

July 1994

Precision Quad 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 Voltage (+25°C).....200 μ V (Max)
(Full Temp.).....350 μ V (Max)
- Low Offset Voltage Drift at Temp.....2 μ V/°C (Max)
- Offset Voltage Match350 μ V (Max)
- High Channel Separation120dB (Min)
- Low Noise ($f \geq 100$ Hz)10nV/ $\sqrt{\text{Hz}}$ (Max)
- Wide Bandwidth.....4MHz (Typ)
- High CMRR/PSRR100dB (Min)
- High Voltage Gain800kV/V (Min)
- Dielectric Isolation

Applications

- Instrumentation Amplifiers
- State-Variable Filters
- Precision Integrators
- Threshold Detectors
- Precision Data Acquisition Systems
- Low-Level Transducer Amplifiers

Description

The HA-5134/883 is a precision quad operational amplifier that is pin compatible with the OP-400, LT1014, OP11, RM4156, and LM148 as well as the HA-4741/883. Each amplifier features guaranteed maximum values for offset voltage of 350 μ V, offset voltage drift of 2 μ V/°C (max), and offset current of 75nA over the full military temperature range while CMRR/PSRR is guaranteed greater than 94dB and open loop gain is guaranteed above 500kV/V from -55°C to +125°C. Room temperature specifications exceed these values such as an offset voltage matching specification between channels of 200 μ V (max) at +25°C.

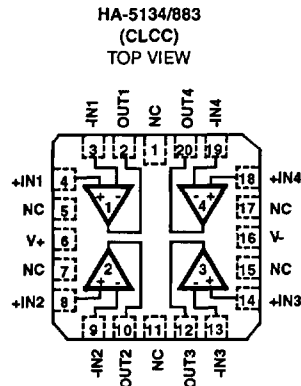
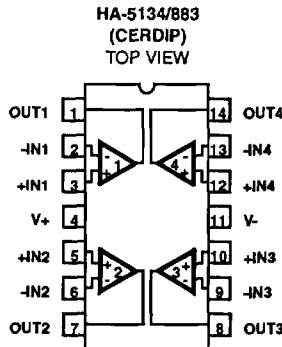
Precision performance of the HA-5134/883 is enhanced by a noise voltage density of 7nV/ $\sqrt{\text{Hz}}$ at 1kHz (typ), noise current density of 2pA/ $\sqrt{\text{Hz}}$ at 1kHz and channel separation of 120dB (min). Each of the four unity gain stable amps on the quad are electrically isolated, having only supply lines in common and are fabricated using Dielectric Isolation to insure quality performance in the most demanding applications.

The HA-5134/883 is ideal for compact circuits such as instrumentation amplifiers, state-variable filters, and low level transducer amplifiers. Other applications include precision data acquisition systems, precision integrators, and accurate threshold detectors in designs where board space is a limitation.

Ordering Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|--------------|-------------------|---------------------|
| HA1-5134/883 | -55°C to +125°C | 14 Lead CerDIP |
| HA4-5134/883 | -55°C to +125°C | 20 Lead Ceramic LCC |

Pinouts



Specifications HA-5134/883

Absolute Maximum Ratings

| | |
|-------------------------------------|---|
| Voltage Between V+ and V- Terminals | 40V |
| Differential Input Voltage | 6V |
| Voltage at Either Input Terminal | V+ to V- |
| Input Current | ±25mA |
| Output Current | Full Short Circuit Protection |
| Output Current Duration | Indefinite (One Amplifier Shorted to Ground) |
| Junction Temperature | +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 | 75°C/W | 20°C/W |
| Ceramic LCC Package | 65°C/W | 15°C/W |
| Package Power Dissipation Limit at +75°C for $T_J \leq +175^\circ\text{C}$ | | |
| CerDIP Package | 1.33W | |
| Ceramic LCC Package | 1.54W | |
| Package Power Dissipation Derating Factor Above +75°C | | |
| CerDIP Package | 13.3mW/°C | |
| Ceramic LCC Package | 15.4mW/°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 | $V_{INC} \leq 1/2 (V+ - V-)$ |
| Operating Supply Voltage | ±15V | $R_L \geq 2k\Omega$ |

