HA-5130/35

Precision Operational Amplifier

Features

- Low Offset Voltage 10μV
- Low Offset Voltage Drift .... 0.4μV/°C
- Low Noise .... $9nV/\sqrt{Hz}$
- Open Loop Gain 140dB
- Unity Gain Bandwidth 2.5MHz
- All Bipolar Construction

Applications

- High Gain Instrumentation
- Precision Data Acquisition
- Precision Integrators
- Biomedical Amplifiers
- Precision Threshold Detectors

Description

The Harris HA-5130/5135 are precision operational amplifiers manufactured using a combination of key technological advancements to provide outstanding input characteristics.

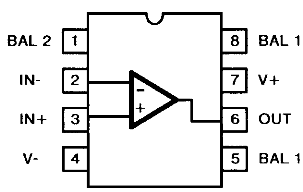
A Super Beta input stage is combined with laser trimming, dielectric isolation and matching techniques to produce 25μV (Maximum) input offset voltage and 0.4μV/°C input offset voltage average drift. Other features enhanced by this process include $9nV/\sqrt{Hz}$ (Typ.) Input Noise Voltage, 1nA Input Bias Current and 140dB Open Loop Gain.

These features coupled with 120dB CMRR and PSRR make HA-5130/5135 an ideal device for precision DC instrumentation amplifiers. Excellent input characteristics in conjunction with 2.5MHz bandwidth and 0.8V/μs slew rate, makes this amplifier extremely useful for precision integrator and biomedical amplifier designs. These amplifiers are also well suited for precision data acquisition and for accurate threshold detector applications.

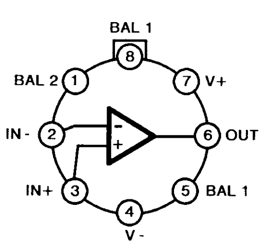
HA-5130/5135 is packaged in an 8 pin (TO-99) Metal Can and an 8 lead Cerdip and is pin compatible with many existing op amp configurations. It offers added features over the industry standard OP-07 in regards to bandwidth and slew rate specifications. For the military grade product, refer to the HA-5135/883 data sheet.

Pinouts

HA7-5130/5135 (CERAMIC MINI-DIP)
TOP VIEW

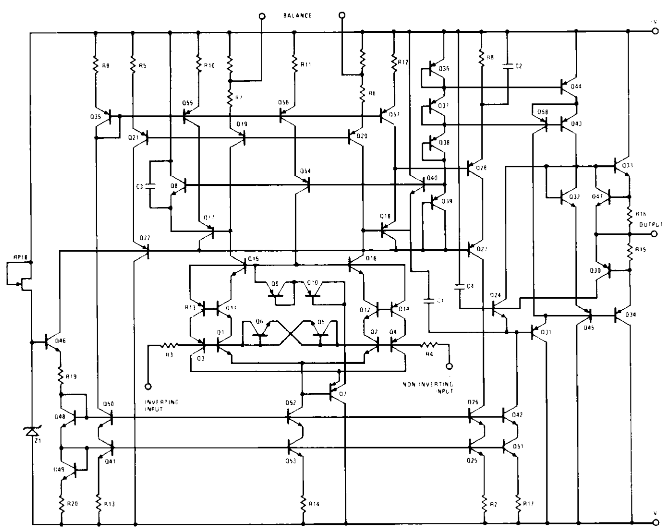


HA2-5130/5135 (TO-99 METAL CAN)
TOP VIEW



(Both BAL 1 Pins are Internally Connected)

Schematic



CAUTION: These devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

Absolute Maximum Ratings (Note 1)

T_A = +25°C Unless Otherwise Stated
Voltage Between V+ and V- Terminals 40.0V
Differential Input Voltage .... ±15.0V
Output Short Circuit Duration .... Indefinite
Power Dissipation (Note 2) 300mW

Operating Temperature Ranges

HA-5130/5135-2 .... $-55^oC \le T_A \le +125^oC$
HA-5130/5135-5 .... $0^oC \le T_A \le +75^oC$
Storage Temperature Range .... $-65^oC \le T_A \le +150^oC$

