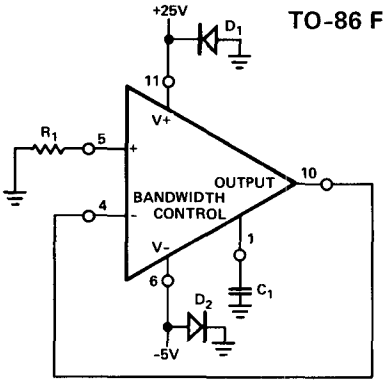
BURN-IN CIRCUITS

1 HA-909

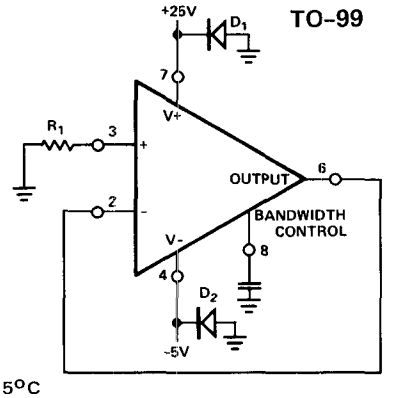
TO-86 Flat Pack



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 µF, 100V

2 HA-909, HA-2500, HA-2502, HA-2510, HA-2512, HA-2520, HA-2522, HA-2600, HA-2602, HA-2620, HA-2622, HA-2050, HA-2050A, HA-2060, HA-2060A

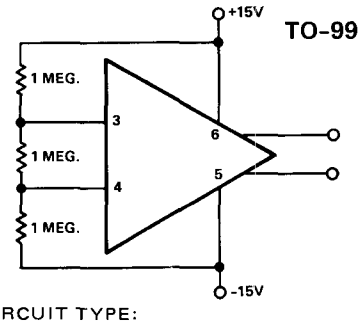
TO-99



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 µF, 100V

3 HA-2000

TO-99



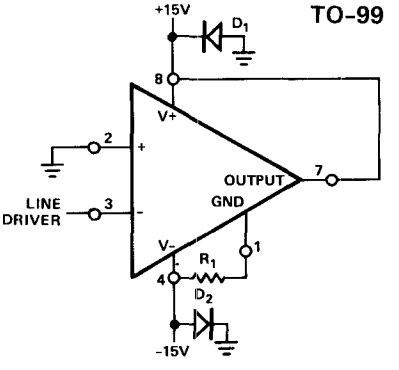
CIRCUIT TYPE:
FET Front End

DESIGNATION:
HA-2000

OPERATING LIFE TEST CONDITION:
1) TEMPERATURE: +125°C
2) VOLTAGE: ±15 Volts

4 HA-2111

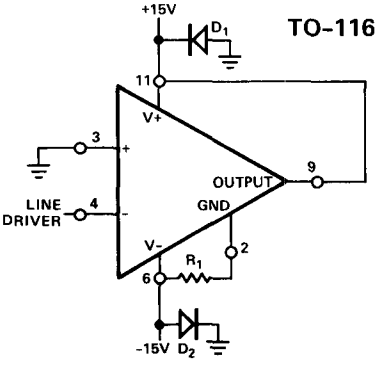
TO-99



NOTES:
T_A = +125°C
R_1 = 300Ω
$D_{1,2}$ = IN4002
Freq: 50 KHz @ 12V peak to peak

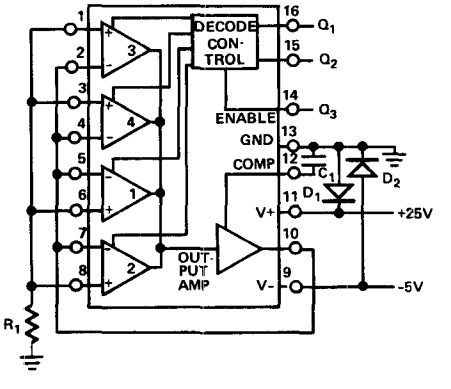
5 HA-2111

TO-116



NOTES:
T_A = +125°C
R_1 = 300Ω
$D_{1,2,}$ = IN4002
Freq: = 50KHz @ 12V peak to peak

