

HARRIS OPERATIONAL AMPLIFIERS

Selection Guide

for Commercial/Industrial Applications

PARAMETER [†]	0°C to +75°C													UNITS
	HA-911	F.E.T. PREAMP		HA-2055	HA-2055A	HA-2065	HA-2065A	PRAM™ HA-2405	S/H HA-2425	HA-2505	HA-2515	HA-2525	HA-2535	
INPUT CHARACTERISTICS														
Offset Voltage	7.5	55	12	65	17	65	15	11	8	10	14	14	5	mV
Drift (Typ.)	15	60	40	60	40	60	40	30	5	20	30	20	5	μV/°C
Bias Current	750	1	1	1	1	1	1	500	400	500	500	500	200	nA
Offset Current	450	.5	.5	.5	.5	.5	.5	100	100	100	100	100	20	nA
Common Mode Range	±12	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±.5	V
INPUT NOISE (3)	1													μVRMS
TRANSFER CHARACTERISTICS														
Large Signal Voltage Gain	15K	.98	.98	5K	5K	70K	70K	25K	25K	10K	5K	5K	100K	V/V
Common Mode Rejection Ratio	74	70	70	70	70	70	70	74	74	74	74	74	80	dB
Bandwidth (Typ.)	7	10(3)	10(3)	20(3)	20(3)	24(3)	24(3)	18(3)	2(3)	12(3)	12(3)	25	20	MHz
OUTPUT CHARACTERISTICS														
Output Voltage Swing	±11	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	±10	V
Output Current (1)	±15	±5	±5	±10(1)	±10(1)	±10(1)	±10(1)	20(3)	±10	±10	±10	±10	±25	mA
Full Power Bandwidth (Typ.) (1)	35	1,000(3)	1,000(3)	2,000(3)	2,000(3)	600(3)	600(3)	200(3)	70(3)	500	1,000	1,500	5,000	kHz
TRANSIENT RESPONSE														
Rise Time (1)	75	50(3)	50(3)	50(3)	50(3)	50(3)	50(3)	20	100(3)	50	50	50	40	ns
Overshoot (1)	40	5(3)	5(3)	25(3)	25(3)	25(3)	25(3)	25	20(3)	50	50	50	50	%
Slew Rate (1)	±2.3	100(3)	100(3)	120(3)	120(3)	35(3)	35(3)	15	5(3)	±20	±40	±80	±250	V/μs
Settling Time (Typ.) (1)	(2)	0.4(3)	0.4(3)	(3) 0.4	0.4(3)	.8(3)	.8(3)	1.5		0.33	0.25	0.20	.5	μs
POWER SUPPLY CHARACTERISTICS														
Supply Current (1)	2.5	1.7	1.7	8.0	8.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0	6	mA
Power Supply Rejection Ratio	74	70	70	70	70	70	70	74	74	74	74	74	80	dB
FUNCTIONAL CHARACTERISTICS														
Offset Adjust	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	
Compensation Components	0	0	0	0 AV>3	0 AV>5	0 AV>5	0 AV>5	0 AV>10	0	0	0	0 AV>3	1	
Output Protection	No	No	No	No	No	Yes	Yes	No	Yes	No	No	No	No	

