

## Dual/Quad Ultra-Low Power Operational Amplifiers

April 1993

### Features

- **Low Supply Current** ..... 45 $\mu$ A/Amp
- **Wide Supply Voltage Range Single** ..... 3V to 30V  
or Dual .....  $\pm$ 1.5V to  $\pm$ 15V
- **High Slew Rate** ..... 1.5V/ $\mu$ s
- **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

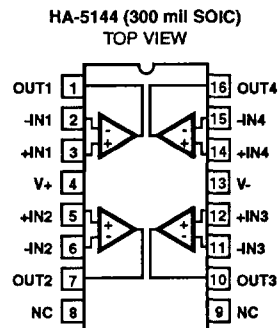
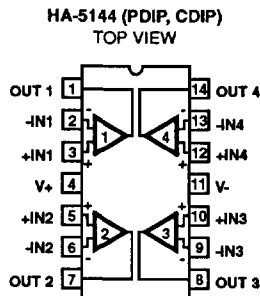
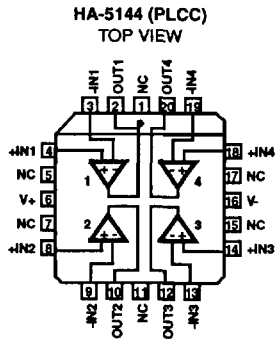
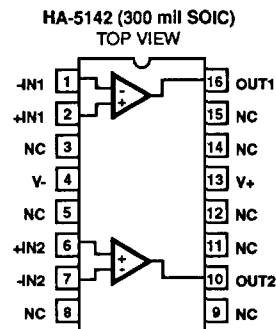
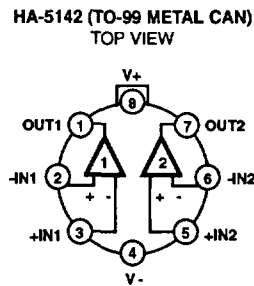
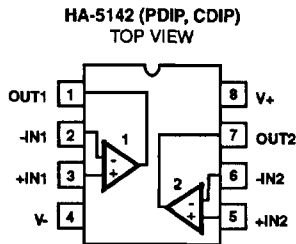
The HA-5142/44 ultra-low power operational amplifiers provide AC and DC performance characteristics similar to or better than most general purpose amplifiers while only drawing 1/30 of the supply current of most general purpose amplifiers. In applications which require low power dissipation and good 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/ $\sqrt$ Hz), for low power operational amplifiers. These characteristics coupled with a 1.5V/ $\mu$ s 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  $\pm$ 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.

2  
OPERATIONAL  
AMPLIFIERS

### Pinouts (See Ordering Information on Next Page)



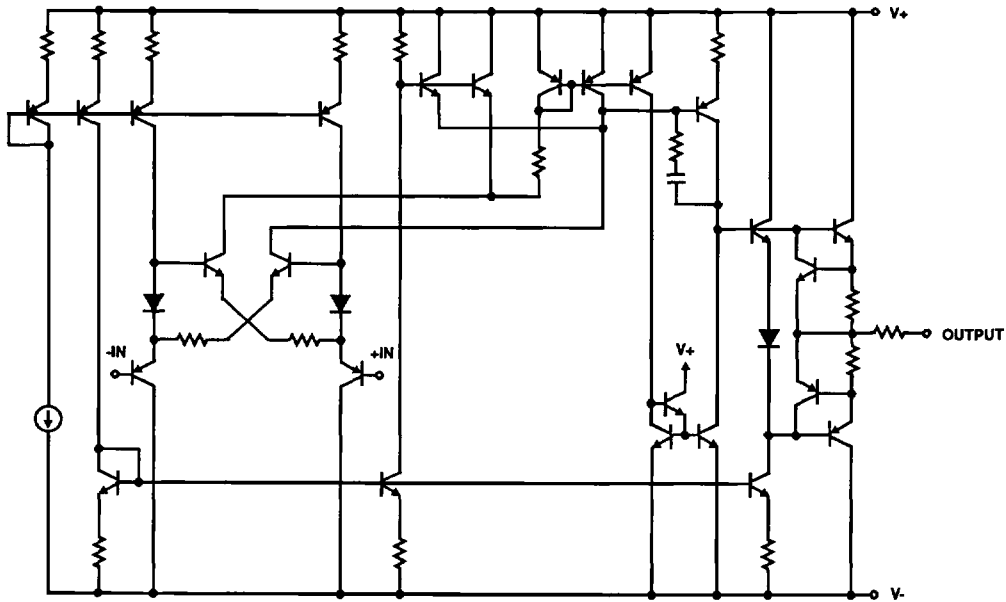
CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.  
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HA-5142, HA-5144

Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE	PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA2-5142-2	-55°C to +125°C	8 Pin Can	HA1-5144-2	-55°C to +125°C	14 Lead Ceramic DIP
HA2-5142-5	0°C to +75°C	8 Pin Can	HA1-5144-5	0°C to +75°C	14 Lead Ceramic DIP
HA3-5142-5	0°C to +75°C	8 Lead Plastic DIP	HA3-5144-5	0°C to +75°C	14 Lead Plastic DIP
HA7-5142-2	-55°C to +125°C	8 Lead Ceramic DIP	HA4P5144-5	0°C to +75°C	20 Lead PLCC
HA7-5142-5	0°C to +75°C	8 Lead Ceramic DIP	HA9P5144-5	0°C to +75°C	16 Lead Wide Body SOIC
HA9P5142-5	0°C to +75°C	16 Lead Wide Body SOIC	HA9P5144-9	-40°C to +85°C	16 Lead Wide Body SOIC
HA9P5142-9	-40°C to +85°C	16 Lead Wide Body SOIC			

Schematic Diagram



## Specifications HA-5142, HA-5144

### 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	0°C ≤ T <sub>A</sub> ≤ +75°C
HA-5142/44-5 .....	-55°C ≤ T <sub>A</sub> ≤ +125°C
HA-5142/44-2 .....	-40°C ≤ T <sub>A</sub> ≤ +85°C
HA-5142/44-9 .....	-65°C ≤ T <sub>A</sub> ≤ +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<sub>S</sub> = 100Ω, C<sub>L</sub> ≤ 10pF, Unless Otherwise Specified

PARAMETER	TEMP	-2, -5, -9 V+ = +5V, V- = 0V			-2, -5, -9 V+ = +15V, V- = -15V			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
<b>INPUT CHARACTERISTICS</b>								
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
<b>TRANSFER CHARACTERISTICS</b>								
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
<b>OUTPUT CHARACTERISTICS</b>								
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

## Specifications HA-5142, HA-5144

### 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	
		<b>TRANSIENT RESPONSE (Notes 2, 3)</b>						
Rise Time	+25°C	-	600	-	-	600	-	ns
Slew Rate (Note 6)	+25°C	0.8	1.5	-	0.8	1.5	-	V/ $\mu$ s
Settling Time (Note 5)	+25°C	-	10	-	-	10	-	$\mu$ s
<b>POWER SUPPLY CHARACTERISTICS</b>								
Supply Current	+25°C	-	45	80	-	100	150	$\mu$ A/Amp
	Full	-	-	100	-	-	200	$\mu$ A/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  $V_{CC} = +5, 0V$ ;  $V_O = \pm 10V$  for  $V_{CC} = \pm 15V$ .
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  $V_{CC} = \pm 15V$ .
6. Maximum input slew rate = 10V/ $\mu$ s.
7.  $V_{CM} = 0$  to 3V for  $V_{CC} = +5, 0V$ ;  $V_{CM} = \pm 10V$  for  $V_{CC} = \pm 15V$ .
8. Full Power Bandwidth is guaranteed by equation:  $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$ .
9.  $\Delta V_S = +10V$  for  $V_{CC} = +5, 0V$ ;  $\Delta V_S = \pm 5V$  for  $V_{CC} = \pm 15V$ .
10. For  $V_{CC} = +5, 0V$  terminate  $R_L$  at +2.5V. Typical output current is  $\pm 3mA$ .
11.  $V_O = 1.4V$  for  $V_{CC} = +5V, 0V$ .
12. See Thermal Constants in "Die Characteristics" section.