6 HA-2400

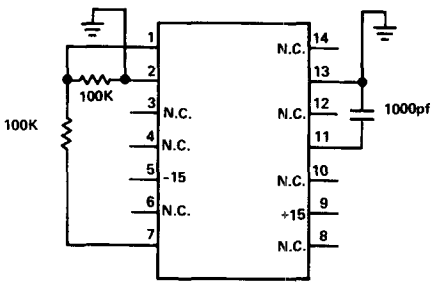


NOTES:
T_A = +125°C
R_1 = 100KΩ
C_1 = 910pF, 50V
$D_{1,2}$ = IN4002
Freq: Q_1 = 100KHz; Q_2 = 50KHz; Q_3 = 25KHz

DASH 8

7 HA-2420

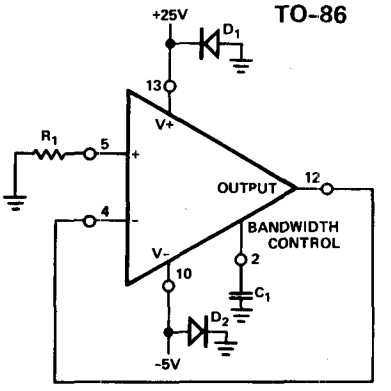
TO-99



NOTE:
T_A = +125°C

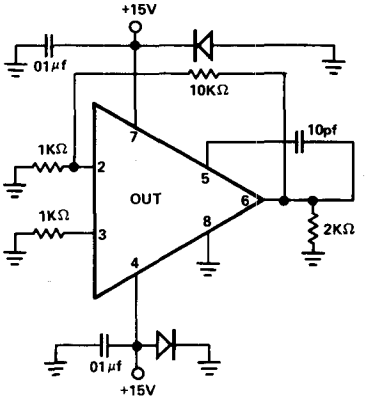
8 HA-2500, HA-2502, HA-2510, HA-2512, HA-2520, HA-2522

