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HA-5112/883

Dual, Low Noise, High Performance Uncompensated Operational Amplifier

October 2004

Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Low Input Noise Voltage Density at 1kHz. . . 6nV/ $\sqrt{\text{Hz}}$ (Max)
4.3nV/ $\sqrt{\text{Hz}}$ (Typ)
- High Slew Rate. 12V/ μs (Min)
20V/ μs (Typ)
- Wide Gain Bandwidth Product ($A_{VCL} \geq 10$) 54MHz
- Low Offset Voltage Drift 3 $\mu\text{V}/^\circ\text{C}$ (Typ)
- High Open Loop Gain (Full Temp.) 100kV/V (Min)
250kV/V (Typ)
- High CMRR/PSRR (Full Temp.) 86dB (Min)
100dB (Typ)
- Low Offset Voltage Drift 3 $\mu\text{V}/^\circ\text{C}$ (Typ)
- No Crossover Distortion
- Standard Dual Pinout

Applications

- High Quality Audio Preamplifiers
- High Q Active Filters
- Low Noise Function Generators
- Low Distortion Oscillators
- Low Noise Comparators

Description

Low Noise and high performance are key words describing the dual, uncompensated HA-5112/883. This general purpose amplifier offers an array of dynamic specifications including 12V/ μs slew rate (min), and 54MHz gain-bandwidth-product for $A_{VCL} \geq 10$. Complementing these outstanding parameters is a very low noise specification of 6nV/ $\sqrt{\text{Hz}}$ at 1kHz (max).

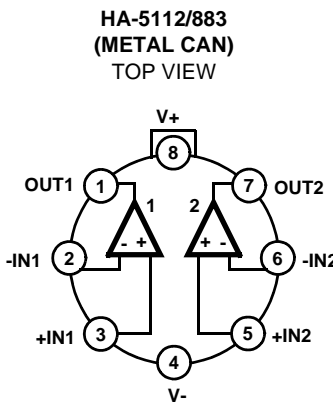
Fabricated using the Intersil standard high frequency D.I. process, these operational amplifiers also offer excellent input specifications such as 2.5mV (max) offset voltage and 75nA (max) offset current. Complementing these specifications are 100dB (min) open loop gain and 55dB channel separation (min). The HA-5112/883 also consumes a very modest amount of supply power (180mW/package).

This impressive combination of features make this amplifier ideally suited for designs ranging from audio amplifiers and active filters to the most demanding signal conditioning and instrumentation circuits.

Part Number Information

| PART NUMBER | TEMPERATURE RANGE | PACKAGE |
|--------------|-------------------|-----------|
| HA2-5112/883 | -55°C to +125°C | 8 Pin Can |

Pinout



Absolute Maximum Ratings

Voltage between V+ and V- Terminals. 40V
 Differential Input Voltage 7V
 Voltage at Either Input Terminal V+ to V-
 Peak Output Current. Indefinite
 (One Amplifier Shorted to Ground)
 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}
 Metal Can Package. 160°C/W 70°C/W
 Package Power Dissipation Limit at +75°C
 Metal Can Package. 645mW
 Package Power Dissipation Derating Factor Above +75°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.

NOTES:

1. θ_{JA} is measured with the component mounted on a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

Operating Conditions

Operating Temperature Range. -55°C to +125°C $V_{INCM} \leq 1/2 (V+ - V-)$
 Operating Supply Voltage. $\pm 5V$ to $\pm 15V$ $R_L \geq 2k\Omega$

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, 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 | -2.0 | 2.0 | mV |
| | | | 2, 3 | +125°C, -55°C | -2.5 | 2.5 | mV |
| Input Bias Current | +I _B | V _{CM} = 0V, +R _S = 10kΩ, -R _S = 100Ω | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| | -I _B | V _{CM} = 0V, +R _S = 100Ω, -R _S = 10kΩ | 1 | +25°C | -200 | 200 | nA |
| | | | 2, 3 | +125°C, -55°C | -325 | 325 | nA |
| Input Offset Current | I _{IO} | V _{CM} = 0V, +R _S = 10kΩ, -R _S = 10kΩ | 1 | +25°C | -75 | 75 | nA |
| | | | 2, 3 | +125°C, -55°C | -125 | 125 | 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 = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| | -A _{VOL} | V _{OUT} = 0V and -10V, R _L = 2kΩ | 4 | +25°C | 100 | - | kV/V |
| | | | 5, 6 | +125°C, -55°C | 100 | - | kV/V |
| Common Mode Rejection Ratio | +CMRR | ΔV _{CM} = +5V, V+ = +10V, V- = -20V, V _{OUT} = -5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -CMRR | ΔV _{CM} = -5V, V+ = +20V, V- = -10V, V _{OUT} = +5V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS | | UNITS |
|--------------------------------|-------------------------------|--|----------------------|---------------|--------|-----|-------|
| | | | | | MIN | MAX | |
| Output Voltage Swing | +V _{OUT1} | R _L = 2k Ω | 1 | +25°C | 10 | - | V |
| | | | 2, 3 | +125°C, -55°C | 10 | - | V |
| | -V _{OUT1} | R _L = 2k Ω | 1 | +25°C | - | -10 | V |
| | | | 2, 3 | +125°C, -55°C | - | -10 | V |
| | +V _{OUT2} | R _L = 10k Ω | 1 | +25°C | 12 | - | V |
| | | | 2, 3 | +125°C, -55°C | 12 | - | V |
| -V _{OUT2} | R _L = 10k Ω | 1 | +25°C | - | -12 | V | |
| | | 2, 3 | +125°C, -55°C | - | -12 | V | |
| Output Current | +I _{OUT} | V _{OUT} = -5V | 1 | +25°C | 10 | - | mA |
| | | | 2, 3 | +125°C, -55°C | 10 | - | mA |
| | -I _{OUT} | V _{OUT} = +5V | 1 | +25°C | - | -10 | mA |
| | | | 2, 3 | +125°C, -55°C | - | -10 | mA |
| Quiescent Power Supply Current | +I _{CC} | V _{OUT} = 0V, I _{OUT} = 0mA | 1 | +25°C | - | 5 | mA |
| | | | 2, 3 | +125°C, -55°C | - | 6 | mA |
| | -I _{CC} | V _{OUT} = 0V, I _{OUT} = 0mA | 1 | +25°C | -5 | - | mA |
| | | | 2, 3 | +125°C, -55°C | -6 | - | mA |
| Power Supply Rejection Ratio | +PSRR | $\Delta V_{SUP} = 10V$, V+ = +10V, V- = -15V V+ = +20V, V- = -15V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |
| | -PSRR | $\Delta V_{SUP} = 10V$, V+ = +15V, V- = -10V V+ = +15V, V- = -20V | 1 | +25°C | 86 | - | dB |
| | | | 2, 3 | +125°C, -55°C | 86 | - | dB |