PARAMETER [†]	0°C to +75°C									-25°C to +85°C			UNITS
	HA-2605	HA-2625	HA-2635	HA-2645	HA-2655	HA-2705	HA-2725	HA-2735	HA-2905	PRAM™ HA-2404	HA-2704	HA-2904	
INPUT CHARACTERISTICS													
Offset Voltage	7	7	300	7	7	7	7	7	.08	7	6	.05	mV
Drift (Typ.)	5	5	(2)	15	8	5	8 to 10	8 to 10	.2	20	5	.2	μV/°C
Bias Current	40	40	200	50	300	70	10 to 40	10 to 40	1	400	50	1	nA
Offset Current	40	40	(2)	50	100	40	7.5 to 20	7.5 to 20	.5	100	30	.5	nA
Common Mode Range	±11	±11	(2)	±35(4)	±13	±11	±10	±10	±10	±10	±11	±10	V
INPUT NOISE (3)													μVRMS
TRANSFER CHARACTERISTICS													
Large Signal Voltage Gain	70K	70K	.85	75K	15K	100K	20K	20K	10 ⁶	25K	100K	10 ⁷	V/V
Common Mode Rejection Ratio	74	74	(2)	74	74	80	74	74	120	80	86	130	dB
Bandwidth (Typ.) (1)	12	35	8	4	8	1	.01 to 10	.01 to 10	3	16(3)	1	3	MHz
OUTPUT CHARACTERISTICS													
Output Voltage Swing	±10	±10	±10	±35(4)	±13	±11	±13.5(3)	±13.5(3)	±10	±10	±11	±10	V
Output Current (1)	±10	±10	±300	±10	18(3)	±22(3)	.5 to 5.0(3)	.5 to 5.0(3)	±7	20(1)	±22(3)	±10	mA
Full Power Bandwidth (typ.)	75	600	8,000	23	30	50	1.5 to 80(3)	1.5 to 80	40	500(3)	50	40	kHz
TRANSIENT RESPONSE													
Rise Time (1)	60	45	30(3)	60(3)	40(3)	(2)	200 to 2,000(3)	200 to 2,000(3)	200(3)	20(3)	(2)	200(3)	ns
Overshoot (1)	40	(2)	25(3)	15(3)	15(3)	(2)	5 to 15(3)	5 to 15(3)	20(3)	25(3)	(2)	20(3)	%
Slew Rate (1)	±4	±20	200	5(3)	2	±10	.1 to .8(3)	.1 to .8	2.5(3)	50	10	2.5(3)	V/μs
Settling Time (Typ.) (1)	1.5	0.30	.5(3)	1.5(3)	1.5(3)	5.0	(2)	(2)	(2)	1.5(3)	5.0	(2)	μs
POWER SUPPLY CHARACTERISTICS													
Supply Current (1)	4.0	4.0	23	4.5	4	0.150	.02 to .2	.02 to .2	5	6.0(1)	0.150	5	mA
Power Supply Rejection Ratio	74	74	66	74	74	80	76	76	120	80	86	130	dB
FUNCTIONAL CHARACTERISTICS													
Offset Adjust	Yes	Yes	No	Yes	Dip Pkg. Only	Yes	Yes	Yes	No	No	Yes	No	
Compensation Components	0	0 (AV>5)	0	0	0	0	0	0	3	0 AV>10	0	3	
Output Protection	Yes	Yes	External	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

(1) At +25°C

(2) Not applicable or not specified

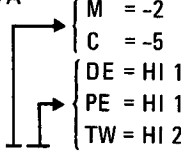
(3) Typical

(4) V supply = ±40V

(5) Dependent upon I_{set} value

* TO-86 only

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

MANUFACTURER	PART NUMBER	HARRIS EQUIVALENT	NOTES
Fairchild Semiconductor	μ A702	HA-2620/2625	C2
	μ A709	HA-909/911	B2
	μ A715	HA-2520/2525	B2
	μ A725	HA-2700/2705	A3
	μ A727	HA-2900/2905	C2
	μ A734	HA-2111/2311	C2
	μ A740	HA-2060/2065	B2
	μ A741	HA-909/911, 2600/2605	B2
		2700/2705	B2
		2640/2645	A2
	μ A747	HA-2650/2655	C2
	μ A748	HA-2620/2625	B2
	μ A772	HA-2510/2515	A2
	μ A776	HA-2720/2725	A2
	μ A791	HA-2630/2635	C2
	SH3002	HI-1800A	C2
	1558/1458	HA-2650/2655	A2
	9616	HD-1488	C2
	9617	HD-1489/A	C2
Intersil	111/211/311	HA-2111/2211/2311	A1
	IH5040*	HI-5040	A1
	thru	thru	
	IH-5051	HI-5051	
	8007	HA-2060/2065	B2
	8008	HA-2600/2605	B2
	8017	HA-2520/2525	B2
	IH5110/5111	HA-2420/2425	C2
	IH5060	HI-506A	A2
	IH5070	HI-507A	A2
			
	* Part Numbers: Intersil	IH5040MDE	
	Harris	HI1-5040-2	
Intronics	FA-550	HA-2055	A1
	FA-551	HA-2065	A1
	A-560	HA-2525	A1
	A-561	HA-2625	A1
	A-570	HA-2535	A1
	CA-580	HA-2905	A1
Motorola	MC1508/1408	HI-1080/1085	C2
	MC1520/1420	HA-2600/2605	C2
	MC1530/1531/1430/1431	HA-2600/2605	C2
	MC1533/1433	HA-2700/2705	C2
	MC1536/1436	HA-2640/2645	A2
	MC1538/1438	HA-2630/2635	C2
	MC1539/1439	HA-2620/2625	B2

NOTES: A. Pin-for-pin replacement
 B. Minor pin-out difference (offset adj., compensation, etc.)
 C. Not pin compatible — consult data sheets.