TO-86



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 µF, 50V

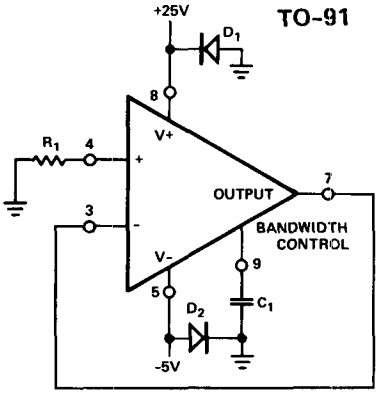
9 HA-2530



NOTE: T_A = +125°C

10 HA-2600, HA-2602, HA-2620, HA-2622

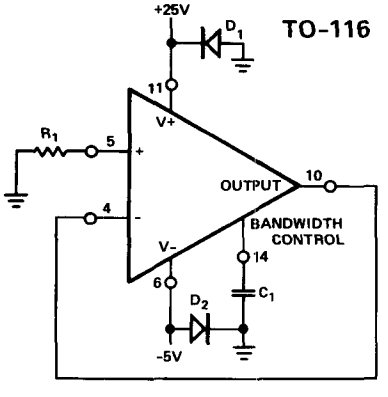
TO-91



NOTES:
T_A = +125°C
R_1 = 1Megohm
C_1 = 0.01 µF, 100V

11 HA-2620/2622

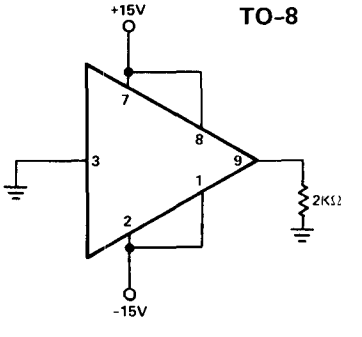
TO-116



NOTES:
T_A = +125°C
R_1 = 1 Megohm
C_1 = 0.01 µF, 100V

12 HA-2630

TO-8



NOTE:
T_A = +125°C

HARRIS OPERATIONAL AMPLIFIERS

Selection Guide for Military Applications

PARAMETER†	-55°C to +125°C													
		F.E.T. PREAMP						PRAM™	S/H					
	HA-909	HA-2000	HA-2000A	HA-2050	HA-2050A	HA-2060	HA-2060A	HA-2400	HA-2420	HA-2500	HA-2502	HA-2510	HA-2512	UNITS
INPUT CHARACTERISTICS														
Offset Voltage	6	25	12	30	17	30	15	7	6	8	10	11	14	mV
Drift (Typ.)	10	50	20	50	20	50	20	20	5	20	20	20	25	µV/°C
Bias Current	300 (1)	10	10	10	10	10	10	400	400	400	500	400	500	nA
Offset Current	300	5	5	5	5	5	5	100	100	50	100	50	100	nA
Common Mode Range	±12	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	V
INPUT NOISE (1)	5													µVRMS
TRANSFER CHARACTERISTICS														
Large Signal Voltage Gain	25K	.98	.98	5K	5K	60K	60K	25K	25K	15K	10K	7.5K	5K	V/V
Common Mode Rejection Ratio	80	80	80	74	74	74	74	80	80	80	74	80	74	dB
Bandwidth (Typ.) (1)	7	10	10	20(3)	20(3)	24(3)	24(3)	16(3)	2	12	12	12	12	MHz
OUTPUT CHARACTERISTICS														
Output Voltage Swing	±12	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	V
Output Current (1)	±20	+5(1)	+5(1)	±10(1)	±10(1)	±10(1)	±10(1)	±20(1)	±10	±10	±10	±10	±10	mA
Full Power Bandwidth (Typ.) (1)	25	1,000(3)	1,000(3)	2,000(3)	2,000 (3)	600 (3)	600(3)	500(3)	70	500	500	1,000	1,000	kHz
TRANSIENT RESPONSE														
Rise Time (1)	75	50(3)	50(3)	50(3)	50 (3)	50(3)	50(3)	20(3)	100(3)	50	50	50	50	ns
Overshoot (1)	40	5(3)	5(3)	25(3)	25(3)	25(3)	25(3)	25(3)	20(3)	40	50	40	50	%
Slew Rate (1)	± 1.2	100(3)	100(3)	120(3)	120(3)	35(3)	35(3)	50(3)	5(3)	± 25	±20	±50	±40	V/µs
Settling Time (Typ.) (1)	(2)	(3) 0.4	(3) 0.4	(3) 0.4	(3) 0.4	(3) 0.8	(3) 0.8	(3) 1.5		0.33	0.33	0.25	0.25	µs
POWER SUPPLY CHARACTERISTICS														
Supply Current (1)	2.5	(1) 1.7	(1) 1.7	(1) 8.0	(1) 8.0	(1) 6.0	(1) 6.0	(1) 6.0	5.0	6.0	6.0	6.0	6.0	mA
Power Supply Rejection Ratio	80	80	80	74	74	74	74	80	80	80	74	80	74	dB
FUNCTIONAL CHARACTERISTICS														
Offset Adjust	Yes*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	
Compensation Components	0	0	0	0AV>3	0AV>3	0AV>5	0AV>5	0AV>10	0	0	0	0	0	
Output Protection	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	

