HARRIS SEMICONDUCTOR

HA-5142, HA-5144

Dual/Quad Ultra-Low Power Operational Amplifiers

April 1993

Features

- **Low Supply Current 45μA/Amp**
- **Wide Supply Voltage Range Single .... 3V to 30V or Dual .... ±1.5V to ±15V**
- **High Slew Rate 1.5V/μs**
- **High Gain 100kV/V**
- **Unity Gain Stable**
- **Available in Duals and Quads**

Applications

- **Portable Instruments**
- **Meter Amplifiers**
- **Telephone Headsets**
- **Microphone Amplifiers**
- **Instrumentation**
- **For Further Design Ideas See Application Note 544**

Description

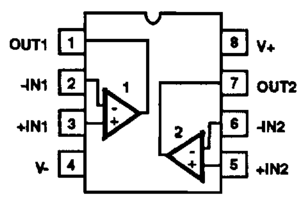
The HA-5142/44 ultra-low power operational amplifiers provide AC and DC performance characteristics similar to or better than most general purpose amplifiers while only drawing 1/30 of the supply current of most general purpose amplifiers. In applications which require low power dissipation and good AC electrical characteristics, this family offers the industry's best speed/power ratio.

The HA-5142/44 provides accurate signal processing by virtue of their low input offset voltage (2mV), low input bias current (45nA), high open loop gain (100kV/V) and low noise (20nV/√Hz), for low power operational amplifiers. These characteristics coupled with a 1.5V/μs slew rate and a 400kHz bandwidth make the HA-5142/44 ideal for use in low power instrumentation, audio amplifier and active filter designs. The wide range of supply voltages (3V to 30V) also allow these amplifiers to be very useful in low voltage battery powered equipment. These parts are also tested and guaranteed at both ±15V and single ended +5V supplies.

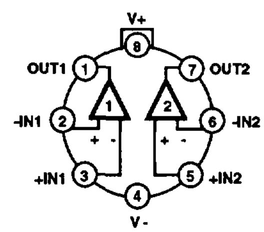
These amplifiers are available with industry standard pinouts which allow the HA-5142/5144's to be interchangeable with most other operational amplifiers. For military grade product refer to the 5142, 5144/883 data sheet.

Pinouts (See Ordering Information on Next Page)