Electrical Specifications V+ = +15V, V- = -15V

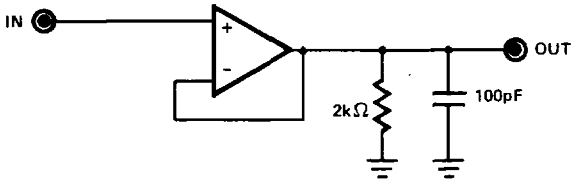
PARAMETER	TEMP	HA-5130-2/-5 MIN	HA-5130-2/-5 TYP	HA-5130-2/-5 MAX	HA-5135-2/-5 MIN	HA-5135-2/-5 TYP	HA-5135-2/-5 MAX	UNITS
INPUT CHARACTERISTICS								
Offset Voltage	+25°C	—	10	25	—	10	75	μV
	Full	—	50	60	—	50	130	μV
Average Offset Voltage Drift	Full	—	0.4	0.6	—	0.4	1.3	μV/°C
Bias Current	+25°C	—	±1	±2	—	±1	±4	nA
	Full	—	—	±4	—	—	±6	nA
Bias Current Average Drift	Full	—	0.02	0.04	—	0.02	0.04	nA/°C
Offset Current	+25°C	—	—	2	—	—	4	nA
	Full	—	—	4	—	—	5.5	nA
Offset Current Average Drift	Full	—	0.02	0.04	—	0.02	0.04	nA/°C
Common Mode Range	Full	±12	—	—	±12	—	—	V
Differential Input Resistance	+25°C	20	30	—	20	30	—	MΩ
Input Noise Voltage 0.1Hz to 10Hz (Note 3)	+25°C	—	—	0.6	—	—	0.6	μV_{p-p}
Input Noise Voltage Density (Note 3)	+25°C							$nV/\sqrt{Hz}$
f_0 = 10Hz		—	13.0	18.0	—	13.0	18.0	
f_0 = 100Hz		—	10.0	13.0	—	10.0	13.0	
f_0 = 1000Hz		—	9.0	11.0	—	9.0	11.0	
Input Noise Current 0.1Hz to 10Hz (Note 3)	+25°C	—	15	30	—	15	30	pA_{p-p}
Input Noise Current Density (Note 3)	+25°C							$pA/\sqrt{Hz}$
f_0 = 10Hz		—	0.4	0.8	—	0.4	0.8	
f_0 = 100Hz		—	0.17	0.23	—	0.17	0.23	
f_0 = 1000Hz		—	0.14	0.17	—	0.14	0.17	
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Note 4)	+25°C	120	140	—	120	140	—	dB
	Full	120	—	—	120	—	—	dB
Common Mode Rejection Ratio (Note 5)	Full	110	120	—	106	120	—	dB
Closed Loop Bandwidth (A_{VCL} = +1)	+25°C	0.6	2.5	—	0.6	2.5	—	MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 6)	+25°C	±10	±12	—	±10	±12	—	V
	Full	±10	—	—	±10	—	—	V
Full Power Bandwidth (Note 7)	+25°C	8	10	—	8	10	—	kHz
Output Current (Note 8)	+25°C	±15	±20	—	±15	±20	—	mA
Output Resistance (Note 8)	+25°C	—	45	—	—	45	—	Ω
TRANSIENT RESPONSE (Note 10)								
Rise Time	+25°C	—	340	—	—	340	—	ns
Slew Rate	+25°C	0.5	0.8	—	0.5	0.8	—	V/μs
Settling Time (Note 11)	+25°C	—	11	—	—	11	—	μs
POWER SUPPLY CHARACTERISTICS								
Supply Current	Full	—	1.0	1.3	—	1.0	1.7	mA
Power Supply Rejection Ratio (Note 12)	Full	100	130	—	94	130	—	dB

NOTES:

1. Absolute maximum ratings are limiting values, applied individually beyond which the serviceability of the circuit may be impaired. Funtional operability under any of these conditions is not necessarily implied.
2. Derate at 6.8mW/°C for operation at ambient temperatures above +75°C.
3. Not tested. 90% of units meet or exceed these specifications.
4. V_{OUT} = ±10V; R_L = 2K. Gain dB = 20 $\log_{10}$ Av
   ∴ 120dB = **1MV/V**
   140dB = **10MV/V**
5. V_{CM} = ±10V DC
6. R_L = 600Ω
7. R_L = 2K; Full power bandwidth guaranteed based on slew rate measurement using $FPBW = \frac{SLEW\ RATE}{2\pi V_{PEAK}}$
8. V_{OUT} = 10V
9. Output resistance measured under open loop conditions (f = 100Hz).
10. Refer to test circuits section of the data sheet.
11. Settling time is measured to 0.1% of final value for a 10V output step and A_V = -1.
12. V_{SUPPLY} = ±5V DC to ±20V DC.

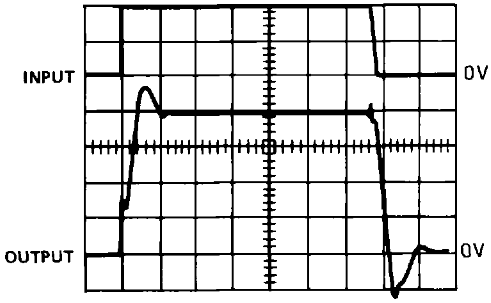
Test Circuits

SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT



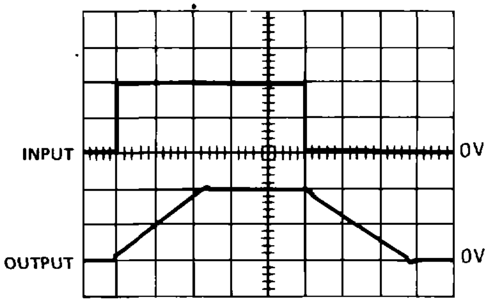
SMALL SIGNAL RESPONSE

Vertical Scale (Volts: 50mV/Div. Output)
(Volts: 100mV/Div. Input)
Horizontal Scale (Time: 1μs/Div.)

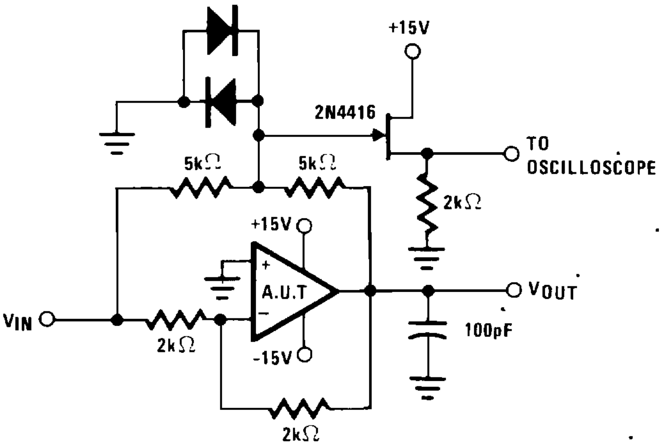


LARGE SIGNAL RESPONSE

Vertical Scale: (Volts: 5V/Div.)
Horizontal Scale: (Time: 5μs/Div.)



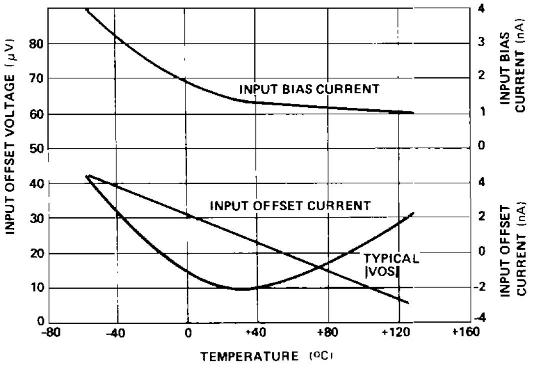
SETTLING TIME CIRCUIT



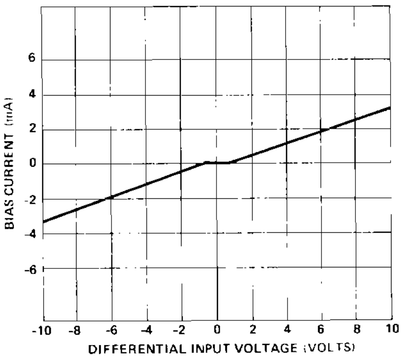
- $A_V = -1$
- Feedback and summing resistors should be 0.1% matched.
- Clipping diodes are optional. HP5082-2810 recommended.

