HA-5135/883

July 1994

Precision Operational Amplifier

Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Low Offset Drift . . . . . 0.4μV/°C (Max)**
- **Low Offset Voltage . . . . . .75μV (Max)**
- **High Gain . . . . . 120dB(1MV/V) (Min)**
- **High CMRR . . . . . .106dB (Min)**
- **High PSRR . . . . . .94dB (Min)**
- **Low Supply Current. . . . . 1.7mA (Max)**
- **Low Noise Voltage Density at 1kHz . . . . . 9nV/√Hz (Max)**
- **Low Noise Current Density at 1kHz . . . . 0.4pA/√Hz (Max)**

Applications

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

Description

The HA-5135/883 is a precision operational amplifier manufactured using a combination of key technological advancements to provide outstanding input characteristics.

A high Beta input stage is combined with laser trimming, dielectric isolation, and matching techniques to produce 75μV (max) input offset voltage and 0.4μV/°C (max) input offset voltage average drift. Other features enhanced by this process include 9nV/√Hz (typ) Input Noise Voltage, 4nA Input Bias Current (max) and 120dB Open Loop Gain (min).

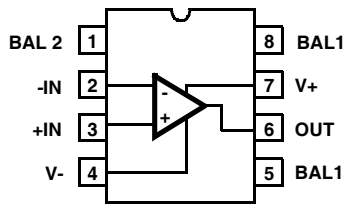
These features coupled with 106dB CMRR and 94dB PSRR make HA-5135/883 an ideal device for precision D.C. instrumentation amplifiers. Excellent input characteristics in conjunction with 0.6MHz (min) bandwidth and 0.5V/μs (min) slew rate, makes this amplifier extremely useful for precision integrator and biomedical amplifier designs. These amplifiers are also well suited for precision data acquisition and for accurate threshold detector applications.

Ordering Information

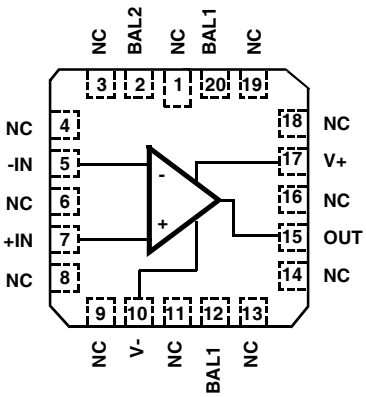
PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA2-5135/883	-55°C to +125°C	8 Pin Can
HA7-5135/883	-55°C to +125°C	8 Lead CerDIP
HA4-5135/883	-55°C to +125°C	20 Lead Ceramic LCC

Pinouts

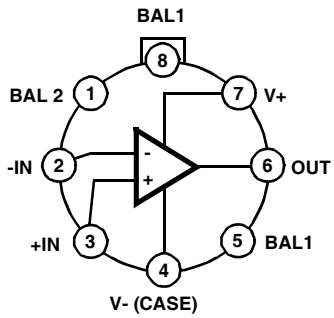
HA-5135/883 (CERDIP)
TOP VIEW



HA-5135/883 (CLCC)
TOP VIEW



HA-5135/883 (METAL CAN)
TOP VIEW



Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 40V
Differential Input Voltage (Note 2) 7V
Voltage at Either Input Terminal. . . . . V+ to V-
Input Current 25mA
Output Current . . . . . Full Short Circuit Protection
Junction Temperature (T_J) . . . . . +175°C
Storage Temperature Range . . . . . -65°C to +150°C
ESD Rating. . . . . <2000V
Lead Temperature (Soldering 10s). . . . . +300°C

Thermal Information

Thermal Resistance	θ_{JA}	θ_{JC}
CerDIP Package	115°C/W	28°C/W
Ceramic LCC Package	65°C/W	15°C/W
Metal Can Package	155°C/W	67°C/W

Package Power Dissipation Limit at +75°C for $T_J \leq +175°C$
CerDIP Package 870mW
Ceramic LCC Package 1.54W
Metal Can Package 645mW
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . 8.7mW/°C
Ceramic LCC Package . . . . . 15.4mW/°C
Metal Can Package . . . . . 6.5mW/°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.