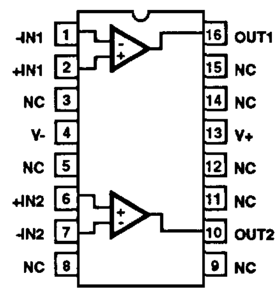
HA-5142 (PDIP, CDIP)
TOP VIEW



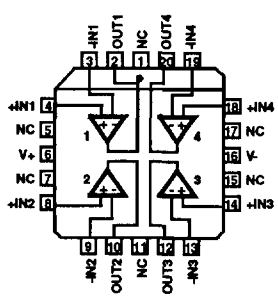
HA-5142 (TO-99 METAL CAN)
TOP VIEW



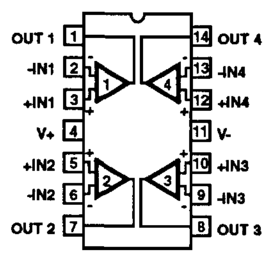
HA-5142 (300 mil SOIC)
TOP VIEW



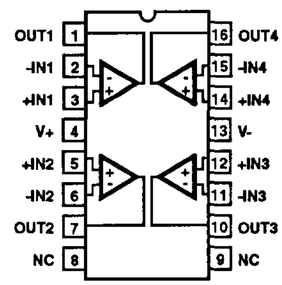
HA-5144 (PLCC)
TOP VIEW



HA-5144 (PDIP, CDIP)
TOP VIEW



HA-5144 (300 mil SOIC)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

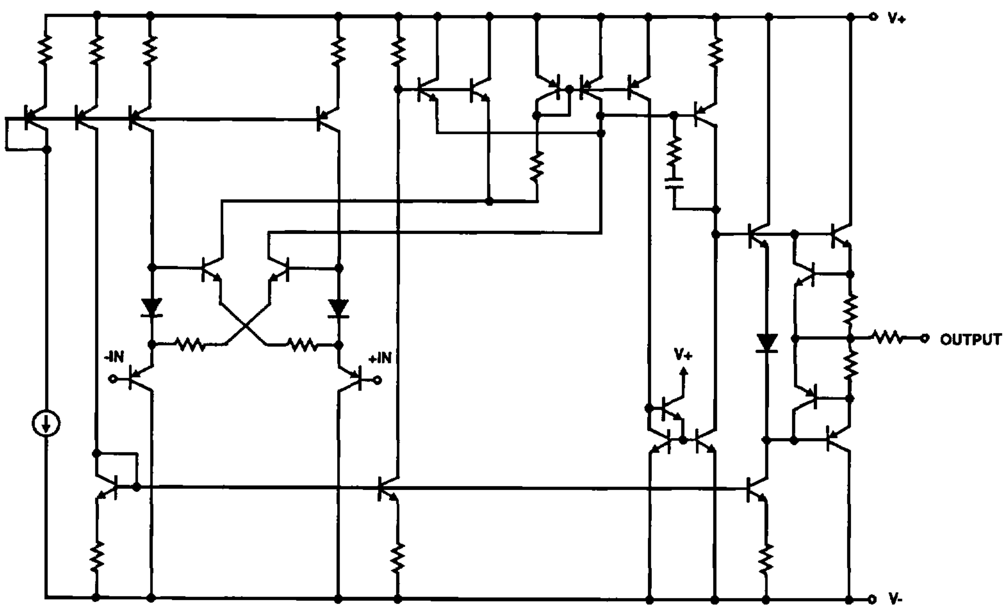
File Number **2909.1**

Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA2-5142-2	-55°C to +125°C	8 Pin Can
HA2-5142-5	0°C to +75°C	8 Pin Can
HA3-5142-5	0°C to +75°C	8 Lead Plastic DIP
HA7-5142-2	-55°C to +125°C	8 Lead Ceramic DIP
HA7-5142-5	0°C to +75°C	8 Lead Ceramic DIP
HA9P5142-5	0°C to +75°C	16 Lead Wide Body SOIC
HA9P5142-9	-40°C to +85°C	16 Lead Wide Body SOIC

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA1-5144-2	-55°C to +125°C	14 Lead Ceramic DIP
HA1-5144-5	0°C to +75°C	14 Lead Ceramic DIP
HA3-5144-5	0°C to +75°C	14 Lead Plastic DIP
HA4P5144-5	0°C to +75°C	20 Lead PLCC
HA9P5144-5	0°C to +75°C	16 Lead Wide Body SOIC
HA9P5144-9	-40°C to +85°C	16 Lead Wide Body SOIC

Schematic Diagram



Absolute Maximum Ratings

Supply Voltage Between V+ and V- Terminals 35V
Differential Input Voltage.................................. 7V
Output Current .... Short Circuit Protected
Junction Temperature (Note 12)....................... +175°C
Junction Temperature (Plastic Package) .... +150°C
Lead Temperature (Soldering 10 Sec.)................. +300°C

Operating Conditions

Operating Temperature Range
HA-5142/44-5 .... 0°C ≤ T_A ≤ +75°C
HA-5142/44-2 .... -55°C ≤ T_A ≤ +125°C
HA-5142/44-9 .... -40°C ≤ T_A ≤ +85°C
Storage Temperature Range................ -65°C ≤ T_A ≤ +150°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications

R_S = 100Ω, C_L ≤ 10pF, Unless Otherwise Specified

PARAMETER	TEMP	-2, -5, -9 V+ = +5V, V- = 0V MIN	TYP	MAX	-2, -5, -9 V+ = +15V, V- = -15V MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS								
Offset Voltage (Note 11)	+25°C	-	2	6	-	2	6	mV
	Full	-	-	8	-	-	8	mV
Average Offset Voltage Drift	Full	-	3	-	-	3	-	µV/°C
Bias Current (Note 11)	+25°C	-	45	100	-	45	100	nA
	Full	-	-	125	-	-	125	nA
Offset Current (Note 11)	+25°C	-	0.3	10	-	0.3	10	nA
	Full	-	-	20	-	-	20	nA
Common Mode Range	Full	0 to 3	-	-	±10	-	-	V
Differential Input Resistance	+25°C	-	0.6	-	-	0.6	-	MΩ
Input Noise Voltage (f = 1kHz)	+25°C	-	20	-	-	20	-	nV/√Hz
Input Noise Current (f = 1kHz)	+25°C	-	0.25	-	-	0.25	-	pA/√Hz
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Notes 2, 4)	+25°C	20	100	-	20	100	-	kV/V
	Full -2, -5	15	-	-	15	-	-	kV/V
	Full -9	12	-	-	12	-	-	kV/V
Common Mode Rejection Ratio (Note 7)	Full -2, -5	77	105	-	77	105	-	dB
	Full -9	70	105	-	70	105	-	dB
Bandwidth (Notes 2, 3)	+25°C	-	0.4	-	-	0.4	-	MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Notes 2, 10)	+25°C	1.0 to 3.8	0.7 to 4.2	-	±10	±13	-	V
	Full	1.2 to 3.5	0.9 to 4.0	-	±10	±13	-	V
Full Power Bandwidth (Notes 2, 4, 8)	+25°C	-	240	-	-	24	-	kHz

Electrical Specifications $R_S = 100\Omega$, $C_L \leq 10pF$, Unless Otherwise Specified **(Continued)**

PARAMETER	TEMP	-2, -5, -9 V+ = +5V, V- = 0V			-2, -5, -9 V+ = +15V, V- = -15V			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
TRANSIENT RESPONSE (Notes 2, 3)								
Rise Time	+25°C	-	600	-	-	600	-	ns
Slew Rate (Note 6)	+25°C	0.8	1.5	-	0.8	1.5	-	V/µs
Settling Time (Note 5)	+25°C	-	10	-	-	10	-	µs
POWER SUPPLY CHARACTERISTICS								
Supply Current	+25°C	-	45	80	-	100	150	µA/Amp
	Full	-	-	100	-	-	200	µA/Amp
Power Supply Rejection Ratio (Note 9)	Full -2, -5	77	105	-	77	105	-	dB
	Full -9	70	105	-	70	105	-	dB

NOTES:

1. Absolute maximum ratings are limiting values, applied individually beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.
2. $R_L = 50k\Omega$
3. $C_L = 50pF$
4. $V_O = 1.4$ to 2.5V for $V_{CC} = +5$, 0V; $V_O = \pm10V$ for $V_{CC} = \pm15V$.
5. Settling Time is specified to 0.1% of final value for a 3V output step and $A_V = -1$ for $V_{CC} = +5V$, 0V. Output step = 10V for $V_{CC} = \pm15V$.
6. Maximum input slew rate = 10V/µs.
7. $V_{CM} = 0$ to 3V for $V_{CC} = +5$, 0V; $V_{CM} = \pm10V$ for $V_{CC} = \pm15V$.
8. Full Power Bandwidth is guaranteed by equation: $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$.
9. $\Delta V_S = +10V$ for $V_{CC} = +5$, 0V; $\Delta V_S = \pm5V$ for $V_{CC} = \pm15V$.
10. For $V_{CC} = +5$, 0V terminate R_L at +2.5V. Typical output current is ±3mA.
11. $V_O = 1.4V$ for $V_{CC} = +5V$, 0V.
12. See Thermal Constants in "Die Characteristics" section.

Die Characteristics

Transistor Count
- HA-5142 66
- HA-5144 132

Substrate Potential* .... V-

Process .... Bipolar-DI

* The substrate may be left floating (Insulating Die Mount) or it may be mounted on a conductor at V- potential.

Thermal Constants (°C/W)	θ_{JA}	θ_{JC}
HA1-5144 (CDIP)	71	13
HA2-5142 (CAN)	111	34
HA3-5142 (Plastic Mini DIP)	92	30
HA3-5144 (PDIP)	108	38
HA4P5144 (PLCC)	74	32
HA7-5142 (Ceramic Mini DIP)	114	35
HA9P5142 (SOIC)	113	35
HA9P5144 (SOIC)	96	26