Performance Curves

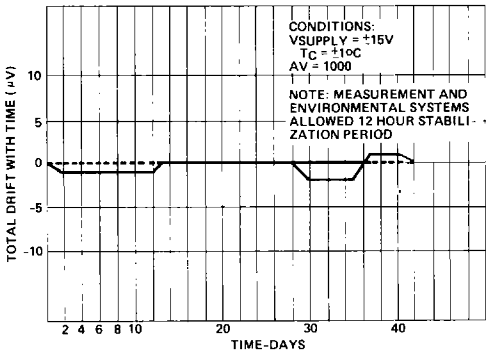
INPUT OFFSET VOLTAGE, INPUT BIAS AND OFFSET CURRENT vs. TEMPERATURE



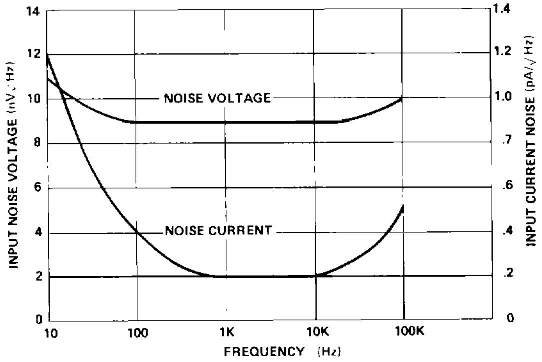
INPUT BIAS CURRENT vs. DIFFERENTIAL INPUT VOLTAGE



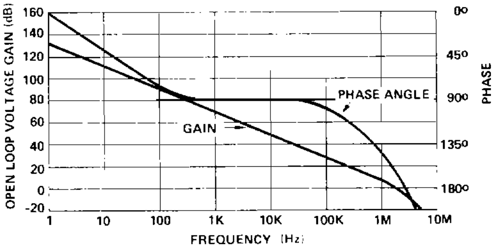
HA-5130 OFFSET VOLTAGE STABILITY vs. TIME



INPUT NOISE vs. FREQUENCY

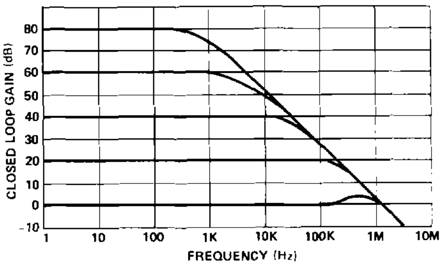


OPEN LOOP FREQUENCY RESPONSE

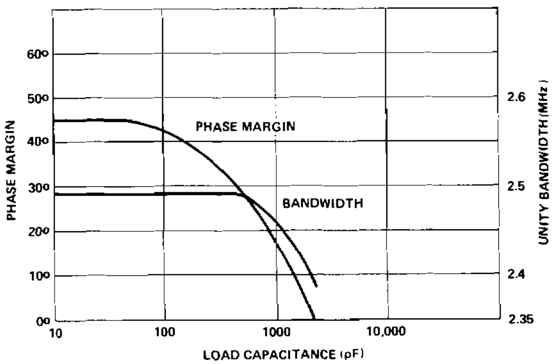


Performance Curves (Continued)

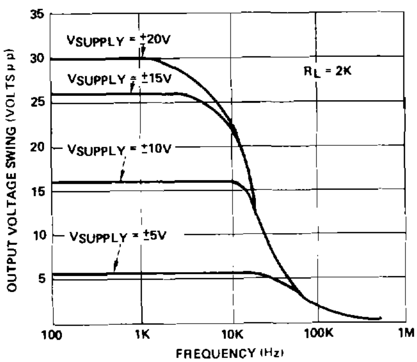
CLOSED LOOP FREQUENCY RESPONSE FOR VARIOUS CLOSED LOOP GAINS