Operating Conditions

Operating Temperature Range. . . . . -55°C to +125°C
Operating Supply Voltage. . . . . ±15V

$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 600\Omega$

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Input Offset Voltage	V_{IO}	$V_{CM} = 0V$	1	+25°C	-75	75	µV
			2, 3	+125°C, -55°C	-130	130	µV
Input Bias Current	I_B	$V_{CM} = 0V$, $R_S = 10k\Omega, 50\Omega$ $\left(\frac{\lvert+I_B\rvert + \lvert-I_B\rvert}{2}\right)$	1	+25°C	-4	4	nA
			2, 3	+125°C, -55°C	-6	6	nA
Input Offset Current	I_{IO}	$V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 10k\Omega$	1	+25°C	-4	4	nA
			2, 3	+125°C, -55°C	-5.5	5.5	nA
Common Mode Range	+CMR	V+ = +3V, V- = -27V	1	+25°C	12	-	V
			2, 3	+125°C, -55°C	12	-	V
	-CMR	V+ = +27V, V- = -3V	1	+25°C	-	-12	V
			2, 3	+125°C, -55°C	-	-12	V
Large Signal Voltage Gain	$+A_{VOL}$	$V_{OUT} = 0V$ and +10V, $R_L = 2k\Omega$	4	+25°C	120	-	kV/V
			5, 6	+125°C, -55°C	120	-	kV/V
	$-A_{VOL}$	$V_{OUT} = 0V$ and -10V, $R_L = 2k\Omega$	4	+25°C	120	-	kV/V
			5, 6	+125°C, -55°C	120	-	kV/V
Common Mode Rejection Ratio	+CMRR	$\Delta V_{CM} = +10V$, V+ = +5V, V- = -25V, $V_{OUT} = -10V$	1	+25°C	106	-	dB
			2, 3	+125°C, -55°C	106	-	dB
	-CMRR	$\Delta V_{CM} = -10V$, V+ = +25V, V- = -5V, $V_{OUT} = +10V$	1	+25°C	106	-	dB
			2, 3	+125°C, -55°C	106	-	dB
Output Voltage Swing	$+V_{OUT}$	$R_L = 600\Omega$	4	+25°C	10	-	V
			5, 6	+125°C, -55°C	10	-	V
	$-V_{OUT}$	$R_L = 600\Omega$	4	+25°C	-	-10	V
			5, 6	+125°C, -55°C	-	-10	V
Output Current	$+I_{OUT}$	$V_{OUT} = -10V$	4	+25°C	15	-	mA
	$-I_{OUT}$	$V_{OUT} = +10V$	4	+25°C	-	-15	mA

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Quiescent Power Supply Current	$+I_{CC}$	$V_{OUT} = 0V$, $I_{OUT} = 0mA$	1	$+25^oC$	-	1.7	mA
			2, 3	$+125^oC$, -55^oC	-	1.7	mA
	$-I_{CC}$	$V_{OUT} = 0V$, $I_{OUT} = 0mA$	1	$+25^oC$	-1.7	-	mA
			2, 3	$+125^oC$, -55^oC	-1.7	-	mA
Power Supply Rejection Ratio	+PSRR	$\Delta V_{SUP} = 10V$, V+ = +5V, V- = -15V, V+ = +15V, V- = -15V	1	$+25^oC$	94	-	dB
			2, 3	$+125^oC$, -55^oC	94	-	dB
	-PSRR	$\Delta V_{SUP} = 10V$, V+ = +15V, V- = -5V, V+ = +15V, V- = -15V	1	$+25^oC$	94	-	dB
			2, 3	$+125^oC$, -55^oC	94	-	dB
Offset Voltage Adjustment	$+V_{IO}$Adj	Note 1	1	$+25^oC$	V_{IO}-1	-	mV
			2, 3	$+125^oC$, -55^oC	V_{IO}-1	-	mV
	$-V_{IO}$Adj	Note 1	1	$+25^oC$	V_{IO}+1	-	mV
			2, 3	$+125^oC$, -55^oC	V_{IO}+1	-	mV