### Die Characteristics

Transistor Count		Thermal Constants (°C/W)	$\theta_{JA}$	$\theta_{JC}$
HA-5142	66	HA1-5144 (CDIP)	71	13
HA-5144	132	HA2-5142 (CAN)	111	34
Substrate Potential*	V-	HA3-5142 (Plastic Mini DIP)	92	30
Process	Bipolar-DI	HA3-5144 (PDIP)	108	38
		HA4P5144 (PLCC)	74	32
		HA7-5142 (Ceramic Mini DIP)	114	35
		HA9P5142 (SOIC)	113	35
		HA9P5144 (SOIC)	96	26

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

Test Circuits

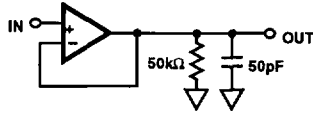
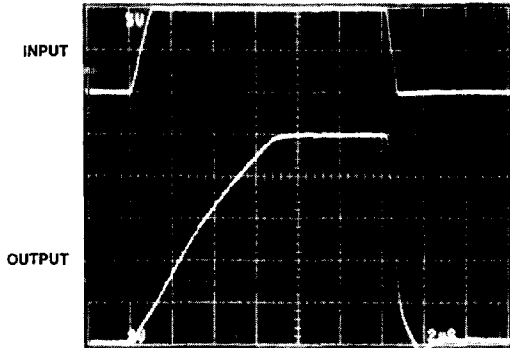


FIGURE 1. SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT

LARGE SIGNAL RESPONSE

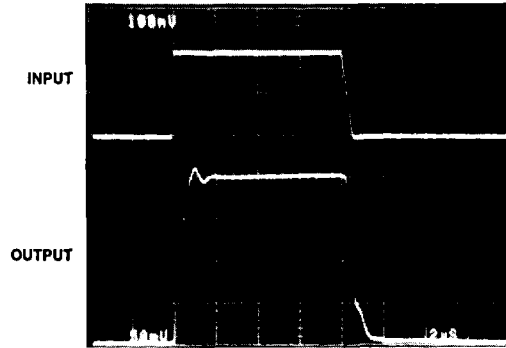
Vertical Scale: (Volts: Input = 5V/Div.; Output = 2V/Div.)  
Horizontal Scale: (Time: 2μs/Div.)



+V<sub>SUPPLY</sub> = +15V, -V<sub>SUPPLY</sub> = -15V

SMALL SIGNAL RESPONSE

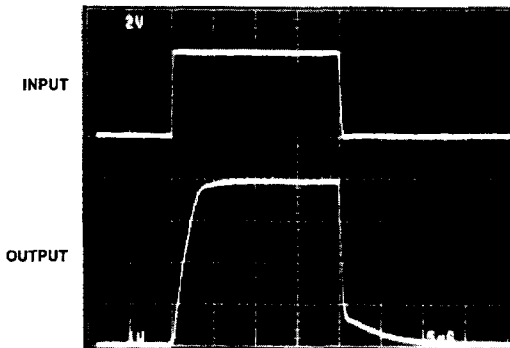
Vertical Scale: (Volts: Input = 100mV/Div.; Output = 50mV/Div.)  
Horizontal Scale: (Time: 2μs/Div.)



+V<sub>SUPPLY</sub> = +15V, -V<sub>SUPPLY</sub> = -15V

LARGE SIGNAL RESPONSE

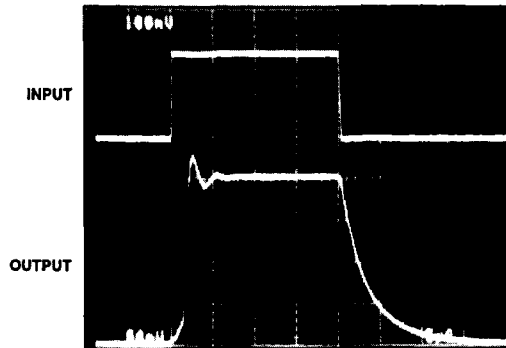
Vertical Scale: (Volts: Input = 2V/Div.; Output = 1V/Div.)  
Horizontal Scale: (Time: 5μs/Div.)