PARAMETER†	-55°C to +125°C														
	HA-2520	HA-2522	HA-2530	HA-2600	HA-2602	HA-2620	HA-2622	HA-2630	HA-2640	HA-2650	HA-2700	HA-2720	HA-2730	HA-2900	UNITS
INPUT CHARACTERISTICS												(5)	(5)		
Offset Voltage	11	14	3	6	7	6	7	± 300	6	± 5	5	5	5	.06	mV
Drift (Typ.)	20	25	5	5	5	5	5	(2)	15	8	5	8 to 10	8 to 10	.3	µV/°C
Bias Current	400	500	100	30	60	35	60	200	50	200	50	10 to 40	10 to 40	1	nA
Offset Current	50	100	20	30	60	35	60	(2)	35	60	30	7.5 to 20	7.5 to 20	.5	nA
Common Mode Range	±10	±10	± .5	±11	±11	±11	11	± 10	±35(4)	±13	±11	± 10	± 10	±10	V
INPUT NOISE (1)															µVRMS
TRANSFER CHARACTERISTICS												(5)	(5)		
Large Signal Voltage Gain	7.5K	5K	100K	70K	60K	70K	60K	.85	75K	20K	100K	25K	25K	10^6	V/V
Common Mode Rejection Ratio	80	74	86	80	74	80	74	(2)	80	80	86	80	80	120	dB
Bandwidth (Typ.) (1)	25	25	20	12	12	35	35	8	4	8	1	.01 to 10	.01 to 10	3	MHz
OUTPUT CHARACTERISTICS												(5)	(5)		
Output Voltage Swing	±10	±10	± 10	±10	±10	±10	±10	± 10	±35(4)	±13	±11	± 13.5(3)	± 13.5(3)	±10	V
Output Current (1)	±10	±10	±25	±15	±10	±10	±10	±400	±12	20(3)	±22(3)	± .5 to 5.0(3)	± .5 to 5.0(3)	±10	mA
Full Power Bandwidth (Typ.) (1)	1,500	1,500	5,000	75	75	600	600	8,000	23	30	50	1.5 to 80(3)	1.5 to 80(3)	40	kHz
TRANSIENT RESPONSE												(5)	(5)		
Rise Time (1)	50	50	40	60	60	45	45	30(3)	60(3)	40(3)	(2)	200 to 2,000(3)	200 to 2,000(3)	200(3)	ns
Overshoot (1)	40	50	45	40	40	(2)	(2)	25(3)	15(3)	15(3)	(2)	5 to 15(3)	5 to 15 (3)	20(3)	%
Slew Rate (1)	±100	±80	±280	±4	± 4	±25	± 20	200	5(3)	± 2	±10	.1 to .8(3)	.1 to .8(3)	2.5(3)	V/µs
Settling Time (Typ.) (1)	0.20	0.20	.5	1.5	1.5	0.30	0.30	.5(3)	1.5(3)	1.5(3)	5.0	(2)	(2)	(2)	µs
POWER SUPPLY CHARACTERISTICS												(5)	(5)		
Supply Current (1)	6.0	6.0	6	3.7	4.0	3.7	4.0	20	3.8	3	0.15	.02 to .2	.02 to .2	5	mA
Power Supply Rejection Ratio	80	74	86	80	74	80	74	66	80	80	86	80	80	120	dB
FUNCTIONAL CHARACTERISTICS															
Offset Adjust	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Dip Pkg. Only	Yes	Yes	Yes	No	
Compensation Components	0 AV>3	0 AV>3	1	0	0	0 AV>5	0 AV>5	0	0	0	0	0	0	3	
Output Protection	No	No	No	Yes	Yes	Yes	Yes	External	Yes	Yes	Yes	Yes	Yes	Yes	

(1) At +25°C
(2) Not applicable or not specified
(3) Typical
(4) V supply = ± 40V
(5) Dependent upon Iset value

* TO-86 only

† Guaranteed for ± 15V supplies and applicable temperature range unless otherwise specified

HARRIS SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HA-2500/2502/2505

High Slew Rate Operational Amplifiers

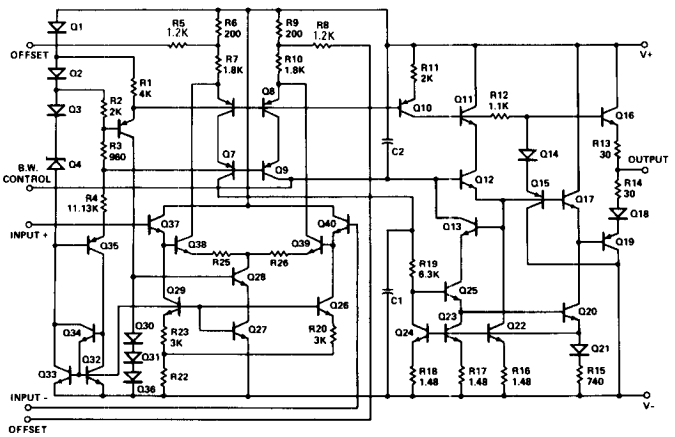
FEATURES

- HIGH SLEW RATE 30V/μs
- FAST SETTLING 330ns
- WIDE POWER BANDWIDTH 500kHz
- HIGH GAIN BANDWIDTH 12MHz
- HIGH INPUT IMPEDANCE 100mΩ
- LOW OFFSET CURRENT 10nA
- TRUE OP-AMP – CAN BE OPERATED NON-INVERTING OR INVERTING
- MEETS OR EXCEEDS MIL-STD-883 REQUIREMENTS