NOTES:

1. Offset adjustment range is [V_{IO} (Measured $\pm1mV$] minimum referred to output. This test is for functionality only to assure adjustment through 0V.
2. The input stage has series 500Ω resistors along with back to back diodes. This provides large differential input voltage protection for a slight increase in noise voltage.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = +1V/V$, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Slew Rate	+SR	V_{OUT} = -3V to +3V, V_{IN} S.R. $\leq 25V/\mu s$	7	$+25^oC$	0.5	-	$V/\mu s$
	-SR	V_{OUT} = +3V to -3V, V_{IN} S.R. $\leq 25V/\mu s$	7	$+25^oC$	0.5	-	$V/\mu s$

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_V = +1V/V$, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Average Offset Voltage Drift	$V_{IO}TC$	$V_{CM} = 0V$	1	-55^oC to $+125^oC$	-	1.3	$\mu V/^oC$
Differential Input Resistance	R_{IN}	$V_{CM} = 0V$	1	$+25^oC$	20	-	$M\Omega$
Average Offset Current Drift	$I_{IO}TC$	Versus Temperature $V_{CM} = 0V$	1	-55^oC to $+125^oC$	-	40	$pA/^oC$
Average Bias Current Drift	I_BTC	Versus Temperature $V_{CM} = 0V$	1	-55^oC to $+125^oC$	-	40	$pA/^oC$
Input Noise Voltage Density	E_N	$R_S = 20\Omega$, $f_O = 1kHz$	1	$+25^oC$	-	11	$nV/\sqrt{Hz}$

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Characterized at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_V = +1V/V$, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Noise Current Density	I_N	$R_S = 2M\Omega$, $f_O = 1kHz$	1	$+25^oC$	-	0.4	$pA/\sqrt{Hz}$
Unity Gain Bandwidth	UGBW	$V_{OUT} = \pm 100mV$, f_O at -3dB	1	$+25^oC$	600	-	kHz
Full Power Bandwidth	FPBW	$V_{PEAK} = 10V$	1, 2	$+25^oC$	8	-	kHz
Minimum Closed Loop Stable Gain	CLSG	$R_L = 2k\Omega$, $C_L = 50pF$	1	-55^oC to $+125^oC$	+1	-	V/V
Output Resistance	R_{OUT}	Open Loop	1	$+25^oC$	-	80	Ω
Power Consumption	PC	$V_{OUT} = 0V$, $I_{OUT} = 0mA$	1, 3	-55^oC to $+125^oC$	-	51	mW

NOTES:

1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.
2. Full Power Bandwidth guarantee based on Slew Rate measurement using FPBW = Slew Rate/($2\pi V_{PEAK}$).
3. Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)

TABLE 4. ELECTRICAL TEST REQUIREMENTS

MIL-STD-883 TEST REQUIREMENTS	SUBGROUPS (SEE TABLES 1 AND 2)
Interim Electrical Parameters (Pre Burn-In)	1
Final Electrical Test Parameters	1 (Note 1), 2, 3, 4, 5, 6, 7
Group A Test Requirements	1, 2, 3, 4, 5, 6, 7
Groups C and D Endpoints	1

NOTE:

1. PDA applies to Subgroup 1 only.

Die Characteristics

DIE DIMENSIONS:
72 x 103 x 19 mils ± 1 mils
1840 x 2620 x 483µm ± 25.4µm

METALLIZATION:
Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

GLASSIVATION:
Type: Nitride (Si3N4) over Silox (SIO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

WORST CASE CURRENT DENSITY:
$6.0 \times 10^4 A/cm^2$

SUBSTRATE POTENTIAL (Powered Up): V-

TRANSISTOR COUNT: 71

PROCESS: Bipolar Dielectric Isolation

Metallization Mask Layout

HA-5135/883