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|-----------------------------|--------------------|---|-------------------|---------------|--------|-----|---------|
| | | | | | MIN | MAX | |
| Input Offset Voltage | V_{IO} | $V_{CM} = 0V$ | 1 | +25°C | -200 | 200 | μV |
| | | | 2, 3 | +125°C, -55°C | -350 | 350 | μV |
| Offset Voltage Match | ΔV_{IO} | $ V_{IO}(\text{Max}) - V_{IO}(\text{Min}) $ | 1 | +25°C | - | 200 | μV |
| | | | 2, 3 | +125°C, -55°C | - | 350 | μV |
| Input Bias Current | $+I_B$ | $V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 50\Omega$ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | nA |
| | $-I_B$ | $V_{CM} = 0V$, $+R_S = 50\Omega$, $-R_S = 10k\Omega$ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | nA |
| Input Offset Current | I_{IO} | $V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 10k\Omega$ | 1 | +25°C | -50 | 50 | nA |
| | | | 2, 3 | +125°C, -55°C | -75 | 75 | nA |
| Common Mode Range | +CMR | $V+ = +5V$, $V- = -25V$ | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -CMR | $V+ = +25V$, $V- = -5V$ | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| Large Signal Voltage Gain | +A _{VOL} | $V_{OUT} = 0V$ and +10V, $R_L = 2k\Omega$ | 4 | +25°C | 800 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 500 | - | kV/V |
| | -A _{VOL} | $V_{OUT} = 0V$ and -10V, $R_L = 2k\Omega$ | 4 | +25°C | 800 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 500 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | $\Delta V_{CM} = 10V$, $V+ = +5V$, $V- = -25V$, $V_{OUT} = -10V$ | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| | -CMRR | $\Delta V_{CM} = 10V$, $V+ = +25V$, $V- = -5V$, $V_{OUT} = +10V$ | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| Output Voltage Swing | +V _{OUT1} | $R_L = 2k\Omega$ | 4 | +25°C | 12 | - | V |
| | | | 5, 6 | +125°C, -55°C | 12 | - | V |
| | -V _{OUT1} | $R_L = 2k\Omega$ | 4 | +25°C | - | -12 | V |
| | | | 5, 6 | +125°C, -55°C | - | -12 | V |

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OPERATIONAL
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Specifications HA-5134/883

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|--------------------------------|-------------------|--|-------------------|---------------|--------|-----|-------|
| | | | | | MIN | MAX | |
| Output Current | +I _{OUT} | V _{OUT} = -10V | 4 | +25°C | 15 | - | mA |
| | | | 5, 6 | +125°C, -55°C | 8 | - | mA |
| | -I _{OUT} | V _{OUT} = +10V | 4 | +25°C | - | -15 | mA |
| | | | 5, 6 | +125°C, -55°C | - | -8 | mA |
| Quiescent Power Supply Current | +I _{CC} | V _{OUT} = 0V, I _{OUT} = 0mA | 1 | +25°C | - | 6.8 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 8 | mA |
| | -I _{CC} | V _{OUT} = 0V, I _{OUT} = 0mA | 1 | +25°C | - | 6.8 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 8 | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$, V ₊ = +20V, V ₋ = -15V V ₊ = +10V, V ₋ = -15V | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$, V ₊ = +15V, V ₋ = -20V V ₊ = +15V, V ₋ = -10V | 1 | +25°C | 100 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 94 | - | dB |

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

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

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|--------------------|----------------|--|-------------------|-------------|--------|-----|------------|
| | | | | | MIN | MAX | |
| Slew Rate | +SR | V _{OUT} = -3V to +3V | 7 | +25°C | 0.75 | - | V/ μ s |
| | -SR | V _{OUT} = +3V to -3V | 7 | +25°C | 0.75 | - | V/ μ s |
| Rise and Fall Time | t _R | V _{OUT} = 0 to +200mV 10% ≤ T _R ≤ 90% | 7 | +25°C | - | 400 | ns |
| | t _F | V _{OUT} = 0 to -200mV 10% ≤ T _F ≤ 90% | 7 | +25°C | - | 400 | ns |
| Overshoot | +OS | V _{OUT} = 0 to +200mV | 7 | +25°C | - | 40 | % |
| | -OS | V _{OUT} = 0 to -200mV | 7 | +25°C | - | 40 | % |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