Test Circuits

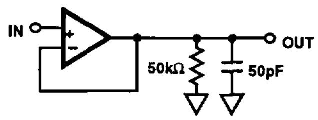
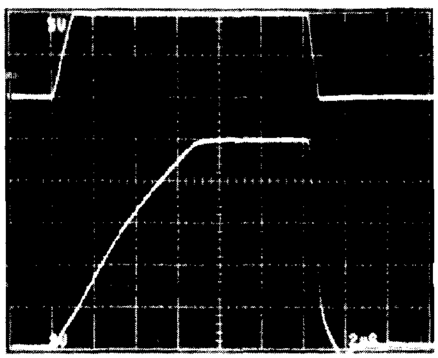


FIGURE 1. SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT

LARGE SIGNAL RESPONSE
Vertical Scale: (Volts: Input = 5V/Div.; Output = 2V/Div.)
Horizontal Scale: (Time: 2μs/Div.)

INPUT

OUTPUT

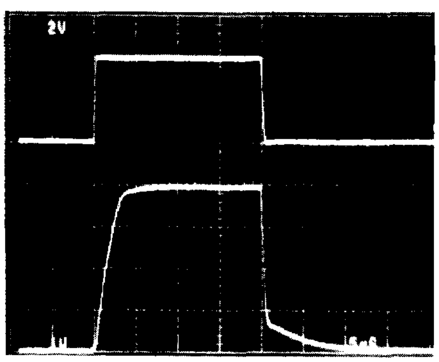


$+V_{SUPPLY} = +15V, -V_{SUPPLY} = -15V$

LARGE SIGNAL RESPONSE
Vertical Scale: (Volts: Input = 2V/Div.; Output = 1V/Div.)
Horizontal Scale: (Time: 5μs/Div.)

INPUT

OUTPUT

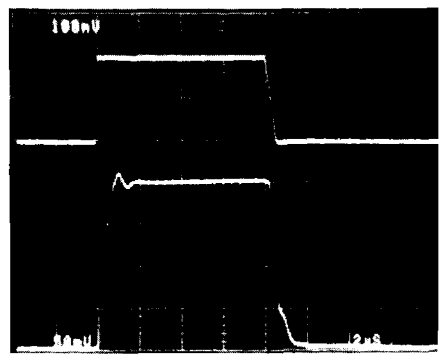


$+V_{SUPPLY} = +5V, -V_{SUPPLY} = 0V$

SMALL SIGNAL RESPONSE
Vertical Scale: (Volts: Input = 100mV/Div.; Output = 50mV/Div.)
Horizontal Scale: (Time: 2μs/Div.)

INPUT

OUTPUT

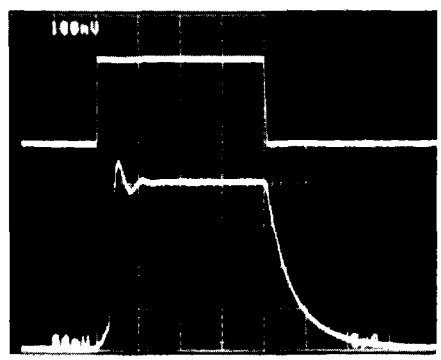


$+V_{SUPPLY} = +15V, -V_{SUPPLY} = -15V$

SMALL SIGNAL RESPONSE
Vertical Scale: (Volts: Input = 100mV/Div.; Output = 50mV/Div.)
Horizontal Scale: (Time: 5μs/Div.)

INPUT

OUTPUT



$+V_{SUPPLY} = +5V, -V_{SUPPLY} = 0V$

Typical Performance Curves $V_S = \pm 2.5V$, $T_A = +25^oC$, Unless Otherwise Specified