+V<sub>SUPPLY</sub> = +5V, -V<sub>SUPPLY</sub> = 0V

SMALL SIGNAL RESPONSE

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



+V<sub>SUPPLY</sub> = +5V, -V<sub>SUPPLY</sub> = 0V

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

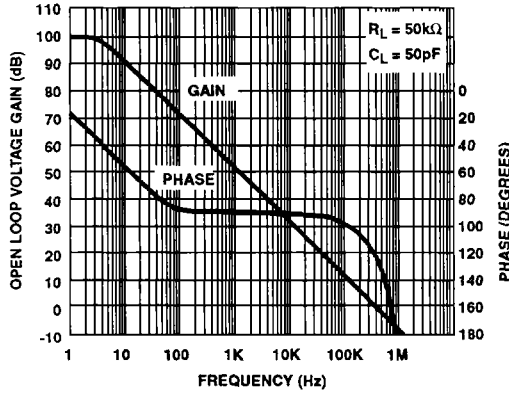


FIGURE 2. OPEN LOOP FREQUENCY RESPONSE

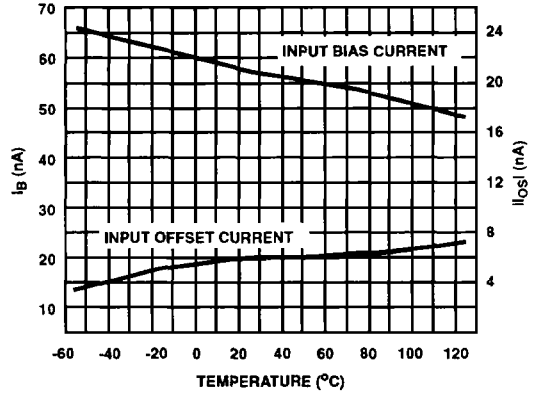


FIGURE 3. INPUT OFFSET CURRENT AND BIAS CURRENT vs TEMPERATURE

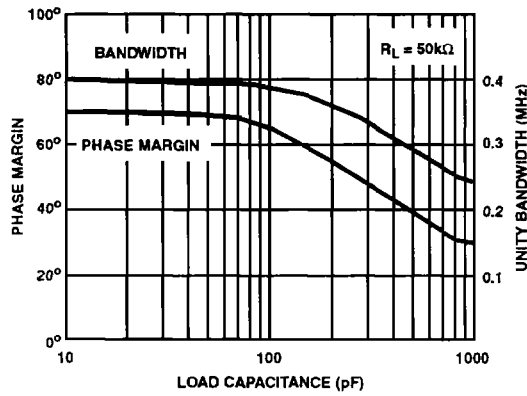


FIGURE 4. BANDWIDTH AND PHASE MARGIN vs LOAD CAPACITANCE

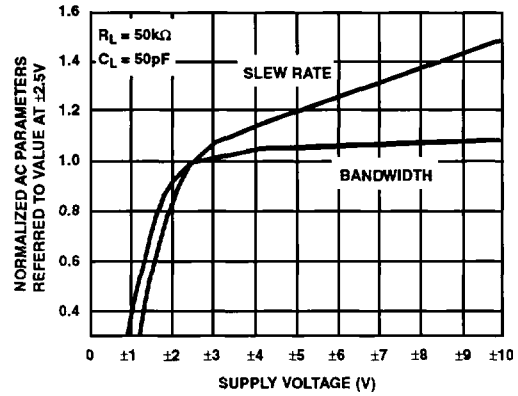


FIGURE 5. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE

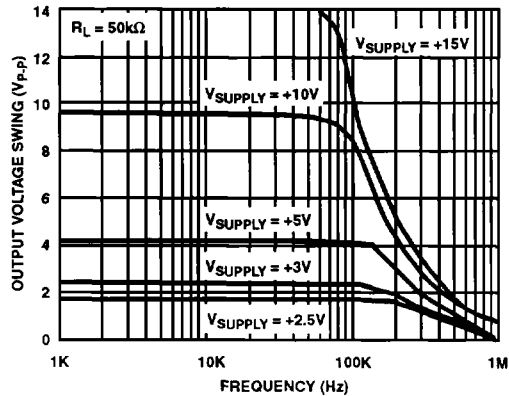