1. Identical electrical specifications
2. Harris part superior in most parameters
3. Parameter tradeoffs — consult data sheets

MANUFACTURER	PART NUMBER	HARRIS EQUIVALENT	NOTES
Motorola (continued)	MC1545/1445	HA-2400/2405	C3
	MC1554/1454	HA-2630/2635	C3
	MC1556/1456	HA-2600/2605	B2
	MC1558/1458	HA-2650/2655	A2
	MC1582L	HD-245	C2
	MC1583L	HD-246	C2
	MC1584L	HD-249	C2
	MC1488L	HD-1488	A1
	MC1489L	HD-1489	A1
	MC1489AL	HD-1489A	A1
National Semiconductor	LH0001	HA-2700	C2
	LH0002	HA-2630	C2
	LH0003	HA-2520	C2
	LH0004	HA-2640	C2
	LH0005	HA-2620	C2
	LH0022/42/52	HA-2060/2065	B2
	LH0023/43	HA-2420/2425	C2
	LH0024	HA-2530/2535	B2
	LH0032	HA-2050/2055	C3
	LH0033/63	HA-2630/2635	C3
	LH0062	HA-2050/2055	B2
	LM101/301/107/307	HA-909/911, 2600/2605, 2700/ 2705	B2
	LM102/302	HA-2600/2605	B2
	LM108/208/308	HA-2700/2704/2705	B3
	LM110/310	HA-2500/2505	B2
	LM111/211/311	HA-2111/2211/2311	A1
	LM112/212/312	HA-2700/2704/2705	B3
	LM216/316	HA-2060/2065	B3
	LM118/318	HA-2510/2515	B2
	LM143/343	HA-2640/2645	A2
	LM163/363	HD-248/548	C3
	LM1488	HD-1488	A1
	LM1489/A	HD-1489/A	A1
Precision Monolithics	OP-01	HA-2600/2605/2500/2505	B2
	OP-05/07	HA-2900/2905	B2
	CMP-01/02	HA-2111/2311	B3
	SSS1558/1458	HA-2650/2655	A2
	DAC-02/04/100	HI-1080/1085	C3
RCA	111/211/311	HA-2111/2211/2311	A1
	CA3020	HA-2630/2635	C2
	CA3078	HA-2720/2730	B2
	CA3100	HA-2520/2525	B2
	CA3130	HA-2060/2065	B2
	CA3558/3458	HA-2650/2655	A2
	CA6078	HA-2720/2730	B2
	CD4016	HI-201	C2
	CD4046	HA-2820/2825	C2

NOTES: A. Pin-for-pin replacement
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 C. Not pin compatible — consult data sheets.

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SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Voltage Between V ⁺ and V ⁻ Terminals	50.0V
Differential Input Voltage	+7.0V
Peak Output Current	+50mA
Internal Power Dissipation (Note 10)	300mW
Operating Temperature Range — HA-909	-55°C ≤ T _A ≤ +125°C
HA-911	0°C ≤ T _A ≤ +75°C
Storage Temperature Range	-65°C ≤ T _A ≤ +150°C

ELECTRICAL CHARACTERISTICS

TEST CONDITIONS: V_{Supply} = ±15.0V unless otherwise specified.

PARAMETER	TEMPERATURE	HA-909 −55°C to +125°C			HA-911 0°C to +75°C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS								
* Offset Voltage	+25°C Full		2.0	5.0 6.0		2.0	6.0 7.5	mV mV
Equivalent Input Noise (Note 9)			1.0	5.0		1.0		μV
* Bias Current	+25°C Full		87	300 750		200 300	500 750	nA nA
* Offset Current	+25°C Full		25 50	150 300		100 150	300 450	nA nA
Offset Current Average Drift	Full		1.0			1.0		nA/°C
Input Resistance	+25°C Full	200 100	600 300		100	250		KΩ KΩ
Common Mode Range	Full	±12.0			±12.0			V
TRANSFER CHARACTERISTICS								
* Large Signal Voltage Gain (Notes 1, 4)	+25°C Full	25K 25K	45K 45K		20K 15K	45K 45K		V/V V/V
* Common Mode Rejection Ratio (Note 2)	Full	80	96		74	90		dB
Unity Gain Bandwidth (Note 3)	+25°C		7			7		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 1)	Full	±12.0			±11.0			V
* Output Current (Note 4)	+25°C	±20			±15			mA
Output Resistance	+25°C		150			500		Ohms
TRANSIENT RESPONSE								
Rise Time (Notes 1, 5, 6 & 8)	+25°C		40	75		40	75	ns
Overshoot (Notes 1, 5, 6 & 8)	+25°C		15	40		15	40	%
* Slew Rate (Notes 1, 5 & 8)	+25°C	+3.5 −1.2	+5.0 −2.0			+5.0		V/μs
POWER SUPPLY CHARACTERISTICS								
* Supply Current	+25°C		1.8	2.5		1.8	2.5	mA
* Power Supply Rejection Ratio (Note 7)	Full	80	92		74	90		dB