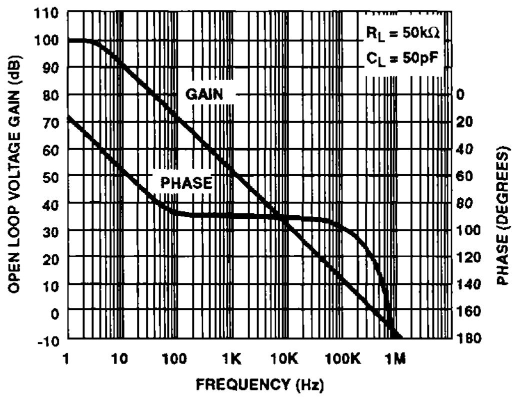


FIGURE 2. OPEN LOOP FREQUENCY RESPONSE

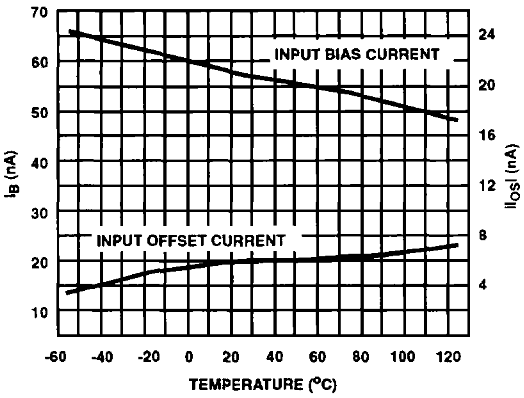


FIGURE 3. INPUT OFFSET CURRENT AND BIAS CURRENT vs TEMPERATURE

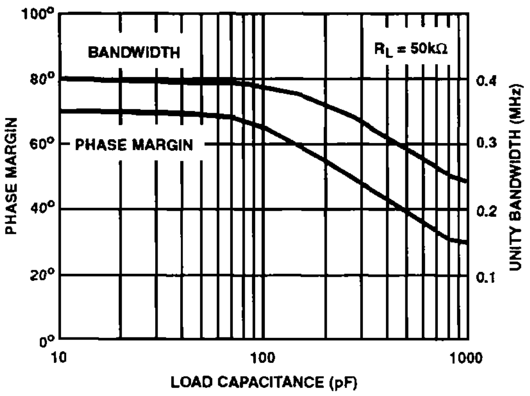


FIGURE 4. BANDWIDTH AND PHASE MARGIN vs LOAD CAPACITANCE

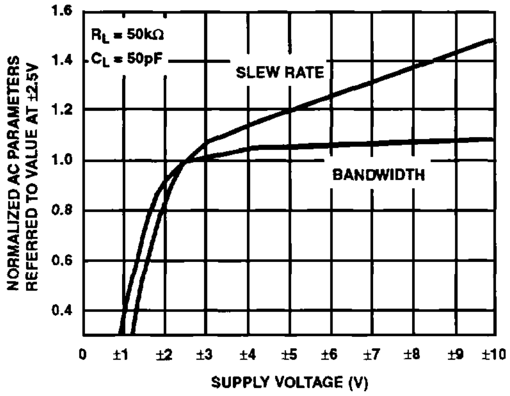


FIGURE 5. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE

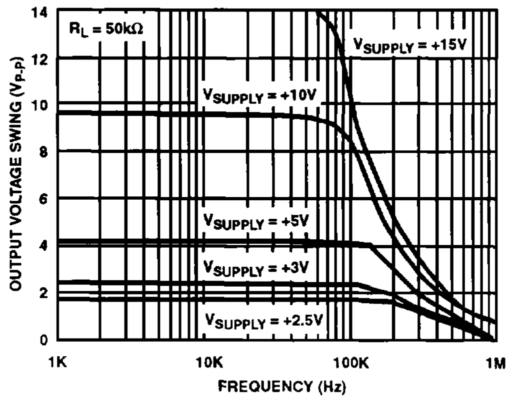


FIGURE 6. OUTPUT VOLTAGE SWING vs FREQUENCY AND SINGLE SUPPLY VOLTAGE

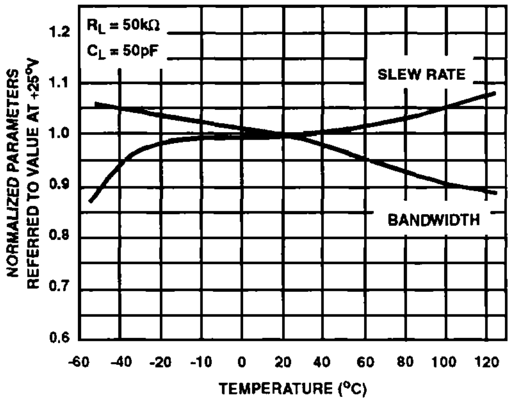


FIGURE 7. NORMALIZED AC PARAMETERS vs TEMPERATURE

Typical Performance Curves $V_S = \pm 2.5V$, $T_A = +25^oC$, Unless Otherwise Specified (Continued)