FIGURE 6. OUTPUT VOLTAGE SWING vs FREQUENCY AND SINGLE SUPPLY VOLTAGE

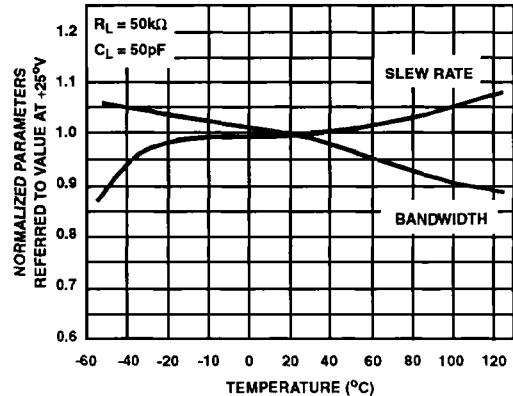


FIGURE 7. NORMALIZED AC PARAMETERS vs TEMPERATURE

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

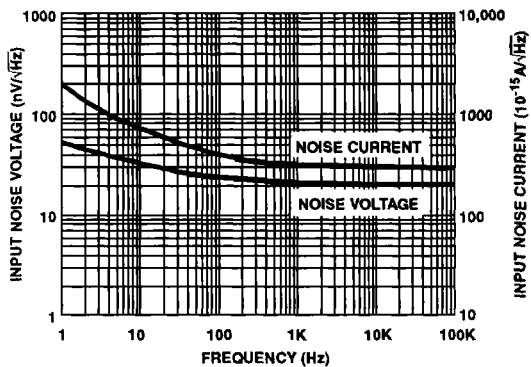


FIGURE 8. INPUT NOISE vs FREQUENCY

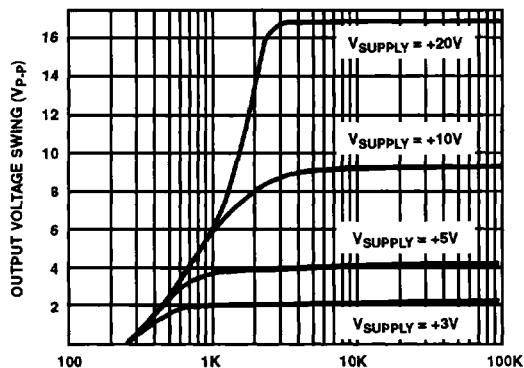


FIGURE 9. MAXIMUM OUTPUT VOLTAGE SWING vs LOAD RESISTANCE AND SINGLE SUPPLY VOLTAGE

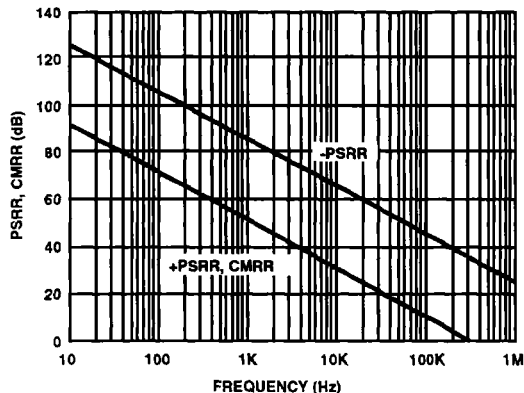


FIGURE 10. PSRR AND CMRR vs FREQUENCY

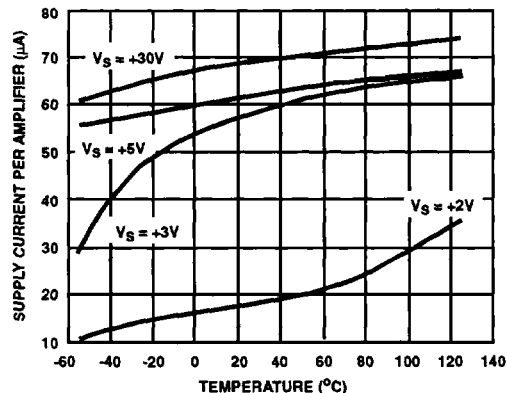


FIGURE 11. POWER SUPPLY CURRENT vs TEMPERATURE AND SINGLE SUPPLY VOLTAGE

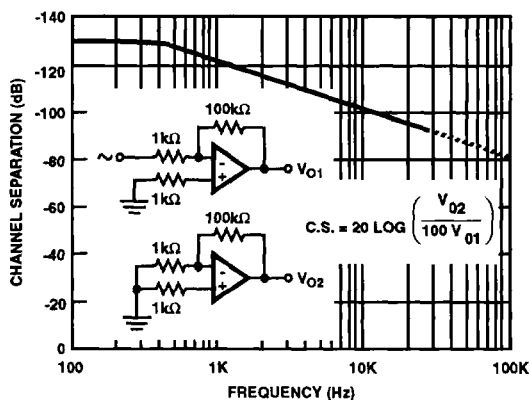


FIGURE 12. CHANNEL SEPARATION vs FREQUENCY