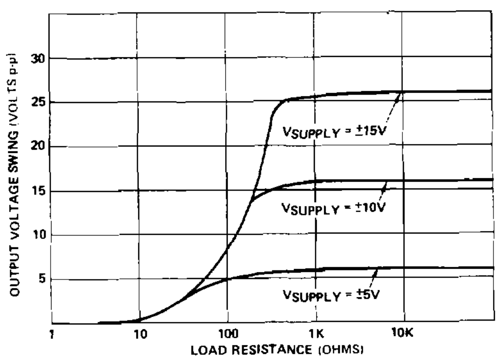
SMALL SIGNAL BANDWIDTH AND PHASE MARGIN vs. LOAD CAPACITANCE



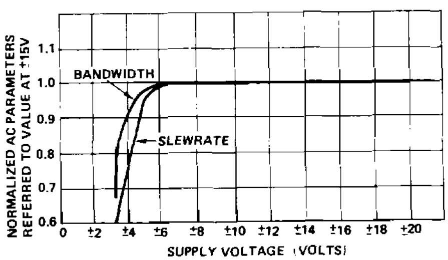
OUTPUT VOLTAGE SWING vs. FREQUENCY AND SUPPLY VOLTAGE



MAXIMUM OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE AND SUPPLY VOLTAGE

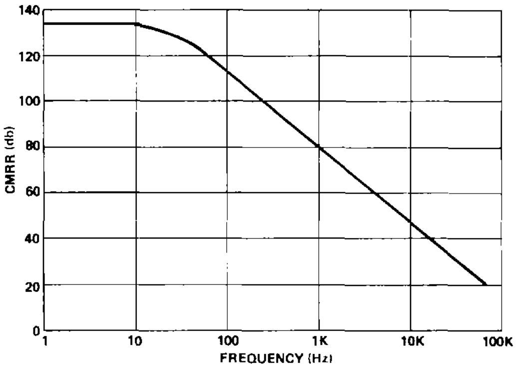


NORMALIZED AC PARAMETERS vs. SUPPLY VOLTAGE

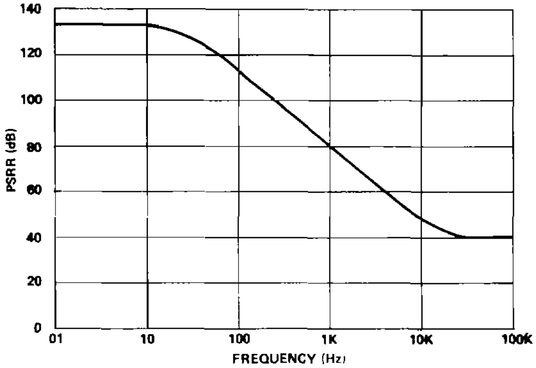


Performance Curves (Continued)

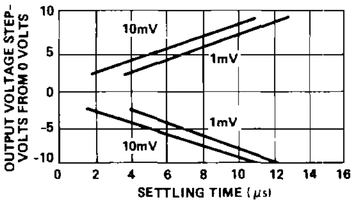
CMRR vs. FREQUENCY



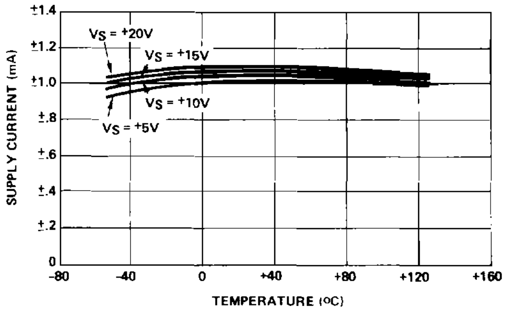
PSRR vs. FREQUENCY



SETTLING TIME FOR VARIOUS OUTPUT STEP VOLTAGES



POWER SUPPLY CURRENT vs. TEMPERATURE AND SUPPLY VOLTAGE



Applying the HA-5130/35 Operational Amplifiers

1. POWER SUPPLY DECOUPLING Although not absolutely necessary, it is recommended that all power supply lines be decoupled with 0.01μF ceramic capacitors to ground. Decoupling capacitors should be located as near to the amplifier terminals as possible.