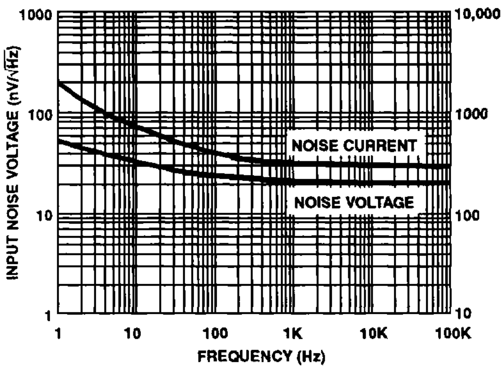


FIGURE 8. INPUT NOISE vs FREQUENCY

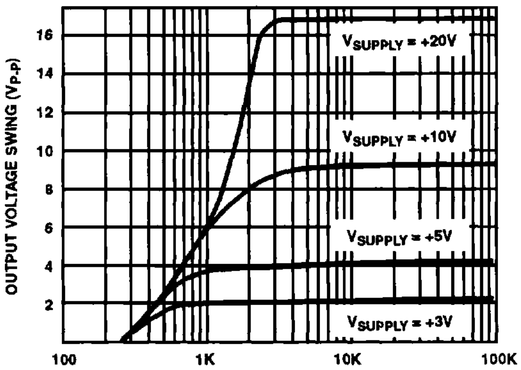


FIGURE 9. MAXIMUM OUTPUT VOLTAGE SWING vs LOAD RESISTANCE AND SINGLE SUPPLY VOLTAGE

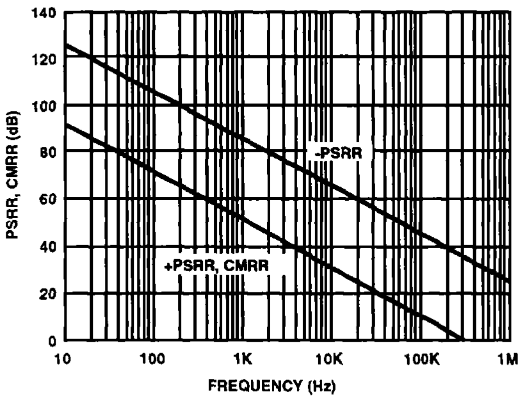


FIGURE 10. PSRR AND CMRR vs FREQUENCY

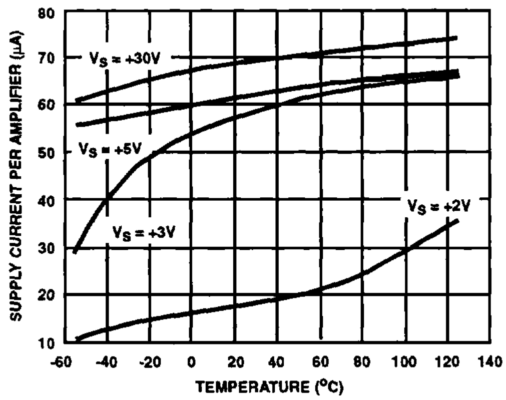


FIGURE 11. POWER SUPPLY CURRENT vs TEMPERATURE AND SINGLE SUPPLY VOLTAGE

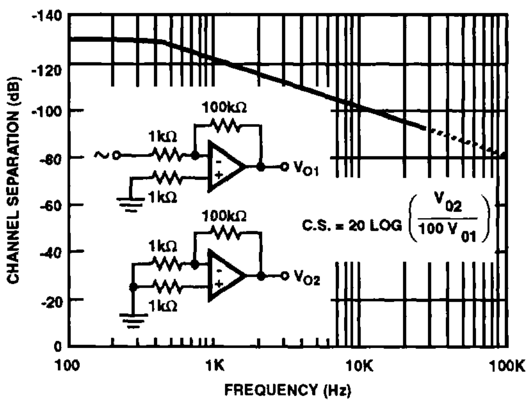


FIGURE 12. CHANNEL SEPARATION vs FREQUENCY

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OPERATIONAL AMPLIFIERS