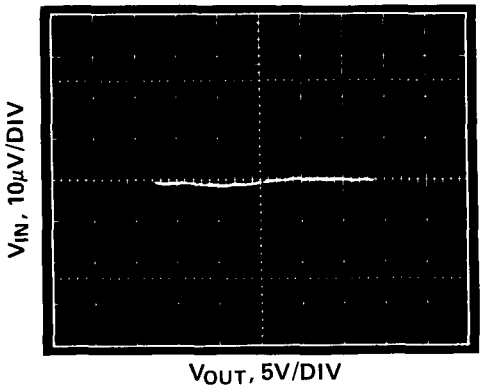
Figure 1. Optional Offset Nulling Circuit and Power Supply Bypassing

The AD OP-07 provides stable operation with load capacitances up to 500pF and ±10V swings; larger capacitances should be decoupled with 50Ω resistor.

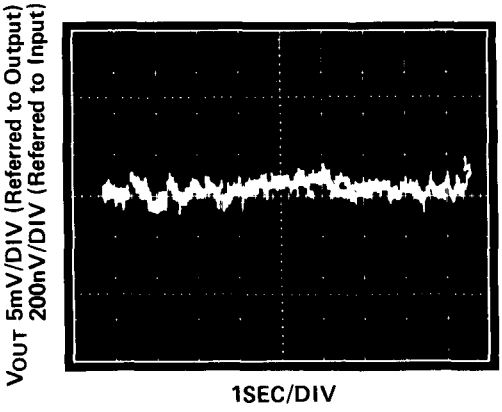
Stray thermoelectric voltages generated by dissimilar metals (thermocouples) at the contacts to the input terminals can prevent realization of the drift performance indicated. Best operation will be obtained when both input contacts are maintained at the same temperature, preferably close to the temperature of the device's package.

Although the AD OP-07 features high power supply rejection, the effects of noise on the power supplies may be minimized by bypassing the power supplies as close to pins 4 and 7 of the AD OP-07 as possible, to load ground with a good-quality 0.01μF ceramic capacitor as shown in Figure 1.

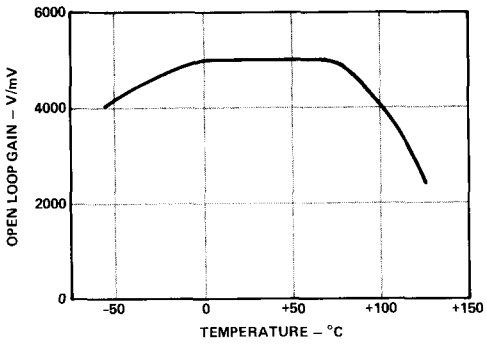
Performance Curves (typical @ T_A = +25°C, V_S = ±15V, AD OP-07 Grade Device unless otherwise noted)



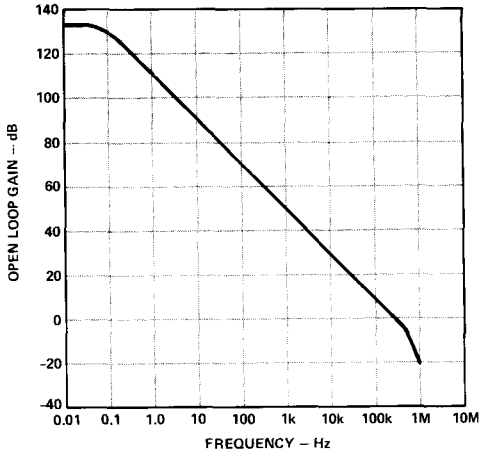
AD OP-07 Open Loop Gain Curve



AD OP-07 Low Frequency Noise (See Test Circuit, on the Previous Page)