2. CONSIDERATIONS FOR PROTOTYPING: The following list of recommendations are suggested for prototyping.

   - Resolving low level signals requires minimizing leakage currents caused by external circuitry. Use of quality insulating materials, thorough cleaning of insulating surfaces and implementation of moisture barriers when required is suggested.
   - Error voltages generated by theromocouples formed between dissimilar metals in the presence of temperature gradients should be minimizec. Isolation of low level circuity from heat generating components is recommended.
   - Shielded cable input leads, guard rings and shield drivers are recommended for the most critical applications.

3. When driving large capacitive loads (>500pF), as small value resistor (≈ 50Ω) should be connected in series with the output and inside the feedback loop.

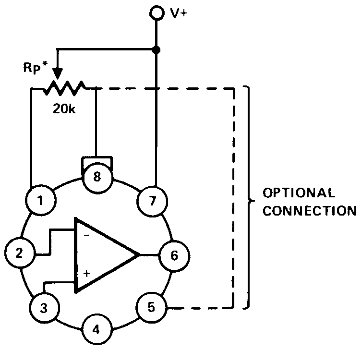
4. OFFSET VOLTAGE ADJUSTMENT: A 20kΩ balance potentiometer is recommended if offset nulling is required. However, other potentiometer values such as 10kΩ, 50kΩ and 100kΩ may be used. The minimum adjustment range for given values is ±2mV.

5. SATURATION RECOVER: Input and output saturation recovery time is negligible in most applications. However care should be exercised to avoid exceeding the absolute maximum ratings of the device.

6. DIFFERENTIAL INPUT VOLTAGES: Inputs are shunted with back-to-back diodes for overvoltage protection. In applications where differential input voltages in excess of 1V are applied between the inputs, the use of limiting resistors at the inputs is recommended.

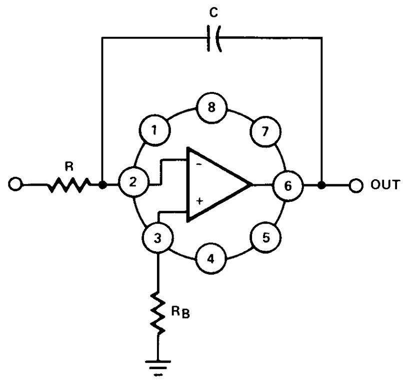
Applications

OFFSET NULLING CONNECTIONS



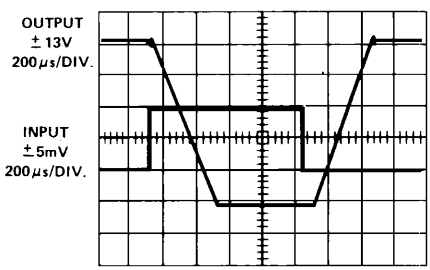
* Although R_P is shown equal to 20K, other values such as 50K, 100K and 1M may be used. Range of adjustment is approximately ±2.5mV. V_{OS} TC of the amplifier is optimized at minimal V_{OS}.
Tested Offset Adjustment is $|V_{OS} + 1mV|$ minimum referred to output.

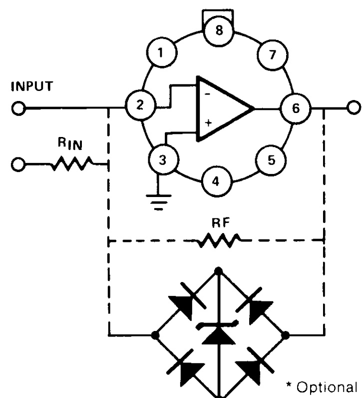
PRECISION INTEGRATOR



The excellent inputs and gain characteristics of HA-5130 are well suited for precision integrator applications. Accurate integration over seven decades of frequency using HA-5130, virtually nullifies the need for more expensive chopper-type amplifiers.

ZERO CROSSING DETECTOR





* Optional for Output Swing Limiting

Low V_{OS} coupled with high open loop Gain, high CMRR and high PSRR make HA-5130 ideally suited for precision detector applications.

PRECISION INSTRUMENTATION AMPLIFIER (A_V = 100)