GENERAL DESCRIPTION

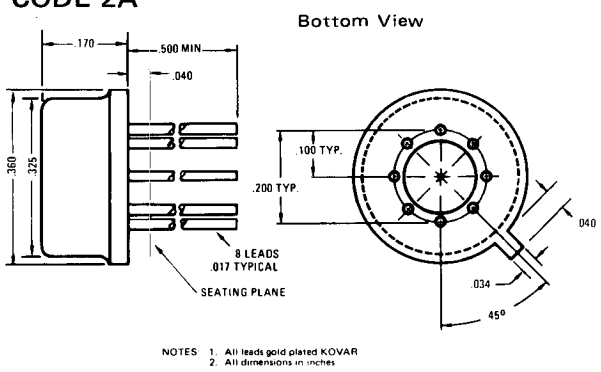
An operational amplifier with excellent D.C. characteristics, featuring high slew rate and fast settling time. Ideal for use in A/D, D/A, and sampled data systems; and for use in wide band R.F. or video systems where wide bandwidth at high output levels is required. The HA-2500/02/05 is internally compensated.

SCHEMATIC



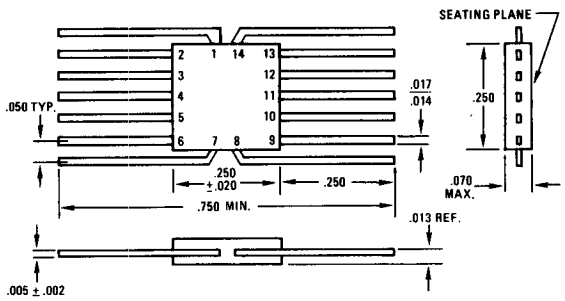
PACKAGES

CODE 2A TO-99



NOTES 1. All leads gold plated KOVAR
2. All dimensions in inches

CODE 9V (METAL BOTTOM) TO-86

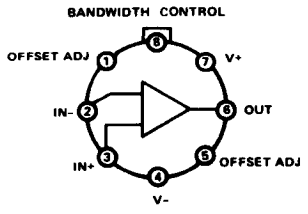


ALL DIMENSIONS ARE IN INCHES.
ALL DIMENSIONS ± .010 UNLESS OTHERWISE SHOWN.

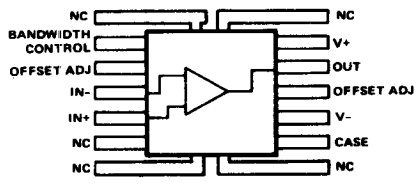
PIN OUT

TO-99

Top View



TO-86



SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	40.0V	Operating Temperature Range – HA-2500/HA-2502	$-55^oC \leq T_A \leq +125^oC$
Differential Input Voltage	±15.0V	HA-2505	$0^oC \leq T_A \leq +75^oC$
Peak Output Current	50mA	Storage Temperature Range	$-65^oC \leq T_A \leq +150^oC$
Internal Power Dissipation	300mW		

ELECTRICAL CHARACTERISTICS

V+ = +15V D.C., V- = -15V D.C.