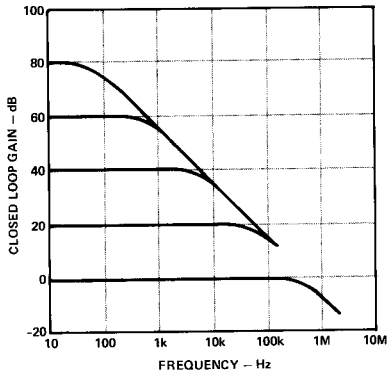


Open Loop Gain vs. Temperature

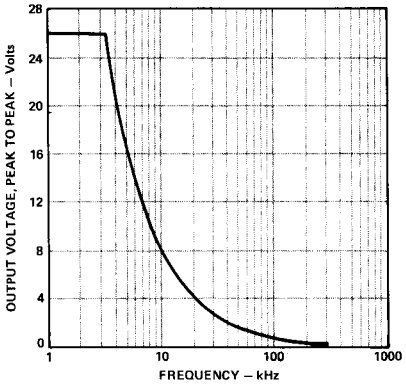


Open Loop Frequency Response

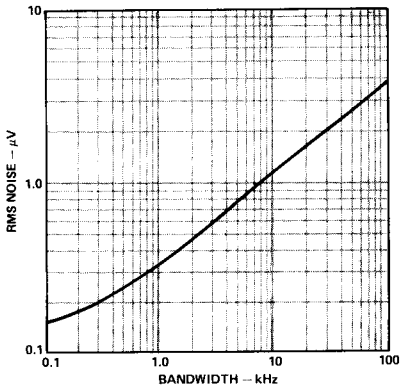
Typical Performance Curves



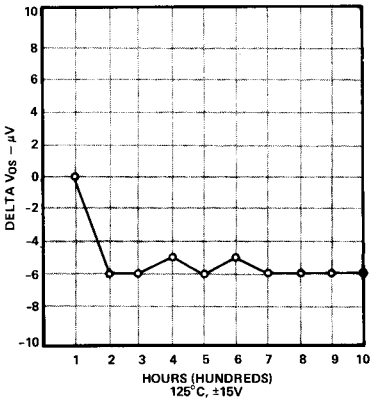
Closed Loop Response for Various Gain Configurations



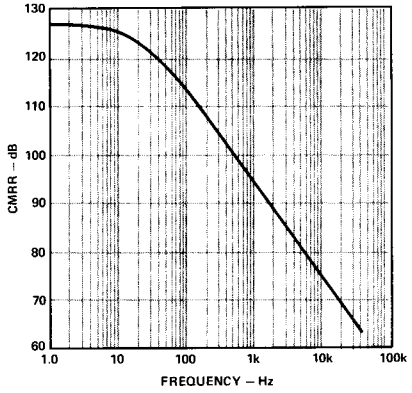
Maximum Undistorted Output vs. Frequency



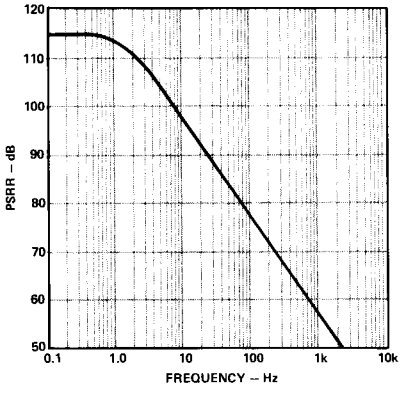
Input Wideband Noise vs. Bandwidth (0.1kHz to Frequency Indicated)



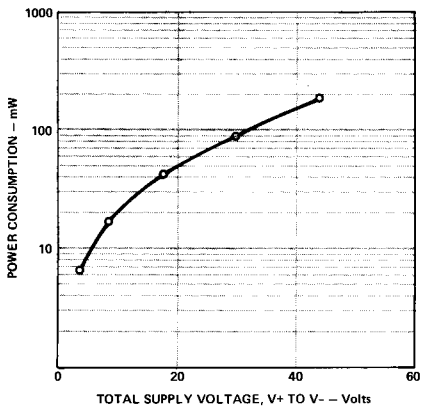
Offset Voltage vs. Time



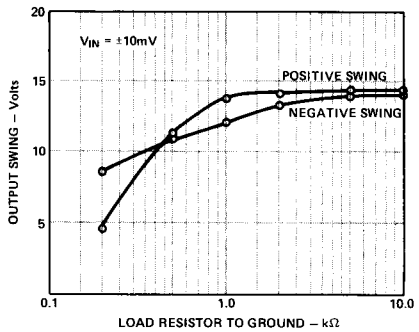
CMRR vs. Frequency



PSRR vs. Frequency



Power Consumption vs. Power Supply



Output Voltage vs. Load Resistance

C568b–8–1/83

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