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

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|----------------------------------|--------------------|--|-------|-----------------|--------|------|------------------------|
| | | | | | MIN | MAX | |
| Average Offset Voltage Drift | V _{IO TC} | V _{CM} = 0V | 1 | -55°C to +125°C | - | 2 | μ V/°C |
| Differential Input Resistance | R _{IN} | V _{CM} = 0V | 1 | +25°C | 20 | - | M Ω |
| Low Frequency Peak-to-Peak Noise | E _{NP-P} | 0.1Hz to 10Hz | 1 | +25°C | - | 0.25 | μ V _{p-p} |
| Input Noise Voltage Density | E _N | R _S = 20 Ω , f _O = 1kHz | 1 | +25°C | - | 10 | nV/ \sqrt Hz |

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TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Characterized at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, 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°C | - | 2 | pA/√Hz |
| Gain Bandwidth Product | GBWP | $V_O = 200mV$, $f_O \geq 100kHz$ | 1 | +25°C | 3 | - | MHz |
| Unity Bandwidth Product | UBWP | $V_O = 200mV$ | 1 | +25°C | 3 | - | MHz |
| Slew Rate | +SR | $V_{OUT} = -3V$ to +3V | 1 | +25°C to +125°C | 0.75 | - | V/μs |
| | -SR | $V_{OUT} = +3V$ to -3V | 1 | -55°C | 0.6 | - | V/μs |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 12 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | +1 | - | V/V |
| Rise and Fall Time | t_R | $V_{OUT} = 0V$ to +200mV | 1, 4 | -55°C to +125°C | - | 400 | ns |
| | t_F | $V_{OUT} = 0V$ to -200mV | 1, 4 | -55°C to +125°C | - | 400 | ns |
| Overshoot | +OS | $V_{OUT} = 0V$ to +200mV | 1 | -55°C to +125°C | - | 40 | % |
| | -OS | $V_{OUT} = 0V$ to -200mV | 1 | -55°C to +125°C | - | 40 | % |
| Output Resistance | R_{OUT} | Open Loop | 1 | +25°C | - | 86 | Ω |
| Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 240 | mW |
| Channel Separation (AC) | CS (AC) | $V_{IN} = 1V_{P.P.}$, $f_O = 100Hz$ | 1 | +25°C | 120 | - | dB |
| | | $V_{IN} = 1V_{P.P.}$, $f_O = 10kHz$ | 1 | +25°C | 120 | - | dB |
| Channel Separation (DC) | CS (DC) | $V_O = \pm 10V$ (20V _{P.P.}), $\Delta V_{IO} \leq 20\mu V$ | 1 | +25°C | 120 | - | dB |

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.).
4. Measured between 10% and 90% points.

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.

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OPERATIONAL AMPLIFIERS

Die Characteristics

DIE DIMENSIONS:

91 x 114 x 19 mils \pm 1 mils
 2300 x 2900 x 483 μ m \pm 25.4 μ m

METALLIZATION:

Type: Al, 1% Cu
 Thickness: 16k \AA \pm 2k \AA

GLASSIVATION:

Type: Nitride (Si₃N₄) over Silox (SiO₂, 5% Phos.)
 Silox Thickness: 12k \AA \pm 2k \AA
 Nitride Thickness: 3.5k \AA \pm 1.5k \AA

WORST CASE CURRENT DENSITY:

2.5 x 10⁵A/cm²
 This device meets Glassivation Integrity Test Requirement
 per MIL-STD-883 Method 2021 and MIL-I-38535 Paragraph 30.5.5.4.

SUBSTRATE POTENTIAL (Powered Up):

Unbiased

TRANSISTOR COUNT: 160

PROCESS: Bipolar Dielectric Isolation

Metallization Mask Layout