PARAMETER	TEMP.	HA-2500 -55°C to +125°C LIMITS MIN.	HA-2500 TYP.	HA-2500 MAX.	HA-2502 -55°C to +125°C LIMITS MIN.	HA-2502 TYP.	HA-2502 MAX.	HA-2505 0°C to +75°C LIMITS MIN.	HA-2505 TYP.	HA-2505 MAX.	UNITS
INPUT CHARACTERISTICS											
* Offset Voltage	+25°C		2	5		4	8		4	8	mV
	Full			8			10			10	mV
Offset Voltage Average Drift	Full		20			20			20		µV/°C
* Bias Current	+25°C		100	200		125	250		125	250	nA
	Full			400			500			500	nA
* Offset Current	+25°C		10	25		20	50		20	50	nA
	Full			50			100			100	nA
Input Resistance	+25°C	25	50		20	50		20	50		MΩ
Common Mode Range	Full	±10.0			±10.0			±10.0			V
TRANSFER CHARACTERISTICS											
* Large Signal Voltage Gain (Note 1,4)	+25°C	20K	30K		15K	25K		15K	25K		V/V
	Full	15K			10K			10K			V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	90		74	90		74	90		dB
Gain Bandwidth Product (Note 3)	+25°C		12			12			12		MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 1)	Full	±10.0	±12.0		±10.0	±12.0		±10.0	±12.0		V
* Output Current (Note 4)	+25°C	±10	±20		±10	±20		±10	±20		mA
Full Power Bandwidth (Note 4)	+25°C	350	500		300	500		300	500		kHz
TRANSIENT RESPONSE											
Rise Time (Notes 1, 5, 6 & 8)	+25°C		25	50		25	50		25	50	ns
Overshoot (Notes 1, 5, 7 & 8)	+25°C		25	40		25	50		25	50	%
* Slew Rate (Notes 1,4,5 & 8)	+25°C	±25	±30		±20	±30		±20	±30		V/µs
Settling Time to 0.1% (Notes 1,4,5 & 8)	+25°C		0.33			0.33			0.33		µs
POWER SUPPLY CHARACTERISTICS											
* Supply Current	+25°C		4	6		4	6		4	6	mA
* Power Supply Rejection Ratio (Note 9)	Full	80	90		74	90		74	90		dB

NOTES:
1. R_L = 2K
2. V_{CM} = ±5.0V
3. A_V >10
4. V_O = ±10.0V
5. C_L = 50pF
6. V_O = ±400mV
7. V_O = ±600mV
8. See transient response test circuits and waveforms page four.
9. ΔV = ±5.0V

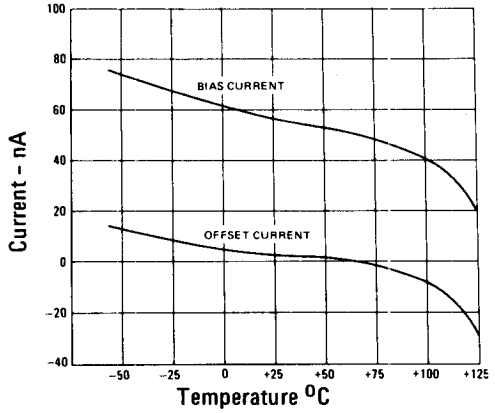
*100% Tested For DASH 8

LINEAR

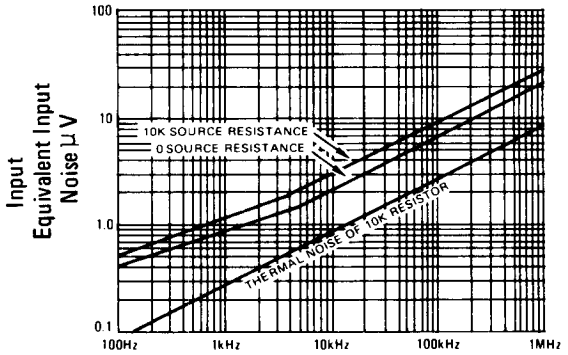
PERFORMANCE CURVES

V+ = 15VDC, V- = 15VDC, T_A = 25°C UNLESS OTHERWISE STATED

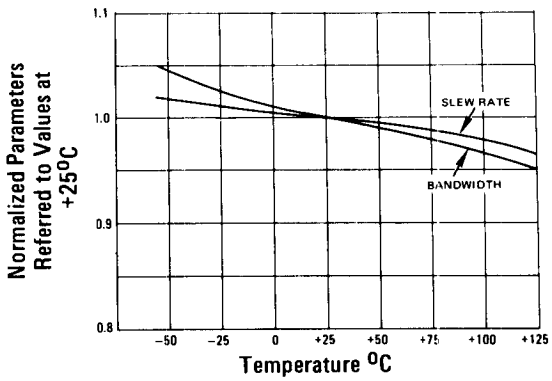
INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE