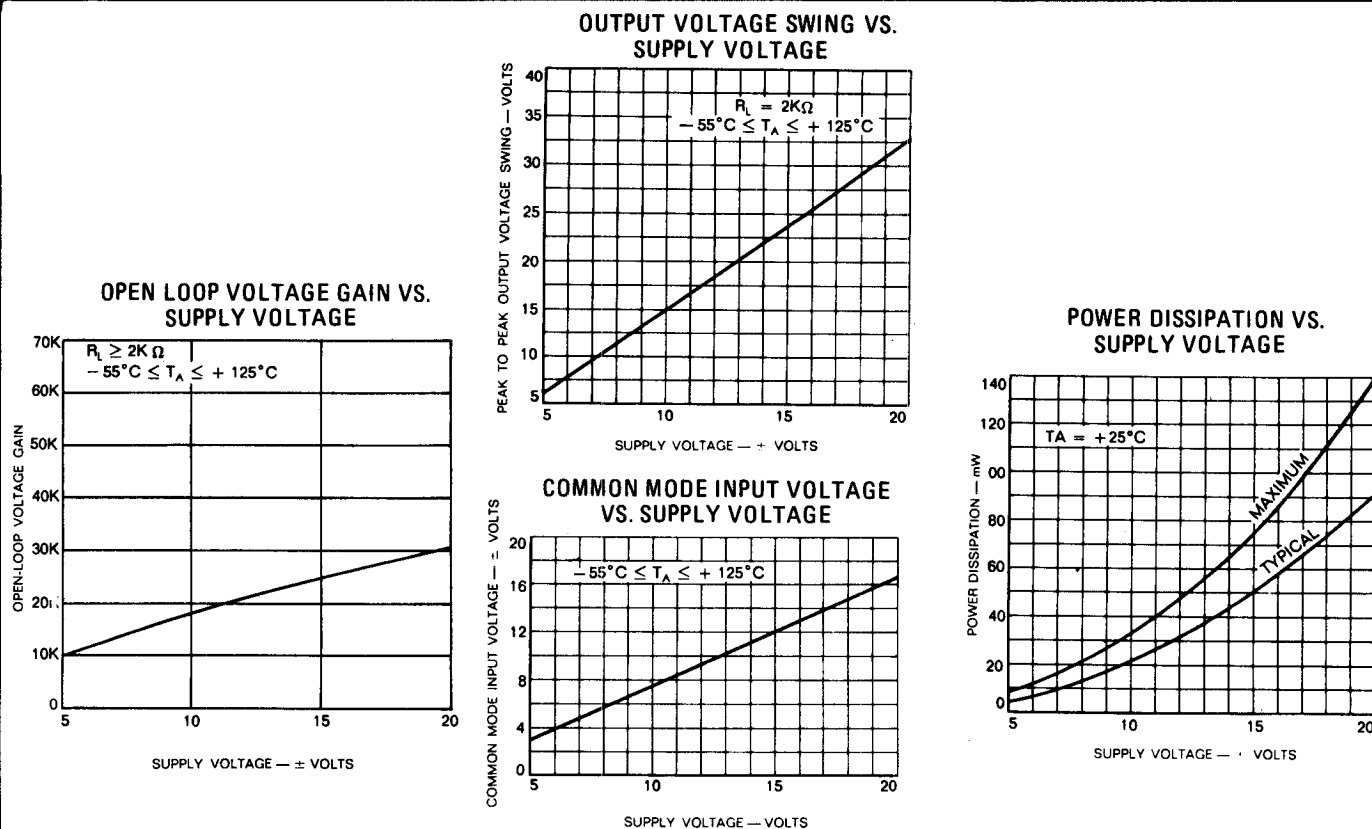
- NOTES: 1. R_L = 2KΩ
2. V_{CM} = ±5.0V
3. V_O < 90mV