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Table 2 Intentionally Left Blank. See AC Parameters in Table 3

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = 10V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|-------------------------------|-----------------|---|-------|-------------|--------|-----|-----------------|
| | | | | | MIN | MAX | |
| Differential Input Resistance | R _{IN} | V _{CM} = 0V | 1 | +25°C | 250 | - | k Ω |
| Input Noise Voltage | E _N | R _S = 20 Ω , f _O = 1000Hz | 1 | +25°C | - | 6 | nV/ \sqrt{Hz} |
| Input Noise Current | I _N | R _S = 2M Ω , f _O = 1000Hz | 1 | +25°C | - | 3 | pA/ \sqrt{Hz} |
| Gain Bandwidth Product | GBWP | V _O = 200mV, f _O = 50kHz | 1 | +25°C | 40 | - | MHz |
| | | V _O = 200mV, f _O = 1MHz | 1 | +25°C | 54 | - | MHz |

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Characterized at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 2k\Omega$, $C_{LOAD} = 50pF$, $A_{VCL} = 10V/V$, Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS | NOTES | TEMPERATURE | LIMITS | | UNITS |
|---------------------------------|-----------|---|-------|-----------------|--------|-----|------------|
| | | | | | MIN | MAX | |
| Slew Rate | +SR | $V_{OUT} = -5V$ to $+5V$ | 1 | +25°C | 12 | - | V/ μ s |
| | -SR | $V_{OUT} = +5V$ to $-5V$ | 1 | +25°C | 12 | - | V/ μ s |
| Full Power Bandwidth | FPBW | $V_{PEAK} = 10V$ | 1, 2 | +25°C | 191 | - | kHz |
| Minimum Closed Loop Stable Gain | CLSG | $R_L = 2k\Omega$, $C_L = 50pF$ | 1 | -55°C to +125°C | 10 | - | V/V |
| Rise and Fall Time | t_R | $V_{OUT} = 0V$ to $+200mV$ | 1, 4 | +25°C | - | 100 | ns |
| | t_F | $V_{OUT} = 0V$ to $-200mV$ | 1, 4 | +25°C | - | 100 | ns |
| Overshoot | +OS | $V_{OUT} = 0V$ to $+200mV$ | 1 | +25°C | - | 40 | % |
| | -OS | $V_{OUT} = 0V$ to $-200mV$ | 1 | +25°C | - | 40 | % |
| Output Resistance | R_{OUT} | Open Loop | 1 | +25°C | - | 232 | Ω |
| Quiescent Power Consumption | PC | $V_{OUT} = 0V$, $I_{OUT} = 0mA$ | 1, 3 | -55°C to +125°C | - | 180 | mW |
| Channel Separation | CS | $R_S = 1k\Omega$, $A_{VCL} = 100V/V$, $V_{IN} = 100mV_{PEAK}$ at 10kHz, Referred to Input | 1 | +25°C | 55 | - | dB |

NOTES:

- 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.
- Full Power Bandwidth guarantee based on Slew Rate measurement using $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
- Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.).
- Measured between 10% and 90% points.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

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

NOTE:

- PDA applies to Subgroup 1 only.

Die Characteristics

DIE DIMENSIONS:

98.4 x 67.3 x 19 mils ± 1 mils
 2500 x 1710 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:

1.43 x 10⁵ A/cm² at 10mA

SUBSTRATE POTENTIAL (Powered Up):

Unbiased

TRANSISTOR COUNT: 93

PROCESS: Bipolar Dielectric Isolation

Metallization Mask Layout