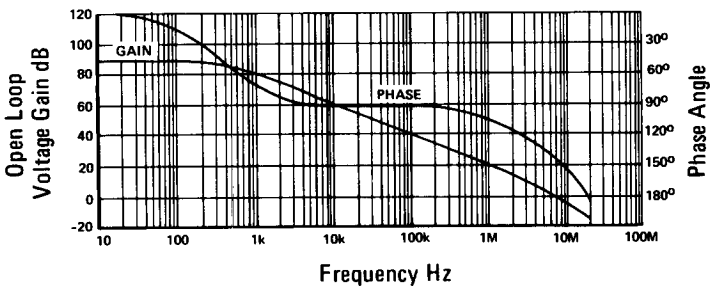
EQUIVALENT INPUT NOISE vs BANDWIDTH



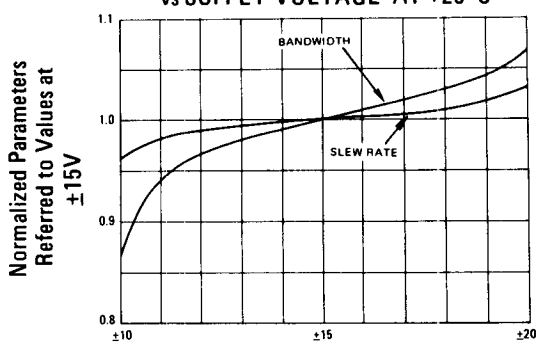
NORMALIZED AC PARAMETERS vs TEMPERATURE



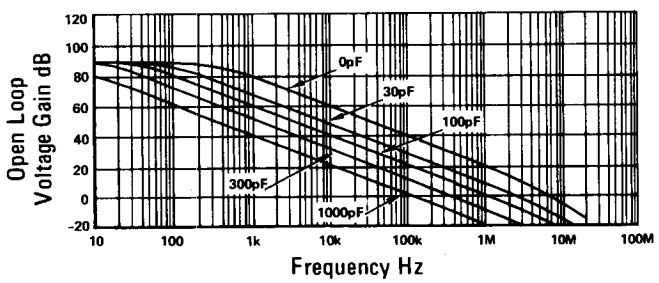
OPEN-LOOP FREQUENCY AND PHASE RESPONSE



NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE AT +25°C

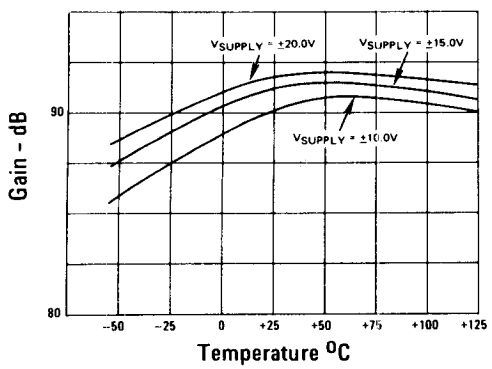


OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM BANDWIDTH CONTROL PIN TO GROUND

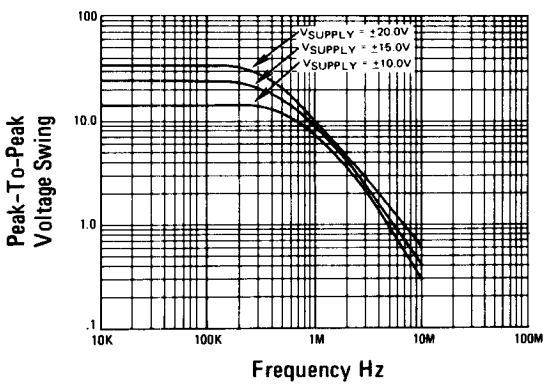


NOTE: External compensation components are not required for stability, but may be added to reduce bandwidth if desired.

OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

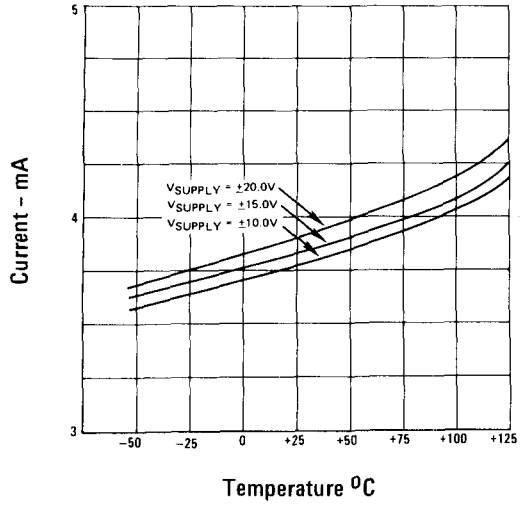


OUTPUT VOLTAGE SWING vs FREQUENCY AT +25°C

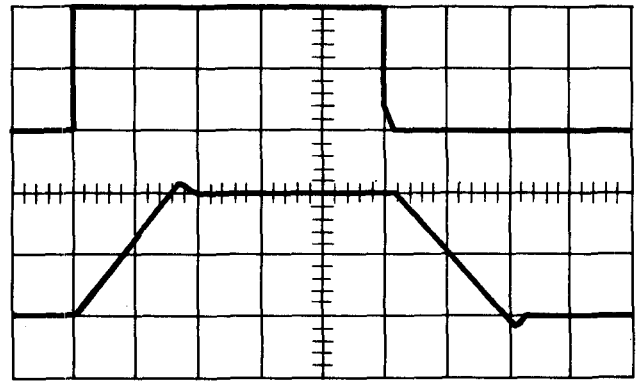


PERFORMANCE CURVES (continued)

POWER SUPPLY CURRENT vs TEMPERATURE



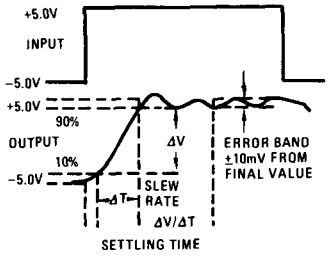
VOLTAGE FOLLOWER PULSE RESPONSE



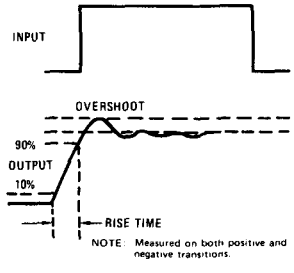
$R_L = 2K\Omega, C_L = 50pF$
Upper Trace: Input
Lower Trace: Output

Vertical = 5V/Div.
Horizontal = 200ns/Div.
$T_A = +25^oC$, $V_S = \pm 15.0V$

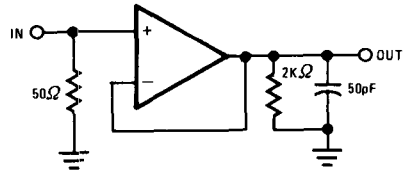
SLEW RATE AND SETTLING TIME



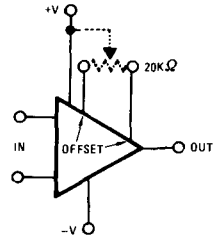
TRANSIENT RESPONSE



SLEW RATE AND TRANSIENT RESPONSE



SUGGESTED OFFSET ZERO ADJUST HOOK-UP



DEFINITIONS

INPUT OFFSET VOLTAGE—That voltage which must be applied between the input terminals through two equal resistances to force the output voltage to zero.

INPUT OFFSET CURRENT—The difference in the currents into the two input terminals when the output is at zero voltage.

INPUT BIAS CURRENT—The average of the currents flowing into the input terminals when the output is at zero voltage.

INPUT COMMON MODE VOLTAGE—The average referred to ground of the voltages at the two input terminals.

COMMON MODE RANGE—The range of voltages which is exceeded at either input terminal will cause the amplifier to cease operating.

TRANSIENT RESPONSE—The closed loop step function response of the amplifier under small signal conditions.

GAIN BANDWIDTH PRODUCT—The product of the gain and the bandwidth at a given gain.

SLEW RATE (Rating Limiting)—The rate at which the output will move between full scale stops, measured in terms of volts per unit time. This limit to an ideal step function response is due to the non-linear behavior in an amplifier due to its limited ability to produce large, rapid changes in output voltage (slewing)...restricting it to rates of change of voltage lower than might be predicted by observing the small signal frequency response.

SETTLING TIME—Time required for output waveform to remain within 0.1 percent of final value.