4. V_O = ±10.0V
5. C_L = 100pF
6. V_O = ±200mV
7. V_{Sup} = ±9.0V to ±15.0V

8. See Transient Response test circuits and waveforms — page 3.
9. 10 — 1000Hz, R_S = 10KΩ
10. Derate by 6.6mW/°C above 105°C

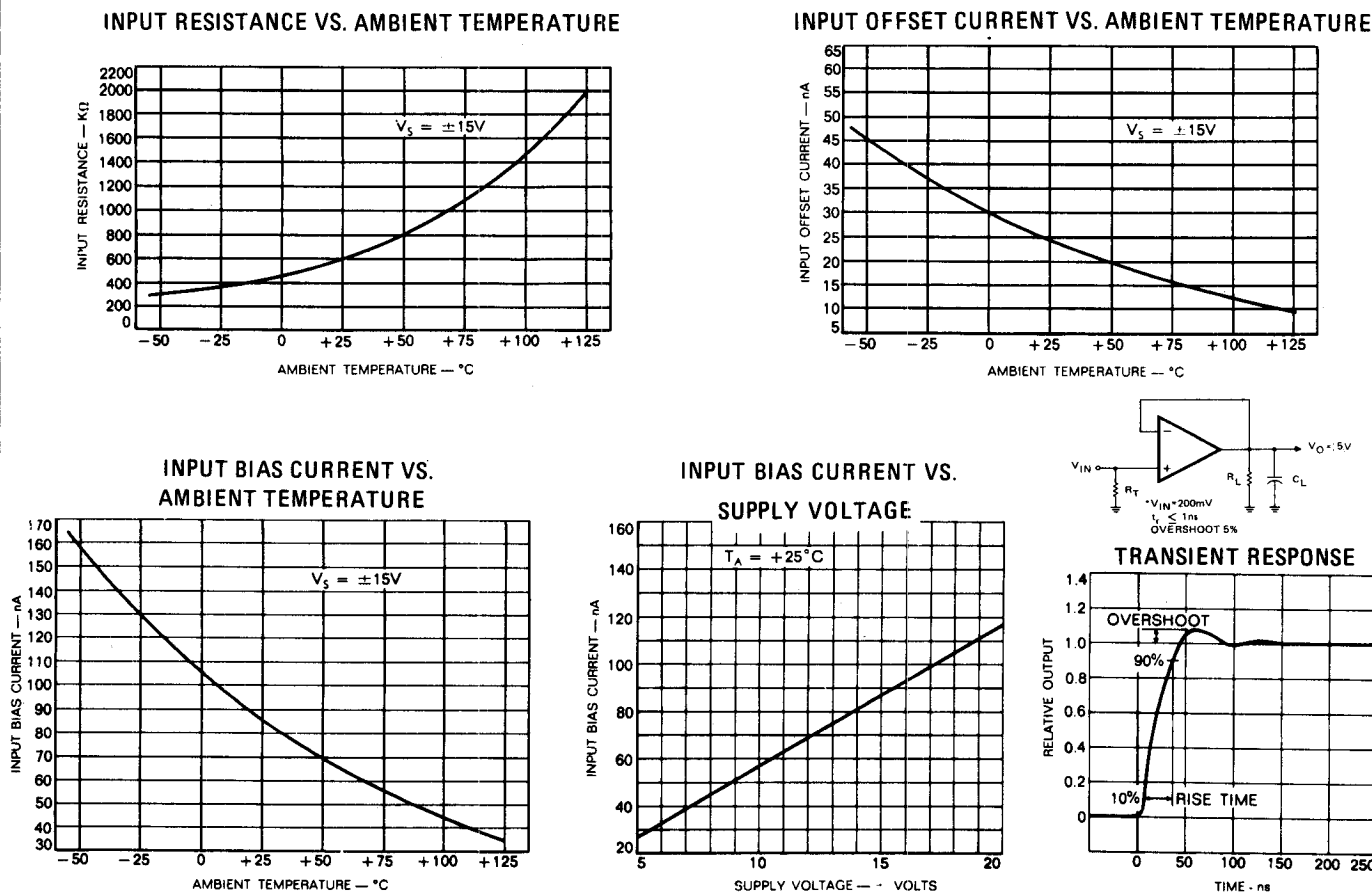
*100% Tested For DASH 8

GUARANTEED ELECTRICAL CHARACTERISTICS

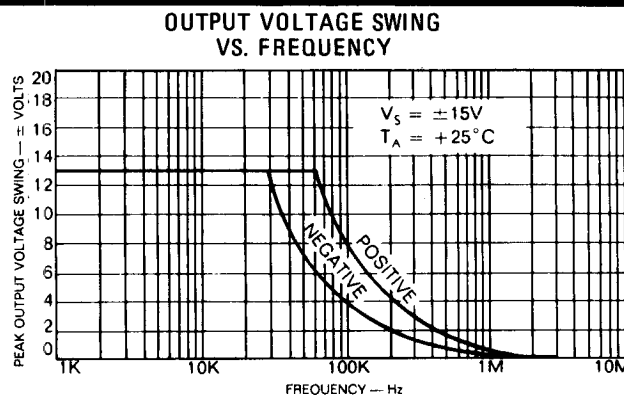
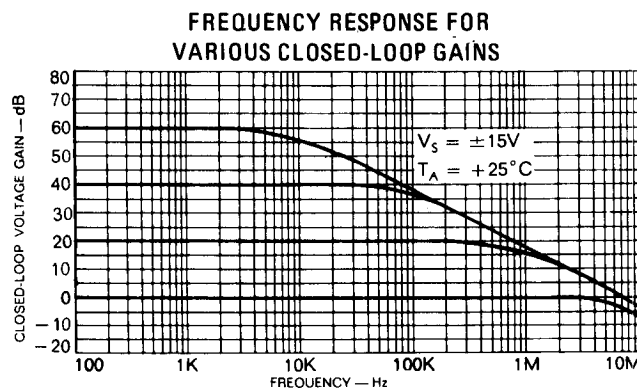


LINEAR

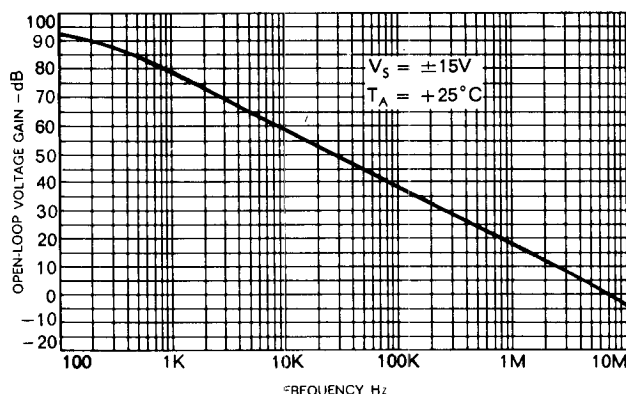
TYPICAL PERFORMANCE CURVES



TYPICAL PERFORMANCE CURVES(continued)



OPEN LOOP FREQUENCY RESPONSE



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 if exceeded at either input terminal will cause the amplifier to cease operating.

Common Mode Rejection Ratio — The ratio of a specified range of input common mode voltage to the peak to peak change in input offset voltage over this range.

Output Voltage Swing — The peak symmetrical output voltage swing, referred to ground, that can be obtained without clipping.

Input Resistance — The ratio of the change in input voltage to the change in input current.

Output Resistance — The ratio of the change in output voltage to the change in output current.

Positive Output Voltage Swing — The peak positive output voltage swing, referred to ground, that can be obtained without clipping.

Negative Output Voltage Swing — The peak negative output voltage swing, referred to ground, that can be obtained without clipping.

Voltage Gain — The ratio of the change in output voltage to the change in input voltage producing it.

Bandwidth — The frequency at which the voltage gain is 3 dB below its low frequency value.

Unity Gain Bandwidth — The frequency at which the voltage gain of the amplifier is unity.

Power Supply Rejection Ratio — The ratio of the change in input offset voltage to the change in power supply voltage producing it.

Transient Response — The closed loop step function response of the amplifier under small signal conditions.

Phase Margin — $[180^\circ - (\phi_1 - \phi_2)]$ where ϕ_1 is the phase shift at the frequency where the absolute magnitude of gain is unity, ϕ_2 is the phase shift at a frequency much lower than the open loop bandwidth.